

**NEW RECORDS AND DISTRIBUTION OF THREATENED
CARABUS (VARIolosus) NODULOSUS CREUTZER, 1799
IN BOSNIA AND HERZEGOVINA (COLEOPTERA: CARABIDAE)**

Dejan KULIJER¹, Ivan RAPUZZI², Adi VESNIĆ³

¹ National Museum of Bosnia and Herzegovina, Zmaja od Bosne 3,
71000 Sarajevo, Bosnia and Herzegovina. E-mail: dejan.kulijer@gmail.com

² Via Cialla 47 33040 Prepotto (UD), Italy. E-mail: info@ronchidicialla.it

³ Department of Biology, Faculty of Science, University of Sarajevo,
Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina.
E-mail: vesnicadi@gmail.com

Abstract – *Carabus (variolosus) nodulosus* Creutzer, 1799 is a species of European conservation concern listed in the Annexes II and IV of the Habitats Directive. In Bosnia and Herzegovina (BiH) it is a rare species, up till now known mainly from historic records. In this paper the authors summarize for Bosnia and Herzegovina all the available data of *C. (v.) nodulosus* from literature, museum and private collections. In total, records from 19 localities are presented, including records of five new populations from central, eastern and northern part of the country. New populations were found in wet habitats along the banks of streams in deciduous and mixed forests at altitudes between 390 and 1.190 m a.s.l. An old record from Trebević Mt. at 1.600 m a.s.l. represents the highest reported altitude for the species. Considering the large number of potentially suitable habitats, especially in the northern and eastern part of BiH, it is expected to confirm a wider distribution of the species in the future. The habitat characteristics of the new finding sites are in accordance with the ecological needs of the species described in detail in literature. The distribution of the species in the West Balkan area (former Yugoslavia countries) is outlined in the paper and a short discussion on the conservation status of the species in Bosnia and Herzegovina is appended.

KEY WORDS: Coleoptera, beetles, Natura 2000, Habitats Directive, Western Balkans

Izveček – NOVI PODATKI IN RAZŠIRJENOST OGROŽENEGA MOČVIR-SKEGA KREŠIČA, *CARABUS (VARIolosus) NODULOSUS*, V BOSNI IN HERZEGOVINI (COLEOPTERA: CARABIDAE)

Močvirski krešič *Carabus (variolosus) nodulosus* Creutzer, 1799 je evropsko zavarovana vrsta, uvrščena na Prilogi II in IV Direktive o habitatih. Močvirski krešič je v Bosni in Hercegovini (BiH) redka vrsta, do sedaj večinoma znana le iz zgodovinskih podatkov. V prispevku podajamo vse podatke vrste za BiH, iz literature, muzejskih in osebnih zbirk. Predstavljeni so podatki za 19 lokalitet, vključno s podatki za pet novih populacij v osrednjem, vzhodnem in severnem delu države. Nove populacije smo našli v vlažnih habitatih na bregovih potokov v listnatem ali mešanem gozdu na višini med 390 in 1.190 m n.m.v. Zgodovinski podatek iz Trebeviča s 1600 m n.m.v. predstavlja najvišjo znano lokaliteto za vrsto. V prihodnje pričakujemo povečanje znanega območja razširjenosti vrste v državi, zlasti v severnem in vzhodnem delu, kjer je veliko število potencialno primernih habitatov. Lastnosti habitata novih najdb sovpadajo z ekološko potrebo vrste, podrobno opisano v literaturi. V prispevku komentiramo tudi razširjenost vrste na zahodnem Balkanu (v bivših Jugoslovanskih republikah) in njeno varstvo v BiH.

KLJUČNE BESEDE: Coleoptera, hrošči, Natura 2000, Direktiva o habitatih, Zahodni Balkan

Introduction

Carabus variolosus (sensu lato) is an endemic European ground beetle belonging to the subgenus *Hygrocarabus* Thomson, 1845. The subgenus includes two (sub)species: *variolosus* Fabricius, 1787 and *nodulosus* Creutzer, 1799. The status of two closely related species or subspecies of one species isn't yet clear (Müller-Kroehling 2006). Although some authors are inclined towards the status of "sister species" because the differences in the male genital morphology and the non-overlapping ranges (e.g. Casale et al. 1982, Turin et al. 2003), the majority of authors favoured the subspecific rank of *C. nodulosus* (e.g. Březina 1994, 1999, Müller-Kroehling 2006). The European Carabologist's Meeting issued a statement in 2007 calling for inclusion of subspecies *nodulosus* in the interpretation of annex species *C. variolosus*. *Carabus variolosus* (sensu lato) is species of European conservation concern and one of 38 beetle species listed in the Annexes II and IV of the Habitats Directive (HD) (Council Directive 92/43/EC 1992, Council Directive 2013/17/EU 2013). At the time when *C. variolosus* was added to the Annexes II and IV of the HD in 2004 both taxa, *variolosus* and *nodulosus*, were regarded as subspecies to *C. variolosus* (Müller-Kroehling 2006, 2014). ETC-BD (2011) accepts that in context of the HD *Carabus variolosus* encompasses the species in the broader sense and includes *Carabus (variolosus) nodulosus*. The status of taxon *nodulosus* as Natura 2000 species is a subject of debate and additional studies are needed to clarify this issue (e.g. Müller-Kroehling 2014, Turin et al. 2003).

Since the taxonomic status of the species is not yet clear and this work has faunistic purposes we decided to treat this taxon as *Carabus (variolosus) nodulosus*. The specimens were inspected personally by I. Rapuzzi and ID keys by Turin et al. 2003 were used for the identification.

The ranges of these two taxa are separated. *C. (v.) nodulosus* has mostly central European distribution, compared to the eastern European distribution of *C. (v.) variolosus*. The distribution of both taxa is presented in Fig. 1. The species distribution in the western Balkans (Former Yugoslavia) is still insufficiently known. In this region the populations of *C. (v.) nodulosus* are mostly found in the Dinaric mountain region (Breuning 1926, Turin et al. 2003, Vigna Taglianti 2013). Slovenia lies in the core range of distribution of the species and most probably presents the global population stronghold with currently known at last of 200 localities (Vrezec et al. 2012, 2015). In Croatia *C. (v.) nodulosus* is mainly distributed in the north and east part of the country in mountain and hill areas, rare and localized in the western part (Gorski Kotar; Istria: Učka Mountain) (e.g. Breuning 1926, Rukavina et al. 2010, Turin et al. 2003). For Serbia it is known only from the east: Užice; Sokolska Planina (collection I. R.), while in Vojvodina (Fruška gora), central and eastern Serbia, *C. (v.) variolosus* is found (Müller-Kroehling 2014, Turin et al. 2003). The southernmost known locality of *C. (v.) nodulosus* is from Ljuboten on the Šar planina Mt., a mountain peak on the border between Kosovo and Macedonia (Turin et al. 2003).

In regard to morphology and life history, both species are very similar. In contrast to *C. (v.) variolosus*, *C. (v.) nodulosus* is slightly larger having relatively broader

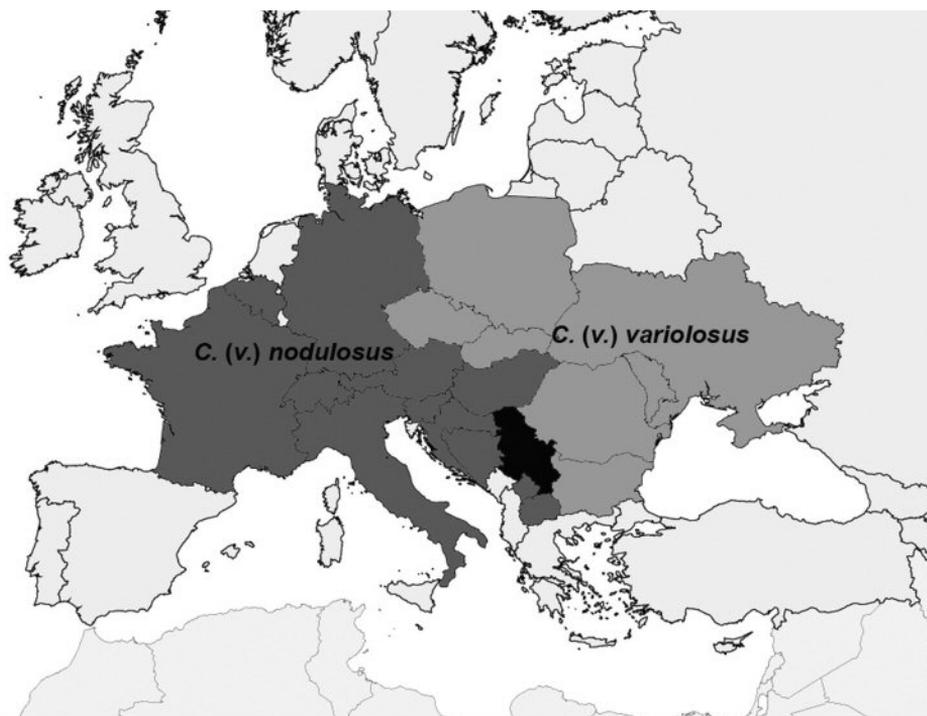


Fig. 1: Distribution of *Carabus (variolosus) variolosus* and *C. (variolosus) nodulosus* in Europe (light grey – *C. (v.) variolosus*; dark grey – *C. (v.) nodulosus*; black – both taxa; (Breuning 1926, Turin et al. 2003, Vigna Taglianti 2013).

body with smoother elytral sculpture and different male genital morphology (for details see Casale & Kryzhanovskij 2003).

The first written report of *C. (v.) nodulosus* for BiH was given by Möllendorff (1873), but he did not include any specific locality. The species was also mentioned for Bosnia by Reitter (1885), who collected various beetles around Sarajevo and Nemila in 1884. Reitter (1896) established var. *hydrophilus* for the *C. (v.) nodulosus* specimens from Bosnia (furthermore without indicating a more detailed locality), that was later synonymized by Breuning (1926).

Apfelbeck (1890) reported one specimen from Trebević Mt. and few years later in addition to Trebević he also said that more specimens are known from south and central Bosnia (Apfelbeck 1894). In his book „Käferfauna der Balkanhalbinsel“ he mentions Travnik, Kiseljak, Sarajevo and Višegrad localities (Apfelbeck 1904). The same localities were listed by Gligić (1942) in his paper on the genus *Carabus* in BiH. Breuning (1926) reports the species from eight localities in BiH: Travnik, Kiseljak, Sarajevo, Višegrad, Preslica plan., Ivan plan., Žepče and Jablanica. In Drešković et al. (2011) the results of the country's first Natura 2000 project were summarised and five species records were listed: Travnik, Kiseljak, Sarajevo, Igman Mt. and Višegrad.

The aim of this paper is to present current knowledge of the distribution of *Carabus (variolosus) nodulosus* in BiH in order to support the establishment of Natura 2000 network and stimulate new research in the country.

Material and methods

Historical data were gathered from available literature: Apfelbeck 1890, 1894, 1904, Breuning 1926, Gligić 1942, Möllendorff 1873, Reitter 1885 and entomological collections: Biological Museum, Lund University (MZLU), Slovenian Museum of Natural History (PMSL), Zoologische Staatssammlung Munich (ZSM) and private collection of A. Casale (Torino, Italia). The most important source of data were the collections of the National Museum of Bosnia and Herzegovina (NMBiH), particularly the entomological collection of Balkan Peninsula, the most significant insect collections for the country with app. 500.000 specimens gathered by Victor Apfelbeck at the end of XIX and the beginning of XX century (Hlaváč & Vít 2008, Kulijer & Marinov 2010, Mihajlova et al. 2008).

This paper also discusses results from two Natura 2000 projects that were implemented in the country (Anonymous 2014, Drešković et al. 2011).

In addition to historic data the paper presents five new records collected by authors from 2015 to 2017 (Fig. 2). New records were gathered during carabidological research in the Balkan Peninsula (I. Rapuzzi) or they represent random findings (A. Vesnić, D. Kulijer). Specimens from Majeвица Mt., Motajica Mt. and Srebrenica are deposited in I. Rapuzzi's collection (Prepotto, Italy) specimens from Konjuh Mt. are deposited in the entomological collections of NMBiH while specimen from Vareš is deposited at the Faculty of Science in Sarajevo.

Old records obtained from literature and collections were often not accurate about the location, giving only the name of mountain or neighbouring town. In these cases the centre of town or the highest peak of the mountain is shown on the map.

Study area

Bosnia and Herzegovina is located in the western part of the Balkan Peninsula. It is predominantly mountainous country which's central and the largest part is occupied by Dinaric Alps, mountain chain that spreads from Slovenia to Albania, forming the largest continuous karst landscape in Europe. To the north of the mountain region lies the lowland region of Posavina, with the lower reaches of several large rivers and the Sava river that forms the natural border with Croatia. To the south the karstic mountains descend gradually towards the Adriatic Sea (Redžić et al. 2008).

Climate of the country is highly variable, with Mediterranean climate dominating in the south, alpine climate in the areas of high mountains and continental in the northern, lowland part of the country (Redžić et al. 2008). The country territory lies within the three biogeographical regions: Continental, Alpine and Mediterranean (EEA 2016).

Results

Material examined:

New data: **Loc. 1.** Vareš, Okolište, N 44.216323° E 18.266306°, 31/IV/2015, 1.190 m a.s.l., 1 adult, leg. & det. A. Vesnić; **Loc. 2.** Konjuh Mt., Mala Zlaća River valley, N 44.336944° E 18.556389°, 06-07/V/2017, 390 - 540 m a.s.l., 4 adults, leg. & det. D. Kulijer & A. Vesnić (Fig. 3a); **Loc. 3.** Majeвица Mt., Veselinovac env., N 44.581944° E 18.805000°, VII/2017, 450 m a.s.l., 2 adults, leg. & det. I. Rapuzzi & F. Kleinfeld (Fig. 3b); **Loc. 4.** Srebrenica, Karačići env., VII/2017, 700 m a.s.l., 1 adult, leg. & det. I. Rapuzzi; **Loc. 5.** Motajica Mt., Srbac env., VII/2016, 500 m a.s.l., 1 adult, leg. & det. I. Rapuzzi.

Collection and museum data: **Loc. 6.** Bjelašnica Mt., Kradenik, 01/IX/1974 (2 adults); 18/IX/1974 (1 adult); 11/IX/1976 (1 adult); 10/X/1976 (1 adult), 850 m a.s.l., coll. Mihljević, NMBiH; **Loc. 7.** Busovača, Tisovac, 08/V/1966, 1 adult, coll. Mihljević, NMBiH; **Loc. 8.** Jablanica, 1901, 1 adult, coll. MZLU; 1902, 11 adults, leg. Wgth., coll. Apfelbeck, NMBiH; 03/XI/1970, 1 adult, coll. Casale, A. (Torino, Italia); 1 adult, 1903 ZSM; **Loc. 9.** Ivan Mt., 1 adult, leg. Apfelbeck, coll. Apfelbeck, NMBiH; **Loc. 10.** Travnik env., 1 adult, leg. Brandis, coll. Apfelbeck, NMBiH; 1 adult, leg. Geschwind, coll. Apfelbeck, NMBiH; 04/XI/1970, 6 adults, leg. & det. Casale, A., coll. Casale, A. (Torino, Italia); **Loc. 11.** Sarajevo, Rečica, 1 adult, coll. Apfelbeck, NMBiH; **Loc. 12.** Trebević Mt., 3 adults, leg. Apfelbeck, coll. Apfelbeck, Apfelbeck, NMBiH; **Loc. 13.** Čemerno (pass between Foča and Gacko), 07/XI/1971, 2 adults, leg. & det. Casale, A., coll. Casale, A. (Torino, Italia); **Loc. 14.** Višegrad, Semeć, 1 adult, coll. Apfelbeck, NMBiH; **Loc. 15.** Nemila, 1 adult, leg. & det. Scheibel, PMSL.

Literature data only: Loc. 16. Žepče (Breuning 1926); **Loc. 17.** Kiseljak (Apfelbeck 1904, Drešković et al. 2011, Gligić 1942); **Loc. 18.** Igman (Drešković et al. 2011); **Loc. 19.** Preslica Mt. (Breuning 1926).

Discussion

Based on the records from museum collections and literature data *Carabus (v.) nodulosus* is historically known from 14 localities in BiH. With our five new records the total number of the localities for the country is 19, located in two biogeographical regions of the country, Alpine and Continental (Fig. 2). Out of 33 specimens in the

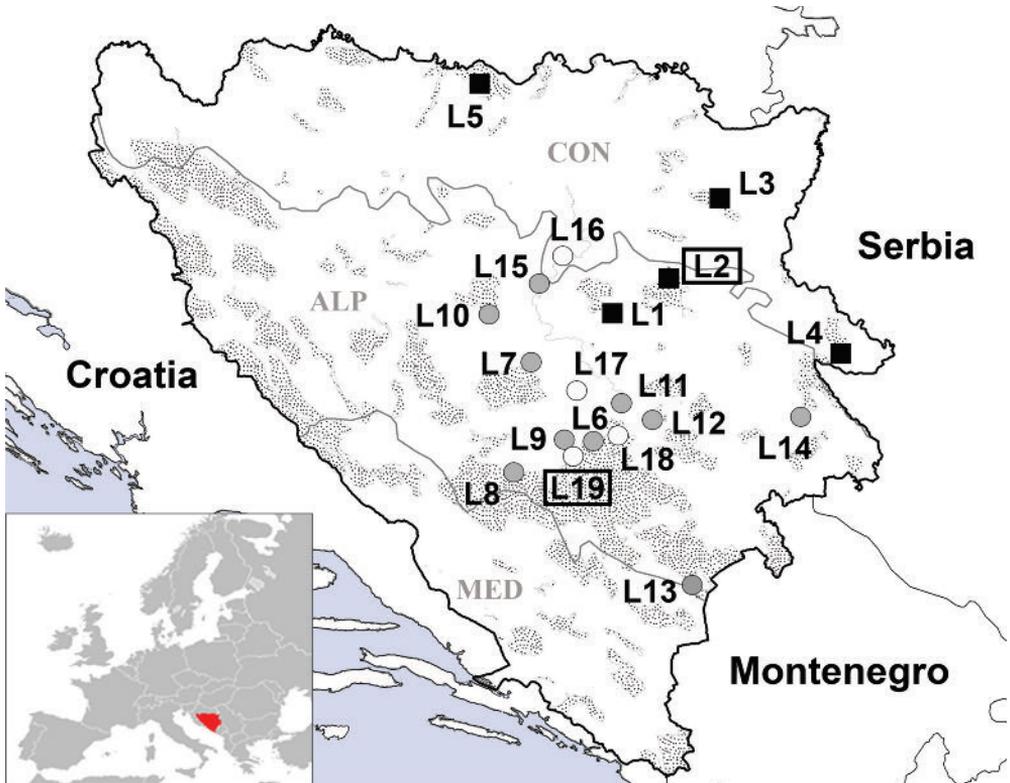
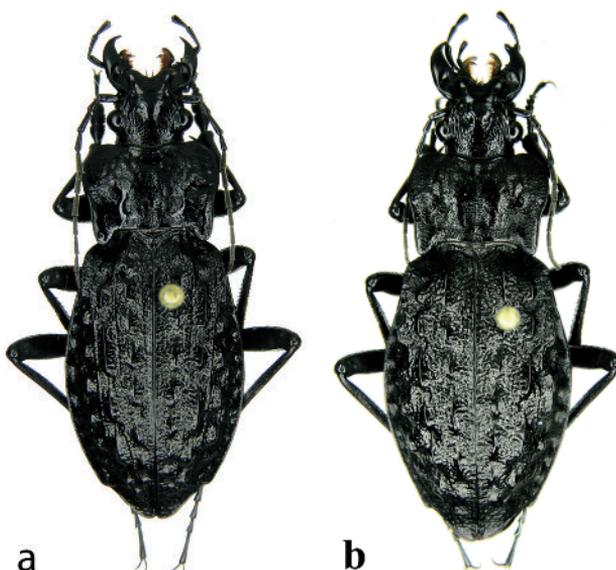


Fig. 2: The distribution of *Carabus (variolosus) nodulosus* Creutzer, 1799 in Bosnia and Herzegovina. The records from the entomological collections are marked with gray circles, records found in literature only with white circles and new data with black squares. Light gray lines on the map indicate the border between biogeographical regions: Continental (CON), Alpine (ALP) and Mediterranean (MED) (EEA 2016). The numbers of localities situated within the borders of proposed Natura 2000 Network areas (shaded) are shown in black frames. Geographical position of Bosnia and Herzegovina in Europe is shown on smaller map.

Fig. 3: Male of *Carabus (variolosus) nodulosus* from Konjuh Mt. (a) and female from Motajica Mt. (b) (photo: I. Rapuzzi)



collection of Viktor Apfelbeck in NMBiH, 20 originate from BiH. For the specimen with label “Damjanović”, the name probably represents the name of the collector, not a locality name, while one specimen only has label „Bosnien (Reitter. Leder.)“. In addition to the Apfelbecks collection, six specimens of *C. (v.) nodulosus* from two localities in Bosnia are found in the insect collection of Boro Mihaljević that it is also stored in the NMBiH. These specimens were collected in 1966 (Busovača) and 1974/76 (Bjelašnica Mt.). A specimen from Jablanica collected in 1901 is stored in the collection of the Biological Museum, Lund University (MZLU) and one individual from Nemila is stored in the collections of the Slovenian Museum of Natural History in Ljubljana (PMSL). One specimen labelled “Jablancici” collected in 1901 and stored in the collections of the Zoologische Staatssammlung Munich (ZSM) probably originates from Jablanica (north Herzegovina), as location with the name Jablancici could not be found in BiH and one specimen from Jablanica collected in 1901 is also present in the ZSM, as well as in MZLU collections. Additional specimens from three localities are stored in the collection of A. Casale (Torino, Italia).

Carabus (variolosus) nodulosus is stenotopic, silvicol and strongly hygrophilous species that inhabits fringes of water bodies and swampy areas in broadleaved and mixed forests (e.g. Casale et al. 1982, Sturani 1962, 1964, Turin et al. 2003). According to Pavičević et al. (1997) it inhabits various deciduous and conifer forest communities in hills and mountains. In Italy the species was reported from streams within a mixed secondary and tertiary deciduous beech forest (Rapuzzi, 2016), while in Croatia it was found at a brook in the beech forest (*Seslerio autumnalis-Fagetum* (Ht.) M. Wraber ex Borhidi 1963) (Rukavina et al. 2010). In north-west Germany the species is found in ancient woodland complexes with many near-natural springs and running waters in several types of deciduous forest (Matern et al. 2007), while in Bavaria it

lives at intact brook margins, seepages, spring swamps and spring marshland in forests or in natural marsh reedlands and occasionally in acidic bogs (Müller-Kroehling 2014).

Our observations of the species habitat in Bosnia and Herzegovina correspond to the descriptions available in literature. In the northern part of Konjuh Mt. the species was found along Mala Zlača River. The slopes on both sides of the river are covered with mixed beech, fir and spruce forest with the domination of broadleaved tree species at the finding sites and many small streams flowing down the hilly slopes (Fig. 5). The first individual was observed on a wet forest road in the evening, while additional three specimens were found during the day. Two were found under the logs in a small canalised stream along the road (Fig. 4) while the third specimen was found dead, trapped in a small dry concrete pool near the hotel, at the edge of forest. Observations distributed along the 5 km stretch of the river and the fact that four specimens were easily observed without target research, suggests the presence of good habitat for the species and possibly presence of larger population at this location.

At Vareš (Okolište) locality one specimen was found in mixed broadleaved and conifer forest (mixed forest of fir, spruce and beech) with trees over 20 meters high. The individual was found moving upstream through shallow water (2 – 5 cm deep) in small (50 cm wide) forest stream. The stream was on a slope with 5 – 10° inclination and south-west exposition. Many tree trunks that were left behind after last year forest logging were observed around the stream.



Fig. 4: *Carabus (variolosus) nodulosus* at Konjuh Mt. (photo: D. Kulijer)



Fig. 5: Habitat of *Carabus (variolosus) nodulosus* at Konjuh Mt. (May 7th 2017) (photo: D. Kulijer).

According to Turin et al. (2003) *C. (v.) variolosus* is distributed up to 1.000 m a.s.l. In Poland the highest known occurrence of *C. (v.) variolosus* is at 1.250 m a.s.l., but most localities are distributed from 300 to 700 m a.s.l. (Bobrek & Górska 2017). Similar altitudes were also reported for *C. (v.) nodulosus* (Matern et al. 2007, Rapuzzi 2016, Rukavina et al. 2010). New Italian population was found at altitudes between 430 and 500 m a.s.l. (Rapuzzi 2016).

In BiH new records are distributed between 390 (Konjuh Mt.) and 1.190 (Vareš) m a.s.l. For museum records, except records from Bjelašnica (850 m a.s.l.), the altitudinal data are not given and the localities are insufficiently precise for the extraction of even approximate altitudinal data. Interesting record is from Trebević Mt. where

Apfelbeck found one individual at 1.600 m a.s.l. (Apfelbeck 1890). This represents the highest locality in BiH and the highest observation of this species for the whole areal. Although the survey of the carabid fauna of this mountain and the surrounding area was conducted in 1980s, the species was not recorded (Tabaković-Tošić 1992).

Conservation reference

Carabus (v.) nodulosus is rare and threatened species across the whole distribution area that has lost significant part of its range, and the distribution within it (e.g. Turin et al. 2003). In the western part of its range main threats are drainage, brook regulation, forest fragmentation and habitat destruction (Müller-Kroehling 2014).

In Bosnia and Herzegovina *C. (v.) nodulosus* is not protected, neither it is included in the two existing red lists, The Red List of Protected Species of Flora and Fauna of Republika Srpska („Crvena lista zaštićenih vrsta flore i faune Republike Srpske”) (Službeni glasnik Republike Srpske 2012) and Red List of wild species and subspecies of plants, animals and fungi („Crvena lista divljih vrsta i podvrsta biljaka, životinja i gljiva”) in Federation of Bosnia and Herzegovina (Službeni list Federacije Bosne i Hercegovine 2014).

Two projects aiming to identify the presence and the distribution of habitats and species listed in Annexes I and II of the HD and prepare the proposition of the future Natura 2000 network in BiH, were conducted until now. The details are summarized by Milanović et al. (2015). *Carabus (v.) nodulosus* was included only in the first proposition of the country's Natura 2000 network when four sites were identified (Drešković et al. 2011). However, the species was excluded from the final reference list for BiH (Milanović et al. 2015). As shown in Fig. 2 only two localities of *C. (v.) nodulosus* fall within the borders of the currently proposed Natura 2000 network sites in BiH. Nevertheless, for most historical data the exact location could be only roughly determined and several localities are very close to the borders of proposed sites. The exact locations of these populations could possibly be within the borders of these sites, but this should be investigated, as well the possible current presence of the species in the area in general.

Although known data on the species distribution in BiH are mostly historical (most data were collected before 1930s), this cannot be regarded as a proof of disappearance of the species, but more likely illustrates the lack of recorders and investigations in the country. Recent discoveries of several new localities confirm this.

Considering that no research or monitoring exists in the country and that available data on the species are scarce and mostly very old, it is impossible to give reliable estimate of its threat status and populations trends in BiH. As in other parts of its range, the main threat for the species is the destruction of its habitats, while climate change, particularly in the south presents additional threat. However, Bosnia and Herzegovina lies in the central part of Dinaric Alps, large mountain chain that covers most of the country. This area is characterised with abundance of forest habitats and numerous streams and small rivers, particularly in altitudes between 200 and 1.000 m a.s.l. This zone occupies app. 62 % of country's territory (Lepirica 2009). These habitats that

are important for *C. (v.) nodulosus* are still well preserved so it can be expected that in BiH significant populations of this threatened European species are present and that its distribution in the country is much wider than currently known. It is probably present in all regions of the country apart from the driest part of the south Herzegovina region. Targeted research of potential habitats and the historical localities of the species should be one of the priorities of Natura 2000 process in the country.

We also expect that *C. (v.) nodulosus* is more common and has wider distribution in the western Balkan region and to find the species in Montenegro because the presence of suitable habitat and the geographical position just in between Bosnia and the population in Ljuboten. In BiH it was found at Čemerno (L13) that is app. 6 km from the Montenegro border. In Macedonia both (sub)species should be present in the country.

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