

TAXONOMIC REVISION OF THE GENUS POLYGALA (POLYGALACEAE) IN ARMENIA

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Polygala is a large genus within the Polygalaceae family. This study presents a comprehensive taxonomic revision of the genus *Polygala* in Armenia, based on detailed morphological studies of living and herbarium specimens. A new identification key for the genus *Polygala* in Armenia has been developed. A detailed description for each taxon including full synonymy, nomenclatural notes, intrageneric relationships, geographical distribution, characteristic habitats, flowering and fruiting periods, references to type specimens, and notes on the conservation status of some species according to IUCN is given. The name *Polygala supina* is presented for the first time as a priority name for the flora of Armenia. According to the presented revision, the genus *Polygala* in the flora of Armenia is represented by 13 species, 2 of which are endemic to the country. *Polygala stoksiana* and *Polygala pruinosa* are reporting for the first time in Armenia. In addition, new floristic regions have been identified for some species.

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Keywords: Flora of Armenia; identification key; Polygalaceae; *Polygala*; species distribution

مرور تاکزونومیک جنس *Polygala* از خانواده Polygalaceae در ارمنستان

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Polygala جنس بزرگی در خانواده Polygalaceae است. این پژوهش مرور تاکزونومیک جنس در ارمنستان براساس مطالعات نمونه‌های هرباریومی و نمونه‌های زنده است. یک کلید شناسایی جدید برای جنس *Polygala* در ارمنستان ارائه می‌شود. اطلاعات کاملی در مورد گونه‌ها شامل شرح، یادداشتهای نامگذاری، روابط درون جنس، پراکنندگی جغرافیایی، رویشگاههای شاخص، زمان گل و میوه‌دهی، منابع نمونه‌های تیپ و یادداشتهایی در مورد جایگاه حفاظتی تعدادی از گونه‌ها بر اساس IUCN ارائه می‌گردد. نام *Polygala supina* برای اولین بار در لیست نام دارای حق تقدم برای فلور ارمنستان ارائه می‌شود. براساس این کار جنس *Polygala* در فلور ارمنستان با ۱۳ گونه حضور دارد که دو گونه آن انحصاری این کشور هستند. گونه‌های *Polygala stoksiana* و *Polygala pruinosa* برای اولین بار از فلور ارمنستان گزارش می‌شوند. هم‌چنین ناحیه جغرافیایی جدید برای تعدادی از گونه‌ها گزارش می‌گردد.

INTRODUCTION

The Polygalaceae is a cosmopolitan family comprising 21 genera (Aleck Yang & Chien-Fan 2013). It belongs to the order Fabales, which also includes the Fabaceae and two minor families: Quillajaceae and Surianaceae (APG IV 2016). The genus *Polygala*

Tourn. ex L. is the largest within the family Polygalaceae, comprising approximately 422 species with a cosmopolitan distribution, excluding the Arctic, Antarctica, and New Zealand (Heywood & al. 2007).

Polygala species are annuals or perennials, sometimes suffrutescent herbs. The simple leaves

are arranged in a spiral pattern. Flowers are in terminal or axillary racemes. Sepals 5, petals 3, \pm united and adnate to the staminal tube, stamens 8, capsule 2-celled, compressed, usually winged. Seeds 1 in each loculus, pilose. The *Polygala* species naturally grow in Eurasia (Eriksen & Persson 2007; Mabberley 2008; Dönmez & al. 2015).

Two clades were recognized in *Polygala* s.str., namely, the New World clade comprising 213 species under three sections, and the Old- World clade with 349 species in 11 sections (Abbott 2009; Pastore & al. 2019).

Several new taxa of *Polygala* have been described recently i.e. *P. azizsancarii* Dönmez from Turkey (Dönmez & Aydin 2018), *P. mazandaranica* Sarvi & Faghir and *P. gullanica* Sarvi & Faghir from North Iran (Sarvi & al. 2020; 2021).

In Armenia, the family Polygalaceae is represented exclusively by the genus *Polygala*, which according to Tamamshyan (1973), comprises 11 species: *Polygala papillionacea* Boiss., *P. hohenackeriana* Fisch. et C. A. Mey., *P. stocksiana* Boiss., *P. pruinosa* Boiss., *P. transcaucasica* Tamamsch., *P. urartu* Tamamsch., *P. anatolica* Boiss. et Heldr., *P. pseudohospita* Tamamsch., *P. sophiae* Kem.-Nath., *P. caucasica* Rupr., *P. alpicola* Rupr. In addition, *P. papillionacea*, *P. stocksiana*, and *P. pruinosa* are listed as species with a possible presence in the country. After this work, no complete and satisfactory research has been conducted on the genus in Armenia.

In 2013, an attempt was made to consolidate the collected data on *Polygala* (Sargsyan 2013). The author for the first time included *P. andrachnoides* Willd., *P. comosa* Schkuhr, and *P. mariamae* Tamamsch. in the identification key to this *Polygala* species of Armenia. Nevertheless, a revision of the genus *Polygala* was required, given the accumulation of uncertain material on this genus at the Takhtajan Institute of Botany Yerevan, Armenia. Additionally, a new nomenclatural revision was needed to clarify the synonymy of the species.

New data on the habitats of *Polygala* species were collected through field studies between 2014 and 2023.

We revised the genus based on our collections and herbarium material from Armenia and neighboring countries (ERE, ERCB).

This article presents a new identification key to the species of *Polygala* in Armenia, reflecting updated research and results.

The new identification key includes a significant taxonomic update: *Polygala andrachnoides* has been replaced by the epithet *P. supina* Shreb.

The article aims to facilitate better identification and understanding of *Polygala* species in Armenia, reflecting the latest research and taxonomic revision. New data on the distribution of the species are presented.

MATERIALS AND METHODS

The study materials included collections from the Institute of Botany of the NAS RA (ERE), Yerevan State University (ERCB), and unprocessed collections from the Institute of Botany of the NAS RA. The study involved type specimens and all herbarium materials from the Caucasus, Turkey, and Iran stored in these herbaria. The photographs of type specimens of certain species and photographs of specimens available in the LE, were provided by K. G. Tamanyan. Field observations and personal collections were carried out in Armenia between 2014 and 2023 using route and stationary methods. Fieldwork and herbarium material were examined.

The comparative morphological method was used in this study. The floristic regions of Armenia were delineated based on A. L. Takhtajan's scheme (1954) (Fig. 1). Morphological analysis of the specimens was conducted using an "OPTIKA SLX-2 Binocular LED Stereo Zoom" microscope. Species identification has been facilitated by the use of several "Floras" and identification guides (Tamamshyan 1936; Grossheim 1962; Cullen 1965; Tutin & al. 1969; Takhtajan 1972; Chrték & Křisa 1977; Jalilian 2005; Eriksen & Persson 2007; Litvinskaya & Murtazaliev 2013; Danin & Fragman-Sapir 2019).



Fig. 1. Map of the floristic regions of Armenia. 1, U.-Akhur. (Upper-Akhuryan); 2, Shir. (Shirak); 3, Arag. (Aragats); 4, Lori (Lori); 5, Ijev. (Ijevan); 6, Apar. (Aparan); 7, Sevan; 8, Gegh. (Gegham); 9, Yerev. (Yerevan); 10, Dar. (Darelegis); 11, Zang. (Zangezur); 12, Meghri. (Meghri).

RESULTS

As a result, it was established that 13 species represent the genus *Polygala* in Armenia. The presence of *P. papilionacea* in Armenia is not confirmed. Novel floristic regions were identified for the *Polygala hohenackeriana*, *P. stocksiana*, *P. pruinosa*, *P. pseudohospita*, *P. anatolica*, *P. urartu*, *P. alpicola* Rupr., and *P. caucasica*.

Identification key to the species of the genus *Polygala* in Armenia

1. Anthers of the middle stamens are longer than the others, and densely hairy at the top. The veins on the wings do not anastomose with each other 2
 - All anthers are the same size, and glabrous. The veins on the wings always strongly or weakly anastomose with each other 3
 2. Capsule elongate-hastate, slightly asymmetrical, with a narrow wing. Leaves are obovate or elongate-obovate, grayish-green 1
 1. *Polygala hohenackeriana* Fisch. et C. A. Mey.

- Capsule hastate, symmetrical, with a broad wing. Leaves are linear-lanceolate, lanceolate, glaucous 2. *P. stocksiana* Boiss.
 3. Anthers stipitate 5. *P. pruinosa* Boiss.
 - Anthers sessile 4
 4. Prostrate or slightly ascending plants. Inflorescences axillary 5
 - Erect or at the base spreading plants. Inflorescences terminal 6
 5. Small, strongly prostrate plant. Wings elliptical, asymmetrical. Capsule elongate-hastate, with very narrow wings 3. *P. supina* Shreb.
 - Larger, prostrate, or slightly ascending plants. Wings broadly ovate, blunt at the top. Capsule round-hastate, almost sessile, unevenly winged 4. *P. pseudohospita* Tamamsch.
 6. Ovary and capsule on a long stipe 7
 - Ovary on a short stipe. Capsule sessile 10
 7. Corolla longer than the wings 8
 - Corolla equal to or slightly shorter than the wings... 9

8. Corolla only slightly exceeds the wings. Leaves narrow, linear-lanceolate, 1-2 cm long. Wings elongate-ovate, with 3-5 veins. Corolla is purple-pink or peach-colored. Capsule elongate-heart-shaped, with a broad wing..... 12. *P. transcaucasica* Tamamsch. - Corolla significantly exceeds the wings. Leaves elongate-obovate, lanceolate, up to 3 cm long. Wings elliptical, with 3 veins. Capsule elongate-hastate, with a narrow wing..... 13. *P. anatolica* Boiss. et Heldr.
9. Corolla shorter than the wings, bright blue (gentian). Wings broadly elliptical, blunt, with 3-5 veins 10. *P. urartu* Tamamsch. - Corolla equal to the wings, predominantly white, occasionally pink or blue. Wings elliptical, sometimes with a tip at the top, with 5 veins 9. *P. mariamae* Tamamsch.
10. Bracts above the inflorescence form a tuft at the end of the raceme at early flowering..... 8. *P. comosa* Schkuhr - Bracts short, not forming a tuft 11
11. Corolla projecting beyond the wings 11. *P. sophiae* Kem.-Nath. - Corolla not projecting beyond the wings 12
12. Lower leaves rounded. Racemes dense, almost not elongating after flowering. Wings obovate or elongate-obovate, blunt at the top. Corolla bright blue or dark blue, shorter than the wings 6. *P. alpicola* Rupr. - Lower leaves oval or obovate. Racemes loose, elongating after flowering (up to 15 cm). Wings narrowly ovate, pointed at the top. Corolla blue or violet-pink, rarely white, equal to the wings 7. *P. caucasica* Rupr.

Polygala Tourn. ex L. 1753, Sp. Pl. 2: 701

1. *Polygala hohenackeriana* Fisch. et C. A. Meyer 1838, Index Seminum (LE, Petropolitanus) 4: 42.-*Polygala vulgaris* var. *hohenackeriana* (Fisch. & C. A. Mey.) Regel 1862, Bull. Soc. Imp. Naturalistes Moscou 34(II): 511.

“Type: Kirovabad. In district Elisabethpol, legit Hohenacker 1836 (LE, photo!)”.

Fl. V. Fr. V-VI. 400-600 m a. s. l. On dry slopes, among phryganoid vegetation, in juniper sparse forests.

Distribution in Armenia: Shir., Yerev., Dar., Zang., Meghri (Map 2).

General distribution: Iran, Lebanon-Syria, Palestine, Sinai, Transcaucasus, Turkey.

2. *P. stocksiana* Boiss. 1854, Diagn. Pl. Orient. ser. 2, 1: 59.-*Polygala hohenackeriana* var. *stocksiana* (Boiss.) Boiss. 1867, Fl. Orient. 1: 472.

“Type: Beloutschistan, Pasht Khana, 1851, Stocks (holo G, iso. K)”.

Fl. V. Fr. V-VI. 800-200 m a. s. l. On dry slopes.

Distribution in Armenia: Yerev., Dar. (Fig. 2).

General distribution: Afghanistan, Pakistan, Transcaucasus, Turkey.

3. *P. supina* Shreb. 1766, Icon. Descr. Pl.:19. -*P. andrachmoides* Willd. 1802, Sp. Pl., ed. 4, 3: 875. -*Polygala bosniaca* Murb. 1892, Acta Univ. Lund. 27 (5): 165.

“Type: Krym. Tauriae montosi (B)”.

Fl. V-VI. Fr. VI-VIII. 2500-3200 m a. s. l. On alpine carpets, mixed-grass meadows, and gravelly slopes.

Distribution in Armenia: Zang. (Figs. 2; 4 C).

General distribution: Albania, Bulgaria, Greece, Krym, Lebanon-Syria, North Caucasus, Romania, Turkey.

4. *P. pseudohospita* (Tamamsch.) Tamamsch. 1949, Fl. URSS 14: 255. -*P. supina* var. *pseudohospita* Tamamsch. 1936, Repert. Spec. Nov. Regni Veg. 39: 326.

“Sintype: Armenia. Nor-Bajazet prope pag. Alexandrovka 6500'. 2. VII. 1923. Grossheim. (ERE!), Armenia, Nor-Bajazet. In monte Bogu-dagh. 30.06.1929, O. Zedelmejer (LE)”.

Fl. VI-VIII. Fr. V-VII. 1700-3000 m a. s. l. Rocky and grassy mountain slopes.

Distribution in Armenia: U. -Akhur., Apar., Sevan, Gegh., Dar., Zang., Meghri (Fig. 2).

General distribution: Transcaucasus.

5. *P. pruinosa* Boiss. 1843, Diagn. Pl. Orient. ser. 1, 1: 8, partim; idem 1867, Fl. Or. 1: 472.

“Type: Greece. Hab. In Graeciae, Attica et Argolide ubi legi Maio ineunte, Thessaliae Aucher pl. Exs. № 909 (G-BOISS.)”.

Fl. V. Fr. V-VI. 1500-2000 m a. s. l. In alpine meadows.

Distribution in Armenia: Dar. (Fig. 2).

General distribution: Transcaucasus, Turkey, Greece, M. Asia.

6. *P. alpicola* Rupr. 1869, Mém. Acad. Imp. Sci. Saint Pétersbourg, Sér. 7, 15 (2): 166 (Fl. Caucasi).

“Lectotype: Caucassus. In montibus versus rivulum Kassant 733-966 hex. 3. July. 1829. (LE, in sched., photo!)”.

Fl. V-VI. Fr. VII-VIII. 1700-3200 m a. s. l. In alpine and subalpine meadows, along forest edges.

Distribution in Armenia: all floristic regions except Shir. and Yerev. (Figs. 2; 4 A).

General distribution: North Caucasus, Transcaucasus.

7. *P. caucasica* Rupr. 1869, Mém. Acad. Imp. Sci. Saint Pétersbourg, Sér. 7, 15 (2): 165 (Fl. Caucasi); Tamamsch. 1936, Feddes Repert. 39: 327.

“Type: Dagestan. Dagestania: Dido, inter Schauri et Kidero, alt. 900 - 950 hex. Ruprecht. 1860. 18. Aug. (LE)”.

Fl. V-VI. Fr. VI-VIII. 1100-2600 m a. s. l. In mountain, subalpine and alpine meadows.

Distribution in Armenia: all floristic regions except Gegh. and Meghri (Figs. 3; 5 A).

General distribution: North Caucasus, Transcaucasus, Turkey.

8. *P. comosa* Schkuhr 1796, Bot. Handb. 2: 324, tab. 194. -*P. polymorpha* var. *comosa* (Schkuhr) K.F.Schimp. & Spenn. 1829 in F.C.L.Spenner, Fl. Friburg. 3: 865. -*P. vulgaris* var. *comosa* (Schkuhr) Regel 1862, Bull. Soc. Imp. Naturalistes Moscou 34(II): 514. -*P. vulgaris* subsp. *comosa* (Schkuhr) Čelak. 1875, Prodr. Fl. Böhmen: 534.

“Type: Germany. Wittenburg, auf dem Appollensberg (HAL)”.

Fl. V. Fr. VI-VII. 1200-2300 m a. s. l. In forests, in clearings, forest edges, among bushes, and on open slopes.

Distribution in Armenia: U. -Akhur., Shir., Ijev., Lori., Arag., Sevan, Dar. (Figs. 3; 5 D).

General distribution: Europe, Chita, Kirgizstan, Mongolia, North Caucasus, North European Russia, Tadzhikistan, Turkey, Uzbekistan, West Siberia.

9. *P. mariamae* Tamamsch. 1936, Repert. Spec. Nov. Regni Veg. 39: 325.

“Type: Georgia. Armenia rossica: Belij Kljuc, 14. VII., Kozlowsky (TBI)”.

Fl. V. Fr. V-VI. 1200-1800 m a. s. l. In mountain meadows, grassy slopes.

Distribution in Armenia: U. -Akhur., Ijev., Lori., Apar., Yerev., Gegh., Sevan, Zang. (Figs. 3; 5 C).

General distribution: Transcaucasus.

10. *P. urartu* Tamamsch. 1936, Repert. Spec. Nov. Regni Veg. 39: 322.

“Type: Armenia. Erivan, m. Gyarny-Jarykh, in frutices, Quercus macranta., in decliv. aust. S. Tamamshian, 29. VI. 1929. (ERE!)”.

Fl. V. Fr. V-VII. 1750-2000 m a. s. l. In open forests, on grassy slopes.

Distribution in Armenia: Sevan, Apar., Yerev. Endemic of Armenia (Fig. 3).

General distribution: Armenia.

11. *P. sophiae* Kem. Nath. 1948, Zametki Sist. Geogr. Rast. 14: 30.

“Isosytype: Armenia. Prope Elenovka m. Arcanoz 6500'-8000'. 17.VI.1928. (ERE!)”.

Fl. V-VI. Fr. VI-VII. 1800-3200 m a. s. l. In alpine and subalpine meadows.

Distribution in Armenia: Sevan, Dar. Endemic of Armenia (Figs. 3; 4 B).

General distribution: Armenia.

12. *P. transcaucasica* Tamamsch. 1936, Repert. Spec. Nov. Regni Veg. 39: 325.

“Type: Armenia. Stepanawan (olim Djelal-Ogly), 21.V.1920, Schelkownikow. (ERE!)”.

Fl. V. Fr. V-VII. 700-2300 m a. s. l. In mountain meadows, forest edges.

Distribution in Armenia: All floristic regions except Shir. (Figs. 3; 4 D).

General distribution: Transcaucasus, Turkey.

13. *P. anatolica* Boiss. et Heldr. 1853, Diagn. Pl. Orient., ser. 2, 1: 57. - *P. major* Jacq. var. *anatolica* (Boiss. et Heldr.) Chodat 1893, in Mém. Soc. Phys. Genève 31(2): 437.

“Syntype: Turkey. Hab. in Caria inter Karadjasu et Geyra (Boiss.), Lydia ad radices Tmoli prope Alascher (Boiss.), Pisidia cirea. Bouldour et Egirdir (Heldr.), Cappadocia ad Euphratem (Aucher № 910) monte Cassio Syriae (Boiss.) (G, K)”.

Fl. V-VI. Fr. VI-VIII. 800-2300 m a. s. l. In meadows and bushes.

Distribution in Armenia: All floristic regions. (Figs. 3; 5 B).

General distribution: Bulgaria, Greece, Iran, Lebanon-Syria, North Caucasus, Transcaucasus, Turkey.

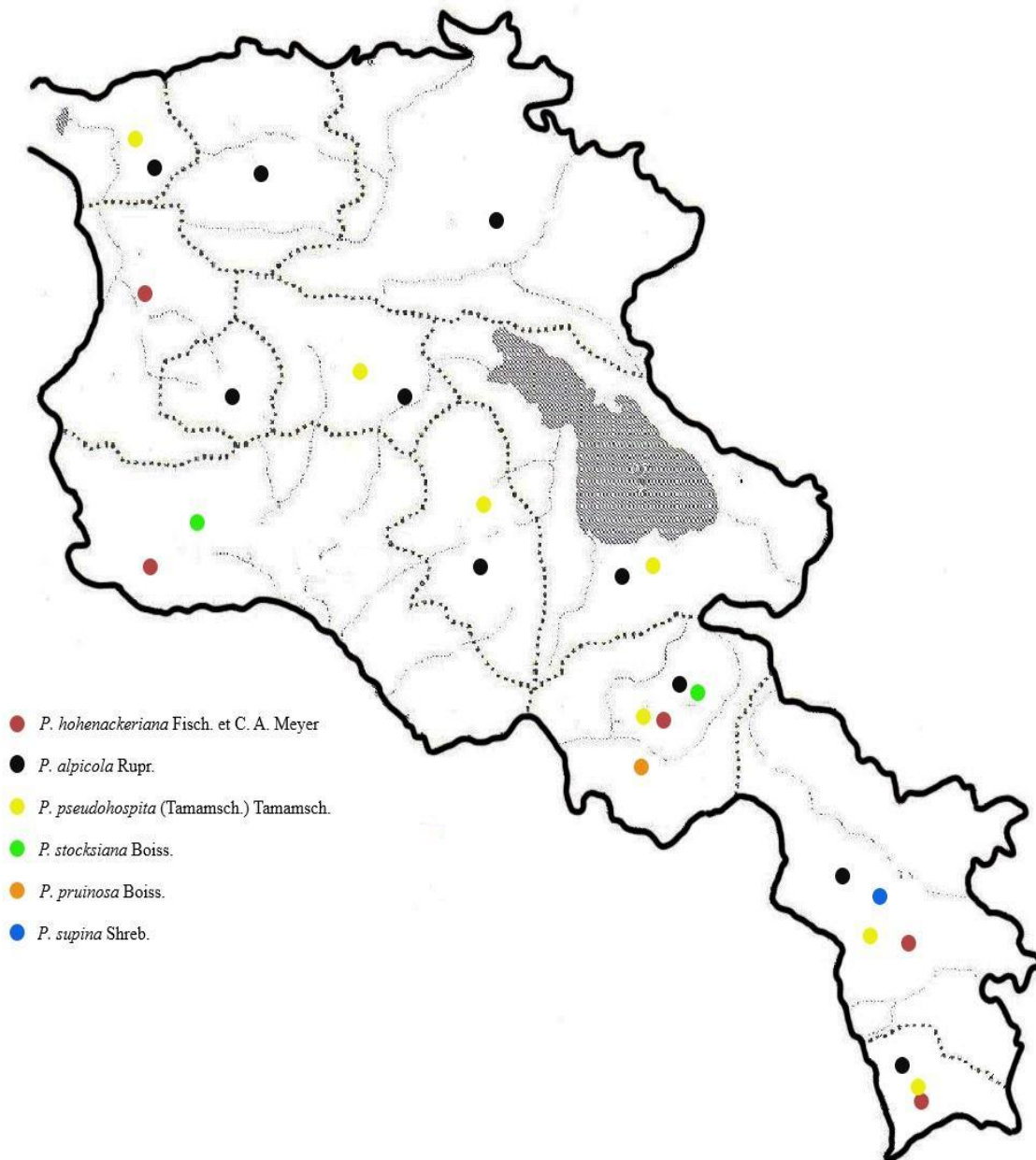


Fig. 2. Distribution map of *Polygala* spp. in Armenia. *P. hohenackeriana* (red circles); *P. alpicola* (black circles); *P. pseudohospita* (yellow circles); *P. stocksiana* (green circles); *P. pruinosa* (orange circles); *P. supina* (blue circles).

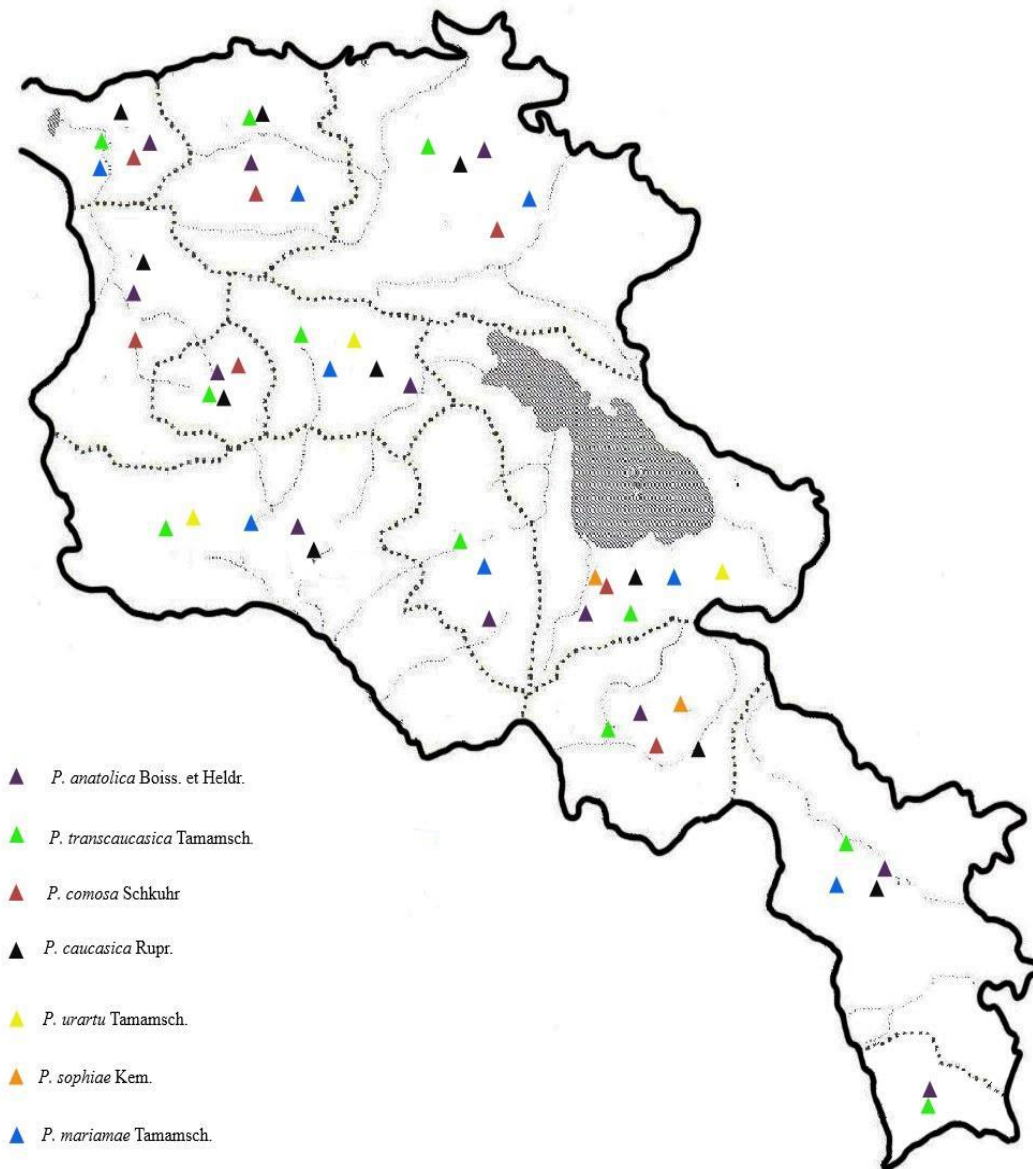


Fig. 3. Distribution map of species in Armenia: *Polygala anatolica* (purple triangle); *P. transcaucasica* (green triangle); *P. comosa* (red triangle); *P. caucasica* (black triangle); *P. urartu* (yellow triangle); *P. sophiae* (orange triangle); *P. mariamae* (blue triangle).

DISCUSSION

Based on the present study, we recognized 13 *Polygala* species, of which *Polygala supina*, *P. comosa*, and *P. mariamae* are new records for the flora of Armenia and *P. papilionacea* was removed from the previous key. The priority name *Polygala supina* has been adopted, with the taxon *Polygala andrachnoides* being considered as synonym of it. The endemic species of Armenia are *Polygala urartu* and *Polygala sophiae*, described in honor of Sofia Georgievna

Tamamshyan (Kemularia-Nathadze 1948).

Polygala species are present in all 12 floristic regions of the republic.

According to Tamamshyan (1973), *Polygala papilionacea*, *P. stovksiana*, and *P. pruinosa* were not known from Armenia. However, the author suggested that these species might occur in Armenia due to their presence in neighboring countries. In particular, she notes that *Polygala papilionacea* and *P. stovksiana* can be found in Upper Akhuryan and Shirak floristic

regions, as they are known from Ghars (Turkey). The presence of the species *Polygala papilionacea* in the territory of Armenia was not confirmed by our studies. Meanwhile *Polygala stoksiana* was found in Yerevan and Darelegis floristic regions. For the both *Polygala pruinosa* Tamamshyan (1973) notes that it could be found in Armenia, as it was known from Nakhichevan. This species was found in Darelegis floristic region of Armenia.

The creation of gardens and the expansion of agricultural lands gradually lead to the reduction of *Polygala* species' habitats.

The *Polygala urartu* is listed in the Red Book of Armenia (Tamanyan & al. 2010) and is endangered according to the IUCN under criteria B1ab (iii,v) B 2ab (iii,v). It grows on grassy slopes in light oak, oak-hornbeam forests, juniper woodlands, and shrubby areas in the middle mountain zone (<https://www.iucnredlist.org/search?query=Polygala%20urartu&searchType=species>). Some species occur

only in one or two floristic regions. Especially *Polygala supina* (Zang.) and *P. pruinosa* (Dar.) are only found in one floristic region, while *Polygala sophiae* is found in two regions (Sevan., Dar.). Additional research must include these species in the Red Book of Armenia.

This taxonomic revision of the genus *Polygala* in Armenia provides an understanding of the diversity and distribution of this genus within the region. Through detailed morphological studies of living and herbarium specimens, we have clarified the taxonomy of *Polygala* in Armenia and updated the identification key for accurate species determination.

The updated key and revised nomenclature enhance the accuracy of species identification and contribute to a better understanding of the genus in the region.

This work improves taxonomic clarity and provides a crucial resource for future research, conservation efforts, and the ongoing documentation of Armenia's rich plant diversity.

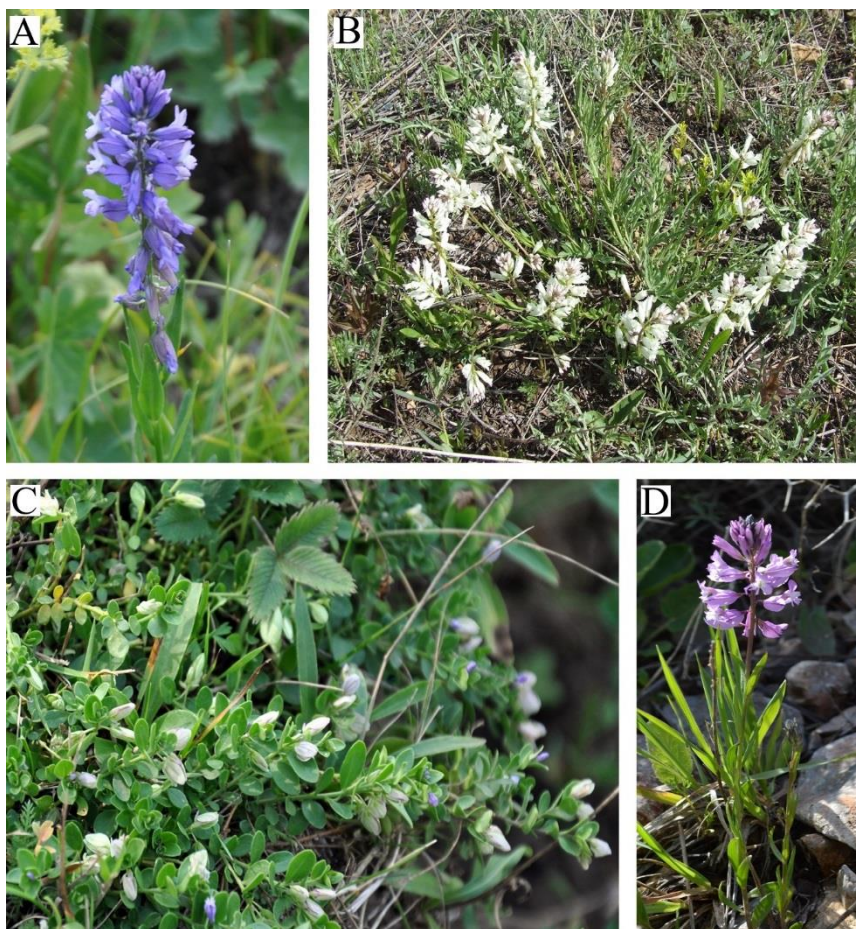


Fig. 4. A, *Polygala alpicola* Rupr.; B, *P. sophiae* Kem.-Nat.; C, *P. supina* Shreb.; D, *P. transcaucasica* Tamamsh.

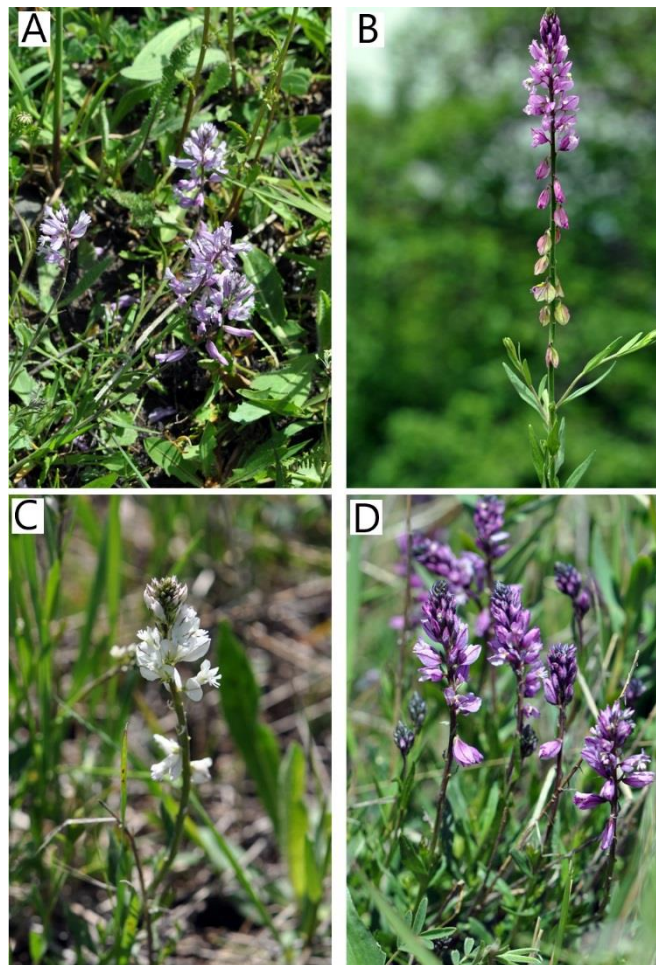


Fig. 5. A, *Polygala caucasica* Rupr.; B, *P. anatolica* Boiss. et Heldr.; C, *P. mariamae* Tamamsh.; D, *P. comosa* Schkuhr.

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