Novelties for the bryophyte flora of Chaco Province, North of Argentina

Novedades para la flora de briófitos de la provincia de Chaco, norte de Argentina

Soledad Jimenez[1]

1. Instituto de Botánica del Nordeste (CONICET-UNNE), Corrientes, Argentina. Facultad de Ciencias Exactas, Naturales y Agrimensura, Corrientes, Argentina. Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina

*msoledadjimenez@exa.unne.edu.ar

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Summary

Background and aim: Bryophytes are an important group of plants in forest ecosystems that act as primary colonizers, moisture regulators and nutrient fixers. Due to their sensitivity to disturbance, they are used as bioindicators in impact studies. Nevertheless, there are extensive areas poorly studied that currently are undergoing significant changes due to agricultural and livestock practices, as is the case in Chaco. As part of a major project which aims to determine the impact on land-use change on the bryophyte diversity in Chaco, samples collected in the region have been analyzed with the aim of updating knowledge of the bryophyte flora in the province.

M&M: Samples from preserved and non-preserved areas from Chaco were studied according to the traditional techniques for bryophytes and mounted in water-glycerin-phenol or Hoyer´s solution.

Results: As a result, 26 species distributed in 19 genera and 13 families, are newly recorded to Chaco Province.

Conclusions: The results improved our understanding of a poorly explored flora in a region with unique characteristics. These findings reinforce the value of floristic studies to collect data about poorly known species and their distribution, and to provide a basis for applied studies. In Argentina, despite efforts made in recent decades, there is still a lack of understanding regarding bryophyte diversity. This, combined with rapid changes in land use, may lead to the alteration or disappearance of bryophyte communities before they are even studied.

Key words

Argentina, Chaco, Fissidentaceae, Frullaniaceae, Pottiaceae, Sematophyllaceae.

Resumen

Introducción y objetivo: Los briófitos son un grupo importante de plantas en ecosistemas boscosos, que actúan como colonizadores primarios, reguladores de humedad y fijadores de nutrientes. Debido a su sensibilidad ante disturbios, son utilizados como bioindicadores en estudios de impacto. Sin embargo, existen extensas áreas escasamente estudiadas que están sufriendo cambios debido a las prácticas agrícolas y ganaderas, como ocurre en Chaco. En el marco de un proyecto mayor cuyo objetivo es determinar el impacto del cambio en el uso del suelo sobre la diversidad briofítica del Chaco, se analizaron las especies recolectadas en la región con el fin de actualizar el conocimiento de esta flora en la provincia.

M&M: Ejemplares provenientes de áreas protegidas y no protegidas de Chaco fueron estudiados de acuerdo a técnicas tradicionales para briófitos, y montados en agua-glicerina-fenol o solución de Hoyer.

Resultados: Como resultado, 26 especies, distribuidas en 19 géneros y 13 familias, son registrados como nuevos para la provincia del Chaco.

Conclusiones: Los resultados mejoran nuestra comprensión de una flora poco explorada en una región de características singulares. Estos hallazgos refuerzan el valor de los estudios florísticos para recopilar datos de especies poco conocidas y su distribución, y proporcionar una base para estudios aplicados. En Argentina, pese a los esfuerzos realizados en las últimas décadas, aún existen vacíos en el conocimiento sobre la diversidad de briófitos. Esto, combinado con los rápidos cambios en el uso del suelo, puede llevar a la alteración o desaparición de comunidades de briófitos antes de que sean estudiadas.

Palabras clave

Argentina, Chaco, Fissidentaceae, Frullaniaceae, Pottiaceae, Sematophyllaceae.

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Introduction

The Province of Chaco in the North of Argentina, together with 12 another political provinces, constitutes the Chaco ecoregion (Cabrera, 1976; Oyarzabal *et al.*, 2018). Within this ecoregion, two districts (Eastern and Western) are recognized according to their rainfall regime and floristic composition, and both are present in the Chaco Province. The Eastern district has a humid climate with an annual rainfall of 1200 mm, with a predominance of *Schinopsis balansae* Engl. (Spanish name "quebracho colorado chaqueño"), while the western district has a dry climate with an annual rainfall not exceeding 500 mm, with a predominance of *Schinopsis lorentzii* (Griseb.) Engl. (Spanish name "quebracho colorado santiagueño") (Burkart *et al.*, 1999; Naumann, 2006; Salgado *et al*., 2014). Due to the high suitability of the area for agricultural production, this ecoregion is one of the most active frontiers of land use change in the country, and conflicts with biodiversity conservation are increasing (Marinaro & Grau, 2015). The role of biodiversity knowledge is of great value, both for scientific studies and for the development of conservation strategies. However, given the low number of studies aimed at understanding biodiversity and the high rate of modification of natural ecosystems, there is a considerable risk of biodiversity loss before it can be described, recorded, or monitored (Gradstein & Sporn, 2010). Therefore, floristic studies that allow the updating of species lists in a region are of fundamental importance (Giorgis *et al*., 2011).

Bryophytes are an important group of plants in forest and woodland ecosystems, as they participate as primary colonizers, moisture regulators and nutrient fixers (Hallingbäck & Hodgetts, 2000; Glime, 2007). Due to their sensitivity to disturbance, they are increasingly used as bioindicators in impact studies (Acebey *et al*., 2003; Turetsky, 2003). Nevertheless, there are still extensive areas that remain poorly studied and are currently undergoing significant changes due to progress in agricultural and livestock practices, such as the Chaco Province. In Argentina, the current checklists of mosses (Matteri, 2003), hornworts and liverworts (Hässel de Menéndez & Rubies, 2009) register 20 species of mosses and seven species of liverworts from the Chaco Province. Despite the efforts made in the last decades by the specialists to increase the knowledge of the bryophyte flora in the country (Colotti *et al.*, 2013, 2016, 2019; Suárez *et al.,* 2014, 2023; Jimenez *et al*., 2015, 2020, 2023; Cottet *et al.*, 2016; Colotti & Suárez, 2017, 2018; Cabral *et al.,* 2020; Valdés *et al*., 2021; Alvarez *et al*., 2023a, b) there still remain areas poorly known. The aim of this work is to update the knowledge of the bryophytes of Chaco Province through the analysis of herbarium specimens, and new collections carried out in preserved and non-preserved areas along the province. As result, 26 species of bryophyte (25 mosses and one liverwort) are added to the known flora of the region.

Material and Methods

Samples examined were collected in protected areas: Parque Nacional Chaco, Reserva Natural Cutural Caraguatá, Parque Nacional El Impenetrable, Reserva Natural Educativa Colonia Benítez, and non-protected areas: Estancia La Media Legua (J.J. Castelli), Estancia Catalina (Miraflores) under different land uses along the province (Fig. 1). Additional samples from the BAH collection at CTES herbarium from the region have been analyzed. A total of 130 samples from Chaco were analyzed. The specimens were studied morphologically using classical techniques for bryophytes and mounted in water-glycerin-phenol or Hoyer's solution (Anderson, 1954). Microscopic characters were studied by using the LM Arcano XSZ-100BNT. Color reaction with KOH 2% was performed on the Pottiaceae family (Zander, 1993). The nomenclatural status of each species was verified using the Tropicos MOBOT database and specific bibliographies for each taxon. One specimen was selected to represent each locality were the species was recorded.

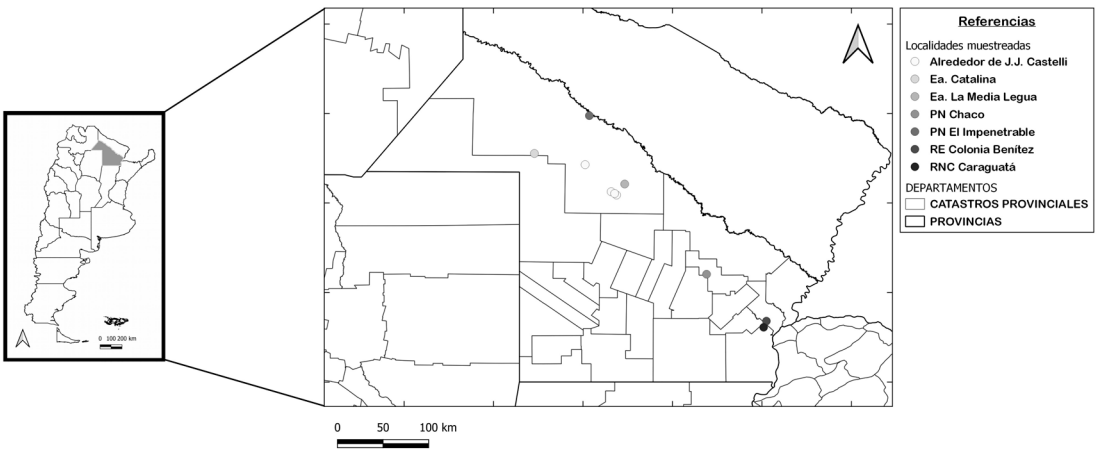

Fig. 1. Map of the sampling locations in Chaco Province, North of Argentina.

Results

Taxonomic treatment

A total of 26 bryophyte species are added to Chaco Province.

Key to the newly recorded species from Chaco

1. Plants with leaves differentiated into lobe and lobule, lobule laminate; underleaves present. Perianth 4-keeled.
Frullania platycalyx

1'. Plants without the above combination of characters.

2. Plants glaucous-green; laminal cells alternating between leucocyst and chlorocyst cells.
Octoblepharum albidum

2'. Plants green, yellowish-green or brown; laminal cells uniform, not alternating between leucocyst and chlorocyst cells.

3. Stems usually erect, solitary or in tufts or cushions; sporophytes terminal on stems or branched innovations.

4. Leaves arranged in 2 rows, leaves exhibiting an extended dorsal and ventral lamina from a vaginant laminae.

5. Leaves elimbated; laminal cells pluripapillose, upper part of costa obscured by bulging chlorophyllose cells.
Fissidens brevipes

5'. Leaves limbated; laminal cells smooth to unipapillose.

6. Leaves bordered all around, laminal cells smooth.
Fissidens crispus

6'. Leaves bordered on the vaginant laminae, laminal cells unipapillose.
Fissidens submarginatus

4'. Leaves arranged in 3 or more rows, without above combinations of characters.

7. Leaves progressively crowded at the apex of the stem, unistratose; laminal cells smooth; capsule cupulate, mouth flared when deoperculate, calyptra mitrate, peristome absent.

8. Leaves oblong-spathulate, costa subpercurrent, margin serrulate in upper ½; capsule immersed, neck inconspicuous.

Physcomitrium lorentzii

8'. Leaves obovate-spathulate to lanceolate, costa ending 2-3 cells below apex; capsule exserted, neck well-differentiated.

Physcomitrium subsphaericum

7'. Leaves distributed homogeneously along the stem, uni or bistratose; laminal cells uni to pluripapillose; capsule globose to cylindrical, calyptra cucullate, peristome double, reduced or absent.

9. Plants epiphytic; stem pinnately branching; leaves ecostated, lamina unistratose, laminal cells smooth; capsule short exserted, seta short, peristome absent.

10. Plants rather delicate, dark-green; stem regularly pinnately branched; leaves oval, apex acuminate; seta short (= 2 mm long).

Braunia exserta

10'. Plants robust, yellowish-green; stem irregularly pinnately branched; leaves oblong, apex of distal leaves ending in a hyaline mucro; seta long (4-6 mm long).

Braunia cirrhifolia

9'. Plants on various substrates; stem variously branching; leaves costate, lamina uni to pluristratose, laminal cells bulging to uni/pluripapillose; capsule immersed to exserted, seta long, peristome double, simple or reduced.

11. Costa with a single stereid band.

12. Plants forming deep cushions, yellowish green above, brown below; KOH color reaction of upper laminal cells yellow or orange; stem central strand present, usually strong.

13. Leaves ligulate, apex obtuse ending in a mucro, margin recurved, laminal cells superficially convex on both sides; guide cells 2-4 in 1-2 layers.

Pseudocrossidium arenicola

13'. Leaves lanceolate, apex acuminate, margin strongly revolute, laminal cells bulging-mammillose ventrally, flat dorsally; guide cells more than 6 in several layers.

Gertrudiella uncinicoma

12'. Plants forming turf, green above, reddish brown below; KOH color reaction of upper laminal cells brick red; stem central strand present or absent.

14. Lamina bistratose distally; propagules absent.

Syntrichia chisosa

14'. Lamina distally unistratose; propagules present (brood leaves in clusters)

Syntrichia ammonsiana

11'. Costa with two stereid bands.

15. Leaves oblong-lanceolate to elliptic, margin plane, dorsal costal epidermis present.

16. Stem central cylinder present; basal laminal cells differentiated straight across leaf; laminal cells bulging-mammillose ventrally, weakly convex dorsally.

Hyophyla involuta

16'. Stem central cylinder present or absent; basal laminal cells differentiated across leaf in a v-shaped area; laminal cells papillose; papillae 3-6 per lumen

Tortella humilis

15'. Leaves ligulate, margin plane to incurved; dorsal costal epidermis absent.

17. Leaves ligulate-lanceolate, margin plane.

Trichostomum brachydontium

17'. Leaves ligulate, margin incurved to involute.

Weissia controversa

3'. Stems creeping or spreading forming mats or wefts; sporophytes lateral on stems.

18. Leaves complanate or not; leaf costa absent or short and forked, laminal cells smooth.

19. Leaves complanate to loosely complanate, lanceolate to oblong-lanceolate, costa absent or short and forked, laminal cells linear to linear-hexagonal, alar cells absent or weakly differentiated.

20. Plants pale green; leaves oblong-lanceolate, costa absent, laminal cells linear-hexagonal.

Leucomium strumosum

20'. Plants glossy green; leaves lanceolate, costa short and forked, weak, laminal cells linear.

Isopterygium tenerum

19'. Leaves not complanate, lanceolate to ovate-lanceolate, costa absent, laminal cells rhomboidal to linear, alar cells well-differentiated.

21. Leaves lanceolate, laminal cells long-rhomboidal, alar cells more or less inflated.

Sematophyllum adnatum

21'. Leaves ovate-lanceolate, laminal cells linear to linear-flexuose, alar cells enlarged and colored.

Sematophyllum subsimplex

18'. Leaves not complanate; leaf costa single, laminal cells smooth to bulging-mamillose.

22. Plants brownish-green, forming dense tangled mats; leaves lanceolate, keeled; costa percurrent; laminal cells bulging-mamillose; peristome reduced, calyptra mitrate, weakly hairy.

Macrocoma tenuis subsp. sullivantii

22'. Plants light to dark green, forming lax to dense mats; leaves lanceolate to ovate-lanceolate; costa reaching above midleaf; laminal cells smooth; peristome complete, calyptra cucullate, smooth.

23. Plants dark green; leaves ovate-lanceolate, costa ending below the apex, laminal cells rhomboidal.

Leskeadelphus angustatus

23'. Plants light green; leaves lanceolate to ovate-lanceolate, costa reaching midleaf to subpercurrent, laminal cells linear to fusiform.

24. Leaves ovate-lanceolate, apex acuminate, twisted; margin serrulate; costa reaching ¾ the leaf length, projecting as a small spine; laminal cells linear.

Rhynchostegium serrulatum

24'. Leaves lanceolate to ovate-lanceolate, apex acute, not twisted; margin entire to serrate; costa reaching ½ to ¾ the leaf length, not projecting as a spine; laminal cells broadly fusiform.

25. Leaves lanceolate, margin entire to weakly serrulate, costa reaching midleaf.

Entodontopsis leucostega

25'. Leaves ovate-lanceolate, margin serrulate to serrate, costa extending 2/3 the leaf length.

Entodontopsis cultelliformis

Marchantiophyta. Frullaniaceae
1. **Frullania platycalyx** Herzog, *Feddes Repert. Spec. Nov. Regni Veg.* 55: 10. 1952.

Diagnostic characters of *F. platycalyx* include the presence of laminate lobules, and underleaf margins plane without a tooth (Gradstein & Costa, 2003; Lima, 2019). It was found growing in intermixed mats with *Forsstroemia producta* (Hornsch.) Paris.

Distribution and habitat. In South America, *F. platycalyx* is distributed in southern Brazil, Argentina, and Paraguay (Gradstein & Costa, 2003; Cañiza *et al.,* 2017; Lima, 2019). In Argentina, *F. platycalyx* has previously been recorded from Buenos Aires and Misiones (Hässel de Menéndez & Rubies, 2009).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Juan José Castelli, a 2 km del empalme de ruta 5 y 9, 25° 54′ 40.19′′ S, 60° 37′ 28.98′′ W, cortícola, abundante, soleado y húmedo, 26-II-2011, Jimenez & Jimenez 91a (CTES).

Bryophyta. Hedwigiaceae
2. **Braunia cirrhifolia** (Mitt.) A. Jaeger, *Ber. Thatigk. St. Gallischen Naturwiss. Ges.* 2: 87. 1876.

This taxon includes robust plants with irregularly pinnate branching, 4-plicate leaves, acuminate apices ending in a hyaline mucro in distal leaves, revolute margins, and sporophyte with a seta well-developed (Biasuso, 1993).

Distribution and habitat. *Braunia cirrhifolia* is a South American species registered in Bolivia, Paraguay, Peru and Argentina (Hermann, 1976; Menzel, 1992; Biasuso, 1993; O'Shea & Price, 2008). In Argentina, the species has been recorded in the central and northwestern regions of the country, from Córdoba, Salta and Tucumán (Matteri, 2003). The distribution range of the species extends to northeastern Argentina, to the Province of Chaco.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Presidencia de la Plaza,* Parque Nacional Chaco, 26° 47′ 40.24′′ S, 59° 37′ 6.76′′ W, en la "ralera", sobre Quebracho, abundante, húmedo y soleado, 21-I-2012, Jimenez & Martín 315 (CTES).

3. **Braunia exserta** Müll. Hal., *Linnaea* 42: 379. 1879.

Braunia exserta can be distinguished from *B. cirrhifolia* by the slender size of the plants and the shorter length of the seta in the former.

Distribution and habitat. This species is found in the Neotropics, and was recorded in Brazil and Argentina (Biasuso, 1993; Fuertes *et al.*, 2015). In Argentina, it has been reported in the northwest of the country, in Tucumán and Jujuy (Biasuso, 1993). Its distribution range extends to the northeast of the country, in the Province of Chaco.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes*, Juan José Castelli, Ea. La Media Legua, 25°47′18.58′′ S, 60° 32′ 2.78′′ W, lote 6, en ramas caídas de Quebracho blanco entre hojarasca, abundante, sombrío y húmedo, 20-VII-2022, Jimenez & Jimenez 694 (CTES).

Bryophyta. Stereophyllaceae
4. **Entodontopsis cultelliformis** (Sull.) B.H. Allen, *Monogr. Syst. Bot. Missouri Bot. Gard.* 132: 272. 2018.

This taxon is characterized by the complanate-foliate disposition of leaves, ovate-lanceolate leaves with serrate margins at the apex and serrulate at the base, and costa reaching 1/3 of the lamina length and ending in a spine (Allen, 2018).

Distribution and habitat. This species is distributed in the Americas from Mexico to Argentina (Matteri, 2003; Allen, 2018). It was previously recorded in the country as *Eulacophyllum cultelliforme* (Sull.) W. R. Buck & Ireland from Misiones and Corrientes (Matteri, 2003).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Presidencia de la Plaza,* Parque Nacional Chaco (26° 47′ 40.24′′S, 59° 37′ 6.76′′ W), cortícola, abundante, sombrío y húmedo, 7-IV-2011, Jimenez & Martín 173 (CTES). *Dpto. Primero de Mayo,* Reserva Educativa Colonia Benítez (27º 19′ 06.02′′ S, 58º 56′′ 58.27′′ W), cortícola sobre raíz de "espina corona", abundante, sombrío y húmedo, 14-IV-2012, Jimenez *et al.* 405 (CTES).

5. **Entodontopsis leucostega** (Brid.) W. R. Buck & Ireland, *Nova Hedwigia* 41: 103. 1985.

This species is easily recognized by the presence of lanceolate leaves with costa reaching the midleaf, elongate and smooth laminal cells, entire margins, and larger alar cells (Buck, 1998).

Distribution and habitat. *Entodontopsis leucostega* is a widely distributed species recorded from Africa, America, and Asia (Buck, 1998). In Argentina, this species has been registered in Salta, Jujuy, and Misiones (Matteri, 2003).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes*, Parque Nacional El Impenetrable (25° 10′ 38.0′′ S, 61° 05′ 44.5′′W), cortícola, 10-V-2019, Serrano BZ1 (CTES).

Bryophyta. Fissidentaceae

6. **Fissidens brevipes** Besch., *J. Bot. (Morot)* 5: 252. 1891.

Diagnostic characters include the presence of papillose laminal cells and costa obscured at the apex by chlorophyllose cells (Pursell, 2007).

Distribution and habitat. Fissidens brevipes is a South American species distributed in Argentina, Brazil, Guyana, and Paraguay (Matteri, 2003; Pursell, 2007). In Argentina, this species has been previously recorded in Formosa and Misiones (Matteri, 2003).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Presidencia de la Plaza,* Parque Nacional Chaco (26° 47′ 40.24′′ S, 59° 37′ 6.76′′ W), al borde del Río Negro, cortícola, abundante, soleado, seco, 21-I-2012, Jimenez & Martín 292a (CTES). *Dpto. Primero de Mayo,* Reserva Educativa Colonia Benítez (27º 19′ 06.02′′ S, 58º 56′ 58.27′′ W), cortícola sobre raíz aflorante, con *Rhynchostegium serrulatum,* escaso, húmedo y sombrío, 14-VI-2012, Jimenez *et al.* 404b (CTES).

7. **Fissidens crispus** Mont., *Ann. Sci. Nat., Bot, sér. 2,* 9: 57. 1838.

Diagnostic characters of *F. crispus* include tightly crispate leaves when dry, with limbate margins ending slightly below the apex, and laminal cells irregularly hexagonal, bulging, and smooth (Pursell, 2007; Taha & Shabbara, 2019).

Distribution and habitat. Fissidens crispus is a pantropical species distributed from the Pacific Coast of the United States, Mexico, Central America, South America, northern Africa, and Europe (Pursell, 2007). This species colonizes moist soil of trails, banks, rocks, rotting logs, and limestone boulders (Pursell, 2007; Taha & Shabbara, 2019). It has been recorded in Corrientes, Misiones, Santa Fe and Tucumán (Matteri, 2003; Alvarez & Villalba, 2021; Filippa & Villalba, 2021; Alvarez *et al.*, 2023). In Chaco, this taxon was collected profusely fructified at P.N. El Impenetrable, alongside the road leading to the trails, in mixed mounds with Pottiaceae species under the bushes.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Parque Nacional El Impenetrable (25° 01′ 28.2′′ S, 60° 55′ 45.5′′ W), terrícola formando montículos mixtos con *Anaschisma lilliputanum* al borde del camino, bajo arbustos, 11-VI-2023, Jimenez *et al.* 766b (CTES). *Dpto. Presidencia de la Plaza,* Parque Nacional Chaco (26° 47′ 40.24′′ S, 59° 37′ 6.76′′ W), terrícola, en la base de arbolito, escaso, húmedo y sombrío, 22-I-2012, Jimenez & Martín 307 (CTES). *Dpto. Primero de Mayo,* Reserva Educativa Colonia Benítez (27º 19′ 06.02′′ S, 58º 56′ 58.27′′ W), terrícola en sendero, abundante, húmedo y sombrío, 14-IV-2012, Jimenez *et al.* 411 (CTES).

8. **Fissidens submarginatus** Bruch, *Flora* 29: 133. 1846.

Fissidens submarginatus is recognized by the presence of a well-defined limbidium extending along the vaginant laminae, and by laminal cells bulging-papillose, with a single sharp papilla over the lumen (Bordin & Yano, 2013; Cabral *et al.*, 2020).

Distribution and habitat. Fissidens submarginatus is an Afro-American species registered on the continent from the United States to southern Paraguay, Brazil, and Argentina (Pursell, 2007; Cabral *et al.*, 2020). This taxon inhabits soil, rock, or termite mounds, as well as at the bases of decomposing trunks and branches (Bordin & Yano, 2013; Cabral *et al.*, 2020).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Primero de Mayo,* Reserva Educativa Colonia Benítez (27º 19′ 06.02′′ S, 58º 56′ 58.27′′ W), terrícola al borde del sendero, abundante, húmedo y sombrío, con *F. crispus,* 14-VI-2012, Jimenez *et al.* 418a (CTES).

Bryophyta. Pottiaceae

9. **Gertrudiella uncinicoma** (Müll. Hal.) G. M. Suárez & Schiavone, *Bryologist* 113: 679. 2010.

Gertrudiella uncinicoma is distinguished by the presence of a well-developed central cylinder at the stem, leaves strongly curled when dry, and guide cells of the costa distributed in 3-4 layers (Jimenez & Suárez, 2017). In Chaco Province, the species forms extensive and dense cushions on soil, intermixed with *Selaginella* sp. and *Hyophila involuta* (Hook.) A. Jaeger, in both preserved and disturbed areas.

Distribution and habitat. *Gertrudiella uncinicoma* is a Neotropical species from Argentina, Bolivia, Chile, Peru and Paraguay (Schiavone & Suárez, 2003; Suárez & Schiavone, 2005, 2010; Jimenez & Suárez, 2017). In Argentina, it has been recorded from Córdoba, Jujuy, Salta, Santiago del Estero, and Tucumán (Schiavone & Suárez, 2003; Suárez & Schiavone, 2005, 2010).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Miraflores, Ea. Catalina (25º 26′ 49.08′′ S, 61º 32′ 36.29′′ W), terrícola formando amplios montículos al costado del camino, abundante, sombrío, 19-VII-2022, Jimenez *et al.* 658b (CTES). Parque Nacional El Impenetrable (25° 01′ 28.2′′ S, 60° 55′ 45.5′′ W), terrícola, V-2019, Serrano BZ5b (CTES).

10. **Hyophila involuta** (Hook.) A. Jaeger, *Ber. Thatigk. St. Gallischen Naturwiss. Ges.* 1: 202. 1873.

Hyophila involuta is easily recognized by the oblong to ligulate shape of the leaves, with two well-developed stereid bands in cross section, and ventrally bulging laminal cells (Zander, 1993).

Distribution and habitat. *Hyophila involuta* is widespread in the Americas, from southern North America, Central and South America, to Asia, Europe and Oceania (Allen, 2002). In Argentina, this taxon has been recorded from Misiones and Tucumán (Matteri, 2003; Ellis *et al.,* 2023).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Parque Nacional El Impenetrable (25° 01′ 28.2′′ S, 60° 55′ 45.5′′ W), terrícola, V-2019, Serrano BZ5a (CTES); Miraflores, Ea. Catalina (25º 26′ 49.08′′ S, 61º 32′ 36.29′′ W), cortícola en base de Quebracho colorado, escaso, sombrío, 19-VII-2022, Jimenez *et al.* 679 (CTES).

Bryophyta. Pylaisiadelphaceae

11. **Isopterygium tenerum** (Sw.) Mitt., *J. Linn. Soc., Bot.* 12: 499. 1869.

These small, slender plants are recognized by the complanate disposition of the leaves, ovate and concave with an acuminate apex, plane margins, a short and double costa, alar cells well-differentiated, and linear laminal cells (Buck, 1998; Allen, 2018). It was found growing on soil at the base of a palm tree, but it colonizes all types of substrates.

Distribution and habitat. This species is widely distributed in the Americas, from eastern North America to Central and South America (Sharp *et al.,* 1994; Churchill & Linares, 1995; Allen, 2018). In Argentina, *I. tenerum* has been reported from Corrientes, Entre Ríos, Tucumán, Tierra del Fuego, and Misiones (Matteri, 2003).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Juan José Castelli, a 13 km del empalme de ruta 5 y 9 (25° 51′ 58.33′′ S, 60° 42′ 23.07′′ W), al borde de laguna pequeña, en la base de palmera entre hierbas, sobre tierra, abundante, sombrío y húmedo, 18-IX-2010, Jimenez & Jimenez 69a (CTES).

Bryophyta. Leskeaceae

12. **Leskeadelphus angustatus** (Taylor) B. H. Allen, *Cat. Brio. Bolivia* 192. 2009.

This taxon is recognized by the lack of paraphyllia, ovate-lanceolate leaves with acuminate apex, slender costa ending below the apex, smooth rhomboidal laminal cells, and well-differentiated alar cells (Allen, 2018).

Distribution and habitat. The distribution range of this species extends from Mexico to southern South America (Allen, 2018). In Argentina, this species has been registered in Corrientes and Salta as *L. catenulatulus* (Müll. Hal.) Herzog (=*L. angustatus*) (Matteri, 2003).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Primero de Mayo*, Reserva Educativa Colonia Benítez (27º 19′ 06.02′′ S, 58º 56′ 58.27′′ W), cortícola en la base de árbol, abundante, sombrío y húmedo, 14-IV-2014, Jimenez *et al.* 414 (CTES).

Bryophyta. Leucomiaceae
13. **Leucomium strumosum** (Hornsch.) Mitt., *J. Linn. Soc. Bot.* 12:502. 1869.

Diagnostic characters of *Leucomium strumosus* include the lack of a central cylinder at the stem, ovate to oblong-ovate leaves, an acuminate apex, margins entire and plane, costa absent, and long-rhomboidal to linear-hexagonal laminal cells (Buck, 1998).

Distribution and habitat. *Leucomium strumosus* is a pantropical species found in America, from Mexico to Panama, Colombia, Venezuela, Ecuador, Peru, Brazil, and Argentina (Sharp *et al*., 1994; Churchill & Linares, 1995, Buck, 1998). In Argentina, this species has been recorded in Corrientes and Misiones (Matteri, 2003). It is usually found growing on soil, rocks, and tree bases.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Primero de Mayo*, Reserva Educativa Colonia Benítez (27º 19′ 06.02′′ S, 58º 56′ 58.27′′ W), cortícola sobre madera en descomposición, abundante, húmedo y sombrío, 14-IV-2012, Jimenez *et al.* 401 (CTES). *Dpto. San Fernando,* Reserva Natural Cultural Caraguatá (27º 23′ 16.7′′ S, 58º 58′ 49.9′′ W), cortícola, escaso, soleado y seco, 2-IV-2011, Jimenez *et al.* 151 (CTES).

Bryophyta. Orthotrichaceae
14. **Macrocoma tenuis** (Hook. & Grev.) Vitt subsp. **sullivantii** (Müll. Hal.) Vitt, *Bryologist* 83: 413.

This species is distinguished by the brown-green color of the mats, and lanceolate keeled leaves with rounded and prominently bulging laminal cells (Sharp *et al.*, 1994; Jimenez *et al*., 2020).

Distribution and habitat. *Macrocoma tenuis* subsp. *sullivantii* is distributed in America and Asia (Redfearn & Wu, 1986; Churchill & Linares, 1995; Matteri, 2003; Valente *et al*., 2020). In Argentina, this taxon has been recorded in Corrientes and Santiago del Estero (Matteri, 2003; Jimenez *et al*., 2020).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Juan José Castelli, a 7 km del empalme de ruta 5 y 9 (25º 34′ 18.3′′ S, 60º 58′ 39.9′′ W), interior de monte, cortícola, escaso, soleado, 18-IX-2010, Jimenez & Jimenez 64 (CTES). *Dpto. Presidencia de la Plaza,* Parque Nacional Chaco (26° 47′ 40.24′′ S, 59° 37′ 6.76′′ W), en Quebrachal, cortícola sobre Quebracho, abundante, seco y sombrío, 6-IV-2011, Jimenez & Martín 162 (CTES). *Dpto. San Fernando*, Reserva Natural y Cultural Caraguatá (27º 23′ 16.7′′ S, 58º 58′ 49.9′′ W), cortícola sobre arbolito, abundante, sombrío, 2-IV-2011, Jimenez *et al.* 146 (CTES).

Bryophyta. Octoblepharaceae
15. **Octoblepharum albidum** Hedw., *Sp. Musc. Frond.* 50. 1801.

This taxon is easily distinguished in the field by the glaucous-green coloration of the mats, the ligulate leaves abruptly broadened at the base, and the plane convex costa in transverse section, with 2-3 layers of hyalocysts on either side of a medial layer of triangular chlorocysts (Allen, 1994; Cairns *et al.,* 2020).

Distribution and habitat. It is a widespread species with pantropical and subtropical distribution, recorded in southern North America, Central and South America, West, Central and South Africa, Asia, and Australia (Allen, 1994; Cairns *et al.*, 2020). In Argentina, this species has been found in Misiones and Salta (Matteri, 2003).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Presidencia de la Plaza,* Parque Nacional Chaco (26° 47′ 40.24′′ S, 59° 37′ 6.76′′ W), cortícola en tronco caído al borde del sendero, abundante, soleado, algo húmedo, 22-I-2012, Jimenez & Martín 312 (CTES).

Bryophyta. Funariaceae
16. **Physcomitrium lorentzii** Müll. Hal., *Linnaea* 42: 260. 1879.

Diagnostic characters that distinguish *P. lorentzii* include oblong-spathulate leaves with acuminate apex, serrulate margins in the upper half, a costa that reaches ¾ of the length of the lamina, seta short and immerse capsule (Colotti & Suárez, 2022).

Distribution and habitat. *Physcomitrium lorentzii* is a South American species recorded from Argentina (Matteri, 2003; Colotti & Suárez, 2022), Chile (Ireland *et al.*, 2006) and Peru (Menzel, 1992). In Argentina, this species has been registered in Córdoba, Jujuy, and Salta (Matteri, 2003; Colotti & Suárez, 2022). Its distribution range extends to the northeast of the country, in the Province of Chaco.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Juan José Castelli, a 13 km del empalme de ruta 5 y 9 (25° 51′ 58.33′′ S, 60° 42′ 23.07′′ W), en la base de palmera al costado de laguna, sobre tierra, escaso, sombrío y húmedo, 18-XI-2010, Jimenez & Jimenez 72 (CTES).

17. **Physcomitrium subsphaericum** Schimp. ex Müll. Hal., *Syn. Musc. Frond.* 2: 544. 1851.

Physcomitrum subsphaericum differs from *P. lorentzii* mainly by the acute apex and subpercurrent costa, and by the presence of an elongated seta that exserts the capsule in the former.

Distribution and habitat. This species is distributed in North, Central, and South America, from Mexico to Argentina, Brazil, and Paraguay (Sharp *et al*., 1994; Matteri, 2003; O'shea & Price, 2008; Cañiza *et al*., 2017; Dias *et al*., 2018, Colotti & Suárez, 2022). In Argentina, this species has been recorded in Corrientes, Entre Ríos, Santa Fe and Tucumán (Matteri, 2003; Filippa & Villalba, 2021; Colotti & Suárez, 2022; Alvarez *et al*., 2023).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Presidencia de la Plaza,* Parque Nacional Chaco (26° 47′ 40.24′′ S, 59° 37′ 6.76′′ W), terrícola en borde de río, barro semi podrido, escaso, húmedo y sombrío, 21-I-2012, Jimenez & Martín 294 (CTES).

Bryophyta. Pottiaceae
18. **Pseudocrossidium arenicola** (Dusén) M.J. Cano, *Nova Hedwigia* 102: 101. 2016.

Pseudocrossidium arenicola is characterized by the presence of a single stereid band in the transverse section of the leaf, and the costa extended as an awn (Cano *et al.*, 2016).

Distribution and habitat. It is a South American species registered from Bolivia to Argentina. In Argentina, it has been recorded in Buenos Aires, Catamarca, Chubut, Jujuy, Salta, Santiago del Estero, and Tucumán (Cano *et al*., 2016; Jimenez *et al.*, 2020). This taxon is often found growing in extensive turfs on soil (Jimenez *et al.,* 2020).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Miraflores, Ea. Catalina (25° 26′ 49.08′′ S, 61° 32′ 36.29′′ W), terrícola, formando amplios montículos al costado del camino, abundante y sombrío, 19-VII-2022, Jimenez *et al.* 686a (CTES).

Bryophyta. Brachytheciaceae
19. **Rhynchostegium serrulatum** (Hedw.) Austin, *Musci Appalach.* 58. 1870.

This taxon is characterized by the presence of weakly complanate, lanceolate to ovate-lanceolate leaves, scarcely differentiated between stem and branches; margin serrulate, apex acuminate and costa reaching ¾ of the lamina length (Buck, 1998; Allen, 2018; Cottet & Messuti, 2019).

Distribution and habitat. *Rhynchostegium serrulatum* is distributed in western and eastern Canada, U.S.A, Mexico, Central America, the Caribbean; and throughout western, northern, and southern South America including Argentina and Uruguay (Sharp *et al*., 1994; Buck, 1998; Fuertes & Marchessi, 2013; Allen, 2018; Cottet & Messuti, 2019). This species was first recorded in Argentina by Cottet and Messuti (2019) in Chubut. Its distribution range extends to northeast, in the Chaco Province.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Primero de Mayo*, Reserva Educativa Colonia Benítez (27º 19´ 06.02´´ S, 58º 56´ 58.27´´ W), cortícola en raíz, formando matas mixtas con *Fissidens* sp., 14-IV-2014, Jimenez *et al.* 404a (CTES).

Bryophyta. Sematophyllaceae
20. **Sematophyllum adnatum** (Michx.) E. Britton, *Bryologist* 5: 65. 1902.

Diagnostic characters of *S. adnatum* include lanceolate leaves gradually acuminate at the apex, long-rhomboidal laminal cells, and alar cells more or less inflated (Buck, 1998; Allen, 2018).

Distribution and habitat. This species has been registered in North, Central, and South America (Sharp *et al*., 1994; Buck, 1998; Allen, 2018). In Argentina, it has been recorded in Buenos Aires (Valdés *et al*., 2021). Its distribution range now extends to the northeastern part of the country, in the Chaco Province.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. San Fernando*, Reserva Natural y Cultural Caraguatá (27º 23´ 16.7´´ S, 58º 58´ 49.9´´ W), cortícola en tronco caído, 2-IV-2011, Jimenez *et al.* 149 (CTES).

21. **Sematophyllum subsimplex** (Hedw.) Mitt., *J. Linn. Soc., Bot.* 12:494. 1869.

Sematophyllum subsimplex is distinguished from *S. adnatum* by the ovate-lanceolate shape of its leaves and the alar cells inflated and colored.

Distribution and habitat. *Sematophyllum subsimplex* is an Afro-American taxon registered from Mexico, Central America, the Caribbean, Western and Northern South America, Brazil, West and West-Central Tropical Africa (Buck, 1998; Allen, 2018). In Argentina, it has been previously recorded in Corrientes, Misiones and Santa Fe (Matteri, 2003; Alvarez & Villalba, 2021; Alvarez *et al.*, 2023). This species grows on tree trunks, branches, decaying logs, stumps, and even on bracket fungi.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Parque Nacional El Impenetrable (25º 10´ 22,9´´ S 61º 05´ 33,5´´ W), en bosque de algarrobo con sotobosque abierto y sombrío, cortícola sobre troncos talados pero no en descomposición avanzada, húmedo, abundante, 13-V-2019, Serrano BZ9 (CTES). *Dpto. Presidencia de la Plaza,* Parque Nacional Chaco (26° 47´ 40.24´´ S, 59° 37´ 6.76´´ W), cortícola, al costado del sendero, abundante, sombreado y húmedo, 6-IV-2011, Jimenez & Martín 159 (CTES).

Bryophyta. Pottiaceae
22. **Syntrichia ammonsiana** (H. A. Crum & L. E. Anderson) Ochyra, *Fragm. Florist. Geobot.* 37: 212. 1992.

Syntrichia ammonsiana is a propaguliferous species recognized by its ligulate to spathulate leaves not constricted at the middle, mucronate apex, plane margins, unistratose lamina, and the presence of vegetative propagules as small brood leaves borne in clusters at the stem apex (Magill, 1981; Gallego & Cano, 2007).

Distribution and habitat. This species was described based on samples collected in North America (Crum & Anderson, 1979) and later recorded in South America and Africa (Magill, 1981; Gallego *et al.,* 2006). In Argentina, it has been registered by Gallego & Cano (2007) in the southern (Patagonia) and northwestern regions of the country (Tucumán). Its distribution range extends northeastern Argentina, in the Chaco Province.

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Parque Nacional El Impenetrable (25° 00´ 47.5´´ S, 60° 57´ 45.8´´ W), cortícola sobre madera en descomposición, abundante, sombrío y seco, 11-VI-2023, Jimenez *et al.* 777 (CTES).

23. **Syntrichia chisosa** (Magill, Delgad. & L. R. Stark) R. H. Zander, *Bull. Buffalo Soc. Nat. Sci.* 32: 269. 1993.

Syntrichia chisosa includes small, red-brown plants with twisted leaves, and it is distinguished from *S. ammonsiana* mainly by the distally bistratose lamina (Gallego & Cano, 2007; Jimenez *et al*., 2020).

Distribution and habitat. *Syntrichia chisosa* is an Afro-American species registered from North to South America, and South Africa (Zander, 1993; Gallego & Cano, 2007). In Argentina, it has been previously recorded in Salta and Santiago del Estero (Gallego & Cano, 2007; Jimenez *et al*., 2020).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Juan José Castelli, a 2 km del empalme de ruta 5 y 9 (25° 53′ 46.93′′ S, 60° 35′ 51.60′′ W), cortícola, abundante, con *Frullania sp.*, húmedo y soleado, 26-II-2011, Jimenez & Jimenez 91b (CTES). *Dpto. Presidencia de la Plaza*, Parque Nacional Chaco (26º 44′ 59.15′′ S, 59º 42′ 59.72′′ W), cortícola sobre Fabaceae, escaso, seco y sombrío, 6-IV-2011, Jimenez & Martín 165c (CTES).

24. **Tortella humilis** (Hedw.) Jenn., *Man. Mosses W. Pennsylvania* 96. 1913.

This species is characterized by its oblong-lanceolate leaves, broadly acute and short apiculate at the apex, margins plane and entire, costa with 2 stereid bands in transverse section, hydroid strand and dorsal epidermis absent, and basal laminal cells differentiated across leaf in a v-shaped area (Zander, 1993; Sharp *et al.*, 1994).

Distribution and habitat. This is a widely distributed species, being recorded in eastern North America, northern South America, North Africa, and Europe (Sharp *et al.,* 1994). In Argentina, *T. humilis* has been previously recorded in the central and northern regions of the country (Córdoba, Corrientes, Formosa, Jujuy, Misiones, Salta, Santa Fe and Tucumán) (Matteri, 2003; Alvarez *et al.*, 2023).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Parque Nacional El Impenetrable (25° 01′ 00.3′′ S, 60° 56′ 40.5′′ W), cortícola en tronco de "itín", escaso, 11-VI-2023, Jimenez *et al.* 774 (CTES).

25. **Trichostomum brachydontium** Bruch, *Flora* 12: 393. 1829.

Trichostomum brachydontium is characterized by the presence of lanceolate leaves, plane margins, short excurrent costa that extend into a mucro, and laminal cells with multifid papillae (Zander, 1993; Sharp *et al.,* 1994). It was found growing in intermixed mats with *Stereophyllum radiculosum.*

Distribution and habitat. This species has a worldwide cosmopolitan distribution and colonizes a wide range of niches (Ros *et al.,* 2022). In Argentina, it has been previously recorded in Salta (Matteri, 2003), Buenos Aires (Valdés *et al.,* 2021), and Santiago del Estero (Jimenez *et al.*, 2020).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. General Güemes,* Miraflores, Ea. Catalina (25° 26′ 49.08′′ S, 61° 32′ 36.29′′ W), monte no aprovechado, en tronco caído con *Stereophyllum radiculosum*, escaso, a media luz, 19-VII-2022, Jimenez *et al.* 674 (CTES). *Dpto. Presidencia de la Plaza*, Parque Nacional Chaco (26º 44′ 59.15′′ S, 59º 42′ 59.72′′ W), en la "ralera", cortícola sobre Quebracho, abundante, húmedo y soleado, 22-I-2012, Jimenez & Martín 314 (CTES). *Dpto. Primero de Mayo*, Reserva Educativa Colonia Benítez (27º 19′ 06.02′′ S, 58º 56′ 58.27′′ W), terrícola al borde del sendero, entre *Doryopterys* sp., escaso y muy húmedo, 14-IV-2012, Jimenez *et al.* 416a (CTES). *Dpto. San Fernando*, Reserva Natural y Cultural Caraguatá (27º 23′ 16.7′′ S, 58º 58′ 49.9′′ W), cortícola, escaso, sombrío y seco, 2-IV-2011, Jimenez *et al.* 150 (CTES).

26. **Weissia controversa** Hedw., *Sp. Musc. Frond.* 67. 1801.

This taxon is differentiated by the lanceolate to oblong-lanceolate shape of the leaves, with a sharply acute apex ending in a mucro, distinctly incurved margins, and a well-developed costa with two stereid bands (Sharp *et al.,* 1994; Allen, 2002).

Distribution and habitat. It is a cosmopolitan species that inhabits soil, rocks, and the bases of trees (Sharp *et al.,* 1994; Allen, 2002). In Argentina, it has been registered from Córdoba and Misiones (Matteri, 2003).

Specimens examined. ARGENTINA. Prov. Chaco: *Dpto. Presidencia de la Plaza*, Parque Nacional Chaco (26º 44′ 59.15′′ S, 59º 42′ 59.72′′ W), al borde del sendero, entre Thelypteridaceae, abundante, sombrío y húmedo, 6-IV-2011, Jimenez & Martín 166a (CTES).

Discussion

A total of 26 bryophyte species are added to the 27 previously recorded in the province, raising the total number of bryophyte taxa in Chaco Province to 53. The distribution range of six of these species extends to the northeastern region of the country (*Braunia cirrhifolia, B. exserta, Physcomitrium lorentzii, Rhynchostegium serrulatum, Syntrichia ammonsiana,* and *Sematophyllum adnatum*). These results improve our understanding of a poorly explored flora in a region that stands out for its unique characteristics and underline the value of floristic surveys as a fundamental source for updating knowledge of biodiversity in a region (Giorgis *et al.*, 2011). It is important to highlight that four of these species have a bicentric Afro-American distribution (*Fissidens submarginatus, Sematophyllum subsimplex, Syntrichia ammonsiana* and *S. chisosa*). The bicentric Afro-American distribution pattern is exhibited by a long list of genera and species of mosses and liverworts (e.g. Schofield & Crum, 1972; Ochyra, 1992; Delgadillo, 1993; Suárez & Schiavone, 2008; Gradstein, 2013; Jimenez *et al.*, 2015). According to Ochyra (1992), this distribution pattern should be considerably extended with progress in both the taxonomy of tropical and south temperate mosses and floristic exploration of under-collected areas, which enhances the value of data obtained from floristic works such as the one carried out here.

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