

## *POLYGALA MINIMA* (POLYGALACEAE) IN WESTERN MEXICO

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**Abstract:** The widespread Neotropical species *Polygala glochidiata* has traditionally been considered the only *Polygala* with uncinata seed hairs to occur in Mexico. A second species with such hairs is shown to occur partly sympatrically with *P. glochidiata* in Jalisco and Nayarit and is referred to *P. minima*, heretofore considered to be a species restricted to southern Brazil, Paraguay, and northern Argentina. A single collection from the state of México is also referred to *P. minima*, while the situation from Oaxaca southeastward into Central America is more complex. Patterns of variation in the *P. glochidiata* complex require further study, but data are presented to dispute the synonymization of *P. minima* into *P. glochidiata* by Bernardi.

**Resumen:** *Polygala glochidiata*, especie neotropical de amplia distribución, ha sido considerada tradicionalmente como la única especie mexicana de *Polygala* con pelos uncinados en la semilla. Sin embargo, una segunda especie con pelos de este tipo se encuentra en Jalisco y Nayarit y es parcialmente simpátrica con *P. glochidiata*. Se considera a esta segunda especie como coespecífica con *P. minima*, una especie anteriormente tratada como restringida al sur de Brasil, Paraguay y el norte de Argentina. Además se considera una sola recolección del estado de México como *P. minima*, mientras que la situación desde Oaxaca hasta Centroamérica es más complicada. Los patrones de variación en el complejo de *P. glochidiata* requieren más estudio; sin embargo, se presentan datos en contra de la sinonimización, efectuada por Bernardi, de *P. minima* con *P. glochidiata*.

**Keywords:** *Polygala*, Polygalaceae, Mexico, Brazil, Paraguay, amphitropical disjunct.

The New World species of *Polygala* with hooked seed hairs form a small complex of taxa centered around the widespread Neotropical *Polygala glochidiata* Kunth\*. Most authors (e.g., Chodat, 1893; Blake, 1924; Marques, 1988; Marques & Gomes, 2002) have treated the variation in this complex by recognizing various combinations of additional species and/or varieties (including, at the species level, *P. fendleri* Chod., *P. millspaughiana* Paiva (= *P. uncinata* Millsp., non Harv. & Sond.), *P. minima* Pohl ex A.W.Benn., *P. misella* Bernardi (= *P. exigua* A.W.Benn., non Hassk.), and *P. oxyrhynchos* Chod.). Bernardi (2000), in his wide ranging look at American *Polygala*, recognizes *P. misella* as a separate species but synonymizes all of the other names into a variable *P. glochidiata*, with no infraspecific taxa. Under

Bernardi's concept, *P. glochidiata* is a widespread species of delicate annuals ranging from southern Arizona and Mexico southward to southern Brazil, Paraguay and northern Argentina, as well as Cuba (Bernardi, 2000).

Under any of the above treatments, all Mexican material has traditionally been included within *Polygala glochidiata* (Blake, 1924) and thus has seemed to present no taxonomic problem, because any Mexican *Polygala* with uncinata trichomes on the seeds has been easily referred to *P. glochidiata*. However, work on a treatment of the Polygalaceae for Rogers McVaugh's *Flora Novo-Galiciana* (McVaugh, 1983 et seq.) reveals the presence of a second, closely related *Polygala* with hooked seed hairs in Jalisco and Nayarit. This taxon (Fig. 1) falls within the variation previously documented for the complex and, as the data below will show, the presence of two non-intergrading

\* Although some have maintained that the correct epithet should be "glochidata", as originally published, this is incorrect (Patterson, Harms, and Wendt, in prep.).

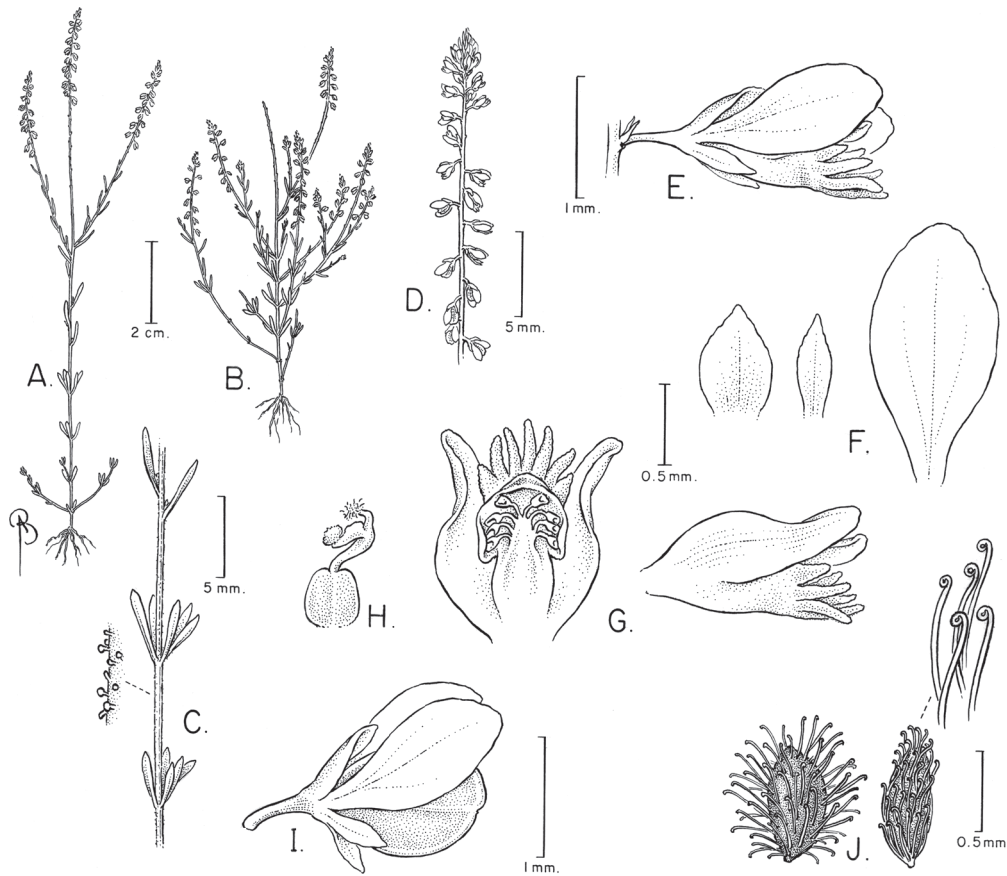


FIG. 1. Mexican *Polygala minima*. A, B. Habit. C. Stem and whorled lower leaves, showing enlarged minute capitate hairs. D. Inflorescence. E. Flower. F. (Left to right) Upper sepal, lower sepal, lateral sepal (wing). G. Flower with sepals removed, showing two upper petals and lower, fimbriate-crested keel petal. H. Gynoecium. I. Fruit with persistent sepals. J. Seeds, showing enlarged uncinuate hairs. A, McVaugh 16389; B-J, Rzedowski & McVaugh 1318. Illustration by Bobbi Angell.

taxa in western Mexico clearly demonstrates that Bernardi's treatment is insufficient and that more than one species must be recognized within his broad concept of *P. glochidiata*.

The second taxon in west-central Mexico appears to be morphologically indistinguishable

from some forms of what Marques (1988) has treated as *P. minima*, a species previously considered to be restricted to southern Brazil, southern Paraguay, and northern Argentina. The principal differences between the two taxa in west-central Mexico are summarized by the following key:

- Wing-sepals (dry) 1.8–2.4 mm long in fruit, medium to dark pink to purple; seed body (excluding apiculum and hairs) 0.8–1.0 mm long; plant often over 15 cm tall . . . . . *P. glochidiata*
- Wing-sepals (dry) 1.4–1.8 mm long in fruit, white to pale pink; seed body (excluding apiculum and hairs) 0.6–0.8 mm long; plant rarely over 15 cm tall . . . . . *P. minima*

The quantitative characters given in the key might be interpreted as simply the two ends of a continuum of variation. However,

a scatter diagram of the wing-sepal and seed sizes (Fig. 2) shows a distinct separation between the two taxa as well as a strong

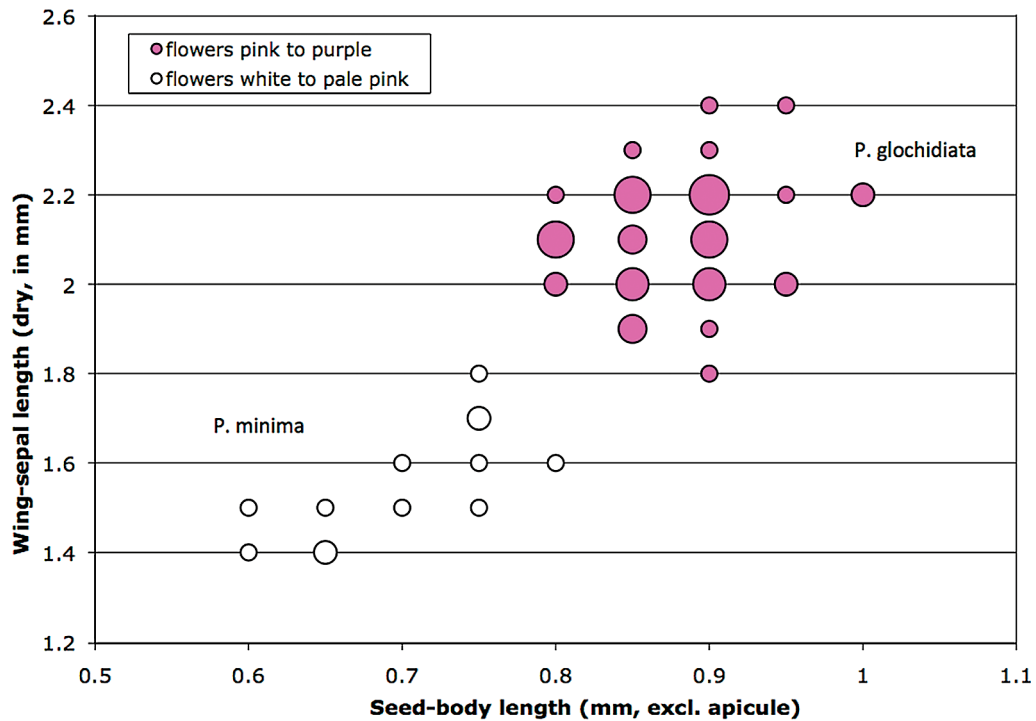


FIG. 2. *Polygala glochidiata* (filled circles;  $n = 50$ ) and *P. minima* (open circles;  $n = 13$ ) in Jalisco and Nayarit: mature seed-body length (excluding apicule and hairs), wing-sepal length (dry, measured in fruit), and flower color. One seed of one plant per population (herbarium collection of separate gathering) measured. Size of circle indicates number of populations yielding that pair of measurements (ranging from 1 population (smallest) to 6 (largest)). Seed-body measured to closest 0.05 mm, wings to closest 0.1 mm.

correlation between these features. This is strongly supported by the usually obvious difference in flower color noted: wing-sepals of *Polygala minima* in Nueva Galicia are most frequently white, with some populations reported as pale pink, while specimens of *P. glochidiata* from that region are consistently reported to have darker lavender or rose to purple wing-sepals.

The distinctness of the two taxa in west-central Mexico is also supported by their distributions. On the one hand, they occasionally grow sympatrically, as reflected by herbarium specimens that are either mixed collections (*Puga 13391*) or separate collections from the same locality and date by the same collector (*Stevens & Fairhurst 1913, 1914; McVaugh 17590, 17599; Anderson 12721, 12723*; full collection details given

below). No intergradation is noted at these localities, supporting the distinctness of the two species. On the other hand, although at times sympatric, they seem to have somewhat different geographical and ecological distributions in the area (Fig. 3). In west-central Mexico (Nayarit, Jalisco, Colima, southern Zacatecas, Aguascalientes, Guanajuato, and Michoacán), *Polygala glochidiata* is a common species throughout the uplands of the area in oak and pine-oak woodlands, grasslands, and tropical deciduous forest at its upper elevational limits. Its known altitudinal range, based on a very large number of specimens from the area, is 1000–2450 m. *Polygala minima*, based on a much smaller number of known collections from the area (cited below), is known only from Jalisco and southern Nayarit (Fig. 3), occurring in pine-oak forests,

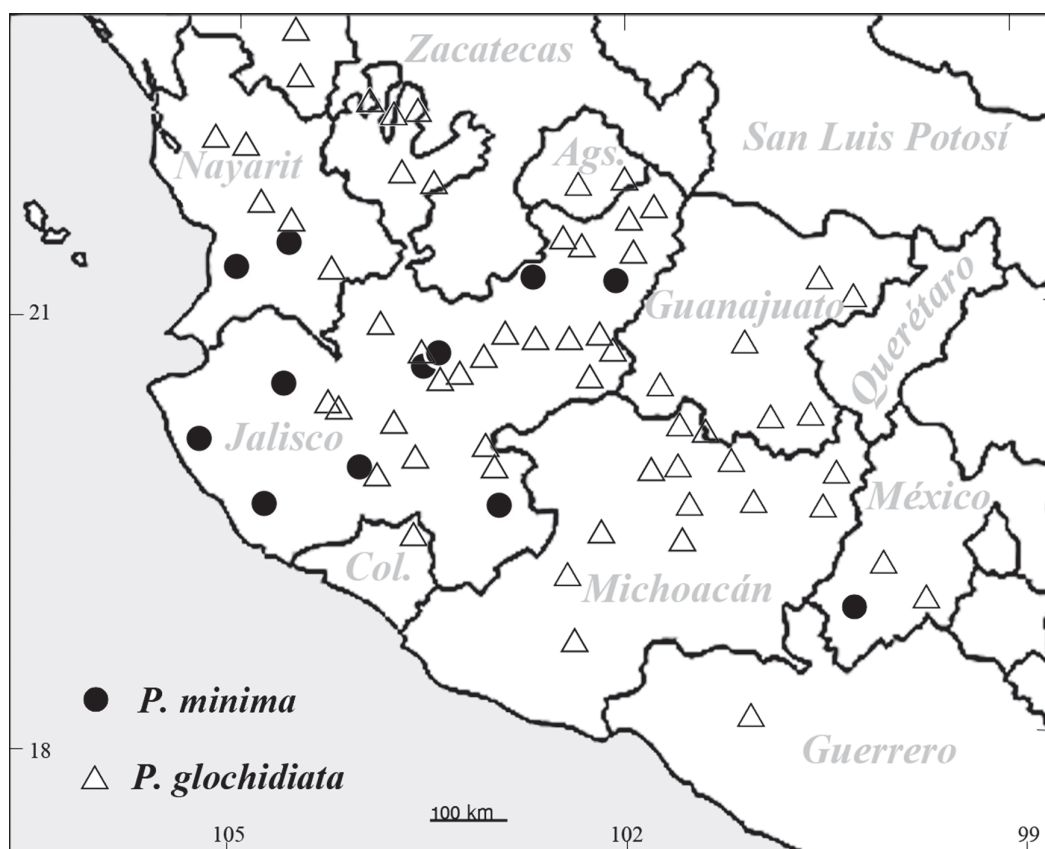


FIG. 3. Distribution of *Polygala minima* and *P. glochidiata* in west-central Mexico.

grasslands, tropical deciduous forest and lowland savanna, at elevations of 50–1900 m. A single collection from just east of the area, in the state of México at an elevation of 2300 m., is also here referred to *P. minima*. Both species are frequently found in disturbed or degraded vegetation and openings, and both tend to be found in wetter open areas and swales. There is thus clearly much overlap ecologically and geographically between the species. It is perhaps easy to place too much emphasis on the apparent lack of *P. minima* in large areas in which *P. glochidiata* is common (e.g., upland areas throughout Michoacán and Guanajuato), given the extremely inconspicuous nature of *P. minima*, but for the same reason, it seems clear that the ecological range of *P. minima* extends to much lower elevations than that of *P. glochidiata* in west-central Mexico.

These data indicate that western Mexican populations of *Polygala* with uncinete seed hairs are best treated as belonging to two separate species. The referral of the small-flowered material to the otherwise South American *P. minima* is of course a separate issue and must be considered in conjunction with patterns of variation within the complex. The preceding paragraphs paint a picture of two clearly distinct taxa, and this certainly seems to be the case in west-central Mexico, where the size differences are correlated with a difference in flower color. However, flower color in annual species of *Polygala* is often variable, both intra- and interpopulationally. *Polygala variabilis* H.B.K., a Neotropical savanna species, is a classic example of this (and hence the epithet). Populations of that

species often include both dark rose/purple- and white-flowered individuals, with the former predominating, while in some areas (e.g., eastern Nicaragua) completely white-flowered populations occur (Wendt, 2001). Therefore, it is not surprising that both *P. minima* and *P. glochidiata* display variation in flower color in other parts of their ranges. Both colored (pink to purple) and white wing-sepals are found in South American *P. minima*, and there is a strong but not absolute geographical component to this variation, with colored flowers concentrated in the northeastern part of the South American range (Goias, Distrito Federal and Minas Gerais in Brazil) and white in the southwestern part of the range (Paraguay and adjacent Argentina). This has led to the recognition by Marques (1988) of varieties based largely on flower color: *P. minima* var. *minima* with pink to purple flowers and *P. minima* var. *oxyrhynchos* (Chod.) Marques with white. In addition, study of the *P. minima* holdings at US indicates that in South American populations the wing-sepal size tends to be somewhat smaller (1.2–1.6 mm) and the seed-body size slightly larger (0.70–0.85 mm) than in the Mexican material, although there is much overlap. In South America, wing-sepal length alone is usually sufficient to distinguish *P. minima* from *P. glochidiata* quite easily (see Marques, 1988). Thus, both North and South American populations here assigned to *P. minima* are easily distinguished from *P. glochidiata* in the narrower sense, although the measurements required are admittedly minute.

*Polygala glochidiata*, in the narrower sense with *P. minima* excluded, has a slightly smaller range than outlined by Bernardi, extending only as far south as Bolivia and southern Brazil; I have seen only one specimen from Paraguay, this along the border with Brazil near Salto del Guairá in Canindeyú (*Fernández Casas & Molero 4194* (MO)). In southern Brazil it overlaps with *P. minima*. *Polygala glochidiata* as thus defined remains a morphologically and ecologically

variable species or complex of taxa that has been treated as comprising several varieties by Marques (1988), based in part on flower color and leaf abundance and disposition. Although, as previously noted, west-central Mexican material appears to be uniformly characterized by medium to dark rose to purple flowers, white-flowered populations of *P. glochidiata* occur as near as eastern and southeastern Mexico (where the species seems to be much less common than in western Mexico), and white flowers appear to predominate from Costa Rica southward. Flower size also varies from slightly smaller to significantly larger (wing-sepals over 3 mm) than western Mexican material.

Interestingly, whereas in west-central Mexico *Polygala minima* is white-flowered and *P. glochidiata* has colored flowers, the opposite appears to be the case where both species are common in Brazil. White is the most frequent flower color of *P. glochidiata* throughout southern Brazil. In areas where both species are common, such as Minas Gerais, pink to purple flowers predominate in *P. minima*, and it is only in areas where *P. glochidiata* does not occur, e.g., most of southern Paraguay and adjacent Argentina, that white appears to predominate in *P. minima*. However, at least occasional white-flowered individuals or populations appear to occur throughout the South American range of *P. minima*.

Thus, in west-central Mexico and southern Brazil, the two known areas in which both species occur in at least moderate abundance, flower color can be a useful but not defining additional character in distinguishing *Polygala minima* from *P. glochidiata* (although the colors are reversed in the two areas). However, in other areas it is not always easy morphologically to distinguish what might simply be smaller-flowered *Polygala glochidiata* from potential *P. minima*. A review of material from throughout the range of *P. glochidiata* indicates that this problem may be most acute in southeastern Mexico (Oaxaca and eastward) and northern Central America. In this area, low-stature,

white-flowered specimens that are referable to *P. glochidiata* based on wing-sepal and seed size and that often occur at much lower elevations than do populations of *P. glochidiata* in west-central Mexico are not markedly distinct from plants with slightly smaller flowers and seeds that would here key to *P. minima*. Northern Hemisphere *P. minima* may actually occur as far south as Honduras or farther, but the exact situation in this area remains unresolved.

Based on the foregoing, it is quite clear that 1) smaller-flowered material from both Mexico and South America is best treated as separate from *P. glochidiata* at the species level, and 2) although there are some differences between the small-flowered material from the two areas, there is much overlap in all morphological characters studied. Putting these findings in the context of the unresolved complexity of the situation as outlined above, I have chosen to follow the most conservative taxonomic solution, which is to treat the Mexican populations as conspecific with *Polygala minima*, with no infraspecific categories recognized within the latter. Further studies may confirm that *P. minima* as here circumscribed is indeed a single species with a widely disjunct distribution similar to, if slightly less dramatic than, the well known amphitropical disjunct plant species distribution (Wen & Ickert-Bond, 2009). But they may also show that smaller-dimensioned plants have evolved independently in the two areas, or that a more complex situation is involved. The present contribution is simply a first step toward a meaningful and useful classification of the *Polygala glochidiata* complex and away from the too-inclusive species concept of Bernardi (2000). Although Bernardi argued that the small size of all parts in *P. minima* could be due simply to environmental effects, the evidence presented above—the distribution of the *P. minima* morphology strongly concentrated in two areas, the sympatric populations of Mexican *P. minima* and *P. glochidiata* in which intermediates are not noted, flower color

differences between *P. minima* and *P. glochidiata* at the regional level in the areas discussed, and (especially notable in South American *P. minima*) the occurrence of *P. minima* in areas in which *P. glochidiata* is absent—all argues against Bernardi's synonymy. The present contribution clearly shows that there is meaningful variation that needs to be treated taxonomically, even if other variation is not yet understood. On the other hand, the kind of variation mentioned above for eastern Mexico and northern Central America makes Bernardi's decision understandable, and he is correct in the sense that simply recognizing *P. glochidiata* and *P. minima* as separate species certainly does not solve the entire taxonomic problem of this complex.

#### MATERIAL EXAMINED

**Western Mexican specimens of *Polygala minima*:** JALISCO: 15 km NW of Los Volcanes on road to Talpa de Allende, Mpio. Atenguillo, 1890 m, 27 Nov 1983, *D. E. Breedlove & F. Almeda* 60663A (CAS); 7–8 km by road S of El Chante on road to Manantlán, 1125–1260 m, 20 Sept 1983, *W. R. Anderson* 12721 (MICH); Arroyo de Las Desgastadoras, base E del cerro El Mamey, al W de Nextipac, Mpio. Zapopan, 1550 m, 9 Oct 1979, *R. Guzmán M., L. M. V. de Puga & C. Hidalgo* 1444 (IBUG); Mpio. Mascota, camino Mascota-Talpa de Allende, a 18 km al N de Talpa, “Los Encinos”, 1475 m, 5 Oct 1982, *E. J. Lott, R. Hernández M. & A. Delgado* S. 1345p.p. [mixed with *P. berlandieri*] (MEXU); 13 mi W of Lagos de Moreno, 1900 m, 1 Sep 1958, *R. McVaugh* 17599 (MICH); cerca de Agua Hedionda, ca. 45 km al E de El Aserradero, Mpio. Tamazula, sobre el camino a Manuel M. Diéguez, 1900 m, 26–27 Oct 1973, *Rzedowski & McVaugh* 1123 (ENCB, MICH); 8 km al N de Cruz de Loreto, sobre el camino a Tomatlán, 50 m, 26 Aug 1976, *Rzedowski & McVaugh* 1318 (ENCB, MEXU, MICH); parte alta del Cerro Huehuentón, 20–25 km al E de Chamela, Mpio. La Huerta, 800 m, 27 Aug 1976, *Rzedowski & McVaugh* 1386 (ENCB, MICH); ca. 4 mi S of Hwy 15 along road to Primavera, ca. 17 mi W of Guadalajara, 3 Sep 1973, *W. D. Stevens & M. Fairhurst* 1913 (ENCB, MEXU); Villa Primavera, Zapopan, 1540 m, 2 Feb 1988, *L. M. Villarreal de Puga* 1339p.p. [mixed with *P. glochidiata*] (IBUG); La Primavera, Cerro al W del Valle de la Salud, 1650 m, 16 Sep 1968, *L. M. Villarreal de Puga* 2065 (IBUG); Presa la Calera, 11 km al N de Teocaltiche, 1700 m, 7 Sep 1973, *L. M. Villarreal* 5155p.p. [mixed with *P.*

*berlandieri*] (IBUG); 25 km al W de Teocaltiche sobre carretera a Nochistlán, 6 Sep 1973, *Villarreal 5155p.p.* [mixed with *P. berlandieri*, same number as previous but different data] (IBUG). **MÉXICO:** Cerro Muñeca, Distr. Temascaltepec, 9 Aug 1932, *G. B. Hinton 1369* (ENCB, LL); same locality, 2300 m, 16 Aug 1932, *G. B. Hinton 1369* (MEXU). **NAYARIT:** Ca. 1.5 mi W of Mazatán on road to Las Varas, ca. 600 m, 27–29 Aug 1959, *C. Feddema 1089* (MICH); km 870, 22 mi SE of Tepic, 1150 m, 26 Aug 1957, *R. McVaugh 16389* (MICH).

**Western Mexican specimens of *Polygala glochidiata* collected at same time and place as specimens of *P. minima*:** **JALISCO:** 7–8 km by road S of El Chante on road to Manantlán, 1125–1260 m, 20 Sept 1983, *W. R. Anderson 1273* (MICH); 13 mi W of Lagos de Moreno, 1900 m, 1 Sep 1958, *R. McVaugh 17590* (MICH); ca. 4 mi S of Hwy 15 along road to Primavera, ca. 17 mi W of Guadalajara, 3 Sep 1973, *W. D. Stevens & M. Fairhurst 1914* (MICH, TEX).

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