



## *Gynoxys revolutifolia* (Senecioneae, Asteraceae): A new species from southern Ecuador

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### Abstract

*Gynoxys* is a very diverse genus of Asteraceae with an Andean distribution from Venezuela to northern Argentina. It comprises about 130 species, 34 of which are recorded in Ecuador. In the present study, we describe *Gynoxys revolutifolia*, a new species occurring in Ecuador between Loja and Zamora-Chinchipe provinces. The new species is a shrub or treelet characterized by coriaceous leaves with a strongly revolute margin. After an accurate revision of the main Ecuadorian herbaria and field surveys, we provide a comprehensive comparison of *G. revolutifolia* with the species it was previously misidentified as. We also provide information concerning the chemical composition, distribution range and conservation status of the new species.

### Resumen

*Gynoxys* es un género muy diverso de Asteraceae con una distribución desde Venezuela hasta el norte de Argentina. El género comprende alrededor de 130 especies, de las cuales 34 están reportadas en Ecuador. En el presente estudio describimos *Gynoxys revolutifolia*, una nueva especie presente en Ecuador, entre las provincias de Loja y Zamora-Chinchipe. La nueva especie es un arbusto o arbolito caracterizado por hojas coriáceas con un margen fuertemente revuelto. Después de una minuciosa revisión en los principales herbarios ecuatorianos y nuevas colectas de campo, proporcionamos una comparación completa de *G. revolutifolia* con las especies con las que fue previamente confundida. También proporcionamos información sobre la composición química, el rango de distribución y el estado de conservación de la nueva especie.

**Keywords:** Andes, Compositae, Loja, Taxonomy, Zamora-Chinchipe

### Introduction

The genus *Gynoxys* Cassini (1827: 455) belongs to the Gynoxyoid group in the subtribe *Tussilaginatae* Dumortier (1827: 65) (Senecioneae, Asteraceae) and includes shrubs, treelets, and trees with leaves alternate or opposite, coriaceous or papyraceous; indument of simple or diversely branched (substellate or T-shaped) trichomes on stems and abaxial leaf surfaces; synflorescences corymbiform or paniculiform; capitula homogamous or heterogamous; yellow florets; anther bases sagittate, auriculate or obtuse, and style branches apically obtuse, truncate or acute (Escobari *et al.* 2023).

*Gynoxys* species grow in the Andean mountains from Venezuela to Bolivia (Nordenstam 2007), plus a single species in northern Argentina (Cabrera 1974). Most species are found in the páramo (Izco *et al.* 2007, Montalvo *et al.* 2018, Camel *et al.* 2019, Quiroz *et al.* 2019, Ansaloni *et al.* 2022) and in montane forests (Sagástegui-Alva & Dillon 1985, Jadán *et al.* 2022). So far, the genus *Gynoxys* comprises about 130 species (Escobari 2023). In Ecuador a total of 34 species have been recorded thus far (Jørgensen & Leon-Yanez 1999, León-Yáñez *et al.* 2011), and 23 of them are putative endemics (Romoleroux *et al.* 2023).

Since its establishment in 1827, some taxonomic changes have been proposed for the genus. Initially, *Gynoxys* comprised only species with opposite leaves (Cassini 1827). Later Cuatrecasas (1955) included species with alternate leaves by transferring the section *Praegynoxys* Cuatrecasas (1951: 72) to *Gynoxys* from *Senecio* Linnaeus (1753: 866). Due to the presence of substellate trichomes (simple trichomes in the rest of the genus), this section was eventually transferred into the genus *Aequatorium* Nordenstam (1978: 59) as a subgenus and finally classified as a separated genus (i.e., *Nordenstamia* Lundin (2006: 15)). This reclassification was based on the differences in trichome architecture (substellate or diverse branched in *Nordenstamia* vs. stellate and peltate in *Aequatorium*), the ray flowers color (yellow in *Nordenstamia* vs. white in *Aequatorium*) and style branch shape (pointed in *Nordenstamia* vs. obtuse in *Aequatorium*). Consequently, although some species have T-shaped (Robinson & Cuatrecasas 1992) and stellate trichomes (Cuatrecasas 1954, Herrera 1980, Sagastegui-Alva & Dillon 1985), *Gynoxys* formally remained as a genus including only species with opposite leaves and simple trichomes (Nordenstam *et al.* 2009). However, based on recent molecular evidence, Escobari *et al.* (2023) merged *Nordenstamia* back into *Gynoxys* and placed all *Nordenstamia* species within the “*Praegynoxys* group” alongside other species with diverse branched trichomes.

## Materials and methods

We examined the *Gynoxys* collections in the main Ecuadorian herbaria: CHEP, HA, HUTPL, HUTI, LOJA, Q, QAP, QCA, QCNE, QPLS, QUSF (acronyms follow Thiers 2023). Additionally, we revised high-resolution images from online-available herbaria (AAU, F, G, GH, K, MO, NY, P, S, US). Measurements concerning leaves, petioles and phyllaries were obtained from digitalized herbarium vouchers and the holotype material using ImageJ 1.53t (Schneider *et al.* 2012). To ensure accurate floral measurements, we collected fresh material and measured the ray and disc florets. The new material collected was designed as holotype. Pictures of the new species were also taken to create a Lankester Composite Digital Plate (LCDP).

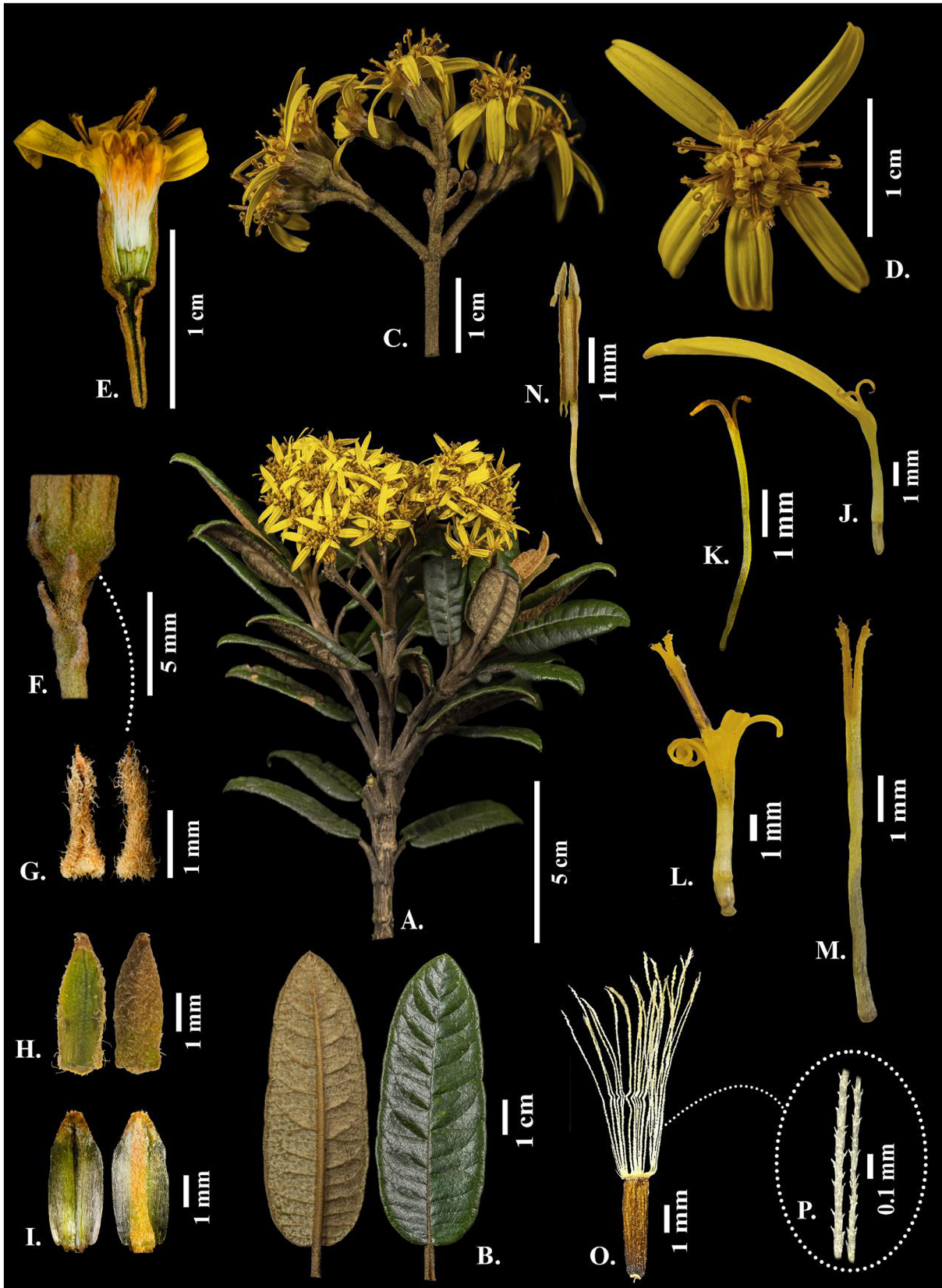
We assessed the preliminary conservation status based on the Geographic range by calculating the Extent of Occurrence (EOO) and Area of Occupancy (AOO) using the coordinates of the studied specimens with the tool GeoCAT (Bachman & Moat 2012) applying a buffer area of  $2 \times 2$  km, as recommended by IUCN (2022). Because of the discrepancy between the geographic coordinates and the collection place recorded on the herbarium vouchers of *J. Homeier*, *F.A. Werner* & *R. Link* 5022 and *I. Arnelas Seco*, *A. Gusmán*, *I. Medina* 9775 we did not use them for calculating EOO and AOO.

## Taxonomy

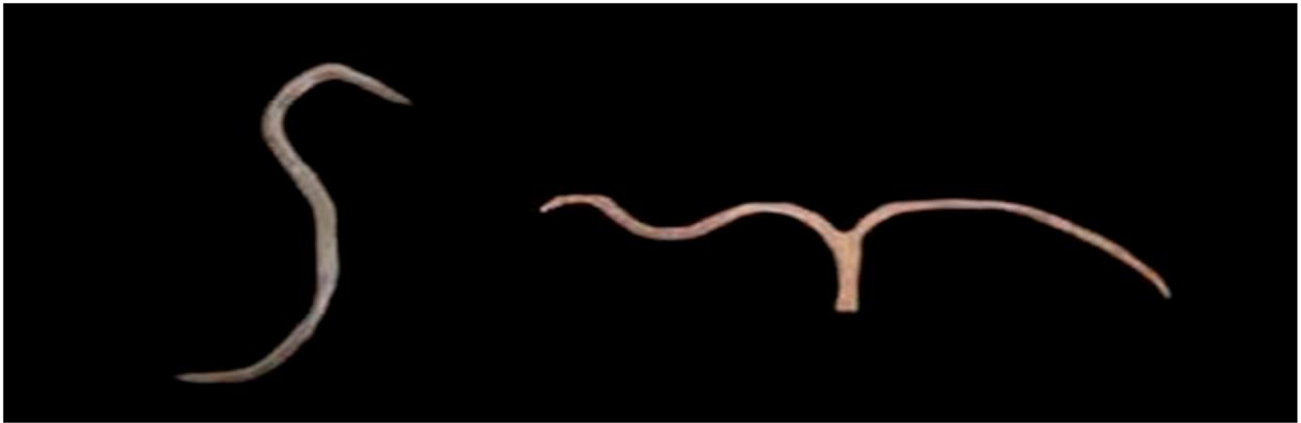
*Gynoxys revolutifolia* R. Arias, Espinosa-Ortega & Revilla, *sp. nov.* (Figs 1, 3)

**Diagnosis:**—The new species differs from all other congeners by having coriaceous leaves with strongly revolute margins (giving it a concave shape) and conspicuous primary and secondary veins (8–12 pairs) on both leaf surfaces, simple and T-shaped trichomes covering the abaxial side of the leaves, involucre with 8 phyllaries with ferruginous unicellular trichomes, 4–5 ray florets with limbs 10–11 mm long and 8–9(–12) disc florets.

**Type:**—Ecuador. Límite provincial Loja/Zamora-Chinchipec: sector El Tiro, junto a la vía nueva Loja/Zamora, 3°59'29"S 79°8'40"W, 2800 m, 8 September 2023 (fl), *R. Ansaloni* & *N. Espinosa-Ortega* 280 (holotype LOJA!; isotypes HA!, HUTPL!, QCA!).



**FIGURE 1.** Lankester Composite Dissection Plate of *Gynoxys revolutifolia* R. Arias, Espinosa-Ortega & Revilla **A.** Flowering branch. **B.** Leaf: abaxial surface (left), adaxial surface (right). **C.** Synflorescence. **D.** Capitulum, front view. **E.** Capitulum, cross-section. **F.** Calyx. **G.** Bracteoles: abaxial surface (left), adaxial surface (right). **H.** Outer phyllaries: abaxial surface (left), adaxial surface (right). **I.** Inner phyllaries: abaxial surface (left), adaxial surface (right). **J.** Ray floret (pappus removed). **K.** Ray floret style. **L.** Disc floret (pappus removed). **M.** Disc floret style. **N.** Anther. **O.** Achene (immature). **P.** Pappus bristles. Photos and preparation by N. Espinosa-Ortega based on the isotype (QCA249764).



**FIGURE 2.** Trichome types in *Gynoxys revolutifolia*. Simple (left), T-shaped (right). Photos by S. Tomasello. Prepared by N. Espinosa-Ortega.

**Description:**—Shrubs or treelets ca. 1.5–2.5 m tall. Stems oppositely branched, with fissured bark, covered by simple, contorted, ferruginous trichomes, underlaid with T-shape trichomes. *Leaves* opposite, simple, petioles (0.7–)0.9–1.3(–1.7) cm long; lamina oblong to ovate, 4–7.2(–8.6) × (0.8–)1.4–2.9(–3.7) cm, base rounded to oblique (rarely slightly cordate), apex obtuse to acute, margin revolute, coriaceous, adaxially glabrous except for the mid vein covered by adpressed trichomes, abaxially densely covered by simple and contorted ferruginous trichomes underlaid with short T-shaped adpressed trichomes (Fig. 3); venation pinnate, with 8–12 pairs of secondary veins on each side, conspicuous on both lamina sides. *Synflorescence* corymbiform, erect and terminal. *Capitula* heterogamous, radiate, 10–12 × 20–26 mm; pedicels (0.56–)0.7–1.37(–1.5) cm long, with 3–5 triangular bracteoles ca. 1.7–2.6 mm long, densely yellow lanate. *Involucre* cylindrical, with a calycle of few bracts ca. 2–2.5 mm long, densely ferruginous tomentose; phyllaries 8, uniseriate, herbaceous, the outer phyllaries lanceolate, (4.5–)5–6(–6.7) × 2 mm, ferruginous tomentose, apex obtuse, the inner phyllaries oblong-lanceolate, 5–6 × 2 mm, the dorsal ridge ferruginous tomentose, margins glabrous, apex obtuse. *Ray florets* pistillate, 4–5, with staminodes; corolla yellow, glabrous, tube 4–5(–6) mm long; limb oblong-elliptic, 10–11 mm × 2–3 mm, 4-nerved, apex tridentate; style 7.2–7.5 mm long, style branches 1.2–1.5 mm long, triangular, with small and few hairs on the tip and lateral sides. *Disc florets* hermaphrodite, 8–9(–12); corolla yellow, (5.6–)6.5–7(–7.5) mm long, glabrous, tube 3–3.5(–4) mm long, with 5 lobes, 2-nerved, 2–3 × 0.65–0.7 mm; anthers ca. 2.9 mm long, apical appendage lanceolate 0.60–0.65 × 0.15–0.20 mm, anther collar cylindrical, base sagittate; style 9.3–9.5 mm long, style branches 2.3–2.5 mm long, triangular, with long and few hairs on the tip and lateral sides. *Achene* glabrous, 3–4 mm long (immature), 5-ribbed. *Pappus* stramineous, barbellate, yellowish, 7–8 mm long.

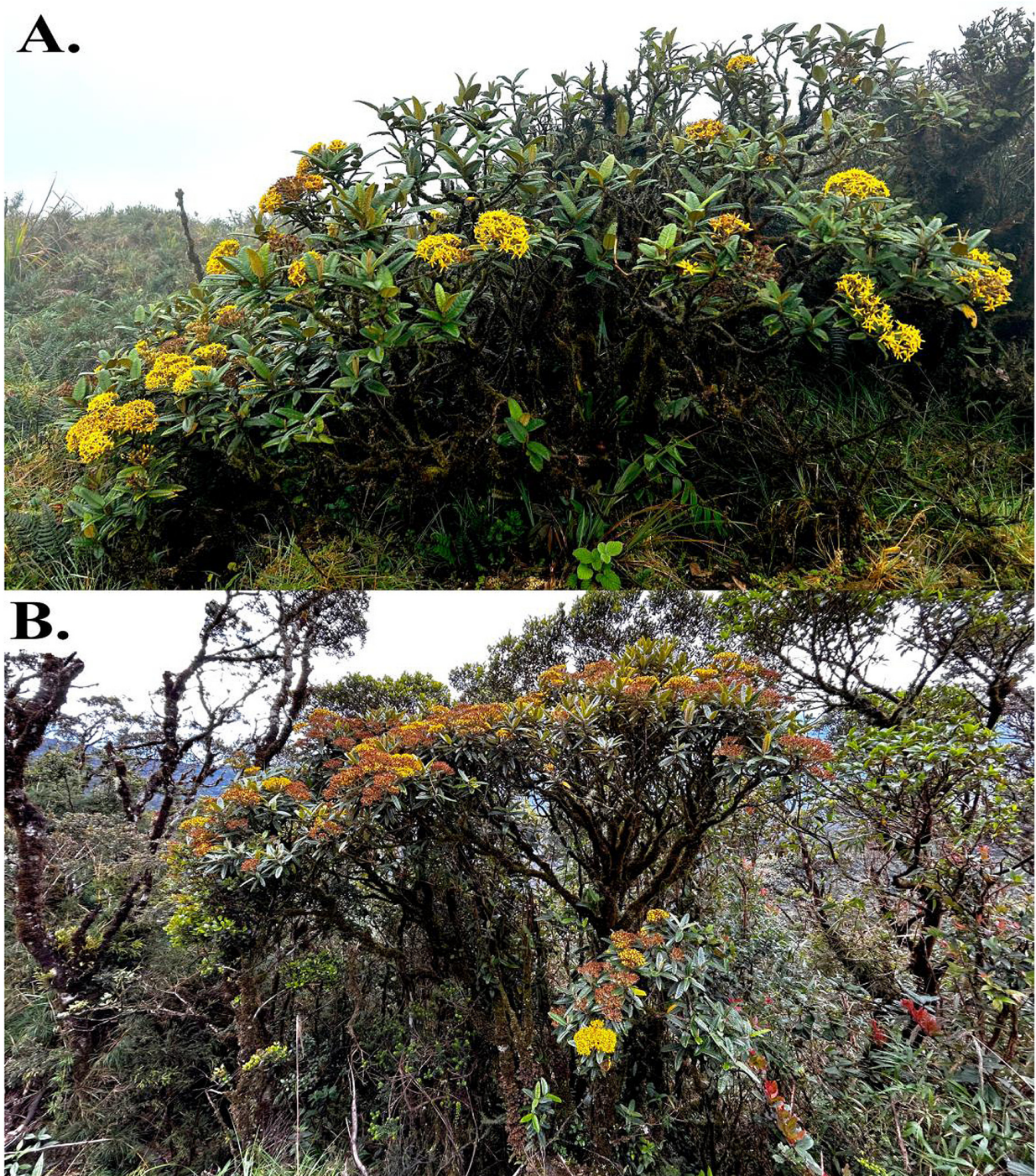
**Etymology:**—The specific epithet of the new species refers to the strong revolute leaf margins.

**Distribution and habitat:**—All known populations are found in the shrubby páramo and elfin forest, between elevations of 2800 and 3300 m (Fig. 3). The species is distributed in the Ecuadorian provinces of Loja and Zamora-Chinchi in three localities: El Tiro, Cajanuma, and Cerro Toledo (Fig. 4). These localities are in the Cordillera Real Oriental, within the Podocarpus National Park territory. This zone is known for its high biodiversity and endemics (Lozano & Bussmann 2005). Particularly, the mountain pass “El Tiro” is covered by shrubby vegetation exposed to high-speed winds, with an average temperature of 7–13 °C (Keating 2000), high precipitation, and nutrient-poor soils (Gradstein *et al.* 2008).

**Phenology:**—Specimens in bloom have been collected between September and November.

**Chemical composition:**—The distilled leaf essential oil from samples collected at El Tiro (*N. Cumbicus* 1986, HUTPL-14664) were previously analyzed by Maldonado *et al.* (2023) using GC-MS & GC-FID techniques, reporting a low yield (0.02% ± 0.004% dry weight); the main components were:  $\alpha$ -pinene (5.3–6.0%), germacrene D (4.9–6.5%),  $\alpha$ -cadinol (3.8–4.4%),  $\alpha$ -humulene (3.0–3.2%), (*E*)- $\beta$ -caryophyllene (2.4–2.8%),  $\delta$ -cadinene (2.2–2.3%), and caryophyllene oxide (1.6–2.2%).

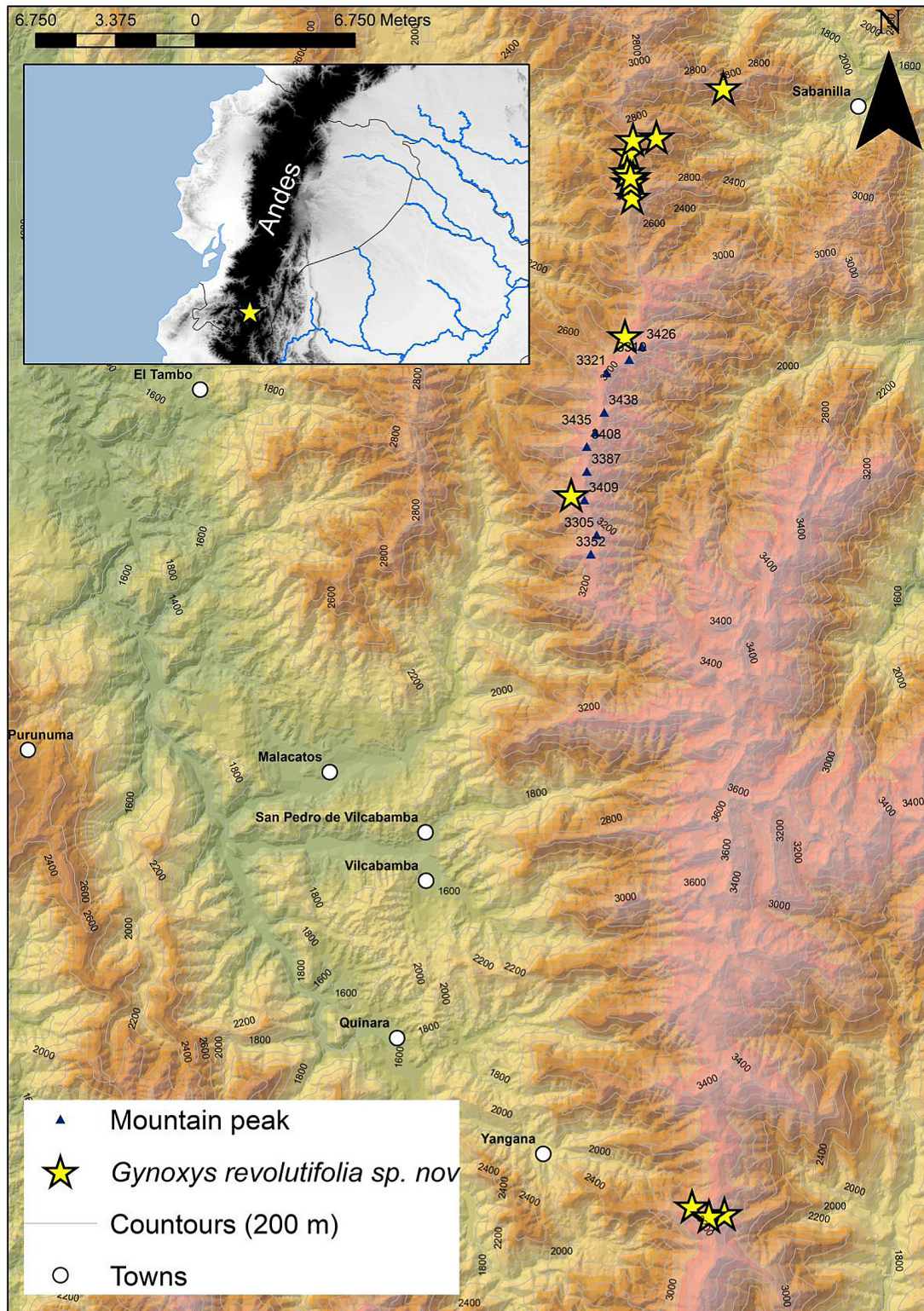




**FIGURE 3.** *Gynoxys revolutifolia*. **A.** Habit, shrub in shrubby páramo, Cerro Toledo-Loja/Zamora Chinchipe border. (*R. Ansaloni & N. Espinosa-Ortega 310*). **B.** Habit, treelet in elfin forest, Yangana-Cerro Toledo road, Loja (*R. Ansaloni & N. Espinosa-Ortega 311*). Photos by N. Espinosa-Ortega.

**Conservation status:**—Based on the very limited EOO (201.63 km<sup>2</sup>) and AOO (32 km<sup>2</sup>) (B1+B2), the confirmed occurrence in only three localities so far (Fig. 4) (B1+B2a) and the continuing and fast decline of south Ecuadorian forest and páramo (Carrión-Paladines *et al.* 2022) (B1+B2ab(ii)), we assign a provisional category of Endangered (B1+B2ab(ii)), following the IUCN (2022) criteria.





**FIGURE 4.** Distribution map of *Gynoxys revolutifolia* in Loja and Zamora-Chinchipe, Ecuador. Prepared by G. Lucero.

**Additional specimens examined (paratypes):**—Ecuador. **Loja:** Parque Nacional Podocarpus El Tiro, 3°59'37" S, 79°8'43" W, 2800 m, 9 January 2002 (sterile), *P. Lozano, B. Merino, T. Delgado & P. Lozano, E-33* (LOJA); same location, 3°59'58" S, 79°8'38" W, 2900 m, 9 January 2002 (sterile), *P. Lozano & al. E-35/E-34* (LOJA); same location, 3°99'10" S, 79°14'57" W, 2823 m, 20 October 2015 (fl.), *I. Arnelas Seco, A. Gusmán & I. Medina 9775* (HUTPL); same location, 3°59'23" S, 79°8'45" W, 2790 m, 6 April 2022 (sterile), *N. Cumbicus 1986* (HUTPL); Parque Nacional Podocarpus, Cajanuma, sendero al mirador, 4°3' S, 79°9' W, 2960 m, 6 September 1997 (fl.), *C. Cerón & E. Ocampo*

34851 (LOJA); Cantón: Loja, parroquia Yangana, borde del camino Yangana-Cerro Toledo, 4°23'7.52" S, 79°7'12.56" W, 2960 m, 11 November 2023 (fl.), *R. Ansaloni & N. Espinosa-Ortega 311* (HUTPL, LOJA, QCA). **Loja/Zamora-Chinchipe:** Loja-Zamora road just east of province border and pass, 3°59' S, 79°8' W, 2780 m, 25 November 1984 (fl.), *P. M. Jorgensen 56400* (AAU, QCNE, US); en la cresta de el paso, yendo hacia la loma de los Balcones, entre Loja y Zamora, 3°59'38" S, 79°8'40" W, 2900 m, 30 September 1995 (sterile), *A. Garmendia & G. Paredes 390* (QCNE); Loja-Zamora road, km 18 (El Tiro), 3°58'57" S, 79°8'43" W, 2800 m, 25 September 2001 (fl.), *J. Madsen 8550* (LOJA); límite provincial entre Loja y Zamora, 3°59' S, 79°9' W, 2900 m, 9 October 2004 (fl.), *J. Caranqui, M. Melampy & J. Lara 1252* (CHEP, MO); límite provincial Loja-Zamora Chinchipe, parte superior de Cerro toledo, borde del camino principal, 4°23'20.99" S, 79°6'49.31" W, 3300 m, 5 November 2023 (fl.), *R. Ansaloni & N. Espinosa-Ortega 310* (HUTPL, LOJA, QCA). **Zamora-Chinchipe:** área del Parque Nacional Podocarpus, Cajanuma, El Mirador, [4°5'30.26" S 79°10'0.72" W], 3000 m, *RBu & SL* (HUTPL); Reserva San Francisco, road Loja-Zamora, ca. 35 Km from Loja, 3°58' S, 79°4' W, 2880 m, 29 September 2012 (fl.), *J. Homeier, F.A. Werner & R. Link 5022* (GOET, HUTPL); cantón Palanda, parroquia Valladolid, ladera oriental de Cerro Toledo, 4°23'18.1" S, 79°6'28.1" W, 3070 m, 21 October 2023 (fl.), *R. Ansaloni & N. Espinosa-Ortega 308* (G, HUTPL, LOJA, QCA).

**Discussions:**—Although many *Gynoxys* species have leaves with revolute margins, none show concave leaves and two trichome types in the abaxial leaf surface; both features make *G. revolutifolia* unique among all described species so far. This species has often been misidentified as *G. cuicochensis* Cuatrecasas (1951: 16) or *G. rugulosa* Muschler (1913: 87). The new species differs from *G. cuicochensis* in leaf length (4–7.2(–8.6) cm vs. 2.5–5.5 cm), leaf margin (strongly revolute vs. slightly curved margins), leaf indumentum (simple and T-shaped trichomes vs. simple trichome) and ray florets number (4–5 vs. 3). From *G. rugulosa*, it differs in leaf texture (coriaceous vs. subcoriaceous), abaxial leaf indumentum (simple and T-shaped trichomes vs. simple), synflorescence bracteoles (triangular vs. linear), phyllaries number (8 vs. 12–15), limb length (10–11 mm vs. 6–8 mm) and disc floret number (8–9(–12) vs. 5–6). Further differences are detailed in Table 1.

**TABLE 1.** Morphological differences between *Gynoxys revolutifolia* and similar species. References are taken from (1) Cuatrecasas (1951); (2) Muschler (1913); (3) presented herein; \* Authors observation based on type material.

Species	<i>G. cuicochensis</i> (1)	<i>G. rugulosa</i> (2)	<i>G. revolutifolia</i> (3)
Trichome type	simple	N/A	simple and T-shaped
Texture leaves	coriaceous	subcoriaceous	coriaceous
Abaxial leaf surface trichomes	simple, densely adpressed tomentose	subglandular-tomentose	simple and T-shaped
Lamina shape	ovate to ovate-oblong	oblong-ovate to ovate	oblong to ovate
Leaf margin	slightly curved	entire to revolute	strongly revolute
Leaf length (cm)	2.5–5.5	7–7.5	4–7.2(–8.6)
Pedicels (cm)	0.1–1.4	N/A	(0.56–)0.7–1.37(–1.5)
Bracteole form	lanceolate	linear *	triangular
Phyllary number	7–8	12–15	8
Phyllary surface trichomes	yellow-gray puberulent tomentose*	gray-puberulent tomentose	densely ferruginous tomentose
# Ray florets (RF)	3	5–6	4–5
Corolla tube length of RF (mm)	2	4	4–5(–6)
Limb length (mm)	7–8	6–8	10–11
# Disc florets (DF)	8–9	5–6	8–9(–12)
Corolla length of DF (mm)	7	8–10	(5.6–)6.5–7(–7.5)
Corolla tube length of DF (mm)	2.2	ca. 5.75	3–3.5(–4)
Pappus length (mm)	5–6*	10–14	7–8

Based on the trichome architecture, *Gynoxys revolutifolia* belongs to the *Praegynoxys* group (*sensu* Escobari *et al.* 2023), which is characterized by diversely branched trichomes. So far, the only known species with a similar trichome architecture (simple trichomes underlain by T-shaped trichomes on their stems and abaxial leaf surfaces) are *G. chingualensis* Robinson & Cuatrecasas (1992: 414) and *G. jaramilloi* Robinson & Cuatrecasas (1992: 415). Another species exhibiting T-shaped trichomes is *G. valenzuelae* (H. Beltrán & J. Calvo) B. Escobari & N. Kilian in Escobari *et*



al. (2023: 87). However, this species stands out by bearing two distinct types of T-shaped trichomes (Beltrán & Calvo 2020) and no simple ones. Because the T-shaped trichomes are found in the inner layer, they can be easily overlooked, and there might be more species of *Gynoxys* having this feature than reported thus far.

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