HYDROCHARITACEAE (C. den Hartog, Amsterdam)

Annual or perennial freshwater and marine plants. *Leaves* submerged, rarely floating or partly emerged, radical or arranged along a stem, spirally whorled, distichous, or in pairs, linear, lanceolate, elliptic, ovate or orbicular, sessile or petioled; petioles mostly sheathing; nerves more or less parallel, straight or curved, connected by perpendicular or ascending cross-veins. Stipules sometimes present. Squamulae intravaginales often present. *Flowers* actinomorphous, rarely faintly zygomorphous (*Vallisneria*), unisexual, and then sometimes with rudiments of the other sex, or rarely bisexual, 1—∞ enclosed between 2, more or less connate, rarely free segments (*spathe*). Spathe sessile or peduncled, often ribbed or winged, tip mostly bifid. *Perianth segments* free, 3 or 6, in the later case differentiated in petals and sepals; sepals often green, mostly valvate; petals mostly coloured, imbricate. *Stamens* 2—∞, in 1 or more whorls, the inner ones sometimes staminodial (*Hydrocharis*), the outer ones often doubled (*Stratiotes*, *Ottelia*); anthers basifixed, 2–4-celled, dorsally or latrorsely lengthwise dehiscent; filaments more or less slender, sometimes absent. *Ovary* inferior, linear, lanceolate or ovate, consisting of 2–15 connate carpels, 1-celled, apex often narrowed into a long, filiform beak; parietal placentas sometimes protruding to the centre of the gynaecium, but never connate, sometimes split into 2 lamellae; styles 2–15, often more or less split into 2 crests. *Ovules* ∞, anatropous, with 2 integuments. *Fruits* linear, lanceolate or ovate, opening by decay of the pericarp, rarely stellately dehiscent (*Thalassia*). *Seeds* ∞, fusiform, elliptic, ovate or globose; testa glabrous or densely set with spines or warts; embryo straight, with a very inconspicuous plumule at the base of a lateral groove, and a thick radicle; the marine genera and *Stratiotes* possess, however, a large, well-developed plumule; albumen 0.

Distribution. About 15 genera with *c.* 100 *spp.*, widely distributed in the tropical and subtropical zones with a few species in the temperate zones. Among the freshwater genera only *Vallisneria* and *Ottelia* occur both in the palaeotropics and in the neotropics. Most other freshwater genera are confined to the Old World [*Hydrilla*, *Hydrocharis*, *Blyxa*, *Lagarosiphon* (Africa), *Nechamandra* (S. Asia), *Stratiotes* (Europe), *Maidenia* (Australia)], only 2 are restricted to America (*Elodea* and *Limnobium*). The marine genera are commonly dispersed along the coasts of the Indian and Pacific Ocean going East as far as Hawaii & Tahiti, but do not reach the American Pacific coast; 2 of them occur also in the West Indies, but further they are absent from the coasts of the Atlantic Ocean! See further under ecology.

Ecology. Many water plants show a reduced rate of fertility whereby sexual reproduction is of rather rare occurrence, but vegetative reproduction is proportionally increased. This is for example shown by the anthropogenous dispersal of *Elodea canadensis* in Europe and of *Eichhornia crassipes* in the Indo-Australian area, which have spread very widely on a remarkable scale in a few decades. It is worthy of note that their (vegetative) characters remained very constant notwithstanding the abundant increase in number of specimens.

Mrs Ernst-Schwarzenbach (Arch. Julius Klaus Stift. Zürich 25, 1950, 483–488; Planta 39, 1951, 542–569) investigated the causes of the reduced fertility in *Elodea canadensis* and *E. occidentalis*. She assumes this is due to the scant fertility of the female flower, which contains only 2–6 ovules per ovary and further to a disturbance in the ripening of the pollen grains. The latter remain coherent in tetrads, whereby the buoyancy capacity is raised, but the possibility that pollen grains come into contact with the stigmatic papillae is lowered. Moreover, she found that only 1–2 pollen grains of each tetrad have germinating capacity.

A remarkable feature in the taxonomy of the *Hydrocharitaceae* is the large number of monotypic genera (*Enhalus*, *Hydrilla*, *Maidenia*, and *Stratiotes*) and small genera possessing 2 or a few species (*Hydrocharis*, *Limnobium*, and *Thalassia*).

Freshwater Hydrocharitaceae. They form the majority of the family. In Malaysia they occur up to *c.* 2000 m altitude, in marshes, pools, ditches, swamps, wet rice-fields, and in slowly running rivers. Most species possess a wide area of distribution; a few endemic species occupy a very limited area, *e.g. Ottelia mesenterium* in the lakes of SE. Celebes (fig. 8) and *Blyxa novoguineensis* in the Fly River area of S. New Guinea. Among the widely distributed species there are 2 types *viz: eurytopic species*

distributed rather evenly throughout their area, without important discontinuities, *e.g. Hydrilla verticillata*, and *Ottelia alismoides*, and *stenotopic species* which are rare or rather rare in their area, with sometimes very wide disjunctions between the separate localities in which they may, however, occur locally abundant, *e.g. Hydrocharis dubia* (fig. 8), *Blyxa japonica*, and *Blyxa octandra*.

The problem involved in this local preference has been discussed on an earlier occasion in this volume (see p. 317–318) with the ecology of the *Alismataceae*.

Marine Hydrocharitaceae. 'Sea-grasses' are phanerogams, which are confined to sea-water, tolerating a salinity of 3½% and more, but which cannot live in brackish water. None has ever been found in continental, salt inland seas or lakes.[1] They are characterized by narrow grass-like leaves, which are not differentiated into a petiole and a leaf blade, the only exception to this rule being that of the genus *Halophila*. All sea-grasses belong to 2 monocotyledonous families, *viz Potamogetonaceae* and *Hydrocharitaceae*. They are very distinct from the other Monocotyledons, obviously representing ancient types, and stand isolated within the families to which they belong.

Their geographic distribution has been studied extensively, particularly by ASCHERSON (in Petermann's Mitth. 17, 1871, 241–248, map 13; in Neumayer, Anl. Wiss. Beob. Reis. ed. 1, 1875, 359–373; ed. 3, 2, 1906, 389–413), OSTENFELD (Proc. R. Soc. Victoria 27, 1914, 179–190; Pflanzenareale 1³, 1927, 35–38, map 21–24), SETCHELL (Bull. Torr. Bot. Cl. 47, 1920, 563–579; Amer. Naturalist 69, 1935, 560–577, f. 1–10), and MIKI (Bot. Mag. Tokyo 48, 1934, 131–142, f. 1–7).

In the *Hydrocharitaceae* they are represented by 3 genera, all of them tropical, *viz Enhalus* (1 *sp.*), *Thalassia* (2 *spp.*), and *Halophila* (9 *spp.*).

According to SETCHELL *l.c.* these hydrocharitaceous sea-grasses are megatherm, living in sea-water with a minimum temperature of 20° C, tolerating rather large fluctuations above that temperature.

Observations by MIKI *l.c.* confirm this; he found the northernmost localities of *Enhalus acoroides* and of *Thalassia hemprichii* in Japan to coincide with a February water isotherm of 23° C and 21° C respectively.

The only exception to this rule is *Halophila ovalis* which enters the temperate region in both the southern and northern hemispheres; its northern border of distribution in Japan agrees with the 10° C February water isotherm. In southern waters it is distributed as far as Tasmania. But also this species is considered to be megatherm as sexual reproduction is only observed in the tropics!

The distribution of the marine genera of *Hydrocharitaceae* shows a marked disjunction. They occur along the coasts of the Indian and Pacific Oceans from E. Africa to Hawaii and Tahiti, and in the Caribbean. The centre of distribution is situated undoubtedly in the Indo-Malaysian region, where the majority of species is found. This distribution indicates that they are old plant types, originated not later than the early Tertiary. In that epoch the isthmian Central American area was closed. It is improbable that these tropical plants have migrated from the Indo-Pacific region into the Caribbean Sea via South America or South Africa. Migration via the Arctic Sea likewise appears not probable. Their absence in the remaining parts of the Atlantic Ocean and the seas connected with it, points to the fact, that they arrived in the West Indies already before the isthmus of Panama arose in the beginning of the Tertiary. There are two points in favour of this hypothesis. *Halophila decipiens var. pubescens* is widely distributed in the Indo-Pacific region as well as in the Caribbean. The closely related *Thalassia hemprichii* and *Th. testudinum* are separated by the isthmus of Panama. OSTENFELD *l.c.* holds that these species are of common descent from one collective parent species, only after the forming of the Panama barrier.

That land barriers can uphold dispersal of sea-grasses to seas offering favourable conditions for their growth is shown by the Mediterranean which, according to the records, did not contain any *Halophila* before the digging of the Suez Canal. At present, however, *H. stipulacea*, a common species in the western part of the Indian Ocean and the Red Sea has passed the Suez Canal and has settled along the coasts of Greece!

In classifying the marine *Hydrocharitaceae* into geographical groups we get the following survey:

Pantropic	1 *sp.*	East African	2 *spp.*
Indo-Pacific	3 *spp.*	Caribbean	3 *spp.*
Malaysian	3 *spp.*		

Dispersal will take place very slowly for the fruits ripen only below the water surface and the seeds have no buoyancy capacity or other structures for wide-distance dispersal. Dispersal by loosened shoots may be neglected, as they soon die off. There is, however, the possibility that certain fishes, sea mammals (*e.g.* the manatee and the dujong), or turtles act in the transportation of seeds to other regions.

Another limiting factor for the distribution is the fact, that sea-grasses only live in shallow water, where they have sufficient light, and are therefore bound to the coastal waters. The depth of their occurrence is dependent to a large degree on the lucidity of the water, but most species cannot grow beyond a depth of 10 m.

Substratum. The sea-grasses prefer coral-sand, mud and sand in quiet localities, not exposed to the heavy surf. Some species endure a short temporary drying up during low tide, even in the tropics (*Enhalus*). Mostly they form extensive submarine meadows (*Thalassia*, *Enhalus*).

(1) Among the sea-grasses only the potamogetonaceous *Zostera nana* occurs in such inland localities in the Caspian.

Associates. Both the coarser and the tiny species occur generally gregariously, the coarser ones really forming under-water meadows. Generally they occur in associations and if one species is found others can be expected nearby, each showing a slight preference to certain local conditions (substratum, depth of water, *etc.*). Little is known about these preferences and associations and this is a nice field for research by local residents of tropical coasts.

Flower biology. Though obviously extremely interesting the flower biology of the *Hydrocharitaceae* is unfortunately inadequately known. The studies of Mrs ERNST-SCHWARZENBACH (Ber. Schweiz. Bot. Ges. 55, 1945, 33–69; Phytomorph. 6, 1956, 296–311) are recent valuable contributions. However, of several genera, *e.g. Blyxa*, no observations have been published at all. From the data obtained in several other genera we may infer that futher study will yield extremely interesting results. It has appeared that in one genus different species may belong to different flower-biological groups. Therefore each species should be studied separately.

Self-fertilization in bud, before the opening of the flowers has been recorded for the bisexual flowers of *Blyxa alternifolia* and *Ottelia alismoides.*

According to Mrs ERNST-SCHWARZENBACH (1956, *l.c.*) *cleistogamy* occurs commonly in the Australian *Ottelia ovalifolia*, in which species the entomophilous *chasmogamous flowers* are rather rarely found and only developed under very restricted conditions. She observed many transitional forms.

Besides the two types of *autogamy* just mentioned, there are, in the *Hydrocharitaceae*, three modes of pollen transport, *viz:*

1. *Entomophilous Hydrocharitaceae*, in which pollination is effected by insects, possess conspicuously coloured petals and nectaries. To this group belong *Ottelia*, *Hydrocharis*, *Limnobium* (*L. stoloniferum* excepted), *Stratiotes*, and *Elodea densa* (*cf.* HAUMAN-MERCK, Rec. Inst. Bot. Errera, 9, 1912, 33–36). *Elodea densa* is pollinated by flies. Further field observations are urgently needed.

2. *Anemophilous* flowers, in which pollen is transported by air, are obviously only found in *Limnobium stoloniferum*, according to BOTTINI (Malpighia 4, 1890, 340–348, 369–377). HAUMAN-MERCK assumes (An. Mus. Hist. Nat. Buenos-Aires 27, 1915, 325–331) that water transport is also effective in this species.

3. *Hydrophilous* flowers, in which pollination takes place under, on, or just above the water surface, is a category difficult to define, as both water and air may be involved; for example air currents for moving the floating ♂ flowers along the water surface or short-distance transport of pollen grains through the air.

According to the degree of participation of both media three subtypes can be distinguished *viz*:

a) *Entirely submerged pollination* is found in *Halophila* and *Thalassia.* The pollen grains are globular but remain adhering to one another forming long strings (fig. 18c–d), an adaptation which may be envisaged as increasing their floating capacity. In other plankton organisms increase of surface is attained by development of appendages; in the potamogetonaceous sea-grass *Zostera* the pollen grains are cylindric in shape.

b) *Semi-aquatic surface pollination* takes place with pollen drifting on the water surface and styles which are at least partially in contact with the water. To this subtype belong *Elodea canadensis* (*cf.* ERNST-SCHWARZENBACH, Ber. Schweiz. Bot. Ges. 55, 1945, 54–56), *E. occidentalis* (*ditto, l.c.* 53), and *E. callitrichoides* (HAUMAN-MERCK, Rec. Inst. Bot. Errera 9, 1912, 35–37).

c) *Aerial surface pollination* is called the condition that the pollination takes place on the surface of the water but in which both pollen and styles remain dry. To this subtype belong *Hydrilla verticillata* (fig. 1b), *Lagarosiphon muscoides* (ERNST-SCHWARZENBACH *l.c.* p. 56–58), *Vallisneria spp.* (see p. 387), and *Enhalus acoroides* (see p. 404).

In the last two subtypes there are two different modes in pollen transport.

The most spectacular is that of *explosive anthers.* The explosion is a direct consequence of a sudden movement of the flower or the floral parts. In *Elodea occidentalis* and *E. callitrichoides*, for example, it is caused by the sudden opening of the buds, in *Hydrilla verticillata* by the abrupt erection of the anthers. Explosive anthers are also known from some anemophilous plants, for instance *Urtica*, *Parietaria*, *Mercurialis annua*, *etc.* The phenomenon is tied up with reduction in the tissue of the anther wall.

In other species the ♂ and ♀ flowers must come into *contact*, by which pollen is transported directly from the anthers on the styles, for example in *Lagarosiphon muscoides*, *Vallisneria spp.*, and *Enhalus.* In *Elodea canadensis* emission of pollen takes place after contact between the ♀ and ♂ flowers, the pollen being brought to the styles in consequence of surface tension.

It is remarkable that the pollination mechanism in *Hydrocharitaceae* is bound to species rather than to genera; for instance in *Elodea* of which some species are hydrophilous and others entomophilous.

Characters which are obviously bound to hydrophilous pollination consist of the tendency to have tepals instead of a perianth differentiated into sepals and petals and the reduction of the latter (for example in the ♀ flowers of *Elodea occidentalis* and *Vallisneria spp.*). This reduction is apparently a consequence of a specialized function in the opening mechanism of the flowers or for a sheltering capacity prohibiting the wetting of the sexual organs (for example the forming of a 'vessel' of the ♂ flowers in *Elodea spp.*, *Hydrilla*, *Vallisneria*, *Lagarosiphon*, and *Enhalus*).

Another adaptation enabling hydrophilous pollination is the functioning of the stamens or staminodes of several species as 'sailing gear': in *Elodea canadensis* the 3 inner stamens are connate into a column and when opened make a petaloid impression; in *Lagarosiphon muscoides* three staminodes function as

a sailing apparatus; in *Hydrilla* the empty anthers function as sails. In the latter case this function has no or only slight significance for the dispersal of pollen.

Finally I want to mention the increased mobility of both ♂ and ♀ flowers in species adapted to hydrophilous pollination. In the species, in which the ovary remains far below the surface, it has a strongly lengthened, filiform-rostrate apex bearing at its tip the perianth and the styles (*Hydrilla*, *Elodea*, and *Lagarosiphon*). In the species in which the ovary comes in anthesis close to the surface of the water, however, it is after anthesis retracted spirally by the coiling peduncle (*Vallisneria*, *Enhalus*, and *Ottelia*). In the ♂ flowers the mobility is still larger by the rupture of the pedicels giving the buds (and flowers) opportunity to rise to and drift freely on the water surface.

Morphology. *Squamulae intravaginales* I have observed in *Hydrilla verticillata*, *Blyxa alternifolia*, and *Halophila decipiens*. They have also been recorded in other *Halophilas* by BALFOUR and in *Enhalus acoroides* by TROLL.

As is known to occur in other aquatic and marsh plants (see vol. 4, p. 258 under *Monochoria* and this volume p. 118 under *Tenagocharis* and p. 324 under *Limnophyton*) individual plants with juvenile foliage may be occasionally fertile and produce flowers and fruit. This form of precocious flowering is found for example in *Ottelia alismoides* (L.) PERS. and *O. ovalifolia* (R.Br.)RICH. (*cf.* ERNST-SCHWARZENBACH, Phytomorph. 6, 1956, 297). In the latter species it seems rather to be the rule. The flowering in a vegetatively juvenile stage is obviously favoured by local ecological conditions retarding the development of mature leaves or leaving no time for their development, *e.g.* growing in deep or swiftly running water or untimely drying out of the spot. In some cases such precociously flowering specimens with leaves still with the juvenile shape have been distinguished as distinct species, but in experimental studies they have appeared to represent only phenotypic stages.

Uses. None of the representatives is of much economic value. Leaves and petioles of *Ottelia alismoides* are used as a vegetable and seeds of *Enhalus* are eaten. The marginal fibre-strands of the leaves of *Enhalus* are sometimes employed for making fishing-nets. Some species may be a pest by their very abundant occurrence in freshwater, for example *Hydrilla verticillata* and *Blyxa alternifolia*. Some species collect mud on the surface of their leaves and may have a purifying effect in polluted waters loaden with silt, for example *Hydrilla* and *Blyxa*.

Some sea-grasses serve as food for dujong, notably the coarser species, *Thalassia*, and possibly *Enhalus*.

Notes. In collecting *Hydrocharitaceae* in the field it should be remembered that flowers must be measured, described, and dried without delay; by their marcescent structure they are very difficult to study from herbarium material; preferably additional material should be preserved in liquid. In some genera, notably *Blyxa*, ripe fruits are necessary for identification. Data on habitat and flower biology are scarce, hence very desirable to investigate in detail.

ARTIFICIAL KEY TO THE GENERA

1. Freshwater plants.
 2. Leaves radical or in rosettes connected by stolons.
  3. Leaves linear (margins parallel), flat.
   4. ♂ Flowers detaching and floating on the water surface. Ovary not long-rostrate. ♀ Peduncle long, coiling after fertilization . . . . . **2. Vallisneria**
   4. ♂ Flowers not detaching. Ovary long-rostrate. ♀ Peduncle not spirally contracting . **3. Blyxa**
  3. Leaves lanceolate to suborbicular, crisped (or juvenile) if linear.
   5. Stolons absent. Spathe with 6 ribs or 2–10 longitudinal wings. Leaves without an aerenchym cushion beneath. Leaves submerged . . . . . **6. Ottelia**
   5. Stoloniferous. Spathe not ribbed or winged. Floating leaves with a thickened aerenchym cushion beneath.
    6. Petals much broader than the sepals. Aerenchym cushion only on the central part of the blade. **4. Hydrocharis**
    6. Petals much narrower than the sepals, in the ♀ flower often wanting. Aerenchym cushion over the entire surface of the blade . . . . . **5. Limnobium**
 2. Leaves on a distinct stem, either in whorls or spiral.
  7. Leaves in whorls of 3–8 . . . . . **1. Hydrilla**
  7. Leaves spirally arranged . . . . . **3. Blyxa**
1. Marine plants.
 8. Plants coarse. Leaves distichous, in tufts on firm rootstocks, ribbon-like, not differentiated into petiole and blade.
  9. Leaves 30–150 cm by 13–17 mm. Rootstock covered with persistent, nigrescent, stiff strands (fibres). **7. Enhalus**
  9. Leaves 10–30 cm by 4–10 mm. Rootstock without such persistent strands (fibres) . **8. Thalassia**
 8. Plants delicate. Leaves opposite, in spaced pairs on thin stems, ovate to lanceolate, mostly differentiated into petiole and blade; leaf pairs on the lateral shoots 1 or more, sometimes approximate and resembling pseudo-whorls . . . . . **9. Halophila**

1. HYDRILLA

L. C. RICH. Mém. Inst. Paris 12, 2 (1812) 9, 61, 73, t. 2 (upper part); B. & H. Gen. Pl. 3 (1883) 450.—*Hydrospondylus* HASSK. Flora 25 (1842) Beibl. p. 33; Cat. Hort. Bog. (1844) 255.—**Fig. 1—3.**

Monoecious or dioecious, caulescent. *Leaves* in whorls of 3–8, sessile, linear to lanceolate, rarely elliptic; midrib conspicuous. *Flowers* unisexual. *Male spathe* subsessile, solitary in the leaf axils, flattened globose, liberating a solitary, small, pedicelled ♂ flower. Sepals 3, strongly convex, imbricate; petals 3, imbricate. Stamens 3, alternating with the petals; anthers erect, latrorsely dehiscent. *Female spathe* sessile, solitary in the leaf axils, cylindrical, top bifid, membranous, containing a solitary ♀ flower. Sepals 3, imbricate, convex; petals 3, imbricate. Ovary cylindric to narrowly conical; beak filiform; styles 3, alternipetalous. *Fruit* cylindrical or narrowly conical. *Seeds* 2–6, oblong-elliptic.

Distr. Monotypic Old World genus.

1. Hydrilla verticillata (LINN. *f.*) ROYLE, Ill. Bot. Himal. (1839) t. 376; PRESL, Bot. Bemerk. (1844) 112; CASPARY, Monatsber. Ak. Berl. (1857) 40; Jahrb. Wiss. Bot. 1 (1858) 494; MIQ. Suppl. (1861) 259; DALZ. & GIBS. Bomb. Fl. (1861) 277; MARTENS, Preuss. Exp. Ost-Asien (Bot. Teil: Tange) (1866) 144; BENTH. Fl. Austr. 6 (1873) 259; HOOK. *f.* Fl. Br. Ind. 5 (1888) 659; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 250, f. 184; KOORD. Minah. (1898) 270; BAILEY, Queensl. Fl. 5 (1902) 1508; HEMSLEY, J. Linn. Soc. Bot. 36 (1903) 1; RIDL. Mat. Fl. Mal. Pen. (Monoc.) 1 (1907) 3; GAGNEP. Fl. Gén. I.-C. 6 (1908) 4, f. 2; BACKER, Teysmannia 22 (1911) 511; EWART & DAVIS, Fl. North. Territory (1917) 21; MERR. Sp. Blanc. (1918) 58; En. Born. (1921) 37; RIDL. Fl. Mal. Pen. 4 (1924) 1; BACK. Handb. Fl. Java 1 (1925) 59; Onkr. Suiker. (1928) 23, Atlas t. 29; FISCHER, Fl. Pres. Madras 8 (1928) 1396; STEEN. Arch. Hydrobiol. Suppl. 11 (1932) 273; Trop. Natuur 23 (1934) 39, 40, 108; COERT, Trop. Natuur 23 (1934) 26, f. 10; BURK. Dict. 2 (1935) 210; MASAMUNE, En. Phan. Born. (1942) 9; ERNST-SCHWARZENBACH, Ber. Schweiz. Bot. Ges. 55 (1945) 36–53, f. 1–13, pl. 1, f. 1–3; BACK. Bekn. Fl. Java (em. ed.) 10 (1949) fam. 203, p. 2.—*Serpicula verticillata* LINN. *f.* Suppl. (1781) 416; ROXB. Pl. Corom. 2 (1802) 33, t. 164.—*H. ovalifolia* RICH. Mém. Inst. Paris 12, 2 (1812) 9, 76, t. 2 (upper part), MIQ. Fl. Ind. Bat. 3 (1856) 235.—*Udora verticillata* SPRENG. Syst. 1 (1825) 170; LLANOS, Fragm. Pl. Filip. (1851) 101; F.-VILLAR & NAVES in Blanco, Fl. Filip, ed. 3, 4[1] (1880) 78.—*Val(l)isneria verticillata* ROXB. Hort. Beng. (1814) 71, *nom. altern., illeg.*; Fl. Ind. ed. Carey 3 (1832) 751.—*H. roxburghii* STEUD. Nomencl. 1 (1840) 780, *nomen.*—*Hydrospondylus submersus* HASSK. Flora 25 (1842) Beibl. 2, p. 33; Cat. Hort. Bog. (1844) 250.—*H. najadifolia* ZOLL. & MOR. *ex* MOR. Syst. Verz. (1846) 91; ZOLL. Syst. Verz. 1 (1854) 69; MIQ. Fl. Ind. Bat. 3 (1856)

Fig. 1. *Hydrilla verticillata* (L.) ROYLE. *a.* Habit of ♀ plant, × 1/3, *b.* mature ♀ flower (schematic vertical section) on the water surface, *c.* sheath and base of peduncle of ♀ flower, *d.* free ♂ flower bud in (oblique) drifting position, *e.* ♂ flower just before anthesis seen from above, each sepal embracing a not yet dehisced anther, *f.* lateral view of a ♂ flower with emptied anthers erected (*b–f* after ERNST-SCHWARZENBACH).

234.—*H. angustifolia* HASSK. Pl. Jav. Rar. (1848) 117; BL. Mus. Bot. 1 (1849) 82.—*H. wightii* PLANCH. Nouv. Ann. Sc. Nat. III, 11 (1849) 79.—*H. dentata* CASP. Bot. Zeit 12 (1854) 56.—*H. polysperma* BLATTER, J. Proc. As. Soc. Beng. *n.s.* 26 (1931) 356.—**Fig. 1–3.**

Glabrous. *Stems* amply ramified; internodes 1/3–5 cm. *Leaves* acute, 8–40 by 1–5 mm, green with red-brown dots and dashes, fine-striate, margin sharply serrate-dentate, rarely entire. *Squamulae intravaginales* 2, in the leaf axils, oblong, membranous, transparent, margin dentate to ciliate, to 1/2 mm long.—*Male spathe* solitary in the leaf axils, but sometimes all leaves of a whorl bearing one, 1 1/4–1 1/2 mm, provided with subulate appendages, in the centre of the top a minute knob, finally bursting open to liberate the flower. *Pedicels* 1–2 mm. *Sepals* ovate to oblong-elliptic, reflexed, 1 1/2–3 by 1 mm, white or reddish white. *Petals* spathulate, spreading to reflexed, 2–3 by 1/2 mm, white or reddish white. *Filaments* oblique, slender, very short; anthers linear, 4-locular; pollen grains globular, glabrous, rather large.—*Female spathe c.* 5 mm; apex shortly bidentate, reddish brown, striped. *Sepals* oblong to obovate, scarious, apex rounded, white, sometimes with reddish dots, 1 1/2–3 by 3/4 mm. *Petals* spathulate, 1 1/2–3 by 1/3–1/2 mm; apex rounded; white, scarious. *Ovary* 3–4 mm; beak 1 1/2–10 cm, with reddish dashes and dots. *Styles* oblique, filiform to subulate, 4/5–1 mm. *Fruit* softly echinate, 7 by 1 1/2 mm. *Seeds* 2 1/4–3 1/4 mm, testa glabrous, dark-brown.

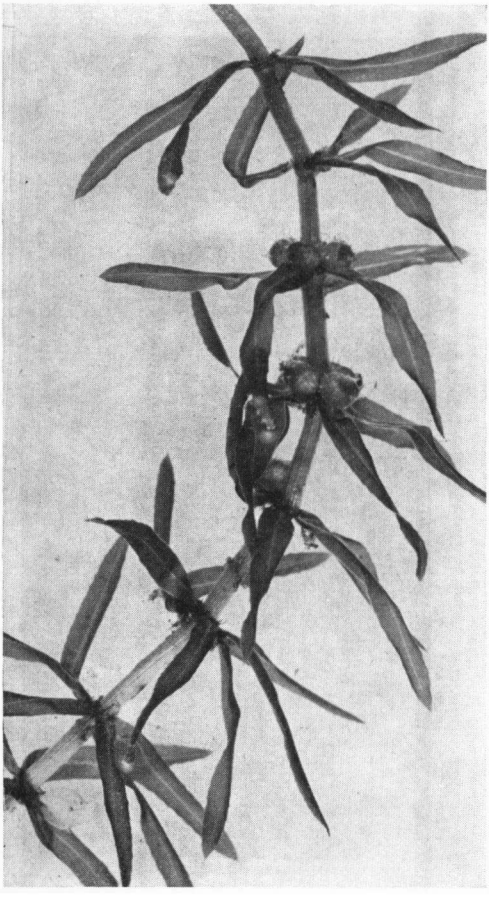

Fig. 2. *Hydrilla verticillata* (L.) ROYLE. ♂ plant with axillary flowers (photo Mrs ERNST-SCHWARZENBACH).

Distr. Widely distributed in the Old World from S. & E. Europe, Africa, S. & E. Asia to Australia; throughout *Malaysia*, very common in W. Malaysia, obviously rather rare in the Moluccas and New Guinea.

Ecol. Often gregarious in ditches, pools, lakes, marshes, wet rice-fields, slow streams, and even in tidal waters. In proportion to the lucidity of the water it goes down to 6–7 m below the water-level, but in such deep waters it does not reach the surface. Also in agitated waters the plant remains bottom-bound. The plants grow very quickly and reproduce both vegetatively and by fruits. Loosened shoots develop into new plants which attach themselves in the mud by fine filiform adventitious roots. Plants produce also subterranean shoots with swollen tips, densely clothed with fleshy, acute or acuminate scale-like leaves. In muddy water the leaves are capable to bind (catch) considerable quantities of mud. From sea-level to 2000 m, *fl. fr.* Jan.–Dec.

Flower biology. Anthesis and pollination have been studied by Mrs ERNST-SCHWARZENBACH (Ber. Schweiz. Bot. Ges. 55, 1945, 36–53) and offer most interesting features.

In the ♂ spathe the pedicel disrupts and the air-filled, ripe bud in rising pushes aside the two tips forming the knob on the spathal apex; this obstacle being passed the bud rises to the surface of the water. At its distal end it is provided with a small part of the pedicel causing the axis of the still closed, drifting bud to make an angle of *c.* 45° with the water surface (fig. 1 d). After having floated for about one hour and a half the bud opens and gets into anthesis in three successive stages, possibly due to repeated changes in the turgescence of its tissues. In the first stage the perianth lobes retract slightly and in the convexity of each sepal a stamen adheres to it (fig. 1 e). During the second stage the sepals recurve and spread out horizontally on the water surface, the petals recurving between the sepals one by one or simultaneously. The third stage follows then after a short interval: a stamen abruptly detaches itself from the hollow sepal, jumping into a horizontal position and in simultaneously opening ejects its pollen around in a sector of 120°. At the same moment its sepal recurves entirely. The same phenomenon happens with the 2nd and 3rd stamen and the sepals to which they pertain. The pollen grains are then situated in a circle of *c.* 20 cm round the opened flower, though slightly irregularly distributed due to the originally oblique position of it. When all stamens are emptied, the position of the flower on

the water surface is changed from oblique to erect; it keeps its balance on the recurved perianth and the pedicel fragment; the emptied anthers are erect and function as sails; movements of air may carry these drifting flowers along the water surface (fig. 1 f).

The loosening of the ♂ flowers and their subsequent rising to the surface takes only place after a preceding bright day; it is still not known which factor is decisive here, temperature or light intensity.

In submerged condition the ♀ flower resembles a closed (inversed) bell, on the bottom of which the short styles are inserted; above the latter there is a large air bubble. During the lengthening of the peduncle, the perianth lobes are already sometimes slightly retreating and the air bubble between them is already visible for the naked eye. In reaching the water surface the perianth lobes retreat further forming a wide funnel immersed in the water surface (fig. 1 b) and not projecting above it. Inside this funnel is dry through the hydrophobous quality of the surface tissue. Therefore, the styles are not wetted and project dry into the air contained in the bottom of the inversed perianth bell. The perianth lobes appear to be limp, at least their turgescence capacity is less than the powers involved by surface tension. This is derived from the fact that with surface movements of the water (waves) menacing to wet the flower parts, the then submerging flower attains anew the position it had in the original submerged state, *viz* it closes temporarily with the tepals embracing an air bubble above the dry styles. It opens again when the wave has passed.

From this most remarkable mechanism it follows that the pollen is not carried to the styles by means of water, but must be transmitted directly by aerial transport to the styles. Pollen grains which reach the water surface are lost for reproductive purpose and the same holds for pollen grains which are retained in the opened anthers.

Uses. When it occurs in great quantities it may be used as manure. It is eaten by some fishes.

Vern. *Indische waterpest*, D, *gangèng*, M, S, J, Md, *gagang*, *ganggang*, *gonggèng*, *lukut tjai*, S, *djari amun*, Minangkabau, *arakankasili*, Tondano, *oma*, Palu (Tado dial.); Philippines: *giñga*, Ibn., *ináta*, *lomotlomotán*, Tag., *lúsai*, Mag.

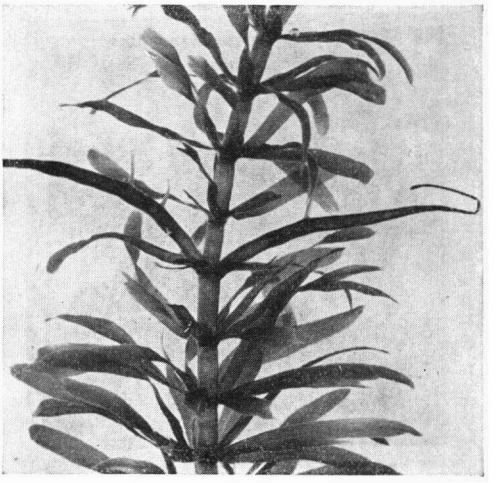

Fig. 3. *Hydrilla verticillata* (L.) ROYLE. ♀ Plant with two fruits developed.

2. VALLISNERIA

MICH. *ex* LINNÉ, Gen. Pl. ed. 5 (1754) 446; Sp. Pl. (1753) 1015; BENTH. & HOOK. *f.* Gen. Pl. 3 (1883) 451.—*Physkium* LOUR. Fl. Coch. (1790) 662, *cf.* MERR. Comm. Lour. (1935) 70.—**Fig. 4.**

Glabrous, dioecious. *Leaves* radical, linear, sheathing at the base, with longitudinal air-channels; apex obtuse, margin faintly dentate or entire; nerves 3–9, parallel, connected by cross-veins, only the midrib reaching the apex, the other nerves gradually joining together near the top. *Male spathe* only shortly peduncled, smaller than the ♀ one, containing many pedicelled flowers which break off and rise to the surface. *Sepals* 3, ovate or oblong-ovate, convex. *Petals* 3, minute. *Stamens* 1–3. *Female spathe* connate, tubular with 2 rounded tops; peduncle very long, spirally contracted after anthesis. *Sepals* 3, ovate or oblong-ovate. *Petals* 3, minute, scarious. Ovary linear, nodding; styles 3, split into 2 lobes. *Fruit* linear, often very long. *Seeds* ∞, oblong to fusiform; testa membranous.

Distr. About 6–10 *spp.* in tropical, subtropical, and the warm-temperate regions, in the Old as well as in the New World.

Ecol. The flower biology of *Vallisneria* has attracted attention long ago; specially the European *V. spiralis* has been the subject of several studies, amongst others by KERNER (Pfl.Leben 2, 1891, 129–131, *cum fig.*).

The ♂ spathe contains a number of flowers which detach in the bud stage, rising to the surface of the water. They remain floating there for some time. The perianth opens abruptly and sepals and stamens

recurve but the latter very soon regain an erect position, in *V. spiralis* widely diverging, in *V. americana* closely approximate. The wall of the anthers shrivels and persists on top of the thick filament as a small appendage, to which the pollen grains adhere.

In the erect ♀ flowers the perianth and the three styles emerge from the water surface.

In *V. spiralis* pollen is transported to the styles if one of the two anthers of a floating ♂ flower comes into contact with one of the styles of the ♀ flowers.

In *V. americana* a similar contact is prohibited by the erect position of the stamens and the horizontal position of the ♀ flowers (*cf.* WYLIE, Bot. Gaz. 63, 1917, 135–145; SVEDELIUS, Svensk Bot. Tidskr. 26, 1932, 1–12, f. 1 c–e, 3 a–b; MARIE-VICTORIN, Contr. Inst. Bot. Un. Montr. *no* 46, 1943). In this species pollen transport is performed if, through wave action, the ♀ flower is temporarily submerged. At that moment, through its hydrophobous epidermis and surface tension, a small depression surrounds the ♀ flower in which pit the ♂ flowers slide down. At that stage, in which the ♀ flower is actually submerged, an air bubble is formed round the styles with which the ♂ flowers are pulled along and pollen transfer can take place. The mechanism strikingly resembles that which is described for *Enhalus acoroides*, see p. 404.

Nothing is yet known of the flower biology in *V. gigantea*.

Note. As several characters cannot be observed in herbarium specimens, *e.g.* the position of the stamens and styles during anthesis, it is in collecting *Vallisneria* species desirable to describe the flowers alive.

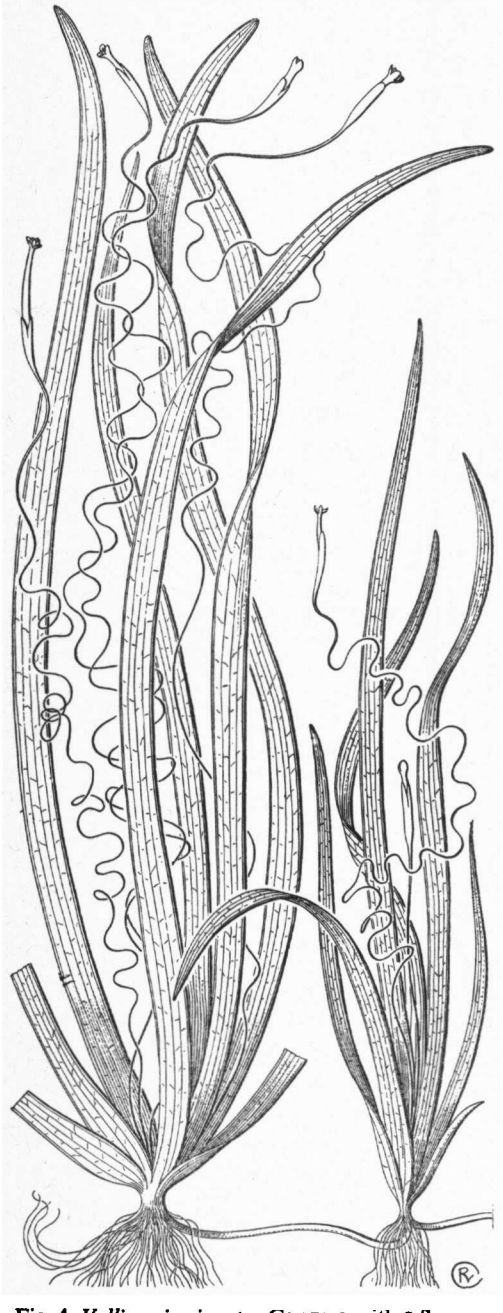

Fig. 4. *Vallisneria gigantea* GRAEBN. with ♀ flowers, × 1/2 (Herb. Philip. 667).

1. Vallisneria gigantea GRAEBNER, Bot. Jahrb. 49 (1912) 68; MERR. Fl. Manila (1912) 69; HALLIER *f.* Nova Guinea 8 (1913) 915; MERR. Sp. Blanc. (1918) 58; BROWN, Min. Prod. Philip. For. 2 (1921) 247; MERR. En. Philip. Fl. Pl. 1 (1922) 26.—*V. spiralis* (*non* LINNÉ) BLANCO, Fl. Filip. ed. 1 (1837) 781; ed. 2 (1845) 538; ed. 3, 3 (1879) 187; BENTH. Fl. Austr. 6 (1873) 259; K. SCH. & LAUT. Fl. Schutzgeb. (1900) 163; GAGNEP. Fl. Gen. I.-C. 6 (1908) 7, f. 4; (Indian form) KENOYER, J. As. Soc. Beng. 15 (1920) 303–304.—*V. spiralis var. subulispatha* MAKINO, J. Jap. Bot. 7 (1931) 6.—*V. subulisphata* KOIDZ. Act. Phytotax. & Geobot. 3 (1934) 147.—*V. asiatica* MIKI, Bot. Mag. Tokyo 48 (1934) 329, *incl. var. biwaensis* MIKI and *var. higoensis* MIKI.—*V. biwaensis* OHWI, Bull. Nat. Sc. Mus. Tokyo 26 (1949) 1.—*V. higoensis* OHWI, Bull. Nat. Sc. Mus. Tokyo 26 (1949) 1.—**Fig. 4.**

Coarse. Stolons *c.* 10 cm, mostly absent. *Leaves* ribbon-like, 15–100 by (1/2–)1–2 cm (sizes depending on the depth of the water); margin faintly dentate, thickened; nerves 5–9; parallel with them there are black and brown stripes which are also visible on the scarious sheath. *Female spathe* 12–20 mm, covering the ovary half-way to 3/4 times of its length, with longitudinal black stripes; peduncles 3–15, coarse, up to 1 m. *Sepals* ovate, convex, 1 3/4–4 by 1–2 mm (of which one a little larger than the other ones), obtuse; green to light-brown-violet, with longitudinal black stripes, glabrous, persistent. *Petals* scarious, *c.* 1/3 mm. *Ovary* 17–25 mm, at 2/3 of the length faintly nodding; styles alternating with the petals, *c.* 2 mm, split into

2 broad, flattened, not fringed lobes to near the base, striped. Ovules ∞, *c.* 1/3–1/4 mm. *Fruit* greenish yellow with black or red-brown stripes, 6–20 cm, crowned by the sepals. *Seeds* ∞, fusiform to cylindrical, 1 1/2–3 mm long.—*Male plants:* unknown in Mal. material. According to MIKI *l.c.*: Spathe oblong; peduncle 2–3 cm long, 2 mm thick. Sepals ovate, reflexed. Stamen 1 (by the fusion of 2), erect. According to KENOYER, however: Stamens 2, widely diverging.

Distr. From S. and E. Asia (Iraq, India, Indo-China, China, Japan, Korea), through Malaysia to E. Australia as far as Tasmania, possibly also in Melanesia (GUILLAUMIN, Fl. Nouv. Caléd. 1948, 22, *sub V. spiralis*), in *Malaysia:* Philippines (Luzon, Mindoro) and New Guinea.

Ecol. In shallow water (1/2–2 m depth) of lakes and slow-running streams and rivers; mostly rooting in sandy and gravelly bottoms, but also found on muddy soil; forming dense vegetations; up to 300 m. *Fl. fr.* Jan.–Dec.

Uses. According to BROWN *l.c.* young leaves are boiled and eaten as a vegetable.

Vern. *Sabután-buáia, cintascintasan,* Tag., *lanteng,* Ibn., *palaipa, baláiba, bal liba,* Ilk., *mariu-bariu,* Bik.

Notes. It has appeared impossible to distinguish, in herbarium material, Malaysian material of *V. gigantea* from the specimens collected in India, Japan, and Australia. From the studies by MIKI and KENOYER it might be concluded that the ♂ flowers of Indian and Japanese specimens are different, but they are seldom found in the herbarium.

The differences between *V. gigantea* and other species are rather unsatisfactory and closer study of living material might show that the genus consists of only one racially differentiated species. A final conclusion can only be drawn on the basis of abundant living material from various sources.

V. spiralis L. differs from *V. gigantea* by the relatively narrower entire leaves (to 1 cm), with always only 5 nerves; ♀ flower mostly smaller than that of *V. gigantea*; spathe covering only the base of the ovary; acute sepals; fringed styles; absence of blackish and brown stripes on leaves, ♀ spathe, and sepals (in *V. spiralis* sometimes black or brown dots).

V. neotropicalis MARIE-VICTORIN, a tropical American species resembles *V. gigantea* very much, but differs by the ciliated margins of the leaves; perianth segments larger (sepals 4–5 1/2 by 2–3 mm, ovate or elliptic, obtuse, shortly apiculate; petals *c.* 1 mm); styles split to 1/3 of the length.

3. BLYXA

NORONHA *ex* THOUARS, Gen. Nov. Madag. 2 (1808) 4; L.C. RICH. Mém. Inst. Paris 12, 2 (1812) 63, 70, 74, t. 4–5; BTH. & HOOK. *f.* Gen. Pl. 3 (1883) 451.—*Diplosiphon* DECNE in Jacquem. Voy. Bot. (1844) 166.—*Hydrotrophus* CLARKE, J. Linn. Soc. Bot. 14 (1875) 8; BTH. & HOOK. *f.* Gen. Pl. 3 (1883) 452.—*Enhydrias* RIDL. J. Bot. 38 (1900) 69.—*Blyxopsis* O.K. in Post & Kuntze, Lexic. (1903) 71, *nom. superfl. pro gen. Enhydrias.*—**Fig. 5–7.**

Submerged stoloniferous plants, monoecious or dioecious. *Leaves* linear, spirally arranged, radical or along a 15–60 cm long stem, base sheathing or semi-amplexicaulous, margin minutely dentate, apex attenuate; nerves parallel, midrib prominent. *Spathe* sessile or peduncled, tubular, with 6 longitudinal ribs, bifid at the tip, 1-flowered, or in ♂ spathes of dioecious plants with up to 10 flowers. *Peduncle* flattened or terete in cross-section, with a nod close under the spathe. *Flowers* unisexual or bisexual, ♀ and ☿ ones sessile, ♂ ones pedicelled. *Sepals* 3, linear or linear-lanceolate, green, persistent. *Petals* 3, linear, longer than the sepals, white, flaccid, fringed. *Stamens* 3, 6 or 9; filaments capillary; anthers linear or lanceolate, bilocular, latrorsely dehiscent. *Ovary* linear, with a long, filiform rostrum, inside with 3 parietal placentas; styles 3, linear, connate at the base. *Fruit* linear or linear-lanceolate; wall membranous. *Seeds* elliptic or fusiform, 1–2 mm; testa glabrous or with 3–8 longitudinal rows of more or less conspicuous tubercles or spines.

Distr. About 10 *spp.* in the Old World tropics from West & Central Africa and Madagascar through South & East Asia and *Malaysia* to North Australia.

Taxon. *Blyxa* has been subdivided by ASCHERSON & GÜRKE (E. & P. Pfl. Fam. 2, 1, 1889, 253) into 2 subgenera, *viz subg. Saivala* (BUCH.-HAM.) ASCHERS. & GÜRKE (dioecious, stamens 6–9) and *subg. Diplosiphon* (DECNE) ASCHERS. & GÜRKE (monoecious, stamens 3). In my opinion this is an artificial division, as the flower structure is in both subgenera very uniform, except for the number of stamens. Furthermore the monoecism of dioecism appears to be of relative value only, as the ♂ flower in the

monoecious species invariably possesses 3 stylodia and ♀ flowers are sometimes provided with one or more stamens.

The *subg. Diplosiphon* has been subdivided into 2 sections by KOIDZUMI (Bot. Mag. Tokyo 31, 1917, 257–258), *viz sect.* '*Acaulis*' and *sect.* '*Caulescens*'. This seems to be a more natural, satisfactory subdivision, but it should be applied to the whole genus, as to *subg. Saivala* one acaulescent and one caulescent species have been referred.

The subdivision of *Blyxa* proposed here is hence:

1. *sect.* **Blyxa.**—*Hydrotrophus* CLARKE, *l.c.*—*Blyxa subg. Diplosiphon sect. Acaulis* KOIDZ. *l.c.* 257.—Leaves radical.—Type: *B. auberti* RICH.

2. *sect.* **Caulescentes** KOIDZ. *l.c.* 258 (*corr. orthogr. mihi*).—*Enhydrias* RIDL. *l.c.*—Leaves on a stem.—Type: *B. japonica* (MIQ.) MAXIM.

Nomencl. The name *S'aiva'la* published by JONES (Asiat. Res. 4, 1799, 275) in his posthumous list of select Indian plants cannot be accepted as a scientific name, although it has been inserted in Ind. Kew. This Sanskrit vernacular name was taken up in WALLICH's Catalogue 5047 for '*Saivala vallisnerioides* B. HAM. *ex* H.B.C.' with the synonym '*Vallisneria 8-andra* ROXB.' It is therefore an illegitimate name.

Note. Species of the *sect. Caulescentes* have been confused by some authors with *Nechamandra alternifolia* (ROXB.) THW. [= *Vallisneria alternifolia* ROXB., *Nechamandra roxburghii* PLANCH., *Lagarosiphon roxburghii* (PLANCH.) BENTH., *Lagarosiphon alternifolia* (ROXB.) DRUCE], which does not occur in Malaysia. Even in the sterile state *Blyxas* are easily recognized by the prominent midrib, *Nechamandra* possessing 4–6 equal, parallel nerves without a prominent one.

KEY TO THE SPECIES[1]

1. Leaves radical (*sect. Blyxa*).
 2. Flowers bisexual. Spathe 1-flowered (rarely 2-flowered). Stamens 3.
  3. Seeds elliptic to ovate, tubercled or echinate.
   4. Seeds with 8 more or less tubercled ribs, without filiform processes . . . . . **1. B. auberti**
   4. Seeds with 8 rows of blunt spines, at both ends with a 1–5 mm long filiform tail **2. B. echinosperma**
  3. Seeds fusiform, smooth . . . . . **3. B. leiosperma**
 2. Flowers unisexual. ♀ Spathe 1-flowered, ♂ one many-flowered. Stamens 9. Seeds with 8 rows of spines, without filiform processes . . . . . **4. B. octandra**
1. Leaves arranged along a stem (*sect. Caulescentes*).
 5. Flowers bisexual. Spathe sessile or very shortly peduncled, 1-flowered. Stamens 3.
  6. Leaves 1–2 mm broad. Seeds with 3–6 rows of more or less blunt spines . . **5. B. alternifolia**
  6. Leaves 1½–3½ mm broad. Seeds smooth . . . . . **6. B. japonica**
 5. Flowers unisexual. Spathe long-peduncled; the ♂ one many-flowered. Stamens 9 **7. B. novoguineensis**

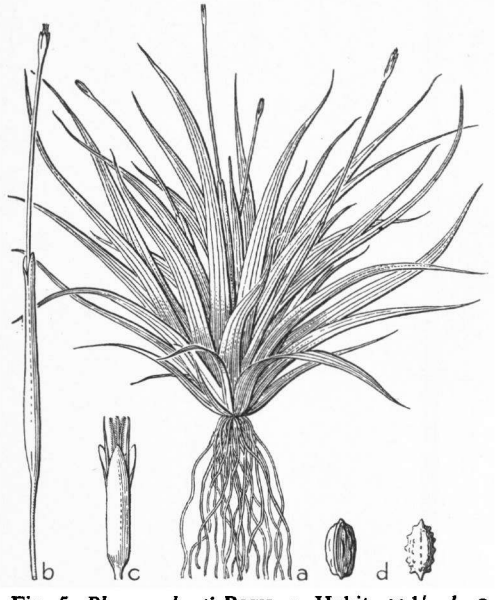

Fig. 5. *Blyxa auberti* RICH. *a.* Habit, × 1/4, *b.* ♀ flower with sheath, *c.* flower, *d.* two seeds, × 5.

1. Blyxa auberti RICH. Mém. Inst. Paris 12, 2 (1812) 19–23, 77, t. 4; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 253; PERRIER DE LA BÂTHIE, Fl. Madag. fam. 26 (1946) 7, f. ii 1–2.—*Diplosiphon oryzetorum* DECNE in Jacquem. Voy. Bot. (1844) 167.—*B. roxburghi* (*non* RICH. 1812) MIQ. Fl. Ind. Bat. 3 (1856) 237; Suppl. (1861) 259.—*B. octandra* PLANCH. *ex* THW. En. Pl. Zeyl. (1864) 332, *pro specimina*.—*B. oryzetorum* HOOK. *f.* Fl. Br. Ind. 5 (1888) 661; GAGNEP. Fl. Gén. I.-C. 6 (1908) 16; STEEN. Trop. Natuur 18 (1929) 199, f. 1, 2a; Arch. Hydrobiol. Suppl. 11 (1932) 272; Trop. Natuur 23 (1934) 40; BACKER, Bekn. Fl. Java (em. ed.) 10 (1949) fam. 203, p. 3.—*B. griffithi* PLANCH. *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 661, *p.p.*—*B. ceylanica* HOOK. *f.* Fl. Br. Ind. 5 (1888) 661; FISCHER, Fl. Pres. Madras 8 (1928) 1397.—*B. malayana* RIDL. Trans. Linn. Soc. II, 3 (1893) 358; Mat. Fl. Mal. Pen. (Monoc.) 1 (1907) 4; Fl. Mal. Pen. 4 (1924) 3; BACK. Handb. Fl. Java 1 (1925) 60; Onkr. Suiker. (1928) 24, Atlas t. 30; BURK. Dict. 1 (1935) 340.—*B. zeylanica* HOOK. *f.* in Trim. Fl. Ceylon 4 (1898) 128.—*B. ecaudata* HAYATA, Ic. Pl. Formos. 5 (1915) 208, f. 77 c–f.—*B. muricata* KOIDZ. Bot. Mag. Tokyo 31 (1917) 258.—*B. coreana* (*non* LÉVEILLÉ) NAKAI, J. Jap. Bot. 19 (1943) 247.—**Fig. 5, 6d–d'.**

(1) Of Asia, Malaysia, and Australia.

Monoecious, acaulous. *Leaves* radical, sheathing at the base, 10–150 by 1/2–1 cm; nerves 5–9, parallel, connected by very thin cross-veins. Peduncles 1 or more, 10–40 cm, often much longer. *Spathe* 1-flowered, up to 10 cm, tips obtuse. *Flowers* bisexual. *Sepals* linear, 7–15 mm, 1-nerved, apex cucullately contracted, margin scarious. *Petals* 10–12 mm. *Stamens* 3; filaments 3–6 mm; anthers linear-lanceolate, 1–2 mm. *Ovary* as long as the spathe; rostrum 3–10 cm, sometimes longer; styles compressed, 6–10 by 1/2 mm. *Fruit* linear, 3–6 cm. *Seeds* ∞, elliptic to ovate, 1–2 mm, testa with 8 longitudinal more or less but distinctly tubercled ribs.

Distr. Widely distributed, from Madagascar and India, northwards to Korea and Japan, eastwards via Malaysia to New Guinea and N. Australia; in *Malaysia:* Sumatra, Malay Peninsula, Banka, Java, Moluccas (Tenimber Isl.), and New Guinea, probably common.

Ecol. In stagnant water of pools, marshes, and wet rice-fields, but also in sluggish streaming rivers, in sunny as well as in shaded spots, often abundant, up to 1250 m. *Fl. fr.* Jan.–Dec.

After flowering fruiting follows very rapidly. The seeds germinate without a resting period. Between the old plants often hundreds of minute seedlings are found, the majority of which perish. According to BARTELS (cf. STEEN. *l.c.* 1934) fishes feed on the seeds which they take from the fruits.

The leaves are variable in size and shape. In specimens growing in shallow water the base is often broadened and the plants obtain a compact habit. Specimens from deeper water have long, ribbon-like leaves, which are narrowed at the base. In deep water the peduncle may be very long, and in anthesis the flower just emerges from the water-level. If the peduncle cannot reach the water-level in water that is too deep, cleistogamy has been observed.

Vern. *Sěsěrowan, tjatjamardan,* S, *seribanju,* M, *rumput lumut,* M.

Note. RICHARD *l.c.* described *B. auberti* as a dioecious species, as he did not find ♂ flowers in his material. As the stamens are very slender and fugacious he has probably overlooked them. In all specimens from Madagascar I studied, I found exclusively bisexual flowers with 3 stamens. The seeds of the Madagascar specimens cannot be distinguished from those of Malaysian and Asiatic specimens.

The lectotype sheet of *B. griffithi* which I studied at Kew, appeared to represent a mixture of *B. auberti* and *B. octandra.*

2. Blyxa echinosperma (CLARKE) HOOK. *f.* Fl. Br. Ind. 5 (1888) 661; MAXIM. *ex* ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 253, f. 187; FISCHER, Fl. Pres. Madras 8 (1928) 1397; STEEN. Trop. Natuur 18 (1929) 199, f. 2b; *ibid.* 23 (1934) 108; RANGASAMY, J. Ind. Bot. Soc. 20 (1941) 123–134, f. 1–29; BACK. Bekn. Fl. Java (em. ed.)10 (1949) fam. 203, p. 3.—*Hydrotrophus echinospermus* CLARKE, J. Linn. Soc. Bot. 14 (1875) 8, t. 1.—*B. lancifolia* HOOK. *f.* Fl. Br. Ind. 5 (1888) 661.—*B. talboti* HOOK. *f.* Fl. Br. Ind. 5 (1888) 661; FISCHER, Fl. Pres. Madras 8 (1928) 1397.—*B. ceratosperma* MAXIM. *ex* ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 253; NAKAI, J. Jap. Bot. 19 (1943) 248.—*B. delavayi* GAGNEP. Bull. Soc. Bot. Fr. 54 (1907) 538.—*B. octandra* (*non* PLANCH. *ex* THW.) MERR. Philip. J. Sc. 7 (1912) Bot. 73.—*B. shimadai* HAYATA, Ic. Pl. Formos. 5 (1915) 209.—*B. somai* HAYATA, Ic. Pl. Formos. 5 (1915) 210, f. 77 g.—*B. echinospermoides* BLATTER, J. Proc. As. Soc. Beng. n.s. 26 (1931) 354.— *B. bicaudata* NAKAI, J. Jap. Bot. 19 (1943) 249.—**Fig. 6a.**

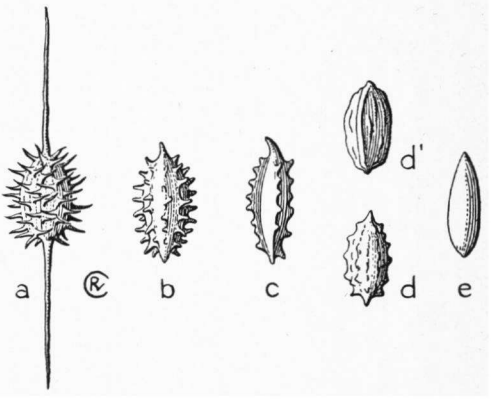

Fig. 6. Seeds of *Blyxas. a. B. echinosperma* (CLARKE) HOOK. *f., b. B. octandra* (ROXB.) PLANCH., *c. B. alternifolia* (MIQ.) HARTOG, *d–d'. B. auberti* RICH. one indistinctly, one more distinctly warty, *e. B. japonica* (MIQ.) Maxim. *ex* A. & G., all × 10 (*a* VAN STEENIS, *b* BRASS 5969, *c* SINCLAIR 10–12–49, *d* DOCTERS VAN LEEUWEN 3796, *d'* BACKER 22908, *e* BRASS 7750).

Monoecious, acaulous. *Leaves* radical, sheathing at the base, 10–120 by 1/2–1 cm; nerves 5–7, parallel, connected by very thin cross-veins. Peduncles 1 or more, 5–30 cm, sometimes much longer. *Spathe* 1-flowered, rarely 2-flowered, 4–10 cm, tips obtuse with scarious margin. *Flowers* bisexual. *Sepals* linear, 1–3 nerved, 6–8 by 1 mm, margin scarious, apex cucullately contracted. *Petals* 13 mm. *Stamens* 3, filaments 3–6 mm; anthers linear-lanceolate, 1–1 3/4 mm. *Ovary* as long as the spathe; rostrum 3 1/2–10 cm, sometimes longer; styles compressed, 7–9 by 1/2 mm, tip obtuse. *Fruit* linear, 3 1/2–7 cm. *Seeds* ∞, elliptic to ovate, 1 1/4–2 by 3/4–1 mm; testa with 8 longitudinal rows of blunt spines, connected by scarious membranes, at both ends with a 1–5 mm long filiform tail.

Distr. Widely distributed in S. and E. Asia (India, Ceylon, Burma, Indo-China, China, Japan, Korea), southwards via Malaysia to tropical Australia, in *Malaysia:* S. Sumatra, Malay Peninsula, Natuna Isl., S. Borneo, W. Java, Philippines (Palawan, Luzon), Moluccas (Key & Aru Isl.), obviously not uncommon.

Ecol. In the same places as *B. auberti* and sometimes growing together with it, but up till now in Malaysia only found at low altitude, up to *c.* 250 m. The roots are often red by precipitated iron compounds from laterite; this is also observed in other *Blyxas*. *Fl. fr.* Jan.–Dec.

Vern. *Lamon ajĕr*, M, Natuna Isl., *rumput ubanan*, M, Djakarta, *kumpai*, S, Bogor.

Note. *Blyxa talboti* HOOK. *f.* was described as having unisexual flowers; HOOKER *f.* knew only female plants. I have studied the type material at Kew which appeared to contain only fruits with ripe seeds; these appeared to be identical with those of *B. echinosperma*, which settles in my opinion their conspecificy.

3. Blyxa leiosperma KOIDZ. Bot. Mag. Tokyo 31 (1917) 257.

Monoecious, acaulous. *Leaves* radical, sheathing at the base, attenuate, 3–13 by 1 1/2–4 mm; nerves parallel, 1–3. Peduncles 1–3, very short 1/4–3 cm. *Spathe* 1-flowered, tips obtuse. *Flowers* bisexual. *Sepals* linear, obtuse, 1-nerved, 6–10 mm. *Petals* white, *c.* 14 mm. *Stamens* 3, filaments capillary; anthers lanceolate. *Ovary* 1–3 cm; rostrum 2–4 cm; styles 3–4 mm. *Fruit* linear, 1 1/2–3 cm. *Seeds* ∞, fusiform, 1 1/2 mm; testa smooth, brown.

Distr. Japan and Hainan (Taam-Chau Distr., Noh Pong Shan, TS'ANG WAI-TAK 878, L.U. 16377, 15–9–1927), twice found, but possibly of wider distribution, not yet found in Malaysia.

Notes. The Hainan sheet was *in sched.* wrongly referred to as *B. octandra* (ROXB.) PLANCH.

The species is distinguished from all other acaulous *Blyxas* by its short peduncle and fusiform, smooth seeds which are highly characteristic; they very much resemble those of the caulescent *B. japonica*, and I cannot distinguish between them.

The Hainan specimens are smaller in size than those from Japan.

4. Blyxa octandra (ROXB.) PLANCH. *ex* THW. En. Pl. Zeyl. (1864) 332, *excl. specimina*; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 253, f. 186; FISCHER, Fl. Pres. Madras 8 (1928) 1397.—*Vallisneria octandra* ROXB. Pl. Corom. 2 (1802) 34, t. 165.—*B. roxburghi* RICH. Mém. Inst. Paris 12, 2 (1812) 23–24, 77, t. 5; BENTH. Fl. Austr. 6 (1873) 258; HOOK. *f.* Fl. Br. Ind. 5 (1888) 660; BAILEY, Queensl. Fl. 5 (1902) 1509; EWART & DAVIS, Fl. North. Terr. (1917) 22.—*B. griffithi* PLANCH. *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 661, *p.p.*—**Fig. 6b.**

Dioecious, acaulous. *Leaves* radical, sheathing and narrowed at the base; 40–60 by 1/2–1 1/4 cm, sometimes much longer; nerves 5–11, parallel, connected by cross-veins. Peduncles 1 or more, 20–120 cm. *Spathes* with 1 female flower, or 5–10 male flowers, 6–10 cm, tips obtuse or acute, with scarious margin. *Sepals* linear, 9–10 by 1 1/2 mm, 1–3 nerved, reddish tinged, apex cucullately contracted. *Petals* 20–25 mm, sometimes longer, 1-nerved. *Stamens* 9; filaments 2–5 mm; anthers 1–2 mm, lanceolate, attenuate. *Ovary* 6–9 cm; rostrum 8–10 cm, but sometimes longer. Styles *c.* 20 mm, faintly hairy. In ♂ plants 3 stylodia connate at the base. *Fruit* linear, 7 1/2–10 cm. *Seeds* ∞, oblong-elliptic, 1–2 by 1/2–1 mm, with one end attenuate, the other end obtuse, without tail at either end; testa with 8 longitudinal rows of more or less long (to 1/2 mm) curved spines.

Distr. Ceylon, India, Burma, Siam, through Malaysia to Australia, in *Malaysia*: S. New Guinea (Middle Fly River, Lake Daviumbu, BRASS 7640 & 7641 and Dagwa, Oriomo River, BRASS 5969).

Ecol. In shallow water, in dense masses, also in shaded small streams. *Fl. fr.* Jan.–Dec.

Note. Sometimes staminodes or well-developed stamens occur in the female flowers. In the material from New Guinea I found a ♀ flower containing one stamen of normal size but the anther appeared to be barren.

5. Blyxa alternifolia (MIQ.) HARTOG, *nov. comb.*—*Hydrilla alternifolia* MIQ. Illustr. (1870) 52.—*Enhydrias angustipetala* RIDL. J. Bot. 38 (1900) 69; Mat. Fl. Mal. Pen. (Monoc.) 1 (1907) 4; WINKLER, Bot. Jahrb. 44 (1910) 518; MERR. En. Born. (1921) 37; RIDL. Fl. Mal. Pen. 4 (1924) 2, f. 160; BURK. Dict. (1935) 924.—*B. angustipetala* MASAMUNE, Trans. Nat. Hist. Soc. Form. 33 (1943) 11, *pro comb., excl. specim.*—**Fig. 6c.**

Monoecious, caulescent. Stems 15–60 cm, ramified. *Leaves* sessile, semi-amplexicaulous, 2–5 cm by 1–1 1/2 mm; midrib connected by very minute cross-veins with the margin; at the leaf base 2 minute axillary, elliptic *squamulae intravaginales*. *Spathe* axillary, sessile, 1-flowered, 1 1/2–2 1/2 cm; tips obtuse. *Flowers* bisexual. *Sepals* linear-lanceolate, acute, 1-nerved, pale green, 3–3 1/2 by 1 mm. *Petals* 1-nerved, silvery white, 5 1/2–7 by 3/4 mm. *Stamens* 3; filaments 2–2 1/2 mm; anthers linear to linear-lanceolate, 3/4–1 mm. *Ovary* 1 1/2–2 cm, rostrum 2 1/2–3 cm; styles 2–2 1/2 mm. *Fruit* linear-lanceolate, 1 1/2–2 cm. *Seeds* 10–20, fusiform, at the ends very acute, 1 1/2–2 mm; testa with 3–6 longitudinal rows of more or less blunt spines, connected by minute scarious membranes.

Distr. Indo-China (Hue: SQUIRES 242) and *Malaysia:* Central Sumatra (Riouw, Pangkalan Kasai: BUWALDA 6775), Malay Peninsula (Malacca, Perlis, and Singapore), Borneo (Martapura, Pontianak, Kuching & Samarahan).

Ecol. Rare lowland species, but locally not uncommon. *e.g.* in the southern part of the Malay Peninsula and Singapore. It forms thick masses in muddy ponds and ditches and may be a pest, growing with great rapidity, often together with *Hydrilla verticillata*, but by its pale green colour it is rapidly distinguished, according to DUNSELMAN, who found it common in ditches near Pontianak. Self-fertilization often occurs, because the stigmas are frequently covered with pollen grains already in bud. *Fl. fr.* Jan.–Dec.

Note. MIQUEL did not describe the seeds, but in the type material of *Hydrilla alternifolia* I found ripe seeds, which could not be distinguished from those of *Enhydrias angustipetala* which proves them to be conspecific. This and the next species show a great similarity in their vegetative parts and can only properly be distinguished by their seeds.

Vern. *Rumput lumut*, M.

6. Blyxa japonica (MIQ.) MAXIM. *ex* ASCHERS. & GÜRKE, E. & P. Pfl. Fam. 2, 1 (1889) 253; KOIDZUMI, Bot. Mag. Tokyo 31 (1917) 258; NAKAI, J. Jap. Bot. 19 (1943) 245, *cum fig.*—*Hydrilla ?japonica* MIQ. Ann. Mus. Bot. Lugd. Bat. 2 (1866) 271; Illustr. (1870) 54.—*B. caulescens* MAXIM. *ex* MAKINO, Bot. Mag. Tokyo 4 (1890) 173; MATSUMURA, Ind. Fl. Jap. 2, 1 (1905) 31; NAKAI, Fl. Kor. 2 (1911) 216.—*B. leiocarpa* MAXIM. *ex* MAKINO, Bot. Mag. Tokyo 4 (1890) 416, *nomen nudum.*—*Enhydrias angustipetala* (*non* RIDLEY) GAGNEP. Fl. Gén. I.-C. 6 (1908) 17, f. 1, C 13–22.—*B. laevissima* HAYATA, Ic. Pl. Formos. 5 (1915) 208, f. 77 a–b.—*Enhydrias angustipetala var. latifolia* RIDL. Fl. Mal. Pen. 4 (1924) 2.—*B. angustipetala* MASAMUNE, Trans. Nat. Hist. Soc. Form. 33 (1943) 11; Fl. Kainant. (1943) 348, *pro specimina, non Enhydrias angustipetala* RIDL.—**Fig. 6e.**

Monoecious, caulescent. Stems 15–60 cm, ramified. *Leaves* sessile, semi-amplexicaulous, 1½–5 cm by 1–3½ mm; midrib accompanied by 6 inconspicuous very fine, parallel veins, connected by very fine cross-veins. *Spathe* axillary, sessile, sometimes very shortly stalked, 1-flowered, 1½–2½ cm, longitudinal ribs sometimes serrulate, tips acute or obtuse. *Flowers* bisexual. *Sepals* linear-lanceolate, 1-nerved, 3–4 by ¾–1 mm, apex acute. *Petals* 6–10 by ½–1 mm, 1-nerved. *Stamens* 3; filaments 1–2 mm; anthers linear-lanceolate, apex attenuate, ¾–1 mm. *Ovary* 1½–2 cm; rostrum 2–3 cm; styles 2½–4 mm. *Fruit* linear-lanceolate, 1½–2 cm by 2½–4 mm. *Seeds* 10–40, fusiform, 1–2 by ¼–½ mm; testa smooth.

Distr. Widely distributed in S. & E. Asia from Bengal and Nepal, northeastwards to Korea and Japan and southwards through Formosa and Malaysia to New Guinea; in *Malaysia* rare: Malay Peninsula (several stations in Perak and the Dindings), Banka (Bakem, Soengei Liat), Borneo (without locality), SE. Celebes (Lepo Lepo near Kendari: BECCARI 9957) and New Guinea (Middle Fly River, Lake Daviumbu: BRASS 7750).

Ecol. Growing in wet sago-swamps, rice-fields, and stagnant pools, exclusively in the lowland, in the Himalayas found up to 1200 m. *Fl. fr.* Jan.–Dec.

7. Blyxa novoguineensis HARTOG, Act. Bot. Neerl. 6 (1957) 47.—**Fig. 7.**

Dioecious, caulescent, ramified. *Leaves* sessile, semi-amplexicaulous, 6–8 cm by 2–3 mm; midrib accompanied by 6–8 parallel inconspicuous veins, connected in their turn by very fine cross-veins. Peduncle axillary, ½ to 15–18 cm, elongating during anthesis. *Spathe* 2½–4 cm, with 5–8 ♂ flowers, tips obtuse. Pedicels 5–7 cm. *Sepals* linear-lanceolate, acute, 1-nerved, green with a dark spot near the apex; 4–5 by 1½ mm. *Petals* 12–15 by 1 mm. *Stamens* 9; filaments 2–3 mm; anthers linear-lanceolate, apex acuminate, 1½–2 by ¼–⅓ mm. Carpel rudiments 3, ovate, 1 mm long, with a 2½–3 mm long slender stylode. Female plants not yet known.

Distr. *Malaysia*: S. New Guinea (Middle Fly River, Lake Daviumbu: BRASS 7638).

Ecol. Very abundant in the lake, in water 1–1½ fathoms deep. *Fl.* Sept.

Fig. 7. *Blyxa novoguineensis* HARTOG, ♂ plant, × ⅗ (BRASS 7638, type).

Doubtful

Blyxa javanica HASSK. Tijd. Nat. Gesch. & Phys. 10 (1843) 121, *nom. nud.*; Cat. Hort. Bog. (1844) 34; ZOLL. Syst. Verz. 1 (1854) 69, *nom. nud.*—The material on which HASSKARL based this species no doubt belongs to *Blyxa*, but as it has no fruits it cannot be identified specifically with certainty. ZOLLINGER 1025 (P) is also sterile.

4. HYDROCHARIS

LINNÉ, Gen. Pl. ed. 5 (1754) 458; Sp. Pl. ed. 1, 2 (1753) 1036; BTH. & HOOK. *f.* Gen. Pl. 3 (1883) 452; SOLEREDER, Beih. Bot. Centralbl. 30, i (1913) 94–98.—**Fig. 9.**

Glabrous, monoecious. Stolons originating from the leaf axils, with gemmulae at the top. *Leaves* swimming or emerged; ovate to suborbicular; apex rounded or acute; base more or less cordate or reniform; on the central part of the under-surface of the swimming leaves mostly a coarsely meshed aerenchym-cushion; nerves curved, parallel, joining the marginal nerve, connected by straight, parallel cross-veins, in their turn connected again by very fine veinlets, parallel with the nerves; petiole near the base with 1 or 2 lingulate, transparent, scarious stipules. *Spathal* segments lanceolate, membranous, unisexual; the male spathe peduncled, containing 1–4 flowers, the female one sessile, 1-flowered. Pedicels of the ♂ flowers short, those of the ♀ flowers rather long. *Sepals* 3, elliptic, obtuse, white or greenish white, persistent. *Petals* 3, larger than the sepals, broad-obovate, with broadly rounded apex and cuneate persistent base, shortly unguiculate. *Stamens* 9–12, anthers bilocular, latrorsely dehiscent. *Ovary* elliptic, nearly 6-celled; styles 6, flat, bifid. *Fruit* berry-like, elliptic to globose, with 6 ribs, bursting irregularly at the apex. *Seeds* ∞, elliptic.

Distr. Three species in the Old World, *viz H. morsus-ranae* L. in Europe, Asia Minor, and Algeria, *H. chevalieri* (DE WILD.) DANDY in Central Africa, and *H. dubia* (BL.) BACKER from Asia to Australia.

1. Hydrocharis dubia (BL.) BACKER, Handb. Fl. Java 1 (1925) 64; DANDY, J. Bot. 70 (1932) 328; COERT, Trop. Natuur 23 (1934) 28; BACK. Bekn. Fl. Java (em. ed.) 10 (1949) fam. 203, p. 5.—*Pontederia ? dubia* BL. En. Pl. Jav. 1 (1827) 33.—*H. cellulosa* BUCH.-HAM. *ex* WALL. Cat. *no* 5042 (1831–32), *nomen nudum.*—*Monochoria ? dubia* MIQ. Fl. Ind. Bat. 3 (1859) 549.—*H. asiatica* MIQ. Fl. Ind. Bat. 3 (1856) 239; Illustr. (1870) 55; ASCHERS. & GÜRKE in E. & P. Nat. Pfl. Fam. 2 (1889) 258; GAGNEP. Fl. Gén. I.-C. 6 (1908) 8, f. 5; HALLIER *f.*, Nova Guinea 8 (1913) 917; SOLEREDER, Beih. Bot. Centralbl. 30, i (1913) 97; Med. Rijksherb. *no* 21 (1914) 1–2; HAYATA, Ic. Pl. Form. 4 (1914) 23.—*H. morsus-ranae* (*non* L.) F.v.M. Fragm. 6 (1868) 199; BTH. Fl. Austr. 6 (1873) 256; BOISS. Fl. Or. 5 (1881) 5; HOOK. *f.* Fl. Br. Ind. 5 (1888) 662; BAILEY, Queensl. Fl. 5 (1902) 1510; BACKER, Teysmannia 22 (1911) 764.—*Boottia renifolia* MERR. Philip. J. Sc. 4 (1909) Bot. 247; STEEN. Arch. Hydrobiol. Suppl. 11 (1932) 239.—*H. parnassifolia* HALLIER *f.* Nova Guinea 8 (1913) 916; SOLEREDER, Med. Rijksherb. *no* 21 (1914) 1–2.—*H. parvula* HALLIER *f.* Nova Guinea 8 (1913) 916; SOLEREDER, Med. Rijksherb. *no* 21 (1914) 1–2.—**Fig. 9.**

Monoecious, sometimes apparently dioecious. Stolons 15–25 cm; gemmulae curved, subulate, at the base often with rootlets, 9–20 by 2–4 mm. *Leaves* emerged and often swimming, ovate-cordate to broad-ovate, 2½–6 by 2½–7½ cm; apex obtusely rounded to broad acute; base more or less cordate or reniform, often truncate, sometimes cuneate; on the central part of the under-surface of the swimming leaves a well-developed, projecting, aerenchym-cushion, disappearing in old specimens; nerves 7–9, cross-veins ascending under an angle of 70°–80°, 1–6 mm spaced, veinlets very fine, ½ mm spaced; petiole thickened towards the base, with wide air-channels, 2½–15 cm, septations 3–4 mm spaced. Stipule 1, obtuse, ½–2½ cm. *Spathe* 1–2½ by ½ cm; the ♂ one up to 2½ cm peduncled; female spathe often smaller than the male one. Pedicels of the ♂ *flowers* slender, 3–6 mm; those of the ♀ ones 1–8½ cm, after anthesis recurved, 1½–2 mm thick. *Sepals* 4–8 by 2½–4½

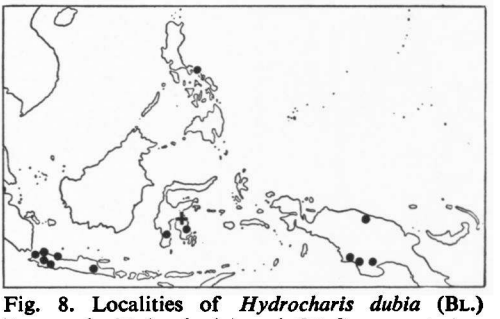

Fig. 8. Localities of *Hydrocharis dubia* (BL.) BACKER in Malaysia (•) and *Ottelia mesenterium* (HALL. *f.*) HARTOG (+).

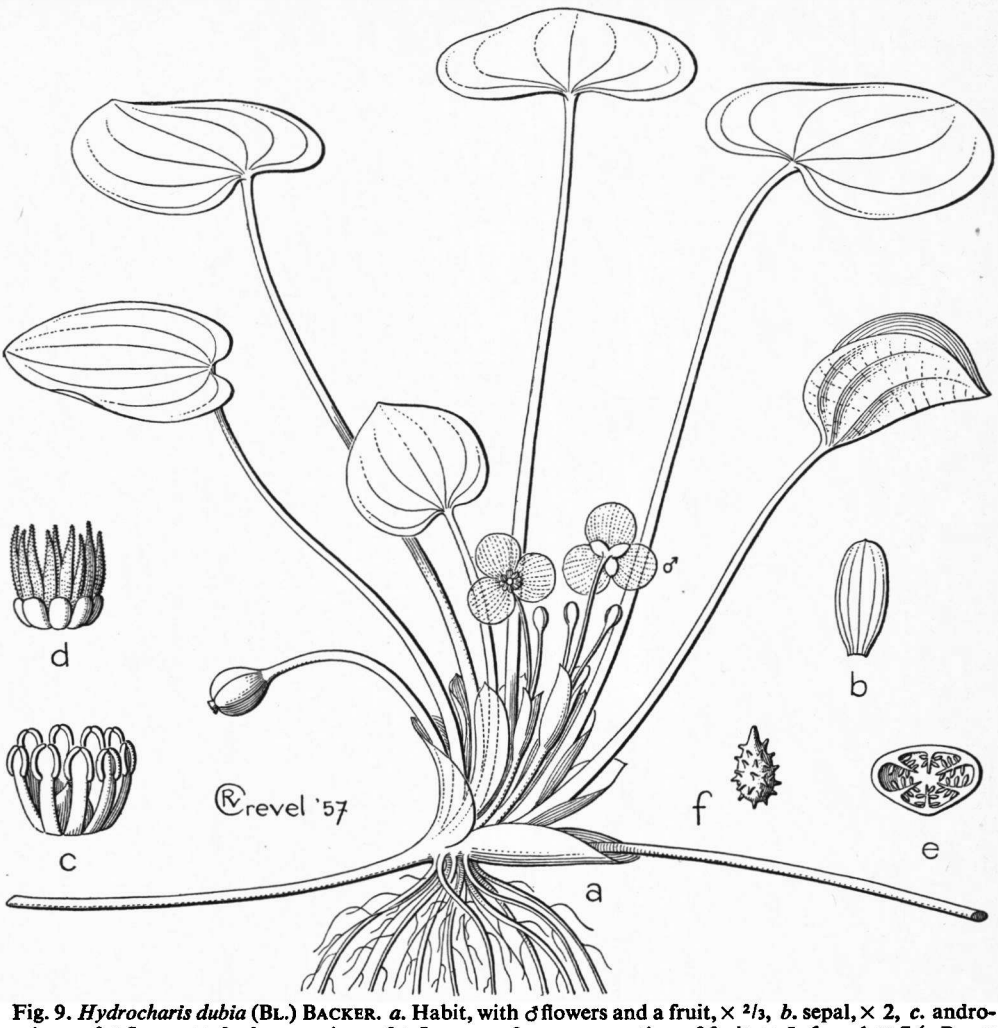

Fig. 9. *Hydrocharis dubia* (BL.) BACKER. *a.* Habit, with ♂ flowers and a fruit, × 2/3, *b.* sepal, × 2, *c.* androecium, of ♂ flower, × 3, *d.* gynaecium of ♀ flower, × 3, *e.* cross-section of fruit, × 5, *f.* seed, × 7 (*a* BRASS 8161, *b–f* after GAGNEPAIN, Fl. Gén. I.-C. 6)

mm, parallel-striped, with brownish spots. *Petals* white or rarely pale yellow, 8–15 mm; claw yellow. *Stamens* 12, 2 before each sepal and each petal, one before the other; the inner epipetalous stamens are staminodial or have a very small, orange-yellow anther; filaments dilated, yellow, hairy, 3½ mm; anthers oblong, basifix, 1–1½ mm; connective broad. ♀ *Flower* with 3 pairs of linear, yellow, episepalous staminodes, those of each pair free or connate; before the petals a nectary. *Ovary* oblong-elliptic, 5–6 by 2½ mm; styles split halfway in 2 arms, yellow, hairy; in the ♂ flowers a glabrous, ribbed, yellow, knoblike rudiment of the carpels. *Fruit* 5–10 by 4–8 mm, filled with a tough mucilage. *Seeds* 1–1½ mm; testa echinate.

Distr. From S. & E. Asia to N. Australia, in *Malaysia:* Java (Bantam: Danu Swamp; G. Sahari-Sentiong in the vicinity of Djakarta; E. of Djakarta: Rawa Tĕmbaga; Preanger: Pasir Kiamis, Rawa Lakbok; Kediri: Rawa Bĕning), S. Celebes (SW. Peninsula: Tempé Lake; SE. Peninsula: Aopa Swamp near Kĕndari), Philippines (Luzon, Camarines Prov.: Bicol River); New Guinea (Sentani Lake; Okaba; Merauke; Lower Fly River, near Sturt Isl.). Fig. 8.

Ecol. Free swimming, or in shallow water rooting in the bottom, in the latter case with many emerged leaves; in pools and marshes, locally gregarious, for example in the Papuan (*Melaleuca leucadendron*) swamp forest, to 1200 m; *fl. fr.* Jan.–Dec.

Use. Sometimes cultivated in fish-ponds as water cover.

Vern. *Frog-bit*, E, *kikkerbeet, duitblad*, D, *ètjèng lalakki*, S, *mangok mangok*, Merauke.

5. LIMNOBIUM

RICH. Mém. Inst. Paris 12, 2 (1812) 32, 66, t. 8; RYDBERG, N. Amer. Fl. 17 (1909) 74; HUTCHINSON, Fam. Fl. Pl. 2 (1934) 31.—*Hydromystria* G. MEYER, Fl. Esseq. (1818) 152; RYDBERG, N. Amer. Fl. 17 (1909) 74.

Monoecious, glabrous. Stolons originating from the leaf axils. *Leaves* radical, swimming or emerged, elliptic or ovate to suborbicular, apex rounded or obtuse, base cuneate, rounded or cordate, under-surface of the swimming leaves covered by an often very thick aerenchym cushion; nerves curved, parallel, joining the marginal nerve, connected by straight, parallel, ascending cross-veins in their turn connected by very fine, parallel veinlets; petiole near the base with a lingulate, transparent, scarious stipule. *Spathe* segments linear-lanceolate, membranous, unisexual; containing 3–9 ♂ flowers or 1 ♀ one; ♂ and ♀ flowers pedicelled. *Sepals* 3, oblong or lanceolate. *Petals* 3, linear-lanceolate, narrower than the sepals and only up to about 1½ times as long, wanting or reduced in the ♀ flowers of some species. *Stamens* 6–12; anthers 2-locular, latrorsely dehiscent. *Ovary* elliptic; styles 6, bifid. *Fruit* berry-like, elliptic. *Seeds* ∞, subglobose.

Distr. A few species in America, in the tropical as well as in the temperate regions, in *Malaysia* introduced.

1. Limnobium stoloniferum (G. MEYER) GRISEBACH, Fl. Br. W. Ind. (1861) 506; VAAS, Bĕrita Pĕrikanan 2 (1950) 168.—*Hydromystria stolonifera* G. MEYER, Fl. Esseq. (1818) 153; ASCHERS. & GÜRKE, E. & P. Pfl. Fam. 2, 1 (1889) 258; BOTTINI, Malpighia 4 (1890) 340–348, 369–377; RYDBERG, N. Amer. Fl. 17 (1909) 74; HAUMAN-MERCK, An. Mus. Hist. Nat. Buenos Aires 27 (1915) 325–331.

Leaves swimming, elliptic to ovate, obtuse, 1¾–2½ by 1–1½ cm, base rounded or cuneate, margin undulate, entire; under-surface covered by a very thick, projecting aerenchym cushion; nerves 5(–7); cross-veins ascending at an angle of *c.* 70°, 2–3 mm spaced; petiole triquetrous, septated, 1½–2 cm (in American specimens much longer); stipule 7–8 mm. *Spathe* 1½–2½ cm long, the ♂ one containing 1–3 flowers, pedicels 3–6 cm; ♀ pedicels after anthesis recurved. *Sepals* white, obtuse, 4–5 by 1½ mm, spreading. *Petals* white, obtuse, 5–7 by 1–1¼ mm, ascending, wanting or strongly reduced in the ♀ flower. *Stamens* 6, filaments partly connate into a tube, 2 mm; anthers linear, 2 mm. Staminodes (in ♀ flower) not seen. *Ovary* 5 mm; styles 1 cm, deeply split. *Fruit* 5–6 mm. *Seeds* 1–1¼ mm, apiculate, at the basal end a part of the funicle; testa brown, reticulate, with numerous, blunt, spirally ribbed spines.

Distr. South & Central America and the West Indies, in *Malaysia* introduced: W. Java (Tĕgalĕga, S. margin of the town of Bandung, VAAS, *l.c.*).

Ecol. In Java found once in very eutrophic, polluted freshwater fish-ponds (Oct. 1950, leg. K. F. VAAS) together with *Pistia*, *Lemna*, and *Eichhornia*, at *c.* 750 m; water rich in Ca and p_H 7–8. According to BOTTINI *l.c.* the species is anemophilous; HAUMAN-MERCK *l.c.*, however, supposes it to be partly anemophilous and partly hydrophilous.

Note. The description of the floral and fruiting part of the plant has been made after American specimens, as the Malaysian material was sterile.

6. OTTELIA

PERS. Syn. Pl. 1 (1805) 400; BTH. & HOOK. *f.* Gen. Pl. 3 (1883) 453; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 257; SOLEREDER, Beih. Bot. Centralbl. 30, i (1913) 85–90; DANDY, J. Bot. 72 (1934) 132–139.—*Damasonium* SCHREB. in Linné, Gen. Pl. ed. 8, 1 (1789) 242, *non Damasonium* MILL. (1754).—*Hymenotheca* SALISB. Trans. Hort. Soc. 1 (1812) 268, *nomen nudum*, non F.v.M. (1859).—*Boottia* WALL. Pl. As. Rar. 1 (1830) 51, *non Bootia* BIGEL. (1824); BTH. & HOOK. *f.* Gen. Pl. 3 (1883) 453; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 255; SOLEREDER, Beih. Bot. Centralbl. 30, i (1913) 90–94.—*Oligolobos* GAGNEP. Bull. Soc. Bot. Fr. 54 (1907) 542.—*Xystrolobos* GAGNEP. Bull. Soc. Bot. Fr. 54 (1907) 544.—**Fig. 10–12.**

Fig. 10. *Ottelia alismoides* (L.) PERS., × 1/3.

Monoecious or dioecious, glabrous. *Leaves* linear, lanceolate, broad-ovate, suborbicular, cordate or reniform, apex rounded, acute or apiculate, base cuneate, truncate or cordate; nerves 3–11, parallel, straight or curved, connected by fine parallel cross-veins, forming often a very characteristic pattern, midrib sometimes prominent; petiole sheathing at the base, often gradually merging into the blade. *Spathe* peduncled, elliptic or ovate, with 6 more or less prominent ribs or 2–10 wings; ♀ and ☿ ones 1-flowered, ♂ ones many-flowered. *Flowers* unisexual or bisexual, ♀ and ☿ ones sessile, ♂ ones pedicelled. *Sepals* 3, linear, oblong or ovate, green with scarious margin, persistent. *Petals* 3, oblong, broad-obovate to orbicular, 2–3 times as long as the sepals, white or coloured. *Stamens* 6–15; filaments filiform, flattened; anthers linear or oblong, latrorsely dehiscent. *Ovary* oblong, narrowed at the top, incompletely divided by the parietal placentas into 6 cells; *styles* 6–15, bifid. (In the ♂ flowers 3 stylodia are present.) *Fruit* oblong, apex attenuate, pericarp thickened. *Seeds* ∞, minute, oblong or fusiform, with rather thick testa.

Distr. About 40 *spp.* almost exclusively distributed in the palaeotropics, extending from Africa through India & SE. Asia to Korea & Japan, *Malaysia* (2 *spp.*), Australia, and New Caledonia, 1 species in Brazil; centres of specific development are found in Central Africa and South China.

Note. I agree with DANDY (J. Bot. 72, 1934, 132–139), that the genera *Boottia*, *Xystrolobos* and *Oligolobos* can not be maintained separate from *Ottelia*. The characters by which these genera were distinguished, *viz* dioecism or the monoecism of the plants, uni- or bisexual flowers, and the number of the flowers in the spathe, though constant for the species, appear to be artificial for grouping of species into genera, subgenera or sections, as by using these characters on the supraspecific level species which are clearly closely allied must be assigned to different genera or infrageneric taxa. DANDY *l.c.* proposed 3 subgenera, based on the structure of the spathe. They are the following:

1. *subg.* **Ottelia** (*Otteliastrum* DANDY). Spathe with 5–10, often very broad wings, sometimes more or less obsolete, and then sometimes difficult to distinguish from *subg. Boottia.*

2. *subg.* **Dipteron** DANDY. Spathe with 2 opposite wings.

3. *subg.* **Boottia** (WALL.) DANDY. Spathe without wings, but more or less prominent ribs are present.

Of the two Mal. species *O. alismoides* belongs to *subg. Ottelia* and *O. mesenterium* belongs to *subg. Boottia.*

In *O. ovalifolia* (R.Br.) RICH. which occurs in New Caledonia and Australia, but has not yet been found in Malaysia, Mrs ERNST-SCHWARZENBACH (Phytomorph. 6, 1956, 296–311) has described the occurrence of cleistogamous flowers.

KEY TO THE SPECIES

1. Leaves broad-ovate or suborbicular with cordate or truncate base, sometimes lanceolate, transparent. Spathe 1-flowered, 5–10-winged. Flowers bisexual, sessile. Stamens 6(–9) . . . **1. O. alismoides**
1. Leaves linear, strongly crisped. Spathe with 6 entire ribs, ♀ ones 1-flowered, ♂ ones with up to 10 long-pedicelled flowers. Stamens 12 . . . . . **2. O. mesenterium**

1. Ottelia alismoides (L.) PERS. Syn. Pl. 1 (1805) 400; RICH. Mém. Inst. Paris 12, 2 (1812) 27–31, 65, 71, 74, 78, t. 7; BLANCO, Fl. Filip. ed. 1 (1837) 461; ed. 2 (1845) 321; ed. 3, 2 (1878) 230; MIQ. Fl. Ind. Bat. 3 (1856) 240; Suppl. (1861) 259; THW. En. Pl. Zeyl. (1864) 332; F.v.M. Fragm. 6 (1868) 199; MIQ. Illustr. (1870) 55; BTH. Fl. Austr. 6 (1873) 257; HOOK. *f.* Fl. Br. Ind. 5 (1888) 662; ASCHERS. & GÜRKE, E. & P. Pfl. Fam. 2, 1 (1889) 257, f. 190; KOORD. Minah. (1898) 271; K. SCH. & LAUT. Fl. Schutzgeb. (1900) 164; BAILEY, Queensl. Fl. 5 (1902) 1510; HEMSL. J. Linn. Soc. Bot. 36 (1903) 3; RIDL. Mat. Fl. Mal. Pen. (Monoc.) 1 (1907) 5; WINKLER, Bot. Jahrb. 44 (1910) 518; BACKER, Teysmannia 22 (1911) 509; HAYATA, Ic. Pl. Form. 5 (1915) 210; EWART & DAVIS, Fl. North. Terr. (1917) 22; MERR. Sp. Blanc. (1918) 59; MERR. En. Born. (1921) 37; BROWN, Min. Prod. Philip. For. 2 (1921) 247; *ibid.* 3 (1921) 169; RIDL. Fl. Mal. Pen. 4 (1924) 3; BACK. Handb. Fl. Java 1 (1925) 63; MERR. Lingn. Sc. J. 5 (1927) 23; BACK. Onkr. Suiker. (1928) 25, Atlas t. 31; FISCHER, Fl. Pres. Madras 8 (1928) 1398; COERT, Trop. Natuur 23 (1934) 28, f. 13; DANDY, J. Bot. 73 (1935) 216; STEEN. Trop. Natuur 23 (1934) 39; BURK. Dict. 2 (1935) 1614; MERR. & METCALF, Lingn. Sc. J. 17 (1938) 567; TÄCKHOLM & DRAR, Fl. Egypt 1 (1941) 124; MASAMUNE, En. Phan. Born. (1942) 9; BACK. Bekn. Fl. Java (em. ed.) 10 (1949) fam. 203, p. 4; ERNST-SCHWARZENBACH, Phytomorph. 6 (1956) 306.—*Ottel ambel* RHEEDE, Hort. Mal. 11 (1692) 95, t. 46.—*Stratiotes alismoides* LINNÉ, Sp. Pl. 1 (1753) 535.—*Damasonium indicum* WILLD. Sp. Pl. 2 (1799) 276; ROXB. Pl. Corom. 2 (1805) 45, t. 185; Bot. Mag. (1809) t. 1201; BL. En. Pl. Jav. 1 (1827) 30; SPAN. Linnaea 15 (1841) 477.—*Damasonium javanicum* BL. En. Pl. Jav. 1 (1827) 30.—*O. ensiformis* BLANCO, Fl. Filip. ed. 1 (1837) 460; ed. 2 (1845) 320; ed. 3, 2 (1878) 229.—*O. javanica* MIQ. Fl. Ind. Bat. 3 (1856) 240; Illustr. (1870) 56; GAGNEP. Fl. Gén. I.-C. 6 (1908) 14.—*O. indica* PLANCH. *ex* DALZ. & GIBS. Bomb. Fl. (1861) 278.—*O. japonica* MIQ. Ann. Mus. Bot. Lugd. Bat. 2 (1866) 271; GAGNEP. Fl. Gén. I.-C. 6 (1908) 13.—*O. condorensis* GAGNEP. Bull. Soc. Bot. Fr. 54 (1907) 543; Fl. Gén. I.-C. 6 (1908) 14, t. I B, 7–12; DANDY, J. Bot. 72 (1934) 138.—*O. philippinensis* OSTENF. Philip. J. Sc. 9 (1914) Bot. 259.—**Fig. 10–11.**

Leaves submerged, often partly emerged, broad-ovate, suborbicular or cordate-reniform, thin, light-green, transparent, margin entire, sometimes dentate, 7–22 by 4½–21 cm; base shallowly cordate (basal lobes obtuse) or truncate; apex rounded, obtuse, sometimes apiculate; besides the normal leaves linear phyllodes (7–10 by ¾–1 cm) and lanceolate leaves with an attenuate apex and the base gradually merging into the petiole are also sometimes present; nerves 7–11, curved, parallel, joining the marginal nerve, connected by cross-veins ascending under an angle of 60–70° and 3–8 mm spaced; these in turn connected by veins of the same order, parallel with the nerves, giving the nervation a rhomboid appearance; rhombs divided into a great number of lesser order by many parallel longitudinal and cross-veinlets; within these little rhombs a very fine reticulum; petiole triangular in cross-section, with longitudinal air-channels, at the base with a broadened pale sheath, sometimes denticulate, 8–50 cm, septations 2–5 mm spaced. Peduncle 4–5-angular, 10–30 cm, in fruit sometimes spirally contracted. *Spathe* elliptic to ovate, with 2 acute tips, glabrous, rarely with seriate tubercles, 1-flowered, 2½–4(–6) cm; wings 5–10 of which 2 are more developed than the other ones, up to ½–1 cm broad, sometimes, however, obsolete, and only visible as ribs, ± flat or crisped, entire, sometimes denticulate. *Flowers* bisexual, sessile. *Sepals* linear or narrow-oblong, apex obtuse, 1-nerved, 10–16 by 2–4 mm. *Petals* obovate with rounded apex, pure white with yellow-spotted base, rarely yellow, obliquely erect, 20–30 mm. *Stamens* 6(–9); filaments with glandular hairs, 4 mm; anthers linear, yellow, basifix, 3½–4½ by ½–¾ mm. *Pollen grains* densely set with numerous, minute tubercles. *Ovary* 2–4 by ½–¾ cm; styles 6(–9), from near the base split into 2 unequal, papillose or hairy arms which are often adhering together with the flat sides, 6–10 mm. *Fruit* oblong-elliptic, rostrate, crowned by the sepals, 2–4 cm long, bursting irregularly near the top. *Seeds* ∞, fusiform, 1–2 by ⅓–⅔ mm.

Distr. Widely distributed, NE. Africa and common in SE. Asia, extending from India eastward to China and Japan, southward throughout *Malaysia* to tropical Australia and the Solomon Isl.; recently found introduced as an alien in the North Italian rice-fields.

Ecol. Common in slow streams and stagnant pools mostly at low altitude but up to 700(–1000 m), often abundant forming a gregarious vegetation on the muddy bottom, going down to 1½ m depth. In very shallow water the tops of the leaves are emerged, in deeper water only the flower is emerged (floating) during anthesis. After pollination the flower is (often) submerged again by contraction of the coiling peduncle. It is not certain whether insects play a part by the pollination in this species. *Fl. fr.* Jan.–Dec.

Pollination. Mrs ERNST-SCHWARZENBACH ob-

served that the peduncles often do not reach the surface of the water (Phytomorph. 6, 1956, 306–307), in which case self-fertilization takes place in the closed, submerged flowers. After lowering of the water level such pollinated flowers may occasionally still open.

Morph. & taxon. The species is exceedingly variable in vegetative characters, depending largely on the depth of the water in which it grows. Plants leaves has been described by GAGNEPAIN *l.c.* from Indo-China as *O. condorensis*. I have seen similar specimens also from the Malay Peninsula (State of Selangor, Ampang, 26–5–'21, HUME 1350). Such phaenotypic forms have no systematic value.

Uses. According to W. H. BROWN (1921 *a*) the fruit is eaten by children; the petioles and leaf blades are used as vegetable. According to him (1921 *b*) the leaves are used in topicals to cure

Fig. 11. *Ottelia alismoides* (L.) PERS. in flower and fruit. Kebun Raya Indonesia June 1956 (photogr. F. HUYSMANS).

in rather deep water have very large broad-ovate, elliptic-ovate or even suborbicular leaves; in less deep water the leaves are smaller, and in very shallow water they are reduced to 5–10 cm length; in the latter case the leaves are ovate with broad-acute apex and cuneate base, while the spathal wings are rather obsolete; this is the form described as a separate species, *O. japonica*. In running water the leaf shape is also very variable; in slow streams leaves are slightly elongated, but in swift running water they become oblong, lanceolate or even strap-shaped. During development from juvenile to mature plants the leaf shape changes in the following sequence: the initial leaves are linear, they are (gradually) followed by lanceolate leaves, then appear elliptic leaves, and finally the broad ovate ones. I have seen all four types of leaves present on a single individual plant. Sometimes young plants develop flowers before the ovate leaves have been formed. Such a (± precociously flowering) form with only lanceolate hemorrhoids. It has been claimed that the plant has rubefacient properties.

Vern. *Duikerbloem*, D, *ètjèng hai-hai*, *tjowèhan*, *tjitjikuran*, S, *bengok*, *kĕladi ayĕr*, *kalago*, M, *tundjung birun*, *krangkong*, J, *ganggang*, Borneo, *lawe lawe*, SW. Celebes, *lila lĕlangko*, Tl near Tondano Lake; Philippines: *tangila*, *espada*, Spanish (Philip.), *kalaboa* or *kalabua*, Bulacan & Rizal on Luzon, *lantén-sápa*, Luzon, Bataan, *lanting*, Luzon, Camarines, *tarabang*, Mindoro.

Note. In North Siam and Indo-China a closely related species occurs *viz O. lanceolata* (GAGNEP.) DANDY (*syn. Boottia lanceolata* GAGNEP. & *Boottia alata* GAGNEP.). Because of the vegetative similarity it can only be distinguished in flowering condition by the following characters: dioecious; ♀ spathe 1-flowered, ♂ spathe with many pedicelled flowers; spathes with 6 wings, at the top with 2 obtuse lobes; stamens 9, unequal, the inner ones twice as long as the outer ones, 11–12 mm. This might possibly be found in NW. Malaysia.

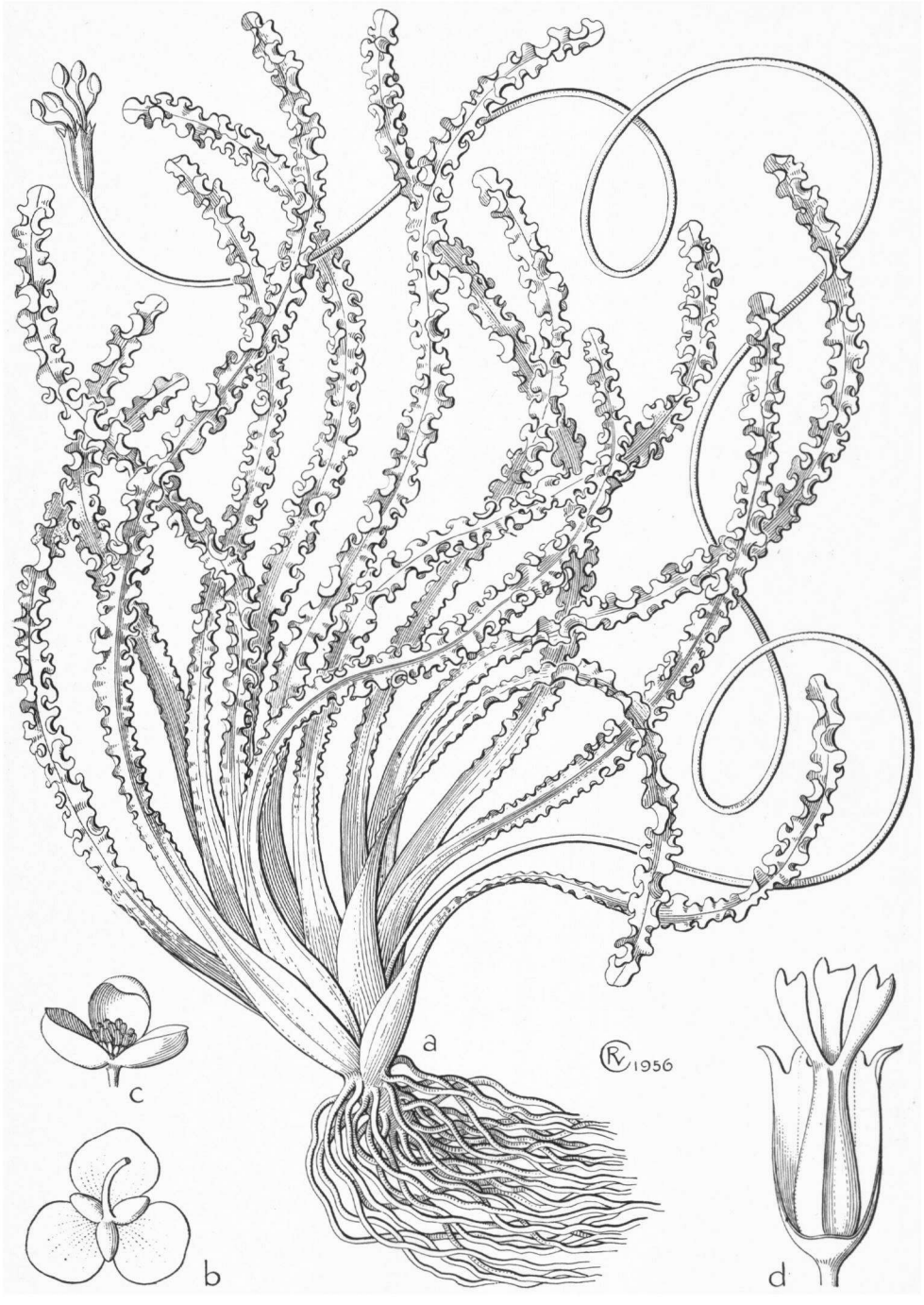

Fig. 12. *Ottelia mesenterium* (HALL. *f.*) HARTOG. *a.* Habit, × 2/3, *b.* ♂ flower, × 2/3, *c.* detail young ♂ bud, petals removed, × 4/3, *d.* ♀ flower, petals removed, × 4/3.

2. Ottelia mesenterium (HALL. *f.*) HARTOG, *nov. comb.*—*Boottia crispifolia* WARB., *nomen seminudum, ex* SARASIN, Reisen Celebes 1 (1905) 317.—*Boottia mesenterium* HALLIER *f.* Med. Rijksherb. *no* 26 (1915) 7; STEEN. Arch. Hydrobiol. Suppl. 11 (1932) 239.—**Fig. 12.**

Roots simple, cord-like, 1–2 mm thick with constrictions *c.* 1 mm spaced. *Leaves* submerged, long, linear, strongly crisped, glaucous, 15–25 by 3/4–1 1/4 cm, gradually decurrent into the petiole and continuing itself as a broad wing on either side of the midrib; margin very fine-serrulate, apex rounded; midrib very thick, broadening towards the base, on either side 1–2 parallel nerves *c.* 1–2 mm distant from the margin, united at the apex, connected by parallel cross-veins, ascending under an angle of 70°–90°, 1–5 mm spaced; petiole sulcate, 10–15 cm, broad, sheathing at the base. Peduncle 50–100 cm, perhaps longer, ribbed, pale green, with longitudinal air-channels. *Spathe* elliptic, 2 1/2–3 1/2 by 1 cm, with 6 longitudinal, entire ribs, at the top with 6 acute, dentate-serrate lobes. ♀ Spathe with 1 sessile flower, ♂ one with up to 10 pedicelled flowers; pedicels slender, up to 10 cm. *Sepals* elliptic to ovate, convex, obtuse, with 5 nerves, 6–11 by 4–6 mm; those of the female flowers more linear, to 15 mm after anthesis, often split at the top. *Petals* white, obovate, unguiculate, *c.* 3 times as large as the sepals, *c.* 20 mm. *Stamens* 12; filaments 3–4 mm; anthers linear, yellow, bilocular, 2–2 1/2 by 1/3–1/2 mm. *Stylodia* (in ♂ flower) 3, filiform. *Ovary* lanceolate, gradually narrowing to the top, with 3 conspicuous longitudinal ridges; styles not seen. *Fruit* lanceolate to elliptic, 2 1/2 cm long, with 3 longitudinal ridges and a short acuminate rostrum. *Seeds* fusiform, 2 by 1/2 mm.

Distr. *Malaysia:* Celebes (Towuti and Matana lakes). Fig. 8.

Ecol. Gregarious in shallow water along the banks of large, deep, ancient lakes, 240–360 m. *Fl. fr.* March–Apr.

Vern. *Tanggula.*

Note. The closest relative of this conspicuous and remarkable plant seems to be *O. crispa* (HAND.-MAZZ.) DANDY, described from the mountains of SW. Szechuan (China), 2600–2800 m. This differs from *O. mesenterium* in having lanceolate to elliptic leaves, 6–10 by 1 1/2–3 cm, with an acute or subcordate base, petiole 6 cm, well set off against the blade, serrate spathal ribs, linear, acute sepals 13 by 2 mm.

The SARASINS mentioned in their narrative a MS-name of WARBURG, whom they had entrusted with their collection of phanerogams; they gave some casual field notes which were not intended (neither by WARBURG nor by the SARASINS) to represent the 'description' of it. As moreover the SARASIN collection is lost in its entirety and HALLIER *f.* gave an ample scientific description in Latin, based on an early TEYSMANN collection of which duplicates are represented in many herbaria, I have found it for scientific reasons not justified to advocate the use of WARBURG's nomen seminudum as a basonym.

7. ENHALUS

L. C. RICH. Mém. Inst. Paris 12, 2 (1812) 64, 71, 74; BENTH. & HOOK. *f.* Gen. Pl. 3 (1883) 454; TROLL, Flora 125 (1931) 427–456.—*Enalus auctt. sphalm.*—**Fig. 13.**

Dioecious, rhizomatous, coarse, marine, submerged plant. *Leaves* few, 2–6, ribbonlike, together enclosed by a flattened, membranous, transparent sheath, apex inaequilateral, faintly serrulate when juvenile; nerves many, parallel, air-channels numerous, septated. ♂ *Inflorescence:* a peduncled spathe consisting of 2 connate blades, the margins of the outer one embracing the inner blade. Flowers small, numerous, pedicelled, on a central stipe, caducous just before anthesis and the mature buds rising to the level of the water. Sepals 3. Petals 3. Stamens 3, alternipetalous; anthers subsessile, 2-locular, latrorsely dehiscing; pollen grains very large. ♀ *Inflorescence* 1-flowered, long-peduncled. Spathe consisting of 2 nearly free blades, one embracing the other with both margins, persistent. Sepals 3. Petals 3. Ovary rostrate, composed of 6 carpels, 1-locular, the 6 parietal placentas far protruding and forming 6 cavities; styles 6, each forked from the base. Ovules ∞, each with 2 integuments, embedded in mucilage. *Fruit* ovate, acuminate. *Seeds* 8–14, obconical, angular, containing starch, embryo containing a large suspensor-cell; the integuments simply stretch so much that they equal the growing embryo; when the fruit is ripe and bursts the testa breaks off around the hypocotyle and remains as a ragged, easily loosened cap on top of the cotyledon.

Distr. Monotypic, Old World tropics from Madagascar as far as Micronesia, Melanesia, and NE. Queensland.

Morph. According to TROLL (*vide infra*) ♂ flowers originally cymosely arranged, but through development of accessory buds later irregularly placed and structure difficult to interpret.

1. Enhalus acoroides (L. *f.*) RICH. *ex* STEUD. Nom. Bot. ed. 2, 1 (1840) 554; ZOLL. Syst. Verz. (1854) 69; ASCHERS. Linnaea 35 (1868) 158, 175; Nuov. Giorn. Bot. Ital. 3 (1871) 299; MIQ. Illustr. (1870) 55; ASCHERS. in Neumayer, Anl. Wiss. Beob. Reisen ed. 1, 1 (1875) 361; HEMSL. Bot. Chall. 1³ (1884) 198; ENGL. Bot. Jahrb. 7 (1886) 447; K. SCH. Bot. Jahrb. 9 (1887) 193; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 254; WARB. Bot. Jahrb. 13 (1891) 258; K. SCH. Notizbl. Berl.-Dahl. 2 (1898) 89; KOORD. Minah. (1898) 270; K. SCH. & LAUT. Fl. Schutzgeb. (1900) 163; SVEDELIUS, Ann. R. Bot. Gard. Perad. 2 (1904) 267–297, t. 24 A, B and 7 fig.; ASCHERS. in Neumayer, Anl. Wiss. Beob. Reisen ed. 3, 2 (1906) 396; KOORD. Exk. Fl. Java 1 (1911) 95; CUNNINGTON, Trans. Linn. Soc. Bot. 7 (1912) 355–371, t. 36; MERR. Int. Rumph. (1917) 84; Sp. Blanc. (1918) 59; BROWN, Min. Prod. Philip. For. 2 (1921) 246; MERR. En. Philip. 1 (1925) 27; BACK. Handb. Fl. Java 1 (1925) 61; TROLL, Flora 125 (1931) 427–456, 15 f.; STEEN. Trop. Natuur 22 (1933) 45; MIKI, Bot. Mag. Tokyo 48 (1934) 136, f. 3; BURK. Dict. 1 (1935) 924; GUILLAUMIN, Bull. Soc. Bot. Fr. 84 (1937) 257; ERNST-SCHWARZENBACH, Ber. Schweiz. Bot. Ges. 55 (1945) 61; GUILLAUMIN, Fl. Nouv. Caléd. (1948) 22; BACK. Bekn. Fl. Java (em. ed.) 10 (1949) fam. 203, 3; STEEN. Webbia 8 (1952) 434; ZANEVELD & VERSTAPPEN, J. Sc. Res. 1 (1952) 63.—*Acorus marinus* RUMPH. Herb. Amb. 6 (1750) 191, t. 75, f. 2.—*Stratiotes acoroides* LINN. *f.* Suppl. (1781) 268.—*Enhalus koenigi* RICH. Mém. Inst. Paris 12, 2 (1812) 64, 78; MIQ. Fl. Ind. Bat. 3 (1856) 237; Suppl. (1861) 259; F.v.M. Fragm. 8 (1874) 219; HOOK. *f.* Fl. Br. Ind. 5 (1888) 663; BAILEY, Syn. Queensl. Fl. Suppl. 3 (1890) 71; VORDERMAN, Teysmannia 4 (1893) 705–709; HOOK. *f.* in Trim. Fl. Ceyl. 4 (1898) 126; BAILEY, Queensl. Fl. 5 (1902) 511; HEMSL. J. Linn. Soc. Lond. Bot. 36 (1903) 3; RIDL. Mat. Fl. Mal. Pen. (Monoc.) 1 (1907) 6; Fl. Mal. Pen. 4 (1924) 4, f. 161; PERRIER DE LA BÂTHIE, Fl. Madag. fam. 26 (1946) 3, f. I, 1–2.—*Vallisneria sphaerocarpa* BLANCO, Fl. Filip. ed. 1 (1837) 780, ed. 2 (1845) 538, ed. 3, 3 (1879) 186.—*Enhalus marinus* GRIFF. Not. Pl. Asiat. 3 (1851) 175; THW. En. Pl. Zeyl. (1864) 332.—**Fig. 13.**

Glabrous. Rhizome creeping, up to 1½ cm diam., closely set with cordlike, unramified roots 10–20 cm by 3–5 mm, densely clothed by the persistent fibrous strands of the decayed leaves; air-channels wide, interrupted by *in sicco* prominent 3–4 mm spaced septations. Sheath *c.* 15 cm long. *Leaves* 30–150 by 1¼–1¾ cm, with rounded or obtuse apex, often distorted, mostly damaged; nerves 13–19, midrib and intramarginal nerves coarser than the others; *c.* 30–40 air-channels parallel with the nerves, visible outside as a fine striping, with irregularly (4–7 mm) spaced septations; margins thickened by coarse, very tough vascular bundles persistent and nigrescent after the decay of the parenchymatic tissue and remaining attached to the rhizome.—♂ *Peduncle* terete, 5–10 cm, submerged. Spathe broadly ovate-lanceolate, obtuse, 5 by 3 cm, faintly keeled, keel and nerves provided with many long, rough hairs, before anthesis closed, in anthesis gaping at the apex, margins rolled. Pedicels 3–12 mm, unequal, very thin, breaking off *c.* ⅓–½ mm below the flowers. *Sepals* clear white, oblong, acute, reflexed, *c.* 2 mm long. *Petals* clear white, ovate, acute, reflexed, broader than the sepals, *c.* 1¾ mm long, cuticle very papillose and waxy. *Stamens* white, erect, 1½–1¾ mm long; pollen grains spherical, with very fine-reticulate surface, without intine, 170–175 μ diam.—♀ *Peduncle c.* 40–50 cm, sometimes even longer, after anthesis coiled and contracted, in fruit unrolled again. Spathe oblong-lanceolate, obtuse, strongly keeled, 4–6 by 1–2 cm, keel and nerves with many, long, rough hairs, before anthesis closed, after anthesis gaping at the apex, margins not curled up. *Sepals* reddish, oblong, glabrous, with rounded apex and recurved margins. *Petals* clear white, finally with reddish apex, oblong-linear, 4–5 cm by 3–4 mm, strongly folded but after pollination smooth, with waxy, papillose surface. *Ovary* laterally compressed, densely set with long fringelike hairs; style branches subulate, *c.* 10–12 mm, densely covered with linear papillae except at the tip. *Fruit* ovate, *c.* 5–7 cm, green, lengthwise ribbed, alternating ribs provided with a black, upwards directed hairy fringe continuing in the acuminate apex, irregularly bursting at the apex when ripe. *Seeds* 1–1½ cm.

Distr. Through the tropical belt of the Indian Ocean (Madagascar, Seychelles, Red Sea, Ceylon, Nicobars, Andamans), common throughout *Malaysia* to the tropical parts of the W. Pacific (Riu-Kiu Isl., Marianes, New Britain, New Ireland, the Solomon Isl., and New Caledonia), and Queensland (Cape York). *cf.* SETCHELL, Am. Nat. 69 (1935) 562, map.

According to MIKI *l.c.* the northern border coincides with the 23° C. February water temperature line.

Ecol. Along shallow sheltered séa-coasts, gregarious and covering large areas with a closed vegetation on sandy and muddy bottoms often mixed with coarser material. The most luxuriant *Enhalus* stands are found in the small depressions on tidal flats between the levels of mean low water and mean low water spring; it goes down, however, to *c.* 4 m depth, flowering only in such places, where it is emerged periodically for a short time during spring-ebb. On reefs it is developed less well. At low tide the leaves lie flabby and nearly exposed on the bottom of shallow pools, all directed seaward by the off-flow of the water. The leaves are mostly covered with a thin film of mud-particles. *Enhalus* is absent from tracts where many rivers debouch into the sea.

Enhalus is associated with other sea-grasses; TROLL *l.c.* mentions for example *Halophila ovalis* (see p. 449) as a companion from the Aru Islands. According to VORDERMAN *l.c.* and BURKILL (Gard.

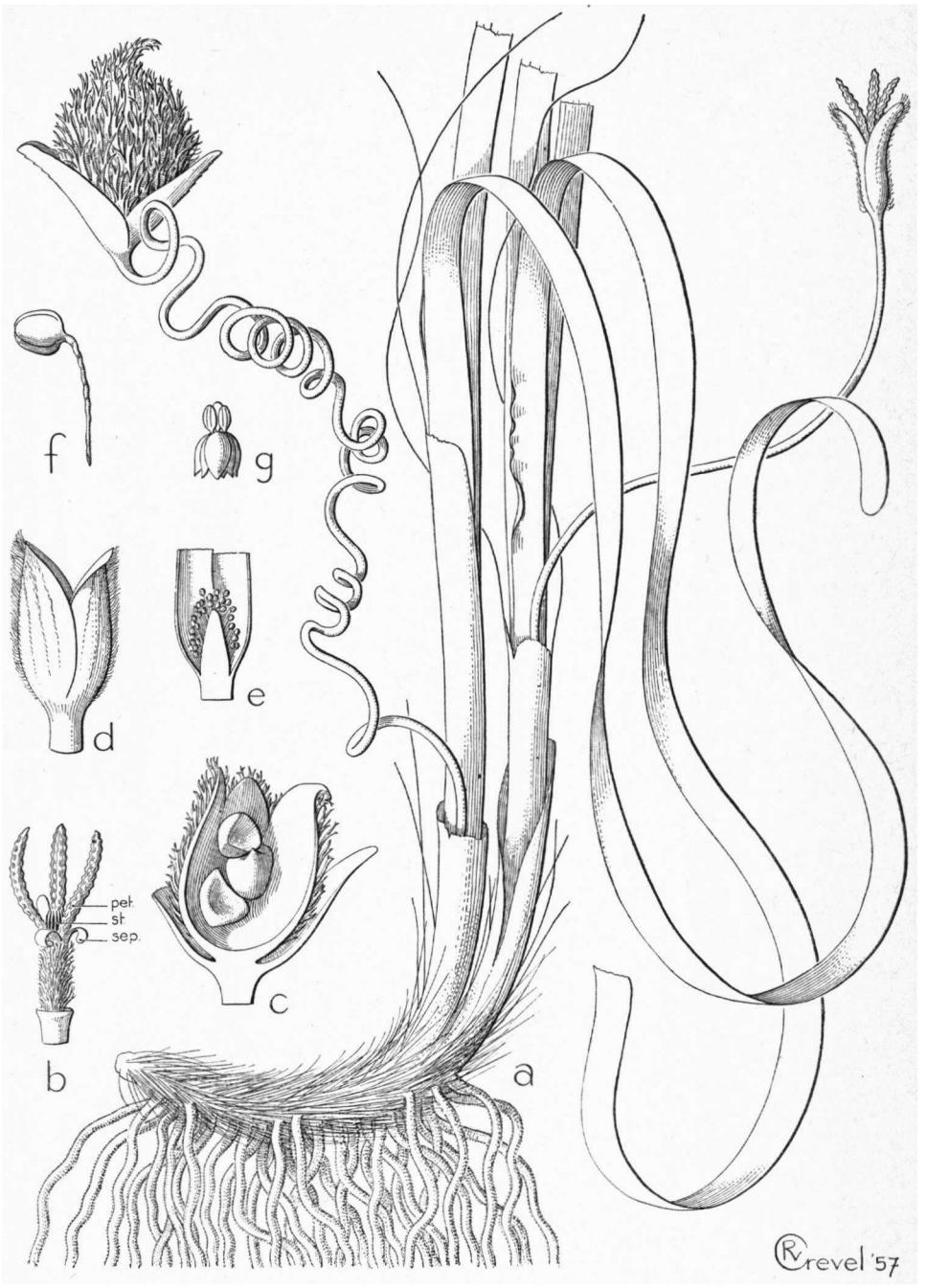

Fig. 13. *Enhalus acoroides* (L.*f.*) RICH. *ex* STEUD. *a.* Habit × 1/2, *b.* ♀ flower, showing *sepals*, *petals*, and *styles*, × 1/2, *c.* longitudinal section of fruit with 3 seeds, × 1/2, *d.* ♂ spathe, × 1/2, *e.* longitudinal section of ♂ spathe with conical receptable and ∞ ♂ flower buds, × 1/2, *f.* ♂ flower bud, × 3 1/2, *g.* opened ♂ flower in drifting position, × 3 1/2 (*a* SINCLAIR 25.11.48, *b–g* after SVEDELIUS *l.c.*).

Bull. S.S. 2, 1918, 444) *Enhalus* is a common food of the manatee *Halicore dujong*; this animal may contribute to the dispersal of *Enhalus*. *Fl. fr.* probably the whole year round.

Flower biology. Of old it was known among fishermen that flowering was periodical and gregarious and coincided with the spring-tides, a few days after new moon and full moon, if these tides occurred during the daytime. Coincidence of sexual reproduction with spring-tides is known to occur in the tropics with several marine animals, *Amphitrite*, *Pecten*, *etc.*, and possibly with some *Algae*.

The remarkable flower biology of *Enhalus*, anthesis and pollination, have been studied in detail by SVEDELIUS, *l.c.* and TROLL, *l.c.* The small ♂ flowers, which occur in great numbers open already in the spathe and during this development the pedicels obviously break. The flowers are liberated only during diurnal low spring-tide, after opening of the spathe. They rise to the surface of the water with the reflexed perianth directed downward and the anthers erect. Through their waxy cuticle the petals are hydrophobous, consequently they crowd together in swarms which move with surface currents and wind.

SVEDELIUS attributed the release of the ♂ flowers to decrease of air-pressure within the ripe bud during the retreat of the sea-water with spring ebb. In TROLL's opinion this reasoning may hold for the opening of the spathe, but it is unlikely that the buds which are enclosed by the latter, are subject to differences in air-pressure causing them to burst. According to TROLL the considerable rise in temperature during low tide, in the *c.* 10 cm deep pools where *Enhalus* abounds, is the decisive factor for the opening of the buds of both the ♂ and ♀ flowers. TROLL could show that the water temperature at spring ebb between 10.00 and 12.00 hours rose from 35,3° C to 39,6° C, that is about 10° C higher than the average water and air temperature in the same place with flood tide. Soil temperatures at 2 cm depth lagged behind about 5° C. It is difficult to prove that the opening mechanism of the flowers is only due to the temperature stimulus, as many factors are changed at exceptionally low tide: the oxygen and carbondioxyde percentages, light intensity, salt concentration, *etc.* Further experiments are needed to single out these separate factors.

When the female flower is in anthesis, the peduncle is sufficiently long to allow the flowers floating on the surface during low water, and during the lowest tide the uppermost part of the peduncle is also on the water surface. By means of the lobes of the spathe the flower is kept floating in a horizontal position *viz* with the axis on a level with the surface. The petals are then extended and float on the surface without being wetted due to the waxy cuticle. As the spathe lobes are more or less strongly recurved they do not prevent the full exposition of the petals. The styles again are not so pushed out, that they are exposed, but are covered both by the basal parts of the petals and by the sepals. By the hydrophobous property of the petals the female flowers 'attract' the free male flowers, and it is often observed, that a drifting female flower is surrounded by numerous males. Pollination can not yet take place, because the styles are covered by the perianth leaves and the anthers rise above the water-level. By rising of the water towards flood the female flowers are submerged; as a result of the surface tension the petals close together catching (sucking in) the male flowers adhering to the margins of the petals.

How pollination takes place within the ♀ flower has not been observed. SVEDELIUS assumed the anthers drop their pollen which is sinking down and can scarcely escape falling upon the styles, which stand vertically and in a circle, owing to the changed position underneath the level of the water. Mrs ERNST-SCHWARZENBACH has given in my opinion a more plausible explanation for the pollination mechanism in assuming the presence of an air-bubble in the submerged ♀ flower due to the hydrophobous quality of the petals covering the styles. Then the pollen can only be transferred by the toppled ♂ flowers within the air-bubble, without touching the water. Free pollen grains, which have been sucked in by the submerged ♀ flowers cannot reach the styles and are of no importance for pollination.

According to SVEDELIUS the pollen grains sink when released in the water, but according to TROLL's observations they are buoyant and can be caught by the female flowers in a similar way as entire flowers.

The embryo which emerges from the fruit is heavier than water; it is sinking down in the mud, where it germinates immediately.

Germination. When the fruit bursts, the exceedingly thin testa also breaks off around the hypocotyl and remains as a ragged easily-loosening cap on top of the cotyledon. Properly the embryo is liberated from the fruit and this represents a form of vivipary. The embryo is heavier than water; it sinks down into the mud and germinates immediately.

Uses. The seeds are edible and RUMPHIUS *l.c.* mentioned their use as food from the Moluccas, VORDERMAN *l.c.* from Bantam (W. Java). The black fibre strands from the leaf margins which persist after the decay of the leaves, are employed in the Moluccas and in New Guinea for making fishing-nets.

Vern. *Latuh*, *latoh*, *dj̆elamun*, J, *lamun*, S, *gudir*, Md, *ibusan*, *samoh*, Kangean, *deringu laut*, M, *setul*, Malaya, *buwa setu*, Riouw, *jari amun*, *j. ambun*, Sumatra, *lamu*, Flores, Bima, *bama*, Makasser, *gohungiri*, Halmah. (Tobelo dial.), *gossongi*, *talamut*, Ternate, *lalamut*, Ambon, *lalanuit*, Luku; Philippines: *lamon*, Tag., Bik., *I aai*, Tag., *mariu-bariu*, Bik., *palaipat-baibai*, Ilk., *bariau-bariau*, Kuy.

8. THALASSIA

BANKS *ex* KÖNIG, Ann. Bot. 2 (1806) 96; BTH. & HOOK. *f.* Gen. Pl. 3 (1883) 455; RYDBERG, J. N.Y. Bot. Gard. 10 (1909) 261.—*Schizotheca* EHRENB. [Abh. Berl. Ak. Wiss. 1832, 1 (1834) 429, *nomen*] *ex* SOLMS in Schweinf. Beitr. Fl. Aethiop. 1 (1867) 194, 246; ASCHERS. Linnaea 35 (1868) 159, 177.—**Fig. 14.**

Dioecious, glabrous. Rhizome creeping, terete, consisting of solid parenchymatic tissue with fine longitudinal air-channels; youngest part covered with membranous scales, leaving annular scars. Roots short, not ramified, densely set with fine hairs. *Leaves* 2–6, distichous, close together within a transparent sheath, linear, often somewhat falcate, *in sicco* slightly undulate, with very fine longitudinal air-channels, visible as a very fine parallel striation; parallel with these many short brown dashes; margin entire; base pale; apex rounded, very fine-serrulate; nerves 9–15, parallel, near the apex joining the intramarginal nerves, mutually connected by square cross-veins. Ligule absent. *Inflorescences* peduncled, on the ♂ plants 1–3, on the ♀ plants 1, all 1-flowered. *Spathal* segments of the ♂ plants only on one side connate, those of the ♀ plants on both sides. ♂ *Flowers* on short pedicels, ♀ flowers subsessile. *Perianth* segments 3, elliptic. *Stamens* 3–12, nearly sessile, light yellow, anthers oblong, erect, 2–4-celled, latrorsely dehiscent. Pollen grains sphaerical, yellow, embedded in a gelatinous mass which later becomes a sort of moniliform chain, germinating already before having reached the stigmas of the ♀ flower.

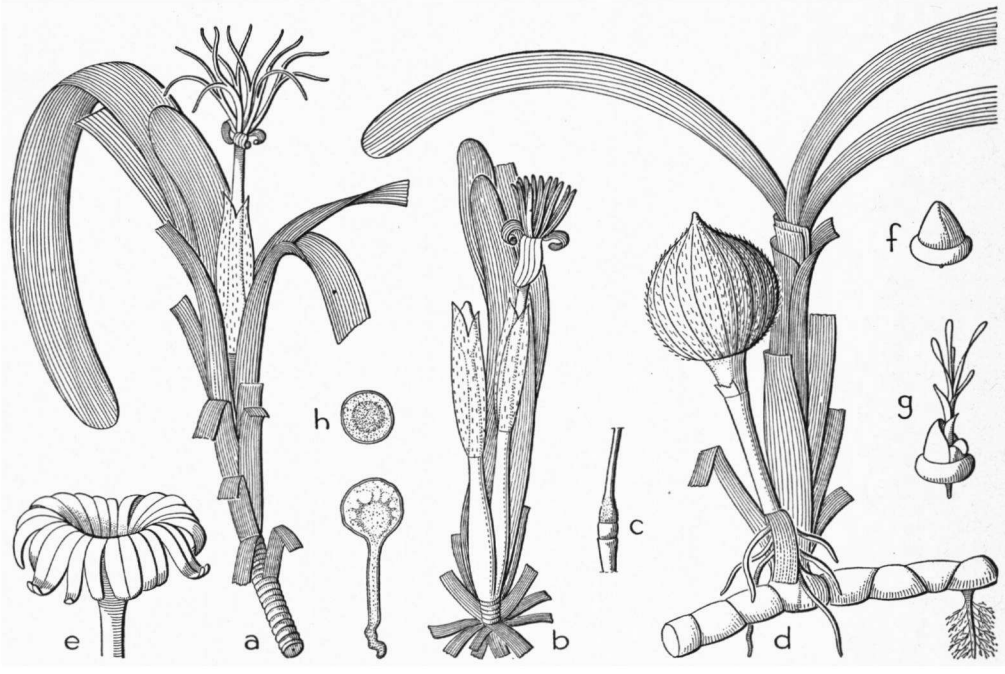

Fig. 14. *Thalassia hemprichii* (EHRENB.) ASCHERS. *a.* Habit ♀ plant, nat. size, *b.* habit ♂ plant bearing 2 flowers, one in anthesis, nat. size, *c.* portion of pistil after fertilization, pedicel articulate below ovary, *d.* ♀ plant with mature fruit, nat. size, *e.* stellately split pericarp of mature fruit, nat. size, *f.* seed, nat. size, *g.* seedling 3 weeks old, nat. size, *h.* mature pollen grain, × 100, *i.* germinated pollen grain, × 100 (after PASCASIO & SANTOS).

Fig. 15. Stagnant shallow pool *c.* 1 m diam. filled at ebb tide with crystal-clear sea-water, bottom with dead coral fragments; edge of the pool fringed with floating *Thalassia* leaves directed more or less towards the centre of the pool. Udjung Genteng, S. Java.

Ovary softly echinate, 1-celled or imperfectly more-celled, with a rather long, partly persistent rostrum; styles 6–12. *Fruit* globose or elliptic, softly echinate, beaked, the fleshy pericarp bursting with a number of stellately spreading valves. *Seeds* few, conical with a thickened basal portion, the conus corresponding with the cotyledon, the broadened base with the radicle (fig. 14 f); testa thin, fugacious; albumen 0.

Distr. Two closely allied species, one in the tropical parts of the Indian Ocean and the western Pacific, the other in the West Indies.

Notes. Species of *Thalassia* show a marked vegetative resemblance with the *Cymodocea spp.*, but are easily distinguished by the absence of a ligule.

1. Thalassia hemprichii (EHRENB.) ASCHERS. in Petermann's Mitt. 17 (1871) 242; Bot. Zeit 33 (1875) 765; in Neumayer, Anl. Wiss. Beob. Reisen ed. 1, 1 (1875) 361; ENGLER, Bot. Jahrb. 7 (1886) 447; K. SCH. Bot. Jahrb. 9 (1887) 193; ASCHERS. & GÜRKE in E. & P. Nat. Pfl. Fam. 2, 1 (1889) 254, f. 188; HOOK. *f.* in Trim. Fl. Ceyl. 4 (1898) 127; K. SCH. Notizbl. Berl.-Dahl. 2 (1898) 89; K. SCH. & LAUT. Fl. Schutzgeb. (1900) 163; HEMSL. J. Linn. Soc. Bot. 36 (1903) 3; ASCHERS. in Neumayer, Anl. Wiss. Beob. Reisen ed. 3, 2 (1906) 397; MERR. Fl. Manila (1912) 71; Philip. J. Sc. 10 (1915) Bot. 2; En. Philip. 1 (1925) 27; BACK. Handb. Fl. Java 1 (1925) 62; PASCASIO & SANTOS, Bull. Nat. & Appl. Sc. Philip. 1 (1930) 1–19, 5 pl.; STEEN. Trop. Natuur 22 (1933) 45, f.f.; MIKI, Bot. Mag. Tokyo 48 (1934) 136, f. 4; GUILLAUMIN, Bull. Soc. Bot. Fr. 84 (1937) 257; TÄCKHOLM & DRAR, Fl. Egypt 1

(1941) 125; GUILLAUMIN, Fl. Nouv. Cal. (1948) 22; BACK. Bekn. Fl. Java (em. ed.) 10 fam. 203 (1949) 4; STEEN. Webbia 8 (1952) 435; ZANEVELD & VERSTAPPEN, J. Sc. Res. 1 (1952) 63; SINCLAIR, Gard. Bull. Sing. 14 (1953) 35; DAWSON, Pac. Sc. 8 (1954) 377, f. 2g; SINCLAIR, Gard. Bull. Sing. 15 (1956) 27, f. 3.—*Schizotheca hemprichii* EHRENB. Abh. Berl. Ak. Wiss. 1832, 1 (1834) 429; *ex* SOLMS in Schweinf. Beitr. Fl. Aethiop. (1867) 194; ASCHERS. Linnaea 35 (1868) 159.—**Fig. 14.**

Roots with longitudinal air-channels, septations *c.* 1¾ mm spaced; some roots erect, with thickened top. *Leaves* 10–40 cm by 4–11 mm. Male plants with 1–2 inflorescences; peduncles in the ♂ plants *c.* 3 cm, those in the ♀ plants 1–1½ cm, after anthesis elongating to 2–4 cm. *Spathal* segments lanceolate, acute (apices unequal in size), entire, persistent (according to HOOK. *f.* in Trimen *l.c.* caducous), 2–2½ by ½ cm, with many short, brown dashes. *Pedicels* of the ♂ flowers 2–3 cm; ♀ flowers subsessile, after anthesis very shortly pedicelled. *Perianth* segments revolute, light brown, 7–8 by 3 mm. *Stamens* 3–12; anthers oblong, occasionally forked, 7–11 by 1–1¼ mm; pollen grains 20–33 μ. *Ovary* conical, 1 cm, its rostrum 2–3 cm; styles 6, at ⅓ from the base split into 2 filiform arms, each on the underside with 2 longitudinal grooves, light brown, after anthesis curling and caducous, 1½–2 cm. *Fruit* globose, rugose, light-green, bursting open with *c.* 20 valves, 2–2½ by 1¾–3¼ cm. *Seeds* 3–9, 8 by 8 mm, the thickened basal portion dark-brown; cotyledon greenish.

Distr. Through the entire tropical region of the Indian Ocean (E. Africa, Seychelles, Red Sea, Ceylon, Andamans, and Cocos Isl.) throughout *Malaysia* to the West Pacific (Riu-Kiu Isl., Indo-China, New Ireland, New Hanover, New Britain, New Caledonia, and Queensland). *cf.* SETCHELL, Am. Nat. 69 (1935) 563, map.

The northern border coincides, according to MIKI *l.c.* with the February water isotherm of 21° C.

Ecol. Common on muddy coral-sand in sheltered, shallow bays, also in pools on tidal flats in open bays, where ocean currents and wave action are not so strong. It forms together with other sea-grasses extensive submarine meadows, wherein it sometimes predominates, *e.g.* at Honduras Bay (Mindoro); there it lives, according to PASCASIO & SANTOS, *l.c.*, together with 6 other sea-grasses, *viz Halophila ovalis*, *H. spinulosa*, *Enhalus acoroides*, *Cymodocea serrulata*, *C. rotundata*, and *Diplanthera uninervis*. It occurs from low watermark, where at ebb-tide it sometimes falls dry, to 5 m depth, depending on the lucidity of the water, but below 3½ m depth it does not form a closed vegetation, and is replaced as dominant species by sterile *Enhalus acoroides*. After storms and in certain monsoons the leaves are often washed ashore in large quantities.

The fruit of *Thalassia hemprichii* ripens below the water surface, and has no buoyancy capacity and it is supposed to be only slowly dispersed by sea currents. As uprooted or otherwise detached plants and shoots soon die, they obviously contribute little to dispersal. Marine mammals and fishes, which feed on the young leaves and fruits, possibly play a role in the dispersal.

The seeds of *Thalassia hemprichii* seem to require a long resting period before they germinate and growth of the seedling is rather slow.

Fl. Dec.–Febr., rarely in other months; *fr.* March–Apr. In Malaysia anthesis is rather rarely observed.

Taxon. The West Indian species, *Th. testudinum* BANKS *ex* KÖNIG, is closely related to *Th. hemprichii*, but differs in some important respects: spathe oblong, with rounded apex and serrulate margin; perianth segments 1 cm long, truncate, and often slightly toothed at the apex; styles 9–12, undivided; fruits elliptic, bursting with 6 valves.

Vern. *Turtle grass*, E, *pama lamun*, M, *isay*, Tag.

Note. If there are two ♂ flowers they do not flower at the same time. The description of the flowers and the fruits has partly been copied from PASCASIO & SANTOS, *l.c.*

9. HALOPHILA

DU PETIT-THOUARS, Gen. Nov. Madag. 2 (1808) 2; BTH. & HOOK. *f.* Gen. Pl. 3 (1883) 455; BALFOUR, Trans. Proc. Bot. Soc. Edinb. 13 (1879) 336; SOLEREDER, Beih. Bot. Centralbl. 30, i (1913) 43–47.—*Barkania* EHRENB. Abh. K. Ak. Wiss. Berl. Ph. Kl. 1832, 1 (1834) 429, *nomen.*—*Lemnopsis* ZOLL. Syst. Verz. 1 (1854) 74–75; *non* ZIPP. 1829, *nomen.*—**Fig. 16–19.**

Monoecious or dioecious. *Stems* creeping, ramified, rooting at the nodes with 1, rarely more unramified roots closely set with fine root-hairs. At the nodes 2 *scales*, one embracing the stem, the other embracing a lateral, often undeveloped shoot, which bears the leaves (rarely with 2 scales below these leaves). *Leaves* opposite, sessile or petioled, linear, lanceolate, oblong-elliptic or ovate, entire or serrulate, rarely hairy; nerves 3, a midrib and on both sides an intramarginal nerve, almost always connected by cross-veins; between the leaves a new shoot appears which again bears scales and 1 or more pairs of leaves, and the inflorescence. *Spathe* sessile, composed of 2 membranous free bracts, one embracing the other, elliptic,

obovate to suborbicular, acute, rounded to emarginate or indented, keeled, keel sometimes serrulate; margin entire, rarely ciliate or serrulate. *Flowers* unisexual, solitary, rarely 1 or more ♂ and one ♀ flower in one spathe.—*Male flower* pedicelled; perianth segments 3, imbricate; stamens 3, alternating with the tepals, anthers sessile, 2–4-celled, dehiscent extrorsely; pollen grains in long chains.—*Female flower* sessile, or almost so. *Ovary* elliptic or ovate, 1-celled, at the apex with a long beak crowned by the 3 reduced tepals, styles linear, (2–)3–5. *Fruit* ovate, rostrate, 1-celled; wall membranous. *Seeds* few to numerous, globose or subglobose.

Distr. Consisting of 9 *spp.*, distributed along the coasts of E. Africa & Madagascar, S. & E. Asia to Japan, via Malaysia to the Australian coasts and in the SW. Pacific eastwards to Tahiti, further in the West Indian seas. The majority of the species is found in the Indo-Malaysian area where 5 *spp.* are recorded; 2 others are limited to the western part of the Indian Ocean, while 3 *spp.* occur in the Caribbean, 2 of which are endemics.

Taxon. Although the genus comprises only 9 *spp.*, they show great differences in vegetative structure. Therefore ASCHERSON and OSTENFELD[1] divided the genus in 4 sections or groups, here accepted as sections:

1. *sect.* **Halophila.**—*Sect. Barkania* (EHRENB.) ASCHERS. Nuov. Giorn. Bot. Ital. 3 (1871) 301.—*Typicae* OSTENF. Bot. Tidsskr. 24 (1902) 240; Pflanzenareale 1, 3 (1927) 37.—Lateral shoot short, 1 cm or smaller, often not developed, with only 1 pair of leaf blades at the top. 5 *spp.* (*H. ovalis*, *H. minor*, *H. decipiens*, *H. linearis* HARTOG, *H. stipulacea*). The area of this section coincides with the area of the genus.

2. *sect.* **Microhalophila** ASCHERS. Nuov. Giorn. Bot. Ital. 3 (1871) 302.—*Pusillae* OSTENF. Bot. Tidsskr. 24 (1902) 240; Pflanzenareale 1, 3 (1927) 37.—Lateral shoot 1–2 cm, with 6–10 leaf blades at the top, petiole with a broad sheath. 1 *sp.* (*H. beccarii*).

3. *sect.* **Aschersonia** HARTOG, *sect. nov.*—*Spinulosae* OSTENF. Bot. Tidsskr. 24 (1902) 240; Pflanzenareale 1, 3 (1927) 37 *p.p.*—Lateral shoot long, with 15–20 pairs of sessile, distichous leaves. 1 *sp.* (*H. spinulosa*). *Ramuli foliis 10–20 paribus, folia sessilia, disticha.*

4. *sect.* **Americanae** (OSTENF.) OSTENF. Pflanzenareale 1, 3 (1927) 37; Bot. Tidsskr. 24 (1902) 240.—Lateral shoot halfway or higher up with 2 scales and at the top 2 or 3 pairs of pseudoverticillate leaves. 2 *spp.* (*H. baillonis* ASCHERS. and *H. engelmanni* ASCHERS., both confined to the West Indies).

KEY TO THE SPECIES

1. Lateral shoot with at most 5 pairs of petioled leaves at the apex.
2. Lateral shoots short, 1 cm or smaller, often not developed, with only one pair of leaves; petiole not or unequal-sided sheathing; midrib joining the intramarginal nerve, cross-veins present.
3. Scales up to 8 mm long, leaves ovate or elliptic. Petiole not sheathing.
4. Lateral shoots scarcely or not developed, glabrous. Leaf margin entire. Dioecious.
5. Leaf blades 10–40 mm, with 12–25 pairs of cross-veins at an angle of 45–60° . **1. H. ovalis**
5. Leaf blades 7–14 mm, with 3–8 pairs of cross-veins at an angle of 70–90° . . **2. H. minor**
4. Lateral shoots ½–10 mm, hairy. Leaf margin serrulate. Monoecious . . . **3. H. decipiens**
3. Scales large, 12–17 mm, bright white, leaves linear. Petiole unequal-sided sheathing **4. H. stipulacea**
2. Lateral shoots longer, 1–2 cm, with 6–10 leaf blades at the top; petiole with a broad sheath; midrib crossing the intramarginal nerve, reaching the apical margin; cross-veins absent . **5. H. beccarii**
1. Lateral shoots with 10–20 pairs of sessile distichous leaves . . . . . **6. H. spinulosa**

1. Halophila ovalis (R.BR.) Hook. *f.* Fl. Tasm. 2 (1858) 45; ASCHERS. Linnaea 35 (1868) 173; Nuov. Giorn. Bot. Ital. 3 (1871) 301; in Neumayer, Anl. Wiss. Beob. Reis. ed. 1, 1 (1875) 367; Bot. Zeit. 33 (1875) 764; BENTH. Fl. Austr. 7 (1878) 182; BALFOUR, Trans. Proc. R. Soc. Edinb. 13 (1879) 290, pl. 8, 9 f. 11–13, 17; 10 f. 27–31; 11 f. 33–36, 40–41, 43–56; 12 f. 57–60, 62–89; F.-VILL. Nov. App. (1882) 298; BOISS. Fl. Orient. 5 (1882) 2, *incl. var.* β *major* (ZOLL.) BOISS.; HEMSLEY, Bot. Chall. 1³ (1884) 198; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 249, f. 182; WARBURG, Bot. Jahrb. 18 (1893) 185; K. SCH. & LAUT. Fl. Schutzgeb. (1900) 163; BAILEY, Queensl. Fl. 5 (1902) 1512; OSTENF. Bot. Tidsskr. 24 (1902) 260; ASCHERS. in Neumayer, Anl. Wiss. Beob. Reis. ed. 3, 2 (1906) 395; MAKINO, Bot. Mag. Tokyo 26 (1912) 209; DOMIN, Bibl. Bot. 85, 1 (1915) 255; MERR. Philip. J. Sc. 10 (1915) Bot. 2; OSTENF. Dansk Bot. Ark. 2, 6 (1916) 38; MERR. En. Philip. 1 (1922) 26; BACK. Handb. Fl. Java 1 (1925) 58; OSTENF. Pflanzenareale 1, 3 (1927) 37, map 23; PASCASIO & SANTOS, Nat. Appl. Sc. Bull. Un. Philip. 1 (1930) 4; STEEN. Trop. Natuur 22 (1933) 45, f. b; MIKI, Bot. Mag. Tokyo 48 (1934) 138, f. 5, 6; SETCHELL, Am. Nat. 69 (1935) 564, map; GUILLAUMIN, Bull. Soc.

(1) OSTENFELD (1902) distinguished 'Abschnitte' and not sections.

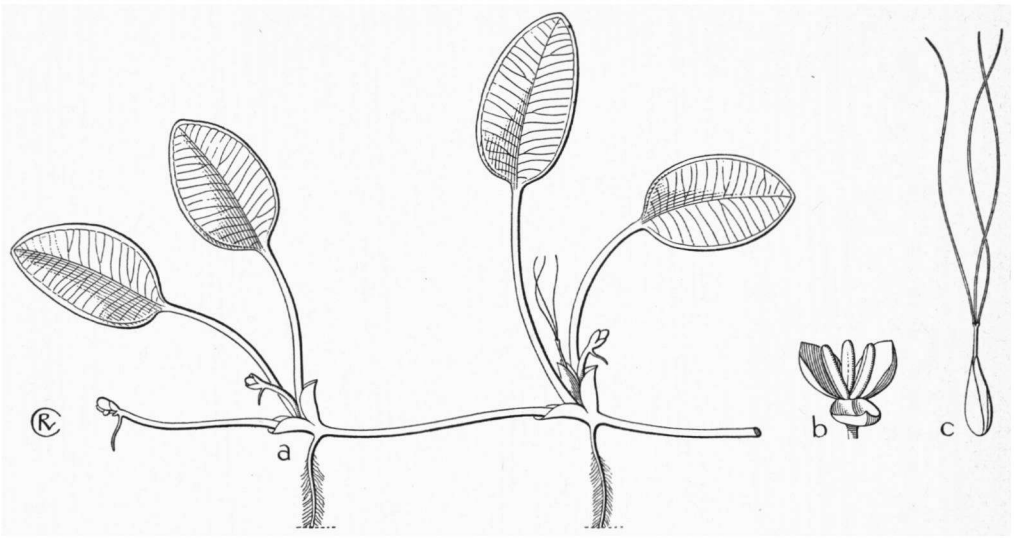

Fig. 16. *Halophila ovalis* (R.Br.) HOOK. *f. a.* Habit, nat. size, *b.* ♂ flower, *c.* ♀ flower, × 3 (*a* WESTENBERG 5, *b–c* after BALFOUR *l.c.*).

Bot. Fr. 84 (1937) 257; TÄCKHOLM & DRAR, Fl. Egypt 1 (1941) 123; GUILLAUMIN, Fl. N. Caléd. (1948) 22; BACK. Bekn. Fl. Java (em. ed.) 10, fam. 203 (1949) 2; STEEN. Webbia 8 (1952) 434; ZANEVELD & VERSTAPPEN, J. Sc. Res. 1 (1952) 63; DAWSON, Pac. Sc. 8 (1954) 376, f. 1 d–f.—*Caulinia ? ovalis* R.BR. Prod. Fl. Nov. Holl. 1 (1810) 339.—*H. ovata* (*non* GAUD.) ASCHERS. Sitz. Ber. Ges. Naturf. Freunde 1867 (1868) 3; F.v.M. Fragm. 8 (1874) 219; HOOK. *f.* Fl. Br. Ind. 5 (1888) 663; in Trimen, Fl. Ceyl. 4 (1898) 128; RIDL. Mat. Fl. Mal. Pen. (Monoc.) 1 (1907) 6; GAGNEP. Fl. Gén. I.-C. 6 (1908) 2, f. 1; RIDL. Fl. Mal. Pen. 4 (1924) 4; TROLL, Flora N.F. 25 (1931) 427; PERRIER DE LA BÂTHIE, Fl. Madag. fam. 26 (1946) 4, f. I, 3–5.—*Kernera ? ovalis* SCHULT. Syst. Veg. 7 (1829) 170.—*Lemnopsis major* ZOLL. Syst. Verz. 1 (1854) 75.—*H. major* MIQ. Fl. Ind. Bat. 3 (1856) 230.—*H. euphlebia* MAKINO, Bot. Mag. Tokyo 26 (1912) 208.—Fig. 16.

Dioecious. *Stems* thin, easily breaking; at the nodes one, sometimes more roots; internodes 1–5 cm. *Scales* transparent, suborbicular or obovate, convex or doubled, faintly keeled, apex emarginate, base more or less auricled, 3–8 mm. *Leaves* oblong-elliptic to ovate, glabrous, 1–4 by 1/2–2 cm; apex rounded, base obtuse, truncate, rounded or acute; margin entire, only 1 pair on a scarcely or not developed shoot; cross-veins 12–25 pairs ascending at an angle of 45–60°, joining the intramarginal nerve, very thin, near the base often forked; midrib at the top united with the intramarginal nerves; petiole 1–4 1/2 cm. *Spathe* broadly lanceolate, acute, 3–5 mm. *Male flower:* perianth segments elliptic, spreading, convex, transparent, white with a dark stripe in the middle, obtuse or faintly apiculate, 4 by 2 mm, pedicel 1 cm. Anthers oblong, 2–4-celled. *Female flower:* ovary ovate, 1–1 1/2 mm, beak 3–3 1/2 mm, styles 3, 13–17 mm. *Fruit* globular, 3–4 mm; wall membranous, beak 3 mm. *Seeds* 20, subglobose, 1 mm; testa tuberculate and reticulate.

Distr. From the coasts of E. Africa & Madagascar through the entire Indian Ocean and Red Sea, through Malaysia as far as Samoa, Tonga and Tahiti, and the Sandwich Isl. southwards to S. Australia and Tasmania, northwards to Japan, according to MIKI *l.c.* as far as the February water isotherm of 10° C at 37° N. Lat.; in *Malaysia* widely distributed: Malaya (States of Kedah and Perak, Singapore), Philippines (Palawan, Bancoran, Biliran, Mindoro, Cebu, Zamboanga), Riouw Arch., Java (Krakatau, islands near Djakarta, Bondowoso, Kangean Islands), Lesser Sunda Islands (Bali, Sumbawa, Flores, Timor), Celebes (Biaro, Kendari), Moluccas (Aru & Key Isl.), and New Guinea (Sorong, Kelana, Boniara).

Ecol. In sheltered localities on sandy as well as on muddy bottoms in which the plants may often be buried almost completely, also on coral-reefs, mostly gregarious. During low water some specimens may come into contact with the air, others going down as far as 5 m below the lowest ebb-mark. The species is well tolerant against pollution of the water; from such waters we even know very luxurious specimens. *H. ovalis* is mostly accompanied by other sea-grasses, *e.g. Enhalus acoroides*, *Thalassia hemprichii* or *Diplanthera uninervis*. *H. ovalis* is the only hydrocharitaceous sea-grass which occurs far beyond the tropics on both the S. and N. hemispheres. In the temperate S. Australian waters it reproduces exclusively vegetatively. From Japan, where it reaches the 10° C February water isotherm only female flowers are known, but also seeds (MIKI *l.c.*). Possibly the reproduction is (only here?) parthenogenetical. SETCHELL (Bull. Torr. Bot. Cl. 47, 1920, 570–571)

assumes that in these temperate regions sexual reproduction occurs, but only during that part of the year when the temperature of the coastal water is high enough for flowering and fruiting. Also in the tropics anthesis takes place rarely: nearly all Malaysian material I have examined was sterile. *Fl. fr.* Sept.–Oct. (BALFOUR *l.c.*).

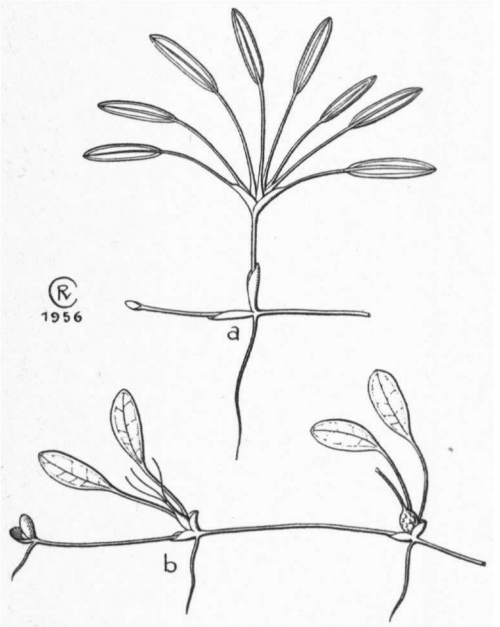

Fig.17. *a. Halophila beccarii* ASCHERS., nat. size (MERRILL vii–1911), *b. Halophila minor* (ZOLL.) HARTOG, nat. size (MERRILL 1098).

Note. Closely allied to *H. minor* from which it is easily to distinguish by the larger size, the greater number of cross-veins, and their smaller angle with the midrib.

In the Firenze Herbarium there is a collection labelled 'Insulae Sandwich GAUDICHAUD 1839'. This is apparently the first record from Hawaii; the species has not been mentioned in HILLEBRAND's Flora of Hawaii, but SETCHELL mapped it to occur there.

2. Halophila minor (ZOLL.) HARTOG, *nov. comb.*—*H. ovata* GAUD. in Freycin. Voy. Bot. (1829) 430, t. 40 f. 1, *nomen illegitimum, excl. syn. Caulinia ovalis* R.Br.; OSTENF. Philip. J. Sc. 4 (1909) Bot. 67–68; MERR. Fl. Manila (1912) 70; En. Philip 1 (1925) 26; OSTENF. Pflanzenareale 1³ (1927) 37, 38, map 23; FISCHER, Fl. Pres. Madras 8 (1928) 1398; STEEN. Trop. Natuur. 22 (1933) 46, f. c; SETCHELL, Am. Nat. 69 (1935) 564, map; STEEN. Webbia 8 (1952) 434.—*H. ovalis* α *ovata* BALFOUR, Trans. Bot. Soc. Edinb. 13 (1878) 335.—*Lemnopsis minor* ZOLL. Syst. Verz. 1 (1854) 75.—*H. lemnopsis* MIQ. Fl. Ind. Bat. 3 (1856) 230.—**Fig. 17b.**

Dioecious. *Stems* thin, easily breaking, with 1 root at the nodes, internodes 1–3 cm. *Scales* transparent, convex or folded, suborbicular to transversely elliptic, acute, rounded or emarginate at the apex, auricled at the base, 2–4 mm. *Leaves* oblong-elliptic to ovate, obtuse or sometimes pointed at the apex, base obtuse or shortly cuneate and acutely decurrent into the petiole, entirely glabrous, translucent-green, 7–14 by 3–5 mm, only 1 pair on a scarcely or not developed shoot; cross-veins 3–8(–11) pairs ascending at an angle of 70–90°, joining the intramarginal nerve; midrib united at the top with the intramarginal nerves; petiole terete, ½–2 cm. *Spathe* obovate to suborbicular, apex acute to acuminate, keeled, transparent, 2½–3 mm. *Male flower* unknown. *Female flower:* ovary ovate, 1½–2 mm, beak 2–5 mm; styles 3, 6–11 mm. *Fruit* elliptic, ovate to globose 2–4 mm; pericarp membranous; beak 2–6 mm. *Seeds* ± 20, subglobose, brown-yellow, ½ mm.

Distr. SE. Asia, from W. India (Madras) to the Gulf of Siam and through Malaysia to the western Pacific Islands (Marianes); in *Malaysia* rare, but widely distributed: Malay Peninsula (Singapore), Riouw Arch., Philippines (Luzon: Manila Bay), Lesser Sunda Islands (Flores), S. Celebes (Salayer), Moluccas (Ambon), New Guinea (Geelvinkbaai, Wariap, Sorong). This species has not yet been found in Java or adjacent islets; BACKER's record (Bekn. Fl. Java 10, 1949, fam. 203, p. 2) was based on a wrongly identified specimen of *H. decipiens.*

Ecol. Growing in sheltered localities on sandy bottoms, often very abundant, quite exposed at low tide. Obviously an annual plant disappearing after having fruited. Sometimes associated with other sea-grasses, specially with *Diplanthera uninervis. Fl. fr.* March–May.

Note. Easily distinguished from the closely related *H. ovalis* by the smaller size and the smaller number of cross-veins and the larger angle they make with the midrib.

3. Halophila decipiens OSTENF. Bot. Tidsskr. 24 (1902) 260 *cum* f.; ASCHERS. in Neumayer, Anl. Wiss. Beob. Reis. ed. 3, 2 (1906) 395; GAGNEP. Fl. Gén. I.-C. 6 (1908) 4; OSTENF. Pflanzenareale 1³ (1927) 37, 38, map 23; STEEN. Trop. Natuur. 22 (1933) 46.—*H. baillonis* (*non* ASCHERS. 1874) HOLM, Bih. Kongl. Svensk Vet. Ak. Handl. 9, 13 (1885) 1–18, pl. 1–3; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 249; ASCHERS. in Neumayer, Anl. Wiss. Beob. Reis. ed. 3, 2 (1906) 395; RYDBERG in N. Amer. Fl. 17 (1909) 67; BOWMAN, Science 43 (1916) 245; Pap. Mich. Ac. Sc. 2 (1922) 5, pl. 2; OSTENF. Pflanzenareale 1³ (1927) 37, 38, map 23.—*H. ovata* (*non* GAUD.) BACKER, Bekn. Fl. Java (em. ed.) 10 (1949) fam. 203, p. 2.—**Fig. 18.**

Monoecious. *Stems* thin, easily breaking, with 1 root at the nodes, internodes 1–4½ cm. *Scales* transparent, scarious, obovate, doubled, keeled, 3–7 mm, outside hairy, apex incised, base amplexicaulous. *Leaves* oblong-elliptic, obtuse or rounded, cuneate at the base, green, at one or both sides faintly covered with short, rigid, unicellular hairs, very fine-serrulate, 10–23 by 3–6 mm, only 1 pair on a 1–10 mm long shoot; cross-nerves 6–9 pairs, ascending, joining the intramarginal nerve; midrib

united at the top with the intramarginal nerves running at *c.* 1/2 mm distance from the margin; petiole 3–15 mm, triquetrous. *Spathe* ovate, acuminate, keeled, scarious, transparent, 3–4 mm, at the margin ciliate, at the keel with fine serrulate teeth, at the outside hairy or not, tearing at the top as the fruit is ripening, containing 1 ♂ and 1 ♀

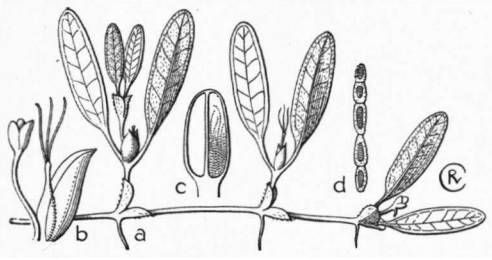

Fig. 18. *Halophila decipiens* OSTENF. *a.* Habit, nat. size, *b.* ♂ and ♀ flower, *c.* anther in section with pollen grains in chains, *d.* part of such a chain of pollen grains
(*a* partly after OSTENFELD, *b–d* after HOLM).

flower, spathe segment enclosing the female flower embracing the other. *Male flower:* perianth segments oblong-elliptic to ovate, obtuse, convex, 1–1 1/2 mm long; anthers *c.* 1 mm, pollen grains elliptic; pedicel 3 mm; after anthesis the complete flower with its pedicel caducous. *Female flower* subsessile; ovary ovate, 1 mm, beak 1–2 mm; styles 3, 2 1/2 mm. *Fruit* broad-elliptic, 2 1/2 by 1 1/2 mm; beak 1 1/2–2 mm; pericarp scarious, transparent. *Seeds c.* 30, ovate, 1/5 mm.

Distr. Rare, but very widely distributed in the tropical parts of the Indian Ocean (Seychelles, India near Bombay, Ceylon near Chilaw, Gulf of Siam), the Pacific (Great Barrier Reef and Tahiti), and in the Caribbean, twice found in *Malaysia:* W. Java [P. Dapur (NW. beach), N of Djakarta: WESTENBERG 1, April 1938, Bo, L] and S. Moluccas (Aru Isl.: MOSELEY, Sept. 1874, K, L).

Ecol. A species confined to deep water, collected at 5–30 fathoms depth on coral-sand. *Fl. fr.* observed Jan.–April, Sept.–Nov., probably the whole year round.

Anat. I found *squamulae intravaginales* in the axils of the leaves, scales, and spathal leaves. They are nearly sessile, elliptic to oblong-ovate, diaphanous, 3/4 mm.

Notes. After the character of the indument of the leaves and the spathal leaves two varieties can be distinguished:

var. **decipiens.**

Leaves hairy on one side only, spathal leaves glabrous.

Distr. Seychelles, Bombay, Gulf of Siam, Java, Aru Isl., Great Barrier Reef.

var. **pubescens,** *nov. var.*—*H. baillonis* (*non* ASCHERS. 1874) HOLM, *l.c.*

Laminae utrinque pubescentes, lateribus externis foliarum spathae pubescentibus.

Distr. Ceylon, Tahiti, Caribbean Sea.

4. Halophila stipulacea (FORSK.) ASCHERS. Bot. Zeit. 25 (1867) 94; Sitz. Ber. Ges. Naturf. Fr. Berl. 1867 (1868) 3; Linnaea 35 (1868) 172, 199, *pro maj. parte*; Sitz. Ber. Ges. Naturf. Fr. Berl. 1869 (1870) 4; in Neumayer, Anl. Wiss. Beob. Reis. ed. 1, 1 (1875) 367; BALFOUR, Trans. Proc. R. Soc. Edinb. 13 (1879) 336, pl. 9 f. 14–15, 18, pl. 10 f. 19–26, pl. 11 f. 32, 37–39, 42, pl. 12 f. 61; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 249, f. 183; OSTENF. Pflanzenareale 1[3] (1927) 37, 38, map 24; TÄCKHOLM & DRAR, Fl. Egypt 1 (1941) 122.—*Zostera stipulacea* FORSK. Fl. Aeg.-Arab. (1775) 158.—*Thalassia stipulacea* KÖNIG, Ann. Bot. 2 (1805) 97.—*Zostera bullata* DELILE, Fl. Egypt. (1813) 145, pl. 53 f. 6.—*H. madagascariensis* STEUD. Nom. ed. 2, 1 (1840) 720.—*Thalassia bullata* KUNTH, En. 3 (1841) 120.—*Barkania stipulacea* ZANARDINI, Mem. Ist. Venet. 7 (1857) 225.—*H. balfourii* SOLEREDER, Beih. Bot. Centralbl. 30, i (1913) 47.

Dioecious. *Stems* 1–2 mm thick, at the nodes with one root; internodes 1–2 cm. *Scales* elliptic or obovate, white, 12–17 by 6–10 mm, folded, incised along the keel, the 2 apical lobes obtuse. *Leaves* linear to oblong-elliptic, green, glabrous, papillose or faintly hairy, obtuse, cuneate at the base, serrulate at the margin, occasionally bullate, 3–6 cm by 2 1/2–8 mm, only 1 pair on a scarcely or not developed shoot; cross-veins ascending at an angle of 45°, joining the intramarginal nerves; midrib united at the top with the intramarginal nerves; petiole 1/2–1 1/2 cm, at the base with an unequal-sided sheath. *Spathe* ovate, acute, keeled, hairy; margin at one side glabrous, the other side ciliate. *Flowers* not seen. *Fruit* elliptic, 5 mm; beak 6 mm; pericarp membranous. *Seeds* 30–40, globose, at both sides apiculate.

Distr. E. Africa, Madagascar, Seychelles, Mauritius, Red Sea, Bahrein Isl., Madras (India: Pamban, Oct. 1922 leg. M.O. PARTHASARTHY IYENGAR *no* 133 A), immigrated into the Aegean Sea according to FRITSCH (Verh. Zool. Bot. Ges. Wien 45, 1895, 104).

In the Rijksherbarium there is a specimen said to have been collected 'near Donai in Sumatra, July 1909'. Apart from the fact that no place 'Donai' is known in Sumatra, the specimen was acquired with the collection D'ALLEIZETTE which is notorious for wrongly localized specimens. There is no doubt whatever that it came from the western part of the Indian Ocean, possibly collected by somebody who, returning from the East, collected it *en route* in the Suez Canal zone where the species is common in the Bitter Lakes area where old, obviously dead, encrusted leaves are sometimes conspicuously bullate.

Ecol. Preferring localities which are always submerged and subjected to a constant current.

5. Halophila beccarii ASCHERS. Nuov. Giorn. Bot. Ital. 3 (1871) 302; in Neumayer, Anl. Wiss. Beob. Reis. ed. 1, 1 (1875) 368; Bot. Zeit. 33 (1875) 765; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 249; TRIMEN, J. Bot. 27 (1889) 166; HOOK. *f.* in Trim. Fl. Ceyl. 4 (1898) 129; BECC. For. Born.

(1902) 360; OSTENF. Bot. Tidsskr. 24 (1902) 240; ASCHERS. in Neumayer, Anl. Wiss. Beob. Reis. ed. 3, 2 (1906) 393; MERR. Philip. J. Sc. 7 (1912) Bot. 228; Fl. Manila (1912) 70; En. Born. (1921) 37; En. Philip. 1 (1922) 25; OSTENF. Pflanzenareale 1³ (1927) 37, 38, map 24; MASAMUNE, En. Phan. Born. (1942) 9; STEEN. Webbia 8 (1952) 435; DAWSON, Pac. Sc. 8 (1954) 376, f. 1a–c.—**Fig. 17a.**

Monoecious. *Stems* thin, at the nodes with 1 root; internodes 1–2 cm. *Scales* embracing the stem, one 4–6 by 1½ mm, the other 2–3 mm. *Leaves* lanceolate, broad-acute at the apex, cuneate at the base, 6–11 by 1–2 mm, glabrous, brown when dry, entire, 6–10 very closely together on a 1–1½ cm long erect shoot; midrib broad, reaching the margin in the apex; intramarginal nerves originating from the midrib just above the base and joining again just under the apex, cross-veins absent; petiole 1–2 cm, sheath 3–4 mm long with a strongly broadened scarious margin. *Spathe* oblong-lanceolate, acute, convex, entire, 2½ mm, containing 1 ♂ and 1♀ flower. ♂ *Flowers* not seen, ♀ *ones* only partly; ovary 1 mm, beak 2 mm; styles 2 or 3; ovules 2–4. *Fruit* ovate, recurved after anthesis, pericarp membranous. *Seeds* 1–4, ovate, acute, inflated, ½–1 mm, testa reticulate.

Distr. Obviously very rare, from the coast of SE. Asia (Ceylon: Batticalva; Burma: Akyab; Indo-China: Nha Trang, Song-Hong-Méo near Quang-Yen) to *Malaysia:* Borneo (Sarawak: near the mouth of Bintula River, BECCARI 3666) and the Philippines (Luzon: Manila Bay). An early record of ASCHERSON (Bot. Zeit. 33, 1875, 765) for Ambon is doubtful, as he omits it in his later works.

Ecol. In shallow brackish water, in inundated muddy localities near river-mouths (Sarawak) or in fish-ponds (Luzon), covering the bottom, and abundant locally.

6. Halophila spinulosa (R. BR.) ASCHERS. in Neumayer, Anl. Wiss. Beob. Reis. ed. 1, 1 (1875) 368; BENTH. Fl. Austr. 7 (1878) 183; ASCHERS. & GÜRKE in E. & P. Pfl. Fam. 2, 1 (1889) 249; OSTENF. Bot. Tidsskr. 24 (1902) 240; BAILEY, Queensl. Fl. 5 (1902) 1512; ASCHERS. in Neumayer, Anl. Wiss. Beob. Reis. ed. 3, 2 (1906) 395; MERR. Philip. J. Sc. 10 (1915) Bot. 2; OSTENF. Dansk Bot. Ark. 2, 6 (1916) 40, f. 25–31; MERR. En. Philip. 1 (1922) 26; OSTENF. Pflanzenareale 1³ (1927) 37, 38, map 24; PASCASIO & SANTOS, Nat. Appl. Sc. Bull. Un. Philip. 1 (1930) 4; HENDERSON, Gard. Bull. S.S. 5 (1931) 240; STEEN. Trop. Natuur 22 (1933) 44, f. d; CLASON, Trop. Natuur 23 (1934) 120; BACK. Bekn. Fl. Java (em. ed. 10, fam. 203 (1949) 2; STEEN. Webbia 8 (1952) 434; SINCLAIR, Gard. Bull. Sing. 15 (1956) 30, f. 1E–F.—*Caulinia ? spinulosa* R.BR. Prod. Fl. Nov. Holl. (1810) 339; F.v.M. Fragm. 8 (1874) 219, 283.—*Kernera ? spinulosa* SCHULT. Syst. Veg. 7 (1829) 170.—*H. stipulacea* (FORSK.) ASCHERS. Linnaea 35 (1868) 172, 199, *pro min. parte.*—**Fig. 19.**

Dioecious. *Stems* at the nodes with 1 *c.* 10 cm long root; internodes 1–5 cm; scars of fallen leaves 3–13 mm spaced. *Scales* elliptic or ovate, with acute, obtuse or incised apex, keeled, membranous, 3–6 mm, soon caducous. *Leaves* 10–20 pairs, distichously arranged along a 5–18 cm long shoot, sessile, oblong-linear, serrulate, rounded, glabrous, 10–23 by 2–5 mm, *in sicco* brown, base semi-amplexicaulous, at one side with an incurved broadening; cross-veins 4–5 pairs, very fine, square, joining the intramarginal nerves; midrib united at the top with the intramarginal nerves.

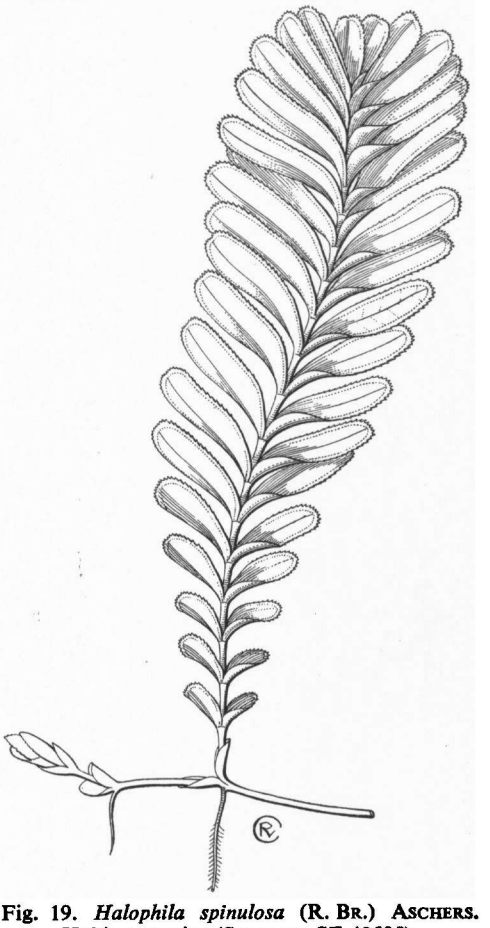

Fig. 19. *Halophila spinulosa* (R. BR.) ASCHERS. Habit, nat. size (SINCLAIR SF 40535).

Spathe membranous, outer segment with an acute and an obtuse keel, near the apex faintly serrulate; inner segment with one keel and a long-pointed apex, *c.* 6–7 mm. *Male flower* shortly pedicelled, perianth segments elliptic, reflexed, obtuse, with an inconspicuous nerve, 3–4 mm; anthers 4-locular, 1½ mm, after anthesis caducous. *Female flower* subsessile; ovary ovate, 3–4 mm, beak 5–6 mm; styles 3–5, 10–12 mm. *Fruit* ovate, compressed, 4–6 mm, beak 3–5 mm; pericarp membranous. *Seeds* 20–30, globose, smooth, transparent, *c.* ½ mm.

Distr. Along the NE. & W. coasts of Australia, not found south of 30° S. lat., in *Malaysia:* Malay

Peninsula (Singapore and adjacent islands, Johore Baru), Riouw Arch. (P. Penyangat), W. & E. Java (Anjer near Sunda Straits, and N. Baluran), Philippines (Luzon: Quinalasag Isl., Manila, Camarines; Mindoro; Mindanao), and New Guinea (Warbusi, Geelvinkbaai, Torres Straits).

Ecol. In shallow water on coral-reefs, but also in deeper water to 6 fathoms, on mud or sandy mud. Sometimes associated with other sea-grasses. PASCASIO & SANTOS *l.c.* mention the species from the submarine meadows of *Thalassia hemprichii*, SINCLAIR collected it among *Enhalus* in Johore. *Fl. fr.* March—Oct.

Notes. Leaf-bearing shoots sometimes with 1–2 lateral shoots, in most cases originating from the axil of the lowest pair of leaves. The first pair of leaves of the lateral shoot consists of entire scales, in the axils of which sometimes again buds are found, which may produce new lateral shoots and one root.

On the scars of fallen leaves sometimes 2 scales occur, between which a lateral shoot develops. The delimitation of scales and leaf blades is not always very clear; as mentioned above specially on the lateral shoots transitions may occur. On a fruiting plant from New Guinea, which had lost its leaves, I found on each leaf scar near the top to 6 mm long scales with an incised apex, between which again innovations of sympodial shoots were visible.

The description of the ♂ flowers has been copied from OSTENFELD (1916).

Dubious

Epigynanthes BL. *ex* NEES, Flora 8 (1825) 679, *nomen nudum*; ENDL. Gen. Pl. (1837) 232 *sub no* 1664, *nomen.*—This name was reduced to *Hydrilla* by Ind. Kew.; I have not found any sheet with a label corroborating this reduction.

E. blumei HASSK. Cat. Hort. Bog. (1844) 53, *nomen nudum.* I have not found this name on the label of any sheet of the Rijksherbarium or Herbarium Bogoriense.

Excluded

Lemnopsis mnioides ZIPPEL, Flora 12 (1829) i, 285, *nomen nudum*; Alg. Konst- & Letterbode 1 (1829) 297, *nomen nudum*, is according to HALLIER *f.* Med. Rijksherb. Leiden 1 (1910) 40, *cf.* Fl. Mal. I, 4 (1949) 68 = *Utricularia orbiculata* WALL.