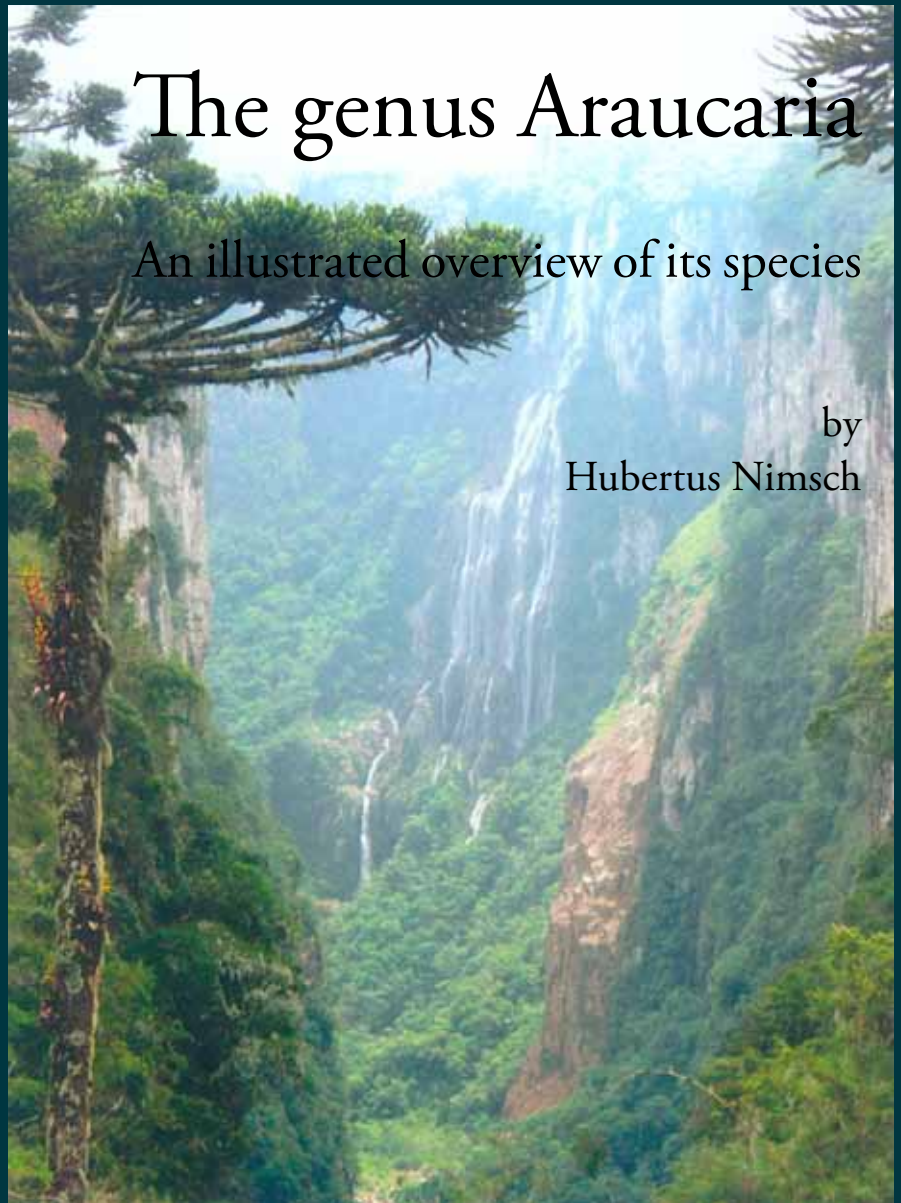


Araucaria



The genus Araucaria

An illustrated overview of its species

by
Hubertus Nimsch



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Quotation: The black-and-white images of cones partially come from Mitteilungen der Deutschen Dendrologischen Gesellschaft – DDG-Bd. 86, 2001, Verlag E. Ulmer, Stuttgart.

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Dedicated with cordial thanks to my highly-valued friend BERNHARD SUPRIN in Nouméa, New Caledonia.

This contribution for an improved knowledge of the genus *Araucaria* was only possible due to his assistance and local knowledge of New Caledonia and thanks to his excellent photographs of *Araucaria* trees on site.



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Preamble

For many years the genus *Araucaria* has held my interest and several journeys to the natural habitats in Chile, Australia, Argentina and New Caledonia have extended my knowledge of the genus. Field trips, even to remote locations, have opened the possibility to gain my own experiences. Especially my last three travels to New Caledonia, a Pacific island of botanical and geobotanical superlatives including endemic genera and species of gymnosperms, together with extensive pictorial material have let the idea ripen to compile an illustrated book of the genus *Araucaria*.

Most of the photos, more than 80%, have been made by B. Suprin and the author. At this point, I would like to express my gratitude to the other authors of illustrations for the permission to use their photos.

In the present work the phylogeny of conifers regarding the genus *Araucaria* will briefly be addressed and followed by a part about the geographic range of living *Araucaria*-species. A geological timetable and an overview of the continental drift of the prehistoric Gondwana-continent in geological times will complete the section.

With the help of a world map the fossil occurrences and the geographic range of living *Araucaria*-species will be illustrated.

Next, the comparative description of the *Araucaria*-species will be highlighted with the help of a previously unknown and unpublished photo selection, which hopefully might contribute to a better understanding of the genus. The characteristics of the genus and their grouping by sections are quoted from GOLTE (1993). The genera *Agathis* and *Wollemia* which belong to the family *Araucariaceae* will be outlined with text and some illustrations.

Thereafter, all 19 *Araucaria*-species of the world will be described in a small text, followed by a distribution map, a brief botanical description, a front image and several special photos. Each species will be accompanied by a photo of a sample of understory plants typical for the habitat. Next synonyms and native and, if present, foreign-language names will be mentioned. Because New Caledonia is fran-

cophone there are only universal terms like «Pin colonnaire» or “Pin de montagne” for all *Araucaria*-species. Terms in English are only known for *Araucaria columnaris*, German terms are artificial and neither useful nor correct. To avoid irritation these terms will not be used. The same is true for the Kanak-clan terms, because there are more than 10 names for only one species.

The species descriptions will be followed by some completing remarks about sowing, planting and breeding and a comparison of species regarding plants, seeds and timber features. Furthermore, several explorers and researchers will be presented who are acknowledged with *Araucaria*-naming.

Many more interesting aspects of palaeobotany, ecology, genetics, pathology, exploitation, species conservation and more are not the subject of this work. Reference will be made to respective specialised literature.

I would like to express my cordial thanks to all people who have contributed their share to the publication of this book; these are B. Suprin, Nouméa, New Caledonia; Dr. Golte, Bonn, Dr. Traiser, Freiburg und Dr. Seehann, Reinbek, all Germany.

I am particularly grateful to my daughter Christina for her layout work and to my wife Martina for proofreading.

I also thank the publishing house Kessel and the printing company Sieber for the pleasant and professional collaboration.

I would also like to express my sincere thanks to Dr. Michaela Deu, Bremen, for this translation in English and Dr. Benoit Sittler, Freiburg, for this translation in French.

St. Ulrich, Germany, September 2011



Fig. 1: *Araucaria columnaris*, Havannah, Nouvelle-Calédonie, Photo by B. Suprin.

Introduction

With regard to the ecology of the genus *Araucaria*, the distribution and habitat requirements, should be pointed to the pioneering and highly interesting work of W. GOLTE (1993). The work of DE LAUBENFELS (1972) is recommended for botanical descriptions of *Araucaria* species. In-depth descriptions of the species *Araucaria angustifolia*, *Araucaria araucana*, *Araucaria heterophylla* und *Araucaria montana* can be found in the “Enzyklopädie der Holzgewächse“ (03/1995, 03/2001, 06/2008, 10/2008). The New Caledonian *Araucaria nemorosa* was comprehensively discussed by T. WATERS (2002).

Drawings of cones were taken from H. GAUSEN (1944-1979), K. H. KINDEL (2001) und H. NIMSCH (2010), illustrations of fossil cones from U. DERNBACH (1992) and ecological and silvicultural aspects from the works of O. O. NTIMA (1968) and N. ENRIGHT(1995).



Fig. 2: *Araucaria heterophylla*, Recent cone, diameter about 8 cm. After U. DERNBACH.

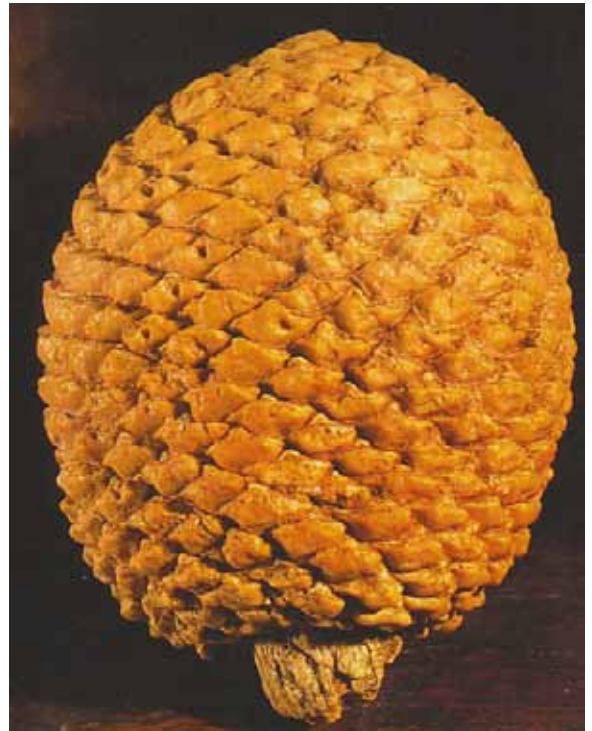


Fig. 3: *Araucaria mirabilis*, Fossil cone, diameter about 11 cm. After U. DERNBACH.

Phylogeny

The *phylogeny* of conifers extends far back in earth history. Fossil evidence for their development is sparser the farther back they date. With the help of this fossil evidence paleobotanists and others have found evolutionary relationships or could close gaps in this development. It will continue to be the task of palaeontology, to try to resolve the outstanding issues.

E.g. ancestors of the living genus *Ginkgo* were present all over the northern hemisphere in the Palaeozoic Era about 300 mya. But today this global distribution is reduced to the living genus *Ginkgo* with a merely relictual distribution in China.

Within the division *Spermatophyta* the class *Pinatae* also dates back to the Paleozoic Era. At the changing point from the Rotliegend formation (Upper Carboniferous to Middle Permian age) to the Zechstein (Upper Permian) about 250 mya the dominance of Pteridophytes and also the older *Coniferophytina* receded, and gymnosperms like *Pinidae*, *Cycadatae* and others took their place at the beginning of the Mesophytic Era (about 225 mya). Within these the

genus *Araucaria* is regarded as the most original. In the Mesozoic it also appeared in the northern hemisphere which was verified by fossils from the Triassic. Among the first conifers was the genus *Walchia* (*Lebachia piniformis*) (Fig.4) from the Rotliegend formation that featured a remarkable similar habitus to living *Araucaria*-species, and the genus *Ullmannia* (*Archaeopodocarpus*) (Fig.5) from the following Zechstein, which was dominated by coniferous trees. *Archaeopodocarpus germanicus* WEIGELT displayed marked heterophylly; both types, loose-positioned, long needles and short, almost scale-like needles were found on the same branch.

Araucarioxylon

Araucarioxylon is understood to mean fossil *Araucaria*-species with araucaroid pitting in the wood from the Mesozoic, e.g. *Araucaria mirabilis* from the Bosque Petrificado, Cerro Cuadrado, Patagonia, Argentina or *Araucarioxylon arizonicum* from the Petrified Forest, Arizona, USA. From the latter trunk lengths of 200 feet = 61 m were found and trunk diameter of 1.20 meters to 2.75 meters. Among the gymnosperms of modern times only the *Araucariaceae*-genera *Araucaria*, *Agathis* and



Fig.: 4: *Walchia* (*Lebachia piniformis*) (SCHLOTHEIM) FLORIN, from the Rotliegend (Lower Permian), represents together with *Voltziaceae* the eldest ancestor of the *Pinaceae*. Reconstruction from: H. Nimsch: A Reference Guide to the Gymnosperms of the World. Koeltz Scientific Books, Champaign, Illinois, USA, 1995.

Wollemia are featuring the araucaroid pitting of the wood.

The fossil ancestors of the genus *Agathis*, e.g. *Agathoxylon* sp., also had araucaroid pitting of the wood like *Araucarioxylon*. Findings of them from NE-China, Korea and Japan could be shown to be from the late Triassic Period.

Dadoxylon is understood to summarise fossil genera and species of the Paleozoic Era like *Cordaites* of the Carboniferous and other conifers. The fossilization of araucaroid wood and the associated cones was effected by the entry of silica under high pres-

sure. The often very colorful petrification of wood and cones can be explained by different proportions of different elements from volcanic ash.

The genera *Ullmannia* and *Walchia* (See Figures 3 and 4) are not immediately related to *Araucaria*, but they certainly belong to their ancestry.

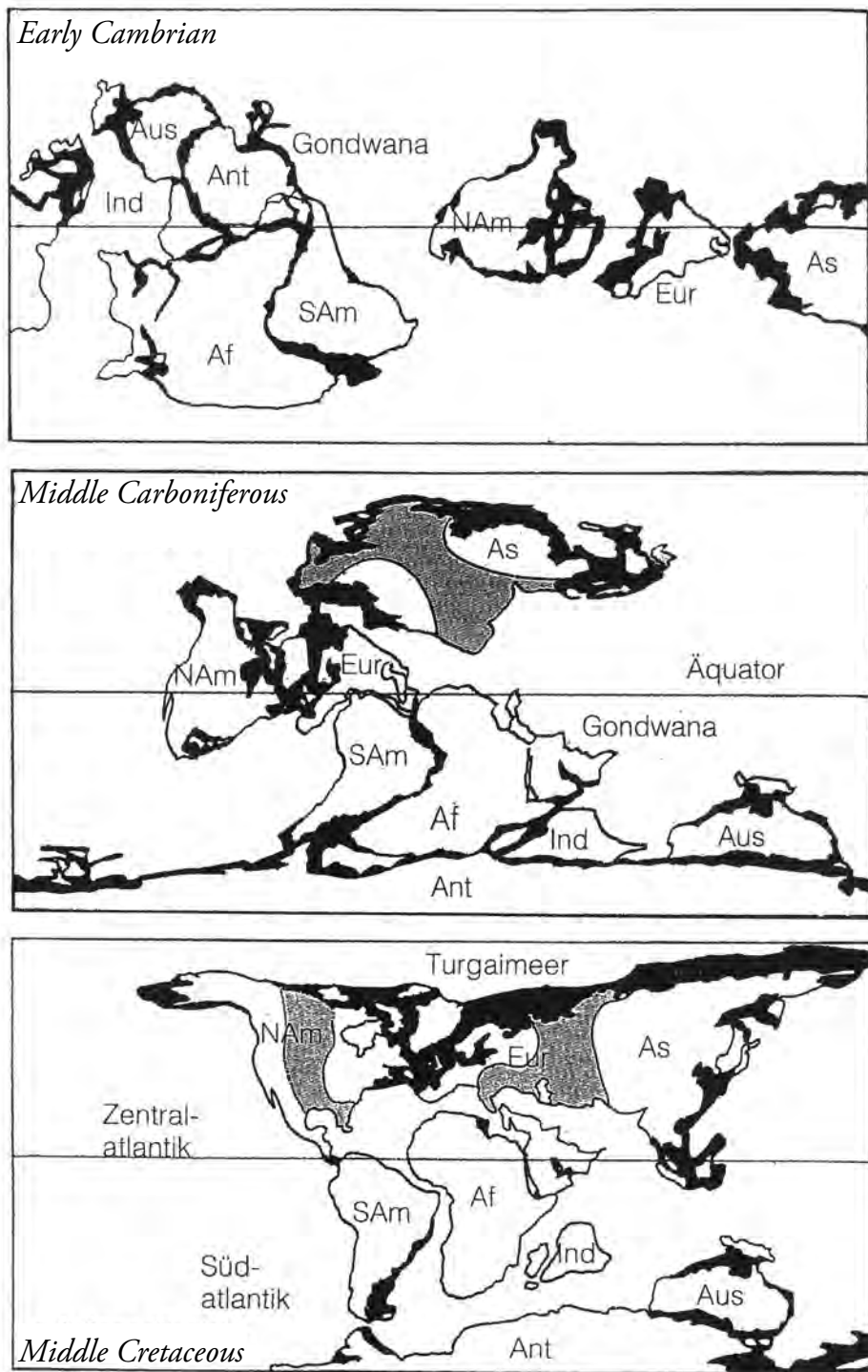


Fig. 5: *Ullmannia* (*Archaeopodocarpus*), WEIGELT, from the Zechstein (Upper Permian). Reconstruction from: H. Nimsch: A Reference Guide to the Gymnosperms of the World. Koeltz Scientific Books, Champaign, Illinois, USA, 1995.

Table 1: Geological Timetable; from H. Nimsch: A Reference Guide to the Gymnosperms of the World. Koeltz Scientific Books, Champaign, Illinois, USA, 1995 (simplified representation).

Million Years Ago (mya)	Era	Period	Plant Era
1.8	Cénozoic Era	Quaternary Period	Late Cenophytic Era Age of Angiosperms
65		Tertiary Period	
142	Mezozoic Era	Cretaceous Period	Late Mesophytic Era Age of Gymnosperms
200		Jurassic Period	
251		Triassic Period	
296	Paleozoic Era	Permian Period	Algues Préphanérogames Stromatolites Cyanobacteries
358		Carboniferous	
418		Devonian Period	
443		Silurian Period	
495		Ordovician Period	
545		Cambrian Period	
		Precambrian	

Table 2: Earth History – Continental Drift; from T. SPECK *Kontinente auf Wanderschaft, Europa in der Urzeit*, Mosaik Verlag, München, 1993.



Present-day continents: Africa (Af), Antarctica (Ant), Australia (Aus), Europe (Eu), North- and Central-America (NAm), Asia (As), India (Ind), South-America (SAm)

■ Expansion of continents

■ Sea overflowed continent areas

By the end of the Lower Cretaceous, before about 125 mya, the genus *Araucaria* got extinct in Europe, Africa and Asia (See distribution map). The presumed close kinship of the fossil *Araucaria mirabilis* from the Cerro Cuadrado, Argentina – based on today's geographic distribution – to the living *Araucaria*-species in South America was refuted due to anatomical and histological details. The species is to place in the immediate vicinity of the recent *Araucaria bidwillii*, Australia.

According to historical records from the region trunks of *Araucaria mirabilis* (Jurassic Period, 180-140 mya) from the Cerro Cuadrado Bosque Petrificado reached a diameter of up to 3 m and lengths about 100 m. The length of the cones was 2.5 cm to 11 cm, the diameter between 2.5 to 8 cm. The microscopic structure of the timber from the above-mentioned period complies with the araucaroid pitting of the wood of living *Araucaria*-species.

The family *Araucariaceae* was globally spread in the Jurassic and the Cretaceous Period, that is 140 - 70 mya. It was found in the northern (e.g. in Greenland) as well as the southern hemisphere (Kerguelen Islands) near Antarctica. Initially, *Araucariaceae*

had been considered as a family of only two genera, *Araucaria* and *Agathis*, and it only was extended in 1994 due to the discovery of the genus *Wollemia* in Australia. Fossil ancestors of *Wollemia* have been dated to 90 to 120 mya.

This is really something special: *Wollemia* has existed for about 100 million years on this planet. Even over the relatively short period of the Christian era with 2,000 years *Wollemia* remained undetected. It actually survived unscathed the discovery of Australia in 1605 and the following eventful years with major changes in all areas. The foresighted protection of natural areas through the establishment of several national parks in Australia - including the Wollemi National Park - also had no effect on the remaining hidden canyons with the Wollemi Pine. It is hoped, that due to positive human influence the species will continue to exist some more million years.

The recent conifers either dominate extensively in the boreal zone and in the mountains of the northern hemisphere with clearly distinct seasons or are distributed in the southern hemisphere without dominance, as patches or in groups, as part of the



Fig. 6: Rainbow Forest Museum, Petrified Forest National Park, from prehistoric times: 200 million years ago, *Araucarioxylon arizonicum*.

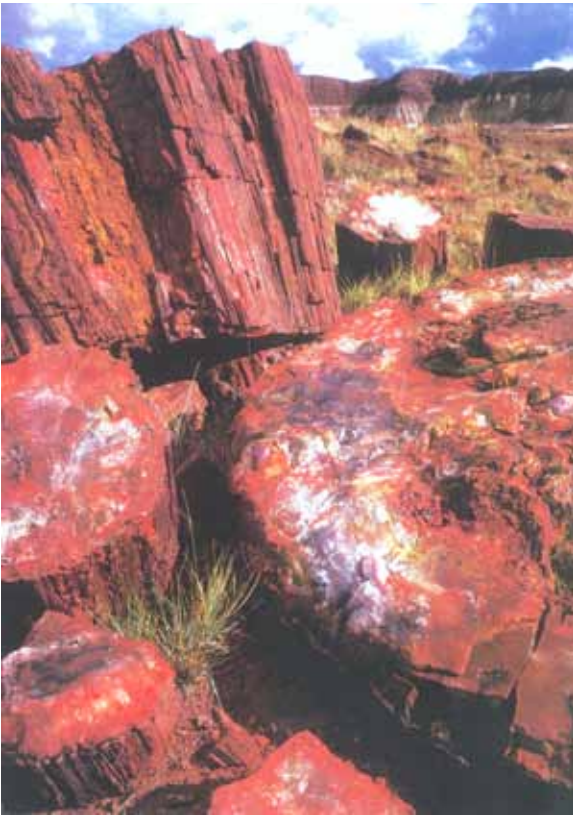


Fig. 7: *Araucarioxylon arizonicum*, Petrified wood from the Tertiary Period (225 - 190 MYA), Petrified Forest, Arizona, USA. Diameter about 100 cm. Photo Muench.



Fig. 8: *Araucarioxylon*, Petrified trunk, National-Park Bosque Petrificado Cerro Cuadrado, Patagonia, Argentina. Photo: H. Nimsch.



Fig. 9: *Araucarioxylon*, Petrified wood with identifiable wood structures, National Park Bosque Petrificado Cerro Cuadrado, Patagonia, Argentina. Diameter about 150 cm at the base. Photo H. Nimsch.

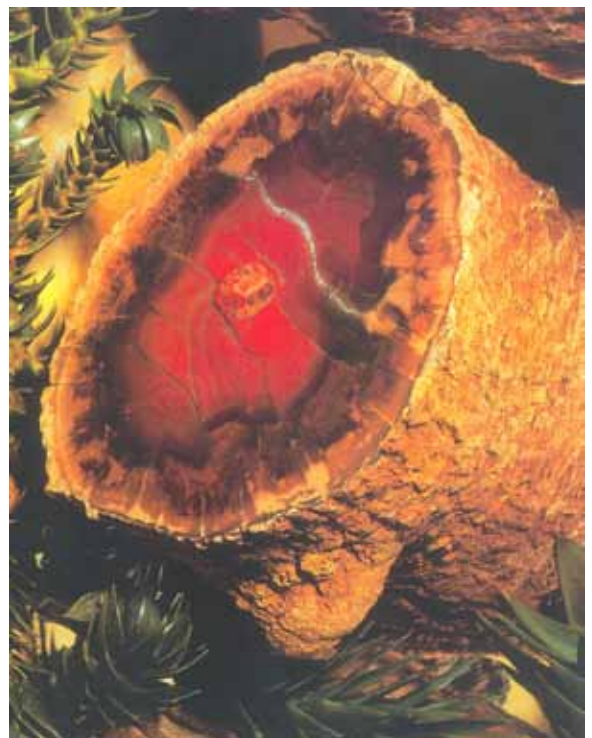


Fig. 10: *Araucarioxylon*. Petrified wood from the Jurassic Period (about 160 mya) from Monumento Natural Bosque Petrificado Cerro Cuadrado, Patagonia, Argentina. From U. DERNBACH: "ARAUCARIA". Diameter about 10 cm. Photo K. Götz (enhanced).

species-rich tropical and subtropical rain forests of the plains or the mountain forests. The status of the *Araucaria* of the southern hemisphere regarding climate, soil and habitat as described by many authors was revised by GOLTE (1993) and stated more precisely from the perspective of a geobotanist:

“In fact, [the geobotanist] can found his work with certainty on the assumption that the conifers and other gymnosperms – just as the ferns (Pteridophytes) which preceded them as an organization level - also currently occupy exactly that ecological place in the natural cover of vegetation of the world which corresponds to their status within phylogeny, meaning here: the gradual adaptation of the plants to the changing conditions on emerged land. If we speak of relic habitats in the case of conifers, which is just appropriate regarding the isolated occurrences of the southern hemisphere genera and species, it is not because angiosperms displaced them there, but because, due to developments in the inorganic world, especially the climate evolution, the physicochemical growth conditions suitable for them (still) are only given there.” GOLTE (1978b).

Range

At present, the genus *Araucaria* with its 19 species only occurs in the southern hemisphere. By its natural habitats in South America, Australia, New Caledonia, New Guinea and Norfolk Island it provides evidence for the historic connection to the primeval continent Gondwana (which broadly defined comprised Antarctica, Africa, the Indian subcontinent and New Zealand). Their geographical range is discussed in detail in the description of each species.

The genera *Agathis* and *Wollemia*, which are seen as belonging to the *Araucariaceae*, are native to the southern hemisphere, although the geographic range of the genus *Agathis* even extends to the northern hemisphere (Borneo, the Philippines etc.). Both in terms of growth habit and foliage and with respect to xylotomical features similarities between living *Araucaria*- and *Agathis*-species and *Wollemia* and fossil species could be found. These characteristics do not exist in other living conifer families any more.

Despite their widely separated habitats the species from South America *Araucaria angustifolia* and *Araucaria araucana* are related very closely. This close relationship (Fig. 11) becomes apparent by the capability of both species to hybridise reciprocally, the same chromosome number, a very similar habitus and similarly large needles with a sharply acuminate apex. Even the associated flora and fauna and climatic conditions at the habitats of both species show many parallels (GOLTE 1993).



Fig. 11: *Araucaria* F 2 hybrid: *Araucaria angustifolia* x *Araucaria araucana*. Photo H. Nimsch.

The species *A. bidwillii* and *A. cunninghamii* are representing the genus *Araucaria* in Australia. Their areas of distribution are located in the mountains on the east coast. While the very small area of distribution of *A. bidwillii* is situated in south-eastern Queensland and is limited to three locations, the range of distribution is much larger in the case of *A. cunninghamii*. It starts in South Australia north of Sydney, extends across the mountains on the east coast to the Cape York Peninsula and continues further north to include the whole island New Guinea.

A. bidwillii is very closely related to the *Araucaria*-species of South America with their large leaves and cones as well as their hypogeous germination. Also, the dome-shaped crowns which always tower above the canopy of the evergreen forests accompanying them show this proximity to the South American species. For the natives, both here and in South America, the edible seeds are still very important.

The distribution area of *Araucaria cunninghamii* which continues across New Guinea is not completely explored in the Indonesian part.

In contrast, the distribution area of *Araucaria hunsteinii*, a species that merely grows in Papua New Guinea, is located in the southeast of the island. Here both, trees of *A. hunsteinii* and *A. cunninghamii* reach their greatest dimensions with regard to height and trunk diameter. Both species do not occur in pure stands, but almost always in mixed stands of evergreen deciduous forests.

The island of New Caledonia is home to 42 species of conifers. It thus represents a botanical particularity. The fact, that there are 13 *Araucaria*-species on the island that all, with the exception of four, are growing on the typical New Caledonia ultrabasic rocks and their weathering products emphasises this particularity. Concerning the habitat the four species mentioned above react differently. While *Araucaria montana* and *Araucaria subulata* can be found on both ultrabasic rocks and weathered soils of other rocks, the species *A. columnaris* only grows on coralline limestone sites by nature. However it was planted by the indigenous inhabitants at all kinds of habitats and showed vague soil requirements. Another species, *A. schmidii*, only roots on crystalline schist and gneissic residual soil.

At maturity several species (*A. columnaris*, *A. subulata*, *A. bernieri*) are characterized by a striking column-shaped habitus or develop a candelabra-shaped tree crown (*A. muelleri*, *A. rulei*). Others grow only in close proximity to the sea (*A. columnaris*, *A. nemorosa*, *A. scopulorum*, *A. luxurians*) or only in mountainous areas (*A. schmidii*, *A. humboldtensis*).

The distribution of three species is limited to forest sites: *Araucaria bernieri*, *Araucaria biramulata* and *Araucaria subulata*.

“Nowhere else on earth such a collection of archaic plants can be found in a confined space than in New Caledonia.” GOLTE (1993).

Norfolk Island is the peak of the submarine ridge (Norfolk Ridge) that extends from New Zealand to Norfolk Island to New Caledonia. The island has an area of only 34 square kilometres and is home to the sole native species *Araucaria heterophylla*. This, however, only has a very small natural distribution area. It is closely related to *Araucaria columnaris* from New Caledonia. *Araucaria heterophylla* can reach up to 70 m in height and has a very symmetrical crown structure. Therefore it is planted worldwide in tropical and subtropical regions as an ornamental tree.

Despite the fact, that the species are widely distributed over the southern hemisphere, all *Araucaria* depend on specific climatic conditions; these are very similar despite the large areal extent of in parts 30 degrees of latitude in New Guinea and eastern Australia and 19 degrees of latitude in South America. These are sites with light, well drained soils with good water storage capacity such as coralline limestone or volcanic weathering products, sites with annual rainfall of 2,000 to 3,000 mm and at times lasting phases of aridity.

The most common original rocks are basalt – e.g. in eastern Australia, Brazil and Norfolk Island – granite, metamorphic rocks, limestone and ultrabasic rocks (Pteridotite). In the distribution areas snowfalls and light frosts occur regularly (Chile, Argentina, Australia and New Guinea). Only New Caledonia and Norfolk Island remain free from frost.

With the exception of southern Brazil and Norfolk Island deciduous shrubs and trees of the primeval southern continent Gondwana, particularly *Nothofagus*, can be found as associated species in almost all distribution areas of *Araucaria*, just as species of the families *Lauraceae*, *Meliaceae*, *Sapindaceae* and others. The faunistic characteristics are also comparable there. GOLTE (1993).

The distribution areas of the South American *Araucaria*-species find their counterparts in those of the species in New Caledonia and that of *Araucaria heterophylla* on Norfolk Island due to comparable climatic patterns characterized by a typical change of precipitation maxima with dry, rainless periods,

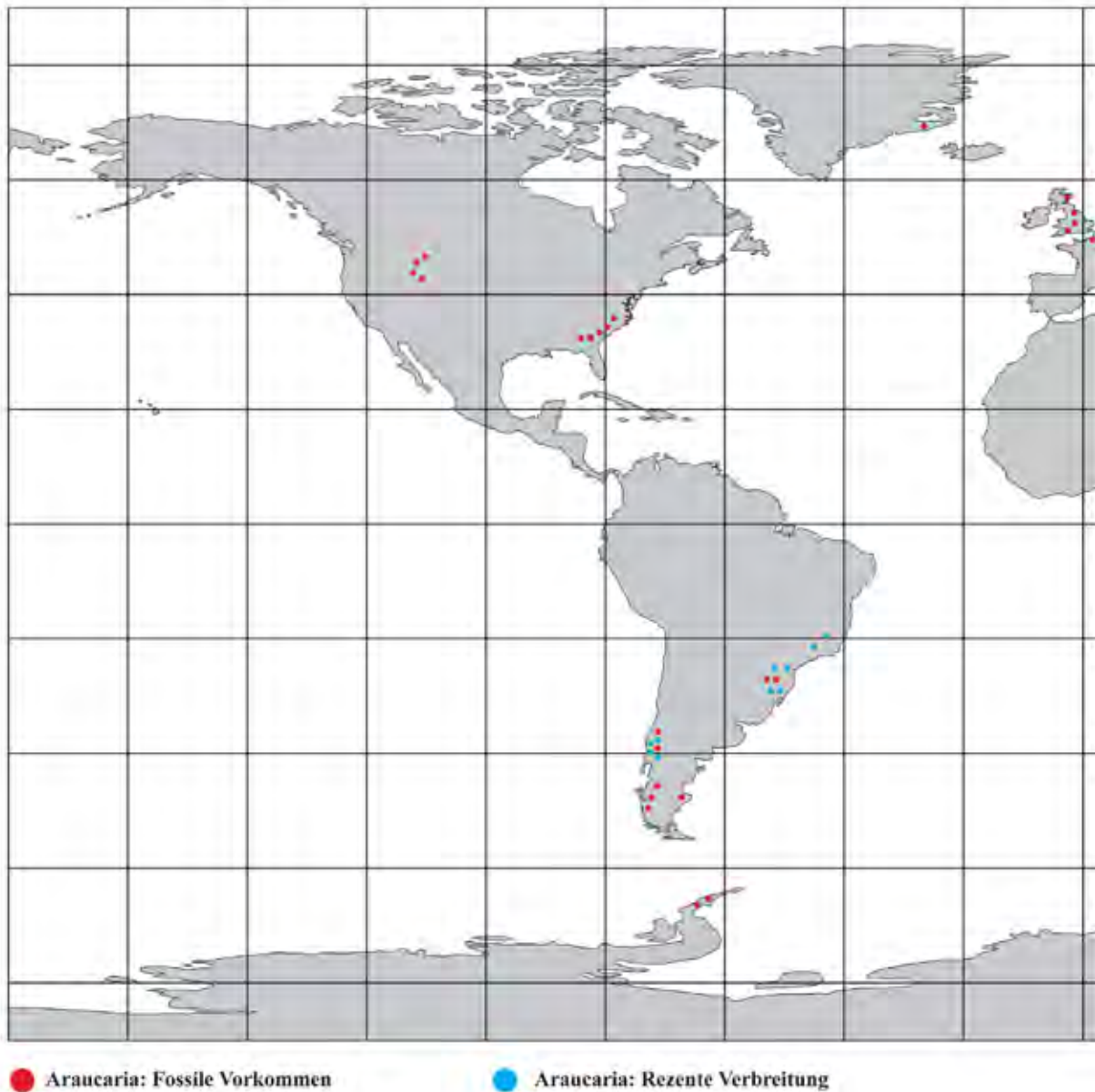


Table 3: *Araucaria*: Fossil findings and recent distribution. Worldwide, fossil *Araucaria* residues have been found and documented, and certainly there will be more findings. The present map, based on FLORIN (1963), and modified, shows the primeval and present distribution of the genus *Araucaria*. It is only intended to give a general overview, but not to be exhaustive.

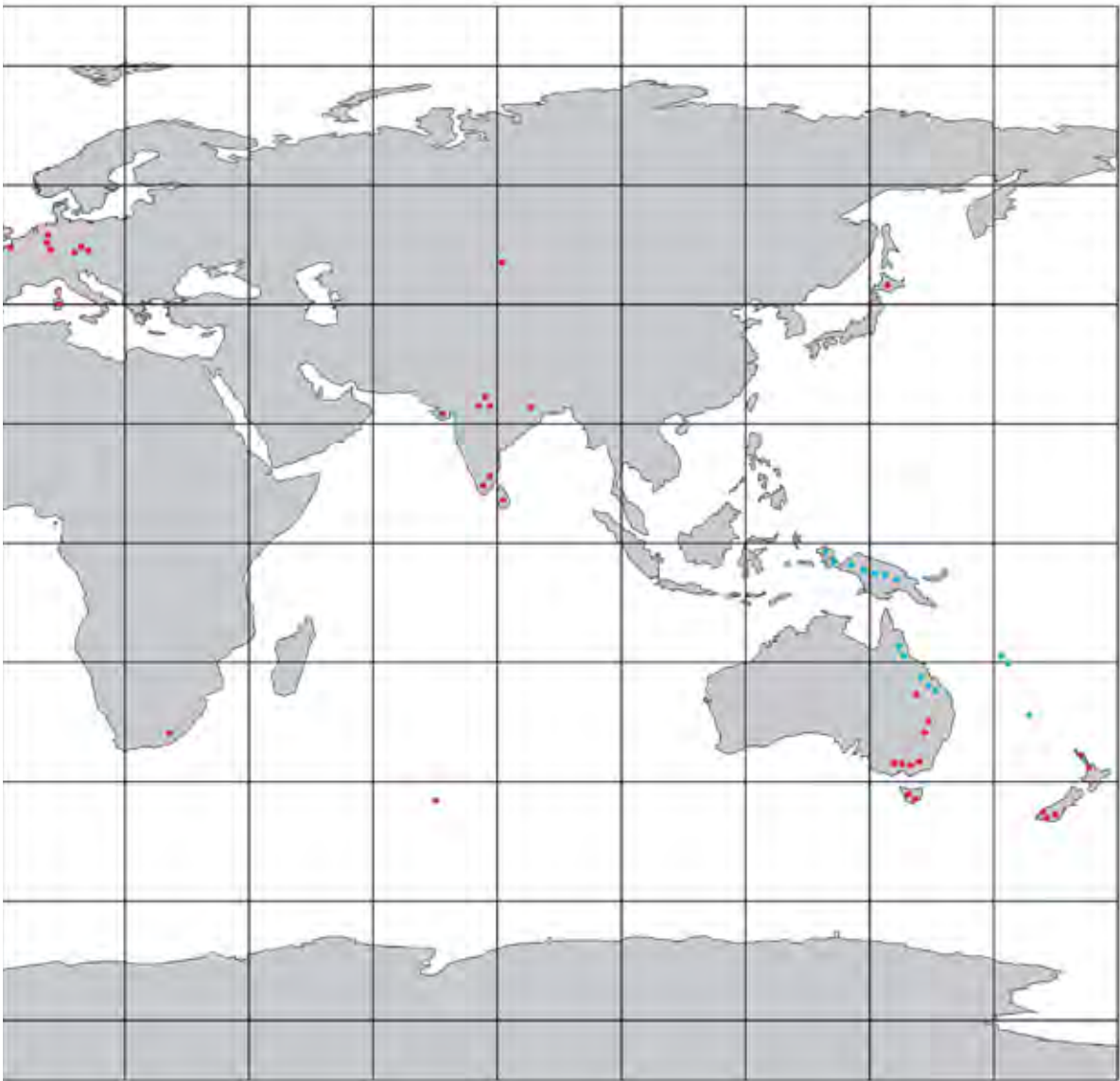
even if these changes in the different habitats do not occur seasonally consistent.

Endangerment and Exploitation

Worldwide and at all natural sites the *Araucaria*-species are exposed to various hazards: The depletion of natural forests continues. Abiotic damage from

storms and fires are still threatening the species. Particularly the New Caledonian species are damaged by mining and subsequent erosion; related to this often large and devastating, barely controllable fires arise. Due to increased development and colonisation the risk by careless handling of fire also increased.

Other, biotic damages are caused by fungi and insects. There are over 200 species of beetles (*Coleop-*



tera) from 17 families known which were found on 12 out of 19 species of *Araucaria*.

In Chile, despite protection regulations, overexploitation continues in private *Araucaria*-forests.

In spite of all protective measures the value of the wood of some species (*A. araucana*, *A. angustifolia*, *A. hunsteinii*) results in further exploitations and thus in a total failure with respect to new *Araucar-*

ia forest stands. The exploitation is often followed by plantation-like monocultures. Reforestation of former *Araucaria*-stands is rarely practiced to a significant extent around the world. Concerning this the positive activities in science and practice of the German-Brazilian initiative “Pro Araucaria” should be mentioned at this point.

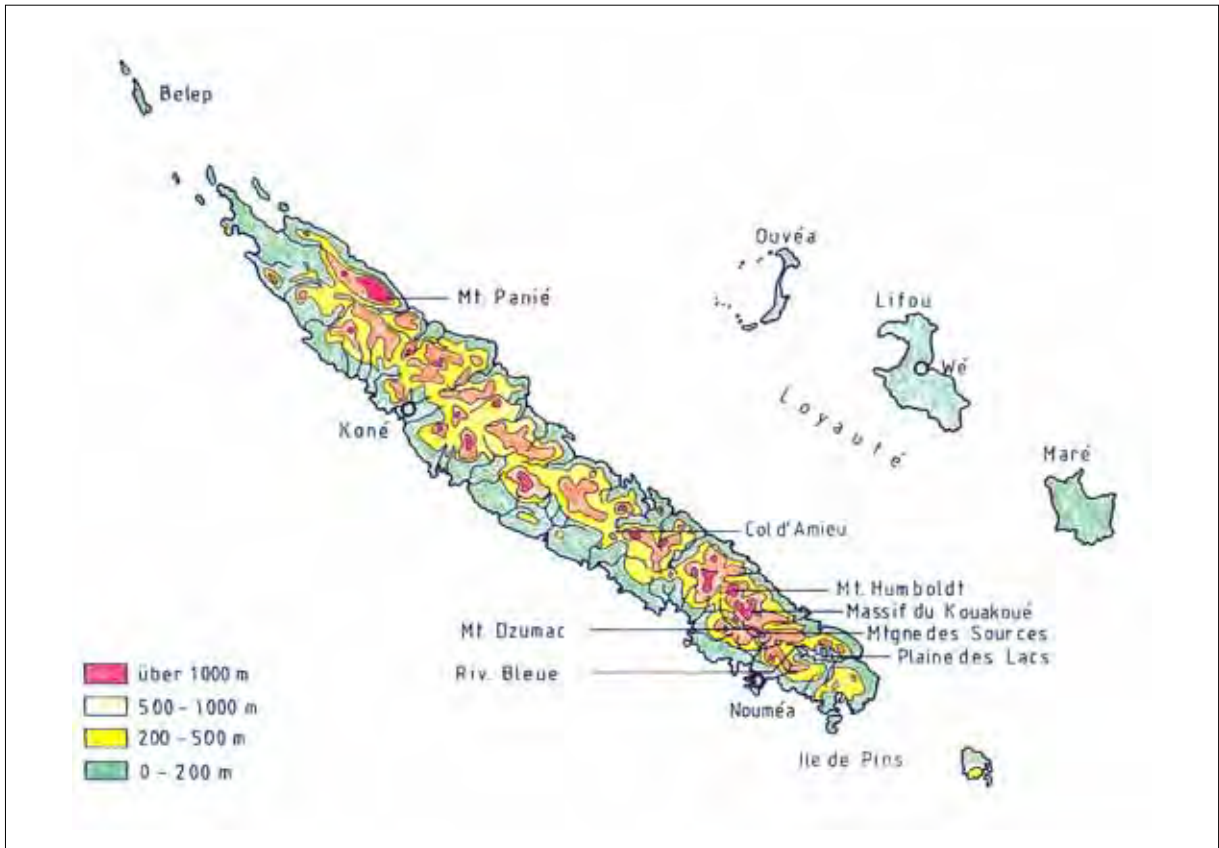


Table 4: Nouvelle-Calédonie, Geomorphology (according to RENSON).

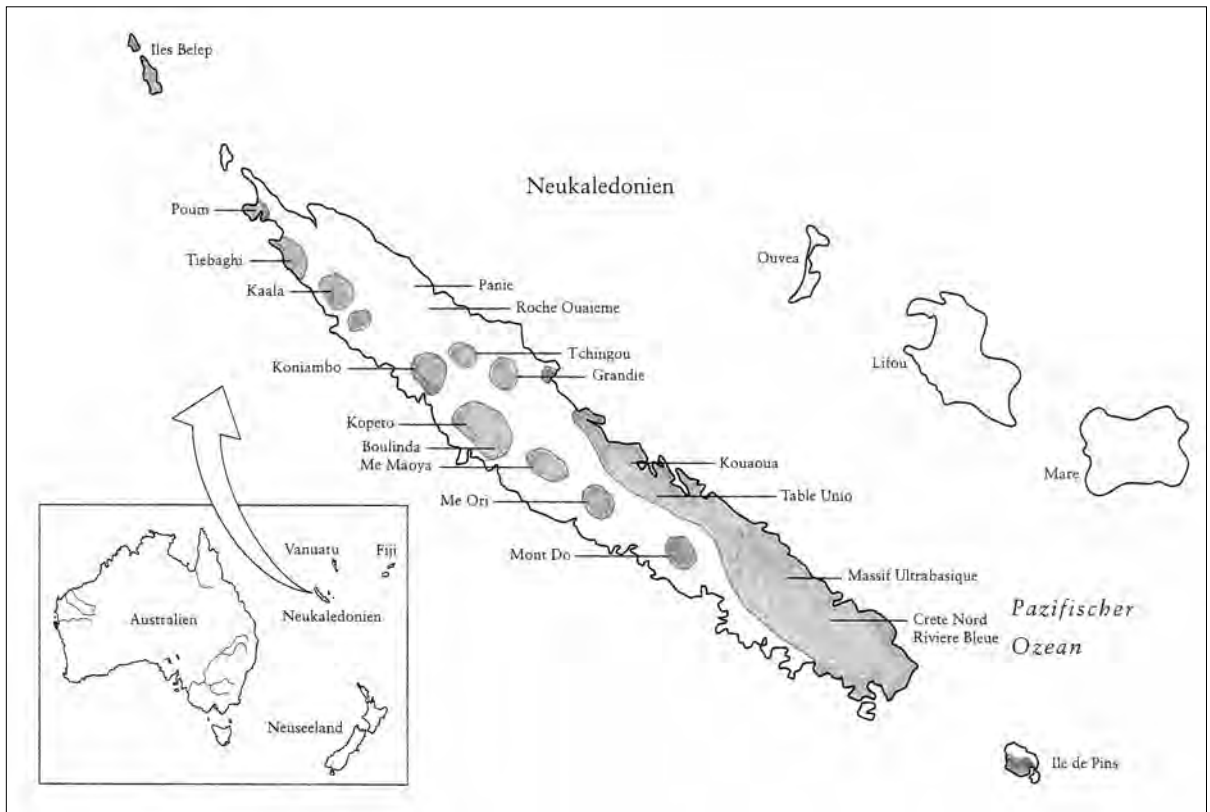


Table 5: Nouvelle-Calédonie: Ultrabasic rocks (according to VEILLON, modified).

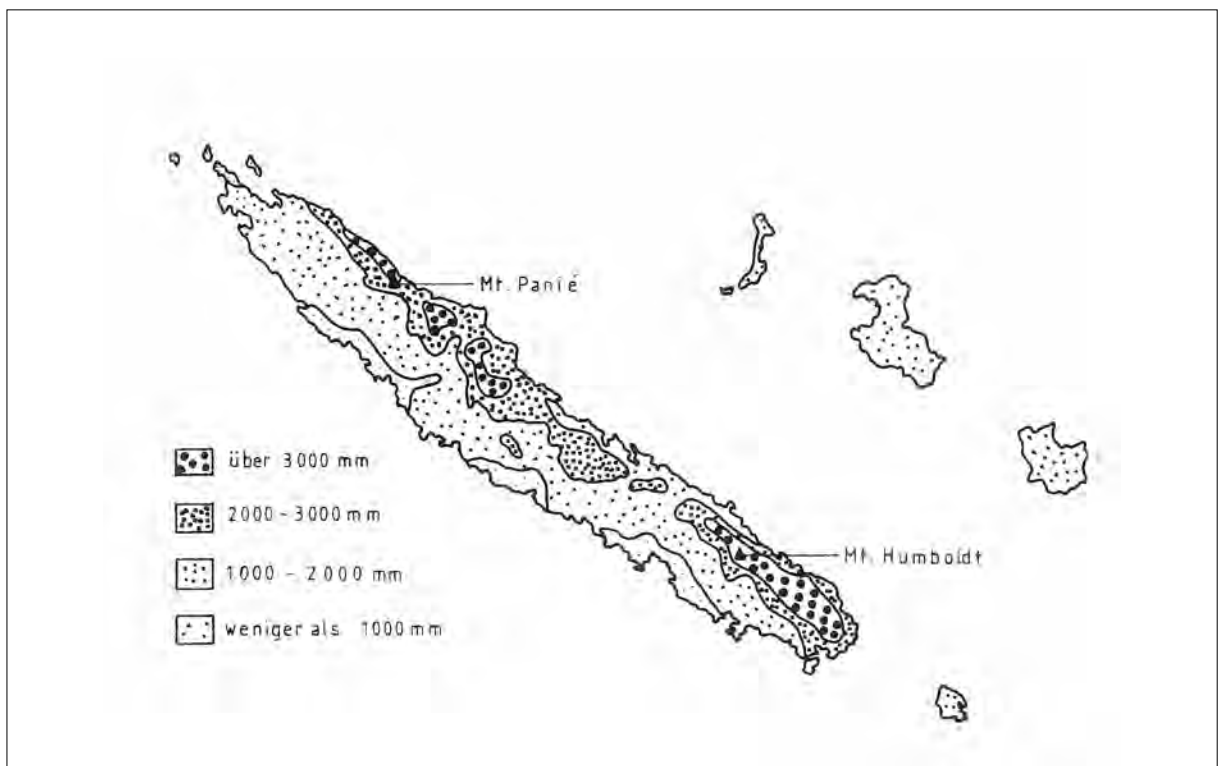


Table 6: Precipitation regime (according to RENSON).

Taxonomy

Family *Araucariaceae*, Genus *Araucaria*

Features and Grouping by Section according to GOLTE (1993)

In 1789, the genus *Araucaria* was established in taxonomy by A. L. DE JUSSIEU after the first few *Araucaria*-species had been discovered a few years earlier. In 1769, *Araucaria angustifolia* was discovered in Brazil. In 1774 *Araucaria columnaris* was found in New Caledonia and *Araucaria heterophylla* in Norfolk Island and, in 1780, *Araucaria araucana* in Chile. Only later, in 1838 the *Araucaria bidwillii* was discovered in Australia and described in 1843.

Section *Eutacta* Endlicher

Leaves reduced, thick, imbricate and often carinate and normally erect.

Male cones are terminal, discretely located; female cones on long peduncles, the fused bract and seed scales (bract-scale complex) provided with thin-skinned wings, indehiscent, seed remaining on the scale during seed dispersal; the bract-scale complex is vascularized by a single vascular bundle branching off the cone stem. Epigeal germination. Cotyledons subsessile, disengaging from the seed during germination. Hypocotyl not fleshy.

This section includes all the New Caledonian species:

- *A. bernieri*, *A. biramulata*, *A. columnaris*, *A. humboldtensis*, *A. laubenfelsii*, *A. luxurians*, *A. montana*, *A. muelleri*, *A. nemorosa*, *A. rulei*, *A. schmidii*, *A. scopulorum*, und *A. subulata*, as well as
- *A. cunninghamii* from Australia and New-Guinea. and
- *A. heterophylla* from Norfolk Island.

Section *Intermedia* White

Leaves large, regularly fine, plane, outspread; sometimes slightly imbricate; juvenile foliage needle-shaped, small and plane. Male and female cones axillary positioned. Bract-scale complex provided with

broad and thin-skinned wings, indehiscent, seed remaining on the scale during seed dispersal. Epigeal germination. Cotyledons subsessile, disengaging themselves from the seed during germination. Hypocotyl not fleshy.

- *A. hunsteinii* K. SCHUMANN Papua New Guinea.

Section *Bunya* Wilde et Eames

Leaves large, plane or slightly imbricate. Male cones axillary positioned. Female cones nearly sessile or on peduncles up to 2 cm long. Bract-scale complex large, heavy, with woody wings; dehiscent, the large "seed" parts from the scale at maturity; bract and seed scales are vascularized by vascular bundles separately branching off the cone stem. Hypogeal germination. Cotyledons have long stems during germination and remain inside the seed coat, coadunate stems form a tube. Hypocotyl fleshy with a long dormant phase underground.

A. bidwillii HOOKER Australia.

Section *Columbea* Endlicher, emend., Wilde et Eames

Leaves large, regularly fine, plane. Male cones axillary positioned, usually two or more on leafy twigs. Bract-scale complex nut-like, without lateral wings, indehiscent, seed remaining on the scale during seed dispersal; the bract-scale complex is vascularized by a single vascular bundle branching off the cone stem. Hypogeal germination. Cotyledons have long stems during germination and remain inside the seed coat, stems not coadunate. Hypocotyl fleshy, without long dormant phase underground.

- *A. angustifolia* (BERTOLINI) O. KUNTZE. South America.
- *A. araucana* (MOLINA) K. KOCH South America.



Fig. 12: *Agathis lanceolata*, (SEBERT et PANCHER) SALISB., Solitary tree at 800 m above sea level, Mt. Dzumac, Nouvelle-Calédonie, 1.2006. Photo H. Nimsch.

Famille *Araucariaceae*, Genus *Agathis*

About 20 species of the genus are distributed in Australia, New Zealand, Malaysia, Indonesia, the Philippines, Polynesia, and New Caledonia. Although *Agathis* is regarded as a purely southern hemisphere genus, its distribution area extends beyond the equator to the north to Malaysia and the Philippines. Regarding the absolute altitude the distribution areas range from sea level up to 1,000 m altitude in New Caledonia and up to 2,000 m altitude in the Philippines. The evergreen, tall, very highly resinous trees are one- or dioecious, have large, lanceolate to elliptic or ovate, leathery, alternately standing leaves, which can reach a lifetime of 15 to 20 years. Size and shape of the leaves are highly variable, often on the same branch of a specimen. The cones mature in the second year and are spherical to broadly rounded, the seeds unilaterally winged. With the huge specimen “Tane Mahuta” – God of the Forest, which



Fig. 13: *Agathis robusta*, (C. MOORE ex F. MUELL.), F. M. BAILE, young tree of the Queensland Kauri, Queensland, Australia, 1. 1979. Photo H. Nimsch.

reaches a height of 51.5 m, 13.8 m in circumference and 244 m³ of log wood volume, the species *Agathis australis* is also known beyond the borders of New Zealand. The natural populations, e.g. of New Zealand, have been greatly depleted since the settlement of the country. They are protected today and only the Maoris are permitted to fell trees. The species are native to tropical and subtropical regions and therefore not winter hardy in Central Europe.

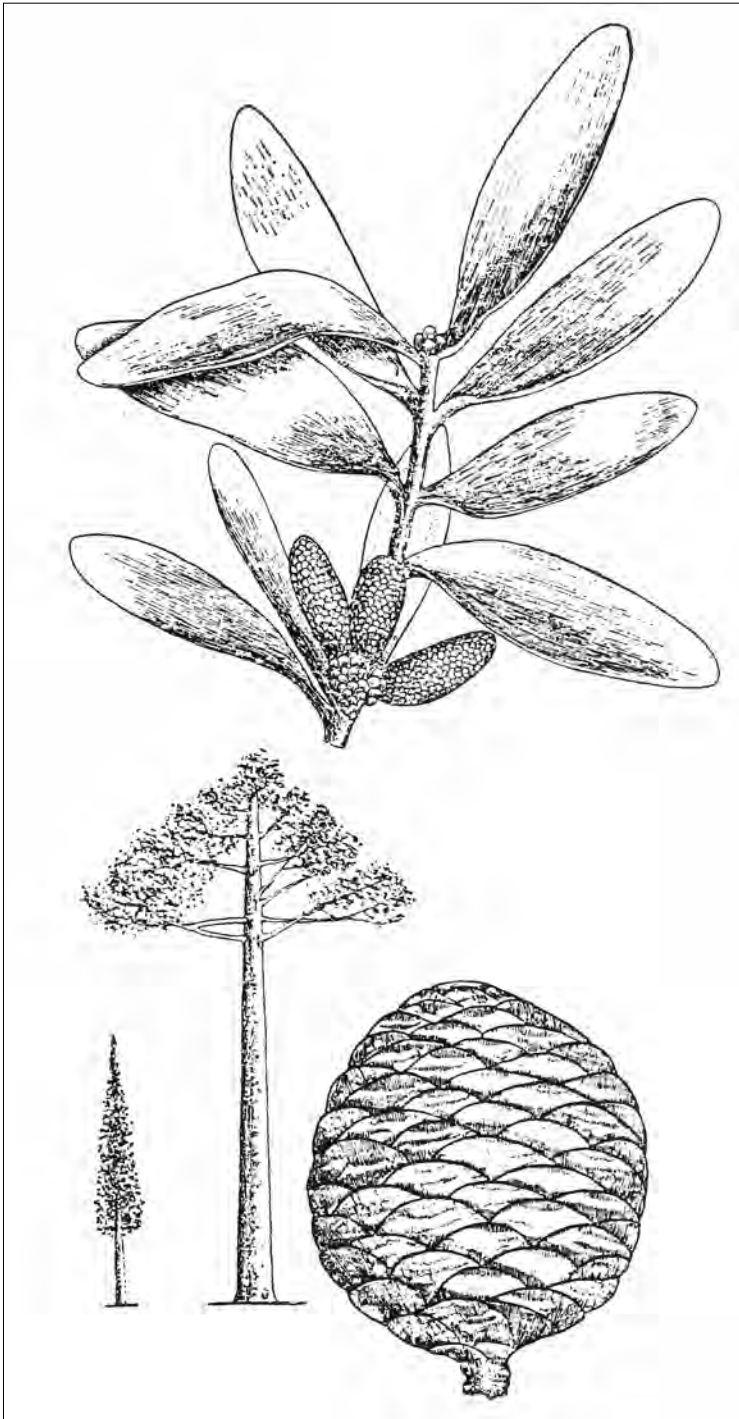


Fig. 14: *Agathis lanceolata*, Adult branchlet with pollen cone x 0.75, mature cone x 0.50, habitus of a young and an old tree (according to SARLIN), Nouvelle-Calédonie.



Fig. 15: *Agathis australis*, (D. DON) SALISB., young tree, Tutamoe Range, New Zealand, 12. 1978. Photo H. Nimsch.



Fig. 16: *Agathis australis*, (D. DON) SALISB., old tree, Tutamoe Range, New Zealand, 12. 1978. Photo H. Nimsch.



Fig. 17: *Agathis moorei*, (LINDL.) Mast., Cone of *A. moorei* at 1,000 m above sea level, Table Unio, Nouvelle-Calédonie, 1.2006. Photo H. Nimsch.



Fig. 18: *Agathis ovata*, Warb., old tree at 600 m above sea level, Col de Yaté, Nouvelle-Calédonie, 1.2006. Photo H. Nimsch.



Fig. 19: *Agathis macrophylla*, Mast, Cones of *A. macrophylla* at 200 m above sea level, Fiji, 12.2005. Photo H. Nimsch.

Famille *Araucariaceae*, Genus *Wollemia*

Discovered just in 1994 in Australia this genus with only one species is a botanical particularity insofar, as it was known for a long time from fossils before being discovered with about 100 living specimens. The species has existed about 90 Mio years on earth, and today the trees are only living at three sites within the Wollemi National Park. Meanwhile, the habitat is legally protected to preserve the species from any damage. Meristem breeding is still in a development phase, and the generative reproduction is limited due to the very small natural location. In contrast, the vegetative reproduction works very well and plants can be bought worldwide for several years now.

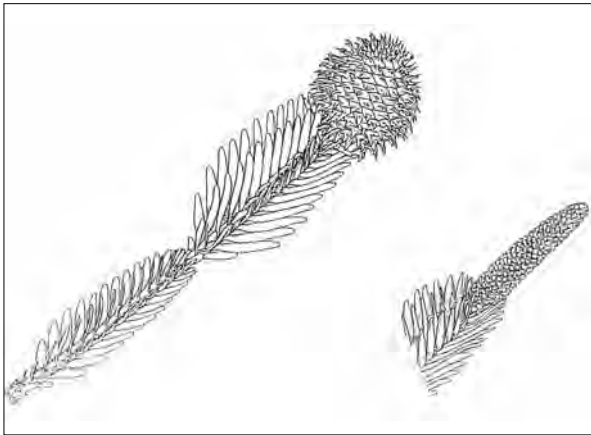


Fig.: 20: *Wollemia nobilis*, W. G. JONES, K. D. HILL et J. M. ALLEN. Branchlet with young female cone and pollen cone.

The trees can reach heights up to 40 m, and the oldest specimens of them are estimated at an age of 1,000 years. The cause for the late discovery probably is the habitat in the inaccessible and craggy canyons of the National Park. In their natural habitat the temperature varies from +45 °C to -5 °C. The needles are 4 cm long (often longer) and up to 5 mm broad and are placed around the branch, but give the impression of standing in four rows (a comparison with the tail of a *Stegosaurus* is possible). Shoots at the base of the trunk indicate a good capability to recover. In the winter rest period the buds are protected by a waxy coating of resin. In the following spring these so-called white “polar caps” are broken by the new sprouts.

The genome of all trees is identical. Quite unusually, even the seedlings have no differences in this regard. The plants are monoecious. First plantings in Europe have confirmed some frost tolerance (-12° C in the

Botanical Garden Merano). As for all Araucarias, it is equally important for planting *Wollemia* on open ground to choose a sheltered location with a permeable substrate. Nevertheless may be assumed that due to its climatic demands *Wollemia* will grow to a small tree only at certain, very sheltered locations in Germany. In the Mediterranean zone and in western European coastal areas conditions for a permanent establishment are much better.



Fig. 21: *Wollemia nobilis*, W. G. JONES, K. D. HILL et J. M. ALLEN, Fossil and recent branchlet.



Fig. 22: *Wollemia nobilis*, W. G. JONES, K. D. HILL et J. M. ALLEN, Bark of an old tree, Wollemi National Park, Australia.



Fig. 23: *Wollemia nobilis*, W. G. JONES, K. D. HILL et J. M. ALLEN, an older pollen cone.



Fig. 24: *Wollemia nobilis*, W. G. JONES, K. D. HILL et J. M. ALLEN, Lateral branch of a young tree, Arboretum Freiburg-Guenterstal, 8.2009. Photo H. Nimsch.



Fig. 25: *Wollemia nobilis*, W. G. JONES, K. D. HILL et J. M. ALLEN, Seven-year-old tree, Arboretum Freiburg-Guenterstal, 8.2009. Photo H. Nimsch.



Fig. 26: *Wollemia nobilis*, W. G. JONES, K. D. HILL et J. M. ALLEN, Main shoot of a young tree, Arboretum Freiburg-Guenterstal, 8.2009. Photo H. Nimsch.



Fig.: 27: *Wollemia nobilis* W. G. JONES, K. D. HILL et J. M. ALLEN, o sld stand in the Wollemi National Park, Australia.

The Araucaria Species

The following is the attempt to describe all recent species of the genus *Araucaria* from South America, Australia, New Caledonia, New Guinea and Norfolk Island in a shortened version. The description of the species follows the structuring by sections, within the sections by the alphabet and by distribution areas. At this place should be pointed out the key to classify the 13 species of *Araucaria* from New Caledonia by D. J. DE LAUBENFELS in "Flore de la Nouvelle-Caledonie et Dépendances".

New Caledonia is described in greater detail by the following tables. Table 1 informs about the geomorphology of the island and table 2 about the specifics of the ultrabasic sites.

Table 3 illustrates correlations between *Araucaria* habitats together with the significantly different precipitation conditions.

The names of *Araucaria* species in the francophone New Caledonia are rather usual as periphrases. They are "Pin Candelabre", "Pin Colonnaire", "Pin de Montagne", "Pin de Bord de Mer" and other terms.

Section Eutacta

Araucaria bernieri



Fig. 28: *Araucaria bernieri*, solitary tree, Plaine des Lacs, Nouvelle-Calédonie. Photo H. Nimsch.

Araucaria bernieri

J. BUCHHOLZ

The *Araucaria bernieri* is limited in its distribution to ultrabasic sites in New Caledonia. These are located on the western coast and south of Grande Terre. In addition, there are still two locations in the north of the island - Poum and Tiebaghi on the south-western coast.

Depending on the location *A. bernieri* can be as tall as 50 m. Due to the columnar growth of old trees it is one of the tallest *Araucaria*-species of New Caledonia. It grows at altitudes of 0 - 700 m above sea level and is one of the three *Araucaria*-species in New Caledonia whose occurrence is limited to forest sites. The other *Araucaria*-species grow in maquis and forest sites, or only on maquis sites. But even here, it is dependent on well-drained ultrabasic soils - like almost all *Araucaria*-species of New Caledonia. These extreme sites are mountain ridges, talus slopes and steep, jagged mountainsides.

On the nutrient-rich low terraces of the medium altitudes of its range the *Araucaria bernieri* reaches optimum height dimensions and corresponding timber volume. In the past this led to overexploitation of these populations for timber extraction. The distribution of the species is usually scattered within the evergreen rain forest, whose canopy is well overtopped by the tall tree crowns, but sometimes also small pure stands can be found.

The species, which is closely related to *Araucaria scopulorum*, shows distinctly reduced growth at the northern mountain habitats compared to the trees at the southern habitats. In its appearance *Araucaria bernieri* looks much alike *Araucaria subulata*, and that is why it remained undetected for a long time.

The IUCN – International Union for Conservation of Nature and Natural Resources – categorized *Araucaria bernieri* as “LR cd” (Lower Risk/conservation dependent/constant control required).

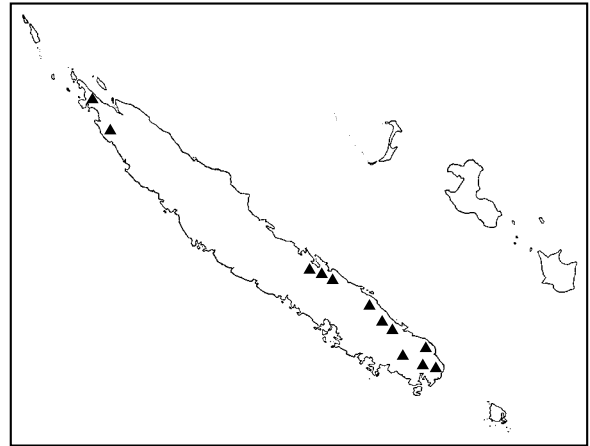


Fig. 29: Distribution map according to DE LAUBENFELS, modified.

Short Description

Araucaria bernieri J. BUCHHOLZ, Bull. Mus. Paris. ser. 2, 21: 280, 1949

Range:	New Caledonia, west coasts in the north and in the south of the island, 0 - 700 m above sea level.
Tree:	Up to 50 m tall, columnar in old age.
Juvenile Foliage:	Three-sided, needle-shaped, up to 7 mm long.
Adult Foliage:	Scale-like, imbricate, three-sided, petiolate, 2 - 5 mm long, apex inward-curving.
Male Inflorescence:	40 - 90 x 8 - 16 mm.
Cones:	The pruinose blue-white (and grey-green) cones are 100 x 80 mm.
Seeds:	Bract-scale complex up to 30 mm long with rounded wings.
Remarks:	Growing up to 50 m in height it ranks together with <i>A. columnaris</i> and <i>A. subulata</i> among the tallest <i>Araucaria</i> -species from New Caledonia.

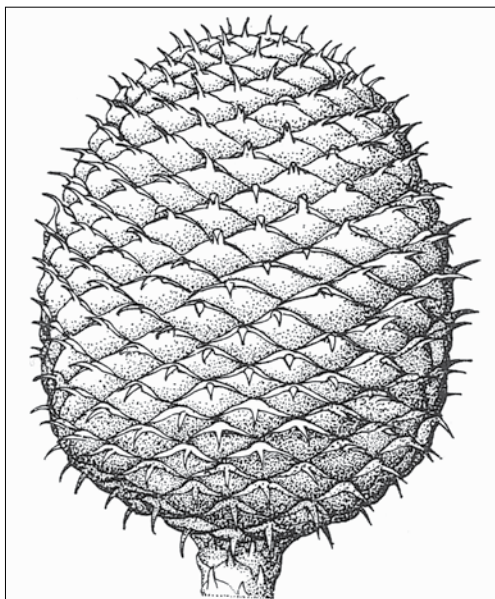


Fig. 30: *Araucaria bernieri*, cone (according to GAUSSEN).



Fig. 31: *Araucaria bernieri*, cones, Doline de Yaté, Nouvelle-Calédonie. Photo B. Suprin.



Fig. 32: *Araucaria bernieri*, main shoot of a young plant of a greenhouse. Photo H. Nimsch.



Fig. 34: *Araucaria bernieri*, lateral branchlet of an old tree from the open ground, Nouvelle-Calédonie. Photo B. Suprin.



Fig. 35: *Araucaria bernieri*, lateral shoot of a young tree from the open ground, Gateblé, Nouméa, Nouvelle-Calédonie. Photo H. Nimsch.



Fig. 33: *Araucaria bernieri*, lateral shoot of a greenhouse plant, Arboretum Freiburg-Guenterstal. Photo H. Nimsch.



Fig. 36: *Araucaria bernieri*, bark, Nouvelle-Calédonie. 3.8.2005. Photo B. Suprin.



Fig. 37: *Araucaria bernieri*, solitary tree, Tiebaghi Ouest, Nouvelle-Calédonie. Photo B. Suprin.



Fig. 38: *Araucaria bernieri*, solitary tree, Col d'Amieu, Nouvelle-Calédonie. Photo B. Suprin.



Fig. 39:
Araucaria bernieri, matured forest,
Xwe Merexwano,
Nouvelle-Calédo-
nie. 2.1.2006.
Photo B. Suprin.



Fig. 40: *Bikkia pachyphylla*, *Rubiaceae*,
floral element.



Pictures in front. Above: In the Araucaria nature woods of Brasil. Below: In the Conguillio National Park of Chile.

Back (from left to right): An old Araucaria in Waitangi, New Zealand. Ripe cone with seed cores. Inflorescences of the Norfolk-Island Araucaria. Forest land of the coast of New Caledonia. Cone of a rare Araucaria species. Male inflorescences of an Araucaria.