

## POLYTRICHACEAE (MUSCI) IN TAIWAN (CHINA)

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**ABSTRACT.** Seventeen species of Polytrichaceae (Musci) occur in Taiwan. *Atrichum* P. Beauv. is represented by two species, *A. crispulum* Schimp. ex Besch. and *A. undulatum* (Hedw.) P. Beauv.; *Oligotrichum* Lam. & Cand. by two species, *O. suzukii* (Broth.) Chuang and *O. obtusatum* Broth.; *Pogonatum* P. Beauv. by ten species including one subspecies, *P. camusii* (Thér.) Touw, *P. cirratum* (Sw.) Brid. ssp. *cirratum*, *P. cirratum* ssp. *fuscatum* (Hyvönen) Mitt., *P. fastigiatum* Mitt., *P. microstomum* (Schwaegr.) Brid., *P. neesii* (C. Müll.) Dozy, *P. nudiusculum* Mitt., *P. perichaetiale* (Mont.) Jaeg., *P. proliferum* Mitt., *P. tahitense* Schimp. in Besch. and *P. urnigerum* (Hedw.) P. Beauv.; *Polytrichastrum* G. L. Sm. by two species, *P. alpinum* (Hedw.) G. L. Sm. and *P. formosum* (Hedw.) G. L. Sm.; and *Polytrichum* Hedw. by one species, *P. commune* Hedw. *Oligotrichum obtusatum* Broth. is recorded for the first time in Taiwan. The paper includes a key for all species, as well as diagnoses, illustrations and distributional data. Nomenclatural notes and discussions on taxonomy are also included.

### INTRODUCTION

Earlier reports of moss species of Polytrichaceae from Taiwan were made by Cardot (1905), Sawada (1914), Sasaoka (1927, 1928) and Ihsiba (1935). Noguchi (1934) reported *Racelopodopsis camusii* Thér. (= *Pogonatum camusii* (Thér.) Touw). Chuang (1937) also summarized the Polytrichaceae of the area in his treatment of the Taiwanese moss flora. Lai and Wang-Yang (1976) verified the presence of *Polytrichum commune* Hedw. var. *commune*, which was not included in Chuang's work. The results were summarized by Kuo and Chiang (1987) in their index.

### MATERIAL AND METHODS

The material consists mainly of specimens and data collected by the senior author and his wife, Soili Stenroos, during field trips in Taiwan in 1987 and specimens collected by Timo Koponen during his visit in 1970. Consequently, a list of relevant collecting sites is presented on a map (Fig. 1). Specimens under each species are presented only with a code of the map locality plus name of collector and collection number. For other specimens the entire label data is given. The study of other specimens is to a great extent limited to those preserved in the Botanical Museum, University of Helsinki (H). Specimens seen from other institutes are indicated by their herbarium acronym. All type specimens studied are marked with "!" and only those collected in China are presented. The nomenclature used is based on earlier revisions and in the case of the genus *Pogonatum* especially on Hyvönen (1989b).

General distribution is given mostly after literature records and therefore some of them are not verified by consulting specimens. The ranges given for China are largely based on records given by Hu and Wang (1987) for the distribution in eastern China, thus the data from other parts of the country is incomplete. The geographical units follow Norris and Koponen (1985)

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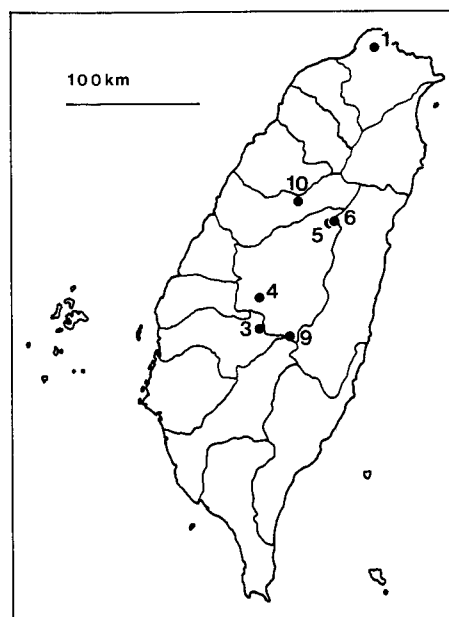


FIG. 1. Map of Taiwan showing location of collecting sites listed separately in the text above.

and the main division is according Wijk et al. (1962).

Collecting sites (Fig. 1)

1b. Taipeh Co.: Yangmingshan National Park, along trail from Shantzuhou to Chuanszu water falls, subtropical secondary rain forest, alt. ca. 400–600 m.

1d. -, -, Tzutzu road to Mt. Tatun, roadsides and subtropical secondary rain forest, alt. ca. 700–800 m.

1f. -, -, Luchiaokeng ecological protection area, trail from Hsiao Kuan-yin to Fonglin water falls, subtropical secondary rain forest, ca. 600–800 m.

3a. Chiayi: Mt. Ali, planted *Chamaecyparis formosensis* – *Cryptomeria japonica* wood on NW slope above Mt. Ali station, warm temperate montane forest zone, ca. 2300–2400 m.

3b. -, -, valley on S-slope with open planted *Chamaecyparis formosensis* wood, warm temperate montane forest zone, ca. 2300 m.

3c. Chiayi: along road sides in Alishan village, warm temperate montane forest zone, ca. 2200 m.

3d. -, Mt. Ali, planted *Cryptomeria japonica* forest on NW slope, warm temperate montane forest zone, ca. 1800–2100 m.

3e. -, -, along railway and trails in planted *Cryptomeria japonica* forest on NW slope, warm temperate montane forest zone, ca. 1800–2000 m.

3g. Chiayi: planted *Chamaecyparis formosensis* – *Cryptomeria japonica* wood on NW slope above Mt. Ali station, warm temperate montane forest zone, ca. 2300 m.

3h. -, Wu feng, Alishan forest recreation area, Alishan, roadside soil banks and cliffs in the village, 2200 m.

4d. Nantou: Chitou experimental forest of National Taiwan University, Mt. Hon-Hong, original warm temperate evergreen rain forest, ca. 1300 m.

- 4e. -, -, planted *Cryptomeria japonica* - *Cunninghamia lanceolata* wood on NW slope, S of forest station, warm temperate rain forest zone, ca. 1200 m.
- 5a. Taichung Co.: near Tayuling, creek bed in *Tsuga chinensis* - *Abies kawakamii* - *Stranvaesia* sp. forest, orohemiboreal zone, ca. 2600 m.
- 6a. Hualien: Shyu-lin, roadsides between Tayuling and Mt. Ho-huan, orohemiboreal zone, ca. 2550-2700 m.
- 6c. -, -, -, lower oroboreal zone, ca. 2700-3100 m.
- 6d. -, -, -, creek bed shaded by narrow strip of *Abies kawakamii* wood, lower oroboreal zone, ca. 2800 m.
- 6f. -, -, -, valley of small stream with deep unforested slopes, lower oroboreal zone, ca. 2800 m.
- 6h. Nantou: Jana-ai-hsiang, Taroko National Park, Mt. Hohuan forest recreation area, ca. 0.5 km along the road from Sung-hsieh hostel to Tayuling, open WNW-slope of schistose gravel, alt. ca. 3160 m.
- 6i. -, -, -, E peak of Mt. Hohuan, SW from Sung-hsieh hostel, peak area of cliff outcrops with meadow and scrub, ca. 3445 m.
- 6j. -, -, -, NE-slope above Sung-hsieh hostel, lower oroboreal *Abies kawakamii*-forest, ca. 3200-3300 m.
- 6k. -, -, -, SSE-slope NE from Sung-hsieh hostel, orohemiboreal *Abies kawakamii* forest with scattered *Tsuga chinensis* var. *formosana*, alt. ca. 3100 m.
- 6l. -, -, -, NNE slope NE from Sung-hsieh hostel, mesic orohemiboreal *Abies kawakamii* forest, alt. ca. 3140 m.
- 6q. -, -, -, NW slope of Mt. Hsiao-chilai, along trail from Sung-hsieh hostel to Mt. Hsiao-chilai, orohemiboreal *Abies kawakamii* forest with scattered *Tsuga chinensis* var. *formosana*, 3120-3170 m.
- 6s. -, -, -, E-slope of Mt. Hohuan, mesic orohemiboreal *Abies kawakamii* forest with scattered *Tsuga chinensis* var. *formosana*, 3100-3140 m.
- 9a. Chiayi-Nantou: Yushan National Park, trail from Tataka saddle parking place to Pai-yun cottage, *Miscanthus* grassland with scattered *Pinus* spp., dry S-SW slope, ca. 2600-3100 m.
- 9b. -, -, -, ESE-slope with orohemiboreal forest of *Tsuga chinensis* var. *formosana* and *Abies kawakamii*, alt. 3100-3400 m.
- 9c. -, -, -, trail from Paiyun cottage to western peak of Mt. Morrison (Yu-shan), mesic lower oroboreal *Abies kawakamii* forest on SE slope, ca. 3500 m.
- 9d. -, -, -, lower oroboreal *Abies kawakamii* forest on NNE slope, alt. ca. 3500 m.
- 9e. -, -, -, old forest fire area on SW slope with dense, low meadow of *Yushania niitakayamensis* with open patches of schistose gravel, ca. 3500 m.
- 9g. -, -, -, trail from Pai-yun cottage to the main peak of Mt. Morrison (Yu-shan) on SW slope, upper oroboreal schistose cliffs and boulder fields, 3800-3996 m.
- 9h. -, -, -, on SW slope, middle oroboreal *Juniperus formosana* scrub with open patches of schistose gravel, 3700-3800 m.
- 10a. Taichung Co.: Hoping-hsiang, 33 km from Tungshih along the road to Ta-huseh-shan forest recreation area, warm temperate rain forest, alt. ca. 1900 m.
- 10b. -, -, -, Ta-huseh-shan forest recreation area, dry SW slope of Hsia-huseh-shan, in lower part with *Miscanthus transmorrisonensis* grassland and upper part *Yushania niitakayamensis* meadow, ca. 2850-2950 m.
- 10c. -, -, -, roadside cliffs and stone-cement walls on SW slope of Hsia-huseh-shan, ca. 2800 m.
- 10d. -, -, -, 35 km from Tungshih, trail from the entrance to forest recreation area to Mt. Saolai, planted, partly cut forest of *Chamaecyparis* sp., ca. 2000 m.
- 10e. -, -, -, -, warm temperate rain forest, ca. 2100-2200 m.
- 10f. -, -, -, ca. 50 km along road no. 230 to logging area 71-1, sheltered stream ravine by the roadside, ca. 2200 m.
- 10g. -, -, -, logging area 71-1, ca. 60 km along the road no. 230, mixed forest of *Chamaecyparis formosensis*, *C. obtusa* var. *formosana*, *Tsuga chinensis* var. *formosana*, *Taiwania cryptomerioides* and Fagaceae on N slope, ca. 2300 m.

10h. -, -, -, Anmashan forest station, mixed moist forest of *Chamaecyparis formosensis*, *C. obtusa* var. *formosensis*, *Pinus armandii*, *P. taiwanensis*, *Tsuga chinensis*, *Trochodendron aralioides*, *Eurya* spp. and Fagaceae on S-NW slopes under the forest station, ca. 2150–2250 m.

10i. -, -, -, open area along the stream on W slope with bushes, alt. ca. 2200 m.

10j. -, -, -, roadside cliffs and soil banks along the road from Tungshih to Anmashan forest station, alt. 2150–2250 m.

10l. -, -, -, dry forest of *Pinus armandii* and *P. taiwanensis* along the road from the artificial pond to giant *Chamaecyparis*, 2400–2500 m.

#### FAMILY POLYTRICHACEAE

The presence of 17 species of Polytrichaceae in Taiwan makes this family one of the more important ones in the flora. Many endemic species have been described from the island in the past few decades. Most of these are, however, found to be conspecific with species of the surrounding regions and consequently they are reduced to synonyms.

Closest affinity of the flora is to mainland Asia to the west, especially the Himalayan area. This is by no means surprising as the island has the highest mountains of SE Asia, thus offering suitable habitats for species of the orotemperate and oroboreal (Hämelt-Ahti et al. 1974) vegetation zones. Many of these species have their nearest occurrence either in Yunnan, at the eastern fringe of the Himalayan mountain ranges, or in the high mountains of the Philippines.

#### KEY TO THE TAIWANESE SPECIES OF POLYTRICHACEAE

The key is based almost entirely on gametophytic characters to enable identification of all specimens. Characters of the sporophyte are given only for *Pogonatum camusii* which as a minute plant is hardly found without them.

1. Lamellae present, nearly on whole width of lamina . . . . . 2
1. Lamellae restricted to the central part of lamina, present only on costa or totally absent . . . . . 13
  2. Apical cells (= apicals) of lamellae smooth . . . . . 3
  2. Apicals of lamellae papillose . . . . . 10
3. Apicals geminate . . . . . 4
3. Apicals solitary . . . . . 5
  4. Practically all apicals geminate and high, blade of leaves wide . . . . . *Pogonatum microstomum* p. 132
  4. Apicals partly or mostly solitary, not higher than lower cells, blade fairly narrow . . . . . *Pogonatum tahitense* p. 131
5. Apicals narrower than subapicals, the latter often geminate and wide; robust plants . . . . . *Pogonatum fastigiatum* p. 129
5. Apicals of lamellae as wide or wider than other cells of lamellae . . . . . 6
  6. Apicals of lamellae with all cell-walls distinctly incrassate; leaf-margins entire, without teeth . . . . . *Pogonatum perichaetiale* ssp. *perichaetiale* p. 133
  6. Only the outer wall of apical cells sometimes incrassate, leaf margins distinctly dentate or serrate . . . . . 7
7. Lamellae 5–7 cells high; sheath fairly abruptly narrowed to lamina . . . . . 8

7. Lamellae up to 3(-4) cells high, sheath gradually narrowed to lamina..... 9  
 8. Apical cells distinctly retuse .....*Polytrichum commune* p. 136  
 8. Apical cells convex, not retuse.....*Polytrichastrum formosum* p. 134  
 9. Lamellae fairly remotely set on lamina, mostly 1-2 cells high, apicals often with some geminations; robust plants .....*Pogonatum cirratum* ssp. *cirratum* p. 128  
 9. Lamellae tightly set on lamina, mostly 2-3 cells high, apicals without geminations, slightly narrower apically than subapicals .....*Pogonatum cirratum* ssp. *fuscatum* p. 129  
 10. Apicals of lamellae very finely papillose or almost smooth .....11  
 10. Apicals of lamellae coarsely papillose .....12  
 11. Apicals of lamellae mostly retuse, in side view distinctly crenate, sheath gradually narrowed to lamina .....*Pogonatum neesii* p. 130  
 11. Apicals of lamellae not retuse, normally convex, in side view only very slightly crenulate, sheath fairly abruptly narrowed to lamina .....*Polytrichastrum formosum* p. 134  
 12. Outer wall of apical cells distinctly incrassate, papillae elongated and often united ..  
 ..... *Polytrichastrum alpinum* p. 134  
 12. Outer wall not distinctly incrassate, papillae roundish and clearly separate .....  
 ..... *Pogonatum urnigerum* p. 133  
 13. Minute plants with reduced leaves without lamellae .....*Pogonatum camusii* p. 126  
 13. Leaves with well-developed lamina and some lamellae .....14  
 14. Teeth present on dorsal side of lamina .....15  
 14. Teeth not present on dorsal side of lamina .....16  
 15. Ventral lamellae 2-3 cells high .....*Atrichum crispulum* p. 123  
 15. Ventral lamellae more than 3, mostly 4-5 cells high .....*Atrichum undulatum* p. 124  
 16. Lamellae restricted to costal area only .....17  
 16. Lamellae ca. 20, present on costa and lamina .....*Pogonatum nudiusculum* p. 130  
 17. Large or robust plants with large marginal teeth; lamellae rudimentary, only one cell high .....*Pogonatum proliferum* p. 126  
 17. Plants smaller, lamellae 2-4 cells high .....18  
 18. Plants minute, leaves crowded and obtuse .....*Oligotrichum obtusatum* p. 124  
 18. Leaves acute .....19  
 19. Leaves with distinctly differentiated sheath and lamina, margins with only a few reduced teeth apically .....*Oligotrichum suzukii* p. 125  
 19. Sheath not clearly differentiated, marginal teeth distinct and present on almost whole length of margins .....*Atrichum crispulum* p. 123

*Atrichum* P. Beauv. nom. cons.

All species of the genus are characterized by the sparsity of ventral lamellae and the fairly tight curling of the leaves when dry. The capsule, when present, also gives a good diagnostic character as it is more slender than in the other genera of the family.

*Atrichum crispulum* Schimp. ex Besch.

(Fig. 4M-N)

Ann. Sci. Nat. Bot. sér. 7, 17: 351. 1893.

*Atrichum spinulosum* (Card.) Miz., J. Jap. Bot. 31: 119. 1956. - *Catharinea spinulosa* Card., Bull. Soc. Bot. Genève sér. 2, 1(3): 130. 1909. - Synonymized by Nyholm (1971).

Both species of the genus *Atrichum* are large and possess well-developed ventral lamellae on the costa, as well as fairly numerous dorsal laminar teeth. The best

distinctive characters are found in the height of the lamellae that are generally only 2–3 cells high in *A. crispulum* but 4–5 cells high in *A. undulatum*. However, there seems to be variation in this character and thus some specimens may be difficult to identify. *A. undulatum* is monoicous (Lou & Koponen 1986) so it is found more often with sporophytes and it also can possess more than one seta on each stem. The orientation of laminar cells in longitudinal rows, mentioned by Lou and Koponen (1986), is also useful character to some extent but perhaps not as reliable as the height of lamellae and difference in the form of costa as illustrated in Fig. 4. The ventral side of the costa is more convex in *A. undulatum*.

Both species are plants of open ground in disturbed habitats, mostly in orotemperate to oroboreal zones in the mountains between 2000–3000 m.

Illustrations: Noguchi & Osada 1960: 140 (fig. 9 as *Atrichum spinulosum*), 141 (fig. 10 as *Atrichum spinulosum*); Nyholm 1971: 23 (fig. 12); Lou & Koponen 1986: 38 (fig. 4g–k).

Distribution (after Lou & Koponen 1986): As 2: China (Anhui, Guangxi, Henan, Jiangxi, Liaoning, Shaanxi, Sichuan, Taiwan, Yunnan, Zhejiang), Japan, Korea; As 3: Thailand.

Specimens examined: 5a. *T. Koponen 17754*; 6q. *Hyvönen 3641, 3648*; 6s. *3751*; 10d. *4098*; 10h. *4375, 4382, 4383*; 10l. *4499*; Chiayi: Mt. Alishan, near the station, ca. 2275 m, 9.IV.1987 *Lai 10095*.

#### *Atrichum undulatum* (Hedw.) P. Beauv.

Prodr. 42. 1805. (Fig. 4L)

*Polytrichum undulatum* Hedw., Spec. Musc. 98. 1801.

Lou and Koponen (1986) list only *Atrichum undulatum* var. *gracilisetum* Besch. for China and exclude var. *undulatum* from Chinese bryoflora. However, they also note the confused situation in the *A. undulatum*-complex and the impossibility to identify sterile specimens to variety. Consequently, we prefer to follow Chuang (1973) and treat *A. undulatum* at the species level only.

For the discussion on ecology as well as distinctive characters see the above text under *Atrichum crispulum*.

Illustrations: Bartram 1939: pl. 28 (fig. 493); Noguchi & Osada 1960: 125 (fig. 1), 130 (fig. 4); 131 (fig. 5), 132 (fig. 6); 133 (fig. 7); 138 (fig. 8); Gangulee 1969: 73 (fig. 28), 74 (fig. 29); Smith 1971: 22 (fig. 38), 45 (fig. 62); Nyholm 1971: 19 (fig. 10), 21 (fig. 11); Li 1985: 433 (fig. 185: 13–17); Lou & Koponen 1986: 38 (fig. 4a–f).

Distribution: Widely distributed in northern Hemisphere.

Specimens examined: 5a. *17897*; Taitung: Siangyang, S cross highway, ca. 2200 m, 24.XII.1977 *Lai 9607*.

#### *Oligotrichum* Lam. & Cand.

Two *Oligotrichum* species of fairly narrow range are present in Taiwan. *O. suzukii* (Broth.) Chuang is endemic to Taiwan and *O. obtusatum* Broth. has been recorded only twice in mainland Asia.

Both species are small plants and readily recognized by their habit in dry condition, i.e. possessing typically incurved and fairly remotely set leaves.

#### *Oligotrichum obtusatum* Broth.

Symb. Sin. 4: 133. 1929. (Fig. 4G–H)

Type: China. Yunnan. In montium inter Dali (Talifu) et Hodjing regione temperata supra vicum

Hsiangschuiho, 26° 15', in silva, trunc. viv. *Rhododendron*, alt. ca. 3400 m, 25.V.1915 *Handel-Mazzetti* 6505 (H-BR!, holotype).

*Oligotrichum obtusatum* is easily distinguished from all other species of the Taiwanese Polytrichaceae by its small size (stems up to 6 mm) and obtuse leaves with few ventral lamellae. The other species of the genus collected on the island is the endemic *O. suzukii*. It has longer stems (up to 20 mm), more acute leaves with essentially entire margins and some reduced lamellae on the dorsal side of the leaves.

*Oligotrichum obtusatum* is probably most closely related to New Guinean *O. novae-guineae* (Bartr.) G. L. Sm. and Himalayan *O. semilamellatum* (Hook. f.) Mitt. Both species are, however, larger plants with stems several centimeters tall and with larger leaves. In the former the ventral lamellae are also generally less developed than in *O. obtusatum*. Gangulee (1969) noted that *O. semilamellatum* is an extremely variable plant and probably a complex taxon. In thorough revisional work *O. obtusatum* may thus turn out to be conspecific with *O. semilamellatum*. As the type material of *O. semilamellatum* was not consulted in this study I am inclined to follow Smith (1976) and accept *O. obtusatum* as a valid species.

This is only the third record of the species and the first one for Taiwan. However, the species is easily overlooked in the field because of its small size and may turn out to be more common in the bryophyte flora when the areas concerned are better examined.

*Oligotrichum obtusatum* is a plant of cool oroboreal zone since it has been collected high up in the mountains above 3000 m.

Illustrations: Chen 1978: 311 (fig. 397).

Distribution: As 2: China (Sichuan, Taiwan, Yunnan); As 3: Nepal.

Specimen examined: 6h. *Hyvönen* 3469.

#### *Oligotrichum suzukii* (Broth.) Chuang

(Fig. 4I–K)

J. Hatt. Bot. Lab. 37: 430. 1973.

*Pogonatum suzukii* Broth., Ann. Bryol. 1: 26. 1928. – Type: China. Taiwan. Taichung: Mt. Higosinoko, 6.VIII.1926 *Suzuki* 2660 (H-BR!, holotype).

*O. formosanum* Nog., Trans. Nat. Hist. Soc. Formosa 24: 294. 1934. – Type: China. Taiwan. Chiayi: Mt. Ali, on wet soil, ca. 2500 m, VIII.1932, *Noguchi* 5944 (NOG, holotype) – Synonymized by Chuang (1973).

We tentatively follow Chuang (1973) in accepting *Oligotrichum suzukii* as a valid species. It is, however, very closely related to the widespread *O. aligerum* Mitt. and was even synonymized with it by Horikawa (1950) and Osada (1966). The more obtuse leaf apex, the essentially entire leaf margins and the rudimentary dorsal lamellae that are sometimes absent are characters distinguishing it from the latter species.

*Oligotrichum suzukii* differs from all other species of Polytrichaceae in Taiwan by its small size and ventral lamellae restricted to the costal area. The other species of the genus, *O. obtusatum* is a smaller species having obtuse leaves with dentate margins and thus easily distinguished from *O. suzukii*.

*Oligotrichum suzukii* is a plant on open soil in mountain areas.

Illustrations: Noguchi 1934: 295 (fig. 1).

Distribution: Endemic to Taiwan.

Specimens examined: 3h. *Hyvönen* 3985; 6a. *T. Koponen* 18007.

*Pogonatum* P. Beauv.

The genus is represented by ten species in Taiwan. Although they can all be classified as pioneer plants of disturbed habitats, they may be divided into two groups. *Pogonatum camusii*, *P. cirratum* ssp. *cirratum* (Sw.) Brid., *P. fastigiatum* Mitt., *P. nudiusculum* Mitt. and *P. proliferum* Mitt. are plants of fairly shady and moist habitats. The second group includes those of open, drier conditions, namely *P. microstomum* (Schwaegr.) Brid., *P. cirratum* ssp. *fuscatum* Mitt., *P. neesii* (C. Müll.) Dozy, *P. perichaetiale* (Mont.) Jaeg. and especially *P. urnigerum* (Hedw.) P. Beauv. which is found in the driest conditions.

The order of the species in the following presentation is arbitrary and roughly based on resemblance of general habit of the species.

*Pogonatum camusii* (Thér.) Touw

(Fig. 2M-N)

J. Hatt. Bot. Lab. 60: 26. 1986.

*Racelopodopsis camusii* Thér., Monde Pl. sér. 2(9): 22. 1907.

*Pogonatum camusii* is easily distinguished from all other species of the genus in Taiwan by its extremely small size (stems ca. 5 mm high) and coarsely papillose seta. The leaves are ovate to triangular with irregular teeth in the apical part and they are totally devoid of ventral lamellae. Because of its small size the plant is easily overlooked in the field and might be much more common than the collections indicate.

We follow Touw (1986) including *Pogonatum camusii* in the genus *Pogonatum*.

*Pogonatum camusii* is a plant of evergreen subtropical rain forests growing on boulders and clayey soil in fairly shady conditions.

Illustrations (after Touw 1986): Brotherus 1909: 1212 (fig. 849 as *Racelopodopsis camusii*); Brotherus 1925: 497 (fig. 775 as *R. camusii*); Horikawa 1934: 718 (fig. 4 as *Pogonatum papillosum* Horik.); Bartram 1939: table 29 (fig. 496 as *Pseudoracelopus mindanensis* Bartr.); Smith 1971: 12 (fig. 13), 68 (fig. 125) as *Racelopodopsis mindanensis* (Bartr.) G. L. Sm.; Rosario 1979: 127 (fig. 98 as *Racelopus pilifer* Dozy & Molk.); Tan & Alvarez 1981: 172 (figs. 14-16 as *Racelopodopsis mindanensis*); Touw 1986: 27 (fig. 12); Hyvönen 1989a: 575 (fig. 3D).

Distribution (after Touw 1986): As 2: Japan, China (Taiwan); As 3: Thailand, Vietnam; As 4: Indonesia, Philippines.

Specimens examined: 1d. Hyvönen 3363.

*Pogonatum proliferum* (Griff.) Mitt.

(Fig. 2F-G)

J. Linn. Soc. Bot. Suppl. 1: 152. 1859.

*Polytrichum proliferum* Griff., Calcutta J. Nat. Hist. 2(8): 475. 1842.*Pogonatum gymnohyllum* Mitt., J. Linn. Soc. Bot. Suppl. 1: 153. 1859. - Synonymized by Smith (1976).

*Pogonatum takao-montanum* Horik., J. Jap. Bot. 11: 505. 7. 1935. - Type: China. Taiwan. Pingtung: Mt. Daijurin, 4.I.1935 Horikawa (HIRO, holotype). - Synonymized by Hyvönen (1989b).

*Pogonatum proliferum* is characterized by its fairly large size, its large and distinct marginal teeth and its leaves with extremely reduced lamellae restricted to the costal area. The sheath is not much wider than the lamina and the leaves are contorted in dry condition so that it might be mistaken for *P. cirratum*, *P. neesii* or *P. nudiusculum*. The near absence of lamellae and the form of the leaves are, however, easily seen diagnostic



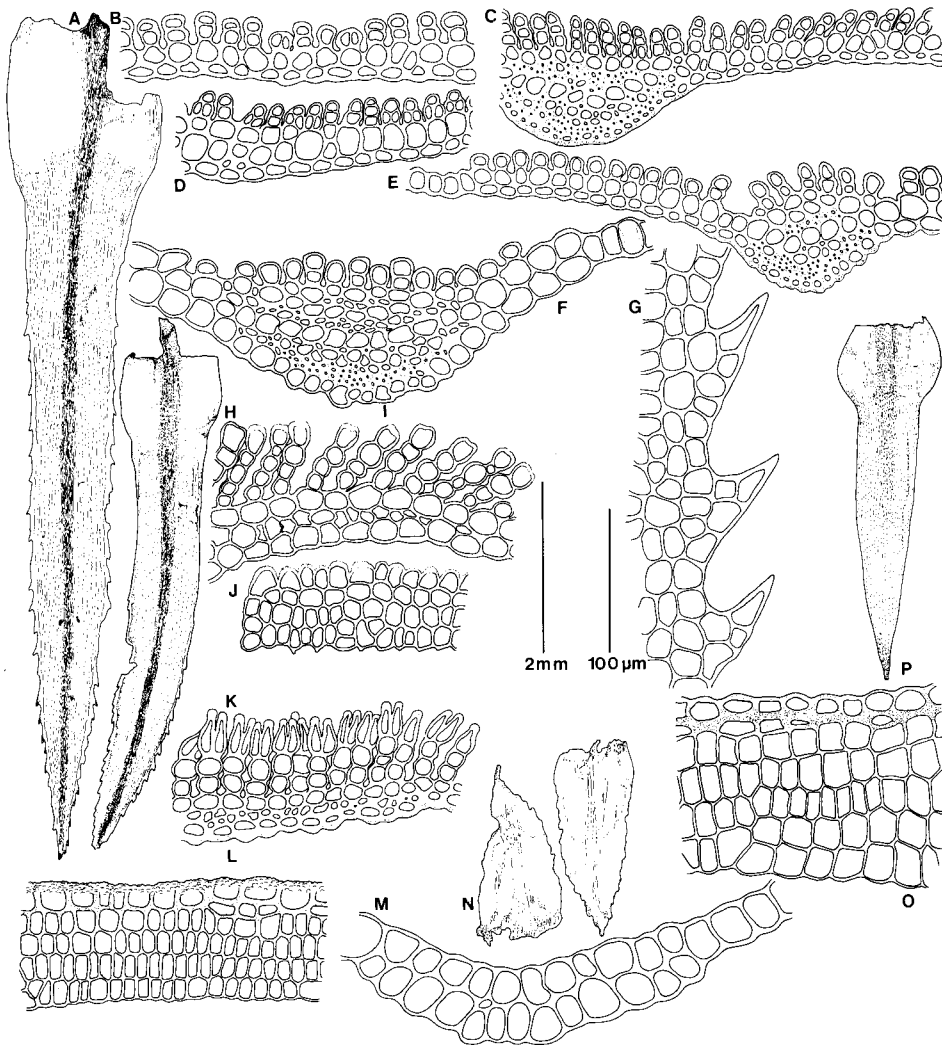


FIG. 2. A-P. - A, B. *Pogonatum cirratum* (Sw.) Brid. ssp. *cirratum*. A. Leaf. B. Leaf cross-section (Hyvönen 4423). - C. *P. cirratum* ssp. *fuscatum* (Mitt.) Hyvönen. Leaf cross-section (Hyvönen 3795). - D. *P. fastigiatum* Mitt. Leaf cross-section (Hyvönen 3653). - E. *P. nudiusculum* Mitt. Leaf cross-section (Hyvönen 4231). - F, G. *P. proliferum* (Griff.) Mitt. F. Leaf cross-section. G. Leaf-margin as see above (Hyvönen 4180). - H-J. *P. neesii* (C. Müll.) Dozy. H. Leaf. I. Leaf cross-section. J. Lamella in side view (Hyvönen 3987). - K. *P. microstomum* (Schwaegr.) Brid. Leaf cross-section (Hyvönen 3767). - L. *P. urnigerum* (Hedw.) P. Beauv. Lamella in side view. (Hyvönen 4285). - M, N. *P. camusii* (Thér.) Touw. M. Leaf cross-section. N. Leaves (Hyvönen 3363). - O, P. *P. perichaetiale* (Mont.) Jaeg. O. Lamella in side view. P. Leaf (Hyvönen 3478). Use mm scale for A, H, N and P and µm scale for B-G, I-M and O.

characters.

The type specimen of *Pogonatum takao-montanum* described by Horikawa have not been studied. The description is, however, clear enough and furnished with illustration so that synonymizing is warranted following Hyvönen (1989b).

*Pogonatum proliferum* can be found in fairly shaded habitats growing mostly on bare soil. It is a plant of orotemperate vegetation zone being collected at altitudes of 2000–2300 m.

Illustrations: Horikawa 1935c: 506 (fig. 7 as *Pogonatum takao-montanum*); Bartram 1939: pl. 29 (fig. 504 as *P. gymnophyllum*); Gangulee 1969: 136 (fig. 61), 138 (fig. 62 as *P. fastigiatum*), 140 (fig. 63 as *P. fastigiatum* var. *darjeelingense* Gangulee, 141 (fig. 64 as *P. gymnophyllum*); Smith 1971: 65 (fig. 100); Hyvönen 1989a: 577 (fig. 4H); Hyvönen 1989b: 38 (fig. 11A, B).

Distribution: Afr 2: Ruanda, Uganda; As 2: China (Guizhou, Guangxi, Taiwan, Zhejiang); As 3: Burma, India, Nepal, Sikkim, Thailand; As 4: Indonesia, Philippines.

Specimens examined: 10d. *Hyvönen* 4097; 10e. 4180, 4209; 10h. 4338, 4417, 4420; Chiayi: Mt. Ali, 25. XII.1926 Suzuki; Taoyuen: Mt. Lalashan, Hushingshiang, 8.IX.1977 Lai 9423.

***Pogonatum cirratum* (Sw.) Brid. ssp. *cirratum***

(Fig. 2A–B)

Bryol. Univ. 2: 110. 1827.

*Polytrichum cirratum* Sw., J. f. Bot. 1800(2): 175, 176. 4. 1801.

*Pogonatum hetero-contortum* Horik., Bot. Mag. Tokyo 49: 593. 25. 1935. – Synonymized by Hyvönen (1989b).

*Pogonatum cirratum* is a widespread and variable species in SE Asia. In Taiwan it is confined to subtropical and orotemperate broad-leaved forests.

*Pogonatum cirratum* ssp. *cirratum* is easily mistaken for ssp. *fuscatum*. The latter, however, grows in more open and drier habitats. In cross-section the leaves of ssp. *fuscatum* have narrow stereid bands, lamellae 2–3 cells high without geminations, and apical cells which are apically narrower than the cells below. In ssp. *cirratum* the stereid bands are wider and the lamellae, which are normally only 1–2 cells high and often with some geminations, are more remotely set on lamina.

*Pogonatum fastigiatum* is a large species which might be confused with *P. cirratum*. It is, however, a plant of higher elevations, being most common in the orohemiboreal vegetation zone. It is also larger than *P. cirratum* and in leaf cross-section the peculiar lamellae of *P. fastigiatum*, with narrow apical cells and many subapical geminations, are easily seen diagnostic characters.

The synonymization of *Pogonatum hetero-contortum* is slightly in dispute as the type specimen has not been studied (cf. Hyvönen 1989b).

In the field even *Pogonatum proliferum*, growing in similar habitats, can be mistaken for *P. cirratum*. A clear look with a hand-lens, however, reveals the restriction of reduced lamellae only on the coastal area of *P. proliferum*.

Illustrations: Swartz 1801: table 4; Dozy & Molkenboer 1856: table XXXIV; Horikawa 1935d: 594 (fig. 25 as *Pogonatum hetero-contortum*); Hyvönen 1986: 132 (fig. 14); Hyvönen 1989a: 577 (fig. 4E); Hyvönen 1989b: 31 (fig. 9A–D).

Distribution: As 2: China (Guangdong, Sichuan, Taiwan, Yunnan), Japan; As 3: Bhutan, Sikkim, Sri Lanka, Thailand; As 4: Indonesia, Malaysia, Papua New Guinea, Philippines; Oc: Solomon Islands.

Specimens examined: 1b. *Hyvönen* 3344; 1f. 3424, 3429, 3437; 4d. *T. Koponen* 17505, 17511; 4e. 17650; 10a. *Hyvönen* 3390, 4008; 10d. 4230; 10h. 4336, 4388, 4423; Taiwan. Pingtung: Raisha, on rocks, 2.VII.1916

*Matsuda 1240*; Taichung Co.: Mt. Pasienshan, 24.XI.1922 *Sasaki 2427*; Nantou: Luku, Chitou, Fenghuang shan, on soil, ca. 1150–1750 m, 12.XI.1971 *Lin* (as *P. spurio-cirratum* Broth. in *Exsiccatae Bryophytes of Taiwan ser. 1: 39*); Taoyuen Co.: Mt. Lalashan, Hushingshang, 8.IX.1977 *Lai 9422*.

***Pogonatum cirratum* ssp. *fuscatum* (Mitt.) Hyvönen (Fig. 2C)**

Acta Bot. Fennica **138**: 32. 1989.

*Pogonatum fuscatum* Mitt., J. Linn. Soc. Bot. Suppl. **1**: 154. 1859.

*P. spurio-cirratum* Broth., Phil. J. Sci. C. **5**: 150. 1910. – Synonymized by Hyvönen (1989a).

Distinguishing ssp. *fuscatum* from the closely related ssp. *cirratum* is difficult. The leaves of the former, however, are normally narrower with lamellae 2–3(–4) cells high and tightly set on lamina. Plants are generally smaller overall than ssp. *cirratum*. Apical cells of the lamellae are also typically narrower apically like in *P. fastigiatum*. The ssp. *fuscatum* also grows on more open and dry habitats than ssp. *cirratum*. So the variation can also be interpreted to be ecological and not warranted to be recognized taxonomically. The subspecies are, however, here tentatively treated separately. The whole *P. cirratum* species complex needs a thorough revision.

In Taiwan ssp. *fuscatum* has been collected at the altitudes of 2100–3400 m in the orotemperate and oroboreal vegetation zones growing on soil and cliffs in open habitats.

Illustrations: Gangulee 1969: 110 (fig. 44); Smith 1971: 66 (fig. 105 as *Pogonatum flexicaule* Mitt.); Hyvönen 1989b: 31 (fig. 9E).

Distribution: As 2: China (Hainan, Taiwan, Xizang, Yunnan, Zhejiang); As 3: Bhutan, Burma, India, Laos, Nepal, Sikkim, Thailand, Vietnam; As 4: Indonesia, Malaysia, Philippines.

Specimens examined: 9b. *Hyvönen 3795*; 10h. *4345, 4458*; 10l. *Stenroos 3536*; Nantou Co.: Meiyuen, 21.VIII.1926 *Suzuki*.

***Pogonatum fastigiatum* Mitt. (Fig. 2D)**

J. Linn. Soc. Bot. Suppl. **1**: 154. 1859.

*Pogonatum arisanense* Okam., J. Coll. Sci. Imp. Univ. Tokyo **38**(4): 21. 9. 1916. – Type: Taiwan. Chiayi: Mt. Ali-shan, 6.IV.1914 *Hayata* (NICH, holotype). – Synonymized by Kuo & Chiang (1987).

*Pogonatum submacrophyllum* Broth., Ann. Bryol. **1**: 27. 1928, hom. illeg. – Type: Taiwan, Taichung Co.: Mt. Noko, 6.VIII.1926 *Suzuki 2662* (H-BR!, holotype). – Synonymized by Kuo & Chiang (1987).

*Pogonatum arisanense* was synonymized with *P. cirratum* by Chuang (1973). However, according to the original description and illustrations we are inclined to follow Kuo and Chiang (1987) and synonymize it with *P. fastigiatum*.

Chuang (1973) repeats the mistake of Gangulee (1969) by treating the large plants of *Pogonatum* whose leaves are without or with very reduced lamellae as *P. fastigiatum*. The correct name, however, is *P. proliferum*.

The study of all the type material, as well as the description, indicates that the name *Pogonatum fastigiatum* is correctly assigned to robust plants of higher elevations with well-developed but low lamellae and peculiar subapical geminations. Another typical feature is the dentate margins of the sheath.

Ecologically *Pogonatum fastigiatum* is clearly a plant of cool environments being most abundant in the orohemiboreal and oroboreal vegetation zones of high mountains.

Illustrations: Okamura 1916: 23 (fig. 9 as *Pogonatum arisanense*); Smith (1971): 66 (fig. 104); Hyvönen 1989b: 28 (fig. 8D–F).

Distribution: As 2: China (Sichuan, Taiwan, Yunnan, Zhejiang); As 3: Bhutan, India, Nepal, Sikkim,

Thailand.

Specimens examined: 3a. *T. Koponen* 16805, 16820; 3c. 17197; 5a. 17849, 17890, 17895; 6c. 18126 (with *P. microstomum*); 6d. 18079; 6f. 18251; 6k. *Hyvönen* 3554; 6l. 3556; 6q. 3652, 3653; 9b. 3700, 3796; 9d. 3811; 10b. 4041, 4048; Pingtung: Mt. Tawushan, on ground, 25.V.1918 *Matsuda* 1254; Taichu: Mt. Tsugitaka, 5. X.1925 *Shimada* 2480.

***Pogonatum nudiusculum* Mitt.**

(Fig. 2E)

J. Linn. Soc. Bot. Suppl. 1: 153. 1859.

*Pseudatrichum nudiusculum* (Mitt.) Smith Merrill, Mem. New York Bot. Gard. 45: 466. 1987.

*Pogonatum hetero-proliferum* Horik., Bot. Mag. Tokyo 48: 461. 4. 1934. – Type: China. Taiwan. Ilan: Mt. Tapingshan, 23.VIII.1932 *Horikawa* (HIRO, holotype); X.1933 *Matsuda*; Nantou: Mt. Morrison, Patungkwang, 21.VIII.1932 *Horikawa* (HIRO, syntypes). – Synonymized by *Hyvönen* (1989b).

*Pogonatum oligotrichoides* Horik., J. Jap. Bot. 11: 416. 2. 1935. – Type: China. Taiwan. Nantou: Mt. Morrison (Kodamayama – Tataka), on soil, 18.VIII.1932 *Horikawa* (HIRO, lectotype); Ilan: Mt. Tapingshan, 24.VIII.1932 *Horikawa* (HIRO, syntype). – Synonymized by *Hyvönen* (1989b).

By its habit *Pogonatum nudiusculum* might be mistaken for *P. cirratum*, *P. proliferum* or large plants of *P. neesii*. In all of them the leaves are contorted when dry. A closer look, however, reveals that in *P. nudiusculum* ventral lamellae are restricted to the central part of the leaves. This applies also to *P. proliferum*. The lamellae of the latter are, however, still more reduced being normally only 1 cell high and restricted to the costal area only. In *P. nudiusculum* the number of lamellae is normally ca. 20–30 and they are 2–3 cells high.

The species was assigned to the monotypic genus *Pseudatrichum* Reim. by Smith Merrill (1987) but we prefer to follow *Hyvönen* (1989b) and include the species in the genus *Pogonatum*.

We follow *Hyvönen* (1989b) in the synonymization of *Pogonatum hetero-proliferum* and *P. oligotrichoides* although these have not been verified by the study of the type material.

*Pogonatum nudiusculum* is a plant of the orotemperate zone being collected at altitudes of 1600–2200 m. It thrives in fairly shaded conditions growing on bare soil.

Illustrations: *Horikawa* 1934: 461 (fig. 4 as *Pogonatum hetero-proliferum*); *Horikawa* 1935b: 416 (fig. 2 as *P. oligotrichoides*); *Bartram* 1939: pl. 29 (fig. 503); *Gangulee* 1969: 133 (fig. 59); *Smith Merrill* 1987: 468 (fig. 1–4 as *Pseudatrichum nudiusculum*); *Hyvönen* 1989b: 28 (fig. 8G–I).

Distribution: As 2: China (Guizhou, Shaanxi, Sichuan, Taiwan, Yunnan); As 3: Bhutan, India, Nepal, Sikkim (*Gangulee* 1969); As 4: Philippines.

Specimens examined: 10d. *Hyvönen* 4231; 10e. 4153, 4193; Pingtung: Mt. Tawushan, on ground 5.I. 1917 *Matsuda* 1248; Ariko, on ground, I.1918 *Matsuda* 1301; Taichu: Mt. Hassen, 24.XI.1922 *Sasaki* 2428; Pingtung: first water resource to Kwai-ku, partially shaded dry slope, on soil, 1600–2190 m, 17.VII.1968 *Chuang* 1267.

***Pogonatum neesii* (C. Müll.) Dozy**

(Fig. 2H–J)

Ned. Kruidk. Arch. 4(1): 75. 1856.

*Polytrichum neesii* C. Müll., Syn. Musc. Frond. 2: 563. 1851.

*Pogonatum junghuhnianum* (Dozy & Molk.) Dozy & Molk., Bryol. Jav. 1: 40. 31. 1856. – *Polytrichum junghuhnianum* Dozy & Molk., Pl. Jungh. 3: 324. 1854. – Synonymized by *Dixon & Potier de la Varde* (1927).

*Pogonatum akitense* Besch., Ann. Sci. Nat. Bot. sér. 7, 17: 354. 1893. – Synonymized by *Hyvönen*

(1989b).

*Pogonatum neesii* belongs to a group of closely related SE Asian taxa which are extremely difficult to distinguish. The species are widespread in East Asia and found also in Australia and Oceania.

*Pogonatum neesii* is a small to medium-sized plant with leaves incurved or curled when dry. It can be mistaken for the closely related *P. inflexum* (Lindb.) Lac. The presence of latter in Taiwan is, however, in dispute and we were unable to distinguish the two species according the characters given by Osada (1965) for Japanese material. In the latter species the apical cells of lamellae are clearly wider than those of *P. neesii* and the leaf-apices are tightly coiled in dry condition. Such plants were not found in the Taiwanese material. Consequently *P. inflexum* is tentatively excluded from the flora.

*Pogonatum neesii* also can be mistaken for some other *Pogonatum* species with contorted leaves. High (5–7 cells) lamellae with retuse apical cells, normally finely papillose and distinctly crenate in side view, are a unique feature in the local flora and make identification fairly simple.

*Pogonatum neesii* grows in open and dry habitats on bare soil and cliffs. It has been recorded at the altitudes of 400–3400 m but it is more common at lower elevations in subtropical and orotemperate vegetation zones.

Illustrations: Dozy & Molkenboer 1856: tab. XXXXI (as *Pogonatum junghuhnianum*) & XXXVI; Fleischer 1923: 1589 (fig. 251); Bartram 1939: pl. 29 (fig. 502 as *P. junghuhnianum*); Osada & Noguchi 1962: 364 (fig. 9–15 as *P. akitense*); Osada 1965: 193 (fig. 8.2 as *P. akitense*); 199 (fig. 11 as *P. akitense*); Gangulee 1969: 104 (fig. 41 as *P. junghuhnianum*), 106 (fig. 42 as *P. akitense*); Smith 1971: 18 (fig. 29); Chen 1978: 303 (fig. 392 as *P. inflexum*); Li 1985: 446 (fig. 192: 1–6 as *P. inflexum*); Hyvönen 1986: 128 (fig. 12); Hyvönen 1989a: 577 (fig. 4C); Hyvönen 1989b: 51 (fig. 15A–C).

Distribution: Eur: USSR; As 1: USSR; As 2: China (Anhuan, Sichuan, Taiwan, Yunnan), Japan, Korea; As 3: Bhutan, Burma, India, Laos, Nepal, Sikkim, Sri Lanka, Thailand, Vietnam; As 4: Indonesia, Malaysia, Papua New Guinea, Philippines; Austr 1: Australia; Oc: Fiji, New Caledonia, Samoa, Vanuatu.

Specimens examined: 1b. Hyvönen 3315, 3317, 3325, 3326, 3337, 3342, 3345, 3348; 1d. 3368, 3376, 3379, 3385, 3387, 3388; 1f. 3414, 3415, 3427, 3428, 3435, 3443, 3452; 3h. 3987, 3988; 6p. 3616; 9b. 3793; 10b. 4018, 4086; 10g. 4284; Pingtung: Aliko, on ground, I.1916 *Matsuda* 1307; Subon, on rocks, 1.IV.1916 *Matsuda* 1239; Raishya, on rocks, 2.VII.1916 *Matsuda* 1241; on ground, 7.VII.1916 *Matsuda* 1244; Taichung Co.: Mt. Pasienshan, 24.XI.1922 *Sasaki* 2422; Taipei Co.: Tansui, 3.V.1925 *Suzuki*; Ilan: Mt. Taipingshan, 16.VIII.1925 *Suzuki* 2440, 2442, 2457; Hsinchu: Mentoy, 16.VIII.1925 *Shimada* 2463; Nantou: Meiyuen, 21.VIII.1926 *Suzuki*; Taihoku: Sohan, 7.XI.1926 *Sasaoka* 2696; Chiayi: Mt. Ali, 25.XII.1926 *Suzuki*; Sintiku: Nihonmatu, on ground, 22.VI.1928 *Simada* 3855; Anaue, on soil, 6.VII.1928 *Simada* 3859; Taitung: way to Mt. Lachialachiaerh, 26th forest compartment, ca. 1600 m, 27.VII.1967 *Chuang* 5045; Taoyuen: Mt. Lalashan, Hushingshang, 8.IX.1977 *Lai* 9431; Taitung: Yakou, hillside near S cross highway, 2750 m, 23.XII.1977 *Lai* 9482; Taipei Co.: Chungku, on stone wall, ca. 1100 m, 29.III.1974 *Chen* (as *P. microstomum* (Schwaegr.) Brid. in Exsiccatae Bryophytes of Taiwan ser. 5: 237).

*Pogonatum tahitense* Schimp. in Besch.

(Fig. 3A–B)

Ann. Sci. Nat. Bot. sér. 7, 20: 31. 1894.

*Pogonatum tahitense* is distinguished from other species of the genus by its small size, narrow leaves and irregularly crenate and geminate apical cells of the lamellae.

*Pogonatum tahitense* has its main distribution in the Pacific islands. The plant was

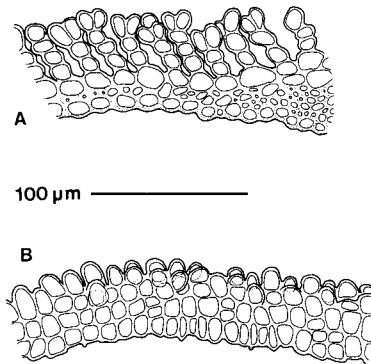


FIG. 3. A-B. *Pogonatum tahitense* Schimp. in Besch. (Suzuki 21.VIII.1926). A. Leaf cross-section. B. Lamella in side view. All specimens illustrated except that of *P. tahitense* (in H-BR) are deposited in H.

only recently reported from SE Asia (Java and Taiwan) by Hyvönen (1989b) and so far it is known from only a few small collections outside the Pacific Islands. Further study of more specimens might reveal that Asian plants are better treated as a separate species but the specimens known so far resemble the Pacific plants so closely that it would be splitting too much to describe them as a new taxon.

There is no indication of the collection site of the only specimen of *Pogonatum tahitense* from Taiwan, but in other parts of the range it is a plant of open sites at fairly low altitudes (300–1275 m).

Illustrations: Hyvönen 1989b: 54 (fig. 16E–F).

Distribution: As 2: China (Taiwan); As 4: Indonesia; Oc: Hawaii, Marguesas and Society Islands.

Specimens examined: Nantoun Co., Meiyuen, 21.VIII.1926 Suzuki.

***Pogonatum microstomum* (Schwaegr.) Brid. (Fig. 2K)**

Bryol. Univ. 2: 745. 1827. (Fig. 2K)

*Polytrichum microstomum* R. Brown ex Schwaegr., Spec. Musc. Suppl. 2(2): 10. 154. 1826.

*Pogonatum mirabile* Horik., Bot. Mag. (Tokyo) 49: 671. 26. 1935. – Type: China. Taiwan. Chiayi: Mt. Morrison, VIII.1932 Horikawa (HIRO, holotype). – Synonymized by Noguchi (1958).

*Pogonatum microstomum* is in many cases easily identified in the field by its typical brownish green color. Plants are normally fairly large and the leaves are stout and firm and only slightly altered when dry. The exceptional bottle-shaped, geminate apical cells of lamellae are also a feature easily revealing the identity of the plant. For distinctions from other species of the genus *Pogonatum* and *Polytrichastrum alpinum* (Hedw.) G. L. Sm. see discussions under each species.

*Pogonatum microstomum* is a plant of fairly open and dry habitats growing on bare soil, especially by road and trail sides. It thrives, however, also in shaded conditions in forests. In Taiwan it has been collected at altitudes of 2300–3996 m in orotemperate to oroboreal vegetation zones in the mountains. It is a fairly widely distributed plant in SE Asia – from Taiwan to India in the west and the Philippines in the south.

Illustrations: Schwaegrichen 1826: tab. 154 (as *Polytrichum microstomum*); Bartram 1939: pl. 29 (fig.

508); Gangulee 1969: 143 (fig. 65); Li 1985: 446 (fig. 192: 7–11); Hyvönen 1989b: 23 (fig. 6F–H).

Distribution: As 2: China (Sinchuan, Taiwan, Xizang, Yunnan); As 3: Bhutan, Burma, India, Nepal, Sikkim, Sri Lanka, Thailand, Vietnam; As 4: Indonesia, Philippines.

Specimens examined: 3b. *T. Koponen* 17034; 6c. *T. Koponen* 18126; 9a. *Hyvönen* 3759, 3765, 3767, 3771, 3787; 9b. 3747, 3794; 9e. 3831, 3843; 9g. 3887; 9h. 3916; 10b. 4019; 10j. *Stenroos* 3509; Nantou: Mt. Morrison, Tataka saddle to Paiyun hostel, 3500 m, 6.IV.1978 *Lai* 10293.

***Pogonatum urnigerum* (Hedw.) P. Beauv. (Fig. 2L)**

Prodr. Cinq. Six. Fam. Aethéog. Mousses Lycopodd. 84. 1805.

*Polytrichum urnigerum* L. ex. Hedw., Spec. Musc. 100. 22. 5–7. 1801.

*Pogonatum wallisii* (C. Müll.) Jaeg., Ber. St. Gall. Naturw. Ges. 1873–1874: 260. 1875 (Adumbratio 1: 722). – *Polytrichum wallisii* C. Müll., Linnaea 37: 171. 1872. – Synonymized by Smith (1971).

A common and abundant species in suitable habitats. Two other species it can be mixed with in the field are *Pogonatum microstomum* and *Polytrichastrum alpinum*. The former is normally more green or olivaceous than *Pogonatum urnigerum*. The coarse papillosity gives the leaves of the latter a fairly strong grayish tint. Study under the microscope will reveal the unique geminate and bottle-shaped apical cells of lamellae in *P. microstomum*. For distinction from *Polytrichastrum alpinum* and *Pogonatum perichaetiale* see discussion under each species.

*Pogonatum urnigerum* is typically a pioneer plant of open and dry habitats growing on soil and in crevices of cliffs. It is a plant restricted to warm temperate and oroboreal vegetation zones of the mountains and has been collected at the altitudes 2000–3996 m.

Illustrations: Bartram 1939: pl. 29 (fig. 509 as *Pogonatum wallisii*); Zanten 1964: pl. XXXIII (fig. 5a–d as *P. wallisii*); Osada 1965: 180 (fig. 3m–u); Gangulee 1969: 146 (fig. 66); Li & al. 1985: 447 (fig. 193: 12–15); Hyvönen 1986: 123 (fig. 9); Noguchi 1987: 31, fig. 11d; Eddy 1988: 38, fig. 26; Hyvönen 1989a: 577, fig. 4A; Hyvönen 1989b: 10 (fig. 1A–E).

Distribution: Widely distributed in Northern Hemisphere with disjunct occurrence in mountains of SE Asia and Africa.

Specimens examined: 3b. *T. Koponen* 17033; 3H. *Hyvönen* 3989; 6h. 3460, 3472; 5a. *T. Koponen* 17921; 6p. *Hyvönen* 3615, 3617, 3618, 3621; 9a. 3764, 3779; 9b. 3983 (with *P. fastigiatum*); 9g. 3875, 3891, 3894, 3895; 10b. 4022, 4085; 10c. 4087; 10f. 4252; 10g. 4285; 10i. 4358, 4368; Ilan: Mt. Taipingshan, 16.VIII.1925 *Suzuki* 2438; 18.VIII.1925 *Suzuki* 2439; Nantou: Mt. Nenkao, 6.VIII.1926 *Suzuki* 2937; Onae, 21.XI.1926 *Suzuki* 2898, 2902, 2909; Hwalien: Luan-shan working station, near Mt. Chi-chiao-chuan, mesophytic slope, on soil 2000 m, 16.VIII.1967 *Chuang* 5568; Tayuling to Mt. Ho-huan, 2565–3000 m, 22.VIII.1967 *Chuang* 5903; Taitung: Yakou, hillside near S cross highway, 2750 m, 23.XII.1977 *Lai* 9536; Taichung Co.: Hoping, Chuanhsing Shan logging station, on soil wall, ca. 2125 m, 1.III.1978 *Lin* (as *Polytrichastrum alpinum* (Hedw.) G. L. Sm. in *Exsiccatae Bryophytes of Taiwan* ser. 2: 91); 41 K, on soil wall, ca. 2150 m, 1.III.1978 *Lin* (as *P. alpinum* (Hedw.) G. L. Sm. in *Exsiccatae Bryophytes of Taiwan* ser. 4: 188).

***Pogonatum perichaetiale* (Mont.) Jaeg. ssp. *perichaetiale* (Fig. 2O–P)**

Ber. Thätigk. St. Gall. Nat. Ges. 1873–74: 257. 1875.

*Polytrichum perichaetiale* Mont., Ann. Sci. Nat. Bot. sér. 2, 17: 252. 1842.

The unique features of this plant among Taiwanese Polytrichaceae, i.e., totally entire leaf margins and apical cells of lamellae with all cells strongly incrassate, make its identification fairly easy. In the field it might be mistaken for a small *Pogonatum urnigerum*, *P. microstomum* or *Polytrichastrum alpinum*. These plants are of similar habitats and all of them share the stout and firm habit. The entire leaf margins of *P.*

*perichaetiale* are, however, easily seen with a hand-lens. Some specimens of *Pogonatum urnigerum* might have fairly weakly developed marginal teeth and might thus resemble *P. perichaetiale*. Clear papillae on the apical cells of the lamellae in *P. urnigerum* are a good diagnostic character and they can be used to distinguish it.

In Taiwan the species has been collected only at high altitudes above 3000 m. According to other collections from mainland Asia it thrives at the altitudes of 750–4572 m. Most of the specimens, however, were collected above 2000 m.

Illustrations: Gangulee 1969: 150 (fig. 68), 151 (fig. 69), 152 (fig. 70); Li 1985: 446 (fig. 192: 14–20); Hyvönen 1989b: 14 (fig. 3A–H).

Distribution: As 2: China (Sichuan, Taiwan, Xizang, Yunnan); As 3: Bhutan, India, Nepal, Sikkim.  
Specimens examined: 6h. *Hyvönen 3478*.

### *Polytrichastrum* G. L. Sm.

We follow Smith (1971) in his treatment of Polytrichaceae and accept his new genus. The genus is represented in Taiwan by two widespread species, *Polytrichastrum alpinum* (Hedw.) G. L. Sm. and *P. formosum* (Hedw.) G. L. Sm.

#### *Polytrichastrum alpinum* (Hedw.) G. L. Sm. (Fig. 4D)

Mem. N. Y. Bot. Gard. 21: 37. 1971.

*Polytrichum alpinum* L. ex Hedw., Spec. Musc. 92. 19 f. 2, b. 1801.

*Polytrichastrum alpinum* is a very widespread species and common also in the mountains of Taiwan. High lamellae, composed normally of 5–7 cells, provide a good distinctive character to separate it from large species of the genus *Pogonatum*. In *P. urnigerum* the lamellae can also be high but the papilosity of the apical cells of lamellae is a distinguishing character. Coarse papilosity is a typical feature of *P. urnigerum* as it is of *Polytrichastrum alpinum* but the papillae are elongated and the outer wall of the apical cells is extremely incrassate in the latter. Distinction from *Polytrichum commune* is also easy by study of apical cells of lamellae, which typically have two distinct knobs in *P. commune*. For distinction from *Polytrichastrum formosum* see the discussion below.

*Polytrichastrum alpinum* is a plant of orotemperate and especially oroboreal vegetation zones reaching the upper slopes of the highest mountains (up to 3800 m) in Taiwan. It has been collected growing on cliffs, on humus and on soil in shaded as well as open habitats.

Illustrations: Osada 1966: 180 (fig. 3 as *Pogonatum alpinum* (Hedw.) Röhl.); Gangulee 1969: 161 (fig. 74 as *Polytrichum alpinum*); Smith 1971: 21 (fig. 33), 36 (fig. 47); Li 1985: 447 (fig. 193: 16–25 as *Polytrichum alpinum*).

Distribution: Widespread in both northern and southern Hemispheres.

Specimens examined: 5a. *T. Koponen 17929*; 6h. *Hyvönen 3456, 3465*; 6i. *3498*; 6j. *3518, 3524*; 6k. *3538*; 6l. *3568*; 6p. *3620*; 6q. *3630, 3661*; 9b. *3797*; 9c. *3709, 3731, 3732*; 9d. *3803*; 9h. *3921*; 10b. *4049*.

#### *Polytrichastrum formosum* (Hedw.) G. L. Sm. (Fig. 4A–C)

Mem. N. Y. Bot. Gard. 21: 37. 1971.

*Polytrichum formosum* Hedw., Spec. Musc. 92. 19. 1a. 1801. – *Polytrichum attenuatum* Menz. ex Brid.,



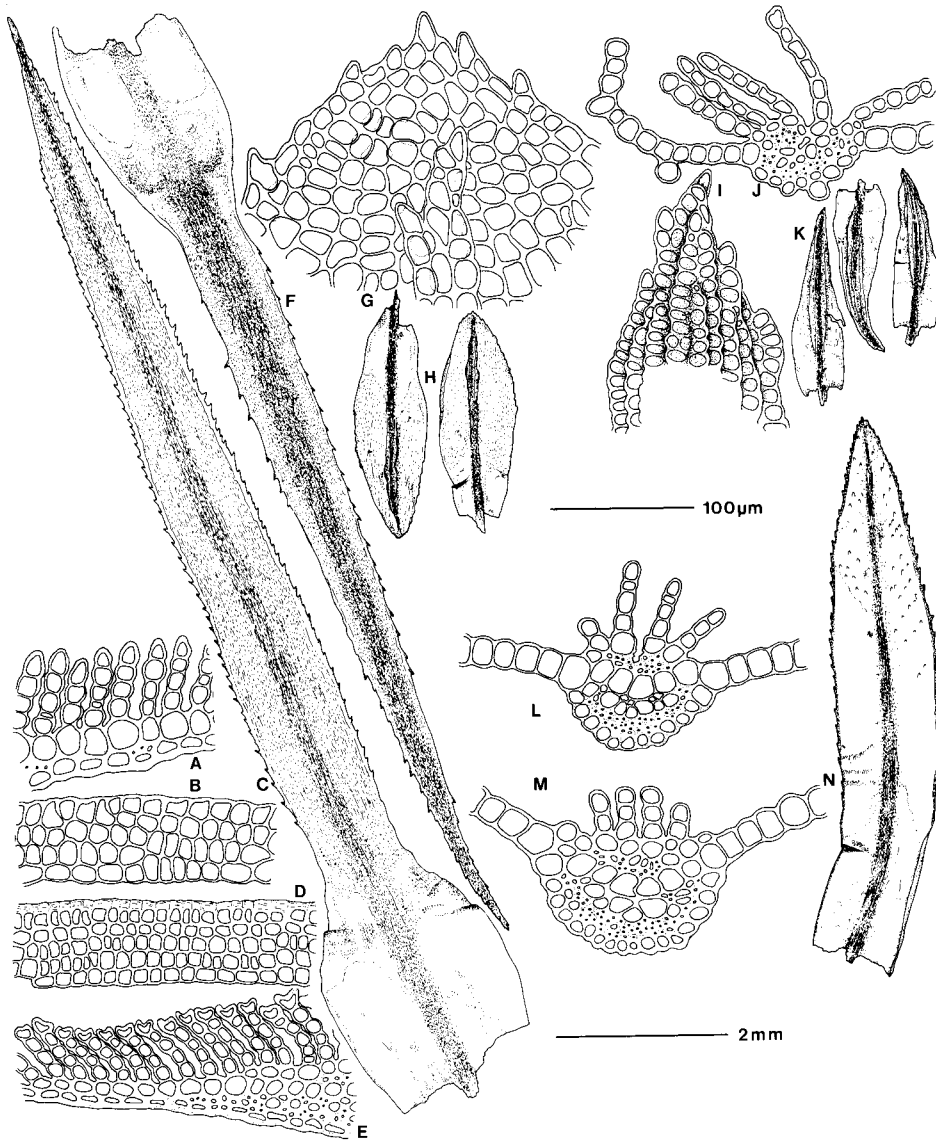


FIG. 4. A-N. - A-C. *Polytrichastrum formosum* (Hedw.) G. L. Sm. A. Leaf cross-section. B. Lamella in side view. C. Leaf (Hyvönen 4039). - D. *P. alpinum* (Hedw.) G. L. Sm. Lamella in side view (Hyvönen 3731). - E, F. *Polytrichum commune* Hedw. E. Leaf cross-section. F. Leaf (Hyvönen 3346). - G, H. *Oligotrichum obtusatum* Broth. G. Leaf apex. H. Leaves (Hyvönen 3469). - I-K. *O. suzukii* (Broth.) Chuang. I. Leaf apex. J. Leaf cross-section. K. Leaves (Hyvönen 3985). - L. *Atrichum undulatum* (Hedw.) P. Beauv. Leaf cross-section (Koponen 17897). - M, N. *A. crispulum* Schimp. ex Besch. M. Leaf cross-section. N. Leaf (Hyvönen 3751). Use  $\mu\text{m}$  scale for A, B, D, E, G, I, J, L and M and mm scale for C, F, H, K and N.

J. f. Bot. 1800(2): 286. 1801. – Synonymized by Turner (1804).

All Taiwanese specimens of *Polytrichastrum formosum* we have studied belong to var. *densifolium* (Mitt.) Osada. The relationships between the varieties studied by Osada and Yano (1966) and Osada (1966) is, however, not presented here.

Diagnostic characters of Taiwanese *Polytrichastrum formosum* are the indistinctly finely papillose apical cells of lamellae which are also denticulate as seen in side view, and the sheath of the leaves that is abruptly narrowed to the lamina as is typical for the genera *Polytrichastrum* and *Polytrichum* Hedw. The latter character will distinguish *Polytrichastrum formosum* from large species of the genus *Pogonatum*. In the field *Polytrichastrum formosum* can easily be mistaken for *P. alpinum* or *Polytrichum commune*. Both of them normally have leaves more remotely set on the stem and this applies especially for the latter species. For certain distinctions of *Polytrichastrum alpinum* and *P. formosum* study under the dissecting microscope in the laboratory is normally needed. Extremely incrassate outer walls of the apical cells of the lamellae in *P. alpinum* are an easily seen distinguishing character. Some large specimens of *Pogonatum urnigerum* may resemble *Polytrichastrum*-species, but the coarsely papillose apical cells of the lamellae are, however, clearly a distinctive character.

*Polytrichastrum formosum* is a plant of the orotemperate vegetation zone at mid-altitudes in the mountains and thus confined to lower elevations than *P. alpinum*. It typically thrives in mesic and fairly shady habitats.

Illustrations: Osada 1966: 20 (fig. 10); Gangulee 1969: 163 (fig. 57 as *Polytrichum densifolium* Wils. ex Mitt.).

Distribution: Widely distributed in northern and southern Hemispheres.

Specimens examined: 3c. *T. Koponen* 17198; 3d. 16994; 3g. *T. Koponen* 17320; 10b. *Hyvönen* 4039; 10h. 4449; 11a: Yuenyang Lake, on forest ground, 24.V.1976 *Lai* 8511; Taichung Co.: Hoping, the entrance to Mt. Chungsueh, on humnus under *Miscanthus* grasses, ca. 2400–2650 m, 27.II.1978 *Lin* (as *Polytrichum commune* var. *swartzii* in *Exsiccatae Bryophytes of Taiwan* ser. 5: 238).

### *Polytrichum* Hedw.

Only one species, *Polytrichum commune* Hedw., has been recorded for Taiwan. The absence of *P. juniperinum* Hedw., a species with almost cosmopolitan distribution that has been collected in all surrounding areas, is surprising.

### *Polytrichum commune* Hedw.

(Fig. 4E–F)

Spec. Musc. 88. 1801.

*Polytrichum commune* can be mistaken as a species of the genus *Polytrichastrum*, *P. alpinum* or *P. formosum*. The stems are usually longer and the leaves more remotely set in *Polytrichum commune*. Under the microscope the typical apical cells of the lamellae with two distinct knobs can be seen and these will reveal the identity of the specimens.

This large species, with a wide distribution in the northern Hemisphere, is fairly rare in Taiwan and surprisingly collected only at low elevations (up to 2200 m). It has not been recorded in the vegetation zones equivalent to the northern boreal zone. One

reason might be the scarcity of suitable habitats since *Polytrichum commune* has been collected in moist or somewhat swampy habitats, which are extremely rare high up in the mountains.

Chuang (1973) reported only *Polytrichum commune* var. *swartzii* (Hartm.) Mönk. from Taiwan. However, the presence of this variety, treated by many authors (e.g. Long 1985) as a species, would be surprising at medium altitudes in Taiwan, because it is mostly confined to high latitudes. None of the specimens we have studied, including the one cited by Chuang (1973), belong to var. *swartzii* and consequently it is excluded from the flora.

Illustrations: Osada 1966: 11 (fig. 5), 13 (fig. 6), 15 (fig. 7); Smith 1971: 6 (fig. 1, 2), 7 (fig. 3), 8 (fig. 5), 20 (fig. 30, 31), 38 (fig. 51); Chen 1978: 314 (fig. 400).

Distribution: Widely distributed in both northern and southern Hemispheres.

Specimens examined: 1b. *Hyvönen* 3346; Taitung Co.: Payu Lake, on Humus, ca. 2200 m, 21.I.1965 *Kurokawa* (H. Inoue: Bryophyta Selecta Exsiccata 42); ca. 1600–2000 m, 28.VII.1967 *Chuang* 5079; Taipei Co.: Yangmingshan National Park, Monhwanhu near Mt. Chihsingshan, *Lai* 8447 (Herb. Lai); Taipei Co.: Chihsing, on black soil of a lake, ca. 1100 m, 29.III.1974 *Lin* (Exsiccatae Bryophytes of Taiwan ser. 3: 139); Yangmingshan National Park, Mt. Seven Star, 900 m, 10.IV.1987 *Lee*.

#### EXCLUDED AND DOUBTFUL TAXA

*Atrichum yakushimense* (Horik.) Miz., J. Jap. Bot. **31**: 119. 1956.

*Catharinea yakushimensis* Horik., Bot. Mag. Tokyo **50**: 560, fig. 38. 1936.

*Atrichum yakushimense* was reported for Taiwan by Lou and Koponen (1986). The record was, however, later confirmed to be erroneous (Lou 1988, pers. comm.).

*Catharinea speciosa* Horik., J. Jap. Bot. **12**: 670, 12. 1936.

*Atrichum speciosum* (Horik.) Nog., Preliminary list Moss. Japan Adjacent Areas 4. 1959, nom. inval. (Art 33.2). – *Atrichum speciosum* (Horik.) Wijk & Marg., Taxon **8**: 106. 1959. – Type: China. Taiwan. Taito: Mt. Chipon (ca. Kiriayama), 31.XII.1932 *Horikawa* (HIRO, holotype).

*Atrichum speciosum* was listed under excluded species by Chuang (1973) and synonymized with *Mnium lycopodiodes* Schwaegr. by Koponen (1981).

*Oligotrichum aligerum* Mitt., J. Linn. Soc. Bot. **8**: 48. 8. 1865.

As discussed above under *Oligotrichum suzukii* the species is tentatively accepted and not treated as a synonym of *O. aligerum*. Only report of the latter species is based on the specimen of *O. suzukii* and consequently *O. aligerum* is excluded from the flora.

*Pogonatum aloides* (Hedw.) P. Beauv., Prodr. Aetheogam. 84. 1805.

*Polytrichum aloides* Hedw., Spec. Musc. 96. 1801.

The senior author has studied a fairly large amount of Asian *Pogonatum* but no specimens of *P. aloides* have been encountered in Taiwan nor in surrounding areas. The species was excluded also by Chuang (1973).

*Pogonatum contortum* Brid. ex Lesq., Mem. Calif. Acad. Sci. **1**: 27. 1868.

*Polytrichum contortum* Menz. ex Brid., J. f. Bot. 1800 (1:2): 287. 1801.

We have not studied the specimen reported by Wang (1968) from Kuei-shan, Hsinchu, but follow Chuang (1973) and exclude the species from the flora since it has not been recorded in other localities.

*Pogonatum formosanum* Horik., Bot. Mag. Tokyo **49**: 59. 6. 1935.

Type: China. Taiwan. Chiayi: Mt. Ali. on the earth, 17.VIII.1932 Horikawa (HIRO, holotype).

In his original description Horikawa (1935a) notes that the new species is closely related to *Pogonatum suzukii*, a species later assigned to the genus *Oligotrichum*. The same probably applies also to the present species. We are even inclined to synonymize it with *O. suzukii* but the number of ventral lamellae is exceptional (ca. 30) and thus much higher than in other specimens of *O. suzukii*. The mammilosity of the exothecium is also a feature not present in *O. suzukii* but instead shows an affinity to the genus *Pogonatum*. As there is no chance to study the type material the identity of the species remains uncertain. The species was, however, provisionally synonymized with *P. subfuscatum* Broth. by Hyvönen (1989b). The latter species is known only of the type material collected in Yunnan.

*Pogonatum inflexum* (Lindb.) Lac., Ann. Mus. Bot. Lugd. Bat. **4**: 308. 1869.

*Polytrichum inflexum* Lindb., Not. Sällsk. F. Fl. Fenn. Förh. **9**: 100. 1868.

Distinction between *Pogonatum inflexum* and *P. neesii* turned out to be problematical in Taiwanese material and we were unable to find as clear distinctive characters as put forward by Osada (1965) for Japanese plants. However, after studying a fairly large amount of material from Taiwan, as well as the type specimens of *P. inflexum*, we are inclined to exclude the species from the flora. The Taiwanese material is rather variable but no specimens show the characters typical for *P. inflexum* (the extremely wide apical cells of lamellae and the tightly coiled leaf-apices in dry condition) collected in Japan or mainland Asia further north.

*Pogonatum japonicum* Sull. ex Lesq., Proc. Am. Ac. Arts Sc. **4**: 278. 1859.

*Pogonatum grandifolium* (Lindb.) Jaeg., Ber. St. Gall. Naturw. Ges. 1873–1874: 253. 1875. – *Polytrichum grandifolium* Lindb., Acta Soc. Sci. Fenn. **10**: 264. 1872.

This northern Asian species has been recorded for Taiwan by Wang (1967). The report was based on a misidentification and corrected by Iwatsuki (1969). No specimens of *Pogonatum japonicum* have been found in collections from Taiwan and consequently it is excluded from the flora.

*Pogonatum nipponicum* Nog. & Osada, J. Hatt. Bot. Lab. **28**: 195. 10. 1965.

The presence of this Japanese species on Taiwan is based on a report by Wang (1970). Unfortunately he did not cite any specimens and thus the verification of the reports is impossible. Consequently the species is tentatively excluded from the flora of Taiwan.

*Pogonatum perichaetiale* subsp. *thomsonii* (Mitt.) Hyvönen, Acta Bot. Fennica **138**: 15. 1989.

*Polytrichum thomsonii* Mitt., J. Linn. Soc. Bot. Suppl. **1**: 155. 1859. – *Pogonatum thomsonii* (Mitt.) Jaeg., Ber. St. Gall. Naturw. Ges. 1873–1874: 257. 1875.

*Pogonatum perichaetiale* spp. *thomsonii* was reported for Taiwan only by Chen (1978) without any specimen citation. It is tentatively excluded from the flora since no specimens were at hand for the study.

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