

## SCHIZAEACEAE (R. E. Holttum, Kew)

Rhizome usually short-creeping with closely-placed fronds, less often wide-creeping or somewhat erect, the young parts covered with thick septate hairs (except *Mohria*, not Malaysian), structure dorsiventral or radial, vascular strand in Malaysian genera a protostele (medullated in *Schizaea*). *Fronds* of very varied structure, their branching showing varying gradations from dichotomous to pinnate; veins usually free; *sporangia* borne on specialized segments of the fronds (sorophores) except in the non-Malaysian *Mohria*. *Sorophores* at the ends of veins of fertile leaflets (*Lygodium*), or in small pinnate groups at the apex of a frond or of its branches (*Schizaea*), or confined to special branches of the frond (*Anemia*, not Malaysian). *Sporangia* arising marginally but becoming superficial due to subsequent extra-marginal growths, large, borne on short massive stalks or sessile, with an almost apical annulus of a single row of elongate thickened cells, dehiscing on a line from annulus to base. *Spores* trilete or monolete (*Schizaea* only), without perispore, the surface usually sculptured. *Gametophytes* filamentous in *Schizaea*, thalloid in other genera, symmetrical or not.

Distribution. The Malaysian genera *Schizaea* and *Lygodium* are pantropic with a few outlying species of both in temperate regions (U.S.A., S. Africa, Chile, Japan, and New Zealand). *Anemia* has its main distribution in tropical America, with a few species in Africa and one in southern India. *Mohria* is confined to southern and eastern Africa and the Mascarene Islands.

Fossils. The older fossils belong to extinct genera, which are quite different in frond-form from living members of the family; their relationship to these living members is shown only by their sporangia and spores. The Upper Carboniferous genus *Senftenbergia* has been most recently and fully described by RADFORTH (Trans. R. Soc. Edinb. 59, 1938, 385-396; *ibid.* 1939, 745-761). The fronds were bipinnate-tripinnatifid, comparable in size with those of *Cyathea* of today, with sterile and fertile parts alike in shape of lamina; the rhizome is not known. The sporangia, attached to the edge of the lamina by very short stalks, were similar in shape to those of the living genus *Anemia* but differed in having an annulus of 2-5 rows of cells, in at least one case not sharply differentiated from the rest of the sporangial wall. The Jurassic genus *Klukia* had fronds of similar form, but the sporangia had an annulus of a single row of cells, much as in *Anemia*. C. F. REED has made the most recent summary of fossil forms in the family (Bol. Soc. Brot. 21, 1947, 71-197); he includes also the genera *Tempyska*, *Acrostichopteris*, *Pelletiera*, and *Schizaeopsis*, from Upper Jurassic and Cretaceous horizons, but sporangia of these have not been seen. Fossils of the living genera *Anemia*, *Lygodium*, and *Schizaea* have been found in late Cretaceous and early Tertiary rocks in Europe and North America (REED, *l.c.*; CHANDLER, Bull. Br. Mus. Nat. Hist., Geol., 2, 1955, 291-314; SELLING, Act. Hort. Gotob. 16, 1944, 1-112); fossils of *Schizaea* have also been found in Eocene of SE. Australia and Pliocene in New Guinea (COOKSON, Proc. R. Soc. Victoria n.s. 69, 1957, 41). Fossils of *Anemia* and *Lygodium* include good leaf-impressions and sporangia; those of *Schizaea* are confined to spores. One species of *Schizaea* is also known from fossils of Quaternary age in Hawaii.

Ecology. *Lygodium* plants are twining climbers, mainly in secondary vegetation (fig. 6, 10), producing fertile leaflets on parts exposed to the brightest light (in most cases, to full sunlight). Fronds of the larger species may climb to a height of 10 m, but others only to 2-3 m. In regions where there is a prolonged dry season the plants may be confined to wet ground. *L. microphyllum*, *L. polystachyum* and *L. salicifolium* have caducous leaflets which fall when old. Whether plants are ever quite bare of leaflets in dry seasons is not recorded; certainly the rhizomes have no power of resisting considerable drought, and most plants are evergreen. *L. japonicum* occurs outside Malaysia in decidedly seasonal climates, and in Malaysia does not occur in the uniformly wet region of Sumatra, Malaya and Borneo. *L. polystachyum*, native of the seasonal climate of the region from northern Malaya to Burma and Indochina, is only found in shady forest; possibly this is also true of *L. merrillii*. All species of *Lygodium* in Malaysia are lowland plants, the highest altitude record being little over 1000 m, apart from *L. japonicum* (to 2500 m).

*Schizaea* plants are all small, and occur in poor acid sandy or peaty soils where the vegetation is rather open (fig. 1, 2), apart from *S. digitata*, which always occurs in light to moderate shade. *S. fistulosa* is a high mountain plant, *S. malaccana* on exposed ridges at moderate elevations, the other species in low country. *S. inopinata* occurs only on limestone. *S. wagneri* and *S. spirophylla* are reported as growing in moss-cushions on trees.

Vegetative morphology. Both *Lygodium* and *Schizaea* are specialized, in quite different ways;



Fig. 1. Unusually dense stand of *Schizaea dichotoma* (L.) SM. on very poor sandy podsol, under shrubs near Pasir Pandjang, west coast of Borneo (DUNSELMAN, 1936).

as above indicated, they are adapted to peculiar habitat-conditions. It is probably significant that neither is represented by fossils earlier than late Cretaceous or Eocene. The sorophores of both genera (and of *Anemia*) are perhaps reduced modifications of the lobes of fertile leaflets of ancestral ferns with fronds like those of *Senftenbergia*. The photosynthetic function of such lobes is transferred in both genera to a lamina developed from the wing of the rachis which occurs throughout the family (see further notes under the genera); such development is much more extensive in *Lygodium* than in *Schizaea* (for a discussion of transference of function, see CORNER in Journ. Linn. Soc. Bot. 56, 1958, 33-48).

Fronds of *Schizaea* are either unbranched (the ultimate condition of reduction) or symmetrically dichotomously branched. Fronds of young plants of *Lygodium* are dichotomously branched, but later fronds develop an elongate sympodial climbing rachis by means of a series of alternate unequal dichotomies. The short branch at each dichotomy of a climbing rachis has a pair of opposite secondary branches beyond which it is dormant (HOLTUM, Phytomorphology 7, 1957, 152). The dormant apices may grow if there is injury to a distal part of the frond. Similar, but not identical, dormancy occurs in the families *Gleicheniaceae* and *Matoniaceae*. Periodic dormancy of apices occurs in *Dennstaedtia*, *Hypolepis* and *Paesia*, which are perhaps derivatives of *Schizaeaceae*.

PRANTL investigated the development of sorophores in *Schizaeaceae*, and stated that the sporangia were marginal in origin (Untersuch. z. Morph. der Gefässkrypt. II, 1881). DIELS doubted PRANTL's observations (in Engler, Pflanzenfam. 1, 4, 1900, 356-372), but later workers confirmed them (BOWER, The Ferns 2, 1926, 163-165). The lamina of the sorophores, and the separate indusia for each of the sporangia in *Lygodium*, are later extra-marginal developments.

Sporangia and spores. The sporangia are the most distinctive feature of the family; they are well illustrated by PRANTL for all genera and his drawings have been frequently copied. The sporangia are large, almost or quite sessile, and all have an almost apical annulus with a longitudinal line of dehiscence. Those of *Lygodium* are peculiar in having an asymmetrically placed lateral attachment. The spores are in most cases rather elaborately sculptured on the surface, and are often specifically diagnostic (see further discussion under the genera).

Gametophyte. The gametophyte of *Schizaea* is filamentous, with antheridia and archegonia on special short branches; some cells have an endophytic fungus. Other genera have more normal gametophytes, sometimes with asymmetric growth; their antheridia are large, and they show some other primitive features (for references up to 1926, see BOWER, *l.c.* 170). Most observations of gametophytes have been of non-Malaysian species.

**Cytology.** The only records are by MANTON & SLEDGE (Phil. Trans. R. Soc., B, 238, 1954, 142-143) and LOVIS (Nature 181, 1958, 1085). *Lygodium scandens* (*L. microphyllum* of present work) in Ceylon had  $n = 30$ . *L. circinnatum* in Ceylon had  $n = 58$ , but a plant in cultivation at Kew had  $n = 29$ . A plant of *L. japonicum* at Kew also had  $n = 58$ . The basic number in *Anemia* is 38; a naturalized plant in Ceylon was tetraploid, a plant in cultivation at Kew diploid. *Schizaea asperula* WAKEF. in New Zealand had  $n = 77$  (LOVIS, *l.c.*); the same number was also found by LOVIS (unpublished) for *S. dichotoma* in New Zealand. In Ceylon LOVIS found that *S. digitata* had a very high number ( $n = 325 \pm 30$ ). These figures indicate that polyploidy is not uncommon in the family, and that the extreme reduction of plant-form in *Schizaea* may be associated with high polyploidy.

**Anatomy.** The fullest account of anatomy in the family is by PRANTL (*l.c.*); later works are cited by BOWER. The rhizome of *Lygodium* has a solid protosteles; the rachis of the climbing frond has also a compact vascular strand (not C-shaped), with very large tracheids in the xylem, no doubt in adaptation to its habit (a slender twining rachis carrying many leaflets, which thus needs a vascular system of capacity large in proportion to its area of cross-section). The rhizome of *Schizaea* has a more or less medullated protosteles, and the stipe has a small compact vascular strand in which the xylem is reduced, more or less 3-armed as seen in cross-section. In both genera there is considerable development of sclerenchyma. The genera *Anemia* and *Mohria* have a more complex vascular anatomy. *Schizaea* shows specialization in the arrangement of stomata, the details of this varying from species to species.

**Economic importance.** The tough slender climbing rachises of *Lygodium* find various uses, either in their natural form, or prepared by splitting for finer purposes. They are used as a substitute for cord (e.g. for tying sheaves of rice), for plaiting into hats, bracelets, etc., for fastening the rims of sieves, and in other ways. There are records of the use of several species of *Lygodium*, and also of *Schizaea dichotoma*, for a great variety of medicinal purposes (see BURKILL, Dict. Econ. Prod. Mal. Pen. 1378, 1975; also HEYNE, Nutt. Pl. Ned. Ind. ed. 2, 96, 97), but no critical study of such uses has been made. Very young leaves of *Lygodium microphyllum* and *L. circinnatum* are eaten in Java (OCHSE, Veg. D.E.I. 1931, 655-657). The plants are also used (especially *Lygodium*) in magical ceremonies connected with house-building, rice culture, fishing, etc.

**Taxonomy.** The early history of the taxonomy of the genus *Lygodium* is very complex, for various reasons. LINNAEUS began badly by including references to three distinct species under his *Ophioglossum scandens* (the basis of *Lygodium scandens* Sw.); and he was unfortunate in having a poor specimen of a sterile frond of an immature plant on which to base his *O. flexuosum*. In the years immediately following 1800, several authors were independently studying specimens of *Lygodium*, and the following generic names were given: *Lygodium* Sw., *Ugena* CAV., *Ramondia* MIRBEL, *Odontopteris* BERNH., *Gisopteris* BERNH. and *Hydroglossum* WILLD. (all in 1801), *Cteisium* MICHX (1803) and *Vallifilix* THOUARS (1809). The following names were also given to *Schizaea*: *Lophidium* RICH. (1792) and *Ripidium* BERNH. (1801). For a full bibliographic statement on these genera, and a discussion of their typification, see PICHISERMOLLI, Webbia 12 (1955) 4-36.

In the case of *Lygodium*, there is so much variation in leaflet-form, due to (a) age of plant, (b) environmental conditions, (c) height above ground from which specimen is taken, (and probably also to polyploidy and hybridization) that, even with ample material, it is not easy to define specific limits, and there was much confusion in the use of names by earlier authors. Different forms of the same species received different names, while in other cases two quite different species were confused under one name. WILLDENOW based his *Hydroglossum pinnatifidum* on two specimens, one sterile and one fertile, belonging to two quite distinct species, and his name, transferred to *Lygodium*, was subsequently used by different authors for both these species. For a detailed discussion of this subject, see ALSTON & HOLTUM, Reinwardtia 5 (1959) 11-22.

The only good monograph of the whole family is that of PRANTL (*l.c.*, 1881), whose very thorough morphological study (of material then available) laid a sound basis on which others, working on various aspects of the family and with new material, could build. DIELS (in Engler, Pflanzenfam.) followed PRANTL with little alteration, as did also CHRISTENSEN (Index Filicum, 1905). As regards nomenclature, PRANTL did not look fully into the typification of *L. scandens* (L.) Sw. and he did not follow some of our modern rules. Also he did not have good material (in a few cases he had no material) of some of the less common Malaysian species.

NAKAI published a survey of the whole family in 1937 (J. Jap. Bot. 13, 139-154). He divided it into the three families *Schizaeaceae*, *Lygodiaceae* and *Anemiaceae* (including *Mohria* in the last) and also raised some infra-generic groups to generic rank. This process was carried further by C. F. REED (Bol. Soc. Brot. 21, 1947, 71-197) who raised the rank of the whole group to that of an Order, *Schizaeales*, with families for the fossil as well as living representatives. He separated *Mohria* as a family distinct from *Anemia*, and raised further subdivisions of *Lygodium* and *Schizaea* to generic rank, but made no critical contribution to the understanding of species, nor any new basic morphological study. COPELAND (Gen. Fil. 1947) made little change from CHRISTENSEN's arrangement.

#### KEY TO THE GENERA

1. Fronds simple and linear, or dichotomously branched with linear branches (which in some non-Malaysian species are joined laterally), the sorophores borne laterally near the apex of the frond

or of its branches; no indusia. Spores monolete . . . . . 1. *Schizaea*  
 1. Fronds of young plants dichotomously branched, of older plants of indefinite growth with twining rachis, the rachis-branches variously branched and bearing leaflets which have sorophores at the ends of their veins; each sporangium protected by a separate indusium. Spores trilete 2. *Lygodium*

1. SCHIZAEA

SM. Mem. Ac. Turin 5 (1793) 419, *nom. cons.*—*Lophidium* RICH. Act. Soc. Hist. Nat. Paris 1 (1792) 114.—*Actinostachys* WALL. *ex* HOOK. Gen. Fil. (1842) t. 111; REED, Bol. Soc. Brot. 21 (1947) 130.—*Microschizaea* REED, *l.c.* 133.—Fig. 1-4.

Rhizome creeping or suberect, the young parts, and bases of stipes, covered with coarse septate hairs, vascular system a medullated protosteles. *Stipes* erect, slender, narrowly winged towards apex in most species. *Fron*d simple or dichotomously branched, lamina reduced to a narrow wing bearing a single (rarely double) row of stomata on the lower surface; two-celled glandular hairs frequent on the surface of fronds, the basal cells persistent and often forming small warts, distal cells shrivelling or falling when old or dried. *Sorophores* pinnately arranged at the apex of a frond or of its branches, each sorophore with a median ridge on its lower (abaxial) surface, the sporangia attached to the sides of the ridge, the reflexed edge of the lamina protecting them. *Sporangia* not quite symmetrically ovoid or ellipsoid, sessile, with distal annulus of a single row of cells; spores pale, monolete, the surface variously sculptured.

*Distr.* Pantropic, comprising *c.* 30 *spp.*, widely distributed also in temperate regions of the southern hemisphere (S. Africa, Chile, New Zealand, Tasmania) but only in N. America in the northern hemisphere.

*Morph.* PRANTL referred to the whole fertile apex of a frond of *Schizaea* (or of a branch of *S. dichotoma*) as a sorophore; he called the lateral appendages *laciniae*. But it seems probable that each lacinia is homologous with a sorophore of *Lygodium*, and the term sorophore is therefore here used for what PRANTL called a lacinia. Photosynthetic tissue in *Schizaea* is reduced to the wings on each side of the axis of a simple frond, or of the branches of *S. dichotoma*. The regular row of stomata associated with this photosynthetic tissue (a double row in *S. inopinata*) corresponds to a similar less regular row along each side of the stipe and rachis of many ferns. In *Lygodium*, there are irregularly scattered stomata on both sides of the narrow rachis-wings.

*Spores.* SELLING published a very full account of the spores of all species known to him in 1944 (Medd. Göteborg. Bot. Trädg. 16, 1-112, p. 1-5). He also discussed the later-known species of the group of *S. digitata* (Svensk Bot. Tidskr. 41, 1947, 431-450). Fossil spores are also known (see remarks on fossils, *supra*).

KEY TO THE SPECIES

- 1. Fronds repeatedly dichotomous . . . . . 1. *S. dichotoma*
- 1. Fronds simple.
  - 2. Sorophores 2½-5 cm long, all attached close together at apex of frond; frond 2 mm or more wide.
    - 3. Sporangia in four rows on the sorophores; one row of stomata on each wing of the frond. 2. *S. digitata*
    - 3. Sporangia in two rows on sorophores; stomata in two rows on each wing of the frond. 3. *S. inopinata*
  - 2. Sorophores much shorter, fronds narrower.
    - 4. Edges of sorophores smooth and glabrous.
      - 5. Fronds more than 1 mm wide, with distinct flat wing on each side of costa; no hairs with sporangia.
        - 6. Costa very prominent on lower surface; stomata in each row very close together 2. *S. digitata*
        - 6. Costa hardly prominent on lower surface; stomata in each row rather widely spaced. 4. *S. spirophylla*
      - 5. Fronds less than 1 mm wide, wing very slightly developed; hairs present with sporangia. 5. *S. wagneri*
    - 4. Edges of sorophores irregularly lobed, the lobes bearing coarse hairs.
      - 7. Sorophores attached along the distal 10-20 mm of the axis of the frond; upper surface of frond deeply grooved, lower surface evenly rounded and bearing superficial rows of stomata. 6. *S. fistulosa*
      - 7. Sorophores attached along the distal 5-10 mm of the axis of the frond; upper surface of frond slightly grooved, stomata in two slight grooves on the distinctly flattened lower surface 7. *S. malaccana*

1. *Schizaea dichotoma* (L.) Sm. Mem. Ac. Turin 5 (1793) 422, t. 9; BL. En. Pl. Jav. (1828) 255; HOOK. & GREV. Ic. Fil. (1827) t. 17; BEDD. Ferns S. India (1863) t. 65; Handb. (1883) 452; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 138; RACIB. Pterid. Buit. (1898) 6; v. A. v. R. Mal.

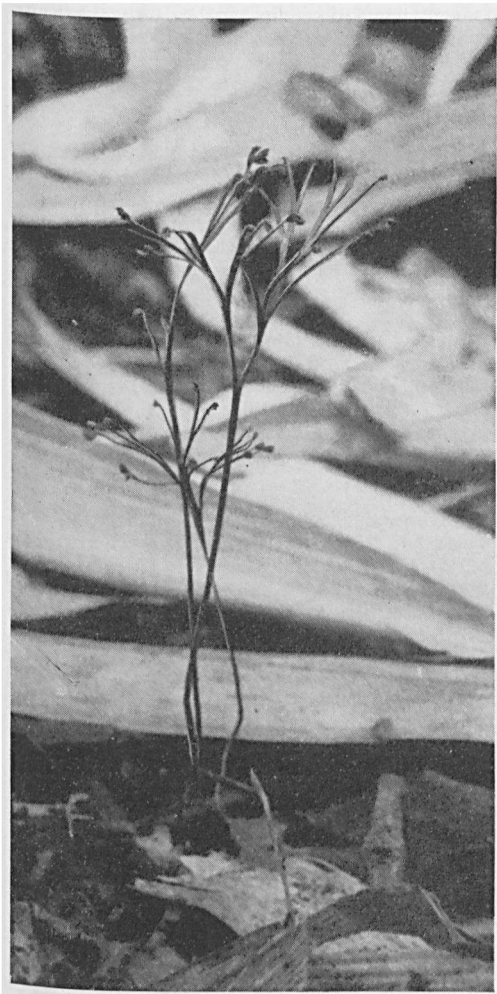


Fig. 2. *Schizaea dichotoma* (L.) Sm. near Kepahiang, Bencoolen, S. Sumatra (DE VOOGD).

Ferns (1908) 116; MERR. Int. Rumph. (1917) 69; BACKER & POSTH. Varenfl. Java (1939) 256, fig. 66; HOLTT. Ferns Mal. (1955) 50, fig. 6.—*Acrostichum dichotomum* LINNÉ, Sp. Pl. (1753) 1068.—*Osmunda dichotoma* SPR. in Schrader, J. Bot. (1799) pt 2, 268.—*Ripidium dichotomum* BERNH. in Schrader, J. Bot. 1800, pt 2 (1801) 127, t. 2, f. 3.—*S. forsteri* SPR. Anleit. 3 (1804) 57.—*S. cristata* WILLD. Sp. Pl. 5 (1810) 88.—*S. biroi* RICHTER, Math. Termesztet. Ertesito 29 (1911)

1074; TROLL, Flora 128 (1933) 339, fig. 1.—*S. copelandica* RICHTER, l.c.—Fig. 1, 2, 4a-d.

Rhizome 3–6 cm below surface of ground, creeping, sometimes to 6 cm or more long, densely covered with coarse shining brown hairs 2–3 mm long. *Stipes* commonly 15–30 cm long (extremes 10–50 cm), narrowly winged towards apex; *frond* commonly 10–20 cm long and wide, dichotomously branched 2–8 times, the basal branches like the stipe, the distal ones gradually with wider wings and 1–1½ mm wide, lacking a prominent costa on the lower surface; all parts with scattered small projections which are the bases of glandular hairs; *sorophores* occupying the distal 3–5 mm of each branch of the frond, 5–10 pairs, the lowest 3–4 mm long, upper ones smaller, edges hairy; *sporangia* in two rows, mixed with conspicuous long brown hairs; spores smooth or minutely granular.

Type: Petiver, Gaz. t. 70, f. 12 (drawing of a specimen from Cochinchina).

Distr. Mascarene Isl., Ceylon and S. India, Burma, Siam, Indochina, throughout *Malaysia* except for East Java and Lesser Sunda Isl., to Tahiti, Australia, and New Zealand.

Ecol. In lightly shaded places, or sometimes in forest, often (always?) in sandy ground, sealevel to 1000 m, rarely abundant.

Note. Small plants like those named *S. biroi* and *S. copelandica* by RICHTER are not uncommon, and have been found at many places near larger plants. As pointed out by TROLL (l.c.) the small little-branched fronds of these small plants are usually fertile, whereas some fronds of much larger plants are sometimes sterile. I have however examined a very large number of specimens and have failed to find any sharp distinction between those with little-branched and much-branched fronds. If one picks out individual specimens, one can separate fronds with long and with short ultimate branches; but in some cases fronds from one collection may show ultimate branches of very diverse length.

Vern. *Atagar payong*, Kedayan, *pirangas*, Murut, *oemiar*, *biak*, E. New Guinea, *paku tjakar ajam*, *radja hantu*, Banka, *rumpul bulu merak*, Billiton, *silaju*, Sum.

Uses. HEYNE records medicinal use (in Billiton) for coughs and affections of the throat and also in childbirth.

2. *Schizaea digitata* (L.) Sw. Syn. Fil. (1806) 150, 380, t. 4 f. 1; BL. En. Pl. Jav. (1828) 255; BEDD. Ferns S. India (1864) t. 268; Handb. (1883) 452; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 133, t. 5 f. 83; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 583; RACIB. Pterid. Buit. (1898) 7; v. A. v. R. Mal. Ferns (1908) 116; BACKER & POSTH. Varenfl. Java (1939) 257, f. 66; SELING, Svensk. Bot. Tidskr. 41 (1947) 431–450; HOLTT. Ferns Mal. (1955) 51, f. 7.—*Acrostichum digitatum* LINNÉ, Sp. Pl. (1753) 1068.—*Actinostachys digitata* WALL. ex REED, Bol. Soc. Brot. 21 (1947) 130.—Fig. 3a-e.

Rhizome very short, creeping or suberect, 3–4 cm below surface of ground, bearing many crowded fronds, apex clothed with brown hairs under 2 mm long. *Fronde*s erect, unbranched, grass-like, 20–35 cm long, base (stipe) slender and triquetrous, rest winged, greatest width 2–4 mm,

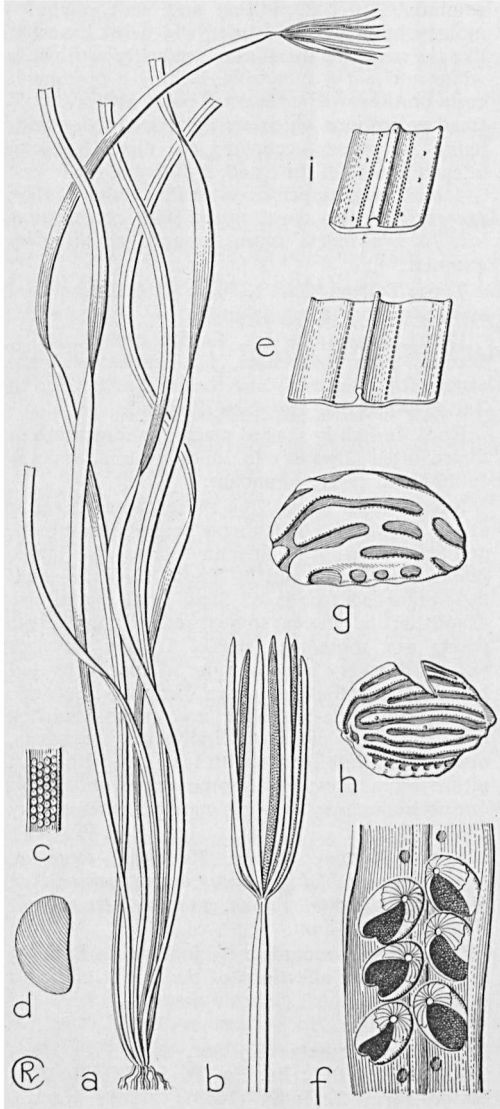


Fig. 3. *Schizaea digitata* (L.) Sw. a. Habit,  $\times \frac{1}{2}$ , b. sorophores, nat. size, c. detail of sorophore,  $\times 5$ , d. spore,  $\times 300$ , e. detail of lower surface showing stomata,  $\times 5$ .—*S. inopinata* SELLING. f. Detail of sorophore,  $\times 18$ , g. spore,  $\times 300$ , h. flattened part of exospore,  $\times 200$ , i. lower surface of leaf, showing stomata,  $\times 5$  (a, e For. Bot. Burma 7670, b–c MATTHEW s.n. (SING), f SYNGE S606, g SYMINGTON CF 37414, h after SELLING 1946).

costa very prominent on lower surface of winged portion and slightly grooved on upper surface, 2-celled glandular hairs abundant on lower surface of wing, stomata in a close even single row on each side of costa. *Sorophores* all attached very close together (apparently digitate), 5–18, all about equal in length, commonly  $2\frac{1}{2}$ –5 cm long (on stunted plants sometimes shorter), little over 1 mm wide, edges thin, entire, glabrous; *sporangia* small, apparently in four rows and completely covering lower surface of sorophore; spores small, finely and evenly obliquely striate.

Type: Herb. Hermann, Ceylon (BM).

Distr. Ceylon, NE. India, Siam, Indochina, Micronesia; in *Malaysia*: throughout except for East Java and Lesser Sunda Isl.

Ecol. In lightly shaded forest, rubber estates, etc., sealevel to 1200 m, rarely very abundant.

Notes. The species was formerly credited with a much wider distribution, due to confusion with other species. SELLING has distinguished most of the latter, and has given a comparative survey of the group and of individual distributions (*l.c.*). *Actinostachys boninensis* NAKAI (*J. Jap. Bot.* 13, 1937, 140) appears to differ from *S. digitata* only in the greater number of sorophores (to 30) which are shorter (8–40 mm long); I have seen no specimens.

3. *Schizaea inopinata* SELLING, *Svensk Bot. Tidskr.* 40 (1946) 274, f. 1–7; HOLTZ. *Ferns Mal.* (1955) 52.—*Actinostachys inopinata* REED, *Bol. Soc. Brot.* 21 (1947) 130.—Fig. 3f–i.

In habit like *S. digitata*, differing as follows: *fronds* to  $2\frac{1}{2}$  mm wide, with a double (occasionally triple) row of stomata on each side of the costa on the lower surface, the wings thicker and more rigid and the edges reflexed on drying, the costa not so strongly raised and rather variable; *sporangia* much larger, in two rows; spores much larger, with broad irregular longitudinal ridges.

Type: Henderson 19460, Gua Tipus, Chigar Perah, Pahang (SING, K).

Distr. Micronesia, in *Malaysia*: Sumatra, Malaya, Borneo, Philippines (Bohol), W. New Guinea.

Ecol. On limestone crags, sealevel to 360 m.

Note. FOSBERG, correctly reporting the occurrence of the species in Micronesia, considered it conspecific with *S. ponapensis* HOSOKAWA (*Am. Fern J.* 40, 1950, 145). I have examined the isotype of *S. ponapensis* in the Arnold Arboretum Herbarium, and find that, apart from its much smaller size (*fronds* to 8 cm long, *sorophores* to 8 mm long) it differs in having a hardly raised costa with a rather widely-spaced single row of stomata on each side of it. The specimen corresponds well with the description of *S. spirophylla* TROLL, and I have placed *S. ponapensis* as a synonym of that species. I saw no spores.

4. *Schizaea spirophylla* TROLL, *Flora* 128 (1937) 343, fig. 2–6.—*S. ponapensis* HOSOKAWA, *Trans. Nat. Hist. Soc. Formosa* 31 (1941) 39.

Rhizome short, apex covered with dark hairs. *Fronde*s unbranched, sometimes twisted, 4–8 cm



Note. See note under *S. inopinata*. The twisting of the fronds of *S. spirophylla* is probably not a constant character; such twisting is also common, but not universal, in *S. digitata*. Stunted plants of the latter may superficially resemble *S. spirophylla* but differ in costa and stomata and in more crowded sporangia.

5. *Schizaea wagneri* SELLING, Svensk Bot. Tidskr. 40 (1946) 278, f. 8–11; HOLTT. Ferns Mal. (1955) 52.—*Actinostachys wagneri* REED, Bol. Soc. Brot. 21 (1947) 131.—*S. paucijuga* HOLTT. Gard. Bull. Sing. 11 (1947) 267.—Fig. 4e–g.

Rhizome short, apex clothed with slender brown hairs 1½ mm long. *Fronde*s simple, 6–20 cm long, base terete, upper part winged and in all ½–¾ mm wide, with rather broad midrib prominent on the lower surface, the stomata rather widely spaced in one row close to each side of the midrib. *Sorophores* 2–5, 7–15 mm long, edges smooth and glabrous, *sporangia* in two rows, mixed with brown hairs; spores finely verrucose.

Type: Grether & Wagner 4177, summit of Mt Tjajiak, 600 m, Manus Isl., Admiralty Is. (S–PA, dupl. at K).

Distr. *Malaysia*: Malaya (P. Rumbia in Perak, Singapore) Borneo, Ambon, W. New Guinea, and Admiralty Is.

Ecol. "Epiphytic in mosses on stumps and bases of trees; abundant at one place, but exceedingly inconspicuous" (GRETHER & WAGNER). In forest near sea (Western New Guinea and Borneo).

6. *Schizaea fistulosa* LABILL. Nov. Holl. Pl. Spec. 2 (1806) 103, t. 250 f. 3; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 135, *excl. var. malaccana* and *var. robusta*; v. A. v. R. Mal. Ferns (1908) 116; C. CHR. & HOLTT. Gard. Bull. S. S. 7 (1934) 210.—*Microschizaea fistulosa* REED, Bol. Soc. Brot. 21 (1947) 134.—*S. propinqua* A. CUNN. in Hook. Comp. Bot. Mag. 2 (1836) 362.—*S. australis* GAUD. Ann. Sc. Nat. Bot. 5 (1825) 98.—*S. chilensis* PHIL. Linnaea 30 (1859–60) 207.—Fig. 4j–l.

Rhizome short-creeping, young parts clothed with shining brown hairs 2–3 mm long; stipes very crowded; *fronds* unbranched, 9–18 (rarely to 30) cm long below the fertile part, width to about 1 mm, upper surface rather deeply grooved, lower surface almost evenly rounded and bearing two rows of stomata which are not in grooves; surfaces bearing scattered glandular hairs the bases of which are slightly prominent. *Sorophores* all about equal, arranged in a distinctly pinnate manner

along the distal 10–20 mm of the axis of the frond, 8–20 pairs, lowest often forked, 4–6 mm long, edges much reflexed and bearing many coarse forward-pointing hairs; *sporangia* in two rows, without hairs; spores smooth.

Type: Labillardière, Australia (F?; not seen).

Distr. Madagascar, Australia, Tasmania, New Zealand, Fiji, New Caledonia, Chile; in *Malaysia*: Borneo (Mt Kinabalu), New Guinea.

Ecol. In alpine bogs at 2400–3750 m, and on fine rock-screes.

Note. Some New Guinea specimens have been distributed as *S. papuana* BRAUSE, which is here placed as a synonym of *S. malaccana*.

7. *Schizaea malaccana* BAK. Syn. Fil. (1868) 428; BEDDOME, Ferns Br. India (1870) t. 255; Handb. (1883) 452; TANSLEY & CHICK, Ann. Bot. 17 (1903) 493–510; v. A. v. R. Mal. Ferns (1908) 116; HOLTT. Ferns Mal. (1955) 52, fig. 8.—*S. fistulosa* var. *malaccana* PRANTL, Unters. Morph. Gefässkr. 2 (1881) 136.—*S. papuana* BRAUSE, Bot. Jahrb. 56 (1920) 211.—*Microschizaea malaccana* REED, Bol. Soc. Brot. 21 (1947) 134.—Fig. 4h–i.

var. *malaccana*.

Habit of *S. fistulosa*, differing as follows: hairs on rhizome pale brown, *fronds* 6–15 cm long, less than 1 mm wide, apical fertile part of axis c. 5 mm long, upper surface of frond nearly flat or shallowly grooved, lower surface when dry with two small grooves in which the stomata are situated; *sorophores* 4–10 pairs, lowest 4–5 mm long, upper ones shorter.

Type: Cuming 379, Mt Ophir, Malaya (K, BM).

Distr. *Malaysia*: Malaya, Borneo, Ambon, W. New Guinea.

Ecol. In open mossy places on mountain ridges, or in moss cushions on trees at 800–2000 m; also in swamp forest in Sarawak at lower altitudes.

var. *robustior* C. CHR. Gard. Bull. S. S. 7 (1934) 210.—*S. hallieri* RICHTER, Med. Rijksherb. n. 28 (1916) 24, t. 1 f. 5, *etc.*; Math. Naturw. Ber. Ungarn 31 (1916) 24, 28, t. 1 f. 5 *etc.*—*Microschizaea hallieri* REED, Bol. Soc. Brot. 21 (1947) 134.

Larger than var. *malaccana*; *fronds* to 25 cm long, 1 mm or more wide; *sorophores* to 15 pairs, spread along 10 mm of the axis, lowest *sorophores* 5–10 mm long.

Type: Clemens 10919, Mt Kinabalu, Borneo (BM, Bo).

Distr. *Malaysia*: Malaya (Gunong Tahan), Borneo, W. New Guinea.

## 2. LYGODIUM

SWARTZ in Schrader, J. Bot. 1800 pt 2 (Nov.–Dec. 1801) 106, *nom. cons.*; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 60; COPELAND, Gen. Fil. (1947) 23; PICHISERMOLLI, Webbia 12 (1956) 10, preprint (1955).—*Ramondia* MIRBEL, Bull. Soc. Philom. Paris 2 (Feb.–Mar. 1801) 179.—*Ugena* CAVAN. Ic. Descr. Pl. 6 (Oct. 1801) 73.—*Odontopteris* BERNH. in Schrader, J. Bot. 1800 pt 2 (Nov.–Dec. 1801) 127, t. 2 f. 4.—*Ripidium* BERNH. l.c. 127, t. 2 f. 3.—*Gisopteris* BERNH. l.c. 129,



t. 2 f. 1.—*Hydroglossum* WILLD. Abh. Kurfürstl. Mainz. Ak. Nützl. Wiss. Erfurt 2, pt 4 (1802) 13, 20.—*Hugona* CAV. ex ROEMER, Arch. Bot. 2 (1801–02) 486.—*Cteisium* MICHX, Fl. Bor. Am. 2 (1803) 275.—*Vallifilix* THOUARS, Gen. Nov. Madag. (1808) 1.—*Lygodictyon* J. SMITH in Hook. Gen. Fil. (1842) t. 111 B.—Fig. 5–15.

Rhizome creeping, below ground surface, protostelic, short with fronds very close together or longer with spaced fronds, young parts densely covered with rather thick rigid multiseptate hairs, branching dichotomous; fronds borne in two rows on upper surface of rhizome, roots mainly from lower surface. *Fronds* of young plants erect, once or twice dichotomously branched and bearing usually palmately lobed leaflets; fronds of older plants with slender elongate twining rachises formed by a succession of very unequal dichotomies, at least the upper part of the rachis (except in *L. polystachyum*) bearing two narrow wings towards the adaxial side, the surface between the wings flat or slightly raised and papillose; all branch rachises and stalks of leaflets similarly winged (fig. 13d), the wings always interrupted to join with those of a lateral branch; *primary rachis-branches* always short, usually hardly developed, ending in dormant apices which are covered with hairs (such apices proliferous if the main rachis beyond them is injured), each primary branch bearing a pair of secondary branches which bear the leaflets; sterile *leaflets* (or their lobes) with costa and oblique lateral veins which are 1–3 times forked (anastomosing in a few species), edges entire or serrate (pinnatifid only in *L. polystachyum*); fertile leaflets often with contracted lamina, bearing narrow *sorophores* spreading from the edges of the lamina at the ends of most of the veins; edges of sorophores serrate, the main vein in each sorophore bearing alternate short lateral veins each of which bears a single sporangium protected by a separate indusium attached along the vein and opening forwards; *sporangia* oblong-ovoid with a short lateral stalk, the annulus at the narrower end which is directed away from the margin of the sorophore, splitting longitudinally when ripe; *spores* trilete, pale, variously sculptured on the surface, lacking perispore. *Gametophyte* thalloid, sometimes asymmetric; antheridia larger and more complex in structure than in most leptosporangiate ferns.

Distr. Pantropic, comprising *c.* 40 *spp.*, also extratropical southwards in New Zealand and S. Africa, northwards in Japan and in eastern U.S.A. to Massachusetts.

Morph. Owing to the peculiar structure of the climbing leaves, it is difficult to apply the usual descriptive terms pinna and pinnule to them, especially where the branching of the leafy parts is dichotomous. The following terms are here used. The *climbing rachis* of the frond (sympodial in structure but for convenience considered as a unit) bears alternate short *primary branches*, each ending in a dormant apex and bearing a pair of apparently opposite *secondary branches*. The secondary branches may bear leaflets or *tertiary branches* pinnately arranged, or they may be once or more times dichotomously branched.

The narrow wings on rachis-branches of all orders, those of the ultimate branches joined to the edge of the lamina, correspond with the wings which are the only lamina in fronds of *Schizaea*, but do not have the very regular single rows of stomata found in *Schizaea* (there are irregularly scattered stomata on both sides of a wing in *Lygodium*). If the sorophores of *Lygodium* are regarded as homologous with the fertile leaflet-lobes of the paleozoic fossil genus *Senftenbergia*, the lamina of *Lygodium* may be considered as a specialized development of the rachis-wing consequent on the reduction of the original lamina-lobes to sorophores.

The dormant apices of the primary rachis-branches are covered with septate hairs. In a group of Malaysian species these hairs have swollen bases, each base formed of a mass of cells; these species are *L. borneense*, *L. longifolium*, *L. auriculatum*, *L. trifurcatum*, and *L. dimorphum*. So far as I know, this type of hair has not hitherto been reported in *Lygodium*.

Taxon. There are four pairs of species which in some measure intergrade. These need experimental study in cultivation to discover how much variation is due to environmental conditions, and also cyto-

logical study. It may be that natural hybridization occurs, and as tetraploids as well as diploids have been already discovered in *L. japonicum* and *L. circinnatum* they may occur also in other species, leading to the possibility of the formation of sterile triploids; apogamy has however not yet been discovered in the genus. The pairs of species which intergrade are: *L. flexuosum* and *L. japonicum*; *L. flexuosum* and *L. salicifolium*; *L. borneense* and *L. auriculatum*; *L. dimorphum* and *L. trifurcatum*. The following species are very distinct: *L. polystachyum*, *L. microphyllum*, *L. circinnatum*, *L. merrillii*, and *L. versteegii*.

## KEY TO THE SPECIES

1. Secondary rachis-branches pinnate, leaflets 10–15 on each side. Sterile leaflets evenly pinnatifid throughout . . . . . 1. *L. polystachyum*
1. Secondary rachis-branches pinnate with fewer leaflets, or dichotomous. Sterile leaflets simple, palmate, or lobed near the base only.
2. Venation of sterile leaflets free.
3. Primary rachis-branches 4–10 mm long below the pair of secondary branches. Rhizome wide-creeping, fronds distinctly spaced.
4. Secondary branches simply pinnate. Leaflets articulate at the base and ultimately deciduous. . . . . 2. *L. microphyllum*
4. Secondary branches amply bipinnate. Leaflets not articulate at the base . . . . . 3. *L. japonicum*
3. Primary rachis-branches hardly elongated, the pair of secondary branches thus almost sessile on the main rachis. Rhizome short, fronds close together.
5. Secondary rachis-branches regularly pinnate, normally with 3–5 leaflets on each side of the axis (young or depauperate fronds may have fewer leaflets).
6. Leaflets all about equal and all stalked (terminal one sometimes geminate), not auricled or branched at the base, or rarely with short spreading basal lobes; leaflet-stalks thickened at their junction with the lamina . . . . . 4. *L. salicifolium*
6. Lateral leaflets larger towards base of secondary branch, smaller distal ones sessile, basal ones stalked and usually auricled or with obliquely spreading lobes, or with subsidiary leaflets below them; leaflet-stalks not thickened at apex . . . . . 5. *L. flexuosum*
5. Secondary branches simple or dichotomously branched one or more times (in some cases, by alternate unequal dichotomy, subpinnate with 1–3 lateral leaflets). Leaflets simple, forked, or palmately branched, never thickened at apex of stalk.
7. Leaflets strongly cordate on outer side at base.
8. Lamina of fertile leaflets reduced to a narrow wing along midrib and bases of veins, each vein usually with an apical sorophore.
9. Fertile tertiary branches evenly deltoid in outline with quaternary leaflets of increasing length towards the base. Sterile leaflets strongly auriculate-cordate at base . . . . . 6. *L. dimorphum*
9. Fertile leaflets not deltoid in outline, 10–15 mm wide (including sorophores), sometimes with 1 or 2 long branches at the base. Sterile leaflets more or less cordate at the base. . . . . 7. *L. trifurcatum*
8. Lamina of fertile leaflets not reduced to a narrow wing along midrib and veins. . . . . 8. *L. auriculatum*
7. Leaflets not strongly cordate at base on outer side.
10. Secondary branches once forked (rarely simple, or one branch forked again). Leaflets always simple. Spores smooth . . . . . 9. *L. borneense*
10. Secondary branches at least twice forked (or lower branches bearing single 3–5-lobed leaflets), sometimes sub-pinnate with 1–2 tertiary members on each side and a terminal leaflet or pair of leaflets. Leaflets often deeply 2-lobed to palmate. Spores verrucose.
11. Margins of sterile leaflets serrate, not much thickened, veins ending in the teeth. Spores coarsely and irregularly verrucose. Dormant apices of primary branches not sunk, hairs with swollen base . . . . . 10. *L. longifolium*
11. Margins of sterile leaflets entire, thickened but not vascular, the raised veins joining the thickened edge. Spores finely and evenly verrucose. Dormant apices sunk, hairs lacking swollen bases . . . . . 11. *L. circinnatum*
2. Venation of sterile leaflets reticulate.
12. Secondary rachis-branches (at least the upper ones) elongate and pinnate.
13. Leaflets on stalks to 3 cm long, palmately lobed or equally bilobed (basal secondary branches may bear only one palmately lobed leaflet on a longer stalk) . . . . . 12. *L. merrillii*
13. Leaflets on much shorter stalks, simple or the apical ones forked . . . . . 14. *L. reticulatum*
12. Secondary branches bearing 3 leaflets (lateral ones sometimes forked), all arising 1–3 mm from dormant apex of primary rachis-branch . . . . . 13. *L. versteegii*

1. *Lygodium polystachyum* WALL. ex MOORE, Gard. Chron. (1859) 671; HOOK. Sec. Cent. (1861) t. 76; Syn. Fil. (1868) 438; BEDDOME, Ferns Br. India (1868) t. 300; Handb. (1883) 458, f. 284;

v. A. v. R. Mal. Ferns (1908) 113; COPEL. Philip. J. Sc. Bot. 4 (1909) 19; TARD. & C. CHR. Fl. Gén. I.–C. 7 (1939) 40; HOLTT. Ferns Mal. (1955) 56, f. 10; ALSTON & HOLTT. Reinwardtia 5 (1959)

11. — *Hydroglossum pinnatifidum* WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2, pt 4 (1802) 21, p.p.—*L. pinnatifidum* (non (WILLD.) SW.) PRANTL, Unters. Morph. Gefässkr. 2 (1881) 83, t. 1 f. 11.—Fig. 5c, 8a-c.

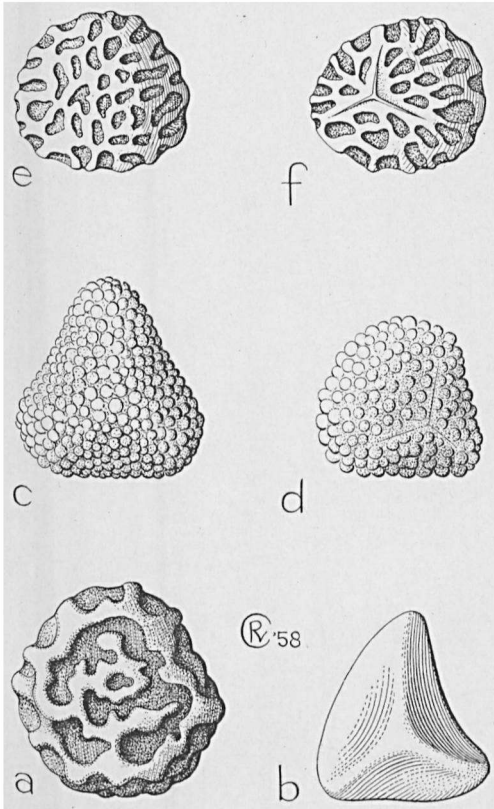


Fig. 5. Spores of *Lygodium*. a. *L. longifolium* (WILLD.) SW., b. *L. borneense* v. A. v. R., c. *L. polystachyum* WALL. ex MOORE, d. *L. circinnatum* (BURM. f.) SW., e-f. *L. microphyllum* (CAV.) R. BR., lateral and upper view. All  $\times 330$ .

Rhizome short-creeping, 3–5 mm diameter, densely clothed with spreading black hairs. Juvenile fronds once or twice dichotomous; stipes up to 30 cm long to the first dichotomy, brown, with short very slender hairs mixed with thick longer multicellular ones; ultimate branches leafy like the secondary rachis-branches of climbing fronds. *Rachis* of climbing fronds  $2\frac{1}{2}$  mm diameter, shortly hairy, not winged; primary rachis-branches very short, ending in a dormant apex covered with brown hairs (the apices of lower primary branches sometimes proliferous); secondary rachis-branches 20–30 cm long, not winged, shortly hairy, bearing 10–15 leaflets on each side and a similar terminal leaflet; sterile leaflets  $3\frac{1}{2}$ – $7\frac{1}{2}$  cm long,  $1\frac{1}{2}$ –2 cm wide, apex rather abruptly narrowed and rounded, base truncate or

cordate, jointed to a hairy stalk 1–4 mm long, sides lobed half-way to the costa or rather more, lobes 4–5 mm wide, oblong with rounded apex, each lobe with a sinuous costule bearing oblique forked lateral veins, costa and costules bearing scattered stiff hairs on both surfaces, the costa also with shorter hairs; fertile leaflets like the sterile but the distal half or more of each lobe narrowed to about 2 mm wide, the narrow part (*sorophore*) 4–10 mm long, bearing sporangia on the under surface; indusia bearing scattered stiff hairs; spores finely and evenly verrucose.

Type: Wallich 177, Penang (K).

Distr. Assam, Burma, Siam, Yunnan, Indochina; in *Malaysia*: northern half of Malay Peninsula.

Ecol. In lowland forest, climbing trees to a considerable height; in the Malay Peninsula especially on limestone except in the extreme north (Kedah) where it is locally common in apparently primary forest. (Further south, limestone provides a drier habitat than other rocks, and on it occur a number of species which have their main distribution in the seasonal climate north of Malaya.)

2. *Lygodium microphyllum* (CAV.) R. BR. Prod. Fl. Nov. Holl. (1810) 162; BL. En. Pl. Jav. (1828) 253; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 583; BEDD. Handb. (1883) 455, t. 282; ALSTON & HOLTT. Reinwardtia 5 (1959) 12.—*Ugena microphylla* CAV. Ic. Descr. Pl. 6 (1801) 76, t. 595; C. CHR. Dansk Bot. Ark. 9, n. 3 (1937) 30.—*L. scandens* Sw. in Schrader, J. Bot. 1800 pt 2 (1801) 106, p.p. excl. syn. LINN.; BEDD. Ferns S. India (1863) t. 61; HOOK. Syn. Fil. (1868) 437, p.p.; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 81, t. 6 f. 101; CHRIST, Farnkr. Erde (1897) 354, f. 1116; RACIB. Pterid. Buit. (1898) 8; v. A. v. R. Mal. Ferns (1908) 113; Philip. J. Sc. 11 (1916) Bot. 116; HEYNE, Nutt. Pl. (1927) 97; BACK. Krakatoa (1929) 254; OCHSE & BAKH. Veg. D.E.I. (1931) 657; BURK. Dict. 2 (1935) 1378; BACKER & POSTH. Varenfl. Java (1939) 258; OGATA, Ic. Fil. Jap. 7 (1936) t. 324; HOLTT. Ferns Mal. (1955) 58, f. 12.—*Ophioglossum filiforme* ROXB. Calc. J. Nat. Hist. 4 (1844) 476, t. 26 f. 3.—*L. scandens* var. *microphyllum* (CAV.) LUERSS. J. Mus. Godeffr. 6 (1874) 4.—*L. scandens* var. *intermedium* CES. Att. Ac. Sc. Fis. Nat. Napoli 7 (1876) 33.—Fig. 5e-f, 6, 7.

Rhizome wide-creeping, dichotomously branched,  $2\frac{1}{2}$  mm diameter, densely clothed with short spreading brownish-black hairs. Juvenile fronds small, commonly once dichotomous (the stipe distinctly winged below the dichotomy), each branch bearing a 4-lobed leaflet not jointed at the base, lobes 3–5 cm long and c. 5 mm wide, thin, glabrous, edges crenately toothed (teeth larger towards apex where veins are unbranched). *Rachis* of climbing fronds glabrous, commonly 2–3 m long, hardly  $1\frac{1}{2}$  mm diameter; primary branches 4 mm or more long, ending in a dormant apex covered with dark brown hairs; secondary rachis-branches pinnate, in all to about 15 cm



Fig. 6. *Lygodium microphyllum* (Cav.) R. Br. and *L. salicifolium* Pr. (larger leaflets on left) on edge of a thicket in the Botanic Gardens, Singapore (HOLTUM).

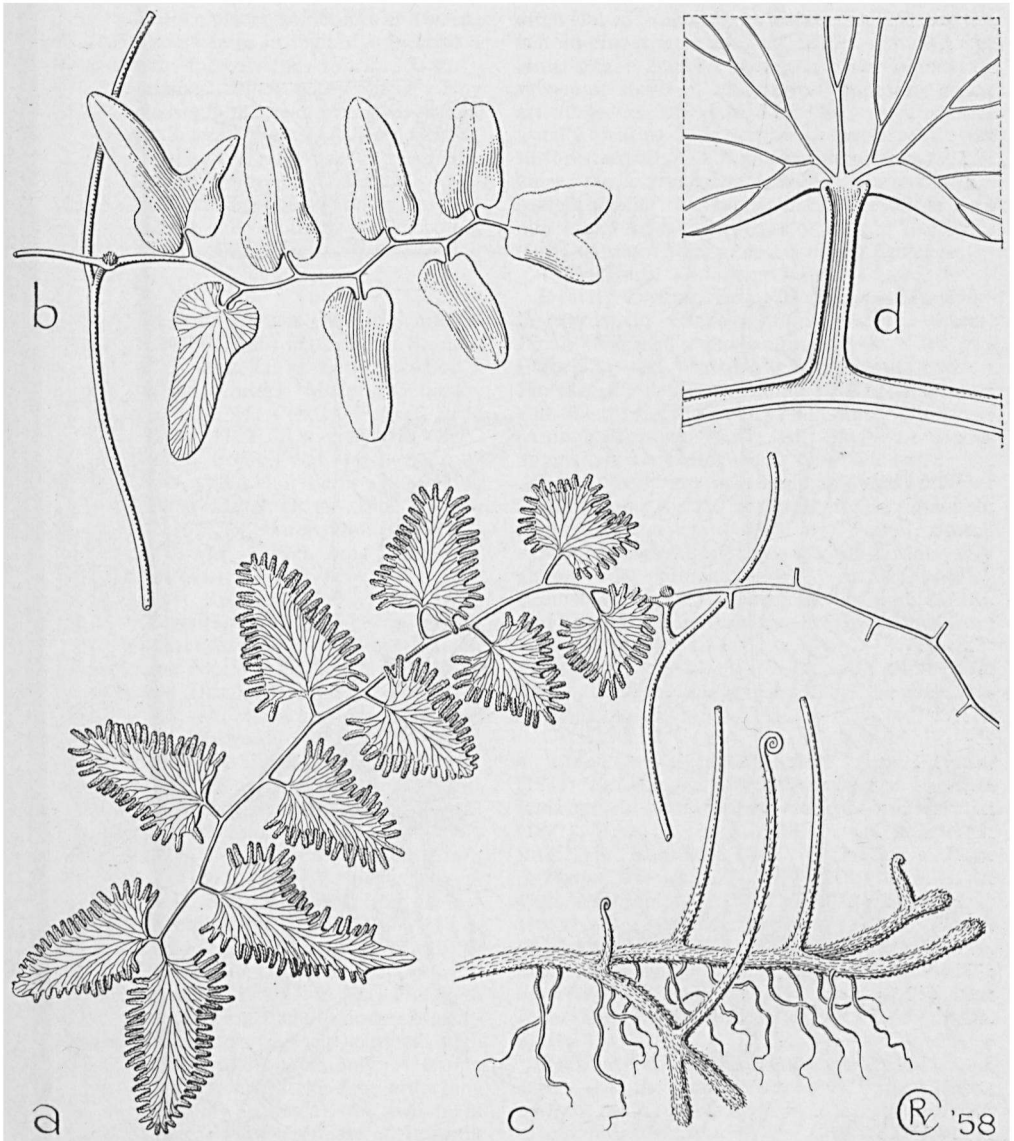


Fig. 7. *Lygodium microphyllum* (CAV.) R. BR. a. Fertile leaf,  $\times \frac{3}{4}$ , b. sterile leaf,  $\times \frac{3}{4}$ , c. rhizome,  $\times \frac{3}{4}$ , d. detail of base of leaflet,  $\times 7$  (a FLOYD NGF 5566, b-d cult. Kew from Ceylon).

long, with 3-6 stalked leaflets on each side (stalks 2-4 mm long) and a similar or geminate terminal leaflet; leaflets quite glabrous, mostly ovate (sterile leaflets often elongate with broader base on young plants), 1-4 cm long (sterile ones sometimes to 6 cm), 6-18 mm wide, edges of sterile ones minutely crenate, a joint always present at base of blade, where the wing which in other species connects stalk and lamina is constricted; fertile leaflets usually shorter than

sterile but with lamina hardly narrowed, soriophores 4-6 mm long; spores with a raised reticulum on the outer surface.

Type: Née, Luzon (MA).

Distr. Tropical Africa, SE. Asia (north to Bengal and Hong Kong and the Riu Kiu Isl.), Melanesia (Solomon Isl., New Caledonia), N. and E. Australia south to N. S. Wales; in *Malaysia*: throughout, but few records from the Lesser Sunda Isl. (certainly to Flores).

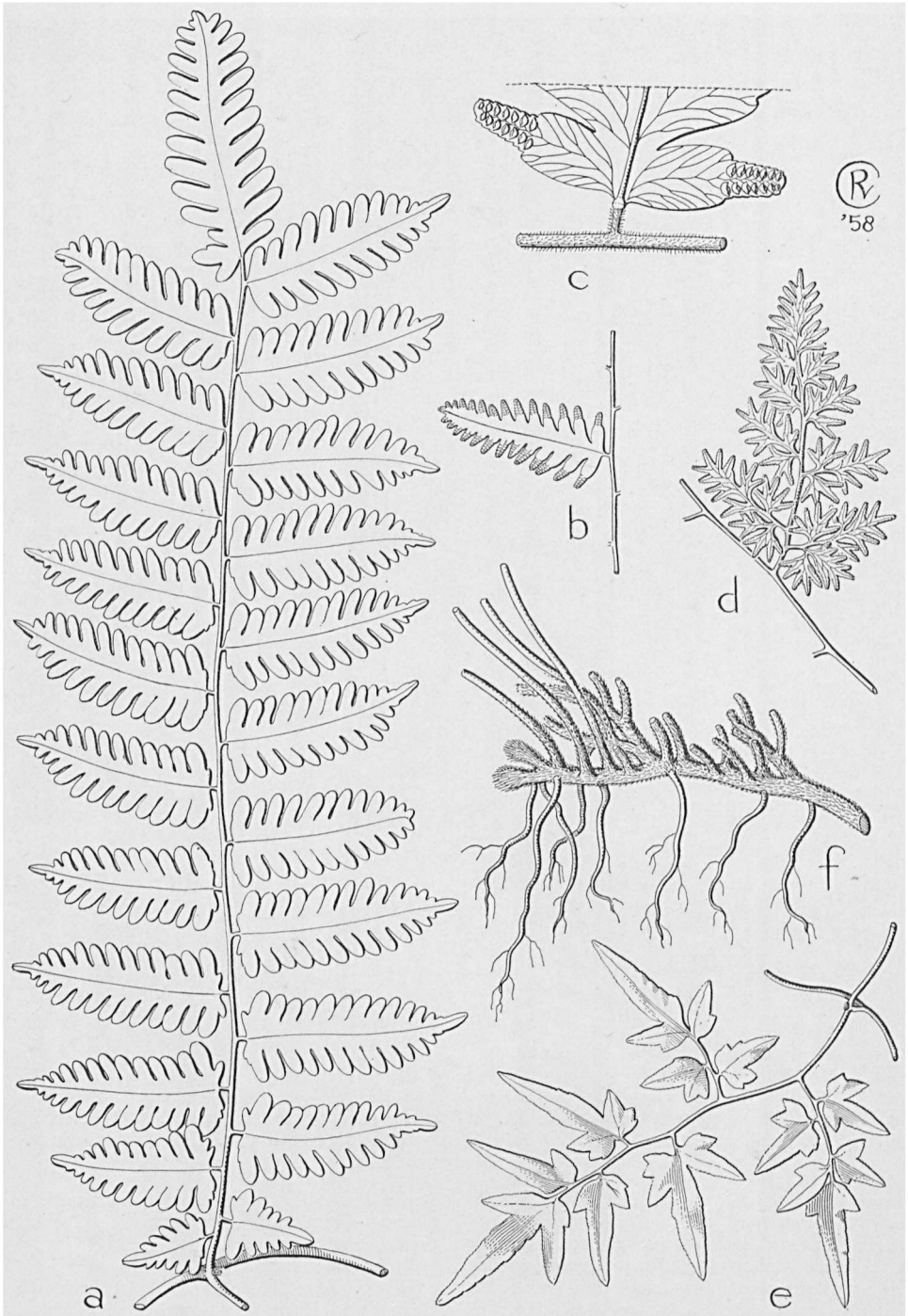


Fig. 8. *Lygodium polystachyum* WALL. ex MOORE. a. Sterile leaf,  $\times \frac{2}{5}$ , b. fertile leaflet,  $\times \frac{2}{5}$ , c. ditto, detail,  $\times 2\frac{1}{2}$ .—*L. japonicum* (THUNB.) SW. d. Fertile leaf,  $\times \frac{2}{5}$ , e. sterile leaf,  $\times \frac{2}{5}$ , f. rhizome,  $\times \frac{2}{5}$ . (a BALANSA 168, b-c MATTHEW s.n., d, f cult. Kew, e SAVINIERRE 71).

Ecol. Edges of secondary forest, or climbing woody plants in open places, sometimes as a weed; in clay soil, or in swamps in regions subject to a dry season; from the lowlands to c. 1300 m.

Vern. *Ribu-ribu*, M, *selada*, *capey papua*, *capay atus*, M, *paku kawat*, Sum., *paku hata bĕjas* (*bias*), *paku hata leutik*, S, *nitong-puti*, Tag., *paku rambat*, Bali, *sickey*, Luhea, *gomoha papua*, Ternate, *paku kawa*, Ambon, *paloge*, N. Celebes.

Uses. Native medicine (leaves macerated and mixed with lime for open wound), magic; young leaves edible; rachises of old leaves used for string and for plaiting.

3. *Lygodium japonicum* (THUNB.) SW. in Schrader, J. Bot. 1800, pt 2 (1801) 106; BEDD. Ferns S. India (1863) 21, t. 64; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 584; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 68, t. 1 f. 10, 15; CHRIST, Farnkr. Erde (1897) 355, 356, f. 1122; RACIB, Pterid. Buit. (1898) 8; HOPE, J. Bomb. Nat. Hist. Soc. 15 (1903) 106; v. A. v. R. Mal. Ferns (1908) 114; MERR. Fl. Manila (1912) 60; DOMIN, Bibl. Bot. 20, Heft 85 (1914) 211, f. 50; HAINES, Bot. Bih. & Or. 6 (1924) 1210; OGATA, Ic. Fil. Jap. 7 (1936) t. 322; BACKER & POSTH. Varenfl. Java (1939) 259; ALSTON & HOLT. Reinwardtia 5 (1959) 14.—*Ophioglossum japonicum* THUNB. Fl. Jap. (1784) 328.—*Hydroglossum japonicum* (THUNB.) WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2, pt 4 (1802) 26.—*L. dissectum* DESV. Mag. Ges. Naturf. Fr. Berl. 5 (1811) 308.—*L. microstachyum* DESV. l.c.; NAKAI, Bot. Mag. Tokyo 39 (1925) 182; OGATA, Ic. Fil. Jap. 7 (1936) t. 323.—*L. pubescens* KAULF. En. Fil. (1824) 47, t. 1 f. 4.—*L. chaerophylloides* DESV. Mém. Soc. Linn. Paris 6 (1827) 205.—*L. cochinchinense* DESV. *ibid.* 206.—*L. tenue* BL. En. Pl. Jav. (1828) 254.—*L. microphyllum* LINK, Hort. Berol. 2 (1833) 141.—*L. japonicum* f. *elongata* v. A. v. R. Bull. Jard. Bot. Btzg II, n. 1 (1911) 10, t. 3; Mal. Ferns Suppl. (1917) 117.—*L. japonicum* var. *microstachya* (DESV.) TARD. & C. CHR. Fl. Gén. I.-C. 7 (1939) 38.—*L. mearnsii* COPEL. Philip. J. Sc. 3 (1908) Bot. 37.—Fig. 8d-f.

Rhizome wide-creeping, dichotomously branched, 2-5 mm diameter, densely clothed with dark brown hairs, fronds commonly 5-10 mm apart. Juvenile fronds erect, the first branching an unequal dichotomy (always?), the two main branches of large fronds bipinnate, deltoid in outline, with palmatisect leaflets, their margins doubly serrate. *Rachis* of climbing fronds hardly 2 mm diameter, glabrous apart from minute hairs on the flattened adaxial surface between the narrow wings; primary rachis-branches 3-10 mm long, the dormant apex covered with pale hairs; *secondary branches* of fronds on young or stunted plants pinnate, on well-grown fronds bipinnate or tripinnate, deltoid in outline, commonly 12 cm long and wide, rachises densely short-hairy on the upper surface and bearing fewer longer hairs elsewhere; sterile tertiary *leaflets* of lower rachis-branches palmate with 5-7 lobes, the middle lobe much longer than the laterals, tertiary leaflets higher up the leaf trilobed with an elongate

middle lobe or pinnate with small oblique and often lobed quaternary leaflets and a usually deltoid-pinnatisect terminal leaflet about 3 cm long, edges acutely biserrate, apex obtuse or subacute; stalks of leaflets to 3 mm long, never articulate or thickened at the apex; costae usually bearing long scattered hairs, veins and surfaces usually glabrous but sometimes short-hairy; *fertile secondary branches* tripinnate, the leaflets smaller than sterile ones, *sorophores* 2-12 mm long; indusia glabrous or with a few hairs if the lamina is hairy; spores finely verrucose.

Type: Herb. Thunberg, Japan (Ups).

Distr. Ceylon, from Himalayas (Kashmir eastwards) to Chekiang in N. China, Korea, Japan (Nagasaki) and southwards to Siam and Indochina and southern China, naturalized in Florida and Texas; in *Malaysia*: Banka, Central and East Java, Celebes, Philippines, Moluccas (Ambon, Ternate, Banda Isl., Sula Isl.), Lesser Sunda Isl. (to Timor), and New Guinea.

Ecol. Climbing in secondary vegetation, at altitudes up to 2550 m; only found native in regions with a pronounced dry season, during which fronds perhaps die (no records in Malaysia); absent from Sumatra, Borneo and the Malay Peninsula (except perhaps the extreme north). Small forms are not always clearly distinct from *L. flexuosum*.

Vern. *Pakis kĕmbang*, J, *paku areuj*, *hata kawat*, S, *nito*, *nitong puti*, Tag., *madik silai*, *durhawa*, *babar*, *talsiga*, Alor.

4. *Lygodium salicifolium* PRESL, Suppl. Pterid. (1845) 102, *p.p. excl. pl.* WALLICH *p.p.* and *syn.* RHEEDE; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 79; v. A. v. R. Mal. Ferns (1908) 113; Bull. Jard. Bot. Btzg III, 5 (1922) 213; BACKER & POSTH. Varenfl. Java (1939) 258; TARD. & C. CHR. Fl. Gén. I.-C. 7, 2 (1939) 41; ALSTON & HOLT. Reinwardtia 5 (1959) 14.—*L. kingii* COPEL. Philip. J. Sc. 6 (1911) Bot. 68; v. A. v. R. Mal. Ferns Suppl. (1917) 117.—*L. pinnatifidum* *sensu* RAC. Fl. Buit. (1898) 7, *p.p.*—*L. flexuosum* *sensu* HOLT. Ferns Mal. (1955) 57, *p.p.*—Fig. 6, 10, 13a-b.

Rhizome and juvenile fronds as in *L. flexuosum*, except that the rachis is thickened at its junction with the midribs of the lobes of the leaflets. *Rachis* of climbing fronds to 2 mm diameter, to 10 m long; primary rachis-branches always very short (hardly measurable), ending in a dormant apex covered with brown hairs; *secondary rachis-branches* normally pinnate, rarely somewhat bipinnate and then the tertiary branches bearing one or more pairs of short spreading lateral leaflets (jointed at the base) and a large terminal one; secondary branch-system usually consisting of about 4 (rarely to 6) leaflets on each side, and a terminal deeply bilobed leaflet (or a pair of leaflets), all leaflets of about equal size and all stalked, the stalks 2-10 mm long and thickened at junction with lamina (old leaflets sometimes deciduous but not regularly so as in *L. microphyllum*); leaflets 4-15 cm long, 1/2-2 cm wide, acute

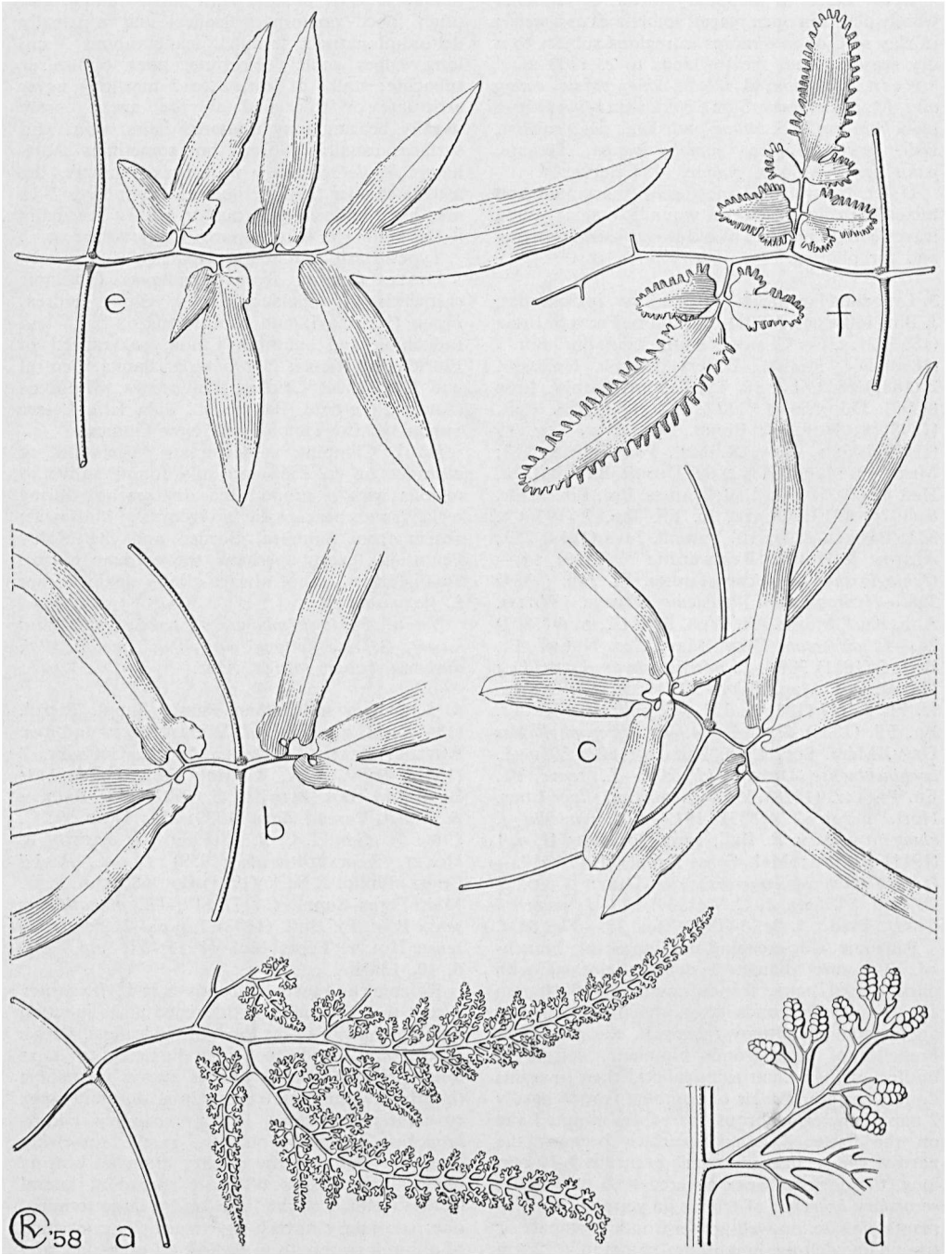


Fig. 9. *Lygodium dimorphum* COPEL. a. Part of fertile leaf,  $\times \frac{2}{3}$ , b-c. parts of sterile leaves,  $\times \frac{2}{3}$ , d. detail of a,  $\times 3$ .—*L. flexuosum* (L.) SW. e. Sterile leaf,  $\times \frac{2}{3}$ , f. fertile leaf,  $\times \frac{2}{3}$  (a LABILLARDIÈRE s.n., b-c CARR 12479, d PEEKEL 6, e HOSE 5024, f HALLIER s.n. from Java).



and attenuate or subobtusate, edges of sterile leaflets finely crenate-serrate, base truncate to cordate, lamina thicker than in *L. flexuosum*; upper surface of costae more or less hairy especially towards the base, lower surface often glabrous, veins usually glabrous; *sorophores* 2–5 mm long, usually constricted at the base, often with hairs on upper surface of midrib; indusia glabrous; spores finely verrucose.

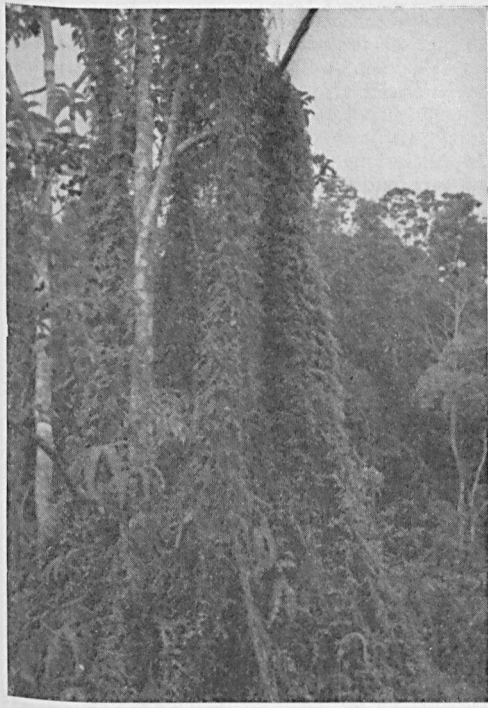


Fig. 10. 'Columns' of *Lygodium salicifolium* Pr. on scattered pole trees of mostly *Ilex cymosa*, surrounded by a dense ground cover of ferns and sedges, *Nepenthes*, and orchids, in an old crater swamp in the Gajo Lands, N. Sumatra, c. 1200 m (1937).

Type: Cuming 365, Singapore (W, K).

Distr. Assam, Siam, Indochina to Yunnan, Formosa, south-east to New Guinea and Micronesia; in *Malaysia*: Sumatra, Malay Peninsula, Banka, W. Java, Borneo, and New Guinea.

Ecol. In open secondary vegetation, sometimes in wet places, in the low country and to 1200 m; reported in teak forest in West Java.

Note. There are specimens which are intermediate between this species and *L. flexuosum*; they may be hybrids. *L. salicifolium* occurs only in regions with a short dry season, whereas *L. flexuosum* will tolerate a longer dry season and has a wider distribution. In Burma and Assam very large forms of both species occur.

Vern. *Hata*, S, *mintuh*, Dayak, *paku kawat*, Sum., *akar sidin*, M.

5. *Lygodium flexuosum* (L.) Sw. in Schrader, J. Bot. 1800, pt 2 (1801) 106; *ibid.* 1801, pt 2 (1802) 304; PRESL, Suppl. Pterid. (1845) 100; BEDD. Ferns S. India (1863) t. 63; CLARKE, Trans. Linn. Soc. Bot. 1 (1880) 584; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 72, p.p.; BEDD. Handb. (1883) 457, f. 283; v. A. v. R. Mal. Ferns (1908) 114; MERR. Fl. Manila (1912) 61; DOMIN, Bibl. Bot. 20, Heft 85 (1914) 209, f. 49; HAINES, Bot. Bih. & Or. 6 (1924) 1211; BACK. Onkr. Suiker 7 (1928) 1, t. 1; BURK. Dict. 2 (1935) 1378; C. CHR. Dansk Bot. Ark. 9, pt 3 (1937) 30; BACKER & POSTH. Varenfl. Java (1939) 259; HOLTT. Ferns Mal. (1955) 57, p.p.; ALSTON & HOLTT. Reinwardtia 5 (1959) 15.—*Ophioglossum flexuosum* LINNÉ, Sp. Pl. (1753) 1063.—*Ophioglossum scandens* LINNÉ, Sp. Pl. (1753) 1063, p.p.—*Ramondia flexuosa* (L.) MIRB. Bull. Soc. Philom. Paris 2 (Feb.–Mar. 1800) 179, t. 12 f. 3.—*Hydroglossum flexuosum* (L.) WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2 (1802) 23, t. 1 f. 3.—*Hydroglossum pinnatifidum* WILLD. *ibid.* 21, p.p.—*L. pinnatifidum* Sw. in Schrader, J. Bot. 1801, pt 2 (1803) 303; HOOK. Syn. Fil. (1868) 438, p.p.—*L. semibipinnatum* R. BR. Prod. Fl. Nov. Holl. (1810) 162.—*L. serrulatum* BL. En. Pl. Jav. (1828) 254.—*L. flexuosum* var. *setulosum* TARD. & C. CHR. Fl. Gén. I.-C. 7 (1939) 39.—Fig. 9e-f.

Rhizome short-creeping and densely covered with roots, the stipes very close together; apex of rhizome covered with dark brown to nearly black hairs. Juvenile fronds once or twice dichotomous, each branch bearing a single leaflet which is deeply palmately 3–7-lobed, the lobes almost equal, the base of the whole leaflet cordate, edges serrate and sometimes crenately lobed. *Rachis* of scandent fronds narrowly winged, flattened and puberulous on the upper surface between the wings; primary *rachis*-branches up to 3 mm long (lower ones longest), dormant apex covered with pale brown hairs; *secondary rachis*-branches pinnate to somewhat bipinnate, narrowly ovate to deltoid in outline, commonly about 15 cm long and 8 cm wide; sterile leaflets of lower branches palmate, often 5-lobed, base strongly cordate; higher secondary branches bearing 3–5 (sometimes to 7) leaflets on each side and an apical one, the apical and lower leaflets asymmetric or more or less lobed at the base, the lowest often with 2 or 3 (exceptionally to 6) separate quaternary leaflets at its base; *sterile leaflets* 3–10 cm long, 8–15 mm wide above the lobed base, apex subacute, edges serrate, lower leaflets stalked, upper sessile, lamina rather thin; costae usually bearing scattered long hairs, less often densely short-hairy, veins often with scattered short hairs on the lower surface, the lamina sometimes similarly hairy; *fertile leaflets* smaller than sterile, *sorophores* 3–5 mm long (rarely up to 10 mm), at the apices of small triangular lobes; indusia glabrous or with a few hairs like those of the lower surface of the lamina; spores finely verrucose.

Type: Hermann, Ceylon (BM).

Distr. Ceylon, from the Himalayas (Dehra Dun eastwards) to southern China, Hong Kong, Riu Kiu Isl., south and south-east to Melanesia and northern Queensland, throughout *Malaysia*.

Ecol. In open places, climbing on shrubs, in teak and bamboo forest, in low country and to 1000 m, not in shady evergreen forest. In very dry or exposed places the veins and lamina are often rather copiously hairy.

Vern. *Ribu-ribu gajah*, *ribu-ribu bĕsar*, *ikat sidin*, M, *paku ribu-ribu*, Asahan, *hata kĕmbang*, J, *durhawa*, Alor, *nito*, Tag., Visc., *tatan*, Orokawa Horata (N.G.), *zangi*, Orokawa Mumuni.

Uses. For tying rice sheaves; in native medicine for skin diseases and fever.

6. *Lygodium dimorphum* COPEL. Philip. J. Sc. 6 (1911) Bot. 67; ROSENST. in Fedde, Rep. 10 (1912) 343; v. A. v. R. Mal. Ferns Suppl. (1917) 116; Philip. J. Sc. 11 (1916) Bot. 116; ALSTON & HOLTT. Reinwardtia 5 (1959) 18.—*L. flexuosum* [non (L.) SW.] GAUDICH. in Freyc. Voy. Bot. (1826) 298.—*L. circinnatum* var. *trifurcatum* CHRIST, Monunia 1 (1900) 93.—*L. novoguineense* ROSENST. in Fedde, Rep. 9 (1911) 427.—*L. trifurcatum* sensu v. A. v. R. Mal. Ferns (1908) 112, 802, p.p.—Fig. 9a-d.

Rhizome short-creeping, bearing fronds very close together, apex densely covered with almost black hairs. Juvenile fronds once dichotomous, each branch bearing a deeply palmatisect leaflet, lobes subequal, base cordate, edges rather irregularly serrate and somewhat thickened. *Rachis* of climbing fronds hardly 2 mm diameter, glabrous or nearly so; primary rachis-branches very short, ending in a somewhat projecting dormant bud covered with light brown hairs having slightly swollen bases; *secondary rachis-branches* bearing sterile leaflets unbranched or more commonly once dichotomous, those bearing fertile leaflets usually sub-pinnate with a few tertiary branches; *sterile leaflets* 10–18 cm long, simple or forked (less often 3-lobed), usually strongly cordate and auriculate at the base on one side (sometimes with a separate rounded leaflet replacing the cordate base), when forked the lamina lobed to within 1 cm of the base, leaflets or lobes 1–2 cm wide, tapering, acute, irregularly doubly serrate, edge somewhat thickened, surfaces glabrous, sometimes sparingly warty; *fertile leaflets* usually with the lamina reduced to a narrow wing (0.2 mm wide) along the costae and along each vein and its branches; tertiary fertile branches deltoid in outline (5 cm or more wide at the base), with quaternary leaflets of increasing length below each terminal one; *sorophores* 2–4 mm long, indusia glabrous; spores minutely verrucose on an unevenly undulating surface (always?).

Type: C. King 134, Papua (MICH, Bo).

Distr. *Malaysia*: Celebes (?), Moluccas (Ambon, Rawak), New Guinea.

Ecol. "Climbing small trees to a height of about 12 feet. Quite common in low wet places along the coast" (RUSSELL, on specimen from

E. New Guinea). Collections have also been made inland, at altitudes up to 1000 m.

Vern. *Canā*, Motuan, *gailei*, Bragi, *paku kawa*, Ambon.

Uses. Used for making arm- and leg-bands.

7. *Lygodium trifurcatum* BAK. in Hook. Syn. Fil. (1868) 437; v. A. v. R. Mal. Ferns (1908) 112, 802, p.p.; WAGNER & GREYER, Un. Cal. Publ. Bot. 23 (1948) 27, t. 8; ALSTON & HOLTT. Reinwardtia 5 (1959) 17.

Scandent *rachis* about 1½ mm diameter; primary rachis-branches very short, hairs on the dormant apex having swollen bases; *sterile secondary rachis-branches* once or twice equally or sub-equally dichotomous (12–20 mm to first dichotomy), the leaflets simple or very deeply bilobed, 10–20 cm long, 1½–2½ cm wide, the outer base of each more or less cordate (rarely strongly auriculate), edges irregularly serrate and slightly thickened; *fertile secondary branches* usually sub-pinnate with flexuous axis bearing two lateral and one terminal leaflets, sometimes twice symmetrically dichotomous; fertile leaflets usually deeply bilobed or geminate, one or both members often having a shorter lobe commonly 9–15 cm long and up to 13 mm wide including sorophores, lamina reduced to a wing along the costa and along each vein-group (sometimes two adjacent vein-groups with a common lamina) the *sorophores* thus in groups of 2–5; sorophores usually 2–3 mm long; spores coarsely and unevenly verrucose, the warts often confluent.

Type: Milne 511, Solomon Isl. (K).

Distr. Melanesia (Solomon Isl. and New Hebrides); in *Malaysia*: Admiralty Isl., Louisiades.

Ecol. "Climbing abundantly in brackish marsh" (GREYER & WAGNER 3997, Admiralty Islands).

Note. The specimen of GREYER & WAGNER has fertile branches more like those of *L. dimorphum* than is usual in *L. trifurcatum*, and has one branch intermediate between sterile and fertile; the fully sterile leaflets are smaller than normal in *L. dimorphum* and only slightly cordate at the base. The two species are very closely allied, and it may be that in the Admiralty Islands, where their areas of distribution overlap, there has been hybridization.

8. *Lygodium auriculatum* (WILLD.) ALSTON, Reinwardtia 5 (1959) 16.—*Ugena semihastata* CAV. Ic. Descr. Pl. 6 (1801) 74, t. 594, *nomen illegit.*, *excl. syn.* REICHARD & RUMPH.; C. B. ROB. Philip. J. Sc. 6 (1911) Bot. 97; C. CHR. Dansk Bot. Ark. 9, pt. 3 (1937) 29.—*Hydroglossum auriculatum* WILLD. Sp. Pl. 5 (1810) 84.—*L. semihastatum* DESV. Mém. Soc. Linn. Paris 6 (1827) 203, *nom. illeg.*; Hook. Syn. Fil. (1868) 437; v. A. v. R. Mal. Ferns (1908) 111, *excl. pl. borneensis*; Mal. Ferns Suppl. (1917) 115; C. CHR. Ind. Fil. Suppl. I (1913) 119.—*L. circinnatum* var. *semihastatum* FOSB. Am. Fern J. 40 (1941) 142.—*L. flexuosum* [non (L.) SW.] PRANTL, Unters. Morph. Gefässkr. (1881) 73, p.p. *quoad syn.* CAV. and WILLD.—Fig. 11.

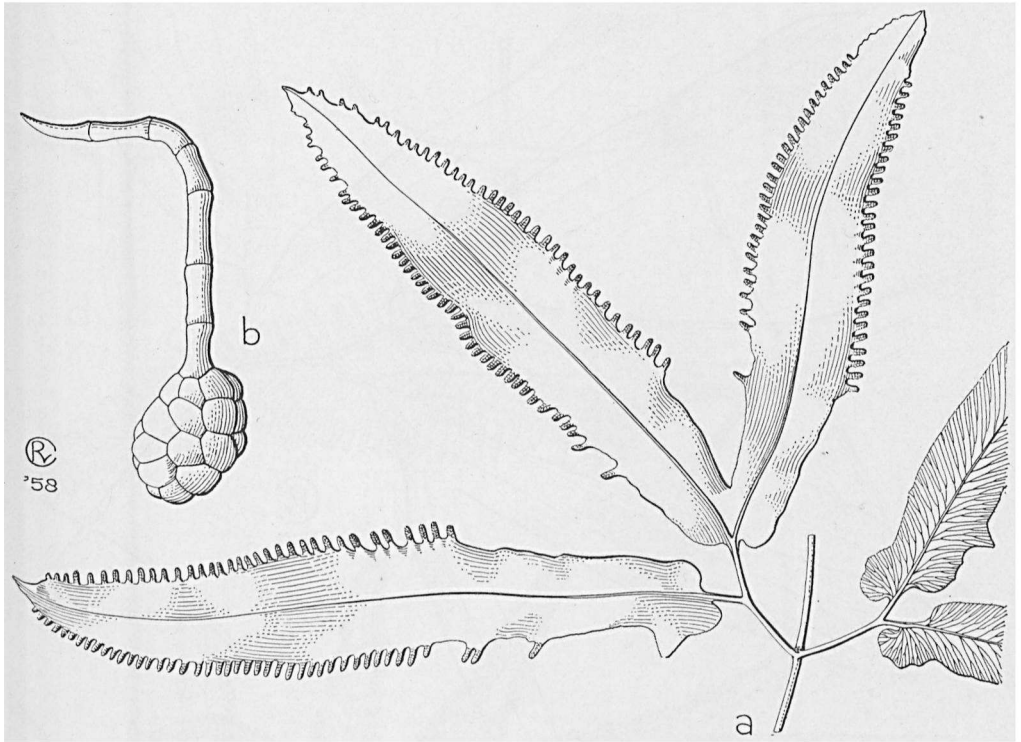


Fig. 11. *Lygodium auriculatum* (WILLD.) ALSTON. *a.* Habit,  $\times \frac{2}{3}$ , *b.* hair,  $\times 65$  (*a-b* LE ROY TOPPING 1287).

Rhizome short-creeping, bearing fronds close together, its apex and bases of stipes densely covered with dark hairs. Juvenile fronds once dichotomous, each branch bearing a palmatisect leaflet, usually 5-lobed, with truncate base, edges closely and irregularly serrate. *Rachis* of climbing fronds hardly 2 mm diameter, usually glabrous; primary rachis-branches very short, dormant apex covered with pale brown hairs having swollen bases; secondary rachis-branches rarely bearing a simple leaflet, most commonly once dichotomous, one branch with a simple, one with a forked leaflet, less often each branch with a simple leaflet; sterile leaflets 12–20 cm long, 12–30 mm wide, subacute, edges not thickened, very shallowly serrate, base usually asymmetric and strongly cordate-auriculate on the outer, rarely on both sides, costae glabrous except near the base on upper surface; lamina of fertile leaflets 12–20 mm (rarely to 30 mm) wide, sorophores 3–9 mm long, constricted at the base, at the apices of short triangular lobes of the lamina; indusia glabrous; spores irregularly warty, variable as between different specimens, in some cases resembling those of *L. longifolium*, in others with many smaller warts of variable size.

Type: Née, Luzon (MA).

Distr. Indochina, Micronesia; in *Malaysia*: E. Borneo, Philippines (Polillo, Luzon, Mindoro,

Samar, Mindanao), to 600 m altitude.

Note. The Micronesian specimens seen (from Guam) are all smaller than Philippine ones, and their secondary branches are regularly twice dichotomous; they may constitute a distinct local race (specimens of Née from Marianas not seen). It may be that this species intergrades with *L. borneense* in Borneo.

Vern. *Nito*, Tag.

Uses. Climbing rachises used for weaving, making hats, and magic (contra-poison) bracelets.

9. *Lygodium borneense* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 29; Mal. Ferns Suppl. (1917) 115; COPEL. Sarawak Mus. J. 2 (1917) 303; HOLTT. J. R. As. Soc. Mal. Br. 6 (1928) 16 with fig.; Ferns Mal. (1955) 56.—*L. semihastatum sensu* v. A. v. R. Mal. Ferns (1908) 111, *p.p. quoad pl. borneenses*.—*L. borneense f. samarindae* v. A. v. R. Bull. Jard. Bot. Btzig II, n. 20 (1915) 29; Mal. Ferns Suppl. (1917) 116.—Fig. 5b, 13c–e.

*Rachis* of scandent fronds glabrous, up to 2 mm diameter; primary rachis-branches very short, dormant apex covered with pale hairs having swollen bases; secondary rachis-branches rarely unbranched, normally once dichotomous (10–20 mm long below the dichotomy), each branch

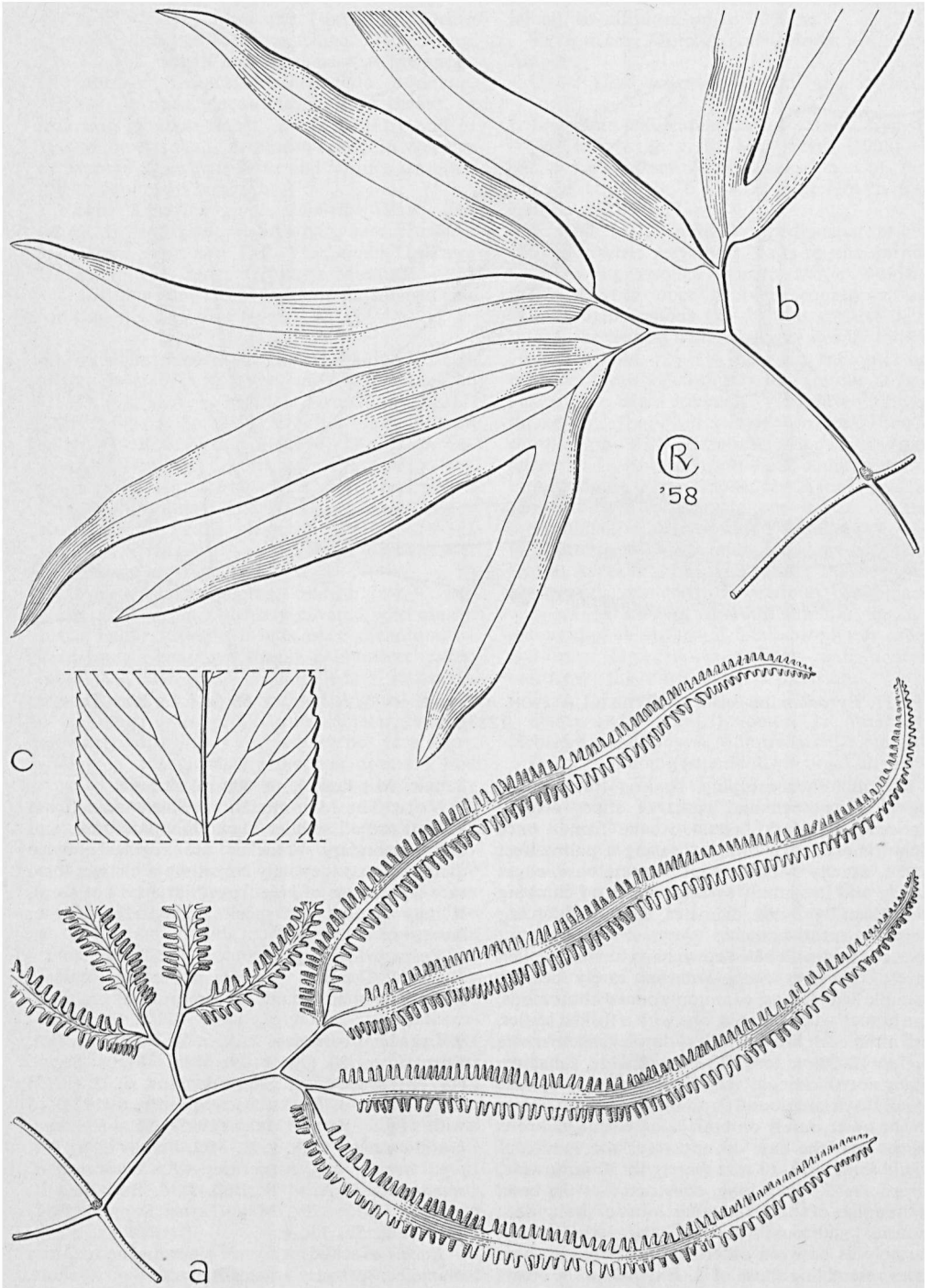


Fig. 12. *Lygodium longifolium* (WILLD.) SW. *a*. Habit, fertile,  $\times \frac{2}{3}$ , *b*. sterile,  $\times \frac{2}{3}$ , *c*. leaf detail showing edge,  $\times 3$  (*a* KING's coll. 259, *b* MOTLEY s.n., *c* HOSE 5034).

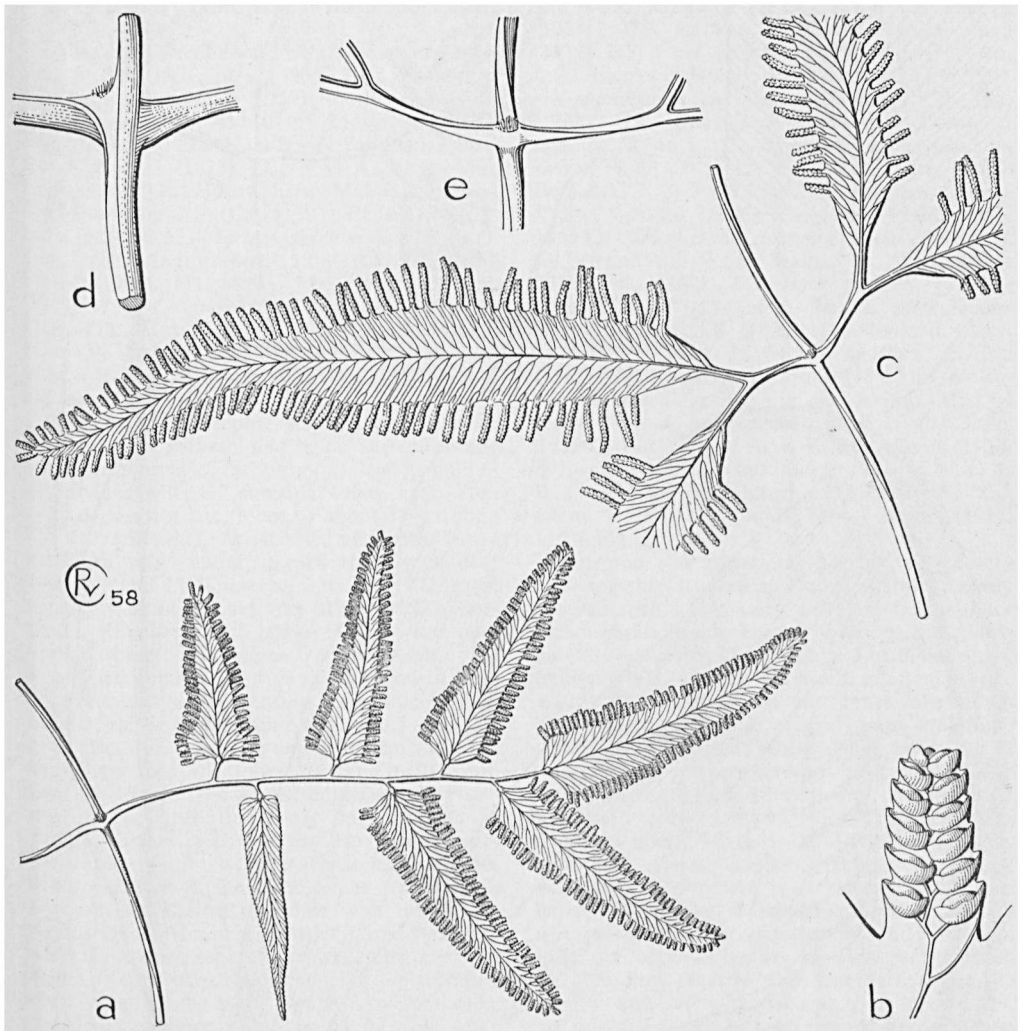


Fig. 13. *Lygodium salicifolium* PR. a. Habit,  $\times \frac{2}{3}$ , b. detail,  $\times 10$ .—*L. borneense* v. A. v. R. c. Habit,  $\times \frac{2}{3}$ , d. detail of branching,  $\times 2\frac{1}{2}$ , e. ditto,  $\times \frac{4}{3}$  (a BERKHOUT s.n., b BRASS 5686, c SFN 18656, d-e ENDERT 2057).

with a simple leaflet or rarely one leaflet double, rarely the secondary branch-system sub-pinnate with two lateral and one terminal leaflets; *sterile leaflets* 20–35 cm long (on upper parts of frond smaller), 3½–5 cm wide, margin more or less distinctly serrulate and slightly thickened, base cuneate (rarely cordate on the outer base), surfaces quite glabrous except the upper surface of the costa towards its base, lamina not verrucose when dry; *fertile leaflets* similar to sterile but slightly smaller, 10–30 cm long, 12–40 mm wide (smallest on upper branches), *sorophores* 4–10 mm long, usually about 2 mm apart, at the apices of small triangular projections of the lamina; spores quite smooth.

Type: Teysmann, Borneo (Bo).

Distr. *Malaysia*: Malaya (SE. Johore only), Sumatra (Mentawai Isl.), Borneo (many localities), Talaud Isl.

Ecol. In light places in freshwater swamp-forest; in Sarawak twice reported in the neighbourhood of limestone hills but certainly occurring also not in the vicinity of limestone; one specimen from Sarawak, found growing with *Imperata* on sandy ground, has unusually small leaflets.

Note. This species has a branching habit closely similar to that of *L. auriculatum*. *L. borneense* usually differs from *L. auriculatum* in the larger size and cuneate base of its leaflets, but some Bornean specimens seem to be intermediate in

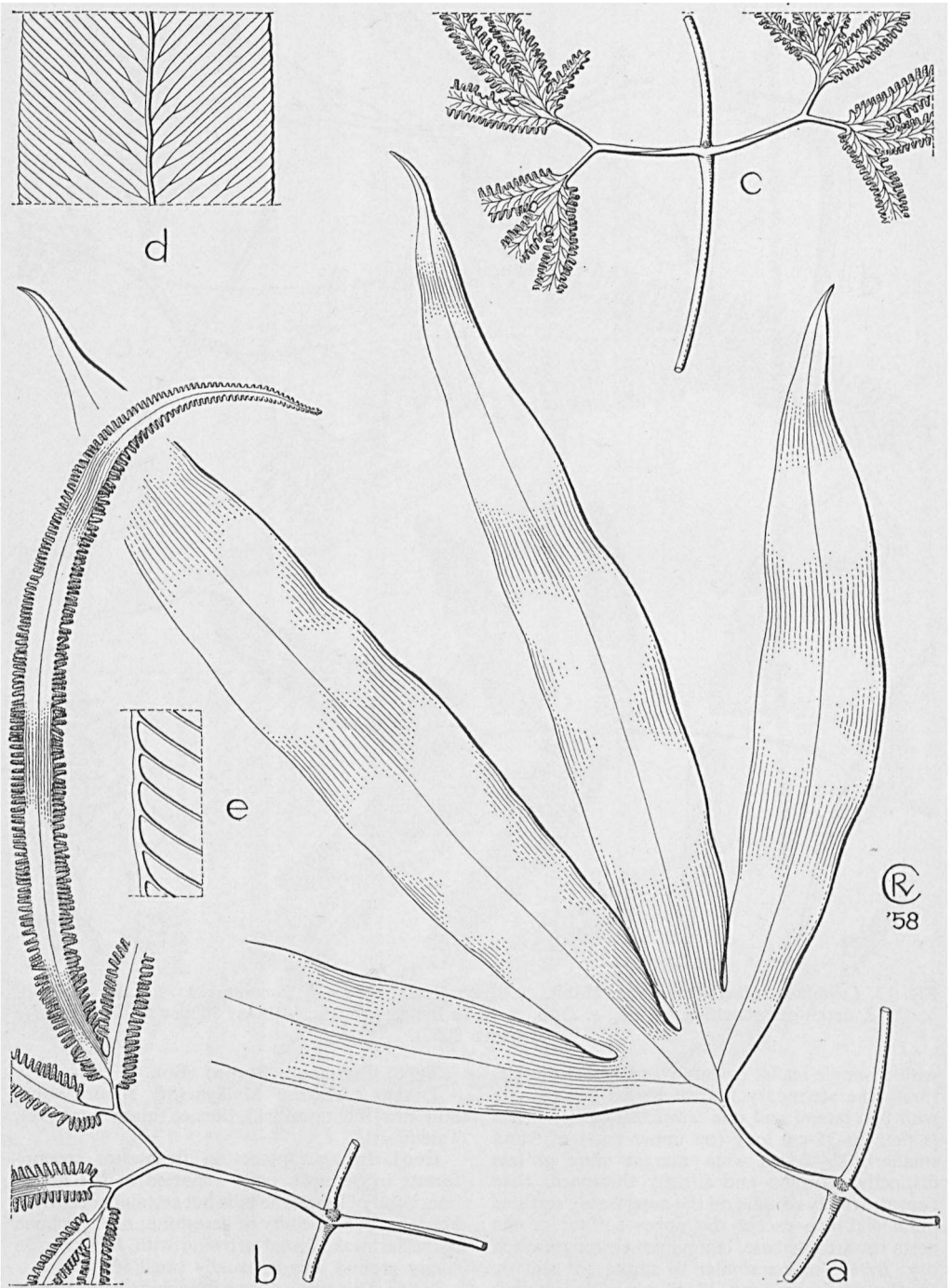


Fig. 14. *Lygodium circinnatum* (BURM. f.) Sw. a. Part of sterile leaf,  $\times \frac{2}{3}$ , b-c. parts of fertile leaves, showing different kinds of branching,  $\times \frac{2}{3}$ , d. veins of sterile leaf,  $\times 3$ , e. ditto, leaf edge,  $\times 9$  (a, d-e CLEMENS 9487, b ZOLLINGER 169, c Lady DALHOUSIE s.n.).

the latter character. So far as observed, *L. borneense* seems to be consistent in its smooth spores.

10. *Lygodium longifolium* (WILLD.) SW. in Schrader, J. Bot. 1801, pt 2 (1803) 305; ALSTON & HOLTT. Reinwardtia 5 (1959) 19.—*Hydroglossum longifolium* WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2, pt 4 (1802) 22, t. 2.—*L. digitatum* PRESL, Rel. Haenk. 1 (1825) 73 (?); v. A. v. R. Mal. Ferns (1908) 112; HOLTT. Ferns Mal. (1955) 55.—*L. dichotomum* (non (CAV.) SW.) BEDD. Ferns S. India (1863) t. 62.—*L. teysmannii* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. 18 (1908) 5; Mal. Ferns (1908) 111, 801; Mal. Ferns Suppl. (1917) 115.—*L. circinnatum* var. *crisatum* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 5; Mal. Ferns (1908) 112, 802.—*L. derivatum* v. A. v. R. Bull. Jard. Bot. Btzg III, 5 (1922) 213.—Fig. 5a, 12.

Rhizome short-creeping, its apex and bases of stipes covered with shining black hairs. Juvenile fronds once or twice dichotomous, leaflets palmately divided with 4–7 subequal lobes, base often more or less cordate, lobes to about 18 cm long and 18 mm wide, acuminate, edges shallowly serrate, a vein ending in each tooth. Scandent frond to about 4 m long, rachis to 2 mm diameter; primary rachis-branches very short, with a dormant apex covered with brown hairs having small swollen bases; secondary rachis-branches 1–3 times dichotomous or sub-pinnate (lowest ones sometimes unbranched and bearing large 6-lobed leaflets); sterile leaflets composed of 2–4 subequal lobes 15 cm or more long and c. 15 mm wide, the sinuses between the lobes reaching to 15 mm from the base of the leaflet, edges regularly serrate, not or little thickened, base cuneate to cordate, surfaces glabrous and usually not warty when dried; fertile secondary branches 1–3 times dichotomous or (if the dichotomies are unequal) more or less distinctly pinnate with two dichotomous tertiary branches (tertiary branches may rarely have three separate leaflets); fertile leaflets simple or more usually consisting of two subequal lobes united at the base, lamina 3–10 mm wide, sorophores commonly 2–3 mm long, less often to 6 mm; spores coarsely and irregularly verrucose.

Type: Herb. Willdenow, Malabar (B).

Distr. Southern India, Hainan; in *Malaysia*: Malaya, Riouw and Lingga Islands, Sumatra, Borneo, Luzon (doubtful).

Ecol. Edges of forest, probably in more exposed places than *L. circinnatum*, and not attaining so large a size as that species.

11. *Lygodium circinnatum* (BURM. f.) SW. Syn. Fil. (1806) 153; BL. En. Pl. Jav. (1828) 253; PRANTL, Unters. Morph. Gefässkr. 2 (1881) 64; BEDD. Handb. (1883) 455; v. A. v. R. Mal. Ferns (1908) 111; C. B. ROB. Philip. J. Sc. 6 (1911) Bot. 102; v. A. v. R. Philip. J. Sc. 11 (1916) Bot. 116; MERR. Int. Rumph. (1917) 69; v. A. v. R. Mal. Ferns Suppl. (1917) 115; W. H. BROWN, Bull. Bur. For. Philip. n. 19 (1919) t. 4; *ibid.*

n. 22 (1920) 328, pl. IV; HEYNE, Nutt. Pl. (1927) 96; BACK. Krakatoa (1929) 253; BURK. Dict. 2 (1935) 1378; BACKER & POSTH. Varenfl. Java (1939) 258, f. 67; HOLTT. Ferns Mal. (1955) 55, f. 9; ALSTON & HOLTT. Reinwardtia 5 (1959) 20.—*Ophioglossum circinnatum* BURM. f. Fl. Ind. (1768) 228.—*Ophioglossum pedatum* BURM. f. *ibid.* 227, t. 66 f. 1.—*Ugena dichotoma* CAV. Ic. Descr. Pl. 6 (1801) 74, t. 594 f. 2; C. CHR. Dansk Bot. Ark. 9, pt 3 (1937) 30.—*L. pedatum* (BURM. f.) SW. Syn. Fil. (1806) 154; MERR. Philip. J. Sc. 19 (1921) 336.—*Hydroglossum circinnatum* (BURM. f.) WILLD. Abh. Kurf. Mainz. Ak. Wiss. Erfurt 2, pt 4 (1802) 24.—*Hydroglossum pedatum* (BURM. f.) WILLD. *ibid.* 25.—*L. dichotomum* (CAV.) SW. Syn. Fil. (1806) 154; HOOK. & GREV. Ic. Fil. 1 (1831) t. 55; HOOK. & BAK. Syn. Fil. (1868) 437; RACIB. Pterid. Buit. (1898) 8.—*Ophioglossum furcatum* ROXB. Calc. J. Nat. Hist. 4 (1844) 478.—*L. basilanicum* CHRIST, Philip. J. Sc. 2 (1907) Bot. 179; v. A. v. R. Mal. Ferns (1908) 802.—*L. circinnatum* var. *monstruosum* v. A. v. R. Bull. Dép. Agr. Ind. Néerl. n. 18 (1908) 5; Mal. Ferns (1908) 112; Mal. Ferns Suppl. (1917) 115.—Fig. 5d, 14.

Rhizome short-creeping, bearing stipes very close together, its apex and bases of stipes densely covered with black hairs. Juvenile fronds once dichotomous, each branch bearing a pedately palmatisect leaflet, lobes usually 4 or 5, subequal, to about 25 by 3½ cm, the midrib of an outer lobe arising near base of the next inner lobe, edges entire, often somewhat crisped, pale and much thickened (translucent when living), apices acute to acuminate, surfaces glabrous but conspicuously warty when dry (not when living), veins uniting with the thickened margin. Rachis of climbing frond to about 10 m long, 2–5 mm diameter, glabrous; primary rachis-branches very short, with sunken dormant apex covered with pale hairs which are not thickened at the base; secondary rachis-branches unbranched and 2–6 cm long, or once dichotomous with each branch 1–2 cm long beyond the fork; sterile leaflets usually with 2–6 subequal diverging lobes which are separate to within 2 cm from the base, entire, margin pale and thickened, base cuneate or truncate, surfaces nearly always warty when dry; fertile secondary rachis-branches unbranched or 1–3 times dichotomous (rarely sub-pinnate); fertile leaflets usually sessile in pairs at the ends of the ultimate branches, or members of a pair partly fused at the base, less often 3–5-lobed (always so if the secondary rachis is unbranched), lamina more or less reduced and commonly 3–6 mm wide, rarely less than 2 mm or approximating in width to the sterile leaflet-lobes; sorophores 2–5 mm long, sessile; spores finely and evenly verrucose.

Type: Java, herb. Burman (G, not seen).

Distr. Ceylon, NE. India to southern China, Siam and Nicobar Isl. to Micronesia, the New Hebrides and Solomons; throughout *Malaysia*.

Ecol. In lightly shaded places in primary or secondary forest, in the lowlands and to 1500 m

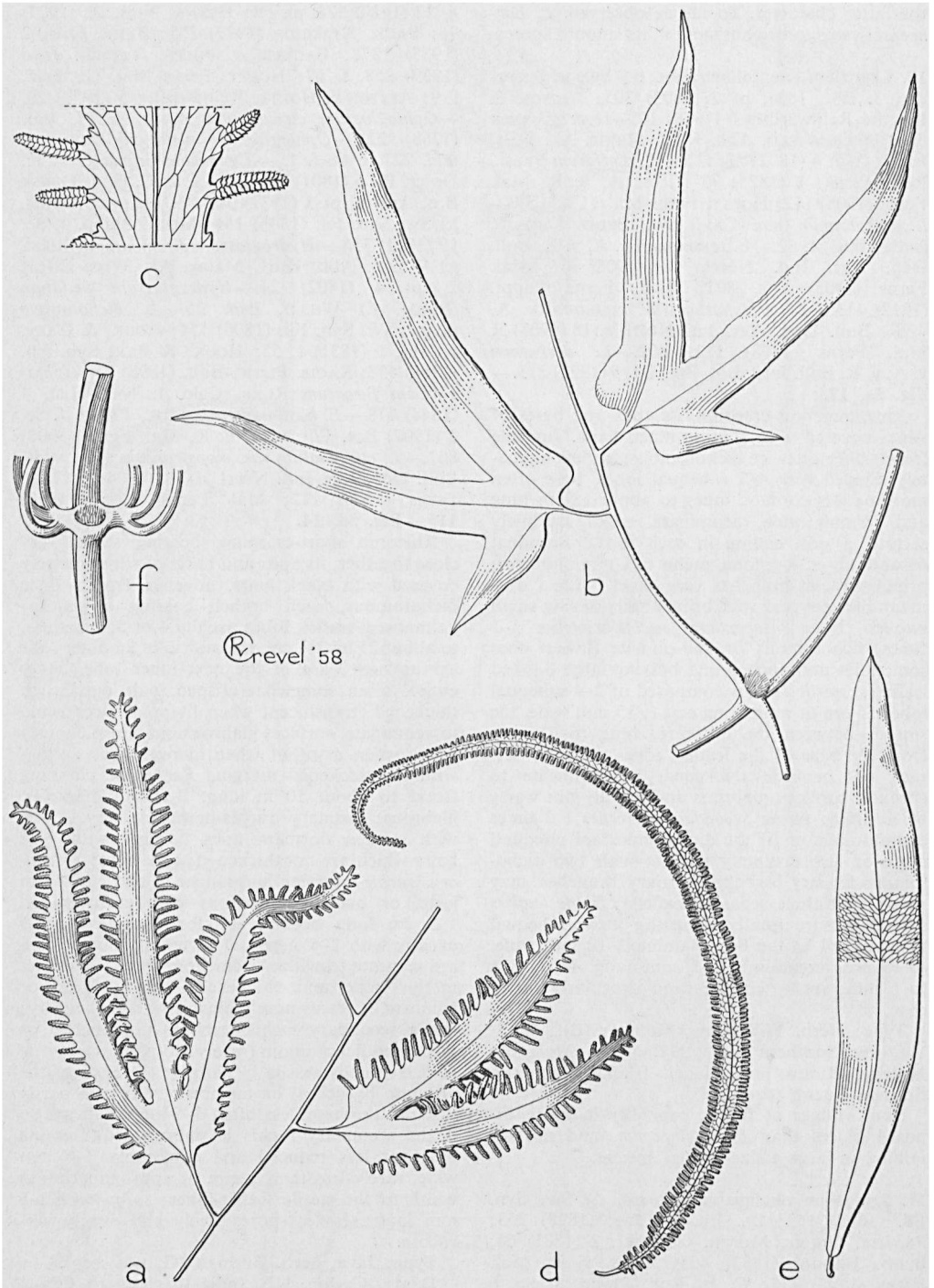


Fig. 15. *Lygodium merrillii* COPEL. *a*. Part of fertile leaf,  $\times \frac{1}{2}$ , *b*. part of sterile leaf,  $\times \frac{1}{2}$ , *c*. detail of fertile leaf,  $\times 1\frac{1}{2}$ .—*L. versteegii* CHRIST. *d*. Part of fertile leaf,  $\times \frac{1}{2}$ , *e*. part of sterile leaf,  $\times \frac{1}{2}$ , *f*. detail, main rachis bearing a primary branch with its secondary branches, each ultimate branch bearing a single leaflet like those shown in *d* and *e*,  $\times 2$  (*a*, *c* MABESA 26112, *b* TOPPING 1318, *d*-*f* LAM 1386).



altitude, never where the ground becomes seasonally very dry.

Vern. *Ribu-ribu dudok, ribu-ribu bukit, paku jari mèrah, akar sidin, kapai bèsar, rèribu, M, tura, Nias, kapai gorita*, Mol., *paku hata, hata areuj*, S, *paku ata, paku ribu-ribu*, Asahan, *paku rambat*, J, *ata*, Bali, *babar*, Alor, *masèm*, Minah., *raga-raga*, Mak., *tjiwang*, Bug., *mongodo*, Tob., *gomoho*, Tern., *gomongo*, Tidore, *nito*, Tag., Visc.

Uses. Medicinal, and for plaiting. In the Philippines used for making hats and cigarette cases, in Ambon for adorning houses for marriage festivals, in Sumatra in rice ceremonies. Young leaves edible.

12. *Lygodium merrillii* COPEL. Philip. J. Sc. 2 (Apr. 1907) Bot. 146, t. 4; *ibid.* 4 (1909) Bot. 20, t. 12; v. A. v. R. Mal. Ferns (1908) 803; Mal. Ferns Suppl. (1917) 118.—*L. matthewii* COPEL. Philip. J. Sc. 3 (1908) Bot. 36; *ibid.* 4 (1909) Bot. 20; v. A. v. R. Mal. Ferns (1908) 803.—Fig. 15a-c.

Rhizome and juvenile fronds not seen. *Rachis* of scandent fronds to 5 mm diameter, minutely hairy (hairs slender and erect), near base also bearing long dark hairs like those on dormant apices; primary rachis-branches very short, dormant apices prominent, covered with long dark brown hairs; *secondary rachis-branches* unifoliate and sterile near the base of a frond, upper ones pinnate; unifoliate secondary branches 6-9 cm long, leaflets c. 25 cm long, palmately 5-6-lobed with acute sinuses to within 6 cm of the base, lobes 2½-4 cm wide, acute and acuminate, shallowly and irregularly crenate-serrate, margin not thickened, veins oblique, anastomosing, with about four rows of elongate areoles between costa and margin, lower surface of lamina and of veins minutely hairy or glabrous; largest upper sterile secondary rachis-branches pinnate, with 2-4 lateral deeply bilobed or palmate leaflets (on stalks to 3 cm long) and a terminal one; *fertile secondary rachis-branches* pinnate (or the largest bipinnate at the base), in all 30 cm or more long, with 5-7 leaflets which are 2-4-lobed; fertile leaflets 8-10 cm long, lamina of each lobe to 1½ cm wide, veins anastomosing, stalks 5-15 mm long; *sorophores* 7-15 mm long, somewhat contracted at base, indusia glabrous or with few pale hairs; spores very coarsely and irregularly verrucose.

Type: Merrill 6057, Mt Halcon, Mindoro (MICH).

Distr. Tonkin and Kweichow; in *Malaysia*: Sumatra, Sarawak, Philippines (southern Luzon,

Leyte and Mindoro).

Ecol. In forest, to 600 m altitude.

13. *Lygodium versteegii* CHRIST, Nova Guinea 8 (1909) 161; v. A. v. R. Bull. Jard. Bot. Btzig II, n. 1 (1911) 10; ? COPEL. Philip. J. Sc. 6 (1911) Bot. 68; ? *ibid.* 11 (1916) Bot. 41; v. A. v. R. Mal. Ferns Suppl. (1917) 118, 499; ALSTON & HOLTT. Reinwardtia 5 (1959) 22.—*L. moszkowskii* BRAUSE, Bot. Jahrb. 49 (1912) 57; v. A. v. R. Mal. Ferns Suppl. (1917) 116.—Fig. 15d-f.

Rhizome and juvenile fronds not seen. *Rachis* of scandent frond to 2½ mm diameter, minutely hairy (hairs very slender, erect); primary rachis-branches very short, the sunken dormant apex bearing pale hairs; *secondary rachis-branches* also very short (1-3 mm long), so that the leaflets appear to be verticillate on the main rachis; leaflets 3 or 4 on each side of a dormant apex; *sterile leaflets* c. 20 cm long, 2-2½ cm wide, entire (margin more or less thickened and cartilaginous), gradually narrowed to the narrow truncate base, sometimes with one or two minute auricles forming separate small lateral leaflets, lamina covered with a close network of conspicuous anastomosing veins, with about 5 rows of areoles between costa and margin (outer areoles progressively smaller), ultimate free veins joining the thickened margin, surface glabrous with scattered warts when dry; *fertile leaflets* often longer than sterile (to 30 cm long) but narrower, usually reduced to a narrowly winged costa with a row of sorophores on each side, less commonly to a lamina 8 mm wide in which there is slight anastomosis of veins; *sorophores* 3-4 mm long, contracted at base; indusia more or less hairy; spores coarsely verrucose.

Type: Versteeg 1400, Noord River, W. New Guinea (P, Bo, G, U).

Distr. *Malaysia*: New Guinea.

Ecol. In open places in forest at altitudes up to 1200 m, climbing to a height of 8 m; also reported as an epiphyte in moss on a tall tree.

14. *Lygodium reticulatum* SCHKUHR, Farnkr. (1809) 139, t. 139; KUHN in Forschungsr. S. M. S. Gazelle 4 Bot., pt 6 (1889) 14; BRAUSE, Bot. Jahrb. 56 (1920) 212.

Similar to *L. microphyllum* in habit and in spores, differing: venation reticulate, lamina firmer, the leaflets usually more elongate.

Distr. Queensland, Fiji to Tahiti, New Hebrides, New Caledonia; reported by KUHN (*l.c.*) from New Ireland but without citation of a specimen, not otherwise known in *Malaysia*.

#### Excluded

*Cheilanthes fuscata* BL. En. Pl. Jav. 2 (1828) 136 = *Mohria caffrorum* (L.) DESV. The type of this plant (L) was identified by ROSENSTOCK and later verified by POSTHUMUS. AS BACKER & POSTHUMUS have pointed out (Varenflora Java p. 144, footnote) various ferns from S. Africa and Macaronesia have been described by BLUME as native in Malaysia, e.g. *Blechnum punctulatum* Sw., *Pellaea pteroides* PRANTL, *Cheilanthes hirta* Sw., *Ch. multifida* Sw., *Asplenium adiantum-nigrum* L., *Hemitelia capensis* R. BR., *Todea barbara* MOORE. Really they had been collected during short stays en route to Java via the Cape of Good Hope and were later mixed up with collections made in Java. It is not improbable that they were collected by KUHLE & VAN HASSELT as the herbarium materials collected by these young men and ardent collectors, who unfortunately fell untimely victims of tropical diseases in West Java, came into the hands of BLUME. On the label there is no indication that the specimen originated from the Moluccas, as stated by BLUME.