

## NAJADACEAE (W. J. J. O. de Wilde, Leyden)

Within the *Helobieae* there has been a great deal of controversial opinion about the evaluation of the genera belonging to the *Potamogetonaceae*, among which *Najas* finds by almost unanimous opinion its closest relatives. Generally *Najas* has been accepted to represent a separate monotypic family on account of the basal ovule and the structure of the anther (with a thin, tight, 2-lipped envelope and apically escaping pollen). The closest allied genus among *Potamogetonaceae* seems to be *Zannichellia*, which is by HUTCHINSON (1934) accepted as a separate family, *Zannichelliaceae*, put together with *Najadaceae* in his order *Najadales*.

Within the *Helobieae* some authors accept the structure of *Najadaceae* as primitive, notably CAMPBELL (1897) and RENDLE (1930), but others find it a derived, advanced state within the order, cf. HUTCHINSON (1934) and LAWRENCE (1951).

An excellent concise account of opinions is given by LAWRENCE (*Taxonomy of Vascular Plants*, 1951, 375–378).

### NAJAS

LINNÉ, *Gen. Pl.* ed. 5 (1754) 445; *Sp. Pl.* (1753) 1015; WILLD. *Mém. Ac. R. Sc. Berl.* (1798) 85; A. BRAUN, *J. Bot.* 2 (1864) 274–279, 8 fig.; P. MAGNUS, *Beitr. z. Kenntn. Gatt. Najas* (1870) 1–63, t. 1–8; C. BAILEY, *J. Bot.* 22 (1884) 305, fig. 1–89; P. MAGNUS in E. & P. *Pfl. Fam.* 2, 1 (1889) 214–218; *Ber. Deut. Bot. Ges.* 12 (1894) 214, t. 11; K. SCH. in *Mart. Fl. Bras.* 3, 3 (1894) 715–734, t. 123–124; RENDLE, *Trans. Linn. Soc. II, Bot.* 5 (1899) 379–444, t. 39–42; *Pfl. Reich Heft 7* (1901); DE WILDE, *Act. Bot. Neerl.* 10 (1961) 164, fig. 1–9.—*Caulinia* WILLD. *Mém. Ac. R. Sc. Berl.* (1798) 87, t. i; cf. DE WILDE, *Willdenowia* 2 (1960) 595–597.—**Fig. 1–8.**

(Mostly) fragile, slender, submersed annuals, rooting from the base and lower nodes. Stems often forked, terete, sometimes provided with teeth (*subg. Najas*). *Leaves* sessile, in pseudowhorls of 3 or more, linear, sometimes more or less subulate or linguiform, 1-nerved; midrib bordered on both sides, especially clearly visible in the lower part of fullgrown leaves, by a mostly distinctly transversely septated intercellular space, here called 'cavity'. *Sheath* more or less auricled, or truncate, or decurrent; upper part of the sheath and margin of the blade, sometimes also the dorsal surface of the midrib, spiny-dentate or spiny to various degree; spine cells yellowish-brown, ascending. Sheath with 2 axillary intravaginal scales (see fig. 2g–l). Plants mostly monoecious. *Flowers* small, unisexual, solitary or sometimes 2–4 together, at the very base of an (sometimes very short) axillary shoot, each often enclosed in a membranous (sub)sessile spathe (♀ fl. in Mal. *spp.* espathaceous). *Spathe* tapering to the top, or constricted into a cylindrical neck, the edge mostly with some erect spines. ♂ *Flowers* consisting of one subsessile or stalked anther, which is tightly enveloped by a membranous 'perianth' apically mostly produced into 2 more or less distinct 'lobes'; anther 1- or 4- (rarely 2-)celled, basifixed, ± pore-like dehiscent at the top; 'pedicel' mostly considerably elongating just before anthesis. ♀ *Flowers* (in Mal.): ovary subsessile, naked, elliptical to oblong, 1-celled, style cylindrical, with (1–)2(–4) linear, often unequal stigmas. Ovule one, basal, erect, anatropous; integuments two. *Fruits* elliptical-oblong (to ovate); style and stigmas persistent; pericarp very thin in the herbarium, not dehiscent, tearing away at the base or dwindling by rotting.

*Seeds* oblong (to ovate), with a conspicuous raphe and a hard, (in Mal. *spp.*) distinctly areolate, mostly brownish testa; embryo straight; hypocotyl and radicle large, plumule well developed; cotyledon terminal, blunt. No endosperm.

Distr. About 35 *spp.*, from the tropical to the temperate parts of the world.

Ecol. Mostly in shallow, stagnant or sluggish waters, ditches, rice-fields, small streams in forest, pools, ponds, swamps, mostly in freshwater, but also in brackish water near coasts and inland, a few species even preferring this habitat. *N. malesiana* is the only species which is preferring streams and ponds in forests. The others are all found in eutroph waters. According to SUNIER (Treubia 2, 1922, 190) *N. indica* is usually found in freshwater sites but occurs in the brackish fish-ponds near Djakarta with a salinity of up to 32 ‰. *N. browniana* seems almost confined to coastal brackish water and is found inland only in the saline water of the Kuwu mudwells, SE of Semarang, as the only aquatic represented there. Further *N. marina* var. *zollingeri* is confined to the alkaline waters of Batur Lake, in Bali, with a rather high content of dissolved minerals. Stems and leaves of *Najas* are not seldom found encrusted with calcium which adds to their brittle nature. Some species are resistant to rather hot water, e.g. *N. tenuifolia* ssp. *pseudograminea* var. *pseudograminea* which is found in the craterlake of Mt Kelud, Central Java, on black mud in water of 60° C; this water contains the usual large amount of minerals in solution common in craterlakes, further sulphates, sulphides, Ca and Mg compounds, etc. BRANDIS recorded *N. graminea* from a hot spring in Burma in water of 92° F, and the first record of it in England was from hot water emitted by a factory (J. Bot. 22, 1884, 326). HERMANN recorded *N. marina* from hot springs in America (Leafl. West. Bot. 1, 1935, 182).

As to depth *Najas* species are adapted to shallow waters; during the German Limnological Sunda Expedition the greatest depth at which *Najas* occurred was fixed at c. 5 m, but these specimens proved all to be sterile (cf. VAN STEENIS, Arch. Hydrobiol. Suppl 11, 1932, 240, 271).

The relatively rare occurrence of *N. marina* in Malaysia and in many parts of its almost ubiquitous range as well, points to a sensitive and selective ecology rather than to random chance dispersal by aquatic birds, especially in connection with its radiation into geographical varieties of sometimes restricted areas. The phenomenon is also found in *Hydrocharitaceae* and *Alismataceae* (cf. Fl. Mal. I, 5, 1957, 317). In checking localities it has appeared that generally one lake seems to have only one species; *N. indica* in Toba, Ranau, Situ Bagendit, Singkang, and Gorontalo lakes, *N. graminea* var. *graminea* in Situ Gunung, Matana & Towuti lakes, *N. tenuifolia* ssp. *pseudograminea* var. *pseudograminea* in Kelud and Rawa Bening (Kediri) lakes, and the same holds for *N. browniana* and the three varieties of *N. marina* which are all found in one lake only, with no other species present. The only exception is Tondano lake, in NE. Celebes in which according to the data on the labels three species have been collected, viz *N. graminea* var. *graminea*, *N. indica*, and *N. tenuifolia* ssp. *pseudograminea* var. *celebica*.

As to altitude most species and localities prefer the lowland areas, but *N. marina* goes up to 1000 m, and several others are found in Toba Lake, 900 m, Tondano Lake, 700 m, Kelud Lake, 1000 m, the highest altitude recorded being 1400 m. In the Himalayas Malaysian species are recorded to over 2000 m.

As to climate none of the species shuns the seasonal areas, and some seem often to be more abundant in them than in everwet areas which may again point to preference for eutroph water.

*Flower biology.* Pollination takes place in submerged condition, but there are no detailed actual observations in Malaysia. The stalk of the anther elongates at maturity pushing the anther, either laterally or terminally, beyond the spathe (if there is any), then sometimes recurving. The pollen grains are either globular or ellipsoid and contain much starch; an exine is absent; they escape from the top of the anther through a hole between the two lobes which diverge. MAGNUS (in E. & P. Pfl. Fam. 2, 1, p. 216) stated that the pollen of *N. marina* germinates before leaving the anther. This has also been observed in other species by MIKI (Tokyo Bot. Mag. 49, 1935, 774, fig. 6 G, P). The pollen tube facilitates of course floating and will increase the chance to fasten to a stigmatic arm of the ♀ flower. Through this mechanical way, without aid of water animals, pollination must take place. As *Najas* mostly grows gregariously the distance between ♂ and ♀ flowers is not large, and small movements in the water may effect contact of pollen and stigmas.

Though in a few instances two species are growing in the same locality and are found mixed in collections they retain their specific characters well and I have not found any trace of hybridization.

*Morph.* The leaves of *Najas* are essentially subopposite, but appear to be placed in pseudowhorls of 3 or more. This phyllotaxis originates as follows: The sheath of the not fully amplexicaulous lower leaf of each pair imbricately overlaps the fully amplexicaulous sheath of the upper one. Only the lower leaf bears an axillary bud growing into a lateral branch. The first internode of this lateral branch is extremely short and its first node becomes in this way almost sessile; it bears a leaf pair, but of this pair only the upper one is developed as a real leaf which forms together with the 2 leaves of the main stem the pseudowhorl of three. The lower leaf of the first node is very much reduced; according to MAGNUS (1870, 1894) it is, in vegetative shoots, represented by a very small scale bearing a vegetative bud in its axil, whereas in fertile lateral shoots a flower occupies the place of this scale. Fig. 1b-c.

The flower would, therefore, be homologous with a scale plus its axillary bud. It has appeared that a fully developed flower of many *Najas* species is surrounded by a spathe (fig. 2d, 2f) and from the

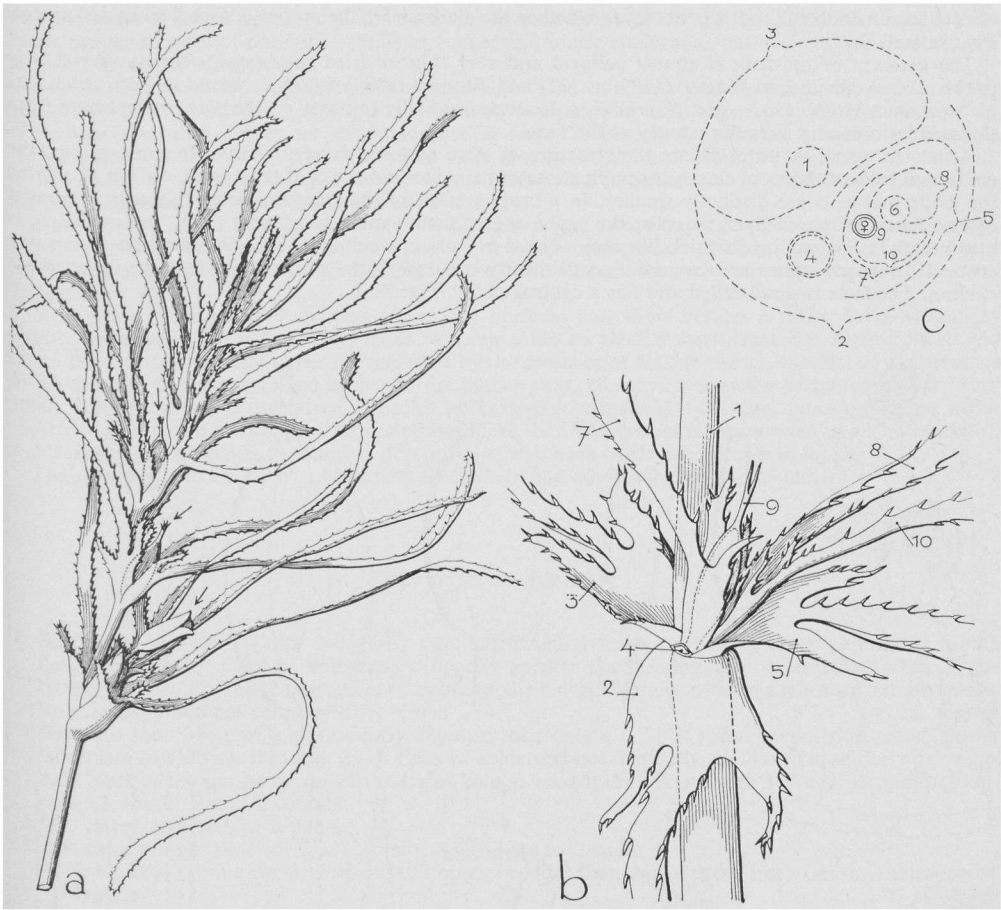


Fig. 1. *Najas tenuifolia* ssp. *pseudograminea* (W. KOCH) DE WILDE var. *pseudograminea*. a. Habit (arrows pointing to an open and 2 closed ♂ flowers respectively),  $\times 5$ , b. situation at a node in which the lowest leaf has been recurved and one flower removed,  $\times 15$ , c. diagram with identical signatures as in b:—1. main axis of stem, 2. lower leaf of a pair, 3. upper leaf of the pair, 6. axis of shoot in axil of lower leaf, bearing: 4. flower (removed here) either ♂ and enveloped by spathal bract or ♀ and naked, representing lower fertile leaf of lateral shoot, and 5. leaf opposite 4, representing upper leaf of the lowest pair of lateral shoot, 6–7–8–9–10 a repetition on the next node of the lateral shoot of 1–2–3–4–5 on the node of the main axis. This drawing represents an average situation; it can be more complicated if the lower leaf pairs on axillary shoots are reduced to mere bracts. Sometimes 2, 3, and 5 form a pseudowhorl of three leaves which is always represented on sterile nodes; in this figure 2, 3, 5, 7, 8, and 10 form a pseudowhorl of six leaves (BACKER 7903).

homology it would appear that the spathe is not representing a perianth but a tubular reduced leaf, and must be understood as homologous with the scale found in its place in vegetative shoots. I have been able to find an almost complete series of transitions between an open scale and a fully closed bottle-shaped spathe (DE WILDE, 1961) and believe to have proved this homology.

In a few cases there are more flowers together with one whorl at a node. As these flowers are always different in size, hence in age, the situation can be explained in that more than one node of the lateral shoot is reduced in a similar way as the first one. This follows also from the fact that the number of leaves of the pseudowhorl may be up to 5 or more in exceptional cases.

In the ♂ flower the anther is tightly surrounded by a very thin membrane which, in *N. marina*, consists of only 2 cell layers. According to MAGNUS (1870, p. 23; 1894, p. 216) this envelope is practically ad-

nate to the anther and ends in two more or less thickened lobes. Whether this would represent a 'perianth' seems doubtful and it is not clear whether the stalk under the anther is a pedicel or a filament. Fig. 2c and 2e.

The pericarp of the fruit is almost pellucid and very thin in dried specimens, clinging very closely to the seed. According to BAILEY (1884, p. 322) and RENDLE (1899, p. 385) it would in fresh specimens be "succulent" in *N. marina* and *N. graminea*. It seems gradually to decay on the plant or separates from the seed by breaking irregularly away at the base.

Anat. As usual in water plants the structure of stem and leaf is very simple. In most species the epidermal cells of the stem closely resemble those of the underlying cells of the cortex, only in *N. marina* the epidermal cells are distinctly smaller. In a cross section of the stem the cortex appears to consist of two layers of parenchymatic cells; the outer one is always more cell layers thick, the inner one is also mostly a few cell layers thick but may consist of only one cell layer (the endodermis). These two cortical layers are connected by radial septa mostly one cell thick, which separate large intercellular cavities. The stele is small-celled and has a central cavity. Fig. 2a-b.

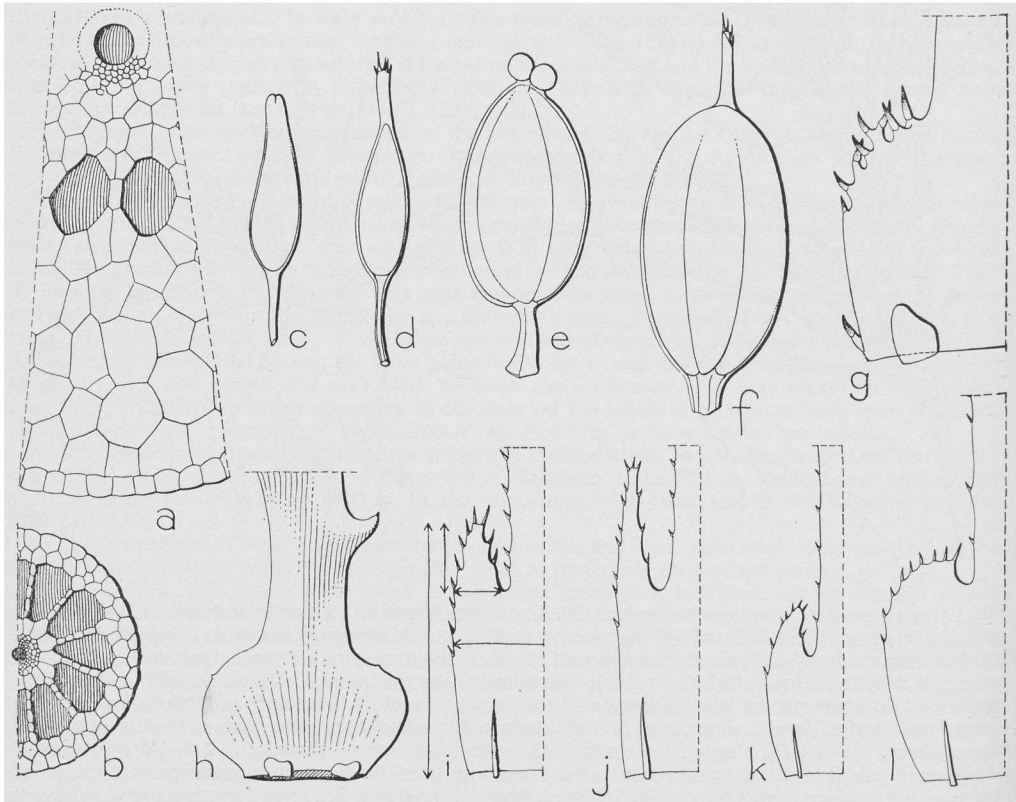


Fig. 2. Details of *Najas*. a. Partial cross-section of stem of *N. marina* var. *zollingeri* RENDLE, b. ditto of *N. kurziana* RENDLE, c. naked ♂ flower, anther 1-celled, of *N. malesiana* DE WILDE, d. spathe ♂ flower, anther 1-celled, of *N. browniana* RENDLE, e. naked ♂ flower, anther 4-celled, of *N. graminea* DEL. var. *graminea*, 'perianth lobes' extraordinarily conspicuous, f. spathe ♂ flower, anther 4-celled, of *N. tenuifolia* ssp. *pseudograminea* (W. KOCH) DE WILDE var. *pseudograminea*, g. half a sheath of *N. marina* var. *sumatrana* DE WILDE, no auricle, squamulae intravaginalis irregularly quadrangular, h. leaf base of *N. marina* L. var. *marina*, ditto, i. half a sheath of *N. tenuifolia* ssp. *pseudograminea* var. *celebica*, (KOORD.) DE WILDE, arrows indicate how and where length and width of auricles and sheath have been measured, squamulae intravaginalis linear, j. ditto of *N. graminea* DEL. var. *graminea*, k. ditto of *N. malesiana* DE WILDE, l. ditto of *N. indica* (a-b  $\times 50$ , c-f  $\times 25$ , g  $\times 10$ , h  $\times 5$ , i-l  $\times 10$ ; a RUTTNER 313, b VAN STEENIS 18226, c MEIJER 5772 (type), d HORSFIELD s.n., e EYMA 3329, f THUNG s.n. (isotype), g JACOBSON s.n. (type), h JENSEN 298, i KOORDERS 17347 (type), j SUNIER s.n., k CLEMENS 9699, l LÖRZING 11067).

The leaf shows in cross section a midrib consisting of small cells covered above and beneath by one to two layers of larger cells and is on both lateral sides accompanied by an intercellular cavity. The blade proper consists of only two cell layers (upper and under epidermis), but has additional subepidermal cell layers in *N. marina*.

**Taxon.** The genus is very coherent in structure and I have followed A. BRAUN (1864) and K. SCHUMANN (1894) in not accepting subgenera, but merely two sections; *sect. Najas* contains only one species, *N. marina*; the other species are accommodated in *sect. Caulinia*. RENDLE found it useful to subdivide his subgenus *Caulinia* into 4 'sections' which were mostly defined according to the presence or absence of the spathe in one or both sexes. I have found (1961) that this character is variable and I have consequently refrained from accepting this subdivision.

**Uses.** According to SUNIER (Treubia 2, 1922, 222) *Najas*, which is profusely found in brackish fishponds (tambaks) near Djakarta, may be important as a source of food for fish. From the Toba Lake it is reported that *Najas* can be utilized as pig food, a use it shares with many other water plants (BACKER, Teysmannia 1911, p. 514).

**Notes.** As the vegetative characters are very uniform and show besides a rather large variability within one species, it has been impossible to frame a key to identify sterile material. Collectors should try to select fertile material either recognizable by the presence of fruit in the lower axils, or the presence of a yellowish or reddish tinged anther in the higher axils. In some species the sexual organs are very small. Dissection and examination of boiled herbarium specimens is a delicate, time-consuming work.

Attention is called to the fact that sometimes more than one species is represented in a single habitat. Measurements of leaves as found in descriptions have been made as is shown in fig. 2i.

Thanks are due to Dr. P. W. LEENHOUTS whose help and advice I have appreciated.

#### KEY TO THE SPECIES

1. Seed (3½–)4–4½(–7½) by 2–2½(–3) mm. Intravaginal scales up to 1½ times as long as broad, fleshy (fig. 2g–h). Cells of epidermis distinctly smaller than underlying cortex cells. Neck of the spathe (only in ♂ fl.!) up to twice as long as broad, the margin without or with a few very minute spines. Internodes sometimes dentate. **SECT. NAJAS** . . . . . 1. *N. marina*
1. Seed less than 3½ mm long, if nearly 3½ mm then only c. 2/3(–¾) mm broad. Intravaginal scales lanceolate to filiform, thin (fig. 2i–l). Cells of epidermis not distinctly smaller than underlying cortex cells. Neck of the spathe more than twice as long as broad, the margin with 3–9 distinct spines. Internodes smooth. **SECT. CAULINIA**.
2. ♂ Flower enclosed in a spathe.
3. Mature anther 1-celled, 1/3–1¾ mm. Spathe up to 2 mm.
  4. Seeds 2½–3 mm long; areoles of testa much broader than long (ladder-like). Leaves often coarsely dentate . . . . . 2. *N. minor*
  4. Seeds up to 2 mm long; areoles of testa about isodiametrical. Leaves not coarsely dentate.
  5. Seeds 1–1.2 by 1/3–0.4 mm. Spathe 0.9–1.2 mm. Blade with (30–)50–60 spines on each side. Auricles mostly long-triangular, ½–0.8 mm long . . . . . 3. *N. kurziana*
  5. Seeds 1½–2 by ½–¾ mm. Spathe 1½–2 mm long. Blade with 12–21 spines on each side. Auricles mostly short triangular, up to ½ mm long . . . . . 4. *N. browniana*
3. Anther 4-celled, when mature 1½–2¼(–2½) mm. Spathe 2–3¾ mm long.
6. Auricles (0–)0.2–0.6(–1) mm long, mostly broader than long, the inner edge without spines. Leaf-blade flat to nearly terete or triangular in cross-section, with 1–30(–40) spines on each side, sometimes moreover with one or more dorsal spines. Fruits solitary. Seeds ¾–0.9 mm broad. Cavities at least half as wide as the leaf-halves, their outer edge not brown. Marginal spines well visible with the naked eye . . . . . 5. *N. indica*
6. Auricles 0.6–1.6(–3) mm long, longer than broad, the inner edge with (0–)1–4 spines. Leaf-blade flat, with 15–60(–70) spines on each side, dorsally always spineless. Fruits solitary or 2(–3) together. Seeds up to ¾ mm broad; cavities variable in width, from very narrow to nearly reaching the margin. Marginal spines (mostly) just visible with the naked eye . . . . . 6. *N. tenuifolia*
2. ♂ Flower not enclosed in a spathe.
7. Auricles less than twice as long as broad, up to 1.1 mm long. Anther 1-celled, when mature 0.6–1 by 0.15–0.3 mm. Seeds 1–1.8 by (0.35–)0.4–0.6 mm; testa with 16–22(–26) longitudinal rows of 24–30 areoles. Leaves 1¼–2½ cm, with (10?–)20–30(–50?) spines along each side. Plant slender, up to 15 cm high . . . . . 7. *N. malesiana*
7. Auricles at least twice as long as broad, 1–5½ mm long. Anther 2- or 4-celled, when mature 1.2–2 by 0.4–1 mm. Seeds 1.8–2.7 by 0.6–0.9 mm (if less than 2 mm long then broader than 0.6 mm and with more than 25 longitudinal rows of areoles). Testa with 20–34 longitudinal rows of 30–45 areoles. Leaves 1¾–6 cm, with 40–185 spines along each side. Plant slender to rather coarse, up to 50(–75) cm high . . . . . 8. *N. graminea*

1. Section *Najas*

*Sect. Eunajas* A. BRAUN, J. Bot. 2 (1864) 275; ASCHERS. Fl. Prov. Brand. 1 (1864) 669 (status not mentioned).—*Subg. Eunajas* ASCHERS. ex RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 389; Pfl. Reich Heft 7 (1901) 7.

Mostly coarse plants. Epidermis distinctly differentiated by smaller cells from the underlying cortex. Internodes often spiny. *Leaves* up to 12(–15, very rarely more) times as long as broad, mostly fleshy, coarsely dentate along the margin and mostly on (or near) either side of the lower portion of the midrib; marginal teeth up to *c.* 15 (very rarely more) on each side. *Sheath* with or without inconspicuous auricles. Intravaginal scales less than twice as long as broad, blunt, often asymmetrical, fleshy (fig. 2g–h). Dioecious. ♂ *Flowers*: spathe constricted into a short (up to twice as long as broad), (sub)cylindrical neck, the margin without, or with a few, very minute spines; anther 4-celled. ♀ *Flowers* espathaceous, bearing (2–)3(–4) stigmas. Seed 3–7½ by 2–3 mm; testa consisting of more than three layers of hardened cells. Areoles often unequal in size, not distinctly arranged in longitudinal rows.

Distr. Monotypic, ubiquist.

1. *Najas marina* LINNÉ, Sp. Pl. (1753) 1015, *incl. var. β et γ*; K. SCH. in Mart. Fl. Bras. 3, 3 (1894) 723, t. 123 f. 2; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 389, t. 39 f. 1–30; *ibid.* (1900) 437; Pfl. Reich Heft 7 (1907) 7, f. 1 A–C, 3 A–Q.—*N. major* ALL. Fl. Ped. 2 (1785) 221; BENTH. Fl. Austr. 7 (1878) 181; HOOK. f. Fl. Br. Ind. 6 (1893) 569; KOORD. Exk. Fl. 1 (1911) 91; MIKI, Bot. Mag. Tokyo 49 (1935) t. 8 f. E–I.—Fig. 2a, g–h, 3.

Plant up to *c.* 70 cm, lower internodes 3–8 cm by 0.9–2.6 mm, glabrous to very spiny. *Leaves* ½–4½ cm by 1½–3½ mm, flat, sometimes triangular in section, almost always fleshy; tip acute to blunt (blade *c.* 3 mm below the tip 1.8–3 mm wide); margin on either side with 5–12(–40) spiny teeth; dorsal surface sometimes without, often with 1–6(–40) spines; teeth up to long triangular or conical; up to as long as the width of the blade; spine cells 0.05–0.15 mm, brownish; midrib *c.* 0.1 as wide as the blade, cavities occupying up to ¾ of the leaf-width, septa indistinct. *Sheath* on either side (without or) with 1–5(–10), mostly inconspicuous spines, 2–6½ by 3–9 mm; auricles absent or up to *c.* 0.2 mm long. *Flowers* solitary. Spathe of ♂ *flower* (in Mal. unknown) *c.* 4½ mm long (Kashmir specimens); neck about cylindrical, 0.3–0.5 mm, edge somewhat lobed, sometimes with (?3) spines; anther 4-celled, *c.* 3½ by 2½ mm; ‘perianth lobes’ rather indistinct; ‘pedicel’ *c.* 0.5 mm, in anthesis longer. Spathe in ♀ *flower* absent; ♀ fl. 1.9–3.8 mm, ovary 0.8–1.2 by 0.6–0.8 mm, style 0.2–0.8 mm, with 2–4 stigmas 0.9–2 mm. *Seeds* (asymmetrical) elliptical to ovate, narrowing to the tip, somewhat compressed, (3½–)4–4.4(–7) by (2–)2.4–2.6 mm; testa shiny with rather irregularly arranged ± isodiametrical, 5–6 angular, unequal-sized areoles.

This ubiquitous species has been split up into a large number of varieties, three of which occur in Malaysia.

## KEY TO THE VARIETIES

1. Leaves 15–25 times as long as broad, flat and thin, (when dry) more or less pellucid. Stem densely dentate; leaf margin with 30–40 slender spiny teeth, ¾–1 mm long, on either side. Style narrow, longer than ½ mm *var. sumatrana*
1. Leaves less than 15 times as long as broad, somewhat fleshy, opaque. Stem smooth; leaf margin with up to 12 broad triangular (conical) spiny teeth on either side. Style thick, up to ½ mm long.
2. Leaves 3–4½ cm by 3–3½ mm; widest in the middle of the blade. Leaf margins each with (5–)8–10(–12) teeth, on the dorsal surface rarely with 1 tooth. Leaf sheath (4–)5–6½ by 7–9 mm. . . . . *var. zollingeri*
2. Leaves up to 3 cm by 3 mm, mostly broadest above the middle. Leaf margins each with (2–)4–7 teeth; dorsal surface with (0–)2–6 teeth. Leaf sheath up to 3.7 by 5.6 mm.

*var. marina*

*var. marina*.—*N. major β angustifolia et ε intermedia* A. BRAUN, J. Bot. 2 (1864) 275, 276.—*N. marina var. angustifolia et intermedia* RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 395, 439, t. 39 f. 13, 28, 14 *et* 29; *ibid.* (1900) 439; Pfl. Reich Heft 7 (1901) 8, f. 3 E, O, F, P.—*N. intermedia* GORSKI, Eichw. Nat. Skizze Lithauen (1830) 126, *non vidi*.—Fig. 2h.

Plant up to 30 cm, lower internodes up to 6 cm by (1.1–)1½–2(–2½) mm. *Leaves* linear or slightly spathulate, (½–)1–2½(–3) cm by 1½–2¾ mm, *c.* 3 mm below the tip 2–3 mm wide, flat to triangular in section, somewhat fleshy; apex blunt, rarely acute; margin on either side with (2–)4–7 coarse spiny teeth, up to the lower 7 mm sometimes without teeth; dorsal surface mostly with 1–6 spiny teeth, rarely unarmed; teeth (long) triangular to conical, up to as long as the width of the blade; spine-cells *c.* 0.05 mm or smaller, brown; cavities

often indistinct, occupying  $\frac{1}{2}$ – $\frac{3}{4}$  of the leaf-width. *Sheath* on either side with 1–2 inconspicuous ( $< 0.05$  mm) spines, 2–3.7 by 3–5.6 mm; auricles absent. Spathes of ♂ *flower* c. 1.8 mm, tip with c. 3 small hyaline spines c. 0.1 mm; anther 4-celled, elliptic c. 1 by 0.7 mm; 'pedicel' c. 0.5 mm. ♀ *Flower* 1.9–2.7 mm; ovary 0.7–1 by 0.7–0.8 mm; style 0.2–0.5 mm by 0.25–0.3 mm, with 2–3 stigmas 0.9–1.3 mm. No seeds present.

*Distr.* According to RENDLE this variety is very widely distributed, from NW. Europe to West Australia, Japan, and the Sandwich Is, in *Malaysia*: South Moluccas (Kei Is). In this area there are wide gaps. Fig. 4.

*Note.* The anther I have observed in this material, the only one I saw of *N. marina* in Malaysia, is far too small for the species and is in my opinion not normally developed. This deserves further field study.

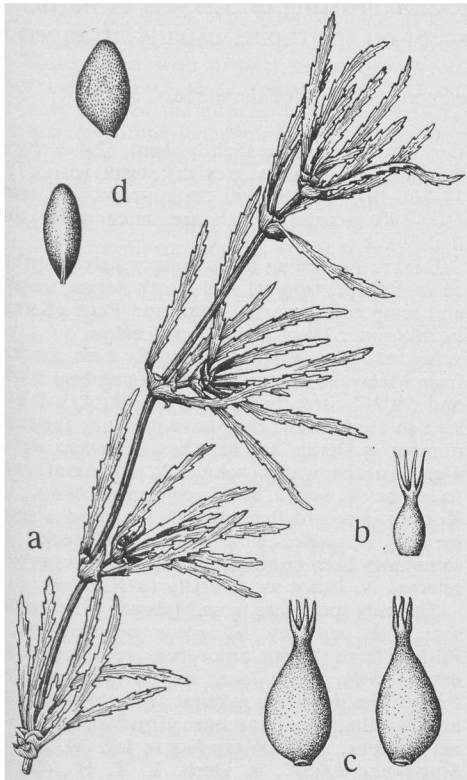


Fig. 3. *Najas marina* L. var. *zollingeri* RENDLE. a. Habit,  $\times 3/5$ , b. ♀ flower, c. fruits, d. seeds,  $\times 3$ .

var. *zollingeri* RENDLE, Trans. Linn. Soc. II, Bot. 5 (1900) 438–439; Pfl. Reich Heft 7 (1901) 7; STEEN. Arch. Hydrobiol. Suppl. 11 (1932) 271, 272, f. 2; RUTTNER, l.c. 374, tab. II.—Fig. 2a, 3.

Up to c. 70 cm, lower internodes up to c. 8 cm by 1.2–2.6 mm, glabrous. *Leaves* linear-lanceolate,  $3\frac{1}{2}$ – $4\frac{1}{2}$  cm by 2.9–3.6 mm, c. 6 mm below

the tip c. 2.5 mm wide, flat, fleshy; apex acute, rarely blunt; margin on either side with (5–)8–10 (–12) coarse, spiny teeth, up to the lower 3 mm sometimes without teeth; dorsal surface without or with 1 tooth; teeth triangular, up to as long as  $\frac{1}{3}$  of the width of the blade; all spine-cells c. 0.1 mm, brown; cavities as wide as to twice as broad as the midrib. *Sheath* on either side with 2–5 inconspicuous spines, 5–6(– $6\frac{1}{2}$ ) by 7–9 mm; auricles absent or up to 0.2 mm long. ♂ *Flowers* not seen. ♀ *Flowers* 2.5–3.8 mm; ovary 0.8–1.2 by 0.6–0.8 mm; style 0.2–0.5 by 0.2–0.4 mm, with 2–4 stigmas 1.6–2 mm. *Seeds* 4–4.3 by 2.4–2.6 mm.

*Distr. Malaysia*: Lesser Sunda Islands (Bali: Batur Lake). Fig. 4.

*Ecol.* Gregarious along the sandy shore, at c. 1030 m. The water of Lake Batur is alkaline and contains a high percentage of dissolved minerals.

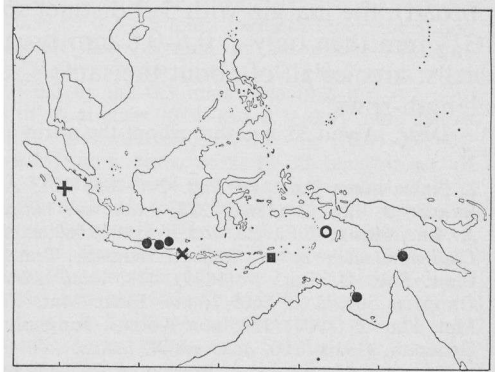


Fig. 4. Malaysian localities of *Najas marina* var. *marina* (O), var. *sumatrana* DE WILDE (+), var. *zollingeri* RENDLE (x), *N. browniana* RENDLE (•), *N. kurziana* RENDLE (■).

var. *sumatrana* DE WILDE, Act. Bot. Neerl. 10 (1961) 169.—Fig. 2g.

Up to 70 cm, lower internodes 3–7 cm, by 0.9–1.4 mm, densely set with prickles (15–20 per 2 mm stem), more densely on (and just below) the nodes. *Leaves*  $3\frac{1}{2}$ – $4\frac{1}{2}$  cm by 2– $2\frac{1}{2}$  mm, flat and thin, apex acute (to slightly obtuse), c. 3 mm below the tip c. 1.8 mm wide. Margin on either side with 30–40 conspicuous spiny teeth, often up to the lower 2 mm unarmed; dorsal surface with as much spines as along one margin, mostly on the midrib; spine-cells c. 0.15 mm, situated on several brown cells, all together  $\frac{1}{4}$ –0.4 mm; all spines (dark) brown; the whole tooth c. conical,  $\frac{3}{4}$ –1 mm,  $\frac{1}{3}$ – $\frac{1}{4}$  as wide as the blade; cavities often indistinct, as wide as the midrib. *Sheath* 3– $3\frac{1}{2}$  by 4– $4\frac{1}{2}$  mm, on either side of the margin with 7–10, on the upper  $\frac{1}{3}$  of the dorsal surface with numerous spines; auricles absent. ♂ *Flowers* not seen. ♀ *Flowers*  $2\frac{1}{2}$ –3 mm; ovary c. 1 by 0.6 mm; style 0.6–0.8 by 0.1 mm, with 2–3 stigmas c. 1.2 mm. *Seeds* greyish-brown, 4– $4\frac{1}{2}$  by  $2\frac{1}{2}$  mm.

*Distr. Malaysia*: West Central Sumatra (Lake of Maninjau), c. 500 m. Fig. 4.

2. Section *Caulinia*

A. BRAUN, J. Bot. 2 (1864) 276; ASCHERS. Fl. Prov. Brand. 1 (1864) 67 (status not mentioned).—*Caulinia* WILLD. Mém. Ac. R. Sc. Berl. (1798) 87.—*Subg. Caulinia* ASCHERS. ex RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 398; Pfl. Reich Heft 7 (1901) 10.

Mostly slender plants. Epidermis not distinctly differentiated from the underlying cortex. Internodes smooth. *Leaves* usually much more than 15 times as long as broad, mostly thin, (mostly) finely dentate along the margin and rarely so on the lower portion of the midrib, with (0–)10–80(–180) spiny teeth on either side. *Sheath* mostly with distinct auricles. Intravaginal scales lanceolate to filiform, thin (fig. 2i–l). Monoecious. ♂ *Flowers* with or without spathe. Anther either 1 or (2-, or) 4-celled. ♀ *Flowers* mostly without spathe, stigmas 2(–3); spathe tapering to the top, or constricted into a long cylindrical neck (more than twice as long as broad), the margin with 3–9 distinct spines. *Seed* less than 3½ mm long, if nearly 3½ mm then only c. 0.6–0.8 mm broad; testa consisting of 3 layers of hardened cells; areoles all of about the same size, except on the raphe, usually arranged in length-rows.

Distr.. About 35 spp. throughout the warm and temperate regions of the globe.

2. *Najas minor* ALL. Fl. Ped. 2 (1785) 221; A. BRAUN, J. Bot. 2 (1864) 277, *excl. var. indica* A. BR.; HOOK. f. Fl. Br. Ind. 6 (1893) 569, *excl. Caulinia indica et N. indica*; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 413, *excl. stirp.* GRIFFITH 5609/5 & 5609/7; *non* RIDL. Mat. Fl. Mal. Pen. 2 (1907) 129; *non* KOORD. Jungshuhn Gedenkb. (1910) 160, *quae est N. indica*.

Up to c. 25 cm, lower internodes 2–5 cm by ½–1 mm. *Leaves* (1–)1¼–2(–3) cm by 0.4–0.6 (–0.7) mm, flat, sometimes subterete or triangular in section; apex acute to slightly obtuse (blade c. 3 mm below the tip 0.3–0.35 mm wide); margin on either side with (5–)7–15(–17) mostly conspicuous spiny teeth, up to the lower 3 mm often unarmed; dorsal surface sometimes with some spines (*cf.* RENDLE); all spines (dark) brown; spine-cells (0.075–)0.15(–0.2) mm; teeth up to as long as half (in the upper portion of the blade as long as) the width of the blade; midrib c. 0.1 as wide as the blade; cavities occupying half to almost the entire width of the blade, often with distinct septa. *Sheath* 1½–3(–3.5) by 1½–3 mm, on either side with 5–10(–15?) spines, the inner side of the auricle unarmed; auricles (*excl.* spines) broad to very broad triangular, truncate to rounded, (0.1–)0.2–0.5 by 0.3–0.7 mm, often shallowly lobed or lacerate. ♂ *Flowers* (mostly?) solitary, enclosed in a spathe 1½–2 mm; above the anther a conical(–cylindrical) neck 0.3(–0.4) mm, tip almost truncate or (slightly) oblique, often somewhat lacerate; anther 1-celled (? see notes), oblong, often somewhat constricted towards the top, 0.8–1.3 by 0.3–0.4 mm; ‘perianth lobes’ inconspicuous; ‘pedicel’ 1/3–2/5 mm, in anthesis 1½–2 mm. ♀ *Flowers* without spathe, often 2(–3) together, in different stages; 1.9–2.3(–2.5) mm; ovary 0.7–0.8 by c. 0.35 mm; style 0.4–0.6 mm, with 2 stigmas 0.6–1 mm. *Seeds* narrow-oblong,

the top sometimes slightly bent, 2.4–3 by c. 0.6 mm; (sometimes greyish); testa with (12–)14–16(–19), ladder-like, length-rows of many (100–150) areoles, which are much wider than high.

Distr. According to RENDLE widely distributed in Europe, tropical and North Africa, tropical and temperate Asia to Japan and Pegu (KURZ), in *Malaysia*: ?Java (Bogor), see below.

Notes. *N. minor* has repeatedly been reported from Malaysia. The two GRIFFITH numbers 5609/5 and 5609/7 cited by RENDLE and RIDLEY I have seen in Herb. Kew; they have no fruit; the latter number is sterile, the first has ♂ flowers with a 4-celled anther which excludes *N. minor*, but points to either *N. indica* or *N. oguraensis* MIKI. The KOORDERS record from Java is based on a specimen of *N. indica* with which this species has sometimes been confused, specially by those who referred *N. indica* as a variety to *N. minor*.

The only specimens from Malaysia which represent with certainty *N. minor* were raised at Zürich from “Schlammproben von Buitenzorg mit *Hydrilla verticillata*, im Gewächshaus von Prof. Ernst in Zürich gekeimt 1933; 1934 von mir im Warmhaus weitergezogen; fruchtend eingelegt am 3. Febr. 1935. WALO KOCH. leg. M. ERNST-SCHWARZENBACH”, in Herb. E. T. H., Zürich.

It is most remarkable that nobody has collected *N. minor* in Buitenzorg or vicinity where so many collections have been made. If these ERNST samples were extracted from the small concrete water-plant tanks in the Botanic Gardens, there is every reason to assume contamination with imported water plants. Contamination with foreign seed could possibly also have happened at Zürich. For the present *N. minor* seems very doubtfully native in Malaysia.

A closely related species is *N. oguraensis* MIKI,



Bot. Mag. Tokyo 44 (1935) 775, t. 7 A-L, which was described from Japan as a rigid plant up to 1 m long with seeds c.  $3\frac{1}{2}$  by 0.6 mm and 4-celled anthers c.  $1\frac{3}{4}$  mm long. I have seen plants from India with a slender habit, seeds (2-)3- $3\frac{3}{4}$  mm and large 4-celled anthers  $1\frac{1}{4}$ - $1\frac{3}{4}$  by  $\frac{3}{4}$  mm which thus come very close to the Japanese species and could well belong to it (Herb. Persoon, in L; SAXTON 491, in K; STEWART 3347, in K).

3. *Najas kurziana* RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 413, t. 41 f. 116-121; Pfl. Reich Heft 7 (1901) 15, f. 4 U; HORN AF RANTZIEN, Kew Bull. (1952) 37.—Fig. 2b.

Up to 15 cm, lower internodes 1-2 cm by 0.5-0.7(-0.8) mm. Leaves  $1\frac{1}{2}$ -2 cm by 0.45-0.95 mm, flat (and thin), apex rounded to obtuse (blade c. 3 mm below the tip 0.4-0.7 mm in width); margin on either side with 30-60 inconspicuous teeth, mainly consisting of the spine-cell, dorsal surface unarmed; spine-cells 0.05-0.1 mm, all (dark) brown; midrib 0.07-0.05 as wide as the blade, cavities occupying 0.1- $\frac{1}{2}$  of the width of the blade, often with distinct septa. Sheath on either side with (3-)5-12 spines, often 1-3 on the inner edge of the auricle, 1.7-2.4 by 1.3-2.2 mm; auricles (broad-)triangular to long-triangular, subentire, tip obtuse or more or less rounded, (0.2-)0.5-0.8 by 0.3-0.5 mm. Flowers mostly up to 5 together, in different stages, often with 1 male, or male solitary. Spathe of ♂ flower 0.9-1(-1.2) mm, neck mostly cylindrical, 0.3-0.4(-0.5) mm, tip almost truncate, entire to slightly lobed; anther 1-celled, oblong, (0.3-)0.4-0.7(-1) by (0.1-)0.15-0.25 mm; 'perianth lobes' inconspicuous. 'Pedicel' 0.1-0.2(-0.3) mm, in anthesis c. 0.8 mm. ♀ Flowers espathaceous, c. (1-)1.4 mm; ovary c. (0.4-)0.5 by 0.2 mm; style 0.3-0.5 mm, with 2(-1) stigmas 0.3-0.4 mm. Seeds 1-1.2 mm by 0.35(-0.4) mm; testa with 16-18 length-rows of 18-26 subquadrate or 5-6-angular areoles.

Distr. India (North Bengal between Kishenganj and Oolabena, KURZ s.n. in CALC & BM, once found), in Malaysia: Lesser Sunda Islands (Port. Timor: in Irabère R., near Uato Carabao, c. 400 m alt., VAN STEENIS 18226), once found. Fig. 4.

Notes. The Timorese collection differs from the holotype only in having c. 50-60 spiny teeth on each leaf margin (in the type there are 30-34).

According to HORN AF RANTZIEN (Kew Bull. 1952, 35-37, t. 3) the African *N. hagerupi* H. a. R. is very closely allied, the only difference being in the anther which is 1.2-1.4 mm long; its fruit is unknown.

4. *Najas browniana* RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 420, t. 42, f. 163-167; Pfl. Reich Heft 7 (1901) 17, f. 5 J.—Fig. 2d.

Up to 15 cm, lower internodes 1-3(-6) cm by 0.5-0.8(-0.9) mm. Leaves  $1\frac{1}{2}$ - $2\frac{1}{4}$  cm by (0.35-)0.4-0.7(-0.8) mm, flat, sometimes slightly fleshy, apex obtuse to rounded, sometimes acute (c. 3 mm below the tip 0.25-0.6 mm wide); margin

on either side with 12-21 spiny teeth largely in the upper portion of the blade; no spines on the dorsal surface; spine-cells < 0.05-0.15 mm, (dark) brown; teeth up to as long as 0.2 of the width of the blade; midrib c. 0.07 as wide as the blade; cavities occupying  $\frac{1}{4}$ - $\frac{3}{4}$  of the width of the blade, septa often indistinct. Sheath on either side with (1-)3-7(-10) spines, no (?) spines on the inner edge of the auricle, (1.5-)2(-2.3) by 1.5-2.9 mm; auricles mostly broad, seldom long-triangular, truncate-rounded to acute, sometimes acuminate, rarely falcate, (0.1-)0.2-0.3(-0.5) by 0.25-0.75 mm, entire to lobed or lacerate (incisions up to halfway (or more) the auricle). Flowers mostly up to 3 together, in different stages, together with one male<sup>1</sup>, or the male solitary. ♂ Flowers: spathe 1.3-2 mm, neck almost cylindrical, 0.3-0.5 mm, the tip almost truncate, entire to lacerate; anther 1-celled, ovate to oblong(-lanceolate), 0.6-0.8 (-0.9) by 0.2-0.3 mm; 'perianth lobes' indistinct; 'pedicel' 0.3-0.6 mm, at anthesis 1- $1\frac{1}{2}$  mm. ♀ Flowers: spathe absent; ♀ fl.  $1\frac{1}{2}$ -2 mm; ovary 0.5-0.8 by 0.2-0.3 mm; style (0.2-)0.5-0.7 mm, with 2 stigmas (0.3-)0.5-0.7(-0.9) mm. Seeds (1.5- and narrow) 1.6-2 by (0.45-)0.5-0.7 (-0.75) mm, testa with 18-30 length-rows of 27-37 subquadrate or 5-6-angular areoles.

Distr. India (once found) and Northern Territory of Australia (Cavern I.), in Malaysia: Java (SE of Semarang: Kuwu mudwells; Surabaya: Keputih tambaks; Madura I.), S. New Guinea (coast between Oriomo and Fly R.). Fig. 4.

Ecol. In the Kuwu saline mudwell area the only aquatic water plant, near Surabaya in brackish water of fish ponds, in Madura in pools near the sea, in S. New Guinea in open *Eleocharis* swamp, all localities as far as known saline and at very low altitude.

Notes. Already found by HORSFIELD at Kuwu, but that specimen was identified by RENDLE as *N. falciculata* (l.c. 1899, p. 418). In his key he placed *N. browniana* along with species possessing 4-celled anthers, although the anther depicted (l.c. t. 42 f. 165) is 1-celled. I have examined the holotype and this proves to be correct, they are mature and 1-celled.

The only specimen from continental tropical Asia is a specimen in the Kew Herbarium bearing three labels, reading: "1217/1830 Tutichorin; *N. rigidula* Herb. Wight prop.; *N. graminea* var. minor Rendle, Flora of Madras, det. C. Binker 19.4.1929".

I am not entirely satisfied that this species is specifically distinct from *N. gracillima* (A. BRAUN) MAGNUS (*N. indica* var. *gracillima* A. BR. ex ENGELM. in A. GRAY) which was originally described from eastern North America. The North American material is very distinct from the material of *N. browniana* in having much longer seeds (c. 2.6-3.3 mm) with elongated areoles and large anthers (c.  $1\frac{1}{2}$  mm). As RENDLE supposed that *N. browniana* would have 4-celled anthers, they appear in his key wide apart. This, however,

(1) Male flower often appressed to the female one.

not being correct, we are faced with the problem of their discrimination through the statements of MIKI who recorded *N. gracillima* from Japan (Tokyo Bot. Mag. 49, 1935, 773, f. 6 A-L) supplemented by many sheets collected by FAURIE in Japan and Formosa which I had on loan from the Geneva Herbarium. Through MIKI's description and FAURIE's material it appears that the plants from Japan and Formosa do not exactly match the North American plants, as they have small anthers (c. 0.7 mm) and smaller seeds (2 by  $\frac{1}{2}$  mm), to which should be added that in the Faurie material I observed seeds up to c. 3 mm long. The areoles of the Japanese plants are about twice as long as wide. The Japanese-Formosan plants are, therefore, more or less intermediate between true *gracillima* and *browniana*. It was beyond the scope of the present revision to go much deeper into this delicate situation, although it should be realized that if these species are merged into one (as three replacing subspecies) which would then possess an enormous distributional area, *N. gracillima* is the oldest binomial for it. The fact that the Japanese plants are largely from rice-fields and that *N. browniana* has, in Malaysia, an exacting natural habitat has added to my provisional decision to keep it apart.

5. *Najas indica* (WILLD.) CHAM. Linnaea 4 (1829) 501; KUNTH, En. (1841) 113; HASSK. Pl. Jav. Rar. (1848) 142; ZOLL. Syst. Verz. 1 (1854) 74; MIQ. Ill. Fl. Arch. Ind. (1871) 44-45, *pro parte, incl. var. macrodictya et var. rigida* A. BR., *nom. nuda*; MAGNUS, Ber. Deut. Bot. Ges. 2 (1894) 218-219; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 399, t. 39 f. 31-45; Pfl. Reich Heft 7 (1901) 10, f. 3 R-T; MERR. En. Philip. 1 (1923) 25; FISCHER, in Gamble, Fl. Madras (1931) 1603; DE WILDE, Willdenowia 2 (1960) 595; Act. Bot. Neerl. 10 (1961) 167, fig. 6-9.—*Caulinia indica* WILLD. Mém. Ac. R. Sc. Berl. (1801) 89, t. 1 f. 3; Sp. Pl. 4 (1805) 182; cf. DE WILDE (1960) *l.c.*—*N. palustris* BLANCO, Fl. Filip. (1837) 660; KUNTH, En. 3 (1841) 590; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 427; Pfl. Reich Heft 7 (1901) 18; MERR. Sp. Blanc. (1918) 57; En. Philip. 1 (1923) 25; VENKATESH, Bot. Notis. 109 (1956) 75-82, f. 1, 3-6, 8-18, 24-27, 29-36.—*N. lobata* BLANCO, Fl. Filip. ed. 2 (1845) 459; NAVES, *ibid.* ed. 3, 3 (1879) 65; Nov. App. (1880) 298; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 427; Pfl. Reich Heft 7 (1901) 18.—*N. tenuifolia* (non R. Br.) MIQ. Fl. Ind. Bat. 3 (1856) 224, *pro specim. sumbaw.* (ZOLL.) *et tranqueb.* (KLEIN); NAVES, Nov. App. (1880) 297.—*N. falciculata* A. BRAUN, J. Bot. 2 (1864) 278, f. 4; MARTENS, Preuss. Exp. Ost-As. Bot. Teil Tange (1866) 143; HOOK. f. Fl. Br. Ind. 6 (1893) 569; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 417, t. 42, f. 145-151; Pfl. Reich Heft 7 (1901) 15; SUNIER, Treubia 2 (1922) 190-195, f. 6; MERR. En. Philip. 1 (1923) 25; BACK. Handb. Fl. Java 1 (1925) 51; HEYNE, Nutt. Pl. (1927) 139; BACK. Onkruid. Suik. (1928) 20; FISCHER in Gamble, Fl. Madras (1931) 1604; STEEN. Arch. Hydrob. Suppl. 11 (1932)

271, t. ii; BURK. Dict. (1935) 1533; BACK. Bekn. Fl. Java (em. ed.) 10 (1949) fam. 210, p. 1.—*N. minor var. indica* A. BR. J. Bot. 2 (1864) 278, *excl. specim. maurit.*; MARTENS, Preuss. Exp. Ost-As. Bot. Teil Tange (1866) 143.—*N. foveolata* A. BR. ex (MAGNUS, Beitr. 1870, vii, 43, *nomen*) RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 416, t. 41, f. 139-144; *ibid.* (1900) 443; Pfl. Reich Heft 7 (1901) 15, f. 4 W; CAMUS in Fl. Gén. I.-C. 6 (1942) 1213.—*N. minor* (non ALL.) HOOK. f. Fl. Br. Ind. 6 (1893) 569, *pro majore parte, pro syn. indica*; KOORD. Jungh. Gedenkb. (1910) 160.—*N. kingii* RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 415, t. 41 f. 126-131; *ibid.* (1900) 442; Pfl. Reich Heft 7 (1901) 15 f. 5 A-C; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 129; Fl. Mal. Pen. 4 (1924) 366; CAMUS in Fl. Gén. I.-C. 6 (1942) 1213, t. 115 f. 13-19; HEINE, Aquar. & Terr. Z. (Datz) 11 (1958) 375, fig. 1-2.—*N. lacerata* RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 416, t. 41 f. 132-138; Pfl. Reich Heft 7 (1901) 15, f. 5 E-F; FISCHER in Gamble, Fl. Madras (1931) 1603, 1604.—Fig. 2 1.

Up to c. 40 cm, lower internodes 2-10 cm by (0.6-0.75-1.2(-1.7) mm. Leaves (1 $\frac{1}{4}$ -)2 $\frac{1}{2}$ -4 $\frac{1}{2}$  (-6) cm by (0.3-0.8-1.2(-1.6) mm, flat to subterete or triangular in section, apex acute to obtuse (blade c. 3 mm below the tip 0.2-0.4(-0.5) mm wide); margin on either side with (1-5-30(-40) conspicuous spiny teeth, sometimes up to the lower 15 mm of the blade unarmed; dorsal surface sometimes with 1-10(-30) spines; spine-cells 0.1-0.25 mm, all (dark) brown; teeth up to as long as half (in the upper part of the blade as long as) the width of the blade; midrib 0.12-0.1 times as wide as the blade; cavities occupying half or almost the entire width of the blade, often with distinct septa. Sheath (2-2.5-4(-5) by (1.5-2-4(-6) mm, on either side with (2-5-12(-20) spines, but unarmed on the inner edge of the auricles; auricles absent to (long-, especially in Indian specimens) triangular, truncate to rounded or almost acute, rarely falcate, (0.1-0.3-0.6(-1) by (0.3-0.5-1 (-1.5) mm, mostly entire, sometimes toothed or lobed, seldom lacerate up to halfway. Flowers mostly solitary. ♂ Flowers: spathe 2.2-3.6 mm, neck mostly cylindrical, 0.3-1 mm, tip almost truncate to very oblique, entire to up to halfway lacerate; anther subsessile, 4-celled, about elliptical to oblong, (1.2-1.5-2.2(-2.5) by 0.7-1.2 mm; 'perianth' lobes mostly distinct, (±) nipple-shaped. 'Pedicel' c. 0.2 mm, in anthesis 2.7-3.5 mm. ♀ Flowers: spathe absent (except in some Indian specimens), (1.7-2-3(-3.4) mm; ovary (0.6-0.7-0.9(-1.2) by (0.25-0.3-0.4(-0.45) mm, style (0.4-0.5-0.8(-1.2) mm, with 2(-1) stigmas (0.4-0.8-1.6(-1.8) mm. Seeds (1.5-1.7-2.3 by 0.75-0.9 mm; testa with (14-16-20(-25) length-rows of (17-22-25(-30) subquadrate or 5-6-angular areoles, which are mostly slightly wider than long.

Distr. ?Africa, tropical continental Asia (Kashmir, Deccan, Bengal, Andamans, Siam, Tonkin) northward to Japan, throughout *Malaysia* (not yet collected in Borneo and Moluccas).

Fig. 5.

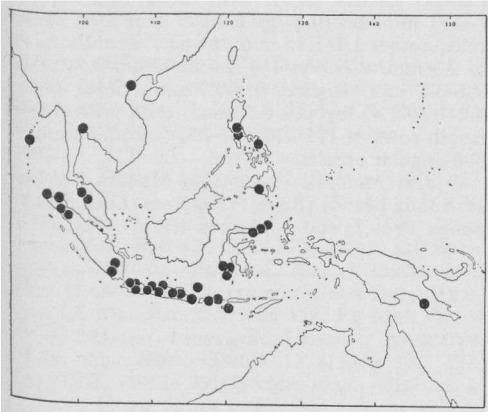


Fig. 5. Malaysian and some adjacent continental Asian localities of *Najas indica* (WILLD.) CHAM.

Ecol. Found in a great variety of habitats, in various biotopes of freshwater, mostly shallow but up to 5 m depth, and c. 1000 m altitude, also found in brackish water of fish-ponds near Djakarta with a salinity of up to 30‰ (SUNIER, l.c.), both in everwet regions and in those subject to a dry season. One of the commonest species in Malaysia.

Vern. *Lumut-siarang*, Toba, *ganggèng*, *Batavia*; Philippines: *aragán*, Ilk., *bangbañgi*, *Bonlábui*, Ig.

Notes. A variable species, the variability obviously mostly due to external conditions. Specimens from India not seldom deviate to forms with thin stems and narrow leaves and rather large seeds (up to 2.3 by 0.9 mm) with many (up to 25) longitudinal rows of many (up to c. 30) rather small areoles of the seed coat.

In Asiatic specimens the ♀ flowers are often enclosed by a spathe, but these may be found together with naked ones on a single individual (cf. DE WILDE, 1961). In Malaysia the ♀ flowers are as far as known always espathaceous.

It was judged beyond the scope of this revision to make a thorough study of African material described under other various names which may possibly be referred to *N. indica* as circumscribed here. I have not the impression that this species occurs in Australia.

6. *Najas tenuifolia* R. BR. Prod. 1(1810) 345; BENTH. Fl. Austr. 7 (1878) 181; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 419, t. 42, f. 158-162; Pf. Reich Heft 7 (1901) 17, f. 5 G-H.—*N. graminea* DEL. var. *tenuifolia* (R. BR.) A. BRAUN, J. Bot. 2 (1864) 278.—*N. celebica* KOORD. Minah. (1898) 270, 637.—*N. pseudograminea* W. KOCH, Ber. Schweiz. Bot. Ges. 44 (1935) 339.—Fig. 1, 2f, i. Up to c. 40 cm, lower internodes 2-6 cm, by (0.5-)0.7-0.85(-1.2) mm. Leaves (1½-)1¾-4 cm by 0.6-1.2 mm, flat, tip blunt (rounded) to acute (blade c. 3 mm below the tip 0.3-0.9 mm

wide); margin on either side with 14-60(-70) spiny teeth; dorsal surface without spines; spine-cells (0.05-)0.1-0.2 mm, on the auricles up to 0.3 mm, on the tip of the spathe rarely up to 0.4 mm long, brownish, rarely yellowish green; teeth shallow, up to c. 0.16, near the tip up to c. 1/3 as long as the width of the blade; midrib 0.1-0.07 as wide as the blade; cavities variable in width, septa sometimes distinct. Sheath (1.5-) 2-4.7(-5) by (1.5-)2-3(-3.5) mm, on either side with 5-25 spines, (0-)1-3(-4) on the inner edge of the auricle; auricles long-triangular, mostly 1½-2 times as long as broad, with an obtuse (rounded) to acute apex, rarely falcate, (0.4-)0.6-1.9(-3) by (0.25-)0.6-1 mm, entire, sometimes shallowly lobed (or somewhat lacerate). Flowers solitary or 2-3 together. ♂ Flowers: spathe 2-3.8 mm, subsessile (very rarely up to 0.8 mm stalked), neck mostly cylindrical, (0.4-)0.5-1 mm, tip almost truncate to oblique, entire to lobed; anther subsessile, 4-celled, ovate-elliptical to slightly oblong, 1.2-2.5 by 0.75-1.1 mm, 'perianth' lobes distinct, (shallowly) rounded. 'Pedicel' c. 0.2 mm, in anthesis 1.5-2.3(-2.7) mm. ♀ Flowers espathaceous, 1.5-3.5 mm; ovary 0.5-0.9(-1) by 0.2-0.35 mm, style 0.4-1(-1.2) mm, with 2 stigmas 0.3-0.8(-1.7) mm. Seeds (1.1-)1.2-2.3 by 0.4-0.75 mm; testa with 16-36 length-rows of (15-)20(-25) or 35-45 subquadrate or 5-6-angular areoles.

Distr. Australia and Malaysia.

Notes. The anther of this species has originally been described by R. BROWN as 1-celled and so it was defined by BENTHAM (1878); RENDLE already observed, however, that this was an error and he is correct as I could verify on the holotype (in BM).

I have divided this species into two subspecies, *ssp. tenuifolia* which occurs both in Australia and Malaysia and *ssp. pseudograminea* which is confined to Malaysia. In order to facilitate identification the two subspecies are opposed here and I have added the characteristics of a closely allied species known only from continental Asia, viz. *N. brevistyla*, which is most closely allied to the Malaysian *ssp. pseudograminea*.

#### KEY TO THE SUBSPECIES

1. Leaves small, 14-24 by 0.4-0.6 mm, often somewhat fleshy, on either side with 17-33 rigid spiny teeth up to as long as the width of the blade. Spathe of ♂ fl. 1.9-2.2 mm; anther small, 1-1.3 by 0.5-0.6 mm. ♀ Flower c. 1.5 mm. Seeds small, 1-1.2 by 0.4-0.45 mm.  
*N. brevistyla* RENDLE
1. Leaves (15-)17-40 by 0.6-1.2 mm, not fleshy, on either side with 14-60(-70) rather shallow spiny teeth, up to 1/3 as long as the width of the blade. Spathe of ♂ fl. 2-3.8 mm; anther 1.2-2.5 by 0.75-1.1 mm. ♀ Flower 1.5-3.5 mm. Seeds (1.1-)1.2-2.3 by 0.4-0.75 mm.
2. Leaves 21-40 mm, apex acute (or slightly obtuse), c. 3 mm below the tip 0.3-0.4 mm in width; margin on either side with 14-35(-42) spiny teeth (spine-cells dark brown);

cavities nearly reaching the margin (their outer edge not brown-coloured); septa often distinct. Flowers solitary. Mature anther 2–2.5 by 0.8–1.1 mm. Seeds 2–2.3 by 0.7(–0.75) mm. . . . *N. tenuifolia* ssp. *tenuifolia*

2. Leaves (15–)17–28 mm, apex blunt (rounded), rarely slightly acute, c. 3 mm below the tip (0.5–)0.7–1 mm in width; margin on either side with 28–60(–70) spiny teeth (spine-cells light brown, rarely yellowish green); cavities occupying 0.12–0.5 of the width of the blade, their outer edge often dark-brown; septa indistinct. Flowers mostly 2–3 together. Anther 1.2–2 by 0.75–0.9 mm. Seeds (1.1–)1.2–2 by 0.4–0.65 mm.

*N. tenuifolia* ssp. *pseudograminea*

ssp. *tenuifolia*.—*N. tenuifolia* R. BR. Prod. (1810) 345; BENTH. Fl. Austr. 7 (1878) 181; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 419, t. 42 f. 158–162; *ibid.* (1900) 443; Pfl. Reich Heft 7 (1901) 17, f. 5 G–H.—*N. graminea* var. *tenuifolia* (R. BR.) A. BRAUN, J. Bot. 2 (1864) 278.

Leaves 2–3¾ cm by 0.6–1.3 mm, on either side with 14–40 (dark) brown spiny teeth. *Sheaths* on either side with 6–17 spines. *Spathe* of ♂ flowers 2.8–3.8 mm, neck 0.7–0.9 mm, bearing up to c. 0.3 mm long spine-cells; anther 2–2.5 by 0.8–1.1 mm. ♀ *Flowers* 2.3–3(–3.5) mm; ovary 0.8 by (0.25–)0.3 mm; stigmas 0.6–0.8(–1.2) mm. *Seeds* 2–2.3 by 0.7–0.75 mm; testa with 26–36 length-rows of 35–40 subquadrate or 5–6-angular areoles.

Distr. Australia, and ?New Caledonia (RENDLE, 1900, p. 443), in *Malaysia*: SE. Celebes (Lepo-lepo near Kendari, BECCARI sh. no. 11810 FIR), once found.

ssp. *pseudograminea* (W. KOCH) DE WILDE, *comb. nov.*—*N. celebica* KOORD. Minah. (1898) 270, 637.—*N. pseudograminea* W. KOCH, Ber. Schweiz. Bot. Ges. 44 (1935) 339.—Fig. 1, 2f, i.

KEY TO THE VARIETIES

1. Spathe (of ♂ fl.) 2–2.8 mm; anther 1.2–1.85 mm. ♀ Flower 1.5–2 mm, stigmas 0.3–0.7 mm. Seeds small, (1.1–)1.2–1.3(–1.4) by 0.4–0.5 mm.

var. *pseudograminea*

1. Spathe (of ♂ fl.) 3–3.5 mm; anther 1.6–2 mm. ♀ Flower 2.7–3.5 mm, stigmas 1–1.7 mm. Seeds 1.9–2.05 by 0.5–0.65 mm. var. *celebica*

var. *pseudograminea*.—*N. graminea* (non DEL.) MIQ. Illustr. (1871) 45, *pro specim. javan.*—*N. tenuifolia* (non R. BR.) AUCT.: BACK. Teysm. 22 (1911) 514, *excl. specim. tobaic.*; Handb. Fl. Jav. 1 (1925) 51; Bekn. Fl. Java (em. ed.) 10 (1949) fam. 210, p. 1.—*N. falciculata* (non A. BR.) COERT, Trop. Natuur 23 (1934) 27, f. 11.—*N. pseudograminea* W. KOCH, Ber. Schweiz. Bot. Ges. 44 (1935) 339; HORN AF RANTZIEN, Kew Bull. (1952) 37.—Fig. 1, 2f.

Leaves (1½–)2(–2¾) cm by (0.6–)0.9(–1.1) mm, green, margin of the blade on either side with 28–53(–63, Buru) spiny teeth, brown; *sheaths*

on either side with 5–15(–23, Buru) spines. ♂ *Flowers*: spathe 2–2¾ mm, neck (0.4–)0.5–0.6(–0.9) mm, bearing up to 0.25 mm long spine-cells; anther 1.2–1.85 mm; 'pedicel' at anthesis up to 2.3 mm. ♀ *Flower* 1½–2 mm; ovary 0.5–0.8 by 0.2–0.3 mm; stigmas 0.3–0.7 mm. *Seeds* (1.1–)1.2–1.3(–1.4) by 0.4–0.5 mm; testa with 16–18 length-rows of (15–)20–23(–25) (sub)quadrate or 5–6-angular areoles.

Distr. *Malaysia*: Java (also Madura I.), Lesser Sunda Islands (Bali), Philippines (Luzon; Pampanga Prov.), and Moluccas (Buru). Fig. 6.

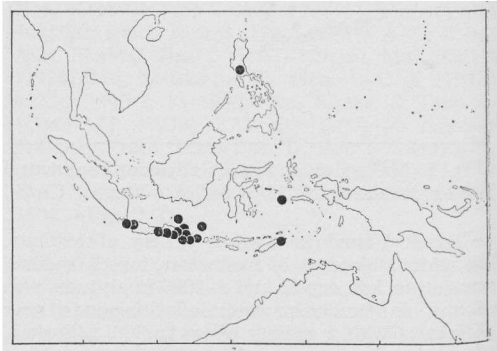


Fig. 6. Localities of *Najas tenuifolia* R. BR. ssp. *pseudograminea* (W. KOCH) DE WILDE var. *pseudograminea*.

Ecol. Common in Java, at low altitude, mostly in freshwater but found in brackish water in Bali (O. JAAG), twice found in the mountains, viz Rana Lake (Buru) at c. 700 m and in the rivulet and craterlake of Mt Kelud in Central Java at 1200 m abundant in sulfurous hot water (up to 60° C) on blackish, muddy soil (CLASON & COERT).

Notes. The identification of the Buru collection is somewhat doubtful.

One plant from Java possessed among numerous naked ♀ flowers and fruits a single one which was enveloped by a spathe (*cf.* DE WILDE, Act. Bot. Neerl. 10, 1961, 167).

var. *celebica* (KOORD.) DE WILDE, *comb. nov.*—*N. celebica* KOORD. Minah. (= Med. Lands Pl. Tuin) 19 (1898) 270, 637; RENDLE, Pfl. Reich Heft 7 (1901) 18; KOORD.-SCHUM. Syst. Verz. (Cel.) (1914) 9.—Fig. 2i.

Leaves 1¾–2¾ cm by 0.95–1.2 mm, often bluish-green (when dry), margin of the blade on either side with 40–60(–70) spiny teeth, yellowish green. *Sheaths* on either side with 10–25 spines. ♂ *Flowers*: spathe 3–3½ mm, neck 0.8–0.9 mm, bearing up to c. 0.4 mm long spine-cells; anther 1.6–2 mm; 'pedicel' at anthesis up to 2.7 mm. ♀ *Flowers* 2.7–3.5 mm; ovary 0.7–0.9(–1) by 0.2–0.35 mm; stigmas 1–1.7 mm. *Seeds* 1.9–2.05 by 0.5–0.65 mm; testa with 16–24 length-rows of 38–45 areoles, which are often somewhat broader than high.

Distr. *Malaysia*: NE. Celebes (Minahassa: Tondano Lake), c. 700 m altitude.

Vern. *Sengit*, tl.

7. *Najas malesiana* DE WILDE, Act. Bot. Neerl. 10 (1961) 168.—*N. graminea* var. *minor* RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 426; Pfl. Reich Heft 7 (1901) 18; CAMUS, in Fl. Gén. I.—C. 6 (1942) 1212.—*N. graminea* var. *angustifolia* RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 427, t. 42 f. 202; Pfl. Reich Heft 7 (1901) 18, f. 5 V; RIDL. Mat. Fl. Mal. Pen. 2 (1907) 128; GIBBS, RIDL. Mat. Fl. Mal. Pen. 2 (1907) 128; GIBBS, J. Linn. Soc. Bot. 42 (1914) 172; MERR. En. Born. (1921) 37; RIDL. Fl. Mal. Pen. 4 (1924) 366; Disp. (1930) 180.—*N. graminea* (non DEL.) RIDL. Mat. Fl. Mal. Pen. 2 (1907) 128; Fl. Mal. Pen. 4 (1924) 365.—*N. bengalensis* HORN AF RANTZIEN, *ad int.* Act. Hort. Gotob. 18 (1950) 192, 193; Kew Bull. (1952) 39, in *clav. angl.*—Fig. 2c, k.

Up to 15 cm, lower internodes 1–3 cm by 0.5–0.8 mm. *Leaves* (1¼–)2(–2½) cm by (0.4–)0.5–0.7(–0.9) mm, flat, apex obtuse or slightly acute (blade c. 3 mm below the tip 0.25–0.5 mm wide); margin on either side with (20–)25–30 (–50–60) inconspicuous teeth, mainly consisting of the spine-cell; dorsal surface without spines; spine-cells (0.05–)0.1(–0.25) mm, (dark) brown; midrib c. 0.05 times as wide as the blade, cavities occupying up to half the width of the blade, often with distinct septa. *Sheaths* (1.5–)2–2.5(–3) by 1–2.5 mm, on either side with (2–)6–14 spines, 0–4 spines on the inner edge of the auricle; auricles long-triangular or linguiform, sometimes falcate, 0.5–0.8(–1.1) by 0.3–0.8 mm, entire (rarely shallowly lobed). ♀ *Flowers* often up to 3 together, in different stages, together with one male (often appressed to the ♀), or male solitary. ♂ *Flowers* without spathe; anther 1-celled, elliptical-oblong, apically sometimes narrowed, 0.6–1 by 0.15–0.3 mm; ‘perianth lobes’ often indistinct; ‘pedicel’ 0.2–0.4, at anthesis c. 1 mm. ♀ *Flowers*: spathe absent; rarely up to 0.3 mm stalked; (1.2–)1.5(–1.8) mm; ovary 0.4–0.8 by 0.2–0.3 mm; style 0.25–0.5 mm, with 2(–1) stigmas 0.3–0.6 mm.

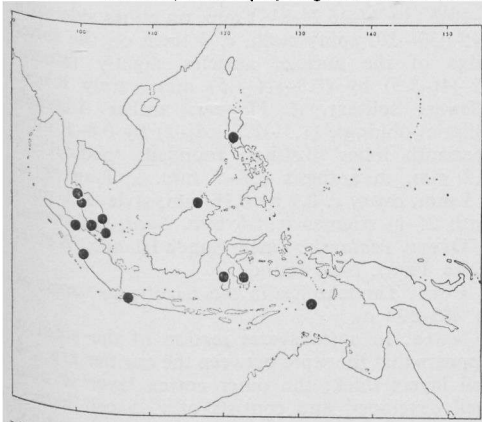


Fig. 7. Malaysian localities of *Najas malesiana* DE WILDE.

*Seeds* (0.9–)1–1.5 by (0.35–)0.4–0.5 to 1.5–1.8 by 0.5–0.6 mm; testa with 16–26 length-rows of 24–30 subquadrate or 5–6-angular areoles.

Distr. India, E. Bengal, Burma, Pegu, Lower Siam, Indo-China, throughout *Malaysia* (not yet found in New Guinea, Lesser Sunda Islands, and the larger parts of Java and Borneo), on the whole rare. Fig. 7.

Ecol. In streams and pools often in the forest, in swamp forest (Tjitjadas), more rarely in rice-fields (Setul, Padang), at low and medium altitude, once at 900–1000 m (Padang).

Vern. *Ganggèng*, S.

8. *Najas graminea* DEL. Descr. Égypt. Hist. Nat. 2 (1813) 282, t. 50 f. 3; Fl. Egypt. (1813) 138, t. 50 f. 3; KUNTH, En. (1841) 115; A. BRAUN, J. Bot. 2 (1864) 278 f. 5, *pro parte*, *excl. specim. javan. et celeb.*, *excl. var. β tenuifolia* A. BRAUN; MIQ. Illustr. (1871) 45, *excl. specim. javan.*; NAVES, Nov. App. (1880) 298; BAILEY, J. Bot. 22 (1884) 305, fig. 1–89, *pro maj. p. incl. var. delilei* MAGNUS; HOOK. f. Fl. Br. Ind. 6 (1893) 569; K. SCH. in Mart. Fl. Bras. 3, 3 (1894) 730, t. 124 f. 2; RENDLE, Trans. Linn. Soc. II, Bot. 5 (1899) 424, t. 42 f. 192–201, *excl. var. minor et angustifolia* RENDLE; *ibid.* (1900) 443; Pfl. Reich Heft 7 (1901) 18, f. 5 Q–V; KOORD. Exk. Fl. Java 1 (1911) 91; MERR. Fl. Manila (1912) 68; En. Philip. 1 (1923) 24; FISCHER, in Gamble Fl. Madras (1931) 1603, 1604; W. KOCH, Ber. Schweiz. Bot. Ges. 44 (1935) 340; MIKI, Bot. Mag. Tokyo (1935) 774, t. 6 M–R; GUILLAUMIN, Bull. Soc. Bot. Fr. 84 (1937) 256; CAMUS, Fl. Gén. I.—C. 6 (1942) 1211; HORN AF RANTZIEN, Act. Hort. Gotob. 18 (1950) 191–193, map; Kew Bull. (1952) 33, 39; VENKATESH, Bot. Not. 109 (1956) 75–82, f. 2, 7, 19–23, 28; DE WILDE, Act. Bot. Neerl. 10 (1961) 167, fig. 1–5.—*N. seminuda* GRIFF. ex VOIGT, Hort. Suburb. Calc. (1845) 694; GRIFF. Not. 3 (1851) 184; Ic. Pl. As. t. 251, f. 2, t. 253–254.—Fig. 2e, j.

Up to 50(–75?) cm, lower internodes 1–10 cm, by (0.6–)0.7–1.5(–2.25) mm. *Leaves* (1¼–)2½–3½(–6) cm by (0.6–)0.7–1(–4) mm, flat, seldom canaliculate, apex obtuse (–rounded), rarely somewhat acute (blade c. 3 mm below the tip 0.4–1.2 mm wide); margin on either side with (40–)60 (–185) inconspicuous spiny teeth, mainly consisting of the spine-cell; dorsal surface without spines; spine-cells 0.05–0.15 mm, yellowish brown; midrib c. 0.07–0.05 times as wide as the blade, cavities occupying up to ¼ of the width of the blade, septa (±) indistinct. *Sheath* (3–)4–5(–10.5) by (2–)3–4(–8.5) mm, on either side with (10–)15–30(–50) spines; 3–8 spines on the inner edge of the auricle; auricles long-triangular, seldom slightly falcate; apex acute, rarely obtuse or acuminate, (1–)2(–5.5) by 0.5–1(–1.5) mm, entire, rarely (shallowly) lobed. *Flowers* often up to 3 together, in different stages, together with one male, or male solitary (in the *var. robusta* all flowers probably solitary). ♂ *Flowers*: spathe 0; anther 4(–2)-celled, elliptical, rarely ovate or oblong, (1–)1.5(–2) by (0.4–)0.7(–1) mm; ‘perianth lobes’ distinct, rounded to globular. ‘Pedicel’ 0.2–0.5 mm,

at anthesis (0.7-)1-2.5 mm. ♀ *Flowers*: no spathe; (1.6-)2(-3.5) mm; ovary (0.6-)0.7(-1) by (0.2-)0.35(-0.4) mm; style (0.4-)0.7(-1.2) mm, with (1-)2(-3) stigmas (0.4-)0.8(-1.6) mm. *Seeds* (in the *var. robusta* unknown) (1.6-, broad seeds) 2.3(-2.7) by (0.6-, long seeds) 0.8(-0.9) mm; testa with 20-34 length-rows of 30-45 subquadrate to 5-6-angular areoles (often slightly higher than broad).

*Distr.* Widely distributed from North Africa and the Middle East, to tropical Asia (Punjab, Deccan, Bengal, Assam, Burma, Cochinchina, *ex lit.*), northwards to Formosa and Japan, southwards to *Malaysia* (not yet found in Borneo and Malaya, rare in Sumatra and Java), New Caledonia, and Australia. Introduced in the rice-fields in North Italy, England (BAILEY, *l.c.*), and probably in Brazil (K. SCHUMANN, 1894, RENDLE 1899, HORN AF RANTZIEN 1950, *ll.cc.*) Fig. 8.

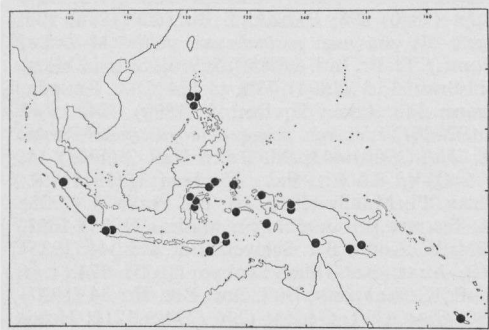


Fig. 8. Malaysian localities of *Najas graminea* DEL.

*Ecol.* Chiefly in the lowland in rice-fields, ditches, small streams, in both everwet and seasonal areas, up to 400 m, rarely at 1000 m (W. Java), once at 1400 m (Wètar), often together with *Nitella*, *Salvinia*, *Marsilea*, *Pistia*, and other aquatics. By BRANDIS noted to occur in a hot spring in Burma at 92° F.

*Note.* As an exception, part of the ♂ flowers, seldom all on one individual, are enclosed by a more or less developed spathe; this seems to be a teratological deviation (DE WILDE, 1961).

*Vern.* *Ganggèng-leutik*, *S. ira-walaki*, Wètar, *welák*, *amila*, Alor; Philippines: *aragán-tamná*, Ilk., *rigmáu*, Tag.

#### KEY TO THE VARIETIES

1. Leaves up to c. 4 cm by 1½ mm, on either side with up to 100 spiny teeth. Stem up to 1½ mm thick. Leaf sheaths up to 6 mm, auricles up to 2½ mm long. ♀ *Flowers* up to 2½ mm long.  
*var. graminea*
1. Leaves 5-6 cm by 3-4 mm, on either side with 160-185 spiny teeth. Stem (1.6-)2-2¼ mm thick. Leaf sheaths (4-)7½(-10½) mm, auricles (2-)4-5½ mm long. ♀ *Flowers* c. 3½ mm long. Robust plant . . . *var. robusta*

*var. graminea.*—Fig. 2e, j.

Up to 50(-75) cm, lower internodes 1-10 cm, by (0.6-)0.7-1.5 mm. *Leaves* (1¾-)2½-3½(-4) cm by (0.6-)0.7-1(-1.4) mm, flat, rarely canaliculate; apex obtuse (-rounded), rarely somewhat acute (blade c. 3 mm below the tip 0.4-1 mm wide); margin on either side with (40-)60(-100) spiny teeth; midrib c. 0.07-0.05 times as wide as the blade; cavities narrow, occupying up to ¼ of the blade; septa indistinct. *Sheaths* (3-)4-5(-6) by (2-)3-4(-5) mm, on either side with (10-)15-20 (-30) spiny teeth; 3-8 teeth on the inner edge of the auricle; auricles about straight, (1-)2(-2.6) by 0.5-1 mm, entire, rarely shallowly lobed. *Flowers* often up to 3 together, in different stages, together with a male, or male solitary. ♂ *Flowers*: anther 4(-2)-celled, elliptical, rarely ovate or oblong, (1-)1.5(-2) by (0.4-)0.7(-1) mm; 'perianth lobes' distinct, rounded to globular; 'pedicel' 0.2-0.5 mm, at anthesis 1-2.5 mm. ♀ *Flowers* (1.6-)2(-2.5) mm; ovary (0.6-)0.7(-1) by (0.2-)0.35(-0.4) mm; style (0.4-)0.7(-1.2) mm, with 2(-3) stigmas (0.4-)0.8(-1.6) mm. *Seeds*, see under the species.

*Distr. etc.* as under the species.

*Note.* The two collections made in the large Matana and Towuti Lakes in Central Celebes deviate slightly in having a condensed habit, short (¾-1¾ cm) rather coarsely dentate leaves with few spines (20-35), a rather short (2- or 4-celled) anther (c. 1 mm) and short stigmas only 0.3 mm long (KJELLBERG 3820 and sine coll. 4, 31-10-09 respectively).

*var. robusta* DE WILDE, Act. Bot. Neerl. 10 (1961) 169.

Up to c. 50 cm, lower internodes c. 5 cm, by (1.6-)2-2.25 mm. *Leaves* 5-6 cm by 3-4 mm, flat, apex rounded to slightly acute (blade c. 3 mm below the tip c. 1.2 mm wide); margin on either side with 160-185 spiny teeth; midrib 0.07-0.05 times as wide as the blade, cavities narrower than the midrib; septa ± distinct. *Sheaths* (4-)7½(-10½) by (4-)6.2(-8½) mm, on either side with (15-)30(-50) spiny teeth, c. 7 teeth on the inner edge of the auricle; auricles slightly falcate, 2-)4(-5.5) by (0.8-)1(-1.5) mm, rarely lobed. *Flowers* solitary. ♂ *Flowers*: anther 4-celled, elliptic(-oblong), (1.5-)1.7-1.8(-2) by 0.8-1 mm; 'perianth lobes' distinct, rounded; 'pedicel' c. 0.2 mm, in anthesis 0.7-? mm. ♀ *Flowers* c. 3.5 mm, ovary c. 0.9 by 0.35 mm; style c. 1 mm, with 2(-1) stigmas c. 1.6 mm. *Seeds* unknown.

*Distr. Malaysia*: Lesser Sunda Islands (Wètar: Lake Tihu), once found.

*Ecol.* The lake lies in the *Eucalyptus* forest at c. 485-500 m.

*Note.* In a transverse section of the stem it appears that the septa between the cavities are 2-4 cell layers thick; the outer cortex layer is also well developed and consists of c. 5 cell layers. This cortex structure is also found in *N. marina*, some specimens of *N. indica*, and the African *N. horrida*.

## Excluded

*Najas obvoluta* BLANCO, Fl. Filip. ed. 2 (1845)  
460; ed. 3, 3 (1879) 66; NAVES, Nov. App. (1880)

332 is according to MERRILL, Sp. Blanc. (1918)  
49 = *Ceratopteris thalictroides* BRONGN. (*Pterido-  
phyta*).

## Excluded

*Lemnopsis* ZOLL. Syst. Verz. 1 (1854) 74 is according to BACKER and VAN STEENIS, cf. Fl. Mal. I, 4  
(1949) 68 = *Halophila* (*Hydrocharitaceae*).

*Najadeae* comprised with MIQUEL, Fl. Ind. Bat. 3 (1856) 223 a large number of genera now partly  
referred to *Potamogetonaceae* and partly to *Hydrocharitaceae*.

*Ruppia* has been referred to *Najadaceae* by ZOLL. Syst. Verz. 1 (1854) 74 = *Potamogetonaceae* or  
*Ruppiaceae*.