

## BLECHNACEAE

(H.P. Nooteboom et al., Leiden, The Netherlands)<sup>1</sup>

*Blechnaceae* (C.Presl) Copel., Gen. Fil. (1947) 155; C.Presl, Epimel. Bot. (1851) 103 ('*Blechnae*'); K.U.Kramer, T.C.Chambers & Hennipman in Kubitzki, Fam. Gen. Vasc. Pl., Pteridophytes and Gymnosperms (1990) 60. — Type genus: *Blechnum* L.  
*Stenochlaenaceae* Ching, Acta Phytotax. Sin. 16, 4 (1978) 18. — Type genus: *Stenochlaena* J.Sm.

Occasionally scandent, terrestrial or epilithic, rarely epiphytic, small to large ferns. *Stem* scaly, creeping, erect or scandent, radially dictyostelic. *Stipes* aggregated to remote, usually well-developed, adaxially grooved, with several vascular bundles usually arranged in a U-pattern. *Lamina* mostly pinnatifid to simply pinnate with entire to pinnatifid pinnae, less frequently simple or lobed, rarely bipinnate. *Sterile-fertile leaf dimorphism* very widespread and developed to various degrees but by no means universal. *Veins* free or anastomosing, in the latter case nearly always without free included veinlets; dissection pattern and/or venation catadromous, at least in the upper part of the lamina. *Fertile pinnae* or segments with at least one row of costal areoles, their outer arch mostly forming the receptacle of the sori or of one long, continuous coenosorus, or a special soral vascularization present. *Rhachis* adaxially sulcate, the groove not continuous with those on the pinna costae. *Sori* short to long and narrow, with few exceptions having an indusium that is attached along the receptacle and free towards the costa or costule (this character rarely found in other ferns); occasionally the indusium wanting, the sporangia spreading along the veins or acrostichoid in arrangement, no sterile appendages borne among the sporangia. *Sporangia* with strong, triseriate stalk; annulus many-celled, the indurated part extending to the stalk, the several-celled stomium weakly differentiated from the many-celled, non-indurated part of the bow. *Spores* monolete.

### ANATOMY AND MORPHOLOGY

Few representatives have so far been studied comprehensively, particularly as to the anatomy of the vegetative organs, the receptacle having received the most attention; e.g., De la Sota & Gouvêa Labouriau (1961). *Stenochlaena* is better known, and its taxonomic position in the present family has partly been established on anatomical grounds (e.g., Mehra & Chopra 1951). The stem is radially dictyostelic, with well-developed, sometimes sclerotic pith. The vascular bundles of the stipe are arranged in a U-pattern, as seen in transection, with the two adaxial bundles larger and the xylem hippocampiform, the number of other bundles, of which there are at least two, dependent upon the size of the leaf (see, e.g., Tardieu-Blot 1932). The stomata are polycytic

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1) For the Introductory paragraphs on p. 1–3 K.U. Kramer†, T.C. Chambers & E. Hennipman (1990) was used. The authors of the different genera are mentioned directly under the genus names.

with anomocytic ones sometimes also present. In this character *Stenochlaena* also agrees with the other genera, but its vascular anatomy is more complicated, probably in connection with its growth habit; see under the genus. Young, unfolding leaves are very often tinged with red, a character possibly of taxonomic significance (Tryon & Tryon 1982). Sporangia spreading onto the indusium have been found in *Blechnum* and *Salpichlaena*, a very rare feature.

*References:* Mehra, P.N. & N. Chopra, Anatomy of *Stenochlaena palustris* (Burm.) Bedd. Ann. Bot. n.s. 15 (1951) 37–45. — De la Sota & Gouvêa Labouriau, Correlaciones entre esporangios y nervadura comisural en *Blechnum occidentale* L. (Filices) Blechnaceae. Ann. Acad. Bras. Ciênc. 33 (1961) 225–239. — Tardieu-Blot, M., Les Aspleniées de Tonkin (1932). — Tryon, R.M. & A.F. Tryon, Ferns and allied plants, with special reference to Tropical America (1982).

### GAMETOPHYTE

See especially Stokey & Atkinson (1952a, b), Stone (1962), Atkinson (1973), and Holbrook-Walker & Lloyd (1973). The prothallia are cordate, or elongate when mature, with a distinct, often firm midrib; they often bear simple or few-celled, partly glandular, chlorophyllous hairs. The gametangia are of the common, advanced leptosporangiate type, but antheridia with elongate end cells are known in some species. Gametophytic characters of *Stenochlaena* again corroborate its placement in the present family.

*References:* Atkinson, L.R., The gametophyte and family relationships, in Jermy, A.C., J.A. Crabbe & B.A. Thomas (eds.), The phylogeny and classification of the ferns (1973) 73–90. Academic Press, London, New York. — Holbrook-Walker, S.G. & R.M. Lloyd, Reproductive biology and gametophyte morphology of the Hawaiian fern genus *Sadleria* (Blechnaceae). Bot. J. Linn. Soc. 67 (1973) 157–164. — Stokey, A.G. & I.R. Atkinson, The gametophyte of *Stenochlaena palustris* (Burm.) Bedd. Phytomorphology 2 (1952a) 1–9. — Stokey, A.G. & I.R. Atkinson, The gametophyte of *Blechnum spicant* (L.) Whither and B. buchtienii Rosenst. Phytomorphology 2 (1952b) 9–15. — Stone, I.G. The ontogeny of the antheridium in some leptosporangiate ferns with particular reference to the funnel-shaped wall. Austral. J. Bot. 10 (1962) 76–92.

### KARYOLOGY AND HYBRIDIZATION

Blechnaceae are one of the cytologically most complex fern families. Probable or certain base numbers found so far are 32 (*Doodia*); 28–37 but most commonly 28 and 33 (*Blechnum*); 33 (*Brainea*, *Sadleria*); 34 and 35 (*Woodwardia*); and 74 (from 37?) (*Stenochlaena*). Tetraploids are frequent in *Blechnum* (Walker 1966, 1973). *Salpichlaena*, with  $n = 40$ , is kept separate from *Blechnum* partly because of the divergent base number. Some authors tentatively regard  $x = 33$  as the basic number in the family (Walker 1973).

A hybrid was reported in *Doodia* (Parris 1972). The variability of many species in the *Blechnum occidentale* complex is largely due to hybridization (see especially Walker 1973: f. 7).

*References:* Parris, B.S., The genus *Doodia* R.Br. (Blechnaceae) in New Zealand. New Zealand J. Bot. 10 (1972) 585–604. — Walker, T.G., A cytotaxonomic study on the pteridophytes of Jamaica. Trans. Roy. Soc. Edinburgh 66 (1966) 169–237. — Walker, T.G., Additional cytotaxonomic notes on the pteridophytes of Jamaica. Trans. Roy. Soc. Edinburgh 69 (1973) 109–135.

## ECOLOGY AND DISTRIBUTION

The family is distributed nearly throughout the world. *Blechnum* is by far the largest genus, with most representatives in the southern hemisphere extending to the mountains of the tropics and relatively few species in the northern hemisphere. *Woodwardia* is a counterpart of *Blechnum* and nearly confined to the northern hemisphere, where its distribution pattern is somewhat disjunct and possibly relict. Most of the other genera are Asiatic-Australasiatic-Pacific. Blechnaceae occur in a wide range of habitats, mostly terrestrial, but are rarely found in dry environments. They play an important part in the vegetation of some oceanic archipelagos like Tristan da Cunha, Juan Fernandez, and Hawaii.

## TAXONOMY AND AFFINITY

Currently c. 9 genera are recognized (*Blechnum* s.l., *Brainea*, *Doodia*, *Pteridoblechnum*, *Sadleria*, *Salpichlaena*, *Stenisioblechnum*, *Stenochlaena*, *Woodwardia*). Most of the existing recognized genera nest within *Blechnum* s.l., and their acceptance is dependent upon a revised circumscription of *Blechnum* s.l., which is manifestly paraphyletic in its current usage (Nakahira 2000; Cranfill 2001). C. 200 spp.; monophyletic, sister to Onocleaceae (Hasebe et al. 1995; Cranfill 2001; Cranfill & Kato 2003). *Woodwardia* (incl. *Anchistea*, *Chieniopteris*, *Lorinseria*) appears to be an early-branching member of the Blechnaceae (Cranfill & Kato 2003). Characters: rhizomes creeping, ascending, or erect, sometimes trunk-like, often bearing stolons, scaly at apex (and on blades), scales non-clathrate; stipes with numerous, round, vascular bundles arranged in a ring; leaves monomorphic or often dimorphic; veins pinnate or forking, free to variously anastomosing, areoles without included veinlets, on fertile leaves forming costular areoles bearing the sori; sori in chains or linear, often parallel and adjacent to midribs, indusiate, with linear indusia opening inwardly (toward midribs); sporangia with 3-rowed, short to long stalks; spores reniform, monolete, perine winged; gametophytes green, cordate;  $x = 27, 28, 31-37$  (*Blechnum* and segregates, *Woodwardia*); 40 (*Salpichlaena*).

*Literature:* Cranfill, R., Systematics, phylogeny and biogeography of the genus *Woodwardia*. Amer. J. Bot. 85, suppl. (1996) 100. — Cranfill, R., Phylogenetic studies in the Polypodiales (Pteridophyta) with an emphasis on the family Blechnaceae (2001) 139. Unpubl. thesis. Berkeley. — Cranfill, R.B. & M. Kato, Phylogenetics, biogeography and classification of the woodwardioid ferns (Blechnaceae); in: Chandra, S. & M. Srivastava (eds.), Pteridology in the New Millennium (2003) 25–48. Kluwer Academic Publishers, Dordrecht. — Hasebe M., P.G. Wolf, K.M. Pryer, K. Ueda, M. Ito, R. Sano, G.J. Gastony, J. Yokoyama, J.R. Manhart, N. Murakami, E.H. Crane, Ch.H. Haufler & W.D. Hawk, Fern phylogeny on rbcL nucleotide sequences. Amer. Fern J. 85 (1995) 134–181. — Nakahira, Y., A molecular phylogenetic analysis of the family Blechnaceae, using the chloroplast gene rbcL. (2000). M.S. thesis, Graduate School of Science, University of Tokyo, Tokyo.

## KEY TO THE GENERA

- 1a. Sporangia borne on, and (almost) confined to, a longitudinal vein on either side of the costa/costule and parallel to it, rarely spreading onto the indusium, or borne on vein arches flanking the costa/costules; indusium at least initially present . . . . 3

- b. Sporangia not confined to such a vein or arch (except in incompletely fertile leaves of *Brainea*); indusium none . . . . . 2
- 2a. Pinnae articulate sporangia with acrostichoid arrangement; stem scandent . . . . . **4. Stenochlaena**
- b. Pinnae non-articulate; sporangia (in fully fertile leaves) following the veins, eventually often seemingly acrostichoid; stem erect, rather trunk-like . . . . . **2. Brainea**
- 3a. Veins free, except for the para costal commissure of fertile leaves bearing the sorus; or a submarginal commissure rarely present; sterile parts without the paracostal commissure. Leaves simple, pinnatifid, or simply pinnate, or, if bipinnate (rare), the rhachis erect; veins of sterile parts quite free . . . . . **1. Blechnum**
- b. Veins anastomosing beside the paracostal commissure or vein arch bearing the sori; or this commissure present in sterile as well as in fertile leaves . . . . . 4
- 4a. Lamina deeply pinnatifid to once pinnate, mostly tapering at the base; veins forming 1–3 series of areoles . . . . . **3. Doodia**
- b. Lamina pinnate and pinnatifid (or almost bipinnate at base) or, if simply pinnate or simple, with very amply anastomosing veins; lamina base various. Lamina hardly or not dimorphic . . . . . **5. Woodwardia**

## 1. BLECHNUM

(T.C. Chambers & P.A. Farrant, Sydney, Australia)

### BIOGEOGRAPHY OF THE GENUS BLECHNUM

Our interpretation of the genus suggests that it is an early group of leptosporangiate ferns (probably late Cretaceous) with a radiate distribution pattern centred on Gondwana, with distinctive but overlapping lines of speciation extending northwards from Antarctica. One of these geographic lines extends through South and Central America to the Caribbean Islands and into the more humid south-eastern areas of North America. Another line extends from southern Africa to central and eastern North Africa. A third line can be traced through some of the subantarctic islands to New Zealand, Tasmania, and the eastern coast of Australia, extending to some of the Pacific Islands of Oceania, and with a branch-line to Malesia (Papua New Guinea, Indonesia, Philippines, and Malaysia). A few species also extend into Asia, including Sri Lanka (2 spp.), southern India (2 spp.), the eastern Himalayas (2 spp.), Taiwan (5 spp.), mainland China (3 spp.), and Japan (4 spp.). Several species are widespread through the subantarctic islands, e.g. the subspecies of *B. penna-marina* (Poir.) Kuhn (Chambers & Farrant 1996). A closely related boreal species, *B. spicant* (L.) Roth, extends around much of the temperate Northern Hemisphere with some speciation in eastern Asia and into Japan. Significant speciation in the genus is evident in some areas of the western Pacific — New Zealand, New Caledonia, eastern Australia, Lord Howe Island, Fiji and some other Pacific Islands, and in Papua New Guinea and associated islands immediately to the north and north-east. Copeland (1939) regarded *Blechnum* as one of the most obviously austral genera, being in his view the only genus of ferns with many more species south of the equator than north of it.

In SE Asia and the Malesian region a number of species are confined to high altitudes, either in montane forest, e.g., *B. fraseri*, *B. hieronymi*, and *B. rosenstockii* or in scrub, grassland or subalpine bogs, e.g., *B. revolutum*. The greatest diversity of species of *Blechnum* in Malesia, as in most other regions, is to be found in areas of high precipitation where habitats are almost perpetually humid. A few species that are normally very distinctive are difficult to identify with certainty in collections from marginal habitats, e.g., *B. revolutum*, a taxon when growing in open montane subalpine regions of Papua New Guinea is distinctive and readily identified, but in collections from sheltered edges of montane forest may be confused with *B. hieronymi*.

Amongst the Malesian species, some represent very widespread elements that have either speciated in, or at present are confined to, specific regions. For example, *B. vestitum* is a Malesian species that is clearly related to, and has been confused with *B. capense* (Willd.) Schldtl. from Africa, *B. chilense* (Kaulf.) Mett. from South America, and *B. procerum* (G.Forst.) Sw. from New Zealand. In New Zealand it is also clearly related to *B. montanum* T.C.Chambers & P.A.Farrant and *B. novae-zelandiae* T.C.Chambers & P.A.Farrant. *Blechnum vestitum* is also related to *B. howeanum* T.C.Chambers & P.A.Farrant and *B. milnei* (Carruth.) C.Chr. from some Pacific Islands, and *B. minus* (R.Br.) Ettiingsh., *B. wurunurum* Parris, and *B. watsii* Tindale, amongst others, from eastern Australia.

A widespread element with a different distribution pattern is *B. fluviatile* which is abundant in humid forest areas in New Zealand, Tasmania, and south-eastern Australia, and is found in Malesia in humid high mountain areas of New Guinea, Sumatra, and North Borneo (Mt Kinabalu).

A few species which prior to this study were regarded as endemic to a particular region are now recognised as being more widespread. *Blechnum revolutum*, previously regarded as endemic to high altitude bog areas in Papua New Guinea, is now also recorded from similar areas in Mindanao in the Philippines. *Blechnum egregium*, a distinctive species for long regarded as endemic to a number of islands of the Philippines, has been identified from Papua New Guinea in this study. *Blechnum whelanii*, previously regarded as endemic to rain forests of N Queensland, is here regarded as being conspecific with *B. nigropaleaceum*, described by Alston (1940) from Papua New Guinea. *Blechnum patersonii* subsp. *queenslandicum* has been identified amongst Papua New Guinea material. *Blechnum vittatum*, long regarded as endemic to the Fiji Islands, is now recognised as extending through the Solomon Islands to Papua New Guinea.

*References:* Alston, A.H.G., Undescribed ferns from New Guinea. *Nova Guinea* n.s. 4 (1940) 109–110, plate iv f. 1. — Chambers, T.C. & P.A. Farrant, Four subspecies of the fern *Blechnum pennamarina*. *Fern Gaz.* 15 (1996) 91–100. — Copeland, E.B., Fern evolution in Antarctica. *Philipp. J. Sci.* 70 (1939) 157–188.

#### MORPHOLOGY AND TERMINOLOGY

Reference to the frond includes the stipe, rhachis, and the lamina. The rhachis is limited to the zone of the lamina that produces leafy outgrowths. The stipe does not give rise to leafy outgrowths but may in some species give rise to non leafy structures. In some species the stipe is very short in relation to the lamina. In many of the lomarioid species

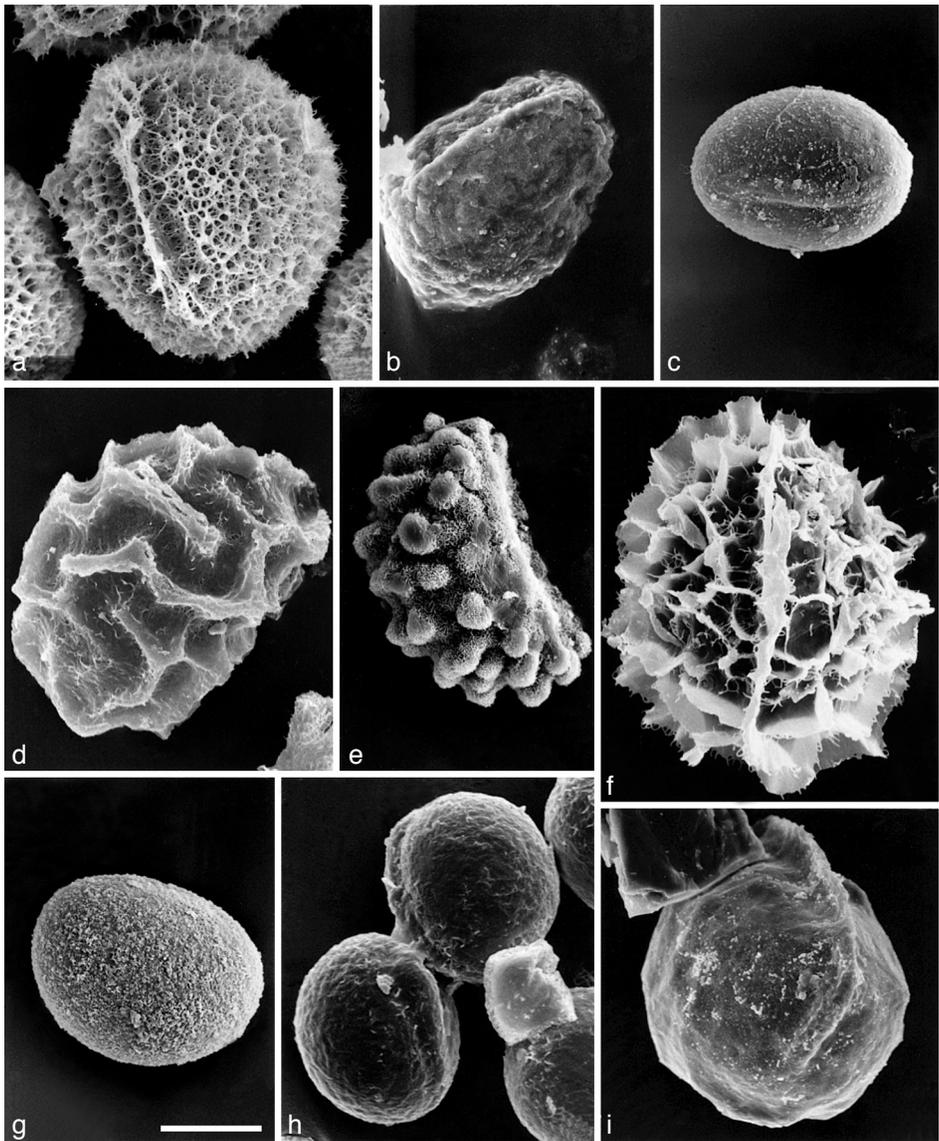


Fig. 1. Scanning electron microscope images of spores. — a. *Blechnum nesophilum*; b. *B. orientale*; c. *B. patersonii* subsp. *queenslandicum*; d. *B. revolutum*; e. *B. rosenstockii*; f. *B. vestitum*; g. *B. vittatum*; h. *B. vulcanicum*; i. *B. whelanii*. — Scale bar for a–i = 20  $\mu$ m.

the stipe of the fertile frond is very much longer than the stipe of the sterile frond; this is especially so in species that produce fertile fronds seasonally. The lamina of most species of the genus is pinnate, pinnatifid, or pinnatisect. An entire lamina when occurring is in most cases produced at an early stage in the development of a plant. Bipinnate, bipinnatifid, and bipinnatisect subdivisions are rare and only occur in one species in the Malesian region, but these conditions are also occasionally found in mutant individuals

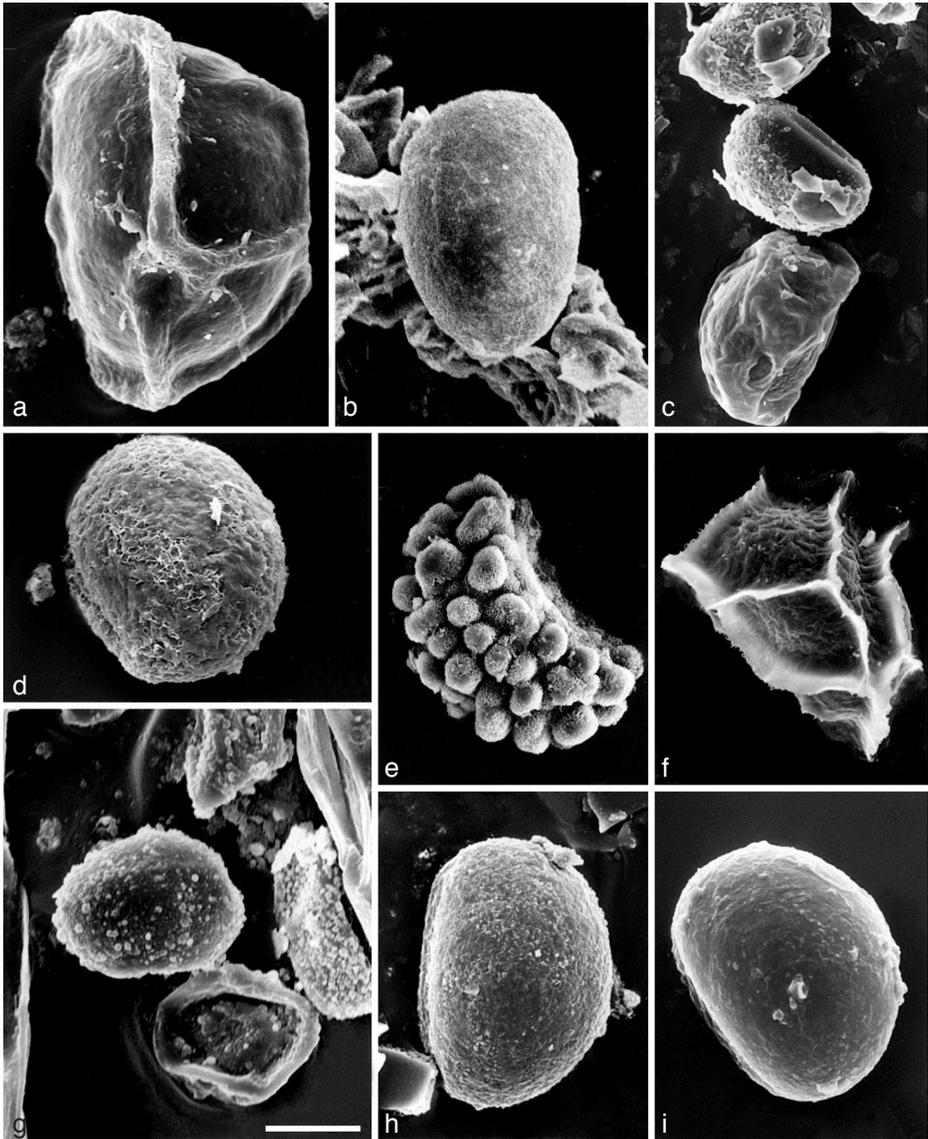


Fig. 2. Scanning electron microscope images of spores. — a. *Blechnum dilatatum*; b. *B. egregium*; c. *B. finlaysonianum*; d. *B. fluviatile*; e. *B. fraseri*; f. *B. hieronymi*; g. *B. indicum*; h. *B. keysseri*; i. *B. melanocaulon* subsp. *melanocaulon*. — Scale bar for a–i = 20  $\mu$ m.

of some other species. The rhizome is a variable structure and when woody and growing erect is referred to as a caudex. A few species produce a caudex sufficiently tall for the plants to be regarded as small tree-ferns. Some species produce a slender creeping rhizome which may be either above ground or subterranean and these can give rise to colonies from one individual; other species produce a massive subterranean rootstock. All species of the genus *Blechnum* in the Malesian region are primarily terrestrial;

occasionally in very humid habitats some species may be epiphytic, usually on fallen logs and rarely if ever high off the ground; none are true lianas.

The characters used to describe the perine and exine features of the spores are as defined in the glossary of Large & Braggins (1991: 160–163). The number of herbarium specimens from which spore preparations were examined is indicated, along with the average measurement of spores. — **Fig. 1, 2.**

*Reference:* Large, M.F. & J.E. Braggins, Spore atlas of New Zealand ferns and fern allies. Suppl. New Zealand J. Bot. (1991).

## BLECHNUM

*Blechnum* L., Sp. Pl. 2 (1753) 1077. — Type: *Blechnum occidentale* L., as ‘*orientale*’ (in error).

*Struthiopteris* Scop., Fl. Carniol. (1760) 288 non C.L. Willdenow, Mag. Neuesten Entdeck. Gesammten Naturk. Ges. Naturf. Freunde Berlin 3 (1809) 160. — Type: *Struthiopteris spicant* L.

*Lomaria* Willd., Mag. Neuesten Entdeck. Gesammten Naturk. Ges. Naturf. Freunde Berlin 3 (1809) 160. — Type: *Lomaria nuda* (Labill.) Willd.

*Blechnopsis* C. Presl, Epimel. Bot. 115 (‘1849’) [1851]. — Type: *Blechnopsis brasiliensis* Desv.

Terrestrial and lithophytic ferns. In Malesia none is persistently epiphytic. Some species develop an above-ground woody caudex up to 2 m high and may form extensive colonies interconnected in the early stages of development either by underground rhizomes or by above-ground stoloniferous connections. Scales on the rhizome are essentially similar to those at the base of the stipe; those on other parts of the plant in some species show a range of forms but are rarely clathrate; hairs are present on some species. The sterile lamina is typically pinnate, pinnatifid, or pinnatisect, rarely entire and if so usually in a juvenile stage of a plant’s development; veins in the majority are free, single, or dichotomising. Heteroblasty (for the succession of sterile fronds) is characteristic for some species. The fertile lamina in many species has the pinnae much reduced in width and the elongate linear sori may almost completely cover the abaxial surface (the ‘lomarioid’ condition). In other species the fertile pinnae appear the same as the sterile, on the adaxial surface. On the abaxial face the linear sori are closely aligned to the costa occupying a narrow region of the pinna undersurface (the ‘eublechnoid’ condition); intermediate arrangements are occasionally to be found in some taxa. An indusium is present in all taxa. Spores are monolete, bilateral and show a range of exine and perispore ornamentation.

*Distribution & Ecology* — A widespread genus with ± 180 species showing considerable diversity; abundant in temperate, warm temperate, subalpine and tropical-montane and some oceanic island habitats; the majority of species are in the Southern Hemisphere.

*Chromosome numbers* — The probable base numbers are 28 and 33 but with a considerable range reported from 28 to 40. Polyploidy (tetraploidy and triploidy) has been reported in some taxa.

*Notes* — 1. The size of mature spore-bearing plants is variable not only from species to species but, in the more plastic species, from plant to plant; this is often a response to ecological conditions.

2. While all species have distinctive, small, early post-prothallial fronds, a few also have very distinctive juvenile foliage, including *B. melanocaulon* subsp. *melanocaulon*, *B. melanocaulon* subsp. *pallens*, *B. patersonii* subsp. *queenslandicum*, and *B. finlaysonianum*. *Blechnum finlaysonianum* is particularly striking as the entire and the lobed fronds of the juvenile state are very different from the exceptionally large pinnate fronds characteristic of mature plants. Only one species (*B. fraseri*) in Malesia is bi-pinnatifid.

3. Many (but not all) of the species are readily recognised by their frond pattern. The identification of several species requires careful examination of basal stipe, rhachis, and costal scales.

4. One taxon, *B. vulcanicum*, and its variants, requires examination for the presence of characteristic pale brown or buff, linear, uniseriate multicellular hairs. While these are usually abundant there are variants in which a detailed search has to be made for these hairs. Several other species which are not closely related to *B. vulcanicum* have hairs, but they are of quite different character.

5. Spore characters are useful for some species. We have used herbarium material examined by scanning electron microscopy (Fig. 1, 2). In some taxa there is variation, more in degree than type, of ornamentation. In one instance the strikingly different spore type of offshore island populations has resulted in the detection and description of a previously undescribed species. At this stage this new species (*B. nesophilum*) has only been found in collections from islands north and east of Papua New Guinea.

KEY TO THE SPECIES

- 1a. Eublechnoid: sterile and fertile fronds similar on adaxial surface; fertile pinnae either the same width as the sterile or almost so; sorus linear, close to and parallel to the costa but not completely covering the abaxial face leaving a wing of photosynthetic surface . . . . . 2
- b. Lomarioid: sterile and fertile fronds distinctive on the adaxial surface; fertile pinnae much narrower than the sterile pinnae; sorus linear, close to and parallel to costa but covering the abaxial face and leaving little or no photosynthetic surface . . . 6
- 2a. Stipes and rhachis with spine-like outgrowths . . . . . **1. B. acanthopodium**
- b. Stipes and rhachis without spine-like outgrowths . . . . . 3
- 3a. Pinnae reduced to small or minute auriculate lobes at the lamina base . . . . . 4
- b. Pinnae not reduced to auriculate lobes at the lamina base . . . . . 5
- 4a. Sori often enlarged to overlap or cover the costa and at maturity may obscure the abaxial costal surface; pinnae apices acuminate; fronds of juvenile plants pinnatifid . . . . . **12. B. orientale**
- b. Sori rarely enlarged to overlap or cover the costa or costal surface; pinnae apices usually attenuate; fronds of juvenile plants entire to lobed **4. B. finlaysonianum**
- 5a. Pinnae articulated with a characteristic socket joint at the rhachis; mature fronds rarely exceeding 100 cm in length; sterile and fertile pinnae 0.5–1.6 cm wide . . . . . **8. B. indicum**
- b. Pinnae without a socket joint at the rhachis; mature fronds frequently exceeding 100 cm in length; sterile and fertile pinnae 0.7–2.5 cm wide, fertile usually in the narrower range . . . . . **19. B. whelanii**

- 6a. Sterile pinnae fully or almost fully adnate to the rhachis for entire length of the lamina . . . . . 7
- b. Sterile pinnae free at rhachis, at least on basal part of lamina . . . . . 13
- 7a. Lamina margins either not dentate or if so only towards pinna apices; lamina pinnate or pinnatisect . . . . . 8
- b. Lamina with conspicuously dentate margins; lamina either pinnate or bipinnate 19
- 8a. Lamina veins, costae and rhachis, and sometimes the stipe, with fine straight uniseriate hairs; basal pair of pinnae semi-adnate, falcate and sometimes also deflexed . . . . . **18. B. vulcanicum**
- b. Lamina without such hairs; basal pair of pinnae not as above . . . . . 9
- 9a. Sterile pinnae reducing to adnate lobes towards the base of the lamina; only dissected fronds known to occur . . . . . 10
- b. Sterile pinnae or pinnules adnate to rhachis with bases broadening to lobes or wings of leaf tissue; both entire and dissected fronds known to occur. . . . . 11
- 10a. Sterile pinnae not obviously falcate; margins crenate to finely serrate and may be dentate towards the pinna apices; scales of the rhizome and basal stipe black, concolorous, entire, shiny and with finely acuminate apices . . . . **3. B. egregium**
- b. Sterile pinnae slightly to distinctly falcate; margins mostly entire; scales of rhizome and basal stipe dark red-brown, shortly acuminate, some with paler margins . . . . . **9. B. keysseri**
- 11a. Continuous wing of lamina extending down rhachis below basal pinnae . . . . . **13. B. patersonii** subsp. **queenslandicum**
- b. Discontinuous wing of lamina tissue, or lobes, extending down rhachis below basal pinnae . . . . . 12
- 12a. Adaxial stipe (and sometimes both surfaces of stipe, rhachis, and costae) deeply pigmented purple-black . . . . . **10a. B. melanocaulon** subsp. **melanocaulon**
- b. Adaxial stipe, rhachis, and costae not deeply pigmented . . . . . **10b. B. melanocaulon** subsp. **pallens**
- 13a. Sterile pinnae margins strongly and persistently revolute; lamina densely and persistently scaly throughout with dark mahogany coloured scales intermingled with irregular lanuginose material . . . . . **14. B. revolutum**
- b. Sterile pinnae margins either not revolute or finely revolute; lamina, if scaly, with scales which are relatively thin and pale fawn to ginger-brown . . . . . 14
- 14a. Scales at base of stipe narrowly elliptic to subdeltoid, acuminate, red or purple-black, sometimes with paler borders; upper stipe and rhachis scales thin, ginger-brown, some with a small dark centre; plants with a creeping rhizome giving rise to a succession of fronds but fronds are tufted at the apex of the rhizome. . . . . **7. B. hieronymi**
- b. Scales at base of stipe, upper stipe, and rhachis not as above; creeping rhizomes not a conspicuous feature . . . . . 15
- 15a. Sterile pinnae short (less than 4 cm long), rounded to oblong with obtuse apices . . . . . **5. B. fluviatile**
- b. Sterile pinnae more than 4 cm long, linear-narrowly elliptic with acute, acuminate or attenuate apices . . . . . 16

- 16a. Sterile pinnae narrowly elliptic; in larger fronds several basal pairs may be petiolate and deflexed; stipe and rhachis often with conspicuous black pigmented lines on the ridges on either side of the adaxial groove . . . . . **17. B. vittatum**
- b. Sterile pinnae oblong-narrowly elliptic, its pinnae sessile, becoming shortly pinnate but not markedly deflexed near the lamina base; stipe and rhachis without black pigmented lines . . . . . 17
- 17a. Pinnae and rhachis densely and usually persistently scaly; scales broadly deltoid, thin, papery, fawn to mid-brown and often weakly bicolorous and intermingled with paler lanuginose scales and variable uniseriate hairs . . . . . **16. B. vestitum**
- b. Pinnae and rhachis either glabrous or with relatively small scales . . . . . 18
- 18a. Basal fertile pinnae sessile or shortly petiolate, with a distinctive expanded, leafy, sterile zone widening towards the rhachis but not as wide as the pinnae of the sterile fronds . . . . . **2. B. dilatatum**
- b. Basal fertile pinnae either having no sterile zone, or a very small but not expanded sterile zone, where the pinnae join the rhachis . . . . . **11. B. nesophilum**
- 19a. Lamina bipinnate to bipinnatisect; caudex 2–3 cm diam., erect, exceptionally up to 200 cm high, forming a miniature tree-fern . . . . . **6. B. fraseri**
- b. Lamina pinnate to pinnatisect; caudex 1–2 cm diam., and semi-erect often sprawling on the forest floor . . . . . **15. B. rosenstockii**

**1. Blechnum acanthopodum** T.C.Chambers & P.A.Farrant

*Blechnum acanthopodum* T.C.Chambers & P.A.Farrant, *Blumea* 46 (2001) 290. — Type: *L.J. Brass* 24859 (holo CANB; iso GH), Papua New Guinea.

*Rhizome* not known. *Fertile and sterile fronds* similar, more or less erect, up to at least 2.5 m long, 50 cm wide. *Stipes* to at least 84 cm, shiny, rich red-brown, scales at the base broadly triangular, up to at least 0.7 by 0.2–0.3 cm at their bases, more or less entire, mid-brown, thin and concolorous, paler than the stipe surface and persistent, rigid, woody, blunt, spine-like outgrowths 0.1 cm diam. at their base and 0.1–0.35(–0.5) cm in length, protruding from the ridges and the inner face and from the deep groove on the adaxial surfaces. *Lamina* linear triangular, pinnate, with at least 40 pairs of pinnae. *Rhachis* and *costae* red-brown, becoming paler and stramineous towards the lamina apex in the dried specimen, glabrous, sometimes with spine-like outgrowths similar to those of the stipe on the basal 1/3 of the rhachis. *Sterile pinnae* linear-narrowly elliptic, up to 25 cm in length and 1.5 cm in width, sessile or subpetiolate, dried specimens coarsely papery, the margins serrate to dentate at their apices, basal pinnae slightly reduced, falcate. *Fertile pinnae* tending to be narrower in width, usually 0.8 cm but widening to over 1 cm towards the base and then narrowing suddenly to the costa at the junction with the rhachis, otherwise similar to the sterile pinnae but with up to 2/3 of the abaxial surface covered by the linear sori on either side of the pinna midrib. *Spores* 71.3 by 60 µm (from 3 herbarium specimens), perine costate, more markedly costate than spores of *B. whelanii*, costae rounded, surface scabrous to minutely rugulose. — **Fig. 3; Map 1.**

*Distribution* — *Malesia*: *Blechnum acanthopodum* is known at present from a single collection from Goodenough Island (a high island) in the D’Entrecasteaux Islands off the north-east coast of Papua.

Notes — 1. The specific epithet refers to the spine-like structures on the stipe and the base of the rhachis.

2. The general morphology suggests that this taxon is related to *B. whelanii* where the presence of minute woody outgrowths along the adaxial ridges may be evidence of structures related to the conspicuous spine-like ‘aerophores’ of *B. acanthopodum*.

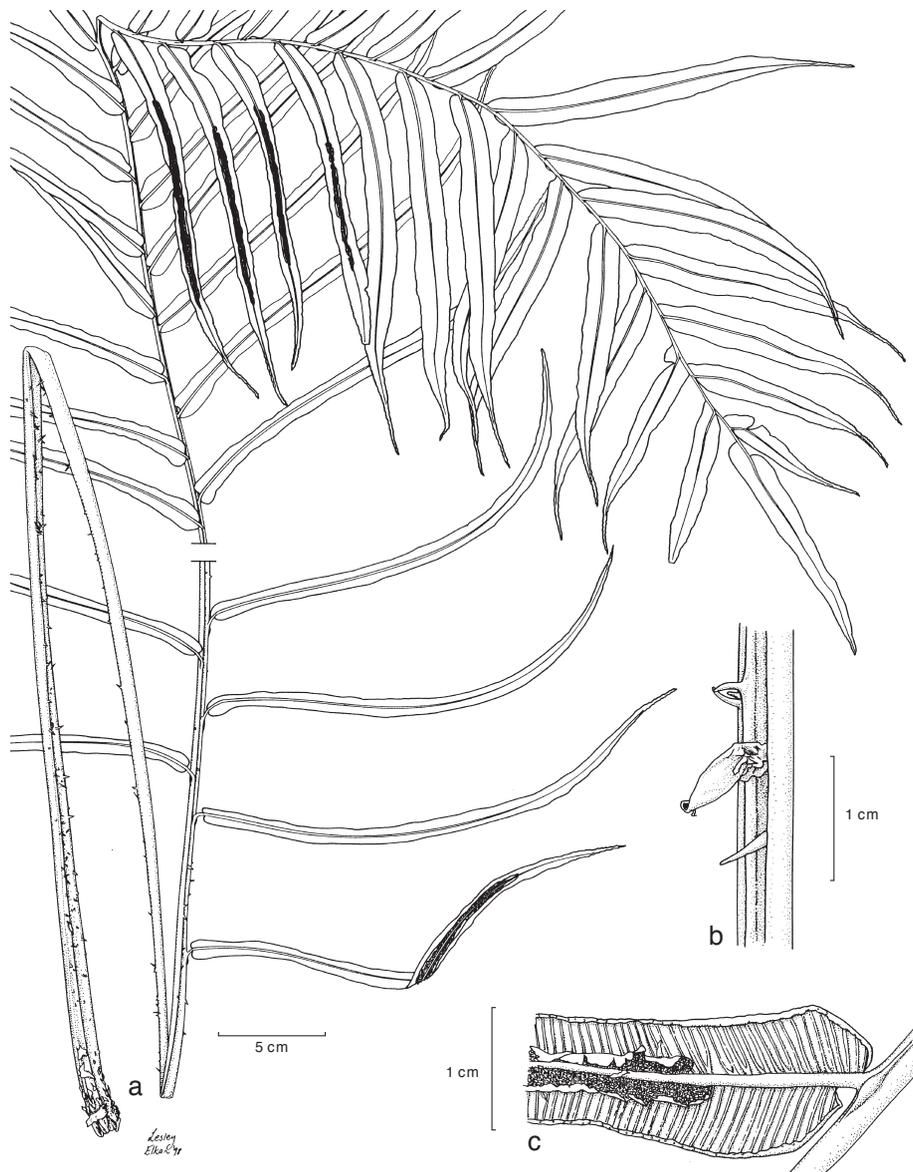
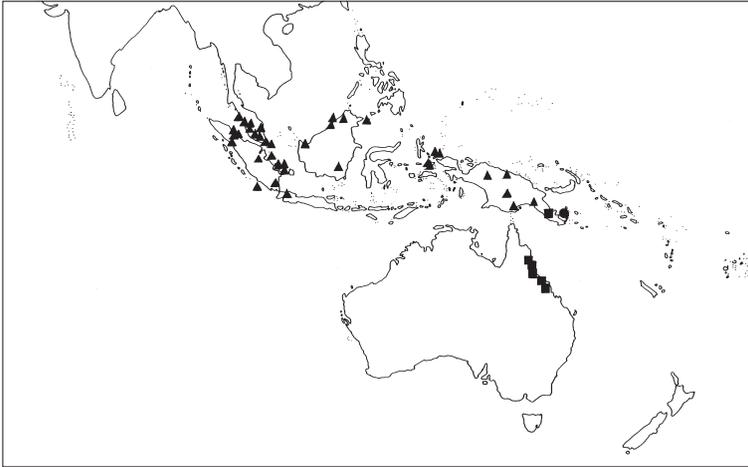


Fig. 3. *Blechnum acanthopodum* T.C.Chambers & P.A.Farrant. a. Mature frond; b. stipe with ‘spines’; c. abaxial surface fertile pinna and attachment to rhachis (*L.J. Brass* 24859, Goodenough Island, PNG (CANB)). — Drawing by Lesley Elkan.



Map 1. Distribution of *Blechnum acanthopodum* T.C.Chambers & P.A.Farrant (●), *B. finlaysonianum* Wall. (▲), and *B. whelanii* F.M.Bailey (■).

3. *Blechnum acanthopodum* resembles *B. whelanii* in lacking auricles down the base of the rhachis, but is significantly larger and has numerous pinnae (c. 42 pairs) and prominent woody ‘aerophores’ at 2–3 cm intervals along the stipe, on either side of the groove on the adaxial or upper surface. The fertile pinnae are 25 by 0.8–0.9 cm, widening slightly near the rhachis and becoming somewhat cordate and shortly petiolate.

## 2. *Blechnum dilatatum* (Brause) T.C.Chambers & P.A.Farrant

*Blechnum dilatatum* (Brause) T.C.Chambers & P.A.Farrant, *Blumea* 46 (2001) 792.

*Blechnum decorum* Brause var. *dilatatum* Brause, *Bot. Jahrb. Syst.* 56 (1921) 157 (‘*dilatata*’). — Type: *Ledermann 11168* (holo B), ‘Nordöstl.-Neu-Guinea, Kaiserin-Augusta-Fluß-(Sepik-)Gebiet’, 1 Aug. 1913.

*Rhizome* tufted, shortly creeping rhizome and sometimes a short but robust erect radial caudex at least 3–5 cm diam. and rarely more than 15 cm above ground; scales linear, narrowly elliptic or triangular, c. 1.6 by 0.4 cm, entire, brown to reddish brown, tending to bicolorous, sometimes shiny. *Fronde*s dimorphic, mature sterile fronds 80–200 by 12–44 cm; fertile fronds of about the same dimensions but with pinnae surfaces very reduced. *Stipes* of sterile fronds 10–120 cm, up to twice the length of the lamina, up to 2.5 cm diam. at the base, smooth, brown or green, drying to fawn or stramineous, persistent and dense scales up to c. 20 cm above the base, scales linear-narrowly elliptic to triangular, acuminate, tapering evenly from a short basal region to a fine hair-like apex, 1.3–2.5 by 0.15–0.3 cm at base, mostly entire (some with well-spaced short outgrowths), brown to shiny reddish brown, sometimes tending to bicolorous with paler margins; fertile fronds often with stipes longer than the lamina. *Lamina* ovate-deltoid, 1-pinnate, widest 3–5 pairs of pinnae above the base, mid to dark green on upper and lower surfaces, sometimes paler underneath for plants from more exposed locations,

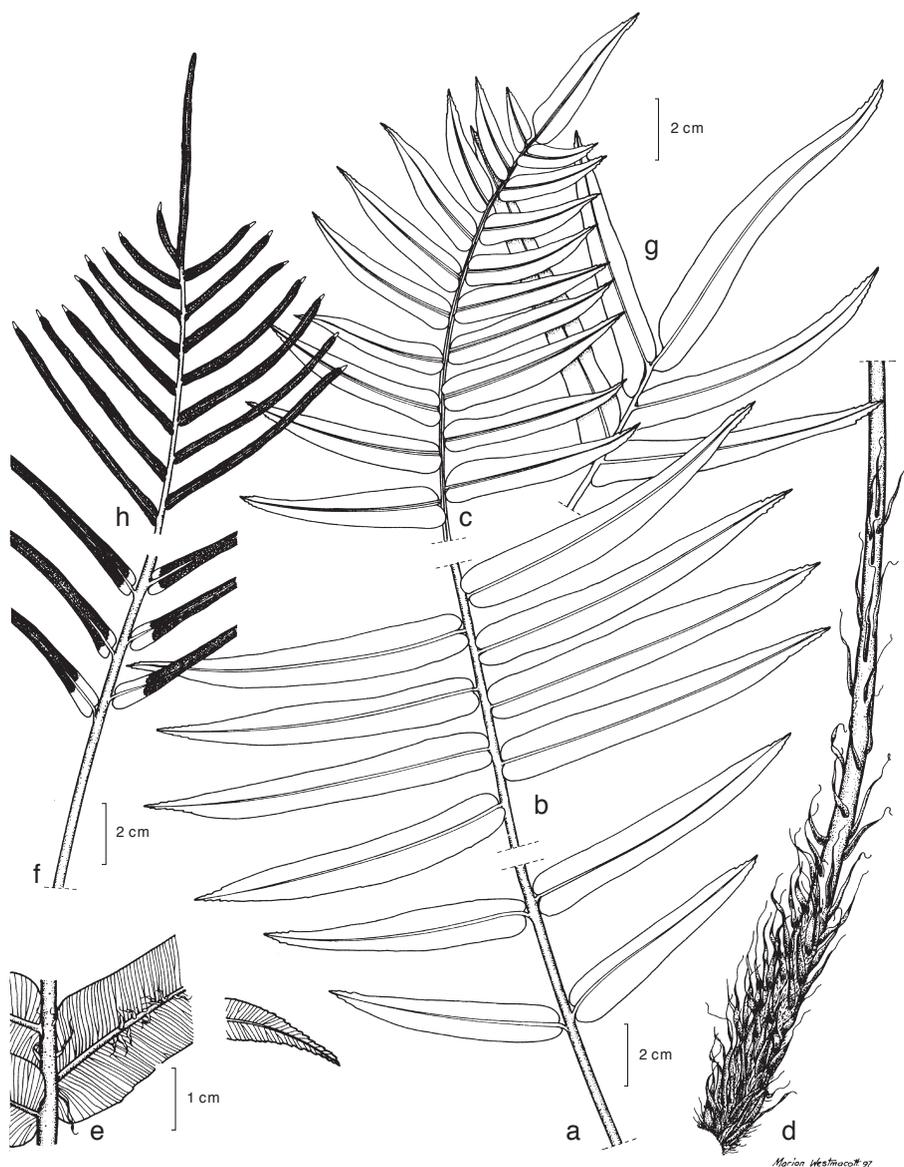


Fig. 4. — a–f: *Blechnum dilatatum* (Brause) T.C.Chambers & P.A.Farrant: forest form. a, b. Abaxial sterile lamina; c. adaxial sterile lamina; d. adaxial base of stipe, sterile frond; e. detail of abaxial sterile pinna; f. base of abaxial fertile lamina [*Pullen 7961*, Baniera, Milne Bay District (CANB)]. — g, h: *Blechnum dilatatum* (Brause) T.C.Chambers & P.A.Farrant: exposed sun form. g. Apex of abaxial sterile frond; h. abaxial fertile frond (*Hoogland & Pullen 6040*, W Highlands near Tomba Village, S Slopes, Mt Hagen Range, PNG (NSW)). — Drawing by Marian Westmacott.

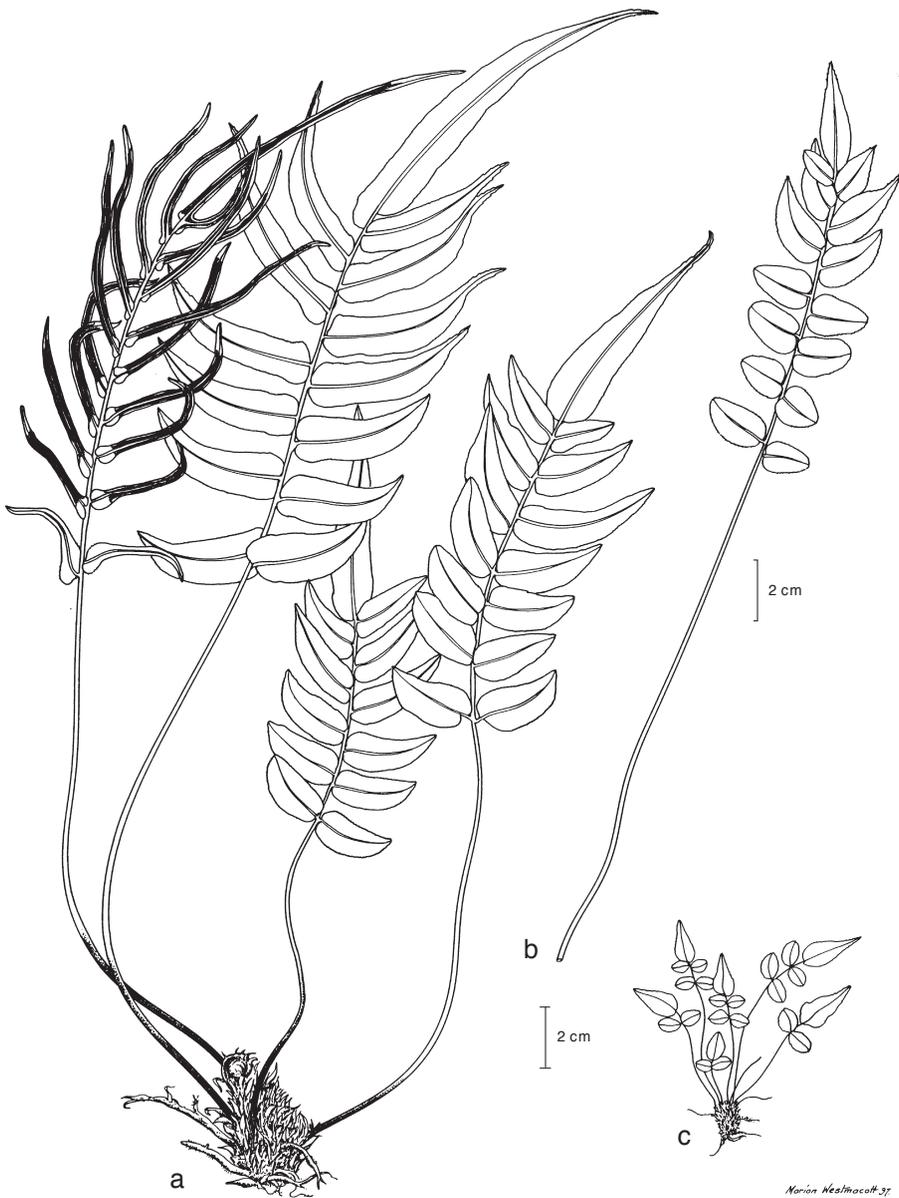


Fig. 5. *Blechnum dilatatum* (Brause) T.C.Chambers & P.A.Farrant. a. Small but mature plant; b. sterile frond of a small form; c. juvenile plant (a: Croft *et al.* 719, NW Slopes Mt Giluwe PNG (CANB); b: M.M.J. van Balgooy 718, Mt Wilhelm (CANB)). — Drawing by Marian Westmacott.

young fronds red, 14–32 pairs of pinnae. *Rhachis* and *costae* brown, green or pale fawn, scales 0.2–0.7 by 0.5–2 mm (0.2–0.3 cm by 0.5–1 mm for costal scales), irregular, linear, narrowly elliptic or triangular (costal scales broad at the base and tapering to apex, entire or toothed), pale whitish to brown, and occasionally with a few cells with slightly

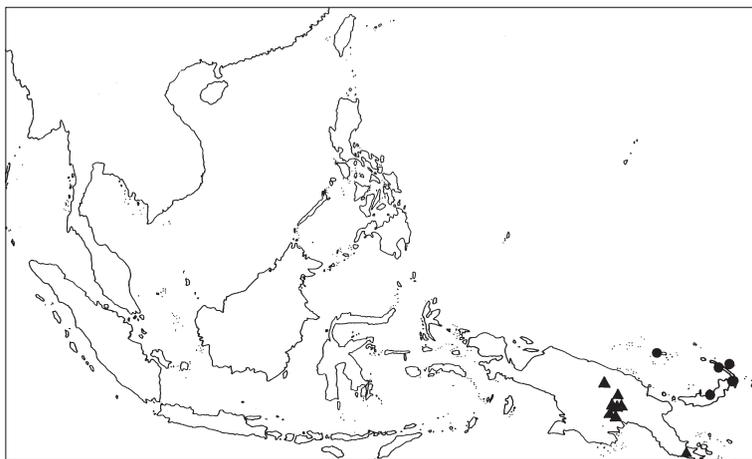
darker point of attachment; scales mostly not persistent. *Sterile pinnae* oblong-narrowly elliptic, rounded at rhachis, acuminate, in mature fronds usually tapering evenly to their apices, 5–22 by 0.8–2 cm, sessile, subpetiolate to shortly petiolate, uppermost few pairs sometimes basiscopically adnate, often crowded and overlapping in plants from open locations, more spaced out for forest plants, coriaceous, coarser for plants from exposed locations, margins often wavy, never revolute, varying from serrate to entire for most of their length, becoming serrate to finely dentate towards their apices, basal pinnae only slightly reduced, lowest pinnae set at an angle of c. 45° to the rhachis, terminal pinnae slightly longer than subterminal ones. *Fertile pinnae* linear, 11–22 by 0.2–0.7 cm, sessile or shortly petiolate, sometimes basiscopically adnate for several pairs below the frond apex, increasingly towards lamina base having an expanded sterile region widening towards the rhachis (but not as wide as the pinnae of the sterile lamina), costal scales narrow, acuminate, mostly pale, often white, sori covering underside of fertile pinnae except for narrower sterile region of c. 1 cm at the pinna apices. *Spores* 77 by 59.7 µm (from 3 herbarium specimens), perine costate and loosely reticulate, costae wide, low and rounded, surface smooth, scabrous or microreticulate, exine smooth to scabrous. — **Fig. 2a, 4, 5; Map 2.**

**Distribution** — *Malesia*: Papua New Guinea mainland (W Highlands, S Highlands, Milne Bay, E Highlands).

**Habitat** — Ranges from full sun to semi shade in reed swamps with standing water, growing amongst tall clumps of Cyperaceae, to anthropomorphic grasslands resulting from shifting cultivation and fire; occasionally in submontane grassland-shrub and, more rarely, in rain forest on mountain ridges. Altitude: between 1500–2700 m.

**Vernacular names** — Iobiob (Tomba W Highlands, *Saunders* 662, CANB); wongare (Enga language) (Lake Inim, W Highlands, *Flenley* ANU 2153, CANB, NSW).

**Notes** — 1. We have concluded that *B. decorum* var. *dilatatum* is not closely related to *B. decorum* Brause. Further, we have reduced this latter to a synonym of *B. hieronymi*. *Blechnum dilatatum* as here defined possesses a consistently pale stipe and rhachis and



Map 2. Distribution of *Blechnum dilatatum* (Brause) T.C.Chambers & P.A.Farrant (▲) and *B. nesophilum* T.C.Chambers & P.A.Farrant (●).

usually has much larger fronds and a much broader lamina (hence the specific epithet *dilatatum*) than does *B. hieronymi*. In *B. dilatatum* the wavy cartilaginous pinna margins are never revolute, and often are entire becoming serrate towards the apices. In both *B. decorum* (now *B. hieronymi*) and *B. dilatatum* the pinnae at the base of the lamina can be either petiolate or sessile.

2. Another species closely related to *B. dilatatum*, *B. nesophilum*, appears to replace *B. dilatatum* on the mountain ridges of the Admiralty Islands, New Britain and New Ireland. *Blechnum dilatatum* differs from *B. nesophilum* in a number of details; these are discussed in the notes with *B. nesophilum*.

3. Specimens of *B. dilatatum* collected from forest habitats have thinner pinnae, more spaced on the rhachis, and may appear at first sight to be distinct from plants collected from open swamp and grassland situations. Plants from the exposed habitats usually have thick leathery pinnae, often overlapping and crowded on the rhachis; fresh specimens are a brighter green on the upper lamina surface and paler green underneath.

4. Juvenile plants of *B. dilatatum* often have 6–10 small fronds 5–10 cm in length with 1–3 pairs of short rounded pinnae 1 cm long and the terminal pinna 2–2.5 cm in length and broadly narrowly elliptic, acuminate to attenuate. Various intermediates indicate a continuous gradient to the large mature plants. The intermediate plants, 25–40 cm in height and with 6–10 pairs of pinnae, often produce fertile fronds; the basal fertile pinnae usually have a broader sterile area adjoining the rhachis while the pinnae towards the apex may possess a small decurrent sterile zone; nearer the apex the pinnae lack the sterile zone; the terminal pinna on both the fertile and the sterile fronds is 10 or more cm long, which is twice the length of the lateral pinnae.

### 3. *Blechnum egregium* Copel.

*Blechnum egregium* Copel. in Perkins, Fragm. Fl. Philipp. 3 (1905) 187; T.C. Chambers & P.A. Farrant, Blumea 46 (2001) 296. — Type: *Copeland 1314* (holo MICH), Mindanao Isl. Prov. Davao, Sibulan River, on shady ground near brooks, 500 m.

*Blechnum nitidum* C. Presl var. *contracta* Hook., Sp. Fil. 3 (1860) 44, t. 156 (non Desv.), for the type only, see note 7. — Type: *Cuming 164* (holo K; iso BM), Luzon.

*Blechnum insigne* Copel., nom. nud. on various early collections.

*Rhizome* erect or semi-erect caudex up to 100 cm in height and 5–10 cm (or more) diam., robust, densely scaly at the apex and with a crown of fronds, scales linear triangular, 0.1–0.2 by 0.2 cm, entire, (apices finely acuminate), very dark brown to black, shiny. *Fronds* more or less dimorphic, erect, 20–150 by 9–30 cm. *Fertile fronds* about same dimensions as the sterile or larger. *Stipes* short, usually less than 1/6 length of the lamina, 3.5–31 cm, 0.2–0.35 cm diam., brown, darker at the base, densely and persistently scaly, scales at the base like those of the rhizome, further up the scales shorter and finer, leaving dark scars if deciduous. *Lamina* of both sterile and fertile fronds narrowly elliptic or ovate-narrowly elliptic, the widest region approximately midway, pinnate at the base becoming pinnatisect then deeply pinnatifid towards the apex, 20–53 pairs of pinnae. *Rhachis* and *costae* dark brown, reddish brown or paler, grooved above and with two lateral grooves from which the pinnae arise, lower surface of rhachis semiterete and sometimes persistently scaly especially towards the lamina base, scales at the base of the rhachis similar to those of the upper stipe, becoming paler and smaller (less

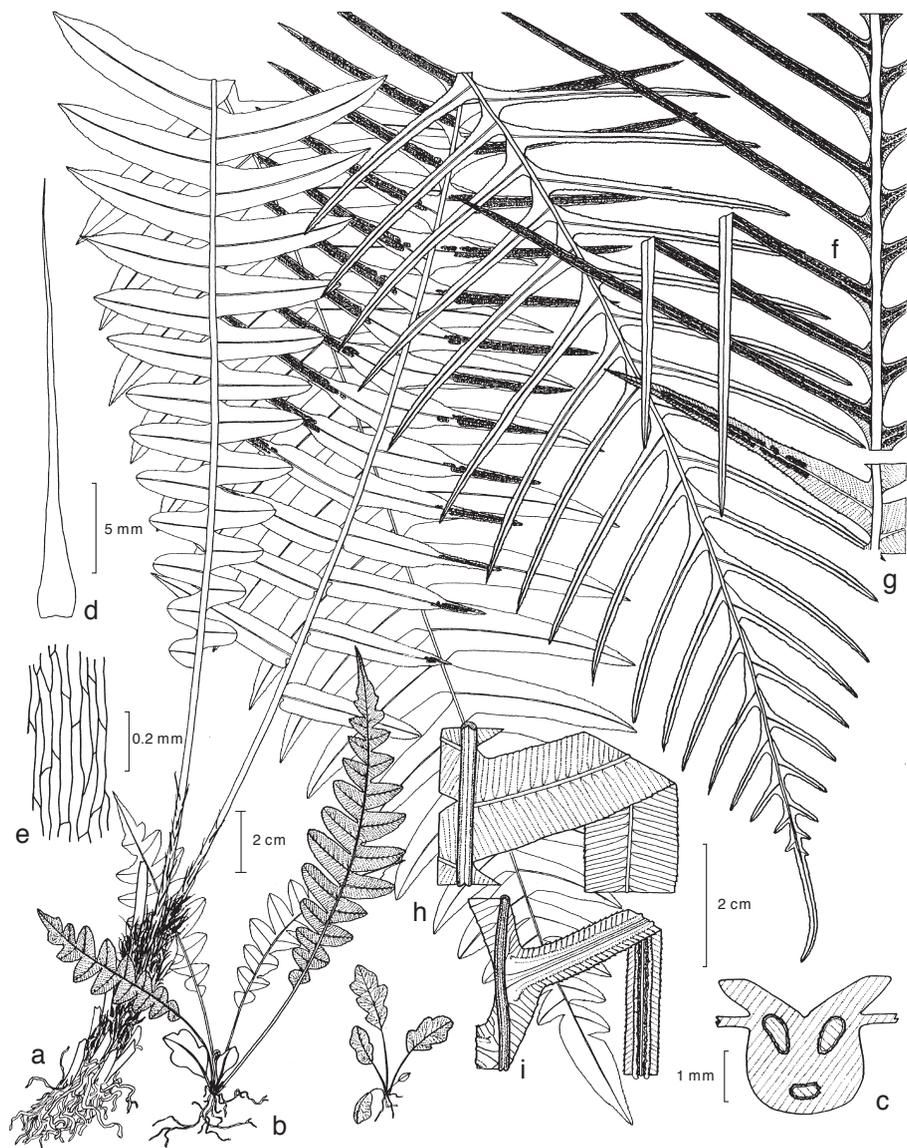
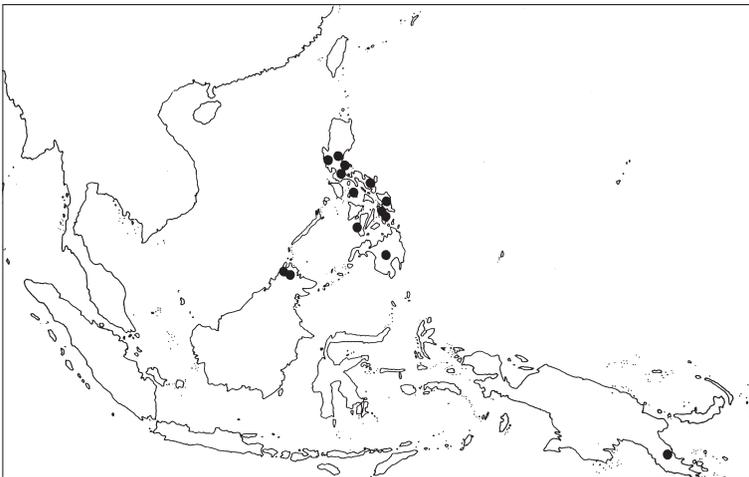


Fig. 6. *Blechnum egregium* Copel. a. Habit; b. sporelings; c. cross section rachis sterile frond; d. basal stipe scale (outline); e. cell detail mid-region scale; f. fertile pinnae abaxial face; g. fertile pinna (abaxial) nearer the lamina base showing the more limited extent of the sori; h. sterile pinna from frond mid-region showing attachment to rachis; i. fertile pinna from frond mid-region showing attachment to rachis and details of soral morphology (a, c–e: *Hernaez 3692*, Mt Makiling, Laguna, Philippines (NSW); b: *M.G. Price 1681*, Mt Makiling, Luzon, Philippines (NSW); f: *M.G. Price 1724*, Mt Makiling, Luzon (NSW); rhizome; g–i: *M.G. Price 526*, Kinabuhayan, Delores, Quezon, Luzon, Philippines (NSW)). — Drawing by K.R. Thiele.

than 0.5 mm) on the costae. *Sterile pinnae* narrowly triangular, acuminate to attenuate, sometimes slightly falcate, pinnae of mid-region 2.5–15 by 0.8–2 cm, adnate to the rhachis, semi-adnate towards the base of the lamina, contiguous except sometimes for lowest pinnae, coriaceous, in living state dark green on upper surface, paler on lower surface, margins crenate to finely and sharply serrate and may be dentate towards their apices, sometimes finely revolute, veins immersed, visible and pale on abaxial surface, mostly once furcate, 9–11 per cm, terminating in clavate glands each in the axil of a serration and on the adaxial surface hardly raised from surface of lamina and concolorous (at least in dried state) with the lamina; basal pinnae sometimes falcate, often reduced to obtuse lobes, sessile or semi-adnate and sometimes deflexed, usually but not always more distant on rhachis, triangular pinnatisect segments at the apex with small terminal segment. *Fertile pinnae* varying from narrow with sori occupying the whole of the undersurface, to those with dimensions the same as the sterile pinnae and with the sori restricted to either side of the costa, pinnae usually widening at least a little towards the rhachis to become broadly adnate and decurrent, 6–20.5 by 0.3–0.8(–2) cm, fertile zone of pinnae often extending into the decurrent base at rhachis especially for pinnae towards apex, but not usually extending to the rhachis on pinnae towards the base of the lamina. *Spores* 48.1 by 35.7  $\mu\text{m}$  (from 10 herbarium specimens), perine scabrous, granulose or microrugulose, exine smooth to granulose. — **Fig. 2b, 6; Map 3.**

**Distribution** — *Malesia*: Borneo (Sabah: Mt Kinabalu), widely distributed through the Philippine Islands and Papua New Guinea. The only specimen seen from the Solomon Islands is at NSW. Unfortunately it lacks details but was collected by J. Duff at ‘San Cristoval’, presumably the most south-eastern island of the group. The collector is presumably John Duff, a member of staff of the Sydney Botanic Gardens until 1884.

**Habitat** — A common lowland jungle and mountain forest species most frequently collected from 300–1500 m, but extending higher on Mt Kinabalu. Most of the Philippine records are from humid jungle areas, occasionally from ridge forest but more frequently from stream banks and protected cliffs.



Map 3. Distribution of *Blechnum egregium* Copel.

Vernacular names — Hoogland (*Hoogland 3293*, Mt Lamington, Papua) reports the local name hariga (Orokaiva language, Mumuni). However, the species is much more abundant in the Philippines and is referred to as patugo on Luzon. It seems likely that various names may be used on different islands.

Uses — Zamoro & Co, Philippines Fl. & Fauna 2 (1986) f. 42 state that “the tender portions of the young fronds are reportedly edible”.

Notes — 1. The name *egregium* comes from the Latin *egregius* meaning excellent; certainly this is one of the most elegant ferns of the genus *Blechnum*.

2. A number of collectors of *B. egregium* have commented on the brilliant scarlet colour of the young fronds and the dark green upper and paler lower surfaces of the mature fronds. The fertile fronds are apparently seasonal in their development and usually occur in the centre of the crown of fronds.

3. There appears to be considerable variation in the way in which pinnae towards the base of the lamina are reduced. Usually there is a gradual reduction in length so that the lowermost few pairs are reduced to lobes. Occasional plants have fronds with the lamina more truncately reduced, with the lowermost pinnae smaller but not reduced to lobes; in a number of collections such plants have been named by Copeland in his handwriting as ‘*Blechnum insigne*’, apparently an unpublished name, and conspecific with *B. egregium*.

4. Another variable feature is the width of the paler borders of the otherwise shiny black scales at the base of the stipes, sometimes so fine that the paler border is only visible by means of a hand lens. Occasional specimens have been examined in which the scales lack a border and range from evenly dark brown to shiny black.

5. Juvenile plants of *B. egregium* have more rounded pinnae and lack the conspicuous dark scales at the base of the stipe. In the advanced juvenile stages the plants of this species could be mistaken for *B. chambersii* Tindale from Australia and New Zealand. *Blechnum egregium* has also been confused with *B. cartilagineum* Sw., an Australian species which also possesses very dark to black shiny scales at the base of the stipe and on the rhizome.

6. *Blechnum egregium*, with its sterile pinnae reducing to small lobes which are either adnate throughout or semi-adnate at the base of the lamina, is easily separated from *B. vittatum*, which may be a closely related species. The basal pinnae of *B. vittatum* are usually sessile or shortly petiolate. Both species have distinctive finely toothed margins. *Blechnum egregium* appears to be related to *B. brasiliense* Desv. from South America and to *B. gibbum* (Labill.) Mett. from New Caledonia and some islands of Vanuatu.

7. There is considerable confusion surrounding the name *B. nitidum*. Presl Reliq. Haenk. 1 (1825) 49; Epimel. Bot. (1851) 116 (*B. nitida*), and Hooker (1860: 44), used the specific name *nitidum*, commenting that Presl had at first confused it with *B. brasiliense* Desv. Hooker continued: “He detected his error however, for the upper part of the frond in our plant resembles *B. brasiliense*, it differs most widely in not having the lower pinnae contracted or dwarfed and he [Presl] introduced it as a distinct species in his Epimeliae Botanicae and referred to it as the *Blechnum* n. 164 of Mr Cuming from Luzon”. However, we are convinced that the plant illustrated in Wilson’s drawing in Hook., Sp. Fil. 3: t. 155 is almost certainly *B. cartilagineum* from Australia. Hooker’s t. 156 *B. nitidum* var. *contracta* illustrates a plant of *B. egregium* although the base of the fronds does not always exhibit this arrangement. The name *B. nitidum* must be

regarded as a nomen confusum. The misinterpretation of these specimens also accounts for the erroneous claims that *B. cartilagineum* which is endemic to Australia occurs in the Philippines and Borneo.

#### 4. *Blechnum finlaysonianum* Wall.

*Blechnum finlaysonianum* Wall., Numer. List 2172 (1830) [nom. nud.] ex Hook. & Grev., Icon. filic. 2 (1831) t. 225; Holttum, Revis. Fl. Malaya 2 (1954) f. 259c, 260b, 261; A.G.Piggott & C.J.Piggott, Ferns of Malaysia in colour (1988) 399, pl. 1222–1225; T.C.Chambers & P.A.Farrant, Blumea 46 (2001) 300. — *Blechnopsis finlaysoniana* (Wall. ex Hook. & Grev.) C.Presl, Epimel. Bot. (1851) 116. — *Salpinchlaena finlaysoniana* (Wall. ex Hook. & Grev.) Fée, Mém. Foug., 5. Gen. Fil. (1852) 79. — *Spicanta finlaysoniana* (Wall. ex Hook. & Grev.) Kuntze, Revis. Gen. Pl. 2 (1891) 821. — Type: *Wallich 2172* (holo ex Icon. Fil. t. 225), in Insula Penang? (Herb. Finlayson). — Morton (Contr. U.S. Natl. Herb. 38 (1974) 303) reports a fragment in Greville Herb. E (Morton photograph 11560E), see note 6.

*Asplenium penangianum* Wall., Numer. List (1829), n. 196 [nom. nud.].

*Blechnum decurrens* Roxb., Calcutta J. Nat. Hist. 4 (1844) 502. — Type: *Hunter s.n.* (holo BR, Morton photograph 20002; iso E, fragment in Herb. Greville, Morton photograph 11560), Prince of Wales Island (Penang Island, Malaysia).

*Blechnopsis latifolia* C.Presl, Epimel. Bot. (1851) 116. — *Salpinchlaena latifolia* (C.Presl) Trevis., Atti Ist. Veneto Sci. Lett. Arti (1869) 575. — Type: *Wallich 57/5* (holo PR, Herb Presl), 'in Martaban et Tenasserim', see note 7.

*Rhizome* stout erect or suberect, short, woody, rarely forming above ground; the apex densely clothed with stiff scales, 0.2–0.3 cm at their bases, 1.1–1.5(–2) cm long and tapering to apices, entire, shiny dark reddish brown, usually with an almost black central zone and a narrow reddish brown margin. *Fertile* and *sterile fronds* similar on the adaxial surface, erect, often very large, 1–2 m or longer and 30–100 cm or wider. *Stipes* relatively short, 3–12 cm, very robust, usually shiny, deeply pigmented to a dark reddish or purple brown, often pale pinkish brown on the deeply grooved adaxial face, scales at the base linear or similar to those on the rhizome. *Lamina* ovate or deltoid, in living material dark green above, grey green on abaxial surface, pinnate, 6–21 or more pairs of pinnae plus a similar number of small auricles spaced 3–5 cm apart down the rachis below the pinnae, the laminae of juvenile plants are narrowly elliptic, entire to irregularly lobed. *Rhachis* and *costae* similarly coloured to the stipes at the base, becoming paler brown (sometimes green in fresh specimens) towards the lamina apex, sometimes the rhachis is very darkly pigmented, especially on the terete abaxial face. *Sterile pinnae* oblong-narrowly elliptic, apices abruptly narrowed to form an acuminate apex, cuneate at base, 23–50 or more by 1.9–4.3 cm wide, sessile or subpetiolate at the lamina base becoming semi-adnate and decurrent basiscopically towards the lamina apex, thinly coriaceous to papery, entire, sometimes finely revolute especially in dried specimens, veins fine, less than 0.1 cm apart at the costa, single or once forked and curving upwards at the margins to terminate in a minute submarginal gland, basal pinnae abruptly reduced in size to minute distantly spaced auricles, apical pinnae as large as or larger than the subapical. *Fertile pinnae* similar, but with sori on abaxial face, orange-brown, very narrow (1 mm), linear and close to either side of and not exceeding the width of the costa and not usually extending to extremities; at maturity the sori remain narrow. *Spores* 39.9 by 29.3  $\mu\text{m}$  (from 8 herbarium specimens), perine sparsely

costate beneath a rugulose envelope, scabrous, tuberculate or microrugulose between costae, exine smooth to scabrous. — **Fig. 2c, 7a–f, Map 1.**

Distribution — *Malesia*: Throughout. *Outside Malesia*: widespread (but usually not common) in many areas of SE Asia, from Indochina extending southwards.

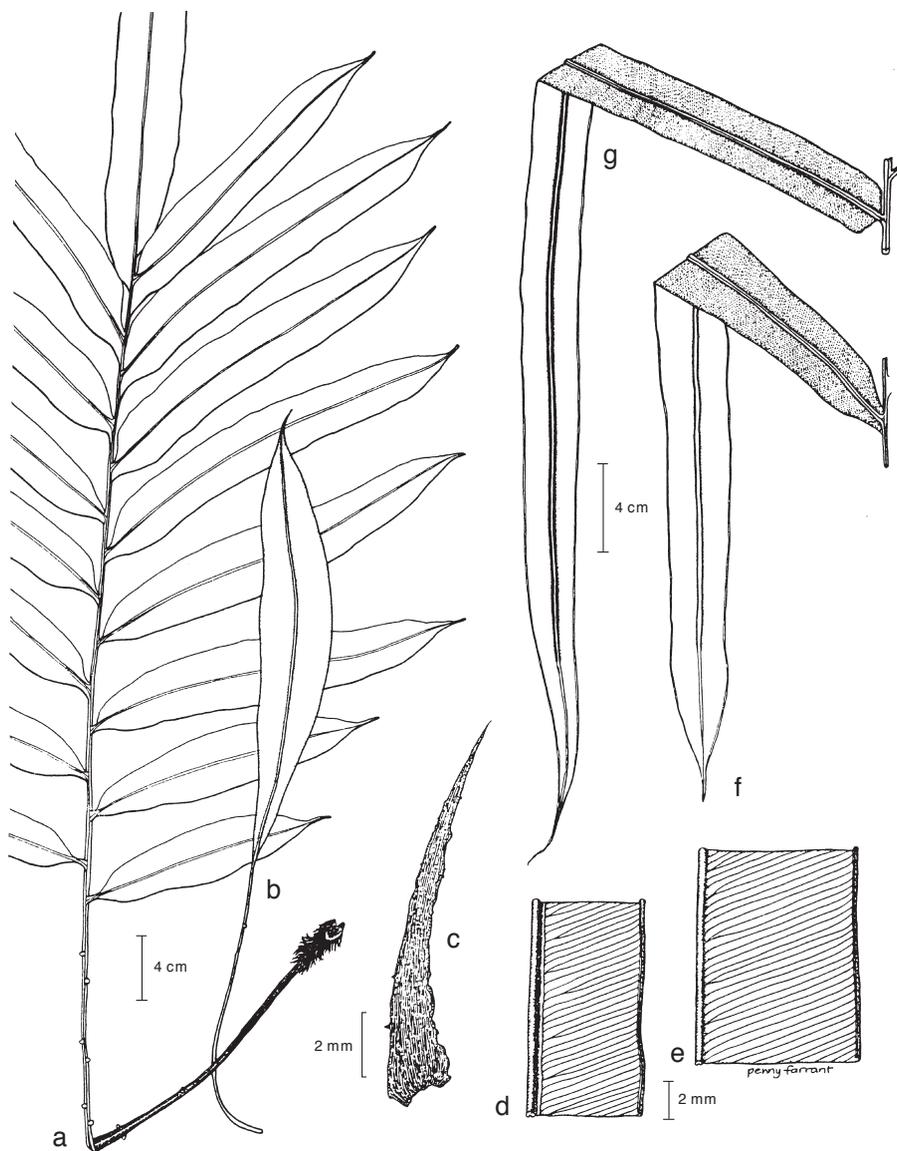


Fig. 7. — a–f: *Blechnum finlaysonianum* Wall. a. Small adult sterile frond, adaxial surface; b. juvenile frond, adaxial surface; c. scale from base of stipe; d. detail of pinna of fertile frond, abaxial surface; e. part of pinna of sterile frond, abaxial surface; f. fertile pinna (a, c–f: Croft *et al.* 1537, PNG (NSW); b: Wallich *et al.*, Penang, Malaya, 1822, ex Morton photo neg. no. 7315, (BM)). — g: *Blechnum orientale* L. Fertile pinna (M.G. Price 467, Philippines (NSW)). — Drawing by Penny Farrant.

Habitat — *Blechnum finlaysonianum* is a plant of humid shady lowland to submontane tropical rain forests. It is a plant of moist shady forest habitats, never in the open, but occasionally on forest margins in protected areas and often along creeks.

Notes — 1. In some of its growth forms this species is easily confused with *B. orientale*, especially when the latter is growing under luxuriant conditions. Herbarium specimens of *B. finlaysonianum* with narrow pinnae may be difficult to separate from *B. orientale*, especially if fragmentary or incomplete. The most useful but not infallible diagnostic character for separating these two species is the gradual tapering of the pinnae in *B. orientale* against the broader sometimes non-tapering pinnae of *B. finlaysonianum* which reduce abruptly to an attenuate apex. Another useful character is the tendency in *B. finlaysonianum* for the pinnae towards the frond base to be shortly petiolate and narrowly cuneate at their point of attachment to the rhachis.

2. The juvenile stages of *B. finlaysonianum* are distinctive and very different from those of *B. orientale*. While the very earliest post-prothallial stages of *B. finlaysonianum* have not been seen, the earliest fronds with mature texture are often entire and narrowly elliptic, tapering at both ends and range in size from 2–5 by 1 cm in the very young stages, to 30 by 5 cm, with a stipe of 2–3 cm. Later juvenile fronds are lobed, with 2–6 sessile lateral pinnae; wherever a pinna arises the main entire leaf is dissected back to its rhachis at that point. The lobes are usually conspicuously decrescent on their basiscopic margins and the base of the lamina sometimes narrows to a thin wing down the rhachis with lobes progressively further apart towards the stipe. The stipe, although variable in length, is proportionately longer than that of the mature frond. Both stipe and rhachis are grooved and pale on the upper (adaxial) surface and dark purplish black on the semi-terete undersurface. This pigmentation of the rhachis usually extends to near the lamina apex.

3. Sometimes the entire and the lobed fronds of *B. finlaysonianum* may be confused with sterile fronds of *B. melanocaulon* subsp. *melanocaulon*. In this regard both species resemble the juvenile stages of the tropical South American *B. volubile* (*Salpichlaena volubilis*); presumably on the basis of this similarity, Fée (1852: 79) placed the species *B. finlaysoniana* into the genus *Salpichlaena*.

4. In terms of ecological preferences, *B. finlaysonianum* invariably grows in shady or semi-shaded forests, while *B. orientale* is more frequent in semi-shaded to full sun habitats (see notes under that species).

5. A possibly distinct taxon from the Philippines (*M.G. Price* 2776, *M.G. Price & Hernaez* 426) is provisionally included in *B. finlaysonianum*. The mature fronds (sterile and fertile) differ from those of typical *B. finlaysonianum* in being much narrower and tapering evenly to the apex rather like those of *B. orientale*. However, the juvenile fronds which range from entire to pinnatifidly lobed, are similar to those of *B. finlaysonianum*. Other differences when compared with *B. orientale* are the relatively few well-spaced pinnae and the strongly decurrent pinnae bases especially towards the frond apex; in *B. orientale* the pinnae are numerous and the pinna bases are usually truncate. The mature fronds of the taxon do not match those of *B. whelanii* which has serrate margins, relatively widely spaced veins and a wider sorus occupying more of the abaxial face of the fertile pinnae.

6. *Blechnum finlaysonianum* var. *amboinensis* Rosenst. *nomen?* Annotation on specimen at L (*Amboina 471*) det. by Rosenstock. This specimen is doubtfully distinct, the pinnae are narrower than average and tend to taper to their apices more evenly (see also note 5 on Philippine specimens). See also discussion by Morton (Contr. U.S. Natl. Herb. 38 (1974) 303).

7. For typification of *Blechnopsis latifolia* see Holttum (Novit. Bot. Univ. Carol. (1968) 29).

## 5. *Blechnum fluviatile* (R.Br.) E.J.Lowe ex Salomon

*Blechnum fluviatile* (R.Br.) E.J.Lowe ex Salomon, Nomencl. Gefässkrypt. 115 (1883); Crookes & Dobbie, New Zealand Ferns, 6th ed. (1963) 301; B.D.Duncan & G.Isaac, Ferns & Allied Plants Victoria, Tasmania & S Australia (1986) 209, f. 20.10; Brownsey & J.C.Smith-Dodsworth, New Zealand Ferns & Allied Plants (1989) 143, f. 179, pl. 33A; T.C.Chambers & P.A.Farrant, Fl. Australia 48 (1998) 371, f. 125E, map 336; Blumea 46 (2001) 303. — *Stegania fluviatilis* R.Br., Prodr. (1810) 152. — *Lomaria fluviatilis* (R.Br.) Spreng., Syst. Veg. 4 (1827) 64. — *Spicanta fluviatilis* (R.Br.) Kuntze, Revis. Gen. Pl. 2 (1891) 821. — Type: *R. Brown s.n.* (lecto BM, here chosen, largest of 3 specimens; isolecto BM, K), Insula Van Diemen [Tasmania], 1804.

*Lomaria rotundifolia* Colenso, Tasmanian J. Nat. Sci. 2 (1846) 179, non Blume (1828). — Type: *W. Colenso s.n.* (holo WELT P3244, in Herb Colenso), dense humid woods near Waikare Lake in decomposed sandstone soil, Dec. 1841.

*Lomaria rotundifolia* Raoul, Choix Pl. Nouv.-Zel. (1846) 9, t. 2, non Blume (1828). — Type: *Raoul s.n.* (ex icon; specimen not seen), Akaroa.

*Lomaria fluviatilis* (R.Br.) Spreng. var. *crispata* West, Otago Witness (26 Apr. 1879). — *Lomaria fluviatilis* (R.Br.) Spreng. var. *multifida* T.Moore, Gard. Chron. n.s. 12 (July 1879) 84 (same plant as that described by West). — Type: *West ex Law & Sommer s.n.* (K, a minor mutant).

*Blechnum nudius* Copel., Univ. Calif. Publ. Bot. 18 (1942) 222; Philipp. J. Sci. 78 (1949) 226, pl. 6. — Type: *L.J. Brass & E. Meijer Drees 9966* (holo MICH; iso L), Dutch New Guinea, Mt Wilhelm, 7 km NE Wilhelmina top, sides of moist sinkholes and chasms in limestone, 3560 m.

*Rhizome* slender, short creeping, usually erect, forming a caudex 0.8–3 cm up to 30 cm in height, densely clothed with blackened bases of old stipes and with conspicuous acuminate 10 by 1.2 mm scales, entire, shiny, reddish brown, sometimes with paler borders. *Fronde*s in the living state forming a distinct spreading crown at the apex of rhizome, with the fertile fronds more erect and surrounded by a drooping or prostrate rosette of numerous olive green sterile fronds, 10–75 by 1.5–7 cm (fertile fronds 1–3 cm wide). *Stipes* very short, up to 10 cm (usually less than 5 cm), stramineous to dark brown, densely scaly, the longest scales at the base and like those of the rhizome, acuminate, entire, brown to reddish brown. *Lamina* linear-oblong-narrowly elliptic, pinnate, 12–60 pairs of pinnae. *Rhachis* and *costae* stramineous to dark reddish brown, densely scaly, scales small, narrowly elliptic acuminate, sometimes falcate, entire, reddish brown, often black at their bases, interspersed with much smaller short uniseriate multicellular whitish hairs, scales extending to veins. *Sterile pinnae* rounded to oblong, obtuse, 0.8–4 by 0.4–1.2 cm, subpetiolate at base of lamina becoming increasingly adnate towards apex, finely cartilaginous, often membranous, mid to dark green in plants growing in shade and semi-shade, entire to crenate or dentate undulate, veins once or twice furcate, often at an acute angle to the costa and terminating in a small submarginal linear to clavate gland, usually visible on both surfaces, basal pinnae shorter and

rounder. *Fertile pinnae* numerous, erect and usually at an acute angle to the rhachis, narrow linear, short 1–2(–3) by 0.15–0.3 cm, sessile or subpetiolate, sori covering undersurface. *Spores* 56.1 by 42.6  $\mu\text{m}$  (from 7 herbarium specimens (Malesian material)), perine rugulose to scabrous, exine smooth to granulose. — **Fig. 2d, 8; Map 4.**

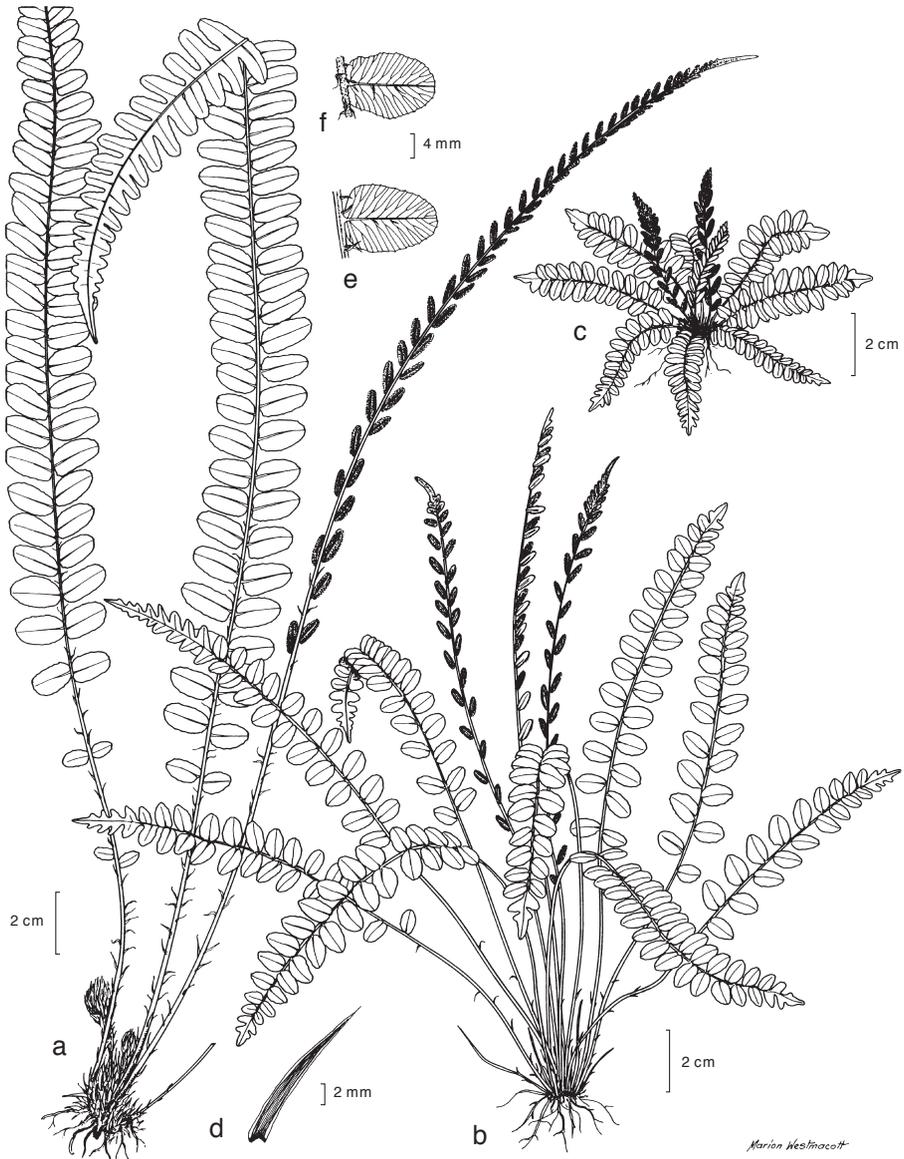
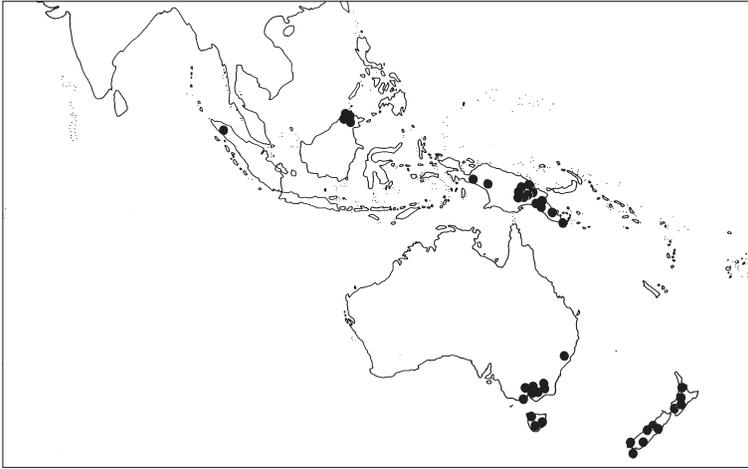


Fig. 8. *Blechnum fluviatile* (R.Br.) E.J.Lowe ex Salomon. a. Large mature specimen; b. medium mature specimen; c. small mature specimen; d. scale from base of stipe; e. pinna and rhachis (adaxial); f. pinna and rhachis (abaxial) (a, d: *Croft 123*, Mt Piora, PNG; b, e, f: *Croft 1282*, E slope Mt Saruwaged, Huon Peninsula, PNG; c: *Croft 93*, N slopes Mt Piora, PNG; all CANB). — Drawing by Marian Westmacott.



Map 4. Distribution of *Blechnum fluviatile* (R.Br.) E.J.Lowe ex Salomon.

Distribution — *Malesia*: Sumatra (Atjeh, Gajolanden), Borneo (Sabah: Mt Kinabalu), Philippines, (one specimen at Leiden (L908.316-471) labelled ‘Polybotryo Hamiltonia Hook.’ ‘Ex insul Philipp. Cuming’, although only a fragment, has sterile and fertile fronds of *B. fluviatile*), Papua New Guinea (Madang, W Highlands, E Highlands, Morobe, S Highlands, Central Papua, Milne Bay). *Outside Malesia*: SE Australia and New Zealand.

Habitat — Ranges from mixed humid broadleaf forests to subalpine vegetation such as tussock grasslands and dwarf scrub in areas of high precipitation with high incidence of mists and fogs.

Vernacular names — Wam (Mendi language, New Guinea) for a very robust specimen from grassland Mt Giluwe, *Schodde 1965* (K). Kiwakiwa (Maori language) (Brownsey & Smith-Dodsworth 1989: 143).

Chromosome number — Variable,  $2n = 66$  in the North Island of New Zealand and in New South Wales and Victoria (Chambers unpubl. data). All populations sampled from the South Island from forested lowland and submontane to montane vegetation are tetraploid with the sporophytic number  $4n = 132$  (Chambers, *Nature* 155 (1955) 215); Tasmanian populations sampled by Quinn (*Pap. & Proc. Roy. Soc. Tasmania* (1961) 1) all exhibited a triploid condition, the sporophyte number being  $3n = 99$ . It has not been possible to detect any consistent morphological differences between these various populations even where some of them have been grown in cultivation under the same conditions. It would be interesting to have cytological data on the Malesian populations.

Notes — 1. The plants described by Copeland as *B. nudius* are extreme ecological variants of *B. fluviatile*. The isotype at Leiden has a long slender trunk and also exhibits exceptionally long stipes (15 cm) with a lamina only 25 cm in length. A note on a specimen collected by *Croft (LAE 61831)* from Isuani grassland (SE slopes Mt Victoria, subdistrict Port Moresby 2700 m,  $8^{\circ}55'S$ ,  $147^{\circ}35'E$ ) confirms this interpretation. This specimen comes from swampy grassland and is very similar to the specimen described by Copeland.

2. Although *B. fluviatile* exhibits considerable variation, especially in the size of fronds and spacing and shape of pinnae, this is a well-circumscribed and probably long isolated species; it does not appear to have any particularly closely related species in the genus. The character of the juvenile plants and of very stunted plants could be confused with forms of *B. membranaceum* (Colenso) Mett. (a species from New Zealand) and for this reason together with its diploid chromosome number of  $2n = 66$  it will be placed with this group of species.

3. The species in cultivation is not tolerant of high light conditions which results in a yellowing of the pinnae. In nature, forest and forest edge specimens are usually in at least partial shade while those from more alpine habitats although exposed to full sky light are mostly found growing in areas of frequent cloud and mist.

## 6. *Blechnum fraseri* (A.Cunn.) Luerss.

*Blechnum fraseri* (A.Cunn.) Luerss., Flora (1876) 292; Crookes & Dobbie, New Zealand Ferns, 6th ed. (1963) 305; Brownsey & J.C.Smith-Dodsworth, New Zealand Ferns & Allied Plants (1989) 143, f. 180, pl. 33B; T.C.Chambers & P.A.Farrant, Blumea 46 (2001) 306. — *Lomaria fraseri* A.Cunn. in Hook., Companion Bot. Mag. 2 (1837) 364; Hook., Icon. Pl. (1837) t. 185; Cheeseman, III. New Zealand Fl. 2 (1914) pl. 242. — *Spicanta fraseri* (A.Cunn.) Kuntze, Revis. Gen. Pl. 2 (1891) 821. — *Diploblechnum fraseri* (A.Cunn.) De Vol, Fl. Taiwan 1 (1975) 153, pl. 52. — *Struthiopteris fraseri* (A.Cunn.) Ching, Sunyatsenia 5 (1940) 243. — Type: *C. Fraser s.n.* (lecto K, here chosen, see note 8), New Zealand (North Island), in shady woods on the East coast, 1825. Other types: see note 9.

*Lomaria fraseri* A.Cunn. var. *philippinensis* H.Christ, Bull. Herb. Boissier 6 (1898) 149, pl. 2a–h. — *Blechnum fraseri* (A.Cunn.) Luerss. var. *philippinense* (H.Christ) Copel., Polypod. Phil. Isl. (1905) 90; Ogata, Icon. Fil. Jap. 8 (1940) pl. 360 (both the Cheeseman and the Ogata plates are very fine drawings); A.G.Piggott & C.J.Piggott, Ferns of Malaysia in colour (1988) 406, pl. 1245–1249. — Type: *Loher 935* (iso K), Philippines, Cordillière central de Luzon, 2000–2700 m, Mt Data, 2250 m.

*Blechnum integripinnulum* Hayata, Icon. Pl. Formosan. 4 (1914) 236, f. 165a–g. — *Diploblechnum integripinnulum* (Hayata) Hayata, Bot. Mag. (Tokyo) 41 (1928) 702. — Type: *T. Kawakami 4902* (n.v.), Taito.

*Rhizomes* of two kinds: slender creeping rhizomes, 0.2–0.5 cm diam. and an erect caudex often 1 m tall and recorded up to 250 cm, usually 2–3 cm diam., rarely up to 6 cm (the base may become thicker due to numerous adventitious roots); the plant appears as a miniature tree fern supporting a radial crown of fronds arising from the base of the caudex just below or at soil level, the slender horizontal rhizomes give rise to colonies of new plants; the apices of both types of rhizomes are densely scaly, scales linear-acuminate, 1–1.2 by 0.1–0.2 cm, entire, dark reddish brown and shiny, mostly bicolorous with the cell walls of the central area dark and the margins a paler reddish brown, sometimes beneath and between these conspicuous scales a mass of softer finer, pale filamentous and more obtuse scales 3–5 cells wide at the base. *Fronde*s 18–70 by 6–25 cm, semiglossy, living material dark green above, medium green underneath, similar or fertile fronds slightly narrower than sterile fronds. *Stipes* very short, (2–)5–20 cm, dark reddish brown at the base, becoming brown or stramineous above, densely scaly at the base, fewer persistent scales above, scales similar to those of the caudex, but smaller and sometimes irregularly toothed. *Lamina* ovate to narrowly elliptic, bipinnatisect to bipinnate, usually becoming bipinnatifid, with conspicuous

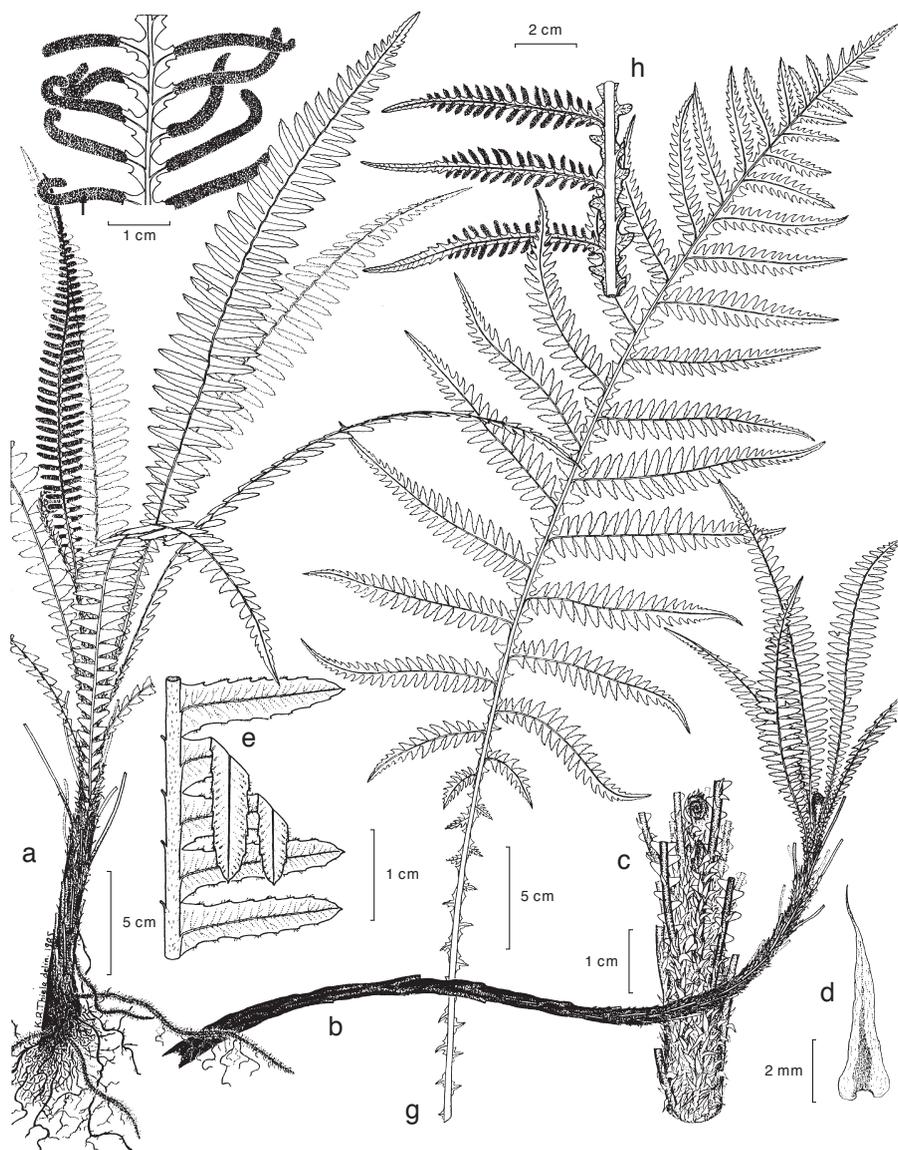


Fig. 9. — a–f: *Blechnum rosenstockii* Copel. a. Habit of an erect specimen; b. habit of typical sprawling specimen; c. apex of caudex; d. scale from base of stipe; e. sterile pinnae (rhachis abaxial surface); f. part of fertile frond (abaxial) (a, c–e: Hoogland & Schodde 6931, E slopes Yaki river Valley, 9000 ft, Wabag Subdist. W Highlands (CANB); b: Wade ANU 7746, W slopes Mt Giluwe, S Highlands, 9000 ft (CANB); f: Keysser 11, 70, Bolan, 2400–3000 m, PNG (UC 391403, type)). — g, h: *Blechnum fraseri* (A.Cunn.) Luerss. g. Sterile frond; h. fertile pinnae, abaxial surface (g: M.G. Price 1141, Benguet Prov., near Bontoc-Baguio Rd., Philippines (NSW); h: Croft 281, Ridge E of Weiten R., S New Ireland, 1900 m (MEL)). — Drawing by K.R. Thiele.

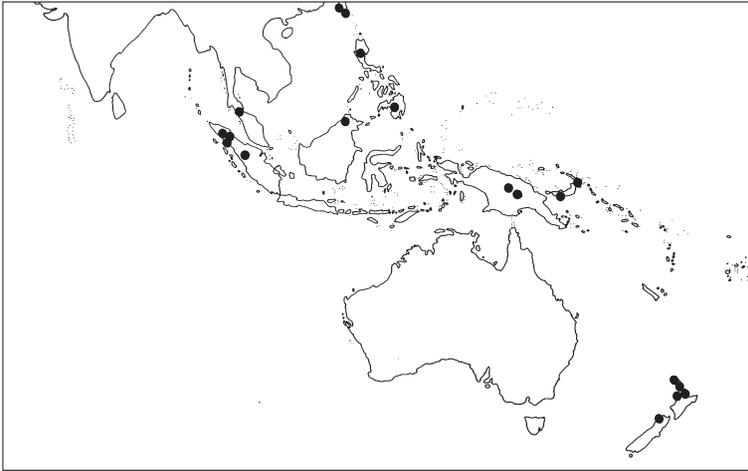
triangular toothed wings adnate to and on either side of the rhachis alternating with the pinnae, the more apical segments of the lamina undivided, (11–)15–27 pairs of pinnae. *Rhachis* and *costae* reddish brown, brown or stramineous with sparse scales (fertile fronds more scaly), scales linear, narrowly elliptic or cordate, acuminate, entire or rarely toothed, red-brown, often with only a midrib of darkened cells and sometimes the whole scale pale buff concolorous and with thin-walled cells. *Sterile pinnae* narrowly elliptic, acuminate, pinnatifidly dissected and tapering or truncate at the rhachis, 3.5–15 by 0.8–3 cm, adnate with winged lobes of tissue on rhachis and well-developed triangular wings adnate to the rhachis between pinnae, pinnae thinly coriaceous, mid green to yellow green in living material, margins ranging from entire to crenate and dentate, basal pinnae either gradually reduced through one or two pairs of pinnae, or abruptly reduced to winged lobes extending down rhachis, the lowest one sometimes small and serrate rather than dissected, pinnae towards apex decreasingly pinnatifidly dissected and increasingly adnate, at frond apex, becoming less dissected and the margins increasingly dentate; lamina becoming pinnatifid and narrowing eventually to toothed adnate segments and with a minute terminal segment. *Sterile pinnules* oblong, acute, 0.5–2.3 by 0.2–0.5 cm, about 20 per pinna in the mid-region, adnate, contiguous, margins entire to serrate or dentate, often slightly thickened and finely revolute, veins simple or once furcate terminating in a linear gland more visible on the adaxial surface and not extending to the pinnule margin. *Fertile pinnae* and *pinnules* slightly contracted and markedly caudate but otherwise usually similar to those of the sterile fronds; pinnules and often also the rhachis lobes with fertile regions of orange brown sori occupying the whole of the undersurface. *Spores* pale in colour, 54.6 by 34  $\mu\text{m}$  (from 5 herbarium specimens), perine verrucose to deeply verrucose, smooth to finely reticulate at base of verrucae, the verrucae microreticulate beneath a scabrous layer which varies in its persistence, exine smooth to granulose. — **Fig. 2e, 9g, h; Map 5**

Distribution — *Malesia*: Widespread but very localised in mountain areas extending from Sumatra and Peninsular Malaysia to Borneo (Sabah: Mt Kinabalu), Philippines (Luzon, Mindoro) south to Papua New Guinea (W Highlands, New Ireland). *Outside Malesia*: The species also extends north to Taiwan and south to New Zealand where it occurs from latitude 35° S of the North Island to latitude 42° S in the South Island, west of the Southern Alps.

Habitat — In tropical and subtropical zones confined to humid mountain forests above 1800 m and more, often much higher, forming extensive forest floor communities of erect miniature tree ferns. In temperate areas (of the North Island of New Zealand) it is found in humid lowland broadleaf and mixed coniferous forests. In the South Island it is confined to a small area near the west coast where it occurs in mixed lowland rain forest.

Vernacular names — In New Zealand known as ‘Miniature tree fern’ and ‘Fraser’s *Blechnum*’, and in the W Highlands district of Papua New Guinea, Wabag subdist., ‘lebali’ (Enga language, Poio) (*Hoogland & Schodde 7186*).

Notes — 1. *Blechnum fraseri* was named in honour of Mr Charles Fraser who, when Superintendent of the Sydney Botanic Gardens and Colonial Botanist between 1816 and 1831, first collected this attractive species in New Zealand.



Map 5. Distribution of *Blechnum fraseri* (A.Cunn.) Luerss.

2. The frond of *B. fraseri* is unusual in possessing conspicuous triangular toothed wings adnate to and on either side of the rachis and alternating with the pinnae.

3. *Blechnum fraseri* is rarely found as single isolated plant but rather as a gregarious community dominating areas ranging from a few square metres to several hundred square metres of the forest floor and sometimes at the margins of forests. This is at least partly the result of reproducing vegetatively by means of short underground rhizomes giving rise sympodially to new trunks. The underground rhizomes usually decay quite early in development and so colonies are rarely found with obvious interconnecting structures.

4. The species appears to require reasonably high light and hence is found in more open forest associations especially on ridges. In the northern part of the North Island of New Zealand it is often associated with the relatively xeric forest floor communities in mature stands of *Agathis australis* Salisb.

5. Three taxa within this species have been variously recognised as distinctive: *Blechnum fraseri* from New Zealand, *B. fraseri* var. *philippinense* from the Philippines, E Malaysia (Sabah in N Borneo), Indonesia (Sumatra), Papua New Guinea (mainland and New Ireland), and *B. integripinnulum* from Taiwan.

6. Our study of *B. fraseri*, *B. fraseri* var. *philippinense*, and *B. integripinnulum* has not revealed any consistent morphological characters that would justify reliable separation into three taxa. Tropical plants referred to as var. *philippinense* are sometimes slightly larger, with broader sterile segments and more well-developed triangular adnate wings to the rachis, and a tendency on many fronds for the lamina to be less abruptly reduced towards the base. However, we have not been able to separate specimens from New Zealand growing in very favourable situations in temperate lowland forests from the taxon referred to as var. *philippinense* from tropical mountain habitats. Conversely several specimens from the tropical areas closely approach the morphology of much of the New Zealand material, e.g. *Jacobs 7159*, Mt Pulog (L) and *M.G. Price 433*, Mt Polis (L), both from Luzon, while a specimen from Mt Halcon, Mindoro, *E.D. Merrill*

5906 (L) is intermediate between the tropical and temperate zone forms. It seems likely therefore that the morphology of the variety is a response to environmental conditions and we have concluded that there is only one recognisable taxon, *B. fraseri*.

7. The spores perhaps indicate some minor genetic difference in that in the New Zealand *B. fraseri* spores the scabrous outer coat tends to persist and the verrucae are not as pronounced as they are in Malesian specimens; in the latter the scabrous layer tends to disintegrate and expose the microreticulations of the verrucae but this could be a response to the tropical environment and the methods of specimen preparation. We have not examined spores of the Taiwan material.

8. Two pencil drawings of enlarged fertile pinnae attached to the undated Fraser specimen at K suggest that this is the specimen from which Hooker's. Icon. Pl. (1837) t. 185 was prepared. *Fraser's 1826* specimen at K, 'ex Allan Cunningham, N.Z. Herb. presented by R. Heward 1862', could well be part of the type collection. The other specimen at K was cited by Cunningham and is the lectotype here chosen.

9. Other types: *Fraser*, no date; residual syntypes: K (2 specimens: '185 *Stegania Fraseri* Bay of Islands off the East Coast of N.Z. C. *Fraser 1826*' and 'At Wangarua, Waimate and Hokianga, in dense forests R. *Cunningham 1834*').

## 7. *Blechnum hieronymi* Brause

*Blechnum hieronymi* Brause, Bot. Jahrb. Syst. 56 (1921) 155; T.C. Chambers & P.A. Farrant, Blumea 46 (2001) 310. — Type: *Ledermann 12217b* (holo B), 'Nordöstl.-Neu-Guinea, Kaiserin-Augusta-Fluß-(Sepik-)Gebiet, Schraderberg, Gebirgswald', epiphytic, 2000 m, June 1913.

*Blechnum decorum* Brause, Bot. Jahrb. Syst. 56 (1921) 156. — Type: *Ledermann 12459a* (holo B; iso BM, fragments), 'Nordöstl.-Neu-Guinea, Kaiserin-Augusta-Fluß-(Sepik-)Gebiet, Felsspitze (Sepik region)', 1400–1500 m, Aug. 1913.

*Lomaria acutiuscula* Alderw., Nova Guinea 14 (1924) 31. — *Blechnum acutiusculum* (Alderw.) C. Chr., Index Filic. Suppl. 3 (1934) 45; Copel., Philipp. J. Sci. 78 (1949) 226, as '*B. latiusculum*' (in error). — Type: *Lam 1543* (BO), mountain ridge near Doorman Summit, epiphytic, 1420 m, Oct. 1920.

*Blechnum brassii* Copel., Univ. Calif. Pub. Bot. 18 (1942) 222. — Type: *L.J. Brass 12287* (holo MICH, photo seen, Herb. Copeland; iso L), Netherlands New Guinea, Bernhard Camp, Idenburg River, epiphytic in mossy forest; one plant climbing on dead trunk at 1800 m, Jan. 1939.

*Rhizome* sometimes epiphytic and scandent, erect, 0.4–2.5 cm thick, clothed with narrowly elliptic to subdeltoïd, acuminate, entire, reddish, brown or black scales, sometimes with paler margins, to 1.9 by 0.4 cm; slender creeping rhizomes give rise to a succession of single fronds. *Fronde*s dimorphic, both sterile and fertile fronds either clustered (or remote if rhizome scandent), 13–45(–130) by 10–20 cm; fertile fronds with little or no photosynthetic surface. *Stipes* 11–20(–70) cm (fertile usually longer), 0.3–0.4 cm diam., reddish brown, dark purplish to purplish black near base and on abaxial surface, scales dense, at base similar in size and colour to those of the rhizome, but towards the rachis smaller lighter stramineous or ginger-brown scales some with a dark central spot and with cordate appressed bases, often mixed with linear twisted hairs and hair-like scales. *Lamina* oblong-narrowly elliptic, abruptly truncate at the base, (11–)14–38 pairs of pinnae; sterile lamina 14–50 by 16 cm; fertile lamina up to 45 by 15 cm. *Rhachis* and *costae* yellowish brown, with varying amount of purple pigmentation on abaxial side of rhachis, scales sparse, deciduous, similar to those of

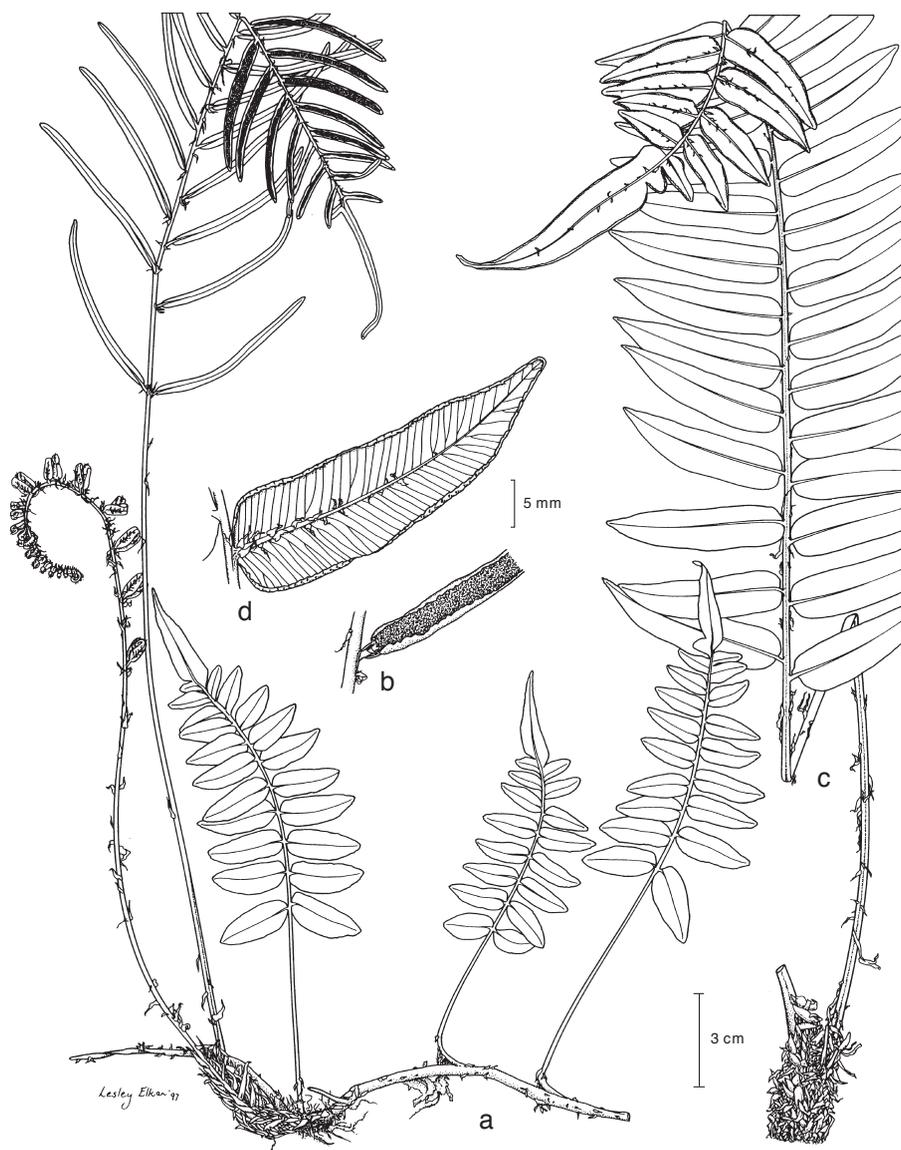


Fig. 10. *Blechnum hieronymi* Brause. a Habit showing creeping rhizome, sterile fronds and a fertile frond; b. detail of abaxial face of fertile pinna from mid-region of frond; c. sterile frond with apical region adaxial surface; d. detail of sterile pinna, abaxial surface (a, b: Hoogland & Pullen 5466, Goroka Subdist. E Highlands Dist. PNG (CANB); c, d: Pullen 5249, W Highlands, Minj-Nona Divide, N slope Kubor Range, PNG (CANB)). — Drawing by Lesley Elkan.

the stipe but smaller and paler or sometimes with dark central spot. *Sterile pinnae* coriaceous, glabrous, in fresh material, olive green on the adaxial surface, paler on the abaxial face; margins slightly revolute and varying from entire to finely serrate and dentate at the apices, narrowly elliptic or linear-narrowly elliptic to oblong, sometimes

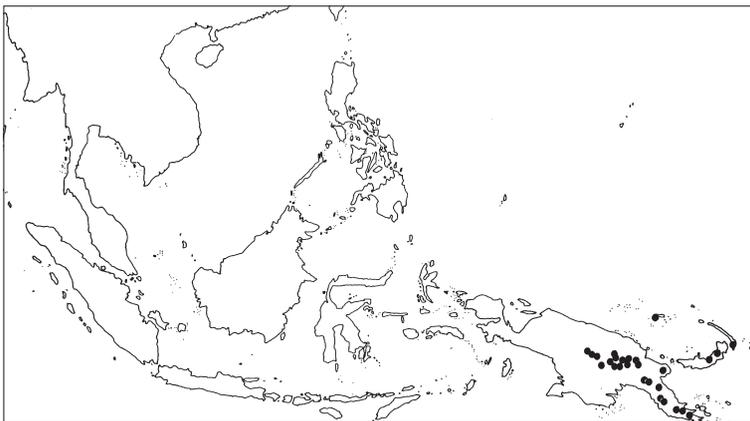
tending to become slightly falcate towards the apex of the lamina, acuminate or acute at apices, rounded at their bases, 6–10(–14) by 0.75–1.7(–2.2) cm, adnate towards apex of lamina, otherwise sessile, shortly or distinctly petiolate, alternate or subopposite, 0.8–2 cm between the costae, most distant distal and mid-region pinnae at an angle of 45° or more to the rhachis, veins slender, thickened at their apices, single or once furcate, sub remote, terminating in an ovoid gland, basal pinnae not or only slightly reduced, more distant, terminal pinna significantly larger than subterminal pinnae, sometimes similar in size to those of the largest mid-frond region. *Pinnae* on small fronds, especially those produced from a slender creeping rhizome, tend to be short ovate or rounded, with wavy margins giving a dentate appearance. *Fertile pinnae* linear acuminate or mucronate, not revolute at maturity, 7.5–12 by 0.2–0.5 cm, 0.8–3.3 cm distant (between costae at rhachis), upper pinnae shorter, adnate, shortly decurrent, lower ones shortly petiolate, sori occupying the whole face except for a short sterile apical zone, 0.1–0.6 cm long. *Spores* 72.2 by 54.5  $\mu\text{m}$  (from 17 herbarium specimens), perine alate to costate-alate and loosely reticulate, lacunae large irregular polygons, wing-like muri with ciliate margins, scabrous, microreticulate or rugulose between muri, exine smooth, scabrous or microverrucose. — **Fig. 2f, 10; Map 6.**

**Distribution** — *Malesia*: Moluccas (Ceram, once reported), New Guinea (Northern Papua, Central Papua), Papua New Guinea (W Sepik, Madang, W Highlands, E Highlands, Morobe, S Highlands, Milne Bay, New Britain, New Ireland).

**Habitat** — Occurs in many of the montane regions from 1200–3500 m, usually in mossy forests, forest edges and stream banks in subalpine grasslands. Occasionally this species is found in more exposed situations in alpine herb fields and ridge top vegetation but more frequent in sheltered habitats, sometimes epiphytic but more usually terrestrial.

**Vernacular names** — Djaholiha (Asaro: Defamo), korrungel (Wahgi: Minj), gag (Hagen: Togoba) *Hoogland & Pullen 5466* (CANB, NSW).

**Notes** — 1. After study of a large number of specimens of *B. hieronymi* from a range of areas and habitats in Papua New Guinea we have concluded that it is not possible to separate *B. hieronymi* from *B. decorum*. The holotypes of *B. hieronymi* and *B. decorum*



Map 6. Distribution of *Blechnum hieronymi* Brause.

are similar to each other in many respects. *Blechnum hieronymi* is reported as epiphytic (on a dead log); and the basal stipe scales of the type are smaller than those of the type of *B. decorum*. The holotype of *B. decorum* is terrestrial with scales closer to those of *B. revolutum* but not as robust.

2. Some of the specimens of *B. hieronymi* resemble specimens of *B. revolutum* collected from forest or forest edge habitats in which *B. revolutum* does not develop such strongly revolute sterile pinnae. The two species, however, can be separated by the scales of the rhizome and basal stipe, which are very much more robust in *B. revolutum*.

3. *Blechnum hieronymi*, while always montane, tends to occur at lower altitudes and in less exposed habitats than *B. revolutum*.

4. The holotype of *B. decorum* var. *dilatatum* is distinct from and not closely related to *B. decorum* and now that we have had the benefit of access to a range of collections we have given this taxon species status as *B. dilatatum*; it forms a large plant with pale green fronds, thick leathery pinnae, and stramineous stipe and rhachis.

5. The frond morphology of the holotypes of *B. acutiusculum* and *B. brassii* are also similar to *B. hieronymi*. Both *B. acutiusculum* and *B. brassii* are reported as epiphytes, the type of the former having an erect caudex and the type of the latter a slender scandent rhizome. All these taxa are readily distinguished from *B. vulcanicum* s.l. in which the pinnae are adnate and the fronds variously bear characteristic straight uniseriate multicellular hairs.

## 8. *Blechnum indicum* Burm.f.

*Blechnum indicum* Burm.f., Fl. Ind. (1768) 231; Holttum, Revis. Fl. Malaya 2 (1954) 446, f. 259a, 260c; Brownlie, Fl. Nouv.-Calédonie 3: Ptéridophytes (1969) 237, pl. xxx, f. 3, 4; S.B.Andrews, Ferns Queensland (1990) 94, f. 7.4A; T.C.Chambers & P.A.Farrant, Fl. Australia 48 (1998) 372, 710; Blumea 46 (2001) 313. — Type: *Coveny 4712* (neo (see Chambers & Farrant 1998) NSW; iso A, AD, BM, BRI, G, K, L, LE, TNS, UC), Evans Head, NSW.

*Blechnum striatum* R.Br., Prodr. (1810) 152. — *Blechnopsis striata* (R.Br.) C.Presl, Epimel. Bot. (1851) 119. — Type: *R. Brown 40* (holo BM), Port Jackson [NSW] 1802–1805.

*Blechnum moluccanum* Desv., Berlin. Mag. 5 (1811) 325, non *Blechnum moluccanum* Roxb. — Type: collector unknown (holo location unknown), Amboina.

*Blechnum stramineum* Labill., Sert. Austro-Caledon. 2 (1824) t. 3. — Type: *La Billardiere s.n.* (holo FI (ex Herb Webbiana)), Austro Caledonia.

*Blechnum cumingianum* Trevis., Atti Ist. Veneto Sci. Lett. Arti 2 (1851) 165. — Type: *Cuming 385* (holo n.v., location unknown), Malacca.

*Blechnopsis malaccensis* C.Presl, Epimel. Bot. (1851) 120. — *Blechnum malaccense* (C.Presl) Fée, Mém. Foug., 5. Gen. Fil. (1852) 74. — Type: *Cuming, Pl. Philipp. 385* (holo RB 144558, ex Herb. A. Feé; iso BM, K), habitat in Malacca.

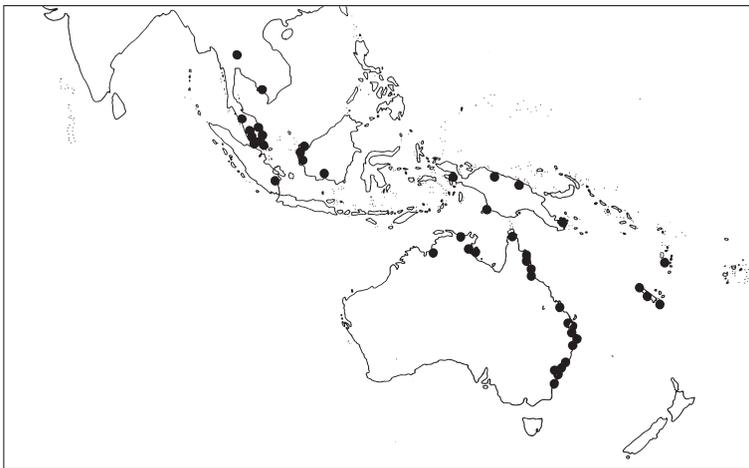
*Blechnum serrulatum* auct. non Rich.: for SE Asian, Malesian, Australian, and Oceania material.

*Rhizomes* of three kinds: 1) Thick (up to 1.6 cm diam.), black, ridged, horizontal dictyostelic with extensive aerenchymatous packing tissue between the vascular bundles, often extensively branched and clothed with small scales 0.3–0.4 by 0.1 cm, linear to triangular, acuminate, entire, dark brown to almost black (these scales leave raised scars when shed); these thick rhizomes give rise to 2) slender creeping rhizomes, which give rise to a regular sequence of fronds and numerous adventitious roots; and also to 3) an erect caudex with a radial arrangement of fronds and densely clothed with old frond

bases and adventitious roots. *Fertile* and *sterile fronds* similar, erect, 23–50(–200) by 6–15(–28) cm. *Stipes* 6–50(–83) cm, very dark at the base fading to brown or stramineous above, scales narrowly elliptic, acuminate, entire, reddish brown to dark brown and sometimes bicolorous, persistent only at the extreme base, with the remainder of the stipe stramineous, smooth and glabrous. *Lamina* ovate to narrowly elliptic, pinnate, with 16–52 pairs of pinnae. *Rhachis* and *costae* stramineous, rhachis usually glabrous, smooth and shiny, costal scales very small, c. 1 by 0.6 mm, broadly triangular, sometimes irregular in shape, entire, clathrate with reddish brown cross walls, usually a few persisting on the abaxial face. *Sterile* and *fertile pinnae* similar in overall shape, oblong-narrowly elliptic, cordate at the base with a characteristic articulated joint to the rhachis, acuminate (often tapering evenly from the base to the apex), 4–16.5 by 0.5–1.6 cm, sessile or shortly petiolate, papery to coriaceous, yellow-green in the living state with an upper surface shiny, margins serrate (sometimes irregularly denticulate), closely spaced veins very fine and 3 or 4 per mm, some dichotomising twice, terminating submarginally with a small gland; basal pinnae similar or slightly shorter; the sori of the fertile pinnae closely parallel to the abaxial costa and usually extending to pinna base but not to the apex. *Spores* 36 by 28  $\mu\text{m}$  (from 5 herbarium specimens), perine granulose, exine smooth. — **Fig. 2g; Map 7.**

**Distribution** — *Malesia*: Throughout (?except Java). *Outside Malesia*: Widely distributed in SE Asia and extending as far south as New Caledonia but not as far east as the Fiji Islands. It also occurs in coastal northern and eastern Australia as far south as latitude 31°01'S.

**Habitat** — The species is adapted to brackish swampy areas and river margins, usually at low altitudes near the coast. There are several records from near thermal springs. In tropical and subtropical areas it often forms extensive almost pure stands in situations fully exposed to sunlight and also in open swamp forests of *Melaleuca*. Less frequently it has been reported from inland situations such as at Mt Cyclops in Papua at between 1100 and 1900 m.



Map 7. Distribution of *Blechnum indicum* Burm.f.

Chromosome number —  $n = c. 37$  (Brownlie, *Pacific Sci.* 19 (1965) 493) for New Caledonian material.

Vernacular names — For such a widespread species there are probably many names but few seem to be recorded. In Sampit in southern Kalimantan the name badjai is reported by *Buwalda 7714* (K) and a related name is reported by *Moh. Enoh 288* (L) pakoe padji besar from Pontianak in W Kalimantan.

Uses — The fresh croziers and young fronds are often seen being sold in bunches in markets in SE Asia. There are also reports of the rhizomes being used to make a coarse flour (e.g. *I. van der Harst s.n.*, Frederik Hendrik Island off the south coast of Papua, refers to the plant as kadu and the flour as akar pakoe pakoe *NSW 295951*). The croziers in some countries are canned and regarded as a delicacy said to be somewhat like asparagus in texture and flavour.

Notes — 1. *Blechnum indicum* is closely related to but distinct from *B. serrulatum* Rich., from South and Central America, Florida, and the Caribbean Islands, which was reported in error from Australia by Hooker & Baker (*Syn. Fil.* 3 (1868)), Bentham (*Fl. Australiensis* (1878)), and others.

2. *Blechnum serrulatum* is most readily distinguished by having pinnae (especially the sterile pinnae) which are broader and not tapering evenly from the base to the apex but are oblong and shortly acute at the apex. Isolated fronds do sometimes have pinnae tapering evenly but specimens with a range of fronds almost invariably have some with oblong pinnae with shortly acuminate apices. The abaxial costal scales of *B. indicum* are clathrate and are very small with reddish brown cross walls; those of *B. serrulatum* are paler, slightly larger and less distinctly clathrate. The veins of the pinnae in *B. indicum* are usually distinct on both surfaces while those of *B. serrulatum* tend to be more immersed and indistinct on the lower surface. The pinnae of *B. serrulatum* are more distinctly coloured with the upper surface shiny and often a dark bronze colour. The pinna margins tend to more regularly serrate to denticulate.

3. The holotype of *B. indicum* from Java is lost. A specimen with what appears to be an original herbarium sheet and label at Herbarium Delessert, Geneva, was identified and annotated on 10.9.1951 by F. Ballard at Kew as *Asplenium longissimum* Blume. The brief Latin description, “Felix Lonchitidis facie, alis denticulatis dupliciter auriculatis” matches that part of the original publication in Burman’s *Flora Indica* 1768. It is not known either when or by whom this specimen of *Asplenium longissimum* was attached to this sheet.

4. We have examined a wide range of specimens from most parts of the Malesian region but have not seen material from Java. This is somewhat puzzling for such an abundant, widespread and widely utilised species. [Note of the editor: It is uncertain whether Pryon, the collector of the type, ever was in Java. The species does not figure in Backer & Posthumus, *Varenflora of Java*].

## 9. *Blechnum keysseri* Rosenst.

*Blechnum keysseri* Rosenst., Feddes Repert. Spec. Nov. Regni Veg. 12 (1913) 527; T.C. Chambers & P.A. Farrant, *Blumea* 46 (2001) 316. — Type: *I.C. Keysser 220p* (holo Stockholm; iso BM, fragment), ‘Nova Guinea germanica in montibus Sattelberg montem superantibus’, 1400–1500 m, Apr. 1913.

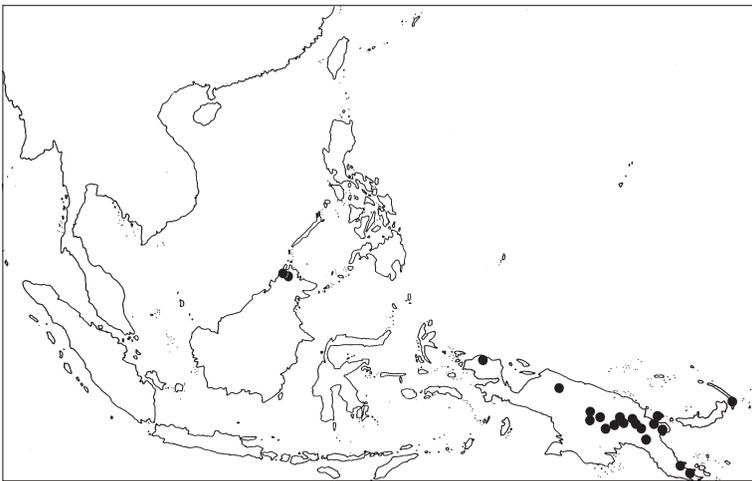
*Blechnum saxatile* Brause, Bot. Jahrb. Syst. 56 (1921) 152. — Type: *Ledermann 11046* (holo B; iso BM, fragment), NE New Guinea, 'Kaiserin-Augusta-Fluß-(Sepik-)Gebiet', 26 Feb. 1913.

*Blechnum ledermanni* Brause, Bot. Jahrb. Syst. 56 (1921) 153. — Type: *Ledermann 11595* (holo B; iso B), NE New Guinea, Schraderberg.

*Blechnum deorso-lobatum* Brause, Bot. Jahrb. Syst. 56 (1921) 154. — Type: *Ledermann 11905* (holo B); syntype: *Ledermann 11932a* (B, BM, fragment), NE New Guinea, Schraderberg.

*Blechnum borneense* C.Chr., Dansk Bot. Ark. 9, 3 (1937) 56. — Type: *E. Mjöberg 398* (holo BM; iso BM), Dutch Borneo, Mt Tibang, 1400–1700 m, Nov. 1925.

*Rhizome* short, semi-erect, erect or rarely scandent, 1 cm diam., densely clothed at the apex with scales which are ovate acuminate, 0.4–1 by 0.1–0.3 cm, entire, shiny, reddish brown sometimes with slightly paler margins. *Fronde*s dimorphic, sterile and fertile fronds 15–100 cm or more in length, 5–28 cm wide; the fertile lamina sometimes smaller than the sterile, but with a longer and more fully pigmented stipe and rhachis; fertile fronds often smaller than sterile and with more fully pigmented stipe and rhachis. *Stipes* 4–20 cm, pigmented purplish black to dark reddish brown, usually on the abaxial face, groove of upper surface of stipe paler, scales at the base similar to those of the rhizome but usually shorter, sometimes surface near the base densely covered with short, fine, reddish brown, multicellular uniseriate hairs which when shed leave a papillose surface, otherwise glabrous and smooth. *Lamina* narrowly elliptic to ovate, the sterile deeply pinnatisect for most of its length becoming pinnate towards the base and pinnatifid at the apex, 7–30 pairs of pinnae plus 0–15 reduced lobes at the base, the sterile lamina usually  $\frac{2}{3}$  the length of the frond; the fertile lamina often only half the length of the frond. *Rhachis* and *costae* pigmented on the abaxial face up to almost the length of the rhachis and the costae, otherwise pale stramineous, sometimes very short fine reddish brown hairs present but more often glabrous. *Sterile pinnae* long narrowly elliptic, slightly to distinctly falcate, acuminate, 6–16 by 0.8–2.5 cm, adnate, contiguous, coriaceous, margins entire, slightly thickened, narrowly revolute, undulate at apices, pinnae dark green on upper surface, mid-green to very pale almost white on



Map 8. Distribution of *Blechnum keysseri* Rosenst.

lower surface, veins immersed, simple or often several times furcate and terminating submarginally in round glands, basal pinnae shorter then abruptly reduced to very short vestigial auriculate lobes, often only 0.2–0.3 cm (or less) long and 1.5 cm broad, contiguous or several cm distant, terminal pinna broader and sometimes larger than the lateral pinnae of the mid-region and may be pinnatifid at its base. *Fertile pinnae* narrow



Fig. 11. *Blechnum keysseri* Rosenst. a. Habit; b. detail abaxial face base of sterile frond; c. sterile pinna abaxial surface; d. detail abaxial fertile pinna and rhachis (a: Schodde 1621; b–d: Croft & Marsh 1364, Bismark Range, PNG; all CANB). — Drawing by Lesley Elkan.

linear acuminate, 5–20 by 0.15–0.45 cm, sori continuous and occupying undersurface except for c. 1 cm at the pinnae apices, adnate and decurrent at the rhachis, basal pinnae shorter than steeply reduced to aborted lobes or minute vestigial outgrowths, usually sterile, increasingly distant and similar to at the base of the sterile lamina. *Spores* 43.2 by 34.7  $\mu\text{m}$  (from 13 herbarium specimens), perine smooth, scabrous, microrugulose or with some reticulation, exine smooth. — **Fig. 2h, 11; Map 8.**

Distribution — *Malesia*: Borneo (Sabah: Kinabalu), Papua, Papua New Guinea (W Sepik, Madang, W Highlands, E Highlands, Morobe, S Highlands, Central Papua New Guinea, Milne Bay, New Ireland).

Habitat — In a range of low and high montane habitats, from forested areas ranging from conifer forests (Mt Nettoti, W Irian) to *Nothofagus*-dominated submontane forests (Mt Giluwe, Papua New Guinea) and moss forests (Kubor Range, Papua New Guinea). It occurs in a variety of ecological niches: often on the sides of steeply sloping ravines and gullies, on rocks alongside rivers and streams, and in open areas on forest floors.

Notes — 1. *Blechnum keysseri* is not well understood and there do not appear to be any characters which would reliably separate it from *B. borneense*, *B. ledermanni*, *B. saxatile*, and *B. deorso-lobatum*. The type specimens of *B. keysseri* are fragmentary and the extended description given here is based on a few additional more complete collections. The very robust specimens *T.G. Walker T8774* and *Jermy 4134* (both BM) considerably extend our understanding of the size variation likely to be found in *B. keysseri*.

2. Specimens of *B. keysseri* are usually easily separated from *B. melanocaulon* which has sterile pinnae conspicuously decurrent at the rhachis. However, some specimens of *B. keysseri* from Papua New Guinea have pinnae that broaden slightly on the basiscopic margin at the rhachis (e.g. *Hoogland 9218*, CANB, NSW).

## 10. *Blechnum melanocaulon* (Brack.) T.C.Chambers & P.A.Farrant

*Blechnum melanocaulon* (Brack.) T.C.Chambers & P.A.Farrant, *Blumea* 46 (2001) 318. — *Lomaria melanocaulon* Brack., U.S. Expl. Exped. 16 (1854) 122. — Type: *Brackenridge s.n.* (holo US, photo seen), Mt Majijaijai, Luzon, Philippine Islands.

*Lomaria cumingiana* Hook., *Fil. Exot.* (1868) in note under *L. patersonii* pl. 49, non *Blechnum cumingianum* Trevis. (1851). — *Lomaria elongata* Blume var.  $\beta$  *cumingiana* Hook., *Sp. Fil.* 3 (1860) 4, t. 143. — Type: *Cuming 200* (holo K, a simple form with entire narrowly elliptic lamina and darkly pigmented stipes for both sterile and fertile fronds), Luzon.

*Blechnum coriaceum* (Brack.) Brownlie, *Pterid. Fl. Fiji* in *Nova Hedwigia* 55 (1977) 315, pl. 34, f. 2. — *Lomaria coriacea* Brack., U.S. Expl. Exped. 16 (1854) 122, nom. illeg., non *Lomaria coriacea* Schrad. (1812). — Type: *W.D. Brackenridge 4* (holo US, n.v.), Fiji.

*Lomaria patersonii* auct. non (R.Br.) Spreng.: Baker, *Syn. Fil.* (1868) 295. — *Blechnum patersonii* auct. non (R.Br.) Mett.: Copel., *Ferns of Fiji*, Bernice P. Bishop Mus. Bull. 59 (1929) 57.

*Rhizome* short creeping to suberect, variable in thickness 1–4 cm diam. including bases of old stipes, scaly at the apex but scales not usually persistent, scales narrowly elliptic-ovate, attenuate to acute, 0.3–1.4 by 0.1–0.4 cm, entire, dark reddish brown sometimes fading and slightly paler at the margins. *Fronde*s both sterile and fertile fronds heteromorphic, dissected fronds 20–90 by 4–30 cm, fertile fronds often longer than sterile. *Stipes* 3–20 cm, up to half the length of the frond (stipes of fertile fronds usually longer than those of sterile fronds), variable in thickness, glabrous except for scales at



Fig. 12. — a–c: *Blechnum melanocaulon* (Brack.) T.C.Chambers & P.A.Farrant subsp. *melanocaulon*. a. Juvenile plant; b. mature plant, sterile fronds and one fertile frond; c. fertile frond (specimen from New Ireland) illustrating some variation in the arrangement of the sori (a, b: *Hernez* 2009, Mt Banahaw, Quezon, 2188 m, Philippines; c: *Merrill*, Mt Banajao, Prov. Laguna, Luzon, Philippines; all NSW). — d: *B. melanocaulon* subsp. *pallens* T.C.Chambers & P.A.Farrant. Sterile frond of a large specimen (*Croft* 309, ridge E of Weitin R. WNW Taron, S New Ireland PNG; NSW). — e: *B. patersonii* (R.Br.) Mett. subsp. *queenslandicum* T.C.Chambers & P.A.Farrant. Small plant illustrating the transition from juvenile to adult foliage (*Stevens* LAE 55619, Milne Bay, Raba Raba Subdist., Mt Suckling, 1980 m; CANB). — Drawing by Marion Westmacott.

the base similar to those of the rhizome, sometimes short pilose reddish brown hairs at base of stipe. *Lamina* narrowly elliptic, tapering evenly to both ends (simple fronds) to ovate or deltoid (lobed, pinnatifid or pinnatisect fronds), 2–13 pairs of pinnae then 0–11 pairs of well-spaced, very reduced vestigial pinnae or crescent shaped lobes extending down the rhachis of larger fronds, fertile lamina shows a similar range of variation from simple entire to pinnate. *Rhachis* and *costae* stramineous, brown, reddish brown, dark purple, or black depending on subspecies, glabrous. *Sterile pinnae* or *lobes* narrowly elliptic, ensiform, tending to falcate, attenuate at apices, constricted near rhachis, often widening at the base, varying greatly in size, 2.5–21 by 1.3–3.2 cm, adnate decurrent, coriaceous, margins with a fine cartilaginous border, entire, often appearing crenate towards their apices on dried specimens due to shrinkage of the very finely revolute margin between the terminal vein glands, veins immersed, inconspicuous but often more conspicuous on the lower surface, single or once furcate, terminating submarginally in a gland, basal segments reduced to progressively smaller and more distant crescent shaped lobes or wing-like auricles, terminal segment as large as or larger than lateral segments, asymmetrically pinnatifid at its base, subterminal segments with a markedly decrescent basisopic wing extending down the rhachis. *Fertile pinnae* narrow linear, 4.5–25 by 0.3–0.5 cm, more distant on rhachis than sterile pinnae, adnate, markedly decurrent and almost contiguous in the upper portion of the lamina but towards the base usually more distant, reduced and sessile or sometimes shortly petiolate, sterile vestigial auricles down the rhachis, sori covering underside of pinnae except for sterile shortly attenuate apices up to 0.6 by 0.1 cm and in the more basal segments a short narrow sterile basal zone. *Spores* 45.3 by 33.9 µm (from 20 herbarium specimens), perine ridged, smooth, scabrous or microrugulose, exine smooth to scabrous or microverrucose. — **Fig. 2i, 12a–d; Map 9.**

Notes — 1. Analysis of Brackenridge’s descriptions of *Lomaria melanocaulon* and *L. coriacea* indicates no significant differences between the two. *Lomaria melanocaulon* is regarded as the older epithet.

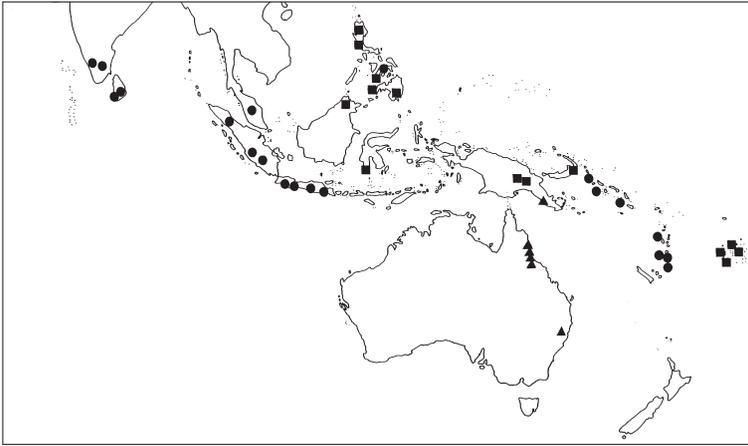
2. *Blechnum melanocaulon* is related to *B. colensoi* (Hook.f.) N.A.Wakef. of New Zealand, a much more robust plant with fewer pinna lobes and with deeply pigmented stipes. *Blechnum melanocaulon* may also be confused with *B. patersonii*, especially *B. patersonii* subsp. *queenslandicum* from NE Australia. The latter however, is winged rather than auriculate at the base of the lamina (although sometimes the wings break up into 1 or 2 auricles at the very base).

KEY TO THE SUBSPECIES

- 1a. Upper stipe, and often also rhachis and costae, deeply pigmented purplish black, at least on adaxial surface . . . . . **a. subsp. melanocaulon**
- 1b. Upper stipe, rhachis and costae of mature sterile frond not deeply pigmented purplish black . . . . . **b. subsp. pallens**

**a. subsp. melanocaulon**

*Stipes* smooth, darkly pigmented on adaxial surface, dark purple, reddish brown, brown or black, fading to pale stramineous on the upper grooved surface. *Rhachis* and



Map 9. Distribution of *Blechnum melanocaulon* (Brack.) T.C.Chambers & P.A.Farrant subsp. *melanocaulon* (■), *B. melanocaulon* subsp. *pallens* T.C.Chambers & P.A.Farrant (●), and *B. patersonii* (R.Br.) Mett. subsp. *queenslandicum* T.C.Chambers & P.A.Farrant (▲).

*costae* sometimes stramineous on grooved upper surface, but on the semi-terete under-surface darkly pigmented purple which may grade to stramineous towards the apex and on *costae*. *Fertile pinnae* 4.5–13 by 0.3–0.5 cm. — **Fig. 2i, 12a–c; Map 9.**

**Distribution & Habitat** — *Malesia*: Borneo (Sabah: Mt Kinabalu), Philippines over a range of altitudes, Sulawesi (G. Bonthain, above c. 2000 m), Papua New Guinea (E Highlands, New Ireland). *Outside Malesia*: Fiji in lowland areas along streambanks in rain forest and in dense undergrowth of mixed open forests and up to 2400 m in mountain forests.

**Notes** — 1. Specimens of *B. melanocaulon* subsp. *melanocaulon* differ from those of subsp. *pallens* which have pale upper stipe and rhachis and which tend to have a greater number of pinnae and lobes. The stipe and underside of the rhachis of subsp. *melanocaulon* is usually deeply pigmented but pigmentation rarely extends beyond the rhachis to the *costae*.

2. Simple fronded forms occur. The medium-sized plants are the most distinctive in that the lower pinnae are suddenly reduced, separate and have no more than two to a few rounded lobes.

#### **b. subsp. *pallens* T.C.Chambers & P.A.Farrant**

*Blechnum melanocaulon* (Brack.) T.C.Chambers & P.A.Farrant subsp. *pallens* T.C.Chambers & P.A.Farrant, *Blumea* 46 (2001) 321.

*Lomaria elongata* Blume, *Enum. Pl. Javae* (1828) 201, non *Blechnum elongatum* Gaudich. (1826). — *Lomaria patersonii* (R.Br.) Spreng. var. *elongata* (Blume) Alderw. (as '*patersonii*'), *Malayan Ferns* (1908) 379, p.p. — *Blechnum patersonii* (R.Br.) Mett. var. *elongatum* (Blume) Domin, *Biblioth. Bot.* 85 (1915) 109. — Type: *Blume s.n.* (holo L), Java, Kandang Badak.

*Lomaria punctata* auct. non Blume: Kunze, *Farrnkräuter* (1842) 91, t. 137.

*Lomaria patersonii* auct. non (R.Br.) Spreng.: Baker, *Syn. Fil.* (1868) 295.

*Blechnum patersonii* auct. non (R.Br.) Mett.: Copel., *Ferns of Fiji*, Bernice P. Bishop Mus. Bull. 59 (1929) 57; A.G.Piggott & C.J.Piggott, *Ferns of Malaysia in colour* (1988) 405, pl. 1242–1244.

*Stipes* very dark at the base, then brown or reddish brown grading on adaxial grooved surface to fawn-brown becoming paler stramineous for the remainder usually on both surfaces. *Rhachis* and *costae* usually pale stramineous, glabrous, sometimes brown or reddish brown, usually darker on abaxial surface and more so for fertile fronds. *Fertile pinnae* 10.5–25 by 0.3–0.5 cm. — **Fig 12d; Map 9.**

Distribution — *Malesia*: Sumatra (G. Kerintji), Peninsular Malaysia (Cameron Highlands), Java, Philippines (Negros), Papua New Guinea (Bougainville). *Outside Malesia*: It extends to Sri Lanka and southern India to the north-west. To the south-east it extends to the Solomon Islands and Vanuatu. There is a record from Upper Burma and a dubious one from Mauritius.

Habitat — Usually found in areas of perpetual high humidity, including tall mossy forest in the Cameron Highlands of Peninsular Malaysia, montane cloud forest with *Pandanus* at 1300 m on Bougainville, at 1900–2200 m and at somewhat higher altitudes on shady streambanks in Sri Lanka, in ravines of southern India, and on ridgetops (montane mossy forests) and river banks in lowland rain forests of Vanuatu. In Java recorded from 1400–2500 m.

Notes — 1. We have selected the subspecific name of *pallens* because stipe, rhachis, and costae are paler than those of *B. melanocaulon* subsp. *melanocaulon*. *Blechnum melanocaulon* subsp. *melanocaulon* has darkly pigmented stipe and rhachis (and sometimes costae), at least on the abaxial surface.

2. In the living state the mature fronds of *B. melanocaulon* subsp. *pallens* are very dark green, shiny, fleshy and brittle and the new fronds brilliant deep pink.

## 11. *Blechnum nesophilum* T.C.Chambers & P.A.Farrant

*Blechnum nesophilum* T.C.Chambers & P.A.Farrant, *Blumea* 46 (2001) 322.

*Rhizome* a ground fern with erect radial caudex, (dimensions not known but judging by the thickness of the frond stipes the caudex must be massive); scales narrowly elliptic c. 3 by 0.3 cm, entire, brown to reddish brown, sometimes shiny. *Fronds* dimorphic, sterile fronds spreading and arched, mature fronds 110–250 by 20–62 cm; fertile fronds erect and with longer stipes but usually the lamina is of smaller dimensions. *Stipes* 50–100 cm, smooth, green, brown or pale fawn, with persistent and, up to c. 20 cm above the base, dense linear-narrowly elliptic scales 1–2 by 0.2–0.3 cm at base, tapering evenly from a short basal region to a fine attenuate hair-like apex, mostly entire, pale to dark brown. *Lamina* ovate-deltoid, 1-pinnate, in living material mid to dark green and glossy or semiglossy on adaxial surface, slightly paler and not so glossy on abaxial surface, young fronds red, lamina widest 3–5 pairs of pinnae above the base, 28–60 pairs of pinnae; fertile lamina of smaller dimensions and dark brown with little or no photosynthetic surface. *Rhachis* and *costae* green, brown or pale fawn, scales linear-narrowly elliptic to triangular, 0.6–1.6 by 0.1–0.2 cm (costal scales to 1 cm long), tapering to apex, mostly entire, varying from silvery-white to pale reddish brown, and occasionally with a few cells with slightly darker point of attachment. *Sterile pinnae* oblong-narrowly elliptic, rounded at rhachis but sometimes tapering to a short petiole and always on mature fronds tapering to attenuate apices, on mature plants 20–33 by 1.3–2.6 cm, shortly petiolate to subpetiolate or sessile, uppermost few pairs often basiscopically adnate,

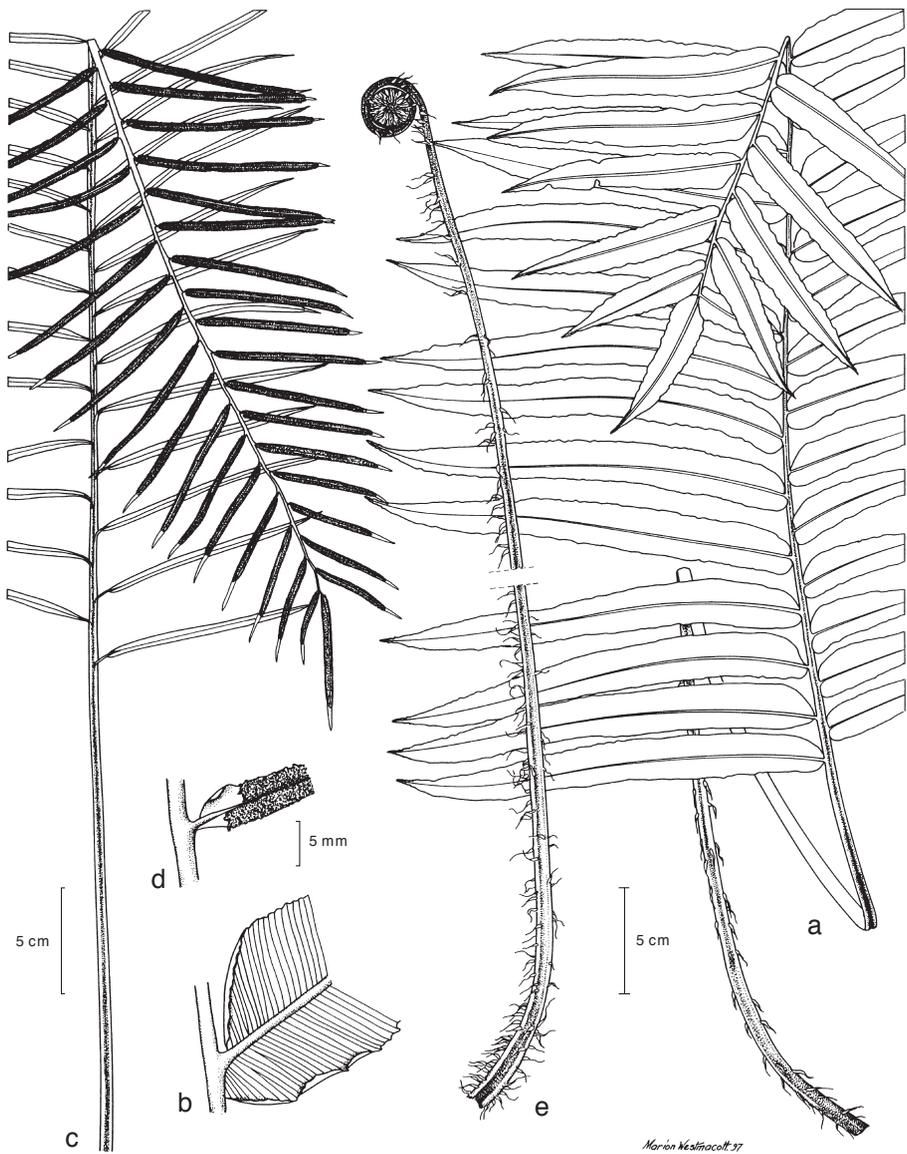


Fig. 13. *Blechnum nesophilum* T.C.Chambers & P.A.Farrant. a. Sterile frond; b. detail of abaxial sterile pinna from mid-region showing relation to rachis; c. fertile frond; d. detail of abaxial fertile pinna below the mid-region of the lamina; e. young expanding sterile frond (Croft *et al.* 1916, W slopes Mt Tumbumpo, New Ireland, PNG; CANB). — Drawing by Marion Westmacott.

papery to coarsely papery, margins often wavy, never revolute, usually finely toothed for most of their length becoming serrate to dentate towards their apices, basal pinnae slightly reduced in length, pinnae in the lower half of the lamina set at right angles to the rachis (more distal pinnae are at an angle of c. 45–60°), terminal pinnae usually a little longer than the subterminal few pairs; veins 0.09 mm apart, single or once furcate

terminating in a clavate gland most of which are in the axils of the serrations. *Fertile pinnae* linear, 11–22 by 0.3–0.55 cm, sessile or shortly petiolate (petioles up to 2 cm), sometimes basiscopically adnate for several pairs below the frond apex, costal scales mostly pale, sori covering underside of fertile pinnae, and extending to the pinnae bases at the rhachis but with a short sterile region at pinnae apices. *Spores* c. 72.1 by 54.6  $\mu\text{m}$  (from 7 herbarium specimens), perine fenestrate to densely reticulate, coralline in appearance, exine smooth to scabrous. — **Fig. 1a, 13; Map 2.**

Distribution — *Malesia*: So far only collected from New Guinea (Manus Island (Admiralty Group), New Britain, New Ireland, Lihir Island) *Outside Malesia*: Solomon Islands (Kolombangara, E San Christobel, Guadalcanal).

Habitat — It is most frequently reported from disturbed ridge habitats in low forest, sometimes grassy and dominated by low forest trees of *Weinmannia*, *Eurya*, *Planchonella*, and *Cryptocarya*, 700–1300 m. It occurs on limestone and volcanic derived soils in areas of high precipitation.

Vernacular names — Not known for the Malesian region but referred to as ‘Buna-Bona’ on San Christobel in the Solomons (*Braithwaite RGS 4302*).

Notes — 1. At first we included specimens here referred to as *B. nesophilum* with the species we have now defined as *B. dilatatum*. However, they differ from *B. dilatatum* in a number of details. Most specimens of *B. nesophilum* are reported to have a short erect radial caudex; the dried lamina is papery, sometimes coarsely papery; the sterile pinnae are long, oblong-narrowly elliptic, markedly attenuate, very finely toothed for most of their length, with dentate margins towards their apices; pinnae in the lower half of the lamina are set at right angles to the rhachis while the more distal pinnae are at an angle of c. 45–60°; the spores are distinctive and have a coralline ornamentation (Fig. 1a) (those of *B. dilatatum* are costate with thick ridges); the fertile pinnae of *B. nesophilum* lack the short sterile base frequently seen in basal fertile pinnae of *B. dilatatum*.

2. The specimen from San Christobel in the Solomons is exceptionally robust with sterile pinnae above the mid-region of the frond 3 cm in width and 32 cm in length; the basal fertile pinnae have petioles up to 2 cm long.

3. *Blechnum nesophilum* may be confused with *B. milnei* (Carruth.) C.Chr. from Fiji and some other Pacific Islands. It is possible that both *B. nesophilum* and *B. milnei* are present on the main islands of Fiji and that *B. milnei* is the species in the low-land rain forests.

4. In the absence of fertile fronds we have provisionally included specimens from the Solomons which almost certainly belong to this taxon.

## 12. *Blechnum orientale* L.

*Blechnum orientale* L., Sp. Pl. (1753) 1077 (as ‘*B. occidentale*’ in error; corrected in (1763) 1535); Hook., Fil. Exot. (1859) pl. 77; Holttum, Revis. Fl. Malaya 2 (1954) 446, f. 259b, 260a, 262a–d; P.M.Zamora & Co, Fl. & Fauna Philipp. (1986) 51, f. 43; A.G.Piggott & C.J.Piggott, Ferns of Malaysia in colour (1988) 400, pl. 1226–1231; S.B.Andrews, Ferns Queensland (1990) 94, f. 7.4B; T.C.Chambers & P.A.Farrant, Blumea 46 (2001) 324. — *Asplenium orientale* (L.) Bernh., J. Bot. Gottingen 1801 (1802) 17. — *Blechnopsis orientalis* (L.) C.Presl, Epimel. Bot. (1851) 117. — *Salpichlaena orientalis* (L.) Fée, Mém. Foug., 5. Gen. Fil. (1852) 79. — *Spicanta orientalis* (L.) Kuntze, Revis. Gen. Pl. 2 (1891) 821. — Type: *P. Osbeck s.n.* (holo LINN), ‘Habitat in China’, see note 6.

- Blechnum longifolium* Cav., Descr. Pl. (1802) 263. — *Blechnopsis longifolia* (Cav.) C.Presl, Epimel. Bot. (1851) 118. — *Salpinchlaena longifolia* (Cav.) Trevis., Atti Ist. Veneto Sci. Lett. Arti (1869) 575. — Type: *Don Luis Née s.n.* (n.v.), ‘Islas Marianas’.
- Blechnum salicifolium* Kaulf., Enum. Filic. (1824) 160, non (Kunze) Ettingsh. — *Blechnopsis salicifolia* (Kaulf.) C.Presl, Epimel. Bot. (1851) 116. — Type: *Chamisso s.n.* (n.v.), Manila.
- Blechnum pectinatum* C.Presl, Reliq. Haenk. 1 (1825) 51, non Hook. — *Blechnopsis pectinata* (C.Presl) C.Presl, Epimel. Bot. (1851) 118. — *Salpinchlaena pectinata* (C.Presl) Trevis., Atti Ist. Veneto Sci. Lett. Arti (1869) 575. — Type: *Haenke s.n.* (iso K, ex Herb. Forbes Young), ‘Insulis Marianis’.
- Blechnum elongatum* Gaudich., Voy. Uranie, Bot. (1826) 395. — Type: *C. Gaudichaud s.n.* (iso FI, Herb. Webbianum ex Herb. Desfontaines [a mid-frond fragment]), ‘Insulis Marianis (Guam)’.
- Blechnum lomarioides* Gaudich., Voy. Uranie, Bot. (1826) 396, non Mett., nec Sodiro. — Type: *M.L. de Freycinet s.n.* (holo FI, ex Herb. Webbianum ex Herb. Desfontaines), ‘Insulis Marianis (Guam)’.
- Blechnum javanicum* Blume, Enum. Pl. Javae (1828) 197. — *Blechnopsis javanica* (Blume) C.Presl, Epimel. Bot. (1851) 118. — Type: *Blume s.n.* (n.v.), ‘crescit in Javae montanis’.
- Blechnum pyrophyllum* Blume, Enum. Pl. Javae (1828) 197, incl. var. B and var. C. — *Blechnopsis pyrophila* (Blume) C.Presl, Epimel. Bot. (1851) 117. — *Salpinchlaena pyrophylla* (Blume) Trevis., Atti Ist. Veneto Sci. Lett. Arti (1869) 575. — Type: ?*Van Hasselt s.n.* in herb. Blume (holo L, barcode L0051109). — Var. B. Type: ?*Van Hasselt s.n.* (holo L, barcode L1151107), May 1823. — Var. C. Type: *Anonymous* (holo L, barcode L0051108 plus two double sheets).
- Blechnum imbricatum* Blume, Enum. Pl. Javae (1828) 198. — *Blechnopsis imbricata* (Blume) C.Presl, Epimel. Bot. (1851) 118. — *Salpinchlaena imbricata* (Blume) Trevis., Atti Ist. Veneto Sci. Lett. Arti (1869) 575. — Type: *Zippel s.n.* (holo L, Buitenzorg, Java; iso? K, ex Herb. Lugd. Batav.), ‘crescit in montanis Javae’.
- Blechnum elongatum* C.Presl, Tent. Pterid. (1836) 103. — *Blechnopsis elongata* C.Presl, Epimel. Bot. (1851) 117. — *Salpinchlaena elongata* (C.Presl) Trevis., Atti Ist. Veneto Sci. Lett. Arti (1869) 575. — Type: *Meyen s.n.* (holo Herb. Presl, n.v. but reported by Holttum, Nov. Bot. Inst. Bot. Univ. Carol. Prag. (1968) 29 as “a large frond with pinnae 25 by 2 cm” of *B. orientale* L.), Manila.
- Blechnum auritum* Goldm., Nov. Actorum Acad. Caes. Leop.-Carol. Nat. Cur. 16 Suppl. 1 (1843) 459. — Type: *I.G. Goldmann s.n.* (n.v.), Manila, location unknown.
- Blechnum macrophyllum* Goldm., Nov. Actorum Acad. Caes. Leop.-Carol. Nat. Cur. 16 Suppl. 1 (1843) 459. — Type: *I.G. Goldmann s.n.* (n.v.), Manila, location unknown.
- Blechnum moluccanum* Roxb., Calcutta J. Nat. Hist. 4 (1844) 502, non Desv. — Type: *Wall. Cat. 57* (lecto BR, with name in hand of Roxburgh, ex photo 19997 Morton), see note 7.
- Blechnum adnatum* Reinw. ex De Vriese, Ned. Kruidk. Arch. 1 (1846) 10. — *Blechnopsis adnata* (Reinw.) C.Presl, Epimel. Bot. (1851) 119. — *Salpinchlaena adnata* (Reinw.) Trevis., Atti Ist. Veneto Sci. Lett. Arti (1869) 576. — Type: *Reinwardt 1700* (n.v.) (holo L, 2 sheets no. 1700 are probably part of the type collection), Celebes insula Banda, June 1821.
- Blechnopsis cumingiana* C.Presl, Epimel. Bot. (1851) 116. — *Salpinchlaena cumingiana* (C.Presl) Fée, Mém. Foug., 5. Gen. Fil. (1852) 79 (non *Blechnum cumingianum* Trevis.). — Type: *Cuming, Pl. Philipp. 166* (holo K), Luzon, habitat in insula Luzon.
- Blechnopsis stenophylla* C.Presl, Epimel. Bot. (1851) 118. — *Blechnum stenophyllum* (C.Presl) Fée, Mém. Foug., 5. Gen. Fil. (1852) 74. — *Salpinchlaena stenophylla* (C.Presl) Trevis., Atti Ist. Veneto Sci. Lett. Arti (1869) 575. — Type: *Cuming, Pl. Philipp. 165*, partim (iso K), habitat in insula Luzon. This fragmentary specimen is characteristic of *B. orientale* from an exposed site with thick leathery but slender narrowly elliptic pinnae.

*Rhizome* forming stout erect or suberect caudex, usually short (6–20 cm) but occasionally forming a tree fern up to 2 m, 4–5 or more cm diam., densely covered with linear-narrowly elliptic scales, 1–2(–3.5) cm long usually less than 0.2 cm wide at the base, entire, shiny reddish brown. *Fronde*s: fertile and sterile fronds similar, erect, variable in size but up to and sometimes more than 200 by 54 cm. *Stipes* very short, 1–9 cm but usually only about 5 cm, and for large fronds up to 2 cm diam., dark purplish,

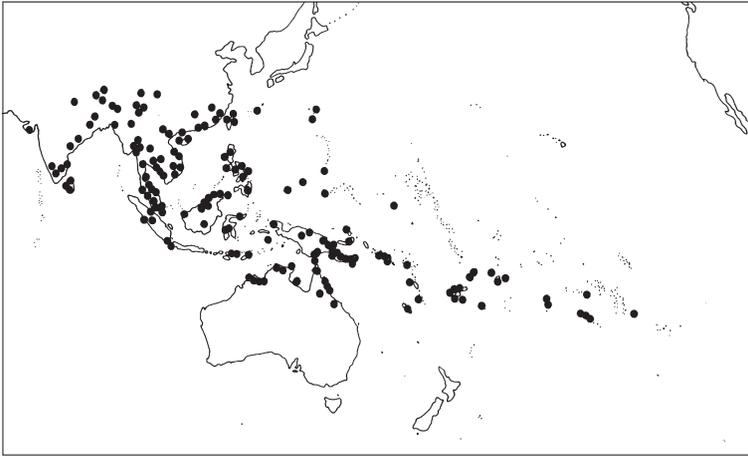
with persistent narrow, acuminate scales tapering to a fine wavy and often twisted apex, mostly entire, brown to reddish brown, surface of stipe often clothed with very fine tangled pale hairs. *Lamina* narrowly elliptic to ovate, pinnate, pinnae dense on the rhachis, 6–70 or more pairs of pinnae (not including auricles), pairs subopposite to alternate usually 2.5–5 cm apart and 0.2–0.3 cm in length and width but the lowermost often less than 0.1 by 0.1 cm. *Rhachis* and *costae* pale pinkish brown, paler on grooved adaxial surface, glabrous or with sparse irregular hairs and slender reddish brown scales. *Sterile pinnae* narrowly elliptic, the apices gradually and evenly tapering to their tips, 5–30 by 0.5–2 cm, increasingly adnate and markedly basiscopically decurrent towards apex, and tending to become truncate or cuneate and sessile to subpetiolate or petiolate towards the lamina base, fresh material very variable in texture but usually coriaceous, margins entire and sometimes revolute (especially in exposed situations), gradually reducing to small rounded leafy auricles towards base, and reducing towards the frond apex, veins very fine immersed simple or forked once sometimes twice, often less than 0.5 mm apart. In juvenile plants the pinnae are fully adnate, those towards the apex are markedly decurrent while those towards the base have rounded obtuse apices and minute auricles extend down the rhachis to the stipe. *Fertile pinnae* similar to sterile pinnae except for presence of narrow sori (0.1–0.2 cm) closely parallel to and on either side of the abaxial costa; sori at maturity may obscure the abaxial surface of the costa. *Spores* 46.7 by 36.9  $\mu\text{m}$  (from 13 herbarium specimens), perine with irregular ridges, loosely reticulate, rugulose or scabrous, exine smooth to scabrous. — **Fig. 1b, 7g; Map 10.**

**Distribution** — *Malesia*: Throughout. *Outside Malesia*: Most abundant and widely distributed species of the genus, extending westwards from longitude 70° E and south of latitude 30° N through SE Asia, northern Australia, and eastwards through the tropical Pacific Islands mostly north of the tropic of Capricorn to longitude 135° E. The species ranges from Nepal through India, Burma and Sri Lanka to China and Japan.

**Habitat** — Occupying a range of habitats, it is often a primary coloniser, from dry exposed soil banks (where mature plants are small) to creek banks, waterfalls, seepage areas, swamps, and open spaces on the margins of lowland and sometimes upland tropical and subtropical forests (where the plants are large). It is essentially a fern of high light conditions and often an important colonising species on bare ground after fire and on exposed and eroding surfaces such as road cuttings and after cultivation in high rainfall tropical areas.

**Chromosome number** — Roy & Singh (Sci. & Cult. 41 (1975) 181), Khare (Sci. & Cult. 46 (1980) 138), and Mahabale & Kamble (Proc. Indian Acad. Sci. 47 (1981) 260) reported for Indian material  $n = 32$ ; Singh & Roy (Indian Fern J. 5 (1988) 181) for Sikkim plants also reported  $n = 32$ . Tsai & Shieh (J. Sci. Engin. 20 (1983) 137) for Taiwan material reported  $n = 33$ , and for Indian material Vasudeva & Bir (Aspects Pl. Sci. 6 (1983) 119) and Manickam & Raj (Cytology of ferns of the western Ghats (South India) today & tomorrow (1988)) also reported  $n = 33$ . Ghatak (Nucleus 20 (1977) 105) for Indian material reported  $n = 34$ . M. Tindale (pers. comm.) has  $2n = c. 64–66$  for Australian collections.

**Vernacular names** — *Blechnum orientale* is a widespread species with many local names and uses. On Waya Island, Yasawa Group, Fiji, *St John 18061* notes it is used for salu-salu (a necklace probably of the new brightly coloured fronds) and called



Map 10. Distribution of *Blechnum orientale* L.

ndondobalawa. On Rotuma Island the same collector (19157) records it as juliaroora. A.C. Smith 5337 records it on Viti Levu, Fiji as solevaleva. In New Guinea various local tribal names are recorded. *Hoogland* 3336 (BM, K) records it as zani in Orokaiva language at Mumuni while at Mt Lamington *Hoogland* 3305 in the same language records it as aduba. In W Java it is referred to as paku hadji (in Sunda) (*Adelbert* 262) and in Malaysia as paku ikan (fish fern) paku lipan (centipede fern), paku ubil, paku ular (snake fern) and paku ulat (worm fern).

Uses — “*Blechnum orientale* L. is used together with *Elephantopus scaber* [an abundant tropical weed in the Compositae] for dropsy. The fern is believed to entice out the ‘centipede’ [or worm or snake] which has lodged in the liver” (Johnson, *Malayan Nat. J.* 11 (1957) 59). A recent paper by Christensen (*Holttum Mem Vol.* (1997)) records the vernacular names pao abu for the Kelabit and kelindang for the Iban people; both groups use the species for medicine and as a vegetable. The Kelabit in Nanga Sumpa pound young fronds and use the resulting paste to treat blisters and abscesses; in Pa Dalih a decoction is made from the young fronds and drunk to treat mouth ulcers. Also in Nanga Sumpa, *B. orientale* is mixed with hot spices and other vegetables and eaten raw as ulam.

Notes — 1. The extreme phenotypic plasticity of *B. orientale* not only allows it to tolerate an exceptionally wide range of habitats but also to have spore bearing plants which range from less than 20 cm in height to over 300 cm and this partly accounts for the extensive list of synonyms.

2. Some variation may be genotypic, understanding of which would require transplant experiments and molecular studies. The growth form varies from small leathery fertile plants on dry exposed soil banks to large harsh ferns of open spaces on the margins of lowland and sometimes upland tropical and subtropical forests.

3. The fronds of the young plants from about the 5-leaf stage resemble scaled-down mature sterile plants and the basal auricles are already present on the rachis. Under some conditions the plants may become fertile even at this early stage. The pinnae of

the earliest fronds are adnate and the apices obtuse while those on slightly older plants are acute.

4. Herbarium specimens from large mature plants can be easily confused with those of *B. finlaysonianum*, but the young plants of *B. orientale* are readily identified as they are scaled-down versions of the mature plants whereas those of *B. finlaysonianum* are very distinctive (see description under that species). Mature plants of the two species are less likely to be confused in the field as *B. finlaysonianum* is essentially a shade fern of forest habitats with pinnae up to 4 cm wide that usually do not taper significantly until the apex, which narrows suddenly to become acuminate or even attenuate then tapers into what appears to be a drip tip. Pinnae of *B. orientale* are usually less than 2 cm wide and taper evenly from the mid-region to an acute apex. The sori of *B. finlaysonianum* are consistently narrower than those of *B. orientale*. The separation of *B. finlaysonianum* and *B. orientale* is normally not difficult. Holttum (1954) points out a number of useful characters for separating these species.

5. Occasional mutant populations of *B. orientale* have been recorded with almost bipinnate fronds. We have not recognised these as separate taxa. At K, *Burbidge s.n.*, 1877–1878, Lantahan, Sabah, is a very large frond with each pinna in the mid-region equivalent to a whole small normal frond with auricles at its base. This matches var. *pinnatum* Bonap. (Notes Pteridol. 14 (1923) 125), the type of which comes from “Annam, 1500 m, *Dr Sallet s.n.*”. Molesworth Allen (Gard. Bull. Straits Settlements. 17 (1959) 263) illustrates a fine bipinnate form from Girdle Hill, Fraser’s Hill, 4200 ft, which she also reports from Batu Lintang Road in Kuching, Sarawak, at sea level.

6. This species was incorrectly listed as ‘*America meridionali*’ in Linnaeus’ Sp. Pl. (1753) 1077. Linnaeus (1753) referred *B. orientale* to a specimen from ‘*America meridionalis*’ and the other, *B. occidentale*, to a specimen ‘*Habitat in China, Osbeck*’, a situation he corrected in 1763. The naming of these two taxa has generally been accepted as an error, a view confirmed by Christensen (Index Filic. (1906)).

7. Another specimen at G (Morton photo 16837) which is part of Roxburgh Herbarium was not selected as lectotype as the name is not in Roxburgh’s hand, see Morton (Contr. U.S. Natl. Herb. 38 (1974) 303), Prince of Wales Island, Moluccas.

### 13. *Blechnum patersonii* (R.Br.) Mett. subsp. *queenslandicum* T.C.Chambers & P.A.Farrant

*Blechnum patersonii* (R.Br.) Mett. subsp. *queenslandicum* T.C.Chambers & P.A.Farrant, *Telopea* 6 (1995) 177, f. 1a–g; *Blumea* 46 (2001) 328. — Type: *Coveny & Hind 7216* (holo NSW 265764; iso BRI, DRA, Z), Australia, Queensland, c. 13 km NW of Julatten P.O., 11.1 km by road WNW of Mt Lewis forestry hut, 20 Sept. 1975.

*Lomaria patersonii* (R.Br.) Spreng. var. *elongata* auct. non (Blume) Alderw.: Alderw., *Malayan Ferns* (1909) 379. — *Blechnum patersonii* (R.Br.) Mett. var. *elongatum* auct. non (Blume) Domin: Domin, *Biblioth. Bot.* 85 (1915) 109, p.p. excluding the type.

*Rhizome* short-creeping to erect up to 3 cm in height and 0.5–2 cm diam., scales 0.4–1 by 0.1–0.3 cm, ovate, acuminate, shiny, entire, concolorous, dark reddish brown or bicolorous with paler margins. *Fronds* both sterile and fertile heteromorphic, erect, 7–80 by 1–23 cm, sterile fronds simple or pinnatisect, fertile fronds simple, pinnatisect or pinnate. *Stipes* below decurrent wings of lamina 1–13 cm long, brown, stramineous

to reddish brown, darkest at base, scales narrowly elliptic to ovate, entire, dark reddish brown to bicolorous. *Lamina* narrowly elliptic (simple fronds), narrowly elliptic to ovate (dissected fronds) with up to 7 pairs of pinnae or lobes, usually continuous narrow wings of lamina tissue extending down rhachis below main area of lamina. *Rhachis* and *costae* stramineous to brown or reddish brown, especially on abaxial surface, glabrous. *Sterile pinnae* or *lobes* narrowly elliptic, acuminate, 2–13 by 0.7–3.2 cm, firm, fleshy, brittle and dark green when fresh, usually coriaceous when dry, adnate and decurrently winged at rhachis, margins thin, reflexed, entire or minutely undulate (undulations associated with glands and vein endings), basal pinnae with decurrent wings extending down rhachis. *Fertile pinnae* or *lobes* of dissected fronds linear, to 25 by 0.3–0.5 cm, adnate to rhachis and decurrently winged. *Sori* covering undersurface of pinnae and wings. *Spores* 40.2 by 29.9  $\mu\text{m}$  (from 9 Australian herbarium specimens), perine smooth, scaberulous, granulose or minutely rugulose, exine smooth to minutely verrucose. — **Fig. 1c, 12e; Map 9.**

Distribution — *Malesia*: Lesser Sunda Islands (Flores, Timor), Papua New Guinea (Milne Bay). *Outside Malesia*: Australia (eastern Qld and north-eastern NSW), with the most distinct and robust forms being found in northern Queensland. We did not see 5 collections from Flores in L.

Habitat — Terrestrial or lithophytic, on moist banks near creeks, in wet sclerophyll forest and in rain forest; in the Milne Bay District in montane forests, often in rocky places and in forested ravines at about 2000 m.

Notes — 1. Andrews (Ferns Queensland (1990)) referred to all N. Queensland specimens under *B. patersonii* prior to our recognition of two subspecies.

2. *Blechnum patersonii* subsp. *queenslandicum* has been confused with *B. colensoi* of New Zealand and with the taxon we recognise here as *B. melanocaulon* subsp. *pallens*. All three when fresh are fleshy and brittle but *B. patersonii* subsp. *queenslandicum* has wings at the base of the lamina rather than auricles.

#### 14. *Blechnum revolutum* (Alderw.) C.Chr.

*Blechnum revolutum* (Alderw.) C.Chr., Index Filic. Suppl. 3 (1934) 46; T.C.Chambers & P.A.Farrant, Blumea 46 (2001) 329. — *Lomaria revoluta* Alderw., Nova Guinea 14 (1924) 31. — Type: *Lam 1708* (holo BO; iso BM, fragment), New Guinea, at foot of Doorman summit, terrestrial in sunny ravine, 3230 m, 24 Oct. 1920.

*Blechnum archboldii* C.Chr., Brittonia 2 (1937) 288. — Type: *L.J. Brass 4318* (holo BM), SW slope Mt Albert Edward, Central Div., 3680 m, shrubby fringe forest.

*Rhizome* both creeping and erect, the creeping rhizome slender 0.3–0.4 cm diam. giving rise to small fronds 2–3 cm apart, and an erect or suberect often massive caudex, 2–5(–7) cm diam., crowned with a rosette usually of 5–8 robust fronds and clothed with bases of old stipes and densely clothed with robust broadly acuminate, entire, shiny dark brown to dark mahogany coloured scales 1–3 by 0.25–0.7 cm, which vary from concolorous to distinctly bicolorous with a dark reddish brown, almost black central region and a reddish brown margin. *Fertile* and *sterile fronds* similar in the range of dimensions (except that fertile fronds usually have longer stipes so that much of the fertile lamina with its narrow linear pinnae is emergent), erect, 30–130 by 4–15 cm. *Stipes* 14–70 cm, strongly grooved on upper face, semi-terete below, variable in colour from

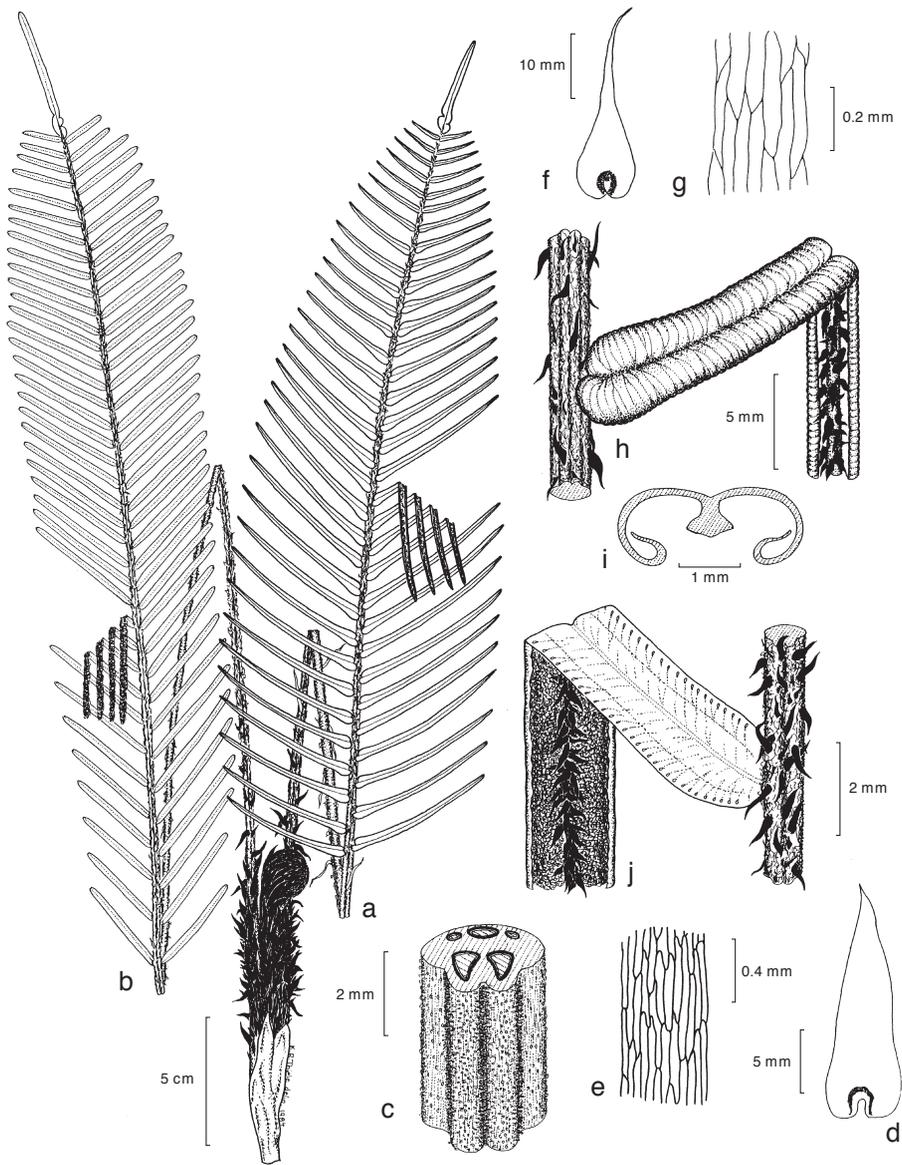


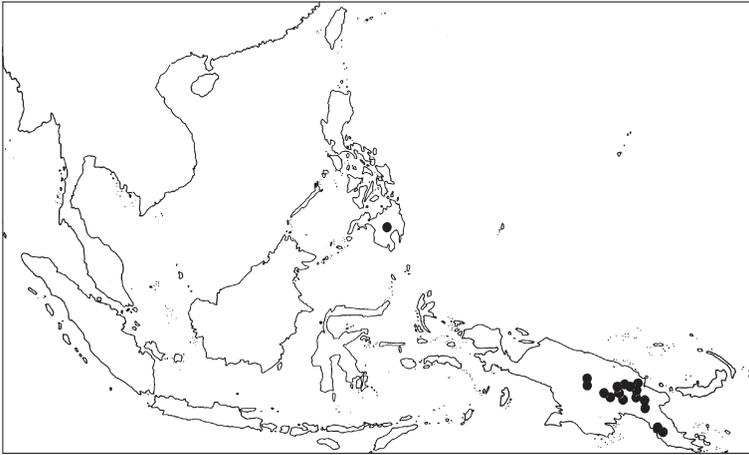
Fig. 14. *Blechnum revolutum* (Alderw.) C.Chr. a. Sterile frond and apex of the caudex; b. fertile frond; c. portion of mid rhachis (indumentum removed); d. scale from lower region of stipe; e. cell detail mid-region of scale; f. abaxial costal scale, sterile frond; g. cell details; h. base of sterile pinna and adaxial face of rhachis; i. cross section sterile pinna; j. base fertile pinna showing adaxial and abaxial surfaces and adaxial rhachis (Croft *et al.* 120, Mt Flora, PNG; CANB). — Drawing by K.R. Thiele.

pale stramineous to (more frequently) dark reddish purple, scales at the bases of stipes persistent, similar to those of the rhizome, those 10 cm above base similar in shape and colour (or sometimes lighter in colour) but somewhat smaller, up to 1.5 by 0.1–0.3 cm, also irregularly distributed lanuginose scales (smaller, matted and appressed scales of various shapes), stipes densely scaly in young stages but many scales deciduous. *Lamina* narrowly elliptic to narrowly ovate, pinnate, 60 cm or more in length, usually longer than the stipe but sometimes shorter, dark green above, mid green below, 6–55 pairs of pinnae. *Rhachis* and *costae* sometimes stramineous but more frequently brown, reddish brown or dark brown, densely scaly, especially on the costal undersurface, with conspicuous persistent acuminate entire scales similar to those of the stipe but smaller and usually paler; some scales (up to 1 by 0.2 cm) with darker centres mixed with irregularly distributed lanuginose fringed paler small linear scales on lower surface of costae, costae deeply grooved on upper surface. *Sterile pinnae* oblong-narrowly elliptic acuminate, frequently set at 45° to the axis of the rhachis and sometimes tending to be falcate, 4–7 by 0.4–0.8 cm, distinctly subpetiolate and distant on the rhachis but more crowded and sometimes semi-adsate towards the apex, brittle and coarsely coriaceous, margins entire and usually very strongly and persistently revolute; veins once or twice furcate, sunken in fine conspicuous grooves on upper surface, prominent on undersurface but obscured by dense scales; veins terminating in ovoid to clavate glands; basal pinnae gradually becoming shorter to approximately half the length of those of the mid-region and more distant, terminal pinna usually but not always longer than the subterminal pairs. *Fertile pinnae* narrowly elliptic obtuse, 4–10 by 0.3–0.5 cm, at maturity less conspicuously to not revolute and enlarging almost to the width of the sterile revolute pinnae, although usually a little shorter and set more closely and at a more acute angle on the rhachis, increasingly falcate towards the frond apex; veins terminating in rounded glands visible on the adaxial surface; sporangia completely covering the abaxial face. *Spores* c. 70.5 by 52.9 µm (from 10 herbarium specimens), perine costate-alate to saccate, loosely reticulate, lacunae irregular polygons, muri thick ridges, surface of perine scabrous to granulose or microreticulate, exine smooth to scabrous. — **Fig. 1d, 14; Map 11.**

**Distribution** — *Malesia*: Philippines (Mindanao), Papua New Guinea (W Sepik, Madang, W Highlands, E Highlands, Morobe, S Highlands, Central Papua New Guinea) where it is a distinctive species frequently with a robust erect caudex up to 1 m tall.

**Habitat** — Common in montane regions above 2500 m, in exposed alpine and subalpine grasslands, and on the edge of alpine shrub and montane forest. Some of the areas in which it is abundant are reported as fire-induced grasslands and the soils are often waterlogged and peaty; the plants of *B. revolutum* are often reported to be growing from a deep mossy layer, the erect trunks of old specimens partly buried in the moss-peat. There are records also from montane areas of the species growing on the margins of lakes and streams and on rocky ground in stream-beds and associated with shrubby species of *Coprosma*, *Vaccinium*, and *Halorhagis*, characteristic of these regions. It is a species adapted to exposed montane habitats often growing in fire-induced grasslands.

**Vernacular names** — Kangermabeh (Wahri: Minj), pingkama (Mairi: Mondo) (noted on specimens of *Hoogland & Pullen 5526*), teda (Mendi language) (*Schodde 1769*, CANB, but duplicate in NSW is probably not the same species).



Map 11. Distribution of *Blechnum revolutum* (Alderw.) C.Chr.

Notes — 1. The creeping underground rhizomes and repeated vegetative reproduction of *B. revolutum* due to the decay of the rhizomes and the creation of separate plants probably account for the local abundance, sometimes dominance, of this species.

2. *Blechnum revolutum* is usually readily separated from other species of the genus in the New Guinea area by the very strongly revolute sterile pinnae, their subpetiolate attachment to the rachis and the persistently densely scaly nature of most of the plant. These general features are also to be found in the tropical montane South American species *B. loxense* (Humb., Bonpl. & Kunth) Hieron., but the two can be separated by the nature of their scales. The South American species, while showing more variability, has basal stipe scales which are much thinner, more fragile, papery, and generally paler while those of the rachis and costae tend to have paler fringed margins and small dark centres.

3. Some Papua New Guinea specimens of *B. revolutum*, especially when growing in protected areas such as edges of lower subalpine and montane rain forest, have sterile pinnae which are not markedly revolute or may be only very finely revolute at the pinna margin. The pinnae are therefore flat rather than inrolled. Such specimens may be confused with *B. hieronymi* but the large broad dark reddish brown scales at the base of the stipe indicate they belong with *B. revolutum*, e.g. *Croft (et al.) LAE 61669*, from the margin of lower subalpine rain forest and Isuani grassland, has these less typical characters.

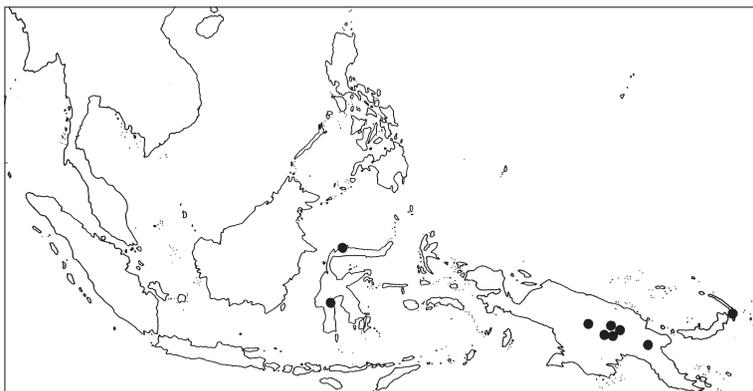
### 15. *Blechnum rosenstockii* Copel.

*Blechnum rosenstockii* Copel., Univ. Calif. Publ. Bot. 12 (1931) 394; T.C.Chambers & P.A.Farrant, Blumea 46 (2001) 332. — Type: *Keysser II 70* (holo UC 391403), New Guinea, Bolan, 2400–3000 m, 1912, see note 6.

*Blechnum fraseri* (A.Cunn.) Luerss. var. *novoguineense* Brause, Bot. Jahrb. Syst. 56 (1921) 159. — Type: *Ledermann 12215* (holo B), NE New Guinea, 2070 m.

*Blechnum tengwallii* Kjellb., Bot. Jahrb. Syst. 66 (1933) 57. — Type: *Kjellberg 1472* (isotype BM, fragment ex C.Chr.), Celebes, B. Poka Pindjang, 2500 m.

*Rhizome* forming a slender caudex less than 1 cm diam., erect up to 1 m, but tending to fall and be suberect, caudex scaly, scales linear, acuminate, entire, or occasionally toothed, 0.5–1.2 by 0.1–0.15 cm, ranging from mid brown to reddish brown shiny concolorous to mostly bicolorous with a darker zone of cells in the central region. *Fertile* and *sterile fronds* of similar dimensions, erect, 20–60 by 2.5–8 cm. *Stipes* short and slender 3–15 by 0.1–0.2 cm, brown to reddish brown, densely scaly at the base and with a few persistent scales above, stipe scales like those of the rhizome but grading to broader, shorter, paler, more peltate scales sometimes with irregularly toothed margins. *Lamina* linear narrowly elliptic, widest above the mid-region and very gradually tapering to the base, pinnatisect, pinnae up to 70 pairs, including triangular lobes at apex and base; lamina of living material dark-green above, mid green below. *Rhachis* and *costae* brown, greenish brown or reddish brown, often paler on underside, scaly at base and with a few persistent pale reddish brown entire acuminate scales above and some broader thin concolorous scales, some with toothed margins. *Sterile pinnae* narrow linear to narrowly elliptic, 1.6–3.2 by 0.3–0.6 cm, broad slightly decurrent base adnate to rhachis, thinly coriaceous to coriaceous, margins often finely revolute and ranging from entire to dentate with shallow to deep teeth or lobes angled towards the pinna apex, veins unevenly furcate, sometimes trifurcate, each branch terminating on the upper surface either in the mid-region or submarginally in a linear clavate gland, basal pinnae reduced to slightly distant triangular outgrowths, apical pinnae progressively reduced to adnate pinnatifid lobes, terminal segment larger than the lateral pinnae and dentate. *Fertile pinnae* slightly narrower than the sterile, shortly apiculate, sometimes a little constricted before the slightly decurrent adnate base, fertile pinnae below the mid-lamina region with sterile adnate decurrent bases; sori orange-brown, occupying the whole width of the undersurface except for sterile zone on either side of the midrib at the rhachis, basal pinnae often completely sterile. *Spores* orange-brown, 54.8 by 36.8  $\mu\text{m}$  (from 5 herbarium specimens), perine verrucose to very deeply verrucose, verrucae covered with scabrous layer which varies in its persistence, surface smooth to finely reticulate at the base of and sometimes entirely covering verrucae, exine smooth to granulose. — **Fig. 1e, 9a–f; Map 12.**



Map 12. Distribution of *Blechnum rosenstockii* Copel.

Distribution — *Malesia*: Sulawesi, New Guinea (Papua New Guinea: W Sepik, W Highlands, Morobe, S Highlands, New Ireland). A rarely collected species from the highlands; all collections are from above 2000 m.

Habitat — Montane and submontane rain forest dominated by *Nothofagus* at about 2700 m and subalpine forest at 3200 m.

Notes — 1. A little known species. The few collections come from widely separated areas, extending from Papua New Guinea to Sulawesi. It seems likely that new localities will be found, most likely in ecologically comparable areas of the region.

2. The slender caudex of *B. rosenstockii* is not usually sufficiently rigid for supporting the crown of fronds in an upright position and this results in the plant exhibiting a sprawling habit. *Blechnum fraseri* has a more rigid caudex holding the crown of fronds in an erect position. Both species tend to have a colonial habit, resulting in a miniature forest of these plants as an understorey of a taller forest.

3. Kjellberg in his description of *B. tengwallii* from Celebes (Sulawesi) described the plant with an erect trunk up to 1 m and more or less 1 cm diam. with the fronds aggregated at the apex, suberect or spreading, the sterile up to 60 by 7 cm narrowed to both ends pinnate or subpinnate slender and bright green. However, Copeland had already named this species as *B. rosenstockii* from a New Guinea collection. He based his original description on an incomplete specimen “because of its exceptional interest, it being the first form known to me intermediate between the body of the genus and the hitherto very isolated *Blechnum Fraseri*”. The holotype consists of an isolated fertile frond 45 by 5 cm broad; the pinnae bases are triangular 0.25 cm across spreading along the rhachis.

4. Croft has pointed out that the material at LAE reveals no intermediates with *B. fraseri* and that “on the three occasions when [he had] seen it in the field, although both species occurred together, no intermediates could be found” (Croft pers. comm.).

5. *Blechnum rosenstockii* is undoubtedly closely related to *B. fraseri* not only because of the similar spores (the verrucae in *B. rosenstockii* are even more prominent) but also they share rhizomes of similar appearance, develop a comparable caudex and have similar rhizome scale characteristics.

6. *Blechnum rosenstockii* de la Sota, Darwiniana 18 (1973) 254, t. 6, 7a is a later homonym.

## 16. *Blechnum vestitum* (Blume) Kuhn

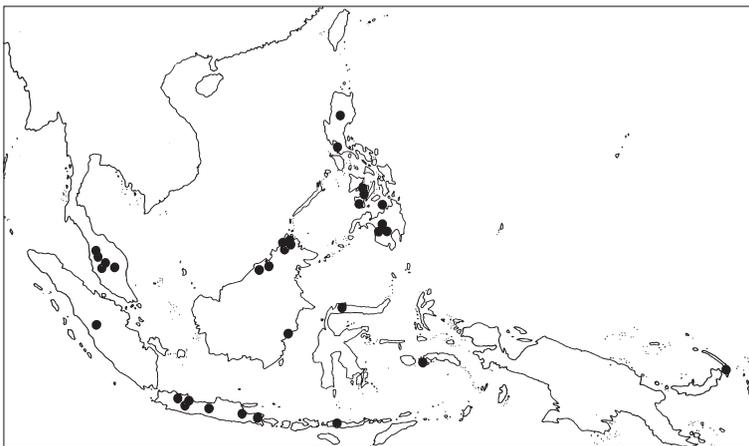
*Blechnum vestitum* (Blume) Kuhn, Ann. Mus. Bot. Lugduno-Batavi 4 (1869) 284, incl. var. B; Holttum, Revis. Fl. Malaya 2 (1954) 449, f. 259D; A.G.Piggott & C.J.Piggott, Ferns of Malaysia in colour (1988) 403, pl. 1237–1241; T.C.Chambers & P.A.Farrant, Blumea 46 (2001) 334. — *Lomaria vestita* Blume, Enum. Pl. Javae 2 (1828) 203. — Type: *Blume s.n.* (holo L, barcode L0051111), ‘crescit in montibus altissimis Javae’. — Var. B. Type: *Blume s.n.* (L), Java.

*Lomaria pyrophila* Blume, Enum. Pl. Javae 2 (1828) 204 (non *Blechnum pyrophyllum* Blume, Enum. Pl. Javae 2 (1828) 197). — Type: *Reinwardt s.n.* (holo L), ‘crescit in fissuris lapidum ejectorum in summo monte ignivomo Ternates’.

*Lomaria rotundifolia* Blume, Enum. Pl. Javae 2 (1828) 204. — Type: *Reinwardt s.n.* (holo L). This is almost certainly an immature plant of *B. vestitum*, ‘crescit in montibus Javae altissimis’.

*Lomaria glandulifera* Heward in Houlston & Moore, Gard. Mag. Bot. 3 (1851) 227. — Type: *Lobb 274* (holo BM), Java.

*Rhizome* stout, erect or suberect, but often subterranean, densely clothed at the apex with conspicuous linear-narrowly elliptic acuminate scales to c. 2 cm by 0.2–0.35 mm at the base, entire, medium to dark brown usually with a dark central zone extending to the apex. *Fronde*s dimorphic, sterile spreading or erect, 65–140(–200) by 14–34 cm; densely and usually persistently scaly; fertile fronds also scaly, erect and with a very reduced lamina surface. *Stipes* of sterile fronds usually much shorter than the lamina, 24–80(–100) cm, brown, reddish brown or dark purple, usually densely clothed with persistent scales, towards the base like those of the rhizome (narrowly elliptic, attenuate at apices, 1.3–2.5 by 0.3–0.5 cm and cordate at base, entire, medium to dark brown), from about 10 cm above the base becoming broader and paler to medium brown, some concolorous but mostly weakly bicolorous with a darker brown central region extending to their apices, a mat of lanuginose material made up of minute tangled uniseriate hairs and small dendritically branched scales forms a layer (usually persistent) closely appressed to the stipe surface; stipes of fertile fronds more erect and up to the same length as the lamina. *Lamina* linear-narrowly elliptic to deltoid, 1-pinnate, 7–42 pairs of pinnae usually closely spaced. *Rhachis* similar colour to stipe and also usually densely scaly with persistent scales similar to those of the stipes, 0.8–1.5 by 0.1–0.3 cm, but towards the apex becoming smaller and intermingled with narrower attenuate, entire, light reddish brown scales, adaxial face of rhachis grooved and often finely verrucose, the abaxial face terete and smooth. *Costae* similar colour or paler than rhachis, the abaxial face with persistent thin narrowly elliptic scales, cordate at base, acuminate or attenuate at apices, much smaller than those of the rhachis, and more or less entire, adaxial face of costae sometimes verrucose. *Sterile pinnae* oblong-narrowly elliptic, often widest some distance from rhachis, acute or sometimes acuminate at apices, cordate at rhachis, 9–19(–28) by 1.7–2.3 cm, shortly petiolate or more usually sessile for most of lamina, basiscopically adnate close to apex, mostly closely spaced on rhachis and sometimes overlapping, coriaceous, margins varying from entire to finely serrate, sometimes revolute, sometimes crenate, veins frequently once furcate and prominent on abaxial face and each terminating in a clavate gland in the axil of a serration on the adaxial surface; basal



Map 13. Distribution of *Blechnum vestitum* (Blume) Kühn.

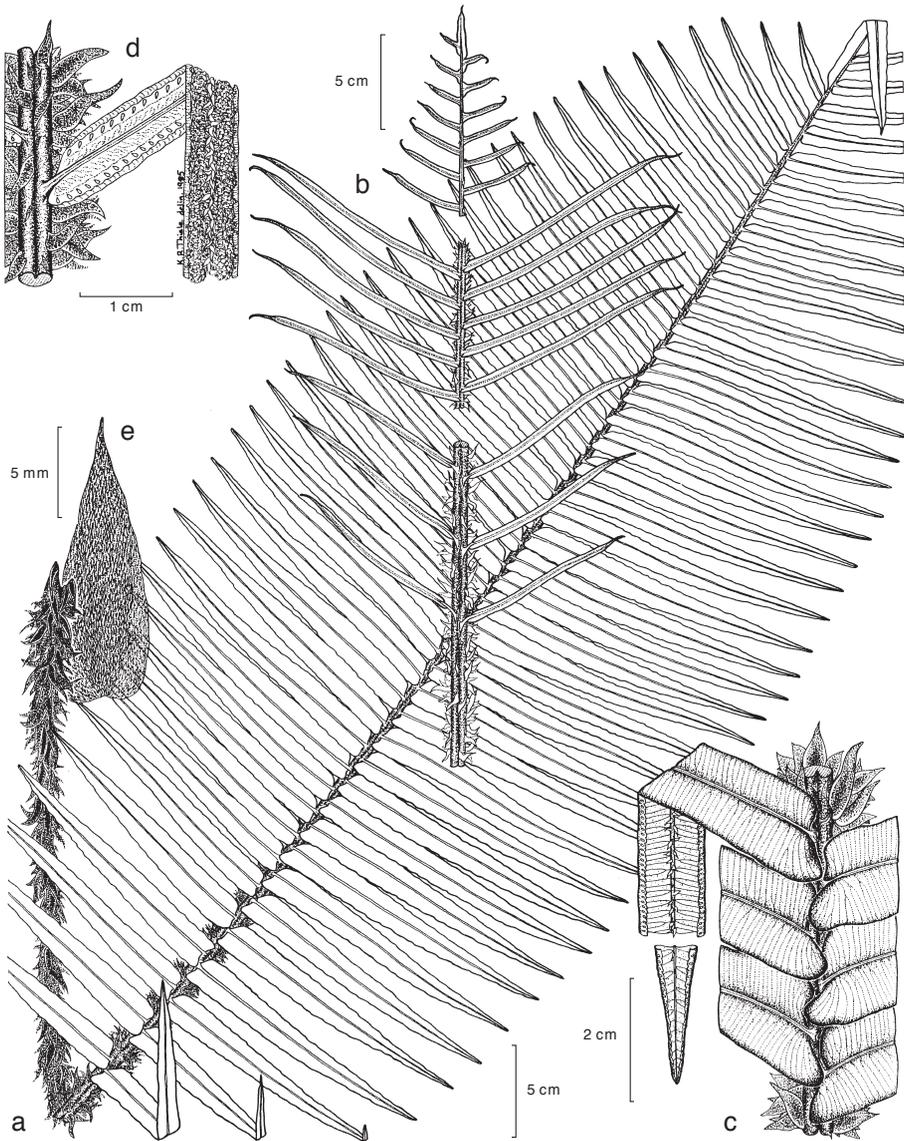


Fig. 15. *Blechnum vestitum* (Blume) Kühn. a. Sterile frond adaxial; b. fertile frond adaxial (base, mid-region, apex); c. sterile pinnae showing details; d. fertile pinna details and rhachis scales; e. scale from base of stipe (*Hoogland 3034*, Tankuban Prahu Volcano near Bandung, W Java, 1850 m; CANB). — Drawing by K.R. Thiele.

pinnae similar to those of mid-frond, or slightly shorter, sometimes slightly auriculate; terminal pinna distinctly longer than subterminal pairs of pinnae. *Fertile pinnae* linear, 9–20 by 0.4–0.6 cm, costal scales persistent on the abaxial face and similar to those of the sterile pinnae, sori covering underside except for short sterile segment at apices. *Spores* 68.8 by 54.8  $\mu\text{m}$  (from 10 herbarium specimens), perine alate or costate-alate,

loosely reticulate, lacunae small polygons, muri wing-like, terminating margins often ciliate or looped, exine smooth to granulose. — **Fig. 1f, 15; Map 13.**

Distribution — *Malesia*: Throughout, in mountainous areas at altitudes of 700–3350 m, but not recorded from Papua New Guinea.

Habitat — Often found in low to tall primary forest, also in open places, on ridges, near mountain summits, near craters, and on the edges of streams, lakes, and swamps. In the Malaysian and Indonesian regions *B. vestitum* is often abundant on mountain tops and ridges, sometimes in the forest and at times in open exposed habitats. Holttum (1954) records it in Peninsular Malaysia as sometimes growing in the same habitat and with somewhat similar habit to *Plagiogyria tuberculata* Copel. (= a variety of *P. egenol-fioides* (Baker) Copel.).

Vernacular name — Kalang Kalang (Moluccas) (*Idjan & Mochtar* 22 (K, L)).

Notes — 1. *Blechnum vestitum* shares a number of morphological characters with the African *Blechnum capense* (L.) Schltr. and also with a number of species from Central and South America and from the Australasian and Pacific region. *Blechnum vestitum* is usually readily separated by the persistent and most conspicuous scaliness of the stipe, rhachis, and the costae. These large papery scales often completely clothe the axes of the frond and sometimes much of the abaxial face of the pinnae.

2. Although widespread through much of the Malesian region *B. vestitum* may be absent from mainland Papua New Guinea where its place is taken by the related *B. hieronymi* and the newly described *B. nesophilum* from some of the nearby islands and the Solomons.

## 17. *Blechnum vittatum* Brack.

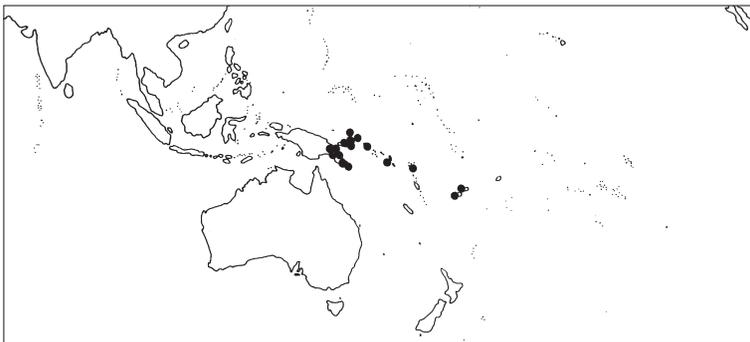
*Blechnum vittatum* Brack., U.S. Expl. Exped. 16 (1854) 131; U.S. Expl. Exped., Atlas Filic. (1855) pl. 16; Brownlie, Beih. Nova Hedwigia 55 (1977) 317, pl. 34, f. 4, 5; T.C. Chambers & P.A. Farrant, Blumea 46 (2001) 337. — *Blechnum cartilagineum* Sw. var. *vittatum* (Brack.) Luerss., Filic. Graeff. (1871) 132. — Type: *Brackenridge* 8 (holo US, n.v.; illustration Brackenridge), 'Feejee' Islands in wetlands.

*Lomaria dentata* Kuhn, Forschungsr. Gazelle, Bot. 4 (1889) 6. — *Blechnum dentatum* (Kuhn) Diels in K. Schum. & Lauterb., Fl. Schutzgeb. Südsee (1901) 130. — *Struthiopteris dentata* (Kuhn) Ching, Sunyatsenia 5 (1940) 243. — Type: A. Naumann 24.7.1875 (holo location unknown; iso BM, fragment in Herb. C. Chr.), 'Neu-Hanover in silvis montanis'.

*Blechnum bamlerianum* Rosenst., Feddes Repert. Spec. Nov. Regni Veg. 10 (1912) 325. — *Lomaria bamleriana* (Rosenst.) Alderw., Malayan Ferns, Suppl. 1 (1917) 254. — Type: G. Bamler (1909) (lecto L, here chosen; iso B, BM, K), Nova Guinea, Kaiser Wilhelmsland, Wareo, 600 m.

*Rhizome* erect or suberect caudex densely scaly at the apex, up to at least 100 cm in height and 3–5 cm diam., scales linear acuminate, 1–4 by 0.02–0.15 cm, black or very dark brown (paler and thinner when covered by other scales), frequently with fine paler margins, entire. *Fronde*s dimorphic or, sometimes, sterile and fertile fronds similar, erect, 34–150 by 12–40 cm, fertile fronds longer and more erect than sterile. *Stipes* 12–58 cm, usually about 1/3 but sometimes over half the frond length, relatively longer for fertile fronds, stramineous to pale brown, darker towards the base, in Fijian and some New Guinean and Solomon Islands specimens and more consistently bicolorous than in Malesian material with a significant lateral black stripe on either side of the groove on

the abaxial face; densely or persistently scaly at the base with a few smaller persistent scales extending up the stipe, scales like those of the rhizome, usually increasingly bicolorous further up the stipe. *Lamina* ovate-narrowly elliptic (smaller fronds 50 by 10 cm) to linear-narrowly elliptic (larger fronds 100 by 20 cm), gradually tapering from the mid-region to a somewhat truncate base, pinnatisect towards apex, pinnate towards base, 16–49 pairs of pinnae. *Rhachis* and *costae* stramineous to pale brown, Fijian and some New Guinea specimens with dark stripes extending for about 1/3 the length of the rhachis and in some specimens a second pair of black stripes associated with a pair of longitudinal grooves on the adaxial face, rhachis sometimes with a few persistent scales similar to those at the top of the stipe, costae pale on both surfaces (grooved on adaxial face, semi-terete on abaxial) often with minute persistent scales and short pale appressed hairs. *Sterile pinnae* 6–21 by 1–2 cm, in the mid-region oblong-narrowly elliptic, acuminate to shortly attenuate in larger fronds, often slightly auriculate on the basiscopic margin near point of attachment, fully adnate and often decurrent down rhachis in the mid-region, pinnae semi-adnate to sessile or even subpetiolate towards base, increasingly adnate towards the deeply pinnatisect frond apex, papery to thinly coriaceous, mid-green, margins slightly crenate to finely toothed, increasingly toothed towards the pinna apices, pinnae contiguous or almost so at the lamina apex, becoming slightly more distant at the base, veins visible on both surfaces, single or dichotomising and each terminating in a minute, linear, pale clavate gland associated with the base of each tooth, veins single and increasingly spaced in the attenuate apical region, pinnae at apex often at 45° and closely set on rhachis, pinnae in mid-region patent, terminal segment often reduced, basal pinnae pairs (for about 1/3 length of lamina) increasingly distant on the rhachis (up to 2–3 cm apart), the lowermost pair or several pairs markedly deflexed, often with cordate bases at the rhachis, on some specimens the pinnae truncately reduced to finely dentate vestigial obtuse triangular lobes. *Fertile pinnae* variable in shape, usually narrower than sterile (lomarioid) but sometimes more or less similar (eublechnoid), if lomarioid then narrow linear 15(–20) by 0.25–0.35 cm, with sori occupying the whole of the undersurface and extending to the rhachis, sessile or very shortly petiolate towards the lamina base, towards the lamina apex adnate and basiscopically decurrent with sori continuing on to decurrent base, if eublechnoid then the sori not usually extending to the rhachis and often somewhat discontinuous. *Spores* 46 by 33 μm (from 24 herbarium



Map 14. Distribution of *Blechnum vittatum* Brack.



Fig. 16. *Blechnum vittatum* Brack. a. Sterile frond; b. fertile frond; c. abaxial fertile pinnae from another frond; d. scale from base of stipe (a, c: *Croft et al. LAE 68681*, S. Fergusson Island, 720 m, Milne Bay Dist. PNG; b, d: *Croft 2101*, lowlands, NW end of New Ireland, PNG; all NSW). — Drawing by Marion Westmacott.

specimens), perine scabrous, granulose, microrugulose, or microverrucose, exine smooth to scabrous. — **Fig. 1g, 16; Map 14.**

Distribution — *Malesia*: New Guinea widespread but intermittent. *Outside Malesia*: Solomon Islands and the Santa Cruz Islands. A single specimen at BM labelled as from

Kuranda, Queensland, *Podenzana s.n.* would extend this species to NE Australia if the locality could be confirmed as correct.

Habitat — Usually a forest species from lowland (rain forest) to lower montane forest areas, *B. vittatum* extends to altitudes of around 600 m in Fiji and 800–1200 m in Papua New Guinea. In Papua New Guinea it occurs in *Castanopsis*-oak forests as a common undergrowth species; it is also found under broken canopy dipterocarp forests and has been reported in open vegetation on recent volcanic deposits on the N slopes of Mt Lamington (Papua) at 950 m, becoming established within two years of an eruption; it occurs in both undisturbed rain forest and secondary forest on Vanikoro in the Solomons.

Uses — *Croft 1112* (NSW 396087) in notes on a specimen from Manus Island (Papua New Guinea) reports “Very young leaves red, apparently eaten by the villagers”.

Notes — 1. *Blechnum vittatum* was originally considered to be endemic to Fiji (Brownlie 1977). However, there appears to be no consistent difference between these plants and plants from the New Guinea area previously known as *B. dentatum*. Although the Fijian specimens usually have black striped stipes, only some of the New Guinea material has black stripes while other plants (e.g. *Croft 2101*, New Ireland, NSW 396084) have, on the same plant, some fronds with stripes and some without.

2. While many of the specimens from outside Fiji also tend to have very coarse lower stipe scales, this character is not consistent across all specimens and it may be related to growth in an exposed habitat. It would seem therefore that stipe coloration and stipe scale thickness are variable characters that cannot be used to separate *B. dentatum* from *B. vittatum*. It should be noted that *B. dentatum* has pinna margins that are no more dentate than those of *B. vittatum*.

3. The unpublished ‘*Blechnum (Eublechnum) hooglandii*’ of Alston, e.g. from Mt Dayman, Maneau Range, 700 m, banks of stream in rain forest, *L.J. Brass 23408* (A) is almost certainly an ecological variant of *B. vittatum*.

4. Possibly closely related is *B. egregium* from the Philippines, with at least one confirmed record from Papua New Guinea; both species produce bright red young fronds. *Blechnum egregium* can be separated by its fully or near fully adnate pinnae, usually gradually reducing in length to the frond base and with a relatively short stipe.

## 18. *Blechnum vulcanicum* (Blume) Kuhn

*Blechnum vulcanicum* (Blume) Kuhn, Ann. Mus. Bot. Lugduno-Batavi 4 (1869) 284; T.C. Chambers & P.A. Farrant, Blumea 46 (2001) 340. — *Lomaria vulcanica* Blume, Enum. Pl. Javae (1828) 202. — *Spicanta vulcanica* (Blume) Kuntze, Revis. Gen. Pl. 2 (1891) 822. — Type: *Blume s.n.* (lecto L, here designed), ‘Muur over de holte aan Goenoeng Batoe’ (wall above the hollow at Goenoeng Batoe. This place is in town, and not the type locality near the crater of Gede).

*Lomaria villosa* Fée, Mém. Foug., 5. Gen. Fil. (1852) 68. — Type: *Lobb 266* (iso BM), habitat in Java.

*Rhizome* creeping to erect often forming a short caudex up to 20 by 3 cm clothed with the densely scaly bases of the old stipes and supporting a small crown of fronds and also under some conditions giving rise (from the growing rhizome apex, and above the ground) to a slender creeping stoloniferous rhizome 0.2–0.3 cm diam. and clothed in narrow triangular, acuminate, entire, reddish brown scales, and on most specimens uniseriate multicellular hairs. *Fronde*s dimorphic, erect or pendulous, 10–70 by 3–30 cm,

fertile fronds usually longer than sterile fronds. *Stipes* usually about half the length of the whole frond, often longer for fertile fronds, 5–40 cm, slender, stramineous to brown, pilose in most specimens, densely and persistently scaly at the base; (hairs sometimes absent at the base of the stipe), scales less dense and less persistent further up the stipe; scales linear to narrow triangular, acuminate, 1–2.5 by 0.1–0.3 cm, entire, concolorous dark reddish brown, shiny, deciduous scales leaving a distinct raised dark scar on the otherwise pale stramineous stipe; hairs sometimes abundant, intermingled with the scales, uniseriate, 0.1–0.35 cm in length, straight, pale or white, varying from sparse and mostly deciduous to dense and persistent. *Lamina* narrowly to broadly elliptic or deltoid, dull green, pinnatisect to pinnate, 6–30 or more pairs of pinnae. *Rhachis* and *costae* stramineous to brown, occasionally glabrous but usually pilose, with persistent fine, uniseriate, straight, pointed pale or white hairs, to c. 0.1 cm long and to c. 7 cells. *Sterile pinnae* oblong to narrowly triangular, often slightly falcate, obtuse (especially in smaller fronds), acute or acuminate (especially in larger fronds), 4–8 by 0.7–1.5 cm, fully adnate throughout except for basiscopic side of lowest pair of pinnae, coriaceous, yellow-green in fresh material, sometimes pilose on both surfaces but usually more so on the abaxial surface (hairs similar to those of stipe, rhachis, and costae); veins free, furcate, margins thickened, crenate, sometimes fringed with hairs, basal pinnae broader, more falcate, markedly deflexed and not adnate basiscopically. *Fertile pinnae* narrower 0.4–0.6 cm in width and spaced on the rhachis, indusium sometimes with associated uniseriate hairs; hairs often also arising from the margin of the pinnae. *Spores* 42.5 by 32.7  $\mu\text{m}$  (from 18 herbarium specimens), perine scabrous to rugulose, exine smooth to granulose or microverrucose. — **Fig. 1h, 17; Map 15.**

**Distribution** — *Malesia*: Sumatra (G. Singgalan), Borneo (Sabah: head of Columbon river, Mt Kinabalu), Java (Gedé: Kandang Badak), Philippines (Luzon), Sulawesi (Bonthain), Lesser Sunda Islands (Flores), Papua New Guinea: E Highlands (Mt Wilhelm), Northern Papua (subdist. Kokoda, W slopes of Mt Kenivem), New Ireland, Bougainville. *Outside Malesia*: Widespread but rarely common and in many locations regarded as extremely rare. A number of specific, subspecific, and varietal names have been applied to geographically isolated populations and certainly some merit recognition but others defy satisfactory definition. The group is currently the subject of a separate study.

**Habitat** — Generally in cool, moist, partly shaded situations, from forest habitats to (more rarely) exposed tall grasslands. Further study is required; on some islands and island groups it appears to have differentiated into distinct taxa all possessing the characteristic uniseriate straight hairs. Specimens seen from the Malesian region conform to the type material from Java.

**Notes** — 1. Named *vulcanicum* from its original type locality on a volcano but not restricted to such places. The holotype was not found.

2. The Malesian material of *B. vulcanicum*, although showing considerable variation, is considered as belonging to a single taxon. The specimens are usually densely pilose especially on the abaxial surfaces of the costae and veins and usually also the rhachis. Some populations completely lack hairs at the base of the stipe in the zone of persistent scales. The hairs of the Malesian material tend to be pale brown or fawn coloured while those from further south, outside Malesia, tend to have paler often silvery white hairs.

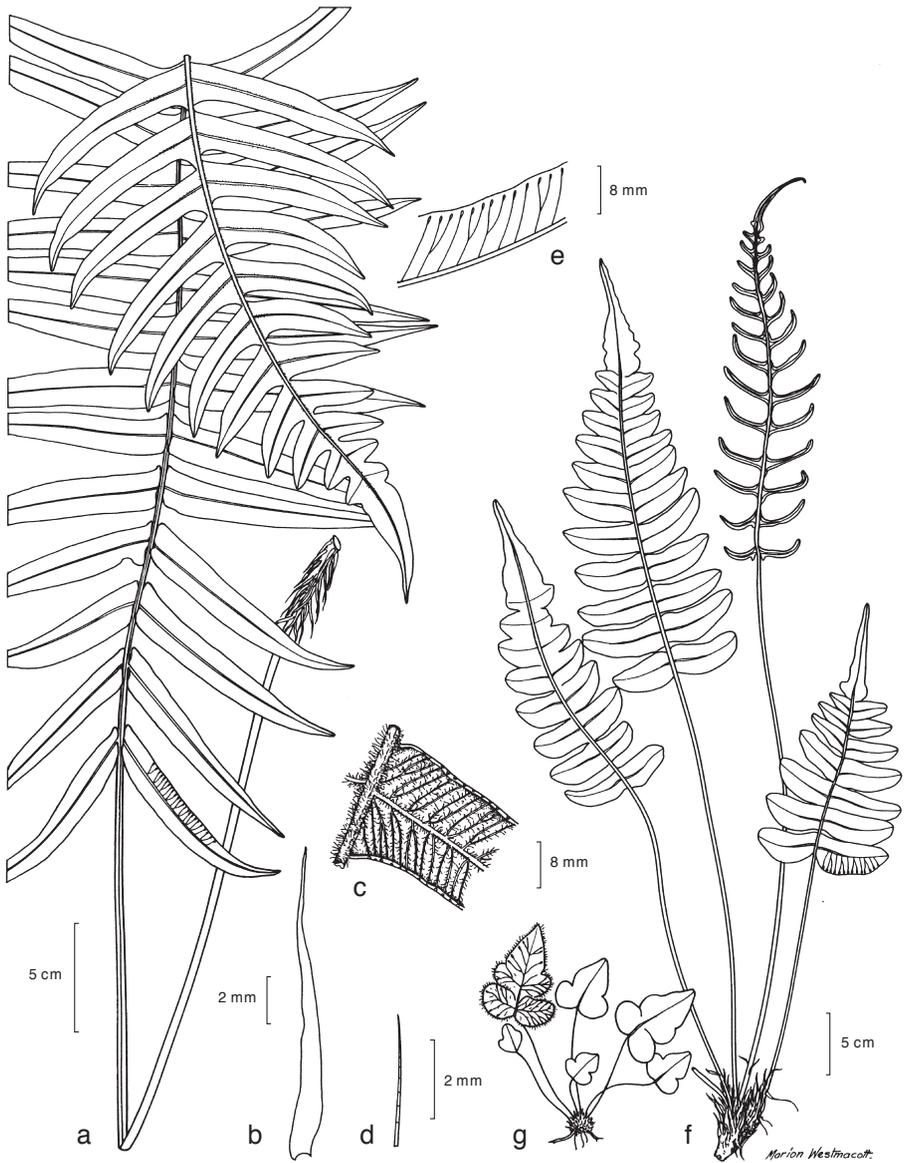
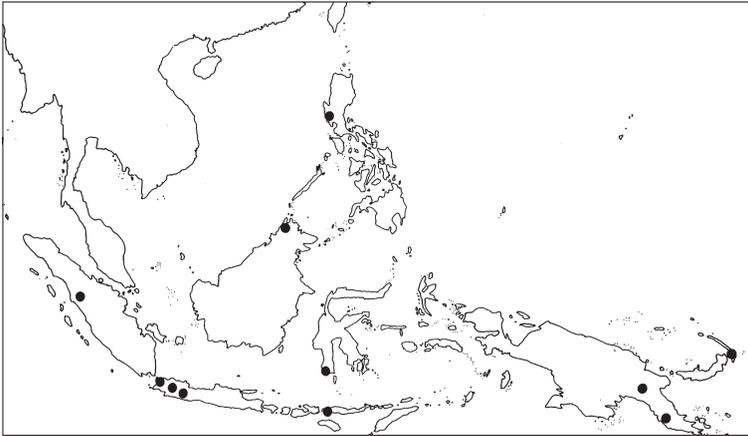


Fig. 17. *Blechnum vulcanicum* (Blume) Kühn. a. Large mature sterile frond; b. basal stipe scale; c. detail pinna, abaxial face; d. rigid uniseriate hair from abaxial surface of pinna; e. detail adaxial surface of pinna showing venation; f. typical smaller plant with fewer pinnae which have obtuse apices and with stipes longer than the lamina; g. juvenile plant (a–e: *Croft* 294, New Ireland (NSW); f: *Croft* LAE 65211, Mt Kenive Kokoda subdist. N. Papua (CANB); g: NSW 488720). — Drawing by Marion Westmacott.



Map 15. Distribution of *Blechnum vulcanicum* (Blume) Kühn.

3. There is a wide range of frond size through the Malesian region; generally plants with larger sterile fronds tend to have pinnae with acuminate apices while those with smaller fronds tend to have pinnae with blunt obtuse apices. Very large sterile fronds tend to have up to 5 pairs of basal pinnae not fully adnate to the rachis and strongly deflexed. There is considerable variation between populations in the distribution of hairs on the fertile pinnae, many almost completely lacking these, but others with their abaxial costae and sometimes also their indusia densely pilose.

4. The taxonomy of *B. vulcanicum* and the closely related taxa is complex. It could be argued either that the whole group should be regarded as one Linnaean species, or that there are several taxa. However, careful study of the available collections suggests that only a few of the variants are sufficiently distinctive and constant to justify separate taxonomic status. These are outside the Malesian region and will be dealt with in a separate paper.

### 19. *Blechnum whelanii* F.M.Bailey

*Blechnum whelanii* F.M.Bailey, Rep. Bellenden-Ker Range (1889) 77; Syn. Queensland Fl., Suppl. 3 (1892); S.B.Andrews, Ferns Queensland (1990) 94, f. 7.4C; T.C.Chambers & P.A.Farrant, Fl. Australia 48 (1998) (see map 348, p. 686 for distribution in NE Australia); Blumea 46 (2001) 343. — Type: *F.M. Bailey s.n.* (holo n.v., location unknown; litho seen, F.M.Bailey, Lithogr. Ferns Queensland (1892) 91; iso BM, K, MEL), Bellenden-Ker Ra., 1200–1500 m, Qld.

*Blechnum nigropaleaceum* Alston, J. Bot. 78 (1940) 225; Nova Guinea n.s. 4 (1940) 109, pl. 4, f. 1. — Type: *Carr 14363* (holo BM; iso CANB, K, L), Papua, Boridi Forest, on tree trunks, 4700 ft [1570 m]. Paratype: *Carr 13336* (BM, CANB, K, L), Papua, Boridi Forest, on tree trunks, 4700 ft [1570 m].

*Rhizome* short creeping, sometimes partly climbing but usually erect, 2 cm diam. and up to at least 15 cm in height, densely scaly at the apex, scales acuminate, entire, black, shiny, 12 by 0.75 mm. *Fertile and sterile fronds* similar or variously dimorphic (but sori never completely covering the underside of fertile pinnae), erect, 17–115 by 6–32 cm. *Stipes* 7–57 cm, usually very long and over half the length of the fronds,

sometimes purplish black either at the base or throughout, or brown, reddish brown or sometimes stramineous above, with persistent dense scales at the base, scales narrow linear to narrowly elliptic, acuminate, 10–15 by 0.75–1.5 mm, entire, shiny reddish brown to black with very fine paler margins, numerous fine irregular hairs grading into minute pale membranous scaly material which may persist over the basal half of the stipe, upper areas of the stipe glabrous, also present are distantly placed small hard outgrowths on the ridges on either side of the groove. *Lamina* narrowly elliptic, ovate or deltoid, pinnate-pinnatisect, 3–14 or more pairs of pinnae. *Rhachis* and *costae* dark reddish brown to stramineous, glabrous at maturity but minutely asperous along the triple ridges and grooves on the upper surface. *Sterile pinnae* linear-narrowly elliptic, acuminate, 5–24 by 1.3–3 cm, 2–5 cm distant on the rhachis, shortly petiolate and tapering to the rhachis at the base of the lamina becoming sessile to adnate and decurrent at the apex, subcoriaceous, margins serrate, veins 7 or 8 per cm, inconspicuous on the upper surface, mostly simple and terminating in a clavate gland, each associated with a serration on the upper surface, basal pinnae similar in length or slightly shorter, the subterminal pair only slightly shorter, the terminal pinna as long as or a little longer than the subterminal pair. *Fertile pinnae* similar to sterile pinnae but usually slightly narrower, (typically 0.7–2 cm), linear, acuminate, the sori c. 0.1 cm wide, close and parallel to each side of the costa, continuous and extending from the pinna base to within 1–3 cm of the apex but not covering the full width of the abaxial pinna surface. *Spores* 50.5 by 42.5  $\mu\text{m}$  (from 2 herbarium specimens), perine costate, scabrous to minutely rugulose, exine smooth to scabrous or verrucose. — **Fig. 1i; Map 1.**

**Distribution** — *Malesia*: New Guinea (Papua New Guinea: Boridi, Owen Stanley Range, Central Papua New Guinea). *Outside Malesia*: Australia (Mt Bellenden-Ker and Mt Lewis areas of north-eastern Queensland).

**Habitat** — In Papua New Guinea it is recorded from 1500–1700 m, growing on tree trunks. In Australia it occurs at 980–1500 m where it is a terrestrial rain forest species most frequently found along creek banks.

**Notes** — 1. Alston (1940) with his original description of *B. nigropaleaceum* made the observation that this species is “allied to *B. whelani* F.M.Bailey, but pinnae more truncate at base ...” With the benefit of a larger range of specimens of *B. whelanii* from Australia (NE Queensland) and comparison of this material with the types of *B. nigropaleaceum* there is an overlapping range of morphological variation. For example *Bostock & Guymer 812*, NNW of Mt Haig, Qld (NSW) where one specimen has truncate, subpetiolate and petiolate pinna bases on the same frond. A comparable range of variation is to be seen on *Carr 13336*, Boridi, Papua New Guinea (CANB 59830, paratype). The one difference (which may be a result of the drying history of the specimen) is that some of the Queensland material has deeply pigmented stipes with the rhachis grading to pale stramineous, whereas the Papua New Guinea material has brown to dark brown stipes and rhachis.

2. There is a single collection of what in this paper is recognised as a new species, *B. acanthopodium*, which may be closely related to *B. whelanii* (see note 2 under *B. acanthopodium*).

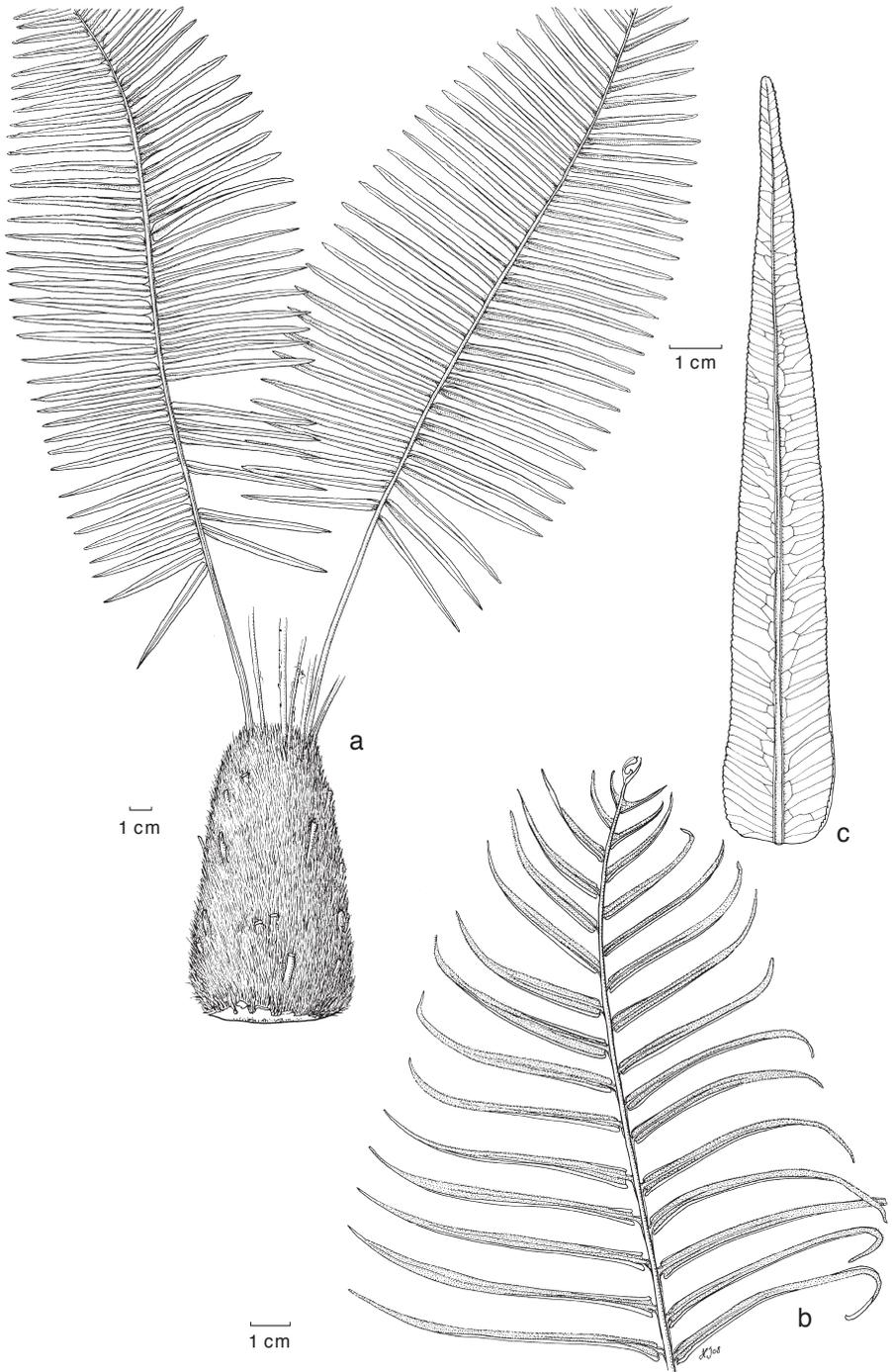


Fig. 18. *Brainea insignis* (Hook.) J.Sm. a. Habit with two fronds; b. top of frond; c. details upper side of pinna (*Elbert 4418*). — Drawing by Hanneke Jelles.

## DUBIOUS SPECIES

*Lomaria punctata* Blume, Enum. Pl. Javæ (1828) 201. — Syntypes: ?*Blume* (L), ‘Gede et Buranggang Javæ insulæ’.

Note — The two collections, one juvenile, the other the apical part of a frond, and both sterile, are according to the labels from two different mountains in W Java. The juvenile plant from Gede probably belongs to the *B. attenuatum*-*B. giganteum* group of African species. The specimen from Buranggang is probably part of a young plant of *B. orientale*.

## 2. BRAINEA

(H.P. Nootboom, Leiden, The Netherlands)

*Brainea* J.Sm., Cat. Kew Ferns (1856) 5.

Small tree ferns; stems erect, c. 100 cm tall and c. 10 cm diam., black, covered with scale bases, apex bearing long, narrow, entire, centrally dark banded scales. *Fronde*s slightly dimorphic, borne in a terminal crown; stipe well-developed, stramineous adaxially unisulcate, to 30 cm long, basal part covered with linear, chestnut brown 2 cm long scales; lamina pinnate (very rarely bipinnate at base), 50–100 cm long; pinnae linear, nearly sessile, 10 cm long, 1 cm broad, margins serrulate; venation catadromous, veins free, simple or once forked, except for the more or less triangular costal row of areolae; undersurface with some small scales along costa and veins; lower pinnae shortened; pinnae on fertile fronds somewhat shorter, much narrower. *Sporangia* borne on costal veins, soon becoming abundant and first covering costal area, then whole underside of pinna. *Spores* ellipsoidal irregularly low-rugose to nearly plain. — **Fig. 18.**

Only one species.

1. *Brainea insignis* (Hook.) J.Sm.

*Brainea insignis* (Hook.) J.Sm., in Cat. Kew Ferns (1856) 5; De Vol, Fl. Taiwan 1 (1975) 152, pl. 51. — *Bowringia insignis* Hook., J. Bot. 5 (1853) 237. — Syntypes: *Champion* 294, 295 (Hong Kong) and *Hooker*, Khasia Hills.

*Brainea formosana* Hayata, Bot. Mag. (Tokyo) 42 (1928) 237. — *Brainea insignis* (Hook.) J.Sm. var. *formosana* (Hayata) Tagawa, J. Jap. Bot. 12 (1936) 542. — Type: *C. Owatari* (Formosa 1896).

Distribution — South China (Guangdong, Guangxi, Yunnan, Guizhou, Fujian), Taiwan; N India to Indonesia; in *Malesia*: Sumatra, Peninsular Malaysia, Philippines (Mindoro), Moluccas (Wetar).

Habitat & Ecology — On open hillsides, margin of forests and sometimes in secondary forests.

### 3. DOODIA

(B.S. Parris, Kerikeri, Bay of Islands, New Zealand)

*Doodia* R.Br., Prodr. (1810) 151; Alderw., Malayan Ferns Suppl. (1917) 256; Backer & Posth., Varenfl. Jav. (1939) 148; Copel., Gen. Fil. (1947) 158; Parris, New Zealand J. Bot. 10 (1972) 587; K.U.Kramer et al. in K.U.Kramer & P.S.Green, Fam. Gen. Vasc. Pl. 1 (1990) 63; Parris, Fl. Australia 48 (1998) 385. — Type: *Doodia aspera* R.Br.

Terrestrial. *Rhizome* erect to ascending and bearing the remains of old stipe bases; rarely short-creeping, sometimes branching, rarely producing stolons. *Rhizome scales* black to brown, occasionally bicoloured, narrowly ovate to linear-ovate, acuminate, sometimes serrate at base. *Fronds* monomorphic or dimorphic. *Stipes* and *rhachises* rounded abaxially; with two rounded ridges adaxially and a groove between them; usually somewhat darker on abaxial surface. *Stipes*, *rhachises* and sometimes *costae* bearing narrowly ovate to linear-ovate acuminate scales that are frequently curved and flexuous towards the apex and are often shed with age. *Young fronds* coloured red in most species, particularly in plants growing in open situations. *Lamina* (in Malesia) pinnate or pinnately divided almost to the rhachis, the basal pair of pinnae always stalked, not adnate; the lowest pairs of pinnae sometimes auriculate, rarely with one pair of basal lobes. *Pinnae* subopposite in lower part of frond, alternate in upper part, serrate, with cartilaginous margin, texture (in Malesia) harsh and brittle. *Lower pinnae* suborbicular to linear-oblong, rarely linear; mid and upper pinnae oblong to linear-oblong, rarely linear; all pinnae obtuse to acute, rarely acuminate at apex. *Veins* sometimes free in small sterile pinnae, usually basally forked with 1–3 series of anastomoses, the first between veinlets of different forks, the second between veinlets of the same fork and sometimes also as the first series, the third the same as the first. *Sori* borne on the anastomoses, discrete, rarely ± confluent, indusium opening towards the costa, linear to lunulate. Spores monolete. *Gametophyte* cordate.

Distribution — About 12 species, but the taxonomy imperfectly known, several species being quite similar. Sri Lanka to Polynesia; in *Malesia*: Java, Lesser Sunda Islands, New Guinea; Australia, New Zealand, the Pacific Islands east to Hawaii and Easter Island.

Taxonomy — The genus has long been recognised as distinct and no subdivisions have been proposed for it.

#### KEY TO THE SPECIES

- 1a. Lamina narrowly triangular to narrowly ovate in outline, fertile and sterile fronds dimorphic; next to basal pair of pinnae as long as or longer than middle pinnae; lowest pairs of pinnae auriculate; stipe and rhachis lacking hairs . . . . **1. D. dives**
- b. Lamina elliptic, narrowly elliptic or narrowly obovate; fertile and sterile fronds not or slightly dimorphic; lower pinnae as long as or shorter than middle pinnae, not auriculate; stipe and rhachis with or without hairs . . . . . 2
- 2a. Stipe and rhachis with hairs; costa of pinna without scales . . . . . **2. D. media**
- b. Stipe and rhachis without hairs; costa of pinna with scales . . . . . **3. D. scaberula**

### 1. *Doodia dives* Kunze

*Doodia dives* Kunze, Bot. Zeitung (Berlin) 6 (1848) 144; Alderw., Malayan Ferns Suppl. (1917) 256; Backer & Posth., Varenfl. Jav. (1939) 148. — *Woodwardia dives* Fée, Mém. Foug., 5. Gen. Fil. (1852) 207. — Type: *Zollinger 2801* (G lecto chosen here; isolecto BM, G, L).

*Rhizome* erect to ascending. *Rhizome scales* black, sometimes bicolored with black centre and brown margin, linear-ovate, acuminate, 3–6 mm long. *Stipe* usually dark brown to black, sometimes mid-brown, (3–)10–30(–40) cm long; scales brown to black, sometimes bicolored like rhizome scales, scattered, 1.5–5 mm long. *Fronde*s dimorphic. *Lamina* narrowly triangular, rarely narrowly ovate; fertile lamina 20–45 by 4–20 cm, sterile lamina 15–40 by 4–22 cm; pinnate, texture harsh, brittle. *Rhachis* usually blackish brown to the middle of the lamina, pale brown above the middle; rarely pale brown throughout, or blackish brown almost to terminal pinna; scales black to brown, scattered, 1–1.5 mm long. Lowest 1–4 pairs of *pinnae* stalked, stalk up to 3 mm long, auriculate, auricles often better developed acroscopically; middle pinnae adnate and decurrent, transition between the two types of attachment abrupt, taking place over 1–3 pairs of pinnae, decurrent wing along rhachis much more pronounced in fertile than in sterile fronds; upper pinnae confluent, with decurrent wing much more pronounced in fertile than in sterile fronds. Longest pinnae usually the 2nd to lowest pairs, occasionally middle pinnae as long as or longer than those lower down; longest fertile pinnae 2.5–11 cm by 5–13 mm, longest sterile pinnae 2–12 cm by 6–15 mm; apex of fertile pinnae bluntly acute to acuminate, of sterile pinnae obtuse to bluntly acute; pinnae (10–)12–16(–22) pairs. Terminal pinna 3.5–8 cm (1/4–1/8 of total frond length). Distance between middle of middle pinnae of fertile fronds (5–)8–15 mm; of sterile fronds 1–7 mm. Costa of pinnae lacking scales. *Sori* usually in two complete rows on each side of the costa, more rarely in one or three rows (the 3rd always incomplete). Indusium (0.5–)1.5–2.5(–3) mm long. — **Fig. 19a.**

Distribution — Sri Lanka and Malesia; in *Malesia*: Java, Lesser Sunda Islands (Lombok, Sumbawa, Flores, Alor, Timor).

Habitat — Terrestrial in forest, on fairly dry loam. Altitude 900–1700 m.

Vernacular name — Sasèsar (Timor).

### 2. *Doodia media* R.Br.

*Doodia media* R.Br., Prodr. (1810) 151; Parris, Fl. Australia 48 (1998) 388 — *Woodwardia media* Fée, Mém. Foug., 5. Gen. Fil. (1852) 207. — *Doodia caudata* (Cav.) R.Br. var. *media* Benth., Fl. Australia 7 (1878) 742. — *Doodia aspera* R.Br. var. *media* (R.Br.) F.M.Bailey, Syn. Queensland Fl. (1883) 704. — Type: *Banks & Solander s.n.* (holo BM), New Holland [Australia].

*Rhizome* erect to ascending. *Rhizome scales* black, linear-ovate, acuminate, 3–5 mm long. *Stipe* black to mid-brown, 7–16 cm long; scales dark brown to black, scattered, 1–3 mm long, those towards base of stipe leaving minute tubercles when shed; hairs whitish to stramineous, minute, simple, 1–few-celled, sparse to common, 0.1–0.2 mm long. *Fronde*s not dimorphic or moderately so. Young fronds conspicuously bright red. *Lamina* narrowly obovate to narrowly ovate, 17–32 by 3–7 cm, pinnate, texture harsh and brittle. *Rhachis* mid-brown throughout; scales dark brown to black, scattered, 0.5–2

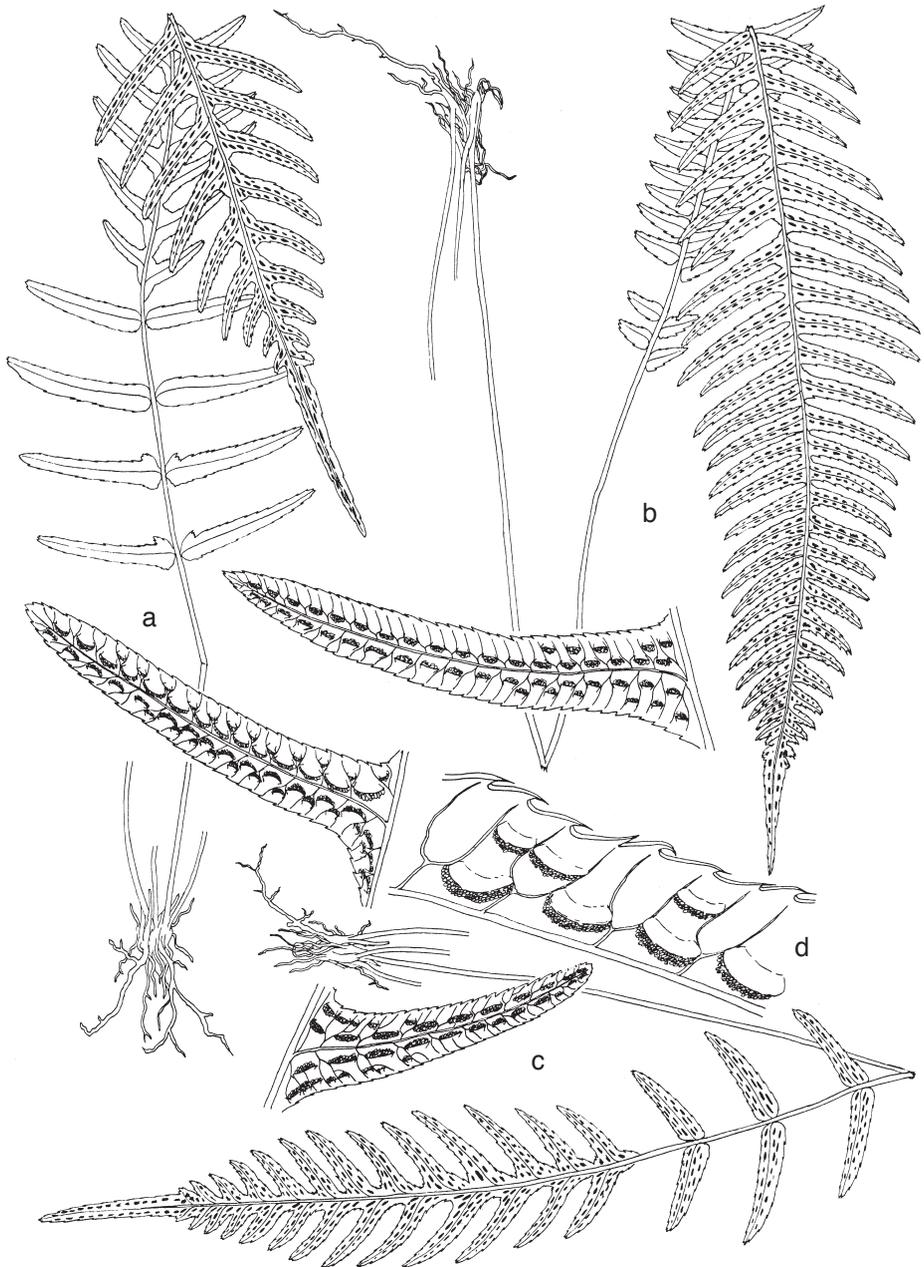


Fig.19. a. *Doodia dives* Kunze. — b. *D. scaberula* Parris. — c. *D. media* R.Br.; d. detail of venation and soral arrangement of *Doodia* (a: *Teysmann s.n.*; b: *Brass 22701*; c: *Floyd 5222*; all L).

mm long, hairs as on stipe. Lower *pinnae* shortly stalked, stalk to 2 mm long, middle to upper *pinnae* adnate to decurrent, transition between the two types of attachment abrupt, taking place over 1–3 pairs of *pinnae*. Longest *pinnae* in middle or basal part of frond, longest fertile *pinnae* 1.5–4 cm by 4–8 mm, longest sterile *pinnae* 2–4 cm by 6–9 mm. Apex of *pinnae* obtuse to bluntly acute; *pinnae* 15–22 pairs. Terminal *pinna* 3.5–8 cm long (1/3–1/7 of total frond length). Distance between middle of middle *pinnae* of fertile fronds 1–5 mm, of sterile fronds 1–2 mm. Costa of *pinna* lacking scales, but with hairs similar to those of stipe and *rhachis*. *Sori* in one, frequently two, complete rows on each side of costa. Indusium 0.5–2 mm long, sometimes bearing hairs similar to those of the costa. — **Fig. 19c.**

Distribution — Australia and Malesia; in *Malesia*: New Guinea (Papua New Guinea).

Habitat — Terrestrial in light shade on banks in secondary forest, and frequently occurring in plantations. Altitude 1000–1200 m.

### 3. *Doodia scaberula* Parris

*Doodia scaberula* Parris, Blumea 24 (1978) 505. — Type: *Brass* 22701 (holo L), Papua New Guinea.

*Rhizome* erect to ascending, sometimes branched. *Rhizome scales* black, linear-ovate, acuminate, 3–5 mm long. *Stipe* dark brown to black, 1–21 cm long; scales black, scattered, 1–3 mm long, those towards base of stipe leaving minute tubercles when shed. *Fronde* ± monomorphic. *Lamina* narrowly elliptic to narrowly obovate, 10–44 by 2–13 cm, pinnate, texture harsh and brittle. *Rhachis* blackish brown in lower part, pale brown in upper part; scales black, scattered, 0.5–2 mm long. Lower *pinnae* very shortly stalked, stalk up to 1 mm long, middle to upper *pinnae* decurrent, transition between the two types of attachment abrupt, taking place over 1–3 pairs of *pinnae*. Longest *pinnae* ± in middle of frond, 1–7 cm by 5–12 mm. *Pinnae* markedly reduced in lower part of frond, lowest pair sometimes longer than pair immediately above, apex obtuse to acute; *pinnae* (14–)20–30(–40) pairs. Terminal *pinna* 2.5–3.5 cm long (1/4–1/10 of total frond length). Distance between middle of middle *pinnae* 1–5 mm. Costa of *pinna* with scales similar to those of *rhachis*. *Sori* in one complete row on each side of the costa, a second row ± completely developed in larger fronds, fragmentary or absent in smaller fronds. Indusium 0.5–1 mm long. — **Fig. 19b.**

Distribution — *Malesia*: New Guinea (Papua New Guinea).

Habitat — Terrestrial or lithophytic, on vertical damp shaded rock and soil faces or recent slides on dry sandy slopes, in openings in submontane and mossy forest and in grass plains. Altitude 1600–2700 m.

Vernacular name — Kambe bingga (Chimbu) Papua New Guinea.

Note — Close to *D. media*, but with stipes and *rhachis* not pubescent, differing from *D. aspera* R.Br. in the lower *pinnae* being attached by their costae rather than being adnate.

#### 4. STENOCHLAENA

(R.E. Holttum† & H.P. Nooteboom, Leiden, The Netherlands)

*Stenochlaena* J.Sm., J. Bot. (Hooker) 3 (1841) 149; Holttum, Gard. Bull. Straits Settlements 5 (1932) 245; Revis. Fl. Malaya 2 (1954) 410; Amer. Fern J. 61 (1971) 119; Croft in L.C. Leach & Osborne, Freshwater Plants of Papua New Guinea (1985) 38. — Type: *Stenochlaena palustris* (*Polypodium palustre* Burm.f.).

Moderate to large, high-climbing ferns with scandent rhizomes, often in swamps or beside rivers. *Rhizome* naked, green, apically bearing many rotund or elongate, peltate scales, radially symmetric, vascular system a complex dictyostele of several large central bundles surrounded by 2 irregular rings of many smaller bundles. *Fronde*s widely spaced, stipes glabrous, ± decurrent with the rhizome, with corresponding vasculature, the lamina pinnate with alternate pinnae and a terminal pinna similar to the lateral pinnae, dimorphic, the fertile lamina much contracted (in one species bipinnate); the sterile lateral pinnae usually articulate, with a basal acroscopic gland, costate with fine, close, free veins arising from a series of narrow, elongate, costal areoles, coriaceous, glabrous, margin cartilaginous and sharply toothed; fertile pinnae narrow, linear, entire. *Sporangia* borne in an elongate coenosorus occupying the area from the costal areoles almost to the margin of the fertile pinnae, supplied by a secondary vascular system, exindusiate, paraphyses lacking, annulus longitudinal, interrupted, of 12–20 thickened cells. *Spores* monoletic, translucent, tuberculate or with continuous or broken ribs.

Distribution — A genus of 6 species, two from Africa, the others from Asia.

Notes — 1. Formerly credited with a pantropical distribution and many more species, due to confusion with the genera *Teratophyllum* and *Lomariopsis*, here placed in Lomariopsidaceae. Holttum (1932) was the first to elucidate this confusion.

2. Somewhat divergent from the other genera of Blechnaceae, mainly in anatomical characters; but venation, stomata, spores, and gametophyte agree best with this family. If the base number would be shown to be really  $x = 37$ , this would constitute another confirmation.

#### KEY TO THE SPECIES

- 1a. Pinnae commonly (9–)15 pairs or more, the sterile pinnae to at least 15 by 3 cm; fertile pinnae with very narrow sterile margin . . . . . 2
- b. Pinnae to 7 pairs; sterile pinnae to 10 by 2.2 cm; fertile pinnae 3 mm wide with thin reflexed sterile margins 1 mm wide . . . . . **1. S. areolaris**
- 2a. Lower pinnae at least appearing fully articulate when dry; pinna-bases cuneate; fertile pinnae 2–3 mm wide; spores evenly tuberculate throughout **4. S. palustris**
- b. Pinnae not distinctly articulate; sterile pinnae with broadly rounded to cordate bases; fertile to at least 5 mm wide; spores with raised ± broken ridges . . . . . 3
- 3a. Sterile pinnae broadly rounded at base, sometimes partly articulate; fertile pinnae (3–)5–8 mm wide; spores with irregular broken ridges . . . . . **3. S. milnei**
- b. Sterile pinnae cordate at base, not at all articulate; fertile pinnae 7–10 mm wide; spores with parallel continuous or broken ridges . . . . . **2. S. cumingii**

**1. *Stenochlaena areolaris* (Harr.) Copel.**

*Stenochlaena areolaris* (Harr.) Copel., Philipp. J. Sci., Bot. 2C (1908) 406; Fern Fl. Philipp. (1960) 427; Holttum, Amer. Fern J. 60 (1970) 122. — *Lomaria areolaris* Harr., J. Linn. Soc., Bot. 16 (1877) 28. — Type: *J.B. Steere s.n.* (iso MICH), Philippines, Luzon, village of Mahayhay.

*Rhizome* slender, less than 3 mm diam. *Stipe* of sterile frond c. 15 cm, of fertile up to 60 cm long; sterile frond to 25 cm long with up to 7 pairs of pinnae; pinnae to 3–13 by 1.2–3.5 cm; fertile pinnae to 10 cm long, 3–6 mm wide, with thin margins 1 mm wide reflexed at right angles. — **Fig. 20.**

Distribution — *Malesia*: Philippines, New Guinea.

Habitat — Climbing on Pandanus.

**2. *Stenochlaena cumingii* Holttum**

*Stenochlaena cumingii* Holttum, Amer. Fern J. 60 (1970) 122. — Type: *Cuming 226* (holo K; iso BM, not *Cuming 226* in Pr!), Luzon.

*Stenochlaena laurifolia* auct. non C.Presl, Holttum, Gard. Bull. Straits Settle. 5 (1932) 259; 9 (1937) 141; Copel., Fern Fl. Philipp. (1960) 428; Holttum, Nov. Bot. Inst. Bot. Univ. Carol. Prag. 1968 (1969) 51, 52.

*Stipes* robust, at the base containing 100 or more vascular bundles. Sterile *pinnae* with broadly cordate base, not articulate; fertile *pinnae* 7–10 mm broad. *Spores* with ± interrupted longitudinal parallel ridges

Distribution — Moluccas, Philippines, New Guinea.

Note — This appears to be a very distinct species, though Copeland has expressed doubts.

**3. *Stenochlaena milnei* Underw.**

*Stenochlaena milnei* Underw., Bull. Torrey Bot. Club 33 (1906) 38; Holttum, Amer. Fern J. 60 (1970) 121; Croft in G.J. Leach & Osborne, Freshwater Plants of Papua New Guinea (1985) 39. — *Stenochlaena juglandifolia* auct. non C.Presl: Holttum, Gard. Bull. Straits Settle. 9 (1937) 139; Copel. Fern Fl. Philipp. (1960) 428. — Type: *Milne 518* (K), Solomon Islands.

Scrambling, long creeping fern, or high climbing epiphyte with base rooted to the ground, fronds widely spaced, horizontal to pendulous with drooping pinnae. *Rhizome* 5–25 mm diam., pale green, sometimes slightly glaucous, smooth, with scattered, dark, small, orbicular scales, especially towards the apex, the growing tip completely covered. *Fronde*s 100–150 cm long, including a *stipe* of 10–50 cm long, sterile pinnae for the most part not articulate to the rachis, lanceolate to oblong-lanceolate or oblong, 9–30 by 3–5 cm, tip acute, slightly attenuate, base often asymmetric, mostly rounded, with a small dark gland on the apical side, margin almost entire to serrulate, especially at the apex; fertile pinnae linear, 15–30 cm by (3–)4–8 mm. *Spores* with irregular broken ridges.

Distribution — *Malesia*: Philippines, Moluccas (Ceram), New Guinea and the Bismarck Archipelago; the Solomon Islands (in New Guinea apparently restricted to along the north coast).

Habitat — Most collections indicated well-drained lowland rain forests, but some are from freshwater swamp forests, sago (*Metroxylon*) swamps, behind mangroves or strand

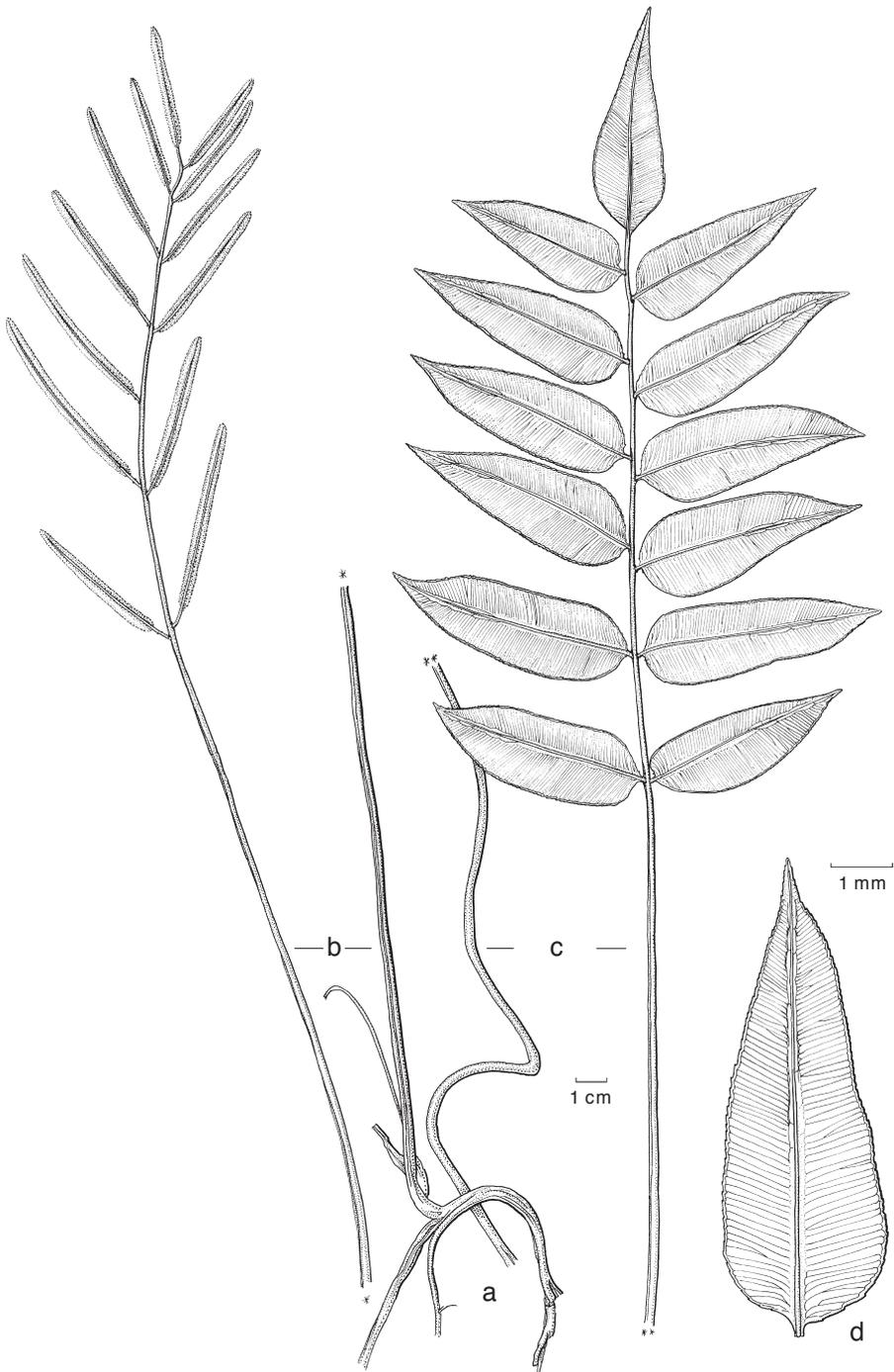


Fig. 20. *Stenochlaena areolaris* (Harr.) Copel. a. Rhizome; b. fertile frond; c. sterile frond; d. pinna showing venation (all: Croft 774).

vegetation, along rivers, etc., sometimes in full sun but prefers a partial shade, sometimes with *S. palustris*. Most commonly a scrambling, high-climbing epiphyte; from sea level to 300 m altitude.

Notes — 1. Resembling *S. palustris* but sterile pinnae always broadly rounded at base and articulation to rhachis not complete; stipe of large fronds containing a larger number of vascular strands; fertile pinnae c. 5 mm wide.

2. This species is closely related to *S. palustris* and has often been misidentified in the past. *Stenochlaena milnei* is a much more robust plant generally occurring in less swampy conditions than *S. palustris*. There are very few specimens that are not assignable to either of these species. The young leaves of this species do not appear to be eaten like *S. palustris*, but this may be a reflection of the relative abundance of the two species. *Stenochlaena milnei* is almost exactly intermediate between *S. palustris* and *S. cumingii* and may represent a hybrid. Cytological evidence is needed.

#### 4. *Stenochlaena palustris* (Burm.f.) Bedd.

*Stenochlaena palustris* (Burm.f.) Bedd., Ferns Brit. India Suppl. (1876) 26; Handb. Ferns Brit. India (1883) 421; Holttum, Revis. Fl. Malaya 2 (1954) 412, f. 241. — *Polypodium palustre* Burm.f., Fl. Ind. (1768) 234. — Type: J. Burm. Thes. Zeyl. (1736) 100, t. 46.

*Lomaria juglandifolia* C.Presl, Reliq. Haenk. (1825) 52; Epimel. Bot. (1851) 164. — Type: *Haenke* (Pr, Herb. Presl), Philippines, Luzon.

*Stenochlaena fraxinifolia* C.Presl, Epimel. Bot. (1851) 163. — Type: *Cuming 347* (Pr, iso BM, US), Philippines, Negros.

*Stenochlaena laurifolia* C.Presl, Epimel. Bot. (1851) 164. — Type: *Cuming 226* (Pr, this is a different species from *Cuming 226* in BM and K, which is *S. cumingii* Holttum), Philippines, Luzon.

Scrambling, long creeping fern, or high climbing epiphyte with base rooted to the ground, fronds widely spaced, horizontal to pendulous with drooping pinnae. *Rhizome* 4–7 mm diam., pale green, sometimes slightly glaucous, smooth, with scattered, dark, small, orbicular scales, especially towards the apex, the growing tip completely covered. *Fronde*s 30–80 cm long, including a stipe of 5–20 cm long, sterile pinnae for the most part articulate to the rhachis, lanceolate to oblong-lanceolate, 7–20 by 1.5–5.5 cm, tip acute, slightly attenuate, base often asymmetric, mostly cuneate, with a small dark gland on the apical side, margin almost entire to serrulate, especially at the apex; fertile pinnae linear, 15–25 cm by 2–3 mm. *Spores* evenly tuberculate.

Distribution — India, throughout southeast Asia; in *Malesia*: Throughout; northeast Australia, and eastwards to Tonga and Samoa.

Habitat — Freshwater swamp forests, sago (*Metroxylon*) swamps, behind mangroves or strand vegetation, along rivers, marshes and on floating vegetation, sometimes in full sun but prefers partial shade. Most commonly a scrambling, high-climbing epiphyte in areas subject to periodic inundation, where the base of the rhizome and lower fronds are frequently wet, but also occurs in lowland rain forest in areas free from flooding; from sea level to 300 m altitude.

Note — The juvenile leaves of this species are deep reddish. In some areas (Manus, Sepik, Upper Fly, Milne Bay etc.) these young fronds are harvested and cooked as a vegetable. See also note under *S. milnei*.

## 5. WOODWARDIA

(R.B. Cranfill, USA & H.P. Nooteboom, Leiden, The Netherlands)

*Woodwardia* Sm., Mém. Acad. Roy. Sci. Turin 10 (1793) 411; J.Sm., Hist. Fl. (1875) 310; Backer & Posth., Varenfl. Jav. (1939) 147; Cranfill, Phylogenetic studies in the Polypodiales (Pteridophyta) with an emphasis on the family Blechnaceae (2001) 139, unpubl. thesis, Berkeley. — Lectotype: *Woodwardia radicans* (L.) Sm., designated by J. Smith (1875).

*Chieniopteris* Ching, Acta Phytotax. Sin. 9 (1964) 37. — Type: *Woodwardia harlandii* Hook. (*Chieniopteris harlandii* (Hook.) Ching).

Plants terrestrial. *Stems* dictyostelic, short-creeping to suberect, > 1 cm diam., covered apically with a dense indument of large, lax, brownish to orangish acute scales. *Stipes* neither swollen nor aerenchymatous, stramineous to reddish brown, lustrous with a dense coat of cordate, acute-tipped orangish to stramineous scales; vascular bundles 5(–7), with two large adaxial bundles and an arc of 3(–5) smaller bundles arranged in an abaxial arc; trophopods present. *Fronde*s monomorphic, densely clustered along the stem, weakly to strongly anthocyanic, rhachises and costae generally grooved, the grooves of the rhachis discontinuous with those of the costae, pinnae not articulate to rhachis; venation catadromous to pseudoanadromous, anastomosing in both trophophylls and sporophylls to form a row of ± regularly quadrilateral anastomoses immediately adjacent to and parallel with the major axes of the laminae ('primary areoles'), irregularly anastomosing exterior of the primary areoles to form one or more ranks of smaller, irregularly shaped triangular to polygonal anastomoses ('secondary areoles') oriented at an angle to the primary areoles and major axes of the laminae, the veins terminating freely at or near the laminar margin. *Laminae* ± coriaceous, wintergreen, weakly to strongly anthocyanic, and serrulate along the margin, capitate glands present; pinnatifid to pinnate-pinnatifid; pinnae not articulate to rhachis, deltate to narrowly ovate, variable in length, and alternate to subopposite. *Sori* discrete, variable in shape and length, superficial to deeply immersed, present along the primary areoles of rhachis, costae and/or costules; indusia linear, membranous to strongly cartilaginous, attached to the exterior vein segment of the primary areole; annuli with 18–24 cells. *Perispore* fragile, tightly appressed over the exospore, forming reticulum of numerous sharp ridges, the surfaces between the ridges variously ornamented.

Chromosome number —  $x = 34$ .

Note — *Woodwardia* is a morphologically diverse assemblage of species characterized largely by a wintergreen habit and a base chromosome number of  $x = 34$ . Complete dried collections of adult, fertile individuals are essential for a reliable determination. An ideal collection of *Woodwardia* should include an entire frond of average dimension, often requiring division of the frond into two or more pieces in order to fit the dimensions of a standard herbarium sheet. At a minimum, a specimen should include 1) the apical third of the frond; 2) a mid-section comprising two to three pinnae; 3) the basal pair of pinnae; and 4) the stipe base with indumenta; along with 5) notes on the overall dimensions of the frond prior to subdivision. When possible, several unexpanded fronds from the crown and a portion of the rhizome should be collected. The material should be fertile with mature or nearly mature sporangia whenever possible. Notes on habit and coloration of the fronds are also helpful.

KEY TO THE SPECIES

- 1a. Fronds gemmiferous; free pinnae in 17–23 pairs, suboppositely arranged (sometimes alternately), usually basally asymmetric by the reduction of the basalmost basispicopic lobe. Sori present mostly along the primary areoles of the costules, although occasionally present along the primary areoles of the costae; indusia thin, membranous, and lax, undifferentiated, irregularly reflexed upon dehiscence of the sporangia . . . . . **1. *W. auriculata***
- b. Fronds gemmiferous with scattered to numerous, articulated gemmae on the adaxial surface of the lamina or gemmiferous on the rhachis by the presence of one or two non-articulate scaly buds; free pinnae 7–16 pairs, alternately arranged, basally ± symmetric or strongly asymmetric by the reduction of several basalmost basispicopic lobes. Sori mostly confined to the primary areoles of the costules; indusia cartilaginous with a thickened basal flange and a membranous conduplicate margin . . . . . **2**
- 2a. Gemmae numerous per frond, adaxial on the surface of the lamina, articulate; free pinnae in 7–12 pairs, basally strongly asymmetric by the reduction of several basalmost basispicopic lobes. . . . . **2. *W. prolifera***
- b. Gemmae one or two per frond, abaxial along the rhachis, not articulate; free pinnae in 11–16 pairs, basally ± symmetric about the costae . . . . . **3. *W. unigemmata***

**1. *Woodwardia auriculata* Blume**

*Woodwardia auriculata* Blume, Enum. Pl. Javae 2 (1828) 196; Backer & Posth., Varenfl. Jav. (1939) 147; Cranfill, Phylogenetic studies in the Polypodiales (Pteridophyta) with an emphasis on the family Blechnaceae (2001) 161, unpubl. thesis, Berkeley. — *Woodwardia radicans* (L.) Sm. var. *auriculata* (Blume) C.Chr., Index Filic. (1906) 658. — Type:*Kuhl & Van Hasselt s.n.* (holo L0052402), Indonesia, Java, Pangerango.

Plants terrestrial. *Stems* stout, short-creeping to suberect, densely clothed at the apex with large, broadly to narrowly lanceolate, orange-brown scales; trophopods present. *Fronds* erect, spreading, wintergreen and subcoriaceous, clustered near the stem apex, egemmiferous. *Stipes* 43–68 cm long, stramineous to mahogany, expanded at base, with two large adaxial vascular bundles and an arc of several smaller abaxial vascular bundles, densely scaly at the base and bearing scurfy remnants of multicellular glands, hairs, and scales distally, the scales sometimes leaving distinct scars after abscising, especially near the stipe base. *Laminae* 45–101 cm long, (very) narrowly ovate, pinnate-pinnatifid, pink to reddish, glandular and scaly during emergence, becoming dark green and glabrate at maturity; free pinnae in 17–23 pairs, the proximal to medial ones 20–33 by 2.8–5.5 cm, suboppositely arranged, deeply pinnatifid, narrowly lanceolate and gradually tapered at apex, often basally asymmetric by the reduction of the basalmost basispicopic lobe, pinna lobes arranged in 24–35 pairs per pinna, narrowly deltate, tapering and separated from one another by broad sinuses often nearly or quite as broad as the lobes, coarsely to obscurely serrulate and frequently involute. *Sori* 2–4 mm long, linear-elongate, superficial, distributed mostly along the primary areoles of the costules, although occasionally present along the primary areoles of the costae, becoming confluent upon dehiscence of the sporangia; indusia thin and undifferentiated, lax and irregularly spreading following sporangial dehiscence, frequently hidden by fully

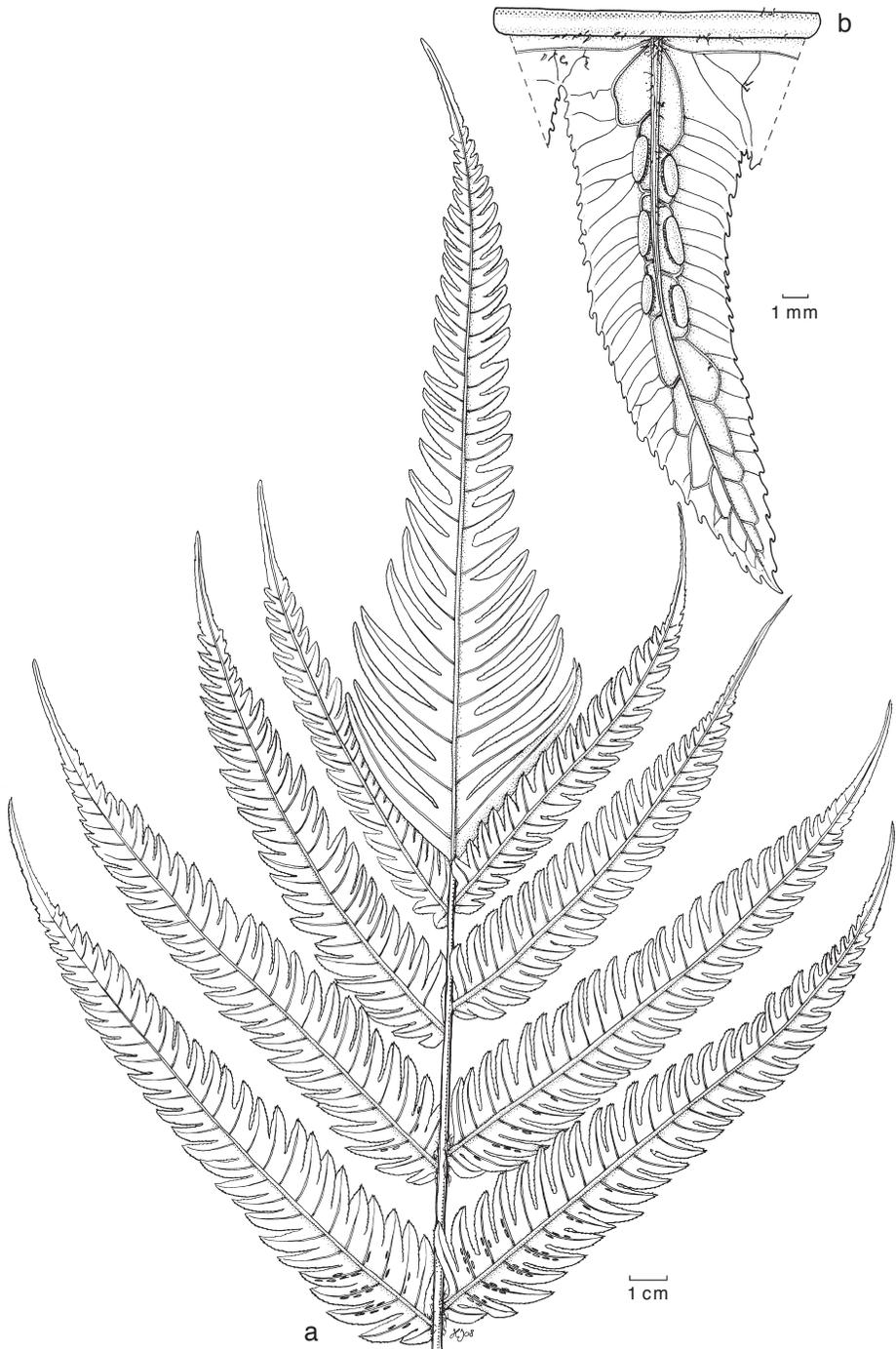


Fig. 21. *Woodwardia auriculata* Blume. a. Top of frond; b. detail of pinnule (a: *Blume s.n.*, barcode L52400; b: *Hochreutiner 1623*). — Drawing by Hanneke Jelles.

dehisced sporangia. *Spores* 64 per sporangium, 30–40 by 15–20  $\mu\text{m}$  (exclusive of the perispore), surrounded by a tightly appressed perispore presenting a reticulum of raised narrow ridges and rugulose expanses between the ridges ornamented with aggregations of rods and cristae. — **Fig. 21.**

Chromosome number — Unknown.

Distribution — In *Malesia*: Sumatra, Malay Peninsula (Cameron highlands, G. Brinchang), Java (W). Altitude 1000–2200 m.

Ecology — Moist, montane, mixed evergreen broadleaf-coniferous forests, generally dominated by species of Fagaceae and Pinaceae. *Woodwardia auriculata* grows in forests having many warm-temperate, east Asian species with Arcto-Tertiary floristic affinities. In Sumatra, this species is infrequent in oak-pine forests in which *Pinus merkusii* is a local dominant.

*Woodwardia auriculata* and *W. japonica* are morphologically very similar and sometimes confused in herbaria. The two species can be reliably distinguished by 1) the number of pinna pairs per frond; and 2) the number of pairs of lobes per pinna. *Woodwardia japonica* has fewer pinnae and fewer lobes per pinna than does *W. auriculata*. In addition, the pinna lobes of *W. auriculata* tend to be acuminate at the apex and the sori tend to appear confluent after sporangial dehiscence more often than in *W. japonica*.

These species are clearly closely related, perhaps diverging as recently as the Pleistocene. Specimens of *W. auriculata* from northern Sumatra sometimes resemble southeast Asian phases of *W. japonica*. The collection *Iwatsuki et al. 1359*, collected near Aceh in northern Sumatra, is an example of some of the more puzzling material. The lance-ovate pinnae with falciform lobes separated by broad sinuses is reminiscent of *W. japonica*. The remaining features, including the acuminate apices of the segments and the large number of pairs of lobes per pinna are features characteristic of *W. auriculata*.

Geographic and elevational isolation between populations of *W. auriculata* and *W. japonica* very likely limit gene flow. The two species, however, may not be entirely reproductively isolated from one another. Considerable morphological variation in southern populations of *W. japonica* and to a lesser extent in northern populations of *W. auriculata* suggests limited interbreeding may have occurred in relatively recent times.

## 2. *Woodwardia prolifera* Hook. & Arn.

*Woodwardia prolifera* Hook. & Arn., Bot. Beechey Voy. (1838) 275, t. 56; Cranfill, Phylogenetic studies in the Polypodiales (Pteridophyta) with an emphasis on the family Blechnaceae (2001) 208, unpubl. thesis, Berkeley. — *Woodwardia orientalis* Sw. var. *prolifera* (Hook. & Arn.) Ching, Bull. Fan Mem. Inst. Biol. 2 (1931) 4. — *Woodwardia orientalis* Sw. subsp. *prolifera* (Hook. & Arn.) Sugim., Keys Herb. Pl. Jap. Pterid. (1966) 341. — Type: *Beechy s.n.*, presumably collected by Lay and Collie in the Ryukyu Islands (GL, deposited at E; isotype K), Japan, Loo Choo.

*Woodwardia angustiloba* Hance, J. Bot. 6 (1868) 176. — Type: *Gregory s.n.* (BM), People's Republic of China, Prope urbem Foochow.

*Woodwardia orientalis* Sw. var. *formosana* Rosenst., Hedwigia 56 (1915) 334. — *Woodwardia prolifera* Hook. & Arn. var. *formosana* (Rosenst.) Ching & P.S. Chiu, in P.S. Chiu, Acta Phytotax. Sin. 12 (1974) 244. — Type: *Faurie 231* (holo n.v.; iso TI), Taiwan, Bankinsing Cascades.

*Woodwardia exaltata* Nakai, Bot. Mag. (Tokyo) 35 (1921) 149. — Lectotype (here chosen): *T. Asai s.n.* (TI), Japan, in silvis insula Hachijo.

Plants terrestrial. *Stems* stout, short-creeping to suberect, densely clothed at the apex with large, broadly to narrowly lanceolate, orange-brown scales; trophopods present. *Fronde*s drooping, wintergreen and coriaceous, clustered near the stem apex, gemmiferous with scattered to numerous, articulated gemmae on the adaxial surface of the lamina, such gemmae generally positioned opposite and replacing a sorus on one or more primary areoles of the costae and costules, each gemma generally developing one or at most two elliptical fronds less than 1 cm long. *Stipes* 33–99 cm long, stramineous to greenish throughout, expanded at base, with two large adaxial vascular bundles and an arc of several smaller abaxial vascular bundles, densely scaly at the base and bearing scurfy remnants of multicellular glands, hairs and scales distally, the scales sometimes leaving distinct scars after abscising, especially near the stipe base. *Laminae* 42–126 cm long, narrowly ovate-deltate, pinnate-pinnatifid, pale green, glandular and scaly during emergence, becoming dark green and glabrous at maturity; pinnae 7–12 pairs, the proximal to medial ones 15–42 and 2–12 cm, alternately arranged, pinnatifid, narrowly ovate, basally strongly asymmetric by the reduction of several basalmost basicopic lobes, pinna lobes falcate-ascending, narrowly ovate (broadly attached to costa, but constricted immediately above), acuminate, separated from each other by broad sinuses, coarsely serrulate along a strongly involute margin. *Sori* 1–3 mm long, linear-elongate to lunate, deeply immersed in the lamina, mostly confined to the primary areoles of the costules; indusia cartilaginous with a thickened basal flange and a membranous conduplicate margin, vaulted, opening along a basal hinge like the lid of a box upon dehiscence of the sporangia. *Spores* 64, 30–34 by 22–25  $\mu\text{m}$  (exclusive of the perispore), surrounded by a tightly appressed perispore presenting a reticulum of raised narrow ridges and rugulose expanses between the ridges ornamented with aggregations of rods and cristae. — **Fig. 22.**

**Typification & Nomenclature** — Gray stated that Beechey's plants are in Arnott's herbarium, which is now deposited at E (Stafleu & Cowan, *Taxon*, Lit., ed. 2, 1 (1976) 67). Since W.J. Hooker was in residence at Glasgow during the preparation of their work on Beechey's Voyage, I interpret the specimen at GL, now deposited at E, as holotype of *W. prolifera*. Nakai cited two collections in his description of *W. exaltata*. I choose the collection annotated Hachijo Island, *Toichi Asai s.n.* (TI) as lectotype of the species.

**Chromosome number** —  $n = 34$ .

**Distribution** — Idzu Peninsula of Honshu and the island of Kyushu, west to Fujian and Guandong Provinces of China, south to Taiwan; in *Malesia*: Philippines (Bataan Islands), nearly confined to coastal regions.

**Ecology** — Warm-temperate, subtropical and tropical mixed broadleaf evergreen forests, frequently where there is disturbance such as roadside banks, disturbed forests, rocky ravines, and meadows. *Woodwardia prolifera* thrives in somewhat disturbed or open situations where it receives at least some partial sun. Fine stands of this species can be found along road-cuts and high up on stream banks and along wet cliffs. Altitude 0–1000 m.

**Notes** — 1. With its drooping fronds, lustrous lamina, and numerous leafy laminar buds, *W. prolifera* is arguably the showiest species in the genus. It is frequently cultivated, especially in glass houses and conservatories, where it thrives. It can be grown outdoors where winter frosts are absent or very light, such as coastal California and

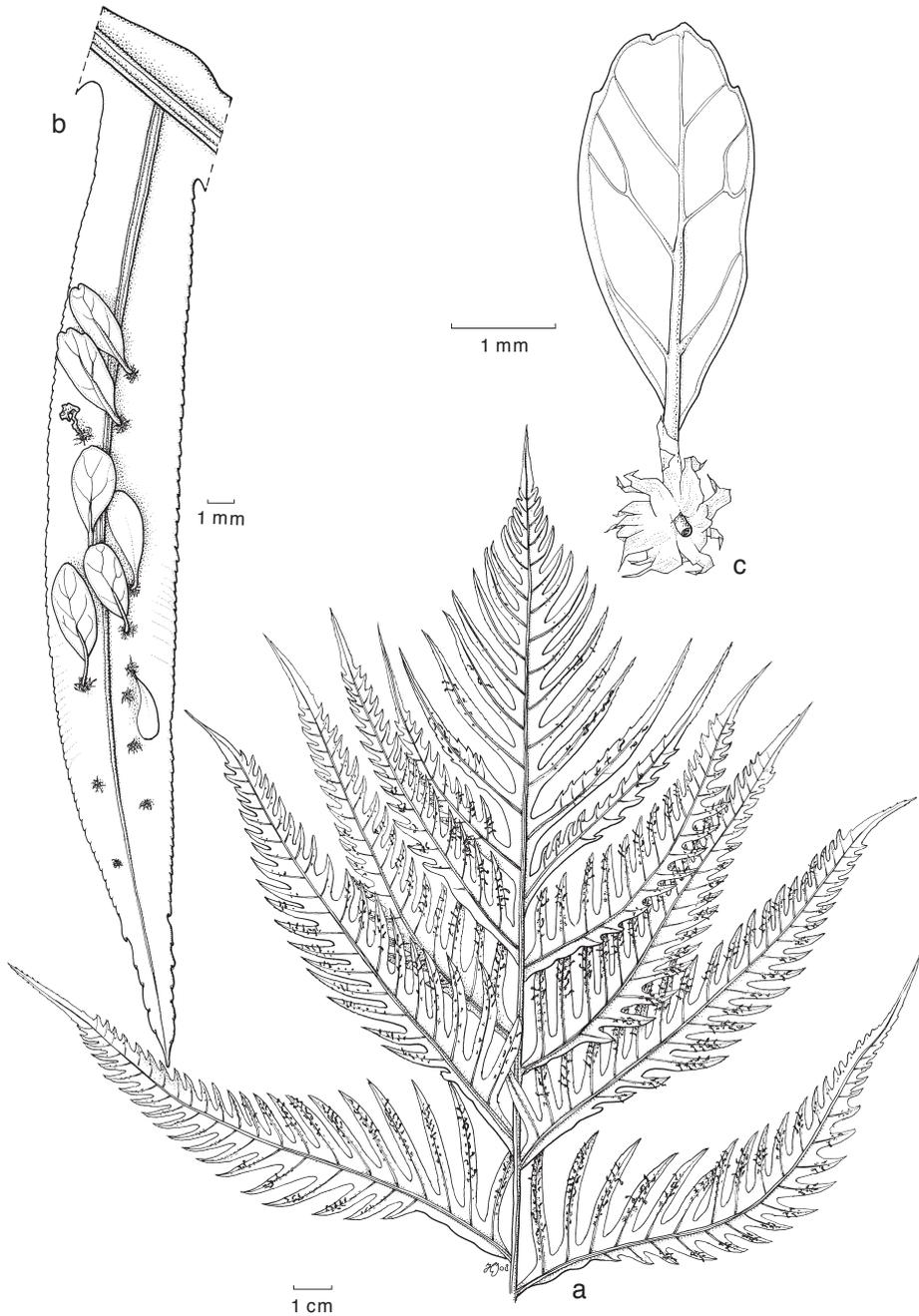


Fig. 22. *Woodwardia prolifera* Hook. & Arn. a. Top of frond; b. pinnule with gemmata; c. detached gemma (all: Tanaka c.s. 13584). — Drawing by Hanneke Jelles.

peninsular Florida. It adapts particularly well to indoor and greenhouse culture, but requires a large amount of space.

2. The variability of pinnae dissection, blade texture and extent of vivipary in *W. prolifera* has prompted workers to describe a number of segregate taxa. Although the variation can be considerable, it appears to be fairly continuous. There is, however, a tendency to produce more strongly asymmetric pinnae toward the southern and eastern portions of its range. Specimens from Japan (e.g., *Tagawa 7934*) and mainland Asia (e.g., *Chang 48411*, *Lau 4230*) produce few gemmae and bear pinnae having only a few of the inferior, basalmost lobes reduced. Material from Taiwan (*Huang 2328*), the Ryukyu Islands (*Conover 1825*) and The Philippines (*Fenix 3773*) are more frequently proliferous and bear pinnae having several to many of the inferior, basalmost pinnae absent or otherwise reduced to a narrow wing. Other features, such as narrowing of the lobes and pinnae and involution of the laminar margins, show a similar but less well-marked trend.

3. Ching (in Chiu 1974) proposed var. *formosana* for plants exhibiting the morphological extreme in which the inferior, basalmost pinnae lobes are absent. Although of striking appearance in the extreme, one can cite numerous specimens varying in the degree to which these lobes have been reduced in size or eliminated altogether. Further, there are no other characters or features to suggest that *W. prolifera* comprises two or more identifiable monophyletic subpopulations that may be proposed as subspecies or varieties. As with all other Asian species of *Woodwardia*, careful field studies and more collections are needed.

4. The origin and differentiation of the laminar gemmae is not understood. Do they represent dormant remnants of the laminar marginal meristem? Or do they arise 'de novo' at a later developmental stage of the lamina. It is, however, clear that the distribution of buds along the adaxial laminar surface is not random. Rather, they always occur above and proximate to primary areoles. Unlike the rachial buds of *W. radicans* and *W. unigemmata*, the laminar buds of *W. prolifera* disarticulate freely from the fronds, leaving a smooth, nearly round saucer-shaped indentation. Whereas rachial buds produce several well-developed fronds and a number of roots while still attached to the parent plant, laminar buds produce but a single frond and no roots while attached to the parent.

### 3. *Woodwardia unigemmata* (Makino) Nakai

- Woodwardia unigemmata* (Makino) Nakai, Bot. Mag. (Tokyo) 39 (1925) 103; Cranfill, Phylogenetic studies in the Polypodiales (Pteridophyta) with an emphasis on the family Blechnaceae (2001) 191, unpubl. thesis, Berkeley. — *Woodwardia radicans* (L.) Sm. var. *unigemmata* Makino, J. Jap. Bot. 2 (1918) 7. — Type: *Hisauichi s.n.* (MAK), Japan, Idzu Province, Joren Falls, 11 Aug. 1917.
- Woodwardia maxima* Ching & P.S.Chiu, in P.S.Chiu, Acta Phytotax. Sin. 12 (1974) 241. — Type: *Chang 4299* (PE), People's Republic of China, Guizhou Prov., Long Mountain Commune.
- Woodwardia latiloba* Ching & P.S.Chiu, in P.S.Chiu, Acta Phytotax. Sin. 12 (1974) 242. — Type: *Dai 102884* (PE), People's Republic of China, Sichuan Prov., Beitsu Mountain.
- Woodwardia yunnanensis* Ching & P.S.Chiu, in P.S.Chiu, Acta Phytotax. Sin. 12 (1974) 242. — Type: *Tsai 51672* (PE), People's Republic Of China, Yunnan Prov., Wen Mountain.
- Woodwardia himalaica* Ching & S.K.Wu, Flora Xizangica 1 (1983) 191. — Type: *Chang et al. 4547* (PE), People's Republic of China, Xizang Zizhiqu Prov., Zham, among rocks, 2300 m, 24 June 1966.

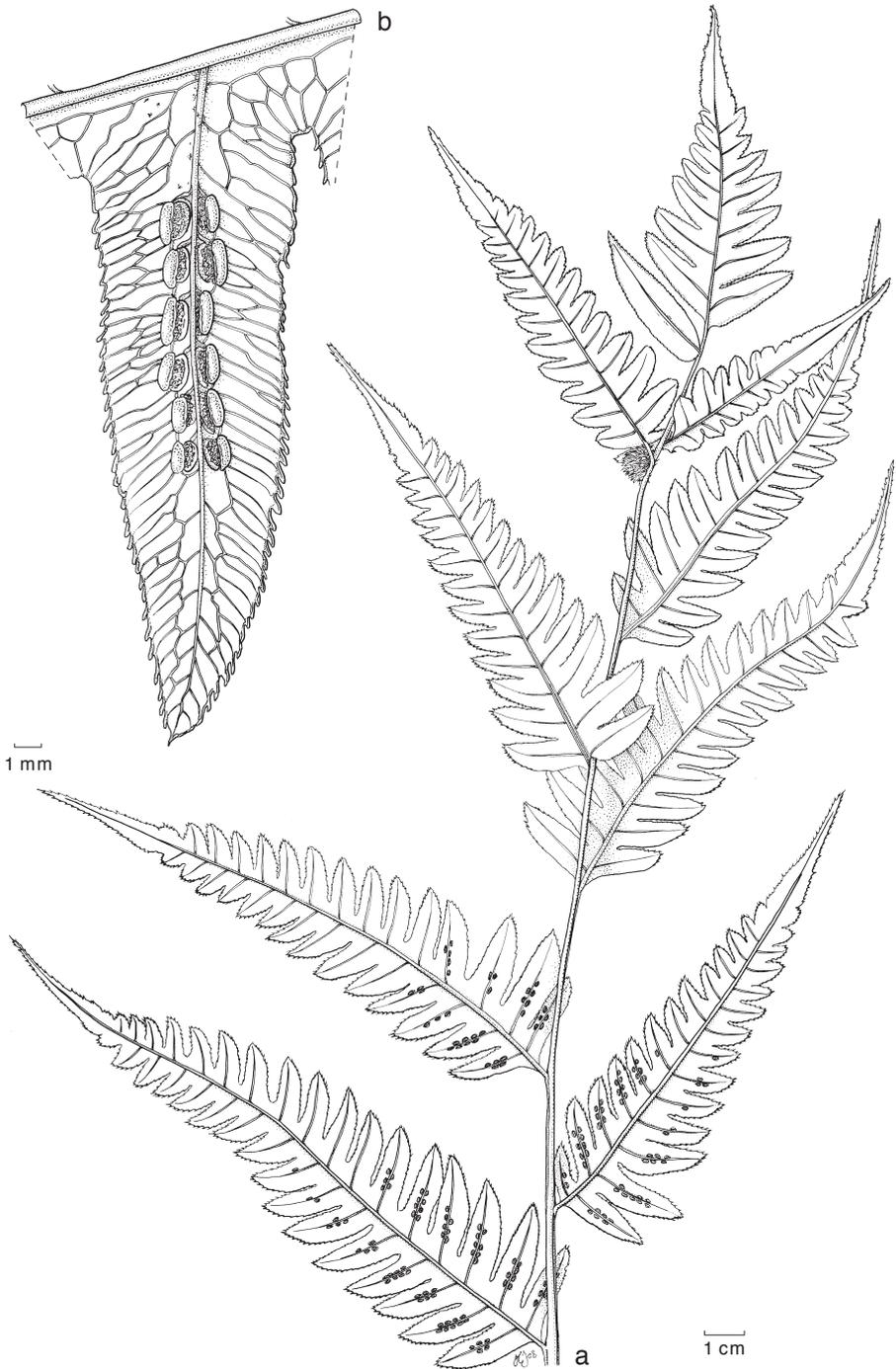


Fig. 23. *Woodwardia unigemmata* (Makino) Nakai. a. Top of frond with one gemma; b. detail of pinule (all: *Brass 11053*). — Drawing by Hanneke Jelles.

Plants terrestrial. *Stems* stout, short-creeping to suberect, densely clothed at the apex with large, broadly to narrowly lanceolate, orange-brown scales; trophopods present. *Fronde*s spreading, wintergreen and coriaceous, clustered near the stem apex, gemmiferous on the rachis by the presence of one or two non-articulate scaly buds at or very near the frond apex, these gemmae usually developing 2–5 fronds and numerous roots while still attached. *Stipes* 32–100 cm long, stramineous to orange-brown, becoming darker toward the base, expanded at base, with two large adaxial vascular bundles and an arc of several smaller abaxial vascular bundles, densely scaly at the base and bearing scurfy remnants of multicellular glands, hairs, and scales distally, the scales sometimes leaving distinct scars after abscising, especially near the stipe base. *Laminae* 30–165 cm long, narrowly ovate, pinnate-pinnatifid, dark red to bronze or brown, glandular and scaly during emergence, becoming dark green and glabrous at maturity; pinnae in 11–16 pairs, the medial ones 18–61 cm and 2–10 cm, alternately arranged, deeply pinnatifid, lanceolate and acute at apex, basally  $\pm$  symmetric about the costae, pinna lobes narrowly deltate, acute, separated from each other by a distinct sinus, coarsely serrulate along a strongly involute margin. *Sori* 1.5–3 mm long, linear-elongate to lunate, deeply immersed in the lamina, confined to the primary areoles of the costules; indusia cartilaginous with a thickened basal flange and a membranous conduplicate margin, vaulted, opening along a basal hinge like the lid of a box upon dehiscence of the sporangia. *Spores* 64, 30–35 by 2–23  $\mu\text{m}$  (exclusive of the perispore), surrounded by a tightly appressed perispore presenting a reticulum of raised narrow ridges and rugulose expanses between the ridges, ornamented with aggregations of rods and cristae. — **Fig. 23.**

Chromosome number —  $n = 34$ .

Distribution — Along the Himalayas from extreme north-eastern Pakistan to Bhutan; south-eastern Tibet to south central China and extreme north-eastern Myanmar; disjunct on the islands of Taiwan; Honshu, Kyushu; in *Malesia*: Luzon and New Guinea.

Ecology — Mixed deciduous, mixed deciduous-coniferous, and subtropical evergreen forests, nearly always occurring in humid, lightly shaded areas, often where the soil is shallow and rocky. Altitude 0–3000 m.

Note — Tardieu-Blot, *Les Aspleniens du Tonkin* (1932). Basayau & Cie, Toulouse and Tardieu-Blot & Christensen, *Fl. Indo-Chine* 7 (1940) reported this species from northern Vietnam (*Chapa* 1924, and *Colani* 2850, both from Tonkin), but I have seen neither specimen. *Woodwardia unigemmata* closely resembles *W. radians*. In addition, *W. unigemmata* is sometimes confused with morphotypes of *W. japonica*, *W. orientalis* and *W. prolifera*. The presence of one or more rachial gemmae is sufficient to distinguish *W. unigemmata* from related budless species. Budless material of *W. unigemmata* may be generally recognized by deltate (as opposed to narrowly ovate) pinna lobes and pinnae that are nearly symmetric in lobing at the base.