

REVISION OF THE MOSS-GENUS NECKEROPSIS (NECKERACEAE)

I. ASIATIC AND PACIFIC SPECIES

by

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INTRODUCTION

This study was started as a revision of the Malaysian species of *Neckeropsis*, but soon it proved to be necessary to include the species from the adjacent areas. The result was a revision covering all Asiatic and Pacific species.

The material studied was obtained from the following herbaria (abbreviations according to Index Herbariorum I, ed. 4, 1959): BISH, BM, BO, BR, BRI, FH, G, GL, GRO, H, K, L, M, MEL, NICH, NSW, NY, PC, PNH, SAN, SING, US.

The spelling of the geographical names is largely in accordance with "The Times Atlas of the World" (1958).

Measurements and illustrations of leaf-cells are all taken at a point about one-third of the length of the leaf from its apex and in its distal half.

ACKNOWLEDGEMENTS

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Many thanks also go to the Directors of the herbaria from which I have been able to study the specimens. The work was performed at the Rijksherbarium at Leyden under supervision of Prof. Dr. H. J. Lam.

HISTORY OF THE GENUS

In 1868 Reichardt found, that the American species *Neckera undulata* differed so much from the other *Neckeras*, that for this species a new genus had to be created, which he called *Neckeropsis*. In his opinion also *Neckera disticha* had to be transferred to that genus, but by lack of material he could not check this.

Neckeropsis became universally accepted after Fleischer (1908) had added all species of the *Neckera* sections *Paraphysanthus* Spruce, *Pseudoparaphysanthus* Broth., and *Taeniocladium* Mitt. In the new delimitation the genus comprised 21 species, of which 12 in the area considered in the present revision. Ever since, the delimitation of the genus has not been altered, but the number of species has considerably increased. Brotherus (1925) already mentioned 19 Asiatic and Pacific species and at the start of this revision 27 species had been inserted under *Neckeropsis*.

DIAGNOSIS OF THE GENUS

This description holds good for the entire genus, but stress is laid upon the characters of the revised species.

Neckeropsis Reichardt 1868.

Synoicous, *cladautoicous* or *dioicous*. Rather small to very robust, yellowish green to sordidly green, sometimes locally purplish or blackish, usually more or less glossy plants, pendent or procumbent, occasionally projecting at right angles from the substrate. *Primary stems* pale coloured, turning blackish when old, flexuous, creeping, with tufts of reddish brown or purple rhizoids, leaves scale-like, arranged all around the stem. *Secondary stems* 5—15(—60) cm long and from 2 up to 5(—7.5) mm wide, occasionally simple, but usually remotely complanately to subpinnately branched with short branches, standing out at right angles from the stem, hardly narrowed towards their rounded tips, sometimes attenuate and flagelliform, in the latter case occasionally bearing tufts of easily detachable microphyllous branchlets. Stems elliptic in cross-section, central strand absent. *Paraphyllia* absent. *Leaves* pseudotetrastichous, slightly dimorphous, 1.3—2.7(—3.5) mm long, widely spreading, usually transversally undulate, sometimes smooth, slightly longitudinally or obliquely undulate, asymmetrically lingulate, at base strongly curved away from the stem, occasionally gradually curved along the entire length of the leaf; base sometimes shortly decurrent, usually provided with small auricles, proximal part clasping the stem; apex truncate to rounded-truncate, exceptionally rounded, often with a small blunt apiculus; margin usually crenulate at apex, for the rest crenulate or almost entire; *nerve* usually simple, rather robust, reaching far above mid-leaf, occasionally shorter or nearly absent, sometimes forked, very short, or faint; *leaf cells* 7—35(—50) by 3.5—7.5(—11) μ , smooth, pellucid to opaque, fairly regularly arranged, rhomboid to oblong-rectangular; walls incrassate, often with a few pores; cells distinctly shortened at apex, irregularly quadrate to rhomboid to rounded, devoid of pores; cells at base linear and incrassate, often porose; often a faint *border* of elongated cells is formed along the distal leaf-margin, usually reaching up to the point, where the leaf is narrowed towards apex; exceptionally distinct borders of

very elongated, highly incrassate cells are present along both margins; base of auricles with a small group of short, irregular cells.

Gametoecia situated along secondary stems and branches. *Male gametoecia* bud-shaped; *leaves* oval, very concave, nerveless or faintly nerved, shortly acuminate; *paraphyses* filiform, hyaline, mostly reaching just beyond the short-stalked, clavate *antheridia*. *Female gametoecia* polymorphous; *outer leaves* oval, shortly acuminate at apex; *inner leaves* usually very large, erect, concave to sheathing, lanceolate, gradually or suddenly acuminate, nerve long and faint to short or lacking; inner leaves occasionally only little longer than the outer ones and sheathing, limb abruptly elongate-ligulate acuminate, spreading or recurved; cells oblong to linear, rather thin-walled to incrassate. *Gametoecial axis* sometimes prolonged as to form a pseudopodium, reaching the length of the capsule at most. *Vaginula* short, straight, cylindrical, covered with short and filiform or long and ligulate to oblong-linear *paraphyses*, in the latter case reaching up to the mouth of the capsule at least. *Seta* yellow or brown, smooth, usually 0.2—0.5 mm long, straight, occasionally up to 2.5 mm long and sometimes slightly curved, not contorted. *Capsule* yellow to brown, ovoid to shortly cylindrical, erect, up to 2.5 mm long, not or slightly contracted below its mouth; exothecial cells large, rounded to short 4—6—9-angular to elongate, highly incrassate, arranged in longitudinal rows, much smaller near mouth, stomata and annulus absent. *Peristome* double, exo- and endostome consisting of 16 teeth. *Exostome teeth* papillose, lanceolate-subulate, median line distinct, occasionally narrowly perforated near apex, trabeculae thin to thick, slightly projecting. *Endostome* more or less pellucid, papillose, basal membrane low, processes linear-subulate, equalling the exostome teeth, median perforations narrow, trabeculae often knotted. *Spores* globose, 13—30 (—45) μ across, pale green, walls highly incrassate, colourless to brown. *Lid* shortly conical, straightly or obliquely rostrate. *Calyptra* mitriform with small basal ruptures or deeply split on one side and more or less cucullate, covered with paraphysal hairs or smooth.

Type species: *Neckeropsis undulata* (Hedw.) Rchdt.

MORPHOLOGICAL REMARKS

Phyllotaxis, leaf dimorphism and ramification (Plate 1)

According to Fleischer and other authors two groups are distinguishable within the *Neckeraceae*. In the first group the leaves are inserted in eight rows, the other group consists of plants with four-rowed leaves. *Neckeropsis* belongs to the latter group.

The leaves of *Neckera* are distinctly arranged in eight rows, viz. two dorsal, two ventral and at both sides of the stem two lateral ones. Two dorsal leaves and two lateral ones are shown in *fig. 1*. The dorsal leaves are attached higher dorsally on the stem than the lateral ones, which implies, that the clasping part of the dorsal leaves is shorter than the corresponding part of the lateral ones. This explains the occurrence of slight dimorphy in the leaves of the *Neckeraceae* (*fig. 2*).

Without giving arguments Wagner (1951) states, that the leaves of *Neckera* are arranged in two spirals as is shown in *fig. 3*. The leaf arrangement

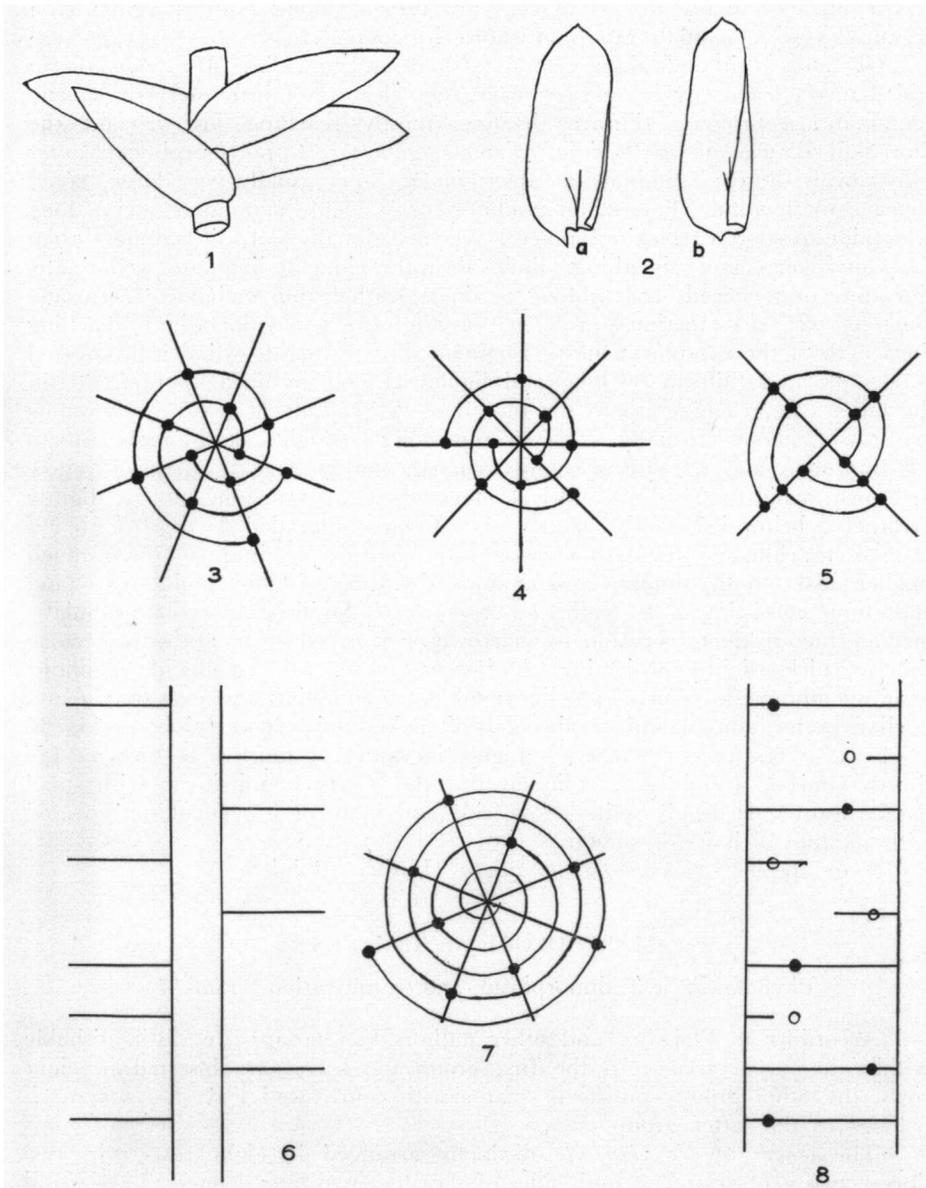


Plate 1. — Leaf arrangement — 1. *Neckera*, detail of a secondary stem — 2. *Neckera*, dorsal (a) and lateral (b) leaf — 3. *Neckera*, leaf arrangement — 4. *Thamnum*, *ibid.* — 5. *Neckeropsis*, *ibid.* — 6. *Neckeropsis*, leaf sequence — 7. *Neckeraceae*, leaf arrangement — 8. *Neckeropsis*, position of the leaves (simplified); horizontal lines: visible part of the leaf insertions; dots: visible nerve insertions; rings: nerve insertions on the posterior part of the stem. (1—5 after Wagner, 1951, 6—8 original).

of *Thamnum* is alike, but here the spirals are turned by 22.5° counter-clockwise (fig. 4), resulting in the occurrence of two median rows, a dorsal one and a ventral one. Wagner agrees with Fleischer in that he states that the leaves of *Neckeropsis* are arranged in four rows. He realises this arrangement by turning one of the *Thamnum*-spirals by 45° . Proceeding in this way, he actually reaches the leaf sequence of *Neckeropsis* (fig. 5, 6).

Basing himself on these differences in leaf arrangement, Wagner (1951, 1952) subdivides the subfamily *Neckeroideae* into two new subfamilies:

1. *Neckeroideae* s.s.: leaves inserted in eight rows;
2. *Homalioidae* (including *Neckeropsis*): leaves inserted in four rows.

According to Van der Wijk (1957) the leaves of *Neckeropsis* are only apparently arranged in four rows. His attention was drawn by the strange leaf sequence, which cannot be explained if an arrangement of the leaves in one spiral with four orthostichies is accepted. In his opinion the complanately foliate stems of *Neckeropsis* have to be considered as highly flattened stems with a $\frac{8}{8}$ leaf arrangement (fig. 7).

During the preparation of the present study many stems of all available *Neckeropsis* species were carefully examined. It became clear from the start, that the leaves of *Neckeropsis* are dimorphous, which would not be the case, if Wagner was right in accepting a four-rowed leaf arrangement. Careful examination of the leaf insertion proved the presence of an arrangement in eight rows; especially the nerve insertions are distinctly eight-rowed (fig. 8). Sometimes the leaf arrangement is altered in places to $\frac{5}{13}$. Since it seems of some interest to compare those points with the situation in the rest of the family, some other *Neckeraceae* were examined, viz.: *Neckera crispata* Hedw., *N. complanata* (Hedw.) Hüb., *Himanthocladium loriforme* (Lac.) Fl., *Homaliodendron flabellatum* (Dicks.) Fl., *Homaliadelphus targionianus* (Gough) Dix. et P. de la V., *Homalia trichomanoides* (Hedw.) B. S. G., *Thamnum alopecurum* (Hedw.) B. S. G., *T. ellipticum* (Bosch et Lac.) Kindb., and *Porotrichum* spec. In all of these cases I arrived at the same conclusion (fig. 7). Even Wagner's median rows in *Thamnum* are absent as a rule. Though the dorsal orthostichies usually lie at nearly equal distances from the median line, aberrations do occur (also in *Neckeropsis*), in which one of the orthostichies approaches the median line. These cases are easily recognisable since the leaves of the orthostichy in question are pointing more sharply towards the tip of the stem than those of the others.

The so-called tetrastichous leaf arrangement is caused by the recurvation of the leaves. The basal part of the dorsal and ventral leaves is more strongly curved away from the stem than the basal part of the lateral leaves, bringing about the situation that the leaves are all pointing in the same direction. Fertile and sterile side-branches are apparently placed in the axils of the lateral leaves, resulting in a complanate arrangement.

As was said before, the leaf arrangement is the same throughout (?) the *Neckeraceae*. A fundamental difference, as was supposed by Wagner, does not exist and I can therefore not agree with him, where he subdivides the *Neckeroideae* into two artificial subfamilies. Moreover, there are other arguments, like the structure of the peristome pleading against his arrangement of the genera.

The structure of the female gametoeccium (*Plate 2*)

Within *Neckeropsis* two types of female gametoeccia can be distinguished, each of which can be divided into two subtypes:

Type 1a. Examples: *N. exserta*, *N. calcicola* (*fig. 1*)

When young, the perigamium consists of about ten cup-forming leaves, enclosing the archegonia and a great number of hyaline, filiform paraphyses. The perichaetial leaves don't increase much in length on fertilisation. New filiform paraphyses are formed, of which the greater part is inserted on the vaginula. While the perichaetial leaves remain small, the seta reaches a fairly great length and the capsule is long exserted.

Type 1b. Examples: *N. lepineaana*, *N. obtusata*, *N. madecassa* (*fig. 2*)

When young, the gametoeccia of types 1a and 1b are just alike (except small differences of specific rank).

The inner perigamial leaves start to elongate on fertilisation. They develop very rapidly and reach their ultimate length long before the development of the sporophyte is completed. Here too, new filiform paraphyses are formed upon the vaginula. The seta remains very short, hiding the capsule between the strongly enlarged perichaetial leaves.

The types 1a and 1b are not restricted to *Neckeropsis* only, but they also occur in other *Neckeraceae* and other moss-families. The next two types are apparently restricted to *Neckeropsis*.

Type 2a. Examples: *N. disticha*, *N. pabstiana*, *N. undulata* (*American species*) (*fig. 3*)

Again the perigamium consists of about ten leaves; it envelops the archegonia, but these are surrounded by a whorl of antheridia. Between the gametangia, filiform, hyaline paraphyses are situated, in which some longitudinal walls may be found, locally causing a width of two (rarely three) cells. Once the development of the sporophyte has started, numerous paraphyses grow out at the base of the fertilised archegonium (*fig. b*). In these paraphyses longitudinal walls are formed, giving them a close resemblance to small ligulate leaves, the more so since in the leaf centre tangential walls are developing, resulting in the formation of a more or less distinct nerve. Numerous transitions, however, are found between filiform and ligulate paraphyses, but it seems that the filiform paraphyses of the young gametoeccium are not transformed into ligulate leaves. The leaf-like paraphyses develop much quicker than the sporophyte and reach their ultimate length before the separation between vaginula and calyptra has taken place (*fig. c*). Between the antheridial whorl and the sporophyte the gametoeccial axis becomes elongated, forming a pseudopodium about as long as the sessile capsule. When mature, the gametoeccium (*fig. e*) consists of:

1. A pseudopodium, bearing unfertilized archegonia and filiform paraphyses, hidden by hardly elongated perichaetial leaves;
2. The capsule, being nearly sessile and completely surrounded by ligulate paraphyses, reaching up to about the mouth of the capsule; the greater part of these paraphyses is inserted on the vaginula.

Decrepit antheridia are situated at the base of the pseudopodium.

Type 2b. Examples: *N. crinita*, *N. andamana*, *N. fimbriata* (fig. 4)

The development of the gametoeonium takes place in the same way as in type 2a with exception of the following differences:

1. The gametoeonia are unisexual, male and female gametoeonia are usually situated along the same branches;
2. When young, the female gametoeonium contains very short leaf-like paraphyses or none;

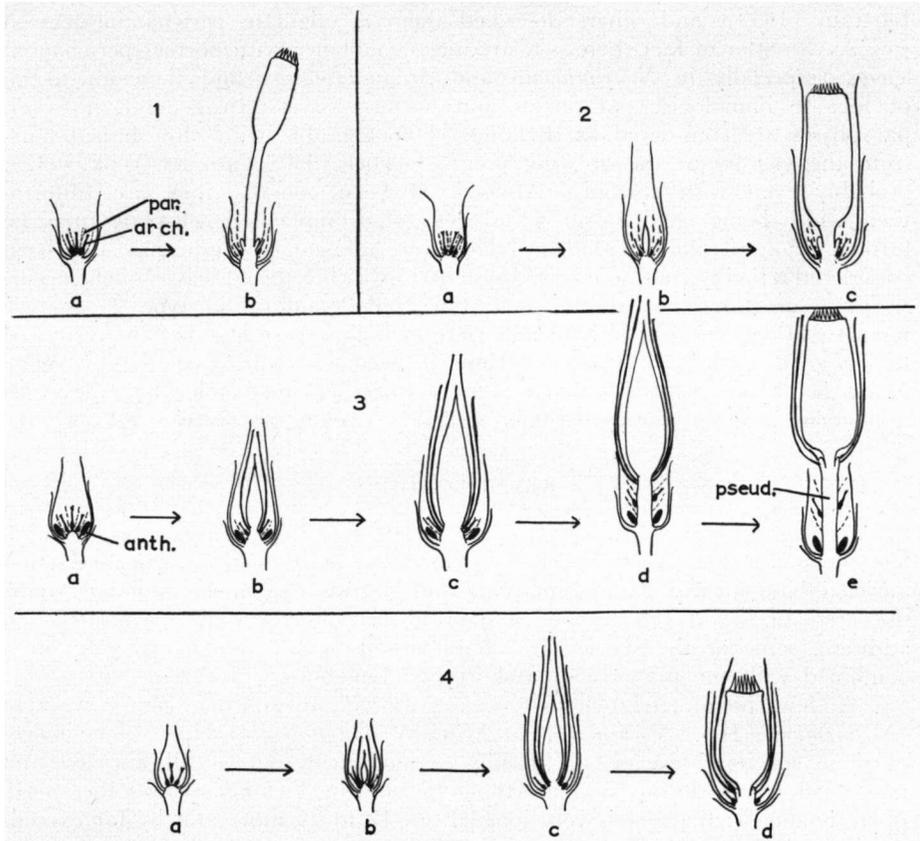


Plate 2. — Structure of the female gametoeonium (p. 378) — 1. Type 1a — 2. Type 1b — 3. Type 2a — 4. Type 2b.

3. Ultimately, the paraphyses are reaching far beyond the mouth of the capsule;
4. The pseudopodium is very short or absent;
5. The inner perichaetial leaves are considerably elongated.

Especially the capsule of *N. andamana* looks like being surrounded by perichaetial leaves, but on closer examination, some of these leaves appear to be paraphyses, inserted on the vaginula and surrounded by a slender whorl of decrepit archegonia.

The gametoezia of *N. nano-disticha* present a transitional form between the types 2a and 2b. The gametoezia of this species are unisexual as a rule, but bisexual ones are not at all rare. The pseudopodium is shorter than is usual in type 2a. The inner perichaetial leaves are rather elongated, the paraphyses are more than one cell in width.

Reichardt (1868) held the opinion, that the capsule-surrounding leaves of the perichaetium of *N. undulata* have to be considered modified paraphyses. Other authors did not follow him: Fleischer (1908), Brotherus (1909, 1925), Bartram (1939), and others described them as 'ligulate perichaetial leaves', etc. As a matter of fact there is a striking resemblance with normal perichaetial leaves (especially in *N. fimbriata* and *N. andamana*) and it seems to be obvious to homologise paraphyses and normal leaves. In general, however, paraphyses are considered as trichomes, homologisable with club-shaped hairs from the vicinity of the growing point (Goebel 1930, Van der Wijk 1932), probably even with rhizoids (Arens 1933). In general, they are filiform, their width being only one or a few cells. Uncomplicated cell-plates may be formed (*Polytrichum*, *Leptodon*). However, the gametoezium has also been considered a highly contracted axial system, in which reduced leaves might occur.

The creation of a short but distinct pseudopodium in type 2a is very remarkable too because it is usually accepted, that pseudopodia are restricted to *Sphagnales* and *Andreaeales*. Here it becomes clear, that they may be found in *Bryales* as well and it is not altogether impossible that they also may occur in other mosses with reduced setae, belonging to that order.

RELATIONSHIPS

Neckeropsis is especially characterised by the complanate, pseudotetrastichous leaf arrangement, the asymmetrical leaves with a wide and often auricled base, nearly parallel margins and a truncate, finely crenulate apex, the areolation and the usually sessile or very shortly stalked capsules. In addition, some of the species are characterised by leaf-like paraphyses, often combined with the presence of a short pseudopodium.

A few pseudotetrastichous species also occur in the genus *Neckera* (*N. birmensis* Hpe, *N. himalayana* Mitt., *N. longe-exserta* Hpe). The leaves of these species, however, are hardly asymmetrical, not at all auricled and tapering towards the apex. Unfortunately, only in *N. longe-exserta* the sporophyte is known; the seta is very long (from 17 to 25 mm) and by far exceeds the longest *Neckeropsis* setae.

Neckeropsis is closely allied with the Malayan-West Pacific genus *Himanthocladium* and confusion has occurred more than once. In general, *Himanthocladium* differs from *Neckeropsis* in its clearly octostichous leaf arrangement, its hardly asymmetrical and irregularly undulate leaves, often strongly widened at base and narrow at the coarsely serrate apex, its usually rounded and irregularly arranged leaf-cells with highly incrassate walls, its small perichaetia and its shortly stalked capsules. A transitional group is formed by *H. pacificum* and *H. flagelliferum*, two closely allied species, of which *H. pacificum* (Broth. et Par.) Broth. distinctly belongs to *Himanthocladium*, whilst *H. flagelliferum* (Broth.) Broth. has more intermediate characters.

Also related with *Neckeropsis* is *Homaliodendron*, comprising plants with

fan-like, pinnate stems and very glossy leaves, all lying in one plane. This genus is built up of three very different sections. Of these, *Incisifolia* is easily recognisable by its leaves, being coarsely and irregularly serrate at their tips and its peristome-teeth, which are usually striate at their base. The section *Circulifolia* is less homogeneous. The plants are often not flabelliform, the leaves are asymmetrical and usually widely spatulate with a widened, rounded and entire or crenulate apex, the peristome-teeth are papillose, but unfortunately from only one species the sporophyte is known, which makes it difficult to decide about the systematic value of this section and its place. In my opinion, some of the species of this section belong to *Neckeropsis*. Brotherus (1925) already supposed, that the Brazilian *H. punctulatum* had better be transferred to *Neckeropsis*. Two Asiatic species have been described under *Neckeropsis* and *Homaliodendron*, namely:

Neckeropsis annamensis (Broth. et Par.) Broth., identical with *Homaliodendron semperianum* (Hpe in C. Muell.) Broth. and

Neckeropsis plagiophiloides Dix., identical with *Homaliodendron fleischeri* Dix.

The sporophytes of these species are unknown, but well-known is the sporophyte of the South-American *Neckeropsis pabstiana*, which is apparently closely related to *N. annamensis* and *N. plagiophiloides* (= *N. fleischeri*). This *N. pabstiana* has pseudopodiate capsules, hidden between leaf-like paraphyses. Leaf-shape, areolation and ramification of the two species mentioned before are neckeropsoid, and this is why I placed them in *Neckeropsis*. The only other *Circulifolia* species available to me are *H. microdendron* (Mont.) Fl. and *H. exiguum* (Lac.) Fl., both definitely not belonging to *Neckeropsis*.

ECOLOGY

The plants have been found growing on trees as well as on rocks, occasionally on rocks only, in humid, sheltered habitats in the tropical and the montane zone, from sea-level up to 2350 m (*N. exserta* var. *exserta*). The species of the section *Pseudoparaphysanthus* (*N. moutieri*, *N. submarganata*) are growing on temporarily inundated places and I also saw a specimen of *N. fleischeri* from such a site.

DISTRIBUTION

The greater part of the species have been collected only a few times and consequently their distribution is insufficiently known. The genus is circumtropical and *N. lepineana*, the commonest species in my range of investigation is panpalaeotropical, but it is more common in Malaysia and the Pacific than in Africa and the Asian continent. Remarkable is its absence in SW-India; one would expect it there and, in fact, some other *Neckeropsis*-species with about the same ecology have been found here. I do not think that the absence of *N. lepineana* is a matter of its being overlooked, for *N. lepineana* is a striking species, often forming mass-vegetations. In Japan, this species is replaced by the allied *N. calcicola* and *N. obtusata*.

The greatest concentration of species occurs in NE-India and the SE-Asiatic Peninsula. Here eight species have been found besides *N. lepineana*, viz.:

A. Ranging from Nepal to Siam (the other parts of the area of the species are indicated between brackets):

N. fimbriata (Malay Peninsula)

N. exserta var. *exserta* (SW-India)

N. andamana (SW-India, Andaman Isl., Luzon, Malay Peninsula?, Java?)

N. crinita (Sumatra?)

B. Restricted to the Malay Peninsula and the Andamans: *N. submarginata*.

C. Indo-China:

N. moutieri

N. semperiana (Mindanao)

N. obtusata (SW-China?, Formosa, Ryukyu Archipelago, Japan)

The species of the Malay Peninsula and the Philippines are closely related to those of the Asian continent. *N. gracilentia* is a common Malaysian species, extending westward to the Nicobar Islands and the Isthmus of Kra and eastward to Samoa. *N. fleischeri* is endemic in Borneo. *N. nano-disticha* more or less characterises Eastern Malaysia and also occurs in Queensland (Australia).

In Japan *N. nitidula* occurs together with *N. calcicola* and *N. obtusata* mentioned before. *N. nitidula* has also been found in Korea and probably in China too.

KEY TO THE SPECIES

- 1a. Both leaf-margins with a distinct border, about 5 cells wide, which are elongate-linear cells and have highly incrassate walls 2
- b. Leaves not or rather faintly bordered along the proximal margin only, border-cells hardly exceeding the lamina-cells, not incrassate 3
- 2a. Leaves minutely longitudinally plicate-striate when dry, lingulate, more than 2.5 times as long as wide 13. *N. submarginata*
- b. Leaves coarsely crisped when dry, obovate-lingulate, about twice as long as wide. 14. *N. moutieri*
- 3a. Nerve faint, ill-defined, occasionally reaching beyond mid-leaf at most, sometimes double 4
- b. Nerve ending just below apex, rather broad, occasionally forked above 8
- 4a. Leaves smooth when moistened, up to 2.5 mm long, obovate, lingulate or cultriform 5
- b. Leaves regularly transversally undulate, sometimes irregularly undulate, usually at least 2.5 mm long, lingulate, apex not acuminate, nearly entire 6
- 5a. Proximal leaf-cells not differing in shape from the distal ones, leaf-apex distinctly acuminate-acute, coarsely serrulate to serrate 12. *N. nitidula*
- b. Proximal leaf-cells much more elongated than the distal ones, apex obliquely truncate, rarely sharply acuminate, minutely serrulate to crenulate 10. *N. fleischeri*
- 6a. Apex rounded, leaves faintly irregularly or transversally undulate, distinctly octostichous to pseudotetrastichous; secondary stems up to 5(—10) cm long, capsule immersed 3. *N. obtusata*
- b. Apex truncate, rarely rounded, leaves regularly transversally undulate, pseudotetrastichous; secondary stems from (10—)15 up to 60 cm long 7
- 7a. Perichaetial leaves up to 4.5 mm long, erect, sheathing, enveloping the capsule, seta up to 1 mm long; nerve extremely short, usually not reaching beyond 1/4 leaf-length 1. *N. lepineana*
- b. Perichaetial leaves about 1.5 mm long, capsule exserted, seta about 2 mm long, nerve usually reaching beyond 1/3 leaf-length 2. *N. calcicola*
- 8a. Leaves smooth, usually very glossy, base not widened to slightly narrowed, auricles absent 9

- b. Leaves distinctly transversally undulate or occasionally faintly and irregularly undulate, base widened, proximally auricled at least 10
- 9a. Proximal leaf-cells much more elongate than the distal ones, leaves more or less arcuate, apex obliquely truncate, rarely distinctly apiculate; nerve thin, ill-defined 10. *N. fleischeri*
- b. Proximal and distal leaf-cells of the same size, leaves curved at base only, apex transversally truncate, shortly acuminate; nerve distinct 11. *N. semperiana*
- 10a. Leaves shallowly undulate, nearly smooth when moistened, proximal border distinct, pale coloured; paraphyses ligulate 9. *N. nano-disticha*
- b. Leaves deeply undulate, proximal border usually faint; paraphyses filiform, ligulate or lanceolate 11
- 11a. Leaves strongly widened towards base, occasionally irregularly undulate, auricles very large, secondary stems coiled up when dry, plants often tinged with purple, peristome bright yellow to orange 6. *N. fimbriata*
- b. Leaves not much widened at base, always transversally undulate; auricles small, stems somewhat flexuous at most, plants rarely tinged with purple, peristome pale coloured, yellowish or greenish 12
- 12a. Stems slender, up to 30 cm long, branches short, attenuate, often flagelliform, often bearing tufts of gemmiform branchlets; dioicous 4. *N. gracilenta*
- b. Stems rather rigid, up to 10 cm long, branches obtuse, rarely flagelliform, gemmiform branchlets absent; autoicous 13
- 13a. Paraphyses filiform, 1 cell in width, capsules shortly cylindrical, exerted upon a distinct stalk, lid obliquely rostrate; leaves very deeply undulate 5. *N. exserta*
- b. Paraphyses ligulate to lanceolate, more than one cell in width, capsules ovate-campanulate, immersed, almost sessile, lid straightly rostrate; leaves not very deeply undulate (capsules nearly always present in great number) 14
- 14a. Paraphyses lanceolate to oblong, leaf-like, calyptra glabrous, leaf-apex distinctly apiculate 8. *N. andamana*
- b. Paraphyses ligulate, nerve-like, calyptra covered with paraphysal hairs, leaf-apex not apiculate 7. *N. crinita*

DESCRIPTION OF THE SPECIES

1. *N. lepineana* (Mont.) Fleischer (1908) 879; Giesenhagen (1910) 786; Herzog (1910) 120; Schröder (1912) 312; Williams (1915) 574; (1917) 358; Jennings (1918) 95; Möller (1919) 321; Dixon (1923) 64; Brotherus (1925) 188; Dixon (1926) 24; Brotherus (1928) 126; Dixon (1932 B) 29, (1934) 30, (1935) 102; Thériot (1937) 131; Bartram (1939) 239, (1945 B) 120; Merrill (1947) 10; Froehlich (1953) 95, (1955) 322; Herzog et Noguchi (1955) 64; Bartram (1957 A) 47, (1957 B) 24. — *Neckera lepineana* Montagne (1848) 107; C. Mueller (1851) 49; Zollinger (1854) 26; Montagne (1856) 23; Dozy et Molkenboer (1864) 61; Mitten (1869) 168; Reichardt (1870) 183; Geheeb (1899) 11; Paris (1898) 851; Brotherus (1900 A) 49, (1900 B) 91; Gepp (1900) 196; Cardot (1901) 115; Paris (1905 A) 295; Gepp (1905) 342; Paris (1909) 9; Brotherus (1909) 842; Levier (1910) 7. — *N. undulata* sensu Montagne (1845) 318, non Hedw. — *N. crinita* Griffith sensu Mitten (1859) 120 pro part. — *N. comorae* C. Mueller (1876) 268; Bescherelle (1880) 272; Paris (1898) 845, (1905) 289; Brotherus (1909) 842. — *Plates 3, 4, 5 (fig. 1—2).*

Type: Tahiti, leg. J. Lépine s.n. (PC; isotypes in G, BM).

Dioicous. Plants very robust, yellowish green, sometimes blackish purple or tinged with purple, often forming mass-vegetations of drooping branches. *Primary stems* normal. *Secondary stems* robust, flexuous and flaccid, occasionally rather rigid, (10—)15—30(—60) cm by (2.5—)3.5—4.5(—7.5) mm, complanately foliate, irregularly remotely or subpinnately branched, sometimes simple, tips hardly narrowed and rounded, rarely attenuate. *Leaves* pseudo-

tetrastichous, asymmetrically lingulate, (1.5—)2.5—3.5 by (0.6—)1—1.8 mm, L/W *). 2—3, apex rounded, truncate or faintly exsculptate, exceptionally with a blunt apiculus, base slightly narrowed, auricles very small and sometimes hardly distinct, especially at the distal side of the leaf longly and narrowly decurrent, proximal part incurved at base, clasping the stem, undulations lunate, 2—6, margin faintly crenulate at apex, entire or nearly

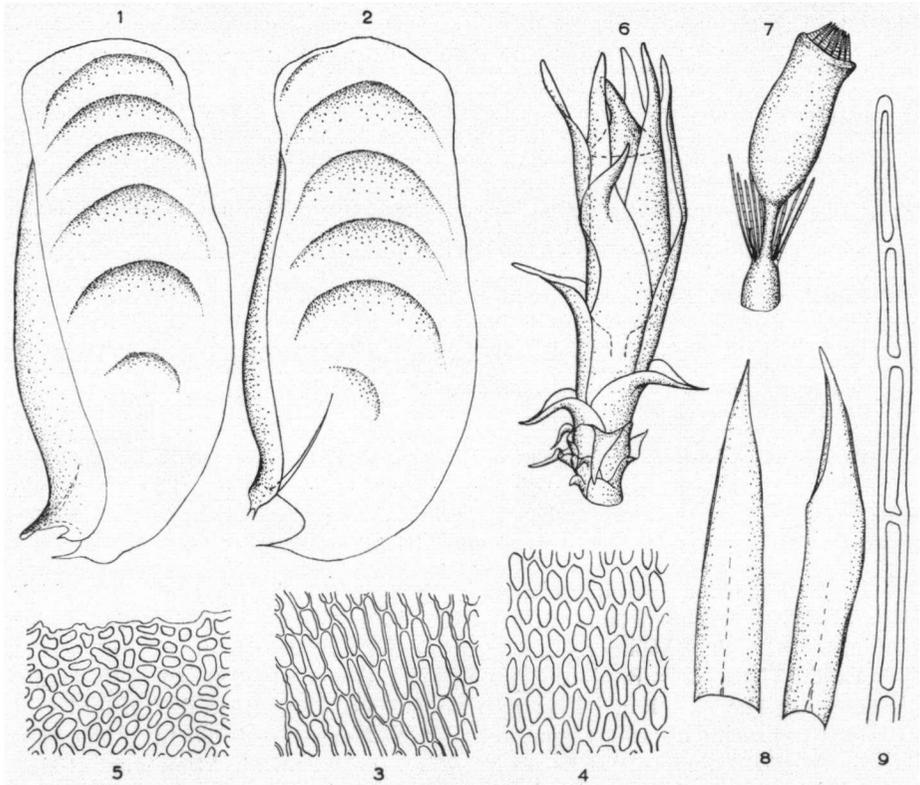


Plate 3. — *N. lepinea* — 1. lateral leaf ($\times 23.5$) — 2. dorsal leaf ($\times 23.5$) — 3, 4. leaf-cells ($\times 270$) — 5. areolation near apex ($\times 270$) — 6. perichaetium ($\times 12$) — 7. capsule and paraphyses ($\times 12$) — 8. perichaetial leaves ($\times 12$) — 9. tip of a paraphyse ($\times 270$).

entire elsewhere, *nerve* short and faint, rarely exceeding $\frac{1}{4}$ of the length of the leaf, simple, forked or trichotomous, sometimes nearly absent. *Cells* pellucid, (10—)20—35(—50) by 3.5—7.5(—10) μ , L/W (2—)3—5(—7), rhomboid or elongate, walls incrassate, often with a few pores, shortly rhomboid to irregularly quadrate or rounded at apex, distinctly arranged in rows, 6—15 by 5—15 μ , L/W 1—2(—3), walls incrassate, solid, cells at base elongate to linear, (20—)30—65(—80) by 6—13 μ , L/W 3—11, walls highly porose, alar cells shorter, very irregularly shaped or rounded, *proximal border* hardly

*) L/W = Length/Width

distinguishable, cells somewhat elongate, walls faintly more incrassate. *Male gametoecia* normal. *Female gametoecia* 1—1.5 mm long, leaves erect with a sheathing base and a concave, triangularly acuminate limb, nerveless or with two very short nerves; inner leaves short, erect, oblong; paraphyses numerous, filiform, hyaline, usually reaching just beyond the numerous archegonia, 0.3—0.4 mm long. *Perichaetia* about 5 mm long, reaching beyond the branch-leaves, tubular, shining yellow; *outer leaves* small, ovate, appressed, but spreading to revolute at apex; *inner leaves* up to 4.5 mm long, erect, lanceolate, sheathing, gradually acuminate, rounded at apex, margin with a few teeth at apex, entire elsewhere, nerve very short and faint, occasionally rather long and reaching up to mid-leaf, cells elongate to linear, walls incrassate, porose. *Paraphyses* numerous, filiform, hyaline, one cell in width, reaching up to the base of the capsule. *Vaginula* short and straight. *Seta* yellowish brown, about 0.5 mm long, straight. *Capsule* yellowish brown, erect, about 2 mm long and 0.8 mm wide when deoperculate, ovoid-ellipsoid to ellipsoid, faintly or not at all constricted below its mouth. *Exostome* yellow, teeth lanceolate-subulate, finely papillose. *Endostome* yellow, processes subulate, finely papillose, median perforations rather large, basal membrane about 50 μ high. *Spores* brown, 20—30 μ , finely papillose. *Lid* about 0.6 mm long, shortly conical, obliquely or rarely straightly rostrate. *Calyptra* pale yellow, about 1.2 mm long, cucullate, remotely covered with paraphysal hairs.

Distribution: Cameroun, Uganda, Tanganyika, Union of South Africa, Comoro Archipelago, Madagascar, Mauritius, Ceylon, India (Kumaon, Bhutan, Khasia), SW-China, Tonkin, Cochin-China, Siam, Nicobar Islands, Malaysia, Australia (Queensland), Marianas, Palau Islands, New Caledonia, Loyalty Islands, New Hebrides, Fiji Islands, Samoan Islands, Cook Islands, Society Islands, Tubuai Islands, Rapa Iti, Gambier Islands, Hawaiian Islands.

CAMEROUN. Yokadouma: *Mildbread 4632* (H).

UGANDA. Mulange: *Dummer 2962* (F).

TANGANYIKA. Bukoba: *Mildbread 254* (H); Ugombe: *Scheffler s.n.* (H); Usambara: *Holst 4316* (M).

SOUTH AFRICA. Cape of Good Hope. Balfour: *Rodrigues 64* (NY).

COMORO ARCHIPELAGO. Without definite locality: *Humblot 1563* (BM). Anjouan (= Johanna): *Hildebrandt 1832* (type of *Neckera comorac*; M, L, NSW), *Speke s.n.* (NY). Mayotte: *Marie 33* (H, M, NY), *188* (NY).

MADAGASCAR. Fianarantsoa: *Indig. Coll. s.n.* (L); Tananarive: *Indig. Coll. s.n.* (M).

MAURITIUS: *Ryres s.n.* (NY).

CEYLON: *Arnott 36* (G), *Thwaites 174* (BM, NY), *s.n.* (NY); Hakgala: *Alston 1145* (BM), *Herzog 65* (FH, L, M); Pusselawa: *Binstead 409* (BM); Deanstone Estate: *Alston 1827* (BM, US).

INDIA. Kumaon. Askote: *Kabir Khan 1898* (PC, M). Khasia. Negrogam: *Griffith 417* (NY). Bhutan. Oongar: *Griffith 419* (NY), *420* (NY); Rocks Sing (?): *Griffith s.n.* (NY).

CHINA. Yunnan. Without definite locality: *Handel-Mazzetti 9560* (H). ?Kiangsou. Chei-Tong: *Courtois 60* (H, L).

TONKIN. Ban Phet: *Bon 1961 bis* (NY); Phu Quoc Oai: *Demange 26* (PC).

COCHIN-CHINA. Poulou-Condore: *Harmand 941* (H).

SIAM. Pungah: *Curtis s.n.* (SING).

MALAY PENINSULA. Perak: *Ridley 378* (NY, SING), *Wray s.n.* (SING); Gunung Rinto: *Henderson SFN 23822* (BM, GRO, L, PNH, SING); Gunung Kerbau: *Haniff 244* (BM, G, L, SING). Kelantan. Gua Papany, G. Ninek: *Henderson SFN 19523* (BM, SING). Pahang. Gua Senyum: *Henderson SFN 22244* (SING), *22281* (SING); Gua Tipus: *Henderson SFN 22553* (BM, SING). Selangor. Gua Batu: *Ridley 477*

(NY, SING); Ginting Sempah: *Hume SFN 9595* (BM, SING, US). Pulau Penang: *Curtis s.n.* (SING).

MALAY ARCHIPELAGO. Without exact locality: *Waitz s.n.*

SUMATRA. Without exact locality: *Korthals s.n.* (BM, GRO, K, L), *Teijsmann s.n.* (L). West Coast. Padang: *Wiltens s.n.* (L); Pajakumbuh, Mt. Sago: *Meyer 6879* (L), *6881* (L); Mt. Bongsu W. of Solok: *Van Borssum Waalkes 2356* (GRO, L); Solok, Lua Tjer: *Van der Wijk 1227* (GRO); S. of Lake Singkarak: *Van der Wijk 1345* (GRO); Indarung: *Van Borssum Waalkes 2730* (GRO, L), *2743* (GRO, L); Mt. Talang: *Van Borssum Waalkes 2388* (GRO, L). East Coast. Sibulangit: *Staal 226* (GRO); Sibajak: *Staal 398* (GRO); Prapat, G. Sisal: *Staal 85* (GRO). Bencoolen. Bukit Besar: *Giesenhagen 33* (H, M); between Keban Agung and Kepahiang: *Giesenhagen 45* (H, M). Palembang. Baturadja: *Breedveld 1* (L).

JAVA. Without exact locality: *Korthals s.n.* (L), *Nagler (= Nagel) s.n.* (BM), *De Vriese s.n.* (L), *Zollinger 4692* (BM). West Java. Tjampea: *Fleischer, Kr. Exs. Vind. 1398* (BRI, FH, G, L, M, NY, NSW, US), *Meyer B 4471* (L), *Nyman 384* (K); G. Burung: *Schiffner 12659* (= *Kr. Exs. Vind. 3980*) (L, M); G. Megamendung: *Moseley s.n.* (BM, NY), *Kurz 575* (M); G. Munara: *Kuhl & Van Hasselt s.n.* (L); G. Magnedon: *Kuhl & Van Hasselt s.n.* (L); Bogor: *Jelinek s.n.* (BM); Tjibodas: *Dadi & Noerta 3* (GRO), *Fleischer MAI 183* (BM, BO, G, GRO, L, M, NY), *Inamasa s.n.* (GRO), *Meyer 159* (BO), *Möller s.n.* (BM, M, NY), *Noerta & Soekar 3336* (GRO, L), *Raap 47* (L), *Schiffner 12662* (L, US), *Verdoorn 30* (BM, BO, GRO, L), *Van der Wijk 168* (GRO), *1101* (GRO), *345h* (GRO); between Tjibodas and Tjikurang: *Noerta & Soekar 2267* (L, GRO); Tjibirum: *Schiffner 12664* (L); G. Gedeh and G. Salak: *Van Gesker s.n.* (L), *Korthals s.n.* (L), *Möller s.n.* (BISH), *Teijsmann s.n.* (L), *De Vriese s.n.* (L), *Zippelius s.n.* (L); G. Pangrango: *Kuhl & Van Hasselt s.n.* (L), *Möller s.n.* (BM); Artja: *Schiffner 12661* (L, US); Tjisarua, *Van der Wijk 1146b* (GRO); Padalarang: *Van der Pijl 483* (BO, GRO); Lembang: *Korthals s.n.* (BM); Bandung, Dago Waterfall: *Meyer B 3495* (GRO, L), *Popta 5* (GRO); Kendang: *Zippelius s.n.* (H, L); G. Papandajan: *Korthals s.n.* (L); G. Guntur: *Verdoorn 50* (BM, BO, GRO, L). Central Java. G. Slamet: *Junghuhn s.n.* (G, L). East Java. G. Wilis: *Clason 2 p.p.* (BO, GRO); Trenggalek: *Stucky s.n.* (GRO, L); Lumadjang: *Zollinger 2344* (BM, G, L, NY); G. Semeru, Ranu Darungan: *Verdoorn 34* (BM, BO, GRO); G. Kendeng near Garahan: *Gandrup 276* (FH), *284* (FH).

CHRISTMAS ISLAND: *Kirkpatrick s.n.* (BM), *Ridley 219* (BM, SING); Flying Fish Cove: *Andrews 2* (BM).

BAWEAN. G. Besar: *Buwalda 3204* (GRO).

LESSER SUNDA ISLANDS. Sumbawa: *Zollinger s.n.* (G). East Timor. Muapitine: *Van Steenis 18179* (GRO).

BORNEO. Without exact locality: *Everett s.n.* (NY). Sarawak. Without exact locality: *Everett 515* (BM); Bau: *Brooks 33* (BM), *Brooke 9878* (SING); Lobong Angin: *Lobb s.n.* (BM); Mt. Bayot: *Nat. Coll. 2133* (BM, BO, K, L, NY). North Borneo. Timbun Mata Island, Mapat River: *Keith 7359* (BM); Mt. Kinabalu, Tenompok: *J. & M. S. Clemens s.n.* (= *Verdoorn 17893*) (BM); Dallas: *Holttum 25345* (BM, SING, US), *25374* (BM, SING, US).

PHILIPPINES. Without exact locality: *Cuming s.n.* (BM). Mindoro. Puerto Galera: *Bartlett 13907* (FH, G, US); Mt. Halcon: *Edaño PNH 9287* (GRO). Luzon: *Semper s.n.* (BM); Bajaran: *Semper s.n.* (BM, M); Benguet: *Merrill 7881* (M, NY), *Mearns BS 3387* (BO, GRO, NY); Baguio: *Elmer 8450* (BM, BO, FH, G, L, M, NSW, NY, US), *Williams 1689* (FH, US); Ifugao: *McGregor BS 20043* (BO, FH, GRO, NY, US); Nuevo Vizcaya, Dupax: *McGregor BS 14342* (L), *14351* (BO, K, L, NY, US); Bataan, Mt. Palacio: *Edaño PNH 9266* (GRO); Rizal: *Reillo BS 19320* (NY, US); Montalban: *Loher M. Sel. et Cr. (Verdoorn) 83* (BM, BO, BR, L, M, NY, SING, US); Laguna, Mt. Makiling: *Baker 7006* (BM); *Bartlett 15606* (FH); Tayabas, Lobayot River: *Leiberg 1248* (BM, FH, NY, US); Malinao: *Baker 6277* (= *Kr. Exs. Vind. 1398b*) (BM, BR, G, L, M, US). Biliran: *McGregor BS 18462* (K, NY, US), *Wallis s.n.* (BM, BR, NY). Negros. Dumaguete, Cuernos Mts.: *Elmer 9708* (BISH, BM, BO, FH, G, L, M, NSW, NY, PC, US), *10020* (BM, BO, FH, G, L, M, NSW, NY, US); Tanjay, Lake Balinsasajao: *Edaño PNH 13120* (GRO, PNH). Panay. Antique: *McGregor BS 32620* (BO, GRO, K, L, NY, US), *32623* (BO, K, NY, US); Iloilo: *Robinson BS 18178* (NY, US); Capiz, Mt. Bulilao: *Martelino & Edaño BS 35824* (BM, NY); Mt. Upao: *Paniza PNH 9273* (GRO). Basilan: *Semper s.n.* (BM, L).

Mindanao. Agusan, Butuan: *Weber* 1333 (BM, BO, GRO, L, NY); Mt. Hilong-Hilong: *Mendoza & Convocar* PNH 10971 (GRO); Lanao, Lake Lanao, Camp Keithley: *M. S. Clemens* 527 (BM, BO, GRO, L, NY, US), „B” (NY), „R” (NY); Cotabato, Mt. Apo: *Williams* 2665 (NY); Davao, Mt. Mansamuga: *Edaño* PNH 12778 (GRO); Mt. Hamiguitan: *Edaño* PNH 12789 (GRO); Quinonoan River: *Edaño* PNH 12910 (GRO).

CELEBES: *Kjellberg* 92 M (BM, GRO, BO). North Peninsula. Minahasa: *De Vriese s.n.* (L); Rurukan: *Hose s.n.* (BM); Tomohon: *Westenberg s.n.* (GRO). Southwest Peninsula. Pankadjene River: *Teijsmann* MAI 437 (type of *fa. gigantea* FL; BM, BO, G, GRO, L, M, NY); Tjamba *Simon Thomas s.n.* (L); Bantimurung: *Buwalda* 3767 (GRO).

MOLUCCAS. Morotai. Sangoue: *Main & Aden s.n.* (GRO). Halmaheira: *De Vriese s.n.* (L). Buru: *Deninger s.n.* (M); Kapalamadang: *Deninger s.n.* (M). Ceram: *De Vriese s.n.* (L).

NEW GUINEA. Without exact locality: *Koch s.n.* (L), *Zippelius s.n.* (L). W. New Guinea. Legarei River: *Gjellerup* 48 (BO, GRO, L), *Janowski* 48 (L) (*Gjellerup* 48 and *Janowski* 48 are probably duplicates from one collection); Merkus-oord: *Jacquinot s.n.* (BM). N. New Guinea. Cycloop Mts.: *Cheesman* 80 (BM); Swart Valley, Kadubaka: *Bergman* 123 (L). S. New Guinea. Aendua near Uta: *Aet* 436 (GRO); Upper Digul River: *Van Zanten* 246 (GRO); Star Mts, Antares: *Van Zanten* 490 (GRO). Papua. Central District. Astrolabe Range: *comm. Von Mueller s.n.* (MEL), *Edelfeldt s.n.* (G); Mt. Durigolo: *Clark* 28 (BM), 91 (BM). NE. District. Kakaya: *Crutwell* M 60 (GRO); Gwadagwada: *Crutwell* M 77 (GRO). Terr. of New Guinea. Morobe District. Sattelberg: *Nyman s.n.* (L), *J. & M. S. Clemens* 264 (L), *Lauterbach* 535a (BM), *Weinland s.n.* (H, L, NY), *Zahn s.n.* (BM, BR, GRO); Madang: *Schütz s.n.* (M); Yunzaing: *J. & M. S. Clemens* 4195 (FH); Wantoat: *J. & M. S. Clemens* 11144 (FH, US); Boana: *J. & M. S. Clemens* 41449 (FH), 41555 (FH), 41742 (FH), 41890.7 (FH); Saruwaged: *Keysser s.n.* (BM).

AUSTRALIA. Queensland. Brisbane: *Bailey s.n.* (BRI, G, NY); Johnstone River: *Lamont* 86 (MEL).

POLYNESIA. Indefinite locality. Raiatea: *Sibbald s.n.* (BM) — this could be Raiatea (Society Group).

MARIANAS. Without exact locality: *Gaudichaud-Beaupré s.n.* (BM, G, NY). Guam: *McGregor* 625 (BM, NY), *Bryan* 1193 *p.p.* (BISH). Saipan: *Hosaka* 2941 (L, US), *Hosokawa* 6697 (BISH).

PALAU ISLANDS. Koror: *Hosokawa* 9074 (BISH).

NEW CALEDONIA AND LOYALTY ISLANDS. New Caledonia: *Compton* 801 A (BM); Mt. Koghi: *Franc* 37 (G, L, M, PC), *Le Rat* 187 (M); Mt. Mon: *Le Rat* 616 (H); Boulouparis: *Eteige s.n.* (M); between Boulouparis and Thio: *Clark Williams* 200 (BRI); Nouméa: *Dupuy s.n.* (G). Lifu: *Léglise s.n.* (H). Maré: *Franc s.n.* (FH).

NEW HEBRIDES. Tana: *Gunn & Frater* 252 (H). Futuna: *Gunn s.n.* (BM, GL), *Graeffe s.n.* (BM, NY). Aneityum: *Gunn s.n.* (BM, GL).

FIJI ISLANDS. Without exact locality: *Seemann* 863 (NY). Naviti: *Milne* 337 (NY). Viti Levu. Nandarivatu: *Degener* 14472 (FH, NY, US), 14782 (BM), *Greenwood* 685 (BM), 697 (BM), *A. C. Smith* 5945 (BISH, L, M); Mba: *A. C. Smith* 4673 (BISH, L, US), 5660 (BISH, L, US); Nandronga and Navosa: *A. C. Smith* 6006 (BISH, L, US). Ovalau: *Graeffe s.n.* (BM, GL), *A. C. Smith* 7528 (US); Vanua Levu, Thakaundrove: *A. C. Smith* 1957 (BISH, FH, NY, US). Taveuni: *A. C. Smith* 8151 (K, PNH, US); Vanua Mbalavu: *Jothill* 573 (BM).

SAMOA GROUP. Without exact locality: *Greenaw s.n.* (NY), *Hills* 8 (BM). Savaii: *Reinecke* 6a (G), *Christophersen* 3065 (BISH). Upolu: *Reinecke* 6 (G, US), 15 (G, L, US), *Graeffe s.n.* (BM, NY), *Weber s.n.* (M); Apia: *Woyke* 1007 (FH, M). Tutuila: *Powell* 2 (BM, FH, MEL, NY), 13 (NY), *s.n.* (NY), *Reinecke* 11 (G), *Setchell* 1162 (BISH, FH, NY, US).

SOUTHEASTERN POLYNESIAN ISLANDS. Cook Islands. Rarotonga: *Cheeseman* 358 (H, NY), *Walker* 738 (BM), 746 (BM). Society Group. Without exact locality: *Bidwill s.n.* (K); Raiatea: *Moore* 46g (BISH); Moorea: *Temarii s.n.* (BM); Tahiti: *Lépine s.n.* (type: BM, G, PC), *Wilkes* 174 (G, NY, US), 186 (NY), *Andersson s.n.* (BM, G, L), *Jelinek s.n.* (BM, G), *Nadeaud* 73 (BM, G), 333 (BM), 339 (G, NY), *Picquenot s.n.* (BM, G, M), *Tilden* 27 (BM, BISH, FH, US), 344 (BISH, BM, FH, US), *De Larminat s.n.* (PC), *Quayle* 98 (BISH), *Setchell & Parks* 5135 (BM, FH,

NY, US), *Savatu 1037* (BM), *Bailey s.n.* (K, NY), *Vernier s.n.* (BM), *Poutin s.n.* (BM, L), *Vasco s.n.* (BM). Tuamotu Islands. Mangareva: *Hombroon s.n.* (BM), *St John 14156* (BISH). Tubuai Islands. Tubuai: *St John & Cooke 16323* (BISH); Raivavae: *Fosberg 11708* (BISH), *St John & Cooke 15997* (BISH). Rapa: *Cooke s.n.* (BISH), *Stokes 318* (BISH).

HAWAIIAN ISLANDS. Kauai: *Welch s.n.* (BISH). Maui: *Baldwin 174* (NY).

Ecology: On trees and rocks (calcareous as well as silicious) under humid conditions (in rain-forest, along streams, near waterfalls, in gullies and cave-entrances), often forming mass-vegetations. Growing from sea-level up to 1700(—2150) m.

Variability. *Neckeropsis lepinea* is a rather variable species. Of 222 samples the variability of some macroscopical characters has been investigated, viz. mode of branching, length, width and tip-shape of the secondary stems, occurrence of flagelliform branches, insertion-angle of the leaves and occurrence of sporophytes. From a part of these samples the variability of some other features has also been investigated.

Mode of branching. Most plants have long, drooping, rather flaccid and flexuous *secondary* stems; the branches are remotely placed and considerably different in length. On the Pacific Islands in particular a rather rigid form occurs next to the normal one; the *secondary* stems of these plants are more or less subdendroidly branched. Numerous transitions between the two forms have been found, sometimes one sample contains both. From the material investigated 88 % was normally branched and 12 % had subdendroid stems. The subdendroid form occurs in the Pacific Islands and on Christmas Island (S. of Java). It also differs from the normal form in its stems, being usually somewhat shorter than the average (15 cm as against 20 cm). I cannot see more than a forma in it.

Length of the secondary stems. The length of the stem varies from 10 to 60 cm, but the greater number of the plants (94 %) are 15—30 cm long. Plants with very long and wide stems (“bis über 40 cm lang und beblättert 4 bis 5 mm breit”) have been described by Fleischer as *fa. gigantea*.

Average width of the leafy stem. The width of the leafy stem varies from 2.5 up to 7.5 mm, but usually the width measures 3.6—4.5 mm. In the Society Islands and Samoa a few plants have been collected with very narrow stems (2.5—3) mm, thus looking etiolated. C. Mueller (1874) distinguished these plants as *var. cladogena*.

Tips of stems and branches. Stem- and branch-tips are usually rounded, but sometimes plants with attenuate tips are found. Such a specimen has been pictured by Dozy & Molkenboer (1864). In 15 % of the material investigated these attenuate branches are predominant and a few times the branches have a flagelliform appearance. Nearly all these attenuate plants have been collected in the Pacific, though some have been found in Java and New Guinea.

Average insertion-angle of the leaves. The insertion-angle of the leaves is very variable. Measurements were always taken in the middle of well-developed secondary stems; the variation ranges from 30° to 90°, but usually the insertion-angle amounts to 60°—80°. Very remarkable are some plants from Madagascar, present in L under the names “*Neckera madecassa*” and “*Neckera goudatiana mitis*”, bearing the number 726 (they

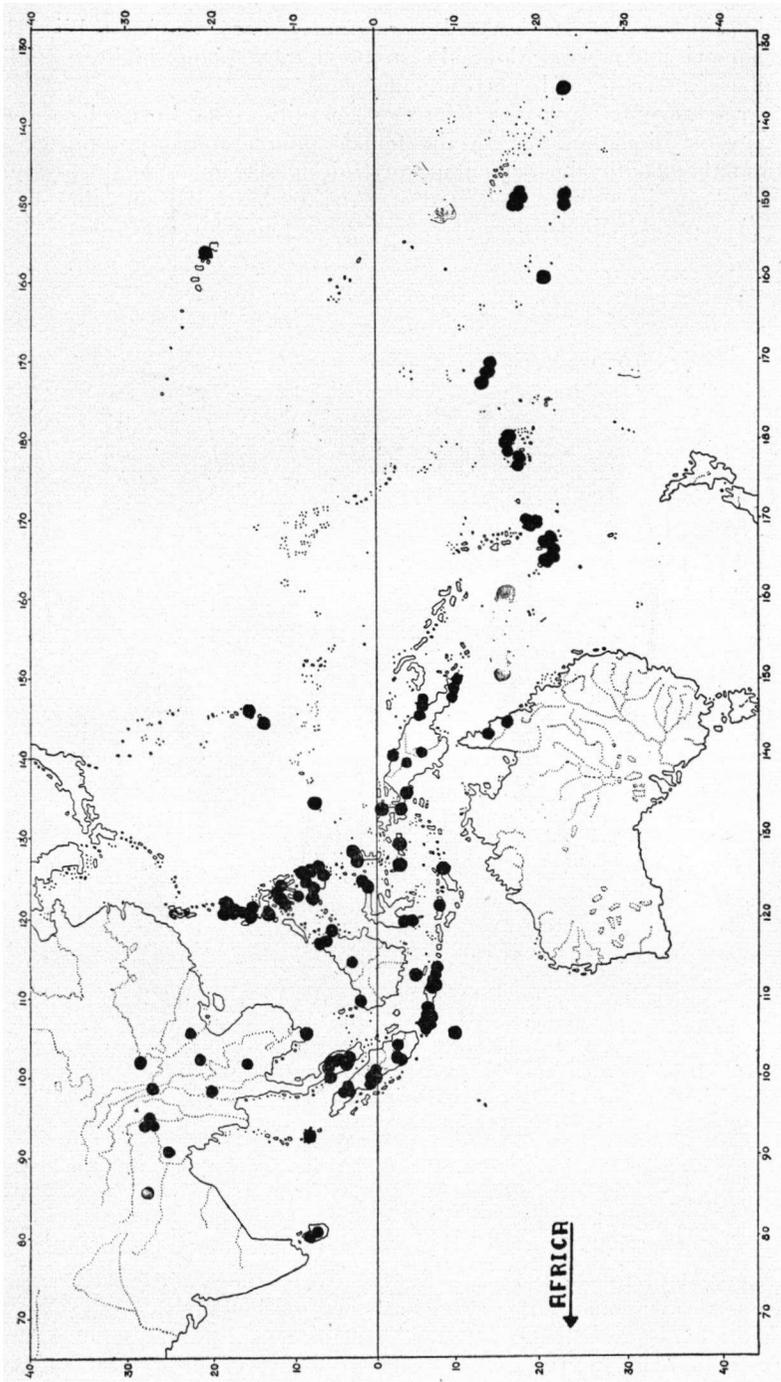


Plate 4. — Distribution of *N. lepincana* (the African part of its area is omitted here).

have nothing in common with *Neckeropsis madecassa* (Besch.) Fl.!). The collectors' name is unknown. Along the stems of these plants highly fastigate leaves regularly alternate with perpendicular ones!

Occurrence of sporophytes. Fruiting specimens have been collected only occasionally: 9% of the female samples bore sporophytes. In Malaysia and the Pacific the percentage of fruiting specimens is almost equal. No fruiting plants have been collected in Africa, Australia and the Asiatic continent. Apparently, the species does not fruit here, but this phenomenon

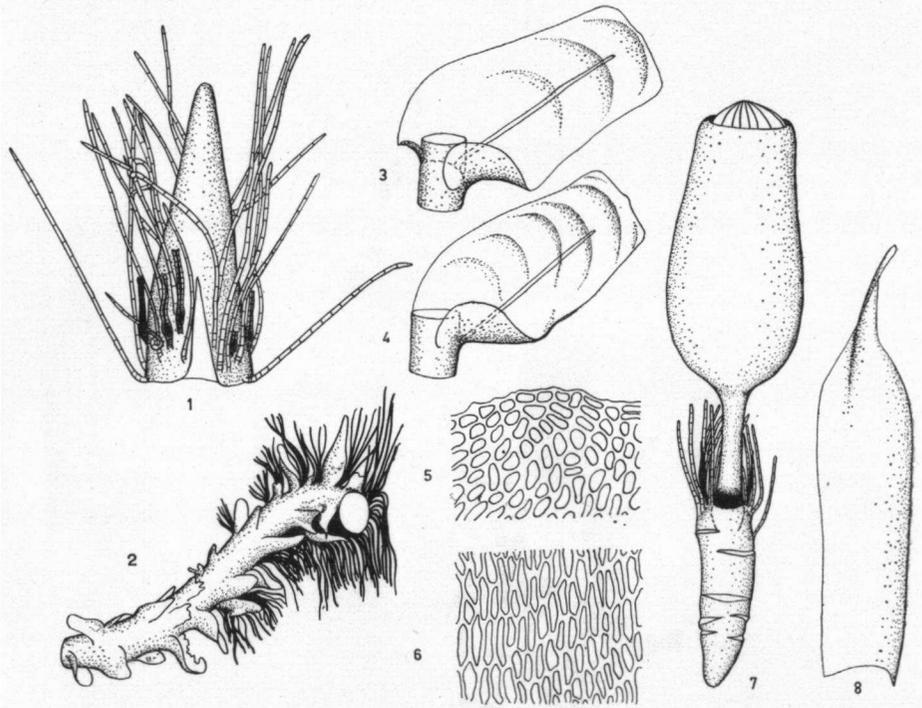


Plate 5. — 1, 2. *N. lepineana* — 1. calyptra ($\times 33.5$, shape and pubescence normal, presence of archegonia only once observed) — 2. primary stem with leaf-scales and tufts of rhizoids ($\times 6$) — 3—6. *N. gracilentia* — 3. dorsal leaf ($\times 23.5$) — 4. lateral leaf ($\times 23.5$) — 5. areolation near apex ($\times 270$) — 6. leaf-cells ($\times 270$) — 7, 8. *N. obtusata* — 7. capsule ($\times 23.5$) — 8. perichaetial leaf ($\times 23.5$).

may well be caused by the low number of collections made in these parts of the area.

Number and length of the nerves. The number of nerves varies from 0 to 3. The length of the nerve is very variable, even on one *secondary* stem. Usually the longest part of the nerve does not exceed $\frac{1}{4}$ leaf-length, but sometimes one of the nerve-branches reaches up to $\frac{2}{3}$.

Seta. Usually the capsule is provided with a short stalk, about 0.5 mm long, but occasionally it is nearly sessile, though Williams 1689 (Luzon) possesses setae of about 0.9 mm and Thwaites' specimen no 174 (Ceylon).

has even setae of 1.5 mm. For the rest, these specimens do not deviate from the normal type and confusion with *N. calcicola* is out of the question, that species having small perichaetia and longer nerves.

Notes. 1. Probably all Japanese specimens belong to *N. calcicola*.

2. The differences between *N. lepineana* and *N. calcicola* are chiefly constituted by characters of the perichaetium and the sporophyte. In habit, the two species are indistinguishable and when sterile, identification becomes difficult. The leaves of *N. calcicola* are usually recognisable by their long nerve, reaching about half-way up the leaf. In *N. lepineana* long-nerved specimens do occur, but these usually have short cells with solid walls or with a few pores only. The leaf-cells of *N. calcicola* are somewhat larger on the average and always distinctly porose.

3. Teijsmann collected a specimen on G. Gedeh (Java), of which the calyptra not only bore paraphysal hairs, but also some decrepit archegonia (Plate 5, fig. 1).

2. *N. calcicola* Noguchi (1956) 124, fig. 1. — *N. lepineana* sensu Noguchi (1950) 17 non Fleischer. — Plate 6 A.

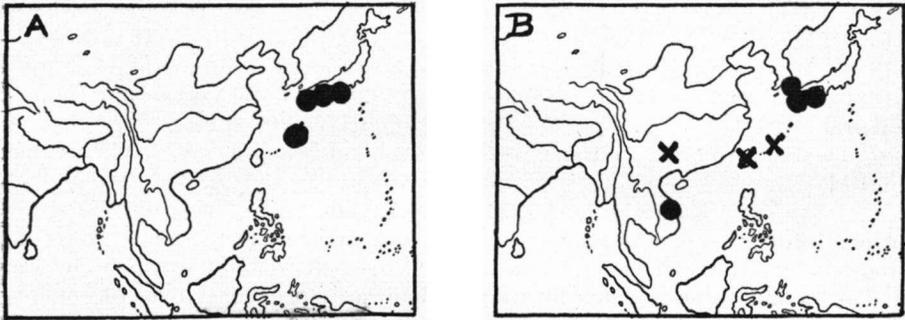


Plate 6. — A. Distribution of *N. calcicola* — B. Distribution of *N. obtusata*; (x): localities cited in literature.

Type: Japan, Honshu, Okayama-pref., Niimi-Shi, Rashomon, leg. Noguchi 36781 (hb. Noguchi, not seen).

Dioicous. Plants habitually indistinguishable from *N. lepineana*. Nerve reaching $\frac{1}{8}$ — $\frac{2}{8}$ up the leaf, sometimes shorter, faint, simple or forked with very unequal branches. Cells pellucid, elongate, (15—)25—45(—50) by 4—7.5 μ , L/W 4—11, walls incrassate, porose, near apex shortly rhomboid or irregularly quadrate to rounded, 12—20 by 6—10 μ , L/W 1—2, near base oblong to linear, 40—90 by 5—8 μ , L/W 5—12.

Young female gametoecea as in the preceding species. *Mature gametoecea* small, situated along the branches. *Outer leaves* small with appressed base and slightly spreading apex. *Inner leaves* about 1.5 mm long, oblong, sheathing, nerveless, entire, apex strongly recurved, lanceolate to shortly subulate acuminate. *Paraphyses* numerous, filiform, about 1.5 mm long, widely exserted, reaching up to about the base of the capsule. *Vaginula* short and straight. *Seta* yellowish brown, 1.8—2 mm long and 0.15 mm across, slightly curved. *Capsule* brown, erect, 1.8—2 by 0.8 mm when deoperculate, ovoid-ellipsoid

to ellipsoid, not constricted below its mouth. *Exostome* and *endostome* as in the preceding species. *Spores* 13—18—20 μ , finely papillose. *Lid* and *calyptra* as in *N. lepineana*.

Distribution: Japan (Honshu, Shikoku, Kyushu), Ryukyu Archipelago (Okinawa).

JAPAN. Honshu. Mie-prov., Osugi-tani: *Ando s.n.* (M); Shiga-pref., Kaminya: *Iwatsuki* (in *NICH* sub no 49029). Shikoku. Prov. Koochi, Tosayama: *Inoue 408* (L, NICH). Kyushu. Kumamoto. Kuma, Konose: *Hattori M. Jap. 18* (GRO, L, M, NICH).

RYUKYU ARCHIPELAGO. Okinawa. Shuri: *Horikawa s.n.* (FH, M).

Ecology: Confined to calcareous rocks.

Notes. 1. Probably all Japanese specimens of *N. lepineana* have to be relabelled *N. calcicola*.

2. The differences between the present species and *N. lepineana* have been pointed out under the latter.

3. *N. obtusata* (Mont.) Brotherus (1925) 187. — *Neckera obtusata* Montagne (1843) 240; Mueller (1851) 58; Montagne (1856) 23; Paris (1898) 854, (1905 A) 303; Brotherus (1909) 844. — *N. tosaensis* Brotherus (1899) 227; Paris (1905 A) 303; Brotherus (1909) 844, (1925) 185; Noguchi (1950) 14; Iwatsuki (1960) 305, 308. — *N. brevicaulis* Brotherus ex Cardot (1911) 276; Toyama (1937) 43; Brotherus (1925) 185. — *Neckeropsis kiusiana* Sakurai (1932) 375, *pro part.* — *Plates 5 (fig. 7—8), 6 B, 7.*

Type: Annam, Tourane, leg. Gaudichaud-Beaupré s.n. (PC? isotypes in BM, L).

Autoicous? Rather robust, light to yellowish green, more or less glossy plants, forming straggling masses of short stems and branches, rigidly projecting from the substrate. *Primary stems* normal. *Secondary stems* up to 5 cm long and 4—5 mm wide and hardly narrowed towards apex or up to 10 cm long and flagelliform, simple or remotely subpinnately branched, branches up to 1.5 cm long. *Leaves* distinctly octostichous to pseudotetrastichous, up to 3 mm long and 1.4 mm wide, L/W 1.8—3, asymmetrically lingulate, rounded or occasionally rounded-truncate at apex, not acuminate, narrowed at base, distal side distinctly decurrent, proximal side narrowly to rather broadly incurved to above mid-leaf, clasping the stem; auricles absent or hardly indicated; lamina usually shallowly undulate, undulations 2—6, transversally or sometimes irregularly arranged; margin minutely crenulate at apex, nearly entire elsewhere; *nerve* simple, thin, rather wide and reaching above mid-leaf, sometimes forked above or double and rather short. *Cells* pellucid, elliptic, 10—30 by 5.5—8(—11) μ , L/W 1.5—2.5(—4), walls rather incrassate, hardly porose or solid, quadrate to rounded and incrassate near apex, elongate to linear, incrassate and porose at base; *marginal border* absent.

Male and female gametoecia on different stems in one sample together. **Male gametoecia** normal. *Perichaetia* tubular, about 4 mm long, reaching a little beyond the stem-leaves; *outer leaves* small, ovate, appressed with spreading apex; *inner leaves* about 3 mm long, erect, lanceolate, sheathing, gradually acuminate, rounded at apex, reaching just beyond the capsule's mouth; margin denticulate-crenulate at apex, entire elsewhere; *nerve* thin and faint, reaching half-way the leaf at most, often wanting; cells elongate

to linear with incrassate, highly porose walls. *Paraphyses* numerous, filiform, hyaline, reaching up to the base of the capsule. *Vaginula* short and straight. *Seta* brownish, straight, about 0.5 mm long. *Capsule* brown, erect, about 1.8 mm long and 1 mm wide, ovoid, not constricted below its mouth. *Exostome* yellow, teeth lanceolate-subulate, smooth or slightly papillose, narrowly trabeculate, median line distinct, perforated. *Endostome* yellow, basal membrane low, processes linear, smooth or slightly papillose, median perforations linear. *Spores* brown, 15–25 μ , papillose. *Lid* shortly conical, obliquely rostrate. *Calyptra* cucullate, densely covered with paraphysal hairs.

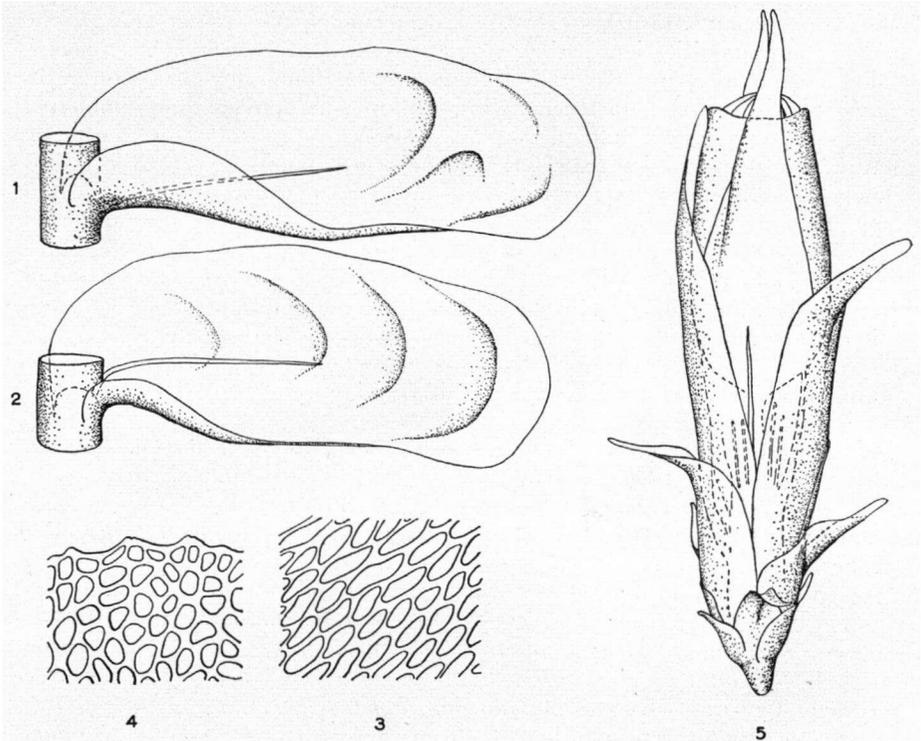


Plate 7. — *N. obtusata* — 1. lateral leaf ($\times 23.5$) — 2. dorsal leaf ($\times 23.5$) — 3. leaf-cells ($\times 270$) — 4. areolation near apex ($\times 270$) — 5. perichaetium ($\times 23.5$).

Distribution: Annam, SW-China?, Formosa, Ryukyu Archipelago, Japan.

ANNAM. Tourane: *Gaudichaud-Beaupré s.n.* (type; BM, L).

JAPAN. Kyushu. Miyazaki-prov. Minaminaka, Kitagō: *Noguchi & Hattori M. Jap.* 29 (L). Kumamoto-prov., Mt. O'hira: *Mayebar M. Jap.* 127 (L). Tsushima. Mt. Ariake: *Osada M. Jap.* 720 (L).

Ecology: Usually growing on tree trunks and -branches, occasionally on rocks. According to Iwatsuki (1960) faithful species of the *Neckeretum tosaensis* Iwats., growing "on the lower to middle portions of trees, rarely

on the bases and in the crowns, in the mountainous areas of southern Honshû, Shikoku and Kyûshû”.

Notes. 1. In my opinion *Neckera tosaensis* belongs to *Neckeropsis* and has to be united with *N. obtusata*. Although I had no opportunity to study the type-specimen of *N. tosaensis*, nor those of *Neckera brevicaulis* and *Neckeropsis kiusiana* (according to Noguchi 1950 these two species are identical with *N. tosaensis*), I could get a good impression of *N. tosaensis* studying exsiccata of that species, identified by Noguchi.

2. Up to now *N. tosaensis* was allocated to *Neckera* on account of its sometimes clearly octostichous phyllotaxis, but as has been explained on p. 377, the pseudotetrastichous leaf arrangement of *Neckeropsis* has to be considered as a modification of the octostichous one. Moreover, in *N. tosaensis* pseudotetrastichous stems may rather frequently be found together with octostichous ones. Large gametoezia with filiform paraphyses and immersed capsules are represented in both *Neckera* and *Neckeropsis*, so the vegetative structure has to turn the scale. Regarding these points, *Neckera tosaensis* is closely related to *Neckeropsis lepineana* and *N. calcicola*, whereas it would occupy an isolated position inside *Neckera*, and this is why I transferred the species to *Neckeropsis*.

3. *Secondary* stems with male gametoezia were always found together with stems bearing female gametoezia, but I never found them on one stem together, nor did I find connections between male and female stems. Perhaps this species is rhizautoicous or cladautoicous with male and female stems sprouting from one primary stem, but this could not be proved.

4. *N. gracilentata* (Bosch et Lac.) Fleischer (1908) 176; Giesenhagen (1910) 786; Dixon (1916) 313; Williams (1917) 358; Möller (1919) 321; Brotherus (1925) 187; Dixon (1926) 23, (1932 A) 36, (1932 B) 29, (1935) 101; Bartram (1939) 239, (1945 A) 50; Froehlich (1953) 95; Bartram (1957 A) 47. — *Neckera gracilentata* Van den Bosch et Van der Sande Lacoste in Dozy et Molkenboer (1864) 62; Mitten (1869) 168; Paris (1898) 849; Brotherus (1900 A) 49, (1900 B) 91; Paris (1905 A) 293; Brotherus (1909) 840. — *Neckeropsis penicillata* Herzog (1916) 242; Brotherus (1925) 187; Dixon (1926) 24. — Plates 5 (fig. 3—6), 8.

Lectotype: Celebes, Tondano, leg. Forsten 44 (L).

Dioicous. Lightgreen or yellowish green, glossy, graceful plants. *Primary stems* normal. *Secondary stems* complanately foliate, slender, pendent or occasionally procumbent, up to 30 cm long and 3 mm wide, flexuous, remotely and simply branched, side-branches at right angles to the stem, usually about 1.5 cm long, rarely longer and branched again, tips acuminate, but sometimes hardly narrowed and rounded, often flagelliform and up to 3 cm long, often bearing tufts of about 0.5(—1.5) cm long microphyllous, easily detachable branchlets. *Leaves* pseudotetrastichous, at nearly right angles to the stem, asymmetrically lingulate, up to 1.8 by 0.8 mm, L/W 1.7—2.3(—2.8), apex truncate, occasionally rounded, often very faintly and bluntly apiculate, base hardly widened, proximal part shortly auricled, shortly and widely incurved at base, clasping the stem, distal part hardly or not at all auricled, often somewhat decurrent; margin minutely crenulate at apex or entire, entire or nearly so elsewhere, sometimes faintly crenulate at base; lamina 2—5-undulate,

undulations lunate, very regularly transversally arranged, *nerve* simple, narrow to rather wide, reaching up to or slightly exceeding $\frac{4}{5}$ leaf-length. *Cells* pellucid, angular or rounded elliptic, 11–30 by 3.5–7.5 μ , L/W 1.8–5.7, walls incrassate, solid, cells near apex shorter, rounded, irregularly quadrate or shortly rhomboid, elongate near base, walls incrassate and porose. *Leaves of the gemmiform branchlets* spreading, ovate-lingulate near the base of the branchlets, shortened towards the tips, the smallest ones being about 0.1 mm long, ovate, appressed and nerveless.

Male plants rare. *Male and female gametoecia* situated along the branches or occasionally along the secondary stems. *Male gametoecia* normal. Young *female gametoecia* ovoid, about 1 mm long; *outer leaves* shortly lingulate, appressed, nerveless; following ones up to 1 mm long, ovate-lanceolate,

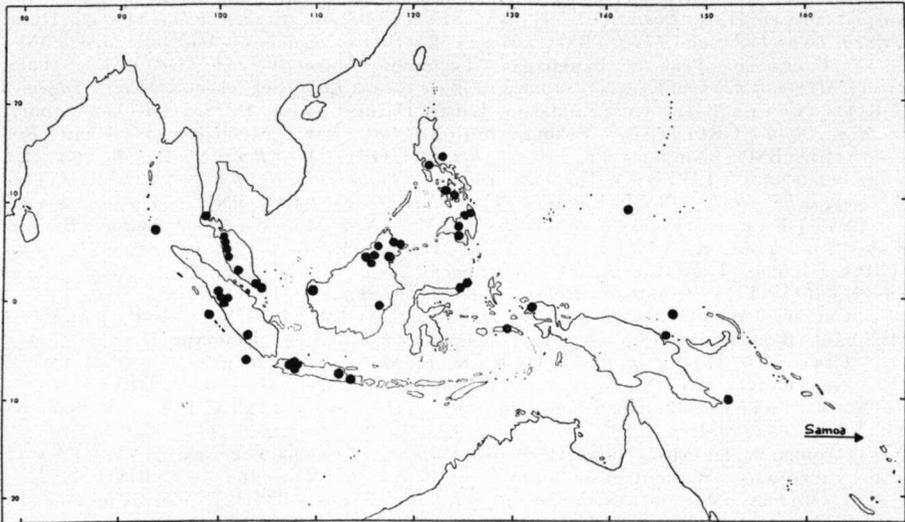


Plate 8. — Distribution of *N. gracilentata*.

nerveless, very concave, apex blunt, somewhat spreading, cells narrowly elliptic, highly incrassate, distinctly shortened towards apex; *inner leaves* decreasing in size towards the centre of the perigamium, ovate-lanceolate, apex acute, nerve faintly indicated; paraphyses numerous, filiform, hyaline, of very unequal size, up to 0.5 mm long, immersed; archegonia normal. *Mature sporophytes* unknown. Inner leaves of *immature perichaetia* large, erect, sheathing. *Capsule* nearly sessile? *Calyptra* covered with paraphysal hairs.

Distribution: Nicobar Islands, Siam (S. of the Isthmus of Kra), Malaysia, Admiralty Islands, Carolines, Samoa.

NICOBAR ISLANDS. Nicobar Minor: *Didrichsen s.n.* (H).

SIAM. Lam Lieng, Ranaung: *Kerr 196d* (BM).

MALAY PENINSULA. Without exact locality: *Allen 959* (GRO). Mts. of Sakai: *Werner s.n.* (type of *N. penicillata*; FH). Kedah. Inchong Estate: *Spare 3024* (BM). Perak. Holyrood Estate: *Spare 3224* (BM). Dindings. Bruas: *Ridley 500* (BM, NY, SING); Gunong Tungul: *Ridley 502* (BM, NY, SING). Selangor. Gua Batu: *Ridley 479* (BM, NY, SING). Singapore. Chua Chua Kang: *Ridley 357* (BM, SING).

RIOUW ARCHIPELAGO. Sungaidompak: *Prawiro 6* (GRO).

SUMATRA. Without exact locality: *Korthals s.n.* (L). West Coast: *Wiltens s.n.* (L); Indarung: *Van Borssum Waalkes 2743* (mixed with *N. lepinea*; GRO, L); Panti: *Jacobson 97h* (BM); Gadut: *Jacobson s.n.* (GRO); Sikungkang: *Van der Wijk 1209* (GRO). East Coast: Deli, Gunung Rinte: *Giesenhagen 91* (M). Bencoolen. Between Keban Agung and Kepahiang: *Giesenhagen 41* (M); between Kepahiang and Tapa Penandjung: *Giesenhagen 48* (H, M), 51 (H, M). Mentawai Islands. Siberut, Siberut: *Van Borssum Waalkes 2709* (GRO, L). P. Enggano. Meok: *Lütjeharms 3636b* (L); Bua Bua: *Lütjeharms 4335* (L); Ekinoia: *Lütjeharms 4962b* (L).

JAVA. Without exact locality: *Zollinger 439* (G, L, NY), 444 (L). West Java. Tjampea: *Fleischer MAI 370* (BM, L, M, NY, PC); Depok: *Holle s.n.* (L); G. Burung: *Schiffner 12656* (L); G. Pantjar: *Schiffner 12657* (L, US); Kota Batu near Bogor: *Schiffner Kr. Exs. Vind. 3979* (L); G. Gedeh: *Teijsmann s.n.* (L); Lembang: *Korthals 89* (L). East Java. Sripit: *Clason s.n.* (GRO); Sumberwuluh: *Fleischer MAIP 589* (immature sporophytes! G, L, M).

BORNEO. Without exact locality: *Korthals s.n.* (L). Sarawak: *Everett s.n.* (BM, NY); Penrissen Hills: *Everett 21* (H, NY, SING); Baram: *Everett 684* (SING); Dulit: *Oxford Exp. 1932 no. 1119* (BM). West Borneo. Sambas. *Micholitz 324* (BM). East Borneo. Peak of Balikpapan, Tegumbit: *Meyer B 1251* (GRO, L); Tulus River: *Meyer B 1281n* (L). North-east Borneo. Long Sek (Longsegah?): *Idjam 3* (GRO). North Borneo. Sandakan, Lahad Datu: *Cuadra A 238e* (GRO); Elopura: *Cuadra 2304d* (GRO, SAN); Sekong: *Binstead 100* (BM); Melalap near Jenom: *Binstead 183* (BM). Nunukan: *Meyer B 4580* (GRO, L), *B 4581* (L), *B 5208* (L).

PHILIPPINES. Luzon. Tayabas, Infante: *Leiberg 1240 p.p.* (NY). Polillo: *McGregor BS 10510* (NY); Lukutan: *Fox PNH 8886* (GRO, PNH). Cebu: *Everett s.n.* (NY). Panay. Iloilo: *Robinson BS 18240* (NY). Mindanao. Agusan, Butuan: *Weyer 1322* (BM, K, NY, US); Mt. Hilong-Hilong: *Mendoza & Convocar PNH 10972* (GRO); Lanao, Lake Lanao: *M. S. Clemens „N”* (H, M, NY, PC); Abaga: *Lynn Zwickey 445* (FH); Cotabato: *Robinson BS 11662 p.p.* (BM, K, NY).

CELEBES. Without exact locality: *De Vriese s.n.* (K, L). North Peninsula. Minahasa, Bojong: *Warburg s.n.* (H); Tondano: *Forsten 44* (lectotype; L).

CERAM: *De Vriese s.n.* (BM, G, H, K, L, M).

NEW GUINEA. W. New Guinea. Sorong, Malano: *Main 541* (GRO). Terr. of New Guinea. Beliau Island: *Biro 132* (H). Woodlark Island. Kulamadau: *Brass 28825* (L).

ADMIRALTY ISLANDS. Nares Harbour: *Moseley s.n.* (Challenger-exp.; NY).

MICRONESIA. Without exact locality: *E. Bailey 16* (NY), *16a* (NY, BISH).

CAROLINES. Without exact locality: *E. Bailey s.n.* (BISH, NY). Kusaie Island: *Takamatsu 557b* (BISH).

SAMOA GROUP. Tutuila: *Powell 95* (BM, NY).

Ecology: *N. gracilentia* is a lowland species, rarely found above 500 m, growing on tree-trunks and branches as well as on calcareous rocks in habitats with a high aerial humidity, but never submerged, in rain-forest, along woodland-streams, near waterfalls, etc.

Notes. 1. Van den Bosch and Van der Sande Lacoste cited a number of specimens, but they did not select a type specimen. They thoroughly studied Forsten's sample, as appears from their remarks upon his sheet. Apparently, a piece of this fairly developed specimen has been pictured in 'Bryologia Javanica', and this is why that sample has been chosen as a lectotype.

2. Often (though not exclusively) epiphytic and epilithic plants show certain differences. The epiphytic form has to be considered as the typical one. The epilithic specimens are usually somewhat smaller, denser and less regularly branched, the branches being more often rounded. Occasionally, tufts of rhizoids develop along the procumbent secondary stems, giving them the appearance of primary stems, which is intensified by the unilateral branches, looking like short secondary stems. In BM two such plants are

labelled *Neckeropsis perintegra* Dix. (*nom. nud.*). Both of these specimens consist of radiculos secondary stems (easily distinguishable from primary stems by shape and size of the leaves) with up to 5 cm long and unbranched or sparingly branched main branches with usually rounded tips. According to Dixon's notes upon the sheets these specimens cannot belong to *N. gracilentia*, since ramifications are absent and the leaves are distinctly widened towards their base. However, the leaves are not more widened than in *N. gracilentia* and even flagelliform branchlets are present. Leaf-structure and areolation are very well in accordance with *N. gracilentia* and in my opinion there are no reasons to separate *N. perintegra*.

3. The number of flagelliform and gemmiform branchlets varies considerably. Many transitions occur between specimens without and with numerous tufts of gemmiform branchlets. The type specimen of *N. penicillata* belongs to the latter category, but for the rest it agrees well with *N. gracilentia*, and accordingly that 'species' is not accepted here.

4. Usually, the present species is easily recognisable by its slender, graceful secondary stems, bearing short, acute and often flagelliform branchlets. *N. gracilentia* could be confused with *N. exserta* only, but this species is monoicous, has shorter stems and longer, more deeply undulate leaves. At the basal part of the stem these leaves are more or less distinctly octostichous and usually strongly widened towards their base. Usually, the leaf-cells are somewhat more elongate, but in both species the areolation is quite variable.

5. According to a statement on the label of the type specimen this moss is applied as an external medicine; for what purpose is unknown to me.

5. *N. exserta* (Hook. in Schwaegr.) Broth. — *Plates 9, 10.*

For synonyms, literature and type specimen see below.

Cladautoicous. Yellowish green, very glossy plants. *Primary stems* normal. *Secondary stems* up to 10(—15) cm long and 4 mm wide, complanately foliate, graceful and flexuous or rigid, remotely branched to pinnate, branches usually not exceeding 1.5 cm, exceptionally branched again, tips hardly narrowed and rounded or attenuate and flagelliform. *Leaves* pseudotetrastichous, octostichous at stem-base, at nearly right angles to the stem, 1.6—2.3 by 0.6—1.1 mm, L/W 2—3, asymmetrically lingulate, apex truncate or rounded, usually very faintly and bluntly acuminate, base widened, more distinctly so near the base of the stem, auricled, proximal leaf-margin shortly and rather widely incurved at base, clasping the stem; margin crenulate at apex, occasionally nearly entire, nearly entire elsewhere, teeth often bicuspidate; lamina 3—5-undulate, undulations deep, lunate, transversally arranged, margin usually rugose at auricles; *nerve* simple, faint, narrow to rather wide, reaching up to or slightly exceeding $\frac{4}{5}$ leaf-length, occasionally forked above. *Cells* pellucid, rhomboid, 7.5—22 by 3.5—7.5 μ , L/W (1.5—)2—4.5(—6.5), walls rather incrassate, solid; cells near apex smaller, irregularly quadrate or rounded, incrassate, near base elongate, rather incrassate, cells of the incurved margin somewhat more elongate, forming an ill-defined border.

Male gametoezia normal. *Perichaetia* small, capsule, seta and paraphyses exerted. *Outer leaves* small, concave, ovate-lingulate, apex acuminate, slightly spreading. *Inner leaves* much more elongate, up to 1.2 mm long, base wide, sheathing, apex narrowly lanceolate-lingulate acuminate, faintly

canaliculate, spreading or recurved; nerve very faint, usually short, sometimes reaching above the middle of the leaf, sometimes wanting; margin coarsely crenulate-serrulate at apex, entire elsewhere; cells of the basal half of the leaf elongate-linear, 27—59 by about 8 μ , L/W 3.5—7, walls moderately incrassate. *Paraphyses* numerous, filiform, hyaline. *Vaginula* brown, erect, about 0.5 mm high. *Seta* yellow to light brown, erect or slightly arcuate, 0.7—2.5 mm long. *Capsule* brown, shortly cylindrical, 1.4—1.8 by 0.6 mm, not constricted below its mouth when deoperculate. *Exostome* yellowish green, teeth lanceolate-subulate, finely papillose, coarsely trabeculate; median line narrow with linear perforations in the apical part. *Endostome* yellowish green,

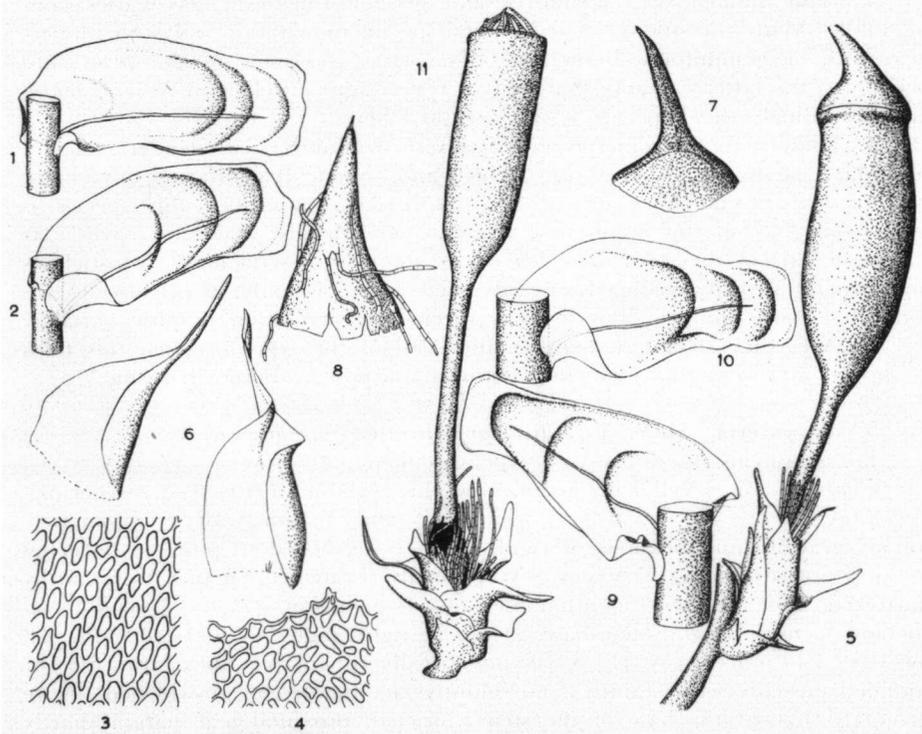


Plate 9. — *N. exserta* — 1—8. *var. exserta* — 9—11. *var. scrobiculata* — 1, 9. dorsal leaves ($\times 23.5$) — 2, 10. lateral leaves ($\times 23.5$) — 3. leaf-cells ($\times 270$) — 4. areolation near apex ($\times 270$) — 5, 11. perichaetium ($\times 23.5$) — 6. perichaetial leaves ($\times 33.5$) — 7. operculum ($\times 23.5$) — 8. calyptra ($\times 23.5$).

processes linear, knotted, finely papillose, provided with median perforations, basal membrane about 75 μ high. *Spores* 14—22 μ , green, walls yellowish, finely papillose. *Lid* brown, up to 1 mm long, conical, obliquely and slightly arcuately rostrate. *Calyptra* yellow, about 1.2 mm long, mitriform or occasionally cucullate, covered with appressed and sinuous paraphysal hairs.

A. *Var. exserta*. — *Neckeropsis exserta* (Hook. in Schwaegr.) Brotherus (1925) 188. — *Neckera exserta* Hooker in Schwaegrichen (1828) 244; C. Mueller (1851) 53; Mitten (1859) 120; Paris (1898) 848, (1905 A) 292;

Brotherus (1909) 841. — *Himanthocladium exsertum* (Hook. in Schwaegr.) Fleischer (1908) 887; Dixon (1926) 24, (1932 B) 29. — ? *Neckera elegantula* Griffith (1847) 464, (1849) t. 87, f. 5.

Type: Nepal, leg. *Wallich s.n.* (K, istotype in L).

Secondary stems up to 11 cm long and 4 mm wide, usually rather closely pinnate, occasionally remotely branched; stem- and branchtips hardly narrowed, never flagelliform or radiculous. *Leaves* usually distinctly complanate and pseudotetrastichous, octostichous exclusively near the base of the stems, 0.6–0.8 mm wide, L/W 2.3–3.1, deeply and regularly transversally undulate. *Seta* 0.7–1.5 mm long.

Distribution: India (S-India, Sikkim, Assam), Nepal, Siam.

INDIA. South India. Palni Hills, Kodaikanal: *Foreau 103* (M). Sikkim. Pembarrie: *Hooker, Hb. Ind. Or. Hook.f. & Thoms. 945* (K). Assam. Garo Hills: *Marten 5641* (M); Jyrong: *Griffith 423* (NY); Sadiya: *Griffith 424* (NY); Chy Kwa (?): *Griffith 425* (NY); Luhit: *Griffith 581* (NY).

NEPAL. *Wallich s.n.* (type; K, L).

SIAM. Doi Chiang Dao: *C. Smith „B”* (mixed with *N. crinita*; BM, SING).

Ecology: Badly known; from sea-level up to 2350 m at least. The Siamese specimen was growing on a branch, along a stream.

Notes. 1. Hooker has not clearly indicated the type specimen. In Schwaegrichen (1828) he wrote: “Collected in Nepal”. The collector is not mentioned, but this must have been Wallich, the only botanist as far as I know who collected plants in Nepal during the years 1820 and 1821. Hooker himself also collected in the same region, but this did not happen before 1848, twenty years after the publication in Schwaegrichen; besides, he only collected *N. exserta* in Sikkim.

2. According to Fleischer the present species belongs to *Himanthocladium* on account of its phyllotaxis and the structure of the female gametoeidia. *N. exserta* deviates a little from the usual *Neckeropsis*-type, but there is no reason to exclude it. Aberrant is the leaf-arrangement, often being distinctly octostichous and only faintly complanate near the base of the secondary stems. Higher up the stems and along the branches the leaves are distinctly complanate-pseudotetrastichous. Pointing to *Neckeropsis* are furthermore the ramification, the regularly transversally undulate leaves, being relatively shorter than in *Himanthocladium*, distinctly auricled at base and only minutely crenulate at apex, and the leaf-cells, being more regularly arranged than in *Himanthocladium*. Pointing to *Himanthocladium*, however, is the structure of the perichaetium and the sporophyte. *Neckeropsis*-capsules are immersed as a rule, but exserted capsules do occur in some species, undoubtedly belonging to the genus (e.g. *N. calcicola*).

3. In his ‘Notulae’ Griffith noted below *N. elegantula* “It. Ass. 294”. When his collection was revised, that number could not be detected. Griffith numbered his specimens on his collecting-sheets, using numbers below 100. Afterwards these numbers have been altered, for another number has been added in another handwriting (probably Mitten’s). Presumably, errors have been made when this was done (see also under *N. crinita!*), so that the type specimen of *N. elegantula* cannot be recognised any more. From the eight specimens of *N. elegantula* available four belong to *N. exserta*, whilst the others represent a species of *Himanthocladium*. If one of these eight

plants represents the type of *N. elegantula*, this has to be a specimen of *N. exserta*, because Griffith pictured capsules, occurring in *N. exserta* only. Moreover, the shape of the leaf in Griffith's figure resembles *N. exserta* rather more than *Himanthocladium*.

4. The specific differences between *N. exserta* and *N. gracilentia* have been pointed out there.

B. Var. *scrobiculata* (Nees) Touw, comb. nov. — *Neckera scrobiculata* Nees ab Esenbeck (1843) 478; C. Mueller (1851) 53; Paris (1898) 858, (1905 A)

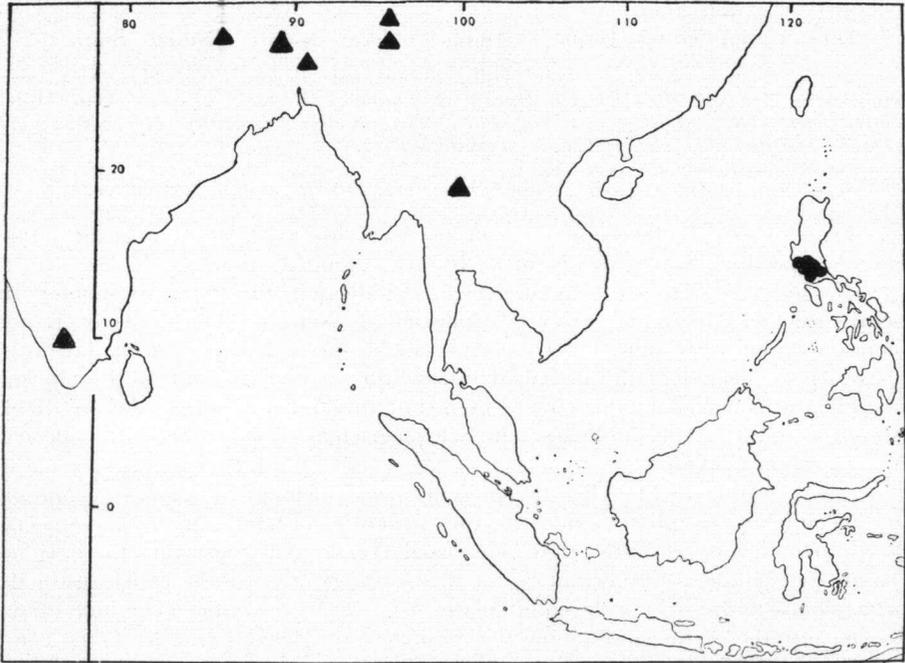


Plate 10. — Distribution of *N. exserta* — (▲). *var. exserta* — (●). *var. scrobiculata*.

302; Brotherus (1909) 841. — *Neckeropsis scrobiculata* (Nees) Brotherus (1925) 188. — *Himanthocladium scrobiculatum* (Nees) Bartram (1939) 243.

Type: Luzon, Hali-Hali, leg. *Meyen s.n.* (BM).

Secondary stems up to 6(—15) cm long and 3.5 mm wide, with only few, rather long branches, occasionally subpinnate; stem- and branchtips often attenuate to flagelliform, often radiculous. *Leaves* usually only slightly complanate, pseudotetrastichous to octostichous, 0.7—1.1 mm wide, L/W 2—2.7, very deeply and rather irregularly transversally undulate, the deep undulations give the leaf a somewhat crisped appearance. *Seta* 1.2—2.5 mm long.

Distribution: Luzon.

Luzon. Without exact locality: *Semper s.n.* (M); Subig: *Micholitz s.n.* (H). Bataan. Lamac: *Edaño PNH 9258* (GRO); *Williams 849* (FH, NY, US). Rizal. Mariquit (Mariquina?): *Semper s.n.* (BM, K, L); Manila, Hali-Hali: *Meyen s.n.* (type; BM); *Reillo BS 19317* (L).

Ecology: On rocks at low altitudes. Only few data extant.

Note. Though the varieties of *N. exserta* are quite easily distinguishable as a rule, a few transitional plants have been found.

6. *N. fimbriata* (Harv.) Fleischer (1908) 878; Brotherus (1925) 187. — *Neckera fimbriata* Harvey (1840) 13; Hooker (1841) t. 21 fig. 4; C. Mueller (1851) 47; Mitten (1859) 122; Paris (1898) 849, (1905 A) 293; Brotherus (1909) 840. — *N. parishiana* Mitten (1859) 121; Paris (1898) 855, (1905 A) 299; Brotherus (1909) 840. — *N. nigrescens* Brotherus (1901) 121, (1909) 840. — *Neckeropsis parishiana* (Mitt.) Fleischer (1908) 878; Brotherus (1925) 187. — *N. nigrescens* (Broth.) Brotherus (1925) 187; Dixon (1932 B) 29. — *N. auriculata* Dixon (1932 B) 29; Giesy et Richards (1959) 580. — *Plates 11, 12.*

Type: Nepal, leg. Wallich s.n. (K).

Dioicous. Rather robust, glossy plants, yellowish green, but usually tinged with purple or occasionally blackish. *Primary stems* normal. *Secondary stems* pendent or procumbent, sometimes radiculous, coiled up a little when dry, up to 15 cm long, usually shorter and up to 4(–5) mm wide, irregularly and remotely branched; branches up to 2.5 mm long, strongly curved when dry, tips hardly attenuate. *Leaves* pseudotetrastichous, slightly complanate, highly asymmetrically ovate to lingulate, 1.5–2.7 by 0.6–1.1 mm, L/W 1.5–3.4, apex rounded-truncate, distinctly acuminate, base often much widened, auricles large, the proximal one clasping the stem; lamina 3–7-undulate, undulations shallow to deep, transversally to obliquely arranged; margin rugose at auricles, crenulate to serrulate at apex and auricles, solid or minutely crenulate elsewhere; *nerve* simple, robust, reaching up to about $\frac{7}{8}$ leaf-length, but never reaching the apex. *Cells* pellucid, arranged in rows, rounded 4(–5)-angular, elliptic to elongate, 9–33 by 3.5–8(–10) μ , L/W 1.5–4(–7), walls incrassate, often porose; cells near apex shorter, rounded quadrate to rhomboid, walls incrassate, solid; cells near base elongate to linear, longitudinal walls highly incrassate, porose; cells at auricles elongate, shorter than elsewhere at base, incrassate, at base of auricles short, irregularly 4–5-angular; *proximal border* usually distinct, reaching far above the middle of the leaf, consisting of distinctly elongated cells.

Male gametoecia normal. *Perichaetia* up to 4(–5) mm long; *outer leaves* small, ovate, appressed; basal part of the next ones concave, appressed, apical part spreading, elongate-lingulate. *Inner leaves* and *paraphyses* intergrading, lanceolate to ligulate, erect, canaliculate, up to 3.5(–4) mm long, reaching far beyond the capsule; margin serrulate at apex, solid or minutely serrulate elsewhere; *nerve* faint, reaching far into the apical part of the leaf; cells elongate to linear, 25–60 by 3.5–6 μ , incrassate, often porose, shortened towards apex, irregularly quadrate to rhomboid, thin-walled. *Vaginula* straight, about 0.2 mm long. *Seta* brown, straight, about 0.3 mm long, almost entirely hidden by the vaginula. *Capsule* brown, erect, 1.8 by 1 mm, at first ovoid and distinctly constricted below its mouth, becoming campanulate and not at all constricted after dehiscence. *Exostome* bright ochraceous to orange, teeth lanceolate-subulate, densely and coarsely papillose, median perforations large. *Endostome* orange, processes linear, densely and coarsely papillose, not perforated, with short appendages in places, basal membrane about 45 μ high. *Spores* brownish-greenish, 25–45 μ , walls incrassate, papillose. *Lid* brown,

about 0.7 mm high, shortly conical, obliquely rostrate. *Calyptra* shortly split on one side, glabrous.

Distribution: Nepal, Sikkim, Burma, Siam, Malay Peninsula.

NEPAL: *Wallich s.n.* (type; K).

SIKKIM: Punkabari, Kurseong: *Decoly & Schaul 2392* (M).

BURMA. Without exact locality: *Dunn s.n.* (NY); Pegu. Toukyeghat: *Kurz 2824* (NY), *2931* (NY). Irrawaddy: *Kurz 3307* (NY). Karenni (Karen Hills): *Kurz 3343* (L). Moulmein: *Parish 12* (type of *N. parishiana*; NY), *92* (NY).

SIAM. Chanthaburi. Khao Sabap: *Kerr 451a* (type of *N. auriculata*; BM), *454* (BM). Ko Chang. Klong Majum: *Schmidt 23* (type of *N. nigrescens*; H, L, M).

MALAY PENINSULA. Langkawi Islands. Pulau Dayang Bunting: *Holtum 15131* (BM, SING).

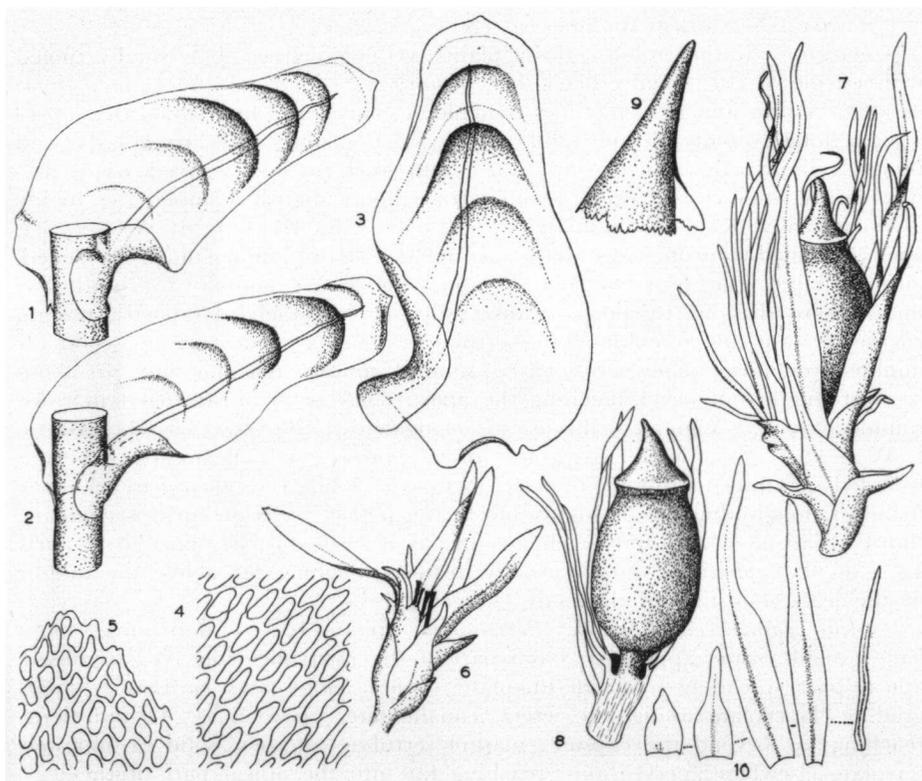


Plate 11. — *N. fimbriata* — 1. lateral leaf ($\times 23.5$) — 2. dorsal leaf ($\times 23.5$) — 1—2. leaves of the long type — 3. lateral leaf of an intermediate specimen, *N. auriculata* ($\times 23.5$) — 4. leaf-cells, long-leaved type ($\times 270$) — 5. areolation near apex ($\times 270$) — 6. young female gametocium ($\times 23.5$) — 7. mature female gametocium ($\times 12$) — 8. *ibid.*, perichaetial leaves and paraphyses removed on one side ($\times 12$) — 9. calyptra ($\times 23.5$) — 10. perichaetial leaves and paraphyses ($\times 23.5$).

Ecology: Badly known. *N. fimbriata* has been collected in the rain-forest, growing on trees and rocks.

Notes. 1. The leaves are extremely variable, in different specimens

as well as on different parts of the same specimen. The type form (which is not the commonest one) has the leaves asymmetrically ovate-lingulate, moderately complanate and rather irregularly undulate. Near apex only 0—2 distinctly transversal undulations are present. The leaf-cells are shortly elliptical, rhomboid or quadrangular, the proximal border is easily recognisable by its elongate-elliptical cells. Often a faint distal border may be recognised. More common are complanate plants with long and often obliquely prolonged leaf-apices (*plate 11, fig 1, 2*). Such apices bear a relatively great number of transverse undulations and the leaf-cells are more elongate than in the short-leaved type, but this does not hold for the proximal border and owing to this the border becomes less distinct. Transitional forms between these extreme leaf-types are common. The type specimen belongs to the short-leaved type, the type specimens of *N. parishiana* and *N. nigrescens* are long-leaved and *N. auriculata* is intermediate.

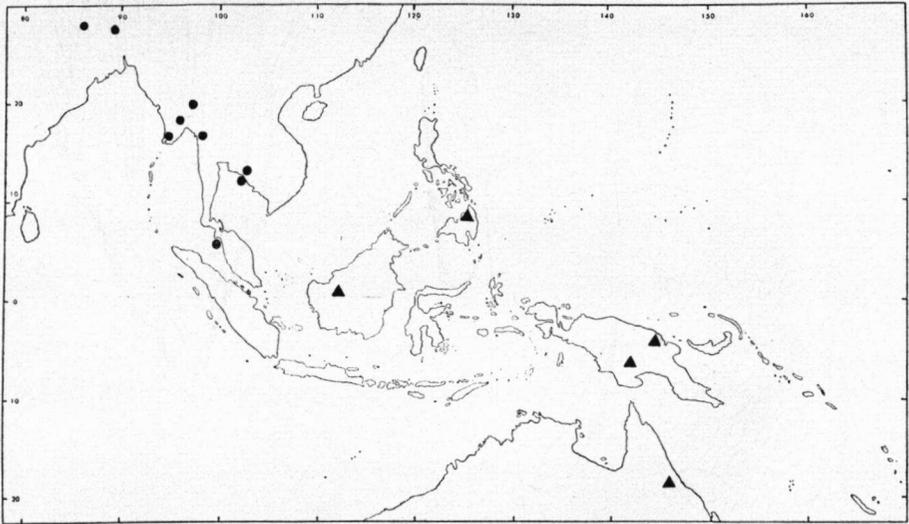


Plate 12. — Distribution of *N. fimbriata* (●) and *N. nano-disticha* (▲).

2. The plants are often tinged with purple or entirely purplish or blackish. Usually, such a discolouration has an ecological significance, but it is difficult to say whether this is the case here, since ecological data are almost lacking.

7. *N. crinita* (Griff.) Fleischer (1908) 878; Brotherus (1925) 187. — *Neckera crinita* Griffith (1847) 464, (1849) t. 84; Mitten (1859) 120, *pro part.* (see note 1); Paris (1898) 846, (1905 A) 290; Brotherus (1909) 840. — ? *Neckeropsis pilosa* Fleischer (1908) 878; Brotherus (1925) 187. — *Plates 13, 14, 15.*

Type: Assam, Nowgong, leg. Griffith 588 (NY).

Cladautoicous. Yellowish to brownish green, slightly glossy plants. *Primary stems* normal. *Secondary stems* rather rigid, straight or somewhat flexuous, up to 9 cm long and 3—4 mm wide, irregularly remotely branched

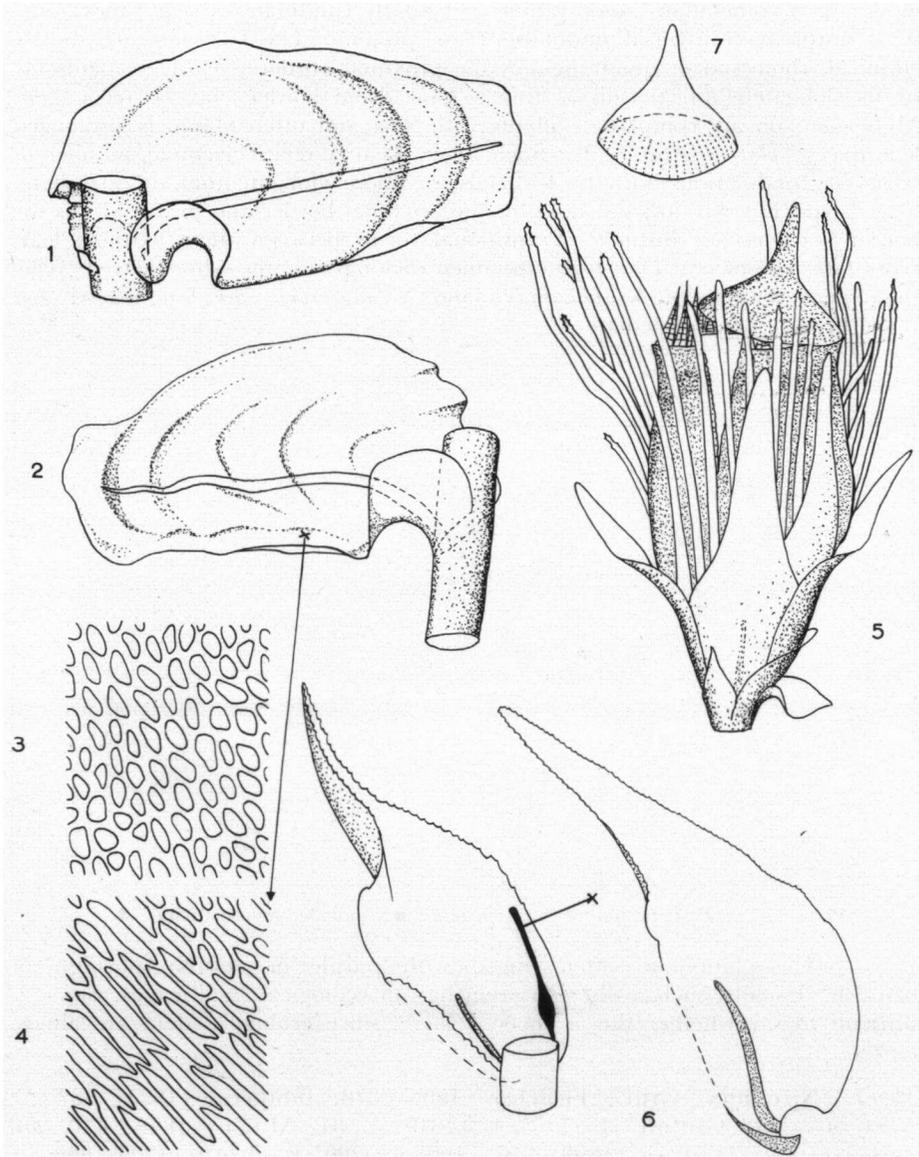


Plate 13. — *N. crinita* — 1. dorsal leaf ($\times 31$) — 2. lateral leaf ($\times 31$) — 3. leaf-cells ($\times 360$) — 4. areolation of the proximal border ($\times 360$) — 5. mature female gametoeccium ($\times 31$, paraphyses partly removed, capsule damaged) — 6. perichaetial leaves ($\times 45$), old archegonium (\times) — 7. lid ($\times 45$).

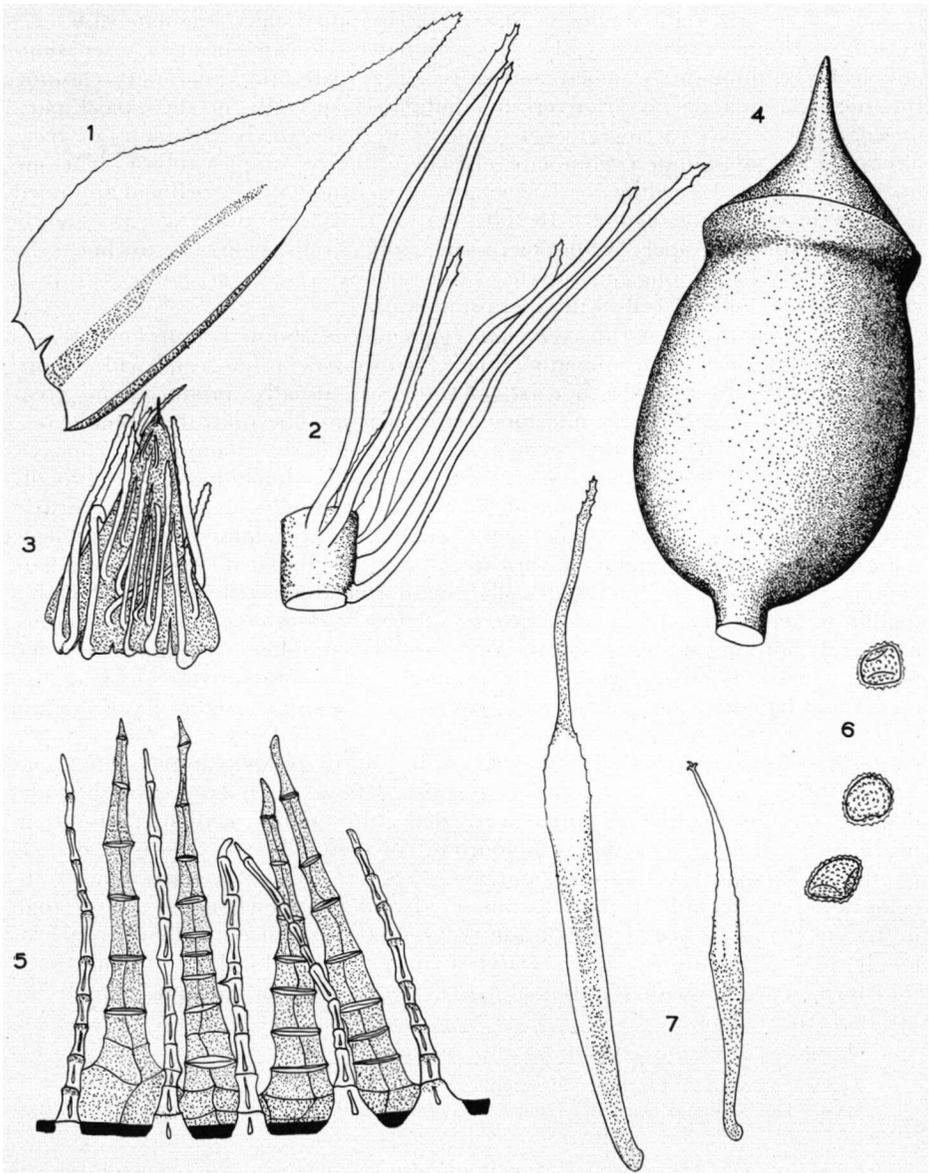


Plate 14. — *N. crinita* — 1. perichaetial leaf ($\times 45$) — 2. vaginula and some paraphyses ($\times 45$) — 3. calyptra ($\times 45$) — 4. capsule ($\times 45$) — 5. peristome ($\times 180$) — 6. spores ($\times 360$), papillae in reality somewhat less coarse than in this figure — 7. anomalous paraphyses, forming transitions between the nerve-like type and the leaf-like type; the nerve-like part is dotted ($\times 45$).

to more or less simply subdendroid, branches up to 2(—3.5) cm long, hardly attenuate, rounded at their tips. *Leaves* pseudotetrastichous, distinctly complanate, at nearly right angles to the stem, asymmetrically lingulate, 1.6—2.3 by 0.7—1.2 mm, L/W 1.8—2.1(—2.7), rounded-truncate at apex, exceptionally feebly acuminate, widened and auricled at base, proximal part clasping the stem; lamina deeply transversally undulate, especially in the apical part, undulations (2—)3—5, margin often rugose at base, finely crenulate at apex, almost entire to minutely crenulate elsewhere; *nerve* simple, robust, reaching up to or slightly exceeding $\frac{5}{6}$ leaf-length. *Cells* moderately pellucid, rounded to more or less hexagonal, 6—18.5 by 3.5—6.5 μ , L/W 1.5—3(—5), slightly shortened towards apex, walls incrassate, solid, cells elongate to linear at base, up to 75 μ long, incrassate, often porose, *proximal border* distinct, consisting of elongate cells with incrassate walls.

Male gametoecia normal. *Female gametoecia* about 1 mm long, leaves oval, very concave, with spreading apex; paraphyses a few cells wide, short, apex crenate. Archegonia normal. *Sporogones* usually produced in great number. *Perichaetia* 2—4 mm long, reaching just beyond the stem-leaves; *outer leaves* small, broadly ovate, apex triangularly acuminate, concave, spreading, nerve absent; *inner leaves* up to 2.3 mm long, basal part broadly ovate, concave, apical part elongate-lingulate, gradually acuminate, concave, erect or spreading; nerve ill-defined, usually not reaching above mid-leaf; margin crenulate, especially in the apical part of the leaf, crenate-crenulate at apex; cells elongate, incrassate, slightly shortened towards apex and highly incrassate, elongate and less incrassate at base. *Paraphyses* very numerous, up to 2.3 mm long, just reaching beyond the lid, nerve-like, sometimes provided with a narrow laminoid border, exceptionally a few of them are looking like a nerveless ligulate leaf; apex crenate. *Vaginula* blackish, straight, about 0.5 mm long. *Seta* brown, straight, about 0.5 mm long, entirely hidden by the vaginula. *Capsule* brown, erect, 1—1.2 by 0.7 mm, shortly ovoid-campanulate, constricted below its mouth. *Exostome* greenish yellow, teeth lanceolate-subulate, densely minutely papillose, often provided with some median perforations near apex. *Endostome* almost colourless, processes linear, knotted, densely papillose, median perforations narrow. *Spores* 15—22 μ , greenish, walls colourless or brownish, densely papillose (papillae somewhat less coarse than in fig. 6). *Lid* brown, 0.3—0.9 mm long, shortly conical, rather shortly or longly and straightly rostrate. *Calyptra* pale coloured, about 1 mm long, mitriform, covered with paraphysal hairs, some of them reaching beyond the apex of the calyptra.

Distribution: Assam, Siam, Sumatra(?).

ASSAM. Nowgong: Griffith 588 (type; NY).

SIAM. Doi Chiang Dao: C. Smith „B”, *pro part.* (mixed with *N. exserta*; BM, SING).

Ecology: The Siamese specimen was growing on a branch along a stream at 1600 m alt. Fleischer found *N. pilosa* on bark along a stream at 100 m alt.

Notes. 1. Griffith only published an illustration of his new species, the text in 'Notulae' being restricted to a short explanation of this figure. Mitten published the first description, but unfortunately he used heterogeneous material. Griffith only mentioned an Assamese specimen, but Mitten also

mentioned a specimen from Ceylon (leg. Thwaites). I found these specimens together on one sheet (NY), bearing the name "*Neckera tricho*". The Assamese specimen is Griffith's and it really belongs to a new species, but Thwaites' specimen from Ceylon belongs partly to *N. andamana*, partly to *N. lepinea* (a sterile plant). Mitten's description of the leaves is based on *N. lepinea*, but for the description of the perichaetium and the sporophyte he used *N. crinita*. This becomes clear from his description and also from the presence of a drawing by Mitten upon the sheet, representing together a leaf of *N. lepinea* and a female gametocidium of *N. crinita*.

Other bryologists have relied upon Mitten's description and consequently a great confusion arose:

- a. Many sterile specimens of *N. lepinea* (particularly from the Asian continent) have been misidentified as *N. crinita*.
- b. Fleischer described a new species (*N. pilosa*), the description of which is completely covered by the real *N. crinita*. Unfortunately, the type specimen of *N. pilosa* appears to be lost, so I could not make a final judgement.
- c. Bartram mentioned in his 'Mosses of the Philippines' (1939) a *N. crinita*. However, the specimens, listed below that species form a mixture of *N. andamana* and *N. nano-disticha*, both related to *N. crinita*.

2. According to Griffith (1847) the type specimen has to bear no. 588. The material present in NY bears no. 433. This figure, however, has not been written by Griffith himself, but probably by Mitten. Presumably, an error has been made in copying the figures from Griffith's list: carelessly whittened, 433 is much alike 588.

3. *N. crinita* might be confused with *N. andamana*. If sporogones are present, *N. crinita* may be recognised easily by its nerve-like paraphyses, those of *N. andamana* being more leaf-like, which is brought about by the wider laminoid border. Besides, the calyptra of *N. crinita* is covered with paraphysal hairs, whilst *N. andamana*'s calyptra is invariably glabrous. Sterile specimens are quite rare; their identification is more difficult. Generally, the leaves of *N. andamana* are distinctly acuminate, the leaves of *N. crinita* being usually rounded, not or very faintly and bluntly acuminate.

8. *N. andamana* (C. Muell.) Fleischer (1908) 878; Brotherus (1925) 187; Dixon (1932 B) 29. — *Distichia andamana* C. Mueller (1878) 84. — *Neckera andamana* (C. Muell.) Paris (1898) 843, (1905 A) 286; Brotherus (1909) 840. — *Neckeropsis crinita* sensu Bartram (1939) 240 *pro part.*, non Fleischer (1908) 878. — *Plates 15, 16.*

Lectotype: Burma, Pegu, Toukyeghat, leg. Kurz 2933 (L; isotype in H).

Cladautoicous. Small plants, light green to yellowish green, slightly glossy. *Primary stems* normal. *Secondary stems* rigid, up to 8 cm long and 2.5—3.5 mm wide, irregularly complanately and remotely branched to more or less subdendroid, branches up to 2.5 cm long, hardly attenuate, rounded at their tips. *Leaves* pseudotetrastichous, projecting at nearly right angles from the stem, asymmetrically lingulate, 1.4—2.2 by 0.6—0.9 mm, L/W 2.1—2.5(—3.2), deeply lunate-undulate, especially in the upper part, undulations 3—5, apex rounded-truncate, usually distinctly acuminate, base widened and auricled,

proximal part clasping the stem; margin often rugose near base, crenulate at apex, nearly entire to minutely crenulate elsewhere; *nerve* simple, robust, reaching up to or slightly exceeding $\frac{4}{5}$ leaf-length. *Cells* moderately pellucid, rounded to more or less hexagonal, 7—29 by 3.5—9 μ , L/W 1.2—4(—6), incrassate, solid, slightly shortened towards apex, rounded, more incrassate; much elongated near base, linear, walls incrassate, often porose; *proximal border* distinct, narrowed towards apex, consisting of elongate cells with incrassate walls.

Male gametoecia normal. *Sporogones* usually produced in great number. *Perichaetia* about 3 mm long, reaching just beyond the stem-leaves; *outer leaves* as in *N. crinita*; *inner leaves* erect, up to 2.8 mm long, reaching beyond the lid, basal part wide, concave, apical part elongate-lingular, gradually acuminate, usually erect, occasionally slightly spreading; *nerve* faint,

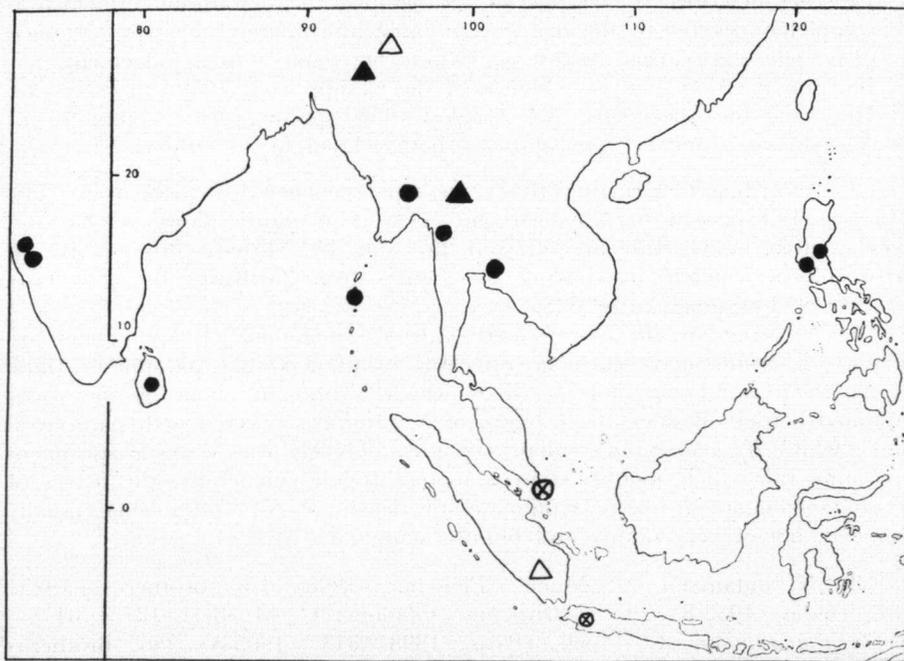


Plate 15. — Distribution of *N. crinita* (▲) and *N. andamana* (●); open triangles and dots refer to uncontrolled or otherwise doubtful references.

sometimes short, usually running far into the acumen; margin sharply crenulate in the upper part of the leaf, coarsely crenulate to crenate at apex; cells elongate to linear, incrassate, shortened towards apex and more incrassate, linear near base, rather thin-walled. *Paraphyses* very numerous, up to 2.4 mm long, reaching beyond the lid, elongate to lanceolate to lingulate, leaf-like with a faint nerve reaching high in the acumen; margin sharply crenulate, becoming coarsely crenulate to crenate at apex. *Vaginula* pale coloured to blackish, straight, about 0.5 mm long. *Seta* brown, straight, about 0.5 mm

long, almost entirely hidden by the vaginula. *Capsule* erect, yellow-brown to brown, 0.9—1.2 by 0.65 mm, shortly oval-campanulate, constricted below its mouth. *Exostome* green-yellow, teeth lanceolate-subulate, densely and finely papillose, usually perforated near apex. *Endostome* brown-yellow to almost colourless, processes linear, knotted, densely and finely papillose, median perforations narrow, basal membrane about 35 μ high. *Spores* 15—23 μ , greenish, with brown, papillose walls. *Lid* brown, shortly conical, about 0.5 mm long, straightly rostrate. *Calyptra* pale coloured, mitriform, up to 0.8 mm long, glabrous.

Distribution: Ceylon, India, Burma, Siam, Malay Peninsula(?), Andaman Islands, Java (?), Luzon.

CEYLON: *Thwaites* 172 (NY).

INDIA. North Canara. Western Ghats; Karwar: *Maxwell* 70 (BM); Siddhapur: *Sedgwick* 6484 (BM). „East India”: *Wallich* (K).

BURMA. Pegu. Toukyeghat: *Kurz* 2933 (lectotype; H, L); Yoma: *Kurz* 3314 (NY); Moulmein Hills: *Stoliczka* 4457 (H).

SIAM. Chaiya Buri: *Kerr* 75 (BM), 76 (BM).

ANDAMAN ISLANDS. South Andaman: *Kurz & Harrut s.n.* (NY).

JAVA. Bogor: *Jelinek s.n.* (BM) — doubtful, see note 4.

LUZON. Nueva Ecija. Cabanatuan: *McGregor* BS 5284 (BM, H, K, NY).
Bataan. Lamao river: *Williams* 850 (FH, NY, US).

Ecology: Growing on tree trunks, branches and calcareous rocks up to 550 m alt.

Notes. 1. The differences between the present species and *N. crinita* have been pointed out under the latter.

2. Mueller was mistaken, when he described this species as being dioicous; *N. andamana* happens to be autoicous, as was already pointed out by Dixon.

3. One of the lids I examined was obliquely rostrate.

4. Only Jelinek found *N. andamana* in Western Java and though that area has been investigated thoroughly afterwards it has never been recorded from there again. It therefore seems likely, that Jelinek erroneously labelled his specimen.

5. Fleischer recorded *N. andamana* from the vicinity of Singapore; I have seen no material from that area.

9. *N. nano-disticha* (Geh.) Fleischer (1908) 879; Dixon (1923) 64; Brotherus (1925) 187. — *Neckera nano-disticha* Geheeb (1889) 4; Paris (1898) 853, (1905 A) 297; Brotherus (1909) 841. — *Neckeropsis bornensis* Fleischer (1908) 879; Brotherus (1925) 187. — *N. crinita* sensu Bartram (1939) 240 p.p., non Fleischer (1908) 878. — *N. sparvelliæ* Dixon (1941) 34. — *Plates* 12, 17.

Type: New Guinea, Papua, Fly River (branch), leg. *Bäuerlen 84 et 98c* (probably destroyed); **neotype:** Mindanao, Agusan, Butuan, leg. *Weber 1290* (L; isotypes in NY, US).

Cladautoicous, occasionally *synoicous*. Brownish green to sordidly green plants, younger parts yellowish green, slightly glossy. *Primary stems* normal. *Secondary stems* complanately foliate, rather rigid, up to 8 cm long and 3.5(—4) mm wide, unbranched or remotely branched, branches up to 2.5(—5) cm long, hardly attenuate, rounded at their tips. *Leaves* pseudo-tetrastichous, asymmetrically lingulate, 1.6—2.4 by 0.5—0.9 mm, L/W 1.9—2.8, rounded-truncate at apex, exceptionally shortly and bluntly acuminate,

occasionally slightly decurrent at base, distinctly auricled, proximal margin shortly incurved, clasping the stem; lamina faintly and irregularly to transversally 1—3-undulate when dry, nearly smooth when moistened; margin minutely crenulate at apex and auricles, nearly entire elsewhere; *nerve* simple, stout, reaching up to about $\frac{9}{10}$ of the length of the leaf, sometimes forked above. *Cells* nearly opaque, irregularly 4—6-angular elliptic, 5.5—18(—24) by 3.5—7.5 μ , L/W 1—3(—6.5), walls solid, moderately incrassate; cells hardly or not shortened towards apex, irregularly quadrate, elongate near base with occasionally porose walls; *proximal border* distinct, pale coloured, reaching up to just below apex, strongly narrowed upwards, consisting of elongate cells

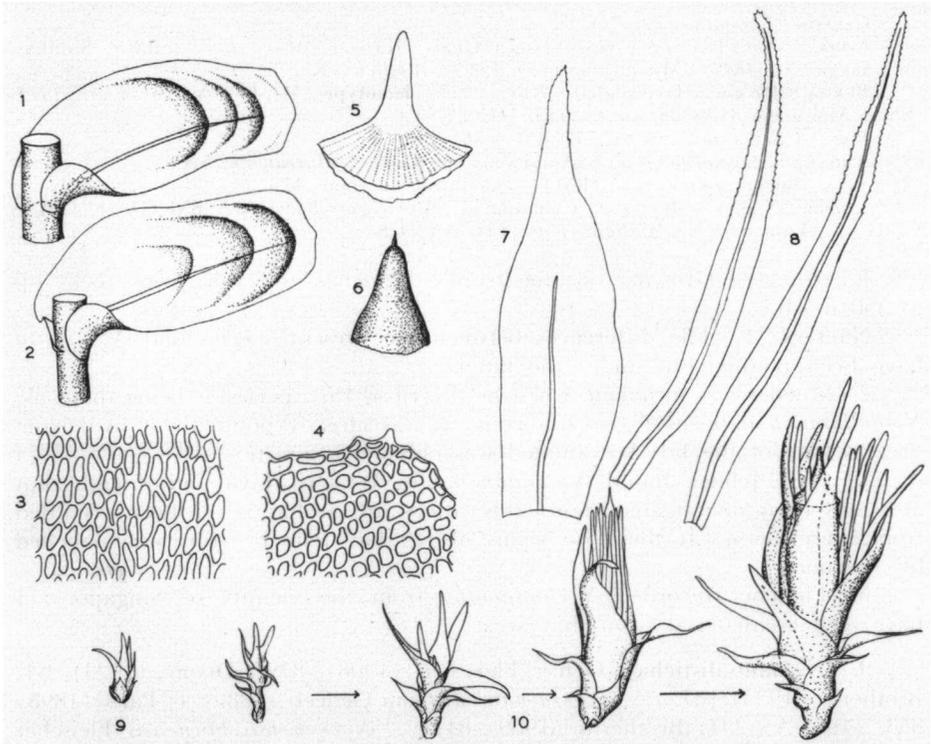


Plate 16. — *N. andamana* — 1. lateral leaf ($\times 23.5$) — 2. dorsal leaf ($\times 23.5$) — 3. leaf-cells ($\times 270$) — 4. areolation near apex ($\times 270$) — 5. lid ($\times 23.5$) — 6. calyptra ($\times 23.5$) — 7. perichaetial leaf ($\times 33.5$) — 8. paraphyses ($\times 33.5$) — 9. male gametocium ($\times 12$) — 10. developmental series of female gametocia ($\times 12$).

with incrassate walls; distal leaf-margin provided with a very faint border; cells at auricles smaller than elsewhere at base.

Male gametocia situated below the female ones, normal, paraphyses filiform. *Perichaetia* about 3 mm long, reaching just beyond the stemleaves; *outer leaves* as in *N. crinita*; following leaves with a larger basal part, distinctly nerved, margin crenulate at apex, entire or minutely crenulate elsewhere; *inner leaves* erect, up to 2.6 mm long, not reaching beyond the

lid, lanceolate and slightly concave, abruptly narrowed at first, gradually narrowed in the apical part of the leaf; nerve thin and faint, reaching far into the acumen; margin crenate at apex, minutely crenulate or almost entire elsewhere; cells extremely variable in shape and size, usually linear with incrassate walls, elliptic-elongate and incrassate at apex, linear and rather thin-walled at base. *Paraphyses* very numerous, up to 2.5 mm long and 3—7 cells wide, usually not reaching beyond the lid, ligulate, often slightly widened and crenate at apex. *Vaginula* about 0.3 mm long, straight. *Seta* about

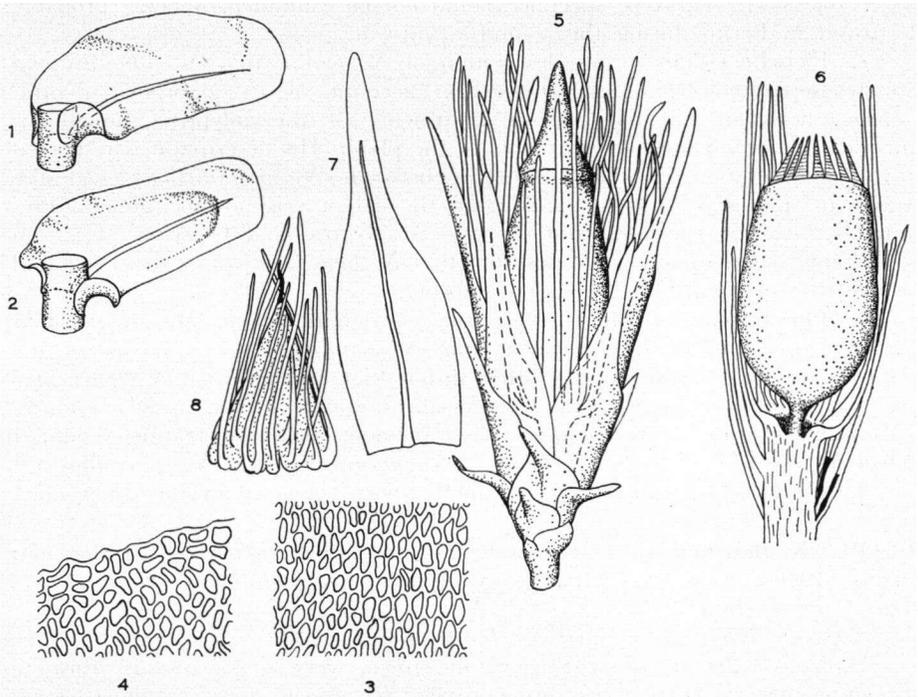


Plate 17. — *N. nano-disticha* — 1. lateral leaf ($\times 23.5$) — 2. dorsal leaf ($\times 23.5$) — 3. leaf-cells ($\times 270$) — 4. areolation near apex ($\times 270$) — 5. mature female gametocidium ($\times 23.5$) — 6. *ibid.*, perichaetial leaves and paraphyses removed on one side ($\times 23.5$) — 7. perichaetial leaf ($\times 23.5$) — 8. calyptra ($\times 23.5$).

0.3 mm long, almost entirely hidden by the vaginula. *Capsule* erect, yellow-brown to brown, 1.2—2.1 by 0.7—0.9 mm, shortly cylindrical, hardly or not constricted below its mouth when deperculate. *Exostome* colourless to greenish or yellowish, teeth lanceolate-subulate, finely papillose, sometimes provided with a few linear median perforations. *Endostome* yellowish, processes linear, knotted, finely papillose, median perforations narrow, basal membrane 50—70 μ high. *Spores* 15—21(—31) μ , green, with brown, papillose walls. *Lid* brown, shortly conical, about 0.8 mm long, straightly rostrate. *Calyptra* pale coloured, mitriform, 1—1.5 mm long, densely covered at base with paraphysal hairs, reaching beyond its apex.

Distribution: Mindanao, Borneo, New Guinea, Australia (Queensland).

MINDANAO. Agusan. Butuan subprov.: *Weber 1290* (lectotype; L, NY, US).

BORNEO. Selimbau: *Teijsmann 8582* (type of *N. bornensis*; BO, GRO, L).

NEW GUINEA. Terr. of New G. Ramu river: *Lauterbach 679* (H).

AUSTRALIA. Queensland. Murray river, Woolkoo: leg. *Sparvell 5237* (type of *N. sparvelliae*; BM).

Ecology: Growing on trunks and branches below 600 m.

Notes. 1. The type specimen could not be examined, it being probably destroyed in Berlin during the second world-war.

2. Fleischer states in his description of *N. pilosa*, that *N. nano-disticha* can be separated from that species on account of its glabrous calyptra. Geheeb, however, did not publish a drawing of the calyptra, though his illustration represents every other part of the plant. His description is restricted to an enumeration of the differences between *N. nano-disticha* and the American species *N. disticha*, and again the calyptra is not mentioned. Presumably, Geheeb's specimens did not possess calyptras and Fleischer's assertion is probably based upon the supposition, that *N. nano-disticha's* calyptra should be like that of *N. disticha*, which is glabrous.

3. On account of Fleischer's erroneous remark Dixon also states, that *N. sparvelliae* can be distinguished from *N. nano-disticha* by means of the glabrous calyptra of the latter. Other differential characters of *N. sparvelliae* are, according to Dixon, its not transversally undulate leaves, its nearly entire leaf-apices and its small, opaque cells. In none of these features could I detect an essential difference between *N. nano-disticha* and *N. sparvelliae*.

4. Lauterbach's specimen is distinctly more robust than the other ones.

10. *N. fleischeri* (Dix.) Touw, comb. nov. — *Homali dendron fleischeri* Dixon (1916) 313, (1935) 103. — *Neckeropsis plagiochiloides* Dixon (1935) 102. — *Plates 18 A, 22.*

Type: Borneo, Tenom, leg. *Binstead 181* (BM).

Dioicous. Bright green to sordidly green, very glossy plants, forming straggling masses. *Primary stems* normal. *Secondary stems* extremely complanately foliate, up to 15(—25) cm long and up to 5 mm wide, unbranched or remotely branched or subpinnate, branches up to 4 cm long, usually hardly narrowed towards their rounded tip, occasionally attenuate and flagelliform. *Leaves* pseudotettrastichous, all lying in one plane, highly asymmetrical, arcuate, cultriform to lingulate to dolabriform, 1.7—2.6 by 0.6—1.2 mm, L/W 2—3, usually obliquely rounded-truncate at apex, often indistinctly and bluntly acuminate, exceptionally sharply acuminate, not auricled at base, proximal margin narrowly incurved; lamina smooth when moistened, irregularly undulate when dry; margin finely serrulate to irregularly crenulate at apex, entire or nearly so elsewhere; *nerve* simple, often arcuate, thin and rather wide, ill-defined, reaching up to $\frac{4}{5}$ leaf-length at most, often not reaching beyond half-way. *Cells* moderately pellucid to opaque, in the concave leaf-part much longer than in the convex part, being elliptic to linear in the latter part of the leaf, 15—32(—45) by 3.5—7.5 μ , L/W 3—9(—12), rather thin-walled, being linear in the concave part of the leaf, 30—120 by 4.5—6 μ , L/W 6—27;

cells at apex irregularly quadrate to hexagonal, 7—18 by 4—7.5 μ , L/W 1—4; cells at base linear.

Male gametoecia normal. *Young female gametoecia* ovoid, about 1 mm long; *outer leaves* shortly oval, concave, acute, nerveless; basal part of the *inner leaves* sheathing, apical part lingulate, spreading, nerve wide, ill-defined, reaching up to $\frac{2}{3}$ leaf-length at most, often wanting; *paraphyses* numerous, filiform, hyaline; *archegonia* normal. *Sporophyte* unknown.

Distribution: Endemic in Borneo; frequent, at least in the northern part.

BORNEO. North Borneo. Sandakan, Elopura, Sapagaya river: *Cuadra A 2309c* (GRO); Segaliud, Lungmanis: *Cuadra A 2359a et b* (GRO); Tenom: *Binstead 181* (type; BM); Sipitang, Mengalang Forest Reserve (Sibubu river); *Wood 1686* (GRO). Sarawak. Sungei Balapau, Tinjar: *Oxford Exp. 1932 no. 2235* (type of *N. plagiophiloides*; BM). West Borneo. Sungei Blocoe: *Jaheri 1120* (L). East Borneo. Long Shoewi: *Maya 7* (GRO); Long Sek (= Longsegah?): *Idjan 3* (GRO); Peak of Balikpapan, Tulus river: *Meyer B 1282h* (BO, L).

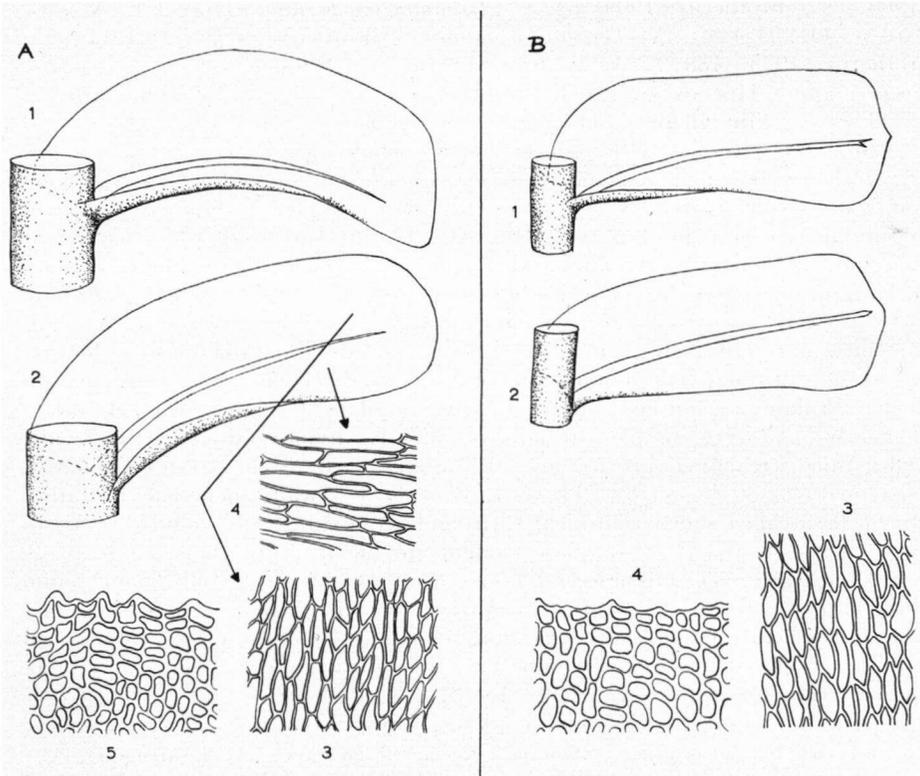


Plate 18. — A. *N. fleischeri* — 1. lateral leaf ($\times 23.5$) — 2. dorsal leaf ($\times 23.5$) — 3. leaf-cells of the convex leaf-part ($\times 270$) — 4. leaf-cells of the concave leaf-part ($\times 270$) — 5. areolation near apex ($\times 270$) — B. *N. semperiana* — 1. lateral leaf ($\times 23.5$) — 2. dorsal leaf ($\times 23.5$) — 3. leaf-cells ($\times 270$) — 4. areolation near apex ($\times 270$).

Ecology: On trees and rocks, occasionally in temporarily submerged places, from sea-level up to 300 m.

Notes. 1. The type specimen of *Neckeropsis plagiochiloides* is widely divergent from the normal forms of *N. fleischeri*. This specimen, however, represents an inundated form, collected on a log in a stream. The secondary stems and the branches are extremely elongated; the leaves are in a bad state, they are less arcuate than usual and the cells are more elongated. Distinctly transitional forms between the normal and the floating forms have been collected and they all undoubtedly belong to one and the same species.

2. The present species differs from the related *N. semperiana* by its very faint nerve and its most unusual areolation; other differences are the arcuate, usually obliquely truncate and exceptionally distinctly acuminate leaves, often somewhat inflexed along their margins and irregularly undulate when dry, especially at apex.

11. *N. semperiana* (Hpe ex C. Muell.) Touw, comb. nov. — *Neckera semperiana* Hampe ex C. Mueller (1862) 381; Paris (1898) 858; Fleischer (1908) 892; Brotherus (1909) 842. — *Homalia semperiana* (Hpe ex C. Muell.) Paris (1904) 321. — *Neckeropsis annamensis* Brotherus et Paris (1911) 55; Brotherus (1925) 188. — *N. krempfii* Thériot (1919) 38. — *Homaliodendron semperianum* (Hpe ex C. Muell.) Brotherus (1925) 192. — *Plates 18 B, 22.*

Type: Mindanao, Zamboanga, leg. *Semper s.n.* (L).

Dioicous? Robust, yellowish green to sordidly green, very glossy plants. **Primary stems** normal. **Secondary stems** rather rigid, up to 7(—15) cm long and 5 mm wide, extremely complanately foliate, simple or remotely branched to subpinnate, branches up to 2 cm long, hardly narrowed and rounded at their tips or longer, attenuate and flagelliform. **Leaves** pseudotetrastichous, all lying in one plane, asymmetrically broadly lingulate, 2—2.5 by 0.9—1.1 mm, L/W 2—2.5, usually slightly widened towards apex, transversally rounded-truncate, distinctly acuminate; base not auricled, proximal margin shortly or not at all incurved; lamina smooth, dry as well as moistened; margin finely serrulate to coarsely and irregularly crenulate at apex, entire elsewhere or nearly so; **nerve** simple, straight or slightly arcuate, stout, rather wide, well-defined, reaching up to just below apex. **Cells** moderately pellucid, hexagonal, 9—30 by 4—8(—11) μ , L/W 1.5—5.5, walls incrassate to rather thin, cells at apex shortly elliptical to irregularly quadrate to rounded, 7.5—18 by 4—9.5 μ , L/W 1—2.5, at base elongate to linear.

Male gametoeccia unknown. **Young female gametoeccia** ovoid, about 1 mm long; **outer leaves** shortly oval, acute, nerveless; **inner leaves** with a sheathing base and a nearly horizontally spreading, elongate-lingulate and concave apical part, nerve absent; **paraphyses** numerous, filiform, hyaline; **archegonia** normal. **Sporophyte** unknown.

Distribution: Annam, Tonkin, Mindanao.

ANNAM. Fong Coi-valley, Nhatrang: *Krempf 1508* (type of *N. krempfii*; PC).
Thua-Thien. Hué, Pic du Midi: *Eberhardt 1889* (type of *N. annamensis*, H).

TONKIN. Hoa-Binh. Cao Phong: *Petelot 141* (H).

MINDANAO. Zamboanga: *Semper s.n.* (type; L).

Ecology: No data extant.

Notes. 1. The differences between the present species and *N. fleischeri* have been pointed out under the latter.

2. The Tonkinese specimen differs from the other ones by its more coarsely toothed leaves and its shorter, more rounded cells.

12. *N. nitidula* (Mitt.) Fleischer (1908) 882; Brotherus (1925) 188; Okamura in Makino (1925) 1287, fide Noguchi, (1940) 981, fide Noguchi; Noguchi (1950) 15, (1955) 44; Herzog et Noguchi (1955) 64; Iwatsuki (1960) 305, 308. — *Homalia nitidula* Mitten (1865) 155; Paris (1898) 565;

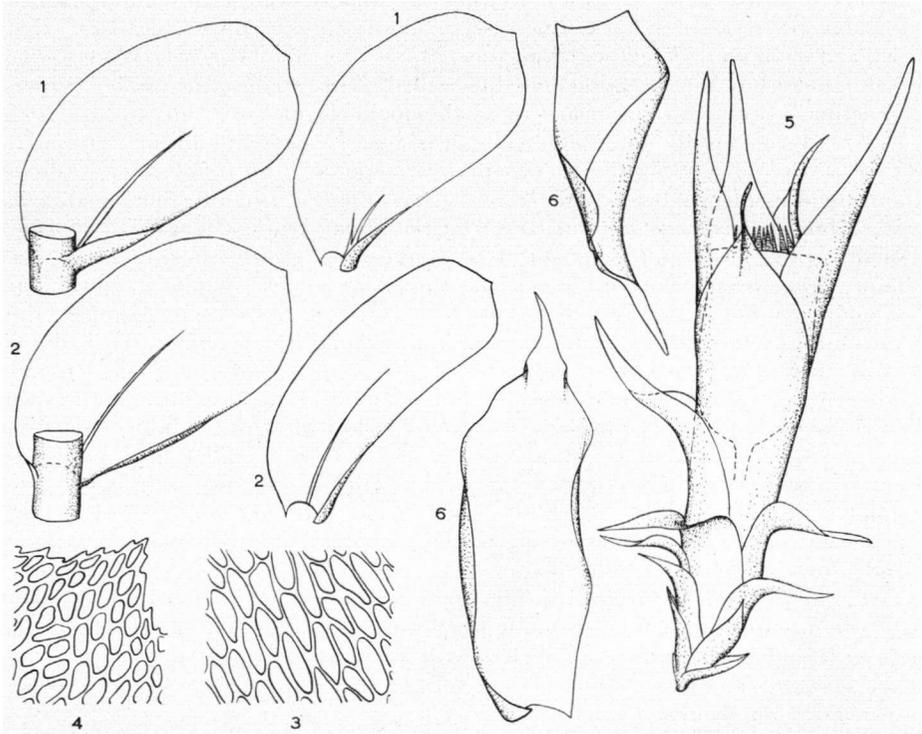


Plate 19. — *N. nitidula* — 1. lateral leaves ($\times 23.5$) — 2. dorsal leaves ($\times 23.5$) — 3. leaf-cells ($\times 270$) — 4. areolation near apex ($\times 270$) — 5. mature female gametecium ($\times 23.5$) — 6. perichaetial leaves ($\times 23.5$).

Bescherelle (1899) 39; Paris (1904) 320. — *Homalia apiculata* Van den Bosch et Van der Sande Lacoste in Dozy et Molkenboer (1845) t. 52 B (unnamed illustration); Van der Sande Lacoste in Miquel (1867) 296. — *Neckera nitidula* (Mitt.) Brotherus (1899) 228; Cardot (1905) 124; Brotherus (1909) 842. — *Neckeropsis kiusiana* Sakurai (1932) 375, *pro part.* — Plates 19, 20.

Type: Japan, Kyushu, Nagasaki, leg. *Oldham s.n.* (not seen, this collection could not be traced).

Dioicous. Slender, light green to pale blue-green, very glossy plants. *Primary stems* normal. *Secondary stems* flexuous to straight, up to 5(—8) cm long and 2—4 mm wide, simple or sparsely complanately branched, branches up to 1.5(—2.5) cm long, with obtuse, rounded tips, sometimes attenuate-

flagelliform and in this case often radiculous. *Leaves* pseudotetrastichous, all lying in one plane, asymmetrical, obovate to lingulate to arcuately cultriform, 1.5—2.3 by 0.6—1.0 mm, L/W 1.75—2.5, apex widened, acute to rounded or rounded-truncate and acuminate, leaves narrowed towards base, not auricled, proximal margin narrowly incurved, lamina smooth, both dry and moistened, *nerve* thin, narrow to rather wide, reaching up to about mid-leaf, usually simple, sometimes forked above or double and in this case reaching up to about $\frac{1}{3}$ leaf-length at most, occasionally almost wanting; margin coarsely serrulate to serrate at apex, finely serrulate to almost entire elsewhere. *Cells* pellucid, elliptic to elliptic-elongate, 20—45 by 8—11 μ , L/W 2.5—5.5, walls incrassate or occasionally thin-walled with highly incrassate corners, sometimes porose; cells near apex rhomboid-elliptic, 13—26 by 8—11 μ , L/W 1.3—2.5, walls incrassate; cells near base elongate to linear, 20—60 by 5—9 μ , L/W 3—9, walls incrassate, often porose; *proximal border* almost indistinguishable, indicated alone by a few rows of slightly elongated cells.

Male gametoecia normal. *Perichaetia* about 3 mm long; *outer leaves* small, ovate, base appressed, apical part spreading, nearly smooth, *nerve* very faint; *inner leaves* elongate, erect, sheathing, up to 3.5 mm long, apical part subulate-acuminate, margin serrulate to serrate at apex, *nerve* simple, thin and faint, sometimes absent, reaching up to mid-leaf at most, cells linear, walls incrassate. *Paraphyses* filiform, hyaline, up to 0.8 mm long, usually not reaching the capsule's base. *Vaginula* short and straight. *Seta* brown, erect, about 0.5(—1) mm long. *Capsule* yellow-brown, reddishly tinged at its mouth, erect, ovoid to ovoid-ellipsoid, 1—1.5 by 0.7—0.9 mm, hardly or not constricted below its mouth. *Exostome* greenish yellow, teeth lanceolate-subulate, finely papillose, papillose-striate at base. *Endostome* greenish yellow, processes linear, densely and finely papillose, with narrow median perforations and brownish yellow, knotted joints; basal membrane about 50 μ high. *Spores* 13—22 μ , greenish with brown walls, finely papillose. *Lid* shortly-conical, about 0.75 mm long, straightly or obliquely rostrate. *Calyptra* widely mitriform, about 1 mm long, remotely covered with paraphysal hairs.

Distribution: Southern Japan, Ryukyu Archipelago, Botel Tobago near Formosa, Korea, China(?).

JAPAN. Without exact locality: *Von Siebold s.n.* (L); *Textor s.n.* (type of *Homalia apiculata*; L); *Kenzo Shiota B 81* (FH). Honshu. Oyama: *Faurie, herb. E. G. Paris 19160* (L); Tokyo: *Sakurai s.n.* (M); Ise: *Uematsu 399* (H, L, M); Osaka, Minoo: *Mizutani 2422* (L, NICH); Kii: *Koide s.n.* (FH, M); Tanabe: *Ui 1010* (H). Shikoku. Tosa, Mt. Ushioya: *Nakanishili 61* (H). Kyushu. Omura: *Sinagawa 14* (FH); Nagasaki: *Faurie 182* (M); *Wichura 1485d* (H), *1485e* (NY); Miyazaki, Minaminaka, Obi: *Hattori M. Jap. 83* (L, M, NSW). Hokkaido? Hakodadi (= ? Hakodate): *Wright s.n.* (L).

KOREA. Tomasa: *Faurie 215* (NY).

CHINA. Without definite locality: *Anonymus s.n.* (L).

Ecology: On trees and rocks, according to Noguchi (1950) also growing terrestrial. According to Iwatsuki (1960) faithful species of the *Neckeretum tosaensis* Iwats. and the *Plagiochiletum japonicae* Iwats. The former association is developed "on the lower to middle portions of trees, rarely on the bases and in the crowns, in the mountainous areas of southern Honshû, Shikoku and Kyûshû", the latter grows "on bases of trees in the valley bottoms in the mountainous regions of southern Kyûshû".

Note. Henry (1928) recorded a specimen of *N. nitidula* from Tonkin, but this collection belongs to *N. semperiana*. Williams mentioned *N. nitidula* from the Philippines, but this specimen belongs to a *Homaliodendron*-species.

13. *N. submarginata* Card. ex Touw. — *N. submarginata* Cardot in sched. — *Plates 21 A, 22.*

An ? dioica. Caules sat rigidi-complanati, usque ad 7 cm longi et 2—3 mm lati, simplices vel remote ramosi. Folia pseudotetrasticha flavoviridia ad pallide brunnea asymmetrico-linguiformia, 1.3—1.6 × 0.5—0.6 mm, in sicco tenuiter et longitudinaliter plicato-striata, in statu immerso plana, apice rotundato-truncata, breviter acuminata, acumine irregulariter crenulato ad serrulato; nervus robustus, evanescens casu quo 2—3 cellulae ab apice remotus, cellulis irregulariter ellipticis, valde inaequalibus, 7—26 × 3.5—9 μ. marginibus incrassatis, aporatis; margines externi bilaterales, apicem folii non attingentes, pallidi, cellulis linearibus, 30—90 × 2—5.5 μ, parietibus crassissimis, cellularum serie marginali breviori. Cetera ignota.

Type: South Andaman, Port Blair, leg. *Man in herb. Levier sub no 2472* (BM; isotype in PC).

Dioicous. Yellowish green to light brown, slightly glossy plants, forming straggling masses of procumbent stems. *Primary stems* normal. *Secondary stems* rather rigid, straight or somewhat flexuose, up to 7 cm long and 2—3 mm



Plate 20. Distribution of *N. nitidula*; open dots refer to uncontrolled references.

wide, simple or irregularly subpinnately branched, branches up to 2 cm long, hardly attenuate, rounded at their tips. *Leaves* pseudotetrastichous, asymmetrically lingulate, 1.3—1.6 by 0.5—0.6 mm, L/W 2.6—3.2, apex rounded-truncate, shortly subacute-acuminate, slightly curved towards the substrate when dry, base not auricled, proximal margin shortly and very narrowly incurved at base; lamina finely longitudinally plicate-striate when dry, smooth when moistened; margin irregularly crenulate to serrulate at apex, entire or almost entire elsewhere; *nerve* simple, robust and wide, reaching up to 2—3 cells below apex, somewhat prominent below. *Cells* hardly pellucid to opaque, irregularly elliptic, 4—6(—8)-angular, very unequal in shape and size, 7—26 by 3.5—9 μ, L/W 1—5(—8), walls incrassate, solid; cells at apex very irregularly quadrate to rhomboid to rounded, 8—15(—22) by 4.5—8 μ, L/W 1—2.5(—3), walls incrassate, solid, cells at base elliptic to elongate to linear, incrassate to rather thin-walled, solid or with a few pores; *borders* distinct along both margins, pale coloured, reaching up to about the

point where the leaf is abruptly narrowed towards its apex, about 5 cells wide and 1 cell in thickness, cells linear, highly incrassate, 30—90 by 2—5.5 μ , marginal row somewhat shorter.

Male gametoecia unknown. *Young female gametoecia* narrowly cup-shaped, about 1.2 mm long; *leaves* erect, lanceolate with concave base and smooth, gradually narrowed apical part, nerve reaching far up into the apical part, ill-defined. *Paraphyses* numerous, filiform, hyaline, reaching up to just beyond the archegonia. *Sporophyte* unknown.

Distribution: Andaman Islands, Malay Peninsula.

ANDAMAN ISLANDS. South Andaman. Port Blair: *Man in herb. Levier* sub no. 2472. (type; BM, PC).

MALAY PENINSULA. Pahang. Gua Tipus: *Henderson SFN 22545* (BM, SING).

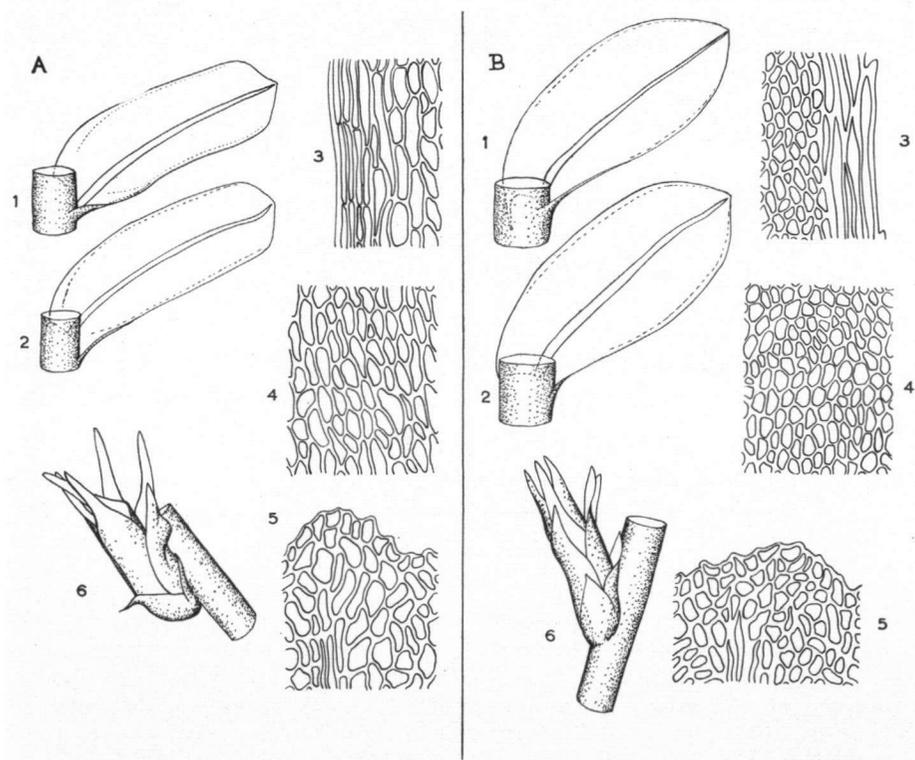


Plate 21. — A. *N. submarginata* — B. *N. moutieri* — 1. lateral leaf ($\times 23.5$) — 2. dorsal leaf ($\times 23.5$) — 3. border-cells at 1/3 of the length of the leaf from its apex ($\times 270$) — 4. leaf-cells ($\times 270$) — 5. areolation near apex ($\times 270$) — 6. young female gametocium ($\times 23.5$).

Ecology: Henderson's plants were growing on wet calcareous rocks along a stream.

Notes. 1. *N. submarginata* is allied to *N. moutieri* and *N. madecassa* (Besch.) Fl. (the latter from Madagascar and Réunion). Of the two last

named species the former has small perichaetia and distinctly exserted, long-stalked capsules, the latter has large perichaetia, enclosing immersed capsules. The young female gametoezia of *N. submarginata* are shaped like those of *N. moutieri*, from which may be inferred that *N. submarginata* has also small perichaetia and exserted capsules.

2. Differential characters between *N. submarginata* and *N. moutieri*, not mentioned in the key are:

a. The borders of *N. submarginata* are reaching up to about the point where the leaf narrows towards its apex (the "shoulders" of the leaf); in *N. moutieri* they reach beyond this point up to just below the apex; the border-cells of *N. moutieri* are much more elongate on the average than those of *N. submarginata*.

b. The leaf-shoulders of *N. moutieri* are often sharply serrulate to serrate, in *N. submarginata* the dentation is usually more minutely serrulate; in both species, however, the dentation is very variable, even in the leaves of one specimen.

c. The leaf-cells of *N. moutieri* are usually shorter than those of *N. submarginata* and they are less variable in size.

14. *N. moutieri* (Broth. et Par.) Fleischer (1908) 882; Brotherus (1925) 188. — *Sciaromium moutieri* Brotherus et Paris (1900) 78. — *Neckera moutieri* (Broth. et Par.) Brotherus (1909) 842. — *Plates 21 B, 22*.

Type: Tonkin, Lao-Kay, between Bao Hoa and Pho Lu, leg. *Moutier s.n.* (PC).

Dioicous. Lightgreen, slightly glossy plants, forming dense, straggling masses. *Primary stems* normal. *Secondary stems* rigid, nearly straight, up to 5 cm long and 2–2.5 mm wide, simple to remotely subpinnately branched, branches up to 2(–4) cm long, hardly attenuate and rounded at their tips. *Leaves* pseudotetrastrichous, asymmetrically ovate-lingulate, 1.4–1.6 by 0.7–0.85 mm, L/W 1.8–2.1, slightly widened and subacute to obtuse at apex, not auricled and hardly or not incurved at base, proximal margin longly decurrent; lamina crisped when dry, smooth when moistened; margin coarsely serrulate to serrate at the point, where the leaf is narrowed towards its apex, entire elsewhere or nearly so; *nerve* simple, robust and wide, reaching up to 2–3 cells below apex, somewhat prominent below. *Cells* opaque, irregularly shortly elliptic, 4–6-angular, 5–12(–15) by (2.5–)4–5.5 μ , L/W (1–)1.5–2.5(–4), walls incrassate and solid; cells at apex hardly or not shortened, irregularly shortly 4(–6)-angular to rectangular to rhomboid; cells at base elliptic to elongate to linear, walls incrassate and solid; *borders* distinct along both margins, yellowish, hardly narrowed upwards and nearly reaching the apex, about 5 cells wide and 1 cell in thickness, cells linear, 55–165 by 2.5–5.5 μ , highly incrassate.

Male gametoezia not seen. *Young female gametoezia* narrowly cup-shaped, about 1.3 mm long; *leaves* erect, lanceolate with a sheathing base and a gradually acuminate, smooth apical part, nerve reaching far into the apical part, ill-defined, sometimes hardly distinguishable. *Paraphyses* numerous, filiform, hyaline, reaching just beyond the archegonia. Other parts not seen. According to Brotherus (1909) the *mature perichaetium* is small-sized and the *capsule* exserted.

Distribution: Tonkin.

TONKIN. Lao Kay. Between Bao Hoa and Pho Lu: *Moutier s.n.* (PC); between Thai Wan (? Trai Van) and Pho Lu: *Moutier s.n.* (L, M).

Ecology: On trees along a stream, presumably inundated, at least temporarily (the older parts of the plants are covered with mud).

Notes. 1. The type material contains no sporophytes. Brotherus (1909) has seen them, but, unfortunately, he did not publish a description.

2. The differences between the present species and *N. submarginata* have been pointed out under the latter.

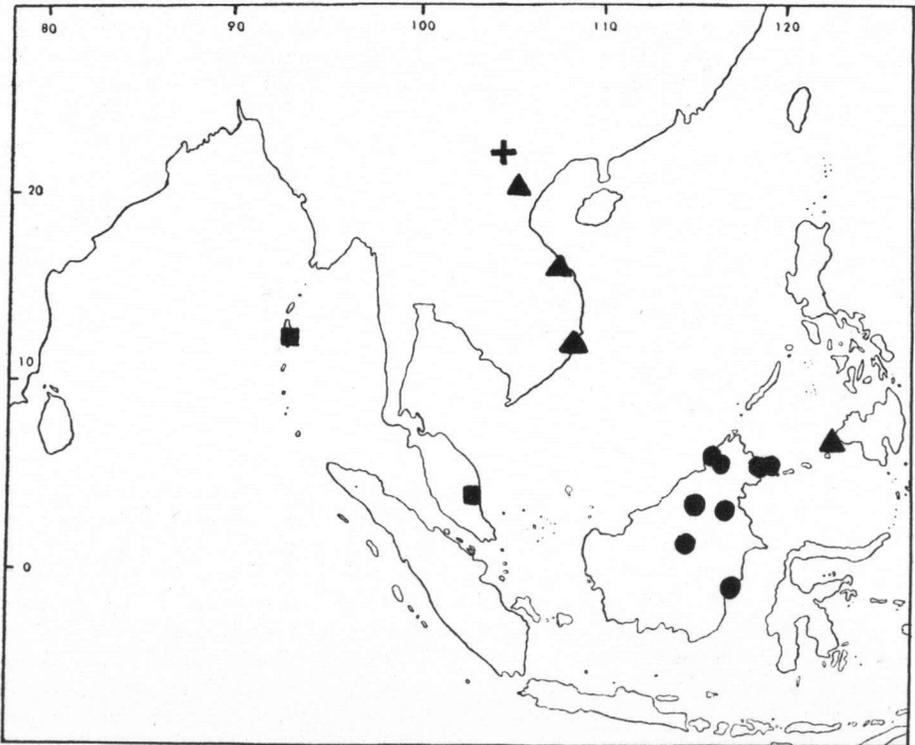


Plate 22. — Distribution of *N. fleischeri* (●), *N. semperiana* (▲), *N. submarginata* (■) and *N. moutieri* (+).

EXCLUDED SPECIES

N. acutata (Mitt.) Fl. — *Himanthocladium plumula* (Nees) Fl.

N. pseudonitidula Okam. — *Homaliodendron exiguum* (Lac.) Fl.

N. sinensis Chen — *Homaliadelphus targionianus* (Gough) Dix. et P. de la V.

N. kiusiana Sak. — mixture of *N. obtusata* (Mont.) Broth. and *N. nitidula* (Mitt.) Fl.; — fide Noguchi (1950), specimens not seen.

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INDEX OF BINOMIALS

Accepted names are printed in roman type, italics refer to synonyms. The numbers between brackets are those of the species in the text. New names and new combinations are denoted by an asterisk.

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|--|---|
| <i>Distichia andamana</i> C. Muell. (8) | <i>N. obtusata</i> Mont. (3) |
| <i>Himanthocladium exsertum</i> (Hook. in Schwaegr.) Fl. (5) | <i>N. parishiana</i> Mitt. (6) |
| <i>H. scrobiculatum</i> (Nees) Bartr. (5) | <i>N. scrobiculata</i> Nees (5) |
| <i>Homalia apiculata</i> Bosch et Lac. (12) | <i>N. semperiana</i> Hpe ex C. Muell. (11) |
| <i>H. nitidula</i> Mitt. (12) | <i>N. tosaensis</i> Broth. (3) |
| <i>H. semperiana</i> (Hpe ex C. Muell.) Par. (11) | <i>N. undulata</i> sensu Mont., non Hedw. (1) |
| <i>Homaliodendron fleischeri</i> Dix. (10) | <i>Neckeropsis acutata</i> (Mitt.) Fl. — excluded |
| <i>H. semperianum</i> (Hpe ex C. Muell.) Broth. (11) | <i>N. andamana</i> (C. Muell.) Fl. (8) |
| <i>Neckera andamana</i> (C. Muell.) Par. (8) | <i>N. annamensis</i> Broth. et Par. (11) |
| <i>N. brevicaulis</i> Broth. ex Card. (3) | <i>N. auriculata</i> Dix. (6) |
| <i>N. comorae</i> C. Muell. (1) | <i>N. bornensis</i> Fl. (9) |
| <i>N. crinita</i> Griff. (7); sensu Mitt. (1 + 7) | <i>N. calcicola</i> Nog. (2) |
| <i>N. elegantula</i> Griff. (? 5) | <i>N. crinita</i> (Griff.) Fl. (7) |
| <i>N. exserta</i> Hook. in Schwaegr. (5) | <i>N. crinita</i> sensu Bartr., non Fl. (8 + 9) |
| <i>N. fimbriata</i> Harv. (6) | <i>N. exserta</i> (Hook. in Schwaegr.) Broth. (5) |
| <i>N. gracilentata</i> Bosch. et Lac. (4) | <i>N. fimbriata</i> (Harv.) Fl. (6) |
| <i>N. lepineaana</i> Mont. (1) | * <i>N. fleischeri</i> (Dix.) Touw (10) |
| <i>N. moutieri</i> (Broth. et Par.) Broth. (14) | <i>N. gracilentata</i> (Bosch et Lac.) Fl. (4) |
| <i>N. nano-disticha</i> Geh. (9) | <i>N. kiusiana</i> Sak. (3 + 12) |
| <i>N. nigrescens</i> Broth. (6) | <i>N. krempfii</i> Thér. (11) |
| <i>N. nitidula</i> (Mitt.) Broth. (12) | <i>N. lepineaana</i> (Mont.) Fl. (1) |
| | <i>N. moutieri</i> (Broth. et Par.) Broth. (14) |
| | <i>N. nano-disticha</i> (Geh.) Fl. (9) |

- N. nigrescens* (Broth.) Broth. (6)
N. nitidula (Mitt.) Fl. (12)
N. obtusata (Mont.) Broth. (3)
N. parishiana (Mitt.) Fl. (6)
N. penicillata Herz. (4)
N. pilosa Fl. (?7)
N. plagiochiloides Dix. (10)
N. pseudonitidula Okam. — excluded
- N. scrobiculata* (Nees) Fl. (5)
 **N. semperiana* (Hpe ex C. Muell.)
 Touw (11)
N. sinensis Chen. — excluded
N. sparvelliae Dix. (9)
 **N. submarginata* Card. ex Touw (13)
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