Podocarpus orarius (Podocarpaceae), a new species from the Solomon Islands and a taxonomic clarification of *Podocarpus spathoides* from Malaysia

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ABSTRACT. *Podocarpus spathoides* de Laub. (Podocarpaceae) is revised and is restricted to material from Malaysia where the type was collected. An emended description is given because the protologue was based on a mixture of different taxa. Plants from the Solomon Islands, previously described as *Podocarpus spathoides* var. *solomonensis* Silba, are here raised to species rank as the new species *Podocarpus orarius* R.R.Mill & M.Whiting. This is currently believed to be endemic to the Solomon Islands where it has been wild-collected on Choiseul, San Jorge and Guadalcanal; cultivated material, apparently originating from the wild, has also been seen from the island of New Georgia. Similar plants occur on neighbouring islands of Vanuatu but require proper evaluation before they can be assigned to the new species. Illustrations of the habit and reproductive characters of *Podocarpus orarius* are provided. Material from Morotai in the Moluccas that has in the past been assigned to *Podocarpus spathoides* is also morphologically distinct from the type but is insufficient for formal naming. The leaf cuticle micromorphology of *Podocarpus spathoides* and *P. orarius* is described and illustrated.

Keywords. conservation assessments, cuticle micromorphology, Malaysia, new species, Podocarpaceae, *Podocarpus*, Solomon Islands, taxonomy

Introduction

Podocarpus spathoides de Laub. (Podocarpaceae) was originally described by de Laubenfels (1985) on the apparent basis of a single specimen, *de Laubenfels 600*, from Gunung Ledang (Mt. Ophir), Peninsular Malaysia, that was cited as its holotype (Fig. 1A). Three years later, in his treatment of *Podocarpus* for *Flora Malesiana*, de Laubenfels (1988) expanded the published concept and distribution of *Podocarpus spathoides* to encompass specimens from a range of scattered islets including Morotai in the Moluccas, Rossel Island in the Louisiades Archipelago between eastern Papua New Guinea and the Solomons, and the Solomon Islands themselves: a distribution that has been repeatedly quoted by later authors, most recently by Farjon (2010a, 2010b). However, examination of specimens received on loan from the Leiden Herbarium (L) has revealed that de Laubenfels had been using the name '*Podocarpus spathoides*' on *determinavit* slips as early as 1979, on specimens from all the above areas. Therefore, although the protologue (de Laubenfels 1985) appears to be based on a single collection from Mt. Ophir, de Laubenfels's description as given in it was actually based on all,

Fig. 1. Type specimens of *Podocarpus spathoides* de Laub. from Malaysia and of some *Podocarpus* species occurring in the Solomon Islands. **A.** Holotype of *P. spathoides* de Laub. (Malaysia: *de Laubenfels P600*, L). **B.** Holotype of *P. orarius* R.R.Mill & M.Whiting (Solomon Islands, *Pitisopa et al. 7*, E). **C.** Isotype of *P. salomoniensis* Wasscher (Solomon Islands, *Brass 2881*, L). **D.** Holotype of *P. insularis* de Laub. (Sudest Island, *Brass 27987*, L).

or nearly all, the material he had seen prior to 1985. This becomes evident when one compares it with his corresponding description in the later *Flora Malesiana* account (de Laubenfels 1988). In both descriptions of *P. spathoides* tree height is given as 3–20 m and bud length as 2–6 mm.

However, in his *Flora Malesiana* account de Laubenfels (1988) added a note that "In Malaya and Rossel I. the foliage buds are no more than 3 mm long, the others are twice as long. In Malaya the trees grow in a summit scrub and are no more than 3–4 m high, elsewhere collectors report 12–20 m high trees" and acknowledged that "more than one similar taxon may be involved here". Female material was also described in the protologue of *Podocarpus spathoides* (de Laubenfels 1985). Curiously, however, the later *Flora Malesiana* account of that species (de Laubenfels 1988) did not include any female reproductive characters in its description. The label of *de Laubenfels P598* from Mt. Ophir said that the specimen was taken from a female tree but no cones are present on the sheet or in the packet and no other female material from Mt. Ophir could be located. The holotype of *Podocarpus spathoides* (*de Laubenfels P600*, L: Fig. 1A), from the same locality, was said to be male but again no cones are present on that sheet and none are visible on the images of the isotypes at RSA and US; the K isotype is also sterile (A. Farjon, *pers. comm.* 26 Jan 2011). In the description below, therefore, we state that both pollen cone and seed cone characters are not reliably known for *Podocarpus spathoides* at the present time, although we have given a translation of the brief description of female cones given by de Laubenfels (1985) in his protologue.

Some years later, Silba (2000) described *Podocarpus spathoides* var. *solomonensis* Silba from easternmost Choiseul (Solomon Islands), distinguishing it from typical Malayan *P. spathoides* by its larger bud scales and being a relatively large tree up to 20 m tall, in comparison to the Malayan plants that are typically only 3–4 m tall. Silba's description was extremely brief and all of it is summarised above. The holotype of this variety (*Whitmore BSIP 5247* at L) has been examined by us and there is no evidence, such as a *determinavit* slip, that it was actually seen by Silba. It was originally identified as *Podocarpus neriifolius* D.Don and later, by de Laubenfels in 1967, as *Podocarpus rumphii* Blume and subsequently as *P. spathoides* by de Laubenfels in 1979.

In October 2008 a joint expedition team from the Royal Botanic Garden Edinburgh and the Ministry of Forests, Honiara, Solomon Islands collected a large suite of specimens from most of the members of the Podocarpaceae known from the Solomon Islands. This included specimens of Silba's taxon *Podocarpus spathoides* var. *solomonensis* which was found growing on the islands of Choiseul (including at the locality where Whitmore collected the specimen that Silba made the type of his variety) and San Jorge, off Santa Isabel, where a similar plant had previously been collected by E.J.H. Corner (see specimen citations). It was noted that, in stark contrast to the exposed mountain ridge-top habitat at altitudes above 1000 m above sea level (asl) favoured by *Podocarpus spathoides* in its *locus classicus* of Mount Ophir, the Solomon Islands plants located on this expedition were always found at very low altitudes (from 1 to 35 m asl) along the coastline. Examination of their gross morphology revealed many differences between these Solomon Islands plants and

Malay *P. spathoides* and it became obvious that, as surmised by de Laubenfels (1988), they were not the same species. This was later confirmed by examination of the cuticle micromorphology of the two taxa by Whiting (2009). Accordingly, these Solomon Islands specimens are described here as the new species *Podocarpus orarius* R.R.Mill & M.Whiting.

De Laubenfels (1985) divided *Podocarpus* L'Hér. ex Pers. into two subgenera, each of which had nine sections. The two subgenera have consistently been recovered with strong support in molecular phylogenies of Podocarpaceae (Conran et al. 2000, Sinclair et al. 2002, Biffin et al. 2011, Knopf et al. 2012). However, the present limits of the sections are, with one or two exceptions, not supported by molecular phylogenetics and they have not been recognised in the most recent world treatment of *Podocarpus* (Farjon 2010a). Consequently, until a new, more meaningful sectional classification is available, the new species is only assigned to subgenus.

Materials and methods

The taxonomic study reported here is based on the examination of twenty-four different collections, eighteen of which belong to the new species *Podocarpus orarius* described below. Four collections represent *Podocarpus spathoides* from the type locality and one each represent taxonomically unassigned specimens from Morotai (Moluccas) and Rossel I. (Louisiades Archipelago, New Guinea) as discussed below. Duplicates of all specimens gathered by *Pitisopa et al.* in 2008 and cited below as being conserved at E will be distributed to BSIP with all but one also duplicated at BISH. The intended allocations are listed in the specimen citations.

The cuticle micromorphology of *Podocarpus spathoides* from the type locality and of the new species *P. orarius* from the Solomon Islands was examined using scanning electron microscopy. Specimens used are indicated by an asterisk (*) in the specimen citations within the species accounts. The cuticle was isolated following the method of Alvin and Boulter (1974) with changes made to suit Podocarpaceae based on work by Kershaw (1997), Stockey et al. (1998) and Stark Schilling (2004). From each specimen, six leaf slices of around 0.8 cm² were placed in glass vials with 6 ml of 20% aqueous chromium trioxide solution. The vials were sealed and kept at room temperature for 96 hours. Isolated cuticles were removed from the solution, washed with distilled water and left to dry on filter paper. Cuticles were checked under the light microscope to check for homogeneity. Two cuticle slices were mounted on an aluminium specimen stub using carbon adhesive discs (Agar Scientific Ltd.). The external surface of the cuticle was observed on untreated leaf slices and leaf slices were placed in chloroform to remove wax. These samples were mounted on to a specimen stub as above. Specimens were sputter coated with 60% gold and 40% palladium for two minutes in an Emscope SC500 sputter coater. Examination of all cuticles was done using a Hitachi S-4700 II scanning electron microscope (SEM) at the University of Edinburgh. Accelerating voltage was 5 kilovolts (kV), working distance varied from 12.8 to 16.5 mm and it was found that optimal images were obtained by setting

LensMode to Analysis, instead of Normal. For the external surface of the cuticle, images were taken of the abaxial and adaxial surface with and without wax at ×250 magnification. Close up pictures were taken of the stomatal complex with and without wax removed, a group of stomata and the guard cells. Images of the internal surface abaxial and adaxial surfaces of the cuticle were taken at ×250 magnification. All stubs are deposited at the Royal Botanic Garden Edinburgh.

Conservation assessments have been applied to both species using the IUCN guidelines (IUCN 2001, IUCN Standards and Petitions Working Group 2010).

Taxonomy

Podocarpus spathoides de Laub., Blumea 30 (1985) 267, descr. emend. hoc loco. Subgen. *Foliolatus* de Laub. TYPE: Malaya, G. Ledang (Mt. Ophir), 3500 ft. [1067 m], 27 Jul 1978, small tree 4 m in mountain thicket, *D.J. de Laubenfels P600* ["male" according to field label; holo L (no cones seen!); iso RSA, image seen (no cones visible!), US, image seen (no cones visible!)]. (Fig. 1A)

Small ***tree*** up to 4 m tall. Characters of bark or branching not currently known. ***Twigs*** of first and second years greenish brown, of third year not seen. ***Terminal buds*** globose or depressed-globose, c. 3.5 × c. 3 mm, protected by at least 8 decussate scales in at least three series and at most equalling bud diameter; outermost scales c. 2.5 × 0.5–0.3 mm, lanceolate or ovate, middle ones c. 3.5 × 0.8 mm, longer and slightly narrower than the inner which are c. 2.7 × 1 mm; all scales lacking keels, outer ones purplish tinged, inner ones brownish, outer ones acute with recurved or reflexed tips, inner ones obtuse and erect, their margins entire, hyaline in distal half, the laminar part of the scale smooth. ***Scale leaves*** absent in reproductive zones. ***Foliage leaves*** spirally arranged, adult ones 3–8 mm apart and diverging from axis at 45–60°, juvenile ones 5–14 mm apart and diverging at 50–85°, all petiolate; petiole 5–8 mm, not distinctly twisted, decurrent; lamina crimson or purplish and glaucous when flushing, turning deep green (drying brownish green) and glossy above, paler and matt beneath with dark midrib, narrowly elliptic, elliptic, narrowly oblong-elliptic or oblong-elliptic, adult ones (30–)55–85 × 9.5–13 mm, juvenile ones rather longer and wider, 65–100 × 14–20 mm, all straight (not falcate), thick and coriaceous, stiff, shallowly transversely convex or flat adaxially; margin not thickened (or only slightly so, when young) nor revolute, normally not undulating unless as a response to insect damage; midrib relatively broad (1.3–2 mm wide), with striate band on either side beneath, raised both above and beneath, on upper (adaxial) surface impressed in a broad channel equivalent to the striate bands of the lower (abaxial) surface, on abaxial surface darker than rest of lamina; apex obtuse or broadly rounded, not ending in a drip tip, sometimes blackening; base cuneate or shortly attenuate. Pollen and seed cones not seen. "***Female cones*** on 2–6 mm peduncles; ***basal foliola*** 1.5 mm long; ***receptacle*** 5 mm long; ***seed*** 7 × 5 mm" (translated by R.R.M. from the Latin protologue of de Laubenfels 1985: 267).

Distribution. Podocarpus spathoides is here regarded as endemic to Peninsular Malaysia and known only from the type locality. Records from the Solomon Islands belong to the new species *Podocarpus orarius* R.R.Mill & M.Whiting described below. Other records from east of Wallace's Line (Rossel I., Morotai, Kepulauan Talaud) are considered in the Discussion but excluded from the species. A specimen (*Paie 32883*, K) has also been collected under the name *P. spathoides* from Lawas, Sarawak but is currently missing from the Kew herbarium so cannot be considered further at present; according to Farjon (*pers. comm.*, 26 Jan. 2011) it was from a tree 18 m tall bearing yellow (presumably unripe) female cones. If it is correctly named, it would truly extend the range of *P. spathoides* to Sarawak as stated by Farjon (2010a, 2010b).

Habitat and ecology. At the type locality *P. spathoides* occurs in low shrubby vegetation and stunted forest on exposed ridges from c. 1000 m asl to the summit (1276 m asl), above the altitudinal limit of *Podocarpus ridleyi* N.E.Gray (Farjon 2010b).

IUCN conservation assessment. In the present state of knowledge, *Podocarpus spathoides* is best regarded as DD (Data Deficient), the category assigned to it by Farjon (2010a, 2010b) albeit for different reasons. Farjon's assessment was based on the assumption that, given the very scattered distribution of the species as circumscribed by him, it could perhaps be more widespread. The much more restricted distribution accepted here paints a totally different picture about the possible threat to the species and the species is more likely to fall within one of the threatened categories. However, at present DD is still appropriate since more data concerning its current status at the type locality, the level of threat there, and the identity of the putative collection from Sarawak, are all required.

Local names. None recorded.

Other specimens seen (* denotes specimen utilised for examination of leaf cuticle).
MALAYSIA. G. Ledang (Mt. Ophir), 4000 ft [1219 m]., 27 Jul 1978, "sprouts ½ m", *D.J. de Laubenfels P596* (L; juvenile); *ibid.*, 4000 ft. [1219 m], 27 Jul 1978, "young plant 2 m", *D.J. de Laubenfels P597* (L); *ibid.*, 4000 ft. [1219 m], 27 Jul 1978, *D.J. de Laubenfels P598* (L*; "female" according to label but no cones present).

Note. If the description of the female cones of *Podocarpus spathoides* given in the protologue by de Laubenfels (1985) can be relied upon (as noted above, no cones from the type locality have been seen to verify their morphology), the Malay plant differs from *P. orarius* in having considerably shorter peduncles and foliola, smaller receptacles and shorter, narrower seeds. These differences, should they hold true, are additional to those given below in the diagnosis of *P. orarius.*

Podocarpus orarius R.R.Mill & M.Whiting, **sp. nov.** Subgen. *Foliolatus* de Laub.
A Podocarpo spathoide de Laub. habitu multo altiore (usque ad 35 m haud 4 m tantum)

gemmis terminalibus in ramulis duplo longioribus anguste conicis non subglobosis squamis diametro gemmae multo longioribus haud aequalibus interioribus caudatis vel longe attenuatis nec exterioribus nec interioribus reflexis, foliis novellis pallide viridibus roseo tincto (haud purpurascentibus) herbaceis demum subcoriaceis tantum (non coriaceis) costa nec supra nec infra elevata inferne quam lamina distincte pallidiore (haud atriore), ramulis cum foliis inferis persistentibus (haud caducis) differt. A Podocarpo insulari de Laub. foliis multo longioribus latioribusque et squamis gemmarum terminalium exterioribus haud valde reflexis insignis. A Podocarpo salomoniensi Wasscher foliis multo latioribus (12–19 mm non 6.5–8 mm) oblongo-ellipticis vel oblongis (haud anguste lineari-lanceolatis) ad marginem planis (haud valde revolutis) costa superne indistincto (haud prominenti) et non sulcato, receptaculo fructifero e bracteis duabus vel tribus (haud quattuor decussatis) composito facile distinguitur. Podocarpo rubenti de Laub. foliis novellis rubentibus similis a qua tandem foliis multo majoribus et receptaculo maturo rubro haud purpureo distincta. Podocarpo neriifolio D.Don foliis novellis rubentibus et foliis longis etiam similis a quo perulis gemmarum primariis longioribus 4–8 mm longis, amentis masculis pedicellatis haud sessilibus, receptaculo majore et seminibus subglobosis differt. TYPE: Solomon Islands, Choiseul Province, Choiseul, Loloko District, mainland opposite Bembalama Island, 07° 21′ 11.4″S 157° 33′ 39.6″E, 20 m, 4 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 7* (ripe female: holotype, E; isotypes, to be distributed to BISH and BSIP). (Fig. 1B, 2 & 3)

Synonyms: *Podocarpus spathoides* de Laub. var. *solomonensis* Silba, J. Int. Conifer Preserv. Soc. 7:1 (2000) 39. — *P. spathoides* de Laub. subsp. *solomonensis* (Silba) Silba, J. Int. Conifer Preserv. Soc. 17:1 (2010) 19. TYPE: Solomon Islands, *T.C. Whitmore* BSIP 5247 (holo L, iso K).

Erect or sometimes leaning single- or less commonly multi-stemmed dioecious ***tree*** to 35 m tall, up to 20 cm dbh. ***Crown*** rather narrow and ellipsoid (Fig. 2A). ***Bark*** (Fig. 2B) smooth, flaking, shallowly fissured; outer bark medium brown, inner bark pinkish brown, wood straw-coloured. ***Twigs*** of first year pale grey green and herbaceous, of second year pale green or brownish green; growing tip purplish. ***Terminal buds*** narrowly conical, 4–8 × c. 1 mm, protected by about 8 decussate, narrowly lanceolate scales in two series and much longer than bud diameter; outer scales 4–8 × 0.2–0.3 mm, longer and slightly broader than the inner which are 3–5.5 × 0.1–0.25 mm; all scales lacking keels, purplish at base (purplish tinge fading with age), green towards tip, long-caudate or long-attenuate, obtuse at extreme tip, erect or the outer ones only slightly recurved, their margins hyaline in distal half, the laminar part of the scale rugose. ***Scale leaves*** present in reproductive zones with an abrupt transition to foliage leaves. ***Foliage leaves*** present on penultimate and lower axes as well as ultimate ones, those on the penultimate and lower axes long-persistent on young trees but caducous on older ones; juvenile and adult foliage leaves similar in shape and size; leaves spirally arranged, those of adult trees 6–25 mm apart and diverging at 60–85°, of juvenile trees 3–15 mm apart and diverging at 60–85°, all leaves petiolate; petiole 4–6

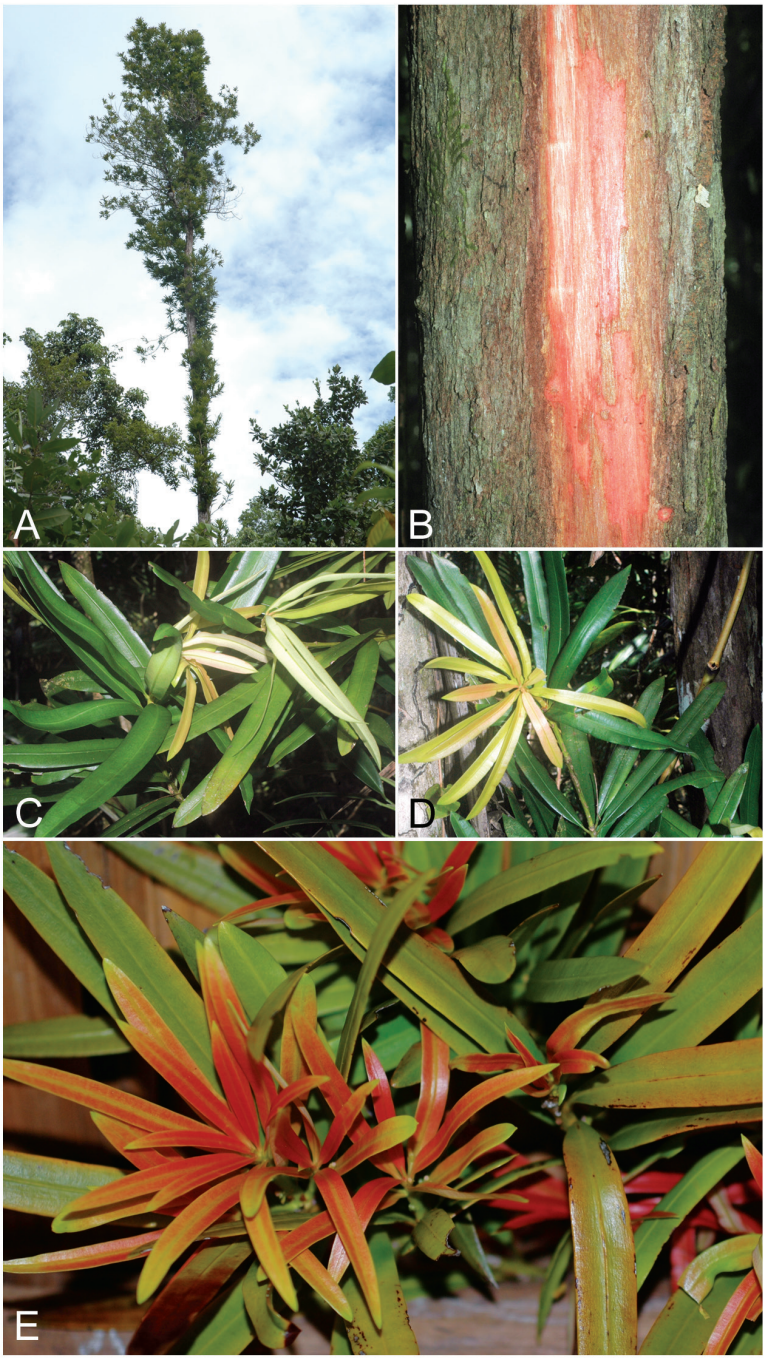

Fig. 2. *Podocarpus orarius* R.R.Mill & M.Whiting: vegetative features. **A.** Habit (*Pitisopa et al. 78*, in field). **B.** Bark (*Pitisopa et al. 6*, in field). **C.** Mature foliage, Choiseul (*Pitisopa et al. 6,* in field). **D.** Flushing leaves, Choiseul (*Pitisopa et al. 6,* in field). **E.** Flushing leaves, Santa Isabel (*Pitisopa et al. 78,* in field). (Photos: M.F. Gardner).

Fig. 3. *Podocarpus orarius* R.R.Mill & M.Whiting: reproductive features. **A.** Male cones (*Pitisopa et al. 5*, in field). **B.** Lower part of male cones in close-up showing peduncle scales and microsporangia (*Pitisopa et al. 5,* E). **C.** Two young female cones (*Pitisopa et al. 91*, E). **D.** Detail of young female cones (*Pitisopa et al. 91*, E). **E.** Ripe (left) and unripe (right) female cones (*Pitisopa et al. 7*, in field). **F.** Ripe female cone close up (*Pitisopa et al. 7*, in field). (Photos: A, E & F, M.F. Gardner; B, C & D, R.R. Mill).

mm, twisted, not or scarcely decurrent; lamina light green tinged pink on both surfaces when flushing (Fig. 2C & 2D) but not glaucous, turning deep glossy green above but much paler beneath (Fig. 2E), younger leaves held suberect but older ones becoming horizontally spreading, (sometimes narrowly) elliptic, oblong-elliptic or oblong, (50–)70–195 × (10.5–)12–20 mm with little difference in size between juvenile and adult leaves, straight, falcate throughout or not, thin, flexible and herbaceous at first becoming thicker, stiff and subcoriaceous with age, shallowly concave adaxially; margin scarcely thickened, very slightly undulating or not, not revolute; midrib narrow (0.2–0.3 mm wide), with indistinct striate band on either side beneath, not or only slightly raised on both surfaces, not impressed on upper (adaxial) surface, on lower (abaxial) surface markedly paler than rest of lamina; apex acute or subacute, not ending in a drip-tip, sometimes blackening; base cuneate or shortly attenuate. ***Pollen cones*** shedding pollen at same time as leaf flushing, shedding from base to tip, lateral, subtended by a scale leaf and arising on current growth just above bud scales of previous season, solitary or paired, up to 12 together but individual groups composed of not more than 3 (Fig. 3A); common peduncle absent; individual pollen cones (Fig. 3B) pedicellate, the pedicel 3–9 mm, shorter than cone, straight, erecto-patent, with spreading pedicel scales and surrounded by basal scales; basal scales c. 4, light brown, suberect and encircling base of pedicel, not keeled, ovate-lanceolate and rather narrow (outer ones c. 3 × 1.5 mm, inner ones c. 1 × 1 mm), acute, muticous, with very narrow entire scarious hyaline margins; scales on pedicels decurrent at base, 5 or usually 6, spirally arranged, c. 1.3–1.7 × 1 mm, pinkish-brown, subadpressed to erecto-patent, not keeled, oblong-ovate, subacute, muticous, with crenulate scarious hyaline margins; pollen cones erect, suberect or spreading outwards, 20–36 × 2–3.5 mm, cream or lemon-yellow, lighter than and contrasting with foliage, tapering slightly distally, narrowly cylindrical, curved from base or in distal half; microsporophyll phyllotaxis 13/34 with c. 32 short spirals of 3–4 microsporophylls and c. 26 long spirals of 5–6 microsporophylls per cone; ***microsporophylls*** c. 250 per cone, c. 1 mm; microsporophyll lamina greenish at base with pinkish tip, the free part at apex broadly triangular or deltate, c. 0.25 × 0.2 mm, not up-turned, with crenulate, somewhat hyaline and fimbriate margin, not scarious, truncate at apex; ***microsporangia*** slightly oblique and divergent, free, cream, ellipsoid, c. 0.7 × 0.5 mm, the stomium elliptic when open with hood at top, the microsporangial walls scarious-margined; pollen milky-white or hyaline. ***Seed cones*** borne on current growth, paired, lateral on a specialized reproductive shoot subtended by a leaf or bract; receptive cones (Fig. 3C & 3D) borne among leaves but presented on long peduncles (up to 16 mm, longer than both the receptive cone complex and the receptacle); subtending scale 1, c. 1 × 0.7 mm, light brown, not keeled, ± rectangular with a narrower, subacute muticous tip and very narrow scarious margin, falling before cone is ripe; peduncles horizontal both when receptive and when ripe, ridged, compressed, broadening distally; ripe cones (Fig. 3E & 3F) horizontal, the peduncle on cones seen 10–11 mm and now shorter than both the whole cone complex and the receptacle; ***prophylls (foliola)*** light green tipped purplish, narrowly lanceolate, c. 2.5 × 0.2 mm, erecto-patent at receptivity, soon caducous, if present when ripe then deflexed, straight throughout their life with acute, ± cucullate apex; ***receptacle*** fleshy

when ripe, composed of 1 fertile and 1 or 2 sterile bracts, asymmetrical, obovoid and infundibular at receptivity, rectangular-ellipsoid at maturity and then 10–13.5 mm along longest edge, 8.5–10.5 mm along shortest edge, 5.5–7.5 mm wide at top, greenish at receptivity (Fig. 3C & 3D), turning yellow and finally deep vermilion at maturity (Fig. 3E & 3F), not glaucous at any stage; fertile bract longer than both ovule and seed, erect at receptivity, with median longitudinal groove; receptacular scales all connate and ± wholly fused, with short, broad, lip-like free tips that are erect *in vivo*, slightly bent outwards and 2–3 × 4–5 mm (fertile bract) and 1–2.5 × 2–3 mm (sterile bract) *in sicco*, swollen and fleshy at maturity; ***seed*** asymmetrically placed on receptacle, subglobose, 11–12 × 9–9.5 mm, laterally compressed, not crested at topographically distal (chalazal) end, without a notch or beak at micropylar end, the micropyle arch-like at receptivity, pinkish brown, 2-pronged; seed coat and epimatium olive green without purplish tinge even when fully ripe, glaucous at receptivity, wrinkled and rugose when dry; ***cotyledons*** unknown.

Phenology. Male and young female cones present in early October (and possibly earlier); new leaves flushing at same time. Ripe female cones (of previous year) also present in early October together with slightly unripe ones; therefore time from pollination to ripening is c. 12 months.

Distribution. At present only known with certainty from the Solomon Islands archipelago and therefore currently regarded as endemic there. However, images of similar material have been seen from Vanuatu (islands of Erromango and Aneityum) that are superficially similar to *Podocarpus orarius*. These sheets have been determined as *Podocarpus insularis* by de Laubenfels (in sched.) but are not that species, the type of which has much smaller leaves as noted above; nor are they *P. neriifolius* which was the only *Podocarpus* species recorded from those islands by Schmid (1975). They have the large, broad leaves of *Podocarpus orarius* but examination of the actual specimens will be necessary to determine whether they are conspecific with it or not. If they are conspecific, they would extend the geographic range of *Podocarpus orarius* to the neighbouring Vanuatu archipelago.

Habitat and ecology. Podocarpus orarius occurs on steep slopes of primary coastal rainforest, often with species of *Gymnostoma* L.A.S.Johnson (Casuarinaceae); also in secondary rainforest; 1–60(–460) m asl. Recent collections on the Solomons have all been by the coast below 40 m asl but, as indicated in the specimen citations below, it has in the past been collected on Guadalcanal up to an altitude of just over 450 m asl. The species should therefore also be searched for at higher altitudes and in the interior of the islands; on Guadalcanal and New Georgia at least, there is evidence (from the information on the labels of *Lipaqeto BSIP 3321* and *Waterhouse 209*) that trees of the species do (or did) occur away from the coast.

IUCN conservation assessment. NT (Near Threatened). There is no substantial evidence of decline although in some coastal areas there has been some forest destruction with a

few mutilated trees of *P. orarius*. Local information suggests that it is likely that these largely intact forests will be targeted for their timber in the near future, therefore this species will be vulnerable to any change in land use. The nearby nickel mines on the island of San Jorge are also a potential future threat. Previously listed as DD, under the name *Podocarpus spathoides*, by Pippard (2008, App. 2 p. 5) based on a 1998 assessment.

Notes. The type of *Podocarpus orarius* was collected at the same site as the type locality of *P. spathoides* var. *solomonensis*. We have chosen to describe a new species rather than raise Silba's varietal epithet to species rank for two reasons: the similarity of '*solomonensis*' to '*salomoniensis*' which is already in use for a completely different species of *Podocarpus*, and the brief and unsatisfactory nature of Silba's protologue which contained only the bare minimum of information required to validate the name. The type of Silba's name was also a sterile specimen, whereas both male and female specimens (the females at two different stages) as well as more juvenile specimens were collected in 2008, allowing the preparation of a much more complete description from these and the other available material.

Local names. Locally known on Choiseul and Guadalcanal as *Dengali* in the Kwara'ae language (*Whitmore 5247*, *Lipaqeto BSIP 3321*) and on Santa Isabel as *Graoragota* (female) in the Maringe dialect of the Cheke Holo language (*Pitisopa et al. 72, 73, 90, 91, 92, 95, 103, 104, 105*). *Graoragota* is also used for *Podocarpus salomoniensis* according to the notes on *Pitisopa et al. 96* (E).

Etymology. The epithet *orarius* is Latin for 'coastal' and alludes to what appears to be, from the majority of collections seen, the typical habitat of the species.

Other specimens examined (* denotes specimen utilised for examination of leaf cuticle): SOLOMON ISLANDS. **Choiseul Province**: Choiseul, ultrabasic hill on coast opposite Bembalama Island, 3 Mar 1964, *T.C. Whitmore BSIP 5247* (L, sterile, holotype of *P. spathoides* var. *solomonensis* Silba; K, isotype of *P. spathoides* var. *solomonensis*); Loloko District, mainland opposite Bembalama Island, 07° 21′ 11.4″S 157° 33′ 39.6″E, 20 m, 4 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 5* (E, BSIP, BISH; male); ibid., *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 6* (E, BSIP, BISH; immature female). **Isabel Province**: Santa Isabel, Turungurungu Island, San Jorge, sea level, 25 Sep 1965, *E.J.H. Corner* 2737 (K, L); Bughotu District, San Jorge, Turunghu Island, east of the village of Talise, 08° 27′ 57.2″S 159° 38′ 21.7″E, 35 m, 16 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 72* (E, BSIP, BISH); ibid., *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 73* (E, BSIP, BISH); Bughotu District, San Jorge, Tupilla Island, 08° 27′ 0.68″S 159° 38′ 28.8″ E, 1 m, 16 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 78* (E*, BSIP; immature female: cuticle of both young flushing leaf and adult leaf examined); Bughotu District, San Jorge, Ramahale Point, 08° 29′ 34.8″S 159° 38′ 59.8″E, 15 m, 17 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 83* (E*, BSIP, BISH; sterile: cuticle of adult leaf examined); Bughotu District, San Jorge, Gobu Bay, 08° 29′ 37.7″S 159° 38′ 47.5″E,

5 m, 17 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 90* (E, BSIP, BISH); Bughotu District, San Jorge, Gobu Bay, 08° 29′ 37.7″S 159° 38′ 47.6″E, 6 m, 17 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 91* (E, BSIP, BISH; young female); Bughotu District, San Jorge, Gobu Bay, 08° 29′ 37.5″S 159° 38′ 47.7″E, 6 m, 17 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 92* (E, BSIP, BISH; immature female); Bughotu District, San Jorge, Simia River c. 0.5 km from mouth of river, 08° 32′ 31.7″S 159° 38′ 45.4″E, 12 m, 18 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 102* (E, BSIP, BISH); Bughotu District, San Jorge, Kogaruta Bay, 08° 30′ 14.4″ S 159° 41′ 1″E, 1 m, 18 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 103* (E, BSIP, BISH); Bughotu District, San Jorge, Tanegula, 08° 29′ 51.1″ S 159° 41′ 4.8″E, 1 m, 18 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 104* (E, BSIP, BISH); Bughotu District, San Jorge, Turunghu Island, east of the village of Talise, 08° 27′ 57″S 159° 38′ 1.7″E, 1 m, 18 Oct 2008, *F. Pitisopa, M.F. Gardner, S. Herrington, P. Kosui, R. Olisae & P. Tofu 105* (E, BSIP, BISH). **Guadalcanal Province**: Guadalcanal, Eastern slopes of Mt. Gallego, 1500 ft. [457 m], 08 Aug 1965, *T. Whitmore 2079* (K). Rere River, c. 3 miles inland, 200 ft. [61 m], 19 Nov 1963, *Z. Lipaqeto BSIP 3321* (K). **Western Province**: New Georgia, grown in garden on coast, originating from interior (Kusage), 26 Jul 1929, *J.H.L. Waterhouse 209* (K, 2 sheets: cited by Gray, 1958 under *P. neriifolius*).

Cuticle micromorphology

Podocarpus spathoides (Fig. 4A–H). ***External surface.*** Adaxial epidermal cells (Fig. 4A) indistinctly visible, abaxial ones (Fig. 4B) clearly visible on external surface of cuticle. Stomatal plugs present, forming a popcorn-like amorphous, very porous interconnected network (Fig. 4C inset). Stomata without Florin rings but surface upraised (Fig. 4C). ***Internal surface: epidermal cells.*** Adaxial epidermis cells (Fig. 4D & 4E) polygonal, square to elliptic or rectangular (either longitudinally or less commonly transversely); walls slightly undulating, no cavities along wall flanges; periclinal surfaces fibrous-granular with numerous small holes. Abaxial epidermal cells (Fig. 4F & 4G) narrowly rectangular to rectangular or oblong-polygonal; those adjoining stomata trapezoidal or arcuate, those within stomata rows transversely elliptic / rectangular or polygonal; walls straight or curved, not buttressed though edges irregularly frilled, cavities along wall flanges indistinct or absent; periclinal surfaces rather coarsely granular. ***Internal surface: stomatal arrangement.*** Stomata in discontinuous rows on abaxial surface (hypostomatic), parallel to long axis of leaf with ± no deflection of individual stomata; stomatal chains developed (Fig. 4F). ***Stomata*** (Fig. 4G & 4H) brachyparacytic, close together within same row, separated by 1 or 2 epidermal cells; adjacent rows widely spaced, separated by (1–)2–3(–5) rows of epidermal cells; horizontal stomata rows absent. ***Stomatal apparatus*** (including subsidiary cells) suborbicular (Fig. 4G & 4H). ***Stoma*** (excluding subsidiary cells) suborbicular to ± square, the opening elliptic and often wide (Fig. 4G & 4H). ***Subsidiary cells:*** 2 most common, 3 frequent, 4 rare; polar subsidiary cells absent; cuticle on outer flanges thick, with no groove but cuticle with a deep crease that is hidden by lateral

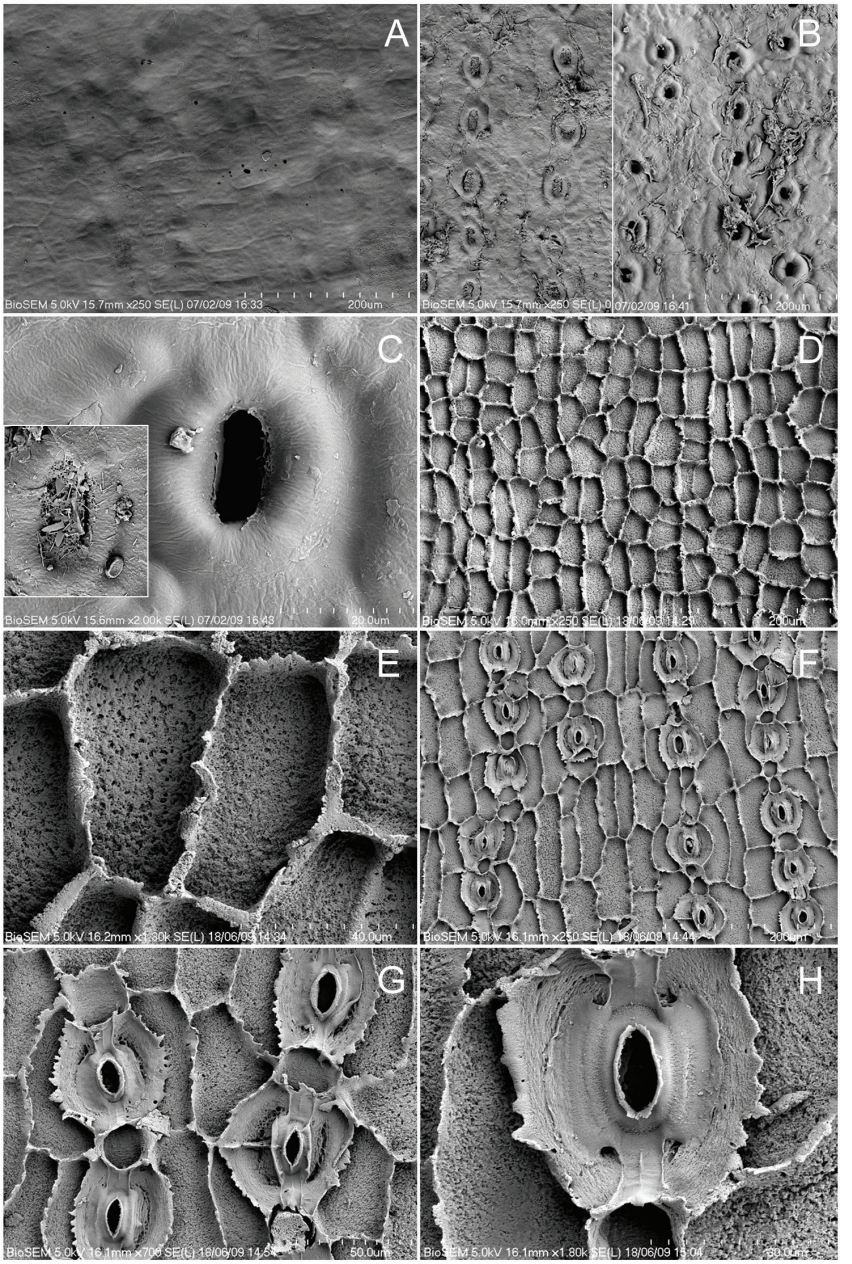

Fig. 4. *Podocarpus spathoides* de Laub.: cuticle micromorphology (all from *de Laubenfels P598*, L). **A.** Adaxial external surface. **B.** Abaxial external surface; composite image showing (left half) untreated cuticle with wax plugs covering stomata, (right half) cuticle treated with chloroform, stomata with wax plugs removed. **C.** external view of stoma; (inset) detail of wax plug before treatment. **D.** Adaxial epidermal surface. **E.** Adaxial epidermal cells. **F.** Abaxial epidermis with stomatal rows and epidermal cells. **G.** Group of stomata. **H.** Stomatal complex. Scale bars: A, B, D, F, 200 micrometres (µm); C, 20 µm; E, 40 µm; G, 50 µm; H, 30 µm. (Photos: M. Whiting).

flange extensions (Fig. 4G, top left); margins of subsidiary cell wall flanges irregularly denticulate, the teeth incurving; thinning of cuticle present in an arc midway across the subsidiary cell; texture fibrous-granular. ***Cuticle flange between guard cells*** smooth towards outside of flange, slightly more rugose towards stoma, apparently not inrolled, not standing out laterally (Fig. 4H). ***Polar extensions*** always present, ribbon-like, thin and broad, wholly fused with subsidiary cells, longer than broad, with a central ridge, flaring outwards from the base (Fig. 4H). ***Cuticle on guard cell surfaces*** rugose.

Podocarpus orarius (Fig. 5A–H & 6A–F). ***External surface.*** Abaxial and adaxial epidermal cells clearly visible on external surface of cuticle (Fig. 5A, 5B, 6A & 6B). Stomatal plugs present (Fig. 5A & 6A), composed of dendroid or coralloid fibrous rodlets (Fig. 5C inset & 6C), porous. Stomata without Florin rings but surface somewhat upraised (Fig. 5C), especially when young (Fig. 6C & 6D). Developing lateral subsidiary cells forming ridges either side of stomata, these ridges continuing along the stomatal rows on young leaves, connecting one stoma with the next (Fig. 6A & 6B), this feature becoming much less evident on mature leaves (Fig. 5B, right). ***Internal surface: epidermal cells.*** Adaxial epidermis cells (Fig. 5D & 5E) rectangular, trapezoidal, square or transversely rectangular; walls straight or curved, not buttressed though edges irregularly frilled, cavities along wall flanges present, more distinct than in *P. spathoides*; periclinal surfaces granular with numerous small, rectangular pits. Abaxial epidermal cells (Fig. 5F & 5G) narrowly rectangular to rectangular or oblong-polygonal, those adjacent to stomata arcuate-rectangular or trapezoidal, those within stomata rows transversely elliptic or suborbicular-polygonal; walls straight, curved, or slightly undulating, not buttressed though edges irregularly frilled, distinct small cavities present along wall flanges; periclinal surfaces granular with scattered small ± rectangular pits. ***Internal surface: stomatal arrangement.*** Stomata in discontinuous rows on abaxial surface (hypostomatic), parallel to long axis of leaf with some noticeably deflected; short stomatal chains sometimes developed. ***Stomata*** (Fig. 5G & 5H) brachyparacytic, close together within same row and separated by (1–)2(–3) epidermal cells; adjacent rows widely spaced and separated by (2–)3–6 rows of epidermal cells; horizontal stomata rows absent. ***Stomatal apparatus*** (including subsidiary cells) transversely oblong or elliptic. ***Stoma*** (excluding subsidiary cells) rectangular, the opening elliptic (Fig. 5H). ***Subsidiary cells:*** 2 most common, 3 or 4 occur; polar subsidiary cells absent; cuticle on outer flanges thick, with no visible groove or crease (Fig. 5G & 5H); margins of subsidiary cell wall flanges irregularly denticulate, the teeth incurving; thinning of cuticle present in an arc midway across the subsidiary cell (Fig. 5H); texture fibrous-granular. ***Cuticle flange between guard cells*** thick, smooth towards edge, finely rugose towards stoma, slightly inrolled or not, not standing out laterally. ***Polar extensions*** always present, ribbon-like, wholly fused with subsidiary cells, longer than broad, with a rather indistinct central ridge, flaring outwards only distally (Fig. 5H). ***Cuticle on guard cell surfaces*** rugose.

The cuticle micromorphology of *Podocarpus spathoides* (Fig. 4) and *P. orarius* (Fig. 5 & 6) at first sight appears very similar and indeed there are many characters

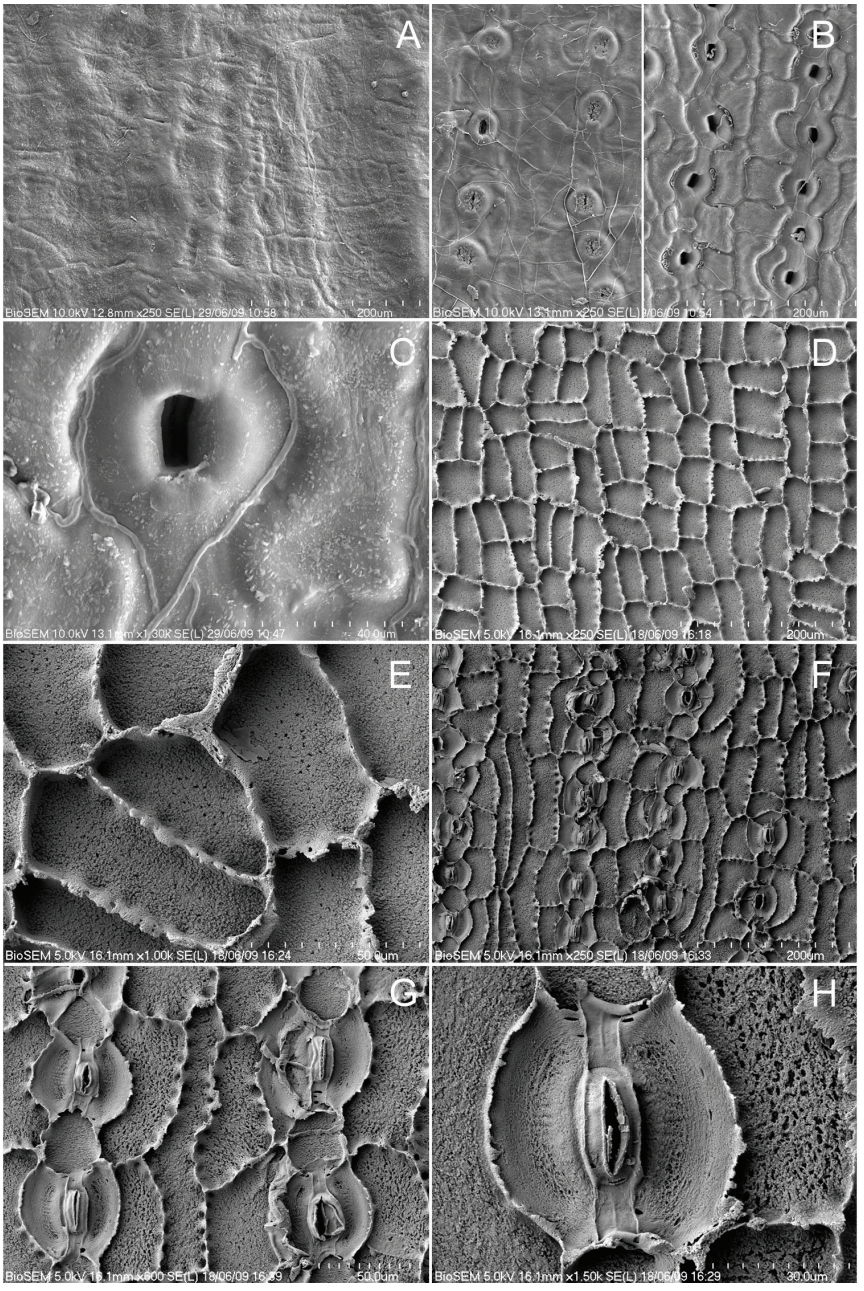

Fig. 5. *Podocarpus orarius* R.R.Mill & M.Whiting: cuticle micromorphology (adult leaves, fully developed, *Pitisopa et al. 78 & 83*). **A.** Adaxial external surface. **B.** Abaxial external surface; composite image showing (left half) untreated cuticle with wax plugs covering stomata, (right half) cuticle treated with chloroform, stomata with wax plugs removed. **C.** External view of stoma; (inset) detail of wax plug before treatment. **D.** Adaxial epidermal surface. **E.** Adaxial epidermal cells. **F.** Abaxial epidermis with stomatal rows and epidermal cells. **G.** Group of stomata. **H.** Stomatal complex. Scale bars: A, B, D, F, 200 µm; C, 40 µm; E, G, 50 µm; H, 30 µm. (Photos: M. Whiting).

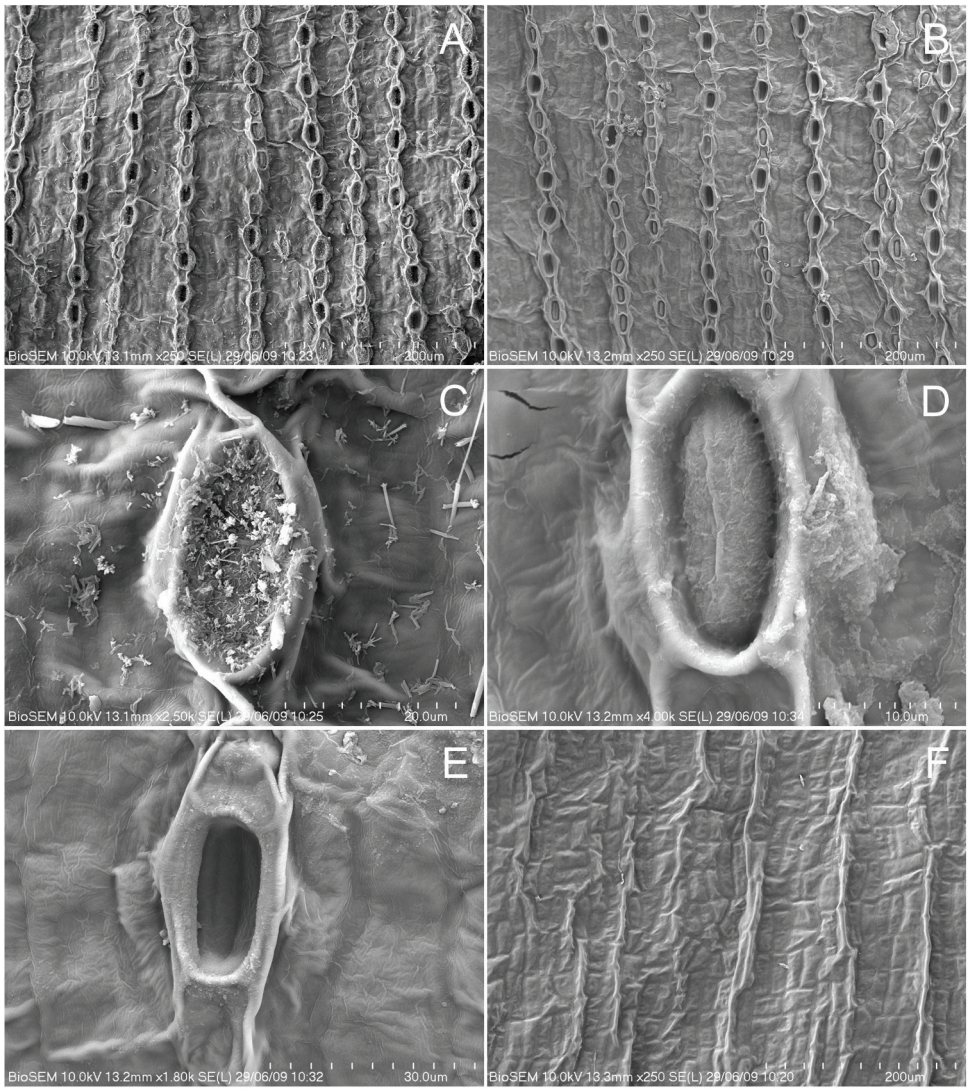

Fig. 6. *Podocarpus orarius* R.R.Mill & M.Whiting: cuticle micromorphology (very young, flushing leaf, *Pitisopa et al. 78*). **A.** external surface, abaxial cuticle, before treatment. **B.** external surface, abaxial cuticle, after treatment with chloroform to remove wax. **C.** Stoma before treatment, showing wax plug apparently sitting on guard cells within peristomatal chamber. **D.** Stoma after treatment with chloroform to remove wax; guard cells closed. **E.** Another stoma with wax removed showing peristomatal chamber. **F.** External surface, adaxial cuticle. Scale bars: A, B, D, F, 200 µm; C, 20 µm; D, 10 µm; E, 30 µm. (Photos: M. Whiting).

in common. However, closer examination of the images reveals some significant differences that, when combined with the gross morphological differences and the major disjunctions in both distribution and altitude, support separation of *P. orarius*. On the external adaxial cuticle, no obvious sculpturing is visible in *P. spathoides* (Fig. 4A) but *P. orarius* has a pattern of ridges and hollows that corresponds to the shapes of the adaxial cells as revealed from the inner cuticle surface (Fig. 5A, 5D & 6F). This pattern is particularly evident on young leaves (Fig. 6F). The sculpturing pattern of the abaxial external cuticle of *P. orarius* is also very prominent, especially after treatment with chloroform to remove wax (Fig. 5B, right); *P. spathoides* also has some sculpturing on this surface but it is different and less distinct (Fig. 4B). The internal cuticle also reveals differences between the Malaysian (*P. spathoides*) and Solomon Islands (*P. orarius*) specimens. In *P. spathoides* the guard cell 'wings' are fairly large and often cover a fairly deep and porous groove on the lateral subsidiary cells, whereas in *P. orarius* the guard cell 'wings' are usually absent or relatively small and the lateral subsidiary cells of the stomatal complex have only a slight groove or porous area. Small cavities (more distinct on the abaxial surface than the adaxial) are present alongside the epidermal cell walls on both leaf surfaces in *P. orarius* (Fig. 5E & 5G) but these were not observed in *P. spathoides* (Fig. 4E & 4G). The periclinal surfaces of the adaxial epidermal cells have a more coarsely granular texture in *Podocarpus spathoides* (Fig. 4E) than in *P. orarius* (Fig. 5E). Finally, the margins of the lateral subsidiary cells are noticeably more irregular and 'jagged' in appearance in *P. spathoides* and are clearly outspread (Fig. 4H) compared with *P. orarius* in which they are almost smooth and even tend to curl inwards (Fig. 5H).

Examination of the cuticle of an immature leaf of *Podocarpus orarius* shows that in this species the wax plug/layer appears to sit on the guard cells within the peristomatal chamber early in development (Fig. 6C & 6D). The lateral subsidiary cells at this point form a narrow ridge either side of the guard cells (Fig. 6C & 6D). These ridges continue beyond the stomata to link all the stomata in the row but the feature gradually becomes less evident as the leaf becomes fully developed (Fig. 5B, right). In other *Podocarpus* species Whiting (2009) found that the wax plug sits high in the peristomatal chamber with a relatively large gap between the wax plug and the guard cells. It was also found that the base of the wax plug often reflected the shape of the guard cells somewhat (Whiting 2009). The shape of the wax plug therefore indicates that it was once seated on the guard cells (as seen in Fig. 6C–E) although the latter have changed in shape or position. It is possible that as the subsidiary cells develop and expand, they push or rotate the guard cells downwards. The layer of wax occurring on the guard cells may be displaced, leaving a wax layer fixed between the subsidiary cells and with a gap between the wax plug and the guard cells. Another explanation would be that the wax plug has been lifted and compressed by the lateral subsidiary cells causing an overall change in shape of the wax plug. There may be an upward movement of the wax plug as the subsidiary cells expand upwards, particularly in *Podocarpus* subgenus *Podocarpus* in which there is a Florin ring. This topic will be discussed in more detail elsewhere (Whiting 2009, Whiting & Mill in prep.).

Discussion

There are three other *Podocarpus* species that have been definitely recorded from the Solomon Islands: *Podocarpus glaucus* Foxw., *P. insularis* de Laub. and *P. salomoniensis* Wasscher (Wasscher 1941, de Laubenfels 1988). *Podocarpus neriifolius* D.Don has also been recorded (Gray 1958, two specimens cited; Whitmore 1966, Farjon 2010a) but many specimens from the Solomons purporting to be that species have been misidentified and we have not so far seen correctly identified material from there. *Waterhouse 209* at K, cited by Gray (1958) under *P. neriifolius*, bears an annotation slip by Buchholz saying, "Under study – probably juv. form of *P. salomoniensis* Wasscher", and a much later *determinavit* slip by A. Farjon who identified it as *P. insularis*. It is none of those three species and in fact belongs to *P. orarius* of which it represents one of the few inland collections seen.

Podocarpus glaucus is a small-leaved (8–18 mm long: Farjon 2010a) species from relatively high altitudes (normally above 1000 m asl) that cannot be confused with *P. insularis*, *P. salomoniensis* or *P. orarius*. Previous records of *P. salomoniensis* have been from San Cristoval (the type locality and others on that island) and San Jorge (*Corner* 2717, K). It has also been recorded from Bougainville (Foreman 1971); this island is politically part of New Guinea although phytogeographically it forms, together with the Solomon Islands (other than the Santa Cruz group), a well-defined unit that has been called the Solomon Islands rain forests ecoregion (ecoregion AA0119: WWF 2001). Until the 2008 expedition, *P. salomoniensis* had not been recorded from Choiseul but on that expedition it was collected there and also re-collected on San Jorge (M.F. Gardner, pers. comm. 15 Nov 2010). During the 2008 expedition, specimens of *P. salomoniensis* were found at very low altitudes (as low as c. 10 m asl) whereas previously the known altitudinal range had been quoted as being 400–900 m asl (Silba 1986). *Podocarpus salomoniensis* has very narrow leaves (Fig. 1C) and is a very distinct, unmistakable species that cannot be confused with any other *Podocarpus* on the Solomons archipelago or indeed anywhere in Malesia.

Podocarpus insularis de Laub. was based on *Brass 27987* (Fig. 1D) from Mt. Riu on Sudest Island; this is the largest island of the Louisiades Archipelago (New Guinea, Milne Bay District) and is now known as Vanatinai. De Laubenfels (1988) gave its distribution as 'New Hebrides [Vanuatu] and all Solomon Islands; in Malesia, New Guinea and adjacent islands: Rossel, Sudest, Misima, Woodlark, Fergusson, and New Britain." The leaves of the holotype (Fig. 1D) and isotype of *P. insularis* measure only 45–70 × 4–7 mm, much shorter and narrower than those of *P. orarius* (Fig. 1B) and smaller also than those of Malaysian *P. spathoides* (Fig. 1A). Farjon in 2007 determined *Whitmore BSIP 5247* at K as *Podocarpus insularis*. Since that specimen is the type of *Podocarpus spathoides* var. *solomonensis*, that name (and the later combination *P. spathoides* subsp. *solomonensis*) would become synonymous with *P. insularis* were Farjon's identification proved to be correct. However, neither the Leiden nor the Kew examples of *Whitmore BSIP 5247* match the type of *Podocarpus insularis*—they have much larger leaves and belong to *P. orarius* described above—and consequently we disagree with Farjon's determination. It is possible that the statement by de Laubenfels

(1988) that *P. insularis* occurs on "all Solomon Islands" is at least partly wrong and that some material of the new species here described as *P. orarius* was included in his original concept of *P. insularis* as well as his circumscription of *P. spathoides*. Until *P. insularis* is revised (a topic beyond the scope of this paper), its account in *Flora Malesiana*, like that of *P. spathoides*, needs to be treated with caution.

Podocarpus neriifolius has large leaves that could perhaps be confused with those of *P. orarius*. However, even in its widest senses as interpreted by Wasscher (1941) and Farjon (2010a), it can be distinguished from *P. orarius* by its shorter, spreading outer bud scales normally not exceeding 5 mm, its shorter receptacles of the female cones (8–10 mm, as opposed to 10–13.5 mm in *P. orarius*), and its purplish-tinged ripe seeds that are more oblong or ovoid than the subglobose seeds of *P. orarius*, being (8–)10–15 × 7–8 mm including the epimatium rather than 11–12 × 9–9.5 mm as in *P. orarius*.

Podocarpus spathoides has also been recorded from the island of Morotai in the north Moluccas, off the north tip of Halmahera (de Laubenfels 1988). The specimen upon which this record was based has been examined and again was found to differ from the Malayan type but although it bears immature male cones it is a rather poor specimen that is here regarded as insufficient as the basis for a formal description. No other material identified as *P. spathoides* has yet been seen from that island. Therefore, formal segregation of the Morotai plant from *P. spathoides* must await the examination of further material, either by discovery of more material in herbaria or by collecting. Similarly, another record of *P. spathoides* from the Moluccas, from the islet of Kepulauan Talaud (Silba 1986) also needs re-evaluation but the material upon which it was based is not known. It is possible that it might have been an error for the Morotai record although Kepulauan Talaud is in a different region of the Moluccas, NE of Sulawesi close to the Philippine Trench.

De Laubenfels (1988) also recorded *P. spathoides* from Rossel Island in the Louisiades Archipelago (New Guinea). These islands lie between New Guinea and the Solomons; Rossel (now known as Yela) is the easternmost of the archipelago. One specimen from Rossel Island has been seen; it was determined in 1979 by de Laubenfels as *Podocarpus spathoides* and is presumably the basis for his record of that species from Rossel Island in *Flora Malesiana* (de Laubenfels 1988). Earlier determinations on this sheet were as *Podocarpus rumphii* (on the sheet's label by an unknown person, possibly the collector) and *P. polystachyus* R.Br. ex Endl. (by de Laubenfels in 1968). De Laubenfels (1988) himself noted that the terminal buds of the Rossel I. specimen were half the size of those from the Solomons, being instead similar in size to those of the type of *P. spathoides* from Mt. Ophir. Also, the leaves are concave adaxially as in *Podocarpus polystachyus* rather than flat as in *P. orarius*. The habitat, "inner edge of mangroves", is one favoured by *Podocarpus polystachyus* in other areas (Wasscher 1941, Farjon 2010b); it also likes rocky shores (Turner et al. 2000) and limestone karst where it can be very dwarfed (Donnelly et al. 2003). All these are different from the habitats favoured by both *Podocarpus spathoides* and *P. orarius*. De Laubenfels (1988) restricted *P. polystachyus* to a range extending only from the Malay Peninsula through islets off Sumatra to Borneo (especially Sabah, Brunei and Sarawak but also a

few localities in W Kalimantan), the Philippines and western New Guinea (especially the Vogelkop Peninsula); Wasscher (1941) gave a similar range except that he did not include any material from New Guinea. Further study of this Rossel Island plant is therefore needed but it does not belong to either *Podocarpus spathoides* as delimited here or to *P. orarius*.

Henderson 186 (K) from the Solomon Islands (Malaita, Maluu), seen only as an image, has much more tapering and narrower leaves than is typical for *Podocarpus orarius*. Its original label bears the identification *Podocarpus insularis* but the specimen more resembles *P. salomoniensis* than either *P. insularis* or *P. orarius*. However it is not typical of *P. salomoniensis* either and examination of the actual specimen is needed before a definite identification can be made.

The work reported here clearly demonstrates that *Podocarpus spathoides* as delimited by de Laubenfels (1985, 1988) was a mixture of at least three taxa and that *P. insularis* may well have been a mixture too. In the case of *P. spathoides*, de Laubenfels himself acknowledged the possibility that his concept of that species might encompass more than one taxon. Despite that, however, the apparently very disjunctly scattered distribution of *Podocarpus spathoides* sensu de Laubenfels (1988) has been regarded as following a biogeographic pattern by Heads (2001, 2003). In the second of those papers (Heads 2003, Fig. 87) this pattern was graphically illustrated by two lines, one connecting the Malay and Rossel I. populations and the other linking Morotai with the Solomons, based on the comments by de Laubenfels (1988) concerning bud size. The present paper has shown that the Malay, Morotai, Rossel I. and Solomons plants all belong to different taxa, not all of which can at present be given formal names due to the insufficiency in quality and/or quantity of the Morotai and Rossel I. material for description or identification. Consequently, the 'pattern' identified by Heads (2003) is in this instance false although in his earlier paper (Heads 2001) he did give other examples of species that show a disjunction between the Malay Peninsula and the Solomons. The present paper emphasises how larger patterns and conclusions, such as in forming biogeographic patterns, might be better based on data generated in unambiguous situations. Particularly in a currently poorly known family such as Podocarpaceae, many of the apparently very wide disjunctions in distribution may turn out to be fictional, based on incompletely understood taxonomy, as in the case of *P. spathoides* that has in part been unravelled here. This also has implications when assessing the conservation status of species such as *Podocarpus spathoides* and *P. insularis*, and highlights that sound taxonomic research is also crucial in underpinning such conservation studies**.**

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