



Pinguicula warijia sp. nov. (Lentibulariaceae), a newly rediscovered species from the Sierra Obscura, northern Mexico

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Abstract

An undescribed species of *Pinguicula* (Lentibulariaceae), first collected in 1972 was recently rediscovered in the Arroyo Babarocos canyon, located in the Sierra Obscura region, in the municipality of Uruachi, Chihuahua, Mexico. This plant is described and illustrated as *Pinguicula warijia*. The taxon is compared with the related species *P. oblongiloba* and *P. zamudioana*, and a key to the species of *P.* section *Orcheosanthus* of western Mexico is provided, along with photographs, distribution map, and taxonomic discussion.

Keywords: Mexican *Pinguicula*, Sierra Madre Occidental, taxonomy

Introduction

The existence of *Pinguicula* sp. (Lentibulariaceae) “Sierra Obscura” has been known since 1972, when Alfred Lau, a German horticulturist living in Fortín de Las Flores, Veracruz, Mexico, collected and photographed a distinctive *Pinguicula* L. (1753: 17), in a small cave in the mountainous region of Sierra Obscura, Chihuahua, Mexico (Lampard, in Lampard *et al.* 1916, p. 684). Unfortunately, the plants he collected did not survive in cultivation, and although he stated that it was an undescribed species, he did not collect voucher material that would allow its study, description, and designation of a type (Moran & Meyrán 1974, Lampard, in Lampard *et al.* 2016). Lau revisited the site in 1997 and collected some seeds that he sent to Stan Lampard, a *Pinguicula* enthusiast, in England, who was able to germinate and flower them successfully, allowing for additional photographs and line drawings to be made; unfortunately, the following year, the plants were lost due to a fungal attack before they could be formally described. Lampard considered the plants to be similar to *P. oblongiloba* de Candolle (1844: 27) (Lampard, in Lampard *et al.* 2016).

No further observations of this plant would be made for 50 years, probably as a result of the imprecise location data provided by Lau, coupled with the rugged topography of the mountainous Sierra Obscura.

Lau (1998) mentioned that this species was found in an extremely difficult-to-reach site, accessible only during the dry season. The mountainous region of the Sierra Obscura is situated along the border of the states of Chihuahua and Sonora. It is an extensive area with rugged topography and marked elevational contrasts, which makes it challenging to find the plant.

The key to identifying the precise locality was found in a statement made by Lau (1998) indicating that in the same area he collected another plant, *Tacitus bellus* Moran & J.Meyrán (1974:77), (Lampard, in Lampard *et al.* 2016),

known today as *Graptopetalum bellum* (Moran & J.Meyrán) D.R.Hunt (1979:130). The holotype label of this plant states that it was collected at an elevation of 1,600 m on some cliffs to the east of the upper part of the Babarocas stream [sic. Babarocos], on the southern slope of the Sierra Obscura, south of El Campito, Chihuahua and 60 km east of Tesopaco, Sonora (JSTOR Global Plants, 07.10.2022).

During botanical explorations in 2020-2021 by some of the authors in the Sierra Obscura region and near the El Serruchito community, they unsuccessfully tried to locate the population of *Pinguicula* sp. “Sierra Obscura”, but a few weeks later, the guide who supported them found and sent photographs of a population of this *Pinguicula*. The authors of this article planned a visit in June 2022. After a long journey, they arrived at a south-facing wall located halfway up the slope, in which there was a small cave with water runoff covered in *Pinguicula* plants in full bloom. Looking closely at the plants, they determined that they were identical to those in Lau’s first published photographs and to the material that Lampard grew. Herbarium specimens were collected, as well as seeds and live plants for cultivation.

After the revision of the plants with specialized literature and comparing them with *Pinguicula oblongiloba*, *P. michoacana* Zamudio & H.D.Juárez (2018: 16), and the recently described *P. zamudioana* H.D.Juárez & Muñiz-Castro (2018: 3), it was confirmed that it is an undescribed species, which is described below.

Materials & methods

Collect and preparation of herbarium specimens were made according to standard procedures (Lot & Chiang, 1986). Photographs and videos were made with a Nikon D7100 DSLR camera. Microphotographs of the seeds were taken under a scanning electron microscope Quanta™ FEG 250 (Thermo Fisher Scientific, USA).

Taxonomy

Pinguicula warijia Zamudio, Hern.Rend., M.Mata-Rosas & M.M.Salinas, *sp. nov.* (Figs. 1–2)

Similar to *Pinguicula zamudioana* but differs in having numerous, sessile, spatulate to elliptic-spatulate leaves (vs. 4–8(10) petiolate, oblong–elliptical to suborbicular leaves), upper calyx lip lobes ovate to elliptic (vs. triangular-lanceolate), lower calyx lip lobes triangular (vs. lanceolate), upper corolla lip lobes suborbicular to oblate (vs. oblong–elliptical to suborbicular), capsule botuliform (vs. subglobose), seeds 1–1.28 mm long, ca. 0.2 mm wide, surface slightly reticulate (vs. ca. 0.5 mm long, ca. 0.1 mm wide, surface reticulate).

Type:—MEXICO, Chihuahua, Uruachi municipality, Arroyo Babarocos canyon near El Serruchito; June 5, 2022, *S.Zamudio, M.Mata-Rosas, M.E.Salinas & J.Hernández-Rendón 17774* (holotype: UAMIZ; isotypes: ENCB, IBUG, MEXU, UAMIZ, XAL).

Perennial herb, homophyllous. Leaves (5)10–25, arranged in a lax basal rosette, sessile, membranous, spatulate to elliptic-spatulate, green or purple, erect or recurved, surface convex, 40–130 mm long, 13–40 mm wide, apex rounded, base attenuate, margin entire, straight, slightly involute towards apex, upper surface densely covered by small, stipitate glands, 0.2–0.25 mm long and numerous sessile glands. Peduncles 1–5 per plant, purple, erect, 60–120 mm long, tapering from 2 mm in diameter at base to 1 mm at apex, covered densely by stipitate glands 0.2–0.25 mm long, uniflorous. Flower 40–60 mm long including the spur. Calyx bilabiate, pale green, outer surface with stipitate glands and these scant on the inner surface, upper lip trilobed almost to the base, lobes ovate to elliptic, apex acute, 2.5–4 mm long, 1.2–2.5 mm wide, lower lip 2–3 mm long, 1.5–3 mm wide, bilobed, lobes triangular, 1.2–2.5 mm long. Corolla bilabiate, pink-violet to purple, with a small white spot at the base of the lower lip or a discontinuous ring of white around the throat, outer surface sparsely covered with short glandular hairs; upper lip bilobed, lobes suborbicular to oblate, 7–12 mm long, 7–14 mm wide, overlapping at the sides, lower lip trilobed, lobes obovate-oblong to suborbicular, 8–18 mm long, 7–17 mm wide, apex rounded, the lobes overlapping or not at the base. Tube very short, infundibuliform, 3–5 mm long, 4–5 mm wide, with multicellular subulate trichomes ca 0.8 mm long, these forming a narrow band on the inner surface that extends from the throat to the tube but not into the spur; trichomes slightly swollen at the junction between the cells, tips formed of several disc-shaped cells, pointed (Lampard in Lampard *et al.* 2016). Spur cylindrical-subulate, curved, 23–32 mm long, 1–1.5 mm wide. Stamens 2–3 mm long, filaments curved, 1.5–2 mm long, covered with short, stipitate glandular hairs, anther subspherical, ca. 1 mm in diameter. Ovary subglobose, green, 1.5–2 mm in diameter, glandular-pubescent, with short stipitate glands, stigma bilobed, pink, subsessile, lower lobe flabellate, 1–1.5 mm long,

ca. 2 mm wide, larger than the upper. Capsule botuliform, 4–6 mm long, 2.5–4 mm wide, covered with short stipitate glands. Seeds numerous (362 ± 80), ellipsoid, 1–1.28 mm long, ca. 0.2 mm wide, surface slightly reticulate.

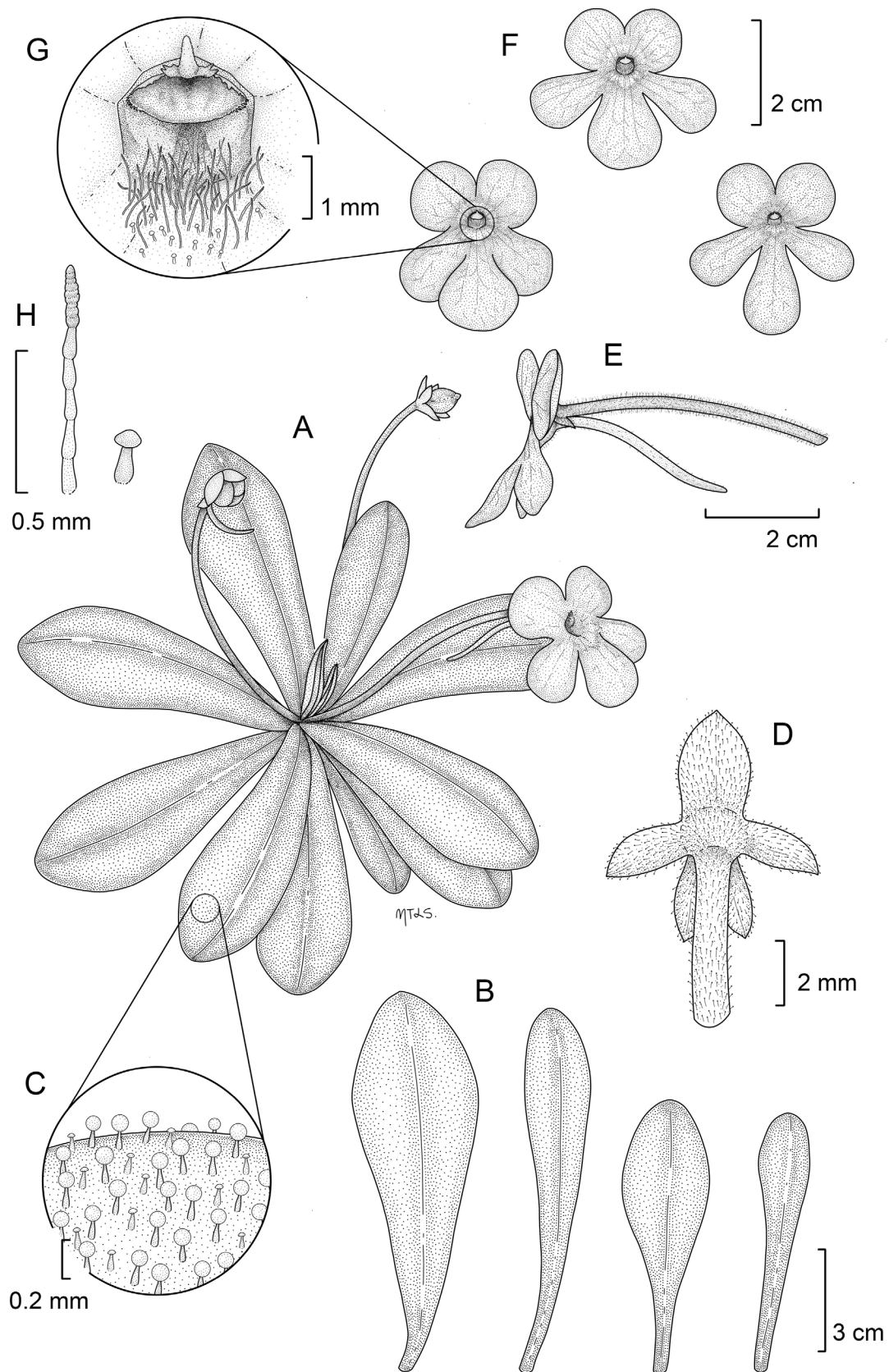


FIGURE 1. *Pinguicula warijia*. A. Habit with rosette, flower, fruit and flower bud. B. Leaf series with variation in size and form. C. Detail of the stipitate glands of the leaf. D. Calyx, back view. E. Flower, lateral view. F. Corolla shape variation, frontal view. G. Detail of the throat of the tube showing the multicellular trichomes and stigma. H. Trichomes of the tube. Drawing by María Teresa Jiménez-Segura.



FIGURE 2. *Pinguicula warijia*. A. Habitat overview. B. Plants growing on igneous rocks on a ca. 30° slope. C. Plants growing upside down on the ceiling of a small cave. D. Detail of the flower. E. Capsule. F. Plant growing in a dry area with reduced leaves. G. A two-tailed swallowtail (*Papilio multicaudata*) butterfly pollinating a *P. warijia* flower. Photos A, F and G by Julián Hernández-Rendón; B, C, D and E by Martín Mata-Rosas.

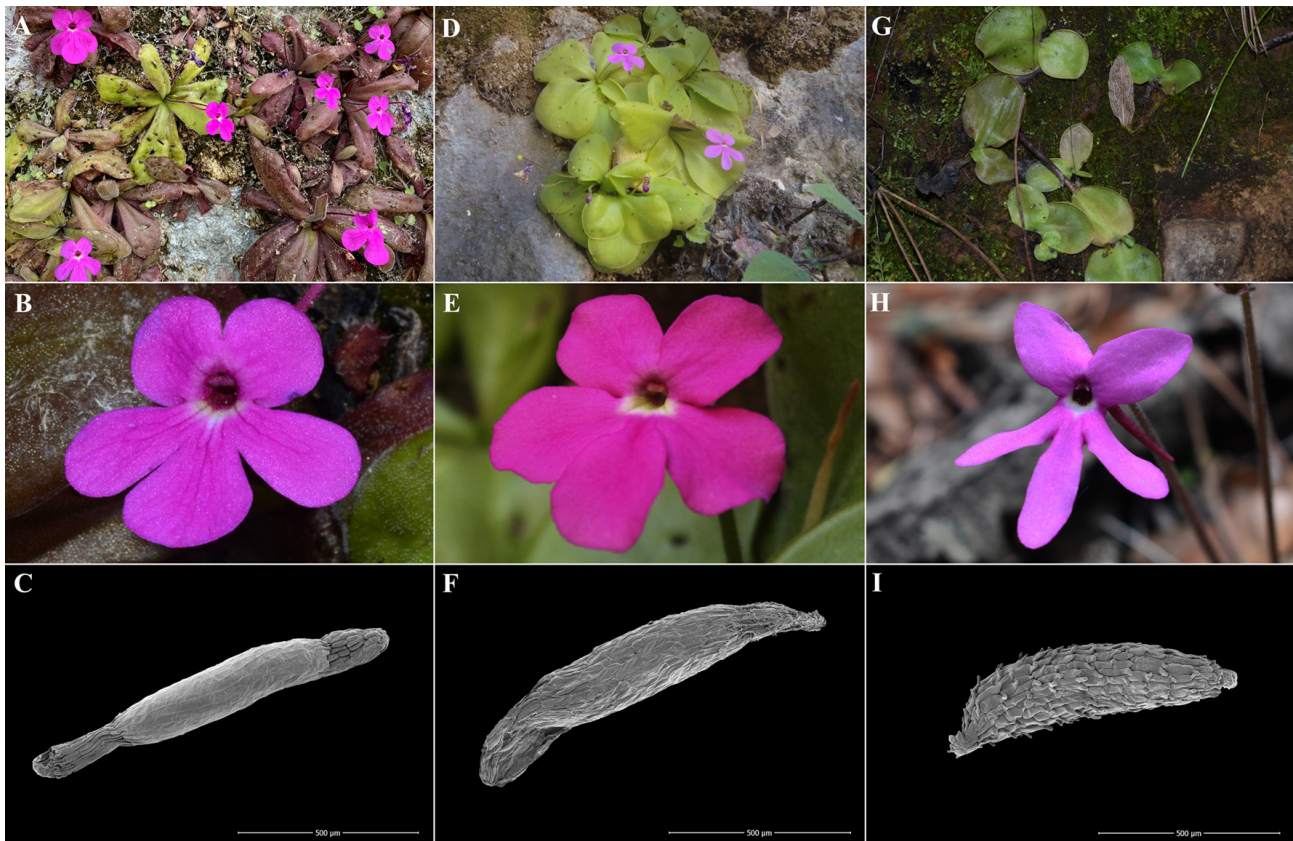


FIGURE 3. A–C, *Pinguicula warijia*. A. Summer rosette. B. Flower. C. Seed. D–F, *Pinguicula zamudioana*. D. Summer rosette. E. Flower. F. Seed. G–I, *Pinguicula oblongiloba*. G. Summer rosette. H. Flower. I. Seed. Photos A and B by Martín Mata-Rosas; D by David Juárez-Gutiérrez; E, G and H by Julián Hernández-Rendón; C, F and I by Greta Hanako Rosas-Saito.

Distribution, ecology and phenology:—So far, this plant is only known from one locality with certainty, and we are not sure if the type locality represents the same site visited by Lau in 1972.

The plant grows on the ceiling and walls of a small south-facing cave, on calcium carbonate concretions accumulated on igneous rocks with continuous water runoff (Fig. 2, A–C). The vegetation surrounding the cave is an ecotone of oak-pine forest and deciduous tropical forest, comprised of *Acaciella* sp., *Agave* sp., *Bursera* sp., *Ceiba* sp., *Jatropha* sp., *Leucaena* sp., *Nolina* sp., *Pinus* sp., *Quercus* spp., *Senegalia* sp., *Yucca* sp., and various types of grasses, at an elevation of 1590–1600 m. The climate is semi-warm sub-humid, with summer rains and an average annual temperature between 18° and 24°C. The average annual precipitation is 700 to 800 mm (CONABIO 1998). The soil on the slopes of the ravine is lithosol, with a very shallow and fragile organic matter cover (INEGI 2014).

According to information and pictures that our guide sent to us throughout the year, this species flowers and fruits all year round. There is enough humidity in the environment to guarantee its continuous growth. However, some plants exposed to drier conditions were observed in which the leaves are significantly reduced in size without changing their shape, allowing the plant to survive short periods of drought and regrow when the humidity of the environment increases with each new rainy season. In some cases, plant size is reduced even more and rosettes are partially buried in the substrate as a form of resistance to drought (Fig. 2, F).

During our *in situ* studies of *P. warijia*, a two-tailed swallowtail butterfly (*Papilio multicaudata* Kirby) was observed spending considerable time visiting the flowers of *P. warijia* in search of nectar (Fig. 2, G). This fact is noteworthy because there are few records of the activity of pollinators visiting *Pinguicula* in nature.

Etymology:—The specific epithet honors the Warijío or Guarijío indigenous people, who inhabit this portion of the Sierra Madre Occidental in the municipalities of Chinipas, Moris, and Uruachi in the state of Chihuahua, as well as in the municipalities of Álamos, Quiriego, and Rosario in the state of Sonora. In addition, it is also the ethnic group to which our guide, Mr. Arnulfo Méndez, belongs. The word Warijío means “the people” or “the people that speak the Guarijía language”. Other names by which this ethnic group is known are Marakawe, Macoragüi, Varihio, Varohío, and warijío(a) (Porras 1997).

Conservation status:—*Pinguicula warijia* is a microendemic species. The population visited was observed to be healthy, and the plants were thriving. The surface covered with plants is less than 100 m² and the population contains fewer than 1000 individuals. Therefore, according to the IUCN Red List (2022) used to evaluate the conservation status, *P. warijia* is thus capable of becoming Critically Endangered (Criteria B2ab(i, ii,v)) or even Extinct in a very short time.

Naturally, this species is affected by the periodic collapse of the cave walls and ceiling, which are very unstable due to the softening of the substrate during the rainy season caused by the excessive accumulation of humidity, so it is very probable that some plants fall and are carried away by sporadic landslides.

Taxonomic relationships:—Due to its morphological characteristics, *Pinguicula warijia* can be included in section *Orcheosanthus* de Candolle (1844: 27), in which it resembles *P. oblongiloba* (Casper 1966; Burelo-Ramos *et al.* 2018). However, it differs from this taxon by the size and color of the flowers (Fig. 3 B vs. H). It can be easily distinguished by having only one type of leaves (homophyllous), while *P. oblongiloba* forms a compact, bulbous, hypogeous winter rosette in addition to its summer leaves (heterophyllous). Other differences include the spatulate or elliptic–spatulate leaves with an attenuate base that is not differentiated into a petiole (Fig. 1, A and B), although Lampard *et al.* (2016: 686) suggest that the leaves are petiolate from observations of cultivated *P. warijia*, in nature the petiole of the lamina is not differentiated, while the overall leaf is spatulate to elliptic-spatulate and the surface convex (vs. oblong-elliptic to suborbicular leaves, with a clearly differentiated petiole and concave surface), calyx lobes ovate, elliptical to triangular (vs. lanceolate), corolla upper lip lobes suborbicular to obovate (vs. oblong-ovate to elliptical), corolla lower lip lobes ovate-oblong to suborbicular (Fig. 1, F and Fig. 2, D) (vs. elliptical to ovate-oblong); capsule botuliform (Fig. 2, E) (vs. subglobose); and seed surface slightly reticulate without papillae (vs. reticulate–papillate or reticulate–coliculate with long papillae) (Fig. 3, C vs. I). These features support and contrast the differences between both species. They also differ in the flowering season, since while *P. warijia* flowers throughout the year, *P. oblongiloba* does so from the end of May to the beginning of August. The habitat is also different; the former is located in the transition between oak-pine forest and tropical deciduous forest, at an elevation of 1590–1600 m, and the latter in a pine-oak forest at (1100–)1500–2500(–2800) m (Table 1).

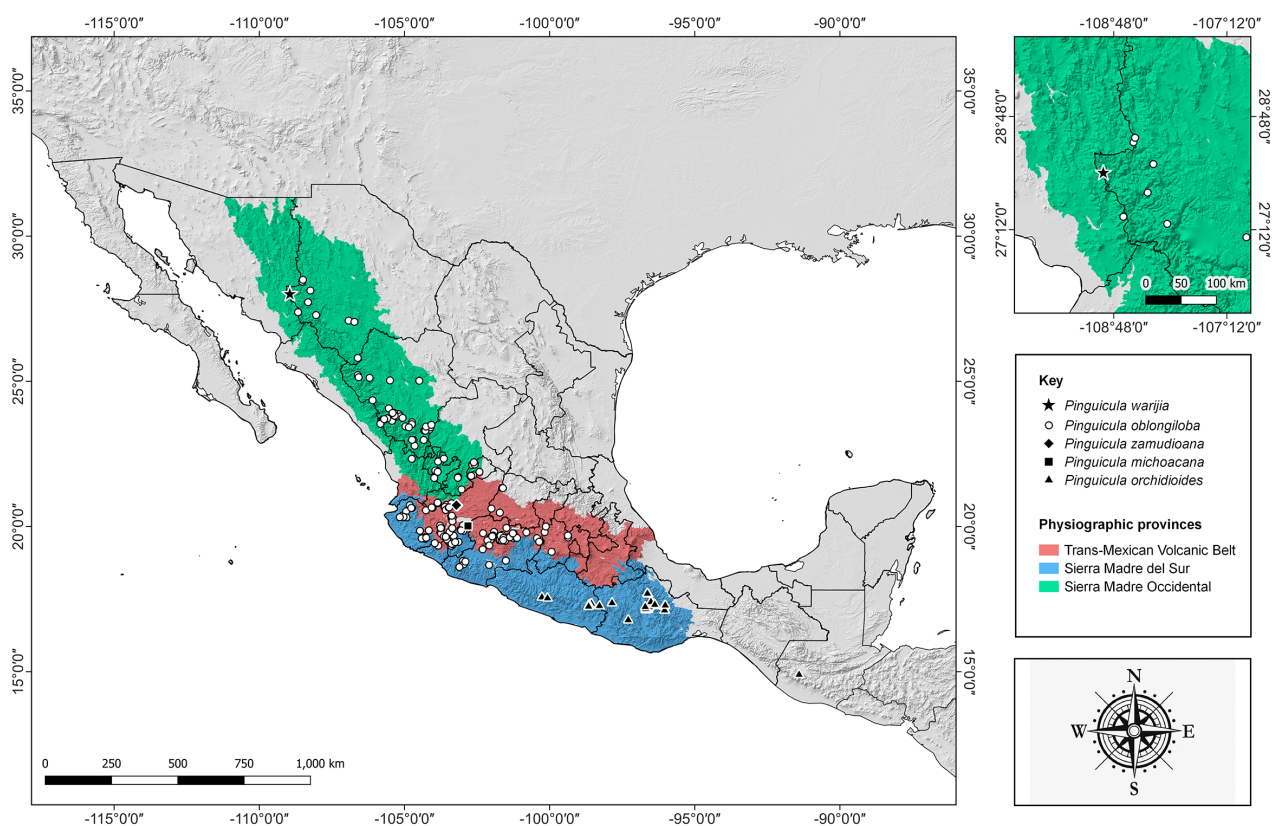


FIGURE 4. Distribution map of *Pinguicula warijia*, and related species *P. oblongiloba*, *P. zamudioana*, *P. michoacana* and *P. orchidioides*. Map made by Abraham Ornelas-Ibarra.

Pinguicula warijia is also similar to *P. zamudioana*, both being homophyllous plants that do not form a winter rosette and which flower throughout the year. However, *P. warijia* differs by having a greater number of leaves, with the base attenuate, margin entire, straight, slightly involute towards apex, the corolla lobes suborbicular to obovate, the greater seeds and the trichomes of the corolla tube are simple and multicellular, subulate (vs. trichomes capitated). Although the microhabitat in which they grow is similar, the locations of these species are separated by about 1000 km (in straight line), and the elevational range in which they are found is different since *P. warijia* is presently only known to grow at 1590–1600 m, while *P. zamudioana* grows at 1100–1250 m (Table 1).

TABLE 1. A comparison of key characteristic for *Pinguicula warijia*, *P. zamudioana*, and *P. oblongiloba*.

Characters	<i>P. warijia</i>	<i>P. zamudioana</i>	<i>P. oblongiloba</i>
Winter rosette	Absent (homophyllous)	Absent (homophyllous)	Present (heterophyllous)
Total summer rosette leaves	(5)10–25	4–8(10)	(2)3–4(8)
Leaf shape	Spatulate to elliptic–spatulate	Obovate–elliptic to suborbicular	Oblong–elliptic to suborbicular
Leaf margin	Flat or slightly involute	Involute	Involute
Leaf size	40–130 mm long, 13–40 mm wide	(15)25–70 mm long, 15–60 mm wide	(16)20–75 mm long, (6)10–55 mm wide
Petiole	Not differentiated	10–20(30) mm long, glabrous	10–45 mm long, ciliated
Peduncles	1–5 per plant, 60–120 mm long, densely covered by stipitate glands	1–4 per plant, (35)40–80 mm long, scattered stipitate glands	1–5 per plant, 50–150(230) mm long, densely glandular–pubescent to glabrous
Flowers	45–60 mm long, including the spur	40–65 mm long, including the spur	(28)30–55 mm long, including the spur
Calyx upper lip lobes	Ovate to elliptic, acute	Triangular–lanceolate	Lanceolate
Calyx lower lip lobes	Triangular	Lanceolate	Lanceolate
Corolla	Pink-violet to purple, with a small white spot at the base of the lower lip or as a discontinuous ring around the throat	Pink, with a small white spot at the base of the lower lip	Pink to purple, with a small white spot at the base of the lower lip
Corolla upper lip lobes	Suborbicular to obovate	Oblong–elliptic to suborbicular	Oblong–ovate to elliptic
Corolla lower lip lobes	Obovate–oblong to suborbicular	Obovate–oblong to suborbicular	Elliptic to oblong–obovate
Pubescence in the interior of the corolla tube	With single multicellular subulate trichomes	With capitate glandular trichomes	With cylindrical or claviform trichomes
Capsule	Botuliform, 4–6 mm long, 2.5–4 mm wide	Subglobose, ca. 3 mm long, ca. 3 mm wide	Subglobose, 3–6 mm long, 2.5–5 mm wide
Seed	Fusiform, ca. 1 mm long, ca. 0.2 mm wide, surface slightly reticulate	Fusiform, ca. 0.5 mm long, ca. 0.1 mm wide, surface reticulate	Fusiform, 0.8–1 mm long, 0.24–0.26 mm wide, Surface reticulate–papillate or reticulate–coliculate with long papillae
Sustrate	Calcium carbonate concretions over igneous rock	Calcium carbonate concretions over igneous rock	Clay soil, over igneous rock
Vegetation	Ecotone between oak–pine forest and tropical deciduous forest	Tropical deciduous forest with cloud forest elements	Pine–oak forest
Elevation	1590–1600 m	1100–1250 m	(1100–)1500–2500(–2800) m
Flowering	Throughout the year	Throughout the year	(May–)June to August

The description of this species and the recently described *Pinguicula michoacana* and *P. zamudioana* establishes a group of taxa related to *P. oblongiloba*, and in a lesser degree to *P. orchidioides*. This complex most likely is derived from a common ancestor and has evolved in western Mexico on igneous substrate in the physiographic provinces of Sierra Madre Occidental and Sierra Madre del Sur mainly (Fig. 4). It is important to mention that within this group of species, *P. oblongiloba* and *P. orchidioides* have the widest ranges and according to Zamudio (1998), both are considered derived from a common ancestor that was separated by the emergence of the Trans-Mexican Volcanic Belt. Due to the prolonged geographic isolation, its populations have been gradually differentiating, each following its evolutionary path (an example of allopatric speciation).

The presence of *Pinguicula michoacana*, *P. zamudioana*, and *P. warijia* within the area of *P. oblongiloba* is noteworthy, each occurring near or very close to the lower limit of distribution of this species and occupying different microhabitats (Fig. 4). Their microendemic distribution reveals an ecological isolation process and their posterior speciation from a common ancestor to grow in isothermic environments, with a constant supply of water, expressed in the occurrence of several genetic changes that led to the modification of the winter rosette in *P. michoacana* or even to the loss of this characteristic in *P. zamudioana* and *P. warijia*. This group of species represents a clear example of stasipatric speciation, where peripheral populations of the central population are differentiated by random genetic changes or mutations, and the differences preserved through ecological isolation until they become independent species.

With this rediscovery, the number of Mexican *Pinguicula* species increases to 52 (Burelo-Ramos *et al.* 2018, Juárez-Gutiérrez *et al.* 2018, Zamudio *et al.* 2018, Zamudio *et al.* 2019, Zamudio & Nevárez-de los Reyes 2020).

The following key separates the species related to *Pinguicula oblongiloba* occurring in western Mexico.

1. Plants homophyllous, with a single type of leaf; blooming throughout the year.....2
 - Plants heterophyllous, with two different types of leaves (winter and summer rosette); blooming from May to August.....3
2. Leaves obovate–elliptic to suborbicular, margin involute, clearly petiolate; distributed in Jalisco..... *P. zamudioana*
 - Leaves spatulate to elliptic–spatulate, margin entire, straight, or slightly involute towards the apex, attenuated base without a defined petiole; distributed in Chihuahua..... *P. warijia*
3. Winter rosette, with an external layer of scarious, ciliated leaves.....4
 - Winter rosette, without an external layer of scarious ciliated leaves; distributed in Michoacán *P. michoacana*
4. Summer leaves oblong–elliptic to suborbicular; corolla lobes oblong–ovate to elliptic; distributed in Sonora, Sinaloa, Chihuahua, Durango, Zacatecas, Aguascalientes, Jalisco, Colima, Michoacán, and Mexico..... *P. oblongiloba*
 - Summer leaves elliptic, narrowly ovate–oblong to lanceolate; corolla lobes elliptical to oblong–lanceolate; plant frequently producing stolons; distributed in Guerrero and Oaxaca in Mexico, and Sololá in Guatemala *P. orchidioides*

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