

NEW LIVERWORT RECORDS FROM THE PERUVIAN ANDES

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Enumeration and distributional data of 28 liverworts new to Peru are presented, accompanied by taxonomic annotations, phytogeographical evaluation and illustrations. Remarkable new Peruvian records include the very rare northern Andean endemic *Platycaulis renifolia* as well as *Frullania pearceana*, hitherto known only from its type locality in Bolivia. Oil bodies are described for the first time in the genus *Platycaulis* and male branches are newly observed in *Radula yanoella*, a species hitherto known only in sterile state.

Key words: Andes, endemism, El Sira, epiphylls, Neotropics, montane forests, Oxapampa, Perú, San Ramón

INTRODUCTION

Peru, despite its rich biodiversity, is bryofloristically-speaking, one of lesser-explored countries of South America. Alexander von Humboldt did not collect bryophytes during his short stay in the country in 1802. The first collections of Peruvian liverworts were made (and published) by Eduard Friedrich Poeppig, who visited Peru between 1829 and 1832 (Menzel 1984, Poeppig 1836). Among subsequent collectors, Richard Spruce (1884, 1885) visited the San Martín Department and described a number of new species from his collections. Following Spruce, other important early Peruvian bryophyte collections include those of Ernst Heinrich Georg Ule and August Weberbauer. In the 20th century, the collections of Eberhard and Pirrko Hegewald, who collected extensively across Peru between 1972 and 1976 (see Menzel 1984, 1986), and those of the Bryotrop Expedition in 1982 stand out. The Bryotrop collections were made mostly on the eastern slopes of the northern Andes in the Departments of Amazonas, Ancash, Cajamarca and San Martín, with collections made across an elevational gradient from lowland Amazonian habitats to the *Polylepis* forests of the upper Andes. A good part of the results of this expedition were published under the editorship of Frey (1987). Kürsch-

ner and Parolly (1998) explored the epiphytic bryophyte communities along the same route of the Bryotrop Expedition. In the present century, published bryological collections for Peru include those of Opisso and Churchill (2008) and Romanski *et al.* (2007, 2011) from the environs of Yanachaga-Chemillén National Park, Pasco Department, of Majestyk and Janovec (2011) from Madre de Dios, as well as Graham *et al.* (2016) from the Reserva Comunal El Sira in Ucayali and Pasco Departments. Several new species were described by Pócs (2019*a, b*) from Junín and Pasco Departments, resulting from the collections made in the framework of several Field Museum expeditions, and this publication represents the continuation of these efforts.

The Field Museum (F) in Chicago has been involved in exploring the biodiversity of the Selva Central [central rainforest] Region of Peru (Fig. 1), targeting the mosses, liverworts and ferns of protected areas including Yanachaga-Chemillén National Park and Bosque Sho'llet Municipal conservation area in Pasco Department, as well as in the Pampa Hermosa National Sanctuary and the Puyu Sacha conservation concession in Junín Department. Fieldwork was carried out in 2016 and 2017 in cooperation with the Universidad Nacional Agraria La Molina, Universidad Nacional Mayor de San Marcos, Lima, and the Herbario Selva Central Oxapampa. Since 2007, the second author (JG) has been conducting biological exploration and botanical collection in the Yanachaga-San Mathias-San Carlos-El Sira complex, part of the UNESCO-designated Oxapampa-Ashaninka-Yanesha Biosphere Reserve in the Selva Central of Peru. This area harbours one of the most intact rainforest blocks in the Andes, and the first results of his bryophyte collecting activities have been published (Graham *et al.* 2016). Together with the third and fourth authors (MK and JL) further collecting expeditions to the area took place in May 2016 and July 2017. As a result, significant bryophyte and pteridophyte materials were collected; their identification was carried out by T. Pócs (EGR), M. Fischer (F), J. Larraín (PUVC) and by C. Rothfels (UC).

MATERIAL AND METHODS

The enumeration below contains liverwort species new to the bryoflora of Peru already identified by T. Pócs. The nomenclature follows Söderström *et al.* (2015) and Gradstein (2021). To establish their novelty to Peru, the authors referred to an (unpublished) new checklist kindly made available by A. Hagborg (F) and L. Söderström (TRH). The specimens cited herein were collected by J. G. Graham in Reserva Comunal El Sira, Ucayali and Pasco Departments, in Yanachaga-Chemillén area and by the members of the two collecting expeditions: J. G. Graham, M. von Konrat, T. Pócs, J. Larraín, C. Rothfels, L. Söderström, J. Havasi and M. Fischer, as well as in other parts of the Selva Central, as listed below.

The capital letters after the locality number indicate different species from the same locality. All cited collections were carried out in 2016 and 2017. The identified specimens from Reserva Comunal El Sira and Santuario Nacional Pampa Hermosa are deposited in Herbario Forestal, Universidad Nacional Agraria La Molina (MOL), Field Museum (F) and Eszterházy Károly University Herbarium (EGR), while collections from Parque Nacional Yanachaga-Chemillén and Concesión para Conservación Bosque Pichita/Puyu Sacha are deposited in Herbario Selva Central Oxapampa (HOXA) Field Museum (F) and Eszterházy Károly University Herbarium (EGR).

Localities

El Sira Communal Reserve

- AA:** Dpto. Ucayali, Prov. Coronel Portillo, Dist. Iparia. Quebrada Manejene, afluente del Río Iparia. Bosque primario. En sombra. Cercana de la Reserva Comunal El Sira. Epífilas. S 9° 6.1', W 4° 31.8'. 250 m.
- AC:** Dpto. Ucayali, Prov. Coronel Portillo, Dist. Iparia. Quebrada Manejene, afluente del Río Iparia. Bosque ribereño sombrío. Cercana de la Reserva Comunal El Sira. Epífilas. S 9° 25.9', W 74° 32.7'. Alt. 350 m.
- AE:** Dpto. Pasco, Prov. Oxapampa, Dist. Oxapampa Parque Nacional Yanchaga-Chemillén. Abra Esperanza. Bosque enano, muy abierto con mucha luz solar, suelo mojado. S 10° 31' 24", W 75° 21' 03". Elev. 2,900 m.
- AK:** Dpto. Ucayali, Prov. Coronel Portillo, Dist. Iparia. Filo entre las cuencas de los Ríos Ariapo y Iparia. Bosque primario. En sombra. Reserva Comunal El Sira. S 9° 28.2', W 74° 34.7'. Alt. 1,800 m.

Yanachaga-Chemillén National Park and Bosque Sho'llet

- AY:** Dpto. Pasco, Prov. Oxapampa, Dist. Huancabamba Parque Nacional Yanachaga Chemillén, Abra Yanachaga. Bosque enano, muy abierto con mucha luz solar, suelo muy mojado. S 10° 22' 46", W 75° 27' 43". Alt. 2,950 m.
- ASA-2:** Dpto. Pasco, Prov. Oxapampa, Dist. Oxapampa Parque Nacional Yanchaga-Chemillén. Abra San Alberto. Bosque nublado, muy accidentado, suelo mojado. S 10° 33' 00", W 75° 21' 09". Alt. 2,800–2,900 m.
- 1606:** Dpto. Pasco, Prov. Oxapampa, Dist. Villa Rica, Bosque Sho'llet, entrando por torre mirador. Bosque bajo (elfin forest). S 10° 40' 34", W 75° 19' 00". Alt. 2,399 m.
- 1608:** Dpto. Pasco, Prov. Oxapampa, Dist. Oxapampa, Bosque Sho'llet, sector Chacos, por camino hacia la torre de telecomunicaciones, pendiente de nordeste. Bosque nublado. S 10° 38' 49.5", W 75° 17' 32". Alt. 2,200 m.
- 1609:** Dpto. Pasco, Prov. Oxapampa, Dist. Oxapampa, Bosque Sho'llet, sector Chacos, por camino hacia la torre de telecomunicaciones, pendiente de nordeste. Bosque bajo (elfin forest). S 10.61611°, W 75.28247°. Alt. 2,290 m.
- 1610:** Dpto. Pasco, Prov. Oxapampa, Dist. Oxapampa, Bosque Sho'llet, sector Chacos, por camino hacia la torre de telecomunicaciones, bosque enano cerca el "Mirador de la Princesa". S 10.61611°, W 75.28247°. Alt. 2,445 m.

- 1614: Dpto. Pasco, Prov. Oxapampa, Dist. Huancabamba, Huancabamba, Prosoya, por camino hacia el interior del predio. Bosques secundarios premontanos degradados y praderas con ganado vacuno. S 10° 24' 45", W 75° 30' 28.5". Alt. 1,900–1,910 m.
- 1616: Dpto. Pasco, Prov. Oxapampa, Dist. Huancabamba, Santa Bárbara, por camino que sale de Lanturachi hacia Santa Bárbara. Bosque enano con muchos helechos arbóreos y chacras, en turbera pequeña y bancos del camino vehicular. S 10° 22' 43", W 75° 37' 09". Alt. 2,889 m
- 1619: Dpto. Pasco, Prov. Oxapampa, Dist. Oxapampa, Cascada Río Tigre, subiendo por la localidad de La Cañera. Alrededores de la cascada con bosque montano secundario. S 10° 40' 54", W 75° 21' 47". Alt. 1,869 m.
- 1623: Dpto. Pasco, Prov. Oxapampa, Sho'let Municipal Reserve of Oxapampa, bosque enano hacia la torre de telecomunicaciones, S 10.616°; W 75.282°. Alt. 2,759 m.
- 1701: Dpto. Pasco, Prov. Oxapampa, Dist. Chontabamba, Bosque La Florida. Bosque bajo (elfin forest), relativamente seco, alternando con arbustales abiertos. S 10° 38' 34", W 75° 25' 49". Alt. 2,280 m.
- 40271 and 40272: Dpto. Pasco, Prov. y Distr. Oxapampa, Parque Nacional Yanachaga-Chemillén, sector San Alberto, cordillera de Yanachaga, por sendero hacia la entrada al parque. Bosque nublado. S 10° 32' 42.6"; W 75° 21' 28.2". Alt. 2,436 m.

Pampa Hermosa National Sanctuary and CC Bosque Pichita/Puyu Sacha

- 1601: Dpto. Junín, Prov. Chanchamayo, Dist. San Ramón, Puyu Sacha, bosque montano con *Weinmannia*, *Podocarpus*, *Ceroxylum*, *Cinchona*, *Cecropia*, *Saraouya*, Lauraceae y Myrtaceae, sendero a la cascada. S 11° 05' 40", W 75° 25' 34". Alt. 2,190–2,200 m.

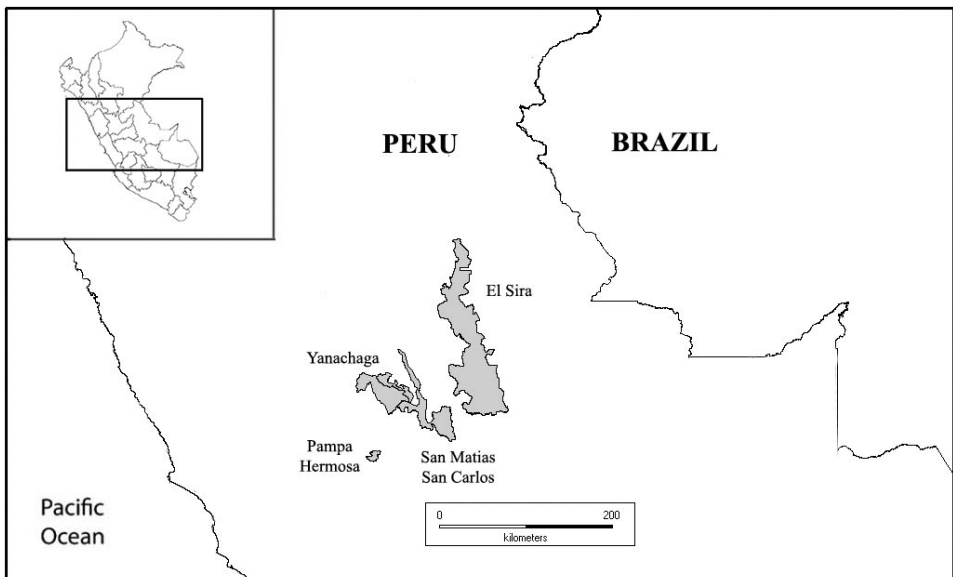


Fig. 1. The geographical position of collecting localities in the Selva Central of the Peruvian Andes

- 1603:** Dpto. Junín, Prov. Chanchamayo, Dist. San Ramón, Puyu Sacha, bosque montano con *Weinmannia*, *Prumnopytis*, *Ceroxylum*, *Cinchona*, *Cecropia*, *Saraouya*, Laraucaee y Myrtaceae, sendero hacia la parcela permanente abajo de las casas de Aprodos. S 11° 05' 33", W 75° 25' 31". Alt. 2,090 m.
- 1604:** Dpto. Junín, Prov. Chanchamayo, Dist. San Ramón, Bosque de Puyu Sacha. Bosque montano con *Weinmannia*, *Prumnopytis*, *Ceroxylum*, *Cinchona*, *Cecropia*, *Saraouya*, Lauraceae y Myrtaceae, sendero "Miranda Bromelias" abajo de las casas de Aprodos. 11° 05' 33", W 75° 25' 31". Alt. 2,150–2,175 m.
- 1708:** Dpto. Junín, Prov. Chanchamayo, Dist. San Ramon. Stunted forest on ridgetop with soil covered by organic layer (< 20 cm). Santuario Nacional Pampa Hermosa. Epífila. S 10° 59.8', W 75° 25.9'. Alt. 1,950 m.
- 19882:** Dpto. Junín, Prov. Chanchamayo, Dist. San Ramón, Huancabamba, Bosque de Puyu Sacha. Bosque montano con *Weinmannia*, *Podocarpus*, *Ceroxylum*, *Cinchona*, *Cecropia*, *Saraouya*, Laraucaee y Myrtaceae, sendero a la cumbre. Epífilas. S 11° 06' 19.0", W 75° 26' 14.7". Alt. 2,810 m.

ENUMERATION OF SPECIES NEW TO PERU

Calypogeia subintegra (Gottsche, Lindenb. et Nees) Bischl., Candollea 18: 75, 1962 – J. G. Graham, V. Coshanti, C. Mateo **AY-2/JO**, sobre rocas. – Scattered in tropical America, nearest occurrences in Colombia and Ecuador (Gradstein 2021).

Cololejeunea bekkerae Tixier, Cryptog. Bryol. Lichénol. 16: 229, 1995 – J. G. Graham **AA/AH**, epífila. – Hitherto known from the Guyanas to Ecuador. A species characterised by the lanceolate lobule with base connate with lobe surface.

Cololejeunea linopteroides H. Rob. (Figs 2–4), Bryologist 67: 457, 1964 – J. G. Graham **AA/AW, AC/AW**, epífila. – Known from Central America to Ecuador. An unmistakable, tiny, shiny epiphyll characterised by the flat stem, sigmoid leaf cells and small lobule.

Cololejeunea sicifolia (Gottsche ex A. Evans) Pócs et Bernecker subsp. *sicifolia*, Polish Bot. J. 54 (1): 8, 2009 – T. Pócs **1608/AT**, epífila. – Very widespread throughout the Neotropics.

Cololejeunea subcardiocalpa Tixier, Bradea 3(6): 39, 1980 – T. Pócs **1601/AX**, J. Graham **1708/EK**, epífila. – Scattered all over tropical America from Mexico to Brazil. With fimbriate, uniseriate hyaline cells occupying most of the abaxial lobe margin and with large lobule.

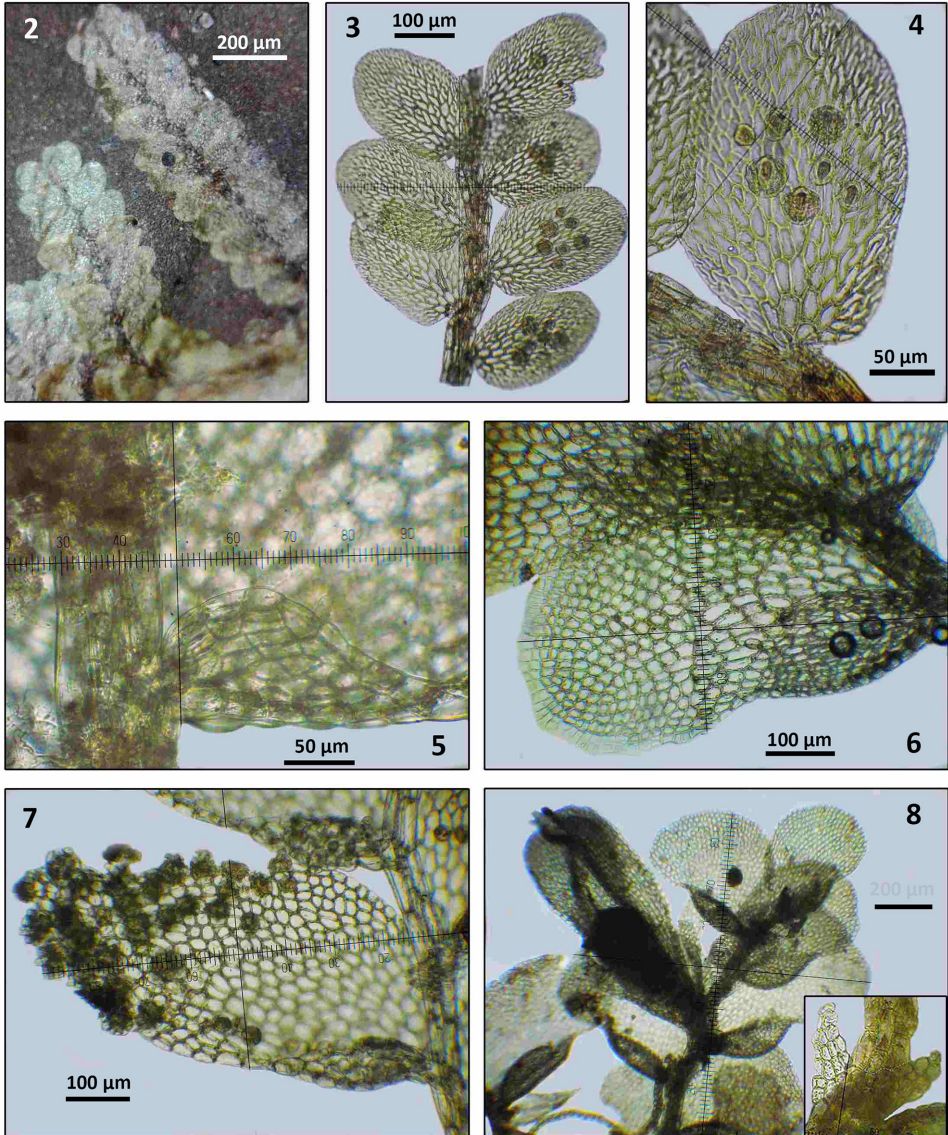
Cololejeunea submarginata Tixier, Bradea 3(6): 40, 1980 – T. Pócs & M. von Konrat **1601/BW**, T. Pócs **1603/AB**, epífila. – A widespread neotropical species characterised by entire hyaline margin and relatively large lobule.

Cololejeunea subscariosa (Spruce) Pócs (Fig. 5), Acta Bot. Hung. 56(1–2): 197, 2014 – T. Pócs **1601/AY, 1614/AD**; T. Pócs & J. Larrain **1604/AC**, epífila. – Widespread in Brazil and parts of the Andes, with smooth hyaline margin and reduced lobule.

Cololejeunea vitaliana Tixier (Fig. 6), Cryptog. Bryol. Lichénol. 16(3): 230, 1995 – J. Larrain **39741/AB**; T. Pócs & M. von Konrat **1601/AZ**, epífila. – It has scattered distribution from Mexico to Brazil. The inflated lobule with two conspicuous teeth are good distinguishing characters of this species.

Cololejeunea yelitzae Pócs et Bernecker (Fig. 7), Acta Bot. Hung. 55(3–4): 386, 2013 – M. von Konrat **1601/CE**, epífila. – Uncommon, it occurs from Costa Rica to Bolivia. With its ovate-lanceolate leaves it is similar to *C. camillae*, but distinct by the very various leaf width, constantly large lobule with a large gap between the two teeth and by the superficial gemmae (only marginal in *C. camillae*).

Colura ulei Jovet-Ast, Rev. Bryol. Lichénol. 22(2–3): 270, 1953 [1954] – J. G. Graham AA/BA, epífila. – A relatively rare species scattered all over the Neotropics. The long cylindrical lobular sac and one median basal valve cell are typical.



Figs 2–8. 2–4 = *Cololejeunea linopteroides* H. Rob. (from Graham AA/AW): 2 = habit, dorsal view. 3–4 = habit and leaf, ventral view. 5 = *Cololejeunea subscariosa* (Spruce) Pócs, lobule (from Pócs & Larráin 1604/AC). 6 = *Cololejeunea vitaliana* Tixier, leaf, ventral view (from Pócs & von Konrat 1601/AZ). 7 = *Cololejeunea yelitzae* Pócs et Bernecker, leaf, ventral view (from von Konrat 1601/CE). 8 = *Diplasiolejeunea alata* Jov.-Ast, habit with perianth, underleaf, ventral view (from Larráin & Rothfels 40272/AB)

Cyclolejeunea chitonia (Taylor) A. Evans, Bull. Torrey Bot. Club 31(4): 194, 1904 – J. G. Graham **AK/Q**, epífila. – It is not common, but distributed all over tropical America from Costa Rica and the Caribbean islands to Brazil (Lücking 1995, Gradstein and Costa 2003). The largest species of the genus with short incision on the underleaf apex.

Diplasiolejeunea alata Jov.-Ast (Fig. 8), Rev. Bryol. Lichénol. 17(1–4): 31, 1948 [1949] – J. Larrain & C. Rothfels **40272/AB**, epífila. – Widespread in the Neotropics from Central America and the Caribbean to Brazil (Schäfer-Verwimp 2004). The small underleaves and the stalked perianth are typical for the species.

Diplasiolejeunea glaziovii Tixier, Bryophyt. Biblioth. 27: 397, 1985 – T. Pócs **1601/BB**, **1614/AF**; M. Fischer & J. Havasi **1706 BB**, epífila. – The species was described from Brazil, but is very close and maybe synonym of *D. brunnea* Steph., as the only difference is the straight (not incurved) second tooth of lobule (Gradstein and Costa 2003).

Drepanolejeunea lichenicola (Spruce) Steph. (Figs 9–10), Sp. Hepat. (Stephani) 5: 335, 1913 – J. Larrain **39741/AJ**; M. von Konrat **19861/AC**, **19882/AE**; T. Pócs **1601/BF**, **1603/AF**, **1604/AG**, **1606/BK**, **1610/AB**, **1619/AT**; C. J. Rothfels **1623/AB**, epífila. – A very common and widespread montane neotropical species characterised by the dentate lobule with a longer tooth at the ventral margin. Bischler (1964, 1967) treated the falcate-leaved *Drepanolejeunea bispinulosa* A. Evans as a synonym, while Schuster (1996) considered it to be a separate species. According to our experience the two taxa are inseparable at the species level.

Drepanolejeunea perissodonta (Spruce) Bischl. (Fig. 11), Rev. Bryol. Lichénol. 33(1–2): 73, 1964 – M. von Konrat **19882/AF**; C. J. Rothfels **1623/AL**; T. Pócs **1601/BG**, epífila. – A species hitherto known only from Central America, similar to the previous species but with wider, straight leaves with smooth dorsal margin.

Drepanolejeunea ramentiflora Steph. (Fig. 12), Sp. Hepat. 5: 338, 1913 – T. Pócs **1601/BH**, **1608/AZ**; M. von Konrat **19882/AG**, epífila. – Similar to the two previous species but its ventral marginal tooth missing or obsolete. It is a very rare species distributed from Central America (Costa Rica) to the northern Andes.

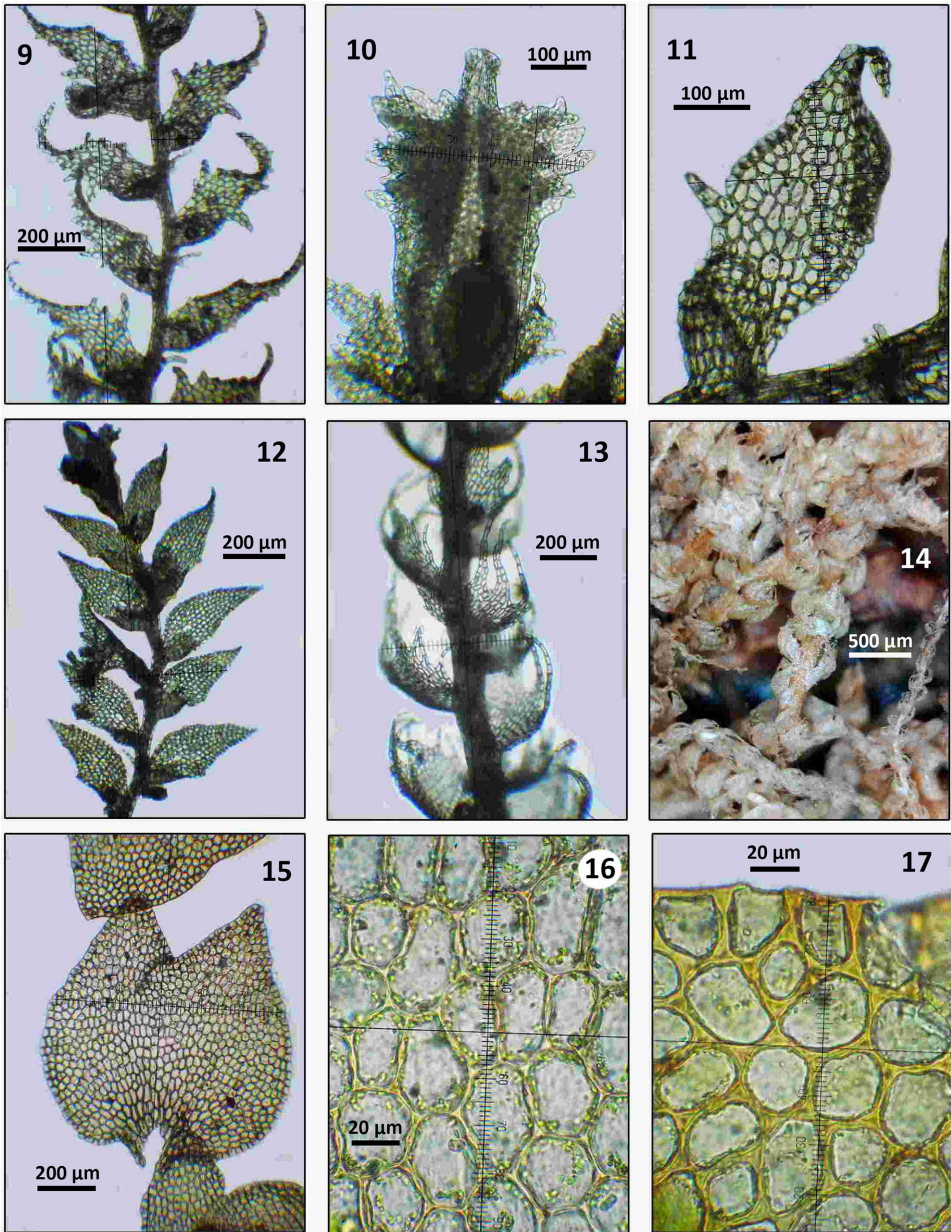
Frullania caulisequa (Nees) Mont., Ann. Sci. Nat. Bot. (sér. 2) 12: 51, 1839 – J. G. Graham, V. Coshanti, C. Mateo **AY-5/E2**, epífita que crece en el tronco del árbol. – A species known as widespread in Brazil but new to the Andes. Well characterised by the very long, narrow cylindrical, curved lobules (Winter and Schäfer-Verwimp 2020). It differs from the closely related Brazilian *Frullania curvilobula* Schäfer-Verwimp, D. F. Peralta et S. M. Siqueira (2012) by its broadly rounded lobe apex.

Frullania pearceana Steph., Sp. Hepat. 4: 515, 1911 – J. Havasi & T. Pócs **1701/BK**, epífila. – Previously known only from its type locality in Bolivia (Yungas). It is unique among the neotropical *Frullania* species by its foliose stylus combined with large underleaves (Stotler 1969).

Kurzia capillaris (Sw.) Grolle subsp. *paramicola* Pócs, Acta Biol. Pl. Agr. 2: 102, 2012 – T. Pócs **1616/D**, sobre taludo. – A high Andean páramo subspecies never occurring below the forest line, characterised by the narrow, 2 cells wide, parallel sided leaf segments of 6–9 cells length (Pócs 2012).

Kurzia flagellifera (Steph.) Grolle, J. Jap. Bot. 39(3): 80, 1964 – J. G. Graham, V. Coshanti, C. Mateo **AY-7/AB**, en tronco caído. – A montane species distributed from Costa Rica through Venezuela and Colombia to Brazil, distinguished from *K. capillaris* by its rectangular cells twice as long as broad.

Lepidozia andicola Beauverd (Figs 13–14), Sp. Hepat. 6: 572, 1924 – J. G. Graham, V. Coshanti, C. Mateo **AE-1/AP**, **AQ**, **DB**, sobre material orgánico que cubre la superficie del suelo. – Distributed in the tropical Andes from Venezuela to Ecuador. Characteristic are the strongly elongate leaf tip cells (3–4× longer than wide; Gradstein 2021).



Figs 9–17. 9–10 = *Drepanolejeunea lichenicola* (Spruce) Steph. (from Pócs 1610/AB): habit, ventral view and perianth. 11 = *Drepanolejeunea perissodonta* (Spruce) Bischler, leaf, ventral view (from Pócs 1601/BG). 12 = *Drepanolejeunea ramentiflora* Steph., habit, ventral view (from Pócs 1608/AZ). 13–14 = *Lepidozia andicola* Beauverd, dorsal and ventral views (from Graham et al. AE-1/AP). 15–17 = *Marsupella miniata* (Lindenb. et Gottsche) Grolle (from Pócs 1609/A): 15 = leaf; 16 = median leaf cells; 17 = marginal leaf cells

Marsupella miniata (Lindenb. et Gottsche) Grolle (Figs 15–17), J. Jap. Bot. 41: 144, 1966 – T. Pócs **1609/A**, sobre suelo del talud. – A paramo species known from Mexico to Bolivia growing always above the forest line. Genus and species new to Peru. The species was often recorded as *Gymnomitrium miniatum* Lindenb. et Gottsche (e.g. Söderström *et al.* 2015) but based on the gynoecium structure this species belongs in *Marsupella* Dumort. subgen. *Homocraspis* (Lindb. ex Schiffn.) Grolle sect. *Homocraspis* (Váňa 2003, Váňa *et al.* 2010). It differs by its V-shaped and deeper leaf incision and subacute leaf lobes from the more widespread *M. emarginata* (Ehrh.) Dumort.

Metzgeria conjugata Lindb., Acta Soc. Sci. Fenn. 10: 495, 1875 – J. Havasi **1706/BA**, epífila. – An almost worldwide distributed species with twinned marginal cells, disjunct and montane in the Neotropics (Mexico, Cuba and Brazil; Costa 2008).

Metzgeria crassipilis (Lindb.) A. Evans, Rhodora 11(130): 188, 1909 – M. von Konrat, **19882/AR**, epífila. – A widespread tropical and warm-temperate, oceanic species that occurs very scattered in the Neotropics, being known only from Mexico, Colombia, Ecuador and the Dominican Republic (Costa 2008, Gradstein 2021).

Platycaulis renifolius R. M. Schust. (Figs 18–23), Phytologia 39(4): 245, 1978 – J. G. Graham, V. Coshanti, C. Mateo **AY-1/AJ**, sobre material orgánico que cubre la superficie del suelo. – A very rare northern Andean paramo species known from Venezuela, Colombia and Ecuador (Gradstein 2021, Schuster 1995). It has very characteristic, broadly reniform, longly decurrent leaves appressed to the stem, erect, bifid, ciliate dentate underleaves, two granulose, *Jungermannia*-type oil bodies per cell (new observation) and a papillose or striate cuticle.

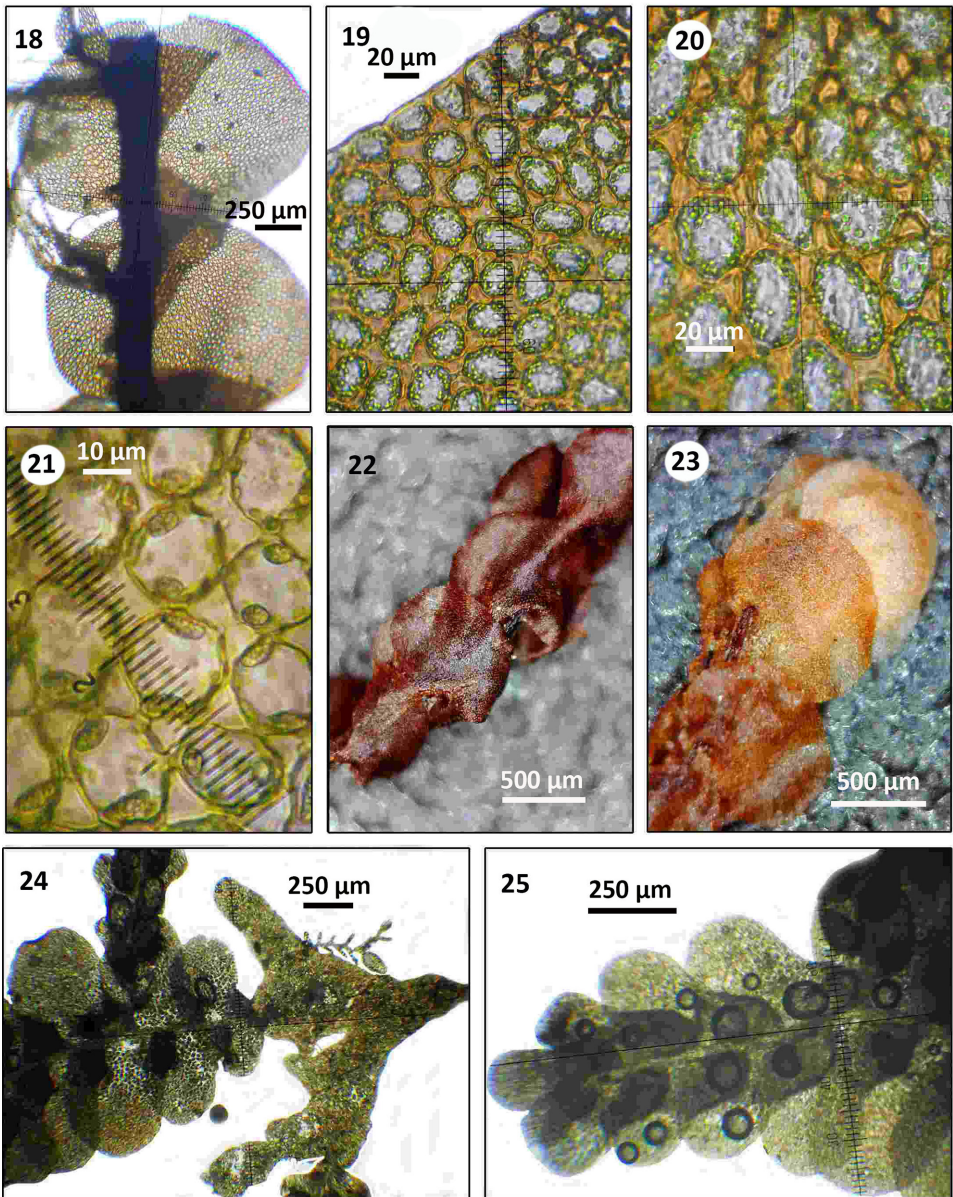
Radula yanoella R. M. Schust. (Figs 24–25), Phytologia 56(2): 72, 1984 – J. Larrain & C. Rothfels **40272/AL**, epífila en bosque nublado. – Only sterile plants were known from French Guiana, Ecuador and Brazil (Gradstein 2021, Schuster 1991). The Peruvian material has male branches, composed of 3–4 leaf-like male bracts, each with one antheridium. *Radula aguirrei* R. M. Schust. is a rare Choco endemic that is according to Gradstein (2021) may be a synonym. We can confirm this, as the Peruvian specimen shows transitional characters between the round, lobulate thallus of *R. yanoella* and the elongate, branching one of *R. aguirrei*.

Radula mammosa Spruce, Mem. Torrey Bot. Club 1(3): 127, 1890 – J. G. Graham **AA/M**, **AK007/M**, epífilas. – This tiny species is distributed in South America (Castle 1939) and differs from the very similar *Radula stenocalyx* Mont. by the lack of gemmae.

Rectolejeunea versifolia (Schiffn.) L. Söderstr. et A. Hagborg, Phytotaxa 220(2): 188, 2015 – J. Larrain **40271**, epífila. – A widespread neotropical species, described from Cuba under the name of *Cheilolejeunea versifolia* Schiffn. and in the past usually called as *Rectolejeunea berteriana* (Steph.) A. Evans, which is a synonym. Distributed from Florida and the Caribbean islands (Schuster 1980) to Brazil (Gradstein and Costa 2003).

DISCUSSION

The above enumeration of new records is the result of the identification of several hundred specimens, but still thousands of specimens, the result of the collecting activity of the second author and of the two expeditions organized by Field Museum, are awaiting identification. Many more new records and even still undescribed new species may be expected among them. Comparing the Peruvian bryoflora with that of Colombia and Ecuador, we



Figs 18–25. 18–23 = *Platycaulis renifolius* R. M. Schust. (from Graham et al. AY-1/AJ): 18 = lateral view; 19 = marginal leaf cells; 20 = median leaf cells; 21 = oil bodies; 22 = habit, lateral view in dry state; 23 = same, in wet state. 24–25 = *Radula yanoella* R. M. Schust. (from Larráin & Rothfels 40272/AL): 24 = habit, ventral view. 25 = male branch, ventral view

should expect to find a relatively similar number of species in the three countries. While in Peru many wet paramo species are not known to occur, instead many xerophytes of puna and desertic vegetation are present in good number, which have not yet been reported to occur northwards. According to the detailed account of Colombian and Ecuadorian liverwort and hornwort flora (Gradstein 2021), 850 accepted species, more than 10% of the world's flora are known. The number of endemics in the Amazonian regions is 28, in the Pacific coastal region (Chocó) 11, in Galápagos Islands 10 and finally in the northern Andes (including Venezuela) more than 80 species are identified, altogether accounting for around 130 species (15%). This is a high endemism rate, compared for example with the island liverwort flora of Cuba, which has only 11.4% of endemic species (Pócs 1988). Comparatively few species have been reported as endemics from Peru (for example *Colura ochyrana*, *Riccardia gradsteinii*, *Frullania heinrichsii*); likely, more endemic species remain to be discovered. With the improvement of our knowledge of the Peruvian bryoflora, more northern Andean endemics (see Gradstein 2021 for a list) that are hitherto not yet known from Peru are expected to be detected in the country. Examples in this paper are *Platycaulis renifolia* and *Zoopsidella grahamii*. Species known only from Bolivia (like *Frullania caulisequa*) or from Brazil may be expected appear as well to occur in Peru.

Many areas in the northern Andes and Amazonia are still little or unexplored. It would be good to collect systematically in these regions, deposit and identify and document the obtained material in major local and international herbaria. This task is of some urgency, as roadless areas are rapidly disappearing and intact forest areas are shrinking, due to human impact. We can expect that forest burning, road construction and the increase of agricultural land will annihilate important bryophyte habitats not yet explored. Global warming and climate change just exacerbates this process, therefore the conservation of existing, and the creation of new national parks and reserves is essential to preserve biodiversity, water resources and sustain a liveable human environment. In existing agricultural land and forests under exploitation it is necessary to introduce up-to-date methods to preserve the present ratio of natural and cultivated areas, as well as to rehabilitate overexploited habitats.

*

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