



A step forward in botanical exploration with three new Polytrichaceae records from Tibet, China

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Abstract

Background

According to the Species Catalogue of China, Tibet, China, has more than 1,000 species of bryophytes, showing its remarkably high biodiversity. Amongst them, the Polytrichaceae is one of the largest family, with six genera and 25 species, one subspecies and two varieties reported previously.

New information

Based on a field survey and specimen identification, the following species have been newly recorded in the bryoflora of Tibet, namely *Oligotrichum obtusatum* Broth., *Pogonatum contortum* (Menzies ex Brid.) Lesq. and *Polytrichum sphaerothecium* (Besch.) Müll. Hal.

Keywords

bryophytes, Tibet, China, new record, checklist

Introduction

The Bryophyte Flora of Tibet has been documented to include 62 families, 254 genera and 754 species, including five subspecies, 53 varieties and three forms (Li 1985). Despite recent additions to the regional bryophyte records, there still remains a significant gap in the comprehensive exploration of the bryophyte flora in Tibet (Ma et al. 2018a, Ma et al. 2018b, Ma et al. 2018c). According to the Species Catalogue of China, the number of moss species in Tibet alone is estimated to exceed 1,000 (Wang et al. 2018).

The family Polytrichaceae Schwägr. represents a significant group of mosses with a global distribution that includes 18 genera and approximately 220 species (Frey et al. 2009). In China, this family is represented by seven genera and 51 species, while Tibet specifically hosts six genera and 25 species, one subspecies and two varieties (Wu and Jia 2004, Isuru et al. 2018, Wang et al. 2018). Members of the family are characterised by relatively large and robust plants that are typically erect and rigid, forming dense tufts or growing scattered or gregariously, resembling conifer seedlings, with well-developed central strand in the stem cross-section. Besides, leaves usually have broad sheathing at the base, with single and rather broad costa and numerous lamellae, usually longitudinally arranged on the ventral surface of the costae, sometimes lamellae or spines present on the dorsal surface. Species in this group are generally dioecious, though some are monoecious and typically feature relatively large sporophytes with rigid setae, hairy calyptrae and nematodontous peristomes with 32–64 teeth. Moreover, the plants have terminal discoid perigonia and capsules that are mostly oblong-ovoid to cylindrical or 4-6-angular, with a single lingulate peristome (Wu et al. 2005, Bell et al. 2021, Merrill 2024).

This study conducted an investigation of wild plant resources in Tibet, China, revealing the presence of five genera and 12 species of Polytrichaceae. Amongst them, three were identified as new records. Detailed descriptions and illustrations of the species are provided and a checklist is also given.

Materials and methods

All the specimens, examined in this study, were collected from Tibet in China at 2018 and deposited in the Herbarium (PE), Institute of Botany, the Chinese Academy of Sciences, Beijing. The newly-collected specimens of Polytrichaceae were identified by Y. Jia and Q. He from the Institute of Botany, Chinese Academy of Sciences. Photographs were taken using a Leica DM 4000 B LED microscope (Leica Microsystems, Wetzlar, Germany). Illustrations of *O. obtusatum*, *P. contortum* and *P. sphaerothecium* were respectively

drawn by Z.D. Yang from Kunming Institute of Botany, Chinese Academy of Sciences, P.C. Wu and M.S. Guo from Institute of Botany, the Chinese Academy of Sciences.

Taxon treatments

Oligotrichum obtusatum Broth.

Material

- a. order: Polytrichales; family: Polytrichaceae; genus: *Oligotrichum*; continent: Asia; country: China; countryCode: China/CN; stateProvince: Tibet; county: Jilong; municipality: Jilong; locality: Latola; verbatimLocality: Shigatse; verbatimElevation: 3954 m; verbatimCoordinates: 28°23'26"N, 85°24'25"E; year: 2018; month: 6; day: 17; habitat: On the roadside soil surface; catalogNumber: PE2155874; recordNumber: 12176; recordedBy: Q. He; identifiedBy: Y. Jia and Q. He; language: cn; occurrenceID: D9CB2D58-4FEC-5582-940F-61363733E69C

Description

Plants rather small, 0.5-1.2 cm high, brownish green to reddish-brown, often in tufts (Fig. 1a and b). Leaves nearly oblong-oval (Fig. 1c), 1.5-2.0 × 0.5-1.0 mm, usually concave; margins serrate; costa somewhat broad, ending near the apex (Fig. 1e); ventral lamellae slightly wavy or crisped, usually in 3-10 rows, 3-5 cells high; on leaf back with only a few spines (Fig. 1c); median leaf cells rounded quadrate to irregularly oval, 9-15 µm wide; basal cells elongate or irregularly rectangular, 18-25 × 8-16 µm, slightly thick-walled (Fig. 1f-h). Dioecious. Perichaetial leaves lanceolate above, sheathing at base (Fig. 1d). Setae reddish-brown, straight; capsules oblong-ovoid to shortly cylindrical, usually curved; peristome teeth 32; opercula conical, shortly beaked. Calyptrae cucullate, smooth. Spores spherical, ca. 10 µm in diameter, finely papillose (Wu and Jia 2004).

Distribution

China (Tibet [present study]; Guizhou, Yunnan and Fujian, India and Nepal (Hyvönen and Lai 1991, Wu and Jia 2004).

Pogonatum contortum (Menzies ex Brid.) Lesq.

Materials

- a. order: Polytrichales; family: Polytrichaceae; genus: *Pogonatum*; island: Asia; country: China; countryCode: China/CN; stateProvince: Tibet; county: Cona; municipality: Langpo; locality: Langpo Ditch; verbatimLocality: Shannan; verbatimElevation: 3654 m; verbatimCoordinates: 27°47'55"N, 91°48'51"E; year: 2018; month: 6; day: 18; habitat: On the rocky soil surface; catalogNumber: PE2155369; recordNumber: 11634; recordedBy: Q. He; identifiedBy: Y. Jia and Q. He; language: cn; occurrenceID: 4CE59F90-8280-55CA-8FDE-83A136F6815C

- b. order: Polytrichales; family: Polytrichaceae; genus: *Pogonatum*; island: Asia; country: China; countryCode: China/CN; stateProvince: Tibet; county: Cona; municipality: Mama; locality: Wild Wolf Valley; verbatimLocality: Shannan; verbatimElevation: 3220 m; verbatimCoordinates: 27°52'12"N, 91°59'04"E; year: 2018; month: 6; day: 11; habitat: On the forest floor; catalogNumber: PE2155421; recordNumber: 11690; recordedBy: Q. He; identifiedBy: Y. Jia and Q. He; language: cn; occurrenceID: 9FBEF4E6-C16A-5962-B171-F48C9A28973C
- c. order: Polytrichales; family: Polytrichaceae; genus: *Pogonatum*; island: Asia; country: China; countryCode: China/CN; stateProvince: Tibet; county: Cona; municipality: Gongri; verbatimLocality: Shannan; verbatimElevation: 3045-3399 m; verbatimCoordinates: 27°54'36"-55°46'N, 91°48'23"-49'09"E; year: 2018; month: 6; day: 12; habitat: On the roadside soil surface; catalogNumber: PE2155455, PE2155456; recordNumber: 11728, 11729; recordedBy: Q. He; identifiedBy: Y. Jia and Q. He; language: cn; occurrenceID: B470F067-EF66-5DD4-B4FC-33C402E71ABD

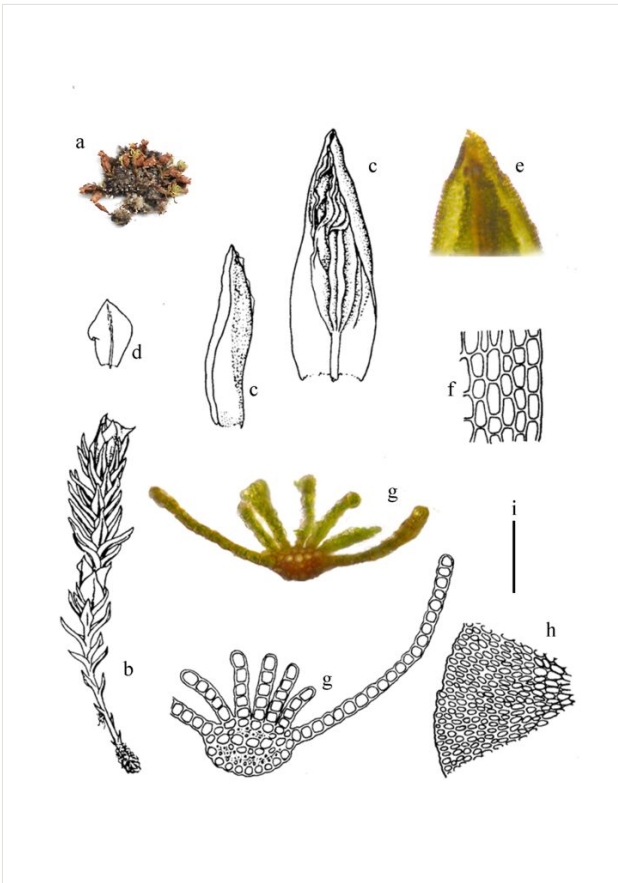


Figure 1. [doi](#)

Oligotrichum obtusatum Broth. **a** Plant; **b** Moist male plant; **c** Leaves; **d** Perigonial leaves; **e** Apex of leaf (dorsal view); **f** Basal leaf cells; **g** Cross sections of leaf; **h** Portion of the cross section of stem. Scale bars: **i** = 1 cm (**a**); **i** = 2.5 mm (**b**); **i** = 1 mm (**c**, **d**); **i** = 200 μ m (**e**, **h**); **a** = 100 μ m (**f**, **g**).

Description

Plants large, dark green, brownish-green when old, tufted in large patches (Fig. 2a). Stems 5-10 cm long, usually simple. Basal leaves small, deciduous; upper leaves erect patent when moist, strongly crisped when dry, slightly constricted from rounded oval base to a broad lanceolate limb, sheathing indistinct, ca. 1 mm wide (Fig. 2c); leaf marginal cells 1-2 layers, up to 3 cells wide, rarely remotely grossly toothed, teeth consisting of several cells, light brown; costae broad, with spines on the back; lamellae ca. 40 ranks, 2-3 cells high, disappearing along leaf margins, (Fig. 2e and f); apical cells of lamellae slightly differentiated (Fig. 2d), larger, round, 15-20 μm in diameter, thin-walled; other cells short-quadrate or nearly rectangular, 12-25 \times 10-15 μm . Dioecious. Male plants dwarfed; perigonial leaves few. Setae single, dark brown, 20-30 mm long; capsules erect, narrowly ovoid, ca. 2.5 \times 1.0 mm (Fig. 2b).

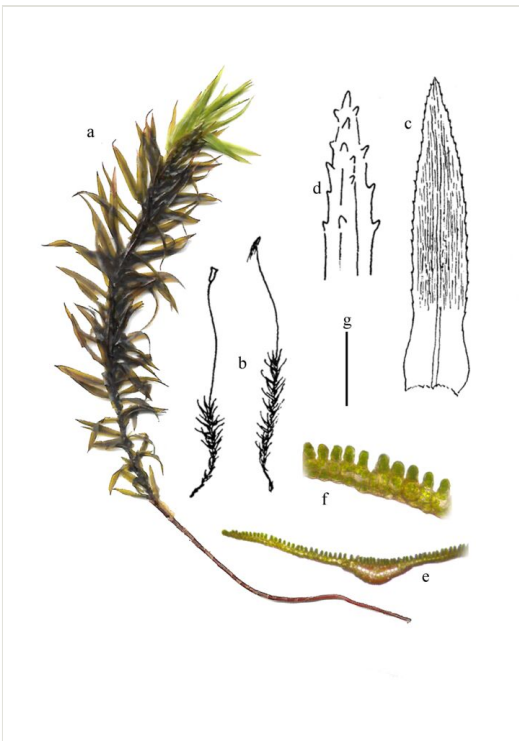


Figure 2. [doi](#)

Pogonatum contortum (Menzies ex Brid.) Lesq. **a** Plant; **b** Habit; **c** Leaf (ventral view); **d** Leaf apex; **e** Cross sections of leaf; **f** Part of cross sections of the lamellae of leaf. Scale bars: g = 1 cm (a); g = 2 cm (b); g = 3 mm (c); g = 1 mm (d); g = 200 μm (e); g = 100 μm (f).

Distribution

China (Tibet [present study]; Sichuan, Guangdong, Guangxi, and Hainan), Japan, Russia (Far East), and western North America (Wu and Jia 2004).

***Polytrichum sphaerothecium* (Besch.) Müll. Hal.**

Material

- a. order: Polytrichales; family: Polytrichaceae; genus: *Polytrichum*; island: Asia; country: China; countryCode: China/CN; stateProvince: Tibet; county: Dingri; municipality: Qudang; locality: Cuoqu; verbatimLocality: Shigatse; verbatimElevation: 3796 m; verbatimCoordinates: 28°05'23"N, 87°21'53"E; year: 2018; month: 6; day: 21; habitat: On the forest floor; catalogNumber: PE2155741; recordNumber: 12035; recordedBy: Q. He; identifiedBy: Y. Jia and Q. He; language: cn; occurrenceID: 6BB4EF1B-4969-55F7-A776-DD969F0109CE

Description

Plants small, brownish-green, slightly glossy, in dense aggregated tufts (Fig. 3a). Stems erect, 1-3 cm high. Leaves slightly incurved, usually appressed on stems when dry, erect-patent when moist, 3-6 × 1.2-1.5 mm, ovate-lanceolate to oblong-lanceolate, acuminate or cucullate at apex, sheathing indistinct (Fig. 3f, g); costa excurrent into a short filiform apex, smooth or a few teeth on back near apex; leaf margins involute, covering ventral lamellae; upper leaf cells quadrate or oblate, 12-15 µm wide, sometimes the length 1-2 times longer than width; median cells rectangular, 18-40 × 8-10 µm; basal cells quadrate to narrowly rectangular, bordered by narrow, hyaline cells; ventral lamellae in ca. 30 rows, 6-11 cells high; marginal cells of lamellae pyriform, thick-walled. Dioecious. Male plants similar to the female ones, occasionally with new innovations. Perigonal leaves ca. 3 mm long, with oblong sheathing base. Perichaetial leaves up to 9 mm long, from an ovate sheathing base, suddenly narrowing to a lanceolate lamina (Fig. 3e). Setae 5-9 mm long, pendulous; capsules nearly spherical, horizontal to cernuous, with distinct discoid apophyses (Fig. 3b); exothecial cells hexagonal to triangular, without mammillae; opercula with short beaks; peristome teeth often more than 32, triangular, acuminate, ca. 30 µm long (Fig. 3d), greyish-yellow, membrane nearly as long as the peristome teeth. Calyptrae triangular, 3-4 mm long, densely covered with long hairs (Fig. 3c).

Distribution

China (Tibet [present study], Jilin), Korea, Japan and the Aleutian Islands (Wu and Jia 2004).

A checklist of the Polytrichaceae in Tibet, China

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

Distribution: China, North Korea, Japan and Thailand (Wu and Jia 2004).

***Atrichum rhynchophyllum* (Müll. Hal.) Paris**

Distribution: China, North Korea and Japan (Wu and Jia 2004).

***Atrichum undulatum* var. *gracilisetum* Besch.**

Distribution: China, Pakistan (Higuchi and Nishimura 2003), Myanmar (Tan and Iwatsuki 1993), North Korea, Japan and the Himalayan Region (Wang et al. 2018).

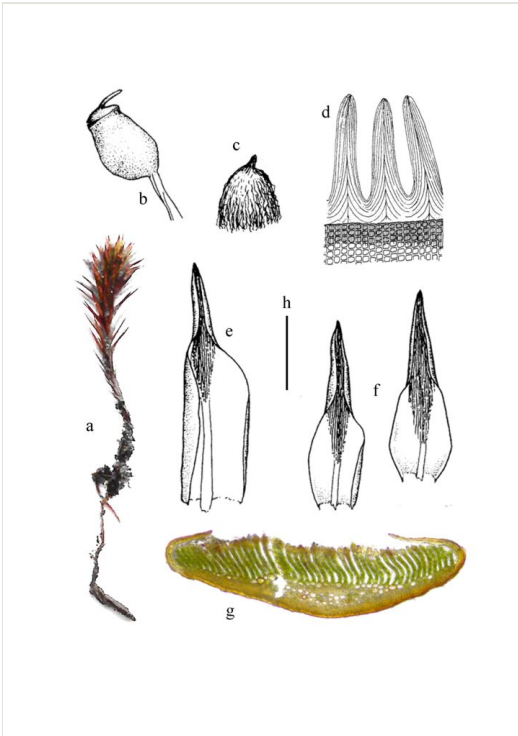


Figure 3. [doi](#)

Polytrichum sphaerothercium (Besch.) Müll. Hal. **a** Plant; **b** Capsule; **c** Calyptra; **d** Peristome teeth; **e** Outer perichaetial leaf; **f** Leaves; **g** Cross section of leaf. Scale bars: h = 1 cm (a); h = 3 mm (b, c); h = 200 μ m (d, g); h = 2 mm (e, f).

***Lyellia crispa* R. Br.**

Distribution: China, the Eastern Himalayas and North America (Wu and Jia 2004).

***Lyellia platycarpa* Cardot & Thér.**

Distribution: Endemic species of China (Wu and Jia 2004).

***Oligotrichum aligerum* Mitt.**

Distribution: China, Bhutan, Japan, Korea, North America, Central America (Wang et al. 2018).

***Oligotrichum crossidioides* P.C. Chen & T.L. Wan ex W.X. Xu & R.L. Xiong**

Distribution: Endemic to China, occurring in the south-western part of the country, as well as in the Himalayan Region (Wu and Jia 2004).

***Oligotrichum falcatum* Steere**

Distribution: China (Tibet), the Himalayan Region, Russia (Siberia), the United States (Alaska), Canada and Greenland (Wu and Jia 2004).

***Oligotrichum hercynicum* (Hedw.) DC.**

Distribution: China (Tibet) (Wu and Jia 2004), Japan, Europe and North America (Merrill 2007).

***Oligotrichum obtusatum* G.L. Sm.**

Distribution: Jilong Township, Jilong County and Gongri Township, Cona County.

Notes: China (Tibet [present study]; Guizhou, Yunnan and Fujian (Wu and Jia 2004) and Nepal (Hyvönen and Lai 1991).

***Oligotrichum semilamellatum* (Hook. f.) Mitt.**

Distribution: Southwest China and the Himalayan Region (Wu and Jia 2004).

***Pogonatum aloides* (Hedw.) P. Beauv.**

Distribution: China, Nepal, Bhutan, India, Sri Lanka, Myanmar (Tan and Iwatsuki 1993), Thailand, Vietnam, Philippines, Indonesia, Japan, Caucasus, North America, North and Central Africa (Wu and Jia 2004).

***Pogonatum cirratum* subsp. *fuscatum* (Mitt.) Hyvönen**

Distribution: China (Wu and Jia 2004), Bangladesh (O'Shea 2003), Nepal, Bhutan, India, Myanmar, Laos (Hyvönen and Lai 1991), Vietnam, Malaysia, Philippines, Chile (He 1998).

***Pogonatum contortum* (Menzies ex Brid.) Lesq.**

Distribution: Mama Township, Langpo Township, Gongri Township, Cona County.

Notes: China (Tibet [present study]; Sichuan, Guangdong, Guangxi and Hainan), Japan, Russia (Far East) and western North America (Wu and Jia 2004).

***Pogonatum inflexum* (Lindb.) Sande Lac.**

Distribution: China, North Korea and Japan (Wu and Jia 2004).

***Pogonatum microstomum* (R. Br. ex Schwägr.) Brid.**

Distribution: Himalayan Region of China and South Asia (Wu and Jia 2004).

***Pogonatum nudiusculum* Mitt.**

Distribution: China, Nepal, Bhutan, India, Sri Lanka and the Philippines (Wu and Jia 2004).

***Pogonatum pergranulatum* P.C. Chen**

Distribution: Endemic species of China (Wu and Jia 2004).

***Pogonatum perichaetiale* (Mont.) A. Jaeger**

Distribution: China, Nepal, Sikkim, Bhutan and southern India (Wu and Jia 2004).

***Pogonatum sinense* (Broth.) Hyvönen & P.C. Wu**

Distribution: China and Bhutan (Wang et al. 2018).

***Pogonatum subfuscatum* Broth.**

Distribution: Widely distributed in southern Asia (Wu and Jia 2004).

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

Distribution: Widespread in the Northern Hemisphere, but not in high-altitude mountains (Wu and Jia 2004).

***Polytrichastrum alpinum* (Hedw.) G.L. Sm.**

Distribution: Widely distributed throughout the world (Wang et al. 2018).

***Polytrichastrum emodi* G.L. Sm.**

Distribution: China (south-western region) and the Himalayan Region (Wu and Jia 2004).

***Polytrichastrum formosum* var. *formosum* (Hedw.) G.L. Sm.**

Distribution: China, the Himalayan Region, Japan, Russia (Far East), Europe, North Africa, the Aleutian Islands and North America (Wu and Jia 2004).

***Polytrichastrum longisetum* (Sw. ex Brid.) G.L. Sm.**

Distribution: China, Japan, Russia (Siberia), Europe, Greenland, North America and New Zealand (Wu and Jia 2004).

***Polytrichastrum papillatum* G.L. Sm.**

Distribution: China (Tibet) and the Himalayan Region (Wu and Jia 2004).

***Polytrichastrum xanthopilum* (Wilson ex Mitt.) G.L. Sm.**

Distribution: China, the Himalayan Region and North America (Wu and Jia 2004).

***Polytrichum juniperinum* Hedw.**

Distribution: It is widespread in northeast and southwest China and Xinjiang, Japan, Russia (Far East), Europe, North and South America and Oceania (Li 1985).

***Polytrichum piliferum* Hedw.**

Distribution: China, Korea, Japan, Russia (Siberia, Sakhalin and Kuril Islands), Chile, Europe, North America, Africa (Wu and Jia 2004).

***Polytrichum sphaerothecium* (Besch.) Müll. Hal.**

Distribution: Qudang Township, Dingri County.

Notes: China (Tibet [present study], Jilin), Korea, Japan and the Aleutian Islands (Wu and Jia 2004).

Discussion

The present study reveals substantial novel insights pertaining to the family Polytrichaceae in Tibet, China, thereby contributing to the progressive refinement of our

comprehension of this diverse group of mosses. The discovery and subsequent documentation of three previously-undocumented species — *Oligotrichum obtusatum*, *Polytrichum sphaerothecium* and *Pogonatum contortum* — not only accentuate the biological richness, but also underscore the existing deficiencies in our taxonomic and ecological understanding of the region.

Oligotrichum obtusatum, designated as Vulnerable (VU) by the Red List of Higher Plants in China (Qin et al. 2017), necessitates significant conservation attention. The species' occurrence in Tibet expands its previously documented geographic range, which was limited to regions including the Russia (Far East) and western North America (Wu and Jia 2004). This discovery warrants further investigation into the dispersal mechanisms and habitat requirements of *O. obtusatum*, especially considering the distinctive climatic and topographical conditions characteristic of Tibet.

Moreover, the documentation of *Polytrichum sphaerothecium*, a species previously recorded exclusively in Jilin (China) and classified as Data Deficient (DD) (Qin et al. 2017), enriches our biological inventories and prompts further ecological and phylogenetic research to elucidate its restricted distribution and ecological preferences. *Pogonatum contortum* is known to be distributed across southwest China, the Russia (Far East), Japan and western North America (Wu and Jia 2004). Notably, it is not presently listed on the List (Qin et al. 2017). The current discovery of the species in Tibet further extends its documented geographical range.

This study significantly enhances the documentation of regional biodiversity by updating the enumeration of Polytrichaceae in Tibet to include six genera and 28 species, one subspecies and two varieties, which not only offers a more comprehensive understanding of the Tibetan bryoflora, but also establishes a critical reference point for future research aimed at taxonomic clarification and conservation initiatives. Continued exploration and detailed study are essential for the conservation of biodiversity and the sustainability of natural resources in the high-altitude ecosystems.

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