The rediscovery of *Frullania weberbaueri* Steph.: The first record for Chile, its conservation status, and lectotypification

El redescubrimiento de *Frullania weberbaueri* Steph., incluyendo su primer reporte para Chile, estado de conservación y lectotipificación

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ABSTRACT

We report the finding of a population of *Frullania weberbaueri* in Parque Nacional Pan de Azúcar, Antofagasta Province, Chile. This taxon was previously known only from the type specimen collected by August Weberbauer in Lima in 1901. The new gathering is fertile so we describe here its sexuality and perianths, together with the oil bodies and the habitat used by the species, and we provide a map of its known distribution. A lectotype for the name is here designated. This is the first record of a liverwort for the deserts of northern Chile, and the southernmost record for *Frullania* sect. *Meteoriopsis*.

Keywords: Antofagasta, Atacama Desert, liverwort, *Frullania* sect. *Meteoriopsis*, "lomas" formations.

RESUMEN

Se reporta el hallazgo de una población de *Frullania weberbaueri* en el Parque Nacional Pan de Azúcar, Provincia de Antofagasta, Chile. Este taxón se conocía previamente sólo de la colección tipo realizada por August Weberbauer en Lima en 1901. La nueva colección está fértil, por lo que se describen aquí la sexualidad y los periantos, junto con los cuerpos oleosos y el hábitat utilizado por la especie, y se provee un mapa de su distribución conocida. Se designa un lectotipo para el nombre. Este es el primer registro de una hepática para los desiertos costeros del norte de Chile, y el registro más austral para *Frullania* sect. *Meteoriopsis*.

Palabras clave: Antofagasta, desierto de Atacama, hepática, *Frullania* sect. *Meteoriopsis*, formaciones de lomas.

INTRODUCTION

While doing fieldwork for the collection of lichens in the "lomas" formations of Pan de Azúcar National Park, Antofagasta Province, northern Chile (25°59'S, 70°36'W), we came across a *Frullania* species growing as a pendent epiphyte on dead plant material on rock walls. It was immediately recognized as an interesting specimen since only a few bryophytes inhabit the "lomas" formations of northern Chile and Perú, and no *Frullania* species had previously been reported for northern Chile (Hässel de Menéndez & Rubies 2009). The taxon was determined as the purportedly extremely rare taxon, *F. weberbaueri* Steph. It previously was known only from the type collection made in 1901 in the mountains of Lima, Peru, by the German botanist August Weberbauer. *Frullania weberbaueri* is treated in the monograph of *F.* subg. *Meteoriopsis* Spruce by Uribe Meléndez (2008). He mentioned a holotype although no specimen was explicitly mentioned in the original protologue (Stephani 1911: 510). Three duplicates of the collection number Weberbauer 27 were studied by Stephani and are available at G. Following the Articles 9.11 and 9.12 of the International Code of Nomenclature for algae fungi and plants (McNeill *et al.* 2012) a lectotype must be designated among the three existing duplicates. It is worth mentioning here that *F.* subg. *Meteoriopsis* sensu Uribe

Meléndez (2008) is now regarded as *F.* (subg. *Meteoriopsis*) sect. *Meteoriopsis* (Spruce) Uribe, von Konrat & Hentschel (Hentschel *et al.* 2015).

MATERIALS AND METHODS

Plants were collected in May 2009 in Pan de Azúcar National Park, Antofagasta Province, northern Chile (25°59'04"S, 70°36'54"W) at 730 m a.s.l. while doing lichen inventories. Nomenclature of initial branching appendages follow von Konrat & Braggins (2001). For the production of microscopic images we used the same set up and protocols as described in Larraín *et al.* (2015).

RESULTS

Frullania weberbaueri Steph., Sp. Hepat. 4: 510. 1911. Type citation: Peruvia, Lima. [Lectotype (selected here): Frull. Weberbaueri St, Peru, Lima, in rupibus, Weberbauer No 27. 1901. Herbarium Genavense (G) G00066925!; Isolectotypes: G00066926!, G00066924!]. Figs. 1 and 2.

Although an extensive description of this taxon is provided by Uribe Meléndez (2008), the availability of fertile material allows to include some morphological aspects of this recent collection that improve the circumscription of the taxon and increase our understanding about its morphological variability. The following description is based in both the lectotype and the new gathering:

Plants up to 12 cm long, bi- to tri-pinnately branched, with branches up to 4.5 cm long and secondary branches up to 1.3 cm long and tertiary branches up to 2.5 mm long, 1.5 mm wide. Stems rounded in cross section, 120-150 µm wide, blackish in older parts becoming clear brown to hyaline in younger parts. Leaf lobes strongly convolute and clasping the stem when dry, extended when moist, wide-ovate, apiculate, sometimes terminating in a short mucro up to 3-4 cells long, slightly to clearly asymmetric, with large auricles either symmetric or asymmetric, not or slightly overlapped one over the other, margins entire to uneven, slightly recurved. Cells of leaf lobes 16-25 x 10-15 µm at midleaf, quadrate to hexagonal and a little larger to the base where they reach 30-35 x 20-25 µm, smaller and irregular in shape towards the apex, with somewhat equally thickened walls at base and midleaf, becoming strongly sinuose towards the apex, where trigones are conspicuous; cells at auricles oval to quadrate with equally thickened walls. Oil-bodies *Bazzania* type, rounded-oval to kidney-shaped, 5.0-9.5 x 3.0-4.8 µm, appearing smooth, 2-4(5) per cell. Lobules parallel and disposed close to the stems, long cylindric, 260-450 x 75-120 µm, with oblique mouth. Cells of lobules rectangular, with sinuose walls. Stylus reduced, erect, consisting of 3-6 uniseriate cells often with terminal slime papilla. Underleaves ovate-hastate, bifid for the distal 1/5-1/4 their length, with apiculate and acute segments, separated by a "v" shaped sinus, margins flat and entire, with long decurrent and undulated auricles, up to 290 µm long, variable in shape, often ovate ended in a long apiculate, sharp projection. Branch appendages: first branch underleaves (BUL1) divided to base into a long ovate, tapering ventral segment, and dorsal saccate segment; first branch leaf-lobes (BL1) transformed into 2 saccate lobules, with stylus very long, to 11 cells long often with a terminal slime papilla. Dioicous. Androecia not seen. Gynoecia at the end of short branches 1-2 mm long located along the main stems or primary branches. Female bracts in two series, the innermost pair bifid and dentate, strongly concave, sheathing the perianth, with one segment larger than the other one, outermost pair similar to vegetative leaves, not concave, bearing a short lobule, border entire to uneven; inner bracteoles strongly dentate, bifid to half their length, outer bracteoles dentate too. Perianths subglobose, 0.8-1.2 mm long including beak, smooth, with three keels; beak relatively long, 90-120 µm long, with tall papillae protruding the mouth. Sporophytes not seen.

Specimen examined: CHILE, Antofagasta Región, Antofagasta Province, Taltal, Pan de Azúcar National Park, Las Lomitas area, lat. 25°59'04"S, long. 70°36'54"W ± 4 m (WGS 84), alt. ca. 729 m, epiphyte on plant detritus over rock, in vertical rock wall with soil accumulations, pendent, micro-exposition W. Leg. R. Vargas 2801, with D. Stanton. 10 May 2009 (COL, CONC, F).

DISCUSSION

Significantly, Uribe Meléndez (2008) remarked that *Frullania weberbaueri* was a very distinctive plant despite the fact it was only known from a single collection, and discussed the diagnostic characters that distinguished it morphologically from closely allied *F. darwinii* Gradst. & Uribe from the Galápagos Islands, and *F. phalangiflora* Steph. from the tropical Andes. *Frullania weberbaueri* is easily separated from the latter two species by the underleaves with flat margins, acute segments, and long decurrent auricles, usually terminated in a sharp and long acumen. The symmetry of the base of leaves, one of the characters indicated by Uribe Meléndez (2008) as diagnostic in distinguishing between *F. phalangiflora* and *F. weberbaueri*, is variable in the new specimens observed, where some leaves are perfectly symmetric at the base whereas others are clearly asymmetric. However, these two taxa can be easily separated by the underleaf traits, as indicated above. The perianths are very similar in both species, although in *F. phalangiflora* they are more globose than in *F. weberbaueri*.

Uribe Meléndez (2008) treatise strongly focused on the morphology and did not give further information about the

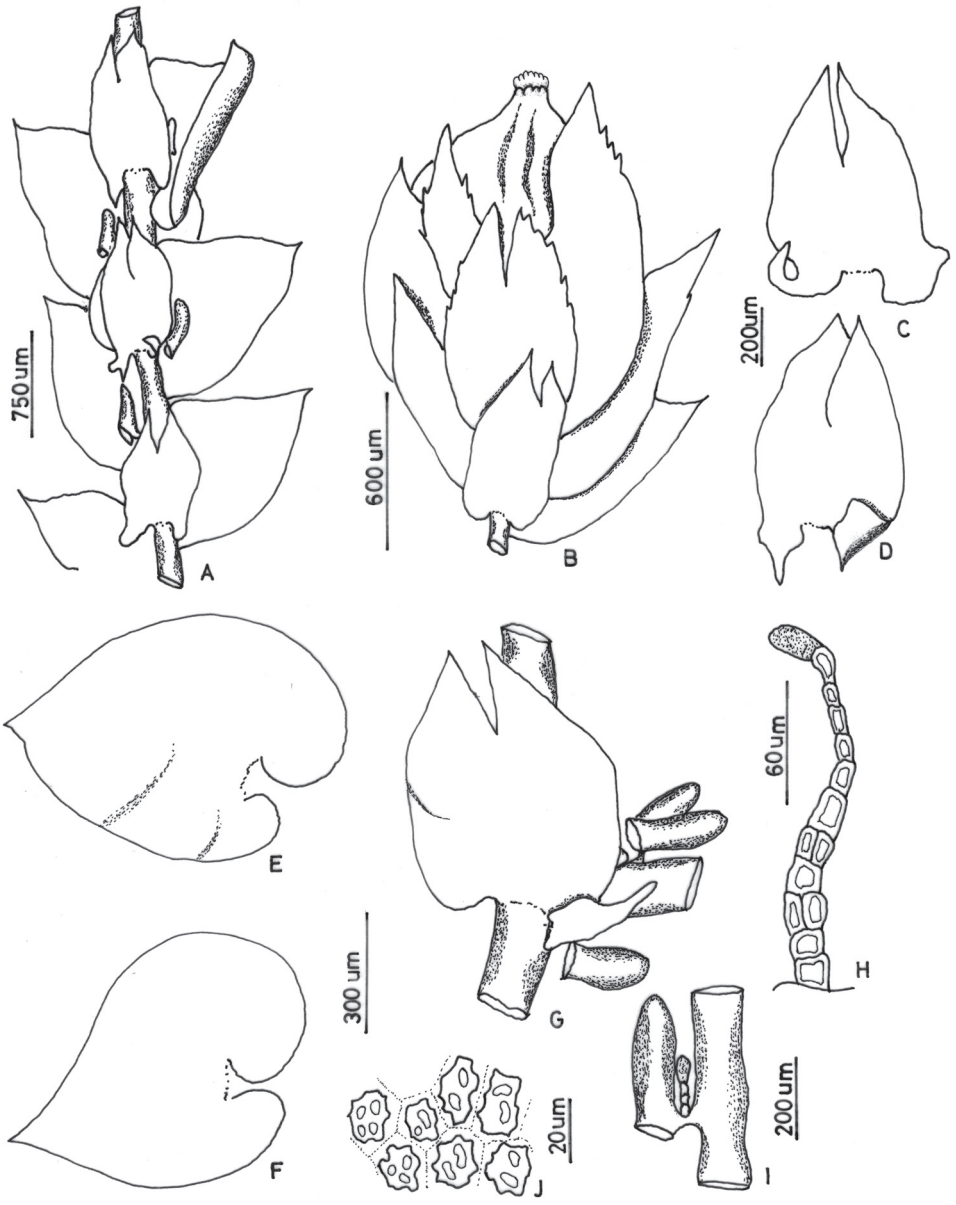

Figure 1. *Frullania weberbaueri* Steph. A. Habit wet, ventral view. B. Perianth surrounded by bracts. C–D. Underleaves. E–F. Leaf lobes. G. Underleaf on main stem showing double lobules of the first branch leaf lobe (BL1). H. Stylus of first branch appendages. I. Branch lobule and stylus. J. Oil-bodies at midleaf. (All from Vargas 2801 at COL).

Figura 1. *Frullania weberbaueri* Steph. A. Hábito en húmedo, vista ventral. B. Perianto rodeado por brácteas. C–D. Anfigastros. E–F. Lobos de las hojas. G. Anfigastro en tallo principal mostrando lóbulos dobles del primer lobo de las ramas (BL1). H. Estilo en los apendices de primera rama. I. Lóbulo y estilo de una rama. J. Cuerpos oleosos en la hoja media. (Todos de Vargas 2801 en COL).

locality details of the type specimen of *F. weberbaueri* both because the scanty information provided by Stephani (1911) and the poor label information of type material. Species of *F.* sect. *Meteoriopsis* grow in high Andean forests, between 1100 and 3800 m a.s.l., with the sole exception of the populations of the Galapagos Islands, where the four taxa occurring there can be found between 300 and 700 m a.s.l. (Uribe Meléndez 2008). Noteworthy, *F. weberbaueri* would be the only taxon of the group, together with *F. darwinii*, restricted to the lowlands of arid or desertic zones (Fig. 3).

Although the information about the type collection of *F. weberbaueri* given both in the protologue and as annotated in the labels of the type collection is very vague, only indicating the general area (Lima) and the substrate ("in rupibus"), one of the isotypes at G has the annotation "Peru, Amankai bei Lima". It would make sense that

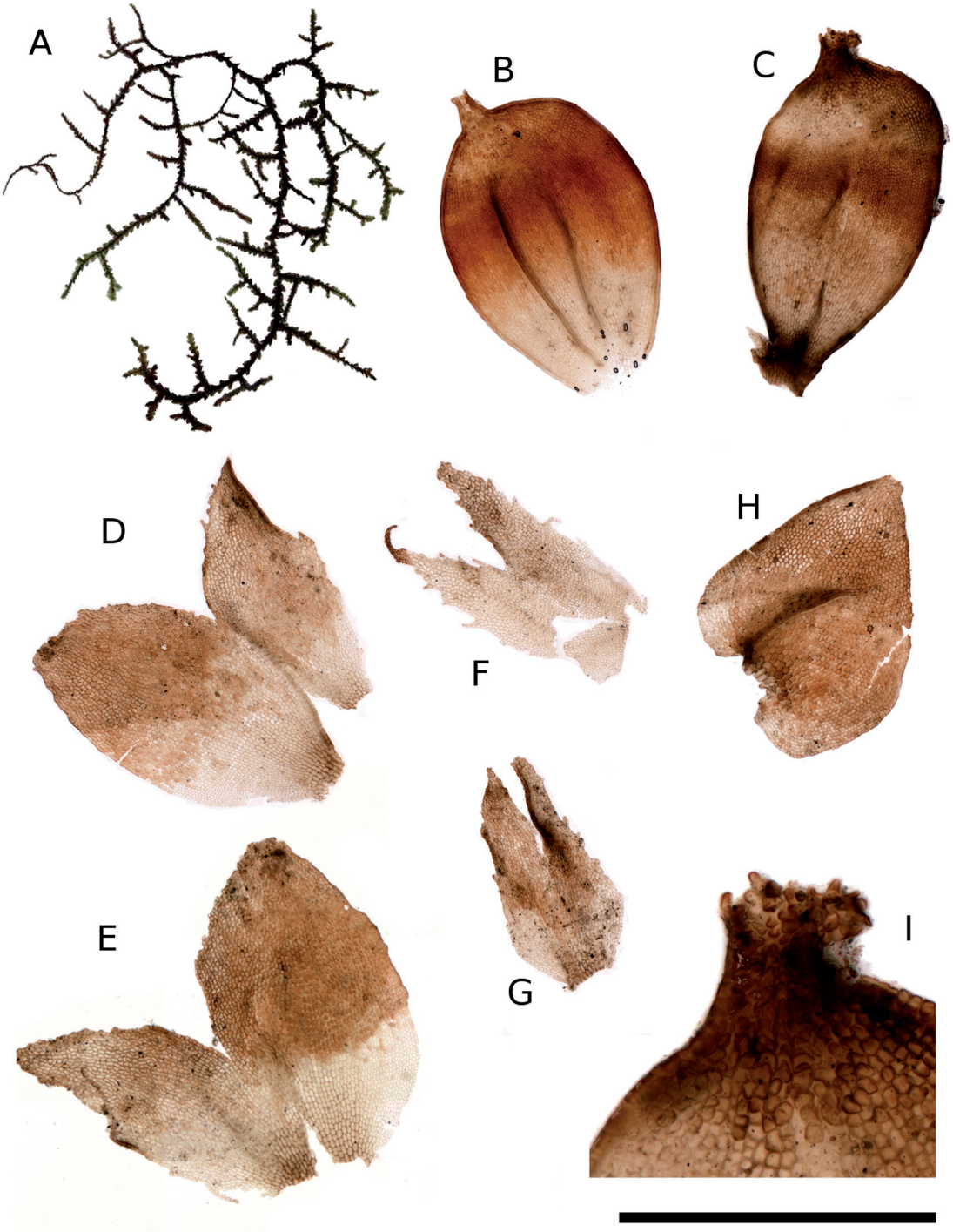

Figure 2. *Frullania weberbaueri* Steph. A. Habit wet, dorsal view, complete plant. B. Perianth, ventral view. C. Perianth, dorsal view. D–E. Inner bracts. F. Inner bracteole. G. Outer bracteole. H. One of the two outer bracts. I. Perianth mouth. (Scale: A = 50 mm; B–H = 1 mm; I = 300 µm; all from Vargas 2801 at F).

Figure 2. *Frullania weberbaueri* Steph. A. Hábito en húmedo, vista dorsal, planta completa. B. Perianto, vista ventral. C. Perianto, vista dorsal. D–E. Brácteas internas. F. Bracteola interna. G. Bracteola externa. H. Una de las dos brácteas externas. I. Boca del perianto. (Escala: A = 50 mm; B–H = 1 mm; I = 300 µm; todos de Vargas 2801 en F).

Weberbauer was referring to the Lomas de Amancaes, a low elevation hill range located in the heart of the city of Lima, separating the districts of Rímac, Independencia, and San Juan de Lurigancho, with altitudes between 300 and 800 m a.s.l. (Trinidad *et al.* 2012). The vegetation of this locality corresponds to the "lomas" formations, which are scattered vegetation islands located on a matrix of hyper-arid low coastal mountains (up to 1000 m a.s.l.) along the Peruvian and north Chilean desertic coasts between 6°S-30°S (Dillon 1997, Dillon & Hoffmann 1997). In these formations fog accumulates during part of the year providing enough moisture for the development of a rich and particular vegetation, full of endemic species (Rundel *et al.* 1991, Dillon *et al.* 2003). The new collection of *F. weberbaueri* was made in the same kind of habitat, although further south and slightly different in terms of topography, climate and vegetation (Rundel *et al.* 1991). The area receives a strong influence of the coastal fog or "camanchaca" in the establishment and perpetuation of the plant community, mostly dominated by *Euphorbia lactiflua* Phil. and *Eulychnia saint-pieana* F.Ritter at the top of the coastal hills (ca. 800 m a.s.l., Rundel *et al.* 1996). Notwithstanding the rich plant community with ca. 207 vascular plants (Rundel *et al.* 1996), a quite rich lichen community develops using all available substrates. Associated species of *F. weberbaueri* at the collection site were the northern Chile and southern Peru coastal endemics *Chrysothrix granulosa* G.Thor. and *Follmannia orthoclada* (Zahlbr.) Frödén, Arup & Søchting, and the Chilean endemics *Roccellinastrum spongoideum* Follmann (growing usually as an epiphyte on cacti spikes), *Caloplaca rubina* Zahlbr., *Arthothelium halophilum* Follmann, *Dolichocarpus chilensis* R.Sant., *Pentagenella gracillima* (Kremp.) Ertz & Tehler, *Pentagenella fragillima* Darb., *Buellia taltalensis* C.W.Dodge, among others. There are almost 90 of these vegetation islands along the coast of northern Chile and Peru (Duncan & Dillon 1991, Dillon 1997, Dillon & Hoffmann 1997), and their bryophyte flora is virtually unknown. Although these are not species-rich habitats for bryophytes, they are clearly underrepresented in herbaria due to several reasons, including the small size and scarcity of the species that can survive in desertic areas, together with the fact that few bryologists visit these ecosystems, being bryophytes often ignored by flowering plant botanists or lichenologists.

This is the first liverwort ever recorded for the coastal desert of northern Chile, and the first one for the Antofagasta Region. Although Hässel de Menéndez & Rubies (2009) did not mention a single liverwort species reported for Chile north of Coquimbo Region, there is a record for *Plagiochasma rupestre* (G.Forst.) Steph. var. *rupestre* from "Atacama", without exact locality (Bischler-Causse *et al.* 2005), based on a collection by Thomas Morong, who collected several flowering plants in the Atacama desert in 1890. The record of *Lophocolea rectangularis* Herzog from "Nordchile: Fundo Siete Hermanos" (Herzog 1954: 43) is likely to refer to Fundo Siete Hermanas, near Viña del Mar in central Chile. There is a locality east of Copiapó, Atacama, called "cerro Siete Hermanos", but this is a place of high elevation and is very dry, and it is highly unlikely that this is the locality where the type of *Lophocolea rectangularis* was collected, since Herzog (1954) describes it as growing on bark together with *Radula* species. A recent contribution reports five new species of liverworts for Arica and Parinacota Region, although they were all collected in the high Andean plateau (Ardiles & Fariña 2014).

Frullania weberbaueri was proposed by Uribe Meléndez (2008) to be classified as a vulnerable taxon, following the criterion D2 of the IUCN (2012). The record of this new population supports that assessment and so the species is proposed to be included as a vulnerable taxon for Chile as well (VU D2). These fragile ecosystems are threatened by multiple factors, including habitat size reduction due to urbanization, road construction, thermoelectric, industrial and urban pollution, goat grazing, erosion, commercial plant collecting, fuelwood collecting, among others (Dillon 1997, Dillon & Hoffmann 1997, Trinidad *et al.* 2012), so efforts in conservation and more bryophyte sampling are urgent in order to know and catalogue their diversity before they disappear.

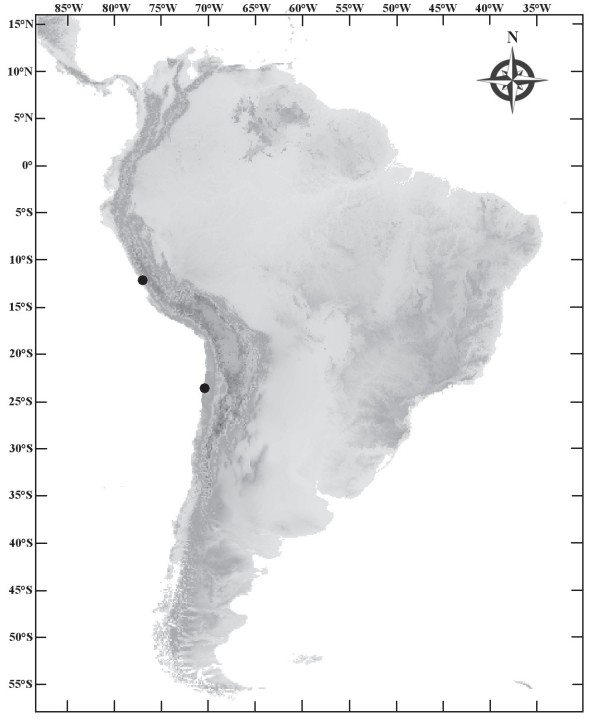

Figure 3. *Frullania weberbaueri* Steph. Distribution map.

Figura 3. *Frullania weberbaueri* Steph. Mapa de distribución.

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