

A new species record and range extension of two species of *Barbula* in China

Sarula, Xue-Liang BAI^{a*}, Dong-Ping ZHAO,
Hong-Xia ZHANG & Cai-Qin DING

Department of Biology, Inner Mongolia University, Hohhot 010021, China

Abstract – New locality records of three species of *Barbula* are added to the Chinese moss flora. *Barbula hiroshii* K. Saito is newly reported to China. Additional localities are reported for *Barbula amplexifolia* (Mitt.) A. Jaeg. and *Barbula convoluta* Hedw. Brief morphological description, range extension, digital photographs of the three species and a new key to Chinese species of *Barbula* are provided.

Pottiaceae / *Barbula* / China / new distribution records

INTRODUCTION

The systematic classification of Chinese Pottiaceae is yet to become exhaustive, as evident by the fact that there are, hitherto, only eight species records reported for the genus *Barbula* in the Chinese moss flora (Li *et al.*, 2001). This, probably, is due to the fact that specimens of Pottiaceae in general, and *Barbula* in particular, have mostly been seen in nature without a sporophyte, making the species determination a very difficult process. As part of our continued investigation of the Chinese bryophyte flora, sterile specimens from different parts of China were examined, relying largely on gametophytic characters for a species determination. This has led to the new identification of three notable *Barbula* species, namely: *B. hiroshii* K. Saito, *B. convoluta* Hedw., and *B. amplexifolia* (Mitt.) A. Jaeg.

Barbula hiroshii is identified as new to the Chinese moss flora, thereby increasing the Chinese *Barbula* species records to nine. *B. convoluta* and *B. amplexifolia* (a.k.a. *B. coreensis*) were earlier reported in the Chinese moss flora with a distribution range limited to Taiwan/Tibet and southwestern/northeastern areas of China respectively (Gangulee, 1972; Saito, 1975; Zander, 1979; Ignatov and Zander, 1993; Li *et al.*, 2001; Smith, 2004; Köckinger & Kučera, 2007). Therefore, the discovery of these two species by this study in new geographical regions of China is herein considered a noteworthy extension of their local distribution range.

* Corresponding author: bxliangmoss@aliyun.com

Barbula amplexifolia* (Mitt.) A. Jaeg.*Figs 1-8****Synonym:** *Barbula coreensis* (Cardot) K. Saito

Plants forming moderately dense turfs, yellowish green above, dark brownish-green below. **Stems** 0.8-1.2 cm in length, with a well-developed central strand and enlarged cortical cells, 0.12-0.15 mm in diameter. **Leaves** crispate when dry, lanceolate, 1.5-1.9 mm long, 0.4-0.5 mm wide; abaxial surface of costa papillose, with blunt, seriate papillae; apex broadly acuminate, mucronate; upper laminal cells quadrate to short rectangular, moderately thick walled, rather small, 5.2-6.5 μm , with 3-5 papillae per cell; leaf base hyaline, often rectangular 18.2-36.4 \times 5.2-10.4 μm ; marginal cells flat rectangular and usually somewhat transversely elongate; gemmae abundant, globose, elliptic or pyriform, 52.5-63.0 μm long, 36.8-52.5 μm in diameter. **Sporophytes** not seen.

Specimens examined: CHINA: Guizhou, Fanjingshan Shan (Mt.), on soil; 27°54' N, 108°36' E, 25 Aug 2010, X.L. Bai 2013 (HIMC); Shanghai, East China Normal University, near the Geographic Building on campus, on soil; c. 18 m, 31°13'38.45" N, 121°24'24.69" E, 3 Oct 2012, R.L. Zhu 20121003-1 (HSNU); Inner Mongolia Autonomous Region, Ordos, Jungar Qi, Dongkongdui town, on soil; 39°36' N, 110°48' E, 5 Sept 2005, X.L. Bai 2005050901 (HIMC); Hubei, Yichang City, Xiling Gorge, on cliff face; 30°54' N, 110°42' E, 13 Jul 2010, X.L. Bai 201007030 (HIMC); Yunnan, Xishuangbanna Tropical Botanical garden, Chinese Academy of Sciences, on soil; Xishuangbanna, Jinghong City, on soil; 22°00' N, 100°48' E, 14 Aug 2005, D.P. Zhao Z1108001, Z1108036 (HIMC).



Figs 1-8. Micrographs of *Barbula amplexifolia* – 1. Habit. 2. Leaves. 3. Gemmae. 4. Transverse section of stem. 5. Costal transverse section. 6-7. Leaf apex. 8. Leaf base. A-D from X.L. Bai 2013, E & F from R.L. Zhu 20121003-1, G & H from X.L. Bai 2013. Scale bars: 1 = 3 mm; 2 = 500 μm ; 3 = 30 μm ; 4-8 = 50 μm .

Distribution: *Barbula amplexifolia* has been earlier reported in India (Gangule, 1972), western North America, the European Alps (Köckinger & Kučera, 2007; Ros *et al.*, 2013), southwestern and northeastern China, Russia (Ignatov & Zander, 1993), Japan and Korea (as *B. coreensis*, see Saito, 1975). This study has extended its geographical distribution to central, eastern and northern China.

Note: The species is very similar to the broad-leaved *Barbula coreensis* (Cardot) K. Saito from Japan (Saito, 1975) and reported in the Moss Flora of China (Li *et al.*, 2001). In 1993, Zander and Ignatov identified *B. coreensis* from the Altai Mountains as actually belonging to *B. amplexifolia*. Since both species have gemmae of similar morphology, we agree that *B. coreensis* is a synonym of *B. amplexifolia*, in accordance with earlier reports (Ignatov & Zander, 1993; Zander, 1979). *Barbula amplexifolia* can be easily distinguished from *B. convoluta* by stiff and sharply pointed leaves with a smooth, short mucro.

***Barbula convoluta* Hedw.**

Figs 9-15

Plants caespitose, yellowish green or bright green above, brown below. **Stems** 3-5 mm high, central strand 0.1-0.12 μm in diameter. **Leaves** more or less crispate when dry, narrow-lingulate, 1.0-1.6 \times 0.24-0.36 mm, broadly acute to obtuse at apex; margins plane, revolute at base; upper laminal cells strongly papillose, opaque, rounded-quadrate, 7.5-8.3 μm ; basal cells rectangular, much



Figs 9-15. Micrographs of *Barbula convoluta* – **9.** Habit. **10.** Leaves. **11.** Leaf apex. **12.** Transverse section of stem. **13.** Basal laminal cells. **14.** Upper laminal cells. **15.** Costal transverse section. All from *X.L. Bai 201107682*. Scale bars: 9 = 2 mm; 10 = 300 μm ; 11-15 = 50 μm .

enlarged, $26.0\text{-}39.0 \times 7.8\text{-}13.0 \mu\text{m}$, obscure in surface view, with fine papillae; costa ending below the leaf apex, $57.2\text{-}62.4 \mu\text{m}$ wide at base; adaxial stereid band weak, surface cells quadrate, densely papillose; abaxial cells linear-oblong. **Sporophytes** not seen.

Specimen examined: CHINA: Heilongjiang, Nangelaqiu Shan (Mt.), the tallest peak of the Udalianchi volcano, on wet soil over swampy regions on shady slopes, where it colonizes small areas; c. 539 m, $48^{\circ}44.213'\text{N}$, $126^{\circ}00.028'\text{E}$, 24 Sept 2011, *X.L. Bai 201107682* (HIMC).

Distribution: *Barbula convoluta* is widely distributed across the Northern Hemisphere from Japan (Honshu and Kyushu), eastern Asia to Europe, and also reported from northern Africa, New Zealand, North America, Central America and the Maltese Islands (Saito, 1975; Smith, 2004; Mifsud, 2012; Cos *et al.*, 2013). In China, it has previously been reported from Taiwan, Shaanxi and Tibet (Li *et al.* 2001). Having found it in Heilongjiang Province, we hereby report it, for the first time, from northeastern region of China.

Note: There are distinctive features, in combination, found in this species, for instance, plane leaf margins, keeled mid-leaf, narrow costa, more broadly acute or rounded leaf tips, the cells of the adaxial surface of the costa long-ovate, and the abaxial cells linear-ovate and papillose.

Barbula hirosii K. Saito

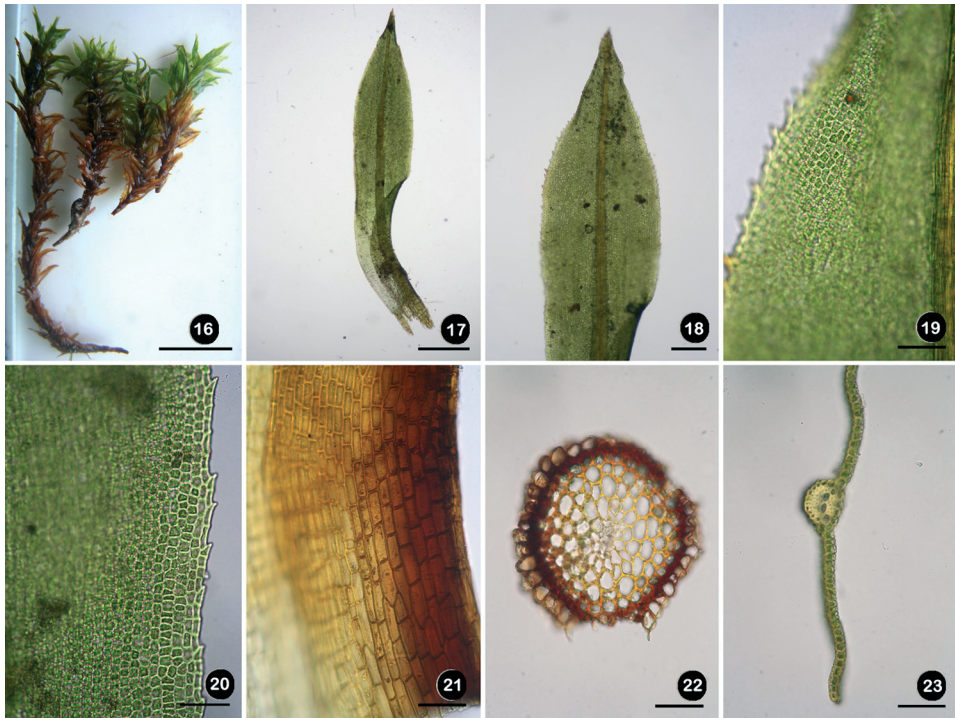
Figs 16-23

Plants green to dark green, forming tall, dense tufts. **Stems** 0.8-2.5 cm long, branches few, hyalodermis well-differentiated. **Leaves** slightly crispate when dry, lingulate, $0.5\text{-}0.7 \times 2.3\text{-}3.4 \text{ mm}$, acute at apex, often conduplicate at base; margins plane throughout, regularly toothed in distal 2/3 part; upper laminal cells quadrate to short-oblong, thick-walled, obscure, $5.2\text{-}10.4 \mu\text{m}$ in length, with 5-8 low, blunt, small papillae; marginal teeth unicellular, almost smooth, thick-walled, green; basal cells much enlarged, $15.6\text{-}41.6 \mu\text{m}$ long, $5.2\text{-}10.4 \mu\text{m}$ wide, hyaline to pale brown, smooth, smaller toward margins; costa percurrent, brown; guide cells in 3 layers, adaxial stereid band well-developed; cells of the adaxial surface quadrate, papillose, cells of the abaxial surface linear-oblong, almost smooth. **Sporophytes** not seen.

Specimen examined: CHINA: Hubei Province, Yichang city, Chexi town, on cliff face; $29^{\circ}42'\text{N}$, $117^{\circ}42'\text{E}$, 14 Jul 2010, *X.L. Bai 201007035* (HIMC).

Distribution: *Barbula hirosii* was formerly reported only by reference to the Japanese holotype. No reports of it have previously been made for China.

Note: Although gemmae have not been found, *B. hirosii* can easily be identified by the toothed leaf margin on the distal half of the leaf, the narrow constriction above the leaf base, the stem with hyalodermis differentiation, the small, blunt and low papillae, and the presence of an adaxial stereid band. Compared to the Japanese materials, the Chinese specimen of this species showed only insignificant differences.



Figs 16-23. Micrographs of *Barbula hiroschii* – 16. Habit. 17-18. Leaves. 19. Upper laminal cells. 20. Leaf marginal cells. 21. Basal laminal cells. 22. Stem transverse section. 23. Costal transverse section. All from X.L. Bai 201007030. Scale bars: 16 = 5 mm; 17 = 500 μ m; 18 = 150 μ m, 19-23 = 50 μ m.

A KEY TO THE IDENTIFICATION OF THE SPECIES OF *BARBULA* IN CHINA

1. Stem hyalodermis present, low papillae, margins toothed. . . . *Barbula hiroschii*
1. Stem hyalodermis absent, high papillae, margins entire or serrulate near apex . . . 2
2. Gemmae absent. 3
2. Gemmae usually present 5
3. Leaf apices usually rounded obtuse; costa percurrent; upper leaf cells with fine or non C-shaped papillae 4
3. Leaf apices usually acute; costa excurrent as a mucro; upper leaf cells with several small C-shaped papillae. *Barbula unguiculata* Hedw.
4. Leaf margins plane *Barbula convoluta*
4. Leaf margins undulate *Barbula chenii* Red f. et B.C. Tan
5. Leaves usually oblong-elliptic to narrowly ligulate; leaf apices usually rounded obtuse, rarely acute at apex *Barbula indica* (Hook.) Spreng.
5. Leaves usually lanceolate to narrowly ovate-lanceolate; leaf apices usually acuminate or acute, rarely obtuse at apex 6

6. Leaf margins irregularly serrulate near apex, entire below
 *Barbula propagulifera* (X.J. Li *et* M.X. Zhang) Redf. *et* B.C. Tan
6. Leaf margins entire, non- serrulate near apex 7
7. Gemmae filiform *Barbula dixoniana* (P.C. Chen) Redf. *et* B.C. Tan
7. Gemmae club-shaped or globose 8
8. Upper leaf cells subquadrate, rather thin-walled; gemmae club-shaped
 *Barbula subcomosa* Broth.
8. Upper leaf cells quadrate to short rectangular, moderately thick walled;
 gemmae globose, elliptic, or pyriform. *Barbula amplexifolia*

Acknowledgments. This work was partly supported by funding from the National Natural Science Foundation of China (# 31170497, 30870160, 30900080), and the Joint Projects of the National Natural Science Foundation of China and the Russian Foundation for Basic Research (# 31011120089). The authors thank Olusegun Ajala and Benito C. Tan for assistance in language editing.

REFERENCES

- GANGULEE H.C., 1972 — *Mosses of Eastern India and Adjacent Regions: A Monograph*. Fascicle 3 (Syrrhopodontales, Pottiales & Dicranales). Calcutta.
- IGNATOV M.S. & ZANDER R.H., 1993 — *Barbula amplexifolia* from the Altai Mountains of Russia. *The bryologist* 96: 638-639.
- KÖCKINGER H. & KUČERA J., 2007 — *Barbula amplexifolia* (Mitt.) A. Jaeger in Europe. *Journal of bryology* 29: 33-40.
- LI X.J., HE S. & IWATSUKI Z., 2001 — Pottiaceae. In: Li X. J. & Crosby M. R. (eds), *Moss flora of China. English Version Vol. 2*, Beijing & New York, Science Press, St. Louis, Missouri Botanical Garden, pp. 114-249.
- MIFSUD S.D., 2012 — An update on the moss flora of the Maltese Islands. *Cryptogamie, Bryologie*, 33: 405-418.
- ROS R.M., MAZIMPAKA V., ABOU-SALAMA U., ALEFFI M., BLOCKEEL T.L., BRUGUÉS M., CROS R.M., DIA M.G., DIRKSE G.M., DRAPER I., EL-SAADAWI W., ERDAĞ A., GANEVA A., GABRIEL R., GONZÁLEZ-MANCEBO J.M., GRANGER C., HERRNSTADT I., HUGONNOT V., KHALIL K., KÜRSCHNER H., LOSADA-LIMA A., LUÍS L., MIFSUD S., PRIVITERA M., PUGLISI M., SABOVLJEVIĆ M., SÉRGIO C., SHABBARA H.M., SIM-SIM M., SOTIAUX A., TACCHI R., VANDERPOORTEN A. & WERNER O., 2013 — Mosses of the Mediterranean, an Annotated Checklist. *Cryptogamie, Bryologie* 34: 99-283.
- SAITO K., 1975 — A monograph of Japanese Pottiaceae (Musci). *Journal of the Hattori botanical laboratory* 39: 373-537.
- SMITH A.J.E., 2004 — *The Moss Flora of Great Britain and Ireland*. Cambridge, Cambridge University Press, pp. 312-333.
- ZANDER R.H., 1979 — Notes on *Barbula* and *Pseudocrossidium* (Bryopsida) [Musci] in North America and an annotated key to the taxa. *Phytologia* 44: 177-214.