

HALORAGACEAE (R. van der Meijden & N. Caspers, Leyden)

Perennial (rarely annual) herbs, or undershrubs, terrestrial or aquatic, sometimes stoloniferous (*Gunnera*). *Leaves* opposite, spiral, or verticillate, in the terrestrial species nearly always simple, in the aquatic ones always partly pinnately divided, pinnately nerved or (in *Gunnera*) palmately nerved. *Stipules* 0, but the leaves often flanked by small, subulate and caducous enations. *Flowers* mostly in spike-like inflorescences, sometimes in a compound panicle, mostly solitary or (sometimes) in clusters of up to a dozen flowers in the axil of a bract or reduced leaf, ♀, monoecious, dioecious or polygamous, perigynous, actinomorphic, mostly 4-merous, or 2-, or (not in Mal.) 3-merous. *Sepals* 4 or 2, rarely (not in Mal.) 3, in ♀ flowers sometimes much reduced to 0, free or little connate, mostly persistent. *Petals* alternisepalous, 4, 2 or 0, rarely 3 (not in Mal.), free, in ♀ flowers absent or strongly reduced, often soon caducous, mostly more or less unguiculate and cochleariform, longer than the sepals. *Stamens* as many as sepals and then epi- or alternisepalous, or twice as many, 8, 4 or 2, rarely (not in Mal.) 3 fertile and 3 sterile, or 1, in ♀ flowers completely reduced; filaments mostly filiform, long and very thin, rarely (not in Mal.) short and thick; anthers 2-celled, basifixed, latrorse, mostly oblong to linear, rarely \pm elliptic. *Disk* 0. *Ovary* 1- or 4-, rarely 2- or (not in Mal.) 3-celled, in the ♂ flowers 0 or reduced; style alternisepalous, free, mostly short, grading into the globose or subulate stigmas which spread in fruit, the stigmatic, more-celled papillae hair-like elongating towards the end of the anthesis (except in *Gunnera*). *Ovules* as many as styles, or (in *Gunnera*) single, apical, pendulous, anatropous and apotropous. *Fruit* nut-like or (in *Gunnera*) a drupe, variously sculptured, indehiscent 1-seeded or breaking up into 4(-2) 1-seeded mericarps. *Seed* with a thin testa; embryo cylindrical, surrounded by a thick, white, oily albumen, or (in *Gunnera*) obcordate and in top of a very copious and oily albumen.

Distribution. Genera 7, with *c.* 150 *spp.*, nearly all over the world, but rather rare in the tropics.

Ecology. Malesian *Haloragaceae* have a varied ecology; in general they prefer damp, often poor soils. *Myriophyllum* consists mostly of aquatics. *Myriophyllum* and *Haloragis* species grow in the lowland ascending into the hills; other representatives are decidedly restricted to the montane zone and the lower part of the alpine zone, *e.g.* *Gunnera macrophylla*, *Haloragis halconensis*, *H. micrantha*, *H. philippinensis*, *Laurembergia coccinea*, and *Myriophyllum pedunculatum*. There is even one restricted to the alpine zone, *viz.* *Myriophyllum pygmaeum*. A few species are bound to a seasonal climate, *viz.* *Myriophyllum dicoccum*, *M. coronatum*, and *Haloragis acanthocarpa*. *Gunnera* shows a remarkable symbiosis with algae.

Flower biology of *Haloragis*, *Laurembergia* and *Myriophyllum*. It seems that at least the Malesian species are protandrous; in the initial stage of anthesis the stigmatic papillae are very short; at this stage the anthers grow to proportionally large size, protrude from the flower on elongating filaments, and shed their pollen; they soon wither and are caducous. In the meantime the ovary has already distinctly enlarged. Then the stigmatic papillae elongate and obviously reach the receptive stage. The structure seems to point to cross-pollination by wind, as already pointed out by Miss GIBBS (1917). Consequently, sizes of flower parts can only be compared when full-grown. The petals also reach their full size only in just opened flowers.

Taxonomy. *Haloragaceae* are generally agreed to be classified with the *Myrtales*. The circumscription of the family has differed and has included the genera *Callitriche* and *Hippuris*. These are now generally regarded as two separate families, though HUTCHINSON still includes *Hippuris* (Fam. Fl. Pl. ed. 2, 2, 1959, 448; Evol. Phyl. Fl. Pl. 1, 1969, 546). They were sometimes placed near *Haloragaceae*, but for example PULLE (Compendium) regarded both as reduced sympetalous families and assumed the reductions to be convergent coinciding with the aquatic habitat, not expressing systematic affinity. This view is sustained by HEGNAUER (Chemotax. 4, 1966, 238; Pharm. Act. Helv. 41, 1966, 585) and WIEFFERING

(Phytochem. 5, 1966, 1064) on chemotaxonomical arguments. MELCHIOR (Engl. Syll. ed. 12, 2, 1964, 438) and TAKHTAJAN (Evol. Angiosp. 1959, 228; Fl. Pl. 1969, 225) place only *Callitricheaceae* near or in *Lamiales*. HUTCHINSON *l.c.* places *Callitriche* in *Onagraceae*.

Within the family *Gunnera* occupies an isolated position, in which it is mostly regarded as a separate subfamily (SCHINDLER, MELCHIOR); also HUTCHINSON includes it in the family. Others regard it to represent a separate family, placing it next to *Haloragaceae*, e.g. VON WETTSTEIN, PULLE, and TAKHTAJAN.

The differences between the two groups are the following:

Haloragoideae: Vessels not polystelic. Ligule-like structures absent. Hairs many-celled, rarely reduced few-celled. Bracteoles present, rarely fully absent. Stigma short, capitate or shortly ligulate, on a more or less distinct style. Ovules 2-4, as many as the styles, crassinucellate, with 2 integuments. Fruits without a stone. Endosperm nuclear. Embryo large, cylindrical, with a long radicle.

Subfam. *Gunneroideae*: Vessels polystelic. Ligule-like structure distinct, sometimes ochrea-like. Hairs one-celled. Bracteoles absent. Stigma long, subulate, sessile. Ovule 1, tenuinucellate, with 1 integument. Fruits with a stone. Endosperm cellular. Embryo small, obcordate, with a short radicle.

However, in general the floral structure is in good agreement to include both in one family. The Australian genus *Glischrocaryon* (*Loudonia*) combines characters of both *Gunnera* and *Haloragis*, being macromorphologically distinctly allied to *Haloragis*, but possessing pollen which resembles that of *Gunnera* (similar type of apertures and exine), thus giving an additional strong argument for keeping *Gunneroideae* as a subfamily of *Haloragaceae*.

Subfam. *Haloragoideae* is divided into tribe *Halorageae* (with a 1-seeded fruit) and tribe *Myriophylleae* (with the fruit breaking up into 4(-2) 1-seeded mericarps).

Chemotaxonomy. As a consequence of the small economic importance of this family chemical information is scanty. Flavonols, leucoanthocyanins, ellagic acid and rather large amounts of tannins have definitely been demonstrated to be present in members of *Haloragaceae*. The tannins are most probably mixtures of hydrolysable and condensed tannins; this is indicated by the presence of ellagic acid and leucoanthocyanins. The terms "myriophyllin cells" and "myriophyllin" often used in anatomical literature are derived from *Myriophyllum*. Myriophyllin cells are idioblasts which are coloured purple by vanillin and hydrochloric acid and myriophyllin is their tannin-like content which gives this reaction (indicating leucoanthocyanins or catechins). Species of *Myriophyllum* bear trichomes giving the "myriophyllin" test. Two species of *Haloragis* have been found to produce prussic acid; the cyanogenic compounds, however, have not been investigated. Oxalate of lime occurs frequently, especially in the form of small clusters.

Accumulation of tannins containing ellagic acid and of condensed leucoanthocyanins fits well with the inclusion of *Haloragaceae* in *Myrtales* in the wider sense. The genera *Callitriche* and *Hippuris* have by some authors been included in or thought affiliated with *Haloragaceae*, but they are biochemically so different that such a relationship seems highly improbable; their chemical characters rather indicate affinities with sympetalous taxa. Reference: HEGNAUER, Chemotaxonomie der Pflanzen 4 (1966) 235-238. — R. HEGNAUER.

Morphology. Though the enations or trichomes occurring near the leaf-base have been sometimes interpreted as stipules, they are according to SCHINDLER (Pfl. R. Heft 23, 1905, 4) enatia to which he ascribes a gland function. However this may be, they are also found on the leaves and in other not prescribed places on the stem, showing that they are not organs in the proper sense. Recently PRAGLOWSKY (Grana 10, 1970, 159-239) revised the palynology of the family.

Uses. The only useful plant in Malesia is *Myriophyllum brasiliense* which is cultivated in fish-ponds.

Note. The treatment of *Haloragis* was done by Mr. N. CASPERS several years ago; while working on *Gunnera* and *Laurembergia*, he fell ill and could not finish this work.

KEY TO THE GENERA

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|---|------------------------|
| 1. Leaves radical, long-petioled, palmately nerved. | 4. <i>Gunnera</i> |
| 1. Leaves not radical, sessile or shortly petioled, pinnately nerved. | |
| 2. At least the lower (submersed) leaves pinnately divided, verticillate. | 3. <i>Myriophyllum</i> |
| 2. All leaves entire to crenate-serrate, opposite, alternate or sometimes in whorls of 3-4. | |
| 3. Fruit breaking up into 2-4 mericarps. Leaves sessile. | 3. <i>Myriophyllum</i> |
| 3. Fruit a one-seeded nutlet. Leaves mostly shortly petioled. | |
| 4. Flowers in axillary clusters, the middle one ♂ or sometimes ♀ and (in Asiatic spp.) very long-stalked, the other ones ♀. | 2. <i>Laurembergia</i> |
| 4. Flowers solitary, all ♀, not long-stalked. | 1. <i>Haloragis</i> |

1. HALORAGIS

J. R. & G. FORST. Char. Gen. Pl. (1776) 31, t. 31; SCHINDL. Pfl. R. Heft 23 (1905) 1-133, 36 fig. ('*Halorrhagis*'); WENT *f.* Nova Guinea 14 (1924) 105-109, t. XI. — *Gonocarpus* THUNB. Nov. Gen. Pl. 3 (1783) 55; Fl. Jap. (1784) 69, t. 15; SCHREB.

Gen. Pl. 1 (1789) 86 (*Gonatocarpus*); KÖN. & SIMS, Ann. Bot. 1 (1805) 546 (*Goniocarpus*). — *Gaura* LOUR. Fl. Coch. (1790) 225. — Fig. 1.

Herbs or small shrubs, prostrate or erect; stems mostly angular by the decurrent edges of the petiole. *Leaves* (in Mal.) simple, decussate or in whorls of 3–4, rarely alternate, pinnately nerved, the margin almost always dentate, serrate, or crenate. Inflorescences terminal. *Flowers* (in Mal.) solitary in the axil of a bract, bisexual, (in Mal.) 4-merous. *Sepals* (in Mal.) 4, valvate in bud, mostly triangular, persistent. *Petals* (in Mal.) 4, imbricate in bud, boat-shaped, caducous. *Stamens* (in Mal.) 8, rarely 4, in the latter case episepalous (in one extra-Mal. *sp.* epipetalous). *Ovary* (in Mal.) often 4-gonous, 8-ribbed, the mid-sepaline ribs less distinctly raised than the others, 4-celled; pericarp enlarging to fruit-size long before the seed is set; styles (in Mal.) 4, cylindrical, often incurved or the stigmas sessile. *Fruit* nut-like, pericarp hard.

Distr. About 60 *sp.*, almost all in Australia (51), also in Chatham I., Carolines (Yap, Palau), a few endemic in Tasmania and New Zealand, in the Pacific eastwards in Rapa I. and Juan Fernandez, in continental SE. & E. Asia in the Himalayas, Japan, and Korea; 3 extra-Australian species in Asia and Malesia, and 1 in New Caledonia; in *Malesia* 5 *sp.*, some in the lowland, others on the mountains.

According to SKOTTSBERG (Nat. Hist. Juan Fern. 2, 1921, 151) the opinion that *H. erecta* would have been introduced in Chile rests upon a mislocalized specimen. SKOTTSBERG described three new species from the Juan Fernandez group all of the affinity of *H. erecta*.

Ecol. Three species are montane to subalpine and prefer generally damp or marshy habitats (*H. micrantha*, *H. halconensis*, *H. philippinensis*). *H. chinensis* is usually found on poor soils from sea-level up to 2200 m; *H. acanthocarpa* is bound to a lowland seasonal steppe and savannah climate on badly drained soils.

Taxon. SCHINDLER divided the genus into two subgenera by the number of stamens, viz 8 (or 6 in 3-merous flowers) in *subg. Haloragis*, or 4 in one W. Australian species forming a monotypic *subg. Pseudohaloragis* in which the 4 *episepalous* stamens are aborted.

However, in *H. philippinensis*, and some other extra-Malesian species, there are also only 4 stamens, but here by abortion of the *epipetalous* stamens. Furthermore, PRAGLOWSKI (Svensk Bot. Tidskr. 63, 1969, 486) observed in two Australian species sterility of anthers, 4 out of 8 stamens or 2 out of 4 stamens, hence, a sort of intermediate stage towards full abortion.

Consequently, it tends to be doubtful to distinguish subgenera on the basis of the number of stamens.

KEY TO THE SPECIES

1. Small, caespitose herb, glabrous in all parts. Stems rooting at the nodes, at least at the base, apex often ascending. Sepals with a thickened and shallowly cordate base. Anthers 0.3–0.7 mm long.
 3. *H. micrantha*
1. Plant hairy, at least in the younger parts. Stems not rooting at the nodes, generally erect. Base of the sepals not thickened and subcordate. Anthers 0.8–2.3 mm long.
 2. Fruit with 8 longitudinal ridges alternating with 8 rows of (3–4) blunt-spiny tubercles, glabrous or appressedly hairy only at the apex. 4. *H. acanthocarpa*
 2. Fruit without rows of intercostal tubercles, or occasionally with 1(–3) blunt, low tubercles between the ribs, and then the fruit covered with appressed, curved hairs.
 3. Robust plants with semi-woody, stiff stems, mostly very much branched. Leaves decussate or, especially in the middle of a branch, in whorls of 3–4; if decussate, then the index of the leaves of the main stem 1.5–2.2. 5. *H. halconensis*
 3. Perennial, slender herbs, the stem mostly branched only at the base, rather thin. Leaves always decussate; leaf-index (2–)2.8–4(–5.5).
 4. Anthers 8. Ripe fruit erecto-patent to patent, mostly not thickened below the sepals, 0.7–1 by 0.8–1 mm (excluding the sepals), with a granular surface, the ribs often ± tuberculate, sometimes with 1(–3) intercostal tubercle(s). Inflorescence mostly much branched. 2. *H. chinensis*
 4. Anthers 4. Ripe fruit nodding, with a distinct, ± triangular thickening at the base of the sepals, 1.3–1.6 by 1–1.3 mm (excluding the sepals), the ribs smooth, the surface in between smooth or granular. Inflorescence little or not branched. 1. *H. philippinensis*

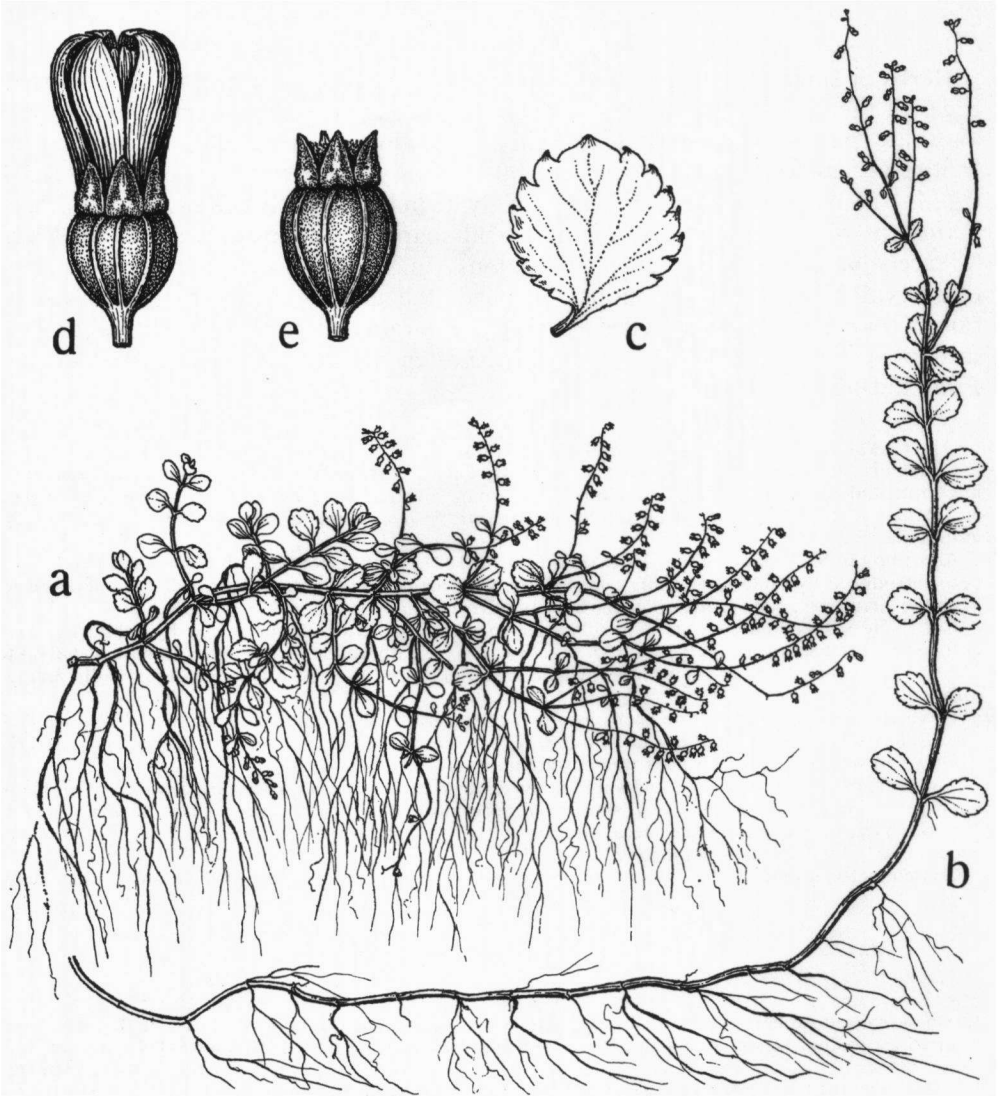


Fig. 1. *Haloragis micrantha* (THUNB.) S. & Z. *a-b*. Habit, *a* in exposed, *b* in shaded situation, nat. size, *c*. leaf, $\times 7$, *d*. flower, $\times 15$, *e*. fruit, $\times 15$ (W. Java, Papandajan, VAN STEENIS 4246, 4296).

1. *Haloragis philippinensis* MERR. Philip. J. Sc. 1 (1906) Suppl. 216; En. Philip. 3 (1923) 221. — *H. tetragyna* (non HOOK. f.) CLARKE, Fl. Br. Ind. 2 (1878) 430, *pro specim. khasyan*. — *H. scabra* var. *abbreviata* SCHINDL. Pfl. R. Heft 23 (1905) 29; ? GUILLAUMIN, Fl. Gén. I.-C. 2 (1920) 715, var. '*attenuata*' (sic). — *H. isomera* PARKER in Fedde, Rep. 29 (1931) 104; HUNDLEY & U CHIT KO KO, List Trees Burma (1961) 98; TARDIEU-BLOT, Fl. Laos, Camb. & Vietn. 4 (1965) 119, t. 1 f. 11-13.

Perennial herb, 9-30 cm, not or little branched,

with a number of stems from the base, each appressed-hairy and with ascending apex. *Leaves* decussate, ovate- to obovate-oblong, or lanceolate, 4-25 by 2½-7 mm, often appressed-hairy on both sides or the upper surface glabrous, margin on both sides with 2-10 small teeth; petiole 0-2 mm. *Racemes* not or hardly branched, 2½-12 cm. Bracts ovate-elliptic to lanceolate, the lower ones almost as large as the upper leaves, gradually diminishing in size upwards, 12-1½ mm, with 1-6 teeth on either side. Bracteoles of various shape, ½-1 mm, widened at the base. Pedicel 0-¾ mm,

glabrous or hairy. *Sepals* $\frac{3}{4}$ –1 by $\frac{1}{2}$ mm, at the base often somewhat thickened, glabrous. *Petals* $1\frac{1}{4}$ –2 mm, the midrib dorsally mostly hairy. *Stamens* 4, episepalous; filaments c. 0.2–0.3 mm; anthers c. 1– $1\frac{1}{2}$ mm. *Styles* 4, 0.2–0.5 mm. *Fruit* nodding, ovoid to broad-ellipsoid, rarely globular, c. $1\frac{1}{4}$ – $1\frac{1}{2}$ by 1– $1\frac{1}{4}$ mm, with a distinct, \pm triangular thickening at the base of the sepals, glabrous or with straight, appressed hairs, surface smooth or granular.

Distr. Assam (Khasya Mts), Burma (Tenasserim, Mergui), Thailand (Penins.: Ranong), S. Vietnam; in *Malasia*: N. Sumatra (Gajo Lands; Tapanuli; Sidikalang; Toba-Batak area) and Philippines (N. Luzon: Benguet Prov.). Fig. 2.

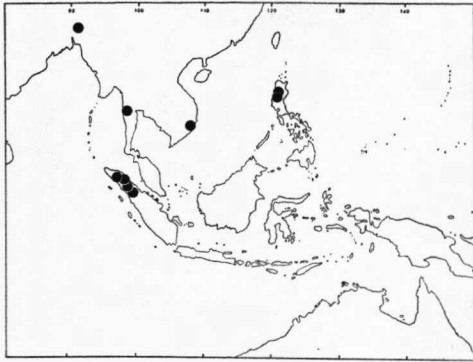


Fig. 2. Distribution of *Haloragis philippinensis* MERR. (except the Thailand locality)

Ecology. Mountain heathland and blangs, plateaus and ridges, sedge turf, *Sphagnum* bogs, and open pine forest, 1200–3400 m. *Fl. fr.* Dec.–May.

Notes. In addition to the morphological characters *H. philippinensis* has another ecology than *H. chinensis*; it is a true mountain species, although in the highest localities of *H. chinensis* the two species are found almost together (Toba-Batak Lands, Benguet).

In his original description MERRILL mentioned three syntypes of which I have examined MERRILL 4357 and 4444 (both in US, the latter also in L). Only the first fits the description and I have chosen this as lectotype; the second is wrongly identified and belongs to *H. chinensis*.

Until 1931 the Khasya specimens have always been confused with *H. scabra* by British botanists, and have been cited under *H. tetragyna* var. *micrantha* by those whose contention it was to merge these two species.

2. *Haloragis chinensis* (LOUR.) MERR. Trans. Am. Phil. Soc. n.s. 24, 2 (1935) 290, 39; TUYAMA, J. Jap. Bot. 16 (1940) 284, f. 5b, 6, incl. var. *yapensis* ex descr.; MERR. Sunyatsenia 5 (1940) 150; MERR. & PERRY, J. Agr. Arb. 23 (1942) 407; *ibid.* 29 (1948) 161; SINCLAIR, Gard. Bull. Sing. 15 (1956) 24; TARDIEU-BLOT, Fl. Laos, Camb. & Vietn. 4

(1965) 120; KENG, Mal. Nat. J. 23 (1970) 123, t. 13. — *Gaura chinensis* LOUR. Fl. Coch. (1790) 225; ed. Willd. 1 (1793) 276. — *Goniocarpus scaber* KÖN. & SIMS, Ann. Bot. 1 (1805) 547, t. 12 f. 6. — *H. scabra* BTH. Fl. Hongk. (1861) 139, excl. *specim. khasyan.*; SCHINDL. Pfl. R. Heft 23 (1905) 28, f. 9A, incl. var. *elongata*; MERR. Philip. J. Sc. 1 (1906) Suppl. 216; BRITTEN, J. Bot. 45 (1907) 135; VALET. Bull. Dép. Agr. Ind. Néerl. n. 10 (1907) 41, incl. var. *novaguineensis* VALET.; MERR. J. Str. Br. R. As. Soc. n. 76 (1917) 102; GUILLAUMIN, Fl. Gén. I.–C. 2 (1920) 715, f. 74–14; MERR. En. Born. (1921) 455; En. Philip. 3 (1923) 221; WENT f. Nova Guinea 14 (1924) 108; KANEH. En. Micr. (1935) 383; H. J. LAM, Blumea 5 (1945) 581. — *H. tetragyna* [non (LABILL.) HOOK. f.] BTH. Fl. Austr. 2 (1864) 484, incl. var. *micrantha*, *quoad specim. asiat. et mal., khasyan. except.*; CLARKE, Fl. Br. Ind. 2 (1878) 430; FORB. & HEMSL. J. Linn. Soc. Bot. 23 (1887) 292.

Erect or suberect, obviously perennial, mostly branched herb, 10–60 cm; stems appressed-hairy, mostly distinctly 4-angular with straw-coloured edges. *Leaves* decussate, ovate to narrow lanceolate, 2–26 by 1–9 mm, hairy, especially the underside of the midrib, margin on either side with 3–10 teeth; petiole 0– $1\frac{1}{2}$ mm. *Racemes* mostly more or less strongly branched, 2–22 by 1–7 cm. Bracts ovate to elliptic, $\frac{1}{2}$ – $1\frac{1}{2}$ by $\frac{1}{4}$ – $\frac{1}{2}$ mm, pubescent, sometimes with 1 tooth on either side. Bracteoles 0.2–0.7 mm long, widened at base. Pedicel 0.2–0.6 mm, glabrous. *Flowers* erecto-patent to patent. *Sepals* 0.5–0.9 by 0.4–0.6 mm, glabrous, often incurved. *Petals* 1– $1\frac{3}{4}$ mm, hairy on the midrib outside, mostly red to brick red, sometimes green. *Stamens* 8; filaments 0.1–0.4 mm; anthers c. 1 mm long. *Styles* incurved, 0.1–0.3 mm. *Fruit* erecto-patent to patent, globular to broadly ellipsoid, 0.7–1 by 0.8–1 mm, not thickened below the sepals, the ribs often \pm tuberculate, sometimes with 1(–3) low intercostal tubercles, glabrous or with incurved and appressed hairs, surface granular and punctate.

Distr. Indo-China (Cochinchina, Tonkin, sec. GUILLAUMIN and TARDIEU-BLOT), S. China (also Kwangtung, Macao, Hongkong, Hainan), through

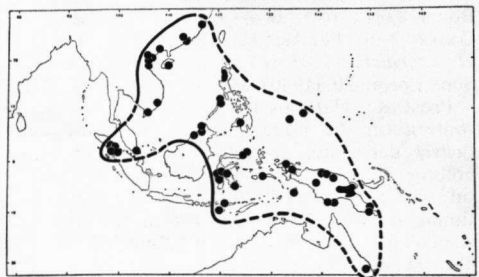


Fig. 3. Distribution of *Haloragis chinensis* (LOUR.) MERR.

Malesia to Micronesia (Carolines: Jap) and Queensland (Kelsey Creek near Proserpine; Atherton Mts, introduced in Hawaii (DEGENER 30591); in *Malesia*: N. Sumatra (Toba-Batak area), Singapore, N. Borneo (Jesselton, Labuan), Celebes, Philippines (Luzon, Calamian Is., Busuanga, Mindanao), Moluccas (Ceram, Aru Is.), Lesser Sunda Islands (Sumba, Flores), New Guinea (also Ferguson I.). Fig. 3.

Ecol. In open spots, between grass, inalang wastes, on poor laterites, river banks, poor sandy dry places, and deforested slopes, from sea-level up to 2200 m. *Fl. fr.* Jan.-Dec.

Note. Allied to *H. philippinensis* but easily distinguishable. More closely allied to *H. tetragyna* HOOK. f. and by BENTHAM (1864) even united with it as *var. micrantha* BTH. l.c.

3. *Haloragis micrantha* (THUNB.) R. BR. [in Flinders, Voy. (1814) App. 550] ex SIEB. & ZUCC. Abh. Bay. Ak. Wiss. M.-Ph. Cl. 4^a (1844) 133; repr. Fl. Jap. Fam. Nat. (1845) 25; HOOK. f. Fl. Tasm. 1 (1860) 121; BTH. Fl. Austr. 2 (1862) 482; HOOK. f. Handb. Fl. New Zeal. (1867) 66; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 100; CLARKE, Fl. Br. Ind. 2 (1878) 430; STAPP, Trans. Linn. Soc. Bot. II, 4 (1894) 149; KING, J. As. Soc. Beng. 66, ii (1897) 310; BAILEY, Queensl. Fl. 2 (1900) 555; SCHINDL. Pfl. R. Heft 23 (1905) 29; GIBBS, J. Linn. Soc. Bot. 42 (1914) 74; ARFAK (1917) 159; GUILLAUMIN, Fl. Gén. I.-C. 2 (1920) 715; MERR. En. Born. (1921) 455; RIDL. Fl. Mal. Pen. 1 (1922) 692; MERR. En. Philip. 3 (1923) 221; WENT f. Nova Guinea 14 (1924) 107; STEEN. Trop. Natuur 21 (1932) 101-102, f. 1-2; ELMER, Leaflet. Philip. Bot. 9 (1933) 3143; STEEN. Bull. Jard. Bot. Btzg. III, 13 (1934) 218; BACK. Bekn. Fl. Java (em. ed.) 4A (1942) fam. 76, p. 2; STEEN. Endeavour 21 (1962) 187, f. 3 (map); LARSEN, Dansk Bot. Ark. 23 (1963) 68; BACK. & BAKH. f. Fl. Java 1 (1963) 266; TARDIEU-BLOT, Fl. Laos, Camb. & Vietn. 4 (1965) 122; CASPERS, Pac. Pl. Areas 2 (1966) 60, map 31; LARSEN, Dansk Bot. Ark. 23 (1966) 395, f. 60; KENG, Mal. Nat. J. 23 (1970) 123; MEIJDEN, Fl. Thail. 2 (1970) 3. — *Gonocarpus micranthus* THUNB. Nov. Gen. Pl. 3 (1783) 55; Fl. Jap. (1784) 69, t. 15; WILLD. Sp. Pl. 1 (1797) 690; KÖN. & SIMS, Ann. Bot. 1 (1805) 546, t. 12 f. 5; DC. Prod. 3 (1828) 66. — *H. tenella* BRONGN. in Duperrey, Voy. Coquille Bot. (1828) t. 68 f. B. — *Goniocarpus rubricaulis* GRIFF. Not. Pl. As. 4 (1854) 688, ex descr. — *H. paucidentata* HOSOKAWA, Trans. Nat. Hist. Soc. Form. 30 (1940) 335. — Fig. 1.

Prostrate, glabrous herb, 5-30 cm long; stems rooting on the nodes, ascending at the apex. *Leaves* decussate, obovate, orbicular, ovate, or oblong, 3-10 by 1½-4 mm, the margin on either side with 1-7 teeth; petiole 0-2 mm. *Racemes* erect, simple or little branched, 1-8 cm long. Bracts lanceolate, acute, ½-1½ by 0.2 mm. Bracteoles filiform or acuminate, 0.1-0.3 mm, with widened base. Pedicels ¼-¾ mm. *Flowers* scattered, erect then nodding. *Sepals* ovate-triangular, 0.3-0.6 mm, subsaccate-thickened and shallowly

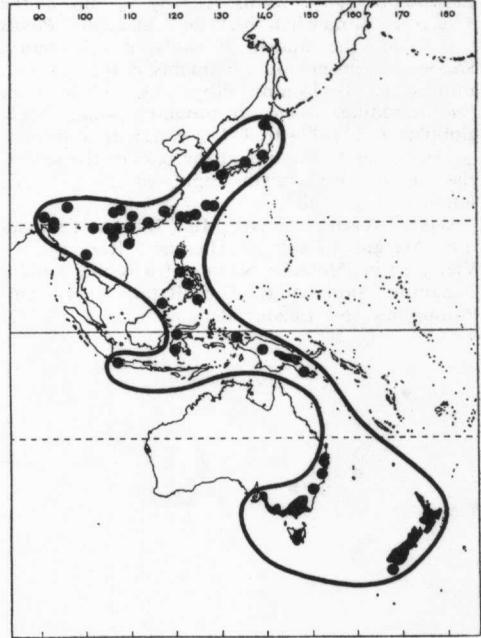


Fig. 4. Distribution of *Haloragis micrantha* (THUNB.) S. & Z.

cordate at the base, often acuminate. *Petals* c. 0.9-1.3 mm, red or rosa. *Stamens* 8; filaments up to 0.6 mm; anthers 0.3-0.7 mm. *Styles* incurved, 0.2-0.3 mm. *Fruit* obovoid-globose to depressed-globose, c. 0.9-1.1 by 0.7-0.9 mm, smooth.

Distr. S. & E. Asia (E. India, N. Thailand, S. & E. China, N. Vietnam, Hainan, Taiwan, Ryukyu Is., Korea, Japan), Australia (New South Wales, Victoria), Tasmania, New Zealand; in *Malesia*: W. Java (Mt Papandajan), N. Borneo (Mt Kinabalu), Celebes, Philippines (Luzon, Mindoro, Negros, Mindanao), New Guinea. Fig. 4.

KING recorded a doubtful collection by SCORTECHINI in Perak (Malaya) of which only a field note was in the Calcutta Herbarium; it has never been found since in Malaya.

Ecol. In marshy mountain turf, moist places along mountain brooks, on wet ridges, summits and plateaus, (1000-1600-3600 m. *Fl. fr.* Jan.-Dec.

Note. The closest allied species is *H. depressa* (A. CUNN.) WALP. from Tasmania. THUNBERG's original description obviously contains some errors (sepals absent, stamens 4).

4. *Haloragis acanthocarpa* BRONGN. in Duperrey, Voy. Coquille Bot. (1828) t. 70; BTH. Fl. Austr. 2 (1864) 483; BAILEY, Queensl. Fl. 2 (1900) 555; SCHINDL. Pfl. R. Heft 23 (1905) 35; EWART & DAVIES, Fl. N. Terr. (1917) 214; MERR. & PERRY, J. Arn. Arb. 23 (1942) 407; SPECHT, Rec. Arnhem Land Exp. 3 (1958) 273. — *H. leptotheca* F. v. M.

Fragm. 3 (1862) 32. — *H. palauensis* TUYAMA, J. Jap. Bot. 16 (1940) 283, f. 3–5a.

Perennial, sometimes woody at the base; stems decumbent or erect, 40–75 cm long, hairy. *Leaves* decussate, ovate, elliptic to lanceolate, on either side with 5–12 teeth, those of the main stem $1\frac{1}{2}$ – $4\frac{1}{2}$ by $\frac{1}{2}$ –2 cm, (often bulbous-based-) hairy; petiole 1 – $2\frac{1}{2}$ (–4) mm. *Panicle* 10–20 by 5–10 cm, hairy. Bracts ovate-lanceolate, $\frac{3}{4}$ – $1\frac{1}{4}$ by $\frac{1}{4}$ mm. Bracteoles ovate-acuminate, 0.2–0.3 mm. Pedicels c. $\frac{1}{2}$ mm, glabrous. *Flowers* scattered, erect, then nodding. *Sepals* c. 0.6–0.8 by 0.5 mm, glabrous, coriaceous in fruit. *Petals* c. $1\frac{1}{4}$ – $1\frac{1}{2}$ mm, red to brown-red, the midrib dorsally pubescent. *Stamens* 8; filaments $\frac{1}{4}$ – $\frac{1}{2}$ mm; anthers c. 1 mm. Styles curved inward, c. 0.1–0.2 mm. *Fruit* ellipsoid-globose, c. 1–2 by 0.8–1.2 mm, glabrous or appressedly hairy at apex, the 8 longitudinal ribs more or less alternating with 8 rows of 3–4 blunt spiny tubercles.

Distr. Northern part of Australia, Micronesia (Carolines: Palau Is.), and *Malesia*: New Guinea and Misool I. Fig. 5.

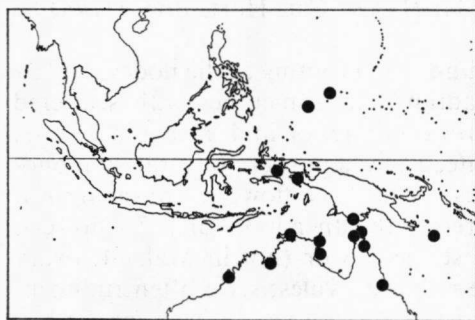


Fig. 5. Distribution of *Haloragis acanthocarpa* BRONGN.

Ecol. In steppe-like country and badly drained savannah forest, also in *Melaleuca* swamps and *Eucalyptus* woodland, surrounding termite mounds, 0–300 m. *Fl. fr.* April–Jan.

5. *Haloragis halconensis* MERR. Philip. J. Sc. 2 (1907) Bot. 288; En. Philip. 3 (1923) 221. — *H. secunda* RIDL. Trans. Linn. Soc. II, Bot. 9 (1916) 41. — *H. suffruticosa* GIBBS, Arfak (1917) 159; WENT f. Nova Guinea 14 (1924) 108–109, incl. var. *ramosa* WENT f. et var. *galioides* WENT f. — *H. gjellerupii* WENT f. l.c. 107. — *H. nemorosa* WENT f. l.c. 107, t. XI B; MERR. & PERRY, J. AGN. Arb. 23 (1942) 408. — *H. fruticosa* WENT f. Nova Guinea 14 (1924) 106, t. XI A. — *H. sanguinea* MERR. & PERRY, J. Arn. Arb. 29 (1948) 162. — *H. microphyllum* HOOGL. Blumea Suppl. 4 (1958) 228.

Erect, branched or unbranched, perennial half-shrubs or shrubs, with often thick, angular stems, up to $1\frac{1}{2}$ m high. *Leaves* decussate, or in whorls of 3–4, often crowded, patent, erect or reflexed,

ovate to oblong or sublanolate, on either side with 2–13 teeth, hairy on both sides, hairs of the upper surface bulbous-based, rarely glabrous, chartaceous to coriaceous, those of the main stem(s) $\frac{1}{2}$ – $3\frac{1}{2}$ by $\frac{1}{2}$ – $1\frac{1}{4}$ cm, of the branches 0.2–1.5 by 0.1–1 cm; petioles 0–2 mm. *Inflorescence* a wide to contracted panicle of which the lower branches are axillary in the upper leaf-axils. Bracts ovate to elliptic, often oblong, $1\frac{1}{2}$ –4 by $\frac{1}{2}$ – $1\frac{1}{2}$ mm. Bracteoles $\frac{1}{2}$ –1 mm long, with widened base. Pedicels $\frac{1}{2}$ – $1\frac{1}{2}$ mm, hairy. *Flowers* erect, then nodding, often secund. *Sepals* triangular-acuminate, $\frac{3}{4}$ – $1\frac{1}{2}$ by $\frac{1}{2}$ –1 mm, glabrous (or slightly hairy on the median dorsal side, sometimes only in a few occasional flowers). *Petals* 2– $3\frac{1}{2}$ mm long, red, red-brown, or sometimes white or yellow, the midrib dorsally hairy. *Stamens* 8; filaments $\frac{1}{4}$ – $\frac{3}{4}$ mm; anthers 1– $2\frac{1}{4}$ mm. Stigmas sessile, globose. *Fruit* obovoid, globose, more rarely ovoid, $1\frac{1}{4}$ – $1\frac{3}{4}$ by $\frac{3}{4}$ –1 mm, 8-ribbed, from which 4 more distinct, appressed-to patently hairy, at least on the ribs.

Distr. *Malesia*: Philippines (Luzon; Mindoro: Mt Halcon; Negros: Mt Canlaon; Mindanao: Mt Apo), E. Celebes (G. Lumut), New Guinea, and Solomons (Bougainville; New Georgia Is.: Kolombangara; Guadalcanal). Fig. 6.

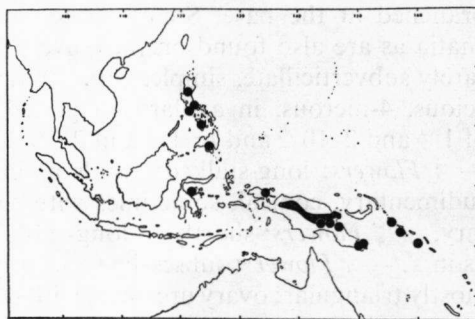


Fig. 6. Distribution of *Haloragis halconensis* MERR.

Ecol. On both dry and marshy or wet places, in peaty marshes, edges of swamps, along streams, both on sand and clayey subsoils, mostly on open heaths and cliffs in exposed situations, but also in forest and cloud-forest, 900–3800 m. *Fl. fr.* Jan.–Oct.

Notes. This species reminds in habit of *H. erecta* (MURR.) SCHINDL. and *H. exalata* F. v. M. of Australia and New Zealand, both of which have developed styles; the first has, moreover, glabrous and 4-winged nuts.

H. halconensis shows an astonishing variability, reflected in the large number of synonyms cited. These 'species' were originally described from distant places and based on one or a few specimens from one locality or mountain. With the increase of collections it appears that the characters on which they have been based are grading.

The variability is partly due to the very diverse

habitats; specimens found in shaded localities have a more rank habit with wider inflorescences, larger leaves and longer internodes than those of exposed habitats. The latter show a condensed habit and are frequently unbranched. Besides, the altitude causes dwarfing of leaves and habit with increasing height.

Apart from this, the variability must be partly ascribed to the fact that in all mountain plants there is a certain trend to local raiation of a wide-spread population, but on the other hand in several localities (Mt Arfak, Mt Gautier) branched and unbranched specimens occur in one locality in which the unbranched specimens occur in open places, the branched ones in less open habitat, on edges of forests and in the forest.

The variability of the species is vegetative and quantitative (degree of branching, leaf-size, hairyness, etc.). I cannot find qualitative differences in flowers or fruit.

From the description of *H. stokesii* F. BROWN, from Rapa I., it would appear that it has sessile stigmas which would point to affinity with *H. halconensis*, but it is described with only 2 stigmas and 4 stamens.

Excluded

Haloragis distichia JACK; cf. Fl. Mal. I, 5 (1958) 479 = *Anisophyllea disticha* (JACK) BAILL. (*Rhizophoraceae*).

2. LAUREMBERGIA

BERG. Descr. Pl. Cap. (Aug. 1767) 350, t. 5 f. 10; KAN. in Mart. Fl. Bras. 13, 2 (1882) 377, t. 68; SCHINDL. Pfl. R. Heft 23 (1905) 61; A. RAYNAL, *Webbia* 19 (1965) 683. — *Serpicula* LINNÉ, Mant. 1 (Oct. 1767) 16; MIQ. Fl. Ind. Bat. 1, 1 (1855) 631. — *Epilithes* BL. Bijdr. (1826) 734; HASSK. Cat. Hort. Bog. (1844) 86 (*Epilithos*). — Fig. 8.

Small perennial herbs, prostrate to ascending, often rooting at the nodes, mainly branched at the base. Stems terete to quadrangular, sometimes with scattered enatia as are also found on the leaves. *Leaves* opposite, or in 4, rarely in 2 rows, rarely subverticillate, simple, entire to dentate. *Flowers* polygamous, rarely monocious, 4-merous, in axillary congested clusters of 1–11 flowers, consisting out of 1 ♂ and 2–10 ♀ and/or 1 ♀ and 2–10 ♀, rarely with either 1–3 ♂ or 1–7 ♀ flowers. — ♂ *Flowers*: long-stalked; sepals as in ♀; stamens 8 or (not in Mal.) 4; ovary rudimentary, conical, sometimes with some reduced ovules; style often rudimentary. — *Flowers*: shortly to long-stalked; petals and anthers as in ♂, for the rest as in ♀. — ♀ *Flowers*: subsessile to shortly stalked; sepals connate at the very base, mostly triangular; ovary urceolate with (4–)8 ribs, imperfectly 4-celled when young, later 1-celled with a central columella. *Fruit* nut-like, pericarp hard, enlarging to fruit-size long before the seed is set.

Distr. Four spp., 1 in S. Africa, 1 in S. Madagascar and Réunion, 1 in Africa, Madagascar and eastern South America, and 1 in S. India, Ceylon, Sumatra and Java. Fig. 7.

Ecol. The Malesian species is a characteristic mountain plant, generally of poor soils.

Taxon. The genus has been subdivided into 3 subgenera by RAYNAL. I refrain from any subdivision as the differential characters used for this purpose occur also in *Myriophyllum* and also in *Haloragis* in which they have not been attributed such high classificatory value. I certainly agree with RAYNAL in a rigid reduction of species proposed by SCHINDLER.

The Indo-Malesian species differs from the others in possessing 8 stamens, and in the central flower being very long-pedicelled and normally ♂.

1. *Laurembergia coccinea* (BL.) KAN. in Mart. Fl. Bras. 13, 2 (1882) 377, t. 68; SCHINDL. Pfl. R. Heft 23 (1905) 68; BACK. Schoolfl. Java (1911) 477; KOORD. Exk. Fl. Java 2 (1912) 705; Fl. Tjibodas 2 (1923) 217; F. BLEY, Diss. Zürich (1925) (embryol.) 1–32, f. 1–20, t. 1–2; STEEN. Arch. Hydrobiol. Suppl. 10 (1932) 315; DOCT. v. LEEUWEN, Verh. K. Ak. Wet. A'dam sect. 2, 31 (1933) 192, f. 37–39, t. 9; STEEN. Trop. Natuur 21

(1932) 102, f. 2, 163; Bull. Jard. Bot. Btzg III, 13 (1934) 218; BACK. & BAKH. f. Fl. Java 1 (1963) 266. — *Epilithes coccinea* BL. Bijdr. (1826) 734. — *Serpicula brevipes* W. & A. Prod. (1834) 338; FYSON, Fl. Nilg. Puln. Hilltops 3 (1920) 45, t. 330. — *Serpicula hirsuta* W. & A. Prod. (1834) 338; WIGHT, Ic. 3 (1845) t. 1001; MIQ. Fl. Ind. Bat. Suppl. (1861) 328, 128, *pro var. incisa* MIQ.; TRIM. Fl. Ceyl. 2 (1894) 148; FYSON, Fl. Nilg.

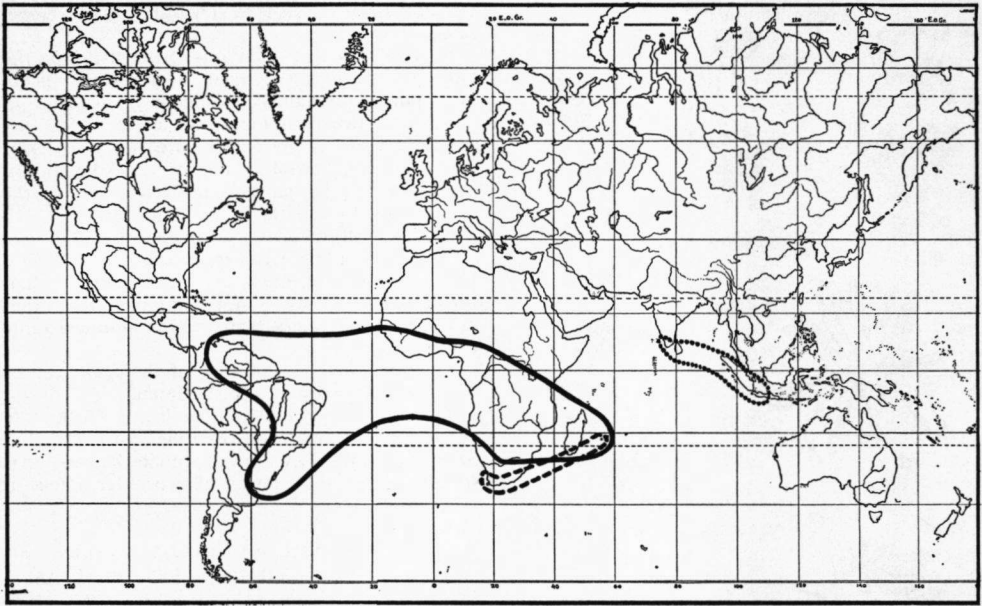


Fig. 7. Distribution of the genus *Laurembergia*; subg. *Serpiculastrum* A. RAYNAL (even line), subg. *Laurembergia* (broken line), subg. *Indolaurembergia* SCHINDL. (stippled line) (after RAYNAL, 1965, slightly corrected).

Puln. Hilltops 3 (1920) 45; Fl. S. Ind. Hill Stat. 1 (1932) 213. — *Haloragis oligantha* ARN. Nov. Act. Caes. Leop.-Car. (1836) 18, non W. & A. 1834. — *Serpicula epilithes* BL. Mus. Bot. Lugd.-Bat. 1 (1849) 110, nom. illeg.; MIQ. Fl. Ind. Bat. 1, 1 (1855) 632. — *Serpicula veronicaefolia* (non BORY) MIQ. Fl. Ind. Bat. 1, 1 (1855) 632. — *Serpicula javanica* MIQ. *ibid.* 1, 1 (1858) 1090; BACK. Schoolfl. Java (1911) 478. — *Serpicula indica* THW. En. Pl. Zeyl. (1859) 123, nom. illeg.; CLARKE, Fl. Br. Ind. 2 (1878) 431; FISCHER, Rec. Bot. Surv. India 9 (1921) 78. — *Serpicula zeylanica* ARN. ex CLARKE, Fl. Br. Ind. 2 (1878) 431, incl. var. *minor* THW. ex CLARKE; TRIM. Fl. Ceyl. 2 (1894) 147. — *L. brevipes* (W. & A.) SCHINDL. Pfl. R. Heft 23 (1905) 67. — *L. glaberrima* SCHINDL. l.c. 67. — *L. grandifolia* SCHINDL. l.c. 66. — *L. hirsuta* (W. & A.) SCHINDL. l.c. 64, incl. var. *angustifolia* SCHINDL., var. *rotundifolia* SCHINDL., var. *typica* SCHINDL., l.c. 65, = var. *hirsuta* p.p.; STEEN. Arch. Hydrobiol. Suppl. 10 (1932) 315, f. 5; Bull. Jard. Bot. Btzg III, 13 (1934) 218. — *L. indica* (THW.) SCHINDL. Pfl. R. Heft 23 (1905) 64, nom. illeg. — *L. javanica* (MIQ.) SCHINDL. l.c. 69, f. 20; BACK. Schoolfl. Java (1911) 478; KOORD. Exk. Fl. Java 2 (1912) 705, f. 89; F. BLEY, Diss. Zürich (1925); HOCHR. Candollea 6 (1936) 467. — *L. wangerinii* SCHINDL. Pfl. R. Heft 23 (1905) 65. — *L. zeylanica* (ARN. ex CLARKE) SCHINDL. l.c. 68, incl. var. *minor* (THW. ex CLARKE) SCHINDL. — *L. agastyamalayana* HENRY, J. Bomb. Nat. Hist. Soc. 62 (1965) 603, fig. — Fig. 8.

var. *coccinea*. — All synonyms, excl. those of var. *zeylanica*.

Internodes 3–6(–10) mm, in sterile branches up to 15 mm, glabrous to pilose in two rows or all round. Stems c. 4–40 cm long, 1–2 mm ø. Lower leaves always opposite, upper ones mostly irregularly alternate, subsessile, or rarely up to 2 mm long petioled; lamina elliptic to obovate-oblong, 5–8 by 2–3½ mm (in sterile branches up to 18 by 12 mm), acute at both ends, almost entire or with some coarse, obtuse to mucronate, often apically thickened teeth especially towards the apex, rather stiff, glabrous to pilose below on the midrib and along the margin. Clusters with 1 ♂ or sometimes ♀ flower, and 2–10 ♀ ones. — ♂ *Flowers*: pedicel 6–12(–20) mm long after anthesis, glabrous to thinly pilose, erecto-patent; sepals narrowly triangular to ovate, 0.4–0.8 by 0.3–0.6 mm, glabrous or with a tuft of short hairs at the apex; petals c. 2½ by 0.8 mm, outside wine-red; stamens 8; anthers c. 1½ by ½ mm; styles 4(–6), rudimentary. — ♀ *Flowers*: pedicel ½(–1) mm; sepals as in ♂. *Fruit* glabrous to densely pilose, with 8 whether or not strongly prominent ribs, episepalous ribs most distinct upwards, alternisepalous ones most distinct below the middle; between the costae often with thickenings which are confluent or consist of 2–4 distinct tubercles; styles 4(–6). *Seed* globular, c. 0.8–1 by 0.7–0.8 mm, brownish.

Distr. S. India (Nilgiris, Pulneys), Ceylon (Adam's Peak, Hakgalla, Pendrotallagalla) and Malesia: N. & Central W. Sumatra, and W. to

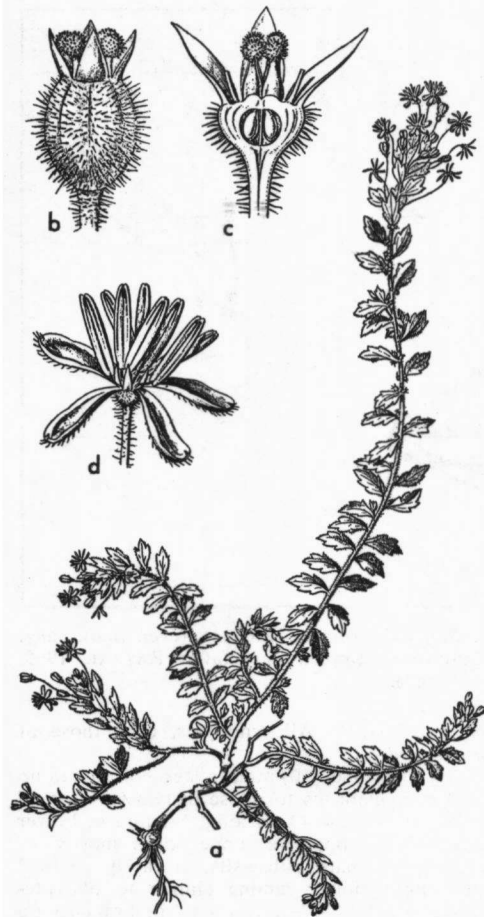


Fig. 8. *Laurembergia coccinea* (BL.) KAN. a. Plant, $\times \frac{1}{2}$, b-d. flowers: b. ♀ flower, c. bisexual flower, anthers removed, lengthwise section, d. ♂ flower, all enlarged (after KANITZ, Fl. Bras. 13, 2; the hairy form).

Central Java (Gedeh to Diëng). Fig. 7 (subg. *Indolaurembergia*).

KANITZ recorded *L. coccinea* from Brazil on the basis of a SCHOTT specimen; I have seen this (in W). This is certainly erroneously localized as SCHINDLER already noted on the label.

Ecol. Moist sunny places, often on stony poor soil, also along brooks, swamps and lake shores, often periodically partly inundated, only in the mountains, 1400-3100 m. Fl. Jan.-Dec.

Notes. All Javanese specimens are glabrous, all Sumatran and Ceylon specimens are hairy, but the S. Indian specimens are either hairy or glabrous. The hairiness is not combined with other differential characters, hence no taxonomical value can be attached to it.

The variation in sculpture of the fruit can be found occasionally in one specimen.

The name *Serpicula epilithes* BL. is illegitimate because it is based on *Epilithes coccinea* BL.; *Serpicula indica* THW. is illegitimate because it is superfluous by the citation of two older names in synonymy.

var. *zeylanica* (ARN. ex CLARKE) MEYDEN, var. nov. — *Serpicula zeylanica* ARN. ex CLARKE, Fl. Br. Ind. 2 (1878) 431, excl. var. *minor* THW. ex CLARKE. — *Haloragis oligantha* ARN. 1836, non W. & A. 1834. — *Serpicula indica* THW. p.p., nom. illeg. — *L. zeylanica* (ARN. ex CLARKE) SCHINDL., excl. var. *minor* (THW. ex CLARKE) SCHINDL. — *L. agastyamalayana* HENRY.

Leaves numerous, largely in 4 rows, linear-lanceolate, with mostly only 1 pair of teeth, or even none, 8-10(-25) by 1-1½(-6) mm. Clusters as in the type variety, or the upper ones consisting only of 1-3 ♂ and the lower ones only ♀.

Distr. Ceylon (Adam's Peak) and S. India (Agastyamalay Hills).

Note. In habit a clear variety, even recorded from Adam's Peak, but obviously replacing.

Excluded

Serpicula verticillata L. f. Suppl. (1781) 416 = *Hydrilla verticillata* (L. f.) ROYLE (*Hydrocharitaceae*).

3. MYRIOPHYLLUM

LINNÉ, Gen. Pl. ed. 5 (1754) 429; Sp. Pl. ed. 1 (1753) 992; DC. Prod. 3 (1828) 68; BTH. Fl. Austr. 2 (1864) 486; SCHINDL. Pfl. R. Heft 23 (1905) 77; MEIJDEN, Blumea 17 (1969) 306. — Fig. 9, 12, 14-16.

Aquatic or terrestrial, glabrous herbs, perennial or (not in Mal.) sometimes annual. Stems mostly branched, erect or decumbent-ascending, often freely floating in aquatic forms, sometimes creeping in terrestrial forms, often with minute outgrowths ('myriophyllin-glands') leaving brown circular scars in the older parts. Leaves often very constantly flanked by 1(-3) 'stipular' outgrowths, which are filiform to subulate, mostly short, becoming dark, caducous; nearly always dimorphous in aquatic forms; immersed ones nearly always whorled,

nearly always pinnately divided into long, filiform or ligulate lobes, very rarely scale-like reduced or absent; aerial leaves mostly whorled in the lower part of the stem, upwards often alternate, sometimes opposite, mostly wider than the immersed leaves and more or less entire, not rarely bract-like. *Spikes* aerial, mostly terminal, sometimes forming an apical tuft of sterile leaves after fruit setting which may or may not perpetuate growth in the next season, or pushed aside by an axillary shoot by which a sympodial structure is emerging, almost always solitary, rarely 1–4 additional axillary in the upper leaf axils. *Flowers* mostly sessile, 1 or more in the axil of a bract or leaf, each with 2 sometimes very inconspicuous bracteoles; ♀, often polygamous with the upper ♂ and the lower ♀, or plant monoecious, rarely dioecious. — ♀ *Flowers*: 4(–2)-merous. Sepals 4 or 0, mostly very small, erect. Petals 4 or 2, whether or not caducous, in the ♀ flowers strongly reduced and covered by the styles or 0. *Stamens* 8 or 4 epipetalous, or 1, in the ♀ flowers 0; anthers often mucronate, rather large. *Ovary* more or less urceolate, nearly always (mostly alternisepalous) 4-sulcate, 4–2-celled, in ♂ flowers reduced or 0; styles 4 or 2. *Fruit* mostly ± urceolate, breaking up into 4 or 2 one-seeded mericarps; pericarp often ± tuberculate, rather thin, the 4 mericarps very hard by the thick endocarp which has a soft tissue in an upper axial spot.

Distr. Almost ubiquitous, except in most of the Arctic and rare in Africa, c. 40 *spp.* with a distinct centre in Australia; in *Malesia* 8 or 9 native *spp.* from which two endemic.

The distribution of most SE. Asiatic and Australian species is insufficiently known, as such inconspicuous aquatics are still 'under-collected'.

Ecol. Nearly all species are growing in aquatic or at least in swamp or damp habitats, locally gregarious, but dry periods are mostly tolerated. Terrestrial forms occur in most species; these are often more abundantly flowering and bear more ripe fruits than the aquatic forms.

Dispersal for most aquatic species may be vegetative, either by detached parts of stems or in temperate species by winterbuds. Endozoic dispersal of fruits by ducks and other birds is recorded from *M. verticillatum* L. and *M. spicatum* L. of which the fruits float for a short time. The hard and rather thick endocarp may stand passage of the guts.

Taxon. In the vegetative parts and habit the species are very variable: plants with immersed leaves easily produce aerial leaves when the water recedes, *vice versa*. Sizes of leaves and bracts respectively show great variation, especially towards the inflorescence. In general it is impossible to identify sterile specimens. Varieties or even species distinguished merely by vegetative or quantitative characters deserve no systematic recognition.

SCHINDLER's subdivision of the genus into 3 subgenera is unsatisfactory; this is in part caused by the fact that he did not examine material of a number of critical species, and in part by the fact that he used unreliable characters, paying amongst others too much attention to the number of stamens. Within *Myriophyllum* ('*Eumyriophyllum*') he distinguished for example 2 sections, viz *Pentapteris* DC. *em.* O.K. and *Tessaronia* SCHINDL., differing in the number of stamens, viz 8 and 4 respectively. However, in *M. spicatum* of § *Pentapteris* their number varies from 8 to 2. *M. indicum* with 8 and *M. tetrandrum* with 4 stamens, are certainly very closely allied, but are placed in two different sections, the first in § *Pentapteris* and the second in § *Tessaronia*. In *M. dicocum* of *subg. Dicarium* the number of stamens varies from 4 to 8.

An inadmissible procedure has been to subordinate *Pelonastes* HOOK. *f.* as a subsection to *subg. Myriophyllum* in an emended sense, although none of HOOKER's original species is attributed to it; these are arranged by SCHINDLER in the new *subg. Brachythecha* SCHINDL.

In my opinion it serves no good use to distinguish subgenera or even sections in the genus.

Notes. The sculpture of the fruits becomes only clearly visible in dried material.

Largely because of the supposed incompleteness of the knowledge on the distribution of the species, I have included 5 extra-Malesian species in the key, which in this way covers all species from Malesia, SE. Asia, Madagascar, and Africa.

For literature on the extra-Malesian species, their distribution and ecology, I refer to my precursory paper in *Blumea* 17 (1969) 304–311.

Pre-identification of some species with simple opposite leaves and ♂ flowers (notably *M. pygmaeum* and *M. pedunculatum*) is rather difficult, but they can easily be assigned to the genus by the presence of dark, subulate pseudostipules and dark-tipped leaves.

KEY TO THE SPECIES

1. All leaves alternate to opposite, entire or dentate, or the lower ones pinnate.
2. ♂ Flower with 2 petals and 1 stamen. Bracteoles minute or 0.
3. ♂ Flower stalked. Fruit with 4 mericarps. North Vietnam. Fig. 15d-f. . . . *M. bonii* TARDIEU-BLOT
3. ♂ Flower sessile. Fruit with 2 mericarps.
4. Fruit with rows of distinct spines at the base.
5. Spines present over the entire dorsal length of the mericarps. Madagascar. Fig. 15g.
M. mezlani SCHINDL.
5. Spines absent in the central part of the mericarps. 11. *M. coronatum*
4. Fruit with rows of tubercles at the base. 10. *M. siamense*
2. ♂ Flower with 4 petals and 4 or 8 stamens. Bracteoles small but conspicuous, at least those of the ♂ flowers.
6. Leaves 2–15 mm long, always opposite. Stamens 8.
7. Flowers (1–)2(–3) on each branchlet, strictly monoecious, on each branchlet of one sex. Stems upwardly very much sympodially branched, with very short internodes 0.3–1 mm long. Leaves caducous. Sepals in ♂ flowers 0. 1. *M. pygmaeum*
7. More flowers on each branchlet, the upper ♂, the lower ♀, or plant dioecious. Stems with much longer internodes, monopodially branched. Leaves not caducous. Sepals in ♂ flower very conspicuous. 2. *M. pendunculatum*
6. Leaves 10–30 mm long, mostly alternate. Stamens 4.
8. Flowers (1–)3–5 together, distinctly stalked. Fruit c. 1¼ by 1 mm, with dorsally rounded mericarps. S. India. Fig. 14q-t. *M. oliganthum* (W. & A.) F.v.M.
8. Flowers solitary, sessile or nearly so. Fruit c. 2½ by 2 mm, in transverse section ± quadrangular with sharp ribs and slightly concave sides. 8. *M. tuberculatum*
1. At least the lower leaves in whorls, nearly always pinnate.
9. Leaf-base ± dilated, those of a whorl, at least in sterile branches, enclosing the stem at the nodes in the upper parts. Bracteoles subulate, sometimes with 1 or 2 lateral laciniae. . . . 4. *M. brasiliense*
9. Stem always visible on the nodes between the leaf-bases. Bracteoles either not subulate, or with more laciniae.
10. Bracteoles digitate or pinnate.
11. Fruit cruciform in section, finely tubercled, rarely smooth.
12. Stamens 8. Anther linear, 1½–1¾ mm. Petals 1½–2 mm. Ceylon, S. India. Fig. 14d-g.
M. indicum WILLD.
12. Stamens 4. Anthers oblong, 0.6–0.8 mm. Petals c. 1(–1½) mm long. 7. *M. tetrandrum*
11. Fruit in transverse section quadrangular with rounded edges, smooth. 6. *M. verticillatum*
10. Bracteoles simple, not dissected: ovate, rhomboid, or lanceolate.
13. Fruit with 2(–4) mericarps, smooth or indistinctly lengthwise lineolate, stalked.
9. *M. dicoccum*
13. Fruit with 4 mericarps of which sometimes 1–2 are visible but reduced and unfertile, not lineolate.
14. Flowers (1–)2–6 together in the leaf-axil; the middle flower ♀, shortly but distinctly stalked.
15. Flowers (1–)3–5(–6) together in the leaf-axil. Fruit rounded, shallowly 4-sulcate, tuberculate. Anthers c. 1 mm long. S. India. Fig. 14q-t. *M. oliganthum* (W. & A.) F.v.M.
15. Flowers 1–3 together. Fruit ± cruciform, dorsally narrowly winged, smooth or punctate. Anthers c. 2 mm long. Madagascar. Fig. 16. *M. axilliflorum* BAKER
14. Flowers always solitary, either all sessile, or the ♂ flowers stalked.
16. ♂ Flower distinctly stalked. Stamens inserted on a 0.1–0.2 mm high androphore. Mericarps apically spreading by the cushion-like thickened style-bases. 3. *M. propinquum*
16. All flowers sessile. Androphore 0. Mericarps not spreading at apex.
17. Mericarps dorsally rounded. Sepals in ♂ flowers distinct, c. ½ by ½ mm. Stamens 8. Petals caducous. 5. *M. spicatum*
17. Mericarps dorsally acute. Sepals indistinct. Stamens 4. Petals strongly recurved after anthesis, persistent until fruit is set. 8. *M. tuberculatum*

1. *Myriophyllum pygmaeum* MATTF. Bot. Jahrb. 69 (1938) 275; MEUDEN, Blumea 17 (1969) 311. — Fig. 9a-b.

Terrestrial or semi-aquatic, growing in dense cushions. Stems very short, very much branched, creeping or decumbent with erect branches or erect, after anthesis sympodially branched, with very short internodes, 0.3–1 mm. *Leaves* opposite, linear to subulate, entire, with a dark thickening on apex above, erecto-patent, ± fleshy, 2–6 by 0.3–½ mm. *Flowers* solitary in the leaf-axils of very

short (5–10 mm long), strictly unisexual branches which are later sympodially overtopped, each bearing only (1–)2(–3) developed flowers and often besides 2–4 deficient higher flowerbuds. — ♂ *Flowers*: stalked, stalk ¼–½ by c. ½ mm, erect. Bracteoles oblong, obtuse, finely mucronate, 1 by 0.3 mm. Sepals 0. Petals with wide base and rounded, nearly flat, finely serrate apex, 1–1½ mm long, rose to red. Stamens 8, filaments up to 1 mm; anthers elliptic, mucronate, 1–1½ by 0.4–½ mm. Rudiment of ovary 0. — ♀ *Flowers*:

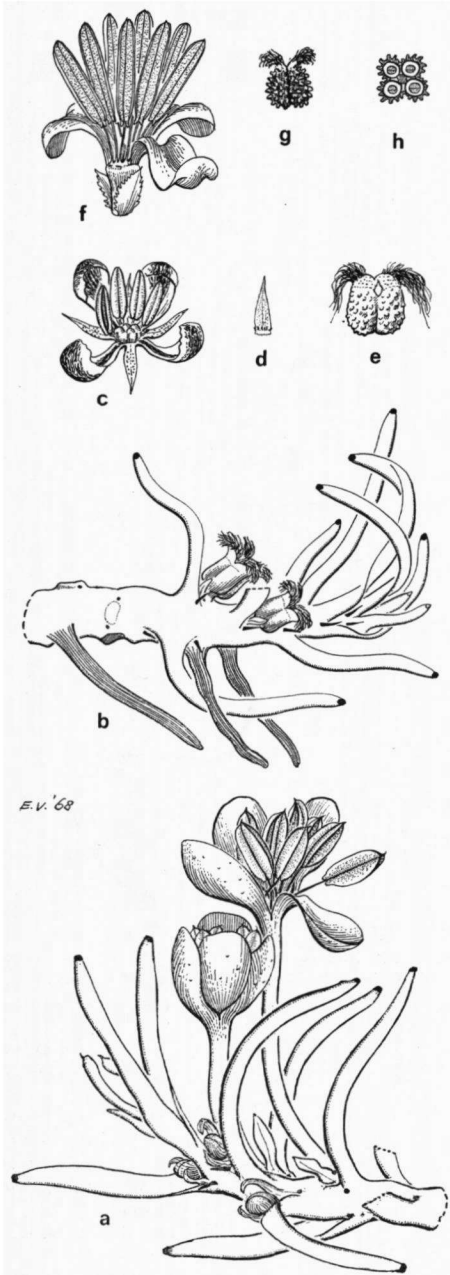


Fig. 9. *Myriophyllum pygmaeum* MATTF. a. Branch with ♂ flowers, b. branch with ♀ flowers. — *M. pedunculatum* HOOK. f. c. ♂ Flower with bracteoles, e. fruit. — *M. propinquum* CUNN. f. ♂ Flower with bracteoles, g. fruit, h. fruit, transverse section (a-b HOOGLAND 9972, c-e ROBBINS 381, f-h N. MARCHANT s.n.). All ×5.

up to 0.2 mm stalked. Bracteoles very small, narrowly triangular, 0.2–0.4 by 0.2 mm. Sepals 0. Petals 0. Styles 0.2 by 0.3 mm. *Fruit* truncate above, shallowly 4-lobed, punctulate, c. 1 by 1 mm.

Distr. *Malesia*: E. New Guinea (Morobe Distr.: Mts Sarawaket and Albert Edward). Fig. 10.

Ecol. In and along very shallow, boggy, partly dried up pools in alpine grassland, growing in dense cushions, c. 3500–3700 m.

2. *Myriophyllum pedunculatum* HOOK. f. in Hook. Lond. J. Bot. 6 (1847) 474; Fl. Tasm. 1 (1860) 122, t. 23; BTH. Fl. Austr. 2 (1864) 489; HOOK. f. Handb. New Zeal. Fl. 1 (1864) 67; SCHINDL. Pfl. R. Heft 23 (1905) 85; CHEESEMAN, Man. New Zeal. Fl. ed. 2 (1925) 625; CURTIS, Stud. Fl. Tasm. 1 (1956) 190; ALLAN, Fl. New Zeal. 1 (1961) 252; MELDEN, Blumea 14 (1966) 245; *ibid.* 17 (1969) 310. — *M. longibracteolatum* SCHINDL. Pfl. R. Heft 23 (1905) 84. — Fig. 9c-e.

Terrestrial or semi-aquatic, whether or not growing in dense cushions. Stem unbranched to much branched, decumbent or erect, after anthesis monopodially accrescent. *Leaves* opposite, erectopatent to reflexed, entire, rarely pinnate, the entire ones linear, (2)–4–15(–25) by 0.4–1 mm, obtuse to mucronate, above at apex with an ovate, darker coloured cushion-like thickening c. 0.2 mm long. *Flowers* solitary in the middle and upper leaf-axils, the lower often bearing the fruits of the last season; the upper 2–4(–8) flowers ♂, the next lower 4–8(–12) flowers ♀; not rarely dioecious. Bracteoles lanceolate-oblong to linear-lanceolate, rarely ± elliptic, acute or acuminate, entire or serrate, 0.6–1.5 by 0.2–0.3(–0.6) mm. — ♂ *Flowers*: up to ½ mm stalked. Sepals lanceolate, acute, serrate, c. 1 by 0.4 mm, ± erect, with tiny whitish tubercles. Petals very concave in the apical part, the borders nearly flat, and finely serrate, the apex mucronate and often recurved, in anthesis erect and 1–1½ mm long, after anthesis elongating, up to 2 mm long, recurvate, persistent. Stamens 8; anthers oblong, c. 1–1½ mm. Ovary rudimentary, c. 0.3 by 0.3 mm. — ♀ *Flowers*: up to 0.2 mm stalked. Sepals lanceolate-oblong, acute, 0.3–0.8 by 0.2 mm. Petals strongly reduced, covered by the styles, shorter than 0.1 mm. Styles with thick, fleshy bases, stigmas after anthesis strongly ligulately recurved, very long papillose. *Fruit* c. 1.2 by 1.2 mm, with apically spreading mericarps, these terete, with distinct tubercles.

Distr. New Zealand (also Chatham and Stewart Is.), Tasmania, Australia (Victorian Alps, New South Wales, also recorded from W. Australia); in *Malesia*: New Guinea (E. Papua: Western Highlands, Morobe Distr.). Fig. 13.

Ecol. In New Guinea in the upper montane and alpine zone, from 2300–3500 m, in the Australian region often descending to the lowland. In swamps, shallow pools, alpine bogs, and inundated river banks.

Notes. In all but one collection I have seen, the leaves are entire, but in one collection from

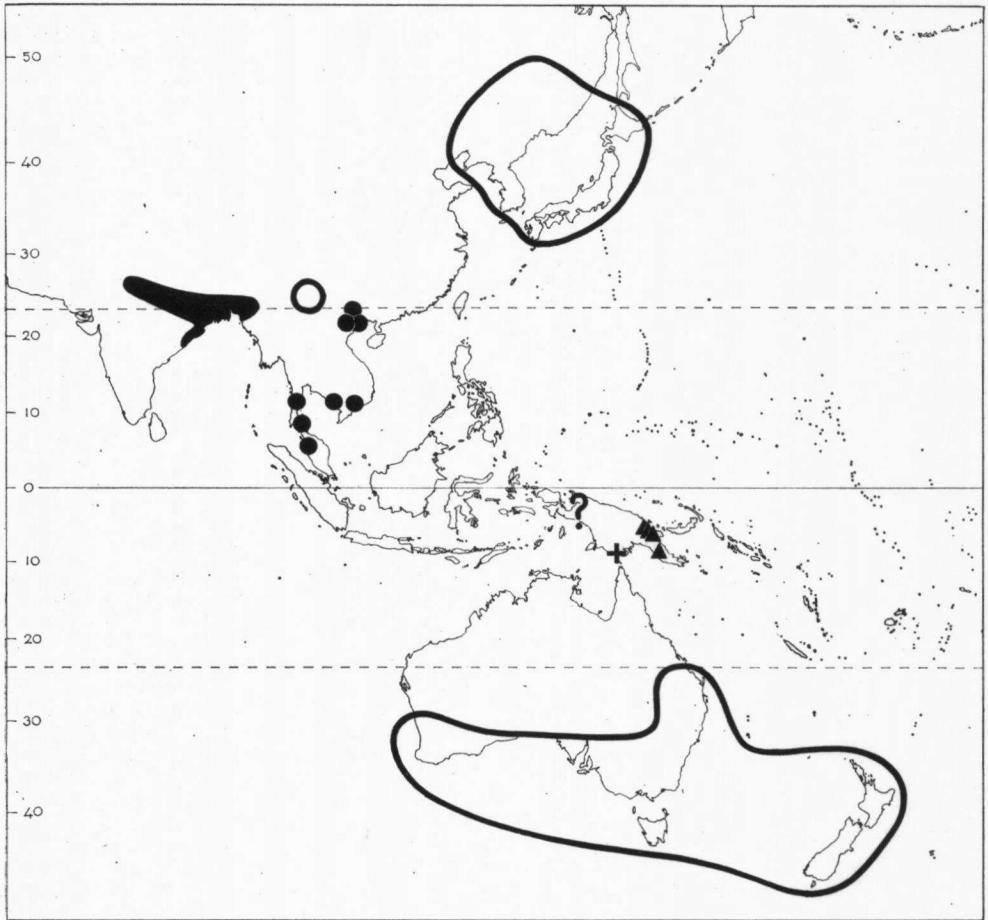


Fig. 10. Distribution of *Myriophyllum propinquum* CUNN. (full line & question mark), *M. tetrandrum* ROXB. (black area and dots), *M. pygmaeum* MATTF. (triangles), and *M. coronatum* MEIJDEN (+).

Victoria (A. C. BEAUGLEHOLE 5887) the medium and lower leaves are pinnate with few filiform lobes. This observation clearly shows the great plasticity of the leaves in this genus.

M. longibracteolatum SCHINDL. differs only in quantitative characters.

M. votschii SCHINDL. from New Zealand is closely allied and might also belong to *M. pedunculatum*.

3. *Myriophyllum propinquum* CUNN. Ann. Nat. Hist. I, 3 (1839) 30; SCHINDL. Pfl. R. Heft 23 (1905) 89, incl. var. *tenuifolium* SCHINDL. l.c. 90; CHEESEMAN, Man. New Zeal. Fl. ed. 2 (1925) 624; EWART, Fl. Vict. (1930) 886, t. 309 excl. c; BLACK, Fl. S. Austr. ed. 2, 3 (1952) 645; CURTIS, Stud. Fl. Tasm. 1 (1956) 190; ALLAN, Fl. New Zeal. 1 (1961) 253; MEIJDEN, Blumea 17 (1969) 310. — *M. variaefolium* Hook. f. in Hook. Ic.

Pl. 3 (1840) t. 289; BTH. Fl. Austr. 2 (1864) 487. — *M. verticillatum* L. β *ussuriense* REGEL, Tent. Fl. Ussur. (1861) 60. — *M. ussuriense* (REGEL) MAXIM. Diagn. Pl. 15 (1873) 183; SCHINDL. Pfl. R. Heft 23 (1905) 86; OHWI, Fl. Jap. (1965) 661. — *M. intermedium* (non DC.) CLARKE, Fl. Br. Ind. 2 (1878) 433, pro syn. *M. variaefolium*; KIRK, Stud. Fl. New Zeal. (1899) 150; CHEESEMAN, Man. New Zeal. Fl. ed. 1 (1906) 151. — Fig. 9f-h.

Aquatic or semiterrestrial. Stem branched or not, erect, ascending or freely floating. Immersed leaves mostly present, rarely absent, in whorls of (4-)5-6(-8), 1-2½ by ¾-1½ cm in outline, with c. 5-10 pairs of 3-25 mm long and c. 0.2 mm wide filiform lobes. Lowermost aerial leaves in whorls of (2-)4-5(-6), pinnate or (less often) entire, the pinnate ones as the immersed leaves, the entire ones linear to linear-lanceolate, flat,

somewhat fleshy, 5–10 by $\frac{1}{2}$ –1 mm, mostly patent. Upper aerial leaves entire, dentate or pinnate, patent to upwards erect, below mostly punctate, the entire ones 10–20 by 0.7–1.5 mm, the pinnate ones 15–20 by 2–7 mm in outline, with 2–7 pairs of erecto-patently incurved, up to 3 mm long lobes. *Flowers* solitary in the upper leaf-axils, the upper ♂, the lower ♀, often ♀ in between, or dioecious. — ♂ *Flowers*: stalk up- and downwards broadened, 0.6–1 by 0.3–0.5 mm. Bracteoles ovate, acuminate, serrate, c. 1 by 1 mm. Sepals lanceolate, acute, finely serrate, c. 1 by $\frac{1}{4}$ mm, soon caducous. Petals soon caducous after anthesis. Stamens 8, inserted on a 0.1–0.2 mm high, a little narrowed androphore; filaments at first mobile, later rather stiff, \pm erect, not caducous; anthers oblong, obtuse, (1–)1.2–2.5 by 0.3–0.4 mm. Rudiment of ovary 0. — ♀ *Flowers*: sessile. Bracteoles \pm ovate to oblong, concave, mostly appressed, entire or finely serrate, obtuse, \pm mucronate, 0.3–0.5 by 0.15–0.3 mm, finally caducous. Sepals 0. Petals 0. Styles spreading at the base, c. 0.2 by 0.1–0.3 mm. Stigmas after anthesis strongly recurved, very long papillose, 0.1–0.4 mm. *Fruit* 0.6–1.2 by $\frac{1}{2}$ –1 mm, the mericarps terete, apically spreading by the cushion-like thickened style-bases, with long tubercles at least at the base, punctate.

Distr. New Zealand, Tasmania, Australia (S. Australia, Victoria, New South Wales, Queensland, W. Australia) and E. Asia: NE. China (Heilong Jang, Whusuli Jiang; Manchuria), Korea, Taiwan, Japan, S. China (S. Yunnan). Fig. 10.

Notes. Extremely variable in the Australian region, especially in vegetative parts. *M. pro-pinquum* and *M. ussuriense* differ only in minor vegetative characters.

The area is strongly disjunct. One sterile collection from West New Guinea (Wissel Lakes, EYMA 4733, at c. 1600 m) might belong to this species or to *M. verticillatum*.

4. *Myriophyllum brasiliense* CAMBESS. in A. St. Hil. Fl. Bras. Mer. 13, 2 (1829) 182; SCHINDL. Pfl. R. Heft 23 (1905) 88; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 391; *ibid.* ed. 3 (1927) 1207; STEEN. Arch. Hydrobiol. Suppl. 10 (1932) 315; CURTIS, Stud. Fl. Tasm. 1 (1956) 190; MASON, Fl. Marshes Calif. (1957) 615, f. 280; BACK. & BAKH. f. Fl. Java 1 (1963) 266; ALSTON, Muelleria 1 (1967) 171; MEIJDEN, Blumea 17 (1969) 171. — *M. proserpinacoides* GILL. ex HOOK. & ARN. Bot. Misc. (1833) 313. — Fig. 14a-c.

Aquatic or semiterrestrial. Stem branched mostly at the base only, perpetuating growth after anthesis. Lower immersed leaves pinnate, segments thread-like. Upper immersed leaves and aerial leaves alternately in whorls of 5 (rarely 4), flanked by 2–3 c. 1 mm long, mostly recurved enatia, hydrophobic and often \pm glaucous. Leaf-base \pm dilated, c. 0.6–1 mm wide, of a whorl at least in the upper sterile shoots enclosing the stem at the nodes, blade oblong in outline, c. 2–4 by $\frac{1}{2}$ –1 cm, rather stiffly patent to erecto-

patent, with 8–18 pairs of subulate, mucronate lobes, 2–8 by c. 0.2 mm. Mostly monoecious or \pm dioecious, sometimes in the middle with ♀ flowers. *Flowers* solitary in the middle and upper leaf-axils. — ♂ *Folwers* (not seen in Mal.): pedicel up to 4 by 0.4 mm, up- and downwards broadened. Bracteoles subulate, 2–3 mm long, \pm flat, often with 1 or 2 lateral laciniae. Sepals narrowly triangular, acute, serrate towards the apex, c. $1\frac{1}{2}$ –2 by $\frac{1}{2}$ mm, at first erect, finally recurved. Petals 4, caducous before anthesis, c. 4 mm long. Stamens 8; anthers linear-lanceolate, c. 4 by 1 mm. Ovary reduced, up to 0.3 mm long, — ♀ *Flowers*: pedicel up to 1 by 0.4 mm, cylindrical, erect. Bracteoles subulate with dilated base, sometimes with 1 lacinia, 1– $1\frac{1}{2}$ mm long. Sepals narrowly triangular, acute, entire or scarcely serrate, 1– $1\frac{1}{2}$ by 0.2–0.3 mm, at first erect, finally recurved. Petals very strongly reduced, subulate, adnate to the torus, up to $\frac{1}{2}$ mm long. Styles 0.2–0.3 mm. *Fruit* (*sec.* SCHINDLER) ovoid, 4-sulcate, c. 1.8 by 1.2 mm, shortly pedicelled, papillose.

Distr. Native in South America (E. Brazil, Uruguay, Argentina, Chile), often cultivated elsewhere in ponds or aquaria; naturalized in Japan ("Yamamoko in Settsu"), in Australia (New South Wales, Victoria, Queensland; New Zealand: North I.), in SW. and SE. North America (casually to New York), and in *Malesia*: locally abundant in W. Java.

Ecol. In Java in ditches, ponds and rice-fields, 400–1500 m, freely floating to creeping-ascending.

Uses. In Java cultivated in fish-ponds; tips are eaten as a vegetable. Easily propagated vegetatively.

Vern. *Paris*, S; *diamond-milfoil*, *parrot-feather*, E.

Note. All naturalized specimens are sterile or have only ♀ flowers and do not produce fruit. Also in South America fruits rarely occur. The only description of the ripe fruit was given by SCHINDLER. An illustration of an apparently ripe fruit is found in GLEASON, New Britt. & Brown III. Fl. 2 (1952) 601.

5. *Myriophyllum spicatum* LINNÉ, Sp. Pl. (1753) 992; MAXIM. Diagn. Pl. 15 (1873) 183, *incl. var. muricatum*; CLARKE, Fl. Br. Ind. 2 (1878) 433; SCHINDL. Pfl. R. Heft 23 (1905) 90; KOORD. Exk. Fl. Java 2 (1912) 708, *excl. syn. M. pusillum* BL.; GUILLAUMIN, Fl. Gén. I.-C. 2 (1920) 717; MERR. En. Philip. 3 (1923) 221; RIDL. Disp. (1930) 546; STEEN. Arch. Hydrobiol. Suppl. 10 (1932) 316; ALLAN, Handb. Fl. New Zeal. (1940) 285; PATTEN, Rhodora 56 (1954) 213; LÖVE, Rhodora 63 (1961) 139; WILD, Harmf. Pl. (1961) 42, t. 14d; SUBRAMANYAM, Aq. Ang. (1962) 17; TARDIEU-BLOT, Fl. Laos, Camb. & Vietn. 4 (1965) 125; OHWI, Fl. Japan (1965) 660; RAYNAL, Fl. Cameroun 5 (1966) 132, fig.; MEIJDEN, Blumea 17 (1969) 309. — *M. exalbescens* FERN. Rhodora 21 (1919) 120. — Fig. 12a-c.

Aquatic. Stem much branched. Immersed leaves in whorls of 4–5, $1\frac{1}{2}$ – $2\frac{1}{2}$ by c. 2 cm in outline, with 7–11 pairs of filiform, obtuse seg-

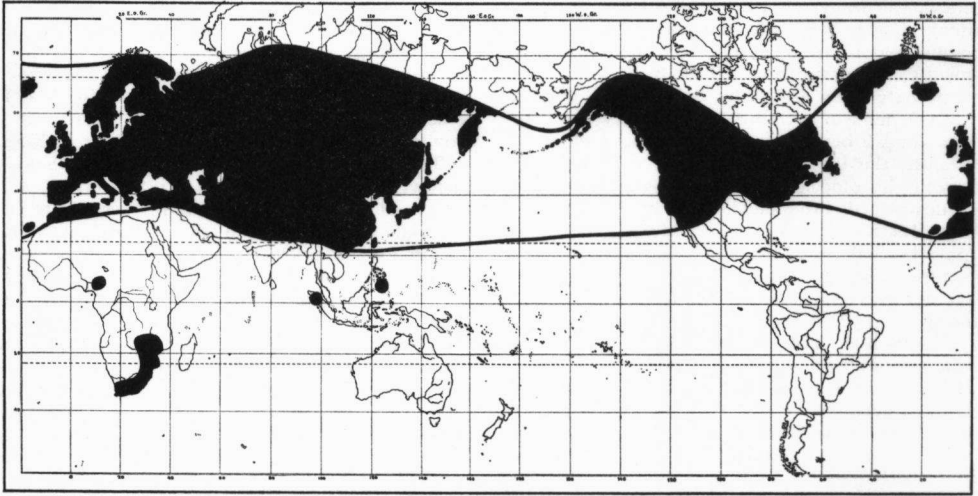


Fig. 11. Distribution of *Myriophyllum spicatum* L. (after PATTEN, 1954, emended).

ments 6–12 mm long. Aerial leaves mostly suddenly much smaller, the lowermost ones always in whorls of 4, mostly pinnate, as the immersed ones. Middle and upper leaves entire, rarely pinnate, obtuse, mostly ovate to obovate, somewhat convex, sometimes spatulate or linear, and flat, 2–10 by 1–2 mm, patent, recurved in fruit. *Flowers* solitary in the middle and upper leaf-axils, the upper ones ♂, the lower ♀, in between often ♀, sessile. Bracteoles broadly ovate, obtuse, erect, with a brown, ± serrate membranous margin, c. 1.2 by 1 mm. — ♂ *Flowers*: sepals ovate to triangular, with a brown membranous mucronate apex, c. $\frac{1}{2}$ by 0.3 mm, erect. Petals at the base ± auriculate, caducous in anthesis, c. 2½ mm long, wine-red. Stamens 8(–2); anthers linear-lanceolate, c. 2 by 0.4 mm. Ovary reduced, up to 0.3 mm. — ♀ *Flowers*: below the middle of the spike with sepals and petals as in ♂, with 8 stamens, above the middle of the spike as the ♂, but often poorly setting fruit. — ♀ *Flowers*: sepals strongly reduced, semiorbicular, with a brown mucronate apex, c. 0.2 by 0.3 mm, erect. Petals reduced, ovate, acute, $\frac{1}{2}$ by 0.3 mm, patent, covered by the stigmas, soon caducous. Styles c. $\frac{1}{2}$ by 0.3 mm. *Fruit* 1½–3 by 1½–3 mm, terete, very deeply and alternisepally 4-sulcate or deeply 4-cleft; mericarps 4, often only 2 fully developed, dorsally rounded, with a distinct, often verrucose marginal ridge, at the back smooth or verrucose, rarely wholly smooth.

Distr. Almost ubiquitous on the northern hemisphere, rare in Africa and in the tropics; in *Malesia*: N. Sumatra (Toba Lake) and Philippines (Mindanao: Lake Lanao, CLEMENS 450, *n.v.*). Fig. 11.

A record from New Zealand rests according to Miss R. MASON on an erroneous identification (LUCY B. MOORE, *in litt.*).

Ecol. Shallow banks of lakes, 670 and 900 m. Terrestrial forms are rare and sterile (*cf.* HEGI, *Fl. Mitt.-Eur.* ed. 2, 5, 2, 1964, 902, f. 2273) and might have been found at Lake Toba (LÖRZING 7718).

Galls are recorded from the Toba Lake by RUTTNER *c.s.* (see ZELLER, *Ber. Deut. Bot. Ges.* 55, 1937, 473–475, f. 1–2). The stems are malformed and have few reduced and short leaves.

Fruit-setting is often poor although ♂ and ♀ flowers are present in the Toba collections.

Notes. Very variable species. Reductions are not rare in the inflorescence, with the upper part

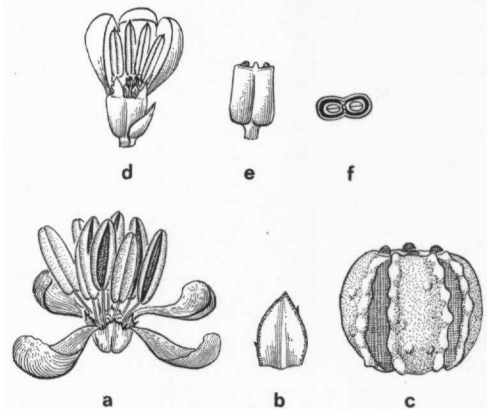


Fig. 12. *Myriophyllum spicatum* L. a. ♂ Flower, b. bracteole, c. fruit. — *M. dicoccum* F. v. M. d. Bisexual flower with bracteole, e. fruit, f. fruit, cross-section (a HOOKER *f.* & THOMSON *s.n.*, b–c *Fl. Turcom.* AS. 1926, d–f BRASS 28669). All × 5.

strongly elongating, the lower part compact.

M. exalbescens FERN. is, apart from the stems which become whitish in drying, in no way otherwise qualitatively different from the European and Asiatic specimens of *M. spicatum* L. Specimens with 'exalbescens' characters (PATTEN, 1954; LÖVE, 1961) are found scattered all over the range of the species, not only in America.

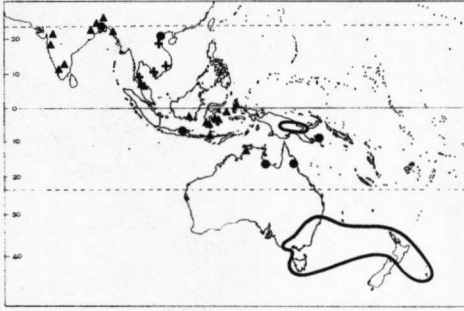


Fig. 13. Distribution of *Myriophyllum pedunculatum* HOOK. f. (full line), *M. tuberculatum* ROXB. (triangles), *M. dicoccum* F. v. M. (dots), and *M. siamense* (CRAIB) TARDIEU-BLOT (+).

6. *Myriophyllum verticillatum* LINNÉ, Sp. Pl. (1753) 992; CLARKE, Fl. Br. Ind. 2 (1878) 87; MASON, Fl. Marshes Calif. (1957) 617, f. 283; OHWI, Fl. Japan (1965) 660; SINCLAIR, Gard. Bull. Sing. 22 (1967) 230; MEIJDEN, Blumea 17 (1969) 309. — *M. spicatum* (non L.) GAERTN. Fruct. (1788) 331, t. 68. — Fig. 14j-m.

Aquatic, sometimes semiterrestrial. Stems few-branched or not, often perpetuating growth after fruit-setting. Immersed leaves in whorls of 4-5(-6), 1-4 by 1-4 cm in outline, with c. 8-16 pairs of mostly opposite, filiform segments, 10-25 mm long. Aerial leaves gradually or sometimes rather suddenly smaller, all pinnate, the lower as the immersed leaves, the upper lanceolate to linear-lanceolate with 8-10 pairs of rather stiff, ± appressed lobes, 5-15 by 2½-4 mm, mostly recurved in fruit. Flowers solitary in the middle and upper leaf-axils, mostly ♀, the upper sometimes ♂, the lower ones often ♀, sessile or subsessile. Bracteoles ± circular in outline, digitate, rarely ± pinniform, c. 1 mm long. Sepals triangular, acute, serrate, c. 1 by 0.8 mm, erect, in ♀ up to 0.3 by 0.4 mm. Petals c. 3-4 mm long, rose, erectopate in anthesis, caducous after anthesis, strongly reduced in ♀ flowers and covered by the styles. Stamens 8; anthers linear-lanceolate, c. 2½ by ½ mm. Styles c. ½ by 0.3 mm. Fruit ovoid, in section ± quadrangular with dorsally rounded, smooth mericarps, c. 3 by 3 mm.

Distr. Europe (north to Lapland, not in Iceland and Greenland; including the African Mediterranean), Asia (temperate and boreal, east to Kamchatka and Japan, south to Afghanistan and Kashmir), North America (Canada, from

British Columbia to New Foundland, south to Maryland and California); in *Malesia*: possibly found in W. New Guinea (Wissel Lakes, 1600 m.)

Notes. The New Guinean collection (EYMA 4733) is sterile. Identification of vegetative plants is extremely difficult in this genus. I share the opinion of SINCLAIR, *l.c.*, that this collection may belong to *M. verticillatum*, although it is not impossible that it should turn out to belong to *M. propinquum*.

Flower characters in the description are taken from extra-Malesian material.

7. *Myriophyllum tetrandrum* ROXB. Fl. Ind. 1 (1820) 470; DC. Prod. 3 (1828) 69; ROXB. Fl. Ind. ed. Carey 1 (1832) 451; W. & A. Prod. (1834) 399; SCHINDL. Pfl. R. Heft 23 (1905) 96; GUILLAUMIN, Fl. Gén. I.-C. 2 (1920) 717; CRAIB, Fl. Siam. En. 1 (1931) 591; TARDIEU-BLOT, Fl. Laos, Camb. & Vietn. 4 (1965) 125; MEIJDEN, Blumea 17 (1969) 308; Fl. Thail. 2 (1970) 2. — *M. indicum* (non WILLD.) PRAIN, Beng. Pl. (1903) 474; Rec. Bot. Surv. India 3 (1908) 210; SUBRAMANYAM, Aq. Ang. (1962) 17; S. R. BENNETT, Tax. Stud. Fl. Howrah (Thesis) (1968) 651. — *M. indicum* ssp. *tetrandrum* (ROXB.) MEIJDEN, Ident. Lists 30 (1960) 426, *nomen et in sched.*; KENG, Mal. Nat. J. 23 (1970) 123. — Fig. 14h-i.

Aquatic or semiterrestrial. Stem branched, erect. Immersed leaves in whorls of (4-)5-6, 2-5 by 1½-4 cm in outline, with c. 12-24 pairs of c. 10-20 mm long, filiform, acute, brown-tipped segments. Lowermost aerial leaves mostly pinnate and rather stiffly spreading with short spreading lobes. Middle and upper aerial leaves mostly narrowly triangular in outline, 2-4 by ½-1 mm, with 6-12 pairs of erecto-patent, subulate, brown-tipped, very acute lobes, more rarely lanceolate to linear-lanceolate, 6-12 by 1-1½ mm long, with few, ± appressed subulate teeth, or almost entire, at first erecto-patent, in fruit recurved. Flowers solitary, ± sessile in the middle and upper leaf-axils, ♀, or the upper ♂. Bracteoles digitate or sometimes ± pinniform, 0.6-1 mm long, both with c. 5 subulate lobes. Sepals triangular, 0.1-0.3 by 0.1-0.3 mm, entire or finely serrate, acute, erect. Petals almost entire, c. 1(-1½) mm long, caducous after anthesis. Stamens 4; anthers ± oblong, 0.6-0.8 by 0.2-0.25 mm, obtuse. Fruit cruciform, c. 2 by 2 mm, mericarps ± ovate, with convex back and ± flattened sides, irregularly and finely tuberculate to smooth.

Distr. N. & E. India (Kashmir, Uttar Pradesh, Bihar, W. Bengal, Assam, Agartala, Manipur, Eastcoast from Ganjam southwards), S. Thailand (Bangtapan Noi: Ta Samet), North Vietnam; in *Malesia*: Malay Peninsula (Kangar; Perlis). Fig. 10.

Ecol. In rather shallow open water of ditches and canals.

Notes. The species was in the past seldom recognized by Indian botanists and mostly reduced to *M. indicum*, following CLARKE (in Fl. Br. Ind. 2, 1878, 433), sometimes to *M. tuberculatum*. Although they differ in the number of stamens,

I believe it to be much closer allied to *M. indicum* WILLD. than to *M. tuberculatum* ROXB., which has the same number of stamens. *M. tetrandrum* and *M. indicum* can only be distinguished in flowering material, the fruits and bracteoles showing no differences. As *M. indicum* and *M. tetrandrum* are replacing, *M. indicum* being confined to Ceylon and the South Deccan and *M. tetrandrum* to NE. India and Indo-China, I have originally assigned them subspecific rank, but as according to PRAGLowski (Grana 10, 1970, 234) their pollen shows distinct differences, I have concluded that they are closely allied but distinct species.

A record from Java (ZOLL. Syst. Verz. 2, 1854, 86, ZOLLINGER 883) belongs to *Limnophila* (Scrophulariaceae).

8. *Myriophyllum tuberculatum* ROXB. Fl. Ind. 1 (1820) 471; DC. Prod. 3 (1828) 69; ROXB. Fl. Ind. ed. Carey 1 (1832) 451; MIQ. Fl. Ind. Bat. 1, 1 (1855) 635; KURZ, J. As. Soc. Beng. 40, ii (1871) 52; CLARKE, Fl. Br. Ind. 2 (1878) 432; SCHINDL. Pfl. R. Heft 23 (1905) 96; SINCLAIR, Bull. Bot. Soc. Beng. 9, 2 (1955) 94; SUBRAMANYAM, Aq. Ang. (1962) 17; SINCLAIR, Gard. Bull. Sing. 22 (1967) 230; VASUDEVAN & KESAN NAIR, J. Bomb. Nat. Hist. Soc. 64 (1967) 391, f. 1-22; MEUDEN, Blumea 17 (1969) 308. — *M. tetrandrum* (non ROXB.) GRAH. Cat. Pl. Bomb. (1839) 76; STEEN. Webbia 8 (1952) 435. — *M. indicum* GRIFF. Not. 4 (1845) 687, non WILLD. 1805, nom. illeg. — *M. spathulatum* BLATT. & HALLBL. J. Ind. Bot. Soc. 2 (1921) 44, fig. (ex descr.); SUBRAMANYAM, Aq. Ang. (1962) 17, f. 11. — Fig. 14 n-p.

Aquatic or semi-aquatic. Stems mostly much branched. Immersed leaves in whorls of 4-5, 2½-4 by 1-1½ cm in outline, with 8-25 pairs of rather weak, ligulate, acute or shortly mucronate segments 10-20 mm long. Aerial leaves in the lower part as the immersed ones, upper ones finally alternate, with less and shorter lobes, uppermost almost entire, 5-20 by 1-3 mm, patent or recurved. Flowers solitary, sessile, in the middle and upper leaf-axils, mostly all ♀, rarely the upper flowers ♂, sometimes the lower ♀. Bracteoles ±

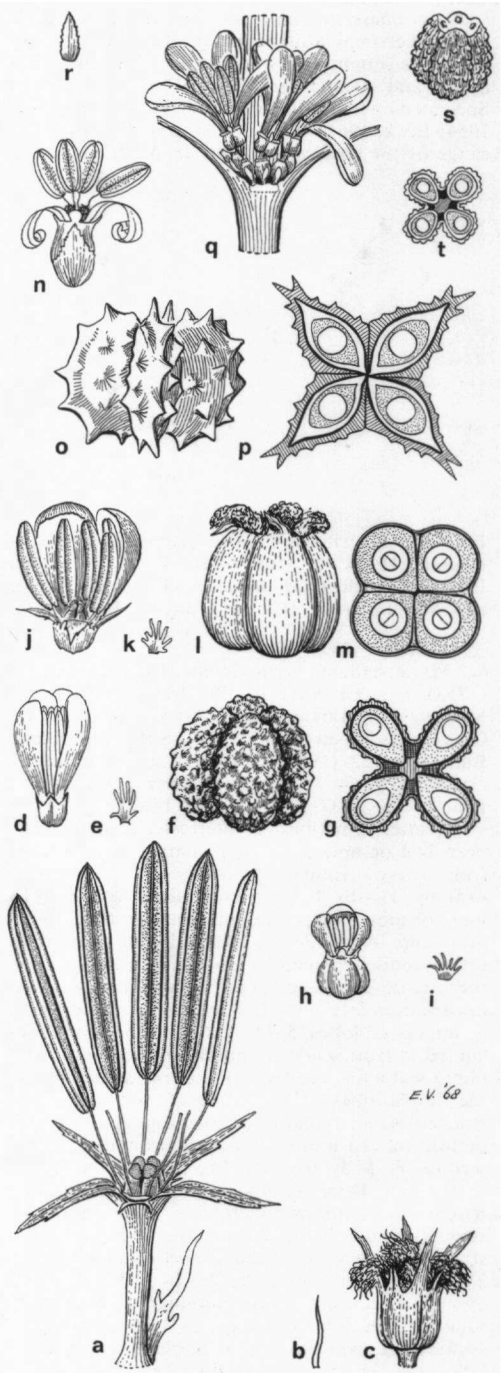


Fig. 14. *Myriophyllum brasiliense* CAMBESS. a. ♂ Flower with bracteole, b. bracteole of ♀ flower, c. ♀ flower. — *M. indicum* WILLD. d. Flower, e. bracteole, f. fruit, g. fruit, transverse section. — *M. tetrandrum* ROXB. h. ♀ Flower, i. bracteole. — *M. verticillatum* L. j. Young ♀ flower, k. bracteole, l. fruit, m. fruit, transverse section. — *M. tuberculatum* ROXB. n. Young ♀ flower with bracteole, o. fruit, p. fruit, transverse section. — *M. oliganthum* (W. & A.) F. v. M. q. Part of inflorescence with ♀ flowers and young fruits, r. bracteole, s. fruit, t. fruit, transverse section (a-c O. BUCHTIEN s.n., d-g THWAITES CP 1549, h-i J. THOMSON s.n., j-m HLB 903.364-343, n-p Herb. GRIFFITH 2441, q-t HOHENACKER 1563).

All ×5, except q which is ×2½.

Fig. 14

rhomboid, serrate, acute, c. 1.2 by 0.8 mm. Sepals very small, \pm orbicular, entire or finely serrate, erect, 0.1–0.25 by 0.1–0.25 mm. Petals in and after anthesis patent and finally recurved-circinnate, not soon caducous, c. $\frac{1}{2}$ – $1\frac{1}{2}$ mm long. Stamens 4; anthers elliptic-oblong, c. $\frac{1}{2}$ –1 by 0.2–0.3 mm. Styles 0.1–0.2 by 0.2 mm, scarcely recurved, with capitate stigmas. *Fruit* quadrangular, between the sharp and alternisepalous ribs slightly concave, indistinctly 4-sulcate, aculeate, finely foveolate, c. 2– $3\frac{1}{2}$ by 2– $3\frac{1}{2}$ mm.

Distr. India (Kerala: Alway; Mysore; Bombay; Khandala; Madhya Pradesh: Sagor; Orissa; W. Bengal; Assam; Khasya), E. Pakistan (Cox's Bazar), Australia (Northern Territory: Fog Dam Sanctuary); in *Malesia*: N. Malay Peninsula (Kedah, Perlis), SE. Borneo (Bandjermasin), SW. (Pangkajene) & SE. Celebes (Kendari), Moluccas (Halmahera; Sulu Is.: Mangoli), and Lesser Sunda Islands (W. Flores: Ruteng). Fig. 13.

Ecol. In shallow, stagnant water at low altitude.

Note. See for the differences with *M. indicum* and *M. tetrandrum* the key, the figures, and note under the preceding species.

9. *Myriophyllum dicoccum* F. v. M. Trans. Phil. Inst. Vict. 3 (1859) 41; BTH. Fl. Austr. 2 (1864) 489; F. v. M. Fragm. 8 (1874) 161; SCHINDL. Pfl. R. Heft 23 (1905) 104; BACK. & BAKH. f. Fl. Java 1 (1963) 266; MEIJDEN, Blumea 17 (1969) 307. — *M. humile* (non MORONG) SCHINDL. Pfl. R. Heft 23 (1905) 101, *pro coll. ind.*; GUILLAUMIN, Fl. Gén. I.–C. 2 (1920) 718. — *M. intermedium* (non DC.) TARDIEU-BLOT, Fl. Laos, Camb. & Vietn. 4 (1965) 126, for the cited BALANSA specimen only. — Fig. 12d-f.

Aquatic. Stem branched, freely floating. Immersed leaves in whorls of 4–5, $1\frac{1}{2}$ – $2\frac{1}{2}$ by c. 1 cm in outline, patent to recurved, with 4–7(–10) pairs of filiform, rather weak, brown-tipped, finely mucronate, 5–10 mm long segments. Lower aerial leaves verticillate or alternate, pinnate, the upper ones obovate-oblong to linear-lanceolate, above the middle with 2–4(–7) pairs of dark mucronate teeth, sometimes entire, patent, upward erecto-patent, 10–25 by 1–3 mm. *Flowers* solitary in the middle and upper leaf-axils, or together with 1 or more reduced, cleistogamous flower(s), δ , on a shortly cylindrical, up to $\frac{1}{2}$ mm long pedicel. Bracteoles \pm elliptic, with appressed, brown, serrate teeth, acute, with 1–3 nerves, $1\frac{1}{2}$ –2 by 0.4–0.8 mm. Sepals \pm ovate obtuse or acute, serrate, with a brown margin, erect, 0.2–0.5 by 0.2–0.5 mm. Petals patent to recurved in anthesis, finally caducous, c. 2 mm long. Stamens 4, rarely 8; anthers stiffly erect, linear lanceolate, c. $1\frac{1}{2}$ by 0.3 mm, with brown mucronate apex. *Ovary* 2-celled, with 1(–2) ovules in each cell, sometimes 3–4-celled with 1 ovule in each cell. Styles 2(–4), 0.2–0.4 by 0.2 mm. Stigma not or slightly recurved. *Fruit* c. $1\frac{1}{2}$ by 1 mm, with 2, sometimes 3 or 4 mericarps, smooth or indistinctly lengthwise lineolate, with a c. $\frac{1}{2}$ by

0.4 mm long, erect or patent stalk. *Cleistogamous flowers*: without perianth segments, ovary 2-celled, \pm circular, laterally flattened, with 2 ovules, fruit c. $\frac{1}{2}$ by $\frac{1}{2}$ mm, with 2 elliptic seeds; bracteoles ovate, c. $\frac{1}{2}$ by 0.4 mm; pedicel up to 4 mm in fruit.

Distr. Australia (Northern Territory: Robinson R.; Queensland: Mareeba R.), E. India (Calcutta Yeels, T. THOMSON), N. Vietnam (Haiphong, BALANSA 1428); in *Malesia*: NE. Java (Madura I.: Burnih Lake). Fig. 13.

Ecol. In lake, at 15 m.

Note. Two specimens from SE. Asia have erroneously been referred to the North American *M. humile* MORONG, which seems more closely allied to *M. dicoccum* than suggested by SCHINDLER, who places them in different subgenera. The description and figure of '*M. intermedium*' by TARDIEU-BLOT fits *M. oliganthum* (W. & A.) F. v. M., but the cited collection of BALANSA belongs to *M. dicoccum*.

10. *Myriophyllum siamense* (CRAIB) TARDIEU-BLOT, Adansonia 5 (1965) 37, f. 1–4; Fl. Laos, Camb. & Vietn. 4 (1965) 128, f. 1–4; MEIJDEN, Blumea 17 (1969) 307, f. 1e; Fl. Thail. 2 (1970) 2. — *M. mezianum* var. *siamense* CRAIB, Fl. Siam. En. 1 (1931) 591. — Fig. 15h.

Semi-terrestrial. Stem much branched, not more than 5 cm high, rooting at the nodes. *Leaves* alternate, rarely subopposite. Immersed leaves not known. Aerial leaves entire or rarely \pm pinnate with 1–2 filiform segments, 2–4 by 0.2–0.4 mm, with a dark cushion-like thickening above at apex. *Flowers* solitary in the upper leaf-axils, the upper δ , the lower δ . Bracteoles inconspicuous or absent. — δ *Flower* nearly sessile. Sepals 0. Petals 2, oblong to lanceolate, flat, entire, acute, erect before anthesis and up to 1 mm long, strongly recurved after anthesis. Stamen 1; filament up to $\frac{1}{2}$ mm; anther elliptic, 0.5–0.9 by 0.3–0.5 mm, mucronate. Rudiment of ovary 0. — δ *Flower* sessile. Sepals and petals 0. Styles shortly conical, distally set with long hairs. *Fruit* 0.5–0.9 mm long. Mericarps 2, oblong, with mostly 2 distinct dorsal crests of 5–7 tubercles over the entire length and some rows of lower tubercles laterally, with a rather indistinct crown of c. 7 short, \pm spiny tubercles.

Distr. Vietnam (Prov. Than Hoa; Prov. Lang Bian; Danhim; Prov. Phu Quoc); in *Malesia*: S. Thailand (Nakhon Si Thammarat: Songkhla). Fig. 13.

Ecol. In small mats on damp, sandy ground at borders of ponds and marshes near the coast.

11. *Myriophyllum coronatum* MEIJDEN, Blumea 17 (1969) 305, f. 1a–c. — Fig. 15a–c.

Terrestrial or semi-aquatic. Stem much branched. *Leaves* opposite, the upper ones semi-opposite to alternate; immersed leaves opposite, pinnate, 0.5–1.2 by 0.6–1.5 mm in outline, with 2–5 c. 0.1 mm wide, filiform lobes; aerial leaves linear, entire or less often \pm pinnate, 3–10 mm long, the entire ones 0.3–1.2 mm wide, with a dark

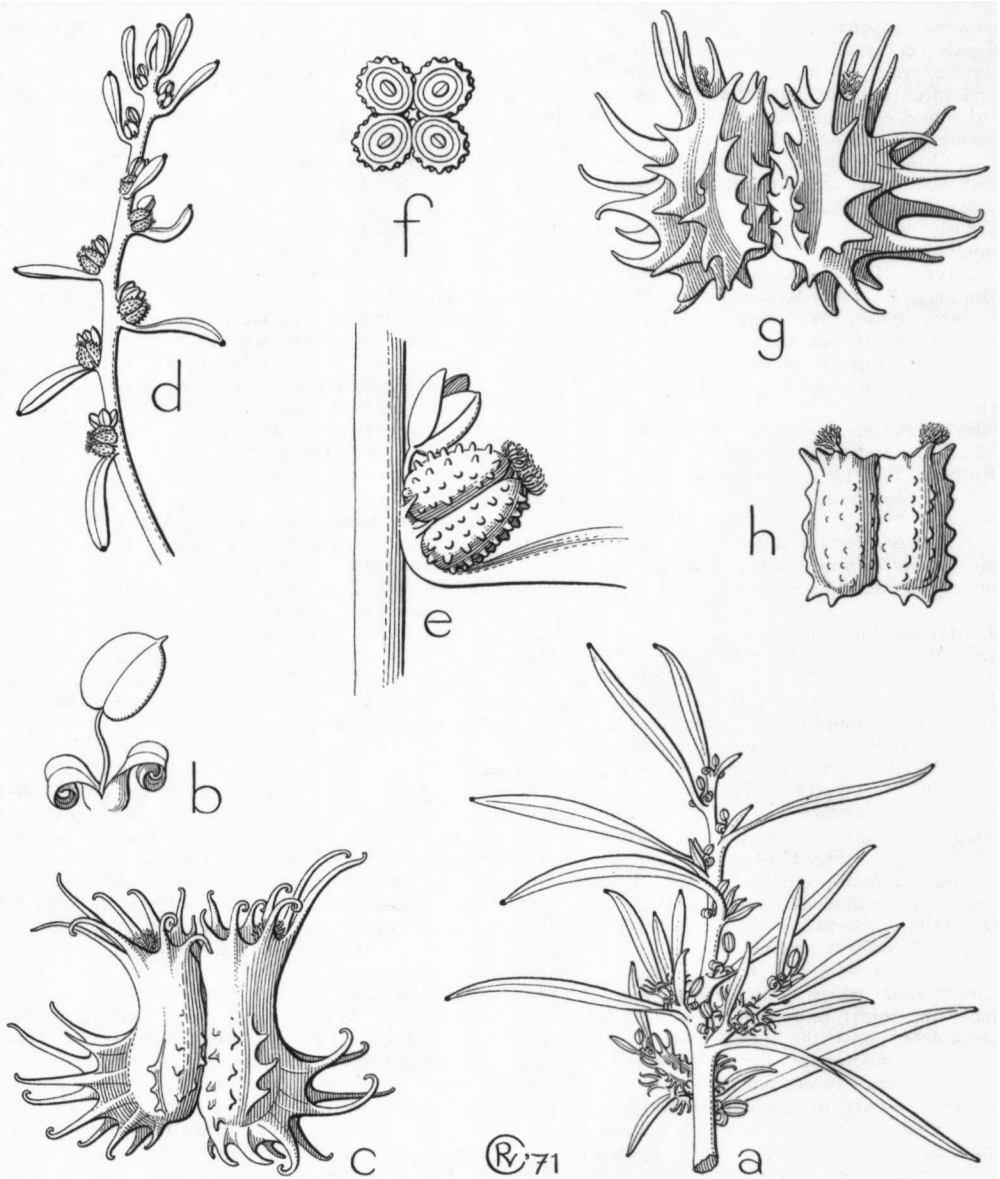


Fig. 15. *Myriophyllum coronatum* MEIJDEN. *a.* Habit, $\times 7$, *b.* δ flower, $\times 25$, *c.* fruit, $\times 25$. — *M. bonii* TARDIEU-BLOT. *d.* Habit, $\times 7$, *e.* fruit and δ flower, $\times 25$, *f.* cross-section of fruit, $\times 25$. — *M. meianum* SCHINDL. *g.* Fruit. — *M. siamense* (CRAIB) TARDIEU-BLOT. *h.* Fruit, $\times 25$ (*a-c* RIDSDALE NGF 33585, *d-f* BON 5897, *g* FERRIER DE LA BATHIE 19310, *h* BON 5290).

cushion-like thickening above at apex, flat, patent. *Flowers* solitary in the upper leaf-axils, the upper δ , the lower ♀ . Bracteoles inconspicuous or 0. — δ *Flowers* nearly sessile. Sepals 0. Petals 2, linear, flat, entire, acute, erect before anthesis and up to 1 mm long, strongly recurvate after anthesis. Stamen 1; filament up to $\frac{1}{2}$ mm; anther elliptic,

0.2–0.6 by 0.1–0.4 mm, mucronate. Rudiment of ovary 0. — ♀ *Flowers* sessile. Sepals and petals 0. Styles shortly conical, distally set with long hairs. *Fruit c.* 1 mm long. Mericarps 2, \pm oblong, at the base with c. 3 dorsal crests, these with 3–5 thin long spines curved upwards, and laterally with some irregular rows of tubercles, upwards slightly

narrowing, smooth or with some tubercles, widening at the top in an asymmetrical crown of c. 8–12 \pm patent spines with recurvate tips, which are dorsally distinctly longer than laterally, the longest up to 0.8 mm long.

Distr. *Malesia*: E. New Guinea (Papua, Western Distr.: near Weam). Fig. 10.

Ecol. Wet depression in savannah, c. 30 m.

Doubtful record

Myriophyllum indicum WILLD.: JUNGH. Java, 2nd Dutch ed., 1 (1853) 470, 'Java (Bandung, abundant)'.

No material could be traced; almost certainly a mis-identification.

Dubious

Ammania pinnatifida LINNÉ f. Suppl. (1781) 127, 'Java'.

The name is cited by DC. Prod. 3 (1828) 69, as possibly synonymous with *Myriophyllum intermedium* DC. No material could be found in Swedish herbaria. See MEIJDEN, *Blumea* 17 (1969) 311.

Myriophyllum pusillum BL. Mus. Bot. Lugd.-Bat. 1 (1849) 111; MIQ. Fl. Ind. Bat. 1, 1 (1855) 634; Suppl. (1860) 328; Sumatra (1862) 128, 328; KURZ, Nat. Tijd. N. I. 27 (1864) 167; WARB. Bot. Jahrb. 13 (1891) 395; K. SCH. & LAUT. Fl. Schutzgeb. (1901) 483.

Although the description is very brief, the said provenance said to be 'Archip. Ind.', it is not improbable that *M. pusillum* is indeed a *Myriophyllum*, possibly *M. tetrandrum* ROXB. Unfortunately the type material could even as early as 1900 not be located. All later records refer to sterile specimens, those by MIQUEL (1860) and KURZ are according to Mr PHILCOX (*in litt.*) probably *Limnophila* (*Scrophulariaceae*).

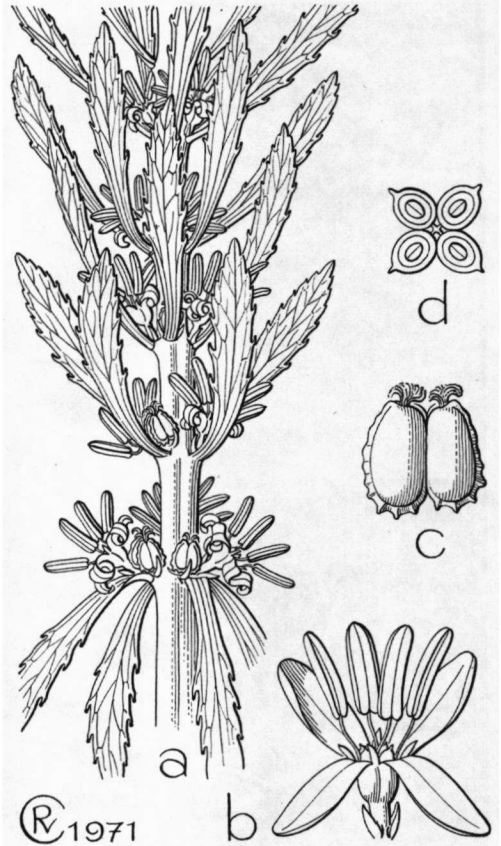


Fig. 16. *Myriophyllum axilliflorum* BAKER. a. Habit, $\times 3$, b. bisexual flower, $\times 7$, c. fruit, $\times 13$, d. cross-section of fruit, $\times 13$ (a–d HILDEBRANDT 4030).

4. GUNNERA

LINNÉ, Syst. Nat. ed. 12 (1767) 597; Mant. 1 (1767) 16; SCHINDL. Pfl. R. Heft. 23 (1905) 104; MATTFELD, *Ostenia* (1933) 102; BADER, Bot. Jahrb. 80 (1961) 281, maps. — *Pseudogunnera* ÖRSTED, Naturh. För. Vidensk. Medd. Kjöbenhavn (1857) 193. — Fig. 17–18.

Perennial, \pm acaulous (sometimes colossal herbs with a stem up to 6 m by 20 cm \varnothing in extra-Mal. spp.), (in Mal.) stoloniferous, with more or less creeping, sub- or slightly supraterranean, thick rhizome. Leaves radical (or in non-Mal. spp. tufted at the end of the stem), reniform-cordate to ovate-truncate, simple to lobed, crenate to compound-dentate, rarely entire, palminerved, often rugose, with more or less conspicuous, simple to much divided, sometimes ochrea-like 'cataphylls' in the very leaf-axil. Panicle, raceme or spike mostly 1, axillary or pseudoterminal, simple or compound. Flowers ebracteolate, bisexual or unisexual, monoecious (or dioecious), if monoecious with δ flowers upwards and φ ones



Fig. 17. *Gunnera macrophylla* BL. on summit of Mt Kaba, Bencoolen, April 1932 (DE VOOGD).

downwards and sometimes with ♀ in between. *Sepals* 2 (rarely in some flowers 3), or 0, equal or unequal, often cuspidate, whether or not caducous. *Petals* 2(-0), in ♀ 0, oblong to spatulate, more or less convex outside, glabrous to pilose, often soon caducous, longer than the sepals. *Stamens* 2; anthers elliptic to oblong. *Ovary* 1-celled, urceolate to compressed-ovoid; styles subulate to filiform, entirely papillose, exerted in anthesis. *Ovule* 1. *Fruit* a drupe or nut-like, coriaceous to more or less fleshy or juicy, almost globular to 3-gonous; stone crustaceous; perisperm copious, oily; embryo apical, very small, pear-shaped to obcordate.

Distr. About 30-50 *spp.*, in South and tropical Africa and Madagascar, Malesia, Tasmania, New Zealand, Antarctica, the Hawaiian Islands, and South and Central America; not in continental Asia and Australia; in *Malesia*: not found in the Malay Peninsula and the Lesser Sunda Islands. Fig. 19.
Ecol. Cold or cool, everwet localities, often on marshy soil, in the tropics only in the mountains, in Malesia above (750-)1000 m.

Symbiosis with Cyanophyceae. — *Gunnera* represents a remarkable case of true symbiosis which seems inherent to all species. Though I am not aware of experiments proving it to be obligatory, this seems likely. The stem and petiole-bases are provided with mucilage producing glands which offer obviously the entrance of the *Nostoc* or *Chroococcus* species, or hydathodes may serve this purpose and the algal cells form fairly large and regular intracellular colonies, as REINKE described (Unters. Morph. Veg.-Organe *Gunnera*, 1873). See also H. SCHNEGG (Flora 90, 1902, 161–208). Infection seems to take place very early. For the Malesian *G. macrophylla* excellent details are described and depicted by BAAS BECKING (Dodonaea 14, 1947, 93–96). Each of the equitant petiole-bases is provided with three warts, one central highest and two lateral basal, immediately below which a root emerges; the *Nostoc* colonies are confined to the warts.

BAAS BECKING suggested that the phycome contained a substance of 'auxin' character, but no later communication followed. Recently, in a preliminary paper, SILVESTER & SMITH (Nature 224, 1969, 1231) found that *Nostoc* in cultures is able to fix nitrogen and that the *Gunnera-Nostoc* symbiosis is capable of nitrogen fixation. It is made certain that the nitrogen absorbed by the *Gunnera (arenaria)* plants in pure cultures on nitrogen-free media came from *Nostoc*. *Gunnera* plants raised from seed and grown on media free of both *Nostoc* and nitrogen compounds showed at the 6 leaf stage yellow chlorotic leaves and poor growth. No experiments were yet made to grow *Nostoc*-free *Gunnera* on media containing combined nitrogen to check whether the symbiosis is obligatory for *Gunnera*; SILVESTER (*in litt.*) suspects perhaps it is not. As *Nostoc* is ubiquitous, all *Gunnera* plants in nature contain *Nostoc* and this may be favourable indeed for its growth on nitrogen deficient soils.

Morph. The evaluation of the so-called 'ligule' or 'stipules' is still under dispute. Their development is various but specific; in *G. magellanica* they are very large, in the New Zealand species they are absent (SCHNEGG, *l.c.*). SKOTTSBERG (Svensk Bot. Tidskr. 22, 1928, 392–415) regarded them as cataphylls. The latter opinion seems unlikely as they are not contained in the leaf spiral as remarked by MATTFELD (Ostenia 1933, 109), but axillary.

Taxon. SCHINDLER subdivided the genus into 5 subgenera, to which MATTFELD added a sixth monotypic one from E. South America, *Ostenigunnera* MATTFELD (1933, *l.c.*) which is very distinct and deserves clearly subgeneric rank. The others are *Misandra* in South America, *Panke* in South America, Juan Fernandez, and Hawaii (20–30 spp.), *Milligania* in New Zealand and Tasmania (9 spp.), *Pseudogunnera* in Malesia (1 sp.), and *Gunnera (subg. Perpensum)* in Madagascar and East Africa (1 sp.).

The characters SCHINDLER used for this classification are the occurrence of stolons, the distribution of the sexes, the structure and size of the 'cataphylls', and the size of the plant. It seems to me that, *Ostenigunnera* excepted, the mutual similarity is so large that distinguishable taxa at most deserve sectional rank, the more so as distinctions are less sharp than presented by SCHINDLER. For example: within *Milligania* occur both species with monoecious and with monoecious or dioecious flowers. In *Perpensum* with bisexual flowers sometimes the upper are ♂, whereas in *Pseudogunnera* between the upper ♂ and lower ♀ sometimes ♀ flowers are found. As to size of leaves *Pseudogunnera (G. macrophylla)* displays an enormous variability in New Guinea, from 2½–70 cm, depending either on altitude or habitat, so that small specimens of *G. macrophylla* from New Guinea so much resemble *Milligania* that RIDLEY, who described such small specimens as a separate species, *G. reniformis*, promptly declared them to be allied to the Tasmanian *G. cordifolia* Hook. f. of subg. *Milligania*.

I believe that the subdivision of *Gunnera* could be improved if only 2 subgenera are recognized: subg. *Gunnera* and subg. *Ostenigunnera*. The first might then be distinguished into two or three sections, viz sect. *Gunnera*, including subg. *Perpensum*, *Pseudogunnera*, and *Milligania*, and occurring in Africa, Madagascar, Malesia, Tasmania, and New Zealand, and sect. *Panke*, including subg. *Panke*, occurring in Central and South America, Juan Fernandez, and the Hawaiian Is. The affinity of the South American subg. *Misandra* is uncertain to me, it may be kept separate, or may be included within sect. *Gunnera*.

Nomencl. The name *Panke* which is still used as the name of a South American subgenus of *Gunnera* already occurs in a work by L. FEUILLÉ (Journ. Obs. 1, 1714, t. 30), as part of a phrase name. This was post-Linnean literatim translated into German by G. L. HUTH (Beschreib. Arnzey Pfl. 1, Nürnberg, 1756, 42, t. 30). In this rare work all plants are beautifully depicted and accompanied by phrase names preceding their description. There is of course no question that FEUILLÉ adhered to the binomial system, i.e. that he distinguished genera and species. The German literatim translation does neither, and from the introduction by HUTH appears that he merely published it as a translation, without himself having the intention to make any changes towards framing it according to the binomial nomenclature. Therefore, this translation has no nomenclature standing.

It must be admitted, though, that not long ago a 'generic' name from this work was rejected nomenclaturally, viz *Urceolaria*, obviously because D. L. DENHAM (Taxon 10, 1961, 247) stated in his proposal that HUTH's names are effectively and validly published and 'must' be accepted. The members of the Committee on nomina generica conservanda have obviously not verified DENHAM's statement on this rare work and were thus misled. In HUTH's translation neither genera nor species were indicated as such; each single species had a different phrase name, or better, was indicated by a phrase indication. Nomenclaturally this translation cannot be used for post-Linnean validation and should be discarded. Consequently we have refrained from proposing *Panke* to be rejected in favour of *Gunnera*.



Fig. 18. *Gunnera macrophylla* BL. group above waterfall Tjibeureum, Mt Gedeh, W. Java, 1750 m (VAN STEENIS).

1. *Gunnera macrophylla* BL. Bijdr. (1826) 513; BENN. Pl. Jav. Rar. (1828) 70, t. 15; MIQ. Pl. Jungh. (1851) 70; Fl. Ind. Bat. 1, 1 (1856) 769, incl. var. *sumatрана* MIQ. L.c. 770; BL. Mus. Bot. Lugd.-Bat. 2 (1856) 101; DC. Prod. 16, 2 (1868) 598; WARB. Bot. Jahrb. 16 (1893) 15, 24, var. *papuana* WARB.; KOORD. Minah. (1898) 451; K. SCH. & LAUT. Fl. Schutzgeb. (1901) 483; SCHINDL. Pfl. R. Heft 23 (1905) 114, f. 33; BACK. Schooffl. Java (1911) 477; RIDL. J. Fed. Mal. St. Mus. 8, 4 (1917) 33; HEYNE, Nutt. Pl. ed. 3 (1927) 1207; C. T. WHITE, Proc. R. Soc. Queensl. 34 (1922) 483; KOORD. Fl. Tjibodas 2 (1923) 217; BAKER, J. Bot. (1924) Suppl. 35; WENT, Nova Guinea 14 (1924) 105; JOCHEMS, Trop. Natuur 15 (1926) 68, f. 4; DE VOOGD, *ibid.* 22 (1933) 226; ELM. Leaf. Philip. Bot. 9 (1933) 3143; STEEN. Bull. Jard. Bot. Btzg III, 13 (1934) 217; Trop. Natuur 30 (1941) 172, f. 4; Bull. Jard. Bot. Btzg III, 17 (1948) 463; BACK. & BAKH. f. Fl. Java 1

(1963) 266. — *G. erosa* BL. Verh. Bat. Gen. 10 (1825) 81, *nom. nud.*; DC. Prod. 16, 2 (1868) 599. — *Pseudogunnera macrophylla* (BL.) ØRSTED, Naturh. För. Vidensk. Medd. Kjöbenhavn (1857) 599. — *Sarcospermum petasites* REINW. MS., in De Vriese, Reinw. Reise (1858) 576, *nomen*. — *G. reniformis* RIDL. Trans. Linn. Soc. Lond. II, 9 (1916) 40, *ex descr.*; WENT, Nova Guinea 14 (1924) 105; STEEN. Bull. Jard. Bot. Btzg III, 13 (1934) 217. — Fig. 17-18.

Perennial, stoloniferous, pilose herb. Stem very short, c. 1–2 cm ø, pilose; rhizome sublignose, elongated, dark. Stolons often numerous, ± terete, the internodes very long, up to c. 40 cm, c. 3 mm ø, with 2 opposite, caducous, small bud-scales, soon producing a new flowering plant at each node. Leaves reniform to cordate, angular, rarely irregularly (2-)3-lobed, acutely irregularly sphaclate-dentate, bullate, venation strongly prominent, reticulate beneath, 2½–70 by 2½–70 cm;

petiole up to 70 cm, 3–10 mm ϕ , \pm terete, widely channelled above, costate, \pm sheath-like at base, shortly decurrent, each of the lower equitant petiole-bases provided with 3 warts, 1 central highest and 2 lateral lower, below which an adventitious root emerges. *Panicles* 1(–3) sub-terminal, shortly peduncled or sessile, often hidden under the leaves, in fruit accrescent to 25–60 cm; lateral spikes very numerous, each in the axil of a bract $\frac{1}{2}$ – $1\frac{1}{2}$ by $\frac{1}{4}$ –1 cm, the lower ones $2\frac{1}{2}$ –9 cm, with $\text{\textcircled{f}}$ flowers, the upper ones with $\text{\textcircled{m}}$ or intermixed with $\text{\textcircled{f}}$ flowers. — $\text{\textcircled{m}}$ *Flowers*: sepals

triangular to broadly triangular, with acuminate or cuspidate, sphacelate apex, erect, 0.6–1.2 by c. 1 mm, glabrous; petals spatulate, mucronate, glabrous or pilose outside, glabrous inside, \pm densely pilose on the margin, caducous before anthesis; filaments up to c. 2 mm, c. 0.3 mm ϕ , erecto-patent, stiffish; anthers \pm elliptic, obtuse or shortly mucronate, $1\frac{1}{2}$ –2 by $1\frac{1}{4}$ – $1\frac{1}{2}$ mm. — $\text{\textcircled{f}}$ *Flowers*: sepals as in $\text{\textcircled{m}}$; petals 0; stigmas sessile, subulate, up to 2 mm long. *Drupe* \pm globose, glabrous, juicy, c. 2 mm; stone flattened globular, c. 1 mm ϕ .

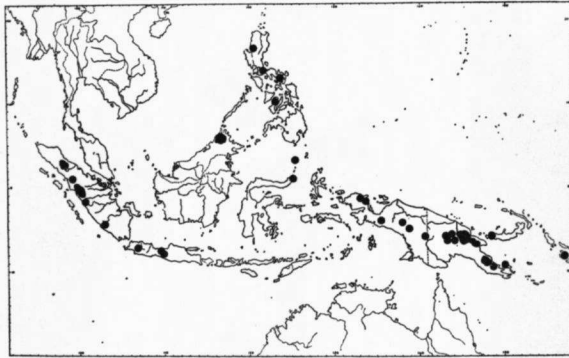


Fig. 19. Distribution of *Gunnera macrophylla* BL.

Distr. Malesia: Sumatra, W. & Central Java, N. Borneo (Mt Kinabalu), Philippines (Luzon, Negros), NE. Celebes (Mt Klabat), Sangehe I., New Guinea (incl. also Goodenough I. & New Britain: Mt Talawe), and Solomon Is. (Kolombangara). Fig. 19.

Ecol. In the mountains from (750–)1250–3000 m. Wet or damp places, along brooks, river banks, near waterfalls, wells and seepage, mostly on open or lightly shaded places in disturbed habitats, pioneering on bare lands, along paths and in light places in secondary forests, often gregarious.

Vern. *Tèratè gunung*, S; Philippines: *balai, baloi*, Ig., Bon.

Morph. The so-called sphacelate teeth on the leaves and the inflorescence-scales are probably hydathodes.

Numerous semiglobular gland-like outgrowths

are found especially on the young leaves, on and near the nerves.

Coalescence of parts of the inflorescence occurs frequently.

Notes. The small specimen described from Mt Carstenz in New Guinea as *G. reniformis* RIDL. is presumably an early flowering juvenile individual developed on a stolon; such specimens have also been collected elsewhere in New Guinea.

Sterile specimens have sometimes erroneously been referred to *Petasites* (*Compositae*) by resemblance of the leaf (VAN STEENIS, 1948, *l.c.*).

Excluded

Hydrospodylus (submersus) HASSK. Flora 25 (1842) Beibl. 2, 33 = *Hydrilla verticillata* (L. f.) ROYLE (*Hydrocharitaceae*).