

## ***Sympetrum flaveolum* in the Dinaric Alps (Odonata: Libellulidae)**

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### **Abstract**

An overview is given on distribution, habitat and flight season of *Sympetrum flaveolum* in Bosnia and Herzegovina, and the status of this species in the Dinaric Alps is discussed. It was found to be common and widespread in Bosnia and Herzegovina. In the data set consulted, *S. flaveolum* was present in 93 localities and it is thus concluded that the species is quite common. Continuity and abundance of observations, including much evidence of reproduction, indicate the presence of permanent populations in the Dinaric Alps in Bosnia and Herzegovina.

### **Zusammenfassung**

*Sympetrum flaveolum* in den Dinarischen Alpen (Odonata: Libellulidae) – Der vorliegende Artikel gibt den Überblick über Verbreitung, Lebensraum und Flugzeit von *Sympetrum flaveolum* in Bosnien und Herzegowina und diskutiert die Präsenz der Art in den Dinarischen Alpen. Die Art ist im Land häufig und weit verbreitet. Mit 118 Nachweisen von 93 Fundorten ist *S. flaveolum* sowohl historisch als auch aktuell die am zweithäufigsten nachgewiesene *Sympetrum*-Art. Die Fundortdichte, zahlreiche Beobachtungen innerhalb eines 120 jährigen Zeitraumes, Reproduktionsnachweise und die Existenz von großen Populationen bestätigen, dass in den Dinarischen Alpen beständige Populationen der Art existieren.

### **Introduction**

*Sympetrum flaveolum* is a common species in large parts of Europe, particularly in the central and northern regions, while in the south it is scarcer and confined to higher altitudes. The species inhabits small, shallow and richly vegetated waters with fluctuating water levels that partially or completely dry out in the summer. These include small pools, ponds, margins of lakes and seasonally flooded meadows (ASKEW 2004; DIJKSTRA & LEWINGTON 2006; BOUDOT et al. 2009).

Some authors consider *S. flaveolum* as a migrant species (e.g. ASKEW 2004; BELANČIĆ et al. 2008; BEDJANIĆ 2014), even a strong migrant (KOTARAC 1997),

while others believe that the species migrates only in some years and under favourable weather conditions (e.g. BOUDOT et al. 2009; WILDERMUTH & MARTENS 2014). According to HARABIŠ & DOLNÝ (2011) *S. flaveolum* has low dispersal ability. The species occasionally colonizes large areas, establishing a temporary population that sometimes can last for several years (BOUDOT et al. 2009; WILDERMUTH & MARTENS 2014).

In southern Europe, *S. flaveolum* has a disjunctive distribution and is mostly confined to higher elevations, while the occurrence in lowland areas is much scarcer (BOUDOT et al. 2009). Many records from the Balkans originate from the mountain areas of south-eastern Bulgaria (MARINOV 2000, 2003, 2007; BOUDOT et al. 2009). In the West Balkans, the Dinaric Alps represent the largest mountain chain that covers a significant part of the region. The species knowledge from this area is poor and the records from most countries are rare (i.e. KOTARAC 1997; BELANČIĆ et al. 2008; BOUDOT et al. 2009; ĐURĐEVIĆ & RAJKOV 2014).

Limited dragonfly records from the Balkans, scattered over space and time, and the tendency of *S. flaveolum* to undergo occasional invasions and the establishment of temporary populations could represent a problem for identification of permanently inhabited areas in this region. In order to contribute to a better knowledge of the distribution of *Sympetrum flaveolum* in the Dinaric Alps and the Balkans, this paper summarizes the data on the species occurrence in the central part of this mountain range located in Bosnia and Herzegovina (W Balkan).

## Material and methods

The Dinaric Alps are located in the West Balkans, between the Pannonian Basin and the Adriatic Sea. This mountain chain spreads from Slovenia to Albania, forming the largest continuous karst landscape in Europe (MIHEVC & PRELOVŠEK 2010). The study area encompasses the central part of the Dinaric Alps, located on the territory of Bosnia and Herzegovina and covering the largest part of the country.

One of the specificities of Dinaric Alps are poljes, large surface karst formations characteristic for the karst region from Slovenia to Montenegro. Some of them are vast, covering 100s of km<sup>2</sup>. The local name “polje” = field, is an internationally accepted term for these karst formations. The karst poljes are large, mainly closed depressions characterized by a flat floor and surrounded by steep mountain slopes (GAMS 1978; PROHIĆ et al. 1998; SCHNEIDER-JACOBY et al. 2006). Many of the poljes in Bosnia and Herzegovina are rich with intermittent or perennial streams and rivers that drain underground. They are temporarily flooded during the winter and spring. Some of the largest and the most significant poljes in the Dinaric Alps are located in Bosnia and Herzegovina (MIHEVC & PRELOVŠEK 2010; KULIJER 2012, 2014). As the karst poljes, particularly from the west Bosnia region, were the research focus of the author in the last few years, many new records originate from this area (i.e. KULIJER 2012).

The study is based on the records from the odonatological database of Bosnia and Herzegovina that includes all available data on dragonflies of the country, as well as the results of field investigations conducted by the author from 2009 to 2014. This database is housed at the National Museum in Sarajevo and managed by the author. Historical records mainly originate from papers and the entomological collection of the National Museum of Bosnia and Herzegovina in Sarajevo. The entomological collection of the National Museum is of great historical importance for the Balkans. It contains approx. 500,000 specimens from the Balkan Peninsula, collected at the end of the 19<sup>th</sup> and the beginning of the 20<sup>th</sup> century (KULIJER & MARINOV 2010). The collection comprises more than 660 dragonflies from Bosnia and Herzegovina collected between 1888 and 1932 (ADAMOVIĆ 1948; KULIJER et al. 2013).

## Results

From 1890 to 2014 *S. flaveolum* was recorded 118 times at 93 localities in Bosnia and Herzegovina (Fig. 1), of which 96 records were collected from 2009 to 2014. For seven historical records collected between the 1890s and 1920s, the exact year of collecting is unknown. The dominance of the records from recent years primarily reflects the higher research intensity in this period, in contrast to only sporadic dragonfly investigations in the past. *Sympetrum flaveolum* is the second most recorded *Sympetrum* species in Bosnia and Herzegovina after *Sympetrum sanguineum* (KULIJER et al. 2013), not only in recent times, but also when the records before 2000 are analyzed. Most of the oldest publications on dragonflies from Bosnia and Herzegovina also report this species (e.g. KLAPALEK 1898; MCLACHLAN 1898; MORTON 1908; ADAMOVIĆ 1948).

The species was recorded from 225 m a.s.l. in Mostarsko blato karst polje to a mountain pond at an altitude of 1,893 m a.s.l. in the Vranica Mountain. The majority of observations (approximately 80%) were made between 700 and 1,650 m a.s.l. Records below 700 m a.s.l. are rare, originating from the karst poljes of southern Herzegovina or the river valleys and settlements. Most of these records from the lowlands could pertain to vagrants from nearby mountain areas.

During the surveys conducted by the author from 2009 to 2014, *S. flaveolum* was one of the most frequently recorded species at mountain ponds and lakes and present at most surveyed sites at higher altitudes.

The localities with the highest number of observed specimens (Fig. 1) are: 1. Paljkovci, Duvanjsko polje (43°41'29"N, 17°15'47"E; 860 m a.s.l.). On 12-viii-2010, 100s of *S. flaveolum* were observed at this locality, many of them in tandems, ovipositing along 1 km of the Šuica River. Paljkovci is part of the Duvanjsko polje along the Šuica River that partly floods during the winter and dries out gradually in the spring. The Šuica River in the Duvanjsko polje also dries out, leaving only some richly vegetated ponds in this lower part of the polje. At the time of survey, this part of the polje was dry and the dragonflies were observed in the field veg-

etation or at ponds that remained in the river bed; **2.** Blidinje jezero, at the Dugo polje, high elevation karst polje in North Herzegovina ( $43^{\circ}36'24''\text{N}$ ,  $17^{\circ}29'41''\text{E}$ ; 1.180 m a.s.l.) is a permanent lake with a large area of shallow water that gradually dries out during the summer. On 21-vii-2010, 1,000s of *S. flaveolum*, mainly tenerals, were observed along a small segment of the lake shore. Tandems were also recorded and numerous exuviae collected; **3.** Prokoško jezero ( $43^{\circ}57'26''\text{N}$ ,  $17^{\circ}45'17''\text{E}$ ; 1,640 m a.s.l.) is a lake on Vranica Mountain with a well vegetated western lake margin. During the investigation of the lake and nearby ponds on 09-viii-2010, 100s of individuals were observed, including tenerals and many females which were ovipositing while in tandem; **4.** At a small desiccating pond at

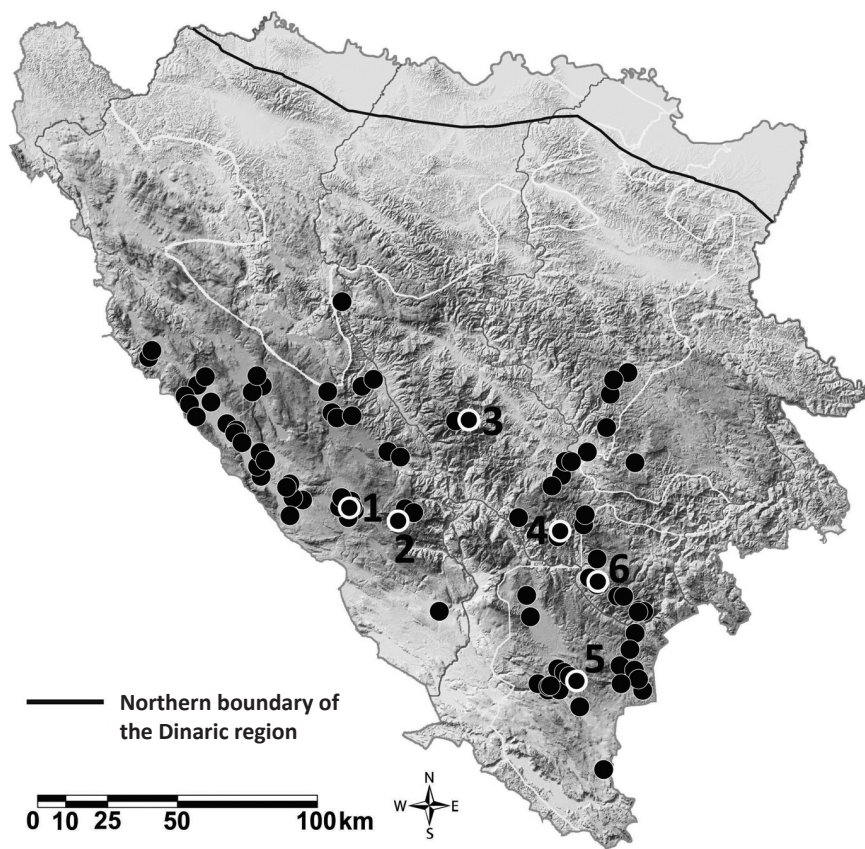


Figure 1. Records of *Sympetrum flaveolum* from Bosnia and Herzegovina (1–6, localities with highest number of recorded individuals). – Abbildung 1: Nachweise von *Sympetrum flaveolum* aus Bosnien und Herzegowina (1–6, Fundorte mit der höchsten Anzahl der erfassten Individuen).

Visočica Mountain (43°35'31"N, 18°12'47"E; 1,775 m a.s.l.) on 30-vii-2009, 100s of adults were observed, including 10s of females which were ovipositing while in tandem; 5. Marshy area at the Lukavačko karst polje (43°06'46"N, 18°17'32"E; 870 m a.s.l.) (Fig. 2a), where 100s of teneral and juveniles were observed on 13-vi-2012; and 6. Kladopoljsko jezero (Fig. 2b) is one of the several lakes on Zelen-gora Mountain (43°25'03"N, 18°25'29"E; 1,400 m a.s.l.). At the lake and nearby large marshy depression, 100s of individuals were observed on 03-viii-2011.

Based on 108 dated records, the flight season of *S. flaveolum* lasts from mid-June to the end of August (Fig. 3), with the extremes being 12<sup>th</sup> June and 28<sup>th</sup> August respectively. The first tenerals were recorded on 12<sup>th</sup> June at the Gatačko polje in East Herzegovina (940 m a.s.l.), while the last observation was made on 9<sup>th</sup> August at mountain ponds and Prokoško jezero on Vranica Mountain in central Bosnia (1,640–1,890 m a.s.l.).

## Discussion

Ponds, pools, richly vegetated lake margins, and peat bogs in the mountain areas, as well as seasonally flooded areas in the karst poljes, are the habitat of this species in Bosnia and Herzegovina. In mountain areas, *S. flaveolum* was recorded at small temporary ponds and richly vegetated lake margins that partially dry out in the summer. In the karst poljes, a large variety of habitats are present, but most observations were made near small and richly vegetated stagnant water bodies that remain in the summer after winter flooding of the poljes. As the species prefers mountain habitats that dry out during summer, the karst poljes at higher altitudes in Bosnia and Herzegovina provide favourable conditions for the species. Many of these poljes are temporarily flooded during the winter and almost completely dry out in late summer.

Characteristics of *S. flaveolum* habitats in Bosnia and Herzegovina fully correspond with the general description (DIJKSTRA & LEWINGTON 2006; BOUDOT et al. 2009). The same habitats are also reported from Bulgaria (BESCHOVSKI & MARINOV 2007), where *S. flaveolum* inhabits richly vegetated stagnant water bodies of variable sizes. They are usually shallow and dry up totally or partially in the spring and summer.

Knowledge of the distribution and habitats of *S. flaveolum* in other countries of the Dinaric region is poor. Many records include scattered or single observations of solitary individuals recorded at a wide variety of habitats (KOTARAC 1997; BELANČIĆ et al. 2008; BEDJANIČ 2014).

In Slovenia, *S. flaveolum* is a rare and protected species (BEDJANIČ 2014) that was classified as critically endangered (KOTARAC 1997). Slovenian records are scattered; the species seems equally rare in the Alps, as well as in the Dinaric Alps (KOTARAC 1997; BEDJANIČ 2014). Ponds, lakes, reservoirs and clay pits are reported as sites where *S. flaveolum* is found (BEDJANIČ 2014). Most country observations include only solitary adults or juveniles from the sites at lower altitudes

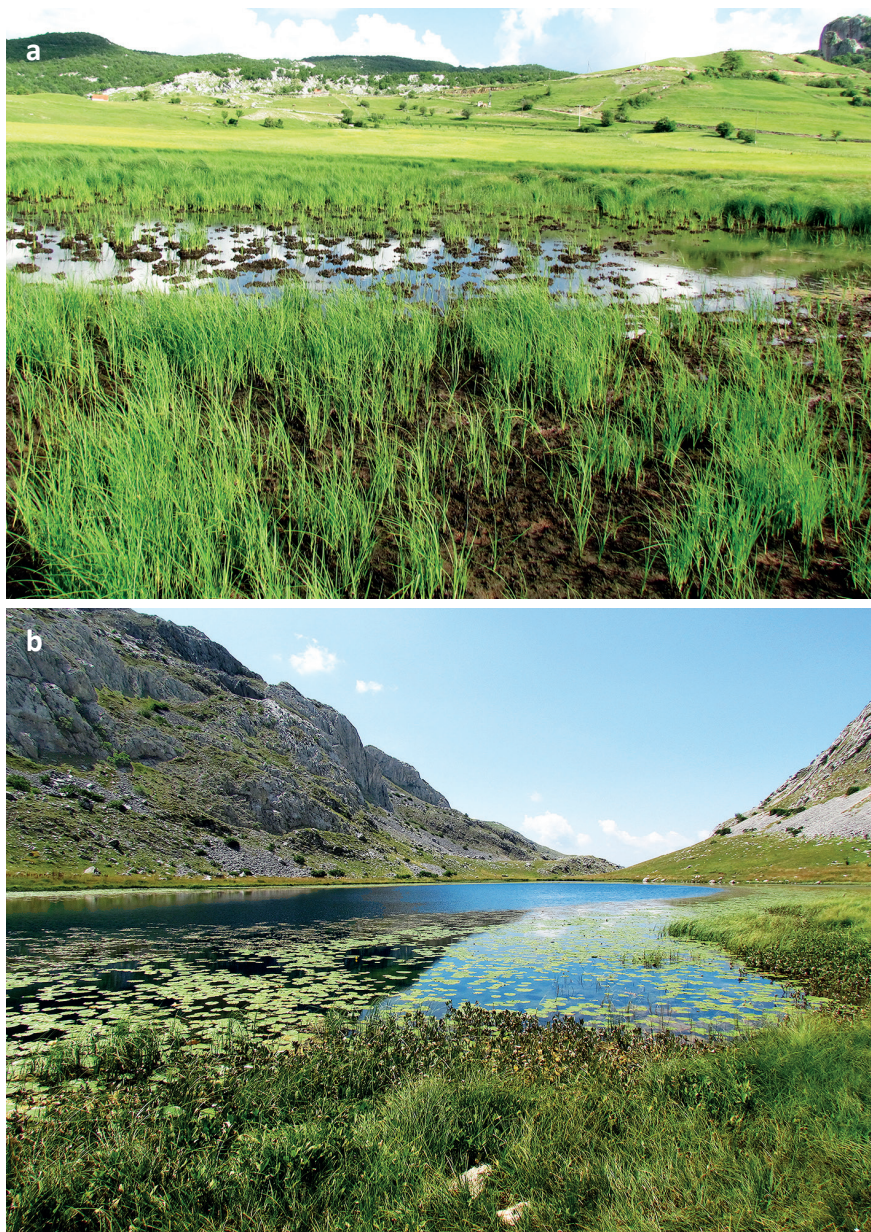


Figure 2. Habitat of *Sympetrum flaveolum* at: a) Lukavačko polje and b) Kladopoljsko jezero. – Abbildung 2: Habitat von *Sympetrum flaveolum* am: a) Lukavačko polje und b) Kladopoljsko jezero.

(KOTARAC 1997; BEDJANIČ 2014). The new finding at Pohorje in the Alps region, at approx. 1,200 m a.s.l. is the observation at the highest altitude; other records are not higher than 750 m a.s.l. (BEDJANIČ 2014).

Records from Croatia are also rare. According to BELANČIĆ et al. (2008), only 14 recent and scattered records exist. Two additional records were reported from the Cetina River in the foothills of Dinara Mountain, close to the border with Bosnia and Herzegovina (VINKO & VILENICA 2013). In the Red List of Croatia, *S. flaveolum* is classified as vulnerable (VU) (BELANČIĆ et al. 2008). Although several Croatian records originate from mountainous areas, most are from areas that do not seem as typical for the species: floodplains of the Drava and Danube rivers, the Dalmatian islands or the Neretva River delta (BELANČIĆ et al. 2008). According to BELANČIĆ et al. (2008), the species inhabits small, shallow, stagnant, and well vegetated waters that mostly dry up in the summer; temporarily flooded meadows and swampy depressions.

Records from Serbia are even scarcer and only a few spatially distant observations exist (BOUDOT et al. 2009; ĐURĐEVIĆ & RAJKOV 2014), the majority from the area close to the Bulgarian border (ĐURĐEVIĆ & RAJKOV 2014).

More records have been reported only from Montenegro, where the species was recently found in new areas (e.g. GLIGOROVIĆ et al. 2008, 2010; DE KNIJF et al. 2013). Considering the mountainous character of this country and the fact that suitable habitats are widely present, it had been expected that *S. flaveolum* would be rather common. In Montenegro, *S. flaveolum* was mostly found at moun-

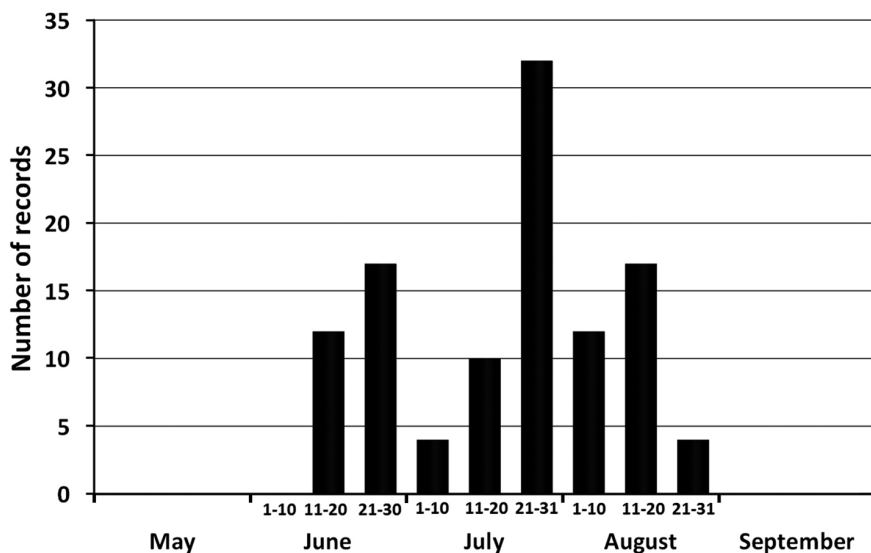


Figure 3. Flight period of *Sympetrum flaveolum* in Bosnia and Herzegovina. – Abbildung 3: Flugzeit von *Sympetrum flaveolum* in Bosnien und Herzegowina.

tain ponds, lakes and adjacent wetlands in the Alpine region (GLIGORVIĆ et al. 2008; DE KNIJF et al. 2013). Plavsko jezero (920 m a.s.l.) with a wetland with hay meadows on peaty soil, bordered by a broad *Scirpus* and *Phragmites* zone, was reported by DE KNIJF et al. (2013) as an important habitat of the species. It was also found at a puddle near Podgorica (GLIGORVIĆ et al. 2008) and the wetlands at the mouth of the Morača River into Skadarsko jezero (GLIGORVIĆ et al. 2010). Both areas are close to the Adriatic coast and belong to the Mediterranean region.

Emergence and flight periods in dragonflies are highly dependent on altitude and temperature. They can also differ significantly between years and regions (CORBET 2004; DINGEMANSE & KALKMAN 2008; HARABIŠ & DOLNÝ 2010). The paucity of data, particularly from mountain areas at the beginning and the end of season, could indicate that the flight period of *S. flaveolum* in Bosnia and Herzegovina is likely to be longer than current data suggests. The recorded emergence period in Bosnia and Herzegovina corresponds to the emergence period at medium altitudes in Central Europe given by WILDERMUTH & MARTENS (2014). The flight period for the same area lasts from late June to the end of September. In Bulgaria, the adults were observed from May to late September (MARINOV 2003), while scarcer records of imagines from Greece suggest the flight period from the end of May to mid-August (LOPAU 2010).

Out of 118 records, 67 originate from the karst poljes (altitude from 225 m to 1,200 m a.s.l.), and 30 from mountain ponds and lakes (altitude from 1,075 m to 1,893 m a.s.l.). However, most of the mountain habitats of the country have still not been investigated. The reason for the dominance of the records from the karst poljes could be the research focus on this area in the last several years. It is still unknown if the species observations from the poljes at lower altitudes are a result of a local reproduction or if they pertain to vagrants or migrating individuals from nearby mountain areas.

The altitudinal zone of *S. flaveolum* in Bosnia and Herzegovina is probably determined by the relief and the availability of suitable habitats. The altitude of most observations corresponds to the altitudinal distribution of these habitats. Most mountain lakes and ponds in Bosnia and Herzegovina are in a zone from 1,400 to 1,800 m a.s.l., while the largest flooded karst poljes are distributed between 700 and 1,200 m a.s.l. However, the species goes up as far as suitable breeding habitats are available, and that is in Bosnia and Herzegovina at app. 2,000 m a.s.l. With the exception of the Dabarsko polje (480 m a.s.l.), records from the altitudes below 700 m a.s.l. are scarce and mostly historical (KLAPALEK 1898; MCLACHLAN 1898; ADAMOVIĆ 1948, collections of the National Museum). These old records are mainly from the Sarajevo city area, located in the valley with several rivers and surrounded with mountains. In the past, parts of this valley were temporarily flooded during the winter. BESCHOVSKI & MARINOV (2007) also reported distribution mainly in the mountain area in Bulgaria and only scarce records from the lowlands. Observations from Bosnia and Herzegovina are partly in contrast with the data from Croatia (BELANČIĆ et al. 2008), where populations are reported from lowlands and coastal areas, all below 100 m a.s.l.

Data on *S. flaveolum* from the central part of the Dinaric Alps, located in Bosnia and Herzegovina, suggests that the species is common and widespread in this area. Both historic and recent data confirm the continuity and abundance of the species. This seems to be in contrast to the status of the species in several other countries of the Dinaric Alps region (Croatia, Serbia and Slovenia), suggesting that Bosnia and Herzegovina, together with Montenegro, harbours the main populations of *S. flaveolum* in the Dinaric Alps. In the countries of the Dinaric region, the species was recorded at a wide variety of habitats and from all altitudes, but significant populations were found only at the altitudes above 700 m a.s.l. in the mountain regions of Bosnia and Herzegovina and Montenegro.

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