# *Lupinus gredensis* (*Fabaceae*), a new non-native species to Bulgaria and the European part of Turkey

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**Abstract.** *Lupinus gredensis* is recorded as a new species for the adventive flora of Bulgaria. It was discovered in the Eastern Rhodope Mountains (Ivaylovgrad and Krumovgrad districts). The species grows in open dry grasslands and roadside ruderal vegetation, on siliceous and serpentine substrates. Its most distinctive feature is the change of the flower color, which is cream to off-white at first, and subsequently, in the ageing flowers of the same inflorescence, turning lilac to mauve. *Lupinus gredensis* is an endemic taxon restricted to the Iberian Peninsula. So far, it has been known as an alien species only in Greece. Revisiting the available records of *L. hispanicus* from Turkey has revealed that they also belong to *L. gredensis*. In Bulgaria, the earliest finding of *L. gredensis*, erroneously identified as *L. luteus*, dates back to 2003. The aim of the present article is to report *L. gredensis* as an addition to the Bulgarian alien flora and to provide data on the main distinguishing characters of the species and its distribution in Bulgaria and Turkey.

**Key words:** alien flora, Anatolia, Balkans, *Leguminosae*, new records

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## Introduction

So far, genus *Lupinus* has been represented by two autochthonous species in the Bulgarian flora: *L. angustifolius* L. and *L. graecus* Boiss. & Spruner, and one dubious native, *L. albus* L., whose origin (wild or cultigenic) is controversial (Kuzmanov 1976). The North American *L. polyphyllus* Lindl., widely used as an ornamental plant, is the earliest known alien species, well established in the natural habitats of the country. It was found for the first time as an invader in the Western Rhodope Mountains in 1976. Over the last two decades, it has been recorded in several more floristic regions of Bulgaria: Balkan Range (Western), Vitosha region, Mt Sredna Gora (Western) and Rila Mts (Vassilev & Pedashenko 2009, Vladimirov 2012,

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Glogov & al. 2018, Petrova 2018, Karakiev 2019).

*Lupinus gredensis* Gand., reported here for the first time, is the second alien species of the genus found to be naturalized in Bulgaria. It is closely related to *L. hispanicus* Boiss. & Reut. and has long been treated as an infraspecific taxon of the latter. Both taxa, native to the Iberian Peninsula and partially sympatric, are very similar in appearance and especially in inflorescences. Their difference is most noticeable in the flower color. In *L. gredensis,* flowers are cream to off-white at first, and subsequently, at the end of anthesis, those in the lower whorls turn lilac to mauve (as a result of pollination), while in *L. hispanicus,* the flowers are lilac to violet throughout flowering. Furthermore, the two species differ also in their stem indumentum and size of the raceme. According to the protologues, *L. hispanicus* has an appressed-hairy stem and 2–4 remote flower whorls (Boissier & Reuter 1842), while *L. gredensis* has longer, spreading stem hairs and a dense spike (Gandoger 1901), with 5–10 flower whorls. The species has just recently been mentioned for Turkey (W Anatolia) (Strid 2016), where it has long been confused with *L. hispanicus*. Therefore, an update and summary of its distribution in Turkey are also presented.

## Material and methods

Plant material has been collected from two localities in the Eastern Rhodope Mountains floristic region of Bulgaria. Morphological characters of *L. gredensis* have been obtained from the studied personal gatherings and compared with data from protologue and relevant literature (Merino 1895, Gandoger 1901, Castroviejo & Pascual 2000), and with the specimens of *Lupinus* stored in Bulgarian herbaria SOA and SOM (the herbarium acronyms follow Thiers 2021). GBIF (Global Biodiversity Information Facility database) records of *L. hispanicus* from Greece and Turkey, kept in herbaria E (Cubey 2021), MA (CSIC-Real Jardín Botánico 2021) and NMBT (Müller & Creuwels 2021), were examined online. Additional data on the distribution of *L. gredensis* (sub *L. hispanicus*) in Turkey were retrieved via online plant image resource Türkiye Bitkileri (2022). The collected specimens have been deposited in the SOM herbarium. Data on the populations and habitats of the species are based on the authors' observations.

## Results and discussion

In 2021, during field work in the Eastern Rhodope Mountains, a new adventive species to the Bulgarian flora was discovered – *Lupinus gredensis*. By its cream flowers turning lilac to mauve at ageing and regularly arranged in distant whorls, it is clearly distinguishable from all hitherto known species of the genus in Bulgaria, whose flowers are white or pale blue and alternately arranged in a raceme.

***Lupinus gredensis*** Gand., Bull. Soc. Bot. France 48: 413. 1901 (Fig. 1).

Annual plant, usually branched from the base. Stems 30–50(–80) cm, erect to ascending, striate, fistulose, patently hirsute to hirsute-villous. Leaves digitate, petioles up to 10 cm, patent-hairy, leaflets 4–9, 1.5–4.5 × 0.5–1 cm, obovate-oblong to lanceolate, mucronate or acute, appressed-hairy beneath, glabrous above (except near the margins), patent-hairy on the margins, stipules 7–12 mm, linear-subulate, patent-hairy, with membranous margins. Racemes 5–15 cm, composed of 4–10 distant whorls, each 4–7-flowered. Flowers 12–15 mm, pedicels 2–2.5 mm, bracts 5–6 mm, ovate-oblong, acuminate, with membranous margins, appressed to subpatently hairy, caducous, bracteoles 3–4 mm, linear-lanceolate, adnate to the base of the calyx. Calyx bilabiate, 6–7 mm, with appressed to subpatent sericeous hairs, upper calyx lip bipartite, lower calyx lip obscure, 3-dentate. Corolla cream to ochroleucous, turning lilac to mauve at the end of anthesis. Legume 40–50 × 6–10 mm, patent-hairy, ferrugineous-brown, erect before ripening, 5–7-seeded, beak 8–10 mm, falcate-incurved. Seeds 4–6 mm, lenticular to globose-lenticular, smooth, uniformly light brown.

### Revisiting the herbarium and online resources

While checking the genus *Lupinus* in the Bulgarian herbaria, we came across two earlier collected specimens of *L. gredensis* from Bulgaria, both from the Eastern Rhodope Mountains. The earliest specimen,

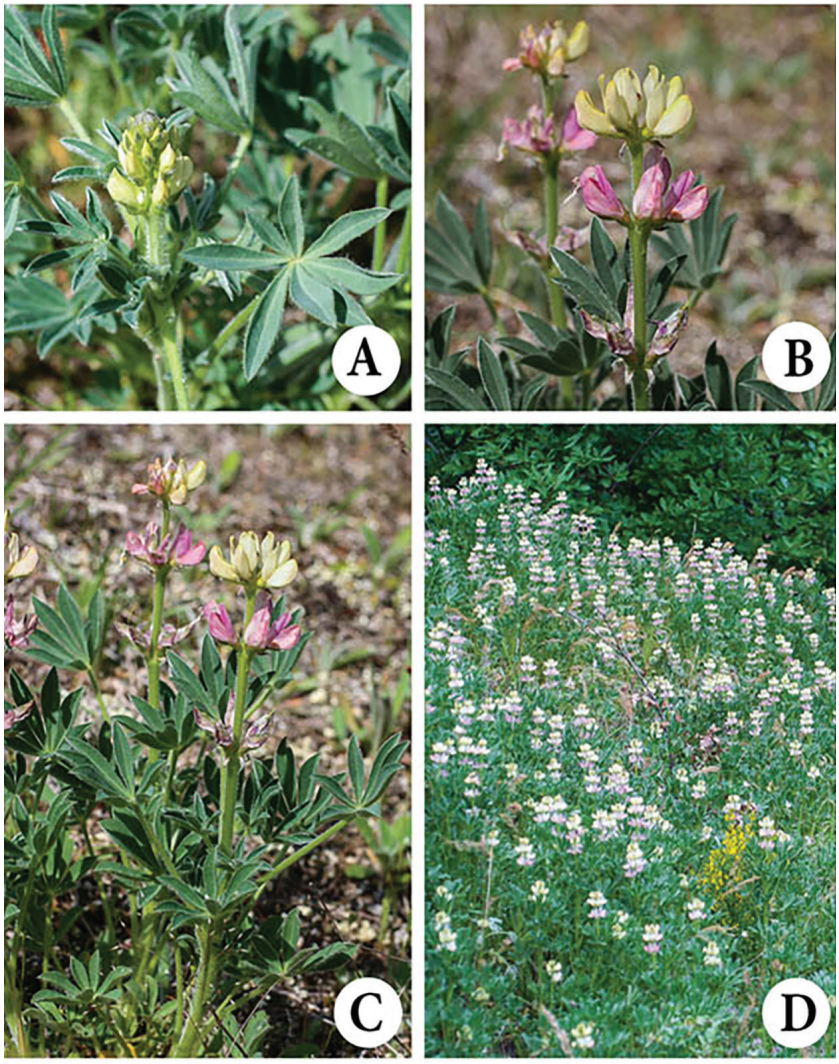


**Fig. 1**. *Lupinus gredensis* in the wild: A – young inflorescence, B – inflorescence at the end of anthesis, C – whole plant, SE of Boturche village, Ivaylovgrad district, D – the population NW of Gorni Yurutsi village, Krumovgrad district.

misidentified as *L. luteus* L., dated back to 2003. It has been collected in an early flowering stage, immediately after bud opening, has spikes with only cream flowers and, in addition, its leaflets are hairy only beneath. In contrast, *L. luteus* (similar to *L. gredensis* in the arrangement of the flowers in whorls), known in Bulgaria as a garden plant, has bright yellow flowers and leaflets pubescent on both sides. The other gathering, confused with *L. polyphyllus*, has been made a decade later (Sopotlieva & al. 2012). This specimen has flowers typically arranged in whorls (vs flowers alternately arranged in *L. polyphyllus*) and the upper flowers are cream, the lower are lilac to mauve (vs flowers bicolored, most commonly with a white standard and blue keel and wings in *L. polyphyllus*). Such a late recording of this species in Bulgaria speaks more in favour of its alien origin in the Bulgarian flora. It can be inferred that *L. gredensis* was introduced to the country at least two decades ago.

Subsequently, a doubtful report of *L. hispanicus* from the European part of Turkey (Aybeke & al. 2010) drew our attention. The characters of the plant from the image, accompanying the publication, undoubtedly conform with those of *L. gredensis* – upper flower whorls with cream flowers, lower with mauve. This appeared to be the first record of that species for the European part of Turkey. The localities of *L. gredensis* at Nasuhbeyli village (Edirne Province, Turkey) and at Meden Buk village (Ivaylovgrad district, Bulgaria) are only 30 km apart, and both date back two decades ago.

Furthermore, three GBIF occurrence records of *L. hispanicus* (Cubey 2021, CSIC-Real Jardín Botánico 2021, Müller & Creuwels 2021) from West and South Turkey apparently belonged to *L. gredensis* due to the fact that a change in the flower color (from cream to lilac) was also found. The earliest specimen (at Nazilli town, Aydın Province) cited in the *Flora of Turkey and the East Aegean Islands* (Chamberlain 1970) is dated back to 1966. Presumably, *L. gredensis* was introduced into the country more than half a century ago.

Finally, the photographs of *L. hispanicus* accessible in the online plant image resource Türkiye Bitkileri (2022) should also be regarded as *L. gredensis*. The plants in the images have inflorescences with cream upper flowers and mauve lower ones.

*Lupinus gredensis*, until recently considered within *L. hispanicus*, is a little-known taxon and has not been accepted in the Turkish flora yet. Thus,

in the latest botanical source, Güner & al. (2012) included it as *L. hispanicus*, apparently referring to Chamberlain (1970). *Lupinus gredensis* was reported for the first time for Turkey by Strid (2016), who most likely has treated the available data on *L. hispanicus* (according to Chamberlain 1970) as belonging to *L. gredensis*. Our revision of more *L. hispanicus* records has confirmed Strid's opinion and has led to the conclusion that the correct name of that taxon in Turkey is *L. gredensis*.

## Taxonomic and nomenclature remarks

*Lupinus gredensis*, a long forgotten species, was restored by Castroviejo & Pascual (1998). They conducted a detailed analysis of its original material, protologue and all related taxa, and finally inferred: two independent species were hitherto merged into *L. hispanicus*, and the name *L. gredensis* should be applied to the taxon with bicolored flowers in a spike, cream upper and mauve lower.

*Lupinus luteus* var. *bicolor* Merino (1895) is the earliest validly published name for *L. gredensis*. Nevertheless, due to a conflict of homonymy, the combination *L. bicolor* (Merino) Rothm. (Rothmaler 1935) (non *L. bicolor* Lindl. 1842) is apparently illegal. Thus, *L. gredensis* has been presently prioritized. Merino (1895) provided its most distinctive feature: "*3–4 verticillis inferioribus violaceis reliquis luteis*". Gandoger (1901), in the protologue of *L. gredensis*, stated that "*corolla albido-ochroleuca nec rubente*". The trait concerning the change of flower color is incorrectly used in the descriptions of *L. hispanicus* in *Flora Europaea* (Amaral Franco & Pinto da Silva 1968) and *Flora of Turkey and the East Aegean Islands* (Chamberlain 1970). In fact, in the protologue of the latter, it is pointed out that it has "*pallide violaceis*" flowers (Boissier & Reuter 1842). This confusion has already been resolved. After the treatment of the genus *Lupinus* for the *Flora Iberica* (Castroviejo & Pascual 2000), *L. gredensis* became a more recognizable species. In Euro+Med PlantBase (ILDIS World Database of Legumes 2010), *L. gredensis* is still treated as an infraspecific taxon of *L. hispanicus*, while in POWO (2019) it is an accepted species.

## Distribution

The native range of *L. gredensis* extends to the central and western parts of the Iberian Peninsula (Castroviejo & Pascual 2000). So far, it has the status of an alien species only in Greece, where it occurs in the northeastern part of the country and in the East Aegean Islands (Dimopoullos & al. 2013, POWO 2019). On the contrary, Strid (2016) believed that *L. gredensis* is a native species to the Greek flora, disjunctly distributed in the Western Mediterranean (W Spain, Portugal and NW Africa) and Eastern Mediterranean (NE Greece, NE Aegean area and W Anatolia). The fact that the species has been present in Greece for a century (see specimen SOA 10227) and also mentioned by Hayek (1927) (sub *L. hispanicus*) is supporting his statement. Nevertheless, the issue of whether it is native or alien to the Greek flora is still controversial.

A new non-native range of the species has now been added (Fig. 2). *Lupinus gredensis* is a new alien species for the Bulgarian flora found in five localities in the Eastern Rhodope Mountains floristic region, and a new invader in the European part of Turkey. It should be also regarded as an adventive species in western and southern Anatolia (Asiatic Turkey), where it has hitherto been treated as *L. hispanicus*. Vertical distribution of *L. gredensis* in Bulgaria and Turkey starts from the sea level and up to 700 m, which coincides with the range occupied by the species on the Iberian Peninsula. By comparison, *L. hispanicus* usually occurs above 600 m a.s.l.

## Habitats and populations

In Bulgaria, *L. gredensis* mainly inhabits the roadside ruderal vegetation and abandoned lands, but occasionally occurs in natural habitats. It predominantly prefers siliceous substrates, similar to those in its natural range (Castroviejo & Pascual 2000), and seldom serpentines. On ruderal terrains, such as the populations near Gorni Yurutsi and Devesilovo villages (Krumovgrad district), it forms dense patches occupying an area of 30–100 $m^2$ and numbering about to few hundred plants (Fig. 1D). By comparison, in the locality at the Boturche village (Ivaylovgrad district), where *L. gredensis* grows in


**Fig. 2.** Distribution map of *Lupinus gredensis* (solid triangles) in Bulgaria and Turkey.

seminatural dry stony grasslands, among sparse scrubs of *Juniperus*, only a few individuals were found.

How the species introduced in Bulgaria remains unknown? Perhaps it has been imported either as an ornamental plant or casually by transportation of cereals and soil mixtures. Rask-Jensen (2018), who has found insect and rodent activities around the sites of *L. polyphyllus* in Norway, maintained that seed dispersal of *Lupinus* were probably dependent upon zoochory. Given the fact that the region of the Eastern Rhodope Mountains is sparsely populated and agriculture is not the main livelihood, it can be assumed that *L. gredensis* was introduced to Bulgaria via some animals. The species most likely penetrated from the adjacent territories in the Greek Rhodopes.

## List of localities and studied specimens

**Bulgaria.** Eastern Rhodope Mountains: S of Meden Buk village, Ivaylovgrad district, in grassy places, 03.05.2003, *D. Stoyanov* (SOM 158423, sub *L. luteus*); around Kalaydzhievo village, Krumovgrad district, in open grasslands with *Juniperus*

*oxycedrus*, 12.06.2012, *D. Sopotlieva, H. Pedashenko & V. Goranova* (SOM 168508, sub *L. polyphyllus*); SE of Boturche village, Ivaylovgrad district, in dry open grasslands among sparse scrubs of *Juniperus oxycedrus*, 320 m, 41.36931°N, 25.95285°E, 17.05.2021, *S. Stoyanov & N. Apostolova-Stoyanova* (SOM 177551); NW of Gorni Yurutsi village, Krumovgrad district, in roadside ruderal vegetation, 560 m, 41.35971°N, 25.90604°E, 17.05.2021, *S. Stoyanov & N. Apostolova-Stoyanova* (SOM 177552, 177553); S of Devesilovo village, Krumovgrad district, in ruderal sites on serpentine, 660 m, 18.05.2021, *S. Stoyanov & N. Apostolova-Stoyanova* (obs.). **Turkey.** All records below have been erroneously treated as *L. hispanicus*: C2 Aydın, Arslanlı (E of Nazilli, along the main highway), 2.5 km N of highway, in the dry bed of Megen Çay River, a tributary of Büyük Menderes, 14.06.1966, *R. Alava & G. Bocquet 5112* (cited by Chamberlain, 1970; E 00333926); B1 Balıkesir, Evciler, Mt. Ido, 560 m, 39°44'N, 26°48'E, 19.06.2001, *S. Castroviejo & S. Nisa 15726* (MA 712174); A1(E) Edirne, Meriç, Nasuhbeyli, Kulaklık locality, in sandy waste, 46 m, 41°14'01.5"N, 26°20'22.7"E, 26.05.2004, *M. Aybeke, C. Kurt & A. Semerci* (TTAE 1331); C3 Alanya, Karakocalı, 23.04.2006, *H. van Loon* (NMBT 095968); B1 Izmir (cited by Chamberlain, 1970); B1 Izmir and Bergama (Türkiye Bitkileri, 2022). **Greece.** At the mouth of Maritsa [Evros] River, in lowland riparian dunes, 05.1917, *B. Stefanov* (SOA 10227, sub *L. hispanicus*); Lesvos, 3 km S of Kalloni, near Kerami, in arable farms, at field margins, 3-6 m, 12.05.1978, *J.R. Edmondson & M.A.S. McClintock 2621* (E 00214555, sub *L. hispanicus*).

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