

***Didymodon ochyrarum* (Pottiaceae, Bryophyta), a new Andean species from tropical South America**

Juan A. Jiménez & María J. Cano

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Abstract: A new moss species, *Didymodon ochyrarum* J.A. Jiménez & M.J. Cano, is described and illustrated from the tropical Andean highlands of Venezuela, Colombia, Ecuador, Peru, Bolivia, Chile and Argentina. The species is distinguished morphologically by its lanceolate to long-lanceolate leaves that are strongly appressed when dry, leaf base widely ovate, acute apices, plane leaf margins and distally bistratose, excurrent costa, epapillose laminal cells, and marginal basal cells running up the margin forming a distinctly differentiated area of transversely thick-walled cells. Drawings and light microscope photographs of the new species are provided, and possible confusion with other closely related taxa is discussed.

Key words: bryophytes, Musci, Neotropics, Tropical Andes, taxonomy

Introduction

Didymodon Hedw. includes approximately 126 species and represents one of the largest genera of Pottiaceae (Zander 1993, 2007). The genus has a cosmopolitan distribution in a wide range of habitats, with one of the largest centers of diversity in the tropical Andes. Here, *Didymodon* species grow in dry forest, montane forest, dry inter-Andean valleys, puna and páramo from sea level to ca. 5000 m.

In the past two decades we have been engaged in studies of the South American Pottiaceae (Cano *et al.* 2010; Cano & Jiménez 2013, 2016; Alonso *et al.* 2017). During this work we carried out numerous expeditions to different countries (Cano *et al.* 2018) where a large number of *Didymodon* samples were collected. Examination of these collections has revealed several *Didymodon* species new to science (e.g. Jiménez & Cano 2008a; Jiménez *et al.* 2012, 2018). In the context of a worldwide taxonomic revision of *Didymodon* some specimens collected by us during our field trips attracted our attention. The specimens, collected on rocks in the high-altitude puna habitat, were apparently similar to *D. molendoides* J.A. Jiménez & M.J. Cano. However, a detailed studied of this material revealed that these specimens are differentiated amongst other characters by its bistratose and smooth leaf lamina. The set of characters exhibited by the plants clearly indicate that they represent an undescribed species. We wish to name the new moss in honour of our respected colleagues Drs. Ryszard Ochyra and Halina Bednarek-Ochyra, Kraków, Poland, in recognition of his great contribution to Bryology, particularly to the knowledge of the austral polar bryophytes and the Grimmiaceae.

Materials and Methods

During the course of a worldwide revision of *Didymodon* about 6000 specimens belonging to this genus have been 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 paper were located in the following institutional or personal herbaria: U, MO, MUB, herbarium Wolfgang Frey (Berlin, Germany), and herbarium Alfons Schäfer-Verwimp (Herdwangen-Schönach, Germany) or collected by the authors on four field trips to Argentina in 2014, Peru in 2013, Bolivia in 2007 and Chile in 2001. The localities are listed on the web site <http://www.pottiaceae.com>. 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.

Taxonomy

Didymodon ochyrarum J.A.Jiménez & M.J.Cano, sp. nov.

Figs. 1, 2

Type: ARGENTINA. SALTA: al NE del Abra de Zenta, 23°09'59"S, 65°01'18"W, 4040 m, 24 March 2014, M.J. Cano & M. Alonso 8316 (holotype: MUB 56393!; isotypes: CORD!, KRAM!).

Diagnosis: Differing from all other species of the genus *Didymodon* by its lanceolate leaves with a broadened ovate base that are strongly appressed when dry, acute apices, plane and bistratose leaf margins, the yellowish colour in KOH, excurrent costa, smooth laminal cells and marginal basal cells transversely thick-walled forming a differentiated area.

Description: Plants small to medium-sized, stiff, forming dense turfs, dull green to above, green-brown to brown below. Stems 0.8–2 cm high, erect, simple or branched, not radiculose; without hyalodermis, sclerodermis differentiated, central strand well-developed; axillary hairs filiform, 3–7 cells long, with 1 brown basal cell and hyaline upper cells. Rhizoids reddish-brown to brown, smooth, sparse at base, lacking above, rhizoidal tubers absent. Leaves strongly appressed when dry, erect-patent to spreading when moist, lanceolate to long-lanceolate from a broad ovate base, 1.4–2.1 × 0.47–0.65 mm, not or scarcely channeled ventrally in the upper part; lamina unistratose, yellowish reaction in KOH; apex acute, not apiculate, not cucullate; margins plane above midleaf, plane or more seldom hardly recurved at base, entire, bistratose in 2–3 rows of cells in the upper third of the leaf, decurrent on stem; costa strong, 62.5–100 µm wide at base, short- to long-excurrent as a stout point, not spurred, not or hardly tapering to the apex; ventral and dorsal surface cells of the costa subquadrate, oblate or oblong in the upper 3/4 or nearly in the whole leaf length, smooth, in 7–12 longitudinal rows at midleaf, in cross-section below midleaf plano-convex, with 4–6 guide cells in 1 layer; (0–)1 layer of ventral stereids, 1(–2) layers of dorsal stereids, hydroids undeveloped; ventral and dorsal surface cells differentiated, smooth; upper and middle laminal cells rounded or shortly oblong, more rarely subquadrate or oblate, 3.2–9.6 × 3.2–6.4 µm, evenly thick-walled, not collenchymatous, not bulging, smooth; basal cells shortly rectangular to quadrate, 4.8–20(–25) × 3.2–8 µm, not hyaline, evenly thick-walled, not bulging, smooth; marginal basal cells oblate, rarely quadrate, 3.2–8 × 6.4–14.4 µm, transversely thick-walled, usually forming a differentiated area of 4–8 rows of cells, extending up the margins to 1/5–1/6 of the leaf length, not bulging, smooth. Gemmae absent. Sexual condition apparently dioicous, only archegonia present. Perichaetial leaves slightly differentiated, long-lanceolate, with a subulate apex, 2.0–2.4 × 0.45–0.50 mm, costa longly excurrent. Sporophyte unknown.

Habitat and distribution: *Didymodon ochyrarum* is a Neotropical alpine species distributed through the Andes from Venezuela to northern Argentina and Chile. At present, the new species is known from nine localities in Venezuela, Colombia, Ecuador, Peru, Bolivia, Argentina and Chile (Fig. 3). It occurs on rocks, fissures of rocks or more rarely on banks in páramo, puna or superpáramo formations. The elevation range for *D. ochyrarum* is between 3080–4795 m although most specimens found were above 3800 m. In our collections, plants of *D. ochyrarum* are frequently associated with *Bryoerythrophyllum bolivianum* (Müll. Hal.) R.H. Zander, *Didymodon laevigatus* (Mitt.) R.H. Zander, *Erythrophyllopsis andina* (Sull.) R.H. Zander, *Leptodontium flexifolium* (Dicks.) Hampe, *Pseudocrossidium replicatum* (Taylor) R.H. Zander and *Rhexophyllum subnigrum* (Mitt.) Hilp. The distribution pattern of the species suggests that it can be found elsewhere of the high tropical Andes.

Additional specimens examined (paratypes): BOLIVIA. CHUQUISACA: Oropeza, cerca de Maragua, 43 km oeste de Sucre, 16 September 2006, S. Churchill et al. 24607 (MO, MUB). COCHABAMBA: entre Quillacollo y Morochata, 1 August 2007, M.J. Cano, J.A. Jiménez & C. Aldana 3538 (MUB). LA PAZ: Cordillera Real, Hichucota valley, Jankho Kkota lake (S Mollo pass, Negruni mountain group), between Illampu and Huayna Potosí, 6 July 1973, G. Frey 1-923 (Herb. W. Frey). CHILE. ARICA Y PARINACOTA: pr. Zapahuira, 26 November 2001, M.J. Cano 254a (MUB). COLOMBIA. ARAUCA: Sierra Nevada del Cocuy, cabezas de la Quebrada El Playón, Patio Bolos, 2 km al NE del Alto Cusirí, 7 March 1973, A.M. Cleef 8867 (U). ECUADOR. NAPO: Papallacta-Pass zwischen Quito und Baeza, Reserva Ecológica Cayambe-Coca, Páramo de la Virgen, A. Schäfer-Verwimp et al. 24464/B (Herb. Schäfer-Verwimp). PERU. LIMA: entre mina Raura y Oyón, 1 June 2013, M.J. Cano, J.A. Jiménez & M. Alonso 7606 (MUB). VENEZUELA. MÉRIDA: Sierra Nevada, below Pico Espejo and Loma Redonda, 19 February 1980, M. Kuc 110E (MUB).

Discussion

Didymodon ochyrarum is distinguished from all congeners by the following combination of diagnostic features: lanceolate to long-lanceolate leaves that are strongly appressed when dry, leaf base usually widely ovate, acute apices, plane leaf margins and bistratose in the upper third of the leaf, yellowish colour in KOH, excurrent costa, cross-section of the costa plano-convex, with one layer of guide cells and two weak stereid bands below midleaf, smooth laminal cells and marginal basal cells running up the margin forming usually a distinctly diffe-

rentiated area of transversely thick-walled cells.

Didymodon ochyrarum appears to be most closely related, both morphologically and phylogenetically (unpublished data), to *Didymodon molendoides* and *D. edentulus* J.A. Jiménez & M.J. Cano, two species recently described from tropical South America. *Didymodon molendoides* is a montane species known from Ecuador and Venezuela (Jiménez & Cano 2014), and *D. edentulus* is a montane-alpine species known from north-central Peru (Jiménez *et al.* 2015). The three species share the stance of the leaves when dry, the shape of the leaves, the plane margins above midleaf, the size and shape of upper and middle laminal cells, and the anatomy of the costa in cross-section. *Didymodon edentulus*, additionally, has epapillose laminal cells and oblate marginal basal cells with transversely thick-walled as has *D. ochyrarum*. However, *D. edentulus* differ from *D. ochyrarum* by having unistratose leaf margins, a costa percurrent or just ending below the apex that is much thinner (only with two cells in width above midleaf), and yellowish orange to red lamina in KOH. *Didymodon molendoides* in addition to sharing the above mentioned characters has other similarities such as the bistratose upper leaf margins, a stout costa and the yellow colour of the lamina in KOH. Nevertheless, this species can be separated readily from *D. ochyrarum* by its smaller leaves (0.6–1.4 mm long), strongly papillose laminal cells, percurrent costa, and bistratose leaf lamina above midleaf.

Although the combination of bistratose and plane leaf margins throughout is unusual in *Didymodon*, in South America there are several species that like *D. ochyrarum* exhibit these character states and may be confused with this taxon. *Didymodon lainzii* J.A. Jiménez & M.J. Cano from the tropical seasonally dry forest of Ecuador and Peru (Jiménez *et al.* 2012) is distinguished from the new species by its linear-lanceolate to oblong triangular leaves and a cross-section of the costa with 2–4 layers of guide cells and without ventral stereids. The widely distributed *D. australasiae* (Hook. & Grev.) R.H. Zander and its close relatives *D. umbrosus* (Müll. Hal.) R.H. Zander are immediately distinguished by their crisped or twisted leaves when dry and hyaline basal laminal cells clearly differentiated with very thin walls. *Didymodon hegewaldiorum* J.A. Jiménez & M.J. Cano, a species known of the dry puna of Peru and Bolivia (Jiménez & Cano 2008b) differs from *D. ochyrarum* in having stems with hyalodermis, obtuse and usually cucullate leaf apices and costa ending below the apex. The recently described *Didymodon buckii* J.A. Jiménez & M.J. Cano known from northwestern Argentina and central Peru (Jiménez *et al.* 2018) is easily distinguishable from *D. ochyrarum* by its linear-oblong leaves with long-cylindric, thickened and caducous leaf apices. In addition, all these taxa unlike the new species have papillose laminal cells. The last taxon of this group with bistratose and plane leaf margins is *D. rigidulus* var. *subulatus* (Thér. & E.B. Bartram) R.H. Zander, a species known from southern United States, Mexico, Bolivia and Peru in America (Churchill *et al.* 2000, 2009; Zander 1994, 2007) and China and Mongolia in East Asia (Zhao *et al.* 2015; Song *et al.* 2015). It, additionally, has an excurrent costa and smooth leaf laminal cells as has *D. ochyrarum*, however, *D. rigidulus* var. *subulatus* can be separated by its bistratose leaf lamina, marginal basal cells not differentiated and longer excurrent costa as a subula.

Because of the habit, the shape of the leaf, excurrent costa and smooth laminal cells, the new species can also be confused with the Neotropical *D. laevigatus*. In addition, both species often grow together. Nevertheless, *D. laevigatus* has elongated cells on the upper ventral surface of the costa and leaf lamina red in KOH.

The specimen of *D. ochyrarum* (Cano 254a) was previously published as *D. acutus* (Brid.) K. Saito, by Cano (2003) as new for Chile. Both species share the lanceolate leaves, an excurrent costa with subquadrate superficial ventral cells, smooth laminal cells, and leaf lamina yellow in KOH. However, *D. acutus* differs from *D. ochyrarum* by having unistratose and recurved leaf margins.

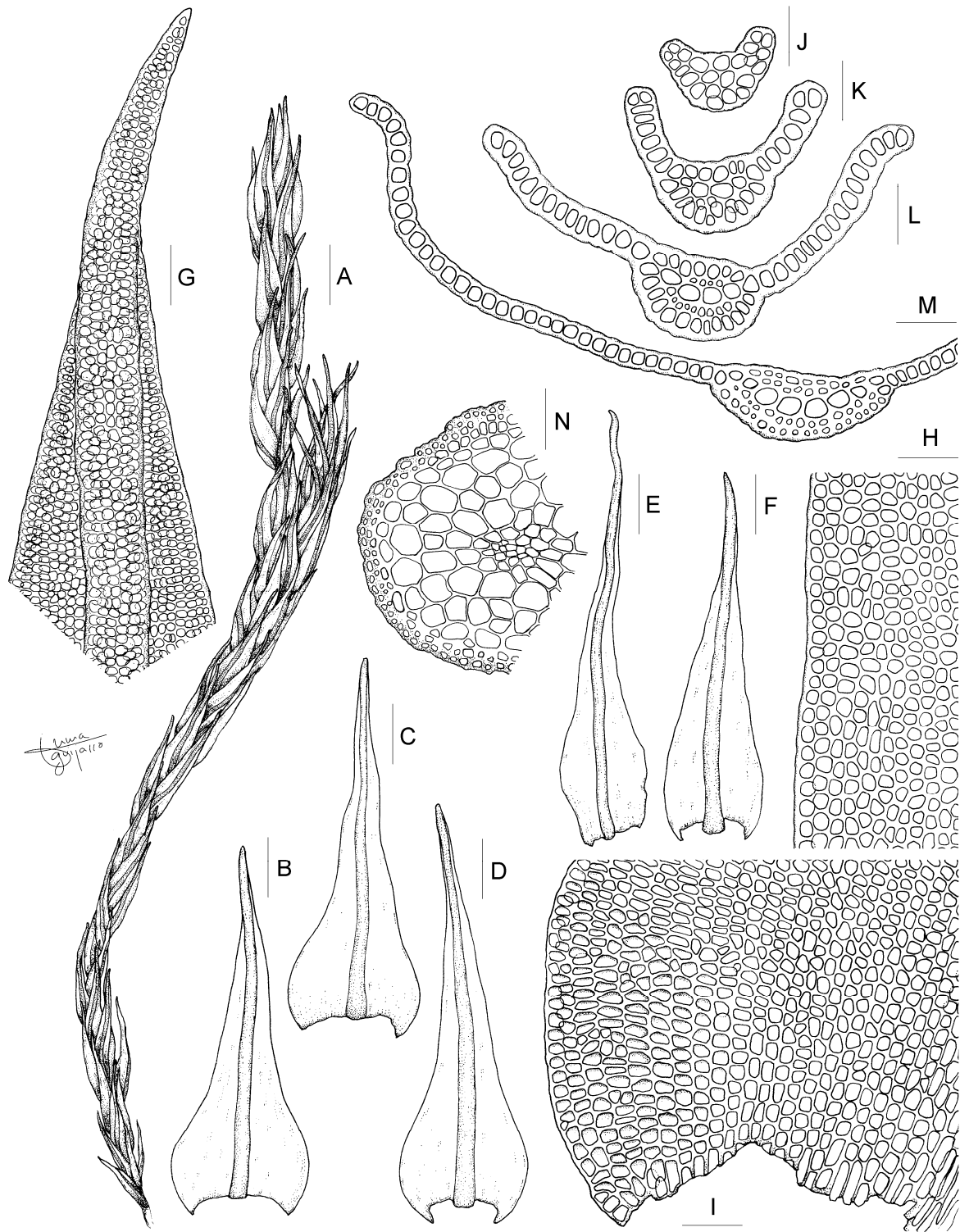


Fig 1: *Didymodon ochyrarum*. **A.** Habit, dry. **B–D, F.** Leaves. **E.** Perichaetial leaf. **G.** Leaf apex. **H.** Upper laminal cells. **I.** Basal laminal cells. **J–M.** Cross-sections of a leaf from apical to basal part. **N.** Cross-section of the stem. Scale bars: A = 1 mm; B–F = 0.3 mm; G = 50 μ m; H, I = 25 μ m; J–M = 35 μ m; N = 40 μ m. All from *Cano & Alonso 8316* (MUB).

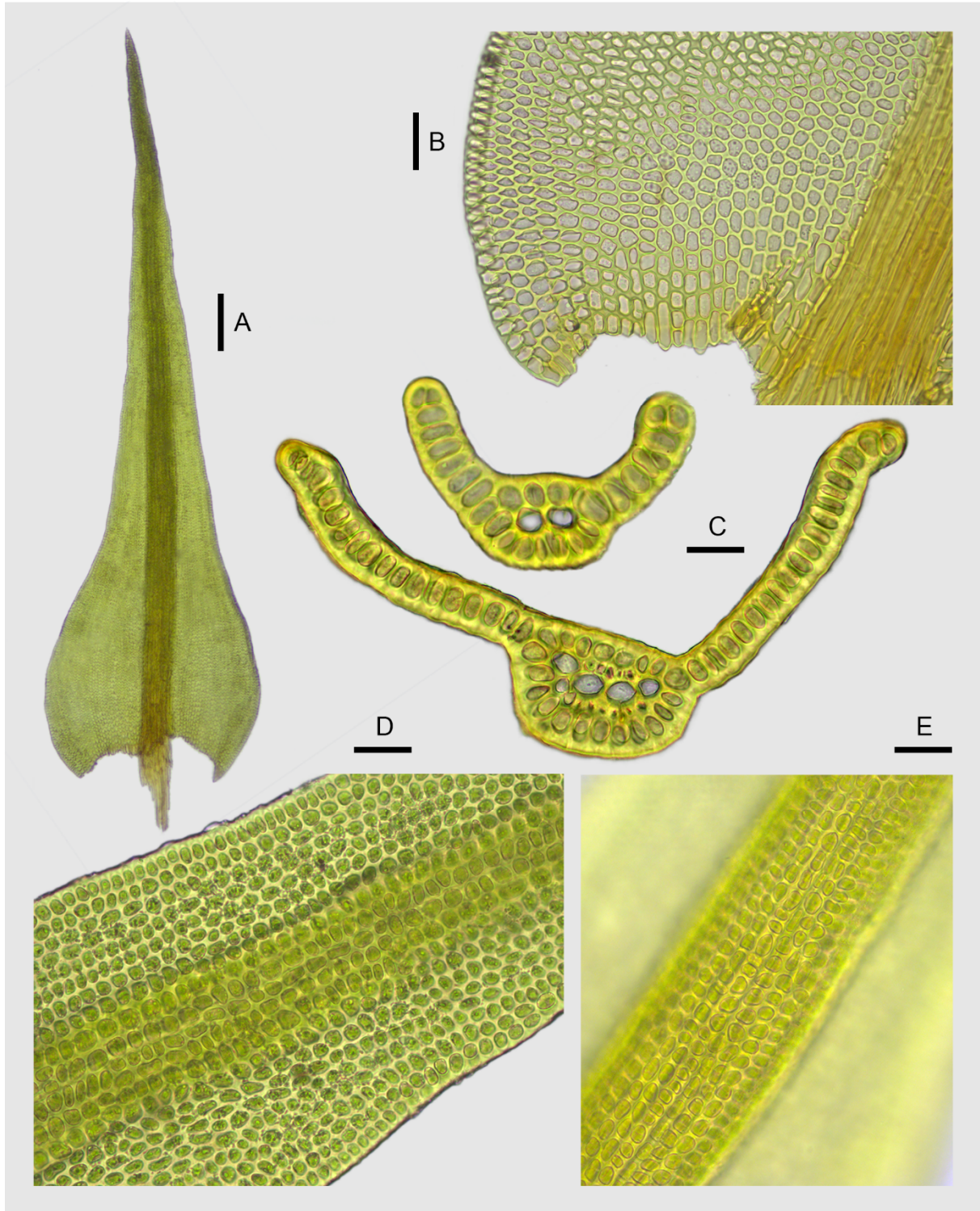


Fig 2: *Didymodon ochyrarum*. **A.** Leaf. **B.** Basal laminal cells. **C.** Cross-section of a leaf at middle and apical part. **D.** Ventral surface of a leaf. **E.** Dorsal surface cells of the costa. Scale bars: A = 0.15 mm; B = 30 μ m; C = 25 μ m; D, E = 20 μ m. A, C from *Cano 254a* (MUB); B, D, E from *Cano, Jiménez & Aldana 3538* (MUB).



Fig 3: Known geographical distribution of *Didymodon ochyrarum*.

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Authors' addresses: Juan A. Jiménez & María J. Cano, Departamento de Biología Vegetal, Facultad de Biología, Universidad de Murcia, Campus de Espinardo, 30100-Murcia, Spain