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Research article

An unusual new record of *Baccharis* (Asteraceae) from the Peruvian Andes and its relation with the northern limit of the dry puna

Un inusual nuevo registro de *Baccharis* (Asteraceae) de los Andes peruanos y su relación con el límite norte de la puna seca

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Abstract:

Background and Aims: The knowledge of the richness and distribution of the flora in the Peruvian Andes is scarce; about 70 taxonomic novelties have been reported for this area in the last decade, a large part belonging to the Asteraceae. The objective of this paper is to contribute to the knowledge of this flora through a new record of *Baccharis acaulis*. In addition, the distribution pattern of this species is examined.

Methods: As part of floristic inventories in the high Andes of Peru, various field trips were carried out, several plant specimens were collected, among them a previously unreported species, which was identified by consulting some specialists and confirmed using taxonomic keys. Furthermore, predicting species distribution based on ecological niche modeling was made use the machine learning algorithm Maxent with the bioclimatic variables of the WorldClim database.

Key results: A species of the genus *Baccharis* was registered for the first time for the flora of Peru. This species is recognized for its unique habit; it is a rhizomatous herb in which the aboveground part consists of small leaf rosettes surrounding a solitary capitulum. The species was collected in the south of the Peruvian Andes. This record extends the known distribution of the species considerably to the north.

Conclusions: This record suggests the need to continue studying the Andean flora, as well as the links of their distribution patterns with the phytogeographical regions.

Key words: Compositae, flora, *Heterothalamus*, new record, phytogeography.

Resumen:

Antecedentes y Objetivos: El conocimiento de la riqueza y distribución de la flora en los Andes peruanos es escaso; en la última década han habido alrededor de 70 novedades taxonómicas para esta área, siendo la familia Asteraceae la de mayor aporte. El objetivo de este trabajo es contribuir al conocimiento de esta flora, a través de un nuevo registro de *Baccharis acaulis*. Además, se examina su patrón de distribución.

Métodos: Como parte de los inventarios florísticos en los altos Andes del Perú, se realizaron numerosos viajes de campo, se recolectaron varios especímenes de plantas, entre ellos una especie no reportada previamente, que se identificó mediante la consulta a algunos especialistas y se confirmó utilizando claves taxonómicas. Además, se predijo la distribución de la especie basada en modelos de nichos ecológicos, utilizando el algoritmo de aprendizaje automático Maxent con las variables bioclimáticas de la base de datos WorldClim.

Resultados clave: Se registró por primera vez para la flora del Perú una especie del género *Baccharis*. Esta especie se distingue por su singular hábito, es una hierba rizomatoza en la que la parte superficial consiste en pequeñas rosetas de hojas que rodean a un capítulo solitario. La especie fue recolectada al sur de los Andes peruanos. El registro extiende la distribución conocida de la especie a una zona más norteña.

Conclusiones: Este registro sugiere la necesidad de continuar estudiando la flora andina, así como los vínculos de sus patrones de distribución con las regiones fitogeográficas.

Palabras clave: Compositae, fitogeografía, flora, *Heterothalamus*, nuevo registro.

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Introduction

The knowledge of the richness and distribution of the flora in the Peruvian Andes is still incomplete, which is reflected by the constant reports of new species and new records for the country (Gonzáles et al., 2016; León et al., 2018), where in the last decade these novelties have reached 70 species and of which 20% corresponds to the Asteraceae (Beltrán, 2009; Montesinos-Tubée, 2014; Montesinos-Tubée et al., 2015, 2017, 2018; Gonzáles et al. 2016; Beltrán and Granda, 2017).

In the present work, *Baccharis acaulis* (Wedd. ex R.E. Fr.) Cabrera, a new record for the high Andean flora of Peru, is documented. This species had not previously been registered by Brako and Zarucchi (1993), Ulloa Ulloa et al. (2004; 2017), Beltrán et al. (2006), and much less for other works that have listed new records or nomenclatural novelties for the Peruvian flora (Dillon and Sagástegui, 2002; Vásquez et al., 2002; Rodríguez et al., 2006; Linares et al., 2010; Gonzáles et al., 2016). This finding is the result of a study whose purpose is to develop the checklist of vascular plants of the Peruvian Andes.

Baccharis L. is a large genus of the tribe Astereae with 300 to more than 500 species (Malagarriga, 1976; Nesom, 1990; Bremer, 1994; Hellwig, 1996) widely distributed in America, but with a mayor diversity throughout the Andes (Müller, 2006). The genus contains about 77 species in Peru (Brako and Zarucchi, 1993; Ulloa Ulloa et al., 2004), 17 of them being endemic to Peru (Beltrán et al., 2006).

Baccharis acaulis was initially described and validly published as *Psila caespitosa* Phil. (Philippi, 1891), and subsequently as *Heterothalamus acaulis* Wedd. ex R.E. Fr. (Fries, 1905); however, due to its paleate female capitula, it has later been subordinated to *Pseudobaccharis* Cabrera (Cabrera, 1944). Finally, it was located inside *Baccharis* (Cabrera, 1975).

This taxon had only been previously mentioned as growing in Peru (Müller, 2013), but no herbarium material was known to support its presence, which is why we make this formal as a new record. Therefore, the objective of this paper is to contribute to the knowledge of the Peruvian flora through a new record of *Baccharis acaulis*. In addition, the distribution pattern of this species is examined in function of its habitats of occurrence.

Material and Methods

Field work and herbarium study

In recent explorations realized in the department of Cusco (South Peru), we collected a specimen of Asteraceae that at first glance did not fit within the known taxa for this area of Peru. A review of available literature and consultations with colleagues was necessary. The collections were deposited in the herbarium of the Museum of Natural History of the National University of San Marcos (USM). Additionally, we consulted the principal Peruvian herbaria (CPUN, CUZ, HUSA, HUT, MOL, and USM) to find more records. These herbarium specimens were studied under a stereomicroscope (Leica-EZ4 1X–4.5X, Leica Microsystems, Wetzlar, Germany).

Potential distribution model

The locations in which the species has been registered were obtained by consulting the collections of the herbaria BOLV, CONC, CORD, GH, JE, K, LP, LPB, MO, NY, P, S, SGO, SI, US and USM.

The machine learning algorithm Maxent version 3.3.3e (Phillips et al., 2006) was used for developing the habitat suitability maps, for being one of the most reliable methods when working with a small number of occurrence records (Elith et al., 2006; Hernandez et al., 2006; Benito de Pando and Peñas de Giles, 2007; Pearson et al., 2007; Wisz et al., 2008; Särkinen et al., 2013). We ran Maxent based on the 25 records from Peru, Bolivia, Chile and Argentina to identify potential suitable habitat areas for *Baccharis acaulis*. The model was run with default settings (see details in Särkinen et al., 2013). To evaluate model performance, we ran the model with cross-validation because it uses all of the data for validation. For the interpretation of the model we used the receiver operating characteristic (ROC) and the area under the curve (AUC) (Hanley and McNeil, 1982; Fielding and Bell, 1997; Segurado and Araújo, 2004; Phillips et al., 2006; Phillips and Dudík, 2008). Values of AUC close to 1 indicate an optimal functioning of the model, values close to 0.5 indicate performance equal to random (Phillips et al., 2006).

The model was run with 19 bioclimatic variables, based on the interpolation of temperature and precipitation data of the WorldClim database (Hijmans et al., 2005) with a 30 arc second spatial resolution (ca. 1 km^2) (Hijmans et al., 2005). After the jackknife analysis, 10 variables were selected to run the final model. The remaining 10 variables included layers describing the seasonality of the habitat (bio1, bio2, bio3, bio5, bio6, bio9, bio10, bio11, bio13, bio14). A final distribution map for *B. acaulis* was produced based on the logistic output format, where all areas with relative suitability greater than 50% were considered as potential areas of occurrence for the species.

Results

Taxonomical details

Baccharis acaulis (Wedd. ex R.E. Fr.) Cabrera, Bol. Soc. Argent. Bot. 16(3): 255. 1975. (Fig. 1).

= *Psila caespitosa* Phil. Anales Mus. Nac. Santiago de Chile Botánica 1891(8): 36, t. 1, f. 4. 1891. SYNTYPES: Chile. Region Antofagasta, province San Pedro de Atacama, planta femenina de Machuca (small Andean village), 3200 m, planta hermaphrodita de Guanaqueros allatae sunt, without date, *Philippi s.n.* (SGO-43827, SGO-64394, LP-002306!).
≡ *Heterothalamus acaulis* Wedd. ex R.E. Fr., Nova Acta Regiae Soc. Sci. Upsal., ser. 4, 1: 79. 1905.
≡ *Pseudobaccharis acaulis* (Wedd. ex R.E. Fr.) Cabrera, Notas Mus. La Plata 9: 248. 1944. TYPE: Argentina. Province Jujuy, department Tumbaya, locality Moreno, 3500 m, 23.X.1901, masculine flowers, *Fries 701* (lectotype: (designated by Müller, 2006) S 04-474!, isolectotype: US 00129267!). Illustrations: Philippi (1891: Tab. I, Figs. 4A-H), Cabrera (1978: Figs. 90A-H), Müller (2006: Figs. 113A-O).

Perennial herb, rhizomatous, creeping, low-growing, forming mats 0.5-2 cm tall; plants with long pale subterraneous rhizomes; leaves sessile, rosette-forming, linear, 5-20 × 0.1-1 mm, sheathing at the base, apex obtuse, fleshy, margin entire, 3-veined at base (1-veined at lamina); synflorescences of solitary sessile terminal capitula, solitary at the apex of dense leaf rosettes; male capitula hemispherical, 4-7 mm long, receptacle without palea, flowers 20-35, involucres 4-6 × 3-5 mm, phyllaries 15-25 in 3-4 series, the outermost phyllaries narrowly ovate and acute, median phyllaries elliptic, broadly lanceolate or ovate, innermost phyllaries longer than outermost ones, linear-oblong, obtuse or subobtuse, all phyllaries whitish green, apically tinged with purple, phyllaries margin rather broadly scarious, short to long-dentate in the distal portion; corolla 3-4 mm long, tube 1.2-1.8 mm long, throat portion 1-1.5 mm long, campanulate, lobes 0.8-1.1 mm long, curved at maturity, pubescent in distal half, anther length double that of filaments; style not or slightly exceeding the corolla, sterile ovary glabrous, pappus with inconspicuously broadened bristles at apex, 2.4 mm long, bristles 25-50; female capitula hemispherical, 4-9 mm long, receptacle with linear palea, flowers 30-50, involucre 3-7 × 3-4 mm, cup shaped, phyllaries 25-40 in 2-4 series, such as the male; corollas 2.5-4.5 mm long, apex inconspicuously denticulate, style branches short but separate, achenes 1-2 mm long, 5-angled, glabrous, pappus 2-seriate, accrescent.

Material examined: ARGENTINA. Province Catamarca, department Belén, Reserva Laguna Blanca, 3260 m, 01.VI.2002, *M. Borgnia 6* (LP). Province Jujuy, department Humahuaca, 3529 m, *B. Ruthsatz 157* (LP). Department Tumbaya, locality Moreno, 3500 m, 23.X.2001, *R. E. Fries 701* (CORD, S, US). Province Salta, department Los Andes, 3800 m, *A. L. Cabrera 10608* (LP); Los Andes, Mina Sijes, 3800 m, 02.XII.1988, *A. Charpin 20789* (SI, US 3107570); Mina Sijes, 3800 m, 3.XII.1986, *L. Novara et al. 5742* (MCNS); San Antonio de Los Cobres, 3800 m, 21.XII.1948, *M. H. Humbert 21077* (P-P00218234); San Antonio de los Cobres, puna de Jujuy, 21.X.1948, *R. E. Fries s.n.* (S); 3800 m, 03.XII.1934, *E. J. Ringuelet 116* (LP). Department Rosario de Lerma, puna de Jujuy, Diego de Almagro, 21.X.1948, *R. E. Fries s.n.* (S); loc. cit., *A. L. Cabrera 10612* (LP). BOLIVIA. Department Cochabamba, province Carrasco, Siberia, 17°49'47"S-64°44'07"W, 2940 m, 20.II.2005, *S. Altamirano Azurduy 3077* (BOLV); Carrasco, Siberia, 17°49'47"S-64°44'07"W, 2940 m, 20.II.2005, *E. Fernández Terrazas 3216* (BOLV). Province Tapacarí, Jacha Rancho, Comunidad de Japo, km 125 Cochabamba - Oruro, 4000 m, *A. Pestalozzi 866* (LPB); Campanani, Comunidad de Japo, km 125 Cochabamba - Oruro, 4180 m, 19.XI.1995, *H. U. Pestalozzi 735* (BOLV); Comunidad de Japo, km 125 Cochabamba - Oruro, Jacha Rancho, 4200 m, 18.IX.1996; *H. U. Pestalozzi 867* (LPB). Department La Paz, province Aroma, Umala, 3810 m, *K. Graf 172* (NY). Province Larecaja, Viciniis

Figure 1: *Baccharis acaulis* (Wedd. ex R.E. Fr.) Cabrera; A. habit; B. details of rhizomatous plant; C. details of male flowering branches; D. details of female flowering branches; E. capitulum showing the rows of phyllaries; F. capitulum of male flowers; G. details of male flowers; H. fruits; I. leaf (upper side), J. details of phyllaries.

Sorata, prope Apacheta de Logena, in graminosis, 4000 m, VIII.1859, *G. Mandon 109* (G, NY, P-P00218233, S). Province Pedro Domingo Murillo, 5.5 km E of the junction with road to Collana, on road between Cota Cota and Palca, open, heavily grazed slopes with some boggy areas along streams and seeps, 16°32'S, 67°58'W, 3900 m, 25.IX.1982, *J. C. Solomon 8248* (MO 3681776, NY, US); "Plain above La Paz, in damp places near borders of lakes, 14500 ft.", *R. Pearce s.n.* (BM); La Paz, 3900 m, *Williams 2342* (NY). Department Oruro, province Avaroa, Pampa de Huancané, 3800 m, *C. Troll 3024* (B). Province Sabaya, sur de Sabaya, Salar de Coipasa, 3670 m, *S. G. Beck 21566* (JE, LPB). Province Sajama, near the village of Sajama along the banks of the Rio Sajama, 4260 m, 18.X.1967, *B. Vuilleumier 317* (GH, MO 3230979, NY, US). Province Sur Carangas, S de Andamarca, Laguna Tacata, 3700 m, Stab B388 (LPB). Department Potosí, province Antonio Quijarro, cerca de Tica Tica, camino Uyuni - Potosí, 3600 m, *E. Jordan et al. 57* (LPB). Province Chayanta, 1.6 km SW de Ocuri, 4000 m, *M. Massy 65* (LPB). Province Enrique Baldivieso, 3 km de Alota, 4000 m, *M. Liberman 222* (LPB). Department Tarija, province José María Avilés, Avilés, cerca Passajes, borde de Laguna (sal), 3255 m, casi plano, suelo limoso, 29.I.1986, *Bastian 635* (LPB); Iscayachi 23.7 km hacia Villazón, Hoyada chica, 3800 m, *S. G. Beck 11025* (LPB). CHILE. Region Antofagasta, province Antofagasta, 4180 m, 23.II.2009, *F. O. Zuloaga 11153* (SI). Province El Loa, Salar de Ascotan, 21.6°S, 68.3°W, 3800 m, 01.II.1997, *S. Teillier 4225* (CONC). Region Arica y Parinacota, Province Parinacota, quebrada profunda antes de Colpitas, 4086 m, 20.X.2012, *A. Moreira 2023* (SGO); Putre, Laguna Chungará, 4590 m, *B. Ruthsatz 7990* (JE). PERÚ. Department Cusco, province Chumbivilcas, Chamaca, arriba de Uchucarco, Laguna Yanacocha, 4364 m, 4.IX.2017, *P. Gonzáles 4192* (USM); Chumbivilcas, Velille, arriba de Chilloroya, Cochapampa, 4305 m, 4.IX.2017, *P. Gonzáles 4195* (USM); Chumbivilcas, Chamaca, Puente Arizona, camino a Uchucarco, 3917 m, 4.IX.2017, *P. Gonzáles 4196* (USM), *4197* (USM); Chumbivilcas, Chamaca, debajo de Mina Catanga, 3973 m, 4.IX.2017, *P. Gonzáles 4198* (USM), *4199* (USM); Chumbivilcas, Chamaca, debajo de Uchucarco, puente hacia Velille, 3845 m, 4.IX.2017, *P. Gonzáles 4200* (USM), *4201* (USM). Province Espinar, Espinar, Alto Huancané, 3961 m, 01.X.2015, *P. Gonzáles 3850* (USM); Espinar, intersección de quebrada Tintaya con río Salado, 3917 m, 8-18.IX.2016, *P. Gonzáles 3958* (USM); 4 km de Espinar, debajo del puente en Río Salado, 3900 m, 30.VIII.2017, *P. Gonzáles 4190* (USM); Espinar, 8-9 km de Espinar, desvío a Kanamarca, 3950 m, 30.VIII.2017, *P. Gonzáles 4191* (USM). Department Puno, province Lampa, Santa Lucia, moist environs on the side of the Río Verde, 14000 ft., 2.II.1939, *J. E. Sharpe 101* (K); province Puno, San Antonio de Esquilache, bogs, 14600 ft., 30.VIII.1934, *D. Stafford 1121* (K).

Real and potential distribution

The distribution of *Baccharis acaulis* covers the Altiplano and adjacent ranges in Peru (Cusco, Puno), Bolivia (Cochabamba, La Paz, Oruro, Potosí, Tarija), northern Chile (Arica y Parinacota, Tarapacá, Antofagasta), and northwestern Argentina (Catamarca, Jujuy, Salta). It can be found in the high Andean wetlands, mainly at the margin of streams and brackish lagoons at 3200-4600 m (Giuliano, 2001; Müller, 2006; Freire et al., 2011; Moreira-Muñoz et al., 2016).

The final model yielded AUC values >0.98 indicating good model performance. The two most important climatic variables were minimal temperature of the coldest month (bio6) and mean temperature of the coldest quarter (bio11). Other important variables included annual mean temperature (bio1), mean temperature of driest quarter (bio9), precipitation of wettest month (bio13) and precipitation of driest month (bio14).

Along the Andes, the potential distribution model indicates the existence of very suitable areas for the presence of *B. acaulis* between 13° and 26°S, whose most extensive areas are between Bolivia and Chile (17°-19°S), as well as between Bolivia and Argentina (21°-23°S) (Fig. 2). The northern limit of the potential area (more than 70%) of distribution predicted along the Andes is only 1.5° of the record found in the department of Cusco, which shows the usefulness and effectiveness of the species distribution models.

In Peru, the potential distribution model showed very suitable climatic conditions for *B. acaulis* in the departments of Cusco, Puno, Apurímac, Arequipa, Ayacucho, Moquegua, and Tacna (Fig. 2). The last five departments remain without confirming the presence of this species. In addition, it identified areas that are reasonably suitable

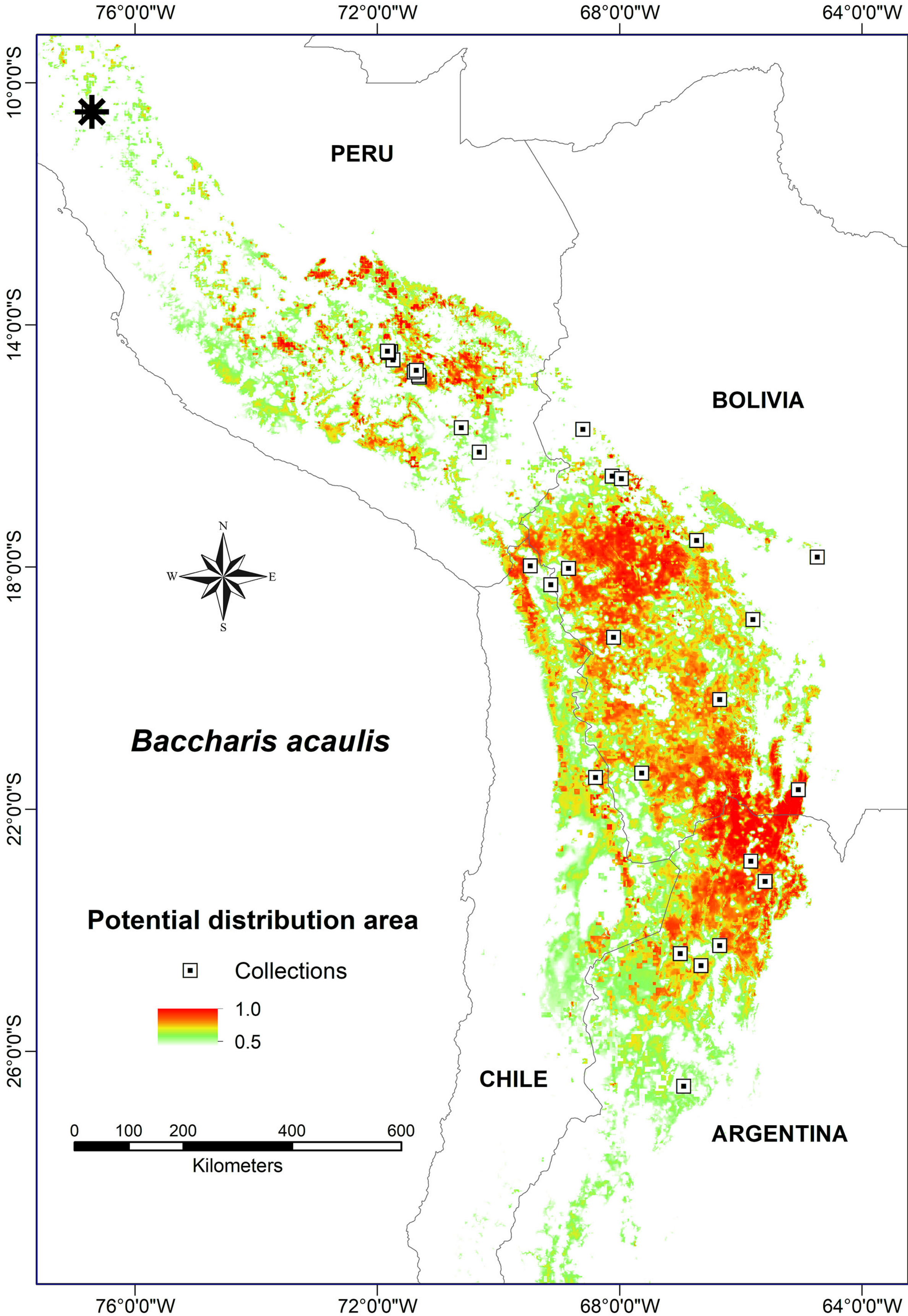

Figure 2: Real and potential distribution map of *Baccharis acaulis* (Wedd. ex R.E. Fr.) Cabrera showing the known collections (white square). The map shows the areas identified with very suitable habitats (>50%). The collection of *Baccharis davidsonii* Cuatrec. are also shown (black asterisk).

towards central Peru, where in a recent expedition we recorded a population of *Baccharis davidsonii* Cuatrec. (Lima, Oyón, Raura, 4770 m, 17.X.2017, *A. Cano et al. 22585* (USM)*, 22587* (USM)), a closely related species in *Baccharis* sect. *Psila* (Phil.) Cuatrec. (Heiden and Pirani, 2016). The model also predicted the presence of *B. acaulis* in Bolivia, Chile and Argentina, but in these countries, there are records of specimens for the regions (Chile), departments (Bolivia) or provinces (Argentina) where their potential distribution is predicted.

In recent evaluations throughout the Peruvian Andes and search efforts in herbaria, five localities of *B. acaulis* were recorded in the Andean zone of southern Peru. These five localities together with the localities of Bolivia, Chile and Argentina suggest a continuity of the distribution of *B. acaulis* throughout the dry puna (13°-26°S).

Ecology

Baccharis acaulis grows always associated with humid areas named wetlands or locally named "bofedales"; however, it is not a main component of this vegetation type (Gonzáles, 2015), as it is only associated with the edges of small rivers or channels that run through the "bofedales" without moving more than four meters from the edge. This suggests a predilection for permanently saturated water soils. *Baccharis acaulis* also grows in brackish areas, and its adaptive mechanisms to those soil are still unknown. On the one hand, in the dry puna, the "bofedales" and "salares" are the only environments with high water availability, being the salt flats those that have a permanent water regime in comparison to the "bofedales" whose regime is very variable and temporary. On the other hand, the recent record of *B. davidsonii* in the central Andes of Peru corresponds to the humid puna, which presents vegetation types with higher humidity than the dry puna (Josse et al., 2011). Despite the greater humidity of the "bofedales" in the central Andes of Peru, *B. davidsonii* as well as *B. acaulis* continue to grow at the edges of this vegetation type and are always associated with water courses. In addition to the "bofedales" in the humid puna, there are other areas with high levels of humidity such as rocky and cryoturbated soils, where some cushions of *B. davidsonii* have also been recorded (own observation).

Discussion and conclusion

Distinctive morphology

Baccharis acaulis differs from all other species of *Baccharis* in its unique habit; it is a rhizomatous herb in which the aboveground part consists of small leaf rosettes surrounding a solitary capitulum (Müller, 2006).

Most species of *Baccharis* are woody shrubs, erect and larger than 10 cm tall; but there are also some small and procumbent shrubs such as *Baccharis caespitosa* (Ruiz & Pav.) Pers., *Baccharis alpina* Kunth, *Baccharis humifusa* Kunth and *Baccharis pumila* Joch. Müll., which form small cushions that grows at ground level. In this context, *B. acaulis* as well as *B. davidsonii* are unique species, because they are the only two high Andean species with herbaceous habit, growing like a rhizomatous rosette.

The capitulescence type in *Baccharis* has several forms (panicles, racemes, spikes); however, the most peculiar forms are the solitary and terminal capitula as registered for *Baccharis acaulis*, *B. alpina*, *B. davidsonii*, *B. pumila* and *B. tola* Phil*.* This form is very common in diverse Andean genera of Asteraceae such as *Hypochaeris* L., *Paranephelius* Poepp., *Senecio* L., *Werneria* Kunth, and *Xenophyllum* V.A. Funk, amongst others.

The unusual characteristics of *B. acaulis* have led to its classification in different genera (Cabrera, 1944, 1955; Cuatrecasas, 1967), and even in a different infrageneric position within *Baccharis*. Müller (2006) placed it in the *Baccharis juncea* (Lehm.) Desf. group due to its glabrous, fleshy and narrow leaves, the pappus of female flowers which is strongly elongated at achene maturity, comprising several bristle series. Giuliano (2001) placed it in the section *Angustifoliae* Baker due to its linear, one-veined leaves, solitary capitula, corollas of female flowers with truncated apex, pappus of female flowers which is biseriate and accrescent, and the achenes with five sides. Recently, it has been placed in *Baccharis* subgen. *Heterothalamus* (Lessing) G. Heiden within *Baccharis* sect. *Psila*, which consists of halophyllous, shrubby cryptophytes with long and multibranched subterraneous rhizomes bearing deciduous scales and presenting ephemeral aerial branches with solitary capitula subtended by leafy rosettes (Heiden and Pirani, 2016).

Phenology

In the dry regions on the Altiplano and in the Andean southern Peru, flowering periods of Asteraceae are largely restricted to the wet season (Müller, 2006), but they may also occur in the dry season (August to December, rarely extended to February) as registered for *B. acaulis*.

Distribution

Müller (2006) mentions that some species of *Baccharis* are restricted to the Altiplano zone centred in Bolivia, southern Peru, northern Chile and northwestern Argentina; among these species is *B. acaulis,* although no collections from Peru were cited.

The habitat exclusively in high Andean zones of *B. acaulis* reaffirms the floristic affinity between wetlands "bofedales" of Bolivia, northern Chile, northern Argentina and southern Peru, due to the homogeneity and environmental continuity of the high Andean wetlands, whose biotic limits do not necessarily respond to international borders (García, 2007; Gonzáles et al., 2016). This distribution pattern of *B. acaulis* agrees with the distribution of other typical species of "bofedales" such as *Patosia clandestina* (Phil.) Buchenau and *Oxychloe andina* Phil. which have registered their northernmost distribution in the south of Peru (Balslev, 1996; Ruthsatz, 2012).

Ecology

Baccharis acaulis grows in humid, often saline, soil for which it needs to present some mechanisms to counteract stress conditions (Lieth and Mochtchenko, 2003; Teillier and Becerra, 2003; Ruthsatz, 2012). Frequently, salt tolerance is associated with tolerance to water stress; however, if salt toxicity is the main cause of the effect of salinity, salt tolerance is not necessarily linked with water stress tolerance (Villagra and Cavagnaro, 2006); this could be the mechanism of *B. acaulis,* since it would be the most important for the ecological success of this species. Furthermore, this salt stress tolerance could be an adaptive factor in the niche differentiation of *B. acaulis* and its capacity to grow in salt soil, since the habitats where *B. acaulis* grows are the unique place with highest level of water in the dry puna.

Apparently, *B. acaulis* is a facultative halophyte which can tolerate salt stress but not drought, as has been reported for other species such as *Suaeda salsa* (L.) Pall. and *Kalanchoe daigremontiana* Raym.-Hamet & H. Perrier (Zhao and Harris, 1992; Zhao et al., 2003). This idea is reinforced by the lower tolerance of *B. acaulis* to water stress (field observations), which supports the affirmation that physiological and ecological responses are different between halophytes and xerophytic plants (Zhao and Harris, 1992; Lieth and Mochtchenko, 2003; Zhao et al., 2003).

Baccharis acaulis should then have mechanisms allowing it to survive under salt stress conditions, which are not related to the presence of salt elimination organs; rather the higher salt tolerance of *B. acaulis* could be related to its ability to counteract the toxic effect rather than the osmotic effect of salt, as has been proposed for other Andean species of *Prosopis* L. (Villagra and Cavagnaro, 2005).

This report is relevant for contributing to the knowledge of an additional species for the Peruvian flora, besides registering the northernmost area (15°S) for the species and showing the biogeographical importance of the dry puna for housing species typical of this zone. It also supports the hypothesis that this area in southern Peru would coincide with the northern limit of the renowned dry puna (Josse et al., 2009, 2011). However, the record of *B. davidsonii* in the central Andes of Peru is more than 700 km away from the populations of *B. acaulis* in southern Peru, being the northernmost distribution limit of *Baccharis* section *Psila*.

Author contributions

JM and PG performed the study of herbarium material, PG performed sampling, manuscript preparation, and data analysis, PG, AC and JM performed interpretation and preparation of the final version.

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