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Didymodon alpinus (Pottiaceae), a new species from Tibet, China

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Appendix 1

Specimens examined

***Gymnostomiella vernicosa* (Harv.) M.Fleisch.**

Burma (Myanmar): *N. Wallich* (LISU 4290); *loc. cit.*, *N. Wallich* (BM 000867659). Rangoon, Gyllenepagoden [Shwedagon Pagoda], *H. Möller*, 28 September 1897 (BM s.n.). **India**: Girgaum Back Road, Bombay, on human walls, *K.R. Kirtikar*, 1910, det. H. N. Dixon (BM s.n.); Allahabad, wall, *W. Dudgeon*, 27 September 1922, *det.* H. N. Dixon. (BM s.n.). **Tanzania**: Zanzibar, Stown Town, 'Poço dos Escravos', 6.166645°S, 39.192956°E, 10 m, *Sérgio*, 02 April 2005 (LISU 257510). **Cape Verde**: Ilha de Santiago, pr. João Teves, na argamassa de uma ponte antiga ao lado da estrada. 15.069681°N, 23.515438°W, 200–300 m, *Sérgio*, 12 September 2015 (LISU 262307); pr. Picos, Cachoeira "Maravilhas", nas paredes da represa que circunda a cachoeira, ass. *Hyophila involuta* (Hook.) A.Jaeger, 15.069681°N, 23.515438° W, 400 m, *Sérgio*, 12 September 2015 (LISU 262307).

***Gymnostomiella vernicosa* (Harv.) M.Fleisch. var. *monodii* (P.de la Varde) Sérgio**

Mauritania: Adar, falaise humide de la source incrustante d'El Berbera, 22 October 1952, *T. Monod 10961*, *det*. P. de la Varde 10892 (isotype: PC 0106072 with illustrations)l; *loc. cit.*, 22 October 1952, *T. Monod 10961*, *det*. P. de la Varde 10892 (isotype: PC 0106071 Herbier M. Bizot**).** Roches suitantes à *Adiantum capillus-veneris* L., prés Atar, 03 January 1959, *T. Monod 12513*, *det.* P. de la Varde 15878c (PC s.n.); Adar du Mauritaine, *A. Naegelé*, 1959, *det.* P. de la Varde 16622 (PC s.n.). **Cape Verde**: Ilha de Santiago, pr. Picos, Cachoeira próximo ada estrada, nas rochas que circundam a cachoeira, ass. *Fissidens flaccidus* Mitt., 15.069681°N, 23.515438° W, 400 m, *Sérgio*, 12 September 2015 (LISU 262306); Ilha de Santiago, Achada do Meio, Estrada para o Tarrafal, talude ao longo da estrada, 15.197031°N, 23.732808°W, 400 m, *Sérgio*, 12 September 2015 (LISU 262308); Ilha de Santo Antão, Pontinha da Janela, de baixo da levada que verte água, 40 m, *Duarte et al.*, 07 December 2005 (LISU 233247).

Didymodon alpinus (Pottiaceae), a new species from Tibet, China

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In the latest checklist of Chinese bryophytes (Jia & He, 2013), 26 species and 3 varieties of *Didymodon* Hedw. were listed and among them were 18 species and 2 varieties from Tibet. Although much taxonomic and floristic research on the bryophytes of Tibet has been published (Li, 1985, 1996; Li *et al.*, 2001), detailed understanding of the Pottiaceae, particularly the genus *Didymodon* is still needed, as updated and careful explanations of some taxonomically important morphological characteristics of the genus have been given by subsequent authors, such as Jiménez *et al.* (2005) and Jiménez (2006). In addition, due to limited accessibility, there are still many unexplored and seldom visited areas in this province. In the light of these facts, further field investigations and re-evaluation of *Didymodon* in this region are needed. During our study of Pottiaceae in the region, we discovered an interesting *Didymodon* specimen with a morphology that did not match with any of the species known in the genus. Consequently we describe it here as a new species *Didymodon alpinus*

Didymodon alpinus J.Kou, X.-M.Shao & C.Feng, ***sp. nov.***

(Figures 1 and 2)

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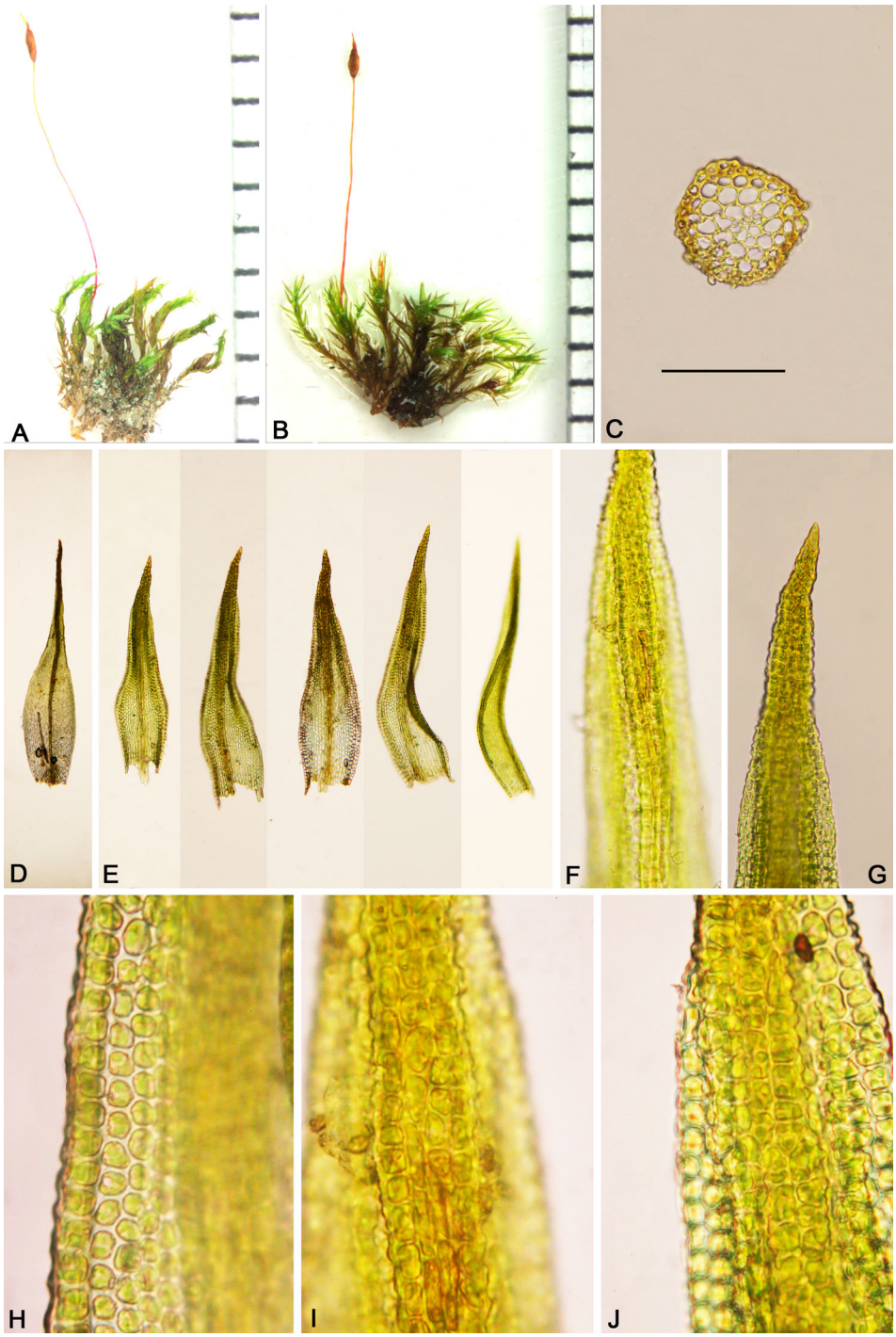

Figure 1 ***Didymodon alpinus*. (A) Plants when dry. (B) Plants when moist. (C) Cross-section of stem. (D) Innermost perichaetial leaf. (E) Leaves. (F) Upper part of leaf (dorsal). (G) Leaf apex (ventral). (H) Median leaf cells. (I) Upper part of costa (dorsal). (J) Upper part of costa (ventral). Scale bar: each scale = 1 mm for A, B; use scale bar on C = 100 μm for C, F–G; = 0.4 mm for D, E; = 40 μm for H–J (All from holotype).**

Diagnosis: *Didymodon alpinus* differs from otherwise similar species in its dry leaves twisting, a short-excurrent costa becoming narrow towards the base, the cross-section of the costa with two guide cells in 1 layer throughout, and 2–3 bulging ventral epidermal cells tapered or non-existent at the base.

Type: **China, Tibet**: Nyingchi Prefecture, Bomê County, Suotong Village, 29°53′24.936″N, 95° 35′10.248″E, on rock, *ca* 2672 m a.s.l., 21 July 2015, *Xiao-Ming Shao & Jin Kou 20150721k034a* (holotype: BAU, isotypes: MUB).

Plants small, growing in slightly loose cushions, greenish in upper part, rusty-red colouration in older leaves, dark green in less exposed parts of the plant. *Stems* branched, 2.5–6 mm high, hyalodermis absent, transverse section rounded-pentagonal, sclerodermis weak or absent, central strand present, small; rhizoidal tubers absent; axillary hairs filiform, short, usually 3–5

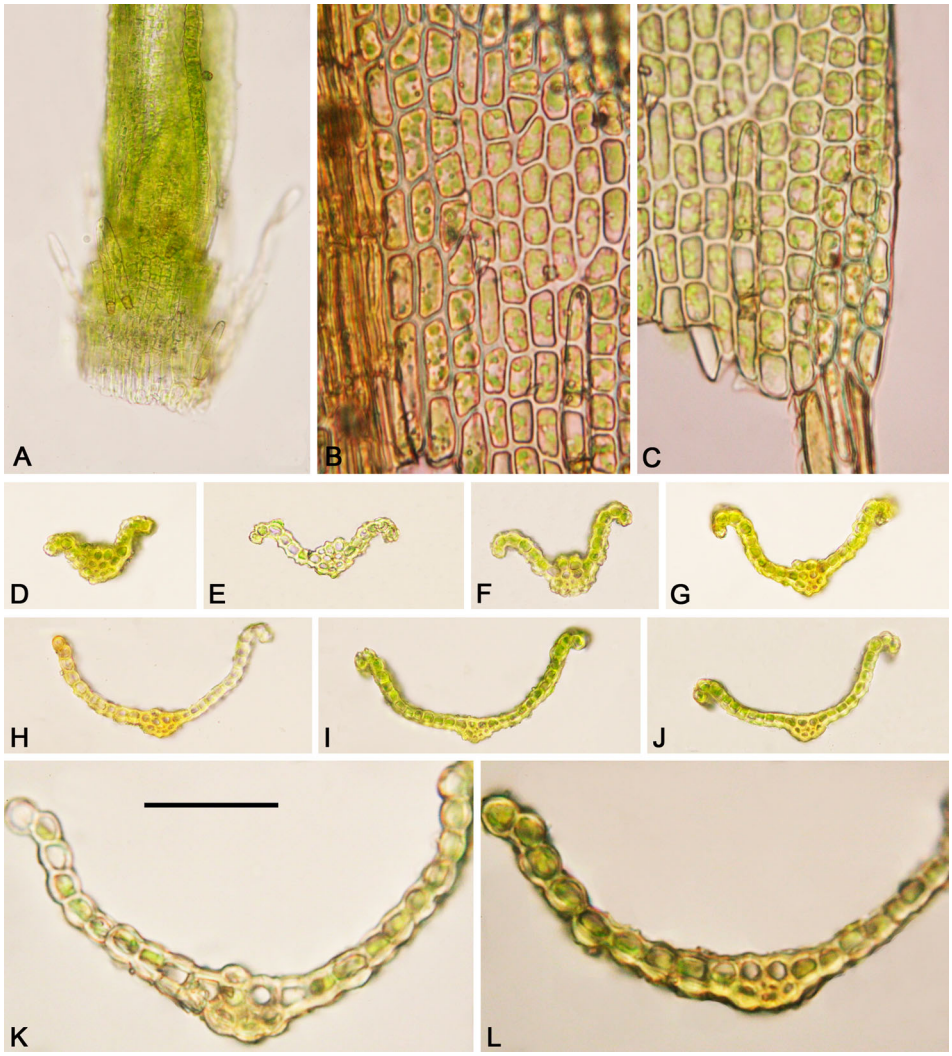

Figure 2. ***Didymodon alpinus*****. (A) Axillary hairs. (B) Basal juxtacostal cells. (C) Basal marginal cells. (D–J) Cross-sections of leaves, sequentially from apex to base. (K–L) Cross-sections of leaves at base, showing ventral epidermal cells of costa tapering or disappearing at base. Use scale bar on K = 100 μm for A, D–J; = 40 μm for B–C, K–L (All from holotype).**

cells long, with one brown basal cell and hyaline upper ones. *Leaves* flexuose or twisted when dry, erect to patent when moist, lanceolate, 0.65–0.83 × 0.13–0.25 mm, channelled ventrally in the upper part, not sheathing; lamina completely unistratose, yellow with KOH; apex acuminate to acute, ending in a conical cell, not cucullate; margins crenulate, narrowly recurved from base to apex, weakly decurrent, completely unistratose. *Costa* 27.5–34.5 μm wide at base, short-excurrent, apiculate with 1–3 smooth cells, becoming narrow towards the base; ventral cells of costa in upper middle part of the leaf quadrate or subquadrate, papillose; dorsal cells of costa in upper middle part of the leaf quadrate or subquadrate, papillose; transverse section rounded or elliptical; with 2 guide cells in one layer throughout, ventral stereids absent, 1–2 layers of dorsal stereids, with or without hydroids, 2–3 ventral surface cells bulging, tapered or non-existent at the base, papillose, dorsal surface cells slightly bulging, papillose. *Upper and middle* laminal cells subquadrate, 7.75–11.25 × 9.5–10.25 μm, with 1–3 simple papillae per cell, thick-walled; basal cells slightly differentiated, smooth, basal juxtacostal cells short-rectangular to rectangular, 12.5–25 × 7–8.75 μm, thick-walled; basal marginal cells short-rectangular, 9.5–21.5 × 4–5.25 μm, thick-walled. Gemmae absent.

Dioicous. Perichaetia differentiated, oblong, inner leaves differentiated, gradually narrowing to a subulate apex, 0.75–0.85 × 0.2–0.28 mm, not sheathing. *Seta* 6.0–7.5 mm in length, twisted to the left, yellowish-orange. *Capsule* erect; theca 0.88–1 × 0.4–0.58 mm in length, yellowish-brown, elliptical; annulus persistent, composed of 2–3 rows of rectangular cells, thick-walled; peristome teeth immature, short, densely papillose; operculum long-conic, 0.4–0.58 mm in length, cells twisted counterclockwise. *Calyptra* cucullate. *Spores* immature, 8.75–10.25 μm in diameter, finely papillose.

Etymology: The specific epithet, *alpinus*, refers to its habitat in a high-altitude environment.

Habitat and distribution: Bomê County is located in southeast Tibet, in the eastern part of the

Nyainqêntanglha Range at the eastern end of the Himalayas. The terrain is lower towards the south and higher towards the north. There are many high mountains in the area, which surrounds the Parlung Zangbo and the Yigong Zangbo Valley, as well as many famous glaciers, such as the Katchen, the Zepu, the Ruoguo, and the Guxiang Glacier. This county forms part of the transition zone between the Qinghai-Tibetan Plateau in southern Tibet and the Hengduan Mountains in eastern Tibet. The area enjoys a sub-humid warm temperate plateau monsoon climate and has an average elevation of about 4625 m, with a mean annual temperature of 8.9°C, an annual rainfall of approximately 700–900 mm, an annual average relative humidity of 72%, and an average 1363.7 hours of sunshine annually. The soil types found in this area are mainly alpine frost desert soil, alpine meadow soil, subalpine meadow soil, dark brown and brown soils. Spruce, sclerophyllous oak, birch, and hemlock are the main tree species. The rangeland vegetation of this county is mainly composed of Chenopodiaceae, Rosaceae, Fabaceae, Gentianaceae, and Asteraceae (Xiang *et al*., 2013).

Didymodon alpinus is currently known only from the type locality at Suotong Village, in Bomê County (Nyingchi Prefecture) in southeast Tibet, China. The site is situated by the side of a country road with forest, pastures, and a stream. The specimen was collected on exposed rock surrounded by a layer of leaf litter.

Discussion

According to Kučera & Ignatov (2015), a rusty red colouration of the older leaves, dark green colouring in less exposed parts of the plant, excurrent costa, bilaterally bulging lamina cells, relatively weak costa with a few guide cells in one layer and an absence of ventral stereids suggest the placement of *D. alpinus* in the *Didymodon* sect. *Rufiduli* (P.C.Chen) R.H.Zander. Within this section, there are three species with recurved margins, relatively weak costa with a few guide cells in one layer and ventral stereids absent, which may be confused with the new species, namely, *Didymodon rivicola* (Broth.) R.H.Zander, *Didymodon rufidulus* (Müll.Hal.) Broth. and *Didymodon zanderi* Afonina & Ignatova. *Didymodon alpinus* can be separated from these three species because of its short-excurrent costa becoming narrow towards the base. In addition, *D. rivicola* further differs from *D. alpinus* by its oblong-ovate leaves appressed when dry, and each laminal cell having a large papilla, while *Didymodon rufidulus* is further distinguished from *D. alpinus* by having ovate- to triangular-lanceolate leaves, and unipapillose or mammillose laminal cells. *Didymodon zanderi* differs from *D. alpinus* by the presence of caducous, relatively broadly acute to somewhat obtuse leaf apices, rather weakly recurved leaf margins and mamillose laminal cells.

Didymodon subandreaeoides (Kindb.) R.H.Zander, *D. perobtusus* Broth. and *D. sicculus* M.J.Cano, Ros, García-Zamora & J.Guerra are similar to *D. alpinus* in having a weak costa with few guide cells in one layer and ventral stereids absent. But the former two species differ from the new species in their ovate to broadly ovate-lanceolate leaves and rounded leaf apex, while *Didymodon sicculus* can be distinguished from the new species by its ovate leaves, acute or rounded leaf apex and margins recurved up to 3/4 of the leaf.

In general appearance, *D. alpinus* resembles *D. constrictus* (Mitt.) K.Saito with its lanceolate leaves, acuminate leaf apex, short-excurrent costa, papillose laminal cells, and short-rectangular basal marginal cells. However, *D. constrictus* can be easily distinguished from *D. alpinus* by the transverse section of its costa with two stereids bands and leaf margins narrowly recurved in the proximal 2/3.

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Taxonomic Additions and Changes: *Didymodon alpinus* J.Kou, X.-M.Shao & C.Feng, *sp. nov.*

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Didymodon fuscus (Müll.Hal.) J.A.Jiménez & M.J.Cano: a South American—Cape winter-rainfall disjunct and a key to South African species of the genus

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With about 127 species worldwide the genus *Didymodon* Hedw. is among the most diverse of the Pottiaceae (Zander, 1993, 2007). Jiménez *et al.* (2017) have commented on the poor representation of the genus in Africa, where only 19 species are recorded. Of these, 6 (*D. australasiae* (Hook. & Grev.) R.H.Zander, *D. jackvancei* R.H.Zander, *D. tophaceopsis* R.H.Zander, *D. tophaceus* (Brid.) Lisa, *D. umbrosus* (Müll.Hal.) R.H.Zander, and *D. xanthocarpus* (Müll.Hal.) Magill) are recorded from South Africa and Lesotho (O'Shea, 2006).

Recent collections from the winter-rainfall area of South Africa yielded several specimens that could not be assigned to any of the species known from the area. Revision of these collections (as well as specimens from other herbaria) by the second author, in the course of a world revision of the genus, revealed their identity as *Didymodon fuscus* (Müll.Hal.) J.A.Jiménez & M.J.Cano, a species previously known only from Chile and a single locality in the adjacent Argentina (Jiménez & Cano, 2006).

A detailed description of *D. fuscus* is provided by Jiménez & Cano (2006), and the South African specimens match this very closely. Although we have not analysed them statistically, there would appear to be a few quantitative differences between the specimens from the two areas. For example, the range in costa width is smaller in South Africa, and the average is slightly less. In the South American populations, dorsal costa cells are quadrate to short-rectangular, whilst in South Africa they tend more often to be short-rectangular to rectangular. Also, South African plants are more often greenish-brown rather than the reddish-brown typical of the South American populations, but exceptions occur in both areas.

Didymodon fuscus is readily distinguished from all other South African species except *D. xanthocarpus* in the combination of lanceolate leaves with firm-walled basal cells, bulging, smooth, lamina cells, orange KOH reaction, and the costa covered by bulging, quadrate cells on the ventral surface, with numerous guide cells in 3 layers but lacking ventral stereids. It shares these characters with *D. xanthocarpus,* but the two are readily separated by a number of features (Figure 1). One of the most prominent is the difference in the basal leaf cells. These are strongly differentiated, elongate and narrow in *D. xanthocarpus*, extending to about a $\frac{1}{4}$ of the leaf length. In many specimens they form a weak, often orange, shiny sheath that is easily seen with a hand lens. In *D. fuscus* the basal cells are scarcely differentiated (often only juxtacostally) and usually quadrate to short-rectangular. In addition, the costa is usually excurrent as a stout point in *D. fuscus* (rarely percurrent in some leaves), whilst in *D. xanthocarpus* it is typically percurrent. Furthermore *D. xanthocarpus* has larger leaves with a more rectangular base and the margins broadly recurved to revolute rather than narrowly recurved.

In South Africa, the species occurs only in the winter-rainfall area (Figure 2), where it is restricted almost entirely to nutrient-rich soils derived from shale in Succulent Karoo (vegetation types follow Mucina & Rutherford, 2006). Exclusion from fynbos is likely an edaphic phenomenon, as this vegetation type usually

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