

# ***Philonotis minuta* (Bartramiaceae, Bryophyta) is proposed as the correct name for *P. brevifolia*, and recorded for the first time in North America from California (U.S.A.)**

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**Abstract** – The study of the type specimen of *Bartramia minuta* Taylor, a species described based on Ecuadorian samples that predates the recently resurrected Chilean *Philonotis brevifolia* Herzog shows that both names displayed the same set of diagnostic characters. In this contribution, *P. minuta* is proposed as the correct name of this taxon, a lectotype is selected, and its distribution is extended to North America, based on samples collected in California.

**Chile / Distribution / Ecuador / lectotype / *Philonotis krausei* / taxonomy / Sudamerica**

## INTRODUCTION

*Philonotis* Brid. is a genus of the Bartramiaceae easily recognized by the small size of the plants, the ovate to lanceolate leaves, laminal cells quadrate to rectangular, papillose to prorate at the angles; capsules ovoid to sub-globose, rugose to strongly furrowed when dry, and reniform, clavate spores (Allen, 1999). American species are commonly found growing on rocks or soil, usually associated with wet sites such as stream banks or seeps, from near sea level to 4700 m (Gradstein *et al.*, 2001; Jimenez *et al.*, 2014, 2016). *Philonotis* includes ca 180 species worldwide; of them only eleven are recorded from North America (*Philonotis calcarea* (Bruch & Schimp.) Schimp., *P. capillaris* Lindb., *P. cernua* (Wilson) D.G. Griffin & W.R. Buck, *P. fontana* (Hedw.) Brid., *P. gracillima* Ångstr., *P. longiseta* (Michx.) E. Britton, *P. marchica* (Hedw.) Brid., *P. seriata* Mitt., *P. sphaericarpa* (Hedw.) Brid., *P. uncinata* (Schwägr.) Brid., and *P. yezoana* Besch. & Cardot) (Griffin, 2014).

As part of the revision of the genus *Philonotis* in South America, some works have been already published (Jimenez *et al.*, 2014; Ellis *et al.*, 2016), and the analysis of several type specimens have been performed, including the one of *Philonotis brevifolia* Herzog. That is a Chilean species proposed as synonym of *Philonotis krausei* (Müll. Hal.) Broth. by Seki (1974) and recently resurrected by the first author (Jimenez *et al.*, 2016).

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*Bartramia minuta* Taylor was established in 1847 based on samples collected in Ecuador by Jameson, latter transferred to *Philonotis* by Jaeger (1875) and finally synonymized under *Philonotis uncinata* (Schwägr.) Brid. by Griffin (1994).

In the spring of 2014 a collection of a small, dark green *Philonotis* species was made by the second author and Edward Dearing from Northern California. It could not be assigned to any of the species recorded from North America (Griffin, 2014) or the known species from Russia (Koponen *et al.*, 2012), China (Koponen, 1998), Mexico (Griffin, 1994) and Europe (Frey *et al.*, 2006; Guerra & Gallego, 2010).

The objectives of this contribution were: i) to know the identity of the specimen collected in California, ii) to study the identity of the *Bartramia minuta* type and its possible conspecificity with other species of the genus *Philonotis* in South America, iii) to characterize *Philonotis minuta* morphologically in order to be distinguished from other nearby species in the USA and to define its current distribution.

## MATERIAL AND METHODS

The Californian *Philonotis* sample was found in a savannah of blue oak (*Quercus douglasii* Hooker & Arnott) and grey pine (*Pinus sabiniana* Douglas) interfacing with chaparral dominated by chamise (*Adenostoma fasciculatum* Hooker & Arnott), toyon (*Heteromeles arbutifolia* (Lindley) Roemer), and leather oak (*Quercus durata* Jepson). The population occurred on a partly shaded, calcitic, vernal seepy bank of heavy soil composed of decomposed metabasalt and argillite. Associates at the site included *Pohlia wahlenbergii* (F. Weber & D. Mohr) A.L. Andrews, a small amount of *Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spence & H.P. Ramsay *ex* Holyoak & N. Pedersen, and immature grasses.

The second author observed a similarity with the description and illustrations of the recently resurrected *Philonotis brevifolia* from South America (Jimenez *et al.*, 2016). On this account, the Californian specimen was sent to the first author for examination.

The sample collected in California was studied and compared with *Bartramia minuta* type specimens housed at BM, NY and OXF, and also with *Philonotis brevifolia* type specimens from JE and LIL-Matteri.

The specimens were analyzed morphologically with conventional techniques for bryophytes and mounted on Hoyer's solution (Anderson, 1954). Microscopic characters were analyzed by using light microscopy (LM) Leica Model CME.

## RESULTS

### Study of *Bartramia minuta* type

The type specimens of *B. minuta* housed at BM, NY and OXF are forming turfs intermixed with two *Philonotis* species: *P. hastata* (Duby) Wijk & Margad. and

*Philonotis osculatiana* De Not. They are easily separable from *B. minuta* because of the distal position of the papillae in *P. osculatiana* and *P. hastata* against the proximal turning distal position of the papillae in the laminal cells of *B. minuta*. The OXF specimen contained scarce mats with a single capsule; also the label includes little information other than collector and locality. Nevertheless, the BM and NY specimens were complete, abundant and well preserved. The specimen used by Taylor was deposited in the Wilson herbarium (currently preserved at BM), so the BM sample was chosen as the most suitable lectotype of *B. minuta*. Identical characters were observed in *Philonotis brevifolia* by Jimenez *et al.* (2016), therefore we concluded that both are conspecific.

***Philonotis minuta*** (Taylor) A. Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1873-74 (*Gen. Sp. Musc.* 5: 81-82) 1875  $\equiv$  *Bartramia minuta* Taylor, *London J. Bot.* 6: 335. 1847. Type citation: Ecuador, near Quito, XI/1846, *Jameson* 25. Type: Pichincha, Quito, *Jameson s/n*. **Lectotype**, designated here: BM-000960362!; isolectotypes: NY-01196135!, OXF-00004748!

= *Philonotis brevifolia* Herzog, *Rev. Bryol. Lichénol.* 23: 79. 1954. Type citation: [Chile] Westpatagonien: Pto. Aysén, auf feuchter Erde, *G.H. Schwabe, n°45/b*. Type: Fl.v. Westpatagonien Pto. Aysén. Leg. *Schwabe n°45/b*, 22/III/1940 Lectotype designated by Jimenez *et al.* (2016): JE- JE04008355!; isolectotype: LIL-Matteri!)  
**syn. nov.**

## Description of *Philonotis minuta*

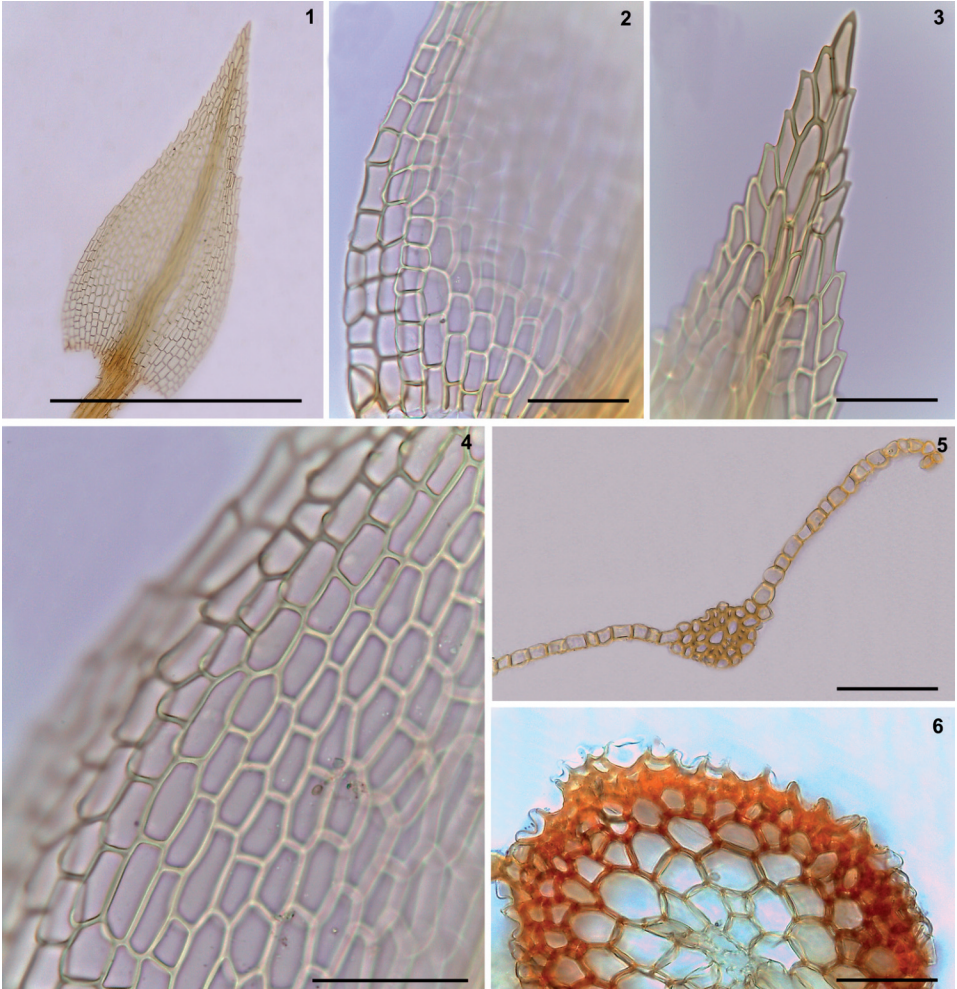
Figs 1-6

*Plants* small (0.7-1 cm), green to yellowish-green, growing in dense turfs. *Stem* reddish-brown, finely tomentose below; cross section rounded, sclerodermis in 2 rows, central strand weakly developed; axillary hairs 2-celled, brown basal cell short, apical cell hyaline and globose, 11-15  $\mu\text{m}$  long. *Rhizoids* smooth. *Leaves* erect when dry, erect-spreading when wet, laxly spaced, ovate-lanceolate, 0.8-1.4  $\times$  0.3-0.4 mm, apex acuminate, margin serrate in the upper half, entire in the lower half, slightly recurved in upper 2/3 of lamina, plane at base; costa well defined, 56-66  $\mu\text{m}$  wide at base of leaf, percurrent to short-excurrent, weakly prorate at both surfaces; in cross-section with one layer of 2-3 guide cells, ventral stereids absent to weakly developed, dorsal stereids in 2-3 layers, epidermis dorsal and ventral present; upper laminal cells short-rectangular to oblong-rectangular, 24-29  $\times$  9-11  $\mu\text{m}$ , with papillae at proximal ends, turning distal to the apex on both surfaces; basal cells rectangular-oblong, 31-39  $\times$  14-19  $\mu\text{m}$ . *Sexual* traits not seen. *Sporophytes* not seen.

## Identity of the Californian sample

Despite the larger size of the Californian specimen and the stronger expression of the papillae, it could be identified as the South American species *P. minuta* because of several important shared morphological traits (specially the ovate-lanceolate leaves, weakly recurved at the apex, laminal cells papillose at proximal angles turning distal to the apex on both surfaces).

Specimen examined: U.S.A. California, Lake County, Goat Rock, 2 miles southwest of Harbin Springs and 2 miles northwest of Middletown. 38° 46' 07.45" N, 122° 37' 40.95" W, 3600 m, Blue Oak woodland and chaparral on seepy roadside clay soil in diffuse light, 17/III/2014, *Toren & Dearing 10144* (CAS, CTES, NY).



Figs 1-6. *Philonotis minuta*. 1. Leaf, 2. Base of leaf; 3. Apex of leaf; 4. Detail of the papillae at the middle of the lamina; 5. Leaf cross section, 6. Stem cross section. Scales bar: 1 = 1 mm; 2-6 = 50  $\mu$ m (all from Toren & Dearing 10144; CTES).

### Geographical distribution of *Philonotis minuta*

It is a Neartic-austral Neotropic species distributed along the Andes Region in South America (Morrone, 2001) in Chile and Ecuador; and is now recorded from the California Floristic Province of North America, in the U.S.A. (Fig. 7). In the former region it inhabits lowlands of anthropogenically disturbed areas, and in the latter region it was found in a narrow ravine by an intermittent stream.



Fig. 7. Distribution map of *Philonotis minuta*. Circles: previously known records. Square: new record.

## DISCUSSION

Despite the complexity of the genus and the difficulty to differentiate species, we agree with Zales (1973) that characters derived from the leaf (leaf shape, margin, apex, costa, position of the papillae on the leaf cells, and leaf cell shape) are stable characters that are not modified by the environment. In reference to this, *Philonotis minuta* is characterized by a combination of leaf characters that include the ovate-lanceolate leaves, acuminate apex, serrate margin at the apex, plane at base and weakly recurved towards the apex, percurrent to short-excurrent costa and short-rectangular, papillose at proximal angles turning distal at the apex on both laminal cells surfaces.

This species is included in section *Philonotis* Broth. by the proximal position of the papillae (Koponen, 2015) along with three of the eleven species recorded in North America (*Philonotis calcarea*, *P. fontana*, and *P. seriata*) (Griffin, 2014). *Philonotis calcarea* primarily can be separated from *P. minuta* by the larger size of the plants (9-10 cm long), the margin serrate throughout, geminate at base, weakly recurved at base and the laminal cells mamilliose at base, turning papillose to the apex, papillae proximal on both surfaces. *Philonotis fontana* differs from *P. minuta* by the larger size of the plants (3-6 cm long), the margin serrate throughout, with geminate cells at base, plane to recurved at base, and the linear to oblong-linear shape of the laminal cells at apex. Finally, *P. seriata* is distinguished of *P. minuta*

Table 1. Comparison of diagnostic characters between *Philonotis minuta* and other species of *Philonotis* section *Philonotis*, with proximal papillae recorded in North America. The most important distinguishing characters with respect to *P. minuta* are written in bold

| <i>Characters</i>            | <i>P. calcarea</i>  | <i>P. fontana</i>  | <i>P. minuta</i>  | <i>P. seriata</i>   |
|------------------------------|---|--|---|---|
| <b>Size of the plants</b>    | <b>Large (9-10 cm long)</b>   | <b>Large (3-6 cm long)</b>   | Small (0.7-1 cm long)   | <b>Large (3-5 cm long)</b>  |
| <b>Shape of leaf</b>         | Lanceolate to ovate-lanceolate  | Ovate-lanceolate   | Ovate-lanceolate  | Lanceolate to ovate-lanceolate  |
| <b>Apex</b>                  | Acuminate   | Acuminate  | Acuminate   | Acuminate to acute  |
| <b>Margin</b>                | <b>Serrate throughout, geminate at base; weakly recurved at base</b>                          | <b>Serrate throughout, geminate at base; plane to recurved at base</b> | Entire to serrate at apex; plane at base, weakly recurved at apex | <b>Denticulate to serrate at apex; plane to narrowly revolute at base</b> |
| <b>Costae</b>                | Sub-percurrent to short-excurrent   | Short to long-excurrent  | Percurrent to short-excurrent                                     | Short to long-excurrent   |
| <b>Laminal cells at apex</b> | Oblong-rectangular  | <b>Linear to oblong-linear</b>   | Short-rectangular to oblong-rectangular                           | Linear to long-rectangular  |
| <b>Laminal cells at base</b> | Oblong-rectangular  | Oblong-hexagonal   | Rectangular-oblong  | Oblong-rectangular  |
| <b>Papillae position</b>     | <b>Laminal cells mamillate at base, papillose at apex. Papillae proximal on both surfaces</b> | Proximal turning distal at apex on both surfaces                       | Proximal turning distal at apex on both surfaces                  | <b>Proximal on both surfaces</b>  |

by the larger size of the plants (3-5 cm long), the denticulate to serrate margin at apex, plane to narrowly revolute at base, the linear to long-rectangular laminal cells at apex, and the papillae position proximal on both surfaces (Table 1).

In recent decades, similar disjunctions to that of *P. minuta* have been noted in several species of hepatics and mosses. Flores *et al.* (2017) documented *Cephaloziella hampeana* (Nees) Schiffn., a widely distributed species along the Holarctic region (Northern Hemisphere of Old and New World) and also present in the northern and southern limits of the Neotropics (Mexico-Guatemala and subtropical Argentina). Mosses have also shown a striking distribution type such as that characterizes *P. minuta*, e.g. *Pleurochaete luteola* (Besch.) Thér. a species with a distribution that extends from the southern U.S.A. along the Andean mountains to northwestern Argentina (Suárez & Schiavone, 2005) and *Pelekium mexicanum* (Mitt.) M. Schiavone & G. Suárez, distributed in Mexico, Guatemala, Costa Rica, and northern Argentina (Schiavone & Suárez, 2007). *Bryum chryseum* Mitt. has been also documented in the U.S.A. from California as far north as Mendocino County (Toren & Heise, 2009) and is also distributed in Mexico (Cárdenas & Delgadillo, 1992), Colombia (Churchill & Linares, 1995), Guatemala (Bartram, 1949), Bolivia (Churchill *et al.*, 2009) and central Chile (Ochi, 1980).

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## REFERENCES

- ALLEN B.H., 1999 — The genus *Philonotis* (Bartramiaceae Musci) in Central America. *Hausknechtia Beiheft* 9: 19-36.
- ANDERSON L.E., 1954 — Hoyer's solution as a rapid permanent mounting medium for bryophytes, *The bryologist* 57: 242-244.
- BARTRAM E.B., 1949 — Mosses of Guatemala. *Fieldiana, Botany* 25: 1-442.
- CÁRDENAS A. & DELGADILLO M.C., 1992 — Los Musgos de la Sierra de Alcaparrosa, México. *Acta botánica Mexicana* 17: 23-33.
- CHURCHILL S.P. & LINARES C.E.L., 1995 — *Prodrómus Bryologiae Novo-Granatensis. Introducción a la flora de musgos de Colombia. Parte 1*. Bogotá, Instituto de Ciencias Naturales, Museo de Historia Natural, Universidad Nacional de Colombia, 924 p.
- CHURCHILL S.P., SANJINES ASTURIZAGA N.N. & ALDANA M.C., 2009 — *Catálogo de las briófitas de Bolivia: diversidad, distribución y ecología*. Santa Cruz, Bolivia, Museo de Historia Natural Noel Kempff Mercado and Missouri Botanical Garden, 340 p.
- ELLIS L.T., ASTHANA A.K., SRIVASTAVA P., OMAR I., RAWAT K.K., SAHU V., CANO M.J., COSTA D.P., DIAS E.M., DIAS DOS SANTOS N., SILVA J.B., FEDOSOV V.E., KOZHIN M.N., IGNATOVA E.A., GERMANO S.R., GOLOVINA E.O., GREMMEN N.J.M., ION R., ȘTEFĂNUȚ S., VON KONRAT M., JIMENEZ M.S., SUÁREZ G.M., KIEBACHER T., LÉBOUVIER M., LONG D.G., MAITY D., OCHYRA R., PARNIKOZA I., PLÁŠEK V., FIALOVÁ L., SKOUPÁ Z., POPONESSI S., ALEFFI M., SABOVljević M.S., SABOVljević A.D., SAHA P., AZIZ M.N., SAWICKI J., SULEIMAN M., SUN B.-Y., VÁNA J., WÓJCIK T., YOON Y.-J., ŻARNOWIEC J. & LARRAÍN J., 2016 — New national and regional bryophyte records, 46, *Journal of bryology* 38(1): 47-63.
- FLORES J.R., VON KONRAT M., LARRAÍN J. & SUÁREZ G.M., 2017 — Disjunct or Continuous? On the Distributional Pattern of *Cephaloziella hampeana* (Nees) Schiffn. ex Loeske (Cephaloziellaceae, Marchantiophyta) in South America. *Cryptogamie, Bryologie* 38(1): 53-59.
- FREY W., FRAHM J.P., FISCHER E. & LOBIN W., 2006 — *The liverworts, mosses and ferns of Europe*. Colchester, Harley Books, 512 p.
- GRADSTEIN S.R., CHURCHILL S. & SALAZAR-ALLEN N., 2001 — Guide to the Bryophytes of Tropical America. *Memoirs of the New York Botanical Garden* 86: 1-577.
- GRIFFIN III D., 1994 — Bartramiaceae. In: Sharp A.J., Crum H. & Eckel M. (eds), *The Moss Flora of Mexico. Volume 1*. Bronx, NY, New York Botanical Garden, pp. 537-574.
- GRIFFIN III D., 2014 — Bartramiaceae. In: Flora of North America Editorial Committee (ed.), *Flora of North America North of Mexico. Volume 28, Bryophyta, part 2*. St. Louis, Missouri Botanical Garden Press, pp. 97-112.
- GUERRA J. & GALLEGRO M.T., 2010 — *Philonotis*. In: Guerra J., Brugués M., Cano M.J. & Cros R.M. (eds), *Flora Briofítica Ibérica. Volume 4. Funariales, Sphachnales, Schistostegales, Bryales, Timmiales*. Murcia, Universidad de Murcia, Sociedad Española de Briología, pp. 256-270.
- JAEGER A., 1875 — Adumbratio flore muscorum totius orbis terrarum. Part 5. *Berichtüber die Thätigkeit der St. Gallischen Naturwissenschaftlichen Gesellschaft 1873-1874*: 53-278.
- JIMENEZ M.S., SUÁREZ G.M. & SCHIAVONE M.M., 2014 — Fruiting material of *Philonotis esquelensis* Matteri (Bartramiaceae, Bryophyta) discovered in Chile, *Boletín de la sociedad Argentina de botánica* 49(4): 463-471.
- JIMENEZ M.S., SUÁREZ G.M. & LARRAÍN J., 2016 — Rediscovery and lectotypification of *Philonotis brevifolia* Herzog (Bartramiaceae, Bryophyta), a neglected species from Chile, *Cryptogamie, Bryologie* 37(2): 113-118.
- KOPONEN T., 1998 — Notes on *Philonotis* (Musci, Bartramiaceae). 3. A synopsis of the genus in China, *Journal of the Hattori botanical laboratory* 84: 21-27.
- KOPONEN T., IGNATOVA E.A., KUZNETSOVA O.I. & IGNATOV M.S., 2012 — *Philonotis* (Bartramiaceae, Bryophyta) in Russia, *Arctoa* 21: 21-62.
- KOPONEN T., 2015 — Notes on *Philonotis* (Bartramiaceae, Musci). 15. *Philonotis* on Mt. Kilimanjaro, Tanzania. *Arctoa* 24: 382-388.
- MORRONE J.J., 2001 — *Biogeografía de América Latina y el Caribe*. Manuales y Tesis Sociedad Entomológica Aragonesa (SEA), volumen 3. Zaragoza, CYTED, ORCYT-UNESCO, Sociedad Entomológica Aragonesa.
- OCHI H., 1980 — A revision of the Neotropical Bryoideae, Musci (First part). *Journal of the faculty of education, Tottori University, natural science* 29: 45-154.
- SEKI T., 1974 — A moss flora of Provincia de Aisén, Chile. Results of the Second Scientific Expedition to Patagonia by Hokkaido and Hiroshima Universities, 1967. *Journal of science of the Hiroshima University, Series B, Division 2 (Botany)* 15(1): 9-101.

- SCHIAVONE M.M. & SUÁREZ G.M., 2007 — Las Thuidiaceae en el Noroeste de Argentina. *Boletín de la sociedad Argentina de botánica* 42(3-4): 211-230.
- SUÁREZ G.M. & SCHIAVONE M.M., 2005 — On the presence of *Pleurochaete* Lindb. (Pottiaceae, Musci) in Argentina. *Lindbergia* 30: 93-96.
- TOREN D.R. & HEISE K., 2009 — *Bryum chryseum* Mitt. (Musci: Bryaceae) new to North America north of Mexico. *Evansia* 26: 98-101.
- ZALES W.M., 1973 — Taxonomic revision of the genus *Philonotis* for North America, north of Mexico. Doctoral dissertation. Vancouver, University of British Columbia.