

Notes on Bryophytes from the Himalayas and Assam

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Abstract. *One new genus and five new species of Asian mosses are described: Mitrobryum with M. koelzii, Syrrhopodon assamicus, Epipterygium koelzii, Macromitrium incrustatifolium, and Thuidium koelzii. Keys to some Indian species of Funaria and Thuidium are given, based in part on a study of type specimens. Asian records are cited for Barbula michiganensis Steere and Ditrichum tortuloides Grout, and notes are given for 47 other species.*

The present study is based primarily upon two collections by Walter Koelz from India, one from the Central Himalayas made during 1948 and the other from Assam made during the years 1949–1953. The Himalayan series is on deposit at the U.S. National Herbarium, the Assam series is to be deposited at the University of Michigan with duplicates at the National Herbarium. Mention is made of some additional collections, including a few of J. P. Srivastava. Two earlier Himalayan collections by Koelz were reported by Bartram (1955, 1960). Unless otherwise indicated, the specimens cited below are in the U.S. National Herbarium.

MUSCI

DITRICHACEAE

DITRICHUM TORTULOIDES Grout. This is the first report for Asia of this eastern North American and Central European moss. Srivastava (1966) reported the Ranikhet collections as *D. heteromallum* (Hedw.) Britt. The species may have been confused with *D. heteromallum* in the past, but the long operculum and long twisted peristome make confusion with *Barbula* more likely.

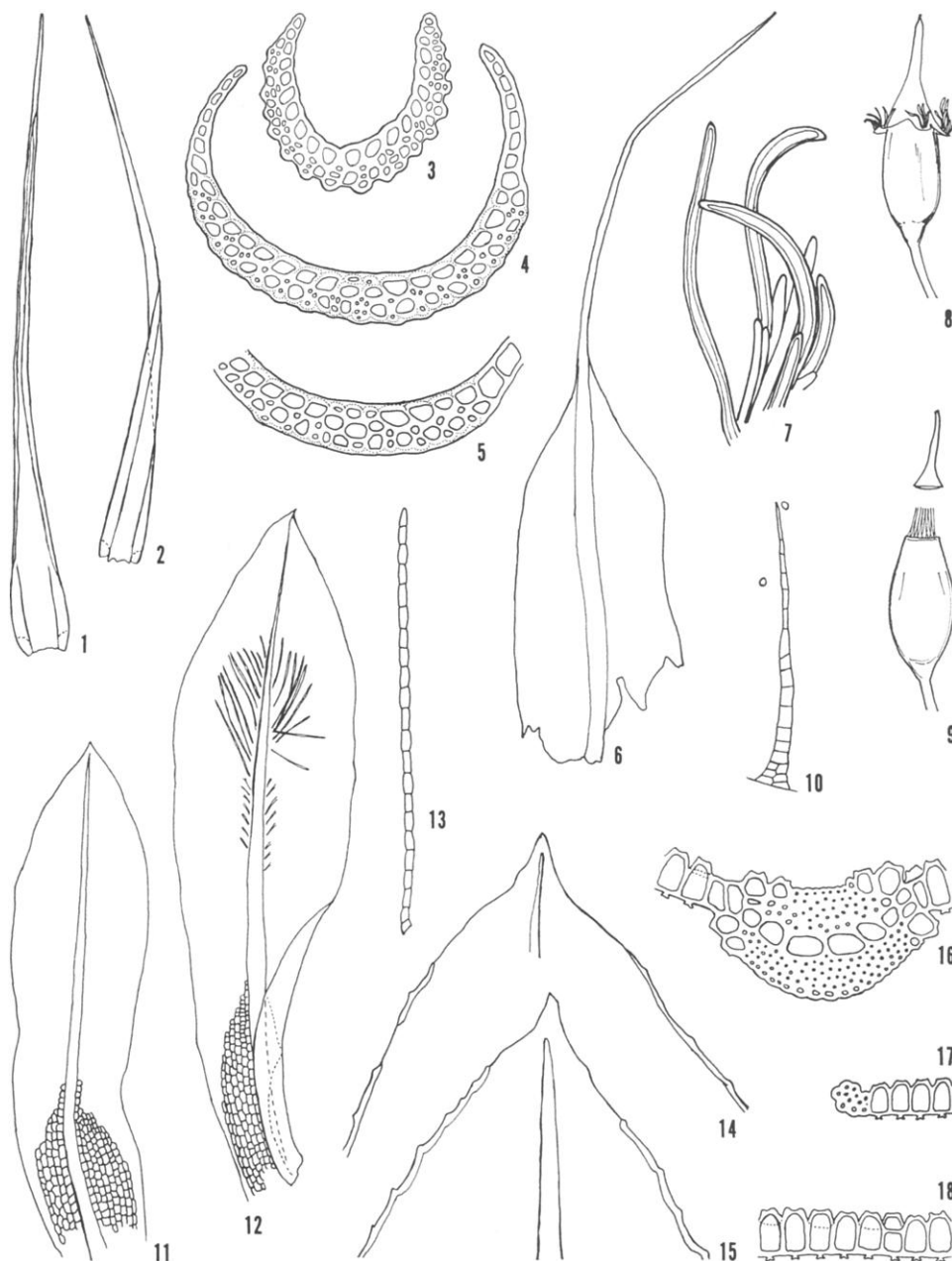
ASSAM: Khasi Hills, Laitlynkot, on ground in open and on boulder in pine forest, *Koelz 23304, 23340*. UTTAR PRADESH: Ranikhet, on sandy soil and on wall, *Srivastava 1140i* (with capsules), *1185ii*.

DICRANACEAE

Mitrobryum koelzii gen. et sp. nov. (Fig. 1–10).

Plantae dioicae, flores feminei et masculi in plantis separatis terminales. Plantae caespitosae, parvulae, luteovirides, ad 5 mm altae. Caulis erectus, parce divisus, dense foliosus. Folia caulina sicca et humida erecto-patentia, haud secunda, ad 4 mm longa, lineari-lanceolata, integra, attenuata, superne canaliculato-tubulosa; nervo basi tertiam folii occupante, strato unico abaxiali stereidarum; cellulis basilaribus distinctis, inflatis, laxis; mediis et superioribus angustis, elongatis, ca. 7 μ latis, 30–75 μ longis, marginalibus versus sensim angustioribus; parietibus haud incrassatis. Folia perichaetalia ad 5 mm longa, inferne ovata, superne abrupte lineari-attenuata. Pedicellus siccus parce flexuosus, 6–7 mm longus, flavus, inferne rufescens. Capsula erecta, ovalis, 1.5 mm longa, flava, sine stomatibus; cellulis plerumque subrectangularibus, parietibus longitudinalibus partim valde incrassatis. Peristomium simplex; dentibus 16, indivisis, lineari-lanceolatis, dense papillois, 0.4 mm longis, ochraceis. Sporae ovaes, diam. 10–13 μ , asperulae. Annulus praesentius. Operculum rostratum, 1 mm longum. Calyptra mitrata, basi dense setifera.

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FIGURES 1-18. Indian mosses. — 1-10. *Mitrobryum koelzii*. 1-2. Leaves, $\times 22$. 3-5. Leaf cross sections, $\times 240$. 6. Perichaetial leaf, $\times 22$. 7. Hairs of calyptra, $\times 100$. 8. Capsule with calyptra, $\times 12$. 9. Capsule with detached operculum, $\times 12$. 10. Peristome tooth, $\times 100$. — 11-18. *Syrrhopodon assamica*. 11-12. Leaves, $\times 22$. 13. Propagulum, $\times 100$. 14-15. Leaf tips, $\times 100$. 16-18. Leaf cross sections, costa, lamina, and margin, $\times 240$.

UTTAR PRADESH: Tehri, Chitona, on earth in forest, 11,000 ft., *Koelz* 22015 (us—holotype).

The new genus is closely related to *Campylopus* and *Pilopogon* in the Dicranaceae. From all closely related genera it is distinct by the mitrate calyptra with setiferous lobes. The nature of the calyptral fringe is unlike the fimbriate condition common in related genera. Here the hairs arise in erect clusters from the outer surface rather than the margin, and they resemble those of the leucobryoid genus *Schistomitrium* in structure and appearance. The new genus is also very distinct in having 16 undivided papillose peristome teeth. Of the related genera only *Pilopogon* is similar, having papillose teeth that are sometimes undivided. *Pilopogon* differs by the cucullate calyptra, straight seta, shorter leaf cells, and the two distinct stereid bands in the costa. The vegetative plants of *Mitrobryum* resemble *Dicranodontium* because of the elongate leaf cells, but even sterile material can be distinguished by the presence of only one distinct stereid band in the costa. The appearance of the transverse section of the costa distinguishes *Mitrobryum* from all relatives but *Campylopus*. In the latter genus, however, cucullate calyptrae, divided striate peristome teeth, undifferentiated perichaetial leaves, and shorter leaf cells all differ. The new genus could key to *Brothera* in Brühl's (1931) key, but the leaf anatomy is totally different.

LEUCOBRYUM JUNIPEROIDEUM (Brid.) C. Müll. The species was originally described from the Canary Islands and Réunion and has only recently been more widely reported—from West and Central Europe (Pilous, 1962) and Madagascar, Turkey, Caucasus, China, and Japan (Bonnot, 1964). From its description, *L. rhizophyllum* Warnst. of Japan, another species with only two layers of leucocysts throughout the leaf, seems very similar if not the same.

ASSAM: Khasi Hills, Pynursla, on log in forest, *Koelz* 23661.

CALYMPERACEAE

Syrhropodon assamicus sp. nov. (Fig. 11–18).

Planta corticola, sterilis, flavoviridis, humilis, ad 5 mm alta. Caulis brevis, erectus, parce divisus, dense foliosus. Foliae dimorphae, inferne anguste oblongae, superne longiores, angustae obovatae, propaguliferae. Folia caulina breve acuta, ad 4.5 mm longa, sicca incurvata, involuta, humida patentia, subplana; marginalibus suprabasilaribus anguste limbatis, superne interrupte limbatis et pauce serrulatis; nervo percurrente, laeve, inferne 75μ lato; cellulis nervalibus ventralibus elongatis; cellulis laminarum basilaribus internis magnis, in area hyalino cancellato valde limitato superne acuto dispositis, basilaribus marginalibus aliquantum elongatis et angustatis, proxime superioribus sensim quadratis; cellulis mediis et superioribus subquadratis, diam. 8–11 μ , dorso plerumque pluripapillosis, ventraliter ad apicem mamillae altae pluripapillosis. Propagula multiseptata lineata, ad 600 μ longa, 15 μ lata, in fasciculis elongatis ventraliter in medio juxta nervum disposita.

ASSAM: Cherrapunjee, on live tree in the open, 4,000 ft., *Koelz* 33658 (us—holotype; MICH—isotype).

The new species has a serrulate but interrupted upper leaf border of elongate cells, a combination of characters known otherwise only in the West African *S. subdisciformis* (Dus.) Fleisch. In the latter species, however, the unbordered portions of the leaf apex are closely serrulate; in the present species they are essentially entire. The nearest records for the genus geographically are in the Malay Peninsula and southward where a number of species—*S. semiliber* (Mitt.) Fleisch., *S. wiemansii* (Fleisch.) Fleisch., *S. watsii* (Broth.) Fleisch.—having interrupted but entire margins occur. Two species

more remote in relationship are *S. tjibodensis* (Fleisch.) Fleisch. of Indonesia and *S. bartlettii* Bartr. of the Philippines, both of which have uninterrupted entire borders, cancellinae rounded above, and short propagula composed of short cells. The common American *S. parasiticus* (Brid.) Broth. has, among other distinctions, leaf cells with single papillae dorsally and nonpapillose mamillae ventrally.

POTTIACEAE

ANOECTANGIUM AESTIVUM (Hedw.) Mitt. In India, the species seems very common at the higher elevations. The widely accepted name *A. compactum* Schwaegr. has recently been placed in synonymy. Schwaegrichen had provisionally placed the older name, *A. aestivum*, in the synonymy of his species.

UTTAR PRADESH: Dhakuri Pass, on earth on forest opening, 10,000 ft., *Koelz* 20137.

ANOECTANGIUM STRACHEYANUM Mitt. This species and *A. euchloron* (Schwaegr.) Mitt. seem relatively distinct from most others in the genus by the quadrate cells extending to the leaf base along the margin. In *A. stracheyanum* further distinctions are the narrowly acute leaf apex and the often highly developed protonemal outgrowths. The name *A. tortifolium*, often used for this species, originated in 1857 with Wilson but was not validated until 1870 by Jaeger, well after Mitten's name was established.

UTTAR PRADESH: Tehri, Gangi, on cliff in shade, 8,000 ft., *Koelz* 21876.

ANOECTANGIUM THOMSONII Mitt. The name *A. crispulum*, often used for this species, has never been validated.

UTTAR PRADESH: Mussoorie, on cliff, 7,000 ft., *Koelz* 21614; Tehri, Jhala Chatti, on earth bank in pine forest, 5,000 ft., *Koelz* 21981.

HYOPHILA PERANNULATA Ren. & Card. The specimen agrees in all described features with the original collection from Sikkim (Renauld & Cardot, 1895). I have found no other reports of the species. The broad annulus, 6–8 cells wide, occurs rather erratically in the Pottiaceae, being noted additionally in *Merceyopsis minutissima* Dix., *Trichostomum perannulatum* Dix. & P. de la Varde, and in *Leptodontium*.

ASSAM: Mawphlang, 6,000 ft., on tree trunk in deep forest, *Koelz* 31837.

BARBULA MICHIGANENSIS Steere. The only previous reports of this propaguliferous moss are from the type locality on the southern shore of Lake Superior. Though there is some variation in the length of the leaf apices, the description and illustrations of the Michigan specimens can be perfectly matched in the Indian material. While probably widely distributed in Assam, the moss apparently has not been recognized in India under any name, being passed over because of its lack of sporophytes.

ASSAM: Khasi Hills, Shillong Peak, bank in forest, 6,000 ft., *Koelz* 24144; Mawphlang, on rock wall in open, 6,000 ft., *Koelz* 31596, 31992.

BARBULA GREGARIA (Mitt.) Jaeg. The specimen shows the same type of massive propagulum that I have observed in the type series in the Mitten Herbarium (NY).

UTTAR PRADESH: Jalki, on earth bank in open, *Koelz* 21685.

DIDYMODON RECURVUS (Griff.) Broth. Natürlich. Pflanzenfam. 1(3): 405. 1902.

Gymnostomum recurvum Griff., Calcutta Jour. Nat. Hist. 2: 482. 1842.

Gymnostomum rufescens Hook. in Schwaegr., Sp. Musc. Suppl. 3(1): 206a. 1827 (*hom. illeg.*).

- Barbula rufescens* Mitt., Jour. Linn. Soc. Bot. Suppl. 1: 33. 1859.
Desmatodon recurvus (Griff.) Mitt., Jour. Linn. Soc. Bot. Suppl. 1: 37. 1859.
Didymodon rufescens (Mitt.) Broth., Natürlich. Pflanzenfam. 1(3): 406. 1902.
Didymodon strictifolius Dix. & P. de la Varde, Arch. Bot. 1: 167. 1927.

Mitten's (1857) citations and misuse of Griffith's name *Gymnostomum recurvum* have left complete nomenclatorial confusion between this and the following species. As shown by Dixon (1922), Griffith's species should be identified with what has been called *Gymnostomum rufescens* Hook. The species is quite distinct in its reddish color and leaves that remain stiff and erect when dry.

ASSAM: Khasi Hills, Pynursla, on tree, 4,000 ft., *Koelz* 23418; Mawphlang, on rock in open, 6,000 ft., *Koelz* 31424.

DESMATODON GEMMASCENS Chen, Hedwigia 80: 297. 1941.

- Gymnostomum longirostre* Griff. (in part), Icon. Plant. Asiat. ii Pl. xcv, Fig. II. 1849(?).
Tortula cacuminata Wils., Jour. Bot. Kew Misc. 9: 322. 1857 (*nom. nud.*).
Desmatodon recurvus sensu Mitt., Jour. Linn. Soc. Bot. Suppl. 1: 37. 1859. (Not *Gymnostomum recurvum* Griff.)
Didymodon gemmascens Broth., Symb. Sin. 4: 38. 1929 (*hom. illeg.*).

The species has a long nomenclatorial history, but surprisingly the name provided by Chen (1941) for a Chinese specimen seems to be the only valid name. The Griffith (1849) illustration is included in the synonymy, provisionally, on the basis of Mitten's (1859) concept and the comments of Dixon (1922). The legend on the Griffith plate indicates that parts I, II, and III represent *Gymnostomum longirostrum*, but it is at least partly and possibly largely in error. The illustration itself seems inadequate for definite identification.

TORTULA WEBSTERI Robins. When this species was described (Robinson, 1965), two points of interest were overlooked. I did not know that Narinder Chopra's determinations of the Webster and Nasir collections from Kashmir had been published (Webster & Nasir, 1965). Unfortunately the names were taken from material as left at the time of Chopra's death and the paper contains many misidentifications. In that material, some of the *Tortula websteri* was completely overlooked and some was reported as *Pohlia nutans* (Hedw.) Lindb. Secondly, and of more interest, is the close resemblance of *T. websteri* to *T. californica* Bartr. The type of Bartram's species, seen through the courtesy of the Farlow Herbarium, shows the following differences: leaves rather ovate rather than oblong, leaf margin nearly plane rather than distinctly reflexed, basal leaf cells of cauline leaves quadrate rather than laxly rhomboidal, and upper leaf cells essentially without thickenings rather than with distinct thickenings in the corners. The two species otherwise seem alike. The quadrate basal cells of *T. californica* are the most obvious distinction.

FUNARIACEAE

PHYSCOMITRIUM CYATHICARPUM Mitt. Mitten (1859) noted the relationship of this species to *P. immersum* Sull. of North America. In view of the conspecificity of many mosses with such distributions, I have compared the two. I find that the operculum of *P. cyathicarpum* has a more prominent apiculus and the leaves are generally laxer with more elongate cells and a more slender apex. This essentially confirms Mitten's observations.

RAJASTHAN: Jaipur, Sawai Madhopur, on ground, in shady semixerophytic forest, *Koelz* 19709.

FUNARIA. The following key to some of the Indian species is based partially on type material in the Mitten Herbarium (NY).

KEY TO SOME INDIAN SPECIES OF FUNARIA

1. Minute plants a few millimeters high; urn of capsule short, hemispherical, membranous (India, Sudan) F. NUTANS
1. Plants with sporophytes over 1 cm high; capsules longer than wide, with firm walls 2
 2. Capsule strongly asymmetric, with large asymmetric teeth (Cosmopolitan) F. HYGROMETRICA
 2. Capsule essentially symmetric, teeth small and straight, or lacking 3
3. Costa excurrent 4
3. Costa ending in or before the apex 5
 4. Operculum flat (India) F. PERROTTETII
 4. Operculum short conical (Tibet, India) F. PILIFER
5. Leaves obovate; base of capsule short, rather abrupt 6
5. Leaves narrowly elliptical; base of capsule long and tapering 7
 6. Leaves membranous, upper margin serrate with distinct border of narrow cells (Java, Burma, Assam) F. WICHURAE
 6. Leaves rather succulent, margin strongly crenulate to entire, without distinct border (India) F. ROTTLERI
7. Capsule 2.5-3 mm long, with small teeth (India) F. PHYSCOMITRIOIDES
7. Capsule about 1.5 mm long, without evident teeth (India) F. WALLICHII

FUNARIA HYGROMETRICA Hedw. For the present I would include here material from lower elevations with strongly compressed capsules (*F. calvescens* Schwaegr.) and material from higher elevations with shorter sporophytes and larger spores (up to 25μ).

FUNARIA NUTANS (Mitt.) Broth. This minute species has recently been reported from Africa (Pettet, 1967), apparently being rather common in the Khartoum region. There seem to be different opinions regarding the type locality of the species. Wilson (1857) cites a locality near Moradabad in the upper Ganges valley. Mitten (1859), citing the same specimen (*Thomson 355*), indicates a locality near Lahore, Punjab, in the upper Indus system. In neither case is the locality East Bengal as stated by Pettet (1967).

RAJASTHAN: Jaipur, Sawai Madhopur, on ground, in shady semixerophytic forest, *Koelz 19709*.

FUNARIA PERROTTETII (Mont.) Broth.

Nielgherries, fragment from Montagne Herbarium (NY—type).

FUNARIA PHYSCOMITRIOIDES Mont.

Nielgherries, fragment from Montagne Herbarium (NY—type). UTTAR PRADESH: Mussoorie, on cliff, 7,000 ft., *Koelz 21584, 21594, 21617, 21618*.

FUNARIA PILIFERA (Mitt.) Broth.

TIBET: Rondu, *Thomson s.n.* (NY—type).

FUNARIA ROTTLERI (Schwaegr.) Broth. Specimen from Mitten Herbarium without data (NY).

FUNARIA WALLICHII (Mitt.) Broth. Brotherus (1924) placed the species in a group with 16 simple peristome teeth, but none of the material cited below shows any peristome teeth.

NEPAL: *Wallich s.n.* (NY—type). UTTAR PRADESH: Urni, Tehri, 7,500 ft., earth bank in forest, *Koelz 21989*. ASSAM: Khasi, "Moflong," *Griffith*, fragment from Hooker Herbarium (NY); Khasi Hills, Laitlynkot, 6,000 ft., on ground and earth bank in open, *Koelz 23310*,

23375; Mawryngkneng, 4,000 ft., on ground in forest, *Koelz* 28558, 28561, 28562; Mawphlang, 6,000 ft., on earth cut in open grassland, *Koelz* 31998, 32002.

FUNARIA WICHURAE (Fleisch.) Broth. The species was described from Java and has been reported by Bartram (1943) from Burma. There are no previous reports for India.

ASSAM: Mawphlang, on earth bank and in cut in open grassland, 6,000 ft., *Koelz* 31993, 31997, 32124.

BRYACEAE

Epipterygium koelzii sp. nov. (Fig. 19–24).

Planta sterilis, humilis, pallido-viridis, inferne rufescens. Caulis procumbens, 5 mm longus. Foliae caulium sterilium dimorphae; foliae dorsales ovales, ad 1 mm longae, breve acutae; foliae laterales obovatae, ad 2.5 mm longae, breve acuminatae; foliae omnes remotae, in sicco vix mutatae, basi angustae, planae, laxi areolatae, parci limbatae, integrae; nervo brevi, plerumque sub medio evanido, saepe crasso et abrupte terminato; cellulis magnis, laxis, mediis ad 75 μ longis, 40 μ latis, marginalibus parce angustioribus, 1–3 serialibus.

UTTAR PRADESH: Kapkot, 4,200 ft., in damp cave, *Koelz* 20056 (us—holotype).

The new species is most distinct in the relatively short and often broad costa. The very broad leaves and lax leaf cells also provide a contrast with the only other species presently recognized from Asia, *E. tozeri* (Grev.) Lindb. A West Indian species, *E. wrightii* (Sull.) Lindb., is very similar, but has somewhat longer costae and has very attenuate tips on the smaller dorsal leaves. From its description, *E. pellucens* Herz. of Bolivia seems to be very closely related, but the type, kindly loaned by the Institut für Botanik at Jena, shows a less succulent appearance, a more attenuate leaf apex on the dorsal leaves, a shorter more rounded leaf base, and a generally rather longer more slender costa. The Bolivian species does not seem particularly distinct from *E. wrightii*.

BRYUM HEMISPHAERICARPUM C. Müll. The determinations are based on the very short broad capsules. The species otherwise is very close to *B. coronatum* Schwaegr.

UTTAR PRADESH: Nainital, Thandi Sarak, 6,300 ft., on wall in between stones, *Srivastava* 890vi (Srivastava, 1966); Jalki, 7,000 ft., in open on earth bank, *Koelz* 21682.

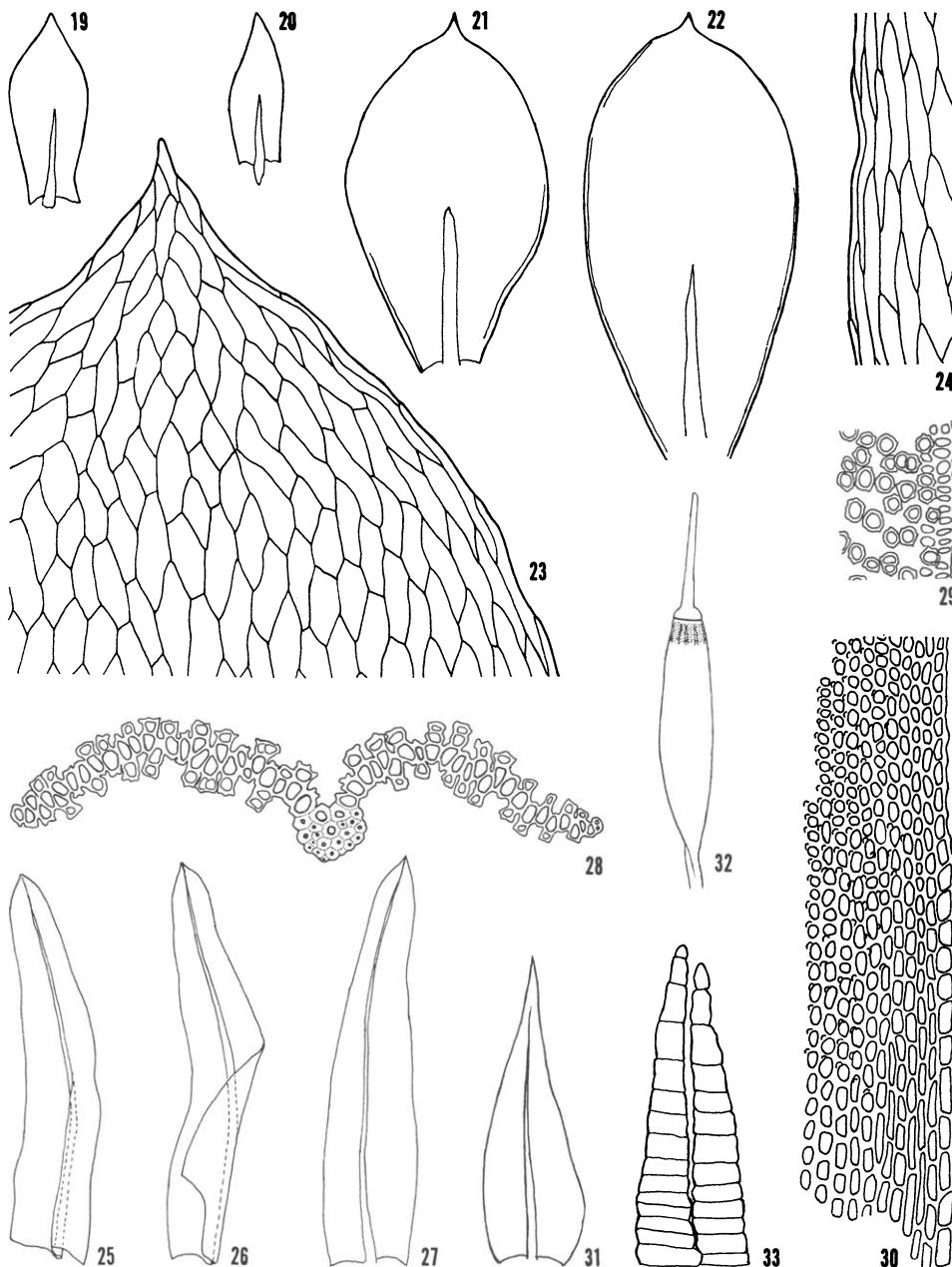
BRYUM TERETIUSCULUM Hook. The species is often treated as a synonym or a variety of *B. alpinum* With. The two species are very similar in aspect, but I find the Indian material with leaves consistently less strict, with margins more strongly recurved and serrate toward the apex, and the capsules more asymmetric.

UTTAR PRADESH: Mussoorie, 7,000 ft., on cliff, *Koelz* 21575; Tehri, Chitona, 12,000 ft., on boulder, *Koelz* 22035. ASSAM: Khasi Hills, Laitlynkot, 6,000 ft., on boulder in open, *Koelz* 23361; Mawphlang, 6,000 ft., on boulder in open, *Koelz* 31584.

MNIACEAE

MNIUM MAXIMOVICZII Lindb. The species is one of the most common in India. What is widely recognized as the *M. rostratum* Schrad. of Europe has the leaf cells as in *M. maximoviczii*, but differs by its more rounded rather than lingulate leaves. The Asiatic species distinguished by Kabiersch (1937) as *M. rostratum*, of which the Japanese specimen (*Ono* 27948) seems representative, has larger cells without a distinctive row along the costa. This Japanese material seems to represent a different and possibly undescribed species.

MANIPUR: Sungtun, *Koelz* 27074. ASSAM: Khasi Hills, *Koelz* 22950; Naga Hills, *Koelz* 25279, 25289; Mawphlang, *Koelz* 31367, 31418, 31459, 31466a, 31490, 31539, 31896, 31925, 31954, 31962, 31969, 32013, 32218.



FIGURES 19-33. Indian mosses. — 19-24. *Epipterygium koelzii*. 19-20. Dorsal leaves, $\times 22$. 21-22. Lateral leaves, $\times 22$. 23. Leaf tip, $\times 150$. 24. Lower leaf margin, $\times 150$. — 25-33. *Macromitrium incrustatifolium*. 25-27. Leaves, $\times 22$. 28. Leaf cross section, $\times 240$. 29. Upper leaf margin. $\times 240$. 30. Basal leaf margin, $\times 240$. 31. Perichaetial leaf, $\times 22$. 32. Capsule, $\times 15$. 33. Peristome teeth, $\times 240$.

ORTHOTRICHACEAE

Macromitrium incrustatifolium sp. nov. (Fig. 25–33).

Planta corticola, fuscoviridis. Caulis primarius repens ad 5 cm longus; multos ramos parallelos, 5–10 mm longos, emittens. Folia sicca adpressa in spira curvata, madida patula, anguste ovata, breviter acuta, interdum minute apiculata, ca. 2.5 mm longa, 0.5–0.7 mm lata; nervo laeve, percurrente, inferne 50μ lato; cellulis laminarum fere ubique subquadratis basi marginalibus et submarginalibus parum elongatis, hyalinis, cellulis basi internis laevis, $7\text{--}8\mu$ latis, $5\text{--}13\mu$ longis, cellulis mediis et superioribus parum major, multas projecturas aggregatas bi- et tricellulares papillosas emittentes. Folia perichaetialia triangularis, longe acuminata, ad 3 mm longa; cellulis elongatis, laevibus. Pedicellus ca. 7 mm longus, rufescens. Capsula erecta, anguste ovalis, 2 mm longa, flavescens, sub ore rufescens. Peristomium simplex; dentibus 32, binis quaternisque aggregatis, anguste triangularibus, pallidis, papillosis. Sporae ovoides, $20\text{--}23\mu$ longae, asperulae. Operculum longe rostratum, ad 1.2 mm longum. Calyptra mitrata, pilosa.

ASSAM: Lushai Hills, Hmuntha, 5,000 ft., on top limb of a forest tree, *Koelz 27473* (vs—holotype, MICH—isotype); Khasi Hills, Nongpoh, 2,000 ft., on boulder in open, *Koelz 22682* (vs, MICH).

The leaves of *M. incrustatifolium* are notable for the lack of elongate basal cells and for the presence of innumerable enations from the upper leaf cells that form a sort of crust over the surface. The short basal leaf cells are suggestive of *Groustiella*, but other structures clearly indicate relationships in *Macromitrium*. I have never considered *Groustiella* an unnatural grouping, but perhaps a more careful characterization is necessary. For the present, I would withhold *Macromitrium incrustatifolium* from *Groustiella* by the lack of narrowly elongate cells on the basal leaf border. Regarding the enations from the upper leaf cells, these usually bi- or tricellular projections occur on both surfaces, but individual lamina cells usually bear only one, either dorsal or ventral. While distinctive and to my knowledge not previously noted in the literature, such projections on the upper leaf cells are not unique to this species. I know two additional species with the same leaf structure, *M. tongense* Sull. from the Pacific islands of which I have seen the type specimen, and an African species from Kenya which I have tentatively determined as *M. amaniense* P. de la Varde. These latter species closely resemble each other and differ from *M. incrustatifolium* by the possession of rather elongate basal cells with thick lateral walls and narrow lumens. The African species differs further by the hairless calyptra and the markedly shorter and broader capsules.

MACROMITRIUM MOORCROFTII (Hook. & Grev.) Schwaegr. I consider *M. rigbyanum* Dix., described from Assam, to be a synonym. The thickening around the mouth of the capsule that is emphasized by Dixon (1937) seems to occur in many species where it has not been noticed. Even so, the structure illustrated for *M. moorcroftii* in Schwaegrichen (1826) is suggestive of this thickening.

ASSAM: Khasi Hills, Pynursla, 4,000 ft., on boulders, logs, and trees in forest, *Koelz 23603*, *23610*, *23660*; Mawphlang, 6,000 ft., on trees in forest and in open, *Koelz 31313*, *31909*; Cherrapunjee, 4,000 ft., on live trees in open, *Koelz 33644*, *33660*, *33699*. UTTAR PRADESH: Almora, Jageshwar, 5,500 ft., on oak tree beside river, *Srivastava 1045i*.

METEORACEAE

PAPILLARIA FORMOSANA Nog. var. PILIFERA Nog. Horikawa and Ando (1964) cite the variety from South India, Burma, and Thailand. The numerous small subquadrate alar cells are rather distinctive.

ASSAM: Mawphlang, 6,000 ft., on trees in forest, *Koelz 31542b*, *31667a*.

BARBELLA STEVENSII (Ren. & Card.) Fleisch. The species was originally described from Sikkim and is represented by numerous collections from that area—*Decoly & Schaul 722b, 1675, 2430; Bretandeanu 13, 817* (all NY). On the basis of characters given by Dixon (1937), I consider *Lindigia asiatica* Dix. of Assam a synonym. This seems true in spite of the fact that Dixon determined another Assam specimen (Khasi Hills, 2,000 ft., Mitten Herb., NY) as *Barbella stevensii* and evidently knew of the latter species. The autoicous nature of the species if taken alone might suggest *Lindigia* rather than *Barbella*.

ASSAM: Naga Hills, Takubama, 7,000 ft., on twig in forest, *Koelz 25967*; Mawphlang, 6,000 ft., on tree in open, *Koelz 31908*.

NECKERACEAE

THAMNIUM SIAMENSE Horik. & Ando. One old capsule showed the following characters: seta 8–9 mm long, distinctly rough above; capsule 1.5 mm long, 1 mm wide; outer and inner peristome papillose, without striations, cilia of the inner peristome rudimentary (apparently naturally so although the teeth are poorly preserved). The sporophyte characters are more those credited to *Porotrichum* than to *Thamniium*, but the vegetative characters, upon which one must usually rely, are clearly those of *Thamniium*. One species of *Porotrichum* from Sikkim, *P. fruticosum* (Mitt.) Jaeg., has similar sporophyte characters, but more oblong leaves, a shorter costa, and longer leaf cells.

ASSAM: Lushai Hills, Blue Mountain, 7,000 ft., on forest tree trunk, *Koelz 32995*.

LESKEACEAE

THUIDIUM. The following key to some of the Asian species of the subgenus *Thuidiella* is based partly on type material in the Mitten Herbarium (NY) and the Bartram Herbarium (FH).

KEY TO SOME INDIAN SPECIES OF THUIDIUM

- | | |
|---|------------------|
| 1. Seta scabrous, at least slightly roughened above | 2 |
| 1. Seta smooth throughout | 9 |
| 2. Seta scabrous throughout; plants regularly bipinnately branched | 3 |
| 2. Seta smooth on lower half or more; plants pinnately to bipinnately branched; branches with few or no paraphyllia | 4 |
| 3. Branches with dense cover of paraphyllia (Himalayas, Ceylon, Burma, Annam, Philippines, Indonesia, Solomon Islands, Samoa) | T. MEYENIANUM |
| 3. Branches with paraphyllia sparse or lacking (Tonkin) | T. BONIANUM |
| 4. Seta 8–12 mm long | 5 |
| 4. Seta 15–20 mm long | 7 |
| 5. Main stems with small remote leaves and few or no paraphyllia; very small delicate plants usually on rocks (Assam, Burma, Philippines, New Guinea) | T. INVESTE |
| 5. Main stems densely covered with paraphyllia, stem leaves mostly contiguous or imbricated; on tree trunks or logs | 6 |
| 6. Seta very slightly roughened above; plants often regularly bipinnate (Nilghiri, Burma, Siam, Tonkin, South China, Java, Philippines) | T. TAMARISCELLUM |
| 6. Seta rough on upper half; plants pinnate to laxly bipinnate (Yunnan, Assam) | T. VENUSTULUM |
| 7. Plants closely and regularly bipinnate; paraphyllia nearly lacking (Central India) | T. BROTHERI |
| 7. Plants pinnate to laxly bipinnate; paraphyllia numerous on main stem | 8 |
| 8. Apical cells of paraphyllia usually bearing many papillae (West Himalaya, Nepal, Sikkim) | T. SPARSIFOLIUM |
| 8. Apical cells of paraphyllia with a single point (Nepal, Assam) | T. MINISULUM |
| 9. Capsules mostly erect and symmetric | 10 |
| 9. Capsules inclined or horizontal, slightly to strongly curved | 11 |

10. Branches curved and clustered together when dry; paraphyllia sparse or lacking on branches; perichaetial leaves with long teeth or cilia on the margins (Himalaya) T. HAPLOHYMENIUM
10. Bipinnate, branches spreading; paraphyllia numerous on branches; perichaetial leaves entire (Yunnan) T. FUSCATUM
11. Paraphyllia densely covering stems and branches (Yunnan) T. VESTITISSIMUM
11. Branches with paraphyllia sparse or lacking 12
12. Seta usually 20 mm or more long; branch leaves more or less acuminate (Yunnan, Burma) T. TALONGENSE
12. Seta 10–15 mm long; branch leaves various 13
13. Apical cells of the paraphyllia pluripapillose; branch leaves lanceolate, acuminate; plants often regularly bipinnate (Nilghiri, Burma, Siam, Tonkin, South China, Java, Philippines) T. TAMARISCELLUM
13. Paraphyllia usually papilliform or with pointed apical cells; ultimate branch leaves obtusely acuminate 14
14. Stem leaves squarrose; leaf cells pellucid or translucent (Assam) T. SQUARROSULUM
14. Stem leaves usually incurved or contorted when dry; leaf cells opaque or obscured by dense papillae 15
15. Plants reddish, rather regularly bipinnate; endostome with cilia in groups of three (Yunnan) T. RUBIGINOSUM
15. Plants yellowish-green, pinnate to laxly bipinnate; endostome with cilia single or in pairs (Nepal, Assam) T. KOELZII

Among the species that have proven indistinct or doubtful are the following: *T. asperulisetum* Ren. & Card. (see *T. minusculum*), *T. burmense* Bartr. (see *T. talongense*), *T. contortulum* (Mitt.) Jaeg. (see *T. sparsifolium*), and *T. subpellucens* Dix. (see *T. squarrosulum*).

THUIDIUM BONIANUM Besch.

TONKIN: Nam Cong, *Bon 2413* (NY—isotype).

THUIDIUM BROTHERI Salm. Brotherus (1925) clarified the relationship of this central Indian species to the Himalayan *T. sparsifolium*. The species was described as possibly dioicous, but it seems unlikely.

THUIDIUM FUSCATUM Besch. The species was distinguished by Beschereille (1892) by the smooth seta, the rigid bipinnate branching, the long nerved and entire margined perichaetial leaves, and the oval, cylindrical, erect capsule.

THUIDIUM HAPLOHYMENIUM (Harv.) Jaeg. Harvey (1840) did not provide a description but did cite that of Schwaegrichen (1829), thus validating the species. Schwaegrichen, and Renauld and Cardot (1899) emphasize the usually erect capsules and pointed rather than obtuse branch leaves. The material seems most distinctive, however, in the branches becoming incurved and forming clusters when dry.

NEPAL: *Wallich H3351* (NY). SIKKIM: Lachen, 10,000 ft., *Hooker 1113* (NY); Nangkli, 7,000–8,000 ft., *Hooker 1114* (NY).

THUIDIUM INVESTE (Mitt.) Jaeg. The very small size and common occurrence on rock are reminiscent of *T. pygmeum* B.S.G. of the north temperate areas, but the latter is easily distinguished by the papillose branches and totally smooth seta.

Thuidium koelzii sp. nov.

Leskea remotifolia Hook. ined.

Planta autoica, tenella, lutescenti-viridis. Caulis repens, subbipinnatus; paraphylliis brevibus, cellula apicali acuta, unipapillata; ramis sine paraphylliis. Folia caulina patula, versus apicem

reflexa, late ovata, ad 0.5 mm longa, longe acuminata; marginibus inferne revolutis, integris vel superne subcrenulatis; costa infra apicem evanida; cellulis obscuris, rotundatis, utrinque uni-bipapillosis. Folia ramea sicca incurvata, madida patentia, ad 0.35 mm longa, oblongo-ovata, subobtusata vel breve acuta, marginibus ubique planis minute crenulatis; costa sub apice evanida; cellulis obscuris, distincte papillosis, cellula apicali truncata multipapillata. Folia ramulina minuta, caeterum rameis similia. Flora mascula minuta gemmiformis. Folia perichaetia erecta interior longissimo-acuminata, superne parce denticulata vel subintegra, costa ad basin acuminis evanida, rete laxo valde pellucido. Capsula in pedicello 12–15 mm longo, laevi, inclinata, ovalis vel subcylindrica, infra orem saepe strangulata. Operculo breve oblique rostrato. Peristomii dentes interni externis aequilongi, ciliis singularibus vel binis, paulo brevioribus, breve appendiculatis interpositis. Sporae ovaes, diam. ca. 13 μ . Calyptra cucullata, nuda.

ASSAM: Mawphlang, on trees and stones, 6,000 ft., *Koelz* 31400 (us—holotype, MICH— isotype), 31852, 31927, 31975. NEPAL: *Wallich* (NY).

Mitten's (1857) concept of *Leskea remotifolia* apparently followed Hooker's as represented by the Nepal specimen (Wallich, NY, E). Unfortunately Hooker never published his species, and neither Mitten nor any other author provided a description. For this reason the name remains invalid. The species seems to have been clearly understood as a leskeoid, however, and it is disconcerting and it seems totally unjustified to refer it to the synonymy of *Hypnum* (*Rhynchostegiella*) *scabrisetum* Schwaegr. on the basis of the misdetermination cited under the latter species by Schwaegrichen (1830), "In Nipal lectum sub *Leskeae remotifoliae* nomine dedit Pr. Hooker." Dixon (1938), citing the Wallich collection in the Edinburgh herbarium, equated it with *Thuidium squarrosulum* Ren. & Card., but Dixon's concept of the latter species seems incorrect as noted below.

Aside from the possible Asian relatives of *Thuidium koelzii* included in the key, there is the very similar American *T. mexicanum* Mitt. which has shorter-pointed stem leaves and more erect cylindrical capsules.

THUIDIUM MEYENIANUM (Hampe) Dozy & Molk. The species is common from low elevations from India to Polynesia and includes *Leskea trachypoda* Mitt. of India and *Hypnum faulense* Reichdt. of Melanesia in its synonymy. My earlier conclusions (1964) regarding synonymy with *T. involvens* of the Western Hemisphere prove completely erroneous. The American species is simply pinnate without paraphyllia on the branches.

ASSAM: Naga Hills, Nichuguard, on stone and tree trunk in forest, 1,000 ft., *Koelz* 33501, 33536.

THUIDIUM MINUSCULUM (Mitt.) Jaeg. As seen in all three Hooker and Thomson collections cited below, the seta of this species is roughened below the capsule. This, in combination with the elongate seta, leads me to place the species in relationship with *T. sparsifolium* of the central and western Himalayas, and to place *T. asperulisetum* Ren. & Card. of Assam in synonymy. I have not seen type material of *T. asperulisetum*, but its described features seem sufficiently clear. Dixon's concept of the species remains unclear, however. A note by Dixon attached to Hooker's Nepal specimen cited below says, "This agrees with *T. squarrosulum* Ren. & Card. in everything but that it has the summit of the seta subscabrous. I think it should go as a (form or) var. *subscabrisetum* of that. It is not *T. asperulisetum* Ren. & Card." Dixon unfortunately gave no indication of his concept of *T. asperulisetum*, but as indicated under *T. squarrosulum*, it is unlikely that Dixon saw authentic material of the species described by Renault and Cardot.

ASSAM: Khasi, *Hooker & Thomson 1071, 1072, 1092* (NY—syntypes); Naga Hills, on twig in forest, 7,000 ft., *Koelz 25967*. EAST NEPAL: *Hooker* (as *T. squarrosulum*) (NY).

THUIDIUM RUBIGINOSUM Besch. The cilia of the endostome being in groups of three is rather distinctive in the *Thuidiella* group. As described (Bescherelle, 1892), the species resembles *T. tamariscellum* in size and branching, but differs in leaf shape. The apical cells of the paraphyllia have not been noted.

THUIDIUM SPARSIFOLIUM (Mitt.) Jaeg. The seta is slightly roughened above in the type materials of both *T. sparsifolium* and *T. contortulum*, and the two seem identical in all other essential characters. The species were named at the same time, but I adopt *T. sparsifolium*. *Thuidium minusculum* seems very closely related but has uniformly pointed apical cells on the paraphyllia. In *T. sparsifolium*, paraphyllia with pointed and pluripapillose apical cells are intermixed and the latter usually predominate.

NEPAL: *Wallich* (NY—holotype). SIKKIM: Kurseing, 3,000–4,000 ft., *Hooker 1124* (holotype of *Leskea* (*Thuidium*) *contortula* Mitt., NY). UTTAR PRADESH: Nainital, 6,300 ft., on stone wall, *Srivastava 897i*.

THUIDIUM SQUARROSULUM Ren. & Card. I would place here *T. subpellucens* Dix. though I have not seen type material of either species. Dixon (1937) distinguished his species from *T. squarrosulum* by the very pellucid leaf cells. Dixon's concept of the latter species must be questioned, however, since, as originally described that species itself has pellucid and translucent leaf cells. According to Dixon, *T. squarrosulum* had leaf cells opaque and obscure and the costa markedly roughened or denticulate, and later Dixon (1938) definitely equated *T. squarrosulum* with *T. remotifolium* Hook. ined. From his various remarks it seems unlikely that Dixon had seen authentic material of either *T. squarrosulum* or another Renauld and Cardot species, *T. asperulisetum* (see *T. minusculum*). I cannot determine the source of Dixon's costal character for *T. squarrosulum*, since *T. remotifolium* also seems to have a smooth costa.

THUIDIUM STEVENSII Ren. & Card. The species has been placed in the *Thuidiella* group by Brotherus (1925), but the description indicates a sterile plant with branching paraphyllia and large appressed blunt stem leaves. This is more suggestive of a depauperate *T. glaucinum* (Mitt.) Jaeg. or some other member of the subgenus *Thuidium*.

THUIDIUM TALONGENSE Besch. The seta is smooth throughout, but its greater length (20 mm) inclines me to relate the species with *T. sparsifolium* and *T. minusculum*. The type series of *T. burmense* Bartr. from the Shan States of Burma (*Svihla 3373, 3351, 3405a, FH*) has been seen and matches in all essential characters the description of *T. talongense* from adjacent Yunnan. The Burmese specimens have paraphyllia with single pointed apical cells, but I have not seen material from Yunnan.

THUIDIUM TAMARISCELLUM (C. Müll.) Bosch & Lac. This species, ranging from India and the coast of China south to Indonesia, seems to vary somewhat in size and regularity of branching, but the paraphyllia consistently seem to end in multipapillose cells.

THUIDIUM VENUSTULUM Besch. I have not seen authentic material from Yunnan, but the very short extensively roughened setae seem very distinctive.

MANIPUR: Karong, ca. 3,500 ft., on tree trunk in open, *Koelz 26271*. ASSAM: Naga Hills, Kohima, ca. 5,000 ft., on live tree in forest, *Koelz 25346*.

THUIDIUM VESTITISSIMUM Besch. The species along with *T. meyenianum* and *T.*

fuscatum has a dense cover of paraphyllia on both stems and branches. Of these, *T. meyenianum* differs by its rough seta and *T. fuscatum* by its erect capsule.

HOOKERIACEAE

ERIOPUS REMOTIFOLIUS C. Müll. The specimen represents a considerable northward extension of the known range of the Indonesian and Philippine species, and is the first Indian record for the genus.

MANIPUR: Sungtun, 7,000 ft., on base of tree, deep forest, *Koelz 27080*.

SEMATOPHYLLACEAE

CLASTOBRYUM SURCULARE Dix. The original Griffith collection cited by Dixon (1933) was from Khasia, but no other collections have been reported.

ASSAM: Khasi Hills, Mawphlang, 6,000 ft., on live pine, *Koelz 32195A*.

CLASTOBRYUM TENUIRAMEUM (Mitt.) Dix. The determination is based primarily on the characterization given by Dixon (1933). The species was originally described from Sikkim.

MANIPUR: Sungtun, 7,000 ft., on tree in deep forest, *Koelz 27065*.

HACENIELLA ASSAMICA Dix. Horikawa and Ando (1964) mention an undetermined specimen from Thailand as a possible *Warburgiella* having linear cells bearing papillae at both upper and lower ends. The described features agree in all respects with the material cited below. It has seemed unlikely to me that this widely distributed and commonly fruiting moss would have remained unnamed until Dixon's (1937) treatment. However, I have failed to find any likely previous name except, as a remote possibility, *Stereodon* (*Rhaphidostichum*?) *glauco-virens* Mitt., the type of which I have not been able to locate.

ASSAM: Naga Hills, Kohima, 7,000 ft., on live tree in forest, *Koelz 25290*; Takubama, 7,000 ft., on live tree in open, *Koelz 25994*; Mawphlang, 6,000 ft., on log in forest and on bank cut in open, *Koelz 31533, 32016, 32125*. MANIPUR: Sungtun, 7,000 ft., on tree in deep forest, *Koelz 27065*.

GAMMIELLA PTEROGONIOIDES (Griff.) Broth. Only a few aged capsules survive on the plant but the following observations have been possible. On one sporophyte a calyptra persists clasping the seta just below the capsule as has been observed in the related genus *Acritodon* from Mexico. The inner peristome while rudimentary seems less so than indicated by Brotherus (1925), having segments with very irregular margins reaching perhaps as high as the outer teeth. The inner peristome seems at least partly adherent to the outer.

ASSAM: Mawphlang, 6,000 ft., on live hedge plant, *Koelz 31606*.

ACROPORIUM BAVIENSE (Besch.) Broth. The species was described from Tonkin, is reported from Thailand (Reed & Robinson, 1967), and seems to include *A. brevipes* (Broth.) Broth. of the Philippines.

ASSAM: Khasi Hills, Mawryngkneng, 4,000 ft., on log in forest, *Koelz 28537, 28587*.

BROTHERELLA YOKAHAMAE (Broth.) Broth. This apparently is the first report of the Japanese species from India. The specimen has been compared with *Takaki 13170* from Saitama Prefecture and agrees in all essential features. The species was reported from Hunan and Yunnan Provinces of China by Brotherus (1929).

UTTAR PRADESH: Tehri, Kophara, 4,500 ft., on log in forest, *Koelz 22247*.

HYPNACEAE

STEREODON FALCATUS (Schimp.) Fleisch. Previous Asian collections of this otherwise Central American species are cited by Brotherus (1929) from Yunnan and Setschwan Provinces of China under the name *S. subfalcatus* (Schimp.) Fleisch. Chinese material had originally been treated as a new species, *S. microsporus* Broth.

ASSAM: Naga Hills, Takubama, 7,000 ft., on mistletoe, *Koelz 25841*.

HEPATICAЕ

ARNELLIACEAE

GONGYLANTHUS HIMALAYENSIS Grolle. The specimen is sterile but matches the vegetative characters given by Grolle (1966).

ASSAM: Khasi Hills, Laitlynkot, 6,000 ft., on earth bank, *Koelz 23375*.

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The Effect of Sulfur Dioxide on the Inhibitory Influence of *Peltigera canina* on the Germination and Growth of Grasses¹

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Abstract. *Peltigera canina* is capable of inhibiting the germination of grass seeds. As the sulfur dioxide content of the atmosphere increases, the inhibitory capacity of *P. canina* decreases.

It has previously been illustrated (Pyatt, 1967) that the lichen *Peltigera canina* (L.) Willd. collected from the sand dunes at Kenfig (Glamorganshire), Wales, is capable of retarding the rate of germination and of limiting the subsequent growth of seedlings of various species of dune grass. It was observed in the field that grasses generally tended not to grow in close proximity to patches of *P. canina*.

During subsequent investigations, it became apparent that *P. canina* growing on the sand dunes near the steelworks at Port Talbot was frequently closely associated with grasses. As the only difference between this area and the one previously discussed is in the distance from the pollution source, an investigation was carried out in an attempt to establish whether the *P. canina* from the polluted area was capable of inhibiting grass germination to an extent comparable with material collected from a very slightly polluted area (Kenfig).

As the results earlier obtained (Pyatt, 1967) are in direct contradiction to those

¹ I thank Professor G. F. Asprey for advice in the preparation of this paper. The seeds were supplied by Suttons of Reading. I am indebted to the Nuffield Trust for a postgraduate scholarship.

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