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## ***Stellaria ruderalis* (Caryophyllaceae) in the Caucasus, new records and species habitat preferences**

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Short communication

## ***Stellaria ruderalis* (Caryophyllaceae) in the Caucasus, new records and species habitat preferences**

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Running title: *STELLARIA RUDERALIS* NEW FOR THE CAUCASUS

**Abstract** – *Stellaria ruderalis* (Caryophyllaceae) is an annual herb of the *S. media* group, recently described in Central Europe and later discovered in other regions of the continent and beyond. Here, we provide novel data on its occurrence in the Caucasus Biodiversity Hotspot, where the species has not been collected since its description as new to science. *Stellaria ruderalis* was discovered at 14 sites in eastern and central Georgia (2022–2023) and northern Armenia (2023). It inhabited various ruderal habitats as well as deciduous and mixed forests. It is presumably a common component of the regional flora, although overlooked to date. Thus, its first IUCN classification is proposed here as Data Deficient (DD).

**Keywords:** biogeography, Caucasus, flora, habitat, *Stellaria media* agg.

### **Introduction**

The Caucasus is a mountainous region forming a boundary between Europe and Asia. For its extraordinarily diverse biota, it is considered one of the 36 global biodiversity hotspots. Its rich vascular plant flora (~6.400 species) has an endemism rate of ~25%, and the related vegetation and habitat diversity is also considerably high. Armenia and Georgia are countries in the South Caucasus, whose floras harbour a significant portion of the taxonomic richness of the hotspot (Mittermeier et al. 2004). Despite intensive research into the regional flora, which has a two-century-long tradition, many neophytes have been discovered only recently (e.g. Kikodze et al. 2010). Examples of regionally novel species are those recently described as new to science (e.g. Piwowarczyk et al. 2023), belonging to which is *Stellaria ruderalis* M. Lepší, P. Lepší, Z. Kaplan et P. Koutecký. This allotetraploid taxon of the *Stellaria media* group (Caryophyllaceae, Alsinoideae) is an annual or winter annual herb, mainly flowering from March to May. Individuals then finish their life cycle, persisting in the dry summer and autumn

periods exclusively in a seed bank. Members of the group are native to Eurasia and North Africa. However, regional differences in their inner taxonomic division do not allow adoption of individual species' distribution without careful investigation of herbarium material or living plants. The current concepts of European members of the group recognize *S. media* (L.) Vill. (s. str.;  $2n = 4x = 40$ ), *S. pallida* (Dumort.) Crép. ( $2n = 2x = 22$ ), *S. neglecta* Weihe ( $2n = 2x = 22$ ), *S. cupaniana* (Jord. & Fourr.) Béguinot ( $2n = 2x = 22$ ; sometimes merged with the previous species), and the most recently described species *S. ruderalis* ( $2n = 4x = 44$ ) (Lepší et al. 2019, El Mokni et al. 2023). Plants of the *Stellaria media* group are a frequent component of various habitats in the Caucasus, including various natural (forests) as well as artificial habitats (trampled sites, road margins, railways, fields), shaded or open (Novák et al. 2023). Our knowledge of the global distribution of *S. ruderalis* is still far from complete. The species was described from the Czech Republic, and was known to occur in Central Europe (Lepší et al. 2019, Novikov et al. 2020, Dudáš et al. 2022), but it has also been recorded in the European Mediterranean Basin, including Sardinia, the Balkans (Lepší et al. 2019) and the Iberian Peninsula (Sáez 2020), as well as Tunisia (El Mokni et al. 2023), Algeria and Morocco (GBIF 2024) in North Africa. There have been no published reports on *S. ruderalis* for the Caucasus to date, nor there are any entries for this species in databases Euro+Med (2006–2023) and POWO (2024). On the other hand, four vouchers collected in Transcaucasia (Armenia, Georgia) and stored under the name *S. media* in the herbarium of the Natural History Museum in Vienna (W) have recently been revised as *S. ruderalis* by J. Walter (GBIF 2024). Moreover, plants with similar seed morphology and chromosome number of  $2n = 44$  from Tbilisi were mentioned by Peterson (1936). This evidence suggests the long-standing occurrence of this species in the area. Still, field observations of the species in the Caucasus are missing since it was described as new to science, and there are no data on its distribution, abundance, and habitat preferences in that area.

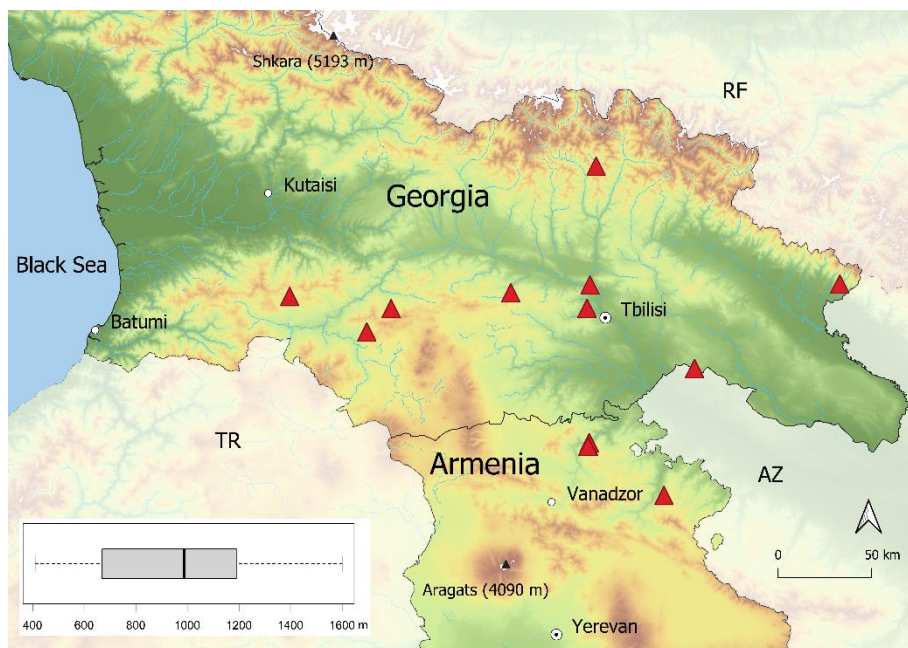
The main goal of our contribution is to report new sites of *Stellaria ruderalis* discovered in Armenia and Georgia since 2022, provide their ecological circumstances and discuss the species' position in the context of regional biodiversity.

### Material and methods

We collected *Stellaria ruderalis* in Armenia and Georgia during botanical field expeditions in 2022 and 2023. We documented each site of the species with a herbarium specimen and acquired its precise geographical position (WGS 84) and elevation by a GPS receiver. Phytosociological relevés were recorded in several sites and stored in the Transcaucasian Vegetation Database (Novák et al. 2023). Soil pH is provided for these sites, which were analysed from dried samples of topsoil (upper 15 cm) in a suspension with deionized water (2:5) by a portable Greisinger instrument. The herbarium specimens were studied morphologically in detail and afterwards stored in the herbaria of Masaryk University, Brno (BRNU), Moravian Museum, Brno (BRNM), and the National Herbarium of Georgia, Botanical Institute of Ilia State University, Tbilisi (TBI). Revisions of all reported herbarium specimens were carried out by Z. Kaplan (Institute of Botany, Czech Academy of Science), one of the authors of the *S. ruderalis* description (Lepší et al. 2019). The nomenclature follows Euro+Med PlantBase (Euro+Med 2006–2023) for plants and EuroVegChecklist (Mucina et al. 2016) for vegetation syntaxa. To provide basic climatic characteristics, we extracted climatic data for the sites from Worldclim 2.1 Bioclim (spatial resolution of 30 seconds). They included BIO1 Annual Mean Temperature and BIO12 Annual Precipitation (Fick and Hijmans 2017).

## Results and discussion

*Stellaria ruderalis* has been discovered at 14 sites (Fig. 1) within the Caucasus Biodiversity Hotspot in Armenia and Georgia since 2022. Based on the aforementioned sources, it should be considered a new member of the regional flora. Below, we provide an overview of our findings of the species in both countries (Fig. 1, On-line Suppl. Tab. 1).



**Fig. 1.** Distribution of the reported *Stellaria ruderalis* sites (red triangles) in Georgia and Armenia. A boxplot provides median (bold line), interquartile range (box) and range of values (whiskers) of elevation of the sites.

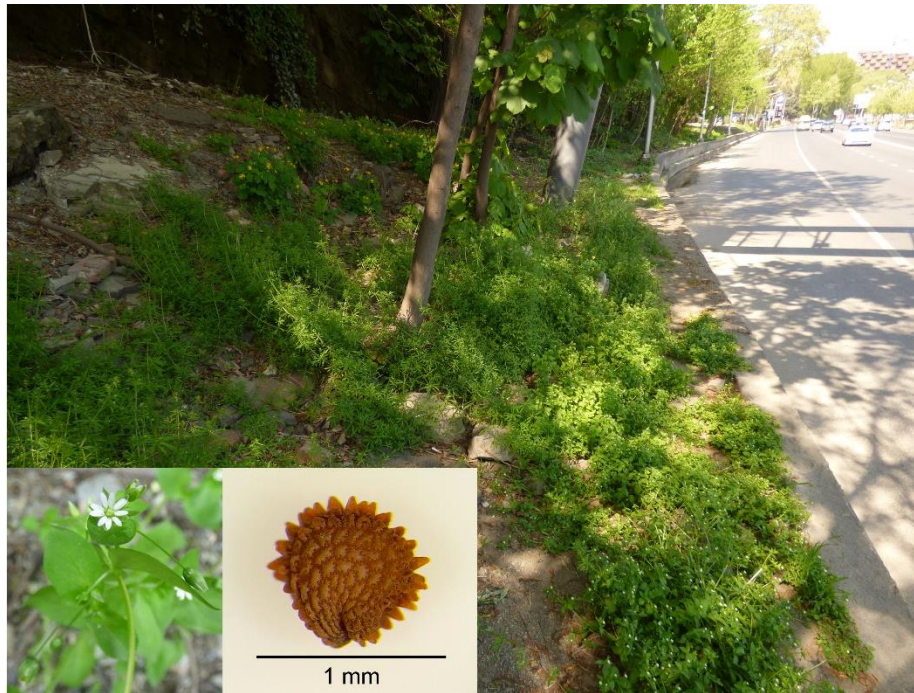
### Sites and their environmental conditions

In Armenia, *Stellaria ruderalis* was discovered in the forested northeastern part of the country (860–1.060 m a.s.l.). The measured topsoil pH at its sites was 5.29–6.82, i.e. moderately to slightly acidic reaction. The site annual mean temperature was 9.1–9.6 °C (median 9.6 °C), while annual precipitation was amounted to 507–537 mm (median 518 mm). In Georgia, we report *S. ruderalis* from ten sites across the central and eastern parts of the country in steppes as well as within deciduous and coniferous forest zones (410–1.600 m a.s.l.). Its populations thrive in contrasting climatic conditions, including sub-Mediterranean and mountain continental types. The sites' annual mean temperature was 5.6–12.3 °C (median 8.6 °C), while the amount of annual precipitation was 516–926 mm (median 727 mm). Our observations indicate that the species may grow along the whole elevation gradient of natural forests.

### Habitats

Armenian sites consisted of deciduous mesophilous (phytosociological class *Carpino-Fagetea*) and xeromesophilous forests (*Quercetea pubescentis*). The species was collected in forests dominated by *Carpinus betulus* and *C. orientalis* where it preferred spots with topsoil disturbed by freely-grazing cows, like other annuals (e.g. *Galium aparine*, *Geranium lucidum*, *Viola arvensis*). Analogically, it was revealed in Georgian deciduous and mixed mesophilous forests (*Carpino-Fagetea*) with *Acer velutinum*, *Carpinus betulus*, *C. orientalis* and *Picea orientalis*. They included both ruderalized types with understory dominated by shade-tolerant

nitrophytes in Tbilisi (Fig. 2) and well-preserved forest types in the Lagodekhi (Greater Caucasus) and Rkoni (Lesser Caucasus) surroundings.



**Fig. 2.** Stands of *Stellaria ruderalis* in the understory of a disturbed nutrient-rich forests (dominated by *Acer velutinum*) with inflorescence and seed details, Georgia, Tbilisi, Zviad Gamsakhurdia Embankment, April 26, 2022. (Photo: P. Novák – habitat, inflorescence, P. Hubatka – seed).

However, most of the Georgian sites consisted of various frequently disturbed and slightly shaded artificial habitats like road embankments, from the colline to the upper mountain belt, with the highest site of the whole dataset at the elevation of 1.600 m (Lesser Caucasus). Sparse thermophilous trampled vegetation in a city pavement (*Digitario sanguinalis-Eragrostietea minoris*) harboured *S. ruderalis* in Mtksheta near Tbilisi. Our observations are aligned with the reported species ecology (Lepší et al. 2019).

### Conservation status and prospective for further research

*Stellaria ruderalis* used to be mentioned as *S. media* (Lepší et al. 2019). The latter species was also found during our surveys in Georgia (e.g. Levitana village, Shida Kartli Region; BRNM 845570). The distribution and ecological differentiation of both species remain unclear in the Caucasus due to this confusion. *S. ruderalis* appears widespread in the investigated regions, having a broad habitat and climatic niche, although overlooked to date. Further investigations in the field and public herbaria are needed to support this assumption. Therefore, we propose a tentative classification of *S. ruderalis* as Data Deficient (DD) according to the IUCN Red List guidelines (IUCN 2024) for Armenia and Georgia.

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### Author contribution statement

P.N. and V.T. share the first authorship, they wrote the initial draft of the manuscript, the former additionally compiled the figures and managed data from GIS layers while the latter solved the taxonomic and biogeographic issues. V.K., P.H., J.R. and G.F. assisted in the fieldwork and processing of the herbarium specimens. P.H. photographed the detail of the seed. All the authors revised the manuscript and approved its final version.

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