

New data on the distribution and threat status of three rare spring geophytes from Bosnia and Herzegovina

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Abstract. The paper provides new information about the distribution and conservation status of three rare spring geophytes in Bosnia and Herzegovina: *Fritillaria meleagris*, *Gagea spathacea* and *Leucojum vernum*. New records, along with data from literature and/or herbarium studies, are presented with distribution maps of 10×10 km UTM grid. Information about the habitat, soil and population size for each record was also given. The IUCN threat status category for Bosnia and Herzegovina was estimated for *F. meleagris*, and reassessed for *G. spathacea* and *L. vernum*.

Key words: distribution, *Fritillaria meleagris*, *Gagea spathacea*, IUCN category, *Leucojum vernum*, spring ephemerals

Introduction

Spring ephemerals are plant species with a very short period (40–60 days in the early spring) of presence of shoots above ground (Lapointe 2001). They are perennial herbaceous species common in the deciduous broad-leaved temperate forests (Lapointe & Lerat 2006, Popović & al. 2016). Due to their short above-ground life, the period of the year in which they can be collected and determined with confidence is limited to a few weeks of early spring. This is one of the main reasons why the distribution area and population numbers of some species of the spring ephemerals are often highly underestimated, which is especially true for species at the margins of their distribution area, already rare in a given region.

Good examples of such neglected spring ephemerals in Bosnia and Herzegovina (Bosnia and Herzegovina) are *Fritillaria meleagris* L., *Gagea spathacea* (Hayne) Salisb., and *Leucojum vernum* L. They are all spring geophytes, mainly found in the *Quercus robur* dominated forest habitats in northern Bosnia and Herzegovina. As

their potential distribution in Bosnia and Herzegovina is limited to the northern parts of the country, which floristically has been only sporadically and superficially researched in the past (Milanović & al. 2013), data on their distribution in Bosnia and Herzegovina are scarce and either very old (as is the case with *Fritillaria meleagris*, which was not confirmed for over 100 years), or very recent (first records for *Gagea spathacea* and *Leucojum vernum* for Bosnia and Herzegovina are several years old).

Although common in Central Europe and albeit chorologically not well investigated in Bosnia and Herzegovina, these species are probably very rare in Bosnia and Herzegovina, given the fact that they grow at the southern edge of their distribution range (Euro+Med 2006). Furthermore, plant populations located on the edge of their distribution are often at their ecological limits as their habitats are of declined suitability, and thus they are more sensitive to changes in ecological conditions. These populations are often predicted to be small and with low genetic quality, which make them harder to conserve (Caissy & al. 2020). Changes in the

water regime, deforestation and intensive agriculture are among the most significant factors causing habitat loss for many plant species in North Bosnia and Herzegovina, including *Fritillaria meleagris*, *Gagea spathacea* and *Leucojum vernum*. Many potential habitats of these species were destroyed in the past and in Bosnia and Herzegovina these three species are mainly found in the forests of *Carpino betuli-Quercetum roboris*, which have lost more than 95% of their area in the last 150 years in the country (Janssen & Rodwell 2016). Although recent trends for these habitats have not been so negative, illegal and unmanaged logging still goes on in these forests (Milanović & al. 2013). Furthermore, land-use changes and changes in the water regime have led to an even greater fragmentation and loss of suitable habitats for these species, such as wet meadows, scrublands, etc. Finally, some local practices in North Bosnia and Herzegovina, such as flower picking, which is especially intensive in early spring, may destroy an otherwise stable population of *F. meleagris* and *L. vernum*. These are some of the main reasons why two out of the three species subject to this study, *Gagea spathacea* and *Leucojum vernum*, already have a threat status category estimated as Critically Endangered and Endangered, respectively (Milanović & al. 2013).

Considering the great number of threats, long period of intensive habitat loss and the fact that they are inherently rare in that part of their distribution area, but keeping the new information about their distribution in mind, this study aims to present new chorological data on *Fritillaria meleagris*, *Gagea spathacea* and *Leucojum vernum* in Bosnia and Herzegovina, their currently known distribution, as well as their threat status category assessment (*F. meleagris*) and reassessment (*G. spathacea* and *L. vernum*).

Material and methods

Research included collecting all literature and herbarium data (SARA) about the distribution of *Fritillaria meleagris*, *Gagea spathacea* and *Leucojum vernum* in Bosnia and Herzegovina. Field research was conducted in the spring of 2017–2020, in suitable habitats of northern Bosnia and Herzegovina. Special attention was given to the research of *Quercus robur* dominated forests in the area around Gradiška, in order to confirm the old and so far only record of *Fritillaria meleagris* in Bosnia and Herzegovina.

Herbarium material collected in the field was stored in the Herbarium of the Faculty of Forestry, University of Banja Luka and the Private Herbarium of Đorđije Milanović. In some cases, photographs of plants were also taken. Material collected in the field was used for determination following the *Flora Europaea* (Richardson 1980, Rix 1980, Webb 1980), and other relevant reference sources (Tomović & Niketić 2005, Jovanović & al. 2009, Kranjčev & Šešok 2016).

The exact locality with WGS84 coordinates, UTM code, plant community/habitat type, soil type, inclination, population characteristics, date of collecting, collector, and origin of the material was given or calculated for each of the treated species. The species distribution in Bosnia and Herzegovina is shown on the maps with a 10×10 km² UTM grid. Localities were recorded with GPS. Short descriptions of habitats and habitats stability were given based on field observations. Nomenclature follows Euro+Med 2006. In some cases, further information about the past and present distribution was obtained from locals.

Threat status for each species was estimated or reassessed following the IUCN criteria and categories (IUCN Species Survival Commission 2012a, b).

Results and discussion

1. *Fritillaria meleagris* L.

New and unpublished records (Fig. 1):

Bosnia and Herzegovina: Lugovi in Petrov Gaj village near Omarska, two subpopulations recorded: 16.834048°E, 44.906718°N; 16.834027°E, 44.901413°N, UTM XK47, *Fraxinetum angustifoliae* forest, pseudogley on tertiary sediments, inclination 0°, numerous individuals, 19 March 2017, coll./det. Đ. Milanović, Priv. Herb. of Đ. Milanović 20/11-002. In the wider area of Petrov Gaj, there are more or less well preserved and structured *Quercus robur* groves in private ownership, scattered across the plain. However, *Fritillaria meleagris* was recorded only in the lower and damper parts of this habitat which are closer to the main watercourse (Gomjenica river), where *Fraxinus angustifolia* is more common in a tree layer.

Bosnia and Herzegovina: Markovići in Marička near Omarska, 16.842184°E, 44.871701°N, UTM XK47, degraded *Quercus robur* and *Carpinus betulus* forest, pseudogley on tertiary sediments, inclination 0°, ca 50

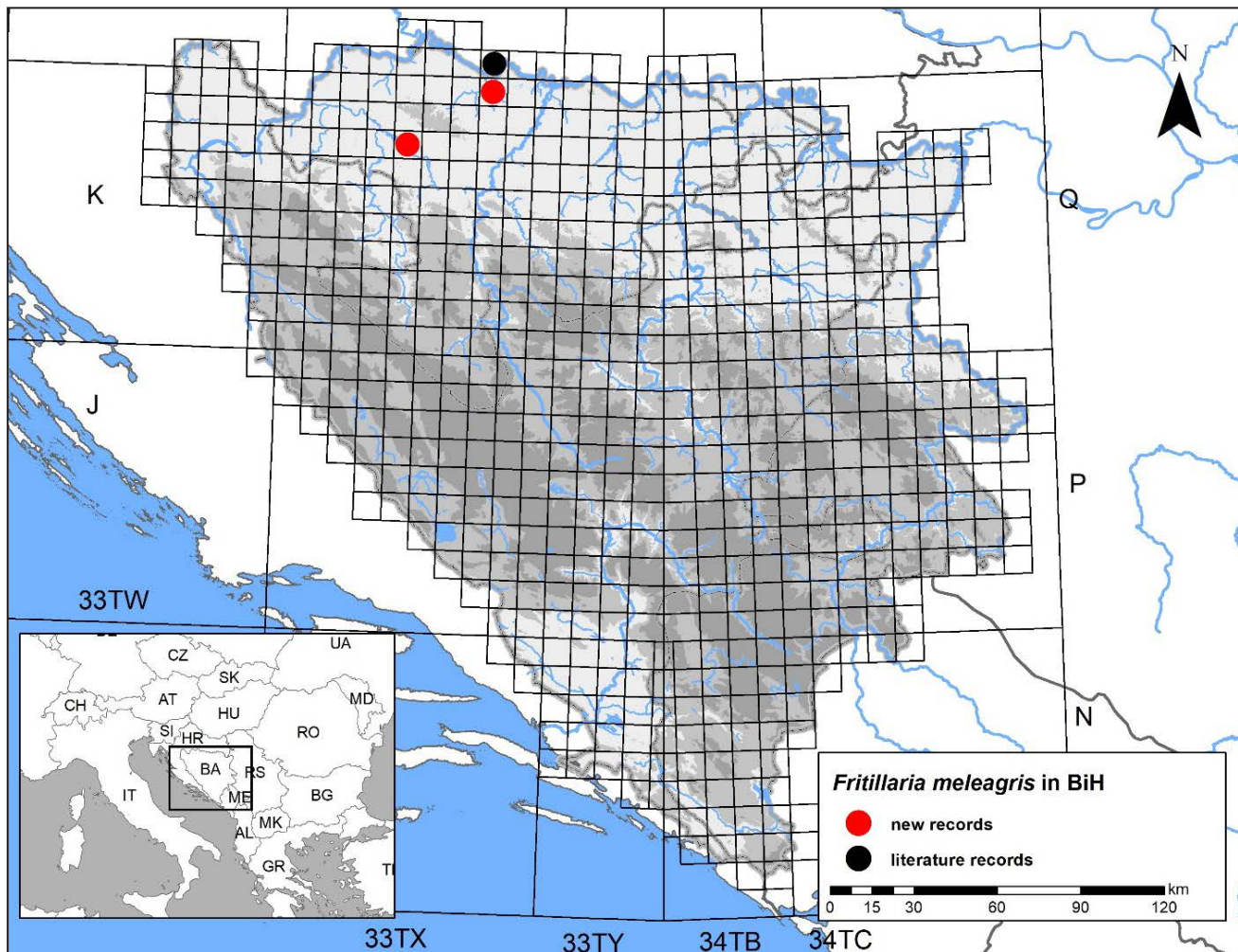


Fig. 1. Distribution of *Fritillaria meleagris* in Bosnia and Herzegovina.

flowering individuals, 19 March 2017, *det.* Đ. Milanović, observation. Population occupies the slightly damper locations in micro-depressions.

Bosnia and Herzegovina: Lakića Gaj in Žeravica near Gradiška, 17.260966°E, 45.121969°N, UTM XK79, *Carpino betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, inclination 0°, ca 50 flowering individuals, 29 March 2013, *coll./det.* Đ. Milanović, Priv. Herb. of Đ. Milanović 20/11-001. This is the only locality in the vicinity of Gradiška, where *F. meleagris* was confirmed. It was recorded in one preserved private forest, and the population is known to the owner of the forest, who prohibits flower picking.

Bosnia and Herzegovina: Rogolji village near Nova Topola, 17.274042°E 45.065625°N, UTM XK79, scrub in the zone of *Carpino betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, inclination 0°, 40 flowering individuals, 9 March 2020, *coll./det.* D. Koljanin, Herb. Fac. Silv. 20/116. The population

is threatened by habitat loss and the fact that it has a highly restricted area of favorable habitat. Chances of spreading to new habitats are reduced by arable fields that represent a barrier.

Bosnia and Herzegovina: Poljice in Rogolji village near Nova Topola, 17.277343°E 45.078241°N, UTM XK79, *Carpino betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, inclination 0°, five flowering individuals, 9 March 2020, *det.* D. Koljanin, observation. The locality is small and surrounded by agricultural fields. The forest is intensely cut.

Bosnia and Herzegovina: Poljice in Rogolji village near Nova Topola, 17.272612°E, 45.075795°N, UTM XK79, *Carpino betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, inclination 0°, four individuals in late phenophase with dry stems, 3 May 2020, *det.* D. Koljanin, observation with photo. The habitat used to be structurally degraded in the past (due to irregular and unmanaged cutting of the

forest); however, the site area is quite large and at present the forest habitat remains stable. Specimens were recorded in late spring and identification was made based on dry stems. Only four individuals were recorded. However, this possibly is due to the unfavorable season of recording, so the real number of individuals is potentially higher.

Distribution and ecology

Fritillaria meleagris has a wide distribution range, encompassing West, Central and East Europe, while in the Balkans this species reaches its southernmost limits of distribution just south of Sava River in northern Central Serbia (Tomović & al. 2007) and in Croatia (with the exception of Mt Velebit) (Ilijanić, & al. 1998, Kranjčev & Šešok 2016). In NW Europe, this species is usually found in wet meadows and pastures, while in SE Europe its ecological amplitude broadens and it can be found in hygrophilous lowland forests too (Ilijanić, & al. 1998, Tomović & al. 2007, Day 2018).

Based on herbarium vouchers collected by Otto Reiser in 1888 and 1889 (SARA 5482, SARA 5483), Fiala (1890) published records from the surroundings of Gradiška. The third existing voucher stored in the SARA Herbarium (50182), also collected from the same area, has an unreadable date of collection and lacks the legator's name. The locality from the surroundings of Gradiška has been recently confirmed in Lakića Gaj in Žeravica (Milanović 2016). The same publication also mentions the new locality in Omarška, but without any precise information. Three new localities were recorded for the first time, all in Rogolji village near Nova Topola, all close to the former flow of Borna river. Mention deserves the fact that, unlike in the remaining distribution area, all localities of *Fritillaria meleagris* in Bosnia and Herzegovina have been found in forests.

Conservation status

Across its distribution range, *Fritillaria meleagris* is an endangered species, with high risk of becoming extinct in many regions due to intensive negative anthropogenic influences, such as habitat loss due to water regime change, transformation of grasslands into arable land, overlogging, as well as massive flower collection during flowering time, which thwarts the already slow reproduction (seed-flower-seed period lasts at least 5 years) (Zhang 1983, Oprea & al. 2015). Population trends for this species are declining (Nikolić & Topić

2005, Tomović & al. 2007) in Croatia and Serbia, while it is listed in the *Red Book of Vascular Flora of Croatia* as Vulnerable (VU) (Nikolić & Topić 2005). Tomović & al. (2007) maintains that populations in Serbia have decreased so much that the species might be considered Endangered (EN).

The principal negative factor for Bosnia and Herzegovina was the large-scale melioration of wet meadows and pastures in northern Bosnia and Herzegovina for the last 70 years, which contributed to the great loss of a suitable habitats for this species. Also, the area of the oak-hornbeam forests is decreasing, with a more than 95% loss in North Bosnia and Herzegovina in the last 150 years (Janssen & Rodwell 2016).

Although the present records in Bosnia and Herzegovina come primarily from woodland habitats, according to the information acquired from locals, this species used to be widespread in the meadows and pastures in the surroundings of the recorded populations in Rogolji 50 years ago. This means that a number of populations were lost in recent decades. All newly discovered populations are with a small number of individuals (the biggest population is with 40 plants) and, consequently, are under a great threat of disappearance. However, given the fact that the species is a spring ephemeral, it should be also mentioned that there are probably more undiscovered localities on suitable habitats across northern Bosnia and Herzegovina.

Although it is not recorded for the territory of the Federation of Bosnia and Herzegovina, it is listed as Critically Endangered in the *Red List of Flora of the Federation of Bosnia and Herzegovina* (Đug & al. 2013). Šilić (1996) assessed it as Vulnerable in his proposal for the *Red List of Vascular Flora of Bosnia and Herzegovina*. However, in our opinion and considering the available data, this species should be categorized as Critically Endangered.

Estimated Red List category: **Critically Endangered** [CR B2ab(iii)].

2. *Gagea spathacea* (Hayne) Salisb.

New and unpublished records (Fig. 2):

Bosnia and Herzegovina: Elezagići village near Gradiška. 17.244202°E, 45.070715°N, UTM XK79, *Carpinion betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, inclination 0°, numerous individuals, 21 March 2020, coll./det. D. Koljanin, Herb. Fac. Silv. 20/117. The species is not rare in the well-

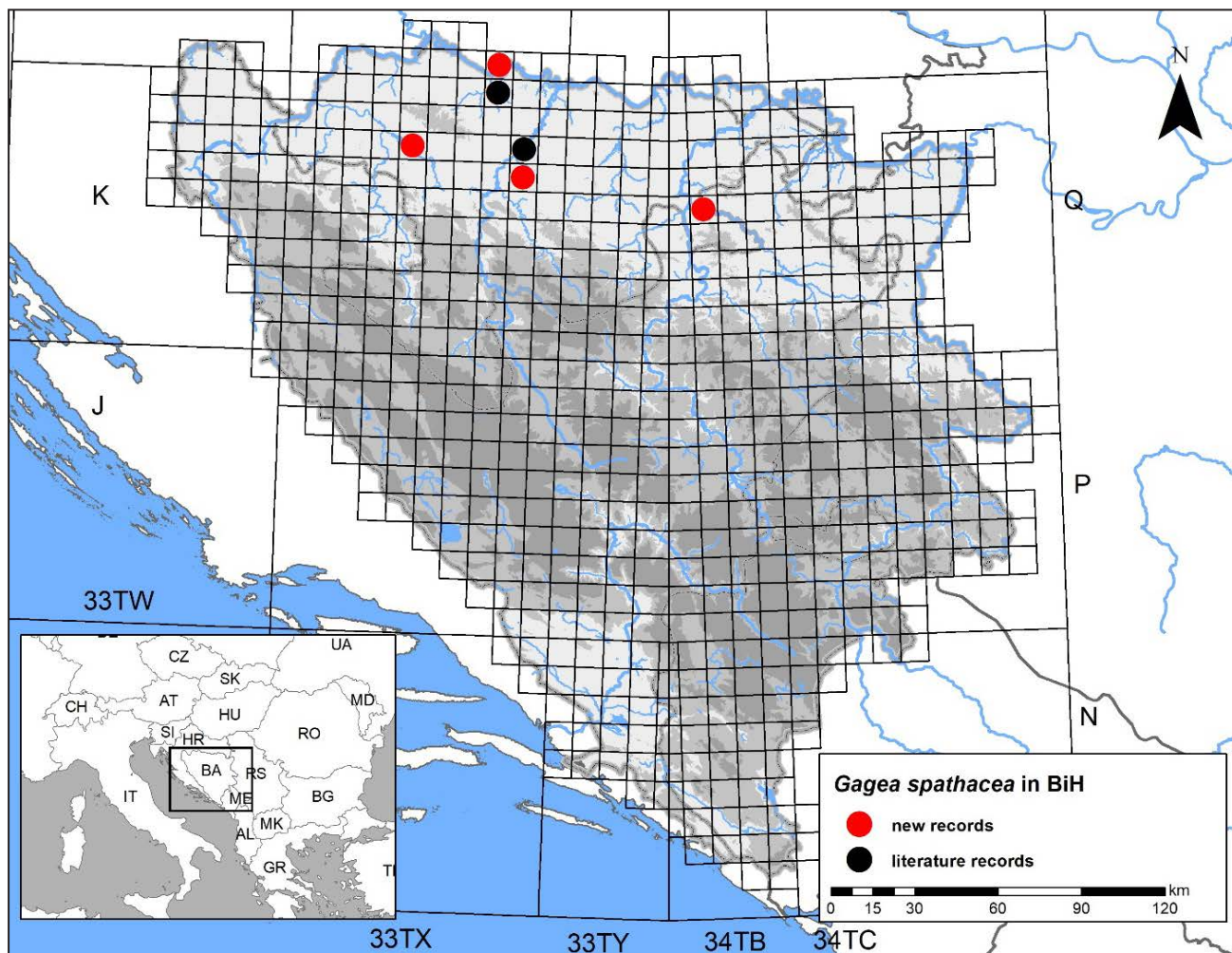


Fig. 2. Distribution of *Gagea spathacea* in Bosnia and Herzegovina.

preserved forests of ass. *Carpino betuli-Quercetum roboris* in Elezagići village.

Bosnia and Herzegovina: Čardačište in Cerovljani village near Gradiška, 17.208515°E, 45.048261°N and 17.204077°E, 45.049542°N. UTM XK79, ass. *Carpino betuli-Quercetum roboris*, pseudogley on tertiary sediments, inclination 0°, numerous individuals, 31 March 2016, *det. Đ. Milanović*, observation.

Bosnia and Herzegovina: Lugovi in Petrov Gaj near Omarska, 16.834048°E, 44.906718°N, UTM XK47, *Fraxinetum angustifoliae* forest, pseudogley on tertiary sediments, inclination 0°, numerous individuals, 19 March 2017, *coll./det. Đ. Milanović*, Priv.Herb. of Đ. Milanović 20/11-003.

Bosnia and Herzegovina: Lug in Malo Blaško near Slatina. 17.317659°E, 44.83442°N, UTM XK86, *Carpino betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, inclination 0°, numerous individuals, 22 March 2017, *det. Đ. Milanović*, observation.

Bosnia and Herzegovina: Posavine near Vrbaška, in the vicinity of Gradiška: 17.173975°E, 45.13708°N, UTM XL70, *Carpino betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, inclination 0°, numerous individuals, 22 March 2017, *det. Đ. Milanović*, observation.

Bosnia and Herzegovina: Boljanić near Dobož: 18.217115°E, 44.688824°N, UTM BQ75, *Carpinus betulus* and *Tilia cordata* forest, pseudogley on tertiary sediments, inclination 0°, numerous individuals, 15 April 2017, *coll. Nemanja Milinović, det. Đ. Milanović*, Herb. Fac. Silv. 17/58.

Distribution and ecology

Gagea spathacea has a wide distribution range in West, North, Central, and East Europe, with a center in the sub-Atlantic regions of Europe. Therefore, this species is relatively rare in South Europe, where it reaches its southernmost distribution limits. In Serbia, it

was recorded in a few localities in western parts of the country (Tomović & Niketić 2005; Tomović & al. 2007), while in Croatia it was recorded at few localities in northern Pannonian and peri-Pannonian parts of the country (Acceto 1982; Marković & Mikulić 1989; Trinajstić 1990).

This species is characteristic of the Pannonian higrphilous and mesophilous oak forests (EUNIS n.d.), which are not heavily disturbed by human activities (Peterson & al. 2004). It is very efficient in nitrogen re-sorption, resulting in a twofold increase of the bulbs' biomass at the end of the growing season (Fichtner & al. 2018). Strikingly, it shows hardly any genetic variation and is virtually sterile, due to the fact that it only reproduces vegetatively by daughter bulbs (Pfeiffer & al. 2012; Fichtner & al. 2018).

In Bosnia and Hercegovina, it was recorded for the first time only recently (Milanović & al. 2013) in three localities northwards from Banja Luka in NW Bosnia and Herzegovina, where it grows only in well-preserved forest stands of *Carpino betuli-Quercetum roboris* (Fig. 2).

Conservation status

The species is categorized as Vulnerable (VU) for Central Europe and has a threat category in most Central European countries (Schnittler & Günther 1999).

Considering the fact that bulbils may only be dispersed within a short range (Pfeiffer & al. 2012), the fragmented oak forests in North Bosnia and Herzegovina hamper the spread of this species. Furthermore, as transport by water streams could play a great role in the dispersal of this species on larger distances (Levichev & al. 2010), changes in weather regime may also reduce its dispersal capacity. Finally, bearing in mind that localities in Bosnia and Herzegovina are at the southernmost limits of distribution of this species, the continuing fragmentation and decline in quality and area of its habitat could eventually result in the extinction of this species from the territory of Bosnia and Herzegovina. That is why, Milanović & al. (2013) has estimated this species as Critically Endangered (CR) in Bosnia and Herzegovina. However, recent researches have shown that the species is a relatively regular member of the forests of *Carpino betuli-Quercetum roboris* in North Bosnia and Herzegovina, with numerous and stable populations, and it is quite possible that new populations will be discovered after more detailed research of the *Carpino betuli-Quercetum ro-*

boris forests in the future. Thus, after the reassessment we propose the change of category from Critically Endangered (CR) to Endangered (EN).

Estimated Red List category: **Endangered** [EN B2ab(iii)].

3. *Leucojum vernum* L.

New and unpublished records (Fig. 3):

Bosnia and Herzegovina: Bjeljevine in Dragelji village near Gradiška 17.141042°E, 45.072036°N, UTM XK79, *Carpino betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, habitat occasionally flooded in spring, inclination 0°, numerous individuals, 13 March 2020, coll./det. D. Koljanin, Herb. Fac. Silv. 20/118.

Bosnia and Herzegovina: Lamovita near Prijedor, 16.856743°E, 44.907337°N, UTM XK27, *Carpino betuli-Quercetum roboris* forest, pseudogley on tertiary sediments, inclination 0°, pseudogley on tertiary sediments, inclination 0°, ca 20 flowering individuals, 19 March 2017, coll./det. Đ. Milanović, Priv.Herb. of Đ. Milanović 20/13-001.

Bosnia and Herzegovina: Dabrak in Gumjera-Careva Gora near Prnjavor, 17.596120°E, 44.936109°N, UTM YK07, beech forest, luvisols, various inclinations along the stream, large population (ca 2 ha) with numerous individuals, 19 February 2020, coll. Lj. Topić, det. V. Stupar, observation with photographs.

Distribution and ecology

The main area of distribution of *Leucojum vernum* is Central Europe, from which it extends locally to South Europe (Pyrenees, North Italy, and northwestern Balkans). This species occurs quite often in NW Croatia, and is a little less common in Slavonia (Nikolić 2005). On the other hand, it is known from only several localities in Serbia (Jovanović & al. 2009).

It is mostly found in deciduous mesophilous or meso-hygrophilous forests, scrubland and meadows on humus-rich soil which could be seasonally flooded (Jovanović & al. 2009, Decocq 2019).

This species was recorded for the first time in Bosnia and Hercegovina several years ago (Milanović & al. 2013) on two localities northwards of Banja Luka, where it grows in forests of *Carpino betuli-Quercetum roboris* (Fig. 3). Two of the new localities also belong to this habitat type, while the locality near Prnjavor belongs to the beech forest habitat, which is more common in the main part of the species distribution area.

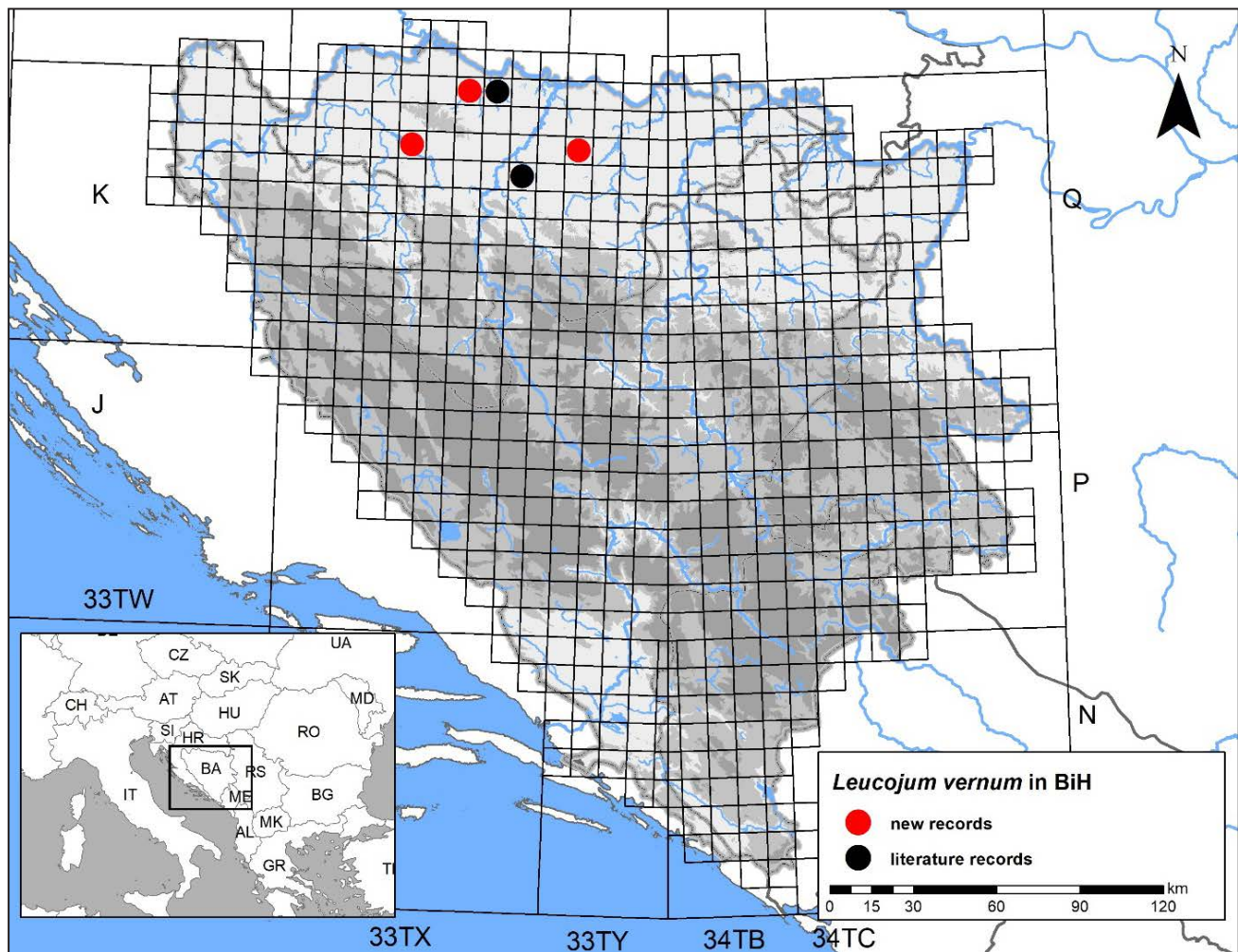


Fig. 3. Distribution of *Leucojum vernum* in Bosnia and Herzegovina.

Conservation status

Global and European status of *Leucojum vernum* is Least Concern (Chadburn 2013), while the species is not listed in Red Lists of the Central European countries (Schnittler & Günther 1999).

Although all known populations in Bosnia and Herzegovina are numerous and seem stable, similarly to the habitats of *Fritillaria meleagris* and *Gagea spathacea*, they are also endangered by a possible habitat loss, due to illegal and unmanaged logging and changes in land use and water regime. Furthermore, in localities closer to the human settlements there is great pressure on the stability of populations due to flower picking. Also, this species there is at the southeastern limit of its distribution in northwestern Balkans, which is one of the reasons why it is so rare in Bosnia and Herzegovina and Serbia. That is why, the threat status category of this species is Endangered (EN) both in Serbia (Jovanović & al. 2009), and in Bosnia and Herzegovina (Milanović

& al. 2013). After reassessment of the threat status of *L. vernum* in Bosnia and Herzegovina, we suggest the category Endangered (EN) to be retained.

Estimated Red List category: **Endangered** [EN B2ab(iii)].

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