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NOTES ON GEOGRAPHIC DISTRIBUTION

New records of *Nototriche hartwegii* A.W.Hill (Malvaceae, Malvoideae) in Ecuador: updated distribution and range extension

Emilio J. Trujillo[1], Katya Romoleroux[1], Priscilla Muriel[1]

1 *Herbario QCA, Facultad de Ciencias Exactas y Naturales, Pontificia Universidad Católica del Ecuador, Av. 12 de Octubre 1076 y Vicente Ramón Roca, 170525 Quito, Ecuador*

Corresponding author: *Priscilla Muriel (epmuriel@puce.edu.ec)*

Abstract. We report a new record of *Nototriche hartwegii* A.W.Hill, an Ecuadorian endemic species originally described from the southern Andes. For decades, its known distribution was restricted to this region. However, recent publications from the past four years have expanded its range into the central Andes of Ecuador. In this study, we document the presence of *N. hartwegii* in two additional sites of the central Andes and, for the first time, in the northern part of Ecuador near the Colombian border, significantly extending the known range of this endemic species.

Key words. Andes, conservation, Ecuador, endangered, páramo

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INTRODUCTION

Nototriche Turcz. is an Andean endemic genus, with around 110 species ranging from Ecuador to Argentina (Ulloa-Ulloa et al. 2018; Mazzei et al. 2024). In Ecuador, *Nototriche* is only found in the páramo region of the high-altitude mountains. This is the alpine ecosystem of the northern Andes and one of the most biodiverse alpine ecosystems around the world, with high endemism (Romoleroux et al. 2023). Nowadays, four species of *Nototriche* are recognized in the country: *N. ecuadoriensis* Fryxell, *N. jamesonii* A.W.Hill, *N. phyllanthos* (Cav.) A.W.Hill, and *N. hartwegii* A.W.Hill (Chanco and Ulloa-Ulloa 2004; Ulloa-Ulloa et al. 2018).

Nototriche hartwegii was described by Hill (1909) and later synonymized under *N. jamesonii* by Paul Fryxell (1992) in the 44th volume of the series *Flora of Ecuador*. However, Chanco and Ulloa-Ulloa (2004) reinstated the species after a taxonomic revision of the genus in Ecuador and established that *N. hartwegii* has a limited distribution, only being found around the páramos of El Cajas National Park at the southern Andes of Ecuador. Recently, Carrasco et al. (2022) recorded three new populations of *N. hartwegii* around the Reserva de Producción Faunística Chimborazo (Carrasco et al. 2022), expanding the distribution of *N. hartwegii* to the central parts of Ecuador. Despite these taxonomic revisions of *Nototriche* over its full geographic range in Ecuador, a more exhaustive sampling is needed to corroborate the real distribution for each species. Such a revision will contribute to the compilation of fundamental information needed for further conservation efforts, including an updated Red List category assessment. Therefore, as part of an ongoing systematic revision of the genus in the country, we undertook a comprehensive sampling of the genus throughout the páramos of Ecuador.

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METHODS

Sampling, field work, and collections. Herbarium acronyms follow Thiers (2025). We sampled herbarium specimens at Herbario Quito Católica (QCA), Herbario Nacional del Ecuador (QCNE), and Herbario de Azuay (HA) to obtain the known distribution of *N. hartwegii* and to identify areas where the species was absent. We also reviewed the online databases of The Natural History Museum (BM), Meise Botanic Garden (BR), Conservatoire et Jardin Botaniques de la Ville de Genève (G), Royal Botanic Gardens (K), Lund University (LD), The New York Botanical Garden (NY), and Muséum national d'Histoire naturelle (P) to compare herbarium specimens with the type of *N. hartwegii*. As part of our fieldwork, we visited the páramos of El Cajas National Park in Azuay province in southern Ecuador, as well as Imbabura volcano in Imbabura province in northern Ecuador, where the new record was made. We collected specimens under the research permit MAATE-ARSFC-2024-0599 and deposited them at the QCA herbarium for later study.

Spatial distribution analyses. After obtaining coordinates of *N. hartwegii* from the specimens housed at the following Herbaria: Quito Católica (QCA), Herbario Nacional del Ecuador (QCNE), and Herbario de Azuay (HA), we built three distribution maps using ArcGIS Pro v. 3.5 (ESRI 2025): one map showing the distribution in 2004 (A), one in 2022 (B), and one with the current distribution (C). Finally, the geospatial analysis was made using the Geospatial Conservation Assessment Tool (GeoCAT) (Bachman et al. 2011) for Extent of Occurrence (EOO) and Area of Occupancy (AOO) following the recommendations of the IUCN (2024).

Morphological analysis. We compared the collections made at Imbabura volcano with the ones collected at El Cajas National Park and with the available species descriptions (Hill 1909; Chanco and Ulloa-Ulloa 2004). We analyzed diagnostic vegetative and reproductive characteristics using a ZEISS Discovery V8 stereoscope.

RESULTS

***Nototriche hartwegii* A.W.Hill, Trans. Linn. Soc. London, Bot. 7(12): 221. 1909**
Figures 1, 3

New records. ECUADOR — Imbabura • Sendero a la cumbre del Volcán Imbabura, lado izquierdo de la arista; 00°15′41.00″N, 078°10′46.99″W; 4396 m alt.; 15.IX.2024; E.J. Trujillo et al. leg. 4 spec., QCA-254655, QCA-254657, QCA-254658, QCA-254659 — Cotopaxi • Páramo de Quispicacha, eastern slope of Loma Pucyucu-chu; 01°05′00″S, 078°50′30″W; 4370–4420 m alt.; 23.X.2006; P. Sklenář leg. 1 spec.; QCA-57055 — Chimborazo • Laguna de Ozogoche; 02°13′S, 078°37′W; 3500 m alt.; 10.XII.2013; J. Caranqui leg. 1 spec.; QCA-223954.

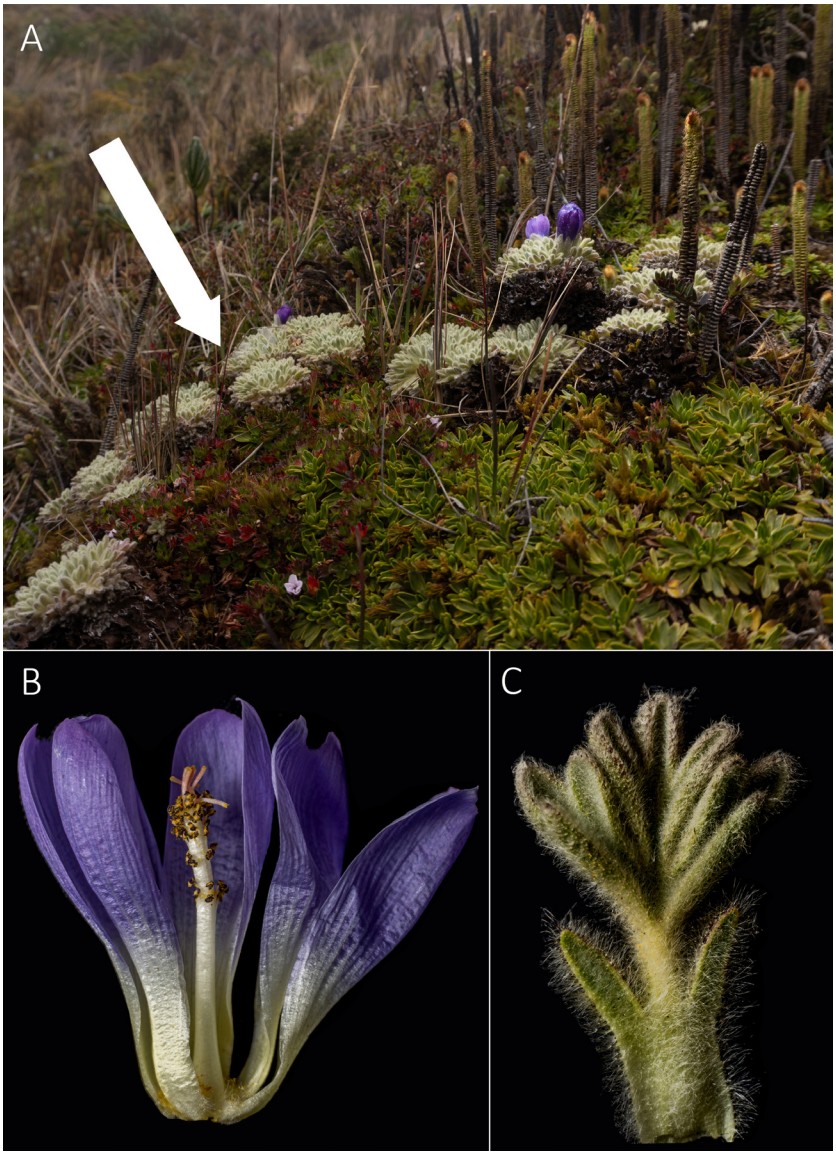

Figure 1. *Nototriche hartwegii* A.W.Hill at Imbabura Volcano, from the collection E.J. Trujillo et al. leg. 1 spec.; QCA-254658. **A.** Habit (pointed to by arrow). **B.** Corolla and staminal tube. **C.** Young leaf showing the adaxial surface. Photographs by Erick Troncoso-López.

Additional specimens studied. ECUADOR — Azuay • Parque Nacional Cajas, road Cuenca-Sayahuasí-Molleturo km 36, trail to Paraguillas, at pass; 02°46'19"S, 079°14'37"W; 4100–4300 m alt.; P.M. Jørgensen, C. Ulloa & J. Caranqui leg. 1 spec.; QCA-57040 • E flanks and summit area of Cerro Amarillo; 02°45'S, 079°15'W; 4300–4400 m alt.; 13.XII.1997; P. Sklenář leg. 1 spec.; QCA- 57056.

Morphological notes. *Nototriche hartwegii* is recognized by the following traits: 1) Individuals are cushion-forming prostrate shrubs with short caulescent leaves in a rosette disposition, sometimes intensely compact. 2) The leaves are palmatilobed, with up to three lobe subdivisions, covered by long stellate trichomes on both surfaces. 3) The stipules are adnate to the petiole, forming a protective membrane, normally called "sheath". 4) The free part of the stipules is slightly lanceolate to oblanceolate, also densely covered with stellate indument. 5) The calyx has five connate sepals, with a free part at the apex forming triangular teeth. 6) The corolla is formed by obovate and free petals, which are purple and fade to white towards their base. 7) The fruit is a schizocarp with 12 mericarps, having long stellate and villous indumentum. The studied individuals from the new localities presented all these traits.

New localities. After the herbaria revision and field work, we identified three new localities where *N. hartwegii* occurs (Table 1). The new populations are located in three different provinces: Chimborazo, Lagunas de Ozogoche; Cotopaxi, Páramos de Quispicacha; Imbabura, Imbabura volcano (Figure 2, 3). The first two were recognized based on herbarium specimens found at QCA, and the last one was a record made at fieldwork.

Conservation analysis results. Our spatial analysis yielded an EOO of 10,492 km^2. However, this estimation includes large areas of lowlands and cities that are not suitable for the growth and survival of this páramo species. The estimated AOO, 28 km^2, is a more realistic of the true occurrence of *N. hartwegi*. Both EOO and AOO are below the quantitative thresholds for Vulnerable (< 20,000 km^2) and Endangered (< 500 km^2), respectively.

Table 1. Localities and coordinates of the seven known populations of *Nototriche hartwegii* A.W.Hill in Ecuador.

Province	Locality	Latitude	Longitude	Publication
Azuay	Parque Nacional El Cajas	02°46'39.00"S	079°14'30.00"W	Chanco and Ulloa-Ulloa 2004
Bolívar	Puente Ayora	01°35'03.84"S	078°49'04.08"W	Carrasco et al. 2022
Bolívar	Pachancho	01°29'58.56"S	078°47'56.40"W	Carrasco et al. 2022
Bolívar	Cruz del Arenal	01°35'14.28"S	078°44'06.00"W	Carrasco et al. 2022
Chimborazo	Lagunas de Ozogoche	02°13.00'S	078°37.00'W	This publication
Cotopaxi	Páramos de Quispicacha	01°50'00.00"S	078°50'30.00"W	This publication
Imbabura	Volcán Imbabura	00°15'41.00"N	078°10'46.99"W	This publication

Figure 2. Locality of the Imbabura volcano in Ecuador, site of the new record of *Nototriche hartwegii* A.W.Hill.

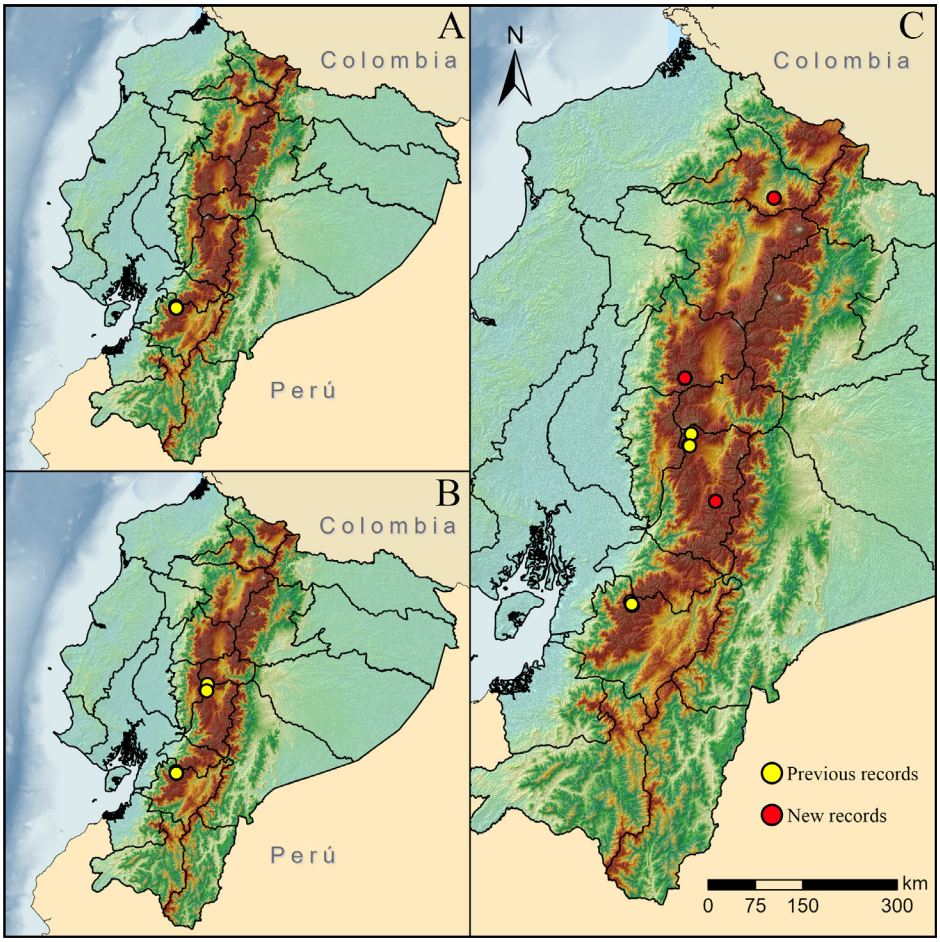

Figure 3. Distribution of *Nototriche hartwegii* A.W.Hill in Ecuador throughout time. **A.** Known distribution in 2004 when the species was re-established by Chanco and Ulloa-Ulloa (2004). **B.** Known distribution in 2022 with new records by Carrasco et al. (2022). **C.** Currently known distribution with new populations (red dots) in the central and northern Andes of Ecuador.

DISCUSSION

Morphological and ecological comparison. At Imbabura volcano, where our new records of *Nototriche hartwegii* were made, the plants possess the vegetative and reproductive diagnostic characteristics of the species as described by Hill (1909). These characters include free petals (Figure 1B), indument presence on the leaves and hair length on leaves, stipules, calyx, and corolla, and having abundant stellate trichomes (Figure 1C). Other relevant traits to consider include the size of the leaf lamina and reproductive structures, which are bigger than those of other *Nototriche* species in Ecuador. Therefore, we now have three populations of the species distributed in Ecuador (Figures 2, 3B). While these individuals share morphological traits, they differ in their habits and ecological preferences at each locality. The populations from Azuay (southern Ecuador) grow in sandy soils, but at Chimborazo (central Ecuador) the populations are found growing in wetlands (Carrasco et al. 2022), and ourly found new localities from Imbabura (northern Ecuador, Figures 2, 3) show that the species can also grow in an intermediate (humid/dry) ecological environment (Figure 2). Also, the habit of the species differs between localities, forming cushions in dry soils and growing as prostrate shrubs in moister environments. Despite the ecological differences, there is no doubt that these populations belong to the same species and illustrate its environmental plasticity. Additionally, our fieldwork confirmed that no other *Nototriche* species grow sympatrically with *N. hartwegii*.

In herbaria, *N. hartwegii* was misidentified as other *Nototriche* species. The newly identified populations at Lagunas de Ozogoche and Páramo de Quispicacha possess only vegetative structures. However, the pubescence type and density, in conjunction with the leaf and stipule morphology, led us to identify the specimens as *N. hartwegii*.

Geographic notes. *Nototriche* is a high-Andean genus distributed in páramos and punas from Argentina north to Ecuador, with its greatest diversity in Peru (Mazzei 2025). It probably has its origin in the south. The altitudinal range of this group is wide compared to other páramo species, growing at 3500–5000 m (Chanco and Ulloa-Ulloa 2004). *Nototriche hartwegii*, an Ecuadorian endemic, inhabits elevations between 4180 m and 4400 m.

Based on the data presented here, *N. hartwegii* is the most well-distributed species of its genus in Ecuador (Figure 3C), with small populations in all parts of the Ecuadorian Andes. The fragmented distribution of *N. hartwegii* might be explained by changing connectivity of the páramos during the glacial periods. Populations were probably connected at some point in their biogeographical history but later separated by the retraction of the páramo area with the increase of temperature (Flantua et al. 2019). *Nototriche hartwegii* is the northernmost species of its genus, and we can affirm that the northern distribution of *Nototriche* is at the Imbabura volcano in Ecuador.

Conservation status. When Chanco and Ulloa-Ulloa (2004) re-established the species, they believed that *N. hartwegii* was endemic to the southern páramos of Ecuador and assessed it as Endangered due to the small populations. This status was maintained in the last conservation Red List assessment of endemic plants of Ecuador by León-Yánez et al. (2011). However, because this species is not endemic to southern Ecuador, an up-to-date assessment is required.

Our geospatial analysis found that both EOO and AOO are below their respective thresholds. However, since EOO is overestimated, we consider that AOO should be used in assessment of this species. AOO is below the upper limit of Endangered (<500 km^2). The new localities (Table 1) are a considerable update for the species range, but the number of individuals is still rather small (<50 individuals) at each of the new locations. Also, the species has a severely fragmented distribution (Figure 3C), with gene flow impossible between populations. Considering this information and knowing the increasing threats to the páramos ecosystem, like climate change and expansion of the agricultural frontier and urban areas (Hofstede et al. 2023), we maintain Endangered under criterion B2ab(iii) of the IUCN (2024) for *N. hartwegii*.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: EJT. Data curation: EJT. Funding acquisition: EJT, PM. Investigation: EJT, PM, KR. Supervision: PM, KR. Writing – original draft: EJT. Writing – review and editing: PM, KR.

Author ORCID iDs

Emilio J. Trujillo https://orcid.org/0009-0001-7725-3626
Katya Romoleroux https://orcid.org/0000-0002-0679-9218
Priscilla Muriel https://orcid.org/0000-0002-7874-8057

Data availability

All data that support the findings of this study are available in the main text.

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