REVISION OF THE GENUS APONOGETON (APONOGETONACEAE)

H. W. E. VAN BRUGGEN [1])

IV. THE SPECIES OF ASIA AND MALESIA

ABSTRACT

In this revision are recorded 9 species from continental Asia and Indonesia, and 2 from New Guinea. Of the latter 1 is new to science. Some species frequently confused in the past could be described exactly. All names have been properly typified and all existing types could be examined by the author. For *A. loriae* and *A. echinatus* a neotype was chosen.

Descriptions are given of all species and a key is provided for their identification. A drawing of the generative parts of all species has been made and a distribution map of each species has been prepared. All examined sheets are enumerated in an identification list.

INTRODUCTION

Up till now there were only few publications of regional interest on the Asiatic species of *Aponogeton*. One of the most important of these was the compilation in the 'Flore Générale de l'Indochine' 6 (1942) by Miss A. Camus.

Some more attention has been paid to the species of India in the past. The titles of these works can be found in the bibliography of each species.

No attempt has been made to provide a full bibliography of each species. As in former publications some species were frequently mixed up this would involve citing many '*sensus*' and '*pro partes*', which does not seem useful.

In the present revision 11 species are distinguished, viz. 9 from continental Asia and Indonesia, and 2 from New Guinea. Of the latter 1 is new to science. *A. robinsonii* and *A. eberhardtii*, both from Vietnam, are closely related mutually and may be conspecific. There is, however, not sufficient material of the former to make a decision. Both have inflorescences consisting of 2 spikes, a rare phenomenon in non-African species. *A. undulatus* appeared to be viviparous, a fact usually ignored in literature; I presume that *A. microphyllum*, of which no specimens seem to exist, belongs to this species. Several Indo-Chinese species I had to reduce to the synonymy under *A. lakhonensis*, which species has a vast area of distribution. The specimens of Teysmann from Celebes (Indonesia) most probably also belong to *A. lakhonensis*. *A. rigidifolius* and *A. crispus*, both from Ceylon, also seem to be closely related mutually, but due to the prohibition by the Ceylonese Government of loaning sheets I could only examine 1 sheet of the former. Therefore I could not decide whether they deserve only infraspecific rank. *A. crispus* is a very variable species and one needs some imagination to believe that all random collections belong to one species; it is also related to *A. echinatus* from India.

To prevent long enumerations of localities and collectors I mostly stated under the heading '*Distribution*' only the localities. The collections are mentioned in the identification list.

[1]) Linthorst Homanstraat 19, Heemskerk, Netherlands.

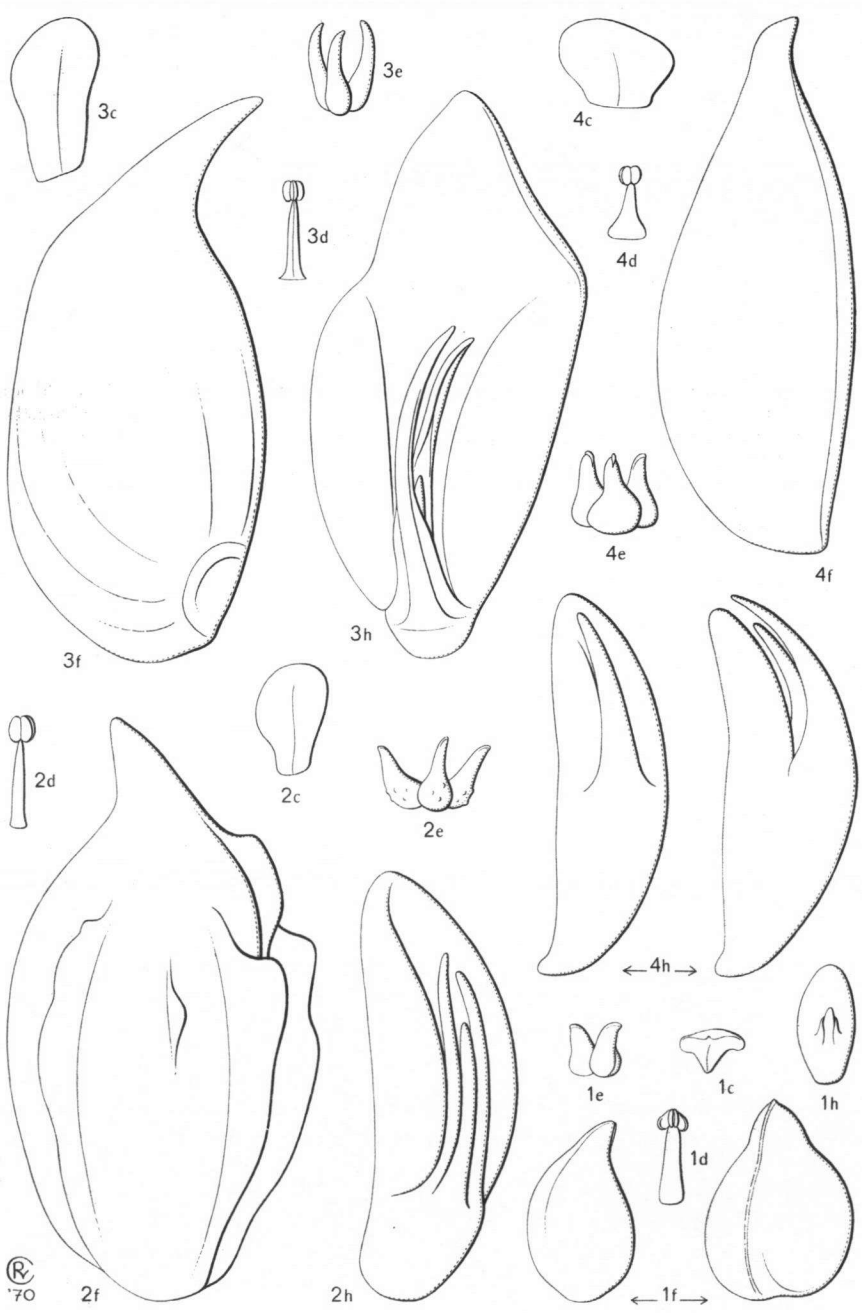

Fig. 1. 1. *Aponogeton tenuispicatus* v. Bruggen (fruit and embryo from type locality, rest from culture). — 2. *Aponogeton echinatus* Roxb. (tepal: *Henry 15945;* rest from culture). — 3. *Aponogeton rigidifolius* v. Bruggen (from culture). — 4. *Aponogeton crispus* Thunb. (embryo: *van Beusekom 1446;* tepal, stamen, and gynaeceum from culture; fruit: *Thwaites CP 2306*, SING). — c. tepal or perianth; d. stamen; e. gynaeceum; f. fruit: h. embryo. All × 7.

Of the 11 species distinguished I could cultivate 6, viz. *A. crispus*, *A. echinatus*, *A. loriae*, *A. natans*, *A. rigidifolius*, and *A. undulatus*, partly thanks to generous support from overseas.

Acknowledgements. I would like to thank Mr. Rajendra Babu (Trivandrum) and Prof. Bole (Bombay) for sending living corms of *A. natans*. Moreover, the latter was very helpful by localizing places in India which could not be found on maps. Dr. Robbins and Mrs. Pulsford (Boroko) sent me living corms of *A. loriae* and Dr. Hoogland (Canberra) and Mr. van Beusekom (Leyden) of *A. crispus*. Dr. Heine and Mrs. Tirel (Paris) assisted me by localizing places in Indo-Chine, and Dr. Sleumer (Leyden) did the same thing with regard to places in Papua. Mr. Sinclair (Singapore) informed me about some interesting data on the collection of *A. undulatus* from Johore. I owe them all a great debt of gratitude.

Furthermore, I am very much obliged to the directors of the following herbaria, from which I could borrow specimens, viz. St. Xavier's College, Bombay (BLAT), the British Museum, Natural History, Botanical Department, London (BM), the Herbarium Bogoriense, Bogor (BO), the Queensland Herbarium, Brisbane (BRI), the Central National Herbarium, Calcutta (CAL), the Herbarium Australiense, Canberra (CANB), Systematisch-Geobotanisches Institut, Goettingen (GOET), The Royal Botanic Gardens, Kew (K), The Rijksherbarium, Leyden (L), Division of Botany, Department of Forests, Lae (LAE), National Herbarium, South Yarra (MEL), Southern Circle Herbarium, Coimbatore (MH), Botanic Garden, Singapore (SING), Universitets Institution för Systematisk Botanik, Uppsala (UPS), and the Herbarium Vadense, Wageningen (WAG). I also have been privileged to study the flowers of Linnaean Herbarium 479.1 in the keeping of the Linnean Society of London.

I am grateful to Dr. R. C. Bakhuizen van den Brink Jr, who prepared the Latin diagnosis of *A womersleyi*, and to Miss R. van Crevel who made the excellent drawings. Finally I am very much indebted to Prof. Dr. C. G. G. J. van Steenis again.

PHENOTYPIC DEVIATION OF CULTIVATED PLANTS

As will appear from the treatment of *A. crispus* the distinction of this species from the related *A. echinatus* caused much brain-racking.

True, herbarium specimens of both species nearly always can be unmistakably identified at first sight, but cultivated specimens from doubtful sources show many intermediate forms and obscure the limits. Only by ignoring the cultivated specimens I could arrive at a conclusion.

Aponogeton species not seldom behave differently in culture than in the open country. *A. bernieranus* has strongly bullate leaves, but this structure disappears for the greater part in cultivated plants. *A. undulatus*, a viviparous species, very seldom flowers in cultivation, but, according to the herbarium material, flowers frequently in nature. *A. rigidifolius* has at its locality perfectly flat leaves, which become waved and curled in culture.

Fortunately, the generative parts of cultivated material differ hardly or not from those of collected specimens.

How these differences in behaviour or habit are caused, is not clear to me. Many species occur in water which is extremely poor in ions, and grow there luxuriantly. The use of similar (but stagnant) water in cultivation usually does not lead to success. On the contrary, most cultivated waterplants grow hardly or not in oligotrophic water. Only in eutrophic water (e.g. obtained by keeping a considerable population of fish) a satisfying growth is to some extent possible. In nature the plants are probably provided with sufficient nutritious substances by the streaming water.

Likewise the influence of the water current on the habit is not clear. Are the leaves of *A. rigidifolius* flat, and those of *A. bernieranus* bullate under the influence of this current? Does this structure change under the influence of stagnant water?

Anyhow, when describing new species on cultivated specimens, one must exercise the greatest care. One needs a thorough insight into the genus in question to prevent the description of 'species' which do not exist in nature at all.


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KEY TO THE SPECIES

1. Embryo crowned with a whorl of linear, tortuous appendages. Spathe up to 5—6 cm. **1. A. appendiculatus**
1. Embryo with a plumule attached between the base and the middle of the embryo, or without plumule, not crowned with a whorl of appendages. Spathe up to ± 2½ cm[1]).
2. Inflorescence with 2 spikes.
3. Spikes up to 3½ cm, slender. Leaves shorter than 4 cm . . . . . **2. A. robinsonii**
3. Spikes up to 14 cm. Leaves longer than 10 cm . . . . . **3. A. eberhardtii**
2. Inflorescence with 1 spike.
4. Tepals longer than ± 5 mm, caducous. Plants stoloniferous. . . . . **4. A. undulatus**
4. Tepals up to ± 3 mm, persistent. Plants not stoloniferous.
5. Ovules 4—8.
6. Testa simple.
7. Cross veins at ± 50° angle. Tepals yellow. Filament not or slightly widened. Fruit with a terminal beak. . . . . **5. A. loriae**
7. Cross veins at ± 70° angle. Tepals white or creamish. Filament strongly widened. Fruit with a short lateral beak. . . . . **6. A. womersleyi**
6. Testa double.
8. Tepals white, pink, or violet, spatulate. Filament not widened. Fruit with a long terminal beak . . . . . **7. A. natans**
8. Tepals yellow, obovate. Filament widened. Fruit with a short lateral beak **8. A. lakhonensis**
5. Ovules 2 (seldom 1).
9. Rhizome cylindrical, up to 1 cm ∅, creeping. Leaves submerged, band-shaped, flat, about 15 or more times as long as wide . . . . . **9. A. rigidifolius**
9. Tuber elongate, globular, or obovoid, mostly more than 1 cm ∅, not creeping. Submerged leaves undulate or crisped, less than 15 times as long as wide.
10. Leaves submerged, very seldom floating. Tepals about as long as wide. Fruit smooth, more than 2½ times as long as thick. Plumule attached near the middle of the embryo and fitted in a narrow groove . . . . . **10. A. crispus**
10. Leaves mostly floating, seldom submerged. Tepals about 1½ times as long as wide. Fruit mostly with irregular excrescences, seldom smooth, less than 2½ times as long as thick. Plumule attached at the base of the embryo and fitted in a wide groove **11. A. echinatus**

1. Aponogeton appendiculatus v. Bruggen, Blumea 16 (1968) 265, fig. 5. — Type: Aleppy, Nov. 1893. *M. A. Lawson 113* (K, 2 sheets, one indicated holotype, the second isotype). — **Fig. 2 : 5; map 1.**

Tuber ± 1 cm ∅, probably elongate and creeping. *Leaves* all submerged; leaf-blades 25—40 by up to 3 cm, flat or slightly undulate; base narrowly cuneate, apex narrowly cuneate and acute or blunt; midrib wide with 2—4 slender parallel nerves on either side; petiole 13—25 cm. *Peduncle* up to 1¼ m, gradually thickening towards the inflorescence; spathe 5—6 cm, attenuate, caducous. *Inflorescence* laxly flowered, about 15 cm, spike solitary. *Flowers* turned towards all directions, very small. Tepals 2, often wider than

[1]) The spathe of *A. womersleyi* is unknown.

Fig. 2. 5. *Aponogeton appendiculatus* v. Bruggen (c, d, e: *Lawson 113;* f. *Rao 4073*). — 6. *Aponogeton robinsonii* A. Camus *(Robinson 1101)*. — 7. *Aponogeton eberhardtii* A. Camus (c, d, e: *Squires 134;* f, h: *Poilane 968*). — 8. *Aponogeton undulatus* Roxb. (small tepal, d, e: from culture; big tepal and f: *Wallich 5168 A;* h. *Clarke 7436*). — 9. *Aponogeton loriae* Mart. (from culture). — 10. *Aponogeton womersleyi* v. Bruggen (small tepal, e, small fruit: *Brass 8671;* big tepal and fruit, d, h: *Womersley & Havel 17717*). — 11. *Aponogeton natans* (L.) Engl. & Krause (c. *Gaudichaud s.n.;* d & e; CAL 499683; f & g: MH 73301). — 12. *Aponogeton lakhonensis* A. Camus (wide tepal, d, and large gynaeceum: *Kerr 1797;* narrow tepal and small gynaeceum: *Sampson s.n.*, 25-5-1884; g and small fruit: *Thorel 2460;* big fruit: *Robinsor 1177*). — c. tepal or perianth; d. stamen or filament; e. ovary or gynaeceum; f. fruit (*A. appendiculatus*: embryo); g. seed; h. embryo. All × 7.

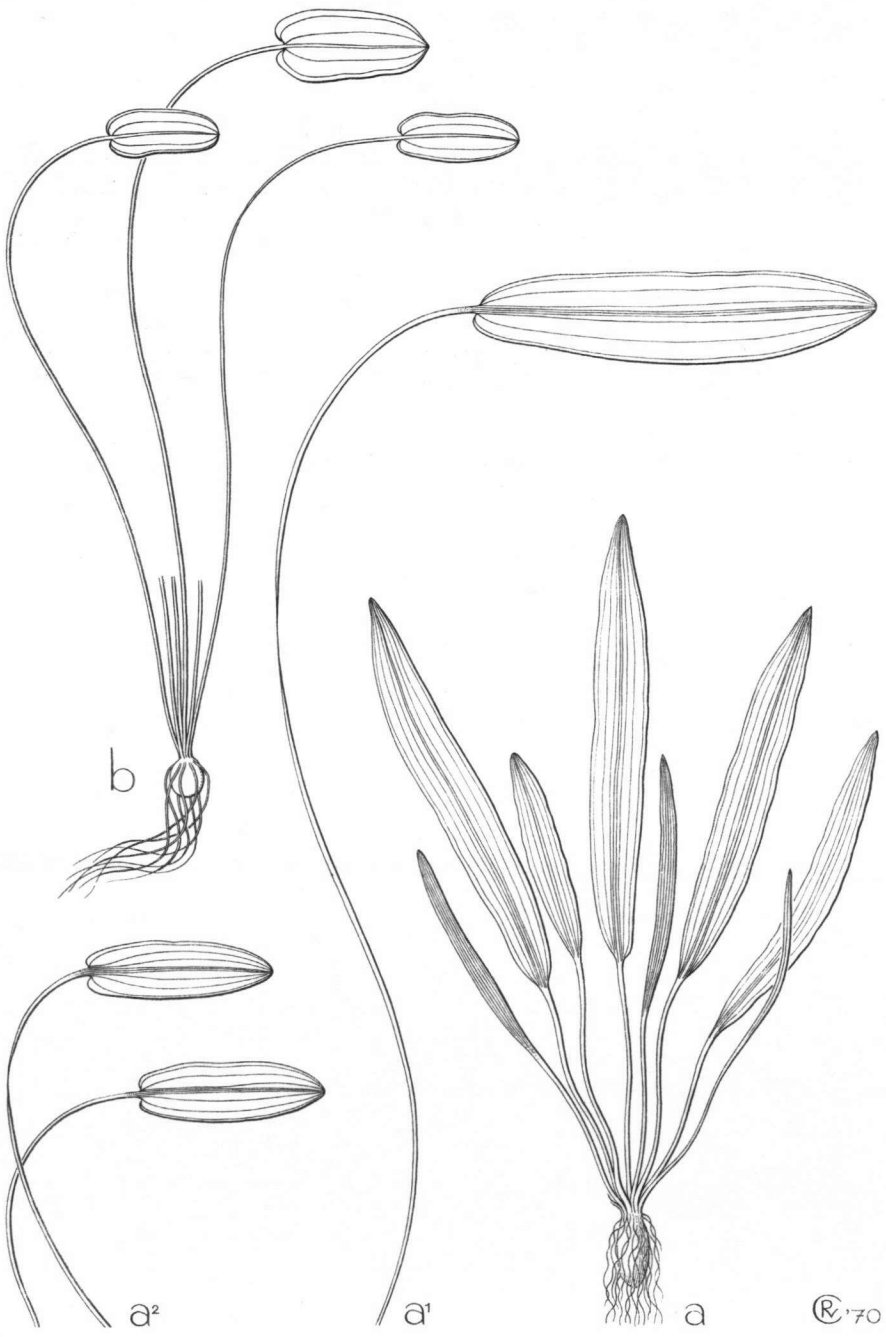


Fig. 3. a. *Aponogeton lakhonensis* A. Camus. a. Habit with submerged leaves (*Harmand s.n.*, P); a^1 and a^2 floating leaves (a^1. *Sampson 15588;* a^2. *Sampson 1268*, both in K). — b. *Aponogeton robinsonii* A. Camus, habit with floating leaves (*Robinson 1101*, P). — All × ½.

long, ¾—1¼ by 1—1½ mm, probably white, 1-nerved. Stamens (4)5(6), ± 1 mm, filaments widened towards the base. Ovaries 2(or 3), ± 1 by ½—¾ mm; ovules 1 or 2. *Fruit* 1¼ by ½—¾ cm, terminally beaked. *Embryo* very unusual, ± 1 by ½ cm, obovate, tuberous, crowned with a whorl of linear tortuous appendages of up to 5 by 1½ mm, with a blunt or acute tip; testa simple.

Distribution: S. India: Aleppy; Canal near Aleppy; Vembanad Lake between Cochin and Aleppy; Spurtank, Egmore, Madras.

Ecology: Submerged in shallow water and backwaters; flowering in August, November, and December.

Notes: As mentioned in the type description *A. appendiculatus* shows a remarkable resemblance to *Cryptocoryne ciliata* (Roxb.) Fisch. *ex*Wydl. with regard to the shape of the embryo. *C. ciliata* seems to grow mostly in brackish waters, mangroves, etc. and the shape of the embryo is sometimes considered to be an adaptation to this environment. I therefore wondered whether *A. appendiculatus* is confined to similar habitats. Mr. K. Rajendra Babu wrote me that most of the lakes of the state Kerala are brackish indeed.

In habit this species shows resemblance with *A. rigidifolius* v. Bruggen from Ceylon, which has, however, a much shorter spathe (± 2 cm) and a normal embryo. By the structure of the embryo *A. appendiculatus* cannot be confused with any other species of the genus.

2. Aponogeton robinsonii A. Camus., Not. Syst. 2 (1911) 203; Fl. Gén. Indochine 6 (1942) 1224. — Type: Nha Trang and vicinity, 11/26-3-1911, *Robinson 1101* (P, isotype in K). — **Fig. 2 : 6; 3 : b; map 2.**

Tuber small, up to 1 cm ∅. *Submerged leaves* ± 2 by ½ cm; base and apex narrowly cuneate; parallel main nerves 5 (7); petiole 7—8 cm. *Floating leaves* oblong, 3—4 by 1—2 cm; base cordate, apex rounded; parallel main nerves 5—7; petiole ± 20 cm (probably depending on the waterdepth). *Peduncle* slender, not thickening towards the inflorescence; spathe caducous. *Inflorescence* with 2 spikes of up to 3½ cm; spikes laxly flowered. *Flowers* small, dorsally arranged. Tepals 2(3), obovate, ± 1 by ½—1 mm, white, 1-nerved. Stamens 6, up to 1½ mm, filaments slightly or strongly widened towards the base and applanate. Ovaries 3, ± 1 by ¾ mm; ovules 4. *Fruit* and *seed* unknown.

Distribution: Vietnam: Nha Trang.

Ecology: Flowered in March; no other data available.

Note: As discussed under *A. eberhardtii* I doubt whether *A. robinsonii* and *A. eberhardtii* are really different species. However, the only collection of the former differs so much from *A. eberhardtii* in habit, that I feel that a decision must be postponed until further evidence is available.

3. Aponogeton eberhardtii A. Camus, Not. Syst. 3 (1914) 84; Fl. Gén. Indochine 6 (1942) 1225, fig. 116. — Type: valley of the upper course of the river Cu Bi, prov. Quang Tri, *Eberhardt 1973* (P, 2 sheets). — **Fig. 2 : 7; 4; map 2.**

Tuber globular or obovoid, up to 1½ cm ∅. *Submerged leaves* up to 40 by 3½ cm; base narrowly cuneate, apex (very) narrowly cuneate with a blunt or acute tip; midrib wide with 3(or 4) parallel main nerves on either side; petiole up to 25 cm. *Floating leaves* up to 19 by 4½ cm; base cordate, apex cuneate with a blunt tip; primary nerves 7. *Peduncle* up to 80 cm, slightly thickening towards the inflorescence. Spathe caducous; *inflorescence* with 2 spikes, scentless; spikes up to 14 cm, sometimes branched, laxly flowered; *flowers* dorsally arranged. Tepals 2, white, (broadly) obovate, 1½—2 by 1½—2 mm, 1-nerved, (sometimes caducous?). Stamens 6, ± 1¾—2 mm, filaments slightly or strongly widening towards

Fig. 4. *Aponogeton eberhardtii* A. Camus. a. Habit with submerged leaves; a'. floating leaf. (*Squires 134*, a in P, a' in SING). Both × ½.

the base. Ovaries 3 or 4, 1½—2 by ¾ mm; ovules 2—4(—5). *Fruit* 10—15 by 3—4 mm with a distinct terminal beak, *Seed* with a simple testa; embryo 7—14 by 2½—3 mm; plumule attached at the base of the embryo, 1-nerved.

Distribution: S. Vietnam: River Cu Bi, prov. Quang Tri; West River, Hué; Phu Son, prov. Khanh Hoa; Tra-My, prov. Quang Nam; Mai Lanh, prov. Quang Tri.

Ecology: slow-running streams in forests at sea level. Collected in flower in February. Tuber edible; vernacular name *Cây-choi.*

Note: Though *A. eberhardtii* and *A. robinsonii* are very different in habit I am not convinced at all that they are really different species, as the differences in the generative parts are hardly structural. It seems quite possible to me that the type of *A. robinsonii* (the only collection of that species) only represents a starved form of the species described above. If this can be proved the name *A. eberhardtii* will have to be entered into the synonymy of *A. robinsonii.*

4. Aponogeton undulatus Roxb., [Hort. Beng. (1814) 26, *nomen*]; Fl. Ind. ed. Carey 2 (1832) 211; Engler et Krause, Pfl. R. Heft 24 (1906) 11, *pro nomen, excl. descr.* — *Spathium undulatum* Edgew., Calc. Journ. 3 (1843) 534, fig. 15. — *Ouvirandra undulata* Edgew. in Hook. Lond. Journ. of Bot. 3 (1844) 404, fig. 18. — Type: *Roxburgh Drawing 936* (K). — **Fig. 2 : 8; map 2; pl. I & II.**

A. microphyllum Roxb., Fl. Ind. ed. Carey 2 (1832) 211; Hook. *f.*, Fl. Brit. Ind. 6 (1894) 565. — Type: *Roxburgh Drawing 1232* (K).

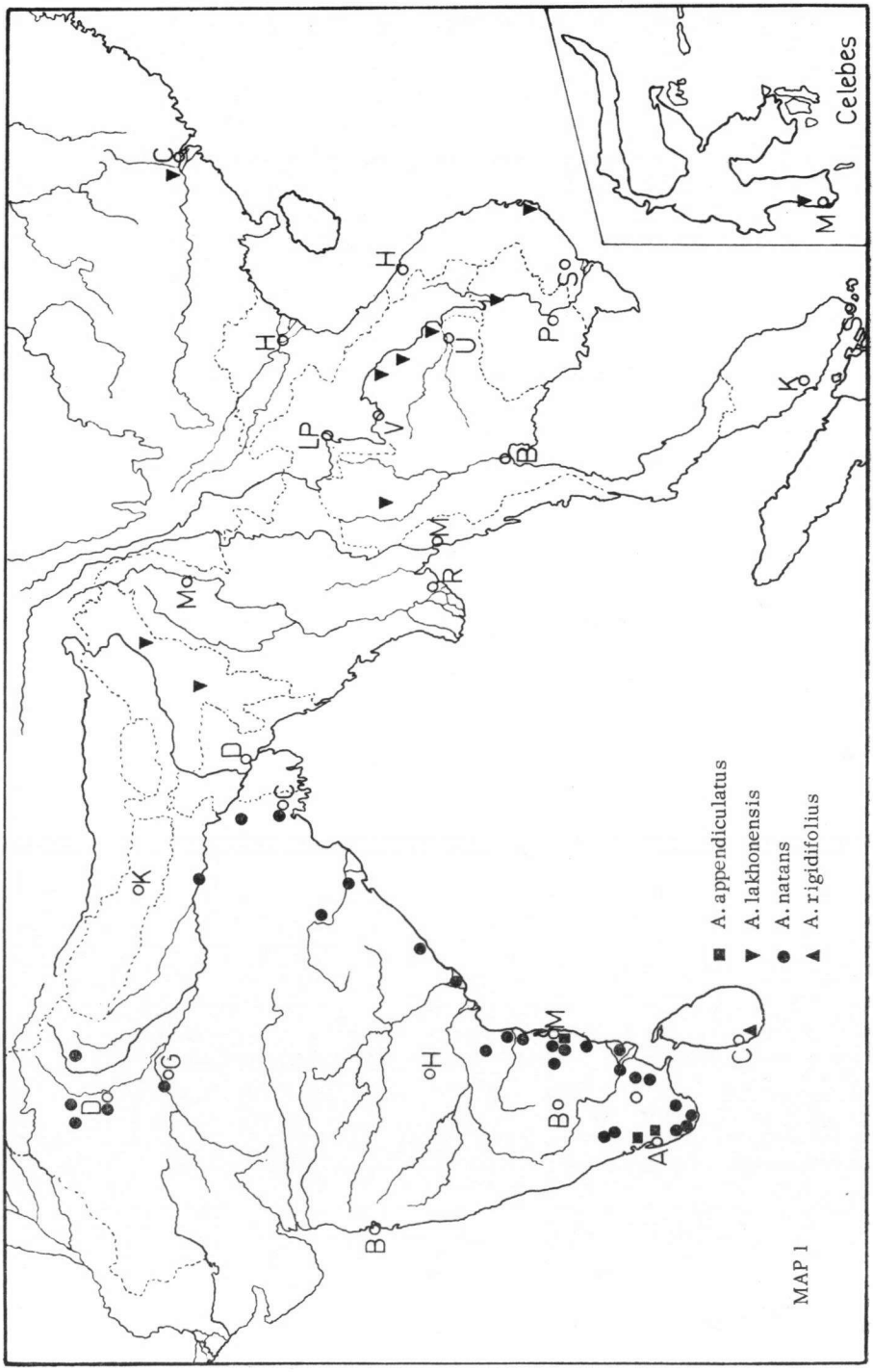
A. stachyosporus de Wit, Med. Bot. Tuinen Belm. Arb. Landbouwhogeschool 2 (1958) 96, fig. 1—3. — Type: *Zewald s.n.* (cult.) 20-9-1958 (WAG).

A. crispus (*non* Thunb.) Hook. *f.*, Fl. Brit. Ind. 6 (1898) 564, *pro parte;* Trimen, Handb. Fl. Ceylon 4 (1898) 372; Gamble, Fl. Pres. Madr. 3 (1931) 1597; Mitra, Flow. Pl. East. Ind. 1 (1958) 9.

A. monostachyon (*non* L. *f.*) Andrews, Bot. Rep. 6 (1797) t. 406.

Tuber globular, obovoid, or elongate, 6—25 mm ∅, smooth. *Submerged leaves* 10—25 by 0.8—4.2 cm, alternately transparent or opaque in an irregular pattern; base (narrowly) cuneate or rounded, apex (narrowly) cuneate or rounded, seldom emarginate, tip blunt; margin undulate; midrib wide with (2)3(4) parallel nerves on either side; petiole 10—35 cm. *Floating leaves* rather rare, up to 20 by 3½ cm; base rounded or cordate, apex cuneate with a blunt tip; parallel main nerves 5 or 7; petiole up to 70 cm. *Peduncle* up to 55 cm, thickening towards the inflorescence. Spathe up to 17 mm, persistent or caducous; *inflorescence* with 1 spike; spike up to 10 cm, laxly flowered; *flowers* turned towards all directions. Tepals 2, seldom 1 or 3, caducous, spatulate or obovate, 1-, rarely 2- or 3-nerved, white or pinkish, (2—)3½—6(—12) by 1—2½(—4) mm. Stamens 6, 1½—2½(—4) mm; filaments slightly widening towards the base, white or pinkish; anthers light-yellow (sometimes blue?), pollen yellow (sometimes blue?). Ovaries 3(or 4), light pink, 1¼—2 by ½—1 mm; ovules 2. *Infructescence* up to 16 cm. *Fruit* 5—7 by 4 mm with a short, terminal, curved beak. *Seeds* with a simple testa; embryo up to 5 by 2 mm; plumule attached near the base of the embryo and lying in a very wide groove. *Runners* resembling peduncles, ascending, up to 35 cm, not or slightly thickened towards the tip. The plantlet is developed at the tip of the runner; in an early stage it is enveloped by a persistent spathe of up to 20 mm. The young plant itself may also put forth one or two short runners, and by repeating up to 7 plantlets may be produced.

Distribution: NW., N., and NE. India: Borivli: National Park; Andheri; Malad: Puspa Park; Saharanpur; Moradabad; Nahuyadabar; Ratungunj (near Monghir); Chandernagore; Darjeeling. E. Pakistan: Dacca. Burma: Kachin Hills; Moulmein. Malaysia: Johore: Sungei Sedili near Mawai.


A. appendiculatus
A. lakhonensis
A. natans
A. rigidifolius
Celebes
MAP 1

Ecology: Ponds and ditches; flowering time July, August, and November. One altitude record available: 1000 ft.

Notes: A. undulatus is very variable in the dimensions of the tepals. Normally they are 5—6 mm long, but in a sheet from Nahuyadabar (which place I could not locate!) the tepals measure ± 12 mm. A characteristic they all share is the fact that the tepals are caducous. The collection of *Shaik Mokim s.n.* from Kachin Hills (Upper Burma) is very different from the other ones. The tepals are much smaller (± 2 mm) and I am not quite sure that they are caducous. Some flowers have indeed no tepals, but I do not know whether they were not developed or had fallen off. I think it to be possible that this collection represents a new species, but for lack of material this could not be proved.

Another collection has been described as *A. stachyosporus*, which differs in the narrowness of the leaves. There is, however, so much variation in the width of the leaves that, in my opinion, the extremes do not deserve a special specific or even varietal rank. For the first time this plant was discovered in the van Cleef Aquarium at Singapore and would have been collected in the Sungei Sedili at Mawai, Johore, by a friend of Mr. Stewart, then in charge of the van Cleef Aquarium (J. Sinclair in litt.). I wonder whether this record is really reliable. Since the second world war Singapore is an important transit port of fishes and waterplants, collected everywhere in tropical Asia. It might be possible that, by mistake, some plants were mixed up.

The last few years many thousands of specimens are imported in Europe and the U.S.A. from Bangkok. They are claimed to be collected in S. Thailand (Haadyai and Chanthaburi), but it is remarkable that, up to now, I did not see herbarium specimens collected in Thailand. Bangkok is also an important transit port.

The type is Roxburgh's drawing 936; this drawing shows the remarkable runners, the persistent spathe and caducous tepals. For the rest, however, the drawing is not very accurate; the tepals are much too short and the leaves too acuminate. Fortunately, there is a specimen in the Wallich Herbarium at Kew which has been labelled *Aponogeton undulatum* R. in Roxburgh's handwriting. It is the left one on a sheet with two collections. This collection shows the long caducous tepals, but no runners. Drawing and specimen complete each other.

During the last hundred years many authors confused *A. crispus* and *A. undulatus*. Partly this is due to Roxburgh's inaccurate description, saying 'Bracts and stamens as in *A. monostachyon*'. On the other hand, most subsequent authors did not pay attention to the words 'stoloniferous' and 'stole bearing' he used in the type-description.

It is remarkable that *A. undulatus* flowers very seldom in cultivation. I have been cultivating specimens from different localities for more than twelve years, but up to now an inflorescence was developed only once. This hinders my research.

As mentioned in the description the mesophyll between the nerves is alternately transparent or opaque in an irregular pattern. Up to now I could not notice this characteristic in other species of *Aponogeton*. This pattern cannot be seen in dried specimens.

In the Flora Indica, ed. Carey 2 (1832) 211, Roxburgh described another species of *Aponogeton*, viz. *A. microphyllum*. Up to now I could not find any specimen of it. The type is Roxburgh drawing 1232. However, this drawing does not correspond in every respect with the description. The latter described the flowers as blue, and the spathe as caducous. The drawing shows white tepals and a persistent spathe. For the rest there are no differences and Hook. *f.* (in Fl. Britt. Ind. 6, 1894, 565) made a mistake in saying that Roxburgh's description differed much from the drawing. Apparently he overlooked that the sheathing bases of the leaves must have been below soil level, as in the other species of *Aponogeton*. In my conviction *A. microphyllum* only represents a poor specimen

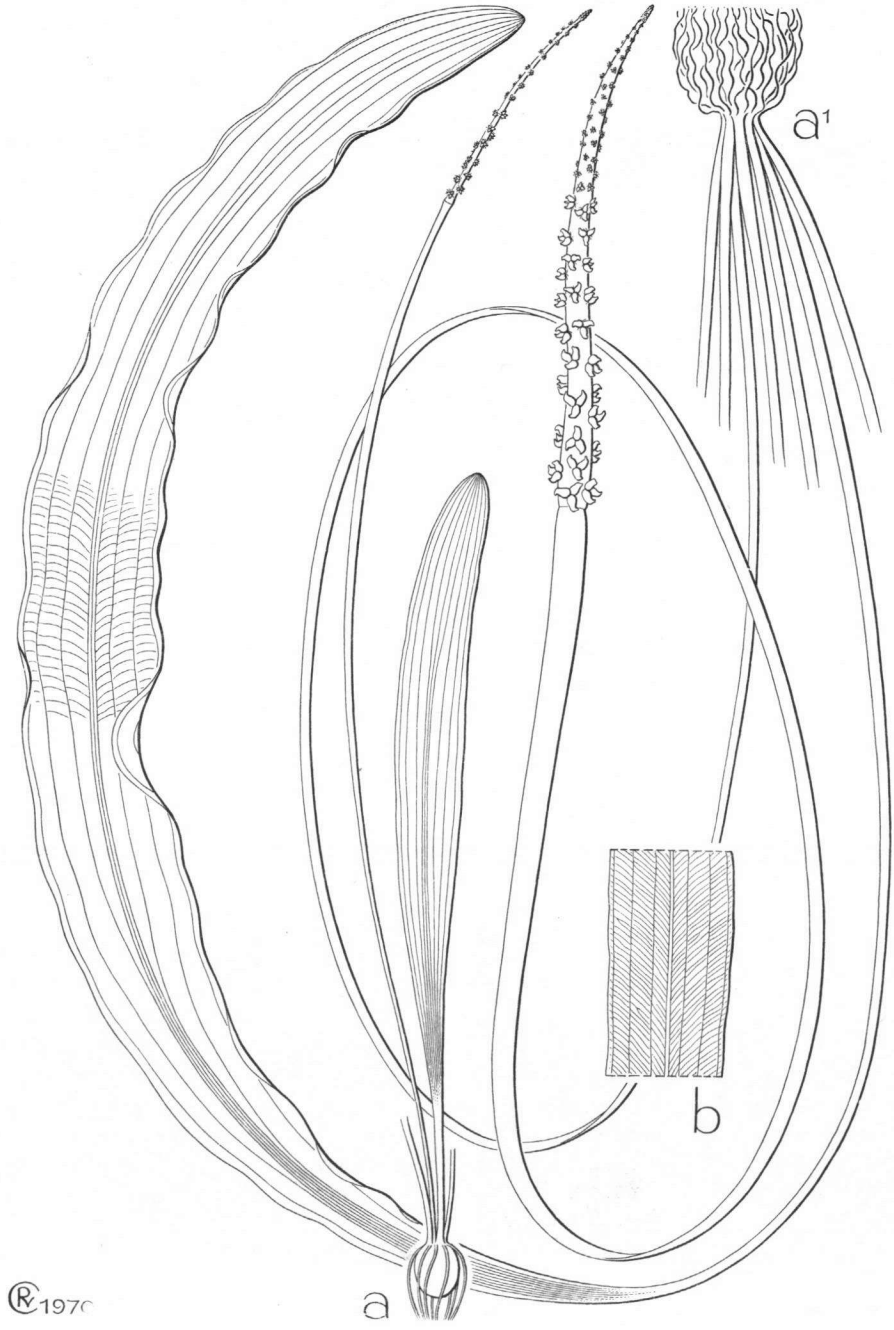
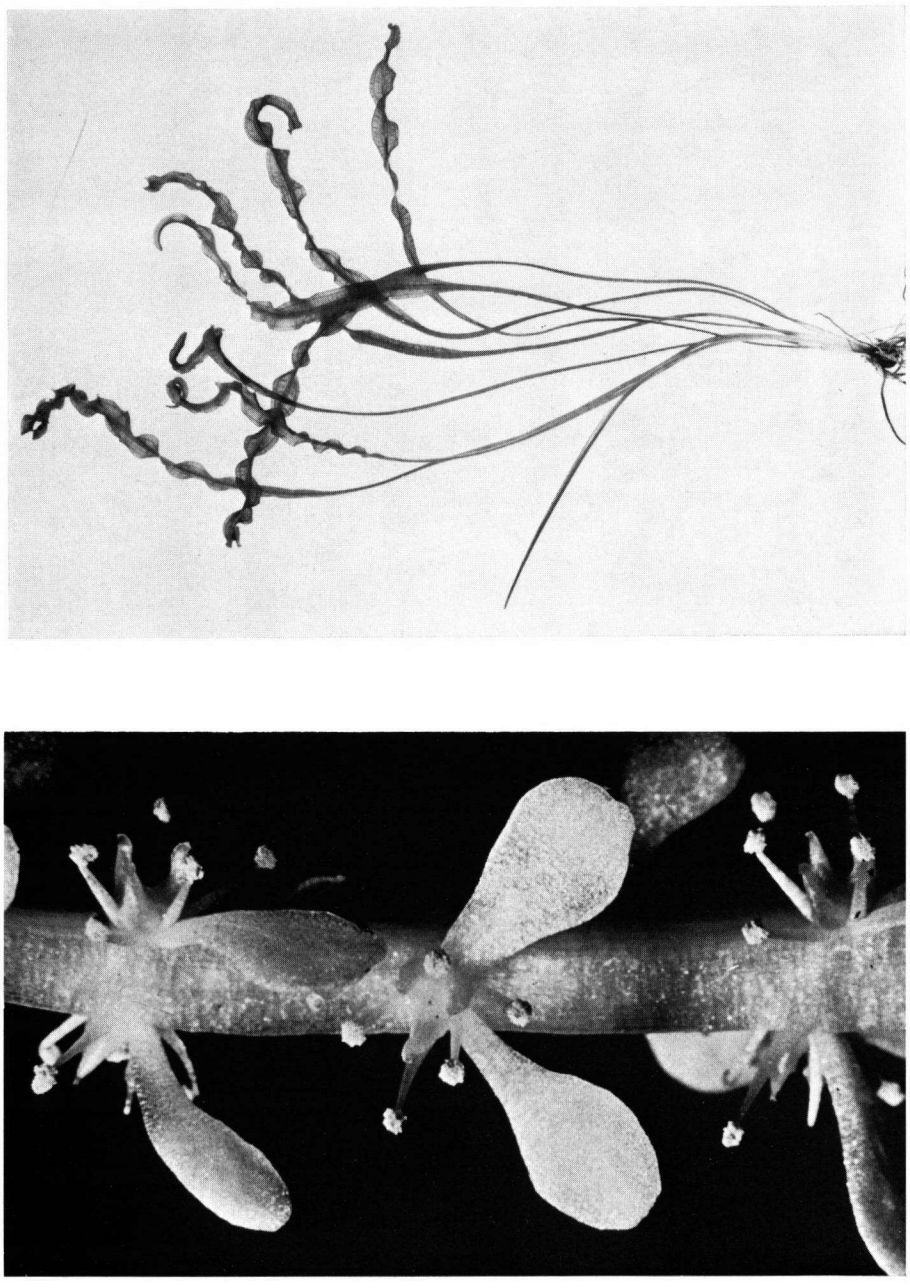
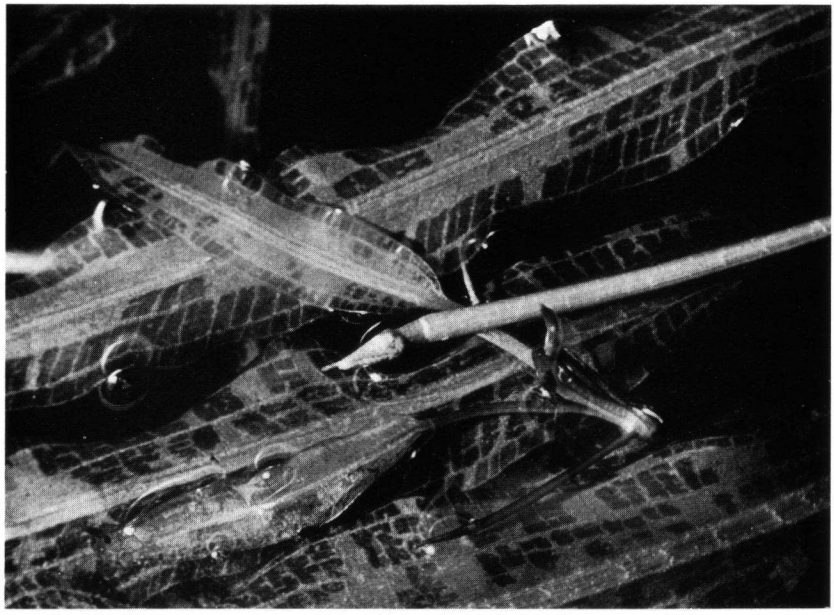


Fig. 5. a. *Aponogeton womersleyi* v. Bruggen, habit (a. *Brass 8671*, L; a'. *Womersley & Havel 17717*, LAE). — b. *Aponogeton loriae* Mart., part of leaf (*Brass 5567*, L). — All × ½.



Pl. 1. *Aponogeton undulatus* Roxb. 1. Part of inflorescence. 2. Narrow-leaved form said to come from Johore.



Pl. 2. *Aponogeton undulatus* Roxb. 1. Leaves lying along the water surface with flower-bud and runner. Note the colour pattern of the leaves. 2. Runner.

Pl. 3. 1. *Aponogeton crispus* Thunb. in lake near Nuwara Eliya (photograph C. F. van Beusekom, 18-9-1969). — 2. *Aponogeton tenuispicatus* v. Bruggen on the type locality (photograph J. Bogner, 2-2-1969).

of *A. undulatus*. The long tepals, the persistent spathe, and the smooth tuber make this plausible.

In *A. undulatus* malformations of inflorescences and runners sometimes occur. I have seen forked inflorescences and a fasciation of runners. De Wit described a digitately branched inflorescence producing reduced spikes and young plants.

5. Aponogeton loriae Martelli, Nuova Giorn. Bot. Ital. 2, 3 (1897) 472, t. 8; Engler et Krause, Pfl. R. Heft 24 (1906) 12; Rendle, J. Bot. (1923) Suppl. 58; Steen., Fl. Mal. I, 4 (1948) 11, *pro nomen et tab., excl. descr.* — Neotype: *Giulianetti and English s.n.*, Magibiri (Astrolabe Range), 14-1-1897 (K). — **Fig. 2 : 9; 5: b; map 3.**

A. crispus (*non* Thunb.) F. v. M., Descr. Not. Pap. Pl. 8 (1886) 51; Ridley, J. Bot. 24 (1886) 359.

A. monostachyon (*non* L. *f.*) Hemsl., Kew Bull. (1899) 113.

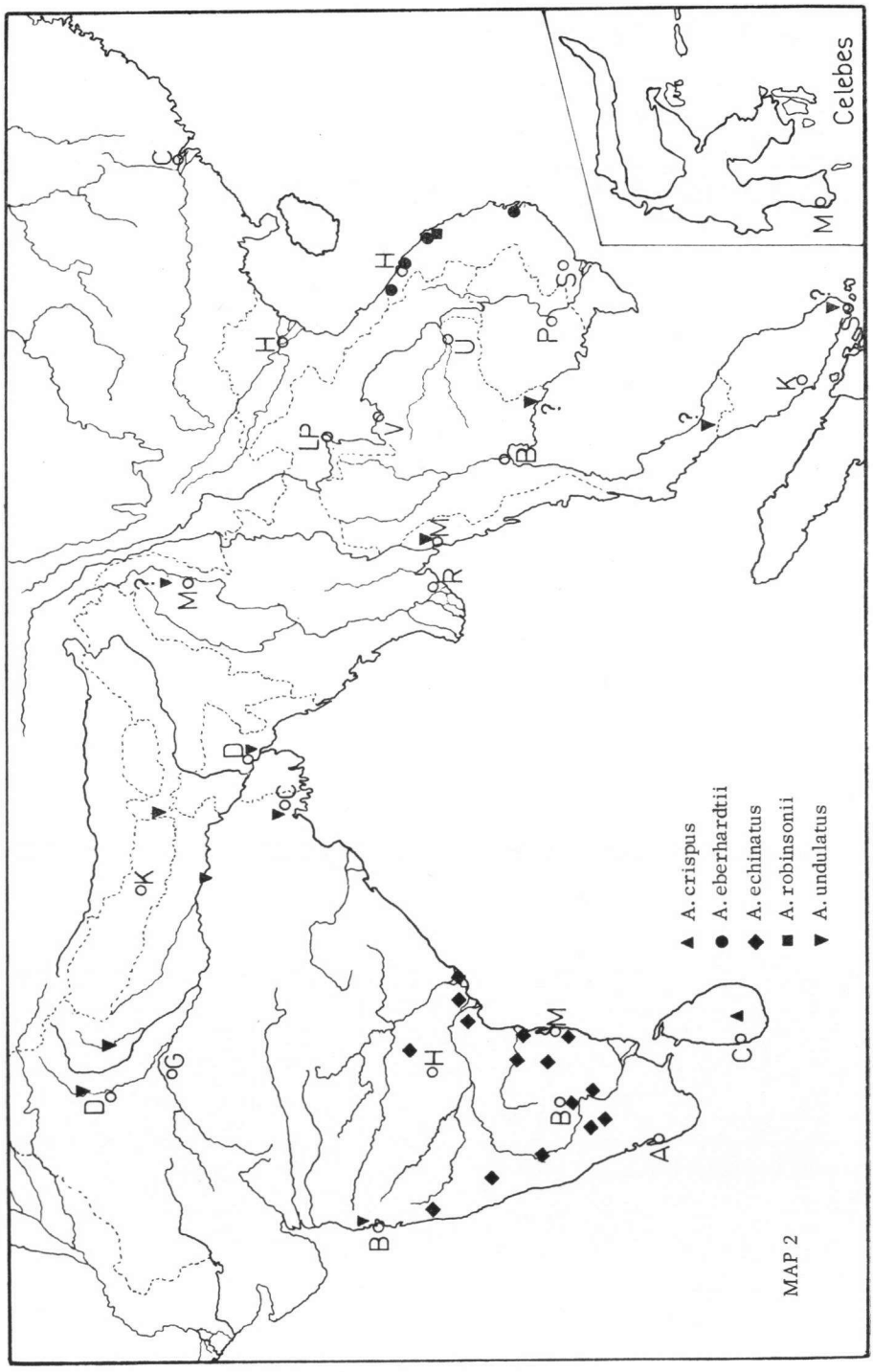
Tuber up to 2½ cm ∅. *Leaves* submerged, very hard in structure; blade greenish-red, 15—65(—80) by 1—3¾ cm; base narrowly cuneate, apex (narrowly) cuneate with a blunt tip; parallel main nerves 7—9, connected by numerous cross veins at a ± 50° angle; margin flat, waved, or slightly crisped; petiole 2—15(—30) cm. *Peduncle* up to 60 cm, ± 3½ mm ∅, not or slightly thickening towards the inflorescence. Spathe up to 22 mm, persistent, seldom caducous; *inflorescence* with one spike; spike up to 12 cm, densely or rather laxly flowered, scentless. *Flowers* turned towards all directions. Tepals 2, obovate, (greenish) yellow, 1—2 by 1—1¾ mm, 1-nerved. Stamens 6, 1½—2 mm, filaments not or slightly widened towards the base; filament, anther, and pollen yellow. Ovaries 3, 1¼—1½ mm by ¾—1 mm, yellow; ovules 4—8. *Infructescence* cylindrical, very dense. *Fruits* up to 6 by 3½ mm, terminally beaked, greenish brown. *Seeds* with a simple testa. Embryo 2½—4 by ¾—1 mm, greenish brown; plumule very small, completely covered by the margin of the cotyledon and therefore invisible.

Distribution: Papua; Central District: Laloki River, *c.* 3 miles E. of Sogeri patrol station (147°25' E, 9°30' S); Kubuna; Koitaki; Sogeri; Sirinumu area, *c.* 3 miles S. of Sogeri; Magibiri (Astrolabe Range); Affluent of Laragi; Stream near Ower's Corner.

Ecology: Common in swiftly flowing, shallow, stony streams between 100 and 600 m above sealevel. Flowering time June-January.

The following data were collected about a locality in a stream near Sirinumu Dam in the morning of August 18th, 1969 (in the middle of the dry season). The depth of water where most plants grew was 2 feet. They grew both in the middle of the stream and towards the banks and seemed to be mostly attached to rocks lying in the stream bed which had a muddy bottom. The water was clear and had an average speed of 0,5 feet per second. The stream, which was ± 10 m wide, flowed through Eucalyptus-savannah, the banks being well covered with grasses up to 1 m tall. The plants were exposed to the sun for most of the day, as the trees were set back from the banks and did not overhang the stream, and were widely spaced. Many of the plants were completely submerged with the leaves lying parallel to the surface in the direction of the stream flow, but some rocks had plants clinging to them whose leaves were lying along the water surface. The plants were covered by large quantities of caddis fly casings clinging to the leaves. The underlying rock in the area trough which the stream flows is volcanic agglomerate which covers a large part of the Sogeri plateau, and the soil is a bright red to red-brown tropical soil. (Mrs. Pulsford in litt.) On October 15, 1969, at noon Dr. Prosser made some physical measurements: Water temperature at 5 cm depth 24.9° C; pH (taken in situ with a radiometer) 7.45; conductivity ± 110 microsiemens/cm by 25° C. (Dr. Robbins in litt).

Notes: A. loriae seems to occur only in the environment of Port Moresby. One collection


A. crispus
A. eberhardtii
A. echinatus
A. robinsonii
A. undulatus
Celebes
MAP 2

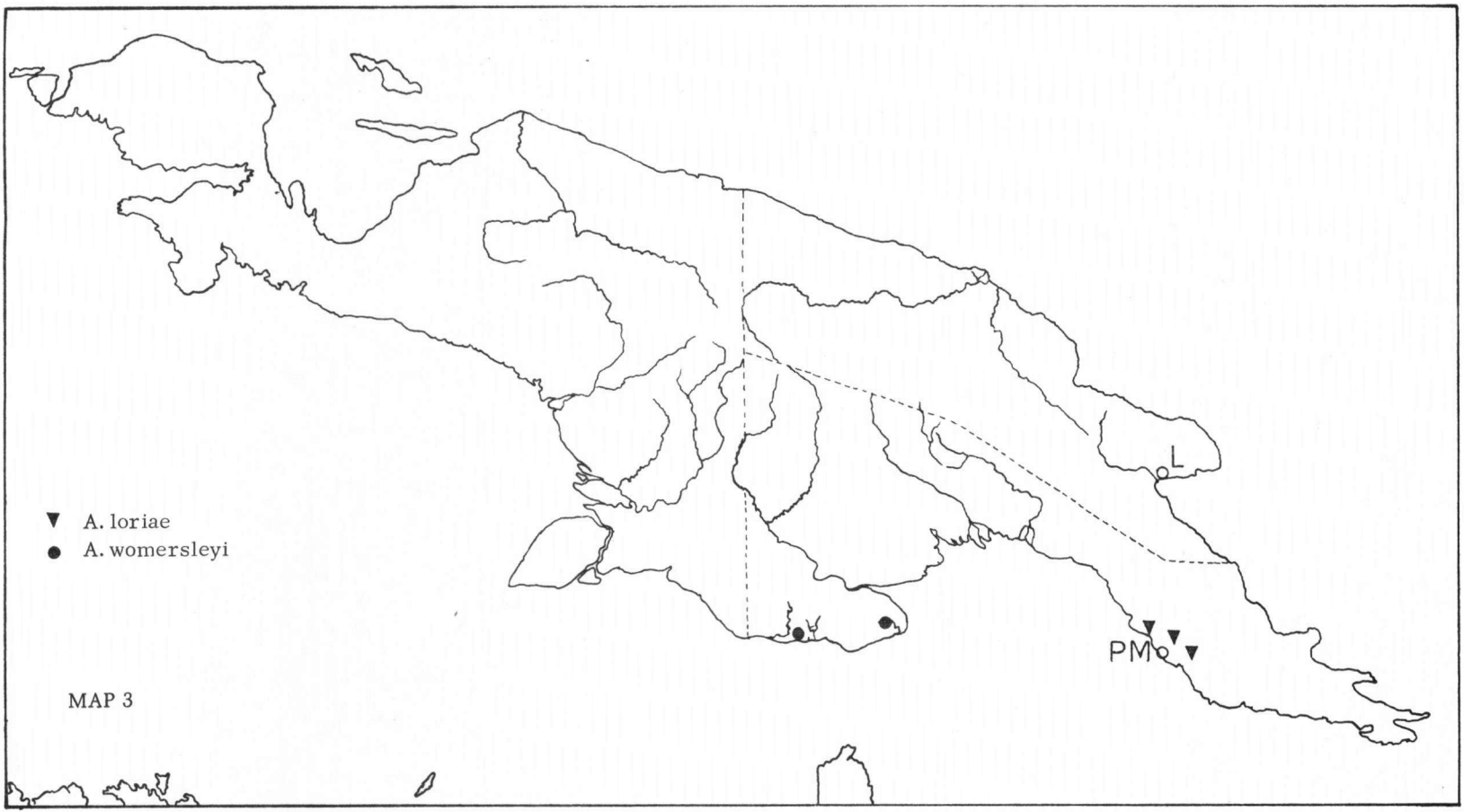
states 'Astrolabe Range, Oriomo River' (*Giulianetti s.n.* in MEL), but these localities are ± 280 miles apart. Therefore this record is worthless, and had to be ignored.

Some specimens collected by Teysmann near Maros and Pangkadjene (Celebes, Indonesia) were wrongly identified as *A. loriae*. *A. bullosus* (Queensland) has also mostly been identified as *A. loriae*. In fact, both species are closely related and there is a striking similarity in the structure of the embryo and the development of the seedling. They can easily be distinguished by the strongly bullate leaves of *A. bullosus* and by its very small stigma. Moreover, *A. loriae* is larger in almost all parts. *A. loriae* is also closely related to *A. elongatus*, and, no doubt, all three come from a common ancestor. Stamens and ovaries of *A. elongatus* are nearly always larger than those of *A. loriae*. In living inflorescences of *A. elongatus* the stamens are distinctly protruding, in *A. loriae* they are not. Some differences between *A. bullosus*, *A. elongatus*, and *A. loriae* are:

	A. bullosus	*A. elongatus*	*A. loriae*
Floating leaves	never	sometimes	never
Structure of blade	rather hard, strongly bullate	herbaceous, waved	very hard, waved
Angle of cross veins	± 70°	± 70°	± 50°
Peduncle	up to 30 cm, not thickening	up to 150 cm, thickening	up to 60 cm, not or slightly thickening
Spathe	persistent	caducous	persistent
Inflorescence	rather lax, up to 5 cm	lax, up to 20 cm	mostly dense, up to 12 cm
Odour of do.	scentless	fragrant	scentless
Length of stigma	± ½ mm	± 1 mm	± 1 mm
Infructescence	dense, cone-shaped	rather lax, cylindrical	very dense, cylindrical
Fruit	terminally beaked	laterally beaked	terminally beaked
Plumule	invisible (internal)	present (external)	invisible (internal)

Until now I did not succeed in tracing the type of *A. loriae*. According to the type description this specimen must have been collected in June 1893, but I have not seen any specimen collected in that year. Therefore I have chosen a neotype which agrees very well with the picture in Martelli's type description.

Thanks to the co-operation of Dr. Robbins and Mrs. Pulsford I received some living specimens of this species, collected in a stream near Sirinumu Dam. The plants appeared to be very difficult to cultivate, and died within a few months. Fortunately they flowered and fruited in that short time, so that I could study flowers and fruits. The description given above has been partly based on this cultivated material. The spathe of these cultivated specimens appeared to be persistent, and remained attached at the base of the



MAP 3

inflorescence. The ripening infructescence immerses gradually, and the spathe then decays. This may be the reason why the spathe is lacking in some herbarium specimens.

6. Aponogeton womersleyi v. Bruggen, *sp. nov.* — Type: Oriomo River, 20-9-1963, *Womersley and Havel 17717* (LAE, 2 sheets, one indicated holotype, the other isotype; isotype in L). — **Fig. 2: 10; 5: a; map 3.**

Tuber usque ad 2½ cm ∅. *Folia* submersa, lamina 20—50 cm longa, 1½—3½ cm lata; basis angustissime cuneata, apex anguste cuneatus vertice obtuso; nervi primarii paralleli 7—9, venulis transversis sub angulo ± 70° interjuncti; margo sinuatus vel applanatus; petiolus 5—35 cm. *Pedunculus* usque ad 1½ m longus, inflorescentiam versus valde incrassatus. Spatha ignota, caduca. *Inflorescentia* spicam unam usque ad 15 cm longam gerens, valde laxiflora. *Flores* omnifarii, parvi. Tepala 2, alba vel lactea, late obovata vel cuneata, ¾—1 mm longa, 1—1¼ mm lata, 1-nervia. Stamina 6, ¾—1¼ mm, filamentis basin versus valde dilatatis ac applanatis. Ovaria 3, usque ad 1 mm longa, ¾ mm ∅; ovula 4—6. *Infructescentia* densissima. *Fructus* viridi-brunnei, 7—8 × 2—3 mm, lateraliter rostrati. *Semina* testa simplice munita; embryo 4—5 × ½ mm; plumula ± ½ mm longa, ad ± ⅛ embryonis longitudinis insidens ac pro parte marginibus cotyledonis obtecta.

Tuber up to 2½ cm ∅. *Leaves submerged*, blade 20—50 by 1½—3½ cm; base very narrowly cuneate, apex narrowly cuneate with a blunt tip; parallel main nerves 7—9, connected by numerous cross veins at a ± 70° angle; margin flat or waved; petiole 5—35 cm. *Peduncle* up to 1½ m, strongly thickened towards the inflorescence. Spathe unknown, caducous. *Inflorescence* with 1 spike of up to 15 cm, very laxly flowered. *Flowers* turned towards all directions, very small. Tepals 2, white to cream, broadly obovate or wedge-shaped, ¾—1 by 1—1¼ mm, 1-nerved. Stamens 6, ¾—1¼ mm, filaments strongly widened towards the base and applanate. Ovaries 3, up to 1 by ¾ mm, ovules 4—6. *Infructescence* very dense. *Fruits* greenish-brown, 7—8 by 2—3 mm, laterally beaked. *Seeds* with a simple testa; embryo 4—5 by ½ mm; plumule ± ½ mm, attached at ± ⅛ of the length of the embryo and partly covered by the margins of the cotyledon.

Distribution: Papua, Western District: Oriomo River, mouth of Yakup Creek, ± 64 km from sea (143° E, 8° 50' S), alt. 50 ft., *Womersley and Havel 17717* (L, LAE); Penzara, between Morehead and Wassi Kussa River, *Brass 8671* (BM, BO, L).

Ecology: Usually rooting on muddy bottoms in shallower parts of the river in savanna forests, presumably in lowlands. At least flowering and fruiting in September and December. Local name *Zo-Inge* (Penzara).

Notes: The two collections of *A. womersleyi* are very different in dimensions, the specimens from Penzara being slender and those from the Oriomo River very large. Yet they are undoubtedly conspecific.

Until now the species has only been found in the Western District, but considering the localities I would not be surprised if one day it were found in West Irian (Indonesia) as well.

The species is an exception in comparison with the other Australian and Papuan species because it has white or creamish inflorescences instead of yellow ones.

A. womersleyi is clearly different from *A. loriae* from the Central District and, even in a sterile state, they cannot be confused, as its cross veins are at a ± 70° angle (in *A. loriae* at a ± 50° angle).

I named the species after Mr. J. Womersley (Lae) because of his merits for the promotion of our knowledge of the New Guinea flora.

7. Aponogeton natans (L.) Engler et Krause, Pfl. R. Heft 24 (1906) 11; Gamble, Fl. Pres. Madras 3 (1931) 1598; Fyson, Fl. S. Ind. Hill Stat. 1 (1932) 684, fig. — *Saururus*

natans L., Mant. 2 (1771) 227. — Type: *König s.n.* (LINN 479. 1, isotype in UPS). — **Fig. 2: 11; map 1.**

A. monostachyon L. *f.*, Suppl. Pl. (1781) 214; Thunb., Nov. Gen. Pl. 4 (1781) 73; Lam., Encycl. 1 (1783) 216; & Poir., Tabl. Encycl. 2 (1793) 409, t. 276, fig. 1; Roxb., Coromandel Pl. 1 (1795) 58, t. 81; Andrews, Bot. Rep. 6 (1797) t. 406, *pro nomen, excl. descr. et tab.;* Roxb., Fl. Ind. ed. Carey 2 (1832) 210; Edgeworth in Hook. Lond. Journ. 3 (1844) 404, fig. XVII; Bth., Fl. Austr. 7 (1878) 188, *pro nomen, excl. descr.;* Hook. *f.*, Fl. Brit. Ind. 6 (1894) 564; Trimen, Handb. Fl. Ceylon 4 (1898) 372; F. M. Bailey, Queensl. Fl. 6 (1902) 1707, *pro nomen, excl. descr.;* A. Camus, Fl. Gén. Indochine 6 (1942) 1225, *pro nomen, excl. descr.;* Larsen, Dansk Bot. Ark. 20, 2 (1962) 134, *pro nomen, excl. descr.* — *Spathium monostachyum* Edgew., Calc. Journ. 3 (1843) 533, fig. 16. — Type: *König s.n.* (LINN 479.1, isotype in UPS).

Parua Kelangu Rheede, Hort. Malab. 11 (1642) 34, t. 15.

Potamogeton indicus Roth *ex* Roem. et Schult., Syst. 3 (1818) 576.

Tuber up to 2 cm ∅. *Submerged leaves* lanceolate, up to 6½ by 1½ cm; base and apex narrowly cuneate; tip blunt; midrib wide, with 2 or 3 parallel nerves on either side; petiole up to 5 cm. *Floating leaves* up to 11½ by 3 cm; base cordate, seldom cuneate; apex (narrowly) cuneate with a blunt tip; parallel main nerves 5 or 7 (9). *Peduncle* up to 45 cm, not thickening towards the inflorescence. Spathe up to 15 mm, caducous; *inflorescence* with one spike of up to 7 cm, densely, seldom rather laxly flowered; *flowers* turned towards all directions. Tepals 2, spatulate, 1½—2 by ½—1 mm, 1-nerved, white, pink, or lilac. Stamens 6, 2½—3 mm, filaments not widened towards the base. Ovaries 3, up to 2 by ¾ mm; ovules ± 8. *Infructescence* ± 8 cm, very dense. *Fruits* up to 4 by 2¼ mm, with a very long (up to 1 mm) terminal beak. *Seeds* ± 1¾ by ¾ mm; testa double, outer one loose, winged, transparent, and reticulately veined; inner one brown, closely fitting the embryo; embryo ± 1¼ by ½ mm, plumule absent.

Distribution: Ceylon; India: Saharanpur; Kaithal; Ranba jungle, Karnal Dt.; Delhi (Shahadra); Gwalior; Bihar; Suri; Calcutta; Sankhjori, Ranpur; Narsinghpur; Srungavarapu Kota, Vishakhapatnam; Godavari Delta; Rudravaram, Siruvel, Kurnool Dt.; Sriharikota, Nellore Dt.; Dachuru, Nellore Dt.; Gudur, Nellore Dt.; Spurtank, Madras; Thirupattur, N. Arcot Dt.; Guindy, Chingleput Dt.; Vandalur, Chingleput Dt.; Kayapakkam, Chingleput Dt.; Pondichéry; Coimbatore; Pundi, Bolampatti valley, Coimbatore Dt.; Kollegal, Coimbatore Dt.; Maruthamalai, Coimbatore Dt.; Udamalpet, Coimbatore Dt.; Karikal; Kallimedu, Thanjavur; Panangudi forest, Sivaganga, Ramnad Dt.; Gomatchiculam, Madurai Dt.; Mundandurai, Tirunelveli; Ilengi Tank, Kuttalam, Tirunelveli; Quibon; Veli, Trivandrum; Nagercoil.

Ecology: stagnant, shallow, most probably temporary waters, ricefields, ponds, and marshes between 0 and 800 m altitude. Flowering time June-February.

Notes: I could cultivate some specimens of this species collected by Mr. Rajendra Babu at Veli (Trivandrum). Though the plants were not difficult to cultivate, I could not obtain any flowers.

A. natans is probably the most common species in India. It is related to *A. lakhonensis* which seems to replace it in SE. Asia, and to *A. queenslandicus* which replaces it in Australia. Some differences are:

	A. natans	*A. lakhonensis*	*A. queenslandicus*
Leaves	floating, seldom submerged	submerged, seldom floating	floating, very seldom submerged
Submerged lvs	up to 6½ × 1½ cm	up to 25 × 6 cm	up to 20 × 3½ cm
Petiole of do.	up to 5 cm	7—35 cm	up to 10 cm
Floating leaves	up to 11½ × 3 cm	up to 17 × 4 cm	up to 11 × 3 cm
Tepals	spatulate, white or lilac	obovate, yellow	obovate, often spatulate, yellow
Filaments	not widened	widened	slightly widened
Ovaries	up to 2 mm	1—1¾ mm	2—3 mm
Fruit	up to 4 × 2½ mm	up to 3 × 2 mm	up to 8 × 5 mm
Beak of fruit	long, terminal	short, terminal or lateral	short, terminal
Seeds	up to 1¾ × ¾ mm	up to 3 × 1 mm	up to 3 × 1 mm

8. Aponogeton lakhonensis A. Camus, Not. Syst. 1 (1909) 273, fig. 18; Fl. Gén. Indochine 6 (1942) 1226. — Type: Laos, River Attopeu-Lakhon Mountains, *Harmand s.n.* (P). — **Fig. 2: 12; 3: a; map 1.**

A. pygmaeus Krause, Bot. Jahrb. 44, Beibl. 101 (1910) 8; A. Camus, Fl. Gén. Indochine 6 (1942) 1227. — Type: Indo-China, *Harmand s.n.* (P).

A. luteus A. Camus, Not. Syst. 2 (1911) 204; Fl. Gén. Indochine 6 (1942) 1227. — Type: Vietnam, Nha Trang and environs, *Robinson 1177* (P).

A. monostachyon (*non* L. *f.*) A. Camus, Fl. Gén. Indochine 6 (1942) 1225; Larsen, Dansk Bot. Ark. 20, 2 (1962) 134.

A. loriae (*non* Martelli) Steen., Fl. Mal. I, 4 (1948) 11.

Tuber elongate or obovoid, up to 2 cm ∅. *Submerged leaves* very variable in shape and size, narrowly oval to linear, up to 25 by 6 cm (e.g. 25 by 6 cm, 15 by 0,9 cm); base (very) narrowly cuneate, apex narrowly cuneate with a blunt tip or rounded; parallel main nerves 7 or 9; petiole 7—35 cm. *Floating leaves* up to 17 by 4 cm, base cordate or (seldom) rounded; apex cuneate with a blunt tip or rounded; parallel main nerves 7 or 9. *Peduncle* only slightly thickening towards the inflorescence. Spathe ± 17 mm, caducous, rarely persistent. *Inflorescence* with 1 spike of up to 8 cm, rather laxly, sometimes densely, flowered. *Flowers* turned towards all directions. Tepals 2, obovate, 1—2 by ¾—1½ mm, yellow, 1-nerved. Stamens 6, 1½—3 mm, filaments widened towards the base. Ovaries 3 or 4(5), 1—1¾ by ¾—1 mm; ovules 4—8. *Infructescence* up to 17 cm. *Fruits* up to 3 by 2 mm, with a terminal or lateral beak. *Seeds* 2—3 by 1 mm; testa double, the outer envelope loose, membranaceous, and reticulately veined, inner one brown, closely fitting the embryo. Embryo 1¼—2½ by ½ mm; plumule absent.

Distribution: China: Canton. Vietnam: Nha Trang and environs; (journey) Mekong-Hué. Thailand: Lampang; between river Se Moun (= River Attopeu) and Lakhon mountains; between Ubon and Kemaratte; between Lakhon and Ban Keum. Cambodja:

Stung Treng. India: Assam: Nagavillage; Haflong, N. Kachar Hills; Jengab Bam Garden, Jaboca. Indonesia: Celebes: Maros; Pangkadjene (near the rocks).

Ecology: Slow running streams, flooded rice fields, and ponds; not frequent but locally rather abundant. Two altitude records available, 240 and 800 m above sealevel. Flowering time at least March, May, September, and October. Near Lampang the whole plant is eaten as salad and is called '*Pak Kuap*'.

Notes: A. lakhonensis is extremely variable in the size of all vegetative and generative parts. As I did not find structural differences I preferred to consider all random collections to belong to one species instead of distinguishing various species. However, some specimens, especially the Indian and Indonesian ones, are incomplete and it may be that future collections lead to another view.

The Vietnamese and Indonesian specimens have only submerged leaves, whereas the specimens from China and Thailand have both submerged and floating leaves. The specimens from India have in comparison with the other ones extremely large submerged and floating leaves.

The type collection of *A. pygmaeus* has been left out of consideration in drawing up the description given above. In my opinion these specimens represent an abnormal form, due to environmental conditions, for example extremely low water. They have no ripe fruits.

Mostly the colour of the tepals has not been recorded, but in most of these cases I could see that the tepals must have been yellow.

A. lakhonensis is closely related to *A. queenslandicus*. It differs, among other things, in the development of many submerged leaves (which seem to be extremely rare in *A. queenslandicus*), by the ovaries which are shorter and wider, and by the much smaller fruits.

9. Aponogeton rigidifolius v. Bruggen, Meded. Landb. Hogeschool Wag. 6 (1962) 91, fig. 1. — Type: Cult., *H. W. E. van Bruggen s.n.* (WAG). — **Fig. 1: 3; map 1.**

Rhizome creeping, cylindrical, up to 1 cm ∅ and 15 cm long. *Leaves* submerged; blade band-shaped, rigid, up to 60 by 3 cm, dark dull green, margin flat; midrib wide with 3 or 4 parallel nerves on either side; base and apex very narrowly cuneate with a blunt tip; petiole up to 55 cm. *Peduncle* up to 90 cm, not or hardly thickened towards the inflorescence. Spathe up to 2 cm, caducous. *Inflorescence* with 1 spike of up to 15 cm, rather densely flowered, scentless; *flowers* turned towards all directions. Tepals 2(3), obovate, 2—3¼ by 1¾—2 mm, white, 1-nerved. Stamens 6(—8), 1½—3 mm; filaments widened towards the base; anthers brownish grey, pollen yellow. Ovaries 3, 2—2½ by ¾—1 mm; ovules 2. *Fruits* up to 12 by 6 mm, terminally beaked. *Seeds* with a simple testa; embryo up to 11(—14) by 4—5 mm (sometimes the embryo is larger than the fruit, the tip of the embryo is then folded back); plumule attached near the base of the embryo, fitted in a very wide groove, and consisting of two leaflets.

Distribution: Ceylon: River Atweltota near Matugama.

Ecology: Mr. F. de Graaf, curator of the Artis Aquarium at Amsterdam, found *A. rigidifolius* in the rather fast running water of the Atweltota near Matugama in the hills of S. Ceylon. The water had a depth of 10—20 cm and of 50 cm in bends of the river (at the end of the dry season). The watertemperature was 23—25° C, the total hardness 6.5 German degree of hardness, and the pH 7.2. The soil consisted of sand. Other waterplants were not found. In the stream some fishes were observed such as *Rasbora vaterifloris, R. daniconius, Barbus filamentosus, B. nigrofasciatus, B. titteya,* and *Aplocheilus lineatus dayi.*

Notes: I have seen but one collection of *A. rigidifolius*, but I could cultivate many

specimens. Because of the long creeping rhizome the plants are mistaken for *Cryptocoryne* by the commercial collectors, and exported as such to Europe and the U.S.A.

It is striking that the leaves of just imported specimens are completely flat and very hard of structure. In cultivation the new leaves become waved, but remain hard and band-shaped. The drawing with the type description represents such a cultivated specimen.

A. rigidifolius can easily be distinguished from *A. crispus* by the creeping rhizome and the flat band-shaped leaves. Yet I am not fully convinced that they are really different species, and they may deserve only subspecific or varietal rank. I could not examine enough material to solve this problem.

10. Aponogeton crispus Thunb., Nov. Gen. 4 (1781) 73; Thwaites, Enum, Pl. Zeyl. (1864) 333; F. v. M., Fragm. Phyt. Austr. 8 (1869) 216, *pro nomen, excl. descr.;* Hook. *f.*, Fl. Brit. Ind. 6 (1898) 564, *pro parte;* Trimen, Handb. Fl. Ceylon 4 (1898) 372, *pro nomen, excl. descr.;* Engler et Krause, Pfl. R. Heft 24 (1906) 12, *pro parte;* Gamble, Fl. Pres. Madr. 3 (1931) 1597, *pro nomen, excl. descr.;* Mitra, Flow. Pl. East. India 1 (1958) 9, *pro nomen, excl. descr.* — Type: Ceylon, *Thunberg s.n.* (UPS). — **Fig. 1: 4; 6; map 2; pl. III above.**

Tuber elongate, up to 2 cm ∅. *Submerged leaves* firm, pale green when young, turning dark green and purplish when older; blade very variable in shape, heart-shaped or narrowly ovate with cordate, truncate, or rounded base, or narrowly oval with cordate base, or linear with narrowly cuneate base, up to 30 by 6 cm (for example 3.5 by 2.3 cm, 20 by 6 cm, 24 by 2 cm, 24 by 4 cm, 30 by 5,5 cm); apex (narrowly) cuneate or rounded, with a blunt or acute tip; margin flat, waved, or crisped; parallel main nerves 7—9; petiole up to 45 cm. *Floating leaves* very rare, narrowly oblong or narrowly obovate, up to 7 by 2 cm; base truncate or rounded, apex cuneate with a blunt tip; parallel main nerves 7—9. *Peduncle* up to 80 cm, slightly or not widening towards the inflorescence. Spathe up to 15 mm, caducous; *inflorescence* with one spike of up to 18 cm, scentless, rather laxly flowered; *flowers* turned towards all directions. Tepals 2, (broadly) obovate, often somewhat wedge-shaped, up to 2 by 2 mm (sometimes even wider than long), white or pink, 1-nerved. Stamens 6, 1½—2½ mm; filaments strongly widened towards the base and swollen, anthers violet. Ovaries 3, up to 1¾ by 1 mm; seldom with some excrescences, ovules 2. *Infructescence* up to 20 cm, rather lax. *Fruit* up to 12 by 5 mm, ± 2½ times as long as thick, smooth, with a short, terminal, often curved beak. *Embryo* up to 8 by 3 mm; plumule attached at or above (seldom below) the middle of the embryo and fitted in a narrow groove; testa simple.

Distribution: Ceylon: Nuwara Eliya; Gregory Lake, Nuwara Eliya; Horton Plains; Hakgala Botanic Garden; Pattipola, Badulla Dt.

Ecology: Locally frequent in shallow (20 cm) or deep (1 m), clear or muddy, stagnant or streaming, probably permanent lakes, pools, and brooks. Altitude 1000—2300 m; flowering time at least March, April, and September. Singhalese name: *Kettekiya;* flower stems eaten.

Notes: A. crispus is very variable in the shape of the leaves. Essentially, two forms can be distinguished, a form with linear, crisped leaves (the typical form), and one with ± ovate, waved leaves. I presume that these differences are genetically defined as I did not see herbarium specimens with both types of leaves. Moreover, my cultivated specimens of the form with ovate leaves do not tend to develop linear leaves. Judging from the herbarium specimens the form with ovate leaves must be much more common than the other form. Thwaites' collection *CP 2306* contains only a few specimens with linear leaves; the majority, however, has ovate leaves.

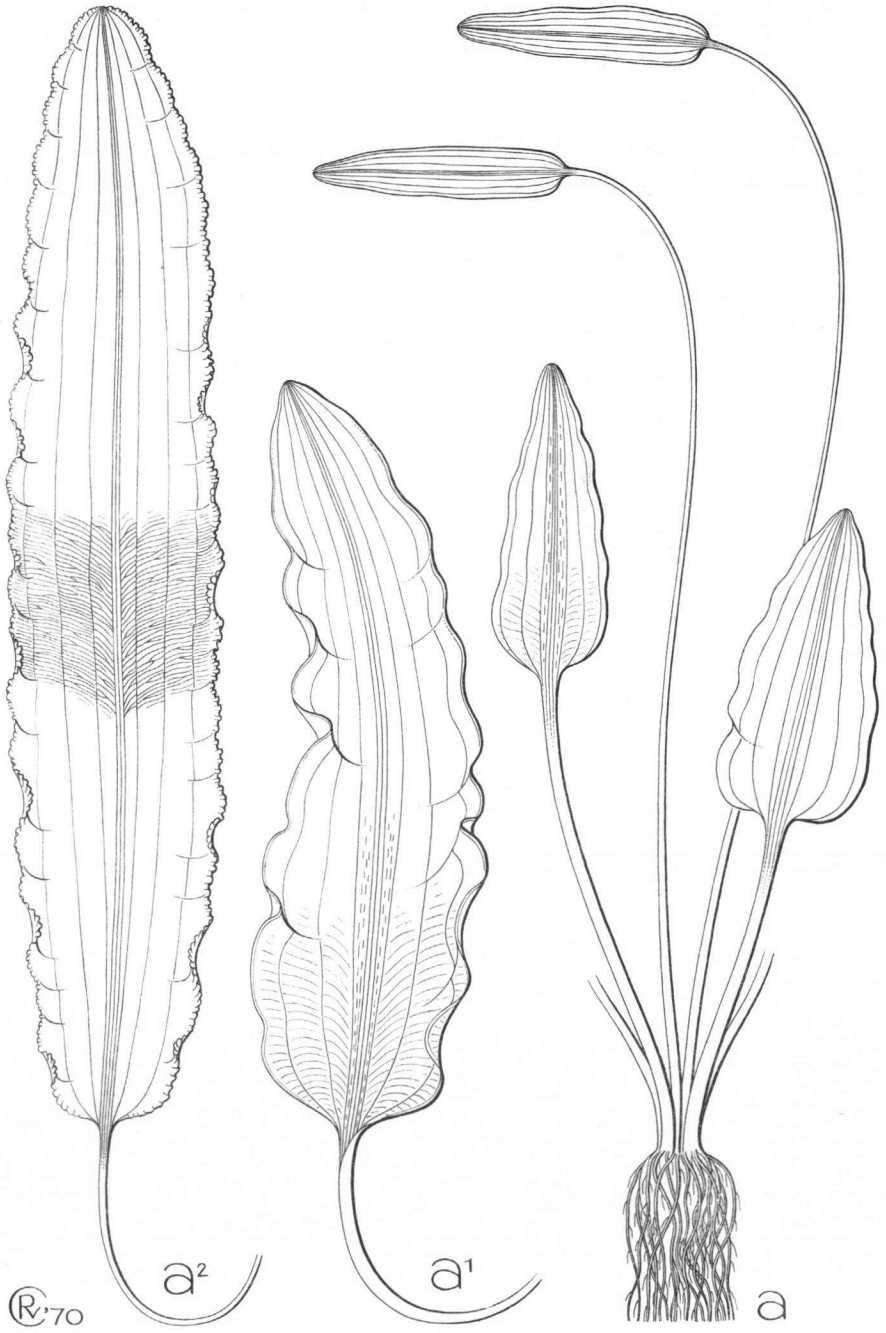


Fig. 6. *Aponogeton crispus* Thunb. a. Habit with submerged and floating leaves; a^1 and a^2. submerged leaf (a. *Hoogland 11520;* a^1 and a^2: *Thwaites CP 2306*, a^1 in SING, a^2 in MH). All × ½.

A. crispus seems to be closely related to *A. echinatus* from India, and I think it to be possible that the latter represents only a variety of *A. crispus*. *A. crispus* has nearly always only submerged leaves and *A. echinatus* nearly always floating leaves. I only saw one collection of *A. crispus* with floating leaves (from Lake Gregory, Nuwara Eliya, *Hoogland 11520*). There are also some slight differences in floral characteristics, but I do not know as to how far these are constant. My insight in the differences between these two species is much obscured by the fact that many cultivated specimens take intermediate shape. They develop a mass of submerged (mostly linear, sometimes oval) leaves and often floating leaves. These plants are claimed to be collected in Ceylon, but data of commercial collectors are, for reasons of competition, nearly always very unreliable. The ovate-leaved form has never been imported here by dealers; this may be in contradiction to the fact that this form seems to be the most common one in Ceylon.

I could cultivate some ovate-leaved specimens, collected in the Hakgala Botanic Garden and near Nuwara Eliya by Dr. Hoogland and Mr. van Beusekom.

In dried specimens of *A. echinatus* the tepals are nearly always clearly protruding and visible with the naked eye, whereas the tepals in *A. crispus* are not protruding and not visible with the unaided eye. Some other differences are:

	A. crispus	*A. echinatus*
Tuber	elongate	obovoid or globular
Leaves	submerged, very seldom floating	floating, seldom submerged
Inflorescence	scentless, rather or very lax	fragrant, dense or rather lax
Tepals	± as long as wide	± 1½ times as long as wide
Filaments	swollen at the base	not swollen at the base
Fruit	smooth, ± 2½ times as long as thick	echinate, seldom smooth, ± 2 times as long as wide
Plumule	attached about the middle of embryo	attached at the base of the embryo

A. crispus is also closely related to *A. rigidifolius* as explained under that species.

Edgeworth mentions in Hook. Lond. Journ. of Bot. 3 (1844) 405 a *nomen nudum*, *Ouvirandra macraeae*. I believe that this refers to Macrae's collection *249* of *A. crispus*.

A. crispus seems to be confined to Ceylon. There is a collection of T. Thomson from Moradabad (*ex* Herb. Hook *f.* et Thomson in K), consisting of 5 inflorescences, 3 of which belong to *A. undulatus* and 2 I believe to *A. crispus*. On drawing the distribution map I left this locality out of consideration, as I am afraid that two collections from different localities have been joined.

11. Aponogeton echinatus Roxb., Flora Indica, ed. Carey 2 (1832) 210; Hook. *f.*, Fl. Brit. Ind. 6 (1894) 564; Mitra, Flow. Pl. East. India 1 (1958) 9. — Neotype: Biccavol, Godavari Delta, 25-12-1901, *Bourne 3200* (K, duplicates in K and CAL). — **Fig. 1: 2; 7; map 2.**

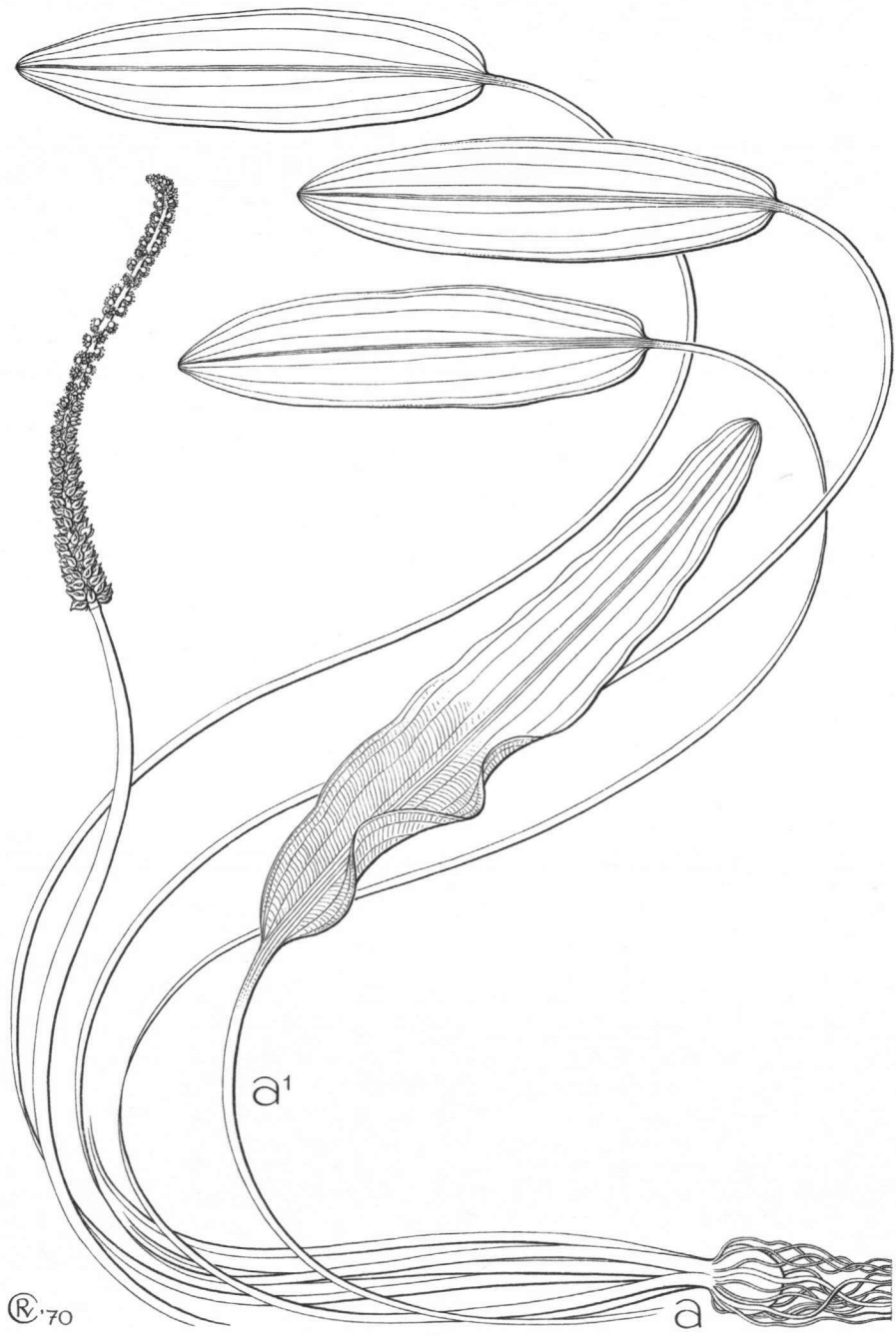


Fig. 7. *Aponogeton echinatus* Roxb. a. Habit with floating leaves (*Bourne 3200*, K); a'. submerged leaf (BLAT, collected in Dharwar). All × ½.

Tuber obovoid, up to 5 cm ∅. *Submerged leaves* probably fugacious membranaceous, up tp 25 by 4½ cm; base cuneate or truncate; apex rounded; parallel main nerves 9. *Floating leaves* variable in size, up to 20 by 5 cm (for example 5.2 by 1.9 cm, 9 by 1.7 cm, 12 by 5 cm, 14 by 3 cm, 20 by 3½ cm); base cordate or rounded, apex rounded, or cuneate with a blunt tip; parallel main nerves (7—)9—11. *Peduncle* up to 75 cm, widening towards the inflorescence. Spathe up to 2½ cm, caducous; *inflorescence* with 1 spike of up to 13 cm, fragrant, densely or rather laxly flowered; *flowers* turned towards all directions. Tepals 2, up to 2¼ by 1¾ mm, white, pink, or violet, 1-nerved. Stamens 6, up to 2½ mm, widened towards the base; anthers violet. Ovaries 3, up to 2 by 1 mm, often with some excrescences, ovules 2. *Infructescence* very dense. *Fruit* up to 12(—18) by 5(—7) mm, about 2 times as long as thick, terminally beaked, often with some irregular hard excrescences, seldom smooth. *Embryo* up to 12 by 5 mm; plumule attached at the base of the embryo, consisting of several leaflets and fitted in a wide or narrow groove; testa simple.

Distribution: S. and Central India: Ooracheroo Lake, Narsapur, Medak Dt.; Pakhal, Warangal Dt.; Concan; Biccavol, Godavari Delta; Kolleru Lake, W. Godavari Dt.; Vinukonda, Guntur Dt.; Dharwar; Cuddapah Dt.; Gudur, Nellore Dt.; Shimoga; Horselykonda, Chittoor Dt.; Horsely Hills, Chittoor; Vandalur; Bangalore; Nilgiri Hills; Bandipur, Mysore Dt.; Gaudigan Lake, Pennagaram, Salem Dt.; Hassanur Tank, Coimbatore.

Ecology: Sometimes in large quantities in lakes, ponds, and tanks between sea-level and 1300 m. Obviously flowering throughout the year.

Notes: As discussed before, *A. echinatus* is closely related to *A. crispus,* and I am not quite sure that they are really different species.

Moreover, in habit it resembles *A. natans* which species seems to have partly the same distribution. In sterile state they cannot be distinguished with certainty. In flowering or fruiting stage, however, they cannot be confused, *A. echinatus* having 2 and *A. natans* *c.* 8 ovules. Moreover, the seeds of the former have a single and of the latter a double testa. Yet most sheets of *A. echinatus* have been labelled as *A. natans* or *A. monostachyon.*

A. echinatus is often imported for aquarium purposes; the plants appear to be very variable in the shape of the submerged leaves and of the fruits. The tubers may reach huge dimensions. I once received a tuber (via Singapore!) which measured ± 8 by 5 cm. It weighed 105 grammes and had a volume of 110 cm^3. It had ± 20 growing points and resembled a small coconut.

The confusion of *A. natans* with *A. echinatus* must be partly due to the obscure description of the latter. In his Coromandel Plants 1 (1795) 58 Roxburgh added to a description of *A. natans:* 'There is a variety, if not a distinct species, with hedgehog'd two-seeded capsules, but in all other respects the same'. Moreover, he drew on the plate of *A natans* 3 carpels which are strongly echinate and two-seeded. In the very short type description, however, the number of seeds is given as 6. I presume that, owing to a mistake, in this case the number of seeds of the complete gynoecium has been given instead of the number of a single ovary. Without any doubt both descriptions refer to the same species.

A collection from Concan *(Stocks, in Herb. Hook. f. et Thomson)* consisting of 4 sheets (3 in K, 1 in L) is very different from the usual type. It has very small tubers and only submerged leaves. The inflorescences are very lax and the flowers very small (tepals ¾—1 by ¾—1 mm; stamens 1½—2 mm, filaments widened towards the base; ovaries 1 by ⅓ mm, ovules 1, sometimes 2). I have seen but one unripe fruit which resembled a miniature-fruit of *A. echinatus.* For the moment I prefer to place these specimens in *A. echinatus* rather than describe them as a new species on the basis of the incomplete material. A recollection would be very desirable.

Edgeworth mentions in Hook. Lond. Journ. of Bot. 3 (1844) 404, a *nomen nudum*, *A. dispermus*. A collection of *Wight s.n.* in K of *A. echinatus* was labelled *A. dispermum*. I therefore believe that the name *A. dispermus* is only a synonym of *A. echinatus*.

IDENTIFICATION LIST

In this list collectors' names have been arranged alphabetically. Specimens without number are indicated with '*s.n.*' and provided with the date of collection if any was mentioned. All collections are provided with the standard abbreviation of the Herbarium, and type-collections are indicated. Some spelling-mistakes may occurr as some, especially old, labels were almost illegible.

Abu Hosein s.n. (8-1902, CAL, P): 4; Armit 124 (MEL): 5.
Barnes 2213 (K): 11; 2214 (K): 11; Beddome 68 (CAL): 4; v. Beusekom 1446 (L): 10; Biswas 4228 (BC): 7; Blackpool s.n. (15-4-1859, CAL): 10; Bourne 3057 (MH): 7; 3200 (neotype, CAL, K): 11; Brass 5567 (BO, L): 5; 8671 (BO, BM, L): 6; v. Bruggen s.n. (10-4-1962, type, WAG): 9.
Carr 12746 (CANB, L): 5; Chalmers s.n. (1885, MEL): 5; Cherian Jacob 18519 (CAL): 11; do. (MH): 7; Chew 40970 (SING): 4; Clarke 7436 (K): 4; 7554 (K): 4; Cleghorn s.n. (1867, MH): 11; Craib 556 (K): 6.
Drummond 26615 (K): 7; 26616 (K): 7.
Eberhardt 1973 (type, P): 3; Edgeworth s.n. (1844, K): 7; 167 (K): 4; Ellis 11807 (MH): 7.
Fernandez R 1600 (BLAT): 4; R 1944 (BLAT): 4; R 1945 (BLAT): 4; R 1946 (BLAT): 4; R 1947 (BLAT): 4; Fischer 628 (CAL, K): 11; 801 (CAL): 11; 2010 (CAL, K): 7; 4098 (CAL): 7; Fyson 32776 (BLAT): 7.
Gamble 12387 (CAL, K): 7; 15141 (K): 11; Gaudichaud s.n. (5-1837, P): 7; Giulianetti s.n. (10-1899, BRI): 5; Giulianetti and English s.n. (14-1-1897, neotype, K): 5; s.n. (1897, K, MEL): 5; Griffith s.n. (K): 4 + 7; 6031 (CAL): 7; 6032 (K): 8; 6033 (CAL, K): 4.
Harmand s.n. (several collections, among which type, P): 8; Hartley 10722 (LAE): 5; Henry 15945 (MH): 11; Hock 170 (CAL): 8; Hoogland 11519 (CANB): 10; 11520 (CANB): 10; 11525 (CANB): 10; Hooper and Ramaswami 39393 (K): 7; Hope s.n. (CAL): 7.
Kerr 1797 (K): 8; Khanna 10 (UPS): 7; Koenig s.n. (type, LINN, UPS): 7.
Lawson s.n. (1885, K): 7; 113 (type, K): 1.
Macrae 249 (K): 10; Maxwell 213 (K): 10; Meebold 6811 (K): 11; 11300 (K): 11; Mir Bux s.n. (7-1919, CAL): 7; Mooney 1350 (K): 7; 2688 (K): 7.
Naganathau 19422 (MH): 7; Naithani 21208 (MH): 11; Narayanasamy 5165 (MH): 7; Narayavats Naganatto 6152 (MH): 7.
Mc. Parish 273 (K): 4; Perrottet s.n. (1835, K, P): 7; s.n. (1836, P): 7; Poilaue 968 (P): 3; 10195 (P): 3; 31337 (L, P): 3.
Rajendra Babu s.n. (1969, L): 7; Ramamurthy 20293 (MH): 7; Ramaswami s.n. (CAL): 7; Robinson 1101 (type, K, P): 2; 1177 (P): 8; Rungachari s.n. (11-1901, K): 1.
Sampson s.n. (22-4-1869, K): 8; s.n. (25-5-1884, K): 8; 1268 (K): 8; 15588 (K): 8; Santapau 204.1H (BLAT): 4; Schodde 2977 (CANB, L): 5; Sebastine 1189 (MH): 7; 6752 (MH): 11; Shah 4669 (BLAT): 4; 4670 (BLAT): 4; 9321 (BLAT): 4; 9322 (BLAT): 4; Shaik Mokim s.n. (1897, CAL): 4?; Sinclair 40652 (L, SING): 4; Squires 34 (BO, BM, K, P, SING): 3; v. Steenis 19520 (L): 10; Stocks s.n. (K, L): 11?; Subbarao 21820 (MH): 7; Subramanyam 3901 (MH): 7; 4328 (MH): 7; 5066 (MH): 11; 6511 (MH): 7.
Teysmann 11901 (BO): 8; 12792 (BO, L): 8; G. Thomson s.n. (K): 7; s.n. (K): 11; T. Thomson s.n. (8-1843, K): 4 + 10; Thorel 2460 (P): 8; Thunberg s.n. (type, UPS): 10; Thwaites CP 2306 (BO, GOET, K, MH, P, SING): 10; CP 2307 (K, P, SING): 7; CP 2308 (CAL, K): 10; CP 3381 (P): 9.
Vajravelu 22437 (MH): 11; Vencoba Rao 2173 (K): 7; 4073 (K): 1.
Wagh 6408 (BLAT): 11; Walker 24 (K): 10; Wallich 5168a (P): 4; Wight s.n. (K): 7; s.n. (K): 10; s.n. (K): 11; 2792 (K, L): 7; Womersley and Havel NGF 17717 (type, L, LAE): 6.
Zewald s.n. (10-1958): 4.

V. NEW DATA ON APONOGETON TENUISPICATUS V. BRUGGEN

A collection of ample material of this obviously rare species, collected on the type locality by Mr. Bogner at Munich, made it possible to complete the type description.

Aponogeton tenuispicatus v. Bruggen, Blumea 16 (1968) 253. — Type: Antanandavahely, *A. Rakotozafy 544*, 20-7-1966 (P). — **Fig. 1: 1; pl. III below.**

Rhizome cylindrical, creeping, 2—3 cm long and 0.5—0.6 cm ∅, brown. *Leaves* submerged or emerged, oval or obovate, 2½—7 by 2—4 cm; base truncate or cordate, apex rounded and apiculate; midrib wide, with 3 slender parallel nerves on either side; margin slightly undulate; upper side dark olive-green, densely covered with minute white dots, lower side wine-red with some white dots; petiole 4—8 cm, ± 2 mm ∅, light wine-red. *Peduncle* 7—10 cm, ± 1½ mm ∅, not thickening towards the inflorescence, light wine-red. Spathe ± 8 mm, caducous, olive-green, tinged with wine-red; *inflorescence* with one spike of 5—8 cm, laxly flowered, scentless. *Flowers* very small, turned towards all directions. Tepals 2, light green, wedge-shaped, up to 1 by 1¼ mm, 1-nerved. Stamens 6, 1¼—1½ mm, filaments hardly widening towards the base; anthers yellow, pollen yellow; filaments often reddish at the base. Ovaries 1, 2, or 3 (4), up to 1¼ by ½ mm, ovules 2. *Fruits* up to 5 by 3 mm with a very short terminal beak, dark olive-green, tinged with wine-red. Seeds with a simple testa; embryo *c.* 2½ by 1¼ (—1½) mm; plumule attached below the middle of the embryo, not fitted in a groove.

Distribution: Madagascar, District Antalaha, Canton Ambohitralanana: affluent of the river Onive near Antanandavahely; *Bogner 275*, 2-2-1969 (K, L, M, P, US); *Rakotozafy 544*, 20-7-1966 (P).

Ecology: *A. tenuispicatus* was growing at the marshy banks of a brooklet with slowly running water. The soil consisted of quartz sand, partly mixed with vegetable mould. The rhizome was rooted at a depth of 2—3 cm. The water temperature was ± 30° C (in the afternoon). The total hardness was 0.40 German degree of hardness, the conductivity 59.6 microsiemens/cm by 20° C, and the salinity 18.5 mg/l Cl (analysis Artis Aquarium, Amsterdam). The habitat was shadowed by trees and shrubs (tropical rainforest), and was at a height of ± 40 m above sealevel. The plants were growing emerged, but they may be submerged in other periods. They were accompanied by *Blyxa aubertii*, some of which also grew emerged in which cases they had very short leaves.

Though the plants flowered abundantly, fruits were comparatively rare. Most inflorescences end up without or with only a few fructifications (field data I owe to Mr. Bogner).

Flowering time at least February and July.

Notes: Mr. Bogner succeeded in re-finding the type locality on indication of Mr. A. Rakotozafy. Though the locality was situated at a distance of not more than ± 800 m of the village Antanandavahely, it was not easy to locate, as it was in a place where one would not expect any *Aponogeton*. Moreover, the habitat was very small.

Mr. Bogner sent me some living specimens. They appeared to be very difficult to cultivate. Though in my culture the plants flowered several times I could not obtain any seeds.

Both in habit and color and ecology there is a remarkable resemblance with some wide-leaved species of *Cryptocoryne*.