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Classe des Sciences naturelles et médicales
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BY

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CONTENTS

ETUDES DU CONTINENT AFRICAIN

Fascicule 6

A REVISION OF THE GENUS *NAJAS* L. *(NAJADACEAE)* IN AFRICA AND SURROUNDING ISLANDS

BY

Ludwig TRIEST (Brussels)

INTRODUCTION

The polymorphism of aquatic macrophytes is a well known source of taxonomic problems - problems which must be tackled before the knowledge necessary for the management and control of weedy species, particularly in the tropics, can be systematised. At present considerable experience is necessary to identify species in genera such as *Najas, Potamogeton* and *Callitriche* (GAUDET, MITCHELL & DENNY, 1981). This study aims to put the discrimination of *Najas* species in Africa on a sounder footing, and make identification easier. This is practically important since several tropical species have become weeds of rice fields, irrigation systems and farm dams and their reactions to control measures are known, or may be inferred, to be taxonomically based, at least in part.

Najas is a cosmopolitan genus of submerged aquatics whose taxonomy and nomenclature present problems (HAYNES, 1979). LINNAEUS started these by having two entirely different concepts of *N. marina* in *Species Plantarum* (1753) and *Flora Suecica* (1745). CASPER (1979) has investigated the problem of typification in depth and concluded that the basis for the name should be the reference to MICHELI (1729) in *Hortus Cliffortianus* (1737) and that there was no evidence that LINNAEUS based his descriptions on specimens currently in the Linnaean herbarium (LINN). In 1785, ALLIONI united MICHELI's 4-seeded (i.e. loculamenta) and 1-seeded species under *N. major*, thus ignoring *N. marina* L. He named MICHELI's third species

N. minor. WILLDENOW (1798) created the genus *Caulinia* with three species: *C. flexilis, C. fragilis* (=*N. minor* All.) and *C. indica*. However R. BROWN (1810) reunited *Najas* and *Caulinia*. Based on collections from Egypt, DELILE (1813) described *N. muricata* and *N. graminea* and PARLATORE (1858) added *C. pectinata*. ASCHERSON (1864) divided the genus *Najas* into two « groups », without mentioning the rank: *Eunajas (N. marina)* and *Caulinia (N. minor* and *N. flexilis)*. A. BRAUN (1864), was the first to revise the genus. He adopted ASCHERSON'S concept of the « groups » and gave them the rank of sections. He accepted 8 species and a total of 16 varieties. Important for the present study are: *N. major* All. var. *ehrenbergii*, var. *angustifolia* (Bourbon), var. *microcarpa* (Canary Islands); *N. minor* All. var. *indica* and var. *setacea* (both from Mauritius). A. BRAUN examined several Egyptian collections, but only one from tropical Africa (Cordofan, *Steudner*). He found good characters in the shape of the leaf sheath and the leaf teeth to distinguish the species. His assistant MAGNUS (1870) made a very important contribution to the knowledge of the morphology of flowers and fruits in *Najas*, and differences he found are still the basis for taxonomic treatments. He described several species, published *N. horrida* A. Br., and distinguished in a separate paper (1883) the variety *N. graminea* var. *delilei* based on several collections from the Nile region in Egypt. In ASCHERSON and SCHWEINFURTH (1887), MAGNUS himself reduced *N. horrida* A. Br. ex Magn. as a synonym of *N. pectinata* (Parl.) Magn. MAGNUS (1889) separated the section *Caulinia* into two subsections: *Americanae* with rounded leaf sheaths and *Euvaginatae* with truncate to auriculate leaf sheaths. In 1894 he described *N. schweinfurthii* and further discussed the female spathe of *N. pectinata*. One year later, K. SCHUMANN (1895) described *N. interrupta*. RENDLE (1899a) first described *N. welwitschii*, before describing more species at the end of the same year in his Systematic revision of the genus *Najas* (1899b, 1900). This monograph has been used worldwide as the basis for many flora accounts. Since then there has been no worldwide revision of the genus. He examined more specimens from tropical Africa than were available to A. BRAUN and MAGNUS. Following A. BRAUN'S (1864) concept in dividing *Najas* into sections, he takes the sections to the subgenus level. He further divided the subgenus *Caulinia* into four sections: *Spathaceae; Americanae; Euvaginatae* and *Nudae*, according to the presence or absence of a spathe around the male and female flower. However these sections have been generally ignored in later works. Important for the present work are: *N. madagascariensis; N. australis; N. setacea* (1899b) and *N. affinis* (1900). He also accepted the following taxa: *N. marina* L. var. *angustifolia* A. Br., var. *microcarpa* A. Br., var. *muricata* (Del.) A. Br. ex K. Schum.; *N. schweinfurthii* Magn.; *N. horrida* A. Br. ex Magn.; *N. interrupta* K. Schum. and *N. graminea* Del.

RENDLE (1901) wrote up the genus for ENGLER'S *Pflanzenreich* since when little attention has been paid to it. It took several decades to discover that the knowledge of African *Najas* was rather fragmentary. In 1937, RENDLE described *N. testui* from Central Africa and in 1941, MAIRE described *N. arsenariensis* from Alger, here considered as a subsp. of *N. marina*, but a remarkable collection nevertheless. HORN

AF RANTZIEN (1950, 1952) provided additional information about African *Najas*. He noticed that the species from west tropical Africa differ considerably from those from other geographic regions of the continent. However he did not have the opportunity to examine more than 15 collections. HORN AF RANTZIEN (1950) first described *N. baldwinii* and *N. liberiensis* (both from Liberia) and afterwards (1952) he described *N. meiklei* (Nigeria) and *N. hagerupii* (Mali). HORN AF RANTZIEN'S key and the species he recognized have been accepted in many floristic works. OBERMEYER (1966) considered *N. interrupta* as a synonym of *N. pectinata*. Recently, there has been a strong tendency towards raising the remaining varieties of *N. marina* to the subspecies level (VIINIKKA, 1976; CASPER, 1979), whilst TZVELEV (1976) takes them to the species level and admits *Caulinia* as a genus.

Though not African, several species of the genus were more closely studied by BAILEY (1884), CAMPBELL (1897), VENKATESH (1956), POSLUSZNY & SATTLER (1976), VIINIKKA (1976) and AGAMI (1985).

In the present revision, emphasis is placed on *Najas* species from the African continent together with the surrounding islands (Canary Islands, Socotra, Seychelles, Aldabra, Madagascar, Réunion and Mauritius) and has involved examination of a large amount of material deposited in the major herbaria, as well as living specimens from Egypt and Burundi. Strong grounds for accepting 13 species and 5 subspecies of the 23 described taxa below the genus level have been found. This study also aims to indicate the taxonomical problematic areas and characters which must be investigated in particular.

As *Najas marina* differs clearly from all other *Najas* species (see descriptions), the subgenera are retained. The four sections however do not reflect natural affinities between species or species groups and therefore are abandoned. Entities distinguished within *N. marina* are ranked at the subspecies level. Keys are based upon material possessing male flowers, female flowers and fruits. Dimensions are taken from mature parts and structures. Doubtful specimens, devoid of either male or female flower or fruits, are mentioned separately. If a variation shows a distinct pattern, this is indicated in the notes to the species concerned. The synonyms presented, are those concerning literature of *Najas* from the regions considered in the present work. The distribution maps are based on complete or undoubtful specimens which were examined during this study.

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VEGETATIVE MORPHOLOGY

Najas species are annual or perennial. Turions in the form of thickened nodes and leaf bases were observed in *N. horrida* (sub *N. pectinata,* OBERMEYER 1966) and in *N. marina* (AGAMI *et al.*, 1985).

Roots are adventitious and unbranched. They arise only from certain nodes, though it may be observed on branches lying on the bottom that roots and leaves may develop from the same node. Following the trend in water plants to vascular reduction, the roots lack true vessels and are, indeed, almost totally devoid of any, even annular elements.

Stems are filiform, up to 1 m in length, rooted, branched and sparsely to very densely clothed with leaves. They are circular in transverse sections, with air-cavities in the cortex and they do not vary much in diameter. In most species the epidermal cells of the stem, closely resemble the underlying cells of the cortex, though in *N. marina* they are smaller. The internodes may be provided with spines, similar to those on the leaf margins.

Small scales may be present in the axils of the leaves, but they are rather inconsistent.

Leaves are sub-opposite in pairs or, more usually, arranged in pseudowhorls of 3 or more. The phyllotaxis originates as follows: the sheath of the incompletely 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. Its first almost sessile node bears a leaf pair, of which only the upper one develops into a real leaf — This then forms with the 2 leaves of the main stem, the pseudowhorl. The lower leaf of the first node of the new branch is very much reduced (MAGNUS 1870, 1894). W.J.J.O. DE WILDE (1961) stated that this reduced leaf is present in vegetative shoots, being the homologue of the spathe around the flower. He found transitions between an open scale and a fully closed bottle shaped spathe but the present study failed to confirm this.

The leaf blade is generally linear (except for short leaves with large teeth) and consists of only two cell layers, the upper and lower epidermis. *N. marina* has additional subepidermal layers. In cross section, the midrib consists of small cells, accompanied by one or two cell layers, with air-cavities on both lateral sides. In several species, transverse septa are well developed. Fibres may be formed on and

near the midrib and on both margins. However the presence or absence of fibres in the leaves sometimes is too inconsistent for use at the species level. The margin on each side may be minutely serrulate with inconspicuous spiny teeth, mainly consisting of a brownish spine-cell or may be serrulate with conspicuous spiny teeth consisting of a brownish spine-cell situated on small, broad to very broad triangular excrescences. In the subgenus *Najas*, the spine-cell rests upon several elongate brown cells, and the midrib may be supplied with teeth similar to those on the leaf margins.

The leaf sheaths are variously shaped. They are rounded, truncate or auriculate. The margins of the sheath or auricle mostly bear brownish spine-cells which are rather distantly arranged.

FLORAL MORPHOLOGY AND REPRODUCTION

The flowers of *Najas* are unisexual and solitary at the very base of an axillary shoot.

The male flower is shortly stalked and consists of a solitary, almost sessile anther which is 1-sporangiate or 4-sporangiate. The anther is surrounded by a « perianth-like » inner envelope, which is two-lipped above. The entire structure may be naked or enclosed in a bottle-shaped spathe.

The female flower is 1-carpellate and contains one basal anatropous ovule. The gynoecial wall ends in a 2-3(-4)-lobed style. A homologue structure of the inner envelope in the male flower is not present in the female flower. The entire structure may be naked or enclosed in a spathe, the neck of which reaches about halfway up the style.

When mature, the short stalk of the anther elongates rapidly and pushes the flower out of the spathe (if present). The pollen escapes apically through the separating lips of the inner envelope. The pollen grains are globular to ellipsoid, rich in starch and devoid of exine. When liberated through the apex of the inner envelope, they have often begun to germinate. Pollination takes place under water and therefore is true hydrogamy. The endosperm development is initially nuclear, becoming cellular by wall-formation beginning at the micropylar pole.

The fruit is a one-seeded achene with a very thin membraneous pericarp and bears the remaining parts of the style and the spathe (if present).

The seed has a testa composed of three or more cell-layers, with the inner layer somewhat membraneous and the middle and outer layer quite stony. The outer layer, however, sloughs partly away in many species, this resulting in the pitting of areoles which are either arranged irregularly or regularly. The arrangement and the shape of the areoles are often a useful character at species level (see descriptions). The endosperm is resorbed by the time of embryo maturation.

A contribution to the embryology of *Najas* was given by SWAMY & LAKSHMANAN (1962) and to the vascular anatomy of the flowers of *Najadaceae* by SINGH (1965).

CYTO- AND CHEMOTAXONOMY

Of the genus, several species have been studied, but only one chromosome counting is known based on African material. The number of the chromosomes varies from $2n = 12$ to $2n = 60$ and the length lies between 1.6-11.3 µm. Supporting literature can be found in DARLINGTON and JANAKI AMMAL (1945) and more recently in SHARMA and CHATTERJEE (1967) and VIINIKKA (1976). In subgenus *Najas*, chromosomes are about 2.5 times the length of those in subgenus *Caulinia*.

Polyploidy is common in *Caulinia*, whilst polyploidy and satellite chromosomes are occasionally observed in *Najas*. Counts on tropical species are rare, and even no karyotype investigations are known based on African material of subgenus *Caulinia*. For *Najas marina* subsp. *armata* from Burundi (Lake Dogodogo), a karyotype $2n = 12$, closely related or, even similar to the European subsp. *intermedia* is observed, while in subsp. *armata* from Israel (Merkaz Sappir), a karyotype $2n = 24$, most likely an autotetraploid, also related to the European subsp. *intermedia* is observed (VIINIKKA *et al.* 1987).

Very little is known about the taxonomic significance of secundary metabolites in *Najas*. Most constituents are lacking or useless for species distinctions (See HEGNAUER, 1963, and BATE-SMITH, 1968).

An extensive study of the isozyme polymorphism in leaves and seeds of the following subspecies of *N. marina* has been carried out: subsp. *marina*, subsp. *intermedia* (both from Europe) and subsp. *armata* (Africa). Concerning subsp. *armata*, fresh material came from Burundi (Lake Dogodogo), Egypt (Wadi Rayan, Wadi Natrun, Nubariya, Maryut swamps, Idku lake and Burullus lake) and Israel (Merkaz Sappir).

Investigated isozyme systems were: alcoholdehydrogenase (ADH), glucose-6-P-dehydrogenase (G6PDH), glutamate dehydrogenase (GDH), isocitric dehydrogenase (IDH), malate dehydrogenase (MDH), malic enzyme (ME), peroxidase (POD), 6-P-gluconate dehydrogenase (6PGDH), shikimic dehydrogenase (SkDH), superoxide dismutase (SOD), xanthine dehydrogenase (XDH) and glucose phosphate isomerase (GPI).

The diagnostic data of ADH, ME, SkDH and XDH in plants from Burundi were described previously and compared with the European taxa (TRIEST & SYMOENS, 1985).

According to the populations and to the isozyme patterns studied here, it is clear that subsp. *armata* shows much more affinities to subsp. *intermedia* than to subsp. *marina*, a feature which is also indicated by their karyotypes (VIINIKKA *et al.* 1987). Moreover, there is a difference in seed ADH within subsp. *armata*. Plants from Burundi showed a single band in the slowest gene and the fastest gene each, while those from Egypt and Israel could show 3 bands in as well the slowest as fastest gene. The latter zymogram most probably is correlated, at least for the Israelian material, with tetraploidism, and even suggests an autotetraploidy rather than allotetraploidy.

This way, investigations on isozyme polymorphism in *Najas marina* becomes a very useful tool to distinguish genetical entities within *N. marina* s.l. It also gives additional evidence to distinguish morphological entities, to obtain clear evidences for accepting polymorphisms and even to illustrate the natural affinities between population groups.

ECOLOGY, WEEDS AND IMPORTANCE

Najas species are widespread in many different habitats : freshwater pools, dams, irrigation ditches, rice fields, shallow edges of rivers, lakes, saline or brackish waters and lagoons. They are also recorded from temporary marshes.

The soil may be muddy (sand, grey or black clay) or rocky (granite, basalt, laterite).

Najas is associated with species of *Chara, Ceratophyllum, Nymphaea, Potamogeton, Utricularia, Hydrilla, Lagarosiphon, Vallisneria, Ottelia, Limnophila, Rotala, Brasenia, Ludwigia, Eleocharis* and *Cyperus*. Pleustic associated plants are *Azolla, Trapa, Eichhornia* and *Pistia.*

A tendency to form extensive pure stands, inhibiting colonization by potential competitors is characteristic of *Najas*, which often develops vigorous and highly homogeneous stands in suitable habitats. The more leafy parts of the plant are easily detached. These fragments might bear flowers and form tangled masses. It is in irrigation canals and ditches that *Najas* spp. cause most trouble by gradually reducing the flow of water (WILD, 1961). *N. marina* subsp. *armata* can colonize new habitats, even on a pure mineral substrate, this as well in irrigation drains as in newly formed lakes (e.g. Wadi Rayan, Egypt). Seeds also can survive drought for several years. Known from farm dams and irrigation ditches are: *N. marina* subsp. *armata, N. welwitschii, N. horrida* and *N. graminea.* Recorded from rice fields are: *N. welwitschii, N. schweinfurthii, N. baldwinii* and *N. graminea.*

The biotic importance of *Najas* spp. is a more limited one. Nevertheless, they are a direct source of food for many sorts of waterfowl. Even giant tortoises have been observed feeding on *Najas* in Aldabra. To fish they give shelter for spawning.

GEOGRAPHICAL DISTRIBUTION

The genus *Najas* has an almost cosmopolitan distribution with the greatest diversity in the tropical and subtropical regions. It is absent from the very cold areas. Several species have a large distribution. *N. marina* s.l., *N. minor* and *N. graminea* are as well known from the Old World as from the New World.

N. marina subsp. *armata* occurs in Africa, further in Central Spain, the Middle East, Sri Lanka and in Australia. Its distribution in Africa is mainly restricted to coastal lakes and to the rift lakes. The closely related subsp. *microcarpa* is known from Gran Canaria and northern Senegal and subsp. *arsenariensis* from Lake Arzeu (Algeria). Subsp. *ehrenbergii* is known from a few localities in the Sahara and further from Arabia and Socotra. Subsp. *commersonii* is restricted to Madagascar, Réunion and Mauritius.

N. minor, further known from Europe, temperate and temperate warm Asia and North America, is not widespread in Africa. It occurs in coastal lakes of Algeria and Tunisia and mainly in the Nile delta. The species is absent from tropical Africa.

N. graminea, further known from Europe (Mediterranean Region), Middle East to tropical Asia, Japan, Australia and California, occurs in northern Africa (Algeria, Nile delta) and in tropical Africa (Soudano-Zambezian Region).

The other species of the genus, considered in the present work are only distributed in Africa (one also in Madagascar) or are endemic to Madagascar, Mascarenes, Aldabra or the Seychelles.

N. horrida, very common and widespread in tropical east — and south east Africa, is also known from isolated localities in the Nile delta, west tropical Africa and Madagascar. *N. welwitschii*, much related to *N. horrida*, has its largest distribution in west tropical Africa and is known from isolated localities south of the equator in Zaire and Angola; it has been found also in Sudan. *N. pectinata*, much related to *N. welwitschii* and *N. horrida* is known from few localities in northern Egypt (Fayoum, Delta, Sinai).

N. testui and *N. schweinfurthii* are closely related species. *N. testui* is known from few localities in Sierra Leone, Ivory Coast, Nigeria, Cameroon, Sudan, Central African Rep., Angola and from the region of the rift lakes. *N. schweinfurthii* is recorded from few localities in the Sudanese Region (Senegal, Cameroon, Sudan, Ethiopia) and in Tanzania.

N. baldwinii is very common in west tropical Africa (Senegal, Guinea-Bissau, Guinea, Sierra Leone, Liberia and Ivory Coast). Isolated localities are known in Cameroon, Central African Rep. and Zaire (Katanga). The species probably further occurs in Sudan and in the western part of Zaire. *N. hagerupii* is a rare species and occurs in few localities of Mali, Ghana, Cameroon and Central African Republic.

Endemic species are: *N. madagascariensis* (Central Madagascar); *N. australis* (Seychelles, Réunion and Mauritius) and *N. setacea* (Seychelles, Aldabra, northern Madagascar and Mauritius).

The distribution maps 1-11 are based on complete or undoubtful herbarium specimens investigated in the present work.

TAXONOMIC TREATMENT

NAJAS L.

Species plantarum, ed. 1 2: 1015 (1753).

Incl. *Caulinia* Willdenow, Mém. Acad. Roy. Sci. Hist. Berlin: 87 (1798).

Submerged herbaceous annuals or rarely perennials, in fresh or brackish waters, monoecious or dioecious. *Roots* simple, adventitious, devoid of root caps. *Stems* rooting from the base and lower nodes, much branched, slender or robust, the internodes sometimes armed with spines (Subg. *Najas*). *Leaves* in pseudowhorls of 3-7, sessile, with an open folded basal sheath and a linear blade. Blade one-nerved, mostly dorsally armed with spines on the midrib in subg. *Najas*; margins serrulate with (0-)4-70 spines per side; apex acute to acuminate, with 1-3 spines per side; spine-teeth not on excrescences or on excrescences to various degree; leaf-sheath clasping the stem or a flower, variously shaped, upper part mostly serrulate or spiny-dentate, basal part enclosing two tiny axillary intravaginal hyaline scales.

Inflorescences consisting of a unisexual, solitary flower at the very base of an axillary shoot, sessile or shortly stalked, each often enclosed in a membraneous spathe; spathe tapering to the top in male flowers or constricted into a cylindrical neck halfway the style in female flowers; the edge of the neck mostly with some spine-cells. *Male flower* consisting of a solitary almost sessile anther; closely adhering to the anther is a thin inner envelope (often named « involucre » or « perianth ») which is bilobed at its apex; peduncle at first short, elongating at anthesis, pushing the anther through the envelope: anther 1- or 4-sporangiate, dehiscing irregularly; pollination hydrogamous; pollen globose to ellipsoid, monocolpate, 3-celled, containing starch granules, the wall with shallow reticulations, thin, without exine. *Female flower* consisting only of an ovoid ovary; ovary subsessile, acarpellate, one-loculed, one-ovuled; ovule solitary, subsessile, erect, anatropous; gynoecial wall two cell-layers thick, ending in a short cylindrical style with 2-3(-4) linear, often unequal stigmatic branches.

Fruit a one-seeded capsule, pericarp very thin, closely enveloping the seed; style, stigma's and surrounding spathe (if any) persistent. *Seed* elliptical oblong to ovate, occasionally asymmetrical at apex or somewhat recurved, with a basal raphe and

a distinctly areolate testa; testa hard, brittle, 3 or more cell-layers thick, pitted; areoles formed by outer 2 layers of testa, variously rectangularly shaped, irregularly arranged or regularly arranged in longitudinal rows, each row of (9-)25-60(-100), the end-walls sometimes raised; embryo straight; hypocotyl and radicle large, plumule well developed; cotyledon terminal, blunt; no endosperm.

TYPE SPECIES: *N. marina* L.

About 30 species, widely distributed, with its greatest diversity in tropical and subtropical regions, but absent from very cold areas. In the present work, 13 species are retained, from which 5 occur in Northern Africa, 8 in Tropical Africa and 6 in Madagascar and Mascarenes.

SPECIES NUMBERED

(Africa and surrounding islands)

1. *N. marina* L.
2. *N. australis* Rendle
3. *N. madagascariensis* Rendle
4. *N. welwitschii* Rendle
5. *N. pectinata* (Parl.) Magn.
6. *N. horrida* Magn.
7. *N. testui* Rendle
8. *N. schweinfurthii* Magn.
9. *N. minor* All.
10. *N. hagerupii* Horn af Rantz.
11. *N. setacea* (A. Br.) Rendle
12. *N. baldwinii* Horn af Rantz.
13. *N. graminea* Del.

DIAGNOSTIC FEATURES

Brackets mean that the character is exceptional within the considered species.

Plants monoecious: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
Plants dioecious: 1

Stems armed: 1
Stems unarmed: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Leaves with spines on midrib: 1
Leaves without spines on midrib: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Leaf narrower than 1.1 mm (incl. teeth on both sides): 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
Leaf broader than 1.1 mm (incl. teeth on both sides): 1, 4, 5, 6, 9

Less than 20 leaf teeth on each margin: 1, 2, 3, 4, 5, 6, 7, 8, 9, 12
More than 20 leaf teeth on each margin: 2, 7, 10, 11, 12, 13

Leaf teeth on excrescences: 1, 3, 4, 5, 6, 7, 8, 9, 12
Leaf teeth not on excrescences: 2, (7), (8), 10, 11, 13

Leaf teeth shorter than 0.14 mm: 7, 10, 11, 13
Leaf teeth shorter than 0.5 mm: 2, 3, 4, 5, 8, 9, 12
Leaf teeth shorter than 1.9 mm: 1, (4), (5), 6

Leaves with septa: 3, 4, 5, 6, 7, 8, 9, 12
Leaves without septa: 1, 2, 7, 8, 10, 11, 12, 13

Septa constricting the margin: 3
Septa not constricting the margin: 4, 5, 6, 7, 8, 9, 12

Leaves with fibres: 7, 8, 10, 12, 13
Leaves without fibres: 1, 2, 3, 4, 5, 6, 8, 9, 11, 12, 13

Leaf sheath rounded: 1, 2, 3, 4, 5, 6
Leaf sheath truncate to auriculate: (3), 7, 8, 9, 10, 11, 12, 13

Male flower in spathe: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Male flower naked: 12, 13

Male spathe shorter than 2 mm: 2, 4, 5, 6, 7, 8, 9, 10, 11
Male spathe longer than 2 mm: 1, 2, 3, 4, 5, 6, 7

Anther shorter than 1.3 mm: 2, 4, 6, 7, 8, 9, 10, 11, 12, 13
Anther longer than 1.3 mm: 1, 3, 5, 6, 7, 9, (11)

Anther 1-sporangiate: 5, 8, 9, 10, 11, 12
Anther 4-sporangiate: 1, 2, 3, 4, 6, 7, 13

Female flower in spathe: 3, 4, 5, 7, 8
Female flower naked: 1, 2, 6, 9, 10, 11, 12, 13

Seed asymmetrical, ovate: 1

Seed symmetrical, elliptical, oblong: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Seed shorter than 2 mm: 2, 4, 6, 7, 8, 9, 10, 11, 12, 13
Seed longer than 2 mm: 1, 3, 4, 5, 6, 7, 9, 13

Seed 0.8-2.1 mm wide: 1
Seed (0.37-)0.5-0.7(-0.8) mm wide: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Areoles regularly arranged: 2, 3, 4, 5, 6, 9, 10, 11, 12, 13
Areoles irregularly arranged: 1, 7, 8

Areoles per 9-15(-23) in each longitudinal row: 7, 8
Areoles per (18-)25-35(-60) in each longitudinal row: 2, 3, 4, 5, 6, 10, 11, 12, 13
Areoles per (60-)80-100 in each longitudinal row: 9

Areoles arranged ladder-like: 9
Areoles never arranged ladder-like: 2, 3, 4, 5, 6, 10, 11, 12, 13

Cell walls raised: 7, 8
Cell walls not raised: 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13

KEY TO SUBGENERA

1. Plants always dioecious, mostly robust; stems usually with spines on the internodes and on the abaxial side of the midrib of the leaf; seed asymmetrically ovate; seed areoles unequal in shape and size, irregularly arranged ..... I. subg. *Najas*

1. Plants monoecious, more rarely dioecious, mostly slender; stems and midrib of the leaf unarmed; seed elliptical oblong; seed areoles all about of the same shape and size, except near raphe, mostly regularly arranged ..... II. Subg. *Caulinia*

I. SUBGENUS **Najas**

≡ «Group» *Eunajas* Ascherson, Fl. Prov. Brandenburg 1: 669 (1864), stat. non ind. — ≡ Section *Eunajas* A. Braun, Journ. Bot. 2: 275 (1864). — ≡ Subgenus *Eunajas* Ascherson ex Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12): 389 (1899).

DIAGNOSTIC FEATURES: *Plants* dioecious, mostly robust. *Stems* usually with spines on the internodes; epidermis distinctly differentiated by smaller cells from the underlying cortex. *Leaves* with blade coarsely serrate, (0-)4-17 spiny teeth on each margin; midrib mostly with spines on the abaxial side; sheaths rounded; intravaginal scales less than twice as long as broad, blunt, often assymetrical. *Male flower* enclosed in a spathe; anther 4-sporangiate. *Female flower* naked. *Seed*

asymmetrically ovate; testa more than 3 cell-layers thick; areoles often unequally in shape and size, irregularly arranged.

SINGLE SPECIES AND TYPE SPECIES: *N. marina* L.

1. **Najas marina** L.

Sp. Pl., ed. 1, 2: 1015 (1753) — TYPE: Vaillant (1722), tab. I, fig. 2, p. 62; in icone sub titulo « Fluvialis pisana foliis denticulatis J.B. 1.38 p. 779 »; in p. 17 sub titulo « Fluvialis vulgaris latifolia ». Lecto-iconotype designated by CASPER (1979).

Plants submerged, dioecious, coarse. *Stems* up to 100 cm long, 0.6-1.7 mm in diameter, unarmed or roughened with spines. *Leaves* (3.6-)7.0-40(-60) mm long, fleshy, acute, 1.2-5.3 mm wide (incl. teeth on both sides) 0.5-2.3 mm wide (excl. teeth on both sides); margin on each side serrulate with (0-)4-17 conspicuous spiny teeth on broad triangular excrescences; the spine-cell resting upon several elongate brown cells; leaf teeth 0.25-1.9 mm long, the ratio of teeth length to leaf width being 0.2-2.3; abaxial side of midrib unarmed or with 1-6 spines, similar to those on the leaf margin and on the stem; septa and fibres absent; leaf sheath 1.6-4.0 mm by (1.2-)2.2-5.1 mm (ratio = 0.4-1.3), rounded, entire or serrulate with 1(-3) spine-cells on each side.

Inflorescences axillary, solitary. *Male flower* enclosed in a spathe, 2.1-4.5 mm (incl. spathe-neck) by 0.8-2.6 mm; the neck of the spathe being 0.5-0.7 mm, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding 0.2-0.6 mm above the anther; anther 1.3-3.3 mm by 0.8-2.4 mm, 4-sporangiate. *Female flower* naked; 2.0-4.2 mm long; ovary 1.0-3.4 mm by 0.4-1.7 mm; style and stigma 0.3-1.4 mm; stigma (2-)3(-4) lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style. *Seed* ovate, slightly assymmetrical, (1.9-)2.5-3.9 mm by 0.8-2.1 mm (ratio = 1.3-2.3(-3.2)); testa pitted with areoles, arranged irregularly; areoles irregular in shape and dimensions.

KEY TO SUBSPECIES

1. Seeds (3.3-)5-6(-7.5) mm long ..... subsp. *marina* (not in Africa)
1. Seeds (1.9-)2.5-3.5(-4) mm long
   2. Leaves 7-40(-60) mm long
      3. Seeds (1.9-)2.0-2.5 mm long
         4. Stems unarmed or almost unarmed; back of midrib spiny; leaves 17-25(-40) mm long ..... 1. a. subsp. *ehrenbergii*.
         4. Stems and back of midrib very spiny, about 10-15(-30) spines in 2 cm; leaves 8.3-11.3(-19) mm long ..... 1. b. subsp. *microcarpa*.

3. Seeds (2.5-)3-3.5(-4) mm long
5. Stems and back of midrib unarmed or almost unarmed, about 0-2 spines in 2 cm; leaves (20-)30-40(-60) mm long; seeds 3.6-4 mm long ..... 1.c. subsp. *commersonii*.
5. Stems and back of midrib very spiny, about (10-)15-30(-50) spines in 2 cm; leaves 7-20(-24) mm long; seeds 2.5-3.5 mm long ..... 1. d. subsp. *armata*.
2. Leaves 3.6-4 mm long (seeds unknown) ..... 1. e. subsp. *arsenariensis*.

1.a. **Najas marina** L. subsp. **ehrenbergii** (A. Br.) Triest comb. nov. — ≡ *N. major* All. var. *ehrenbergii* A. Br., Journ. Bot. 2: 275 (1864). — ≡ *N. marina* L. var. *ehrenbergii* (A. Br.) K. Schum in Mart. Fl. Bras 3,3:725 (1894); Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12): 394, pl. 39, fig. 10, 27 (1899), p.p. quoad Arabia et Socotra; Rendle in Engler, Pflanzenr., H. 7: 8 (1901) p.p. quoad « Arabien » et « Socotra »; Maire, Fl. Afr. Nord 1: 205-206 (1952) p.p. quoad Touarga (*Trotter*) (non vidi); Cuénod, Fl. anal. et syn. Tun.: 43 (1954). TYPE: « Arabia, Wady Djara et Kamme, in fluviis, II. 1920-1926 », Ehrenberg s.n. (holo-: B †; lecto-: K; iso-: BR, L, LE), lectotype designated here.

— *N. major* auct. non All.: Boissier, Fl. Orient. 5: 27 (1882) p.p. quoad Algeria; Balfour, Trans. Roy. Soc. Edinb. 31: 301 (1888); Durand & Schinz, Consp. Fl. Afr. 5: 500 (1894); Battand. & Trabut, Fl. Algérie 1, 2: 10 (1895); Battand. & Trabut, Fl. Algérie, Tunisie: 315 (1905); Ozenda, Fl. Sah. sept. & centr.: 127 (1958); Ozenda, Fl. Sahara, ed. 2: 127 (1977); Keith, Prelim. Check List Libyan Fl. 2: 681 (1965).

— *N. marina* L. var. *angustifolia* auct. non (A. Br.) K. Schum. in Mart.: Rendle, Trans. Linn. Soc., Ser. 2, Bot. 5 (12): 395 (1899), p.p. quoad *Bornmüller* 1838.

— *N. marina* auct. non L.: Corti, Fl. et Veg. del Fezzan et Gat: 29-30 (1942); Quézel & Santas, Nouv. Fl. Alg.: 53-54 (1962) p.p. syn. *N. major;* Keith, Prelim. Check List Libyan Fl. 2: 681 (1965).

— *N. marina* L. var. *communis* auct. non Rendle in Ascherson & Graebner: Maire, Fl. Afr. Nord 1: 205-206 (1952) « vaguement indiqué en Algérie par Boissier ».

Stems unarmed or almost unarmed, about 0(-4) spines in 2 cm; leaves 17-25(-40) mm long and 1.4-1.9(-2.2) mm broad (incl. teeth on both sides) and 0.8-1.0(-1.5) mm broad (excl. teeth); margins each with 5-14 teeth; seeds 2-2.5 mm long and 1.3-1.5 mm broad (ratio: 1.5-1.7).

NOTES: 1. ♂: non vidi; ♀: VIII; fr.: II, VIII.

2. Close to subsp. *brachycarpa* and subsp. *microcarpa*, because of the broadly ovate and small seeds.

3. Also close to subsp. *commersonii*, because of the unarmed or almost unarmed stems.

4. I did not see the specimens mentioned by CORTI (1942) from « El-Hofra: Traghen, laghetto d'acqua dolce » 15.V.33, *Corti* 1177, fr. et 26.III.34, *Corti* 1178-1179, ster.

GEOGRAPHICAL DISTRIBUTION: Libya, Egypt, Iraq, Arabia, Oman & Socotra (African distribution: Fig. 1).

SELECTED SPECIMENS:

Libya: Taurgha, 1.II.1969, *Abu Raya* s.n. (CAI); Fezzan «Traren source», III.1944, *Killian* s.n. in Herb. Maire (BRVU, MPU).

Egypt: «In fossis Oasis magnae», III.1906, *Muschler* s.n. (K).

Socotra: Galamir, 18.V.1881, *Schweinfurth* 709 (K, P); III-IV.1880, *Balfour* 732 (BM, K).

1.b. **Najas marina** L. subsp. **microcarpa** (A. Br.) Triest comb. nov. — ≡ *N. major* All. var. *microcarpa* A. Br., Journ. Bot. 2: 276 (1864); A. Br., Monatsber. Berl. Acad. 9, 12: 866 (1867). — ≡ *N. microcarpa* (A. Br.) Christ, Bot. Jahrb. 9: 153 (1888). — ≡ *N. marina* L. var. *microcarpa* (A. Br.) Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12): 396 (1899); Rendle in Engler, Pflanzenr. H. 7: 8 (1901). — ≡ *N. major* Roth var. *microcarpa* Bolle ex Pitard & Proust, Les Iles Canaries, Fl. Archipel: 369 (1908); Erikson, Hansen & Sunding, Fl. Macronesia, Checklist of Vasc. Pl. 2, revised ed. 1: 83 (1979). — ≡ *N. marina* L. var. *bollei* (A. Br.) K. Schum. in Mart., Fl. Bras 3, 3: 725 (1894). — TYPE: Gran Canaria, Laguna Maspalomas, *Bolle* s.n. (holo-: B†; lecto-: K; iso-: Z), lectotype designated here.

— *N. marina* L. subsp. *armata* auct. non (Lindb. f.) Horn af Rantz.: Raynal, Adansonia sér. 2, 7 (3): 341 (1967); Lebrun, Enum. Pl. vasc. Sénégal, Inst. Elev. & Médec. vét. Pays trop., Et. Bot. 2: 121 (1973).

— *N. marina* auct. non L.: Kunkel, Die Kanar. Insel u. ihre Pflanzenwelt: 64, 124 (1980).

Stems very spiny, about 20-30 spines in 2 cm; leaves 8.3-11.3(-19) long and c. 3.7 mm broad (incl. teeth on both sides) and c. 0.6-1.2 mm broad (excl. teeth); margins each with 4-7 teeth; seeds 1.9-2.3(-2.5) mm long and 1.2-1.4(-1.6) mm broad, ratio: 1.4-1.6.

NOTES: 1. Only known from the type locality and northern Senegal.

2. Subsp. *microcarpa* is close to subsp. *armata* when regarding the spiny habit; however it differs in its smaller but proportionally broader seeds.

3. Subsp. *microcarpa* also is close to subsp. *ehrenberghii* and subsp. *brachycarpa*. These are the only taxa with such small seeds.

4. In Laguna Maspalomas, *Najas marina* grows together with *Ruppia* and *Potamogeton* (KUNKEL, 1980).

5. ♂ : VI, XI (Senegal)
♀ : VI,
fr.: VI, XI (Senegal).

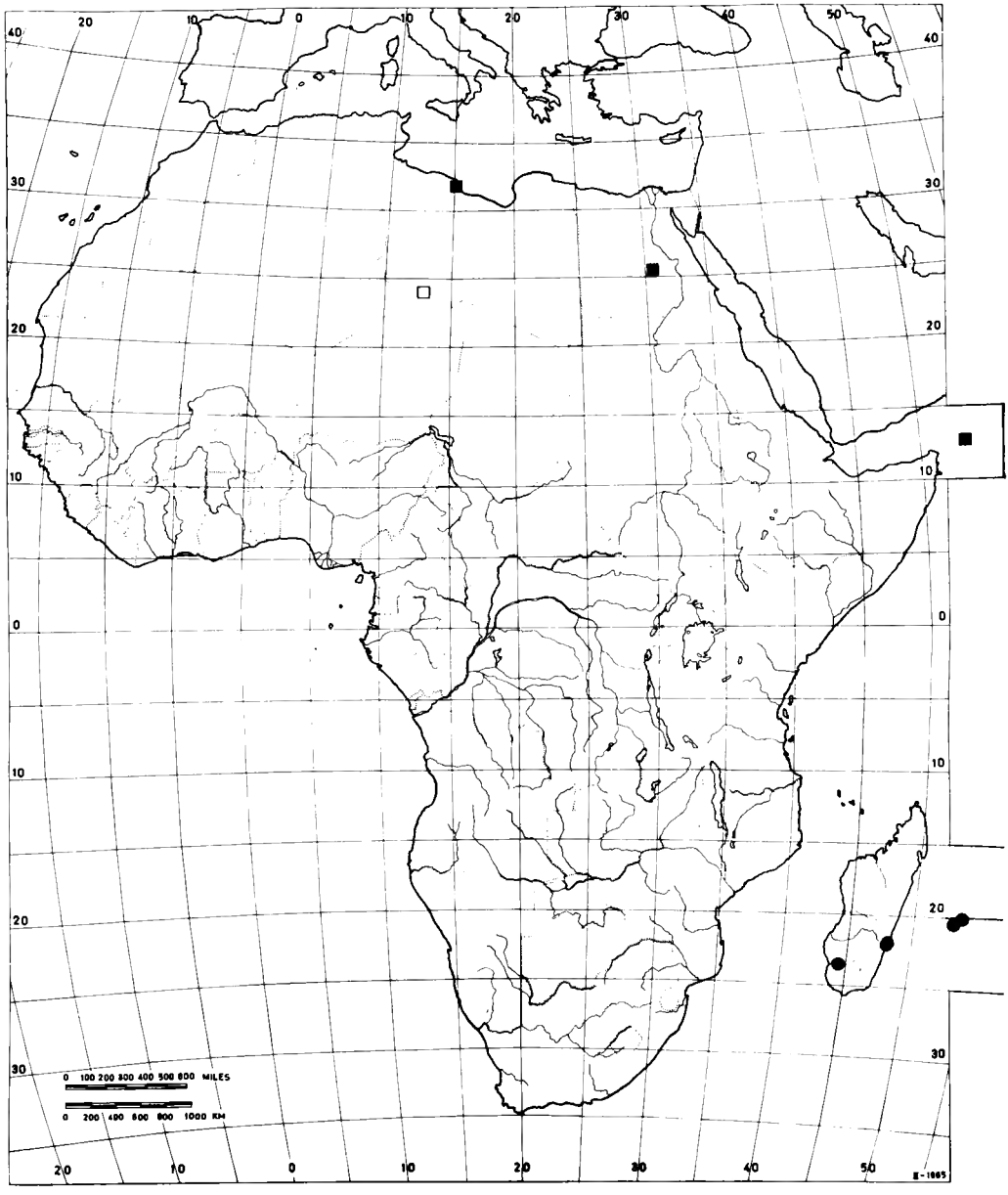

FIG. 1. — *N. marina* subsp. *commersonii* (circles) and subsp. *ehrenbergii* (squares; open square is an uncertain locality).

GEOGRAPHICAL DISTRIBUTION: Gran Canaria and northern Senegal (fig. 2).

SELECTED SPECIMENS:

Canary Islands: Gran Canaria, « Laguna Maspalomas », *Bolle* s.n. (K, Z).

Senegal: Richard-Toll, 26.XI.1960, *J. & A. Raynal* 6633 (P); « Lac de Guiers », 20.VI.1966, *Audru* 3315 (ALF, P); « NW du Lac de Guiers », 10.XI.1984, *Bamps* 7571 (BR, BRVU).

1.c. **Najas marina** L. subsp. **commersonii** Triest subsp. nov. — *Planta submersa dioica, internodiis saepe inermibus vel pauce spinulosis [spinulis 0 (– 2) in 2 cm]. Folia (20–) 30-40 (– 60) mm longa; lamina 1.2-2.9 (– 4) mm lata (inclusis spinulis) et 0.5-1.1 (– 2.2) mm lata (exclusis spinulis), marginibus utrinque dentibus 8-17 patentibus munitus. Flores masculini in spathella 2.7-4.5 mm longa. Flores feminei 3.3-4,2 mm longi; ovarium c. 3-3.4 × 1.1-1.7 mm; stylus c. 0.3-0.8 mm. Semina 3.6-3.9 × 1.4-1.7 mm.* — TYPE: La Réunion, « Etang du Gol », VII-VIII.1771, *Commerson* s.n. ♀, fr. (holo – : P; iso – : G, K).

— *N. marina* auct. non L.: Perrier de la Bâthie in Humbert, Fl. Madag, 22e fam.: 2, fig. 1, 1-3 (1950).

— *N. major* All. var. *angustifolia* auct. non A. Br.: A. Br., Journ. Bot. 2: 275 (1864) p.p. quoad Bourbon.

— *N. marina* L. var. *angustifolia* auct. non (A. Br.) K. Schum. in Mart.: K. Schum. in Mart., Fl. Bras. 3, 3: 276 (1894) p.p.; Rendle, Trans. Linn. Soc., ser. 2, Bot. 5, (12): 395, pl. 39, fig. 13, 28 (1899) p.p. quoad Bourbon; Rendle in Engler, Pflanzenr., H. 7: 8, fig. 3E, 0 (1901) p.p. quoad Bourbon; Scott, Fl. Mascar. 195: 1-3 (1984).

— *N. palustrella* in schedula: *Commerson* 132 (P); *Pourret* s.n. (P); Coll. ? (MPU); Herb. Candolle s.n. (G).

— *N. palustrina* in schedula: *Commerson* 132 (P); *Commerson* s.n. (G, K); Herb. Candolle s.n. (G).

Stems unarmed or almost unarmed, about 0 (– 2) spines in 2 cm; leaves (20–) 30-40 (– 60) mm long and 1.2-2.9 (– 4) mm broad (incl. teeth on both sides) and 0.5-1.1 (– 2.2) mm broad (excl. teeth); margins each with 8-17 teeth; seeds 3.6-3.9 mm long and 1.4-1.7 mm broad (ratio: 2.1-2.7).

NOTES: 1. Subsp. *commersonii* mostly has pale olive green to yellowish stems and leaves.

2. Subsp. *commersonii* is also found in salt water (lagoons), together with compact specimens of *N. horrida* (Decary 6257).

3. ♂ : VI-VII-VIII (Réunion); X (Madagascar)
♀ : VII-VIII (Réunion)
fr. : VI-VII-VIII (Réunion)
sterile : I (Mauritius); V-VI (Madagascar).

GEOGRAPHICAL DISTRIBUTION: Madagascar and Mascarenes (fig. 1).

SELECTED SPECIMENS:

Madagascar: East: Itampolo, VI.1910, *Perrier de la Bâthie* 4404 (P); Ambila, S. Tamatave, 13.V.1928, *Decary* 6527 (P). South West: «Onilahy valley, near Tongombory», 1-8.X.1924, *Humbert* 2709 (P).

Réunion: «Etang du Gol», VII-VIII.1771, *Commerson* 132 ♂ (P); ibid., VII-VIII.1771, *Commerson* s.n. ♀, fr. (G, K, P); ibid., VII.1905, Herb. d'Alleizette s.n. (L); ibid. coll.? (MPU); s.l., *Pourret* s.n. (P); Herb. Candolle s.n. (G).

Mauritius: «Pointe de Flacq», 10.I.1947, *Morin* s.n. (BM).

1.d. **Najas marina** L. subsp. **armata** (Lindb. f.) Horn af Rantz., Kew Bull. 7,1: 29-30 (1952), Robyns & Tournay, Fl. Spermat. Parc Nat. Albert, 3: 17 (1955); Van der Ben, Expl. hydrobiol. Lacs Kivu, Edouard et Albert, 4 (1): 46, 50, 53, 55, 57, 82-97, 126, 166-168, tab. VI (1959) p.p.; Troupin, Ann. Mus. Roy. Afr. Centr., sér. in-8°, Sc. écon., 7: VI.266 (1971); Lewalle, Bull. Jard. bot. nat. Belg., 42: 244 (1972); Reeckmans, Lejeunia, nouv. sér., 100: 45 (1980); Triest & Symoens, Fl. Afr. Centr., Najadaceae: 4 (1983); Triest & Symoens, Bull. Jard. bot. nat. Belg., 55 (1/2): 261-269 (1985); Triest et al., Aq. Bot. 24: 373-384 (1986). — ≡ *N. muricata* Del., Descr. Egypte, Hist. Nat. 2: 281, pl. 50, fig. 1 (1813) non Thuill., Fl. Paris ed. 2: 510 (1799); Cham., Linnaea 4: 500 (1829); A. Br., Journ. Bot. 2: 276 (1864); Boissier, Fl. Orient. 5: 27-28 (1882); Battand. & Trabut, Fl. Alger, Monoc.: 11 (1884); Aschers. & Schweinf., Ill. Fl. Egypte (Mém. Inst. Egypte 2,1): 144 (1887); Schweinf., Beitr. Fl. Aethiop.: 292 (1887); Durand & Schinz, Consp. Fl. Afr. 5: 500 (1894); Battand. & Trabut, Fl. Algérie 1, (2): 10 (1895); Battand. & Trabut, Fl. Algérie Tunisie: 315 (1905); Battand., Algérie, Suppl. phan.: 84 (1910). — ≡ *Caulinia muricata* (Del.) Sprengler, Syst. Veget. ed. 6, 1: 20 (1825). — ≡ *N. marina* L. var. *muricata* (Del.) A. Br. ex K. Schum. in Mart., Fl. Bras., 3, 3: 725 (1894) non Hartm., Handb. Skand. Fl., ed. 9, 1: 197 (1864); Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12): 397, pl. 39, fig 12 (1899); Rendle, l.c., (13): 440 (1900); Rendle in Engler, Pflanzenr. H.7: 8,9, fig. 3D (1901); Bennett in This.-Dyer, F.T.A. 8, 2: 226 (1901); Engler, Pflanzenw. Afr. in Engler & Drude, Veget. Erde 9, 2: 98 (1908); Muschler, Man. Fl. Egypt 1: 22, 23 (1912); De Wild., Pl. Bequaert, 4: 309 (1928); Aly Ibrahim Ramis, Bestimmungstabellen Fl. Aeg.: 20 (1929); Emberger & Maire, Cat. Pl. Maroc. 4: 922 (1941). — ≡ *N. delilei* Rouy, Fl. France 13: 294 (1912); Mouterde, Nouv. Fl. Liban et Syrie 1: 24 (1966). — ≡ *N. armata* Lindb. f., Acta Soc. Sci. Fenn. B, 1, 2: 8 (1932); Täckholm V. & G. & Drar, Fl. Egypt 1: 113-114 (1941); Täckholm V., Stud. Fl. Egypt, ed. 1: 582 (1956); Täckholm V., Stud. Fl. Egypt, ed. 2: 622 (1974). — ≡ *N. marina* L. var. *delilei* (Rouy) Maire, Fl. Afr. Nord 1: 205-206 (1952); Cirujano & Lopez Alberca, Anal. Jard. Bot. Madrid, 40 (2): 415-419 (1984). — *N. marina* L. subsp. *delilei* (Rouy) Oberm. in Codd, de Winter & Rycroft,

Fl. S. Afr. 1 : 82-83 (1966), non valid, uncorrectly attributed to Maire; Musil, Grunow & Bornman, Bothalia 11 : 185 (1973); Welsh & Denny, Biol. Journ. Linn. Soc., 10, 1 : 72, 73, 76, 79 (1978); Reekmans, Lejeunia, nouv. sér., 100 : 45 (1980); Musil & Ward, Garcia de Orta, Sér. Bot., Lisboa, 6 (1-2) : 151-162 (1983-84). — TYPE : Egypt, « Fâreskour », Delile in Herb. Delile (holo- : MPU). The locality is given in the original description, but not mentioned on the label.

— *N. marina* L. var. *ehrenbergii* auct. non (A. Br.) Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12) : 394, pl. 39, fig. 10, 27 (1899) p.p. quoad *Letourneux* s.n.; Rendle in Engler, Pflanzenr. H.7 : 8, fig. 3 B & N (1901) p.p. quoad Tunis; Maire, Fl. Afr. Nord, 1 : 205-206 (1952) p.p. quoad Tunis, « teste Rendle, Pflanzenr. »; Cuenod, Fl. anal. & syn. Tun. : 43 (1954) p.p. quoad « Tunis, Rendle, rare ».

— *N. marina* auct. non L. : Jahandiez & Maire, Cat. Pl. Maroc, 1 : 20 (1931); Van Meel, Explor. hydrobiol. Lac Tanganika (1946-1947) 1 : 52 (1952); Van Meel, Explor. hydrobiol. Lac Tanganika (1946-1947) 4, 1 A : 86, 87, 90, 114 (Table 4) (1954); Quézel & Santas, Nouv. Fl. Algérie : 53-54 (1962) pro syn. *N. muricata*; Jacot Guillarmod, Bontebok 2 : 44 (1982); Weisser & Stadler, Proc. Int. Symp. Aquat. Macr. (18-23.IX.1983) : 298-305 (1983).

— *N. minor* auct. non All. : Maire, Fl. Afr. Nord, 1 : 207-208 (1952) p.p. quoad *Gauthier* s.n., Lake Fetzara.

— *N. pectinata* auct. non (Parl.) Magn. : Richards & Morony, Check list Fl. Mbala & Distr. : 252 (1969); Triest & Symoens, Fl. Afr. Centr., Najadaceae : 5 (1983) p.p. quoad *Kinet* 178.

Stems very spiny, about (10 –) 15-25 spines in 2 cm.; Leaves 6 – 20 (– 24) mm long and (1.1 –) 1.5-5.3 mm broad (incl. teeth on both sides) and 0.5-2.3 mm broad (excl. teeth); margins each with 4-10 teeth; seeds 2.5-3.5 mm long and 0.8-2.1 mm broad, ratio : 1.3-2.3 (– 3.2).

NOTES : 1. There is much variability within many characters of *N. marina* subsp. *armata*. Most of these variations are possibly (mainly) due to eco-physiological factors such as total mineralisation and salt concentration of the water. It is also remarkable how the distribution of this subspecies is almost restricted to coastal areas (Lagoons, lakes near the coast and Nile delta) and to Rift Lakes in the Middle East and Africa.

2. The specimens from Sri Lanka and Spain were sterile and could as well belong to subsp. *brachycarpa* or *microcarpa* respectively.

3. Whether subsp. *armata* occurs in Sicily could not be stated here. In FI there are collections from Sicily, clearly belonging to *N. marina* subsp. *marina* var. *marina* (e.g. *Ross.* s.n., Palermo, a specimen cited in many works).

4. Subsp. *armata* from Northern Africa and Minor Asia, can have somewhat smaller seeds than those from tropical and southern Africa; 2.5-3.1 × 0.8-2.0 mm versus 2.7-3.5 × 1.5-2.1 mm, respectively.

5. An extensive study on the auto-ecology of Israelian *Najas marina* is recently achieved by Agami.

6. An Israelian population had $2n = 24$ chromosomes, most probably related as well to subsp. *intermedia* ($2n = 12$) as to subsp. *armata* from Burundi ($2n = 12$). See also chapter on cyto- and chemotaxonomy.

7. The delimitation between subsp. *armata* and subsp. *intermedia* is very difficult in Asia Minor.

8. *N. marina* subsp. *armata* was collected mixed with *N. minor* near Gheit el Nassara in Egypt (Simpson 1649) and with *N. horrida* in Tonya, Uganda (*Lowe* s.n.).

9. Specimens from Northern Africa and Middle East mostly were collected when flowering or fruiting (90 %), while sterile plants are rather rare (10 %). On the contrary, in tropical and northern Africa, the proportion of fertile collections has decreased (30 %) whilst that of the sterile collections has increased (70 %). Several collections from tropical Africa show creeping stems with young plants, suggesting a perennial propagation.

GEOGRAPHICAL DISTRIBUTION: Africa (mainly coastal areas and rift lakes), Spain, Turkey, Syria, Israel, Iraq and Sri Lanka (African distribution: fig. 2).

SELECTED SPECIMENS:

Morocco: « Guelta de l'oued Aabar », 29.VI.1961, *Sauvage* (Miss. Prov. Tarfaya) 16393 (MPU); Goulimine, « Cours inférieur du Dra, guelta Terga », 21.I.1947, *de Brettes, Panouse & Sauvage* in Herb. Sauvage 4896 (MPU); Marrakech, Agdal, 21.V.1926, *H. Lindberg* 3027 (H); ibid., 20.VII.1926, *Maire* s.n. in Herb. Maire (MPU, P); « ad ostium omnis Ait-Amer », 15.VI.1939, *Maire & Weiller* s.n. in Herb. Maire 51 (BRVU, MPU, P).

Algeria: « A l'Alma dans le Boudouaou », XI.1887, Herb. Duval-Jouve s.n. (MPU); Oued Boudouaou, IX.1878, *Battandier & Trabut* s.n. in Herb. Maire (BRVU, MPU, P); Oued Boudouaou and Oued Reghaiä, 1879, *Battandier* s.n. (P); Annaba, Seba, *Letourneux* 186 (P); Lake Fetzara, *Gauthier* s.n. in Herb. Maire (MPU); s.l., 1878, *Battandier* s.n. in herb. Delacourt (K).

Egypt: Alexandria, II.1877, *Fürstenau* s.n. (ZT); Maryut swamps, c. 15 km W. Alexandria, 28.V.1986, *Triest & El Khanagry* 585 (BR, BRVU, CAI, CAIM); 188 km from Cairo on desert road Cairo-Alexandria, 20.VIII.1971, *Imam, Ibrahim & Mahdi* s.n. (CAI); ibid., 180 km from Cairo, 24 IX.1971, *Imam, Ibrahim, Mahdi & Sisi* (CAI); ibid., 160 km from Cairo, Nubariya, 27.V.1986, *Triest & El Khanagry* 558 (BR, BRVU, CAI, CAIM); Idku lake, N. Shore, 28.V.1986, *Triest & El Khanagry* 593 (BR, BRVU, CAI, CAIM); Borollos lake, Masrof fua, 15.IX.1928, *Mustafa & Sabet* s.n. (CAI); ibid., between Hamul & Baltim, 10.IX.1929, *Hafnawy* s.n. (CAI); ibid., S. of Baltim, 29.V.1986, *Triest & El Khanagry* 607 (BR, BRVU, CAI, CAIM); Dumyât (Damiette) V.1821, *Sieber* s.n. (BM, BR, FI-W, G, K, M, P); ibid., I.1822, in Herb. Mertens & Herb Fischer s.n. (LE); ibid., Herb Ledebour s.n. (LE); ibid., Herb. Klinge s.n. (LE); ibid., Herb. Bernhardi (MO); ibid., *von Reichenbach* s.n. in Herb. Sieber (BRVU); *Shuttleworth* s.n. (BM); Herb. Steven s.n. (H); ibid., Gheit el Nassara, 1.V.1922, *Simpson* 1001 (CAIM, K); ibid. *Simpson*

1649 (K); Esbeh, 29.VII.1826, Herb. Delessert s.n. (G); Fariskiir, 1821, *Ehrenberg* s.n. (LE, MPU); Kafr el Dauwār, X.1876, *Letourneux* s.n. (AAU, BM, LY); ibid, 1881, Herb. Sickenberger s.n. (Z); Lake Mahasama, 26.VI.1924, *Simpson* 2885 (K); Benha, 15.XI.1926, *Hassan* 4246 (CAIM, K); Abu Hammad, 24.XII.1928, *Shabatai* Z850 (CAIM); Bilbeis, 11.VIII.1927, *Simpson* 5224 (CAIM, K); Giza, 28.X.1926, *Hassan* 4093 (CAIM, K); Geziret el Roda, 6.IX.1927, *Simpson* 5434 (CAIM, K); El Murabein, Sidi Ghazi, Gharbia, 3.XI.1967, *Täckholm, Imam & El Hadidi* s.n. (CAI); Wadi Natrun, canal near Birket Umm Richa, 26.V.1986, *Triest & El Khanagry* 556 (BR, BRVU, CAI, CAIM); Fayoum, 1845, *Figari* s.n. (FI, LE); Qarun Lake, 1881, Herb. Sickenberger s.n. (Z); ibid., 12.III.1883, *Deflers* 1240 (MPU); ibid., 6.XII.1956, Bot. Dept. Exc. (CAI); ibid., 13.X.1967, *Täckholm, Imam & El Hadidi* s.n. (AAU, CAI, G, K, MO, TUR); ibid., 20.XI.1968, *El Hadidi* s.n. (CAI); ibid., 4.III.1969, *Wanntorp & Sjödin* 2023 (K); ibid., 16.X.1970, *Imam, Mahdi & Ibrahim* s.n. (CAI); Sennuris, 8.XII.1967, *Täckholm, Imam & El Hadidi* s.n. (CAI); Wadi Rayan, first lake, 25.V.1986 *Triest, El Khanagry & Diwan* 553 (BR, BRVU, CAI, CAIM); Kharga Oasis, 16.I.1928, *G. Täckholm* s.n. (CAI); Aswan High Dam Lake, 14.IV.1986, *M. Ali* 4535 (ASW); Auja river, Jarisheh, Arab. Coll. s.n. (K); « In Reg. infr. ad. », 1820-1826, *Ehrenberg* s.n. (BR, K, P); s.l., 1832, *Sieber* s.n. (P); *Gay* s.n. (K); *Delile* s.n. in Herb. Delile (MPU); 1822, *Sieber* s.n. In Herb. Delile (MPU); 1834, *Wilkinson* s.n. (BM); 1822, comm. Steven (LE); Herb. Schultes (M).

Ethiopia : Harar Prov., Lake Hertalle, 26.XI.1972, *Ash* 1773 (K, MO).

Uganda : Lake Mobutu Sese Seko (Albert), *Stuhlman* 2841 (BM); ibid., Tonya, 4.III.1950, *Lowe* s.n. (BM).

Zaïre : Haut Zaïre, Bogoro, 1921, *Claessens* 1266 (BR); Lake Edward, Rutshuru, 10.IX.1953, *Robyns* 4075 (BR); ibid., Kabare, 21.VIII.1914, *Bequaert* 5376 (BM, BR); ibid, Mbirisi, 8.II.1953, *Van der Ben* 73 (BR); Lake Kivu, N.W. Idjwi, 22.II.1953, *Van der Ben* 156 (BR); Lake Tanganyika, Mulongwe-Uvira, 12.III.1957, *Kinet* 178 (BR, K); ibid., Ruhanga, 23.IX.1979, *Ankei* 79/0040 (BR).

Rwanda : Lake Kivu, Cyangugu, *Vervoort* 7 (BRVU).

Burundi : Rusizi delta, 15.II.1968, *Lewalle* 2837 (BR, K, WAG); ibid., 14.XI.1971, *Lewalle* 6288 (BR, G); ibid., 14.XI.1971, *Reekmans* 1162 (BR); ibid., Katumba, 12.IX.1974, *Reekmans* 3510 (BR, MO), ibid., 13.IX.1974, *Van der Veken* 11208 (BR, Z); ibid., Lake Dogodogo, 19.IV.1983, *Mpawenayo* s.n. (BRVU); Bujumbura, XII.1960, *Hendrickx* 7849 (BR).

Tanzania : Nyumba Ya Mungu Reservoir, off Mikocheni, 9.VIII.1974, *Welsh & Denny* NYM 96 (Herb. Denny); ibid., Samanga, 21.VIII.1974, *Welsh & Denny* NYM 133 a, b, c (Herb. Denny); Lake Tanganyika, Karema, « Dragage », 22.XII.1946, *Van Meel* 331 (BRLU).

Zambia : Lake Tanganyika, Niamkolo Bay, 3.VIII.1904, *Cunnington* 17 (BM); ibid., Mpulungu, 9.III.1952, *Richards* 1012 (K); ibid., 20.X.1947, *Greenway & Brenan* 8243 (BM, K).

Malawi: Lake Malawi, Nkhotka Kota, *Cunnington* 9 (BM); Shire river near Liwonde, 20.III.1956, *Jackson* 1828 (K).

Mozambique: Inhambane Distr., Lake Poelela, III. 1838, *Gomes e Sousa* 2107 (K); ibid., 26.I.1954, *Schelpe* 4506 (BM); ibid., 2.IV.1970, *Correia & Marques* 1543 (BRVU, WAG).

Botswana: Tsokotse Pan, 7.XIII.1978, *P.A. Smith* 2565 (K).

Republic of South Africa: Natal: Ndumu Game Reserve, Nyamiti Pan West, 7.X.1972, *Ward* 8052 (K); Kosi System, Nhlange Lake East, 9.I. 1974, *Ward* 8520 (E, K, MO); ibid., NPB launching site, 10.I.1974, *Ward* 8530 (K); Richards Bay, Msingazi Canal, 7.I.1975, *Ward* 8748 (K). Cape Prov.: George, Ronde Vlei, I.1924, *Stephens* s.n. (BM); Knysna, Lake Pleasant, 20.VII.1966, *Déathe* s.n. (K).

1.e. **Najas marina** L. subsp. **arsenariensis** (Maire) Triest comb. nov. — ≡ *N. arsenariensis* Maire, Bull. Soc. Hist. Nat. Afr. Nord, 31: 215-216 (1941); Maire, Fl. Afr. Nord, 1: 206-207 (1952); Quézel & Santas, Nouv. Fl. Algérie: 53-54 (1962). — TYPE: Algeria, Lake Melah, « Saline d'Arzeu », *Battandier* s.n. in Herb Maire (holo-: MPU; iso-: P).

Stems not very spiny, about 0-10 spines in 2 cm; leaves 3.6-4.0 mm long and 1.6-2.6 mm broad (incl. teeth on both sides) and c. 1 mm broad (excl. teeth); margins each with 0-2 teeth; seeds unknown.

GEOGRAPHICAL DISTRIBUTION: Only known from the type locality: **Algeria**, Lake Melah, Arzew (Fig. 2).

NOTES: 1. MAIRE (1941) stated that the type collection of *N arsenariensis* could belong as well to the subgenus *Najas* as to the subgenus *Caulinia*. Characters of subgenus *Najas* were: « les internœuds muriqués; la plante paraît dioïque (♂ pas trouvé) ». Characters of subgenus *Caulinia* were: « sa gracilité; l'absence des dents dorsales sur les feuilles et la gaine; ♀ perianthées (non nues); tégument séminal semble? une couche de cellules sclérifiées ». However, the type collection at MPU and P clearly belongs to subgenus *Najas*. It has only male flowers and lacks fruits. This does not agree with the original description in which fruits were described with only a unicellullar layer of the testa. These must have been the male flowers with the spathe misinterpreted as the testa.

2. This collection remains remarkable because of the extremely small leaves (shorter than 4 mm; 0-2 leaf teeth; sheath, 1.2-1.5 mm wide). It was collected in Lake Melah, formed in an old river valley, which communicates with the sea by a channel about 1 km long through the dunes. The salinity reaches 8.5 $g.l.^{-1}$ (MORGAN, 1982).

3. Apparently close to subsp. *aculeolata* Tzvelev, when regarding the extremely short leaves. The seed areoles of subsp. *aculeolata* are more or less regular. This character could not be verified yet on material from Lake Melah.

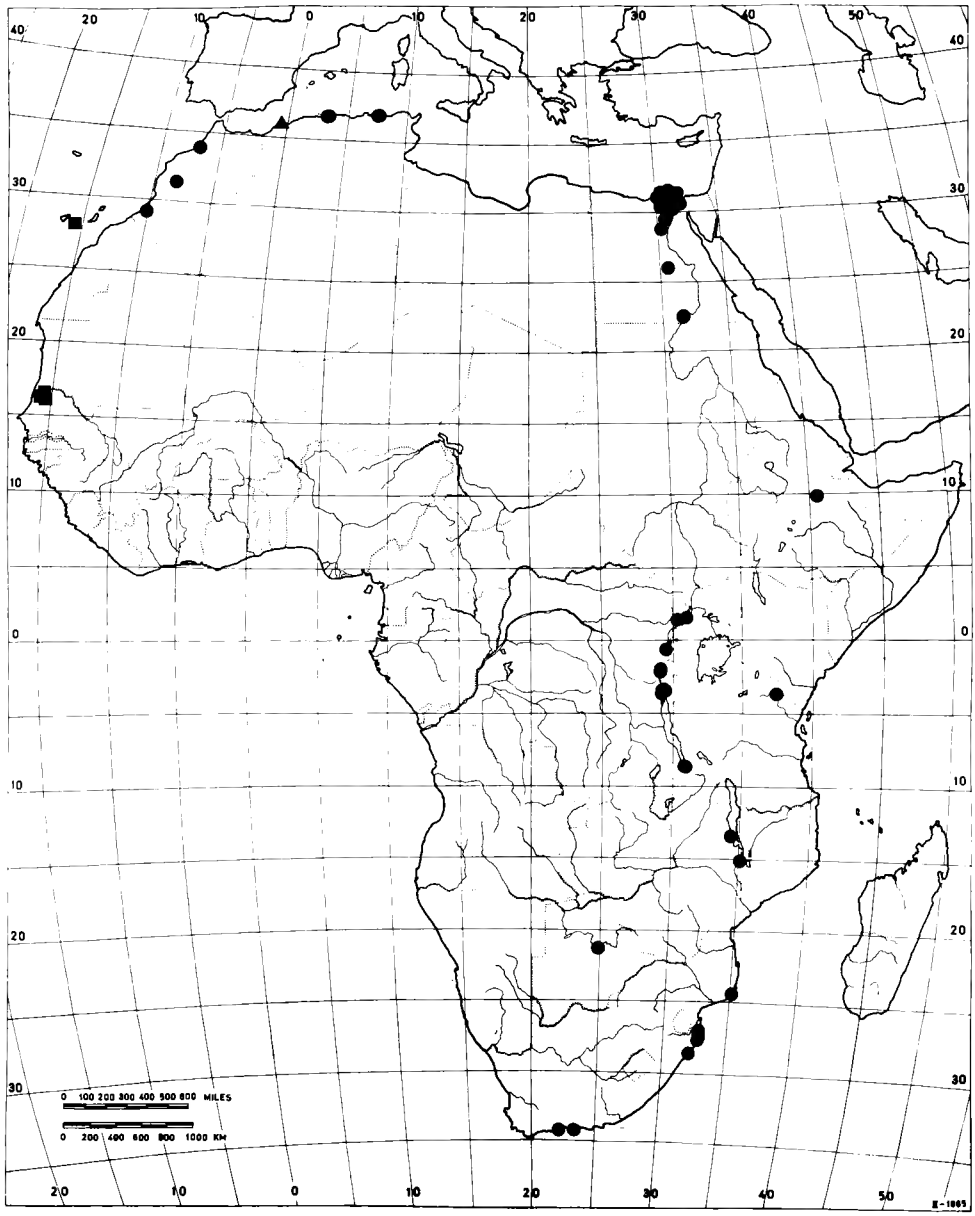

FIG. 2. — *N. marina* subsp. *armata* (circles), subsp. *microcarpa* (squares) and subsp. *arsenariensis* (triangle).

II. SUBGENUS **Caulinia** (Willd.) A. Br. ex Rendle

Trans. Linn. Soc., ser. 2, Bot. 5 (12): 398 (1899)

≡ Genus *Caulinia* Willd., Mém. Acad. Roy. Sci. Hist. Berl.: 87 (1798). — ≡ « Group » *Caulinia* (Willd.) Ascherson, Fl. Prov. Brandenb. 1: 670 (1864), stat. non ind. — ≡ Section *Caulinia* (Willd.) A. Braun, Journ. Bot. 2: 276 (1864).

DIAGNOSTIC FEATURES: *Plants* monoecious, mostly slender. *Stems* unarmed; epidermis not distinctly differentiated from the underlying cortex. *Leaves* with blade minutely to coarsely serrate, (2-) 5-30 (-70) spiny teeth on each margin; midrib glabrous; sheaths rounded, truncate or auriculate; intravaginal scales lanceolate to filiform. *Male flower* naked or enclosed in spathe; anther 1- or 4-sporangiate. *Female flower* naked or enclosed in spathe. *Seed* elliptical oblong; testa 3 cell-layers thick; areoles all about of same size (except near raphe), mostly regularly arranged.

SPECIES: 12 in Africa and surrounding islands (Socotra, Aldabra, Madagascar and Mascarenes).

LECTOTYPE SPECIES: *Caulinia flexilis* Willd. — *Najas flexilis* (Willd.) Rostk. & Schmidt (Lectotype designated by HAYNES, 1979).

KEY TO SPECIES

1. Leaf sheath rounded.
   2. Leaf teeth not on excrescences (or only little protruding); septa absent ..... 2. *N. australis*
   2. Leaf teeth on excrescences, exceeding 1/5 to 3 times the leaf width, at least in the upper half of the leaf; septa mostly present.
      3. Male and female flower each in spathe.
         4. Anther 4-sporangiate.
            5. Leaf margin constricted; the lower half of leaf margin without teeth ..... 3. *N. madagascariensis*
            5. Leaf margin not constricted; the whole margin provided with teeth 4. *N. welwitschii*
         4. Anther 1-sporangiate ..... 5. *N. pectinata*
      3. Male flower in spathe; female flower naked ..... 6. *N. horrida*
1. Leaf sheath truncate to deeply auriculate.
   6. Seed areoles arranged irregularly, (9-) 11-15 (-23) in each longitudinal row; cell walls raised; male and female flower each in spathe.
      7. Anther 4-sporangiate; seeds (1.8-) 2.1-2.3 (-2.6) mm long ..... 7. *N. testui*
      7. Anther 1-sporangiate; seeds (1.1-) 1.3-1.5 (-1.6) mm long ..... 8. *N. schweinfurthii*
   6. Seed areoles arranged regularly, (18-) 25-100 in each longitudinal row; cell walls not raised; male flower naked or in spathe; female flower naked.
      8. Seed areoles broader than long, arranged ladder-like, (60-) 80-100 in each longitudinal row; male flower in spathe ..... 9. *N. minor*
      8. Seed areoles longer than broad, arranged per (18-) 25-35 (-60) in each longitudinal row, never ladder-like; male flower in spathe or naked.
         9. Male flower in spathe; anther 1-sporangiate.
            10. Leaves with fibres near each margin, near and on the midrib; seed areoles 21-30 in each longitudinal row; leaf sheath 1.3-1.5 (-1.8) mm long ..... 10. *N. hagerupii*

10. Leaves without fibres; seed areoles 28-36 in each longitudinal row, leaf sheath 1.7-2.4 mm long ..... 11. *N. setacea*

9. Male flower naked; anther 1- or 4-sporangiate.

11. Leaf teeth mainly on excrescences, auricle 0.12-0.55 (-0.93) mm long; anther 1-sporangiate ..... 12. *N. baldwinii*

11. Leaf teeth not on excrescences; auricle (0.4-) 0.8-1.2 (-1.5) mm long; anther 4-sporangiate ..... 13. *N. graminea*

2. **Najas australis** Bory ex Rendle

Trans. Linn. Soc., ser. 2, Bot. 5 (12): 421-422, pl. 42, fig. 172-176 (1899) p.p. quoad Mauritius et Bourbon; Rendle in Engler, Planzenr. H. 7: 17, fig. 5K (1901) p.p. quoad Mauritius et Bourbon; Horn af Rantz., Kew. Bull. 7,1: 32 (1952) p.p. quoad Mauritius et Bourbon; Scott, Fl. Mascar. 195: 3 (1984) p.p. — TYPE: Mauritius, *Bory de St. Vincent* in Herb. Willdenow 17093 (holo-: B; iso-: BM, P, microfiche K).

— *N. indica* auct. non (Willd.) Cham.: Durand & Schinz, Consp. Fl. Afr. 5: 499-500 (1894); Jacob de Cordemoy, Fl. Réunion: 135 (1895).

— *N. minor* All. var. *indica* auct. non (Willd.) R. Br. A. Br., Journ. Bot. 2: 278 (1864) p.p. quoad *Bory de St. Vincent* in Herb. Willd.

— *N. graminea* auct. non Del.: Johnston, Trans. Proc. Bot. Soc. Edinb. 20, 59: 401 (1895).

— *N. madagascariensis* auct. non Rendle: Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (13): 441 (1900); Scott, Fl. Mascar. 195: 2 (1984) p.p. quoad « St. Paul ».

— *N. australis* Bory ex Cham., Linnaea 4: 501 (1829) (unvalid publ., only as synonym of *N. indica);* A. Br., Journ. Bot. 2: 278 (1864) (only as synonym of *N. minor* All. var. *indica).*

— *Caulinia alternifolia* Willd. ex Cham., Linnaea 4: 501 (1829) (unvalid publ., only as syn. *N. indica*).

— *N. alternifolia* Willd. ex A. Br., Journ. Bot. 2: 278 (1864) (unvalid publ., only as syn. *N. minor* All. var. *indica).*

Plants submerged, monoecious, slender. *Stems* unarmed, up to 50 cm long, about 0.5 mm in diameter, often plumose above because of the closely packed leaves. *Leaves* 20-42 mm long, flat, acute, linear-lanceolate, 0.43-1.00 mm wide (incl. tooth on both sides), 0.26-0.65 mm wide (excl. teeth on both sides); margin on each side minutely serrulate with 10-40 inconspicuous spiny teeth, mainly consisting of the brownish spine-cell (a unicellular tooth, invisible to the unaided eye); leaf teeth 0.05-0.15 (-0.23) mm long, the ratio of teeth length to leaf width being 0.07-0.30 (-0.42); midrib without spines; septa and fibres absent; leaf sheath rounded, 1.77-4.50 mm long (incl. spine-cells) and 1.3-2.9 mm wide (ratio = 1-2), serrulate with (2-) 8-12 spine cells on each side.

Inflorescences axillary, male and female flowers solitary, generally on different branches. *Male flower* enclosed in a spathe c. 2 mm (incl. spathe-neck) by 0.7 mm; neck of the spathe about 0.7 mm, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding c. 0.2 mm above the anther; anther c. 0.8 mm by 0.5 mm, 4-sporangiate. *Female flower* naked; ovary 1.3-1.6 mm by 0.4-0.5 mm; style and stigma 1.1-1.6 mm; stigma 2-lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style. *Seed* 1.6-1.9 mm by 0.5-0.6 mm, elliptical oblong (ratio = 3.0-3.2); testa pitted with areoles, the latter arranged regularly in longitudinal rows, each row of c. 30-35; areoles rectangular, 0.050-0.065 mm long.

DIAGNOSTIC FEATURES: Plants monoecious; stems and midrib of leaf unarmed; leaves 0.43-1.00 mm wide (incl. teeth on both sides); leaf teeth not on excrescences; leaf teeth 0.05-0.15 (-0.23) mm long; septa and fibres absent; leaf sheath rounded; male flower in spathe; anther c. 0.8 mm long; 4-sporangiate; female flower naked; seed elliptical oblong, 1.6-1.9 mm long; areoles arranged regularly per c. 30-35 in each longitudinal row, never ladder-like; cell walls not raised.

NOTES: 1. *N. australis* does not occur in Madagascar. RENDLE (1899b, 1901) and PERRIER DE LA BÂTHIE (1950), stated it does.

2. *Johnston* s.n. (23.X.1888) is cited in RENDLE (1899b) under *N. australis* and in RENDLE (1900) under *N. madagascariensis.*

3. *De L'Isle* s.n. (22.XII.1875), from « La Digue », Seychelles, was collected mixed with *N. setacea.*

4. The collections *Humblot* 351 (cited in RENDLE, 1899b and PERRIER DE LA BÂTHIE, 1950) and *Decary* 7826 (cited in PERRIER DE LA BÂTHIE, 1950) are *Ceratophyllum.*

GEOGRAPHICAL DISTRIBUTION: Seychelles, Réunion and Mauritius (Fig. 3).

SELECTED SPECIMENS:

Seychelles: La Digue, 22.XII.1875, *De L'Isle* s.n. (P).

Réunion: St. Paul, 1875, *De L'Isle* 141 (BM, P); Ravine du Bernica, 5.IX.1962, *Cadet* 244 (P); « Exutoire de la source du Moulin à eau », 20.IV.1968, *Cadet* 1342 (K); Ravine de l'Hermitage, 30.III.1969, *Cadet* 2155 (K); St. Benoit, IX.1875, *De L'Isle* 563 (BM); 567 (P); s.l., *Bory de St. Vincent* s.n. in Herb. Delessert (G).

Mauritius: « Rivière de Moka », 23.X.1888, *Johnston* s.n. (BM, K); s.l., *Commerson* 133 (P); III.1888, Benneth comm. (K); 1843, *Bory de St. Vincent* s.n. (BM); *Bory de St. Vincent* in Herb. Willdenow 17093 (microfiche K); *Robilliard* s.n. (BM).

3. **Najas madagascariensis** Rendle

Trans. Linn. Soc. ser. 2, Bot. 5 (12): 402-403, pl. 10 fig. 55-63 (1899); Rendle in Engler, Pflanzenr. H. 7: 10-11, fig. 4A (1901) p.p. quoad Madagascar; Perrier

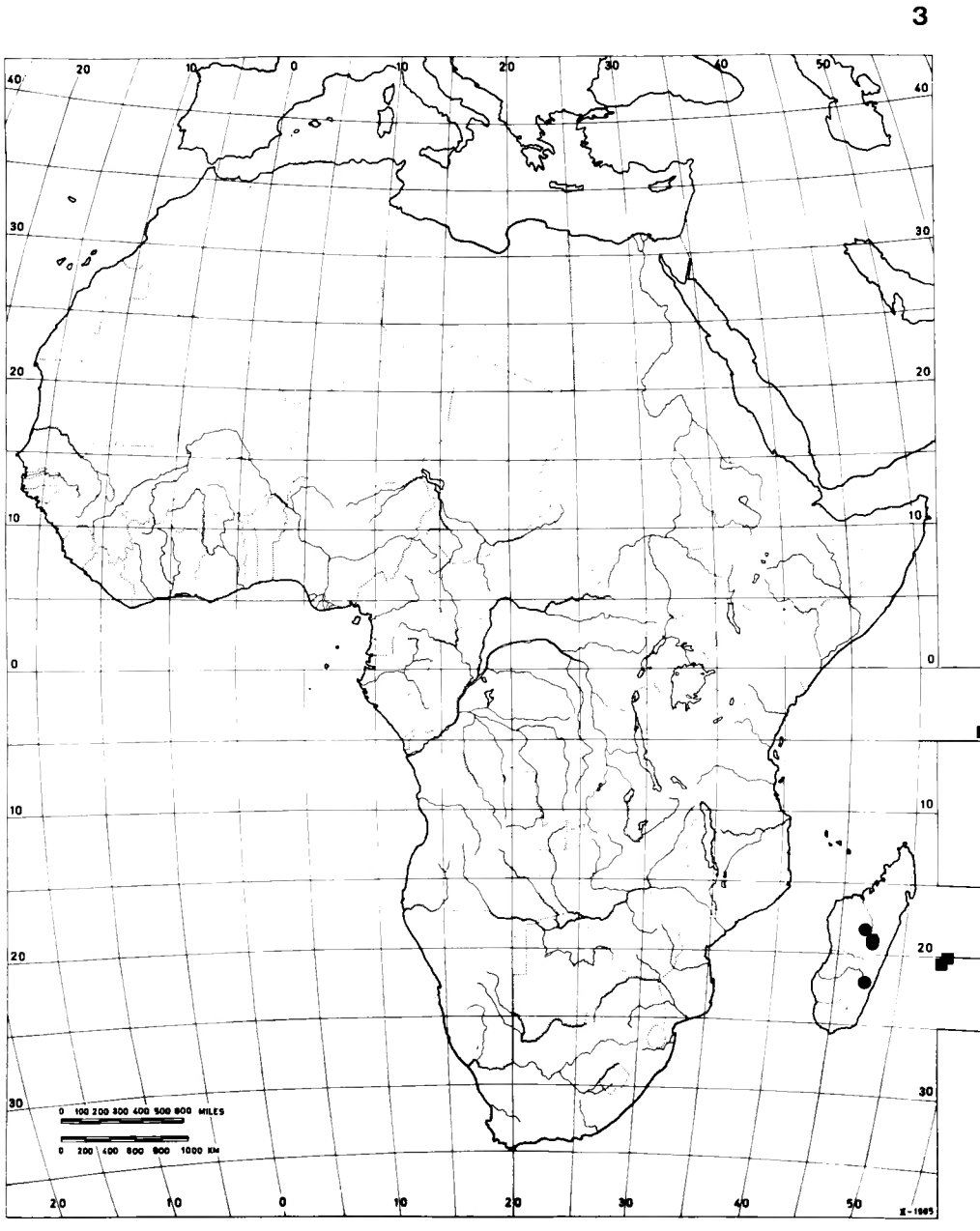

FIG. 3. — *N. madagascariensis* (circles) and *N. australis* (squares).

de la Bâthie in Humbert, Fl. Madag. 22e fam.: 4-5; fig. 1, 7-10 (1950) pro majore parte; Horn af Rantz., Kew Bull. 7, 1 : 31 (1952) p.p. quoad Madagascar. — TYPES: Madagascar, Tananarive, X.1880, *Hildebrandt* 4027 (holo-: B †; lecto-: BM; iso-: G, K, M, P), lectotype designated here; Central, *Baron* 3339 (syn- BM, K, P); *Baron* 3419 (syn-: K, P).

— *Najas australis* auct. non Bory ex Rendle: Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12): 421-422, pl. 42. fig. 172-176 (1899) p.p. quoad *Baron* 2629; Rendle in Engler, Pflanzenr. H.7: 17, fig. 5K (1901) p.p. quoad *Baron* 2629; Perrier de la Bâthie in Humbert, Fl. Madag., 22e fam.: 4, fig. 1, 11, 14 (1950) p.p. quoad *Baron* 2629; Horn af Rantz., Kew Bull. 7, 1 : 32 (1952) p.p. quoad Madagascar.

Plants submerged, monoecious, slender. *Stems* unarmed, up to 40 cm long, c. 0.5 mm in diameter, often plumose above because of the closely packed leaves. *Leaves* 13-45 mm long, flat, acute, linear-lanceolate, 0.42-0.94 mm wide (incl. teeth on both sides), 0.27-0.58 mm wide (excl. teeth on both sides); margin at least in the lower half of the leaf without teeth or minutely serrulate with inconspicuous spiny teeth, mainly consisting of the brownish spine-cell (a unicellular teeth, invisible to the unaided eye) and serrulate in the upper half with up to 17 conspicuous spiny teeth on small triangular excrescences; leaf teeth (0.05-) 0.10-0.26 mm long, the ratio of teeth length to leaf width being 0.1-0.3 in the lower part of the leaf (if any) and up to 0.9 in the upper part; midrib without spines; septa clearly visible and constricting the margin; fibres absent; leaf sheath rounded, 1.61-5.30 mm long (incl. spine-cells) and 1.50-3.87 mm wide (ratio = 1.1-1.7), serrulate with 3-8 (-14) spine-cells on each side; the sheath sometimes with a sinus which makes it then slightly auricled.

Inflorescences axillary, male and female flowers solitary, generally on the same branch but the male ones more to the top of the plant. *Male flower* enclosed in a spathe, 2.2-4.0 mm (incl. spathe-neck) by 0.8-1.0 mm; the neck of the spathe about 0.5 mm, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding 0.1-0.2 mm above the anther; anther c. 1.5 mm by 0.7 mm, 4-sporangiate. *Female flower* enclosed in a spathe, 2.0-3.0 mm (incl. spathe-neck) by 0.4 mm, the neck of the spathe being 0.6-1.0 mm, bearing brownish spine-cells on the apex: ovary c. 1.3 mm by 0.4 mm; style and stigma c. 1.0 mm; stigma 2-lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style and spathe. *Seed* elliptical oblong, 2.2-3.0 mm by 0.65-0.76 mm (ratio = 3.0-3.4); testa pitted with areoles, the latter arranged regularly in longitudinal rows, each row of 28-40; areoles rectangular to hexagonal, 0.056-0.08 mm long.

DIAGNOSTIC FEATURES: Plants monoecious; stems and midrib of leaf unarmed; leaves 0.42-0.94 mm wide (incl. teeth on both sides); 0-17 leaf teeth on each margin; leaf teeth on excrescences; leaf teeth (0.05-) 0.10-0.26 mm long; leaves with septa constricting the margin; fibres absent; leaf sheath rounded or slightly auricled; male flower in spathe, 2.2-4.0 mm long; anther c. 1.5 mm long, 4-sporangiate; female

flower in spathe; seed elliptical, oblong, 2.2-3.0 mm long; areoles arranged regularly per 28-40 in each longitudinal row, never ladder-like; cell walls not raised.

NOTES: 1. RENDLE (1899b, 1901), PERRIER DE LA BÂTHIE (1950) and HORN AF RANTZIEN (1952) believed that *N. madagascariensis* occured in Madagascar, Mauritius and Réunion. In fact, the distribution of *N. madagascariensis* is restricted to Central Madagascar. The specimens from Mauritius and Réunion mentioned earlier under *N. madagascariensis*, are considered here as either *N. australis* of *N. setacea*.

2. *N. madagascariensis* taxonomically comes very close to *N. welwitschii*.

GEOGRAPHICAL DISTRIBUTION: Central Madagascar (Fig. 3).

SELECTED SPECIMENS:

Madagascar: Central: Tananarivo, X. 1880, *Hildebrandt* 4027 (BM, G, K); ibid., 4026 (LE); ibid., Anosivato, 22.IV.1928, *Decary* 6264 (P); Ankazobé, Ambohimalaza, *Decary* 7733 (K, P); Farafanga Prov., Fort-Carnot, 11.X.1926, *Decary* 5658 (P); s.l. *Baron* 2629 (K, P); 3339 (BM, K, P); 3419 (K, P).

4. **Najas welwitschii** Rendle

Welwitsch Catal. Afr. Pl. 2, 1: 95 (1899); Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12): 401, pl. 39, fig. 46-52, pl. 40 fig. 53-54 (1899); Rendle in Engler, Pflanzenr., H. 7: 10 (1901); Bennett in This.-Dyer, F.T.A. 8, 2: 227 (1901); Horn af Rantz., Kew Bull. 7, 1: 32 (1952); Triest & Symoens, Fl. Afr. Centr., Najadaceae: 8 (1983). — TYPES: Angola, « Barra do Dande, Lagoas de Bombo », on the left of river Dande, *Welwitsch* 247b (lecto-: BM; iso-: K, P), lectotype designated here; Angola, « Barra do Bengo, Lagoa de Quifandongo », *Welwitsch* 247 (syn-: BM; iso-: COI, G, K, LE, P).

= *N. affinis* Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (13): 440-441 (1900); Rendle in Engler, Pflanzenr., H. 7: 10 (1901); Bennett in This.-Dyer, F.T.A. 8, 2: 226-227 (1901); Hutchinson in Hutchinson & Dalziel, F.W.T.A., ed. 1, 2, 2: 308 (1936); Horn af Rantz., Kew Bull. 7, 1: 32 (1952); Berhaut, Fl. Sénégal ed. 1: 53 (1954); Berhaut Fl. Sénégal ed. 2: 90 (1967); Hepper, F.W.T.A. ed. 2, 3, 1: 20 (1968); p.p. quoad *Leprieur*; Cook, Vegetatio 15: 232, 237 (1968); Lebrun, Enum. Pl. Vasc. Sénégal, Inst. Elev. & Médec. Vét. Pays Trop., Et. Bot. 2: 121 (1973). — TYPE: Sénégal, « In regio Senegalensi verisimiliter lecta », *Leprieur* (in Herb. Cosson) (holo-: P; iso-: BM, K).

— *N. pectinata* auct. non (Parl.) Magn.; Durand & Schinz, Consp. Fl. Afr. 5: 500 (1894) p.p. quoad Martin 81; Magn. in Ascherson & Schweinf., Ill. Fl. Egypte (Mém. Inst. Egypte 2, 1): 145 (1889) p.p. quoad Martin St. Ange; Hutchinson in Hutchinson & Dalziel ed. 1, 2, 2: 308 (1936) p.p. quoad Walo, near Keurmbaye, *Leprieur*; Roberty, Petite Fl. Ouest-Afr.: 370 (1954); Berhaut, Fl. Sénégal ed. 1: 53 (1954); Berhaut, Fl. Sénégal ed. 2: 90 (1967); Cufodontis, Bull. Jard. Bot. Nat.

Belg. 38, 4, suppl. : 1201 (1968) p.p. quoad « Fazokl »; Hepper, F.W.T.A. ed. 2, 3, 1 : 20 (1968) p.p. quoad *Leprieur* et *Hall* cc 725; Lebrun, Enum. Pl. Vasc. Sénégal, Inst. Elev. & Médec. Pays Trop., Et. Bot. 2: 121 (1973); Lebrun et al., Cat. Pl. vasc. Niger (2e suppl.), Bull. Soc. Bot. Fr., 130, Lettres bot. (3): 253 (1983); Symoens, Fl. Cameroun 26: 66 (1984) p.p. quoad *J. & A. Raynal* 12671.

— *N. horrida* auct. non A. Br. ex Magn. : Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12): 422-423, pl. 42, fig. 183-191 (1899) p.p. quoad *St. Ange* et *Leprieur*; Rendle in Engler, Pflanzenr. H. 7 : 17, fig. 2, 5 N-P (1901) p.p. quoad *St. Ange* et *Leprieur*; Bennett in This.-Dyer, F.W.T.A., 8, 2 : 228 (1901) p.p. quoad *Leprieur* et *St. Ange*; Brown, Catal. Sudan Flow. Pl. : 86 (1906) p.p. quoad « Fazoghli »; Broun & Massey, Fl. Sudan: 368 (1929) p.p. quoad « Fazoghli ».

— *N. meiklei* auct. non Horn af Rantz. : Hepper, F.W.T.A. ed. 2, 3, 1 : 20 (1968) p.p. quoad *Hall* cc 723.

— *N. graminea* auct. non. Del. : Triest & Symoens, Fl. Afr. Centr., Najadaceae: 6, 8 (1983) p.p. quoad Kisantu, *Vanderyst* s.n., 27.I.1907.

Plants submerged, monoecious, slender or robust. *Stems* unarmed, up to 100 cm long, 0.4-1.0 mm in diameter, often bushy above because of the curved leaves. *Leaves* 9.2-20(-40) mm long, flat or bulk, acute, linear-lanceolate; 0.50-1.53 mm wide (incl. teeth on both sides), 0.32-0.72 mm wide (excl. teeth on both sides); margin on each side serrulate with 6-20 conspicuous spiny teeth on broad triangular excrescences; leaf teeth 0.14-0.54 mm long; the ratio of teeth length to leaf width being 0.24-1.3; midrib without spines; septa clearly visible; fibres absent; leaf sheath sloping to rounded 0.96-3.87 mm (incl. spine-cells) by 1.29-3.10 mm (ratio : 0.5-1.2), serrulate or lacerate with 1-14 spine-cells on each side.

Inflorescences axillary, male and female flowers solitary, on different branches or on the same branch, but the male ones more to the top of the plant. *Male flower* enclosed in a spathe, 1.45-3.0 mm (incl. spathe-neck) by 0.40-0.64 mm; neck of the spathe about 0.5 mm, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding 0.1-0.2 mm above the anther; anther 0.88-1.0 mm by 0.32-0.50 mm, 4-sporangiate. *Female flower* enclosed in a spathe, 1.45-3.00 mm (incl. spathe-neck) by 0.29-0.88 mm, the neck of the spathe along about halfway the style, with or without brownish spine-cells on the apex; ovary 0.64-2.33 mm by 0.25-0.78 mm; style and stigma 0.50-1.40 mm; stigma 2-lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style and spathe. *Seed* elliptical oblong, 1.60-2.50 mm by 0.46-0.85 mm, (ratio = 2.7-3.9); testa pitted with areoles, the latter arranged regularly in longitudinal rows, each row of 20-32; areoles squarrish to rectangular, 0.056-0.080 mm long.

DIAGNOSTIC FEATURES : Plants monoecious; stems and midrib of leaf unarmed; leaves without spines on midrib; 6-20 leaf teeth on each margin, leaf teeth on excrescences; leaf teeth 0.14-0.54 mm long; septa present; fibres absent; leaf sheath rounded; male flower in spathe; anther 0.88-1.00 mm long; 4-sporangiate; female

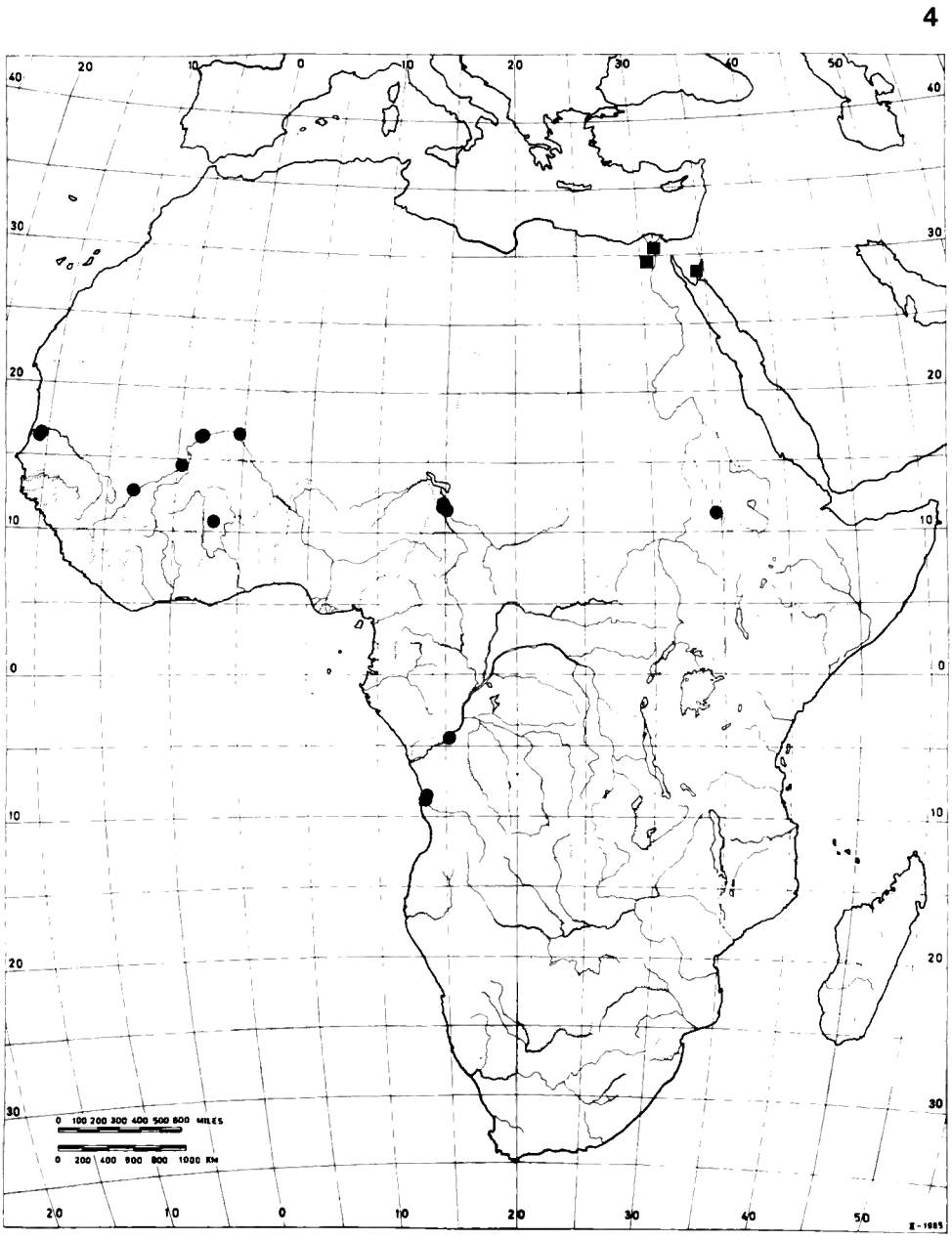

FIG. 4. — *N. welwitschii* (circles) and *N. pectinata* (squares).

flower in spathe; seed elliptical, oblong; areoles arranged regularly per 20-32 in each longitudinal row; never ladder-like; cell walls not raised.

NOTES: 1. The general aspect of *N. welwitschii* is very similar to *N. horrida* and *N. pectinata*. Sterile specimens are easy to identify as belonging to this group, by the rounded leaf sheaths, and large leaf teeth, both clearly visible tot the naked eye. However identification at species level is impossible without flowers.

2. *N. welwitschii* and *N. horrida* are known from the same area in Northern Senegal, Mali, Northern Cameroon and from the Blue Nile region in Sudan.

3. *N. welwitschii* is found mixed with *N. graminea* in Senegal (*Bamps* 7566).

4. *N. welwitschii* is collected in rice fields in Senegal (*Bamps* 7566).

GEOGRAPHICAL DISTRIBUTION: tropical Africa (Fig. 4).

SELECTED SPECIMENS:

Senegal: « In regio Senegalensi verisimiliter lecta », *Leprieur* in Herb. Cosson s.n. (BM, K, P); « Oualo », Keurmbaye, V.1827, *Leprieur* s.n. (K, P); « Pays de Walo », 1829; *Leprieur* s.n. (P); s.l., *Bory de St. Vincent* s.n. (P); Tignet, 28.I.1966, *Audru* 3160 (ALF); 3164 (ALF); 13 km W Richard Toll, 10.XI.1984, *Bamps* 7566 (BR);

Mali: Bamako, 3.III.1963, *Demange* 1131 (P); Niger River, Tombouctou, Bougoubéri, 4.III.1932, *Chevalier* 43836 (P); ibid., Kabara, Rharous, 5.III.1932, *Chevalier* 43836 (P); ibid., Bourem, 14.III.1950, *Chevalier* (BRVU, P); Saré Kina, Namaroye, I.1961, *Demange* 1128 (P).

Niger: Kokomani, 8.XII.1979, *Garba Saadou* 1497 (ALF).

Ivory Coast: Parc Komaé, 10.VI.1977, *César* 607 (ALF).

Ghana: Lawra, 4.IX.1965, *Hall* cc 723 (K); cc 725 (K).

Cameroon: Maltam, 25 km WNW. Kousséri, 26.XII.1964, *Raynal* 12671 (P, YA); S. Kousséri, Logone River, 15 km S. Logone Birni; 7.X.1964, *W. de Wilde & B. de Wilde-Duyfjes* 3680 (WAG).

Chad: 20 km S. N'Djamena, road to Bongor, 1.I.1965, *W. & J. de Wilde & B. de Wilde-Duyfjes* 5156 (BR).

Sudan: Fazughli (« Fazogl »), 1850, *St. Ange* 81 (K, P).

Zaïre: Kinshasa, XI.1908, *Vanderyst* s.n. (BR).

Angola: Barra do Bengo Distr., « Lagoa de Quifandango prope Quiseguele », XI.1853, *Welwitsch* 247 (BM, COI, G, K, LE, P); Barra do Dande, « Lagoas de Bombo », IX.1858, *Welwitsch* 247b (BM, K, P).

Probably *N. welwitschii:*

Senegal: Upper Volta, Lake Guiers, VI.1821, *Roger* s.n. (K).

Upper Volta: Pontiéba, near Dano, *Bognounou* 60 (P).

Nigeria: N. Ilorin Prov., Shagunu, c. 16 km N. Bussa, 80 km S. Yelwa, Rd between Babana and Kubi, c. 56 km W. Shagunu, 9.VIII.1965, *Cook* 523 (K, Z).

Cameroon: About 5 km N. Tildé-Logone, about 35 km SW. Kousséri, 30.IX.1964, *W. de Wilde & B. de Wilde-Duyfjes* 3584 (WAG).

Zaïre: Lisala, 25.IX.1932, *Hauman* 526 (BRLU); Kisantu, 27.I.1907, *Vanderyst* s.n. (BR).

5. **Najas pectinata**

(Parl.) Magn. in Aschers. & Schweinf., Ill. Fl. Egypte (Mém. inst. Egypte 2, 1): 145 (1889) p.p. quoad *Figari*; Magn. Ber. Deutsch Bot. Ges. 12: 219, fig. 2, (1894); Durand & Schinz, Consp. Fl. Afr. 5: 500 (1894) p.p.; Täckholm V. & G. & Drar, Fl. Egypt 1: 114-115 (1941); Horn af Rantz., Kew Bull. 7, 1: 38 (1952) p.p. quoad Medinet el Faiyum; Täckholm V., Stud. Fl. Egypt ed. 1: 582 (1952); Quézel & Santas, Nouv. Fl. Algérie 1: 53-54 (1962); Oberm. in Codd. de Winter & Rycroft, Fl. South. Afr. 1 :83 (1966) p.p. quoad *Figari* (typus); Cufodontis, Bull. Jard. Bot. Nat. Belg. 38, 4, suppl.: 1201 (1968) p.p. quoad *Figari*; Täckholm V., Stud. Fl. Egypt ed. 2: 622 (1974). ≡ *Caulinia pectinata* Parl., Fl. Ital. 3: 665 (1858). — TYPE: Egypt, Medinet-el-Fayoum, *Figari* s.n. (holo-: FI).

— *N. horrida* auct. non A. Br. ex Magn.: Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12): 422-423, pl. 42, fig. 183-191 (1899) p.p. quoad « note »; Muschler, Man. Fl. Egypt 1: 23-24 (1912) p.p. quoad Medinet-el-Fayoum.

Plants submerged, monoecious, robust. *Stems* unarmed, 0.8-1.0 mm in diameter, bushy above because of the curved leaves. *Leaves* 9-15 mm long, acute, linear-lanceolate, 1.0-1.9 mm wide (incl. teeth on both sides) and 0.44-0.64 mm wide (excl. teeth on both sides); margin on each side serrulate with 6-12 conspicuous spiny teeth on broad triangular excrescences; leaf teeth 0.23-0.63 mm long, the ratio of teeth length to leaf width being 0.66-1.0 mm; septa clearly visible; fibres absent; leaf sheath rounded, 1.6-2.0 mm (incl. spine-cells) by 1.6-2.0 mm (ratio c.1), serrulate with about 4-8 spine-cells on each side.

Inflorescences axillary, male and female flowers, solitary, on the same branches, male flowers more to the top or even together with female flowers. *Male flower* (also according to the original description) enclosed in a spathe; spathe 1.5-1.7 mm (incl. spathe-neck) by 0.4-0.5 mm, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding c. 0.15-0.2 mm above the anther; anther 1.37-1.45 by 0.37-0.45 mm, 1-sporangiate. *Female flower* enclosed in a spathe, 1.8-2.0 (-2.9) mm (incl. spathe-neck) by 0.4-0.5 mm, the neck of the spathe being c. 0.7 mm, bearing brownish spine-cells on the apex; ovary 0.8-1.0 mm by 0.3-0.4 mm; style and stigma up to 1.4 mm; stigma 2-lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style and spathe. *Seed* elliptical oblong, 2-2.3 (-2.8) mm by 0.53-0.71 mm (ratio = 3.33-3.96); testa with areoles, the latter arranged regularly in longitudinal rows, each row of 20-30; areoles squarish, rectangular or seldom hexagonal, 0.07-0.1 mm long.

DIAGNOSTIC FEATURES : Plants monoecious; stems and midrib of leaf unarmed; 6-12 leaf teeth on each margin; leaf teeth on excrescences; leaf teeth 0.23-0.63 mm long; septa present; fibres absent : leaf sheath rounded; male flower in spathe; anther 1-locular; female flower in spathe; seed elliptical oblong, areoles arranged per 20-30 in each longitudinal row, never ladder-like; cell walls not raised.

NOTES : *N. pectinata* is only known from few localities. I have seen no other specimens from the Fayoum area. I never found any 1-locular anthers in the specimens considered under *N. welwitschii* and *N. horrida*. The occurrence of a spathe surrounding the female flower makes it differ from *N. horrida*.

GEOGRAPHICAL DISTRIBUTION : Egypt, incl. Sinai (Fig. 4).

SELECTED SPECIMENS :

Egypt : Delta region : Shubra, 14.X.1984, Sickenberger s.n. (Z), p.p. mixed with *N. graminea*; Giza, el Konaisa, 25.VIII.1927, *Simpson* 5270 (CAIM, K) « In fossis prope Fayoum », feb.-marzo (da *Figari* in Aprile 1844), *Figari* s.n. (FI). — Also in Sinai region : « Arabia Petrea regione Sinai Nelle acq. stagn. alla forgente di Ouadi Ouatir, Magg. », Wadi Watir near Aqaba Gulf, 1845 ?, *Figari* s.n. (FI).

6. **Najas horrida** A. Br. ex. Magn.

Beitr. : VII, 46, 47 (1870); Magn. in Ascherson & Schweinf., Ill. Fl. Egypte (Mém. Inst. Egypte 2, 1) : 145 (1889) pro majore parte; Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12) : 422, pl. 42, fig. 183-191 (1899) pro majore parte; Rendle in Engler, Pflanzenr., H. 7 : 17, fig. 2, 5 N-P (1901) pro majore parte; Bennett in This.-Dyer, F.T.A. 8, 2 : 228 (1901) pro majore parte; Broun, Catal. Sudan Fl. Pl. : 86 (1906) pro majore parte; Engler, Pflanzenw. Afr. in Engler & Drude, Veget. Erde 9, 2 : 98 (1908); Hochreutiner, Ann. Cons. & jard. bot. Genève 11 : 47 (1908); Peter, Wasserpfl. & Sumpfgew. Deutsch-Ostafr. : 108 (1928); Broun & Massey, Fl. Sudan : 368 (1929) pro majore parte; Aly Ibrahim Ramis, Bestimmungstabellen Fl. Aeg. : 20 (1929) p.p. quoad Delta; Perrier in Humbert, Fl. Madag., 22^{e} fam. : 4, fig. 1, 4-6 (1950); Van Meel, Explor. hydrobiol. Lac Tanganika (1946-1947) I : 52, 67 (1952); Süssenguth, Mitt. bot. Staatssamml. München 8 : 339-340 (1953); Van Meel, Explor. hydrobiol. Lac Tanganika (1946-1947) 4, 1 A : 90, 108, 114 (table 4) (1954). — TYPE : Nigeria, Nupe, *Barter* 1065 (holo- : B †; lecto- : K; iso- : BRVU, LE, P), lectotype designated here.

= *N. interrupta* K. Schum. in Engler, Pflanzenw. Ost-Afr. c : 94 (1895); Bennett in This.-Dyer, Fl. Capens. 7 : 51 (1897); Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (12) : 423 (1899); Rendle in Engler, Pflanzenr. H. 7 : 17 (1901); Bennett in This.-Dyer, F.T.A. 8, 2 : 228 (1901); Engler, Pflanzenw. Afr. in Engler & Drude, Veget. Erde 9, 2 : 98 (1908); Marloth, Fl. S. Afr. 4 : 9, fig. 1a (1915); Peter,

Wasserpfl. & Sumfpgew. Deutsch-Ostafr.: 108 (1928); Horn af Rantz., Kew Bull. 7, 1: 38 (1925); Van Meel, Explor. Hydrobiol. Lac Tanganika (1946-1947) 4, 1A: 109 (1954). — TYPE: Tanzania, Lake Victoria, « Unja, zwischen Magu and Kagehi », XI.1885, *Fischer* 614 (holo-: B †; lecto-: K; iso-: BM, LE, Z), lectotype designated here.

— *N. pectinata* auct. non (Parl.) Magn.: Durand & Schinz, Consp. Fl. Afr. 5: 500 (1894) pro majore parte; Hutchinson in Hutchinson & Dalziel, F.W.T.A. ed. 1, 2 (2): 308 (1936) pro majore parte; Trochain, Contrib. Et. Végét. Sénégal: 104 (1940); Andrews, Annals appl. Biol. 32, 2, 3, 4, 5, text fig. 5, 8, 9, table 1, 10, table 3, 11, 12, 13, plate 1, fig. 2 (1945); Horn af Rantz., Kew Bull. 7, 1: 38 (1952) pro majore parte; Roberty, Petite Fl. Ouest-Afr.: 370 (1954); Berhaut, Fl. Sénégal ed. 1: 53 (1954); Andrews, Flow. Pl. Sudan 3: 238 (1956); Wild, Kirkia 2: 37 (1961); Podlech in Merxm., Prodr. Fl. S. W. Afr.: 146 (1966); Oberm. in Codd, de Winter & Rycroft, Fl. S. Afr. 1: 83 (1966) pro majore parte (non typica); Berhaut, Fl. Sénégal ed. 2: 90 (1967); Hepper, F.W.T.A. ed. 2, 3 (1): 20 (1968) p.p.; Drar & Täckholm, Publ. Cairo Univ. Herb., n° 3: 87 (1970); Lewalle, Bull. Jard. bot. nat. Belg. 42: 70, 244 (1972); J. P. Lebrun, Audru, Gaston & Mosnier, Cat. Pl. Vasc. Tchad mérid., Inst. Elev. & Médec. Vét. Pays Trop., Et. Bot. 1: 185 (1972); J. P. Lebrun, Enum. Pl. Vasc. Sénég., Inst. Elev. & Médec. Vét. Pays Trop., Et. Bot. 2: 121 (1973); Musil, Grunow & Bornman, Bothalia 11: 185, 187, 188, 189, 190 (1973); Agnew, Upl. Kenya wild Flow.: 653 (1974); Tweedie, Kew Bull. 31: 256 (1976); Welsh & Denny, Biol. Journ. Linn. Soc. 10, 1: 73, 74, 76, 77, 84, 87, 88 (1978); Raynal-Roques in Durand & Lévêque, Fl. Faune aquat. Afr. sah.-soud. 1: 129, pl. 4, fig. 40 (1980); Triest & Symoens, Fl. Afr. Centr., Najadaceae: 5-6 (1983) pro majore parte; Symoens, Fl. Cameroun 26: 66, 67 (Pl. 15, fig. 1-3) (1984) pro majore parte.

— *N. minor* auct. non All.: Bennett in This.-Dyer, F.T.A. 8, 2: 227 (1901); Van Meel, Explor. Hydrobiol. Lac Tanganika (1946-1947) 4, 1A: 109 (1954). — Probably also: Baron, Rev. Madag. 8, 9: 825 (1906), Peter, Wasserpfl. & Sumpfgew. Deutsch-Ostafr.: 108 (1928).

— *N. marina* L. var. *angustifolia* auct. non (A. Br.) Rendle: Fries, Svensk. Bot. Tidskr. 7: 255 (1913); Fries in Von Rosen, Schwed. Rhod. Congo Exped. 1: 188 (1916).

— *N. australis* auct. non Bory ex Rendle: Perrier in Humbet, Fl. Madag., 22^{e} fam.: 4, fig. 1, 11-14 (1950) p.p. quoad *Decary* 327; 7824 et *Perrier de la Bâthie* 1740; 13218.

— *N. welwitschii* auct. non Rendle: Richards & Morony, Check List Fl. Mbala & Distr.: 252 (1969), p.p. quoad *Richards* 15303, non vidi (probably belongs to *horrida*).

Plants submerged, monoecious (or dioecious?), mostly robust. *Stems* unarmed, up to 100 cm long, 0.4-2.0 mm in diameter, often bushy above because of the curved leaves. *Leaves* 3.2-20 (-29) mm long, flat, bulk or fleshy, acute, linear-lanceolate, 0.56-2.40 (-3.22) mm wide (incl. teeth on both sides), (0.16-) 0.24-1.0 (-1.60) mm

wide (excl. teeth on both sides); margin on each side serrulate with (2-) 5-12 (-16) conspicuous spiny teeth on broad to very broad triangular excrescences; leaf teeth 0.15-1.38 mm long; the ratio of teeth length to leaf width being (0.35-) 0.55-1.57 (-3.08); midrib without spines; septa clearly visible; fibres absent; leaf sheath rounded, (1.21-) 1.50-2.30 (-3.87) mm (incl. spine-cells) by (1,10-) 1.46-2.68 (-5.8) mm (ratio = 0.5-1.4), serrulate or lacerate with 1-15 spine-cells on each side.

Inflorescences axillary, male and female flowers solitary, generally on different branches (different plants?). *Male flower* enclosed in a spathe, 1.3-2.9 (-3.5) mm (incl. spathe-neck) by 0.32-1.2 mm; neck of the spathe long 0.32-0.72 mm tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding 0.16-0.40 mm above the anther; anther 0.88-2.30 mm by 0.55-1.20 mm; 4-sporangiate. *Female flower* naked, (1.3-) 2.0-3.0 (-4.2) mm long; ovary 0.5-2.4 mm by 0.2-0.9 mm; style and stigma 0.64-1.77 mm; stigma 2- or 3-lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style. *Seed* elliptical oblong, 1.6-3.2 mm by 0.48-0.84 mm (ratio = 3.2-4.2); testa pitted with areoles, the latter arranged in longitudinal rows, each row of (18-) 25-35 (-40); areoles squarish, rectangular or seldom hexagonal, 0.05-0.1 mm long.

DIAGNOSTIC FEATURES: Plants monoecious; stems and midrib of leaf unarmed (2-) 5-12 (-16) leaf teeth on each margin; leaf teeth on excrescences; leaf teeth 0.15-1.38 mm long; septa present; fibres absent; leaf sheath rounded; male flower in spathe; anther 4-sporangiate; female flower naked; seed elliptical, oblong; areoles arranged regularly per (18-) 25-35 (-40) in each longitudinal row; never ladder-like; cell walls not raised.

NOTES: 1. The specimens from Damiette (Egypt) clearly belong to *N. horrida* because of the 4-sporangiate anther and the naked female flower. They cannot be regarded as *N. pectinata*. The same conclusion was reached by Muschler (1912) after examining specimens from Sherbin (Egypt).

2. The specimens from Madagascar have longer seeds (2.5-3.2 mm) than those from the continent (1.6-2.6 mm) and may have a spathe up to 3.5 mm long around the male flower instead of up to 2.9 mm on the African continent.

3. *N. horrida* shows considerable plasticity in its general habit which may be coarse, with curved rigid leaves or slender with straight, lax leaves. Curved and straight leaves were found on different collections from the same locality or even on the same specimen. (f.e. Gibbs-Russell 2562). Concerning the plasticity of *N. horrida*, there should be a relationship between very compact specimens and the total mineralisation or salinity of the water. This appearance is also known in *N. marina* subsp. *armata* and in *Hydrilla* (see COOK & LÜÖND 1982, fig. 1C). Evidence was found in collections from the same locality at K, for example: *Tanner* 1651 (*Hydrilla*), 1652 (*N. horrida*) and *Greenway & Brenan* 8244 (*Hydrilla*), 8248 (*N. horrida*). *N. horrida* growing in the lagoons of East Madagascar, has leaves 1.2-1.7 mm wide (incl. teeth on both sides), but only reaches 0.8-1.0 mm in Lake Alaotra and Lake Kinkony.

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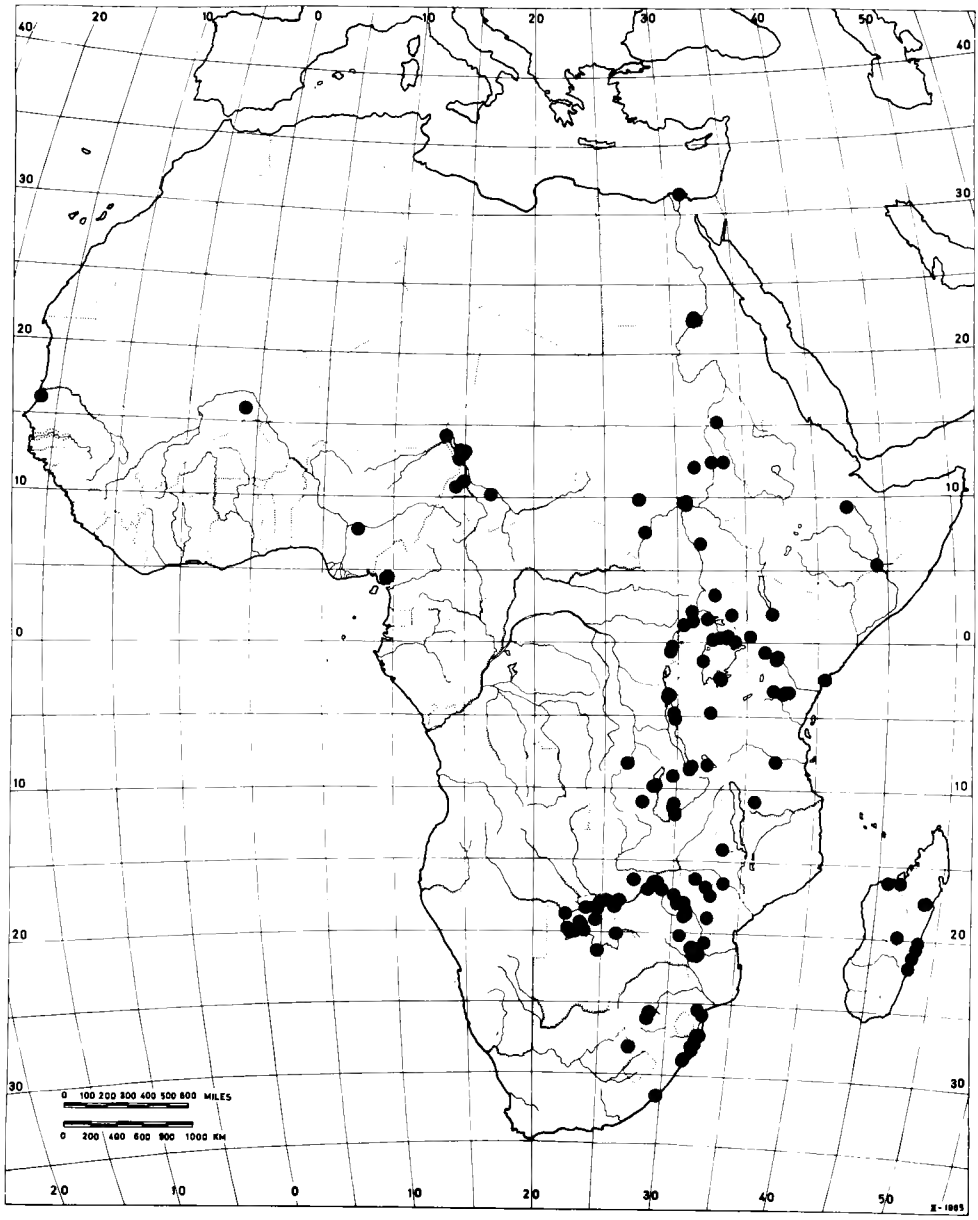

FIG. 5. — *N. horrida*.

4. OBERMEYER (1966) presumed that specimens from Natal, Transvaal and South West Africa were found dioecious in the herbarium and in the wild state. In the present study, both sexes were rarely found together on the same collection. However, it was impossible to decide whether the flowers on different branches had originated form the same plant or not, thus the plants being monoecious or dioecious. Further investigations are strongly recommended to collectors in the field, because herbarium material could give no evidence here (many sterile collections; a plant never is entirely mounted on a sheet; branches easily break off and are collected when floating to the edge; broken pieces often are put together in an envelope).

5. *N. horrida* was collected mixed with *N. graminea* at Mumpswe Pan in Botswana (*Drummond & Seagrief* 5163), with *N. marina* subsp. *armata* at Tonya in Uganda (*Lowe* s.n.) and with *N. marina* subsp. *commersonii* at Ambila in Madagascar (*Decary* 6527).

GEOGRAPHICAL DISTIBUTION: Africa, incl. Madagascar (Fig. 5).

SELECTED SPECIMENS:

Egypt: Nile delta, Dumyât, XII.1905, *Muschler* s.n. (K); Nile valley, Aswan, Etfu, 2-4.V.1986, *Shahean et al.* 3395 (ASW); Lake Nasser, *Ali* 4122 (ASW).

Senegal: St. Louis. N'tal near N'et Yone, 2.I.1934, *Trochain* 2292 (BM, P).

Mali: Gossi, 27.X.1970, *Boudet* 6865 (ALF).

Niger: Lake Chad, Nguigmi, 17.II.1968, *Léonard* 4529 (BR); ibid., Kotou Bay, 22.II.1968, *Léonard* 4560 (BR).

Nigeria: Nupe, 1858, *Barter* 1065 (BRVU, K, LE, P).

Cameroon: Lake Chad, North Delta, Chari, 31.I.1968, *Maley* 232 (P); Dega, near Guirvidig, 10.X.1964, *Letouzey* 7266 (K, P, WAG, YA); about 40 km N Waza, 28.XII.1964, *W. & J. de Wilde & B. de Wilde-Duyfjes* 5102 (P, WAG); Elephant Lake, near Barombi (=Kumba), 30.VIII.1890, *Preuss* 452 (BM, BRVU, COI, K, LE, M); ibid., 21.II.1975, Ekema E 235 (K); « Johann-Albrechtshöhe », 1896, *Staudt* 488 (COI, G, K, LE, P, Z, ZT).

Chad: Lake Chad, VI.1921, Herb. d'Alleizette 7889 (L); ibid., Maloumra, 9.II.1968, *Léonard* 4485 (BR); ibid. NE Kare Katia, 11.I.1968, *Léonard* 4295 (BR); ibid., 30 km E Bol, 15.XII.1969, *Hepper* 4202 (BR, K); ibid., Hadjer el Hamis, 5.I.1965, *W. & J. de Wilde & B. de Wilde-Duyfjes* 5218 (BR, MO, P, WAG); ibid., 28.XI.1969, *Hepper* 4046 (BR, K, WAG); Between Djougia & Mani, 26.I.1968, *Léonard* 4401 (BR); Between Djimtilo & Lake Chad, « Bras central », 30.I.1968, *Léonard* 4429 (BR); Between Djimtilo & Lake Chad, 31.1.1968, *Léonard* 4441 (BR); Dogoumbou, Ba-Ili, 24.XI.1968, *Fotius* 1188 (ALF, P).

Central African Republic: Mandjia, Dar Goulla, 7-28.III.1903, *Chevalier* 7854 (K, P).

Sudan: Al Masid, 60 km S. Khartoum, 10.II.1965, *W. & J. de Wilde & B. de Wilde-Duyfjes* 5723 (BR, K, WAG); Between Sennar & Wadi Medani, 77 km

from Sennar, 21.III.1938, *Drar* 793 (CAI); Gezira channel, 3.IV.1978, *Denny* 61 (Herb. Denny); ibid., 10.II.1965, *W. & J. de Wilde & B. de Wilde-Duyfjes* 5710 (BR, K, MO, P, WAG); Kordofan, El'Abbasiya, E. Nuba Mts., 12.XI.1961, *Wickens* 840 (K); Abu Guma, *Brown* 665 (K); Lake No, 17.VI.1929, *Simpson* 7212 (BM, K); ibid., station n° 2, 7.IV.1978, *Denny* 13 (Herb. Denny); ibid., station n° 3, 7.IV.1978, *Denny* 15 (Herb. Denny); Bahr el Ghazal,, 5.III.1930, *Simpson* 7631 (BM, K); ibid., « Gazellen-Fluss », 15.II.1869, *Schweinfurth* 1137 (LE, K, P); Bahr-el-Arab, « Djur-Mündung », 22.II.1869, *Schweinfurth* 1228 (K); Jonglei Prov., 9 km S Maar, 18.II.1980, *Lock* 80/82 (K); s.l. *Schweinfurth* 4242 (BM).

Ethiopia : Harar Prov. Lake Alemaya, 17.I.1965, *Burger* 3606 (FT, G, K,WAG); ibid., 30.XII.1968, *J. de Wilde* 4307 (BR); ibid., 29.I.1966, *W. de Wilde & B. de Wilde-Duyfjes* 9838 (WAG); Harar Prov., Calafoh, 13.IX.1971, *Ash* 1148 (K).

Zaire: Lake Mobutu, Mahagi, 27.VIII.1953, *Robyns* 4002 (BR); ibid., 28.VIII.1953, *Taton* 1222 (BR); ibid., Kasenyi, VIII.1949, *Schwetz* (BR); ibid., 6.V.1953, *Van der Ben* 364 (BR); ibid., 22.IX.1955, *Christiaensen* 1102 (BR, WAG); Lake Edward, Rutshuru, 10.IX.1953, *Robyns* 4074 (BR); ibid., Vitshumbi, 6.I.1953, *Van der Ben* 27 (BR); ibid., 30.III.1953, *Van der Ben* 293 (BR); Lake Tanganyika, Makobora, 21.IX.1979, *Ankei* 79/0035 (BR); « Bas Katanga » : Lake Kisale, 27.II.1911, *Bequaert* 66 (BR); « Haut Katanga » : Lake Kainse, Kaindu, 28.XII.1959, *Symoens* (BR); ibid., 13.IV.1960, *Symoens* 7351 (BR); Lake Kifukula, Mundie, 29.XII.1959, *Symoens* 6945 (BR, BRVU); Katuba, Kafubu river, 8.VII.1981, *Malaisse* 11854 (BR).

Burundi : Rusizi Delta, 17.X.1970, *Lewalle* 4826 (BR, MO, P); ibid., 17.XI.1971, *Lewalle* 6301 (BR); Bujumbura, 29.X.1967, *Lewalle* 2161 (BR); ibid., XII.1960, *Hendrickx* 7995 bot (BR); ibid., 19.I.1961, *Hendrickx* 7843 bot (BR); Kiringi, 11.III.1979, *Reekmans* 7688 (BR, BRVU, K, MO).

Uganda : Acholi Distr., 6-8 km SE Palabek, 18.II.1969, *Lye & Lester* Ly-2131 (K); Bunyoro Distri., 2-5 km N of Kafu river on Gulu road, 16.II.1969, *Lye & Lester* Ly-2017 (K); Saroti, Wera, 15.IX.1954, *Lind* 331 (K); Lake Mobutu, Tonya, 4.III.1950, *Lowe* s.n. (BM); Jinja Distr., IV.1955, *Greenway* s.n. (BR, K); ibid., 16 km E Jinja, 3.X.1952, *Wood* 474 (BR, K); ibid., Bugungu, XII.1937, *Chandler* 2071 A (K); Lake Victoria, Entebbe, XII.1937, *Chandler* 2071 B (BR, K,P); ibid., XI.1930, *Snowden* 1835 (K); Vicinity of Kisimbiri, from Entebbe to Butiaba, 1909-10, *Mearns* 2455 (BM); s.l., « Lake », *Bagshawe* s.n. (BM).

Kenya : South Turkana, Ayangyani swamp, 12.VI.1970, *Mathew & Gwynne* 6789 (K); Bunyala, Lukala, 12.III.1950, *Bally* 7892 (K); Lessos Dam, Eldoret, 18.XII.1964, *Lind, Agnew & Kettle* 5893 (WAG); Lake Naivasha, 17.VI.1929, *Jenkin* A 158 (BM); ibid., VIII.1931, *Dent* s.n. (BM.); ibid., 1.V.1932, *Napier Bax* 1845 (K); ibid., IV.1938, *Chandler* 2272 (BR, K); ibid., 27.I.1959, *Van Zinderen Bakker* 925 (K); ibid., 19.X.1969, *Polhill* 293 (BRVU, FT, K, P); ibid., 16.XII.1969, *Richardson* 6 (K); ibid., 18.IX.1977, *Marzio Mauro* s.n. (Herb. Denny); Rift Valley, Kijabe, 1929, *Humbert* 9266 (P); Sukari Dam River, 7.V.1956, *D. F. Smith* s.n.

EAH 11059 (K); Kipini Distr. N bank of Tana river, Mlangu ya Simba, 6.XI.1957, *Greenway & Rawlins* 9468 (FT, K); Lake Chala, 7.IV.1947, *Starzènski* 50 (BR).

Tanzania: Lake Victoria, Bukoba, 20.VI.1905, *Cunnington* 50 (BM); ibid., between Magu and Kageyi, XI. 1885, *Fischer* 614 (BM, K, LE, Z); Mwanza, Capri Point, 10.X.1953, *Tanner* 1652 (K); Arusha Distr. A.N.P., Lake Kawangaya Matheo, 4.XI.1969, *Richards* 24587 A (K); Lake Jipe, XII.1929, *Wettstein* s.n. (M); ibid., Comm. Game Dep. B 4636 (K): Nyumba Ya Mungu Res., Samanga, 21.VIII.1974, *Denny & Welsh* NYM 134, NYM 135a (Herb. Denny); Kigoma Harbour, 21.XI.1962, *Verdcourt* 3395 (BR, K); Wala river, 10.III.1882, *Boehm* 86 (BM); Malagarasi Swamps, 26.VIII.1952, *Lowe* s.n. (BR, K); Ufipa Distr. (Sumbawanga Distr.), Kasanga, 29.III.1959, *McCallum-Webster* T 518 (BR, K); ibid., Lake Kwela, 11.III.1959, *Richards* 11142 (BR, K); ibid., 18.III.1950, *Bullock* 2653 (K); ibid., 10.III.1959, *McCallum-Webster* s.n. (K); Selous Game Reserve, 16 km N Mlahi, 17.X.1975, *Vollesen* 2862 (K); Songea Distr., Likonde river, SE Songea, 26.VI.1956, *Milne-Redhead & Taylor* 10910 (K); Kolambo, 7.IX.1935, *Greenway* 4056 (K).

Zambia: Lake Tanganyika, Mbala Distr., Mpulungu, 20.X.1947, *Greenway & Brenan* 8248 (BM, K); ibid., 20.XI.1950, *Bullock* 3486 (K); ibid., mouth of Losa river, VI.1889, *Hore* s.n. (BM); Mporokoso Distr., Kalungwishi river ferry, 18.I.1960, *Richards* 12412 (K); Lake Bangweulu, Luwingu, Chaluwi Isl., 13.X.1947, *Greenway & Brenan* 8201 (BM, K); ibid., Kaminda, *Fries* 933 (Z); ibid., 19.II.1959, *Watmough* 289 (K); Tushingo Channel, ENE Kansenga, 7.VI.1962, *Symoens* 9596 (BR, K); Lake Chali, 16.II.1959, *Watmough* 268 (BR, K); ibid., 5.VI.1962, *Symoens* 9554 (BR, BRVU, K); Lake Ishiba Ngandu, 9.I.1959, *Van Zinderen-Bakker* 907 (K); ibid., 13.VIII.1936, coll. ? (BM); Mapanza, Munyeke river, 4.X.1953, *Robinson* 335 (BR, K) ibid., Choma, 15.II.1959, *Robinson* 3245 (K, M); Lake Kariba, 30.IX.1981, *Munkonge* HKM5 (Herb. Denny); Gwembe Distr., Siavonga, in lake, 15.X.1972, *Kornaś* 2386 (K); Zambesi river, 24.V.1960, *Mortimer* 176 (K, M); ibid., Livingstone Distr., 16.I.1929, *Young* 474 (BM).

Zimbabwe: Victoria Falls Distr., Zambesi river, 28.XI.1949, *Wild* 3221 (BM); Wankie Distr., Katsatetsi river, 10.V.1972, *Gibbs-Russell* 1953 (K, MO); Matetsi Safari Area 4, 8.VI.1980, *Gonde* 312 (BR, MO); Lake Kariba, Sinamwenda, 28.VII.1983, *Denny* 1174 (Herb. Denny); Kariba Gorge, IX.1960, *Goldsmith* 105/60 (BM, K); Urungwe Distr., Sanyati-Chiroti river junction, 21.IX.1953, *Wild* 4229 (K, MO); Sanyati-Fulechi river junction, 11.X.1957, *Phipps* 761 (K); Distr. Sinoia, 17.III.1952, *Whellan* 650 (K); Sinoia caves, Lumagundi, VI.1920, Herb. Eyles 2354 (BM); ibid., 12.VII.1921, Herb. Eyles 3158 (K); ibid., Chinhoyi, 6.VIII.1983, *Denny* 1224 (Herb. Denny); Mazoe Distr., Henderson Res. Stat. Fisch., 15.IV.1973, *Gibbs-Russell* 2562 (K, MO); 2563 (K, MO), Makabusi river, 21.IX. 1947, Wild 2001 (BM): Darwin Distr., Chimanda Tribal Trust Land, 5.IX.1958, *Phipps* 1312 (K); Mkota Tribal Trust Land, 11.VI.1950, *Whellan* 463 (BM): Harare Distr., 19.II.1927, *Eyles* 4738 (K); ibid., III.1949, *Tubb.* s.n. SRGH 22695 (BM): ibid., Muzururu river, 8.I.1973, *Gibbs-Russell* 2513 (BR, K, MO); Marandellas Distr.

Chipta Tribal Trust Land, 29.IV.1972, *Gibbs-Russell* 1983 (K, MO); Ngamo station, 3.VII.1930, *Stephens* s.n. (BM); Fort Victoria, Umshandige Dam, 9.X.1949, *Wild* 3007 (BM, BR, MO); ibid., Triangle Ranch, XI.1946, *Bates* s.n. SRGH 16665 (BM): Mtilikwe river, 26.I.1949, *Wild* 2762 (BM): Nuanetsi Distr., Nuanetsi river, upstream Buffalo Bend, 28.IV.1961; *Drummond & Rutherford-Smith* 7570 (K): Chivirira Falls, 6.VI.1950, *Wild* 3429 (BM, MO); Chipinga Distr., lower Rupembi river, 24.I.1957, *Phipps* 149 (K); Lundi river near Fishan, 28.VI.1962, *Drummond* 7774 (BRVU, K).

Malawi: Dedza Distr., Ndebvu, Dzalanyama Forest, 29.VI.1967, *Salubeni* 671 (K).

Mozambique: Tete Distr., Mazoe river, Digue, 21.IX.1948, *Wild* 2583 (K); Maputo (Lourenço Marques) Distr., Ressano Garcia, 22.XII.1897, *Schlechter* 11883 (BM, BR, COI, E, G, K, L, LE, MO, P, WAG, Z); Komati river, Marracuene (Vila Luisa), 20.II.1961, *Balsinhas* 292 (BM).

Botswana: Northern Distr., Linyanti river, Kabulabula, 24.VII.1930, *Stephens* 71 (BM); Savuti marsh, *Gibbs-Russell* 2351 (MO); Okavango river, Sepopa, 6.V.1975, *Gibbs-Russell* 2905 (BR, K, MO); Mboma Island, 17.XI.1972, *P.A. Smith* 257 (K): Okavango swamp, Txatxanika lagoon, 1.III.1972, *Gibbs-Russell & Biegel* 1487 (BR, K, MO); ibid., Mboroga river, *Ellis* 3048 (MO); Karongana river, 23.VIII.1975, *P.A. Smith* 1453 (K, MO); lower Boro river, 31.XII.1974, *Hiemstra* 203 (BR, K); Thamolakane river, upstream Crocodile camp, 22.1.1972, *Gibbs-Russell & Biegel* 1367 (BR, K, MO); ibid., 8 km NE Maun, 19.III.1965, *Wild & Drummond* 7162 (K): Thaoge river, Xanajo, 22.IX.1974, *P.A. Smith* 1109 (K, MO); Matsebe river, Tsetse Camp, 16.III.1961, *Richards* 14741 (K); Mumpswe Pan, 40 km NNW mouth Nata river, 21.IV.1957, *Drummond & Seagrief* 5163 (K); Botleti river, 3.XII.1978, *P.A. Smith* 2546 (K).

Namibia: Eastern Caprivi, Linyanti delta, Lake Lehambezi, 6.X.1970, *Vahrmeijer* 2171 (K); Niangana, V.1934, *Dinter* 7264 (BM, BRVU, G, K, M, Z); Okavango Runtu, 9.V.1939, *Volk* 1883 (M); ibid., Lagoon at Kapuko camp, 6 km W of Mupini Mission station, 7.III.1956, *de Winter & Marais* 5031 (M).

Republic of South Africa: Transvaal Prov., Pretoria Distr., Edendale Bridge Dam, 23.V.1968, *Strey & Leistner* 8383 (H, K, M, WAG); Rietvlei Dam, 13.III.1945, *Repton* 2002 (K); Pienaars river Dam, 26.V.1964, *Mauve & Vahrmeyer* 4303 (MPU); ibid., 12.VI.1964, *Mauve & Vahrmeyer* 4307 (FT, MPU); s.l. *McLea* s.n. in Herb. Bolus 6283 (K, Z). Natal Prov., Ubombo, Pongolo flood plain, Nhole Pan, 26.XI.1976, *Ward* 9037 (K); Kosi system, lower Manzimnyama outlet, 9.I.1974, *Ward* 8515 (K); ibid., Sihddla river, 22.VIII.1976, *Ward* 8982 (K); Mkuze flood plain, south end Muzi swamp, 10.X.1972, *Ward* 8086 (K); ibid., channel SW Denezana pan, 19.X.1971, *Ward* 7300 (K); Hlabisa Distr. 2.V.1955, *Ward* 2566 (K); ibid., Hluhluwe Game res., 6.I.1956, *Ward* 2945 (E); Mtubatuba, Hluhluwe valley, Mkumbane Pan, 1.I.1973, *Ward* 8215 (K); Ingwavuma; Ndumu Game Res., 28.VII.1959, *Tinley* 457 (E); Mtimona, 1.IX.1967, *Venter* 3961 (K); Mangeza Lake, Ngoya, 26.VIII.1976, *Musil* 368 (K, MO); Richards Bay, Umsingazi Lake,

20.III.1973, *Musil* 174 (K, MO); Cape Prov., Port St. Johns, Intafufu river, 12.X.1968, *Wagner* 6 (K); s.l., *Junod* 527 (BM, G).

Madagascar: **West**: Marovoay, E. Majunga, VII.1921, *Perrier de la Bâthie* 13832 (P): Mares de l'Horombe, VIII.1925, *Perrier de la Bâthie* 17372 (P): Antsirabé, lake Andraikido, IX.1909, Herb. D'Alleizette s.n. (L); ibid., I.1927, *Perrier de la Bâthie* 17892 (P): Lake Kinkony, X.1904, *Perrier de la Bâthie* 1740 (P); ibid., 28.V.1930; *Decary* 7824 (P). **Central**: Lake Alaotra, *Perrier de la Bâthie* 13218 (P); ibid., Imérandroso, 25.VI.1921, *Decary* 327 (P). **East**: Vatomandry Distr., 18.II.1904, *Guillot* 96 (G, P); Mananjary Prov., III-IV.1909, *Mission Geay* 7206 (P); 7956 (P); 7962 (P); Between Tamatave and Mananjary, S. Mahanoro, X.1921, *Perrier de la Bâthie* 14204 (P); 14243 (P); S. Tamatave, Ambila, 29.IV.1928, *Decary* 6403 (P); ibid., 13.V.1928, *Decary* 6527 (P): s.l. *Jumelle* s.n. (K).

7. **Najas testui** Rendle

Journ. Bot. 75: 51-53, fig. A-I (1937); Horn af Rantz., Acta Horti Gotoburg. 18: 194 (1950); Horn af Rantz., Kew Bull. 7, 1: 32 (1952); Symoens, Fl. Cameroun 26: 65 (1984). — TYPE: Central African Republic, 120 km NE Yalinga, « Marais tributaire du Gbwetou, Affluent du Chinko », 22.I.1922, *Le Testu* 3625 (holo-: BM; iso-: K, L, P).

= *N. meiklei* Horn af Rantz., Kew Bull. 7 (1): 34-35, fig. 1-2 (1952); Hepper, F.W.T.A. ed. 2, 3 (1): 20 (1968) p.p. quoad Nigeria et Hall 3463; Symoens, Fl. Cameroun 26: 64, 65 (1984). — TYPE: Nigeria, Minna Div. « In stream below Gwari Hill near Minna », 3.XIII.1949, *Meikle* 710 (holo-: K).

— *N. welwitschii* auct. non Rendle: Richards & Morony, Check list Fl. Mbala Distr.: 252 (1969) p.p. quoad *Richards* 15172.

— *N. graminea* auct. non Del.: Wickens, Jebel Marra, Kew Bull. add. ser. *5*, 154, p. 57 (1977); Triest & Symoens, Fl. Afr. Centr., Najadaceae: 6, 8 (1983) p.p. quoad *Liben* 840; Symoens, Fl. Cameroun 26: 66, 67 (pl. 15, fig. 4-7), 68 (1984) p.p. quoad *W. de Wilde* 3344 et *Letouzey* 13333.

Plants submerged, monoecious, slender. *Stems* unarmed, c. 0.5 mm in diameter, often plumose above because of the closely packed leaves. *Leaves* (6.5-) 11.8-32.0 mm long, flat, acute, linear-lanceolate, (0.26-) 0.42-0.72 (-1.1) mm wide (incl. teeth on both sides), 0.24-0.53(-0.87) mm wide (excl. teeth on both sides), margin on each side minutely serrulate with inconspicuous spiny teeth, mainly consisting of the brownish spine-cell or serrulate with 7-30 conspicuous spiny teeth on small triangular excrescences; leaf teeth (0.05-) 0.09-0.14 mm long, the ratio of teeth length to leaf width being 0.13-0.30 (-0.50); midrib without spiny teeth; septa absent or clearly visible; fibres absent or present on margin or/and near midrib; leaf sheath (1.3-) 1.9-2.4 (-2.9) mm (incl. auricle and spine-cells) by (1.37-) 2.60 (-3.22) mm

(ratio = 0.8-1.6), truncate to auriculate, the auricle being 0.24-0.96 mm long (incl. spine-cells) and 0.2-1.0 mm wide (ratio = 0.75-1.74), serrulate or lacerate with 2-8 spine-cells on each side; apex of the auricle rather obtuse.

Inflorescences axillary, male and female flowers solitary or several together, each at the very base of an (sometimes very short) axillary shoot; male and female flowers generally on different branches. *Male flower* enclosed in a spathe, (1.2-) 1.9-2.5 mm (incl. spathe-neck) by 0.4-1.0 mm; neck of the spathe 0.6 mm long, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding 0.16-0.32 mm above the anther; anther 1.0-2.4 mm by 0.36-1.0 mm, 4-sporangiate. *Female flower* enclosed in a spathe, (1.1-) 1.5-3.0 mm (incl. spathe-neck) by 0.4-0.6 mm, the neck of the spathe reaching about halfway up the style, bearing no brownish spine-cells on the apex; ovary (0.5-) 1.0 (-1.77) mm by (0.3-) 0.6 mm: style and stigma 0.8-1.3 mm; stigma 2-lobed.

Fruit with persistent, thin, membraneous pericarp and remaining parts of style and spathe. *Seed* elliptical oblong to ovate, (1.85-) 2.10-2.30 (-2.60) mm by (0.41-) 0.56-0.79 mm [ratio = (2.3-) 3.1-3.8]; testa pitted with areoles, the latter arranged irregularly in longitudinal rows, each row of 10-14 (-23); areoles 0.11-0.23 mm long; cell walls raised.

DIAGNOSTIC FEATURES: Plants monoecious; stems and midrib of leaf unarmed; leaves (0.26-) 0.42-0.72 (-1.1) mm wide (incl. teeth on both sides); leaf teeth mostly on excrescences; leaf teeth (0.05-) 0.09-0.14 mm long; fibres present; leaf sheath truncate to auriculate; male flower in spathe; anther 4-sporangiate; female flower in spathe; seed elliptical, oblong; areoles arranged irregularly per 10-14 (-23) in each longitudinal row; cell walls raised.

NOTES: 1. In contrast to the original description, the leaf sheaths are not rounded but truncate to auriculate (somewhat rounded in young leaves at the top of the plant, but never in mature leaves!). The seed areoles were described as « more or less hexagonal ». All ripe seeds found on *Le Testu* 3625 from BM and P showed irregularly arranged areoles, with raised cell walls.

2. Sterile specimens of *N. testui, N. schweinfurthii, N. minor, N. hagerupii* and *N. baldwinii*, cannot be distinguished from each other. Ripe seeds at least are necessary and, for certain determination, flowers of both sexes also.

3. The general aspect of the group *N. testui, N. schweinfurthii* and *N. minor* may be very similar to the group *N. welwitschii, N. pectinata* and *N. horrida*. However these groupes differ in the shape of the leaf sheath.

4. Specimens without male flowers, that may belong either to *N. testui* or *N. schweinfurthii* are mentioned separately under *N. schweinfurthii*.

5. *N. testui* occurs in marshes and ponds near rivers. It has not been recorded from rice fields.

GEOGRAPHICAL DISTRIBUTION: tropical Africa (Fig. 6).

SELECTED SPECIMENS:

Sierra Leone: Kailahun, Benduma, 13.XI.1977, *Jupp* s.n. (Herb. Denny).

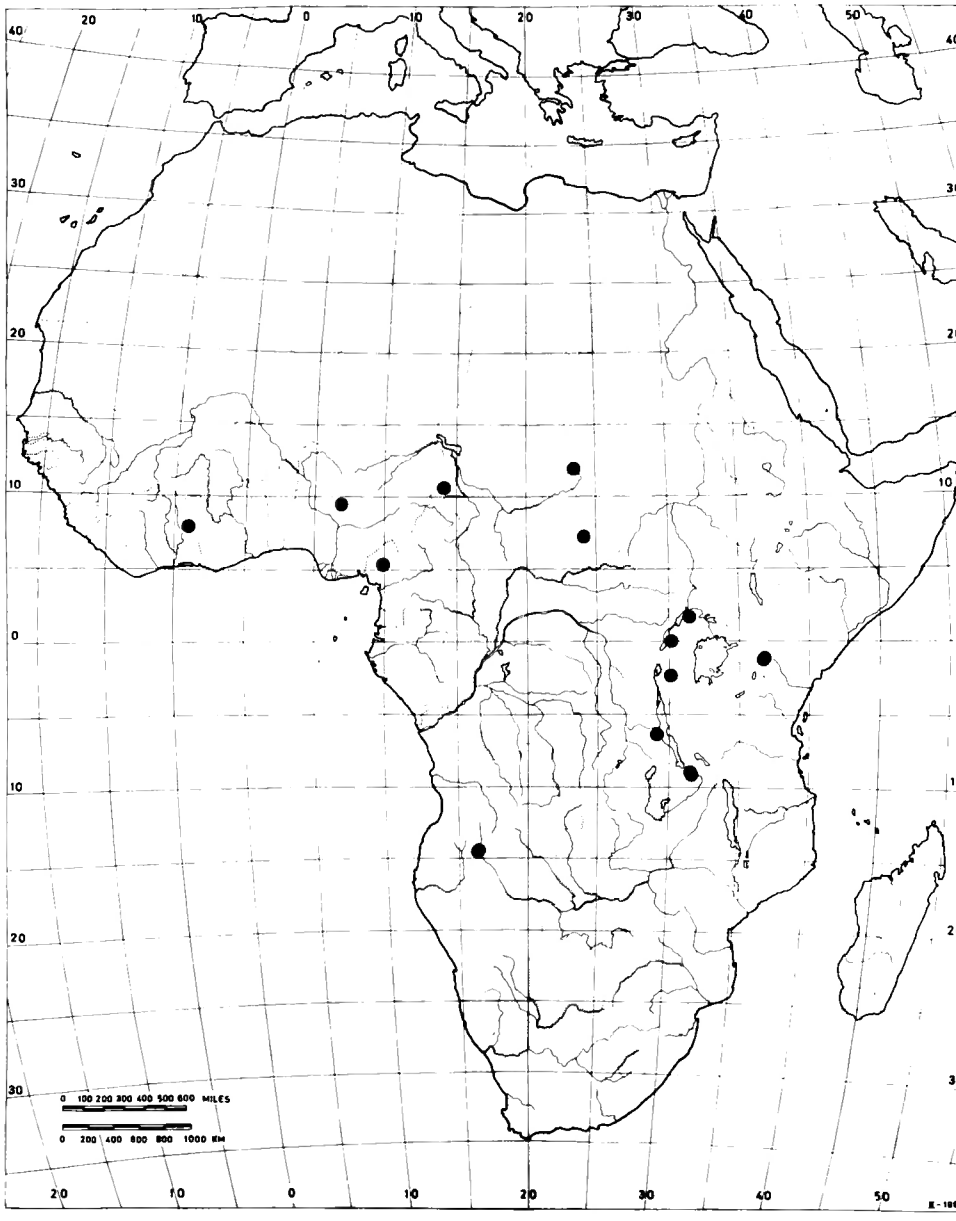

FIG. 6. — *N. testui*.

Ivory Coast: Bassawa, 16.XI.1966, *Aké Assi* 9259 (K).

Nigeria: Minna Div., « In stream below Gwari Hill near Minna », 3.XII.1949, *Meikle* 710 (K).

Cameroon: About 2 km NE. Mokolo, 16.IX.1964, *W. de Wilde & B. de Wilde-Duyfjes* 3344 (BR, BRVU, K, P, WAG); 18 km SSW Dschang, Piste Santchou-Bale, 26.XI.1974, *Letouzey* 13333 (BRVU, K, P).

Central African Republic: 120 km NE. Yalinga, « Marais tributaire du Gbwetou, affluent du Chinko », 22.I.1922, *Le Testu* 3625 (BM, K, L, P).

Sudan: Jebel Marra, Zalingei, 11.IX.1964, *Wickens* 2497 (K).

Zaire: « Haut Shaba », Muhila plateau, near Mutungulu river, 16.V.1971, *Lisowski* 96237 (BR, BRVU).

Uganda: Bunyoro, Budongo forest, near Sonso river, XI.1935, « Flora of Uganda » s.n. (BM); Lake George, Biggs Bay, 25.VI.1949, *Lowe* 97 (BM).

Rwanda: Bugesera, Uruanda river, 26.X.1953, *Liben* 840 (BR).

Kenya: Kiambu Prov., Ngong Forest, Karen pond, 4.XI.1934, *Taylor* 1596 (BM, K); Nairobi, Kirichwa Ndogo valley, 15.VIII.1947, *Bally* 5236 (K).

Zambia: Mbala (Abercorn) Distr., Kawimbe, 24.III.1959, *McCallum-Webster* A 628 (K); ibid., Lumi river, 30.V.1961, *Richards* 15172 (K).

Angola: Huila Distr., Cutato river, Ganguelas, Vila da Ponte, V.1906, *Gossweiler* 3858 (BM, COI); ibid. 6.V.1906, *Gossweiler* 3936 (BM, COI).

Probably *N testui* (4-sporangiate anther, but no seeds):

Ghana: Dawhwenya, 20.I.1968, *Hall* cc 37176 (K); 54.5 mile from Accra to Ada, 29.V.1966, *Hall* 3463 (K).

8. **Najas schweinfurthii** Magn.

Ber. Deutsch. Bot. Gesell. 12: 219-220, fig. 3 (1894); Rendle, Trans. Linn. Soc, ser. 2, Bot. 5 (12): 400-401, tab. 40, fig. 64-67 (1899); Rendle in Engler, Pflanzenr. H. 7: 10 (1901); Bennett in This.-Dyer, F.T.A. 8, 2: 227 (1901); Broun; Catal. Sudan. Flow. Pl. 86 (1906); Broun & Massey, Fl. Sudan: 368 (1929); Horn af Rantz., Kew Bull. 7, 1: 31 (1952); Andrews, Flow. Pl. Sudan 3: 237 (1956). — TYPE: Sudan, Djur « Grosse Seriba Ghattas », 28.VIII.1869, *Schweinfurth* 2140 p.p. mixed *N. graminea* Del., see note 1. (holo-: B †; lecto-: BM; iso-: K p.p.), lectotype designated here.

— *N. graminea* auct. non Del.: Symoens Fl. Cameroun 26: 66, 68 (1984) p.p. quoad *de Wilde* 3262 et prob. *J. & A. Raynal* 10842.

Plants submerged, monoecious, slender. *Stems* unarmed, c. 0.5 mm in diameter, often plumose above because of the closely packed leaves. *Leaves* 9.9-23.6 mm long,

flat, acute, linear-lanceolate, (0.24-) -0.6-1.0 mm wide (incl. teeth on both sides), (0.16-) 0.32-0.43 mm wide (excl. teeth on both sides); margin on each side serrulate with 6-16 conspicuous spiny teeth on small triangular excrescences; leaf teeth (0.04-) 0.12-0.31 mm long, the ratio of teeth length to leaf width being (0.2-) 0.3-0.8; midrib without spiny teeth; septa absent or clearly visible; fibres absent or present on margin or/and near midrib; leaf sheath 1.13-2.10 mm (incl. auricle and spine-cells) by 1.29-1.80 mm (ratio = 0.9-1.4), truncate to auriculate, the auricle being 0.1-0.5 mm long (incl. spine-cells) and 0.2-0.6 mm wide (ratio = 0.6-1.5), serrulate or lacerate with 1-7 spine-cells on each side; apex of the auricle rather obtuse.

Inflorescences axillary, male and female flowers solitary, or several together, each at the very base of an (sometimes very short) axillary shoot; male and female flowers generally on different branches. *Male flower* enclosed in a spathe, 1.2-1.5 (-2.0) mm (incl. spathe-neck) by 0.30-0.65 mm; neck of the spathe 0.2-0.3 mm long, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding c. 0.1 mm above the anther, anther 0.73-0.81 mm by 0.27-0.32 mm, 1-sporangiate. *Female flower* enclosed in a spathe, 1.16-1.53 (-2.0) mm (incl. spathe-neck) by 0.30-0.65 mm, the neck of the spathe reaching about halfway along the style, with or without brownish spine-cells on the apex; ovary 0.65-0.88 mm by 0.20-0.37 mm; style and stigma 0.64-1.10 mm: stigma 2-lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style and spathe. *Seed* elliptical oblong to ovate, (1.13-) 1.30-1.45 (-1.61) mm by 0.48-0.64 mm (ratio = 2-3.2) testa pitted with areoles, the latter arranged irregularly in longitudinal rows, each row of (9-) 11-13 (-15); areoles 0.10-0.16 mm long; cell walls raised.

DIAGNOSTIC FEATURES: Plants monoecious; stems and midrib of leaf unarmed; leaves (0.24-) 0.6-1.0 mm wide (incl. teeth on both sides); 6-16 leaf teeth on each margin; leaf teeth mostly on excrescences; leaf teeth (0.04-) 0.12-0.31 mm long; leaf sheath truncate to auriculate; male flower in spathe; male spathe 1.2-1.5 (-2.0) mm long; anther 0.73-0.81 mm long, 1-sporangiate; female flower in spathe; seed elliptical, oblong; seed (1.13-) 1.30-1.45- (-1.61) mm long; areoles arranged irregularly per (9-) 11-13 (-15) in each longitudinal row; cell walls raised.

NOTES: 1. Schweinfurth collected a mixture of two *Najas* species under his No. 2140. The material in P and Z, and also one separate plant on the K sheet, belong to *N. graminea*. MAGNUS' description corresponds with the BM material (therefore designated here as lectotype) and also with the second plant of the K sheet.

2. *N. schweinfurthii* is recorded from rice fields in Senegal (Ntiago) and in Cameroon (20 km E Mokolo) and often from temporary marshes elsewhere.

3. See also note 2 under *N. testui*.

4. *Hepper* 2829 is cited in F.W.T.A. 3, 1: 20 (1968) under *N. meiklei*.

GEOGRAPHICAL DISTRIBUTION: tropical Africa (Fig. 7).

7

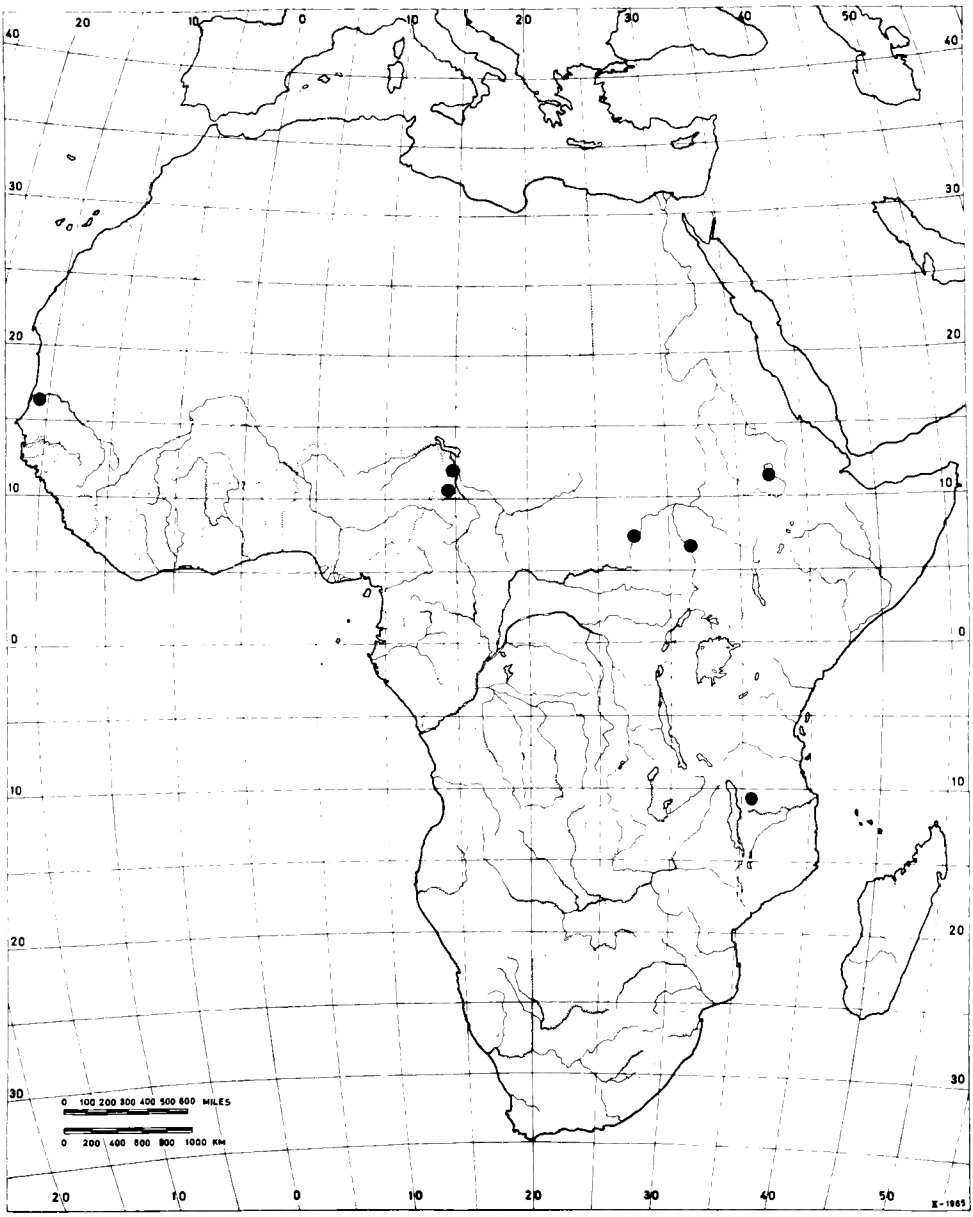

FIG. 7. — *N. schweinfurthii.*

SELECTED SPECIMENS:

Senegal: Ntiago, near Taoué river, 27.XI.1960, *J. & A. Raynal* 6642 (P).

Cameroon: About 20 km E. Mokolo, 14.IX.1964, *W. de Wilde & B. de Wilde-Duyfjes* 3262 (BR, BRVU, K, P, WAG); about 20 km W Kousséri, along main road to Nigeria, 30.IX.1964, *W. de Wilde & B. de Wilde-Duyfjes* 3577 (WAG).

Chad: Koyar, 30.XI.1969, *Fotius* 1867 ter (P).

Sudan: « Djur, Grosse Seriba Ghattas », 28.VIII.1869, *Schweinfurth* 2140 (BM, K); Jonglei Prov., 2 km W. Nyang, near Maar, 80 km N. Bor, 10.II.1981, *Lock* 81/20 (K).

Ethiopia: Godjam Prov., 5 km E. Bahar Dar, along road to Blue Nile Falls, 29.IX.1969, *J. de Wilde* 5783 (K, WAG).

Tanzania: Songea Distr., 6.5 km W. Songea, 30.IV.1956, *Milne-Redhead & Taylor* 9964 (BR, K, P); ibid., Valley near river Mtanda, 9.5 km SW Songea, 24.VI.1956, *Milne-Redhead & Taylor* 10891 (K).

Prob. *N. testui* or *N. schweinfurthii* (Collections without male flowers):

Ivory Coast: Between Yérébodi and Sanlo, 17.XI.1966, *Aké Assi* 9273 (K).

Nigeria: Donga river, 8 mls SW Gembu, 1.II.1958, *Hepper* 2829 (K).

Cameroon: Mankim, 70 km SSW Yoko, 16.IV.1963, *J. & A. Raynal* 10842 (BRVU, P, YA).

9. **Najas minor** All.

Auct. Syn. Stirp. Horti Taur.: 3 (1773); Id., Fl. Pedem, 2: 221 (1785); Cham. Linnaea, 4: 500-501 (1829); A. Br., Journ. Bot., 2: 277 (1864); Boissier, Fl. Orient., 5 (1): 28 (1882); Schweinf., Beitr. Fl. Aethiop.: 292 (1887); Aschers. & Schweinf., Ill. Fl. Egypte: 145 (1887); Durand & Schinz, Consp. Fl. Afr. 5: 500 (1894); Rendle, Trans. Linn. Soc. ser. 2 Bot. 5 (12): 410-413, t. 40, fig. 105-115 (1899); Rendle, l.c., (13): 442 (1900); Rendle in Engler, Pflanzenr., H 7: 14, fig. 1D-F, fig. 4S (1901); Muschl., Man. Fl. Egypt., 1: 23 (1912); Aly Ibrahim Ramis. Bestimmungstabellen zur Fl. von Aeg.: 20 (1929); Maire, Etud. fl. vég. Sahara, 3: 409 (1940); Täckholm V. & Drar, Fl. Egypt 1: 115 (1941); Maire, Fl. Afr. Nord, 1: 207-208, fig. 123 (1952); Horn af Rantz., Kew Bull. 7, 1: 33 (1952); Cuénod, Fl. anal. et syn. Tun.: 43 (1954); Täckholm V., Stud. Fl. Egypt: 582 (1956); Leredde, Trav. Inst. Rech. sahar., Alger, Sér. du Tassili 2, 455 p.p. (1957); Ozenda, Fl. Sahara sept. et centr.: 127 (1958); Ozenda, Fl. Sahara: 127 (1977); Quézel & Santas, Nouv. Fl. Algérie: 53-54 (1962); Keith, Prelim. check list Libyan Fl. *2*: 681 (1965); Täckholm V., Stud. Fl. Egypt.: 622 (1974). ≡ *Caulinia fragilis* Willdenow, Mém. Acad. Roy. Sci. Berl.: 88, t. 1, fig. 2 (1798); Battand. & Trabut, Flore Alger, Monoc.: 11 (1884); Battand. & Trabut, Fl. Algérie 1, (2): 10 (1895); Battand. & Trabut, Fl. Algérie

Tunisie: 315 (1905); Leredde, Bull. Soc. Hist. Nat. Toulouse, 89: 2 (1954). — ≡ *N. fragilis* Delile, Descr. Egypte, Hist. nat., *2*: 175 (1813). — ICONOTYPE: Micheli, Nov. Pl. Gen. 2, t. 8, fig. 3 (1729).

= *N. minor* All. var. *longifolia* Corti, Fl. et Veget. Fezzan e Gat: 30 (1942); Corti in Keith, Prelim. check list Libyan Fl. *2*: 681 (1965). — TYPE: Libya, « Fezzan occidentale, Reg. di Qat - 1180-1186: Elbárcat, 700 m, forsetto emiss. della sorg. grande, abondantissima, 2-3-34, en fior. » (non vidi).

— *N. horrida* auct. non A. Br. ex Magn.: Rendle, Trans. Linn. Soc., ser. 2, Bot. 5 (13): 443 (1900).

— *N. pectinata* auct. non (Parl.) Magn.: Maire, Fl. Afr. Nord 1: 208 (1952).

— *N. minor* All. *forma laxa foliis angustis* (A. Br.) in schedula, *de la Perraudière* in Herb. Cosson, 2.VII.1861 (=mixtum *N. minor* et *N. graminea).*

Plants submerged, monoecious, slender or robust. *Stems* unarmed less than 0.5 mm in diameter, plumose above because of the closely packed leaves or bushy above because of the curved leaves. *Leaves* (5-) 7-22 mm long, flat or bulk, acute, linear-lanceolate, (0.32-) 0.73-1.10 (-1.77)mm wide (incl. teeth on both sides), (0.19-) 0.40-0.53 (-0.64) mm wide (excl. teeth on both sides); margin on each side serrulate with (7-) 10-18 conspicuous spiny teeth on small or broad triangular excrescences; leaf teeth (0.07-) 0.17-0.34 (-0.52)mm long; the ratio of teeth length to leaf width being 0.34-0.81; midrib without spiny teeth; septa clearly visible; fibres absent; leaf sheath 1.61-2.26 mm (incl. auricle and spine-cells) by 0.13-0.32 mm (ratio = 1-2), truncate to auriculate, the auricle being 0.13-0.32 mm long (incl. spine-cells) serrulate or lacerate with (4-) 8-12 spine-cells on each side; apex of the auricle obtuse.

Inflorescences axillary, male and female flowers solitary, generally on different branches. *Male flower* enclosed in a spathe c. 1.8 mm (incl. spathe-neck) by 0.6 mm; neck of the spathe about 0.5 mm, tapering at the top, bearing no brownish spine-cells on the apex; inner envelope protruding c. 0.1 mm above the anther; anther c. 1.3 mm by 0.5 mm, 1-sporangiate. *Female flower* naked, 3.2-4.0 mm long; ovary 1.6-2.0 mm by 0.42-0.65 mm; style and stigma 1.6-2.3 mm; stigma 2-lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style. *Seed* elliptical oblong, 1.74-2.74 mm by 0.45-0.65 mm (ratio = 3.4-4.3); testa pitted with areoles, the latter arranged regularly and ladder-like in longitudinal rows, each row of (60-) 80-100; areoles rectangular c. 0.03 mm long and 0.1 mm wide.

DIAGNOSTIC FEATURES: Plants monoecious; stems and midrib of leaf unarmed; (7-) 10-18 leaf teeth on each margin; leaf teeth on excrescences; leaf teeth (0.32-) 0.73-1.10 (-1.77) mm long, septa present; fibres absent; leaf sheath truncate to auriculate; male flower in spathe; male spathe c. 1.8 mm long; anther c. 1.3 mm long, 1-sporangiate; female flower naked; seed elliptical oblong; areoles arranged regularly and ladder-like per (60-) 80-100 in each longitudinal row; cell walls not raised.

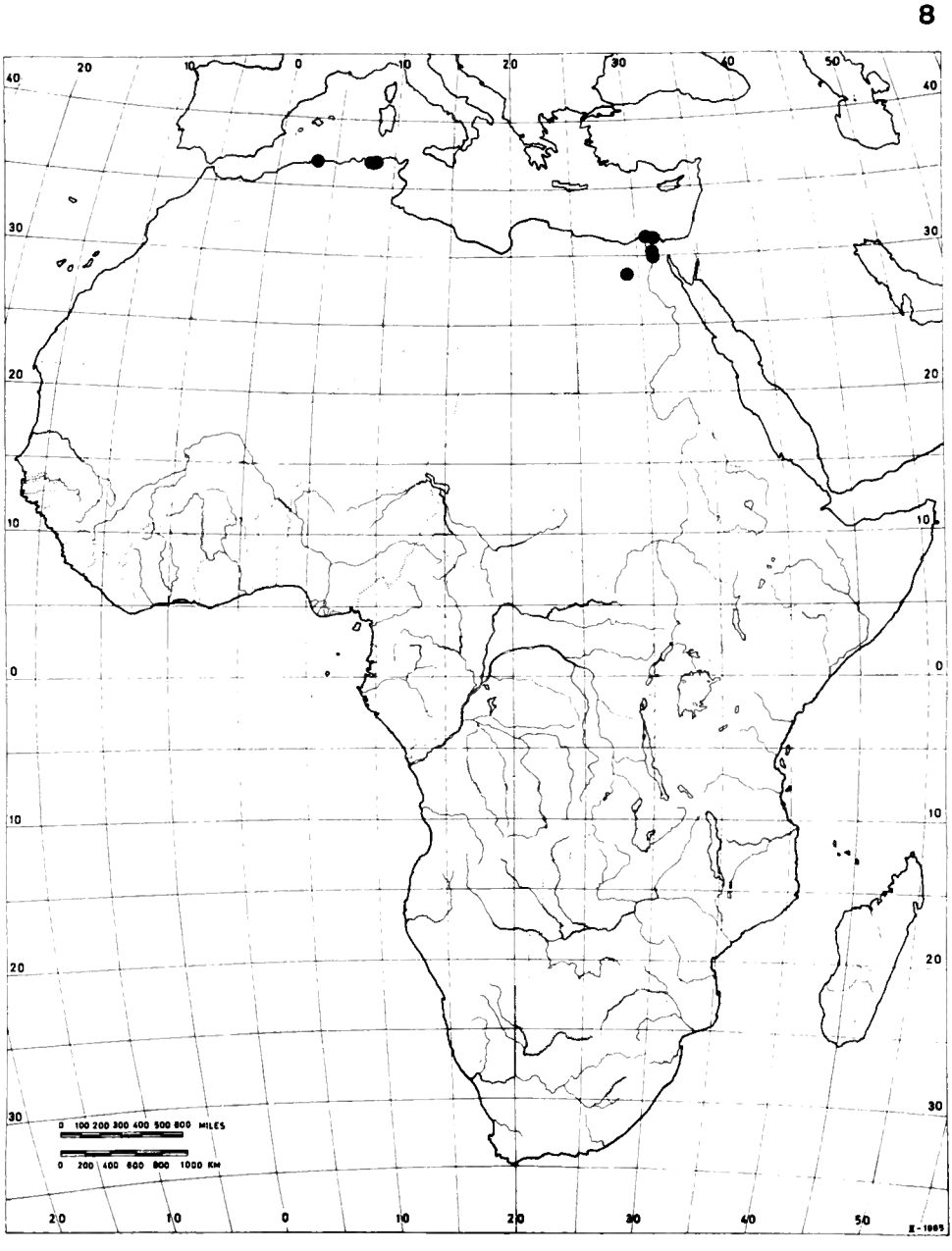

FIG. 8. — *N. minor*.

NOTES : 1. *N. minor* is an easy species to distinguish when ripe seeds are available.

2. The general appearance of *N. minor* can be similar to *N. horrida* or *N. pectinata*. It seems only to be known from Northern Africa.

3. A very compact specimen was mixed together with *N. marina* subsp. *armata* near Gheit el Nassara in Egypt (*Simpson* 1649) and a laxer one with *N. graminea* from Senhadja in Alger (*de la Perraudière* in Herb. Cosson 18).

4. MORGAN (1982) mentions a salinity of 0.1-0.4 $g.l^{-1}$ for Lake Oubeira and Lake Tonga (Algeria).

5. See also note 2. under *N. testui*.

GEOGRAPHICAL DISTRIBUTION : N. Africa, Europe, Asia and N. America. (African distribution : fig. 8).

SELECTED SPECIMENS :

Algeria : La Réghaia, 21.IX.1878, *Battandier* s.n. in Herb. Maire (BRVU, MPU); Lake Freitis, *Letourneux* s.n. in Herb. Maire (BRVU, MPU); ibid., Senhadja, near Annaba, X.1869, *Durando* s.n. in Herb. Maire (MPU); Senhadja, Constantine Prov., 2 (3).VII.1861, *de la Perraudière* s.n. in Herb. Cosson 18 (P); La Calle, Lake Oubeïra, 24.VI.1841, Herb. Durieu s.n. (P); La Calle, Lake Tonga, *Gauthier* s.n. in Herb. Maire (MPU).

Tunisia : Lake Ichkeul, « Ain Hallelif ad basin Djebel Schkeul », 27.VI.1887, *Letourneux* s.n. (P); Oued Boudjima, 1843, Coll ? 1185 in Herb. Cosson 18 (P).

Egypt : Rashid (« Rosetta »), 1825 ?, *Delile* s.n. (BRVU); Dumyât (« Damiette ») near Gheit el Nassara, 6.X.1922, *Simpson* 1649 (K); Shibin el Qanater, Tahanoub, Terraet el Ayyata, 22.VI.1973, *Ibrahim, Mahdi, Sisi, Abdel Aziz* s.n. (AAU, H); Ibshan, near Mansura, 15.VII.1926, *Simpson* 4001 (K); Heluan, III.1906, *Muschler* s.n. (K); Chonbrah, 16.VIII.1882, *Sickenberger* s.n. (WAG); VIII.1887 (G); X.1891 (G); s.l., Herb. Richard s.n. (P); *Delile* s.n. (FI-W; MPU); Bawiti, 24.IV.1876, *Ascherson* 498 (K, P); s.l., *Delile* in Herb. Steven, s.n. (H).

10. **Najas hagerupii** Horn af Rantz.

Kew Bull. 7, 1 : 35-38, fig. 3 (1952); Hepper, F.W.T.A. 2nd ed. 3, 1 : 21 (1968). — TYPE : Mali, Gao « Niger Military Territory », 17.IX.1927, *Hagerup* 368a (holo- : K; iso- : P).

— *N. baldwinii* auct. non Horn af Rantz.; Hepper, F.W.T.A., 2nd ed. 3, 1 : 21 (1968) p.p. quoad *Hall* cc 892.

— *N. graminea* auct. non Del.; Symoens, Fl. Cameroun 26 : 66, 68 (1984) p.p. quoad *W. de Wilde* 3102.

Plants submerged, monoecious, slender. *Stems* unarmed, c. 0.5 mm in diameter, often plumose above because of the closely packed leaves. *Leaves* 9.8-19.0 (-25.0) mm long, flat, acute, linear-lanceolate, 0.44-0.84 mm wide (incl. teeth on both sides),

0.37-0.71 mm wide (excl. teeth on both sides); margin on each side minutely serrulate with 22-50 inconspicuous spiny teeth, mainly consisting of the brownish spine-cell (a unicellular teeth, invisible to the unaided eye); leaf teeth 0.03-0.06 mm long, the ratio of teeth length to leaf width being 0.06-0.11; midrib without spiny teeth; septa absent; fibres present on margin and near midrib; leaf sheath 1.30-1.50 (-1.82) mm (incl. auricle and spine-cells) by 0.96-1.13(-1.76) mm (ratio = 1.1-1.6), auriculate, the auricle being 0.32-0.66 mm long (incl. spine-cells) and 0.11-0.16 mm wide (ratio = 2-3), serrulate or lacerate with 2-6 spine-cells on each side; apex of the auricle acuminate.

Inflorescences axillary, solitary or 2-4 together, each at the very base of an (sometimes very short) axillary shoot; male and female flowers generally on different branches. *Male flower* enclosed in a spathe, 1.0-1.37 mm (incl. spathe-neck) by 0.40-0.80 mm; neck of the spathe 0.3-0.5 mm long, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding 0.16-0.32 mm above the anther; anther 0.64-0.88 mm by 0.35-0.62 mm, 1-sporangiate; pedicel about 0.2 mm; at anthesis about as long as the anther. *Female flower* naked, 1.53-1.90 mm long; ovary 0.90-1.30 mm by 0.40-0.56 mm; style and stigma 0.5-0.6 mm; stigma 2-3 lobed.

Fruit with persistent, thin, membraneous pericarp and remaining parts of style. *Seed* elliptical oblong 1.30-1.80 mm by 0.37-0.45 mm (ratio = (2.1) 3-4.5); testa pitted with areoles, the latter arranged regularly in longitudinal rows, each row of 21-30; areoles 4 (-5)-angled, 0.04-0.06 mm long.

DIAGNOSTIC FEATURES: Plants monoecious; stems and midrib of leaf unarmed; leaves (0.37-) 0.44-0.84 mm wide (incl. teeth on both sides) (18-) 22-50 leaf teeth on each margin; leaf teeth not on excrescences; leaf teeth 0.03-0.06 mm long; septa absent; fibres present; leaf sheath truncate to auriculate; male flower in spathe; male spathe 1.0-1.37 mm long; anther 0.64-0.88 mm long, 1-sporangiate; female flower naked; seed elliptical, oblong; seed 1.3-1.8 (-1.9) mm long; areoles arranged regularly per 21-30 in each longitudinal row; never ladder-like; cell walls not raised.

NOTES: 1. *N. hagerupii* occurs in marshes and pools.

2. See note 2. under *N. testui*.

GEOGRAPHICAL DISTRIBUTION: West tropical Africa and Central African Republic (Fig. 9).

SELECTED SPECIMENS:

Mali: Gao, 17.IX.1927, *Hagerup* 368a (K, P).

Ghana: Lawra, Bahari, 5.XI.1965, *Hall* cc 768 (K); ibid., Kamba, XI.1958, *Harris* s.n. (K); Busunu, Damongo to Yapei, 10.IX.1965, *Hall* cc 892 (K).

Cameroon: About 30 km Maroua, 7.IX.1964, *W. de Wilde & B. de Wilde-Duyfjes* 3102 (BR, BRVU, P, WAG, YA).

Central African Republic: Ubangi, « 7 km aval Mobaye » near N'Dengou, I.1913, *Tisserant* 79 (P); Ubangi region, VI.1914, *Tisserant* 80 (P).

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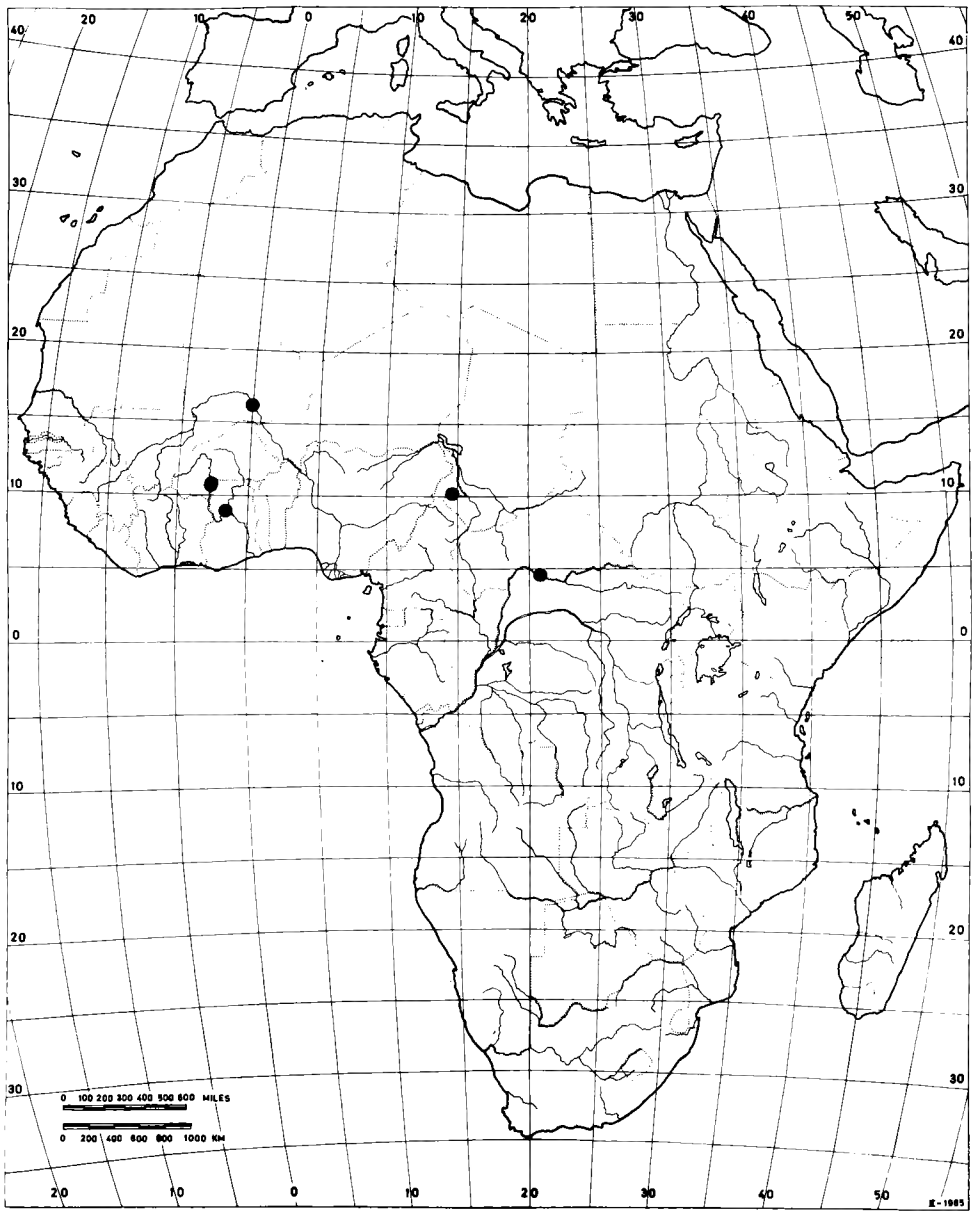

FIG. 9. — *N. hagerupii.*

11. **Najas setacea** (A. Br.) Rendle

Trans. Linn. Soc., ser. 2, Bot. 5 (12): 422, pl. 42, fig. 177-182 (1899); Rendle, ibid., (13): 443 (1900); Rendle in Engler, Pflanzenr., H. 7: 17, fig. 5 L-M (1901); Horn af Rantz., Kew Bull. 7, 1: 32 (1952) p.p., non Réunion. ≡*N. minor* All. var. *setacea* A. Br. Journ. Bot. 2: 278 (1864). — TYPE: Mauritius, *Néraud* in Herb. Richard (holo-: B†; lecto-: P; iso-: K), lectotype designated here.

— *N. graminea* auct. non Del.; Fosberg in Westoll & Stoddart, Philos. Trans. Roy. Soc. Lond. B, Biol. Sc. 260: 223, 225 (1971); Whittion., ibid.: 252, 253 (1971); Grubb, ibid.: 355, 356 (1971); Fosberg & Renvoize, Fl. Aldabra, Kew Bull. add. ser. 7: 295, fig. 1-3 (1980).

— *N. australis* auct. non Bory ex Rendle; Scott, Fl. Mascar. 195: 3 (1984) p.p.

Plants submerged, monoecious, slender. *Stems* unarmed, up to 30 cm long. c. 0.5 mm in diameter, often plumose above because of the closely packed leaves. *Leaves* 14-25 mm long, flat, acute, linear-lanceolate, 0.43-0.61 mm wide (incl. teeth on both sides), 0.32-0.48 mm wide (excl. teeth on both sides); margin on each side minutely serrulate with inconspicuous spiny teeth, mainly consisting of the brownish spine-cell (a unicellular teeth, invisible to the unaided eye) or serrulate with 18-30 (-36) rather conspicuous spiny teeth on small triangular excrescences; leaf teeth 0.03-0.08 (-0.12) mm long; the ratio of teeth length to leaf width being 0.08-0.20 (-0.40); midrib without spiny teeth; septa and fibres absent; leaf sheath 1.7-2.4 mm (incl. auricle and spine-cells) by 0.96-1.77 mm (ratio = 1.36-1.84), truncate to auriculate, the auricle being 0.24-0.30 (-0.71) mm long (incl. spine-cells), serrulate or lacerate with 2-5 (-9) spine-cells on each side; apex of the auricle acuminate.

Inflorescences axillary, solitary, male and female flowers on different branches. *Male flower* enclosed in a spathe, c. 1.3 mm (incl. spathe-neck) by 0.20 mm, tapering at the top, bearing brownish spine-cells on the apex; inner envelope protruding c. 0.15 mm above the anther, anther 0.68 mm by 0.15 mm, 1-sporangiate. *Female flower* naked, 2.1-2.6 mm long; ovary 1.1-2.0 mm by 0.3-0.4 mm; style and stigma 0.8-1.1 mm; stigma 2-lobed. *Fruit* with persistent, thin, membraneous pericarp and the remaining parts of style. *Seed* elliptical oblong; 1.5-1.77 mm by 0.43-0.55 mm (ratio = 2.9-4.1); testa pitted with areoles, the latter arranged regularly in longitudinal rows, each row of 28-36; areoles squarrish, 0.04-0.06 mm long.

DIAGNOSTIC FEATURES: Plants monoecious; stems and midrib of leaf unarmed; leaves 0.43-0.61 mm wide (incl. teeth on both sides); 18-30 (-36) leaf teeth on each margin; leaf teeth not on excrescences; leaf teeth 0.03-0.08 (-0.12) mm long; septa and fibres absent; leaf sheath truncate to auriculate; male flower in spathe; male spathe c. 1.3 mm long; anther c. 0.68 mm long, 1-sporangiate; female flower naked; seed elliptical oblong; seed 1.50-1.77 mm long; areoles arranged regularly per 28-36 in each longitudinal row; never ladder-like; cell walls not raised.

NOTES: 1. Male flowers of *N. setacea* were never observed before.

2. *N. setacea* comes close to the Asiatic species *N. indica* (Willd) Cham. It differs however by the unilocular anther.

3. *N. setacea* was mixed with *N. australis* at La Digue, Seychelles (*De L'Isle*, 22.XII.1875).

4. *N. setacea* does not occur in Réunion. RENDLE (1899 b) believed it did, but made the correction himself (1900).

GEOGRAPHICAL DISTRIBUTION: Aldabra, Seychelles, Mauritius and N. Madagascar (Fig. 11).

SELECTED SPECIMENS:

Aldabra: South Island, S.W. Cinq Cases Camp, 24.I.1968, *Fosberg* 49035 (BRVU, K, MO).

Seychelles: La Digue, 22.XII.1875, *De L'Isle* s.n. (P); s.l., *Hariot* s.n. (BM, K, P).

Mauritius: s.l., *Néraud* s.n. in Herb. Richard (K, P).

Madagascar: North, Linyvatou, *Boivin* 2357 (P).

12. **Najas baldwinii** Horn af Rantz.

Acta Horti Gotoburg. 18: 187-190, fig. 11-19 (1950); Horn af Rantz., Bot. Notis. 1951, 4: 382 (1951); Horn af Rantz., Kew Bull. 7, 1: 40 (1952); Hepper, F.W.T.A., ed. 2, 3, 1: 21 (1968) p.p. quoad Sierra Leone et Liberia. — TYPE: Liberia, Western Prov., Kolahun Distr., Gondolahun, 3.XI.1947, *Baldwin Jr.* 10116 (holo-: K; iso-: COI, MO).

= *N. liberiensis* Horn af Rantz., Acta Horti Gotoburg. 18: 190-191, fig. 2-10 (1950); Horn af Rantz., Bot. Notis. 1951, 4: 382 (1951); Horn af Rantz., Kew Bull. 7, 1: 39-40 (1952); Aké Assi, Contrib. Et. florist. Côte d'Ivoire: 222 (1963). — TYPE: Liberia, Voinjoma, Distr., 15 mls E. Voinjama, 23.X.1947, *Baldwin Jr.* 9925 (holo-: K).

— *N. graminea* auct. non Del.: Raynal, A., Annales Fac. Sci. Univ. Dakar 9: 225 (1963); Symoens, Fl. Cameroun 26: 66, 68 (1984) p.p. quoad *Letouzey* 7257.

— *N. pectinata* auct. non (Parl.) Magn.: Hepper, F.W.T.A. ed. 2, 3, 1: 20 (1968) p.p. quoad *Hall* cc 420.

— *N. graminea* auct. non Del.: Lo & Maynart, Mém. Inst. fr. Afr. Noire, 92: 98 (1982); Triest & Symoens, Fl. Afr. Centr., Najadaceae: 6, 8 (1983) p.p. quoad *Vanderyst* s.n., 15.I.1907; *Pauwels* 1769; 2664; *Gillet* 472; 1006; 1514 et *Hurner* 58.

— *N. graminea* Del. var. *minor* in schedula *Chevalier* 6582 (P).

— Probably also: *Lagarosiphon schweinfurthii* auct. non Casp.: De Wild. & Th. Durand, Pl. Gilletianae, 2: 101 (1901) (Bull. Herb. Boiss., sér. 2, I: 841); De Wild.,

Et. Fl. Bas et Moy. Congo, 1 : 94 (1904); (Ann. Mus. Congo, Bot., sér. 5, 1) p.p. quoad « Kisantu, 1900 (*J. Gillet* 1006) »; Th. & H. Durand, Syll. Fl. cong. : 514 (1909) p.p. quoad « 1900 (*J. Gillet*). — V : Kisantu (*Gillet* 1006) ».

Plants submerged, monoecious, slender. *Stems* unarmed, c. 0.5 mm in diameter, often plumose above because of the closely packed leaves. *Leaves* (7.2-) 10.8-21.5 (-29.0) mm long, flat, acute, linear-lanceolate, (0.32-) 0.37-0.75 (-1.05) mm wide (incl. teeth on both sides), 0.15-0.48 (-0.71) mm wide (excl. teeth on both sides); margin on each side serrulate with (4-) 10-29 (-40) conspicuous spiny teeth on small triangular excrescences; leaf teeth (0.05-) 0.07-0.16 (-0.20) mm long; the ratio of teeth length to leaf width being (0.14-) 0.21-0.58 (-0.75); midrib without spiny teeth; septa absent or clearly visible; fibres absent or present on margin or/and near midrib; leaf sheath (1.2-) 1.4-2.1 (-2.7) mm (incl. auricle and spine-cells) by 0.8-1.9 (-2.6) mm (ratio = 0.1-0.3), truncate auriculate, the auricle being 0.12-0.55 (-0.93) mm long (incl. spine-cells) and 0.20-0.56 mm wide (ratio = 0.55-1.50), serrulate or lacerate with 1-7(-10) spine-cells on each side; apex of the auricle rather obtuse to acuminate.

Inflorescences axillary, solitary or 2-4 together, each at the very base of an (sometimes very short) axillary shoot; male and female flowers generally on same branches and often together at the same node. *Male flower* naked; inner envelope protruding 0.08-0.16 mm above the anther; anther 0.56-1.13 mm by 0.16-0.40 mm, 1-sporangiate. *Female flower* naked, 0.88-2.70 mm long; ovary 0.48-1.90 mm by 0.27-0.64 mm; style and stigma 0.40-0.88 mm; stigma 2-lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of the style. *Seed* elliptical oblong, 1.21-1.70 (-2.10) mm by 0.38-0.54(-0.83) mm (ratio = 2.6-4.2); testa pitted with areoles, the latter arranged regularly in longitudinal rows, each row of 18-32; areoles rectangular or hexagonal, 0.05-0.08 mm long.

DIAGNOSTIC FEATURES : Plants monoecious; stems and midrib of leaf unarmed; leaves (0.32-) 0.37-0.75 (-1.05) mm wide (incl. teeth on both sides); leaf teeth on excrescences; leaf teeth (0.05-) 0.07-0.16 (-0.20) mm long; leaf sheath truncate to auriculate; male flower naked; anther 0.56-1.13 mm long, 1-sporangiate; female flower naked; seed elliptical oblong; seed 1.21-1.70 (-2.10) mm long; areoles regularly arranged per 18-32 in each longitudinal row; never ladder-like; cell walls not raised.

NOTES : 1. *N. baldwinii* mostly occurs in rice fields or rice field ditches in Senegal (Basse-Cassamance); Mali (Koba) and Sierra Leone (Kasewe, Kumaru, Katahur, Njala).

2. See note 2. under *N. testui*.

3. W.J.J.O. DE WILDE (1960) described *N. malesiana* from Malaysia; this species comes close to *N. baldwinii*, and there is a need of further analysis of their differences.

4. *N. baldwinii* often is recorded from temporary pools.

GEOGRAPHICAL DISTRIBUTION : West and Central tropical Africa (Fig. 10).

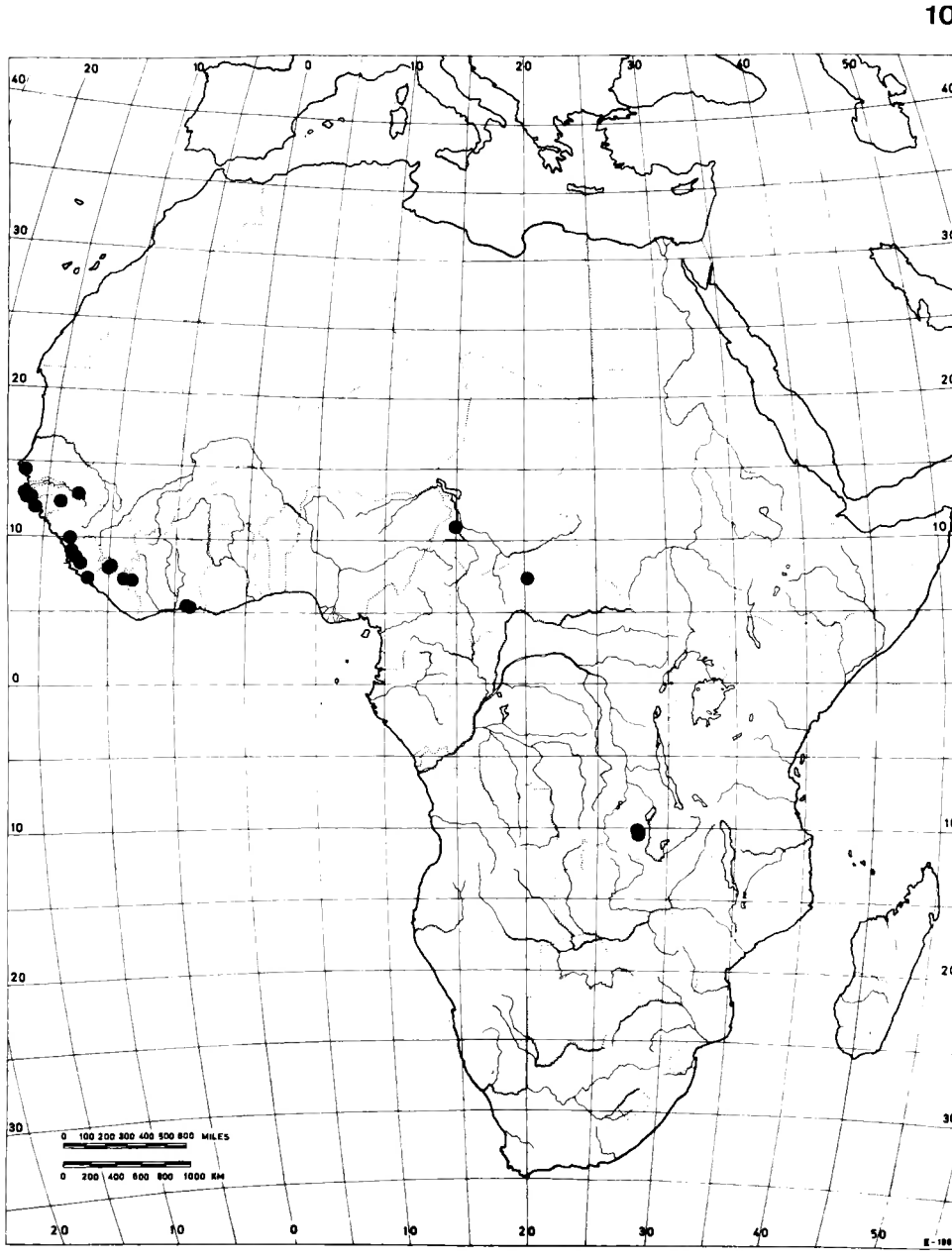

FIG. 10. — *N. baldwinii*.

SELECTED SPECIMENS:

Senegal: Ndiéguéme, SW. Lake Tanma, 18.VII.1960, *J. & A. Raynal* 6070 (P); Niokolo Koba, « marais Diamowel », 27.XII.1960, *J. & A. Raynal* 6878 (P); Basse-Cassamance, Kafountine, 11.IX.1984, *Vanden Berghen* 6333 (BR, BRVU) N. Kagnout, 9.XI.1983, *Vanden Berghen* 5993 (BRVU), 6003 (BRVU); ibid., Médina, 7.I.1977, *Vanden Berghen* 1773 (BR, BRVU); ibid., Djibelor, 1.XI.1979, *Vanden Berghen* 3695 (BRVU); 3699 (BRVU).

Guinea-Bissau: Buruntuma, XI.1962, *Pereira* 4035 (K); Bissau, Pussubé, 24.XI.1945, *Santo* 2234 (BRVU, COI, P); Malato (?), *Beliz* 4035 (K).

Guinea: Friguiagbé, 28.IX.1939, *Chillon* 1721 (BRVU, P); Koba station, XI.1956, *Jacques-Félix* 7375 (K, P).

Sierra Leone: Kambia N.P., 3.XI.1963, *Morton & Gledhil* SL 88 (K, WAG); Rokupr, 25.IX.1947, *Jordan* 115 (K); ibid., 6.X.1947, *Jordan* 128 (K); Near Njala, 23.IX.1933, *Deighton* 2797 (K); Kasewe, 17.VIII.1977, *Denny* s.n. (Herb. Denny); Komary, 9.IX.1977, *Jupp* s.n. (Herb. Denny); Katahur, 15.IX.1977, *Jupp* s.n. (Herb. Denny).

Liberia: Voinjoma Distr., 15 mls E. Voinjoma, 23.X.1947, *Baldwin Jr.* 9925 (K); Kolahun Distr., Gondolahun, 3.XI.1947, *Baldwin Jr.* 10116 (COI, K); Gbedin, 16.IX.1950, *Harley* 1656 (K, WAG).

Ivory Coast: Between Danané and Guinea, 18.I.1965, *Aké Assi* 7710 (K); Abouabou, 13.VII.1970, *Aké Assi* 11263 (K); I.R.H.O. between Gr. Bassam and Abidjan, 13.VII.1963, *W. de Wilde* 616 (BR, K, P, Z).

Cameroon: Dega, near Guirvidig, 70 km ENE Maroua, 10.X.1964, *Letouzey* 7257 (BR, BRVU, P, YA).

Central African Republic: Dar Banda, between Koukourou river and Kaga Nze (Dije?), 4.XII.1902, *Chevalier* 6582 (BR, BRVU, K, P).

Zaire: Shaba, Kundelungu plateau, « 18 km SE du Poste de la Lualala », 21.IV.1971, *Lisowski* 96203 (BR, BRVU); ibid., « 9.5 km NE de la source occidentale de la Lutshipuka, 22.IV.1971, *Lisowski* 96204 (BR, BRVU); Manika plateau, Kentala valley, 25.III.1975, *Malaisse* 8571 (BR).

— Probably *N. baldwinii* (sterile specimens or male flowers lacking):

Sierra Leone: Near Kambia, Magbema, 14.VIII.1951, *Jordan* 471 (K); Bo to Makeni Road, 22.II.1965, *Morton* SL 874 (K).

Liberia: Monrovia, 23.XI.1934, *Dinklage* 3285 (BR).

Ivory Coast: Mankono, 30.IX.1955, *Nozeran* (MPU); 50 km W Bania, 16.IX.1967, *Geerling & Bokdam* 896 (K, WAG).

Ghana: 3 km N. Pong Tamale, 27.VIII.1965, *Hall* cc 420 (K).

Sudan: Wad Medani, Gezira Scheme, 10.II.1965, *W. & J. de Wilde & B. de Wilde-Duyfjes* 5709 (WAG).

Zaire: Bas-Zaïre, Kisantu, 15.I.1907, *Vanderyst* s.n. (BR); ibid., 25.IV.1959, *Pauwels* 2664 (BR); ibid., 1900, *Gillet* 472 (BR); 1006 (BR); 1514 (BR); ibid., Kinata, 23.II.1959, *Pauwels* 1769 (BR); Shaba, Kapona-Manono, 2.II.1953, *Hurner* 58 (BR); Kundelungu plateau, « 10.9 km NNW du poste Lualala, mare de source au ruisseau Munua, affluent de la Nungwe », 21.IV.1971, *Lisowski* 96233 (BR).

13. **Najas graminea** Del.

Descr. Egypte, Hist.-Nat. 2: 282, pl. 50, fig. 3 (1813); Cham., Linnaea 4: 502-503 (1829); A. Br., Journ. Bot. 2: 278 (1864); Boissier, Fl. Orient. 5: 28 (1882); Battand. & Trabut, Fl. Alger, Monoc.: 11 (1884); Schweinf., Beitr. Fl. Aethiop.: 292 (1887); Balfour, Trans. Roy. Soc. Edinb. 31: 301 (1888); Rendle, Trans. Linn. Soc. ser. 2, Bot. 5 (12): 424-426, pl. 42, fig. 192-202 (1899); Rendle, l.c., (13): 443 (1900); Rendle in Engler, Pflanzenr., H. 7: 18, fig. 5 q-v (1901); Bennett in This.-Dyer, F.T.A. 8, 2: 226 (1901); Broun, Catal. Sudan Flow. Pl.: 86 (1906); Engler, Pflanzenw. Afr. in Engler & Drude, Veget. Erde 9, 2: 98 (1908); Muschler, Man. Fl. Egypt. 1: 24-25 (1912); Aly Ibrahim Ramis, Bestimmungstabellen Fl. Aeg.: 20 (1929); Broun & Massey, Fl. Sudan: 367-368 (1929); Trochain, Contrib. vég. Sénégal: 84 (1940); Täckholm V. & G. & Drar, Fl. Egypt 1: 115-116 (1941); Horn af Rantz., Acta Horti Gotob. 18: 192, map (1950); Horn af Rantz., Kew Bull. 7, 1: 39 (1952); Maire, Fl. Afr. Nord 1: 209, fig. 124 (1952); Berhaut, Fl. Sénégal ed. 1: 53 (1954); Andrews, Flow. Pl. Sudan 3: 237 (1956); Täckholm V., Stud. Fl. Egypt ed. 1: 582 (1956); Adam, Bull. Inst. fr. Afr. Noire 23, sér. A (3): 713, 715 (1961); Quézel & Santas, Nouv. Fl. Algérie: 53-54 (1962); Oberm. in Codd, de Winter & Rycroft, Fl. S. Afr. 1: 83, 85 (1966); Berhaut, Fl. Sénégal ed. 2: 90 (1967); Cufodontis, Bull. Jard. Bot. Nat. Belg. 38, 4; suppl.: 1201 (1968); Greenway, Journ. E. Afr. nat. Hist. Soc. 27: 174, 197 (1969); Lebrun, Enum. Pl. Vasc. Sénégal, Inst. Elev. & Médec. Vét. Pays Trop., Et. Bot. 2: 121 (1973); V. Täckholm, Stud. Fl. Egypt. ed. 2: 622 (1974); Triest & Symoens, Fl. Afr. Centr., Najadaceae: 6, 8 (1983) p.p. quoad *Troupin* 1836; Symoens, Fl. Cameroun 26: 66-67 (1984) pro majore parte. ≡ *Caulinia graminea* (Del.) Battand. in Battand. & Trabut, Fl. Algérie 1, 2: 10 (1895); Battand. & Trabut, Fl. Algérie Tunisie: 315 (1905). ≡ *N. graminea* Del. var. *delilei* Magn., Ber. Deutsch. Bot. Ges. 1: 522 (1883); Bailey, Journ. Bot. 22: 305, fig. 1-89 (1884); Magn. in Aschers. & Schweinf., Ill. Fl. Egypte (Mém. Inst. Egypte 2, 1): 146 (1887); Durand & Schinz, Consp. Fl. Afr. 5: 499 (1894). — TYPE: Egypt, s.l. « Dans les canaux des rizières, à Rosette et dans le Delta », *Delile* s.n. (holo-: MPU; iso-: H, in Herb. Steven; photo: CAI). The locality is given in the original description, but not mentioned on the label.

= *N. graminea* Del. var. *vulgata* Magn. in Aschers. & Schweinf., Ill. Fl. Egypte (Mém. Inst. Egypte 2, 1): 145-146 (1887); Durand & Schinz, Consp. Fl. Afr. 5: 499 (1894); Maire, Fl. Afr. Nord 1: 209 (1952). — TYPE: Egypte, « Grande Oasis »

Schweinfurth 620 (syn-: B†; lecto-: P), lectotype designated here; Egypt, Dakhel, *Ascherson* s.n. (syn-: B†).

— *N. liberiensis* auct. non Horn af Rantz.; Hepper, F.W.T.A. ed. 2, 3, 1 : 21 (1968) p.p. quoad *Jaeger* s.n.

— *N. minor* All. forma *laxa foliis angustis* A. Br. in schedula, *de la Perraudière* in Herb. Cosson s.n., 2.VII.1861 (mixtum *N. minor* + *N. graminea*!).

Plants submerged, monoecious, slender. *Stems* up to 60 cm high, unarmed, 0.4-1.5 mm in diameter, often plumose above because of the closely packed leaves. *Leaves* (9.2-) 14-20 (-33) mm long, flat, acute, linear-lanceolate, (0.24-) 0.5-0.8 (-1.0) mm wide (incl. teeth on both sides), (0.19-) 0.4-0.7 (-0.84) mm wide (excl. teeth on both sides); margin on each side minutely serrulate with (18-) 34-70 inconspicuous spiny teeth, each mainly consisting of the brownish spine-cell (a unicellular tooth, invisible to the unaided eye); leaf teeth 0.02-0.07 (-0.12) mm long, the ratio of teeth length to leaf width being 0.03-0.10 (-0.22); midrib without spiny teeth; septa absent; fibres absent or present on margin and near midrib; leaf sheath (1.4-) 2.0-3.0 (-3.9) mm (incl. auricle and spine-cells) by 0.9-2.1 mm (ratio = 1.1-1.9 (-2.9)), deeply auriculate, the auricle being (0.4-) 0.8-1.2 (-1.5) mm long (incl. spine-cells) and (0.16-) 0.2-0.3 (-0.5) mm wide (ratio = (1.4-) 2.0-4.5 (-6.5)), serrulate with 3-14 spine-cells on each side; apex of the auricle acute.

Inflorescences axillary, male and female flowers solitary, or 2-4 together at the same node but the male ones more to the top of the plant. *Male flower* naked; inner envelope protruding 0.05-0.13 mm above the anther; anther 0.7-1.3 mm by 0.3-0.5 mm, 4-sporangiate. *Female flower* naked, 1.6-3.7 mm long; ovary 0.7-1.6 mm by 0.26-0.87 mm; style and stigma 0.5-1.8 mm; stigma 2 (-3) lobed.

Fruit with persistent, thin, membraneous pericarp and the remaining parts of style. *Seed* elliptical oblong, (1.26-) 1.5-2.4 (-4.20) mm by (0.42-) 0.5-0.7 (-0.81) mm, sometimes slightly recurved [ratio = (2.2-) 2.6-4.0 (-5.2)]; testa pitted with areoles arranged regularly in longitudinal rows, each row of (23-) 25-35 (-60); areoles mostly hexagonal, 0.06-0.08 mm long.

DIAGNOSTIC FEATURES:

Plants monoecious; stems and midrib of leaf unarmed; leaves (0.24-) 0.5-0.8 (-1.0) mm wide (incl. teeth on both sides); (18-) 34-70 leaf teeth on each margin; leaf teeth not on excrescences; leaf teeth 0.02-0.07 (-0.12) mm long; septa absent; leaf sheath truncate to auriculate; male flower naked; anther 0.7-1.3 mm long, 4-sporangiate; female flower naked; seed elliptical, oblong; areoles arranged regularly per (23-) 25-35 (-60) in each longitudinal row; never ladder-like; cell walls not raised.

NOTES: 1. The African specimens belong to the typical var. *graminea* which is widespread throughout the Old World. W.J.J.O. DE WILDE (1962) described var. *robusta* de Wilde from Malaysia (Wètar, Lake Tihu). This robust plant differs from var. *graminea* by the leaves 50-60 by 3-4 mm; 160-185 teeth on each margin;

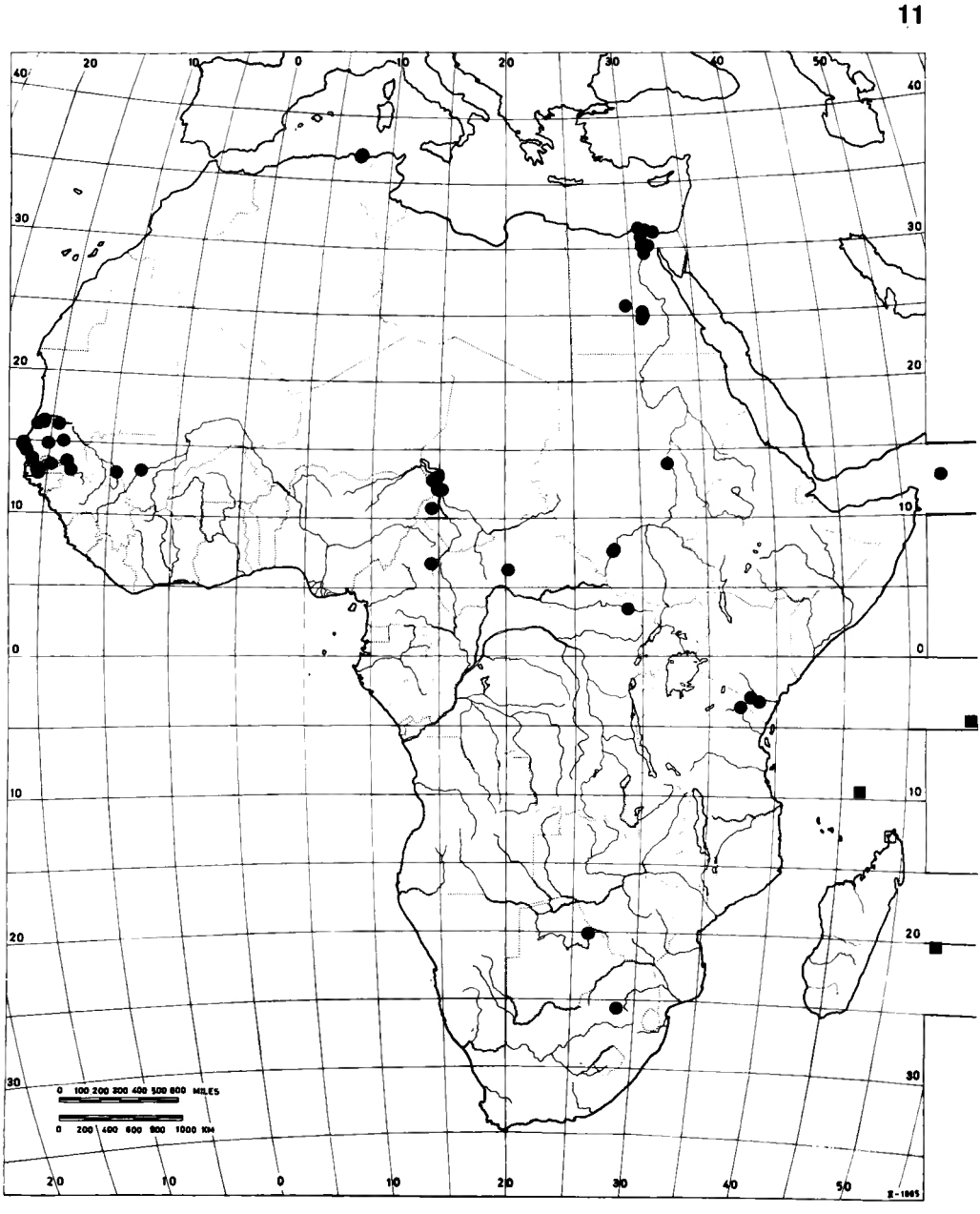

FIG. 11. — *N. graminea* (circles) and *N. setacea* (squares).

stem (1.6-) 2-2.3 mm thick; leaf sheath (4-) 7.5 (-10.5) mm, auricle (2-) 4-5.5 mm long. *N. graminea* from tropical Africa always has leaves with fibres near the midrib and on the margins. This fibres are mostly, but not always lacking in specimens from Egypt. MAGNUS (1883) considered the latter as a distinct variety. However as the specimens can be distinguished by no other character, it is safer to disregard the variety until the absence or presence of fibres has been checked for the whole distribution area of *N. graminea*.

2. Extremes: *Audru* 2874 (Senegal) has short leaves (c. 9-15 mm) and small seeds (1.26 × 0.42 mm); *Chevalier* s.n. (Senegal) has long seeds (4.2 mm; ratio 5.2) with 55-60 areoles; *Chevalier* 34009 (Senegal) and *Chevalier* 6751 (Lake Chad) have somewhat recurved seeds.

3. *N. graminea* was collected mixed with *N. welwitschii* in Senegal (*Bamps* 7566), with *N. pectinata* in Egypt (*Sickenberger* s.n.), with *N. horrida* in Botswana (*Drummond & Seagrief* 5163), with *N. minor* from Senhadja, Algeria (*de la Perraudière* s.n. in Herb. Cosson 18) and with *N. schweinfurthii* from « Seriba Ghattas », Sudan (*Schweinfurth* 2140). *N. graminea* and *N. minor* are both recorded from Lake Freitis in Algeria.

4. *N. graminea* was collected from rice fields in Senegal (*Bamps* 7566) and Egypt (*El Hadidi*, 13.VIII.1967).

GEOGRAPHICAL DISTRIBUTION: S. Europe, subtropical and tropical regions of Africa, Asia and Australia. As an adventive in California (U.S.A.). (African distribution: Fig. 11).

SELECTED SPECIMENS:

Algeria: Lake Freitis, near Senhadja, 2.VII.1861, *de la Perraudière* s.n. in Herb. Cosson 18 (G, P); ibid., X.1869, *Durando* s.n. in Herb. Maire (MPU).

Egypt: Dumyât, « Damiette », 4.XI.1887, *Schweinfurth* s.n. (BM, MPU); ibid., XII.1905 *Muschler* s.n. (K); Rashid, « Rosetta », IX.1876, *Letourneux* s.n. in Herb. Rouy (LY); ibid., III.1906, *Muschler* s.n. (K); Kafr el Zaiyât, 24.X.1885, *Schweinfurth* s.n. (BM, MPU, Z); Menzaleh, 10.VII.1887, *Schweinfurth* s.n. (BM, MPU); Near Cairo, X.1864, *Schweinfurth* 1412 (K, MO, Z); Qalyub, 19.XI.1922, *Simpson* 1296 (CAIM, K); El Merj, 14.X.1894, *Sickenberger* s.n. (Z); loc. 7, 14.X.1894, *Sickenberger* s.n. (Z); Boulaq-Dakrur, 16.X.1885, *Deflers* s.n. (MPU); Giza, 12.X.1928, *Shabetai* z 200 (CAIM); Mena House, 19.X.1926, *Hassan (Abd el Khalek)* 4078; 4079; 4080 (CAIM, K); Heluan, 10.X.1927, *Simpson* 5364 (CAIM, G, K); ibid., III.1906, *Muschler* s.n. (K); Dakhla Oasis, 12.III.1874, *Ascherson* 2264 (K); « Great Oasis », IV.1906, *Muschler* s.n. (K); ibid., El Khargeh, II.1874, *Schweinfurth* 620 (P); ibid., Ain Andreka, 23.I.1924, *Simpson* 2411 (CAIM, K); ibid., Birka, Gennah, 11.IV.1928, *Simpson* 5984 (CAIM, K); ibid., Ain Eshtakhrab, 11.IV.1928, *Simpson* 5988 (CAIM, K), ibid., 16.I.1928, *G. Täckholm* s.n. (CAI); ibid., Baris, 8.II.1952, *Täckholm & Kassas* 85 (CAI); ibid., 1.II.1959, *Ghabbour* s.n. (CAI); ibid., Hibis, 13.VIII.1967, *El Hadidi* s.n. (CAI); loc ?, 29.IX.1880,

Sickenberger s.n. (Z); s.l., *Delile* s.n. in Herb. Delile (MPU, photo in CAI); Herb. Salzmann s.n. (MPU).

Senegal: Ross Béthio, 7.X.1965, *Audru* 2874 (ALF, P); 13 km W Richard-Toll, 10.XI.1984, *Bamps* 7565; 7566 (BR); Richard-Toll, 11.X.1969, *Hepper* 3628 (K, WAG); Saldé, 55 km W Kaédi, 15.X.1969, *Hepper* 3695 (K); Between N'Ghar and Namari, 10.VII.1934, *Trochain* 3729bis (P): Niakoulrab, *Berhaut* 1793 (P); Dogar, 27.IX.1953, *Berhaut* 3382 (P); Vélor, 19.X.1953, *Berhaut* 3821 (P); Tièl, 22.X.1961, *J. Raynal* 7703 (P); Iles de la Madeleine, 7.XI.1960, *J. & A. Raynal* 6598 (P); Nianing, road to Joal, 3 km SEE village, 08.IX.1960, *J. & A. Raynal* 6341 (P); Tambacounda, 20.IX.1953, *Berhaut* 3281 (P); ibid., 22.XI.1929, *Chevalier* 34009 (P); ibid., 7 km N Tambacounda, 23.XI.1929, *Chevalier* 34014 (BRVU, P); Tambacounda, « Pont de la rivière Sandougou », 20.XI.1984, *Vanden Berghen* 7214 (BR, BRVU); Niokolo Koba, N.P., 9 km S of fork from Niokolo to Banharé, 28.XII.1960, *J. & A. Raynal* 6981 (P); Saré-Sara, near Kolda, 23.XI.1984, *Vanden Berghen* 7255 (BR, BRVU).

Gambia: Maccarthy Div., near Bansang, 1952, *Duke* 4 (K).

Mali: Kita, VII.1944, *Jaeger* s.n. (K); Kéna, 13.IX.1937, *Roberty* 2704 (P).

Cameroon: 30 km N Maroua, Mayo Ouldeme, 16.X.1964, *Letouzey* 7360 (BRVU, K, P, YA); 20 km N Maroua, Papata, 23.IX.1964, *W. de Wilde & B. de Wilde-Duyfjes* 3491 (BR, BRVU, K, P, WAG, YA): About 20 km W Kousséri, along main road to Nigeria, 30.IX.1964, *W. de Wilde & B. de Wilde-Duyfjes* 3578 (WAG); 3579 A (WAG), 3579 B (BR, BRVU, K, P, WAG); 25 km WNW Kousséri, near Maltam, 28.IX.1964, *Letouzey* 7072 (BRVU, K, P, WAG); Maltam, 23.I.1968, *Léonard* 4385 (BR); 30 km NE Meiganga, Mikila, 9.X.1963, *Letouzey* 6128 (P).

Chad: Between Djougia & Mani, 26.I.1968, *Léonard* 4475 (BR); About 8 km S N'Djamena, along road to Bongor, 3.I.1965, *W. & J. de Wilde & B. de Wilde-Duyfjes* 5178 (BR, K, P, WAG); NE of Milandi, 26.VIII.1964, *Audru* 945bis (ALF).

Sudan: Arashkol, Omkenem, 12.X.1862, *Steudner* 213 (BM, K, Z); Kuchuk Ali, Seriba, 5.V.1869, *Schweinfurth* 1717 (E, K, P); « Djur, Grosse Seriba Ghattas », *Schweinfurth* 2140 (K, P, Z).

Socotra: s.l., II-III.1880, *Balfour* 731 (BM, K); s.l., s.d., Comm. Balfour 732 (LE).

Central African Republic: Between Bongoran and Gongonbissi river, XI-XII.1902, *Chevalier* 6751 (P): Bambari, near Maroubas, 29.VI.1922, *Tisserant* 620 (BM); 660 (P); 820-660 (P).

Zaire: Ubangi-Uele, Garamba, *Troupin* 1836 (BR).

Kenya: Voi Distr., Tsavo N.P., Lake Kandere, 19.I.1967, *Greenway & Kanuri* 13060 (FT, K), E. Ongalea Mountains, Kiriani, 6.IV.1893, *Gregory* s.n. (BM).

Tanzania: Arusha Chini, 19 km S. Moshi, 22.X.1964, *Beesley* 40 (BRVU, K).

Botswana: Northern Distr., Mumpswe Pan, 40 km NNW mouth Nata river, 21.IV.1956, *Drummond & Seagrief* 5163 (K).

Republic of South Africa: Transvaal Prov., 32 km N Pretoria, near Petronella, 17.II.1965, *Mauve* 4342 (BM, K).

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INDEX OF NAMES

Accepted names are in bold

marina L. s.l.
- — subsp. **armata** (Lindb. f.) Horn af Rantz.
- — subsp. **arsenariensis** (Maire) Triest.
- — subsp. **commersonii** Triest.
- — subsp. delilei (Rouy) Oberm., uncorrectly attributed to Maire = **N. marina** L. subsp. **armata** (Lindb. f.) Horn af Rantz.
- — subsp. **ehrenbergii** (A. Br.) Triest.
- — subsp. **microcarpa** (A. Br.) Triest.
- — var. angustifolia (A. Br.) K. Schum. = **N. marina** L. subsp. **commersonii** Triest p.p.
- — var. bollei (A. Br.) K. Schum. = **N. marina** L. subsp. **microcarpa** (A. Br.) Triest.
- — var. delilei (Rouy) Maire = **N. marina** L. subsp. **armata** (Lindb. f.) Horn af Rantz.
- — var. ehrenbergii (A. Br.) K. Schum. = **N. marina** L. subsp. **ehrenbergii** (A. Br.) Triest.
- — var. microcarpa (A. Br.) Rendle = **N. marina** L. subsp. **microcarpa** (A. Br.) Triest.
- — var. muricata (Del.) A. Br. = **N. marina** L. subsp. **armata** (Lindb. f.) Horn af Rantz.

meiklei Horn af Rantz. = **N. testui** Rendle.
microcarpa (A. Br.) Christ = **N. marina** L. subsp. **microcarpa** (A. Br.) Triest.

minor All.
- — var. indica A. Br. = **N. minor** All.
- — var. longifolia Corti = **N. minor** All.
- — var. setacea A. Br. = **N. setacea** Rendle.
- — forma laxa foliis angustis A. Br. (in sched. *de la Perraudière* in Herb. Cosson 3.VII.1861), not published = **N. minor** All.

muricata Del. = **N. marina** L. subsp. **armata** (Lindb. f.) Horn af Rantz.
palustrella (in sched. *Commerson* 132), not published = **N. marina** L. subsp. **commersonii** Triest.
palustrina (in sched. *Commerson* 132), not published = **N. marina** L. subsp. **commersonii** Triest.

pectinata (Parl.) Magn.

schweinfurthii Magn.

setacea Rendle.

testui Rendle.

welwitschii Rendle.

INDEX OF SPECIMENS

AFRICA

Abu Raya 1.II.1969: N. marina subsp. ehrenbergii.

Aké Assi 7710; 11263: N. baldwinii. — 9259: N. testui. — 9273: prob. N. testui/N. schweinfurthii.

Ali 4122: N. horrida. — 4535: N. marina subsp. armata.

Ankei 79/0035: N. horrida. — 79/0040: N. marina subsp. armata.

Ascherson 498: N. minor. — 2264: N. graminea.

Ash 1148: N. horrida. — 1773: N. marina subsp. armata.

Audru 945bis; 2874: N. graminea. — 3160; 3164: N. welwitschii. — 3315: N. marina subsp. microcarpa.

Bagshawe s.n.: N. horrida.

Baldwin 9925; 10116: N. baldwinii.

Balfour 731: N. graminea. — 732: N. marina subsp. ehrenbergii.

Bally 5236: N. testui. — 7892: N. horrida.

Balsinhas 292: N. horrida.

Bamps 7565: N. graminea. — 7566: N. graminea & N. welwitschii. — 7571: N. marina subsp. microcarpa.

Baron 2629; 3339; 3419: N. madagascariensis.

Barter 1065: N. horrida.

Bates s.n., SRGH 16665: N. horrida.

Battandier s.n. in Herb. Maire, 21.IX.1878: N. minor. — s.n. in Herb. Maire (Saline d'Arzeu): N. marina subsp. arsenariensis. — s.n., 1879: N. marina subsp. armata. — s.n. in Herb. Delacourt, 1878: N. marina subsp. armata.

Battandier & Trabut s.n., IX.1878, in Herb. Maire: N. marina subsp. armata.

Beesley 40: N. graminea.

Bequaert 66: N. horrida. — 5376: N. marina subsp. armata.

Berhaut 1793; 3281; 3382; 3821: N. graminea.

Boehm 86: N. horrida.

Bognounou 60: prob. N. welwitschii.

Boivin 2357: N. setacea.

Bolle s.n.: N. marina subsp. microcarpa.

Bory s.n.; s.n., 1843; s.n. (Herb. Delessert); s.n. (Herb. Willdenow 17093): N. australis. — s.n.: N. welwitschii.

Bot. Dept. Exc. (CAI): N. marina subsp. armata.

Boudet 6865: N. horrida.

Brenan & Greenway 8248: N. horrida.

Brown 665: N. horrida.

Bullock 2653; 3486: N. horrida.

Burger 3606: N. horrida.

Cadet 244; 1342; 2115: N. australis.

César 607: N. welwitschii.

Chandler 2071A; 2071B; 2272: N. horrida.

Chevalier 6582: N. baldwinii. — 6751; 34009; 34014: N. graminea. — 7854: N. horrida. — 43836; s.n., 14.III.1950: N. welwitschii.

Chillon 1721: N. baldwinii.

Christiaensen 1102: N. horrida.

Claessens 1266: N. marina subsp. armata.

Commerson 132; s.n.: N. marina subsp. commersonii. — 133: N. australis.

Cook 523: prob. N. welwitschii.

Correia & Marques 1543: N. marina subsp. armata.

Cosson (in Herb. Cosson 18) 1185: N. minor.

Cunnington 9; 17: N. marina subsp. armata. — 50: N. horrida.

D'Alleizette (Herb.) s.n., VII.1905: N. marina subsp. commersonii. — s.n., IX.1909; 7889, VI.1921: N. horrida.

Déathe s.n.: N. marina subsp. armata.

de Brettes, Panouse & Sauvage 4896: N. marina subsp. armata.

de Candolle (Herb.) s.n.: N. marina subsp. commersonii.

Decary 327; 6403; 7824: N. horrida. — 5658; 6264; 7733: N. madagascariensis. — 6527: mixed, N. horrida and N. marina subsp. commersonii.

Deflers 1240: N. marina subsp. armata. — s.n., 16.X.1885: N. graminea.

Deighton 2797: N. baldwinii.

de la Perraudière s.n. in Herb. Cosson 18: mixed, N. minor & N. graminea.

Delessert (Herb.), 29.VII.1826: N. marina subsp. armata.

Delile s.n.: N. graminea; N. minor; N. marina subsp. armata.

De l'Isle s.n., 22.XII.1875: mixed, N. australis and N. setacea. — 141; 563; 567: N. australis.

Demange 1128; 1131: N. welwitschii.

Denny s.n., 17.VIII.1977: N. baldwinii. — 13; 15; 61; NYM 134; 1174; 1224: N. horrida.

Denny & Welsh NYM 135a: N. horrida.

Dent s.n.: N. horrida.

de Wilde J.J.F.E. 4307: N. horrida. — 5783: N. schweinfurthii.

de Wilde W.J.J.O. 616: N. baldwinii.

de Wilde W. & de Wilde-Duyfjes 3102: N. hagerupii. — 3262; 3577: N. schweinfurthii. — 3344: N. testui. — 3491; 3578; 3579A; 3579B: N. graminea. — 3584: prob.N. welwitschii. — 3680: N. welwitschii. — 9838: N. horrida.

de Wilde W. & J. & de Wilde-Duyfjes 5102; 5218; 5710; 5723: N. horrida. — 5156: N. welwitschii. — 5178: N. graminea. — 5709: prob. N. baldwinii.

De Winter & Marais 5031: N. horrida.

Dinklage 3285: prob. N. baldwinii.

Dinter 7264: N. horrida.

Drar 793: N. horrida.

Drummond 7774: N. horrida.

Drummond & Seagrief 5163: mixed, N. horrida and N. graminea.

Drummond & Rutherford-Smith 7570: N. horrida.

Duke 4: N. graminea.

Durando s.n. in Herb. Maire, X.1869: N. minor. — s.n. in Herb. Maire, X.1869: N. graminea.

Durieu (Herb.) s.n., 24.VI.1841: N. minor.

Duval-Jouve (Herb.) s.n., XI.1877: N. marina subsp. armata.

Ehrenberg s.n. (type): N. marina subsp. ehrenbergii. — s.n.: N. marina subsp. armata.

Ekema E 235: N. horrida.

El Hadidi, 13.VIII.1967: N. graminea. — 20.XI.1968: N. marina subsp. armata.

Ellis 3048: N. horrida.

Eyles (Herb.) 2354; 3158; 4738: N. horrida.

Figari s.n., II-III (1844?); (1845?): N. pectinata.

Figari s.n., 1845: N. marina subsp. armata.

Fischer 614: N. horrida.

Fosberg 49035: N. setacea.

Fotius 1188: N. horrida. — 1867ter: N. schweinfurthii.

Fries 933: N. horrida.

Fürstenau s.n.: N. marina subsp. armata.

Garba & Saadou 1497: N. welwitschii.

Gauthier s.n. in Herb. Maire: N. marina subsp. armata; N. minor.

Gay s.n.: N. marina subsp. armata.

Geay (Mission) 7206; 7956; 7962: N. horrida.

Geerling & Bokdam 896: prob. N. baldwinii.

Ghabbour 1.II.1959: N. graminea.

Gibbs-Russell 1953; 1983; 2351; 2513; 2562; 2563; 2905: N. horrida.

Gibbs-Russell & Biegel 1367; 1487: N. horrida.

Gillet 472; 1006; 1514: prob. N. baldwinii.

Goldsmith 105/60: N. horrida.

Gomes e Sousa 2107: N. marina subsp. armata.

Gonde 312: N. horrida.

Gossweiler 3858; 3936: N. testui.

Greenway 4056, 7.IX.1935; s.n., IV.1955: N. horrida.

Greenway & Brenan 8201; 8248: N. horrida. — 8243: N. marina subsp. armata.

Greenway & Kanuri 13060: N. graminea.

Greenway & Rawlins 9468: N. horrida.

Gregory s.n.: N. graminea.

Guillot 96: N. horrida.

Hagerup 368a: N. hagerupii.

Hall CC 420: prob. N. baldwinii. — CC 723; CC 725: N. welwitschii. — CC 768; CC 892: N. hagerupii. — 3463. CC 37176: prob. N. testui.

Hariot s.n.: N. setacea.

Harley 1656: N. baldwinii.

Harris s.n.: N. hagerupii.

Hassan Abd el Khalek 4078; 4079; 4080: N. graminea. — 4093; 4246: N. marina subsp. armata.

Hauman 526: prob. N. welwitschii.

Hefnawy, 10.IX.1929: N. marina subsp. armata.

Hendrickx 7843 bot.; 7995 bot.: N. horrida. — 7849 bot.: N. marina subsp. armata.

Hepper 2829: prob. N. testui/N. schweinfurthii. — 3628; 3695: N. graminea. — 4046; 4202: N. horrida.

Hiemstra 203: N. horrida.

Hildebrandt 4027: N. madagascariensis.

Hore s.n.: N. horrida.

Humbert 2709: N. marina subsp. commersonii. — 9266: N. horrida.

Hurner 58: prob. N. baldwinii.

Imam, 14.IX.1971: N. minor.

Imam, Ibrahim & Mahdi 20.VIII.1971: N. marina subsp. armata.

Imam, Ibrahim, Mahdi & Sisi, 24.IX.1971: marina subsp. armata.

Imam, Mahdi & Ibrahim 16.X.1970: N. marina subsp. armata.

Jackson 1828: N. marina subsp. armata.

Jacques-Félix 7375: N. baldwinii.

Jaeger s.n.: N. graminea.

Jenkin A 158: N. horrida.

Johnston s.n.: N. australis.

Jordan 115; 128: N. baldwinii. — 471: prob. N. baldwinii.

Jumelle s.n.: N. horrida.

Junod 527: N. horrida.

Jupp s.n., 9.IX.1977; 15.IX.1977: N. baldwinii. — s.n., 13.XI.1977: N. testui.

Killian s.n. in Herb. Maire: N. marina subsp. ehrenbergii.

Kinet 178: N. marina subsp. armata.

Kornas 2386: N. horrida.

Léonard 4295; 4401; 4429; 4441; 4485; 4529; 4560: N. horrida. — 4385; 4475: N. graminea.

Leprieur s.n. in Herb. Cosson; s.n., V.1827; s.n., 1829: N. welwitschii.

Le Testu 3625: N. testui.

Letourneux 186; s.n., X.1876: N. marina subsp. armata. — s.n., IX.1876 in Herb. Rouy: N. graminea. — s.n., 27.VI.1887; s.n. in Herb. Maire: N. minor.

Letouzey 6128; 7072; 7360 : N. graminea. — 7257 : N. baldwinii. — 7266 : N. horrida. — 13333 : N. testui.

Lewalle 2161; 4826; 6301 : N. horrida. — 2837; 6288 : N. marina subsp. armata.

Liben 640 : N. testui.

Lind 331 : N. horrida.

Lind, Agnew & Kettle 5893 : N. horrida.

Lisowski 96237 : N. testui. — 96203; 96204; 96233 : N. baldwinii.

Lock 80/22 : N. horrida. — 81/20 : N. schweinfurthii.

Lowe 97 : N. testui. — s.n., 4.III.1950 : mixed, N. marina subsp. armata and N. horrida. — s.n., 26.VIII.1952 : N. horrida.

Lye & Lester Ly-2017; Ly 2131 : N. horrida.

McCallum-Webster s.n., 10.III.1959; T 518, 29.III.1959 : N. horrida. — A 628, 24.III.1959 : N. testui.

McLea s.n. (Herb. Bolus 6283) : N. horrida.

Maire, 20.VIII.1909 : N. minor. — s.n. in Herb. Maire, 20.VII.1926 : N. marina subsp. armata.

Maire & Weiller s.n. in Herb. Maire 51 : N. marina subsp. armata.

Malaisse 8571 : N. baldwinii. — 11854 : N. horrida.

Malato Beliz 4035 : N. baldwinii.

Maley 232 : N. horrida.

Marzio Mauro s.n. : N. horrida.

Mathew & Gwynne 6789 : N. horrida.

Mauve 4342 : N. graminea.

Mauve & Vahrmeyer 4303; 4307 : N. horrida.

Mearns 2455 : N. horrida.

Meikle 710 : N. testui.

Milne-Redhead & Taylor 9964; 10891 : N. schweinfurthii. — 10910 : N. horrida.

Morin s.n. : N. marina subsp. commersonii.

Mortimer 176 : N. horrida.

Morton & Gledhill SL 88 : N. baldwinii.

Morton SL 874 : prob. N. baldwinii.

Mpawenayo s.n. : N. marina subsp. armata.

Munkonge HKM 5 : N. horrida.

Muschler s.n., XII.1905 : N. horrida, N. graminea. — s.n., III.1906 : N. marina subsp. ehrenbergii; N. minor; N. graminea. — s.n., IV.1906 : N. graminea.

Musil 174; 368 : N. horrida.

Mustafa & Sabet, 15.IX.1928 : N. marina subsp. armata.

Napier Bax 1845 : N. horrida.

Néraud s.n. in Herb. Richard : N. setacea.

Nozeran s.n. : prob. N. baldwinii.

Pauwels 1769; 2664 : prob. N. baldwinii.

Pereira 4035 : N. baldwinii.

Perrier de la Bâthie 1740; 13218; 13832; 14204; 14243; 17372; 17892 : N. horrida. — 4404 : N. marina subsp. commersonii.

Phipps 149; 761; 1312: N. horrida.

Polhill 293: N. horrida.

Pourret s.n.: N. marina subsp. commersonii.

Preuss 452: N. horrida.

Raynal 6070; 6878: N. baldwinii. — 6633: N. marina subsp. microcarpa. — 6341; 6598; 6981; 7703: N. graminea. — 6642: N. schweinfurthii. — 10842: prob. N. testui or N. schweinfurthii. — 12671: N. welwitschii.

Reekmans 1162; 3510: N. marina subsp. armata. — 7688: N. horrida.

Repton 2002: N. horrida.

Richard (Herb.) s.n.: N. minor.

Richards 1012: N. marina subsp. armata. — 11142; 12412; 14741; 24587A: N. horrida. — 15172: N. testui.

Richardson 6: N. horrida.

Roberty 2704: N. graminea.

Robyns 4002; 4074: N. horrida. — 4075: N. marina subsp. armata.

Robilliard s.n.: N. australis.

Robinson 335; 3245: N. horrida.

Roger s.n.: prob. N. welwitschii.

Salubeni 761: N. horrida.

Salzmann (Herb.) s.n.: N. graminea.

Santo 2234: N. baldwinii.

Sauvage (Miss. Prov. Tarfaya 16393): N. marina subsp. armata.

Schelpe 4506: N. marina subsp. armata.

Schlechter 11883: N. horrida.

Schweinfurth 620; 1412; 1717; s.n., 24.X.1885; s.n., 26.X.1885; s.n., 10.VII.1887; s.n., 4.XI.1887: N. graminea. — 709: N. marina subsp. ehrenbergii. — 1137; 1228; 4242: N. horrida. — 2140: mixed, N. schweinfurthii and N. graminea.

Schwetz s.n.: N. horrida.

Shabetai Z 850: N. marina subsp. armata. — Z 3850: N. minor. — Z 200: N. graminea.

Shahean 3395: N. horrida.

Shuttleworth s.n.: N. marina subsp. armata.

Sickenberger s.n., 16.VIII.1882; s.n., VIII.1887; s.n., X.1891: N. minor. — s.n., 14.X.1894: mixed, N. pectinata and N. graminea. — s.n., 29.IX.1880: N. graminea.

Sieber s.n., V.1821; s.n., 1832; s.n. in Herb. Delile: N. marina subsp. armata.

Simpson 1001; 2885; 5224; 5434: N. marina subsp. armata. — 1296; 2411; 5364; 5984; 5988: N. graminea. — 1649: mixed, N. marina subsp. armata and N. minor. — 4001; 5419: N. minor. — 7212; 7631: N. horrida. — 5270: N. pectinata.

Smith D.F. s.n., EAH 11059: N. horrida.

Smith P.A. 257; 1109; 1453; 2546: N. horrida. — 2565: N. marina subsp. armata.

Snowden 1835: N. horrida.

St. Ange 81: N. welwitschii.

Starzénski 50: N. horrida.

Staudt 488: N. horrida.

Stephens s.n., I.1924: N. marina subsp. armata. — s.n., 3.VII.1930; 71, 24.VII.1930: N. horrida.

Steudner 213: N. graminea.

Strey & Leistner 8383: N. horrida.

Stuhlmann 2841: N. marina subsp. armata.

Symoens 6923; 6945; 7351; 9554; 9596: N. horrida.

Täckholm G., 16.I.1928: N. graminea. — 16.I.1928: N. marina subsp. armata.

Täckholm V., Imam & El Hadidi 13.X.1967; 3.XI.1967; 8.XII.1967: N. marina subsp. armata.

Täckholm V. & Kassas 85: N. graminea.

Tanner 1652: N. horrida.

Taton 1222: N. horrida.

Taylor 1596: N. testui.

Tinley 457: N. horrida.

Tisserant 79; 80: N. hagerupii. — 620; 660; 820-660: N. graminea.

Triest & El Khanagry 556; 558; 585; 593; 607: N. marina subsp. armata.

Triest, El Khanagry & Diwan 553: N. marina subsp. armata.

Trochain 2292: N. horrida. — 3729bis: N. graminea.

Troupin 1836: N. graminea.

Tubb s.n., SRGH 22695: N. horrida.

Vahrmeyer 2171: N. horrida.

Vanden Bergen 1773; 3695; 3699; 5993; 6003; 6333: N. baldwinii. — 7214; 7255: N. graminea.

Van der Ben 27; 293; 364: N. horrida. — 73; 156: N. marina subsp. armata.

Van der Veken 11208: N. marina subsp. armata.

Vanderyst s.n., 15.I.1907: prob. N. baldwinii. — s.n., 27.I.1907: prob. N. welwitschii. — s.n., XI.1908: N. welwitschii.

Van Meel 331: N. marina subsp. armata.

Van Zinderen-Bakker 907; 925: N. horrida.

Venter 3961: N. horrida.

Verdcourt 3395: N. horrida.

Vervoort 7: N. marina subsp. armata.

Volk 1883: N. horrida.

Vollesen 2862: N. horrida.

Von Reichenbach s.n. in Herb. Sieber: N. marina subsp. armata.

Wager 6: N. horrida.

Wanntorp & Sjödin 2023: N. marina subsp. armata.

Ward 2566; 2945; 7300; 8086; 8215; 8515; 8982; 9037: N. horrida. — 8052; 8520; 8530; 8748: N. marina subsp. armata.

Watmough 268; 289: N. horrida.

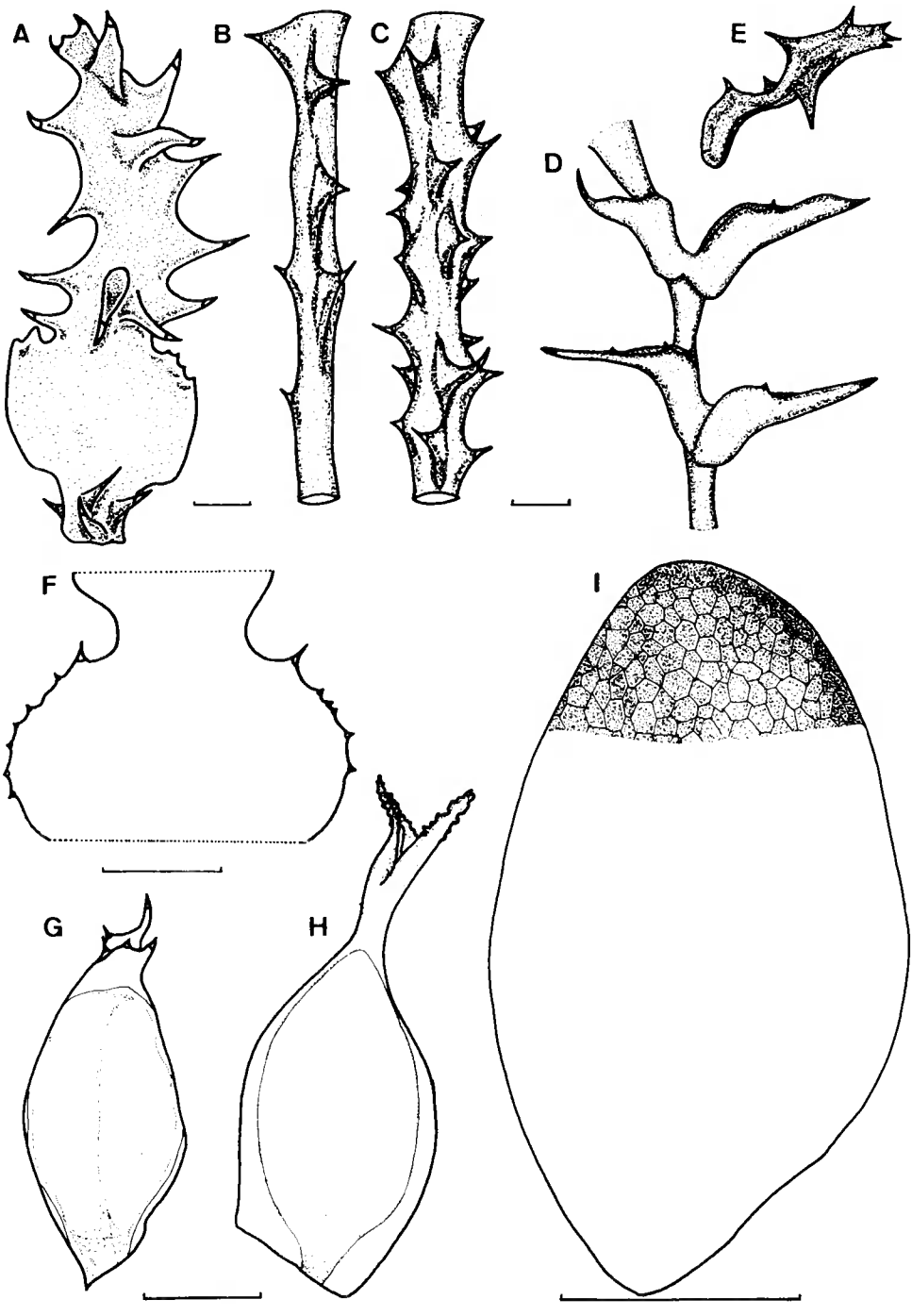
Welsh & Denny NYM 96; NYM 133 a, b, c: N. marina subsp. armata.

Welwitsch 247; 247 b: N. welwitschii.

Wettstein s.n., XII.1929: N. horrida.

Whellan 463; 650: N. horrida.
Wickens 840: N. horrida. — 2497: N. testui.
Wild 2001; 2583; 2762; 3221; 3007; 3429; 4229: N. horrida.
Wild & Drummond 7162: N. horrida.
Wilkinson s.n.: N. marina subsp. armata.
Wood 474: N. horrida.
Young 474: N. horrida.

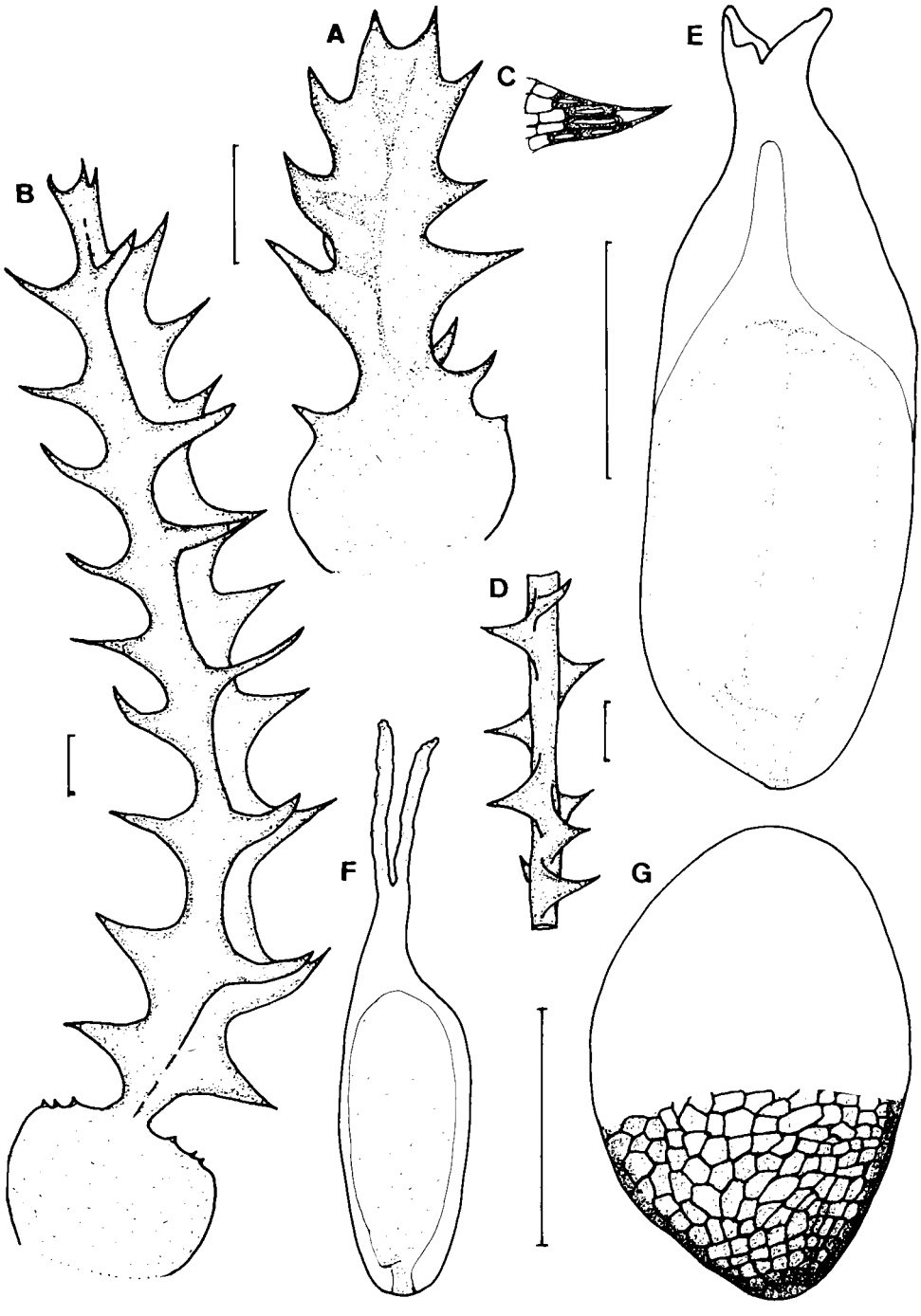
INDEX OF PLATES



N. marina subsp. *armata* (A-C, F-I)
and subsp. *arsenariensis* (D,E) North Africa

A. Leaf, *Simpson* 1649; B. Stem, *Hassan* 4246; C. Stem, *Shuttleworth* s.n.; D. Part of plant, *Battandier* s.n. in Herb. Maire, type *N. arsenariensis;* E. Leaf, *Battandier* s.n. in Herb. Maire, type *N. arsenariensis;* F. Leaf sheath, *Simpson* 5434; G. Male flower, *Von Reichenbach* s.n. in Herb. *Sieber;* H. Female flower, *Simpson* 1001; I. Seed, *Letourneux* s.n. X.1876. (Scales = 1 mm, fig. A-E: 8×; F-H: 16,5×; I: 33×)

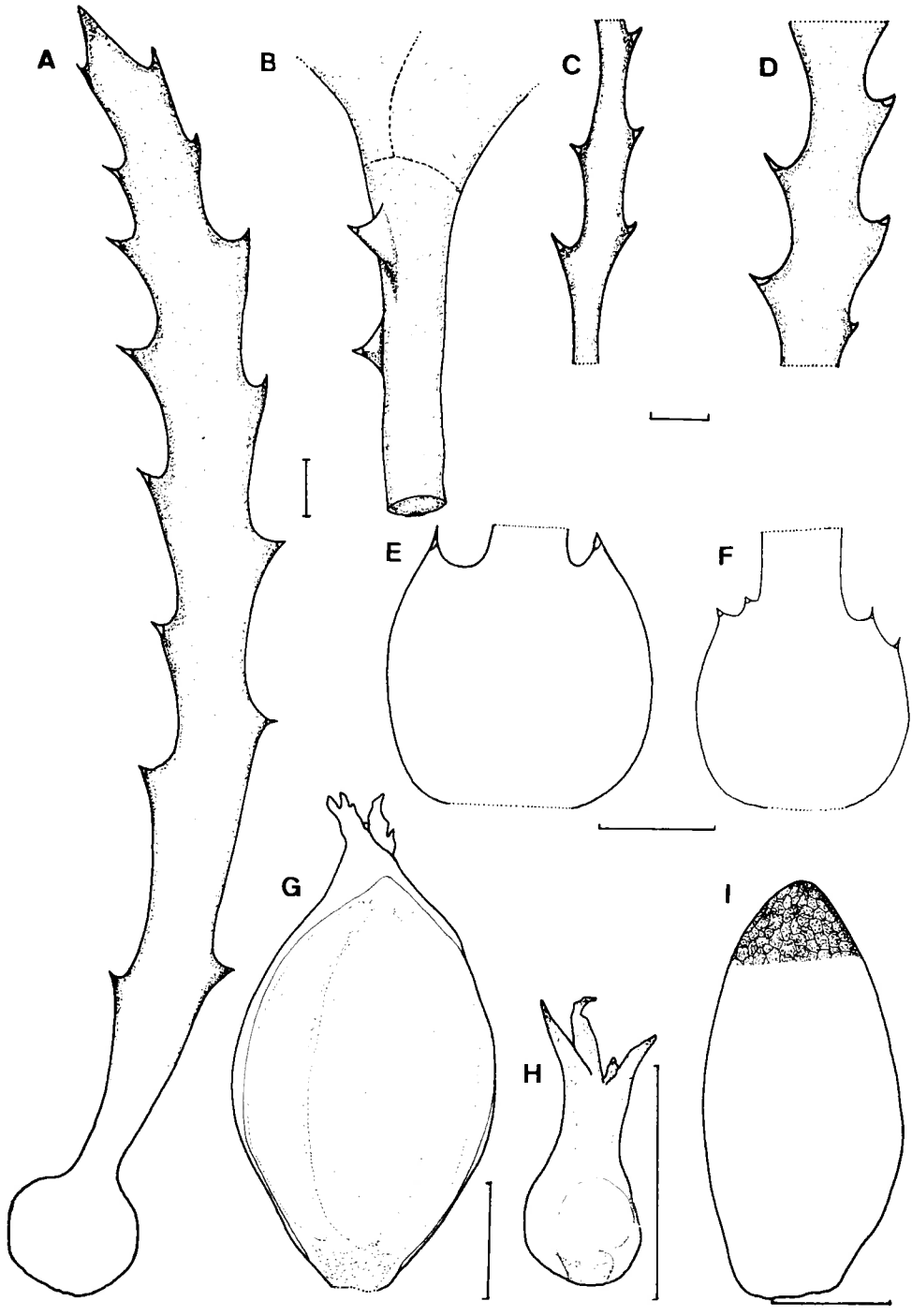
Plate II



N. marina subsp. *armata* (A-C)
and subsp. *microcarpa* (D-G) Tropical Africa

A. Leaf, *Mpawenayo* s.n.; B. Leaf, *Cunnington* 9; C. Leaf tooth, spine-cell resting upon several elongated brown cells, *Mpawenayo* s.n.; D. Stem, *Audru* 3315; E. Male flower, *Audru* 3315; F. Female flower, *Audru* 3315; G. Seed, *Audru* 3315. (Scales = 1 mm, fig. A: 16,5×; B, D: 8×; C, E-G: 33×)

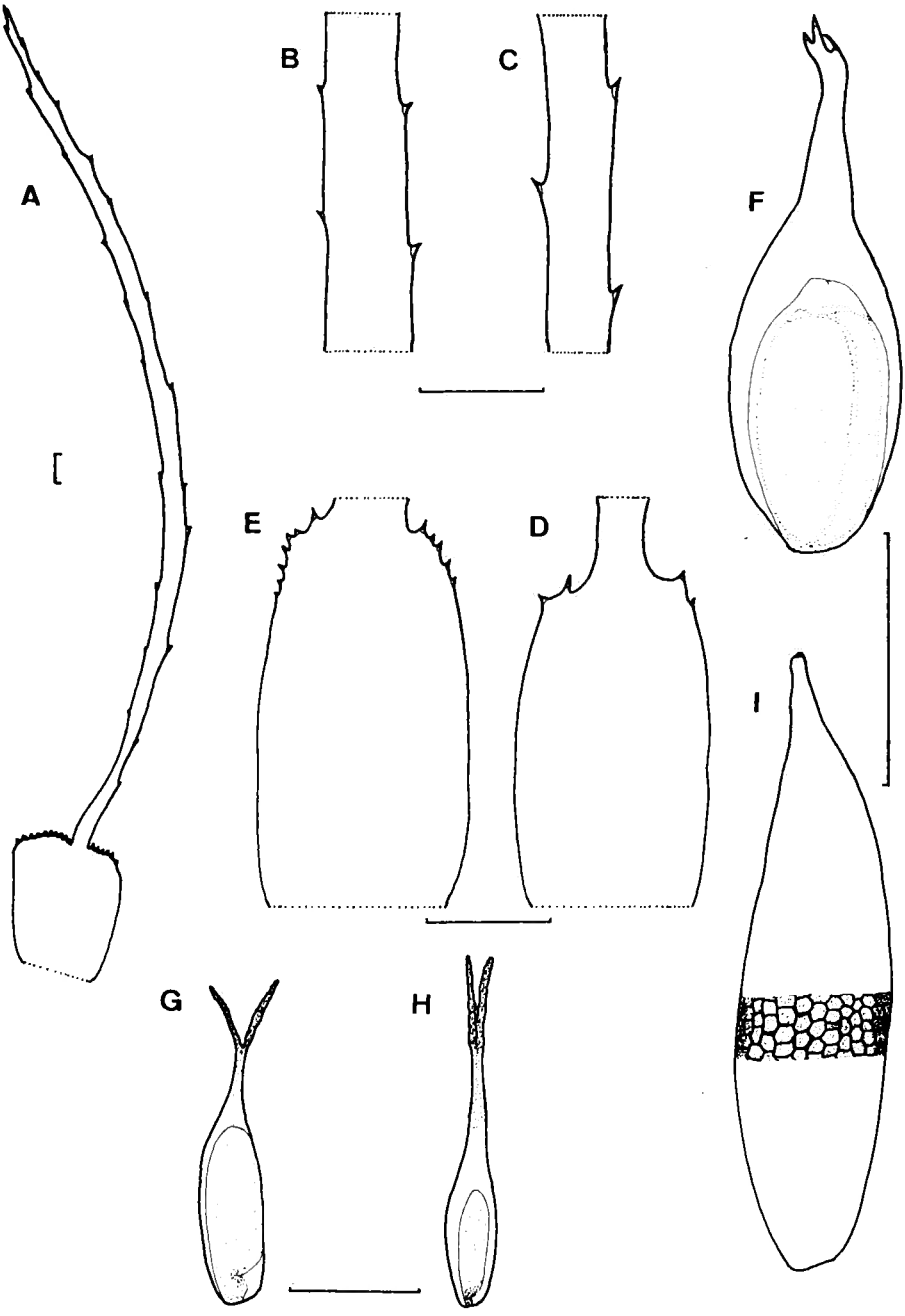
Plate III



N. marina subsp. *ehrenbergii* (A-D, F, H) and
subsp. *commersonii* (E, G, I)

A. Leaf, *Schweinfurth* 709; B. Stem, *Balfour* 732; C. & D. Part of leaf, *Killian* s.n. in Herb. Maire; E. Leaf sheath, *Decary* 6527; F. Leaf sheath, *Balfour* 732; G. Male flower, *Commerson* 132; H. Female flower (Juv.) *Schweinfurth* 709; I. Seed, *Commerson* 132. (Scales = 1 mm, fig. A-D, F: 8×; E, G, I: 16,5×; H: 33×)

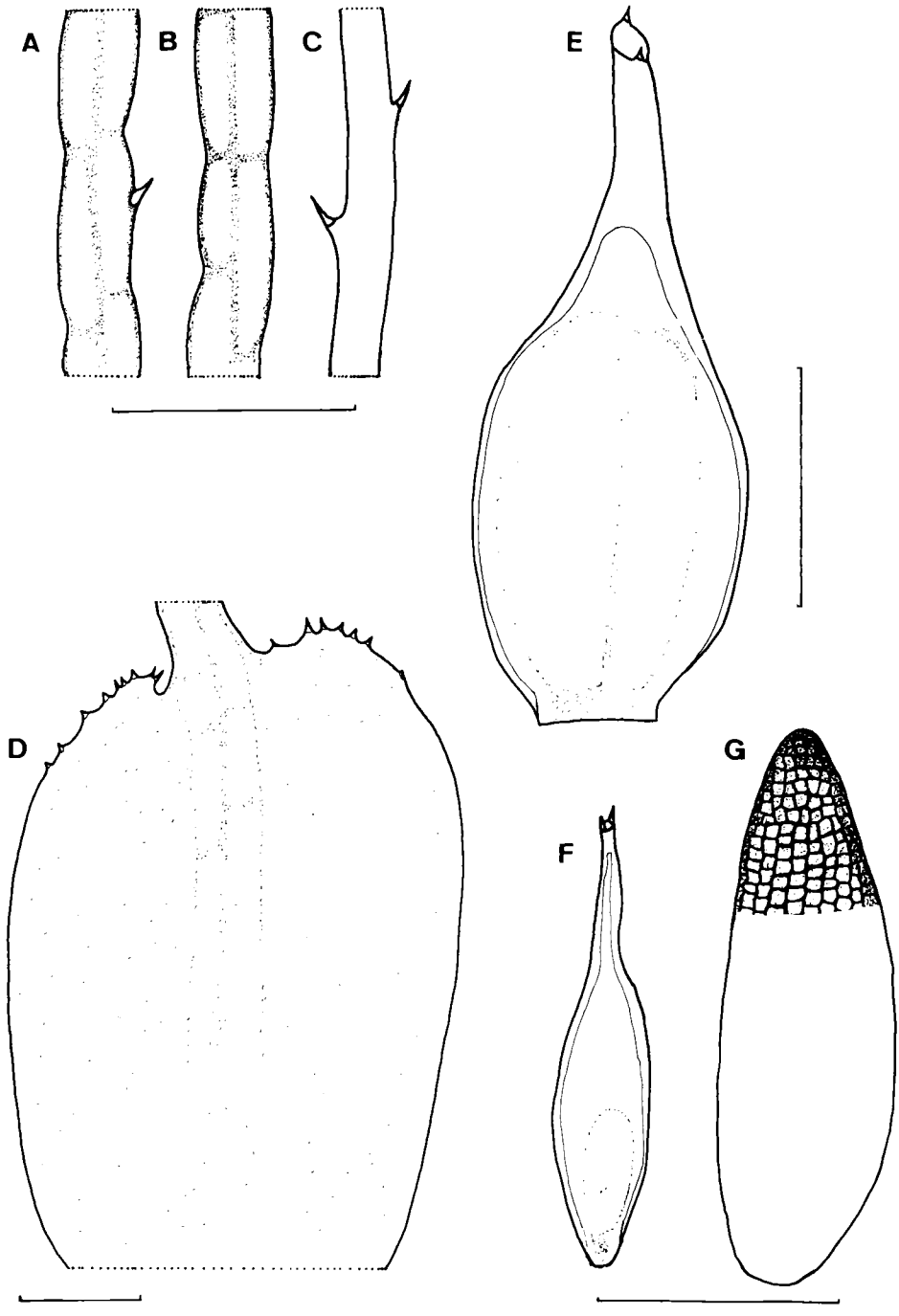
Plate IV



N. australis

A. Leaf, *Johnston* s.n.; B. Part of leaf, *De L'Isle* 567; C. Part of leaf, *Bory* s.n., 1843; D. Leaf sheath, *De L'Isle* 141; E. Leaf sheath, *Commerson* 133; F. Male flower, *De L'Isle* 141; G. Female flower, *Cadet* 2115; H. Female flower, *Commerson* 133; I. Fruit, *Bory* s.n. (Scales = 1 mm, fig. A: 4×; B-E, G, H: 16,5×; F, I: 33×)

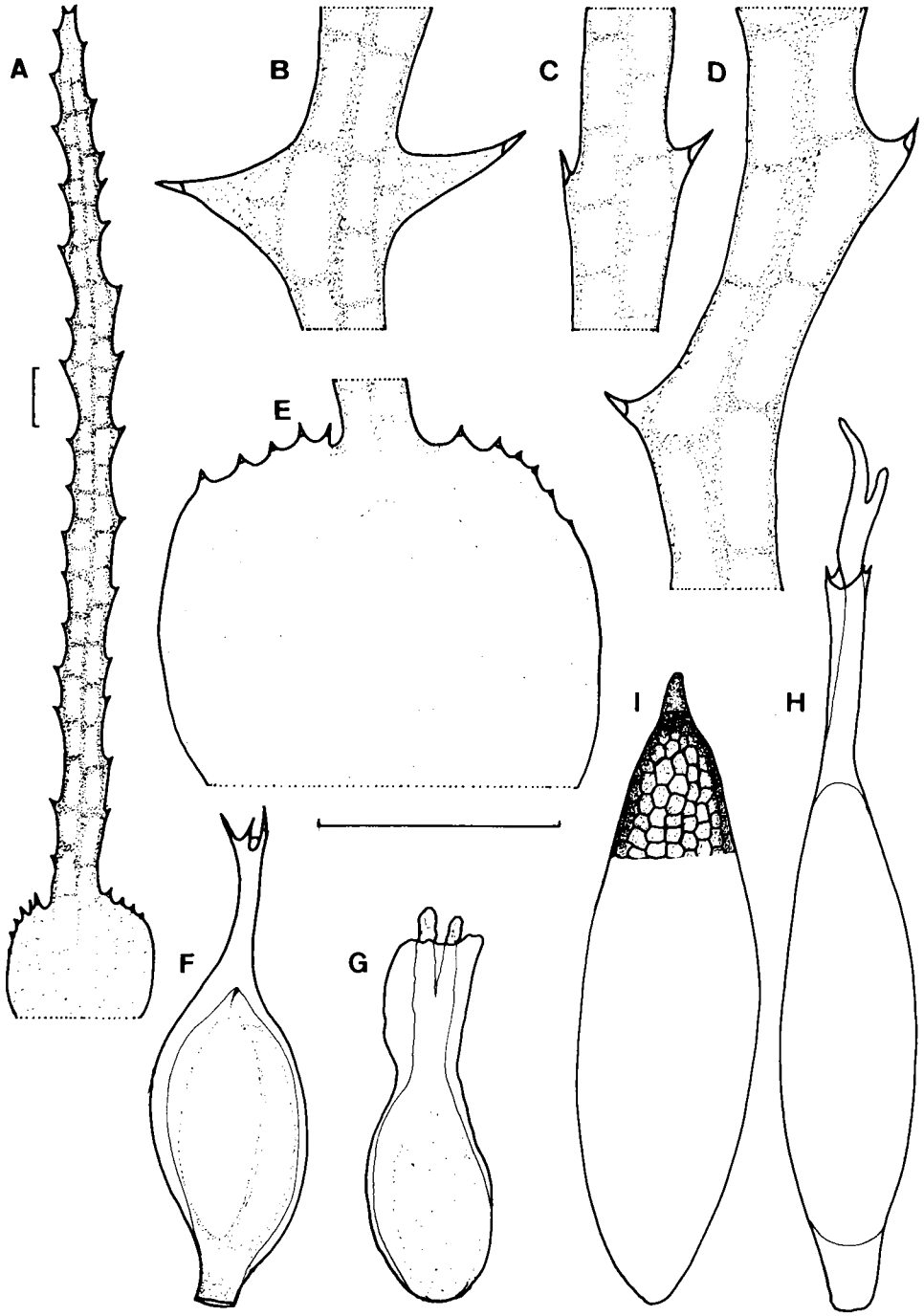
Plate V



N. madagascariensis

A. Lower part of leaf, *Baron* 3339; B. Lower part of leaf, *Decary* 6264; C. Upper part of leaf, *Decary* 6264; D. Leaf sheath, *Baron* 3339; E. Male flower, *Hildebrandt* 4027; F. Female flower, *Decary* 6264; G. Seed, *Hildebrandt* 4027. (Scales = 1 mm, fig. A-C, E-G: 33×; D: 16,5×)

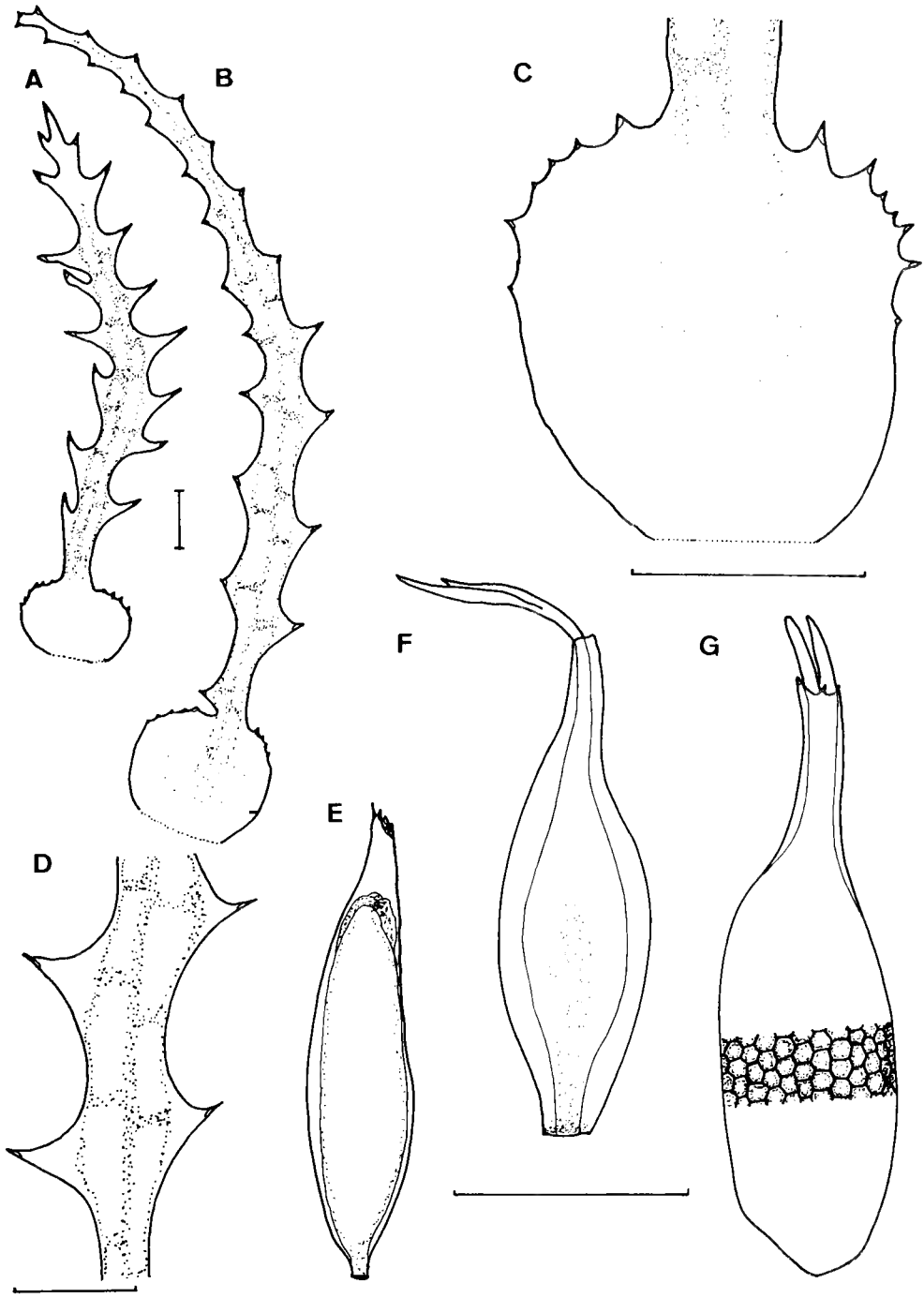
Plate VI



N. welwitschii

A. Leaf, *Leprieur* s.n. in Herb. Cosson; B. Part of leaf, *St. Ange* 81; C. Part of leaf, *Welwitsch* 247b; D. Part of leaf, *de Wilde* 5156; E. Leaf sheath, *Leprieur* s.n. in Herb. Cosson; F. Male flower, *Leprieur* s.n., 1829; G. Female flower, *St. Ange* 81; H. Female flower, *de Wilde* 5156; I. Seed, *Welwitsch* 247b. (Scales = 1 mm, fig. A: 8×; B-I: 33×)

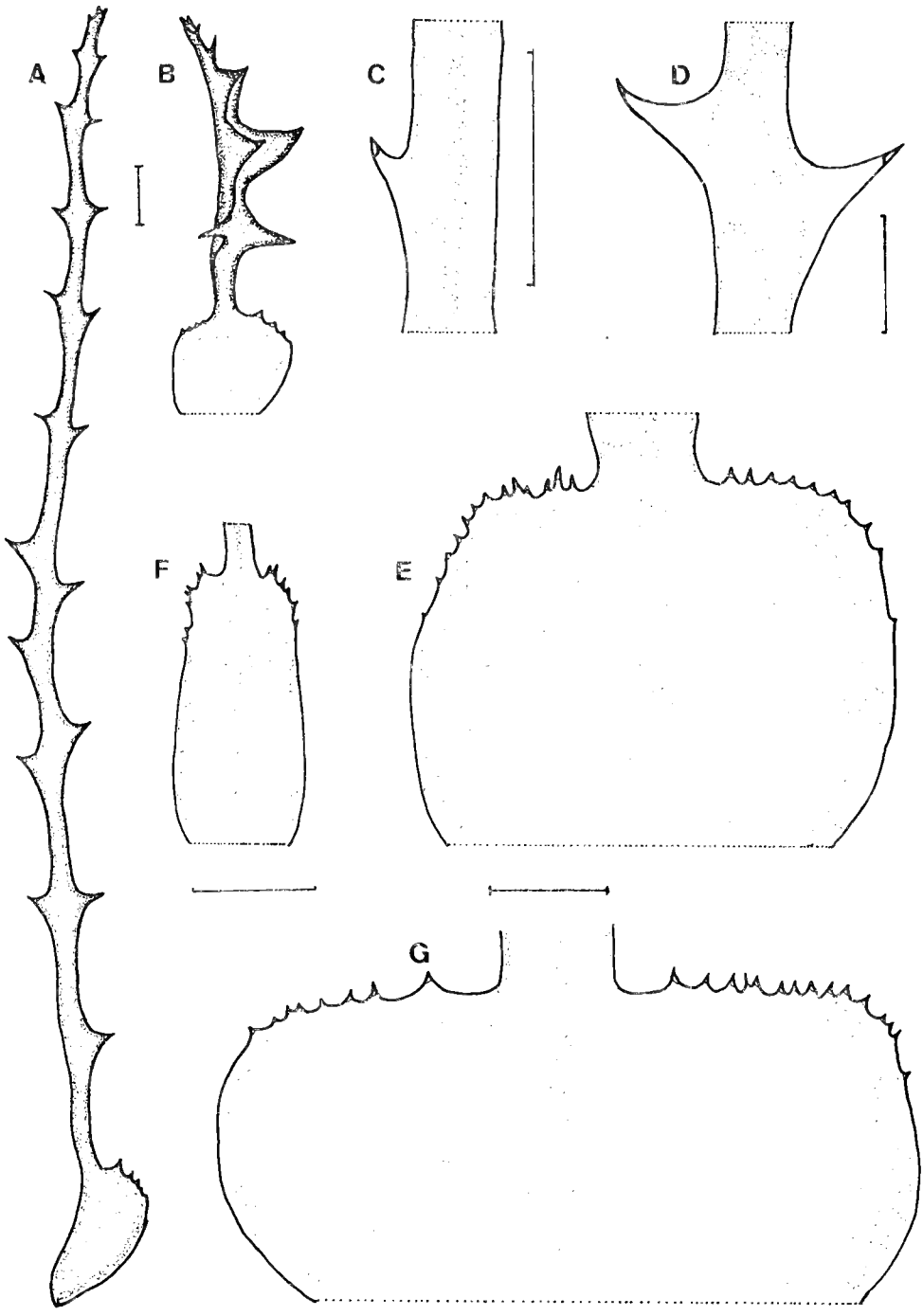
Plate VII



N. pectinata

A. Leaf, *Figari* s.n., 1845; B. Leaf, *Sickenberger* s.n., 14.X.1894; C. Leaf sheath, *Sickenberger* s.n., 14.X.1894; D. Part of leaf, *Sickenberger* s.n., 14.X.1894; E. Male flower, *Sickenberger* s.n., 14.X.1894; F. Female flower, *Figari* s.n., 1845; G. Fruit, *Figari* s.n., 1845. (Scales = 1 mm, fig. A, B: 8×; D: 16,5×; C, E, F, G: 33×)

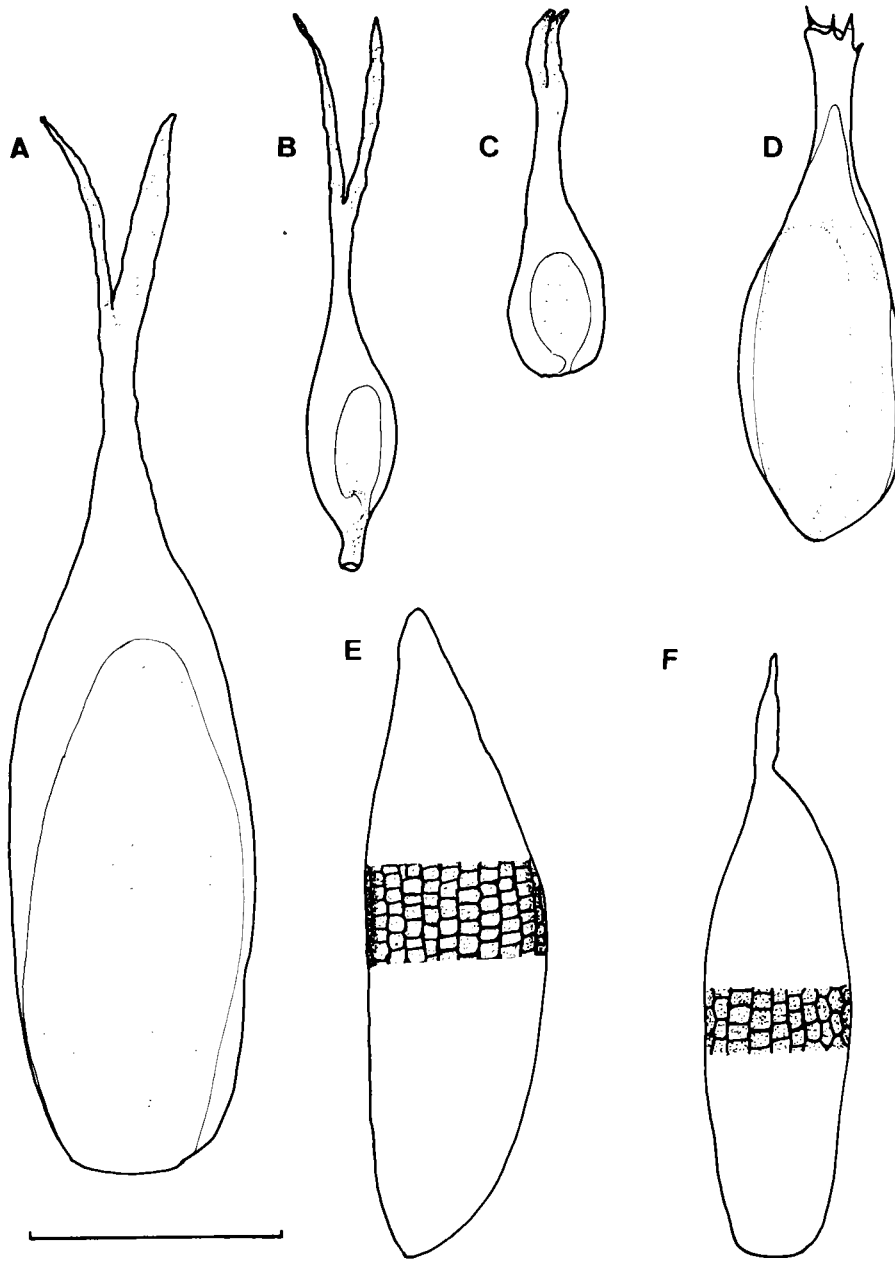
Plate VIII



N. horrida (tropical Africa)

A. Leaf, *Drummond* 7774; B. Leaf, *de Wilde* 5218; C. Part of leaf, *Fischer* 614; D. Part of leaf, *Barter* 1065; E. Leaf sheath, *Barter* 1065; F. Leaf sheath, *Mortimer* 176; G. Leaf sheath, *Hore* s.n. (Scales = 1 mm, fig. A, B: 8×; C: 33×; D-G: 16,5×)

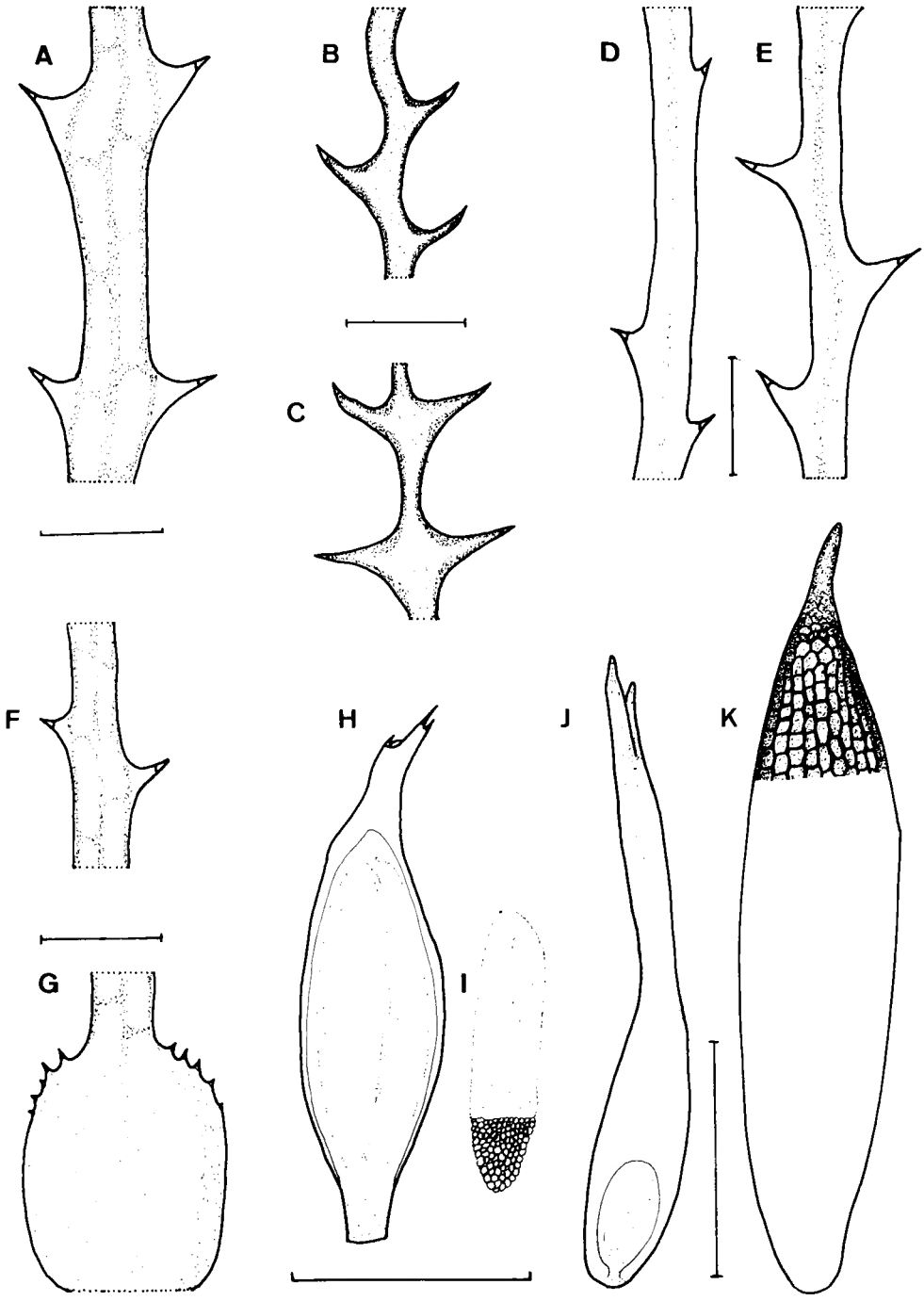
Plate IX



N. horrida (tropical Africa)

A. Female flower, *Burger* 3606; B. Female flower, *Vollesen* 2862; C. Female flower, *Barter* 1065; D. Male flower, *Lind, Agnew & Kettle* 5893; E. Fruit, *Humbert* 9266; F. Fruit, *de Wilde* 5102. (Scale = 1 mm, all figures 33×)

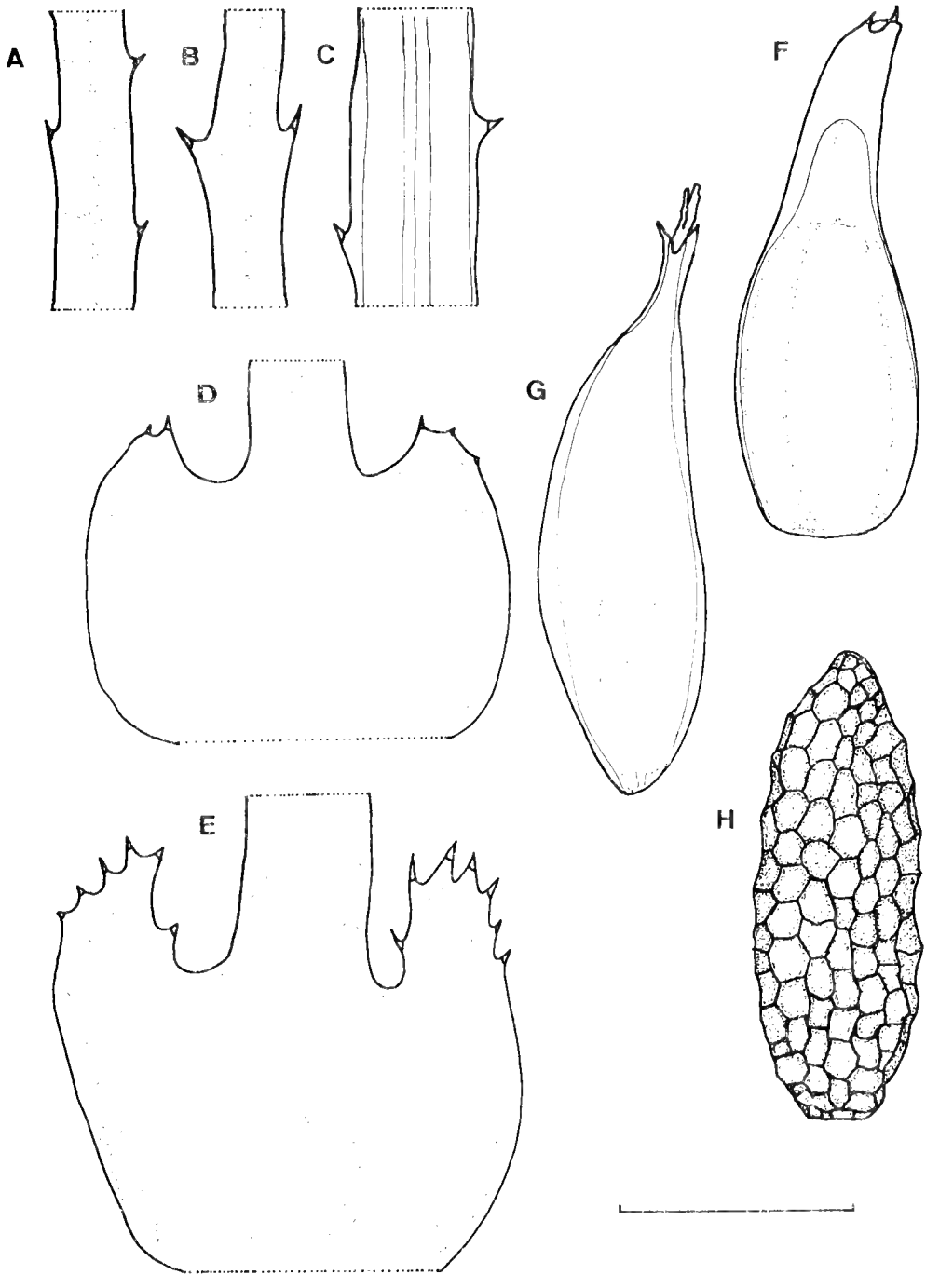
Plate X



N. horrida (Madagascar)

A.&B. Part of leaf, *Perrier* 14243; C. Part of leaf, *Mission Geay* 7206; D.&E. Part of leaf, *Perrier* 1740; F. Part of leaf, *Perrier* 13218; G. Leaf sheath, *Decary* 6403; H. Male flower, *Decary* 6403; I. Locule, *Decary* 6403; J. Female flower, *Perrier* 17372; K. Seed, *Perrier* 17372. (Scales = 1 mm, fig. A-G: 16,5×; H-K: 33×)

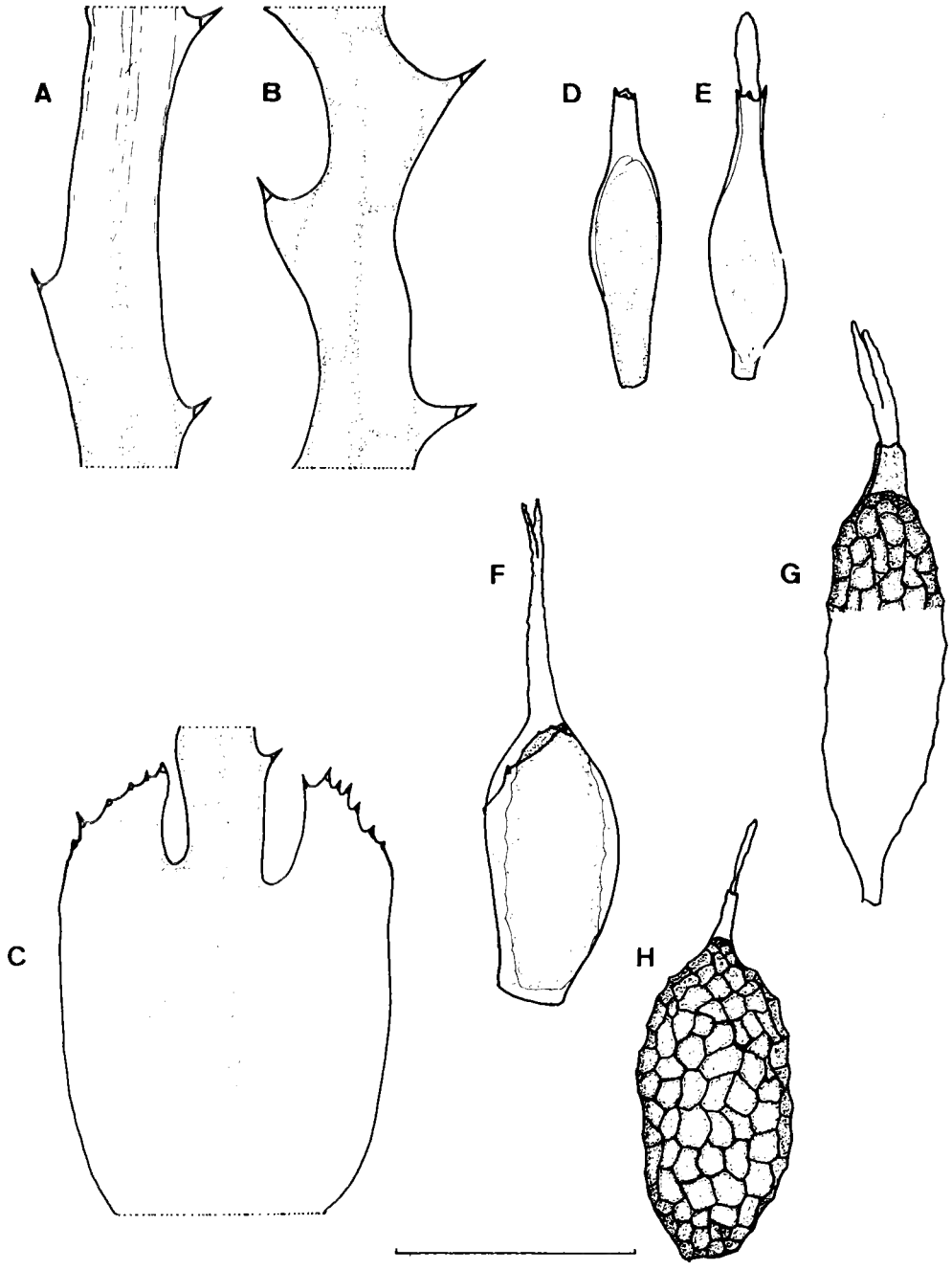
Plate XI



N. testui

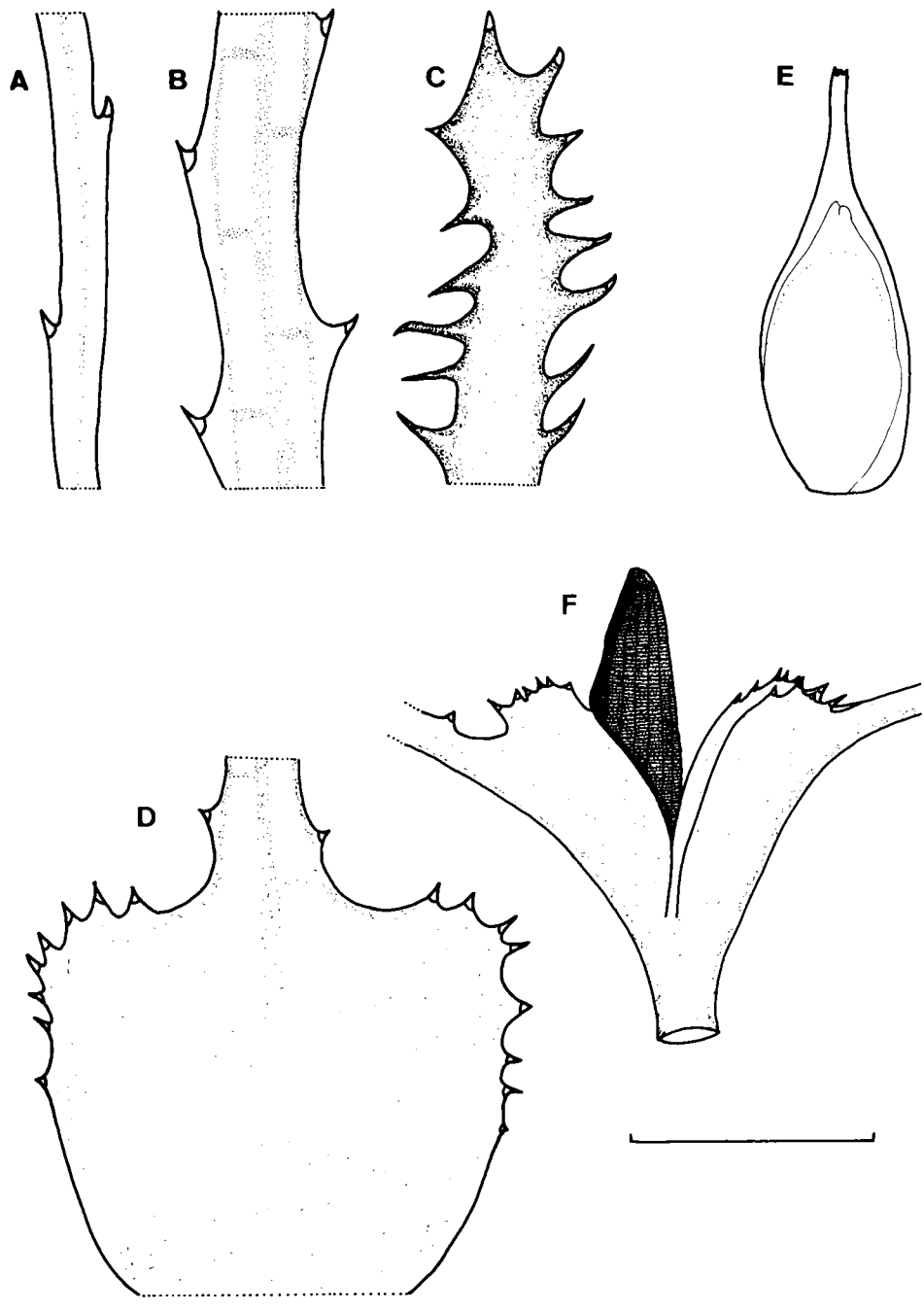
A. Part of leaf, *Le Testu* 3625; B. Part of leaf, *Gossweiler* 3858; C. Part of leaf (under polarised light), *Lowe* 97; D. Leaf sheath, *Le Testu* 3625; E. Leaf sheath, *Liben* 840; F. Male flower, *Lowe* 97; G. Female flower, *Le Testu* 3625; H. Seed, *Le Testu* 3625. (Scale = 1 mm, all figures 33×)

Plate XII



N. schweinfurthii

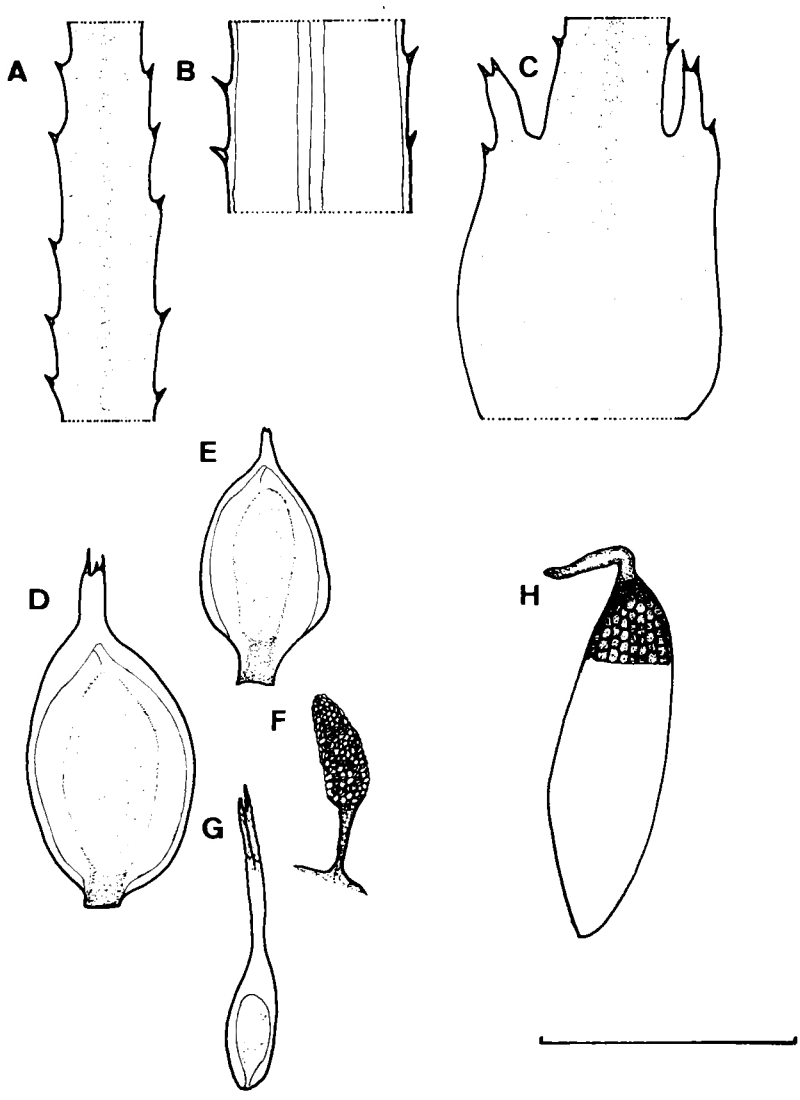
A. Part of leaf, *de Wilde* 3262; B. Part of leaf, *Raynal* 6642; C. Leaf sheath, *Schweinfurth* 2140; D. Male flower, *de Wilde* 3262; E. Female flower, *de Wilde* 3262; F. Female flower with unripe seed, *Raynal* 6642; G. Fruit, *Schweinfurth* 2140; H. Fruit, *Fotius* 1867 ter. (Scale = 1 mm, all figures 33×)



N. minor

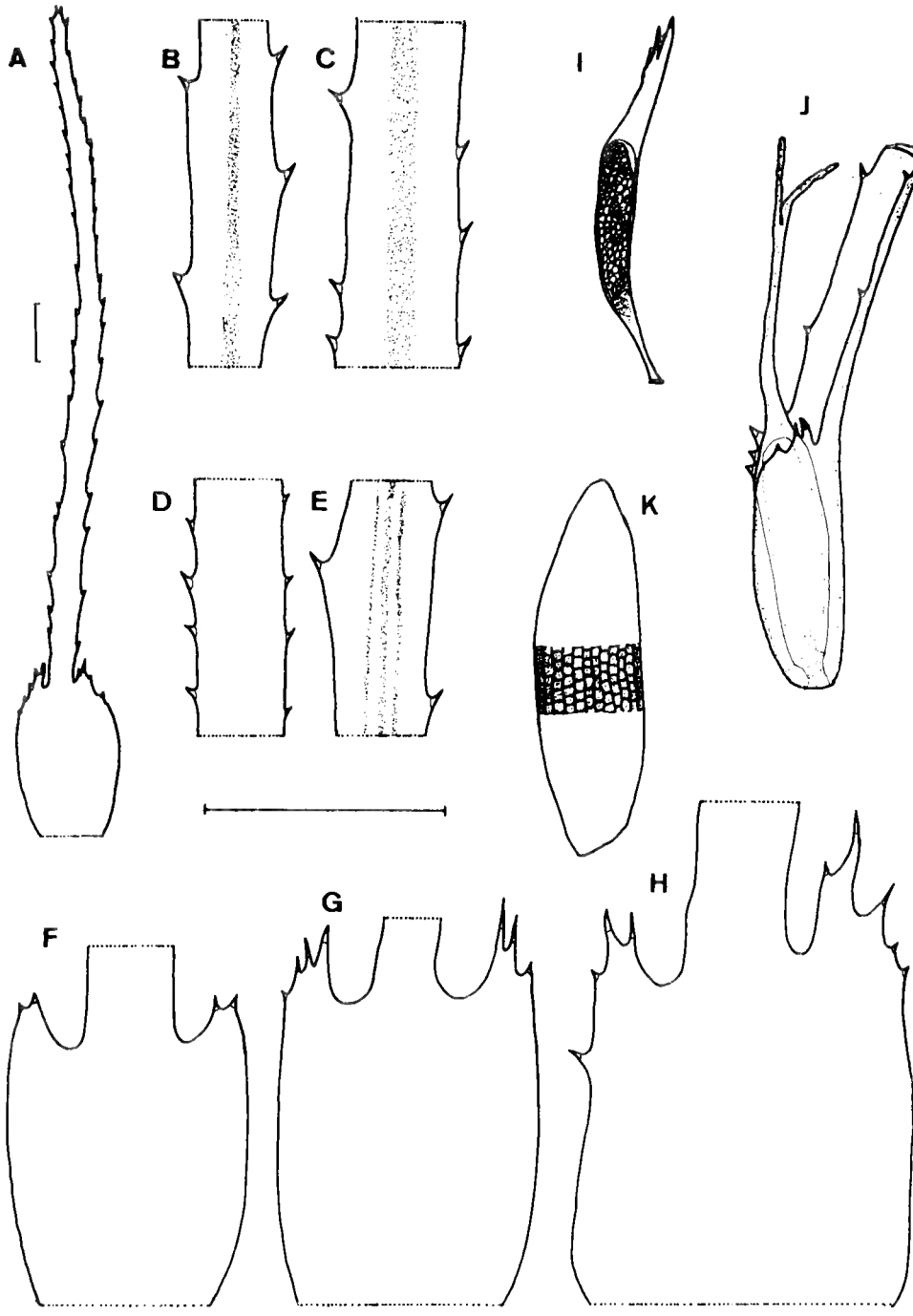
A. Part of leaf, *Letourneux* s.n., 27.VI.1887; B. Part of leaf, *Simpson* 4001; C. Part of leaf, *Simpson* 1649; D. Leaf sheath, *Simpson* 5270; E. Male flower, *Letourneux* s.n., 27.VI.1887; F. Fruit, between two leaf sheaths, *Battandier* s.n. in Herb. Maire, 21.IX.1878. (Scale = 1 mm, all figures 33×)

Plate XIV



N. hagerupii

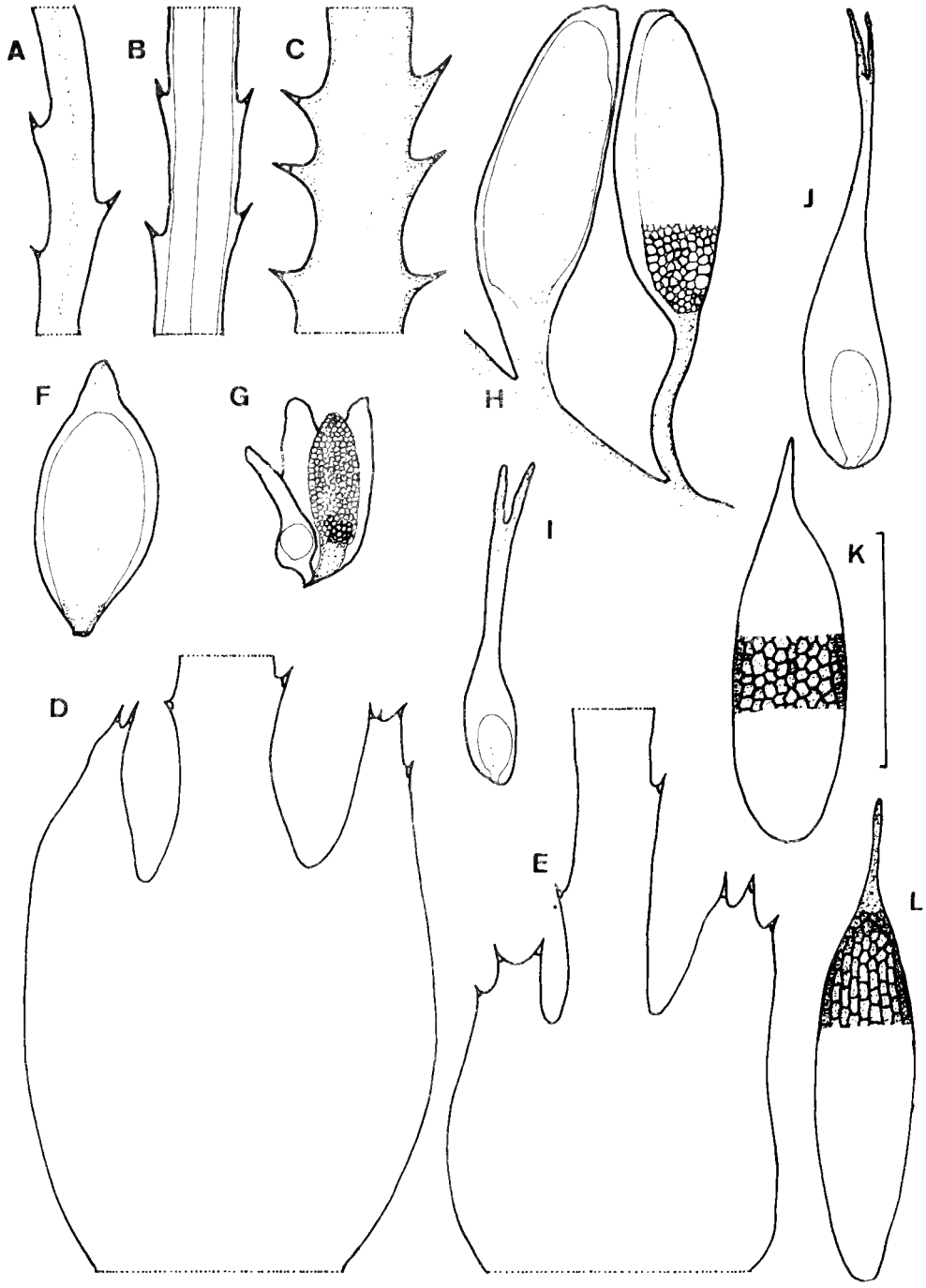
A. Part of leaf, *Hall* cc 892; B. Part of leaf, under polarised light, *Tisserant* 80; C. Leaf sheath, *de Wilde* 3102; D. Male flower, *Harris* s.n.; E. Male flower, *de Wilde* 3102; F. Locule, *de Wilde* 3102; G. Female flower, *Tisserant* 79; H. Fruit, *Harris* s.n. (Scale = 1 mm, all figures 33×)



N. setacea

A. Leaf, *Hariot* s.n. in Herb. Richard; B. Part of leaf, *Hariot* s.n. in Herb. Richard; C. Part of leaf, *De l'Isle* s.n., 22.X.1875; D. Part of leaf, *Néraud* s.n. in Herb. Richard; E. Part of leaf, *Boivin* 2357; F. Leaf sheath, *Néraud* s.n. in Herb. Richard; G. Leaf sheath, *Hariot* s.n.; H. Leaf sheath, *De L'Isle* s.n., 22.X.1875; I. Male flower, *Hariot* s.n.; J. Female flower, *Hariot* s.n.; K. Seed, *Néraud* s.n. in Herb. Richard. (Scales = 1 mm, all fig. 33×, except A: 8×)

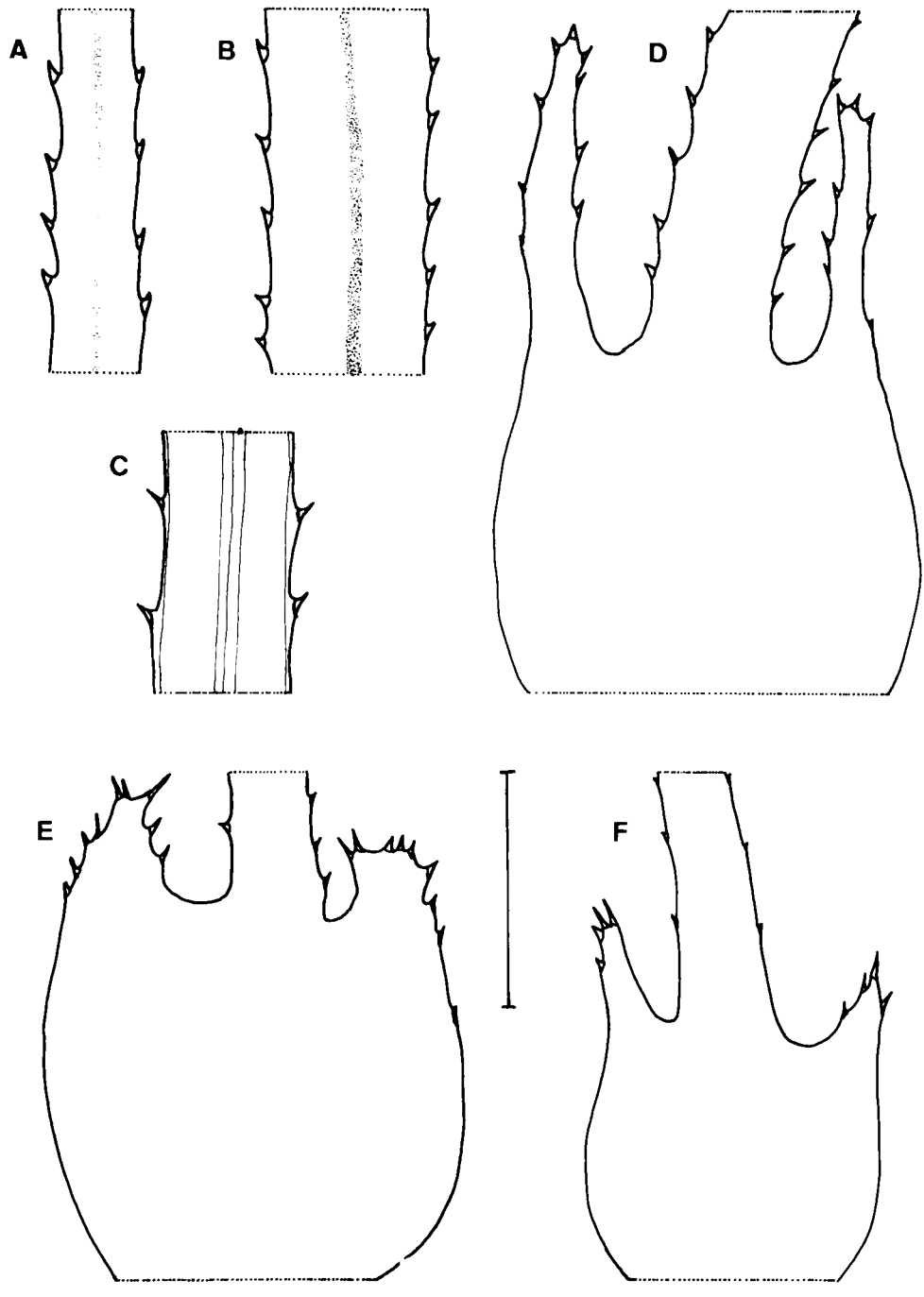
Plate XVI



N. baldwinii

A. Part of leaf, *Morton & Gledhill* 88; B. Part of leaf, *Baldwin* 10116; C. Part of leaf, *Jordan* 115; D. Leaf sheath, *Baldwin* 9925; E. Leaf sheath, *Baldwin* 10116; F. Male flower, *Baldwin* 10116; G. Male flower (inner envelope dehiscing), together with young female flower, *Vanden Berghen* 5993; H. Male flowers at anthesis, *Deighton* 2797; I. Female flower, *Baldwin* 10116; J. Female flower, *Baldwin* 9925; K. Fruit, *Vanden Berghen* 6003; L. Fruit, *Baldwin* 10116. (Scale = 1 mm, all figures 33×)

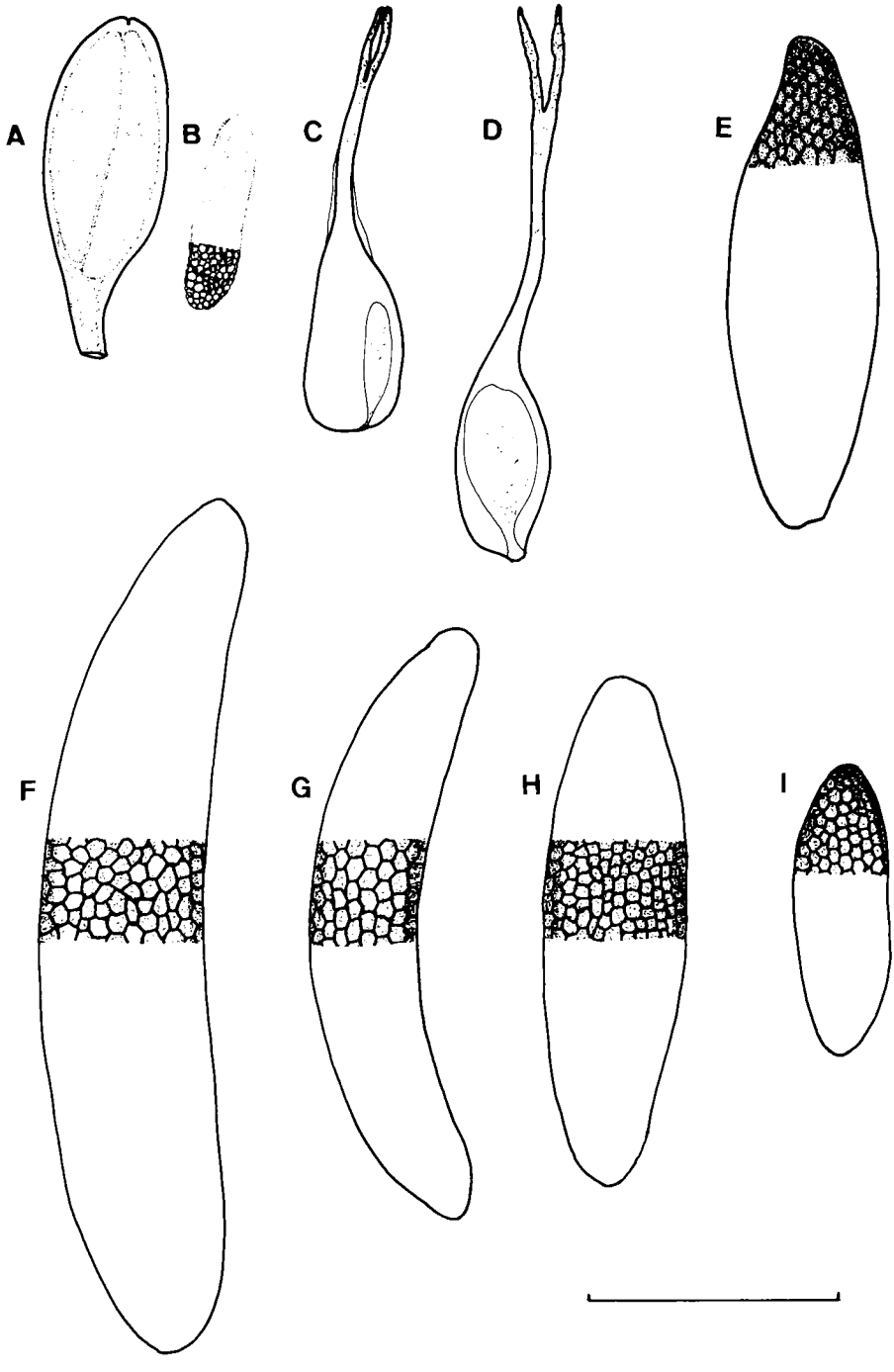
Plate XVII



N. graminea

A. Part of leaf, *Sickenberger* s.n., 14.X.1894; B. Part of leaf, *Muschler* s.n., IV.1906; C. Part of leaf, *Hepper* 3695; D. Leaf sheath, *Hepper* 3628; E. Leaf sheath, *Tisserant* 620; F. Leaf sheath, *Audru* 2874. (Scale = 1 mm, all figures 33×)

Plate XVIII



N. graminea

A. Male flower, *Raynal* 6341; B. Locule, *Raynal* 6341; C. Female flower, *Hepper* 3695; D. Female flower, *Berhaut* 1793; E. Seed, *Hassan* 4079; F. Seed, *Chevalier* 34009; G. Seed, *Chevalier* 6751; H Seed, *Raynal* 6981; I. Seed, *Audru* 2874. (Scale = 1 mm, all figures 33×)