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A new species record of *Tortula* and range extension of one species of *Grimmia* in China

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Abstract – Two species, *Tortula brevissima* Schiffn. and *Grimmia indica* (Dixon & P. de la Varde) Goffinet & Greven are added to the Chinese moss flora. The former is newly reported for China and East Asia. The latter has been found in Tibet for the first time. Brief morphological descriptions, distribution details, and digital photographs of the two species are provided.

China / East Asia / Grimmiaceae / new records / Pottiaceae / Tibet

INTRODUCTION

Pottiaceae and Grimmiaceae are the most important xerophytic moss families in the world (Zander, 1993; Hastings & Greven, 2007). The former contains 181 species in 39 genera in China (Li *et al.*, 2001; Jia & He, 2013; Feng *et al.*, 2014; Sarula *et al.*, 2014). In the framework of investigations on the xerophytic moss flora of Tibet in China a small-sized species of *Tortula* and an interesting species of *Grimmia* belonging to these two large families were found. They were collected in different samples and at different times, but both of them have a similar habitat, which is dry and at high altitude, lacking cover and with strong sunlight. Following examination we confirmed a new record species for East Asia, *Tortula brevissima* Schiffn., and a range extension for *Grimmia indica* (Dixon & P. de la Varde) Goffinet & Greven in China. This increases the number of *Tortula* species in China from 8 to 9, and of *Grimmia* from 26 to 27 (Li *et al.*, 2001; Jia & He, 2013).

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***Tortula brevissima* Schiffn.**, *Ann. Natur. Hofmus. Wien* 27: 481, 1913 **Figs 1-8**

Plants in compact tufts, yellowish-green above, brownish-green below. **Stems** sparsely branched, 1.5-2.0 mm in length, with central strand and enlarged cortical cells, sclerodermis absent, hyalodermis absent. **Leaves** twisted when dry, erect-patent when moist, ovate to ligulate, 1.05-1.37 mm long, 0.53-0.63 mm wide; apex obtuse to rounded-obtuse; margins recurved from base to upper part of leaf, entire; costa strong above, short- to long-excurrent as a smooth awn, in transverse section terete, with dorsal epidermis, dorsal stereid band 2-3 cells thick, hydroids present, guide cells 2 in 1 layer, ventrally with a pad of 4-9 radially elongate cells, each with several terminal bifid papillae; upper laminal cells quadrate to rounded-quadrate, thin walled, 20.8-33.8 × 13.0-18.2 μm, papillae simple or bifid, 5-8 per lumen; cells in leaf base hyaline, often rectangular or rounded-rectangular, 23.4-41.6 × 15.6-28.6 μm. **Propagula** absent. Autoicous. **Setae** erect, 4.5-7.2 mm in length, brown. **Capsule** cylindrical, often slightly curved, 1.3-2.1 mm, yellow-green; peristome with low basal membrane; peristome teeth 32, filiform, twisted counter-clockwise, papillose; annulus of 2(-3) cell rows; lid brown, narrowly conic. **Spores** 8-11 μm, smooth.

Specimen examined: China. Xizang (Tibet), Langkazi county, on grass, 29°0′57.636″N, 90°23′46.824″E, 4461 m, 26 Aug. 2011, *S.S. Song Xz53g02a* (BAU).

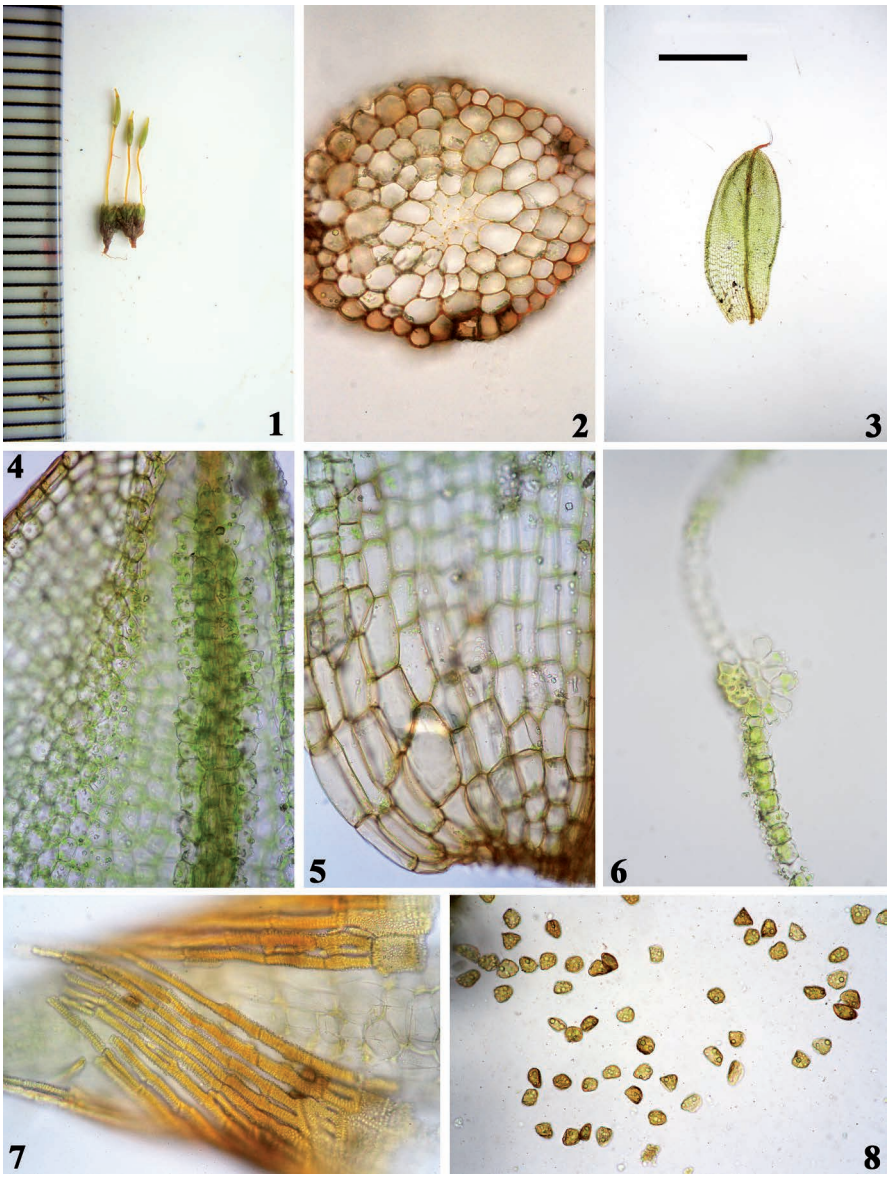
Distribution: *Tortula brevissima* is known from many countries in Mediterranean, Europe and Asia (Kürschner & Parolly, 1998; Privitera & Puglisi, 1999; Ros *et al*., 2013). It was recently found in North America (Kellman, 2012). In Asia, this species has, however, a limited distribution in the Middle East. Our study reports it in Tibet in China for the first time. *Tortula brevissima* is therefore new to East Asia.

Notes: According to Kellman (2012), *T. brevissima* is defined by its smooth hair-point, costa with an adaxial pad of radially elongate cells, small laminal cells, and twisted peristome teeth. Morphologically, it is similar to *Tortula muralis* Hedw., *Tortula brevipes* (Lesq.) Broth., *Tortula guepinii* (Bruch & Schimp.) Broth. and *Crossidium seriatum* H.A.Crum & Steere (Kürschner & Parolly, 1998; Privitera & Puglisi, 1999; Kellman, 2012). Werner *et al*. (2002) conducted a study into the molecular phylogeny of *Tortula* and some related genera based on chloroplast *rps*4 sequences. In that study, *T. brevissima* is closely related to *T. muralis, T. vahliana* (Schultz) Mont., and *C. seriatum*.

With the addition of *Tortula brevissima,* eight species and one variety of *Tortula* are known from China. They are separated by the following key.

KEY TO SPECIES OF *TORTULA* IN CHINA

1. Upper costa covered ventrally by a massive pad of inflated cells.....2
1. Upper costa covered ventrally by a row of normal-sized cells.....3
   2. Hairpoint present, smooth, flexuose ca. 1/2 the leaf length, peristome teeth twisted ¾-1 ½ turns, spores small, 8-11 μm ..... *T. brevissima*
   2. Hairpoint absent, peristome teeth erect or weakly twisted, spores larger, 13-22 μm..... *T. atrovirens* (Sm.) Lindb.
3. Upper leaf cells smooth..... *T. mucronifolia* Schwägr.
3. Upper leaf cells papillose 4



Figs 1-8. *Tortula brevissima*. **1.** Plant when dry, the length for each frame is 1 mm; **2.** Cross-section of stem; **3.** Leaf; **4.** Upper part of leaf; **5.** Lower part of leaf; **6.** Cross-section of leaf; **7.** Peristome teeth; **8.** Spores. Use transversal scale bar as 78 μm for 2, 4-8; 0.78 mm for 3 (from China, *S.S. Song Xz53g02a*. BAU).

4. Costa subpercurrent or percurrent.....5
4. Costa excurrent, ending in a short or long awn.....6

5. Plants 3-5 mm high; margins recurved nearly throughout leaf length; peristome teeth twisted, with low basal membrane..... *T. leptotheca* (Broth.) P.C.Chen
5. Plants to 20-30 mm high; margins more or less plane or only slightly recurved near base; peristome teeth erect, without basal membrane ....*T. yuennanensis* P.C.Chen

6. Leaves spathulate, margins plane or nearly so; setae ca. 5 mm long ....*T. planifolia* X.J.Li
6. Leaves oblong-elliptic, margins distinctly recurved; setae more than 10(-25) mm long.....7

7. Leaf margins bordered by elongate, rather thin-walled cells; peristome teeth with high basal membrane, ca. 1/3 -1/2 of the teeth length..... *T. subulata* Hedw.
7. Leaf margins bordered by short, more incrassate cells; peristome teeth with low basal membrane, not extending above the mouth of the capsule.....8

8. Leaf apices rounded-obtuse; costa excurrent as a rather long, hyaline awn.. .....*T. muralis* var. *muralis* Hedw.
8. Leaf apices broadly acute or mucronate; costa percurrent or just as a short mucro ..... *T. muralis* var. *aestiva* Brid. ex Hedw.

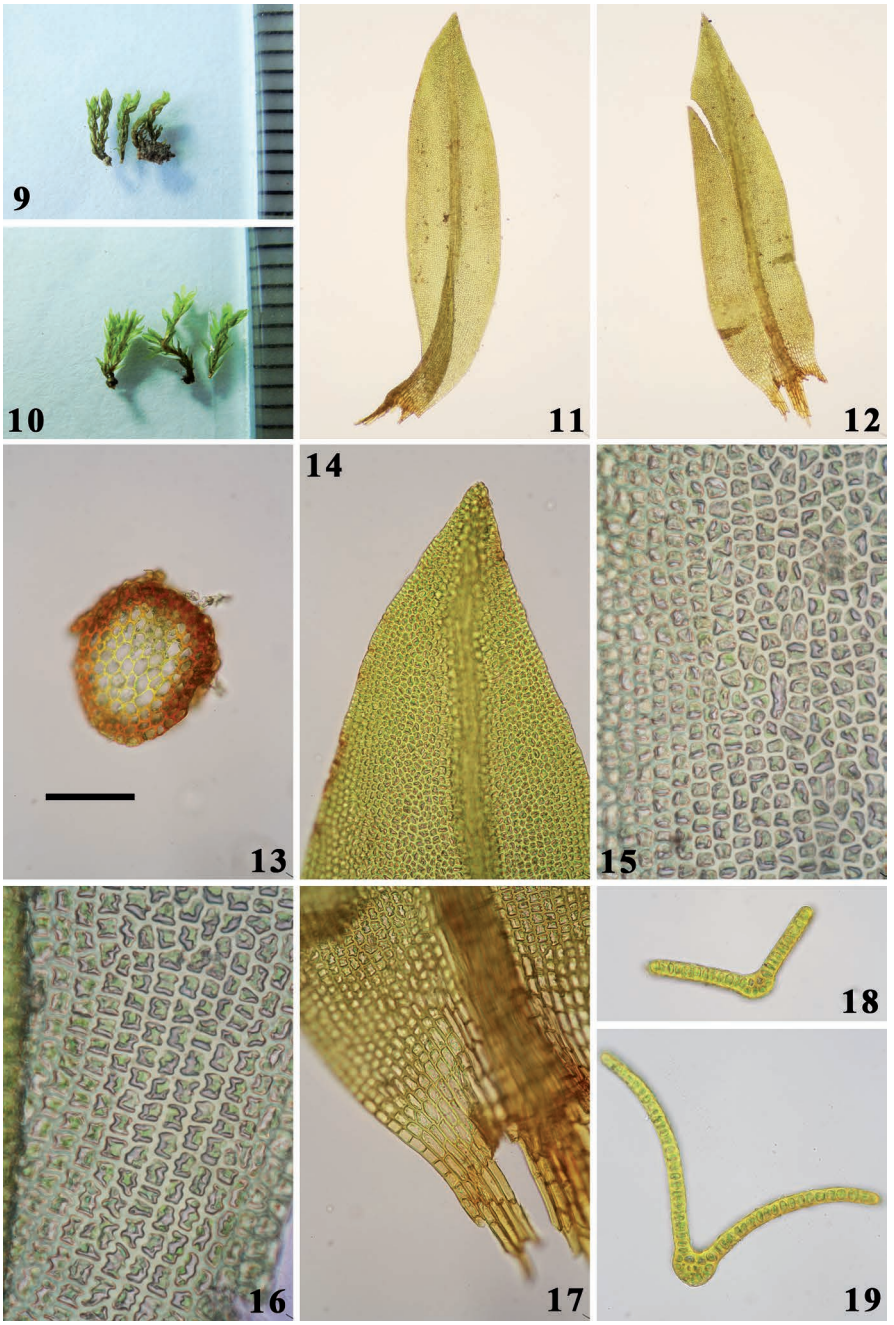
***Grimmia indica* (Dixon & P. de la Varde) Goffinet & Greven,** *J. Bryol.* 22: 141. 1999 **Figs 9-19**

Plants forming dense mats, green above, reddish-brown below. **Stems** 2.8-5.1 cm in length, central strand absent. **Leaves** appressed when dry, spreading when moist, ovate-lanceolate, 0.91-1.12 mm long, 0.30-0.35 mm wide; hair-points absent; margins plane to slightly recurved in leaf base; costa smooth, percurrent, slightly widened at leaf base, semi-terete to nearly terete, mainly with 2 guide cells, consisting of almost undifferentiated cells in 2-4 layers; leaf lamina smooth, unistratose throughout, upper and median laminal cells irregularly isodiametric with sinuose and incrassate walls, smooth; basal marginal cells quadrate to short-rectangular, basal juxtacostal cells rectangular with slightly sinuose and incrassate walls. **Sporophytes** not seen.

Specimens examined: China. Xizang, Dazi county, on rock, 29°39′20.448″N, 91°20′15.288″E, 4130 m, 5 Jun. 2014, *J. Kou STZ20140705018* (BAU).

Distribution: *Grimmia indica* is a rare species which has a limited distribution area, currently known only from three countries (India, China and Nepal) and these localities are in the Himalayas (Greven, 2002). In China, this species has previously recorded only once, in Yunnan Province (Greven & Koponen, 1996). The present study extends its geographical distribution to Tibet, China, and this site is close to the Himalayas.

Notes: *Grimmia indica* was considered a species that is mainly distributed in the Himalayas. It has also been recognized in Chinese regions which are situated close to the Himalayas (Fig. 20). Unfortunately, its occurrence was not accepted in the latest revision of *Grimmia* in China (Cao *et al.*, 2003) and the latest checklist of Chinese bryophytes (Jia & He, 2013). These works make no reference to the presence of *G. indica* in China, and it is likely that the authors did not study any specimens of this species and were not aware of Greven & Koponen's paper (1996). *Grimmia indica* is a unique species in the genus *Grimmia* because only the leaf areolation suggests that it may be a member of this genus, while other characters such as



Figs 9-19. *Grimmia indica*. **9.** Plant when dry, the length for each frame is 1 mm; **10.** Plant when moist, the length for each frame is 1 mm; **11-12.** Leaf; **13.** Cross-section of stem; **14.** Upper part of leaf; **15.** Mid-leaf cells; **16.** Transitional part of leaf; **17.** Basal laminal cells; **18-19.** Transverse section of leaf. Use transversal scale bar as 0.312 mm for 11-12; 78 μm for 13-14, 17-19; 31.2 μm for 15-16 (from China, *J. Kou STZ20140705018*. BAU).

Fig. 20. Known geographic distribution of *Grimmia indica* in the world. Yellow stars represent the distribution areas known in the past, the red star represents the new distribution area (the satellite image from Google Earth).

the presence of an apophysis, the leaf apex ending in a transparent apiculus and the peristome teeth not divided in the lower half are unknown in any other species of *Grimmia* (Maier, 2002). It was originally described as a species of *Trigonodictyon* in the Orthotrichaceae (Potier de la Varde, 1928; Goffinet, 1998). Later, Goffinet & Greven (2000) transferred it to *Grimmia* and renamed it as *G. indica*, at the same time synonymizing *Grimmia apophysata* Gangulee with it. Recently, Maier (2010) excluded *G. indica* from *Grimmia* based on the peculiarities of *G. indica* in *Grimmia*. Here, in agreement with Greven & Koponen (1996), we believe that *G. indica* could still be retained as a member of *Grimmia*. Nevertheless, the systematic position of *G. indica* needs to be studied further.

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