Bryophyte flora of Hunan Province, China 27. Polytrichaceae (Bryophyta)

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In the Hunan Province of China, the family Polytrichaceae is represented by three genera: *Atrichum* Hedw. with four species, *Pogonatum* P. Beauv. with nine, and *Polytrichum* with two species. *Atrichum yakushimense* (Horik.) Mizut., *Pogonatum dentatum* (Brid.) Brid. and *P. nudiusculum* Mitt. are reported from Hunan for the first time. The floristic affinities and ranges of the taxa are discussed. *Atrichum angustatum* (Brid.) Bruch & Schimp., *Pogonatum dentatum*, *P. urnigerum* (Hedw.) P. Beauv., *Polytrichum commune* Hedw. and *P. formosum* Hedw. are circumpolar species of the northern hemisphere. *Atrichum crispulum* Schimp. ex Besch. is disjunct between eastern North America and southeast Asia, and the rest of the species belong to the Southeast Asian temperate to meridional (warm temperate) element. *Pogonatum cirratum* (Sw.) Brid. subsp. *cirratum*, *P. cirratum* subsp. *fuscatum* (Mitt.) Hyvönen, *P. neesii* (Müll.Hal.) Dozy and *P. spinulosum* Mitt. can be described as Himalayan – Japanese in their their distribution. *Atrichum subserratum* (Harv. & Hook. f.) Mitt., *Pogonatum fastigiatum* Mitt., *P. nudiusculum* and *P. proliferum* (Griff.) Mitt. are Sino – Himalayan, and *Atrichum yakushimense* Sino – Japanese. All taxa occur in areas with primary vegetation but are also successful in colonizing man-made habitats and substrates such as road- and trail-sides. *Pogonatum neesii* seems to be the most common species on such sites in Hunan and can be considered as fairly common. *Atrichum angustatum* and *Pogonatum spinulosum* are rather rare, and the other species are rare or very rare with only a few specimens in the material studied. The altitudinal ranges of many taxa are much lower in Hunan than reported previously from China.

CONTENTS

1. Introduction

Between 1997−2001, five bryological expeditions were arranged by the Department of Systematic Biology and the Cryptogam Herbarium of the Botanical Museum of the University of Helsinki, and the Forestry Department of Hunan Province to gather basic knowledge on Hunan bryophytes. About 15000 specimens were collected. The project "Bryophyte flora of Hunan Province" was described and parts 1−20 listed by Koponen *et al.* (2014) and parts 20−25 by Piippo (2017). This paper is the 27th part of the series, the previous part being that of Koponen (2019).

2. Material and methods

Essential background information about material and methods, and abbreviations of collecting localities and geographical areas used in this study, are provided in parts 1, 3 and 17 (Koponen *et al*. 2000, 2004, 2014) and 24 (Enroth & Koponen 2017). Our collections were made in nine Nature Reserves: Badagongshan, Daweishan, Hupingshan, Mangshan, Shunhuangshan, Taoyuangdon, Wulingyuan, Yankou and Yunshan (Figs. 1, 2), or in their close vicinities. A small collection was made in Changsha City, mainly on Mt. Yelu.

In this paper, we cite the nomenclature including the basionyms and the synonyms previously reported or used for Polytrichaceae in Hunan. Illustrations useful for identification are listed. In "Habitats and substrates in Hunan" information from the labels of our specimens is provided. If a species was collected from only four sites or fewer, habitat and substrate details are given in full. Where there were more specimens, a summary of habitats and substrates is provided.

The specimens are listed following an alphabetic order for the nine Nature Reserves. Numbers of the collecting localities are in *italics*. During the project only one series of collecting numbers was used. The collectors of each specimen are given in the list of collecting localities as listed above.

Occurrence of species in Hunan is presented using Norrlin's frequency scale of seven grades (Nyström 1938, see Sollman & Koponen 2017).

The ranges of taxa in China and their total ranges are based on literature and our earlier studies (Lou & Koponen 1986, Hyvönen 1986, 1989). Details of nomenclature and typification and lists of synonyms are not repeated here. The traditional abbreviation "c.fr" indicates that the specimen has sporophytes. Specimens were studied using both dissecting and compound microscopes. In order to study cellular details with cells inflated to their normal dimensions, specimens were first soaked in alcohol (c. 95%), after that in c. 5% KOH, and then in water. For most species of Polytrichaceae, also in this material, cross-sections of leaves were required to study details of the apical/marginal cells of the adaxial lamellae in order to confirm identification.

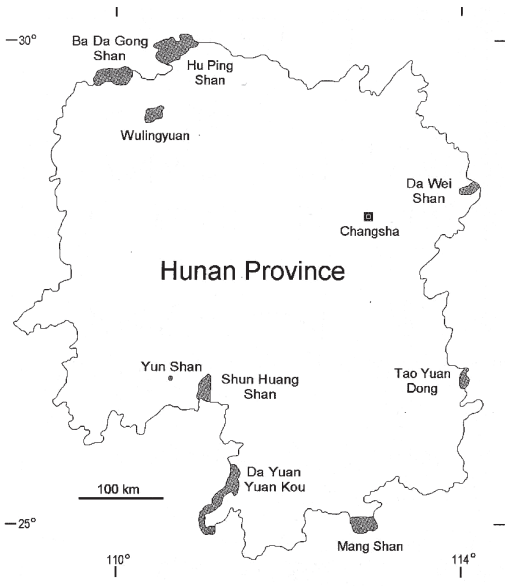

Fig. 1. Map of Hunan Province of China showing the locations of Nature Reserves studied during the Project "Bryophyte flora of Hunan Province".

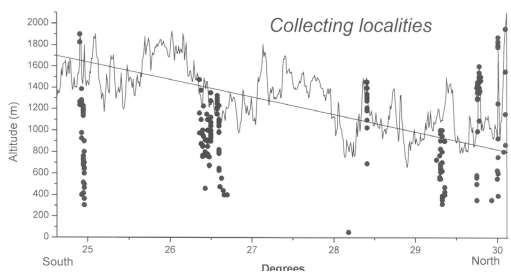

Fig. 2. The altitudinal distribution of collecting localities in Hunan. The diagonal line refers to the limit between the meridional and orotemperate zones.

3. Polytrichaceae Schwägr. 1830

Polytrichaceae is the only family of the class Polytrichopsida and the order Polytrichales containing c. 20 extant genera and over 200 species (Frey & Stech 2009, Bell *et al.* 2015). Smith (1971) pioneered the modern treatise of the taxonomy of the family, with Hyvönen *et al*. (2004) and Bell and Hyvönen (2010a) presenting the latest hypotheses of its phylogeny. In Hunan, the family Polytrichaceae has three genera and 14 species, one of them with two subspecies.

Key to the species of Polytrichaceae of Hunan

The key of *Atrichum* is adapted from Lou & Koponen (1986).

1. Leaves with a margin formed of specialized elongated cells 2
   − Leaves without specialized margin 5
2. Leaves without adaxial (ventral) lamellae, or lamellae only one cell high ..... *Atrichum yakushimense*
   − Leaves with adaxial (ventral) lamellae 2–6 cells high 3
3. Leaves obovate, ovate or ovate-lanceolate, undulate or smooth, leaf cells usually > 20 µm 4
   – Leaves, at least the upper ones, lingulate or triangular-lanceolate, distinctly undulate; leaf-cells < 18 µm ..... *A. angustatum*
4. Lamellae well developed, in the middle of leaf 4−5 in number, and 3–6 cells high; leaves with small marginal teeth mostly only in the distal part, leaf apex obtusely acute ..... *A. subserratum*
   − Lamellae 2−4, often reduced, 2−4 cells high; large, sharp marginal teeth also in the basal part of the leaves; leaf apex long acute ..... *A. crispulum*
5. Plants very small, scattered on persistent protonema, stems normally < 2 mm; adaxial lamella lacking on the membranous leaves that are composed entirely of the sheath, with no blade differentiated; apical cells of the leaves clearly papillose ..... *Pogonatum spinulosum*
   − Plants with stems clearly > 2 mm 6
6. Leaves with adaxial lamellae only in the central part of the leaves, with wide unistratose margins without adaxial lamellae 7
   − Leaves with lamellae covering almost the whole width of the blade, with only narrow, unistratose margin 8
7. Adaxial lamellae up to 20 in number ..... *P. nudiusculum*
   − Adaxial lamellae < 12 in number ..... *P. proliferum*
8. Apical (marginal) cells of the adaxial lamellae coarsely papillose 9
   − Apical (marginal) cells of the adaxial lamellae smooth or only with indistinct, fine papillae 10
9. Apical (marginal) cells of the adaxial lamellae flat and wide as seen in cross-section ..... *P. dentatum*
   − Apical (marginal) cells of the adaxial lamellae round as seen in cross-section ..... *P. urnigerum*
10. Apical (marginal) cells of the adaxial lamellae retuse as seen in cross-section ..... *Polytrichum commune*
    − Apical (marginal) cells of the adaxial lamellae round as seen in cross-section 11
11. Margins of the adaxial lamellae practically straight or only slightly crenate as seen in side view 12
    − Margins of the adaxial lamellae distinctly crenate as seen in side view ..... *Pogonatum neesii*
12. Leaves with a distinct sheathing basal part, and a firm, apical blade; leaves appressed and incurved, not contorted, in dry condition; adaxial (ventral lamellae) mostly 4−6 cells high ... *Polytrichum formosum*
    − Leaves gradually widened towards sheathing basal part; leaves clearly contorted when dry, adaxial

(ventral) lamellae < 2−3(−4) cells high 13
13. Plants large, with stems up to 12 cm, apical (marginal) cells of the adaxial lamellae clearly smaller than other cells of the lamellae, geminate apical cells fairly common ..... *Pogonatum fastigiatum*
− Plants mostly medium-sized, with stems < 10 cm long; cells of the adaxial (ventral) lamellae more or less of equal size 14
14. Stems predominantly < 5 cm long; some of the apical (marginal) cells of the adaxial (ventral) lamellae slightly smaller than other cells of the lamellae..... *P. cirratum* subsp. *fuscatum*
− Stems mostly > 5 cm (even up to 10 cm) long; cells of the adaxial (ventral) lamellae of equal size ... . *P. cirratum* subsp. *cirratum*

3.1. ***Atrichum*** P. Beauv. 1804

Frey and Stech (2009) gave the species number 20 for the genus worldwide, but Nyholm (1971) revised the number to 15 in addition to a small number of varieties. More recently Perley and Jesson (2015) found evidence for numerous allopolyploids and hybrids in the genus. Lou and Koponen (1986) revised *Atrichum* in China. In Hunan, four species are known.

1. ***Atrichum angustatum*** (Brid.) Bruch & Schimp.

Bryol. Eur. 4: 237 (fasc. 21−22, Monogr. 9). – *Polytrichum angustatum* Brid., Muscol Recent. Suppl. 1: 79. 1806.

Catharinea rhystophylla Müll.Hal., Nuovo Giorn Bot. Ital., n.s. 3: 93. 1896. − *Atrichum rhystophyllum* (Müll.Hal.) Paris., Index Bryol. Suppl. 17. 1900.

Taxonomy. Lou and Koponen (1986) discussed the taxonomy of *Atrichum undulatum* and its closest relatives and used the name *A. rhystophyllum* of the species they were able to distinguish from other taxa by its sexual condition and clear-cut morphological characters of the gametophyte. North American authors (e.g. Crum & Anderson 1981, Ireland 1982, Smith Merrill 2007) had used the name *A. angustatum* for the same taxon. Smith (2004) synonymized *A. rhystophyllum* with *A. angustatum* at the species level, and the name is now accepted in the "Checklist of mosses of Europe and Macaronesia" (Hill *et al*. 2006) and used in the "Flora Briofitica Ibérica" (Brugués *et al*. 2007). However, Ignatov and Ignatova (2003) had previously accepted *A. angustatum* in their "Moss flora of the Middle European Russia".

Illustrations. Nyholm 1971: 30 (fig. 17, as *A. rhystophyllum*); 31 (fig. 18, as *A. angustatum*); Crum and Anderson 1981: 1250 (fig. 620); Ireland 1982: 669 (pl. 381); Lou and Koponen 1986: 36 (fig. 2 a−f; cited as as *A. subserratum* due to technical mistake); Noguchi 1987: 21 (fig. 8 C, as *A. rhystophyllum*); Wu and Wang 2005: 310 (pl. 743, as *A. rhystophyllum*); Ignatov and Ignatova 2003: 92 (fig. 55); Brugués *et al*. 2007: 106 (fig. 41).

Habitats and substrates in Hunan. The habitats of *Atrichum angustatum* are "second growth or disturbed forests, planted forests, or open habitats such as road sides and road side cliffs" (Koponen *et al*. 2000). The few additional specimens cited here do not add much to this characterisation. The altitudinal range is from 50 to 1900 m (Fig. 3). Substrates: sandy soil (13 specimens), soil (7), clay (3), gravel (2), humus (1) and silt (1). – Frequency in Hunan: rather rare.

Range in Hunan. *Atrichum angustatum* was recorded first to Hunan by Lou and Koponen (1986, Rao *et al.* 1997, as *A. rhystophyllum*). **Changsha City.** *1*. (Koponen *et al.* 2000, as *A. rhystophyllum*); Mt. Yuelu (Wu & Wang 2005). − **Badagongshan.** *40a*. 50415, at road in evergreen warm temperate forest, open, mesic roadside cliff, 1240–1340 m. *86b*. 58651 c.fr., *Meta-*

sequoia glyptostroboides plantation mixed with warm temperate trees and bushes, on humus, 1090 m. − **Daweishan.** *DAW24b*. 63412, dense bamboo (*Phyllostachys bambusana*) forest on moderate mountain slope, on soil in full shade, 1400 m. − **Mangshan.** *3a*, *12a*. *14a*. (Koponen *et al.* 2000, as *A. rhystophyllum*). − **Wulingyuan.** *16b*, *16c*, *16d*, *18a*, *18c*, *18d*, *18e*, *19a, 19b*, *19d*, *19e* (Koponen *et al.* 2000).

Range in china. Jia and He (2013) listed *Atrichum angustatum* (as *A. rhystophyllum*) from eight provinces in central China. According Wu and Wang (2005) it usually grows on fairly moist roadsides and forest ground, at 950−2500 m.

Total range. Am 1: (Smith Merrill 2007); Eur: (Hill *et al*. 2006); As 1: Russian Far East (Ignatov *et al*. 2006, Ignatov 2017); As 2: Chi Ja Ko (Lou & Koponen 1985).

2. ***Atrichum crispulum*** Schimp. ex Besch.

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

A. henryi (E.S. Salmon) E.B. Bartram, Ann. Bryol. 8: 31. 1935. – *Catharinea henri* E.S. Salmon, J. Bot. 40: 1, *pl. 249, figs. 1−8*. 1902.

Taxonomy and illustrations. Nyholm 1971: 14 (fig. 6, as *A. henryi*); 23 (fig. 12, as *A. crispulum*); Lou and Koponen 1986: 38 (fig. 4 a−k); Noguchi 1987: 25 (fig. 9 A); Wu and Wang 2005: 308 (pl. 742).

Habitats, substrates and range in hunan. *Atrichum crispulum* was reported to Hunan by Chang (1978, as *A. henryi*) and Rao *et al.* (1997). **Wulingyuan.** *18b*. 52624, secondary growth warm temperate forest, on sand on cliff, at 630

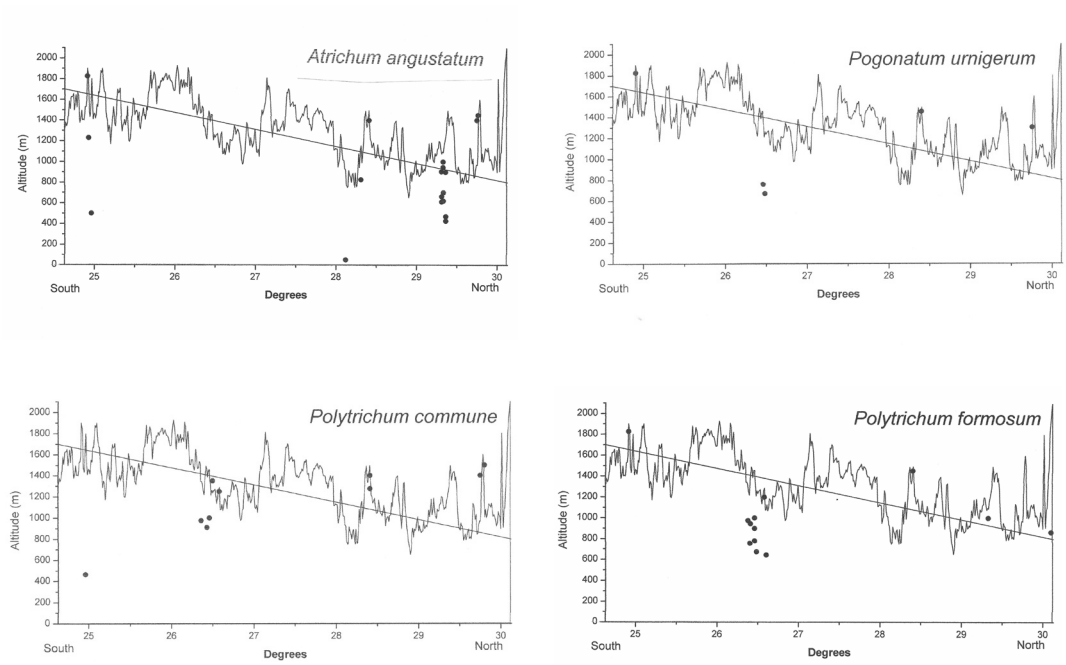

Fig. 3. Altitudinal ranges in Hunan. The diagonal line marks the appropriate upper border of the meridional zone and, at the same time, the lower border of the orotemperate zone. – Species of Holarctic, continuously or discontinuously circumpolar, boreal to temperate element. *Atrichum angustatum* (Brid.) Bruch & Schimp., *Pogonatum urnigerum* (Hedw.) P. Beauv., *Polytrichum commune* Hedw., and *Polytrichum formosum* Hedw.

m (Koponen *et al.* 2000). − Frequency in Hunan: Very rare.

Range in china. *Atrichum crispulum* was reported in 11 provinces of southern China by Jia and He (2013). It commonly grows on wet roadsides, forest ground, or on soil and rocks at 1700−3100 m (Wu & Wang 2005).

Total range. Am 1: (Smith Merrill 2007); As 2: Chi Ja Ko; As 3: Tha (Lou and Koponen 1986).

3. ***Atrichum subserratum*** (Harv. & Hook. f.) Mitt.

J. Proc. Linn. Soc. Bot., Suppl. 1: 150. 1859. – *Polytrichum undulatum* var. *subserratum* Harv. & Hook. f., J. Bot. (Hooker) 2: 3. 1830.

Taxonomy and illustrations. Lou and Koponen 1986: 36 (fig. 2, i−n, cited as *A. rhystophyllum* due to technical mistake); Wu and Wang 2005: 312 (pl. 744).

Habitats, substrates and range in hunan. *Atrichum subserratum* was recorded for Hunan by Koponen *et al.* (2000) from **Wulingyuan.** *17b*. 52121, on gravel at 550−580 m in second growth warm temperate forest. – Frequency in Hunan: Very rare.

Range in china. Wu and Wang (2005) and Jia and He (2013) listed *Atrichum subserratum* for Fujian and Yunnan. According to Wu and Wang (2005) it grows on moist soil along roadsides or forest ground at 750 m.

Total range. As 2: Chi; As 3: In Ne (Lou & Koponen 1985).

4. ***Atrichum yakushimense*** (Horik.) Mizut.

J. Jap. Bot. 31: 119. 1956. – *Catharinea yakushimensis* Horik., Bot. Mag. (Tokyo) 50: 560, *fig. 38*. 1936.

Taxonomy and illustrations. Horikawa 1936: 560 (fig. 38); Noguchi and Osada 1960: 44 (fig. 11); Nyholm 1971: 15 (fig. 7); Iwatsuki and Mizutani 1972: pl. 2 (fig. 28); Noguchi 1987: 25 (fig. 9 B); Wu and Wang 2005: 314 (pl. 746).

Habitats, substrates and range in hunan. *Atrichum yakushimense* is not listed for Hunan by Jia and He (2013). **Wulingyuan.** *19b.* 52012, Huangshizhai, on slope in second growth evergreen warm temperate forest, mesic sand in partial shade, 700 m. – Frequency in Hunan: Very rare.

Range in china. Jia and He (2013) recorded *Atrichum yakushimense* from Anhui, Jiangxi, Hubei, Chongqin, Guangdon, Guangxi, Guizhou and Yunnan provinces of China. Lou and Koponen (1986) mentioned also Taiwan. According to Wu and Wang (2005) it is common on moist soil along roadsides, forest ground or rocks, at 2000−3000 m. – First record for Hunan.

Total range. As 2: Chi Ja.

3.2. ***Pogonatum*** P. Beauv. 1804

The genus has been revised by Hyvönen (1989) and Koskinen and Hyvönen (2004). It has over 50 species worldwide and is the largest genus of the Polytricopsida. A new revision with expanded sampling is in preparation by Hyvönen *et al*. Nine species are known for Hunan.

1. ***Pogonatum cirratum*** (Sw.) Brid. subsp. ***cirratum***

Bryol. Univ. 2: 110. 1827. – *Polytrichum cirratum* Sw., J. Bot. (Schrader) 1800(2): 175. *pl. 4*. 1801.

Taxonomy. Only a few of the specimens had sporophytes. *Pogonatum cirratum* is a plant with a wide range and a large variation in its morphology. In Hunan the distinction between the two subspecies, *P. cirratum* subsp. *cirratum* and subsp.

fuscatum, is also problematic and it is impossible to give any clear distinguishing characters. *Pogonatum cirratum* has unbranched stems but a dendroid form (as *P. cirratum* s. lat) has been found on Mt. Kinabalu (Bell & Hyvönen 2010b).

Illustrations. Hyvönen 1989a: 31 (fig. 9 A−D); Bell & Hyvönen 2010b (fig. 2, as *Pogonatum cirratum* s. lat.).

Habitats and substrates in Hunan. Several localities of *Pogonatum cirratum* subsp. *cirratum* were in primary, mixed evergreen forests, but more often it was taken from second growth forests, *Cunninghamia lanceolata* plantations or bamboo thickets, along rivers and streams. Other habitats influenced by human activities are road-side cliffs. Most of the collection sites are in the warm temperate zone at 270−1280 m (Fig. 4). The habitats were in partial or full shade and moist or mesic, only a few of them being marked as open sites. Substrates: Boulder, cliff or rock outcrop (15 specimens), soil (5), sand (3) and base of trunk of *Metasequoia* by road-side (1). – Frequency in Hunan: Rather rare.

Range in Hunan. *Pogonatum cirratum* subsp. *cirratum* was recorded to Hunan by Koponen *et al.* (2000) and Jia and He (2013). **Badagongshan.** *39a*. 50533. – **Mangshan.** *5*. 51375. *6*. 51468, 51468a. *7a*. s.n. *7d*. 49239. *9a*. 49048 c.fr. *10a*. 50828. *10c*. 51269. *11c*. 51191. *12b*. 50596. – **Shunhuangshan.** *S2b*. 71139. *S5*. 70548 c.fr. *S9*. 70788 c.fr. – **Wulingyuan.** *16c*. 52863a. *16d*. 53370. *16c*. 52863. *17c*. 58457. *18d*. 52660. – **Yankou.** *74d*. 59805. *75b*. 59450, 59581. *79a*. 59491, 59523 c.fr. – **Yunshan.** *Y4*. 70046. *Y6c*. 70357, 70358.

Range in China. *Pogonatum cirratum* subsp. *cirratum* is known from 16 provinces in southern China (Jia & He 2013). According to Wu and Wang (2005), it grows in subtropical mountain regions at middle to low altitude on rocks covered with soil, at 220−3200 m.

Total range. As 2: Chi Ja; As 3: Bhu In Sri Tha; As 4: Ind PNG (Hyvönen 1986). Range map (as *Pogontum cirratum* s.lat.) is by Bell and Hyvönen (2010b).

2. ***Pogonatum cirratum*** (Sw.) Brid. subsp. ***fuscatum*** (Mitt.) Hyvönen

Acta Bot. Fennica 138: 32. 1989. – *P. fuscatum* Mitt., J. Proc. Linn. Soc. Bot., Suppl. 1: 154. 1859.

P. spurio-cirratum Broth., Philippine J. Sci. 5: 150. 1910.

P. spurio-cirratum var. *pumilum* Reimers, Hedwigia 71: 74. 1931.

Taxonomy and illustrations. Noguchi 1987: 43 (fig. 14 A, as *P. spurio-cirratum*); Hyvönen 1989a: 31 (fig. 9 E). − Only a few specimens had sporophytes.

Habitats and substrates in Hunan. *Pogonatum cirratum* subsp. *fuscatum* is not as common in Hunan as *P. cirratum* subsp. *cirratum*. The habitats are quite similar - most of them are in warm temperate secondary forests, or forests disturbed, for example, by grazing. One collection was in *Pinus massoniana* plantation and another in deciduous mixed forest by a trail-side. The altitudes are a little higher than those of *P. cirratum* subsp. *cirratum*, at 400−1540 m (Fig. 4). The sites were in full or partial shade, and mesic. It was collected from cliffs or rock crevices (6 specimens) and from sand (2). − Frequency in Hunan: Rare.

Range in Hunan. *Pogonatum cirratum* subsp. *fuscatum* was recorded to Hunan by Reimers (1931, as *Pogonatum spurio-cirratum* var. *pumilum* fo. *hemisphaericum* Reimers), Koponen *et al*. (2000), Rao *et al*. (1997) and Jia and He (2013), and from **Changsha City** by Brotherus (1929, as *P. spurio-cirratum*). − **Badagongshan.** *55a*. 54302. *55c*. 58822. – **Mangshan.** *3a. 4b. 7a. 9a. 14a*. Koponen *et al*. (2000). − **Shunhuangshan.** *S6*. 70577. *S17*. 71100 c.fr. – **Taoyuangdon.** *26*. 56608 c.fr. *35*. 56414. – **Wulingyuan.** *17a*. *18e*.

(Koponen *et al.* 2000). – **Yuankou.** *75b*. 59408. *79a*. 59489. – **Yunshan.** *Y16*. 70310.

Range in china. *Pogonatum cirratum* subsp. *fuscatum* is known from many Southern Chinese provinces (Jia & He 2013) and usually grows in warm and moist forests on the ground and on tree trunks, at 200−3450 m (Wu & Wang 2005). These authors also mention "tree trunks" as a habitat where the species has been found but this must be treated as a mistake, or else must refer to cases where plants have been collected on the bases of trunks, or with a considerable amount of soil accumulated upon coarse bark.

Total range. As 2: Chi; As 3: Bhu Bu In Laos Ne Tha Viet; As 4: Ind Ma Phi (Hyvönen 1989a).

3. ***Pogonatum dentatum*** (Brid.) Brid.

Bryol. Univ. 2: 122. 1827. – *Polytrichum dentatum* Menz. ex Brid., J. Bot. (Schrader) 1800(1): 287. 1801.

P. capillare (Michx.) Brid., Bryol. Univ. 2: 127. – *Polytrichum capillare* Michx., Fl. Bor. Amer. 2: 234. 1803.

Taxonomy. *Pogonatum dentatum* is a common plant of northern latitudes with a circumpolar distribution. As discussed in Hyvönen (1989a) it is easily distinguished from all other species of the genus by apical (marginal) cells of the adaxial lamellae that are coarsely papillose, flat and wide as seen in cross-section, as well as teeth on the margins of the lower part of the blade that are typically pointing out from the leaf margin at almost a right angle.

Illustrations. *Pogonatum dentatum* is described and illustrated in many North American, European and East Asiatic floras, e.g. Smith (1978, 2004), Crum and Anderson (1981), Ireland (1982), Noguchi (1987, as *P. capillare*), Hyvönen 1989a: 12 (fig. 2), Ignatov and Ignatova (2003) and Ignatov (2017).

Habitats, substrates and range in Hunan. *Pogonatum dentatum* was not listed for Hunan by Jia and He (2013). **Hupingshan.** *67*. 53514, San-He village, evergreen mixed, deciduous broad-leaved forest, on humus at open, mesic road side, at 1450 m. − Frequency in Hunan: Very rare.

Range in china. According to Wu and Wang (2005), *Pogonatum dentatum* was known previously from Guizhou and Jilin, and according to Jia and He (2013), from Jilin, Xingjiang and Honkong provinces of China. It grows mostly on sandy soils facing south, at 1180 m (Wu & Wang 2005). − New to Hunan.

Total range. Holarctic, mainly in arctic and boreal bioclimatic vegetation zones. – Range map: Hyvönen 1989a: 74 (fig. 24).

4. ***Pogonatum fastigiatum*** Mitt.

J. Proc. Linn. Soc. Bot., Suppl. 1: 154. 1859.

Taxonomy and illustration. Hyvönen 1989a: 28 (fig. 8 D−F).

Habitats, substrates and range in Hunan. Reported from Hunan by Chang (1978, Yang 1983, Rao *et al*. 1997, Jia and He 2013) and from **Changsha City**, Mt. Yuelu by Wu and Wang (2005). − **Mangshan.** *7d*. 50713, Guizizhai, core area of the forest reserve, primeval warm temperate forest sloping to river, at brook on wet soil in partial shade, 1180 m. – Frequency in Hunan: Very rare.

Range in china. *Pogonatum fastigiatum* is known from 11 provinces in southern China (Jia & He 2013) and grows on the ground of moist and warm forests and in grasslands, at 800−2250 m (Wu & Wang 2005).

Total range. As 2: Chi; As 3: Bhu In Ne Tha (Hyvönen 1989a, range map p. 77, fig. 28).

5. ***Pogonatum neesii*** (Müll.Hal.) Dozy

Bryol. Jav. 1: 40, *pl. 36*. 1856. – *Polytrichum neesii* Müll.Hal., Syn Musc. Frond. 2: 563. 1851.

Taxonomy and illustrations. Hyvönen 1989a: 51 (fig. 15 A−C); Hyvönen 2006a: 135 (figs. A−D); Ignatov 2017: 78 (fig. 30). − *Pogonatum neesii* frequently has sporophytes.

Habitats and substrates in Hunan. *Pogonatum neesii* was only rarely collected in primary habitats such as mature *Cunninghamia lanceolata* dominated evergreen forest, mature secondary evergreen broad-leaved forest and primary evergreen forests. In these habitats, *P. neesii* grows on brook and stream banks. More often it was collected from young secondary forests or among bushes, forest plantations (*Cunninghamia lanceolata*, *Magnolia biloba* subsp. *biloba*, *Metasequoia glyptostroboides*, *Phellodendron amurense*, *Tapiscia sinensis*), orchards or pastures. However, even where the habitat was described as more or less undisturbed forest, the specimens were collected from trail- or road-sides. These are mentioned as habitats on the labels of 54 specimens. Obviously, the common occurrence of *P. neesii* is due to human activities that create numerous suitable habitats, its dispersal being enhanced by its abundant spore production. Substrates in open places were dry and on shaded trail-sides marked as mesic or moist. The altitudinal distribution in Hunan extends from the warm temperate to the orotemperate zone (375−1600 m, Fig. 4). Substrates: sand (38 specimens), cliff, boulder, stone, top of rock (24), soil (21), clay (8), gravel (3), humus (3), brook side bank (2) and rotten stump (2). − Frequency in Hunan: fairly common.

Range in Hunan. Reported to Hunan by Koponen *et al.* (2000) and Jia and He (2013). **Badagongshan.** *40a*. 50410, 50431, 55592. *42*. 55727. *42a*. 59130. *43*. 54840. *46*. 54556, 54583. *48*. 48652, 48657, 48692, 48736. *49*. 48800. *50*. 48780, 50100. *51*. 50389 *54*. 54632. *55a*. 47986, 54252. *55b*. 54390. *55c*. 58769. *80*. 58351. *81b*. 58392, 58401, 58407, 58408. *84*. 58546A. *86b*. 58656. *87*. 58877. *92*. 61174. – **Daweishan.** *DAW4*. 62393, 62420. *DAW15*. 62319. *DAW16*. 61792. *DAV23*. 61664, 63155. *DAW26a*. 61685. *DAW27*. 61874, 61889, 61891. *DAW31*. 63324. – **Hupingshan.** *58*. 53624. *59*. 53263. *61*. 49922, 49923, 49939, 52230. – **Mangshan.** *8*. 49015. *12b*. 50569. – **Shunhuangshan.** *S2b*. 71107. *S3*. 70413. *S5*. 70522, 70532. *S7*. 70627. *S12a*. 70828. *S14*. 71035. *S16*. 71056. – **Taoyuangdon.** *20a*. 56815, 56817, 57462. *20b*. 57599. *21d*. 55938. *21e*. 55145. *22*. 56886, 56888. *23b*. 55796, 55800, 55865. *25a*. 56862. *25b*. 56851. *25c*. 56626A. *27*. 55214, 56513. *29*. 56466, 56473. *30*. 57450, 57454. *31*. 55412. *34*. 57041, 57111. *38*. 56645. 56647, 56649, 56651. – **Wulingyuan.** *15c*. 53255. – **Yuankou.** *74a*. 60094. *74b*. 59885, 59890. *74d*. 59789. *76b*. 59999, 60005. *77a*. 59628, 59630, 59631. *77b*. 59412, 59474. *78d*. 59739, 59746, 59883. – **Yunshan.** *Y3*. 70036. *Y4*. 70059. *Y6b*. 70346. *Y7a*. 70109, 70122. *Y10*. 70404. *Y11a*. 70166. *Y12a*. 70200, 70202. *Y14*. 70331. *Y16*. 70314.

Range in China. Wu and Wang (2005) listed *Pogonatum neesii* from Chongqing, Guizhou, Hainan, Taiwan and Yunnan provinces. Jia and He (2013) mentioned Hong Kong, Hubei, Hunan, Jiangsu, Jiangxi, Taiwan and Zhejiang. According to Wu and Wang (2005) it grows on the ground of moist and warm forests and tree trunks at 1300−1950 m.

Total range. According to Hyvönen (1989a, range map, p. 78, fig. 30), *Pogonatum neesii* has a wide range extending all the way from the Caucasus mountains through SE Asia to the Himalayas and even further south to Australia and Oceania.

6. ***Pogonatum nudiusculum*** Mitt.

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

Taxonomy and illustrations. Hyvönen 1989a: 28 (fig. 8 G–I). − Only one specimen had sporophytes.

Habitats and substrates in Hunan. Nearly all of the collecting localities for *Pogonatum nudiusculum* were in the Badagongshan area, in orotemperate mixed broad-leaved and evergreen forests along brooks, or in plantations of various trees, at 1400–1600 m (Fig. 4). Only one collection was from lower elevation secondary forest with planted *Metasequoia glyptostroboides* and *Cryptomeria japonica*, at 300 m. Substrates: Cliff or boulder (4 specimens), gravel (1), clay (2), soil (1), sand (1) and rotten wood (1). − Frequency in Hunan: Very rare.

Range in Hunan. *Pogonatum nudiusculum* was not listed to Hunan by Jia and He (2013). **Badagongshan.** *43*. 54750. *44b*. 50261. *45*. 50358, 55568. *47*. 54547. *55c*. 58778 c.fr., 58818, 58819, 58823. – **Wulingyuan.** *17c*. 58475.

Range in China. *Pogonatum nudiusculum* was reported previously from Guizhou, Sichuan, Taiwan and Yunnan (Wu & Wang 2005), plus Gansu and Xizang provinces of China (Jia & He 2013). It grows on the ground in mountain forests and in grasslands, at 2500−3600 m (Wu & Wang 2005). – New to Hunan.

Total range. As 2: Chi; As 3: Bhu In Ne; As 4: Phi (Hyvönen 1989a, range map p. 77, fig. 28).

7. ***Pogonatum proliferum*** (Griff.) Mitt.

J. Proc. Linn. Soc. Bot., Suppl. 1: 152. 1859. – *Polytrichum proliferum* Griff., Calcutta J. Nat. Hist. 2: 475. 1842.

Taxonomy and illustrations. De Sloover 1986 (as *Pogonatum ugandae* P. de la Varde); Hyvönen 1989a: 38 (fig. 11 A, B); Hyvönen 1989b: 577 (fig. 4 H).

Habitats, substrates and range in Hunan (Fig. 4). *Pogonatum proliferum* was recorded for Hunan by Koponen *et al.* (2000) and Jia and He (2013). **Badagongshan.** *55b.* 54392, deciduous forest (*Betula*, *Carpinus*, *Quercus*, *Tilia* etc. on mountain ridge, open and dry base trunk of tree, at 1600 m. – **Mangshan.** *8*, *9a*, *14a,* at 1185−1902 m, on sand, soil, gravel and cliffs (Koponen *et al*. 2000). − **Yunshan.** *Y4.* 70049 c.fr., mature secondary evergreen broad-leaved forest on steep mountain slope, in full shade on rock outcrop by trail, at 1165 m. – Frequency in Hunan: Very rare.

Range in China.. Jia and He (2013) listed *Pogonatum proliferum* from seven southern Chinese provinces. According to Wu and Wang (2005) it usually grows on the ground in forests or along forest margins, at 1400−2200 m.

Total range. Afr 2: Ruanda, Uganda; As 2: Chi; As 3: Bu In Ne Tha; As 4: Ind Phi (Hyvönen 1989a, range map p. 77, fig. 29).

8. ***Pogonatum spinulosum*** Mitt.

J. Proc. Linn. Soc. Bot., Suppl. 8: 156. 1864.

Taxonomy and illustrations. Osada 1965: 176 (fig. 1); Noguchi 1987: 33 (fig. 12 B); Hyvönen 1989a: 46 (fig. 13 E−G); Wu and Wang 2005: 341 (pl. 726, figs. 23−28); Ignatov 2017: 72 (fig. 25). − All specimens have sporophytes.

Habitats and substrates in Hunan. Most localities for *Pogonatum spinulosum* were in the orotemperate zone in more or less primary deciduous and mixed deciduous − evergreen forests. Habitats influenced by human activities were forest road-side, road-side in grassland, dense bamboo thicket and plantation and under bushes, at 600−1902 m (Fig. 4). Habitats were open, in partial or full shade and most substrates were given as moist or mesic. Substrates: Sand (6 specimens), soil (4), cliff (1), clay (2), gravel (1), grassland

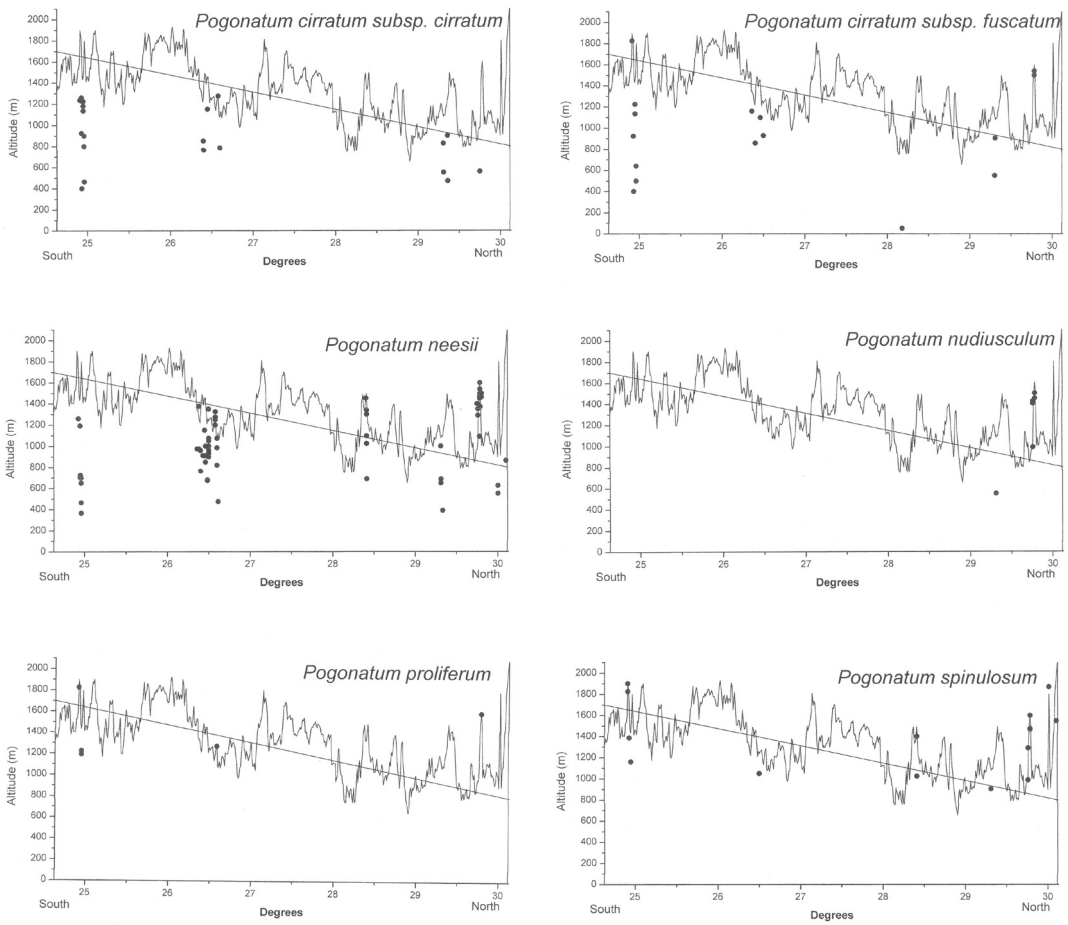

Fig. 4. Altitudinal ranges in Hunan. The diagonal line marks the appropriate upper border of the meridional zone and, at the same time, the lower border of the orotemperate zone. – Species of Southeast Asian temperate to meridional (warm temperate) element. *Pogonatum cirratum* (Sw.) Brid. subsp. *cirratum*, *P. cirratum* (Sw.) Brid. subsp. *fuscatum* (Mitt.) Hyvönen, *P. neesii* (Müll.Hal.) Dozy, *P. nudiusculum* Mitt., *P. proliferum* (Griff.) Mitt. and *P. spinulosum* Mitt.

(1) and rotten stump (1). – Frequency in Hunan: Rather rare.

Range in Hunan. *Pogonatum spinulosum* was reported to Hunan by Koponen *et al.* (2000), Wu and Wang (2005), and Jia and He (2013). **Badagongshan.** *40a*. 55617 c.fr. *47*. 48949 c.fr. *50*. 50133 c.fr. *51*. 50390 c.fr. *55b*. 54397 c.fr. – **Daweishan.** *DAW16*. 61997 c.fr. *DAW24b*. 62233 c.fr. – **Hupingshan.** *61*. 48567 c.fr. *67*. 53521 c.fr. *71*. 53953 c.fr. – **Mangshan.** *7c*, *13*, *14a*, *14b* (Koponen *et al.* 2000). – **Taoyuangdon.** *31*. 55402 c.fr. – **Wulingyuan.** *18e*. (Koponen *et al.* 2000).

Range in China.. *Pogonatum spinulosum* has a wide range in central and northern China and has been reported from 16 provinces (Jia & He

2013). It commonly grows on moist slopes at low-altitude, soil walls and forest ground, at 800−2400 m (Wu & Wang 2005).

Total range. As 1: Russian Far East; As 2: Chi Ja Ko; As 4: Phi (Hyvönen 1989a; range map, p. 78, fig. 30).

9. ***Pogonatum urnigerum*** (Hedw.) P. Beauv.

Prodr. Aethéogam. 84. 1805. – *Polytrichum urnigerum* Hedw., Sp. Musc. Frond. 100, *pl. 22, figs 5−7*. 1801.

Taxonomy and illustrations. *Pogonatum urnigerum* is described and illustrated in many North American, European and East Asiatic floristic works, e.g. Smith (1978, 2004), Crum and Anderson (1981), Ireland (1982), Noguchi (1987), Hyvönen 1989a: 31 (fig. 1 A−E), Ignatov and Ignatova (2003), Brugués *et al*. (2007), Smith Merrill (2007) and Ignatov (2017). − All specimens are without sporophytes.

Habitats, substrates and range in Hunan (Fig. 3). *Pogonatum urnigerum* was reported for Hunan by Koponen *et al*. (2000), but not listed for the province by Jia and He (2013). **Badagongshan.** *40b*. 50462, dry deciduous – evergreen forest along brook on open and dry cliff, at 1240−1360 m. – **Daweishan.** *DAW31*. 61907, open grassland with shrubs (*Symplocos paniculata*) and large boulders on mountain top, at 1430−1480 m. – **Mangshan.** *14a*. (Koponen *et al*. 2000). – **Taoyuangdon.** *20a*. 57569, around Zhu-Lian waterfall and its brook, on open, mesic boulder, at 670 m. *21b*. 55131, shore cliff and boulders of Wang-Yang River, on open and mesic cliff, at 760 m. – Frequency in Hunan: Rare.

Range in china.. *Pogonatum urnigerum* has a wide range in central and northern China, having been reported from 20 provinces (Jia & He 2013) and commonly grows on the ground in rather dry sunny forest, or on rock (Wu & Wang 2005).

Total range. *Pogonatum urnigerum* has a wide range in the northern hemisphere from arctic to temperate bioclimatic zones. Southern disjunct occurrences are in corresponding oro-zones, e.g. in New Guinea (Hyvönen 1986). – Range map: Hyvönen 1989a: 74 (fig. 23).

3.3. ***Polytrichum*** Hedw. 1801

Frey and Stech (2009) give the number of species worldwide as 39. However, the genus has not been revised globally and the actual number of species might be less (Bell and Kariyawasam, pers. comm.). The problem of the generic differentiation of *Polytrichum* and *Polytrichastrum* was solved by Bell and Hyvönen (2010c). In Hunan, two species of *Polytrichum* are known.

1. ***Polytrichum commune*** Hedw.

Sp. Musc,. Frond. 88. 1801.

Taxonomy and illustrations. Taxonomy of *Polytrichum commune* and its allies (e.g. *P. perigoniale* Michx.) is still uncertain. We take here a conservative view and treat all specimens as *P. commune*, but it would not be surprising, if some of the specimens from Hunan prove to belong to some of the closely related taxa instead. However, assigning them confidently will be possible only upon completion of the worldwide revision of the whole group. *Polytrichum commune* is described and illustrated in many North American, European and East Asiatic flora works, e.g. Smith (1978, 2004), Crum and Anderson (1981), Ireland (1982), Noguchi (1987), Ignatov and Ignatova (2003), Hyvönen 2006b: 141 (fig. 15 A−E); Brugués *et al*. (2007), Smith Merrill (2007) and Ignatov (2017). − Sporophytes were not present in the specimens.

Habitats and substrates in Hunan. *Polytrichum commune* was collected mostly in the orotemperate zone at 330−1500 m (Fig. 3) from two wet habitats: swampy wetland in a moist

stream valley and from a small open peat bog in a small kettle valley dominated by low shrubs. All of the other habitats were more or less influenced by human activities: road and trail-sides, plantations of *Phellodendron chinense* and *Liriodenron chinense*, bamboo stand and *Miscanthus* grassland. Most of these sites were open and dry or mesic. Substrates: sand (6 specimens), soil (4), rock outcrop (3), litter (1), peat (1). – Frequency in Hunan: Rare.

Range in hunan. Yang (1983) and Jia and He (2013) reported *Polytrichum commune* from Hunan but no vouchers or literature references were cited. **Badagongshan.** *42a*. 59131, 59132. *53*. 54619. – **Daweishan.** *DAW19*. 61747, 63226, 63232. *DAW24a*. 63354. *DAW24b*. 62088. *DAW28*. 62369. – **Shunhuangshan.** *S3*. 70443. *S16*. 71040. – **Taoyuangdon.** *29*. 56459. *38*. 56648, 56652, 56654. – **Yuankou.** *74d*. 59852, 59853. – **Yunshan.** *Y11a*. 70180.

Range in china.. *Polytrichum commune* was reported from 14 provinces in China by Jia and He (2013), and, according to Wu and Wang (2005), it grows on substrates along roadsides or on the ground in forests at 1100−3000 m.

TOTAL RANGE. Widespread species of the northern hemisphere.

2. ***Polytrichum formosum*** Hedw.

Sp. Musc. Frond. 92, *pl. 19, fig. 1a*. 1881. – *Polytrichastrum formosum* (Hedw.) G.L. Smith, Mem. New York Bot. Gard. 2(1(3): 37. 1971.

Taxonomy and illustrations. The taxonomy of *Polytrichum formosum* and its closely related taxa (e.g. *P. densifolium* Wilson ex Mitt.) is still unclear in the same way as discussed above under *P. commune*. All specimens from Hunan are collectively identified as *P. formosum*. It was already noted by Yano (1957) in his treatment of Japanese species that specimens with two different numbers of chromosomes (n = 7, and n =14) can be found. Subsequently *P. densifolium* has been treated at a varietal level by Osada (1966) and Smith Merrill (2007) but as a distinct species by Ivanova *et al*. (2015). The situation might be quite complicated, involving possibly allopolyploidy and hybridization as illustrated by Perley and Jesson (2015) for some species of North American *Atrichum*, and thus further, more detailed studies are needed to get it settled. We take a conservative view here because a comprehensive treatment of this would be out of scope of this regional study. *Polytrichum formosum* (as *Polytrichastrum formosum*) is described and illustrated in many North American, European and East Asiatic floras, e.g. Smith (1978, 2004), Crum and Anderson (1981), Ireland (1982), Noguchi (1987), Ignatov and Ignatova (2003), Wu and Wang 2005: 354 (pl. 767, figs. 8−14), Hyvönen 2006c: 139 (fig. 14 A−C) and Brugués *et al*. (2007) and Ignatov 2017, as *Polytrichum formosum*). − All specimens were without sporophytes.

Habitats and substrates in hunan. *Polytrichum formosum* was collected at 565−1480 m (Fig. 3) mostly from habitats influenced by human activities, such as bamboo forests, plantation of *Cunninghamia lanceolata*, and road- and trail-sides. Primary habitats were open grassland on mountain top, cliffs and boulders at river sides, mature *Cunninghamia lanceolata* forest and evergreen – deciduous broad-leaved forest. Habitats were open or in partial shade and mesic; once it was collected from a seepage on a cliff. Substrates: Boulder, cliff or rock outcrop (13 specimens), sand (1) and clay (1). − Frequency in Hunan: Rare.

Range in hunan. *Polytrichum formosum* (as *Polytrichastrum formosum*) was recorded to Hunan by Koponen *et al.* (2000) and Jia and He (2013). **Daweishan.** *DAW31*. 61905. – **Hupingshan.** *61*. 49920. – **Mangshan.** *14a*. Koponen *et al.* (2000). – **Shunhuangshan.** *S4*. 70506. *S8*. 70817. *S12a*. 70858. – **Taoyuangdon.** *20a*. 57590. *21c*. 55155. *23a*. 55919. *29*. 56442. – **Wulingyuan.** *19e*. Koponen *et al.* (2000). − **Yunshan.** *Y9*. 70402.

Y12a. 70203.

Range in china. Jia and He (2013) recorded *Polytrichum formosum* (as *Polytrichastrum formosum* var. *formosum*) from 21 provinces of China. According Wu and He (2005) it grows on alpine and subalpine forest ground, at 2700−3800 m.

Total range. Widespread species of the northern hemisphere.

4. Excluded and doubtful taxa

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

Prodr. Aethéogam. 42. 2005. – *Polytrichum undulatum* Hedw., Sp. Musc. Frond. 98. 1801.

Atrichum undulatum was reported to Hunan by Yang (1983) but without citation of specimens, see Rao *et al*. (1997, Note 10). – Lou and Koponen (1986) excluded *A. undulatum* var. *undulatum* from the Chinese flora and accepted only *A. undulatum* var. *gracilisetum* Besch., with Wu and Wang (2005) following this.

Polytrichum ohioense Ren. & Cardot

Rev. Bryol. 12: 11. 1885.

Jia and He (2013) recorded *Polytrichum ohioense* (as *Polytrichastrum ohioense* (Ren. & Cardot) G.L. Smith) to Hunan without citing a voucher specimen or literature reference. This North American endemic species (Smith Merrill 2007) was not found in our collections.

5. Discussion

5.1. Habitats, substrates and ranges

According to Hyvönen (1989a), *Pogonatum neesii* is the most common species of *Pogonatum* in SE Asia. This agrees with its frequency in our material. It has a wide altitudinal range, and many man-made habitats are suitable for its growth. It is

Table 1. The altitudinal ranges of taxa in Hunan (present study) and in China (Wu and Wang 2005). The significant additions to the lowest altitudinal records are marked by **bold.**

	Hunan	**Wu and Wang (2005)**
Atrichum angustatum	**50**−1900	950−2500
A crispulum	**630** m	1700−3100 m
A. subserratum	570	750
A. yakushimense	**700**	2000−3000
Pogonatum cirratum subsp. *cirratum*	270−1280	220−3200
P. cirratum subsp. *fuscatum*	400−1540	200−3100
P. dentatum	1450	1180
P. fastigiatum	**50**−1180	800−2250
P. neesii	**375**−1600	1300−1950
P. nudiusculum	**300**−1600	2500−3600
P. proliferum	**1165**−1600	1400−2200
P. spinulosum	**600**−1902	800−2400
P. urnigerum	700−1480	not given
Polytrichum commune	**330**−1500	1100−3000
P. formosum	**565**−1480	2700−3800

recorded from only c. 10 Chinese provinces by Wu and Wang (2005) and Jia and He (2013), and not many specimens are listed. Probably it will in time be shown to be equally common in other "second step" provinces neighbouring Hunan. Its wide range from Asia to Australia is difficult to explain. The effective production of spores may favour long range dispersal, but various human activities cannot be ruled out as means for transporting diaspores to man-made habitats.

The few records of *Polytrichum commune* and *P. formosum* from the northern part of China (Wu and Wang 2005) are not congruent with their general distribution and frequency.

A comparison of our data with the altitudinal ranges in Wu and Wang (2005) shows several extensions, especially for the lowest altitudinal occurrences of taxa (Table 1). The highest point in Hunan is only at c. 2000 m, and accordingly, the highest records from Hunan are within the previously recorded altitudinal ranges. The reason for these extensions might be that the floristic study of the lowland regions has received less attention, with botanists having mostly aimed to collect on higher ground.

5.2. Phytogeography

5.2.1. Range extensions

The following species are recorded for first time for the Hunan Province of China.

Atrichum yakushimense
Pogonatum dentatum
P. nudiusculum

5.2.2. Floristic elements

The species of Polytrichaceae occurring in Hunan can be divided into floristic elements following the grouping presented in the earlier parts of the Hunan series (Koponen and Piippo 2004, Koponen 2014, Enroth and Koponen 2017, Sollman and Koponen 2017, Tan and Koponen 2017, see also Piippo and Koponen 2003). This grouping is based on the total range of the species and their ranges in China and Hunan.

Holarctic, continuously or discontinuously circumpolar, boreal to temperate element

Atrichum angustatum
Pogonatum dentatum
P. urnigerum
Polytrichum commune
P. formosum

Pogonatum dentatum, P. urnigerum, Polytrichum commune and *P. formosum* have wide ranges in the northern hemisphere and they are all common plants of peatlands, forests or rocky habitats. In Hunan they occur both in the warm temperate and orotemperate zones. The total range of *Atrichum angustatum* is more temperate and disjunctive.

Southeast Asian temperate to warm temperate element

These taxa range from the Himalayas to Japan and may have orotemperate, disjunct occurrences in more southern areas such as Papua New Guinea, Philippines, Thailand and Vietnam. Two subelements have been recognized (Koponen 2014): 1) Sino – Himalayan taxa occurring in the Himalayas and central China, including "second step" areas, and 2) Sino – Japanese taxa occurring in central China and Japan but absent from the Himalayas.

Himalayan – Japanese

Pogonatum cirratum subsp. cirratum
P. cirratum subsp. fuscatum
P. neesii

P. spinulosum

Sino – Japanese

Atrichum yakushimense

Sino - Himalayan

Atrichum subserratum
Pogonatum fastigiatum
P. nudiusculum (+ Sri Lanka, Philippines)
P. proliferum (disjunction in central Africa)

Atlantic N America – SE Asia element

Atrichum crispulum

The floristic affinities of mosses between southeastern Asia and Atlantic North America has been discussed by Iwatsuki (1958, 1972) and Iwatsuki and Sharp (1967). The latest list of this element (Iwatsuki 1992) includes 34 mosses. *Atrichum crispulum* is an addition to the list of species that are disjunct between Atlantic North America and SE Asia.

6. Conservation

In several earlier reports on the bryoflora of Hunan (see references under Chapter 5.2.2.), the conclusion has been that the vulnerable taxa survive best in conserved primary forest and streamside sites. In this respect the species of the Polytrichaceae differ from most of the other bryophytes; they spread easily to habitats created by human activities, such as road- and trail-sides, and survive in disturbed sites such as secondary forests and plantations. The rare species such as *Atrichum crispulum*, *A. subserratum*, *A. yakushimense* and *Pogonatum nudiusculum* were collected from disturbed as well as undisturbed habitats. These taxa seem not to be endangered in Hunan. Exceptions may be *P. fastigiatum,* which was found only in the core area of Mangshan Nature Reserve, and *P. proliferum,* collected mostly from primary habitats in Badgongshan National Nature Reserve.

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Index to names

The species occurring in Hunan are in **bold**.