

## ALISMATACEAE (C. den Hartog, Amsterdam)

Annual or perennial aquatics and marsh plants, sometimes laticiferous. *Leaves* basal and erect, sometimes floating, rarely all submerged, sometimes some reduced to phyllodes, lanceolate to sagittate, rarely broad-elliptic to ovate, entire, with a hydathode on the apex, curvined, nerves more or less parallel and gradually joining the marginal nerve, connected by ascending cross-veins; petiole sheathing, mostly with air-channels, often septated. *Inflorescences* mostly erect, racemose or paniculate; peduncle sometimes hollow, mostly with air-channels. Bracts 3(-2) per whorl of flowers or branches. *Flowers* actinomorphic, bisexual or unisexual (and then rarely with rudiments of the other sex). *Sepals* 3, imbricate, green, parallel-nerved, convex, persistent. *Petals* 3, imbricate, white or faintly coloured, marcescent. *Stamens* 3-∞, free, in a whorl; filaments filiform or dilated; anthers 2-celled, basifix, sometimes versatile, latrorsely lengthwise dehiscent. *Carpels* 2-∞, free, in the Mal. *spp.* spirally arranged on the receptacle (in extra-Mal. *Alisma* in a whorl); style 1, ventrally or terminally inserted on each carpel, persistent. *Ovule* 1 (in extra-Mal. *Damasonium* 2 or more), basal, campylotropous, rarely anatropous (*Damasonium*), micropyle extrorse, rarely introrse (*Luronium*). *Achenes* in a head (or whorl in *Alisma*), free, rarely connate at the base. *Seeds* oblong or horseshoe-shaped; testa membranous; embryo horseshoe-shaped; albumen 0; radicle extrorse, rarely introrse (*Luronium*).

**Distribution.** About 10 genera with *c.* 70 *spp.*, all over the temperate and tropical zones except in the Pacific area (Micronesia, Melanesia, and Polynesia). The largest genera are *Sagittaria* and *Echinodorus* both centering in the New World.

**Ecology.** Malaysian representatives are confined to low altitudes, *Sagittaria sagittifolia ssp. leucopetala* ascending to *c.* 1000 m. Habitats are marshes and pools, swamps and wet rice-fields, and other stagnant shallow waters.

Most representatives are rare or very rare in Malaysia, though their general distribution can be very wide. The reason of this is obscure. It can neither be ascribed to scarcity of collections, at least not in Java, or of collectors interested in water plants, nor can it be correlated with a scarcity of swamps and swampy areas in Malaysia.

This phenomenon of rarity combined with a wide distribution is certainly not unique among water plants but has been found in many other cases, in Malaysia both species and genera, for example: *Aldrovanda*, *Aponogeton*, *Blyxa* § *Caulescentes*, *Brasenia*, *Ceratophyllum submersum*, *Eriocaulon setaceum*, *Hydrocharis dubia*, *Myriophyllum*, *Najas marina*, *Nymphoides moonii* and other *spp.*, *Potamogeton spp.*, *Sparganium*, *Tenagocharis*, and *Trapa*.

It is true that some of these species require apparently special mineral waters (calcium for *Aldrovanda*, other minerals for *Najas marina*, as far as is known from their localities). It is also true that a number of species are only found in ancient swamps in which man has not interfered with drainage or otherwise polluted the waters. It could also be understood that dispersal capabilities are scarce in Malaysia, but there is little reason for this assumption in relation to what is known about means of dispersal.

Save the record by VAN WELSEME (Trop. Natuur 4, 1915, 174) that the fruits of *Sagittaria* possess buoyancy by virtue of air-containing exocarpeillary tissue, no observations made in Malaysia have come to my knowledge. However, many extra-Malaysian data on means of dispersal in *Alismataceae* have been recorded in RIDLEY's invaluable 'Dispersal' (1930).

*Vegetative dispersal* can take place by tubers and rhizomes transported by water in rivers (*Sagittaria*); floating seedlings derived from seeds germinated under water have been observed in *Echinodorus ranunculoides*. Furthermore in two *Caldesias* vegetative 'buds' ('turions') are produced in the inflorescence giving rise to new plants which can be transported by water.

*Seed dispersal by water* has been proved for various species in which achenes possess buoyancy capacity; those of *Alisma plantago* have subepidermal air-tissue and may float for many months; after decay of this tissue the seed sinks. The wings of the achenes in *Sagittaria* contain light air-tissue as well as a large-celled, light epidermis. The achenes of *Limnophyton obtusifolium* are well adapted to floating by two lateral air-chambers between endo- and exocarp.

*Exozoid dispersal* has been observed in *Alisma* and will doubtless take place in other species; achenes have been found on breast and feet of various birds, and as the light, often winged, flat achenes float on

the surface of the water they get easily attached to the feathers merely by the wet. Achenes have also been found in bird's nests.

*Endozoic dispersal:* HOCHREUTNER fed roaches (*Leuciscus rutilus*) with achenes of *Alisma plantago*; after the stomachal passage seed was found partly viable (Bull. Herb. Boiss. 1899, 450). It is quite likely that fish feed on species of the family. HOLMBOE found achenes of *Alisma* in the stomach of dippers (*Cinclus aquaticus*) and the same has been observed with the mallard, a duck (*Anas platyrhyncha*), with achenes of *Alisma*, *Sagittaria*, etc., in which these readily pass the stomach with the seed unharmed, and with wood ducks (*Aix sponsa*).

The above-mentioned data point to a well-stacked array of favourable dispersal methods and one would expect that in regions where water is abundant in marshes, pools, ditches, ponds, and swamps, *Alismataceae* would not be rare. Furthermore, archipelagic conditions would not hamper their dispersal as aquatic birds are known to cover large distances and are able to bridge seas and straits separating islands, although the absence of *Alismataceae* from Micronesia, Melanesia, and Polynesia is most remarkable!

As dispersal by water birds will generally be rather random one would expect wide distributional areas with each an irregular pattern of localities, but with few wide disjunctions. This is found indeed as mentioned above under the ecology. But disjunctions are in many cases—and that not only in *Alismataceae* but in many other water plants—so wide and species so exceedingly rare in large areas, that one can hardly suppose this to be due to random dispersal alone.

It is a matter of fact that *Alismataceae* are exceedingly rare in Malaysia and this concerns all Malaysian species except *Sagittaria guayanensis* which is relatively frequent in its area. The *Sagittarias* introduced in Malaysia also show hardly any sign of rapid extension of their area which stands in sharp contrast to the aggressiveness of for example *Eichhornia* and *Elodea* which fulfilled their napoleonic ambitions merely by vegetative dispersal.

Therefore, there must be other factors underlying the curious distribution of so many water and marsh plants and this will probably be found in their narrow tolerance for edaphic conditions taken in the widest sense. Experiments are needed to elucidate the nature of these factors.

*Morphology.* The exceedingly thin 'squamae intravaginales' have been recorded in *Caldesia* by BUCHENAU. ARBER (Ann. Bot. 39, 1925, 169, f. 1-3) found them in very young stages of *Sagittaria* (dorsally on the leaf-base), so that their occurrence in *Alismataceae* seems certain.

*Taxonomy.* Formerly *Butomaceae* and *Alismataceae* have been treated as two tribes of one family by BENTHAM & HOOKER (Gen. Pl. 3, 1883, 1003), a position in which they are still maintained by RENDLE (Class. Fl. Pl. ed. 2, 1, 1953, 213). On the other hand HUTCHINSON (Fam. Fl. Pl. 2, 1934, 26, 32) arranges them under two distinct families belonging to two different orders, *Butomales* and *Alismatales*.

PICHON (Not. Syst. 12, 1946, 170-183) after having compared a number of anatomical structures (laticiferous ducts, leaves, hydathodes, ovules) accepted a close relationship and merged *Butomaceae* with *Alismataceae* except for *Butomus*.

A similar close relationship was suggested by JOHRI (Proc. Ind. Ac. Sc. B 4, 1936, 128-162) on the basis of comparative embryology and he is of opinion that the separation of *Alismataceae* and *Butomaceae* into two different orders is unnecessary.

*Alismataceae* are distinguished from *Butomaceae* by the basal solitary ovule (or in *Damasonium* 2 or more in the inner angle); in *Butomaceae* ovules are numerous, scattered, and parietal.

They are more rapidly distinguished from *Hydrocharitaceae* in which the carpels are connate and the ovary inferior with many scattered parietal ovules in each cell.

*Uses.* The family does not contain many economic plants. Some introduced species of *Sagittaria* are used as ornamentals in pools and ponds. An important cultigen of *Sagittaria sagittifolia* is cultivated by the Chinese, partly as fodder for pigs (the whole plant), but mostly for the edible tubers (see p. 333).

*Note.* In collecting *Alismataceae* it is to be noted that both flowers and fruits should be collected and that flowers should be measured and dried immediately after the collecting in the field, as by their marcescent structure they cannot be accurately measured and drawn from herbarium specimens. Further, ecological data on precise soil conditions, water composition, pollination, and seed dispersal are very valuable as hardly anything is known in these aspects.

#### KEY TO THE GENERA

1. Carpels crowded on a minute receptacle. Achenes swollen, round in cross-section.
2. Leaves ovate to elliptic. Flowers bisexual. Achenes without air-chambers . . . . . 1. *Caldesia*
2. Leaves broadly sagittate. Flowers male and bisexual. Achene with 2 lateral air-chambers. . . . . 2. *Limnophyton*
1. Carpels inserted on a large, easily observable, globular or oblong receptacle. Achenes more or less compressed.
3. Bracts (in Mal. spp.) 2. All flowers bisexual. Receptacle globular to oblong. Achenes not, slightly, or strongly compressed. Seeds broad-elliptic, testa connate at the incision and wholly enclosing the hippocrepiform embryo . . . . . 3. *Echinodorus*
3. Bracts under each whorl 3. Flowers unisexual, or on the lower part of the inflorescence sometimes bisexual. Receptacle globular. Achenes strongly laterally compressed. Seeds hippocrepiformous. . . . . 4. *Sagittaria*

1. CALDESIA

PARLATORE, Fl. Ital. 3 (1858) 599; BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 15.—*Alisma sect. Caldesia* B. & H. Gen. Pl. 3 (1883) 1005.—Fig. 1-2.

*Leaves* broad-elliptic to broad-ovate, apex blunt, base cordate (rarely truncate outside Mal.). *Panicle* pyramidal; branches and pedicels on the branches in whorls of 3, each branch and each pedicel sustained by an oblong-lanceolate bract. *Flowers* bisexual. *Petals* white. *Stamens* 6(-11); filaments filiform. *Carpels* 2-9(-20) crowded, not in a whorl; style ventrally inserted, slender; *achene* swollen, without lateral air-chambers; endocarp formed by large, radially arranged sclerenchymatic cells (colouring red with phloroglucin); exocarp spongy or membranous. *Seed* oblong.

Distr. 3 spp. from Africa & Madagascar and South and Central Europe through South and East Asia, and Malaysia to Australia.

Notes. Closely allied to *Alisma* which differs in having the carpels in a whorl and a non-sclerenchymatic endocarp. In *Alisma* the cell-walls of the endocarp contain lignin and colour red with phloroglucin but are not typically sclerenchymatic, consequently the achene is softer than in *Caldesia*.

The revision of the Malaysian species necessitated to revise the extra-Malaysian species as well and they have consequently been incorporated here for general use in a key to all the species of the genus.

KEY TO THE SPECIES

- 1. Leaves not pellucid-punctate. Veins connecting the nerves parallel and ascending at an angle of 60° and 1/3-1/2 mm spaced. Bracts scarious. Sepals erect after flowering. Achenes elliptic, dorsally with 3-5 longitudinal smooth ribs.
- 2. Leaves broad-elliptic, apex acute, base deeply cordate. Lowest bracts up to 1 cm long. Stamens 6. Carpels 5-8 . . . . . 1. *C. parnassifolia*
- 2. Leaves reniform, apex emarginate, base truncate. Lowest bracts up to 2 cm long. Stamens 9(-11). Carpels 12-20. All parts coarser or larger than in the preceding species . . . . . 2. *C. grandis*
- 1. Leaves pellucid-punctate. Veins connecting the nerves parallel and perpendicular to the nerves, at least 1 mm spaced. Bracts herbaceous. Sepals reflexed and revolute after flowering. Achenes reniform, dorsally provided with 4 more or less warty or spiny ribs . . . . . 3. *C. oligococca*

1. *Caldesia parnassifolia* (BASSI ex L.) PARL. Fl. Ital. 3 (1858) 599; *incl. var. majus* MICHELI in DC. Mon. Phan. 3 (1881) 35; *incl. major & nilotica* BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 16, f. 6 A-C; SAMUELSSON, Svensk Bot. Tidskr. 24 (1930) 113-116; PERRIER DE LA BÂTHIE, Fl. Mad. fam. 25 (1946) 6, f. II 1-3; STEEN. Nova Guinea n.s. 7 (1956) 7.—*Alisma parnassifolium* BASSI ex LINNÉ, Syst. Nat. ed. 12, 3 (1768) 230; Mant. 2 (1771) 371; BASSI, Comm. Bonon. 6 (1783) 33; F.v.M. Fragm. 8 (1874) 214.—THISELTON-DYER, Fl. Trop. Afr. 8 (1901) 208.—*Alisma reniforme* D. DON, Prod. Fl. Nepal. (1825) 22; WIGHT, Ic. (1840) t. 322; BTH. Fl. Austr. 7 (1878) 186; HOOK. f. Br. Ind. 6 (1893) 560; BAILEY, Queensl. Fl. 6 (1902) 1703; GAGNEP. Fl. Gén. I.-C. 6 (1942) 1205.—*Alisma calophyllum* WALL. Cat. (1832) 4997, *nomen nudum*.—*Caldesia reniformis* MAKINO, Bot. Mag. Tokyo 20 (1906) 34; HOLTHUIS, Blumea 5 (1942) 161.

Glabrous. *Leaves* floating, broad-ovate to broad-elliptic or suborbicular, 2 1/2-6 cm long measured along the midrib, base deeply cordate with broadly rounded basal lobes, apex obtuse, in smaller specimens sometimes broad-acute; nerves 13-17, connected by very numerous, straight, parallel, fine crossbar-veins, 1/3-1/2 mm spaced, ascending at 60°; petiole c. 25(-50) cm, with few lengthwise air-channels, prominently septate at

distances of 4-8 mm when dry. *Inflorescences* few or one, peduncle hollow, with lengthwise air-channels, finely ribbed when dry, including the panicle c. 75 cm long. *Panicle* mostly shorter than the peduncle, pyramidal, branches and flowers on the branches regularly in subsequent whorls of 3, sometimes seemingly in whorls of 4-6 but then 1-3 pedicels represent really 1-flowered branches with each 3 bracts above the base of the 'pedicel'; each branch and pedicel sustained at the base by a membranous, acute, oblong-lanceolate bract, lower ones 1 cm long, subsequent ones gradually smaller. Pedicels 1 1/2-4 cm. *Sepals* elliptic, bluntly rounded, remaining erect, pale green with hyaline margin, c. 3 1/2-4 1/2 by 2-2 1/2 mm. *Petals* white, in bud elliptic, bluntly rounded, very thin, somewhat exceeding the sepals. *Stamens* 6, filaments white or pale yellow, broadened towards the base, persistent, 2-2 1/2 mm; anthers bright yellow, compressed, 1 by 1/3-1/2 mm. *Carpels* 5-8, not all developing into achenes, compressed, obovate, including the style 2-2 1/2 mm; style subterminal, c. 1-1 1/2 mm; stigma punctiform. *Achene* elliptic; laterally faintly compressed, dorsally with 3-5 longitudinal ribs, incl. style c. 3-4 mm long; exocarp spongy, brown, endocarp consisting of a layer of thick-walled sclerenchymatic, radial cells, each cell-wall inside provided with ribs. *Seed* c. 2 by 1 mm, pale brown.

Distr. From North and Central Africa & Madagascar to South & Central Europe, through Southeast Asia to China, Japan, and North Australia, in *Malaysia*: SW. Celebes (Lake Lura, SARASIN 1240, *non vidi*, SAMUELSSON *l.c.*), Moluccas (Talaud), and E. New Guinea (Cape Vogel Peninsula), only thrice found. Fig. 3.

Ecol. Permanent lowland swamps, rooting in shallow water, in Celebes at 650 m. *Fl.*, *fr.* May, Sept.

In the axils of the bracts of the rachis there are sometimes instead of flowers vegetative lateral branches  $\frac{3}{4}$ – $1\frac{1}{2}$  cm long: cigar-shaped turions consisting of many imbricate, acute, lanceolate bracts; they occur in European, Asiatic, and Malaysian specimens and have been described by BUCHENAU (Abh. Naturw. Ver. Bremen 2, 1871, 482) and BANERJI (J. Bomb. Nat. Hist. Soc. 50, 1952, 685–687).

According to BUCHENAU (Pfl. R. p. 2) along the northern frontier of the area of distribution in Central Europe 'winter buds' are formed on prostrate stolon-like stems at the close of the season, representing a way of vegetative reproduction.

Notes. MAKINO *l.c.* has not succeeded in adding much to the differences between the specimens of the European population and those from the tropical parts of the Old World. Malaysian specimens agree very well with luxuriant South European specimens which have never more than 13 nerves in the leaf; in tropical specimens there are 13–17 nerves. There is apparently a small racial difference, by some authors evaluated in the rank of *forma*, by others in the rank of variety. An experimental taxonomical study might show the precise value of the differences found.

## 2. *Caldesia grandis* SAMUELSSON, Svensk Bot. Tidskr. 24 (1930) 116 *cum ic.*

For the differences with *C. parnassifolia* see the key. *Leaves* broader than long, suborbicular, base truncate, apex emarginate, measured along the midrib 11 cm, width 14 cm; nerves 13–17; petiole septate. *Sepals* 4–5 by  $2\frac{1}{2}$  mm. *Stamens* 9(–11, *cf.* SAMUELSSON). *Carpels* (12–)17(–20); style  $2\frac{1}{2}$  mm; achenes not seen.

Distr. India (East Bengal, Khasia Hills: Jowai, Nonkreem, Nunklow, Nurtiung, Khalol), not yet found in Malaysia.

Ecol. Apparently a mountain species, 1000–1500 m. Turions occur between the flowers in the whorls of specimens examined by me.

Note. A closer morphological and cytological investigation of this local species is suggested to our Indian colleagues in order to increase present data.

## 3. *Caldesia oligococca* (F.v.M.) BUCH. Bot. Jahrb. 2 (1882) 479; Pfl. R. Heft 16<sup>2</sup> (1903) 16; BACKER, Handb. Fl. Java 1 (1925) 53; Bekn. Fl. Java (em. ed.) 10 (1949) fam. 204, p. 2.—*Alisma oligococcum* F.v.M. Fragm. 1 (1858) 23; *ditto* 4 (1866) 169; *ditto* 8 (1874) 214; BTH. Fl. Austr. 7 (1878) 185; MICHELI in DC. Mon. Phan. 3 (1881) 37; HOOK.

*f. Fl. Br. Ind.* 6 (1893) 560; in Trim. Fl. Ceyl. 4 (1898) 370; THISELTON-DYER, Fl. Trop. Afr. 8 (1901) 208; BAILEY, Queensl. Fl. 6 (1902) 1703; BACKER, Bull. Jard. Bot. Btzg II, no 12 (1913) 7; GAGNEP. Fl. Gén. 1.-C. 6 (1942) 1206.—*Alisma apetalum* HAM. in Wall. Cat. (1832) 4996, *nomen*.—*Alisma acanthocarpum* F.v.M. Fragm. 1 (1858) 23; *ditto* 4 (1866) 169; *ditto* 8 (1874) 214; BTH. Fl. Austr. 7 (1878) 185; MICHELI in DC. Mon. Phan. 3 (1881) 38; BAILEY, Queensl. Fl. 6 (1902) 1702.—*Alisma glandulosum* THWAITES, En. Fl. Zeyl. (1864) 332.—*Caldesia acanthocarpa* BUCH. Bot. Jahrb. 2 (1882) 479; Pfl. R. Heft 16<sup>2</sup> (1903) 17, f. 6 F, G.—Fig. 1–2.

Glabrous. *Leaves* floating, sometimes also some submerged linear phyllodes (12 cm by 4 mm), ovate, base deeply cordate, lobes obtuse, incision narrow, apex blunt, pellucid-dotted, 6–10 cm long measured along the midrib; nerves 9–17; crossbar veins 1–5 mm spaced, straight and parallel, at 90° with the nerves, in their turn again connected by small reticular veinlets; petiole 35–70 cm, ribbed, when dry with more or less prominent septations 2–8 mm spaced. *Panicles* 1–3, pyramidal,  $\frac{1}{4}$ – $\frac{1}{2}$  as long as the strongly ribbed, angular, hollow peduncle, including the latter 50–115 cm. Bracts connate at the base, oblong-lanceolate, apex attenuate, herbaceous, pellucid-dotted, the lower ones ( $1\frac{1}{2}$ –)3– $11\frac{1}{2}$  by ( $\frac{2}{3}$ –)1– $1\frac{2}{3}$  cm, upwards rapidly decreasing in size, upper ones only 1– $1\frac{1}{2}$  cm; nerves linear, prominent at the undersurface. Pedicels 1– $3\frac{1}{2}$  cm. *Sepals* elliptic, bluntly rounded, green with scarios margin,  $1\frac{1}{2}$ –4 by 1– $2\frac{1}{2}$  mm, after anthesis reflexed and revolute, more or less lengthwise grooved. *Petals* white, elliptic, acute, very thin, shortly unguiculate,  $2\frac{1}{2}$ –6 mm. *Stamens* 6; filaments very thin, dilated towards the base, persistent,  $2\frac{1}{3}$ –2 mm; anthers versatile,  $\frac{1}{3}$ –1 mm long. *Carpels* 2–10, suborbicular to obovate, compressed, not all developing; style inserted ventrally halfway down,  $\frac{3}{4}$ – $1\frac{1}{2}$  mm; stigma punctiform. *Achenes* laterally compressed, kidney-shaped,  $1\frac{1}{2}$ –5 mm long, dorsally with 4 longitudinal ribs densely set with blunt spiny warts, which are interconnected by scarios membranes; sometimes the 2 outer ribs nearly smooth and only the inner ones provided with blunt, more or less conspicuous warts; exocarp membranous; endocarp consisting of a layer of large sclerenchymatic radial cells, without ribs on the inner cell-walls. *Seeds*  $1\frac{1}{2}$ –2 by  $\frac{1}{4}$ – $\frac{1}{2}$  mm, reddish brown.

Distr. W. Africa (Nigeria), Southeast Asia (India, Ceylon, and Indo-China) to North and East Australia, in *Malaysia*: W. and E. Java (between Djakarta and Tg. Priok, and Djatirotto); Lesser Sunda Islands (Timor: near Niki Niki, MONOD DE FROIDEVILLE 1725). Fig. 3.

Ecol. In pools and ditches, and along river-banks; emerged in the dry season; from sea-level to 600 m. By rise of the water during the flowering period the panicle is transformed into an umbel-like inflorescence by development of branches and pedicels keeping the flowers above the surface of the water. *Fl.* Febr.–May, in Australia also found in June–Oct.

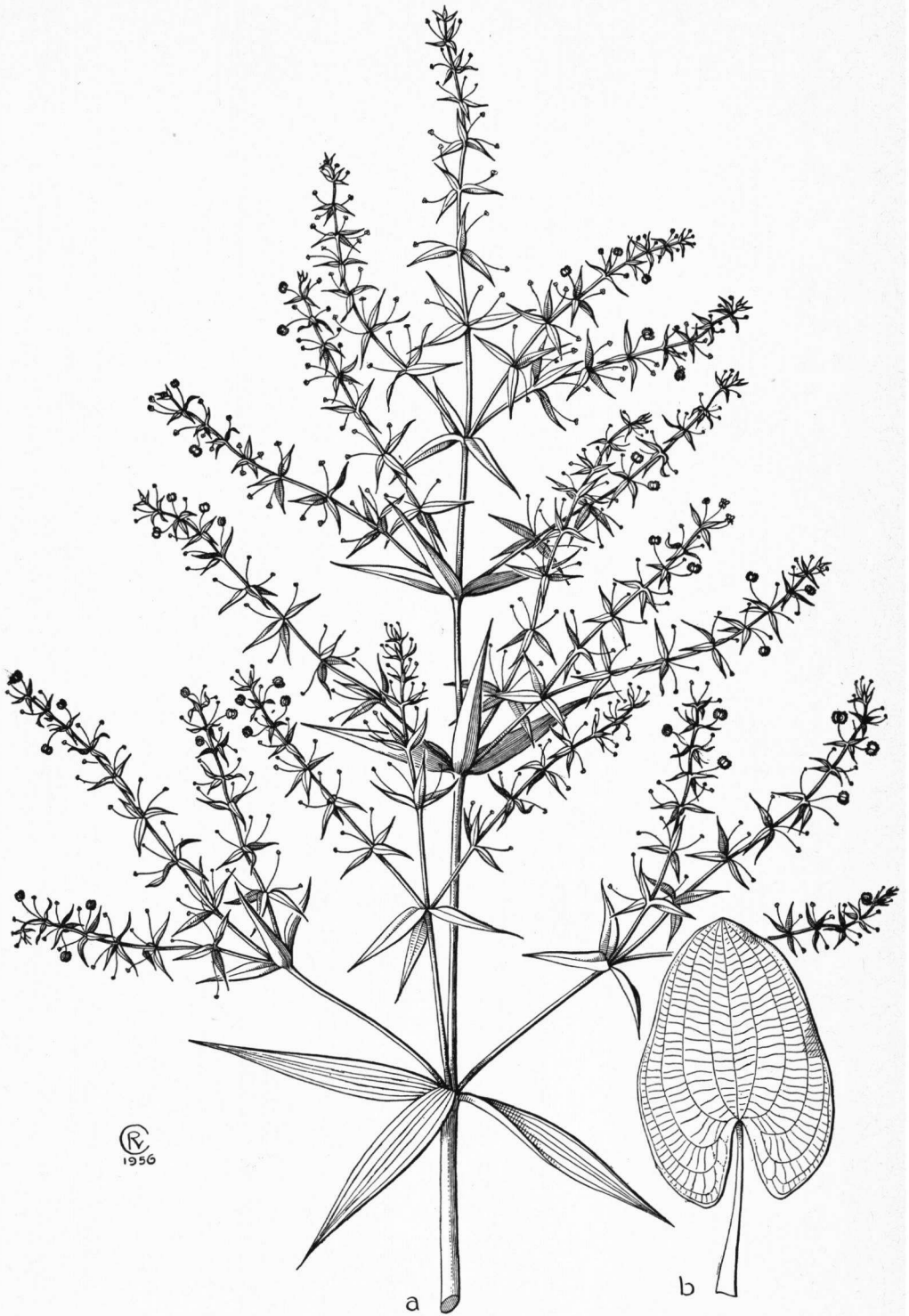


Fig. 1. *Caldesia oligococca* (F.v.M.) BUCH. var. *echinata* HARTOG. a. Habit,  $\times 2/5$ , b. floating radical leaf  $\times 2/5$  (Java).

Note. The species is very variable in the size of the bracts, size of the flowers, size and form of the achenes, the striation of the sepals, and the distances between the crossbar veins in the leaf-blades.

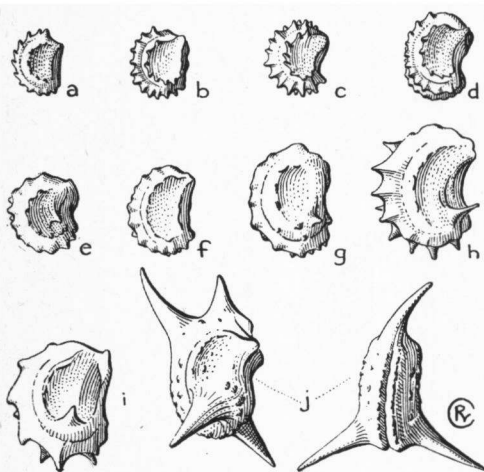


Fig. 2. *Caldesia oligococca* (F.V.M.) BUCH. Fruits of the three varieties: a-d. var. *echinata* HARTOG, e-i. var. *oligococca*, j. var. *acanthocarpa* (F.V.M.) HARTOG (a from Indo-China, b from W. Java, c from Djatirotto (E. Java), d from Ceylon, e from Timor, f Tower Hill, Queensland, g Daintree R., ditto, h Mt Ellis, ditto, i Kelsey Creek, ditto, j Normanton, ditto. All  $\times 3$ ).

This caused F. v. MUELLER to distinguish two species in Australia (1858, *l.c.*); BENTHAM already suggested that these might be reduced to varietal rank. It appears to me that they represent extremes within one specific population.

In view of the very few specimens available it seems convenient for the present to distinguish three varieties; it should be added that additional material may show, however, that they are connected by intermediates and do not represent sharply delimited infraspecific taxa.

var. *oligococca*.—Fig. 2e-l.

Crossbar veins 1-2 mm spaced. Lowermost bracts  $1\frac{1}{2}$ -6 cm long. Sepals 2-4 by  $1\frac{1}{2}$ -2 $\frac{1}{2}$  mm, strongly striated. Petals 3-6 mm long. Filaments  $1\frac{1}{2}$ -2 mm, anthers  $\frac{1}{2}$ - $\frac{3}{4}$  mm. Achenes kidney-shaped, laterally compressed, 3-6 mm, dorsally with 4 longitudinal ribs; inner ribs provided with more or less conspicuous warts, rarely nearly smooth;

outer ribs nearly smooth, often with a small wart near the apex or faintly tubercled.

Distr. N. Australia, Queensland, in *Malaysia*: Lesser Sunda Islands (Timor).

var. *echinata* HARTOG, *nov. var.*—*Alisma glandulosum* THW. En. Fl. Zeyl. (1864) 332.—Fig. 1, 2 a-d.

Crossbar veins 2-5 mm spaced. Lowermost bracts 5-11 $\frac{1}{2}$  cm long. Sepals  $1\frac{1}{2}$ -2 by 1 mm, not or hardly striated. Petals 2 $\frac{1}{2}$  mm long. Achenes kidney-shaped, laterally compressed,  $1\frac{1}{2}$ -3 mm long, dorsally with 4 longitudinal ribs densely set with blunt spiny warts, which are interconnected by scarios membranes.

Distr. W. Africa (Nigeria), S.E. Asia (India, Ceylon, and Indo-China), in *Malaysia*: Java.

var. *acanthocarpa* (F.V.M.) HARTOG, *nov. comb.*—*Alisma acanthocarpum* F.V.M. *Fragm.* 1 (1858) 23.—Fig. 2j.

Crossbar veins c. 1 mm spaced. Lowermost bracts  $2\frac{1}{2}$ -3 $\frac{1}{2}$  cm long. Sepals 3 $\frac{1}{2}$  by 2 mm, prominently striated. Petals 4-6 mm. Filaments 2 mm, anthers 1 by  $\frac{1}{2}$  mm. Achenes kidney-shaped, laterally compressed, 5-8 mm, dorsally with 4 longitudinal ribs which are faintly tubercled to nearly smooth; outer 2 ribs at the apex provided with a lateral, conical, acute spine 2-3 $\frac{1}{2}$  mm long, base 1 mm thick, divergent under 60-90°; inner ribs producing together 1, occasionally 2, dorsal spines.

Distr. N. Australia and Queensland.

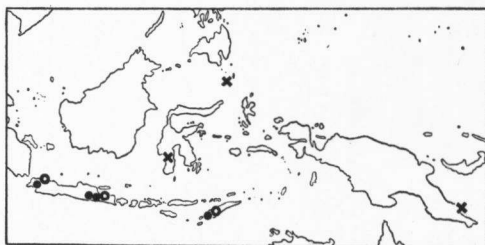


Fig. 3. Localities in *Malaysia* of *Caldesia parnassifolia* (X), *C. oligococca* (O), and *Limnophyton obtusifolium* (●).

(1) Nervi transversales distantes 2-5 mm. Bractae infimae 5-11 $\frac{1}{2}$  cm longae. Sepali  $1\frac{1}{2}$ -2 mm longi, 1 mm lati, non vel vix striati. Petali 2 $\frac{1}{2}$  mm longi. Achenae reniformes, lateraliter compressae,  $1\frac{1}{2}$ -3 mm longae, dorsaliter costis 4 longitudinalibus densissime verrucosis praeditae, verrucis obtusis spinulosis membranis scariosis conjunctis.

Fig. 4. *Limnophyton obtusifolium* (L.) MIQ. a. Habit of small specimen,  $\times \frac{1}{2}$ , b. bud (opened from herbarium specimen),  $\times 5$ , c. fruit,  $\times 5$ , d. large leaf from mature specimen,  $\times \frac{1}{2}$  (a SHAIK MOKIM 851, b JUNGHUHN s.n., c POSTHUMUS s.n.).



Fig. 4. *Limnophyton obtusifolium* (L.) MIQ. For legend see base of opposite page.

## 2. LIMNOPHYTON

MIQUEL, Fl. Ind. Bat. 3 (1855) 242; B. & H. Gen. Pl. 3 (1883) 1005; BUCHENAU, Pfl. R. Heft 16<sup>2</sup> (1903) 21.—Fig. 4.

Basal leaves sagittate. Panicle pyramidal with branches and flowers in  $\infty$ -merous, 3-bracteate whorls; lower whorls with bisexual flowers, upper ones  $\sigma$ . Sepals reflexed after anthesis. Petals white. Stamens 6, in pairs opposite the sepals; filaments strongly broadened towards the base. Carpels 15- $\infty$ , crowded on a small receptacle. Achene swollen; exocarp spongy, endocarp hardly sclerenchymatic, with on both sides a lateral air-chamber between the endo- and exocarp. Seed horseshoe-shaped.

Distr. Possibly monospecific; palaeotropics, from Africa & Madagascar eastward as far as Malaysia (Timor).

Note. From Africa a few other species than the present one have been described which possibly represent only forms of the one treated here. *L. parviflorum* PETER matches *Caldesia sagittarioides* OSTENF. from Indo-China and apparently represents a juvenile flowering form. Such forms are well known to occur in water plants and have often been described as separate species, cf. under *Monochoria* (Fl. Mal. 4, p. 258) and *Tenagocharis* (*ibid.* 5, p. 118).

1. *Limnophyton obtusifolium* (L.) MIQ. Fl. Ind. Bat. 3 (1855) 242; MICHEL, in DC. Mon. Phan. 3 (1881) 39; HOOK. f. Fl. Br. Ind. 6 (1893) 560; in TRIM. Fl. Ceyl. 4 (1898) 370; THISELTON-DYER, Fl. Trop. Afr. 8 (1901) 209; BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 22, f. 10; BACKER, Handb. Fl. Jav. 1 (1925) 53; COERT, Trop. Natuur 23 (1934) 7; GAGNEP. Fl. Gén. I.-C. 6 (1942) 1207; PERRIER DE LA BÂTHIE, Fl. Mad. fam. 25 (1946) 9, f. I 7-13; BACKER, Bekn. Fl. Java (em. ed.) 10 (1949) fam. 204, p. 3.—*Culitamar* RHEEDE, Hort. Mal. 11, t. 45.—*Sagittaria obtusifolia* LINNÉ, Sp. Pl. (1753) 993.—*Alisma sagittifolium* WILLD. Sp. Pl. ed. 4, 2 (1799) 277; KUNTH, En. Pl. 3 (1841) 151.—*Alisma kotschyi* HOCHST. ex A. BRAUN in Flora 26 (1843) 499.—*Alisma obtusifolium* THWAITES, En. Pl. Zeyl. (1864) 332.—*Dipseudochorion sagittifolium* BUCH. Flora 48 (1865) 245.—*Caldesia sagittarioides* OSTENF. Philip. J. Sc. 9 (1914) Bot. 259; SAMUELSON, Svensk Bot. Tidskr. 24 (1930) 113.—*L. parviflorum* PETER, Abh. Ges. Wiss. Göttingen 13 (1928) 41; in Fedde, Rep. Beih. 40 (1938) 119.—Fig. 4.

Robust, possibly annual. Leaves floating, pellucid-punctate, broadly sagittate, with blunt, rounded or emarginate apex (in extra-Mal. sometimes broad-acute or apiculate), basal lobes broad-triangular very acutely tipped, 12½-13 cm (measured along midrib) by 20-23 cm (greatest width); nerves 17-19, upper ones directed towards the apex, the others radiating towards the basal lobes, the 4th and sometimes also the 5th pair branched, all connected by parallel veins under an angle of 60° and 3-6 mm spaced, again connected by reticulate veins 2nd order; petiole sparsely patent-short hairy, ribbed with longitudinal septate air-channels, septations distinct in dried young specimens. To 80 cm long. Peduncle erect, sparsely patent hairy, angular, strongly ribbed, with longitudinal air-channels. Panicle pyramidal, flowers in whorls of 13-18, the lowest whorl in addition with 3-4 lateral branches. Bracts up to 3 cm long, lanceolate acuminate, mostly reflexed. Pedicels 2-4½ cm, mostly reflexed after anthesis.

Sepals elliptic, bluntly rounded, in the bisexual flowers 5½-7 by 3½-4 mm, in the  $\sigma$  flowers 4-4½ by 2½ mm. Petals white, in bud orbicular to broad-elliptic, larger than the sepals, short-unguiculate, extremely delicate, in  $\sigma$  flowers larger than in the  $\sigma$  flowers. Stamens 6, in the  $\sigma$  flowers those of each pair spaced one before each margin of a petal, in the  $\sigma$  flowers the bases of the filaments touching; filaments 2 mm, broadened and thickened towards the base; anthers 1½ by ¾ mm. Carpels 15-20, obovate, laterally compressed, provided with some reticulate, scarious ribs, 1½-3 mm; style subterminal; stigma narrow knob-shaped, feebly lobed, glandular-papillose. Achenes obovate with cuneate base, 4-5(-8) mm, with a fine reticulation of scarious ribs, short-beaked. Seed 4 mm long.

Distr. From tropical Africa & Madagascar through Southeast Asia (India, Ceylon, Annam) to Malaysia: W.-E. Java (Depok; Rawah Bening near Tulungagung, Kediri; Babad, W of Mt Lamongan), Lesser Sunda Islands (Timor: near Niki Niki). Fig. 3.

RIDLEY has recorded this species from the Malay Peninsula: 'a small pool, Pulau Tawar, Pahang' (Trans. Linn. Soc. Lond. II, 3 (1893) 385) but has in his subsequent revisions omitted this record which appeared to be a misidentification for *Sagittaria guayamensis*.

Ecol. In swamps and pools below 600 m, according to COERT *l.c.* only growing in a certain period of the year and terrestrial parts dying off in the other part of the year, in Timor found in a small lake drying up in the dry season, fl. fr. April-Aug.

Note. Under unfavourable circumstances growth in specimens is sometimes arrested; in these specimens the leaf-shape varies from broad-ovate with acute apex (2-3 by 1½-1¾ cm) to broad-sagittate with blunt or apiculate apex (2-3 by 1¾-2 cm). Such not full-grown depauperized specimens have sometimes been described as distinct species (*Caldesia sagittarioides* OSTENF., *Limnophyton parviflorum* PETER), but represent merely phenotypic forms.



## 3. ECHINODORUS

L. C. RICHARD, Mém. Mus. Hist. Nat. Paris 1 (1815) 365; ENGELMANN in A. Gray, Man. Bot. ed. 1 (1848) 460, *descr. emend.*; BUCHENAU, Pfl. R. Heft 16<sup>2</sup> (1903) 23; PICHON, Not. Syst. 12 (1946) 172; FASSETT, Rhodora 57 (1955) 133–156, 174–188, 202–212.—*Alisma* sect. *Echinodorus* SCHULTES, Syst. 7 (1830) 1605.—*Baldellia* PARL. Nuov. Gen. Sp. Monoc. (1854) 57.—*Sagittaria* sect. *Echinodorus* BAILL. Hist. Pl. 12 (1894) 84.—*Ranalisma* STAFF, in Hook. Ic. Pl. (1900) t. 2652; BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 11; HUTCHINSON, Fam. Fl. Pl. 2 (1934) 34; DALZIEL & HUTCHINSON, Fl. Trop. W. Afr. 2 (1936) 303.—Fig. 5.

Emerged leaves long-petioled, linear-lanceolate to ovate, base acuminate, blunt or cordate, submerged phyllodes (if present) linear. *Inflorescence* racemose or a panicle with whorls, sometimes an umbel which in some species is only 1–3-flowered. Bracts 2 or 3. *Flowers* ♂. *Sepals* green, dorsally striped or grooved. *Petals* delicate, often much exceeding the sepals. *Stamens* 6, 9, 12 or ∞; filaments filiform; anthers oblong. *Carpels* ∞, spirally arranged on a globular or oblong receptacle; style terminal. *Achenes* not, slightly, or strongly compressed, with lateral ribs or not, beaked. *Seeds* broad-elliptic, the testa following the hippocrepiform seed but connate in the incision.

Distr. About 25–30  *spp.* mostly in tropical America, only 4  *spp.* in the Old World; two in Europe, one in tropical Africa [*E. humilis* (KUNTH) BUCH.], and one in tropical Southeast Asia and Malaysia (Malay Peninsula).

Notes. RICHARD segregated *Echinodorus* from *Alisma* in the briefest way possible '*Alismae polyandrae*' which was at that time sufficient. The 2 tropical Old World species are distinguished by strongly compressed, non-ribbed achenes and pauciflorous 1–3-flowered inflorescences with only 2 bracts; they belong to *subg.* *Ranalisma* (STAFF) HARTOG, *stat. nov.*, typified by the Asiatic-Malayan species.

Following PICHON (Not. Syst. 12, 1946, 173), in some recent European floras, for example that of CLAPHAM *c.s.*, the European *E. ranunculoides* (L.) ENGELM. has been distinguished as representing a monotypic, distinct genus *Baldellia* which is characterized by the occurrence of only 6 stamens; the other characters, mentioned by PICHON, cannot be maintained, because they simply do not exist. Its elevation to generic rank has been proposed without a revision of the genus as a whole and based on examination of too scant material. As a matter of fact the characters of this species can at most be classified in the subsectional level, if such a fine subdivision of the genus is deemed desirable. BUCHENAU did not give it and FASSETT, in his revision of the tropical American species, *i.c.*, has shown that among the American species there are far more important characters for sectional and subgeneric rank than can be advanced in favour of a separate generic status of the European species. Local florists should avoid such splitting as they are not in a position to judge its necessity and consequences and unduly set up nomenclature.

1. *Echinodorus ridleyi* STEEN. Arch. Hydrobiol. Suppl. 11 (1932) 240, footnote.—*Ranalisma rostrata* STAFF in HOOK. Ic. Pl. (1900) t. 2652; BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 11, f. 4; RIDLEY, Mat. Fl. Mal. Pen. (Monoc.) 2 (1907) 126; Fl. Mal. Pen. 4 (1924) 362, f. 206.—*E. rostratus* GAGNEP. Bull. Soc. Bot. Fr. 76 (1929) 274, *non* ENGELM. 1848; Fl. Gén. I.-C. 6 (1942) 1200, f. 114, 1–6.—Fig. 5.

Tender plant with creeping stolons (fruiting peduncles) producing new rosettes with intervals. Emerged leaves broad-elliptic to ovate, base rounded to slightly cordate, apex rounded blunt-apiculate, 1–3½ by 2½–2½ cm; nerves 3–5, connected by crossbar veins ascending at 60° and 1–3 mm spaced, in their turn connected by about parallel longitudinal secondary crossbar veinlets spaced ½ mm; petiole thin, ribbed, hollow, with a basal membranous sheath, 4–20 cm long, with prominent septations spaced 4–6 mm. *Peduncle* solitary, 4–10 cm. *Umbel* 1–3-flowered, sometimes

bearing turions in the place of the lateral flowers which develop 1 or 2 leaves, sustained by 2 membranous bracts, these lanceolate, slightly keeled, acutely tipped, connate at the base, both with a small dorsal rootlet at the base, 3–6 mm long. Pedicels 1–1¾ cm. *Flowers* c. 1 cm diam. *Sepals* broad-elliptic, blunt, reflexed after anthesis, pale green, 4–6 mm long. *Petals* elliptic to obovate, white, 4–6 mm long. *Stamens* 9, in one whorl; filaments filiform, 2 mm; anthers oblong, 1½–¾ mm. *Carpels* ∞, spirally arranged on prominent receptacle elongated after anthesis, obliquely elliptic, laterally compressed; style terminal, subulate, 1 mm. *Achenes* very obliquely obovate-orbicular, with many glands, strongly compressed laterally, broadly unequal-winged, 3–4 mm, terminal beak 2–3 mm. *Seed* elliptic, 2 mm, light brown.

Distr. Southeast Asia (Annam: Hue, SQUIRES 412) and Malaysia: Malay Peninsula (Selangor:

Gua Batu woods, RIDLEY 8464; SCORTECHINI 126 Herb. Mus. Perak), thrice found.

Ecol. Open muddy place in jungle (RIDLEY), in Annam collected with *Monochoria* which will have been probably in open swamps or rice-fields, fl. fr. July, in Annam Jan.-May.

Notes. Unfortunately I have had no material additional to the original sheets of STAFF and GAGNEPAIN, but it appeared that the morphology of this curious, obviously very rare plant has not been understood completely.

STAFF mentions mainly 1-flowered plants and

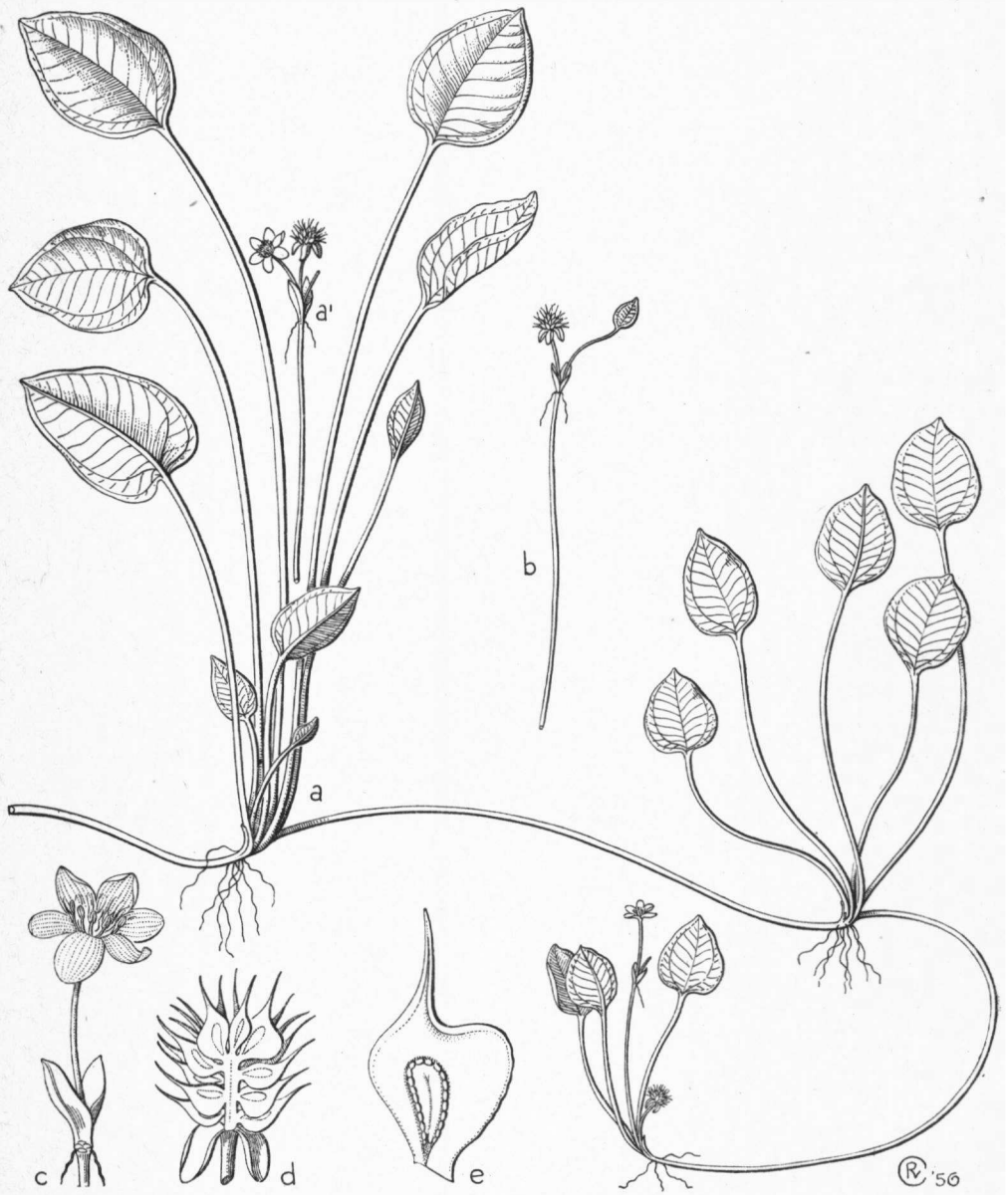


Fig. 5. *Echinodorus ridleyi* STEEN. a. Habit, with 2 rosettes on the pseudo-stolons, a'. inflorescence showing roots on bracts below two flowers (one beyond anthesis), b. ditto, with developing leaf,  $\times \frac{2}{3}$ , c. flower,  $\times 2$ , d. fruiting flower,  $\times 3$ , e. fruit,  $\times 8$  (a-a' partially after STAFF, partly after RIDLEY 8464, b SCORTECHINI 126, c-d after STAFF, e RIDLEY 8464).

GAGNEPAIN saw only 1-flowered specimens. In both cases, however, the other flowers were substituted by turions which already develop one or a few leaves (fig. 5b) while still in flower and the bracts of the umbel bear each a rootlet at the same time. Towards the fruiting stage the umbel is already transformed into a whole new plant which bends downward towards the mud. Consequently a young plant still attached to the mother rosette by the old peduncle may bear both a young

peduncle and a non-peduncled, but only pedicelled fruithead (fig. 5a, end below).

From this structure it can be inferred that the peduncle after having flowered serves as a stolon forming a new plant on the place of the aging inflorescence. I have found a similar structure in the African *E. humilis*, the European *E. repens*, the American *E. radicans*, and in the European *Luronium natans*. Whether also true stolons occur in the genus is unknown and should be verified in the field.

4. SAGITTARIA

LINNÉ, Sp. Pl. 1 (1753) 993; Gen. Pl. ed. 5 (1754) 429; J. G. SMITH, Rep. Mo. Bot. Gard. 6 (1895) 27; BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 37; BOGIN, Mem. N.Y. Bot. Gard. 9 (1955) 188.—*Sagittaria* sect. *Lophiocarpus* KUNTH, En. Pl. 3 (1841) 161.—*Alisma* sect. *Lophiocarpus* SEUB. Fl. Bras. 3, 1 (1847) 106.—*Lophiocarpus* MIQ. Ill. Fl. Arch. Ind. (1870) 50, non TURCZ. 1843.—*Lophotocarpus* DURAND, Ind. Gen. Phan. (1888) 627.—Fig. 6–12.

Emerged leaves sagittate or lanceolate, floating ones mostly cordate, submerged phyllodes linear. Inflorescence mostly a raceme with 1–14 mostly 3-flowered whorls, each sustained by a whorl of 3, more or less connate bracts, sometimes a panicle. Flowers mostly unisexual: upper ones ♂, lower ones ♀ or ♀. Pedicels erect or ascending, those of ♀ flowers often thickened and reflexed after anthesis. Sepals reflexed in ♂ flowers, in ♀ flowers appressed, patent, or reflexed. Petals delicate, white or rarely pink, sometimes with purple spot at the base. Stamens 7–∞; filaments filiform, subulate, or dilated. Carpels spirally arranged in a head on a large, globular receptacle. Style terminal, erect or obliquely directed inward. Achenes laterally compressed, beaked, winged, mostly membranous. Seed horse-shoe-shaped.

Distr. About 25 spp., mainly in temperate and tropical America, in the Old World only 3 species native, absent from Australia and the Pacific, others introduced and partly naturalized.

Note. I agree with PICHON (Not. Syst. 12, 1946, 177) and BOGIN *l.c.* that the genus *Lophotocarpus* cannot be upheld and maintained separately from *Sagittaria*; the differences are small and only a single one holds; in my opinion they can at most be evaluated at sectional rank, as follows:

Sect. *Sagittaria*. Sepals in mature pistillate flowers reflexed. Pedicels mostly ascending, rarely recurved and thickening in fruit. Perfect flowers rarely present.

Sect. *Lophiocarpus* KUNTH, En. Pl. 3 (1841) 161.—Subg. *Lophotocarpus* BOGIN *l.c.*. Sepals in mature pistillate flowers appressed or spreading. Pedicels recurved and more or less thickened in fruit. Perfect flowers occasionally present.

KEY TO THE SPECIES

- 1. Mature ♀ flowers with appressed or patent sepals.
- 2. Sepals of mature ♀ flowers closely appressed. Fruiting pedicels strongly thickened. Coarse plant.
- 3. Water plant with floating cordate-ovate leaves. ♀ Flowers with a whorl of stamens. Achene much compressed, with broad, blunt-spiny wings, a more or less warty ridge on the lateral sides, and no prominent beak . . . . . 1. *S. guayanensis* ssp. *lappula*
- 3. Emerged leaves sagittate. ♀ Flowers only exceptionally with stamens. Achene flattened, narrowly winged, without lateral ridges, but with a beak 1/2–1 mm long . . . . . 2. *S. montevidensis*
- 2. Sepals of the mature ♀ flowers widely patent. Fruiting pedicels hardly thickened. Delicate water plant. . . . . 3. *S. subulata*
- 1. Sepals of mature ♀ flowers with reflexed sepals.
- 4. Emerged leaves linear to lanceolate. Filaments hairy.
- 5. Nerves arising from the leaf-base. Bracts connate and scarious. Filaments dilated. Fruiting pedicels recurved and thickened . . . . . 4. *S. platyphylla*
- 5. Nerves arising from the midrib. Bracts nearly free, thick and striped. Filaments filiform. Fruiting pedicels ascending, not thickened . . . . . 5. *S. lancifolia*
- 4. Emerged leaves sagittate. Stamens glabrous . . . . . 6. *S. sagittifolia* ssp. *leucopetala*

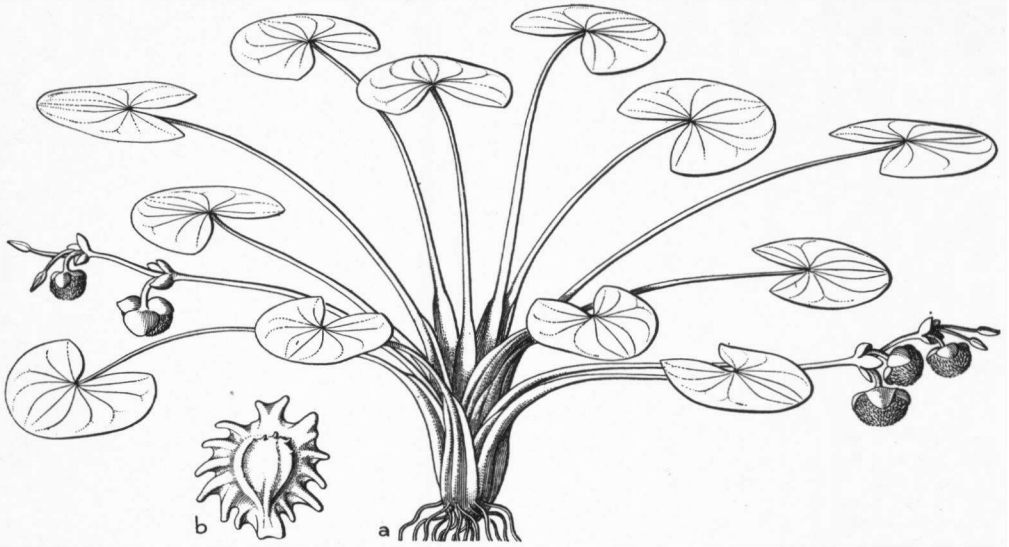


Fig. 6. *Sagittaria guayanensis* H.B.K. *ssp. lappula* (D. DON) BOGIN. a. Plant  $\times 2/3$ , b. fruit,  $\times 4$  (SCHIFFNER 1482).

1. *Sagittaria guayanensis* H.B.K. Nov. Gen. Sp. 1 (1816) 250.

I perfectly agree with BOGIN (*l.c.* 192) that only 2 subspecies can be distinguished, and not 4 as was proposed by BUCHENAU, viz:

*ssp. guayanensis*: Achenes plump,  $1\frac{1}{2}$ – $2\frac{1}{2}$  by  $1\frac{1}{4}$ –2 mm, wings shallowly crested, occasionally smooth, faces 1–3-winged, typically strongly echinate, occasionally smooth or unadorned.—Throughout tropical America.

*ssp. lappula* (D. DON) BOGIN, *l.c.*: Achenes compressed,  $2\frac{1}{2}$ –4 by  $1\frac{3}{4}$ –3 mm, wings typically deeply crested, rarely nearly smooth, their faces usually prominently 1-ribbed, the rib occasionally remotely echinate, rarely unadorned.—Tropics of Africa, Asia, and Malaysia, see below.

The original spelling *guayanensis* for the epithet has been retained here, though many recent authors have followed BUCHENAU who, for reasons of easy pronunciation, changed it into *guyanensis*.

*ssp. lappula* (D. DON) BOGIN, Mem. N.Y. Bot. Gard. 9 (1955) 192, f. 5.—*S. lappula* D. DON, Prod. Fl. Nep. (1825) 22.—*S. pusilla* BL. En. Pl. Jav. 1 (1827) 34, non NUTT. 1818; ZOLL. Syst. Verz. (1854) 65.—*S. cordifolia* ROXB. Fl. Ind. ed. CAREY 3 (1832) 647.—*S. blumei* KUNTH, En. Pl. 3 (1841) 158.—*S. obtusissima* HASSK. Cat. Pl. Hort. Bog. (1844) 26.—*Lophiocarpus cordifolius* MIQ. Illustr. (1870) 50; BUCH. Abh. Naturw. Ver. Bremen 7 (1880) 30, incl. var. *madagascariensis*.—*Lophiocarpus lappula* MIQ. *l.c.*—*Lophiocarpus guayanensis* MICHELI, in DC. Mon. Phan. 3 (1881) 62; GAGN. Fl. Gén. I.-C. 6 (1942) 1201, f. 114, 7–12.—*S. guayanensis* H.B.K.; HOOK. f. Fl. Br. Ind. 6 (1893) 561; RIDL. Mat. Fl. Mal. Pen. (Monoc.) 2 (1907) 127; Fl. Mal. Pen. 4 (1924) 363; HEND. Mal.

Wild Fl. (Monoc.) (1954) 202, f. 120A.—*Lophiocarpus guayanensis* J. G. SMITH, Rep. Mo. Bot. Gard. 6 (1895) 61, *pro specim. geront.*; THISELTON-DYER, Fl. Trop. Afr. 8 (1901) 210; *pro var. lappula et var. madagascariensis* BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 36, f. 12 B-C; KOORDERS, Exk. Fl. Java 1 (1911) 92; BACKER, Handb. Fl. Java 1 (1925) 54; BACKER, Onkr. Suiker. (1928) 20, Atlas t. 26; PERRIER DE LA BATHIE, Fl. Mad. fam. 25 (1946) 4, f. II 4–5; BACKER, Bekn. Fl. Java (em. ed.) 10 (1949) fam. 204, p. 3.—*Lophiocarpus formosanus* HAYATA, Ic. Pl. Form. 5 (1915) 249.—Fig. 6.

Laticiferous water plant. Leaves floating, ovate with rounded or emarginate apex, base deeply cordate, basal lobes obtuse,  $1\frac{1}{2}$ – $6\frac{1}{2}$  cm long measured along the midrib, greatest width  $2\frac{1}{2}$ – $10\frac{1}{2}$  cm; submerged phyllodes sometimes present, linear to lanceolate, shortly petioled, 5–11 by  $1\frac{1}{2}$ – $1\frac{1}{2}$  cm; nerves 15–17, prominent on the undersurface, the inner 6–8 directed apically, the others towards the lobes, on the undersurface connected by parallel cross-veins under an angle of *c.* 70° spaced 1–2 mm, upper surface with veins densely reticulate; petiole ribbed, *c.* 15–30 cm with air-channels and *in sicco* prominent septations spaced 2–4 mm; sheath with a broad scarious margin. Peduncles 1–7, rather flaccid, floating, ribbed, with wide air-channels, short-petent hairy towards the apex incl. the raceme 15–40 cm. Racemes *c.*  $\frac{1}{3}$  as long as the peduncle, with 2–6 whorls of 2–3 flowers; 1–4 lower whorls with ♂ flowers, the upper ones ♀. Bracts 3 in each whorl, broad-elliptic, connate, rounded at the top, green with scarious margin,  $\frac{4}{5}$ –2 cm long. Pedicels up to 1 cm, after anthesis thickened and recurved. Sepals broadly triangular-ovate, blunt, keeled, 8–11 by 7–10 mm. Petals obovate to orbicular,

very broadly rounded at the apex, delicate, white with sometimes a small purple spot above the yellowish base, 12–15(–18) mm. *Stamens* in the ♂ flowers 8–12, in an interrupted whorl grouped opposite to the sepals, in the ♂ flowers 6–10, in a whorl, exceeding the rudiments of the pistils, filaments 2–3 mm, much dilated and flattened towards the base, fine-papillose; anthers oblong, 1½ by ¾ mm. *Carpels* ∞, elliptic to suborbicular, with a dorsal and a ventral, undulate, membranous crest; style terminal directed inward, c. 1 mm; stigma punctiform. *Achenes* ∞, 3–4 mm, elliptic, short-stalked, with broad, blunt-spiny crest, spines connected by a thin membrane, c. 1 mm high; lateral ridges without or with minute warts; beak broadly scarious-margined; exocarp with a very fine reticulate relief. *Seed* brown, 1½ mm.

Distr. Tropics of Africa and Southeast to East Asia (also Formosa), in *Malaysia*: Sumatra, Malay Peninsula, Java & Madura Isl., Celebes.

Ecol. Ditches and wet rice-fields, 10–1000 m, often in great quantity, fl. Jan.–Dec. Flowers are closed in the morning, open at noon or somewhat later but never very widely, and close at dusk.

Vern. *Kĕladi ajer, kĕlipok padang*, Mal. Pen., *ĕtjĕng, S.*

Note. The data on the colour of the flowers have been copied from BACKER; no field notes are available. It seems that the presence or absence of a basal, purple spot on the petals is not geographically (racially) defined as is the case in *S. sagittifolia* (see p. 332).

2. *Sagittaria montevidensis* CHAM. & SCHLECHTEND. *Linnaea* 2 (1827) 156; MICHELI in DC. *Mon. Phan.* 3 (1881) 75; J. G. SMITH, *Rep. Mo. Bot. Gard.* 6 (1895) 57, t. 29; BUCH. *Pfl. R. Heft* 16<sup>2</sup> (1903) 43; BACKER, *Ann. Jard. Bot. Btzg. Suppl.* 3 (1909) 413; SMALL, *N. Am. Fl.* 17 (1909) 62; VAÑ WELSEME, *Trop. Natuur* 4 (1915) 174, f. 109–110; BACKER, *Handb. Fl. Java* 1 (1925) 55; BRUGGEMAN, *Ind. Tuinb.* (1939) 168, f. 181; BACKER, *Bekn. Fl. Java* (em. ed.) 10 (1949) fam. 204, p. 4; BOGIN, *Mem. N.Y. Bot. Gard.* 9 (1955) 195, f. 2 e–f.

Robust, glabrous, with stolons ending in a tuberous thickened apex. *Leaves* emerged, erect, sagittate; terminal lobe very broad-ovate, apex broad-acute to acuminate, 4–20 cm long measured along the midrib, width near leaf-base 2–25 cm; basal lobes lanceolate to broad-ensiform, ending in very narrow ends, 4–25 cm long, about half as wide as the terminal lobe; nerves in the terminal lobe 9–15, in the basal lobes 6–8, connected by parallel cross-veins under an angle of 60°, spaced 2–5 mm, again connected by reticulate veinlets; petiole nearly terete, ribbed, with longitudinal air-channels, with septations 3–5 mm spaced. *Peduncles* robust, erect, blunt-angled to terete, ribbed, with longitudinal air-channels, septations 5–7 mm apart. *Raceme* 40–50 cm long, with 14 whorls of 3–6 flowers, the lowest whorl besides sometimes with 1–2 branches, lowest 2–4 whorls ♀, other ♂. Bracts connate, keeled, scarious, the free parts attenuate, lanceolate, 1–1½ cm long. Pedicels of the ♀ flowers recurved and thickened after anthesis

2–7 cm, those of the ♂ flowers obliquely erect, thin, c. 4 cm. *Sepals* elliptic to obovate, with scarious margin, 8–11 by 4–5 mm, appressed, accrescent to 15 mm. *Petals* transversely elliptic, faintly sinuate at the apex, campanulately bent together, 18–22 by 22–28 mm, white with a rather large, dark-red yellow-margined spot, the coloured part persistent after flowering. *Stamens* ∞; filaments 2–3 mm, filiform, often slightly dilated, faintly hairy; anthers 1½ by ½ mm, oblong. *Carpels* ∞, elliptic; style terminal ½–1 mm; stigma punctiform. *Achenes* obovate to elliptic, 2–3 by 1–1½ mm, dorsally and ventrally narrowly winged, with 1 dorsal resin duct; beak terminal, ½–1 mm, obliquely erect adaxially. *Seed* red-brown, 1½–2 mm.

Distr. Native of South America, in *Malaysia*: adventive along the bank of a canal near Djakarta, first found in 1903 (BACKER *l.c.*). According to BRUGGEMAN also cultivated in the botanic gardens at Tjibodas and Sibolangit; fl. Jan.–Dec.

Note. Several authors have recorded the occurrence of rudimentary carpels in ♂ flowers and a whorl of 9–12 stamens in ♀ flowers. I could not observe this in the Javan specimens. The latter belong to *ssp. montevidensis*.

3. *Sagittaria subulata* (L.) BUCH. *Abh. Naturw. Ver. Bremen* 2 (1871) 490; J. G. SMITH, *Rep. Mo. Bot. Gard.* 6 (1895) 44, t. 13; BUCH. *Pfl. R. Heft* 16<sup>2</sup> (1903) 58; SMALL, *N. Am. Fl.* 17 (1909) 52; BACKER, *Handb. Fl. Java* 1 (1925) 55; BACKER, *Bekn. Fl. Java* (em. ed.) 10 (1949) fam. 204, p. 4; BOGIN, *Mem. N.Y. Bot. Gard.* 9 (1955) 203, f. 10 a–c.—*Alisma subulata* LINNĒ, *Sp. Pl.* 1 (1753) 343.—*Echinodorus subulatus* ENGLM. in A. Gray, *Man. Bot.* (1848) 460.—Fig. 7.

Delicate water plant with long, subterranean stolons and tubers. Submerged phyllodes linear, 10–30 cm by ½–1 mm; floating leaves often absent, if present lanceolate or elliptic, base rounded, blunt or cuneate, apex blunt or rounded, 2½–5 cm long; nerves 5, connected by not very distinct cross-bar veins ascending at 45° and 1–2½ mm spaced, these in turn connected by fine-reticulate veinlets; petiole with longitudinal air-channels, and *in sicco* prominent septation 1½–6 mm spaced; sheath scarious-margined. *Inflorescences* 1–2, flaccid, submerged, 10–40 cm long, flowers in anthesis just above the water. Raceme consisting of 2–14 whorls of 3 flowers, only 2 flowers of the lowest whorl ♀, the others ♂. Bracts spatulate, connate, the free ends 6 mm. Pedicels of the ♀ flowers rather thick, after anthesis somewhat thickened, wide-patent or recurved, in the ♂ flowers slender, 1½–3½ cm. *Sepals* after anthesis wide-patent, broad-elliptic, broad-acute, 2–3 by 1–1½ mm. *Petals* clear white, broad-ovate, ½–1 cm long. *Stamens* mostly 7 (rarely 8 or 13), one central surrounded by a whorl of the others (rarely 2 whorls); filaments glabrous, thickened at the base, 2/3–1 mm; anthers oblong, ½–2/5 mm. *Achenes* ∞, rather thick, obovate, with a narrow dorsal and ventral wing and on both sides narrow, faintly crenate, lateral wings; beak terminal, ensiform, obliquely directed adaxially, 1/5–2/5 mm. *Seed* pale brown.

Distr. East North America (Massachusetts to Florida), introduced in *Malaysia*: Java (BACKER *l.c.*).

Ecol. Cultivated in Java in shallow water tanks and fishponds, fl. Jan.–Dec.



Fig. 7. *Sagittaria subulata* (L.) BUCH. Cultivated in Kebun Raya Indonesia (photogr. F. HUYSMANS).

Note. Description made from data by BACKER *l.c.* and from additional American material. According to the description given by BACKER the material cultivated in *Malaysia* belongs to *ssp. subulata*.

4. *Sagittaria platyphylla* (ENGELM.) J. G. SMITH, Rep. Mo. Bot. Gard. 6 (1895) 55, t. 26; BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 57; SMALL, N. Am. Fl. 17 (1909) 53; KERN, Trop. Natuur 32 (1952) 127 *cum fig.*—*S. graminea* MICHX. var. *platyphylla* ENGELM. in A. Gray, Man. ed. 5 (1867) 494; MICHELI in DC. Mon. Phan. 3 (1881) 70; BOGIN, Mem. N.Y. Bot. Gard. 9 (1955) 208, f. 11 a–c.—Fig. 8.

Perennial, glabrous, with subterranean stolons. Emerged leaves erect, narrow-elliptic to lanceolate, acute, gradually narrowed towards the base, 5½–10 by 1–3 cm; in extra-Mal. specim. also phyllodes; nerves 5–7, arising at the leaf-base,

prominent on the undersurface, connected by parallel cross-veins spaced c. 1 mm under an angle of c. 45°; petiole sharply triangular, narrowly winged, ribbed, with air-channels, 25–40 cm *in sicco* with distinct septations c. 5–7 mm spaced; sheath broad. Peduncles erect, very bluntly triangular, with air-channels, incl. the raceme 30–40 cm. Raceme about ¼ as long as the peduncle, with 4–6 whorls of 3 flowers, the lower 2 whorls ♀, the others ♂. Bracts connate, broad-ovate to sub-orbicular, obtuse, margin scarious, c. 3–4 mm. Pedicels 8–20 mm, obliquely erect, fruiting pedicels recurved and strongly thickened. Flowers c. 2 cm diam. Sepals blunt elliptic, broadly scarious-margined, recurved after anthesis, 4–4½ mm long. Petals white, transverse elliptic, short-unguiculate, slightly sinuate at the apex, 10 by 13 mm. Stamens 12–18; filaments c. 1 mm, strongly dilated, flattened, slightly hairy; anthers oblong, ¼–1 mm. Carpels ∞, obliquely elliptic, 1 mm; style apical though ventrally inserted, sometimes curved; stigma punctiform. Fruiting heads globular, 8–10 mm. Achenes obovate, 2 by 1 mm, dorsally and ventrally winged, with 2 additional dorso-lateral ribs, slightly compressed; beak ⅓ mm, apical, obliquely erected inward. Seed pale brown.

Distr. Native in North America (Mississippi & Gulf of Mexico), introduced in *Malaysia*: West Java (Dèpok; Bogor).

Ecol. In wet rice-fields, between Djakarta and Bogor, up to 250 m, found for the first time by J. H. KERN *l.c.* in 1950; almost certainly escaped from plants formerly cultivated in the Botanic Gardens, Bogor.

5. *Sagittaria lancifolia* LINNÉ, Syst. Nat. ed. 10, 2 (1759) 1270; MICHELI in DC. Mon. Phan. 3 (1881) 73, *pro var. major*; J. G. SMITH, Rep. Mo. Bot. Gard. 6 (1895) 47, t. 16; BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 52; SMALL, N. Am. Fl. 17 (1909) 57; BACKER, Handb. Fl. Java 1 (1925) 55; BRUGGEMAN, Ind. Tuinb. (1939) 168, f. 180; BACKER, Bekn. Fl. Java (em. ed.) 10 (1949) fam. 204, p. 4; BOGIN, Mem. N.Y. Bot. Gard. 9 (1955) 214, f. 15 a–c.—Fig. 9–10.

Robust, glabrous. Emerged leaves erect, oblong-lanceolate, acute, gradually narrowed towards the base, thickish, pale green, 20–60 by 6–20 cm; phyllodes linear; nerves 5–11 of which 4–10 arise from the midrib, prominent beneath, connected by c. 1 mm spaced, parallel veins under an angle of 60–70°; petiole robust, 50–80 cm, blunt-triangular, ribbed, with air-channels, *in sicco* prominent septations spaced 3–4 mm; sheath broad. Peduncle hollow, ribbed, incl. the raceme 1–2½ m. Raceme consisting of 3–12 whorls of 3 flowers, the lower 1–4 whorls ♀, the others ♂; occasionally a few branches from the lowest whorl. Bracts more or less connate at the base, 8–20 mm, oblong to broad-triangular, very acute towards the apex, thickish, parallel-stripped. Pedicels in ♀ 2½–7½ cm, ascending, slender. Sepals ovate, thickened, 8–12 mm, recurved after anthesis. Petals obovate, white, c. 16–25 mm. Stamens ∞; filaments hairy, filiform, slightly thickened at the base, 3–4 mm;

anthers oblong,  $1\frac{1}{2}$ -2 by  $\frac{1}{3}$ - $\frac{1}{2}$  mm. *Carpels*  $\infty$ , elliptic, dorsally and ventrally with a scarious wing, incl. the style c. 1 mm; style  $\frac{1}{3}$ - $\frac{1}{2}$  mm, apical, thick; stigma punctiform. *Achenes* obovate to falcate with a broad dorsal, a narrow ventral, and 2 lateral wings,  $1\frac{1}{2}$ -2 $\frac{1}{4}$  by  $\frac{4}{5}$ -1.1 mm; beak obliquely attached, thick,  $\frac{1}{2}$  mm. *Seed* red-brown, c. 1 mm.



Fig. 8. *Sagittaria platyphylla* (ENGELM.) J. G. SMITH. a. Habit  $\times \frac{1}{4}$ , b. calyx,  $\times 3$ , c. petal, nat. size, d. stamen,  $\times 7$ , e. fruiting flower,  $\times 3$ , f. fruit,  $\times 7$  (KERN 12677).

**Distr.** Native in tropical South America (from the Amazon to Florida), introduced in *Malaysia*: W. Java.

**Ecol.** Escaped in small quantities from the Botanic Gardens, Bogor, 250 m. According to BRUGGEMAN also cultivated; *fl.* Jan.-Dec.

**Note.** The description has been made after American material. According to the description by BACKER (1925 *l.c.*) the material cultivated in Java belongs to *ssp. lancifolia*.



Fig. 9. *Sagittaria lancifolia* L. Cultivated in Kebun Raya Indonesia (photogr. F. HUYSMANS).

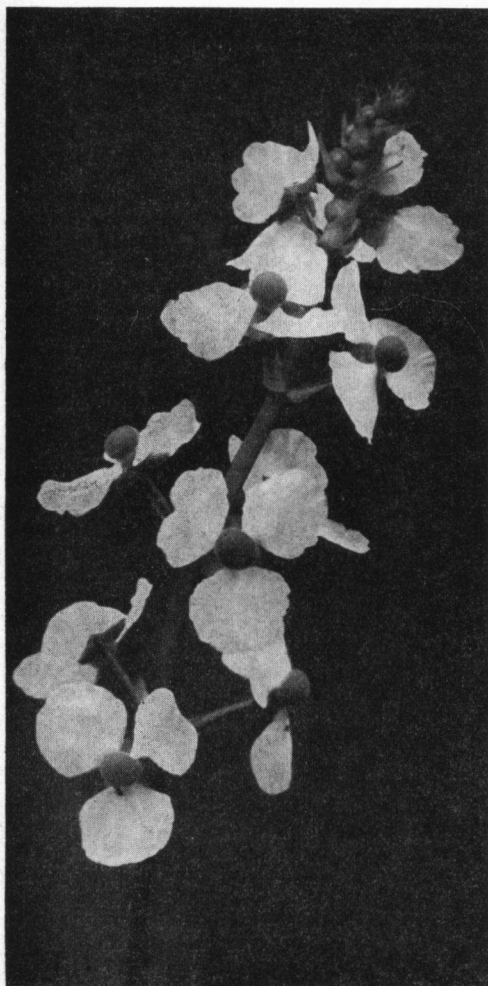


Fig. 10. *Sagittaria lancifolia* L. Detail of inflorescence of fig. 9 (photogr. F. HUYSMANS).

6. *Sagittaria sagittifolia* LINNÉ, Sp. Pl. 2 (1753) 993.

In European and N. Asian specimens, E in Siberia to long. 105°, the petals are white with a distinct, purple or carmine, basal spot, the anthers are purple or carmine, the sepals are appressed or spreading after anthesis, and the basal lobes of the leaves are blunt at the extreme tip.

The South & East Asian and Malaysian specimens are distinct by pure white petals, yellow anthers, sepals reflexed after anthesis, and basal lobes of the leaves ending in a very acute, needle-like tip.

These characters suffice to recognize two taxa, geographically excluding each other, one temperate and one warm-temperate to tropical to which GLÜCK (*vide infra*) assigns specific rank, whereas BOGHN did not distinguish them. They are here

accepted to represent two distinct geographical races, hence of subspecific rank; their distribution has been well mapped by GLÜCK.

*ssp. leucopetala* (MIQ.) HARTOG, *comb. nov.*—*S. trifolia* L. Sp. Pl. 2 (1753) 933.—*S. sagittata* THUNB. Fl. Jap. (1784) 242.—*S. obtusa* THUNB. Fl. Jap. (1784) 242.—*S. sinensis* SIMS, Bot. Mag. 39 (1814) t. 1631; GLÜCK, Ann. R. Bot. Gard. Calc. 150th Ann. vol. (1942) 59–90, f. 1–23.—*S. hirundinacea* Bl. En. Pl. Java 1 (1827) 34; HASSK. Tijds. Nat. Gesch. Phys. 9 (1842) 133; Cat. Hort. Bog. (1844) 26; Pl. Jav. Rar. (1848) 103; MIQ. Fl. Ind. Bat. 3 (1855) 241.—*Alisma sagittifolium* LLANOS, *Fragm. Pl. Filip.* (1851) 69, *non* WILLD. 1799; F.-VILL. & NAVES, in Blanco, Fl. Filip. ed. 3, 4<sup>1</sup> (1880) 51.—*S. sagittifolia* var. *leucopetala* MIQ. Ill. Fl. Arch. Ind. 2 (1870) 49; BUCH. Pfl. R. Heft 16<sup>2</sup> (1903) 48; BACKER, Handb. Fl. Java 1 (1925) 55; Bekn. Fl. Java (em. ed.) 10 (1949) fam. 204, p. 4.—*S. sagittifolia* L.; MERR. Philip. J. Sc. 2 (1907) Bot. 421; Sp. Blanc. (1918) 58; En. Philip. 1 (1922) 25 (*sagittaeifolia*); OCHSE & BAKH. Ind. Groent. (1931) 8, f. 6; GAGNEP. Fl. Gén. I.-C. 6 (1942) 1203, f. 115, 1–5.—*S. leucopetala* BERGMANS, Vaste Pl. & Rotsheesters (1924) 479.—Fig. 11–12.

Glabrous, laticiferous. Emerged leaves erect, sagittate, with linear to lanceolate lobes; terminal lobe acutely attenuate, 4–9<sup>1</sup>/<sub>2</sub> cm long measured along midrib, 1–3 cm wide; basal lobes with needle-like tips, 1–1<sup>1</sup>/<sub>2</sub>(–2) times as long as the terminal one, as wide as it; nerves in the terminal lobes 5–7(–9), in the basal ones 4(–5), connected by ± parallel cross-veins under an angle of 45–70°, these connected again by veinlets parallel with the main nerves; petiole sharply triangular, ribbed, with air-channels, 20–60 cm, septations c. 4–5 mm spaced *in sicco* distinctly prominent; sheath with broad scarios margin. Peduncles 1–5, erect, sharply triangular, often hexa- or polygonal, incl. the raceme 25–50(–90) cm. Raceme <sup>1</sup>/<sub>3</sub>–<sup>1</sup>/<sub>2</sub> as long as the peduncle, with 2–6 whorls of 3 flowers, 1–3 lower whorls ♀ and mostly with 1–2 lateral branches, the other flowers ♂. Bracts only slightly connate at the base, broad-elliptic, acute, keeled, scarios-margined, 7 mm. Pedicels obliquely erect, <sup>1</sup>/<sub>2</sub>–1<sup>1</sup>/<sub>2</sub> cm, in ♀ thicker than in ♂. Sepals broad-elliptic to suborbicular, blunt with scarios margins, 3–6 by 2<sup>1</sup>/<sub>2</sub>–4 mm, after anthesis reflexed. Petals white, without a basal purple spot, suborbicular to broad-elliptic, much larger than the sepals (12–15 mm *sec.* BACKER), unguiculate. Stamens ∞, filaments glabrous, about as long as the anthers; anthers yellow, oblong, 1<sup>1</sup>/<sub>2</sub> by <sup>3</sup>/<sub>4</sub> mm. Carpels ∞, ovate, incl. the style c. 1 mm; style terminal, sometimes slightly curved; stigma punctiform. Fruiting heads globular, c. 1 cm. Achenes obovate, 3–5 by 1<sup>1</sup>/<sub>2</sub>–3 mm, with a broad dorsal and ventral wing, sides smooth; beak apical, straight, c. <sup>1</sup>/<sub>2</sub> mm. Seed light brown, 1<sup>1</sup>/<sub>2</sub> mm.

Distr. From the SE. corners of the Black Sea and of Arabia eastward and southward to Japan and Malaysia, the N. border approximately between lat. 40–50° (GLÜCK, *l.c.*, fig. 23), in Malaysia: apparently indigenous only in N. Sumatra, SW. &





Central Celebes, and the Philippines (Mindanao, Samar, Leyte, Catanduanes, Luzon), introduced in Java, Borneo, and the Malay Peninsula, and in Australia, the Pacific, and ?N. America.

Ecol. In swamps and wet rice-fields, of very local occurrence, surprisingly rare, up to 1050 m, fl. Jan.-Dec.

Uses. Besides the native plant, there occurs an imported form or strain of *Sagittaria sagittifolia* in Malaysia, which has everywhere been imported by the Chinese. This has been described as *S. sinensis* SIMS and is cultivated in China partly as fodder for pigs (the whole plant), partly for the starch-containing, edible tubers which are produced on the ends of stolons. This plant is much coarser generally than the wild arrow-head and BURKILL (Dict. 1935, 1942), who calls it *var. sinensis*, says that the Chinese brought it to the north of Malaya, where its cultivation is steadily increasing southwards from Wellesley to Perak, Pahang, and Selangor, for the sake of the edible tubers, the plants being fed to pigs.

Some authors assume this form to flower rarely. Taxonomically it is generally considered to belong to *S. sagittifolia* and has even not been distinguished as a distinct variety in recent monographs.

The same form was apparently cultivated much earlier by the Chinese in Banka where KURZ (Nat. Tijds. N.I. 27, 1864, 221) records it from Chinese settlements round Muntok. This was also mentioned by HEYNE (Nutt. Pl. 1927, 139) and it was described and figured by OCHSE & BAKHUIZEN VAN DEN BRINK *l.c.*, who say it is rarely cultivated by Chinese near Djakarta, producing tubers 3-6 by 2-3½ cm on 15-35 cm long stolons.

Chinese in the Philippines equally cultivate this edible form, according to W. H. BROWN (Useful Pl. Philip. 1, 1950, 87), for the tubers in Camarines and round Baguio (Luzon).

HILLEBRAND (Fl. Haw. 1888, 457) recorded its introduction in Hawaii by Chinese, and A. C. SMITH (Bull. Torr. Bot. Cl. 70, 1943, 533) assumes it of recent introduction in Fiji; WILDER (Bull. Bish. Mus. 86, 1931, 16) gives it as introduced in Raratonga. In Australia EWART (Fl. Vict. 1930, 95) says it is naturalized locally in Victoria since 1910.

FILET (Plant. Bot. Tuin Weltevr. 1855, 10) mentions *S. sagittifolia* as a vegetable, but this use cannot have been general and on a large scale as it is exceedingly rare in Java; probably he was misled by the vernacular names *bia-bia* and *ètjèng*, which apply equally to the very common *Monochoria*s.

STEINMANN interpreted (Trop. Natuur 23, 1934, 219) some bas-reliefs on Borobudur stupa in Central Java as representing a broad-leaved form of *S. sagittifolia ssp. leucopetala*. As has been mentioned it is at present very rare in Java and certainly introduced.

Fig. 11. *Sagittaria sagittifolia* L. *ssp. leucopetala* (MIQ.) HARTOG. a. Habit,  $\times 2/5$ , b. fruit,  $\times 5$  ← (Celebes).

BOGIN (*l.c.* 222) mentions that *S. latifolia* WILLD. (Sp. Pl. 4, 1805, 409) is cultivated as a vegetable in California by Chinese and Japanese and that this has apparently been imported by them in Hawaii, but recorded there under the name *S. sagittifolia* L.

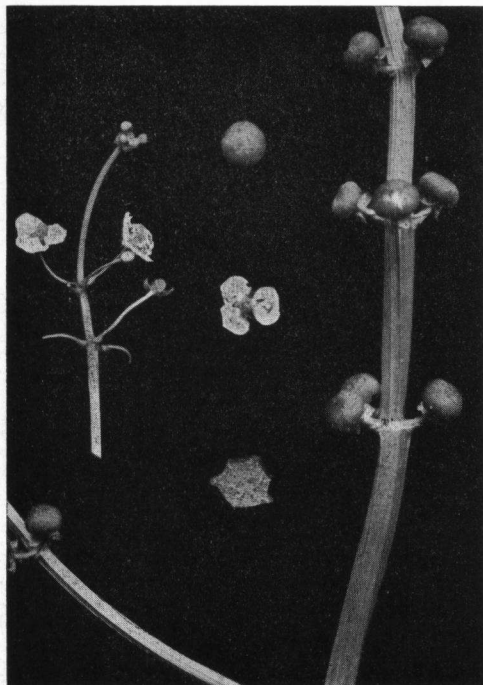


Fig. 12. *Sagittaria sagittifolia* L. *ssp. leucopetala* (MIQ.) HARTOG. Parts of inflorescence in flower and fruit, fruiting flower, open flower, and cross-section of peduncle. Kebun Raya Indonesia (photogr. F. HUYSMANS).

Vern. *Ètjèng, béa-béa, S, M. bia bia, M, ètjèng gèndjèr, S, kalopak, tjunkait*, Celebes, *arrow weed, arrow-head*, E, *pijklruid*, D; Philippines: *gauai-gauai*, S.L.Bis., *tikóg*, Bik; *ubi kèladi, kèladi chabang*, Mal. Pen., for the cultivated form.

Notes. Wild Malaysian specimens have very narrow leaves, in distinction to the introduced form which possesses much coarser leaves with a terminal lobe up to 10 cm wide. As a matter of fact such variations in shape and size of the leaf have led MAKINO and others to distinguish infra-specific and even specific taxa. I agree with GLÜCK and BOGIN that these forms do not deserve taxonomic recognition; they are minor variations occurring parallel both in *ssp. leucopetala* and *ssp. sagittifolia*.

JOHRI (Proc. Ind. As. Soc. B 1, 1935, 341) mentions occasional occurrence of rudimentary carpels in ♂ flowers.

#### Cultivated

*Alisma plantago* LINNÉ, Sp. Pl. 1 (1753) 342; BRUGGEMAN, Ind. Tuinb. (1939) 161; BACKER, Fl. Java (em. ed.) 10 (1949) fam. 204, p. 2.—This ubiquitous is not found native in Malaysia and has been cultivated in Java, but so far as known to me only in the Botanic Gardens.

#### Dubious

*Sagittaria triflora* NOROÑA, Verh. Bat. Gen. K.W. 5 (1790) 84, *nomen nudum*.—Only the vernacular name *bia bia* is given; this is used both for *Sagittaria spp.* and for *Monochoria*; its precise specific identity remains, therefore, uncertain.

#### Excluded

*Lurionium natans* (L.) RAFIN. Aut. Bot. (1840) 63. —*Elisma natans* (L.) BUCH. Jahrb. Wiss. Bot. 7 (1868) 25; STEEN. Bull. Jard. Bot. Btzg III, 13 (1934) 174–175; Trop. Natuur 34 (1935) 54–56, f. 1; BACKER, Fl. Java (em. ed.) 10 (1949) fam. 204, p. 2.—The specimen of this European plant, said to have come from Java, has been erroneously localized, as has been proved by VAN DER WERFF (Blumea 7, 1954, 599–601).