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Contents.

Of the Royal Gardens at Kew,

During the Year 1879.

Royal Gardens, Kew,

January 1, 1880.

SIR,

THE number of visitors (569,134) to the Royal Gardens during the past year exhibits a very great falling off (156,288) as compared with 1878. No return so small has been recorded since that for 1872. The deficiency may, with confidence, be attributed to the miserable weather which prevailed during the whole of last summer, and which culminated in the disastrous hailstorm of the morning of August 3, which wrecked the greater part of the glass houses and compelled their closure to visitors for the remainder of the summer.

The bank holiday of the following day, August 4, brought the greatest number of visitors (51,949) admitted in any one day during the year.

The experiment of opening the gardens at 10 a.m. on the mornings of the four bank holidays still appears to me to be scarcely justified by its success. The following figures give the total numbers admitted during the day, and also the numbers of persons who on each occasion entered before 1 a.m.

The lessons given to the young gardeners in the evening twice a week through about nine months of the year still continue to give satisfactory results, and may be regarded as having settled down into part of the routine of the establishment. The demonstrations in elementary meteorology, physics, and chemistry have been given in the large room of the Jodrell Laboratory, which during the dark winter months is seldom required for the purposes of physiological study, the smaller rooms being sufficient for any investigation which may be then in progress.

Hail-storm.—

Early in the morning of August 3, Kew was visited by a severe hail-storm, which is believed to have inflicted damage upon the Royal Gardens to which their previous existence fortunately supplies no parallel. There is, in fact, no record of breakage of glass by hail in Kew on any previous occasion. The hailstones averaged 5 inches in circumference, and descended with such violence as to bury themselves in the ground.

The amount of glass broken was necessarily very great and was unavoidably increased in the repairs. The total number of panes replaced is shown in the accompanying enumeration:—

Some idea of the magnitude of the destruction may be obtained from the fact that the broken glass amounted to 18 tons.

The large extent of the repairs which had to be immediately undertaken involved much replacement of decayed woodwork and extensive repainting. The progress of the works was rendered still more a matter of anxiety and labour by the comparatively low temperature and heavy rains which closed the summer of last year. This involved a heavy expenditure in tents and tarpaulins to temporarily protect the denuded houses. Two large temporary buildings had also to be erected for the protection of the workmen. Thanks to the energetic action of the Board, the necessary works were carried out with the aid of contractors with promptitude and despatch. The whole expenditure was covered by a supplementary vote in the Estimates. Although the collections generally suffered much from exposure to wet and cold, the actual number of losses has not been large. The injury done under such circumstances can, however, only be expected to slowly reveal itself.

BOTANIC GARDENS.

Palm House.—

As the hot-water apparatus described in the Report for 1877 is of a novel construction, I think it necessary to state that it gives entire satisfaction, whether as regards wear, the economical consumption of fuel, or the diffusion and easy control of heat. Many plants now flourish which had for many years previous to its introduction led a languishing life, and even some that it was impossible to cultivate at all, such as the cocoanut palm, grow well; and I have no reason to doubt that the original intention of the building, namely, its devotion to palms and plants of that class, may be eventually carried out. Already some of these from tropical regions flower and fruit to perfection, whilst the collection of *Cycadæ* and *Pandanæ* has increased greatly in extent and beauty. Of the *Pandaneæ*, the finest specimen in Europe, that in the northern wing facing the entrance, has now reached the glass, not only over its head, but on both sides, and as from its bulk and weight it cannot be removed from its position, if accommodation is not given for its further development in its present position it must be destroyed. The tub in which it grows stands on the iron, grating over the hot-water pipes; if the latter were removed the tub might be lowered 4 feet, and so much top and lateral (the roof of the building being curved) space bo obtained for its further spread of foliage. This is of course a question of expense, and the object to be attained being only temporary the desirability of incurring it or not will have to be carefully considered. Having regard to the great attraction of the plant to the general public and to the scientific visitors from all parts of the world, I think it only right that the assurance should be given, that whatever conclusion may be arrived at, it will not be hastily formed. I should add that the specimen has been lopped on various occasions and will stand no further mutilation without complete destruction of its distinctive features.

Herbaceous Ground.—

The collection of Liliacea has been arranged along the west side of the wall bounding the Herbaceous Ground on the west, and the *Amaryllidæ* to the south end of the Herbaceous Ground.

A quantity of duplicate herbaceous plants have been sent for the ornamentation of the London Parks.

A cemented brick tank has been built for open air water plants, 80 feet long by 20 broad, and raised 20 inches above the ground. It as divided into bricked compartments, and a constant run of water through it is provided.

The planting of named specimens of rare plants along the principal walks of the Botanic Garden has been proceeded with; the path from the gate leading to Brentford Ferry from the broad walk is now lined with exotic, chiefly Asiatic and American, maples of which 23 kinds are thus disposed, and a collection of rare oaks has been planted on the left of the path between the Brentford Gate and that opening on the Sion Vista.

The wooden staging which occupied the centre of the Orchid House, and which was in a state of decay, has been replaced by one of brick and slate.

The ruinous condition of the Tropical Fern House, alluded to in the Report for 1878, has been remedied, and the repair of the woodwork of various other houses has been overtaken at the same time as the replacement of the glass destroyed by the hail-storm in August 1879, the effects of which are elsewhere detailed. In effecting these repairs pine wood has been largely replaced by teak, which it is hoped will eventually prove a great economy. I may mention that the teak-wood tallies, giving the names of the collection plants in the Arboretum, &c., which were placed in the ground in 1872, show no signs of decay.

The following plants of special botanical interest, amongst others of less importance, have flowered during the past year in the Royal Gardens:—

- *Æchmea Lindeni*, K. Koch.
- *Allium harataviense*, Regel; Bot. Mag. 6451.
- *Alloplectus peiltatus*, Oliver.
- *Alocasia scabriuscula*, N. E. Br. sp. n.
- *Aloe Greenii*, Baker, sp. n.
- *Androscepia gigantea*, Brong.
- *Aphelandra pumila*, Bull; Bot. Mag. 6467.
- *Arisœma concinnum*, Hk. f.
- *Arisœma galeatum*, N. E. Br.; Bot. Mag. 6457.
- *Arisœma nepenthoides*, Mart.; Bot. Mag. 6446.

- *Arisæma utile*, Hk. f.
- *Bœa hygrometrica*, R. Br.; Bot. Mag. 6468.
- *Billbergia nutans*, Wendl.; Bot. Mag. 6423.
- *Cajanus indicus*, Spr.; Bot. Mag. 6440.
- *Chionodoxa nana*, Boiss; Bot. Mag. 6453.
- *Chirita dimidiata*, Wall.
- *Chusquea pallida*, Munro.
- *Coreopsis aristosa*, Michx.; Bot. Mag. 6462.
- *Crassula impressa*, N. E. Br.
- *Crinum Kirkii*, Baker, sp. n.
- *Crinum podophyllum*, Baker, sp. n.
- *Crawfurdia speciosa*, Wall.
- *Dendrobium Findlayanum*, Parish; Bot. Mag. 6438.
- *Disa polygonoides*, Ldl.
- *Draœna floribunda*, Baker; Bot. Mag. 6447.
- *Ebermaiera nitida*, S. Moore; sp. n.
- *Eria stricta*, Lindl.
- *Fourcroya cubensis*, var. *inermis*, Baker.
- *Gasteria Bayfieldi*, S. Dyck, var. *minor*.
- *Gasteria squarrosa*, Baker, sp. n.
- *Habenaria intermedia*, Don.
- *Hemigraphis colorata*, T. And.
- *Heterostalis Heugeliana*, Schott.
- *Hippeastrum vittato-solandriflorum*, Baker.
- *Hymenocallis Harrisiana*.
- *Hymenocallis macrostephana*, Baker, sp. n.; Bot. Mag. 6436.
- *Ixora*, sp. aff. *Findlaysonianæ*, Wall.
- *Lamprococcus Weilbachii*, Morren; Bot. Mag. 6435.
- *Leianthus longifolius*, Griseb. var.
- *Liparis spathulata*, Ldl.
- *Loasa prostrata*, Don; Bot. Mag. 6442.
- *Luzuriaga radicans*, Ruiz, et Pav.; Bot. Mag. 6465.
- *Pandanophyllum humile*, Hassk.?
- *Pitcairnia zeœfolia*, K. Koch.
- *Pitcairnia Andreana*, Lind.; Bot. Mag. 6480.
- *Polystaclya rufinula*, Rchb. f., sp. n.
- *Pleurothallis velaticaulis*, Rchb. f., sp. n.
- *Psychotria jasminifiora*, Lind. & André; Bot. Mag. 6454.
- *Rhododendron lepidotum*, Wall. var. obovatum; Bot. Mag. 6450.
- *Rhododendron elœagnoides*, Hk. f.
- *Salvia nana*, H. B.
- *Saracha Jaltomata*, Schl.
- *Scutellaria purpurascens*, Swartz; Bot. Mag. 6464.
- *Trillium nivale*, Riddell; Bot. Mag. 6449.
- *Tulipa Schrenkii*, Regel; Bot. Mag. 6439.
- *Tulipa triphylla*, Regel; Bot. Mag. 6459.
- *Tillandsia bulbosa*, Hook. var. *picta*.
- *Tillandsia flexuosa*, Swartz.
- *Tillandsia streptophylla*, Schied.
- *Trichocentrum tigrinum*, Lind. and Reich, var.

THE ARBORETUM.

The efficient keep of this fine piece of ground, and its ever-increasing classified collection of hardy trees and shrubs, is a source of continual labour and much consideration, especially with regard to its future. The condition of Kensington Gardens is a standing warning as to the possible future condition of the trees at Kew. These grounds are in many respects similar; in both the soil is very bad and requires copious supplies of loam many of the trees are old and stricken with disease; and the increasing number of visitors renders it impossible to preserve them in the wild condition which was formerly their most attractive feature.

As the forested portion decreases, and what was wild wood becomes converted into a lawn with specimen trees and shrubberies, so does the expense of keep increase; and large spaces must be devoted to new plantations if the sylvan scenery, whether as forest or park, is to be kept up. This involves not only young trees (of which we have, happily, an abundant supply of our own raising of the rare as well as the common kinds) but trenching the ground for planting, good soil to put in with the young plants, and continuous labour in keeping the ground open to the rain and clear of weeds.

As in Kensington Gardens many years ago, so more recently at Kew, the brambles, thyme, and other wild plants which once (till within the last 12 years at Kew) clothed the gravelly and sandy tracts, have, together with the ferns in the woods, disappeared, and their places are now occupied by lawn grass, which requires constant mowing.

The devotion of the Kew pleasure ground to the purpose of a classified Arboretum (for which it was so liberally and graciously relinquished by Her Majesty) has greatly complicated the problem of its keep; not only by involving an expenditure apart from that of the general care of the woods, lawns, and paths, &c., but by introducing a new demand in many respects antagonistic to the maintenance of the objects for which the grounds was originally laid out and planted with forest trees. During the first 10 years of the Directorship of Kew, nearly the whole of the ground was a game preserve, covered by timber, and the clearing of open spaces (whether for the purpose of replanting or for meeting the requirements of the Arboretum) was prohibited. The result was the loss of many old trees, the absence of young ones to replace them, and the ruin of the collections, which, being planted in the woods, were starved for want of light and of soil, as well as strangled by the roots and destroyed by drip from the surrounding and overhanging trees. For the last 15 years this policy has been modified; and the interest shown by the public, and especially by horticulturists, in the Arboretum, has led to its requirements being regarded as paramount.

Hitherto every effort has been made both to preserve the beauty of the grounds and to consider the necessities of the young collections of trees as to light, air, and freedom for growth. The principal clearances made for planting the specimens have been along the frequented paths and in the form of long, straight, or winding avenues cut through the woods, thus bringing the collections into prominence and enabling the public to see the specimens and to find the way to them. In the coming year I hope to be able to report that the whole collection has been arranged in this manner, and that the principal walks and avenues are lined with objects of interest systematically disposed, with abundant space left for additions. In the course of this arrangement the majority of the trees have had to be planted much nearer to one another than they can remain; and after the lapse of a few years every alternate one in most cases, and two out of three in some cases, will have to be moved backwards to admit of the full development of itself and its neighbours. Though this plan of close planting has great disadvantages, it is in many respects advantageous; it is economical, the young trees being near to one another and to the path, less labour is involved in staking, weeding, watering, and cleaning; they are also kept better under inspection, and above all, the necessity for destroying many large trees growing in the ground behind them has been obviated.

I need not say that this plan of close planting with a view to subsequent dispersal would not have been adopted had it been possible to create the Arboretum by one effort, and had the formation of a complete collection of trees and shrubs been the only object to be attained. The Kew Aboretum has been the creation of a quarter of a century, and is the result of slender means. The sums expended on the area it occupies have been as much devoted to the preservation of its ornamental character, and to the formation and keep of walks, lawns, and paths, as to the requirements of the young specimen trees, &c.

The number of hands employed in the grounds has been the same for 15 years, whilst the amount of kept ground has far more than doubled, and the collections have quadrupled in extent; consequently, large areas are insufficiently attended to, young plantations are left for years untrenched and unweeded, and the fences of evergreen shrubs planted for their protection get into a very ragged state. Under the present arrangement, caused by want of funds, a proportion of the otherwise constant labourers employed in mowing and watering during the summer months are dismissed during the winter months, when most needed for ground work, tree-lopping, &c. Some of these men having been thrown out of work, and hence upon the neighbouring parishes, has led to representations being made by the guardians of the poor, and I would suggest that the present want of labourers in the Arboretum might best be met by the employment of these men (or some of them) during the winter months.

I now proceed to enumerate some of the principal improvements made in the Arboretum.

The ground along the path leading by the river from the Brentford Gate has been trenched in long beds, and the collection of elms replanted and greatly enlarged by species contributed, especially by Messrs. Booth of Hamburgh, Van Volxem of Brussels, Lee of Hammersmith, and Osborne of Fulham. Further clearances have been made in the plantations between that path and the river, so as to expose the fine specimens of rare elms that were planted there by my predecessor 20 years ago. A top-dressing of good soil is urgently required for the whole of this area.

The trees of *Planera* and the allied genera have been removed into the adjoining Rhododendron Dell.

The plantations along the Grass Avenue skirting the river have all been greatly improved, very poor specimens removed and replaced by Holm oaks, which will eventually render the avenue practically an evergreen one.

I regret to say that this portion of the grounds suffers greatly from the unconsumed smoke of the gas works and manufactories at Brentford, which is not only most prejudicial to the plants, but so blackens the labels that they become illegible in a few years.

The old oak collection by the river, beyond the great Horse-chest-nut, has been conspicuously ticketed with large wooden labels. This collection contains 100 trees upwards of 30 years old, chiefly Asiatic and American, together with younger specimens added within the last two years. It is grievously in want of trenching and a supply of better soil, without which these rare and interesting exotic forest trees will make little further progress.

The American oaks on the mound at the bottom of the Sion Avenue have been exposed to view by the removal of the shrubs by which they were being choked, and the more conspicuous of these have also been named.

The contemplated breaking up of the large beds of young specimen oaks, chestnuts, beeches, hornbeams, &c. (mentioned in last year's Report), and the planting of them in systematic sequence has not been accomplished this year, but preparations for proceeding with it in early spring are rapidly advancing.

In the new Pinetum most of the nurses have been removed, and many of the young pines which were suffering from overcrowding have been transplanted.

The specimens of *Cupressineæ* and allied genera of *Coniferæ* along the walk skirting the Queen's Cot tage grounds having begun to suffer from crowding, the beds containing them have been enlarged and new ones made, so as to admit of those specimens being planted further apart. These specimens will have to be placed still further apart before space can be given for their full development. A choice collection of named Pyri, chiefly presented by Prof. Decaisne, of the Jardin des Plantes, has been planted on the left of the path leading westward from the Lion Gate.

The species of *Ribes, Deutzia, Philadelphia.*, *Hydrangea*, and *Escallonia* have been removed from the neighbourhood of the Thorns, Pyri, &c. to beds prepared for them on either side of the long straight walk at the back of the Temperate House, beyond the Holly collection. More deciduous trees have been planted along the Pagoda Vista, where, however, the soil is so exceptionally bad that the results of these and previous plantations are far from satisfactory. Considering the importance of this avenue, and the miserable growth of the Deodars, now 30 years old (which it was hoped would be its grand feature), it is most desirable that no efforts or expense should be spared to encourage the growth of some good trees along it for the sake of both shade and ornament.

A small map of the Arboretum showing the positions of the principal walks and the collections arranged along them is attached to the last edition of the Guide Book, and is sold separately. Notice boards containing directions to the entrance gates and principal objects in the grounds, together with the names of the classes of the trees and shrubs planted along the walks and avenues, are being prepared for fixing at the entrance gates of the Aboretum, and at the points of divergence of the principal paths.

A miscellaneous assortment of duplicate trees from the Gardens and Arboretum has been planted along the east side of the Richmond Road by the proprietors of the houses built and "being built there. These, together with those planted by ourselves on the west side of the road years ago, will form an avenue almost the whole way from the Cumberland Gate to the Lion Gate, to which there is no roadside rival near the metropolis.

INTERCHANGE OF PLANTS AND SEEDS.

The following is a statement of the plants, &c. sent out during the past year, and included in consignments:—

Argan Tree.—

The account given of this interesting and useful tree (*Argania Sideroxylon)* in the appendix to the book by myself and Mr. Ball on Morocco and the Great Atlas has been reproduced in the gardening journals, and has excited a renewed interest in its cultivation. It is only known in the native state in an exceedingly limited area of Morocco, where the husk of the fruit is greatly valued for cattle food, while the Seed kernel is the source from which an excellent oil is extracted.

At different times the seed has been procured and distributed to various colonies, where, however, its slow growth has led to disappointment. In 1870 a supply was obtained through the kindness of Mr. C. W. Carstensen, H.B.M. Vice-Consul, Mogador.

Amongst other places the Botanic Garden at Saharunpore was supplied, where, however, the plant, though probably well suited for N. W. India, does not appear to have survived. I am glad, however, to hear from Mr. F. Abbott, of the Royal Society of Tasmania's Gardens in Hobart Town; that the Argan tree has been fruiting there for some years.

Columbian Barks.—

As stated in the Kew Report for 1878, p. 10, the number of plants of the Calisaya of Santa Fé was reduced to 15, and of Hard Carthagena bark to 10, at the close of the winter of 1878-1879. These plants were, however, fairly vigorous, and it was therefore judged desirable to make the attempt to transmit part of them to India during the summer and autumn. Under instructions from the India Office, one plant of the Hard Carthagena bark was intrusted to Mr. W. B. Liddell, the managing director of the Nilgiri Tea and Cinchona Company (Limited). The case containing the plant was shipped for Madras at the end of July, but the plant succumbed during the voyage.

Subsequently to this it was arranged that Mr. Adolf Biermann, the Curator of the Royal Botanical Garden, Calcutta, who was returning to India after absence on sick leave in consequence of the severe injuries he had received from a tigress which had escaped into the Botanical Garden, should take with him all the plants of Calisaya of Santa Fé and of Hard Carthagena bark which it was prudent to send out. The former were destined for the Nilgiris, the latter for Sikkim. He accordingly left Kew on October 29 with two cases which had been carefully packed under the superintendence of Mr. Cross (the gardener employed by the Government of India in the culture and preparation of these plants at Kew), and which contained seven plants of the Calisaya of Santa Fé and four of the Hard Carthagena bark. On November 12, Mr. Biermann wrote from the Isthmus of Suez that so far the Cinchonas had travelled safely, and that "if nothing particular happens, I hope they all will reach their destination in fair condition." The four Hard Carthagena bark plants reached the Cinchona plantations at Darjeeling in capital order. Mr. J. Gammie reported (January 11 of present year): "There is every probability of their yielding a nice lot of cuttings soon after the warmer weather sets in. They have all lost their tops from canker contracted on the voyage, but the roots and lower parts of the stems are in excellent condition for yielding cuttings, which are what we want. They will give us a better start than twenty small u plants would have done. I had them taken out of their pots at once and planted in a bed of good light soil under glass. With us Cinchonas are most apt to die of canker if kept long in pots."

Dr. King subsequently wrote:—"The last reports of the Carthagena Cinchonas are that they are growing vigorously. The sending of this species here is another matter for which the Indian Government is deeply indebted to Kew."

As a measure of precaution, in order to preserve the species in cultivation, and with the approval of the Secretary of State for India, a plant of the Hard Carthagena bark was also entrusted to Mr. Morris, Director of Government Gardens and Plantations in Jamaica, who succeeded in conveying it to that island, for which he left England on November 10th.

No report has reached Kew from the officials of the Madras Government with regard to the reception at Ootacamund of the valuable plants of Calisaya of Santa Fé, the establishment of which in the Old World is looked forward to with such anxious interest by all who are interested in Cinchona cultivation. At the commencement of the present year I received, through the kindness of Dr. King, the following statement from Mr. Biermann:—

"Five of the plants were alive on reaching Ootacamund, and before delivering them I drew attention to their precarious state after a long trying journey (38 days). After the plants had been for fully three weeks at Ootacamund they were in hopes of pulling through at least one or two of them. The plants began suffering in the Red Sea, about two days before reaching Aden . . . I must say I received every possible assistance on board the P. and O. steamer 'Hydaspes.'"

At the date of this report there still remain at Kew, under the charge of Mr. Cross, five plants of the Calisaya and three of the Carthagena. With respect to the former, the enterprise is still by no means impossible of success. As to the latter, I am happy to be able to add, while this report is in preparation, the following satisfactory reports, which show that with respect to it no further anxiety need be felt. Mr. Morris writes:—

"Our specimen of Carthagena bark is in splendid condition. We have now 17 well-established cuttings, with promise of more."

Dr. King writes:—

"You will be glad to hear that the Carthagena Cinchona promises well. The four original plants are in excellent health, and Mr. Gammie has taken 36 cuttings from them, which are still too recent to speak confidently about, but which look most promising. From the free way the original plants grew I believe the Carthagena will turn out to be well suited to Sikkim."

Cinchona.—

Assam.—

Mr. Mann reports with respect to the small patches of Cinchona plantations below Nungklow, in the Khasia Hills:—" *Cinchona officinalis* appears to be healthy, the other two species (*Cinchona succirubra* and *Cinchona micrantha)* all present a very sickly appearance, and most of them have only a few leaves at the extremities of the branches. Both species flower sparingly and form no good seedpods. This condition of the plants is ascribed not so much to the climate and altitude as to the very steep slope and shallow surface soil resting on rock, which does not retain sufficient moisture to suit these plants. The plants of *Cinchona succirubra*, near Jirang, look very much better, and both altitude and situation, as well as the soil in that place, seem to be more suited to this species than in the Nungklow plantations."

Burma.—

Major Seaton reports rather unfavourably on the prospects of Cinchona cultivation. The plantation appears to have been made as far back as 1871:—" All things considered, the Cinchona experiment does not promise well. The oldest trees dying off, and the trees of very small size flowering and fruiting freely, aw only too sure signs that the tree finds itself in a site not adapted to its requirements." It appears, however, that a Ceylon planter has made inquiries about a grant of land in the neighbourhood. It is possible, that with the technical knowledge as to the methods of cultivation of Cinchona, and of obtaining a speedy financial return from it, which have been worked out in Ceylon, a better face may be put upon the experiment in Burma.

Central Africa.—

Dr. Lowe, Inspector of Hospitals of the Soudan, informs me that at Gadarif, near the frontier of Abyssinia, *Cinchona succirubra* does well.

Ceylon.—

The enterprise of the planters, and the necessity of obtaining a speedy return for invested capital, has led to much more rapid methods of harvesting the bark crop being adopted in this island than at the first commencement of the enterprise would have been thought possible. The following statement appeared in the "Ceylon Observer" for Sept. 13th, 1878:—" Over large areas in Ceylon it seems as if *Cinchona officinalis* came to maturity in four and a half years, while if trees begin to show signs of canker or decay at even two and a half years, the bark ought at once to be utilized. Bark of such trees will pay well for the gathering. We once sent to Messrs. Howard a specimen of bark from three and a half years old trees. The verdict was, 'good' marketable bark as it stands.'"

Jamaica.—

Mr. Morris writes:—

"My chief care at the Cinchona plantation is the establishment of large open air nurseries instead of the glass propagating houses which I found here. I sow the seed under thatched sheds and prick out the plants into beds shaded by ferns. This is a simple inexpensive style which is universally adopted in Ceylon, but unknown here. I fear that the system of glass houses and propagating and hardening frames has done much to frighten people from trying Cinchona here, and besides [the Government plantations] have never been able to distribute more than a few hundred plants, as they had not enough for their own use. In a few months, by next planting season, I shall have 80,000 which I can conveniently spare, and by the end of the year, possibly 500,000."

* * *

"Unless the trees are planted thickly enough to 'bower' the ground, as the planters say, the cost of weeding is nearly 4l. per acre per annum. By the third year the trees, if well planted and well supplied, ought to cover

the ground and save all subsequent weeding."

Mauritius.—

Mr. Cantley reports:—"The Cinchonas have grown but slowly. Few experiments have been made with the plants, owing to more pressing work. The plants planted in the forests at a greater altitude than that of the gardens have not grown satisfactorily, but it is hoped some method of growing this useful plant, which will give beneficial results, may still be hit upon; only it must differ considerably from that of other countries."

Sikkim.—

In his report for 1878-1879 on the Government Cinchona plantations in Bengal, Dr. King states: —"The most interesting feature in the details of the crop is the fact that four acres of yellow barks *(Cinchona Calisaya)* planted during 1871-1872 yielded, when coppiced, at the rate of no less than 1,882 lbs. per acre. The present is the first season during which *Calisaya* has been cropped, and if this result can be taken as an indication of the rate of produce to be expected, the future prospects of the cultivation of this species are reassuring."

No locality with perfectly suitable climatic conditions having yet been found for the growth of *Cinchona Calisaya* in British Sikkim, Dr. King was authorised by the Government of Bengal to visit Java to examine the conditions under which the Dutch have there succeeded in growing the tree successfully.

The Government of Bengal, in reviewing the operations of the Cinchona plantations in British Sikkim for 1878-1879, arrives at the satisfactory conclusion that the enterprise is in every way a financial success. "The total amount of capital, with interest at 4 per cent., that has been sunk in the Cinchona plantations and in the manufactory is approximately 10 lakhs of rupees; the receipts for the year 1878-1879, therefore, after paying all expenses, yielded interest of about 4¼ per cent, on the capital outlay, and even if subsequent years show no improvement, as it may be confidently assumed they will do, a sufficient annual income would almost have been realized.

"But this system of computing profits falls very far short of doing justice to the real benefit which the Government has derived from the Cinchona plantations. The 5,500 lbs. of alkaloid taken by the different medical departments replaced an equal amount of quinine that would otherwise have been purchased and supplied to hospitals and dispersaries. At the very moderate rale of Rs. 80 per lb., the cost of this would have come to Rs. 4,40,000, and this amount, plus the actual sales to the public and Staits Settlements Rs. 41,540, in allRs. 4,81,540, is the true measure of the gain to Government from the Cinchona manufacture. looking at the financial question in this way, as may most fairly be done, the plantations by the end of the current year will have cleared off the entire capital that has been invested in them."

Up to the end of 1378-1379 Dr. King shows that the total saving effected to Government by the use of febrifuge in the place of quinine had already amounted to 7¾ lakhs of rupees. He continues: "As for the febrifuge itself, extended experience of its administration appears to have increased the confidence both of the medical profession and of the general public in its virtues as a febrifuge. Complaints of its nauseating effects are now seldom heard of, and there appears to be little doubt that these were originally largely due to the practice of giving too large doses of a drug which is really about as powerful a febrifuge as quinine."

With regard to price, Mr. C. H. Wood, the Government Quinologist, anticipates that the cost of the febrifuge will ultimately be brought to about eight annas an ounce.

Singapore.—

Mr. Murton (Superintendent of the Botanic Gardens) reports:—" All attempts to grow this here have proved fruitless, but *Cinchona Calisaya* and *Cinchona succirubra* are likely to do well at 2,000 feet elevation in Perak."

Tinnivelly.—

Col. Beddome reports:—" A few plants were sent from the Nilgiris for trial in this district (1856), and the *Cinchona suedrubra* plants were put down at an elevation of about 3,000 feet, in a small clearing in the ghat forests; they have been left entirely to nature, but owing to the moister climate, the growth contrasts very favourably with that of Neddivattum or elsewhere on the Nilgiris. During my last inspection I found one of the larger trees to be nearly 50 feet high; it had three large stems at about 1 foot from the base, the leaves having, it was said, been broken by a monkey when young."

Eucalyptus.—

Seeds of species of this Australian genus are continually asked for, and supplied from Kew. The following notices represent the progress made in their cultivation in various parts of the world:—

Assam.—

Mr. Gustav Mann reports:—" *Eucalyptus Globuhis* is by far the fastest growing species cultivated in the Khási Hills, and next to it comes *Eucalyptus rostrata"*

Bengal.—

Dr. King remarks:—"The Eucalypti from Queensland give little more hope of success than the more southern species, by the planting of which in the plains of Bengal sanguine people hoped to abolish malaria."

Bombay, Northern Division.—

Mr. Shuttleworth reports:—" Seeds of different varieties of Eucalyptus were sown, nearly all failed. A few of *E. rostrata* are surviving."

Bombay, Southern Division.—

Col. Peyton reports that the plantations of difierent species of Eucalyptus do not appear to prosper, and their numbers are rapidly diminishing. . . They are weedy and whip-like in growth, and require to be propped up to prevent falling over." Near Dharwar what is supposed to be *E. resinifera* appears to prosper. "Four trees are remarkably fine, although only six years old. They have attained on an average 40 feet high, and are 5 inches in diameter 5 feet from the ground."

Jamaica.—

Mr. Morris reports:—"Of Australian trees the most desirable here is *Grevillea robusta*, which is adapted for nearly all elevations, and stands wind well. The gums (*Eucalyptus*) get very much blown and seldom look well except in clumps, where, for the first four or five years they are sheltered on the outside by other trees."

Saharunpore.—

Mr. Duthie reports:—" There are at present upwards of 31 species under cultivation in these gardens. . . . The healthy appearance of some of the kinds and the rapid growth they are making are sufficient reasons for encouraging their extensive cultivation in India." This is in accordance with what is known of the climate of that (extra-tropical) part of India.

Singapore.—

Mr. Murton reports:"—When sown *in situ* they seem to thrive fairly well in Singapore, but do not appear to stand transplanting. *Eucalyptus siderophloia, E. Baileyi,* and one or two other species are growing well in the nursery."

Zanzibar.—

Dr. Kirk informs me:—"The *Eucalyptus citriodora* from Queensland is now in less than two years from seed about 18 feet high, with wide branches."

Fodder Plants.—

1.Guinea Grass.—

Dr. Imray informs me that this grass *(Panicum jumentorum)* takes the place of all other fodder grasses in Dominica, "it requires so little cultivation, and is so hardy, for our climate that is. By keep- Drawing of plants ing the weeds down and a little manure occasionally, it may be cut down crop after crop for many years. I have had a guinea grass piece treated in this way for full twenty years."

2. PRICKLY COMFREY.—

Extended trials have shown that this plant *(Symphytum peregrinum*), although possessing great merits as an early fodder crop in cool and temperate countries, is physically unadapted for cultivation in hot countries. I quote the following statements—in addition to those published in last year's Report (pp. 12, 13)—from Australia and India.

Madras.—

The Agri-Horticultural Society report:—" Experiments with Prickly Comfrey have failed, the plants which were in the gardens, though receiving rather more than their fair share of attention, having one by one perished."

Saharunpore.—

Mr. Duthie reports:—" I do not believe that the conditions at Saharunpore as regards either climate or soil are favourable for the profitable cultivation of this plant. At Chajuri it thrives fairly well. Three crops were taken during the year from 35 roots growing 3 feet apart. The average weight of each crop was 30 lbs."

South Australia.—

Dr. Schomburgk reports from Adelaide:—"Prickly Comfrey has again been a thorough failure, and it is now a fact that this plant is of little use, at least on the South Australian plains."

"Prickly Comfrey" has been identified by Mr. Baker with a plant long known as naturalised in the neighbourhood of Bath, from which locality specimens are to be found in herbaria in this country under the name of *Symphytum asperrimum*.

The accompanying plate is borrowed from the Botanical Magazine, where, under Tab. 6466, an account of its botanical characers will be found. The knowledge of this plant and of its capabilities being now widely diffused, it will rot be necessary to refer to it again.

3. TÉOSINTÉ.—

Bombay.—

Mr. Woodrow reports:—"*Euchlæna luxurians* produced a heavy crop of forage when treated as a garden plant, but not better than would be given by sugar-one in the same circumstances. When treated as a fixed crop, under the same conditions as Jowarœ, the produce was inferior to that crop."

Queensland.—

Mr. Valter Hill reports from Brisbane; —" The seeds received by me were duly planted, and grew both strong; nd healthy, flowering about the month of May. From the opportunity I have had of judging of its nutritve qualities, I am not of opinion that it can be grown to much advanage in this colony, the stalks appear to be too fibrous and hard to possess much nourishment. I shal, however, make further experiments."

Saharunpore.—

Mr. Duthie reports:—"As far as cultivation is concerned success has been complete. The majority were fine healthy plants, and an abundant supply of excellent seed was produced."

Singapore.—

Mr. Murton reports:—" This grass, although useful, does not bear out its reputation in the Straits. Large quantities of seeds have been distributed, but all accounts from the Native States state that it pays far better to grow maize, as the same ground that will grow Teosinte will produce excellent maize."

South Australia.—

Dr. Schomburgk reports from Adelaide that, notwithstanding the disastrous drought of the early part of 1879, the prevailing dryness did not injure the plants, showing not the slightest effect on their leaves, which preserved their healthy green, while the blades of the other grasses suffered materially. . . At the Government garden at Palmerston, in the Northern Territory, the growth of the *Euchlcena* has been surprising. In the course of five or six months the plants reached the height of 12 to 14 feet, and the stems on one plant numbered 56. The plants after mowing down grew again several feet in a few days. The cattle delight in it in a fresh state also when dry. Undoubtedly there is not a more prolific forage plant known. . . . I can recommend it as a most valuable summer forage plant in our dry climate, especially if it can be planted in a moist soil. The only drawback with us will be that the ripening of the seed crop will be problematical, as early frosts will kill the plant."

4. TAGASASTE.—

We are indebted to Dr. G. V. Perez for seed of this forage plant (*Cytisus proliferus* var.) It is a shrub indigenous to the Canaries, the leafy branches of which are said to be a useful fodder. It requires a light dry soil, and is rather intolerant of frost in winter. The plants should be placed six to ten feet apart, may be cut two or three times a year, and will last 10 to 20 years. Thirty-five pounds of fresh chopped Tagasaste mixed with 20 lbs. of chopped straw is said to be sufficient for the daily nourishment of a horse or cow. The seed is very slow in germinating.

The seed was pretty widely distributed from Kew. It is too soon to expect the results of trials at present.

Madras.—

Most of the seedlings died off after germination. Colonel Grant reports at commencement of present year:—"At present only two or three are looking healthy, and from them I should think very little fodder could ever be obtained."

South Australia.—

Dr. Schomburgk reports from Adelaide:—" The seeds were sown, and all came up. The growth of the plant is vigorous. Some of the plants having reached two to three feet, looking healthy, not in the slightest degree affected by the severe dry weather we have had to contend with. I have many plants for distribution."

India-rubber.—

According to Hecht, Levis, and Kahn's Report for 1879, Para rubber (*Hevea*) is still the largest source of supply. The total import into England during the year was 4,651 tons. Liverpool received 25 tons of Ceara Scrap rubber, and 900 tons of African *(Landolphia*), while London imported 350 tons from Assam (*Ficus elastica*), 250 tons from Borneo *(Willughheia*), and 550 from Mozambique (*Landolphia*). Considerable attention has been paid at Kew during the past year to the examination of the African Landolphias and Malayan rubber-yielding Willughbeias, and the results will be given in the next report. Owing to the unfailing interest in Kew of Dr. Kirk, H. B. M. Consul-General at Zanzibar, a considerable stock of Landolphias, of which in 1877 we had none in cultivation (Kew Report, 1877, p. 32), has been got together. Plants of one kind will be distributed to tropical colonial gardens in the course of the present year.

The following extracts from reports and other documents carry on the history of the introduction of the South American species into Old World cultivation (*see* Kew Report, 1878, pp. 14 and 15).

1. CASTILLOA.—

Singapore.—

Mr. Murton reports:—"The plants of Hevea and Castilloa in the gardens are now large plants, but hitherto propagation from the strong growths they are making seems rather difficult, whereas they used to propagate freely from the weak wood produced while in pots."

2. CEARA SCRAP (*Manihot Glaziovii).*—

Burma.—

Major Seaton reports:—" A quantity of seed of this India-rubber tree was received during the latter part of the season from the Botanical Gardens, Peradeniya, Ceylon; and at the request of Dr. Thwaites, an intelligent lad was deputed to Ceylon to receive instructions in the cultivation of India-rubber plants."

Calcutta.—

Dr. King reports:—" The Ceará rubber promises to grow well in Calcutta. The seedlings received from Kew have thriven vigorously, and some of them are now 20 feet high. The Director of the Botanic Garden in Ceylon having, at the request of the Secretary of State for India, undertaken the propagation of this species, a quantity of seeds of it were distributed by him to Indian officers during the year. Supplies were, I understand, sent to the Conservators of Forests in Burmah and Assam, and to the Inspector-General of Forests for Madras. A large supply was received at this garden, and a thousand seeds were sent, at the request of the Conservator of Forests for Bengal, to the officer in charge of the forest plantation near Chittagong. The seeds received here have begun to germinate, and I expect before long to be in a position to issue supplies of seedlings for trial in different parts of the country. The plant appears to thrive very well in Upper India, and if the quality of rubber yielded by it in this country turns out to be good, its introduction may prove of much importance."

Singapore.—

Mr. Murton reports:—" Ceara Scrap rubber must be omitted from the list of rubbers adapted to the climate of the Malayan Peninsula, as it has invariably rotted off during continued wet weather."

Zanzibar.—

Dr. Kirk informs me that with him the Ceara rubber yields seed most abundantly, but the seeds are slow to germinate.

3. HEVEA,.—

Burma.—

Major Seaton reports:—"At Mergui eight Para India-rubber trees, the survivors of the batch of seedlings received from Dr. King in 1877, continue to do well in the office compound, and vary in height from 8 feet to *25* feet. They are large enough to admit of a considerable number of cuttings being taken from them."

Calcutta.—

Dr. King reports:—" Pará rubber, of which fourteen plants were alive in the garden at the date of last report, continues be as disappointing as ever. Most of these 14 plants are still alive, but they have not grown much, and it is quite clear to me that it is vain to hope that this species can ever be cultivated to profit in this part of India. Plants may be coaxed into growing in conservatories, but the species is by far too thoroughly tropical to withstand without protection the vicissitudes of the climate of Northern India. As I have before reported, I believe it is useless to try it anywhere in India except in the south of Burma or the Andamans, and perhaps in Malabar. I learn from Dr. Thwaites that in the Botanic Garden at Peradeniya, in Ceylon, there are plants of *Hevea* of about 30 feet high, and that these are of the same age as the plants here, the highest of which is barely 6 feet in height."

Jamaica..—

Mr. Jenman reported:—"I regret to say that there are only two plants of the Pará rubber in the garden, one which I brought with me, and which is now a vigorous young tree 10 feet high, the other, the only one saved out of a case of 16 plants sent from Kew Gardens over two years ago, but which unfortunately on its arrival in Kingston was locked up in the Custom House for a fortnight, to the influence of which, after the voyage, all but the one succumbed. The atmospheric conditions of this district appear favourably adapted to the successful cultivation of the Para rubber."

Zanzibar.—

Dr. Kirk states:—"The Pará rubber is a less quick grower than the Ceara, and does not branch. It is 10 feet high."

Liberian Coffee.—

The following extracts will show the progress made in different parts of the world of this important plant. (*See* Kew Report, 1878, pp. 15-17.)

Burma.—

Lt.-Col. H. P. Hawkes, Honorary Superintendent of the Government Gardens at Rangoon, reports:—" The Liberian coffee continues to thrive. It is now showing signs of flowering, and will be in full bloom about the middle of next month. I hope, therefore, to be able to venture upon some estimate of the probable economic value of this coffee at the close of next year."

Dominica.—

Dr. Imray writes to us:—" I am glad to say that the Liberian coffee cultivation may now be fairly considered as established in this island. The fine, healthy, luxuriant trees on my small plantation, with a crop of berries on many of them, afford sufficient evidence of the climate being congenial to the plant. The cultivation is successful, and only awaits extension by others taking it up. I have several thousand seedlings planted out in the open, and thriving well. I lost a good many seedlings, however, by putting them out when too small. To ensure their rooting they should be pretty well grown before they are transferred to the field. Protection of some kind or other is also advisable at first, as well from the scorching rays of the mid-day sun as from strong winds. When fairly rooted and growing, the plants are hardy enough, and will bear a good deal of exposure and neglect.

"My trees still remain free from the attacks of that dire scourge of the coffee plant in this part of the world, the *Cemiostoma Coffeelum*, and yet not altogether exempt from its attacks, especially in the first stage of its growth. As I shall relate, I had planted many hundred seeds in boxes and bamboo joints, and they showed above ground at the usual time, about six weeks after planting. At first the seedlings appeared quite healthy, but after a time I observed brown spots on the cotyledonary leaves. I did not pay much heed to this appearance, believing the plant altogether impervious to the assaults of the white fly, but as they rapidly became all affected in the same manner, I carefully examined some of the brown spots on the leaves, and found to my horror that the destruction was unmistakably caused by the larva of the white fly ! I was quite taken by surprise, as the grown plants had escaped its ravages. It was, however, only the seminal leaves that had been attacked, but if they were destroyed before the stem leaves were formed the plant would certainly perish; and, indeed, in this manner many were lost. I killed the larva in the leaves, and brushed off the chrysalis wherever it appeared, and thus saved most of the seedlings until the stem leaves began to grow; and these, as you may suppose, I watched with great interest as they grew, and to my intense relief discovered that the insect left them untouched. The seedlings steadily increased in size, throwing out fresh leaves, and most of them have been planted out in the field, and are thriving well, with not a speck of the blight on them.

This is a notable and curious fact in the history or study of this destructive creature. There were no blighted coffee trees growing very near to these seedlings, but in the adjacent field were some trees with the blight on them. From these the moth, by a marvellous instinct, or whatever the impulse that guides it may be called, had found out among myriads of other leaves the cotyledons just as they had emerged from the ground, and decided that they were exactly suited for the deposit of its eggs, and the nourishment of the larva when hatched.

"This, however, is not the only attempt the insect has made to gain a footing on the Liberian coffee. On carefully examining the large trees some six or eight months ago, a few leaves were found where the insect really had established itself, but in a very feeble manner. Some of the larvæ were lively enough, but others small and weak, and the skeletons, if I may so speak of others that had died, were found in the brown patches of the leaf, when the upper and under cuticle were separated. Very few cocoons were observed, and these were smaller than usual.

"There must have been something exceptional in the structure of those leaves that the insect had selected to deposit its ova, and from the blight not having extended it may be inferred that, although the eggs of the fly were deposited, and the larva when hatched had found its way to the cellular structure of the leaf, this was not found in sufficient quantity, or of such quality, as to form a healthy pabulum; hence the larva either died in the leaf, or formed a small and weak chrysalis which failed to produce the moth. Be that as it may, the very reassuring fact remains that the blight did not spread, and that at the present time the insect is not to be found in any of its stages among the well grown trees or the seedlings, although carefully searched for. The most striking point is, that though the seminal leaves were rapidly devoured, the stem and branch leaves of the seedlings remained untouched. Doubtless the soft juicy substance of the seminal leaf affords suitable nourishment, while the reverse is the case with the comparatively dry and fibrous parenchyma of the ordinary leaf.

"The fact of the Cemiostoma attacking the seminal leaves of Liberian coffee has a very important practical bearing in the cultivation of the plant in the countries where this blight exists. For if nurseries of Liberian coffee are formed near to a single tree with the blight on it, the seedlings will be quickly attacked and, possibly, all destroyed. Nurseries should be established as far distant as possible from the blighted coffee trees, and the seedlings should be assiduously watched, so as to destroy the insect in its larva state as soon as a brown spot indicates its presence, and this may be done by simply scraping the spot with the nail. When the stem leaves appear, and have grown somewhat, the plant is safe. I gave a few seeds to several persons in the island, but these, so far as I learn, have for most part failed, the plants having died, and from the description given of brown spots having been seen on the leaves, I have no doubt the white fly was the cause of their destruction. I purpose sending some remarks to the local paper soon, giving instructions as to the mode of cultivating Liberian coffee, and warning all of the absolute necessity of protecting the seedlings from the ravages of the white fly, or very few will be saved."

Jamaica.—

Mr. Jenman reported, 22nd February 1879:—" There is a great demand for this coffee, which the garden is quite unable to meet at present. All attempts which have come to my knowledge on the part of private parties to import either plants or seeds have proved failures. Another small parcel of seed received some months ago from Kew Gardens produced between four and five dozen plants, the majority of which I have planted out to increase the number of our stock plants . . . I am glad to be able to report that the first few trees received have this year (1878) borne a small crop of fruit, which has recently been gathered and sown."

Seychelles.—

Mr. C. S. Salmon, the Chief Commissioner, writes:—About 150 plants of Liberian coffee—mostly raised from seed you sent—have been planted at Mahé Island at elevations varying from the shore to 1,500 feet above sealevel. It comes best, apparently so far, in the open without shade. One plant at an elevation of about 300 feet, without any shade and close to a granite rock giving out considerable heat, has about 100 strong looking flowers on it. This plant is 18 months old."

Singapore.—

Mr. Murton reports:—" The Arabian coffee here is severely attacked by the disease [*Hemileia vastatrix*], which has destroyed all hopes of our being able to supply seeds for planters in the Peninsula. The Liberian coffee has not yet shown any signs of being attacked, although some Perak planters have been scared by yellow blotches on the younger parts of the branches. [They appear to have no connection with the disease.] The species is evidently very impatient of deficient drainage. The plants raised from seeds received from Kew in May 1878 are now blooming profusely. Eight hundred fruits from our plants have been sent to Government Hill, Penang, and 500 sent to Perak. Very favourable reports have been received from the Native States regarding the progress of the plants of this species there, and there can be now no doubt that the Liberian coffee has found a congenial home in the Malay Peninsula and adjacent islands, and its future propagation may now be left to planters."

Queensland.—

Mr. Bernays informs me that the Liberian coffee introduced [Kew Report, 1877, p. 17] from Kew has found a firm footing on the Herbert River, where it gives high promise of attaining complete success. The foliage of many specimens is rich and full, and, as there are signs of bloom also, it is not unlikely that ripe berries may this season follow."

Zanzibar.—

Dr. Kirk writes while this report is in preparation:—"Several useful plants take well to the climate; my Liberian coffees (the last lot) are now in flower."

Mahogany Cultivation in Old World.—

This may now be regarded as an accepted success. The tree grows well in many parts of India and in Ceylon, and in the former there is a local demand for the wood. In this country new uses are found for it, one of the most recent being for the linings and panellings of railway carriages instead of teak, which is now exclusively used for ship-building. It is not easy to see any valid arguments against the cultivation of a tree the timber of which is of admitted excellence for a variety of purposes and the growth of which is apparently attended with little difficulty. As late as 1876 the Government of Bengal was adverse to mahogany planting. This policy has now, however, been modified, and in his report for 1878-1879 Dr. Brandis, the Inspector-General of Forests, reports:—" Of the exotic trees which are cultivated by way of experiment, mahogany is the most important, and its success seems not improbable, though it is too early yet to form final conelusions upon the subject. Mahogany is also cultivated as an experiment in Burma and the Chittagong district of Bengal. The tree is known to thrive well near Calcutta, and every effort should be made to cultivate it in those forest districts where climate and other circumstances are favourable.

Bombay, Southern Division.—

Col. Peyton reports:—"A small parcel of seed was received from the Superintendent of the Botanical Gardens. It was not understood how to treat them, and only 18 germinated. They were put out at Yellápur, and are now splendid specimens, varying from 1 foot 8 inches to 4 feet 7½ inches. Subsequently another parcel of seed was received. They are now understood, and are germinating famously. They require much watering, good air and light, and a light covering only of earth."

Burma.—

Lt.-Col. H. P. Hawkes, Honorary Superintendent of the Government Gardens at Rangoon, reports:—" The mahogany experiment has been an unqualified success. The seeds were sown on the 7th September 1878. When the plants were exactly a year old three of them were measured, and found to be 8 feet 3 inches, 7 feet 5 inches, and 6 feet 1 inch in height respectively, with a girth of from 3? to 3? inches, a rate of growth which, as far as my experience goes, is altogether unprecedented, even in the case of indigenous trees. In addition to this rapid growth, the maliogany tree appears to be very hardy, and promises to bear with impunity the extremes of heat and moisture characteristic of the Burmese climate. Of the hast 112 plants raised from seed! not one has failed. We have a large number planted out, and they seem to thrive in the poorest soil where it is difficult to keep other plantsalive. "

"I believe that this tree has a great future before it. The Forest Department now plant teak almost exclusively, and there is no other tree which can altogether take its place, especially in those situations where structures made of it are liable to the attacks of white ants. But there are many purposes for which a light handsome wood is required; this want would be met by the mahogany, and there would doubtless be a considerable demand for export"

Major Seaton reports:—" In the Tenasserim Circle, the four mahogany trees planned out in 1875, near a monastery at the foot of the Toungwine range, near Moulmein, continue to thrive, the maximum and minimum heights of the trees being 17 fee; and 7 feet respectively."

Queensland.—

A supply of seed of Honduras maho any has been sent from India to tie Acclimatisation Society, Brisbne, which has distributed a portion to the Botanic Gardens of Bowen, Rockhampton, and Maryborough.

Saharunpore.—

Mr. Duthie reports:—" The tree appears to thrive well in these gardens. There are some fine large specimens about 60 years old, one of which measures 8 feet 9 inches in girth at 4 feet from the ground. The tree flowers regularly every year, but as yet no seed has been produced."

Singapore.—

Mr. J. Fisher writes to me:—"The mahogany raised from the seed sent me some 11 years ago looks very healthy indeed, and is now about 50 feet in height."

Mesquit Beans.—

Bengal.—

Dr. King reports:—"The plants of *Prosopis juliflora* continue to thrive, but have not yet flowered."

Punjab.—

From a report furnished to the Government it appears that the general result of experiments is to show that with ordinary care and with good seed there is no difficulty in growing *Prosopis juliflora* in the Punjab."

With regard to the caution given in the Kew Report for 1877, p. 20, it is pertinently remarked:—"Any new kind of food given in quanties to animals unaccustomed to it may cause disease, or, under certain special circumstances, may cause death. Opinions are divided as to what it is that causes cattle in this country in certain seasons to sicken and die from eating 'jowar' stalks; but there is no doubt that under certain not very well understood conditions cattle do die from eating 'jowar' stalks, though ordinarily such stalks are good for fodder."

Saharunpore.—

Mr. Duthie reports:—"The plants of *P. glandulosa* are very healthy looking, and have grown considerably during the past year, though in a straggling, bramble-like fashion. . . . Every plant of *P. pubescens* " died before the rains were over."

Writing June 15, 1879, he remarks: "I am glad to tell you that several plants of *Prosopis glandulosa* are bearing fruit abundantly, and I believe it is doing the same at Cawnpore."

South Australia.—

Dr. Schomburgk reports great difficulty in establishing *P. pubescens*. "Notwithstanding all the care used we lost them all. The plants seem to fail during winter. The other species, *P. juliflora*, does uncommonly well in our climate . . . . I hope that the seed will grow and the trees flourish, so as to induce a further demand for large quantities wherewith to stock the" arid plains of South Australia on a large scale, thereby vastly increasing the resources of that peculiar country in a stock-raising view."

Pithecolobium Saman.—

Bombay, Northern Division.—

Mr. Shuttleworth reports:—" Success was very fair; germination took place in 8 to 10 days, and at the end of the year some of the plants were from 6 to 8 feet high. . . In Satara 400 plants are thriving, and seem to be hardy and able to stand drought during the cold and hot weather months."

Bombay, Southern Division.—

Col. Peyton reports:—" Came up splendidly everywhere. About 2,500 plants were raised from the small parcel of seed received. The growth is very rapid and vigorous, and many of the plants put out have attained a height of from 3 to 8 feet. To germinate them they require copious watering, and some are now noticed germinating over the old sowings of last year."

Burma.—

Major Seaton reports: —" *Pitliecolobium Soman* has been distributed throughout the Pegu circle, and from all quarters is reported to have grown luxuriantly."

Calcutta.—

Dr. King reports:—"The rain trees in this garden seeded for the second time, and large quantities both of seed and seedlings have been distributed. The sweet succulent pod of this tree is said to be an excellent food for cattle, and if it proves acceptable to the Indian bullock the rain tree may become highly useful as a fodder plant, while its rapid growth and umbrageous habit will certainly make it a favourite for planting by road sides and near cantonments."

Dr. King further informs me:—"*Pithecolobium Saman* seeds in India only in the Botanic Garden, Calcutta, and our trees are quite unequal to supply the demand. It seeds also in Ceylon, but Dr. Thwaites told me that he had great difficulty in saving the pods from frugivorous bats. At Calcutta, where the same species of bat is common, it has not found out yet how nice the pods are."

Saharunpore.—

Mr. Duthie reports:—" The effect of the cold season on this plant obviously indicates the undesirability of attempting its extensive cultivation in this part of India."

Sind.—

Major McRae:—"The seed sown last July has succeeded very well, the plants (a month later) being of an average of over 6 feet in height."

Tasmania.—

Mr. Abbott reports:—" From seeds received from Kew, plants of *Pithecolobium Saman* have been raised . . . . It is probably better suited for cultivation in warm climates, but hitherto the plaints have done well with us."

The receipts have been during the past year 3,754 living plants of all kinds, and 2,900 packets, bags, and boxes of seeds from 196 contributors. They were distributed as follows:—

I. Britain.

The usual exchanges have been made with the Botanic Gardens of Dublin, Edinburgh, Glasnevin, and Oxford; with the Royal Horticultural Society, Chiswick; with the Royal Botanic Society, Regent's Park; also with the principal nurserymen, especially with Messrs. Backhouse of York, Barr and Sugden of Covent Garden, Bull of Chelsea, Carter of Holborn, Dickson and Co. of Edinburgh, Dickson and Sons of Chester, Henderson of St. John's Wood, Jackson and Son of Kingston, Laing of Forest Hill, Lee of Hammersmith, Little and Ballantyne of Carlisle, Low and Co. of Clapton, Osborn of Fulliam, Rodger, McClelland, and Co. of Newry, Thompson of Ipswich, Veitch of Chelsea, Ware of Tottenham, and Wills of South Kensington.

Contributions have been received from upwards of 100 different sources; of these the principal have been:—

Ashburton, Lady; box of Cape *Irideæ*, bulbs, &c.
Atkins, J.; *Pulmonaria dahurica, Saxifraga primulina*, &c.
Bagwell, Mrs.; seeds of *Anemone coronaria* and others.
Bradford, E.; seeds *Perilla ocimoides, Polygonatum tinctorum*, &c.
Briggs, T. A.; *Pyrus Briggsii*.
Briggs, Sir T. G.; Ward's case of plants from Bermuda.
Broome, C. E.; *Habenaria chlorantha, Lysimachia thyrsiflora, Eryngium alpinum*.
Christy & Co., T.; seeds *Duboisia myoporoides*.
Clark, Col. T.; hybrid *Haemanthus, Hymenocallis Harrisiana*.
Crewe, Rev. H.; *Gladiolus permeabilis*.
Darwin, Ch.; fruit of supposed hybrid *Solanum, Drosophyllum lusitanicum*.
Egerton, Sir. P.; *Hymenocallis macrostephana*.
Ellacombe, Rev. H. N.; *Tritoma Burchelli*.
Elwes, H. J.; *Arisæma nepenhoides, Milla longipes, Tulipa* sp.
Hall,—.; *Gentiana bavarica* and other Swiss alpines.
Head, A., Crystal Palace; Large clump of *Rhapis humilis*.
Hillhouse, W.; *Riecia fluitans*.

Henry, I. A.; *Alströmeria* sp., *Gunnera* sp., *Stenomesson Hartwegii, Lychnis apetala, Clematis Colensoi, Hibiscus corylifolius, Perezia multiflora, Rhodostachys littoralis, Puya andina, Puya paniculatay Veronica Lyallii, V. salicornioides, Primulas*, roses, &c.

Jennings, R.; *Eucalyptus Gunnii* (Cider Gum of Tasmania).

Joad, G.; *Falkia repens*.

Judge, J. H.; *Mormodes aromatica, Peonia Whitmanniana*, &c.

Latham, J.; seeds *Raphia* sp.

Law son, Rev. W. L.; *Adiantum cuneatum*, var. *Lawsoni, Asplenium septentrionale* and other ferns.

MacLeay, Sir G.; Hardy orchids.

Masters, Dr.; seeds *Fischeria* sp.

Maw, G.; *Hyacintlius Pulzolzi, Colchicum* sp., *Chionodoxa, Croci, Narcissi*, &c.

Melville, D.; collection of *Galanthus*.

Murray, Maj.-Gen.; seeds *Commidendron robustum*.

Nares, Capt. Sir G.; Ward's case containing *Callixene* sp., *Campsidium* sp., *Hymenophyllum cruentum, Philesia buxifolia*.

Peacock, J.; *Aloe socotrina, Echeveria pulverulenta, E. Funkii, Fourcroya variegata*, &c.

Peek, Sir H., Bart.; collection of cultivated musas.

Philpotts, Canon; large plant of *Cattleya crispa*.

Post, Rev. G. E.; *Ornithogalum latifolium*.

Rawson, Rev. A.; *Moræa tristis*.

Rashleigh, J.; *Pinus Edgariana*.

Redhead, M.; seeds of choice palms, *Chorisia speciosa, Ipomœa aurea*, &c.

Routledge, T.; *Bambusa arundinacea, Dendrocalamus strictus*.

Thompson, R.; seeds of *Befaria glauca, Cobœa pendulifiora, Gaultheria* sp., *Lobelia* sp., *Espeletia neriifolia* (Incense tree), *Solanum* sp. bearing beautiful fruit, cinchonas, musas, &c.

Walker M. A.; *Hibiscus* sp., Natal

Wilkie, J. F.; choice succulents.

Woodbridge, J.; *Hymenocallis macrostephana*.

II. Continent.

Jacob Makoy, & Co., Belgium; *Croton Domei, Eurya angustifolia*, var. *variegata, Maranta Kerchoveana, M. Binotii, Paullinia thalictrifolia*, var. *argentea, Simonisia chrysophylla*.

Kreuter, Dr., Vienna; seeds of melon from Kurdistan.

Max. Leichtlin, Baden-Baden; *Allium Sewerzowi, Iris Kochii, I. Cingiatti, Ixiolirion montana, Incarvillea Olgæ, Tulipa Kaufmanni, Milla longipes*; seeds of choice plants, including *Crawfurdia speciosa, Ampelidearum* gen. n., &c.

Orr, J., Cannes; *Saxifraga florulenta*.

Perez, Dr. V., Canary Islands; seeds *Cytisus proliferus* (Tagasaste).

Regel, Dr., St. Petersburg; many choice *Aroids, Carludovica Wallisii, Corydalis Kolpakowskiana, Leontice altaica, Orithya dasystcmon, Tulipa triphylla* and many other choice bulbs, Irids, seeds of *Rhododendron kamschaticum*.

Salviati, Marquis Corsi, Florence; *Conophallus Titanum, Heterospathe elata, Musa sumatrana*.

Reichenbach, Prof., Hamburg; *Calla palustris, Polygonatum latifolium, Salvinia natans*.

Smet, Louis de, Ghent; succulents, ferns, &c., *Anthurium Laucheanum*.

Todaro, Prof., Palermo; seeds of trees, shrubs, &c.

Van Houtte, Louis, Ghent; *Cycas Boddami, Encephalartos Ghellinckini, Macrozamia Perowskiana*, &c.

Van Volxem, J., Brussels, *Berberis quindiuensis, Carica erythrocarpa*, true "Lacquer Tree" from Japan.:

Wendland, M. A. L., Hanover; new and choice palms, aroids, &c.

III. Asia.

Aitchison, Dr., Afghanistan; collections of seeds of trees, shrubs,

Baker, Sir S., Cyprus; seeds *Smilax* sp.

Beck, J., Cashnere; seeds of Indian trees, shrubs &c.

Brandis, Dr., Madras; seeds *Thamnocalamus spithiflorus*.

Bushell, Dr. S. W, Peking; fruit of *Pistachia sirensis*, and of *Cratœgus pinnatifila*, from which a delicious sweetmeat is made by the natives.

Cattell, Surgeor-Major, 10th Hussars; seeds *Pnus* sp. n., Afghanistan.

Cooper, W. N., Ningpo; seeds of "Pai-Cha" (*Euonymus* sp.).

Collett, Major H., Afghanistan; seeds of *Buddleia* sp.? *Dionysia tapetodes*.

Duthie, J. F., Salarunpore; seeds of *Euchlana luxurans*.

Ellis, R., Forest Dept., Punjab; seeds of trees and shrubs with Native names, am of *Trillidium Govanii*.

Ford, C., Hong Kong; many packets of seeds, including those of *Nymphœa pygmœa Phœnix Hanceana*, *Symplocos œcora*, Japanese Gourd (*Luffa* sp.),&c.

Gammie, J., Darjeeling; *Also-phila Oldhamii*, sp with branching habit, *Arisœmas* and other aroids; seeds of *Pandanus inguifer*, *Chirita* sp., *Impatiens*, &c.

Hance, Dr. H. Hong Kong; seeds of *Zingiber carallinum*, Hance sp. n.

India Office, Ward's case of *Arracacha esculenta*.

King, Dr., Calcutta; Ward's case containing *Areca* sp., *Calamus* sp., *C. latifolius, Caryota* sp., *Korthalsia* sp., *Myristica longifolia, Talauma Hodgsoni*, &c., *Nipa fruticans*, seeds of *Chirita dimidiata, Euryale ferox, Hodgsonia heteroclita, Styrax serrulata*, various palm seeds, box of bulbs, rhizomes, &c., *Begonia Josephi, &c*.

Murton, H. J., Singapore; two Ward's cases containing *Durio zibethinus, Dipteris Horsfieldii, Davallia* sp., *Phyllagathis rotundifolia, &c*.; Ward's case of "*Gutta Susu*" or "*Singgarip" Faradaya papuana*, seeds, &c.

Rama Varnia, First Prince of Travancore; seeds of *Areca Dick-soni*, &c.

Scheffer, Dr., Buitenzorg; *Orania macroclada, Polypodium Dipteris;* seeds of *Kentia costata* and other palms.

Scott, J., Calcutta; seeds of hybrid Date palms.

Thwaites, Dr., Ceylon; box of *Dendrobium McCarthiæ, D*. sp. *Monochilus regius, Sonerila robusta, Cinchona* seeds, &c.

IV. Africa.

Ayres, C., Cape Town; *Disa grandiflora*, large bulb from Walwich Bay; various other Cape bulbs.

Barkly, Sir Henry; *Hoodia* sp.

Bolus, H., Cape Town; seeds of *Protea cynaroides*, &c., *P*. sp.

Home, J., Mauritius; Ward's case of ferns, small palms, &c., various palm seeds.

Hutton, H., Beaumont; seeds of *Strophanthus* sp.

Kirk, Dr., Zanzibar; three Ward's cases containing *Euphorbia* sp., *Hypoœis villosa*, seedling and other Landolphias, *Meyenia* sp., *Keramanthus Kirkii, Musa Living-stoniana, Actiniopteris radiata, Pellœa Doniana* and other ferns, *Aroideœ, Chlorophytum macro-phyllum, Angraecum* sp. and other orchids; seeds of *Landolphia*.

Lanyon, Col.; seeds of *Baobab* from Transvaal.

Letourneux, M., Alexandria; Egyptian bulbs, *Allium subhirsutum, Bellevalia* sp., *Muscari* sp., *Lep-topetium alexandrinum*.

Lyle, W. B., Natal; *Eulophia* sp., *Disa polygonoides*, &c.

McOwan, Prof., Somerset East; various seeds, stupelias, and aloes, *Olinia cymosa*.

Ohlson,—, Damaraland; seeds of "Narras" (Acanthosicyos).

Perry, W. W.; orchids from Pemba Island, *Boucerosias*, seeds of *Canavalia obtusifolia, Mucuna pruriens*, &c.

Tidmarsh, E., Grahamstown; various seeds.

Wilson, Rev. C. S., Uganda, Central Africa; seeds of wild coffee, *Loasa* sp. and "Bombo" (native name).

Wilson, J., Port Elizabeth; tubers of *Herschelia cœlestis*.

Wood, J. M., Natal; seeds of *"Gerrardanthus."*

V. New World.

Austin, Mrs. R. M.; Californian seeds.

Booker, W. L., H.B.M. Consul, San Francisco; seeds of *Brahea*.

Department of Agriculture, Washington; various seeds, including those of *Prosopis juliflora*, Early Minnesota amber *Sorghum*, &c., seedling *Abies*, &c.

Ernst, Dr., Caracas; seeds of the "Cow tree," *Brosimum galactrodendron*, "Caricillo" (native name), *Ipomæa muricata, Menispermacearum*, gen. now., *Smilax* sp. n., real Caracas sarsaparilla, *Solanum Karstenii*, &c.

Espeut, W. B., Jamaica; seeds of *Aristolochia gigas*.

Gabb, F. E., Honduras; box of orchids, bromeliads, &c., *Anthurium tetragonum?*

Imray, Dr., Dominica; Ward's case of plants, including *Blakea, trinervia, Costus* sp., &c.

Jenman, G. S., Jamaica; Ward's cases of ferns, &c., including *Acrostichum pallidum, Asplenium hastatum, A. myriophyllum, Gymnogramma schizophylla, Hemionites pinnata, Lygodium volubile, Nephrodium hastatum, N. Jenmani*, var. *setosum, Rhipidopteris peltata, Polypodium hastæfolium*, &c.; various palm and other seeds, including those of *Victoria regia*; six casks of Mahogany seeds, box of *Orchids*, &c.

Laffan, Major-Gen. Sir R. M., Bermudas; *Adiantum* sp., *Aspleniums, Nephrodium bermudianum*, Baker sp. n., *Polypodium taxifolium, Pteris heterophylla*.

Prestoe, H., Trinidad; Ward's case containing *Bertholletia excelsa, Caryoear nuciferum, Dipteris odorata, Hemionitis cordata, Hevea pauciflora, Hyospathe pubigera, Maranta* sp., *Myristica fatua, Schizæa trichomanes*; two boxes of orchids; various seeds, including those of *Attalea Cohune, Simaba Cedron*, &c.

Portella, Dr. F., Rio de Janeiro; Ward's case containing *Citrus* sp., Cipo-bravo" or "Cruzeiro" *(Bignonia* sp.?), *Costus* sp., "Pa-coba" (*Amomaceæ*), &c.

Sargent, Prof. C. S., Harvard; large collections, including seeds of many choice trees, shrubs, &c., two large cases of seedlings of rare *Abies, Pinus*, &c.

Wittig, E., Rio de Janeiro; seeds of *Cæsalpinia ferrea* (Iron Wood).

VI. Australia and New Zealand.

Bernays, L., Brisbane; box of cycads, orchids, seeds, &c.

Colonial Museum, Wellington; seeds of Australian shrubs.

Corrie, A., Eastney; seeds of *Melaleuca nodosa* (Tea tree), *Lophostemon australe, Smilax glycyphylla* (Sarsaparilla vine).

Field, H. C., Waganui; *Asplenium trians, Hymenophyllum scabrum, H. dilatum*.

Hill, W., Brisbane; Ward's case containing sugar canes with local names, *Antidesma Dallachiana, Bignonia Turneri, Bowenia, Faradaya splendida, Ficus Cairnsi, Milletia megasperma*, two large stems of *Catakidozamia MacLeayi;* seeds of cycads, *Eucalypti, Areea Aliciæ*, &c.

Johnson, A. F., Christchurch; *Gleichenia Cunninghamii*.

McKelvie.—., through Dr. Allman, New Zealand; seeds.

Moore, C., Sydney; Ward's case of palms, &c.

Mueller, Baron F. von, Melbourne; many packets of seeds, including those of choice *Eucalypti, Claytonia* sp., *Gossypium australe, Glyptostrobvs heterophyllus* (Chinese swamp pine), *Ipomæa Daven-portii, I.* sp., *Neptunia monospermy, Verticordia grandis, &c*.

Schomburgh, Dr., Adelaide; seeds of *Eucalypti, Gossypium Sturtii*, &c.

Supply of Specimens for Science and art Department, &c.

A supply of plants for the Art schools, and for the examinations in botany of the Science and Art Department, have been regularly furnished. A large number of specimens of flowering plants, as well as other botanical materials, have been supplied for the various examinations of the University of London.

Indian and Colonial Botanic Gardens.

The following botanical appointments have been made by the Colonial Office, on the recommendation of the Director:—

H. Trimen, M.B. Lond., F.L.S., Senior Assistant in the Department of Botany, British Museum, to be Director of the Royal Botanic Gar-den, Ceylon, in the place of Dr. Thwaites, C.M.G., F.R.S., who retires on a pension, with the title of Honorary Government Botanist.

D. Morris, B.A., Trin. Coll. Dub- lin, F.G.S., Assistant Director of the Royal Botanic Garden, Ceylon, to be Director of the Botanical Department, Jamaica.

H. Marshall Ward, Scholar of Christ's College, Cambridge, to be employed for two years as cryptogamist, in the investigation of the Coffee-leaf disease in Ceylon. He will be subordinated to the Director of the Botanic Garden, and will have the use of the Assistant Director's house.

G. S. Jenman, Superintendent of the Botanic Garden, Castleton, Jamaica, to be Superintendent of the Botanic Garden, Georgetown, Dememra.

G. Syme, late foreman in the employ of Messrs. W. Barron & Son, Borrowash, Derbyshire, to be Superintendent of the Botanic Garden, Castleton, Jamaica, in the place of G. S. Jenman.

J. Waby, Gardener, Botanic Garden, Trinidad, to be Head Gardener, Botanic Garden, Georgetown, Demerara.

T. B. Songer, in the employ of the Royal Gardens, to be Gardener, Botanic Garden, Trinidad, in the place of J. Waby.

The following appointment was also made by the India Office, on the recommendation of the Director:—

R. Pantling, in the employ of the Royal Gardens, to be Gardener in the Sikkim Cinchona Plantation.

Select Notes from Official Correspondence.

Candelillo.—

In the Kew Report for 1877 (p. 29) reference is made to a disease of the coffee plant, which is known in Venezuela under this name, in the following terms:—"The young twigs and the under surface of the leaves are densely covered by a white felted mycelium, strings of which appear to pass from the former to the latter. Professor Ernst has accordingly proposed for it the name of *Erysiphe scandens*. The Rev. M. J. Berkeley remarks that it is similar in appearance to the 'leaf rot.' of Mysore, which is produced by a distinct fungus, *Pellicularia Koleroga*, Cooke *(see* Kew Report for 1876, p. 20). It is possible that the disease mentioned as having occurred in Jamaica may be identical with the Candelillo."

Professor Ernst has forwarded to Kew copious specimens of diseased coffee leaves affected with this fungus, and these have been care-fully examined by Dr. Cooke, who independently confirms Mr. Berkeley's suggestion as to its identity with the Koleroga. Professor Ernst referred the fungus in Venezuela to the genus *Erysiphe* with doubt. Dr. Cooke reports:—"I have carefully examined the leaves. I found in some cases, plentifully, the globose rough spores of the *Pellicularia* on short branches or pedicles, the latter remaining persistent, after the fall of the spores. The habit and character of the mould is entirely different from *Erysiphe*, which latter is always more or less pulverulent, and never, as far as I am aware, are the threads connected into a stratum by a gelatinous film. Neither is the action upon the leaf at all similar in its destructive character to the Koleroga. Although the stratum is thinner, and much less dense than in Mysore specimens, the character is the same, and so characteristic are the features which the threads present (an unusual occurrence in fungi of this kind; that I recognized under the microscope the identity of this with the Koleroga. From the character of the threads, apart from all other evidence, I should doubt its ultimate development into an *Erysiphe*."

The occurrence of a parasitic fungus of a very specialized type in coffee plantations, both in the Old and New World, is a somewhat remarkable circumstance. It is, however, possible that it has been introduced into Mysore from South America or the West Indies.

Dominica Pimento.—

Dr. Imray writes:—"Mr. Thiselton Dyer has informed me that the species of *Pimento*. sent to Kew is not *P. acris* but *P. officinalis*. I was not aware that we had two species of this tree in the island until pointed out by Mr. Dyer; such is the case, however. I find them very distinct on examination, and the people of the island who are acquainted with our forest trees are aware of the fact. *P. officinalis* is, I suppose, the same as *P. vulgaris* of Griesbach. No doubt this is the species that produces the Jamaica pepper of commerce, and unfortunately it is the leaves of this species that are selected for the distillation of bay oil (although both kinds are used) of which I spoke in one erf my letters to you, part of which has been transferred to the pages of the Kew Report. Nearly all the northern district of the island is already exhausted of these leaves, which means that most of the trees have been destroyed. It is not only the Crown lands that are thus denuded of a valuable timber tree, the seeds of which might also be turned to account, but private property is invaded, the bay-leaf gatherers not being very particular about boundaries. It is to be regretted that the Government of the colony does not interfere to prevent the wholesale waste of this most useful tree."

Food-products.—

1.*Arracacha*.—

The Indian Government are desirous of introducing this esculent vegetable into India. *Arracacha. Esculenta* is cultivated in the cooler mountainous districts of South America, where the roots form the staple diet of the inhabitants. Steps have been taken at Kew (where plants are now growing) to procure the seed, and as success in cultivation appears to depend on the method of treatment, I place on record here some particulars obligingly communicated to me by Mr. Henry Birchall, of Bogotà.

About 6,000 feet is nearly the upper level of any extensive cultivation of this plant, though it produces at points a good deal higher. It is rather difficult to obtain the seed, as from habit the peons invariably pull up the flowering plants, as they do not produce the edible root. I have several times missed getting the seed by the stupidity of the men who weeded the plantations.

As regards cultivating from seed, my own experience is *nil*; but my neighbours assure me that by repeated replanting of the young plants at last the roots are developed.

When this is attained the plant throws out a multitude of shoots from the crown. These being broken off are prepared by slicing the base neatly and then putting them in a hole dibbled about 5 or 6 inches deep, and require no further care than ordinary weeding, for which the rows and plants should be 3 feet apart.

"In our climate the root conies to perfection in eight to ten months, and the weight of a good specimen will be 8 to 10 lbs. No doubt if scientifically cultivated, and in properly loosened soil, much larger roots would be obtained. We do not even plough, but stick the seed in immediately after burning off the forest or the brushwood, as the ease may be. It is cheaper to take new ground then to cultivate properly the old, as we have no command of skilled labour or good apparatus."

2. Chestnut-flour.—

We are indebted to Mr. D. E. Colnaghi, H.B.M.'s Consul at Florence, for specimens of the dried chestnuts, flours, and *necci* (the cakes made from them), which are so important an article of subsistence in the Apennines. The collection of the specimens for Kew was due to the kindness of Dr. L. Bacci, of Castigliano, in the mountains of Pistoja.

The fresh chestnuts are dried, or rather roasted, for three days and nights in a *seccatoio*, or drying room, on a latticed floor covering a chamber in which a fire is lighted. The husk is then easily removable, and the kernel is ready to be ground into flour, which is of a pinkish colour. This is mixed to the consistence of cream with water, and poured on fresh chestnut leaves to be baked into small circular cakes, *necci*, between heated stones.

The collection having been divided between the Museum of the Royal Gardens and the Food Collection, Bethnal Green, Professor Church, who has charge of the latter, has obligingly furnished us with the following analysis of the flour:—

The cakes were found to contain only 6.7 per cent, of proteids, with 3.4 per cent, of flour. The large amount of dextrin is due to the high temperature to which the chestnuts are subjected in the process of drying. Professor Church thinks that chestnut-flour ought to be of easy digestibility, and a suitable children's food, considering that it contains over 40 per cent, of nutritious matters soluble in pure water.

3. Thé de Montagne.—

The Museum of the Royal Gardens is indebted to Mr. George Maw for a specimen of a product used, according to the Rev. Wentworth Webster, who procured it, as tea in the Basses Pyrenées in France, and on the Spanish side of the Pyrenees in Navarre. It was found to consist of the dried shoots of a species of *Lithospermum*, which was identified with probability as *L. officinale*.

Paper Materials.—

1.*Bamboo*.—

The energy and persistence with which Mr. Routledge has advocated the claims of bamboo as a paper material have attracted much attention in India. The nature of the problem which has to be solved has been discussed in previous Kew Reports (1877, pp. 35, 36, and 1878, pp. 42 to 44), and need not be further dwelt upon. It is now generally conceded by those interested in the matter that the young bamboo shoots must be cropped so as not to impair the vitality of the clumps. Dr. King, Superintendent of the Royal Botanical Garden, Calcutta, remarks that the plan of taking a few shoots annually from each clump is the principle on which bamboos have been cut in India from time immemorial.

That without such caution the bamboo cannot be cut indefinitely, even in countries where it is merely used for local purposes, is shown by the fact that in the Government forests in India it has been found necessary to give the bamboos rest. For example, Dr. Brandis, Inspec-tor-General of Forests, states in his recent report that "in some forest tracts of the Damoh district the growth of the bamboo had been so greatly restored by four years protection against cutting that it was lately found possible, subject to certain restrictions, to reopen these blocks for the cutting of bamboos. Dr. King lays down very clearly the questions which now remain to be settled. They are whether commercial success can be obtained (1), by forming plantations of bamboos for the collection of succulent shoots; (2), by collecting the immature shoots of wild bamboos in the forests and carrying them to a paper factory; or (3), by fitting up a floating paper stock mill and moving it about on rivers by the banks of which bamboos naturally abound."

2. Broussonetia papyrifera.—

The bark of the well-known paper mulberry supplies the material from which the tappa cloth of Polynesia and the bulk of the paper of Japan and China is manufactured. The Japanese cultivate the plant very much in the same way that we grow osiers, and they use only the young shoots for the manufacture of paper. A sample of the bark which came into the hands of Mr. Routledge is stated by him to be nearly, if not quite, the best fibre I have seen." . . "I must admit it is even superior to bamboo." . . "It requires very little chemicals, and gives an excellent yield 62.5 per cent, in the grey, *i.e.*, merely boiled, and 58 per cent bleached."

3. Esparto.—

It is evident from the mode in which this grass (*Macrochloa tenacissima,* also known as Alfa) is collected in Mediterranean countries that the supply must eventually materially diminish, if it does not altogether die out. It grows sporadically in strong ground under conditions which do not admit of any steps being taken for its cultivation. Mr. Routledge writes in the early part of last year:—"I have just had two large cargoes of Alfa from Tripoli, and the rapid deterioration of this comparatively new district is striking; the grass when first it was introduced was long and strong; now some of it is as fine and short as the shortest Spanish. I have a quantity varying from 6 to 10 inches only. It is the inevitable result of overcropping."

Esparto is consequently becoming relatively scarcer in the market, while its price is rising. Paper manufacturers arc therefore anxiously on the look-out for some material equal in quality to esparto and procurable with as much facility, and at as reasonable a price as esparto was when first introduced.

4. Guadua.—

The giigantic bamboos of the Old World belonging to the genera *Bambusa* and *Dendrocalamus* are represented by those belonging to *Guadua* in the tropics of the New World. In order to ascertain how far a supply of this kind of bamboo would be available, Mr. Routledge and some other gentlemen interested in the matter sent Mr. Thomson (late Superintendent of the Cinchona Plantations, .Jamaica) on a mission to Venezuela, to explore the bamboo forests. The species met with by Mr. Thomson appeared to be *Guadua amplexifolia*. He reports:—This guadua grows about the same size as *Bambusa vulgaris*, viz., from 50 to 60 feet in height, with culms 5-6 inches in diameter. The latter are much thicker in texture than the bamboo stems, and their fibrous tissue is much tougher, so that much more labour is required to cut them down than in the case of the bamboo. And this applies equally to the young stems, *i.e.*, young shoots of bamboo, say 10 feet high, are easily cut with a knife, but each stem of guadua of a corresponding size and expansion requires more than one blow from a sharp axe."

The bamboo (guadua) forest over large extents of country is generally of the same age, and consequently the plants flower and die simultaneously, a circumstance which only happens after protracted intervals, but which when it does happen is succeeded for a time by an almost total disappearance of the plant. This had happened in Venezuela about the time of Mr. Thomson's expedition and Mr. Routledge informs us: "I regret to say that I do not, see much inducement to proceed with the undertaking I proposed. To do so would involve laying out regular plantations, and having regard to the uncertain political condition of the country, the difficult and dear labour, and some other drawbacks, the prospect of commercial success is not sufficiently tempting for me and my friends to embark in the undertaking."

5. Indian Forest Fibres.—

The important collection of Indian forest products transmitted to Kew by the Indian Forest Department (*see* Kew Report, 1878, p. 50) included an extensive series of bark fibres. Specimens of all these were placed in the hands of Mr. Routledge, of the Ford Works, Sunderland, to whom Kew is under constant obligation for information and assistance in connection with the paper manufacture. He was good enough to test them all as regards their yield when converted into rough (paper) stock, and he has furnished us with the following report:—

Of these fibres, No. 1 is decidedly best, possessing the characteristics of strong linen rags, *i.e.*, of coarse flax and hemp; the raw bark is worth *7l.* to *8l.*, possibly *9l.*, per ton; the bleached stock 20*l.* to 22*l.*

"No. 7 is the next best bark, worth 6l. to 7l. per ton raw. None of the others are of much value for white papers, excepting, perhaps, Nos. 5 and 9; say 5l. to 7l. for No. 5, and 5l. to 6l. for No. 9. It would, however, be necessary to make a practical working trial, that is, to make paper from all of them (excepting No. 1) before pronouncing positively as to value. No. 1 I believe fully worth what I have appraised it at."

"All of these raw barks required a very large dose of bleach to bring them to even the low colour they are. No doubt opening them out by willowing or teasing them, both before and after boiling, would materially improve them. I do not consider, with the exception of Nos. 1 and 7, it would pay to import them from India."

6. Molinia cærulea.—

The proposition of using this common British grass for the purpose of papermaking was mentioned in the Kew Report for 1878, p. 45. Mr. N. G. Richardson, of Tyaquin, county Galway, has since actively promoted its experimental cultivation in the west of Ireland. At a private meeting held at Athenry a committee was formed to raise subscriptions to plant ten Irish acres of bog with it at Tyaquin. Mr. W. Smith, of Golden Bridge Mills, had manufactured paper from this grass, with which he was so well satisfied that he was prepared to buy 1,000 tons if any one would supply him."

7. Portuguese esparto.—

A grass sent for identification by Mr. Routledge under this name was determined to be *Stipa capillata*. He informed us that it would make paper, but that the yield of fibre was not even equal to straw, say 33 per cent.

8. Rye-straw.—

The claims of rye-straw (*Secale cereale)* have been urged as a paper material by Mr. Noble. It has the prima facie merit of being a home-grown ma-terial. Mr. Noble says:—"Rye (not 'rye-grass') should be sown early in October, so as to be cut green in May and June, in time to get the land clear for turnips and other vegetables. I have found it best to sow four bushels per acre for the purpose of getting a heavier crop, stifling the weeds, which would be injurious to the purpose for which it is intended; and the thinner and longer the stems are grown the more fibre they produce."

Mr. Noble believes that rye-straw will make paper not inferior to that made from esparto, and that papermakers can afford to give a price for it which will be sufficiently remu-nerative to the farmer to grow it.

Mr. Routledge remarks upon the proposal to use it:—"It is very largely used in the States, also on the Continent. It will make a harder and firmer paper than any other cereal straw, except, perhaps, maize."

Razor-strops.—

1.*Agave americana*.—

H.E. W. Robinson, the Governor of the Bahamas, sent to Kew for report specimens of "perpetual razor-strops," which were apparently cut from the dried flowering stem of this plant. On inquiry in London they were not found to meet with much favour. They, however, afforded a striking instance of Governor Robinson's determination not to overlook the development of any product of the colony he administered, however apparently insignificant. I may add that a razor-strop of this material imported from Peru, now many years ago, was in daily use by a member of my family for a very long period, and highly approved of.

2. Herminiera elaphroxylon.—

We are indebted to Messrs. Thomas Christy and Co. for a sample of a similar article, of which the opinion was more favourable, and which was apparently made from the wood of the "Ambash" (*Herminiera elaphroxylon)*, the curious pith-wood of the Nile. It has the advantage of being obtainable in larger pieces than Agave stems, and can, therefore, be cut into strops with a more uniform texture. According to Colonel Grant it may be obtained in abundance. He informs me that in three years it almost choked up the channel of the Bahr-el-Gazelle," and the natives use its light logs to assist them in swimming across rivers.

Textiles.—

1.*Bunkuss*.—

In the Bengal Catalogue of Indian products shown at the London Exhibition of 1862 (Section I., pp. 137, 168) mention is made of a grass known by this name, which grows in the Terai, and is used in N.W. India for making ropes. A specimen sent to Kew from Saharunpore, for identification, by Mr. Duthie, proved to be *Spodiopogon angusti-folius*. Mr. Duthie states that it is also known under the name of Baib grass, and he has furnished the Kew Museum with an interesting series of articles made from it, including, besides rope, shoes, door-mats, floormatting, and a lota-holder for draw-ing water from a well.

2. Curculigo latifolia.—

The Kew Museum is indebted to Mr. F. W. Burbidge (now Curator of the Trinity College Botanic Garden, Dublin) for a very complete series of specimens illustrating the manufacture of cloth in Borneo (where they were obtained by him during his travels) from a species of *Curculigo*, which has been identified by Mr. Baker with *C. latifolia*, Dry-and. The Dusan in N.W. Borneo, near Kina Balu, prepare the fibre by macerating and beating the leaves. It is woven into a very close cloth, about ten inches wide, in a loom of very simple construction, such as is used in Brittany for weaving saddle girths. A heavy wooden sword is used for driving close the woof after it is thrown by the shuttle between the threads of the warp. The strong fibrous leaves of *Curculigo seychellensis* are employed in the Seychelles for wrapping plugs of tobacco (Baker, Flora of Mauritius, p. 368), and this is apparently the only other known instance of the economic use of a hypoxidaceous plant.

3. Ningpo hats.—

In a Foreign Office Report on the trade of Ningpo (Commercial Reports, China, No. 7 (1878) pp. 113, 114), Mr. W. M. Cooper, H.B.M. Consul at Ningpo, referred to these hats as follows:—The export of hats woven by hand from a small species of *Carex* (sedge) has grown within three years to great proportions, no less than 15,000,000 having this year been exported. The plant is indigenous, and is to be found in damp spots among the hills, but that employed for the manufacture is cultivated in rice grounds. The hats are made by the women and children at their homes, and sold by them at ½*d*. to 2*d*. each. They are strong and serviceable, and are bought wholesale by the foreign merchants, who send them to London, whence, I believe, they are shipped, principally to the Southern States of America." These hats were very abundant in London last year, and we thought that specimens obtained for the Kew Museum were made of some kind of rush. Mr. Cooper, has, however, obligingly sent us a specimen of the plant actually used for the purpose, which proves to be identical with that from which China matting is made, and which Dr. Hance has determined to be *Cyperus tegetiformis*, Roxb. The only difference is, that in making the hats the culms are used whole, while for matting they are split into two.

Woods and Timbers.—

1.*Eagle-wood*.—

The gradual extermination of this tree (*AquilariaAgallo-chum)* in the islands in the Mergui Archipelago was pointed out in the Kew Report for 1878, p. 36. Major Seaton reports that 200 seedlings have been procured and planted out in South Tenasserim.

2. Lin-a-Loa.—

Our attention has been drawn to a scented wood used in San Francisco in the manufacture of furniture. By the kindness of Mr. W. L. Booker, H.M.'s Consul in that city, a specimen of the wood and a box lined with it have been obtained for the Kew Museum. Mr. Booker states:—"It comes in pieces about the size of a railroad sleeper from the highlands, of Mexico, but I have been unable to ascertain what it is botanically. The wood is only used for veneering or in the manufacture of small fancy articles."

We had no difficulty in identifying Mr. Booker's specimens with a wood which already existed in the Kew Museum, and which appears to be yielded by a species of *Bursera*. It has indeed been known in Mexico for the last half century, and was referred to by Guibourt under the name, of *Bois de Citron du Mexique [see* Journal of the Pharmaceutical Society, 2nd series, Vol. X., pp. 590-593]. Further material in the shape of dried specimens, with both fruit and flowers, is much to be desired for the purpose of ascertaining definitely the tree which produces it. The name Lin-a-Loa is clearly a corruption of Lign Aloës, which has been identified with *Aquilaria Agal-locha*, otherwise known as Eagle-wood [Kew Report, 1878, p. 36]. This is, however, a tree confined to the Old World, and the Mexican one has no connection with it. The wood of the latter is imported into this country for manufacture into perfumery, a fragrant oil known as otto of linaloe being distilled from it.

3. Nan-mu Tree.—

Reference has already been made, in the Kew Report for 1877, p. 33, 34, to this interesting Chinese timber-tree. Through the kind intervention of E. Bradford, Esq., F.L.S., Deputy Inspector-General of Hospitals, Mr. Arthur Davenport, H.B.M.'s Consul at Shanghai, made inquiries with a view to obtain better botanical data for its determination. He obtained the following informaton from Mr. Baber:—Two days journey southeast of Chungking, in Szechuen, I found several specinens of about a foot in diameter, one of them having a straight branchless trunk of 100 feet in height, with the branches and foliagerising 25 feet above that; anothernad 70 feet of bare straight stem, and 90 feet of total altitude. Although the trunks are branchles, yet in many cases they send out shoots resembling saplings, which rise parallel with the trunk. The wood is white and close graned, and I do not believe that the pillars at the Ming tombs near Peking are of this wood. They look more like true teak. I have seen some much larger trees than the above, some two feet and more in diameter, straight and of great altitude. They are used in Szechuen for bridge work. I alnost despair of procuring the flows, for people who have spent ther lives beneath the trees have never seen them in flower, and the young trees which the missionaries have planted in places do not flower, possibly on account of their youth. If the tree produces any noticeable flowers at all it must be on the summit, which is inaccessible."

Eventually, however, through the instrumentality of Père Vincot, who resides at Chungking, flowering specimens were transmitted to the Kew Herbarium. From these the accompanying figure has been pre-pared, and they entirely confirm the previous identification of the tree by Professor Oliver (from the leaves alone) as a near ally of *Phœbe pallida* (one of the Laurel family). The genus *Phœbe* is now merged in *Persea*, and Professor Oliver has described the Nan-mu under the name of *Persea nan-mu*, distinguishing it from *Persea (Phœbe) pallida* chiefly in stature, in the form of the acumen of the leaves, and the character of the indumentum."

4. Pai-cha wood.—

We are indebted to Mr. W. M. Cooper, H.B.M. Consul at Ningpo, for a block of this wood *(see* Kew Report, 1878, pp. 41 and 42), and a carving showing the extremely delicate work of which it admits. The wood was placed in the hands of Mr. R. J. Scott for report. He informs us:—"The most striking quality I have observed in this wood is its capacity for retaining water and the facility with which it surrenders it. This section, which represents onetenth of the original piece, weighed 3 lbs. 4½ ozs. At the end of 21 days it had lost 1 lb. 6¾ ozs. in an unheated chamber. At the end of another 14 days, in a much elevated temperature, it only lost ¼ oz. In its present state of reduced bulk, its weight is 1 lb. 10 ozs. It is not at all likely to supersede box; but it may be fit for coarser work than that for which box is necessary."

5. "Rhus Thunbergii."—

We were indebted to Mr. II. Hutton, of Albany, S. Africa, for a quantity of seed of the plant sent and distributed under this name (Kew Report, 1877, p. 20). It is, however, no species of *Rhus*, nor is it allied to that genus, and was supposed to be *Sideroxylon argenteum* (of which *R. Thunbergii is* a known synonym). Having some doubt about the identification, he has sent us specimens, and it is clear that the seeds distributed do not belong to *Sideroxylon argenteum (Rhus Thunbergii)* but to *Sideroxylon inerme*. Mr. Hutton writes:—It is the white milkwood of the Cape, of which I have sent the seeds, our most durable hard wood, and we are fencing extensively with it for standard poles."

Mr. Duthie reports from Saharunpore:—Seeds received from Kew last year (1878) were sown in April, and took one month to germinate; the growth since has been slow, but the plants are perfectly healthy."

MUSEUMS.

The principal objects received during the past year have been:—Towards the end of the year the vast accumulated collections of vegetable products and matters relating to them were transferred from the department of the Secretary of State for India to the First Commissioner of Works, and deposited at Kew under conditions which were still under consideration at the end of the year. Arrangements are being taken for the disposal of the whole by intercalation with the existing collections at Kew, and by distribution of the duplicates.

Aitehison, Dr.; twenty specimens of vegetable products from Afghanistan.

Barclay, Gray, and Co.; samples of Sketch of Persea Nanmu, Ohv. oil-cakes from *Elæis guinccnsis* and *Cocos nucifera*.

Barrow Flax and Jute Company; specimens of Kalameit tapestry made of jute, also jute yarns.

Bradford, E.; fruits of Manchurian jute (*Abutilon Avicenniæ),* portions of plant of Manchurian indigo (*Polygonum tinctorium),* and leaves of Nan-muh tree.

Burgoyne, Burbidges, Messrs., & Co.; a collection of forty samples of drugs of vegetable origin, specimens of thymol prepared from *Ptychotis Ajowan* and menthol from Chinese oil of peppermint.

Canto, Don Jose da; sample of tea grown and manufactured at St. Michael's, Azores.

Carter, James, & Co.; eighteen specimens of forage grasses.

Chantre, C.; double Lisbon Copal, oil of Japan mint *Mentha ar-vensis),* and other specimens.

Christy, T.; various new com-mercial vegetable products.

Clark, J. & Co.; specimens of birchwood illustrating the manufacture of spools or reels.

Cooper, W. M.; (Ningpo) wood of Pai-cha (*Euonymus* sp.) used for carvings, frames, cabinets, &c., also carving in same wood representing opium smokers.

Cordua, Carl; seeds of four species of *Lupinus*.

Ducie, Earl; fruits of cherry plum *(Prunus cerasifera*, Ehr.).

Fry, J. S., and Sons; seeds of the various kinds of cocoa (*Theobroma Cacao)* known in commerce; also samples of prepared cocoa.

Fryer, John; samples of Poo-urh tea from Yunnan.

Gamble, J. S.; seventeen speci-mens of Indian woods.

Gardner, Joseph, and Sons; Cornel wood used for making bobbins for flax spinning, and specimens of the bobbins; also specimens of Caucasian box-wood, with "bushes" for "bushing" the ends of cotton and woollen bobbins.

Glasgow, City Industrial Museum; ancient hand quern, formerly used for grinding oats, from N. of Ireland.

Henriques, J.; basket made of *Juucus* sp. by peasants in neighbourhood of Coimbra; straw hat and straw veneered box made by pri-soners at Oporto; samples of various kinds of toothpicks made at Coimbra, and wood of *Salix* sp. used for making the same.

Home, John; trunk of Fiji Island sandal wood (*Santalum Yasi*, Seem.).

India Museum; its entire collec-tion of raw products of India.

Jenman, G. S.; caudices of *Cyathea Nockii*, pods of *Pithecolobium Saman*, fruits of *Grias cauliflora*, &c.

St. John, Spencer; fruits of Cherimoyer (*Anona Cherimolia)* from Lima.

Macfarlane, J. F., Edinburgh; seven samples of Opium alkaloids, specimens of Salicin and Bibirine sulphate.

Manning, Collyer, and Co.; five specimens of foreign-made hats of various vegetable fibres.

Ormcrod, Miss E.; various mor-phological specimens.

Parry, C. C.; vegetable products from Mexico.

Protector Fluid Co.; specimens of raw and boiled Gum euphorbium, and sample of anti-corrosive paint prepared from the gum, used for painting ships' bottoms.

Robinson, His Excellency Go-vernor; tobacco grown and cured in the Bahamas, and cigars made from the same.

Ross, Mrs.; specimens of flour of chestnuts (*Castanea vulgaris*), and cakes made from the same, Tuscany.

Routledge, T.; specimens of paper-stock prepared from barks of various Indian trees.

Sargent, C. S.; specimens of coniferous woods.

Senier, Harold; "Loofah" flesh-brushes *(Luffa ægyptiaca)*.

South Kensington Museum; twelve specimens illustrative of food and tobacco selected from Bethnal Green Museum.

Treutler, Dr.; specimens of wood and bark of *Quercus Robur,* var. *pedunculata,* showing arrested branchbuds.

Trevelyan, Sir W. C.; excrescence on trunk of ash tree. Result of the injury of the young stem by the larvae of *Prays Curtisellus*.

Physiological Laboratory.

The principal researches con-ducted in the Laboratory during the past year have been those of—

H. Marshall Ward, on the Development of the Embryo-sac, published in the Journal of the Linnean Society, vol. xvii., pp. 519-546.

Prof. Church, continued Investigation on Albinism in Leaves, published in the Journal of the Chemical Society, January 1880.

The Laboratory has also been employed for the experimental demonstrations given to the employes of the Royal Gardens, *see infra*, p. 5, and for the examination of the University of London for the degree of Doctor of Science in the subject of Physiological Botany.

HERBARIUM.

The most important accessions to this department consist of:—A very complete set of the plants collected in Sumatra by Prof. Beccari, of Florence, presented by himself.

An almost complete herbarium of the Canadian Flora, formed by Prof. Macoun, of Belleville, the joint property of that gentleman and of the Canadian Commissioners of the Paris Exhibition.

A herbarium of upwards of 1,500 Fijian plants collected by Mr. Home, F.L.S, Director of the Mauritius Botanical Gardens, when on a mis-sion to the Pacific Islands to procure sugar-canes.

A very large collection of Mexican and South U.S. plants, collected by Dr. Parry when on a botanical expedition from Central Mexico to the United States.

A continuation of M. Glaziou's Brazilian collections (nearly 1,500 species); also of Welwitsch's West African ones, presented by the Government of Portugal; and the completion of Brown's Australian Herbarium; the British Herbarium of the Botanical Exchange Club; a very fine collection of European roses and rubi from G. C. Joad, Esq., of Wimbledon.

The principal contributors have been:—

Europe.

Bennett, A. W.; *Polygaleæ* (9).
Botanical Record Club; Herbarium of.
Cooke, M. C.; British and miscellaneous Fungi (125) (purchased).
Danford, Mrs.; Levant (18).
Fitch, W. H.; Servian (45).
Gandoger,—; *Rosæ* (411) (purchased).
Joad, G. C.; *Rosæ* and *Rubi* (420).
Henriques, J.; Portugal (107, and drawings).
Heldreich, Prof.; Greece (177, purchased).
Kunze; *Fungi exsiccati* (200, purchased).
Larbalestier; Lichens (purchased).
Sanio, Dr. C.; German (42).
Société Dauphinoise pour l'Echange; (471, purchased).
University College, London; a miscellaneous collection.
Van Thuemen, F.; *Mycotheca Universalis* (300, purchased).
Westcndorp,—; Belgian cryptogams (100).
Wittrock, V., and Nordstedt, O.; *Algæ* (100, purchased).
Vise, Rev. J. E.; *Microfungi* (100 purchased).

Various European plants have been received from Dr. Archangeli, Dr. Huntingdon (Italy), J. A. Jenner, J. O. Mansell Pleydell, H. T. Mennell, Prof. Oliver, Rev. W. H. Painter, Rev. W. Rogers, J. Sanders, C. E. Browne, Rev. W. A. Leighton, J. E. Williams.

North and Temperate Asia.

Aitchison, Dr.; collections made as botanist to the Kuram field force in Afghanistan (about 1,000).
Collett, Major H.; Afghan (81.)
Ford, Chas. S.; China and Hong Kong (108).
Markham, Capt. A. H.; Nova Zembla (80).
Perry, W. Wykeham; Scind and Persian Gulf, &c. (95).
Post, Prof.; Syria (137).

Preston, Rev. T. A.; China (22).

A few Japanese plants have been received from J. Bissett; Chinese, from E. Bradford, A. Davenport, and Dr. Hance.

Tropical Asia.

Baccari, Prof.; Sumatra (900).
Beddome, Col.; Madras Presisidency (200).
Duthie, J. F.; N.W. India (10), and drawings.
Meyer, Dr. A. B.; Riedel's Timor plants (17).
Murton, H. J.; Singapore (94).

Small contributions have been received of Himalayan plants from Robt. Ellis and J. Gamble; and of Bornean orchids, collected by F. W. Burbidge, from Messrs. Veitch.

Africa and African Islands.

Barber, Mrs. M. E.; Gold Fields (44).
Bolus, H.; Capo Restiaceæ and Ericeæ (115).
Cosson, Mons.; Letourneux's Egyptian (138).
Kirk, Dr. J.; Zanzibar and Comoro (43).
Perry, W. Wykeham; Madagascar and Comoro (15).
Schweinfurth, Dr.; Egypt, &c. (76).
Portugal, Government of; Welwitsch's African (665).
Stone, General; Purdy's Darfur (132).
Wood, J. M.; Natal (657).

Smaller contributions have been received of S. African plants from Sir H. Barkly and T. T. Chamber-lain; of Madagascarian, from Miss Gilpin; and of Liberian, from E. H. Holmes.

North America.

Curtiss, A. H.; Florida (250 purchased).
Farlow, Anderson, and Eaton; *Algæ* (30).
Macoun, J.; British N. America (2,805, partly purchased).
Parry, C. C.; Mexican and New Mexican (1,250).
Ravenel; American *Fungi* (200, purchased).

Smaller contributions have been received from Drs. Eaton and Engelmann, Messrs. Hemsley, Lemmon, Mohr, Townshend, Sereno Watson, and Miss Frances J. Myers, and (Bermuda plants) from Sir J. H. Lefroy.

West Indies.

Brace, L. J. K., communicated by H.E. Gov. Robinson; Bahamas (150).
Holme, Rev. H. K.; Montserrat (60).
Meyer, G. L.; Tobago (33).
Murray, H. B.; St. Lucia (39).
Prestoe, H.; Trinidad (10).

Central and South America.

Coppinger, Dr.; Patagonia (17).
Ernst, Dr.; Caraccas (8).
Glaziou, A.; Brazils (1,447).
Kalbreyer; New Grenada (298).
Lorentz, Dr.; Argentine Provinces (51, purchased).
Thurn, E. F. im; British Guyana.

Türckheim, Mons.; Guatemala (108, purchased).

Australasia, Polynesia, and Antarctic Islands.

Bennett, the late J. J.; completion of Brown's Australian Herbarium (1,056).
Berggren, Dr.; New Zealand (30).
Buchanan, Rev.; New Caledonia (61).
Carson, D.; Australia (9).
Cheeseman, T. F.; New Zealand (10).
Gray, Dr. A.; Kerguclen's Land (55).
Hill, Walter; Frazer's Island (5).
Home, John; Fiji Islands (1,530).
Kirk, Thos.; New Zealand (7).
Mueller, Baron von; Australia (6).

An excellent microscope has been presented to the Herbarium by Mr. B. Daydon Jackson, F.L.S.

Many engravings and drawings of plants have been presented, in augmentation of the classified collection in the Library, by Messrs. Fitch, Duthie, J. Henriques, Dr. Kirk, the Director, and the Assistant Director.

The botanical correspondence of the late W. Wilson, the eminent muscologist, has been presented by Dr. James Kendrick, of Warrington.

Mr. C. B. Clarke, F.L.S., late of the Education Department in Bengal, and for some time Superintendent of the Royal Botanical Gardens in Calcutta, has been deputed by the

Indian Government to devote three years at Kew to assisting in the publication of the Flora of British India.

BOTANICAL PUBLICATIONS

prepared, in connexion with the work of the Herbarium.

Bentley and Trimen's "Medicinal Plants," containing numerous figures of plants drawn in the Royal Garden, has been concluded.

"Icones Plantarum," vol. xiv., part, i., has been published, illustrating new and rare plants communicated to the Herbarium.

"Biologia Centrali-Americana," Botany, by W. B. Hemsley (formerly an assistant in the Herbarium). Two parts of this magnificent work, with 13 quarto plates, have been prepared in the Herbarium, and the work is being actively progressed with.

Balfour, Dr. I. B., has published in the "Philosophical Transactions," the Botany of the Transit of Venus Expedition to the Mascarene Islands, in 4th, with forty plates.

The plants collected in Kerguelen's Land, by the naturalists attached to the branch of the Transit Expedition despatched to that island, have been published, also in the "Philosophical Transactions," by the Director and other botanists, with five plates.

Mr. Elwcs has published part vii. of his folio illustrated work on the genus *Lilium*.

The 105th volume of "The Botanical Magazine" has been published by the Director, containing chiefly plants that have flowered in the Royal Gardens.

Dr. Berggren, of Sweden, who was commissioned by the Swedish Academy to explore the cryptogamic botany of New Zealand, has been collating his collections with those at Kew.

Dr. R. Braithwaite is preparing monographs of the genera and species of British mosses, and M. Cogniaux, of Cucurbitaceæ.

Prof. Trail, of Aberdeen, has been publishing in the Journal of the Linnean Society an account of his collection of Amazon Palms, which are preserved at Kew; also his remarkable collection of plants whose leaves are tenanted by tropical ants.

Mr. B. Daydon Jackson has been occupied in the Library in preparing for publication a supplement to Pritzel's "Thesaurus Literature Botanicæ."

Dr. Aitchison is actively employed by the Indian Government in working up his Afghan collections made whilst Botanist to the Kuram Field Force.

Baron von Ettingshausen and Mr. J. A. Gardner have been employed on a special study of English Tertiary fossil plants.

Mr. C. B. Clarke is engaged on a monograph of the Commelynaceæ for De Candolle's "Monographiæ Phanerogamarum," and on Indian Ferns for the Linnean Society's Transactions.

Mr. J. Horne has been engaged on the arrangement, &c. of his extensive Fijian collections.

Dr. M. Masters has been preparing the Ericeæ for the Flora Capensis.

Messrs. H. and J. Groves have been engaged on the Characeæ, with the view of publishing a complete monograph of the Order.

The "Flora of British India" by the Director, assisted by various botanists. The 6th part of this work, completing the Polypetalæ, has been published.

I have, &c.

(Signed)
JOS. D. HOOKER, *Director*,
To the Right Honourable
The First Commissioner of Her Majesty's Works and Buildings.

Appendix.

Number of Visitors in the Year 1879, *as compared with* 1878.

1878. 1879. Total number on Sundays---267,113 239,540 Total number on weekdays---458,309 329,594 725,422 569,134 Greatest monthly attendance (August)---142,963 Smallest monthly attendance (January)---4,252 Greatest weekday attendance (August 4th)---51,949 Smallest weekday attendance (January 18th)---13 Greatest Sunday attendance (July 27th)---21,909 Smallest Sunday attendance (February 23rd)---73 Number of Visitors in each month. 1878. 1879. .— January---10,134 4,252 February---14,017 5,127 March----24,338 20,515 April----110,440 51,913 May----81,426 41,538 June----140,342 112,310 July----109,357 82,587 August----134,360 142,963 September---57,491 69,654 October----30,587 23,185 November---8,194 10,501 December---4,736 4,589 Bank Holidays. April 14th--19,430 (before 1 p.m. 2,557) June 2nd--15,205 (" 1,094) August 4th--51,949 (" 3,088) December 26th-752 (" 286) [7566.—750.—10/80.]

Official Copy. Report On the Progress and Condition of the Royal Gardens at Kew, During the Year 1878. English royal crest London: Printed by George E. Eyre and William Spottiswoode, Printers to the Queen's Most Excellent Majesty. For Her Majesty's Stationery Office. Sold by W. Clowes & Son, 13, Charing Cross. 1879
Price One Shilling.

Contents.

During the Year 1878.

Royal Gardens, Kew,

January 1, 1879.

SIR,

THE number of visitors to the Royal Gardens during the past year exhibits a considerable increase over any previously reported. It is nearly 26,000 in excess of the attendance in 1874, the highest previously recorded, and 37,450 in excess of the attendance of the previous year, 1877. As in preceding years, the bank holiday in August brought the greatest crowd, though the number, 57,121, was slightly less than that, in 1877, not-withstanding that the Gardens were opened three hours earlier in the day.

In accordance with the decision of the Board, to which I willingly assented (Kew Report for 1877, p. 10), the Gardens have been thrown open to the public at 10 a.m. on the four bank holidays. Considering the persistence and energy with which the movement for a daily early opening was pressed, I confess I am surprised at the small success, from that point of view, which has attended the experiment. I am confirmed in my belief that the demand does not really correspond to any widely-felt public want, and that the present ordinary hour of opening is entirely adequate to the convenience and needs of metropolitan visitors, while I am more than ever convinced that the early opening would be highly prejudicial to the unique character of the Royal Gardens as a place of public resort.

It must never be lost sight of that Kew is a highly-kept garden, with all the beauty and amenity of a private establishment, and not an ordinary park for open-air recreation. On April 22 the total number of visitors from 10 a.m. to 7 p.m. was 46,201, the number in the preceding year from 1 to 7 p.m. being 29,296. But the numbers before 1 o'clock are only in the proportion of 1 out of 15 of the total number of visitors.

The figures for each hour are as follows:—

On June 10 the proportion of early visitors (6,703) to the total (56,715) is rather greater, while on August 5, when the number of early visitors was 3,997, it again bears about the same ratio of 1 to 15. On December 26 the entire number of visitors throughout the day was only 119.

The lessons given to the young gardeners in the evening, about twice a week throughout the year, and upon which the attendance is voluntary, continue to give satisfactory results. The subjects of the lectures are elementary meteorology, physics, and chemistry during the winter months, and structural, systematic, geographical, and economic botany during the summer. The importance of this instruction in fitting the young men for public appointments in the colonies and elsewhere, which we are so constantly asked to fill up from Kew, cannot be over estimated.

BOTANIC GARDENS.

Palm House.—

The hot-water apparatus described in the Report for 1877 (pp. 10, 11, with plan and sections) has proved eminently successful, and there has been no drawback of any kind in its working. An equable and sufficient temperature has been obtained throughout the winter months, and the growth of the plants has been proportionately vigorous. The consumption of fuel is very moderate, and the stoking, though requiring more care than with ordinary boilers, is in no sense more complicated or onerous. The flow and return pipe which has been carried round the gallery is a novel feature in the heating of large houses, and in every respect a most important one; it not only (by heating the upper part of the house) checks the rapid absorption and loss of the heat given off from the pipes in the body of the house, but reduces very much the amount of drip in wet weather, which results from the condensation or vapour on the iron rafters. I feel satisfied that no plant-house of any considerable height, whether built of wood or of iron, should be unprovided with a flow and return pipe at an elevation of at least half the height of the building, both for the good of the plants, and the preservation of the material used in construction. The Palm House heating apparatus has been inspected by visitors interested in horticulture from all parts of the kingdom and the continent, including His Majesty the King of the Belgians.

The extensive collection of *Bromeliaceæ*, of which the bulk is to be found on the shelves of the east transept in the Palm House, has been carefully revised and catalogued by Mr. J. G. Baker, F.R.S., assistant keeper of the Herbarium. The list is attached to this Report as Appendix II., in continuation of the series of such catalogues which I promised in the Report for last year in which the *Aroideæ* were given.

Tropical Fern House (No. 2).—

The repairing and repainting of this important and popular house has again been postponed, and it is now fast passing into a condition which can only be described as ruinous. The rafters are extensively decayed, and in many places affected with dry rot. It is a matter well worthy of consideration whether some hard wood, such as teak or blue gum, could not be used in place of pine for the woodwork, which would be more durable under the moist conditions necessary for the cultivation of Ferns.

Mr. Peacock's Collection of Succulents.—

At the close of last year Mr. John T. Peacock of Sudbury House, Hammersmith, expressed a wish to exhibit in some public establishment his well-known and valuable collection of succulent plants. After consultation with the Board, it was decided to offer to Mr. Peacock for the purpose the South Octagon of the Temperate House. This proposal having been accepted, the collection has been deposited there by Mr. Peacock for a period of three, years. It is particularly rich in specimen plants and in species of *Agave*, in which respect it supplements the immense general collection already in the possession of the Royal Gardens.

The introduction of uncommon specimen trees along the paths is being proceeded with, and will soon become an important feature. These are provided with upright slate tallies, lettered in black on a white ground, which have been found to be the most economical and efficient kind of tally.

The following plants of special botanical interest, amongst others of less importance, have flowered during the past year in the Royal Gardens:—

- *Adenium speciosvm*, Forsk.
- *Albuca Wakefieldii*, Baker, sp. n.

- *Albuca juncifolia*, Baker, sp. n.; Bot. Mag. 6395.
- *Allium Erdelii*, Zucc.; Bot. Mag. 6426.
- *Anemonopsis macrophylla*, Sieb. et Zucc.; Bot. Mag. 6413.
- *Aponogeton spathaceum*, var. *junceum*, Lehm. (sp.); Bot. Mag. 6399.
- *Argemone hispida*, A. Gray; Bot. Mag. 6402.
- *Aristolochia trilobata*, L.; Bot. Mag. 6389.
- *Aster Townshendii*, Hook. f.; Bot. Mag. 6430.
- *Campanula macrostyla*, Boiss.; Bot. Mag. 6394.
- *Chionodoxa Luciliæ*, Boiss.; Bot. Mag. 6433.
- *Chlorophytum polyrhizon*, Baker, sp. n.
- *Clematis grewiaflora*, D.C.; Bot. Mag. 6369.
- *Crassula alpestris*, L. f.
- *Cotyledon ramosissima*, Haw; Bot. Mag. 6417.
- *Crinum Forbesianum*, Herb. *Crinum Macowani*, Baker; Bot. Mag. 6381. *Crocus Elwesii*. Maw, sp. n. *Crocus etruscus*, Pari.; Bot. Mag. 6362.
- *Daphne Blagayana*, Freyer. *Deherainia smaragdina*, Dcne; Bot. Mag. 6373.
- *Derris elliptica*, Benth. (" Tubah").
- *Dioscorca vittata*, Hook. f.; Bot. Mag. 6409.
- *Encephalartos Frederici Guilielmi*, Lehm. (male).
- *Erythræa venusta*, Gray; Bot. Mag. 6396. *Escallonia fioribunda*, H. B. K.; Bot. Mag. 6404.
- *Euchlæna luxurians*, D. R. & Aschs.; Bot. Mag. 6414. *Eucomis amaryllidifolia*, Baker, sp. n.
- *Fritillaria Hookeri*, Baker; Bot. Mag. 6385.
- *Fimbristylis Drummondi*, Bcklr. *Grammanthes chloræflora*, var. *cæsia*, E. Meyer, (sp.); Bot. Mag. 6401.
- *Grevillea ericifolia*, Br.; Bot. Mag. 6361.
- *Griffinia ornata*, T. Moore; Bot. Mag. 6367.
- *Hæmanthus Arnottii*, Baker, sp. n. *Hedysarum Mackenzii*, Richardson; Bot. Mag. 6386.
- *Huernia flava*, N. E. Br. sp. n.
- *Huernia reticulata*, Mass. *Iris balhana*, Janka. *Iris cashmiriana*, Baker. *Loasa vulcanica*, Ed. André; Bot. Mag. 6410.
- *Loxococcus rupicola*, Wendl. & Drude; Bot. Mag. 6358.
- *Mascarenhasia*, sp. n.
- *Malcolmia strigosa*, Boiss.
- *Mesembryanthemum hirtum*, N.E. Br. sp. n.
- *Montbretia Pottsii*, Baker. *Nardostachys Jatamansi*, D.C. (Spikenard).
- *Nymphæa alba*, L., var. *rosea*. *Ornithogalum aurantiacum*, Baker, sp. n.
- *Pentstemon Clevelandi*, A. Gray.
- *Podolepis rugata*, Labil.
- *Scoliopus Bigelovii*, Torrey.
- *Sedum Semenovii*, Mast.
- *Sempervivum Reginæ Ameliæ*, Held. & Sart.
- *Senecio subscandens, Hochst.;* Bot. Mag. 6363.
- *Stapelia Curtisii*, Haw.
- *Stapelia glandulifera*, Haw. *Stapelia glanduliflora*, Mass. *Stapelia erectiflora*, N.E.Br., m.s., sp. n.
- *Stapelia tsomoensis*, N.E.Br., m.s., sp. n.
- *Stapelia glabricanlis*, N.E.Br., m.s., sp. n. *Tulipa kolpakowskiana*, Regel.
- *Tillandsia circinalis*, Griseb. *Tillandsia paucifolia*, Baker.
- *Villarsia capitata*. Hook.; Bot. Mag. 6420.

ARBORETUM.

Whilst the loss of old trees in this piece of ground, by decay and the winter gales, goes on as usual, the plantations of young ones are flourishing, and have, in some places, attained a height of 15 to 20 feet. Still there is a great deal to be done both in removal of old trees and the planting of new; and as the plantations of the latter require digging twice a year, it is obvious that the keeping of the sylvan scenery of the Arboretum will ever entail a heavy cost, quite irrespective of the labour which must be bestowed upon the collections that are interspersed amongst the more openly timbered parts, and occupy the open spaces.

The most extensive of the young plantations is that along the river side, extending from the Brentford Ferry

Gate to opposite Sion House, which was made in 1862 with the object of hiding the town of Brent-ford. It occupied the ground which had already been devoted to the collection of elms, walnuts, hickories, and a portion of that devoted to oaks, and contained 8,750 trees, besides shrubs in large quantities to act as nurses to the young trees. Owing to the badness of the soil and to the exposure to the west and southwest, this plantation made very slow growth for the first 10 years, since which period it has been more rapid, and the elms especially have, in many cases, assumed a very handsome appearance. From time to time this plantation had been thinned here and there, and in 1868 an avenue parallel to the river was cut through it; but it was not till the present year that it was taken in hand as a final measure, when all the trees that interfered with those best worth keeping, together with the old shrubs, have been removed. During this clearing, many of the specimen elms and oaks which had been buried in the plantation have been exposed; of these the elms, being grafts in many cases, had, with a few exceptions, either dwindled or perished, but the oaks had greatly improved, and the Quercetum by the river, to which large additions of species are being yearly made, is already an important feature. The specimens will be provided with hanging wooden labels, giving their names and native countries.

The oak collection has been further extended by the transplantation of many species and varieties (whose roots were cut for the purpose last year *(see* 1877 Report, p. 13) to the sides of the paths from the nursery beds in which they were brought forward; these also have been provided with conspicuous labels.

The collection of beeches, chest-nuts, hornbeams, &c. will have to be disposed of next year in a similar manner.

The collection of poplars along the path leading to the south from that which goes to the Brentford Gate has been much enlarged and improved by contributions of rare and new kinds, especially from Messrs. Van Volxen of Brussels and Booth of Hamburgh, gentlemen whose liberality to this establishment has been continuous for many years. To these and to Messrs. Lee of Hammersmith, Osborne of Fulham, and other firms whose names are recorded on p. 19, I have to tender my sincere acknowledgments for many contributions and much public-spirited support.

The beds of *Rosaceæ* to the west of the Pagoda Avenue have been supplied with fresh soil, thinned of shrubs, which had been planted amongst them as nurses, and improved in various ways.

A collection of varieties of ivy has been made by the curved walks leading up to the King William Temple on the south side.

A bed for the collection of *Clematis* has been made on the west side of the small garden near the Temple of Minden.

New beds for the heaths and allied plants *(Ericaceæ)* in the ground to the west of King William's Temple have been finished and filled with specimens for the most part generously presented by the leading nurserymen.

INTERCHANGE OF PLANTS AND SEEDS.

The receipts have been, during the past year, 4,803 plants of all kinds and 2,337 packets of seeds from 239 contributors. They were distributed as follows:—

Cinchona.—

1. *Ceylon*.—

The cultivation of Cinchona in Ceylon has had, during the past year, to struggle with serious difficulty owing to unfavourable weather. Mr. Morris writes (February 14th, 1878):—

"At Hakgalla the Cinchona plantation has suffered very severely from the unusually wet season. Nearly all the large trees, 20 or 30 feet high, and about 12 years old, are dying; the stock plants and about 300,000 cuttings have been killed. We hope to recover ourselves in time, and by opening fresh nurseries, there is every possibility of being able to meet the demand for plants. The private plantations have suffered very severely. Great care is required in selecting the aspect, soil, and exposure to which the plants are likely to be subjected. If these are carefully considered and we have moderate seasons the plantations are in a fair way to succeed. On the other hand, if we have many seasons of continuous wet weather like the last the plants will suffer very seriously.

It is satisfactory, however, to find that the bark of the trees which were cut down by the planters on showing signs of bad health "sold in the London market at prices little, if anything, below those obtained for the finest unbroken strips, peeled from perfectly healthy" trees. Most of such trees are sending up shoots again.

It is possible that it may be necessary in Ceylon to modify the practice of Cinchona cultivation. It is now stated there "that returns can be obtained from a Cinchona plantation at almost as early a date after planting as from coffee or tea. For the longevity of the trees a climate distinguished by moderate wind and rain and open and deep soil may be necessary." From more recent accounts Cinchona planting seems to have recovered entirely from the temporary discourage- ment of the early part of last year, and to now bid fair to add enormously to the wealth and prosperity of the island.

2. *Introduction of Columbian Barks into India.*—

The Indian Government sent Mr. R. Cross to New Grenada for the purpose of bringing to England, for eventual transmission to India, plants of the species of *Cinchona*, yielding the "Soft Columbian" and "Hard Carthagena" barks of commerce. He arrived in this country in March of last year with five wardian cases containing 400 plants of the former and 200 of the latter. The Hard Carthagena included as many as six different kinds. The barks of all were, however, very carefully analysed by Mr. Howard, the well known quinologist. With regard to the Soft Columbian known as "Calisaya of Santa Fé," Mr. Howard reported that the bark analysed, and which was taken from the rejected cane-like shoots brought home by Mr. Cross, "was of the very best description, and such as indicates the probability of a much larger production of alkaloid in the bark of more mature and developed" trees." This bark yielded 6.24 per cent, of alkaloids, of which 3.25 per cent, was quinine and 1.90 was cinchonidine. Mr. Howard considers that "if the young plants can be safely conveyed to India and established there it may not improbably prove *second to none."*

Of the "Hard Carthagena" bark plants the only one which Mr. Howard considered worthy of attention was the kind from Coralis Inza, in the Magdalena Valley. This yielded 4.75 per cent, of alkaloids, of which 1.88 was quinine and 1.18 was cinchonidine. "If a free grower, as I think would be the case, it might be well worth naturalising in India. The bark has met with a ready sale in commerce."

The plants were placed under Mr, Cross's charge at Kew, where every facility was afforded him for establishing and propagating them. On the 16th of October of last year he reported as follows to the Under Secretary of State:—

"On arrival in this country in March the plants of the 'Calisaya of Santa Fé,' carried all the way from the banks of the Caqueta River, were thought to be in a weak state. I am glad to state that, although the collection is now somewhat reduced, there are in all 40 plants more or less growing and rooting, and which I am convinced will soon become good established plants.

"The majority are from cuttings, but there are some also from original imported root pieces growing also, although these in general seemed unwilling to take root freely. The dry weather of summer was not so favourable for the development of growth, but the chief cause was the diminished vitality of the root pieces which were carried overland so great a distance. When it is considered that these were dug up and brought from the damp forest, whence rise one of the most important tributaries of the Amazon, across the eastern Cordillera down to Popayan, where in order to check the growth they were alternately covered up and exposed for nearly three months, then carried down to the hot Cauca Valley to the Pacific, after which there was a month of sea voyage, I think the result will be deemed rather remarkable."

"Of the other sort from the Magdalena valley (which caused the delay of the three months referred to) there are only 12 growing plants, but some of these are good."

At the close of the winter Mr. Cross reported that the collection of Santa Fé plants was reduced to 15 plants, and that of Hard Carthagena to 10. He considered, however, that the fate of both sorts was still quite safe.

3. *Jamaica.*—

Further information confirms the prospect of success in the cultivation of Cinchona in Jamaica (*see* Kew Report for 1877, p. 15).

Mr. Thomson reports (August 13th, 1878,) that in the parish of Manchester the growth of Cinchona is an accomplished success. "The average height of the group of trees which I examined is over 25 feet, the largest specimen, however, measured 35 feet, with its trunk near the ground 2 feet in circumference; this latter size is about equal to our best specimens at the Government plantation, now nine years old. The trees in question are finely developed and very healthy, and are growing in an ordinary coffee field. These trees are growing at the remarkably low elevation of 2,000 feet. A few hundred pounds of bark taken from some of the same batch of trees was stripped and sent to England last year; this bark realised 2*s.* 1*d.* per lb., a very satisfactory price considering the age of the trees (seven years) and particularly the low elevation at which they were grown. . . . . . . Thousands of acres in this beautiful parish, with an altitude of about 3,000 feet, present conditions more especially adapted to plant."

A parcel of bark of *Cinchona succirubra* from Jamaica sold in London in September of last year fetched 2*s.* 10*d.* per lb., being a higher price than was reached by either East Indian or Ceylon bark sold at the same time.

Mr. Nock, who is in charge of the Cinchona plantation at Gordon Town, informs me while this Report is in preparation, that "having cut down 100 trees of *C. succirubra* about 10 years old, the yield of bark amounted to 1,391 lbs. of trunk bark, and 269 lbs. of branch bark, making a total of 1,660 lbs. of green bark. I expect this to lose three-quarters in drying, which will bring it down to 415 lbs., which at 2*s.* 6*d.* per lb. will realise over 50*l.* As the trees are planted 303 to the acre, an acre is worth at 10 years over 150*l.*, which proves Cinchona cultivation in Jamaica to be a profitable undertaking. The average height of the 100 trees was 22 feet, not including 3 feet of the young wood at top. The average circumference close to the ground being 18 inches, and at 5 feet above the ground 13 inches. The tallest tree was 35 feet, with a circumference close to the ground of 30 inches. The smallest was 11 feet high, circumference 13 inches." The Government has authorised the extension of this plantation by 100 acres.

Cork-oaks for the Punjâb.—

Mr. Baden-Powell reports the progress up to 1877 of the Cork-oaks sent out from Kew in 1875 (Kew Report for 1875, p. 8). At Pálampur 28 are alive, and most of them look healthy. They are about a foot-and-a-half high. At Kúlú 50 survive. Their height varies from a few inches to 2 feet. At Dhobi there are only six, one is about 2 feet high; it is in a sunny spot surrounded by a basket open at the top, and this is the only one that looks healthy and vigorous.

Fodder Plants.—

The discovery of new and easily cultivated fodder plants, especially those adapted to hot countries, is a matter which now excites great attention in India and the colonies. It is inevitable that this should be the case, as the primitive physical conditions of newly settled countries gradually give way before the changes brought about by their occupation for agricultural and other industrial purposes.

Both in North and South Australia the conservation of the natural pasture is already attracting grave consideration. Where the mischief has gone too far and is irremediable the vegetation which is gone must be replaced by some substitute foreign to the soil. Some of the more important of the fodder plants which during the past year have come under our notice at Kew are discussed in the following paragraphs:—

1. *Prangos pabularia*.—

An application for seeds of this plant has been addressed to Kew from Queensland, where attention has been directed to it as a cure for fluke in sheep. Without estimating its merits in that respect, I felt obliged to point out that the plant was a native of Tibet, was no longer in cultivation in this country, and would, therefore, be difficult to procure. In Tibet it was useful in dry districts in defect of all other forage plants. It failed, however, in Kashmir, and is utterly unfitted for Queensland. Its cultivation was attempted in England some 30 years ago, and entirely disappointed all expectations.

2. "*Prickly Comfrey*."—

This is a species of *Symphytum* which has recently been prominently brought into notice as a forage plant. It is apparently identical with a *Symphytum* which has long been naturalised in the neighbourhood of Bath and elsewhere, and which has been identified by botanists with. *S. asperrimum*, a native of the Caucasus. Neither the naturalised nor the forage plant appear to be really identical with that species, but have been found by Mr. Baker to agree with *Symphytum peregrinum*, which appears to be not certainly known as wild anywhere, but to be probably a hybrid of garden origin between *Symphytum officinale* and *S. asperrimum*.

Prickly Comfrey, with, it must be confessed, little judgment, has been tried in a variety of countries where the climate is wholly unsuited to its habit of growth. The result has been attended with a good deal of disappointment. In England it has been found very useful for winter fodder, as it forms large, tufts of root-leaves which start into growth early in the year, and bear several cuttings. It is greedily eaten by animals which refuse ordinary Comfrey, the habit and appearance of which is not very dissimilar.

In India Mr. Buck, Director of the Department of Agriculture and Commerce of the North-west Provinces, reports:—"The general result of the experiment in this department is that the climate of the plains is quite unsuitable to the Prickly Comfrey, the plant having failed whenever it has been tried; but there is still some chance of its succeeding under proper treatment in the hills." (Journ. Agri. Hort. Soc. Ind., N.S., Vol. vi, p. 54.) On the other hand, the Rev. G. Richter reports from Coorg:—"The Prickly Comfrey appears to be firmly established in Coorg; fields seen in different coffee plantations are as luxuriant as can be desired."

Dr. Schomburgk, Director of the Adelaide Botanic Garden, is convinced that the plant is of little use, at least, to the South Australian plains:—"During the winter months the plants throve satisfactorily and produced some fine leaves, but in the month of October the leaves began to suffer, and . . . . . dried up before any of the grasses . . . . . . The same complaint we hear from New South Wales, Victoria, even from tropical countries, such as Queensland, Ceylon, Singapore, &c., where the planters have been disappointed with it."

3. *Téosinté*.—

A new tropical fodder-grass, which has attracted a good deal of attention, deserves to be mentioned in this place. The seeds were originally sent in 1868 to M. Durieu de Maisonneuve, Director of the Botanic Garden at Bordeaux, from Guatemala. He communicated the first notice of the plant which hits appeared to the Société d'Acclimatation at Paris in 1872. Subsequently the seeds were widely distributed by the Society, and I have received their produce in quantity from Dr. King in Calcutta, and from Dr. Schweinfurth in Cairo. From Kew they have been sent to Bahamas and the West Indies generally, Cyprus, South and Tropical Africa, Australia, the United States, and numerous applicants and correspondents.

The grass is essentially tropical in its habits. Mons. Thozet in Queensland found single seeds to give rise to as many as 32 stems, each 12 feet high. Dr. Schweinfurth is said to have harvested at Cairo as many as 12,000 seeds as the produce of three single grains, and Vice-Consul Calvert states that at the same place in July of last year "the plant, after having been mown down, grew one foot in four days."

Dr. R. C. Sandars, of Azimgurh, reports to the Agri-Horticultural Society of Madras:—"Each seed was put in at intervals of five feet, but some two months back each plant had so spread that all touched; some have from 100 to 120 shoots. To give air to those plants which I wished to seed, I had some of the plants cut nearly to the ground. Cattle eat what was cut most greedily, both in its fresh state and also when dry; and the plants which were cut instantly grew again, and are now fit to cut afresh. The plants have had the advantage of the jail garden, which includes a rich soil and abundance of water."

It is also suggested that it would be a valuable fodder for elephants during the hot months.

Mr. Murton writes from Singapore (2nd October 1878):—"I am going in largely for the *Euchlæna;* it promises to turn out a capital fodder-plant for this place."

Dr. Schomburgk reports from Adelaide:—"I am in hopes that the plant will turn out a great acquisition to our summer fodder plants . . . . Notwithstanding that after planting our young plants have never been watered, and considering the great dryness of the season, their growth is vigorous."

From the United States the Commissioner of Agriculture reports the attempt to extract sugar from the stalks, "but though a fair proportion of syrup was obtained, crystallisation could not be induced, and the results were unsatisfactory."

Botanically the grass is of very great interest. It is remarkable that before its introduction as a fodder-plant it was unknown to science, and it was at first incorrectly referred to the genera *Trip-sacum* and *Reana*. It unites the habit of maize (*Zea*) with, in many respects, the structure of *Tripsacum*. As *Euchlæna* and *Tripsacum* are incontestably American genera, this fact supplies, as has been pointed out, an argument for the new world origin of maize, a matter which has been disputed.

Euchlæna luxurians grew and flowered under stove treatment in the Royal Gardens last year. It was figured in the Botanical Magazine (Tab. 6414) from this source this being the first published illustration of the plant. An impression of the plate is given with this report.

Description of the Analytical Figures.—1, portion of female spike of the natural size; 2, diagram explanatory of the position, &c. of the dilated rachis (a) and of the female spikelet (*b* outer, *c* inner empty glume, *d*.lower flowering glume); 3, vertical section through rachis and outer empty glume, showing points of attachment above and below of successive joints of the inflorescence; 4, tips of the stigma; 5, diagram explaining the relative position of the parts of the male spikelet; figs. 2-5 all much enlarged.

India-rubber.—

Hevea and Castilloa.—

I have to report the continued satisfactory progress of the South American rubber-yielding plants, the establishment of which in Ceylon and India is recorded in the Kew Report for 1877 (pp. 15-17).

Mr. Morris, the Assistant Director of the Royal Botanic Garden, Ceylon, writes (18th May 1878):—"The rubbers are doing remarkably well, both here (Peradeniya) and at Heneratgodde. The Heveas are nearly 12 feet high and look quite handsome trees. The Castilloas had grown so much that. I quite failed to recognise them. They grow into broad spreading trees with a very majestic air."

Dr. Thwaites, the Director, reported up to the end of last year:—"The rubber plants are thriving very satisfactorily, but *Hevea* and *Castilloa* do not seem disposed to flower yet. We manage to strike a good many cuttings of *Hevea*, but *Castilloa* we cannot strike from cuttings of the stem, and the roots are not yet large enough to furnish good chunks for getting plants from."

While this Report is in preparation Dr. Thwaites writes to me (17th April 1879):—"I have sent off 516 plants raised from cuttings of *Hevea brasiliensis* to the Conservator of Forests at Moulmein in charge of a person he sent to take care of them. I am expecting a man from the Conservator of Forests at Madras for some *Hevea* plants to be tried in the neighbourhood of Calicut. Our *Hevea* plants are now becoming more branched, and so it is to be hoped they will flower before very long, and save us the necessity of raising plants from cuttings, which is not easy from comparatively young plants. I have sent the Conservator of Forests at Moulmein also two growing plants of *Castilloa* which we managed to take up from the ground successfully, and I hope they will reach him in good order. From the appearance of the trees I hardly think that *Castilloa* will produce seeds for some years, and until it becomes a very large tree."

The propagation of *Castilloa* is still continued at Kew. Progress is slow on account of the small stock which has been retained to work upon, but otherwise the difficulty of which Dr. Thwaites complains has not been met with.

At my request Mr. Murton, the Superintendent of the Botanic Gardens, Singapore, has sent plants of *Hevea*, *Castilloa*, and also of the Ceara rubber, to Queensland, where they have arrived in good condition.

From Singapore the two former have also been introduced into Perak, where Mr. Low reports (February 3rd, 1879):—"The *Heveas* are now 12 to 14 feet high. They take to the country immensely. The *Castilloa* is a large tree, 10 feet high, with branches 5 feet long." Mr. Murton adds:—"As regards their propagation, which Mr. Low seems to have found rather difficult, I find that the half-ripened shoots with a shield of hard wood are best; but, unless kept tolerably dry, are very apt to rot off."

Sketch of plants by L. Reeve & co. London

From Kew, plants of *Hevea* have been sent to Dr. Kirk, at Zanzibar, and also to Fiji; in the latter case without success.

With regard to the *Hevea* plants sent to Assam (see Kew Report for 1877, p. 15), Mr. Mann reports:—"Soon after transplanting the leaves turned white and dropped off, and subsequently the wood of the young trees withered away gradually, and by July there was not one of the plants alive. This failure had been anticipated, and is attributed to the comparatively low temperature in Assam."

2. *Ceará Rubber*.—

At the end of August of last year consignments of plants of the Ceará. rubber, consisting, in each instance, of two wardian cases containing 80 plants, and one dry box containing 40 plants, were sent to Lieut.-Colonel Beddome, Conservator of Forests, Madras, and Dr. King, of the Royal Botanic Gardens, Calcutta. Of those sent to Madras all were alive on arrival in the wardian cases, while of the contents of the dry box about half were saved. Those originally sent to Dr. King (see Kew Report for 1877, p. 16) arrived in rather bad condition. Few were saved, and the growth of these did not impress Dr. King favourably. "They all look more or less weak and lanky, as if the climate were too damp for them." This was, perhaps, a premature judgment from want of familiarity with the habit of the plant. Dr. King now writes:—"Ceará rubber is going to be a success here."

At Ceylon, in April one of the plants first sent out had already made an attempt to flower, and by the end of the year Dr. Thwaites was distributing copious supplies of seed to Calcutta, Burmah, Madras, and Singapore (where, however, it-seems unable to stand the wet season).

I regard, therefore, the work of Kew completed as regards the Ceará rubber. Living plants of it have been distributed during the past year to Dominica, Fiji, Jamaica, Java, Sydney, Trinidad, Queensland, and Zanzibar.

Liberian Coffee.—

I quote the following from a report furnished to the Colonial Office by the President of Dominica:—

"The Liberian coffee plants are thriving in many parts of the island, but under the fostering care of the Hon. Dr. Imray, to whom the community is entirely indebted for the real establishment of the coffee tree in Dominica. Some of the early imported trees have borne fruit, and the Creole seeds have been sown and are coming up, and the plants showing every sign of vigour and health . . . . . The native coffee is still suffering from blight The Liberian coffee trees, although in close proximity to the native coffee, seem to bid defiance to the ravages of this scourge, while the luxuriance of its foliage causes a painful contrast."

Dr. Imray writes to me in May of last year:—"I have several hundred seedlings coming on, raised from the seeds of the plants sent by you. The trees have again flowered, and there is a large crop on them for next year. They still continue very healthy, and increase in size. I cordially join in your aspirations that the dire consequences of natural selection may be averted as regards the *Cemiostoma*. Hitherto all its efforts have failed, and as the operation of natural selection and the survival of the fittest is somewhat tardy, we may look forward to a period of at least two or three millions of years before the creature can possibly have 'acquired' an instrument strong enough to tap the flinty cuticle of a Liberian coffee leaf.

"Further observation has shown me that there is a considerable difference between the two species of coffee in regard to the ripening of the fruit, which may be of some importance if the cultivation extends in the island. In *C. arabica* when the berry is full it soon takes on a rather bright red colour, quickly softens, becomes detached from the tree, and falls to the ground. The outer coating of the pericarp is thin, and the surface smooth; within there is a loose sweetish tasted pulp, from which the seeds are separated without much difficulty. The pericarp of the seed of *C. liberica* is a hard fibrous covering, rather rough on the surface as compared with *C. arabica*, of a greenish-red colour, containing very little pulpy matter, and, so far as I have observed, never *softening* on the tree, or indeed after it is gathered, but in a very slight degree. The peduncle is short and very strong, and the fruit, instead of dropping when ripe, as in *Coffea arabica*, remains firmly fixed; in time it shrivels up, but still (so far as I have noticed) continues attached to the branch, becoming dark-coloured and very hard.

"From this difference in the ripening of the berries of Liberian coffee, I think I have been rather misled as to the length of time required for their full maturity. I believe I might have gathered all the berries on my trees six weeks or two months earlier. I waited week after week, watching when the softening process would commence. Having some misgivings, however, I gathered a few berries and planted the seeds. In six weeks (the usual time) they began to germinate and appeared above ground. I hesitated no longer, but at once collected all the seeds that were quite full and of a red colour. They never look so bright as the coffee of the country.

"In former times, when the cultivation of coffee in this island was general, the plantations that were short-handed often suffered considerable loss, for as the coffee ripened all at once, unless the berries were gathered immediately they dropped on the ground and rotted. With the Liberian coffee no such loss need be feared, for the berry remains so long on the tree that ample time would be allowed to gather in the crop with comparatively few hands."

Mr. Murton reports from Singapore:—"Two of the plants from the number sent here in August 1877 from Kew, when they were not two inches high, were setting fruit at the end of 1878. A few plants were sent to Sarawak, but I have heard nothing about them, except that they arrived in excellent condition. I find this species of coffee very easy of propagation by cuttings, but the plants appear to grow very slowly after being rooted, and this plan of raising a stock is not, in my opinion, to be recommended."

From Ceylon I have received a report of the first Liberian coffee estate opened at Kalutara. An average tree was found, in November of last year, to bear 1,500 berries, which was calculated to be at the rate of 150 bushels to the acre, equivalent to 8.3 cwt. of clean coffee. It is hoped that by its means vast tracts in Ceylon of abandoned or semi-abandoned low lying land will be redeemed for cultivation.

From Southern India the reports are not very favourable, and the climate is no doubt unsuitable. The Rev. G. Richter states, August 30, 1878:—"The various experiments with Liberian coffee do not appear to be encouraging. The most successful plants blossomed this season but scantily and have now some berries. Those lately received from Kew, and distributed in small pots by the Mysore Government, have not done well with me and several other planters. Though transplanted into bamboo baskets and kept in a conservatory, they remained sickly, contracted leaf-disease, and are not healthy, even after being put out into good rich soil in the open garden."

At my request Dr. Thwaites obligingly forwarded to the Maharajah of Johore 400 young plants of Liberian coffee, and he has also been so good as to send to Fiji a parcel of the seeds.

Mahogany Seed for India.—

All the available supplies of mahogany seed which reach Kew in a sound condition have been sent with all possible expedition to India through the Inda Office. As stated in the last Kew Report, mahogany produces good marketable furniture wood in Bengal and Burma.

Lieut.-Col. Beddome, Conservator of Forests, Madras Presidency, reports (April 20, 1878):—"The mahogany grows so splendidly at Nelumbur, and in amongst the teak trees (not objecting to shade), that it is a pity large supplies of its seeds cannot be procured."

Capt. Doveton, Conservator of Forests, Central Provinces, reports that at Telenkheri mahogany does well.

Supplies of the seed have also been sent from Kew to Mauritius.

Mesquit Beans.—

The attempt (see Kew Report for 1877, p. 20) to secure the introduction into India and the colonies of these cattle-feeding plants, which are found so useful in hot dry countries, has met with a varied amount of success. The Screw Bean (*Prosopis pubescens)* appears to be the most difficult to establish.

Dr. Schomburgk reports from Adelaide that the South Australian climate does not suit the growth of the Screw Bean, about 100 young plants in pots having perished. In the case *Prosopis juliflora*, trees of last year's planting reached the height of 5 to 6 feet.

Mr. Bernays writes from Brisbane that both *P. pubescens* and *P. juliflora* are growing in the open ground from Kew seeds, and that there are strong young trees of the latter in Bowen Park also raised from the seed sent from Kew.

Mr. Keit, Curator of the Natal Botanic Gardens, writes to me:—"Regarding *Prosopis pubescens*, I beg to state that the seeds sown here germinated freely and grew for some time, but, notwithstanding all the care bestowed upon them, the young plants were, especially after rain, attacked and subsequently destroyed by a minute fungus. But I am glad to be able to add that one of my correspondents residing in the country has succeeded in rearing a couple of young plants, which are doing well. It appears to me that the interior of the country is more suitable for the cultivation of these plants than the coast districts."

Mr. Duthie, of the Saharunpore Botanic Gardens, states that "*Prosopis juliflora* is doing very well, and should give seed next year or the year after. *P. pubescens* failed during the rains."

In Southern India, Lieut. Col. Beddome reports that the experimental planting of *Prosopis juliflora* at Cuddapah promises to be a success.

Pithecolobium Saman.—

This South American tree is referred to below in what is said with respect to the Rain tree. According to Spruce, in its native country the pods are greedily eaten by deer and cattle. Mr. Jenman, the Superintendent of the Castleton Botanic Garden, Jamaica, has pointed out to the Colonial Office the remarkable merit of the tree for cultivation in hot tropical countries, as the foliage affords a very grateful shade, while the pods supply fodder of excellent quality. The following remarks are extracted from Mr. Jenman's report:—

"*Pithecolobium Saman*, popularly known in Jamaica as *Guango*, was originally introduced from the American mainland, but has now become thoroughly naturalised in all the dry regions, it is a lofty tree, in habit resembling the English oak. Trees are not uncommon seventy feet high, the spread of whose branches covers a diameter of one hundred and thirty feet. Owing to the folding of the leaves at night, the shade of the tree is said not to impede the deposit of dew beneath its branches. Grass grows freely even up to the trunk.

"The fruit is a bright dark-coloured pod when ripe, six to ten inches long, hardly one inch wide by a quarter of an inch thick, in substance consisting of a sugary amber-coloured pulp. The pods are borne in great profusion and hang prior to their maturity dangling in clusters from every branchlet. As they ripen they drop to the ground, and are picked up and eaten with much relish by all stock, even sheep and goats. Cattle may be seen lingering about the trees waiting for the passing breeze to shake the fruit down. Its excellent quality as a fodder is evident by its fattening effect. Stock having access to it improve markedly during the time it is in season.

"From the sugary nature of the fruit, it will keep a good while packed after maturity. It is therefore often gathered, packed in barrels, and kept for use till the dry early spring season has parched up grass and made herbage scarce. There is no doubt, I think, that it would make as good a preserved cattle-food mixed with other ingredients as the Carob (*Ceratonia Siliqua)*, which is largely imported into England from the shores of the Mediterranean for this purpose. *Pithecolobium Saman* thrives best in dry hot plains having a rainfall of from thirty to sixty inches. Though of quick growth the wood is hard and very ornamental in the grain."

Seeds of this tree received from Jamaica were sent to the following places: Bombay, Brisbane, Calcutta, Ceylon, Hong Kong, Madras, Mauritius, Natal, Saharunpore, Travancore, and a further supply was distributed through the India Office.

It is of course premature to expect any immediate result from the experiment. I learn, however, that in August of last year the Agri-Horticultural Society of Madras had a large number of fine young plants ready for distribution. About the same time Mr. Ford, in Hong Kong, had upwards of 1,000 good healthy plants." Mr. Duthie reported from Saharunpore in September:—"The *Pithecolobium* is doing most splendidly here; every seed is germinating, and the plant is looking healthy in every respect."

Dr. King reports from Calcutta:—"There are in the garden two sets of this tree, one consisting of five trees about 11 years old, and the other consisting of 84 trees, which were planted in an avenue four years ago. The tree is an extremely rapid grower, and seems perfectly at home in the climate and soil of Lower Bengal. The habit of growth and softness of the timber make the tree of little value as a building material, but it would probably answer well as a firewood tree, and as a shade tree I know nothing to equal it in Bengal .... The older trees have this year for the first time given seed; the pod is quite as sweet as that of the Carob, and is abundantly produced, and altogether I consider *Pithecolobium Human* a much more hopeful source of cattle-fodder than the Carob, while as a rapid grower it is unrivalled."

Wagatea spicata.—

Mr. G. M. Woodrow, Superintendent of the Botanical Gardens, Ganesh Khind, Poona, has sent to Kew seeds of *Wagatea spicata*, a scrambling thorny shrub, native of the Concan, and interesting on account of the beauty of its foliage and flowers. The pods have been found by the Government analyst to contain 15 per cent, of tannic acid, and some tons have been sent home to test their value for tanning.

Seeds were distributed from Kew to Demerara, Dominica, Jamaica, Trinidad, and other correspondents.

The following is a statement of the plants, &c. sent out during the past year, and included in 365 consignments:—

I. Britain.

The usual exchanges have been made with the Botanic Gardens of Birmingham, Edinburgh, Glasnevin, Manchester, and Oxford; with the Royal Horticultural Society, Chiswick; the Royal Botanic Society, Regent's Park; and also with the principal nurserymen, especially with Messrs. Backhouse of York, Barr and Sugden of Covent Garden, Bull of Chelsea, Dicksons and Co. of Edinburgh, Dickson and Turnbull of Perth, Henderson of St. John's Wood, Ireland and Thompson of Edinburgh, Jackson and Son of Kingston, Kinghorn and Son of Richmond, Lawson Seed and Nursery Company of Edinburgh, Kinmont and Kidd of Canterbury, Low of Clapton, New Plant and Bulb Company of Colchester, Osborn of Fulham, Parker of Tooting, Paul and Son of Waltham, Robertson and Co. of Edinburgh, Rodger, McClelland, and Co. of Newry, Rollison and Sons of Tooting, Smith of Worcester, Stuart Mien and Allen of Kelso, Stausfield and Son of Todmorden, Thompson of Ipswich, Veitch and Sons of Chelsea, Ware of Tottenham, Williams of Holloway, and Wills of Kensington.

Contributions have been received from upwards of 100 different sources; of these the principal have been:—

- Atkins, J.; *Mamillaria senilis* and choice herbaceous plants.
- Bennett, A.; *Carduus tuberosum, Echium plantagineum*, and other rare British plants.
- Christy, Thos.; *Urostigma Vogelii* of the West Coast of Africa; *Platycerium æthiopicum;* seeds of *Kentia* and *Sterculia Kola*.
- Clark, Col. T.; *Urginea exuviata*.
- Clowes, Miss Agnes; *Ranunculus Lyallii*.
- Cooper, Thos.; *Cotyledon coruscans, Aloe striatula*.
- Corderoy, J.; *Stapelia Corderoyi* and other choice succulents.
- Crewe, Rev. H. Harpur; *Crocus syriacus, Calceolaria lobata*.
- Cruttenden, Capt.; large plants *Adenium obesum*.
- Darwin, Ch.; grass from South Brazil with cleistogamic flowers; seeds various plants.
- Dickson, Prof. A.; *Isoetes echinospora* from Glen Callater.
- Duff, M. E. Grant, M.P.; plants of *Ambrosinia Bassii* (Bot. Mag.6360).
- Ellacombe, Rev. H. N.; *Siphocampylos bicolor, Galanthus nivalis;* var. *Sharlocki, Narcissus calathinus*, and other choice herbaceous plants; seeds *Echeandra eleutherandra*.
- Elwes, H. J.; choice lilies, *Halenia elliptica, Cyrtanthus, Pleione Hookeri, Paranephclius uniflorus,* choice herbaceous plants, and hardy and other bulbs.
- Ewbank, Rev. H.; *Omphalodes Luciliæ*, var. *alba*, and other herbaceous plants.
- Head, A.; *Amherstia nobilis. Asparagus plumosus, Begonia Listeri, Cycas revoluta* 10 feet high, Kumquat, *Phalænopsis*, sp., and a variety of other plants from India.
- Hiern, W. P.; *Isolepis Holoschænus, Polygonum maritimum*.
- Henry, I. A.; *Ranunculus pinguis*.
- Holmes, E. M.; *Pastinaca grandis* the Doo-goo of Royle's Mat. Medica, seeds of *Physostigma venenosum, Angræcum* sp. n. of West Tropical Africa, and other seeds and plants.
- Hooke, B.; *Mutisia decurrens;* many choice herbaceous plants, particularly a collection of Hellebores.
- Howard, J. E.; *Mantisia saltatoria*.
- Irvine, Jas.; seeds Liberian coffee; palm seeds, including *Elæis* and two species of *Raphia* from the Cameroon Mountains.
- Joad, G.; *Hypericum Coris, Campanula petræa, Calceolaria plantaginea*, and many rare and choice herbaceous plants.
- Laver, H.; *Euphorbia arborescens*, var.
- Lawrence, Sir Trevor; collection of choice orchids.

- Lewis, Earl of; two large specimens of *Cyathea*.
- MacLeay, Sir G.; *Billbcrgia melanantha, Nidularium Schcremetieffii, Hippiella atrosanguinea*, and other choice stove plants; rare herbaceous plants, including a fine crown of *Gunnera manicata;* miscellaneous seeds.
- Maw, G.; several choice *Narcissi, Crocus syriacus, Iris lacustris, &c*.
- Miles, F.; seeds *Nymphæa alba, N. cærulea, Primula*, sp. n., plant *Senecio pulcher*.
- Parish, Rev. C.; *Dendrobium Findlayanum, D. Fytchianum, Vanda cærulea*, and many other choice orchids.
- Paterson, Dr.; *Encephalartos villosus*, var.
- Peacock, J.; *Aloe socotrina*.
- Perry, W. W.; seeds *Echiochiton*, stems *Vitis*, sp. n., species of *Boucerosia, Dracæna Ombet, Balsamodendron Playfairi*, Hk. f., species of *Boswellia*, &c.
- Roberts, Maccubbin, & Co.; seeds of *Adansonia madagascariensis*.
- Roezl, B.; *Odontoglossum Edwardsii* and other new kinds.
- Salter, Jas.; various kinds of *Salix*.
- Sherrings, R. V.; *Dicksoaia coniifolia* and other ferns.
- Walker, A. O.; *Adiantum*, sp. n. aff. *subvolubili*.
- Wigan, Fred.; large specimen *Cyathea medidlaris*.
- Williamson, Prof.; *Drosera spathulata* and *Dionæa muscipula*.
- Wilson, Geo.; *Polygala lutea* and other choice herbaceous plants, lilies.
- Young, Liston; *Cheilanthes chlorophylla* and *Rhapis humilis*.

II. Continent.

- Arcangeli, Dr., Florence; collec-of seeds, plant *Pistacia Terebinthus*.
- Bommer, Prof. J. E., Brussels; *Asplenium laxum, Cyathca funebris*, and various choice ferns.
- Bouché, A., Berlin; *Encephalartos Hildebrandti, Cycas Thouarsii*, and palms.
- Decaisne, Prof. J., Paris; *Azolla pinnata, Salvinia nutans, Asphodeline damascena*, &c.
- Frœbel & Co., Messrs., Zürich; choice species of *Yucca*, European species of *Rhododendron*, herbaceous plants and seeds.
- Godefroy-Lebeuf, A., Argenteuil; *Torenia Bailloni*, many herbaceous plants, *Pseudodracontium* (gen. n.) *anomalum*, N.E. Br.
- Groves, H., Florence; *Narcissus*, sp. n., several choice species of *Tulipa, Iris Sisyrinchium*, seeds *Ononis ornithopodioides*.
- Krelage & Son, E. H., Haarlem; *Hippeastrum concolor*, Baker, sp. n.
- Leichtlin, Max., Baden-Baden; *Coptis brachypetala, Edraianthus Kitaibelii, E. pumiliorum, Euryangium Sumbul*, and many other choice herbaceous plants, *Clematis Pitcheri, Bomarea oligantha*, sp. n., *Massonia*, sp.n., *Cyrtantlius Tuckeri, Schizophragma hydrangeoides*, seeds *Acantholimon venustum*.
- Post, Dr. G. E., Syria; bulbs *Allium Erdelii* (Bot. Mag. 6426).
- Regel, Dr., St. Petersburg; seeds *Pugionum cornatum*, various *Coniferæ*, &c., bulbs *Fritillaria (Rhinopetalum) Karelini* (Bot. Mag. 6406), *Leontice vesicaria, Cypripedium macranthum, Selaginella sanguinolenta*, sp. n., many choice bulbs.
- Reichenbach, Prof., Hamburg; *Leontice altaica* and *Vallisneria spiralis*, mas.
- Smet, Louis de, Ghent; *Agave Victoria; Reginæ, A. Shawii, A. Desertii*, and several other choice kinds, *Echeverias*.
- Van Houtte, Louis, Ghent; collection of trees and shrubs, including *Pterostyrax hispidum* and *Xanthoceras sorbifolia; Tropæolum speciosum*.
- Vilmorin, Andrieux et Cie, Paris; tubers *Dioscorea Batatas*.

III. Asia.

- Agri-Hort. Society, Madras; wardian case containing *Schleickera trijuga* and other plants.
- Aitchison, Dr.; collection of seeds from Kashmir, *Eremurus himalaica*, seeds *Malcolmia strigosa*, bulbs, &c.
- Beddome, Lieut.-Col., Madras; seeds of *Bentinckia*, prickly bamboo, *Musa* spp., and palms.
- Duthie, J. F., Saharunpore; roots *Nymphæa pygmæa;* seeds *Abies smithiana, Chamærops Fortunei, C.*

martiana, and others.

- Ellis, R., Forest Dept., Punjab; various seeds *Delphinium brunonianum, &c*.
- Ford, C., Hong Kong; wardian case *Rhodoleia, Arundina chinensis* and *Alsophila tomentosa*.
- Gammie, J., Darjeeling; trunks *Cycas pcctinata, Hemitelia decipiens*, and other tree-ferns; seeds *Ilex insignis* and *Luculia gratissima*.
- Gardiner, Col. P. F., Hazara; corms saffron crocus of Kashmir *(Crocus sativus*, var. *kashmirianus),* several bulbs, &c.
- Hance, Dr. H. F., Hong Kong; various seeds.
- King, Dr., Calcutta; seed collections *Rhododendron* and *Coniferæ*, set of seeds from Sikkim, seeds of *Euchlæna (Reana) luxurious, Chamærops martiana, Nipa fruticans*, and *Cycas Rumphii*, large collection of Indian ferns, including *Nephrodium cochleatum, N. sligmosum*, and *N. flaccidum*.
- Murton, H. J., Singapore; wardian case of *Durio zibethinus*, of *Ptychosperma singaporensis* and seeds of same, case of orchids and box of palm seeds.
- Scheffer, Dr., Buitenzorg; wardian cases of various plants, inclusive of *Shoreu, Orania regalis,* and *P holidocarpus Thuri*, seeds *Soya hispida*, &c.
- Thwaites, G. H. K, Ceylon; wardian cases containing *Arundinaria griffithiana, Boucerosia umbellata, Diospyros quæsita, Dipterocarpus hybridus*, and *D. glandulosus*, &c., seeds of *Nepenthes*, tubers of *Ipsea spcciosa*.

IV. Africa.

- Ayres, Ch., Cape Town; seeds *Leucadendron argenteum*.
- Bolus, H., Graaf Reinet; *Disa barbata*, Satyriums, seeds *Acanthosicyos horridus, Pelargonium* stems, and various bulbs.
- Bowker, Commandant J. H., Basutoland; *Aponogeton spathaceum*, var. *junceum* (Bot. Mag. 6399), cuttings *Aloe Barberæ* and seeds.
- Hay, His Excellency Sir J. D., Tanjiers; seeds *Juaiperus phænicea*.
- Hutton, H., S. Africa; seeds *Rhus Thunbergii* and of other trees and shrubs.
- Keit, Wm, Natal; *Encephalartos Ghellincki, E. villosus, Hæmanthus Catherinæ, Crinum* sp., and orchids.
- Kirk, Dr., Zanzibar; fine trunk *Encephalartos Hildebrandti;* cases containing *Landolphia, Cocos nucifera, Adenium;* orchids from Johanna.
- McOwan, Prof., Somerset East; seeds *Aloe hanburyana, Podanthes pulchra*, and *Stapelia;* bulbs *Scilla*, &c.
- Monteiro, Mrs. Rose, Delagoa Bay; *Crinum forbesianum* and other plants in wardian case.
- Oliver, Captain, St. Heleua; fine collection of St. Helena ferns, contained in three wardian cases, including *Acrostichum dimorphum, Asplenium platybasis, Dicksonia arborescens, Nephrodium Napoleonis*, and *Polypodium molle*.
- Salmon, C. S.; case of palms from the Seychelles.
- Schweinfurth, Dr.; seeds *Euchlæna (Reana) luxtirians* and of *Smithia Pfundi*, South Kordofan.
- Tidmarsh, E., Grahamstown; box of *Hemitelia* stems.
- Wakefield, Rev. T.; bulbs *Albuca Wakefieldi*, sp. n. (Bot. Mag. 6429), rhizomes from Nyika country.
- Whitehead, H., St. Helena; two cases of ferns *Dicksonia arborescens,*&c.

V. New World.

- Austin, Mrs. R. M., California; bulbs and seeds.
- Barlee, His Excellency F. P., Belize; several kinds of seeds, including those of *Pachira aquatica*.
- Capanema, Dr., Brazil; seeds *Merostackys Clausseni*, Munro.
- Department of Agriculture, Washington; various tree and shrub seeds, seeds *Sabal Palmetto* and *Nelumbium luteum*.
- Engelman, Dr., St. Louis; seeds *Yucca filamentosa*, var. *bracteata*.
- Ernst, Dr., Caraccas; roots of *Asagræa officinalis*, seeds *Bomarea bredemeyeriana*.
- Gray, Prof. Asa, Harvard; roots of *Aralia quinquefolia*.
- Huxham, Rd.; orchids and bulbs from Bahia.
- Imray, Dr., Dominica; *Blakea*, *Alloplectus cristatus* and *Chætogastra*.
- Jenman, G. S., Jamaica; valuable fern collections, including *Asplenium erosum, Dicksonia coniifolia,*

Nephrodium pedatum, N. Jenmanii, Cyathea gracilis, C. pubescens, &c., tree ferns, clumps of *Chusquea;* seeds of *Pithecolobium Saman*, *Persea gratissima*, *Mammea americana*, *Copernicia*, and other palms, mahogany, &c.; *Broughtonia sanguinea* and other orchids.

- Merrill, J. Warren, Boston; *Davallia clavata* and other ferns.
- Missouri Botanic Garden; collection of herbaceous seeds.
- Philippi, R. A., Santiago; seeds *Prumnopitys elegans* and *Ceroxylon australe*.
- Prestoe, H., Trinidad; seeds *Carica* sp., *Colvillea racemosa*, and others, miscellaneous orchids.
- Sargent, Prof. C. S., Harvard; large seed collections, including *Antirrhinum nuttallianum, Frasera thyrsiflora, Staphylea Bolanderi, Juniperus californica*, var. *utahensis, Garry a Fremonti, Cercidophyllum japonicum*, &c.; collection of young oaks, *Coniferæ*, and other shrubs; various herbaceous plants, *Nymphæa flava*, *Erythronium albidum*, seeds of the new *Eucharidium Breweri;* collection of ferns from the Sandwich Islands, also North American species; choice succulents.
- Sturtevant, E. D., New Jersey; *Nelumbium luteum*, *Nymphæa flava*, and *Sarracenia purpurea*.

VI. Australia and New Zealand.

- Abbott, F., Bot. Garden, Tasmania; seeds of *Eucalypti*, wardian case of miscellaneous plants.
- Bancroft, Dr. Jos.; cuttings of *Nerium* with *Loranthus* or *Viscum* seeds attached, seeds *Cassytha* sp. and *Duboisia myoporoides*.
- Bernays, L. A., Brisbane; seeds of probably new *Nymphæa*, seeds of *Kentia* and *Ptychosperma*.
- Guilfoyle, W. R., Melbourne; wardian case containing *Alpinia cærulea*, *Coprosma microphylla*, and others; various seeds.
- Hector, Dr., New Zealand; seeds of *Pittosporum crassifolium*, *Olearia Haastii*, and various others.
- Hill, W., Brisbane; various *Cycadeæ, Platycerium alcicorne majus (P. Hillii*), seeds *Ptychosperma Drudei*.
- Moore, C., Sydney; poison plants of Santa Cruz Island, large collection of seeds.
- Mueller, Baron von, Melbourne; seeds of many interesting plants, *Atriplex vesicaria* (used as fodder), *Nuytsia floribunda*, *Duboisia myoporoides*, *Villarsia* spp., &c.
- Parr, Wm. Fillingham, Fiji; wardian case of choice plants, *Ptychosperma Seemanni, Sagus vitiensis, Dammara vitiensis, &c*.
- Schomburgh, Dr., Adelaide; wardian case of plants in variety.

Supply of Specimens for Science and Art Department, &c.

A supply of plants for the Art Schools and for the examinations in botany (about 16,000 specimens) of the Science and Art Department have been regularly furnished. A large number of specimens of flowering plants as well as other botanical materials have been supplied for the various examinations of the University of London.

Applications have been received from several medical schools in the metropolis for assistance in the illustration of the lectures on botany. To comply with this request would necessitate growing large quantities of a number of plants suitable for the purpose, and the matter has been referred to the Board, by whom it is still under consideration.

Indian and Colonial Botanic Gardens.

Exchanges and correspondence are constantly maintained between Kew and the numerous botanic gardens which exist in British dependencies. This constant intercommunication is, on the one hand, indispensable to the maintenance and perfection of the Kew collections, on the other hand, it is of great advantage in facilitating the exchange from one garden to another of the vegetable products of different parts of the Empire. I am anxious, however, to see the botanic gardens establish to a greater extent than at present a chain of independent interchanges, which would increase their own usefulness and enormously facilitate the work which is done at Kew. We have attempted, for example, to send plants to Fiji, but with but little success, on account of the great distance. Any particular plant could, however, be established in Ceylon with moderate difficulty; from thence it could be sent to Singapore, and so on to Brisbane and Sydney, and finally to Fiji. At each successive stage, in case of a failure, the difficulty of renewing the attempt would be much smaller than if it were necessary to start afresh from Kew.

I am the more led to make these remarks from having had my attention repeatedly drawn by applications made to Kew from residents in the colonies to the fact that some of the most important functions of a Colonial botanic garden, are often apt to be lost sight of. Such institutions are obviously likely in most cases sooner or later to develop into the pleasure grounds of the towns and cities near which they are situated. But without disparaging their public usefulness in this respect, it is important that their primary function of promoting the botanical interests of their respective colonies should not be forgotten. That there is some risk of this happening I can only assume from the constant applications made direct to Kew for information, seeds, or plants which it is clearly the business of the botanic garden of the applicants' colony either to supply or procure.

This leads to another point. No colonial garden can discharge its functions efficiently if the superintendent does not occasionally make journeys with a view to discovering new and interesting plants for the purpose of interchange with other establishments. But the demands made upon his time often prevent the superintendent attending to this part of his duty, which is so important in keeping up an imperial system of exchange, besides promoting the interest of the garden under his charge, and varying the monotony of a life of unintelligent routine. I am afraid that this is sometimes overlooked by the local governments and managers; one superintendent is tied by meteorological observations, another by growing vegetables for sale. In every case where some obstacle of this kind is allowed to override the legitimate freedom of action of the superintendent, I am convinced the interests of his establishment suffer in a variety of ways, and that the policy is a short-sighted one.

Bengal Cinchona Plantation.—

On the application of the Government of India, Robert Pantling was recommended from the Royal Gardens as a gardener for the Sikkim Cinchona plantations, and has proceeded to Calcutta.

Demerara Botanic Garden.—

The Government of British Guiana have for some time had under consideration the establishment of a botanic garden near the town of Georgetown. I am glad to say that this is now in a fair way of being accomplished. With the permission of the Government of Trinidad, Mr. Prestoe, the Government botanist of that colony, visited British Guiana during the month of September, for the purpose of deciding on a site and furnishing a plan.

Mr. Prestoe writes to me:—The country for miles on the seaboard is one dead level, and this unpleasant feature has been intensified by almost complete denudation in favour of sugar-cane culture. Along the coast the destruction of the 'Cuneda' trees is costing thousands of pounds for artificial breakwaters, to prevent the indefinite encroachment of the sea on the estates. 40,000*l.* was spent in two years by one company alone for a sea-wall, consisting of hardened mud and bastions, and another large proprietor has spent about 80,000*l.* in about the same time.

"The dead level operates fatally against the realisation of any design for really beautiful grounds that should, of course, be comprised in in any public gardens, except at enormous expense and prolonged delay, and thus the Guiana gardens will ever be under a great disadvantage. I trust, however, to be able to modify this disadvantage by the formation of a large ornamental lake. The parcel of land available for the gardens, &c. is about 140 acres, and in shape is a parallelogram. Almost the only large trees for miles round are a few Erythrinas, originally planted as an avenue across the ground, and but for these—fortunately a very good and striking feature—the ground is an open flat. The gardens will therefore be a new work in every particular. Extensive drainage works will, of course, be necessary, and the authorities are even prepared to effect it by steampump, if found necessary.

"The Lamaba fresh water canal (of 21 miles length) bounds the future gardens on the north side at an elevation of 4 or 5 feet, so that there will be a ready water supply for dry weather, which is sometimes excessively severe.

"In the design for the garden I intend to make provision for the cultivation of native timber and other economic trees as one of the most important features, with the double effect of familiarising colonists with the features and uses of the components of their vast forests, and furnishing material for study in connexion with forest conservancy, and especially to meet the great requirement of reafforesting the immense tracts of seaboard lands which have been and still are being abandoned for sugar cultivation."

Jamaica.—

Mr. Robert Thompson, Superintendent of the Botanic Gardens (in charge of the Cinchona plantations), has retired upon pension. The botanical establishments in the island are likely to be reorganised, with a view to making them more useful, and so opening up new industries. There seems no reason why the West Indies should not enter upon a new course of prosperity if they would endeavour to grow fruits and vegetables commanding a comparatively high price in the United States, instead of staple commodities like sugar, which there appears to be great difficulty in making remunerative.

Singapore.—

I regret to have to record the sudden death of G. Smith, whose appointment from the Royal Gardens as assistant to the Superintendent of the Botanic Gardens, Singapore, was noted in the last Report (p. 21).

Official Correspondence.

This department of the work of the Royal Gardens yearly augments both in the number of communications which we receive and the variety of the subjects with which they deal. The plan of recording in these reports some of the more generally interesting matters which are thus brought under our notice has proved very useful to our correspondents in distant countries. Large portions of the Report for last year have been reprinted in various colonial journals, and have been also translated into German. By giving this wide diffusion to carefully considered expressions of opinion, prepared in the first instance perhaps to meet a single inquiry from a Government department, a great deal of labour in replying on the same subject to successive applicants has been saved.

In matters dealing with the ravages of insects I have had to rely on the kind assistance of Mr. R. M'Lachlan, F.R.S., who has aided us with an amount of knowledge and patient research which the Government could hardly have counted upon obtaining at the hands of a scientific man not in official employ. It appears to me a somewhat striking anomaly that we do not possess in this country any practical entomologist in the service of the Government who would occupy the same position as those employed by several of the members of the United States of America. I do not overlook the existence of the Entomological Department of the British Museum; but the officers attached to it are necessarily occupied with the custody of the collections in their charge. What is wanted is a consulting entomologist who should be at the disposal of the different Government offices, and who should receive a retaining fee in return for investigating and reporting upon the various questions with regard to which, as will be seen from the following pages, the residents in various British dependencies are constantly needing his aid.

African Oil Palm for Labuan.—

In my Report for 1876 I stated that a correspondence had taken place with the Colonial Office on the subject of the introduction of the *Elæis guineensis* from the West Coast of Africa into the island of Labuan, and that I had taken steps to obtain seeds from Africa and also detailed information as to the methods in use there in the extraction of the oil. The substance of a very full report transmitted to me, through the Colonial Office, from Mr. Freeling, the Governor of the Gold Coast, was printed in the Gardeners' Chronicle for June 30, 1877, and was also sent to Labuan. A supply of fresh seeds was received from the West Coast of Africa in March of the same year, and despatched to Labuan, where they were received and planted on the island of Daat in the following August. Mr. Treacher, the Acting Governor, reports that 700 young trees were yielded by this experiment, and "notwithstanding a drought which was quite exceptional and lasted for nearly five mouths, flourished and were transplanted in July last." Mr. Burbidge (formerly engaged in the Royal Gardens), who is travelling in Borneo for Messrs. Veitch and Sons of Chelsea, saw the trees before and after transplantation, and pronounced them to be in the most healthy condition.

Anisoplia Austriaca at Taganrog.—

Copies of correspondence were received from the Foreign Office relative to the ravages of this beetle upon growing corn in Southern Russia, where it appears to have effected very great mischief. At our suggestion the matter was referred to the Entomological Society. A sub-committee was appointed by this body, and a very full report submitted to the Board of Trade by Mr. M'Lachlan, F.R.S., and Mr. C. O. Waterhouse. From this it appears that the *Anisoplia* is allied to the common cockchafer, but is much smaller. The larvæ feed upon the roots of corn and grasses, and form a cocoon probably at the end of the second year. In the following spring the perfect insect makes its appearance, and then becomes mischievous by feeding upon the green corn in the ear.

In 1867 there was a visitation of this insect in Hungary, and enormous numbers were caught by stretching a long cord over a field and drawing it along by a horse at either end, so as to dislodge the insects: these flew away and were afterwards collected by hand and destroyed. The sub-committee attached great importance to the collection and destruction of the greatest possible numbers of the perfect insects, and also to the protection of insectivorous birds. They thought that there was no reason to apprehend the recurrence year after year of such multitudes of beetles. Their extraordinary abundance in particular seasons was due to causes imperfectly understood, but which, it might be taken as certain, were not of constant operation.

Arrow-Poison.—

Living specimens of the plants which are used in making the arrow-poison of the New Hebrides were procured by Mr. Braithwaite, of the mission ship Day Spring," and conveyed to the Sydney Botanic Garden. At the instance of Fleet Surgeon A. B. Messer, examples were transmitted to Kew for identification (Kew Report for 1877, p. 42). They did not arrive, however, in a condition very suitable for determination,—indeed, dried specimens would have been more useful,—and upon two only can an opinion be pronounced with any certainty. That called Natoto is undoubtedly *Excœcaria Agallocha*, as had been previously made out by the Rev. Thos. Powell. Another sent without a name is *Vitis acuminata*, which is certainly innocuous. This is probably the plant called in Montague Island Na mamakaru, and in Sandwich Island Namkatikut. It is the only arrow - poison plant which could be described as a creeper, and the juice expressed from the cooked leaves is mixed with the other ingredients of the mixture used for coating the arrows.

Ascension.—

The small garrison at Ascension is almost entirely dependent for vegetables upon those which are raised in the island. The following report, which was transmitted by the Admiralty to Kew for advice, revealed a state of things which called for very serious consideration: "Three acres of cabbage and one acre of Kohl-Rabi were planted out in the weather gardens and promised to be a fine crop up to the end of November (1877), when they were attacked by the caterpillars and black grub in such numbers as to render it impossible to save them; this has been a great loss, as the cabbage would have supplied the island for some months; now only a few of the most forward will be fit for use . . . . The caterpillars and grubs are now so numerous that it is useless to put in any crops in the outlying gardens, the pastures are also alive with them, and they are doing much damage to the young grass.

"Five acres of land in the sheep-walk gardens have been prepared for planting sweet potatoes, &c., but the caterpillars have so damaged the young vines as to prevent any cuttings being taken from the plants saved for the purpose."

The first thing to be done was to ascertain the exact nature of the insects which did the damage. Acting on this suggestion, the Admiralty obtained and transmitted to Kew a collection of the larvæ and mature insects, and these were submitted to Mr. M'Lachlan for identification. He reported that it was probable that all had been introduced into Ascension, and that most of them were species of wide distribution.

The most mischievous kinds he considered to be the following; they are all Noctuid moths:—

Agrotis segetum, extremely common in Europe and very destructive. Found also in India, Cape of Good Hope, &c., &c. The moth is nocturnal, as is also the larva, the latter retiring into the earth during the day. This is the most to be dreaded on account of its abundance and concealed mode of life.

Prodenia retina, a moth of very wide distribution. There does not appear to be any record of its larva; having appeared in sufficient numbers to be injurious.

Plusia aurifera, a common African species.

Plusia U-aureum, the Ascension insect cannot be separated from that of the North of Europe.

Leucania, apparently identical with *L. Loreyi*.

It is noteworthy that the island of St. Helena has long been infested with similar insect pests, which, indeed, allowing for divergence of entomological determination, might even be identical with those of Ascension. Mr. Melliss informs me that the green caterpillar of *Plusia aurifera*, and the brown caterpillars of *Leucania extranea* and *Prodenia testaceoides*, are abundant in St. Helena, and are at times very destructive of vegetation, especially cabbage and Kohl-Rabi crops. In that island young broods of the common barn-door fowl and domestic duck are found useful in destroying these caterpillars, which they devour greedily. The black grub of St. Helena is *Agrotis obliviosa;* at times, particularly after one or more dry seasons, this is exceedingly destructive to crops. "The grubs," Mr. Melliss states, "are seldom seen above ground, but just beneath the surface they voraciously attack the young stems and shoots of vegetation. The earth-coloured moths are nocturnal in their habits and therefore are seldom seen. Both grubs and moths are of an exceedingly sluggish disposition, and do not readily migrate. General Beatson found that the best mode of ridding the land of them is to starve them by a clean fallow during the warm dry weather."

Various opinions were obtained as to the kind of birds which might be introduced into Ascension to keep the insects in check. The island being treeless, rooks would be unlikely to thrive. Sparrows also would be useless, because the grubs are subterraneous and too large for them to feed upon. The general agreement was that starlings would be most useful. Mr. Bartlett, of the Zoological Society, reports:—"No bird would answer better; they can be obtained in the spring in largo numbers; they are very hardy and easily kept on the voyage, and will thrive in any climate where insects are abundant." If the common starling failed, that known in Mauritius as the martin (*Acridotheres tristis)* might be tried.

Later in the year we were again applied to with regard to a beetle which was found very destructive to grape vines imported into Ascension from S. Africa. The specimens were submitted to Mr. M'Lachlan, who obligingly furnished a report upon them, from which I extract the following remarks:—"Mr. F. P. Pascoe, a specialist in exotic *Curculionidæ*., informs me that they belong to the genus *Siderodactylus*, which is peculiarly South and West African, and of limited extent. He considers the species not to have been previously noticed, and has named it *S. ornatus*. So far as I am aware, nothing has been previously recorded of the habits of the genus. The larvæ probably feed underground at the roots of herbaceous plants, and undergo their transformation in the earth. As remedies it might be desirable to dust the vines with powdered sulphur or with Paris Green, so much vaunted as a preventative against the attacks of the Colorado Beetle in America; or the beetles them-selves might be collected on sheets or circular nets placed round the vines, after being dislodged by a shake or sudden blow on the lower part of the stem."

Bahamas.—

I learn with satisfaction the continued success which follows the energetic attempts of his Excellency Governor Robinson to develop the agricultural industries of these islands.

The exportation of *Tomatos* has grown with extraordinary rapidity, as shown by the following figures:—

Governor Robinson thinks that there is no reason why the Bahamas should not, like the Bermudas, be able to send to the United States market 150,000 boxes of Tomatos annually of a value of from 10,000*l.* to 12,000*l.*

In July of last year *Onions* (of which I had sent out some of the best procurable European seed) were for the first time exported from the Bahamas. Governor Robinson states:—"Nearly 4,000 tons weight of Madeira onions are sent from Bermuda to the New York market annually, and I think it has been abundantly proved that it only requires in dustry and energy on the part of the farmers in these islands to enable them to enter into successful competition with those islands which have hitherto enjoyed something akin to a monopoly in the export of these products."

Governor Robinson also reports the exportation of *Tobacco* from the Bahamas for the first time in July 1878, when 2,000 lbs. of fine tobacco from Vuelta Abajo seed were sent to New York.

Bahama cigars have been also sold for export, to America at the rate of 40 dollars per 1,000.

"Thousands of cigars of native tobacco and manufacture are now smoked in this Colony, and though they fall far short of Havana cigars, I believe their radical defect is rather in the incomplete fermentation and cure of the leaf than in its inferiority to that of the plant grown in the island of Cuba."

Bamia Cotton.—

This appears to be nothing more than a fastigiate variety of Egyptian cotton (Kew Report for 1877, pp. 26, 27). This habit is a very common form of variation, the Lombardy poplar and Irish yew being well-known examples. Some disappointment has been expressed by the recipients of the seed (in the Bahamas, Fiji Islands, and elsewhere) which we distributed at the plant growing up with the ordinary bushy habit of the cotton plant. The explanation appears to be that when the demand set in for the seed and the price rose, it was unscrupulously adulterated.

Mr. Chapman reports from Alexandria:—"Here the Bamia plant is mostly a failure, requiring an immense amount of water, and growing too tall, as high as 15 feet."

On the other hand, Acting-Consul Calvert reports from the same place at the end of last year:—"The Bamyah cotton, introduced in this country four years ago, the cultivation of which is yearly increasing, is giving satisfactory results to the grower and consumer, and has commanded this season exceptionally high values, having obtained in Liverpool the classification of extra fine Ashmuni, and the comparatively small quantity available this season has been eagerly sought after."

It has been tried experimentally in various parts of India with varying success. The quality of the cotton has not appeared to be materially different from that of ordinary Egyptian.

Chinese Coffin-woods.—

The inquiries made at the instance of the Inspector - General of Forests in India with regard to the identity of the Nanmu wood, so highly valued by the Chinese for coffins, has elicited a good deal of additional information upon the subject. Mr. Cecil C. Smith, late Colonial Secretary at Hong Kong, has sent us a collection of 10 different kinds of wood used by the Chinese for coffins. He writes: "I regret much that I have been unable to give you the botanical names of the different kinds of wood, but you know far better than I do that without dried or fresh specimens of the trees producing them in flower and fruit it is impossible to ascertain their botanical origin. The wood is brought down from distaut places, and it is hopeless to get the specimens referred to from Chinese sources. The prices charged by different undertakers have been averaged, and I give you the figures in sterling. The extreme prices are not added, for they run out to fabulous amounts. In one case that I know of the coffin of a mandarin cost over 600*l.* It was, as usual, of wood alone."

I give Mr. Cecil Smith's list, as it is quite possible that a copy of this report may find its way into the hands of some person in China who may be able to assist us in the identification of some of these woods:—

- Pine from the upper four districts of Ting-chow, in Fokkien. Price 10*l.* to 150*l.*
- Pine from the Tsing - lan (river), in Ting-chow, in Fok-kien. Price 6*l.* to 100*l.*
- Pine from Lan - chow, in Kwang-si. Price from 4*l.* to 60*l.*
- Pine from Fu - chuen, in Kwang-si. Price from 4*l.* to 40*l.*
- Pine from Foo-chow, in Fokkien. Price from 4*l.* to 40*l.*
- Pak-heung or Fragrant Cedar from Kwang-si. Price 34*l.*
- Yan-sha from Sz-chuen. Price 80*l.*
- Wai-muk (or Mast End) from Kwang-si. Price 2*l.*
- Pine from Tung-kong (Eastern River) in Wai-chow, in Kwang-tung. Price 1*l.*
- Pine (common kind), named Sz-ui-luk, from Sz-ni, in Kwangtung. Price 15*l.*

The woods are all coniferous, but we have not succeeded in identifying any of them further. Nos. 1-5 probably all belong to the same species. The wood is dark, cedar-coloured, and exceedingly fragrant.

No. 6 is a pale compact wood, also fragrant. It is very similar in texture to the wood of *Cupressus funebris*, which is also said to be used in China for coffins.

No. 7 is a light wood of a dark cedar colour, very fragrant, and with very close annual rings.

Nos. 8-10 may all possibly belong to the same species. They are lighter, paler in colour, and Jess fragrant than Nos. 1-5. The value of all these woods, in the estimation of the Chinese, appears to depend upon their scent, and it is a question whether, seeing the high prices which scented woods command, it would not pay to import similar-kinds into China.

Cinchona-disease in Jamaica.—

Mr. Thomson, late Superintendent of the Botanical Gardens, Jamaica, has drawn my attention to a disease affecting trees of *Cinchona succirubra* in Jamaica, which first attracted notice in 1877. He describes the course of the disease in the following terms:—"A tree, say, 20 feet high, appears in the early stage of decline to be quite luxuriant, with the exception of a slight discoloration of the foliage; near the centre of the trunk, which is quite healthy above and below, a space varying from a few inches to a few feet is contracted; the bark is utterly dead, and the wood underneath the bark is equally affected. Towards the heartwood the wood becomes fresh, and through this the vital functions of the upper part of the plant are maintained irrespective of the lifeless condition of the bark, &c."

This description evidently points to the disease being quite local, and confined to the main stem some feet above the ground. That the roots are unaffected is shown by the lower part of the stem sending up young shoots freely after the death of the upper portion. Under the bark of the diseased trees a small wood-louse (*Podura*) is met with. The trees when diseased are also bored by a small Bostrychoid beetle, but this only appears to complete the destruction which is brought about independently.

On making a section of a diseased stem it is evident that the external portion of the wood, the cambium layer, and the bark are all perfectly dead, and there is little doubt that this is brought about by their being permeated by the mycelium of a fungus, the spores of which probably lodge in fissures of the bark, at the bottom of which the tissues are sufficiently soft to be readily invaded by the mycelial filaments produced by the spores. The injury caused to the tree by the diseased condition of the young wood and bark of the stem is exactly of the same kind as is effected by ringing. All above the zone of injury dies, while the stem below remains unaffected and is capable of throwing up vigorous shoots.

Fortunately the number of trees attacked is comparatively small. The disease, which is doubtless quite incurable, will be best met by felling the trees and securing the bark as soon as they appear unhealthy. All the waste and *débris* should be scrupulously burned. The base of the stem will generally coppice freely if it is thought worth while to take advantage of that method of renewing the plantation.

Cinchona febrifuge.—

Dr. King reports:—"Increased experience in the use of the new medicine during the past year has served to establish a large amount of confidence in it. Complaints of its nauseating are now rarely heard, and many medical practitioners of experience affirm that instead of being less potent in the cure of fever than quinine, the Cinchona febrifuge is quite equal, if not superior, to the more expensive drug. The proper dose of the febrifuge is, moreover, found to be about the same as or even less than the dose of quinine."

The nausea and vomiting which the febrifuge has been credited with producing appear to have been the result of the too large doses which were given. Similar effects would have followed from equally large doses of quinine. The presence of aricine in the febrifuge, to which these unpleasant effects were attributed, appears to be doubtful, according to Dr. O. Hesse (Pharm. Journ. 3rd ser., vol. ix., p. 839).

"Quinine," Dr. King states, during the year 1877-78, was very high in price, and in Calcutta it for some time stood at 20 rupees per ounce, a sum for which 16 ounces of the febrifuge were always obtainable. The saving to Government by the substitution of Cinchona febrifuge for quinine in their hospitals and dispensaries has already been considerable. I calculate that at a moderate estimate it amounts to over three lakhs of rupees (30,000*l.* sterling)."

Cocoa-nut Beetle in Zanzibar.—

Dr. Kirk has sent us specimens of a beetle whose larva is very destructive to cocoa-nut trees from two to five years old. Until the time of the hurricane the plantations suffered little, but after the scope given for their development by the thousands of rotting and fallen palm trunks, they became a serious danger, and plantations often lost 25 per cent, of their young trees. These may be saved by cutting out the larva when the chewed leaf seen on the outside of the shoot shows that the plant has been attacked. If the central shoot is destroyed by the larva, the plant either dies or puts out a lateral shoot; this only happens when the plant is very young.

The beetle sent by Dr. Kirk was identified by Mr. M'Lachlan as *Oryctes monoceros. O. insularis* destroy cocoa-nuts in Reunion, and another species is very injurious in Penang. He suggests that all fallen trees should be burned, and that infected trees should be cut down and destroyed as soon as possible.

Coffee-disease in Ceylon—

The devastations of the Ceylon coffee plantations by the microscopic fungus *Hemileia vastatrix*, and the energetic attempts which have been made to check them by the discovery and application of remedial agents, have been followed at Kew with deep interest, and have involved much correspondence. I regret to add, from intelligence recently received, that the island of Java, in which, at the end of March of the present year, it made its appearance simultaneously in several distant spots, must be added to the list of countries afflicted with this pest.

The early history of the *Hemileia* has been sufficiently detailed in the Kew Report for 1876, pp. 18-20. The investigations of the Rev. R. Abbay, which were referred to as in progress, have been communicated to the Linnean Society and published in its journal (vol. xvii., pp. 173-184). They, doubtless, leave points on which further research is desirable, and possibly others which are susceptible of correction; but we are so far indebted to the Rev. R. Abbay for the first detailed account of the life, history, and morphology of this most important organism.

Copies of the plates which accompanied Mr. Abbay's paper are distributed with this report, and will Drawing of Hemineia Vastatrix Drawing of Hemileia Vastatrix be intelligible with the following descriptive references.

Plate XIII.

1. Portion of leaf (half natural size) with disease spots. These are at first pale, afterwards becoming orange-coloured, and covered on the under surface with a bright yellow, then orange-coloured dust. The dark spot in the centre is due to the presence of another but unimportant fungus, a black *Aspergillus*.

2. Portion of cuticle of under surface of leaf viewed from outside, showing stomata and clusters of sporangia (which contain the spores), the aggregate of which forms the dust above mentioned × 150.

3. Portion of cuticle of under surface of leaf viewed from inside, showing mycelial filaments connected

with dark bodies, which exteriorly bear the sporangia × 150.

4. Dark body extricated from the leaf; it bears a cluster of sporangia above, and has the mycelical filaments attached to it below × 200.

5. 6, 7. Mycelium from the interior of a "diseased" coffee leaf × 350.

8, 9. Clusters of sporangia, from which the ripe individuals have been separated by washing × 400.

10, 11, 12. Figures showing structures (possibly some parasitic organism) found on sporangia clusters from Sumatra × 250.

Plate XIV.

1, 2. Sporangia with stalk detached × 800.

3. Sporangium with contained spores × 800.

4, 5, 6, 7, 8. Spores with and without attached fragments of sporangia × 1,000.

9, 10. Spores germinating within a sporangium × 600.

11, 12, 13. Spores germinating × 1,000.

14, 15. Mycelium produced by germinating spores × 500.

16, 19. Mycelium with immature conidial fruit; 16 × 700; 19 × 500.

17, 18. Mycelium with granulated protoplasm; 17×700; 18×1000.

20. Mature conidial fruit × 1,000.

21. Conidium germinating × 1000.

The disease has also been studied in Ceylon by Mr. Morris, Assistant Director of the Royal Botanic Gardens, Peradeniya, from the practical point of view of finding some means of combating its attacks. Mr. Morris was eventually detached entirely to this duty, with the permission of the Government and the approval of Dr. Thwaites. The following is a brief summary of his results:—The *Hemileia* is, of course, propagated from year to year by spores which, if Mr. Abbay is correct, are contained in the sporangia forming the orange-coloured dust on the under surface of the leaves of diseased plants. These sporangia become detached, and are powdered over the leaves, twigs, branches, and stems of the coffee plants, and on the ground beneath. They are also blown about by the wind, but, except this is very strong, are probably not carried to any very great distance.

The spores germinate and produce the filamentous or thread-like mycelium described by Mr. Abbay. Mr. Morris found that in infected plantations, although invisible to the naked eye, it could be shown by the microscope that in what may be called its *first stage*, the filaments of the *Hemileia*, covered—however little this might be suspected—the ground and every part of the stems, branches, and leaves of the coffee trees growing upon it. It continues generally in this stage from December to March. During this period, besides the vigorous growth of the mycelial filaments, the fungus possibly multiples itself by the forma- tion of reproductive bodies called conidia, which are detached from the filaments, and germinate and grow precisely in the same manner as spores.

The *second stage* begins where the filaments enter the stomata on the under surface of the leaves. They now assume a thicker, more branched, and coral-like aspect as they ramify amongst the loosely packed intercellular tissue of the interior of the leaves. The ends of the branches of the mycelium come in contact with individual cells, tap their contents, and progressively destroy them, feeding on their contents.

This continues till the last or third stage is reached. The filaments having reached maturity once more, push their way through the stomata and produce on the outside the clusters of orange-coloured kidney-shaped sporangia.

Mr. Morris has clearly shown that it is only in the first stage, when the *Hemileia* is purely external in its mode of life, and has inflicted little or no injury upon the coffee plants, that it can be advantageously attacked. To the extent to which the mycelium can be destroyed in this stage without interfering with the health of the coffee plant will be proportioned the alleviation of the further and injurious stages of the disease and its chance of perpetuation to another season. The most important of the numerous remedies which have been proposed may be briefly noticed.

1. *Mr. Wall's method of Fumigation*.—Mr. Morris finds that "the fumes of burning sulphur, whether applied by the aid of umbrellas or in the open field, have invariably had an injurious effect upon the trees, and, by causing them to shed their leaves, have aggravated the disease they were intended to cure. What is still more conclusive with regard to this method is that fumigation has not in the least degree diminished the amount of leaf disease."

2. *Mr. Northmore's Salt-water Treatment*.—Mr. Morris has found that neither sea-water nor solutions of sea-salt have any effect in killing the *Hemileia*.

3. *Mr. Morris' Sulphur-lime System*.—Mr. Morris writes:—"I have obtained very important results with a

mixture of sulphur and coral-lime in the proportion of one to three. The action of the sulphur seems to be much quickened and the cost reduced to almost a third. In addition to this, no special blower is required, for a cooly supplied with the mixture in a bag can powder the tree very effectually by hand, and the smallest quantity of the powder deposited on the under side of the leaves is sufficient to destroy the filaments very thoroughly. The planters can now treat the whole of their estates in a week or 10 days, and at a cost not exceeding *50s*. per acre. I cannot hope to see anything more satisfactory than this. The coral-lime used, which must be unslaked, will prove a valuable dressing to the soil, and thus the leaf-disease specific, pure and simple, viz., the sulphur will cost only 20*s*. to *25s*. per acre."

Cyprus.—

The occupation of this Island by the British Government led to much information, especially with regard to the forests, being sought from this establishment. The amelioration of the swamps, which it was hoped might be effected by planting *Eucalyptus*, was also eagerly desired, and some mistakes were perhaps made in the laudable wish to effect something with as little delay as possible. My suggestion that an Indian forest officer should be sent to the Island to survey and report on the existing forests, and the best mode of utilising and preserving them, was adopted, and Deputy-Conservator Wild, who was detached to this service, has sent home an excellent report. Packets of seeds of *Eucalyptus*, and other trees and shrubs likely to be useful, have been procured and sent out to Cyprus from Kew.

Dragon's Blood of Africa.—

This drug, which now only rarely finds its way into commerce, has been known in medicine from the earliest historical times. Under the name of Cinnabar its African origin is mentioned by Discoride's, and it is recorded by a writer attributed to the first century as the production of the Island of Socotra.

Till quite recently nothing has been known as to its history. Dr. Hildebrandt, however, discovered in Somaliland a *Dracæna*, which yielded Dragon's Blood. The specimen of this plant in the Kew Herbarium consists unfortunately of nothing more than an inflorescence; it has, however, afforded Mr. Baker sufficient data for the description of the plant as a new species under the name of *Dracæna schizantha* (Journal of Botany, 1871, p. 77). Hildebrandt himself speaks of it as having a habit resembling that of *D. Draco* (Berlin, Monatschr des Gartenb., 1878, p. 313). A species closely resembling the latter, but quite distinct from *D. schizantha*, is the plant found in Nubia, and imperfectly described by Kotschy and Peyritsch under the name of *Dracæna Ombet*. There can be little doubt that this would supply Dragon's Blood no less than the well-known Dragon's tree of the Canaries.

We possess now at Kew a fine young living plant of the *Dracæna* which yields the Dragon's Blood of Socotra. For this we are indebted to Mr. W. Wykeham Perry, of H.M.S. Undaunted, which during the past year was stationed at Aden. The want of definite information about the Socotra plant which is pointed out in the Admiralty Manual of Scientific Inquiry attracted Mr. Wykeham Perry's notice, and with the aid of Captain Hunter, Assistant-Resident at Aden, he obtained for us a fine specimen which had been brought from Socotra, as well as the Myrrh and Frankincense plants to be hereafter referred to.

Mr. Baker identifies the Socotra *Dracæna* (having made a special study of the genus) with *D. Ombet*. But in the absence of flowers the identification cannot be regarded as final, and the plant might even turn out to be the same as that of Somaliland.

Mr. Wykeham Perry obtained the following information respecting it from Captain Hunter:—

"The tree grows only at an elevation of about 1,500 feet above the sea. The natives of Socotra state that the tree is dioecious; that the male and female plants grow at a distance from each other; that the fruit is a berry in clusters, and that the plants of both sexes yield gums.

"The difference in the appearance of the two trees consists in the presence or absence of short stumpy branches from which the head of spiky leaves springs. It is not until the tree is a few years old that any difference in growth appears. In the male tree the branches appear to be thrown out to an unlimited extent. In the female there are no branches at all, but the stem is sometimes forked. It grows to the height of 20 feet, and some-what resembles a mushroom in appearance.

"To obtain the drug called Dra- gon's Blood the bark is scraped, and after 15 or 20 days the gum exudes and is collected in March. It is chiefly exported from Aden to Bombay, where it is used by the goldsmiths."

I learn from Captain Burton that a similar, if not the same, *Dracæna* abounds in parts of Arabia visited by him [see Proceed. R. Geogr. Soc.], and this corroborates the older statements of Welstead to the same effect.

Eagle-wood.—

The Forest Report for British Burma for 1876-77 contains an interesting account of this singular product, the Akyaw of the Burmese and Kayu-garu of the Malays. It is obtained from the islands in the Mergui Archipelago, of which it is the only valuable article of forest produce. Akyaw has been described as consisting of "lumps of hardened scented resin found imbedded in the trunk." But it is clear that this is not exactly the true state of the case, as the hardened masses are always composed of a basis of more or less decayed wood, the tissues of which are infiltrated with the resin. It is found in all parts of the trunk of the tree; and most frequently in the alburnum, but only where decay following intentional or accidental injury has attacked it. By artificially injuring the growing tree in a systematic manner the yield might probably be increased. It is generally believed to be produced by *Aquilaria Agallochum*, Roxb., but the native collectors state that there are two kinds of trees which furnish the Akyaw, but that the substance from both is identical. The great bulk of that which is collected is sent to Penang and Singapore and shipped from thence to China, where small pieces are used for torches, incense, and medicine. In the islands of the Mergui Archipelago it is estimated that 8,000 trees are cut down every year, and the extermination of the tree in all readily accessible places is only a question of time.

Eucalyptus.—

The Inspector-General of Forests has forwarded to Kew for identification specimens of a species which grows well in the Changa Manga plantations in the Punjab. It proved to be *E. melanophloia*.

In Mauritius finds that *E. calophyllus* does particularly well, and has now raised 30,000 seedlings from seed produced in the island.

Frankincense.—

Amongst the living plants sent to Kew from Aden by Mr. Wykeham Perry were several living examples, probably the first which have ever reached this country, of the species which produce the gum resin Olibanum or Frankincense. They were accompanied by a manuscript drawn up by Captain F. M. Hunter, Assistant-Resident at Aden. This contains a great deal of valuable information, which it is to be desired that Captain Hunter would publish in full. Notwithstanding the careful researches of Mr. Carter, Dr. Birdwood, and others, there is much evidently still to be done in the botanical determination of the plants which, as will be seen below, the native collectors of the gum discriminate.

According to Captain Hunter there are four distinct sources of the names which attach to the Olibanum of commerce:—

- The Somali name of each kind of Olibanum yielding tree.
- The Somali name of each kind of Olibanum.
- The Arab name for each commercial sort of Olibanum after blending of the different kinds and reassortment.
- The name derived from the place of export.

A further complication arises, according to Captain Hunter, from the fact that the Somal names vary in different parts of the country east and west of the 47th meridian of longitude. He thinks there are in all five different kinds, as follows:—

1. *Mohr Lafôd*.—Captain Hunter remarks that "it is not improbable that *Mohr Ad* and *Mohr Lafôd* are the same. The gum of the latter is, however, obtained in strips, occasionally upwards of a foot long, but *Mohr Ad* is said never to yield such lengthened tears. *Lafôd* is probably derived from the Arabic *lafeh*, plural *lafât*, strips (especially of a turban), the Somal giving a *d* sound to the feminine Arabic termination. *Ad* in Somali is an adjective root meaning white. The name is given either because the bark is light coloured or because the gum is whitish. Both the *Mohr Lafôd* and *Mohr Ad* are described as growing on the coast range, especially near water-courses."

Mohr Lafôd has produced leaves at Kew. It would be premature, perhaps, to pronounce any definite opinion upon it in its present state, but it is probably a smooth-leaved form of *Boswellia Carterii*, Birdw. *Mohr Ad*, which reached Kew dead, is identified with *Boswellia Bhau-Dajiana*, Bdw., which may be itself an extreme form of *B. Carterii*.

2. *Madao*, Captain Hunter states, "is a Somali root meaning black. The name is either derived from the dark colour of the bark or because the gum of this variety becomes black on exposure to the air. This tree is comparatively rare, and its gum is not held in much estimation, as it is sticky, and when mixed with other varieties is apt to discolour them and afterwards injure their market value. *Mohr Madao* is referred to *Boswellia Carterii*, Bdw.

3. *Dadbêd* and *As* are supposed to be the same. "The tree is common near the sea. The gum is reddish in colour." No specimens of this kind were sent to Kew, and absolutely nothing is known about them.

4. *Karâon*.—"This tree is alleged to be more rare, and to grow isolated on the tops of hills. The gum is held in little estimation, and is only mixed with the others to increase quantity and weight." Nothing is known of this plant, and the specimens received at Kew have not grown.

5. *Yegaar*.—The gums of the four preceding kinds are all mixed together by the Somal to be subsequently divided into two qualities, the best of which is again assorted by the Arab traders. *Maieti* (which is the same thing as *Lubân Matti* of commerce) is the produce of the plant called *Yegaar,* which is known to botanists as *Boswellia frereana,* Bdw.; it is never assorted or mixed with the other kinds. Captain Hunter informs me that it is said not to grow westward of the 46th meridian of longitude. In Socotra there is a tree called by the natives *Amîru* which strongly resembles the *Yegaâr,* and its gum is even more pungent. Nothing is known botanically of the *Amîru*.

"Without drawing further upon Captain Hunter's valuable notes, it will be evident that much remains to be done to place our knowledge of Frankincense yielding trees upon a really satisfactory footing.

Captain Hunter also brought to this country a collection of authentic specimens of all the different kinds of Frankincense met with in com- merce, with their distinctive names. Unfortunately, in the Custom-House examination all the contents of the several boxes got hopelessly mixed, and the collection was valueless for purposes of study.

Gutta-shea.—

Shea butter is a vegetable fat, extracted by crushing and boiling from the seeds of *Butyrospermum Parkii,* a member of the family *Sapotaccæ*. Since 1851 it has been brought to this country from Western Africa in gradually increasing quantities, and the annual import is now said to amount to from 300 to 500 tons. It is principally used for soap-making. It does not make a very good detergent soap, but it makes an excessively hard one, and is therefore useful for mixing with other kinds in manufacturing soaps for domestic purposes.

Mr. W. Henderson, of Glasgow, has sent to the Kew Museum a specimen of a substance which has attracted some attention, and to which he has given the name of Gutta-shea. It is present in Shea butter to the amount of .5 to .75 per cent. It appears to resemble in many respects gutta-percha, but is more brittle. It is insoluble in alcohol, a mixture of alcohol and ether, acids, and alkalies. It is slightly soluble in pure ether and ordinary animal and vegetable oils and fats. From the extremely small proportion in which it is present in Shea butter, its extraction would not be profitable. And regarded as a bye-product, it does not appear to be suitable for any purpose to which gutta-percha itself is applied. The Kew Museum possesses a specimen of a substance akin to the latter in its properties which is yielded by the Shea butter tree. It is possible that the so-called Gutta-shea, which is present along with fatty matter in the seeds, may have some connexion with this.

India-rubber.—1.

Ficus elastica.—

The future supply of India-rubber being a matter of so much interest, it will be interesting to note Mr. Mann's operations in the cultivation of this important species in Assam, which are detailed in his report for 1876-77, received at Kew at the beginning of last year:—

"The planting of caoutchouc-trees has not as yet emerged altogether from the experimental stage, for although no doubt remains that the tree will grow most luxuriantly in the locality chosen, the different ways in which the young trees have been planted did not all succeed equally well. The plants planted in cane baskets in the forks of trees, although many of them are alive and healthy, remained stationary, or almost so. Many of the trees planted simply in the ground also did badly, and there is no doubt that Rubber-trees should not be planted in this way.

"The trees planted on low split stumps or in earthenware cylinders on low stumps of trees, on piles of wood put crossways and mixed with earth, and on small mounds of earth about 2 to 3 feet in height, have all done exceedingly well; all plants will in future be planted on mounds of earth, stumps, piles of wood, or what-ever is most handy, raised about 3 feet from the ground."

Mr. Mann found that the best cuttings do not transplant so well as seedlings, and that raising plants from seed is the method of propagation which must be chiefly depended on.

In a subsequent report, which reached Kew at the close of last year, he gave further particulars of this enterprise, explaining, amongst other matters, that "drainage about the roots is insured by planting upon mounds." The total area under cultivation at Charduar was 572 acres, 112 acres additional having been cleared for planting.

2. *Fijian India-rubber*.—

In the last Kew Report (pp. 31, 32) reference was made to two plants from Fiji which were said to produce rubber. One of these was identified with certainty as *Alstonia plumosa*. The other was referred with doubt to *Tabernæmontana pacifica*.

From ampler materials collected by Mr. Horne, the Director of the Botanic Garden, Mauritius, during his visit to Fiji, it appears that the plant described by Seeman under the latter name is probably not really itself distinct from *Alstonia plumosa*, and it is therefore not improbable that both the caoutchouc-yielding plants in Fiji belong to this species.

Two other species of *Alstonia* also yield caoutchouc. One of these is *A. scholaris* (see Journ. Soc. Arts, 1864, p. 30), which is widely distributed through the tropics of the old world. The other is *A. costulata*, a native of the Malayan archipelago, which is described by Maingay as "abounding in pure caoutchouc."

3. *Hevea in British Guiana*.—

Mr. Prestoe, Government botanist of Trinidad, whose mission to British Guiana has already been adverted to, informs me that he met with a species of *Hevea* at the penal settlement on the Mazaruni river. Mr. Prestoe writes to me:—"The three plants you kindly sent me last year enabled me to detect the tree on two islands in the Essequibo—of course at a distance. I secured some 50 seedlings. Darkness and the departure of the steamer prevented my doing more; but I have no doubt, from what I saw, that this tree exists in the forests of Guiana in unbounded plenty. Some of the leading colonists knew of the India-rubber being sometimes collected by the Indians, but I met with no one who had any notion of the tree producing it, the supposition being that it was produced by a species of large-leaved *Ficus*."

Mr. Prestoe forwarded leaves of the *Hevea* collected by him. It is identical with a plant collected in British Guiana by Dr. Hancock, and is probably *Hevea pauciflora*. It is remarkable that the existence and uses of so important a plant in the forests of British Guiana should have so long remained in oblivion, and Mr. Prestoe's detecting it during his brief visit to the colony is an instance of the services which botanical science in the hands of an energetic official can render to colonial industry. The matter is of the more importance since the exportation from the colony of Gum Balata, which at one time attracted considerable attention, has now almost ceased.

4. *Liberian Rubber*.—

Mr. Thomas Christy has introduced a new rubber plant to this country from Liberia, which we succeeded in identifying at Kew with *Urostigma Vogelii*, a species first collected at Grand Bassa by Vogel, and described in the Niger Flora. It belongs to the same family as the fig. The rubber is made up into balls about the size of a large orange. It is valued in the London market at Is. 6*d*. per lb., and if sent home cleaner would command a higher price.

5. *Malayan and African Rubbers*.—

These products have the point in common that they are produced by nearly allied, though distinct, climbers belonging, like *Alstonia* referred to above, to the natural family *Apocynaceæ*. Much information about them, accompanied by specimens and sketches, has been received at Kew from Mr. Murton, Superintendent of the Botanical Garden, at Singapore, Mr. Burbidge, during his travels in Borneo for Messrs. Veitch, Mr. W. H. Treacher, the Administrator of Labuan, and Dr. Kirk, Her Majesty's Consul-General at Zanzibar. The complete study and examination of these materials has not yet been completed, and the results will be given in the next Kew Report.

Madagascar Baobab.—

Some seeds imported into Liverpool in considerable quantity from S. W. Madagascar were identified with some difficulty as those of a Baobab, and I have little doubt that they are those of the tree described by Baillon as *Adansonia madagascariensis*, but of which the Kew Herbarium possesses no specimens. The Rev. J. Richardson, in the interesting account of his journey to St. Augustine's Bay, printed at the Mission Press at Antananarivo, describes in the following terms an individual which he met with of this curious species:—

"On the banks of a stream we saw the most ugly specimen of a tree that I have ever beheld . . . . It is a Baobab (*bontóna*) tree. The height of the trunk is about 12 or 14 feet, while its diameter, about 6 feet from the base, is 22 feet; its branches are most insignificantly small. It looked like a fat two gallon bottle, the neck of which had been knocked off, and a few birch twigs placed there instead!"

Myrrh.—

"It must be confessed," remarks Hanbury (Pharmacographia, p. 125), "that the botany of the Myrrh trees is still encompassed with uncertainty." It was, therefore, with peculiar interest that a complete set of the plants yielding the several kinds of Myrrh known in eastern commerce were received at Kew from Mr. W. Wykeham Perry, who obtained them from Capt. Hunter at Aden.

These plants were in a living but leafless state when they reached Kew. Being mostly destitute of roots, which could not be readily extricated from the stoney soil in which they originally grew, only few of them are likely to survive, and they have, therefore, not yielded all the information which they would undoubtedly have afforded had they grown and flowered. The following notes will, however, show that they have added something to our knowledge.

1. Myrrh proper.—

Mr. Wykeham Perry sent two large plants of the kinds which yield true Myrrh. They have lived, as he hoped would be the case, to reach England, but having no roots can hardly be expected to survive or put out any growth. They had before their last journey made others of many weeks without earth, and had sprouted after being placed in sand in Capt. Hunter's garden. One came from the Somali Coast near the 47th meridian of longitude. Its gum is called by the Arabs *môr*, by the Somal *mulmul*, and by Indians *Hîrabol*. The tree itself is called *Didthin* by the Somal. The same plant was collected by Hildebrandt in Somali land in 1873; it has been identified by him with the *Balsamo-dendron Myrrha* of Nees von Esen-beck, who collected it at Ghizan, on the Arabian coast of the Red Sea (see Trimen, Pharma. Journ., 3rd ser., vol. ix., pp. 893-894). The other specimen was sent as "the true Myrrh tree of Arabia." It came from the hills in the Fadthli district, some 60 miles from Aden. "It was believed to be the same species as the Somali plant." This may be so, but it is wanting in the excessive spininess of *B. Myrrha*, and a small flowering branch previously received from Mr. Wykeham Perry appeared to agree with *B. Opobalsamum*, Kth., found in Abyssinia by Schweinfurth, and which is believed to be identical with the *B. Ehrenbergianum*, Berg, from the Arabian coast of the Red Sea. According to Hanbury, *B. Opobalsamum* is a Myrrh-yielding plant, and if it affords the Myrrh of Southern Arabia, that would account for the difference of quality which is found in Arabian Myrrh as compared with the African, which is doubtless the produce of *B. Myrrha*. It will be obvious that good dried herbarium specimens of Myrrh-yielding plants are still a desideratum to botanical science.

2. *Bêsabol*.—"This drug," says Hanbury (1. c., p. 129), "is of African origin, but of the plant which yields it nothing is known." Mr. Wykeham Perry has sent us two specimens of it, and these fortunately have produced abundance of foliage. They cannot be botanically identified with any certainty at present, if indeed the species be not hitherto undescribed. It, however, is evidently allied to *Balsamodendron Kataf* Kth., a species first described by Forskal under the name of *Amyris Kataf*. He had only seen it in Arabia in a cultivated state.

Mr. Wykeham Perry informs me that the plant sent by him is called by the Somal *Hâdi*, and its gum *Habaz Hâdi;* it is purchased almost entirely by Indian merchants for export to Bombay, and is by them called Bêsabol. It is found only in the centre of the Somali promontory, and not in Arabia at all. Forskal relates that the gum of *Balsamodendron Kataf* is used by Arab women for washing their hair, which is precisely the purpose for which that next to be mentioned is employed in Somaliland.

3. *Hodthai*.—This is a plant *(Balsamodendron Playfairii*, HK. f.) of which the Kew Herbarium possesses excellent specimens, for which it is indebted to Col. Playfair, who collected them on the Somali coast. The use of this gum is said to be confined to the Somal themselves, who use it, as stated above, as a hair detersive.

Orange-fly of Queensland.—

We have received through the Colonial Office specimens of "a fly which attacks the oranges, lemons, and peaches, and causes great damage in the orchards. It is not found in very dry weather, but as soon as rain sets in it becomes plentiful and very destructive. Moths afterwards use the opening made to suck the juice of the fruit." Mr. McLachlan having examined the specimens, reports that it is allied to, but probably distinct from, the genus *Ceratitis*, known as destructive to oranges in Madeira.

Paich'ha as a Substitute for Boxwood.—

In the Gardeners' Chronicle for April 20, 1878, Mr. Jean van Volxem has drawn attention to a Chinese wood largely in use at Ningpo for wood-carving, and which he considers suitable for engraving purposes as a substitute for boxwood. Mr. W. M. Cooper, Her Majesty's Consul at Ningpo, has obligingly furnished me with the following information upon the subject:—"The tree and wood are common here; it is known as Pai-ch'ha (literally white tea or camellia). The Chinese language is a bad one for nomenclature, and the compound of two words has a different meaning to their primitives. The wood in universal use for book-blocks, wood-engravings, seals, &c. is that of the pear-tree, of which large quantities are grown in Shang-tung, and Shan-se especially. Pai-ch'ha is sometimes used as an indifferent substitute. Pai-ch'ha is a very white wood of fine fibre, without apparent grain, and cuts easily, is well suited for carved frames, cabinets, caskets, &c., of which large quantities are manufactured here for export. The tree itself resembles somewhat the *Stillingia*, but has a rougher bark, larger and thinner leaves, which are serrated at the edge, more delicate twigs, and is deciduous."

"Boxwood is known as Huangzang (literally yellow poplar). In the south of this province and Fuk-kien boxwood is grown principally for native furniture and export to Japan. It is prized on account of its durability and freedom from warping; it is sold by weight at prices varying from to 6 dollars (of 3*s.* 10*d.*) per picul of 133 lbs. English."

Mr. Cooper sent fruits of the Pai-ch'ha, which proved to be those of an undescribed species of *Enonymus*.

Paper Materials.—1.

***Bamboo*.—**

The possibility of utilising profitably the young stems of bamboo as a paper material is still attracting—mainly owing to the untiring enthusiasm of the well known paper-maker Mr. Routledge—a good deal of attention both in the East and West Indies. The excellence of the paper which can be made from it is not contested, and I am informed that there are some especial technical merits about bamboo paper-stock which in the eyes of the manufacturer make it particularly desirable. There is no reason to suppose that these are peculiar to the particular species of bamboo, *Bambusa vulgaris*, which, originally a native of Tropical Asia, is now widely cultivated throughout the tropics of both hemispheres. They are, no doubt, shared, more or less, by all the members of this family of arborescent grasses, which are far more numerous and distinct than is generally supposed by those who are not botanists. The species of *Guadua* in Tropical America are therefore quite as suitable for Mr. Routledge's experiments as the species of *Bambusa* and *Dendrocalamus* of the East Indies.

The point which at present has to be settled is whether bamboo forests and plantations can be so managed as to yield year by year a regular supply of young stems suitable for the paper-maker's purpose. The further question then arises whether this can be done at an expense which will leave the manufacturer a working profit. The importance of the first point has already been pointed out in former reports, and has been clearly insisted upon by Dr. Brandis in his instructions to the Indian Forest Department:—"A method of treatment must, if possible, be discovered by which a plantation or natural forest of bamboos may be made to yield a succession of complete crops of young shoots throughout the year. Our present experience is that a large proportion of old stems is required in a bamboo clump to produce full-sized shoots. . . . Under ordinary circumstances, if bamboo clumps are cut over in the forest, all mature stems being cut down at one time, the result is a crop of slender stems." Dr. King has stated the same fact in his report on the Calcutta Gardens, published last year (July 10, 1878): "It is pretty well known that bamboo clumps, if entirely cut down, yield for several years but few and small succulent shoots, and, in fact, not unfrequently die."

In British Burma the stems of bamboo are applied to an immense number of useful purposes, and the practice of obtaining a supply of stems without destroying the clumps appears to be well understood. Dr. Ribbentrop, the Conservator of Forests, reports:—"The bamboo jungles near villages on the Pegu choung prove that constant cutting does not materially affect the reproduction, and cutting them down within a couple of feet from the ground maintains a perfectly unimpaired action of the roots, as may be observed on the bamboo hedges in Rangoon. At the same time, a bamboo plantation cannot be kept indefinitely without restocking. This has been the case with the artificial plantations of *Dendrocalamus Brandisii* in Burma, the original stocks of which die after about 60 or 70 years; others would be doubtless shorter lived. The *Dendrocalamus Brandisii* plantations in Burma are kept up by interplanting with new stocks."

The Rev. C. Parish, the well known botanist, who has long resided in Burma, is of opinion that when the bamboo is well estabisbed it may be cut annually. "The shoots should not all be cut every year, for if this were done the root-stock would die; only about half the clump should be cut yearly."

If a regular supply of, the stems suitable for paper making can be organised, there seems no reason to doubt there being a more than abundant area of supply. Dr. Brandis states:—"It will interest you to learn that there are about 1,800 square miles of almost pure bamboo forest in the Arrakan division of British Burma, within a moderate distance from the coast, and all accessible by navigable streams." The latter is a point of great importance, as the carriage of the bamboo stems is one of the practical difficulties in utilising the material. Mr.

Routledge points out that to compete with other materials, it cannot, on account of its bulky nature "possibly be imported from the tropics in its raw or natural condition, or even if crushed and dried. It must be made into stock—a fibrous or tow-like condition, which will enable it to be baled up under hydraulic pressure, occupying no more space than cotton or jute, and thus delivered to the paper maker ready for bleaching and converting into paper."

It of course remains to be seen if this can be done at a remunerative cost. Dr. Schlich, the Conservator of Forests in Bengal, is decidedly of opinion that it cannot. He states:—"Experiments recently made in the Central Provinces, where labour is cheap, prove that it will cost twice as much to produce the paper-stock than paper manufacturers are willing to pay for it, and this, irrespective of the original price of the bamboos."

Mr. Thomson, the late superintendent of the Cinchona plantations in Jamaica, is very sanguine as to the success of the project in the West Indies. He wrote to me August 23rd of last year:—"Some two thousand tons of bamboo were cut and shipped to America from a limited area (within a few miles) four years ago; much of tins was cut from the same stools twice in three years, and I have lately seen acres of these bamboos that were cut *en masse* four years ago quite as luxuriant in every respect as other clumps that are never cut"

He further wrote to Mr. Routledge:—"It is well known that generally crops of bamboo shoots are only produced after heavy rains, a fall of from 15 to 30 inches; such rains usually occur two or three times a year in Jamaica; the time young shoots take to spring from the ground up to about 25 feet (they are at this height in a fit condition for the paper-makers' requirements), after such rains averages five weeks. Irrigation would produce constant action at the roots, and there can be no doubt that by the process of cutting, several crops a year may be secured, indeed a continuous succession of cropping could be assured by systematic cultivation and irrigation."

The subject is so important, and one in which success is so much to be desired, that I have not hesitated to represent it at some length, and in its most favourable light.

The discovery of a new paper-material is a subject which excites the most lively interest. It is one on which we are continually responding to inquiries, and it is useful to record here the history of various substances which have been proposed (and specimens of which are deposited in the Kew Museum) in order to save the trouble of renewed investigations about them in the future.

Some disappointment, I think, may be prevented by giving currency to the following remarks by Mr. Routledge upon the general subject, the commercial side of which no one is more fitted to discuss:

"It is only the exceedingly low cost of freight from Spain and Algeria (due to exceptional circumstances) which has enabled Esparto to become as it were naturalised in the paper trade; ... none of the cereal straws, seeds, or grasses can be economically imported into this country, even with their low normal cost, due to the heavy freight and carriage charges, and having regard to the quality of paper they would produce. ... It may be assumed, therefore, that although some of these fibres may possibly be used for paper-making in the countries where they grow, it will not pay to bring them to this country."

2. *Baobab*.—

This was referred to in my Report for 1876 as a desirable subject for experimental cultivation in India. Dr. King now reports very unfavourably of its prospects:

"Such plants as enjoy the shade of a large tree in the neighbourhood of the plantation continue to look very fairly healthy, but those that stand in the open look very sickly. . . . Considering, moreover, the comparatively slow growth of the species (a tree of 20 years old grown in the open girths about 3½ feet at the base, and is about 15 feet high), I am driven to the conclusion that Baobab is not likely to afford in India a sufficiently cheap paper fibre."

This seems conclusive. I am informed, however, that the Baobab coppices well, sending up numerous shoots of 10 to 12 feet in a year. It is suggested, therefore, that if the trees once get to a fair size they might be coppiced annually, after the manner of osiers. But, of course, if Bamboo succeeds it is not worth while expending any trouble on Baobab.

3. *Californian "Cactus*."—

In the Kew Report for 1877 reference was made (pp. 36, 37) to a paper material known under this name in commerce, the botanical identity of which however was doubtful, owing to the want of adequate materials for determination. The specimens of the stems, which are the part used in the manufacture, suggested that they might belong to a *Dasylirion* or *Beaucarnea*. The nature of the plant has now been cleared up, and it proves to be a species of the well known genus *Yucca*, various other representatives of which are cultivated in gardens, and the habit of which is very similar to that of the genera mentioned above. It is the *Yucca brevifolia* of Engelmann (notes on the genus *Yucca*, p. 47). In California it has been identified, but incorrectly, with the

Yucca Draconis, originally described by Linnæus. The plant forms forests in the Mohave desert; the Southern Pacific Railway runs through them for several miles, and "the growth "extends south for some 300 "miles." The trees must be of great age, and should the manufacture of paper from them be commercially successful, one of the most singular pieces of vegetation will no doubt be utilised off the face of the earth.

4. *Eriophorum comosum*.—

This plant is well known in North-western India, where, under the name of *bhabar-ghas*, it is largely used as a material for ropes. It was submitted by Dr. King to Mr. Routledge, who writes to us:—"A small quantity of bleach brings it up to a good colour. The ultimate fibre is very fine and delicate, rather more so than esparto, and of about the same strength; the yield, however, is 42 per cent. somewhat less. I think I may venture to say it will make a quality of paper equal to esparto."

Two other grasses, *Imperata cylindrica* and *Saccharum spontancum*, were also reported upon by Mr. Routledge, but they were inferior to the *Eriophorum*. "I do not "consider, he says, that it would pay commercially to attempt to treat any one of these fibrous materials for conversion into stock for European use, although very possibly, if procurable in abundance and at cheap rates, they might be employed for paper-making locally with advantage."

5. *Molinia cœrulea*.—

This well known British grass has been brought forward as a paper material by Mr. Craig Christie. Mr. Routledge states:—"Without testing this on a practical scale, and making some paper from it, I cannot report definitely, but it appears to me to equal low class esparto at least." The supply would, however, be very limited, and the cost of collecting no doubt considerable.

6. *Trinidad Spear-grass*.—

Samples of this grass (*Andropogon condensatum*) were sent over to this country by Mr. Prestoe, who believed that it would come very near esparto for paper-making. Mr. Routledge, however, feels himself unable to endorse that opinion.

7. *Typha latifolia*.—

Samples of this plant, which is widely distributed over the northern hemisphere, have been sent to this country from different quarters. The yield of fibre is very low, only 28 per cent.; "it is also very difficult to bleach,. and loses most of its strength when subjected to that process."

Perak.—

The resources of this almost unknown and entirely undeveloped area of the Malay peninsula have during the past year attracted some attention in Ceylon, where land for planting is now said; to be difficult to obtain on remunerative terms. Perak has been visited by Mr. Handy side, a Ceylon planter, who has formed a high opinion of the capabilities of the country. The papers which have been communicated to me on the subject include a report from this gentleman, printed in the Singapore Daily Times of October 23 of last year, from which I extract a few paragraphs.

"Anyone entering Perak the usual way, viz. by Laroot, will be disappointed with the soil, especially on the plains, for the first 20 miles inland. It is poor for agricultural purposes, but rich in tin. * *

"On nearing the capital, Kwala-Kangsa, 23 miles from Laroot, the soil, and I may say climate, improves very much; from white sand it gradually turns into a rich brown alluvial, especially on approaching "the banks of the Perak River, on both sides of which sugar, tobacco, tapioca, cacao, cocoa nuts, Liberian coffee, cardamoms, paddy, maize, &c. could be grown to pay well * * * Good as the soil is here, it cannot compare with the rich limestone chocolate coloured land of the Kinta, Epan, Gaping, and Kampar districts, some 20 miles further cast. I have seen nothing like it in Ceylon for depth or quantity. A great portion of it is still in virgin forest; in some parts of which I saw the cardamom of commerce flowering under shade. * *

"Before coming to Perak I was of opinion that, being near the equator, coffee would need a higher elevation than Ceylon; since then I have seen reason to alter it. The monsoons are not so well defined; the rain is better distributed throughout the year, but there are generally a few dry months between January and March. I now think that coffee can be successfully grown at from 500 to 800 feet lower than in Ceylon in the open. * * *

"The coffee-trees growing under shade at a few hundred feet have a rich dark green foliage and very healthy appearance. * * * The Liberian kind at Taiping looks very healthy." [The plants were received from Singapore, to which place they had been transmitted from Kew.]

"Having been pretty well all over the country and studied its climate and resources, I consider that I am under the mark when I say that there are on the hills of Perak 500,000 acres (considerably more than in cultivation on Ceylon hills) suitable for the cultivation of coffee, tea, and probably cinchona, not to speak of all the low country products."

Rain-tree.—

At the close of 1877 a paragraph went the round of the papers describing, on the authority of the United States Consul at Loreto, a tree existing in the forests near Moyobamba in Northern Peru.—"The tree is stated to absorb and condense [the humidity of the atmosphere with astonishing energy, and it is said that the water may frequently be seen to ooze from the trunk and fall in rain from its branches in such quantity that the ground beneath is converted into a perfect swamp. The tree is said to possess this property in the highest degree during the summer season principally, when the rivers are low and water is scarce, and the Consul, therefore, suggests that the tree should be planted in the arid regions of Peru for the benefit of the farmers there."

This singular story led to many applications to Kew, amongst others, from the India Office on behalf of the Agri-Horticultural Society of Madras and from the Société Economico-agraria of Malta.

Professor Ernst, of the University of Caracas, had already published a very similar account in the "Botanische Zeitung "(1876, pp. 35, 36). The tree observed was *Pithecolobium Saman*. Professor Ernst states:—"In the month of April the young leaves are still delicate and trans parent. During the whole day a fine spray of rain is to be noticed under the tree, even in the driest air, so that the strongly tinted iron-clay soil is distinctly moist. The phenomenon diminishes with the development of the leaves, and ceases when they are fully grown." Professor Ernst attributes the "rain" to secretion from glands on the foot-stalk of the leaf on which drops of liquid are found, which are rapidly renewed on being removed with blotting paper.

Mr. Spruce, the well-known South American traveller, has, however, obligingly supplied us with an explanation which appears quite complete as far as the original Moyobamba rain-tree is concerned. He writes:—

"The Tamia-caspi, or rain-tree, of the Eastern Peruvian Andes is not a myth, but a fact, although not exactly in the way popular rumour has lately presented it. I first witnessed the phenomenon in September 1855 when residing at Tarapoto (lat. 6½° S., long. 76° 20# W.), a town or large village a few days eastward of Moyobamba. . . . A little after 7 o'clock we came under a lowish spreading tree, from which, with a perfectly clear sky overhead, a smart rain was falling. A glance upwards showed a multitude of cicadas sucking the juices of the tender young branches and leaves, and squirting forth slender streams of limpid fluid. . . . My two Peruvians were already familiar with the phenomenon, and they knew very well that almost any tree, when in a state to afford food to the nearly omnivorous cicada, might become (pro tem.) a Tamia-caspi or rain-tree. This particular tree was evidently, from its foliage, an Acacia. Among the trees on which I have seen cicadas feed is one closely allied to the Acacias, the beautiful Pithecolobium Soman . . . . Another leguminous tree visited by cicadas is Andira inermis, and there are "many more of the same and other families which I cannot specify. . . . .Although I never heard the name Tamia-caspi applied to any particular kind of tree during a residence of two years in the region where it is now said to be a speciality, it is quite possible that in the space of 21 years that have elapsed since I left Eastern Peru that name may have been given to some tree with a greater drip than ordinary; but I expect the cicada will still be found responsible for 'the moisture pouring from the leaves and branches 'in an abundant shower,' the same as it was in my time."

This and other information was communicated to "Nature" by the Assistant Director (28th February 1878, pp. 349, 350). So much is reproduced here for the information of correspondents of Kew, many of whom continue to make inquiries upon the subject.

Professor Ernst is still of opinion that in Venezuela the *Pithecolobium Saman* produces a rainy mist without the intervention of insects. In Jamaica and India the occurrence has not, however, been observed.

In the early part of the last century a similar story was placed on record, and is to be found in "A "Journey Overland from the Gulf "of Honduras" by John Cockburn (London, 1735, pp. 40-42).

"Near the mountains of Vera Paz (Guatemala) we came out on a large plain where were numbers of fine deer, and in the middle stood a tree of unusual size spreading its branches over a vast compass of ground. We had perceived at some distance off the ground about it to be wet, at which we began to be somewhat surprised, as well knowing there had no rain fallen for near six months past. At last, to our great amazement, we saw water dropping, or, as it were, distilling fast from the end of every leaf."

South African Bamboo.—

During the past year Commandant J. H. Bowker sent to Kew a sample of the Bamboos which he informs us are found mostly on the northern slopes of the high mountain range dividing the east and west watershed of

South Africa, and mostly on the most exposed sites. A paragraph extracted from the Natal Mercury having gone the round of the English papers, we received several inquiries about these Bamboos, and it may be useful to place on record the information we possess on the subject.

The plant is, doubtless, the *Arundinaria tessellata*, Munro, which has been long known to botanists, though singularly enough it has never been seen in the flowering state, and its true genus is, therefore, somewhat conjectural. General Munro remarks [Trans. Linn. Soc., vol. xxvi, p. 31] that it has "a remarkable and unusual range of elevation, from 500 to 6,500 feet above the sea." A whole district of South Africa is called "Bambus-bergen after it. Mr. Bowker writes:—"The bamboos are much used by the natives for spear handles, house-building, fences, and gates to sheepfolds, &c. They can be got from 3 feet to 25 in length, and in any quantity. I have used a rod made from it for many years past and found it superior in spring and strength to any other I could get. I think they could be turned to account as coach-whip handles, umbrella handles, walking sticks, &c.; the root grows into almost every shape, and could be cut into handles of different patterns."

The samples sent by Mr. Bowker were obligingly reported upon by Mr. Henry Howell, a wholesale merchant of such articles. The result is not very favourable, for which the character of the samples was possibly partly to blame. Mr. Howell writes:—"I have made a thorough inspection of the South African bamboos, and my opinion is that the canes which are regularly imported from China are far superior in every respect. It is, of course, impossible to judge of the larger and more perfect canes, as the only samples we have are very small, very short, and of very indifferent growth. I have some Chinese bamboos in my warehouse about 20 feet long, gradually tapering from about 1½ in. diameter to 1 in. at the point, and I should think nothing could surpass them in their adaptability for fishing rods, for which they are greatly used. The South African canes, unless far superior to the samples sent, would have no place in the market in competition with the Chinese. It is a pity the roots were not left on the bamboos, as possibly they may have had a character which would enable us to manipulate them to suit the taste of umbrella dealers. If you should have any specimens longer and larger than the ones in question I might be able to give a more definite opinion, but my impression is that if a large quantity of them (like the specimens) were offered in the market they would not find purchasers at anything like a remunerative price."

Sugar-cane disease.—

In the Kew Report for 1877 the history of the various insect pests which had proved so injurious to the sugarcane in Queensland was given in some detail.

During the past year a further correspondence has taken place upon the subject between this establishment and the Colonial Office, and a large series of specimens, carefully selected and sent over to this country in various preservative fluids by Mr. J. T. Staiger, F.L.S., Government Analytical Chemist, has been received for examination.

It appears now to be placed beyond question that the "rust" is due to the punctures of a minute acarus which exists upon the diseased cane in myriads. The exact scientific determination of this parasite would be, as I am informed by Mr. McLachlan, F.R.S., who has again most obligingly assisted us in this matter, a point requiring research of some difficulty. Mr. McLachlan states, however, that "the creature looks very like a *Tyro- glyphus*, but the habits do not altogether accord with those of that genus."

I am glad to state that the treatment with lime suggested by Dr. Bancroft, and that with carbolic acid recommended in the Kew Report for 1877 (p. 38), promises to be quite effectual in keeping this pest under control. Mr. MacKay reports to the Legislative Council of Queensland the result of experiments upon diseased canes subjected to the following treatment directed by Dr. Bancroft, which I quote here as likely to be efficacious in other Colonies:—"I. Clean the joints entirely from all trash as carefully as possible. 2. Immerse for twenty-four hours in water and carbolic acid at a temperature to bear the hand—1 lb. of acid to 50 gallons of water. 3. Make milk of lime—2 lbs. of lime to 1 gallon of water; immerse the plants in this for a few minutes. 4. Lift out and spread in the sun, turning them over to dry for one day before planting.

"Out of twenty-four different varieties of cane so treated, I am glad to say that all except two have come up sound and healthy, and the two are but lightly touched with the disease, a few spots only showing on the outer ends of the leaves, while the heart of the cane is quite green and healthy. The old stools or roots, from which were taken the plants so treated have all come up diseased; some of them died out, so that there can be no doubt that the mixture had its effect."

The *pou blanc or pou à poche blanche* referred to in pp. 38, 39, of Kew Report for 1877, is reported upon by Mr. McLachlan from the specimens sent to Kew during last year as "no doubt the same as the well-known Mauritian pest" (*Icerya sacchari*).

Vegetable-ivory substitutes.—

The palm whose seeds are used instead of ivory for a variety of small carved articles is a native of Central America and New Grenada. The consumption of them in this country, as well as in France and other parts of the Continent, is now believed to be enormous. The imports into Britain are stated to be worth £100,000 a year, and Birmingham is said to consume as much as a ton weight in a single day. The necessary result is that an eager demand has sprung up for new sources of supply of a similar material. The true vegetable-ivory palm being limited to a restricted district of the new world is not available elsewhere. But other hard-seeded palms will doubtless be tried, and the following have already come under our notice:

1. *Hyphæne kernels*.—

These have been imported into Liverpool from S.W. Madagascar as a substitute for vegetable-ivory, for which they seem little fitted. They appear to be yielded by *Hyphœne crinita*, with which Dr. Kirk identifies II. *natalensis* and *H. petersiana*. It is described as "a low palm bearing nuts with a sweetish rind, tasting like the locust bean, carob, or St. John's bread, and from which a spirit is distilled." The extension of this genus of palms, so characteristic of the flora of tropical Africa into Madagascar, is not less interesting than the presence of the *Adansonia* already mentioned.

2. *Raphia seeds*.—

The seeds of a palm which agree closely with those of *Raphia Hookeri* have been imported into Liverpool to be crushed as an oil-stuff. The quantity obtainable was, however, too small for this purpose, and the importer proposed to use the nuts for carving, for which they probably proved too soft, besides wanting uniformity of texture. They were stated to come from Liberia under the name of Taqua nuts. This is a name belonging to the true Ivory-nuts of S. America (*Phytelephas macrocarpa*), which is now likely to be applied indiscriminately to any palm seed hard enough to be carved.

3. *Sagus seeds*.—

The seeds of another palm appear within the last year to have found their way into commerce in considerable quantity from the Friendly Islands as a vegetable-ivory substitute. This is the *Sagus amicarum*, Wendl., the seeds of which have the shape and dimensions of a medium sized apple. The resemblance is still more complete if the core has been supposed to be scooped out by an opening at the bottom, the seeds of this *Sagus* having a considerable hollow cavity in the centre.

Amongst the collections of the Challenger expedition Mr. Moseley sent home seeds of another species of *Sagus* from San Christoval, one of the Admiralty Island group. This is probably a distinct species from *S. amicarum*, the surface of the seeds being marked by rounded ribs running longitudinally from the central depression on the upper surface, while the opening into the internal hollow cavity is almost closed up.

The Fiji Islands which intervene between the Solomon and Friendly groups contain yet a third species of *Sagus*, the *S. vitiensis*, Seem., the seeds of which are yet smaller than either of those mentioned above. Whether they have been tried as a vegetable-ivory substitute I am unable to say.

MUSEUMS.

The revision of the collections in No. 1 Museum has been completed, as well as that of the *Graminaceœ* in Museum No. 2. A large number of economic objects which had deteriorated by time and exposure to light and air have been withdrawn, and in many cases replaced by fresh specimens, due to the liberality of donors whose names are given below.

Notwithstanding the most careful weeding of the collections, the space for their display is still far too small, and an increase of the accommodation in both Museums No. 1 and 2 is urgently required. In the former case it is hoped, that this may be obtained by the erection of a new staircase, in the latter by an extension at the west end.

As in former years, the duplicates have been distributed to kindred institutions at home and abroad.

In No. 3 Museum a stand with a number of swing-frames has been placed, in which a large collection of views of the Royal Gardens in earlier stages of their history have been placed, and also a series of photographs of various colonial gardens. The latter collection we should be very glad to extend and render more complete.

I defer to my next Report a notice of the magnificent collection of forest produce received from the Government of India, and which is in process of unpacking and arrangement while this Report is in preparation.

The principal objects received during the past year have been:—

Bancroft, Dr. J.; samples of Pi-turi (*Anthocercis Hopwoodii*), and Goa powder (*Andira Araroba*).

Barlee, H. E., Governor; fruits and flowers of *Pachira aquatica*.

Bremner, A. W., & Co.; ten samples of leaf-tobacco of commerce.

Burbidge, F. W.; samples of rubber and stems of rubber-yielding plants of Borneo; leaves of *Curculigo latifolia*, affording a fibre, and native instruments used in weaving the same; cigarette wrappers, made of leaves of *Nipa fruticans;* cigarettes wrapped in leaves of Banana; fruits of *Scorodoprasum borneense*, and other specimens.

Chantre, C.; numerous specimens of gums, resins, drugs, and other vegetable products.

Christy, T.; a large series of Japanese drugs of vegetable origin, and sample of rubber from *Urostigma Vogelii*.

Church, Prof. A. H.; fine samples of beet-root sugars and specimens of French leaf tobaccos.

Corbyn, Stacey, & Co.; samples of Chaulmugra oil (*Gynocardia odorata*).

Cox, Brothers, Messrs., Dundee; series illustrating the uses and manufacture of jute.

Cross, R.; sample of best soft Columbian Cinchona bark from banks of Caqueta river, and specimens of plant producing the same.

Curtiss and Harvey, Messrs.; samples of willow and alder wood, and charcoal made from same used in the manufacture of gunpowder.

Duthie, J. F.; photographic views in Botanic Gardens, Saharunpore, and seeds and fruits of Indian economic plants.

Dyer, W. T. T.; hat made of *Juncus effusus* in China, and worn in Switzerland; sample of Crin Vegetal made in Algeria from *Chamœrops humilis*.

Fox, Major-Gen. Lane; drupe of a *Pandanus* used in Nicobar to brush the feet, and specimens of resinous wood (*Dipterocarpus*) used as torches.

French Government; collection of woods from French colonies.

Gardner, Messrs. Joseph, and Sons; shuttles as used in cotton spinning, made of Persian boxwood, American cornel (*Cornus florida*), and Persimmon (*Diospyros virgi-niana*).

Henderson and Sons, Messrs.; samples of Shea butter (*Butyrospermum Parkii*), Gutta shea, and soap made from Shea butter.

Howard, J. E.; fine collection of Cinchona barks and samples of Cinchona alkaloids.

Irving, James; spadix of *Elais guineensis* and portions of spadices of *Raphia* spp.

Keit, W.; cones of Natal Cycads.

Layard, E. C.; H.M. Consul, New Caledonia; small Kava bowl, dresses made of leaves of *Freycinetia* and cocoa-nut fibre, spear of palm wood from Kingsmill Islands, and other articles.

Levisohn, L. J.; leaves, stem, and fruits of *Yucca baccata* from Los Vegas, New Mexico, used as I soap.

Linseed Association (A. G. Kemp, Secretary); numerous samples of linseed, rapeseed, sesamum, &c.

Lockhart, Dr.; water bottles and other [articles made of gourds, ornamented on the surface by growing them in moulds.

Maw, G.; fine specimens of maple sugar from Ontario.

Montserrat Company (per Joseph Sturge); samples of lime juice and lime juice biscuits.

Mueller, Baron Von; fruits of *Capparis Mitchelii*.

Murton, H. J.; samples of gutta-putih, gutta-taban, gutta-singgarip, &c., and specimens of the stems of the trees yielding them; also "golos" or knives used by the Malays in "ringing" or tapping the trees.

New South Wales, Government of; stems of *Dicksonia antarctica, Alsophila australis*, and *A. leich-hardtiana*.

Reichenbach, Dr.; cones of *Picea erythrocarpa, P. chlorocarpa*, fruits of *Trapa uerbanensis*, and *Sagus amicarum*.

Roberts, Macubbin, & Co.,Messrs.; seeds of *Adansonia madagascariensis*, cloth made of fibre of *Raphia Ruffia*.

Routledge, Thos.; sections of the stem of *Yucca brcuifolia*, and paper made from the same; also samples of paper made from bamboo, &c.

Sargent, C. S.; specimens of cones, wood, and bark of various species of *Pinus* and *Abies*.

Siemens, Dr. C. W.; specimens of raw gutta-percha from Borneo, moulded by natives in the forms of animals.

Smith, C. Laver; numerous specimens of dye lichens.

Smith, W. Anderson; meal bag formerly used in the island of Lewis, made of *Juncus effusus*.

Turnbull & Co., Messrs.; series illustrating distinctive distillation of wood.

Wishart and Lloyd, Messrs.; samples of commercial tobaccos grown in the Fiji Islands.

PHYSIOLOGICAL LABORATORY.

During the past year the Jodrell Laboratory has been employed by Prof. Burdon Sanderson, F.R.S., in his continued researches on the electrical phenomenon of plants exhibiting spontaneous movements; by Prof. Church in studying albinism in plants; by the Rev. R. Abbay in working at the development on living coffee plants of *Hemileia vastatrix;* and by Mr. F. Darwin for observations on the physiology of leaves.

HERBARIUM.

The most considerable contribution to this department, and, considering its importance in respect of the agricultural interests of this country, India, and the colonies, the most important of the kind, perhaps, ever contributed to such an institution as Kew, is the Mycological Collection of the Rev. M. J. Berkeley, F.R.S. For upwards of half a century Mr. Berkeley has been well known as the most accomplished and persevering student of the *Fungi*; his labours and writings on the ravages which these plants inflict on our field-crops, gardens, orchards, vineyards, forests, &c. have benefited mankind, and greatly enlarged the domain of science; whilst his systematic and microscopical researches into their structure and the classification of the vast natural family to which they belong have; been extended to species from every j quarter of the globe. The herbarium in question contains type specimens of the microscopic and other vegetable parasites, whose effects have been known from time immemorial, but the nature of most; of which has been determined only within the last half century; and it illustrates his numerous published contributions to the Journal of the Royal Horticultural Society, the Gardeners' Chronicle, Linncan Society's Journal and Transactions, and many other works of a like nature, As examples of the value to the country of Mr. Berkeley's labours, it needs only to allude to the potato, vine, hop, and onion diseases, upon which he has written valuable memoirs and suggested remedies that have earned for him the gratitude of his countrymen and the recognition of the Government.

Mr. Berkeley's herbarium is of great extent, in perfect order and preservation, and he is now occupied with its transference to Kew, to which it is presented.

The herbarium of the late N. J. Dalzell, Esq., of the Hon. East India Company's service, has been presented by his widow. As containing the type specimens of "The Bombay Flora," a work published by himself and the late Dr. Gibson, it is of special interest. It contains upwards of 1,200 species, and many duplicates; and its contents have been shared with the herbariums of the Botanical Gardens of Calcutta and Saharunpore.

M. E. Cosson, of Paris, has been a most liberal contributor to the Kew Herbarium for very many years. His gifts during the present year amount to nearly 2,000 species, chiefly from Southern Algeria, Morocco, and Eastern Persia, on the borders of Afghanistan, which latter, collected by the veteran botanist and traveller, Bunge, are of especial interest.

Other contributions of exceptional interest are Godefroy-Lebeufs Cambodian plants; Welwitsch's Ango-Ian, &c. (from the Portuguese Government); Post's Syrian; Bur-bidge's Bomean, presented by Messrs. Veitch, and containing a magnificent series of pitcher-plants; Hildebrandt's tropical E. African; and many Central African were from Dr. Kirk, Col. Grant, Mr. Wakefield, &c.

Mr. John Miers, F.R.S., the eminent South American traveller and botanist, has presented the duplicates of his extensive herbarium. It contains many types of his published plants of Chili, Brazil, and the Argentine Provinces.

M. Casimir De Candolle has presented a valuable set of tracings of drawings of *Aroideæ*, and Mr. W. Saunders, F.R.S., photographs of upwards of 70 species of Agave.

The very complete collection of cones and leaves of Pines belonging to Mr. George Gordon, late of the Royal Horticultural Society's Gardens, has been presented by the Director, and deposited, the cones in the Museum, and the foliage specimens in the Herbarium. It contains the type specimens of almost every species scribed in Gordon's Pinetum, a standard work amongst nurserymen and foresters, of which a second edition has lately appeared. He has also presented the late Dr. Burchell's collection of drawings of St. Helena plants, made in the beginning of the century, and many of the plants of which are now all but or altogether extinct.

The following is a list of the names of the principal contributors to the Herbarium during 1878:—

Europe.

- Archangeli, Dr.; Italian (128).
- Beccari, Dr. (Herb. Mus. Florent.); Italian (181).
- Ball, J.; various (180).
- Brotherton,—; British (10).
- Church, Prof.; drawings of British ferns (13).
- Cosson, Dr. E.; Schur's European plants (590).
- Geheeb, A.; mosses (100).

- Godefroy-Lebeuf, A.; Portuguese (300).
- Groves, H.; Italian (112).
- Henriquez, J.; Portuguese (316).
- Henriquez, J.; *Algæ, Fungi*, and drawings (89).
- Jardin des Plantes, Paris; *Hepaticœ* (105).
- Jardin des Plantes, Paris; various (44).
- Massalongo, Prof.; Italian Hepaticœ (purchased, 70).
- Plowright, C. B.; British *Fungi* (purchased, 100).
- Rabenhorst, Dr. L.; *Algte* (purchased, 100).
- Société Dauphinoise; French (purchased, 530).
- Thuemen, Baron von; Mycotheca (purchased, 300).
- Todaro, Prof.; Palermo (4).
- Vize, J. L.; *Micro-Fungi*, (purchased, 100).
- Wittrock and Nordstedt; *Algæ* (purchased, 100).

Asia.

- Aitchison, Dr.; N.W. Indian (27).
- Brandis, Dr.; *Eucalypti* (cult.) (14).
- Burton, Capt.; Midian (272).
- Cosson, Dr. E.; Bunge's Persian plants (690).
- Dalzell, Mrs. (Herbarium of N. J. Dalzell (1,297).
- Davidson, Col., R.E.; N.W. Indian (41).
- Godefroy-Lebeuf, A.; Cambodian, &c. (571).
- Jamieson, Dr. G. H. T.; N. Indian (39).
- Jardin des Plantes, Paris; Malayan and Polynesian (520).
- King, Dr., of Calcutta; Kurz's Burmese plants (282).
- King, Dr., of Calcutta; various Indian (84).
- Macarthy, Rev. J.; Chinese (23).
- Murton, H. J.; Malayan (62).
- Perry, W. Wykeham, R.N.; Aden (94).
- Post, Prof. G. E.; Syrian, &c. (780).
- Preston, Rev. T. A.; Everard's Chinese and others (69).
- Scheffer, Dr.; Malayan Archipelago (263).
- Veitch, Messrs.; Burbidge's Bornean and Suluan (547).
- Veitch, Messrs.; Marie's Chinese and Columbian (29).

Africa.

- Balfour, Prof.; Buchanan's Tropical African (78).
- Bolus, Harry; South African (87).
- Cantly, N.; Mauritian *Fungi*.
- Christy, T.; Liberian (6).
- Cordukes, S.; Natal (12).
- Cosson, Dr. E.; Marion's Atlantic (92).
- Cosson, Dr. E.; Letourneux's Egyptian (104).
- Cosson, Dr. E.; Moroccan (133).
- Duthie, J. F.; Tropical African (9).
- Grant, Col.; Wakefield's East African (142).
- Hildebrandt, Dr.; Tropical African (purchased, 241).
- Home, J.; Mauritian *Fungi*.
- Keit, N.; Natal mosses, &c. (32).
- Kirk, Dr. J.; Bishop Steere's E. African (242).
- Knobel, W.; S. African (27;.
- Macowan, Principal P.; S. African (36).
- Monteiro, Mrs.; Delagoa Bay plants collected by the late J. T. Monteiro (8).
- Oates, C. G.; S. African (30).
- Perry, W. Wykeham, R.N.; Somali Land (14).

- Phillips, R. E.; S.W. African (12).
- Portugal, Government of; continuation of Welwitsch's collections (705).
- Rehman, Dr.; Cape *Fungi* (purchased, 520).
- Stone, General; Pfundt's Kordo-fan (500).
- Whitehead, Rev. H.; St. Helena (6).
- Wood, J. M.; Natal (133).

America.

North America and West Indies.

- Austin, Mrs. R. M.; Californian (153).
- Barlee, His Excellency F. P.; Honduras (13).
- Brace, L. J. K.; Bahamas (135).
- Cosson, Dr. E., Mexican (373).
- Curtiss, A. H.; Florida (purchased, 200).
- Davenport, G. E.; Ferns of N. America (9).
- Farlow, Eaton, & Anderson's American *Algœ;* (50).
- Fendler,—; Trinidad Ferns (purchased, 78).
- Gray, Prof. A.; various N. American (337).
- Jardin des Plantes, Paris; W. Indian (116).
- Jenman, G.; Jamaica Ferns (120).
- Murray, H. B.; St. Lucia Ferns (77).
- Pringle, C. G.; Northern U. States (300).
- Ravenel,—; N. American *Fungi* (purchased, 200).

South America.

- Balansn, M.; Paraguay (purchased, 2,044).
- Glaziou, A.; Brazilian (703).
- Grisebach, Prof.; Argentine (710).
- Lorentz, Dr.; Uruguay (purchased, 170).
- Miers, J.; South America, various.
- Veitch, Messrs.; Kalbreyer's New Grenada (303).

Australia and Polynesia.

- Bennett, J. J., Executors of the late; continuation of R. Brown's Australian (1,400).
- Cheeseman, T. F.; New Zealand (11).
- Kirk, T.; New Zealand (26).
- Powell, Rev. Thos.; Samoa (90).
- Whitmee, Rev. T. J.; Polynesia (248).

It will be interesting to place on record here, as evidence of the continually growing interest of botanists in all parts of the world in the Kew Herbarium, the following statement of the total number of distinct contributions, large and small, made to it for each successive year since 1864.

BOTANICAL PUBLICATIONS prepared in connexion with the work of the Herbarium.

"Flora of British India," by the Director, assisted by other botanists. Part V. continuing Vol. 2. has been published.

"Flora of Australia," by G. Bent-ham, F.R.S. The seventh and concluding volume has been published.

The conclusion of the Spicilegium Floræ Maroccanæ by John Ball, F.R.S., has been issued by the Lin-nean Society.

A second edition of the Student's Flora of the British Islands has been published by the Director.

Bentley and Trimen's Medicinal Plants, of which parts 28-36 have been published, contains numerous figures of plants figured from the Royal Gardens.

Mr. H. T. Elwes has published part 5 of his illustrated monograph of the genus *Lilium*.

Icones Plantarum, vol. xiii., pts. III. and IV., illustrating new and rare plants preserved in the Herbarium have been published.

The 104th volume of the Botanical Magazine has been published. A large proportion of the new and rare plants have flowered in the Royal Gardens.

I have, &c.

(Signed)
JOS. D. HOOKER, *Director*.
To the Right Honourable
The First Commissioner of Her Majesty's Works and Buildings.

Appendix I.

Appendix II.

List of Bromeliaceæ cultivated in the Royal Gardens, Kew.

- Acanthostachys strobilacea, Klotzsch. Brazil.
- Æchmea aurantiaca, *Baker*. Brazil. *Canistrum aurantiacum*, E. Morren.
- Æchmea calyculata, *Baker*. South America. *Hoplophytum calyculatum*, E. Morren.
- *Macrochordium luteum*, Regel.
- Æchmea cœlestis, *Baker*. Brazil. *Hoplophytum cœleste*, K. Koch.'
- Æchmea cœrulcsceus, Baker. South America.
- *Lamprococcus cœrulescens*, Regel.
- Æchmea distichantha, *Lemaire*. Paraguay and Brazil.
- *Billbergia polystachya*, Paxton.
- Æchmea fasciata, *Baker*. South Brazil. *Billbergia fasciata*, Lindl.
- *Bilbergia rhodocyanea*, Lemaire.
- Æchmea glomerata, *Hook*. Brazil. *Hohenbergia erythrostachys*, A. Brong.
- *Pironneava morreniana*, Regel.
- Æchmea legrelliana, *Baker*. Tropical America.
- *Ortgiesia palliolata*, E. Morren.
- Æchmea Lindeni, *K. Kocyh*. Brazil.
- Æchmea Marise-reginse, *Wendl*. Costa Rica.
- Æchmea odora, Baker. West Indies and Guiana.
- *Billbergia odora*, Miquel.
- Æchmea Ortgiesii, *Baker*. Tropical America.
- *Ortgiesia tillandsioides*, Regel.
- Æchmea *var*. subexserta, *Regel*.
- Æchmea pineliana, *Baker*. South Brazil.
- *Echinostaclujs pineliana*, A. Brong.
- Æchmea Veitchii, *Baker*. New Granada.
- *Cheualliera Veitchii*, E. Morren.
- Ananassa sativa, *Lindl*. Tropical America.
- Ananassa *uar*. bracteata, *Lindl*.
- Ananassa *uar*. porteana, *K. Koch*.
- Ananassa macrodontes, *E. Morren*. Tropical America. *Bromelia macrodosa*, Hort.
- Billbergia Brongniartii, *Regel*. Brazil.
- *Portea kermesina*, A. Brong.
- Billbergia Euphemise, E. *Morren*. Brazil.
- Billbergia horrida, Regel. Brazil.
- Billbergia iridifolia, *Lindl*. Brazil.
- Billbergia liboniana, *De Jonghe*. Brazil.
- Billbergia macrocalyx, *Hook*. Brazil.
- Billbergia Moreli, *A. Brong*. Brazil.
- *B. glymiana*, De Vricse.
- *B. pulcherrima*, K. Koch.
- *B. Wetherilli*, Hook.
- Billbergia *var*. paucifolia, *Baker*.
- Billbergia nutans, *Wendl*. Brazil.
- Billbergia pallescens, *K. Kock*. Brazil. *B. pallida*, Hort.
- Billbergia porteana, *A. Brong*. Brazil.

- Billbergia pyramidalis, Lindl. Brazil.
- Billbergia *uar*. bicolor, *Lindl*.
- Billbergia quesneliana, *A. Brong*. Guiana. *Quesnelia rufa*, Gaudich.
- Billbergia speciosa, *Thunb*. Brazil. *B. amœna*, Lindl.
- Billbergia thyrsoidea, *Mart*. Brazil.
- Billbergia *var*. longifolia, *K. Koch*.
- Billbergia *var*. splendida, *Lemaire*.
- Billbergia vittata, *A. Brong*. Brazil.
- *B. amabitis*, Beer.
- *B. Leopoldi*, K. Koch.
- *B. moreliana*, Lemaire.
- Billbergia *uar*. macracantha, *Baker*.
- Billbergia zebrina, *Lindl*. Brazil.
- *Helicodea zebrina*, Lemaire.
- Bromelia antiacantha, *Bertol*. Brazil.
- *B. Sceptrum*, Fenzl.
- *Agallostachys antiacantha*, Beer.
- Bromelia bicolor, *R. & P*. Chili.
- *B. Joinuillei*, Van Houte.
- *B. pitcairniœfolia*, K. Koch.
- Bromelia carnea, *Beer*. Tropical America.
- *B. longifolia*, Paxt. non Rudge.
- *Ruckia Ellemeeti*, Regel.
- Caraguata lingulata, *Lindl*. Tropical America.
- Caraguata Zahnii, *Hook fil*. Central America.
- Catopsis nitida, *Hook*. Tropical America. *Tillandsia nitida*, Hook. *Tussacia nitida*, Beer.
- Cryptanthus acaulis, *Beer*. Brazil.
- *C. undulatus*, Klotzsch. *Tillandsia acaulis*, Lindl.
- Cryptanthus *var*. purpureas, *Baker*.
- Cryptanthus *var*. zonatus, *Visiani*.
- Cryptanthus bivittatus, *Regel*. South Brazil.
- *Billbergia biuittata*, Hook.
- Disteganthus basilateralis, *Lemaire*. Guiana.
- Dyckia brevifolia, *Baker*. South Brazil. *D. sulphurea*, K. Koch.
- Dyckia frigida, *Hook fil*. Brazil.
- Dyckia rariflora, *Schultes fil*. Brazil.
- Hechtia argentea, *Hort*. Mexico.
- Hechtia Gheisbreghtii, *Lemaire*. Mexico.
- Hechtia glomerafa, *Zucc*. Mexico.
- Karatas agavæfolia, *E. Morren*. Tropical America.
- *Bromelia agavœfolia*, A. Brong.
- Karatas Legrellæ, *E. Morren*. North Brazil.
- Karatas Plumieri, *E. Morren*. Tropical America.
- *Bromelia Karatas*, Linn.
- Karatas sphacelata, *Baker*. Chili.
- *Bromelia sphacelata*, R. & P. *Greigia sphacelata*, Regel.
- Lamprococcus fulgens, *Beer*. Guiana.
- *Æchmea fulgens*, A. Brong.
- Lamprococcus *uar*. discolor, *Beer*.
- *Æchmea discolor*, Hook.
- Lamprococcus Weilbachii, *E. Morren*. Tropical America.
- *Æchmea Weilbachii*, *F*. Diebr.
- *L. Laurentianus*, *K*. Koch.
- Macrochordium bromeliæfolium, *Beer*. Tropical America.
- *M. strictum*, Beer.
- *M. tinctorium*, Beer.
- Nidularium amazonicum, *Linden and Morren*. North Brazil.
- Nidularium cruentum, *Regel*. South Brazil.

- *Billbergia cruenta*, Graham.
- Nidularium fulgens, *Lemaire*. Brazil.
- Nidularium Laurentii, *Regel*. Brazil.
- Nidularium Meyendorfii, *Regel*. Brazil.
- *Billbergia olens*, Hook.
- *Bromelia Carolinæ*, Beer.
- Nidularium purpureum, *Beer*. Brazil.
- Nidularium sarmentosum, *Regel*. Brazil.
- Nidularium Scheremetieffii, *Regel*. Brazil.
- Nidularium spectabile, *Moore*. Brazil.
- *N. eximium*, Hort.
- Nidularium triste, *Regel*. Brazil.
- *N. marmoratum*, Regel.
- Pitcairnia Alteusteinii, *Lemaire*. Columbia.
- *Puya Alteusteinii*, Klotzsch. *Puya undulatifolia*, Hook.
- Pitcairnia andreana, *Linden*. New Granada. *P. lepidota*, Regel.
- Pitcairnia angustifolia, *Ait*. West Indies.
- Pitcairnia aphelandnefolia, *Lemaire*. Brazil.
- *Pepinia aphelandræfolia*, Andre.
- Pitcairnia australis, *K. Koch*. Brazil.
- *P. rubicunda*, K. Koch.
- Pitcairnia bromeliæfolia, *L'Horit*. West Indies.
- Pitcairnia cinnabarina, *A. Dietr*. Brazil.
- Pitcairnia Decaisnei, *K. Koch*. Tropical America.
- *P. fulgens*, Decaisne.
- Pitcairnia echinata. *Hook*. New Granada.
- Pitcairnia ferruginea, *R. & P*. Peruvian Andes.
- *P. asterotricha*, Popp, and Endl.
- *Puya grandiflora* Hook.
- Pitcairnia heterophylla, *Beer*. Mexico and Columbia.
- *P. cernua*, K. Koch and Bouché.
- *P. exseapa*, Hook.
- Pitcairnia imbricata, *A. Brong*. Mexico.
- *Neumannia imbricata*, A. Brong.
- Pitcairnia karwinskiana, *Schultes fil*. Mexico and Columbia.
- *P. ringens*, L., K. & O.
- *P. warcewicziana*, Klotzsch.
- Pitcairnia moritziana, *K. Koch* Guatemala.
- Pitcairnia muscosa, *Mart*. Brazil.
- Pitcairnia odorata, *Regel*. Tropical America.
- *Cochliopetalum Schuchii*, Beer.
- Pitcairnia paniculata, *R. & P*. Peru.
- *P. excelsa*, E. Morren.
- *P. longifolia*, Hook.
- Pitcairnia punicea, *Lindl*. Mexico.
- *Pepinia punicea*, A. Brong.
- Pitcairnia ramosa, *Jacq*. Tropical America. *P. furfuracea*, Sims.
- Pitcairnia recurvata, K. Koch. Tropical America. *P. polyanthoides*, A. Brong. *Paya recuruata*, Scheidw.
- Pitcairnia staminea, *Lodd*. Brazil.
- *Cochliopetalum stamineum*, Beer.
- Pitcairnia sulphurea, *Andrews*. West Indies.
- Pitcairnia tabulajformis, *E. Morren*. Mexico.
- Pitcairnia undulata, *Scheidw*. Tropical America.
- *P. speciosissima*, E. Morren.
- Pitcairnia xanthocalyx, Mart. Tropical America.
- *P. flavescens*, Baker.
- Pitcairnia zeaifolia, *K. Koch*. Guatemala.
- Puya chilensis, *Mdlina*. Chili.

- *Pourretia coarctata*, R. & P.
- Puya cœrulea, *Miers*. Chili. *P. Whytei*, Hook.
- Puya floccosa, *Regel*. Southern Andes. *Pitcairnia floccosa*, Regel. *Puya lanuginosa*, Hort. non Schultes fil.
- Ronnbergia morreniana, *Linden and André*. New Granada.
- Tillandsia bulbosa, *Sw*. Tropical America.
- Tillandsia corallina, *K. Koch*. Tropical America.
- *Encholirion corallinum*, Linden.
- Tillandsia Durahi, *Visiani*. South Brazil.
- *T. circinalis*, Griseb.
- Tillandsia Gardneri, *Lindl*. South Brazil.
- *Anoplophytum Rollisoni*,. E. Morren.
- Tillandsia glaucophylla (Hook). New Granada.
- *Vriesea glaucophylla*, Hook.
- Tillandsia ionantha, *Planch*. Tropical America.
- Tillandsia karwinskiana, *Schultes fil*. Mexico.
- Tillandsia Lindeni, *Regel*. Ecuador and Peru.
- *T. hamaleana*, E. Morren.
- Tillandsia Malzinei, *E.Morren*. Mexico.
- *Vriesea Malzinei*, E. Morren.
- Tillandsia polystachya, *Linn*. Tropical America.
- Tillandsia regina, *Bell*. Brazil.
- *T. giyantea*, Mart.
- *Vriesea glazioviana*, lemaire.
- Tillandsia Saundersii, *K. Koch*. Braal.
- *Encholirion Saunderii*, Hort.
- Tillandsia splendens, *A. Brong*. Guiara.
- *T. zebrina*, Hort.
- *Vriesea speciosa*, Hoot.
- Tillandsia streptophylla, *Scheidw*. Mexico.
- Tillandsia stricta, *Sw*. Tropical America.
- *Anoploph ytum strictun*, Beer.
- Tillandsia tenuifolia, *Linn*. Tropical America.
- *T. setacea, Sw*.
- Tillandsia usneoides, *Linn*. Tropical America.
- Tillandsia xiphioides, *Ker*. Uruguay.
- Tillandsia xiphostachys, *Hook*. Columbia.
- *Vriesea xiphostachys*, Hook.
- Doubtful plants, to which garden names have been given, but which are not yet known in flower, and of which therefore the genus is still uncertain:
- Ananassa bernstorfiana, *Hort*.
- Ananassa Medilonii, *Hort*.
- Billbergia elegans, *Hort*.
- Billbergia fascicularis, *Hort*.
- Billbergia formosa, *Hort*.
- Billbergia melanacantha, *Hort*.
- Billbergia Wistii, *Hort*.
- Bromelia Acanga, *Hort*.
- Bromelia desmetiana, *Hort*.
- Bromelia Riguieri, *Hort*.
- Dyckia regalis, *Hort*.
- Hechtia glymeana, *Hort*.
- Hechtia longifolia, *Hort*.
- Hechtia Maclellani, *Hort*.
- Mclinonia incarnata, *Hort*.
- Mclinonia rubiginosa, *Hort*.
- Pitcairnia dasylirioides, *Hort*.
- Pourretia flexilis, *Hort*.

- Pourretia mexicana, *Hort*.
- Puya meridensis, *Hort*.
- Tillandsia porphyrautha, *Hort*.
- Tillandsia tessellata, *Hort*.

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Fig. 1.

On the Development of the Enamel in the Teeth of Mammals,

As Illustrated by the various Stages of Growth demonstrable in the Evolution of the. Fourth Molar of a Young Elephant (Elephas indicus), *and of the Incisor Teeth in the Fœtal. Calf* (Bos taurus).

By George Rolleston, M.D., F.R.S.
Linacrk Professor of Anatomy and Physiology, Oxford.

Reprinted from the "TRANSACTIONS OF THE ODONTOLOOICAL SOCIETY OF GREAT BRITAIN."

Fortiter Molire Confidenter Opperire London: Wyman & Sons, 74-5, Great Queen Street, Lincoln's-Inn Fields, W.C. 1871

On the Development of the Enamel in the Teeth of Mammals, as illustrated by the various Stages of Growth demonstrable in the Evolution of the Fourth Molar of a young Elephant, Elephas indicus, *and of the Incisor Teeth in the Foetal Calf*, Bos taurus. By Professor ROLLESTON.

GENTLEMEN,—

A NAKED-EYE examination of a spirit preparation of a developing molar tooth of an Elephant, such as is represented in fig. 1, appears to be sufficient to show that in development the dentine takes precedence of the enamel in the tooth. In such a tooth a certain number of the more anteriorly placed denticles may be seen to be formed of caps of dentine, of a yellowish colour, encrusted, for various distances from their apices downwards, with opaque white deposits of enamel. Posteriorly to the denticles of this composite character, we see a few denticles consisting of dentine alone, upon which no deposition of enamel has as yet taken place; and, most posteriorly of all, we see processes of the dentinal pulp, which, as yet, are devoid of any covering of dentine.

If, in the second place, we proceed to take note of the capsular processes in which the denticles are enclosed, we shall observe that the inner (reflected) surfaces of certain of these capsules are roughened over by deposit, in correspondence with the enamel deposit already noticed on the denticles which they surround. The deposit on the inner surface of the capsule is soft, and consists of cylindriform cells packed closely together, and forming, when their interior surface is looked down upon, a mosaic arrangement by their apposition, whilst in the immediate neighbourhood of their exterior (their still attached) surface, numerous bloodvessels are seen ramifying. There can be no doubt that we have here the often-described proximal, and, as yet, but imperfectly calcified ends of the enamel-cells, which have broken away in the preparation from the more thoroughly calcified segments constituting the enamel deposit on the denticles. It is, in fact, the layer which has been supposed to be at once the function less "membrana præformativa "of Raschkow, and the functionally protective, however otherwise physiologically inert, "*cuticula dentis*," or "Nasmyth's membrane."

If now, in the third place, we take a thin microscopic section of the anterior part of the lower jaw of a foetal calf (*see* fig. 2), made in a sagittal direction, so as to show several developing teeth of various ages *in situ*, we are enabled easily to recognize the representatives of the various structures visible to the naked eye in the molar tooth of the elephant, and to harmonize the apparently conflicting statements which have been made as to the relations held by the tissue forming the enamel prisms, on the one hand, to the stellate tissue of the non-vascular enamel organ, and, on the other, to the vascular tooth-capsule. In such a section of a tooth, in which the enamel has already begun to be deposited, we can see (fig. 2, c), the factor of the enamel organ, which is made up of stellate, loosely-compacted anastomosing cells, the so-called "spongy substance," occupying or forming a triangular area with the apex upwards. The apex of this triangular space marks the lowest level to which the formation of enamel has advanced in its progress downwards from the summit of the tooth. Above this point, or, in other words, where the formation of the enamel has called for an abundant supply of mineral matter, the non-vascular stellate tissue has disappeared, and allowed the vessels of the tooth-capsule to come into close relation with the enamel-forming cells which draw so largely upon what they contain. Below this point the stellate tissue gradually re-assumes its original proportions, and in a section of the lateral portions of the spoon-shaped incisors of the calf it may be seen to pass completely round the calcifying dental pulp from its buccal to its lingual surface. The area occupied by this stellate tissue in fig. 2 corresponds, of course, to the parts of the cavities of the capsular processes of fig. 1, which lie below the level of the enamel deposit on the denticles; the disappearance of the stellate tissue in the molar of the elephant, and the separation in that preparation of the upper part of the capsule from the depositing enamel, are alike what the Germans call *artefacta*.

Much of what has been advanced in this short paper may be found explicitly or implicitly stated in some one or other of the numerous memoirs or treatises on the development of the teeth which have appeared of late. It is believed, however, that as yet it has not been recorded that the enamel of the Elephant's molar, as also that of the Mastodon's, presents the very same decussating arrangement of the inner portion of its enamel which Mr. Tomes has figured ("Phil. Trans.," 1850, pi. xliv., xlv., xlvi.), as noted by him in the Rodentia, less the Leporidæ and Hystricidæ. Thus the rodent affinities of the elephant, which have so often been commented upon, receive a fresh illustration.

Description of Figure 1.

FIG. 1. Portion of left half of lower jaw of young Elephant, *Elephas indicus*, showing the fourth molar in course of development, and a part of the third molar, some of the denticles of which were in use, and some still within their socket. The teeth are seen from the inner side, the bony wall having been removed, and the capsule of the posterior tooth having been reflected. The dentinal pulp is coloured blue, the dentine yellow; the vessels are represented as seen when filled with a red injection. From a preparation made by Mr. C. Robertson.

- Part of inner side of lower jaw interposed between the posterior denticles of the third and the anterior denticles of the fourth molar.
- Part of third molar tooth. Its anterior denticles were in use; some of its more posteriorly placed were just about to cut the gum, and the most posteriorly placed were still within the bony socket.
- Processes of dentinal pulp, dividing to supply the denticles of third molar.
- Sac of tooth reflected and fastened out over the jaw above and below.
- Capsular processes surrounding denticles. On the internal or dentinal aspect of the most anteriorly placed of these, *d*1, a granular deposit is observable. This deposit corresponds to a depost, *g*1, of similar appearance, which encrusts the upper part of the cap of dentine, *f*1, and it represents the proximal ends of the enamel columns which have broken away from the more perfectly calcified segments which constitute the (enamel) deposit, *g*1, on fl.
- Processes of the dentinal pulp passing up to form the successive denticles of which the composite molar is made up.
- A number of processes homologous with those similarly lettered, but differing from them in having as yet formed no cap of dentine upon their exterior surface.
- Caps of dentine which have been formed by the processes of dentinal pulp, *e*1, *e*2, *e*3, *e*4, *e*5. Upon the three most anteriorly-placed of these caps of dentine, *f*1, *f*2, *f*3, a deposit of enamel has taken place, the area occupied by which diminishes in length from before backwards, in correspondence with the lessening evolution of the denticles. Upon the two most posterioly placed, *f*4, *f*5, of the dentinal caps no deposition of enamel has as yet taken place.
- Level to which the deposit of enamel has reached upon the dentinal caps*f*1, *f*2, *f*3, respectively.

J Drummond, del. J. Erxieben, [*unclear:* lith].

Wyman & Sons. Printers

Description of Figure 2.

FIG. 2. Section of anterior portion of lower jaw of fœtal calf, *Bos taurus*, taken in an antero-posterior or sagittal direction; showing the enamel organs of two teeth, one larger and the other smaller, *in situ*. The section has passed through the lateral portion of each tooth; and as the incisors in this species have their crowns laterally expanded, whilst their fangs are compressed from side to side, the central stem of the dentinal pulp is not seen in this section, and the enamel organ passes entirely round its lateral expansion. The dentinal pulp

itself is not represented in either of the two teeth; two contour-lines, bounding the apical half of the space which it occupied in the larger of the two teeth, show the extent to which the deposition of enamel and dentine severally had proceeded upon it. In the smaller of the two teeth the deposition of enamel has not commenced, and the enamel organ has as yet suffered no diminution of its "spongy," or "gelatinous," or "stellate "tissue. This drawing being semi-diagrammatic, segments only of the histological elements making up the epithelium of the gum, the epidermis of the lip, the tooth-sac, and the enamel organs, have been given; the contour-lines prolonged in each case from the external boundaries of these segments, appearing to indicate sufficiently the relations held in nature by the several structures.

- Anterior surface of lip.
- Epidermis of lip.
- Epithelium of gum.
- Tooth-sac, which at this stage in the development of the tooth, and before it receives any support from the bony structures in the jaw, is clearly marked off by layers of condensed cellular tissue from the strata of *cutis vera*, which are interposed between it and the external epidermis. The loose spongy central portions of the tooth-sac bear some resemblance, when viewed with the unassisted eye, to the similarly placed stellate element of the enamel organ; they differ from it, however, by being vascular, and even highly vascular; whilst they differ from the *cutis vera*, not merely by their greater looseness of texture and their greater vascularity, but also, as seen in the figure, by the absence of glands, of hair-bulbs, and of muscular tissue.
- Enamel organ. From the point to which the line *e* is drawn, downwards, the enamel organ of the larger tooth is seen to possess all the three structures; viz., the inner epithelium, the stellate or spongy tissue, and the outer epithelium, which the enamel organ of the smaller tooth (*h*1) still possesses. Above the point to which the line *e* is drawn, the stellate tissue has disappeared, and the two layers of the enamel organ's epithelium have come into apposition. Thus the epithelial cells of the inner layer, which produce the enamel prisms, or "fibres," come into closer relation with the bloodvessels of the tooth-capsule, whence alone, in the absence of vessels in the enamel organ, they can provide themselves with the requisite mineral matter.
- Space in the larger tooth occupied by the laterally projecting portion of the spoon-shaped dentinal pulp.
- Corresponding space in the smaller tooth: in neither tooth did the central stem of dentine come into view in this section.
- Contour-line indicating the extent to which the deposition of enamel has proceeded in the larger tooth. This line corresponds to the similarly lettered granular deposit in fig. 1. Internally to this line, a second line is seen describing a similar contour, but reaching considerably further down. It indicates the extent to which the cap of dentine reaches downwards upon the exterior of the pulp; this extent being considerably greater (as is seen also in fig. 1) than that attained to by the deposit of enamel at this period of development.
- Line of junction, in the larger and smaller tooth respectively, of the stellate tissue of the enamel organ to its inner layer of epithelium. In both enamel organs the outer layer of epithelium is drawn as more nearly columnar than it is in nature.

The President's Address At the Second Annual Meeting New Zealand medical Association,

By Alexander Johnston, M.D. (St. Andrew's),
On the 12th May, 1887.

Vignette

Gentlemen,—I have the honour this afternoon to address you upon opening the second annual session of the New Zealand Medical Association. This society was conceived and brought forth only last year by the Medical Society of Dunedin. I have now to congratulate its parent upon the vitality and vigour it already displays. The attendance of members from a distance shows that in its early infancy our Association has a power of locomotion that promises a vigorous and important career. Those members who have honoured us with their presence will, I hope, accept the thanks of the members of the Wellington Branch of the Association, on whose behalf I now welcome them, and hope to show that the compliment paid is duly appreciated.

Gentlemen, when I was told that it would be my duty to address you upon the opening of our proceedings at this meeting my thoughts naturally turned back to my experience of the practice of Medicine and Surgery in the colony during the past thirty-five years, but, alas, I found no field for my subject there When the early colonists arrived in New Zealand, they were obliged, by the heavily-bushed nature of the country and the warlike character of the Natives, to settle down at various convenient places upon the coast. These small centres of population in a few years became provinces, under local government, with separate, and, I might say, different interests. Under these circumstances the medical practitioners of New Zealand were as much separated as the medical men in the different colonies of Australia—indeed, the practitioners of Auckland could more quickly and more easily communicate with their brethren of New South Wales and Victoria than with those of Dunedin. This curious position accounts for the absence of co-operation among the medical men in the past, and consequent loss of medical history in this colony. Now, if I attempted to make one, it could only relate to the struggles of single practitioners in isolated districts, who, without assistance or support from colleagues, heroically accepted heavy responsibilities with but small pecuniary reward, performing their duty with credit to themselves, and generally gaining the respect arid affection of their fellow pioneers, and assisting the introduction and advancing the progress of civilization in this modern land of promise. Most of you here to-day know something of, or can readily understand, the trials and difficulties to be encountered during the first quarter of a century of life in a wild country, already inhabited by an intelligent and warlike, but uncivilized, people, whose place on earth it was our mission to occupy. Let us hope that our present promising prospects may steadily improve, and the aspirations of the founders of this Association may be realized, and result in the acquisition by the medical profession of a more influential position in the good government of the country than it has hitherto possessed.

Gentlemen, there are already many subjects proposed for your consideration at this meeting; nevertheless, I shall now take the liberty of mentioning one or two others, which, in my opinion, are of vital importance, not only to us as a body, but in a greater degree to the general public. We probably shall not be able during our short session to discuss these questions; but I wish to draw your attention to them, in the hope that the different Branches of our Association may seriously consider them in the course of the ensuing year. One subject which in my opinion requires our earnest attention is the education provided for, and the time and opportunity at present allowed to, students to attain sufficient knowledge to pass the examinations necessary for registration as legally qualified medical and surgical practitioners; and how far these practitioners are fitted by this education, and these examinations, to commence the actual practice of their profession. I am very diffident in addressing you upon this subject: you are younger men than I, of a new school, and probably will not agree with all I say. But I feel so certain that sufficient time is not, in the present day, allowed to students to enable them to acquire a sufficient knowledge for the practice of their profession, before they receive the legal qualification, that I shall persevere with my subject, and trust that you will receive my remarks with patience. I will go back fifty years, and give you some information upon the training and education then required to enable men to pass the examinations for the double qualification of Medicine and Surgery, and ask you to compare that training and education with the education only which is now provided, and leave you to judge whether the modern system of high-pressure theoretical teaching is producing practitioners as likely to be successful in the general practice of Medicine as if they were trained and educated under the old system. I do not object to—indeed I warmly advocate, the higher education now required: my contention is that sufficient time is not allowed to enable young men to acquire it thoroughly, and so be able to retain it. The great aim of the medical student to-day is to obtain his legal qualification, regardless of the knowledge and experience necessary to practise it. His time of study is curtailed, but the curriculum is extended. However well this looks as a programme, as a fact it can only result in a temporary and superficial acquisition of knowledge, crammed into the student's brain with no permanent benefit, inasmuch as time is not allowed for its reception and assimilation. Under the old system the student was introduced to the profession by articles of apprenticeship. Upon entering the surgery, he was occupied during the first year assisting the dispenser, not only compounding prescriptions, but making all preparations required for them, learning to read and write prescriptions, and obtaining a practical knowledge of drugs and pharmacy. He was then gradually allowed to assist in the attendance upon the club and pauper patients coming to the surgery for minor ailments; his spare time was occupied in preparing for his preliminary or matriculation examination, and in acquiring a knowledge of the bones, thus getting a sound groundwork of the elements of anatomy before beginning his work in the dissecting-room. At the end of his third year he was a valuable assistant, attending midwifery, minor surgery, and visiting patients; so that when he commenced hospital practice, and lectures, he was in a position to understand the instruction there given. After three years of this work he was ready to pass his examinations with credit, and become not only legally, but practically, well qualified to take his place in the ranks of general practice. At the present time, the requirements for the double qualification are only a proof of four years' study of Medicine and Surgery, one of which may be given as a certificate from any legally qualified practitioner; this, and three years' certificates of attendance upon hospital practice and the necessary lectures, is now deemed sufficient to allow a student to present himself for examination; and if successful he is at once admitted to the register of general practitioners, thus receiving his legal qualification before he has any practical knowledge of his business. The multiplicity of subjects in the extended curriculum, and the abbreviated period of study allowed for its attainment, must result in a competition with time for the earliest arrival at a standard goal of education, which, being gained, is found to be only superficial plate. Under an agreement with the University of Edinburgh, Otago is recognised as a school where two years' study counts towards the four years' University work required before a student can be admitted to examination; therefore, provided he brings certificates of having passed his matriculation, and studied two years at Otago, he can proceed to his M.B. examination at Edinburgh with only two years' residence in that University. I have seen one or two specimens of this arrangement: in my opinion they are not satisfactory as results. One of them told me his experience—it was a really painful one. He said it was one continued struggle to prepare for the examinations, or, as he expressed it, four years' work pressed into two. He tried well, but did not succeed—he was rejected at his final examination; and when ultimately successful he was consoled, and even thankful, for the extra time afforded him for acquiring a better knowledge of his profession than if he had been successful in pulling through the examination at his first attempt. Gentlemen, the University of New Zealand, apparently jealous of the success of her rival at Otago in forcing her students to the goal of legal qualification by means of the University of Edinburgh, has now brought forth a Bachelor of Medicine of her own creation. I do not believe that this degree will carry much weight outside New Zealand; and, as a prophet is scarcely known in his own country, I would not give very much for its chance of success within. In my opinion, the reputation of the University of Otago will be safer with her students stamped as graduates of a Medical University of ancient foundation, and of undoubted modern reputation, than the University of New Zealand will be with her graduates the result of three years and a half's study. I do believe that an intelligent youth, with a natural taste for the trade, may in that time be made an efficient and successful carpenter or bootmaker; but to train and educate a man for the profession of Medicine, with all the acquirements called for by the rapid progress of our age, requires, and must occupy (at least with any hope of future success), a longer period than forty-two months, as now required by the curriculum of the New Zealand University for the degree of Bachelor in Medicine. Gentlemen, there is no royal road to the study of Medicine. The appointments, appliances, and conveniences necessary for its acquirement will not be established satisfactorily in New Zealand for the next fifteen or twenty years. Population must be the basis to start upon; and until there are large centres of population in the colony it will be impossible to apply the appointments of medical schools successfully, however great may be the amount of money spent in their establishment. Nevertheless, since the University of New Zealand is recognised as an institution for the education of students, and for their qualification legally to practise Medicine and Surgery, making her degrees eligible for registration upon the Medical List of the Colony, it is the duty of this Association to apply its utmost endeavours to make the education required for the attainment of these degrees not only thorough and lasting upon the mind, but of practical utility when required upon the field of active practice. To do this, it is necessary to obtain representation of the profession at the Board of Advice, by the appointment of well-known leading medical practitioners to the Senate of the University, who, by their actual knowledge of the work, will be able to indicate the training and course of study required, and also to judge the merits, acquirements, and practical knowledge of students applying for the legal qualification. Gentlemen, I leave this subject to your future consideration, and I trust that the course of action I have indicated meets with your concurrence, so that the newly-established unity of action produced by the foundation of this society may lead to the scientific cultivation, and at the same time to the practical advancement, of our revered profession.

Another question has exercised my mind for some considerable time, without much hope of relief; but the fact of having a general Medical Society now established leads me to hope that it may prove a means of successfully opening up the subject of Public Health.

I believe New Zealand has the reputation of keeping fairly up with the advanced requirements of modern civilization. There is more money spent in this colony in free education, in proportion to population, than in any other. There has been legislation for the prevention of disease among the lower animals, and so strictly are these laws administered that the introduction of horses, cattle, and dogs is absolutely prohibited; even the vegetable world has not escaped, phylloxera and codlin moth each requiring an Act of Parliament to protect the health of our vegetable kingdom. With all this care it is incomprehensible, and even difficult to realize, that our grim old enemies disease and death are allowed to walk daily in our midst, bringing ruin, desolation, and grief among us, without an effort being made to check their career. We cannot expect to stop the march of death! But, if the Government would carry out the measures taught by the progress of science during the last twenty-five years, we should be able to keep our dreaded foes from our doors until our natural term of life on earth has expired. We cannot, in this age, hold Nature responsible for a high rate of mortality, since science has revealed the means of preventing disease. It is now full ten years since a very elaborate and lengthy Act was passed by the New Zealand Legislature for the protection of the public health. It provides for a Central Board and any amount of Local Boards of Health throughout the colony, but unfortunately, and, I believe, solely in consequence of the expense of administering it, the Act turns out to be a sham. The Central Board of Health, instead of being an independent body of experts, is composed of some six or seven Civil servants, receiving no extra pay for this work, and taking no interest in it; naturally they are under the influence of the President, who is a Minister of the Crown. This Board appears to have no definite time fixed for its meetings, and usually is in a passive condition, only occasionally being jerked into vitality by the report of disease in the distance. When these reports arrive, a meeting is hurriedly called, resulting in a letter to the Health Officer of the port, instructing him to inspect every ship on arrival, and to look out sharply for any cases there may be of the disease expected. But, as far as I know, there is not the least preparation made for the reception and proper treatment of such cases if any were unfortunately to arrive. Our quarantine buildings were built many years ago, when immigrants were carried in sailing ships—before the direct ocean steamers were thought of. Hitherto we have been fortunate in the arrival of our steamers in good health; but we cannot expect our good luck to be always present, and if a large vessel like the German steamer "Preussen," with 600 or 700 people, and small-pox on board, were now to arrive here, we should be found in a pitiable state of unreadiness and confusion, which would result in an outcry of indignation, panic, and heavy expenditure. The same, or even more reckless, condition of affairs is allowed to exist immediately among us—typhoid and scarlet fever are allowed to scatter our people, and to bring desolation and despair to our families, for the want of that organization and administration which is the duty of the Government to carry out. This duty is recklessly neglected, because it would necessitate the creation of a new department and the expenditure of money. The money spent on education is not thought too much, but one-twentieth of that sum cannot be obtained for the administration of an Act which, in a great measure, would prevent disease, very materially extend the natural term of life in this country, and allow thousands to escape the too frequently recurring times of grief and trouble. If our existing Public Health Act were vigorously carried out by an independent Board of Health, with an efficient staff of properly qualified Health Officers, spending all their time in the performance of their duty throughout the country, such diseases as typhoid fever, and many others now prevalent in this new and thinly-populated country, could be stamped out, and the rate of mortality would be reduced, to the advancement and prosperity of the country, and to the increased happiness of the people. I trust that the members of the New Zealand Medical Association will therefore take every opportunity of giving information to the public, and especially to their representatives in Parliament, upon this nost important subject, and thus by united influence bring pressure upon the general Government of the Colony, and force it to take a new departure towards the protection of the public health, without which protection the very large expenditure upon the education of the people will be thrown away, in consequence of the beneficent influence upon their mind and character being lost for the want of healthy bodies to act upon.

Gentlemen, there is one other matter to which I beg to call your attention: it is the compilation of a Code of Medical Ethics. This I sincerely trust may be agreed upon during our present session. My own experience shows me that each year brings evidence of the necessity for it; and, unless we are satisfied to allow all *esprit de corps*, all honourable and honest emulation, and the dignity of a learned and distinguished profession to disappear for ever, we shall at once endeavour to establish, and mutually agree to support, a strict and definite Code, to be compiled and issued under the authority of this Association for the guidance of its members. The facilities now afforded for entering the profession necessarily introduce into the practice of Medicine a certain number of undesirable men, who are perfectly unconscious of the respect due to the profession they pretend to practise. These practitioners, not immediately finding occupation, start the system of advertising and touting for patients; and, being naturally endowed with commercial instincts, they gradually degrade the consulting-room to the position of a shop. These unworthy members of the profession, filled with envy, and jealous of the higher social position given to their more honourable rivals, usually resort to misrepresentation and slander to assist them, which course, though it may appear for a time to be successful, usually redounds to their own discredit. Such men should not be allowed to enter this Association, but should be made to accept the inconvenience and annoyance their own misconduct brings upon themselves; and they have no reason to complain that members of an honourable society will not receive them as friends and associates.

Gentlemen, as we have many subjects coming up for discussion, and our session can only last a very few days, I will not detain you longer; but, thanking you very sincerely for the patience and attention you have so kindly accorded me, I now propose that we at once proceed to the business of the day.

Vignette

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4. *The Origin and Development of the North-west Winds of New Zealand*.

By JOHN T. MEESON, B.A.

THE nor'westers of Canterbury—though they seem, and in some respects are, so exceptional in character—in point of fact are nothing but the winds common to the whole of New Zealand, and, indeed, common to our latitudes in the Southern Hemisphere, right round the earth—winds blowing towards the area of abnormally low pressure (29° to 29 3°) which prevails generally about lat. 56° S., but modified very materially in character by their passage across the Southern Alps, which, though not much higher than two miles even in their topmost peaks, have power to affect the currents of air shown by cirrus clouds to prevail to the height of five miles. These winds are, in fact, the *Return Trades*, and would be north winds if they followed the direction which they first take after forming at the Zone of Calms; but, having come from parts of the earth where the rotatory motion is great to places where it is less, they have acquired, for the opposite reason to that which Hadley gives to explain the western tendency of the Trades, an eastern proclivity: and as they proceed to higher latitudes after becoming lower surface winds at the Tropic of Capricorn, they become more and more westerly until they merge into the "roaring forties "with which all voyagers to this part of the world have a somewhat intimate acquaintance. Dove remarks that "all winds are liars," and it must never be forgotten that the apparent horizontal direction of a wind, on account of the shape and aërial motion of the earth, is never or hardly ever the real one.

These roaring westerly winds show frequently unmistakable cyclonic disturbance, which, by applying Buys Ballot's, or, as it should perhaps be called, Galton's law, can be roughly located. That law recognises the fact that the wind blows along isobars with less pressure on the left in the Northern Hemisphere, but on the right in the Southern: in other words, if you stand with your back to the prevailing wind, in the Southern Hemisphere the lowest depression of the barometer will be on your right hand—*i.e.*, in the case of the nor'westers, to the south-west. If we knew in New Zealand, as meteorologists in the Old World do know, the exact measurement of the acute angle between the direction of the wind and the lie of the isobar—that is, the inclination of the wind to the isobar—we might fix the position of the cyclonic centre much more precisely. But the narrowness of New Zealand, the few observing stations therein established, the waste of waters round about, and the small number of ships navigating it and bringing in their weather reports, must make it extremely difficult to draw isobars of a thoroughly reliable nature in our colony.

Now, the cyclones, formed at various points in the northwest gale like eddies in a mighty stream, sometimes are so large as to absorb the whole current and stretch over vast areas. But, just as Loomis shows (*Nature*, 11th July, 1878) that American storms in the Northern Hemisphere originate in a district near the Rocky Mountains, two-thirds of them north of lat. 36°, and move on to the east through the general circulation of air in that direction, and as Dove considers that many of the storms of the Temperate Zones are tropical ones diverted from their path at or about lat. 30° north and south, and as the English meteorologists recognise certain fairly-definite storm-tracks across the Atlantic, ramifying frequently from certain definite spots and skirting the North Atlantic anticyclone while journeying usually in a north-east direction, so it perhaps should be possible for us to arrive at some conclusion as to the starting-points and general paths of our New Zealand cyclones, though the means that we have of doing so, for reasons already indicated, are exceedingly limited. Even in Europe, with its army of observers, its delicate appliances, and numerous stations, it is very difficult to trace the connection, by continuously advancing minima, between tropical cyclones and their prolongations into the Temperate Zone. Here, therefore, the work must be considerably harder.

In the North Atlantic there is a great anticyclone stretching over the intertropical area and the more southern part of the North Temperate Zone. Along the northern edge of this is the birthplace of the innumerable cyclones of every size and intensity which incessantly move to some point east or northeast along the shores of and crossing the British Isles—to be worn out in the polar regions north of the Scandinavian peninsula. Similarly, in the Southern Hemisphere and in corresponding latitudes there is formed in winter a more or less continuous anticyclone, producing the fine weather of Australia at that season, interrupted, however, occasionally by bad spells, squalls, and thunderstorms, and thoroughly broken in the summer season, when the vast mass of the Australian Continent, with its atmospherical rarefaction in the Torrid Zone (when the sun is south of the Equator), must exercise large attractive action on all sides. This anticyclone at the latter season contracts very much, and leaves a breadth of low pressure over the Pacific between New Zealand and Queensland, in the vicinity of which a considerable number of the north-west storms which dash against or cross our Islands are probably generated. Hence the forecasts of Mr. Wragge, the Government Meteorologist at Brisbane, have a special value for New Zealand. On our western coasts these storms meet with a great impediment to their further progress south-eastwards in the masses of the Southern Alps, over which many of them fail to pass, and either spend themselves in dashing against the mountains or, with that affection for skirting mountain-chains and coast-lines for which they are remarkable all over the world, go off to the south and round the Island at Foveaux Strait. To what extent the Southern Alps modify the character of the north-west storm before it reaches the Province of Canterbury, and how this modification is brought about, I have considered in another paper.

Dove divides the storms of the Temperate Zones into—

- Extensions of Torrid Zone storms;
- Storms arising at the external edge of the Torrid Zone, from the meeting of the Return Trades with surface winds opposed to them;
- Storms produced by the mutual lateral interference of polar and equatorial currents flowing in opposite directions.

Our north-west storms seem to belong to the classes 2 and 3, though occasionally we may have one which is simply a prolongation of a Torrid Zone atmospherical disturbance. Some of our storms are undoubtedly identical with those that dash up against the south side of the Australian anticyclonic area—traceable sometimes so far to the north-west as Mauritius—the region, be it remembered, of Indian Ocean hurricanes—but sometimes apparently coming from points much farther to the south, bringing bad weather to the extreme southerly districts of Victoria and to Tasmania, and then crossing over from Bass Straits to New Zealand in twenty-four hours. Such storms, after leaving Australia, always seem to make for the south-east. Even when at first, after leaving Bass Straits, they hug the east coasts of New South Wales and apparently make for the north-east, they turn at right angles to their course before they go very far, and merge into the Return Trades.

It does not follow that, because much of our north-west weather is cyclonic in character, all of it necessarily is so. Some of it may be produced by broad gales which are defined by Dove as strong winds, blowing in with tolerable steadiness from one point of the compass. The phenomena, as far as we in Canterbury are concerned, would be nearly the same whether this were so or not, for the gyration of the wind on one side of a cyclone is the same as that produced by the ordinary currents of the atmosphere, and the effect of the mountains would be similar in both cases. It therefore, as far as our present investigation is concerned, does not seem very important whether we adopt the *rotary theory* of Redfield or the *inblowing theory* of Espy. Dove certainly seems to speak of gales as something quite distinct from the cyclones of Piddington. But, as has been remarked, "the law of storms is the law of wind everywhere," and the terms "gale," "cyclone," and "tromb "only indicate similar movements of the atmosphere affecting areas of different magnitudes. A gale, in fact, may be assumed to be a portion of a huge cyclone whose true character is concealed from us because we are not able to carry on sufficiently wide simultaneous observations. The true cyclone itself is perhaps popularly misunderstood. It does not necessarily imply the violence of the tempest or hurricane, such violence only occurring when the isobars are very near—that is, when the depression is deep and the baric gradient steep. It sometimes is as much as 0 2, though the normal rate of barometric change is not more than 0.02 to more than 0.05.

Do our violent north-westers evidence the passing of cyclones over our heads to the south-east? Loomis and other meteorologists agree that storms as a rule in our latitude travel to the eastward—to the north-east in the Northern Hemisphere, to the south-east in the Southern. They make their way in that direction because of the rotation of the earth, the rain being drawn eastward, Blasius thinks, by traction of deficient air. That being so, however, I do not think that many of our north-west cyclones pass directly over Canterbury to the south-east, for the following reasons: It is very seldom indeed that the wind goes suddenly round from north-west to south-east, or that the central calm of the cyclone is observable, which would always be the case if we were here in the direct-path of the storm. Bain falls also very rarely, and the fall of the rain determines, or is supposed to determine, to a large extent the path of the disturbance; for it gives out heat and thus causes the air to expand and whirl upwards, making a comparative vacuum which the air behind fills, and so the direction of the whole slanting and inverted aërial whirlpool is determined.

What Loomis says about rain or snow on the west side retarding the progress of a cyclone is instructive. It favours the idea that our north-west storms, through the heavy rain they deposit on the Southern Alps, are stopped, worn out by dashing against or amongst the mountains, or else diverted, as already observed, along the coast-line and the flanks of the range. North-westers are experienced in the Chatham Islands, but there, as on the west coast of New Zealand, they are the rain-bringers and quite different from our dry *föhn*. They have similar origin to ours, but an independent one. As to whether we are in the line or path of the cyclone or not—apart from barometrical indications—the winds and clouds, especially cirrus and cirro-stratus, if we could perfectly interpret them, would be an infallible sign.

- When we are in the line of the storm—*e.g.*, the anticyclone being to the north-east—cirrus clouds would be over the north-west and parallel to the horizon.
- When we are north-east of the line of the storn, the bank of cirro-stratus is visible on the west or west-south west horizon, and the upper current is south-west. The bank spreads, and a north-west wind springs up beneath the clouds above are cirro-cumulus, not cirro-stratus.
- When the depression is to the east or left of us, the cirro-stratus bank is north-north-west; the sky thickens; the south-east wind freshens; the upper wind is north-east. If there be rain, it is cold and continuous; the sky dears slowly; the barometer rises, and stratus clouds come into view.
- If we are in the rear of the cyclone, which has already passed to the south-east, the clouds are frequently cumulus; there will be a few upper threads of cirrus stretching from north-east to south-west; south-west winds with showers will come, and there will be the same wind to the highest regions.

Some such rules as these—which I have adopted from Ley—will show us how we are situated with regard to the cyclonic centre. The diagnosis of our "nor'westers" almost invariably brings them under rules (2) and (4). But, of course, full and detailed synoptic charts—if we could obtain them in New Zealand—would be a far more certain criterion as to the point in question than clouds and winds. When the anticyclone is not to north-east but to east of us, and depression going south,—or west of us, and depression going north-east,—similar rules will apply; the system of points, however, being moved, in the first case, 4 points back, or, in the second case, 8 points forward.

To understand the development and character of our northwest gales in New Zealand we cannot do better than study closely the nature of the south-west storms of Great Britain, under the guidance of such meteorologists as Ley, Abercrombie, and Scott. The British sou'wester is the counterpart of the New Zealand nor'wester. But the former is accompanied usually, and almost everywhere, by heavy rains, because of the absence of a huge mountain-chain athwart its path; whereas the latter is so accompanied only along the west coast of New Zealand. The requisite changes in the direction of wind, &c., for the Northern Hemisphere being made, we see, however, the strong resemblance between the two winds. The barometer falls in England as the south-west wind approaches; the thermometer rises in the south-east or right side of the cyclonic path, and, as the storm progresses, the wind gradually veers to the west, and eventually into the bracing north-west. Abercrombie explains these phenomena as being the marks of a V depression formed either along the south prolongation of the trough of a cyclone, or else in the *col* between two adjacent anticyclones. If this be so, and our north-west, followed by south-west, storms (or some of them) be similar in origin, we experience under their influence the result of a V depression formed along the northern prolongations of the troughs of cyclones passing away to the south-east. When pouring rain comes from the south-west after a north-west wind of long or short continuance, we are, indeed, forcibly reminded of the "southerly bursters" of Australia, which also, it appears, are owing to a V depression passing to the southeastward along the southern coasts of that island, the point of the V being to the north, with the wind north in front, and south-west or south in rear. The phenomena of our northwest weather, although possessing a general similarity, are, it must be remembered, of various types, and some of these types may be explicable in the above fashion. The arch is sometimes absent altogether; the increase of temperature varies considerably; so does the duration of the storm, and the character of the south-west wind which supervenes; and therefore we can readily understand that, with somewhat similar north-west weather, the same fundamental shape of isobar will not always be found.

Mr. Cockburn Hood and Mr. Charles Knight (Trans. N.Z. Inst., vol. vii.) think our north-west winds are simply the hot winds of Australia which mount high into the atmosphere after leaving that island-continent, and gather moisture from the intervening sea. But surely there is a fallacy here. A high upper wind would not lick up moisture, and, if it did, it could not hold it for a journey of 1,200 miles, because of the low temperature it would acquire at its elevation. Sometimes, truly, as on "Black Thursday," the north-west weather of Australia may reach as far as New Zealand, for general weather is occasionally very widespread in its influence, as was evidenced quite recently (9th and 10th September, 1889) when the ship "Otago," two or three thousand miles to the south-east of New Zealand, nearly succumbed to the same succession of north-west followed by south-west cyclones as swept at that time over this colony. There is also such great similarity in some respects between the hot winds of Australia—blowing for two or three days together with excessive heat and violence from the north-west, and followed as they are by the cold south-west with deluges of rain and a fall of the thermometer often of 30° or 40° in an hour or two—and the nor'westers of Canterbury, that, making allowance for differences arising from local geographical peculiarities, it is impossible to suppose otherwise than that the two have some similarity of origin. The Australian wind blows however over an arid continent, and thus increases rather than diminishes its heat as it travels, and it meets with little or no obstruction from high mountains calculated to drive it up into higher and colder regions. On the other hand, the north-west wind of New Zealand by the time it reaches our shores has crossed a wide ocean and gathered from it both moisture and heat as it travelled, and here it meets at a comparatively high latitude with mountains 10,000ft. high, which are quite capable of relieving it of its watery burden. The distance between Australia and New Zealand is not so great as to lead us to doubt the occasional identity of some of our cyclonic disturbances with those prevailing over the water, and it must be remembered we are directly in the line of travel; and cyclones, though they often fill up or diverge from their path, and otherwise conduct themselves in a most unreliable manner, yet as a rule keep a definite track and travel very far. Notwithstanding all these considerations, I do not argue for any identity, except a very occasional one, between the hot winds of Australia and New Zealand. Our nor'westers for the most part have quite an independent origin.

5. *On the Characteristics of the Nor'-westers of Canterbury, New Zealand*.

By JOHN T. MEESON, B.A., Christchurch, New Zealand.

- INTRODUCTION and description of phenomena of nor'westers.
- Inquiry into the cause of their excessive heat. Compression, the usual explanation, inadequate. True explanation must take account of—(1) Original heat of equatorial aërial current, (2) heat given out when rain precipitated, (3) different capacities of wet and dry air for holding heat, and Dr. Hann's reasoning about the Swiss *föhn*, (4) development of heat on the left front of all cyclone; why south-west winds not hot though over high mountains. Original and acquired heat of equatorial winds. Great effect of warm ocean-currents in heating air above them. Conclusion *re* heat.
- Cold nor'westers.
- The behaviour of the barometer in a nor'wester.
- The north-west arch (of clouds).
- The south-west wind and subsequent gyration.
- North-west rains east of the Southern Alps.
- Other *föhn* winds than the New Zealand nor'westers.
- Their generally beneficial character.

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Paper by J. T. Meeson, B.A.

7. *On the Relation between Rainfall and Forest*.

By J. T. MEESON, B.A., of the Inner Temple, Barrister-at-law, Christehurch.

CAPTAIN CAMPBELL-WALKER, in his able and exhaustive paper (Appendix to Trans. N.Z. Inst., Vol. ix.) "On the Climatic and Financial Aspect of Forest Conservancy as applicable to New Zealand," after enumerating and illustrating many ways in which the presence of forests undoubtedly tends to ameliorate the climate of a country, as well as to increase and conserve its water-supply, and therefore its productivity, "records his opinion that so far nothing has been found to establish the theory that extensive denudation will of itself cause a marked decrease in the rainfall" (Par. xxviii.), "although the facts as he has seen and compared them in this colony almost convince him that forests have a direct influence on the amount of it." However—he significantly goes on to ask—"May not the presence of the trees be the effect of the rainfall, and not the cause of it? "and confesses that he feels no kind of certainty one way or the other, but takes comfort from the fact that Dr. Brundis, the Inspector-General of Forests in India,—no mean authority,—and doubtless many others, have like himself failed to make up their minds about the matter. He even avers "that statistics in this colony tend to prove that the rainfall has increased at stations in the neighbourhood of which woods have been extensively cut down."

Now, I firmly believe that this attitude of mind on the important subject in question is precisely that of many thoughtful people. They feel that there is an intimate relationship between rainfall and forest, but are not prepared to assign priority of existence to either. Nevertheless the usual opinion originated by those who clearly perceive the beneficial effects of an arboreous covering, and the evils resulting from the wanton destruction of such covering, in most newly-settled countries, has been that rainfall will be very seriously affected by deforestation and largely increased by reforestation. To this dictum quite lately more than one authority much more competent to form an opinion than myself has demurred. I follow on the same side, and venture to discuss the question in a somewhat novel fashion.

I have prepared, and have now before me, two maps of Now Zealand—the one showing approximately by degrees of shading the average annual rainfall in the different parts of the colony; the other showing, also approximately, from the information supplied by Captain Walker while acting as Conservator of Forests in New Zealand (Report on Forests: C.—3, Appendix to Journals H. of R., 1877), where the great forest-areas principally lie, and the comparative extent of them. The similarity between the two maps is evident at a glance, so much so indeed that, with some trifling exceptions, principally on the eastern side of the Islands—in Cook County and the Province of Marlborough, *e.g.*—it may be said that the more darkly shaded areas in the two are nearly coincident; and it is impossible to do otherwise than conclude that between rainfall and forest there is, in some way, the connection of cause and effect.

To construct, even roughly, a map of the forests of New Zealand is no easy matter: no authentic map of that character is in existence; and the materials for constructing one, as supplied by the source already indicated, are neither precise nor adequate. There is pretty accurate information as to the amount of forest which was in the hands of our Government in 1877; but at that time very much had already teen alienated, especially of kauri, totara, and other commercially valuable timber, and of course a large quantity still remaned in the possession of the Natives.

The total area of forest at the disposition of the State ire 1877 was as follows :—

That is to say, besides the acreage already alienated to private individuals or still remaining in the hands of the Maoris, there would seem to have been at the date in question over eleven and a half millions of acres of forest out of a total area of sixty-four millions. Captain Walker quotes Sir J. Hector as giving the total area of forest in New Zealand as 12,130,000 acres, but considers that it is probably much more than that; and so it apparently is, for in the "Handbook of New Zealand" for 1886 the estimated proportion of forest-land—that is, the percentage of the entire area in each provincial district—is given as under :—

There are marked discrepancies between these figures of 1886 and the ones previously quoted from Captain Walker's report of 1877. In some cases those of the later date are much larger than those of the earlier. This might arise from the the former including forest-lands already alienated by the Crown and also those areas of woodland still possessed by the Natives. The discrepancy, however, in the case of Nelson is too great to be accounted for in this way. I have no means whatever of explaining it. In any case the figures are very large, and clearly show that there is a vast area of fores still left in the colony, which certainly deserves the credit that it possesses of being, as regards arboreous vegetation, one of the richest portions of the globe; but the destruction that has gone on since European settlement began must have been enornous if we may judge from an estimate made by Sir J. Hector and quoted in the "Encyclopædia Britannica," to the effect that in 1830 there were probably 20,370,000 acres of forest in New Zealand. That the area should have diminished by at least one-third in less than fifty years shows the immediate recessity of steps being taken towards forest-conservation. This, however, by the way.

The above figures, and the map drawn in accordance therewith, show us pretty clearly that the great forest-areas in New Zealand are on the western side of the Islands—*on the western slopes*—and, if they are below 4,500ft. in height, on the *summits* of the mountain-chains. The densest forests, as far as the North Island is concerned, would seem to be in the Taranaki Province, of which more than four-fifths is forest-clad, and in the Wellington Province (on the Tararua and Ruahine Ranges), of which more than half the surface is so covered; and, as regards the South Island, the Province of Westland has proportionately and absolutely the greatest amount of forest-area, as much as three-fifths of its surface being forest. There are vast areas of wooded country also at the extremities of the colony—that is, in the Provinces of Auckland, and Otago and Southland. In Nelson and Marlborough the mountain-ranges are less elevated generally, and more broken, and the forest spreads over the land extensively, hut with large bare areas intervening, so that the proportion of area forest-covered is riot so large as in the districts previously named. Canterbury and Hawke's Bay, with their naked plains and comparatively sparsely-timbered hills, and a very extensive bare area in the interior of Otago, are absolutely and relatively the poorest in forest of all the provinces, and these are precisely the areas which are most subject to warm north-westers and have least rainfall, being most protected by mountain-chains against the prevalent rain-bringing or equatorial winds.

Similarly, a rainfall map prepared on the basis of authentic statistics shows that the greatest rainfall in New Zealand occurs on the western slopes of the Southern Alps and the mountain-ranges in Taranaki; and, generally speaking, the colony has its heaviest precipitation on its western side—as so frequently occurs elsewhere in corresponding latitudes—and there is less and less as the eastern shores are approached. Heavy rains also occur over the extreme northern and southern areas; and local circumstances bring about exceptionally-heavy rainfalls in various other districts of limited area, particularly in the Provinces of Nelson and Wellington, and on the east coast of Southland. The conclusion is inevitable. Rainfall and forest must, as a general rule, be related to one another as cause and effect; and, though the two may have reacted on one another to a limited extent, yet for the most part the rainfall has brought about the forest, rather than the reverse.

Mountain-ranges as a rule are, as is well known, better covered with forests than level country. I do not think this arises, as Darwin supposed, because plains are in themselves less favourable to the development of arboreous growth than broken and hilly country; for some of the most extensive and dense forests in the world extend over areas level as a table. Mountain slopes and summits—particularly if at all formidable—are little interfered with by man or cattle, and there growth goes on more or less comparatively undisturbed; and, as good drainage and various aspects and different kinds of soil in such situations are sure to be found, there various forms of vegetable life, suitable to the climate, through the instrumentality of birds and winds spring into existence. But the main cause why woods thrive on mountains better than on plains is that rainfall increases, within certain limits, 3 or 4 per cent, for every 100ft. of elevation.

Captain Walker, as if arguing desperately against his own convictions, asks, if forests follow rainfall, "Why should not rain have fallen and forests been created on the eastern slopes of the mountains on which the clouds laden with moisture from the Pacific first impinge? "The answer is conveyed in the question. Bain has not fallen on the eastern slopes of our Alps, because in this latitude the rain-bringing winds are western, and comparatively little rain comes from the east at all. The rain from the west has been intercepted by the mountains, and, as there has been little rain, forests have not been called into existence on the eastern slopes, except in a few places where low passes have permitted the moisture to cross to the leeward side.

That woods do undoubtedly tend to the equalisation of temperature, screen the soil from the sun, check evaporation (which in open country is five times as great as in woods) particularly from pools and streams, render the air about them to some extent cooler and moister than it would be otherwise through the immense surface that the leaves expose to radiation and copious evaporation, and mechanically bind the soil and check the running-off of moisture from its surface—all this, in addition to their grace and beauty of form and colour,—for I share all Lord Beaconsfield's enthusiasm about trees,—must be granted. I will even go further and say that, in consequence of some of the effects herein just enumerated, there would be a slight increase of the rainfall in a country if forests could be grown to occupy a large area previously bare. In France it has been computed that 5 per cent, more rain falls over woodland than in the open; but one would like to examine this calculation closely and see if here also effect has not been put for cause, and cause for effect.

Besides, all kinds of trees are certainly not equally beneficial as regards conserving moisture or giving shade or cooling the air. Some plants—sunflower, *e.g.*—pump water out of the ground enormously; and the drying capacity of the Eucalyptus, as far as the ground around it is concerned, is considered one of its special and peculiar virtues. Even in the case of other trees, the amount of moisture which they draw up from the ground by their sometimes far-reaching spongioles is really enormous. True it is that transpiration and consequent evaporation are constantly going on during growth, and sometimes are so copious that an individual tree will perspire its own weight of water in twenty-four hours; and this undoubtedly does render the air around cooler and moister, though it must be remembered the ground is proportionately robbed of its moisture. According to some people, trees are as good as artesian wells, and will draw water from heaven as Franklin's kite drew electricity from the clouds. They certainly do draw water in large quantities, but it is rather from the earth than from the sky.

That forests, in a wide sense, operate to materially change the climate of a country, as many have contended, I believe therefore to be a serious mistake, resulting from the confounding of cause and effect. The power attributed to trees of drawing rain from heaven is a matter indeed on which many people have held the most extreme views. James Brown, in "The Forester," says, "It is in the power of man to alter, modify, and regulate the climate in which he lives to suit the various kinds of crops he cultivates." One gentleman I know—a well-known *litterateur* of a city in Australia, and the editor of its leading journal—who always entertained the idea that the miraculous virtue of drawing rain lay especially in the *Melia azedarach* or white cedar. This, therefore, he largely planted in the grounds attached to his house, but it is needless to say that the rainfall over his few acres was not sensibly larger than that of the locality generally. Such notions remind one of the old story of King Canute and his courtiers on the sea-shore. Professor Tate, of Adelaide, who holds vews similar to my own, in a lecture delivered by him some years ago went so far as to say that "European experience bused on records kept since 1688, and extending up to the present day, failed to prove that the rainfall had decreased as the trees had been destroyed, and that a similar remark might be ap- plied to the United States, covering a period of sixty-six years." *Per contra*, our later visitor, Mr. David Christie Murray, told me a short time ago that in the Ardennes, where he had lived for many years, it had been observed that the rainfall had been seriously affected by the destruction of the indigenous forest.

There is a good deal of evidence—much of it more or less untrustworthy—on both sides of the question; but I believe the balance falls on the side of the views which I have expressed, and this is what we should expect from *a priori* considerations. The powers of nature which determine general weather are too Titanic for man to hope to overcome. He does not even thoroughly understand them yet, for meteorology is the newest of the sciences. But what knowledge we do possess goes to show that nine-tenths of the rain that falls is cyclonic, and thus general weather depends on widely-operating physical laws, which man will best recognise his own interests by bowing to as inevitable. In India, where at one time they largely held the notion that they could by reforestation modify an extremely hot and, considering their requirements, dry climate, after large experience in this kind of work they have entirely changed their views, and no longer struggle to avert the inevitable or accomplish the impossible. Some of the British colonies, however, still attempt this feat. They have so long repeated the ordinary phrases about forests causing rain that they have come to believe them eternal verities.

As long as the configuration of New Zealand has been what it is, the prevailing western winds have deposited their precious burden on the western sides and summits of the Southern Alps, and on those portions of their eastern flanks and the country beyond to which they could travel without mounting more than, say, 4,000ft. This is one of those wide and general features of climate depending on our latitude (the "roaring forties"), our insular position, and the existence of a high range of mountains running from north to south near the western shores. To alter this feature in any material way whatever, man is perfectly impotent; and, where the rain falls heavily, there the forest heavily covers the land; where less heavily, there the trees grow in patches; where very lightly, there the shady woods are wanting, and the plains are treeless. Above, say, 4,500ft. forest-growth ceases, and stunted vegetation only is found; for at that height cold checks growth, and, instead of rain, for the most part snow falls.

Of course, the nature of the soil and other circumstances are factors of the greatest importance; but, generally speaking, in a country unoccupied by civilised man the forest-areas will be the areas of heavy rainfall. A good map showing clearly the forests of New Zealand, if we took into account the woods destroyed by settlers and accidental fires, would exhibit the main features of the annual rainfall. In countries that have been long settled and cultivated it is impossible to determine what were the areas of virgin forest. It is only in a country such as ours, just placed in the hands of civilised man, and where the aboriginal inhabitants have not been given to felling and clearing on an extensive scale, that such an inquiry becomes possible; and, as to determining or helping to determine what are or have been the areas of greatest precipitation, it may surely be considered, next to exact meteorological statistics, as of paramount importance.

Certainly different kinds of trees require different degrees and amounts of moisture, as of heat, light, and elevation, to develope them. Some, indeed, seem specially adapted by nature for dry climates and positions: they have hairs covering their leaves, which thus attract a larger proportion of dew, or their leaves are needlelike, or set on edge, so that during a drought the sun has less effect on them. It would almost appear as if the Eucalyptus when grown in a moister climate than that in which it is indigenous alters its habit of growth. In New Zealand here, its leaves grow less edgewise, more open and flat to the sky, as if they felt they could safely expose themselves to a less powerful sun in a climate where moisture is happily so plentiful as to temper materially his ardent days. But all these are quite exceptional characteristics of particular species, and are instances of modification of form to protect life and accommodate it to its environment.

It would be quite possible to bring out the truth of the proposition submitted as to the relationship between rainfall and forest by a survey of the surface of the earth genenlly. Some instances could be given which pointedly confirm the theory: *e.g.*, the northern and eastern portions of the Island of Madagascar, where the climate is moist, are clothed with magnificent forest, whereas elsewhere in the island the vegetation is remarkably scanty, there being only a narrow arbore-ous belt along the shores. But it is very difficult to conduct the inquiry as to the earth generally with precision, because there are large areas in the world over which the extent of woodland is very imperfectly mapped out, or, indeed, known; and unfortunately, too, these are precisely the regions where the rainfall is conjectured rather than measured. Moreover, where the forest-area and the mean annual average of rain are well known and duly recorded, there the condition precedent that the forest be indigenous and virgin does not obtain; for the countries referred to have been so long settled that few spots, if any, are left in true primitive wildness. Similar uncertainty, indeed, may exist as to the reading of such cases as Makatu Island, in the Fijis, where the windward and pre- sumably rainy side is densely wooded, while the leeward side is timberless. Moseley, the naturalist of the "Challenger" expedition, thinks the forests there are owing to heavier rainfall; but we have no meteorological statistics from the island, and, as the windward side is the steeper of the two, it may be that the natives, though barbarian, in bygone days have cleared the leeward side for cultivation. The Island of Madeira, as the name implies, was once entirely timber-covered: now, however, through ruthless destruction by Zargo and others, the island is bare except on one side, and that is the windward and rainy. Fire is powerless in a land of incessant rain, or, if it temporarily succeeds, the damage done is speedily repaired.

It is believed that before human inhabitants became numerous in the world its surface was almost entirely covered with forest. Possibly at that remote period—and the latest inquiries into the question of the antiquity of man show that it must have been very remote indeed—the mean annual rain-all on the earth was everywhere considerably greater than it is now. Whether that was so or not, in our own day the most extensive natural forests in the world would seem to be generally, though not exclusively, in those parts where the rainfall is known or conjectured to be heavy, if not the heaviest.

For example, the greatest and most productive forests on earth are in America; and that Continent, as a whole, has undoubtedly a humid climate. British America has 900,000,000 acres of valuable timber. British Columbia and the Washington and Oregon Territories of the United States are densely timbered, and the immense *Sequoia (Wellingtonia) gigantea*, is only found where the western slopes of the Nevada Range intercept the heavy western rains from the Pacific. Passing to South America, we find in the silvas of the western portion of the great plain of the Amazon an area of nearly a million English square miles covered with impenetrable forest and jungle (Brown's "Forester"). In all these lands the rainfall is heavy, in some parts very heavy. Loomis (map, Amer. Jour, of Science, 1882) shades them so as to show a mean annual average of at least 50in., and often over 7 Sin. In Neeah Bay, Washington Territory, the amount is 123in.; in Blockhouse, Oregon, 96in.; in Halifax, N.S., 54in.; in New Westminster, 58in. What it is in the forests of Brazil, particularly in the uplands towards the Andes, I cannot discover, but it must be very large, for, the latitude being tropical, the trade-wind striking against the eastern flanks of the mountains must cause immense precipitation. The Andes are clothed with forest along their entire length either on one side or both sides, because the mountains catch the eastern, rains in one latitude and the western in another. Contrast with this luxuriant arboreous vegetation—resulting, as I contend, from heavy rainfall—the barrenness of Peru and northern Chili, the treeless condition of the pampas of La Plata, Banda Oriental, and Patagonia, and the deserts of Utah and Nevada, in all of which countries the mean annual rainfall is less than 10in. (6in. at Fort Bridger, Utah; 5in. at Fort Churchill, Nevada; 4in. at Mendoza, La Plata; and 0in. at Lima).

Darwin, in his "Journal of Researches" (p. 46), *à propos* of the entire absence of trees in Banda Oriental, notices many of the above facts respecting South America, and discusses the question with which we are engaged at some length. He thinks, as I have already remarked, that extremely level countries such as the pampas seldom appear favourable to the growth of trees, and that this may be possibly attributed to the force of wind or kind of drainage. The fact is, however, that quite recently the *Eucalyptus globulus* has been extensively planted in different parts of the pampas, and, being a tree that can stand drought well, it succeeds despite the pampero, even better than in Australia, becoming both richer and denser in foliage. But, apart from this experimental proof that Darwin was in error on this point, it must be observed that the most extensive tracts of level country with which we are acquainted are flanked on their western sides by mountain-chains cutting off the oceanic winds and rains (Guyot's "Earth and Man "); and this factor, from the point of view of one who believes that rainfall determines forest, is not to be lost sight of. I confess I do not see that the argument as to force of wind and drainage in level tracts is very cogent. Darwin himself subsequently records that he found little or 110 vegetation whatever on the Sierra de la Ventana—a group or chain of hills 3,000ft. high on the eastern side of the Patagonian plain and at no great distance from the South Atlantic. Now, the treeless uniformity of Patagonia ought to have been broken by this elevated ground, if Darwin's reasoning was conclusive; for shelter would be found either on one side or another of the chain, and drainage would be generally good on its slopes. Darwin refers to Maclaren's article in the "Encyclopædia Britannica "as "inferring with much probability that the presence of woodland is determined by the annual amount of moisture," and emphatically says that, confining our view to South America, we should certainly be tempted to believe that trees flourished only under a very humid climate, for the limit of the forest-land follows in a most remarkable manner that of the damp winds. He seems, however, to attach importance to the fact that the Falkland Isles can boast of few plants deserving even the title of bushes. Such carefulness about making wide generalisations is eminently characteristic of the great naturalist. A trifling exception like this, however,—and even though many more might be given,—could be probably accounted for by quite exceptional circumstances, such as being swept by cold and stormy oceanic winds, which accounts similarly for the stunted vegetation of our own Chatham Islands, and does not appear to justify hesitancy about accepting a law which is widely and generally observable. Forest argues heavy rainfall, but heavy precipitation of rain must be accompanied by other circumstances to result in the growth of wide areas of timber.

Of the Dark Continent and its forests our information—though, thanks to the attention which this part of the world has of late been receiving, not by any means meagre—is as yet only general. Of exact statistics we have scarcely any; but the explorations of recent travellers—particularly the indefatigable and indomitable Stanley—show us that almost impenetrable woods fill up the heart of the land, more or less from the Atlantic Ocean to the Indian; and Loomis's map gives us a rainfall of over 75in. for the whole of this wide tropical belt. Northward of it stretches from the Atlantic to the eastward of Central Asia—only broken by the Hindoo Coosh and the Himaleh Mountains—a vast treeless desert, almost rainless.

In India, owing to the beneficial action of the monsoons, a copious rainfall of above 75in. is found along the coasts and at the base of the stupendous chain to the northward, with very excessive precipitation in certain limited areas—Cherapungi, *e.g.*, in Assam, where the fall is over 600in. in the year. The valuable forests of pine, box, sal, teak, ebony, and deodar therefore here are very extensive, and now all are most carefully conserved—not so much with the view of securing a continuance of the rainfall as for the sake of preserving and economizing national wealth. As regards teak (*Tectonia grandis*) it is well known that it grows best where the rainfall is heaviest. Burmah, Java, Sumatra, and Borneo, as regards rain and forest, are equally liberally endowed by nature. All have a truly tropical average of over 75in. (213in. at San donay, Burmah; 220in. at Buitenzorg, in Java; and 181in. at Padang, Sumatra); and all are remarkably well wooded. Siberia, north and north-east of the Altai Mountains, is one enormous forest. It has, however, only a moderate rainfall of from 10in. to 50in. according to locality. The forest here, therefore, does not cause heavy precipitation. But it must be remembered that this is a high latitude, and evaporation is comparatively small. A little rain, therefore, under such circumstances is very effective. The same remarks apply to a large part of Russia in Europe. Japan, again, is well wooded and has a rainfall of over 65in. On the other hand, the steppes of Tartary and Mongolia are nearly treeless, and have less than 10in. of rain in the year.

In Europe, man's action has been powerful enough to completely alter the face of the land, but we know from history that till comparatively recent times it was covered with forest, and this may be presumed to have been the effect of the rainfall with which the Continent is blessed, through its latitude, its being intersected by great oceanic areas, and the action of the Gulf Stream and the Return Trades bringing copious moisture from the Southern Hemisphere—a rainfall coming more or less throughout the year, very heavy in particular spots, but not tropically heavy anywhere, yet quite sufficient, considering the high latitude, to promote vigorous arboreous growth almost in every comer.

Australia has a poor mean average of rainfall throughout its vast interior (5in. at Alice Springs, 6in. at Charlotte Waters), the greater part of which lies within an anticyclonic region of high pressure and the dry south-east trades. This is a land, therefore, subject to very severe droughts, periodically blighting the face of nature from the 18th to the 30th parallel of latitude, and occasionally embracing the whole continent; and as a consequence—though Darwin ("Journal of Researches," p. 47), with scantier information than we possess, speaks of the whole of Australia in spite of its arid climate as being covered by lofty trees—I believe we should be correct in saying that the interior for many thousands—yes, even hundreds of thousands—of square miles is nearly absolutely treeless. Along the eastern coasts and mountains the rainfall is heavier (48in. at Brisbane, 49in. at Sydney: compare 20in. at Adelaide and 25in. at Melbourne), and the arboreous vegetation is more profuse; while the Australian Alps in the southeastern corner, being within the area and influence of the cyclonic depressions that pass along the southern coast in regular succession, are covered with Eucalyptus woods, and there the massive *E. amygdalina* attains its gigantic size.

This review is too cursory and sketchy, but, when taken in conjunction with the more careful examination of the rainfall and forest of New Zealand, previously given, it may perhaps he considered enough to give semblance of truth to the proposition that *the native forests of a country are located in those districts blessed with abundant rainfall, and by the said rainfall are mainly brought into existence*. That a reflex action of forest in producing rain also may exist to a limited extent, I quite believe; but, as I have implied, I think it is a power supposed by most people to be much greater than it actually is. Of course, also, what constitutes sufficient abundance of rain for arboreal development depends on latitude and several other circumstances.

A notice in *Research* of the 1st October, 1889, states that Dr. Hamberg, of the Central Meteorological Institute of Stockholm, has been detailing in a public address the results of his thirteen years' experience and investigations on the influence of forests upon climate. These were carried on at numerous stations—some on free open land, some on forest-clearings, and some in the depths of woods—and related more especially to temperature, humidity of air, and rainfall. He found that temperature was more equable under trees than on free land, and on free land than in clearings; and that, while forests afforded shelter against cold and cutting winds, they did harm on the whole in respect to the sun's heat by depriving the earth of it, and fostering frost through lowering the temperature on the ground on clear nights. As regards the moisture of the air and the rainfall, his researches went to show that in Sweden, at all events, forests are simply *without influence*. In Gothland, *e.g.*, the new forests, presumably extensive, had not increased the rainfall in the least. He concluded that climate rested on a more solid basis than that of forests, and that forests deserved preservation for more weighty reasons than their influence on climate. At the meeting where this address was given, Baron von Kroemer agreed with the views of Dr. Hamberg, and went so much further as to say that even as regards protection trees were not always desirable, for in Scania, *e.g.*, corn dried much more quickly after rain on free land than in clearings. There is no doubt that in a cold country like Sweden the beneficial effects of forests would be less than in a tropical country like Ceylon, *e.g.*, where Colonel Clarke, after many years of observations, came to the conclusion that "forests make climate more equable, increase the relative humidity of the air, and *perhaps increase the rainfall*," and also regulate the water-supply, making springs more sustained and rivers more continuous giving besides protection against strong winds, and preventing the soil from being washed away by heavy rains (*Nature*, 18th October, 1888). This is pithy testimony given by an authority who commands attention; but there is nothing in that testimony which militates against my views, herein expressed.

The proposition which I have endeavoured to establish is one which some people will be disposed to regard as so self-evident as to need no demonstration. It is one which, nevertheless, is frequently lost sight of when the relationship between rainfall and forest is discussed; and it can be maintained quite consistently by those who hold, as I do, that the wholesale destruction of the forests of a country must be, as a rule, prejudicial in various ways to its future interests; though in the process of settlement such destruction, or at all events a large part of it, is inevitable. Indeed, I often think that, even for the sake of preserving old types of the fauna and flora of the land, it would be well if blocks of country here and there, not neessarily very extensive, were, like the Suli lands of Timor, eld inviolably sacred as against axe or gun, or destructive insrument of any kind. To deny, however, that reforestation wold materially increase rainfall is quite a different thing from daying that deforestation must in some respects prove calamitus. Let us plant trees by all means where the ground cannot otherwise be more profitably employed. By so doing we sail clothe the earth with beauty, and shelter it alike from, he bitter blast and the fiery sun, and conserve its refreslng moisture for the benefit of plants and animals. But *we sall not materially affect the mean annual rainfall*, for that is determined by the operation of cosmic laws which neither he wisdom nor the will of man can change.

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On the Characteristics of the Nor-westers of Canterbury, New Zealand.

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THE general features of a typical nor'-wester, as experienced in Christchurch, have, unfortunately, this season been only too familiar to us all. It is, therefore, not necessary to repeat here the full description of the phenomena with which the author commenced his paper. The thermometrical, barometrical, nephological, and other effects of the nor'-wester having been given, the high temperature of the wind was next explained. It had been customary to account for it as the result of compression on the eastern side of the Southern Alps, for it was well known that dry air in descending gained heat at the rate of 1° Fahr. for every 180ft. of vertical measurement. The pneumatic tinder-box clearly enough showed that compression resulted in heat. But compression on one side of the mountains only restored the temperature lost by expansion on the other side—provided the air on both sides were subject to the same conditions of barometric pressure, temperature, velocity, and humidity. Here, however, came in a point of the greatest importance. The north-west wind, on reaching the western slopes of the Southern Alps, was heavily charged with moisture, and this rendered latent the heat brought by the wind from the lower latitudes. Now, wet air in an ascending current lost heat much more slowly than dry—namely, 1° Fahr. for every 300ft. of altitude; because the expansion during ascent resulted in the precipitation of rain, and thus latent heat was rendered sensible. This difference in the rate of losing and gaining heat on the part of wet and dry air was the chief immediate cause of the uncomfortable warmth of our nor'-westers; for, assuming that the wind in Westland was at 60° Fahr., on reaching 9,000ft. in elevation it would fall to 30°—*i.e.*, 9000°/300 would be lost—and on reaching Christ-church there would be an increment of 9000°/180 Fahr.—*i.e.*, 50° Fahr.—which would make, with the 30° Fahr. retained at the summit of the Alps, a temperature of 80°. This reasoning was first given by Espy and Maury (in 1861) without special application, and Dr. Hann, Herschell, and others subsequently used it to explain the föhn wind of Switzerland, a quite analogous wind, which even Dove had failed to account for satisfactorily. This reasoning applied to our nor'-wester, which was a true föhn. But even that explanation did not get to the root of the matter, for it only showed how heavy rain in Westland rendered sensible in Canterbury the heat previously latent. Therefore the question still remained, Whence came that heat? It was brought from the tropics. The hot equatorial wind or return trade, also, in crossing warm oceanic currents, gathered up further moisture and heat as it travelled to higher latitudes. Furthermore, the northwest weather was mostly cyclonic, and all meteorologists agree that, whatever the cause might be—and as yet it was unexplained—a peculiar kind of stifling oppressive heat, giving neuralgia, headache, rheumatism, &c., invariably was developed on the front of a cyclone. In the Southern Hemisphere this heat-spot would be found on the *left* front of the path of the storm, and, granting that the cyclones producing our nor'westers sheered off to the south of New Zealand, being divertd by the Southern Alps, we should be justified in locating the heat-patch over the Canterbury Plains. Cold nor'-westers occurred occasionally, and were sometimes probably only local. If they occurred in winter, when the initial heat of the winds was great, and little precipitation on the mountains accompanied them, they were not difficult to understand; but they occurred at other seasons, and were then not easy to explain. The clouds of dust which made a nor'-wester so unpleasant were thought by Sir J. von Haast—probably erroneously—to explain the loess formation of the Lyttelton hills and elsewhere. The remarkable fall of the barometer on the approach and during the continuance of a nor'-wester accorded with Dove's law of the Southern Hemisphere generally—the steepness of the baric gradient indicating the intensity of the disturbance. The glass usually went down to 29.2in., and once quite recently had even descended to 28.68in., though in twenty-four hours, when south-west intervened, it had risen to 30in. again. Why the glass fell in a nor'-wester was a difficult question. Maury's explanation about aqueous vapour driving out and being lighter than air did not meet the case so well as what Loomis said about light hot air filling the whole space usually occupied by colder and denser air. The north-west arch of clouds, a very beautiful and distinctive mark of the approach of the equatorial wind, was developed probably by contact and difference of temperature between the north-west wind and the ordinary air lying over the plain. It lay really parallel to the range, but assumed to us the arch form from the operation of a principle of perspective. It altered its position, unless dissipated altogether, as the wind veered round to the exhilarating south-west, whence came the cold squalls which showed the passage of the storm. North-west rains along the foot of the hills, and particularly in certain spots, were then adverted to, and other instances were given of föhn winds, corresponding to our nor'-westers—particularly the chinook of North America. Though very unpleasant, and occasionally disastrous, our nor'westers deserved more than a passing good word. Dry heat was needful for ripening wheat and fruit. It also killed or blew away the germs of disease, melted the snows on the hills, &c. Most of the health resorts of the world were situated under the protection of mountain-chains across which warm winds blew; and among the many circumstances to which Canterbury owed that salubrity which accounted for its excellent grain, its toothsome mutton, and the average fine physique of its sons and daughters, not the least important, perhaps, was the much-abused nor'-wester.

Proposals for A Missionary Alphabet,

Submitted to

The Alphabetical Conferences

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Proposals for A Missionary Alphabet.

THE want of a standard system of orthography has been experienced by all persons engaged in the study of languages, written or unwritten. The philologist, the historian, the geographer, and more than all the missionary,—he whose message of good tidings is to all nations,—are harassed in their labours by the diversity of alphabets; and the difficulties hence arising may be judged second only to those caused by the diversity of language:—that main barrier, we may confess with Humboldt and with St. Augustine, against the establishment of the Civitas Dei, and the realisation of the idea of Humanity.

Whatever may be thought of the practicability of finally supplanting all existing alphabets by one uniform system of notation, it is at least our duty, and for the members and directors of Missionary Societies a sacred duty, not to increase the existing diversity, but to do all in our power towards preparing the way for the accomplishment of that highest, though as yet indefinite, aim of society towards which Christianity has from the first been striving.

For the practical solution of the problem, "*How to establish one uniform system of notation which shall be acceptable to the scholar, convenient to the missionary, and easy for the printer*," we must consider three points:—

- *Which are the principal sounds that can be formed with our organs of speech, and therefore may be expected to occur in any of the dead or living dialects of mankind?*

  This is a physiological question.
- *How can these principal sounds, after proper classification, be expressed by us in writing and printing so as to preserve their physiological value, without creating new typographical difficulties?*

  This is a practical question.

- *How can this physiological alphabet be applied to existing languages, and*
  - *to unwritten dialects;*
    This depends on a good ear.
  - *to written dialects;*
    This depends on philological research.
- In the application of the physiological alphabet to languages not yet fixed by writing, the missionary should be guided entirely by ear, without paying any regard to etymological considerations, which are too apt to mislead even the most accomplished scholar.
- In transcribing languages possessed of an historical orthography, and where, for reasons best known to the archæologist, one sign may represent different sounds, and one sound be expressed by different signs, new and entirely distinct questions are involved, such as must be solved by archæological and philological research. We shall, therefore, discuss this part (III. *b*.) separately, and distinguish it by the name of "Transliteration," from the usual method of "transcribing " as applied to unwritten tongues.

I.

Which are the principal Sounds that can be formed with our Organs of Speech, and therefore may be expected to occur in any of the dead or living Dialects of Mankind?

On the first point, which must form the basis of the whole, we have the immense advantage that all scholars who have written on it have arrived at results almost identically the same.

In a very able article by Professor Heise, in Hoefer's Zeitschrift für die Wissenschaft der Sprache, iv. 1. 1853, the following authorities are quoted:—

Chladni, Über die Hervorbringung der Menschlichen Sprachlaute, in Gilbert's Annalen der Physik. vol. Ixxvi. 1824.

A. J. Ribbeck, Über die Bildung der Sprachlaute. Berlin, 1848.

K. M. Rapp, Versuch einer Physiologic der Sprache. Stuttgardt, 1836.

H. E. Bindseil, Abhandlungen zur Allgcmeinen Vergleichenden Sprachlehre. Hamburg, 1838

J. Müller, Elements of Physiology. London, 1842. vol. ii. p. 1044.

W. Holder, Elements of Speech: an Essay of Inquiry into the natural Production of Letters. London, 1669__This is one of the earliest and best works on the subject.

An excellent account of the researches of the most distinguished physiologists on the human voice, and the formation of letters, is found in Ellis, "The Alphabet of Nature."—A work full of accurate observations and original thought.

We are here still in the sphere of physical science, where facts are arranged by observation, and observation may be checked by facts so as to exclude individual impressions and national prejudice. The classification of vowels and consonants proposed by modern physiologists is, so far as general principles are concerned, exactly the same as the one contained in Sanskrit grammars composed in the fifth century before Christ, and appended to the different collections of the sacred writings of the Brahmans,—the four Vedas. These grammatical treatises, called "Prâti*s*âkhyas," exist in manuscript only, and have not hitherto been published. The classification established by physiologists, as the result of independent research, would receive the most striking confirmation by a translation of these writings, now more than two thousand years old. But, on their own account also, these phonetic treatises deserve to be published. Their observations are derived from a language (the Vaidik Sanskrit) which at that time was studied by means of oral tradition only, and where, in the absence of a written alphabet, the most minute differences of pronunciation bad to be watched by the ear, and to be explained and described to the pupil. The language itself, the Sanskrit of that early period, had suffered less from the influence of phonetic corruption than any tongue from which *we* can derive our observations; nay, the science of phonetics (*S*ikshâ), essential to the young theological student (who was not allowed to learn the Veda from MSS.), had been reduced to a more perfect system in the schools of the Brahmans, in the fifth century before Christ, than has since been anywhere effected. Our notions on the early civilisation of the East are of so abstract a nature that we must expect to be startled occasionally by facts like these. But we now pass on to the general question.

CONSONANTS AND VOWELS.

If we regard the human voice as a continuous stream of air, emitted as breath from the lungs and changed into vocal sound as it leaves the larynx, this stream itself, as modified by certain positions of the mouth, would represent the vowels. "The vowels," as Professor Wheatstone says, "are formed by the voice modified, but not interrupted, by the various positions of the tongue and the lips." In the consonants, on the contrary, we should have to recognise a number of stops opposing for a moment the free passage of this vocal stream. These consonantal stops, against which the waves of the vowels break themselves more or less distinctly, are produced by barriers formed by the contact of the tongue, the soft palate, the palate, the teeth, and the lips with each other.

CONSONANTS

Gutturals, Dentals, and Labials.

According to an observation which we find already in Vaidik grant' mars, the principal consonantal stops in any language are:—

the guttural (k),
the dental (t),
the labial (p).

The pure *guttural* sound, without any regard as yet to its modifications (whether tenuis, media, aspirata, nasalis, semi-vocalis, or flatus), is produced by stopping the stream of sound by means of a contact between the root of the tongue and the throat, or, more correctly, the soft palate, or the velum pendulum. The throat is called the "place," the root of the tongue the "instrument," of the guttural.

The pure *dental* sound is produced by contact between tongue and teeth. Here the teeth are called the " place," and the tip of the tongue the "instrument."

The pure *labial* sound is produced by contact between the upper and lower lip; the upper lip being the "place," the lower the "instrument."

All consonants, excluding semi-vowels and sibilants or flatus, are formed by a complete contact between the active and passive organ.

Formation of the Tenuis.

If the voice is stopped sharp by the contact of the organs, so as to allow for the moment no breath or sound to escape, the consonant is called tenuis (tenuis), hard or surd (k, t, p).

Formation of the Media.

If the voice is stopped less abruptly, so as to allow a kind of breathing to continue after the first contact has taken place, the consonant is called *media* (media), soft or sonant (g, d, b). The soft consonant does not arrest the sound at once, but allows it to be heard during a moment of resistance.

The difference between a surd and sonant consonant is best illustrated by a speaking-machine. "The sound p," as Professor Wheat-stone says, "was produced by suddenly removing the left hand from the front of the mouth, which it had previously completely stopped; the sound b, by the same action; but instead of closing the mouth completely, a very minute aperture was left, so that the sound of the reed might not be entirely stifled." This coincides fully with the description given by Mr. Ellis. "In pronouncing ba," he says, "the vowel is uttered simultaneously with the act of relieving the lips from contact, or rather *before* they are quite released. If we separate them before the vowel is uttered, allowing the breath to be condensed during a very brief space of time, the sound pa is heard. There is a similar distinction between ab and ap: in the former the effect of the voice remains throughout the consonant, and we may feel a slight tremor of the lips while it is being produced; in the latter the vowel, properly so called, entirely ceases before the contact is completed."

Formation of Semi-vowels.

If there is only an approach or a very slight contact between the organs, and the voice is slightly stopped or compressed as it reaches the point of contact, the consonants are called half-consonants or semi-vowels. They are sonant like the media, owing to the process of their formation here described ('h, l, w).

At the end of words and before a tenuis the semi-vowels are frequently pronounced as a flatus, or they become evanescent. In the Dutch 'dag,' we have the nearest approach to a guttural semivowel. If a Saxon pronounces the same word, he changes the *d* into *t*, and the guttural semi-vowel into the guttural flatus aspcr, like *ch* in 'loch.' In other parts of Germany, the final guttural is sounded as a media or as tenuis, while in the English 'day' the guttural semi-vowel has become evanescent. The same applies to French "sou " instead of "sol," and "vaut " instead of "valet." In Sanskrit no semi-vowel is tolerated at the end of words or before a tenuis.

Professor Wheatstone's researches prove that a distinguishing mark of the semi-vowels consists in their having no corresponding mutes. This applies not only to y, r, I, but also to w and 'h. It should be remarked, however, that, in the guttural and palatal series, the semi-vowel and flatus lenis can hardly be distinguished except in theory.

Formation of Sibilants (flatus).

If there is no contact at all, and the breath passes between the two organs without being stopped, still not without giving rise to a certain friction on passing that point of contact where guttural, dental, and labial consonants are formed, we get the three sibilants, or the "winds," as they are more properly called by Hindu grammarians. These are, the pure breathing, without even a guttural modification, commonly called spiritus asper and lenis; the thick guttural flatus, as heard in "loch;" the sharp and soft s for the dentals; and the sharp and soft f for the labials. The sibilants or flatus are distinguished from all other consonants by this, that with them a breathing is really emitted, while the consonants are only so many stops which preclude the emission of vocal sound. A candle applied to the mouth will at once show the difference between the labial flatus asper, as in "find," and the consonantal stops, such as p, b, or even the labial semi-vowel, as heard in "wind." In this respect the sibilant flatus approaches nearer to the vowels than even the semi-vowels.

As we distinguished between tenuis and media in the consonants, we must admit a twofold intonation for the flatus or the sibilants also. A flatus or sibilant cannot be modified exactly in the same manner as a consonant produced by contact; but, by an analogous process, it may become either "asper" or "lenis," rough or soft. We are best acquainted with this distinction in the primitive and unmodified breathing which necessarily precedes an initial vowel. The spiritus asper and lenis in Greek are modifications of that initial breathing which is inherent in every vowel sound at the beginning of a word or of a syllable. It comes out freely as the spiritus asper in Homer and greek script, frontier, while it is tempered and to our ears hardly audible in 'Aristotle and greek script, hill. In ancient languages the spiritus asper is frequently represented by the dental flatus (s), and the spiritus lenis by a semi-vowel, as, for instance, the Diganima Æolicum.

The dental flatus, as a tenuis or rather as flatus asper, is heard in sin and seal; while the media or lenis is frequently represented by the English z, as in zeal and breeze.

The sharp labial flatus is the pure f, which the Greeks could not pronounce, and which we hear in "find" and "life." The flat corresponding sound is heard in "vine" and "live." This also is a difficult letter to pronounce, and is therefore avoided by many people, or changed into b, as Scaliger said,

"Haud temere antiquas mutat Vasconia voces,
Cui nihil est aliud vivere quàm bibere."

Strictly speaking, and in accordance with our own definitions, every consonant at the end of a word, unless followed by a slight vocal exhalation such as is heard in drug, loud, sob, must become a tenuis. Now, if we take words where the final consonant is a flatus, but where, by the addition of a derivative syllable, the flatus ceases to be really final, we shall see distinctly how the flatus asper and lenis interchange. The sharp dental flatus is heard in "grass" and "grease." Here the s is really final, although an e is put at the end of grease. If we form the two verbs, to graze and to grease, we have the corresponding flat s, the common German s. Exactly the same grammatical process applied to the labial flatus changes "life" into "live," *i.e.* the sharp labial flatus into the flat.

Some languages, as, for instance, Sanskrit, acknowledge none but sharp sibilants; and a media followed by a flatus is changed in Sanskrit into a tenuis.

Formation of Nasals.

If, in the three organs, a full contact takes place and the vocal breathing is stopped, not abruptly, but in the same manner as with the sonant letters, and if afterwards the vocal breathing be emitted, not through the mouth, but through the nose, we get the three full nasal consonants n., n, and m, for the guttural, dental, and labial series. A speaking-machine leaves no doubt as to the manner in which a tenuis may be changed into a narisonant letter. "M," as Professor Wheatstone says, "was heard on opening two small tubes representing the nostrils, placed between the wind-chest and the mouth, while the front of the mouth was stopped as for p."

In most cases the peculiar character of the nasal is determined by the consonant immediately following. In "ink," the n is necessarily guttural; and if we try to pronounce it as a dental or labial, we have to stop after the n, and the transition to the guttural k becomes so awkward that, even in words like to "in-cur," most people pronounce the n like a guttural. No language, as far as I know, is fond of such incongruities as a guttural n. followed by any but guttural consonants, and they generally sacrifice etymology to euphony. In English we cannot pronounce em-ty, and therefore we pronounce and write emp-ty. In the Uraon-Kol language, which is a

Tamulian dialect, "enan " is *I*, and the possessive prefix is "in," *my*. But in the Journal of the Asiatic Society of Bengal we find " im-bas," *my father;* but "ing-kos," *my child*. Cicero alludes to the same where he speaks of the n adulterinum. He says, that "cum nobis " was pronounced like "cun nobis."

At the end of words and syllables, however, the three nasal sounds, guttural, dental, or labial, may occur independently; and as it is necessary to distinguish a final m from a final n (greek script , *bonum*), it will be advisable also to do the same for a final guttural nasal, as the French "bon," "Lundi," or the English "to sing." It is true that in most languages the final guttural nasal becomes really a double consonant, *i.e.* n + g, as in "sing," or n + k, as in "sink;" still, as the pronunciation on this point varies even in different parts of England, it will be necessary to provide a distinct category, and afterwards a distinct sign, for the guttural nasal.

In some languages we meet even with an initial guttural nasal, as in Tibetan "nga-rang," *I myself*. Whether here the initial sound is really so evanescent as to require a different sign from that which we have as the final letter in "rang," is a question which a native alone could answer. Certain it is that in the Tibetan alphabet itself both are written by the same sign, while Csoma tie Körös writes the initial guttural n by ñ, the final by ng; as "ña-rang."

We have now, on physiological grounds, established the following system of consonants:

***Formation of Aspirates*.**

According to Sanskrit grammarians, if we begin to pronounce the tenuis, but, in place of stopping it abruptly, allow it to come out with what they call the corresponding "wind" (flatus, wrongly called sibilans), we produce the *aspirata*, as a modified tenuis, not as a double consonant. This is admissible for the tenuis aspirata, but not for the media aspirata. Other grammarians, therefore, maintain that all media; aspiratæ are formed by pronouncing the mediæ with a final '*h*, the flatus lenis being considered identical with the spiritus; and they insist on this principally because the aspirated sonants could not be said to merge into, or terminate by, a surd sibilant. Accepting this view of the formation of these aspirates, to which we have no corresponding sounds in English, we may now represent the complete table of the chief consonantal sounds possible in any dialect, as follows:—

It should be remarked that in the course of time the fine distinctions between k*h*, g*h*, and '*h*, between p*h*, b*h*, and *f*, become generally merged into one common sound. In Sanskrit only, and in some of the southern languages of India, through the influence of Sanskrit, the distinction has been maintained. Instead of Sanskrit t*h* we find in Latin the simple t; instead of d*h*, the simple d, or, as a nearer approach, the f (d*hu*ma—fumus, &c.). The etymological distinction maintained in Sanskrit between "d*ha*," to *put, to create, and " da," to give*, is lost in Persian, because there the two initial sounds d and d*h* have become one, and the root "d*a*" has taken to itself the meaning both of creating and giving. Whatever objections, therefore, might be raised against the anticipated representation of the tenuis and media aspirata by means of an additional *h* or h, they would practically apply only to a very limited sphere of languages. In Sanskrit no scholar could ever take kh for k+h, because the latter combination of sounds is grammatically impossible. In the Tamulian languages the fine distinctions introduced into their orthography have hardly found their way into the spoken dialects of the people at large.

***Modifications of Gutturals and Dentals*.**

From what has been said before on the formation of the guttural and dental sounds, it must be clear that the exact place of contact by which they are produced can never be fixed with geometrical precision, and that by shifting this point forward or backward certain modifications will arise in the pronunciation of individuals, tribes, or nations. The point of contact between the lips is not liable to the same changes, and the labials are, therefore, the most constant sounds in all dialects.

A. *Dialectic Modifications of Gutturals and Dentals*.

Where this variety of pronunciation is only in degree, without affecting the nature and real character of a guttural or dental consonant, we need not take any notice of it. Gutturals from a Semitic throat have a deeper sound than our own, and some grammarians have made a new class for them by calling them pectoral letters. The guttural flatus asper, as heard in the Swiss "ach " is deeper, and as it were more pectoral, than the usual German ch: but this is owing to a peculiarity of the organs of speech; and whatever letter might be chosen to represent this Swiss ch in a phonetic alphabet, it is certain none but a Swiss could ever pronounce it. Sanskrit grammarians sometimes regard h as formed in the chest (urasya), while they distinguish the other gutturals by the name of tongue-root letters (*g*ihv*a*mul*i*ya). These refinements, however, are of no practical use; because, in dialects where the guttural sound is affected and diverted from its purer intonation, we generally find that the pure sound is lost altogether; so that the two hardly ever co-exist in the same language.

B. *Specific Modifications of Gutturals and Dentals*.

1. *Palatals as Modifications of Gutturals*.

But the place of contact of the gutturals may be pushed forward so far as to lie no longer in the throat, but in the palate. This change has taken place in almost all languages. Latin "cantus" is still "canto" in Italian, but in English "chant." In the same manner, the guttural tenuis in the Latin "vocs" (*vox*) has been softened in Sanskrit into the sound of the English ch, at least where it is followed by certain letters. Thus we have:

"vachmi," *I speak*,
but "vakshi," *thou speakest*,
"vakti," *he speaks*.

The same applies to the media. Latin "largus" is Italian "largo," but English "large." The Latin guttural media g in "jungo" is softened in Sanskrit into the sound of the English j. We have Sanskrit "yuga," Latin "jugum;" but in the verb we have:

yunaj + mi, *I join*.
yunak + shi, *thou joinest*.
yunak + ti, *he joins*.

The identity of many words in Latin and Sanskrit becomes palpable at once, if, instead of writing this modified guttural, or, as we may now call it, *palatal* sound, by a new type, we write it by a modified *k*. Sansk. "chatvar," or as some write "tschatwar," does not look like "quatuor;" but Lithuanian "keturi" and Sanskrit "*k*atvar" speak for themselves. Sanskrit "cha" or "tscha" does not look like Latin "que;" but Greek "*k#*" and Sanskrit "*k*a" assert their relationship without disguise. Although, therefore, we are forced to admit the palatals, as a separate class, side by side with the gutturals, because most languages retain both sets and use them for distinct etymological and grammatical purposes, still it will be well to remember that the palatals are more nearly related to the gutturals than to any other class, and that in most languages the two are still interchangeable.

That the pronunciation of the palatals may vary again, like that of the gutturals, requires no explanation. Some people imagine they perceive a difference between the English palatal in "church," and the Italian palatal in "cielo," and they maintain that no Englishman can properly pronounce the Italian palatal. If so, it only proves what was said before, that slight modifications like these do never co-exist in the same language; that English has but one, and Italian but one palatal, though the two may slightly differ. But even if we invented a special letter to represent the Italian palatal, no one except an Italian would be able to pronounce it, not even for his life, as the French failed in "ceci" and "ciceri" at the time of the Sicilian Vespers. All consonants, therefore, which are no longer gutturals, and not yet dentals, should be called palatals. That palatals have again a tendency to become dentals, may be seen from words like "greek script" instead of "*k*atv*a*ras" or "keturi."

Frequently the pronunciation of the palatals becomes so broad that they seem, and in some cases really arc, double consonants. Some people pronounce "church " (kirk) as if it were written "tchurtch." If this pronunciation becomes sanctioned, and we have to deal with a language which has as yet no historical orthography, it must be left to the ear of the missionary to determine whether he hears distinctly two consonants, or one only though pronounced rather fully and broadly. If he hears distinctly the two sounds t + ch, or *t+sh*, he should write both, particularly if in the same language there exists another series of letters with the simple palatal sound. This is the case, for instance, in Tibetan and its numerous dialects. If, therefore, the missionary has to deal with a Bhotîya dialect, which has not yet been fixed by the Tibetan alphabet, the simple palatals should be kept distinct from the compound palatals, tsh, dsh, &c. In the literary language of Tibet, where the Sanskrit alphabet has been adopted, an artificial distinction has been introduced, and the compound sounds, usually transcribed as tsh, tsh*h*, and dsh, are distinguished by a diacritical mark at the top from the simple palatals, the sound of which is described as like the English ch in *church*, and j in *join*. How this artificial distinction should be rendered in transliteration, will have to be considered under III. *b*. If we have once the palatal tenuis, the same modifications as those described above give us the palatal media, the two aspiratæ, the nasal, the semi-vowel, and the sibilant.

The sound of the tenuis is given in the English "church;" of the media, in "to join." The semi-vowel we have in the pronunciation of "yea." The nasal again hardly exists by itself, but only if followed by palatals. We have it in "inch" and "injure." Where the Spaniards use an ñ, they write a double by a simple sound; for the sound is the nasal followed by the corresponding semi-vowel, ny. The French express the same sound in a different manner. The French "besogne," if it occurred in an African language, would have to be expressed by the missionary as "bezonye."

As to the palatal flatus or sibilant, we must distinguish again between its sharp and flat sound. The sharp sound is heard in "sharp," or French "chose." The flat sound is less known in English, but of frequent occurrence in French; such as "je," and "joli," very different from the English "jolly." It is a sound of frequent occurrence in African languages.

See the Rev. Dr. Krapf's "Outline of the Elements of the Kisuáheh Language:" Tübingen, 1850, page 23.

The difference between the hard and soft palatal flatus may best be illustrated by a reference to the modern languages of Europe. A guttural tenuis in Latin becomes a palatal tenuis in English, and a palatal sibilant in French; cantus, the chant, le chant. Here the initial sibilant in French is a tenuis or asper like the English sh in "she." A guttural media in Latin becomes a palatal media in English, and a palatal sibilant in French; elegia, the elegy, l'élégie. Here the sibilant sound of the French g is the same as in "genou" or "je;" it is the soft palatal sibilant, sometimes expressed in English by s, as in erasure and pleasure.

It should be remarked, however, that the proper, and not yet assibilated sound of the palatal flatus asper is not the French ch as heard in "Chine," but rather the German ch in "China," "mädchen," "ich," " könig." Both sounds are palatal according to our definition of this term; but the German might be called the simple, the French the assibilated palatal flatus. Ellis calls the former the "whispered guttural sibilant," and remarks that it is generally preceded by a vowel of the i class. The corresponding "spoken consonant" or the flatus lenis, was discovered by Ellis in such words as "kön'ge."

2. *Linguals as Modifications of Dentals*.

While the pure dental is produced by bringing the tip of the tongue straight against the teeth, a peculiarly modified and rather obtuse consonantal sound is formed if the tongue is curled back till its tip is at the root, and the dome of the mouth then struck with its back or under-surface. The consonants produced by this peculiar process differ from the dentals, both by their place and by their instrument, and it has been common in languages where these peculiar consonants occur to call them "linguals." Although this name is not quite distinct, the tongue being the agent in the palatals and dentals as well as in these linguals, still it is preferable to another name which has also been applied to them, Cerebrals a mere mistranslation of the Sanskrit name "M*u*rdd*h*anya."

"M*u*rddhanya," being derived from "m*u*rddhan," *head* or *top,* was a technical name given to these letters, because their place was the top or highest point in the dome of the palate, the greek script of the Greeks. The proper translation would have been "Cacuminals." "Cerebrals " is wrong in every respect; for no letter is pronounced by means of the brain, nor docs "m*u*rddhan" mean brain. It is not advisable to retain this name, even as a technical term, after it has been proved to owe its origin to a mere mistranslation. It is a word which has given rise to confused ideas on the nature of the lingual letters, and which ought therefore to be discarded from philological treatises, though the mistranslation and its cause have hitherto failed to attract the observation of either Sanskrit or comparative grammarians

These linguals vary again in the degree of obtuseness imparted to them in different dialects, and which evades graphical representation. All letters that cease to be pure dentals by shifting the point of contact backward from the teeth, must be considered as linguals; and many languages, Semitic as well as Arian, use them for distinct etymological purposes. As with the palatals, we have with the linguals also a complete set of modified consonants. The lingual tenuis, tenuis aspirata, media, media aspirata, and nasal have no corresponding sounds in English, because, as we shall see, the English organ has modified the dental sounds by a forward and not by a backward movement. The semi-vowel is the lingual r, produced by a vibration of the curled tongue in which the Italians and Scotch excel, and which we find it difficult to imitate. The English and the German r become mostly guttural, while, on the contrary, the Semitic guttural semi-vowel, 'hain, takes frequently the sound of a guttural r. It might be advisable to distinguish between a guttural and a lingual r; but most organs can only pronounce either the one or the other, and the two therefore seldom co-exist in the same dialect.

The lingual sibilant is a sound peculiar to the Sanskrit; and as, particularly in modern Indian dialects, it interchanges with the guttural tenuis aspirata, its pronunciation must have partaken of a certain guttural flatus.

There is a peculiarity in the pronunciation of the dental tenuis aspirata and media aspirata, which, though it exists but in few languages, deserves to be noticed here. In most of the spoken idioms of Europe, although a distinction is made in writing, there is hardly any difference in the pronunciation of t and t*h*, or d and d*h*. The German "thun," *to do*, the French " théologie," are pronounced as if they were written "tun," " téologie." In the Low German and Scandinavian dialects, however, the aspiration of the t and d (according to Grimm's law, an organic aspiration) has been preserved to a certain extent, only the consonantal contact by which they are produced takes place no longer between the tongue and the inside of the teeth, but is pushed forward so as to lie really between the tongue and the edge of the teeth. This position of the organs produces the two well-known continuous sounds of th, in "think" and "though." There is a distinct Runic letter to express them, Runic letter and in later MSS. a graphical distinction is introduced between script and #, tenuis and media. The difference between the tenuis and media is brought out most distinctly by the same experiment which was tried for f and v. (page 7.). We have the tenuis in "breath," but it is changed into media in "to breathe."

We may consider these two sounds as dialectical varieties of the real t*h* and d*h*, which existed in Sanskrit, but which, like most aspirated sonant and surd consonants, have since become extinct. To many people the pronunciation of the English th is an impossibility; and in no dialect, except perhaps the Irish, does the English pronunciation of the th coexist with the pure and simple pronunciation of t*h* and d*h*. Still, as their sound is very characteristic, it might be desirable to mark it also in writing, so that even those who do not know the peculiar accent and pronunciation of a language, should be able to distinguish by the eye the English sound of the th from the usual t*h* and d*h*.

The principal consonantal sounds, without any regard as yet to their graphic representation, may now be classified and defined as follows. Where possible, the approximate sound is indicated by English words.

VOWELS.

The Physiological Scale of Vowels.

If we recall the process by which the semi-vowels were formed in the three principal classes, and if, instead of stopping the vocal sound by means of that slight remnant of consonantal contact or convergence, which characterized the formation of the semi-vowels, we allow the full volume of breath to pass over the point of contact and there to vibrate and sound, we get three pure vowel sounds, guttural, palatal, and dental, which can best be expressed by the Italian *A, I, U,* as heard in psalm, ravine, flute.

Formation of the Labial Vowel.

Let us pronounce the labial semi-vowel, the English w in woe, and, instead of stopping the vocal sound as it approaches the labial point of contact, emit it freely through the rounded aperture of the lips, and we have the vowel u. Here also the experiment of the candle will elucidate the process that takes place, but of which we are hardly conscious. The mere semi-vowel w, not followed by any vowel, should not produce any disturbance in the flame; at least not more than might be occasioned by the motion of the lips, which is the same for all consonants. The labial flatus, f, on the contrary, will disturb the flame considerably, and the vowel u may extinguish it.

Formation of the Palatal Vowel.

The same process which changes w into u, changes the guttural semi-vowel 'h into a, and the palatal semi-vowel y into i. Let us pronounce the y in yea without any vowel after it, and it only requires the removal of that stoppage of sound which takes place between tongue and palate, in order to allow the vowel i, as in ravine, to be heard distinctly.

Formation of the Guttural Vowel.

Let us pronounce the guttural semi-vowel as heard in the Dutch dag or the Hebrew 'hain, and, if we try to change this semi-vowel gradually into the vowel a, we feel that what we effect is merely the removal of that stoppage which in the formation of the semi-vowel takes place at the very point of guttural contact.

The vowels, as was said before, are formed by the voice modified, but not interrupted, by the various positions of the tongue and the lips. "Their differences depend," as Professor Wheatstone adds, "on the proportions between the aperture of the lips and the internal cavity of the mouth, which is altered by the different elevations of the tongue."

Succession of Vowels, natural and artificial.

The organic succession of vowel sounds is the same as for consonants,—guttural, palatal, labial, a, i, u. The succession of vowel sounds produced by the gradual lengthening of a cylindrical tube joined to a reed organ-pipe, as described by Professor Willis

Transactions of the Cambridge Philosophical Society, vol. iii. paper 10. 1828-29.

, is an interesting experiment as to the scale of vowels in the abstract. It gives, or, at least, is reported to give,

But as these pipes are round and regular, while the construction of the pipe formed by larynx, throat, palate, jaws, and lips is not, the succession of vowels given by these pipes cannot be expected to correspond with the local succession of vowels as formed by the organs of speech.

Kempelen states that if we pay attention to the successive contraction of the throat only, we shall find, indeed, that the aperture of the throat is smallest if we pronounce the Italian i, and that it gets gradually larger as we pronounce e, a, o, u; while if we pay attention to the successive contraction of the lips, which is quite as essential to the formation of the vowels as the contraction of the throat, the scale of vowels is a different one. Here the aperture of the lips is largest if we pronounce the a; and it gradually decreases as we go on to the e, i, o, and u.

Hence, if we represent the opening of the lips by Roman, and the opening of the throat by English figures, taking the smallest aperture as our unit, we may, according to Kempelen, represent the five vowels in a mathematical progression:

i = III. 1. e = IV. 2. a= V. 3. o = II. 4. u = I. 5.

It has been remarked by Professor Purkinje, that the conditions for the formation of some of the vowels, particularly of a and e, as heard in far and name, have not been quite correctly stated by Kempelen. The production of both these sounds depends principally on the form of the cavity of the throat between the root of the tongue and the larynx; in both cases this space is large, but largest in the pronunciation of e. The size of the opening of the mouth is the same in the two cases; not different, as Kempelen states. The position which he ascribes to the lips in pronouncing o is also unnecessary.

Sec J. Müller, Elements of Physiology, p. 1047.

The experiments of Professor Willis show that, if we look on the instrument by which the vowels are formed as a vibrating membranous tongue, with one tube prefixed, and another added below the tongue, the shortest length of the tube gives i; the longest, u; and an intermediate one, a. But as the human organ of speech is not a regular tube, we must insist on this, that in the mouth the shortest length is indicated by the point of palatal contact, the longest by the point of labial, and the intermediate by the point of guttural contact; and that here, by the simultaneous operation of the guttural and labial aperture, the vowels i, u, and a are formed.

The Lingual and Dental Vowels.

Besides the three vowels struck at the guttural, palatal, and labial points of contact, the Sanskrit, in strict analogy, forms two peculiar vowels as modifications of the lingual and dental semi-vowels. *R* and *L*, subjected to the same process which changes 'h into a, *y* into i, and w into u, become ri, li, or r# and l#. At least these sounds ri and li, approach as near to the original value of the Indian vowels as with our alphabet we can express it. According to their origin, they may be described as r and I opened and vocalised.

Unmodified Vowels.

If we attempt in singing to pronounce no particular vowel, we still hear the vowel-sound of the Italian a. This vowel expresses the quality of the musical vibrations emitted from the human larynx and naturally modified by a reverberation of the palate. Hut if we arrest the vibrations before they pass the guttural point of contact—if, either in a whispered or a vocalised shape, we emit the voice without allowing it to strike against any part of the mouth—we hear the unmodified and primitive sound as in but, bird, lull. It is the sound which, in Professor Willis's experiments, "seems to be the natural vowel of the reed," or, according to Mr. Ellis, "the voice in its least modified form." We hear it also if we take the larynx of a dead body, and blow through it while compressing the chordæ vocales.

In these experiments it is impossible to distinguish more than *one* sound; and most people admit but *one* unmodified vowel in English. According to Sir John Herschell, there is no difference in the vowels of the words spurt, assert, dirt, virtue, dove, double, blood. Mr. Ellis considers the u in cur as the corresponding long vowel. Other writers, however, as Sheridan and Smart, distinguish between the sounds of bird and work, of whirl'd and world; and in some languages this difference requires to be expressed. It is a very delicate difference, but may be accounted for by a slight palatal and labial pressure, by which this obscure sound is affected after having escaped the guttural reverberation.

In English almost every vowel is liable to be absorbed by this obscure sound; as begg*a*r, off*e*r, b*i*rd, work, b*u*t. It is sometimes pronounced between two consonants, though not expressed in writing; as el-m, mar-sh, schis-m, rhyth-m. Here it is the breath inherent in continuous consonants. In French it is the e muet, as in entendre, Londres. In German it is doubtful whether the same sound exists at all, though I think it may be heard occasionally in such words as leb*e*r, leb*e*n.

Quantity of Vowels.

All vowels may be short or long, with the exception of the unmodified breathing (Rapp's "Urlaut"), which is always short. The sound of the long a we have in psalm, messa (*It*.); short, in Sam.

The sound of the long i we have in neat, Italia; short, in knit.

The sound of the long u we have in fool, usarono (*It.*); short, in full

The examples are mostly taken from Ellis, who distinguishes between the short a in messa and the stopped a in Sam; a distinction which, though essential in a theoretical analysis, does not require to be expressed in alphabetical notation.

The sound of # we have in bird.

The sound of # we have in work.

DIPHTHONGS.

From the organic local succession of the three simple vowels a, i, u, it follows that real compound vowels can only be formed with a, as the first and most independent vowel, for their basis. The a, on its onward passage from the throat to the aperture of the mouth, may be followed or modified by i or u. It may embrace the palatal and labial vowels, and carry them along with it without having to retrace its steps, or occasioning any stoppage, which of course would at once change the vowel into the semi-vowel. In Sanskrit, therefore, the palatal and labial vowels, if brought in immediate contact with a following a, relapse naturally into their corresponding semi-vowels, y and w, and never form the base of diphthongs. The vowels i + a, or u + a, if pronounced in quick succession, become ya and *w*a, but they will never coalesce into one vocal sound, because the intonation of the a lies behind that of i; the vocal flatus has to be inverted, and this inversion amounts in fact to a consonantal stoppage sufficient to change the vowels i and u into the semi-vowels y and w.

The four Bases of Diphthongs.

According to our definition of diphthongs, their basis can only be guttural; but as the guttural a may be short or long, and as the two unmodified vowels (#, #) lie even behind the guttural point of contact, we get really a four-fold basis for diphthong sounds. Each of the four vowels (#â##) being liable to a palatal or labial modification, we may on physiological grounds expect eight different compound vowels.

This can best be represented by a diagram:

Diagram representing compound vowels

Diphthongs with # as base.

If the short a is quickly followed by i and u, so that, as the Hindus say, the guttural is mixed with the palatal and labial vowels like milk and water, we get the diphthongs ai and au, pronounced as in French. They correspond in sound to the Italian e and o, and to the English sounds in sailor and home.

Diphthongs with # as Base.

If the a, as the first element, retains more of its independent nature, or is long, then *â* + i pronounced together give the German diphthong ai, as in pie and buy; a + u give the German diphthong au, as in proud.

Diphthongs with # as Base.

If, instead of the short or long a, the base of the diphthong becomes #, we get the combinations ei and eu, both of rare occurrence except in German, where the sound of ei (English isle), is thinner than that of ai (English ire). In eu, the two vowels are still heard very distinctly in the Italian Europa. In German they coalesce more, and almost take the sound of oy in boy.

Diphthongs with # as Base.

In the diphthong oi also, the pronunciation may vary according to the degree of speed with which the i follows the #. O and u, on the contrary, coalesce easily, and form the well-known deep sound of ou in bought, or of a in fall.

Different Kinds of Diphthongs.

Although the sounds of the Italian e and o are here classed together, as diphthongs, with the English sounds of i and ou, this is not meant to deny a difference in degree between the two. The former might be called monophthongs, because the ear receives but one impression, as when two notes are struck simultaneously. It is only by theoretical analysis that we can detect the two component partsof e and o—a fact well known to every Sanskrit scholar. The âi and âu, on the contrary, are real diphthongs; and an attentive ear will perceive ah + fee in the English "I," ah + oo in the English "out." Sir John Herschell compares these sounds to quick arpeggios, where two chords are struck almost, but not quite simultaneously.

In African dialects, as, for instance, in Zulu, some Missionarie say that two vowels combine for the formation of one sound, as in hai (no), Umcopai (a proper name); others, that there are no diphthongs, but that, whenever two vowels meet, the separate power of each is distinctly marked and preserved in pronunciation.

An Essay on the Phonology and Orthography of the Zulu and kidred Dialects in Southern Africa, by L. Grout, p. 441.

This may defend on a peculiar disposition in the organ of hearing as well as it the organ of speech.

Objections are likely to be raised against our treating the vowel in "bought" and "fall" as a diphthong. There is, however, a diphthong sound which stands to au (proud) in the same relation as oi (voice) to ai (vice). I imagine to hear it in the English broad, which has the same vowel as all, bawl, Paul, nor, war; and we certainly have it in the Swedish å The labial element, no doubt, is very slight; still, let any body pronounce â and ou (far and bought), and a looking-glass will tell him that he adds a distinct labial pressure in order to change the â into ou.

Vowels broken by E *or* I.

In some languages we find that certain vowels are modified by an inherent #, or, as some say, by i. The vowels most liable to this modification are a, o, u.

The a, with an inherent e, becomes German ä, as in väter, very nearly the same sound as in the English substantive bear. O, by the same influence, takes the German sound of ö in König, or that of the French eu in peu. U, in German, becomes ü, the French u in jurer.

To many organs these sounds are so troublesome that they are sometimes avoided altogether, as in English. Their pronunciation varies in different dialects; and the German ä sounds in some places like *e*, the French ü like u.

If we remember how the simple vowel sounds were represented by Kempelen in a mathematical progression according to the amount of aperture of the throat and lips required for their formation, we shall see that what takes place, if an a is changed to ae, an o to oe, and an u to ue, is in each case a diminution of the guttural aperture. While the pure a is formed by 5 degrees of labial and 3 degrees of guttural aperture, the ae is produced by 5 degrees of labial, but only 1 degree of guttural aperture. Thus, in the pronunciation of oe, the labial aperture remains at 2 degrees, and in the pronunciation of ue at 1 degree; but in either case the guttural aperture is respectively reduced from 4 degrees and 5 degrees to 1 degree. We may, therefore, represent the broken vowels (Grimm's Umlaut) in the following manner:—

ae=V. 1; oe=II. 1; ue=I. 1.

There is one class of languages, the Tataric, where these broken sounds are of frequent occurrence, and of great importance. The "harmony of vowels " which pervades these dialects would be lost altogether (as it is, to a great extent, if Tataric languages are written with Arabic letters), unless to these vowels a distinct category were assigned. Besides the broken or softened a, o, and u, the Tataric languages have a fourth vowel, a softening of the i, which we hear in "will." Thus we have, in Yakute:

All the vowels in a Yakute word depend on the first. If the first is hard, all following vowels must be hard; if soft, all become soft. Again, if the vowel of one syllable is heavy, that of the next can only be the same heavy vowel, or its corresponding light vowel. If it is light, that of the next syllable must be the same light vowel, or its corresponding heavy vowel. For instance, if the first syllable of a word has a, the next can only have a or i; if ä ä or ï; if o, o or u; if ö, ö or ü.

The vowels would, therefore, come under the following physiollogical categories:—

It has frequently been remarked that the short vowels in English (hat, bed, pit, pot, full) differ from their corresponding long vowels, not merely in quantity, but in quality also. As they mostly occur in unaccented syllables, they have lost that vocal timbre which the short vowels in German and Italian have preserved. Still it is not necessary to invent new signs for these surd vowels, because in origin they correspond exactly to the short vowels in other languages, only that they are uniformly modified by a peculiarity of pronunciation inherent in the English tongue. The English language has lost the pure short vowels altogether; and it is not by the eye, but by the ear only, that foreigners can learn the peculiar pronunciation of the short vowels in English.

II.

How can these principal Sounds, after proper Classification, be expressed by us in writing and printing, so as to preserve their physiological Value, without creating new typographical Difficulties?

The results at which we have arrived in the first part of our inquiry are those on which, with very slight and unimportant exceptions, all may be said to agree, who, whether in India or Europe, have attempted to analyse scientifically the elements of human speech. There are, no doubt, some refinements, and some more accurate subdivisions, as will be seen in the extracts given from the Pr*a*tis*akh*yas, which it will be necessary to attend to in exceptional cases, and particularly in philological researches. But, as far as the general physiological outlines of our phonetic system are concerned, we hardly expect any serious difference of opinion.

Widely different opinions, however, start up as soon as we approach the second question, how these sounds are to be expressed in writing. Omitting the different propositions to adopt an Oriental alphabet, such as Sanskrit or Arabic, or the Greek alphabet, or newly invented letters, whether short-hand or otherwise, we shall take it for granted that the Latin alphabet, which, though of Semitic origin, has so long been the armour of thought in the struggles and conquests of civilisation, has really the greatest and most natural claims on our consideration.

There are two principles regulating the application of the Latin alphabet to our physiological sounds on which there has ben a general agreement since the days of Halhed and Wilkins:

- *That each sound shall have but one representative letter, and that therefore each letter shall always express the same sound.*
- *That each simple sound shall be expressed by a single lette, and compound sounds by compound letters.*

If with these two principles we try to write the forty-fourconsonants of our physiological alphabet by means of the twenty-for consonants of the Latin, it follows that we must add to the latter diacritical signs, in order to make them answer our purpose.

Now, in the adoption of diacritical signs, another principle should be laid down:

"That the same modification should always be expressed by tie same diacritical mark."

In a theoretical system we might even go a step beyond this, and lay it down as a principle that the same diacritical mark should always express one and the same modification. The advantages which would result from the adoption of such a principle are palpable; but the variety of diacritical marks which it would entail upon us, and the number of new types which would have to be cast to carry it out consistently, must strongly militate against it, particularly in the construction of a Missionary alphabet. Here, as in all branches of Missionary labour, it must be our aim to obtain the greatest results by the smallest means.

Guttural, Palatal, and Dental Tenuis.

The guttural, dental, and labial tenues are naturally expressed by k, t, p.

Guttural, Palatal, and Dental Media.

The modification which changes these tenues into medi æ should consistently be expressed by a uniform diacritical sign attached to k, t, p. For more than one reason, however, we prefer the Latin letters, g, d, b.

It is understood that g, after once being chosen as the representative of the guttural media, like g in gun, whatever vowel may follow, can never be used promiscuously both for the guttural and the palatal media, as the English g in gun and gin.

How to express Aspirates?

The aspirated tenues and mediæ in the guttural, dental, and palatal series, which, according to the description given above, are not compound, but simple though modified sounds, should be written by simple consonants with a diacritical mark of aspiration. This would give us:

k', t', p, g', d', b'.

These types have been cut many times since Count Volney founded his prize at the French Academy for transcribing Oriental alphabets, and even before his time. They exist at Berlin, Paris, Leipzig, Darmstadt, Petersburg, and several other places. They have been cut in different sizes and on different bodies. Still the difficulty of having them at hand when required, making them range properly, and keeping always a sufficient stock, has been so great even in places like London, Paris, and Berlin, that their adoption would defeat the very object of our alphabet, which is to be used in Greenland as well as in Borneo, and is to be handled by unexperienced printers even in the most distant stations, where nothing but an ordinary English font can be expected to exist. In our Missionary alphabet we must therefore have no dots, no hooks, no accents, no Greek letters, no new types, no diacritical *appendages* whatsoever. No doubt, Missionary Societies might have all these letters cut and cast on as many sizes and bodies as necessary. Punches or fonts might be sent to the principal Missionary stations. But how long would this last? If a few psalms or catechisms had to be printed at Bangkok, and if there were no hooked letters to represent the aspirated palatal sound by a single type (k#), is it likely that they would send to Calcutta or London for this type, which, after it arrived, might perhaps be found not to range with the rest? It is much more likely that, in the absence of the type prescribed by the Missionary Societies at home, each missionary would find himself thrown on his own resources, and different alphabets would again spring up in different places. Besides, our alphabet is not only to be an alphabet of missionaries. In time it is to become the alphabet of those tribes and nations whose first acquaintance with writing will be through the Bible translated into their language and transcribe in a rational alphabet. Fifty or a hundred years hence, it may be the alphabet of all the civilised nations of Africa, Australia, and the greater part of Asia. Must all the printers of Australian advertisements, the editors of African newspapers, the publishers of Malay novels or Papua primers, write to Mr. Watts, Crown Court, Temple Bar, for new sorts of dotted and hooked letters? I do not sty it is impossible; but many things are possible, and still not practical; and these new hooked and dotted types seem to me decidedly to belong to this class.

In questions of this kind, no harm is done if principles are sacrificed to expediency; and I therefore propose to write the aspirate letters, as all English and most French and German scholars have written them hitherto, by

kh, th, ph, gh, dh, bh.

What do we lose by this? The spiritus asper (') is after all but a faintly disguised II, changed into I- and -I, for asper and lenis, and then abbreviated into 'and'. Besides, the languages where these simple aspirates occur are not many; and in India, where they are of most frequent use, the phonetic system is so carefully arranged that there no ambiguity can arise whether kh be meant for an aspirated guttural tenuis or for k followed by the semi-vowel h. If the semi-vowel h comes in immediate contact with k, k + h is changed into g + gh, or a stop (vir*a*ma) has to be put after the k. This might be done where, as in discussing grammatical niceties, it is desirable to distinguish between kh and k-h. The missionary, except in India, will hardly ever suffer from this ambiguity; and if the scholar should insist on its being removed, we shall see immediately how even the most delicate scruples on this point could be satisfied.

There is still, if we examine the alphabets hitherto proposed or adopted, a whole array of dots and hooks, which must be eliminated, or at least be reduced, as far as possible; and though we might, after gaining our point with regard to the h, get through gutturals, dentals, and labials, we still have new and more formidable enemies to encounter in the palatals and linguals.

How to express Palatals?

Palatals are modifications of gutturals, and therefore the most natural course would be to express them by the guttural series, adding only a line or an accent or a dot, or any other uniform diacritical sign to indicate their modified value. So great, however, has been the disinclination to use diacritical signs, that in common usage, where the palatal tenuis had to be expressed, the most anomalous expedients have been resorted to in order to avoid hooks or dots. In English, to represent the Sanskrit palatal tenuis, ch has been used; and as the h seemed to be too much in the teeth of all analogy, the simple c even has been adopted, leaving ch for the aspirated palatal. On the same ground, the Germans write tsch for the palatal tenuis, and tschh for the aspirate. The French write tch and tchh. The Italians do not hesitate to use ci for the tenuis, though I do not see how they could express the corresponding aspirate. The Russians recommend their #; and the Brahmans would probably recommend a Sanskrit type. Still all, even the German tschh, are meant to represent simple consonants, which, as in Sanskrit, would not make a preceding short vowel long. That in English the ch, in Italian ci, and in German tsch, have a sound very like the palatal tenuis, is of course a mere accident. In English the ch is not always sounded alike; and its pronunciation in the different dialects of Europe varies more than that of most letters. Besides, our alphabetic representative of the palatal sound is to be pronounced and comprehended, not by a few people in Germany or Italy, but by all the nations of Africa and Australia. Now to them the ch would prove deceptive; first, because we never use the simple c (by this we make up for the primary alphabetical divorce introduced by the libertus of Spurius Carvilius Ruga), and, secondly, because the h would seem to indicate the modification of the aspirate.

The natural way of writing the palatals, so as not to obscure their close relationship to the gutturals, would be, k, kh, g, gh.

But here the same difficulty arises as before. If the dots or marks are printed separately, the lines where these dots occur become more distant than the rest. For one such dotted letter the compositor has to compose a whole line of blanks. These will shift, particularly when there are corrections, and the misprints are endless. In Tumour's edition of the Mahavansa, which is printed with dotted letters, we get thirty-five pages quarto of errata to about a hundred pages of text. But they might be cast on one body. True, they might be—perhaps they will be. At all events they have been; and Volney offered such types to anybody that would ask for them. Still, when I inquire at a press like the University press of Oxford, they are not forthcoming. We must not expect that what is impossible in the nineteenth century at Oxford, will be possible in the twentieth century at Timbuktu.

Now the difficulty, so far as I can see, was solved by a compositor to whom I sent some MS., where each palatal letter was marked by a line under it. The compositor, not knowing what these lines meant, took them for the usual marks of italics, and I was surprised to see that this answered the purpose, saved much trouble and much expense, and, on the whole, did not look badly. As every English font includes italic letters, the usefulness of these modified types for our Missionary alphabet "springs to the eyes," as we say in German. They are sufficiently startling to remind the reader of their modified pronunciation, and at the same time they indicate, as in most cases they ought, their original guttural character to the reflecting philologist. As in ordinary books italics are used to attract attention, so also in our alphabet. Even to those who have never heard the names of guttural and palatal letters, they will show that the *k* is not the usual k. Persons in the slightest degree acquainted with phonetics will be made aware that the *k* is, in shape and sound, a modification of the k. All who admit that palatals are modifications of gutturals would see at once that the modification intended by *k* could only be the palatal. And as to the proper pronunciation of the *k*, as palatal tenuis, in different dialects, people who read their own language expressed in this alphabet will never hesitate over its pronunciation. Others *must* learn it, as they now learn the pronunciation of Italian ci and chi, or rest satisfied to know that *k*, stands for the palatal tenuis, and for nothing else. Sooner or later this expedient is certain to be adopted. Thus we get, as the representatives of the palatals,

k, kh, g, gh.

Now, also, it will appear how we can avoid the ambiguity before alluded to,—whether the h of aspirated consonants expresses their aspirated nature or an independent guttural semi-vowel or flatus. Let the h, where it is not meant as a letter, but as a diacritical sign, be printed as an italic *h*, and the last ground for complaint will vanish. Still this is only needful for philological objects; for practical purposes the common h may remain.

In *writing*, the dots or lines under the palatals will have to be retained. Still they take too much time thus employed to allow us to suppose that the Africans will retain them when they come to write for themselves. They will find some more current marks; as, for instance, by drawing the last stroke of the letter below the line. In writing, however, anybody may please himself, so long as the printer knows what is intended when he has to bring it before the public. As a hint to German missionaries, I beg to say that, for writing quickly in this new alphabet, they will find it useful in manuscript notes to employ German letters instead of italics.

An accidental, though by no means undesirable, advantage is gained by using italics to express the palatals. If we read that Sanskrit vâch (or vâtch, or vâtsch) is the same as Latin vox, but that sometimes vâch in Sanskrit is vâk or vac, the eye imagines that it has three different words to deal with. By means of italics, vâk and vâ*k* are almost identical to the sight, as kirk and *kurk* (church), would be if English were ever to be transcribed into the missionary alphabet. The same applies to the verb, where the phonetic distinction between va*k*mi, vakshi, vakti, can thus be expressed without in any way disguising the etymological identity of the root. It would be wrong if we allowed the physiological principles of our alphabet to be modified for the sake of comparative philology; but where the phonetic changes of physiological sounds and the historical changes of words happen to run parallel, an alphabet, if well arranged, should be capable of giving this fact clear expression.

If the pronunciation of the palatals is deteriorated, they sometimes take the sound of tch, ts, s, sh, or even th. Ccelum (Greek script) becomes Italian cielo; where the initial sound is the same as in church (kirk). In old Friesic we have "tzaka" instead of English "check." In French, "ciel" is pronounced with an initial sharp dental s; " chose," with an initial sharp palatal s. In Spanish, the pronuncia- tion of a c before e and i is that of the English th. In these cases when we have to deal with unwritten languages, the sounds, whether simple or double, should be traced to their proper phonetic category, and be written accordingly. It will be well, however, to bear in mind that pronunciation may change with time and vary in different places, and that the most general representation of these sounds by palatals or italicized gutturals will generally prove the best in the long run.

It must be clear that, with the principles followed hitherto, it would be impossible to make an exception in favour of the English j as representative of the palatal media. It would be a schism in the whole system, and would besides deprive us of those advantages which comparative philology derives from a consistent representation of modified sounds: that Sanskrit yuga (Greek Script) is derived from " yu*g*," to join, would be intelligible to everybody; while neither the German, to whom j is y, nor the Frenchman, nor the Spaniard would see the connexion between j and g.

The wish to retain the j is natural with Missionary Societies. It would enable us to spell uniformly the name of our Lord—and in all the translations of the Bible which the pious zeal of the mother country is now sowing over the virgin soil of Africa, Australia, and Asia, that one name at least would stand unaltered and uncorrupted in all tongues and all ages. But we may consider this from another point of view. As with other words, and with many of the most sacred in our own language, their full and real meaning seems to grow more clear and distinct the more the material body of the words changes and decays, and the more their etymological meaning becomes dim and forgotten, so will it he with the name of our Lord. Let the name grow and change and vary in all the tongues of the earth, and the very variety of the name will proclaim the unity of Him who has promised to all tongues the gift of His Holy Spirit. And would it avail, even if now we insisted on this point? A thousand years ago, and all the nations of Europe wrote and pronounced this name uniformly; but at the present day there are hardly two languages where the name is pronounced exactly alike; and in several the spelling has followed the pronunciation. It will ultimately be the same in Africa, whatever we do at present. But if an exception is here to be made, let it be a single exception, while we retain the regular notation for every other word in which the pure palatal media occurs.

How to express Linguals?

The linguals, as modifications of the dentals, have been hitherto written by common consent as dentals with dots or lines. In writing, this method must be retained, though no doubt a more current form will soon grow up if the alphabet is used by natives. They will probably draw the last stroke of the t and d below the line, and connect the body of the letter with the perpendicular line below. The linguals, therefore, will be, t, th, d, dh; only here also the printer will step in and convert the dotted or underlined letters into italics, *t, th, d, dh*.

I am at a loss how to mark that peculiar pronunciation of the dental aspirate, whether tenuis or media, which we write in English simply by th. It is not of frequent occurrence; still it occurs not only in European, but in Oriental languages,—for instance, in Burmese. If it occurs in a language where no trace of the pure dental aspirate remains, we might safely write th (and dh) or t*h* (and d*h*), as we do in English. The Anglo-Saxon letters Anglo-Saxon Letters and ð would be very convenient; but how few fonts, even in England, possess these forms! Again, Anglo-Saxon Letters*h* and *z*h, and even Anglo-Saxon Letters and Anglo-Saxon Letters, have been proposed; but they are liable to still stronger objections. Where it is necessary to distinguish the aspirated th and dh from the assibilated, I propose for the latter a dot under the h (th and dh). But I think th and dh will, on the whole, be found to answer all practical purposes, if we only look to people who have to write and read their own language. Philologists, whatever we attempt, cannot be informed of every nicety and shade in pronunciation by the eye. They must learn from grammars or from personal intercourse in what manner each tribe pronounces its dental aspirate; and comparative philology will find all its ends answered if th represents the organic dental aspirate, until its pronunciation deteriorates so far as to make it a flatus or a double consonant. In this case the Missionary also will have to write it *Is*, or *ss*, or whatever sound he may happen to hear.

The five principal classes of physiological sounds would, therefore, have the following typographic exponents:—

How to express the Nasals?

In each of these five classes we have now to look for an exponent of the nasal.

Where the nasal is modified by the following consonant, it requires no modified sign, for reasons explained in the first part of our essay. The nasal in sink and sing is guttural; in inch and injure, palatal; in hint and bind, dental; in imp and dumb, labial.

But where these nasals occur at the beginning of words or at the end of syllables, each must have its own mark. Let the dental nasal be n, the labial nasal m, the lingual nasal *n*. Where the guttural nasal is really so evanescent as not to bear expression by ng, we must write n and a dot after it (n.), which makes no difficulty in printing, and will very rarely occur. What we call the palatal n is generally not a simple but a compound nasal, and should be written ny. For transliterating, however, we want a distinct sign, because the palatal nasal exists as a simple type in Sanskrit, and every single type must be transliterated by a single letter. Here I should propose the Spanish ñ.

The lingual n occurs in Sanskrit only. Its character is generally determined by lingual letters either following or preceding. Still, where it must be marked in Sanskrit transliterations, let it be represented by an italic *n*.

How to express the Semi-vowels?

The Latin letters which naturally offer themselves as the counterparts of the semi-vowels, are 'h, y, r, l, and w.

The delicate sound of the guttural semi-vowel occurs very rarely in Arian languages. In Semitic dialects, however, the guttural semi vowel has usually been considered as the guttural semi-vowel. In Hebrew it is sometimes not pronounced at all, or, as we should say, it is changed into the flatus lenis; whence, in the Arabic alphabet, to remove this ambiguity and to show in every word the full or weak pronunciation of the guttural semi-vowel, the guttural semi vowel was split in two: the one, the guttural semi vowel little more than the flatus lenis; the other, the guttural semi vowel, the hollow guttural semi-vowel which only a Semitic throat is able to utter, and which comes very near to the guttural flatus asper as heard in "loch."

The palatal semi-vowel is usually transcribed in Germany by j, which, as far as archæological arguments go, would certainly be the most appropriate sign to represent the semi-vowel corresponding to the palatal vowel *i*. As, however, the j is one of the most variously pronounced letters in Europe, and as in England it has been usual tc employ it as a palatal media, it is better to discard it altogether from our alphabet, and to write y.

The lingual semi-vowel is r; if in some dialects the r is pronounced very near to the throat, this might be marked by an italic *r*, or *r*h.

The dental semi-vowel is written 1. The *mouillé* sound of 1 may be expressed by an italic *l*.

Where the labial semi-vowel is formed by the lips, let it be written W. More usually it is formed by the upper lip and the edge of the lower teeth. It then becomes what the Hindus call a labio-dental semi-vowel, but is hardly to be distinguished from the labial flatus lenis.

How to express the Flatus (Sibilants)?

As the unmodified flatus, or, as it should more properly be called, the spiritus asper and lenis, can only occur before a vowel, the printer will find no difficulty in representing these two sounds by the usual signs 'and ' placed before or over the vowel which follows. At the beginning of words there could be no reasonable objection to this mode of representing the very slight and hardly consonantal sound of the spiritus asper and lenis. But it will take some time before our eyes are accustomed to it in the middle of words. In such cases the Greeks did not mark it. They wrote Greek script, chariot, but Greek script, with beautiful chariots; they wrote Greek script, man, but Greek script, manliness. Nor in fact does there seem to be any necessity for marking the spiritus lenis in the middle of words. Every vowel beginning a syllable has necessarily the spiritus lenis; as going, seeing. As to the spiritus asper, which we have in "vehement," "vehicle," I fear that "ve'ement," "ve'icle," will be objected to by the printer. If so, we have still the h as a last resource to express the spiritus asper in this position.

The guttural flatus asper, as heard in loch, might be expressed by an Italic *h*. The flatus lenis cannot be distinguished in pronunciation from the guttural semi-vowel, and has therefore never received an alphabetical exponent. If it.should be necessary, however, to assign a type to this physiological category, we should be obliged to write the flatus asper by '*h*, and the flatus lenis by '*h*.

The dental flatus sibilans, pronounced sharp as in "sin" or "grass," has, of course, the best claims on the letter s as its representative. Its corresponding soft sound, as heard in please or zeal, is best expressed by z; only we must take care not to pronounce it like the German z. The more consistent way of expressing the sonant flatus would be to put a spiritus lenis over the s. This, however, would hardly be tolerated, and would be against the Third Resolution of our alphabetical conferences, where it was agreed that only *after* the Roman types, and the modifications of Roman types as supplied by common fonts (capitals, italics, &c.), had been exhausted, diacritical signs should be admitted into the standard alphabet.

As all palatals are represented by italics, the palatal sibilant would naturally be written with an italic *s*. This would represent the sharp sound as heard in "sharp " or "chose." The soft palatal sibilant would have the same exponent as the soft dental sibilant, only changed into italics (*z*). This would be the proper sign for the French sound in "je," "genou," and for the African soft palatal sibilant, which, as Dr. Krapf, Mr. Tutschek, and Mr. Boyce remark, will never be properly pronounced by an adult European.

Where it is necessary to express the original, not yet assibilated, palatal flatus, which is heard in könig and kön'ge, an italic y, with the spiritus asper arrd lenis, would answer the purpose ('*y* and *y*)

The labial flatus should be written by f. This is the shap flatus, as heard in "life" and "find." The soft labial flatus ought consistently to be written as f with a spiritus lenis. But here again I fear we must sacrifice consistency to expediency, and adopt that sign with which we are familiar, the Latin v. As we express the labial semivowel by w, the v is still at our disposal, and will probably be preferred by the unanimous votes of missionaries and printers.

The lingual flatus is a sound peculiar to Sanskrit, and, owing to its hollow guttural pronunciation, it may be expressed there, as it has been hitherto, by s followed by the guttural h (sh). The Sanskrit knows no soft sibilants; hence we require but one representation for the lingual sh.

The different categories of consonantal sounds which we represented at the end of the first chapter by means of English words may now be filled out by the following graphic exponents:—

Spiritus asper:'.

Spiritus lenis: '.

Although these exponents of the physiological categories of articulated sound have not been chosen because their present pronunciation in English, or French, or German is nearest to that physiological category which each has to represent, still, as we have avoided letters of which the pronunciation fluctuates very much (such as c, j, x, q), it will be found, on the whole, that little violence is done by this alphabet to the genius of any of these languages, and that neither an Englishman, nor a German, nor a Frenchman will ever feel much hesitation as to how any one of our letters should be pronounced.

***Vowels*.**

The pronunciation of the vowels is more liable to change than that of the consonants. Hence we find that literary languages, which retain their orthography in spite of changes in pronunciation have no scruple in expressing different sounds by the same sign; or, where two originally different vowels have sunk down to one and the same intermediate sound, we see this same sound expressed often by two different vowels. In the selection, therefore, of letters to express the general vowel sounds of our physiological alphabet, we can pay less attention to the present value of each vowel sign in the spoken languages of Europe than we did even with the consonants. And as there it was impossible, without creating an unwieldy mass of consonantal signs, to express all the slight shades of pronunciation by distinct letters, we shall have to make still greater allowance for dialectical varieties in the representation of vowels, where it would be hopeless should we attempt to depict in writing every minute degree in the sliding scale of native or foreign pronunciation.

The reason why, in most systems of phonetic transcription, the Italian pronunciation of vowels has been taken as normal, is, no doubt, that in Italian most vowel signs have but one sound, and the same sound is generally expressed by one and the same vowel. We propose, therefore, as in Italian, to represent the pure guttural vowel by a, the pure palatal vowel by i, and the pure labial vowel by u.

Besides the short a, we want one, or according to others, two graphic signs to represent the unmodified sound of the vocal breathing, which may be deflected from its purity by a slight and almost imperceptible palatal or labial pressure. These are the sounds which we have in "birch" and "work," and which, where they must be distinguished, we propose to write # and #. As we do not want the signs of vowel and vowel to mark the quantity of vowels, we may here be allowed to use this sign vowel to indicate indistinctness rather than brevity.

In most languages, however, *one* sign will be sufficient to express this primitive vowel; and in this case the figure 0 has been recommended as a fit representative of this undetermined vowel.

Among the languages which have an alphabet of their own, some, as, for instance, Sanskrit, do not express these sounds by any peculiar sign, but use the short a instead. Other languages express both sounds by one sign; for instance, the Hebrew Shewa, the pronunciation of which would naturally be influenced, or, so to say, coloured either by the preceding or the following letter. Other idioms again, like Latin, seem to express this indistinct sound by e, i, o, or u. Besides the long e in res and the short e in celer, we have the indistinct # in words like adversum and advorsum, septimus and septumus, where the Hindus write uniformly saptama, but pronounced it probably with vowels varying as in Greek and Latin. Besides the long o in odi, and the short o as in moneo, we have the indistinct o or u in orbs or urbs, in bonom or bonum. In Wallachian, every vowel that has been reduced to this obscure, indefinite sound, is marked by an accent, a, e, i, b, u; but if Wallachian is written with Cyrillic letters, the ' Yerr' ('b) is used as the uniform representative of all these vowels. In living languages one sign, the figure o, will be found sufficient, and in some cases it may be dispensed with altogether, as a slight Shewa sound is necessarily pronounced, whether written or not, in words such as mil-k, mar-sh, el-m, &c. The marks of quantity,? and are superfluous in our alphabet; not that it is not always desirable to mark the quantity of vowels, but because here again, as with the dotted consonant, a long syllable can be marked by the vowel in italics, while every other vowel is to be taken as short. Thus we should write in English bath, b*a*r, but ass, bank; ravine, and pin; b*u*t (i.e. boot), and butcher. We should know at once that a in bath is long, while in ass it is short.

All compound vowel sounds should be written according to the process of their formation. Two only, which are of most frequent occurrence, the guttural short a, absorbed by either i or u, might perhaps be allowed to retain their usual signs, and be written e and o, instead of ai and au. The only reason, however, which can be given for writing e and o, instead of ai and au, is that we save a letter in writing; and this, considering how many millions of people may in the course of time have to use this alphabet, may be a saving of millions and millions of precious seconds. The more consistent way would be to express the gutturo-palatal sound of the Italian e by ai, the a being short. The French do the same in "aimer," while in English this sound is expressed by ey in prey, by ay in pray, by a in gate, and by ai in sailor. The gutturo-labial sound of the Italian o should be written au, which the French pronounce o. For etymological purposes also this plan would be preferable, as it frequently happens that an o (au), if followed by a vowel, has to be pronounced av. Thus in Sanskrit bh*u*, to be, becomes bhau (pronounced bho), and if followed by *a*mi, it becomes bhav-*a*mi, I am.

The diphthongs, where the full or long guttural *a* is followed by i and u, should be written *a*i and *a*u. "To buy" would have to be written b*a*i; to bow, b*a*u. Whether *a*u coalesce entirely, as in German, or less so, as in Italian, is a point which in each language must be learned by ear, not by eye.

Most people would not be able to distinguish between *a*i and ei. Still some maintain that there is a difference; as, for instance, in German kaiser and eis. Even in English the sound of ie in "he lies" is said to be different from that of "he lies." Where it is necessary to mark this distinction, our diagram readily supplies *a*i and ei.

The diphthong eu is generally pronounced so that the two vowels are heard in succession, as in Italian Europa. Pronounccd more quickly, as, for instance, in German, it approaches to the English sound of oy in boy. According to our diagram, we should have to write #i and #u; but ei and eu will be preferable for practical purposes.

The same applies to the diphthong #i. Here, also, both vowels can still be heard more or less distinctly. This more or less cannot be expressed in writing, but must be learned by practice.

The last diphthong, on the contrary, is generally pronounced like one sound, and the deep guttural O seems to be followed, no by the vowel u, but only by an attempt to pronounce this vowe, which attempt ends, as it were, with the semi-vowel w, instead of the vowel. In English we have this sound in bought, aught, saw; and also in fall and all.

The proper representation of these diphthongs would be #i and #u; but oi and ou will be found to answer the purpose as well except in philological works.

For representing the broken sounds of a, o, u, which we lave in German väter, höhe, güte, in the French prêtre, pcu, and une, but which the English avoids as sounds requiring too great an efort, no better signs offer themselves than ä, ö, ü. They are objecionable because they are not found in every English font. For the I'ataric languages a fourth sound is required, a broken or soft i. Tis, too; we must write ï.

The Sanskrit vowels, commonly called lingual and dental, are best expressed by *r*i and *l*i, where, by writing the *r* and *I* as italics, no ambiguity can arise between the vowels *r*i and *l*i, and the semi-vowels r and I, followed by i. Instead of i, # also or the figure O may be used.

Thus have all the principal consonantal and vowel sounds been classified physiologically and represented graphically. All the distinctions which it can ever be important to express have been expressed by means of the Roman alphabet without the introduction of foreign letters, and without using dots, hooks, lines, accents, or any other diacritical signs. I do not deny that for more minute points, particularly in philological treatises, new sounds and new signs will be required. In Sanskrit we have Visarga and the real Anusv*a*ra (the N*a*sikya), which will require distinct signs (*h*, *m*) in transliteration. In some African languages, clicks, unless they can be abolished in speaking, will have to be represented in writing. On points like these an agreement will be difficult, nor would it be possible to provide for all emergencies. It is an advantage, however, that we still have the c, j, and x at our disposal to express the dental, palatal, and lateral clicks. Further particulars on this and similar points I must reserve for a future occasion, and refer the reader, in the mean time, to the very able article of the Rev. L. Grout, alluded to before. But I cannot leave this subject without expressing at least a strong hope that, by the influence of the Missionaries, these brutal sounds will be in time abolished, at least among the Kaffirs, though it may be impossible to eradicate them in the degraded Hottentot dialects. It is clear that they are not essential in the Kaffir languages, for they never occur in Sechuana and other branches of the great Kaffir family.

If uniformity can be obtained with regard to the forty-four consonantal and the twenty-four vocal sounds, which are the principal modulations of the human voice fixed and sanctioned in the history of language, so far as it is known at present; if these sounds are always accepted, as defined above, solely on physiological grounds, and henceforth expressed in those letters alone which have been allotted to them solely for practical reasons, a great step will have been made towards facilitating the intellectual intercourse of mankind and spreading the truths of Christianity.

But the realisation of this plan will mainly depend, not on ingenious arguments, but on good-will and ready co-operation.

III.

How can this Physiological Alphabet be applied to existing Languages?

a. *To unwritten Languages*.

After the explanations contained in the first and second parts there is little more to be said on this point.

The missionary who attempts to write down for the first time a spoken language, should have a thorough knowledge of the physiological alphabet, and have practised it beforehand on his own language or on other dialects the pronunciation of which he knows.

He should put from recollection, as much as possible, the historical orthography of German, English, French, or whatever his language may be, and accustom himself to write down every spoken sound under the nearest physiological category to which it seems to belong. He should first of all endeavour to recognise the principal sounds, guttural, dental, and labial, in the language he desires to dissect and to delineate; and where doubtful whether he hears a simple or a modified secondary sound, such as have been described in our alphabet, he should always incline to the simple as the more original and general.

He should never be guided by etymological impressions. This is a great temptation, but it should be resisted. If we had to write the French word for knee, we should feel inclined, knowing that it sounds *gi*nokyo in Italian and genu in Latin, to write it *g*#nu. But in French the initial palatal sound is no longer produced by contact, but by a sibilant flatus, and we should therefore have to write z#nu. If we had to write down the English sound of knee, we should probably, for the same reason, be willing to persuade ourselves that we still perceived, in the pronunciation of the n the former presence of the initial k. Still no one but an etymologist could detect it, and its sound should be represented in the Missionary alphabet by "*ni*."

Those who know the difficulty of determining the spelling of words according to their etymology, even in French or English, although we can follow the history of these languages for centuries, and although the most eminent grammarians have been engaged in analysing their structure, will feel how essential it is, in a first attempt to fix a spoken language, that the writer should not be swayed by any hasty etymo- logical theories. The Missionary should give a true transcript of a spoken language, and leave it to others to decipher it. He who, instead of doing this, attempts, according to his own theories, to improve upon the irregular utterance of savages, would deprive us of authentic documents the loss of which is irreparable. He would act like a traveller who, after copying an inscription according to what he thought, ought to have been its meaning, destroyed the original; nay, he may falsify unawares the ethnic history of the human race.

Several sentences having been once written clown, the Missionary should put them by for a time, and then read them aloud to the natives. If they understand what he reads, and if they understand it even if read by somebody else, his work has been successful, and a translation of the Bible carried out on these principles among Papuas or Khyengs will assuredly one day become the basis for the literature of the future.

Although the basis of our Standard Alphabet is purely physiological, still no letter has been admitted into it, which does not actually occur in one of the well known languages of Asia or Europe. The number of letters might easily have been increased, if we had attempted to represent all the slight shades of pronunciation, which affect certain letters in different languages, dialects, patois, or in the mouth of individuals. But to increase the number of letters is tantamount to diminishing the usefulness of an alphabet.

It may happen, indeed, as we become acquainted, through the persevering labours of Missionaries, with the numerous tongues of Africa, Polynesia, and Asia, that new sounds will have to be acknowledged, and will have an independent place allotted to them in our system. But here it should be a principle, as binding as any of the principles which have guided us in the composition of our alphabet, that

"No new sound should ever be acknowledged as such, until we are able to give a clear and scientific definition of it on physiological grounds."

We are too prone perhaps to imagine, particularly where we have to deal with languages gathered from the mouth of a single interpreter, or in the intercourse with a few travellers, that we hear sounds of an entirely new character, and apparently requiring a new sign. But if we heard the same language spoken for a number of years and by a thousand speakers, the natural variety of pronunciation would make our ears less sensitive, and more capable of appreciating the general rule, in spite of individual exceptions. We are not accustomed to pay attention to each consonant and vowel, as they are pronounced in our own language; and if we try for the first time to analyse each word as we hear it, and to write down every vowel and consonant in a language we do not understand, say Russian or Welsh, we shall be able to appreciate the difficulties which a Missionary has to overcome, if he tries to fix a language alphabetically, before he himself can converse in it freely. It has happened, that travellers collecting the dialects of tribes in the Caucasus or on the frontiers of India, have brought home and published lists of words gathered on the same spot and from the same people, and yet so different in their alphabetical appearances, that the same dialect has figured in ethnological works, under two different names. Much must be left to the discretion of Missionaries; for in most cases it is impossible to control the observations which they have made in countries hitherto unexplored, and in dialects known to themselves alone. But it will be found that Missionaries who know their language best, and have used it for the greatest number of years, familiar thus with all its sounds and accents, are least clamorous for new types, and most willing to indicate, in a general manner, what they know can never be represented with perfect accuracy. Too much distinction leads to confusion, and it shows a spirit of wise economy in the Phenician, the Greek, the Roman; and Teutonic nations, that they have contrived to express the endless variety of their pronunciation by so small a number of letters, rather than invent new signs and establish new distinctions. Attempts have been made occasionally, at Rome and elsewhere, to introduce new letters; but they have failed; and though we may feel no scruple to introduce new signs, and marks and accents into the African alphabets; though *we*, with our resources, may succeed for a time in framing an alphabet of our own where each letter, besides its simple value, has two or three additional values expressed by one, two, or three accents piled one upon the other,—common sense, without appealing to history, should teach us, that Africa will never bear what Europe has found insupportable.

The following alphabet, taken out of the general system of sounds, defined physiologically and represented graphically in the preceding pages, will be found to supply all that is necessary for the ordinary purposes of the Missionary, in his relation to tribes whom he has to teach the writing and reading of their own spoken language, pronounced inevitably by them with shades of sound that no alphabet can render. In philological works intended for a European public, the case will be different. Here it will be necessary to represent the accents of words, the quantities of vowels, and other features essential for grammatical purposes. Here the larger alphabet will come in; and it will always prove a reserve-fund to the scholar and Missionary, from which they can draw, after their usual supply of letters has been exhausted.

It should be borne in mind, that although in this smaller alphabet it would be easy to suggest improvements, no partial alteration can be made with any single letter, without disturbing at once the whole system of which it is but a segment.

***Missionary Alphabet*.**

If we compare this list of letters with the Anglo-Hindustani alphabet, so ably advocated by Sir Charles Trevelyan, the differences between the two are indeed but small; and if we had only to agree upon a small alphabet sufficient to express the sounds of the spoken Hindustani, there is no reason why the Anglo-Hindustani alphabet should not be adopted. It expresses the general sounds which occur in Oriental dialects, and it employs but five dotted letters, for which new types would be required.

The defects of this system become apparent, however, as soon as we try to expand it; and we are obliged to do this even in order to write Hindustani, unless we are ready to sacrifice the etymological distinction of words by expressing Hindustani script and Hindustani script by h, Hindustani script and Hindustani script by s, Hindustani script and Hindustani script by t, and Hindustani script and Hindustani script by z. If distinct types must be invented to distinguish these letters, the array of dotted letters will be considerably increased. Even in Hindustani we should have to use different diacritical marks where we have to express two, three, or four modifications of the same type; and it would become extremely perplexing to remember the meaning of all these marks. Our difficulties would be considerably increased if we tried to adapt the same letters to more developed alphabets, like Sanskrit and Arabic; and if we went on adding hooks and crooks, crosses and half-moons, dots and accents, &c., we should in the end have more modified than simple types.

These modified types might, no doubt, be reduced to a certain system; and, after determining the possible modifications of guttural and dental consonants, each diacritical mark might be used as the exponent of but one modification. A glance at the comparative table of the different systems of transliteration will show how this has been achieved by different scholars more or less successfully.

But it is only after this has been done, after all letters have been classified, after their possible modifications have been determined, after each modification has been provisionally marked by a certain exponent—such as the accent for expressing the palatal, dots for expressing the lingual modification,—it is *then* only that the real problem presents itself: "How can all these sounds be expressed by us in writing and printing, without sacrificing all chances of arriving in the end at one uniform and universal alphabet? " It is clear that every type that has to be compounded or cast afresh is an impediment in the progress of uniformity, because those who have once provided themselves with diacritical types will not change them for others, and those who have but a common English font at their disposal will express the necessary modifications as best they can. The question, then, that must be solved, is not whether we should take dots or hooks, but whether it is possible to express all essential modifications in such a manner as to take away all excuse for individual crotchets, by proposing an expedient accessible to every one. This can be done if we avail ourselves of the resources of our fonts, which invariably contain a supply of one class of modified letters—italics. Many scholars, from Halhed down to Ellis, have seen the use to which these letters could be put in transliterating Oriental languages; but they have not hitherto been employed systematically. The principle by which we have been guided in making use of italics is this:

As in each language most letters are liable to but one modification, let that modification, whatever it be, be expressed by italics.

We thus reduce the number of letters, in our physiological alphabet, that require diacritical marks, on account of their being liable to more than one modification in the same language, to two: and while our Missionary alphabet is thus accessible in every part of the world, we reserve our few diacritical dots to the purposes of transliteration, where, as in Arabic, we may have to represent the same type with more than one diacritical mark.

b. *To written Languages*.

Though this is a question which for the present hardly falls within the compass of Missionary labours, still it may be useful to show that, if required, our alphabet would also be found applicable to the transliteration of written languages. Besides, wherever Missionary influence is powerful enough, it should certainly be exerted towards breaking down those barriers which, in the shape of different alphabets, prevent the free intercourse of the nations of the East.

The philologist and the archæologist must, indeed, acquire a knowledge of these alphabets, as in the case when their study is a language extinct, and existing, perhaps, in the form of inscriptions alone. But where there is no important national literature clinging to a national alphabet, where there are but incipient traces of a reviving civilisation, the multiplicity of alphabets—the worthless remnant of a bygone civilisation bequeathed, for instance, to the natives of India—should be attacked as zealously by the Missionary as the multiplicity of castes and of divinities. In the Dekhan alone, with hardly any literature of either national or general importance, we have six different alphabets—the Telugu, Tamil, Canarese, Malabar, Tuluva, and Singhalese—all extremely difficult and inconvenient for practical purposes. Likewise, in the northern dialects of India almost every one has its own corruption of the Sanskrit alphabet, sufficiently distinct to make it impossible for a Bengalese to read Guzerati, and for a Mahratta to read Kashmirian letters. Why has no attempt been made to interfere, and recognise at least but one Sanskritic alphabet for all the northern, and one Tamulian alphabet for all the southern, languages of India? In the present state of the country, it would be bold and wise to go even beyond this; for there is very little that deserves the name of a national literature in the modern dialects of the Hindus. The sacred, legal, and poetical literature of India is either Arabic, Persian, or Sanskrit. Little has grown up since, in the spoken languages of the day. Now it would be hopeless, should it ever be attempted, to eradicate the spoken dialects of India, and to supplant them by Persian or English. In a country so little concentrated, so thinly governed, so slightly educated, we cannot even touch at present what we wish to eradicate. If India were laid open by highroads, reduced by railways, and colonised by officials, the attempt might be conceivable, though, as to anything like success, a trip through Wales, and a glance at the history of England, would be a sufficient answer. But what might be done in India, perhaps even now, is to supplant the various native alphabets by Roman letters. The people in India who can write are just the men most open to Government influence. If the Roman alphabet were taught in the village schools—of late much encouraged by the Government, particularly in the north-western provinces—if all official documents, in whatever language, had to be transcribed into Roman letters to obtain legal value; if the Government would issue all laws and proclamations transcribed in Roman characters, and Missionaries do the same with their translations of the Bible and other works published in any dialect of India, I think we might live to see one alphabet used from the "snows " to Ceylon.

Let us see, then, how our physiological Missionary alphabet could be applied to languages which have not only an alphabet of their own, but also an established system of orthography.

We have here to admit two leading principles:—

First, *that in transliterating written languages, every letter, however much its pronunciation may vary, should always be represented by the same Roman type, and that every Roman type should always represent the same foreign letter, whatever its phonetic value may be in different combinations*.

Secondly, *that every double letter, though in pronunciation it may be simple, should be transliterated by a double letter, and that a single letter, although its pronunciation be that of a double letter, should be transliterated by a single letter*.

If these two principles be strictly observed, everyone will be able to translate in his mind a Canarese book, written with Roman letters, back into Canarese letters, without losing a tittle of the peculiar orthography of Canarese. If we attempted to represent the sounds in transcribing literary languages, we should be unable to tell how, in the original, sounds admitting of several graphic representations were represented. In written languages, therefore, we must rest satisfied with transliterating letters, and not attempt to transcribe sounds.

This will cause certain difficulties, particularly in languages where pronunciation and spelling differ considerably. In Arabic we must write al ra'*h*man, though we pronounce arra'*h*man; and even in Greek, if we had to transliterate Greek script, we should, no doubt, have to write 'eggus, though none but a Greek scholar would know how to pronounce this correctly ('engüs). But if, instead of imitating the letters, we attempted to represent their proper pronunciation at a certain period of history, how should it be known, for instance, in transcribing the French of the nineteenth century, whether "su" stood for "sou," halfpenny, or "sous," under, or "soul," tipsy. In historical languages the system of orthography is too important a point to be lost in transcribing, though it is a mistake to imagine that in living languages all etymological understanding would be lost if phonetic reforms were introduced. The change in the pronunciation of words, though it may seem capricious, is more uniform and regular than we imagine; and if all words were written alike according to a certain system of phonetics, we should lose very little more of etymology than we have already lost. Nay, in some cases, the etymology would be re-established by a more consistent phonetic spelling. If we wrote "foreign" "for#n," and "sovereign" "sover#n," we should not be led to imagine that either was derived from "reign," regnum, and the analogy of such words as "Afric#n" would point out "foranus"or " foraneus" as the proper etymon of "for#n." But although every nation has the right to reform the orthography of its language, with all things else, where usage has too far receded from original intention, still, so long as a literary language maintains its historical spelling, the principle of transliteration must be to represent letter by letter, not sound by sound.

Which letter in our physiological alphabet should be fixed upon as the fittest representative of another letter in Arabic or Sanskrit, in Hindustani or Canarese, must in each case depend on special agreement. If we found that Sanskrit script in Sanskrit had in most words the nature of the guttural spiritus, we should have to write it' or h, even though m some respects it may represent the guttural semi-vowel. If Hebrew script in Hebrew can be proved to have been originally the simple guttural semi-vowel, it will have to be written 'h, even though it was pronounced as semi-vocalis fricata("h), as guttural flatus asper ('*h*), as guttural media aspirata (gh), or not pronounced at all. Likewise, if English were to be transliterated with our alphabet, we should not adopt any of the principles of the "Fonetic Nus;" but here also, if the letter h had been fixed upon as on the whole the fittest representative of the English letter h, we should have to write it even where it was not pronounced, as in honest.

It will be the duty of Academies and scientific societies to settle, for the principal languages, which letters in the Missionary alphabet will best express their corresponding alphabetical signs.

The first question, taking a type, for instance, of the Sanskrit alphabet, would be, "What is its most usual and most original value? " If this be fixed, then, "Is there another type which has a better claim to this value? "If so, their claims must be weighed and adjusted. When this question is settled, and the physiological category is found under which the Sanskrit type has its proper place, we have then to look for the exponent of this physiological category in the Missionary alphabet, and henceforth always to transliterate the one by the other.

The following lists will show how some of the Arian, Semitic, and Turanian languages have been transliterated, and how all these alphabets and their transcriptions can be expressed by means of the Missionary alphabet. Objections, I am aware, can hardly fail to be raised on several points, because the original character of several Hebrew, Arabic, and Sanskrit letters has been so frequently controverted. If the disputed value of these letters can be clearly settled by argument, be it so; and it will then never be difficult to find the exponent of that physiological category to which it has been adjudged. Failing this, the question should be decided by authority or agreement; for, of two views which are equally plausible, we must, for practical purposes, manifestly confine ourselves to one.

Comparative Table,

Showing Some of the Chief Systems of Transcription and Transliteration Hitherto Adopted in England, France, and Germany, and Their Correspondence with the Missionary Alphabet

Text of a Hymn of the Rigveda,

Transcribed with the Missionary Alphabet.

Na-asad as*i*n, no sad as*i*t tad*a*n*im*, na-as*i*d rag*o*, no vy*o*m*a* par*o* yat,
Kim *a*var*i*va*h*? kuha kasya *s*armann? ambha*h* kim as*i*d gahana*m* gabh*i*ra*m*?
Na m*r*ityur as*i*d, am*r*ita*m* na tarhi; na r*a*try*a* ahna *a*s*i*t praketa*h*—
*A*n*i*d av*a*ta*m* svadhay*a* tad *e*ka*m*, tasm*a*d dba-anya*m* na para*h* ki*m*ka na-*a*sa.
Tama *a*sit, tamas*a* *gulham* agr*e* 'prak*e*ta*m* salila*m* sarvarn *a* ida*m*,
Tu*kh*y*e*na-*a*bhv apihita*m* yad *a*s*i*t tapasas tan mahin*a*-a*g*a*y*ata-*e*ka*m*.
K*a*mas tad agr*e* samavartata-adhi, manas*o* r*e*ta*h*, prathama*m* yad *a*s*i*t,
Sat*o* bandhum asati niravindan h*r*idi prat*i*sliy*a* kavay*o* man*i*sh*a*.
Tira*s*k*i*n*o* vitat*o* ra*s*mir *e*sb*a*m adha svid *a*s*i*d? upari svid *a*s*i*t?—
Retodh*a* *a*san, mahim*a*na *a*sant, svadb*a* avast*a*t, prayati*h* parast*a*t.
K*o* addh*a* veda, ka iha pravo*k*at, kuta *agata* kuta iyam vis*r*ish*lih*?
Arv*a*g d*e*v*a* asya visar*g*a*n*ena-atb*a* k*o* v*e*da yata *a*babh*u*va?
Iya*m* vis*r*ish*t*ir yata *a*babh*u*va, yadi v*a* dadb*e* yadi v*a* na,
Y*o* asya-adhyaksba*h* param*e* vyomant, s*o* anga v*e*da—yadi v*a* na v*e*da.

Oxford, Christmas,

1853.

The End,

LONDON:
A. AND G. A. SPOTTISWOODE,
New-street-Square.

Intercolonial Exhibition, 1866-7. Australian Vegetation, Crest

Indigenous or Introduced,

Considered Especially in its Bearings on the Occupation of the Territory, and with a View of Unfolding its Resources.

BY Ferdinand Mueller, P.H.D., M.D., F.R.S.,
Director of the State Garden of Melbourne.

Melbourne: Blundell & Co., Printers, 51 & 53 Flinders Lane West. MDCCCLXVII.

Australian Vegetation.

THE great continent of Australia exhibits throughout its varied zones marked diversities in the physiognomy of its vegetation. These differences stand less in relation to geographical latitudes than to geological formations, and especially climatical conditions. Yet it is in few localities only where the peculiar features, impressed by nature as a whole on the Australian landscape, cannot at once be recognised. The occurrence of eucalypts and simple-leaved acacias in all regions, and the preponderance of these trees in most, suffice alone to demonstrate that in Australia we are surrounded largely by forms of the vegetable world which, as a complex, nowhere re-occur beyond its territory, unless in creations of ages passed by.

In a cursory glance at the vegetation, as intended on this occasion, it is not the object to analyse its details. In viewing vegetable life here, more particularly as the exponent of clime, or as the guide for settlement, or as the source of products for arts and manufactures, we may content ourselves by casting a view only on the leading features presented by the world of plants in this great country. While the absence of very high and wooded mountains imparts to the vegetation throughout a vast extent of Australia a degree of monotony, we perceive that the occurrence of lofty forest ranges along the whole eastern and south-eastern coast change largely there the aspect of the country, and in this alteration the mountainous island Tasmania greatly participates. Thus the extensive umbrageous forest regions of perpetual humidity commence in the vicinity of Cape Otway; extend, occasionally but not widely interrupted, through the southern and eastern part of Victoria, and thence, especially on the seaside slopes of the ranges, throughout the whole of extra-and intra-tropical East Australia in a band of more or less width, until the cessation of elevated mountains on the northern coast confines the regions of continued moisture to a narrow strip of jungle-land margining the coast. In this vast line of elevated coast-country, extending in length over nearly 3000 miles, and which fairly may pass as the "Australian jungle," the vegetation assimilates more than elsewhere to extra-Australian types, especially to the impressive floral features of continental and insular India. Progressing from the Victorian promontories easterly, and thence northerly, we find that the eucalypts, which still preponderate in the forest of the southern ranges, gradually forsake us, and thus in Eastern Gippsland commences the vast assemblage of varied trees, which so much charms by its variety of forms, and so keenly engages attention by the multiplicity of its interest. Bathed i n vapour from innumerable springs or torrents, and sheltered under the dark foliage of trees very varied in form, a magnificent display of the ferntrees commences, for which further westerly we would seek in vain the climatic conditions. Even isolated sentries, as it were, of the ferntree-masses are scattered not further west than to the craters of extinct volcanoes near Mount Gambier, and although colossal *Todea-ferns*, with stems six to ten feet high, and occasionally as thick, emerge from the streamlets which meander through the deep ravines near Mount Lofty, on St. Vincent's Gulf, we miss there the stately palm-like grace of the *Cyatheæ*, *Dichsoniæ*, and *Alsophilæ*, which leave on the lover of nature who ever beheld them the remembrance of their inexpressible beauty. These fern-trees, often 20 to 30, occasionally 50 to 70 feet high, and at least as many years old, if not older, admit readily of removal from their still mild and humid haunts to places where, for decorative vegetation, we are able to produce the moisture and the shade necessary for their existence. Of all ferntrees of the globe that species which predominates through the dark glens of Victoria, Tasmania, and parts of New South Wales, the *Dicksonia Antarctica* (although not occurring in Antarctic regions), is the most hardy and the least susceptible to dry heat. This species, therefore, should be chosen for garden ornaments, or for being plunged into any park glens; and if it is considered that trees half a century old may with impunity be deprived of their foliage and sent away to distant countries as ordinary merchandise, it is also surprising that a plant so abundant has not yet become an article of more extended commerce.

A multitude of smaller ferns, many of delicate forms, are harboured under the shade of the jungle-vegetation, amounting in their aggregate to about 160 species, to which number future researches in

North-East Australia will undoubtedly add. The circular *Asplenium nidus*, or great nest-fern, with fronds often six feet long, extends to the eastern part of Gippsland, but the equally grand staghorn-ferns (*Platycerium alcicorne* and *P.grande*) seemingly cease to advance south of Illawarra, while in Northern Queensland *Angiopteris evecta* count amongst the most gorgeous, and two slender *Alsophilœ* amongst the most graceful forms. The transhipment of all these ferns offers lucrative inducements to traders with foreign countries. Epiphytal orchids, so much in horticultural request, are less numerous in these jungle tracts than might have been anticipated, those discovered not yet exceeding 30 in number. Their isolated outposts advance in one representative species—the *Sarcochilus Gunnii*—to Tasmania and the vicinity of Cape Otway, and in another—*Cymbidium canalicidatum*—towards Central Australia. The comparative scantiness of these epiphytes contrasts as strangely with the Indian orchid-vegetation, as with the exuberance of the lovely terrestrial co-ordinal plants throughout most parts of extra-tropical Australia, from whence 120 well-defined species are known. Still more remarkable is the almost total absence of orchids, both terrestrial and epiphytal, from North and North-West Australia, an absence for which in the central parts of the continent aridity sufficiently accounts, but for which we have no other explanation in the north than that the species have as yet there effected but a limited migration. To the jungles and cedar-brushes—the latter so named because they yield that furniture-wood so famed as the red cedar (*Cedrela taona*, a tree identical as a species with the Indian plant, though slightly different in its wood)—are absolutely confined the *Anonaceœ, Laurineœ, Monimieœ, Meliacœ:, Rubiaceœ, Myrsineœ, Sapoteœ, Ebenaceœ*, and *Anacardieœ*, together with the *Baccate Myrtaceœ*, and nearly all the trees of *Euphorbiaceœ, Rutaceœ, Apocyneœ, Celastrineœ, Sapindaceœ*, which, while often outnumbering the interspersed eucalypts, seem to transfer the observer to Indian regions. None in the multitude of trees of these orders, with exception of our tonic-aromatic sassafras-tree *(Atherospermum moschatum)* and *Hedycarya Cunninghami*, which supplies to the natives the friction-wood for igniting, transgress in the south the meridians of Gippsland. Palms cease also there to exist, but their number increases northward along the east-coast, while in Victoria these noble plants have their only representative in the tall cabbage or fan palm of the Snowy River—that palm which, with the equally hardy *Areca sapida* of New Zealand, ought to be established wherever the date is planted for embellishment. Rotang palms (*Calami* of several species) render some of the northern thickets almost inapproachable, while there also on a few spots of the coast the cocoanut-tree occurs spontaneously. A few peculiar palms occur in the Cassowary country, near Cape York, and others around the Gulf of Carpentaria as far west as Arnhems-land. The tallest of all, the lofty Alexandra-palm *(Ptychosperma Alexdrœ)*, extends southwards to the tropic of Capricorn, and elevates its majestic crown widely beyond the ordinary trees of the jungle. The products of these entire forests is as varied as the vegetation which constitutes them. As yet, however, their treasures have been but scantily subjected to the test of the physician, the manufacturer, or the artisan. The bark of *Alstonia constricta*, like that of allied Indian species, is ascertained to be febrifugal, so that of *Chionanthus axillaris* and *Brucea Sumatrana*. Caoutchouc might be produced from various trees, especially the tall kinds of Ficus. The lustre and tint of the polished wood of others is unrivalled. Edible fruits are yielded by *Achras Australia, Achras Pohlmaniana, Mimusops kauki, Zizyphus jujuba, Citrus Australis, Citrus Planchonii, Eugenia myrtifolia, Eugenia Tierneyana, Parinarium nonda*, the candle-nut-tree *(Aleurites triloba)*, and the cluster fig-tree (*Ficus vesca*, which produces its bunches from the stem); also by species of *Owenia* and *Spondias*, and by several brambles and vines. Starchy aliment or edible tubers are furnished by *Tacca pinnatifida*, by several *Cissi (C. opaca, C. clematidea*, acrid when unprepared), *Marsdenia viridiflora, Colocasia antiquorum, Alocasia macrorrhiza*, by a colossal *Cycas*, some *Zaraiœ*, and several kinds of yam (*Dioscorea bulbifera, Dioscorea punctata*, and other species). *Back-housia citriodora* and *Myrtus fragrantissima* yield a cosmetic oil; so also Eucalyptus *citriodora*, a tree not confined to the jungle, and two linds of *Ocimum. Semecarpus anacardium*, the marking nut-tree, is a nitive of the most northern brush-country. The medicinal *Mallotus Philippinensis* and the poisonous *Excœcaria Agallocha* are more frequent. *Baloghia lucida* furnishes a red dye never to be obliterated.

Many of the trees of the coast-forests of East-Australia range from the extreme north to the remotest south, among them the *Palm-panax;* others, like *Arancaria Cunninghami*, extend only to the northern part of New South Wales, while some, including *Arancaria Bidwillii*, or the *Bunya-Bunya* tree, so remarkable for its large edible nutlike seeds, and the Australian Kauri, *Dammara robusta*, are confined to very circumscribed or solitary areas. The absence of superior spice plants (as far as hitherto ascertained) amidst a vegetation of prevailing Indian type is not a little remarkable, for *Cinnamomum Laubatii* ranks only as a noble timber-tree, and the native nutmegs are inert. The scantiness of acanthaceous plants is also a noticeable fact. *Podostemoneœ* have not yet been found. Many plants of great interest to the phytographer are seemingly never quitting the north-eastern peninsula; among these the *Banksian banana (Musa Banksii)*, the pitcher-plant *(Nepenthes Kennedyana)*, the vermillion-flowered *Eugenia Wilsonii*, the curious *Helmholtzia acorifolia*, the marshal-tree, *Archidmdron Vaillantii* (the only plant of the vast order of *Leguminosœ* with numerous styles), the splendid *Diplanthera quadrifolia, Ficus magni-folia*, with leaves two feet long, the tall *Cardwellia sublimis*, and the splendid *Cryptocarya Mackinnoniana*, are especially remarkable. *Rhaphidopliora, Pothos, Piper*, together with a host of *Lianes*, especially gay through the prevalence of *Ipomœas*, tend with so many other plants to impart to the jungle part of Australia all the luxuriance of tropical vegetation. Of the two great nettle-trees, the *Laportea gigas* occurs in the more southern regions, while *Laportea photinifolia* is more widely diffused. *Helicia* is represented by a number of fine trees far south, some bearing edible nuts. *Doryanthes excelsa*, the tall especially, is confined to the forests of New South Wales. The flowers of *Oberonia palmicola* are more minute than those of any other orchideous plant, although more than 2000 species are known from various parts of the globe. The display of trees eligible for avenues from these jungles is large. The tall fern-palm *(Zamia Denisonii)*, one of the most stately members of the varied Australian vegetation, is widely, but nowhere copiously, diffused along the east-coast; it yields a kind of sago, like allied plants. The beans of *Castanospermum Australe*, which are rich in starch, and those of *Entada pursaitha*, from a pod often four feet long, are with very many other vegetable substances, on which Mons. Thozet has shed much light, converted by the aborigines into food.

If plants representing the genera *Berberis, Impatiens, Rosa, Begonia, Ilex, Rhododendron, Vaccinium*, or, perhaps, even firs, cypresses, and oaks, do at all occur in Australia as in the middle regions of the mountains of India, it will be on the highest hills of North-East Australia—namely, on the Bellenden Ker Ranges, mountains still unapproachable through the hostility of the natives—where they will find the cooler and simultaneously moist tropical climate congenial to their existence. But whatever may be the variety and wealth of the primitive flora of East Australia, it is only by the active intelligence and exertions of man that the greatest riches can be wrought from the soil. Whatever plants he may choose to raise—whether costly spices, luscious fruits, expensive dyes; whether cacao, manihot, or other alimentary plants; whether sugar, coffee, or any others of more extensive tropical tillage—for all may be found wide tracts fitted for their new home.

The close access to harbours facilitates culture, while the expansive extent of geographical latitude on the east-coast admits of choosing such spots as in each instance present the most favourable climatic conditions for the success of each special plantation. Beyond the coast ranges the country westward changes with augmenting dryness generally at once into more open pastoral ground. Basaltic downs and gentle verdant rises of eminent richness of herbage may alternately give way to Brigalow scrubs, or sandstone plateaux, or porphyritic or granitic hills, and with the change of the geological formation a change, often very apparent, will take place also in the vegetation. Inland we will lose sight of the glossy, dense, umbrageous foliage, which now only borders a generally low coast in the north, terminating there frequently in mangroves. *Strychnos nux vomica* occurs among the coast bushes here, and also an *Antiaris (A. macrophylla);* but whether the latter shares the deadly poison of the Upas tree of Java and Sumatra requires to be ascertained. *Tamarindus Indica* is known from Arnhems-laud, and the French bean *(Phaseolus vulgaris)* in a spontaneous state from the north-west coast. Eucalypts, again, form away from the sea the prevailing timber, but with the exception of the red gum tree *(Eucalyptus rostrata)*, which lines most of the rivers of the whole of the Australian interior, the southern species are replaced by others, never of gigantic growth, in some instances adorned with brilliant scarlet or crimson blossoms. But neither these nor many distinct kinds of northern *Acacias* and *Melaleucas* stamp on the country the expression of peculiarity. Familiar Australian forms usually surround us, though those of the cooler zone, and even the otherwise almost universal *Senecios*, are generally absent. *Cyperus vaginatus*, perhaps the best of all textile rushes, ranges from the remotest south to these northern regions. *Hibiscus tiliaceus*, with other malvaceous plants, is here chosen by the natives for the fibre of their fishing nets and cordage. An occasional interspersion of the dazzling *Erythrina, vespertilio*, of *Bauhinia Leichhardti, Erythrophlceum Laboucheri, Livistonia palms*, and many *Terminaliæ*, some with edible fruits, *Cochlospermum, Gregorii, C. heteronemum*, remind, however, of the flora of tropical latitudes, which, moreover, to the eye of an experienced observer is revealed also in a multitude of smaller plants, either identical with South Asiatic species or representing in peculiar forms tropical genera. The identity of about 600 Asiatic plants (some cosmopolitan) with native Australian species has been placed beyond doubt, and to this series of absolutely identical forms, as well derived from the jungle as from grounds free of forest, unquestionably several hundred will yet be added.

Melaleuca leucadendron, the *Cajeput*-tree of India, is among Indo-Australian trees one of the most universal; it extends as one of the largest timber-trees of North Australia along many of its rivers, and in diminutive size over the dry sandstone table-lands. The Asiatic and Pacific *Casuarina equisetifolia* accompanies it often in the vicinity of the coast. By far the most remarkable form in the vegetation of Nortk-West Australia is the Gouty-Stemtree *(Adansonia Gregorii);* but it is restricted to a limited tract of coast-country. It assumes precisely the bulky form of its only congener, the Monkey-Breadtree, or Baobab of tropical Africa *(Adansonia digitata)*, dissimilar mainly in having its nuts not suspended on long fruit-stalks. Evidence, though not conclusive, gained in Australia, when applied to the African Baobab, renders it improbable that the age of any individual tree now in existence dates from remote antiquity. This view is also held by Dr. G. Bennett, of Sydney. The tree is of economic importance; its stem yields a mucilage indurating to a tragacanth-like gum. It is also one of the few trees which introduces the unwonted sight of deciduous foliage into the evergreen Australian vegetation. Numerous swamps and smaller lakes exist within moderate distance of the coast; as in many other parts of Australia, these waters are surrounded by the wiry Polygonum *(Muehlen-beckia Cunninghami)*, and in Arnhems-land occasionally also by rice plants, not distinct from the ancient culture-plant. But here, in almost æquinoctial latitudes, the stagnant fresh waters are almost invariably nourishing two waterlilies of great beauty *(Nympkcea stellata* and *Nymphoœa gigantea)*, which give, by the gay display of their blue, pink, or crimson shades of flowers, or by their pure white, a brilliant aspect to these lakes; and even the Pythagorean bean *(Nelumbo nucifera)* sends occasionally its fine shield-like leaves and large blossom and esculent fruits out of the still and sheltered waters. But how much could this splendour of lake-vegetation be augmented if the reginal Victoria, the prodigious waterlily of the Amazon River, was scattered and naturalised in these lakes, to expand over their surface its stupendous leaves, and to send forth its huge snowy and crimson fragrant flowers. It would add to the aliment which the natives now obtain from these lakes and swamps by diving for the roots and fruits of the *Nymphœæ*, or for the tubers of *Heleocharis sphacelata*, of species of *Aponogeton*, or by uprooting the starchy rhizomes of *Typha augustifolia* (the Bullrush), when eager of adding a vegetable component to their diet of Unio shells, or of water-fowls and fishes, all abounding on these favourite places of their resort. *Trapa bispinosa*, already living, like the Victoria, in the tanks of our conservatories, ought, with *Trapa natans*, for the sake of its nuts not only to be naturalised in the waters of the north, but also in the lagoons and swamps of the south. Around these lakes Screwpines *(Pandanus spiralis* and *Pandanus aquaticus)* may often be seen to emerge from the banks, the latter, as recorded already by Leichhardt, always indicative of permanent water. The young top-parts of the stems of these *Pandans*, when subjected to boiling, become free of acridity, and thus available in cases of emergency for food. *Opilia amentacea* and the weeping *Eugenia eucalyptoides*, together with a native cucumber *(Cucumis jucunda)*, are here among the few plants yielding edible fruit. Purslane *(Portulaca oleracea)* abounds, and in sandy soil it is found pleasantly acidulous. It will always be acceptable, as a salad or spinage, especially in affections from scurvy, and its amylaceous seeds might in cases of distress be readily gathered for food. A delicious tall perennial spinage *(Chenopodium auricomum)* is not unfrequent. Beyond one kind of *Sandarach Callitris* no pines exist in the north, except the *Araucaria Greyi*, noticed on a circumscribed spot on the Glenelg River. The true bamboo *(Bambusa arundinacea)* lines, as far as yet observed, only the banks of a few of the rivers of Arnhems-land.

To the pastoral settler, for whom more particularly the generally open *Eucalyptus* country or the treeless or partly scrubby tracts are eligible, it must be of significance that the rainfall occurs with frequency during the hottest part of the year. Hence, during the summer, grass and herbage is pushing forth with extraordinary rapidity and exuberance, while a judicious burning at the cooler season, together with the effect of regular dews, is certain to produce fresh forage during the drier months. An almost endless variety of perennial nutritious grasses, allied to Indian species, or even identical with them, are known to exist. The basaltic downs of the north and north-west produce almost precisely that same vegetation which has rendered Darling and Peak Downs so famed in the east. This almost absolute identity of plants is a sufficient indication of great semblance of climate, for which the rise of the country, though one not very considerable, to some extent may account. On the ranges which divide the waters of the east-coast from those of Carpentaria, the vine luxuriates; its fruit indeed suffers occasionally from frost.

How far the tracts south of the more littoral northern country may continue to bear prevailingly the feature of fertility cannot be predicated. There can be no greater fallacy than to prejudge an untraversed country—a fallacy to which explorers are prone, and which, in some instances, has retarded advancement of geographical discoveries and of new locations of permanent abodes, while, in other instances, it has led to disastrous consequences. A country should be judged with caution. Even from elevations comparatively inconsiderable, as such nearly always proved away from the eastern coast, the orb of vision is limited. A traveller may, buoyant with hope, commence his new daily conquest on the delightful natural lawns or the verdant slopes of a trap formation; and before many hours' ride he may, to his dismay, be brought without water to a bivouac between the sand waves of decomposed barren rocks. But as suddenly a few hours' perseverance may bring him again into geological regions of fertility when he least expected it; smiling landscapes may again burst into his view, and he may establish his next camp on limpid water, sufficient for the requirements of a future city. The nature of a country is not ruled by climate and latitude alone, but quite as much, if not more, by its geological structure. Glancing on the map of an unexplored country, we are apt to take in our conjectures the former alone for a guide, until the latter by actual field-operations becomes our stronghold in topographical mapping. It would thus be unsafe to assume that the great western half of the interior consists mainly of desolate, uninhabitable desert-country, or even to contend that the reappearance on Termination Lake, or on the Murchison River, of so very many of the plants which give to the saltbush country, or the Mallee and Brigalow scrubs, on the extensive depression of the Darling-system, their physiognomy, necessitates their uninterrupted extension from the rear of Arnhems-land to the Murray Desert, or to Shark Bay. From demonstrating facts like these we dare no more infer but that likely many similar tracts of flat country are stretching over portions of the wide intervening spaces. But who will predict more? May not the large system of salt-lakes formed by the drainage of rain into cavities of saline flats be found limited to the less distant portions of the interior of Western Australia, and may it not thus, by a gradual rise of the ground (evidently manifest northerly), give place to a system of fresh-water lakes or lagoons, or even of such springs as rewarded the exertions of the keenly searching explorers west of Lake Eyre? And although it must be admitted that no ranges simultaneously lofty and wooded, and thus originating springs and rivulets for the formation of larger rivers, are likely to exist to any extent in the extra-tropical part of the western interior, because such rivers have not found their way to the coast; yet it is still possible, and rather probable, that mountains as high, and much less bare than Gawler Range, and even much more extensive, may give rise to interior watercourses, along which the dwellings of new colonists may be established, and to which our pasture-animals may flock, but which in their sluggish progress cannot force their way to the ocean, and are thus lost in numerous more or less ample inland basins. Years hence, on even less favoured spots, artesian borings may afford the means of stay for a dense population, should, as may be anticipated, mineral riches prove to be scattered not merely over the vicinity of the west-coast and Spencer's Gulf, but also over interjacent areas of geological similarity. York's Peninsula, close to settlements, was long left an uninhabited and desolate spot, until its richdom of copper-ore was disclosed. So other unmapped parts of Australia are also likely to prove rich; and, although equal facilities for the transit of the mineral treasures would not always exist, its discovery would be certain to lead to the occupation of the country and to the extension of pastoral colonisation, until an increasing population and augmented conveniences for traffic could turn mineral wealth, however distantly located, advantageously to account. But how vastly might not any barren tracts of the interior be improved, and how many a lordly possession be founded, by patient industry and intelligent judgment! Storage of water, raising of woods, dissemination of perennial fodder-plants, will create alone marvellous changes; and for these operations means are readily enough at command. Even the scattering of the grains of the common British *orache (Atriplex patulum)*, an annual but autumnal plant, would, on the barest ground, realise fodder for sheep; and the number of plants which for such purpose could be chosen are legion. The storage of rainwater might in any rising valley be so effected as to render it, simply by gravitation, available for irrigating purposes.

As a curious fact, it may be instanced that in some of the waterless sandy regions of South Africa the copious naturalisation of melon-plants has afforded the means of establishing halting places in a desert country. On the sandy shores of the Great Bight, and also anywhere in the dry interior, such plants might be easily established. The avidity with which the natives at Escape Cliffs preserved the melon-seeds, after they once had recognised the value of their new treasure, holds out the prospect of the gradual diffusion of such vegetable boons over much unsettled country.

No part of Australia has the marked peculiarities of its vegetation so strongly expressed, and no part of this great country produces so rich an assemblage of species within a limited area, as the remotest southwestern portion of the continent. Indeed, the southern extremity of Africa is the only part of the globe in which an' equally varied display of vegetable forms is found within equally narrow precincts, and endowed also with an equal richness of endemic genera. It is beyond the scope of this brief treatise to enter fully into a detailed exposition of the constituents of the south-western flora. It may mainly suffice to view such of the vegetable products as are drawn already into industrial use, or are likely to be of avail for the purpose. Foremost in this respect stands perhaps the mahogany-eucalypt *(Eucalyptus marginata)*. The timber of this tree exhibits the wonderful quality of being absolutely impervious to the inroads of the limnoria, the teredo, and chelura, those minute marine creatures so destructive to wharves, jetties, and any work of naval architecture exposed to the water of the sea; it equally resists the attacks of termites. In these properties the red gumtree of our own country largely shares. The mahogany-eucalypt has, in the Botanic Gardens of this city, been brought for the first time largely under cultivation, and as clearly the natural supply of this important timber will sooner or later prove inadequate to the demanded requirements, it must be regarded as a wise measure of the Governments of France and Italy now to establish this tree on the Mediterranean shores, a measure for which still greater facilities are here locally afforded.

The tuart *(Eucalyptus gomphocephala)* is another of the famed artisan's woods of south-western Australia. The karri eucalypt *(Eucalyptus eolossea or diversicolor)* attains in favourable spots a height of 400 feet. *Eucalyptus megacarpa* constitutes the blue gumtree, which rivals that of Tasmania and Victoria in size, but is otherwise very distinct. Its timber, as well as that of the tuart, on account of their hardness, are employed for tramways and other works of durability. The fragrant wood of several species of santalum forms an article of commercial export. Some kinds of Casuarina, quite peculiar to that part of Australia, furnish superior wood for shingles and for a variety of implements. Several species of Acacia, especially *Acacia acuminata*, the raspberry-scented Wattle, equally restricted to the south-west coast, yield fragrant and remarkably solid wood and a pure gum. To this part of Australia was naturally also restricted the *Acacia lophantha*, which has for the sake of its easy and rapid growth and its umbrageous foliage assumed such importance even beyond Australia for temporary shelter-plantations. Many other products, such as gum-resins, sandarach, tanner's bark, all of great excellence, are largely available; but these substances show considerable similarity to those obtained in other Australian colonies.

The extraordinary abundance, however, of the Xanthorrhœas through most parts of the south-west territory gives special interest to the fact (1845) promulgated by Stenhouse, that anthrazotic, or nitro-picric acid—a costly dye—may, with great ease and little cost, be prepared from the resin of these plants. Indeed, this is the richest source for this acid, the resin yielding half its weight in dye. Fibre of great excellence and strength is obtained from the bark of *Pimelea clavata*, a bush widely distributed there. It resembles that of bast from *Pimelea axiflora* in Gippsland, and that from *Pimelea microcephala* of the Murray and Darling desert. A fern-palm *(Zamia Fraseri)* attains in West Australia a height of fifteen feet. It is there, like some congeners of America and South-Africa, occasionally sacrificed for the manufacture of a peculiar starch, though the export of the steins (and perhaps of those of the xanthorrhœas also) would prove much more profitable, inasmuch as these, when deprived of their noble crown of leaves, though not of their roots, will endure a passage of many months, even should the plants be half a century old. Such any wool-vessel might commodiously take to Europe. This alimentary fern-palm, well appreciated by the aborigines for the sake of its nuts, together with a true kind of yam *(Dioscorea hastifolia)*, the only plant on which the natives in their pristine state anywhere in Australia bestowed a crude cultivation, are, with species of *Borya, Sowerbœa, Hcemodorum, Ricinocarpus, Macarthuria, Chloanthes, Aphano-petalum, Xylomelum, Caleana, Calectasia, Petrophila, Leschenaultia, Pseu-danthus, Nematolepis, Nuytsia (the terrestrial mistletoe), Leucokena, Com-mersonia, Rvlingia, Keraudrenia, Mirbelia, Gastrolobium, Labichea, Melickrus, Monotaxis, Actinotus*, and *Stypandra*, remarkable for their geographical distribution; because as far as we are hitherto aware, these West Australian genera have no representatives in the wide interjacent space until we approach towards the eastern, or in a few instances to the northern regions of Australia, *Zamia* alone having been noticed in South Australia *(Zamia Macdonnellii)*, but there as an exceedingly local plant. Neither climatic nor geologic considerations explain this curious fact of phytogeography. Over some of the heathy tracts of scrub-country towards the south-west coast, poisonous species of *Gastrolobium (Gastrol. bilobum, G. oxylobioides, G. calycinum, G. callistachys)* are dispersed. These plants have in some localities rendered the occupation of country for pastoral pursuits impossible, but these poison-plants are mostly confined to barren spots, and it is not unlikely that by repeated burnings, and by the raising of perennial fodder-plants, they could be suppressed and finally extirpated. Fortunately, in noother parts of Australia *Gastrolobium* occurs, except on the inland tract from Attack Creek to the Suttor River, where flocks must be guarded against access to the scrub-patches harbouring the only tropical species *(Gastrolobium grandiflorum)*. The deadly effect occasionally produced by *Lotus Australis*, a herb with us of very wide distribution, and extending also to New Caledonia, and the cerebral derangements manifested by pasture animals which feed on the Darling River pea *(Swainsona Greyana)*, need yet extensive investigation, but may find their explanation in the fact that the organic poisonous principle is only locally, under conditions yet obscure, developed; or in the probable circumstance that, like in a few other leguminous plants, the deleterious properties are strongly concentrated in the seed. The gorgeous desert-pea *(Clianthus Dampierii)*, which in its capricious distribution has been traced sparingly from the Lachlan River to the north-west coast, offers still to seed-collectors a lucrative gain.

A prominent aspect, in the vegetation of south-west Australia emanates from the comparatively large number of singularly beautiful *Banksia*-trees, preponderant there as the arborous *Grevilleœ* in North Australia, The existence of but two of that genus, *Banksia Australis* and *B. ornata*, in the extensive tract of interior and coast land from the head of the Australian Bight to the vicinity of Port Phillip, renders the occurrence of an increased number of trees of this kind in East Australia again still more odd. Rutaceous and goodeniaceous plants, though in no part of the Australian continent rare, attain in the south-west their greatest numerical development, and should not be passed silently, or, like *Epacrideœ*, as merely ornamental plants, though still so rare in our gardens: but these elegant plants deserve also attention for their diaphoretic properties, or for the bitter tonic principle which pervades nearly all the species of the two orders. *Stylideœ* are here still more numerous than in our north, and comprise forms of great neatness; while sundews *(Droserœ)* are also found to be more frequent than in any other part of Australia, and indeed of the globe. When, glittering in their adamantine dew, they reappear as the harbingers of spring from year to year, they are greeted always anew with admiration. But the greatest charm of the vegetation consists in the hundreds of myrtaceous bushes peculiar to the west, all full of aromatic oil; among these again the feather-flowered numerous *Verticordœ*, the crimson *Galotlmmni*, and the heathy *Calytlvrices*, vie with each other as ornaments. Still also of this order many gorgeous plants exist in other parts of, especially extra-tropical, Australia, The numerous bushes of *Leguminosœ* and *Proteaceœ* in south-west Australia are .also charming. The introduction of all these into

European conservatories might be made the object of profitable employment. Annual herbs of extreme minuteness, belonging chiefly to *Compositæ*, *Umbelliferæ*, *Stylideæ*, and *Gentrolepideæ*, are here, as in other parts of extra-tropical Australia, in their aggregate more numerous than minute phanerogamic plants in any other part of the globe. A line of demarcation for including the main mass of the south-west Australian vegetation may almost be drawn from the Murchison River or Shark Bay to the western extremity of the Great Bight; because to these points penetrates the usual interior-vegetation, which thence ranges to Sturt's Creek, to the Burdekin, Darling, and Murray River, while the special south-west Australian flora ceases to exist as a whole beyond the limits indicated.

The marine flora of south-west Australia is likewise eminently prolific in specific forms, perhaps more so than that of any other shore. Many of the algæ are endemic, others extend along the whole southern coast and Tasmania, where again a host of species proved peculiar; some are also extra-Australian. The whole eastern coast contrarily, and also the northern and the north-western, with the exception of a few isolated spots, such as Albany Island, contrast with the southern coast as singularly poor in algæ. In a work exclusively devoted to the elucidation of the marine plants of Australia—a work which as an ornament of phytographic literature stands unsurpassed, and which necessitated lengthened laborious researches of its illustrious author, the late Professor Harvey, here on the spot—the specific limits of not less than 800 algæ are fixed. Some of these are not without their particular uses. A few yield caragaheen, all bromine and iodine. *Macrocystis pyrifera*, the great kelp, which may be seen floating in large masses outside Port Phillip Heads, attains the almost incredible length of many hundred feet, while a single plant of the leathery broad *Uruillea potatorum* constitutes a heavy load for a pack-horse.

The wide depressed interior, once supposed to be an untraversable desert, consists, as far as hitherto ascertained, much less of sandy ridges than of sub-saline or grassy flats, largely interspersed with tracts of scrub, and occasionally broken by comparatively timberless ranges. The great genus *Acacia*, which gives to Australia alone about 300 species (and, therefore, specific forms twice as numerous as that of any other Australian generic type), sends its shrubs and trees also in masses over this part of the country, where with their harsh and hard foliage they are well capable to resist the effect of the high temperature during the season of aridity, while they are equally contented with the low degree of warmth to which, during nights of the cool season, the dry atmosphere becomes reduced. Handsome bushes of *Eremophila*, with blossoms of manifold hue, decorate the scrubs throughout the whole explored interior. Among the desert *Cassiæ* two simple-leaved kinds are remarkable. Of the *Acaciæ* none here, except. *A. Farnesiana*, have pinnated leaves, and even one is leafless; the pinnated *Acacia* being restricted to the more littoral tracts, and even there from the Great Bight to Guichen Bay entirely absent. If shelter plantations of the rapidly-growing eucalypts, acacias, and casuarinas were raised, a vast var ety of useful plants could be reared along the watercourses of the more central parts of Australia. Saltbushes in great variety stretch far inland, and his is the forage on which flocks so admirably thrive. Probably the extensive Asiatic steppes have to boast of no greater diversity of salsolaceous plants than our own. Nevertheless, even here much could be added to the productiveness of these pasturages by the introduction of other peremial fodder herbs. Grasses, wherever they occur, are varied, and a large slare is perennial, nutritious, and widely diffused. As corroborative, it may be instanced that *Anthistiria ciliata*, the common kangaroo-grass, alnost universally ranges over Australia, and thus also over the central steppe; the continent. It extends, indeed, to Asia and North Africa also. Besides, through the interior, grasses, especially of *Panicum* and *Andropogon*, are numerous, either on the oases or interspersed with the shrubs on barren spots. *Festuca* or *Triodia irritans*, the porcupine-grass of the settlers, is restricted to the sands of the extra-tropical latitudes; *Festuca* or *Triodia viscida*, chiefly to the sandstone table-lands of the tropics.

Only in the south-eastern parts of the continent and in Tasmania are the mountains rising to alpine elevations. Mount Hotham, in Victoria, and Mount Kosciusko, in New South Wales, form the culminating points, each slightly exceeding 7000 feet in height. In the ravines of these summits lodge perennial glaciers; at 6000 feet snow remains unmelted for nearly the whole of the year, and snowstorms may occur in these elevations during the midst of summer. At 5000 feet the vegetation of shrubs generally commences, and up to this height ascend two eucalypts, *Eucalyptus coriacea* and *Gunnii*, forming dense and extensive thickets; *E. coriacea* assuming, however, in lower valleys, huge dimensions. Both these, with most of our alpine plants, would deserve transplanting to middle Europe and to other countries of the temperate zone, where they would well cope with the vicissitudes of the climate. In Tasmania the winter snowline sinks considerably lower, and in its moister clime many alpine plants descend there along the torrents and rivulets to the base of the mountains which here are constantly clinging to cold elevations. Mount William is the only sub-alpine height isolated in Victoria from the great complex of snowy mountains, but it produces, beyond *Eucalyptus alpina* and *Pultenæa rosea*, which are confined to the crest of that royal mountain, only *Celmisia longifolia* and little else as the mark of an alpine or rather subalpine flora. *Celmisia* also is one of the few representatives of cold heights in the Blue Mountains; and from New England we know only `and *Gual-theria hispida*, as generally indicating spots on which snow lodges for some of the winter months. The mountains of Queensland would need in their tropical latitudes a greater height than they possess for nourishing analogous forms of life, but the truly alpine vegetation of the high mountains of Tasmania contrasts in some important respects with that of the Australian Alps—namely, therein, that under the prevalence of a much higher degree of humidity plants which delight to be bathed in clouds, or in the dense vapours of the surrounding fern-tree valleys, are much more universal; and that the number of peculiar alpine *genera* is much greater than here. Thus, while in Tasmania the magnificent evergreen beach *(Fagus Cunuingliami)* covers many of the ranges up to sub alpine rises, it predominates as a forest tree in Victoria only at the remotest sources of the Yarra, the Latrobe, and the Goulburn rivers, and on Mount Baw-Baw. To this outpost of the Australian Alps (now so accessible to metropolitan tourists) are restricted also several plants, such as *Oxalis Magellanica* and *Libertia Lawrencii*, which are almost universal on all the higher hills of Tasmania. *Fagus Cunuingliami*, though descending into our ferutree-ravines, transgresses nowhere the Victorian land-boundaries, but a noble fagus-forest, constituted by a distinct and equally evergreen species, *Fagus Moorei*, crowns the high ranges on which the Bellinger and M'Leay rivers rise. This, however, the snowy mountains of Tasmauia and of continental Australia have in common, that the majority of the alpine plants are not representing genera peculiar to colder countries, but exhibit hardy forms, referable to endemic Australian genera, or such as are allied to them. So, as already remarked, we possess alpine species, even of *eucalyptus* and of *acacia*, besides of *hibbertia, oxylobium, bossiæa, pultenæa, eriostemon, boronia didiscus, epacris, leueopogon, prostanthera, grevillea, hakea, persoonia, pimelea, kunzea, baeckea, stackhousia, mitrasacme, xanthosia, coprosma, velleya, prasophyllum;* yet *anemone, ealtha, antennaria, gaultheria, alchemitta, seseli, oenothera, huanaca, abrotanella, ligusticum, astelia, gunnera*, and other northern or western types, are not altogether missing, though nowhere else to be found in Australia but in glacier regions.

About half a hundred of the highland plants are strictly peculiar to Victoria, the rest prove mainly identical with Tasmanian species; but a few of ours, not growing in the smaller sister land, are, strange as it may appear, absolutely conspecific with European forms. Rather more than one hundred of the lowland-plants ascend, however, to the glacial regions; some of these are simultaneously desert-species.

The only genus of plants absolutely peculiar to the Victorian territory, *Wittsteinia*, occurs as a dwarf sub-alpine plant, of more herbaceous than woody growth, restricted to the summits of Mount Baw-Baw; this, moreover, remained hitherto the only representative of *vaccinieæ* in all Australia; it produces, like most of the order, edible berries.

The verdant summer herbage of valleys, which snow covers during the winter months, will render with increasing value of land-estates these free, airy, and still retreats in time fully occupied as pasturage during the warmer part of the year. Here, in sheltered glens, we have the means of raising all the plants delighting in the coolest clime. Rye-culture could probably be carried on at considerable elevation.

Of all the phanerogamic plants of Tasmania, about 130 are endemic; of those about 80 are limited to alpine elevations, or descend from thence only into cool umbrageous valleys. The generic types peculiar to the island are again almost all alpine *(milligania, campynema, hewardia, pterygopap-pus, tetracarpœa, anodopetalum, cystanthe, prionotis, mieroeachrys, diselma, athrotaxis, pherosphœra, bellendena, cenarrhenes, archeria)*, only *acradenia* and *agastachys* belonging seemingly to the lowlands, but show at once a fondness for a wet, insular clime. The few Tasmanian genera, represented besides only in Victoria, are *richea, diplarrhena, drymophila, juncella*. In the Tasmanian highlands-Aura endemic shrubby asters and *epacrideai*, and the singular endemic pines of various genera, constitute a marked feature. A closer and more extended inquiry into the geological relation of great assemblages of vegetation will shed probably more light on the enigmatic laws by which the dispersion of plants is ruled. Australian forms predominate also in Tasmania at snowy heights, so *Eucalyptus gunnii, E. coccifera*, and *E. umigera*. The famous Huon-pine *(Dacrydium Franklini)*, the Palmheath *(Richea pandanifolia)*, the celery-topped pine *(Phyllncladus rltomboidulis)*, and the deciduous beech *(Fagus Gunnii)*, are among the most striking objects of its insular vegetation. Mosses, lichenastra, lichens, and conspicuous fungs abound both in alpine and low regions; indeed, cryptogamic plants, except *Algs* and microscopic fungs, are nowhere in Australia really frequent except in Tasmania, in the Australian Alps, and in the fern-tree glens of Victoria and part of New South Wales. The musktree *(Aster argophyllus)* of Tasmania and South-east Australia is the largest of the few trees produced by the vast order of *Compositce* in any part of the globe, while *Prostanthera lasianthos*, its companion, exhibits the only real tree known in the extensive family of *Labiatœ*. The almost exclusive occupation of vast littoral tracts of Gippsland, and some of the adjoining islands, by the dwarf *Xanthorrhœa minor*, is remarkable. Mistletoes do not extend to Tasmania, though over every other part of Australia; neither the Nardoo *(Marsilea quadrifolia)*, of melancholic celebrity, though to be found in every part of the continent, and abounding in innumerable varieties throughout the depressed parts of the interior. Equisetaceæ occur nowhere. The total of the species to be admitted as well defined, and hitherto known, from all parts of Australia, approaches (with exclusion of microscopic fungi) to 10,000.

It has been deemed of sufficient importance to append to this brief memoir an index of all the trees hitherto discovered in any part of Australia. Such statistics lead to reflection and comparison. They also bring more prominently before the contemplative mind the real access which in any branch of special knowledge may have been obtained. In this instance it is the only table with which this document has been burdened, though kindred lists might have readily been elaborated. Nor would this imperfect sketch of Australian vegetation have been extended to any detailed enumerations whatever, did not the *trees impress on the vegetation of each country its most distinctive feature*, and had we not learned how great a treasure each land possesses in its timber—whether as raw product to artisans or as objects of therapeutic application, whether as material for the products of manifold factories or as the source of educts in the chemical laboratory, whether as the means of affording employment to the workman or even as the medium for regulating the climate. May we revert only to the circumstance as elucidating the great physiographic characters of countries and their mutual relation, that notwithstanding the close proximity of New Zealand, *none* of its trees (though very many of its herbs) are positively identical with any observed in Australia; and yet hundreds of ours can in no way be distinguished from Indian trees. Moreover, in a philosophical contemplation of the nature of any country and the history of its creation, our attention is likely to be in the first instance engaged in a survey of the constituents of its pristine forests, and greatly is to be feared that in ages hence, when much of the woods will have sunk under ruthless axes, the deductions of advanced knowledge thereon will have to be based solely on evidence early placed on record.

The marvellous height of some of the Australian, and especially Victorian trees, has become the subject of closer investigation, since of late, particularly through the miners' tracks, easier access has been afforded to the back-gullies of our mountain-system. Some astounding *data*, supported by *actual* measurements, are now on record. The highest tree previously known was a *Karri-Eucalyptus (Eucalyptus colossea)*, measured by Mr. Pemberton Walcott, in one of the delightful glens of the Warren River of Western Australia, where it rises to approximately 400 feet high. Into the hollow trunk of this Karri three riders, with an additional packhorse, could enter and turn in it without dismounting. On the desire of the writer of these pages, Mr. D. Boyle measured a fallen tree of *Eucalyptus amygdalina*, in the deep recesses of Dandenong, and obtained for it the length of 420 feet, with proportions of width, indicated in a design of a monumental structure placed in the Exhibition; while Mr. G. Klein took the measurement of a eucalyptus on the Black Spur, ten miles distant from Healesville, 480 feet high! Mr. E. B. Ileyne obtained at Dandenong as measurements of height of a tree of *Eucalyptus amygdalina:* Length of stem from the base to the first branch, 295 feet; diameter of the stem at the first branch, 4 feet; length of stem from first branch to where its top portion was broken off, 70 feet; diameter of the stem where broken off, 3 feet; total length of stem up to place of fracture, 365 feet; girth of stem three feet from the surface, 41 feet. A still thicker tree measured, three feet from the base, 53 feet in circumference. Mr. George W. Robinson ascertained in the hack-ranges of Berwick the circumference of a tree of *Eucdyptus amygdalina* to be 81 feet at a distance of four feet from the ground, and supposes this eucalypt, towards the sources of the Yarra and Latrobe rivers, to attain a height of half a thousand feet. The same gentleman found *Fagus Cunninghami* to gain a height of 200 feet and a drcum-ference of 23 feet.

It is not at all likely that in these isolated inquiries chance has led to the really highest trees, which the most secluded and the least accessible spots may still conceal. It seems, however, almost beyond dispute that the trees of Australia rival in length, though evidently not in thickness, even the renowned forest-giants of California, *Sequoia Wellingtonia*, the lighest of which, as far as the writer is aware, rise in their favourite haunts at the Sierra Nevada to about 450 feet. Still, one of the mammoth-trees measured, it is said, at an estimated height of 300 feet, 18 feet in diameter! Thus to Victorian trees for elevation the palm must apparently be conceded. A standard of comparison we possess in the spire of the Münster of Strassburg, the highest of any cathedral of the globe, which sends its lofty pinnacle to the height of 466 feet, or in the great pyramid of Cheops, 480 feet high, which if raised in our ranges would be overshadowed probably by eucalyptus trees.

The enormous height attained by not isolated, but vast masses of our timber-trees in the rich diluvial deposits of sheltered depressions within Victorian ranges, finds its principal explanation, perhaps, in the circumstance that the richness of the soil is combined with a humid geniality of the climate, never sinking to the colder temperature of Tasmania, nor rising to a warmth less favourable to the strong development of these trees in New South Wales, nor ever reduced to that comparative dryness of air which even to some extent in the mountain-ravines of South Australia is experienced. The absence of living gigantic forms of animal life amidst these the hugest forms of the vegetable world is all the more striking.

Statistics of actual measurement of trees compiled in various parts of the globe would be replete with deep interest, not merely to science, but disclose also in copious instances magnitudes of resources but little understood up to the present day. Not merely, however, in their stupendous altitude, but also in their celerity of growth, we have in all probability to accede to Australian trees the prize. Extensive comparisons instituted in the Botanic Gardens of this metropolis prove several species of eucalyptus, more particularly *Eucalyptus globulus* and *Eucalyptus obliqua*, as well as certain acacias—for instance, *Acacia decurrens*, or *Acacia* *mollissima*—far excelling in their ratio of development any extra-Australian trees even on dry and exposed spots, such into which spontaneously our blue gumtrees would not penetrate. This marvellous quickness of growth, combined with a perfect fitness to resist drought, has rendered many of our trees famed abroad, especially so in countries where the supply of fuel or of hardwoods is not readily attainable, or where for raising shelter, like around the cinchona-plantations of India, the early and copious command of tall vegetation is of imperative importance. To us here this ought to be a subject of manifold significance. I scarcely need refer to the fact that for numerous unemployed the gathering of Eucalyptus seeds, of which a pound weight suffices to raise many thousand trees, might be a source of lucrative and extensive employment; but on this I wish to dwell, that in Australian vegetation we probably possess the means of obliterating the rainless zones of the globe, to spread at last woods over our deserts, and thereby to mitigate the distressing drought, and to annihilate perhaps even that occasionally excessive dry heat evolved by the sun's rays from the naked ground throughout extensive regions of the interior, and wafted with the current of air to the east and south, miseries from which the prevalence of sea-breezes renders the more littoral tracts of West and North Australia almost free. But in the economy of nature the trees, beyond affording shade and shelter, and retaining humidity to the soil, serve other great purposes. Trees, ever active in sending their roots to the depth, draw unceasingly from below the surface-strata those mineral elements of vegetable nutrition on which the life of plants absolutely depends, and which with every dropping leaf is left as a storage of aliment for the subsequent vegetation. How much lasting good could not be effected, then, by mere scattering of seeds of our drought-resisting acacias and eucalypts and casuarinas at the termination of the hot season along any watercourse, or even along the crevices of rocks, or over bare sandsor hard clays, after refreshing showers? Even the rugged escarpments of the desolate ranges of Tunis, Algiers, and Morocco, might become wooded: even the Sahara itself, if it could not be conquered and rendered habitable, might have the extent of its oases vastly augmented; fertility might be secured again to the Holy Land, and rain to the Asiatic plateau or the desert of Atacama, or timber and fuel be furnished to Natal and La Plata. An experiment instituted on a bare ridge near our metropolis demonstrates what may be done.

Not Australia alone, but some other countries, have judiciously taken advantage of the facilities afforded by Australian tree-vegetation for raising woods, an object which throughout the interior might be initiated by rendering this an additional purpose of the expeditions to be maintained in the field for territorial and physiographical exploration; and more, it might deserve the reflection of the Legislature, which allots to the pastoral tenants their expansive tracts of country, whether or not along with squatting pursuits—indeed, for the actual benefit of the pastoral occupant himself—the inexpensive first steps for general forest-culture in the woodless regions should be commenced.

Within the ranges which produce these colossal trees but few-habitations exist; indeed, we might traverse a line of a thousand miles as yet without a dwelling. The clime is salubrious; within the sheltered glens it cannot in excellence be surpassed. Hot winds, from which our exposed plains, as well as any rises of northern and western aspect, so much suffer, never reach the still and mild vales of the forests; frosts are only experienced in the higher regions. Speaking of Victoria especially, it is safe to assert that there alone many thousand square miles of mountainous country, timbered with stringybark-trees *(Eucalyptus obliqua)*, are as yet lying dormant for any other but isolated mining operations. And yet, might not families which desire to strike out a path of independent prosperity, which seek a simple patriarchal life in a salubrious locality of seclusion, and which command the needful strength of labour within their own circle, choose these happy glens as their permanent abodes? Though the timbered rises of the ranges may be as yet unlucrative for cultivation, or even be sterile, the valleys are generally rich, irrigated by clear brooks, and spacious enough for isolated homes, and the limited number of pasture animals pertaining to them. The costlier products of culture might be realised, especially so in the fern-tree-glens; tea, and possibly cinchona, and coffee also; so lucrative fibres, dye plants of easy growth and simple preparation, as instanced by grass-cloth, or madder; or medicinal plants, such as senna, and various herbs, or, perhaps, even the *Erythroxylon coca*, a plant of almost fabulous properties. Or should the settler prefer, beyond raising the simple requirements for his rural life, to devote his attention solely to the gain which the surrounding timber treasures are certain to offer, he will find ample scope for his energy and industry. The Eucalypts, as now proved by extensive and accurate experiments, will yield him tar in abundance; they will furnish fibres, even those of stringybark, as one of the cheapest and most extensively available paper material. By a few simple appliances he may secure, simultaneously with the tar, also wood-vinegar and wood-spirit; and these again might locally be at once converted into dye materials and varnishes. He might obtain potash from woods, and volatile oils from the leaves of Eucalypts in almost any quantity, by artless processes, and with scarcely any cost. He might gather the gum-resins and barks for either medicinal or tanning purposes, or he might effect a trade in fern-trees; he might shake the *Eucalyptus* grains out of their capsules, and might secure locally other mercantile substances far too numerous to be enumerated here. Whoever may choose these ranges as a permanent home, and may direct thoughtfully his attention to the future, will recognise that the mere scattering of the acorns of the cork-tree or the seeds of the red cedar over cleared and yet sheltered ground, or the planting of the vine and olive, will yield to his descendants sources of great riches.

In closing these concise and somewhat chaotic suggestions, which scarcely admit of methodical arrangement, unless by expansion into the chapters of a volume, we may—indulging in a train of thoughts—pass from special to general considerations.

Belgium, one of the most densely populated of all countries, and yet one of the most prosperous, nourished within an area less than one-half that of Tasmania a population three times exceeding that of all the Australian colonies; yet one-fifth of the Belgian territory consists of forests. Not to any considerable extent smaller than Europe, our continent is likely to support in ages hence a greater population; because, while here no frigid zone excludes any portion of the territory from productiveness, or reduces it anywhere to very circumscribed limits, it embraces a wide tropical tract, destined to yield us products nowhere to be raised under the European sky. The comparatively unbroken uniformity of vast tracts of Australia certainly restricts us for the magnificent sceneries and the bracing air of the countries of our youth here to the hilly coast-tracts; but still we have not to endure the protracted colds of middle and north European winters, nor to contend with the climatic difficulties which beset tillage operations or pastoral pursuits, and which by patient perseverance could not be removed or be materially lessened.

While we are deprived of advantages so pleasing and so important as those of large river communications, we enjoy great facilities for land traffic, facilities to which every new discovery of coal-layers will add.

Judicious forest culture, appropriate to each zone, will vastly ameliorate the clime, and provide for the dense location of our race; for transplanting of almost every commodity both of the vegetable and animal empire, we possess, from the alp to the steppes, from the cool mountain-forests to the tropic jungles, conditions and ample space.

River-waters, now flowing unutilised to the ocean, when cast over the back plains, and artesian borings also, will effect marvellous changes. Steam power and the increased ingenuity of machinery applied to cultivation, will render the virgin soil extensively productive with far less toil than in older countries, while the teachings of science will guard us against the rapacious systems of culture and the waste of fertilisers which well nigh involved ruin to many a land. Of ferocious land animals, Australia is free. We have neither to encounter extensive hordes of savages to dispute the possession of the soil, nor the still more dangerous opposition of half-civilised barbarians, such as for ages yet may obstruct the progress of civilisation in the great interior of Africa.

Our continent, it may be foretold prophetically, will ere long be regarded of so high a territorial value that *no* tract, however much disregarded now, will remain unoccupied. Our continent, surrounded moreover by the natural boundaries of three oceans, free and unconnected, must advance, by extraneous influences undisturbed, by ancient usages unretarded, to that greatness to which British sovereignty will for ever give a firm stability.

The Trees of Australia, Phytologically Named and Arranged, with Indications of their Territorial Distribution.

No plants have been inserted in this list unless their height approached to 30 feet, although in a few instances they attain only exceptionally this standard. But *Cystanthe procera* and *Epacris heteronema* in the deep, swampy forest-recesses of South Port, and *Corrœa Lawrenciana* in the dark ferntree ravines towards Cape Otway, rise to the adopted standard-height; whilst *Melaleuca squarrosa*, in the deep irriguous forest-glens at Sealer's Cove, has been noted 80 feet high, with a stem 40 feet long and two feet thick. It was preferable to admit these and a few other generally shrubby plants into this tree-list, were it only to render the luxuriance of the vegetation on these hardly ever traversed spots universally understood. The list comprises approximately 950 trees. Of these 88 occur in South-Western Australia, 63 in the territory of the colony of South Australia, 146 in that of Victoria, 66 in Tasmania, 385 in New South Wales, not less than 526 in Queensland, 212 in North Australia, and 29 in Central Australia. To the number of the Tasmanian and Victorian trees future observers will add but little. The list of those from Western Australia and South Australia is certain to receive additions by further discoveries in the interior, but probably the increase will not be extensive. About 25 trees from New South Wales known to exist could not be recorded, the corresponding material in our museum admitting of no accurate examination. The cedar brushes, moreover, as well as the interior, are likely to yield still a limited number of hitherto unknown trees to future search. Queensland and North Australia are throughout the littoral and jungle tracts as yet imperfectly explored, and we yet expect to derive from these hundreds of additional trees, many of which doubtless will be of special interest and value both to the phytographer and the artisan. Central Australia, according to the narrower or wider limitation we may arbitrarily assign to it, is likely to furnish a considerable number of new trees, while others will be traced in that direction; but probably no new kinds of any great dimensions will be found. The construction of tabulated lists of trees indigenous to other parts of the globe would serve manifold useful comparisons; as yet none of those of Europe even are extant. It is contemplated to construct for all those trees which are not already provided with vernacular names free of ambiguity, and such as bear a logical meaning, new English appellations, as far as possible in consonance with the uses or the phytographic name of the tree.

[W.A. indicates West Australia; S.A., South Austrsilia; T., Tasmania; V., Victoria N.S.W., New South Wales; Q.L., Queensland; N.A., North Australia; C.A., Central Australia.]

Dicotyledoneæ.

I.—Choripetaleæ.

II.—Synpetaleæ.

III.—Amentaceæ.

Monocotyledoneæ.

Acotyledoneæ.

The monocotyledonous and acotyledonous trees, not actually furnishing timber for ordinary purposes, might have been excluded. Gomphandra Aus-traliana, F.M., among Oleoineæ, from Queensland, was casually omitted.

Vignette

Blundell and Co., Printers, Flinders Lane West, Melbourne.

On the Application of Phytology to the Industrial Purposes of Life.

A Popular Discourse,

Delivered at the Industrial Museum of Melbourne, on 3rd November, 1870,

By Ferdinand Von Mueller, C.M.G., M.D., Ph.D., F.R.S.,

Comm. Ord. Santiago, Kn. of Orders of Austria, France, Prussia, Italy, Wuertemberg, Denmark, Mecklenburg, Gotha; Government Botanist for Victoria, and Director of the Botanic Gardens of Melbourne.

Called upon somewhat suddenly to choose the theme for the discourse of this evening, I made my choice unguardedly. I anticipated in my thoughts how, during the intended instructive recreation of this hour, the bearings of intimate botanic knowledge on many an industrial pursuit might readily be demonstrated by some impressive facts. But on reflection, I saw myself at once surrounded by so varied and bewildering a multitude of objects, that to do justice in a few words to my theme became a hopeless task. But while I offer this mere introductory address for a series of lectures in the phytologic section of this institution, we might learn by a rapid glance over an area of knowledge singularly wide, that only

The Lecture was illustrated by large wall paintings of "Eucalyptus amygdalina" (the most gigantic tree anywhere in British territory), of "Brachychiton Delbechei" (the Bottle-tree of Bast Australia), of "Ctreusgiganteus" (the huge Cactus of New Mexico); also by numerous Vegetable Chemicals, and samples of Raw Material; by about one hundred different hinds of Paper, from various substances; by microscopic *drawings of Starches, and by a host of living Plants of medicinal, or economic, or industrial value*.

through many successive discourses, explaining subjects in detail, the student can become aware of the importance of phytologic knowledge in its relation to the industrial purposes of life. In all zones, except the most icy, mankind depends on plants for its principal wants. For our sustenance, clothing, dwellings, or utensils; for our means of transit, whether by sea or land; indeed, for all our ordinary daily requirements, we have to draw the material largely—and often solely—from the vegetable world. The resources for all these necessities must be—it cannot be otherwise—manifold in the extreme, and singularly varied again in different climatic zones, or under otherwise modified conditions.

To render, therefore, these vegetable treasures accessible to our fullest benefit, not only locally but universally, must ever be an object of the deepest significance. Increasing requirements of the human races and augmented insight into the gifts of nature render now a days quite imperative the closest appliances of science to our resources and our daily wants.

"*Omnia tellus optima ferat*!" has become the motto of our Acclimatisation Society; or let me quote from Virgil:—"*Non omnis fert omnia tellus, hic segetes, illic veniunt felicius uvae*." Striving to unite the products of many lands, it suffices for us nowhere any longer to discriminate among these resources with merely crude notions; but it becomes necessary to fix accurately, also, as far as plants are concerned, their industrial value, trace their origin, test their adaptability, investigate their productiveness, durability, qualities; and to reduce all these inquiries to a sound basis by assigning to any species that position in the phytologic system, by which it can be recognised by any one in any part of the globe. When the wants of phytography are satisfied we have to call to aid chemistry, therapy, geology, culture, microscopic investigation, pictorial art, and other branches of knowledge, to illustrate the respective value of the species, and the degree of its importance to any particular community. But in the discussions of one evening we can do no more than to touch succinctly only on a few of those vegetable objects most promising to our own colony for introduction, or most accessible among those indigenous here; we may glance on them, also, with a view of learning how their elucidation might practically be pursued, and the knowledge thus gained be diffused. To aid in the latter aim the phytologic section in the Industrial Museum is to be established; of the requirements of this section I shall say a few passing words.

The products and educts of the vegetable world are immense; any display of them in the order of science, as intended for this museum, roust carry with it a permanency of impressive instruction which any other modes of teaching, sure to be more ephemerous, fail to convey. But these efforts at diffusing knowledge should be seconded by means not inadequate to a great object, and should be worthy of the dignity and name of this rising country. Who would not like to see the best woods of every country stored up here in instructive samples—nearly a thousand kinds alone to choose from as far as our continent is concerned? Who would not wish to have here at hand for comparison the barks, exudations, grains, drugs, as raw material? Who would not desire to have ready access to a series of oils, whether pressed or distilled, whether from indigenous or imported plants? Who would not have it within his power to compare the starches, dyes, casts of our luscious fruits, or the paper-material, tars, acids, coals of various kinds, fibres, alkaloids, and other medicinal preparations from various plants?

Why not place here a series of all the weapons and implements, traced accurately to their specific origin? From such even in many instances we have learnt, through keen observations of the first nomadic occupants of the soil, the use of many kinds of wood. All these objects, crude or prepared in the multitudinous way of their adaptations, ought to be accompanied wherever necessary by full explanatory designations, microscopic sections, and other means of elucidation; while the periodic issue of descriptive indices, detailing still more copiously the derivation, uses, preparation, and monetary value of such objects, will enable us to serve the full intentions for which this museum section has been formed.

Lectures, however valuable, demonstrations, however instructive, cannot alone form the path of extensive industrial education; most minds indeed prefer to dwell tacitly on the objects of their choice, and muse quietly about the adaptability of any of them for operations or improvements in which they may be specially interested.

How many inventions have received their first impulse from an institution such as we wish to form! Investigators, eminent in their profession, will doubtless unite here, sooner or later, to bring to bear the sum of their knowledge, earned by a lifelong toil, for giving vitality to that information which is to enter guidingly into the ordinary purposes of life. Thus, the happiness and prosperity of our fellow-men should be en- hanced and exalted, and one of the loftiest objects of our striving after truths be fulfilled.

But the unassuming worker, conscious how far his own honest intentions advanced beyond his best results, may well exclaim with Moore, in his soft melodies:—

"Ah! dreams too full of saddening truth,

Those mansions o'er the main.
Are like the hopes I built in youth,
As sunny, and as vain!"

Let us first take a glance at one of our innumerable forest glens. We see in the deep rich detritus of rocks and fallen leaves, accumulated in past centuries, some of the grandest features of the world's vegetation. Fern trees

Alsophila Australis, R. Br.

rise, at least exceptionally, to a height of eighty feet, higher, therefore, than any in other parts of the globe, unless in Norfolk Island. Mammoth-Eucalypts abound, having in elevation rivals only in the Californian Sequoia Wellingtonia; we may, indeed, obtain from one individual tree planks enough to freight almost a ship of the tonnage of the "Great Britain." Todea Ferns, now sought in trade, occur in these recesses, weighing, deprived of their fronds, almost a ton; and if the Xanthorrhœas do resemble, as popularly thought, our once spear-armed natives, then the Todea stems bear certainly as justly a resemblance to large black bears, as has been comically contended. The Fan Palms,

Corypha (Livistona) Australis, R. Br.

though only occurring in East Gipps Land, within our territory, rank among the most lofty of the globe, though also among the most hardy. All this in our latitude seems astounding—but more, it demonstrates also great riches; and I allude to it here only because I wished to show how a vegetation so prodigious points to the facilities of a natural magnificent industrial culture. The complex of vegetation is always an indicator of the soil and climate; as such alone, plants deserve close study. In this instance it reveals untold treasures, and yet without phytographic knowledge they could never be understood, nor any intelligent appreciation of them be conveyed beyond the locality.

But can this grand picture of nature not be further embellished? Might not the true Tulip tree, and the large Magnolias of the Mississippi and Himalaya, tower far over the Fern trees of these valleys, and widely overshade our arborescent Labiatae?

Rhododendron arboreum attains a height of 30 feet, while Rh. Falconeri rises to 50 feet, with leaves half a yard long.

Might not the Andine Wax Palm, the Wettinias, the Gingerbread Palm, the Jubaea, the Nicau, the northern Sabals, the Date, the Chinese Fan-palms, and Rhapis flabelliformis, be associated with our Palm in a glorious picture? Or turning to still more utilitarian objects, would not the Cork tree, the Red Cedar, the Camphor tree, the Walnuts and Hickories of North America, grow in these rich, humid dales with very much greater celerity than even with all our tending in less genial spots? Could not, of 400 coniferous trees and 300 sorts of oaks, nearly every one be naturalised in these ranges, and thus deals, select tanning material, cork, pitch, turpentine, and many other products be gained far more readily there than elsewhere in Victoria, from sources rendered our own? Ought we not to test in these valleys how far the Sisso, the Sal, the Teak, may prove hardy, and as important here as our Blackwood and Eucalypts abroad? Or shall I enumerate all the ornamental woods for furniture, machinery, instruments, which from an endless array of genera and species might be chosen as introducable indeed from most lauds; many of these, perhaps, to find an asylum in our mountains before—like in St. Helena and other isolated spots—the remarkable and endemic trees are swept by man's destructive agency from the face of the globe? Shall I speak in detail of the trees which yield dyes, and many medicinal substances? If the Turkey Box tree should continue the best for the wood-engraver, it would in these valleys assume its largest dimensions. I do not hesitate in affirming that out of about 10,000 kinds of trees, which probably constitute the forests of the globe, at least 3000 would live and thrive in these mountains of ours; many of them destined to live through centuries, perhaps not a few through twice a thousand years, as great historic monuments. Within the railway fences, hitherto in this respect unused, trees might be raised as material for restoring locally the sleepers, posts, and rails, prior to their decay. The principles of physiology, the revelations of the microscope, and the results of chemical tests guide us, not only in our selection of the trees, but often teach us beforehand the causes and reasons of durability or decay.

The longevity of certain kinds of trees is marvellous. British oaks are estimated to attain an age of 2000 years. The Walnut tree, the Sweet Chesnut, and Black Mulberry tree, live through many centuries, if cared for. Wellingtonias are found to be 1100 years old. Even the South European Elm, which since the time of the Romans has also made Britain its home, is known to stand 600 years. Dr. Hooker regards the oldest Cedars yet existing at Mount Lebanon as 2500 years old. Historic records are extant of Orange trees having attained an age of 700 years, yet aged trees continue in full bearing under favourable circumstances; a single tree is said to have yielded in a harvest 20,000 oranges. Individual Olive trees are also supposed to have existed ever since the

Christian era. The European Cypress, the British Yew, the Ginkgo, and the Kauri afford other remarkable instances of longevity.

The Date Palm gratefully bears its rich crop of fruit for 200 years. The Dragon tree of Orotava is another familiar example of extraordinary longevity. Here, in Victoria, the Native Beech and several Eucalypts are veritable patriarchs of the forests, and of a far more venerable age than is generally supposed.

So much for the lasting of some of our work, to encourage planting operations.

If Cook, who stepped with the pride of an explorer on these shores precisely a century ago, could view once more the scene of his discoveries, he would be charmed by the sight of noble cities, and the happy aspect of rural industry; but he would turn his eyes in dismay from the desolation and aridity which a merciless sacrifice of the native forests has already so sadly brought about—a sacrifice arising from an utter absence of all thoughts for the future. Ever since antiquity this work of forest destruction has gone on in every country, until sooner or later such reckless improvidence has been overtaken by a resentful Nemesis, in hindering the progress of national prosperity, and the comfort of whole communities.

After lengthened periods of toil there partially arose, but partially only, what an early guardianship might have readily retained for most countries. When I largely shared in the labours of establishing for Australian trees a reputation abroad, I certainly did also entertain a hope to awaken here likewise a universal interest in the dissemination of an almost endless number of trees from the colder and subtropic girdles of the whole globe. (Vide Phil. Inst., 1858, p. 93-109.) A few scattered trees are of no national moment. We want the massive upgrowth of the Pitch Pines, just as on the Pine barrens of the United States; we want whole forests of the Deal Pines, both cis and transatlantic; we want overall our mountains the Silver Fir, already the charm of the ancients; we want the Australian Red Cedar, scarcely any longer existing in its native haunts; we want the Yarrah tree, forest-like as in West Australia; we want the various elastic Ash trees, which are so easily raised; we want, indeed, no end of other trees, because the greater part of Victoria is ill-wooded; because our climate is hot and dry; because extensive coal layers we have not yet found. What practical bearing can all the teaching in this hall, all the display in this museum, really exercise, if finally the artizan finds himself without an adequate and inexpensive material for his work? Annually the timber of 150,000 acres is cut away in the United States to supply the want for railway sleepers alone. The annual expenditure there in wood for railway buildings and cars is .£7,600,000. In a single year the locomotives of the United States consume £11,200,000 of wood. The whole wood industries of the United States represent now an annual expenditure of one hundred millions sterling. There 400,000 artisans are engaged alone in woodwork. Here in Victoria, notwithstanding the activity of many sawmills, we imported only last year timber to the value of £270,572 for our own use. As these remarks may find publicity, I have appended further notes on timber trees, eminently desirable for massive introduction, but do not wish to exhaust by details the patience of this audience.

But it would be vain to expect that Europe and America will continue for ever to furnish for us their timber. The constantly increasing population and the augmented requirements of advancing industries will render no longer yonder woods accessible also to us before the century passes, because even in those northern countries the timber supply will then barely satisfy local wants.

An idea may be formed of forest value when we enter on some calculations of the supply of timber or other products available from one of our largest Eucalyptus trees. Suppose one of the colossal Eucalyptus amygdalina at the Black Spur was felled, and its total height ascertained to be 480 feet, its circumference towards the base of the stem 81 feet, its lower diameter to be 26 feet, and at the height of 300 feet its diameter 6 feet. Suppose *only half* the available wood was cut into planks of 12 inches width, we would get, in the terms of the timber trade, 426,720 superficial feet at one inch thickness, sufficient to cover 93?4 acres. The same bulk of wood cut into railway sleepers, 6 feet x 6 inches x 8 inches, would yield in number 17,780. Not less than a length of 23 miles of three-rail fencing, including the necessary posts, could be constructed. It would require a ship of about 1000 tonnage to convey the timber and additional firewood of half the tree; and 666 drayloads at 11?2 tons would thus be formed to remove half the wood. The essential oil obtainable from the foliage of the whole tree may be estimated at 31 pounds; the charcoal, suppose there was no loss of wood, 17,950 bushels; the crude vinegar, 227,269 gallons; the wood tar, 31,150 gallons; the potash, 2 tons 11 cwt. But how many centuries elapsed before undisturbed nature could build up by the subtle processes of vitality these huge and wondrous structures!

Some feelings of veneration and reverence should also be evinced towards the native vegetation, where it displays its rarest and grandest forms. It is lamentable that in all Australia scarcely a single spot has been secured

On the River Hastings some magnificent dales have been lately protected by the Government of New South Wales for the sake of the incomparably beautiful and grand native vegetation, an example deserving extensive imitation. The forests of the Bunya Araucaria, occupying only a limited natural area, are also secured against in-rusion by the Government.

for preserving some relics of its most ancient trees to convey to posterity an idea of the original features of our primeval forests. Though it may appear foreign to my subject, I cannot withhold also on this occasion an imploring word, more particularly when I notice land-proprietors in East Australia to hold not even sacred a single native Banyan-tree, which required centuries for building its expansive dome and its hundreds of columnar pillars; nor to allow a single Cyrtosia Orchid to continue with its stem trailing to the length of thirty feet, and to remain with its thousands of large fragrant blossoms the pride of the forest. That very Cyrtosia gives a clue to the affinity and structure of other plants, not nearer to us than Java; and its destruction, with probably that of many others which the naturalist for ever is now prevented to dissect, or the artist to delineate, or the museum custodian to preserve, will be a loss to systematic natural history, also, for ever. Again, in a spirit of Vandalism, a Fan-palm, after a hundred years' growth, is no longer allowed to raise its slender stem and lofty crown in our own forests of Gipps Land, simply because curiosity is prompted to obtain a dishful of palm cabbage at the sacrifice of a century's growth.

Let it be remembered that the uncivilised inhabitants of many a tropical country know how to respect the original, and not always restorable gifts of a bountiful providence. They will invariably climb the Palm tree to obtain its nuts or to plait its leaves; so, also, a resident in our forests might obtain from a grove of our hardy palms, if still any are left in this land of Canaan, an annual income by harvesting the seeds as one of the most costly articles of horticultural export.

Speaking of palms, let me observe that the tall Wax-palm of New Granada (Ceroxlyon andicola) extends almost to the snow line. It is needless to add, that we might grow this magnificent product of Andine vegetation in many localities of the country of our own adoption. Each stem yields annually about 25 lb. of a waxy, resinous coating, which when melted together with tallow forms an exquisite composition for candles. Chamaerops Fortunei, a Chinese Fan-palm of considerable height, is here hardy, like in South Europe; so would be, probably, the Gingerbread Palm (Hyphaene Thebaica). Of the value of some palms we may form an appreciation when we reflect, that Elais Guineensis, which at the end of this century should be productive in Queensland and North-west Australia, yields from the fleshy outer portion of its nut the commercially famed palm oil, prepared much in the manner of olive oil; the value of this African palm oil imported in 1861 into England was two millions sterling, the demand for it for soap manufacture, and railway engines and carriages, being enormous.

The import of Palm Oil into Britain during 1868 was nearly a million cwt. (900,059 cwt.)

The Chilian Jubaea or Coquito Palm grows spontaneously as far south as the latitude of Swan Hill, and is rich in a melliginous sap.

Each tree yields 90 gallons of sap at a time, used for the preparation of palm-honey.

A Date palm planted now would still be in full bearing 200 years hence.

When hopeful illusion steps beyond the stern realities of the day, it cannot suppress a desire that enlightened statesmanship will always wisely foresee the absolute requirements of future generations. The colonist who lives in enjoyment of his property near the ranges and sees a flourishing family growing up around him, asks ominously what will be the aspect of these forests at the end of the century, if the present work of demolition continues to go on? He feels that though the forests not solely bring us the rain, through forests only a comparatively arid country can have the full advantage of its showers, as bitter experience has taught generation after generation since Julius Cæsar's time. The colonist reflects with apprehension, that while no year nor day when passed into eternity can be regained, no provision whatever is made for the coming population, in whose welfare, perhaps as the head of a family, and perhaps even bearing political responsibility, he is interested. He would gladly co-operate in the labours of a local forest board, just like members of road boards and shire councils enter cheerfully on the special duties allotted to their administration. His local experience would dictate the rules under which in each district the timber and other products of the forest could be most lucratively utilised without desolation for the future; and he would be best able to judge, and to seek advice how the yield of the forest could be advantageously maintained, and its riches methodically be increased. All this will weigh more heavily on his mind when he is cognisant that even in Middle Europe, in countries so well provided with coals, and of a much cooler clime than ours, the extent of the forests is kept scrupulously intact, and their regular yield remains secured from year to year and from century to century. He would rest satisfied if only the trifling revenue of the forests could be applied by him and his neighbours to an inexpensive restoration of the woods consumed. He would delight in seeing the leading foreign timber trees disseminated with our own Red Gum tree, Red Cedars, Yarrahs, or Black woods, not by hundreds but in time to come by millions, well aware that the next generations may either censure reproachfully the shortcomings of their ancestors, or may point gratefully to the results of an earnest and well-sustained foresight of future wants. As a first step, at least in each district a few square miles should be secured for subsequent forest nurseries in the best localities, commanding irrigation by gravitation, and ready access also, before it is too late, and all such spots are permanently alienated from the Crown.

Physical science must yet largely be called to our experimental aid before we can dispel the many crude notions in reference to the effect of forest vegetation on climate in all its details. It is thus a startling fact, as far as experiments under my guidance hitherto could elucidate the subject, that on a sunny day the leaves of our common Euealypts and Casuarinas exhale a quantity of water several times, or even many times, larger than those of the ordinary or South European Elm, English Oak, or Black Poplar; while from the foliage of our native Silver Wattle only half, or even less than half, the quantity of water is evaporated than from the Poplar or Oak. This degree of exhalation, so different in various trees, depends on the number, position, and size of their stomata, and stands in immediate correlation to the power of absorption of moisture. Besides, if the evaporation of Eucalyptus trees is so enormous during heat, and if the often horizontal roots of these trees thus render soil around them very dry, in consequence of the copious conveyance of moisture to the air, they simultaneously, by the rapidity of their evaporation in converting aqueous to gaseous liquid, or water into vapour, cause a lowering of the temperature most important in our climate during the months of extreme heat, while their capability of absorbing moisture during rain or from humid air must be commensurately great.

It is beyond the scope of this address to dwell further on facts like these; but I was anxious to demonstrate by a mere example how much we have yet to learn by patient research before we will have recognised in all its details the important part which forest vegetation plays in the great economy of nature. Concerning forest culture, I would very briefly allude to an instance showing how by the teachings of natural science and thoughtful circumspection the rewards of industrial pursuits may become surprisingly augmented. In the uplands of the Madras Presidency an ingenious method has been adopted in gathering the harvest of Cinchona bark, in recent very extensive plantations, by removing it in strips without destroying the cambium layer. Then by applying moss to the denuded part of the stem, not only is the removed portion of the bark renewed within a year to the thickness of three years' growth, but the protection of the tender bark against the influence of light and air allows nearly all the quinine and other alkaloids to remain retained in the cortical layer without decomposition, while in the ordinary three years' bark half or more of these principles is lost.

Facts like these lead us to appreciate the important bearings of the natural sciences on all branches of industry; but they warn us also to pause before we give our further consent to the unlimited and reckless demolition of our most accessible forest lauds, on the maintenance of which so many of our industries depend.

Just as it required, even under undisturbed favourable influences, centuries before our forest riches were developed to their pristine grandeur, so it will need, in the ordinary laws of nature, at least an equal lengthened period before we can see towering up again the sylvan colosses, which eminently con- tributed to the fame of the natural history of this land—if, indeed, the altered physical condition of the country will render the restoration of the trees on a grand scale possible at all.

Has science drawn in vain its isothermal girdles around the globe, or has the searching eye of the philosopher in vain penetrated geologic structure, or in vain the exploring phytographer circumscribed the forms? Well do we know what and where to choose; botanic science steps in to define the objects of our choice, which other branches of learning teach us to locate and rear.

The Tea would as thriftly luxuriate in our wooded valleys as in its native haunts at Assam, and yield a harvest far more prolific than away from the ranges. Indeed, we may well foresee that many forest slopes will be dotted in endless rows with the bushes of the Tea, precisely as our drier ridges are verdant with the vine. Erythroxylon Coco, the wondrous stimulating plant of Peru, should be raised in the mildest and most sheltered forest glens, where the stillness of the air excludes the possibility of cutting frosts. Hop, cultivated as a leading industry in Tasmania since a quarter of a century, will also take a prominent place on the brooks of our mountains. Peru Bark trees of various kinds should in spots so favoured be subjected to culture trials. How easily could any swampy depression, not otherwise readily of value, be rendered productive by allowing plants of the handsome New Zealand flax lily quietly to spread as a source for future wealth. How far the demand of material for industrial purposes may quickly exceed the supply may be strikingly exemplified by the fact, that hundreds of vessels are exclusively employed for bringing the Esparto grass (not superior to several of our most frequent sedges) from Spain to England, to augment the supply of rags for the endless increasing requirements of the paper mills. Conversion of manifold material, even sawdust, into paper is carried on to a vast extent; a multitude of samples placed here before you will help to explain how wide the scope for paper material may extend. But the factories want material, not only cheap, but readily convertible, and adapted to particular working.

In all these selections, a few glances through the microscope, and the result of a few chemical reactions taught in this hall, may at once advise the artisan in his choice.

Phytologic enquiry is further to teach us rationally the nature of maladies to which plants are subject, just as it discloses even the sources of many of the most terrific and ravaging diseases of which the human frame is the victim. The microscope, that marvellous tool for discovery, has become also the guardian of many an industry. The procesess of morbid growth, or the development and diffusion of the minute organism, between which descriptive botany knows how to discriminate, are thus traced out as the subtle and insidious causes which at times involve losses that count by hundreds of thousands in a single year, even in our yet small communities. But while the microscope discloses the form and development of the various minute organisms which cause, through the countless numbers of individuals, at times the temporary ruin of main branches of rural industry, it leaves us not helpless in our insight how to vanquish the invaders. In correctly estimating the limits of the specific forms, calling forth or concomitant with some of the saddest human maladies, phytography shares in the noble aim of alleviating human sufferings, or restoring health and prolonging vital existence.

But it comes most prominently within the scope of this industrial museum to delineate for the agricultural and forest section, in explanatory plates, the morbid processes under which crops and timber may succumb, and an industry be paralyzed or a country be verily brought to famine; it devolves on us, also, simultaneously to explain the effect of remedial agents, such as sound reasoning from inductive science suggests or confirms. To array samples of all field products which our genial clime allows us to raise is doubtless the object of an instructive institution, more particularly in a young country, to which immigration streams mainly from a colder zone; but this display of increased capabilities, and of more varied products of a mostly winterless land, may entice the inexperienced to new operations without guarding him against failures. I should even like to see tables of calculations in this museum, from which could be learnt the yield and value of any crop within a defined acreage and from a soil chemically examined; but from this I would regard inseparable a close calculation of the costs under which each particular crop can only be raised. Unfortunately, surprising data are often furnished concerning the productiveness of new plants of culture; but it is as frequently forgotten, that the large yield is as a rule dependent on an expenditure commensurately large.

Among the most powerful means for fostering phytologic knowledge for local instructive purposes, that of forming collections of the plants themselves remains one of the foremost. No school of any great pretension should be without a local collection of museum plants, nor should any mechanics' institute be without such. It serves as a means of reference most faithfully; it need not be a source of expenditure; it might be gathered as an object of recreation; it may add even to the world's knowledge. Through the transmission of numbered duplicate sets of plants to my office the accurate naming may be secured.

Parcels of plants pressed and dried, and afterwards closely packed, can be inexpensively forwarded by post, and by the excellence of the Australian postal arrangements can be sent from distant stations of the interior, from whence botanical specimens of any kind, for ascertaining the nature and range of the species, are most acceptable; while full information on such material will at once be rendered.

From such a normal collection in each district the inhabitant may learn to discriminate at once with exactness between the different timber trees, the grasses, the plants worthy of ornamental culture, or any others possessing industrial or cultural interest. The sawyer, as well as the trader in timber, may learn how many of the 140 Australian Eucalypts occur within his reach—how phytography designates each of them by a specific appellation acknowledged all over the globe. Phytologic inquiry, aided by collateral sciences, will disclose to him beforehand the rules for obtaining the wood at the best seasons, for selecting it for special purposes, for securing the best preservation. Phytochemistry will explain to him what average percentage of potash, oils, tar, vinegar, alcohol, tannic acid, &c., may be obtained under ordinary circumstances from each. He will understand, for instance, that the so-called Red Gum tree of Victoria, the one so famed for the durability of its wood and for the peculiar medicinal astringency of its gum resin, is widely different from the tree of that vernacular named in Western Australia; that it is wanting in Tasmania, yet that it has an extensive geographic range over the interior of our continent; and that thus the experiences gained on the products of this particular species of tree by himself or others are widely applicable elsewhere. Through collections of these kinds the thoughtful colonist may have his attention directed to vegetable objects of great value in his own locality, of the existence of which he might otherwise not readily become aware. New trades may spring up, new exports may be initiated, new local factories be established. Phytographic works on Australian plants, now extant in many volumes, can readily be attached and rendered explanatory of such collections. A prize held out by the patrons of any school might stimulate the juvenile gatherer of plants to increased exertions; his youthful mind will be trained to observation and reflection, and the faculties of a loftier understanding will be raised.

To the adult also, and particularly often to the invalid, new sources of enjoyment may thus be disclosed. What formerly was passed by unregarded, will have a meaning; every blade over which he stepped thoughtlessly before will have a new interest; and even what he might have admired will gain additional charm; but while penetrating wonders he never dreamt of before he ought piously to ask who called them forth?

"Bright flowers shall bloom wherever we roam,
A voice divine shall talk in each stream;

The stars shall look like worlds of love,
And this earth shall be one beautiful dream."

—*Thos. Moore's Irish Melodies*.

What one single plant may do for the human race is perhaps best exemplified by the Cotton plant. The Southern States of North America sent to England in 1860 nearly half a million tons of cotton (453,522 tons), by which means, in Britain alone, employment was given to about a million of people engaged in industries of this fabric, producing cotton goods to the value of £121,364,458. From Rice, which like the Cotton will mature its crop in some of the warmer parts of Victoria,

Particularly if the hardy mountain Rice of China and Japan is chosen, which requires no irrigation. The ordinary rice has been grown as far north as Lombardy.

sustenance is obtained for a greater number of human beings than from any other plant. In the greater part of the Australian continent, wherever water supply could be commanded, the Rice would luxuriate. I found it wild in Arnheim's Land in 1855. Of Sugar Cane the hardier varieties may within Victoria succeed in East Gipps Land, and other warmer spots. Great Britain imported in 1863 not less than 586,600 tons.

The total import of Sugar into Britain was—

Even our young colony imported last year to the value of nearly a million sterling (£948,329). Think of the commerce in other vegetable products, such as require in different places our local fostering care in order to add still more to our resources. Of various Tobaccoes we imported into Victoria in 1869 (deducting exports) to the value of £83,788; of Wine, £84,687; of Cereals, £781,250; of Paper, £123,158. I will not enter on any remarks about Sugar-beet, on which one of our fellow-colonists has lately compiled an excellent treatise. Of Tea, in 1865 Britain required for home consumption eighty-five millions of lbs.

The total import of Tea into Britain was—

What a prospect for tea growth in Victoria, where this bush cares neither for the scorching heat of the summer nor for the night-frosts of our lower regions; whereas in the forest glens of our country, Tasmania, and elsewhere, the Tea-bush would yield most prolific harvests. Test plantations for manifold new cultures were recommended by me years ago in one of my official reports to the Legislature; one plantation for the desert, one for subalpine regions, one for the deep valleys of the woodlands. The two latter might be in close vicinity at the Black Spur, and thus within the reach of ready traffic. The outlay in each case would be modest indeed. What an endless number of new industrial plants might thus be brought together within a few hours' drive of the city, under all the advantages of rich soil, shelter, and irrigation! What an attractive collection for the intelligent and studious might thus be permanently formed.

I will not weary this audience by giving a long array of names of any plants resisting alpine winters, such as in our snow-clad higher mountains they would have to endure. We know that the Apple will live where even the hardy Pear will succumb; both will still thrive on our alpine plateaus. The Larch, struggling in vain with the dry heat of our open lowlands, would be a tree of comparatively rapid growth near alpine heights. The Birch, in Greenland the only tree, in Italy ascending to 6000 feet, in Russia the most universal, and there yielding for famed tanning processes its valued bark, is living—to quote the forcible remarks of an elegant writer—"is living on the bleak mountain sides from which the sturdy Oak shrinks with dismay." Add to it, if you like, the Paper Birch, and a host of arctic, Andine, and other alpine trees and bushes. Disseminate the Strawberries of the countries of our childhood, naturalise the Blackberry of northern forest moors. The American Cranberry-bush (Vaccinium macrocarpum), with its large fruits, is said to have yielded on boggy meadows, such as occupy a large terrain of the Australian Alps, fully one hundred bushels on one acre in a year, worth so many dollars. If once established, such plant would gradually spread on its own account for the benefit of future highland inhabitants. The Sugar Maple would seek these cold heights, to be tapped when the winter snow melts. For half a century it will yield its saccharine sap, equal to several pounds of sugar annually.

Let us translocate ourselves now for a moment to our desert tracts, changed as they will likely be many years hence, when the waters of the Murray River in their unceasing flow from snowy sources will be thrown over the back plains, and no longer run entirely into the ocean, unutilised for husbandry. The lagoons may then be lined, and the fertile depressions be studded, with the Date Palm; Fig trees, like in Egypt planted by the hundreds of thousands to increase and retain the rain, will then also have ameliorated here the clime; or the White Mulberry Tree will be extensively extant then instead of the Mallee scrub; not to speak of the Vine in endless variety, nor to allude to a copious culture of Cotton in those regions. To Fig trees and Mulberry trees I refer more particularly, because it must be always in the first instance the object to raise in masses those utilitarian plants which can be multiplied with the utmost ease and without special skill, locally, and which, moreover, as in this case, would resist the dry heat of our desert clime. When recommending such a culture for industrial pursuits, it is not the aim to plant by the thousand but by the million. Remember, also, that a variety of the Morus Alba occurs in Afghanistan, with a delicious fruit; and that the importation of Figs into Britain alone, from countries in climate alike to large tracts of Victoria, has been of late years about one thousand tons annually. What the Fig tree has effected for rainless tracts of Egypt is now on historic record.

I have spoken of horticultural industries as not altogether foreign to this institution—indeed, as representing a rising branch of commerce. Were I to enter on details of this subject the pages of this address might swell to a volume. But this I would mention, that in our young country the manifold facilities for rearing exotic plants in specially selected and adapted localities could only as yet receive imperfect consideration. We have, however, ample opportunities of selecting genial spots for the growth of such singular curiosities as the Flytrap plant (Dionæa Muscipula) and the Pitcher plants (Sarracenias) of the bogs and swamps of the pine barrens and savannahs of Carolina, if we proceed to moory portions of our springy forest land. There is no telling, too, whether the Pitcher plants of Khasya and China (species of Nepenthes) could not readily be grown and multiplied in similar localities, and the hardier of grand Epiphytes among the orchids, such as the subalpine Oncidium Warczewickyi) of Central America, which might readily be reared in our glens by horticultural enterprise, together with all the hardier Palms which modern taste has so well adopted for the ready decoration of dwelling rooms.

Such plants as the Beaucarnea recurvata of Mexico, with its 5000 flowers in a single panicle, and the hardier Vellozias from the bare mountain regions of Brazil, would endure our open air; while the innumerable South African heaths, Stapeliæ, the Mesembryanthema, Pelargonia, lily-like plants, and many others, once the pride of European conservatories, can with increased sea traffic now gradually be introduced as beautiful objects of trade into this country, where they need no glass protection. It leads too far to speak of the still more readily accessible numerous showy plants of South-west Australia, but among which, as a mere instance, the gorgeous Anigozanthi, the lovely Stylidia, the gay Banksiæ, and the fragrant Boronias may be mentioned.

Before leaving this topic, I may remind you that many esculent plants of foreign countries are deserving yet of test culture, and, perhaps, general adoption in this country. The Dolichos sesqnipedalis of South America is a bean, cultivated in France on account of its tender pod. The Arracha esculenta, an umbellate from the cooler mountains of Central America, yields there, for universal use, its edible root. The climbing Chocho of West India (Sechium edule) proved hardy in Madeira, and furnishes a root and fruit both palatable and wholesome. Vigna subterranea is the Earth Nut of Natal. The Tara of Tahiti (Calocasia macrorrhiza), though perfectly enduring our lowland clime, is as yet, with allied species, but little cultivated—neither the Soja of Japan (Glycine Soja), nor the Caper of the Mediterranean. The Sea-kales (Cratnbe Maritima and C. Tatarica) might be naturalised on our sandy shores.

Regarding fibres, much yet requires to be effected by capitalistsand cultivators to turn such plants as the Grasscloth shrub, which I distributed for upwards of a dozen years, to commercial importance for factories. A kind of Jute (Corchorus olitorius) succeeds as far north as the Mediterranean, and grows wild with the Sunn Hemp (Crotalaria juncea) in tropical Australia; the latter plant conies naturally almost to the boundaries of our colony. A Melbourne rope factory offers £30 for the ton of New Zealand Flax, and can consume six tons per week. Hemp, used since antiquity, produces along with its fibre the Hypnotic Churras. England imported in 1858 Hemp to the value of more than one million pounds.

The import of Hemp and Jute into Britain during 1868 was 3,281,268 cwt.; during 1869, 3,551,838 cwt. The undressed Hemp imported in 1868 was valued at £2,022,419.

This may suffice to indicate new resources in this direction. For Sumach our country offers in many places the precise conditions for its successful growth, as I confirmed by actual tests. Tannic substances, of which the indigenous supply is abundant and manifold, would assume still greater commercial importance by simple processes of reducing them to a concentrated form. How on any forest river might not the Filbert tree be naturalised; on precipitous places, among rocks, it would form a useful jungle, furnishing, besides its nuts, the material for fishing-rods, hoops, charcoal crayons, and other purposes. From a single forest at Barcelona 60,000 bushels are obtained in a year. (For these and many other data brought before you in this lecture you may refer further, most conveniently, to a posthumous work of the great Professor Lindley, *Treasury of Botany*, edited by Mr. Th. Moore, with the aid of able contributors.) Even the Loquat would attain in our forest glens the size of a fair, or even large tree.

Osiers and other willows used for basket work, for charcoal, or for the preparation of salicine, might line any river banks, quite as much for the sake of shade and consolidation of the soil as for their direct utilitarian properties. In the forest ranges any dense line of Willows and Poplars will help to check the spread of the dreadful conflagrations in which so much of the best timber is lost, and through which the temperature of the country is for days heightened to an intolerable degree far beyond the scenes of devastation, while injuries are inflicted far and wide to the labours in the garden or the field. In the most arid deserts the medicinal Aloes might readily be established, to yield by a simple process the drug of commerce. Gourds of half a hundredweight have been obtained in Victoria, and show what the plants of the Melon tribe might do here, like in South Africa, for eligible spots in the desert land. Among the trees for those arid tracts, the glorious Grevillea robusta, with its innumerable trusses of fiery red and its splendid wood for staves, is only one of the very many desirable; just as in the oases the Carob tree will live without water uninjured, because its deeply-penetrating roots render it fit to resist any drought. But it may be said that much that I instance is well known and well recorded—so, doubtless, it is, in the abstract—but variety requires to be distinguished from variety, species from species, and their geography, internal structure, and components need carefully be set forth, before any industry relating to plants can be raised on sound ground in proper localities, and be brought to its best fruitfulness.

Even a pond, a streamlet—how, with intelligent foresight, may it be utilised and rendered lucrative to industry! The "Water Nuts,

Several species of Trapa.

naturally distributed through large tracts of Europe and Asia, afford at Cashmere alone for five months in the year a nutritious and palatable article of food to 30,000 people. Can the Menyanthes not be made a native here—one of the loveliest of water plants, one of the best of tonics? The true Bamboo, which I first proved hardy here, used for no end of purposes by the ingenious Chinese—can we not plant it here at each dwelling, at each stream, a grateful yielder to industrial wants, not requiring itself any care, an object destined to embellish whole landscapes? An Arundinaria Bamboo from Nepal (A. falcata) proved very tall and quite hardy even in Britain; and yet taller is the Mississippi Arundinaria (A. macrosperma)—indeed, rivalling in height the gigantic Chinese or Indian Bamboo.

Imagine how there might arise on the bold rocky declivities of the Grampians the colossal columns of the Cereus gigan-teus of the extra-tropic Colorado regions—huge candelabras of vegetable structure, which would pierce the roof of our museum hall if planted on the floor, and would be as expansive in width as the pedestal of the monument consecrated to our unfortunate explorers. Picture to yourselves an Echino-cactus Visnago of New Mexico, lodged in the wide chasm of our Pyrenees, one of these monsters weighing a ton, and expanding into a length of nine feet, with a diameter of three feet. Think of such plants mingled with the Canarian Dragon tree, one of which is supposed to haw lived from our Redeemer's time to this age, because four centuries effected on these Giant Lilies but little change. Welwitchia here, like in rainless Damaralaud, might grow in our desert sands as one of the most wonderful of plants, its only pair of leaves being cotyle-donous and lasting well-nigh through a century. Or associate in your ideas with these one of the medicinal Tree Aloes of Namaqua, or one of the Poison Euphorbias, never requiring pluvial showers (Euphorbia grandidens), some as high as a good-sized two-storeyed dwelling-house; transfer to them also Cereus senilis, thirty feet high, which with all its attempts to look venerable only succeeds to be grotesque; add to these extraordinary forms such Lily trees as the Fourcroya longæva, with a stem of forty feet and an inflorescence of thirty feet, whereas Agave Americana, Agave Mexicana and allied species, while they quietly pass through the comparatively short space of time allotted to their existence, weave in the beautiful internal economy of their huge leaves the threads, which are to yield the tenacious Pita cords, so much in quest for the rope bridges of Central America.

Some of the Echinocacti extend as far south as Buenos Ayres and Mendoza, and would introduce into many arid tracts of Victoria, together with the almost numberless succulents of South Africa, a great ornamental attraction, which horticultural enterprise might turn to lucrative account; just like our native showy plants will yet become objects of far higher commercial importance, than hitherto has been attached to them. The columns of Cereus Peruvianus rise sometimes to half a hundred feet; some Cacteæ are in reality the vegetable fountains of the desert. Such plants as Echinocactus platy-ceras, with its 50,000 thorns and setæ, should be cultivated in our open grounds for horticultural trade, whereas the Cochineal Cacti (Opuntia Tuna, O. coccinellifera and a few other species), might well be still further distributed here, in order that food may be available for the Cochineal insects when other circumstances in Australia will become favourable for the local production of this costly dye.

These are a lew of the many instances which might be adduced to demonstrate how the landscape pictures of Victoria might be embellished in another century, and new means of gain be obtained from additional manifold resources.

But while your thoughts are carried to other zones and distant lands, let us not lose sight of the reason for which we assembled, namely, to deal with utilitarian objects and the application of science thereon. All organic structure, however, whether giants or pygmies, whether showy or inconspicuous, have their allotted functions to fulfil in native, are destined to contribute to our wants, are endowed with their special properties, are heralding the greatness of the Creator. But here in this hall I would like to see displayed by pictorial art the most majestic forms in nature, were it only to delineate for the studious the physiognomy of foreign lands, irrespective of any known industrial value of the objects thus sketched. The painter's art in choosing from nature does impress us most lastingly with the value and grandeur of its treasures. Each plant, as it were, has a history of discovery of its own; who would not like to trace it? And this again brings us face to face with those who carried before us the torch of scientific inquiry into the dark recesses of mystery, and shed a flood of light on perhaps long-concealed magnificence and beauty. The youth, aroused to the sublime feeling of wishing at least to follow great men in independent researches, may be animated, if in a hall like this each division were ornamented with the portraits of the foremost of those discoverers, who through ages advanced knowledge to the standard of the present day.

"Deeds of great men all remind us
We can make our lives sublime,
And departing leave behind us
Footprints on the sands of time.

"Though oft depressed and lonely,
Our fears are laid aside,
If we remember only
Such also lived and died.

"Learn from the grand old masters,
Or from the bard sublime,
Whose distant footsteps echo
Through the corridor of time."

LONGFELLOW.

Discovery proceeds step by step. Commenced by original thinkers, enlarged by sedulous experimenters, fostered by the thoughtful portion of the community, and by any administration of high views, it is utilised by well-directed enterprise, and marches onward steadily in its progress. Gutten-berg and his collaborators gave us the printing art, which has done more to enlighten the world than all other mechanisms taken together; and though four centuries have altered much in the speed and cost of producing prints, they have not materially changed the forms of this glorious art, as the beautifully-decorated pages of the earliest printed bibles testify. Thus we have reason to be yet daily grateful for this invaluable gain from the genius of days long passed.

Thoughtless criticism is but too often impatient of success, and demands results premature and unreasonable. Incompetent and perversive censure may even carry the sway of public opinion—misleading, and misled; and still worse organised tactics may apply themselves, for sinister purposes of their own, to disturb the quiet work of the discoverer, mar the results of his labours, or paralyse the vitality of research, not understanding, or not wishing to understand, its direction or its object.

And yet, should we have no faith in science, whether it reveals to us the minutest organisms in a perfection unalterable,

As an instance of the marvellous complexity, and yet exquisite perfection of the minutest creatures, the organ of vision in insects may be adduced. Most careful observers have ascertained that the eyes of very many insects are compound, contain numerous eyelets; each of these provided with a distinct cornea, lens, iris, pupil, and a whole nervous apparatus. In our despised ordinary house fly may be counted about 4000 of these most subtle instruments of vision; in some dragon flies about 12,000. Reliable microscopists have counted even 17,355 in a kind of butterfly, while in the beetle genus mordella these most delicate eyelets have been found to rise to the almost incredible number of 25,088.—*(From Th. Rym. Jones.)*

or the grandest doctrines of truth, sure ever to bear on human happiness and the peace of our soul; should we have no faith in science, whether it unravels the metallic treasures of the depth and the coals of the forests of bygone ages, or by eternal laws permits us to trace the orbits of endless celestial worlds through space; no faith, if it allows us through spectroscopic marvels to count unerringly the billions of oscillations of each ray of dispersed light within a second; or if it discloses the chemism of distant worlds, and therewith an applicability of research, both tellurial and sidereal, ever endless and inexhaustible. Science, as the exponent of Godlike laws, draws us in deepest veneration to the power divine. That is true science!

"As into tints of sevenfold ray
Breaks soft the silvery shimmering white;
As fade the sevenfold tints away,
And all the rainbow melts in light;
So from the Iris sportive call
Each magic tint the eye to chain,
And now let truth unite them all,
And light its single stream regain."

—*Bulwer Lytton, from Schillcr*.

If a series of experiments with colouring principles from coal tar and bituminous substances led to the invention of the brilliant anilin colours, and brought about an almost total change in many dye processes, how many new wonders may not be disclosed to technology by the rapid strides of organic chemistry? As is well-known, three or four chemic elements are only engaged in forming numberless organic compounds, by a slight increase or decrease or rearrangement of the atomic molecules, constructing, for instance, from these three or four elements, ever present and ever attainable, the deadly Hydrocyanic Acid, the terrible Atropin, or the dreadful Aconitin at one time; or at another time, harmless Ammonia combinations universally used for culinary and other purposes of daily life. Our wood-tars, we may remember, are left as yet almost unexamined as regards their chemic constituents. Few of our timbers have been chemically analysed; few other of our vegetable products are as yet accurately tested. What an endless expanse for exploration does organic chemistry thus offer us! We are called on, among a thousand things, to trace out similar mutual relation and counteraction of such extremely powerful plants as the Belladonna and Calabar Bean. Here medicine, chemistry, and phytology, go hand in hand. How, again, is any analysis of the chemic constituents of any plant, for cultural purposes or otherwise, to be applied, unless we command a language of phytographic expressions, which will name with never-failing precision the object before us, and give to its elucidation value and stability?

We may speak chemically of potash plants, lime plants, and so forth; we may wish to define thereby the direction of certain industrial pursuits, and we may safely thereby foretell what plants can be raised profitably on any particular soil or with the use of any particular manure; but how is this knowledge to be fixed without exact phytologic information, or how is the knowledge to be applied, if we are to trust to vernacular names, perplexing even within the area of a small colony, and useless, as a rule, beyond it? Colonial Box trees by dozens, yet all distinct, and utterly unlike Turkey Box; colonial Myrtle, without the remotest resemblance to the poet's myrtle; colonial Oaks, analogous to those Indian trees, which as Gasuarinai were distinguished so graphically by Rumpf already 200 years ago, but without a trace of similarity to any real oak—afford instances of our confused and ludicrous vernacular appellations. A total change is demanded, resting on the rational observations and deductions which science already has gained for us. Assuredly, with any claims to ordinary intelligence, we ought to banish such designations, not only from museum collections, but also from the dictionary of the artisan.

One of the genera of Mushrooms, certainly the largest of them (Agaricus), contains alone about a thousand species well distinguished from each other, a good many even occurring in this country. For the practical purposes of common life it becomes an object to distinguish the many wholesome from the multitude of deleterious kinds, or the circumstances under which the harmless sorts may become hurtful. In France the cultivation of mushrooms in underground caverns has become a branch of industry not altogether unimportant. How, in other instances, is many a culinary vegetable to be distinguished from the poison herb without the microscope of the phytographer being applied to dissections, or without the language of science recording the characters? How many a life, lost through a child's playfulness, or through the unacquaintance of the adult even with the most ordinary objects of knowledge among plants, might have been saved, even in these times of higher education, if phytologic knowledge was more universal? The species of fungi, which can be converted into pleasant, nutritious food are far more numerous than popularly supposed, but for extending industries in this direction botanic science must assume the guardianship. In a technologic hall like this, I should like to see instructive portraits also of all the edible and noxious plants, likely to come within the colonist's reach.

Among about one thousand kinds of Fig-trees which, (so Mons. Alphonse de Candolle tells me) through Alons. Bureau's present writings for the Prodromus, are ascertained to exist, only one yields the fig of our table, only one forms the famed Sycamore fig, planted along so many roads of the Orient; only one constitutes our own Ficus macrophylla, destined, in its unsurpassed magnificence, to overshade here our pathways. How are these thousands of species of Ficus, all distinct in appearance, in character, and in uses—how are they to be recognised, unless a diagnosis of each becomes carefully elaborated and recorded, headed by a specific name?

Without descriptive botany, all safe discrimination becomes futile. To bear our share in building up an universal system of specific delimitation of all plants is a task well worthy of the patronage of an intelligent and high-minded people. The physician is thereby guided to draw safe comparisons in reference to the action of herbs and roots which he wishes to prescribe, as available from native resources. Thus it was through Victorian researches, that not only the close affinity of Goodeniaceæ to the order of Gentianeæ was brought to light, but simultaneously a host of herbs and shrubs of the former order gained for therapeutic uses. When once it was ascertained that the so-called Myrtletree of our forest moors was a true Beech, the artisan then also found offered to him a timber of great similarity to that of the beech forests of his British home.

Of the grass genus Panicum, we know the world possesses, according to a recent botanic disquisition, about 850 species, all more or less nutritive. But one only of these is the famous Coapin of Angola (Panicum spectabile), one the Warree (Panicum miliaceum), one the Bhadlee (Panicum pilosum), one the Derran (P. frumentaceum). We might dispense perhaps, as far as these few are concerned, with their scientific appellations, though not even the mere task of naming has become therewith easier, and no information whatsoever of their characteristics has been gained. But if we wish to refer to any of the many hundred other species of Panicum, in what way are we to express ourselves if even their vernacular names could be collected from at least a dozen of languages, and impressed on any one's memory? They are, as may readily be imagined, very different indeed in their special nutritiveness, degree of endurance, and length of life. Of 140 species of Bromus, only one is the Prairie Grass, which attained already a great celebrity as a pasture grass naturalised in this country; and it is only one other Bromus, among the many nutritious kinds, which carries the palm as the most fattening fodder grass for cold, marshy pastures, and gradually, through depasturing, surpresses completely all other grasses and weeds; so it is proved on the marshlands of Oldenburg. This Bromus (B. secalinus), as far as I am cognisant, is nowhere as yet economically cultivated in Victoria.

Nothing would be easier than to commence disseminating a number of the best grasses in addition to those already here; for instance, the Canadian Rice Grass (Hydropyrum esculentum) for our swamp lands. Their nutritive value must be tested by analysis and other experiments, just like that of the Saltbushes of the Murray Flats. Hence ample scope for the exertions of science also in this direction.

In Cotta's celebrated publishing establishment at Stuttgart, a most useful work is issued by my friend, Prof. Noerdlinger, on the structure of timber of various kinds, illustrated by microscopic sections of the wood itself; for the latter fascicles I furnished some material from this colony. The work should be accessible in this museum to all interested in wood work.

How much we have yet to learn of the value of our forest products is instanced when we now know from Spanish physicians to combat ague with Eucalyptus leaves, or when Count Maillard de Marafy, from experiments instituted this year in Egypt, announced to us that Eucalyptus leaves can be used as a substitute for sumach. (Egypte Agricole, 1870.)

Already in the earlier part of this lecture I spoke of the Peru Bark Plants; but the Cinchonas are not all of the same kind. Some endure a lower degree of temperature than others, some are richer in quinine, others richer in cinchonine, others in quinoidine; and this again is much subject to fluctuations under different effects of climate and soil. Great errors may be committed, and have been committed, by adopting from among a number of species the least valuable, or one under ordinary circumstances almost devoid of alkaloid, though a representative of the genus cinchona, and not unlike the lucrative species. When calculations in India prognosticate the almost incredible annual return of 130 per cent, after four years on the original outlay for Cinchona plantation, it is supposed that the conditions for this new industrial culture are to the utmost favourable. That one of the best species did not thrive there at all in proportion to expectations, is owing, in my opinion, to geologic conditions. The cinchonas before you, reared in soil from our Fern tree gullies, I intended to have tested for the percentage of their alkaloids prior to this evening; but the timely performance of this investigation was frustrated. I think, that I have proved the hardiness or adaptability of these important plants for the warm Palm valleys of East Gipps Land, as many indigenous plants from that genial spot are quite as much, if not more, susceptible of the night frosts of our city than the Cinchonaæ, if harsh cutting winds are kept from the latter. But as yet I am unacquainted with the likely results of remunerative Cinchona cultivation within the boundaries of this colony, as far as such depends on the constituents of the soil. That inquiries of this kind are not mere chimeras, may be conceded after an explanation of this kind for the benefit of future technology. Geology, one of the brightest satellites which rotate around the sun of universal science, continues to send its lustre into the darkness which yet involves so many of the great operations in tellurian nature. Further insight into the relation of this discipline of science to vegetable physiology is certain to shed abundance of light also on many branches of applied industry. The causes why the Ironbark trees of our auriferous quartz ridges differ so materially from the conspecific tree of alluvial flats can only be explained geologically. So it is with the narrow-leaved Eucalyptus amygdalina on open stony declivities as compared with the broad-leaved Eucalyptus fissilis, which in such gigantic dimensions towers up from our deep forest valleys. But all this has an important bearing on technological exertions in manifold directions. The timber chosen by the artisan from a wrong locality may impair the soundness of a whole building; or a factory may prove not lucrative simply because it is placed on a wrong spot for the best raw material.

A thousand of other industrial purposes might yet be served by a close knowledge of plants. So the designer might choose patterns far more beautiful from the simple and ever perfect beauty of nature than he gains from distorted forms copied into much of our tapestry; thus a room, nowadays, as a rule, decorated with unmeaning, and often, as far as imitation of nature is concerned, impossible figures, might become, geographically or phytographically, quite instructive. If here the founders of territorial estates—some, perhaps, as large as the palatinates of the Middle Ages—should wish to perpetuate the custom of choosing a symbol for family arms, they, as the Highland clans adopted special plants of their native mountains for a distinguishing badge, might select as the ancestral emblem the flowers of our soil, destined, perhaps, to be traced, not without pride, by many a lineage through a hundred generations.

Precise knowledge of even the oceanic vegetation, in its almost infinite display of forms, offers not merely the most delicate objects for design, but brings before us its respective value for manure, or the importance of various herbage on which fishes will browse; while such marine weeds may as well be transferred from ocean to ocean as ova of trout have been brought from the far north to these distant southern latitudes. Who could foresee when first Iodine was accidentally discovered in seaweeds, through soda factories, or Bromine subsequently appeared as a mere substance of curiosity, what powerful therapeutic agents thereby were gained for medicine, what unique results they would render for chemical processes, of what incalculable advantages they would prove in physiological researches or microscopic tests; and how, without them, photographic art could not have depictured with unerring fidelity millions of objects, whether of landscapes or of the starry sky, whether of the beings dear to us or the relics of antiquity, whether enlarging the scope of lithography or recording the languages which the flashing of telegraphic electricity sends to a dwelling or to an empire? Even the vegetable fossils, deep buried in the earth or in the cleavage of rocks, when viewed by the light of phytology become so many letters on the pages of nature's revelation, from which we are to learn the age of strata, or may trace the sources of metallic wealth, or by which we may be guided to huge remnants of forests of bygone ages, stored up for the utilisation of this epoch, or may comprehend, as far as mortal understanding serves us, successive changes in tellurian creation.

When Ray, and subsequently Jussieu, framed the first groundwork for the ordinal demarcation of plants; when Tournefort by defining generic limits brought further clearness into the chaos of dawning systematic knowledge, and when Linné gave so happily to each plant its second or specific name, but little was it indeed foreseen what a vast influence these principles of sound methodic arrangement would exercise, not only on the easy recognition of the varied forms of vegetable life, but also on the philosophic elucidation of their properties and uses, and this for all times to come. Many even at the present day, and among them at times those on whom the destinies of whole states and populations may depend, can recognise in phytographic and other scientific labours but little else than a mere play work; yet without such labours every solid basis for applying the knowledge of plants to uses of any kind would be wanting. We would stray, indeed, unguided in a labyrinth between crude masses or inordinate fragments, instead of dwelling in a grand and lasting structure of knowledge, unless science, also in this direction, had raised its imperishable temples. But how much patient and toilsome research had to be spent thus to bring together in a systematic arrangement all the products of this wide globe; how many dangers of exploring travellers had to be braved to amplify the material for this knowledge, and how many have to pass away even now-a-days, persecuted and worried like Galileo at his time, no one yet has told, nor will tell. Well may we feel with the great German poet, as expressed in Bulwer Lytton's beautiful wording:—

"I will reward thee in a holier land,
Do give to me thy youth!
All I can grant you lies in this command—
I heard, and trusting in a holier land,
Gave my young joys to truth."

But is there nothing higher than the search of earthly riches, and is to this all knowledge of the earth's beautiful vegetation also to be rendered subservient 1 Is there nothing loftier than to break the flowers for our gaieties or to strew them along a mirthful path? There is! They raised the noblest feelings of the poet at all ages, they spoke the purest words of attachment, they ever were the silent harbingers of love. They smilingly inspired hope anew in unmeasured sadness, and on the deathbed or at the grave they appear to link together, as symbols of ever-returning springs, the mortal world with immortality; they ever teach us some of the sublimest revelations of our eternal God.

The laurel crown of the hero was a people's highest reward of chivalrous and glorious deeds.

The myrtle, or orange wreath for bridal curls, remains the proudest gift to youthful hope.

The little blooming weed, content in a parched and dreary desert, revived the strength of many a sinking wanderer (Mungo Park); the ever unalterable beauty and harmony of floral structures preaches the truths of eternal laws in the universe—a faith that gave expression to Schiller's memorable words, as repeated by that leading British statesman, "It's not all chance the world obeys." (Gladstone.) The innocent loveliness of nature's flowers has often aroused anew the shaken spirit of the philosopher, and to these and other gifts of nature the American bard alludes, when he speaks of the great zoologist, Agassiz, of whose friendship I may well be proud.

"And whenever the way seemed so long,
Or his heart began him to fail,
She would sing a still more wondrous song,
Or tell a more marvellous tale."

And when it seems that all hopes of the weeping mother are extinguished, or even the teachings of religion may well-nigh forsake her, then the deep meaning of some of our noblest poems inspired by nature is understood, and faith in eternity once more embraced.

"And the mother gave in tear and pain
The flowers she most did love,
She knew she would find them all again
In the fields of light above."

"And with childlike credulous affection
We behold their tender bud expand,
Emblems of our own great resurrection.
Emblems of the bright and better land."

Mason, Firth, and M'Cutcheon, Printers, Melbourne.

BY GERARD KREFFT, ESQ., F.L.S., Curator and Secretary, Australian Museum.

Mammals.

(Recent species.)

THE fauna of Australia is distinguished by a large number of Marsupial animals, which are now extinct in almost every other part of the world, and considered to be the oldest Mammals known. A few living species allied to our Dasyures still exist in America, and fossil remains were found in France and England which indicate the presence of Marsupials at a very early period when mammalian life was in its infancy; in fact the general belief is that the first Mammals belonged to the Marsupial or Pouched tribe. The isolated position of Australia may have caused these animals to retain their stronghold here much longer than in other countries; and it is almost certain that many of their predecessors were also Marsupials, equal in size to the Rhinoceros and the Hippopotamus.

The living species are of moderate growth, and the largest do not exceed two hundred pounds in weight.

They are divided in carnivorous or flesh-eating, and herbivorous or grass-eating sections, with a few genera of mixed feeders.

At a rough estimate we know 110 Marsupials in Australia, to which must be added—

- 24, Bats,
- 1 Dog,
- 30 Eats and mice,

and a number of Seals and Whales which, inhabiting the ocean, are not restricted in their habitat.

The most curious Australian animals are the duck-billed Platypus and the spiny Ant-eater; both are peculiar to this country. Marsupials are found in New Guinea, on some of the islands of the Pacific, and in America.

Of the Placental series the curious Water-rats or Beaver-rats must be mentioned, as being purely Australian. The dog was no doubt a very early introduction, because fossil remains were discovered contemporaneous with the great extinct Marsupials of post-pleiocene times. Of Man, we have but scanty evidence regarding the length of his existence here; in not one instance were weapons or implements obtained with the remains of fossil animals. Stone weapons are still used by many tribes, and the primitive art of splitting, grinding, and shaping various rocks into hatchets and spear-heads, is not yet lost.

The measurements of a series of Australian skulls is given at the head of the list, and some of these greatly resemble the ancient skulls found at the Neanderthal cave, and near Engis.

The Mammals are arranged as follows :—

Class Mammalia.

A. Placentalia.

Bimana. Human Race.

HOMO.

Homo sapiens. Australian or Melanian Variety.

The following are the measurements of some of the skulls of Australian Aborigines in the collection of the Museum at Sydney.

Greatest Length. Breadth. Depth from the anterior margin of the occipital foramen to the middle of the coronal suture. Locality. 615/16 52/16 53/16 Brisbane. 77/16 57/16 Hobarton. 78/16 55/16 59/16 ? 74/16 412/16 52/16 ? 613/16 415/16 5 ? 76/16 510/16 56/16 Mudgee. 73/16 53/16 57/16 ? 63/16 56/16 51/16 ? 612/16 56/16 415/16 ? 7 415/16 65/16 ? 79/16 54/16 55/16 ? 614/16 414/16 51/16 Brisbane. 76/16 53/16 54/16 ? 614/16 53/16 510/16 ? 79/16 511/16 51/16 ? 614/16 412/16 52/16 ? 615/16 52/16 51/16 ? 76/16 415/16 54/16 ? 76/16 53/16 415/16 ? 78/16 55/16 515/16 ? 71/16 415/16 54/16 Mudgee. 74/16 55/16 58/16 ? 614/16 512/16 513/16 ? 614/16 610/16 59/16 ? 76/16 58/16 510/16 ? 7 58/16 52/16 ? 7 53/16 55/16 Pine Mountain. 614/16 56/16 57/16 ? 615/16 52/16 54/16 Murrumbidgee. 614/16 58/16 58/16 Cape York. 615/16 412/16 5 Bondi. 82/16 510/16 54/16 Port Fairy. 714/16 56/16 510/16 Hunter's Bay. 77/16 55/16 514/16 Rockhampton. 76/16 57/16 53/16 Do. 71/16 52/16 51/16 Kiama. 615/16 54/16 414/16 Do. 711/16 57/16 59/16 Mudgee? 75/16 52/16 56/16 Brisbane. 77/16 58/16 511/16 Cape York,

Cheiroptera—Bat-Tribe.

a. *Frugivorous Bats*.

PTEROPUS.

P. poliocephalus.
P. conspicillatus.
P. funereus.
P. scapulatus.

These large Bats are best known by the name of Flying-foxes; they inhabit the east and north coast; in South Australia and on the west coast they have not been observed yet.

b. *Insectivorous Bats*.

HARPYIA.

Harpyia australis. A new species of Bat, recorded from Cape York.

Molossus.

Molossus australis. Victoria.
Molossus Wilcoxii. New South Wales and Queensland.

Taphozous

Taphozous australis. North-east coast.

Rhinolophus.

R. megaphyllus. New South Wales.
R. cervinus. North-east and north coast.
R. aurantius. Port Essington.

Nyctophilus.

N. Geoffroyi. West Australia.
N. Gouldi. New South Wales.
N. unicolor. Tasmania.
N. timoriensis. West Australia.
N. australis. New South Wales.

Scotophilus.

S. Gouldi. Southern parts of Australia.
S. morio. Southern parts of Australia.
S. microdon. Tasmania.
S. picatus. South Australia.
S. Greyi. Port Essington.
S. pumilus. New South Wales.

Vespertilio.

V. macropus. South Australia.
V. tasmaniensis. Tasmania.

Nycticejus.

N. australis. East coast of Australia.

Our knowledge of the smaller Bats is not very extensive, and in most descriptions of species the chief characteristics, the number, shape, and arrangement of their teeth, is omitted. Australia has not one genus peculiar to the country.

Canidæ.—Dog-Tribe.

Canis.

C. Dingo.

The Australian Native Dog or Dingo inhabits almost every part of Australia, and interbreeds freely with the domestic dog. In the more settled districts this destructive animal has been nearly exterminated. Dingos occur of almost any color,—black and tan, tan spotted with white or pure tan, and yellowish. In Tasmania no Dingos have been observed by the first settlers, nor have fossil remains of dogs been found there.

Phocidæ.—Seal-Tribe.

Stenorhynchus.

S. leptonyx. Tasmania and southern portions of Australia,

Arctocephalus.

A. lobatus. Southern and eastern coasts of New South Wales and Tasmania.
A. cinereus. South and West coasts.

The seals of the Australian coast frequently ascend rivers to a great distance, and during the time of floods may be carried into some lake or lagoon, whence, after the subsidence of the water, retreat is impossible. Through animals of this kind being left in an extensive lake the fable of the Bunyip may have arisen. A large Seal, now in the Australian Museum, captured in fresh water, had devoured a full-grown Platypus (Ornithorhynchus anatinus.) Three species are common on the Australian coastline, though many others inhabit the Antarctic Ocean.

Rodentia, or Rat-Tribe.

a. Long-eared Rats.

HAPALOTIS.

H. albipes. New South Wales, Victoria, and South Australia.
H. apicalis New South Wales, Victoria, and South Australia.
H. hemileucura. Queensland.
H. hirsutus; North Australia.
H. penicillata. North Australia,
H. conditor. New South Wales.
H. longicaudata. Western Australia.
H. Mitchellii. New South Wales, Victoria, and South Australia,
H. arboricola, New South Wales.

b. Short-eared Rats.

MUS.

M. fuscipes. Southern Australia.
M. vellerosus. South Australia.
M. longipilis. Victoria River.
M. cervinipes. New South Wales.
M. assimilis New South Wales,
M. manicatus. Port Essington.
M. sordidus. New South Wales.
M. lineolatus. New South Wales.
M. Gouldi. From East to West coast.
M. nanus. New South Wales and Western Australia.
M. albocinereus. Western Australia.
M. novæ-hollandiæ. New South Wales.
M. delicatulus. North Australia.
M. macropus. North Australia.
M. personatus. North Australia.

c. Water Rats.

HYDROMYS.

H. chrysogaster. Various parts of Australia.
H. fulvolavatus. Various parts of Australia.
H. leucogaster. Various parts of Australia.
H. fuliginosus. Various parts of Australia.
H. lutrilla. Various parts of Australia.

Numerous Eats have been described according to the colour of their fur; but few authors have examined the dentition of their new creations, so that in course of time their number will probably suffer a reduction. We consider the five Water-rats to be varieties of a single species.

Sirenia.—Dugong-Tribe.

HALICORE.

H. Dugong.

The Dugong is not found on the coast of New South Wales, but inhabits the more northern seas; it is still plentiful near Brisbane, and chased on account of its valuable oil, said to be superior to cod-liver-oil.

Cetacea.—Whale-Tribe.

BALÆNA.

B. australis(?).

The "Right Whale" is still observed in Australian waters. A fine skeleton, 96 feet long, is in the Melbourne Museum.

PHYSETER.

P. macrocephalus.

Sperm Whales are also caught occasionally. A skeleton, 35 feet long, is in the Australian Museum, at Sydney.

KOGIA.

K. Graii.

Of this curious and rare species of Whale, specimens are now and then obtained. A skin and two skeletons are in the Australian Museum, at Sydney.

DIOPLODON.

D. seychellensis.

A rare Whale,—a skeleton of which was lately purchased of some of the inhabitants of Lord Howe Island, is now in the Australian Museum, at Sydney. Many other cetaceans inhabit the Australian seas, but we cannot enumerate all the species in this paper.

MESOPLODON?

A fine skeleton, allied to the above genus, has just been secured for the Museum, which contains also several skeletons and many skulls of the so-called "Killers" and Porpoises.

B. Marsupialia.

Rhizophaga.—Wombat-Tribe.

PHASCOLOMYS.

P. Wombat. Tasmania, and islands of Bass' Straits.
P. latifrons. Eastern parts of South Australia.
P. platyrhinus. New South Wales.
P. niger. Port Lincoln, South Australia.

There are four distinct species of Wombats now living, all of an average size, and seldom exceeding 100 lbs. in weight. The western species existed in New South Wales during the post-pleiocene period. Wombats are nocturnal in their habits, and live in burrows. Their flesh is very palatable.

Carpophaga.—Phalanger-Tribe.

PHASCOLARCTOS.

P. cinereus. Koala, or Native Bear.

Only one species of this singular form is known, which inhabits the southern and eastern portions of Australia, and extends to the tropics.

PHALANGISTA.

P. canina.

P. fuliginosa.

P. vulpina.

These three animals are varieties of the common Opossum. The first inhabits the Clarence River District, the second is found only in Tasmania, and the third is distributed generally over Australia. All have a brushy tail.

P. Cookii.

P. viverrina.

P. laniginosa.

The Ring-tailed Phalangers or Opossums are varieties of each other, and found in almost every part of Australia; the first occurs on the east coast; the second in the interior, on the south coast, and also in Tasmania; the third is a local variety of the Clarence River District. All these animals (Phalangers) are about the size of a half-grown cat; and they resemble in their dentition the great Flying Phalanger of the genus Petaurista.

DROMICIA.

D. gliriformis.

D. concinna.

D. unicolor.

The Dromicias inhabit the southern portion of Australia and Tasmania. They are small Ring-tail Phalangers, and never grow larger than about the size of a common mouse. Little is known of these creatures, which are seldom captured; they live principally on honey and soft insects.

CUSCUS.

C. brevicaudatus.

C. maculatus.

Inhabitants of North Australia, which are allied to the Phalangers proper; they appear to be rather more carnivorous than the rest, and both have been added only lately to the Australian fauna.

DACTYLOPSILA.

D. trivirgata.

The habitat of this animal is also North Australia; it is a curious form connecting the Flying Phalangers with the genus Phalangista; the membrane between arms and legs is absent, but the tail has a feathery appearance, and resembles that of the little Acrobata; skull and dentition are like Belideus flaviventer; the size of the animal is about that of a common rat.

PETAURISTA.

P. taguanoides. Great Flying Phalanger.

A species closely allied to the Ring-tail Phalangers; the skulls of these two genera are much alike, their teeth also resemble each other. Habitat, East Australia; not found on the Plains of the interior, or on the West coast.

BELIDEUS.

B. flaviventer.

B. sciureus.

B. breviceps.

Of these Flying Phalangers the first is the largest, and about the size of a cat, but less bulky; the other two are much smaller; they inhabit South and East Australia, and have not yet been recorded from the West coast. They are restricted to mountain districts, and not found on the Plains of the interior. B. notatus and

B. ariel are varieties of the B. breviceps.

ACROBATA.

A. pygmæa.

The smallest of the tribe, less than a common mouse in size, and distinguished by a feathery tail. Habitat, the southern and eastern portions of Australia.

TARSIPES.

T. rostratus.

This little creature, with its almost toothless jaws, belongs certainly to the Phalanger family, and connects it with the Monotremata. The teeth are very diminutive and soon lost, except the canines, a few of the back teeth, and the lower incisors, which are very fine, straight, and almost horizontally inserted in the ramus. The tongue is rather long, covered with hair near the tip, enabling the animal to insert it into flowers and obtain their honey.

Poephaga.—Kangaroo-Tribe.

The Kangaroos vary considerably in size and in the form of their teeth; and the smaller species are generally furnished with strong canines. Some of them have prehensile tails, and they can ascend small trees; others have long pliable tails and very short tarsi; these are known as Rock-Wallabies or Rock-Kangaroos, and frequent mountain districts. Others again possess short stiff tails and long heads; they resemble in appearance the Bandi-coots, and where on the one hand the prehensile-tailed group of Bettongs approaches the Phalangers we observe on the other side, in the Rat Kangaroos, an inclination to the Bandicoot family in their elongated skulls and stiff and short tails.

Space will not permit to go into detail, and we divide the family as follows :—

A.—*Large Kangaroos with small premolar teeth, which are soon lost*.

MACROPUS.

a. Male and female, uniform in colour.

M. major. Southern and Eastern Australia.

M. ocydromus. West coast.

M. fuliginosus. South Australia.

M. antilopinus. North Australia.

M. Isabellinus. North-west Australia,

M. Parryi. Eastern Australia.

b. Female, different in colour from the male.

M. rufus. Plains of the interior.

M. robustus. Rocky districts of the East coast.

In both these animals the female is of a much lighter colour, sometimes almost white.

The large Kangaroos attain a weight of 200 lbs. and more.

B.—*Kangaroos of smaller size, with permanent premolar teeth; weight of adult up to* 50 *lbs*.

HALMATURUS.

H. dorsalis. New South Wales and Queensland.

H. ruficollis. New South Wales.

H. Bennettii. Tasmania.

H. Ualabatus. New South Wales.

H. Mastersii. New South Wales and Queensland.

Ruficollis and Bennettii are stated to be varieties of each other; so are Ualabatus and Mastersii, though very different in colour. H. agilis is also a large species from the north-east coast.

Animals up to 30 *lbs. weight*.

H. Greyi. South Australia,

H. manicatus. West Australia.

H. Derbianus. South Australia.

H. Hautmanni. Hautmann's Abrolhos, W.A.

H. Billardieri. South coast districts and Tasmania.

"*Pademelons*," *or small Kangaroos, and from* 10 *to* 15 *lbs. in weight*.

H. parma. East coast of N. S. Wales.
H. dama. West Australia.
H. Thetidis. Coast districts of New South Wales.
H. stigmaticus. North-east coast.
H. brachyurus. West Australia.
H. Wilcoxi. Clarence District and Southern Queensland.

These animals inhabit the mountain districts near the coast, and are seldom, if ever, found on the plains of the interior.

Rock-Wallabies or Rock-Kangaroos, with long pliable tail not incrassated at the base, inhabiting mountain districts on the southern, eastern, and western coast-line. Weight of animal up to 30 *lbs. :—*

Petrogale penicillata. Eastern parts of New South Wales.
Petrogale inornata. Eastern parts of New South Wales.
Petrogale xanthopus. South Australia.
Petrogale brachyotis. West and north-west coast.
Petrogale lateralis. West and north-west coast.
Petrogale concinna. West and north-west coast.

Strong-armed Kangaroos or Tree-Kangaroos.

DENDROLAGUS.

D. ursinus. New Guinea.
D. ursinus. New Guinea.

These animals ascend trees, and are distinguished by their powerful fore-limbs and long pliable tail, which resembles that of the Rock-Wallabies. A third species, Dorcopsis Bruni, also inhabits New Guinea, but is terrestrial, though the fore-legs are more strongly developed than is usual in Kangaroos. The weight of these animals we should judge to be about 30 lbs. The D. Bruni was the first Kangaroo ever discovered, many years before Cook's voyages.

Silky-haired or Nail-tail Kangaroos.

ONYCHOGALEA.

O. unguifer. North-eastern parts of Australia.
O. frænata. Plains of the interior of New South Wales and Victoria.
O. lunata. Plains of the interior of South and West Australia.

This group comprises the small silky-haired Wallabies or Kangaroos of the interior; they weigh seldom more than 8 or 10 lbs., and are about the size of a common hare. Their light-grey fur is of a peculiar softness; the tail has a bare nail-like tip. This and the following genera possess more or less developed canine teeth.

Hare Kangaroos.

LAGORCHESTES.

L. fasciatus. West Australia.
L. hirsutus. West Australia.
L. conspicillatus. West Australia.
L. leporoides. Plains of New South Wales, South Australia, and "Victoria.
L. Leichardti. North-east coast and Victoria,

The Hare-kangaroos, so called from their resemblance to that well-known rodent, are the fleetest of the whole tribe, and though they do not exceed a common hare in bulk, they will make clear jumps of 8 and 10 feet high; their arms are exceedingly short, and when progressing cannot be noticed, as they are pressed close to the body and are hidden by the long fur; the hind legs are very long and slender, and the tail rather short and stiff and not incrassated at the base; the canines are well developed.

Bettongs or Jerboa Kangaroos.

BETTONGIA.

B. cuniculus. Tasmania.
B. Graii. New South Wales, South and West Australia.
B. campestris. South Australia.

These three species of Bettongs resemble each other very much, and are probably nothing but local varieties. The western and southern animal, that is, B. Graii and B. campestris, form extensive burrows which the Tasmanian species does not; their tails are more or less prehensile; weight, 8 to 10 lbs.

B. penicillata. Interior of New South Wales.

B. Ogilbyi. West Australia.

These two animals also resemble each other; they are very small, probably not more than 4 or 5 lbs. in weight; their tail is prehensile, and they can climb well. We have seen them get over a close palisade-fence 8 feet high. This group connects the Kangaroo-tribe with the Phalangers.

Rat Kangaroos.

HYPSIPRYMNUS.

H. murinus. New South Wales.

H. apicalis. Tasmania.

H. Gilberti West Australia.

H. platyops West Australia.

The true Rat-Kangaroos approach the Bandicoot-tribe, and some of the best naturalists nave classed them as Bandicoots when the skull could not be examined; their limbs are of more equal length; and the tail is like that of the Bandicoots,—short and rather stiff; the head of the Rat-Kangaroo is elongate (that of II. platyops excepted), and the canine teeth are strongly developed.

Entomophaga.—Bandicoot-Tribe.

PERAMELES.

P. nasuta. New South Wales.

P. Gunnii. Tasmania.

P. myosurus. West Australia.

P. fasciata. South Australia.

P. obesula. Southern Australia and Tasmania.

The Bandicoots are distributed over every part of Australia, hut never in great numbers; the first species is of the size of a rabbit, and the next three are as largo as a common Norway rat. The last is heavier, but stands very low on its legs, and .has a harsh and coarse fur. The tribe did not receive sufficient attention from naturalists, who generally fail to give a description of the teeth; it is highly probable that another species or two exist in the north and in New Guinea, and that some of our continental animals, such as P. myosurus and P. fasciata, are varieties only.

PERAGALEA.

P. lagotis. Rabbit-eared Peragalea or Rabbit-rat of the Colonists.

An aberrant form of the Peramelidæ;, with rather long compressed and crested tail, inhabiting the interior of South Australia, New South Wales, and West Australia, The head is very elongate, the ears long, and the fur soft and silky; the canine teeth are strong and recurved, very powerful, and the grinders conical, without fangs, except a few tubercles. The Peragalea burrows, and is not gregarious, a pair only occupying one of the warrens.

Chæ Ropus.

C. castanotis. The interior of New South Wales, South, and West Australia.

The Chæropus is known as the pig-footed Bandicoot, having only two functional toes to the fore-feet; the hind legs are like those of the Kangaroo and Bandicoot. The teeth of this animal are feeble, in particular the canines; the tail resembles that of the Peragalea, with a crest of hair on the upper edge.

The dentition of the Bandicoots resembles the carnivorous section, the Dasyures.

Sarcophaga.—Native-Cat Tribe.

The largest species of this group are few in number, and only one of them, an inhabitant of Tasmania, is formidable, and may become dangerous to man. The smaller kinds represent the shrews and hedgehogs of the Placental series, and they do not exceed a rat in size; some are not larger than a common shrew-mouse. We divide the Dasyures in the following sections :—

Tasmanian "*Tigers*."

THYLACINUS.

T. cynocephalus. Greyhound tiger.
T. breviceps. Bull-head tiger.

Both inhabiting Tasmania, the bull-head species having a more powerful dentition than the T. cynocephalus, and in particular the premolar teeth closer together; the palatial opening is also much smaller in the T. breviceps, and the head shorter.

Tasmanian "Devil."

SARCOPHILUS.

This section contains but one example, the Sarcophilus ursinus, a very ferocious but small animal, the habitat of which is restricted to Tasmania. This species should be classed with the Dasyures proper, on account of its dentition, which is the same as in the next group; premolars, 2-2/2-2; the Thylacine having 3-3/3-3 of these teeth.

Native-Cats.

DASYURUS.

D. maculatus. Eastern and Southern coast districts, Tasmania, and islands of Bass's Straits. The largest of the tribe, with spotted tail.

D. viverrinus. The common Native-cat has a wide distribution over the southern and eastern parts of Australia; it is also found in Tasmania.

D. Geoffroyi and D. hallucatus are varieties from Western Australia, the interior of South Australia, New South Wales, and Queensland. These animals are furnished with a rudimentary nailless thumb to the hind foot.

Spiny-tails.

CHÆTOCERCUS.

C. cristicauda.

A small animal of the size of a half-grown rat, with premolars 3-3/2-2, a rather thick tail, and a black hairy crest on the upper edge. Habitat, South Australia.

Tapoa-tafas, or Brush-tails.

PHASCOGALE.

P. penicillata inhabits almost every part of Australia; it is a small animal the size of a rat, with black brushy tail, and of a uniform grey colour. The premolars number as in the genus Thylacinus.

P. calura is a smaller species, found in the interior of New South Wales, South and West Australia; both are arboreal.

Broad-footed "Pouched-Mice."

ANTECHINUS.

A. Swainsoni. Tasmania,
A. apicalis. West and South Australia.
A. flavipes. Australia generally.
A. Stuarti. Sydney.
A. maculatus. Queensland.
A. miniutissimus. Queensland.

The first four are about the size of a half-grown rat. The last not larger than a small mouse; they frequent shrubs and trees, except A. Swainsonii, which is terrestrial in its habits.

Slender-footed "Pouched-Mice."

PODABRUS.

P. macrourus. Queensland.
P. crassicaudatus. Interior of New South Wales.
P. albipes. Australia generally.
P. murinus. Australia generally.
P. fuliginosus. Australia generally.
P. feruginifrons. Australia generally.
P. apicalis. Australia generally.

Several other small slender-footed Marsupials have been described, but merely on account of a slight difference in coloration; nothing being said about their teeth. We consider the above five species varieties only. The slender-footed animals which have been arranged under the genus Podabrus are principally terrestrial in their habits. A larger kind, P. Mitchellii, from the interior of New South Wales, should be added to this list. The original is in the Australian Museum, but much mutilated; it was discovered by the late Surveyor-General of New South Wales, Sir Thomas L. Mitchell, K.C.B.

Jumping "Pouchcd-Mice."

ANTECHINOMYS.

The above genus was established for the reception of the little animal described as "Phascogale lanigera." The Phascogales are arboreal in their habits, and have short legs and broad feet, with a thumb behind. The A. lanigera has long slender legs, a line long tail with small brush at the tip, and no thumb; it moves by a succession of jumps, and is strictly terrestrial.

Brush-tailed Ant-eaters.

MYRMECOBIUS.

M. fasciatus.

The Western Districts of New South Wales, South Australia, and Western Australia, are inhabited by this curious animal, which approaches the Monotremous section of the Marsupials. The teeth number 52, but they are small, and stand far apart. The long and slender tongue is used to capture ants and their eggs, upon which the animal principally preys.

C. Monotremata.

Spiny Ant-eaters.

ECHIDNA.

E. hystrix. New South Wales, Victoria, South and West Australia, and Queensland.
E. setosa. Tasmania.

The Spiny Ant-eaters have a wide distribution all over the Australian Continent; they abound, however, more on the east coast, and reach north as far as Cape York.

The Hairy Ant-eater is a variety inhabiting Tasmania.

Professor Owen has written some interesting papers on the Monotremes, and proved the existence of two cavities or pouches, without the usual nipple, in which the young are confined, the milk draining into these cavities from the mammary glands. It has been stated by a close observer that these animals are plentiful in winter and spring in certain districts, but that they disappear in summer. Our informant thinks they live underground. Anteaters experience little inconvenience with 4 or 5 feet of earth above them, and it takes fully half-an-hour to drown one. The young of these creatures are exceedingly rare. They feed on ants, ant-eggs, and probably on grass also, as some of it was found in their stomachs on several occasions.

Duck-bills.

ORNITHORHYNCHUS.

O. anatiuus.

Australia generally, is the habitat of this curious creature, which, though plentiful, is still very little known as regards its economy, propagation, &c. Dr. Bennett discovered the young of a Platypus 30 years ago, but very few, if any, specimens have since been obtained, and no further progress has been made towards the solution of the still pending and highly interesting physiological question—Does the Platypus lay eggs?

Fossil Mammals.

THE fossil-bones of Australian Mammals in the Australian Museum collection are arranged as follows :—

Placentalia.

Canidæ.—Dog-Tribe.

CANIS.

Remains of the dog are scarce in every part of Australia where fossil-bones occur; there can be no doubt, however of the presence in this country of a dog during the postpleiocene period; a few teeth were obtained at Wellington; they resemble the teeth of the common Dingo of the present day.

Rodentia, or Rat-Tribe.

HAPALOTIS AND MUS.

All the fossil-bones and teeth are from Wellington, where they occur in large quantities. As far as we have been able to ascertain, some six or more species existed, nearly all of which have very peculiar grinders, and differ from most of the living Rodents.

Edentata.—Sloth-Tribe.

MYLODON.

Mylodon? australis.

The presence of some animal, allied to the above extinct American genus, is indicated by a single terminal phalanx, or nail-bone, with its peculiar protecting hood, partly broken.

Implacentalia.

Marsupialia.

Rhizophaga.—Wombat-Tribe.

PHASCOLOMYS.

Wombats are well represented in a fossil state, and existed to the number of twenty species at least during post-pleiocene times. A modern Wombat of 90lbs. weight is considered heavy, but some of the ancient fossil animals, judging from the size of their teeth and bones, must have been more than twice as bulky. The Wombats are closely allied to the Phalangers (the "Opossums and Plying Squirrels"), and are distinguished from all other Marsupials by their incisor teeth, which, like those of the rodents, number two above and two below.

Carpophaga.—Phalanger-Tribe.

PHALANGISTA.

Bones of animals of this group, to which the well-known "Opossums" and "Flying Squirrels" belong, are rare; the only specimens observed, two fragments of a lower jaw, indicate species allied to, or identical with, the living Vulpine Phalanger (P. vulpina), and the "Sugar Squirrel" (Belideus breviceps). The curious "Native Bear" is also a Phalanger, and forms the connecting link between the Wombats and the "Phalangers proper" (the "Opossums" and "Flying Squirrels"). All these creatures have a nailless thumb to the hind foot; they also possess, like the Kangaroo family, the two small inner toes joined by a membrane. Wombats, Phalangers, and Kangaroos (including Wallabies and Kangaroo-rats), seldom produce more than *two* young at a time; *one* at a birth is, however, the general rule. The Phalanger family comprises some of our very largest creatures, namely, the gigantic Diprotodons, Zygomaturi, and Nototheri, about the position of which there has been much discussion. Looking at the dentition, and comparing the incisors only, the observer is struck at once with their close resemblance to the teeth of an ordinary native bear. The short tail of both the "Native Bear" and "Wombat" appears to have been peculiar to the large extinct species also; though this supposition is only based on negative evidence—the absence of any caudal vertebra? of a size in proportion to the other large bones which have been found.

DIPROTODON.

The collection consists of many fragments of jaws and teeth of great size, indicating ten or more species.

ZYGOMATURUS.

This large animal is represented in our collection by two or three species,—the original *Zygomaturus trilobus*, the *Z. Macleayi*, and a still undescribed one, lately discovered by Dr. Mildred Creed, near Scone.

NOTOTHERIUM.

Of the *Zygomaturus* we know the skull and teeth of the upper series, and of the Notothere only the lower jaw. But many of these mandibles may yet prove to be those of *Zygomaturus*. It will be necessary, however, to obtain clearer evidence on the subject, as, for instance, palate and jaw of the same animal found close together and properly fitting; specimens of this kind are still missing.

THYLACOLEO.

This animal was first described by Professor Owen; it is evidently a Phalanger and comes close to the "Flying Squirrel" *(Belideus flaviventer*). The great premolar of Thylacoleo is not found in *Belideus*, and the grinders differ much in the two species, but the incisors above and below are of the same shape, and skull and jaw, when compared with the much larger Thylacoleo, appear to be formed on a similar model. That it was erroneous to consider the Thylacoleo a formidable carnivore, and a match for the ponderous Diprotodons, is plainly discernible from the remains (nearly perfect jaws) in our collections; many of the "trenchant" teeth are worn quite flat, the incisors are weak, and the upper ones often rounded off to conical prints, unfit to hold or tear tough substances such as flesh.

Besides these remains, others indicating a smaller allied species have come to hand.

PLECTODON.

This genus is distinguished by lower incisors of a peculiar form, much shorter and more round than those of *Thylacoleo;* a portion of the enamel laps over, and covers the inner side of the tooth like a fold;—hence the generic term.

Poephaga.—Kangaroo-Tribe.

MACROPODIDÆ.

Numerous species of all sizes, some several times larger than any modern Kangaroo, existed in Australia in former ages, but their remains are much scattered about, and upper and lower jaws are seldom found together; to distinguish the bones as those of particular species is out of the question, and we must content ourselves at present to class them as Kangaroo, or Kangaroo-rat bones. The fossils which resemble, or are identical with, modern species, may of course be more correctly classified.

As a general rule, most of the fossil Kangaroos have shorter and stouter tarsi than living species possess, and the greater number, including the largest of the tribe, must be arranged with the *Halmaturi* or Wallabies, a group of Kangaroos with permanent and often large premolar teeth.

The Kangaroos proper, of which our common Great Kangaroo is the type, soon shed their premolars, and continue to lose the grinders also in such a manner that sometimes only a pair of teeth are left in each ramus. The Wallabies, on the other hand, wear the teeth down. Looking at a Kangaroo's incisors, we find the first of the upper series comparatively small, and the third very broad; whilst the Wallabies have the third tooth large in a vertical direction, and in most species this tooth is deeply indented by a fold.

In *all recent* Kangaroos, Wallabies, and Kangaroo-rats, the rami of the lower jaw are movable; in many fossil Kangaroos this peculiar characteristic is wanting, and the two mandibles are firmly anchylosed, as may be observed in the two fossil species *Halmaturus Scottii* and *Halmaturus Thomsonii*.

The premolars of the fossil species are often very bulky, with a deep hollow in the middle of the tooth—another characteristic peculiar to extinct animals of this tribe.

The following genera belong to the family *Macropodidæ:—*

BETTONGIA.

Comprising the Kangaroo-rats, or more correctly speaking, the "Bettongs," with long hind legs, and more or less prehensile tail. Of these animals many remains were found at Wellington, all of which appear to be identical with the common Bettong *Bettongia rufescens*, now living in New South Wales.

HYPSIPRYMNUS.

This genus had very few representatives, and comprises the smaller Kangaroo-rats, with short stiff tails and short hind-legs; all *Hypsiprymni* progress in the same manner as the Bandicoots.

MACROPUS.

The typical species is our *Macropus major* or Great Kangaroo. Fossil remains of closely allied species, and of others, resembling *M. ocydromus*, *M. rufus*, and *M. robustus*, are in our collection.

HALMATURUS.

This genus, distinguished by permanent and often very large premolar teeth, is numerously represented in a fossil state, and cannot be estimated at less than thirty or more species; the Wombat-like Kangaroos, with short anchylosed jaws, are here included.

Entomophaga.—Bandicoot-Tribe.

PERAMELIDÆ.

Fossil Bandicoots are not rare, but their bones are generally much broken; those observed were collected at Wellington, and represent, with slight differences, the two living species, *Perameles obesula*, the short-nosed Bandicoot, and *Perameles nasuta*, the long-nosed. Bandicoot. A few remains of the Peragalea were also obtained; the teeth are larger and slightly different from the *Peragalea lagotis* of the present day. The discovery of this animal was made during our last visit to the caves, in company with Professor Thomson, when nearly all the most important specimens were found. The Peragalea is known by the English term of "Rabbit-rat," probably on account of the long slender ears; the native name on the Lower Murray is "Wuirrapur"; and "Jacko," on the Darling. The number of young produced in a litter by Bandicoots does not exceed four.

Sarcophaga.—Native-Cat-Tribe.

DASYURIDÆ.

The rich deposits in the Caves of Wellington have supplied us with evidence of the existence of two species of "Native-cats," that is, a common *Dasyurus viverrinus*, and a "Tiger-cat," *Dasyurus maculatus;* besides these small carnivores we have to record the presence in post-tertiary Australia of the formidable *Sarcophilus vrsinus*, the "Tasmanian Devil," and the still more ferocious *Thylacinus cynocephalus*, Thylacine or "Tasmanian Tiger." The number of teeth belonging to these creatures, collected at the Wellington Caves, amount to several hundred; other remains (skulls and jaws) are as plentiful, and many of their owners must have died at a ripe old age, because their canine teeth are often worn level with the rest of the series.

Phascogale, Antechinus, and Podabrus.

These small animals represent the Shrews and Hedge-hogs of the Placental division. The difficulty of discovering their remains is very great, a tiny jaw, less than ? of an inch in length, proves the existence in post-pleiocene Australia of mammals not larger than a small mouse.

Section Monotremata.

Genus—Echidna.

A fractured femur is referred to the above genus, and was discovered at Wellington; another specimen, part of a humerus, was obtained at the Darling Downs, and described as E. Owenii; both are exhibited in the Museum collection.

This closes the list of our Mammals, in which nearly all still living genera are represented, with the following exceptions, namely:—Bats (*Cheiroptera*), and "Water-rats," of the peculiar Australian genus Hydromys. Of the Marsupial Order the missing genera are the Myrmecobius and the Ornithorhynchus.

Birds.

The Avi fauna of Australia is considerable, though perhaps not so rich as that of other countries under the same latitude. Australia is famous for the beauty of her many parrots, over sixty species of which are found here; the honey-eaters are also numerous and varied in plumage, while bower-building satin birds, mound-raising Megapodes, and stately Emus, are peculiar to this favoured region. Game species abound; there are many pigeons, ducks, geese, plovers, and quail, and every bay or island along the coast-line is swarming with noisy seabirds. Some large groups are however altogether absent; we have no woodpeckers, no humming-birds, no Trogons, and few good songsters. Other handsome forms compensate in some measure for this loss. Numerous game and singing birds have been imported from other parts, and all thrive well, and thanks to laws for the protection of game during a few months of the year, there will always be good sport in the shooting season.

We cannot go into detail with our birds, and must refer students to Gould's Handbook, from which we extract a list of all the genera and species, with a revised habitat by Mr. George Masters.

The total number of species is about 690, which are distributed as follows:—

Many of these species are however mere varieties of each other, but as new discoveries are constantly made, the number given as 670 will be tolerably correct.

Table of Distribution—Birds of Australia.

Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Aquila audax * * * * * * * ——Hieraëtus morphnoïdes * * * * * Polioaëtus leucogaster * * * * * * * Haliastur leucosternus * * * ——sphenurus * * * * * * Pandion leucocephalus * * * * * * * Falco hypoleucus * * ——melanogenys * * * * * * * ——subniger * ——lunulatus * * * * * * * Hieracidea berigora * * * * * ——occidentalis * * Tinnunculus cenchroïdes * * * * * Leucospiza raii * * * * ——novæ-hollandiæ * * * * * Astur radiatus * * ——approximans * * * * * ——cruentus * * Accipiter torquatus * * * * * * * Gypoictinia melanosternon * * * * * Milvus affinis * * * * * * ——isurus * * * * * Elanus axillaris * * * * * * ——scriptus * * Baza subcristata * * Circus assimilis * * * * * * ——jardinii * * * * * Strix castanops * ——candida * * ——novæ-hollandiæ * * * * * * ——tenebricosus * * ——delicatulus * * * * * * Hieracoglaux strenuus * * ——rufus * * ——connivens * * * * * Spiloglaux marmoratus * ——boobook * * * * * * ——maculatus * * * * Ægotheles novæ-hollandiæ; * * * * * * ——leucogaster * Podargus strigoides * * * ——cuvieri * ——megacephalus * * * ——brachypterus * ——phalænoïdes * ——papuensis * ——plumiferus * * ——marmoratus *

Birds of Australia— Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Eurostopodus albogularis * * * ——guttatus * * * * * * Caprimulgus macrurus * Chætura caudacuta * * * * * * * Cypselus pacificus * * * Hirundo frontalis * * * * * * * ——fretensis * Hydrochelidon nigricans * * * * * * * Lagenoplastes ariel * * * * * Cheramœca leucosterna * * * * * Merops ornatus * * * * * * Eurystomus pacificus * * * * Dacelo gigas * * * * ——leachii * * ——cervina * Todiramphus sanctus * * * * * * ——pyrrhopygius * * * * * ——sordidus * Cyanalcyon macleayi * * * Syma flavirostris * Tanysiptera sylvia * Alcyone azurea * * * * ——diemenensis * ——pulchra * ——pusilla * Artamus sordidus * * * * * * ——minor * * * ——cinereus ** ——albiventris * * ——melanops * ——personatus * * * ——supercilious * * * * ——leucopygialis * * * * * Pardalotus punctatus * * * * * * ——rubricatus ** ——quadragintus * ——striatus * * * * * ——affinis * * * * ——melanocephalus * * ——uropygialis * ——xanthopygius * * * Strepera graculina * * * ——fuliginosa * * * * * ——arguta * * * ——anaphonensis * * * * * Gymnorhina tibicen * * * * ——leuconota * * * ——organicum * Cracticus nigrogularis * * * *

Australian Vertebrata—fossil and Recent. Birds of Australia.—continued. Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australis. Northern Australia. Tasmania. Cracticus picatus * ——argenteus * ——quoyii * ——torquatus * * * * ——cinereus * ——leucopterus * Grallina picata * * * * * * Graucalus melanops * * * * * * ——parvirostris * ——mentalis * * * ——hypoleucus * ——swainsonii * * Pteropodocys phasianella .. * * * * * Campephaga jardinii * * * * ——karu * * ——leucomela * * ——humeralis * * * * * * Pachycephala gutturalis * * * * * ——glaucura * ——melanura ——rufiventris * * * * * ——falcata * ——lanoïdes * ——rufogularis * * ——gilbertii * ——simplex * ——olivacea * * * Colluricincla harmonica * * * ——rufiventris * ——brunnea * ——selbii * ——parvula ** ——rufigaster * * Falcunculus frontatus * * * * * ——leucogaster * Oreoca cristata * * * * * Chibia bracteata * * * Manucodia gouldii * Rhipidura albiscapa * * * * * * ——preissi ——rufifrons * * * ——dryas * ——isura * Sauloprocta motacilloïdes * * * * * ——picata .. * Sesura inquieta * * * * * Piezorhynchus nitidus * Arses kaupi .. * Myiagra plumbea * * *

New South Wales. Birds of Australia— Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Myiagra concinna * ——nitida * * * ——latirostris * Machærirhynchus flaviventer * Micrœca fascinans * * * * ——assimilis * ——flavigaster * Monarcha carinata * * ——trivirgata * * * ——leucotis * ——albiventris * Gerygone albogularis * * ——fusca * * * ——culicivora * * ——magnirostris * ——lævigaster * ——personata * ——chloronota * Smicrornis brevirostris * * * * *? ——flavescens * Erythrodryas rhodinogaster * * * ——rosea * * * Petroca multicolor * * * * * * ——goodenovii * * * * * ——phœnicea * * * * * Melanodryas cucullata * * * * * ——picata * Amaurodryas vittata * Pœcilodryas cerviniventris * ——superciliosa * Drymodes brunneopygia * * * ——superciliaris * Eopsaltria australia * * * ——griseogularis * * ——leucogaster * ——capito * * ——leucura * Menura superba * * * ——victoriæ * ——alberti * * Psophodes crepitans * * * ——nigrogularis * Sphenostoma cristatum * * * * Malurus cyaneus * * * * ——longicaudus *? * ——melanotus * ——splendens * ——elegans * ——pulcherrimus *

Australian Vertebrata—fossil and Recent. Birds of Australia.—continued. Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Malurus lamberti * * * ——amabilis * ——coronatila * ——leucopterus * * * * * ——leuconotus ——callainus * ——hypoleucus * ——melanocephalus * * ——cruentatus Amytis textilis * * * ——striatus * * * ——macrourus Stipiturus malachurus * * * * * * Sphenura brachyptera * * * ——broadbenti * ——longirostris * Atrichia clamosa * ——rufescens * Hylacola pyrrhopygia * * * * * ——cauta * Pycnoptilus floccosus *? Cisticola magna *? ——exilis * * * * ——lineocapilla * ——isura * * * ——ruficeps * * * Sericornis citreogularis * * ——humilis * ——osculans * ——frontalis * * * ——lævigaster * ——maculatus * * * * * ——magnirostris * * Acanthiza pusilla * * * ——diemenensis * ——uropygialis * * * ——apicalis * ——pyrrhopygia * ——inornata * * ——nana * * * * ——lineata * * * * ——magna Geobasileus chrysorrhous * * * * ——reguloïdes * * * * Ephthianura albifrons * * * * * ——aurifrons * * * * ——tricolor * * * * Xerophila leucopsis * Pyrrholæmus brunneus * *

New South Wales. Birds of Australia— Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Origina rubricata * * * * Calamanthus fuliginosus * ——campestris Chthonicola sagittata * * * * Anthus australis * * * * * * * Cincloramphus cruralis * * ——cantillans * * * Ptenœdus rufescens * * * * * * Sphenæacus galactotes * * * * ——gramineus * * * * * * Calamoherpe australis * * * * ——longirostris * Mirafra Horsfieldii * * * *? Zonæginthus bellus * * * * ——oculeus * Stictoptera bichenovii * * ——annulosa * Ægintha temporalis * * * Bathilda rufiicauda * * * Aidemosyne modesta * * * Neochmia phaëton * * Stagonopleura guttata * * * * Tæniopygia castanotis * * * * * * Poëphila gouldiæ * ——mirabilis * ——acuticauda * ——personata * ——leucotis * * ——cincta * * Donacola castaneothorax * * ——pectoralis * Munia flaviprymna * Emblema picta * Pitta strepitans * *

——mackloti * ——iris * ——simillima * Cinclosoma punctatum * * * * * ——castaneonotum * * * ——cinnamomeum * * ——castaneotborax * * Oreocincla lunulata * * * Ptilonorhynchus holosericeus * * ——rawnsleyi * Ailurœdus smithii * * Chlamydodera nuchalis * ——maculata * * * ——guttata * ——cerviniventris *

Australian Vertebrata—Fossil and Recent. Birds of Australia.—continued. Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Sericulus melinus * * Mimeta viridis * * ——affinis * * ——flavocincta * Sphecotheres maxillaria * * ——flaviventris * Corcorax melanorhamphus * * * * Struthidea cinerea * * Corvus australis * * * * * * * Calornis metallica * Pomatostomus temporalis * * * ——rubeculus * ——superciliosus * * * * * ——ruficeps * * Meliornis novæ-hollandiæ * * * * * ——longirostris * ——sericea * * * ——mystacalis * Lichmera australasiana * * * * * Glyciphila fulvifrons * * * * * * ——albifrons * * * * * ——fasciata * * * Stigmatops ocularis * * * * * ——subocularis * Ptilotis lewinii * * * ——sonora * * * * * ——cassidix * * ——versicolor * ——fasciogularis * ——flavigula * * * * ——leucotis * * * * ——notata * ——auricomis * * ——cratitia * * ——cockerelli * ——ornata * * ——plumula * ——flavescens * ——flava * ——penicillata * * * * ——fusca * * * ——chrysops * * * * ——filigera * Stomiopera unicolor * Plectorhyncha lanceolata * * * Meliphaga phrygia * * * * Lichnotentha picata * * Entomonhila picta * * * Previously described by Professor M 'Coy as Ptilotis lead beateri,

New South Wales. Birds of Australia— Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Conopophila albigularis * ——rufigularis * Acanthogenys rufigularis * * * * * Anthochæra inauris * ——carunculata * * * * * Anellobia mellivora * * * * * ——lunulata * Tropidorhynchus corniculatus * * * ——buceroides * ——argenticeps * ——citreogularis * * * ——sordidus * Acanthorhynchus tenuirostris * * * * * ——superciliosus * Myzomela sanguinolenta * * * * * ——erythrocephala * ——pectoralis * ——nigra * * * * * * ——obscura * Entomyza cyanotis * * ——albipennis * Melithreptus validirostris * ——gularis * * * * ——lunulatus * * * * . ——chloropsis * ——albogularis * ——melanocephalus * Myzantha garrula * * * * * ——obscura * ——lutea * ——flavigula * * Manorhina melanophrys * * * Dicæum hirundinaceum * * * * * * Nectarinia australis * Zosterops cærulescens * * * * * ——gouldi * ——luteus * Ptilorhis paradisea * * ——victoriæ * Craspedophora magnifica * Climacteris scandens * * * * ——rufa * ——erythrops * * ——melanonota * ——melanura * ——leucophæa * * * * Orthonyx spinicaudus * * * ——spaldingi * Sittella chrysoptera * * *

Australian Vertebrata—Fossil and Recent. Birds of Australia.—continued. Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Sittella leucocephala * * ——leucoptera * ——pileata * * * ——striata * Cuculus canoroides * Cacomantis pallidus * * * * * * * ——flabelliformis * * * * * * ——insperatus * * * * * ——dumetorum * ——castaneiventris * Mesocalius osculans * * * * * Lamprococcyx plagosus * * * * * * * ——minutillus * ——basalis * * * * *? Scythrops novæ-hollandiæ * * * * Eudynamis flindersi * * Centropus phasianus * * ——macrourus * ——melanurus * Cacatua galerita * * * * * * * ——leadbeateri * * * * * ——sanguinea * * ——roseicapilla * * * * * Licmetis tenuirostris * * * * ——pastinator * Calyptorhynchus banksii * * ——macrorhynchus * ——naso * ——leachii * * * * ——funereus * * ——xanthonotus * * ——baudinii * Microglossum aterrimum * Callocephalon galeatum * * Polytelis barrabandi * * * ——alexandræ * ——melanura * * * * * Aprosmictus scapulatus * * * Ptistes erythropterus * * * ——coccineopterus * Platycercus barnardi * * * * ——semitorquatus ——zonarius * ——pennantii * * ——adelaidensis * ——flaviventris * ——flaveolus * * ——palliceps * * ——cyanogenys *

New South Wales. Birds of Australia— Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Platycercus venustus * ——eximius * * * * * ——splendidus * * ——icterotis * Purpureicephalus pileatus ** Psephotus hæmatorrhous * * * * ——xanthorrhous * ——chrysopterygius * ——pulcherrimus * * ——multicolor * * * * ——hæmatonotus * * * * Euphema chrysostoma * * * * ——elegans * * * * * ——aurantia * * * * * ——petrophila * ——pulchella * * * ——splendida * * ——bourkii * * * Melopsittacus undulatus * * * * * * Calopsitta novæ-hollandiæ .. * * * * * * Pezoporus formosus * * * * * * Geopsittacus occidentalis * Lathamus discolor * * * * Trichoglossus multicolor * * * * * ——rubritorquis * ——chlorolepidotus * * * Ptilosclera versicolor * Glossopsitta australis * * * * * ——porphyrocephala * * ——pusilla * * * * * Cyclopsitta coxeni * * Ptilinopus swainsonii * * ——ewingii * Lamprotreron superbus * * Megaloprepia magnifica * * ——assimilis * Leucomelæna norfolciensis .. * * Myristicivora spilorrhoa * * Lopholaimus antarcticus * * Chalcophaps chrysochlora .. * * * ——longirostris Leucosarcia picata * * * Phaps chalcopetra * * * * * * * ——elegans * * * * * * ——histrionica * * * * * Geophaps scripta * * * ——smithii * Lophophaps plumifera * * ——ferruginea *

Australian Vertebrata—Fossil and Recent. Birds of Australia.—continued. Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Lophophaps leucogaster * Ocyphaps lophotes * * * * * Petrophassa albipennis * Erythrauchæna humeralis * * * * Geopelia tranquilla * * * * ——placida * Stictopelia cuneata * * * * * * Macropygia phasianella * * * Talegallus lathami * * * Leipoa ocellata * * Megapodius tumulus * * Turnix melanogaster * * ——varius * * * * * * ——scintillans * ——melanotus * ——castanotus * ——velox * * * * ——pyrrhothorax * * * * Pedionomus torquatus * * Coturnix pectoralis * * * * * Synocus australis * * * * * ——diemenensis ——sordidus * ——cervinus * Excalfatoria australis * * * * * Dromaius novæ-hollandiæ * * * * *? * * ——irroratus *? * Casuarius johnsonii * * Choriotis australis * * * * * * Œdicnemus grallarius * * * * * *? Esacus magnirostris * Hæmatopus longirostris * * * * * * * ——fuliginosus * * * * * * * Lobivanellus lobatus * * * * ——personatus * Sarciophorus pectoralis * * * * * Squatarola helvetica * * * * * * * Charadrius orientalis * * * * * * * Eudromias australis * * Cirrepidesmus asiaticus? * Ægialites monacha * * * * * * Ochthodromus nigrifrons * * * * * Ægialophilus ruficapillus * * * * * * * ——inornatus * * * * * * * ——-? bicinctus * * * * * * Erythrogonys cinctus * * * * * A cassowary with a red helmet and brown plumage was discovered by Wall, but no specimen preserved. A black species with horn-coloured helmet was subsequently found by Mr. R. Johnson, presented to the Museum, and first described by Krefft as C. Johnsonii.

New South Wales. Birds of Australia— Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Actiturus bartramius * Glareola grallaria * * * ——orientalis *? Himantopus leucocephalus * * * * * * Cladorhynchus pectoralis * * Recurvirostra rubricollis * * * * * * * Limosa melanuroides * ——uropygialis * * * * * * * Limnocinclus acuminatus * * * * * * * Ancylochilus subarquatus * * * * * * * Actodromas australis * * * * * * * Tringa canutus * ——tenuirostris ** Terekia cinerea * Actitis hypoleucos * * * * * * Glottis glottoïdes * * * * * * Totanus stagnatilis * Gambetta pulverulentus * Strepsilas interpres * * * * * * * Gallinago australis * * * * * * * Rhynchæa australis * * * * * * Numenius cyanopus * * * * * * * ——uropygialis * * * * * * * ——minor * * * * * Carphibis spinicollis * * * * Threskiornis strictipennis * * * * Falcinellus igneus * * * * * Platalea regia * * * * Platibis flavipes * * * * Grus australasianus * * * * * Xenorhynchus australis * * * * * Ardea cinerea * ——sumatrana * ——pacifica * * * * * * ——novæ-hollandiæ * * * * * * Herodias alba * * * * * * ——egrettoides * * * * * ——melanopus * * * * * ——garzetta * ——asha * * * * ——picata * Demiegretta jugularis * * * * * * ——greyi * Nycticorax caledonicus * * * * * * Botaurus poiciloptilus * * * * * * Butoroides flavicollis * * * * * * ——macrorhyncha * * ——javanica * Ardetta pusilla * * *

Australian Vertebrata—Fossil and Recent. Birds of Australia.—continued. Name of Species. New South Wales. Queensland. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Porphyrio melanotus * * * * * * ——bellus * Tribonyx mortierii ——ventralis * * * * * Gallinula tenebrosa * * * * ——ruficrissa * Fulica australis * * * * * Parra gallinacea * * Hypotæenidia philippensis * * * * * * Rallus brachipus * * * * * * Rallina tricolor * Eulabeornis castaneiventris * Porzana fluminea * * * * * * ——palustris * * * * * * ——-? tabuensis * * * * * * Erythra quadristrigata ** Chenopis atrata * * * * * * Cereopsis novæ-hollandiæ* * * * * * Anseranas melanoleuca * * * * Chlamydochen jubata * * * * * * Nettapus pulchellus ——albipennis * * * Tadorna radjah * * * Casarca tadornoïdes * * * * * * Anas superciliosa * * * * * * ——punctata * * * * * * Stictonetta nævosa * * Spatula rhynchotis * * * * * * ——clypeata * Malacorhynchus membranaceus .. * * * * * * Dendrocygna gouldi * * * ——eytoni * * * Nyroca australis * * * * * * * Erismatura australis * * Biziura lobata * * * * * * Larus pacificus * * * * * * Bruchigavia jamesonii * * * * * * ——gouldi * * Stercorarius catarrbactes * * * * * * Sylochelidon caspia * * * * * * Thalasseus cristatus * ——poliocercus * * * * * * ——bengalensis * Sterna melanorhyncha * * * * * ——gracilis * ——melanauchen * * Sternula nereis * * * * * * Gelochelidon macrotarsa * Gygis candida * *

New South Wales. Birds of Australia— Name of Species. New South Wales. Queens Lands. Victoria. South Australia. Western Australia. Northern Australia. Tasmania. Hydrochelidon leucopareia * * * * * Onychoprion fuliginosa * * * * * * ——panayensis * * * * * * Anous stolidus * * * * * * ——melanops * * * * * ——leucocapillus * Procelsterna albivitta * * * * * Diomedea exulans * * * * * *? * ——brachyura * * * * * * ——cauta * * * * * * ——culminata * * * * * * ——chlororhynchos * * * * * * ——melanophrys * * * * * * Phœbetria fuliginosa * * * * * * Ossifraga gigantea * * * * * * Majaqueus conspicillatus * Adamastor cinerea * * * * * * Pterodroma macroptera * ——atlantica * * * * * ——solandri * * * * * * Æstrelata leucocephala * * * * * * ——mollis *? ——leucoptera * * * * * * ——cooki * * Halobæna cœrulea * * * * * * Puffinus nugax * * * * Nectris brevicaudus * * * * * * ——carneipes * Thiellus sphenurus * * * * * Thalassocia glacialoïdes * * * * * Daption capensis * * * * * * Prion turtur * * * * * * ——ariel * * * * ——banksii * * * * * * ——vittatus * * * * * * Procellaria nereis * * * * * * Oceanites oceanica * * * * * * Fregetta melanogaster * * * * * * ——grallaria * * * Pelagodroma fregata * * * Haladroma urinatrix * * * * * Pelecanus conspicillatus * * * * * * * Phalacrocorax novæ-hollandiæ .. * * * * * ——varius * * * * * * ——leucogaster * * * * * ——melanoleucus * * * * * * ——stictocephalus * * * * * Plotus novæ-hollandiæ .. * * * * * Tachypetes aquila *

Australian Vertebrata—Fossil and Becent. Birds of Australia—continued. Name of Species. New South

Wales. Queensland. Victoria South Australia. Western Australia Northern Australia. Tasmania. Tachypetes minor * * Phaëton phœnicurus * * Sula australis * * * * * * ——cyanops * * * * * fiber * ——piscator * Podiceps australis * * * * * * ——nestor * * * * * * ——gularis * * * * * * Chrysocoma catarractes * Eudyptula minor * * * * * * ——undina *

Fossil Birds.

Ornithic remains are by no means plentiful in Australia, and such bones as have been found do not differ much from those of living genera. The Emu (Dromaius) existed, and also a species of Moa, about the size of the *Dinornis robustus*. The specimen proving the presence of the gigantic bird, a large femur, was found on the Leichhardt Downs in Queensland, 86 feet below the surface, and is now in the Australian Museum.

Reptiles.

Chelonia.—Tortoise-Tribe.

a. Hydraspididæ. Fresh-water Turtles.

The Australian Tortoises are few in number, and all belong to one family. They inhabit almost every pool, creek, or river, but the genera are not equally distributed. In New South Wales three or four species occur, which are probably also found in Victoria and South Australia. From West Australia we have to record only two kinds, the remainder inhabiting Queensland and the North Coast. Like our snakes and frogs, some of the Australian Tortoises are closely allied to South American genera.

Chelodina.

C. Colliei. West Australia.

C. oblonga West Australia.

Few specimens are known of the first species; the second is common near King George's Sound and the Southern Districts of the Swan River Colony. The shell is not produced, and affords no shelter to the very long neck of the animal. According to Dr. Gray it is found in North Australia also. Mr. George Masters has frequently taken specimens in the brakish lakes on the West coast.

C. expansa.

This is rather a large species, 11 inches long by 8 broad; it does not occur near Sydney, and inhabits the larger rivers. Coloration, uniform greenish above and yellowish below, without marble spots.

C. longicollis. Long-necked Tortoise.

This animal occurs in large numbers near Sydney; it is the most common and best known of the tribe; the lower shell is generally marbled.

C. sulcata.

Dr. Gray figures a shell of this Tortoise in his catalogue of shield reptiles; it occurs near Sydney, but is seldom captured.

Chelymys.

C. macquaria. The Macquarie Tortoise.

A large species, 11 x 8 inches, inhabiting the river after which it is named. This tortoise, has a deep narrow interrupted groove along the vertebra] line.

Elseya.

E. dentata.

The late Dr. Elsey, who accompanied Gregory's expedition, discovered this species in the Northern rivers. The Australian Museum has specimens from the Burnett and some from the Port Curtis District.

E. latisternum.

Closely allied to the last; both may be distinguished from other Australian Tortoises by a pair of tubercles or beards on the chin. This closes the fresh-water species as far as they are known to us at present; there is no doubt, however, that more exist in Australia. A few undescribed forms are even now in the Australian Museum collection.

b. CHELONIDÆ—MARINE-TURTLES.

Marine-turtles have long compressed fin-shaped non-retractile feet, the toes being enclosed in a common skin, with one or two projecting claws. The following species occur on the Australian coast:—

CAOUANA.

C. olivacea. Loggerhead Turtle. This species is carnivorous, and eats fishes, mollusca, and crustacea.

CHELONIA.

C. virgata, Green Turtle. This is the edible species which feeds on Algæ.

CARETTA.

C. squamata. Hawk-bill Turtle.
This reptile produces the Tortoise-shell, and is carnivorous.

DERMATOCHELYS.

D. coriacea. The Luth.
The Leathery Turtle or Luth is the largest of the tribe; it is herbivorous, and yields a large quantity of oil. A fine specimen in the Australian Museum, perhaps the most gigantic ever taken, was caught off Wollongong, on the coast of Illawarra, and measures 9 feet in length.

Fossil Chelonia.

The carapace of a fresh water species was found at the Caves of Wellington. It was broken in removing it, and measured about 8 inches in length.

Sauria.—Lizard-Tribe.

The Lizards of Australia are very numerous, and are distributed over every part of the country; a few species also inhabit Tasmania, and two kinds Lord Howe Island. We are indebted to Dr. John Edward Grey, F.R.S., for the first systematic catalogue of our reptiles; and his list of Lizards is still the standard guide for students. Dr. Gray enumerates 129 species, which number must have greatly increased since the list was published. To give even short descriptions of each kind is impossible in the present paper; but some characteristics will be pointed out, so that an idea may be formed of this numerous tribe of animals.

Lizards live chiefly in tropical and semi-tropical climates, and prefer dry sandy or rocky open scrub country to luxurious forests; none are venomous.

The largest grow to 30 feet; others do not exceed a few inches in length; their diet is varied, and supplied by both the animal or vegetable kingdom; in fact, we remember a fine large New Guinea species which subsists principally on leaves. Our Sleeping-lizard, "*Cyclodus gigas*," is very fond of certain berries called "jee-bungs," and during the season is often filled with them. Lizards do not reject dead animals like the Ophidians, and are therefore excellent scavengers.

The greater number lay eggs generally with a soft skin or shell, and of irregular form, which they deposit under stones, exposed to the sun, among the decaying leaves of the stag-horn fern, under bark or sand, in crevices of rocks, and in other places where heat is generated, and the embryo brought to maturity. No Saurian has ever been noticed to incubate her eggs like the Bock-snakes or Pythons. Nearly all the Lizards found in Australia are peculiar to the country.

CROCODILIDÆ.—CROCODILES.

CROCODILUS.

C. porosus.

The Australian Crocodile is a distinguished production of Queensland, where it reaches the enormous length of 30 feet, and becomes occasionally troublesome to settlers. It is vigorously hunted down, and wherever the country is opened up the Crocodiles soon retire.

TOMISTOMA.

T. Krefftii.

Another much smaller species of Crocodile, which inhabits the shallow lagoons of the interior of Queensland. It seldom exceeds 6 feet in length. Dr. J. E. Gray, F.R.S., has lately described the head of the animal, which is all we know of it at present. The form is narrow and Gavial-like. A few fine young specimens of the rare *Crocodilus pondicereanus* have lately been purchased for the Australian Museum; these were obtained near New Guinea, and are probably found in our northern waters also.

Forked-tongued Lizards.

MONITORIDÆ—MONITORS.

These Lizards are best known as Lace-lizards and "Iguanas," and are distinguished by a forked-tongue. They inhabit almost every part of Australia, but are not found in Tasmania, They burrow in the ground, and are excellent climbers and good swimmers; some grow to 8 or 9 feet in length, though the largest have but a small head in comparison with a Crocodile.

ODATRIA.

O. punctata.

Spotted Odatria, a small spotted species, about 15 inches long when full grown; inhabits North Australia.

O. ocellata.

Eyed Odatria, with larger spots and whitish margin around them. From the same district.

HYDROSAURUS.

H. Gouldii. West Australia,

H. varius. Australia generally.

H. giganteus. North Australia.

H. Bellii. North-east coast.

These are the largest of the tribe; four species are recorded, which vary much in colour, but are probably only varieties.

Flat-tongued Lizards.

CRYPTOBLEPHARUS.

C. Burtonii Western Australia.

C. lineo-ocellatus. Western Australia.

MORETHIA.

M. anomala. Western Australia.

MENETIA.

M. Greyii. Western Australia,

LERISTA.

L. lineata. East coast.

All of small size, with short or rudimentary limbs, and but little known.

PYGOPIDÆ.—SLOW-WORMS.

(With paddle-like extremities near the vent.)

PYGOPUS.

P. lepidopodus.

This Pygopus has a wide distribution, and is found all over the mainland, but not in Tasmania. It is common near Sydney, and often mistaken for a snake; the tail is very brittle and the tongue flat. Snakes have a forked tongue, and cannot reproduce their tail when lost or injured.

P. squamiceps.

A Pygopus from the west coast. There are several undescribed species in the Museum collection.

DELMA.

D. Fraseri.

A much smaller Pygopus from West Australia with rudimentary fore-limbs.

D. Grayii.

Another small species. The exact habitat is not known.

APRASIA.

A. pulchella, West Australia.

A. octolineata. Adelaide.

Small worm-like species, not found in New South Wales.

LIALIS.

L. Burtonii. Burton's Lialis.

L. punctulata. Spotted Lialis.

Two snake-like Lizards, with a pair of slight rudimentary flapper-like hind limbs; head square behind, with long and pointed snout; tail rather thick; sometimes a stripe on each side from the head down the body; scales with fine black dots. These Lizards occur of all colors, from almost white or creamy yellow to reddish brown.

They have a wide distribution, but are not found in the southern part of the mainland or in Tasmania. The eye is pale yellow, with vertical pupil, and a slight noise is heard when the animal is handled or is in pain. We remark this because very few Saurian reptiles possess a voice.

SCINCIDÆ.—SKINK-TRIBE.

The greater number of our Lizards belong to this family; they inhabit sandy or stony districts; are very quick in their movements in summer, and hybernate during the cold season under rocks or bark; seldom in holes below ground.

The first group, the genus Hinulia, contains species of 6 or 8 inches in length; the members of the genus Mocoa are smaller; all are ground Lizards.

HINULIA.

H. Gerrardii. Clarence River and Queensland.

H. elegans. Near Sydney and East coast generally.

H. Greyii. West Australia.

H. tenuis. West Australia.

H. Labillardieri. West Australia.

H. australis. Australia generally, except Victoria,

H. essingtonii. North Australia and West coast.

H. inornata. West Australia.

H. tæniolata, Near Sydney, and on the East coast generally.

A variety or perhaps a distinct species inhabits Tasmania.

H. Whitii. Sydney, Tasmania, and the East coast far to the north.
H. Richardsonii. West Australia, South Australia, and Quensland.
H. fasciolata. Queensland, Rockhampton.
H. branchialis. North-west Australia, Champion Bay.

Mocoa.

M. Guichenoti. Southern Australia, from east to west.
M. trilineata. West Australia.
M. ocellata. Australia.
M. Entrecasteauxii. Australia.
M. microtis. Swan River.
M. Owenii. East coast.

Carlia.

C. melanopogon. North Australia.

Lygosoma.

L. australe. Swan River.
L. Bougainvillii. Australia,
L. laterale. South Australia.
L. Schomburgkii. South and West Australia.
These four species have an elongate body, with short limbs; they average about 5 or 6 inches in length.

Tetradactylus.

T. decresiensis. Kangaroo Island, Swan River.

Hemiergis.

H. polylepis. South Australia,
H. decresiensis. Kangaroo Island.

Chelomeles.

C. quadrilineatus. West Australia,

Siaphos.

S. æqualis. Near Sydney, and on the East coast.
Five small species, 3 or 4 inches long, with very short limbs; the last is bronze above, bright yellow below.

Omolepida.

O. casuarinæ. Near Sydney, South-east coast, and Tasmania.

A very elongate form, with short legs and long toes; tail very long. Large specimens measure up to 14 inches and more; common near Botany.

Rhodona.

R. punctata. West Australia.
R. Gerrardii. West Australia.
R. punctato-vittata. Queensland.
Small Blind-worm, like Lizards, with tubercular fore limbs, and short legs with developed toes behind.

Soridia.

S. lineata. West Australia.

S. miopus. West Australia.

Very small snake-like Lizards, with a pair of tubercles near the vent, which represents the hind limbs.

ANOMALOPUS.

A. Verreauxii. Queensland.

MABOUIA.

M. macrura. North Australia.

TRACHYDOSAURUS.

T. rugosus.

T. asper.

Stump-tail Lizards, with formidable rugose scales. These well-known species inhabit the plains of the interior; their legs are short, and their movements slow. The body-scales are very large and rough, resembling the scales of fir cones; the colour varies considerably, from brown to almost brick red. The tail is short and flat. The female produces a pair of young ones of considerable size about the end of January. Many persons consider these Lizards highly venomous; it must be borne in mind, however, that vertebrated animals, with limbs ever so rudimentary, possess no poison fangs.

CYCLODUS.

C. gigas. Australia generally.

C. occipitalis. South Australia.

C. adelaidensis. South Australia.

C. nigroluteus. Tasmania.

The above four species are best known under the name of "Sleeping-lizards." They resemble the "Stump-tails," but their scales are smooth, the tail is round, and of moderate length, and the body generally banded with broad stripes. One species is peculiar to Tasmania; the other three inhabit the mainland. These animals have a broad bluish tongue, which is frequently thrust out; they feed on the berry called "jee-bung," and also on other berries and leaves, besides insects.

SILOBUSAURUS.

S. Stokesii. Named in honor of Capt. Stokes, E.N., one of our Australian discoverers.

This Lizard has a short rather flat tail, armed with powerful spines; it does not exceed 6 or 8 inches in length, and inhabits West Australia.

EGERNIA.

E. Cunninghami. Named in honor of Allan Cunningham, E.L.S., the Botanist and Australian Explorer.

This species is common near Sydney, but can only be captured during the cold season when hybernating under stones. The Egernia has rather a flat body, covered with prickly scales, and an armed tail, which is not so spiny as that of Stokes's Lizard. The geographical distribution of this reptile must be extensive, as specimens have been obtained near Adelaide and in Queens-land. The general colour is brown above, and red below.

TROPIDOLEPISMA.

T. Kingii. Admiral P. P. King, E.N., whose services to Australia are well known, discovered this reptile on the West coast.

It is nearly as largo as the Cyclodus or Sleeping-lizard, and rare in collections.

T. nitidum. Wide Bay, Queensland.

T. majus. Clarence River, New South Wales.

These two species are found on the East coast. C. majus exceeds the Sleeping-lizard in size; it is jet-black.

Thick-tongued or Night-lizards.

GECKOTIDÆ. GECKOS.

Of the twenty or more Night-lizards, recorded as inhabitants of Australia, only a few are well known; and these are looked upon with dread by the less informed settlers. The Geckos are distinguished by their nocturnal eyes, thick tails, and granular skin, which is without the usual imbricate scales observed in other Lizards. They pass the day under stones, in crevices of rocks, or under bark; and their feet, bearing movable disks, enable them to run up straight walls, or adhere on the roof of caves.

ŒDURA.

Œ. marmorata. "Turnip-tail;" rather a large species, found on the North-east coast.
Œ. rhombifera is recorded from West Australia.

STROPHURA.

S. spinigera, A Gecko, with very granular body, inhabits West Australia and New South Wales.

DIPLODACTYLUS.

D. vittatus.
D. ornatus.
These two species are stated to inhabit West Australia, and they are also observed near Sydney, and on the east coast generally; we consider both to be one and the same species.
D. ocellatus. West Australia.
D. bilineatus. West Australia.
D. polyophthalmus. West Australia.
D. furcosus. South Australia.
These four species are rather rare in collections.

HEMIDACTYLUS.

H. vittatus. North Australia.

PERIPIA.

P. variegata. West Australia.

GEHYRA.

G. australis. North Australia and West Australia.

GONIODACTYLUS.

G. australis. West Australia,

HETERONOTA.

H. Binoe. West and North Australia.

PHYLLURUS.

P. platurus. New South Wales, Queensland, South Australia, and probablyVictoria.
P. inermis. New South Wales, Queensland, South Australia, and probablyVictoria.
P. Myliusii. New South Wales, Queensland, South Australia, and probablyVictoria.
These species occur near Sydney, where they are much dreaded by some persons, who apply the name of "Rock-scorpion" to them. They possess a distinct shrill voice, and like most Geckos change colour from light to dark; their broad flat tails are often lost and soon reproduced; adults measure about 6 inches in length; seldom more.

AGAMIDÆ.—THE AGAMAS.

The last family of Lizards comprises animals which have a thick tongue, adhering to the gullet, the head covered with numerous small shields, and generally a long tapering not fragile tail. The eye and eyelids are well developed and the pupil is round.

CHELONASIA.

C. brunnea. West Australia.

GINDALIA.

G. Bennettii. North-west coast.

Both are rare and little known species.

PHYSIGNATHUS.

P. Lesueurii. Water-lizard.

A common species, in almost every part of Australia, of largo size, 3 or 4 feet in length, with bright yellow throat and copper-red breast; the colouration is more or less bright during certain seasons, and in young animals indistinct. This species may be seen basking on trees or logs near the water, from which it plunges in as soon as disturbed; it keeps a long time under the surface, and moves along the bottom without difficulty.

The larger species of beetles form the principal food of this Lizard.

CHLAMYDOSAURUS.

C. Kingii.

Another and most important discovery of the late Admiral P. P. King is the "Frilled-lizard," which is restricted to Queensland and the north coast. It is a well-known reptile, which has the power of erecting the loose frill-like skin round its neck in such a way that it resembles a collar, not unlike the gigantic lace collars of Queen Elizabeth's time. This Lizard stands remarkably high on her legs; and when, not long ago, Professor Huxley discussed the question of "the most reptile-like birds and birdlike reptiles," we experimented on one of these Frilled-lizards, and observed her, when startled, to rise with the fore legs off the ground, squat like a kangaroo, and hop once or twice to get out of our reach. There is certainly no other Lizard known which could take up such a position, and this observation may prove of interest to comparative anatomists.

LOPHOGNATHUS.

L. Gilbertii. From North and West Australia.

Named in honor of another gallant Australian explorer.

DIPOROPHORA.

D. bilineata. From North Australia.

Many of these specimens we have never seen, and the books in which they are described are not at our disposal; hence these brief notices.

GRAMMATOPHORA.

G. cristata. West Australia.
G. muricata. Australia generally (not Tasmania.)
G. reticulata. West Australia.
G. barbata. Australia generally.
G. angulifera. South and West Australia.
G. maculata. Australia. Bay of Sea Dogs.
G. ornata. New South Wales. South and West Australia.
G. Decresii. West Australia.
G. lævis. West Australia, Champion Bay.
G. temporalis. North Australia.

G. calotella. North Australia.

The members of the genus Grammatophora are not of large size.

The Bearded-lizard (G. barbata) is perhaps the largest and best known of this tribe; some species are arboreal, and a few prefer open plains or scrub-country. G. ornata inhabits the flats on both sides of the Murray, and is remarkable for its bright colors of blue and yellow about back and neck. The lively long-tailed grey or sometimes black Lizard, which is frequently seen basking on fences or old stumps, is G. muricata. This species changes colour as well as the rest of the Agamas, and can scarcely be distinguished from the object on which it may be resting.

TYMPANOCRYPTIS.

T. lineata. South Australia.

T. cephalus. West Australia, Nicol Bay.

MOLOCH.

M. horridus. Australian Moloch.

This reptile is one of the most singular species on record; it is covered with large and small spine-bearing tubercles in the most extraordinary manner; has a very small head and mouth, and is sluggish in its movements. The Moloch has the power to change colour, not only from light to dark but some parts also from yellow to grey or red. South Australia and Western Australia is the habitat of this strange creature.

Dr. J. E. Gray, of the British Museum, has figured about fifty species of Australian Lizards, which may be purchased at the low price of 7s. 6d. We refer those interested, to this valuable work.

Fossil Saurian Reptiles.

Many remains of fossil reptiles have been discovered in Australia during the last ten or fifteen years. Teeth of great Crocodiles were first obtained by the late Mr. Stutchbury, on the Darling Downs. The almost complete skeleton of another large Saurian (a Plesiosaurus, if we remember correctly), was found farther north, and the caves of Wellington yielded bones of the smaller species of the genus *Hydrosaurus, Cyclodus*, *Trachydosaurus*, *Tropidolepisma*, and *Grammatophora*. All these remains were however fragmentary, and have not yet been fully described.

Ophidian Reptiles.

Ophidia—Snakes.

The geographical distribution of snakes is very extensive. They inhabit almost every country from the south of Sweden and Siberia to Tasmania, None have as yet been recorded from New Zealand. India, America, and tropical Africa, appear to be the strongholds of the highly venomous species; and in these countries the dangerous Rattlesnakes, Copper-heads, Puff Adders, and Lance-heads, are met with—all of which have very long movable fangs, and belong to genera which are not found in Australia. Only five species are dangerous to man when full grown—the Black Snake *(Pseudechis porphyriacus)*, the Brown Snake (*Diemenia superciliosa*), the Brown-banded snake (*Hoplocephalus curtus)*, the Broadscaled Snake (*Hoplocephalus superbus*), and the Death Adder *(Acanthopis antarctica)*; all these retire under ground during the cold season, only a few young specimens being found under stones.

Our Death Adder is the nearest approach to the Viper, but its fangs are permanently erect, and its bite is not nearly so dangerous as that of the above-mentioned species. It is only found in the warmer parts of Australia, and not in Tasmania, South Victoria, or South-west Australia.

Only three species of snakes inhabit Tasmania, though foreign naturalists enumerate many more. Tasmanians distinguish the "Diamond Snake" (*Hoplocephalus superbus)*, the "Carpet Snake," and "Black Snake," (*Hoplocephalus curtus)*, and the "Whip Snake" (*Hoplocephalus coronoidcs)*. The first is identical with the Continental *Hoplocephalus superbus*. The second two are varieties of each other.; the young brought forth differing greatly in colour even in the same litter. The dark variety has been described as *Hoplocephalus fuscus* by M. Steindachner; but Mr. George Masters captured a large number of both kinds of snakes in Tasmania, and took from a gravid female, thirty-five young, seventeen of which were banded, and of a light colour, and the rest black.

The third Tasmanian snake is very small, only about 16 or 20 inches long, and, though venomous, not dangerous. This reptile is known as the Whip Snake (*Hoplocephalus coronoides),* and is allied to the New South Wales Black-bellied Snake (*Hoplocephalus signatus),* and to Masters' snake *(Hoplocephalus mastersii)* of South Australia.

We do not know exactly how many snakes Victoria produces. In the South, the Tiger Snake (*Hoplocephalus curtus*) and the Tasmanian Diamond Snake (*Hoplocephalus superbus)* are met with; also the little Black-bellied Snake (*Hoplocephalus signatus)* and the Black Snake *(Pseudechis porphyriacus)*. Near the New South Wales boundary, on the Murray, we find, in addition, the Death Adder (*Acanthophis antarctica),* the Green-bellied or Grey Snake *(Diemenia reticulata)*, the Brown Snake *(Diemenia superciliosa)*, and probably also the innocuous Green Tree Snake (*Dendrophis punctulata)*, and the Carpet Snake *(Morelia variegata)*.

There occur in South Australia, in addition to the above, several small venomous Ophidians; the Death Adder is, however, very scarce, and, further west, altogether absent. Near King George's Sound are found many snakes of the brown-banded species, of a very marked colour, and with the bands much more distinct than in eastern specimens; small *Hoplocephali*, and particularly *Hoplocephalus coronoides,* abound on the barren hills near the Sound, but of the Ophidio-fauna further to the north-west our knowledge is limited.

Returning to New South Wales, we observe, in addition to the specimens enumerated from Victoria, the Diamond Snake (*Morelia spilotes)*, and the Brown Tree Snake *(Dipsas fusca)*, but miss the Tasmanian Diamond Snake (*Hoplocephalus superbus)*. There is also a goodly number of small Ophidian reptiles, which will be fully described hereafter. Near the Queensland boundary, in the Clarence and Richmond River District, a new form has been discovered which differs from other Australian venomous species in having scales strongly keeled; this species has been described as *Tropidechis carinata*. A small ringed snake, with a very short head and tail, belonging to the South American genus *Brachyurophis*, is met with on the Clarence, as also are many other diminutive Ophidians which do not inhabit the southern districts. There the Diamond Snake disappears, and the sombre-coloured Carpet Snake takes its place, but no other Rock Snake is observed until the tropics are fairly entered.

Northern Queensland is rich in harmless Pythons; *Nardoa gilbertii* and *Aspidiotes melanocephalus* occur near Port Denison, and at the Gulf of Carpentaria two species of the genus *Liasis* have been observed. The harmless Fresh-water Snakes (*Cerberus australis* and *Myron richardsonii)* appear to be restricted in their habitat to the northern rivers.

A second harmless Tree Snake (*Dendrophis calligastra)* has lately been discovered near Cape York, and a variety of the Australian Brown Tree Snake (*Dipsas fusca)* extends even to New Ireland. This large island produces a second Tree Snake belonging to the genus *Dendrophis*, probably a new species, and a Python *(Liasis amethystinus*) which grows to a considerable size. The islands to the south-east of the Solomon Group are inhabited by harmless Pythons only. *Enygrus bibronii* is the most common of them, and found on the Solomon, New Hebrides, and Fiji Group, and the rearer *Bolyeria multicarinata*, which is generally but erroneously recorded by Foreign naturalists as inhabiting the shores of Port Jackson, must also be referred to the islands east of New Guinea.

A small venomous snake, allied to the Australian genus *Dieme-nia*, is peculiar to Viti Levu, the principal island of the Fijis; two other venomous species have been discovered at the Solomon Islands, but no large or dangerous venomous snake is on record from any other locality in the South Pacific. At New Caledonia, snakes have not been noticed; they are also absent from New Zealand, where a few lizards and frogs represent the reptilio fauna.

Twenty-one innocuous and forty-two venomous Australian snakes have been described, but of the latter not more than five species are dangerous to man or the larger animals, and these retire under ground for nearly five months in the year. It is, of course, most desirable to distinguish the dangerous from the harmless species by external characters; and, by a little attention to the subject, this may be easily done.

See Krefft's Snakes of Australia, page 10.

An Australian snake that is not thicker than a man's little finger, whatever may be its length, cannot by its bite endanger the life of an adult human being.

Günther states that "poisonous snakes are armed with a long canaliculated tooth in front of the upper jaw, with a duct which carries the poisonous fluid from a large gland to the tooth. This venom-gland corresponds with the parotid salivary gland of the mammals, and is situated on the side of the head, above the angle of the mouth; it is invested by a dense fibrous sheath, which is covered by a layer of muscular fibres. At the moment the snake opens its mouth to bite, these muscles compress the gland, and force its contents through the excretory duct into the channel of the venom-tooth, whence it is injected into the wound. The structure of the venom-tooth is not the same in all poisonous snakes; in some it is fixed to the maxillary-bone, which is as long, or nearly as long, as in the non-venomous snakes, and generally bears one or more ordinary teeth on its hinder portion. The venom-tooth is fixed more or less erect, is not very long, and its channel is generally visible as an external groove. The poisonous snakes with this dentition have externally a more or less striking resemblance to the non-venomous ones; and on this account they are designated as venomous Colubrine Snakes, and form the second sub-order of snakes." All our Australian venomous serpents belong to this sub-order (except the "Death Adder," *Acanthophis antarctica*, which occupies an intermediate position between the venomous Colubrine Snakes and the venomous snakes properly so called).

Australia has few Ophidian genera, when compared with other countries in the same latitude. The four Blind Snakes, two Colubrides, two Fresh-water Snakes, and three Tree Snakes, are not peculiarly Australian; while the six species of Bock Snakes are not found beyond this region—that is, not in India or the Islands of the Archipelago;—Timor, New Ireland, and the Fiji Group, being the extreme northern limits of the geographical distribution. Twenty-three species constitute the whole of the Australian non-venomous snakes; and, not counting the Blind Snakes, we have but five harmless Ophidians in New South "Wales. The second suborder, comprising the venomous Colubrine Snakes, is, however, very large; and forty-two well-defined Australian species are known at present. Nearly all the larger kinds have the power of dilating the skin of the neck, and resemble in this respect the Hooded Snakes or "Najas" of India. The Brown-banded Snake *(Hoplocephalus curtus)*, the large-scaled Snake (*Hoplocephalus superbus)*, the Black Snake (*Pseudechis porphyriacus)*, and the Orange-bellied Snake (*Pseudechis australis)*, belong to this group, and are perhaps our most dangerous Ophidians. Two other large snakes—the Brown Snake (*Diemenia superciliosa)* and the Northern Banded Snake (*Pseudonaja nuchalis)*—and all the small venomous but not dangerous species, do not distend their necks when angry, and probably bear a close resemblance to the *Elapid*æ of South America. The whole are peculiar to the Australian region, except the Short-tailed Snake (*Brachyurophis australis)*, which, according to Günther, belongs to an American genus. The real position of the Death Adder (*Acanthophis antarctica)* has not yet been pointed out; in form a true viper, this snake has its poison fangs permanently erect, and will therefore be classified according to its dentition with the *Elapidæ*. From late experiments it also appears that the venom of this reptile is less dangerous than that of the first-mentioned four species; thus, a Frog (*Hyla aurea)* and a young Sleeping-lizard *(Cyclodus gigas)*, severely bitten by a Death Adder, lived for more than twelve hours after the bite. The snake was fresh, and very vigorous, and the fangs were left in the wound for two minutes.

It will be necessary also to say a few words about the Sea Serpents which visit our coast, as they belong to the second sub-order, and are frequently overlooked in adding up the Australian fauna.

Two well-known forms—the Ringed Sea Snake *(Platurus laticaudatus)* and the Yellow-bellied Sea Snake (*Pelamis bicolor)*—are occasionally thrown ashore on the coast of New South Wales; but eight other species have been noticed further north. Sea Snakes are rare in collections; and, in arranging the riches of the Australian Museum, one of these aquatic reptiles has been found that cannot be classed with other known forms, and will constitute the type of the new genus Emydocephalus.

We arrange the Ophidian order as follows:—

First Sub-Order.—Innocuous Snakes.

Typhlopidæ.—Blind Snakes.

TYPHLOPS.

- polygrammicus. Schlegel's Blind Snake, Queensland.
- bituberculatus. Peter's Blind Snake, South Australia.
- Güntheri. Günther's Blind Snake, Queensland.
- nigrescens. Gray's Blind Snake, New South Wales.
- Rüppelli. Rüppell's Blind Snake, New South Wales.
- Preissi. Preiss' Blind Snake, New South Wales.
- bicolor. Schmidt's Blind Snake, New South Wales.
- australis. Australian Blind Snake, West Australia.
- Wiedii. Wied's Blind Snake, Queensland.

- unguirostris. Queensland Blind Snake, Queensland.

Colubridæ.—Colubers.

CORONELLA.

1. australis. Australian Coronella, North coast.

Natricidæ.—Water Colubers.

TROPIDONOTUS.

1. picturatus. Fresh-water Snake, East and North coast.

Homalopsidæ.—True Fresh-Water Snakes.

CERBERUS.

1. australis. Australian Bockadam, North coast.

MYRON.

J. Richardsonii. Richardson's Water-snake, North coast.

Dendrophidæ.—Tree Snakes.

DENDROPHIS.

- punctulata. Green Tree Snake, East and North coast.
- calligastra. Northern Tree Snake, East and North coast.

Dipsadidæ.—Night Tree Snakes.

DIPSAS.

1. fusca. Brown Tree Snake, East and North coast.

Pythonidæ.—Rock Snakes.

MORELIA.

- spilotes. Diamond Snake, South-east coast.
- variegata. Carpet Snake, Australia generally, except South Victoria,

ASPIDIOTES.

1. melanocephalus. Black-headed Snake, North-east and North coast.

LIASIS.

- Childrenii. Children's Rock Snake, North-east and North coast.
- olivacea. Olive-green Rock Snake, North coast.

NARDOA.

1. Gilbertii. Gilbert's Rock Snake, North-east coast.

Second Sub-Order.—Venomous Colubrine Snakes.

Elapidæ.—Elapides.

DIEMENIA.

- psammophis. Schlegel's Snake, North-east coast.
- olivacea. Spotted-headed Snake, North-east coast.
- reticulata. Grey Snake, Australia generally, the south excepted.
- Mülleri. Müller's Snake var., Australia generally, the South excepted.
- superciliosa. Brown Snake, Australia generally.
- torquata. Percy Island Snake, Percy Island, East coast.

PSEUDONAJA.

1. nuchalis. North Australian Brown Snake, North-west and North coast.

PSEUDECHIS.

- porphyriacus. Black Snake.
- australis. Orange-bellied Brown Snake, North-east coast.
- scutellatus. Variety of orange-bellied Brown Snake, Rock-hampton.

BRACHYSOMA.

- diadema. Scarlet-spotted Snake, Australia generally, except South coast.
- triste. MacGillivray's Snake, North coast.

FURINA.

- calonotos. Doubtful species.
- bimaculata. West Australia (?)

BRACHYUROPHIS.

1. australis. Short-tailed Snake, East coast.

HOPLOCEPHALUS.

- curtus. Brown-banded Snake, Australia generally.
- superbus. Large-scaled Snake, Western districts.

- ater. Flinder's Snake, South Australia.
- variegatus. Broad-headed Snake, South-east coast.
- Stephensii. Stephen's Snake, Port Macquarie.
- pallidiceps. Pale-headed Snake, Queensland and N. S. Vales.
- Gouldii. Gould's Snake, South-west Australia.
- spectabilis. Port Lincoln Snake, South Australia.
- coronatus. Crowned Snake, West Australia.
- coronoides. Tasmanian Snake, Tasmania.
- Mastersii. Masters' Snake, South Australia.
- signatus. Black-bellied Snake, Queensland.
- temporalis. Temporal-desert Snake, South and West Australia.
- Ramsayi. Ramsay's Snake, New South Wales.
- minor. Desert Snake, South-west Australia.
- nigriceps. Blacknaped Snake, New South Wales.
- nigrescens. Black-backed Snake, East coast.
- nigrostriatus. Black-striped Snake, North-east coast.

TROPIDECHIS.

1. carinata. Clarence River Snake.

PETRODYMON.

1. cucullatum. Red-bellied Snake.

CACOPHIS.

- Krefftii. Krefft's Dwarf Snake, East coast.
- Fordei. Forde's Dwarf Snake, Queensland.
- Harriettæ. Harriett's Dwarf Snake, Queensland.
- Blackmanii. Blackmail's Dwarf Snake, Queensland.

VERMICELLA.

- annulata. Ringed Snake, Australia generally.
- lunulata. Half-ringed Snake, North-east coast.

ACANTHOPHIS.

1. antarctica. Death Adder, Australia, Eastern and Northern portion.

DENISONIA.

1. ornata. Ornamented Snake, Queensland.

Hydrophidæ.—Sea Snakes.

PLATURUS.

- scutatus. Ringed Sea Snake, Australian seas.
- Fischeri. Fischer's Sea Snake, Australian seas.

AIPYSURUS.

- anguilliformis. Eeel-like Sea Snake, Australian seas.
- fuscus. Brown Sea Snake, Australian seas.
- lævis. Juke's Sea Snake, Australian seas.

EMYDOCEPHALUS.

- annulatus. Ringed Sea Snake, Australian seas.
- tuberculatus. Tortoise-headed brown Sea Snake, Australian seas.

DISTEIRA.

1. doliata. Dumeril's Sea Snake, Australian seas.

ACALYPTUS.

1. superciliosus. Bibron's Sea Snake, Australian seas.

HYDROPHIS.

- Stokesii. Stoke's Sea Snake, Australian seas.
- Belcheri. Belcher's Sea Snake, Australian seas.
- elegans. Elegant Sea Snake, Australian seas.
- ocellata. Eyed Sea Snake, Australian seas.

ENHYDRINA.

1. bengalensis. Bengal Sea Snake, Australian seas.

PELAMIS.

1. bicolor. Yellow-bellied Sea Snake, Australian seas.

Batrachian Reptiles.

BATRACHIA.—FROGS.

This sub-order of the class Reptilia is well represented in Australia, and about forty or more species are described. Nearly the whole of these have been observed on the East coast, so that many novelties may be expected when the interior of the country and its western parts have become better known.

Frogs are found almost everywhere, in particular near water, though at times they are seen far away from it. They are all more or less nocturnal, and may be collected by the aid of a light after dark, or during the day-time by removing the loose baric of certain trees, turning over logs or stones, or examining any crevices in the soil which are likely to be damp. The paper-like bark of a species of *Melaleuca* (the tea-tree of the settlers) harbors many Hylæ or tree-frogs; they are also found on Grass-trees (*Xanthorhoæ*), on the dwarf-palms or Zamias, and on other plants which retain moisture, or are frequented by a variety of insects. When basking in the rays of the sun they generally assume a pale colour, the pupil is contracted and scarcely visible, and the frog is supposed to be asleep. How far this is correct may be judged from bringing an insect within reach of him—he will soon wake up and swallow it. Night is however the proper time to observe them; then they are most active, and generally of a darker colour. The variable hues which pass over some of the tree-frogs in particular are truly wonderful; they will change from white to dark-grey, from bright-green to almost black, from slate-colour to a rich green, and so on, till one is bewildered how to describe them.

Frogs are voracious feeders; they devour each other at every chance, as long as the victim is but a trifle smaller than the aggressor; and the elastic bag known as a frog's stomach often contains such a varied collection of things that it will almost appear incredible to non-observers. Nothing dead is accepted by frogs—all must be living food; and they generally watch till the intended prey moves before they make a spring. If the victim is a small insect, the tongue is thrown out as quick as thought, and the fly or beetle devoured, but when too large a sound grip is retained, and the arms are freely used to work the creature down into the stomach. Large beetles, spiders, centipedes, worms, butterflies, caterpillars, snails, crabs, prawns, small snakes, and lizards have been removed from the digesting apparatus of various frogs, and, it may sound incredible, the remains of young birds were found, and on one occasion a large mouse or perhaps a young rat.

We have just tried the experiment and put a common house-mouse into a glass jar with a large green frog

(Pelodryas), secured by a glass stopper. We intended to watch but were called away, and on our return ten minutes afterwards the mouse had vanished and the frog increased in size.

Tree-frogs are safe weather-prophets, and whenever they begin to chirp or croak rain is not far off. We have not yet heard of the remains of fossil frogs being found in Australia, and with regard to the frequent discoveries of "toads in solid rock" those statements must be received with caution. All the frogs presented to the Museum, and said to be so obtained, proved to be common Sydney species.

No tailed frogs, such as Newts, Salamanders, or Olms, inhabit this country.

The *Batrachia salientia*,

The list of frogs has been compiled from Dr. Günther's excellent "Catalogue of the *Batrachia salientia*, in the collection of the British Museum," the best work published on the subject.

the tailless section, is arranged as follows:—

A. Aglossa.

Frogs without a tongue.

Myobatrachus.

M. paradoxus. Swan River.

Above brownish-grey, beneath greyish; no teeth, except two large horizontal fangs, tympanum hidden; toes, 5, free.

B. Ophistioglossa.

Frogs with a tongue, adherent in front and more or less free behind.

a Ophistoglossa Oxydactyla.

Frogs with tapering cylindrical fingers and toes.

Ranidæ.

Frogs with webbed toes, cylindrical processes of the sacral vertebra and without paratoids.

Myxopihies.

M. fasciolatus. Queensland, Clarence River, and Illawarra Districts.

Dr. Albert Günther, F.R.S., informs us that the present species is the most Rana-like form hitherto discovered in Australia. This frog has rather a large head, and exceeds the common golden frog in size. Its legs are striped, the general colour grey, lighter below.

Crinia.

C. verrucosa. Australia.

C. georgiana. King George's Sound.

C. affinis. West coast.

C. tasmaniensis. Tasmania.

C. lævis. Tasmania.

C. fasciata. East and West coast.

These are small species, about an inch in length; they inhabit swamps and shallow pools, have all their toes free, and are destitute of large glands. Nearly all have a series of tubercles on the back, and are spotted with bright pink or orange on the inner side of the hind legs. A fly often deposits her eggs behind the tympanum, or on the back of these little frogs, and we have several times noticed single individuals infested with four such larvæ. When the larva has reached maturity it drops out and the frog dies. The result of the usual transformation of the insect is a small yellow fly, to which the late W. S. Macleay has given the name of *Batrachyomia*.

We have subsequently ascertained that the same parasite infests other Australian frogs.

Cystignathidæ.

Frogs with free toes, cylindrical processes of sacral vertebra, and without paratoids.

LYMNODYNASTES.

L. dorsalis. Australia generally.

On each calf a large gland; head broad; snout of moderate length and rounded; back with a distinct vertebral line. It would be useless to try and give the true color of any frog, because the changes are numerous, and cannot be defined.

L. Dumerilii. Adelaide.

This is an allied species, perhaps identical with L. dorsalis.

L. platycephalus. Adelaide.

Probably another variety of L. dorsalis.

L. Salminii. From the Clarence River to the far north.

This new species resembles L. Krefftii, and differs from it chiefly in its two or three elongate red stripes on the back.

L. Krefftii. South-east coast.

One of the most common frogs near Sydney; not so short as the previous three species, and without a distinct dorsal stripe. General colour, dark greenish-brown; lighter below.

L. tasmaniensis. Tasmania and South-east coast.

This frog is smaller than the other members of the genus, much spotted, of a lighter colour, and the male with a yellow vocal sack; some specimens have a distinct red vertebral line. Gland on the calf absent.

L. affinis. From the Clarence River.

Closely allied to L. tasmaniensis.

L. ornatus.

A northern frog, with slightly webbed toes, a marbled back, and without a gland on the leg.

PLATYPLECTRUM.

P. marmoratum. From Port Stephens to the far north.

This is one of the rarer species, discovered through the exertions of Mr. Wilcox, at the Clarence River. It is a rather stout species, with marbled back and whitish belly. The total length is eighteen lines. It resembles *Cryptotis brevis* at first sight.

Discoglossidæ.

Frogs with webbed toes, dilated sacral vertebra, and without paratoids.

CHIROLEPTES.

C. australis. From the Clarence River to the far north.

We find the Chiroleptes widely distributed, and sometimes of a considerable size. The head is very large, perhaps the largest of any Australian frog; the fingers are free, the toes partly webbed, the back covered with some flat warts. General colour, greenish grey, slightly marbled. The tympanum or ear-disk is distinct; the tongue elliptic, and slightly notched behind. We have taken many valuable insects, and once a half-grown rat from the stomach of one of them. Some very large specimens are in the Australian Museum collection.

C. alboguttatus. Cape York.

This is a northern species, which we have not yet obtained.

Asterophrydidæ.

Frogs with free toes, with the processes of the sacral vertebra dilated, and without paratoids.

CRYPTOTIS.

C. brevis.

Head, large; body, rather stout, covered with numerous rather smooth tubercles; grey or brownish marbled above and below; fingers and toes tapering, free to the base; a pair of tooth-like processes at the symphysis of the lower jaw; total length, about 20 lines; inner side of legs pink-spotted.

Alytidæ.

Frogs with webbed toes, dilated processes of the sacral vertebra, and with paratoids.

HELEIOPORUS.

H. albopunctatus. West and North Australia,

A short and stout form, with a broad and swollen head, large eyes, short extremities, four fingers quite free, and five toes which are half-webbed. Skin of the back, granular; of the belly, smooth. Vomerine teeth in a straight, in the middle interrupted line, between the inner nostrils. Above brownish with round white spots, or more or less marbled.

UPEROLIIDÆ.

Toes and fingers free, sacral vertebra dilated, and with paratoids.

UPEROLEIA.

U. marmorata. New South Wales and West Australia.

This frog has, no doubt, a wide distribution, but nearly all our specimens came from the east coast and a few from the west. The back is more or less mottled or marbled, and there is always a bright orange spot on the inner side of the leg; general size to inch long.

Brachycephalidæ.

Small frogs with free toes, dilated sacral vertebra, and without paratoids.

PSEUDOPHRYNE.

P. australis. East coast.

One of the smallest frogs known, with bright scarlet markings on the head and back; black and white marbled below. The scarlet spots turn white in spirits. Pound in moist localities under logs and stones; never in swamps or lagoons. A much larger variety occurs near Lake Macquarie of a bright red colour above, black and white marbled below.

P. Bibronii. East coast.

Coloration more uniform than in the previous species, with no broad marks but only a few yellow spots on the back.

Engystomatidæ.

Toad-like frogs with free toes, dilated sacral vertebra, and without paratoids.

CHELYDOBATRACHUS.

C. Gouldii. West Australia.

Head protruding globular, ear-disk distinct, extremities very short, no teeth, and rather elongate tongue; skin smooth with a few flat warts; fingers and toes free.

b. Ophisthoglossa Platydactyla.

Tips of fingers and toes dilated into a disk, ear perfectly developed.

Polypedatidæ.

Frogs with webbed toes, processes of the sacral vertebra cylindrical, and without paratoids.

HYPEROLIUS.

H. bicolor. New South Wales and Queensland.

The Hyperolius is a very small frog, not exceeding an inch in length; the vomerine teeth are wanting; the colour above is a very pale green, inner side of legs bright orange, and white below.

Hylodidæ.

Toes free, sacral vertebra cylindrical, and without paratoids.

Platymantis.

P. vitianus. Fiji Islands, Solomon Group, perhaps North Australia.

We mention this species, because it is one of the few representatives of the Batrachian order found on the islands of the Pacific, A second species has been described by Dr Günther as P. platydactyla; the habitat is however not given. The first grows to a considerable size.

Hylidæ.

Toes webbed, processes of sacral vertebra dilated, and without paratoids.

Litoria.

First finger opposite to the other three. Fingers slightly webbed, toes half-webbed, ear-disk distinct.

L. Freycineti. Port Essington.

L. nasuta. North and East coast.

L. Wilcoxi. Clarence River.

These three allied species are distinguished by their elongate form and exceedingly long hind legs, which enable them to jump great distances. The colouration differs but slightly, generally brownish or red, more or less mottled or striped.

L. aurea.

This is the most common of all our frogs and the one which has the widest distribution. The popular name is "Blue-frog" or "Golden-frog," from the blue inner skin of the legs and the bronze or golden marks on the back. The ground tint is green and whitish below. A variety occurs in West Australia with marbled belly. The voice of the males is very loud, and when pinched they scream almost like a child.

L. latopalmata. Port Denison.

We believe this to be a well distributed species, which occurs at Adelaide, near Sydney, and probably in intermediate districts. The general colour is grey or reddish grey, with some black spots on the inner side of the legs.

Pelodryas.

P. cæruleus.

The largest of Australian frogs; bright green above, with a few white spots on the side; inhabits the whole of Australia and New Guinea. It is not found in Tasmania, This is the frog whose deep voice is always heard before rain. It lives about dwelling-houses, secreted under rafters or in post holes;—devours mice.

Hyla.

No finger opposite to the three others; toes completely webbed.

H. Ewingii. Australia and Tasmania.

A small frog, 1¼ or 1½ inch in length. Above greyish or reddish, more or less spotted with a darker band in the middle of the back. The Museum is in possession of specimens from almost every part of Australia, the west coast excepted.

H. Krefftii. East coast.

Rather rare in collections; colour when dark of a rich chestnut with fine black spots, and a vertebral band from between the eyes to the vent; inner sides of legs bright pink. When asleep or exposed to the sun this frog changes almost to dead white. We procure our specimens from a district covered with Zamias, and find them between the fronds of this dwarf palm; in winter under stones in moist rocky places, or under the bark of the tea-tree. The male has a loud shrill voice.

H. Verreauxii. East coast.

This tree-frog is very common almost everywhere on the eastern border; the colour is uniform greyish-brown, with a darker band from between the eyes to the vent. Males with a yellowish vocal sack. The shrill almost bird-like voice of this little frog is very remarkable after or during rain, and as deafening as the noise of the locusts. Verreaux's frog has been tamed on several occasions, and we remember one which lived for years in a shell on the mantel-piece of a hospitable homestead in the Hawkesbury District. He was in the habit of coming out at night, hopping about for a short distance, but generally preferred to wait for the flies which the children gathered for him. This specimen had grown to more than double its usual size. Another frog of the same kind, kept in a fern-case, always cried lustily when one of the larger species tried to swallow it, and being released would keep on its deliverer's shoulder for hours together.

H. jervisiensis.

Probably a variety of the former species.

H. rubella. North-east and North coast.

This is the smallest tree-frog known to us, and distinguished by a black throat.

H. phyllochroa. Australia, East and North-east coast.

A handsome green species, of small size. Common among ferns and in hot-houses.

H. infrafrenata. Cape York.

H. ingrofrenata. Cape York.

Both species have been lately described by Dr. Günther, F.R.S. The ground colour is probably green.

H. citropus. East coast.

This rare frog inhabits high trees and lays up in moist localities under stones during the cold season. It attains a considerable size, nearly as large as the golden frog. The colour varies; sometimes it is purple-grey with a wash of green on the back; at other times slate-grey or almost green; and young specimens taken during winter from under stones appear quite white. The inner side of the legs is pink. Very few examples are in collections; they occur near Sydney, at Kissing Point, Ryde, at Hunter's Hill, and other localities.

H. Peronii. Australia.

Pérons tree-frog is found principally on the east and north coast; it changes colour from light-grey with pale green spots to almost brown, the green spots still being distinct. The inner skin of the legs and the flanks are bright yellow and black.

This closes the list of Australian frogs.

Fishes.

Compiled from Dr. Günther's "Catalogue of the Fishes in the British Museum,' 8 Vols., 8vo., 1859 to 1870." The latest work published. This descriptive catalogue should be in every Australian's library; it contains the characteristics of 4,219 species, and took (as the learned author says) the best ten years of his life to complete it. The price is moderate; about £4 or £5.

(Inhabiting the Australian Seas and Rivers.)

SUBCLASS I.—Teleostei.

Fishes with ossified skeleton and completely separated vertebræ; the posterior extremity of the vertebral column either bony, or covered with bony plates. Bulb of the aorta simple, with two opposite valves at the origin; branchiæ free.

ORDER I.—Acanthopterygii.

Part of the rays of the dorsal, anal, and ventral fins not articulated, forming spines. The inferior pharyngeal bones separated. .. Air-bladder, if present, without pneumatic duct.

BERYCIDÆ.

Form of body oblong or rather elevated, compressed; eyes lateral, large; cleft of mouth extending on the sides of the muzzle, more or less oblique; villiform teeth in both the jaws, and generally on the palate. Eight or four branchiostegals. Opercular bones more or less armed. Scales ctenoid, seldom bony, or wanting. Ventral fins thoracic, with more than five soft rays, in one genus with less. Cæca pylorica in increased number.

Tropical and temperate seas.

Monocentris japonicus. Port Jackson. (Mr. Fitzhardinge.)

Trachychthys australis. Coast line. Port Jackson.

——elongatus. Australia and New Zealand.

Beryx affinis ("Nannygey"). Port Jackson.

Holocentrum operculare. North coast.

PERCIDÆ.

Body generally oblong, and covered with ctenoid scales; lateral line continuous.

Some species of *Amlassis* excepted.

Mouth in front of the snout, with lateral cleft, rarely at the lower side. Eye lateral. All or some of the opercles serrated or armed.

Except *Apsilus*.

Seven or six branchiostegals.

Cfr. *Percilia*.

Dentition complete; teeth pointed, in villiform bands, with or without canines; teeth either on the vomer, or on the vomer and palatine bones. No barbels.

Except *Pogonoperca*.

Cheek not cuirassed. Dorsal fin formed by a spinous portion and by a soft; ventrals thoracic, with one spine and five soft rays. Stomach cæcal; pyloric appendages generally in small number. Swim-bladder present, simple.

In *Pileoma* and *Boleosoma* absent.

Intestines little folded.

Carnivorous fishes, inhabiting the fresh waters and seas of all parts of the globe.

Lates colonorum. Rivers of New South Wales. "Perch" of settlers.

Psammoperca waigiensis. North coast.

Enoplosus armatus. Port Jackson.

Serranus guttatus. Port Jackson. "Blue-fish"?

——ouatalibi. Lord Howe Island.

——crapao. Port Essington.

——variolosus. Coast line.

——hexagonatus. North coast.

Plectropoma semicinctum. West coast, Port Jackson.

P. dentex. King George's Sound.

——cyanostigma. Port Jackson.

——cinctum. Norfolk Island.

——serratum. King George's Sound.

Trachypoma macracanthus. Norfolk Island.

Grammistes punctatus. Australian coast.

Myriodon waigiensis. Port Essington.

Mesoprion carponotatus. Ditto.

——waigiensis. Ditto.

——Johnii. North-west coast.

——annularis. Coast line.

Glaucosoma Bürgeri. West coast.

Ambassis Commersonii. North coast.

Mionorus lunatus. Cox's River, N.S.W.

Apogon Rüppelli. Australian seas.

——quadrifasciatus. North coast.

——fasciatus. Port Jackson. "Red mullet."

——Victoriæ; South coast.

Apogonichthys aprion. Port Essington.

Oligorus macquariensis. Australian rivers. "Murray cod," "Cod perch," grows to 80 lbs. weight.

Arripis georgianus. Port Jackson.

——salar. Tasmanian coast.

——truttaceus. Port Western.

Dules ambiguus. West coast.

——riverrina. Fresh waters of New South Wales.

PRISTIPOMATIDÆ.

Body compressed and oblong, covered with scales, the serrature of which is sometimes exceedingly fine and sometimes wanting. Lateral line continuous, not continued on the caudal fin. Mouth in front of the snout, with lateral cleft. Eye lateral, of moderate size. Five, six, or seven branchiostegals. Teeth in villiform bands, with pointed and conical canines in some of the genera; no molars or trenchant teeth in the jaws, generally no teeth on the palate; jaws toothless in two of the genera. No barbels. Cheek not cuirassed. One dorsal fin, formed by a spinous and soft portion of nearly equal development, the former of which either contains strong spines or is continuous with the latter; anal similarly developed as the soft dorsal; the lower rays of the pectorals branched; ventrals thoracic, with one spine and five soft rays. The bones of the head with a rudimentary or moderately developed muciferous system. Stomach cæcal; pyloric appendages in small or moderate number. Air-bladder present, more or less simple. Pseudobranchia; well developed.

Carnivorous fishes, without molar or trenchant teeth, inhabiting the seas of the temperate and tropical regions; a few entering fresh waters.

Therapon ellipticus. Macquarie River.
——unicolor. Gwydir River.
——servus. Cape York.
——Cuvieri. Port Jackson.
——caudovittatus. Harvey River, West coast.
Helotes sexlineatus. Port Jackson. "Yellow-tail."
——octolineatus. South-west coast.
Macquaria australasica. Bell River.
Pristipoma hasta. Cape York. Diagramma affine. North-west coast,
——polytænia. North coast.
——nitidum. Australian coast.
Hyperoglyphe porosa. Port Jackson.
Gewes subfasciatus. Ditto.
——ovatus. Ditto. (?)
——filamentosus. Cape York.
——argyreus. Port Jackson.
Scolopsis longulus. Torres Straits. Synagris furcosus. North coast.
——tæniopterus. North-east coast.
Pentapus vitta. West coast.
——paradiseus. North coast.
Erythrichthys nitidus. New Zealand, West coast of Australia.

MULLIDÆ.

Body elongate, slightly compressed, covered with large scales without or with an extremely fine serrature. Profile of the head more or less parabolic; hyal apparatus with two long barbels. Lateral line continuous. Mouth in front of the snout, with the cleft lateral and rather small. Eye lateral, of moderate size. Four branchiostegals; pseudobranchise. Dentition feeble, more or less complete. Two dorsal fins, remote from each other; anal similar to the second dorsal; ventrals with one spine and five rays. Air-bladder, if present, simple and of variable size; stomach siphonal.

Inhabitants of nearly all the tropical seas, extending in Europe on to the coasts of the temperate region. Some species entering rivers.

Upeneichthys porosus. Port Jackson.
Upeneus signatus. Port Jackson.

SPARIDÆ.

Body compressed and oblong, covered with scales, the serrature of which is exceedingly minute, and sometimes wanting. Tail not armed. Lateral line continuous, not continued on the caudal fin. Mouth in front of the snout, with lateral cleft. Eye lateral, of moderate size. Five, six, or seven branchiostegals. Either trenchant teeth in front of the jaws, or lateral series of molar teeth;

Some species of *Lethrinus* appear to make an exception, but their teeth are thick, and approach to molars; they are, moreover, readily distinguished by their naked cheek.

generally no teeth on the palate. One dorsal fin, formed by a spinous and soft portion of nearly equal development; anal with three spines; the lower rays of the pectorals generally branched, in one group simple; ventrals thoracic, with one spine and five rays. The bones of the head with a rudimentary muciferous system. Air-bladder present, often bifid posteriorly. Pseudobranchiæ well developed.

Herbi-and carnivorous fishes, inhabiting the seas of the temperate and tropical regions; a few entering rivers.

Girella tricuspidata. Port Jackson.

——simplex. Port Jackson.

——zonata. Port Jackson.

Tephræops Richardsonii. West coast. Haplodactylus punctatus. Tasmanian coast.

——arctidens.

——lophodon. Port Jackson.

Lethrinus chrysostomus. Australian seas.

Pagrus unicolor. Port Jackson. "Schnapper," "Bream."

Chrysophrys hasta, West coast.

——australis. Port Jackson. Fresh-water.

SQUAMIPINNES.

Body compressed and elevated, covered with scales, which are sometimes exceedingly finely ciliated, and sometimes smooth. Lateral line continuous, not continued on the caudal fin. Mouth in front of the snout generally small, with lateral cleft. Eye lateral, of moderate size. Six or seven branchiostegals. Dentition formed by villiform or setiform bands, without canines or incisors; some of the genera with teeth on the palate. Dorsal fin formed by a spinous and soft portion of nearly equal development; anal with three or four spines, similarly developed as the soft dorsal, and both many-rayed. The vertical fins more or less densely covered with small scales; the spinous portions sometimes not scaly. The lower rays of the pectorals branched; ventrals thoracic, with one spine and five soft rays. Stomach cæcal; pyloric appendages in moderate number; intestines generally with many convolutions. Air-bladder present, more or less simple. Pseudobranchia) well developed.

Mostly carnivorous fishes, inhabiting the seas between the Tropics, especially of the Indian region; a few entering rivers or spreading beyond the Tropics.

Chætodon sexfasciatus. Port Jackson. West coast.

Chelmo rostaratus. West coast.

——marginalis. Ditto.

Heniochus macrolepidotus. North coast.

Holacanthus semicirculatus. Ditto.

Scatophagus multifasciatus. Port Jackson.

CIRHITIDÆ.

Body compressed and oblong, covered with cycloid scales; lateral line continuous. Mouth in front of the snout, with lateral cleft. Eye lateral, of moderate size. Cheeks not cuirassed. Generally six, sometimes five, in one genus three branchiostegals. Dentition more or less complete, composed of small pointed teeth, sometimes with the addition of canines. One dorsal fin, formed by a spinous and soft portion of nearly equal development. Anal with three spines, generally less developed than the soft dorsal

Cfr. the genus *Latris*.

. The lower rays of the pectoral fins simple and generally stout; ventrals thoracic, but remote from the root of the pectorals, with one spine and five rays.

Carnivorous fishes, inhabiting the seas of the tropical regions and the southern temperate parts of the Pacific.

Chironemus georgianus. King George's Sound.

——marmoratus. West coast.

——maculosus. King George's Sound.

Chilodactylus carponemus. South coast.

——macropterus. North coast of Tasmania.

——aspersus. Tasmanian coast.

——nigricans. King George's Sound.

——gibbosus. West Australian coast.

Nemadactylus concinnus. Tasmanian coast.

Latris hecateia, Tasmanian coast.

——ciliaris. New Zealand coast.

TRIGLIDÆ.

Form of the body oblong, compressed or subcylindrical; eyes generally lateral, the cleft of the mouth extending on the sides of the muzzle; sometimes of hideous aspect—eyes directed upwards and the cleft of the mouth subvertical. Dentition feeble; teeth in villiform bands; generally without canines. Some bones of the head armed; suborbital ring articulated with the præoperculum. Epidermoid productions very variable. Two separate dorsal fins, or two distinct portions of the dorsal fin

Except in Aspidophoroides.

. Anal fin similarly developed as the soft dorsal. Ventrals thoracic, often with less than five soft rays. Five to seven branchiostegals; pseudobranchiæ; air-bladder often absent.

Carnivorous fishes, found in all seas,—a few only entering fresh waters. Some inhabit exclusively the fresh waters of both the Arctic regions. All live at the bottom of the water, being bad smimmers; a few are able to raise themselves into the air.

Scorpæna cruenta. Tasmanian coast.

——bynoensis. North-west coast.

——cardinalis. Australian seas.

——panda. West coast.

Glyptauchen panduratus. South-west coast.

Pterois volitans. Port Jackson.

——Kodipungi. Coast of Australia.

Centropogon australis. Fresh water and Australian coast.

——robustus. Ditto.

Pentaroge marmorata. Tasmanian coast.

Prosopodasys cottoides. Coast of New Zealand.

Aploactis Milesii. South-west coast.

Synancidium horridum. North coast.

Platycephalus insidiator. North coast. "Flathead."

——tasmanius. Port Jackson.

——lævigatus. Western part Port Jackson.

——inops. King George's Sound.

——nematophthalmus. Victoria. (Port Essington Settlement.)

——cirronasus. Botany Bay and Port Jackson.

Trigla kumu. Australian coast.

——polyommata. Tasmanian coast.

TRACHINIDÆ.

Body elongate, low, naked, or covered with scales. Teeth in villiform bands, with pointed and conical canines in some of the genera; no molars or trenchant teeth. The infraorbital ring does not articulate with the præoperculum. One or two dorsal fins, the spinous portion being always much less developed and shorter than the soft; the anal similarly developed as the soft dorsal; ventrals with one spine and five rays.

In *Epicopus* with one spine and six rays.

Gill-opening more or less wide; five, six, or seven branchiostegals; pseudobranchiæ. No prominent papilla near the anus. Air-bladder generally absent; pyloric appendages in moderate number, or wanting.

Carnivorous fishes, living at the bottom of the shores of nearly all the seas.

Anema monopterygium. New Zealand coast.

Kathetostoma læve. Port Arthur.

Leptoscopus macropygus. Port Jackson.

Percis nebulosa. West coast.

——nycthemera. New Zealand coast.

——colias. Ditto.

Aphritis Urvilli. Tasmanian and South Australian Rivers.

Sillago maculata. Port Jackson. "Whiting."

——punctata. South coast.

——ciliata. Cape York. "Koopooroa."—Native name.

Notothenia cornucola. New Zealand coast.

POLYNEMIDÆ.

Body compressed and oblong, covered with scales, feebly ciliated or without serrature. Lateral line continuous, continued on the tail. Mouth at the lower side of the snout, with lateral cleft. Eye lateral, large.

Seven branchiostegals; pseudobranchiæ. Villiform teeth in the jaws and on the palate. Two separate dorsals,—the second, the caudal, and the anal fin more or less covered with minute scales. Several filiform appendages below the pectoral fin, entirely free and articulated. Ventrals thoracic, with one spine and five rays. The bones of the head with the muciferous system well developed. Air-bladder varying in form and structure, and sometimes wanting.

Tropical regions of the Atlantic; East Indian seas to the Pacific. Entering rivers.

Polynemus indicus. Port Jackson.

——macrochir. Ditto.

SPHYRÆNIDÆ.

Body elongate, subcylindrical, covered with small cycloid scales; lateral line continuous. Cleft of the mouth wide, armed with strong teeth. Eye lateral, of moderate size. Seven branchiostegals; pseudobranchiæ; and air-bladder present. Two dorsal fins, remote from each other; anal similar to the second dorsal; ventrals abdominal, composed of one spine .and five rays.

Carnivorous fishes inhabiting the seas of the temperate and tropical regions. One genus only.

Sphyræna novæ-hollandiæ). Port Phillip, south coast.

——obtusata. Port Jackson.

SCOMBRIDÆ.

Body generally elongate, compressed, naked, or covered with scales of small or moderate *(Nomeina)* size; eye lateral. Dentition variable. The infraorbital bones do not articulate with the præoperculum. The spinous dorsal less developed than the soft or than the anal, either continuous with, or separate from, the soft portion, sometimes entirely absent. The soft dorsal and the anal sometimes divided posteriorly into finlets. Ventrals thoracic,

Jugular in Pteraclis *and* Hypsiptera.

sometimes rudimentary or entirely absent. No prominent papilla near the vent. Gill-opening wide; generally seven branchiostegals, pseudobranchiæ

Absent in *Coryphæna*.

, and an air-bladder

Absent in *Elacate*, *Echeneis*, *Stromateus*, and *Coryphæna*.

; pyloric appendages generally in great number.

Inhabitants of the high seas of nearly all the regions, many of the species having a very wide range.

Scomber australasicus. Port Jackson. "Mackerel."

Naucrates ductor. Ditto. "Pilot Pish."

Elacate nigra. Ditto. "King-fish."

Echeneis remora. Ditto. "Sucking-fish."

——naucrates. Ditto. Ditto.

Gasterochisma melampus. New Zealand coast.

Platystethus cultratum. Norfolk Island.

Zeus faber. Port Jackson. "Sun-fish."

Cyttus australis. South coast.

CARANGIDÆ.

Body generally compressed, oblong or elevated, covered with small scales or naked; eye lateral. Dentition variable. The infraorbital bones do not articulate with the præoperculum. The spinous dorsal less developed than the soft or than the anal, either continuous with, or separated from, the soft portion, sometimes rudimentary.

A single short dorsal in the second group.

The posterior rays of the dorsal and anal fins sometimes semi-detached. Ventrals thoracic, sometimes rudimentary or entirely absent. No prominent papilla near the vent. Gil-opening wide; generally seven branchiostegals and pseudobranchiæ;

Absent in *Lichia* and *Trachynotus*.

air-bladder present; pyloric appendages generally in great number.

In small number in *Equula* and *Lactarius*.

Inhabitants of the seas of the temperate and tropical regions, many of the species having a very wide range.

Trachurus trachurus. Port Jackson. "Horse-Mackerel."

Caranx georgianus. South-west coast.
——leptolepis. East coast.
——hippos. North coast.
Seriola gigas. Port Jackson.
Chorinemus lysan. West coast.
Temnodon saltator. Port Jackson.
Platax vespertilio. North coast.
——orbicularis. North-west coast.
Psenes leucurus. Port Jackson.
Equula edentula. Australian coast.
——interrupta. North-west coast.
Pempheris compressus. Port Jackson.

XIPHIIDÆ.

Body elongate, compressed, naked, or covered with rudimentary dermal productions. Teeth none, or rudimentary. The upper jaw (ethmoid, vomer, and intermaxillaries) much produced, sword-shaped. One or two dorsal fins, without a distinctly spinous portion. Ventrals absent, or rudimentary and thoracic. Seven branchiostegals; pseudobranchiæ and air-bladder present. Pyloric appendages in great number.

Mediterranean; open seas between or near the tropics.

Histiophorus gladius. Port Jackson. "Sword-fish."

GOBIIDÆ.

Body elongate, low, naked, or scaly. Teeth generally small, sometimes with canines. The infraorbital ring does not articulate with the præoperculum. The two dorsal fins separated, or more or less united,

No spinous portion can be distinguished in *Luciogobius*, a genus but im-perfectly known.

the spinous portion being always the less developed, and composed of flexible spines; the anal similarly developed as the soft dorsal; ventrals with one spine and five rays;

Four in *Trypauchen*, *Microcephalia* and *Trypauchenichthys*.

sometimes both ventrals united into a disk. Gill-opening moro or less narrow, the gill-membranes being attached to the isthmus; four gills; pseudobranchiæ. A prominent papilla near the vent.

No anal papilla in Asterropteryx.

Air-bladder generally absent. Pyloric appendages, none.

Carnivorous fishes, living at the bottom of the shores and of the fresh waters of the temperate and tropical regions. This family offers numerous instances of the fact that a part of the individuals of one and the same species are entirely confined to fresh waters, whilst others live in the sea.

Gobius lentiginosus. Coast of New Zealand.
——amiciensis. Coast of New Zealand.
——ornatus. North-west coast.
——criniger. North-west coast.
——bynoensis. West coast.
——papuensis. North coast.
Eleotris mogurnda. Clarence and northern rivers.
——gobioides. New Zealand rivers.
——Coxii. New South Wales rivers.
——compressus. New South Wales rivers.
——australis. New South Wales rivers.
——grandiceps. New South Wales rivers.
——brevirostris. Cape York.
——lineoeatus. Queensland rivers.

BATRACHIDÆ.

Habitus cottoid; skin naked or with small scales; the system of muciferous channels well developed. Teeth conical, small, or of moderate size. The spinous dorsal very short, the soft and the anal long. Ventrals jugular, with two soft rays; pectorals not pediculated. Gill-opening a more or less vertical slit before the pectoral, rather narrow. Gills, three; pseudobranchiæ absent; an air-bladder.

Carnivorous fishes, living on the bottom of the coasts of the tropical regions, several species advancing into the temperate seas.

Batrachus diemensis. Coasts of Australia,

——dubius. Coasts of Australia,

PEDICULATI.

Head and anterior part of the body very large, without scales. Teeth in cardiform or villiform bands. The spinous dorsal either composed of a few more or less isolated spines, or entirely absent. Ventrals jugular, with four or five soft rays, absent in Ceratias; the carpal bones prolonged, forming a sort of arm for the pectorals. Gill-opening reduced to a small foramen, situated in or near the axil. Gills two and a half, three, or three and a half; pseudobranchiæ absent.

Carnivorous fishes, inhabiting the seas of the temperate and tropical regions.

Brachionichthys hirsutus. Tasmanian coast.

Saccarius lineatus. New Zealand coast.

Antennarius marmoratus. Australian coast.

——urophthalmus. Australian coast.

BLENNIIDÆ.

Body elongate, low, more or less cylindrical, naked, or covered with scales, which are generally small. The infraorbital ring docs not articulate with the prceoperculum. One, two, or three dorsal fins, occupying nearly the whole of the back,—the spinous portion, if distinct, being as much developed as the soft, or more; sometimes the whole fin composed of spines; anal fin long; ventrals jugular,

Thoracic in Pseudoblennius.

composed of a few rays, and sometimes rudimentary or entirely absent. Air-bladder generally absent; pyloric appendages none. Pseudobranchiæ present.

Except in Dactyloscopus *and* Patæcus

Carnivorous fishes, living at the bottom of the shores of all regions; several inhabiting fresh waters.

Blennius tasmanianus. Coasts of Tasmania.

Petroscirtes filamentosus. North coast.

——punctatus. North coast.

——variabilis. Port Jackson.

Salarias Dussumieri. North coast.

——fasciatus. North coast.

——meleagris. Coast of Australia.

Patæcus fronto. Coast of Australia.

——maculatus. Port Jackson.

Clinus anguillaris. Coast of Australia.

——despicillatus. Coast of Tasmania.

Cristiceps argentatus. Port Jackson.

——nasutus. Port Jackson.

——roseus. West coast.

——australis. West coast.

Tripterygium varium. Coast of New Zealand.

——nigripinne. Coast of New Zealand.

——Forsteri. Coast of New Zealand.

——medium. Coast of New Zealand.

——fenestratum. Coast of New Zealand.

ACANTHOCLINIDÆ.

Body elongate, low, compressed, covered with small scales. One dorsal fin, occupying nearly the whole of the back, by far the greater part being composed of spines; anal fin long, with the number of the spines exceeding that of the rays; ventrals jugular, composed of a few rays. Dentition complete. Four gills, pseudo-branchiæ. Air-bladder, none; pyloric appendages, none.

Coasts of New Zealand. Carnivorous fishes.

Acanthoclinus littoreus. Coast of New Zealand.

TEUTHIDIDÆ.

Body compressed and oblong, covered with very small scales. Lateral line continuous; tail not armed. Eye lateral, of moderate size. A single series of trenchant incisors in the jaws; palate smooth. One dorsal fin, the spinous portion being the more developed; anal with seven spines. Ventral fins thoracic. Pseudobranchiæ well developed.

Herbivorous fishes, inhabiting the tropical seas of the East Indian region and the western parts of the Pacific.

Teuthis javus. Hobson's Bay.

——tumifrons. West coast.

——nebulosa. Australian coast, Port Jackson.

ACRONURIDÆ.

Body compressed, oblong or elevated, covered with minute scales. Lateral line continuous; tail generally armed with one or more bony plates or spines, which are more developed with age, and frequently absent in very young individuals. Eye lateral, of moderate size. Mouth small; a single series of more or less compressed, sometimes denticulated, sometimes tapering incisors in each jaw; palate smooth. One dorsal fin, the spinous portion being the less developed; anal with two or three spines; ventral fins thoracic. Pseudobranchiæ well developed; air-bladder present, forked posteriorly. Intestines with more or less numerous circumvolutions.

Seas between the tropics. Herbivorous fishes.

Acanthurus triostegus. West coast.

——grammoptilus. North coast.

——triostegus. West coast.

NANDIDÆ.

Body oblong, compressed, covered with scales. Lateral line interrupted. Dorsal fin formed by a spinous portion and by a soft, the latter being the less developed; anal fin with three spines, and with its soft portion similar to the soft dorsal. Ventral fins thoracic, with one spine and five or four soft rays. Dentition more or less complete, generally feeble. Five or six branchios-tegals; gills, four, or three and a half; pseudobranchiæ present in the marine, absent or hidden in the fresh-water genera. An air-bladder. No superbranchial organ.

Carnivorous fishes.

Plesiops cæruleo-lineatus. Australian coast.

Trachinops tæniatus. Port Jackson.

ATHERINIDÆ.

Body more or less elongate, subcylindrical, covered with scales of moderate size; lateral line indistinct. Cleft of the mouth of moderate width, with the dentition feeble. Eye lateral, well developed. Gill-opening wide; four gills; pseudobranchiæ; five or six branchiostegals. Two dorsal fins; the spines of the first feeble; the second of moderate length; anal like the soft dorsal, or rather longer. Ventral fins abdominal, with one spine and five rays. Vertebras very numerous in the caudal and abdominal portions.

Carnivorous fishes inhabiting the seas of the temperate and tropical regions; several species entering or living in fresh water.

Atherina hepsetoides. Tasmanian coast.

——microstoma. Tasmanian coast.

——presbyteroides. Tasmanian coast.

——pinguis. Port Jackson.

——endrachtensis. South-west coast.

——pauciradiata. North-west coast.

Atherinichthys jacksoniana. Port Jackson.——nigrans. Northern rivers.

MUGILIDÆ.

Body more or less oblong and compressed, covered with cycloid scales of moderate size; lateral line, none. Cleft of the mouth narrow or of moderate width, without or with feeble teeth. Eye lateral, well developed. Gill-opening wide; four gills; pseudo-branchiæ; five or six branchiostegals. Two short dorsal fins, the anterior with four stiff spines; anal a little longer than the dorsal opposite. Ventral fins with one spine and five rays, abdominal, suspended from the elongate caracoid bone. Number of vertebras twenty-four.

Fresh waters and coasts of all the temperate and tropical regions. Feeding on soft organic substances or very small animals.

Mugil dobula. Australian rivers and coast.

——waigiensis. North-west coast.

——compressus. Rivers and coast of New South Wales.

——Peronii. North-west coast.

Agonostoma Forsteri. Australian coast.

Myxus elongatus. Port Jackson.

TRICHONOTIDÆ.

Body elongate, subcylindrical, covered with cycloid scales of moderate size. Eyes directed upwards. Teeth in villiform bands. The infraorbital ring does not articulate with the præoperculum. One long dorsal fin, with articulated, not branched rays, and without a distinct spinous portion; anal long; ventrals jugular, with one spine and five rays. Gill-opening very wide, seven branchiostegals; pseudobranchiæ. No prominent papilla near the anus. Air-bladder and pyloric appendages absent. Caudal vertebræ much more numerous than those of the abdominal portion.

Carnivorous fishes, living near the shores of the East Indian Archipelago and of New Zealand.

Hemerocoetes acanthorhynchus. Coast of New Zealand.

GOBIESOCIDÆ.

Body rather elongate, anteriorly depressed, naked. Teeth conical or compressed. A single dorsal fin on the tail, without spinous portion; anal short; ventrals widely apart from each other, with one spine hidden in the skin and four (five) rays. A large adhesive apparatus between them, the posterior portion of which is suspended on the caracoid bones, which are partly free, in the axil of the pectoral fins. Three gills or three and a half. Air-bladder absent. Intestinal tract short, wide, without pyloric appendages.

Carnivorous fishes. Most of the species live in the seas of the temperate regions of both hemispheres; two are known to inhabit seas between the tropics.

Diplocrepis puniceus. Coast of New Zealand.

Crepidogaster tasmaniensis. Coast of Tasmania.

——spatula. Swan River.

Trachelochismus pinnulatus. Coast of New Zealand.

CENTRISCIDÆ.

Form of the body compressed, oblong or elevated; the anterior bones of the skull are much produced, and form a long tube terminating in a narrow mouth. Teeth, none. Body either covered with a cuirass or with non-confluent ossifications; scales, none, or small. Two dorsal fins; the spinous short, and with one of the spines strong; the soft and the anal of moderate extent; ventral fins small, without spine, or rudimentary, abdominal. Branchiostegals three or four; air-bladder large, four gills and pseudobranchiæ;. Pyloric appendages, none; intestinal tract rather short.

Mediterranean and north-eastern shores of the Atlantic. Eastern coasts of Africa. Coasts of China, Japan, and Australia.

Centriscus humerosus. Australian coast.

FISTULARIDÆ.

Fishes of greatly elongated form; the anterior bones of the skull are much produced, and form a long tube terminating in a narrow mouth. Teeth small. Parts of the skeleton and dermal productions form external mails; scales none, or small. The spinous dorsal fin is either formed by feeble isolated spines or entirely absent; the soft dorsal and anal of moderate length; ventral fins abdominal, composed of six rays, without spine; they are separate from the pubic bones, which remain attached to the humeral arch. Branchiostegals, five; air-bladder large; four gills; pseudobranchiæ;. Pyloric appendages in small number; intestinal tract short.

Tropical parts of the Atlantic and of the Indian Oceans.

Fistularia serrata. Port Jackson.

ORDER II.—Acanthopterygii Pharyngognathi.

The inferior pharyngeal bones are coalcsced, with or without a medium longitudinal suture. Part of the rays of the dorsal, anal and ventral fins not articulated, forming spines. Air-bladder without pneumatic duct.

POMACENTRIDÆ.

Body compressed, more or less short, covered with ctenoid scales. Dentition feeble, palate smooth. The lateral line does not extend to the caudal fin or it is interrupted. One dorsal fin, with the spinous portion as well developed as the soft, or more. Two, sometimes three, anal spines; the soft anal similar to the soft dorsal. Ventral fins thoracic, with one spine and five soft rays. Branchiostegals five, six, or seven; gills three and a half; pseudobranchiæ and air-bladder present. Pyloric appendages in small number; intestinal tract of moderate length. Tropical seas.

Pomacentrus unifasciatus. Port Jackson.
Dascyllus aruanus. Coast of New Zealand.
Parma microlepis. Port Jackson.
——squamipinnis. Ditto.
——polylepis. Norfolk Island.
Heliastes hypsilepis. Port Jackson.

LABIUM.

Body oblong or elongate, covered with cycloid scales. The lateral line extends to the caudal or is interrupted. One dorsal fin, with the spinous portion as well developed as, or more than the soft; the soft anal similar to the soft dorsal. Ventral fins thoracic, with one spine and five soft rays. Palate without teeth; only one lower pharyngeal bone without median suture. Bran- chiostegals, five or six; gills, three and a half; pseudobranchiæ and air-bladder present. Pyloric appendages, none; stomach without cæcal sac. Marine fishes inhabiting the seas of the temporal and tropical regions.

Xiphochilus fasciatus. Cape York.
Chœrops macrodon. North-east coast.
——cyanodon. North coast and Harvey River (Fresh-water).
Labrichthy's celidota. Australian coast.
——bothryocosmus. Australian coast.
——psittacula. Tasmanian coast.
——inscripta. Norfolk Island.
——laticlavius. Tasmanian coast and South-west coast.
——luculenta, Port Jackson.
——tetrica. South and West coast.
——parila. Coasts of Australia.
——punctulata. Swan River.
Cheilinus radiatus. North-east coast.
Hemigymnus melanopterus. North-east coast.
Stethojulis strigiventer. North coast.
Platiglossus miniatus. North-east coast.
Julis aneitensis. North-east coast.
Coris auricularis. South and West coast.
——lineolata. West coast.
Odax balteatus. Tasmanian coast and Port Jackson "Kelp-fish."
——frenatus. Tasmanian coast and Port Jackson "Kelp-fish."
——Richardsonii. Tasmanian coast and Port Jackson "Kelp-fish."
——radiatus. West coast.
——vittatus. New Zealand.
Olistherops cyanomelas. King George's Sound.
Siphonoguathus argyrophanes.

GEREIDÆ.

Body compressed, elevated or oblong, covered with sparoid scales. Lateral line continuous. Dorsal fin with the spinous and soft portions equally developed, and with a scaly sheath along the base, which is separated by a groove from the other scales. Anal with three (two) spines and with the soft portion similar to the soft dorsal. Ventral fins thoracic, with one spine and five soft rays. Teeth small, palate toothless. The lower pharyngeal bones are firmly united by a suture. Branchiostegals, six; gills, four; pseudobranchiæ present; glandular; air-bladder present. Stomach without caeca! sac; pyloric appendages, rudimentary. Oviparous.

Tropical seas.

Gerres subfasciatus. Port Jackson.

——ovatus. Australian coast.

——filamentosus. North coast.

ORDER III.—Anacanthini.

Vertical and ventral fins without spinous rays

With the exception of Gadopsis.

. The ventral fins, if present, are jugular or thoracic. Air-bladder, if present, without pneumatic duct.

GADOPSIDÆ.

A small portion of the dorsal and anal fins is formed into true spines.

Gadopsis marmoratus. Fresh waters of Australia and Tasmania, "Black-fish."

GADIDÆ.

Body more or less elongate, covered with small smooth scales. One, two, or three dorsal fins, occupying nearly the whole of the back; rays of the posterior dorsal well developed; one or two anal fins. Caudal free from dorsal to anal, or, if they are united, the dorsal with a separate anterior portion. Ventrals jugular, composed of several rays, or, if they are reduced to a filament, the dorsal is divided into two. Gill-opening wide; the gill membranes generally not attached to the isthmus. Pseudo-branchiæ none or glandular, rudimentary. An air-bladder and pyloric appendages generally present.

Mostly inhabitants of the sea. Arctic and temperate regions.

Lotella rhacinus. Coast of New Zealand.

——bacchus. Ditto.

——callarias. Port Jackson.

OPHIDIIDÆ.

Body more or less elongate, naked or scaly. Vertical fins generally united into one; no separate anterior dorsal or anal; dorsal occupying the greater portion of the back. Ventral fins rudimentary (reduced to a filament) or absent, jugular (except in Brotulophis). Gill-openings wide, the gill-membranes not attached to the isthmus. Pyloric appendages none, or in small number.

Inhabitants of the seas of nearly all regions. Fierasfer Homei. Australian coast.

Congrogadus subducens. North and West coast.

Macruridæ.

Body terminating in a long compressed, tapering tail, covered with spiny keeled or striated scales. One short anterior dorsal, the second very long, continued to the end of the tail, and composed of very feeble rays; anal of an extent similar to that of the second dorsal; no caudal. Ventral fins thoracic or jugular, composed of several rays. Pseudo branchiae none; sis or seven branchiostegals. Air-bladder present. Pyloric appendages numerous.

Temperate parts of North Atlantic, Mediterranean, Japanese, and Australian seas.

Macrurus australis. Tasmanian coast.

Coryphænoides denticulatus. South coast.

PLEURONECTIDÆ.

Body strongly compressed, flat, with one of the two sides, which is always turned upwards, coloured, whilst the other is colourless and only sometimes spotted. Both eyes are placed on the coloured side; and although the bones are present on both sides of the skull they are not equally developed or symmetrical.

This is unique in the division of vertebrate animals.

Dorsal and anal fins exceedingly long, without divisions. Gills four; pseudobranchiæ well developed; air-bladder none.

Carnivorous fishes, living on the sandy bottom of the coasts of all the regions; many ascend rivers.

Brachypleura novæ-zeelandiæ. New Zealand coast.

Pseudorhombus Russellii. North coast.

Ammotretis rostratus. Tasmanian coast.

Rhombosolea monopus. Australian coast.

——tapirina. Ditto.

——leporina. Ditto.

Peltorhamphus novæ-zeelandiæ. Norfolk Island.

Solea microcephala. Port Jackson.

Order IV.—Physostomi.

All the fin-rays articulated; only the first of the dorsal and pectoral fins is sometimes more or less ossified. The ventral fins, if present, are abdominal, without spine. Air-bladder, if present, with a pneumatic duct.

Siluridæ.

Skin naked or with osseous scutes, but without scales. Barbels always present; maxillary bone rudimentary, almost always forming the base of a maxillary barbel. Margin of the upper jaw formed by the intermaxillaries only. Suboperculum absent. Air-bladder generally present, communicating with the organ of hearing by means of the auditory ossicles. Adipose fin present or absent.

Inhabitants of the fresh waters of all the temperate and tropical regions, some entering the salt water, but keeping near the coast.

Plotosus anguillaris. Moreton Bay. "Cat-fish."

Neosilurus hyrtlii. Queensland Rivers.

Copidoglanis tandanus. Port Jackson.

——obscuras. Port Jackson.

——brevidorsalis. North-west coast.

Cnidoglanis megastoma. Port Jackson.

——lepturus. Port Jackson.

——microcephalus. North-west coast.

Arius australis. Clarence River.

Arius venaticus. North-west coast.

Arius vertagus. North-west coast.

Haplochitonidæ.

Body naked or scaly. Margin of the upper jaw formed by the intermaxillary; opercular apparatus complete. Barbels, none. Gill-opening wide; pseudobranchiæ well developed. Air-bladder simple. Adipose fin present. Ovaries laminated; the eggs fall into the cavity of the abdomen, there being no oviduct. Pyloric appendages, none.

Fresh-water fish from the temperate parts of South America and South Australia, representing the Salmonoids of the northern hemisphere.

Prototroctes marama. Rivers of Southern Australia. "Herring." "Grayling."

Scopelidæ.

Body naked or scaly. Margin of the upper jaw formed by the intermaxillary only; opercular apparatus sometimes incompletely developed. Barbels, none. Gill-opening, very wide; pseudobranchiæ well developed. Air-bladder, none. Adipose fin present. The eggs are enclosed in the sacs of the ovarium, and excluded by oviducts. Pyloric appendages few in number or absent. Intestinal tract very short.

Pelagic or deep-sea fishes. Splendid food fishes.

Saurus myops. Port Jackson.

Saurida undosquamis. North-west coast.

Aulopus purpurissatus. Port Jackson. "Sergeant Baker."

Alepidosaurus ferox. Port Jackson.

SALMONIDA.

Body covered with scales, head naked; barbels none. Margin of the upper jaw formed by the intermaxillaries mesially, and by the maxillaries laterally. Belly rounded. A small adipose fin behind the dorsal. Pyloric appendages generally numerous, rarely absent. Air-bladder large, simple; pseudobranchiæ present. The ova fall into the cavity of the abdomen before exclusion.

Fresh waters of the temperate and arctic regions of the northern hemisphere, many species periodically descending to the sea. One genus from New Zealand; two genera pelagic.

Retropinna Richardsonii. Rivers of New Zealand.

Retropinna (?). Rivers of New South Wales.

GALAXIDÆ.

Body naked; barbels none. Margin of the upper jaw chiefly formed by the intermaxillaries, which are short and continued by a thick lip, behind which are the maxillaries. Belly rounded. Adipose fin none; dorsal opposite to anal. Pyloric appendages in small number. Air-bladder large, simple; pseudobranchiæ none. The ova fall into the cavity of the abdomen before exclusion.

Fresh waters of the temperate zone of the southern hemisphere.

Galaxias alepidotus. Rivers of New Zealand.

——truttaceus. Rivers of Tasmania.

——olidus. Rivers of New South Wales.

——fasciatus. Rivers of New Zealand.

——attenuatus. Rivers of Tasmania.

——Krefftii. Rivers of New South Wales.

——punctatus. Rivers of New South Wales.

——brevipinnis. Rivers of New Zealand.

——Scottii. Rivers of New South Wales.

——Waterhousii. Rivers of South Australia.

Neochanna apoda. Rivers of New Zealand.

SCOMBRESOCIDÆ.

Body covered with scales; a series of keeled scales along each side of the belly. Margin of the upper jaw formed by the intermaxillaries mesially, and by the maxillaries laterally. Lower pharyngeals united into a single bone. Dorsal fin opposite the anal, belonging to the caudal portion of the vertebral column. Adipose fin none. Air-bladder generally present, simple, sometimes cellular, without pneumatic duct. Pseudobranchiæ hidden, glandular. Stomach not distinct from the intestine, which is quite straight, without appendages.

Marine fishes of the temperate and tropical zones, many species entering or inhabiting fresh waters. Belone depressa. North-west coast.

——ferox. Port Jackson.

——Krefftii. Hunter River.

Scombresox Forsterii. New Zealand.

Hemirhamphus regularis. Australian coast. "Gar-fish."

——robustus. Tasmania.

——intermedius. Tasmania.

Arrhamphus sclerolepis. Fitzroy River, Queensland.

Exocœtus robustus. Australian coast.

——nigripinnis. West coast.

GONORHYNCHIDÆ.

Head and body entirely covered with spiny scales; mouth with barbels. Margin of the upper jaw formed by the intermaxillary, which, although short, is continued downwards as a thick lip, situated in front of the maxillary. Adipose fin none; the dorsal fin is opposite to the ventrals, and short, like the anal. Stomach simple, without blind sac; pyloric appendages in small number. Pseudobranchiæ; air-bladder absent. Gill-openings narrow.

Southern temperate parts of the Atlantic and Pacific; Japan. Gonorhynchus Greyi. Australian coast.

OSTEOGLOSSIDÆ.

Body covered with large hard scales, composed of pieces like mosaic; head scaleless, its integuments nearly entirely rephced by bone; lateral line composed of wide openings of the mucusduct. Margin of the upper jaw formed by the intermaxillaries mesially, and by the maxillaries laterally. The dorsal fin belongs to the caudal portion of the vertebral column, is opposite and very similar to the anal fin; both approximate to the rounded caudal (with which they are abnormally confluent). Gill-openings wide; pseudobranchiæ none; air-bladder simple or cellular. Stomach without cæcal sac; pyloric appendages two.

Large fresh-water fishes of the tropics.

Osteoglossum Leichhardti. Queensland, Rivers Dawson and Burdekin. The true "Barramundi" (Masters).

CLUPEIDÆ.

Body covered with scales; head naked; barbels none. Abdomen frequently compressed into a serrated edge. Margin of the upper jaw formed by the intermaxillaries mesially, and by the maxillaries laterally; maxillaries composed of three, sometimes movable, pieces. Opercular apparatus complete. Adipose fin none. Dorsal not elongate; anal sometimes very long. Stomach with a blind sac; pyloric appendages numerous. Gill-apparatus much developed, the gill-openings being generally very wide. Pseudo-branchia) large, except in *Megalops*. Air-bladder more or less simple.

Inhabitants of all seas, many species entering fresh waters.

Engraulis encrasicholus. Tasmania and New Zealand.

Chatoëssus Erebi. Northern Australian Rivers Murray, Clarence, Burnett, Fitzroy, &c. "Bony-bream," Burnett settlers (Masters).

Clupea novæ-hollandiæ. Northern Rivers of New South Wales. "Sprat."

Clupea sagax. Australian coast.

Spratelloides delicatulus. Ditto.

Megalops cyprinoides. Fresh waters of North coast.

Chanos salmoneus. North coast.

SYMBRANCHIDÆ.

Body elongate, naked or covered with minute scales; barbels none. Margin of the upper jaw formed by the intermaxillaries only, the well-developed maxillaries lying behind and parallel to them. Paired fins none. Vertical fins rudimentary, reduced to more or less distinct cutaneous folds. Vent situated at a great distance behind the head. Ribs present. Gill-openings confluent into one slit situated on the ventral surface. Air-bladder none. Stomach without cæcal sac or pyloric appendages. Ovaries with oviducts.

Fresh waters and coasts of Tropical America and Asia. Coasts of "Western Australia and Tasmania.

Chilobranchus dorsalis. Tasmanian fresh waters, and North coast of Australia.

MURÆNIDÆ.

Body elongate, cylindrical or band-shaped, naked or with rudimentary scales. Vent situated at a great distance from the head. Ventral fin none. Vertical fins, if present, confluent, or separated by the projecting tip of the tail. Sides of the upper jaw formed by the tooth-bearing maxillaries, the fore part by the intermaxillary, which is more or less coalescent with the vomer and ethmoid. Humeral arch not attached to the skull. Stomach with a blind sac; no pyloric appendages. Organs of reproduction without efferent ducts.

Inhabitants of the fresh waters and seas of the temperate and tropical regions.

Anguilla Reinhardtii. Australian fresh waters. "Eel."

——latirostris. New Zealand.

——australis. New Zealand and Tasmania.

Conger vulgaris. Tasmania. "Conger eel."

Congromuræna habenata. New Zealand.

Muræesox cinereus. Hunter River.

Ophichthys cephalozona. North coast.

——calamus. West coast.

——cancrivorus. North coast.

Muræna Helena. Australian coast.

——macassariensis. North coast.

——Nubila. Norfolk Island.
——Richardsoni. West coast.
——flavomarginata. Norfolk Island.
——callorhyncha. West coast.
——afra. Port Jackson.
——nebulosa. East coast.
Leptocephalus Morrisi. East coast.

PEGASIDÆ.

Body entirely covered with bony plates, anchylosed on the trunk and movable on the tail. Barbels none. The margin of the upper jaw is formed by the intermaxillaries and their cutaneous prolongation, which extends downwards to the extremity of the maxillaries. Gill-cover formed by a large plate, homologous to the operculum, præoperculum, and suboperculum; interoperculum a long fine bone, hidden below the gill-plate. One rudimentary branchiostegal. The gill-plate is united with the isthmus by a narrow membrane; gill-opening narrow in front of the base of the pectoral fin. Gills four, lamellated. Pseudo-branchiæ and air-bladder absent. One short dorsal and anal fin, opposite to each other. Ventral fins present. Ovarian sacs closed.

Indian Ocean and Australian seas.

Pegasus natans. Moreton Bay.
——lancifer. Tasmanian coast.

ORDER V.—Lophobranchii.

The gills are not laminated, but composed of small rounded lobes, attached to the branchial arches. Gill-cover reduced to a large simple plate. Air-bladder simple, without pneumatic duct. A dermal skeleton, composed of numerous pieces arranged in segments, replaces more or less soft integuments. Muscular system not much developed. Snout produced. Mouth terminal, small, toothless, formed as in Acanthopterygians.

SYNGNATHIDÆ.

Gill-openings reduced to a very small opening near the upper posterior angle of the gill-cover. One soft dorsal fin; no ventrals, and sometimes one or more of the other fins also absent.

Chiefly marine fishes, occurring in all parts of the tropical and temperate regions; many species entering fresh waters.

Syngnathus semifasciatus. Tasmania.
——pelagicus. South coast.
——Grayi. North coast.
——margaritifer. Port Jackson.
——pœcilolæmus. South coast.
Ichthyocampus scalaris. West coast.
——filum. New Zealand.
Nannocampus subosseus. West coast.
Stigmatophora argus. Port Jackson.
——nigra. Australian coast.
Gastrotokeus biaculeatus. Cape York.
Solenognathus Hardwickii. West coast.
Phyllopteryx foliatus. Port Jackson.
——eques. Port Lincoln.
Hippocampus abdominalis. Tasmanian coast.
——antiquorum. North coast.
——breviceps. South coast.
——angustus. Ditto.
——novæ-hollandiæ. Port Jackson.

ORDER VI.—Plectognathi.

Teleosteous fishes with rough scales, or with ossifications of the cutis in the form of scutes or spines; skin sometimes entirely naked. Skeleton incompletely ossified, with the vertebra) in small number. Gills pectinate; a narrow gill-opening in front of the pectoral fins. Mouth narrow; the bones of the upper jaw generally firmly united. A soft dorsal fin, belonging to the caudal portion of the vertebral column, opposite to the anal; sometimes elements of a spinous dorsal besides. Ventral fins none, or reduced to spines. Air-bladder without pneumatic duct. Nearly all are marine fishes.

SCLERODERMI.

Snout somewhat produced; jaws armed with distinct teeth in small number; skin with scutes or rough. The elements of a spinous dorsal and ventral fins generally present. Marine fishes of the temperate or tropical regions.

("LEATHER-JACKETS.")

Tricanthus biaculeatus. North coast.
Balistes stellatus. North-east coast.
——niger. North coast.
Balistes aculeatus. North coast.
——verrucosus. North coast.
Monacanthus partialis. North coast.
——ogirostris. North coast.
——prionurus. North coast.
——trossulus. West coast.
——oculatus. South coast.
——megalurus. Port Jackson.
——tomentosus. Port Jackson.
——sulcatus. East coast.
——granulosus. Port Jackson.
——rudis. Tasmania.
——Ayraudi. Port Jackson.
——penicilligrus. Port Jackson.
——hippocrepis. Port Jackson.
——Gunnii. Tasmania.
——convexirostris. New Zealand.
——multiradiatus. South Australia.
——trachylepis. East coast.
——Peronii. South coast.
——Brownii. South coast.
——spilomelanurus. Port Jackson.

Group of OSTRACIONTINA—("COFFIN FISHES.")

Ostracion concatenatus. Port Jackson.
——cubicus. South Australia.
——cornutus. North coast.
——rhinorhynchus. North-west coast.
——diaphanus. Port Jackson.
Aracana aurita. South coast.
——ornata. South coast.
——lenticularis. Port Jackson.

GYMNODONTES.

Body more or less shortened. The bones of the upper and lower jaw are confluent, forming a beak with a trenchant edge, without teeth, with or without median suture. A soft dorsal, caudal, and anal are developed,—approximate. No spinous dorsal. Pectoral fins, no ventrals.

Marine fishes of the temperate and tropical regions. Some species confined to fresh-water.

PORCUPINE-FISHES, OR TOAD-FISHES.—(Flesh poisonous.)

Tetrodon hypselogenion. Port Jackson.

——Hamiltonii. Ditto.
——Richei. South Australia.
Tetrodon immaculatus. Port Jackson.
——hispidus. East coast.
Diodon hystrix. Port Jackson.
——maculatus. Port Jackson.
Chilomycterus jaculiferus. New Zealand.
Dicotylichthys punctulatus. Port Jackson.
Atopomycterus nychthemerus. South coast.

SUB-CLASS II.—Dipnoi.

Fishes with the skeleton partly cartilaginous, partly osseous; no occipital condyle. Bulbus arteriosus with two longitudinal valves; air-bladder double, lung-like, communicating by a duct and glottis with the hæmal side of the œsophagus, with a pulmonary vein. A narrow gill-opening on each side, with a rudimentary gill-cover; some of the branchial arches without gills; gills free, membranaceous. Nostrils double on each side. Intestine with a spiral valve. Optic nerves not decussating. Oviducts distinct. Ventral fins abdominal.

SIRENOIDEI.

Body eel-shaped, covered with cycloid scales. Vertical fins a continuous border to the compressed tapering tail. Pectoral and ventral fins subulate. A single maxillary dental plate is opposed to a single mandibular one. Scapular arch attached to the occiput. Vent not in the median line. No pseudobranchiæ.

Fresh-water fishes of tropical Africa, America, and Australia.

Ceratodus Forsteri. Burnett River, Queensland.
——miolepis. Mary River, Queensland.

This is not the true "Barramundi"; the native name is "Teevine" or "Redfish" *(Masters)*.

SUB-CLASS III.—Ganoidei.

Not yet discovered in Australia,

SUB-CLASS IV.—Chondropterygii.

Skeleton cartilaginous; skull without sutures. Body with medial and paired fins, the hinder pair abdominal; caudal fin with produced upper lobe. Gills attached to the skin by the outer margin, with several intervening gill-openings; rarely one gill-opening only. No gill-cover. No air-bladder. Three series of valves in the bulbus arteriosus. Intestine with a spiral valve. Optic nerves commissurally united, not decussating. Ovaries with few and large ova, which are impregnated and, in some developed internally. Embryo with deciduous external gills. Males with prehensile organs attached to the ventral fins.

ORDER I.—Holocephala.

(SHARK TRIBE.)

One external gill-opening only, covered by a fold of the skin, which encloses a rudimentary cartilaginous gill-cover; four branchial clefts within the gill-cavity. The maxillary and palatal apparatus coalescent with the skull.

CHIMÆRIDÆ.

Form of the body elongate; pectoral fins free; anterior dorsal fin above the pectorals. Mouth inferior. Dental organs confluent into two pairs of laminæ in the upper jaw, and into one pair in the lower. No spiracles. Males with a peculiar prehensile organ on the upper part of the snout. Skin naked in the adult.

Callorhynchus antarcticus. Australian seas.

ORDER II.—Plagiostomata.

From five to seven gill-openings. Jaws distinct from skull.

Sub-Order I.—Selachoidei.

Gill openings lateral. Body more or less cylindrical.

(*Sharks*.)

Carchariidæ.

The first dorsal fin opposite to the space between pectoral and ventral fins, without spine; an anal fin. Eye with a nictitating membrane. Mouth crescent-shaped, inferior.

Carcharias gangeticus. North coast.
——brachyurus. East coast.
Galeocerdo Rayneri. East coast.
Galeus canis. East coast.
Zygæna malleus. East coast.
Mustelus antarcticus. East coast.

Lamnidæ.

The first dorsal opposite to the space between the pectoral and ventral fins, without spine; an anal fin. No nictitating membrane. Mouth crescent-shaped, inferior; nostrils not confluent with the mouth. Gill-openings generally wide. Spiracles none, or minute.

Odontaspis americanus. South coast.

Scylliidæ.

The first dorsal fin above or behind the ventrals, without spine; an anal fin. No membrana nictitans. Spiracle always distinct. Mouth inferior. Teeth small, several series being generally in function.

Scyllium maculatum. East coast.
Parascyllium variolatum. South coast.
Chiloscyllium ocellatum. North-west coast.
——trispeculare. Ditto.
Crossorhinus barbatus. South coast.
——tentaculatus. East coast.

Cestraciontidæ.

Two dorsal fins, with spines, the first opposite to the space between the pectorals and vantrals; the second in advance of the anal. Nostrils and buccal cavity confluent. Mouth rather narrow, the upper lip divided into seven lobes, the lower with a fold. Spiracles small, below the posterior part of the eye. Gill-openings rather narrow. Dentition similar in both jaws, viz., small obtuse teeth in front, which in young individuals are pointed and provided with from three to five cusps. The lateral teeth large, pad-like, twice as broad as long, arranged in oblique scries, one series being formed by much larger teeth than those on the other series.

Pacific and East Indian Archipelago.
Cestracion Phillipi. South and East coast.
——galeatus. Port Jackson.

Spinacidæ.

Two dorsal fins; no anal. Mouth but slightly arched; a long, deep, straight oblique groove on each side of the mouth. Spiracles present; gill-openings narrow. Pectoral fins not notched at their origin.

Acanthias vulgaris. Australian coast.
——Blainvillii. Australian coast.

Rhinidæ.

Spiracles wide behind the eyes. Nostrils with skinny flaps on the margin of the snout. Teeth conical, pointed, distant. Dorsal fins without spines on the tail; no anal. Temporal and tropical seas.

Rhina squatina, Port Jackson. "Angel Shark."

Body depressed, flat. Mouth anterior. Pectoral fins large, expanded, in the plane of the body, with the basal portion prolonged forwards, but not grown to the head. Gill openings rather wide, lateral partly covered by the base of the pectoral spiracles.

Pristiophoridæ.

The rostral cartilage is produced into an exceedingly long flat lamina, armed along each edge with a series of teeth (saw).

Pristiophorus cirratus. Port Jackson.

——nudipinnis. Ditto.

SUB-ORDER II.—Batoidei.

Gill-openings ventral. In a few of the genera, which we place first, the habit is still that of the Sharks; but the body is depressed; and in the typical genera the trunk, which is surrounded by the immensely developed pectoral fins, forms a broad flat disk, with a thin and slender tail. Spiracles always present. Five pairs of gill-openings. No anal fin; dorsal fins, if present, on the tail. Temperate and tropical seas; some species pelagic; some entering fresh waters, or entirely limited to rivers within the tropics. *Rays*.

PRISTIDÆ.

The snout is produced into an exceedingly long, flat lamina, armed with a series of strong teeth along each edge (saw).

The endoskeleton of the saw consists of three, sometimes five, rarely four, hollow subcylindrical tubes, tapering towards the end, incrusted with osseous deposit, which has a granular appearance, and is perforated by small foramina. These tubes are the rostral processes of the cranial cartilage as they are observed in nearly all Rays, though shorter and much less developed. It is very difficult to remove them out of the saw in their integrity. However, one of these bodies, which is in the British Museum, became detached in an at present unexplained manner, and is perfectly intact. It was described by Dr. Gray under the name of "*Myriosteon*" (Proc. Zool. Soc. 1864, April 12), and remained a puzzle to zoologists until Prof. KÖlliker, during a recent visit to London, examined it microscopically, and arrived at the conclusion that it must be "part of the endoskeleton of a Plagiostome." After the nature of this specimen had been thus determined we discovered that it is one of the lateral tubes of the saw of *Pristis, (Günther.)*

Pristis pectinatus. North coast.

RHINOBATIDÆ.

Tail strong and long, with two well-developed dorsal fins; a caudal and a longitudinal fold on each side. Disk not excessively dilated, the rayed portion of the pectoral fins not being continued to the snout. No electric organ.

Rhinobatus granulatus. North coast.

Trigonorhina fasciata. Port Jackson.

TORPEDINIDÆ.

The trunk is a broad, smooth disk; tail with rayed dorsal (absent in Temera) and caudal fins, and a longitudinal fold along each side. Anterior nasal valves confluent into a quadrangular lobe. An electric organ composed of vertical hexagonal tubes between the pectoral fins and the head.

Narcine tasmaniensis. Tasmanian coast.

Hynops subnigrum. West coast.

RAJIDÆ.

Disk broad, rhombic, generally with asperities or spines; tail with a longitudinal fold on each side. The pectorals extend to the snout. No electric organ. No serrated caudal spine.

Raja Lemprieri. Tasmanian coast.

TRYGONIDÆ.

The pectoral fins are uninterruptedly continued to, and confluent at, the extremity of the snout. Tail long and slender, without lateral longitudinal folds; vertical fins none, or imperfectly developed; often replaced by a strongly serrated spine.

Trygon tuberculata. Port Jackson.

MYLIOBATIDÆ.

The disk is very broad in consequence of the great development of the pectoral fins, which, however, leave the sides of the head free, and reappear at the extremity of the snout as a pair of detached (cephalic) fins.

Rhinoptera polyodon (?). Australian coast.

Ceratoptera Alfredi. Port Jackson. "Sea Devil."

The original specimen, 15 feet wide, is in the Australian Museum.

SUB-CLASS V.—Cyclostomata.

Skeleton cartilaginous and notochordal, without ribs, and without real jaws. Skull not separate from the vertebral column. No limbs. Gills in the form of fixed sacs, without branchial arches, six or seven in number on each side. One nasal aperture only. Heart without bulbus arteriosus. Mouth anterior, surrounded by a circular or subcircular lip, suctorial. Alimentary canal straight, simple, without cæcal appendages, pancreas, or spleen. Generative outlet peritoneal. Vertical fins rayed.

PETROMYZONTIDÆ.

Body eel-shaped, naked. Subject to a metamorphosis. In the perfect stage with a suctorial mouth armed with teeth simple or multicuspid, horny, sitting on a soft papilla. Maxillary, mandibulary, lingual, and suctorial teeth may be distinguished. Eyes present (in mature animals). External nasal aperture in the middle of the upperside of the head. The nasal duct terminates without perforating the palate. Seven branchial sacs and apertures on each side behind the head. The inner branchial ducts terminate in a separate common tube. Intestine with a spiral valve. Eggs small.

The larva; without teeth and with a single continuous vertical fin. Mordacia mordax. Tasmanian rivers "Lampreys."

——geotria australis. Tasmanian rivers "Lampreys."

Inhabitants of the fresh waters and coasts of the temperate regions of both hemispheres. Suck themselves fast to other fish, and live by scraping off their flesh. *(Günther.)*

Myxinidæ.

Body eel-shaped, naked. The single nasal aperture is above the mouth, quite at the extremity of the head, which is provided with four pairs of barbels. Mouth without lips. Nasal duct with cartilaginous rings, penetrating the palate. One median tooth on the palate and two comb-like series of teeth on the tongue. Branchial apertures at a great distance from the head. The inner branchial ducts lead into the oesophagus. A series of mucous sacs along each side of the abdomen. Intestine without spiral valve. Eggs large, with a horny ease provided with threads for adhesion. Inhabitants of the seas of the temperate regions of both hemispheres; burrow into other fishes, and feed on their flesh. *(Günther.)*

Bdellostoma cirrhatum. New Zealand and Australian rivers.

SUB-CLASS —VI. Leptocaedii.

Skeleton membrano-cartilaginous and notochordal, ribless, no brain. Pulsating sinuses in place of heart. Blood colourless. Kespiratory cavity confluent with the abdominal cavity; branchial clefts in great number, the water being expelled by an opening in front of the vent. Jaws none.

CIRROSTOMI.

Body elongate, compresscd, scaleless, limbless. Mouth a longitudinal fissure, with subrigid cirri on each side, inferior. Vent at a short distance from the extremity of the tail. A low rayless fin-like fold runs along the back, round the tail, past the vent, to the respiratory aperture. Eye rudimentary. Liver reduced to a blind sack of the simple intestine. One genus only occupying the lowest scale in the class of vertebrata.' Found imbedded in sand on many coasts of the temperate regions of both hemispheres.

Branchiostoma lanceolatum.

Dredged in Bass's Straits by H.M.S. " Herald," at a depth of from 10 to 12 fathoms.

This brings the list of recent Australian fishes to a close.

The new species which have been described during the last few years are not included in it because the literature is not at my command, but all fresh discoveries will be added should the present work reach a second edition.

It is very important to know the animals of a country, and in particular the useful ones, because some men starve in the midst of plenty, property is sacrificed, and great enterprises are brought to a disastrous termination through the pioneer's ignorance of the natural products. The fresh-water fishes, always valuable in aboriginal economy, are constantly overlooked, and little is known of them beyond the coast districts. Leichhardt discovered fine eating fishes in the Burdekin more than twenty years ago; since then thousands of pounds have been expended for the importation of trout, tench, and carp, whilst the superior fishes of our own rivers are forgotten. The famous " devonian" fish, *Ceratodus Forsteri*, was made known to the outer world in May last, though both settlers and aborigines feasted on it years before. A second species

Probably Ceratodus miolepis. *(Günther.)*

was found by Mr. Buchanan, of Maryborough, shortly afterwards; and Mr. George Masters obtained no less than nineteen fine specimens during his last expedition to the Burnett.

It is indeed wonderful how every pool and creek teems with animal life; numerous muscles, various kinds of cray-fish, turtles, frogs, lizards, fresh-water snakes, and other creatures, can be caught without much trouble, and all these are more nourishing to a starving human being than the wretched nardoo, on which the lamented Burke and Wills tried to subsist.

More attention should be paid to the study of natural history in our schools, the establishment of district museums encouraged, and the children taught to observe the habits and economy of different animals, in particular those which are useful, by which means the wealth of the country would be much increased.

I regret that this paper is not more attractive to the general reader, but time and space are precious; it is only the outline of a complete natural history of Australian Vertebrata, the first ever published, and to be fully wrought out at no very distant period.

Gerard Krefft.

Australian Museum, Sydney,

February 17, 1871.

Address of Sir Joseph Dalton Hooker, C.B., K.C.S.I., The President, Delivered at The Anniversary Meeting of the Royal Society, on *Friday, November* 30, 1877.

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Royal Society.

Address of the President, Delivered at

The Anniversary Meeting, *November* 30, 1877.

Gentlemen,

FOLLOWING precedent, I have at the commencement of my Annual Address to record the losses by death of eminent Fellows of this Society which have taken place since the last Anniversary. Though, happily, these losses are not so numerous as they have been in late years, the number amounts to twenty-three, and the list includes the names of men of great distinction in science, and among them of one to whom the Society is under lasting obligations for his active interest in its welfare during upwards of a quarter of a century. Need I name Mr. Gassiot, the founder of the Scientific Relief Fund, the munificent subsidizer of the Kew Observatory, and the ever-ready and liberal promoter of scientific investigation—Mr. Fox Talbot, the discoverer of photogenic drawing (the Talbotype process), proved to be the fruitful parent of photography—Sir Henry James, under whose administration the operations of the Ordnance Survey of Great Britain were greatly extended, and its resources utilized in various ways, especially through the application of scientific processes all tending to the advancement or diffusion of knowledge—Mr. Robert Were Fox, eminent for his researches on the temperature and the magnetic and electrical condition of the interior of the earth, especially in connexion with the formation of metallic veins, and who was, further, the inventor of some and improver of other instruments now everywhere employed in ascertaining the properties of terrestrial magnetism? In Sir William Fergusson we have lost a surgeon of rare ability and manual dexterity and an operator of great repute; in Mr. David Forbes an accomplished traveller, chemist, and mineralogist; and in Dr. Bowerbank a naturalist of the old school, whose enthusiasm and genial encouragement kindled into a flame the scientific spark that lurked in the breast of many an amateur. There have further been removed by death from the list of Foreign Fellows two recipients of the Copley Medal, the venerable Yon Baer and the comparatively young Le Verrier, together with a traveller and physicist of rare attainments, Erman, the narrative of whose travels is one of the richest storehouses of scientific information (hat has hitherto been given to the world in the narrative form.

Finance.—As heretofore, I must refer to our Treasurer's Report for evidence of the satisfactory condition of the Society's finances. Not but that this is a matter that requires constant vigilance, as the demands upon our pecuniary resources annually enlarge, owing mainly to the rapid increment of matter brought before us and found worthy of publication in our Transactions and Proceedings, and, above all, to the number of expensive illustrations which accompany many of them. This, and the prospect of the results of the Government Fund for the encouragement of research being laid before the Society for publication, appeared to me to render it desirable that a Committee should be appointed to inquire into and report upon the receipts and expenditure of the Society, and that the subject of the outlay on printing and paper should be referred to the Library Committee for report, together with that of the compilation of the Catalogue of Scientific Papers, the labour and expense of which were likely to increase with that enormous development of scientific literature which characterizes this century.

On the recommendation of that Committee, our printing has been transferred to a well-qualified firm of printers, on such conditions as will enable us, we hope, to effect an important saving in our annual charge for printing. It is thought, moreover, that the compilation of the Catalogue of Scientific Papers, which, though no part of our ordinary work, had been voluntarily undertaken and paid for by the Society, and diligently conducted under the supervision of your officers, should not be allowed to press unduly upon our resources, and that the time had come when application should be made to the Government Fund for aid to enable us to meet the increasing demands on our income for the work of the Catalogue.

And further, as tearing on the question of finance, your Council have resolved that the difference between the amount of Life composition payable by newly-elected Fellows who have and those who have not previously to election contributed a paper to the Transactions should cease, and that a part of the funded property of the Society should be invested in secure Stocks yielding a larger interest than the Government funds.

Presents.—It is always with peculiar pleasure that I announce the presentation of good portraits of scientific worthies. Two in oils, received during the vacation, are now hung on our walls: one of Sir John Herschel, a very faithful likeness, presented by our Fellow, Mr. John Evans; the other, presented by our late Secretary, Dr. Sharpev, is that of Haller, the physiologist, anatomist, botanist, and poet, whose genius and labours were the admiration of his contemporaries, as they have been ever since of his successors. It is not without pride that our countrymen can record the facts that an English sovereign, George II., was the first who recognized the merit of Haller, the Swiss, by bestowing on him his earliest preferment, a professorship in Göttingen, and ever after showing him every mark of respect, and that, on a subsequent occasion, an English University, Oxford, offered him a professorship. The portrait is an excellent one, in perfect preservation, and forms a most valuable addition to our gallery.

I have also to inform you that a sum of £500 has been contributed anonymously by five Fellows to the Society's funds for general purposes, and that our Foreign Secretary has proposed that his office should, as long as he holds it, be regarded as an honorary one, with charge of the Society's foreign correspondence. This very liberal proposal was accepted by the Council, only in so far as resolving that the Foreign Secretaryship should be placed on the same footing in respect of salary as it was before the year 1805; that is to say, that the honorarium should be limited, as in former years, to the proceeds of the original endowment.

Our Fellow, Dr. William Farr, has presented to the Society an annotated copy of Thomson's 'History of the Royal Society,' containing the dates of death of Fellows who died subsequently to the publication of that work, as far as these could be obtained from the Society's Minutes and from printed books, together with a complete chronological list of all the Fellows admitted since 1812 down to 1876. These, with other documents which he has added, enable Fellows to ascertain the names, and dates of birth and death, of every person admitted into the Society since its origin, and hence, to a great extent, supplies valuable data for determining the vitality of scientific men at different periods. In his letter accompanying these very valuable documents Dr. Farr observes that the records of the Royal Society were allowed for years to remain defective as to particulars which were formerly accurately recorded, and that Halley and others seemed to have been alive to the importance of such facts relating to the scientific men of their age. In future, the date and place of birth of Fellows will be registered regularly and accurately, in accordance with Dr. Farr's excellent suggestion, for which, as for the documents, a unanimous vote of thanks was returned by your President and Council.

The Catalogue of Scientific Papers.—In my last year's Address I informed you that the Lords of the Treasury had granted the funds necessary for printing the decade 1804-73 of the Catalogue of Scientific Papers; and I have now to announce that the first (the seventh of the series) of the two volumes of which it will consist is published. It contains more than a thousand pages. The expediency of the Society's further undertaking the compilation of an "Index of Subjects "having been urged upon the Library Committee, was carefully considered by them. To this end the members were supplied with printed specimens of a well-considered plan adapted to the decade 1804-73, with the request that they would favour the Council with their opinion upon it; when it appeared that, owing to the number of subjects often comprised in one paper, and the differences of opinion as to which of these were worthy of citation, and under what name, the task would be one of prodigious labour and unsatisfactory result, and far beyond the Society's mean?. The printing of the eighth volume is steadily progressing, together with the compilation of the decade for 1874-83.

The Meteorological Council.—The Report of the Treasury Committee of Inquiry into the working of the late Meteorological Office was published last summer. It includes that of the Committee of this Society (none of the members of which had served on the Treasury Committee); and the recommendations of the two bodies are almost identical. As a member of the former, and cognizant of the views of the Government as to the future of the Office, I may state that those views were from the first, and throughout, favourable to giving a more scientific character to the work than it had hitherto possessed, recognizing the principle, that its aim and endeavour should be to advance meteorology as a science, while directing and controlling all such practical operations as were required for the public service. The main difference between the recommendations of the Treasury Committee and our own is that we favoured the retention of the Office under a department of the Crown, with a Government officer as Director, in preference to leaving it subject to a Committee or Council of Control. The Treasury Committee, influenced by the evidence of very eminent scientific men to this effect, that meteorology was not as yet in a scientific condition, and that to render it so required the combined labours of men with various attainments, as also by the fact that there was no department of Government capable of controlling purely scientific investigations, recommended that, as a tentative measure, a modified Committee of Control (to be called a Council) should replace the old Committee, and that the Royal Society should be asked to nominate the members, and, after a period of five years, to review their labours.

Other recommendations, in which both Committees concurred, were, that ocean meteorology should be transferred to the Admiralty, that the maxims which determine the issue of storm-warnings should be put in a clear shape and issued to the public, that the number and position of both the continuously-recording and the eye-observing stations should be revised, that the latter should be increased so as to satisfy the claims of the Registrars-General, Medical Council, Agricultural Societies, and other bodies, and that a fair approximation to the meteorological condition of the whole British Isles should be daily obtained and published.

Far more important to us, however, than these practical measures, is the strong expression of opinion on the part of both Committees that scientific hypothesis and discussion should be pursued as a duty incumbent on the Office, and that, to this end, an annual grant should be made for the purpose of remunerating investigators, selected by the Council, on a scale proportionate to the work performed.

At the request of H.M. Treasury, and in communication with them, your Council drew up the following suggestions for the administration of the Meteorological Office, which, having been approved, are now put in practice:—That the Office be in future administered by a paid Council, consisting of a Chairman and four effective members, together with, as *an ex officio* member, the Hydrographer of the Navy, whose services were rendered necessary by the Admiralty having declined to undertake the ocean meteorology; that £1000 should be granted for the remuneration of the Members of Council, who should be persons in a position to devote adequate time and attention to the duties of the Office, and to the inauguration of investigations and experiments designed to place meteorology on a scientific basis, to advance it, and to promote its usefulness to the community; that paid inspectors of stations should be appointed for Scotland and Ireland, and £500 be granted for this purpose; that a sum of £1000 per annum be granted for the payment of individuals, to be selected by the Council, to be engaged in special scientific researches; and that £1500 be granted for new land-stations, and £500 for the extension of telegraphy to Sundays. The result of these new measures will be to raise the annual grant for the Meteorological Office from £10,000 to £14,500.

Your Council having further been requested to nominate the effective members of the Meteorological Council for the approval of the Lords of the Treasury, proceeded to do so in accordance with the spirit of the resolutions which gave scientific research so prominent a position—keeping in view, at the same time, the necessity of obtaining the services of as many members of the old Committee as possible, their knowledge of the details of the Office being at first indispensable, and their efficiency already proved. The result has been the appointment of Ml Henry Smith, Savilian Professor of Geometry at Oxford, as Chairman, and your Senior Secretary, Mr. F. Galton, Mr. De La Rue, and General Strachey as the other members. The services of Mr. Scott, who has so bug and so ably directed the practical operations of the Office, and of Mr. Toynbee, whose labours in ocean meteorology are so well know) to you, and of the other officers being all retained, nothing would seem to be wanting, in men or money, to develop the science of meteorology, and to supply the public with data for all the useful purposes contemplated in the establishment of the Meteorological Office. It is to be hoped that the tentative measure thus inaugurated will lead, in five years, to the constitution of a national Meteorological Office under the undivided control of a man of high scientific attainments.

Government Fund of£4000 *per Annum for Five Years*.—The constitution of the Committee for the administration of this fund, under the authority of the Lord President of the Council, has been provisionally settled, and as much of the first year's grant as was available for the last quarter of the financial year March 31, 1876, to April 1, 1877, was allotted in March last.

The first meeting of the Committee took place on January 11th, when it was resolved:—that four subcommittees should be constituted—namely, (A) Mathematics, Physics, and Astronomy, (B) Biology, (C) Chemistry, (D) General Purposes; and that all applications for grants should be addressed to the Secretaries of the Society, and referred by them to one of the first three subcommittees for examination and report and recommendation; that the subcommittees' reports and recommendations should be printed and circulated among the members of the General Committee not less than one week before the meeting at which the grants would be discussed; and that the grants applied for should be limited to sums required for a period not exceeding twelve months. It was further resolved that a report of progress should be required of the recipient at the end of the year in which the grant was made, and that instruments of permanent value purchased out of the Fund, or supplied by the Government on the recommendation of the Royal Society, should be regarded as the property of the Government.

The Committee meetings are fixed for February in each year; those of the subcommittees will take place whenever summoned by the Secretaries of the Society; and notice has been given that applications for grants are to be sent to the Secretaries of the Royal Society not later than December 31st in any year.

At the meeting of the General Committee in March last the subcommittees reported that 102 applications had been received, and that the amount applied for was £14,459. Of the 102 applications 33 were approved, and sums of £300 and under (the total being £2220 Is. 6*d.* for instruments, assistance, and materials, and £1810 for personal remuneration) were granted.

The results of this step towards the endowment of research will. I hope, be narrowly watched, in the interests both of science and of this Society, which, in undertaking to administer for the Government a sum so largely devoted to personal remuneration, has assumed a very onerous responsibility, and largely increased the burthen of your Secretaries.

Reports of Naturalists sent by the Society to Rodriguez and Kerguelen Island.—These are being printed uniformly with our Transactions, under the editorship of Dr. Gunther and your President. They will consist of a series of papers, illustrated with plates, on all branches of the natural history of the islands, contributed by the naturalisis themselves and various coadjutors, whose services are gratuitous. The cost of printing will be defrayed by the liberality of your Treasurer, and some of the plates have been presented by the contributors.

The Polar Expedition.—The scientific results of the Polar Expedition, and especially the biological, appear to me to have, in most departments, quite come up to our expectations; and considering that but one season was available for collecting and observing (and we all know how short that is in the arctic regions), they are indeed most creditable to the gentlemen who contributed them. Geology has proved by far the most prolific field of research. Perhaps Botany comes next, and this, and the insects which have been worked up by Mr. M'Lachlan, prove that, between 80° and 83° N., in Grinnell Land, the conditions for the existence of these organisms are far more favourable than are those of lands a long way to the southward.

The flora of the series of channels between 80° and 83° N., the shores of which have been botanized by the officers of the Polar Expedition, have yielded upwards of 70 flowering plants and ferns, which is a much greater number than has been obtained from a similar area among the polar islands to the south-westward, and is unexpectedly large. All are from a much higher latitude than has elsewhere been explored botanically, except the islets off the extreme north of Spitzbergen. The species are, with two exceptions, all Greenlandic. The exceptions are *Androsace septentrionalis*, which, though found in the northern regions of all the continents, has never elsewhere been seen north of lat. 72°, and *Pedicularis capitata*, an American and North-Asiatic species, not hitherto recorded north of the same parallel.

Spitzbergen, stretching from latitude 76° 30# to 80° N., quite to the south of the positions here referred to, has contributed not more than 100 flowering plants and ferns, notwithstanding that its west coast is washed by the Gulf-stream, and that its shores have been diligently explored by many trained collectors. Fifteen of the plants collected by the Expedition have not been found anywhere in Spitzbergen. Compared with Melville Island, in lat. 75° N., and Port Kennedy, in 72° N., the contrast is even more striking, these well-hunted spots, both so much further south, yielding only 07 and 52 species respectively.

This extension of the Greenland flora to so very high a latitude can only be accounted for by the influence of warm currents of air, or of the air being warmed by oceanic currents, during some period of the summer; and I look with great interest to the meteorological observations made during the voyage, which are being discussed by Sir George Nares, who hopes to have them completed in a couple of months. The observations on the temperature of sea-water will, he expects, give new information; and the study of certain warm gales and warm currents that were observed in lat. 82° and 83° N. can hardly fail to increase our knowledge of the local climate.

May not these phenomena of vegetation and temperature indicate the existence of large tracts of land clothed with vegetation in the interior of Greenland, far within the mountain-ranges of its ice-clad coast, and protected by these from the heavier snowfalls and from the accumulation of glacial ice which borders that island on all sides'?

The fossil plants collected have been examined and reported upon by Professor Heer. Of these the most important are the Miocene. They consist of 25 identifiable species, of which 18 are known Arctic Miocene fossils. All but one had been previously found in Spitzbergen. The most interesting of them is the Conifer, assumed to be identical with the existing American "Bald Cypress," *Taxodium distichum*, a plant which is now confined to Eastern North America, from lat. 39° southwards, and to which specimens found in the Miocenes of Prance, Italy, Prussia, Greenland, and N.W. America have also been referred.

Professor Heer further thinks that he has identified the remains of a Spruce with the European and Asiatic Norway Spruce (*Abies excelsa*), which occurs as a fossil only in Postpliocene beds. Its existence in the Miocene period only in such a high latitude would indicate that it is a polar form which has migrated southward in more recent times.

This tracking of the Miocene flora so far to the northward was one of the principal scientific objects to be accomplished by the Polar Expedition; and the fact that the character thereof continues to be neither polar nor arctic, but temperate, supports the hypothesis that during the era in question a vegetation analogous to that now prevailing in the temperate latitudes entirely covered the north-polar area of the globe.

Other branches of Geology have yielded very valuable results in the hands of Mr. Etheridge, who has worked up the very large number of Palaezoic fossils collected especially by Capt. Feilden. These, with the Carboniferous, Miocene, and Postpliocene fossils, animal and vegetable, and the abundant rock specimens, have thrown more light on the former condition of the circumpolar regions than perhaps all the collections of previous expeditions.

Capt. Evans has been so good as to supply me with the results of the magnetical observations made during the voyage, which were in general accordance with those of the American expeditions to Smith's Sound. Nearly continuous hourly observations of the Differential Decli- nation Magnetometer were taken throughout the winter from October to April. With an inclination of nearly 85°, and a horizontal force of 1.13, the westerly declination disturbance occurred usually between 9 a.m. and 5 p.m., the easterly between 9 p.m. and 5 a.m., the are ranging through 8°. The greatest range (Feb. 19, 1876) reached 5° 48#; the lowest (July 12, 1876) was scarcely 7#. Compared with the results of previous expeditions, we find that, at Rensselaer Harbour, with horizontal force of 1#14 and inclination nearly 85°, the ranges were respectively 4° 52# and 1° 1#; while at Port Bowen, with horizontal force 0° 46# and inclination 88°, they were 11° 56# and 0° 35# respectively. The mean daily range of declination was 86°-8, and mean declination 101° 42# W.

The observers were on the alert to observe any signs of connexion between the auroral displays and declination-disturbances, but to no purpose; for, as with Parry in Port Bowen, and Kane in Rensselaer Harbour, no evidence was discoverable. On the other hand, various previous voyagers have registered a marked connexion, as at Port Kennedy by Maguire, at Point Barrow by M'Clintock, and in the Spitzbergen seas by Weyprecht. Considering that there can be no doubt as to the trustworthiness of all these observers, a decisive solution of the question is greatly to be desired.

Sir William Thomson and Prof. Everett have examined the few observations made for the amount of atmospheric electricity, with the result of finding that they confirm the observations of former explorers.

Sir George Nares has obligingly sent me a resume of some of the principal meteorological results, and their comparison with those taken at Polaris Bay in 1871-72: for example:—

Minimum temperature of earth 20 inches beneath surface, #13°.0.

The warmer temperature at Floeberg Beach was clue to its exposure to the warm winter gales, from which Discovery Bay was cut off. The still warmer temperature of Polaris Bay is partly attributable to there being some uncovered water in the neighbourhood.

The barometer indicated and foretold changes in the weather is in temperate regions.

Making due allowance for unavoidable sources of error, the temperalures of the sea observed on the west shores of Smith's Sound prove the existence of a stratum of cold outer water (temperature about 29°) lying between the locally heated surface-water and a depth of twenty to thirty fathoms, flowing southward in summer, as also of an underlying stratum with a temperature of about 30°. This latter was not found near Floeberg Beach; but, coupled with the 1872 observations of the 'Polaris,' which showed a temperature of 32°.8 at 203 fathoms in lat. 80° 44# N. (midway between Franklin and Hals Islands, in Robison Channel), and 32°.1 at 17 fathoms in Polaris Bay, it would appear that the warm underlying water forces itself to the north ward on the east side of Robison Channel. Its entrance into the polar sea or not will depend on the depth of water at the north end of the channel. They also prove the non-existence of a lower temperature of the water than 28°.8 at a depth below 275 fathoms in Smith's Sound or Baffin's Bay. The coldest portion of the arctic water appears not to affect Hayes Sound or Discovery Bay to so great an extent as that of the direct channel.

The Rev. Dr. Hanghton, to whom the tidal observations of the 'Discovery' and 'Alert' were entrusted, informs me that he has completed the preliminary discussion of the whole, and hopes to present the final results of those of the 'Discovery' to this Society before June next. He remarks that the 'Discovery' was better provided for observations than the 'Alert,' and, fortunately, her position was better also, as she lay nearer the head of the tide at Cape Payer. The officer charged with the observations, Lieut. Archer, made them hourly for seven months, with only six days of interpolation. The officers of the 'Alert' were able to make hourly observations for two months only, with fifteen days of interpolation.

Dr. Haughton has already arrived at the following general conclusions:—1. The tide which comes down Smith's Sound from the north is generically distinct from the Behring's Straits tide and from the Baffin's Bay tide. 2. It must therefore be the East-Greenland Atlantic tide; and consequently Greenland is an island. 3. This new tide contains a sensible tertio-diurnal component of much interest.

The mean coefficients of the components are:—

The '*Challenger' Expedition*.—You will hear with gratification that the Lords of the Treasury, after advising with your Council, have appropriated the munificent sum of £25,000 for publishing the biological results of the voyage in a style and with a completeness worthy of the Expedition and the nation. Adopting a course as wise as it is liberal, Sir Wyville Thomson has, with the approval of your Council and the Government, chosen for his collaborators the ablest specialists, irrespective of their nationality. It is creditable to our country that, with but few exceptions, it has supplied thoroughly competent and willing workers in most of the departments; and association with such foreign naturalists as Agassiz, and Haeckel cannot fail to be gratifying to themselves and assuring to the public. I had the advantage of inspecting the Echino- dermata in Professor Agassiz's charge in the Peabody Museum at Harvard College, and of learning the progress he had made in the examination of the vast body of materials entrusted to him. These, he informed me, far surpassed Sir Wyville's estimate in number of species and of interesting and novel forms; and I was surprised to find that the whole had already been sorted, that the greater part was named and ready for return to Edinburgh, and that nearly a dozen exquisite lithographic plates of new and rare forms were prepared for publication.

Sir Wyville Thomson informs me that he is already far advanced towards the publication of two quarto volumes, and that he estimates the whole being completed in fourteen, of the form and size of the Philosophical Transactions.

Transit of Venus.—'Sir George Airy has been pleased to inform me that the inferences from the telescopic observations of the transit of Venus, made in the British expeditions for records of that phenomenon, under the superintendence of the Astronomer Royal, have now been published—first, in response to an order of the House of Commons; secondly, in a more elaborate communication to the Royal Astronomical Society. The number of districts of observation was five, but each of these included a principal and some subordinate stations. The number of observers was eighteen, and as some of them observed both ingress and egress of Venus at the Sun's limb, the total number of observations was fifty-four. The concluded value of equatorial mean solar parallax was 8#754. The calculation of the photographic records of the transit is advancing rapidly.

The Report on the results of the total Solar Eclipse of 1875, announced in my last year's Address as being drawn up by Mr. Lockyer, is now in our hands.

The Harvard College Observatory (U.S.).—During my recent visit to the United States, I was for a short time a guest at the Cambridge Botanic Garden, and consequently in close proximity to the fine Observatory of Harvard College, to which I paid several visits, being most kindly received by Professor Pickering, successor to the distinguished astronomer, W. C. Bond. The system carried out in this observatory is known to British Astronomers to be so productive of good results that I felt sure that some account of it would be acceptable to the Fellows of the Royal Society; and I therefore availed myself of Mr. Pickering's good offices to obtain a few particulars.

The current work of the Observatory is threefold, and consists of observations with the 15-inch equatorial, with the 8-inch aperture meridian circle, and communication of true time-signals to the public.

The principal work of the equatorial is photometrical, an instrument having been devised by the Astronomer by which two stars may be compared directly without using an artificial star as an intermediate step in the measurement. By this means the relative brightness of the components of numerous double stars, including some having only very faint components, as also the relative brightness of the satellites of Jupiter and Saturn, has been determined.

At the time of my visit Prof. Pickering was engaged in a special study of the newly discovered satellites of Mars, one of which, the outer, I had the satisfaction of observing through the equatorial. Their brightness he had determined by three very ingenious methods:—1st, by comparison with an image of Mars shining through a very minute circular hole placed at the focus of the telescope; 2nd, by comparing the satellite with a minute image of Mars formed in the field of the large telescope by a small auxiliary telescope; 3rd, by reducing the light of the inner satellite by one, two, or three plates of microscope-glass, until its brightness was equal to that of the outer satellite. Of these methods the second showed that the outer satellite does not partake of the red colour of Mars.

The meridian circle was, or had lately been, in use for the following purposes:—1st, the determination of the position of all stars brighter than the 9th magnitude contained in the zone 50°.55° N.; 2nd, observations of Mars during the opposition of last summer for the solar parallax; 3rd, observations of a list of composite stars, at the request of Mr. Gill, for determining the solar parallax by means of Ariadne; 4th, preparations are being made for the determination of the absolute position of a catalogue of stars, independently of all previous observations, and, 5th, for the publication of a catalogue of polar stars observed in 1872-1873; 6th, with the assistance of the U.S. Coast Survey, a beginning has just been made of the measurement of all stars in the northern hemisphere brighter than the 6th magnitude, whose positions have not recently been determined with precision.

Time-signals for the meridian of Boston are sent by telegraph every two seconds from the Observatory; they are used by the local railways, are transmitted over a large area of New England, and they strike the noon-bells in Boston and in many of the smaller towns.

Besides the above, several thousand observations for atmospheric refraction were made, with the assistance of the Rumford Committee, during last summer with a micrometer level, simple in construction and accurate and rapid in action, invented by Mr. Pickering.

United States' Scientific Surveys.—Of the many surveys of the United States territories undertaken, some by the Central Government, others by State governments, and still others by private enterprise, more or less aided by public funds, none has effected so much for science as that directed by Dr. Hayden. Its publications, distributed with great liberality, are in every scientific library, and its Director is honoured no less for the energy and zeal with which he has laboured as a topgrapher and geologist, than for the enlightened spirit in which he has ought to render the resources of the Survey available for the advancement of all branches of natural knowledge by every means in his power, nd with admirable impartiality.

Having obtained an extended leave of absence from my offical duties at the Royal Gardens, I, at the close of our last session, accepted an invitation from Dr. Hayden to join his survey, and, in company with our Foreign Member, Prof. Asa Gray, to visit, under his conduct, he Rocky Mountains of Colorado and Utah, with the object of contributing to the records of the Survey a report on the Botany of those States.

I have thus had some opportunity of learning for myself the extent and value of the operations of the Survey, which are so interesting that I venture to think a brief sketch of its rise and progress and a few of its results may be acceptable to you.

When the territory of Nebraska was admitted into the Union 1867, Congress set apart an unexpended balance of £1000 for a Geological Survey of the new State; and Dr. Ilayden, then a young mar who had distinguished himself as an indefatigable palseontological observer and collector (in various expeditions since 1853), was appointed to conduct it. In 1808 the operations of the Survey were continued, and carried westward into the Rocky Mountains of Wyoming, the rich Tertiary and Cretaceous beds of which were examined and described in detail, and the famous Yellowstone district, with which Dr. Hayden's name will ever be associated, was reconnoitred. The value of the Survey was immediately appreciated, and in 1869 a large appropriation was voted by Congress for placing it on its present footing under the supervision of the Secretary of State for the Interior. In 1869 and 1870 operations were carried on in Colorado and New Mexico; and full reports on the meteorology, agriculture, zoology, and palasontology of these regions, of great interest and importance, were drawn up and subsequently published. In 1871 the detailed survey of this Yellowstone district was begun, and those marvellous natural features were carefully studied, which have excited the liveliest interest in Europe, and have induced Congress, on Dr. Hayden's representations, to appropriate the whole area as a Government reserve, thus securing to naturalists free access to natural phenomena which in other places, both in Europe and America, are too often monopolized by speculators and closed to the public.

In 1872 the Survey was further extended, and was organized into two corps, each provided with a topographer, geologist, mineralogist, meteorologist, and naturalist, and the States of Idaho and Montana were embraced in its operations; in 1873 it was pushed into Colorado, thence into Utah, and on its completion in 1876, an area of not less than 70,000 square miles, much of it exceedingly mountainous, had been included in the Survey.

The literature of the Survey consisted, in 1876, of 41 volumes, classified as follows:—1, annual reports, with maps and sections; 2, bulletins for giving speedy publicity to new facts; 3, miscellaneous publications, comprising tables of elevations, catalogues of plants and animals, and meteorological data; 4, monographs on various branches of natural history, especially palaeontology, copiously illustrated with admirable plates in quarto, among which are the works of Leidy, Lesquereux, Coues, C. Thomas, Cope, Parry, Meek, Packard, Silliman, Hayden himself, and others, all of whom are well known on this side of the Atlantic; lastly, the number of photographs now exceeds 4000, and includes, besides geological and geographical features of great interest, views of ancient architectural remains, and of 1200 Indians, belonging to 74 tribes.

In giving these particulars I speak from some personal knowledge. I wish that the same could be said of the local habitation of the Survey and its museum, which, I am assured, contains a very extensive and instructive collection; but these are at Washington, and my pressing duties here and at Kew prevented my visiting the federal capital.

The most important scientific results hitherto derived from the labours of Dr. Hayden and his parties are unquestionably the geological: such as the delineation of the boundaries of the Cretaceous and Tertiary seas and lakes that occupied more than one basin of the mountains of Central N. America, and the marvellous accumulation of fossil Vertebrates that these ancient shores have yielded. Over an area of many hundred thousand square miles in North America there have been found, within the last very few years, beds of great extent and thickness, of all ages from the Trias onwards, containing the well-preserved remains of so great a multitude of flying, creeping, and walking things, referable to so many orders of plants and animals, and often of such gigantic proportions, that the palae-ontologists of the States, with museums vastly larger than our own, are at a loss for space to exhibit them. So common indeed are some species, and so beautifully preserved, that I saw numbers of them, especially insects, plants, and fishes, exposed for sale, and eagerly purchased by travellers, with confectionery and fruit, at the stalls of the railway stations, from the eastern base of the Pocky Mountains all the way to California.

An examination of some of these fossils has brought to light the important fact that in North America there is no recognized break between the Cretaceous and Tertiary beds. This is due to the interpolation of a vast lignitic series the fossils of which furnish conflicting evidence. Concerning this series Dr. Hayden, who has traced it over many hundred miles, observes

Report of Geological Survey, 1874, p. 20.

that the character of its pala:ontological, as well as of its strictly geological results is such, that whether the entire group be placed in the Lower Tertiary or tipper Cretaceous is unimportant, and that the testimony of palæontologists will probably always be as conflicting as at present.

Professor Marsh, of Yale College, Newhaven, one of the highest authorities in America, has found that not even invertebrate fossils afford a satisfactory solution of the difficulty. "These," he says, "throw little light on the question;" and he is obliged to assume that "the line, if line there be, must be drawn where the Dinosaurs and other Mesozoie Vertebrates disappear, and are replaced by the Mammals, henceforth the dominant type."

This last passage I have taken from the lucid address of Professor Marsh to the meeting of the American Association for the Advancement of Science, held last autumn at Nashville, to which I must refer for an exposition of the riches of the fossil Vertebrate fauna of these regions, of the convincing proofs they afford of the doctrine of Evolution, and of the light they throw on the introduction, succession, and dispersion of existing organisms in the New World. Among the suggestive observations with which this address abounds is another in reference to this question of the disputed horizons of the Cretaceous and Eocene beds—namely, its dependence on the relative value to be given to evidence derived from plant and animal remains, He concludes that plants afford unsatisfactory measure of geological periods as compared with animals—a conclusion at which I had long ago arrived. We agree further that a chief cause of this difference of value is the less complex organization of plants, which hence furnish less evidence of the influences of environing conditions; to which might be added the feeble conflict among the higher members of the vegetable kingdom as compared with the vertebrates, their stationary habits, and the duration of similar, if not identical, forms through long geological ages, which has always appeared to me to be one of the most signal characteristics of the early condition of the higher plants as compared with the higher animals. Other, and perhaps even more cogent, reasons for plants being so little satisfactory is, that their reproductive organs, those upon which the classification is principally based, are rarely preserved, and seldom in connexion with the vegetative organs, which are abundantly preserved; and that, with regard to these, the vegetative organs, their prevalent and best-preserved characters, outline and venation, vary in individual species to a surprising degree, and, being repeated in groups otherwise in no way related, become too often fallacious guides.

Another result, previously obtained in respect of other organisms, but ably worked out by Professor Marsh as regards the Vertebrates, is that all the Tertiary beds of North America—Eocene, Miocene, and Pliocene—are of older date than the corresponding beds in Europe. This, though apparently supported by his conclusions that the main migrations of animals took place from the American to the Asiatic continent (which he deduces from the American, as compared with the European, life-histories of the Edentata, Marsunpialia, Ungulata, Rodentia, Carnivora, and even Primates), is a very bold generalization. Without presuming to question the abundance and teachings of the American data, I cannot but think that his theory of migration is, in the present state of palaeontology, premature, especially under our almost absolute ignorance of the "Vertebrate fossils of the continents of Asia and Africa. The prodigal palaeontological wealth of the United States, as compared with the poverty of that of Europe as yet known, may be likened to that of a metropolitan museum or library as contrasted with a provincial collection; and with regard to Central Asia especially, there are indications, in the narratives of travellers and the reports of natives, of vast accumulations of vertebrate fossils there existing. These may revolutionize our present ideas, as Falconer's and Cautley's discoveries in the outer Himalayas did those of our predecessors; and he would be a rash speculator who, having studied what is known of the physical geography of Asia north of that range, ignored the probability of the existence there of fossiliferous Cretaceous and Tertiary seas and lake-basins, in comparison with which those of the Rocky Mountains may sink into insignificance, both as to extent and productiveness. Professor Huxley has, indeed, suggested, as an alternative or escape, the possible former existence of a submerged continent, from which both Asia and America derived their types of animals and plants, which is tantamount to an opinion that the subject is not yet advanced enough for other than speculation.

Other results of Professor Marsh's labours are equally instructive—such, I mean, as support the doctrine of Evolution; but these have been made known to the scientific public of this country by Mr. Huxley, who examined the Yale College Museum last year. Since then, as I was informed by the Professor, during a visit to the same museum, his species and specimens have largely increased in number and proportionately in value—that is, from the patæontological point of view; and the address which I have quoted gives a summary of the state of the whole collection up to the present time.

A few words on the magnificent collection of vegetable remains, Cretaceous and others, that have been studied and described by Mr. Leo Lesquereux in various published Reports of the U. S. Geological Survey, and in separate works issued under its auspices, may be fitly spoken here. It would be difficult to overrate the value of these contributions to fossil Botany, which, in its present state of advancement, affords no results comparable with those obtained from the animal kingdom for fixing the limits of periods, tracing the direction of migrations and the areas of distribution, or for following the devious paths of evolution. In the whole range of the natural sciences no study is so difficult, and at the same time so fruitless, if we regard the amount of results accepted by botanists, as compared with the prodigious labour their acquisition by palæontologists has demanded. Of all the orders of fossil plants of the formations referred to the Grymnosperms alone have, as a rule, yielded much trustworthy information; and this is due to their texture, to the peculiar character of their vegetative and reproductive organs, to the frequent adhesion of these to the branchlets, to their gregarious habits, to their wide distribution, and to their close affinity with existing species. Of other orders and genera of plants, with the exception of a few with well-characterized foliage, as the Palms, the identifications of a large proportion hitherto published are not recognized as having much claim to confidence by those who have the largest acquaintance with the varied forms of the vegetative organs of plants. And if the identification of the fossil leaves of one country is so hazardous, what must be the risk of identifying the fossil leaves of one continent with those of another? a forlorn hope which has constantly to be resorted to. The result, in the case of the North-American Cretaceous and Tertiary floras, has been the discovery of certain well-ascertained plants, which would appear to show that various prevalent existing American genera have inhabited that continent from a very early period; but that, along with them, there existed types of European, Asiatic, and Australian genera, temperate and tropical, that are no longer associated anywhere on the globe in a state of nature. It is well, under such perplexing conditions, that men of ability and unconquerable zeal (such as Heer, Saporta, and Lesquereux) are to be found who will undertake to investigate them; and while thanking them cordially for what they have done, I would urge upon them the importance of constant reference to large Herbaria, in order to enable them fully to appreciate the variability of foliar organs, and the deceptive nature of the characters they present.

Though doubtless the most productive to science generally, Dr. Hayden's is, I need hardly say, neither the oldest of the States' Surveys nor the first that brought its resources to bear on other matters than geography and geology. Indeed, from the beginning of the century, the Americans have busied themselves with inquiries into the resources and productions of their States—never on any recognized system, too often under difficulties and discouragements, not seldom to be nipped in the bud, or, worse still, sacrificed when the fruit was fit for gathering, through the ignorance or parsimony of the holders of the national purse; but, thanks to the single-mindedness of the labourers, never without some good, and often with great results. The Coast Surveys are admirable alike for their system, for their breadth of purpose, for the attainments and ability of the officers in charge of them, and for the minute topographic accuracy aimed at and attained—an accuracy which, I need not say, is unattainable by such surveys as that here briefly described. The various surveys for railways across the continent have contributed a very library to natural science in many departments; and some of the individual States have, through the like agency, contributed greatly to our knowledge of their natural history and other products. For an excellent and full account of the history, labours, and results of all these, I must refer you to Prof. "Whitney's article on "Geographical and Geological Surveys" in the 'North American Review' for July and September 1875, which he was so kind as to send me at the moment of my departure from the States. Prof. Whitney's own Geological Survey of California and Nevada is one of the very best of the series. It was begun in 1864, and continued for ten years; but after the publication of a topographical map, and some very valuable results, including natural history, at a most moderate cost, the whole work was stopped by the State Legislature, and the geological maps and sections, though admirable and paid for, have consequently never been given to the public! The last of these Surveys which I shall mention is that of Kentucky by Professor Shaler, the State Surveyor, of which the first volume of the Report has just appeared, containing, besides articles on prehistoric remains, fossil Brachiopods, and caverns and cavern-life, an exhaustive article by Mr. Allen, of singular interest, on the Bisons of America, living and extinct.

The American Flora.—Though I have as yet little to say of the results of Dr. Gray's and my own investigations under the Survey, I have every reason to hope that, having been extended through the Sink, Salt, or desert regions west of the Rocky Mountains, and thence across the Sierra Nevada to the Pacific coast, they will, with the materials previously obtained by my fellow traveller and myself, enable us to correlate our several researches into the distribution of North-American plants, and to point out the lines along which the migrations of the existing types were directed, and the countries whence they migrated.

As regards the components of the United-States flora, these seemed to us to be threefold, and to be intermixed throughout the continent—an endemic American, a European, and an Asiatic: it seemed that the flora was a ternary compound, so to speak, while that of the temperate Old World was, in a continental point of view, binary—Europe and Asia having many types in common, but very few representatives of the strictly American flora. The distribution of North-American plants, unlike the European, is mainly in a meridional direction, the difference of the floras of the Eastern, Central, and Western States being wonderfully great—far greater than those of similarly situated regions in the Old World. The European components extend over the whole breadth of the continent, diminishing, however, to the westward. The American components present many localized genera, inhabiting the Eastern, Central, and Western States respectively; they increase in numbers and peculiarity, as also in restriction of range, towards the west. The Asiatic components are found both in the Eastern and Western States, but hardly at all in the Central; and some of them are common to both the east and west, while others are peculiar to each. But whereas the European components prevail on the side towards Europe, the maximum of Asiatic representation is on that remote from Asia. This has been conspicuously shown by Gray's discovery, in the Eastern States, of single representatives of Japanese genera previously Supposed to be monotypic; and what is most noteworthy is, that such representatives are in some cases extremely rare and local plants, found in single and very restricted areas, indicating a dying-out of the Asiatic representation in America.

The evidences of climatic changes in past eras of the existing flora of the continent are seen in the prevalence of arctic and northern species of plants in the alpine zones of the meridional mountain-chains, the Appalachian, Rocky Mountains, and Sierra Nevada, even as far south as the 33rd parallel. These plants had spread southwards during a period of cold, and on its subsequent mitigation had retired to the lofty situations they now inhabit. To the former existence of a warmer climate we may partly look for the extension of Mexican types to the dry regions west of the Rocky Mountains up to the 41st parallel; and to it may be attributed the remarkable northward extension of the Cacti in a very narrow meridional belt, scarcely one hundred miles broad, along the eastern flanks of the same mountains, from their head-quarters in New Mexico, in the 33rd, almost to the 50th parallel.

Of existing influences that determine the development in amount of the vegetation of a country, and the extension in various directions of its components, none are so powerful as the distribution of rainfall and of vapour in the atmosphere. This subject will repay a careful study in America, especially in connexion with the presence or absence of woodlands and forests, an excellent map of which by Professor Brewer, of New haven, was published in 1873 by the Supreme Government, in which the density of the forests in each State is portrayed by five shades of colour.

I must not end my notices of some of the labours of our scientific brethren in the United States without expressing my admiration of the spirit and the manner in which the Government and people have cooperated in making known the physical and biological features of their country, and my conviction that the results they have given to the world are, whether for magnitude or importance, greater of their kind than have been accomplished within the same time by any people or government in the older continents. How great would now be our knowledge of the climate and natural features of India and of our Colonies had the excellent Trigonometrical Survey of the one and the territorial and Geological Surveys of the others been supplemented by Reports such as those to which I have directed attention!

The President then proceeded to the presentation of the Medals.

The Copley Medal has been awarded to Professor James Dwight Dana, of Tale College, Newhaven, United States, for the numerous, varied, and important contributions to Mineralogy, Geology, and Zoology with which he has enriched science during more than fifty years. Professor Dana's first published paper bears the date of 1823, while the year 1877 finds him, as ever, vigorously at work.

Commencing his career with the inestimable advantage of a sound training in mathematics, physics, and chemistry, one of Professor Dana's earliest writings is an essay upon the connexion of electricity, heat, and magnetism. He then turned his attention to mineralogy; and, after exhibiting his thorough study of both the crystallographic and the chemical aspects of minerals by the publication of a large number of separate memoirs, he produced a systematic treatise on mineralogy, which at once took the place it still holds among standard works upon the subject.

In geology, the diversity and importance of Professor Dana's labours are not less remarkable. Not only have multitudinous detached essays, embodying the results of wide and accurate observations in all parts of the world, and on all classes of geological phenomena, proceeded from his pen, but his 'Manual of Geology,' of which a new edition appeared two years ago, is at once a most clear and comprehensive statement of the present state of geological science, and a complete, though necessarily condensed, monograph of the geology of North America; and, it may be added, few treatises on this branch of knowledge show so thorough and practical an acquaintance with all those sciences which are auxiliary to geology, or so extensive and profound a study of the phenomena presented by the existing condition of the globe, from the knowledge of which every rational attempt to reconstruct the past history of the earth, upon the data afforded by its rocks and their organic contents, must start.

As naturalist to the United States Exploring Expedition, which made a circumnavigatory voyage, under the command of Captain Wilkes, in the years 1838 to 1842, Professor Dana enjoyed unusual opportunities for zoological investigation; and his remarkable works on the Zoophytes and the Crustacea observed during the voyage testify to the admirable use which he made of those opportunities. Nor has Professor Dana confined himself to the merely descriptive side of zoology; but, drawing general conclusions from his vast store of accurate observations, he has published views on classification and on questions of general morphology of much originality and breadth of view.

The Medal was received for Prof. Dana by the Hon. Edwards Pierre-point, United States Minister. The President, in delivering the Medal, expressed his assurance of' the esteem and regard in which Prof. Dana was held by the Royal Society, not less for his own scientific achievements than for the liberal aid he has always rendered to other investigators.

A Royal Medal has been awarded to Mr. Frederick Augustus Abel, for his physico-chemical researches on gunpowder and explosive agents.

Mr. Abel's career as a contributor to chemistry commenced about 30 years ago. Between 1847 and 1865 he contributed a number of papers to the Chemical Society, which were published in their Journal: some of the investigations were made in conjunction with other chemists; among these were the action of nitric acid on cumol (1847), and researches on strychnine (1849), when the composition of that alkaloid was finally established. They were followed by papers relating to metallurgy (copper) and analytical processes, one of which, on the application of electricity to the explosions of mines, may have led to his various works on explosives, on which the claims of Mr. Abel for the distinction of a Royal Medal mainly rest. So far back as 1863 he directed his attention to the study of gun-cotton in consequence of the development of its manufacture in Austria for artillery purposes, and in that year communicated to the British Association a report on the preliminary results arrived at by his experiments on the Austrian process, and the products furnished by it.

In 1866 a memoir was sent to our Society, which was published in the Phil. Trans, vol. clvi. p. 269, "On the Manufacture and Composition of Gun-cotton." In this paper, as the result of a long series of experiments, made with great accuracy, the conditions were laid down for its uniform manufacture and purification; and the true nature of gun-cotton (tri-nitro-cellulose) was finally established by an exhaustive series of analytical and synthetical experiments.

This paper was followed by another in 1867, published in the Philosophical Transactions, vol. clvii., entitled, "On the Stability of Gun-cotton," which was considered worthy of being made the Bakerian Lecture for that year. This memoir details the results of four years' extensive experiments on the effects of light and heat on gun-cotton, and upon the protective action of water at low and high temperatures. It will be recollected that the uncertain stability which had been characteristic of gun-cotton was conclusively traced to minute quantities of unstable substances remaining in the fibre, even after the most careful purification by the methods hitherto known, and the efficiency of simple measures for securing the stability of gun-cotton was established. This led ultimately to the development of a system of manufacture of gun-cotton which permitted of its ready manufacture in a high state of purity (pulping).

Mr. Abel did not, however, confine his attention to gun-cotton; and, indeed, in 1864 had sent in a paper to the Royal Society, which was published in the 'Proceedings,' vol. xiii., on "Some Phenomena exhibited by Gun-cotton and Gunpowder under special conditions," in which the behaviour of these substances when exposed to high tempera- tures in rarefied atmospheres and in different mechanical conditions was described.

In 1869 a memoir, entitled "Contributions to the History of Explosive Agents," was printed in the Philosophical Transactions, vol. clix. In this memoir is discussed the influence of more or less strong confinement and other mechanical conditions under which the *detonation* of such compounds and mixtures was developed. It will be recollected that some striking results were obtained in the examination of the behaviour of explosive compounds when exposed to initiative detonations of different character.

These phenomena were more fully discussed in a second memoir, published in the Philosophical Transactions for 1874, vol. clxiv.; it includes an exhaustive investigation of the transmission of detonation from one mass of gun-cotton, fulminates, and nitro-glycerine to other distinct masses in the open air, and also through the agency of tubes. The causes of interference with the transmission of detonation-force, and the development of detonation as distinguished from explosion, were clearly discussed. The influence of dilution by solids and by liquids on the susceptibility of explosives to detonation, and also the velocity with which detonation is transmitted by different explosive agents under various conditions, was carefully studied. Some important results were obtained by the comparison of the behaviour of the liquid nitro-glycerine and the solid pulped and compressed gun-cotton devised by Mr. Abel. Among other things, the detonation of gun-cutton when thoroughly saturated with water, the transmission of detonation to distinct masses of gun-cotton enclosed in receptacles in which the space between the masses was filled up with water, and, further, the value of water as a violent disruptive agent (as in shells) when it was caused to transmit the force generated by the detonation of very small quantities of gun-cotton, which it surrounded, were established.

The last memoir published in the Philosophical Transactions, on "Fired Gunpowder," is a joint production of Mr. Abel and Captain Noble; and as the merit of the investigation, which has occupied the authors for some years, is divided, I do not dwell particularly upon it, except as affording evidence of the continuity of Mr. Abel's researches in physico-chemistry, which places him at the head of all other workers in the line of research which has mainly engaged his attention, and which has been productive of practical results of the greatest importance to this country.

A Royal Medal has been awarded to Prof. Oswald Heer, of Zurich, for his numerous researches and writings on the Tertiary plants of Europe, of the North-Atlantic Islands, North Asia, and North America, and for his able generalizations respecting their affinities, their geological and climatic relations.

It is mainly to Prof. Heer's labours that we owe those great advances made of late in our knowledge of the Miocene, Pliocene, and Post-Pliocene floras of Central Europe, which establish upon broad but safe grounds the close analogy existing between the vegetation of these epochs and that of the present period in Eastern North America and Eastern Asia. To Prof. Heer also we are mainly indebted for the remarkable discovery that a rich and varied arboreous vegetation, strikingly similar to what now obtains in temperate and subtropical countries, once extended to the Arctic Circle and far beyond it—a fact of which no adequate explanation has been found, and the importance of which, in relation to all questions as to the former geological and geographical conditions of the northern hemisphere, cannot be overestimated.

Prof. Heer's youthful studies were directed to botany and entomology. His scientific authorship commenced in 1836; and the early bent of his mind towards the higher problems of natural science is evinced by one of his very first memoirs, being 'Sur la Geographie Botanique de la Suisse,' published in 1837. His earliest work on fossil plants was upon those of the Rhone valley, published in 1846, since which period he has been uninterruptedly and indefatigably engaged on the comparative study of recent and fossil plants and in sects—describing and illustrating them with a completeness and exactitude that have been thoroughly appreciated by geologists and botanists, and appending to the systematic descriptions of them geological and climatic considerations, remarkable alike for their caution and significance. Amongst his numerous works his 'Flora fossilis Helvetia,' 'Flora Tertiaria Helvetise,' and 'Flora fossilis Arctica' are conspicuous examples of well-directed labour and great learning; while the number of his minor works on various branches of biology testify to a life spent in successful devotion to science.

During Prof. Heer's long and laborious career he has been conspicuous for the liberal aid he has given to other investigators, and for the disinterested spirit in which he has worked out the collections brought by the government and private expeditions of various European nations from the northern and arctic regions. In particular, we are beholden to him for the labour he has bestowed upon our own Arctic collections, made during the last fifteen years, from that of Belcher to that of Nares, and especially for his elaborate and exhaustive memoir on the Miocene flora of Bovey Tracey, published in the 'Philosophical Transactions,'—labours all the more praiseworthy from being, for some years past, pursued in a recumbent posture, to which grievous bodily ill-health has confined him.

The Medal was received for Prof. Heer by M. Henri Vernet, Consul-General for Switzerland, to whom the President acknowledged the Society's obligations to Prof. Heer for his elucidations of the Geology of England and of the Flora of the Bovey-Tracey Coalfield, published in the Philosophical Transactions; and on behalf of the Society expressed his hope that Prof. Heer might soon be restored to health.

For the Davy Medal, now for the first time awarded, Prof. Robert Wilhelm Bunsen and Gustav Robert Kirchhoff, both Foreign Members of the Society, in recognition of their researches and discoveries in spectrum-analysis, have been selected.

The method of spectrum-analysis, as established by these two eminent men, must rank among the most important extensions of our means of investigating the properties of matter. Before that discovery, the chemical constitution of matter was examined solely by the study of the changes which take place within the narrow range of cases of which we can grasp and weigh the substance under investigation; but the tests employed in spectrum-analysis have no necessary dependence upon the distance of the material from the observer. It has enabled us to see, not only further, but deeper; for, on the one hand, it has led to the detection of many of the chemical constituents of masses distant from our planet, and, on the other hand, it has enabled us to discover many constituents of terrestrial minerals which had escaped detection until our ordinary methods of analysis were guided by the more refined tests afforded by the spectrum-analysis.

Address to the Mathematical and Physical Section of the British Association.

Brighton, AUGUST 14TH, 1872.

By Warren De La Rue, Esq., D.C.L., Ph.D., F.R.S., V.P.C.S., V.P.R.A.S.

MY predecessors in this Chair have addressed you on many subjects of high interest in Mathematical and Physical Science: I do not contemplate passing in review the recent discoveries in Astronomy or Physical Science, but intend to confine myself, in the main, to Astronomical Photography; and in selecting this branch of science as the subject of this introductory discourse, I think that I shall have your approval, not only because I have given special attention to that subject, but also because it is about to be applied to the determination of a fundamental element of our system, the solar parallax, by observations of the transit of Venus in 1874, and probably also in 1882.

Nothing is so lastingly injurious to the progress of science as false data; for they endure often through many centuries. False views, even if supported by some amount of evidence, do comparatively little harm; for every one takes a salutary interest in proving their falseness; and when this is done the path to error is closed, and the road to truth is opened at the same moment.

It will be conceded that Photography, when applied to scientific observation, undoubtedly preserves facts. But the question has sometimes been raised, are photographic records absolutely trustworthy representations of the phenomena recorded? If not, what is the extent of truth, and where are the inlets for errors and mistakes? Not only has photographic observation gained a wide range of applications in astronomy, but in every other branch of physical science its help is daily more and more taken advantage of; and although, in speaking of this art, I shall confine myself to astronomy, the observations which I propose to make may be suggestive with reference to other branches of physics.

As an instance of the application of this art to optical physics I may in this place call attention to the very successful delineation of the solar spectrum by Mr. Lewis M. Rutherfurd, of the United States. In Mr. Rutherfurd's spectrum, obtained by the camera, many portions and lines are shown (in the ultra-violet for instance) which, while imperceptible to the retina of the-eye, impress themselves on the sensitive film. As a fact, lines which are single in Angstrom's and Kirchhoff's maps, have been recorded by photography as well-marked double lines. I will now review the application of the art to astronomy.

Stellar photography was for some time applied at Harvard-College Observatory, U.S., to double stars, for the purpose of determining by micrometric measurement their relative angle of position and distance. The zero of the angle of position was found by moving the telescope in right ascension after an impression had been taken, and taking a second one on the same plate; this process gave two sets of photographic images on the same plate; and the right line passing through the series gave the direction of the daily motion of the heavens. The probable error of a single measurement of the photographic distance of the images was found to be ±0#.12, or somewhat smaller than that of a direct measurement with the common filar micrometer. The late Professor Bond, who applied photography to stellar astronomy, confining himself to stars brighter than the seventh magnitude, discussed the results in various numbers of the 'Astronomische Nachrichten.' No astronomer more unbiased could have been selected to decide on the comparative value of the photographic and direct observational method. His discussion shows that the probable error of the centre of an image was ±0# 051, and that of the distance of two such centres was ±0###072. Adopting the estimate of Struve, ±0"'217, as the probable error of a single measurement of a double star of this class with a filar micrometer, Professor Bond shows that the measurement of the photographic images would have a relative value three times as great. He derived the further important conclusion, that deficiency of light can be more than compensated for by proportionate increase in the time of exposure. A star of the ninth magnitude would give a photographic image, after an exposure of ten minutes, with the Cambridge equatorial.

In the reproduction of stars by photography, recently undertaken by Mr. Rutherfurd, the objects to be secured being so minute, special precautions were found to be necessary in depicting them upon the sensitive film, so that their impressions might be distinguishable from accidental specks in the collodion plate. To prevent any such chance of mistake, Mr. Rutherfurd secures a double image of each luminary, the motion of the telescope being stopped for a short time (half a minute) between a first and second exposure of the plate; so that each star is represented by two close specks, so to speak, upon the negative, and is clearly to be distinguished by this contrivance from any accidental speck in the film. A map of the heavens is thus secured, very clear though delicate in its nature, but yet one upon which implicit reliance can be placed for the purposes of measurement. Professor Peirce aptly says, "This addition to astronomical research is unsurpassed by any step of the kind that has ever been taken. The photographs afford just as good an opportunity for new and original investigation of the relative position of near stars as could be derived from the stars themselves as seen through the most powerful telescopes. They are indisputable facts, unbiased by personal defects of observation, and which convey to all future times the actual place? of the stars when the photographs were taken."

Mr. Asaph Hall, who shared with Professor Bond the work of measuring the photographic images and of reducing the measurements, has very recently subjected the photographic method to a critical comparison, with a view to deciding on its value when applied to the observation of the transit of Venus. He appears, as regards its application to stellar observations, to underestimate the photographic method in consequence of want of rapidity; but he admits that in the case of a solar eclipse, or of the transit of a planet over the sun's disk, it has very great advantages, especially over eye-observations of contacts, inner and outer, of the planet and the sun's limb, and that the errors to which it is subject are worthy of the most thorough investigation. The observation of a contact is uncertain on account of irradiation, and is also only momentary; so that, if missed from any cause, the record of the event is irretrievably lost at a particular station, and long and costly preparations rendered futile. On the other hand, when the sky is clear, a photographic image can be obtained in an instant and repeated through-out the progress of the transit, and even if all the contacts be lost, equally valuable results will be secured, if the data collected on the photographic plates can be correctly reduced, as will be proved hereafter to be undoubtedly possible. That the transit of Venus will be recorded by photography may now be announced as certain, as preparations are energetically progressing in England, France, Russia, and America for obtaining photographic records. There is also a probability of Portugal taking part in these observations; for it is contemplated by Senor Capello to transport the Lisbon photoheliograph to Macao. There are at present five photoheliographs in process of construction for the observing parties to be sent out by the British Government, under the direction of the Astronomer Royal, Sir George B. Airy. The Russian Government will supply their own parties with three similar instru- ments; and I am also having constructed one of my own for this purpose and for future solar observations. All these instruments, made precisely alike, will embody the results of our experience gained during the last ten years in photoheliography at the Kew Observatory whilst belonging to this Association. One only of them, namely the photoheliograph which has been at work for some years at Wilna, is of a somewhat older pattern; but how great an advance even this instrument is on the original at Kew is proved by the delightful definition of the most delicate markings of the sun in the pictures which have reached this country from Wilna.

Hitherto sun-pictures have been taken on wet collodion; but a question has been raised whether it would not be better to use dry plates. On this point M. Struve informs us that, in two places, at Wilna, under the direction of Colonel Smysloff, and at Bothkamp, in Holstein, under Dr. Vogel, they have perfectly succeeded in taking instantaneous photographs of the sun with dry plates.

As far, however, as my own experience has gone, I still believe that the wet collodion is preferable to the dry for such observations.

Now, with reference to contact observations, which it must be remembered are by no means indispensable as far as photography is concerned, it may be conceded that there will attach to the record of the internal contact a certain amount of uncertainty, although not so great as that which affects optical observation. The photograph which first shows contact may possibly not be that taken when the thread of light between Venus and the sun's disk is first completed, but the first taken after it has become thick enough to be shown on the plate; and this thickness is somewhat dependent on incidental circumstances—for example, a haziness of the sky, which, although almost imperceptible, yet diminishes the actinic brilliancy of the sun, and might render the photographic image of the small extent of the limb which is concerned in the phenomenon too faint for future measurements. On the other hand, having a series of photographs of the sun with Venus on the disk, we can, with a suitable micrometer, such as I contrived for measuring the eclipse-pictures of 1866 and which since then has been in continuous use in measuring the Kew solar photograms

In this micromotor, which is capable of giving radial distances, angles of position, and also rectangular coordinates, the accuracy of linear measurements does not depend on the doubtful results given by a long rim of a micromotor screw.

, fix the position of the centre of each body with great precision. But the reduction of the measured distances of the centre to their values in are is not without difficulty. Irradiation may possibly enlarge the diameter of the sun in photographic pictures, and it may diminish the size of the disk of a planet crossing the sun, as is the case with eye-observations; but if the images depicted are nearly of the same size at all stations whose results are to be included in any set of discussions, then the ratio of the diameters of Venus and the sun will be the same in all the plates, and it will be safe to assume that they are equally affected by irradiation. The advantage which, therefore, will result by employing no less than eight instruments precisely alike, as are those now being made by Sir. Dallmeyer on the improved Kew model, is quite obvious. If other forms of instruments, such as will hereafter be alluded to, be used, it will be essential that a sufficient number of them be employed in selected localities to give also connected sets for discussion.

To give some idea of the relative apparent magnitudes of the sun and Venus, I may mention that at the epoch of the transit of 1874 the solar disk would, in the Kew photoheliograph, have a semidiameter of 1965-8 thousandths of an inch, or nearly two inches; Venus a semidiameter of 63-33 of these units; and the parallax of Venus referred to the sun would be represented by 47-85 such units, the maximum possible displacement being 95-7 units or nearly 1/10 of an inch.

When the photographs have been secured, the micrometric measurements which will have to be performed consist in the determination of the sun's semidiameter in units of the scale of the micrometer, the angle of position of the successive situations of the planet on the disk, as shown on the series of photographs, and finally the distances of the centres of the planet and the sun. These data determine absolutely the chord along which the transit has been observed to within 0##1; and an error of 1# in the measurement would give an error of only 0##185 in the deduced solar parallax. Moreover the epoch of each photographic record is determinable with the utmost accuracy, the time of the exposure being from 1/50 to 1/100 of a second or even less.

Now, although the truth of the foregoing remarks will be fully admitted, it will yet be well to point out in this place the inherent or the supposed defects of the photographic method. These defects may principally be comprised under the head of Possibility of Distortion; and the importance of an investigation into this source of error will appear at once obvious in all cases where the position of a definite point with reference to a system of coordinates has to be determined from measured photographs, especially in such a refined application of it as that which it will have in the determination of the solar parallax.

The distortion of a photographic image, if such exist, may be either extrinsic or intrinsic—that is, either optical or mechanical. The instrumental apparatus for producing the image may produce optical irregularities before it reaches the sensitive plate; or an image optically correct may by irregular contraction of the sensitive film in the process of drying, and other incidents of the process, present on the plate a faulty delineation.

It has been proposed, in order to obviate any possible alteration of the sensitive surface, to use the Daguerreotype instead of the collodion process. The former, however, is so little practised, and, moreover, is so much more troublesome, that it docs not seem to be advisable to adopt it, especially as the subsequent measurements would present greater difficulties than occur with collodion pictures.

In general, two ways present themselves for clearing observations from errors. Either methods may be devised for determining the numerical amount of every error from any source, or by special contrivances the source of error may be contracted to such insignificant limits that its effect in a special case is too minute to exert any influence upon the result. Both these roads have been followed in the inquiry into the optical distortion of photographic images.

As regards the first, let it be supposed that, as in the Kew instrument, the primary image is magnified by a system of lenses before reaching the sensitive plate. The defects inherent to the optical arrangement will clearly affect every photographic picture produced by the same instrument; and hence a method suggests itself for determining absolutely the numerical effect of distortion at every point of the field. Let us assume that the same object, which may be a rod of unalterable and known length, be photographed in precisely the same manner in which celestial events are photographically recorded, the object being at a considerable distance; it may successively be brought into all possible positions in the field of the photoheliograph, and the length of the image on the photograph may be measured afterwards at leisure by means of a micrometer. These lengths will change relatively wherever distortion takes place; but by laying down these varying lengths we shall obtain an optical distortion-map of the particular instrument; and tables may be constructed giving in absolute numbers the corrections to be applied to measurements of positions on account of the influence of optical distortion. In this way the optical distortion of the combined object-glass and secondary magnifier is ascertained. The chief source of distortion if such exist, will be in the secondary magnifier; and in order to ascertain its amount a reticule of lines drawn at equal distances upon glass may (as has been done recently by Paschen and Dallmeyer) be placed in the common focus of the object-glass and secondary magnifier. The required data are then immediately given by the measurement of the resulting pictures of the parallelograms on the reticule. Mr. Dallmeyer has ascertained in this manner that no sensible distortion exists in the secondary magnifier constructed by him. The truth of the principle being granted, it was applied to a preliminary series for finding the distortion which affects the Kew instrument, which is not nearly so perfect as those more recently constructed; and the results were so far satisfactory that, instead of a single rod, a proper scale, fifteen feet in length, representing a series of rectangles distributed over half the radius of the field, has been erected; and the process of absolutely determining the optical distortion of the Kew photo-heliograph is now in active progress, and will be used for the new instruments to be employed in observing the transits of Venus.

The second method of dealing with optical distortion aims at total exclusion of this source of error. It has been proposed by American astronomers, who intend taking part in the coming observations of the transit of Venus, to exclude the secondary magnifier, and, in order to obtain an image of sufficient diameter, to employ a lens of considerable focal length, say 40 feet, which would give an image as large as with the Kew photoheliograph—namely, 4 inches in diameter. As it would be inconvenient to mount such an instrument equatorially, it is proposed to fix it in the meridian in a horizontal position, and reflect the sun in the direction of its axis by means of a flat mirror moved by a heliostat. There cannot be any doubt about the fact that the image so produced would be nearly free from optical distortion, if the interposed mirror did not introduce a new source of error. The difficulty of producing a plane mirror is well known; and there is a difficulty in maintaining its true figure in all positions; there is also a liability of the disturbance of the rays by currents of heated air between the mirror and object-glass: moreover, with such an instrument position-wires could not be defined with sharpness on the photographs. On the whole, greater reliance may be placed on a method which admits the existence of a distorting influence, but has at the same time means of checking and controlling it numerically.

Great attention has been paid by me at various times to those effects of distortion which might arise from the process of drying. The results to which the experiments lead seem to prove that there is no appreciable contraction except in thickness, and that the collodion film does not become distorted, provided the rims of the glass plates have been well ground: this point is a fundamental one. But in such observations as that of the transit of Venus, no refinement of correction ought to be neglected; hence fresh experiments will be undertaken to set at rest the question whether distortion of the film really takes place when proper precautions are taken. This will be done both by the method I have employed before, and also in accordance with M. Paschon's proposal to measure images of such reticules as above described: this reticule might, as he has suggested, be photographed during the transit of Venus, so that each plate would thus bear data for the correction due to unequal shrinkage, if such were to take place.

It has been objected by some astronomers who have casually examined solar photograms that the limb of the sun appears, as a consequence of the gradual shading off, even under a small magnifying power, not bounded by a sharp contour; but the measurements of such photograms which have been made during the last ten years of pictures, taken under the most varying conditions which influence definition, have proved that even the worst picture leads to a very satisfactory determination of the sun's semidiameter and centre; moreover an independent examination of this question by M. Paschen gave as the result that the mean error of a determination is only ± 0.008 millimetre with a sun-picture of 4 Paris inches in diameter; this corresponds to ±0#.135, and it is nearly three times less than that resulting from a measurement with the Konigsberg heliometer.

Nevertheless it will be seen from the foregoing remarks that I have not hesitated to arouse your attention to the fact that Astronomical Photography is about to be put to the severest test possible in dealing with such a fundamental problem of astronomy as the determination of the sun's distance from the earth. An intimate knowledge of the subject, however, and experience with respect to work already accomplished in the Kew ten-year solar observations, inspire me with a confident anticipation that it will prove fully equal to the occasion.

So much for performances to be looked forward to in the future: now let me briefly review what Astronomical Photography has already undoubtedly accomplished.

In the first instance the possibility proved of giving to the photographic method of observation a trustworthiness which direct observations can never quite obtain, will render the results of our discussion of the ten years' solar observations at Kew more free from doubts than those observational series on the Sun's spots which have preceded ours. The evidence of a probable connexion between planetary positions and solar activity, and the evidence which we have published on the nature of spots as depressions of solar matter, could never have been brought forward but for the preservation of true records of the phenomena through a number of years, while the closer agreement of the calculated results in reference to solar elements is itself evidence of the intrinsic truthfulness of the method, and gives the highest promise that our final deductions, which will be completed in the course of the ensuing year, will not be unworthy of the exertions which I, in conjunction with my friends B. Stewart and B. Loewy, have constantly devoted to this work during a period of fully ten years. Not only will some doubtful questions be set finally at rest by it, but new facts of the greatest interest will result, bearing on the laws which appear to govern solar activity.

By nothing, however, would the claims of photographic observation, as one of the most important instruments of scientific research, seem to be so thoroughly well established as by the history of recent solar eclipses. It will be recollected that in 1860 for the first time the solar origin of the prominences was placed beyond doubt solely by photography, which preserved a faithful record of the moon's motion in relation to these protuberances. The photographs of Tennant at Guntour, and of Vogel at Aden, in 1868, and also those of the American astronomers at Burlington and Ottumwa, Iowa, in 1869, under Professors Morton and Mayer, have fully confirmed those results. In a similar manner the great problem of the solar origin of that portion of the corona which extends more than a million of miles beyond the body of the sun has been by the photographic observations of Col. Tonnant and Lord Lindsay in 1871 set finally at rest, after having been the subject of a great amount of discussion for some years.

The spectroscopic discovery in 1809 of the now famous green line, 1474 K, demonstrated undoubtedly the self-luminosity, and hence the solar origin of part of the corona. Those who denied the possibility of any extensive atmosphere above the chromosphere received the observation with great suspicion; but in 1870 and again in 1871 it was fully verified. So far, therefore, the testimony of spectroscopic observations was in favour of the solar origin of the inner corona.

Indeed the observations of 1871 have proved hydrogen to be also an essential constituent of the "coronal atmosphere," as Janssen proposes to call it,—hydrogen at a lower temperature and density, of course, than in the chromosphere. Janssen was further so fortunate as to catch glimpses of some of the dark lines of the solar spectrum in the coronal light, an observation which goes far to show that in the upper atmosphere of the sun there are also solid or liquid particles, like smoke or cloud, which reflect the sunlight from below. Many problems, however, even with refer-once to the admittedly solar part of the corona, are unsettled. The first relates to the nature of the substance which produces the line 1474 K. Since it coincides with a line in the spectrum of iron, it is by many considered due to that metal; but then we must suppose either that iron vapour is less dense than hydrogen gas, or that it is subject to some peculiar solar repulsion which maintains it at its elevation, or other hypotheses may be suggested for explaining the fact. Since the line is one of the least conspicuous in the spectrum of iron and the shortest, and as none of the others are found associated with it in the coronal spectrum, it seems natural; as many have done, to assume at once that it is due to some new kind of matter. But the observations of Angstrom, Roscoe, and Clifton, and recently those of Schuster regarding the spectrum of nitrogen, render it probable that elementary bodies have only one spectrum, and since in all experimental spectra we necessarily operate only on a small thickness of a substance, we cannot say what new lines may be given out in cases where there is an immense thickness of vapour; and hence we cannot conclude with certainty that because there is an unknown line in the chromosphere or corona, it implies a new substance. Another problem, the most perplexing of all, is the reconciliation of the strangely discordant observations upon the polarization of the coronal light; but I will at once proceed to the points on which photography alone can give us decisive information.

The nature and conditions of the outer corona (the assemblage of dark rifts and bright rays which overlies and surrounds the inner corona) was very incompletely studied; and the question whether it is solar was not finally settled in the opinions of astronomers of high repute. Some believed it to be caused by some action of our atmosphere; and others supposed it due to cosmical dust between us and the moon. The bright light of the corona and the prominences most undoubtedly cause a certain amount of atmospheric glare; and although it is difficult to see how this is to account for the rays and rifts, it would be rash to deny that it may do so in some manner yet to be discovered. It is quite certain that some of the phenomena observed just at the beginning and end of totality are really caused by it. A light haze of meteoric dust between us and the moon might give results much resembling those observed; but when we come to details this theory seems to be doubtful.

Here photography steps in to pave the way out of the existing doubts. If the rays and rifts were really atmospheric, it would hardly be possible that they should present the same appearance at different stations along the line of totality: indeed they would probably change their appearance every moment, even at the same station. If they are cislunar, the same appearances could not be recorded at distant stations. It is universally admitted that proof of the invariability of these markings, and especially of their identity as seen at widely separated stations, would amount to a demonstration of their extraterrestrial origin. Eye-sketches cannot be depended on; the drawings made by persons standing side by side differ often to an extent that is most perplexing. Now photographs have, undoubtedly, as yet failed to catch many of the faint markings and delicate details; but their testimony, as far as it goes, is unimpeachable. In 1870, Lord Lindsay at Santa Maria, Professor Winlock at Jerez, Air. Brothers at Syracuse, obtained pictures some of which, on account partly of the unsatisfactory state of the weather, could not compare with Mr. Brother's picture obtained with an instrument of special construction

Mr. Brothers had, in 1870, the happy idea to employ a so-called rapid rectilinear photographic lens, made by Dallmeyer, of 4 inches aperture and 30 inches focal length, mounted equatorially, and driven by clockwork; and he was followed in this matter by both Col. Tennant and Lord Lindsay in 1871 The focal imago produced, however, is far too small (3/10 of an inch, about); therefore it will be desirable in future to prepare lenses of similar construction, but of longer focal length and corresponding aperture.

; but all show one deep rift especially, which seemed to cut down through both the outer and inner corona clear to the limb of the moon. Even to the naked eye it was one of the most conspicuous features of the eclipse. Many other points of detail also come out identical in the Spanish and Sicilian pictures; but whatever doubts may have still existed in regard of the inner corona were finally dispelled by the pictures taken in India, in 1871, by Colonel Tennant and Lord Lindsay's photographic assistant, Mr. Davis.

None of the photographs of 1871 shows so great an extension of the corona as is seen in Mr. Brother's photograph, taken at Syracuse in 1870; but, on the other hand, the coronal features are perfectly defined on the several pictures, and the number of the photographs renders the value of the series singularly great. The agreement between the views, as well those taken at different times during totality as those taken at different stations, fully proves the solar theory of the inner corona. We have in all the views the same extensive corona, with persistent rifts similarly situated. Moreover there is additional evidence indicated by the motion of the moon across the solar atmospheric appendages, proving in a similar manner as in 1860 in reference to the protuberances, the solar origin of that part of the corona.

It will be well here to mention a difficulty which occurs in recording the fainter solar appendages, namely the encroachment of the prominences and the corona on the lunar disk when the plates have to be overexposed in order to bring out the faint details of the corona. It is satisfactory to find that whenever a difficulty arises it can be mastered by proper attention. Lord Lindsay and Mr. Ranyard have successfully devoted themselves to experiments on the subject. They tested whether reflections from the back surface of the plate played any part in the production of the fringes: for this purpose plates of ebonite and the so-called non-actinic yellow glass were prepared; and it was immediately found that the outer haze had completely disappeared in the photographs taken on ebonite, while on the yellow glass plates it is much fainter than on ordinary white glass plates. By placing a piece of wetted black paper at the back of an unground plate, the outer haze was greatly reduced; but by grinding both the back and the front sup- faces of a yellow glass plate, and covering the back with a coating of black varnish, it was rendered quite imperceptible, thus showing the greatest part of the so-called photographic irradiation to be due to reflection from the second surface.

In connexion with the solution of the most prominent questions connected with the solar envelopes, it may not be without great interest to allude to another point conclusively decided during the last annular eclipse of the sun, observed by Mr. Pogson on the 6th of June of this year, as described by him in a letter to Sir George B. Airy. In 1870 Professor Young was the first to observe the reversal of the Frauenhofer lines in the stratum closest to the sun. Now, in 1871 doubts were thrown upon the subject. It appeal's that the reversed lines seem to have been satisfactorily observed by Captain Maclear at Bekul, Colonel Tennant at Dodabetta, and Captain Fyers at Jaffna. The observations of Pringle at Bekul, Respighi at Paodoxottan, and Pogson at Avenashi were doubtful, while Mosely at Trincomalee saw nothing of this reversal, which is, according to all accounts, a most striking phenomenon, although of very short duration. Mr. Lockyer missed it by an accidental derangement of the telescope. The reversal and the physical deductions from it are placed beyond doubt by Mr. Pogson's observations of the annular eclipse on June 6th. At the first internal contact, just after a peep in the finder had shown the moon's limb lighted up by the corona, he saw all the dark lines reversed and bright, but for less than two seconds. The sight of beauty above all was, however, the reversion of the lines at the breaking-up of the limb. The duration was astonishing—five to seven seconds; and the fading-out was gradual, not momentary. This does not accord with Captain Maclear's observations in 1870, who reports the disappearance of the bright spectrum as "not instantly, but so rapidly that I could not make out the order of their going." Professor Young again says that "they flashed out like the stars from a rocket-head." But discrepancies in this minor point may be accounted for by supposing differences in quietude of that portion of the sun's limb last covered by the moon.

The mention of the solar appendages recalls to mind another instance in which photography has befriended the scientific investigator. I allude to the promising attempt which has been made by Professor Young to photograph the protuberances of the sun in ordinary daylight. A distinct reproduction of some of the double-headed prominences on the sun's limb was obtained; and although as a picture the impression may be of little value, still there is every reason to believe, now that the possibility of the operation is known, that with bettor and more suitable apparatus an exceedingly valuable and reliable record may be secured. Professor Young employed for the purpose a spectroscope containing seven prisms, fitted to a telescope of 6½-inch aperture, after the eyepiece of the same had been removed. A camera, with the sensitive plate, was attached to the end of the spectroscope, the eyepiece of which acted in the capacity of a photographic lens, and projected the image on the collodion film. The exposure was necessarily along one, amounting to three minutes and a half. The eyepiece of the spectroscope was unsuitable for photographic purposes, and only in the centre yielded a true reproduction of the lines free from any distortion. A larger telescope, with a suitable secondary magnifier, will be required, in order to secure a more defined image.

I have hitherto spoken of the successful applications of photography to astronomy; but I must point out also some cases where it has failed. Nebulae and comets have not yet been brought within the grasp of this art, although, perhaps, no branch of astronomy would gain more if we should hereafter succeed in extending to these bodies that mode of observing them. There is theoretically, and even practically, no real limit to the sensitiveness of a plate. Similarly with reference to planets great difficulties still exist, which must be overcome before their phases and physical features can be recorded to some purpose by photography; yet there is great hope that the difficulties may be ultimately surmounted. The main obstacle to success arises from atmospheric currents, which are continually altering the position of the image on the sensitive plate; the structure of the sensitive film is also an interfering cause for such small objects. A photograph taken at Cranford of the occultation of Saturn by the moon some time ago exhibits the ring of the planet in a manner which holds out some promise for the future.

The moon, on the other hand, has been for some time past very successfully photographed; but no use has hitherto been made of lunar photographs for the purposes of measurement.

The photographs of the moon are free from distortion, and offer therefore material of incalculable value as the basis of a selenographic map of absolute trustworthiness, and also for the solution of the great problem of the moon's physical libration. This question can be solved with certainty by a series of systematic measurements of the distance of definite lunar points from the limb. Mr. Ellery, Director of the Observatory of Melbourne, has sent over an enlargement of a lunar photograph taken with the Great Melbourne Telescope, in which the primary image is 3-3/16 inches in diameter. Such lunar negatives would be admirably adapted for working out the problem of the physical libration, and also for fundamental measurements for a selenographic map; the more minute details, however, would have to be supplied by eye-observations, as the best photograph fails to depict all that the eye sees with the help of optical appliances. On the other hand, selenographic positions would be afforded more free from error than those to be obtained by direct micrometrical measurements.

Although, as I have stated, I do not contemplate passing in review recent discoveries in astronomy, I must not omit to call your attention to some few subjects of engrossing interest. First, with reference to the more recent work of Dr. Huggins. In his observations ho found that the brightest line of the three bright lines which constitute the spectrum of the gaseous nebulae was coincident with the brightest of the lines of the spectrum of nitrogen; but the aperture of his telescope did not permit him to ascertain whether the line in the nebulae was double, as is the case with the line of nitrogen. With the large telescope placed in his hands by the Royal Society, he has found that the line in the nebula; is not double, and in the case of the groat nebula in Orion it coincides in position with the less refrangible of the two lines which make up the corresponding nitrogen-line. He has not yet been able to find a condition of luminous nitrogen in which the line of this gas is single and narrow and defined like the nebular line.

He has extended the method of detecting a star's motion in the line of sight by a change of refrangibility in the line of a terrestrial substance existing on the star to about 30 stars besides Sirius. The comparisons have been made with lines of hydrogen, magnesium, and sodium. In consequence of the extreme difficulty of the investigation, the numerical velocities of the stars have been obtained by estimation, and are to be regarded as provisional only. It will be observed that, speaking generally, the stars which the spectroscope shows to be moving from the earth, as Sirius, Betelgeux, Rigel, Procyon, are situated in a part of the heavens opposite to Hercules, towards which the sun is advancing; while the stars in the neighbourhood of this region, as Areturus, Vega, and *a* Cygni, show a motion of approach. There are, however, in the stars already observed, exceptions to this general statement; and there are some other considerations, as the relative velocities of the stars, which appear to show that the sun's motion in space is not the only or even in all cases the chief cause of the observed proper motions of the stars. In the observed stellar motions we have to do probably with two other independent motions—namely, a movement common to certain groups of stars and also a motion peculiar to each star. Thus the stars #, # #, # # of the Great Bear, which have similar proper motions, have a common motion of recession; while the star a of the same constellation, which has a proper motion in the opposite direction, is shown by the spectroscope to be approaching the earth. From further researches in this direction, and from an investigation of the motions of stars in the line of sight in conjunction with their proper motions at right angles to the visual direction obtained by the ordinary methods, we may hope to gain some definite knowledge of the constitution of the heavens.

This discovery supports, in a somewhat striking manner, the views which Mr. Proctor has been urging respecting the distribution of the stars in space. According to these views there exist within the sidereal system subordinate systems of stars forming distinct aggregations, in which many orders of real magnitude exist, while around them is relatively barren space. He had inferred the existence of such systems from the results of processes of equal-surface charting applied successively to stars of gradually diminishing orders of brightness. He found the same regions of aggregation, whether the charts included stars to the sixth order only or were extended, as in his chart of the northern heavens, to the tenth and eleventh orders; and these regions of aggregation are the very regions where the elder Herschel found the faintest telescopic stars to congregate. Applying a new system of charting to show the proper motions of the stars, he found further evidence in favour of these views. The charts indicated the existence of concurrent motions among the members of several groups or sets of stars. Selecting one of the more striking instances as affording what appeared to him a crucial test of the reality of this *star-drift*, Mr. Proctor announced his belief that whenever the spectroscopic method of determining stellar motions of recess or approach should be applied to the five stars #, #, #, #, and £ Ursae Majoris, these orbs (which formed a drifting set in the chart of proper motions) would be found to be drifting collectively either towards or from the earth: this has been confirmed.

The time has now come for more closely investigating the various theories which have been propounded by such profound thinkers as Tyndall, Tait, Reynolds, and others, to account for the phenomena of Comets. I do not propose to enter into a statement of these theories; but I venture to call your attention to Zollner's views, which have recently given rise to a great amount of controversy. In doing so, I am solely influenced by a desire to give information on this subject, without implying thereby that I give my adherence, or even preference, to his theory.

See Appendix, p. 12.

The vaporization of even solid bodies at low temperatures suggests that a mass of matter in space will ultimately surround itself with its own vapour, the tension of which will depend upon the mass of the body (that is, upon its gravitative energy) and the temperature. If the mass of the body is so small that its attractive force is insufficient to give to the enveloping vapour its maximum tension for the existing temperature, the evolution of vapour will be continuous until the whole mass is converted into it. It is proved by analysis that such a mass of gas or vapour in empty and unlimited space is in a condition of unstable equilibrium, and must become dissipated by continual expansion and consequent decrease of density. It follows that celestial spaces, at least within the limits of the stellar universe, must be filled with matter in the form of gas.

A fluid mass existing in space at a distance from the sun or other body radiating heat would, if its mass were not too great, be converted entirely into vapour after the lapse of sufficient time. But if the fluid mass approach the sun, solar heat would occasion a more rapid development of vapour on the sunward side; and the total vaporization would require an incomparably short time with reference to the interval necessary in the former case; this time would be shorter the smaller the mass of the body. Professor Zollner points to the smaller comets, which often appear as spherical masses of vapour, as examples of such bodies, while the spectra of some of the nebula; and smaller comets render the existence of fluid masses giving out vapour highly probable.

The self-luminosity and train of comets he refers to other causes. Two causes only are known through the operation of which gases become self-luminous—elevation of temperature (as bycombustion), or electrical excitement. Setting aside the first as involving theoretical difficulties, the second cause is demonstrated by him to be sufficient to account for the self-luminosity and the formation of the train, provided it be granted that electricity may be developed by the action of solar heat, if not in the process of evaporation, at least in the mechanical and molecular disturbances resulting from it. The production of electricity by such processes within the limits of our experience, must be admitted as a well-known tact. The spectrum of the vaporous envelope of a comet, illuminated in this manner, must necessarily be that produced by the passage of an electrical discharge through vapour identical in substance with a portion of the comet's nucleus, from which the envelope is derived. As, according to this supposition, water and liquid hydrocarbons are important constituents of these bodies, the spectra of the comets should be such as belong to the vapours of these substances; and in this manner the resemblance and partial coincidence of the observed cometic spectra with those of gaseous hydrocarbons is explained.

The form and direction of the train indicate undoubtedly the action of a repulsive force; and Professor Zollner asserts that the assumption of an electrical action of the sun upon bodies of the solar system is necessary and sufficient to account for all the essential and characteristic phenomena of the vaporous envelope and the train. The direction of the train, towards or from the sun, is, according to this theory, to be easily explained by, the supposition of a variability in the mutual electrical conditions. This accords perfectly with the phenomena observed in the development of electricity by vapour-streams in the hydroelectric machine, where the sign of the electricity depends upon the presence or absence of various substances in the boiler or the tubes.

The theory acquires an additional interest from Schiaparelli's remarkable discovery of the identity of the paths of certain comets with great meteor-streams, since the meteoric masses must inevitably be converted into vapour on approaching the sun, with exhibition of the characteristic appearances of the comets.

The intimate connexion of planetary configuration and solar spots, of the latter and terrestrial magnetism and auroral phenomena, must tend to establish also a connexion between solar spots and solar radiation. It is demonstrated by the researches of Piazzi Smyth, Stone, and Cleveland Abbe, that there is a connexion between the amount of heat received from the sun and the prevalence of spots—a result clearly in harmony with those derived from recent investigations into the nature of the solar atmosphere. Further, in a paper by Mr. Meldrum, of Mauritius, which will be read before you during this session, most remarkable evidence is given on the close connexion of these phenomena. It appears that the cyclones of the Indian Ocean have a periodicity corresponding with the sun-spot periodicity; so that if an observer in another planet could see and measure the sun-spots and cyclones (earth-spots), he would find a close harmony between them. Such a connexion will probably be found to exist over the globe generally; but with reference to the Indian Ocean it may be stated as a matter of fact, from Mr. Meldrum's discussion of twenty-five years' observations, that in the area lying between the equator and 25° south latitude, and between 40° and 110° east longitude, the frequency of cyclones has varied during that period directly as the amount of sun-spots. I am glad to be able to announce that Mr. Meldrum, in order to place the deductions on a still broader foundation, proposes to investigate these laws on a plan perfectly in agreement with our method of determining the areas of solar disturbances, the results of which have been published from time to time during the last ten years. Moreover the observations on the periodic changes of Jupiter's appearance, and the observations of Mr. Baxendell that the convection-currents of our earth vary according to the sunspot period—all these results, seemingly solitary, but truly in mysterious harmony, point to the absolute necessity for establishing constant photographic records of solar and terrestrial phenomena all over the world. No astronomer or physicist should lose any opportunity of assisting in this great aim, by which alone unbiased truthful records of phenomena can be preserved. What is more, no system of observations can be carried on at a less expense.

We have hopes of seeing the photographic method as applied to sun-observations joined to the work of the Greenwich Observatory; but what is further wanted is the erection of instruments for photographic records'and of spectroscopes in a number of observatories throughout the world, so as to obtain daily records of the sun and to observe magnetical and meteorological phenomena continuously in connexion with solar activity. Meteorological observation is storing up useful facts; but they can only be dealt with effectually if investigated in close parallelism with other cosmical phenomena. Only when this is done may we hope to penetrate the maze of local meteorological phenomena and elevate meteorology to the rank of a science. The time has really come not only for relieving private observers from the systematic observation of solar phenomena, but for drawing close ties between all scattered scientific observations, so as to let one grand scheme embrace the whole; and no method seems to be so well adapted to bring about this great achievement than the method of photographing the phenomena of nature, which in its very principle carries with it all extinction of individual bias.

In conclusion I cannot refrain from making a passing allusion to a Royal Commission, presided over by the Duke of Devonshire, which has been sitting for some time past; for I believe that its labours will have an important bearing on all that relates to scientific education and the promotion of science in this country. The time has come when the cultivation of science must be protected and fostered by the state; it can no longer be safely left to individual efforts. If England is to continue to hold a high position among civilized nations, the most anxious care must be given to the establishment by the state of such an organized system for the advancement of science and the utilization of the work of scientific men as will be in" harmony with similar organizations in neighbouring states—for examples, France, Germany, and Russia.

Appendix.

Certain conclusions at which Professor Zollner arrives in the investigation of several points bearing on the theory which he defends are, quite independent of the latter, of high scientific value.

First, with reference to the density of atmospheric air, which (in accordance with the considerations mentioned in stating his views) he supposes to fill the interstellar space everywhere, he assumes for the purposes of calculation that the temperature of space is that of melting ice, and finds that the lower limit of density for a portion of gas in space is 1/10246 of that of the air at the earth's surface, a value so small that if a mass of air which, at its ordinary density upon the earth's surface, occupies a volume of one cubic decimetre (a litre), were reduced to the density expressed by this fraction, it would fill a sphere whose radius would not be traversed by a ray of light in less than 1098 years. These values indicate a density which would have no appreciable effect whatever upon rays of light or upon the motion of bodies in space, and which would become still less if the temperature of space be taken, with Fourier, at #60° C., or with Pouillet, at #132°C. But as every solid body must, by virtue of its gravitative energy, condense the gas into an atmospheric envelope round itself, the density' of the latter will solely depend on the size and mass of the body. Professor Zollner finds by calculation that, for instance, the density of air thus forming an atmosphere round the moon must be 1/10332 of that of the air of the earth's surface. This is in accord with the 10332 fact that no trace of a lunar atmosphere has as yet been detected. But the values become very great for the larger planets, quite great enough to manifest absorptive effects upon the light reflected from them. Considering that there are peculiarities in the spectra of Uranus, Neptune, and also of Jupiter, which appear to indicate atmospheric influences, Professor Zollner's results are not without deep interest, and certainly suggestive of further inquiry.

Secondly, with reference to the supposition that a body may be at the same time under the influence of gravitative and electrical agencies, it was necessary for the author of this theory to discuss the quantitative difference in their effect upon ponderable masses at a distance. The discussion shows that, if the mass increases, gravitation preponderates over electricity; if the mass decreases sufficiently, the contrary takes place. It follows that the cometary nuclei, as masses, are subject to gravitation, while the attenuated vapours developed from them yield to the action of free electricity of the sun. Professor Zollner has based upon Hankel's numerous and careful researches on the determination of atmospheric electricity, in absolute measure, an analytical inquiry into the motion of a small sphere under the action of gravity and atmospheric electricity, which leads to some remarkable results. Supposing the free electricity of the sun to be not greater than that repeatedly observed on the earth's surface, and to be uniformly distributed, it would communicate to a sphere having a diameter of 11 millimetres and a weight of 1/100 of a milligramme, and starting from the sun, by the time it had moved as far away as the mean distance of Mercury, a velocity per second of 3,027,000 metres, or 408.4 German geographical miles

Fifteen to a degree of longitude on the Equator.

This velocity is such that in two days it would pass over a space of 70,540,000 German geographical miles, a magnitude quite of the same order as those recorded by cometary astronomy. The discussion was undertaken to prove that there is no need for assuming the existence of any unknown repulsive agency, but that electrical energy not greater than that observed on the earth's surface is amply sufficient to account satisfactorily for the phenomena presented by cometic trains.

Inaugural Address

Delivered at the Forty-fourth Annual Meeting Of the British Association for the Advancement of Science

Held at Belfast, August, 1874

By Professor John Tyndall, D.C.L., LL.D.

President of the Association.

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Inaugural Address

By Prof. John Tyndall, D.C.L., LL.D., F.R.S.

AN impulse inherent in primeval man turned his thoughts and questionings betimes towards the sources of natural phenomena. The same impulse, inherited and intensified, is the spur of scientific action to-day. Determined by it, by a process of abstraction from experience we form physical theories which lie beyond the pale of experience, but which satisfy the desire of the mind to see every natural occurrence resting upon a cause. In forming their notions of the origin of things, our earliest historic (and doubtless, we might add, our pre-historic) ancestors pursued, as far as their intelligence permitted, the same course. They also fell back upon experience, but with this difference—that the particular experiences which furnished the weft and woof of their theories were drawn, not from the study of nature, but from what lay much closer to them—the observation of men. Their theories accordingly took an anthropomorphic form. To supersensual beings, which, "how., ever potent and invisible, were nothing but a species of human creatures, perhaps raised from among mankind, and retaining all human passions and appetites,"

Hume, "Natural History of Religion."

were handed over the rule and governance of natural phenomena.

Tested by observation and reflection, these early notions failed in the long run to satisfy the more penetrating intellects of our race. Far in the depths of history we find men of exceptional power differentiating themselves from the crowd, rejecting these anthropomorphic notions, and seeking to connect natural phenomena with their physical principles. But long prior to these purer efforts of the understanding the merchant had been abroad, and rendered the philosopher possible; commerce had been developed, wealth amassed, leisure for travel and for speculation secured, while races educated under different conditions, and therefore differently informed and endowed, had been stimulated and sharpened by mutual contact. In those regions where the commercial aristocracy of ancient Greece mingled with its eastern neighbours, the sciences were born, being nurtured and developed by free-thinking and courageous men. The state of things to be displaced may be gathered from a passage of Euripides quoted by Hume. "There is nothing in the world; no glory, no prosperity. The gods toss all into confusion; mix everything with its reverse, that all of us, from our ignorance and uncertainty, may pay them the more worship and reverence." Now, as science demands the radical extirpation of caprice and the absolute reliance upon law in nature, there grew with the growth of scientific notions a desire and determination to sweep from the field of theory this mob of gods and demons, and to place natural phenomena on a basis more congruent with themselves.

The problem which had been previously approached from above was now attacked from below; theoretic effort passed from the super to the sub-sensible. It was felt that to construct the universe in idea it was necessary to have some notion of its constituent parts—of what Lucretius subsequently called the "First Beginnings." Abstracting again from experience, the leaders of scientific speculation reached at length the pregnant doctrine of atoms and molecules, the latest developments of which were set forth with such power and clearness at the last meeting of the British Association. Thought no doubt had long hovered about this doctrine before it attained the precision and completeness which it assumed in the mind of Democritus,

Born 460 B.C.

a philosopher who may well for a moment arrest our attention. "Few great men," says Lange, in his excellent "History of Materialism," a work to the spirit and the letter of which I am equally indebted, "have been so despitefully used by history as Democritus. In the distorted images sent down to us through unscientific traditions there remains of him almost nothing but the name of the 'laughing philosopher,' while figures of immeasurably smaller significance spread themselves at full length before us." Lange speaks of Bacon's high appreciation of Democritus—for ample illustrations of which I am indebted to my excellent friend Mr. Spedding, the learned editor and biographer of Bacon. It is evident, indeed, that Bacon considered Democritus to be a man of weightier metal than either Plato or Aristotle, though their philosophy "was noised and celebrated in the schools, amid the din and pomp of professors." It was not they, but Genseric and Attila and the barbarians, who destroyed the atomic philosophy. "For at a time when all human learning had suffered shipwreck, these planks of Aristotelian and Platonic philosophy, as being of a lighter and more inflated substance, were preserved and come down to us, while things more solid sank and almost passed into oblivion."

The principles enunciated by Democritus reveal his uncompromising antagonism to those who deduced the phenomena of nature from the caprices of the gods. They are briefly these:—1. From nothing comes nothing. Nothing that exists can be destroyed. All changes are due to the combination and separation of molecules. 2. Nothing happens by chance. Every occurrence has its cause from which it follows by necessity. 3. The only existing things are the atoms and empty space; all else is mere opinion. 4. The atoms are infinite in number, and infinitely various in form; they strike together, and the lateral motions and whirlings which thus arise are the beginnings of worlds. 5. The varieties of all things depend upon the varieties of their atoms, in number, size, and aggregation. 6. The soul consists of free, smooth, round atoms, like those of fire. These are the most mobile of all. They interpenetrate the whole body, and in their motions the phenomena of life arise. Thus the atoms of

Democritus are individually without sensation; they combine in obedience to mechanical laws; and not only organic forms, but the phenomena of sensation and thought are also the result of their combination.

That great enigma, "the exquisite adaptation of one part of an organism to another part, and to the conditions of life," more especially the construction of the human body, Democritus made no attempt to solve. Empedocles, a man of more fiery and poetic nature, introduced the notion of love and hate among the atoms to account for their combination and separation. Noticing this gap in the doctrine of Democritus, he struck in with the penetrating thought, linked, however, with some wild speculation, that it lay in the very nature of those combinations which were suited to their ends (in other words, in harmony with their environment) to maintain themselves, while unfit combinations, having no proper habitat, must rapidly disappear. Thus more than 2,000 years ago the doctrine of the "survival of the fittest," which in our day, not on the basis of vague conjecture, but of positive knowledge, has been raised to such extraordinary significance, had received at all events partial enunciation.

Lange, 2nd edit., p. 23.

Epicurus,

Born 342 B.C.

said to be the son of a poor schoolmaster at Samos, is the next dominant figure in the history of the atomic philosophy. He mastered the writings of Democritus, heard lectures in Athens, returned to Samos, and subsequently wandered through various" countries. He finally returned to Athens, where he bought a garden and surrounded himself by pupils, in the midst of whom he lived a pure and serene life, and died a peaceful death. His philosophy was almost identical with that of Democritus; but he never quoted either friend or foe. One main object of Epicurus was to free the world from superstition and the fear of death. Death he treated with indifference. It merely robs us of sensation. As long as we are, death is not; and when death is, we are not. Life has no more evil for him who has made up his mind that it is no evil not to live. He adored the gods, but not in the ordinary fashion. The idea of divine power, properly purified, he thought an elevating one. Still he taught, "Not he is godless who rejects the gods of the crowd, but rather he who accepts them." The gods were to him eternal and immortal beings, whose blessedness excluded every thought of care or occupation of any kind. Nature pursues her course in accordance with everlasting laws, the gods never interfering. They haunt

"The lucid interspace of world and world
Where never creeps a cloud or moves a wind,
Nor ever falls the least white star of snow,
Nor ever lowest roll of thunder moans,
Nor sound of human sorrow mounts to mar
Their sacred everlasting calm."

Tennyson's "Lucretius."

Lange considers the relation of Epicurus to the gods subjective; the indication probably of an ethical requirement of his own nature. We cannot read history with open eyes, or study human nature to its depths, and fail to discern such a requirement. Man never has been, and he never will be, satisfied with the operations and products of the understanding alone; hence physical science cannot cover all the demands of his nature. But the history of the efforts made to satisfy these demands might be broadly described as a history of errors—the error consisting in ascribing fixity to that which is fluent, which varies as we vary, being gross when we are gross, and becoming, as our capacities widen, more abstract and sublime. On one great point the mind of Epicurus was at peace. He neither sought nor expected, here or hereafter, any personal profit from his relation to the gods. And it is assuredly a fact that loftiness and serenity of thought may be promoted by conceptions which involve no idea of profit of this kind. "Did I not believe," said a great man to me once, "that an Intelligence is at the heart of things, my life on earth would be intolerable." The utterer of these words is not, in my opinion, rendered less noble but more noble, by the fact that it was the need of ethical harmony here, and not the thought of personal profit hereafter, that prompted! his observation.

A century and a half after the death of Epicurus, Lucretius

Born 99 B. C.

wrote his great poem, "On the Nature of Things," in which he, a Roman, developed with extraordinary ardour the philosophy of his Greek predecessor. He wishes to win over his friend Memnius to the school of Epicurus; and although he has no rewards in a future life to offer, although his object appears to be a purely negative one, he addresses his friend with the heat of an apostle. His object, like that of his great forerunner, is the destruction of superstition; and considering that men trembled before every natural event as a direct monition from the gods, and that everlasting torture was also in prospect, the freedom aimed at by Lucretius might perhaps be deemed a positive good. "This terror," he says, "and darkness of mind must be dispelled, not by the rays of the sun and glittering shafts of day, but by the aspect and the law of nature." He refutes the notion that anything can come out of nothing, or that that which is once begotten can be recalled to nothing. The first beginnings, the atoms, are indestructible, and into them all things can be dissolved at last. Bodies are partly atoms and partly combinations of atoms; but the atoms nothing can quench. They are strong in solid singleness, and by their denser combination all things can be closely packed and exhibit enduring strength. He denies that matter is infinitely-divisible. We come at length to the atoms, without which, as an imperishable substratum, all order in the generation and development of things would be destroyed.

The mechanical shock of the atoms being in his view the all-sufficient cause of things, he combats the notion that the constitution of nature has been in any way determined by intelligent design. The interaction of the atoms throughout infinite time rendered all manner of combinations possible. Of these the fit ones persisted, while the unfit ones disappeared. Not after sage deliberation did the atoms station themselves in their right places, nor did they bargain what motions they should assume. From all eternity they have been driven together, and after trying motions and unions of every kind, they fell at length into the arrangements out of which this system of things has been formed. His grand conception of the atoms falling silently through immeasurable ranges of space and time suggested the nebular hypothesis to Kant, its first propounder. "If you will apprehend and keep in mind these things, Nature, free at once, and rid of her haughty lords, is seen to do all things spontaneously of herself, without the meddling of the gods."

Monro's translation. In his criticism of this work (*Contemporary Review*, 1867), Dr. Hayman does not appear to be aware of the really sound and subtile observations on which the reasoning of Lucretius, though erroneous, sometimes rests.

During the centuries between the first of these three philosophers and the last, the human intellect was active in other fields than theirs. The Sophists had run through their career. At Athens had appeared the three men, Socrates, Plato, and Aristotle, whose yoke remains to some extent unbroken to the present hour. Within this period also the School of Alexandria was founded, Euclid wrote his "Elements," and he and others made some advance in optics. Archimedes had propounded the theory of the lever and the principles of hydrostatics. Pythagoras had made his experiments on the harmonic intervals, while astronomy was immensely enriched by the discoveries of Hipparchus, who was followed by the historically more celebrated Ptolemy. Anatomy had been made the basis of scientific medicine; and it is said by Draper

"History of the Intellectual Development of Europe," p. 295.

that vivisection then began. In fact, the science of ancient Greece had already cleared the world of the fantastic images of divinities operating capriciously through natural phenomena. It had shaken itself free from that fruitless scrutiny "by the internal light of the mind alone," which had vainly sought to transcend experience and reach a knowledge of ultimate causes. Instead of accidental observation, it had introduced observation with a purpose; instruments were em ployed to aid the senses; and scientific method was rendered in a great measure complete by the union of induction and experiment.

What, then, stopped its victorious advance? Why was the scientific intellect compelled, like an exhausted soil, to lie fallow for nearly two millenniums before it could re-gather the elements necessary to its fertility and strength? Bacon has already let us know one cause; Whewell ascribes this stationary period to four causes—obscurity of thought, servility, intolerance of disposition, enthusiasm of temper; and he gives striking examples of each.

History of the Inductive Sciences," vol. i.

But these characteristics must have had their causes, which lay in the circumstances of the time. Rome and the other cities of the empire had fallen into moral putrefaction. Christianity had appeared, offering the gospel to the poor, and by moderation if not asceticism of life, practically protesting against the profligacy of the age. The sufferings of the early Christians and the extraordinary exaltation of mind which enabled them to triumph over the diabolical tortures to which they were subjected,

Depicted with terrible vividness in Renan's "Antichrist."

must have left traces not easily effaced. They scorned the earth, in view of that "building of God, that house not made with hands, eternal in the heavens." The Scriptures which ministered to their spiritual needs were also the measure of their science. When, for example, the celebrated question of antipodes came to be discussed, the Bible was with many the ultimate court of appeal. Augustine, who flourished A.D. 400, would not deny the rotundity of the earth, but he would deny the possible existence of inhabitants at the other side, "because no such race is recorded in Scripture among the descendants of Adam." Archbishop Boniface was shocked at the assumption of a "world of human beings out of the reach of the means of salvation." Thus reined in, science was not likely to make much progress. Later on, the political and theological strife between the Church and civil governments, so powerfully depicted -by Draper, must have done much to stifle investigation.

Whewell makes many wise and brave remarks regarding the spirit of the Middle Ages. It was a menial spirit. The seekers after natural knowledge had forsaken that fountain of living waters, the direct appeal to nature by observation and experiment, and had given themselves up to the re-manipulation of the notions of their predecessors. It was a time when thought had become abject, and when the acceptance of mere authority led, as it always does in science, to intellectual death. Natural events, instead of being traced to physical, were referred to moral causes, while an exercise of the phantasy, almost as degrading as the spiritualism of the present day, took the place of scientific speculation. Then came the mysticism of the Middle ages, magic, alchemy, the Neo-platonic philosophy, with its visionary though sublime attractions, which caused men to look with shame upon their own bodies as hindrances to the absorption of the creature in the blessedness of the Creator. Finally came the scholastic philosophy, a fusion, according to Lange, of the least mature notions of Aristotle with the Christianity of the west. Intellectual immobility was the result. As a traveller without a compass in a fog may wander long, imagining he is making way, and find himself, after hours of toil, at his starting-point, so the schoolmen, having tied and untied the same knots, and formed and dissipated the same clouds, found themselves at the end of centuries in their old position.

With regard to the influence wielded by Aristotle in the Middle Ages, and which, though to a less extent, he still wields, I would ask permission to make one remark. When the human mind has achieved greatness and given evidence of extraordinary power in any domain, there is a tendency to credit it with similar power in all other domains. Thus theologians have found comfort and assurance in the thought that Newton dealt with the question of revelation, forgetful of the fact that the very devotion of his powers, through all the best years of his life, to a totally different class of ideas, not to speak of any natural disqualification, tended to render him less instead of more competent to deal with theological and historic questions. Goethe, starting from his established greatness as a poet, and indeed from his positive discoveries in natural history, produced a profound impression among the painters of Germany when he published his "Farbenlehre," in which he endeavoured to overthrow Newton's theory of colours. This theory he deemed so obviously absurd, that he considered its author a charlatan, and attacked him with a corresponding vehemence of language. In the domain of natural history Goethe had made really considerable discoveries; and we have high authority for assuming that had he devoted himself wholly to that side of science he might have reached in it an eminence comparable with that which he attained as a poet. In sharpness of observation, in the detection of analogies, however apparently remote, in the classification and organization of facts according to the analogies discerned, Goethe possessed extraordinary powers. These elements of scientific inquiry fall in with the discipline of the poet. But, on the other hand, a mind thus richly endowed in the direction of natural history, may be almost shorn of endowment as regards-the more strictly called physical and mechanical sciences. Goethe was in this condition. He could not formulate distinct mechanical conceptions; he could not see the force of mechanical reasoning; and in regions where such reasoning reigns supreme he became a mere *ignis fatuus* to those who followed him.

I have sometimes permitted myself to compare Aristotle with Goethe, to credit the Stagirite with an almost superhuman power of amassing and systematizing facts, but to consider him fatally defective on that side of the mind in respect to which, incompleteness has been justly ascribed to Goethe. Whewell refers the errors of Aristotle, not to a neglect of facts, but to "a neglect of the idea appropriate to the facts; the idea of mechanical cause, which is force, and the substitution of vague or inapplicable notions, involving only relations of space or emotions of wonder." This is doubtless true; but the word "neglect" implies mere intellectual misdirection, whereas in Aristotle, as in Goethe, it was not, I believe, misdirection, but sheer natural incapacity which lay at the root of his mistakes. As a physicist,. Aristotle displayed what we should consider some of the worst attributes of a modern physical investigator—indistinctness of ideas, confusion of mind, and a confident use of language, which led to the delusive notion that he had really mastered his subject, while he as yet had tailed to grasp even the elements of it. He put words in the place of things, subject in the place of object. He preached induction without practising it, inverting the true order of inquiry by passing from the general to the particular, instead of from the particular to the general. He made of the universe a closed sphere, in the centre of which he fixed the earth, proving from general principles, to his own satisfaction and that of the world for nearly 2,000 years, that no other universe was possible. His notions of motion were entirely unphysical. It was natural or unnatural, better or worse, calm or violent—no real mechanical conception regarding it lying at the bottom of his mind. He affirmed that a vacuum could not exist, and proved that if it did exist motion in it would be impossible. He determined *à priori* how many species of animals must exist, and showed on general principles why animals must have such and such parts. When an eminent contemporary philosopher, who is far removed from errors of this kind, remembers these abuses of the *à priori* method, he will be able to make allowance for the jealousy of physicists as to the acceptance of so-called *à priori* truths. Aristotle's errors of detail were grave and numerous. He affirmed that only in man we had the beating of the heart, that the left side of the body was colder than the right, that men have more teeth than women, and that there is an empty space, not at the front, but at the back of every man's head.

There is one essential quality in physical conceptions which was entirely wanting in those of Aristotle and his followers. I wish it could be expressed by a word untainted by its associations; it signifies a capability of being placed as a coherent picture before the mind. The Germans express the act of picturing by the word *vorstellen*, and the picture they call a *vorstel- lung*. We have no word in English which comes nearer to our requirements than *imagination*, and, taken with its proper limitations, the word answers very well; but, as just intimated, it is tainted by its associations, and therefore objectionable to some minds. Compare, with reference to this capacity of mental presentation, the case of the Aristotelian, who refers the ascent of water in a pump to Nature's abhorrence of a vacuum, with that of Pascal when he proposed to solve the question of atmospheric pressure by the ascent of the Puy de Dome. In the one case the terms of the explanation refuse to fall into place as a physical image; in the other the image is distinct, the fall and rise of the barometer being clearly figured as the balancing of two varying and opposing pressures.

During the drought of the Middle Ages in Christendom, the Arabian intellect, as forcibly shown by Draper, was active. With the intrusion of the Moors into Spain, cleanliness, order, learning, and refinement took the place of their opposites. When smitten with the disease, the Christian peasant resorted to a shrine; the Moorish one to an instructed physician. The Arabs encouraged translations from the Greek philosophers, but not from the Greek poets. They turned in disgust "from the lewdness of our classical mythology, and denounced as an unpardonable blasphemy all connection between the impure Olympian Jove and the Most High God." Draper traces still further than Whewell the Arab elements in our scientific terms, and points out that the under garment of ladies retains to this hour its Arab name. He gives examples of what Arabian men of science accomplished, dwelling particularly on Alhazen, who was the first to correct the Platonic notion that rays of light are emitted by the eye. He discovered atmospheric refraction, and points out that we see the sun and moon after they have set. He explains the enlargement of the sun and moon, and the shortening of the vertical diameters of both these bodies, when near the horizon. He is aware that the atmosphere decreases in density with increase of height, and actually fixes its height at 58½ miles. In the Book of the Balance Wisdom, he sets forth the connection between the weight of the atmosphere and its increasing density He shows that a body will weigh differently in a rare and a dense atmosphere: he considers the force with which plunged bodies rise through heavier media. He understands the doctrine of the centre of gravity, and applies it to the investigation of balances and steelyards. He recognizes gravity as a force, though he falls into the error of making it diminish at the distance, and of making it purely terrestrial. He knows the relation between the velocities, spaces, and times of falling bodies, and has distinct ideas of capillary attraction. He improves the hydrometer. The determination of the densities of the bodies as given by Alhazen approaches very closely to our own. "I join," says-Draper, "in the pious prayer of Alhazen, that in the day of judgment the All-Merciful will take pity on the soul of Abur-Raihan, because he was the first of the race of men to construct a table of specific gravities." If all this be historic truth (and I have entire confidence in Dr. Draper), well may he "deplore the systematic manner in which the literature of Europe has contrived to put out of sight our scientific obligations to the Mahommedans."

"Intellectual Development of Europe,' p 359.

Towards the close of the stationary period a word-weariness, if I may so express it, took more and more possession of men's minds. Christendom had become sick of the school philosophy and its verbal wastes, which led to no issue, but left the intellect in everlasting haze. Here and there was heard the voice of one impatiently crying in the wilderness, "Not unto Aristotle, not unto subtle hypotheses, not unto Church, Bible, or blind tradition, must we turn for a knowledge of the universe, but to the direct investigation of nature by observation and experiment." In 1543. the epoch-making work of Copernicus on the paths of the heavenly bodies appeared. The total crash of Aristotle's closed universe with the earth at its centre followed as a consequence and "the earth moves" became a kind of watchword among intellectual freemen. Copernicus was the Canon of the Church of Frauenburg, in the diocese of Ermeland. For three-and-thirty years he had withdrawn himself from the world and devoted himself to the consolidation of his great scheme of the solar system. He made its blocks eternal; and even to those who feared it and desired its overthrow it was so obviously strong that they refrained from meddling with it. In the last year of the life of Copernicus his book appeared: it is said that the old man received a copy of it a few days before his death, and then departed in peace.

The Italian philosopher Giordano Bruno was one of the earliest converts to the new astronomy. Taking Lucretius as his exemplar, he revived the notion of the infinity of worlds; and combining with it the doctrine of Copernicus, reached the sublime generalization that the fixed stars are suns, scattered numberless through space and accompanied by satellites, which bear the same relation to them as the earth does to our sun, or our moon to our earth. This was an expansion of transcendent import; but Bruno came closer than this to our present line of thought. Struck with the problem of the generation and maintenance of organisms, and duly pondering it, he came to the conclusion that nature in her productions does not imitate the technic of man. Her process is one of unravelling and unfolding. The infinity of forms under which matter appears were not imposed upon it by an external artificer; by its own intrinsic force and virtue it brings these forms forth. Matter is not the mere naked, empty *capacity* which philosophers have pictured her to be, but the universal mother, who brings forth all things as the fruit of her own womb.

This outspoken man was originally a Dominican monk. He was accused of heresy, and had to fly, seeking refuge in Geneva, Paris, England, and Germany. In 1592 he fell into the hands of the Inquisition at Venice. He was imprisoned for many years, tried, degraded, excommunicated, and handed over to the civil power, with the request that he should be treated gently and "without the shedding of blood." This meant that he was to be burnt; and burnt accordingly he was, on Feb. 16, 1600. To escape a similar fate, Galileo, thirty-three years afterwards, abjured, upon his knees, and with his hand on the holy gospels, the helio- centric doctrine. After Galileo came Kepler, who from his German home defied the power beyond the Alps. He traced out from pre-existing observations the laws of planetary motion. The problem was thus prepared for Newton, who bound those empirical laws together by the principle of gravitation.

During the Middle Ages the doctrine of atoms had to all appearance vanished from discussion. In all probability it held its ground among sober-minded and thoughtful men, though neither the Church nor the world was prepared to hear of it with tolerance. Once, in the year 1348, it received distinct expression. But retractation by compulsion immediately followed, and thus discouraged, it slumbered till the 17th century, when it was revived by a contemporary of Hobbes and Descartes, the Pere Gassendi.

The analytic and synthetic tendencies of the human mind exhibit themselves throughout history, great writers ranging themselves sometimes on the one side, sometimes on the other. Men of lofty feelings, and minds open to the elevating impressions produced by nature as a whole, whose satisfaction, therefore, is rather ethical than logical, have leaned to the synthetic side; while the analytic harmonizes best with the more precise and more mechanical bias which seeks the satisfaction of the understanding. Some form of pantheism was usually adopted by the one, while a detached Creator, working more or less after the manner of men, was often assumed by the other.

Boyle's model of the universe was the Strasburg clock with an outside artificer. Goethe, on the other hand, sang

"Ihm ziemt's die Welt im Innern zu bewegen,
Natur in sich, sich in Natur zu hegen."

The same repugnance to the clockmaker conception is manifest in Carlyle.

Gassendi is hardly to be ranked with either. Having formerly acknowledged God as the first great cause, he immediately drops the idea, applies the known laws of mechanics to the atoms, and thence deduces all vital phenomena. God who created earth and water, plants and animals, produced in the first place a definite number of atoms, which constituted the seed of all things. Then began that series of combinations and decompositions which goes on at the present day, and which will continue in the future. The principle of every change resides in matter. In artificial productions the moving principle is different from the material worked upon; but in nature the agent works within, being the most, active and mobile part of the material itself. Thus this bold ecclesiastic, without incurring the censure of the Church or the world, contrives to outstrip Mr. Darwin. The same cast of mind which caused him to detach the Creator from His universe led him also to detach the soul from the body, though to the body he ascribes an influence so large as to render the soul almost unnecessary. The aberrations of reason were in his view an affair of the material brain. Mental disease is brain disease; but then the immortal reason sits apart, and cannot be touched by the disease. The errors of madness are errors of the instrument, not of the performer.

It may be more than a mere result of education, connecting itself probably with the deeper mental structure of the two men, that the idea of Gassendi, above enunciated, is substantially the same as that expressed by Prof. Clerk Maxwell at the close of the very noble lecture delivered by him at Bradford last year. According to both philosophers, the atoms, if I understand aright, are the *prepared materials*, the "manufactured articles," which, formed by the skill of the Highest, produce by their subsequent interaction all the phenomena of the material world. There seems to be this difference, however, between Gassendi and Maxwell. The one *postulates*, the other *infers* his first cause. In his manufactured articles, Prof. Maxwell finds the basis of an induction which enables him to scale philosophic heights considered inaccessible by Kant, and to take the logical step from the atoms to their Maker.

The atomic doctrine, in whole or in part, was entertained by Bacon, Descartes, Hobbes, Locke, Newton, Boyle, and their successors, until the chemical law of multiple proportions enabled Dalton to confer upon it an entirely new significance. In our day there are secessions from the theory, but it still stands firm. Only a year or two ago Sir William Thomson, with characteristic penetration, sought to determine the sizes of the atoms, or rather to fix the limits between which their sizes lie; while only last year the discourses of Williamson and Maxwell illustrate the present hold of the doctrine upon the foremost scientific minds. What these atoms, self-moved and self-posited, can and cannot accomplish in relation to life, is at the present moment the subject of profound scientific thought. I doubt the legitimacy of Maxwell's logic; but it is impossible not to feel the ethic glow with which his lecture concludes. There is, moreover, a Lucretian grandeur in his description of the steadfastness of the atoms:—"Natural causes, as we know, are at work, which tend to modify, if they do not at length destroy, all the arrangements and dimensions of the earth and the whole solar system. But though in the course of ages catastrophes have occurred and may yet occur in the heavens, though ancient systems may be dissolved and new systems evolved out of their ruins, the molecules out of which these systems are built, the foundation stones of the material universe, remain unbroken and unworn."

Ninety years subsequent to Gassendi the doctrine of bodily instruments, as it may be called, assumed immense importance in the hands of Bishop Butler, who, in his famous "Analogy of Religion," developed, from his own point of view, and with consummate sagacity, a similar idea. The bishop still influences superior minds; and it will repay us to dwell for a moment on his views. He draws the sharpest distinction between our real selves and our bodily instruments. He does not, as far as I remember, use the word soul, possibly because the term was so hackneyed in his day, as it had been for many generations previously. But he speaks of "living powers," "perceiving" or "percipient powers," "moving agents," "ourselves," in the same sense as we should employ the term soul. He dwells upon the fact that limbs may be removed and mortal diseases assail the body, while the mind, almost up to the moment of death, remains clear. He refers to sleep and to swoon, where the "living powers" are suspended but not destroyed. He considers it quite as easy to conceive of an existence out of our bodies as in them; that we may animate a succession of bodies, the dissolution of all of them having no more tendency to dissolve our real selves, or "deprive us of living faculties—the faculties of perception and action—than the dissolution of any foreign matter which we are capable of receiving impressions from, or making use of, for the common occasions of life." This is the key of the bishop's position: "Our organized bodies are no more a part of ourselves than any other matter around us." In proof of this he calls attention to the use of glasses, which "prepare objects "for the "percipient power" exactly as the eye does. The eye itself is no more percipient than the glass, and is quite as much the instrument of the true self, and also as foreign to the true self, as the glass is. "And if we see with our eyes only in the same manner as we do with glasses, the like may justly be concluded from analogy of all our senses."

Lucretius, as you are aware, reached a precisely opposite conclusion: and it certainly would be interesting, if not profitable, to us all, to hear what he would or could urge in opposition to the reasoning of the bishop. As a brief discussion of the point will enable us to see the bearings of an important question, I will here permit a disciple of Lucretius to try the strength of the bishop's position, and then allow the bishop to retaliate, with the view of rolling back, if he can, the difficulty upon Lucretius. Each shall state his case fully and frankly; and you shall be umpire between them. The argument might proceed in this fashion:—

"Subjected to the test of mental presentation (*Vorstellung*) your views, most honoured prelate, would present to many minds a great, if not an insuperable, difficulty. You speak of 'living powers,' 'percipient or perceiving powers,' and 'ourselves;' but can you form a mental picture of any one of these apart from the organism through which it is supposed to act? Test yourself honestly, and see whether you possess any faculty that would enable you to form such a conception. The true self has a local habitation in each of us; thus localized, must it not possess a form? If so, what form? Have you ever for a moment realized it? When a leg is amputated the body is divided into two parts; is the true self in both of them or in one? Thomas Aquinas might say in both; but not you, for you appeal to the consciousness associated with one of the two parts to prove that the other is foreign matter. Is consciousness, then, a necessary element of the true self? If so, what do you say to the case of the whole body being deprived of consciousness? If not, then on what grounds do you deny any portion of the true self to the severed limb? It seems very singular that, from the beginning to the end of your admirable book (and no one admires its sober strength more than I do), you never once mention the brain or nervous system. You begin at one end of the body, and show that its parts may be removed without prejudice to the perceiving power. What if you begin at the other end, and remove, instead of the leg, the brain? The body, as before, is divided into two parts; but both are now in the same predicament, and neither can be appealed to prove that the other is foreign matter. Or, instead of going so far as to remove the brain itself, let a certain portion of its bony covering be removed, and let a rhythmic series of pressure and relaxations of pressure be applied to the soft substance. At every pressure 'the faculties of perception and of action' vanish; at every relaxation of pressure they are restored. Where, during the intervals of pressure, is the perceiving power? I once had the discharge of a Leyden battery passed unexpectedly through me: I felt nothing, but was simply blotted out of conscious existence for a sensible interval. Where was my true self during that interval? Men who have recovered from lightning-stroke have been much longer in the same state; and indeed in cases of ordinary concussion of the brain, days may elapse during which no experience is registered in consciousness. Where is the man himself during the period of insensibility? You may say that I beg the question when I assume the man to have been unconscious, that he was really conscious all the time, and has simply forgotten what had occurred to him. In reply to this, I can only say that no one need shrink from the worst tortures that superstition ever invented if only so felt and so remembered. I do not think your theory of instruments goes at all to the bottom of the matter. A telegraph operator has his instruments, by means of which he converses with the world;, our bodies possess a nervous system, which plays a similar part between the perceiving powers and external things. Cut the wires of the operator, break his battery, demagnetize his needle: by this means you certainly sever his connection with the world; but inasmuch as these are real instruments, their destruction does not touch the man who uses them. The operator survives, *and he knows that he survives*. What is it, I would ask, in the human system that answers to this conscious survival of the operator when the battery of the brain is so disturbed as to produce insensibility, or when it is destroyed altogether?

"Another consideration, which you may consider slight, presses upon me with some force. The brain may change from health to disease, and through such a change the most exemplary man may be converted into a debauchee or a murderer. My very noble and approved good master had, as you know, threatenings of lewdness introduced into his brain by his jealous wife's philter; and sooner than permit himself to run even the risk of yielding to these base promptings he slew himself. How could the hand of Lucretius have been thus turned against himself if the real Lucretius remained as before? Can the brain, or can it not, act in this distempered way without the intervention of the immortal reason? If it can, then it is a prime mover which requires only healthy regulation to render it reasonably self-acting, and there is no apparent need of your immortal reason at all. If it cannot, then the immortal reason, by its mischievous activity in operating upon a broken instrument, must have the credit of committing every imaginable extravagance and crime. I think, if you will allow me to say so, that the gravest consequences are likely to flow from your estimate of the body. To regard the brain as you would a staff or an eyeglass; to shut your eyes to all its mystery, to the perfect correlation that reigns between its condition and our consciousness, to the fact that a slight excess or defect of blood in it produces that very swoon to which you refer, and that in relation to it our meat, and drink, and air, and exercise have a perfectly transcendental value and significance; to forget all this does, I think, open a way to innumerable errors in our habits of life, and may possibly in some cases initiate and foster that very disease, and consequent mental ruin, which a wiser appreciation of this mysterious organ would have avoided."

I can imagine the bishop thoughtful after hearing this argument. He was not the man to allow anger to mingle with the consideration of a point of this kind. After due consideration, and having strengthened himself by that honest contemplation of the facts which was habitual with him, and which includes the desire to give even adverse facts their due weight, I can suppose the bishop to proceed thus:—"You will remember that in the 'Analogy of Religion,' of which you have so kindly spoken, I did not profess to prove anything absolutely, and that I over and over again acknowledged and insisted on the smallness of our knowledge, or rather the depth of our ignorance, as regards the whole system of the universe. My object was to show my deistical friends who set forth so eloquently the beauty and beneficence of Nature and the Ruler thereof, while they had nothing but scorn for the so-called absurdities of the Christian scheme, that they were in no better condition than we were, and that for every difficulty they found upon our side, quite as great a difficulty was to be found on theirs. I will now with your permission adopt a similar line of argument. You are a Lucretian, and from the combination and separation of atoms deduce all terrestrial things, including organic forms and their phenomena. Let me tell you in the first instance how far I am prepared to go with you. I admit that you can build crystalline forms out of this play of molecular force; that the diamond, amethyst, and snow-star are truly wonderful structures which are thus produced. I will go further, and acknowledge that even a tree or flower might in this way be organized. Nay, if you can show me an animal without sensation, I will concede to you that it also might be put together by the suitable play of molecular force.

"Thus far our way is clear, but now comes my difficulty. Your atoms are individually without sensation, much more are they without intelligence. May I ask you, then, to try your hand upon this problem? Take your dead hydrogen atoms, your dead oxygen atoms, your dead carbon atoms, your dead nitrogen atoms, your dead phosphorus atoms, and all the other atoms, dead as grains of shot, of which the brain is formed. Imagine them separate and sensationless; observe them running together and forming all imaginable combinations. This, as a purely mechanical process, is *seeable* by the mind. But can you see, or dream, or in any way imagine, how out of that mechanical act, and from these individually dead atoms, sensation, thought, and emotion are to arise? You speak of the difficulty of mental presentation in my case; is it less in yours? I am not all bereft of this *Vorstellungs-kraft* of which you speak. I can follow a particle of musk until it reaches the olfactory nerve; I can follow the waves of sound until their tremors reach the water of the labyrinth, and set the otoliths and Corti's fibres in motion; I can also visualize the waves of ether as they cross the eye and hit the retina. Nay, more, I am able to follow up to the central organ the motion thus imparted at the periphery, and to see in idea the very molecules of the brain thrown into tremors. My insight is not baffled by these physical processes. What baffles me, what I find unimaginable, transcending every faculty I possess—transcending, I humbly submit, every faculty you possess—is the notion that out of those physical tremors you can extract things so utterly incongruous with them as sensation, thought, and emotion. You may say, or think, that this issue of consciousness from the clash of atoms is not more incongruous than the flash of light from the union of oxygen and hydrogen. But I beg to say that it is. For such incongruity as the flash possesses is that which I now force upon your attention. The flash is an affair of consciousness, the objective counterpart of which is a vibration. It is a flash only by our interpretation. *You* are the cause of the apparent incongruity; and you are the thing that puzzles me. I need not remind you that the great Leibnitz felt the difficulty which I feel, and that to get rid of this monstrous deduction of life from death he displaced your atoms by his monads, and which were more or less perfect mirrors of the universe, and out of the summation and integration of which he supposed all the phenomena of life—sentient, intellectual, and emotional—to arise.

"Your difficulty, then, as I see you are ready to admit, is quite as great as mine. You cannot satisfy the human understanding in its demand for logical continuity between molecular processes and the phenomena of consciousness. This is a rock on which materialism must inevitably split whenever it pretends to be a complete philosophy of life. What is the moral, my Lucretian? You and I are not likely to indulge in ill-temper in the discussion of these great topics, where we see so much room for honest differences of opinion. But there are people of less wit, or more bigotry (I say it with humility) on both sides, who are ever ready to mingle anger and vituperation with such discussions. There are, for example, writers of note and influence at the present day who are not ashamed to assume the 'deep personal sin' of a great logician to be the cause of his unbelief in a theologic dogma. And there are others who hold that we, who cherish our noble Bible, wrought as it has been into the constitution of our forefathers, and by inheritance into us, must necessarily be hypocritical and insincere. Let us disavow and discountenance such people, cherishing the unswerving faith that what is good and true in both our arguments will be preserved for the benefit of humanity, while all that is bad or false will disappear."

It is worth remarking that in one respect the bishop was a product of his age. Long previous to his day the nature of the soul had been so favourite and general a topic of discussion, that when the students of the University of Paris wished to know the leanings of a new professor, they at once requested him to lecture upon the soul. About the time of Bishop Butler the question was not only agitated but extended. It was seen by the clear-witted men who entered this arena that many of their best arguments applied equally to brutes and men. The bishop's arguments were of this character. He saw it, admitted it, accepted the consequences, and boldly embraced the whole animal world in his scheme of immortality.

Bishop Butler accepted with unwavering trust the chronology of the Old Testament, describing it as "confirmed by the natural and civil history of the world, collected from common historians, from the state of the earth, and from the late inventions of arts and sciences." These words mark progress: they must seem somewhat hoary to the bishop's successors of to-day.

Only to some; for there are dignitaries who even now speak of the earth's rocky crust as so much building material prepared for man at the Creation. Surely it is time that this loose language should cease.

It is hardly necessary to inform you that since his time the domain of the naturalist has been immensely extended—the whole science of geology, with its astounding revelations regarding the life of the ancient earth, having been created. The rigidity of old conceptions has been relaxed, the public mind being rendered gradually tolerant of the idea that not for six thousand, nor for sixty thousand, nor for six thousand thousand, but for aeons embracing untold millions of years, this earth has been the theatre of life and death. The riddle of the rocks has been read by the geologist and palæontologist, from sub-cambrian depths to the deposits thickening over the sea-bottoms of to-day. And upon the leaves of that stone book are, as you know, stamped the characters, plainer and surer than those formed by the ink of history, which carry the mind back into abysses of past time compared with which the periods which satisfied Bishop Butler cease to have a visual angle. Everybody now knows this; all men admit it; still, when they were first broached these verities of science found loud-tongued denunciators, who proclaimed not only their baselessness considered scientifically, but their immorality considered as questions of ethics and religion: the Book of Genesis had stated the question in a different fashion; and science must necessarily go to pieces when it clashed with this authority. And as the seed of the thistle produces a thistle, and nothing else, so these objectors scatter their germs abroad, and reproduce their kind, ready to play again the part of their intellectual progenitors, to show the same virulence, the same ignorance, to achieve for a time the same success, and finally to suffer the same inexorable defeat. Sure the time must come at last when human nature in its entirety, whose legitimate demands it is admitted science alone cannot satisfy, will find interpreters and expositors of a different stamp from those rash and ill-informed persons who have been hitherto so ready to hurl themselves against every new scientific revelation, lest it should endanger what they are pleased to consider theirs.

The lode of discovery once struck, those petrified forms in which life was at one time active, increased to multitudes and demanded classification. The general fact soon became evident that none but the simplest forms of life lie lowest down, that as we climb higher and higher among the superimposed strata more perfect forms appear. The change, however, from form to form was not continuous—but by steps, some small, some great. "A section," says Mr. Huxley, "a hundred feet thick will exhibit at different heights a dozen species of ammonite, none of which passes beyond its particular zone of limestone, or clay, into the zone below it, or into that above it." In the presence of such facts it was not possible to avoid the question, Have these forms, showing, though in broken stages and with many irregularities, this unmistakable general advance, been subjected to no continuous law of growth or variation? Had our education been purely scientific, or had it been sufficiently detached from influences which, however ennobling in another domain, have always proved hindrances and delusions when introduced as factors into the domain of physics, the scientific mind never could have swerved from the search for a law of growth, or allowed itself to accept the anthropomorphism which regarded each successive stratum as a kind of mechanic's bench for the manufacture of new species out of all relation to the old.

Biassed, however, by their previous education, the great majority of naturalists invoked a special creative act to account for the appearance of each new group of organisms. Doubtless there were numbers who were clear-headed enough to see that this was no explanation at all, that in point of fact it was an attempt, by the introduction of a greater difficulty, to account for a less. But having nothing to offer in the way of explanation, they for the most part held their peace. Still the thoughts of reflecting men naturally and necessarily simmered round the question. De Maillet, a contemporary of Newton, has been brought into notice by Prof. Huxley as one who "had a notion of the modifiability of living forms." In my frequent conversations with him, the late Sir Benjamin Brodie, a man of highly philosophic mind, often drew my attention to the fact that, as early as 1794, Charles Darwin's grandfather was the pioneer of Charles Darwin. In 1801, and in subsequent years, the celebrated Lamarck, who produced so profound an impression on the public mind through the vigorous exposition of his views by the author of "Vestiges of Creation," endeavoured to show the development of species out of changes of habit and external condition. In 1813, Dr. Wells, the founder of our present theory of dew, read before the Royal Society a paper in which, to use the words of Mr. Darwin, "he distinctly recognizes the principle of natural selection; and this is the first recognition that has been indicated." The thoroughness and skill with which Wells pursued his work, and the obvious independence of his character rendered him long ago a favourite with me; and it gave me the liveliest pleasure to alight upon this additional testimony to his penetration. Prof. Grant, Mr. Patrick Matthew, Von Buch, the author of the "Vestiges," D'Halloy, and others,

In 1855 Mr. Herbert Spencer (" Principles of Psychology," 2nd edit., vol. i., p. 465) expressed "the belief that life under all its forms has arisen by an unbroken evolution, and through the instrumentality of what are called natural causes."

by the enunciation of views more or less clear and correct, showed that the question had been fermenting long prior to the year 1858, when Mr. Darwin and Mr. Wallace simultaneously but independently placed their closely concurrent views upon the subject before the Linnean Society.

These papers were followed in 1859 by the publication of the first edition of "The Origin of Species." All great things come slowly to the birth. Copernicus, as I informed you, pondered his great work for thirty-three years. Newton for nearly twenty years kept the idea of Gravitation before his mind; for twenty years also he dwelt upon his discovery of Fluxions, and doubtless would have continued to make it the object of his private thought had he not found that Leibnitz was upon his track. Darwin for two-and-twenty years pondered the problem of the origin of species, and doubtless he would have continued to do so had he not found Wallace upon his track.

The behaviour of Mr. Wallace in relation to this subject has been dignified in the highest degree.

A concentrated but full and powerful epitome of his labours was the consequence. The book was by no means an easy one; and probably not one in every score of those who then attacked it had read its pages through, or were competent to grasp their significance if they had. I do not say this merely to discredit them; for there were in those days some really eminent scientific men, entirely raised above the heat of popular prejudice, willing to accept any conclusion that science had to offer, provided it was duly backed by fact and argument, and who entirely mistook Mr. Darwin's views. In fact, the work needed an expounder; and it found one in Mr. Huxley. I know nothing more admirable in the way of scientific exposition than those early articles of his on the origin of species. He swept the curve of discussion through the really significant points of the subject, enriched his exposition with profound original remarks and reflections, often summing up in a single pithy sentence an argument which a less compact mind would have spread over pages. But there is one impression made by the book itself which no exposition of it, however luminous, can convey; and that is, the impression of the vast amount of labour, both of observation and of thought, implied in its production. Let us glance at its principles.

It is conceded on all hands that what are called varieties are continually produced. The rule is probably without exception. No chick and no child is in all respects and particulars the counterpart of its brother or sister; and in such differences we have "variety" incipient. No naturalist could tell how far this variation could be carried; but the great mass of them held that never by any amount of internal or external change, nor by the mixture of both, could the offspring of the same progenitor so far deviate from each other as to constitute different species. The function of the experimental philosopher is to combine the conditions of nature and to produce her results; and this was the method of Darwin.

The first step only towards experimental demonstration has been taken. Experiments now begun might, a couple of centuries hence, furnish data of incalculable value, which ought to be supplied to the science of the future.

He made himself acquainted with what could, without any manner of doubt, be done in the way of producing variation. He associated himself with pigeon-fanciers—bought, begged, kept, and observed every breed that he could obtain. Though derived from a common stock, the diversities of these pigeons were such that "a score of them might be chosen which, if shown to an ornithologist, and he were told that they were wild birds, would certainly be ranked by him as well-defined species." The simple principle which guides the pigeon-fancier, as it does the cattle-breeder, is the selection of some variety that strikes his fancy, and the propagation of this variety by inheritance. With his eye still upon the particular appearance which he wishes to exaggerate, he selects it as it re-appears in successive broods, and thus adds increment to increment until an astonishing amount of divergence from the parent type is effected. Man in this case does not produce the elements of the variation. He simply observes them, and by selection adds them together until the required result has been obtained. "No man," says Mr. Darwin, "would ever try to make a fantail till he saw a pigeon with a tail developed in some slight degree in an unusual manner, or a pouter until he saw a pigeon with a crop of unusual size." Thus nature gives the hint, man acts upon it, and by the law of inheritance exaggerates the deviation.

Having thus satisfied himself by indubitable facts that the organization of an animal or of a plant (for precisely the same treatment applies to plants) is to some extent plastic, he passes from variation under domestication to variation under nature. Hitherto we have dealt with the adding together of small changes by the conscious selection of man. Can Nature thus select? Mr. Darwin's answer is, "Assuredly she can." The number of living things produced is far in excess of the number that can be supported; hence at some period or other of their lives there must be a struggle for existence; and what is the infallible result? If one organism were a perfect copy of the other in regard to strength, skill, and agility, external conditions would decide. But this is not the case. Here we have the fact of variety offering itself to nature, as in the former instance it offered itself to man; and those varieties which are least competent to cope with surrounding conditions will infallibly give way to those that are competent. To use a familiar proverb, the weakest comes to the wall. But the triumphant fraction again breeds to over-production, transmitting the qualities which secured its maintenance, but transmitting them in different degrees. The struggle for food again supervenes, and those to whom the favourable quality has been transmitted in excess will assuredly triumph. It is easy to see that we have here the addition of increments favourable to the individual still more rigorously carried out than in the case of domestication; for not only are unfavourable specimens not selected by nature, but they are destroyed. This is what Mr. Darwin calls "natural selection," which "acts by the preservation and accumulation of small inherited modifications, each profitable to the preserved being." With this idea he interpenetrates and leavens the vast store of facts that he and others have collected. We cannot, without shutting our eyes through fear or prejudice, fail to see that Darwin is here dealing, not with imaginary, but with true causes; nor can we fail to discern what vast modifications may be produced by natural selection in periods sufficiently long. Each individual increment may resemble what mathematicians call a "differential" (a quantity indefinitely small); but definite and great changes may obviously be produced by the integration of these infinitesimal quantities through practically infinite time.

If Darwin, like Bruno, rejects the notion of creative power acting after human fashion, it certainly is not because he is unacquainted with the numberless exquisite adaptations on which this notion of a supernatural artificer was founded. His book is a repository of the most startling facts of this description. Take the marvellous observation which he cites from Dr. Cruger, where a bucket with an aperture, serving as a spout, is formed in an orchid. Bees visit the flower: in eager search of material for their combs they push each other into the bucket, the drenched ones escaping from their involuntary bath by the spout. Here they rub their backs against the viscid stigma of the flower and obtain glue; then against the pollen-masses, which are thus stuck to the back of the bee and carried away. "When the bee, thus provided flies to another flower, or to the same flower a second time, and is pushed by its comrades into the bucket, and then crawls out by the passage, the pollen-mass upon its back necessarily comes first into contact with the viscid stigma," which takes up the pollen; and this is how that orchid is fertilised. Or take this other case of the *Catasetum*. "Bees visit these flowers in order to gnaw the labellum; on doing this they inevitably touch a long, tapering, sensitive projection. This, when touched, transmits a sensation or vibration to a certain membrane, which is instantly ruptured, setting free a spring, by which the pollen-mass is shot forth like an arrow in the right direction, and adheres by its viscid extremity to the back of the bee." In this way the fertilising pollen is spread abroad.

It is the mind thus stored with the choicest materials of the teleologist that rejects teleology, seeking to refer these wonders to natural causes. They illustrate, according to him, the method of nature, not the "technic" of a man-like artificer. The beauty of flowers is due to natural selection. Those that distinguish themselves by vividly contrasting colours from the surrounding green leaves are most readily seen, most frequently visited by insects, most often fertilised, and hence most favoured by natural selection. Coloured berries also readily attract the attention of birds and beasts, which feed upon them, spread their manured seeds abroad, thus giving trees and shrubs possessing such berries a greater chance in the struggle for existence.

With profound analytic and synthetic skill, Mr. Darwin investigates the cell-making instinct of the hive-bee. His method of dealing with it is representative. He falls back from the more perfectly to the less perfectly developed instinct—from the hive-bee to the humble-bee, which uses its own cocoon as a comb, and to classes of bees of intermediate skill, endeavouring to show how the passage might be gradually made from the lowest to the highest. The saving of wax is the most important point in the economy of bees. Twelve to fifteen pounds of dry sugar are said to be needed for the secretion of a single pound of wax. The quantities of nectar necessary for the wax must therefore be vast; and every improvement of constructive instinct which results in the saving of wax is a direct profit to the insect's life. The time that would otherwise be devoted to the making of wax is now devoted to the gathering and storing of honey for winter food. He passes from the humble-bee with its rude cells, through the Melipona with its more artistic cells, to the hive-bee with its astonishing architecture. The bees place themselves at equal distances apart upon the wax, sweep and excavate equal spheres round the selected points. The spheres intersect, and the planes of intersection are built up with thin laminae. Hexagonal cells are thus formed. This mode of treating such questions is, as I have said, representative. He 'habitually retires from the more perfect and complex, to the less perfect and simple, and carries you with him through stages of *perfecting*, adds increment to increment of infinitesimal change, and in this way gradually breaks down your reluctance to admit that the exquisite climax of the whole could be a result of natural selection.

Mr. Darwin shirks no difficulty; and, saturated as the subject was with his own thought, he must have known, better than his critics, the weakness as well as the strength of his theory. This of course would be of little avail were his object a temporary dialectic victory instead of the establishment of a truth which he means to be everlasting. But he takes no pains to disguise the weakness he has discerned; nay, he takes every pains to bring it into the strongest light. His vast resources enable him to cope with objections started by himself and others, so as to leave the final impression upon the reader's mind that if they be not completely answered they certainly are not fatal. Their negative force being thus destroyed, you are free to be influenced by the vast positive mass of evidence he is able to bring before you. This largeness of knowledge and readiness of resource render Mr. Darwin the most terrible of antagonists. Accomplished naturalists have levelled heavy and sustained criticisms against him—not always with the view of fairly weighing his-theory, but with the express intention of exposing its weak points only. This does not irritate him. He treats every objection with a soberness and thoroughness which even Bishop Butler might be proud to imitate, surrounding each fact with its appropriate detail, placing it in its proper relations, and usually giving it a significance which, as long as it was kept isolated, failed to appear. This is done without a trace of ill-temper. He moves over the subject with the passionless strength of a glacier, and the grinding of the rocks is not always without a counterpart in the logical pulverization of the objector. But though in handling this mighty theme all passion has been stilled, there is an emotion of the intellect incident to the discernment of new truth which often colours and warms the pages of Mr. Darwin. His success has been great; and this implies not only the solidity of his work, but the preparedness of the public mind for such a revelation. On this head a remark of Agassiz impressed me more than anything else. Sprung from a race of theologians, this celebrated man combated to the last the theory of natural selection. One of the many times I had the pleasure of meeting him in the United States was at Mr. Winthrop's beautiful residence at Brookline, near Boston. Rising from luncheon, we all halted as if by a common impulse in front of a window, and continued there a discussion which had been started at table. The maple was in its autumn glory; and the exquisite beauty of the scene outside seemed, in my case, to interpenetrate without disturbance the intellectual action. Earnestly, most sadly, Agassiz turned and said to the gentlemen standing round, "I confess that I was not prepared to see this theory received as it has been by the best intellects of our time. Its success is greater than I could have thought possible."

In our day great generalizations have been reached. The theory of the origin of species is but one of them. Another, of still wider grasp and more radical significance, is the doctrine of the Conservation of Energy, the ultimate philosophical issues of which are as yet but dimly seen—that doctrine which "binds nature fast in fate "to an extent not hitherto recognized, exacting from every antecedent its equivalent consequent, from every consequent its equivalent antecedent, and bringing vital as well as physical phenomena under the dominion of that law of causal connection which, as far as the human understanding has yet pierced, asserts itself everywhere in nature. Long in advance of all definite experiment upon the subject, the constancy and indestructibility of matter had been affirmed; and all subsequent experience justified the affirmation. Later researches extended the attribute of indestructibility to force. This idea, applied in the first instance to inorganic, rapidly embraced organic nature. The vegetable world, though drawing almost all its nutriment from invisible sources, was proved incompetent to generate anew either matter or force. Its matter is for the most part transmuted air; its force transformed solar force. The animal world was proved to be equally uncreative, all its motive energies being referred to the combustion of its food. The activity of each animal as a whole was proved to be the transferred activities of its molecules. The muscles were shown to be stores of mechanical force, potential until unlocked by the nerves, and then resulting in muscular contractions. The speed at which messages fly to and fro along the nerves was determined, and found to be, not as had been previously supposed, equal to that of light or electricity, but less than the speed of a flying eagle.

This was the work of the physicist: then came the conquests of the comparative anatomist and physiologist, revealing the structure of every animal, and the function of every organ in the whole biological series, from the lowest zoophyte up to man. The nervous system had been made the object of profound and continued study, the wonderful and, at bottom, entirely mysterious controlling power which it exercises over the whole organism, physical and mental, being recognized more and more. Thought could not be kept back from a subject so profoundly suggestive. Besides the physical life dealt with by Mr. Darwin, there is a psychical life presenting similar gradations, and asking equally for a solution. How are the different grades and orders of mind to be accounted for? What is the principle of growth of that mysterious power which on our planet culminates in Reason? These are questions which, though not thrusting themselves so forcibly upon the attention of the general public, had not only occupied many reflecting minds, but had been formally broached by one of them before the "Origin of Species" appeared.

With the mass of materials furnished by the physicist and physiologist in his hands, Mr. Herbert Spencer, twenty years ago, sought to graft upon this basis a system of psychology; and two years ago a second and greatly amplified edition of his work appeared. Those who have occupied themselves with the beautiful experiments of Plateau, will remember that when two spherules of olive-oil suspended in a mixture of alcohol and water of the same density as the oil, are brought together, they do not immediately unite. Something like a pellicle appears to be formed around the drops, the rupture of which is immediately followed by the coalescence of the globules into one. There are organisms whose vital actions are almost as purely physical as that of these drops of oil. They come into contact and fuse themselves thus together. From such organisms to others a shade higher, and from these to others a shade higher still, and on through an ever-ascending series, Mr. Spencer conducts his argument. There are two obvious factors to be here taken into account—the creature and the medium in which it lives, or, as it is often expressed, the organism and its environment. Mr. Spencer's fundamental principle is, that between these two factors there is incessant interaction. The organism is played upon by the environment, and is modified to meet the requirements of the environment. Life he defines to be "a continuous adjustment of internal relations to external relations."

In the lowest organisms we have a kind of tactual sense diffused over the entire body; then, through impressions from without and their corresponding adjustments, special portions of the surface become more responsive to stimuli than others. The senses are nascent, the basis of all of them being that simple tactual sense which the sage Democritus recognized 2,300 years ago as their common progenitor. The action of light, in the first instance, appears to be a mere disturbance of the chemical processes in the animal organism, similar to that which occurs in the leaves of plants. By degrees the action becomes localized in a few pigment-cells, more sensitive to light than the surrounding tissue. The eye is here incipient. At first it is merely capable of revealing differences of light and shade produced by bodies close at hand. Followed as the interception of the light is in almost all cases by the contact of the closely adjacent opaque body, sight in this condition becomes a kind of "anticipatory touch." The adjustment continues; a slight bulging out of the epidermis over the pigment-granules supervenes. A lens is incipient, and, through the operation of infinite adjustments, at length reaches the perfection that it displays in the hawk and the eagle. So of the other senses; they are special differentiations of a tissue which was originally vaguely sensitive all over.

With the development of the senses the adjustments between the organism and its environment gradually extend in *space*, a multiplication of experiences and a corresponding modification of conduct being the result. The adjustments also extend in time, covering continually greater intervals. Along with this extension in space and time, the adjustments also increase in speciality and complexity, passing through the various grades of brute life and prolonging themselves into the domain of reason. Very striking are Mr. Spencer's remarks regarding the influence of the sense of touch upon the development of intelligence. This is, so to say, the mother-tongue of all the senses, into which they must be translated to be of service to the organism. Hence its importance. The parrot is the most intelligent of birds, and its tactual power is also greatest. From this sense it gets knowledge unattainable by birds which cannot employ their feet as hands. The elephant is the most sagacious of quadrupeds—its tactual range and skill, and the consequent multiplication of experiences, which it owes to its wonderfully adaptable trunk, being the basis of its sagacity. Feline animals, for a similar cause, are more sagacious than hoofed animals—atonement being to some extent made, in the case of the horse, by the possession of sensitive prehensile lips. In the *Primates* the evolution of intellect and the evolution of tactual appendages go hand in hand. In the most intelligent anthropoid apes we find the tactual range and delicacy greatly augmented, new avenues of knowledge being thus opened to the animal. Man crowns the edifice here, not only in virtue of his own manipulatory power, but through the enormous extension of his range of experience, by the invention of instruments of precision, which serve as supplemental senses and supplemental limbs. The reciprocal action of these is finely described and illustrated. That chastened intellectual emotion to which I have referred in connection with Mr. Darwin is, I should say, not absent in Mr. Spencer. His illustrations possess at times exceeding vividness and force, and from his style on such occasions it is to be inferred that the ganglia of this apostle of the understanding are sometimes the seat of a nascent poetic thrill.

It is a fact of supreme importance that actions, the performance of which at first requires even painful effort and deliberation, may by habit be rendered automatic. Witness the slow learning of its letters by a child, and the subsequent facility of reading in a man, when each group of letters which forms a word is instantly and without effort fused to a single perception. Instance the billiard-player, whose muscles of hand and eye, when he reaches the perfection of his art, are unconsciously co-ordinated. Instance the musician, who by practice is enabled to fuse a multitude of arrangements, auditory, tactual, and muscular, into a process of automatic manipulation. Combining such facts with the doctrine of hereditary transmission, we reach a theory of instinct. A chick, after coming out of the egg, balances itself correctly, runs about, picks up food, thus showing that it possesses a power of directing its movements to definite ends. How did the chick learn this very complex co-ordination of eye, muscles, and beak? It has not been individually taught; its personal experience is *nil*; but it has the benefit of ancestral experience. In its inherited organization are registered all the powers which it displays at birth. So also as regards the instinct of the hive-bee, already referred to. The distance at which the insects stand apart when they sweep their hemispheres and build their cells is "organically remembered." Man also carries with him the physical texture of his ancestry, as well as the inherited intellect bound up with it. The defects of intelligence during infancy and youth are probably less due to a lack of individual experience than to the fact that in early life the cerebral organization is still incomplete. The period necessary for completion varies with the race and with the individual. As a round shot outstrips a rifled one on quitting the muzzle of the gun, so the lower race in childhood may outstrip the higher. But the higher eventually overtakes the lower, and surpasses it in range. As regards individuals, we do not always find the precocity of youth prolonged to mental power in maturity, while the dulness of boyhood is sometimes strikingly contrasted with the intellectual energy of after years. Newton, when a boy, was weakly, and he showed no particular aptitude at school; but in his eighteenth year he went to Cambridge, and soon afterwards astonished his teachers by his power of dealing with geometrical problems. During his quiet youth his brain was slowly preparing itself to be the organ of those energies which he subsequently displayed.

By myriad blows (to use a Lucretian phrase) the image and superscription of the external world are stamped as states of consciousness upon the organism, the depth of the impression depending upon the number of the blows. When two or more phenomena occur in the environment invariably together, they are stamped to the same depth or to the same relief, and are indissolubly connected. And here we come to the threshold of a great question. Seeing that he could in no way rid himself of the consciousness of space and time, Kant assumed them to be necessary "forms of thought," the moulds and shapes into which our intuitions are thrown, belonging to ourselves solely and without objective existence. With unexpected power and success Mr. Spencer brings the hereditary experience theory, as he holds it, to bear upon this question. "If there exist certain external relations which are experienced by all organisms at all instants of their waking lives—relations which are absolutely constant and universal—there will be established answering internal relations that are absolutely constant and universal. Such relations we have in those of space and time. As the substratum of all other relations of the Non-Ego, they must be responded to by conceptions that are the substrata of all other relations in the Ego. Being the constant and infinitely repeated elements of thought, they must become the automatic elements of thought—the elements of thought which it is impossible to get rid of—the 'forms of intuition.'"

Throughout this application and extension of the "law of inseparable association," Mr. Spencer stands on totally different ground from Mr. John Stuart Mill, invoking the registered experiences of the race instead of the experiences of the individual. His overthrow of Mr. Mill's restriction of experience is, I think, complete. That restriction ignores the power of organizing experience furnished at the outset to each indi- vidual; it ignores the different degrees of this power possessed by different races and by different individuals of the same race. Were there not in the human brain a potency antecedent to all experience, a dog or cat ought to be as capable of education as a man. These predetermined internal relations are independent of the experiences of the individual. The human brain is the "organized register of infinitely numerous experiences received during the evolution of life, or rather during the evolution of that series of organisms through which the human organism has been reached. The effects of the most uniform and frequent of these experiences have been successively bequeathed, principal and interest, and have slowly mounted to that high intelligence which lies latent in the brain of the infant. Thus it happens that the European inherits from twenty to thirty cubic inches more of brain than the Papuan. Thus it happens that faculties, as of music, which scarcely exist in some inferior races, become congenital in superior ones. Thus it happens that out of savages unable to count up to the number of their fingers, and speaking a language containing only nouns and verbs, arise at length our Newtons and Shakespeares."

At the outset of this address it was stated that physical theories which lie beyond experience are derived by a process of abstraction from experience. It is instructive to note from this point of view the successive introduction of new conceptions. The idea of the attraction of gravitation was preceded by the observation of the attraction of iron by a magnet, and of light bodies by rubbed amber. The polarity of magnetism and electricity appealed to the senses; and thus became the substratum of the conception that atoms and molecules are endowed with definite, attractive, and repellant poles, by the play of which definite forms of crystalline architecture are produced. Thus molecular force becomes *structural*. It required no great boldness of thought to extend its play into organic nature, and to recognize in molecular force the agency by which both plants and animals are built up. In this way out of experience arise conceptions which are wholly ultra-experiential.

The *origination* of life is a point lightly touched upon, if at all, by Mr. Darwin and Mr. Spencer. Diminishing gradually the number of progenitors, Mr. Darwin comes at length to one "primordial form;" but he does not say, as far as I remember, how he supposes this form to have been introduced. He quotes with satisfaction the words of a celebrated author and divine who had "gradually learned to see that it is just as noble a conception of the Deity to believe He created a few original forms, capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws." What Mr. Darwin thinks of this view of the introduction of life I do not know. Whether he does or does not introduce his "primordial form "by a creative act, I do not know. But the question will inevitably be asked, "How came the form there?" With regard to the diminution of the number of created forms, one does not see that much advantage is gained by it. The anthropomorphism, which it seemed the object of Mr. Darwin to set aside, is as firmly associated with the creation of a few forms as with the creation of a multitude. We need clearness and thoroughness here. Two courses, and two only, are possible. Either let us open our doors freely to the conception of creative acts, or, abandoning them, let us radically change our notions of matter. If we look at matter as pictured by Democritus, and as defined for generations in our scientific text-books, the absolute impossibility of any form of life coming out of it would be sufficient to render any other hypothesis preferable; but the definitions of matter given in our text-books were intended to cover its purely physical and mechanical properties. And taught as we have been to regard these definitions as complete, we naturally and rightly reject the monstrous notion that out of *such*matter any form of life could possibly arise. But are the definitions complete? Everything depends on the answer to be given to this question. Trace the line of life backwards, and see it approaching more and more to what we call the purely physical condition. We reach at length those organisms which I have compared to drops of oil suspended in a mixture of alcohol and water. We reach the *profogenes* of Haeckel, in which we have "a type distinguishable from a fragment of albumen only by its finely granular character." Can we pause here? We break a magnet and find two poles in each of its fragments. We continue the process of breaking, but however small the parts, each carries with it, though enfeebled, the polarity of the whole. And when we can break no longer, we prolong the intellectual vision to the polar molecules. Are we not urged to do something similar in the case of life? Is there not a temptation to close to some extent with Lucretius, when he affirms that "Nature is seen to do all things spontaneously of herself without the meddling of the gods "? or with Bruno, when he declares that matter is not "that mere empty *capacity* which philosophers have pictured her to be, but the universal mother who brings forth all things as the fruit of her own womb "? The questions here raised are inevitable. They are approaching us with accelerated speed, and it is not a matter of indifference whether they are introduced with reverence or irreverence. Abandoning all disguise, the confession that I feel bound to make before you is that I prolong the vision backward across the boundary of the experimental evidence, and discern in that matter, which we in our ignorance, and notwithstanding our professed reverence for its Creator, have hitherto covered with opprobrium, the promise and potency of every form and quality of life.

The "materialism" here enunciated may be different from what you suppose, and I therefore crave your gracious patience to the end. "The question of an external world," says Mr. J. S. Mill, "is the great battle-ground of metaphysics."

"Examination of Hamilton," p. 154.

Mr. Mill himself reduces external phenomena to "possibilities of sensation." Kant, as we have seen, made time and space "forms "of our own intuitions. Fichte, having first by the inexorable logic of his understanding proved himself to be a mere link in that chain of eternal causation which holds so rigidly in nature, violently broke the chain by making nature, and all that it inherits, an apparition of his own mind.

"Bestimmung des Menschen."

And it is by no means easy to combat such notions. For when I say I see you, and that I have not the least doubt about it, the reply is, that what I am really conscious of is an affection of my own retina. And if I urge that I can check my sight of you by touching you, the retort would be that I am equally transgressing the limits of fact; for what I am really conscious of is, not that you are there, but that the nerves of my hand have undergone a change. All we hear, and see, and touch, and taste, and smell, are, it would be urged, mere variations of our own condition, beyond which, even to the extent of a hair's breadth, we cannot go. That anything answering to our impressions exists outside of ourselves is not a *fact*, but an *inference*, to which all validity would be denied by an idealist like Berkeley, or by a sceptic like Hume. Mr. Spencer takes another line. With him, as with the uneducated man, there is no doubt or question as to the existence of an external world. But he differs from the uneducated, who think that the world really is what consciousness represents it to be. Our states of consciousness are mere *symbols* of an outside entity which produces them and determines the order of their succession, but the real nature of which we can never know.

In a paper, at once popular and profound, entitled "Recent Progress in the Theory of Vision," contained in the volume of lectures by Helmholtz, published by Longmans, this symbolism of our states of consciousness is also dwelt upon. The impressions of sense are the mere signs of external things. In this paper Helmholtz contends strongly against the view that the consciousness of space is inborn; and he evidently doubts the power of the chick to pick up grains of corn without some preliminary lesson. On this point, he says, further experiments are needed. Such experiments have been since made by Mr. Spalding, aided, I believe, in some of his observations by the accomplished and deeply lamented Lady Amberley; and they seem to prove conclusively that the chick does not need a single moment's tuition to teach it to stand, run, govern the muscles of its eyes, and peck. Helmholtz, however, is contending against the notion of pre-established harmony; and I am not aware of his views as to the organization of experiences of race or breed.

In fact the whole process of evolution is the manifestation of a Power absolutely inscrutable to the intellect of man. As little in our day as in the days of Job can man by searching find this Power out. Considered fundamentally, it is by the operation of an insoluble mystery that life is evolved, species differentiated, and mind unfolded from their prepotent elements in the immeasurable past There is, you will observe, no very rank materialism here.

The strength of the doctrine of evolution consists, not in an-experimental demonstration (for the subject is hardly accessible to this mode of proof), but in its general harmony with the method of nature as hitherto known. From contrast, moreover, it derives enormous relative strength. On the one side we have a theory (if it could with any propriety be so called) derived, as were the theories referred to at the beginning of this address, not from the study of nature, but from the observation of men—a theory which converts the Power whose garment is seen in the visible universe into an Artificer, fashioned after the human model, and acting by broken efforts as man is seen to act. On the other side we have the conception that all we see around us, and all we feel within us—the phenomena of physical nature as well as those of the human mind—have their unsearchable roots in a cosmical life, if I dare apply the term, an infinitesimal span of which only is offered to the investigation of man. And even this span is only knowable in part. We can trace the development of a nervous system, and correlate with it the parallel phenomena of sensation and thought. We see with undoubting certainty that they go hand in hand. But we try to soar in a vacuum the moment we seek to comprehend the connection between them. An Archimedean fulcrum is here required which the human mind cannot command; and the effort to solve the problem, to borrow an illustration from an illustrious friend of mine, is like the effort of a man trying to lift himself by his own waistband. All that has been here said is to be taken in connection with this fundamental truth. When "nascent senses" are spoken of, when "the differentiation of a tissue at first vaguely sensitive all over "is spoken of, and when these processes are associated with "the modification of an organism by its environment," the same parallelism, without contact, or even approach to contact, is implied. There is no fusion possible between the two classes of facts—no motor energy in the intellect of man to carry it without logical rupture from the one to the other.

Further, the doctrine of evolution derives man, in his totality, from the interaction of organism and environment through countless ages past. The human understanding, for example—the faculty which Mr. Spencer has turned so skilfully round upon its own antecedents—is itself a result of the play between organism and environment through cosmic ranges of time. Never surely did prescription plead so irresistible a claim. But then it comes to pass that, over and above his understanding, there are many other things appertaining to man whose prescriptive rights are quite as strong as that of the understanding itself. It is a result, for example, of the play of organism and environment that sugar is sweet, and that aloes are bitter, that the smell of henbane differs from the perfume of a rose. Such facts of consciousness (for which, by the way, no adequate reason has ever yet been rendered) are quite as old as the understanding itself; and many other things can boast an equally ancient origin. Mr. Spencer at one place refers to that most powerful of passions—the amatory passion—as one which, when it first occurs, is antecedent to all relative experience whatever; and we may pass its claim as being at least as ancient and as valid as that of the understanding itself. Then there are such things woven into the texture of man as the feeling of awe, reverence, wonder—and not alone the sexual love just referred to, but the love of the beautiful, physical, and moral, in nature, poetry, and art. There is also that deep-set feeling which, since the earliest dawn of history, and probably for ages prior to all history, incorporated itself in the religions of the world. You who have escaped from these religions in the high-and-dry light of the understanding may deride them; but in so doing you deride accidents of form merely, and fail to touch the immovable basis of the religious sentiment in the emotional nature of man. To yield this sentiment reasonable satisfaction is the problem of problems at the present hour. And grotesque in relation to scientific culture as many of the religions of the world have been and are—dangerous, nay, destructive, to the dearest privileges of freemen as some of them undoubtedly have been, and would, if they could, be again—it will be wise to recognize them as the forms of force, mischievous, if permitted to intrude on the region of *knowledge*, over which it holds no command, but capable of being guided by liberal thought to noble issues in the region of *emotion*, which is its proper sphere. It is vain to oppose this force with a view to its extirpation. What we should oppose, to the death if necessary, is every attempt to found upon this elemental bias of man's nature a system which should exercise despotic sway over his intellect. I do not fear any such consummation. Science has already to some extent leavened the world, and it will leaven it more and more. I should look upon the mild light of science breaking in upon the minds of 'the youth of Ireland, and strengthening gradually to the perfect day, as a surer check to any intellectual or spiritual tyranny which might threaten this island, than the laws of princes or the swords of emperors. Where is the cause of fear? We fought and won our battle even in the Middle Ages: why should we doubt the issue of a conflict now?

The impregnable position of science may be described in a few words. All religious theories, schemes, and systems, which embrace notions of cosmogony, or which otherwise reach into its domain, must, in so far as they do this, submit to the control of science, and relinquish all thought of controlling it. Acting otherwise proved disastrous in the past, and it is simply fatuous to-day. Every system which would escape the fate of an organism too rigid to adjust itself to its environment, must be plastic to the extent that the growth of knowledge demands. When this truth has been thoroughly taken in, rigidity will be relaxed, exclusiveness diminished, things now deemed essential will be dropped, and elements now rejected will be assimilated. The lifting of the life is the essential point; and as long as dogmatism, fanaticism, and intolerance are kept out, various modes of leverage may be employed to raise life to a higher level. Science itself not unfrequently derives motive power from an ultra-scientific source. Whewell speaks of enthusiasm of temper as a hindrance to science; but he means the enthusiasm of weak heads. There is a strong and resolute enthusiasm in which science finds an ally; and it is to the lowering of this fire, rather than to a diminution of intellectual insight, that the lessening productiveness of men of science in their mature years is to be ascribed. Mr. Buckle sought to detach intellectual achievement from moral force. He gravely erred; for without moral force to whip it into action, the achievements of the intellect would be poor indeed.

It has been said that science divorces itself from literature. The statement, like so many others, arises from lack of knowledge. A glance at the less technical writings of its leaders—of its Helmholtz, its Huxley, and its Du Bois-Reymond—would show what breadth of literary culture they command. Where among modern writers can you find their superiors in clearness and vigour of literary style? Science desires no isolation, but freely combines with every effort towards the bettering of man's estate. Single-handed, and supported not by outward sympathy, but by inward force, it has built at least one great wing of the many-mansioned home which man in his totality demands. And if rough walls and protruding rafter-ends indicate that on one side the edifice is still incomplete, it is only by wise combination of the parts required with those already irrevocably built that we can hope for completeness. There is no necessary incongruity between what has been accomplished and what remains to be done. The moral glow of Socrates, which we all feel by ignition, has in it nothing incompatible with the physics of Anaxagoras which he so much scorned, but which he would hardly scorn to-day. And here I am reminded of one amongst us, hoary, but still strong, whose prophet-voice some thirty years ago, far more than any other of this age, unlocked whatever of life and nobleness lay latent in its most gifted minds—one fit to stand beside Socrates or the Maccabean Eleazer, and to dare and suffer all that they suffered and dared—fit, as he once said of Fichte, "to have been the teacher of the Stoa, and to have discoursed of beauty and virtue in the groves of Academe." With a capacity to grasp physical principles which his friend Goethe did not possess, and which even total lack of exercise has not been able to reduce to atrophy, it is the world's loss that he, in the vigour of his years, did not open his mind and sympathies to science, and make its conclusions a portion of his message to mankind. Marvellously endowed as he was—equally equipped on the side of the heart and of the understanding—he might have done much towards teaching us how to reconcile the claims of both, and to enable them in coming times to dwell together in unity of spirit and in the bond of peace.

And now the end is come. With more time, or greater strength and knowledge, what has been here said might have been better said, while worthy matters here omitted might have received fit expression. But there would have been no material deviation from the views set forth. As regards myself, they are not the growth of a day; and as regards you, I thought you ought to know the environment which, with or without your consent, is rapidly surrounding you, and in relation to which some adjustment on your part may be necessary. A hint of Hamlet's, however, teaches us all how the troubles of common life may be ended; and it is perfectly possible for you and me to purchase intellectual peace at the price of intellectual death. The world is not without refuges of this description; nor is it wanting in persons who seek their shelter and try to persuade others to do the same. I would exhort you to refuse such shelter, and to scorn such base repose—to accept, if the choice be forced upon you, commotion before stagnation, the leap of the torrent before the stillness of the swamp. In the one there is at all events life, and therefore hope; in the other, none. I have touched on debatable questions, and led you over dangerous ground—and this partly with the view of telling you, and through you the world, that as regards these questions science claims unrestricted right of search. It is not to the point to say that the views of Lucretius and Bruno, of Darwin and Spencer, may be wrong. Here I should agree with you, deeming it indeed certain that these views will undergo modification. But the point is, that, whether right or wrong, we claim the freedom to discuss them. The ground which they cover is scientific ground; and the right claimed is one made good through tribulation and anguish, inflicted and endured in darker times than ours, but resulting in the immortal victories which science has won for the human race. I would set forth equally the inexorable advance of man's understanding in the path of knowledge, and the unquenchable claims of his emotional nature which the understanding can never satisfy. The world embraces not only a Newton but a Shakespeare—not only a Boyle, but a Raphael—not only a Kant, but a Beethoven—not only a Darwin, but a Carlyle. Not in each of these, but in all, is human nature whole. They are not opposed, but supplementary—not mutually exclusive, but reconcilable. And if, still unsatisfied, the human mind, with the yearning of a pilgrim for his distant home, will turn to the mystery from which it has emerged, seeking so to fashion it as to give unity to thought and faith, so long as this is done, not only without intolerance or bigotry of any kind, but with the enlightened recognition that ultimate fixity of conception is here unattainable, and that each succeeding age must be held free to fashion the mystery in accordance with its own needs—then, in opposition to all the restrictions of Materialism, I would affirm this to be a field for the noblest exercise of what, in contrast with the *knowing* faculties, may be called the *creative* faculties of man. Here, however, I must quit a theme too great for me to handle, but which will be handled by the loftiest minds ages after you and I, like streaks of morning cloud, shall have melted into the infinite azure of the past.

Walker, May, & Co., Printers, 9 Mackillop Street, Melbourne.

The Principal Timber Trees Readily Eligible for Victorian Industrial Culture,

with indications of their native countries and some of their technologic uses.

An Enumeration Offered by Ferd. Von Mueller,
C.M.G., M.D., Ph.D., F.R.S., F.L.S., F.R.G.S., C.M.Z.S., Commander of the Order of St. Jago, Vice-President of the Acclimation Society of Victoria.

This enumeration originated in a desire of the writer to place before his fellow colonists a succinct list of those trees, which in our geographic latitudes can be grown to advantage. Calls for such information arose gradually in the department of the Botanic Garden of Melbourne, not merely because it impressed itself more and more on the mind of every thoughtful settler, that the wanton waste of the native forests should be checked, but that also largely should be added to our timber riches by means of copious and multifarious introductions from abroad, and that for these introductions the widest possible scope should be allowed. Nevertheless this list is far from claiming completeness, either as a specific index, or as a series of notes on the principal technologic applicability of the trees most accessible. Indeed it may be regarded simply as a precursor of larger essays, such as the intended forest administration will gradually call forth. Meanwhile, however, this brief explanatory catalogue may facilitate locally that information, which hitherto was afforded by the authors correspondence chiefly.

It seemed beyond the scope of this writing to tabulate the trees here enumerated, in reference to climatic regions. The inhabitant of colder and moister mountains in this colony, or the settler in the hotter and more arid tracts of country, can readily foresee from the brief geographic notes given with each tree, which kind should be chosen for the spot, selected by him for wood-culture; but if doubts in this respect should arise, the needful advice will readily be offered by the writer.

Though this list was originally prepared and alluded to as an appendage to a lecture.

The Application of Phytology to the Industrial Purposes of Life.

recently delivered at the Melbourne Industrial Museum, I was honored by my colleagues of the Council of the Acclimation Society in their giving publicity to this document along with their last annual report, the

Society being quite as anxious to foster the introduction and multiplication of industrial plants, as the continued acquisition and diffusion of foreign animals of utilitarian importance.

Unquestionably also, the periodical issue of essays on animals and plants, to be introduced or to be diffused, will give additional strength to the Society's labours.

Should, therefore, this small literary offer prove acceptable to the supporters of the Victorian Acclimation Society, then the writer would feel sufficiently encouraged to offer in a similar form,

A short essay on such plants and trees as well was promulgated by the Philos. Society of Victoria 1868, pp. 93—105.

a list of other plants, recommendable here for more general cultivation; and, although such indices only to some extent contain original research, they are likely to bring together information, more condensed and more recent, than it would be attainable in costly or voluminous works of even several languages, and yet such treating perhaps only of countries with far narrower climatic zones than ours.

Possibly this publication may aid us also to render known our colonial requirements thus far abroad, while it will offer likewise some information to speed interchanges.

For our Industrial Museum and such similar institutions, as doubtless ere long on a limited scale will be connected with each Mechanics' Institute, this unpretensive treatise may help to explain the real wealth, which we possess in our unfortunately almost unguarded forests, or point out the manifold new treasures, which we should raise independently in our woodlands, while also these pages might stimulate both public and private efforts, to provide by timely thought fulness those increased timber resources, without which the next generations of this land can be neither hale nor prosperous.

I.—Coniferous Trees.

Araucaria Bidwilli, Hook.

Bunya Bunya. Southern Queensland. A tree 160 feet in height, with a fine grained, hard and durable wood; the seeds are edible.

Araucaria Brasiliensis, A. Rich.

Brazilian Pino. A tree, 100 feet high, producing edible seeds. Ought to be tried in our fern gullies.

Araucaria Cookii, R. Br.

In New Caledonia, where it forms large forests. Height of tree 200 feet.

Araucaria Cunningham!, Ait.

Moreton-Bay Pine.—East Australia, between 14° and 32° S. latitude. The tree gets 130 feet high. The timber is used for ordinary furniture,

Araucaria excelsa, R. Br.

Norfolk-Island Pine.—A magnificent tree, sometimes 220 feet high, with a stem attaining ten feet in diameter. The timber is useful for ship-building and many other purposes.

Araucaria imbricata, Pav.

Chili and Patagonia. The male tree attains only a height of 50 feet, but the female reaches 150 feet. It furnishes a hard and durable timber, as well as an abundance of edible seeds, which constitute a main article of food of the natives. Eighteen good trees will yield enough for a man's sustenance all the year round. In our lowlands of comparative slow growth, but likely of far more rapid development, if planted in our ranges.

Callitris quadrivalvis, Vent.

North Africa. A middling-sized tree, yielding the true Sandarac resin.

Cephalotaxus Fortunei, Hook.

China and Japan. This splendid yew attains a height of 60 feet, and is very hardy.

Cryptomeria Japonica, Don.

Japan and Northern China. A slender evergreen tree, 100 feet high. It requires forest valleys for successful growth. The wood is compact, very white, soft and easy to work.

Cupressus Benthami, Endl.

Mexico, at 5 to 7,000#. A beautiful tree, 00 feet high. The wood is fine grained and exceedingly durable.

Cupressus Lawsoniana, Murr.(*Chamæcyparis Lawsoniana*, Parl.)

Northern California. This is a splendid red-flowered cypress, growing 100 feet high, with a stem of 2 feet in diameter, and furnishes a valuable timber for building purposes, being clear and easily worked.

Cupressus Lindleyi, Klotzsch.

On the mountains of Mexico. A stately cypress, up to 120 feet high. It supplies an excellent timber.

Cupressus macrocarpa, Hartw.(*C. Lambertiana, Gord*.)

Upper California. This beautiful and shady tree attains the height of 150 feet, with a stem of 9 feet in circumference, and is one of the quickest growing of all conifers, even in poor dry soil.

Cupressus Nutkaensis, Lamb. (*Chamcecyparis Nutkaensis, Spach*.)

North-West America. Height of tree 100 feet. Wood used for boatbuilding and other purposes; the best for mats and ropes.

Cupressus obtusa, F. von Muell. (*Retinospora obtusa, S. & Z.*)

Japan. Attains a height of 80 feet; stem 5 feet in circumference. It forms a great part of the forests at Nipon. The wood is white-veined and compact, assuming, when planed, a silky lustre. It is used in Japan for temples. There are varieties of this species with foliage of a golden and of a silvery-white hue.

Two other Japanese cypresses deserve introduction, namely: Cupr. breviramea (*Chamcœcyparis breviramea, Maxim*.), and Cupr. pendens, (*Chamæcyparis pendula*, Maxim.)

Cupressus pisifera, F. von Muell. (*Chamaecyparis pisifera*, S. & Z.)

Japan. It attains a height of 30 feet, producing also a variety with golden foliage.

Cupressus sempervirens, L.

Common Cypress of South Europe. Height of tree up to 80 feet. It is famous for the great ago it reaches, and for the durability of its timber, which is next to imperishable. At present it is much sought for the manufacture of musical instruments.

Cupressus thurifera, Humb. B. & K.

Mexico; 3,000 to 4,500 feet above sea-level. A handsome pyramidal tree, upwards of 40 feet high.

Cupressus thuyoides, Linné. (*Chamœcyparis sphœroidea*, Spach.)

White Cedar of North America; in moist or morassy ground. Height of tree 80 feet; diameter of stem 3 feet. The wood is light, soft, and fragrant; it turns red when exposed to the air.

Cupressus torulosa, Don.

Nepal Cypress. Northern India; 4,500 to 8,000 feet above sea level. Height of tree 150 feet; circumference of stem, as much as 16 feet. The reddish fragrant wood is as durable as that of the Deodar Cedar, highly valued for furniture. The tree seems to prefer the limestone soil.

Dacrydium cupressinum, Soland.

New Zealand. Native name, *Rimu*; the Red Pine of the colonists. This stately tree acquires the height of 200 feet, and furnishes a hard and valuable wood. With other New Zealand conifers particularly eligible for our forest valleys. A most suitable tree for cemeteries, on account of its pendulous branches.

Dacrydium Franklini, Hook. fil.

Huon Pine of Tasmania; only found in moist forest recesses, and might be planted in our dense fern-tree gullies. Height of tree 100 feet; stem-circumference 20 feet. The wood is highly esteemed for ship-building and various artizan's work.

Dammara alba, Rumph. (*D. orientalis*.Lamb.)

Agath Dammar. Indian Archipelagos and mainland. A large tree, 100 feet high, with a stem of 8 feet in diameter; straight and branchless for two-thirds its length. It is of great importance on account of its yields of the transparent Dammar resin, extensively used for varnish.

Dammara Australia, Lamb.

Kauri Pine. North island of New Zealand. This magnificent tree measures, under favourable circumstances, 180 feet in height and 17 feet in diameter of stem. The estimated age of such a tree being 700 or 800 years. It furnishes an excellent timber for furniture, masts of ships, or almost any other purpose; it yields besides the Kauri resin of commerce, which is largely got from under the stem of the tree. The greatest part is gathered by the Maories in localities formerly covered with Kauri forests; pieces, weighing 100 lbs., have been found in such places.

Dammara macrophylla, Lindl.

Santa Cruz Archipelagus. A beautiful tree, 100 feet high, resembling D. alba.

Dammara Moorei, Lindl.

New Caledonia. Height of tree about 60 feet.

Dammara obtusa, Lindl.

New Hebrides. A fine tree, 200 feet high; with a long, clear trunk; resembling D. Australis.

Dammara ovata, Moore.

New Caledonia. This tree is rich in Dammar resin.

Dammara robusta, Moore.

Queensland Kauri, A tall tree, known from Rockingham's Bay and Wide Bay. It thrives well even in open, exposed, dry localities at Melbourne.

Dammara Vitiensis, Seem.

In Fiji. Tree 100 feet high; probably identical with Lindley'a D. longifolia.

Fitzroya Patagonica, Hooker fil.

Southern parts of Patagonia and Chili. A stately tree, 100 feet high, up to 14 feet in diameter of stem. The wood is red, almost imperishable in the open air or under ground; it does not warp, and is easy to split. It comes into commerce in boards 7 feet long, 8 inches wide, ½ inch thick, and is used for roofing, deals, doors, casks, &c. The outer bark produces a strong fibre used for caulking ships. Like many other trees of colder regions, it would require here to be planted in our mountain forests.

Frenela Actinostrobus, Muell. (*Actinostrobus pyramidalis Mig*.)

From S.W. Australia, though only a shrub, is placed here on record as desirable for introduction, because it grows on saline desert flats, where any other conifers will not readily succeed. It may become important for coast cultivation.

Frenela Macleayana, Parl.

New South Wales. A handsome tree of regular pyramidal growth, attaining a height of 70 feet; the timber is valuable.

Frenela verrucosa, A. Cunn.

Also several other species from Victoria and other parts of Australia are among the trees, which may be utilized for binding the coast and desert sand. They all exude Sandarac.

Ginkgo biloba, L. (*Salisburia adiantifolia, Smith*.)

Ginkgo tree. China and Japan. A deciduous fan-leaved tree, 100 feet high, with a straight stem 12 feet in diameter. The wood is white, soft, easy to work, and takes a beautiful polish. The seeds are edible, and when pressed yield a good oil. Ginkgo trees are estimated to attain an age of 3000 years.

Juniperus Bermudiana, L.

The Pencil Cedar of Bermuda and Barbadoes. This species grows sometimes 90 feet high, and furnishes a valuable red durable wood, used for boat building, furniture and particularly for pencils, on account of its pleasant odor and special fitness. Many of the plants called Thuya or Biotia Meldensis in gardens, belong to this species.

Juniperus brevifolia, Antoine.

In the Azores up to 4,800#; a nice tree with sometimes silvery foliage.

Juniperus Cedrus, Webb.

A tall tree of the higher mountains of the Canary Islands.

Juniperus Chinensis, L.

In temperate regions of the Himalaya, also in China and Japan. This tree is known to rise to 75 feet. Probably identical with the Himalayan Pencil Cedar (Juniperus religiosa, Royle); it is remarkable for its reddish close-grained wood.

Juniperus communis, L.

One of the three native conifers; of Britain, attaining under favorable circumstances a height of nearly 50 feet, of medicinal uses; the berries also used in the preparation of gin.

Juniperus drupacea, Labill. Plum Juniper.

A very handsome long-leaved Juniper, the Habhel of Syria. It attains a height of 30 feet, and produces a sweet edible fruit, highly esteemed throughout the Orient.

Juniperus excelsa, Bieberst.

In Asia Minor, 2 to 6000 feet above the sea level. A stately tree, 60 feet high.

Juniperus flaceida, Schlecht.

In Mexico, 5 to 7000 feet high. A tree of 30 feet in height, rich in a resin, similar to Sandarach.

Juniperus foetidissima, Willd.

A tall beautiful tree in Armenia and Tauria, 5000 to 6,500 feet.

Juniperus Mexicana, Schiede.

Mexico at an elevation of 7000 to 11,000 feet. A straight tree, 90 feet high, stem 3 feet diameter, exuding copiously a resin similar to Sandarac.

Juniperus oceidentalis, Hook.

North California and Oregon, at 5000 feet. A straight tree, 80 feet high, with a stein of 3 feet diameter.

Juniperus Phœnicea, L.

South Europe and Orient. A small tree, 20 feet high, yielding an aromatic resin.

Juniperus procera, Hochst.

In Abyssinia. A stately tree, furnishing a hard useful timber.

Juniperus recurva, Hamilton.

On the Himalayas, 10 to 12,000 feet high. A tree attaining 30 feet in height.

Juniperus sphaerica, Lindl.

North China. A handsome tree, 40 feet high.

Juniperus Virginiana, L.

North American Pencil Cedar or Red Cedar. A handsome tree, 50 feet high, supplying a fragrant timber, much esteemed for its strength and durability; the inner part is of a beautiful red color, the outer is white; it is much used for pencils.

Libocedrus Chilensis, Endl.

In cold valleys on the southern Andes of Chili, 2000 to 5000 feet. A fine tree, 80 feet high, furnishing a hard resinous wood of a yellowish color.

Libocedrus decurrens, Torr.

White Cedar of California, growing on high mountains. Attains a height of fully 200 feet, with a stem 25 feet in circumference.

Libocedrus Doniana, Endl.

North island of New Zealand, up to 6000 feet elevation. A forest tree 100 feet high, stem 3 feet and more in diameter. The wood is hard and resinous, of a dark reddish color, fine grained, excellent for planks and spars.

Libocedrus tetragona, Eudl.

On the Andes of North Chili, 2000 to 5000 feet. This species has a very straight stem, and grows 120 feet high. The wood is quite white, and highly esteemed for various artisans' work, indeed very precious.

Nageia (Podocarpus) amara, Blume.

Java, on high volcanic mountains. A largo tree, sometimes 200 feet high.

Nageia (Podocarpus) cupressina, R. Br.

Java and Phillipine Islands. Height of tree 180 feet, furnishing a highly valuable timber.

Nageia (Podocarpus) dacrydioides, A. Rich.

In swampy ground of New Zealand; the "Kahikatea" of the Maories, called White Pine by the colonists. Height of tree 150 feet; diameter of stem 4 feet. The white sweet fruit is eaten by the natives; the wood is pale, close-grained, heavy, and among other purposes, used for building canoes.

Nageia (Podocarpus) ferruginea, Don.

Northern parts of New Zealand. The Black Pine of the colonists; native name "Miro." Height of tree 80 feet; it produces a dark red resin of a bitter taste; the wood is of a reddish color, very hard.

Nageia (Podocarpus) Lamberti, Klotzsch.

Brazils. A stately tree, yielding valuable timber.

Nageia (Podocarpus) Purdieana, Hook.

Jamaica, at 2500 to 3500 feet. This quick-growing tree attains a height of 100 feet.

Nageia (Podocarpus) spicata, Br.

Black Rue of New Zealand. Tree 80 feet high; wood pale, soft, close and durable.

Nageia (Podocarpus) Thunbergii, Hook.

Cape of Good Hope. A large tree, known to the colonists as "Geelhout"; it furnishes a splendid wood for building.

Nageia (Podocarpus) Totara, Don.

New Zealand. A fine tree, 120 feet high, with a stem of 20 feet in circumference; it is called mahogany pine by the colonists. The 'reddish close-grained and durable wood is valuable both for building and for furniture, and is also extensively used for telegraph posts; it is considered the most valuable timber of New Zealand. Many other tall timber trees of the genus Podocarpus or Nageia occur in various parts of Asia, Africa and Amcrica, doubtless all desirable, but the quality of their timber is not well known, though likely in many cases excellent. Nageia is by far the oldest published name of the genus.

Phyllocladus rhomboidalis, Rich.

Celery Pine of Tasmania. A stately tree up to 60 feet high, with a stem of 2 to 6 feet in diameter. The timber is valuable for ships' masts. It will only grow to advantage in deep forest valleys.

Phyllocladus trichomanoides, Don.

Celery Pine of New Zealand, northern island; it is also called Pitch Pine by the colonists. This tree attains a height of 70 feet, with a straight stem of 3 feet in diameter, and furnishes a pale close-grained timber, used particularly for spars and planks; the Maories employ the bark for dying red and black.

Pinus Abies, Du Roi.(*Pinus Picea Linné*.)

Silver Fir, Tanne. In Middle Europe up to 50° N. Eat., forming dense forests. A fine tree, already the charm of the ancients, attaining 200 feet in height, and 20 feet in circumference of stem, reaching the age of 300 years. It furnishes a most valuable timber for building, as well as furniture, and in respect to lightness, toughness and elasticity it is even more esteemed than the Norway Spruce, but is not so good for fuel or for charcoal. It also yields a fine white resin and the Strassburg turpentine, similar to the Venetian.

Pinus Abies var. Cephalonica, Parlatore. (*Pinus Cephalonica*, Endl.)

Greece. 3 to 4000 feet above the sea. A tree 60 feet high, with a stem circumference of 10 feet. The wood is very hard and durable, and much esteemed for building.

Pinus Abies var. Nordmanniana, Parlatoro. (*P. Nordmanniana*, Steven.)

Crimea and Circassia, 6000 feet above the sea. This is one of the most imposing firs, attaining a height of 100 feet, with a perfectly straight stem. It furnishes a valuable building timber. The Silver Fir is desirable for our mountain forests.

Pinus alba, Ait.

White Spruce. From Canada to Carolina, up to the highest mountains. It resembles P. Picea, but is smaller, at most 60 feet high. Eligible for our alpine country.

Pinus Alcocquiana, Parlatore.

Japan, at an elevation of 6 to 7000 feet. A fine tree, with very small blue-green leaves; the wood is used for light household furniture.

Pinus amabilis, Dougl.

Californian Silver Fir. North California, at an elevation of 4000 feet. A handsome fir, 200 feet high, circumference of stem 24 feet; the stem is naked up to 100 feet.

Pinus Australia, Michx.

Southern or Swamp Pine, also called Georgia, Yellow Pitch or Broom Pine. In the Southern States of N. America The tree attains a height of 70 feet. It furnishes a good timber for furniture and building. It is this tree, which forms chiefly the extensive pine barrens of the United States, and yields largely the American turpentine.

Pinus Ayacahuite, Ehrenb. (*P. Loudoniana*, Gord.)

In Mexico, at an elevation of 8000 to 12,000 feet. An excellent pine, 100 to 150 feet high, with a stem diameter of 3 to 4 feet, yielding a much esteemed white or sometimes reddish timber.

Pinus balsamea, L.

Balsam Fir, Balm of Gilead Fir. Canada, Nova Scotia, New England. An elegant tree, 40 feet high, which with Pinus Fraseri yields the Canada Balsam, the well-known oleo-resin. The timber is light, soft and useful for furniture. It thrives best in cold swampy places. Eligible for our alps.

Pinus Canadensis, L.

Hemlock Spruce. In Canada and over a great part of the United States, on high mountains. A very ornamental tree, 100 feet high, with a white cross-grained and inferior wood. The tree, however, is extremely valuable on account of its bark, which is much esteemed as a tanning material; it is stripped off during the summer months. The young shoots are used for making spruce beer.

Pinus Canariensis, C. Smith.

Canary Pine. Canary Islands, forming large forests at an elevation of 5 to 6000 feet. A tree 70 feet high, with a resinous durable very heavy wood, not readily attacked by insects. It thrives well in Victoria, and shows celerity of growth.

Pinus Cedrus, L.

Cedar of Lebanon. Together with the Atlas variety on the mountains of Lebanon and Taurus, also in N. Africa. The tree grows to a height of 100 feet, and attains a very great age; the wood is of a light reddish color, soft, easy to work, and much esteemed for its durability.

Pinus Cedrus var. Deodara.

Deodar Cedar. On the Himalaya mountains, 4 to 12,000 feet above sea level. A majestic tree, 150 feet high, and sometimes 30 feet in circumference of stem. The wood is of a whitish yellow color, very close-grained and resinous, and furnishes one of the best building timbers known; it must, however, not be felled too young. The tree also yields a good deal of resin and turpentine.

Pinus Cembra, L.

On the European Alps, also in Siberia and Tartary. The tree attains a height of 60 feet; the wood is of a yellow color, very soft and resinous, of an extremely fine texture and is extensively used for carving and cabinet work. The seeds are edible, and when pressed yield a great quantity of oil. A good turpentine is also obtained from this pine.

Pinus cembroides, Zucc. (*P. Laveana*, Schiede and Deppe.)

Mexican Swamp Pine. A small tree, 30 feet high, growing at an elevation of 8000 to 10,000 feet. The timber is not of much use, but the seeds are edible and have a very agreeable taste.

P. Cilicica, Ant. and Kotsch.

Cilician Silver Fir. Asia Minor. 4000 to 6500 above sea leyel. A handsome tree of pyramidal growth 160 feet high. The wood is very soft and used extensively for the roofs of houses, as it does not warp.

Pinus contorta, Dougl.

On high damp ranges in California, attaining 50 feet in height. It is valuable as a shelter tree in stormy localities.

Pinus Coulteri, Don.

California, on the eastern slope of the coast range at an elevation of 3000 to 4000 feet. A pine of quick growth, attaining a height of 75 feet; it has the largest cones of all pines.

Pinus Douglasii, Sabine.

Oregon Pine. N.W. America' forming very extensive forests. A largo conical shaped tree, up to 300 feet in height, with a stem of 2 to 10 feet diameter. Only in a moist forest climate of rapid growth.

Pinus dumosa, Don (*P. Brunoniana Wall*.)

Bootan, Sikkim and Nepal, 10.000 feet above sea level. A very ornamental fir, rising to 70 or 80 feet.

Pinus excelsa, Wall.

The Lofty or Bootan Pine. Himalaya, forming large forests at from 6000 to 11,500 feet elevation. A fine tree, 150 feet high, furnishing a valuable, close-grained, resinous wood, as well as a good quantity of turpentine.

Pinus Fortunei, Parlatore.

China, in the neighbourhood or Foochowfoo. A splendid tree, 70 feet high, somewhat similar in habit to P. Cedrus.

Pinus Fraseri, Pursh.

Double Balsam Fir. On high mountains of Carolina and Pennsylvania. This tree, which gets about 20 feet high, yields with P. balsamea Canada Balsam.

Pinus Gerardiana, Wall.

Nepal Nut Pine. In the N.E. parts of the Himalaya at an elevation of 10,600 to 12,000 feet, forming extensive forests. The tree gets 50 feet high, and produces very sweet edible seeds, also turpentine.

Pinus grandis, Dougl.

Great Silver Fir of North California. A splendid fir, 200 feet high and upwards, growing best in moist valleys of high ranges; the wood is white and soft.

Pinus Haleppensis, Mill.

Aleppo Pine. South Europe and North Africa, This well known pine attains a height of 80 feet with a stem of from 4 to 5 feet in diameter. The timber of young trees is white, of older trees of a dark color; it is principally esteemed for ship building, but also used for furniture. The tree yields a kind of Venetian turpentine, as well as a valuable tar. It thrives well in waterless rocky places, also on the sandy sea coast. P. maritima is a variety of this species. Content with the poorest and driest localities, and rapid of growth.

Pinus Hartwegii, Lindl.

Mexico, 9000 to 13,000 feet above sea level. A pine, 50 feet in height, with a very durable wood of a reddish color; it yields a large quantity of resin.

Pinus Larix, L.

Common Larch; deciduous. On the European Alps up to 7000 feet. It attains a height of 100 feet, sometimes rising even up to 160 feet, and produces a valuable timber of great durability, which is used for land and water buildings, and much prized for ship buildiug. The bark is used for tanning and dyeing. The tree is of great importance for its yield of the Venetian turpentine, which is obtained by boring holes into it in spring; these fill during the summer, supplying from ½ to ¾ pint of turpentine. In Piedmont, where they tap the tree in different places and let the liquid continually run, it is said that from 7 to 8 may be obtained in a year", but the wood suffers through this operation. P. L. var. Rossica, Russian Larch, grows principally on the Altai mountains from 2,600 to 5,600 feet above sea level; it attains a height of 80 feet. The species would be important for our upland country.

Pinus leiophylla, Schiede and Deppe.

7000 to 11,000 feet up on the mountains of Mexico. A tree 90 feet high. The wood is excessively hard.

Pinus leptolepis, Sieb and Zucc.

Japan Larch. In Japan, between 35° and 48° N. lat., up to an elevation of 9000 feet. The timber is highly valued by the Japanese.

Pinus longifolia, Roxb.

Emodi Pine or Cheer Pine. On the Himalaya mountains, from 2000 to 7000 feet. A handsome tree with a branchless stem of 60 feet; the wood is resinous and the red variety useful for building; it yields a quantity of tar and turpentine. The tree stands exposure and heat well.

Pinus Massoniana, Lamb. (*P. Sinensis*, Lamb.)

China and Japan. This pine attains a height of 60 feet, and supplies a resinous tough and durable wood, used for buildings and furniture. The roots, when burned with the oil of Brassica Orientalis, furnish the Chinese Lampblack.

Pinus Menzieuii, Dougl.

North West America. A very handsome tree, which grows to a height of 70 feet, and furnishes a valuable timber; it thrives best in moist ground.

Pinus Hudsonica, Poir. (*P. Banksiana*, Lamb.)

Grey Pine; North America, up to 64° N. lat. Height of tree 40 feet, in the cold north only a shrub. The wood is light, tough and easily worked.

Pinus Jeffreyi, Murr.

North California, on a sterile sandy soil. A noble pine, 150 feet high; stem 4 feet thick.

Pinus Kæmpferi, Lamb.

Chinese Larch; also called Golden Pine. China. This is the handsomest of all the larches. It is of quick growth, and attains a height of 150 feet; The leaves, which are of a vivid green during spring and summer, turn to a golden yellow in autumn. The wood is very hard and durable.

Pinus Koraiensis, Sieb. and Zucc.

China and Japan. A handsome tree, 30 to 40 feet high, producing edible seeds.

Pinus Lambertiana, Dougl.

Giant or Sugar Pine. North-west coast of America; mostly in great altitudes. A lofty tree, upwards of 300 feet high, with a straight, naked stem of from 20 to 60 feet in circumference. It thrives best in sandy soil, and produces a soft, white, straight grained wood, which for inside work is esteemed above any other pine in California, and furnished in large quantities. The cones are 18 inches long; the seeds are edible, and used as food by the natives. Would come best to perfection in the humid regions of our higher mountains.

Pinus Laricio, Poir.

Corsican Pine. South Europe. It attains a height of 120 feet. The wood is white, towards the centre dark, very resinous, coarse-grained, elastic and durable, and much esteemed for building, especially for waterworks. There are three main varieties of this pine, viz.: P. L. Poiretiana, in Italy; P. L. Austriaca, in Austria; P. L. Pallassiana, on the borders of the Black Sea. The tree grows best in calcareous soil, but also in poor, sandy soil, where, however, the timber is not so large nor so good. It yields all the products of P. silvestris, but in greater quantities, being perhaps the most resinous of all pines.

Pinus Mertensiana, Bong.

Californian Hemlock Spruce, North-west America. The wood is white and very soft, but is often used for building. The tree is from 100 to 150 feet high, by a stem diameter of 4 to 6 feet.

Pinus mitis, Michx.

Yellow Pine of North America. In dry sandy soil, attaining a height of 60 feet. Wood durable, fine-grained, moderately resinous, valuable for flooring.

Pinus monophylla, Torr. and Frem.

Stone or Nut Pine of California, on the Sierra Nevada and Cascade Mountains, 6,500 feet. The seeds are edible, of an almond-like taste, and consumed in quantity by the natives. Height of tree only 35 feet; thickness of stem 8 to 10 inches.

Pinus montana, Du Roi. (*P. Pumilio Hænke*.)

On the Alps and Carpathians up to the highest points, covering largo tracts, and thriving on the poorest soil. The tree, which grows about 25 feet high, in favourable localities 50, yields much oil of turpentine. The wood is used for carving and for firewood. Only available to advantage for our highlands.

Pinus Montezumae, Lamb. (*P. Devoniana*, Lindl.) (*P. Grenvilleœa*, Gord.)

Mexico. A handsome Pine, 80 feet high; wood white, soft and resinous.

Pinus monticola, Dougl.

California, at an elevation of 7,000 feet. It thrives best in poor soil of granite formation, and attains the height of 200 feet, with a stem of 1½ to 4 feet thick. The wood is white, close-grained.

Pinus muricata, Don.

Bishop's Pine. California. Found up 7,500 feet. This pine grows to about 40 feet.

Pinus nigra, Ait.

Black Spruce. North-East America, Occurring extensively between 44° and 53° N. latitude. This tree, which is termed Double Spruce by the Canadians, attains a height of 70 feet, and furnishes a light elastic timber of white colour, excellent for yards of ships. The young shoots are used for making spruce-beer, and the small roots serve as cords. It likes swampy forest land.

Pinus nobilis, Dougl.

Noble White Fir. North west coast of America, on the Columbia River and the mountains of North California, where it forms extensive forests at 6 to 8,000 feet. A majestic tree, 150 to 200 feet high, with regular horizontal branches. It furnishes a valuable timber for building.

Pinus orientalis, L.

Sapindus Fir. In Asia Minor, at 4,000 feet. The tree rises to about 80 feet, and resembles somewhat the Norway Spruce. The wood is exceedingly tough and durable.

Pinus parviflora, Sieb.

In Japan. It only gets about 25 feet high; but is much used as an avenue tree; wood for fine furniture and boat-building.

Pinus Pattoniana, Parl.

California; 5 to 6,000 feet above sea-level. A very fine fir, 300 feet high, with a perfectly straight stem. The wood is bard, of a reddish colour, with handsome veins; but poor in resin.

Pinus patula, Schiede and Deppe.

In Mexico; at an elevation of 8 to 9,000 feet. A graceful pine, 80 feet high.

Pinus pendula, Soland, (*P. microcarpa*, Lamb.)

Small-coned American Larch; Black Larch or Tamarack. Frequent in Vermont and New Hampshire. A pine of pyramidal growth, 100 feet high. The timber is white, heavy, resinous, and as highly valued as that of the Common Larch.

Pinus picea, Du Roi.(*P. Abies*, L.)

Norway Spruce, Fichte, Middle and Northern Europe and Northern Asia; rising from the plains to an elevation of 4,500 feet, and forming extensive forests. The tree attains a height of 150 feet or even more, and furnishes an excellent timber for building and furniture; commonly known under the name of White Deal. It also produces the Burgundy Pitch in quantity, while the bark is used for tanning. Though enduring our dry summers, this spruce would have to be restricted for timber purposes to the damp mountains.

Pinus Pinaster, Soland.

Cluster Pine. On the shores of the Mediterranean. The tree is of quick growth, and rises to 60 feet in height; the wood is soft and resinous; it yields largely the French turpentine. Among the best pines for consolidation of sandy coast land, and converting rolling sands into pasture and agricultural land. For ease of rearing and rapidity of growth, one of the most important of all pines.

Pinus Pinoeana, Gord.

Mexico, up to 9000 feet above sea level. A very remarkable pine, having drooping branches like the Weeping Willow; 60 feet high. Most desirable for cemeteries.

Pinus Pindrow, Royle.

In great abundance on the spurs of the Himalaya mountains, 8 to 12,000 feet above the sea level. A fine straight stemmed tree, 100 feet high.

Pinus Pinea, L.

Stone Pine. Frequent in the countries bordering on the Mediterranean: height of tree 60 feet; the wood is whitish, light, but full of resin, and much used for buildings, furniture and ships. The seeds are edible, somewhat resembling almonds, but of a taste resinous though not disagreeable; they only ripen in their third year. This pine grows as easily and almost as quickly as the Cluster Pine.

Pinus Pinsapo, Boiss.

Spanish Fir. In Spain, on the Sierra Nevada, 4 to 6000 feet. A tree of 60 feet high, with branches from the ground.

Pinus ponderosa, Dougl.(*P. Benthamiana*, Hartw.)

Yellow or Pitch Pine of the mountains of N.W. America. Height of tree up to 225 feet, with a stem of 24 feet in circumference, of comparatively quick growth; the wood is heavy, and for general purposes preferred to that of any other pine. Has proved well adapted even for dry localities in Victoria.

Pinus Pseudo-Strobus, Lindl.

In Mexico. This tree is superior in appearance to any other Mexican pine; height 80 feet.

Pinus Pyrenaica, Lapeyr.

In the South of Spain and on the Pyrenees. A fine ornamental tree of quick growth, 80 feet high; the wood is white and dry, poor in resin.

Pinus radiata, Don.(*P. insignis*, Dougl.)

California. A splendid pine, fully 100 feet high, with a straight stem 2 to 4 feet in diameter. It is of remarkably rapid growth, a seedling, one year old, being strong enough for final transplantation; the wood is tough, and much sought for boat-building and various utensils.

Pinus religiosa, Humb.

Oyamel Fir. Mexico, 4 to 9000 feet above the sea level. A magnificent tree with silvery leaves, growing 100 feet high; stem 6 feet in diameter; the wood is particularly well fit for shingles.

Pinus resinosa, Soland.

Red Pine. N. America, principally in Canada and Nova Scotia. It gets 80 feet high and 2 feet in diameter; the wood is red, fine-grained, heavy and durable, not very resinous, and is used for ship-building.

Pinus rigida, Mill.

American Pitch Pine. From New England to Virginia. It grows to a height of 80 feet; the timber, when from good soil, is hard and resinous and used for building; but the tree is principally important for its yield of turpentine, resin, pitch and tar.

Pinus rubra, Lamb.

Hudson's Pine, Red Spruce. Nova Scotia, Newfoundland and other northern parts of the American Continent. A straight slender tree, 70 feet high; the wood is of a reddish color and highly esteemed

Pinus Sabiniana, Dougl.

Californian Nut Pine or White Pine, Most frequent on the western slopes of the Rocky Mountains, intermixed with other trees; 160 feet high; stem 3 to 5 feet in diameter; the wood is white and soft; the clustered heavy cones attain a length of 1 foot; the feeds are edible. Proves in dry localities of Victoria to be of quick growth.

Pinus serotina, Michx.

Pond Pine. Southern States of North America, in black morassv soil, principally near the sea coast; it is 50 feet high, stem 18 inches in diameter; the wood is soft.

Pinus silvestris, L.

Scotch Fir, Foehre. Middle and Northern Europe, up to 70° N. Lat., and North Asia, thriving best in sandy soil. A very valuable tree, fully 100 feet high, growing to the age of about 120 years. The lied Baltic, Norway, or Riga deals are obtained from this pine, as well as a large portion of the European pine tar. Proves well adapted even for the drier parts of Victoria.

Pinus Sibirica, Turcz. (*P. Pichta*, Fisch.)

Siberian Pitch Fir. On the Altai Mountains; it reaches a height of 50 feet.

Pinus Strobus, L.

Weymouth Pine or American White Pine. N.E. America, growing on any soil, but preferring swampy ground; it is found 160 feet high, with a stem of 4 to 6 feet in diameter; the wood is soft, white, light, free of knots; almost without resin, easy to work, and much esteemed for masts; it yields American turpentine and gallipot.

Pinus Tæda, L.

Frankincense or Loblolly Pine. Florida and Virginia, in sandy soil, attaining a height of 80 feet; the timber is esteemed for ship-building. It also yields turpentine in good quantity, though of inferior quality.

Pinus tenuifolia, Benth.

Mexico, at an elevation of 5000 feet, forming dense forests; height of tree 100 feet, stem up to 5 feet in diameter.

Pinus Teocote, Cham, and Schlecht.

Okotc or Torch Pine. Mexico, 5 to 8000 feet above the sea level. Tree 100 feet high, stem 3 to 4 feet in diameter; the wood is resinous and durable.

Pinus Tsuga, Ant.

In the northern provinces of Japan, 6 to 9000 feet above the sea. The tree gets only 25 feet high; its timber is highly esteemed for superior furniture, especially by turners.

Pinus Webbiana, Wallich.

King Pine, Dye Pine. On the Himalaya Mountains, at an elevation of 12 to 13,000 feet. A splendid fir 70 to 80 feet high, with a stem diameter of generally 3 to 4 feet, but sometimes even 10 feet. The wood is of a white color, soft, coarse-grained and very resinous; the natives extract a splendid violet dye from the cones.

Sciadopitys verticillata, Sieb.

The lofty and curious Umbrella Fir of Japan, 140 feet high; resists severe frosts; wood white and compact.

Sequoia sempervirens, Endl.(*Taxodium sempervirens*, Lamb.)

Red Wood or Bastard Cedar of N. W. America, chiefly California. A splendid tree, 300 feet high, occasionally with a diameter of the stem of 55 feet. The wood is reddish, close-veined, but light and brittle. One of the most colossal trees of the globe.

Sequoia Wellingtonia, Seem.(*Wellingtonia gigantea*, Lindl.)

Mammoth Tree. California, up to 5000 feet above the sea. This, the biggest of all trees, attains a stem of 320 feet in length and 112 feet in circumference, the oldest trees being estimated at 1100 years; the total height of a tree will occasionally be 450 feet; a stem broken at 300 feet had yet a diameter of 18 feet. The wood is soft and white when felled, afterwards it turns red.

Taxodium distichum, Rich.

Virginian Swamp or Bald Cypress. In swampy places of North America. A large and valuable tree, 100 feet high, with a stem circumference of sometimes 40 feet, of rapid growth, with deciduous foliage like that of the Larch and Ginkgo; it is found fossil in the miocene formation of many parts of Europe. The wood is fine-grained, hard and durable; it yields an essential oil and a superior Kind of turpentine. Useful for avenues on swampy margins of lakes or river banks.

Taxodium mucronatum, Ten.

The famed Montezuma Cypress of Mexico, 120 feet high, with a trunk 44 feet in circumference; it forms extensive forests between Chapultepec and Tescuco.

Taxus baccata, L.

Yew. Middle and South Europe and Asia, at 1000 to 4000 feet elevation. Generally a shrub, sometimes a tree 40 feet high, which furnishes a yellow or brown wood, exceedingly tough, elastic and durable, and much esteemed by turners. The tree is of very slow growth, and reaches a great age, perhaps several thousand years; some ancient ones are known with a stem of fifty feet in girth.

Taxus brevifolia, Nuttall. (*T. Lindleyana*, Laws.)

N. W. America. Western Yew. A stately tree, 75 feet high, with a stem of 5 feet in circumference. The Indians use the wood for their bows.

Thuya gigantea, Nutt.

N. W. America, on the banks of the Columbia River. The Yellow Cypress of the colonists. A straight, graceful tree, 200 feet high, furnishing a valuable building timber of a pale or light yellow color.

Thuya oeeidentalis, L.

N. America, particularly frequent in Canada. A fine tree, 70 feet high; the wood is reddish or yellowish, fine-grained, very tough and resinous, and well fit for building, especially for water work. The shoots and also an essential oil of this tree are used in medicine; the bast can be converted into ropes.

Thuyopsis dolabrata, Sieb and Zucc.

Japan. A majestic tree, furnishing an excellent hard timber of a red color.

Torreya Californica, Torr. (*T. myrislica*, Hooker.)

In California. Tree 80 feet high.

Torreya grandis, Fortune.

China. A tree 60 feet high, with an umbrella-shaped crown; it produces good timber.

Torreya nucifera, S. and Z. (*Caryotaxus nucifera*, Zucc.)

Japan. Height of tree about 80 feet. From the nuts the Japanese press an oil, used as an article of food.

Torreya taxifolia, Arnott.

Florida. A tree 50 feet in height, with a firm, close-grained, durable wood of a reddish color.

Widdringtonia juniperoides, Endl.

South Africa, 3000 to 4000 feet above sea level. A middling sized tree, rich in resin.

II.—Miscellaneous Trees, Not Coniferous.

Acacia acuminata, Benth.

A kind of Myall from Western Australia, attaining a height of 40 feet.

Acacia decurrens, Willd. (*A. mollissima*, Willd. *A. dealbata*, Link.)

The Black Wattle or Silver Wattle. From the eastern part of S. Australia, through Victoria and N. S. Wales, to the southern part of Queensland, in open plains a small or middle sized tree, in deep forest recesses a lofty tree, of singularly rapid growth. Its wood can be used for staves and many other purposes, but its chief use would be to afford the first shelter, in treeless localities, for raising forests. Its bark, rich in tannin, and its gum, not dissimilar to Gum Arabic, render this tree also important. Other quick growing trees, useful in various ways, growing in any soil and enduring drought, can be used simultaneously, by mere dissemination, in ploughed ground, for dense temporary belts of shelter, or for quick yielding fuel plantations, such as *Acacia pycnantha, A. lophantha, Casuarina quadri-valvis, Casuarina suberosa, Eucalyptus melliodora. Eucalyptus viminalis* and many other Eucalypts, all easily growing from seed.

Acacia homalophylla, Cunn.

The Victorian Myall, extending into the deserts of N.S. Wales. The dark brown wood is much sought for turner's work on account of its solidity and fragrance; perhaps its most extensive use is in the manufacture of tobacco pipes. Never a tall tree.

Acacia Melanoxylon, R. Br.

The well known Blackwood of our river flats and moist forest valleys, passing also under the inappropriate name of Lightwood. In irrigated valleys of deep soil the tree will attain a height of 80 feet, with a stem several feet in diameter. The wood is most valuable for furniture, railway carriages, boat-building, casks, billiard tables, pianofortes (for sound-boards and actions), and numerous other purposes. The fine-grained wood is cut into veneers. It takes a fine polish, and is considered equal to the best Walnut. Our best wood for bending under steam. For further details refer to the volumes of the Exhibitions of 1862 and 1867.

Acer campestre, L.

Extends from Middle Europe to North Asia. Height 40 feet, in shelter and deep soil; the yellow and purple tint of Its foliage in autumn render the tree then particularly beautiful. The wood is compact and fine-grained, and sought for choice furniture. The tree can he trimmed for hedge growth. Comparatively quick of growth, and easily raised from seed. These remarks apply to almost all kinds of Maples.

Acer dasycarpum, Ehrhart.

The Silver Maple of North America. Likes rather a warmer climate than the other American Maples, and therefore particularly desirable for us here. Height 50 feet; wood pale and soft, stem sometimes 9 feet in diameter.

Acer macrophyllum, Pursh.

Large Oregon Maple. Tree 90 feet high, of quick growth, stem 16 feet in circumference; wood whitish, beautifully veined.

Acer Negundo, L.

The Bos Elder of North America. A tree, deciduous like the rest of the Maples; attains a height of about 50 feet, and is rich in saccharine sap. Proved well adapted for our country.

Acer palmatum, Thunb.

This beautiful tree with deeply cleft leaves is indigenous to Japan where various varieties with red and yellow tinged leaves occur. Should it be an aim to bring together all the kinds of Maples, which could be easily grown in appropriate spots of Victoria, then Japan alone would furnish 25 species.

Acer platanoides, L.

The Norway Maple, extending south to Switzerland, 70 feet high. The pale wood much used by cabinetmakers.

Acer Pseudo-platanus, L.

The Sycamore Maple or British Plane. Attains a height of over 100 feet. The wood is compact and firm, valuable for various implements, instruments and cabinet work. It furnishes like some other maples a superior charcoal.

Acer rubrum, L.

The Red Maple, North America. A tree attaining 80 feet, fond of swampy places; wood close-grained. The trunk when twisted furnishes also curled maple wood. Grows well with several other maples, even in dry open localities of this part of Australia, although the foliage may somewhat suffer from our hot winds.

Acer saccharinum, Wang.

One of the largest of the maples. In the colder latitudes of North America, 80 feet high. Wood of rosy tinge, when knotty or curly furnishes the Birdseye and curly Maplewood. In the depth of winter the trees, when tapped, will yield the saccharine fluid, which is so extensively converted into maple sugar, each tree yielding 2 to 4 lb. a year. The trees can be tapped for very many years in succession, without injury. The Sugar Maple is rich in potash. Numerous other maples exist, among which as the tallest may be mentioned, *Acer Creticum*, L., of South Europe. 40 feet; *A. Iævigalum, A. sterculiaceum* and *A. villosam*, Wallich, of Nepal, 50 feet; *A. pictum*, Thunb., of Japan, 80 feet.

Æsculus Hippoeastanum, L.

Indigenous to Central Asia. One of the most showy of deciduous trees, more particularly when during spring "it has reached the meridian of its glory, and stands forth in all the gorgeousness of leaves and blossoms." Height 60 feet. It will succeed in sandy soil on sheltered spots; the wood adapted for furniture; the seeds a food for various domestic animals; the bark a good tanning material. Three species occur in Japan, and several, but none of great height, in North America and South Asia.

Ailantus glandulosa, L.

S.E. Asia. A hardy deciduous tree, 60 feet high, of rather rapid growth, and of very imposing aspect in any landscape. Particularly valuable on account of its leaves, which afford food to a silkworm *Bombyx Cynthia*), peculiar to this tree; wood pale yellow, of silky lustre when planed, and therefore valued for joiners' work. In South Europe planted for avenues.

Alnus glutinosa, Gærtn.

The ordinary Alder. Throughout Europe and extra tropical Asia, 70 feet high; well adapted for river banks; wood soft and light, turning red, furnishing one of the best charcoals for gunpowder; it is also durable under water, and adapted for turners and joiner's work. *A. incana Willd*. is an equally high and allied species.

Amyris terebinthifolia, Tenore.

Brazil. Is here perfectly hardy, and is content in dry ground without any irrigation. It proved one of the best among the smaller avenue trees, is beautifully spreading and umbrageous, and probably of medicinal value.

Angophora intermedia, Cand.

South East Australia. This is the best of the Angophoras, attaining a height of 50 feet, and growing with the rapidity of an Eucalyptus, but being more close and shady in its foliage. It would be one of our best trees to line public roads, and to effect shelter plantations.

Baloghia lucida, Endl. (*Codiæum lucidum*, J. M.)

East Australia. A middle sized tree. The sap from the vulnerated trunk forms, without any admixture, a beautiful red indelible pigment.

Betula alba, L.

The ordinary Birch of Europe and extratropical Asia. It attains a height of 80 feet, and would here thrive best in moist glens of the ranges, or in the higher regions of our mountains, where it would form up at the Alpine Zone excellent shelter plantations. The durable bark serves for roofing. Wood white, turning red. The oil of the bark is used in preparing the Russian leather.

Betula nigra, L.

The Black or River Birch of North America. One of the tallest of Birches. If grown on the banks of a limpid stream, it will bear intense heat. The wood is compact, of a light colour.

Betula papyracea, Ait.

The Paper Birch of North America. A larger tree than B. alba, with a fine-grained wood and a tough bark; much used for portable canoes. It likes a cold situation.

Betula lenta, Willd.

The Cherry Birch of North America. A tree of middle size, liking moist ground. Bark aromatic. Wood rose coloured or dark, finegrained, excellent for furniture. Several Birches occur in Japan, which might well be tried here.

Carpinus Betuius, L.

The Hornbeam. A tree of 80 feet high. Middle and South Europe. Wood pale, of a horny toughness and hardness, close-grained, but not elastic. This tree would serve to arrest the progress of bushfires, if planted in copses or hedges like willows and poplars around forest plantations. A smaller species, Carpinus Americana, Mich., yields the Ironwood of North America. Four species occur in Japan (*C. cordata, C. erosa, C. laxiflora, C.japonica* (Blume). *Carpinus viminea* (Wallich) is a species with durable wood from the middle regions of Nepal.

Carya alba, Nuttall.

The Shellbark-Hickory. A deciduous tree, 90 feet high, which delights in rich forest soil; a native of North America, Wood strong, elastic, and tenacious, but not very durable. Yields the main supply of Hickory nuts. All the hickories are extensively used in North America for hoops.

Carya amara, Nuttall.

The Bitternut Tree or Swamp Hickory. A tree, 80 feet high, in swampy grounds of North America. Wood less valuable than that of other Hickories.

Carya glabra, Torrey.(*Carya porcina*, Nuttall.)

The Hognut Tree. A tree, 80 feet high, in forest land of North America. Wood very tough; the heart-wood reddish or dark-coloured; much used for axletrees and axehandles.

Carya oliviformis, Nuttall.

The Pecan Nut Tree. A lofty tree, fond of river banks in North America.

Carya sulcata, Nuttall.

The Furrowed Hickory and Shellbark Hickory of some districts; also Shagbark Hickory. A tree, 80 feet high, in damp woods of North America. Heart-wood pale-coloured. Seed of sweet pleasant taste.

Carya tomentosa, Nuttall.

The Mocker Nuttree or White Heart Hickory. A big tree of North America. Likes forest soil, not moist. Heart-wood pale-coloured, remarkable for strength and durability. Seeds very oily. Nut small, but sweet. A variety produces nuts as large as an apple.

Castanea sativa, Miller.(*C. vesca Gærtner*.)

The Sweet Chesnut Tree. South Europe and temperate Asia, as far as Japan, and a variety with smaller fruits extending to North America. It attains an enormous age; at Mount Etna an individual tree occurs with a stem 204 feet in circumference. The wood is light and coarse-grained; the importance of the tree rests on its adaptability for shade plantations, its nutritious nuts and timber value.

Castanopsis argentea, A. Candolle.

A lofty tree in the mountains of India, produces also edible chesnuts. Other species of the genus Castanopsis are valuable.

Casuarina glauca, Sieber.

The Desert Sheoak, widely distributed through Australia, but nowhere in forest-like masses. This species attains, in favourable places, a height of 80 feet. Its hard durable wood is valuable. Important for its rapid growth, resistance to exposure for shelter plantation, and a speedy supply of fuel, a remark which applies also to the following species.

Casuarina quadrivalvis, Labillard.

The Coast Sheoak of South-east Australia, but not merely living in coast sand, but also on barren places up to the hills inland. Height to 60 feet. The male tree is very eligible for avenues, the foliage of the species being drooping. Cattle are fond of the foliage. For arresting the ingress of coast sand by belts of timber, this is one of the most important trees. It produces, like other Casuarinas, seeds early and copiously, and is easily raised.

Casuarina suberosa, Willd.

The Erect Sheoak of South East Australia. Height to 40 feet. A beautiful shady species. *Casuarina trichodon* (Miq.), *C. Fraseriana*, (Miq.), and *C. Huegeliana* (Miq.), are arboreous species of South-west Australia, all valuable for their wood.

Cedrela Taona, Roxburgh.

The Singapore Cedar. A mere variety of this is the Red Cedar of East Australia (*Cedrela Australis*, Cunn.) The light beautiful wood, easily worked and susceptible of high polish, is much in request for furniture, for the manufacture of pianofortes, for boat-building and a variety of other work. As this important tree is largely extirpated in the cedar brushes, it is highly desirable to form of it in our rich forest gullies independent plantations for future local supply. The Red Cedar is hardy at Melbourne, but in our open exposed gardens and poor soil of slow growth.

Celtis Australis, L.

The Lotus tree of South Europe and North Africa. Of longevity, 50 feet high, available for avenues. Berries edible. Wood hard and dense, eligible particularly for turners and carvers' work.

Celtis Occidentalis, L.

The Huckberry Tree. A fine forest tree in Obio, and other parts of North America. Height, 80 feet. The variety called *C. crassifolia* is the best. The sweet fruits edible. Wood elastic and fissile.

Ceratonia Siliqua, L.

The Carob tree of the Mediterranean regions. It attains a height of 30 feet and resists drought well. Wood pale red. The saccharine pods, Algaroba or St. John's Bread, of value for domestic animals. The seeds germinate readily.

Cinnamomum Camphora, Nees.

The Camphor tree of China and Japan, attaining a height of about 40 feet. It endures the occasional frosts of Port Phillip, though the foliage will sutler. The wood, like all other parts of the tree, is pervaded by Camphor, hence resists the attack of insects.

Corylus Colurna, L.

The Constantinople Nut tree, the tallest of Hazels, attaining 60 feet in height, of rather quick growth. This, as well as the European Hazel (*Corylus Avellana, L.*) and the Japan Hazel (*C. heterophylla, Fischer*) might be grown for copses in our forest gullies.

Corynocarpus lævigata, Forst.

The Karaka of New Zealand and the principal forest tree of the Chatham Islands, attaining the height of 60 feet. The wood is light, and used by the natives for canoes. The pulp of the fruit is edible. Cattle browse on the foliage. In rich humid soil the tree can be adopted for avenues.

Diospyros Virginiana, L.

The N. American Ebony or Parsimon. A tree 60 feet high. Wood very hard and blackish. The sweet variety yields a good table fruit.

Engelhardtia spicata, Blume.

The spurious Walnut tree of the mountains of Java and the Himalayas. It reaches a height of 200 feet.

Eucalyptus amygdalina, Labill.

In our sheltered springy forest glens attaining not rarely a height of over 400 feet, there forming a smooth stem and broad leaves, producing also seedlings of a foliage different to the ordinary state of *Euc. amygdalina*, as occurs in more open country. This species or variety, which might be called Eucalyptus regnans, represents the loftiest tree in British territory, and ranks next to the Sequoia Wellingtonia in size anywhere on the globe. The wood is fissile, well adapted for shingles, rails, for housebuilding, for the keelson and planking of ships and other purposes. Labillardiere's name applies ill to any of the forms of this species. Seedlings raised on rather barren ground near Melbourne have shown the same amazing rapidity of growth as those of *Euc. globulus*; yet, like those of *Euc. obliqua*, they are not so easily satisfied with any soil.

Eucalyptus citriodora, Hooker.

Queensland. It combines with the ordinary qualities of many Eucalypts the advantage of yielding from its leaves a rather large supply of volatile oil of excellent lemon-like fragrance.

Eucalyptus diversicolor, F. v. Mueller.

The Karri of S. W. Australia. A colossal tree, exceptionally reaching to the height of 400 feet, with a proportionate girth of the stem. The timber is excellent. Fair progress of growth is shown by the young trees, planted even in dry exposed localities in Melbourne. The shady foliage and dense growth of the tree promise to render it one of our best for avenues. In its native localities it occupies fertile, rather humid valleys.

Eucalyptus globulus, Labill.

Blue Gumtree of Victoria and Tasmania. This tree is of extremely rapid growth and attains a height of 400 feet, furnishing a first-class wood; shipbuilders get keels of this timber 120 feet long; besides this they use it extensively for planking and many other parts of the ship, and it is considered to be generally superior to American Rock Elm. A test of strength has been made between some Blue Gum, English Oak, and Indian Teak. The Blue Gum carried 14 lbs. weight more than the Oak and 17 lbs. 4ozs. more than Teak upon the square inch. Blue Gum wood, besides for shipbuilding, is very extensively used by carpenters for all kinds of out-door work, also for fence rails, railway sleepers—lasting about 9 years,—for shafts and spokes of drays, and a variety of other purposes.

Eucalyptus gomphocephala, Candolle.

The Tooart of S. W. Australia; attains a height of 50 feet. The wood is close-grained, hard and not rending. It is used for shipbuilding, wheelwright's work and other purposes of artisans.

Eucalyptus marginata, Smith.

The Jarrah or Mahogany tree of S. W. Australia, famed for its indestructible wood, which is attacked neither by Chelura nor Teredo nor Termites, and therefore so much sought for jetties and other structures exposed to sea-water, also for any underground work, and largely exported for railway sleepers. Vessels built of this timber have been enabled to do away with all copperplating. It is very strong, of a close grain and a slightly oily and resinous nature; it works well, makes a fine finish, and is by shipbuilders here considered superior to either Oak, Teak, or indeed any other wood. The tree grows chiefly on ironstone ranges. At Melbourne it is not quick of growth, if compared to our Blue Gum (*Euc. globulus*, Lab.) or to our Stringybark (E. obliqua, l'Her.), but it is likely to grow with celerity in our ranges.

Eucalyptus rostrata, Schlechtendal.

The Red Gum of Victoria, South Australia and many river flats in the interior of the Australian continent. Although a native tree of this colony, it has been introduced into this list on account of its wood being of extraordinary endurance underground, and for this reason so highly valued for fence-posts, piles and railway sleepers; for the latter purpose it will last at least a dozen years, and, if well selected, much longer. It is also extensively used by shipbuilders—for main stem, stern post, inner post, dead wood, floor timbers, futtocks, transomes, knight head, hawsepieces, cant, stern, quarter and fashion timber, bottom planks, breasthooks and riders, windlass, bowrails, &c. It should be steamed before it is worked for planking. Next to the Jarrah from West Australia this is the best wood for resisting the attacks of sea-worms and white ants. For other details of the uses of this and other native trees refer to the Reports of the Victorian Exhibitions of 1862 and 1867. The tree attains a height of fully 100 feet. The supply for our local wants falls already short, and cannot be obtained from Tasmania, where the tree does not naturally exist.

Eucalyptus Sideroxylon, Cunn.

Iron Bark tree. It attains a height of 100 feet, and supplies a valuable timber, possessing great strength and hardness; it is much prized for its durability by carpenters, ship-builders, &c. It is largely employed by waggon-builders for wheels, poles, &c.; by ship-builders for top sides, tree nails, the rudder (stock), belaying pins and other purposes; it is also used by turners for rough work. This is considered the strongest wood in our colony. It is much recommended for railway sleepers, and extensively used in underground mining work.

Excæcaria sebifera, J. M. (*Stillingia sebifera*, Mich.)

The tallow tree of China and Japan. The fatty coating of the seeds yield the vegetable tallow. The wood is so hard and dense as to be used for printing blocks; the leaves furnish a black dye. The tree endures the night frosts of our open lowlands, though its foliage suffers.

Fagus Cunninghami, Hooker.

The Victorian and Tasmanian Beech. A magnificent evergreen tree, attaining colossal dimensions, and only living in cool damp rich forest valleys, not rarely 200 feet high. The wood much used by carpenters and other artisans', the myrtlewood of the trade. It requires to be ascertained by actual tests in the forests, whether the allied tall evergreen New Zealand Beeches possess any advantage over ours for forest culture, they are: *Fagus Menziesii*, Hooker, the Red Birch of the colonists; *Fagus fusca*, Hook., the Black Birch; *Fagus Solandri*, Hook, the White Birch. A magnificent beech, *Fagus Moorei*, F. von Muell. occurs in New England.

Fagus silvatica, L.

The deciduous beech of Britain, of most other parts of Europe and extra tropical Asia, and as *Fagus ferruginea*, Ait. in a particular variety, extending through North America. The trunk has been measured in height 118 feet, the head 850 feet in diameter; the wood is hard, extensively used by joiners and ship-builders. An allied Beech, *Fagus Sieboldii*, Endl., occurs in Japan. All these could here be grown to advantage only in our springy mountain forests.

Ficus Sycamorus, L.

The Sycomore Fig tree of the Orient, copiously planted along the road sides of Egypt. The shady crown extends to a width of 120 feet. Though introduced, we have as yet no local means of raising this tree in quantity, and must therefore rely on fresh importations of cuttings or more particularly seeds.

Ficus macrophylla, Desfont.

The Moreton Bay Fig-tree, which is indigenous through a great part of East Australia. Perhaps the grandest of our avenue trees, and among the very best to be planted, although in poor dry soil its growth is slow. In our latitudes it is quite hardy in the lowland. The foliage may occasionally be injured by grasshoppers. Easily raised from seed.

Fraxinus Americana, L .

The White Ash of North America. A large tree, 80 feet high, which delights in humid forests. Timber valuable, better resisting extreme heat than the common Ash. The Red Ash (*Fraxinus pubescens, Lam.*), the Green Ash (*F. viridis*, Michx.), the Black Ash (*F. sambucifolia*, Lam.), and the Carolina Ash (*F. platycarpa*, Michx.), are of smaller size.

Fraxinus excelsior, L.

The ordinary Ash of Europe and West Asia. Height 80 feet, of comparatively quick growth, known to attain an age of nearly 200 years. Rich soil on forest rivulets or riverbanks suit it best; wood remarkably tough and elastic, used for agricultural and other implements, for oars, axletrees and many other purposes. Six peculiar kinds of ash trees occur in Japan, some also in the Indian Highlands; all might be tried here.

Fraxinus fioribunda, Don.

Nepal Ash, 40 feet high.

Fraxinus Ornus, L.

The Manna Ash of the Mediterranean regions. Height about 30 feet. It yields the medicinal manna.

Fraxinus quadrangulata, Michx.

The Blue Ash of North America. One of the tallest of the Ashes, 70 feet high, with an excellent timber.

Fraxinus viridis, Mich.

The Green Ash of North America. Height 70 feet; wood excellent.

Gleditschia triacanthos, L.

The deciduous Honey Locust tree of North America. Height up to 80 feet. Wood hard, coarse-grained, fissile. Sown closely, this plant forms impenetrable, thorny, not readily combustible hedges. An allied species the G. horrida, Willd in East Asia. The Water Locust tree of North America (*Gleditschia monosperma*, Walt.), will grow in swamps to 80 feet.

Grevillea robusta, Cunningh.

Our beautiful Lawntree, indigenous to the subtropical part of East Australia, 100 feet high, of rather rapid growth, and resisting drought in a remarkable degree; hence one of the most eligible trees for desert-culture. Our cultivated trees yield now already an ample supply of seeds. The wood is valued particularly for staves of casks.

Guevina Avellana, Molina (*Quadria heterophylla*, R, & P.)

The evergreen Hazel tree of Chili, growing as far as 30° S. It attains a height of 30 feet, and yields the Hazel nuts of S. America

Gymnocladus Canadensis, Lamark.

The Chirot. A North American timber and avenue tree, attaining a height of 80 feet; allied to Gleditschia, but, as the name implies, thornless. The wood is strong, tough, compact, fine-grained, and assumes a rosy color.

Juglans cinerea, L.

The Butternut tree of N. America. About 50 feet high; stem-diameter 4 feet. Likes rocky places in rich forests. Wood lighter than that of the Black Walnut, durable and free from attacks of insects.

Juglans nigra, L.

Black Walnut tree. Attains a height of 70 feet; trunk 4 feet in diameter; found in rich forest land in N. America. Wood purplish brown, turning dark with age, strong, tough, not liable to warp or to split; not attacked by insects. Seed more oily than the European Walnut.

Juglans regia, L.

The ordinary 'Walnut tree of Europe, but of Central Asiatic origin; it attains a height of fully 80 feet, and lives many centuries. Wood light and tough, much sought for gunstocks, furniture and other things. The shells of the nut yield black pigment, Trees of choice quality of wood have been sold for £600, the wood being the most valuable of middle Europe. Can be grown in cold localities, as it lives at 2000 feet elevation in middle Europe. The Californian Walnut tree (*Juglans rupestris*, Engelmann) and the Chinese Walnut tree (*Juglans Mandchurica*, Maxim.) ought to be introduced here.

Leucadendron argenteum, Brown.

The Silver tree of South Africa is included on this occasion among forest trees, because it would add to the splendour of our woods, and thrive far better there than in our gardens. Moreover, with this tree many others equally glorious might be established in our mild forest glens as a source of horticultural wealth, were it only to obtain in future years a copious supply of seeds. Mention may be made of the tall Magnolia trees of N. America

(*Magnolia grandiflora*, L., 100 feet high; *M. umbrella*, Lam., 40 feet; *M. acuminata*, L., 80 feet; *M. cordata*, Michx. 50 feet; *M. Fraseri*, Walt., 40 feet; *M. macrophylla*, Michx., 40 feet), *M. Yulan*, Desf of China, 50 feet; *Magnolia Campbelli*, Hook., of the Himalayas, 150 feet high and flowers nearly a foot across; *M. sphærocarpa*, Roxb., also of the Indian Highlands, 40 feet; the North American Tulip tree (*Liriodendron tulipifera*, L.), 140 feet high, stem 9 feet in diameter; the Mediterranean Styrax tree (*Styrax officinalis*, L.); *Stenocarpus sinuosus*, Endl., of East Australia (the most brilliant of the *Proteacea*); the crimson and scarlet Ratas of New Zealand (*Metrosideros florida*, Sm.; *M. lucida*, Menz.; *M. robusta*, Cunn., 80 feet high; *M. tomentosa*, Cunn., 40 feet); *Fuchsia excorticata*, L., also from New Zealand, stem 2 feet in diameter; the crimson-flowered Eucalyptus ficifolia of West Australia; *Rhododendon Falconeri*, Hooker, from Upper India, 50 feet high, leaves 18 inches long. In the Sassafras gullies, here alluded to, also may be planted the great *Melaleuca Leucadendron*, L., the true Asiatic Cajuput tree, which grows to a height of 100 feet; even the North European Holly (*Ilex Aquifolium*), which occasionally rises to 60 feet, though both from regions so distant.

Liquidambar Altingia, Blume.

At the Red Sea and in the mountains of India and New Guinea, at 8000 feet, and probably hardy in the warmer parts of our colony. The tree attains a height cf 200 feet. It yields the fragrant balsam known as liquid Storax.

Liquidambar styraciflua, L.

The Sweet-Gum tree. In morasses and on the springs of the forests of N. America, with a wide geographic range. The tree attains vast dimensions of its crown; the stem 10 feet in diameter. The terebin-thine juice hardens, on exposure, to a resin of benzoin odour. Wood fine-grained.

Macadamia ternifolia, F. von Muell. (*Helicia ternifolia*, F. M.)

The Nut tree of subtropic East Australia, attaining a height of 60 feet; hardy, as far south as Melbourne; in our forest valleys likely of fair celerity of growth. The nuts have the taste of hazels.

Morus rubra, L.

The Red Mulberry tree of North America is the largest of the genus, attaining a height of 70 feet; it produces a strong and compact timber. The White Mulberry tree (*Morus alba*, L.), with others, offering food to the silkworms, should be planted copiously everywhere for hedges or copses.

Maclura aurantiaca, Nuttall.

The Osage Orange of North America. Greatest height 60 feet; wood bright yellow, very elastic, fine-grained. For deciduons thornhedges the plant is important; its value for silkworms needs further to be tested.

Ostrya carpinifolia, Scopoli.

South Europe and Orient. The Hop Hornbean. A deciduous tree, 60 feet high.

Ostrya Virginica, Willdenow.

Leverwood tree of North America, 40 feet high, in rich woodlands. Wood singularly hard, close-grained and heavy, in use for levers and other implements.

Pistacia vera, L.

Indigenous in the Orient, as far as Persia. A deciduous tree, 30 feet high, yielding the Pistacia Nuts of commerce, remarkable for their green almond-like kernels. The likewise deciduous Mediterranean *Pistacia Terebinthus*, L., yielding the Chio Turpentine, the *P. Atlantica*, Desf., and the evergreen South European *Pistacia Lentiscus*, L., furnishing the mastix, grow rarely to the size of large trees.

Planera Japonica, Miquel.

Considered one of the best timber trees of Japan.

Platanus occidentalis, L.

The true Plane tree of the East part of North America. More eligible as an avenue tree, than as a timber tree;

diameter of stem at times 14 feet; wood dull red.

Platanus orientalis, L.

The Plane tree of South Europe and Middle Asia. One of the grandest trees for lining roads and for street planting, deciduous like the other planes, rather quick of growth, and not requiring much water; attains a height of 90 feet. The wood is well adapted for furniture and other kinds of cabinet work.

Platanus racemosa, Nuttall.

The Californian Plane tree. Wood harder and thus more durable then that of P. occidentalis, also less liable to warp.

Populus alba, L.

The Abele or White Poplar of Europe and Middle Asia. Height 90 feet. It proved here an excellent avenue tree, even in comparatively waterless situations, and gives by the partial whiteness of its foliage a pleasing effect in any plantation. *Populus canescens*, Sm., the grey Poplar, is either a variety of the Abele or its hybrid with the Aspen, and yields a better timber for carpenters and millwrights.

Populus balsamifera, L.

The Tacamahac or Balsam Poplar, of the colder, but not the coldest parts of North America, 80 feet high. Its variety is *P. candicans, Aiton*.

Populus grandidentata, Michaux.

North America, 60 feet high. A kind of Aspen.

Populus heterophylla, L.

The downy Poplar of North America. Height 60 feet.

Populus monilifera, Aiton. (*P. Canadensis*, Desf.)

The Cottonwood tree of North America. Height 100 feet. One of the best poplars for the production of timber.

Populus nigra, L.

The European Black Poplar, extending spontaneously to China. It includes *Populus dilatata*, Aiton, or as a contracted variety, *P. fasti- giata*, Desf., the Lombardy Poplar. Greatest height 150 feet. Growth rapid, like that of all other poplars. Wood soft, light and of loose texture, used by joiners, coopers and turners, furnishing also superior charcoal. Bark employed in tanning. The tree requires damp soil.

Populus tremula, L.

The European Aspen. Height 80 feet. It extends to Japan, where also a peculiar species, *Populus Sieboldii* (Miq.) exists. The aspen wood is white and tender, and in use by coopers and joiners.

Populus tremuloides, Michaux,

The North American Aspen. Height 50 feet. It extends west to California, where a particular species, *Pop, trichocarpa*, Torrey, occurs; All Poplars might be planted like all Willows, in our gullies, to intercept forest-fires, also generally on river-banks.

Quercus Ægilops, L.

South Europe. A tree of the size of the British Oak. The cups, known as Valonia, used for tanning and dyeing; the unripe acorns as Camata or Camatena, for the same purpose. The wood is capital for furniture.

Quercus alba, L.

The White or Quebec Oak. A most valuable timber tree, 100 feet high; diameter of stem, 7 feet. Wood in use by ship-builders, wheelwrights, coopers and other artisans.

Quercus annulata, Smith.

A large Oak of Nepal, which provides a very, good timber.

Quercus aquatica, Walter.

North America. Height of tree 60 feet; it furnishes a superior bark for tanning, also wood for ship-building.

Qercus Cerris, L.

South Europe, of the height of the English Oak, in suitable localities of quick growth. The foliage deciduous, or also evergreen. The wood available for wheelwrights, cabinetmakers, turners, coopers; also for building purposes.

Quercus coccifera, L.

The deciduous Kermes Oak of South Europe; so called from the red dye, furnished by the *Coccus ilicis*, from this Oak. It also supplies tanner's bark. The huge and ancient Abraham's Oak belongs to this species,

Quercus coccinea, Wangenheim.

The Black Oak of North America. Height 100 feet; stem-diameter, 5 feet. Foliage deciduous. The yellow dye, known as Quercitron, comes from this tree. Bark rich in tannic acid,

Quercus cornea, Loureiro.

China. An evergreen tree, 40 feet high. Acorns used for food.

Quercus falcata, Michaux.

North America. Foliage deciduous. Lives in dry sandy ground. A good-sized tree with excellent tanner's bark.

Quercus Ilex, L.

The Holly Oak of South Europe. Height of tree 50 feet. Wood in use for ship-building, bark for tanning. From varieties of this tree are obtained the sweet and nourishing Ballota and Chesnut acorns.

Quercus Incana, Roxb.

A Himalayan timber tree of great dimensions, beautiful, evergreen.

Quercus infeetoria, Oliv.

Only a small tree, with deciduous foliage. Chiefly from this tree the galls of commerce are obtained.

Quercus lancifolia, Roxb.

A tall timber tree of the Himalayas. Wood valued for its durability.

Quercus macrocarpa, Michx.

The Bur Oak of North America. Tree 70 feet high. The timber nearly as good as that of the White Oak.

Quercus palustris, Du Roi.

The Marsh Oak of North America. Height 80 feet; of quick growth The wood, though not fine-grained, is strong and tough.

Quercus Prinus, L.

The North American Swamp Oak. A tree, 90 feet high, available for wet localities. Foliage deciduous. Wood strong and elastic, of fine grain. A red dye is produced from the bark.

Quercus Robur, L.

The British Oak, extending through a great part of Europe and Western Asia, attaining a great age and an enormous size. Extreme height 120 feet. Two varieties are distinguished:—1. *Quercus sessilflora*, Salisbury. The Durmast Oak, with a darker, heavier timber, more elastic, less fissile. This tree is also the quickest of the two in growth, and lives on poorer soil. Its bark is also richer in medicinal, dyeing and tanning principles. 2.

Quercus pedunculata, Willd. This variety supplies most of the oak-timber in Britain for ship-building, and is the best for bending under steam. It is also preferred for joiner's work.

Quercus rubra, L.

The Red Oak of North America. Height 100 feet; diameter of stem 4 feet. The wood is not of value; but the bark is rich in tanin. Autumnal tint of foliage beautifully red.

Quercus semecarpifolia, Smith.

In the Himalayas. Height of tree often 100 feet; girth of stem 18 feet. It furnishes a first-class timber;

Quercus serrata, Thunberg.

One of the 23 known Japan Oaks. It yields the best food for the oak silkworm (*Bombyx Yamamai*.)

Quercus Sideroxylon, Humboldt.

Mountains of Mexico, at 8,000 feet elevation. An Oak of great size, of compact timber, almost imperishable in water. *Q. lanceolata, Q. chrysophylla, Q. reticulata, Q. laurina, Q. obtusata, Q. glaucescens, Q. Xalapensis (Humb.) and Q. acutifolia* (Nee), are among the many other highly important timber Oaks of the cooler regions of Mexico.

Quercus squamata, Roxburgh.

One of the tallest of the Himalayan Oaks. Wood lasting,

Quercus Suber, L.

The Cork Oak of South Europe and North Africa; evergreen. It attains an age of fully 200 years. After about 20 years it can be stripped of its bark every or 7 years; but the best cork is obtained from trees over 40 years old, Height of tree about 40 feet, Acorns of a sweetish taste,

Quercus Sundaica, Blume.

One of the oaks from the mountains of Java, where several other valuable timber oaks exist.

Quercus Toza, Bosc.

South Europe. One of the handsomest oaks, and one of the quickest of growth. Foliage evergreen.

Quercus virens, L.

The Live Oak of North America, evergreen, 50 feet high. Supplies a most valuable timber for shipbuilding; it is heavy, compact, finegrained; it is moreover the strongest and most durable of all American Oaks. Like *Q. obtusiloba*, Michaux., it lives also on seashores, helping to bind the sand, but it is then not of tall stature. Of many of the 300 Oaks of both the Western and Eastern portion of the Northern hemisphere, the properties remained unrecorded and perhaps unexamined; but it would be important to introduce as many kinds as possible for local test-growth. The acorns, when packed in dry moss, retain their vitality for some months. The species with deciduous foliage are not desirable for massive ornamental planting, because in this clime they shed their dead leaves tardily during the very time of our greatest verdure.

Rhus vernicifera, Cand.

Extends from Nepal to Japan. It forms a tree of fair size, and yields the Japan varnish.

Rhus succedanea, L.

The Japan Wax tree, the produce of which has found its way into the English market. The Sumach (*Rhus coriaria*, L.), and the Scotino (*Rhus Cotinus*, L.), both important for superior tanning and for dyeing, thrive here quite as well as in South Europe. They are more of shrubby growth.

Robinia Pseudacacia, L.

The North American Locust Acacia. Height to 90 feet. The strong hard and durable wood is for a variety of purposes in use, and particularly eligible for tree nails. The roots are poisonous. The allied Robinia viscosa attains a height of 40 feet.

Sassafras officinale, Hayne.

The deciduous Sassafras tree, indigenous from Canada to Florida, in dry open woods. Height 50 feet; leaves lobed; wood and bark medicinal, and used for the distillation of Sassafras oil.

Sophora Japonica, L.

A tree of China and Japan, resembling the Laburnum, up to 60 feet high; wood hard and compact, valued for turner's work. All parts of the plant purgative; the flowers rich in a yellow dye.

Salix alba, L.

The Huntingdon or Silky Willow of Europe and Middle Asia. Height 80 feet, circumference of stem 20 feet; wood light and elastic, available for carpenter s work and implements, bark for tanning. The golden Osier (*Salix vitellina*, L.), is a variety. The shoots are used for hoops and wickerwork.

Salix Babylonica. Tournefort.

The Weeping Willow, indigenous from West Asia as far as Japan. Important for consolidating river banks.

Salix caprea, L.

The British Sallow or Hedge Willow; grows also to a tree; wood useful for handles and other implements, bark for tanning. It is the earliest flowering willow.

Salix cordata, Muehlenb.

One of the Osiers of North America.

Salix daphnoides, Villars.

Middle Europe and Northern Asia, as far as the Amoor. A tree of remarkable rapidity of growth, 12 feet in four years.

Salix fragilis, L.

The Crack Willow. Height 90 feet, stem to 20 feet in girth. A variety of this species is the Bedford Willow, *Salix Russelliana*, Smith, which yields a light elastic tough timber, more tannin in its bark than oak, and more salicine (a substitute for quinine) than most congeners.

Salix lanceolata, Smith.

One of the Basket Willows, cultivated in Britain.

Salix lucida, Muehlenb.

One of the Osiers of North America.

Salix purpurea, L.

Of wide range in Europe and West Asia. One of the Osiers.

Salix rubra, Hudson.

Throughout Europe, also in West Asia and North Africa; is much chosen for Osier beds. When cut down, it will make shoots 8 feet long in a season.

Salix triandra, L.(*S. amygdalina*, L.)

The Almond Willow, through nearly all Europe and extratropical Asia. Height of tree 30 feet. Shoots 9 feet long, for hoops and white basket work, being pliant and durable.

Salix viminalis, L.

The common Osier of Europe and North Asia, attains the height of 30 feet. One of the best for wicker-work and hoops; when cut it shoots up to a length of 12 feet. It would lead too far to enumerate even the more important willows all on this occasion. Professor Andersson, of Stockholm, admits 158 species. Besides these, numerous hybrids exist. Many of the taller of these willows could here be grown to advantage.

Tilia Americana, L.

The Basswood tree or North American Linden tree, growing to 52° North Latitude. Height of tree 80 feet, diameter of stem 4 feet; wood pale and soft. *Tilia heterophylla*, Vent., the Silver Lime of North America, and Tilia Manchurica, Rupr., of South Siberia might be tested.

Tilia Europæa, L.

The common Lime of Europe, extending naturally to Japan, the large leaved variety of South European origin. Height up to 120 feet, exceptionally 50 feet in girth. The wood pale, soft and close-grained, sought for turnery and carving; the bast excellent for mats.

Ulmus alata, Michx.

The Whahoo Elm of North America. Height of tree 30 feet; wood fine-grained,

Ulmus Americana, L.

The White Elm of North America, a tree fond of moist river banks, 100 feet high; trunk 60 feet, 5 feet in diameter.

Ulmus campestris, L.

The ordinary Elm, indigenous to South Europe and temperate Asia, as far East as Japan. Several marked varieties, such as the Cork Elm and Wych Elm, exist. The Elm in attaining an age of several centuries becomes finally of enormous size. The wood is tough, hard, fine-grained and remarkably durable, if constantly under water; next to the Yew, it is the best of European woods, where great elasticity is required, as for archery bows. It is also used for keels, blocks and wheels. Bast tough.

Ulmus Floridana, Chapman.

The West Florida Elm, 40 feet high.

Ulmus fulva, Michx.

The Slippery or Red Elm of North America, 60 feet high; wood red, tenacious.

Ulmus racemosa, Thomas.

The Cork Elm of North America.

For fuller information on trees, long known, refer to Loudon's Classic "Arboretum;" also for many further details to Lindley's Treasury of Botany, to Asa Gray's Manual, to Nuttall's North American Sylva, to Lawson's Pinetum and many local works; also to the volumes of the Exhibitions of 1862 and 1867.

The trees marked with an asterisk should receive prominent attention in Victorian woodculture. The dimensions given are the greatest, of which the writer could trace reliable records.

Reprinted from the Annual Report of the Victorian Acclimation Society, 1870-1871.

Stillwell and Knight, Printers, Collins Street East, Melbourne,

Intercolonial Exhibition of 1866-1867. Report on Vegetable Products. Crest

By Dr. Ferd. Mueller, F.R.S.

Blundell & Co., Printers Melbourne 51 & 53 Flinders Lane West. MDCCCLXVII

Jurors' Report on the Vegetable Products in the Intercolonial Exhibition of 1866.

Introductory Notes to the Victorian Collection of Timber at the Intercolonial Exhibition.

THIS series of wood samples was brought together on behalf of the Royal Commission. It comprises representatives of barely one-half of the timber trees known to exist within the limits of the Victorian colonial area; but, inasmuch as the localities richest in the diversity of their trees are also the least accessible; as, moreover, but in few places the timber is obtainable at frequented shipping ports, and as but very slender means were available for bringing together a display of all our timber, the collection is now less extensive than that formed in 1861 for the London Exhibition. Nevertheless, it comprises nearly all the leading kinds of wood, which have attracted hitherto more or less commercial attention, and displays—at least in some samples—the huge dimensions of many of our trees, broad planks of blackwood, evergreen beech, red gumtree, and a few other kinds of eucalypts, having been secured. To demonstrate still more fully the gigantic size of some of our timber trees would have involved means over which I had no command; but a drawing in the Victorian Timber Court will more readily exemplify how, by a moderate outlay, the colossal sizes of our trees could be brought before the eye of the general population. This design demonstrates, in a monumental structure, how the slabs of various sections of the stem and branches could be placed over each other for showing the proportionate dimensions. Thus, for instance, we might have a fair illustration of a tree of *Eucalyptus amygdalina*, ascertained by Mr. D. Boyle to have attained, in the valleys of Dandenong, a height of 420 feet. These trees do not merely exceptionally rise to this amazing height, but, contrarily, very many, in the deep recesses of the mountains, advance to the same magnitude; and this we see repeated in regard to other tall kinds of *Eucalyptus* in other parts of the country. It would appear from measurements hitherto extant as if, even in Tasmania, the sizes of trees fall short of ours, perhaps because of the mean annual heat of the forest ranges in that island being somewhat less than the temperature of our wooded mountains. There is only one instance on record which brings certain of our highest trees in rivalry with those of the other Australian colonies—the instance of a measurement of the *Karri Eucalypt*, on the Warren River, of Western Australia, where Mr. Pemberton Walcott's measurements gave a result of, approximately, 400 feet. It is by no means thus unlikely that Victoria possesses the most elevated trees of the globe, excelling even those so famed for enormous height in California. It would be of the highest interest if actual measurements of these giants of the forest could be obtained wherever they occur; and in Australia they would be of all the more significance, as here the extraordinary dimensions of the trees is not so much the result of very great age but extreme rapidity of growth—a quality which has rendered our trees already so celebrated, and caused their introduction—for fuel, shelter, building purposes, and other intentions—to be effected into many of those countries which bear a clime similar to ours.

It may on this occasion not be out of the scope of reference to draw attention to the very promising quantity of tar, acetic acid and wood spirits obtainable from timbers, either not sufficiently accessible for the operations of sawmills, or (as in the instance of the *Melaleuca ericifolia*, which covers all our swamps) not of sufficient size to be used for building purposes. A series of these tars, &c., prepared under my direction by Mr. A. Hoffmann, in the laboratory of the Botanic Gardens, from ten of our trees, of which nine are very widely prevailing over most others, is placed in the Exhibition, and will become the subject of a special memoir. When viewing our trees, it should also be remembered that not merely for the purposes indicated, but also for obtaining potash, tannic and gallic acid, dye material, volatile oil, and paper material, trees of such vast abundance should find full appreciation. One branch of industry has already sprung up for utilising the latter-mentioned products. I refer to the extensive distillation of oil from Eucalypts and species of *Melaleuca*. This industry was initiated by the distillation of about thirty species of oils for the last London and Victorian Exhibition. It was undertaken at my request, and from material selected by myself, chiefly by Mr. Joseph Bosisto, the present Mayor of Richmond, who, with a most praiseworthy spirit of enterprise, when thus becoming aware of the great yield of oils, gave to this branch of industry commercial dimensions. This use of our native trees might be advantageously followed up in other directions, and for other purposes, for the benefit of unprovided families, and for the lucrative employment of capital.

The main number of the wood specimens were secured by the Royal Commission through a few special emissaries; but some valuable additions were made by the contribution of Wimmera timber through Samuel Wilson, Esq.; Gippsland woods from near Port Albert, by Mr. Commissioner Tyers; Murray timber, by Allan Hughan, Esq., and Peter Beveridge, Esq.; Mount Macedon timber, by J. Snowball, Esq.; and Berwick timber, by G. W. Robinson, Esq. These contributions have added more to the specimens than to the species, and are interesting for comparing the same wood from various—occasionally even geologically different—localities. In adopting a nomenclature for the woods it is difficult, without new inventions, to assign to them other than strictly scientific names; it would, indeed, be a great gain if the present colonial names, on account of their ambiguity or their want of logical meaning, or their absolute incorrectness, could be entirely discarded, and new names, based on the well-fixed appellations by which they are now fully known in the scientific world, could be substituted. It is my intention to elaborate this subject in detail. A convenient method to demonstrate within narrow space the qualities of wood, both scientifically and technologically, was adopted by the writer at the last Exhibition, in preparing the specimens as small boxes in book-form, the back-title giving the systematic name and native country of each special tree. According to this design a fine collection of wood-books (if we may term them so) was caused to be prepared by Colonel Champ, and it could be wished that for our future Industrial Museum every kind of wood, at least of Australia, might be secured in this form for the sake of easy access and comparison. Planed and polished surfaces are thus readily and elegantly shown, while the cavity of the imitation book serves for placing in it samples of such products as the particular tree may yield.

Victorian Timber Exhibited by the Commissioners of the Intercolonial Exhibition.

Notes on the size and distribution of these trees within the territory of Victoria, by Ferd. Mueller, M.D., F.R.S.

Atherosperma Moschatum: Labillardiere—*The Sassafras Tree*.—In deep, wet, forest ravines. A middle-sized tree.

Hedycarya Cunningliami: Tulasne—*Native Mulberry Tree*.—Extends through the whole southern fern-tree country, where it forms a middle-sized tree.

Eupomatia Laurina: R. Brown.—Occurring only in the most eastern part of Gippsland, where the tree attains a height of 40 feet.

Pittosporum Undulatum: Ventenat.—In the humid forest glens from Western Port and Dandenong, eastward throughout Gippsland. Attains in favourable localities a diameter of 2 feet.

Pittosporum Bicolor: Hooker.—In the fern-tree gullies; also in the beech-regions. A small, and occasionally a middle-sized tree.

Codonocarpus Cotinifolius: Ferd. Mueller—*The Radish Tree*.—In the Mallee scrub rather sparingly. Attains a height of 30 feet.

Busbeckia Mitchelli: Ferd. Mueller—*The Caper Tree*.—A small tree, very rare in the Mallee scrub opposite Euston.

Brachychiton Populneum: R. Brown—*The Bottle Tree*.—In more open forest valleys on the Hume River, the Snowy River, and thence to the eastern limits of Gippsland. Height of the tree, up to 60 feet. Wood exceedingly soft.

Acacia Melanoxylon: R. Brown—The *Blackwood Tree*, also by colonists called the *Lightwood Tree*.—On fertile banks and flats of rivers, also on basaltic ridges; not rare in deep forest gullies; attaining a height of 120 feet and a diameter of the stem of 3 to 4 feet.

Acacia Implexa: Bentham.—On open ridges of the lower silurian formation in many parts of the colony, but nowhere common. A middle-sized tree.

Acacia Penninervis: Sieber.—Scattered through the eastern half of the colony over ridges and ranges, gregarious on some of the bushy sub-alpine declivities and plateaux.

Acacia Supporosa: Ferd. Mueller.—Restricted to the east part of Gippsland. A middle-sized tree.

Acacia Verticillata: Willdenow.—In swampy forest valleys common, where it becomes a small tree.

Acacia Salicina: Lindley.—Not unfrequent in the Mallee scrub. The wood dark, heavy, and durable. A small or occasionally middle-sized tree.

Acacia Homalophylla: All. Cunningham—*The Myall*.—In the Mallee scrub on many localities.

Acacia Osswaldi: Ferd. Mueller.—In the Malice scrub not uncommon, always remaining a small tree. The plant is exquisitely adapted for tall hedges.

Acacia Stenophylla: All. Cunningham.—In Victoria restricted to the banks of the Murray and the Lower Wimmera and Avoca. A middle-sized tree.

Acacia Decurrens: Willdenow (*A. Mollissima W*., and *A. Dealbata* Link)—*The Wattle*.—Frequent throughout the colony, except the desert tract. In the ferntree gullies forming a tree 150 feet high.

Eucalyptus Rostrata: Schlechtendal—*The Red Gumtree*.—Along river banks—almost everywhere.

Eucalyptus Leucoxylon: Ferd. Mueller—*The Ironbark Tree*.—On many of our less fertile ridges, usually indicating an auriferous country.

Eucalyptus Melliodora: All. Cunningham.—On low open ridges, particularly of the miocene formation. A middle-sized tree, comprised among those called on some places *Box Trees*, on others *Peppermint Trees*, on some, again, *Yellow Box Trees*.

Eucalyptus Viminalis: Labillardière—*The Manna-Eucalypt*. On grassy ridges; not rare. A middle-sized tree.

Eucalyptus Goniocalyx: Ferd. Mueller—*One of the White Gumtrees*.—A gigantic tree, occurring in nearly all our moist forest ranges, intermixed with other Eucalypts.

Eucalyptus Corymbosa: Smith—*The Bloodwood-Eucalypt*.—In Victoria confined to the eastern part of Gippsland. A rather large tree.

Eucalyptus Longifolia: Link—*The Woollybutt-Eucalypt*.—Restricted in Victoria to the eastern part of Gippsland, forming a tall, stately tree.

Eucalyptus Amygdalina: Labillardière—*One of the Peppermint Trees*.—In forest country of the southern and eastern parts of the colony; in more open places a middle-sized tree, in deep ravines of colossal size. This species may be the tallest of the globe, perhaps only rivalled by the *Wellingtonia gigantea* of California. In the Dandenong Ranges it has been measured repeatedly 420 feet, and towards the sources of the Yarra it is said to attain a still greater height. It is this tree also which yields the largest percentage of oil from the foliage, varying from 2 to 4 per cent, from fresh leaves and branchlets.

Eucalyptus Stuartiana: Ferd. Mueller—*One of the White Gumtrees*.—In moist localities, as well in plains as ranges. A tree of an enormous size in Victoria, perhaps only surpassed by the *Eucalyptus amygdalina* and the *Karri Eucalypt* of West Australia *(E. diversicolor or E. colossea)*.

Eucalyptus Obliqua: L'Heritier—*The Stringybark Tree*.—Constitutes the main mass of the forests in wide extent of our more barren mountains. The height of trees of greatest size ranges from 300 to 400 feet.

Eucalyptus Globulus: Labillardière—*The Blue Gumtree of Victoria and Tasmania* (but not of New South Wales and West Australia).—Restricted to Victoria and Tasmania. The tree is confined to forest valleys, except near the coast, where, usually of diminutive size, it will occupy open saces. In deep declivities it grows to nearly the same colossal size as *I. amgydalina, E. goniocalyx, E. Stuartiana* and *E. obliqua*.

Melaleuca Ericifolia: Smith—The so-called *Tea-tree*, though never used or preparing any beverage.—It fills most of our swamps of brackish, as well as fresh water, and lines also innumerable watercourses. It is never a large tree, but, on the contrary, generally small, though it may be seen accasionally 50 to 60 feet high.

Melaleuca Squarrosa: Smith.—Common in swamps of many southern forest regions, but not often growing to the size of a tree. In favourable situations the stem attains a diameter of two feet.

Leptospermum Laevigatum: Ferd. Mueller.—Everywhere on the sandy coast.—Never a large tree.

Tristania Laurina: R. Brown.—Along the rivers of East Gippsland. But a small tree.

Angophora Intermedia: Candolle.—The spurious Apple-tree of East Gippsland; it advances not farther westward. A fine, umbrageous, middle-sized tree, of fair celerity of growth, well worthy of being adopted as an avenue-tree.

Pomaderris Apetala: Labillardière.—In forest glens and along wooded river banks; not rare in the southern and eastern part of the colony, but never seen away from moist, shady, and sheltered forest valleys.

Senecio Bedfordii: Ferd. Mueller—*The Duke's Tree*.—A small tree, in all fern-tree gullies and in other shady springy glens.

Aster Argophyllus: Labillardière—*The Musk-tree*.—Confined to moist, unbrageous forest gullies, but there abundant. It never exceeds 60 feet in. height, and is generally lower.

Cassinia Aculeata: R. Brown.—In moist, wooded tracts of the colony frequent. Oftener a shrub than a small tree.

Coprosma Microphylla: All. Cunningham.—In forest-swamps and periodically inundated river-banks. Not rare throughout the southern and eastern districts. More generally a shrub than a small tree, but never even a middle-sized tree.

Panax Palmaceus: Ferd. Mueller.—*The Palm-Panax*.—In Victorian territory only to be found, on the south-eastern borders of New South Vales. The slender palm-like stem attains seldom above 1 foot diameter, hough not rarely a height of 80 feet. The wood is singularly light and soft.

Myrsine Variabilis: R. Brown.—In the forest glens and on river banks in the southern and eastern parts of the colony. Generally a small, occasionally a middle-sized tree.

Myoporum Platycarpum: R. Brown—*The Sugar-tree*.—In the Mallee scrub. A small tree, exuding from its bark a saccharine substance.

Santalum Persicarium: Ferd. Mueller—*Native Sandalwood*.—In the Murray desert. A small tree; its wood is far inferior to the filmed sandalwood of commerce.

Santalum Acuminatum: A. De Candolle—*The Native Peach*.—In the Mallee scrub. Always only a small tree.

Exocarpus Cupressiformis: Labillardière—*The native Cherry-Tree.*—Widely distributed over the more fertile open ridges, and through both barren and fertile forest ranges. A small or middle-sized tree, of comparatively quick growth.

Banksia Serrata: Linné—*The Heath Honeysuckle*.—On the sandy heaths of Gippsland rather frequent. A small, or occasionally midde-sized, tree.

Banksia Australis: R. Brown—*The common Native Honeysuckle*.—In less fertile localities all over the colonial territory, ascending to sub-alpine elevations. A small, or middle-sized tree.

Lomatia Fraserii: B. Brown.—In forest valleys, especially among fern trees, not very common, but ascending to high cold elevations along the rivulets. A good-sized tree.

Hakea stricta: Ferd. Mueller—*The Water-tree*.—In the Mallee desert A small tree, water obtainable from the root.

Casuarina Quadrivalvis: Ventenat—*The Drooping Sheoak*.—Frequent in grass lands of plains and hills, and along the sandy coast. A quick-growing, middle-sized tree.

Casuarina Leptoclada: Miquel—*The Straight Sheoak*.—On grassy ridges of the lower as well as higher regions, not rare. A moderate-sized tree.

Casuarina glauca: Sieber—*The Desert Sheoak*.—In the Mallee scrub. A middle-sized tree.

Fagus Cunninghami: Hooker—*The Native Beech*.—In the most secluded recesses of the mountains, from Dandenong to Mount Baw-Baw, on the various remote sources of the Latrobe river, at Wilson's Promontory, and in the Cape Otway ranges. A magnificent tree, attaining a height of 200 feet. On the Mount Baw-Baw ranges this beech mainly constitutes for many miles the forest. It exists only in Victoria and Tasmania.

Callitris Verrucosa: It. Brown—*The Desert Cypress Pine*.—More or less copiously dispersed through the Mallee scrub, in some directions abundant. A middle-sized tree.

Callitris Cupressiformis: Ventenat—*The Mountain Cypress-Pine*.—On rocky, not densely timbered ranges; thus, on the Grampians, the Ovens ranges, and the Genoa ranges. A middle-sized tree.

Remarks on Timber from east Gippsland, by Lockhart Morton, Esq.

Eucalyptus Longifolia: Link—*Woollybutt*.—This seems an excellent timber. It is like ironbark, much used for wheel spokes. It bears a high character for durability when used for fencing purposes. As posts, it is said to stand undecayed in the ground for twenty years. The bark is fibrous. This wood is esteemed an excellent fuel.

Brachychiton Populneum: R. Brown—*Currijong*.—This is a soft timber. When dry, it is soft and spongy. The wood is fibrous, and the young wood immediately below the bark is sweet, juicy, and, I believe, nutritious. The bark is thick, and abounds with strong, coarse fibre.

Eucalyptus Corymbosa: Smith—*Bloodwood*.—The value of this timber is not known, except as an excellent fuel. It is not an easily split timber, and the number of resin-veins throughout it is much against its being used. It is said to be very durable when used in fencing. The bark is almost void of fibre.

Angophora Intermedia: Candolle—*Spurious Apple-tree*.—This wood is but little used, except as fuel; for this purpose it is considered very good. It is said to be used for naves by wheelwrights. The bark contains but little fibre.

Banksia Serrata: L.—This timber is soft, and short in the grain; it is high-coloured, and singularly marked. The bark is very thick, and seems to contain much tannin, as well as a reddish-purple dye. I have seen moleskin trousers which had been tanned and dyed with this and wattle-bark; the colour was a rich dark purple.

Acacia Supporosa: F. Mueller—*Native Hickory*.—This I consider a valuable wood for many purposes. It is exceedingly tough and elastic; would make good gig-shafts, handles for tools, gun-stocks, &c., and seems to contain some inflammable material. Tall straight spars, fit for masts, can be obtained from 50 to 100 feet long and 18 inches in diameter.

Panax Palmaceus: Ferd. Mueller—This timber is soft and very light, floating even when unseasoned half out of water. The wood is white, and has a large pith. The trees are generally from fifteen to eighteen inches in diameter at the butt, and rise with a clear straight stem to the height of fifty or sixty feet; then throw out branches at right angles, adorned at their extremities with a dense mass of foliage.

Exocarpus Cupressiformis: Labill.—*Native Cherrytree*.—This is a soft fine-grained timber, and is the best wood I know for carving.

Names of Different Woods, &c., Used by the Yarra Natives for Weapons and Implements.

Ascertained by C. Walter, the Material identified by Dr. Mueller, F.R.S.

BINNAP (Manna Gumtree, *Eucalyptus viminalis*—Labill.), for Geeaus (flat shields).

BALLEE (Cherrytree, *Exocarpus cupressiformis*—Labill.), for Gurrecks (spear-throwers).

BURGAN (Mountain Teatree, *Kunzea peduncularis*—Ferd. Mueller), for Goyjums (kangaroo spears), Breapang or Warra-Warras (fighting sticks with bead ends), Gudjerons (waddies or clubs), Wankins (fighting boomerangs).

DARGOYNE (Messmate, *Eucalyptus)*, for Goyjums (spears).

DJELWUCK *(Hedycarya Cunninghamii*—Tulasne), for Spear Ends and Fire-sticks (native fire kindler).

KARAWUN (*Xerotes longifolia*—R. Brown), for Baskets.

BOWAT *(Poa Avstralis*—R. Brown), for Net Bags (ballang cowat).

MOOEYANG (Blackwood, *Acacia melanoxylon*—R. Brown), for Mulgar or Club Shields.

WOOLIP (Light Tea-tree Shrub, *Leptospermum lanigerum*—Aiton), for Goyiums (kangaroo spears).

WAYETUCK (She-oak, *Casuarina leptoclada*—Miquel), for Boomerangs.

WOOEGOOK, or WANGNARRA (Stringybark-tree, *Eucalyptus obliqua*—L'Heritier), the fibre of which is used for strings on Baskets, Spears, &c.

JARK (Gum, from any portion of *Acacia mollissima*—Willdenow), which is used for fixing the bottom ends of the Spears and taken from a small wattle-tree (*Acacia*) in the Loddon district.

GARRONG (Wattle-tree, *Acacia mollismna*—Willdenow), for Mulgas (club shields), Boomerangs, and Spears.

MYALL (*Acacia homalophylla*—A. Cunningham).

MALLEE *(Eucalyptus gracilis*—Ferd. Mueller).

TARNOCK (drinking vessel), and also a model of a Coorong (canoe), bark of *Eucalyptus viminalis*—Labill.

EASIP (Spurious Ironbarktree, *Eucalyptus leucoxylon*—Ferd. Mueller).

BAGGUP (*Xanthorrhœa Australis*—R. Brown).—The peduncle is used for the lower portions of Spears.

Notes on some of the Timber Specimens from New South Wales.

By Charles Moore, Esq., F.L.S., Director of the Botanic Gardens, Sydney.

1. *Trochocarpa Laurina:* R. Br.—A small-sized tree, plentiful in all the cedar brushes from Brisbane Water to the Tweed River.

2. *Weinmannia Paniculosa:* Ferd. Mueller.—A tree of moderate size, found in all the thick brushes on the eastern coast of N. S. Wales from the Manning to the Tweed rivers.

3. *Sloanea Australis:* Ferd. Mueller.—A large tree, frequently attaining a height of 200 feet, with a clear trunk of 50 feet and a diameter of 3 to 4 feet, plentiful at Camden Haven and on the Richmond River. Specimen of wood cut from a branch.

7. *Atherosperma Micranthum:* Tulasne—*Brush Box*.—A tree of small size, very plentiful on the Manning and Hastings rivers.

8. *Tarrietia Argyrodendron:* Bentham.—A tree attaining a large size, frequently with a clear straight trunk of 70 feet, with a diameter of from 3 to 4 feet, called stonewood by the colonists; found in abundance on all the rivers on the east coast of New South Wales from the Manning to the Tweed rivers.

10. *Geissois Benthamii:* Ferd. Mueller.—A tree of large size, frequently attaining a height of 200 feet, with a clear trunk of 60 feet, and a diameter of 1½ to 2 feet. This specimen was cut 30 feet from the base.

12. *Schizomeria Ovata:* Don.—A tree of large size, found in all the thick brushes on the east coast of New South Wales from the Manning to the Richmond rivers.

13. *Orites Excelsa:* R. Br.—A moderate-sized tree, found on all the rivers on the east coast of New South Wales.

14. *Pennantia Cunninghamii:* Miers.—A moderate-sized tree, found in the thick brushes on the Manning and Hastings rivers.

19. *Helieia Glabriflora:* Ferd. Mueller.—Small tree, found in the mountain brushes on the Hastings River.

20. *Anopterus Macleayana:* Ferd. Mueller.—A small-sized tree, with large and handsome foliage, plentiful at Port Macquarie, and found in many other places in thick brushes on the east coast of New South Wales.

21. *Cargillia Pentamera:* Woolls and Mueller.—A moderate-sized tree, plentiful in the mountain brushes on the Hastings River, where it is called *black myrtle*. This name is also applied to another species of Cargillia by the settlers on the Clarence River.

22. *Stenocarpus Salignus*: R Brown—*Port Macquarie Silky Oak*.—Found in all the thick brushes on the east coast of Australia. Timber much used by coopers.

23. *Litsaea Dealbata:* Nees.—A tree of moderate size, found in abundance near Port Macquarie, and in many of the thick brushes on the Hastings and M'Leay rivers.

24. *Syncarpia Leptopetala:* Ferd. Mueller.—A tree of moderate size, very plentiful in some of the thick brushes on the Hastings River. Wood very hard when fresh, but not much used.

25. *Callitris Macleayana:* Ferd. Mueller—*Port Macquarie Pine*.—A small-sized tree, found near Port Macquarie, where it is much used for shingles.

28. *Castanospermum Australe:* A. Cunningham—*Moreton Bay Chesnut, or Bean-Tree*.—A tree of very large size, and found in abundance in the brushes from the M'Leay River to Cape York.

29. *Helicia Ternifolia:* Ferd. Mueller.—A small-sized tree, found in the thick brushes on the Richmond and Tweed rivers, where it is called by the colonists *Nut Tree*

The seeds are edible, according to Walt. Hill, Esq. They resemble those of the Chilian Guevina.

30. *Dysoxylon Rufum:* Benth.—*Rosewood* of the Colonists.—A tree of large size, found on all the rivers of the coast of New South Wales. Used for making furniture.

31. *Stenocarpus Sinuosus:* Endlicher.—This is a very handsome tree, of moderate size, plentiful in the thick brushes on the Richmond and Tweed rivers.

32. *Elaeocarpus Grandis:* Ferd. Mueller.—A tree attaining a very large size, found in the thick brashes on all the rivers north of the Clarence, on the east coast of New South Wales.

33. *Akania Hillii:* J. Hooker.—A handsome tree of small size, found in the thick brushes on all the rivers on the east coast of New South Wales, from the Manning to the Tweed rivers.

34. *Helicia Praealta:* Ferd. Mueller.—A moderate-sized tree, found in the thick brushes on the Clarence and Richmond rivers. Wood used by coopers.

35. *Cedrela Taona:* Roxburgh—*Red Cedar* of the Colonists.—Found in all brush forests on the coast of New South Wales, on the Richmond, Bellinger, and Tweed rivers. This wood is yet obtainable in considerable quantity, but will soon become a scarce article, as it is not to be procured of any size from other localities than those indicated.

36. *Grevillea Robusta:* A. Cunningham—*Silky Oak* of the colonists.—This tree attains a considerable size, and is found in the brushes on the east coast of Australia, from the Clarence River to Cape York. Wood used by coopers, wherever it can be obtained.

37. *Cinnamomum Camphora:* F. Nees—*Camphor-Tree*.—Grown in the Botanic Gardens, Sydney.

39. *Rhus Rhodanthema:* Ferd. Mueller—*Light Yellow Wood*.—A tree attaining a considerable size in the brush forests on the Richmond River. Timber sometimes used for cabinet-work.

Queensland Timber.

Introductory Remarks.

THE species of timber trees of New South Wales far exceed in number those of Victoria, while again those of Queensland surpass considerably the number of the trees of New South Wales. The wood collection formed in Queensland represents but a small share of the species obtainable from the rich vegetation of its wide colonial territory, and the specimens submitted to the jurors are again but a portion of the series originally transmitted; but as of many no duplicates were extant, the withdrawal of a full collection from the Victorian Exhibition for timely shipment to Paris left many species unrepresented; the jurors, therefore, can refer now only to such woods as are left. These consist of two principal collections, one formed by Walter Hill, Esq., on behalf of the Royal Commission of Brisbane, in the vicinity of that city; the other by A. Thozet, Esq., on behalf of the Local Exhibition Committee of Rock-hampton. The one collection presents, therefore, the southern species, the other the more northern kinds of woods. Some specimens of timber not occurring at either place have been contributed by Dr. Mueller, and these represent trees from Cooper's Creek and the Paroo, and others from the vicinity of Rockingham's Bay, in the far north. The collection is phyto-graphically named, with the exception of a small share of specimens of which no corresponding objects for botanical reference were available. The majority of woods represent jungle plants, and they are all in a certain measure indicative of the climate of the corresponding districts. They are, in the majority of cases, allied to those of trees which we are accustomed to see in the moist tropical jungles of India. These trees, while so manifold in variety, can thus likewise be applied to purposes equally manifold; but they are generally not so gregarious as many of our southern timber-trees. In the jungle, none ever predominantly constitutes the main bulk of the forest; and what in the more northern part of Australia is gained by the superb magnificence and extraordinary diversity of the trees, is recompensed in the south by the extreme copiousness of few species. Yet these also can be drawn into very many important uses, and by their vast preponderance afford great facilities for supplying material to factories on a most extensive scale. This observation to a certain extent holds good also to the open, and especially more interior parts of East Australia (whether Queensland or New South Wales), where from the rises of the coast ranges, westward chiefly, a monotony of tree-vegetation of eucalyptus, and in lesser degree of acacia, re-occurs. Many of the East Australian jungle-trees have been only of late drawn within the precincts of science—some even only on this occasion. On systematically scientific names sole reliance has therefore been placed; and it is to be hoped that, should ever special vernacular names be bestowed on these woods, the selection of appellations will be made with such care as will guard against any further extension of that ambiguity and confusion which renders true discrimination of the various Australian woods already, in most instances, by popular language an impossibility.

Notes on Some of the Wood Specimens from Southern Queensland.

By Walter Hill, Esq., Director of the Botanical Gardens, Brisbane.

13. *Flindersia Schottiana:* F. Mueller.—Stem 12 to 16 inches diameter; 60 to 70 feet high. This species

occurs plentifully in the scrub near the coast. It is of slender growth. The wood is soft, and soon perishes when exposed.

45. *Owenia venosa:* F. Mueller.—*Sour Plum;* 8 to 12 inches diameter; 20 to 30 feet high. A fine shady tree, common in scrubs. The wood is hard, of a reddish colour, and its great strength renders it fit for wheelwright work.

82. *Melia Azedarach L.; White Cedar*.—24 to 30 inches diameter; 40 to 60 feet high. A nice deciduous tree. The wood is soft, and not considered of any value.

153. *Spondias pleiogyna:* F. Mueller.—*Sweet Plum;* 20 to 45 inches diameter; 70 to 100 feet high. A beautiful tree, having a cylindrical erect trunk, growing sometimes 80 feet in height without branches. It has a rich dark glossy green pinnate foliage, and the wood is hard and heavy, dark red, finely marked, and susceptible of a high polish.

48. *Harpullia pendula:* Planch.—*Tulipwood;* 14 to 24 inches diameter; 50 to 80 feet high. A beautiful growing tree, with glossy green pinnate leaves; found in great abundance on the banks of rivers. The wood has a firm fine texture, and is curiously veined in colouring. It is much esteemed for cabinetwork.

97. *Cupania anacardioides:* A. Rich.—18 to 24 inches diameter; 30 to 50 feet high. A moderate-sized tree, but the wood is not appreciated.

103. *Cupania nervosa:* F. Mueller.—12 to 20 inches diameter; 30 to 45 feet high. The wood of this tree is nicely grained.

79. *Bursaria spinosa:* Cavan.—6 to 9 inches diameter; 20 to 30 feet high. A slender tree, growing in the borders of scrubs, some distance from the sea. The timber is hard, of a close texture, and admits of a good polish.

125. *Bursaria spinosa:* Cavan.—6 to 9 inches diameter; 20to 30 feet high. The grain is white and close.

30. *Acacia pendula:* A. Cunn.—*Weeping Myall;* 6 to 12 inches diameter; 20 to 30 feet high. A graceful tree, small, with pendant foliage. The wood is hard, possessing a close texture, and a rich dark colour. From Mr. Coxen, in the neighbourhood of Dalby.

91. *Barklya syringifolia:* Ferd. Mueller.—12 to 15 inches diameter; 40 to 50 feet high. This is a most beautiful tree, with dense bright-green glossy foliage. It is common; the wood hard and close-grained.

112. *Erythrina vespertilio:* Benth.—*Cork-tree;* 12 to 25 inches diameter; 30 to 40 feet high. A beautiful tree when in flower. The wood is soft, and is used by the aborigines for making war-shields.

146. *Bauhinia Hookeri:* Ferd. Mueller.—10 to 20 inches diameter; 30 to 40 feet high. An ornamental spreading tree, with pale-green rich foliage. The wood is heavy, and of a dark reddish hue. Presented by H. Miller, Esq.

73. *Backhousia citriodora:* Ferd. Mueller.—9 to 12 inches diameter; 18 to 20 feet high.

43. *Phyllanthus Ferdinandi:* J. Mueller.—12 to 24 inches diameter; 50 to 60 feet high. A beautiful tree; common on the banks of creeks and rivers.

47. *Excœcaria Agallocha, L.—Poison Tree;* 12 to 14 inches diameter; 40 to 50 feet high. A slender tree, resembling some of the Fig species in appearance of the foliage. It is frequently met with in the scrub. The wood is hard, and fine grained. The juice is white and nauseous; a single drop falling into the eye will injure the sight.

49. *Sarcocephalus cordatus Miq.—Leichhardt's Tree;* 24 to 36 inches diameter; 60 to 80 feet high. A splendid erect shady tree, with dark-green broad foliage. The wood is soft, but close grained, of a light colour, and easily worked.

21. *Eremophila Mitchelli:* Benth.—*Sandal Wood;* 9 to 12 inches diameter; 20 to 30 feet high.—The wood is very hard, beautifully grained, and very fragrant. It will turn out handsome veneers for the cabinetmaker. From Mr. C. Coxen, in the neighbourhood of Dalby.

78. *Maba obovata: R. Br*.—10 to 15 inches diameter; 30 to 50 feet high. A small tree, frequently to be seen in the Rosewood scrubs. The timber is hard, fine grained, and likely to be useful for cabinet work.

129. *Cargillia Australis: R. Br*.—18 to 24 inches diameter; 60 to 80 feet high. A slender-growing tree, with elongated trunk, and elegant rigid foliage. The grain is close, very tough and fine, of little beauty, but likely to be useful for many purposes.

5. *Podocarpus elata: R. Br.—A Pine;* 24 to 36 inches diameter; 50 to 80 feet high. A very beautiful tree, with elongated cylindrical trunk. It occurs very frequently in the scrubs along the coast. The wood is hard, fine-grained, flexible, and elastic.

15. *Stenocarpus sinuosus:* Endlicher—*Tulip Tree*, 18 to 24 inches diameter, 40 to 60 feet high. This is a most beautiful tree, on account of its clean growth and large pinnatified foliage. It occurs often in the scrubs some distance from the coast. This wood is very nicely marked, and would admit of a good polish.

18. *Exocarpvs latifolia: R. Br.—Broad-leaved Cherry*, 6 to 9 inches diameter, 10 to 16 feet high. A

beautiful small tree, with scaly black-coloured bark. The wood very hard and fragrant. Excellent for cabinet work.

26. *Morus calcar Galli:* A. Cunn.—*Cockspur Thorn,* 3 to 4 inches diameter, 20 to 80 feet high. A rambling thorny shrub. Duramen dark yellow colour, hard, and used in dyeing yellow and brown.

NOTE.—A public record of acknowledgment is due to Messrs. Anderson and Wright for having caused the Victorian timber to be cut gratuitously into the required sizes for the Exhibition.

Brief Notes on the Geographical Distribution of the Trees, of Which Timber is Extant in the South and North Queensland Division of the Intercolonial Exhibition.

By Ferd. Mueller, M.D., F.R.S.

[The matter which is printed in smaller type emanated from A. Thozet, Esq., the gentleman who so carefully collected the timber at Rockhampton.]

1. *Polyalthia Nitidissima:* Benth.—A rather gigantic tree, when considered as representative of the order of *Anoneæ*. It ranges through the whole of the littoral forest tract of Queensland.

1. *Polyalthia Nitidissima:* Benth.—*A nonaceæ* (Aboriginal name, Pankalville).—4 to 10 inches in diameter; 30 to 60 feet high. Trunk erect, graceful; pyramidal head; leaves shining; wood white, soft, and pliable; found in scrubs and beds of creeks.

2. *Bursaria Spinosa:* Cavanilles.—Dispersed over nearly the whole Australian continent; common also in Tasmania.

3. *Pittosporum Rhombifolium:* All. Cunningham.—In the coast forests of the northern part of New South Wales and the southern part of Queensland.

21. *Pittosporum Rhombifolium:* All. Cunningham—*Pittosporaceæ*—6 to 12; 50 to 80. A very erect scrub tree; bark whitish and smooth; the wood of a uniform white colour; when fresh cut emits a very agreeable delicate odour, not unlike mignonette.

4. *Pittosporum Ovatifolium:* Ferd. Mueller.—A tree of fair size, ranging from the extreme north of Queensland considerably southward.

20. *Pittosporum Ovatifolium:* Ferd. Mueller—*Pittosporaceæ* (Konawareu).—4 to 8; 20 to 35. A small tree, met with on creeks and occasionally in scrubs; flowers fragrant.

5. *Citriobatus Megacarpus:* Ferd. Mueller.—Never a large, occasionally a small tree, but usually a shrub. In many of the Brigalow scrubs of Queensland.

19. *Citriobatus Pauciflorue:* All. Cunningham—*Pittosporaceæ* (Karry).—4 to 8; 6 to 15. An ornamental, prickly shrub, of a spherical growth, and white fragrant flowers; trunk short; wood hard and tough; takes a good polish. Will answer admirably in a garden for edgings of borders.

6. *Scolopia Brownii:* Ferd. Mueller.—Dispersed through the whole moist littoral forest tract of New South Wales and Queensland.

7. *Busbeckia Mitchellii:* Ferd. Mueller.—In the Brigalow scrubs, and also in some of the desert tracks of South Australia, Victoria, New South Wales, Queensland, and North Australia.

8. *Flindersia Schottiana:* Ferd. Mueller.—This tree extends from the northern parts of New South Wales to the vicinity of Rockingham Bay. It is confined to forest gullies.

9. *Owenia Acidula:* Ferd. Mueller.—In the Brigalow scrubs of Queensland and New South Wales.

10. *Owenia Venosa:* Ferd. Mueller.—In the more open forest regions of Queensland.

15. *Owenia Venosa:* Ferd. Mueller—*Mdiaceæ; Sour Plum* (Pyddharr).—12 to 25; 50 to 70. A fine shady tree with pinnated leaves, on winged petioles; wood hard, of a rose colour. Its great strength renders it fit for wheelwrights' work.

11. *Melia Azedarach:* Linne.—A small tree, ranging never very far away from the coast through North Australia, Queensland, and the northern parts of New South Wales.

17. *Melia Azedarach:* Willd.—*Meliaceæ; White Cedar*.—12 to 16; 30 to 70. This tree is very handsome when in flower; wood soft, sometimes used for staves.

12. *Spondias Pleiogyna:* Ferd. Mueller.—In the less dense forests of Queensland, towards the coast.

14. *SpondiasPleiogyna:* Ferd. Mueller—*Meliaceæ; Sweet Plum* (Orey Rancooran).—A beautiful tree, having a cylindrical, erect trunk, growing sometimes 80 feet in height, without branches; fine dark green glossy foliage; wood hard and heavy, of a dark red-brown colour, finely marked; takes a very high polish.

13. *Xanthoxylon Brachyacanthum:* Ferd. Mueller.—In most of the jungles of Queensland and of the northern parts of New South Wales.

25. *Xanthoxylon Brachyacanthum:* Ferd. Mueller—*Butaceæ* (Merrivi).—3 to 8; 30 to 80. A tall, slender,

prickly tree; wood close-grained, bright yellow, nicely marked. Will answer for veneering.

14. *Ailantus Imberbiflora:* Ferd Mueller.—Queensland, about the tropic of Capricorn, towards the coast.

26. *Ailantus Imberbiflora:* Ferd. Mueller—*Simarubuæ*.—A large, noble, cylindrical, erect tree, branchy towards the top; flowers fragrant in racemes; would be very ornamental in a plantation. From wounds made in the bark a resinous substance exudes, which burns with a brilliant flame. Found in dense scrubs. Wood light, soft, and appears to be of little durability.

15. *Geijera Salicifolia:* Schott.—In more or less open forests as well of Queensland as of New South Wales.

23. *Geijera Salicifolia:* Schott—*Butaceæ* (Koko).—4 to 12; 20 to 35. Found growing at the edge of scrubs, on poor sandy soil; bark almost smooth.

16. *Acronychia Laevis:* Forster.—In the moist forests from East Gippsland through New South Wales and Queensland, to the north coast.

16*b*. *Pagetia Medicinalis*: Ferd. Mueller.—As yet only found in the forests around Rockhampton.

17. *Atalaya Hemiglauca:* Ferd. Mueller.—A small tree of the Brigalow scrubs of Queensland and New South Wales.

8. *Atalaya Hemiglauca:* Ferd. Mueller—*Sapindaceæ*.—4 to 12; 15 to 25. Found in open forests, generally on poor soil; wood not durable.

18. *Cupania Anacardioides:* A. Richard.—Widely dispersed through the littoral forest tracts of New South Wales, Queensland, and North Australia.

9. *Cupania Anacardioides:* Richard—*Sapindaceæ*.—6 to 15; 50 to 80. A tree often met with in scrubs; beautiful pinnated leaves.

19. *Cupania Xylocarpa:* All Cunningham.—A tree widely dispersed through the moister forest regions of New South Wales and Queensland.

11. *Cupania Xylocarpa:* A. Cunningham—*Sapindacæ*.—12 to 24; 50 to 70. A scrub tree, with smooth bark, branching high. May prove useful for wheelwrights' work.

20. *Cupania Nervosa:* Ferd. Mueller.—In many of the jungles of New South Wales and Queensland.

10. *Cupania Nervosa:* Ferd. Mueller.—*Sapindaceæ; Spurious Beech*.—6 to 12; 30 to 40. Wood very tough and durable, used for stock-whip handles; growing in groups in open forests, also in scrubs.

21. *Harpullia Pendula:* Planchon.—In many of the denser forests of New South Wales and Queensland.

7. *Harpullia Pendula:* Planchon—*Sapindaceæ; Tulip-wood*.—6 to 15; 30 to 50. This line scrub tree has pinnated light green leaves; wood soft, easily worked.

22. *Sterculia Quadrifida:* R. Brown.—In the coast jungles of North Australia, Queensland, and the northern part of New South Wales.

3. *Sterculia Quadrifida:* R. Brown.—*Sterculiaceæ* (Convavola).—6 to 24; 20 to. 40. Found in scrubs and creeks; wood soft, spongy; soon rots.

23. *Elæocarpus Obovatus:* Don.—Occurs in many of the moist forest tracts of New South Wales and Queensland.

4. *Elæocarpus obovatus;* G. Don.—*Tiliaceæ*.—6 to 15; 50 to 70. A tall tree, of common occurrence in dense scrubs; wood close-grained and tough.

24. *Phyllanthus Ferdinandi:* J. Mueller.—Not rare in the brushwoods of New South Wales and South Queensland.

25. *Excæcaria Agallocha;* Linne.—A tree of the jungles of Queensland and North Australia.

85. *Excæcaria Agallacha:* Linne.—*Euphorbiaceæ; River Poisonous Tree* (Balavola Karping).—12 to 30; 40 to 70. Found bordering the estuaries of saltwater rivers and creeks; produces by incision in the bark an acrid, milky juice, which is so volatile that nobody, however careful, can gather a quarter of a pint without being affected. The symptoms are an acrid burning sensation in the throat, sore eyes and headache; a single drop falling into the eyes it is believed will cause loss of sight. The natives of Cleveland Bay use this poisonous juice to cure certain ulcerous chronic diseases (Murrell's testimony). Wood light, white, and soft; will answer for carving and marqueterie.

26. *Mallotus Phillippinensis:* J. Mueller.—Not rare in the coast forests of Queensland, and of the Northern part of New South Wales.

84. *Mallotus Phillippinensis:* J. Mueller—*Euphorbiaceæ*.—6 to 15; 30 to 40. A scrub tree; wood close-grained and tough.

27. *Rhamnus Vitiensis;* Bentham.—Scantily occurring in the east part of Queensland.

32. *Rhamnus Vitiensis:* Bentham—*Rhamnaceæ* (Murtilam).—6 to 12; 30 to 40. Scrub tree; trunk and branches whitish, very smooth; berries quarter-inch in diameter; wood close-grained, of a light reddish and pink colour; may be useful for engraving.

28. *Siphonodon Australia:* Bentham.—In the jungle forests of the northern parts of New South Wales and

the southern parts of Queensland.

31. *Siphonodon Australia:* Bentham—*Celastrineæ* (Umpurr).—12 to 24; 60 to 80. A tall scrub tree, trunk 40 to 60 feet clear; branches short, tortuous; compactly arranged in a short pyramidal head; wood close-grained, of a uniform yellowish colour, taking a good polish.

29. *Elæodendron Melanocarpum:* Ferd. Mueller.—In the more open parts of the littoral forests of Queensland.

30. *Elæodendron Melanocarpum;* Ferd. Mueller—*Celastrineæ* (Korawal).—4 to 10; 40 to 60. A slender, erect tree, in scrubs; not very abundant.

30. *Acacia Harpophylla*: Ferd. Mueller.—As yet only known from capricornic eastern Australia.

34. *Acacia Harpophylla:* Ferd. Mueller—*Leguminosæ*—Brigalow (Orkor).—An erect, tall tree; very abundant; branchy towards the top; covers large tracts of the rich scrub lands of Middle Queensland, giving a singular appearance to the forest scenery; wood hard, heavy, close-grained; and of a dark-pale colour, giving a strong odour of violets. In use for building purposes. The aboriginals make with it almost all their boomerangs, spears, and clubs.

31. *Acacia Julifera:* Bentham.—In many of the littoral regions of Queensland.

35. *Acacia Julifera:* Benth—*Leguminosæ*.—4 to 10; 20 to 30. A small tree, generally found growing in poor soil; wood prettily marked, easily worked.

32. *Acacia Macradenia:* Bentham.—In the coast and inland tracts of Queensland, about the tropic of Capricorn.

39. *Acacia Macradenia:* Bentham—*Myall* (Toney).—12 to 18; 30 to 50. In scrubs and open forests; beautiful black, hard, and close-grained wood, taking a very high polish.

33. *Acacia Pendula:* All. Cunningham.—In the interior districts of New South Wales and Queensland.

34. *Acacia Salicina:* Lindley.—Occurring in the depressed scrubby interior regions of the whole Australian continent.

37. *Acacia Salicina:* Lindley—*Leguminosæ* (Bakka).—6 to 12; 20 to 40. This is mentioned by Sir Thomas Mitchell as the tree, the bark of which is, from its deleterious properties, used by the natives of New South Wales for poisoning fish in small lagoons. It is used in the Fitzroy River for a like purpose by the natives. Wood dark and pretty; easy to work.

35. *Acacia Bidwillii:* Bentham.—In various parts of Queensland, more particularly towards the coast.

38. *Acacia Bidunlli;* Bentham—*Leguminosæ; Bidwill's Acacia* (Waneu).—4 to 8; 20 to 30. In ridges and plains; wood coarse, soft, and not durable.

36. *Pithecolobium canescens:* Ferd. Mueller.—In Queensland, about the tropic of Capricorn.

42. *Pithecolobium Canescens:* Ferd. Mueller—*Leguminosæ* (Walkor).—10 to 24; 30 to 50. An ornamental tree; flowers yellow. The sap of this wood is of a light-yellow colour, wood not unlike cedar towards the centre, but harder; very much prized by cabinet makers.

37. *Pithecolobium Thozetianum:* Ferd. Mueller.—In the forests of Queensland, about the tropic of Capricorn.

43. *Pithecolobium Thozetianum:* Ferd. Mueller—*Leguminosæ*.—12to 30; 40 to 60; A tree of common occurrence in stony scrubs; trunk erect, with a thin whitish bark; very branchy and shady towards the top; wood very hard, heavy, tough, and close-grained; may prove useful for gig shafts.

38. *Pithecolobium pruinosum:* Bentham.—In most of the jungles of New South Wales, and also in the south of Queensland.

47. *Pithecolobium Pruinosum:* Bentham—*Leguminosæ* (Talingora).—4 to 15; 30 to 50. A small scrub tree, generally with many stems; branches and flowers of a rusty colour; wood soft, not durable.

39. *Bauhinia Hookeri:* Ferd. Mueller.—Widely distributed through the forest regions of Queensland,

45. *Bauhinia Hookeri:* Ferd. Mueller—*Leguminosæ; Mountain Ebony* (Warwor).—10 to 24; 30 to 40. An ornamental spreading tree, with pale-green, handsome, deciduous foliage, and bearing large white flowers of sweet perfume; wood supple and heavy, of a dark-reddish hue; will answer well for veneering.

40. *Bauhinia Leichhardtii:* Ferd. Mueller.—In the desert-interior of South Australia, New South Wales, Queensland, and North Australia.

41. *Barklya Syringifolia:* Ferd. Mueller.—In the jungles of several parts of Queensland.

44. *Barklya Syringifolia:* Ferd. Mueller—*Leguminosæ*.—4 to 8; 20 to 30. A handsome scrub tree, with large, cordate, shining leaves; flowers a bright yellow.

42. *Erythrina Vespertilio:* Bentham.—Rather frequent in Central and North Australia, Queensland, and in the most northern parts of New South Wales.

46. *Erythrina Vespertilio:* Bentham—*Leguminosæ; Coral Tree* (Wotheugn).—12 to 30; 30 to 50. A graceful deciduous open forest tree; very abundant; branches prickly; flowers bright red in racemes, and formed before the leaves show; wood soft, very light when dry; used by the aboriginals for making their shields. The

dry logs of the dead trees are also used by them as a means of fording large rivers or creeks.

43. *Eucalyptus Rostrata:* Schlecht.—Dispersed over river flats and along banks of streams throughout nearly the whole of Australia, but seemingly not occurring in Tasmania. It is the "Red Gumtree" of East Australia, but not of West Australia.

44. *Eucalyptus Microtheca:* Ferd. Mueller.—Widely dispersed through the more central regions of the continent.

53. *Eucalyptus Microtheca:* Ferd. Mueller—*Black Box* (Koloneu).—24 to 120; 100 to 180. This tree, abundant in rich alluvial scrub land, can be considered the giant of our tropical forests. The bark black, slightly fissurated and persistent on the whole length of the trunk, becoming smooth and ash-coloured in the branches; wood with figures not unlike walnut, but darker, heavier, and closer-grained. Piles made of the young trees have been used with advantage for the construction of the Great Northern Railway.

45. *Eucalyptus Citriodora:* Hooker.—Not common in some of the open forests of New South Wales and Queensland.

52. *Eucalyptus Citriodora:* Hooker—*Myrtaceæ; Citron-scented Gum* (Kangar).—12 to 13; 50 to 80. This tree is not often met with on ridges along the eastern coasts of Australia; bark ash-coloured and smooth; wood easily worked.

46. *Lumnitzera Racemosa:* Willd.—In the littoral tracts and the islands of Queensland and North Australia.

50. *Lumnitzera Racemosa:* Willd.—*Combretaceæ* (Karkin).—2 to 6; 10 to 15. A small tree, found within the tidal saltwater in rivers and creeks; the branches and the thick fleshy leaves easily broken; wood prettily marked.

47. *Backhousia Citriodora:* Ferd. Mueller.—In the southern forests of Queensland.

48. *Barnngtonia Careya:* Ferd. Mueller.—In the more open forest regions of Queensland and North Australia.

54. *Barringtonia Careya:* Ferd. Mueller—*Barringtoniaceæ; Broad-leaved Apple Tree* (Barror).—A small tree of a crooked growth, but very graceful, with broad leaves and handsome pink and white flowers; found in abundance in rich alluvial soils; wood of a blood-red colour towards the centre; subject to crack; requiring, like some European timber, to be submerged before being worked. According to James Murrell the natives of Cleveland Bay use the bark of the stem for stupefying fish in fresh water, and the bark of the root for the same purpose in salt water.

49. *Terminalia Thozetii:* Bentham.—In the eastern part of Queensland.

49. *Terminalia Thozetii:* Bentham—*Combretaceæ*.—12 to 36; 50 to 90. An erect trunked tree; abundant in scrubs; wood close-grained and tough, of a pale-yellow colour, splitting freely.

50. *Homalium Vitiense:* Bentham.—In the capricornic regions of Queensland.

80. *Homalium Vitiense:* Bentham—*Homaliaceæ*.—12 to 24; 50 to 70. A tree found in scrubs, with erect cylindrical trunk; spreading crooked branches towards the top; wood white, close-grained and durable; may prove useful for wheelwrights' work.

51. *Sarcocephalus Cordatus:* Miquel.—Not rare in the littoral forest tracts of Queensland and North Australia.

57. *Sarcocephalus Cordatus:* Miquel; *Rubiaceæ:* Ferd. Mueller—*Leichhardt's Tree* (Toka).—24 to 40; 60 to 100. A magnificent, erect, shady tree, with dark-green deciduous foliage; handsome, very fragrant, globular flower, and having a bitter-flavoured granulated fruit; wood soft, of a light bright-yellow colour; some varieties of this timber have a beautiful wavy grain; very easily worked; will answer for carving; it has the peculiarity of being difficult to ignite. The trees should be cut in winter, when deprived of their leaves, and submerged, or the timber will be subject to the attack of insects.

52. *Canthium Oleifolium:* Hooker.—Through the Brigalow scrubs and more open forests of the northern part of New South Wales, the whole of Queensland, and North Australia.

56. *Canthium Oleifolium:* Hooker—*Rablaceæ*.—A shrub met with in poor soil.; wood hard and tough.

53. *Brassaia Actinophylla:* Endlicher.—In deep wet forest recesses of Queensland.

55. *Brassaia Actinophylla*: Endlicher—*Araliaceæ; Umbrella Tree* (Pinankaral) 6 to 12; 30 to 40. Leaflets on a common stalk 8 to 12 inches long; handsome, highly ornamental; wood soft, not durable.

54. *Earlia Excelsa:* Ferd. Mueller.—Kare in forests of Queensland, about Capricorn. It is probably the largest tree in the extensive order of *Acanthaceæ*.

75. *Earlia Excelsa:* Ferd. Mueller—*Acanthaceæ*.—3 to 6; 15 to 25. A large and highly-ornamental shrub, with many stems; small, dark green leaves; flowers tubular, crimson; wood close-grained.

55. *Achras Amtralis:* R. Brown.—In the woods of the coast-tracts of New South Wales and the southern parts of Queensland.

64. *Achras Pohlmaniana Sapotaceæ:* Baleam.—12 to 20; 40 to 70. A tall scrub tree, with beautiful foliage; bark thin, grey yellowish; wood of a uniform pale yellow colour; close-grained.

55b. Achras Pohlmaniana: Ferd. Mueller.—East Australia, about Capricorn. Fruit edible.

56. *Maba Obovata*; R. Brown.—In the more open forests, widely distributed through Queensland.

63. *Maba Obovata:* R. Brown.—*Ebenaceœ—Ebony;* (Ronone).—5 to 12; 20 to 30. This tree is very abundant in all scrubs, but does not attain a large size; wood hard and tough; very close-grained, black ebony at the heart; sap white and pink. Used for mallet and chisel handles.

57. *Cargillia Australia:* R. Brown.—In the forest regions towards the coast through New South Wales and Queensland.

62. *Cargillia Australis:* R. Brown.—*Ebenaceœ*.—A small tree found in scrubs.

58. *Eremophila Bignoniflora:* Ferd. Mueller.—In the Brigalow scrubs of New South Wales and Queensland.

72. *Eremophila Bignoniflora:* Ferd. Mueller.—*Myoporinœ;* (Pombel).—6 to 24; 30 to 35. A tree generally with many stems of irregular growth; wood hard, fragrant, and most elegantly marked with green and yellowish figures; takes a high polish.

59. *Eremophila Mitchellii:* Bentham.—In the Brigalow scrubs of New South Wales and Queensland.

73. *Eremophila Mitchellii:* Bentham.—*Myoporinœ; Bastard. Sandalwood* (Balvory).—6 to 12; 20 to 30. A small tree, growing in open forest land; wood hard, of brown colour, nicely waved. Owing to a strong aromatic odour, resembling that of sandal-wood, furniture made of this timber may be free from the attack of insects.

60. *Vitex Macrophylla:* R. Brown.—In the densest coast forests of most northern parts of Queensland.

61. *Diplanthera tetraphylla, R. Br*.—In the densest coast forests in the remotest north of Queensland.

62. *Chionanthus Effusiflora:* Ferd. Mueller.—In the woods along the coast of Queensland, especially in the more northern parts.

66. *Chionanthus Effusiflora:* Ferd. Mueller—*Oleaceœ* (Eurpa).—6 to 15; 30 to 60. Found in mountains, scrubs, and creeks; wood hard and tough.

63. *Alstonia Constricta:* Ferd. Mueller.—As well in the moist jungles as in the dry Brigalow scrubs of the whole of Queensland and the northern parts of New South Wales. This tree attains a much larger size in the jungles than in the scrubs.

69. *Alstonia Constricta:* Ferd. Mueller—*Apocynaceœ; Fever Bark*.—6 to 15; 40 to 70. Of common occurrence in scrubs, and occasionally in open forests; bark thick, yellow, deeply fissurated, of an intense bitterness. It is said that this bark possesses the same properties as quinine.

64. *Ardisia Pseudo-Jambosa:* Ferd. Mueller.—In the dense forests of Queensland, about the tropic of Capricorn.

65. *Ardisia Pseudo-Jambosa:* Ferd. Mueller.—*Myrsineœ* (Gaon Gaon).—4 to6; 10 to 25. A shrub or small tree, found in sandy creeks and scrubs, affecting very shady places; fruit globular, crimson, the size of the European cherry; well deserving room in every garden.

65. *Stenocarpus Sinuosus:* Endl.—The tree occurs in the southern parts of Queensland and the northern parts of New South Wales, in forest ravines.

66. *Cardwellia Sublimis:* Ferd. Mueller.—Restricted to the humid most northern forest country of Queensland.

67. *Xylomelum Scottianum:* Ferd. Mueller.—As yet only found in the most remote north-east of Queensland, in forest gullies.

68. *Darlingia Spectatissima:* Ferd. Mueller.—Known only from the most northern part of the east coast of Queensland.

69. *Hakea Stricta:* Ferd. Mueller.—In the deserts of South Australia, Victoria, New South Wales, and the south-west of Queensland.

70. *Grevillea Striata:* R. Brown.—In the dry interior tracts of North and Central Australia, Queensland, and the north of South Australia and of New South Wales.

77. *Grevillea Striata:* R. Brown—*Proteaceœ; Silvery Honeysuckle* (Turraie).—6 to 15; 30 to 50. A tree found scattered on plains and ridges, with narrow, long, striated silvery leaves; wood reddish dark, very curiously marked, easy to work, used for bullock yokes.

71. *Ficus Vesca:* Ferd. Mueller.—On river banks in the more northern parts of Queensland.

92. *Ficus Vesca:* Ferd. Mueller.—*Urticaceœ; Leichhardt's Clustered Figtree* (Porpa). 12 to 36; 40 to 60. Found in scrubs, also on the banks of rivers and creeks; the fruit, which is of a light-red colour when ripe, hangs in clusters along the trunks and on some of the largest branches; timber soft; may answer for packing cases.

72. *Morus Calcar Galli:* A. Cunningham.—In the forests not distant from the coast, in various parts of New South Wales, and of the south of Queensland.

73. *Celtis Ingens:* Ferd. Mueller.—In the jungle forests of Queensland and the northern parts of New South Wales.

94. *Celtis Ingens:* Ferd. Mueller—*Urticacœ*.—6 to 12; 30 to 50. A middle-sized scrub tree of rare

occurrence; wood white, soft, and pliable.

74. *Santalum Lanceolatum:* R. Brown.—Sparingly distributed over North Australia, Central Australia, the northern parts of South Australia, and a large portion of Queensland.

75. *Exocarpus Latifolia:* R. Brown.—In many parts of Queensland and North Australia.

79. *Exocarpus Latifolia:* R. Brown—*Thyineleæ; Broad-leaved Native Cherry* (Oringorin).—6 to 10; 15 to 35. A small scrub tree; bark almost black, scaly; wood hard, with the fragrance of roses; takes a good polish.

76. *Casuarina Tenuissima:* Sieber.—In more open forests, from East Gippsland, through New South Wales to the southern parts of Queensland.

95. *Casuarina Tenuissima:* Sieber—*Casuarineæ; Mountain Oak* (Burcutha).—6 to 15; 30 to 45. On the mountain sides, at an elevation of 1000 feet, this little tree begins to make its appearance; timber close grained, with figures white and pink. 77. *Podocarpus Elata:* R.Brown.—Rather scantily dispersed through the whole littoral tracts of New South Wales and Queensland.

Wood Books.

Colonel Champ exhibits specimens of Victorian wood, converted into small boxes of book form, according to a design adopted by that gentleman at the Exhibition of 1861, and then suggested by Dr. Mueller. Nothing could be more convenient and more interesting than a library (to speak allegorically) of such imitation books, representing the different timber of different countries, which could be systematically, or alphabetically, or geographically arranged. Australia alone could furnish for such a collection more than a thousand volumes.

Barks Forwarded to the Exhibition by Ferd. Mueller, M.D.

- Eugenia Smithii
- Eucalyptus sp.
- Banksia serrata
- Eucalyptus inophloia
- Acacia subporosa
- Eucalyptus Stuartiana
- Eucalyptus longifolia
- Acacia penninervis
- Eucalyptus obliqua, and Fibre of
- Pittosporum undulatum
- Melaleuca ericifolia

Victorian Woods Manufactured into Paper Knives.

Exhibited for the Commissioners by Dr. Mueller.

- Pittosporum undulatum
- A the rosperma moschatum
- Acacia implexa
- Senecio Bedfordii
- Myrsine variabilis
- Myoporum insulare
- Banksia serrata
- Acacia melanoxylon
- Eucalyptus rostrata
- Aster argophyllus
- Eucalyptus inophloia
- Hedycaria Cunninghamii
- Eucalyptus (black butt)
- Eucalyptus corymbosa
- Leptospermum sp.
- Melaleuca squarrosa
- Casuarina stricta
- Exocarpus cupressiformis
- Eucalyptus oleosa
- Acacia subporosa
- Callitris verrucosa

- Panax palmaceus
- Pomaderris apetala
- Eucalyptus longifolia
- Lomatia Fraserii

Products of dry Distillation of Victorian Woods.

IN placing before the visitors of the Intercolonial Exhibition the products obtained by dry distillation from a series of the most widely-distributed timber trees of this country, I had a double object in view. I wished to render known new sources of employment for both labour and capital; and I desired likewise to point to inducements hitherto very imperfectly understood, for the occupation of a vast extent of the densely timbered ranges, in which, as yet, no dwelling is to be found. The climate of these free mountains is salubrious, and, indeed, delightful, and the material for lucrative work is accessible in unbounded abundance. While in northern countries the fir, which yields us the Stockholm tar, is so precious as to admit of the selection of roots and branches alone for the purpose of distillation, the stems being needed for the softwood deals which we import, we can here subject, without restrictions dictated by economy and by limited supply in old countries, an infinitely larger mass of wood to industrial processes. While in northern countries the inclemency of the climate renders forest operations for a part of the year surrounded with difficulties, and while the toiling labourer there can but raise a scanty supply of food from the earth, we can in this genial zone call forth in exuberance cereals and other main- stays of aliment from a grateful soil, and can turn into ever-verdant and never-frozen valleys the pasture animals needed for our local sustenance. Moreover, by the cultivation of many highly valuable plants, excluded from less genial zones, and of such plants as need more humidity and more shelter than our open cereal tracts do afford, the paths of prosperity become still more numerous, by which families may seek for their hardy offspring independence and healthy occupation. Thus, they may engage in work which yields for paper-mills the raw material, in the production of tar, acids, and potash, in the artless distillation of volatile oils; and these occupations may be combined in sheltered glens with the rearing of Chinese tea, Peruvian bark, senna, cork, sumach, perhaps even coffee, and very many other products highly remunerative, while less secluded portions of the ranges, under singular facilities for irrigation, will yield olives, vine, oranges, and an almost endless variety of other fruits.

Wherever, therefore, the miner has vainly searched for the metallic treasures of the soil, we should see, under circumstances so favourable to rural pursuits, the dwellings of families arise. In sketching a hopeful picture of future forest life, I have not thought of Victoria alone. The results of the investigations in some of the new timber resources, here preliminarily placed on record, might readily be a guidance to settlers in the woods in all the surrounding colonies, where most of the trees here experimentally operated on likewise occupy extensive localities not readily accessible to cereal culture or ordinary pastoral pursuits. The primary information furnished on this occasion refers to the yield of tar, wood vinegar, and wood spirits from such of our timber as in all instances as stated are of vast prevalence, and in most cases restricted to barren rises or to swampy depressions.

The percentage of tar, and the strength of the wood vinegar from native timber, as defined in the adjoining table, bears fair comparison with the results attained in other countries from other trees. But for greater facility of comparison, a scale from the yield of some European trees is in juxtaposition annexed. Though there is no great material difference between the tars and vinegars obtained by the heating of various woods under exclusion of air, I found it desirable to exhibit the full series of the products. The wood employed was air-dried, the amount torrefied in each case 25 lbs. The details of the operation were well carried out by Mr. Hoffmann, to whose skill I also entrusted the determination of the percentage of yield of the tar and vinegar, and again the proportion of the wood spirits, acetic acid, and other constituents of the latter. The charcoal remaining as a residue after the torrefication of the wood has also been placed in the Exhibition, to show its texture in each instance, some of the kinds being probably eligible as an ingredient for gunpowder. The quantities of potash have not been ascertained, as I intend to make it ere long a subject of special inquiry. In referring to the tables on these products of dry distillation, it must be remembered that the degree of heat to which the wood is subjected, as well as the degree of rapidity of its action, exercises a modifying influence on the results. Hence the percentage must be regarded as one of approximate calculation only; besides, wood of the same species from different climatic localities will not precisely give the same yield of products and educts. Mr. Hoffmann employed hydrochloric in preference to sulphuric acid in liberating the acetic acid from the lime, a process having several advantages (which here need not be pointed out), which largely compensates for the somewhat greater cost of that acid. It remains yet to refer, at least cursorily, to the uses to which the products of wood distillation find their principal application. Tar, so extensively needful for naval purposes, and for building structures, might in these southern countries, much more extensively than hitherto, be used for protecting ironworks exposed to the air against oxydation, the application of tar being less costly, more lasting, and often even more sightly, than that of oil-paint. Soft-wood, if coated with eucalyptus-tar, assumes an excellent appearance, and if in ornamental structures a touch of varnish is added, this tar becomes the most eligible article for securing duration. If the production of tar is to be the main object of secluded combustion of wood, the primitive Scandinavian means might be adopted, which involve but little more appliances than burning wood for coals.

The wood vinegar has its manifold applications. It serves for the fabrication of numerous kinds of articles for dyes, for special chemical purposes, and from it acetic acid may be obtained, or a rectified vinegar, applicable to culinary purposes. As Dye-Mordant, a solution of sesqui-acetate of alumina (the so-called red liquor) is largely used in calico printing. The sesqui-acetate and the simple acetate of iron are in quest to effect, connected with ferrocyanid of potassium, blue dyeing for woollen ware, and with various admixtures to produce avariety of colours in dyeing of cotton and silk. The simple acetate of iron yields, with madder (a plant like other dye-plants introduced into Victoria), a violet colour; and with the sesqui-acetate of alumina, brown and black dyes.

The chemical formula of the wood spirit is not identical with that of alcohol, but it is highly valuable as a solvent for resins in the preparation of varnish. It is but right to remark that a large factory, to which timber is floated on the Derwent, near Hobart Town, has commenced its distillation of wood within the last year; and that to Mr. Hugh Gray, of Ballarat, the credit is due of having, for the Exhibition of 1861, prepared tar and wood vinegar from a species of eucalypt, and of having given approximately the percentage. (*Vide Jurors' Report, 1861, 20.)*

Table Showing the Yield of Charcoal, Crude Wood Vinegar, and Uncondensible Gases, for 100 Parts of the Different Woods.

Casuarina Banksia Acacia Acacia Melaleuca Eucalyptus Eucalyptus Eucalyptus Eucalyptus Angophora Systematic Name Quadrivalvis Australis Melanoxylon Mollissima Ericifolia Leucoxylon Rostrata Obliqua Globulus Intermedia Lab. R.Br. R. Br. Willd. Sm. F. Muell. Schl. l'Herit. Lab. Cand. Species Of Wood Drooping Common Wattle Swamp Ironbark Redgum Stringybark Bluegum Spurious Vernacular Name Blackwood. Sheoak. Honeysckl. Acacia. Tea Tree. Tree. Tree. Tree. Tree. Apple Tree. Charcoal............. .... 27.500 29.500 29.250 26.125 27.875 28.500 29.250 29.125 28.750 29.000 Crude Wood Vinegar................... 42.812 40.062 40.250 44.750 46.000 44.875 41.125 43.750 45.500 43.812 Tar .... 7.125 6.562 7.062 73.125 6.750 6.312 6.687 6.062 6.250 6.187 Uncondensible Gases.................. 22.563 23.876 28.488 22.000 19.375 20.313 22.938 21.063 19.500 21.001 100.000 100.000 100.000 100.000 100.000 100.000 100.000 100.000 100.000 100.000

Table

SHOWING the amount of pure Hydrated Acetic Acid, the amount in gallons of proof Vinegar of the revenue (Sp. Gr. 1.0085), represented by the Hydrated Acetic Acid, real Wood Spirit, and Wood Vinegar Tar residue contained in the Crude Wood Vinegar, obtained from 100 pounds of the woods; likewise, the measure of the Crude Wood Vinegar and the amount of dry Acetate of Lime it furnished; further, the amount of pure Hydrated Acetic Acid and real Wood Spirit in the Crude Wood Vinegar per cent.

Species Of Wood. Systematic Name. Vernacular Name. Weight of rudeWood Vinegar. Measure of crudeWood Vinegar in ounces. Weight of dry Acetate of Lime produced. Amount of pure Hydrated Acetic Acid. Amount of proof Vinegar in gallons. Amount of pure hydrated Acetic Acid in the crude Wood Vinegar per cent. Amount of real Wood Spirit. Amount of real Wood Spirit in the crude Wood Vinegar per cent. Weight of Wood Vinegar Tar residue. Casuarina Quadrivalvis.. Drooping Sheoak............... 42.812 640 5.31 2.550 4.10 5.956 2.128 4.970 3.687 Banksia Australis.......... Common Honeysuckle.. 40.062 636 5.44 2.264 3.64 5.651 2.111 5.269 3.750 Acacia Melanoxvlon..... Blackwood.................... 40.250 648 5.50 2.278 3.66 5.659 1.684 4.183 4.250 Acacia Mollissima........ Wattle Acacia .... 44.750 664 5.00 1.656 2.66 3.700 2.027 4.529 4.500 Melaleuca Ericifolia..... Swamp Tea Tree .... 46.000 700 5.12 1.918 3.08 4.169 1.938 4.213 5.625 Eucalyptus Leucoxylon. Ironback Tree .... 44.875 672 3.69 1.442 2.32 3.213 1.596 3.556 3.312 " Rostrata ... Red Gumtreo................ 41.125 660 4.06 1.126 1.81 2.737 2.017 4.904 3.312 " Obliqua .... Stringybark Tree.......... 43.750 656 3.88 1.155 1.85 2.640 2.069 4.729 4.937 " Globulus ... Blue Gumtreo .... 45.500 676 3.94 1.171 1.88 2.573 1.810 3.978 5.312 Angophora Intermedia.. Spurious Apple Tree.... 43.812 664 3.56 1.245 2.00 2.841 1.792 4.090 4.125

Table

SHOWING the amount of Crude Wood Vinegar, Empyreumatic Oil and Charcoal obtained from the distillation of the undermentioned (chiefly European) varieties of Wood, calculated for 100 pounds; also, the amount of pure Hydrated Acetic Acid in the Wood Vinegar; and further, the amount of pure Hydrated Acetic Acid in the Wood Vinegar per cent.—*By Stolze*.

Species Of Wood. Weight of crude Wood Vinegar. Amount of pure Hdrated Acetic Acid. Amount of pure Hydrated Acetic Acid in the Wood Vinegar, per cent. Weight of Empyreumatic Oil. Weight of Charcoal. Systematic Name. Vernacular Name. Betula Alba .... White Birch .... 44.53 4.86 10.92 8.59 24.21 Fagiis Sylvatica ... Red Beech................ 43.75 4.69 10.73 9.37 24.21 Tilia Platvphylla... Large-leafed Linden 42.96 4.44 10.33 11.71 22.65 Quercus Kobur..... Oak........................... 42.96 4.27 9.93 9.37 25.78 Fraxinus Excelsior Common Ash............ 46.87 4.09 8.74 8.59 23.43 Æsculus Hippocastanum Horse Chesnut......... 46.09 3.75 8.14 10.15 21.87 Populus Dilatata.. Lombardy Poplar..... 46.09 3.66 7.94 8.59 23.43 PopulusAlba......... White Poplar........... 46.09 3.57 7.74 7.81 23.43 Prunus Padus ..... Bird Cherry .... 43.75 3.21 7.35 7.81 21.87 Salix viminalis.... Basket Willow .... 46.09 3.20 6.95 9.37 21.87 Rhamnus catharticus. Buckthorn.............. 46.87 3.16 6.75 8.59 21.87 Haematoxylon Campechiamim Logwood .... 44.53 3.09 6.95 9.37 12.5 Aluus glutinosa .. Alder .... 46.09 2.74 5.96 9.37 21.87 Juniperus Communis Juniper .... 45.31 2.61 5.76 10.93 22.65 Pinus Abies .... White Fir .... 41.40 2.38 5.76 13.28 21.09 Pinus Sylvestris...... Common Pine .... 42.18 2.34 5.56 11.71 21.87 Juniperus Sabina... Common Savine ..... 43.75 2.34 5.36 11.71 22.65 Pinus picea .... Red Fir 39.84 1.97 4.96 14.06 23.43

Paper Materials.

In a retrospective view on prior discoveries of paper material, it is not easy to ascertain how far substances also attainable beyond Australia may have been tested and even employed. That British true rushes *(Junci)* are eligible, that they contain about 40 per cent, of pulp-substance, and that they form a splendid substitute for rags, is long since ascertained. From this observation and calculation the inference may be drawn that the generality of rushes, sedges, and kindred plants, all allied in structure and texture, may be drawn, under the prospect of similar facility for working and similar yield, into use. This the experiments here instituted prove to be the case. *Garices* and many grasses furnish approximately 30 per cent, fibre, malvaceous plants average 10 to 20 per cent., and not more is obtained from the stalks of beans, peas, hops, buckwheat, potatoes, heather, broom bushes, and many other plants tried. The yield from Victorian material is much larger, moreover the supply infinitely vaster, and locally much less expensively attainable and much easier worked. Besides, the substances just indicated are generally wanted in great agricultural countries for refertilisation of fields. Nettles produce about 25 per cent, of pulp fibre, fit for a beautiful paper, easily bleached. A main staple for admixture to rag-pulp has been found in pinewood and straw of cereals. The Museum of the Melbourne Botanic Garden possesses samples of writing and printing papers, manufactured in Southern Germany, for which 30 to 40 per cent, of pinewood and 12 to 15 per cent. China-clay have been employed; wrapping paper made of 50 per cent, of pinewood, and tissue paper containing 40 per cent, pinewood; good printing paper obtained by adding 20 per cent, of aspenwood; glazed packing paper containing again 30 per cent, of pinewood; writing paper of superior quality, prepared in France, from 75 per cent, of esparto, and others solely made of that grass; paper prepared in Switzerland from wood solely, and turned out fit for packing and even inferior writing paper, and fair though not elastic millboards; packing paper made in Belgium, and printing paper prepared in Prussia, containing a large proportion of maize straw and the straw of other cereals.

The prior experiments on exclusively Australian material are very limited, as far as the writer is aware. Years ago stringy bark was shipped and tested in Britain, but seems to have borne only the character of fitness for merely coarse and brittle packing paper. Mr. Alexander Tolmer, of Adelaide, eight years ago caused paper to be made of the Australian marshmallow *(Lavatera plebeja)*, and of the sword-rush of the sand-coast *(Lepidosperma gladiatum)*. New Zealand Flax was pointed out as a fitting substance for paper twenty-two years ago. Good paper of an inland *Lepidosperma* rush, not so heavy and bulky as that experimented on by Mr. Tolmer, was prepared by Mr. Newberry, and referred to by the director of the Geological Survey in his last annual report, published in March. Some of the kinds of material now brought in paper-form before the public at the Intercolonial Exhibition were pointed out several years ago, and nearly the whole of the substances now drawn into use and submitted to the jurors were enumerated as eligible by the writer in the earlier part of 1866, in a note furnished on special inquiry to the *Australasian*. The percentage of pulp obtainable from the new paper fibres has not been exactly ascertained in these first, and to a certain extent preliminary, experiments; but, inasmuch as the raw stuff can be gathered in endless quantity, and as it proved evidently rich in pulp, the tabulation of the percentage was reserved for future more extended experiments. With the exception of one of the samples of stringy bark paper, all the kinds sent to the Exhibition were neither subjected to chlorine nor drawn through size. In addition, I would remark that forest regions and coast lines, swamps, and flats subject to inundations, should prominently yield the material for the factory; for on open pastures or otherwise occupied tracts of country, even paper material cannot be harvested for an unlimited period, at the expense of the soil, with impunity. In factories situated in the vicinity of forests, the soda expended in paper manufactures might be profitably regained by evaporation of the ley and calcining it with coal or sawdust. The value of Esparto, or Sparta, the grass so extensively shipped from the Mediterranean to British paper mills, varies from £5 10s. to £6 per ton. In viewing the immense supply of various kinds of paper material here cheaply available, there is no reason why they should not form, closely pressed, an article of export probably less inflammable than rags; and still more, it may safely be antici pated that, together with the consumption of rags in local factories, the new articles indicated will largely enter into the fabrication of paper, the product of Victorian industry.

The increasing scarcity of rags, scraps, and kindred substances has rendered their supply as a main article for paper making more and more inadequate, while the importation of the Esparto-fibre from the Mediterranean countries has likewise failed most fully to supply the augmented want. Hence, a variety of other substances have been tried, but few drawn into use, for the manufacture of especially the coarser kinds of paper; still, even for these, the raw material is in demand, and substitutes for the finer flax and hemp rags have been for some time much in request for the better kinds of writing-paper Under such circumstances arose, to a great extent, the desire of the late Duke of Newcastle, that throughout the British colonies investigations should be instituted into the adaptabilities of any vegetable substances eligible for paper manufacture and other textile fabrics. In compliance with the request of His Grace, I had for several years carried on inquiries, microscopical as well as technological, in this direction, whenever opportunities offered; and with the recent establishment of a laboratory in the department under my control, I was able to give these researches a practical bearing, and was thereby enabled to place in the Exhibition samples of thirty kinds of paper prepared, on my desire, by Mr. Christian Hoffmann, each kind representing the unmixed fibre of the particular plant operated on. It was not the aim to produce elegant paper, but only to show the crude nature of pressed and dried paper-pulp, without action of bleaching or glutinising substances thereon. In the selection, besides, every kind of material was discarded which could not be obtained in vast abundance, and also all plants were excluded closely allied to others already selected, otherwise the samples of the series could have been largely augmented. It may suffice on this occasion briefly to enumerate what the collection exhibits, to indicate the geographical range of the species operated on, and to point out what allied plants could likewise be drawn into use. I deemed it also desirable to notice briefly the particular use to which in each instance this paper material could be applied.

I.—Paper from Barks.

1. *Eucalyptus Obliqua*: L' Herit.—The *Stringybark Eucalypt* of Victoria, Tasmania and South Australia.—The paper prepared from the bark of this tree is not merely suited for packing, but also for printing, and even writing. It may also be employed for mill and paste boards. The pulp bleaches readily. I regard it as the most important material drawn on this occasion into use, for be it remembered that this tree covers many of the barren ranges from St. Vincent's Gulf to Gipps-land, and that it equally abounds in Tasmania. Its bark, as is well known, is extremely thick and bulky; it moreover separates with the utmost facility, and is hence

universally used for thatching rural dwellings in or near the ranges. Indeed, the supply is available by millions of tons. It has been argued that sad inroads would be made into our forests by turning this material as indicated to account; but even the bark left unutilised by the splitters would furnish an enormous supply; and if the sacrifice of small portions of widely-extended forests were brought within judicious limits by legislative enactments, possibly not any injury could occur; while indeed at present the annually more or less extensive conflagrations of the Stringy bark forests destroy an infinitely larger number of trees, than ever could sink under the axe of settlers scattered through the mountains. The area within Victoria alone wooded almost exclusively with Stringy bark forest extends over many thousand square miles, generally as yet without any habitations. Allied trees, likewise with thick, fibrous bark, occur in West Australia, Queensland, and North Australia, though not so extensively. Other bark may be similarly converted into paper. The whole thick stratum of the bark was employed. It yields readily to mechanical appliances on account of its lax and loose texture, and is also easily acted on by caustic soda for conversion into pulp.

2. *Eucalyptus Rostrata:* Schlechtendal.—The *Red Gumtree* of South-Australia and Victoria (but not of West Australia).—The paper prepared from the bark of this tree proves much coarser than that of the *Eucalyptus obliqua;* the pulp may be either used as admixture to that of packing paper and pasteboards, or in the composition, or perhaps as sole ingredient, for blotting and filtering paper. The species ranges nearly over the whole Australian continent along river flats.

3. *Eucalyptus Amygdalina:* Labillardière.—One of the so-called *Peppermint-trees*, more oily in its foliage than any of its congeners. It extends through the southern and eastern parts of Victoria, the whole of Tasmania, and the southern parts of New South Wales. The inner bark is adapted for the preparation of all kinds of coarser paper.

4. *Eucalyptus Globulus:* Labillardière—The well-known *Blue Gumtree* of Victoria and Tasmania.—Paper prepared from the bark of this tree answers for packing and perhaps for printing.

5. *Eucaylptus Goniocalyx:* Ferd. Mueller—One of the *White Gum-trees*, called in some districts the *Spotted Gumtree*.—It is confined to the more fertile ranges of Victoria and the south of New South Wales. The foliage is rich in volatile oil. The bark yields a good packing paper, but hardly material for any good writing paper.

6. *Eucalyptus Corymbosa:* Smith—The *Bloodwood-tree* of East Australia.—Occurs from the southern part of Queensland to the eastern part of Gippsland. The paper from the bark of this Eucalypt is remarkable for its great firmness. It makes thus a very strong wrapping paper.

7. *Eucalyptus Leucoxylon:* Ferd. Mueller.—This tree passes in various districts under varied names—for instance, it is the *White Gumtree* of St. Vincent's Gulf, the spurious *Ironbark-tree* of some parts of Victoria, and the *Mountain Ash* and *Ironbark-tree* of parts of New South Wales. The bark can be converted into rough packing paper.

8. *Eucalyptus Longifolia:* Link.—The *Woollybutt* of New South Wales and Gippsland.—The fibre of the bark again adapted for packing paper.

9. *Eucalyptus Stuartiana:* Ferd. Mueller.—One of the *White Gumtrees* of the eastern parts of South Australia, Victoria, Tasmania, and the south of New South Wales. Called, strange to say, the *Appletree*, about Dandenong; the *Water Gumtree* of Tasmania may belong to the same species; it is designated locally with still other names. The bark of this often very big tree furnishes again good material for packing paper, and like others, for pasteboard.

10. *Acacia penninervis:* Sieber.—A tree, not of very large size, extending from South Queensland through New South Wales to East Victoria; of rather rare occurrence in Tasmania. The bark of this acacia was chosen merely to demonstrate, that also from the bark of very many species of this great genus a rough kind of packing paper can be produced.

11. *Melaleuca ericifolia:* Smith.—The so-called *Swamp-Teatree*. Universal in inundated places and stagnant waters, both of the littoral and mountain tracts of south-east Australia and Tasmania. The friable lamellar bark can be converted into an excellent blotting paper—perhaps, also, filtering paper. It is worthy of record that many species of this genus yield a very similar bark, formed of innumerable membranous layers. The most gigantic species of the genus *Melaleuca leucodendron*, which is common in South Asia and tropical Australia, exhibits such a bark, which thus may be turned to account.

II.—Paper from Foliage.

12. *Casuarina quadrivalvis:* Labillardiere.—The *Drooping Sheoak*. A common tree of the coast as well as the inland tracts of South Australia, Victoria, Tasmania, and New South Wales. The stringy foliage formed by the cylindrical concrescence of the branchlets with the leaves can be converted into an excellent pulp for packing, and even printing paper and millboard. The mechanical contrivances for preparing the pulp are of particular ease.

13. *Casuarina leptoclada:* Miquel.—The *Erect Sheoak*. Restricted to Victoria and New South Wales. The

foliage in its use is akin to that of the former species. Different Casuarinæ occur in the other Australian colonies, in South Asia, and the Pacific Islands, but none of the species has been employed before for paper manufacture, and consequently the investi-gations instituted in Victoria may be found even of value in a country so anciently industrial as China.

III.—Paper from Grasses, Rushes and Allied Plants.

14. *Scirpus maritimus:* Lirme.—The *Soltmarsh Clubrush*. This plant being almost cosmopolitan, occurs frequently in more or less brackish waters of, at least extra-tropical, Australia. It seems like the following previously not yet tried, or at all events not yet extensively used for paper manufacture, for which it is singularly well adapted, being, like most rushes, so readily converted into pulp. The amount of bleaching material for all these rushes is trifling. It is sufficiently common here to deserve attention, though not so frequent as in Middle Europe. Apparently the paper is firm enough to stand the impressions of type.

15. *Scirpus lacustris:* Linne.—The *Lake Clubrush*. It grows in moist parts nearly all over the globe, and so it is here also frequent in some places. Being of gregarious occurrence, the plant is readily collected. The paper from it is remarkably good, and hence well adapted at least for printing and tissue paper, but probably also for writing.

16. *Cyperus lucidus:* R. Brown.—The *Shining Gallingale*, a rush-like plant, common in many parts of Australia, shown to be adapted both for printing, tissue, and writing paper. All these rush-like plants bleach with great facility.

17. *Cyperus vaginatus:* R. Brown.—The *Sheated Gating ale*, one of the most widely and most copiously distributed of the rush-like plants of all Australia. Its fibre is extraordinarily tough, and accordingly can be formed into a very tenacious paper, which, moreover, proves one of great excellence. The raw material is available by thousands of tons on periodically flooded river flats, swampy depressions, and other moist localities, where a continued harvest of the plant cannot possibly exhaust the soil.

18. *Heleochavris sphacelata:* E. Brown—The *Stout Spikerush*. Abounds in the swamps of South-east Australia and Tasmania. It yields a paper as good for printing as for writing and tissue.

19. *Heleocharis acuta:* R. Brown.—The *Slender Spikerush*. Common in moist ground over a vast extent of Australia. Closely allied to the *Creeping Spikerush* of Middle Europe and other parts of the globe, which, although so frequent, has seemingly never yet been converted into paper. The local experiments here show this and many other cyperaceous plants exquisitely adapted for good printing and tissue paper, and a by no means very inferior writing paper. Better appliances will necessarily improve on the quality of the paper.

20. *Lepidosperma gladiatum:* Labillardière.—The *Sword-Rush* of the coast. A plant everywhere to be found on the sandy shores, where it greatly tends to bind the shifting sand. It was, nine years ago, subjected by Mr. Tolmer, of Adelaide, to successful tests for paper-fabrication. The article produced from it is of strong texture, and inasmuch as the plant can be collected in enormous quantities on ground not arable, it should find its way deservedly into factories with the many other kinds of material now pointed out. All the species of *Lepidosperma* are of like utility, but not all are equally bulky, nor equally gregarious. It grinds largely into pulp, like many other rushes.

21. *Juncus vaginaius:* R.Brown.—The *Sheated Rush*. Very abundant in moist parts of the whole extra-tropical part of Australia. Resembling several Middle European common rushes, which, like ours, would be worth collecting as material for printing, tissue, and likely also fair writing paper. The pulp is of equability. Many other species could, in the same way, be used.

22. *Xerotes longifolia:* R. Brown.—The *Toothed Dry-Rush*. This plant is dispersed through south-east Australia and Tasmania, and can be employed both for printing and writing paper. It is, however, scarcely so readily collected as many of the other plants just referred to. It has the recom-mendation of great tenacity for it. Several allied species will yield similar material. The aborigines make baskets from the *Dry-Rush*.

23. *Dichelachne crinita:* J. Hooker.—The *Horsetail-Grass*, one of the toughest of all kinds. It is almost universally diffused over extra-tropical Australia, and occurs also in New Zealand. This grass yields a tenacious paper, especially fit to be used for a thin packing or wrapping paper. Whilst, under disadvantages, working with small quantities of the pulp, the operator found it not needful to separate fragments of the *arista, glumæ,* &c., which appear as an admixture; but as in this instance it was not the aim to procure an elegant paper, no such provisions which machinery provides were adopted to separate the interspersed particles. It is not unlikely to make fair printing and the less costly kinds of writing and tissue paper.

24. *Stipa semibarbata:* R. Brown.—A grass to be found almost every-where throughout South-east Australia and Tasmania. The paper from this grass is very substantial, though not so strong as that of the preceding kind. On these two grasses only experiments were made to demonstrate their adaptability for the purpose in view. There are several other stipæ and besides grasses of other genera, which may finally be introduced with these into factories.

25. *Xanthorrhœa minor:* R. Brown.—This stemless liliaceous plant, of the particular genus which produces the different grass-trees of Australia, extends on temporarily inundated flats with heathy subsoil almost uninterruptedly over very many square miles of country in the Western Port district, Gippsland, and other Victorian localities; there are occasionally lines of from thirty to fifty miles' extent hardly interrupted by any other vegetation. The broad rigid tufts approach each other to the exclusion or gradual suffocation of most other plants of the spot. The harsh foliage, under such circumstances locally available in unlimited quantities, is shown to be easily converted into an excellent printing and also good writing paper; the percentage of pulp is large. This experiment teaches us also, that the wiry leaves of the different grass-trees may all be collected for paper mills, because all have a similar tissue. Thus an ample new resource is opened, especially for West Australia, where various *Xantliorrhœa* abound, and are vernacularly passing by the puzzling 'appellation of "Blackboys."

26. *Typha augustifolia*, *Linn*.—The *Bulrush* or *Reedmace*, identical, as it seems, with the common narrow-leaved species of Britain and many other parts of the globe. The pulp of the weighty foliage is easily to be pressed into good printing, tissue, and an acceptable writing paper. So far as I have been able to ascertain, the plant has previously not received any attention in paper factories.

27. *Phormium tenax:* Forster.—The *New Zealand Flax-Lily*. Paper has been placed in the Exhibition from material grown in Victoria. . The readiness with which the large richly fibrous leaves can be turned into pulp for a very substantial paper, entitles the plant not alone to our consideration, but also the fact that it may be permanently established with the greatest ease in any swampy ground. At present the limited supply of the *Phormium* reared here is only sufficient to serve as tying material in gardens, vineyards, &c. The adaptation of the *Phormium* for paper-making is not a new one. Mr. Luke Natrads, as early as 1844, exported the New Zealand Flax prepared as raw material for paper, and, I may mention, in the form of square solid lumps, to lessen freight. The subject from that time to the present clay has been one of almost constant discussion, and it is to be hoped that a local mill will ere long utilise so excellent a material. The paper here obtained from *Phormium* is the strongest of all.

28. *Confervaceous Algæ*, with *Oedogonium* and other allied freshwater weeds, cohere into extensive teguments on the bottom of our shallow swamps, when during the summer heat the water evaporates. The paper obtained from these *Algæ* would serve well, on account of its strength, for packing. At certain times and in certain localities these water weeds can be collected in enormous quantity. The application for the purpose appears to be a new one, and was first suggested by Dr. Greeves.

29. *Musa Banksii:* Ferd. Mueller.—In the forest glens of north-east Australia. This plant yields a fair paper for almost all purposes, according to the methods employed in reducing the fibre of the leaves and stalks to pulp. It has, on this occasion, merely been chosen to illustrate that all bananas, and thus the Manilla rope plant, and, besides, numerous allied products of the vegetable world, might, in tropical countries, be utilised for the preparation of coarser paper. The Banksian banana here operated on was grown in Victoria. The bleaching process, however, is not an easy one. Banana leaves yield approximately 40 per cent, of fibre for pulp. The treatment to which these fibres were subjected has been the same as that by which the esparto—or sparta—grass *(Lygeum Spartea)* is reduced to pulp. They were immersed in a solution of caustic soda, obtained from quicklime and common carbonate of soda, varying in strength according to the requirement of the fibre, but always inexpensive. In operating on Victorian raw fibres, it may be of advantage to know that the Mediterranean esparto, which contains about 56 per cent, ligneous fibre, needs application of a caustic liquid, prepared from one-eighth of soda in proportion to the grass. The process of boiling is extended over six or eight hours, whereby oil, albumen, resin, gum, and starch are abstracted. As substitutes for rags, all the materials indicated here deserve preference over many of the articles elsewhere tried or employed. Thus ferns yield generally only from 20 to 25 per cent, of pulp.

Gums.

Gum, a good deal resembling that of gum arabic, is extant in Mr. Thozet's collection from *Acacia harpophylla* (F.M.), and *Acacia Bidwillii* (Benth.), and in Dr. Mueller's collections from *Acacia pycnantha* (Benth.), *Acacia decurrens* (Willd.), and *Acacia homalophylla* (Cunn.). The number of *arborescent* species of *Acacia* furnishing gum is not inconsiderable. It has been exported for cotton-printing, glueing purposes, and other applications. The species indigenous in Australia are of greater celerity of growth than the African gum-acacias. The supply can be rendered abundant.

Picric Acid.

A sample of this substance is placed in the Exhibition, prepared from grass-tree resin in the laboratory of the Botanic Gardens. The importance of the gum-resin of xanthorrhœa for varied industrial purposes had not escaped attention. As early as 1845 varnish was prepared from it, the balsamic fragrance of which is remarkably long retained. In a report presented to the Victorian Parliament in September, 1865, it was pointed out that, among the many gratifying results from bringing native vegetable raw material under notice at the Great Exhibition of 1862, one of the more important had been the general recognition of a large percentage of picric acid in the xanthorrhœa resin, this acid being so extensively used as a yellow dye, and on a basis of indigo for green colour. In some of the western parts of Victoria, and particularly in Gippsland and the Western Port district, the *Xanthorrhœa Australis* abounds on morassy as well as sandy heaths. Other species occur in South Australia, New South Wales, and Queensland, but in West Australia these odd plants form a principal feature in the vegetation—all yield the fragrant resin alluded to, so rich in picric acid; and in West Australia, therefore, particularly, it ought to become an article of highly-profitable commercial export. Mr. Hoffmann tinged some silks, placed in the Exhibition, with picric dye, prepared by him in the laboratory of Dr. Mueller's department. The discovery of picric acid in xanthorrhœa resin we owe to Dr. Stenhouse, as early as 1845.

Senna.

A very fine sample was sent by Mons. Thozet from Rockhampton, where the climate evidently is much more genial for the growth of the different kinds of *Senna-Cassia* than that of Victoria. Nevertheless it is likely, that in the rich soil and in the mild humid air of the fern-tree ranges of Victoria, Senna culture might be pursued as a byework with advantage.

Gastrolobium.

This genus embraces several species highly poisonous, and hence very destructive to sheep, cattle, and horses. In West Australia they are the bane of many pasture tracts, but fortunately in all other parts of Australia only one species is known to exist—*Gastrolobium grandiflorum* (F. M.), which ranges from the Suttor River of Queensland to the rear of Arnhem's Land. This is the species which Mons. Thozet forwarded, with a view that its medicinal properties might be tested, an investigation which is to be conducted conjointly on the West Australian species cultivated in the Botanical Gardens. It is likely that the poisonous principle is strongest in the seeds, as in some leguminous plants. It may, on this occasion, be worthy of record that the *Lotus Australis*, a plant of such wide distribution through this continent, and also occurring in New Caledonia, proves in some tracts unexpectedly highly deleterious, and thus caused vast losses at one season among the flocks in the Lake Torrens regions. Experiments thereon were made by Dr. Eades, Mr. Miscamble, Dr. Mueller, and the late Mr. Angus M'Millan, but it was shown also that the same species gathered on the shores of Port Phillip is inert. It was further shown by Drs. Rudall and Mueller that the cultivated plants of the Darling-river pea *(Swainsona Greyana*, Lindl.), which has such an extraordinarily deleterious effect on stock at certain seasons, was innocuous when given here in large quantity to sheep. The seeds of all these suspicious plants will be subjected to rigorous toxicological and chemical examination at an early period.

The *gastrolobium* scrubs can undoubtedly be destroyed by repeated burning and dissemination of perennial grasses and fodder herbs.

Tea.

Already, during the Melbourne Exhibition in 1861, and the London Exhibition of 1862, Tea from plants of the Botanic Garden was placed before the public, and now again a fair sample is shown. In the Fern-tree gullies tea plantations are likely to luxuriate quite as much as in the favourable parts of China and in Assam. As an instance of the prolific growth and remunerative yield of this plant in Assam, it may be instanced that from Mimguldye 4000 lbs. of prepared Tea, realised on a plantation of 40 acres, were sent to England last year; the shrubs being planted only in 1863 by a former Victorian colonist, James Daniel Bruce, Esq., the son of Charles Alex. Bruce, who discovered the Assam variety in that locality as a spontaneous plant. The shrubs grew in two years six to eight feet. The Assam wild plant and the Chinese cultivated plant, when crossed, produce a very superior Tea. Both are mere forms of one species.

The only sample in the Exhibition is that prepared in the Melbourne Botanic Gardens from bushes which yielded their product already for the Exhibition of 1861. In the fern-tree gullies, and in other sheltered fertile valleys of our extensive mountain tracts, the plant would still more prosper; and if for the curling process steam rollers were employed, and thus manual labour saved, a new culture industry could be rendered, doubtless, remunerative, while it would give additional employment to the juvenile and infirm of the labouring classes, and a tea to some of the kinds now in ordinary use could be realised from Victorian soil.

Sandarac.

This resin, of which fine specimens, secured by Mr. Peter Beveridge, from the Murray pine, are placed in the Exhibition, is the exudation of the various species of *Callitris*. The Mediterranean species is not unlike the six or seven Australian species hitherto discovered. In Victoria we have three species of *Callitris*—one rather rare on the coast, a second on generally open mountains, and the third abundant in the many parts of the Murray desert. It is singular that our article has hitherto not attained a standing in commerce.

Mylitta Australia.

A subterranean fungus, to be found in various parts of Victoria and the adjoining colonies. It attains in ordinary cases several pounds weight, but exceptionally it may be found weighing half a cwt.; boiled it becomes edible, hence this truffle has been named by settlers native bread.

Gardenia Resin, from new Cadedonia.

The species of gardenia yielding this resin remains as yet phytographically unknown. It is probably allied to a species discovered by myself in North Australia, *Gardenia resinosa*, so called on account of its large amount of resinous exudation. The resin from New Caledonia had evidently been fused; it is brittle. On fracture, it presents a yellowish colour; it is tasteless, but possesses an odour reminding of ginger. When leniently heated it assumes a waxy consistence. It dissolves almost without residue in cold alcohol; contains, therefore, only a trifle of gummy substance. The alcoholic solution is limpid and yellow, rendered milky by addition of water. When dissolved in boiled alcohol, it forms after cooling a large deposit. Evaporation of the spirit leaves a pellucid, greenish-yellow resin. This pure resin dissolves in ether, oil of turpentine, and partly in strong alkaline solutions.

Opium.

A trifle of this drug was prepared in the Botanic Gardens, merely to show how with facility this substance might be locally obtained, especially in places where juvenile labour or that of the infirm is to be rendered available. It is almost needless to point out that the clime of Victoria resembles greatly that of the countries from which opium now is mainly obtained.

Aromatic Plants.

In the Queensland Court are leaves of the *Eucalyptus citriodora* (Hooker), a tree to be found in the north of New South Wales and the south of Queensland. The distilled oil forms a superb cosmetic, and the yield is fair. Another lemon-scented tree occurs in the southern forest tracts of Queensland, *Backhausia citriodora* (F. M.), discovered there by Walter Hill, Esq. The loaves of this tree also deserve distillation.

Ayapana.

Such is the name of a herb yielded by the *Eupatorium triplinerve* of Vahl, or *Eupatorium ayapana* of Ventenat, a plant indigenous to the tropical parts of South America, and now cultivated in many of the warmer parts of the globe. The plant, in a living state, may be seen at the Botanic Gardens of Melbourne. It is pervaded by a highly powerful aromatic odour, emanating from essential oil. Probably to this it principally owes its celebrated virtue of neutralising the effects of snake poison. We have no record to what extent in the more or less intense and diversified manifestations from different snake poisons we can rely on the efficacy of the plant, which may in some regards act like large doses of alcoholic liquids, with so much advantage administered in many cases, and in other regards it may owe its value to the powerful sudorific properties which this herb possesses. Under any circumstances, the *therapeutic* value of the ayapana ought to be subjected to trials, for it holds out great hopes of being of high importance in all cases where, through internal medicines, cutaneous secretion is profusely to be called forth.

Chinese Grass-Cloth.

The plant yielding the fibre for this textile fabric, *Boehmeria nivea*, or the *Rhea* of Eastern Asia, grows vigorously in the Botanical Gardens of Melbourne. There can be no doubt that among cultivated fibre plants the *Rhea* will assume finally a prominent rank. Fibre has been exhibited grown at Melbourne and at Rockhampton.

New Snuff.

The remarkable sternutatory property of *Myriogyne minuta* and *M. Cunninghami* induced Dr. Mueller to have snuff prepared from them. These weeds grow almost everywhere in this country on moist or occasionally-inundated localities. *Myriogyne minuta* occurs all over Australia, and through a great part of Asia.

Barks.

All the following were gathered by A. Thozet, Esq., in the vicinity of Rockhampton:—

Bark (as well from the stem as root) *of Alstonia constricta:* F. M.—The *Bitterbark* of Queensland and the north of New South Wales.—This bark seems to have been advantageously drawn into use in cases of intermittent fever, but as yet no published pathologic records exist on the subject. The bark is yielded by a small or middle-sized tree, now and then to be met with in umbrageous forests, as well as in the Brigalow scrubs. It owes its bitterness not to an alkaloid, but, as shown by Mr. Zeyher in Professor Wittstein's laboratory in Munich, to other principles. It is unnecessary to refer further to the subject, since it has been carefully treated in a published memoir. Comparison with other apocynaceous trees throws no light on the specific nature of this bark. In many respects it resembles that of Quassia, .unless the resemblance is traced to *Thevetia nereifolia*, which is rather famed in tropical America as a febrifuge, or to *Wrightia antidysenterica*, equally renowned in Ceylon, or the *Alstonia scholaris* of Madagascar and various parts of India and North Queensland, never as yet admitted into general medicine.

Bark of Acacia harpophylla, F. M.; *Croton insulare*, Baill.; *Sarcocephalus cordatus*, Miquel; *Xantlioxylon brachyacanthum*, F. M.; *Bobea putuminosa*, F. M.; *Melodorum Leichhardtii*, Benth.; *Rhammus Vitiensis*, Benth.—It is expected that all these will serve either as dye stuffs, or for tanning, or for medicinal purposes. Their test will necessarily involve extended researches, which have only commenced. (*Vide* Appendix.)

The bark of *Chionanthus* (Linociera) *picropldoia* is intensely bitter, and it may be administered in intermittent fevers, like that of some other plants of the oleaceous order.

The barks of the following plants yield textile fabrics, but we have as yet no means of calculating whether the expense attending their gathering and preparation stands in proportion to their mercantile value:—*Pipturus propinquus* (Wedd.), a tree ranging from the north of New South Wales through the littoral mountains of Queensland. *Brachychiton populneum* (R. Brown), occurring from the eastern parts of Victoria to the southwestern parts of Queensland. *Brachychiton Delabechei* (F.M.), the true bottle tree of the Brigalow scrubs of New South Wales and Queensland. *Abutilon oxycarpum* (F. M.), a shrub of various parts of New South Wales and Queensland, and replaced in other parts of Australia by many different kinds of Sida, Abutilon, and other malvaceous plants, yielding likewise textile fabrics; as, for instance, that of *Hibiscus tiliaceus*, which is extensively used in tropical Australia as well as India, the Pacific groups, and elsewhere, by the natives for fishing nets, cordage, &c.

Barks from Various Parts of Australia.

Pimelea Clavata: (Lab.).—The bark of this shrub was sent by Pemberton Walcott, Esq., of Warren River, West Australia. The species is not unfrequent in that part of Australia. The bark is extremely tough, and largely employed by the natives for their nets, fishing lines, and kindred objects. The exhibitor is of opinion that the bark could be profitably collected for textile fabrics. If so, it is the only species of sufficiently large and gregarious growth to render the fibre commercially available. A beautiful fibre, of similar utility to the natives of Queensland and to the Yarra tribe, is gained from *Pimelea hypericina* (Cunn.), *Pimelea pauciflora* (R. Br.), and *Pimelea axiflora* (F. M.), all tall species of our forest gullies, the two former occurring likewise in Tasmania. The Murray River natives use the bark of *Pimelea microcephala*, a shrub of the desert.

The numerous Pimeleæ are, perhaps, of greater significance as medicinal plants. The acridity of their bark is more or less analogous to that of *Daphne mezereum;* the bark of *Pimelea stricta* (Meissn.), from St. Vincent's Gulf, being the most acrid of all. The proportion of acrid resin, on which the blistering properties depend, has as yet not been ascertained in any of our species.

Tanners' Material.

The inquiries into the value of a series of indigenous substances likely recommendable for tanners' use, instituted in our phytochemical laboratory, have not as yet progressed far, the processes of investigation involving considerable sacrifices of time. It is intended to contrast the percentage of tannic acid contained in barks already in use here with that of many others probably much richer. Besides, it will be of importance to ascertain the extent of tannizing principles of the gum-resins exuded by the various eucalypts, and to tabulate also the relative quantity of tannic acid in many kinds of foliage. In an annexed table the first results are given of the analyses instituted with great care and patience by Mr. C. Hoffmann. Of many eucalypts the resinous exudations may be obtained in rather large quantity and with great convenience. The supply available at the places where the artisans of sawmills or splitters operate is actually boundless. Often the resin is most easily obtained while still in a state of solution, from which it is readily reduced to dryness or concentration. In either form the gum-resin might constitute an extensive article even of export. The following kinds are exhibited:—

- Gum-resin of *Eucalyptus corymbosa* (Sm.), the Blood wood tree of Gippsland and New South Wales.
- Of *Eucalyptus amygdalina* (Labill.), the Messmate tree of some districts of Victoria; also found in Tasmania.
- Of *Eucalyptus leucoxylon* (F. M.), a tree not uncommon in South Australia, Victoria, and New South Wales.
- Of *Eucalyptus rostrata*, the Red Gumtree, so universal in Australia. This special kind is preferred to others as a therapeutic, a stringent, and is particularly administered in Europe and India in cases of diarrhoea which assumed a chronic state. To this category of objects belongs also a sample of Venetian sumach, or scotino, obtained from *Rhus cotinus*, cultivated in the Melbourne Botanic Gardens. There is nothing to prevent this plant being reared here quite as well as on the Mediterranean shores as a dye and tanning article. Tanners' bark, after having served its purpose, might perhaps in some instances be utilised as paper material, and as a source of acetic acid. In reference to this subject, Mr. Hoffmann instances the patent of Mr. A. P. Halliday, of Salford. The coal even is utilised again for steel manufacture, for manure, and for deodorising purposes. Merely to show that the tanning substances could also be employed for writing ink, the bark of *Acacia penninervis* was chosen as a source of tannic acid for the ink exhibited. For black and some other dyes, several of the barks alluded to are available.

Table Showing the Percentage of Tannic (Tannin) and Gallic Acid in the Bark of some Victorian Trees.

These proportions are the mean of two closely agreeing analyses, and have in some cases been further corroborated by a third analysis.

List of Preparations from the Phytochemical Laboratory of the Botanic Garden.

Description of Specimen.

Wood Spirit Prepared from Wood of—

- Casuarina quadrivalvis
- Banksia Australia
- Acacia melanoxylon
- Melaleuca ericifolia
- Acacia mollissima
- Eucalyptus leucoxylon
- Eucalyptus obliqua
- Eucalyptus globulus
- Eucalyptus rostrata
- Angophora intermedia

Acetic Acid Prepared from Wood of—

- Casuarina quadrivalvis
- Banksia Australis
- Acacia melanoxylon
- Melaleuca ericifolia
- Acacia mollissima
- Eucalyptus leucoxylon

- Eucalyptus obliqua
- Eucalyptus globulus
- Eucalyptus rostrata
- Angophora intermedia

Tar Prepared from Wood of—

- Casuarina quadrivalvia
- Banksia Australis
- Acacia melanoxylon
- Melaleuca ericifolia
- Acacia mollissima
- Eucalyptus leucoxylon
- Eucalyptus obliqua
- Eucalyptus globulus
- Eucalyptus rostrata
- Angophora intermedia

Charcoal Prepared from Wood of—

- Casuarina quadrivalvis
- Banksia Australis
- Acacia melanoxylon
- Melaleuca ericifolia
- Acacia mollissima
- Eucalyptus leucoxylon
- Eucalyptus obliqua
- Eucalyptus globulus
- Eucalyptus rostrata
- Angophora intermedia.
- Pure Wood Spirit, prepared from wood of Eucalyptus globulus.
- Pure Acetic Acid, prepared from wood of Eucalyptus globulus.
- Grey Acetate of Lime, the "distilled wood-vinegar" employed in its preparation, obtained from wood of E. globulus.
- A portion of the foregoing preparation purified.
- Acetate of Soda, prepared from a portion of the sample No. 43.
- Proto-acetate of Iron. The crude Acetic Acid employed in its preparation obtained from wood of E. globulus.

  Samples illustrating the application of the foregoing as a mordant and a dye.
- A piece of woollen material mordanted with a portion of the Proto-acetate of Iron (specimen No. 46).
- A piece of cloth mordanted with a portion of the same preparation as the foregoing.
- A piece of cloth mordanted with a portion of the Proto-acetate of Iron (specimen No. 46), and finished off with logwood.
- A piece of cloth dyed with a portion of the Proto-acetate of Iron (specimen No. 46) and Red Prussiate.
- Acetate of Peroxide of Iron—Sesqui-acetate of Iron. The acid employed in its preparation derived from the same source as that employed in the preparation of the Proto-acetate.
- Samples illustrating the application of the foregoing as a mordant.
- A piece of woollen material mordanted with a portion of the Sesqui-acetate of Iron (specimen No. 47).
- Sesqui-acetate of Alumina. Red Liquor. Acetate of Lime employed in its pre-paration, prepared from Acetic acid, obtained from wood of E. globulus. Samples illustrating the application of the foregoing as a mordant.
- A piece of cloth mordanted with a portion of the red liquor (specimen No. 48), and dyed with logwood.
- A piece of cloth subjected to the same treatment as the foregoing, in which, however, a trifling quantity of magenta has been employed in addition to the logwood.
- Varnish prepared from the gum-resin of Xanthorrhœa Australis, dissolved in Wood Spirit prepared from wood of E. globulus.
- Wood Vinegar Tar.
- Wood Vinegar Tar Residue.

- Residue left after treatment of the Wood Vinegar Tar Residue with boiling water.
- Wood coated with some of the Wood Vinegar Tar (specimen No. 50).
- Wood coated with some of the Tar (specimen No. 28).
- Wood coated with some of the Xanthorrhœa Varnish (specimen No. 49).
- Writing Ink, in the making of which the bark of Acacia penninervis has been employed in the place of galls.
- Tea made from plants growing in the Botanical Gardens.
- Picric Acid, prepared from the gum-resin of Xanthorrhœa Australis.

  Samples illustrating the application of the foregoing as a dye.
- A piece of Silk dyed with some of the Picric Acid (specimen No. 58).
- A piece of Silk dyed with some of the Picric Acid (specimen No. 58), and Extract of Indigo.
- Snuff prepared from Myriogyne minuta.
- Aqueous extract prepared from the leaves of E. Stuartiana.
- Essential Oil distilled from the leaves of E. Stuartiana.
- Paper made from—
  - Stems and leaves of Dichelachne crinita.
  - Bark of Acacia penninervis.
  - Stems of Cyperus vaginatus.
  - Stems of Cyperus lucidus.
  - Leaves of Casuarina leptoclada.
  - Leaves of Casuarina quadrivalvis.
  - Bark of Eucalyptus leucoxylon.
  - Bark of Eucalyptus obliqua.
  - Bark of Eucalyptus obliqua, bleached
  - Bark of Eucalyptus Stuartiana.
  - Bark of Eucalyptus longifolia.
  - Bark of Eucalyptus globulus,
  - Bark of Eucalyptus rostrata.
  - Bark of Eucalyptus goniocalyx.
  - Bark of Eucalyptus amygdalina.
  - Bark of Eucalyptus corymbosa.
  - Stems of Heleocharis sphacelata.
  - Stems of Heleocharis acuta.
  - Stems of Juncus vaginatus.
  - Stems of Lepidosperma gladiatum.
  - Bark of Melaleuca squarrosa.
  - Bark of Melaleuca ericifolia.
  - Leaves of Phormium tenax.
  - Leaves and stems of Stipa semibarbata,
  - Stems of Scirpus lacustris.
  - Stems of Scirpus maritimus.
  - Leaves of Typha augustifolia.
  - Fibre of Oedogonium, &c.
  - Leaves and stems of Xerotes longifolia.
  - Leaves of Xanthorrhœa minor.
  - Bark of Boehmeria nivea, the Chinese grasscloth plant, grown in the Botanic Gardens.
- Sumach prepared from plants of Rhus Cotin us growing in the Botanical Gardens.
- Young Fustic, prepared from plants growing in the Botanical Gardens.
- Opium, from Poppy plants growing in the Botanical Gardens.
- Extract of Poppy Heads, prepared from plants growing in the Botanical Gardens.

Raw Material for Paper.

Fibre from Bark of Eucalyptus—

- E. Stuartiana.
- E. Obliqua.

- E. Longifolia.
- E. Amygdalina.
- E. Corymbosa.
- E. Leucoxylon.

Vegetables Used for Food by the Aborigines.

Two collections occur in the Exhibition—one illustrating the alimentary substances obtained from plants by the natives in the more northern parts of Queensland. This collection owes its existence almost entirely to the strenuous efforts made by M. Thozet to obtain information on the subject, whose elaborate detailed remarks are appended. In cases of emergency even travellers might derive great advantage from the information thus brought together through that gentleman's intelligent assiduity.

The second collection was forwarded by E. M. Officer, Esq., on the Wim-mera River. It comprises the following kinds:—Roots of *Arthropodium setosum*, F. M.; *(Dichopogon setosus Kunth); Arthropodium laxum*, Sieb.; *Geranium dissectum*, L.; *Convolvulus erubescens*, Sims; *Prasophyllum patens*, R. Br.; *Anthericum bulbosum*, R. Br.; *Rumex bidensy* R. Br.; *Microseris Forsteri*, J. Hook.; *Scirpus maritimus*, L.; *Typha augustifolia*, L.; *Triglo-chin procerum* R. Br.; *Lyperanthus nigricans*, R. Br.; *Sieber a ericoides*, Benth.; *Diuris palustris*, Lindl.; youug roots of *Xanthorrhcea Australis;* flowers (rich in mellaginous sap) of *Banksia ornata*, F.M.; fruits of *Styphelia adscendens*, R. Br.

There are very many other substances used as edibles by the aboriginals, but on this occasion only those could come under review which were in reality sent to the Exhibition. The laudable example set to elucidate this subject should be followed up in other parts of Australia before the aboriginal population passes away.

List of Some of the Roots and Fruits Used as Vegetable food by the Aboriginals of Northern Queensland, Australia. by a. Thozet, esq.

Without Preparation.

Roots.

1. HIBISCUS heterophyllus, Vent. Native Sorrel. *Batham*,—Banks of rivers and creeks, occasionally on plains. A rather tall shrub, part of the stem and young branches covered with small prickles. Leaves entire or lobate. Flower white and pink or yellow, with purple centre. (Roots of young plants, young shoots, and leaves eatable.)

2. BRACHYCHITON platanoides, R. Br. Platan-leaved Bottle-tree. *Ketey*.—In scrub land. A tree of a beautiful pyramidal growth when young, becoming enlarged in the centre with old age. (Roots of young plants eatable.)

3. BRACHYCHITON Delabechei, F. Muell. Bottle-tree. *Binkey*.— Generally in stony scrub land. Remarkable by its enlarged trunk, similar in shape to a lemonade bottle; some measure six to eight feet in diameter. (Roots of the young plants eatable.) The natives refresh themselves with the mucilaginous sweet substance afforded by this tree, as well as make nets of its fibre. They cut holes in its soft trunk, where the water lodges and rots them to the centre, thus forming so many artificial reservoirs. On their hunting excursions afterwards, when thirsty, they tap them one or two feet below the old cuts, and procure an abundant supply.

4. VITIS opaca, F. Muell. Round Yam. *Yaloone* (large); *Wappoo Wappoo* (small).—In clayey soil. Small creepers; leaflets usually three, four, or five, dark green and smooth. Berries black and globular. Tubers very numerous, some weighing five to ten pounds. Eaten in hot weather like water-melons (the small and young are the best); they are, however, difficult to digest. Probably the yam alluded to by Leichhardt; in his "Journal of an Overland Expedition," page 150, he says—"Both tubers and berries had the same pungent taste, but the former contained a watery juice, which was most welcome to our parched mouths."

5. DIOSCOREA punctata, R. Br. Long Yam. *Kowar*.—In scrubs and creeks. A small rough, twining creeper. Leaves heart-shaped and smooth. Flowers terminal The clusters of the winged capsule look, to an unacquainted observer, like the flowers of the common hop. (Small young tubers eatable.)

6. HELEOCIIARIS sphacelata, R. Br. Rush. *Kaya*.—Lagoons, creeks, and ponds. Small, almost spherical tubers, six to twelve on each plant.

Stems or Flower-Stalks.

7. NYMPHÆA gigantea, Hook. Blue Waterlily. *Yako Kalor* (Rkh. tribe), *Kaooroo* (Clev. B. tribe).—Abundant in all lagoons and ponds. Flower-stalks of the unexpanded flowers, after being broken and deprived of their fibrous part, are eatable.

8. XANTHORRHÆA sp. Grass Tree. *Kono*.—Over ridges and mountain sides. Small part of the extremities of the young shoots, and the white tender base of leaves, eatable.

9. LIVISTONIA Australis, Mart. Cabbage-tree Palm. *Konda*.—In valleys and gorges. 70 to 120 feet in height. (White part of the undeveloped leaves eatable.) " Several of my companions suffered by eating too much of the cabbage palm."—*Leichhardt'8 0. L. Expedition*, page 72.

Fruits.

10. MELODORUM Leichhardtii, Benth. *Merangara*.—Scrub. A small shrub, sometimes a strong tall creeper. Bark aromatic. Producing in the top of our scrub trees an oblong or almost round fruit, with one or two seeds.

11. CAPPARIS Mitchelli, Lindl. Wild Pomegranate. *Mondo*.

The aboriginal name is given in allusion to the heel of a native, the fruit when ripe resembling that part of the foot.

—In open plains. A small tree of a very crooked growth. Bark longitudinally fissurated. Trunk and branches covered with short prickles, the branches nearly always drooping. Flowers white. Fruit large, oblong or spherical, 2 to 3 inches in diameter.

12. CAPPARIS canescens, Banks. Native Date. *Mondoleu*.

Diminutive of *Mondo*.

—In scrub and open forest land. A creeper, ascending shrubs or large trees, with stipulate hooked prickles. Leaves oblong. Flowers white. Fruit pyriform, ½ inch diameter.

13. CAPPARIS nobilis, F. Mueller. Small Native Pomegranate. *Rarum*.—In scrub. A small tree, with prickles on the branches. Leaves oval-oblong. Flowers white. Fruit globular, 1 to 1½ inch in diameter, with a small protuberance at the end. Small, almost spherical tubers, six to twelve in each plant.

14. GREWIA polygama, Roxb. Plain Currant. *Karoom* (Rockh. tribe), *Ouraie* (Clev. Bay tribe).—Among grass. A small shrub. Large, alternate, ovate, serrated leaves. Berries brown and smooth, two or four in an axillary peduncle. Leichhardt speaks of this small plant in his Journal, page 295—"I found a great quantity of ripe Grewia seeds, and on eating many of them it struck me that their slightly acidulated taste, if imparted to water, would make a very good drink; I therefore gathered as many as I could, and boiled them for about an hour; the beverage which they produced was at all events the best which we had tasted on our expedition, and my companions were busy the whole afternoon in gathering and boiling the seeds." The same explorer states also that *d l'instar* of the natives they obtained another good beverage by soaking the blossoms of the tea tree *(Melaleuca leucadendron)*, which were full of honey, in the water used for drinking.

15. SPONDIAS pleiogyna, F. Muell. Sweet Plum. *Rancooran*.—Scrub. A beautiful tree with erect trunk and pinnate glossy leaves. Eatable part *(sarcocarp)* red.

16. RHAMNUS Vitiensis, Benth. *Murtilam*.—Scrub. A tree. Trunk and branches whitish. Leaves very smooth, shining, serrate, crenulate, and green on both sides. Berries ¼ inch diameter.

17. ZTZYPHUS jujuba, Lam. Torres Straits Jujube Tree.—The trunk and branches covered with prickles. Leaves ovate, rarely orbicular, green, smooth above, and white tomentose underneath. Fruit ovoid, yellow when ripe, ½ to ¾ inch diameter.

18. RUBUS rosæfolius, Sm. Native Raspberry. *Neram*.—In creeks and valleys.

19. TERMINALIA oblongata, F. Muell. *Yananoleu*.—Scrub and open forest. A large tree, with branches spreading almost horizontally. Spikes a little longer than the leaves, with white yellowish flowers. Fruit purple, flattened and winged.

20. BARRINGTONIA careya, F. Muell. Broad-leaved Apple Tree. *Barror*.—In open forest—alluvial soil. A small tree. Flowers white and pink. Fruit like a middle-sized apple.

21. EUGENIA my rtifolia, Sm. *Buyan Buyan*.—In creeks. Rich bright foliage, with abundant white blossoms. Fruit rose and red, pyriform and drooping.

22. CUCUMIS jucunda, P. Muell. Native Cucumber. *Pumpin*.—On rich alluvial soil and amongst grass. Fruit from ½ an inch to ¾ of an inch in diameter and 1 to 1½ inch in length. The natives bite off one end, press the pulpy substance and seeds into their mouths, and throw away the outer skin or rind, which is very bitter.

23. SARCOCEPHALUS cordatus, Miq. Leichhardt's Tree. *Toka* (Rockh. tribe), *Taberol* (Clev. B. tribe).—Banks of rivers and creeks. Stem erect. Leaves broad, oblong, deciduous. Flowers globular and fragrant. Fruit 1½ to 2 inches diameter, usually spherical, but varying much in shape, very soft when ripe, pulp

slightly bitter.

24. TIMONIUS Ruinphii, Cand. *Kavor Kavor*.—Beds of creeks. Fruit ½ inch in diameter, in shape not unlike the crab apple of Europe.

25. MABA geminata R. Br. Scrub box, or ebony. *Ronone*.—In scrub. A small tree, with dark scaly bark. Leaves ovate or obovate, almost sessile. Fruit small, egg-shaped, orange red when ripe.

26. ACHRAS Australis, R. Br. *Baleam*.—In scrub. A tall straight tree. Bark thin, grey yellowish. Leaves obovate, obtuse. Fruit as big as a middle-sized plum, with four or five smooth, shining, flattened seeds.

27. CARISSA ovata, R. Br. Nativo Scrub Lime. *Karey* (Rockh. tribe), *Ulorin* (Clev. B. tribe).—In scrub. A small prickly shrub. Flowers white, fragrant. Fruit, ½ inch diameter, egg-shaped.

28. MYOPORUM diffusum, R. Br. *Amulla*.—Among grass. A diffuse, almost prostrate, small herbaceous plant. Leaves alternate dentate at their base, lanceolate, acute. Fruit ¼ of an inch diameter, on an axillary solitary peduncle, white and pink when ripe, slightly bitter.

29. EXOCARPUS latifolius, R. Br. Native Cherry. *Oringorin*.—In scrub. A small tree. Bark almost black, scaly. Leaves thick, dark green. Fruit—red when ripe.

30. FICUS aspera, Forster. Rough-leaved Fig-tree. *Noomaie* (Rockh. tribe), *Balemo* (Clev. B. tribe).—In scrubs and plains. Fruit black when ripe.

31. FICUS vesca, F. Mueller. Leichhardt's Clustered Fig-tree. *Parpa*.—In scrubs, banks of rivers and creeks. A good-sized tree. Leaves ovate, lanceolate, acute, dark, smooth, green above, and pale green underneath. The fruit, which is of a light red colour when ripe, hangs in clusters along the trunk, and on some of the largest branches.

32. PIPTURUS propinquus, Wedd. Native Mulberry. *Kongangn*.—In creeks. A soft shrub, almost herbaceous. Leaves broadly ovate, serrate, acuminate, tomentose, and white underneath. Fruit white, transparent.

33. MUSA Banksii, F. Mueller. Native Banana. *Morgogaba* (Clev. B. tribe).

34. PANDANUS pedunculatus, R. Br. Screw Pine. *Kaor*.—Principally on the sea coast. The eatable part is the side of the seeds adhering to the rachis.

Seeds.

35. NELUMBO nucifera, Gaertn. Pink Water Lily. *Aquaie*.—In lagoons. A splendid aquatic plant. The stalk of the leaves erect; the latter peltate, slightly concave, one or two feet diameter. Flowers pink, live to eight inches diameter. Seeds, 20 to 35; more than three-quarters imbedded in a large flat-topped torus.

(2 *bis)* BRACHYCHITON platanoides, R. Br.

(3 *bis)* BRACHYCHITON Delabechei, Ferd. Mueller.

37. STERCULIA quadrifida, R. Br. *Convavola*.—In scrubs and creeks. Leaves ovate or cordate. The pod, which contains three to six black ovoid seeds, is of a bright crimson colour when ripe.

(7 *bis)* NYMPILEA gigantea, Hook.

With Preparation.—baked Only.

Roots.

37. PHASEOLUS Mungo, Linn. *Komin* (Rockh. tribe), *Kadolo* (Clev. B. tribe).—Found slightly twining among grass. Stems and branches hairy. Leaflets 3, narrow, 3 to 4 inches long, acute. Flowers pale yellow. Pod cylindrical, 2 to 4 inches long. Roots the shape of small long carrots.

38. ACACIA Bidwilli, Benth. Bid will's Acacia. *Waneu.*—Usually in stony ridges. A small tree, prickly when young. Small leaflet 15 to 25 pairs, J inch long. (Roots of the young plants eatable).

(5 *bis)*. DIOSCOREA punctata, R. Br. Large old roots.

(6 *bis*). HELOCHARIS sphacelata, R. Br. The small tubers, baked, are roughly pounded between two stones, and made in the same shape as almond cake.

(7 *ter)*. NYMPHÆA gigantea, Hook. The tubers.

39. APONOGETON sp. *Warrumbel* (Rkh. tribe), *Koornabaie* (Cl.B. tribe.)—Shallow water in lagoons and ponds. A small aquatic plant. Leaves oblong, lying on the surface of the water. Rachis erect. Flowers numerous, small, and yellow. Tubers spherical, ½ in. to 1 in. in diameter.

Stems.

40. DENDROBIUM canaliculatum, R. Br. *Yamberin*.—Very abundant on the decayed trunks and branches, principally of gumtree. (The bulbous stems, after being deprived of the old leaves, are eatable.)

Pod.

(36 *bis)*. STERCULIA quadrifida, R. Br.—The mucilaginous substance of the unripe pod eatable.

Fruits.

41. AVICENNIA offinalis. Mangrove. *Egaie* (Clev. Bay tribe), *Tagon Tagon* (Rkh. tr.).—Generally in estuaries of rivers and creeks. A small tree, but some-times attaining 18 inches in diameter. Small numerous roots protrude at the base of the crooked trunks. Leaves pale green above, and white tomentose underneath. Fruit heart-shaped, with two thick cotyledons. The aboriginals of Cleveland Bay dig a hole in the ground, where they light a good fire; when well ignited they throw stones over it, which, when sufficiently heated, they arrange horizontally at the bottom, and lay on the top the *Egaie* fruit, sprinkling a little water over it; they cover it with bark, and over the whole earth is placed, to prevent the steam from evaporating too freely. During the time required for baking (about two hours), they dig another hole in the sand; the softened *Egaie* is put into it; they pour water twice over it, and the *Midamo* is now fit for eating. They resort to that sort of food during the wet season, when precluded from searching for any other.—*Murrell's Testimony*. (The late James Murrell was a wrecked sailor, who lived seventeen years amongst one of the Cleveland Bay tribes, in Northern Queensland, Australia). Near Mount Elliott and Cleveland Bay, there is also an eatable root, *Wangoora*, probably a species of Ipomæa. The roots, very bitter, are cut in two, put into water for one hour or one hour and a half, and are afterwards baked for three or four hours, in the same way as the *Egaie;* they then carry it in a dilly bag *(Yella barda)* to the water's edge, where, by pouring water over and pressing it, they make the starch fall upon the bark in the same way as arrowroot falls from the cylinder into the trough; they wash it three or four times until the water is very clear, and the yellow fecula is then fit for use.—*Murrell's Testimony*. This plant may be the same as the one alluded to by Leichhardt, page 284:—"I tried several methods to render the potatoes, which we had found in the camps of the natives, eatable, but neither roasting nor boiling destroyed their sickening bitter-ness; at last, I pounded and washed them, and procured the starch, which was entirely tasteless, but thickened rapidly in hot water like arrowroot, and was very agreeable to eat, wanting only the addition of sugar to make it delicious—at least, so we fancied."

Poisonous in a Raw State.

Tubers—pounding, Desiccation.

42. CALADIUM macrorhizon, Vent. *Hakkin* (Rockh. tribe), *Banganga* or *Nargan* (Clev. Bay tribe).—In moist shady places. A strong herbaceous plant, with very largo sagittate leaves. The young bulbs, of a light rose colour inside, found growing on large old rhizomes, are scraped, and divided into two parts, and put under the ashes for about half an hour. When sufficiently baked, they are then pounded by hard strokes between two stones—a large one, *Wallarie*, and a small one, *Kondola*. All the pieces which do not look farinaceous, but watery when broken, are thrown away; the others, by strokes of the *Kondola*, are united by twos or threes, and put into the fire again; they are then taken out and pounded together in the form of a cake, which is again returned to the fire and carefully turned occasionally: this operation is repeated eight or ten times, and when the *Hakkin*, which is now of a green greyish colour, begins to harden, it is fit for use.

43. TYPHONIUM Brownii, Schott. *Meirin*.—In sandy shady places. A small herbaceous plant. Leaves sagittate, entire, or three lobate. Flowers purple, dark, of a disagreeable odour. The tubers, which are yellow inside, are manipulated in the same way as the *Hakkin* but none are watery, and they are made to adhere together after the first roasting.

Seeds—pounding, Maceration, Desiccation.

44. ENTADA scandens, Benth. *Barbaddah* (Clev. B. tr.)—A strong climber. Pod 2 to 4 feet in length, and 3 to 4 inches in breadth. The seeds, 1½ to 2 inches diameter, are put into the stove oven and heated in the same way, and for the same time as the *Egaie;* they are then pounded fine and put into a dilly-bag, and left for ten or twelve hours in water, when they are fit for use.—*Murrell's Testimony*.

45. CYCAS media, R. Br. Nut Palm. *Baveu*.—Very common on the mountain sides and in valleys. A graceful tree, with a crown of fruit the size of a walnut, yellow when ripe. The nuts are deprived of their outer succulent cover *(sarcocarp)*, and are then broken; and the kernels having been roughly pounded, are dried three or four hours by the sun, then brought in a dilly-bag to the water stream or pond, where they remain in running water four or five days, and in stagnant water three or four days. By a touch of the fingers the proper degree of softness produced by maceration is ascertained. They are afterwards placed between the two stones mentioned,

reduced to a fine paste, and then baked under the ashes in the same way that our bush people bake their damper.

Seeds—pounding, Maceration.

46. ENCEPHALARTOS Miquelii, Ferd. Mueller. Dwarf Zamia. *Banga*.—Mountains and valleys. Found generally in the same locality as the palm nut, with a large cone-fruit not unlike a pine-apple. The seeds, orange red when ripe, and separating freely, are baked for about half an hour under ashes; the outside covers and the stones are then broken, and the kernels, divided by a stroke of the *Kondola*, are put into a dilly-bag and carried to a stream or pond, where they remain six or eight days before they are tit for eating.

47. ENCEPHALARTOS Denisonii, Ferd. Mueller. Leichhardt's aborescent Zamia. Prepared in the same way as E. Miquelii.

Appendix.

THE colouring principle of all the following barks is perfectly soluble in water; cotton, woollen, and silken goods dyed with the aqueous infusion assumed the colours below specified.

The affinity of vegetable tissues for colouring matter being in general not so great as that of animal tissues, the woollen material was in nearly all cases dyed of a more decided and darker colour. The exceptions were—the infusion of the bark from the root of *Sarcocephalus cordatus*, and the infusion of the bark of *Alstonia constricta;* with these, cotton, woollen, and silken material assumed a colour of equal intensity.

Ranged according to their percentage of tannin the barks would stand thus:—

The barks of *Acacia harpophylla*, *Petalostigma quadriloculare*, and *Melodorum Leichkardtii* rank first; they afford highly astringent infusions, and evidently contain a notable amount of tannin. Next come the barks of *Croton insulare*, and *Rhamnus Vitiensis;* then the barks of *Chionanthus picrophloia*, *Xanthoxylon brachyacanthum Erythroxylon Australe*, and *Guettardella putaminosa*. Lastly, the barks of *Sarcocephalus cordatus*, *Alstonia constricta*, and *Morinda tinctoria*.

The bark of *Croton insulare*, on being distilled with water, yields an oil of an agreeable spicy odour, not unlike mace.

The bark of *Melodorum Leichkardtii* likewise yields an oil, on being distilled with water, possessing a pleasant cinnamon odour.

I.—COTTON FABRIC. II—WOOLLEN FABRIC. III.—SILKEN FABRIC. Name of Bark. From Colour of the Dyed Fabric. The Dyed Fabric wrought through a solution of a fixed alkali: colour changed to The Dyed Fabric wrought through a solution of an acid: the colour was The Dyed Fabric wrought through a solution of bichromate of potash: colour changed to Colour of the Dyed Fabric. The Dyed Fabric wrought through a solution of bichromate of potassa: colour changed to The Dyed Fabric wrought through a solution of proto-sulphate of iron: colour changed to Colour of the Dyed Fabric. The Dyed Fabric wrought through a solution of extract of indigo: colour changed to Bark of Chionanthus picrophloia Queensland Pale brownish yellow Brownish yellow Render'd paler but brighter Pale brown Pale brownish yellow Brownish yellow Greenish yellow— Bark of Acacia harpophylla "Palo reddish brown Light reddish brown" Dark brown Reddish br'wn Dark brown Dark dingy olive green— Bark of Xanthoxylon brachyacanthum "Pale brownish yellow Brownish yellow" Pale brown Brownish vol- low Dark brownish yellow Greenish yellow— Bark of Croton insulare "Pale reddish brown Light reddish brown" Dark reddish brown Pale reddish brown Light brown Pale dingy olive green— Bark of Petalostigma quadriloculare "Pale brownish yellow Brownish yellow" Dark brownish yellow Brownish yellow Light brown Dark dingy olive green— Bark from root of Sarcoceph alus cordatus "Bright canary yellow Yellow" Yellow faintly ting'd brown Bright canary yellow Yellow faintly ting'd brown Dull yellow Golden yellow Pretty sea green Bark of Melodorum Leichhardtii "Pale brownish red Bright light red" Dark rich brownish red Bright brownish red Dark brownish red Dark dingy olive green— Bark of Erythroxy-lon Australe "Pale brownish yellow Brownish yellow" Light brown Pale brownish yellow Light brown Greenish yellow— Bark of Rhamnus vitiensis "Palo reddish brown Reddish br'wn" Light brown Pale reddish brown Dark brown Pale dingy olive green— Bark of Guettar-della putaminosa "Pale brownish yellow Brownish yellow" Brownish yellow Brownish yellow Dark brownish yellow Greenish yellow— Bark of Alstonia constricta "Canary yellow Canary yellow" Yellow faintly ting'd brown Canary yellow Yellow faintly ting'd brown Dull yellow Bright canary yellow Rich grass green Bark from root of Morinda tinctorial N. Caledonia Pale orange yellow Pale orange yellow Changed to dull yellow Pale reddish brown Dull orange yellow Dark dull orange yellow Light brown—

Two Papers on the Vertebrata of the Lower Murray and Darling;

And on the Snakes of Sydney,

Read before the Philosophical Society of New South Wales, 10*th September*, 1862,

By Gerard Krefft.

Sydney: Reading and Wellbank, Printers, Bridge Street 1865

On the Vertebrata of the Lower Murray and Darling;

Their Habits, Economy, and Geographical Distribution.

SOME of the observations embodied in this paper date back as far as the year 1852, but the greater number are the results of a nine months' sojourn on the Lower Murray and Darling, where, encamped in the neighbourhood of Gol Gol, I was enabled, with the assistance of Messrs. Williams and their devoted natives, to thoroughly investigate the fauna of that part of Australia.

I cannot speak too highly of the valuable co-operation of these gentlemen, the same whom Mr. Landsborough met on his return journey at the Warrego pushing on towards the Gulf, and whom he designates "the best of Australian Bushmen."

The Placental Mammals of this district are of course few. They belong to the Bats, (*Nyctophilus, Scotophilus, Rhinolophus,*) the Rodents, (*Hydromys, Hapalotic, Mus,*) and the Carnivora, which are represented here, as in the rest of Australia, by the Dingo alone.

Cheiroptera.

The Bats of the Murray and Darling all belong to the family Vespertilionidæ, as the large so-called "Vampire Bat" or "Flying Fox" *(Pteropus)* is not found in those regions.

Owing to the superstitions of the natives, who look upon every Bat as a departed friend and relative, who according to their ideas with regard to the transmigration of souls, has seen better days among themselves, has thrown spear and boomerang, and feasted upon Kangaroo, Wallaby, and Emeu, the number of Bats collected during my journey was very limited indeed.

When at Gunbower Creek I caught the first of these creatures, and I was seriously informed by the natives, that it was "brother belonging to black-fellow, who will kill lubra if you kill him."

Farther down the river this superstition vanished more and more; still they never assisted in procuring specimens of this family.

The following are the species collected:—

1. NYCTOPHILUS GEOFFROYI.

Geoffroy's Nyctophilias—

observed at various places between Gunbower Creek and the Junction of the Darling.

2. SCOTOPHILUS PUMILUS.

The Little Bat—

of which a single specimen was caught near Milldura, 20 miles from the Darling.

3. SCOTOPHILUS MORIO.

Chocolate Bat—

specimens of which have been captured on the Lower Darling. I have been informed that a "tailed Bat" was also an inhabitant of that part of Australia, but I did not succeed in securing a specimen. I suppose that it is a new species of the genus Molossus, of which only a single representative is as yet described from this country, discovered some years ago by the late Dr. L. Becker, in the neighbourhood of Melbourne.

4. RHINOLOPHUS MEGAPHYLLUS.

The Large-leaved Horse-Shoe Bat—

frequently observed near Gunbower Creek.

Carnivora.

CANIS DINGO.

The Dingo, Warrigal of the natives, is the only Australian representative of the large Group of carnivorous animals inhabiting every other part of the globe: and as our "Native Dog" has already established a reputation for himself, I shall be as brief as possible. In spite of the many enemies of the Dingo he is as plentiful as ever on the Lower Murray and Darling; neither the strychnine of the settlers, nor the guns or spears of the Aboriginals could exterminate the breed: which no doubt is also maintained by stray shepherds' dogs—not all the so-called Dingos being of the pure "Warrigal" blood.

There is a black and tan coloured variety. Various litters taken by myself had generally four pups, sometimes a pair of each colour. The natives, who hate the Dingo most cordially for his living on the fat of the land, kill him on every opportunity and eat his flesh, which is by no means of ill flavour, though I have partaken of it under stress of hunger, and I will not vouch that I should sit down to roast Dingo with the same gusto now as ten years ago in the Murray scrub.

A question has been raised as to the origin of the Dingo in Australia, and several high authorities are of opinion that the dog was introduced there by man; if so, this must have been at a very remote age, as the first molar tooth of a dog has been found with other fossil remains in the breccia of the Wellington caves.

In those days of *Diprotodons*, not only did the Dingo exist, but also some of the animals now restricted to the island of Tasmania, as *Thylacinus* and *Sarcophilus*, teeth of which I have discovered in the same breccia, and which are now on view at the Australian Museum.

Rodentia.

The third group of the Australian Mammalia consists of the Rodents, which are largely represented, and, to some extent, partake of the structure of the Kangaroo; many having their hind limbs much elongated, and moving by a succession of jumps, in which they use the hind legs only. A few (4 species) are aquatic (*Hydromys*), expert swimmers and divers, and a great many are arboreal, and apparently the representatives of the squirrels in Australia.

All the species observed by me on the Lower Murray, are strictly nocturnal, and all bring forth 4 young ones (born blind) at a time.

1. HYDROMYS CHRYSOGASTER.

Golden-bellied Beaver Rat.

All the specimens of this rat procured by me are from Gun-bower Creek and Lake Boga, where this animal re very plentiful. It is strictly nocturnal, and was often observed after sundown, gambolling upon the shores of that beautiful lake. The Black Snake is a sore enemy to the young progeny of this *Hydromys*; for I captured a specimen, which, upon being opened, proved to have swallowed a full dozen young Beaver Rats, about the size of new-born kittens.

This Rat is not found on the Lower Darling, at least, I was assured by the natives that they had never seen it.

2. HAPALOTIS CONDITOR.

Building Hapalotis.

Koel or Kohl of the natives.

Captain Sturt described this animal first, though Sir Thomas Mitchell mentioned it before him.

It is one of the many species which will soon be extinct, as I found that it had already retreated before the herds of sheep and cattle across the Murray. Only a few empty nests were occasionally met with south of that river. The few specimens collected were captured by the natives about 10 miles north of the Darling Junction; though many empty nests, or rather huts, were met with, occupied by *Hapalotis apicalis*, which, it appears, often takes a fancy to the roomy structures of the building *Hapalotis*, and ejects the original inhabitant. I kept both species together in a box, but they never agreed, and, though the building *Hapalotis* is much larger in size, it could never hold its own against *Hapalotis apicalis*. They feed on various seeds, bulbous roots, insects, and the smaller species of *Hapalotis*, or birds' eggs, &c., and bring forth 4 young at a time.

3. HAPALOTIS APICALIS.

White-tipped Hapalotis.

Tillikin of the natives.

Mr. Gould figures this species, of which he mentions merely that he received it from South Australia. I observed the first specimens in the neighbourhood of Euston, and found it in great numbers upon Sir Thomas Mitchell's old track on both sides of the Murray. It also occurs on the Darling, and I have no doubt that the late lamented Explorers called Rat Point (in the neighbourhood of fort Bourke) after this *Hapalotis*.

They are gregarious in their habits. I have dislodged as many as 15 specimens from a single tree, and kept large numbers in captivity. They became quite tame; and many which had escaped would return to join my frugal supper at night, and help themselves, to damper especially. This is a very graceful animal, strictly nocturnal in its habits, and its flesh white, tender, and well-tasted.

4. HAPALOTIS MITCHELLII.

Mitchell's Hapalotis.

Kahlpere of the natives—

is another animal which the late Sir Thomas Mitchell first discovered. I have no doubt that it is widely distributed over the Australian continent, but I was not able to procure specimens at Gunbower Creek, or at the Junction of the Loddon. The first pair obtained were brought to me by natives in the neighbourhood of the Murrumbidgee. This animal is very plentiful on the Darling: and as many as 50 specimens were often procured by the native women in an afternoon. It burrows into the ground, and is dug out by them. *Hapalotis Mitchellii* is strictly nocturnal in its habits, and the female produces 4 young at a time. Though they are easily kept in captivity, they often kill each other, if not well supplied with food; they also have a disagreeable habit (to the naturalist, at least) of gnawing each others toils off.

5. MUS SUBRUFUS?

Dusky mouse.

Pethack of the natives.

Apparently an undescribed species (for which I would propose the name of *Mus subrufus*) is found in large numbers between Gol Gol Creek and the Darling; it is nocturnal and gregarious, and, like *Hapalotis Mitchellii*, burrows into the ground; 4 young are produced at a time by the female.

All the Rodents are eaten by the natives, but only in case of no other food being at hand, as a large number of these little creatures are wanted to satisfy the hunger of a black-fellow.

This closes the list of the Placental Mammalia, which I had an opportunity of observing. But there are, no doubt, still many species of Rodents new to science; in fact, several skins of *Hapalotis* were received through native tribes living some 100 miles further north, but all were in such bad preservation, that it was found impossible to give a correct description of them.

Marsupialia.

By far the larger number of animals inhabiting the extensive plains on the Murray and Darling are marsupial; and with a few exceptions truly *nocturnal* in their habits.

This accounts for the apparent scarcity of animal life; and often do travellers mention, that except an occasional Kangaroo, they have never met with any mammalian animal in the interior of the country.

Two-thirds of the smaller mammalia collected and examined by me on the Murray were new to many old residents, and even the natives, who, in many parts, have acquired habits different from their former mode of life, had almost forgotten the existence of some of these species. With the aid of the Messrs. Williams and the natives, I succeeded in procuring every species known to exist in that part of Australia; and in finding also a number of animals of this order which hitherto had been only known to frequent Western and South Australia.

The following are the different genera:—

I may also mention the Genus *Phascolomys* (the Wombat), as I know upon reliable authority that *P. latifrons* has been killed in the neighbourhood of the "North-west Bend" on the Murray.

The two genera *Petaurus* and *Phascolarctos*, the so called "*Flying Squirrels*" and "*Native Bear*," are not represented; both frequent the rocky and mountainous districts only.

1. DASYURUS GEOFFROYI.

Native Cat or Tiger Cat of the Settlers.

"Kettrie" of the Natives.

This is the most blood-thirsty of the Marsupial animals inhabiting the Murray scrubs, solitary in its habits, strictly nocturnal, and the terror of the feathered tribe, particularly of the yellow crested Cockatoo. Afraid of nothing, it will, when hungry, attack any other animal; a mother will eat even her own progeny, if she has nothing else to fall back upon.

I have often detected the lair of this *Dasyurus* by the heap of feathers and bones generally collected at the foot of the tree upon which it dwells; it is eaten by the natives. The female is not furnished with the usual pouch, and in June or July brings forth often as many as 6 young at a time, so that every teat is occupied, 6 being the number of mamma) generally observed in this species. The Native Cat of our neighbourhood (*Dasyurus viverrinus*) is somewhat smaller in size, with a more bushy tail, and the female furnished with 6 teats; this may not be constantly the case, though I am informed by my friend, Mr. E. P. Ramsay, that various specimens examined by him had not more than 6 teats, only 4 of which were in milk. Owing to the absence of a pouch, many of the weak young drop off, and only a few, generally 3 or 4, reach maturity.

All my attempts to domesticate the young have proved fruitless; they never learnt to recognise the hand that fed them, and though I kept a pair nearly six months, at the end of that time they were found only more ferocious than ever; having made their escape at last, they kept near the huts and tents of the camp, completely clearing the place of mice and other vermin. Wherever a spot is infested with mice or rats in the bush (and some of the stations are overrun with them) there is no better remedy than to procure a few young *Dasyuri*, which having been kept on the ground for a few months, and turned out into the store-house, will soon "effect a clearance."

The range of this species extends, according to Gould, as far as the West Coast.

The Natives inhabiting the country near the junction of the Darling, have some superstitions regarding this animal, and "Jacob," an old chief on the River, often assured me, that "Kettrie make rain and rainbow." As his kinsmen are not fond of rain, I suppose they kill as many Kettries as possible.

2. PHASCOGALE CALURA.

Handsome tailed Phascogale.

Kultarr, (native name.)

This is without doubt the most handsome species of the genus. It is ashy grey above, white underneath, with long bushy black tail, the upper half of the basal part of which is of a rich chesnut colour.

The few specimens which have found their way to Europe were procured at the Williams River, Western Australia; but when the intervening country between the Murray River and the West coast is better known to Naturalists, it will probably be found that the range of this beautiful creature extends over the larger half of the continent. The few specimens brought to me by the natives were generally found in hollow limbs of trees. I kept several alive for a considerable time, feeding them with live mice or small birds. Their movements were cat-like, but very graceful; like all the members of this genus they are strictly nocturnal in their habits. A female specimen, caught in the beginning of June, had 8 very small young ones attached to the teats, which were 10 in number: no regular pouch was observable, the long hair only covering the young progeny.

My specimens were captured near Williams' Station, Gol Gol Creek, about 10 miles from the Darling Junction.

3. PHASCOGALE PENICILLATA.

Brush-tailed Phascogale.

This species, nearly allied to *P. calura* is, no doubt, still more widely distributed. It is occasionally found in the neighbour- hood of Sydney, and extends its range right across the continent to the west coast. On the Murray River, it is exceedingly rare; the only specimen I found was secured in the neighbourhood of Mount Hope. I have subsequently received specimens through the natives, when at Port Lincoln; and examined some which had been captured at Albany on King George's Sound, and have found them to be identical with the original Tapoa-Tafa of White.

The only female specimen I saw had no pouch, but 10 teats covered with long hair. I suspect that, as in the other species, a large number of young is brought forth; but how many reach maturity must yet be left to be determined.

4. Phascogale lanigera.

Woolly Phascogale.

Kultarr (native name.)

Two single specimens of this little *Phascogale* were obtained through the natives at Gol Gol Creek: one a female with 10 teats and 7 young. The hind legs in this species are long and slender, and the natives informed me, that it lived upon the ground, unlike the other species of this genus; most of which are arboreal.

The little creature, which I kept alive for several weeks, was fond of flesh, and, when put into a box with a number of Rodents, attacked the frightened mice immediately.

The natives informed me, that the animal was very rare; in fact, they had a dispute about its name, and called it "Kultarr," just as they did with *Phascogale calura*, while some asserted they had never seen the animal before.

Though I offered high rewards for another specimen, I did not succeed in procuring any more than these.

This species is also strictly nocturnal in its habits.

5. Antechinus flavipes.

Rusty footed Antechinus,

Warum (native name.)

This lively little animal is the most abundant of the *Antechini*, and, though nocturnal, is often seen during the day time. Its range extends from the east to the west coast. It used to be so common near the camp on the Murray, that I have often captured several specimens whenever a load of wood was brought in. I kept many alive and always found that, like the species of the *Phascogale*, it would attack and kill any number of mice, if put into the same box. The shallow pouch of the female is provided with 10 teats, and as many young are sometimes attached to them. I find several entries in my diary corroborating these facts:—

- Aug. 17. 1 female Antechinus flavipes with 10 young.
- Aug. 19. 1 female Antechinus flavipes with 9 young.
- Aug. 20. 1 female Antechinus flavipes with 9 young.

Several females procured in September had only 6 young, of much larger size, attached to the teats.

This animal is common on the North Shore, Sydney.

6. Antechinus albipes.

White-footed Antechinus,

Tram-Trammit (native name.)

One of the smallest of this genus, and widely distributed over the whole of the southern part of the continent from Swan River to Port Jackson. The specimens I obtained on the Plains of the Murray are identical with specimens from this Colony, and with those inhabiting South and Western Australia.

The female is furnished with a rather shallow pouch containing 10 teats; and in specimens captured in July and August, from 6 to 9 young, of the size of a pea. The Natives caught this species frequently on the Sand-hills near our camp, in King George's Sound. *A. albipes* frequents rocky places, and is often found under stones. I have also found specimens under stones near Manly Beach.

It bears captivity very well. I have lately found several specimens, and succeeded in keeping them about six weeks alive; they thrive very well, and I killed them only on account of their rather strong odour, if fed on flesh. Though small, they are very ferocious, and they will attack mice of double their size, without fear.

7. PODABRUS CRASSICAUDATUS.

Thick-tailed Podabrus.

Mondellundellun (native name.)

All the specimens of this species ever sent to Europe came from the West coast of this continent; but as I have obtained specimens from various parts of the Murray River, I doubt not that it inhabits the intervening country between the Swan River colony and New South Wales. I have never seen this handsome little Podabrus from the eastern part of Australia, though a species with a much longer tail *(Podabrus macurus)* occurs in the neighbourhood of Brisbane, and further north. I have kept several specimens alive for months, but always found it necessary to separate them on account of their ferocity. I have more than once lost a number of valuable Rodents through inadvertently adding a *Podabrus*, or any species of *Antechinus* to them; they fall upon the poor mice immediately, and kill many more than they can possibly eat. If not supplied with food, they attack and devour each other.

Females, which the natives brought in July and August, had from 6 to 9 young ones in the rather shallow pouch. The number of teats is 10; and, as I found several with the whole number in milk, I believe that as many as 10 young are brought forth at a birth.

All the species of the genus *Antechinus* are rather sensitive to cold; and, when the thermometer fell as low as 30° a great many perished.

Beyond a hoarse screech, I never noticed any voice. A singular peculiarity in all the Dasyuridæ is, that they carry their ears folded down, never erect, when alive: and, though I do not want to find fault with Gould's beautiful work, I must say, that, in this respect, the representations he gives of this tribe of the animals of Australia are not over true to nature.

8. MYRMECOBIUS FASCIATUS.

Banded Myrmecobius.

This singular animal which also inhabits the Plains bordering on the Murray and Darling, is not found close to the first named river: and, as far as my inquiries among the natives went, has never occupied that part of the country. It does not now inhabit any part of Victoria, and I think the Murray may be taken as its southern boundary. A quarrel existed between the Darling natives and the tribe which accompanied me, so that I was not able to procure any live specimens of this singular animal, but its existence is proved sufficiently. I have been informed by Mr. Scott, the owner of a Station at Tapio, about 80 miles from the Darling Junction, that the Banded *Myrmecobius* is by no means rare; and that the natives could procure specimens for me; but a few bad skins were all I obtained.

How many young ones the female produces, and with how many teats she is furnished, I am unable to say; the only fact proved is, that the range of *Myrmecobius fasciatus* is not limited to the West Coast, and, that according to the natives, it is not nocturnal in its habits.

9. CHÆROPUS OCCIDENTALIS.

The Eastern Chæropus.

Landwang (native name.)

This singular animal which Sir Thomas Mitchell first discovered in his expedition to the Darling, June 16, 1836, is still found on the plains of the Murray; though it is exceedingly rare, and is disappearing as fast as the native population. The large flocks of sheep and herds of cattle occupying the country will soon disperse those individuals which are still to be found in the so-called settled districts, and it will become more and more difficult to procure specimens for our national collection.

During a period of six months, I encamped not far from the spot where Sir Thomas Mitchell secured his tail-less animal. I had the greatest difficulty in obtaining a few specimens, but succeeded at last, and as I believe that nobody has ever been able to observe the habits of this singular creature in a state of nature, I will quote from my diary, October 4th, 1857:—

"After returning from a short excursion into the scrub, I fell in with a party of natives who had succeeded, at last, in securing a pair of the *Chœropus*, (male and female.) They wanted all manner of things for them, from a pair of blankets to a cutty pipe; and as I was very anxious to sketch them from life I emptied my pockets there and then; and promised a grand entertainment for the night with plenty of damper and sugar and tea."

On arrival at the camp, the two animals were secured in a bird cage; and I was busy for several hours sketching my charges in different positions.

Gould's figures of *Clœropus occidentalis* are spiritless, being taken from dry skins. I was in the habit of showing a copy of Sir Thomas Mitchell's tail-less specimen to the natives, urging them to procure animals of that description; of course, they did not recognize it as a "Landwang," and I was furnished in consequence with a large number of the common Bandicoot *(Perameles obesula)* minus the tail, which, to please me, had been screwed clean out.

About sun-down, when I was about to secure my animals for the night, one of the nimblest made its escape, jumping clean through the wires of the cage.

At a quick pace it ran up one of the sandstone cliffs, followed by myself, all the black-fellows, men, women, and children, and their dogs.

Here was a splendid opportunity for observing the motions of the animal; and I availed myself of it. The *Chœropus* progressed like a broken down hack in a canter, apparently dragging the hind quarters after it; we kept in sight of the fugitive; and, after a splendid run up and down the sand hills, our pointer, who had been let loose, brought it to bay in a salt bush.

A large tin case was fitted up for the habitation of these animals, and provided with coarse barley grass, upon which, as the natives informed me, they feed. Insects, particularly Grasshoppers, were also put into the box, and, though they were rather restless at first, and made vain attempts to jump out, they appeared snug enough in the morning, having constructed a completely covered nest with the grass and some dried leaves.

During the day time, they always kept in their hiding places, and, when disturbed, quickly returned to them; but, as soon as the sun was down, they became lively, jumping about and scratching the bottom of the case, in their attempts to regain liberty. I kept these animals upon lettuces, barley grass, bread, and some bulbous roots, for six weeks, until the camp was broken up, when they were killed for the sake of their skins.

I think that about 8 specimens of this species were secured during our stay; several of which, proved to be females with good sized young ones in the pouch, which is very deep and runs upwards, not like that of a Kangaroo. All were provided with 8 teats, and bore 2 young ones, only one pair of teats being drawn.

I may mention here that the *Chœropus* drinks a good deal of water, but will neither touch meat nor attack or eat mice, as the other members of this family do.

Their dung, which I often examined when out hunting, was entirely composed of grass, very dry, about the size of sheep's trundles, but much longer, so that I believe, that in a state of nature, they feed principally upon vegetables. They are very good eating, and I am sorry to confess that my appetite more than once over-ruled my love for science; but 24 hours upon "*pig face" (mesembryanthemum*) will damp the ardour of any naturalist.

The young which I took from the pouch of several females, never exceeded 2 in number, and were so far advanced, that I conclude that the breeding season is in May or June. It is a curious fact, that the third toe in the fore feet of the *Chœropus* is much more developed in the young than in the adult animal: in fact, the former looked more like a young *Perameles*, than a *Chœropus*; the limbs being short and strongly made—the basal half of the tail, which in the adult is covered with long black hair, is of a dark purple colour in the nude young animal. The eye of this species, which is very large and brilliant, is represented much too small in Gould's figures.

10. PERAGALEA LAGOTIS.

Rabbit Rat.

Wuirrapur, (Murray natives.)

Jecko, (Darling tribes.)

This beautiful animal, like many other species, has long ago retreated to the north of the Murray. It is social, not gregarious, in its habits, only found in pairs scattered over the wide plains formerly the sole domain of the Kangaroo and Emeu. It digs into the ground, forming a burrow like a rabbit, but with only one entrance, and differs herein from *Bettongia Graii*, the burrows of which are provided with several outlets, and may easily be distinguished from those of the *Peragalea*.

As this "Rabbit Rat" often prefers entering the ground on a hill side, and as hills, even of very slight elevation, are often scarce on these extensive plains, it will sometimes happen, that the *Peragalea* takes advantage of the mound raised upon a departed black-fellows grave, providing for itself a habitation beneath the natives weary bones. Upon this ground an investigator asserted, some years ago, that this animal dug out the dead bodies of the natives and fed upon them. I think that every naturalist that has the slightest knowledge of the habits of this animal, will agree with me, that it is no resurrectionist, and if it takes advantage of the "mound," it is only for convenience sake, and not for criminal purposes.

It is nocturnal in its habits, feeds upon grass, roots, insects, &c., and always retires before dawn. Its flesh is very good eating, though the fur has a peculiar sweetish smell which is retained for years after the skin has been cured.

The natives seldom unearth the animal; the holes being very deep, and often found to be uninhabited. I procured a few specimens only, among which, was an adult female, with a very deep pouch, 8 teats, and two large young.

All the spots which, in the adult, are covered with black hair, were of a purple colour in the nude young specimens, which appeared to be about four months old; so that, according to my diary, their breeding season will be about the beginning of May. The pouch runs upwards.

11. PERAMELES FASCIATA.

Banded Perameles.

Thill, (native name.)

Moncat (native name.)

One of the many animals whose range extends from the east to the west coast of the Continent, it is common on all parts of the Murray River, and is also found in Victoria, in South Australia, parts of Western Australia, and in the immediate neighbourhood of Sydney.

Though provided with strong claws it seldom burrows, except in search of its food, which consists of insects, bulbous roots, various herbs, &c. Nocturnal and social in its habits, the striped (so called) "Bandicoot" seeks shelter, during the day time, in hollow logs, or under stones, although sometimes it constructs a sort of nest like the *Chœropus*.

This animal bears captivity well, and becomes very expert in catching mice. I had several about the camp; and they proved as useful as cats.

I was in the habit of feeding the specimens kept in a large tin case with various kinds of Rodents, which they killed with astonishing quickness.

The *Perameles* would tumble the mice about with its fore paws, break their hind legs, and eat generally the head only. I have seen a single individual kill as many as twenty mice in a very short time, breaking their bones successively, after which it would begin to satisfy its hunger.

During the months of May, June, July, and August, female specimens provided with 8 teats, and containing from 2 to 4 young were captured by the natives. Those obtained in August, had grown to the size of a young rat; fur, cream coloured, without the markings upon the haunches, which appear at a more nature age.

The flesh is palatable. The pouch runs upwards.

12. PERAMELES OBESULA.

Short-nosed Perameles.

Bandicoot of the settlers.

Pirrikin, Murray natives.

This animal is the most common of the *Peramelidæ*, inhabiting the whole of the Southern part of the Continent and Tasmania. How far its range extends to the north, I have been unable to ascertain, though I know that it is frequently met with on the Clarence River.

The flesh is delicious, especially when *done* in the native style, that is, the hair removed, and the game roasted upon the coals. From May to September, females with from 2 to 3 young ones in the pouch were frequently captured. In October or November, the young progeny begin to shift for themselves.

The pouch is very deep, the entrance upwards, and contains 8 teats.

13. PHALANGISTA VULPINA.

Vulpine or Brush-tailed "Opossum"—

So well known to everybody, that I shall not enlarge upon it; but merely remark that this species is the staff of life to the natives.

I often admired my native friends, when after a hard day's unsuccessful hunting they dropped in at the camp empty handed; how carefully they would examine the large flooded Gum-trees (*Eucalyptus rostratus*), fringing the river banks, how nimbly they would get a footing upon some hollow limb, and with what perseverance "Possum" was dislodged, and perhaps, accidentally dropped into the river, whence it had to be rescued by the black-fellow's better half: for it was the question of "to eat or not to eat."

How often the *Phalangista vulpina* produces young, I am not able to tell with certainty. I think, judging by the large numbers in every forest, several times a year. The female is provided with only 2 teats, and seldom carries more than one young one at the time.

14. PHALANGISTA VIVERINA.

Ring-tailed Opossum.

Pirrath of the Murray natives.

A rare animal on the Murray and Darling. I secured no more than two specimens during my stay there. It is much lighter in colour than the species inhabiting the Swan River colony. The pouch in the female is provided with 2 teats.

It is one of the characteristics of the flat country traversed by the Murray and Darling, that no other species of the *Phalangistidæ* are found there.

The first *Belidæus* I captured on my return, at Mount Ida, McIvor Range, 80 miles distant from the Murray, is, according to Gould, a new species, and is figured by him in part XI. of his Mammalia, 15, as "*Belidæus notatus*."

As I made many enquiries of the Natives about the genus *Petaurus*, and found that these animals are not known to them, I do not hesitate to consider their range to be restricted to the mountainous coast districts.

All the members of this family are nocturnal, and the female is provided with one pair of mammæ only. In the "Flying Squirrels" the number of young is sometimes 2; but the Koala or "Native Bear" never produces more than a single young one at a time.

I now proceed to the Kangaroo, whose form and habits seem to have struck the discoverers of Australia with special wonder. Large Plains are admirably adapted to the habits of these animals, and the low lands of the Murray have once swarmed with their numbers as they do now with cattle and sheep. At the present time, large flocks of Kangaroos are a rare sight; and though I have seen as many as sixty or eighty together, I think that this is the exception, not the rule.

The most formidable, and no doubt the handsomest species of the whole tribe is,

15. OSPHRANTER RUFUS.

The Great Red Kangaroo.

Bullucur of the Murray natives.

Which has become very scarce upon the left bank of the Murray, but is still found in considerable numbers in New South Wales and South Australia. The range of this species to the eastward does not extend much beyond Mount Hope.

This large beautiful animal, about which a great deal has been written, ought to be well known to every colonist, and yet it is only a few months ago that the very existence of such a creature was doubted by an enlightened "critic," who was pleased to designate this species as ante-diluvian; indeed it must sound like a fable-to people who know little or nothing about such matters, if they are informed that the male of this species is of a foxy red, and the female of a bluish grey colour.

The Red Kangaroos, like the great Kangaroo, (*Macropus major*) feed in flocks, and, when disturbed, the old males cover the retreat of the fleet females who are off first, so that specimens of the latter sex are rare, the dogs generally stopping the progress of the rear-guard of the red "old men."

In wet weather, when the chalky top soil of the "Malley scrub" is softened, these Kangaroos are easily captured: they sink deep into the ground, and any black-fellow's cur, trained for such work, will stick to the tail of the Kangaroo until his master is able to come up and crack its skull, or run a spear through it.

The female produces one young at a time, which she carries in her pouch until it is of considerable size. As in all the other members of this family, the number of mammæ is four.

The flesh is very palatable—I prefer it to that of *Macropus major*.

16. MACROPUS MAJOR.

The Great Kangaroo.

Bullucur of the Murray natives.

A much more common species than the preceding, and similar in its habits, the female producing only one young one at a time. The pouch has 4 teats.

Dr. James C. Cox has lately presented two young of this species to the Museum, which were *both* taken from the same pouch. I mention this as being of very rare occurrence; they are about ½ inch long.

17. ONYCHOGALEA FRÆNATA.

Bridled Nail-tailed Kangaroo.

Merrin of the Murray natives.

The most common of all the smaller species of the Kangaroo tribe; often seen out during the day-time, though, when observed in captivity, much livelier at night; gregarious, the female producing one young at a time, generally in the beginning of May; pouch containing 4 teats. Its flesh is white and well tasted.

18. LAGORCHESTES LEPOROIDES.

Hare Kangaroo.

Turatt of the Murray natives.

Common upon the level country between the Murray and Darling; strictly nocturnal and solitary in its habits; it is seen during the day-time only, and is generally found asleep under some salt bush, or in any other sheltered locality. The Hare Kangaroo is the fleetest of the whole tribe, and will, when hotly pressed, take leaps more than 8 feet high.

A single young one is produced at a time; pouch furnished with 4 teats. This species is easily tamed, and I have kept several at the camp, which lived well on biscuit, bread, or boiled rice.

Its flesh is delicious, in fact some of the best meat I ever tasted.

19. BETTONGIA RUFESCENS.

Rufous Bettongia.

Kangaroo Rat.

This animal, so common in the neighbourhood of Sydney, has not been observed by me to the westward of the Murrumbidgee, where *Bettongia penicillata* appears to take its place. Not a single specimen was procured by the natives during my stay at the Darling Junction; so that I have no doubt about the extent of its range. This animal is easily tamed, and I have kept a young one about the size of a large rat for several weeks. The little animal often followed me upon my excursions, seeking shelter upon the approach of danger by creeping between my boots and trousers.

Only one young is brought forth in June, though the pouch contains 4 teats. The flesh of this animal is also very palatable.

20. Bettongia Penicillata.

Pencil-tailed Bettongia.

Pattuck of the Murray natives.

The smallest of the whole family, nocturnal in its habits. Those occasionally seen during the day time have been disturbed. It is not very quick, and is easily caught, even by common dogs. I have from time to time kept numbers of these animals in captivity in an enclosure of pine logs about seven feet high, which they used to climb with a nimbleness truly astonishing, and thus often escaped. During the day time I always noticed these creatures crouching into some corner; the tail brought forward between the hind legs, the head between their paws; fast asleep. I noticed that they are very partial to the thick clusters of *Polygonum* scrub so frequent on the Murray.

Female specimens, with never more than 1 young attached to one of the 4 teats, were frequently brought to me by the natives. Single specimens, with a white brush at the end of the tail, occur occasionally.

This *Bettongia* and *B. Ogilbeyi* appear to be so closely allied to each other that I should consider them the same species.

21. Bettongia Graii.

Gray's Jerboa Kangaroo.

Booming of the Murray natives.

This burrowing *Bettongia* has long retreated before the herds of cattle with winch the plains bordering on the Murray are now stocked; and it is no longer to be found south of that river, so, at least, the natives assured me, and whenever we went out hunting for it, we always had to cross to the New South Wales side.

Not a single specimen of my collection was procured in Victoria. Although this species is constantly furnished with a brush of white hairs at the end of the tail, I consider it identical with Gould's *B. Graii*, in which the white mark is wanting.

It is a truly nocturnal animal, which always leaves its burrow long after the sun is down, in fact, never before it is quite dark. I often watched near their holes, gun in hand, listening to their peculiar call; but I always had great difficulty in procuring specimens, as they are very shy, and hardly to be distinguished from the surrounding objects.

The best plan is always to dig them out; an operation in which the black-fellows are very expert, though it is rather tedious work; the holes running into each other, and being sometimes ten feet deep; and several shafts may have to be sunk, before a couple of "Boomings" can be secured.

I have often seen several acres of ground covered with their holes.

I have no doubt that this, and, perhaps, many of the other species, breeds several times during the year, but brings forth one young only. The pouch of the female is furnished with 4 teats.

It is difficult to keep them in captivity, as they are very wild indeed; and either escape by a burrow, or kill themselves in running their heads against the enclosure.

These are all the Marsupial animals proper which I have observed; it will however be necessary to say a few words about the sub-class of the Marsupial Group, the Monotremata, which is represented by the following species.

22. Ornithorhynchus anatinus.

The Duck-billed Platypus.

This singular animal does still exist in most of the tributaries of the Murray, as the Loddon, Avoca, Campaspe, &c. It is extremely shy, and little is yet known about its habits and economy. It burrows into the river bank from below the water level, and according to Bennett, brings forth 3 young ones at a time; some found by that naturalist were one inch and seven-eighths in length. Its food consists of fresh water worms, mollusca, worms, insects, &c.

This is about all we know of the *Platypus*, and cannot I do better for the benefit of science than draw attention to Professor Owen's remarks in his elaborate paper on the monotremata; The great anatomist says:—

"The principal points in the generative economy of this paradoxical species still remain to be determined by actual observation.

- Manner of copulation.
- Season of copulation.
- Period of gestation.
- The nature and succession of the temporary structures developed for the support of the foetus during gestation.
- The exact size, condition, and powers of the young at the time of birth.
- The act of suckling.
- The period during which the young requires the lacteal nourishment, and the age at which the animal attains its full size."

Knowing that many gentlemen in the country take great interest in Natural History, and have frequent opportunities of observing the *Ornithorhynchus*, I beg to draw their attention to the questions yet to be solved.

24. Echidna hystrix.

The Spiny Echidna.

This singular animal, of which I have seen two preserved skins at Mount Hope, is almost less known than the Platypus. Its geographical range does not extend far into the flat country, and it is generally found in mountain ranges among rocks and stones; a shepherd at Mount Hope assured me that the animals which he had preserved were captured at the mount; the natives further down the river did not appear to be aware of the existence of such an animal as the Echidna; their food is said to consist principally of ants and their eggs, though I have kept many in captivity and offered them the food mentioned, but without success. Upon hen-eggs they subsist for some time; they also like bread and milk, but seldom live longer than two or three months in captivity. I have reason to believe that, strange as it may appear, the Echidna lives upon grass also, as I have examined several which had the intestines full of digested grass or herbs.

Of the generation of this species nothing is as yet known, nor have I ever seen a very young Echidna, none at least less than six or eight inches long.

Reptilia.

To investigate the Reptilian fauna of a country, a longer stay than six months is necessary, and the species which I am going to enumerate must be considered as but a small portion of the reptiles inhabiting those districts. The country consists of large plains without a stone upon them, studded with salt-bush, pine forests, or mallee scrub, affording the agile reptiles unusual facilities for escape during the summer. In the cold season these creatures, owing to the nature of the country, retreat into the ground, so that they can only be obtained with great difficulty; and this is the cause that the collection made during my sojourn on the Murray was but a scanty one.

Those which were observed belonged to the following genera:— Chelonia. 1. Chelodina. a. Leptoglossæ. 2. Hydrosaurus. 3. Pygopus. 4. Lialis. 5—7. Hinulia. 8. Mocoa. Sauria. b. Geissosaura. 9. Siaphos. 10. Trachydosaurus. 11. Cyclodus. 12. Tropidolepisma. 13—15. Diplodactylus. c. Pachyglossæ. 16—18. Phyllurus. 19—22. Grammatophora. not venomous. 23. Morelia. 24. Acanthophis. Ophidia. 25—26. Diemenia. venomous 27—28. Pseudechis 29. Hoplocephalus. 30. Limnodynastes. 31—33. Hyla. Batrachia. 34. Pelodryas.

Chelonia.

I. Chelodina longicollis.

The long-necked Tortoise.

This aquatic reptile is found in considerable numbers in the Murray and its tributaries. It affords food to the natives, especially during the summer, when the lagoons are dry, as it can then be procured in large numbers without difficulty. Their eggs, which are deposited in the beginning of January, amount to 15 or 20, perhaps even more, as the natives, who consume them in quantities, informed me.

Like all tortoises, the present species is very tenacious of life. On one occasion, a specimen was brought to the camp pierced by a spear: for the sake of experiment, it was put into a case, and kept for a few months, at the end of which, the wound was found completely closed, and the animal as lively as if nothing had happened to it.

Sauria.

2. Hydrosaurus varius.

The Lace Lizard.

I believe the present striped species, and the large spotted or Gigantic Lace Lizard *(H. giganteus)* to be identical; this is one of the most common forms on the plains of the Murray; so common, in fact, that I have often captured half a dozen of them on my return to the camp; they were generally found basking in the sun, close to their holes, down which they disappeared with extraordinary swiftness when disturbed. They grow to a large size, as much as 7 or 8 feet long, and feed upon carrion, as well as upon living animals; on various occasions several pounds of bones, and once a large "opossum" was taken from the stomach of one of these reptiles.

Their eggs, of which they deposit some 10 or 15, are large, covered with a tough leathery membrane; the young lizards being more than 10 inches long, at the time of birth.

The present species is well distributed over almost every part of Australia.

3. Pygopus lepidopodus.

The Pygopus.

This, at first appearance, snake-like form, is occasionally met with, but not so frequently as other Lizards: its flat tongue, the two rudimentary limbs near the anus, and its ear-holes, easily distinguish it from a true snake.

The number of eggs deposited by the present species, seldom exceeds 3 or 4, they are of very elongate form, 3 or 4 times as long as they are broad, and are generally hatched by the powerful rays of the sun in 3 or 4 weeks. This lizard also has a very wide distribution.

There has been a second species of Pygopus observed on the Murray, marked with much more brilliant colours than any hitherto known; but owing to the mutilated state of the specimen which was captured by the natives, it was found impossible to preserve it or give a correct description thereof.

4. Lialis Burtoni.

Burton's Lialis.

This is another snake-like form, with pointed muzzle, a single specimen of which came under my notice; its range is very extensive, as I have at various times received specimens from the Clarence River, and from farther north. Sir George Grey mentions its occurrence in Western Australia. In its habits, it is similar to the Pygopus.

5. Hinulia elegans.

Elegant Hinulia.

6. Hinulia Australis.

Australian Hinulia; and

7. Hinulia tenuis.

Slender Hinulia.

Are three species of Scincoid Lizards, occasionally observed. The first is generally found beneath the rough bark of trees. I believe that there are many more representatives of the genus *Hinulia*, but owing to their nimbleness, it was impossible to capture many of them. The number of eggs deposited by these Lizards has not been ascertained correctly; perhaps they are viviparous, and if so, may bring forth 10 to 12 young.

8. Mocoa trilineata.

New Holland Moco.

This widely distributed small Lizard has been frequently captured, it is very common under bark, or among dead leaves or branches. Its eggs are deposited among decomposed leaves in moist places, and are from 10 to 16, and perhaps more in number. I have often taken as many as 50 out of one of these breeding places, but I believe that they were the produce of several lizards.

In the neighbourhood of Sydney, where *M. trilineata* is very common, the eggs are generally laid between the fronds of the so called "Staghorn fern."

9. SIAPHOS EQUALIS.

The Siaphos.

This is another small Lizard, with very short three-toed limbs; it frequents shady or dark places, and lays bat a limited number of eggs.

10. TRACHYDOSAURUS RUGOSUS.

Rugose Stump-tail.

A large, lazy, and very common kind of Lizard, generally known as the "Sleeping Lizard," which frequents open sandy plains, and may be captured in large numbers during a hot summer's day.

The number of young produced, seldom exceeds 4, those dissected by me had 2 embryos only. I believe these Lizards do not inhabit the east coast, at all events they are not found near Sydney, or at the Hastings or Clarence Rivers.

In Western Australia, particularly in the neighbourhood of King George's Sound they are very common.

11. CYCLODUS GIGAS.

Giant Cyclodus.

Whether this species is identical with the large *Cyclodus* of the east coast I cannot at present determine. Peters has described a *Cyclodus* from South Australia, and Dr. Schomburgk who discovered this new species informs me that our common Giant *Cyclodus* does not exist near Adelaide; if this is correct, the *Cyclodus* found on the Murray, would be referable to Peters' *C. occipitalis*.

One or two specimens of this Lizard were captured by the natives.

I had been always under the impression that these reptiles produced 2 or perhaps 3 young only, but not long ago I dissected a large female specimen and took therefrom fifteen well formed young, each about from 5 to 6 inches long.

This species is prized by the natives as an article of food.

12. TROPIDOLEPISMA KINGII.

King's Tropidolepisma.

This species, (the smallest of the genus) is alone found on the Murray, its range extends almost from the east to the west coast, though in the immediate neighbourhood of Sydney it does not occur.

The number of eggs or young produced by this Lizard has not been ascertained.

13. DIPLODACTYLUS VITTATUS.

Yellow Crowned Diplodactyle.

This little Gecko is rather rare, as not more than 5 specimens were procured through the natives during my stay on the Murray; its distribution is very extensive, and, in fact, includes almost every part of Australia. The Australian Museum is in possession of specimens from the North East Coast, from the Murrumbidgee, and from South and West Australia. Near Sydney this species is tolerably common. It is oviparous, producing about 6 eggs.

14. DIPLODACTYLUS ORNATUS.

Beautiful Diplodactyle.

I do not think that there is another species of Lizard, so common and so widely distributed as this; every tree along the river banks harbours large numbers of them, and wherever a piece of dry bank is removed, this little Gecko is sure to be found beneath, in company with various species of Coleoptera, Blattæ, and spiders. In stony localities it frequents the shady side of rocks, &c. In its habits this Lizard is truly nocturnal.

15. DIPLODACTYLUS OCELLATUS.

The Eyed Diplodactyle.

Of this rare Lizard a few solitary specimens were captured, and these were in bad preservation and scarcely to be recognized. The Museum has, however, lately received well preserved specimens from the Murrumbidgee, through the kindness of Mr. William MacLeay, M.L.A., so that I am able to enumerate this Gecko, as inhabiting the Murray Plains.

16. PHYLLURUS PLATURUS.

Broad-tailed Gecko.

17. PHYLLURUS INERMIS.

Spineless Gecko.

18. PHYLLURUS MILIUSII.

Thick-tailed Gecko.

Have been obtained in the McIvor ranges and near Mount Hope; on the Murray Plains, no specimens were observed, though they may exist there. These three Geckos are common near Sydney and at the Clarence and Richmond Rivers; the last mentioned species also occurs in Western Australia.

19. GRAMMATOPHORA CRISTATA.

Crested Grammatophora.

The distribution of the present species does not extend, as far as my experience goes, beyond the mountainous districts; upon the dividing range specimens were frequently observed, but in the plain country they disappeared. The natives informed me that this lizard existed near Mount Hope, but they never captured it.

Near Sydney, where this species is common, it is generally found in the neighbourhood of water, diving into it when disturbed and remaining at the bottom for a considerable time. Specimens which I have in captivity, would lie at the bottom of a water vessel for hours without coming to the surface to breathe. I have watched one under water for more than forty minutes, I was then called away, but on my return half an hour afterwards I could not see the least indication that the lizard had stirred; again I watched it for some twenty minutes longer, and gave it up at last, the reptiles being apparently under no necessity to breathe.

20. GRAMMATOPHORA MORICATA.

The Common Grammatophora.

This is a well-known and very common species found in nearly every part of Australia. It is fond of basking in the sun, and may be frequently observed sitting motionless on old stumps upon road side fences, &c. From 5 to 8 eggs are generally produced, and deposited in the sand.

21. GRAMMATOPHORA ORNATA.

Yellow spotted Grammatophora.

This species is found in large number upon all the open plains, every tuft of grass .and every salt bush sheltering several of these gaily coloured creatures; they vary considerably in their markings, more so even than the previous species *G. muricata*. The number of eggs produced amounts to about 8.

22. GRAMMATOPHORA BARBATA.

Bearded Grammatophora.

This formidable looking reptile is better known under the name of "Jew Lizard." It cannot be considered a common form on the Murray, but its distribution extends from the East to the West Coast; how far it ranges North I have not been able to ascertain, I know however that it occurs at Wide Bay, and is probably found all over the continent.

The number of eggs produced by this reptile is most likely from 6 to 8, perhaps more.

Ophidia.

23. MORELIA VARIEGATA.

The Carpet Snake.

I am inclined to think that the Carpet Snake and the Diamond Snake are identical, varying in colour in different localities; Carpet Snakes occur in every part of Australia, the South East Coast excepted; they differ from the Diamond Snake in nothing but their markings, which consist of a series of brown blotches with darker margins, whilst the Diamond Snake is of a glossy bluish black, with a bright yellow spot in the centre of nearly every scale.

The Carpet Snake does not appear to be so common on the plains or in the mountain districts, and a single specimen only was secured; this snake feeds upon birds, small mammals, &c., and produces a large number of eggs; from 20 to 30 as the natives informed me.

24. ACANTHOPHIS ANTARCTICA.

The Death Adder.

Of this highly venomous snake, I obtained but a single specimen at Lake Boga; it brings forth about 10 or 12 young ones.

25. DIEMENIA PSAMMOPHIS.

Grey Diemenia.

The present species so common near Sydney is not often met with on the Murray, only one specimen being secured during 6 months; its bite is not considered dangerous, causing only a slight irritation, not as bad as the sting of a bee; the total length seldom exceeds 3 feet.

26. DIEMENIA SUPERCILIOSA.

Brown Snake.

A species, which like many others, ranges from the East to the West Coast, and perhaps extends over the whole continent, as I have received specimens from Cape York. Near Sydney, and along the East Coast, the young are distinctly black, banded with a black patch upon the head; but the young found on the Lachlan and in other localities to the westward are not banded. I have received specimens from Adelaide which are plain coloured with black patches upon head and neck, but without bands. In a few years these bands and black spots disappear more or less, and the adult snake is generally of an uniform brown color; there are some individuals on the coast, however, in which the bands may be traced when full grown. In the specimens taken on the Murray no bands or black marks could be detected.

This snake is highly venomous, and produces some 20 eggs, which are deposited in the sand under some bramble or decayed leaves; it is frequently confounded with the following species.

27. PSEUDECHIS AUSTRALIS.

Yellow-bellied Brown Snake.

Hitherto considered to be a variety of the Black Snake, from which it differs in nothing but the colour, being brown above and yellow or orange beneath. This Snake does not occur near Sydney; but it appears to be common as far north as Port Denison, from whence specimens have been obtained.

It is highly venomous.

28. PSEUDECHIS PORPHYRIACUS.

Black Snake.

One of the most common and most venomous Snakes, distributed over almost every part of Australia, common on the Murray, and producing some twenty young annually.

29. HOPLOCEPHALUS CURTUS.

Brown-banded Snake.

This, the most vicious of all our reptiles, closely allied to the Indian Cobra, is very common on the plains, in particular in the reed-beds near Swan Hill, and in other swampy places; the natives appear to be in great dread of this reptile, and assured me that its bite was certain death.

This species is also found in almost every part of Australia.

These are all the Snakes actually observed by me, but no doubt they do not represent all the species which exist in these extensive plains.

Batrachia.

Frogs.

Of this order not many species were collected.

30. LIMNODYNASTES DORSALIS.

Striped Swamp Frog.

In a reed-bed near Lake Boga a single specimen was obtained. It is a common species near Sydney, on the Clarence River, near Rylston, and in many other localities.

31. HYLA AUREA.

Common Golden Tree Frog.

This species, widely distributed over Australia, is the most common of all our Batrachians: the natives when pinched for food capture large numbers of it by the light of a torch at night; a supply of this frog can always be secured wherever there is fresh water near.

32. HYLA PERONII.

Yellow-Legged Tree Frog.

This species, which ranges also over a great part of the continent, is generally found during the day-time under the bark of the "Flooded Gam" *(Eucalyptus rostrata)*.

33. HYLA ADELAIDENSIS.

Adelaide Tree Frog.

This species is not common on the Murray; its range extends as far as Western Australia.

34. PELODRYAS CÆRULEUS.

Great Green Tree Frog,

The largest of our Batrachians, found in every part of Australia, and in New Guinea. I have seen specimens as large as a man's fist. This species feeds upon almost every living object that can be swallowed: lizards, frogs, all kinds of insects, and young birds—for I have once taken the nestling of a small honey-eater out of the stomach of one of these insatiable reptiles.

This concludes my notice of the reptilian fauna of the Lower Murray, which, as before mentioned, will prove much richer both in genera and species than it appears at present to be. I could enumerate some 5 or 6 more species, but these were in such bad preservation that it was found impossible to determine their character with certainty.

On Snakes

Observed in the neighbourhood of Sydney.

HAVING paid much attention to the reptiles found near this city, I am now able to give an account of the snakes to be met with in the vicinity, and to point Out which of them may be considered dangerous to man or larger animals.

There are four highly venomous snakes observed to inhabit nearly every part of Australia, while a fifth large venomous species exists besides these on the North-west coast; and these are the only dangerous ones known to us as yet.

All the remaining species, as far as my knowledge goes, are too small to inflict a dangerous wound.

In the beginning of spring, when reptiles re-appear, there is generally a great supply of snake stories brought before the public by the daily press, but it is of very rare occurrence that we hear of death being caused by the bite of any of these animals.

If we compare our reptile-fauna with other countries under the same latitude, I think that we have sufficient reason to be thankful for the absence of the deadly Vipers, the Rattlesnakes and Puff-adders of India, America, and Africa—all of which have fangs an inch or more in length; we actually have not yet discovered a single species in which the teeth exceed one-fourth of an inch, and I doubt whether any of our snakes can inflict a wound through ordinary cloth or a common leather boot.

All our venomous snakes belong to the second sub-order of the class Ophidia, viz:—to the Colubrine snakes with permanently erect immoveable fangs in front. Of innocuous, or not venomous Colubrine snakes, we have three species near Sydney, all of which are Tree-snakes. If we except the Diamond snake, which belongs to the Boa family, we find that all not venomous Colubrine snakes may be easily distinguished from the venomous species by the deep curve which the gape of the mouth forms; whilst, in the venomous snakes, the gape is always a more or less straight line. In the members of the Boa family the line is straight, as in venomous snakes, but these are easily distinguished by the rudimentary limbs, in shape like a small spur situated near the anus.

I have added Dr. Günther's description of the two species of Sea-Snakes which occur on our coast; both of which may be considered harmless, having only very small fangs—and I take this opportunity to thank that eminent naturalist for the kind assistance he has so frequently rendered me. I also beg to assure those contributors to the Museum who have furnished me with the means of adding to the knowledge of our Reptiles, that I shall always consider myself under deep obligations to every one of them.

FIRST SUBORDER.

Ophidii Colubriformes Innocui.

Innocuous Colubrine Snakes.

Snakes without grooved fang in front, comprising the following families:—

- *Typhlopidæ*, or Blind Snakes.
- *Dendrophidæ*, or Tree-Snakes.
- *Dipsadidæ*, or Nocturnal Tree-Snakes; and
- *Pythonidæ*, or Rock-Snakes.

1.—TYPHLOPIDÆ; OR BLIND SNAKES.

Typhlops. *Schneid*.

Typhlops rüpelli. *Jan*.

The Blind Snake.

Scales in 22 rows. Rostral large and broad above, narrowing below; Preoculars much larger at the base than at the tip, third upper labial in contact with the ocular and preocular. Anterior scales smaller than the posterior ones. Tail short, cylindrical, very obtuse, three times the length of its diameter, and ending in a small spine.

The color of this harmless little reptile is brownish grey above, and yellowish below; each scale of the back being bordered with yellowish white, the markings becoming obsolete towards the tail; the form is cylindrical, enlarging towards the tail.

Of all our harmless snakes, the present species is the least offensive; it lives under ground, and is frequently found in Ants' nests, upon the larvæ of which it principally exists; its total length does not exceed 18 inches. I believe that the present species has a very wide range, and that it will be found to inhabit the greater part of the Australian Continent; specimens from the Murray River, from South Australia, and from Queensland are in the collection of the Australian Museum.

2.—Dendrophidæ; or Tree-Snakes.

Dendrophis. *Boie*.

Dendrophis punctulata. *Gray*.

The Green Tree-Snake.

Scales in 12 or 13 rows.
Anal bifid.
Ventrals 207.
Subcaudals 106/106.

Of slender form, above green or pale olive brown, beneath bright yellow, sides and under parts of head the same colour; eyes large, pupil rounded. Outer edge of scales white, as may be seen on stretching the skin.

1 anterior 2 posterior oculars, scales smooth, those of the vertebral row much larger, polygonal; scales of outer rows elongated, narrow, quadrilateral, and very imbricated.

Maxillary teeth smooth and of equal length.

This snake, one of the few not venomous Australian species, is a gentle harmless creature, which at any time may be handled with impunity; it never attempts to bite, and of many hundred individuals which I had an opportunity to observe alive, not a single one could be induced to inflict a wound.

If we except Tasmania and the southern part of Victoria, we find the Green Tree Snake from north to south, and from east to west; it frequents trees, feeds upon insects, frogs, lizards, small birds and birds' eggs, and grows to a considerable length, but seldom if ever exceeding 6 feet.

I have reason to believe that the female is oviparous, laying about 20 or more eggs in November or December; young individuals differ considerably from the adult in colouring, being not of so bright a green; and having a grey instead of a light yellow belly. The winter is generally passed under hollow logs or beneath flat stones in sunny but often damp localities.

3. Dipsadidæ, or Nocturnal Tree-Snakes.

Dipsas. *Auct*.

Dipsas Fusca *Gray;*

The Brown Tree-Snake.

Scales in 19 rows.
Anal entire.
Ventrals 236.

Subcaudals 87/87.

Form slender, body and tail compressed, elongate head much depressed, triangular, broad behind, very distinct from neck; scales on the vertebral line much larger, regularly six-sided, vertical shield broad, occipitals obtuse behind, one loreal; eight upper labials, the third and fourth and sometimes the fifth touching the orbit; one anterior two posterior oculars; eye large, pupil elliptical; nostril moderate, between two shields; posterior maxillary teeth longest and grooved.

Above, light brown or reddish brown, with numerous black rather oblique, sometimes obsolete cross bands; belly uniform salmon coloured.

The present species has not been so much noticed in the neighbourhood of Sydney as the Green Tree-snake, but this may be owing to its nocturnal habits; it is found along the East Coast, and ranges as far as Port Essington; individuals observed in captivity appeared very gentle in disposition, and could be freely handled without showing any inclination to bite, they passed the day coiled up amongst the branches of trees, but became very active at night, noiselessly gliding through the foliage in search of their prey, which, as in the Green Tree snake, consists of birds, birds' eggs, insects, frogs, lizards, and the smaller mammalia.

I am unable to state whether the female is oviparous or not; the number of young produced annually does probably not exceed 20. Total length of adult about 6 feet.

4. Pythonidæ, or Rock-Snakes.

Morelia. *Grey*.

Morelia Spilotes. The Diamond Snake.

Scales in 47 rows.
Ventrals 276.
Anal bifid.
Subcaudals 80/80.

Head shields small, scale-like; three pairs of distinct frontal plates, vertical plate indistinct, rostral shield with a pit on each side, first and second upper labials pitted; of the lower labials the first seven are smooth, then follow seven deeply pitted scales, and 3 or 4 smooth ones, nostrils lateral, in a single plate with a groove beneath; eyes lateral; pupil elliptical, erect; scales smooth; subcaudal plates in two rows, two spur-like appendages near the vent.

Coloration:—

Bluish black above, almost every scale with a yellowish (white in spirits) elongate spot in the centre; there is a series of dark-edged irregular blotches upon the back, each bearing in the middle a few very bright yellow-colored scales; these spots or blotches vary considerably in different individuals, specimens from Port Macquarie having almost the markings of the Carpet Snake, but still retaining the yellow spot in each scale, which in *M. variegata* is wanting. Some specimens occur with a pale yellow streak from the side of the head to the vent: in fact we very rarely find two of these snakes which do not differ considerably in their markings.

The range of the Diamond Snake (*M. spilotes*) is restricted to a very limited area of country, being found in no other part of Australia than from Port Macquarie to Jervis Bay, or perhaps Cape Howe; and from the coast to the western slopes of the Blue Mountains and the Liverpool Range. In the plains watered by the Lachlan, the Murray and the Murrumbidgee, the present species is not found, the Carpet Snake *(Morelia variegata)* taking its place there.

The Diamond Snake is a common species in the county of Cumberland, in the Blue Mountains and the Illawarra district; it is a harmless creature, which may be picked up by any body without ever offering to bite; though it is a strictly nocturnal snake, individuals are nevertheless met with during the day-time, either basking in the sun and digesting their food, or, having been disturbed, in search of a place of shelter. Like the other species of the family Pythonidæ, they prey upon birds, and the smaller species of Mammals; young individuals feeding upon insects, frogs, or birds' eggs; the female deposits 30 or more eggs in December or January, which in a month or two the sun brings to maturity. I am not aware that the mother cares any longer about her progeny, after laying the eggs; and I have never seen or heard of a single instance where she coiled herself upon the eggs so deposited.

Diamond Snakes are found in almost every kind of country as long as it offers sufficient shelter; they prefer open stony ridges studded with low trees and well supplied with water, the edges of swamps and lagoons are frequented by them, as they find there a considerable supply of Water-rats *(Hydromys)*, young Ducks, and other water-fowl; they also often visit the hen roosts of the farmer, or surprise "Opossums" *(Phalangista)* or "Flying Squirrels" *(Petaurus)*, upon the branches of high *Eucalypti*.

The largest specimen, to my knowledge, that has been captured near Sydney, and properly measured, without being stretched, was 10 feet 3 inches long; that individuals of 11 feet or more in length occur, I doubt not, though they are very rare indeed, and have never come under my notice.

The way in which Diamond Snakes capture their prey is as follows:—

The snake suspends itself from the branch of some low bush or tree and watches for the victim, which often plays about near its unseen enemy. The reptile, with its neck and head bent into the form of an S, deliberately measures its distance, uncoiling more of its body if necessary, and often almost touching the animal it is in wait for; as soon as the snake is sure to reach its victim, it darts forward, generally catching the prey by one of the hind legs, and instantly takes a turn around its body, soon extinguishing life through its powerful pressure. As soon as the animal is quite dead, the process of swallowing begins, the snake always commencing with the head; this done, the reptile will often for days together bask in the sun, until the food is so far digested as to impede its movements no longer.

If a snake is disturbed during this state, it will almost always throw up the half digested carcass.

In a state of nature they never touch any food except living animals. I once, however, observed a Diamond Snake, which was kept in a cage, swallow a rat which had been killed by a Brown-banded snake (*Hoplocephalus curtus.)*

The present species is greatly infested by various kinds of Intestinal worms, including a Tape worm, clusters of which I have frequently taken from the stomach of this reptile.

Before concluding, a few remarks will be necessary with regard to the Carpet Snake (*Morelia*, *variegata)*.

There is very little, if any difference in the distribution and number of scales between the Diamond and Carpet Snakes, the only character in which both snakes vary, is the coloration; the first having a yellow spot in the centre of each scale, whilst the latter has the back ornamented with numerous irregular black edged brown blotches; the belly, as in the Diamond Snake, being yellowish. I have mentioned before the remarkable fact, that the Carpet Snake is found in every part of Australia, except the Coast District, say from Cape Howe to the Hastings, and about 100 miles inland; at Port Macquarie both species occur, but at the Clarence River, according to Mr. James F. Wilcox, the Carpet Snake alone is found. Dr. J. E. Gray has indeed tried to distinguish the one from the other by the vertical plate, which he considers distinct in *Morelia variegata*, and indistinct in *M. spilotes*. But after examination of large numbers of both species, I do not think that the above is a character much to be relied upon, and I am led to believe that both Snakes are but varieties of the same species.

There is, according to Duméril and Bibron, the famous French Herpetologists, a second species of Snake of the Boa family to be found near Sydney, namely,

The Bolyeria, *D. & B.*

Bolyeria Multicarinata. *D. & B.*

This, however, is not the case. I have hunted the country near Sydney for years, and have never come across a single snake of this description; high regards have been offered for it, with no better success, and no specimen ever existed in the Australian Museum. I have, however, lately purchased a snake which answers to the description given, and which was obtained at some of the islands near New Guinea.

Second Suborder.

Ophidii Colubriformes Venenosi.

Venomous Colubrine Snakes.

Snakes with an erect immoveable grooved or perforated fang in front of the maxillary.

Gape of mouth forming a straight line.

This suborder, if we include the genus *Acanthophis* with the first family, comprises the

- *Elapidæ* or Elapides; and the
- *Hydrophidæ*, or Sea-Snakes.

1. Elapidæ; or Elapides.

Diemenia. *Gray*.

Diemenia psammophis. *Schleg*.

The Grey Snake.

Scales in 15 rows.
Anal bifid.
Ventrais 177.
Subcaudals 85/85.

The present species has been described by Dr. Günther as *D. reticulata*, under which name I have frequently alluded to it. It appears, however, that the snake to which Günther refers in his *Cat. of Colubrine Snakes*, when quoting Schlegel's figure (*Abbildungen* Tab. *46,* No. 14), is that author's *D. psammophis*, which name has the priority, and ought to be adopted instead of, *D. reticulata*. The coloration is a uniform grey above, and greenish below, the central part of the ventrals being conspicuously marked with green; tips of scales and skin between them, black; and of tail, salmon colour; a yellowish dark edged streak crossing the rostral shield. The eye is encircled first by a black and then by a yellowish line, both ending in a point below the orbit.

The present species is found in nearly every part of Australia, the extreme North and South excepted. I have taken it eight years ago on the Murray and Darling, and since then specimens have come to hand from Brisbane, Port Curtis, and Rock-hampton. All these snakes differ no more from those of Sydney than these do amongst themselves. Much dependence can never be placed upon coloration as a distinguishing character in snakes, as in this no two reptiles vary so much as a snake about to shed its skin differs from itself after this operation has been successfully performed. I believe the present species to be the most common in our neighbourhood.

It frequents sandy localities, feeds on insects, small frogs, lizards, &c., and its bite does not cause any more irritation than the sting of a bee; from 15 to 20 eggs are deposited by the female under stones exposed to the sun, generally in the beginning of December, and perhaps earlier, as I have on more than one occasion taken the young snakes at the end of that month and in the beginning of January. This reptile is generally found from two to three feet in length, very rarely exceeding four feet. During the cold season the grey snake retires under flat stones exposed to the sun; it very seldom, if ever, goes into the ground; it is very sensitive to cold, and the least frost suffices to destroy it. I have found sometimes five and more of these reptiles under the same stone.

Diemenia Superciliosa. *Fischer*.

Ringed Diemenia.

Scales in 17 rows near neck.
Scales in 15 rows near tail.
Subcaudals 73/73.
Anal bifid.
Ventrals 228.

Superciliaries larger than vertical; occipitals widely forked, rounded, broad; rostral high, reaching to the surface of crown; one nasal, one anterior, two posterior oculars; superciliaries prominent above the eye; anterior ocular grooved near the top; posterior frontals much larger than the anterior ones, bent down on the sides and with nasal, anterior ocular, and second and third upper labial replacing the loreal; belly flat. Dark brown above, a lighter band just crossing behind the occipitals; side of face and chin much lighter than the other parts of the body; belly yellowish, sides of ventrals and lower edge clouded with purple grey, forming a series of irregular blotches, each ventral with a distinct darkish streak on its lower edge. Half-grown and sometimes adult individuals show traces of from seventy to seventy-five black rings, which in the young snakes are very distinct. The following description is applicable to young specimens up to three years old:—

Muzzle light brown; a black triangular spot covering the region between the eyes and the occiput as far as the hinder margin of the occipitals—this streak is bent down on the sides of the face, and behind this dark spot is a white narrow streak and another broad dark band reaching down to the edge of the labial shields; then follows again a white streak and a second black band, but much smaller than the previous one, and so alternately a broader brownish and a narrow black band to within an inch of the apical half of the tail; the black bands are occasionally interrupted, leaving a blank on the other side of the body; including these interrupted streaks, from seventy to eighty may be counted upon body and tail, seventy-five is the usual number. The belly in young and half-grown individuals is covered with yellowish spots, which at a more mature age form into the black blotches mentioned in the description of the adult.

The great difference in the coloration of young half-grown and adult individuals has given rise to a variety of names: for some time I tried in vain to reduce them, but at last succeeded by bringing together a complete series of this snake in various stages of growth, from the egg upwards. Dr. Albert Günther to whom drawings as well as specimens in good preservation were submitted, states in a paper read before the Zoological Society of London,

"The young specimens, then, found by Mr. Krefft, do not belong to *Furina textilis*, Duméril and Bibron, which has three posterior oculars, but to *Diemansia annulata*, described by myself in '*Colubr. Snakes*,' p. 213. And the old individual sent by Mr. Krefft is identical with *Pseudœlaps superciliosus*, Fisch. Mr. Jan, of Milan, (who says that he has examined the Snakes of the Hamburg Museum) describes the adult Snake under two names, *Pseudœlaps sordellii* and *Ps. kubinyi*, the latter being founded upon an accidental variety, in which some of the head shields are confluent. The synonomy of this species therefore would be:—

- *Diemansia superciliosa*. an Adult.
- 1856. *Pseudœlaps superciliosus*. Fisher in Abhandl. Geb. Naturwiss. III., part 107., taf. 2 fig. 3. (head not quite correct).
- 1859. *Pseudœlaps sordellii*. Jan in Rev. and Magaz. Zool. pl. C. (head).
- 1859. *Pseudœlaps kubinyi*, Jan, 1. c. (founded on an accidental variety) C. (young).
- 1858. *Diemansia annulata*, Günth. Colubr. Snak., p. 2 B.
- 1862. *Furina textilis*, Krefft, Proc. Zool. Soc. p. 149."

The geographical range of this species extends over almost every part of Australia, as I have seen specimens from Cape York, Adelaide, the Murray, and other localities. When full grown, this Snake may be dangerous to man; in its habits it is diurnal, and found generally in rocky localities; young Snakes are frequently found under stones during the cold season, while those of a more mature age retire into the ground.

BRACHYSOMA. *Günther*.

Brachysoma diadema. *Günther*.

The Red-Capped Snake.

Scales in 15 rows.
Anal bifid.
Ventrals 175.
Subcaudals?

Body elongate and rounded; head flat, distinct from neck; muzzle broad and obtuse; rostral high, slightly grooved, reaching to surface of crown; one nasal pierced by the large nostril; anterior oculars triangular, posterior one much larger, five-sided and bent down on the sides; occipitals moderate, rounded, scarcely forked behind; 6 upper labials, the third and fourth forming the orbit; eye small, pupil sub-elliptical, erect. Two temporal shields, the upper in contact with both post oculars, the lower much larger, wedged in between the last two labials.

Above, purplish brown, each scale with yellow centre very distinct in the first 4 or 5 rows on each side; head and neck black above, except a lunated spot just behind the occiput, which is brick-red, and turns white in spirits.

Beneath yellowish, front of lower jaw with a black spot. "Upper jaw with grooved fang in front, separated from the other teeth by an interval; an elongate series of six or seven teeth behind; palatine teeth equal in length; anterior teeth of lower jaw longest." (*Günther*.)

This very handsome little Snake is not uncommon near Sydney, though few people have ever seen it; during the cold season I have met with specimens under thin flat stones at Manly, Lane Cove, and other rocky localities; before I had an opportunity of proving its existence near Sydney, it had been known from Western Australia and the North East coast only. This Snake is venomous, but never offers to bite, and may be handled with impunity; it is oviparous, laying from 8 to 10 eggs. Its food consists, like that of other small species, in minute Blattæ, young frogs of the genus *Pseudopkryne*, ants, ants' eggs, &c.

PSEUDECHIS. *Wagl*.

Pseudechis porphyriacus. *Shaw*.

The Black Snake.

Scales in 17 rows.

Anal bifid.
Ventrals 180 to 200.
Subcaudals 14, 4¼1. Sometimes all subcaudals entire.

This snake is so well known that but a short description of it will be necessary. Body elongate and rounded; tail moderate, not distinct from trunk: head rather small, quadrangular with rounded muzzle; shields of crown regular; 2 nasals, no loreal; one anterior and 2 posterior oculars; scales smooth, imbricate, in 17 rows; anal bifid; first subcaudals entire, hinder ones two-rowed; in some individuals all the subcaudals are entire. Black above, each scale of the outer series, red at the base and black at the tip; ventral shields with black posterior margins; muzzle light brown; ventral plates from 180 to 200.

The Black Snake is, I believe, the most common of all our venomous snakes; it frequents low marshy places, is fond of water, dives and swims well, and subsists principally upon frogs, lizards, insects, and the smaller mammalia, in particular the young of *Hydromys leucogaster*. On one occasion 16 young of this rat were taken out of a single Black Snake, so that the reptile must have plundered four rats' nests.

When irritated the Black Snake raises about two feet of its body off the ground, flattens out the neck like a Cobra, and then darts at its prey or enemy. The bite of this snake is highly venomous, killing good sized dogs or goats within an hour.

The number of young brought forth in March generally amounts to 15 or 20. During the winter the Black Snake retires into the ground.

I believe that the Black Snake is found in almost every part of Australia. On the Murray and farther north a Snake occurs which has generally been considered a variety of the Black Snake; it is identical with it in almost every particular except colour, being brown instead of black, and orange beneath. Whether this is really a distinct species or merely a variety is not quite certain. Dr. Günther has distinguished the brown variety, however, as *P. australis*, and I mention this as it is a belief with some people that the Brown Snake and the Black Snake are identical, and the coloration sexual. It is to be remembered that the Brown Snake of Sydney, *(Diemenia superciliosa*) is generically distinct from the Black Snake.

HOPLOCEPHALUS. *Cuv*.

Hoplocephalus nigrescens. Gthr.

Black-backed Hoplocephalus.

Scales in 15 rows.
Ventrals 173 to 176.
Anal entire.
Subcaudals 37.

Scales in 15 rows, 6 upper labials, the second of which is pointed above, the third truncated. Uniform bluish grey or purple black above; ventral shields whitish, blackish on the sides. Description:—Body rather elongate, rounded; tail somewhat short, not distinct from trunk; head oblong, depressed, not distinct from neck; eye small, pupil sub-elliptical. Rostral shield, very broad and low, and very obtuse superiorly; anterior frontals moderate, broader than long, rounded in front; posterior frontals rather large, five-sided, each with two hinder edges forming together a right angle; vertical, six-sided, about as broad as long, with parallel outer edges, an obtuse angle in front, and a pointed one behind; occipitals oblong, obtusely rounded behind; superciliary moderate; two posterior oculars, one anterior just reaching to the upper surface of the head; the post frontal, nasal, anteorbital and second upper labial meet at a point and replace the loreals; six upper labials: the first is very low, situated below the nasal, the third and fourth enter the orbit; front series of temporals formed by two shields, one of which is in contact with the post orbitals. Chin-shields of nearly equal size, several scales between the hinder chin-shields and the first ventral; the median line of the upper part of the tail is occupied by a series of hexagonal scales; a series of small teeth behind the grooved front tooth.

The present species is subject to considerable variation of colours during the course of the year; sometimes before changing its skin the back and head are of a leaden hue, and the ventral scales uniform whitish; after the old skin has been cast off, the upper coat assumes a shining deep purple or bluish black; the ventral scales are at this time rose-coloured, which hue is invariably lost in spirits. The ventral scales of many subjects examined I found clouded on the sides; sometimes the greater part of the scales, in particular those near the vent, were blackish, and the subcaudals entirely so. I believe that this is the only snake of the genus *Hoplocephalus* in which the tongue is white.

The rocky neighbourhood of Middle Harbour (Port Jackson) is the locality where I first found this new species, but since then specimens have been obtained from Port Macquarie and the Clarence River, which do not differ in colour from those inhabiting the neighbourhood of Sydney; it is highly probable that the geographical distribution of this species extends still farther to the northward; but, owing to its nocturnal habits, collectors will experience great difficulty in capturing it.

During the cold season, from May to September, I have frequently found this Snake hybernating (if I may so express their dormant state) under loose flat stones, singly or in pairs, but never in company with other Ophidians; and more than once a dozen specimens were the result of a day's hunting.

It is very singular that no Snakes of this kind were ever met with between Sydney and Long-Bay, or towards the South-head, and I believe that they never frequented that district, otherwise the species would have been known long before this, as even White, in his Voyage to New South Wales, figures such rare Snakes as *Vermicella annulata*, and *Hoplocephalus variegalus*.

With regard to its habits, I may mention that it is strictly nocturnal, feeding on the smaller Batrachians, as *Pseudophryne australis*, and *Uperoleia marmorata*, specimens of which I have found in its stomach. It is rather sluggish in its disposition, and, though venomous, not dangerous to man or the larger animals.

The female produces about 20 young annually.

HOPLOCEPHALUS SIGNATUS. *Jan*.

Black-bellied Hoplocephalus.

Scales in 17 rows.
Ventrals 157.
Anal bifid.
Subcaudals 51.

Body short and rounded; tail short, distinct from trunk; head triangular, distinct from neck: above brownish olive, head much lighter coloured, with a white-edged dark streak from behind the eye to the back of the neck.

Description—head shields regular; vertical, six sided, with obtuse angle in front, and a sharp one behind; superciliaries rather large, nearly as long as the vertical occipitals; much forked behind, sometimes angular, but more generally rounded; nasal large, pierced by the nostril; one anterior, two posterior oculars; rostral high, with a groove along its lower edge; six upper labials, third and fourth coming into the orbit; a white or yellowish-edged dark streak from behind the eye to the back of the bead, no collar; eye moderate, pupil rather sub-elliptical; in young individuals the pupil appears always quite rounded; scales six-sided, much larger on the sides than upon the back; skin between the scales black.

Young specimens have the whitish streak behind the eye very distinct and often extended on the other side as far as the nostril; the apical half of the tail is either whitish or salmon-coloured below; in other respects they do not differ from the adult in colour, except that the whitish hue on the sides of the neck is less distinct. In the adult subject the head is often much paler than the other part of the body, which is either olive brown or brownish black above, and bluish black or bluish grey below; the fourth part of each ventral scale is clouded with grey on the sides, leaving a much darker band in the middle, which, approaching the neck, diminishes in size; the sides of the neck below and the chin shields being of a yellowish hue. Individuals occur occasionally, which are almost black above; others, particularly those about to shed their skin, appear pale brown above, and bluish grey below; in removing any of the ventral plates, the skin below is always jet black.

Habitat.—

The present species abounds in sandy or swampy localities near Sydney; the country between the City and Botany is much frequented by these snakes; they appear to be nocturnal, and are seldom observed during the day-time; they often prey upon each other, but generally upon the smaller Batrachians *(Cystignathus* and *Pseudophryne*) which I have frequently taken from their stomachs; various kinds of insects, small lizards, &c., are also devoured by them. The venom of this snake does not effect the larger vertebrated animals. I have at various times experimented upon cats and goats with it, but without a single fatal result; in fact the animals bitten did not appear to be affected at all.

Mrs. Edw. Forde of Ash Island, to whom I am greatly indebted for much valuable information respecting the reptilian fauna of the Hunter River, informs me that *Hoplocephalus signatus* is the most common of the Snakes on Ash Island, and that it is frequently captured and carried about by domestic cats, generally at night, proving at once its nocturnal habits and the slight effect its venom has upon these animals.

At Port Macquarie, this Snake occurs in large numbers, also at the Richmond and Clarence Rivers, but from beyond Brisbane I have never seen any specimens. I believe that it is also found in the neighbourhood of Melbourne. It is probably identical with *Hoplocephalus flagellum* (M'Coy).

The female produces from 15 to 25 young ones annually, total length 20 inches, tail 4 inches, cleft of mouth ? of inch.

HOPLOCEPHALUS VARIEGATUS. *D. and B.*

Broad-Headed Snake.

Scales in 21 rows.
Anal entire.
Ventrals 210.
Subcaudals 45 to 50.

Body and tail moderate; head flat, broad behind, very distinct from neck, obtuse in front; eye moderate, pupil sub-elliptical; vertical shield rather small, six sided, frontals of nearly equal size, large posterior ones rounded behind; occipitals regular, rather broad, forked; large lower temporal shield wedged between fifth and sixth lower labial; 6 lower labials, the last of which is the largest; one large pre-ocular in conjunction with nasal; anterior, frontal and second upper labial replacing the loreal.

Above black, irregularly spotted with yellow (white inspirits), forming a series of broad black blotches upon the back.

Beneath shining greyish black, each ventral plate with a large yellow spot on each side; first and second row of scales yellow, with here and there a black one intermixed; all the light scales more or less shaded towards the point.

We know little or nothing as regards the geographical distribution of this reptile; the few specimens in European collections were obtained by Mons. Verreaux, near Sydney, and so rare has this snake always been that up to 1858 no specimen of it was to be found in the British Museum. Since then I have been able to collect several hundreds of these snakes, which are strictly nocturnal in their habits, and seldom if ever observed during the day time. They may be procured from under stones in sunny localities during the cold season, and all the stony ridges around Sydney have harboured them in large numbers. At the present time they begin to become scarce, many of their favourite haunts being invaded by the gardener or the builder.

The bite of this snake is not sufficiently strong to endanger the life of man. I have been wounded by it several times, and experienced no bad symptoms beyond a slight headache; the spot where the fang entered turning blue to about the size of a shilling, for a few days.

Cats, dogs, and goats have been frequently experimented upon without any fatal result.

In January or February the female produces from 15 to 20 young ones, which, though only a few inches long, will show fight if one attempts to lift them; the adults always look formidable if attacked.

The snake which Schlegel describes as *Naja bungaroides* Abbildungen, Tab. 48, fig. 17 and 18, is nothing but a variety of the present species. The Australian Museum is in possession of a specimen from the Hastings, which is banded instead of having the irregular blotches of *H. variegatus*.

HOPLOCEPHALUS CORTUS. *Schleg*.

The Brown-banded Snake.

Scales in 18 rows anteriorly, and in 19 posteriorly.

Ventrals 169.
Subcaudals 44.

Body rounded, rather depressed, tail moderate, not distinct from trunk; head large, broad, very distinct from neck, crown flat, muzzle rounded; superciliaries slightly prominent, and sometimes two grooves before the eye. All the shields of the head very broad, the vertical almost square, with an obtuse angle behind; occipitals deeply forked, sides sometimes jagged, with a broad scale fitting the notch. Scales never in less than 18 rows; above olive brown with from 60 to 70 darker cross-bands, in some specimens the scales between the dark bands are anteriorly edged with yellow, the two outer rows of scales yellowish, more or less clouded, but without any distinct spot in the centre of each scale as in *H. superbus*. Belly yellow, ventral plates frequently clouded or spotted with dark grey anteriorly, growing darker towards the tail; the subcaudals, which are entire, being almost uniform blackish.

The coloration of this snake varies considerably; on the East Coast light-brown specimens are much more frequent than dark ones, whilst Western Australian snakes of this species are very dark-brown, and the cross-bands remarkably distinct. This reptile has been frequently alluded to by some authors as *H. superbus*, but I have always maintained that no continental species has ever been found with 15 rows of scales, and the vertical shield more than twice as long as broad; the main characters by which the two snakes can easily be distinguished. I am certain that more than 300 specimens have passed through my hands, and in not one instance did they answer to Dr. Günther's description of *H. superbus*.

I will give here the main points in which both Snakes differ:

I have had some correspondence with Dr. Albert Günther regarding the habitat of the two Snakes, and I am glad to see the learned Doctor's statement in the *Annals of Natural History* for November, 1863, that "*Hoplocephalus superbus* proves to be a Tasmanian species."

It would be interesting to know whether the Tasmanian Snake is able to inflate the skin of the neck when irritated, but judging from its small size this is not likely to be the case, and we must leave to Tasmanian Naturalists the solution of this question. In the continental Snake the power to raise itself off the ground for half the length of the body, and to flatten out the neck like a Cobra, is well known, the Black Snake being the only other reptile which has been provided with the same power. A few words more and I have done with this, the most dangerous of all our Snakes.

Its habitat is, I believe, the temperate part of Australia from East to West. I have taken it on the Murray, in South Australia and Victoria, and received specimens from almost every part of New South Wales and from King George's Sound. The present species is not far removed from the Indian Cobra *(Naja tripudians)*, and its bite is as deadly. A good sized dog bitten became paralyzed within three minutes, and was dead in fifty minutes afterwards; a goat died in thirty-five minutes; another goat which escaped whilst experimented upon, was found dead in the street after a few hours; a Dingo met the same fate in forty-eight minutes; an Echidna *(Echidna hystrix)* lived six hours, and a Common Tortoise, an animal which will live a day with its head cut off, was dead in five hours after being bitten.

Antidote vendors seeing the effect of the poison, never dared to peril their reputation in the attempt to save the animals so bitten; I must mention, however, that in making these experiments, chance bites, where the snake makes a dart, bites, and retires, were out of the question, and I grant that under such conditions man or animal may recover; but if the snake's head is applied to the lip or ear of some animal and the fangs well pressed into the wound, there is little hope of recovery. Let me also give a few words of advice to such men as go about exhibiting these reptiles, and showing their prowess by allowing themselves to be bitten, professing that they possess an antidote against the poison; generally speaking, these persons are more or less impostors; they break off the fangs of the snake, but do not know how soon they are reproduced, and thus frequently fall victims to their ignorance. The Indian jugglers have more sense, and entirely remove the teeth, as most of the specimens of *Naja tripudians* prove which are received from India.

The young of this snake, from 15 to 20 in number, are generally observed about the end of February; they are then from 7 to 8 inches long, and subsist on small frogs, lizards, or insects. During the cold season this snake retires into the ground, as I have never met with half-grown or adult specimens under stones.

PETRODYMON. *Krefft*.

PETRODYMON CUCULLATUS.

Red-bellied Snake.

Scales in 15 rows.
Anal 1/1.
Ventrals 187.
Subcaudals 4¼1.

Purplish brown above, with a series of darker longitudinal lines along the upper part of the body, leaving a light elongate mark in the middle of each scale. Beneath yellow, bright red in adult specimens, each ventral plate clouded on the upper edge with purplish brown, much interrupted on the posterior part of the body. Divisional line of subcaudal plates marked in a similar manner, leaving the outer edges of the plates yellowish. Upper part of head purplish brown as far as the middle of posterior frontals, covering the vertical part of superciliaries, and reaching beyond the occipitals; this elliptical spot is joined to the back by a narrow band of the same colour running along the median line of the neck. A light-greyish band encircles the dark-brown mark, divided by the narrow line by which this mark is joined to the back. Upper and lower labials dotted with brown spots. Body rounded, bead rather flat, depressed; tail short, distinct from trunk, and ending in a conical spine or nail about a quarter of an inch long.

Scales in 15 rows (not in 13, as mentioned by Dr. Günther, whose description as *Diemenia cucullata* was taken from a very bad specimen); 6 upper labials, the third and fourth forming the lower edge of the orbit, the second labial *not* in contact with the posterior frontal; rostral broad, low, very obtuse superiorly; shields of the head regular, all more or less rounded posteriorly, and slightly imbricate, vertical twice as long as broad; one anterior and two posterior oculars, one temporal in contact with both oculars, four or five scale-like temporals behind; eye very small, pupil elliptical and erect.

About 3 years ago—in 1860—I captured a single individual of this species; since then, owing to the exertions of friends in the country, specimens from Ash Island, Hunter River, Port Macquarie, the Clarence River, and other localities have been received, so that its geographical range has been ascertained for many hundred miles along the east coast. This snake is strictly nocturnal in its habits, sluggish and of gentle disposition, never offering to bite when handled, and though venomous, it is so in a very slight degree only, as has been proved by experiments; its length seldom, if ever, exceeds 20 inches. Rocky and desolate places are frequented by it, and in such localities it is occasionally found under flat stones during the cold season.

VERMICELLA. *Gray*.

VERMICELLA ANNULATA

The Ringed Vermicella.

Scales in 15 rows.
Ventrals 225.
Anal bifid.
Subcaudals 18/18.

The following is Dr. Günther's description:—"Body elongate, rounded, slightly compressed behind; tail very short; head moderate, not distinct from neck, similar to *Elaps*; rostral shield very large, rounded, raised above the surface of snout; occipitals rather narrow; two posterior oculars; anterior large, replacing the loreal together with the nasal; nasal shield single, pierced in the centre by the small nostril; six upper labials, third and fourth coming into the orbit; one large temporal shield in contact with the upper posterior ocular, two smaller ones behind. Scales smooth, large, rather rounded behind, in fifteen rows. Anal and subcaudals bifid. Tail ending in an obtuse conical scale. Two small fangs in front of upper jaw, no other teeth behind; palatine and mandibulary teeth equal in length. Crown of head and muzzle black; a yellowish, in fresh specimens white, band across the posterior frontals, a second on the neck; body and tail encircled by alternate black and white (in spirits) rings. Length of cleft of mouth ½#; length of tail 1½#; total length 28#."

The ringed Vermicella, like all other nocturnal snakes, is very seldom met with, and apparently little known to the colonists. I often capture it during the cold season without taking any precaution whatever, as I know from experience that this gentle creature will never bite; but even if it should do so, the wound would be small and of no danger whatever. I have never succeeded to make it bite of its own accord, but had to open its mouth forcibly if I wished to try an experiment. White, in his Voyage to New South Wales, gives a figure of this interesting snake, but little was known until a few years ago with respect to its geographical range. We find it as far south as Eden, Twofold Bay; it occurs again in Western Australia, is tolerably common near Brisbane, and may probably be found much further north. Mr. William Taylor has lately presented a young specimen of this snake to the Museum, which was captured at the Culgoa River; it is not unlikely that this species is found all over the continent from east to west.

In its habits it is nocturnal, and closely allied to the genus *Elaps*, inhabiting South America; in fact it bears, like our Batrachians, according to Günther, a closer resemblance to the South American than to the Indian fauna.

ACANTHOPHIS. *Daud*.

ACANTHOPHIS ANTARTICA. *Wagl*.

The Death Adder.

Scales in 21 rows.
Ventrals 127.
Anal entire.
Subcaudals 42.

Head large, depressed, broad behind, regularly shielded, no loreal, 2 nasals, nostrils between; 8 rows of dorsal scales, keeled to the root of the tail; grey, sometimes salmon coloured above, minutely punctulated; back and tail with about 4 or 5 white spots speckled with pink, lower lip flesh coloured (white or yellowish white in spirits), with a pale black dot in the centre of each scale; beneath salmon coloured (yellow in spirits); tail distinct from trunk, short, thin, and ending in a recurved soft spine.

The colour of the Death Adder is subject to a good deal of variation, northern specimens from Rockhampton and Port Denison have the dark cross-bands of the back considerably smaller than those from the neighbourhood of Sydney, and the markings in the centre of the upper and lower labials and chin shields are of a pale greyish hue in the former. Specimens of a copper-red colour, as occasionally occur near Richmond, Randwick, and Long Bay, have seldom come under my notice from other parts of the continent.

Its habits and economy are tolerably well known. It is fond of warmth and sunshine, frequents sandy localities, is sluggish in its movements, and does not jump backwards if going to bite. When irritated this snake flattens itself out generally in the form of an S, turning round to one side or the other with astonishing rapidity, but never *jumping* at its enemy. As regards the supposed venomous sting in the tail, I can assure everybody interested in this matter that the caudal appendage is a mere ornament, quite soft, which nobody could run into his finger if he tried, and I am astonished that the fables which ignorance has circulated in a former and darker age, have not been exposed long before this.

In April or May they go into winter quarters, having during the summer months accumulated a sufficient quantity of fat, to be under no further necessity of catching frogs, grasshoppers, or field-mice during the next season. The burrow of some small rodent, or the hole furnished by a decayed root, is selected and taken possession of until the warm sunshine of spring recalls the sluggish reptile to fresh activity.

I believe that the Death-adder is found in almost every part of Australia north of 36°. The Australian Museum is in possession of specimens from many parts of New South Wales and from various localities in Queensland. The British Museum received this snake from Port Essington and the north-west coast, and I have taken it myself on the Murray and Darling. Its length seldom exceeds 30 inches. A very large specimen measured 2 feet 2½ inches to the vent, and 4½ inches to the tail; total, 2 feet 7 inches; around the body, 6 inches.

2. HYDROPHIDÆ, OR SEA SNAKES.

PLATURUS. *Latr*.

PLATURUS SCUTATUS. *Laur*.

The Ringed Sea Snake.

Scales (front part) 21 to 23 series.
Ventrals from 213 to 241.

Body subcylindrical, of moderate length, shields of the head subnormal in number and arrangement, nostrils lateral, in a single nasal shield, both nasals being separated from each other by a pair of anterior frontals. Scales imbricate, smooth, ventral shields well developed, tail with 2 series of subcaudals (Gthr.)

Body covered with a series of black rings, 20 to 50; crown of the head black, the first and second black mark of the head and neck are joined below by a longitudinal band commencing from the chin; snout and side of the head yellow, with a black band running through the eye (Gthr).

This Snake is frequently thrown ashore after stormy weather near Manly Beach, Coogee Bay, Botany, and other localities. Its range is very extensive, and it is common in the Bay of Bengal, the China Seas, and on the Australian and New Zealand coast; it lives on fishes, and is not much dreaded by the natives of the South Sea Islands who, I am told, handle this snake with impunity.

PELAMIS. *Daud*.

Pelamis bicolor. *Daud*.

The Black and Yellow Sea Snake.

"Head long, with very long spatulate snout; neck, rather stout; body of moderate length; nasal shields contiguous, longer than broad, pierced by the nostrils posteriorly; only one pair of frontals; scales not imbricate, not polished, tubercular or concave; ventral shields none or very narrow; lower jaw without notch in front; 2 or 3 postorbitals; neck surrounded by from 45 to 51 longitudinate series of scales: from 378 to 440 scales in a lateral longitudinal series between the angle of the mouth and the vent." (Günther.) The coloration of this snake varies considerably; the most prevailing colour is, the upper part of the head and the back uniform black, the sides and belly uniform brownish olive or yellow, the latter colour predominating just after the snake has shed its skin. Both the black and yellow colours are sharply defined. Tail with a series of black spots. This snake, which occasionally occurs on our shores, has a wide range, and appears to be as common on the Indian Ocean as it is here. The coast of New Zealand may be taken as its most southern limit. Dr. Gray, speaking about the Hydridæ in the *Brit. Mus. Cat. of Snakes,* remarks "that they are true Sea-Snakes; that they coil themselves up on the shore, living on sea-weeds, and lay their eggs on the shore." This observation is not correct if applied to the present species, as I have more than once taken gravid females with from four to six well-developed young of such a size as are sometimes met with swimming about, and apparently a few days old only. That they live on sea-weed is doubtful also, for though I have dissected almost every specimen which has come into my hands, I have found nothing but fishes or the remnants of such in the stomach.

These are all the specimens of Snakes observed near Sydney; and as the country has been well searched for more than five years, it will be difficult to discover new species.

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On the Manners and Customs of the Aborigines of the Lower Murray and Darling, by

GERARD KREFFT.

[Read 2nd August, 1865.]

IT is much to be regretted that many of our fellow-colonists who have had ample opportunities for observing the aboriginal inhabitants of Australia, have never made an attempt to record the manners and habits of a people now without a doubt upon the verge of extinction: and as every observation—be it apparently ever so trifling—will become of greater interest from year to year, I may be held excused if I come before you to-day with some *bonâ-fide* notes relating to the Aborigines of the Lower Murray and Darling. Nearly eight years have passed since they were made, and many of the natives, then in the prime of life, have disappeared already, and but few of them will be remembered by the settlers who now occupy their hunting grounds.

Unlike the American Indian, who slowly retreated before the settler, the Australian clung to the soil upon which he was born, but he did not become civilised; he tried to eke out an existence, feeding upon his Kangaroos and Emus, and occasionally interfering with the squatters' stock: but finding that he could not do so with impunity, he came to terms, bartered his opossum rug for blankets; his game for flour; beef, or mutton; his services as a shepherd Or stock-rider for other luxuries of civilised life; and at last he became dependent for almost everything upon the occupant of his own domain. The consequence of all this is obvious. A native once used to flour, tea, sugar, and tobacco, can hardly exist without them; hence very few independent tribes remain within the settled districts, and the younger members of them have almost forgotten the vegetables or the game upon which their fathers once feasted.

If these people did not retreat before the white man it was not their fault; they have only the alternative of making a compromise with the settler, or of fighting the next tribe they come in contact with; and generally they adopted the first—they remained upon the soil which had given them food for so many years, took to rum and tobacco, sacrificed their wives and daughters to the white man (if a free offer may be called a sacrifice), and at last, almost ceased to increase in numbers as the women became either barren or produced a weak half-caste offspring, who were not fit to endure the same privations, or obtain their food in the same ingenious manner as their black brethren.

The Aboriginal population of Victoria in 1847 amounted to about 5000; in 1858, shortly after these notes had been taken, their number had been reduced to 1768, men, women, and children; and if they have decreased at the same rate to the present day there will scarcely be a thousand souls left.

When I started from Melbourne, in October 1857, for the Lower Murray, I counted the number of natives who visited our camp at every station, and the following is the result, the average distance being about 25 or 30 miles from post to post. Between Melbourne and Spring Plains—about 70 miles—no native was observed.

which, in round numbers, would amount to about 400 souls.

Between Melbourne and the Campaspe, the natives have very much degenerated, they were, in fact, represented by a few old men and decrepit women, and two or three diseased wretched children; but, nearing the Murray, their condition appeared to improve, and at Gunbower Creek they were found in considerable numbers, most of the men fine stalwart fellows, some more than six feet and one nearly seven feet in height.

Fishes, crayfish, the eggs of tortoises, ducks, emus, the mallee hen, and the black swan, appeared to be their principal food at that time, they were therefore tolerably independent and remarkably lazy as I thought, though on consideration it appeared to me that their philosophy was quite correct; why should they exert themselves?

They did not lay in stores, and many of their viands being of a perishable nature, and to be had almost every day, there was no reason why they should work like their civilised brethren; there are only two beings which appeared great fools in their eyes, namely a white man and a working bullock.

My stay at Gunbower Creek was not of sufficient duration to study the manners and habits of these people; the men all carried guns (some very queer looking fowling pieces), they were all tolerably good shots, but when trusted with ammunition would invariably come home empty handed, though their own camp fires seemed to be well supplied with a variety of game.

After a while, many of the smaller animals were bartered for tobacco and flour, but in not one instance could they be induced to kill a bat; they even asked, when I had captured one of these creatures alive in the tent, to let it go, as it was "brother belonging to black fellow."

They told me that if it was killed, one of their lubras would be sure to die in consequence. They had their corobbories of a moonlight night, keeping our party awake with monotonous songs, and once they even had a sort of quarrel, and in consequence a fight—a woman, as usual, being at the bottom of it—but after all nobody was hurt, and I missed a good opportunity of observing their burial rites.

There were, however, a few graves in the neighbourhood of Mr. Gardiner's station, in a thick pine scrub, enclosed by a rude brush fence, and covered with large pieces of cork. They appeared neglected, and were much more rude in shape than the graves subsequently encountered farther down the river. The settlers treated the poor blacks invariably with great kindness, in return for which they would look after the squatters' property with a keen eye. They would never allow the men to destroy any old fences or huts for the sake of a few dry slabs or a piece of bark; and if no heed was taken of their remonstrances, would invariably report it at the next station. If their watchful eyes observed the tracks of a few stray sheep, they immediately altered their course, and took me miles out of my road to—as it appeared—no purpose whatever, until the stragglers were overtaken, and safely delivered at the head-station.

Like all the other tribes they would share their food with each other, and if out hunting, and having too many followers for the few pounds of flour and tea with which we started, it was frequently found necessary to starve part of the garrison, by making the natives who accompanied us, eat their rations before our eyes, so that the idle camp followers were compelled to look after opossums, and leave us alone.

Following the course of the Murray, I noticed about 18 or 20 natives encamped near Campbell's Station, one of them a remarkable character, being an aged woman in good condition, with a large white beard; the natives at this place appeared to subsist principally upon fish, of which 3 or 4 kinds including the Murray Cod *(Oligorus macquariensis),* were roasting on their camp fires.

At the Loddon Junction more natives were observed, all armed with fishing spears, and freely offering their women for a small number of hooks and lines.

At Reedy Lake, about ten men and women were noticed, and at Lake Boga, six; the natives who visited the camp at Lake Boga were remarkable on account of their powers of mimickry, and the good English they spoke; all had been under the tuition of the Moravian Missionaries, and one appeared to make a livelihood by offering to preach like one of them; he had a way of his own of saying home truths, like "white-fellow always pray give it daily bread, but bail give it damper." It appears that the Moravian Missionaries had made an attempt to teach the natives agriculture, but I fear with little success. A few small plots of ground enclosed with a brush fence, and overgrown with weeds, were all that was left of these "native gardens," to which their owners pointed with considerable pride.

In this part of the country where extensive reed beds are of common occurrence, the natives live for several months during the year on "Typha roots," or Wongal *(Typha Shuttleworthii)*; at a certain period, I believe January or February to be the months, the women enter these swamps, take up the roots of these reeds, and carry them in large bundles to their camp; the roots thus collected are about a foot to eighteen inches in length, and they contain besides a small quantity of saccharine matter, a considerable quantity of fibre. The roots are roasted in a hollow made into the ground, and either consumed hot or taken as a sort of provision upon hunting excursions; they are at the best but a miserable apology for flour, and I almost believe that it was more on account of the tough fibre thus obtained that these roots are made an article of food.

As soon as a sufficient quantity of "Wongal" had been roasted, the whole tribes settled around the improvised oven, every body chewing the roots most vigorously; the lumps of rejected fibre were afterwards collected by the women, and spun into threads from which their fishing-nets and other domestic utensils were manufactured, these nets forming the staple article of barter between the tribes inhabiting the reed-beds and those parts where no Wongal was produced. If we take into consideration the large nets for catching water-fowl in use, it is indeed astonishing how great the perseverance of these people (and how sound their teeth) must have been, and it is not to be wondered at that the possession of one of these nets has always been considered to be a sort of fortune to its owner.

At the present time no more fishing-nets of Wongal fibre are manufactured, as the natives barter twine from the settlers instead.

Between Lake Boga and the Junction of the Murrumbidgee, some sixty or seventy natives were observed encamped in small lots near the river or lagoons, most of them occupied with fishing. We passed several graves, the last near Coghill's Station, of the simple form noticed at Gunbower Creek, whilst a little farther on a regular hut had been erected over the departed native; and at Hamilton's Station were two graves of this description, in a very good state of preservation. The form of these sepulchres changed again soon, being, instead of bark, covered with grass and reeds; a fishing net generally enclosing the whole fabric.

Nearly all the trees along the river-bank showed more or less traces of the presence at one time of a large number of natives: square pieces of bark for drying their opossum skins upon had been cut, often to the height of 20 feet above the ground; there were also many signs upon these trees where canoes of great dimensions had once been removed, whilst fresh cuttings of this kind rarely occurred.

It may be of interest to give a short description of the manner in which a canoe is manufactured:—

The tree selected is generally the species of Eucalyptus, known to the settlers as "*Flooded Gum*," by which the river banks from Swan Hill to the Darling Junction are invariably fringed; the trunk must be free from branches or knots, and, if possible, slightly bent; having found a suitable tree of this kind, a large forked branch is cut, and the tree being jammed between, it serves the native as a sort of ladder; he begins by making two incisions which at first run parallel to each other, and then closing more and more join at the ends, the whole having the form of an elongate shield. The outer bark is then removed sufficiently to permit the introduction of a number of flattened sticks of tough wood, each about a quarter of an inch thick; these sticks are wedged under the piece of bark, which is to form the canoe; they bend easily, and soon loosen it from the trunk. With a couple of grass-ropes around the bark, it is then allowed to slide down, and is put upon the stocks in a regular way. Dry leaves, grass, and small branches, having been collected and put into the still flat piece of bark, they are fired, and the sides soon begin to turn up; when sufficiently bent, 3 or 4 sticks are introduced, to prevent the bark from curling any more; accidental cracks or holes in the canoe are filled up with clay from the river-bank, and the boat is ready for use.

These canoes are generally propelled with long elastic spears, and considerable progress is made on smooth water, as lakes or lagoons; but to steer the frail bark dead against the stream in such a river as the Murray is almost impossible; when going up stream, the natives keep close alongside the river banks, where the current is less, but they never travel long distances up the river, but frequently visit friendly tribes by going overland, and having manufactured a canoe, they drift down the stream, back to their own hunting grounds.

A supply of clay is always kept in these canoes, and often when the bark is not of sufficient depth, a clay rim or dam is raised on both ends, to prevent the water from coming in; being all good swimmers, the natives appear very careless with their frail craft, and if she sinks, which is however very seldom the case, they quietly swim ashore and build another. To sit perfectly quiet is the first rule, balance yourself well, keep baling out any water which may run in, and trust to the native who propels the boat; the least motion from one side to the other suffices to fill and sink it, there being seldom more than about an inch of board. Being at home in the water, like Newfoundland dogs, they appear to think that every white man who trusts himself to their bark canoes, must necessarily be the same, and if half-a-dozen men are willing to cross the river at once, the natives have generally no opposition to offer, and would almost as soon see some of their passengers drowned as cross the river twice.

When out fishing at night, they have a small fire burning in the bow of the canoe, which is for that purpose covered with clay; some of the fishes are attracted hereby, and many of them speared. A loop of grass-rope, or green hide, attached to the side of the canoe, through which the spear is run into the bottom of the river, answers the purpose of an anchor.

Passing farther down the Murray, the natives increased in numbers, and at a lagoon near Kilkine, we found some 50 or 60 of them assembled for the purpose of "making young men;" these wretched youths being passed through various ordeals, one of which was to mount the candidate upon the shoulders of the biggest man in the tribe, to run round the camp fires with him, all the rest following with hideous noises, and to deposit him without as much as a shirt on, in some part of the scrub. Five or six of them passed the night there, shivering and hungry, until released by the men the next morning, and introduced to the adults of the tribe as "men." I do not think that these ceremonies were gone through in the orthodox style, and the youths did not appear to believe in them at all; they assured me they only submitted because of their rights hereafter to take a lubra unto themselves.

Both men and women were well made, with highly intelligent countenances; but, except the young girls, none of them wore any covering whatever. When the men approached at the first interview, they wore two or three feathers of the White Cockatoo in their hair—a sign of their being messengers of peace,—and two of them who accompanied our party to the Darling Junction, never removed these feathers as long as they were upon the hunting grounds of another tribe.

On no occasion did I notice any of the natives to travel at night, and whenever noises were heard, for which they could not account, they were invariably put down to the credit of Devil-Devil, and no promise whatever could induce them to leave their fires.

A few miles from Milldura, at a place called Mondellemin by the natives, a permanent camp was established, and in a few days some twenty of them, including men, women, and children, were assembled near our huts; they could not at first understand what brought us there, but when we purchased some of the native animals captured by them, they ever after brought in a good supply and became our permanent huntsmen. The boys would go out to collect insects, the women to look for small mammals, and the men looking for the larger game; they would try their best to please, and obtain the reward offered for some of the more rare creatures, but not succeeding, they would as quickly try to pass off some common animal as the one which we were in want of.

Being very anxious to obtain Mitchell's tail-less Chœropus *(Choeropus ecaudatus)* high rewards were offered, though in vain; the cunning natives, not succeeding in finding the animal required, were in the habit of bringing any number of the common bandicoot, *(Perameles obesula)* with the tail screwed out.

Altogether they became very useful, and very much attached to us, (as long as our flour bags lasted, at least); but whenever the stock of flour diminished, they would break up their camps, and pay visits at the neighbouring stations; returning as quick as possible when they heard that a steamer had arrived with fresh supplies. At one time, when about fifty bags were in store, I observed two natives trying to count them; but, their numerals being limited to one and two, this became rather a difficult task; *rangul* means two, and *meta* one, so that *rangul, rangul, meta* is equivalent to five, and so on ad infinitum; of course, to count *fifty* in this fashion was too much for them, so informing the tribe that there were *thousands* of flour bags in the store, they returned shortly after, with a stick, into which they made a notch for every bag, keeping henceforth as good an account as the storeman. Nothing could keep them near the camp, or induce them to exert themselves in hunting, except seeing a good supply of flour on hand; and when some two months before our return to Melbourne, the stock became very low, and I feared to lose the natives, they were completely oat-manoeuvred; as I filled the empty bags with sand during the night, and piled them up with the rest.

Never did I behold such astonished faces as the natives showed on the next morning; they examined the ground for miles, looking for dray tracks, and as no steamer had passed, could not account for the flour thus arrived, and as usual, put it down to the agency of "Devil-Devil."

I have often tried to find out if they had any ideas of religion, but without success; I know that the younger children often learn to read and to write, and I believe that Mr. Goodwin, of Yelta, has had some very successful scholars, but I do not think that the adults ever understood the principles of Christianity.

Once I met old Jacob, a Darling chief, in Mr. Goodwin's house, intensely looking at a colored print, representing our Lord as the "Good Shepherd," with a lamb upon his shoulders. Jacob addressed me in his quaint way of—"make a light! name belonging to that one Shepherd?"

I tried to explain the meaning of the picture, but to no purpose, and all I got out of poor Jacob was:—"bail shepherd belonging to this country! never see him carry lamb on his shoulders, he always leave him along the bush." Taking the print literally, I do not think Jacob was far wrong.

The natives living near Mr. Goodwin's place were much more comfortable in many respects than any of the tribes seen before; they could always count upon a certain price in the shape of flour, tea, and sugar, for any work performed; they lived in closed sort of huts, which had somewhat of a permanent character; but I have reason to believe that all the good examples of Mr. Goodwin and his assistant, were counteracted by the presence of a lot of hard-drinking and hard-swearing bushmen at the Darling Junction public-house, opposite.

Here, at Yelta, or rather on the New South Wales side of the River, the natives had always assembled in large numbers for the purpose of feasting upon fish and bartering their famous Myall-spears for reeds, Wongal-twine, and nets the produce of other parts of the country; in olden times no doubt their stone hatchets were exchanged in a similar manner, as from Gunbower Creek to the Darling Junction there is not a stone to be met with the size of a man's fist. I have been told that the green stone, serpentine, or jade tomahawks used by the natives, were obtained at Mount Macedon, and that a certain locality on the side of the mount had been considered neutral ground by the neighbouring tribes, who went there for the purpose of obtaining suitable material for their weapons.

About this time of the year, in the month of July, a similar gathering had taken place; and one night I visited the camp, accompanied by Mr. Goodwin. There was no moon when we crossed the river, and following our guide, we soon found ourselves in the midst of about two hundred natives, stretched around their camp-fires, which formed a semi-circle, the middle being occupied by "old Jacob," the famous chief, who appeared to keep them merry by telling a number of tales; all were busy except Jacob. Some tried to straighten young shoots of the Myall, by heating them in the ashes, and then bending the wood into shape—keeping their feet and the whole weight of their body upon it; others were occupied knitting nets, using the same instrument as our fishermen do, and working with their hands and feet; the women were cooking fish, of which a large supply had been obtained during the day,—carefully reserving the taboo'd fish called Manor, for the use of the aged, no youth or lass being permitted to partake of it;—carving their waddies, or preparing opossums' skins for their rugs, kept others busy, and all this time the sonorous voice of old Jacob could be distinctly heard, and shouts of laughter testified how well the old man's tales were appreciated.

When the moon rose, the men left their occupation, some ascending trees to cut down branches, others painting themselves with gypsum, for the forthcoming corobboree, and shortly after the dance commenced,—performed by some fifty or sixty men, with bushes tied to their ancles. Their ribs, arms, and thighbones, were traced with gypsum upon the dark skin, and made them appear as so many skeletons; the women and young girls formed a sort of orchestra, beating opossum rugs, and singing their monotonous airs; all the dancing men, and some of the more aged ones who sat near the women, were provided with two short thick pieces of hardwood, which they beat to the time of the song. All this time one of their "doctors," as he was termed, experimented upon another blackfellow, as it would appear, in trying to deliver him of an immense worm which he seemed to pull out of his patient's mouth; I found afterwards that this worm was part of the intestines of an opossum; they went on enjoying themselves when I left, keeping the dance up until the small hours, and, of course, sleeping far into the day.

The following morning we inspected their fishing gear, which was simple enough. For river or lagoon fishing, when the water is clear, they have a three-pronged spear, with which they strike the fish, either from their canoes or from logs in the water. Sometimes they fish at night, as mentioned before, and then a fire is lit in the bow of the canoe to attract the fish. They also have iron spears, and I was told that they would dive, and take up a position alongside a sunken log, keeping the spear horizontal with the right hand and the big toe, and running it through every fish which came within range; sometimes five or six fish have been speared during the sixty or eighty seconds they remain under the water.

I do not think that they use large nets for fishing in the river, but the women are very expert with hook and line, and with a sort of flat net fixed to a bent stick about 6 or 8 feet in length, similar to a dredge; this, of course, is only fit for shallow lagoons, the outlets of which, when the flood-waters begin to fall, are closed with sticks or basket-work to prevent the fish escaping, thus creating a considerable reserve for the following months.

The principal fishes used as food by the natives are the Murray Cod, *(Oligorus macquariensis);* Silver Perch, (*Lates colonorum);* Cat Fish, *(Copidoglanis tandanus);* and Manor, *(Chatoëssus come*); most of the other species are small; I believe however, that both kinds of Australian Mullet *(Mugil dobula*, and *Mugil compressus)*, and another species of so-called Perch inhabit the Murray, and its tributaries.

As I am speaking about nets, I may as well mention their contrivance for catching water-fowl, in particular ducks. Wild ducks are as much prized by the natives as they are with us, and having studied the habits of these shy birds well, they have at last contrived a plan to catch them, which is a complete success. A large net, sometimes 20 feet deep by 100 feet long, is spanned across a creek or river, to the two ends to which a string is fastened, resting upon some branch of a tree, being kept in readiness by two natives, who are posted beneath this tree, and the net completely immersed in the water. Some two or three miles higher up the creek, a party of natives start the birds, which invariably follow the bend of the creek, though sometimes at a height of a hundred feet or more; as soon as they are nearing the net, another native who is posted in the scrub gives a peculiar whistle—similar to a species of hawk—throwing a flat piece of wood or a boomerang among the startled birds, which immediately stoop to the level of the water's edge; quick as lightning the net is raised, the ducks get entangled in its meshes, and become an easy prey to the women and children, who jump in to secure them.

I have seen from 50 to 100 ducks taken in this manner at a haul. Black Duck, (*Anas superciliosa);* Shovellers, (*Spatula rhynchotis);* Teal, *(Anas punctata*); Pink-eyed or Whistling Ducks, (*Malacorhynchus membranaceus*) *;* Wood Ducks, (*Bernicla jubata);* and White-eyed Ducks, *(Nyroca australis);* being the species most common.

Of fresh water crustaceans, we find the large river Cray-fish, *(Potamobius serratus,)* distinguished by its spiny back and white pincers, and a species of Prawn, which is frequently eaten raw by the natives.

The large cray-fish is secured in a very simple manner: a canoe is fastened in the stream, and two or three natives paddle with their hands in the water, the great crustacean makes a dart at their fingers with its pincers, and before he finds out his mistake, he is safely landed into the canoe—the pincers being immediately broken off.

Other kinds of food which the lagoons or river supply are tortoises, *(Chelodina)*, generally taken during the hot summer days when the water is low, also muscle shells *(Unio)* large mounds of which may be traced upon the river banks at intervals for hundreds of miles.

Most of the natives being supplied with guns, they are able to surprise almost every kind of bird, though they generally shoot water-fowl only. The Emu is still hunted in the primitive style by hunters carrying bushes in their hands, and so trying to steal a march upon the rather stupid bird; as soon as they are within range their spears are thrown and the bird secured.

Fishes, cray-fish, insects, frogs, lizards, snakes, all birds, and the smaller mammals, are generally roasted upon the coals; whilst emus are treated in the following manner:—The feathers are singed off, and a large hole is made in the ground, filled with leaves, dry branches, &c., the fire being well supplied with fuel for an hour or so; the ashes and embers are then cleaned out, the bottom covered with fresh gum-leaves; the carcase is put upon these, covered over with leaves again, and the whole with earth and lumps of clay (the size of a man's fist) which have previously been heated; a fire is again lit upon the top, and after another hour the bird is done, tasting as sweet as if prepared by the best professed cook.

Of Mammalia which are hunted by the native for the sake of their skins or their flesh, the common opossum *(Phalangista vulpina)*, stands first. In the Mallee scrub, where the trees are of stunted growth, these animals are plentiful, and easily secured: whilst upon the river banks, where gum-trees one hundred or two hundred feet in height give them shelter, this is a more laborious task; still even upon the highest tree poor 'Possum is never secure. I have seen one of these nimble blacks after a rainy day, when his stomach called loud for meat, carefully scan every tree along the river bank, until the trace of 'Possums' nails were found in one of the old "gums;" tomahawk in hand, he mounted it, the first branch being about sixty feet above ground; even then, he had to cut through a thick branch, and it was almost dark when he extracted an old opossum, which however, before it could be killed, dropped into the river below; his wife had been watching him, however, and plunging into the stream, she secured their supper for that night.

If nothing is to be had in the shape of meat, the last resource is, in summer time at least, to light a few branches and hunt for frogs, which may also be secured, summer or winter, beneath the bark of the flooded gum trees. Native cats, (*Dasyurus geoffroyii)* all species of rats and mice, and the smaller wallabies, (*Habmaturus,)* are also eaten, and some of them obtained almost every day. The large kangaroos (*Macropus major* and *Osphranter rufus*) are generally hunted by a number of men with their dogs, the time chosen being after a heavy shower of rain, when the large animals sink deep into the chalky soil of the Mallee scrub.

After a kangaroo has been killed, the successful hunter secures the kidney fat, which however is very small in quantity, it is generally attached to a string around the neck, and of course women and children who see this sign rejoice, and bring home the carcass, if it is not too far; or should more than one animal have been slaughtered, the tribe removes for a day or two, to eat the meat on the spot.

A species of burrowing kangaroo-rat, *(Bettongia campestris*) and a sort of bandicoot, (*Peragalea lagotis)*, are dug out occasionally.

The kangaroo-rat, called Booming, is common in the scrub, and its burrows often cover a couple of acres of ground: the natives trace the direction of the holes, by inserting long slender twigs, and then sink a shaft, which sometimes requires to be from ten to twelve feet deep; when they labour, they work with a will, and more than once I have noticed a couple of natives to sink three such shafts in a day. A pointed stick to loosen the earth, a sort of scoop to throw it up, or if too deep, to fill a kangaroo skin with it, are all the digging utensils they require.

The burrowing bandicoot, known as Wuirrappur to the natives, is dug up in a similar manner. In fact there is scarcely a living animal from the grub of a large beetle to a whale, which an Australian rejects. The vegetable kingdom does not offer, however, a great variety of food.

One or two herbs,—the Quandong, and a root the size of a radish, are all the vegetables I have ever noticed these people to eat, though the so called "Pigface" *(Mesembryanthemum œquilaterale)*, must not be forgotten; it appears to be the only substitute for salt they have, and whenever their women have been out, they invariably return with some bunches of this plant.

Being dependent upon a variety of food which is not always in season, or more plentiful at one time than at another, they lead of course, a wandering life, and on this account do not erect any permanent dwelling. A simple break-wind of gum-branches is all they require, and sometimes a few sheets of bark are stripped to make their huts more comfortable, but beyond this they do not go; these light structures are shifted, or rather turned, should there be a change of wind, or they are left altogether in case the vermin become too troublesome.

Their weapons are just as simple; a few reed-spears with hardwood ends, a throwing stick, a sort of shield, besides clubs or waddies and boomerangs, comprise the whole of their armoury. The boomerang appears to have been a late introduction, and I have never seen a native on the Murray who made use of it as a defensive weapon.

Their social position is naturally a very low one; they do not appear to have any idea of a Supreme Being, they possess no religious rites, and every man who is strong and cunning enough to enforce his authority and to subject the weak, will always be a chief among them. Marriage ceremonies they have none, and when a native takes a lubra to himself for good, it is pretty certain that, however young she may be, she has had connection with most of the men of the tribe. These women are often obtained by stealing them from another tribe, in which case the unhappy creature is generally beaten into a state of insensibility, or they are exchanged, any man giving his own sister for that of another; thus many young men who have no sister to offer, are deprived of the blessings of the conjugal state, or rather they possess no lubra which they may order about, or make a slave of.

They exchange wives out of compliment to visitors of other tribes, during the time of their stay; and they freely offer both their wives and daughters to any European who may have a piece of damper, a fish-hook, or any other present to bestow. They treat their children kindly, though they do not hesitate to destroy them sometimes at their birth, and particularly if the babe is a cripple; still I remember a man, named Piper, with malformed feet, who was then about twenty-five years of age, and able to make a living as well as any other blackfellow.

The children do almost what they like; it sounds ridiculous, though it is a fact, when I say that they often leave the mother's breast, to take the pipe out of her mouth, and have a smoke; they suckle their children often for four years and more. Of their dogs the natives are almost as fond as of their children. Women do not hesitate to suckle pups; and it is not to be wondered at, that under such circumstances, the dogs become much attached to the aboriginals: and if only with them for a few nights, they seldom follow their white master again. They sleep with their dogs, gnaw at the same bone with them, and though they do not feed them well, the kind treatment makes up for the, rest; and as I mentioned before, a well-bred dog left with blackfellows for a few days, is a lost dog for ever.

It has been stated that they were in the habit of killing their aged men and women; this, however, must be a mistake, as I have noticed them to carry an old man about from place to place, who had been a cripple for 8 or 10 years. Cases of insanity are, I believe, of very rare occurrence; though I remember a single instance,—a boy about 14 years of age was pointed out to me as a "silly boy:" but I had not sufficient time to observe him, he played football with the other boys of the tribe and appeared to be the most expert of them.

Though they have not the faintest idea of religion, they are yet very superstitious: the universal belief that every death in their own little circle is caused by a member of a neighbouring tribe, and that vengeance will be taken accordingly is one of the principal causes perhaps of their rapid disappearance from among us. As soon as a native has breathed his last, messengers are sent to friendly families in the neighbourhood, and if bad news travels fast in civilised countries, it appears to travel much faster in the Australian bush. It is only with great reluctance that they pronounce the name of a departed friend, and if their wailings and the personal chastisement they inflict upon themselves, upon such occasions are proofs of their sorrow, their feelings must be intense.

The men seldom if ever wail, though they often inflict fearful gashes, principally upon their heads, mixing the blood with gypsum and thus cause the formation of a thick crust or skull cap which is frequently renewed. I have noticed a fine young fellow mourning the death of a young girl, (neither sister nor bride,) stretch like Mucius Scævola his right arm into the fire until that limb was almost roasted, the skin cracked and hanging around it in large patches.

The women perform the noisy part of the business, howling incessantly for days and weeks, and only leaving off during meal time, and when tired out they fall asleep for a few hours. The deeper they mourn the more gypsum is laid on, so that some times nothing bat the eyes, ears, and mouth, remain uncovered. Their burial rites I have had no opportunity to observe, but always found the graves well kept, and have generally seen the most romantic spots selected for the last resting place of their departed.

On the Lower Darling these sepulchres were generally made in some shield-like enclosure of brush wood, shaded by drooping acacias or cypress-pines, and covered with a rude hut of bark or brush wood, into which for a long period afterwards casual passers-by—friends of the lost one—implant a green bough, so that by the number of these boughs one may judge in what estimation the poor creature was held who rested beneath. Their strong belief that they will re-appear as white men, is well known, as also the desire to see a certain likeness in white men with one or another of their lost friends. The way in which they try to find out in which direction to take vengeance for a deceased member is singular. After the sand has been smoothed around the grave and the brush enclosure is formed, they leave the ground, returning from time to time until by some insect or other accidental cause the smooth surface has been disturbed, and in that direction retaliation is sought; of late they are satisfied to throw a waddy or a few harmless spears at the first unlucky strange black they may thus encounter; while formerly they tried to shed blood at least, if not able to kill their victim.

Before concluding I shall say a few words about their artistic skill, which is confined to the embellishment of their rude weapons and skin coverings; they seldom go beyond a series of straight lines at various angles, red and white being the usual color to set off the pattern. They are however tolerably good observers, as there is no difficulty whenever they carve the figure of a fish, a bird, or a mammal, upon a sandstone rock, or trace the same on a piece of blackened bark, to recognise the genus of the animal thus represented. The numerous bays and inlets of Port Jackson abound with such carvings, but on the Murray I have never seen any thing beyond a few tracings, on sheets of blackened bark, probably done during a rainy day.