



Didymodon hengduanensis (Bryophyta, Pottiaceae), a new species from the Hengduan Mountains, Southwestern China

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Abstract

Didymodon hengduanensis is described as a new species from the Hengduan Mountains in the provinces of Sichuan and Yunnan, China. It is characterized mainly by its lanceolate to ovate-lanceolate and appressed-incurved leaves when dry, acute leaf apices, recurved to revolute margins, the yellowish color in KOH, percurrent to subpercurrent costa, and marginal basal cells forming a distinctly differentiated area of smooth and transversely thick-walled cells. Drawings and light microscope photographs of the new species are provided. The principal characters that separate it from the most similar species are discussed.

Key words: Asia, *Didymodon*, Gaoligongshan, mosses, Sichuan, taxonomy, Yunnan

Introduction

The Hengduan Mountains are located at the eastern end of the Himalayan range in southwestern China. They extend from western Sichuan and northern Yunnan provinces to eastern Tibet in China and into northernmost Myanmar. This region is characterized by a series of parallel mountain ranges and rivers flowing from north to south, with sharp altitudinal differentiation. These mountains have been identified as one of the world's 35 biodiversity hotspots and have been recognized as the biologically richest temperate region in the world (Nie *et al.* 2005, Mittermeier *et al.* 2011). This great diversity is due to its extremely complex topography and climate, the island-like isolation of the numerous high peaks, and the existence of a wide variety of habitats, from subtropical evergreen broadleaved forests up to snow peaks and glaciers at over 6,000 m.

During a period of nine years, from 2002 to 2010, two of the co-authors (DGL and JRS) in collaboration with the Chinese Academy of Sciences, Kunming, made large collections of bryophytes in the Hengduan Mountains. Collecting expeditions were mainly focused on the eastern slopes of these mountains, the Gaoligongshan region, in the western part of Yunnan adjacent to Myanmar (Long 2008). Although a bryophyte flora of the Hengduan Mountains has been published (Wu & Wang 2000) knowledge of the region is still insufficient because many areas remain poorly known or unexplored (Shevock *et al.* 2006, Long 2011). Examination of collections from these field trips has revealed numerous taxa new to science (e.g., Enroth & Ji 2006, Long & Vána 2007, Vána & Long 2008, Bednarek-Ochyra & Ochyra 2010, Blom *et al.* 2011, Caparrós *et al.* 2011, Shevock *et al.* 2011) suggesting likewise that bryophyte richness in this region is far from fully known.

In the course of a worldwide taxonomic revision of *Didymodon* Hedwig (1801: 104) the first author had the opportunity to study the *Didymodon* specimens collected by DGL and JRS in Hengduan Mountains. Among these collections several specimens of an interesting taxon were found that did not match the concept of any of the species known in the genus. Additional specimens of the same moss were found in a collection from the same area obtained from Blanca Lasso de la Vega (Málaga, Spain) and deposited in MUB. The new species is here described, illustrated, and compared with other closely related species.

Material and methods

During the course of a worldwide revision of *Didymodon* about 6,000 specimens belonging to this genus were studied with the typical anatomical and morphological methods applied for the Pottiaceae (Zander 1993). In addition, most of the type material of the taxa attributed to this genus in the world has been studied. The specimens included in this study were housed in the herbaria CAS, E, and MUB. Microscopic examinations and measurements were taken with an Olympus-BX41 light microscope, while microphotographs were obtained with a Jenoptik ProgRes C7 camera mounted on this microscope. Specimens were examined in 2% potassium hydroxide.

Description

Didymodon hengduanensis J.A. Jiménez, D.G. Long, Shevock & J. Guerra *sp. nov.* (Figs. 1, 2)

Diagnosis: Differing from all other species of the genus *Didymodon* by its lanceolate to ovate-lanceolate and appressed-incurved leaves when dry, acute leaf apices, recurved to revolute margins, the yellowish color in KOH, percurrent to subpercurrent costa, and marginal basal cells forming a distinctly differentiated area of smooth and transversely thick-walled cells.

TYPE:—CHINA. YUNNAN: Lushui County, Gaoligongshan Range, southern end of the Hengduanshan, Nu Jiang (Salween River) watershed, at Pianma Fengxue Pass northwest of Liuku at km marker 58 about 38 km from Lushi, 15 October 2002, *Shevock 23596* (holotype: KUN; isotypes: CAS, E, H, MO, MUB, NY, PE).

Plants 1–3.7 cm high, growing in dense turfs, dull to yellowish green above, brown to red-brown below. Stems erect, simple or branched, sometimes radiculose at base, without hyalodermis, sclerodermis undifferentiated, central strand developed; axillary hairs filiform, 2–5 cells long, with 1 brown basal cell and hyaline upper cells. Rhizoidal tubers absent. Leaves appressed-incurved when dry, erect-patent, sometimes spreading when moist, lanceolate to ovate-lanceolate, 1.8–2.6 × (0.6–)0.7–0.95 mm, channelled ventrally in the upper part; lamina unistratose, KOH reaction yellowish; apex acute, not apiculate, not cucullate; margins recurved to revolute from base to 3/4 of the leaf, entire, unistratose, often decurrent on stem; costa 67–100 µm wide at base, percurrent to subpercurrent, not spurred, tapering to apex, ventral surface cells of the costa subquadrate, oblate or shortly rectangular, smooth, dorsal surface cells of the costa subquadrate or oblate, seldom shortly rectangular, smooth, in cross-section below midleaf semicircular, with 4–6 guide cells in 1 layer, 2 layers of ventral stereids, 2 layers of dorsal stereids, semicircular in shape, without hydroids, ventral surface cells differentiated, smooth, dorsal surface cells differentiated, smooth; upper and middle laminal cells subquadrate or oblate, rarely shortly rectangular, 3.5–9.6 × 4.8–9.6 µm, evenly thick-walled, not bulging, with 1(–2) simple low papillae centered over the lumen; juxtacostal basal cells rectangular, rarely quadrate, 7.5–45 × 5–10 µm, slightly and evenly thick-walled, smooth or ventrally with single, very low papillae; marginal basal cells oblate, rarely subquadrate, often with lumens angular, 3.2–10(–15) × 4.8–12.8 µm, transversely thick-walled, extending up to approximately midleaf, forming a distinctly differentiated area of 5–11 rows of smooth cells. Gemmae absent. Sexual condition dioicous. Perichaetial leaves differentiated, more sheathing than vegetative leaves, oblong-lanceolate, abruptly narrowed to a subulate apex, 2.2–2.8 × 0.65–0.8 mm, margins plane, costa excurrent. Seta 1.2–2 cm long, weakly twisted to the left, orange to reddish brown. Capsule erect; theca cylindrical, 1.7–2.6 × 0.5–0.75 mm, brown to reddish brown; annulus persistent, composed of 1 row of rectangular, thick-walled cells; peristome of 32 teeth spirally twisted, 1.2–1.5 mm, orange, papillose; operculum long rostrate, 1.3–1.6 mm long, cells in twisted rows. Calyptra not seen. Spores 10–17.5 µm in diameter, weakly papillose, yellowish brown.

Paratypes:—CHINA. SICHUAN: Yajiang County, east slope of pass west of Yajiang on Highway 318, 2 September 2010, *Long 39775* (E). YUNNAN: Heqing County, camino a Lijiang desde Dali, 21 September 2014, *Lasso de la Vega s.n.* (MUB 49677). Gongshan County, Bingzhongluo Xiang, east slope of Gaoligong Shan, Nu Jiang (Salween) catchment, moraine across valley on SW slope of Gawagapu Mountain, 21 August 2006, *Long 35955* (CAS, E, KUN); Shangri-la County, Pudacuo National Park, 25 September 2014, *Lasso de la Vega s.n.* (MUB 49673).

Etymology:—The specific epithet, *hengduanensis*, refers to the Hengduan Mountains where the species occurs.

Distribution and Habitat:—At present, *Didymodon hengduanensis* is known from five localities in Sichuan and Yunnan provinces, southwestern China (Fig. 3). All occurrences lie within the Hengduan Mountains region between unusually wide altitudinal extremes of 2500 and 3970 m. It occurs on both calcareous and granitic rocks and boulders with accumulated soil or more rarely on disturbed soil, in a variety of habitats, both in the *Abies* forest zone and also above the tree-line amongst shrubby *Rhododendrons* and bamboo, and on an alpine moraine ridge.

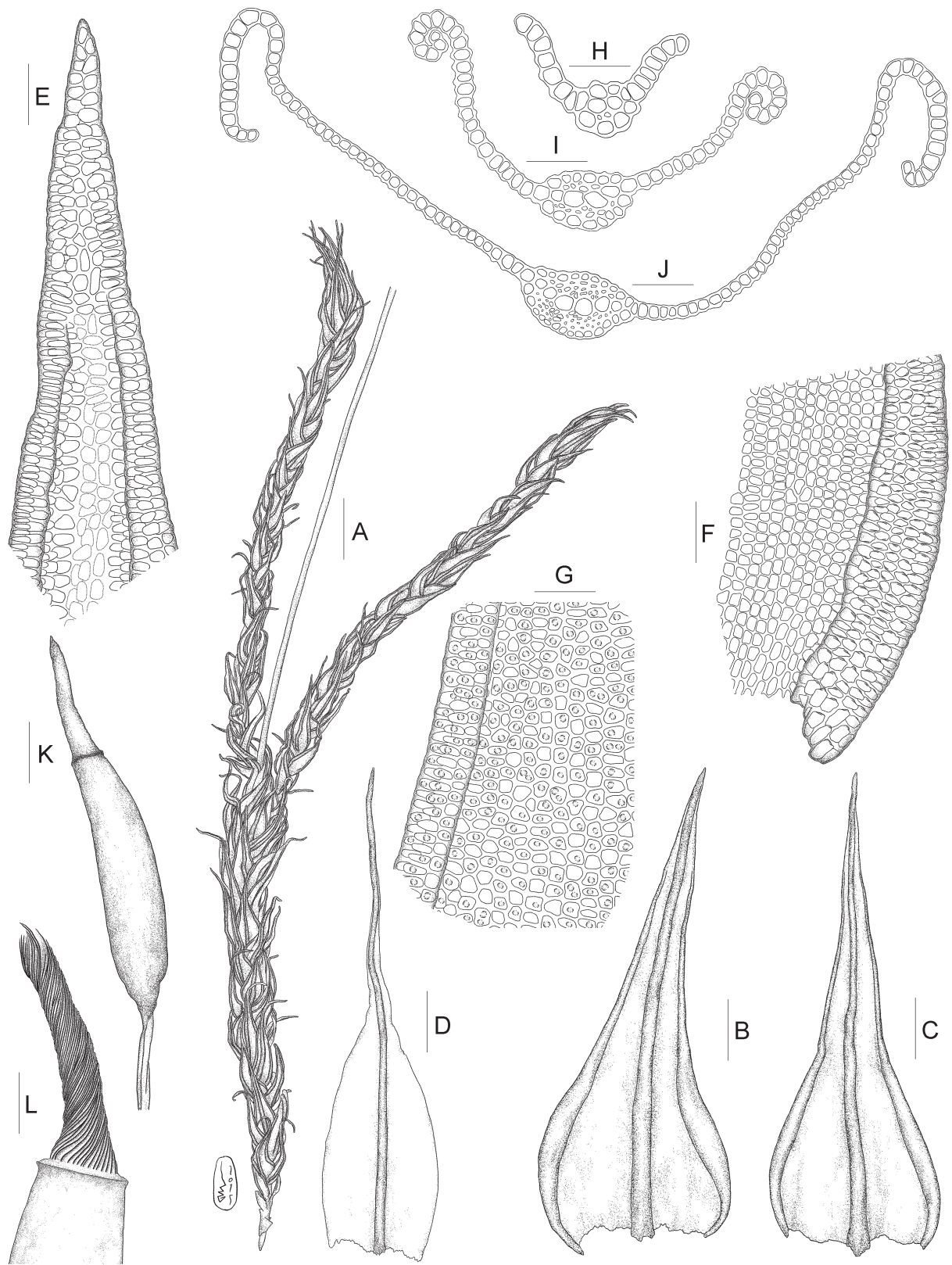


FIGURE 1. *Didymodon hengduanensis*. A. Habit, dry. B–C. Leaves. D. Perichaetial leaf. E. Leaf apex. F. Basal laminal cells. G. Upper laminal cells. H–J. Transverse sections of a leaf from apical to basal part. K. Capsule. L. Peristome. Scale bars: A = 2 mm. B–D = 300 µm. E = 30 µm. F, H–J = 40 µm. G = 25 µm. K = 0.6 mm. L = 300 µm. All from holotype.

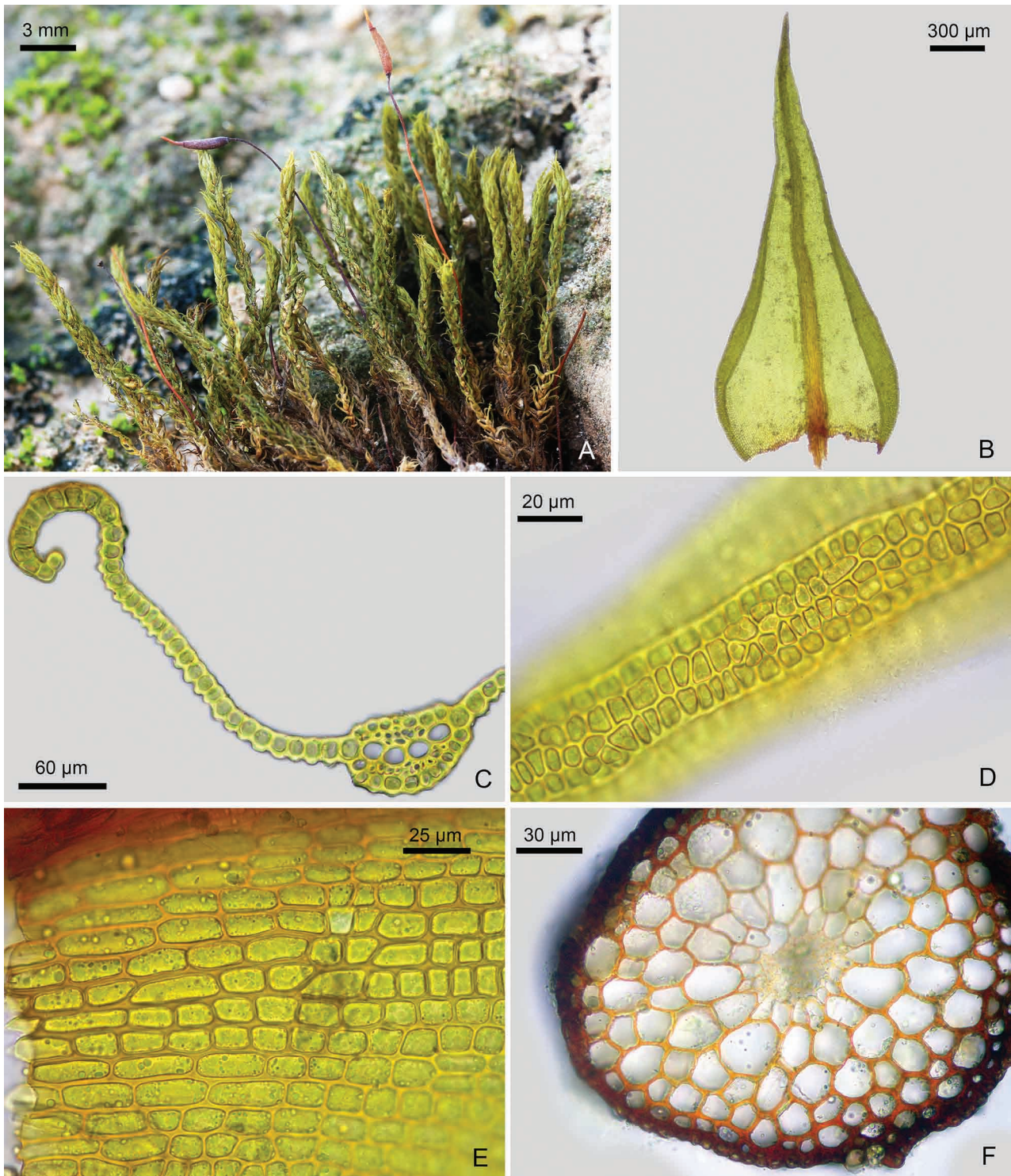


FIGURE 2. A. Habit of *Didymodon hengduanensis* in dry state. B. Leaf. C. Cross-section of a leaf near base. D. Dorsal surface cells of the costa. E. Juxtacostal basal cells. F. Transverse section of stem. All from holotype.

Discussion

Didymodon hengduanensis is a remarkable species characterized by its lanceolate to ovate-lanceolate leaves that are channelled ventrally and appressed-incurved when dry, acute apices, margins recurved to revolute from base to 3/4 of the leaf, the yellowish color in KOH, percurrent to subpercurrent costa, and marginal basal cells running up the margin forming a distinctly differentiated area of smooth and transversely thick-walled cells. In addition, the sporophyte has a long and twisted peristome.

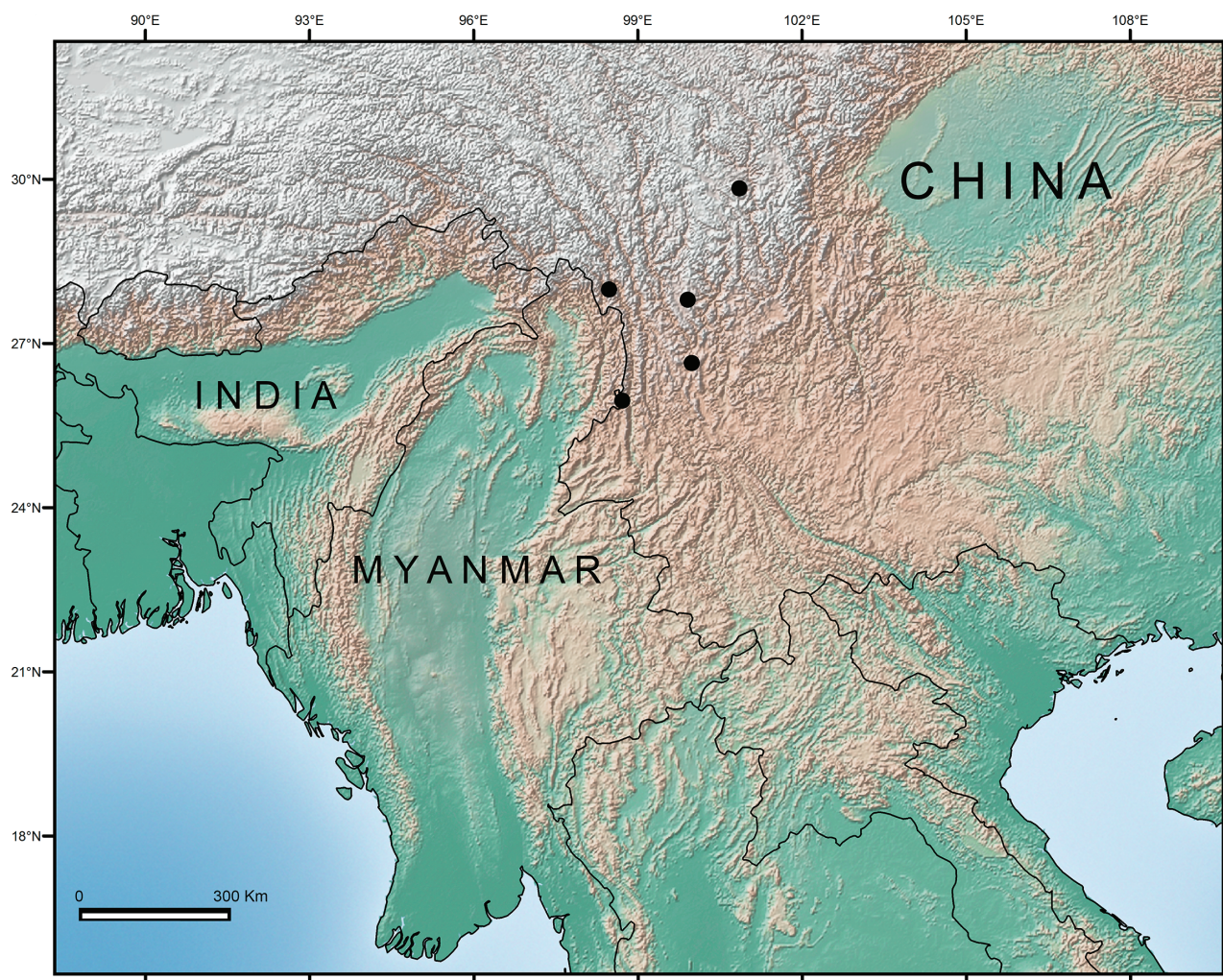


FIGURE 3. Known geographical distribution of *Didymodon hengduanensis*.

The presence of differentiated marginal basal cells is a rare feature within *Didymodon*, shared only by two other species, *D. leskeoides* Saito (1975: 508) and *D. californicus* Jiménez *et al.* (2014: 105). *Didymodon leskeoides*, an uncommon species known from Asia (mainly from the Himalayas) and North America (Zander 2007, Sollman 2010), could be confused with *D. hengduanensis*. It, like the new species, may have lanceolate to ovate-lanceolate leaves with acute apices, a percurrent costa, smooth laminal cells and a similar costa structure. However, *D. leskeoides* can be easily distinguished from it by its elongate cells on the upper ventral surface of the costa and red color of the lamina in KOH. *Didymodon californicus*, a Californian endemic (Jiménez *et al.* 2014), can be separated by its plane leaf margins and a costa without a ventral stereid band.

In the habit, leaf shape, the curvature of the margins, and the anatomical structure of the costa, the Eurasian *D. validus* Limpricht (1888: 557) (Jiménez 2006) is similar to *D. hengduanensis*. Nevertheless, *D. validus* differs from the *D. hengduanensis* in having smooth laminal cells and a long-excurrent costa.

Didymodon tectorum (Müller 1896: 101) Saito (1975: 517), an essentially East Asian-North American species but also known from a few scattered localities in Sub-Saharan Africa and El Salvador (Zander 2007, Búcaro *et al.* 2012, Hedderson *et al.* 2014), and its close relative *D. cordatus* Juratzka (1866: 177) known from Europe and Asia (Jiménez 2006, Zhao *et al.* 2013, Kürschner & Ochyra 2014) could be confused with the new species. Both species share with *D. hengduanensis* some similarities, such as the strongly recurved to revolute leaf margins, the shape, size and papillosity of the upper and middle laminal cells, and peristome morphology. However, they are immediately distinguished from *D. hengduanensis* by their costa clearly excurrent as a mucro, the presence of multicellular gemmae on branched rhizoids in the leaf axils, and marginal basal cells not differentiated.

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References

- Bednarek-Ochyra, H. & Ochyra, R. (2010) *Bucklandiella shevockii* (Bryophyta, Grimmiaceae), an exquisite new species from Yunnan, China. *Polish Botanical Journal* 55: 499–506.
- Blom, H.H., Shevock, J.R., Long, D.G. & Ochyra, R. (2011) Two new rheophytic species of *Schistidium* (Grimmiaceae) from China. *Journal of Bryology* 33: 179–188.
<http://dx.doi.org/10.1179/1743282011Y.0000000020>
- Búcaro, R.D., Touw, A. & Stech, M. (2012) Bryoflora salvadorensis. I. Introduction and contributions to the moss flora of El Salvador. *Tropical Bryology* 34: 1–11.
<http://dx.doi.org/10.11646/bde.34.1.1>
- Caparrós, R., Garilleti, R., Lara, F., Long, D.G. & Mazimpaka, V. (2011) Two new species of *Ulota* (Orthotrichaceae, Bryopsida) with multicellular spores, from the Hengduan Mountains, southwestern China. *Journal of Bryology* 33: 210–220.
<http://dx.doi.org/10.1179/1743282011Y.0000000008>
- Enroth, J. & Ji, M. (2006) *Shevockia* (Neckeraceae), a new moss genus with two species from southeast Asia. *Journal of the Hattori Botanical Laboratory* 100: 69–76.
- Hedderon, T.A.J., Bizuru, E., Mujawamariya, M. & Raondry-Rakotoarisoa, N. (2014) New and additional moss records for Rwanda. *Journal of Bryology* 36: 72–75.
<http://dx.doi.org/10.1179/1743282013Y.0000000079>
- Hedwig, J. (1801) *Species Muscorum Frondosorum*. J.A. Barth, Lipsiae [Leipzig], 352 pp.
- Jiménez, J.A. (2006) Taxonomic revision of the genus *Didymodon* Hedw., (Pottiaceae, Bryophyta) in Europe, North Africa and Southwest and Central Asia. *Journal of the Hattori Botanical Laboratory* 100: 211–292.
- Jiménez, J.A., Toren, D. & Shevock, J.R. (2014) *Didymodon californicus* (Pottiaceae), a new species from California, U.S.A. *Phytotaxa* 158: 105–110.
<http://dx.doi.org/10.11646/phytotaxa.158.1.9>
- Juratzka, J. (1866) Bryologisches. *Botanische Zeitung* 24: 177–179.
- Kürschner, H. & Ochyra, R. (2014) Novelties in the moss flora of Oman, Saudi Arabia and Yemen, including the most outstanding *Vesicularia montagnei* (Bél.) Broth. (Hypnaceae). *Cryptogamie, Bryologie* 35: 93–97.
<http://dx.doi.org/10.7872/cryb.v35.iss1.2014.93>
- Limpricht, K.G. (1885–1889) *Die Laubmoose Deutschlands, Österreichs und der Schweiz 1*. Eduard Kummer, Leipzig, 836 pp.
- Long, D.G. (2008) Bryophytes abroad: the Gaoligong Shan mountains of the Sino-Burmese border. *Field Bryology* 96: 28–38.
- Long, D.G. (2011) Bryophyte exploration of south-west Sichuan, China. *Field Bryology* 103: 32–39.
- Long, D.G. & Váňa, J. (2007) The genus *Gottscheia* Grolle (Jungermanniopsida, Lophoziaaceae) in China, with a description of *G. grollei*, sp. nov. *Journal of Bryology* 29: 165–168.
<http://dx.doi.org/10.1179/174328207X227410>
- Mittermeier, R.A., Turner, W.R., Larsen, F.W., Brooks, T.M. & Gascon, C. (2011) Global biodiversity conservation: the critical role of hotspots. In: Zachos, F.E. & Habel, J.C. (Eds.) *Biodiversity hotspots: distribution and protection of conservation priority areas*. Springer, Heidelberg, pp. 3–22.
http://dx.doi.org/10.1007/978-3-642-20992-5_1
- Nie, Z.L., Wen, J., Gu, Z.J., Boufford, D.E. & Sun, H. (2005) Polyploidy in the flora of the Hengduan mountains hotspot, southwestern China. *Annals of the Missouri Botanical Garden* 92: 275–306.
- Saito, K. (1975) A monograph of Japanese Pottiaceae (Musci). *Journal of the Hattori Botanical Laboratory* 39: 373–537.
- Shevock, J.R., Ochyra, R. & Buck, W.R. (2006) Observations on the ecology and distribution of *Hydrocryphaea wardii*, a Southeast Asian monospecific genus, reported new for China from Yunnan Province. *Journal of the Hattori Botanical Laboratory* 100: 407–418.

- Shevock, J.R., Ochyra, R., He, S. & Long, D.G. (2011) *Yunnanobryon*, a new rheophytic moss genus from southwest China. *The Bryologist* 114: 194–203.
<http://dx.doi.org/10.1639/0007-2745-114.1.194>
- Sollman, P. (2010) Several pottiaceous mosses reported new for Bhutan. *Nova Hedwigia, Beiheft* 138: 207–213.
- Váňa, J. & Long, D.G. (2008) *Hamatostrepta concinna* gen. et sp. nov. (Jungermanniopsida, Scapaniaceae), a new Asiatic leafy liverwort from the Sino-Burmese border. *Fieldiana Botany, New Series* 47: 133–138.
<http://dx.doi.org/10.3158/0015-0746-47.1.133>
- Wu, P.-C. & Wang, M.-Z. (2000) *Bryoflora of Hengduan Mountains (southwest China)*. Academia Sinica, Beijing, 742 pp.
- Zander, R.H. (1993) Genera of the Pottiaceae: mosses of harsh environments. *Bulletin of the Buffalo Society of Natural Sciences* 32: 1–378.
- Zander, R.H. (2007) *Didymodon*. In: Flora of North America Editorial Committee (Eds.) *Flora of North America. North of Mexico* 27. Oxford University Press, New York and Oxford, pp. 539–561.
- Zhao, D.P., Bai, X.L., Wang, J.N. & Liu, Y. (2013) *Didymodon cordatus* Jur. (Pottiaceae), new to the moss flora of China. *Bangladesh Journal of Plant Taxon* 20: 259–261.
<http://dx.doi.org/10.3329/bjpt.v20i2.17402>