First record of a Balkan population of *Ceriagrion tenellum* outside the influence of the Mediterranean climate (Odonata: Coenagrionidae)

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Abstract

Ceriagrion tenellum is rare in the Balkan Peninsula and has hitherto been known as restricted only to the areas under the influence of the Mediterranean climate. On 21 July 2011 and on 3 June 2012 the species was found at the small Đol Lake in the valley of Pliva River, central Bosnia and Herzegovina. Altogether 14 dragonfly species could be observed at the site. This is the first finding of a population of *C. tenellum* in the Danube catchment and in the area outside the Mediterranean region of the Balkans. All known records from the eastern Adriatic were gathered and the distribution of the species in the Adriatic region is outlined. In Bosnia and Herzegovina *C. tenellum* is found at seven localities. The species prefers habitats with rich and diverse water vegetation and the presence of flowing water. This finding is discussed in relation to the distribution and the habitats of the species in the East Adriatic and Europe. A short discussion on the threats and the conservation status in the Balkan region is appended.

Zusammenfassung

Erstnachweis von *Ceriagrion tenellum* auf dem Balkan außerhalb des Mittelmeerraums (Odonata: Coenagrionidae) – *Ceriagrion tenellum* ist selten auf der Balkan-Halbinsel, da es auf die von mediterranem Klima beeinflussten Bereiche beschränkt ist. Am 21. Juli 2011 und am 3. Juni 2012 wurde die Art am Djol See im Tal der Pliva, zentrales Bosnien-Herzegowina, gefunden. Insgesamt wurden hier 14 Libellenarten gefunden. Dies ist auf dem Balkan der erste Nachweis von *C. tenellum* im Einzugsgebiet der Donau sowie außerhalb der mediterran beeinflussten Region. Alle bekannten Fundorte an der östlichen Adriaküste wurden zusammengestellt und die Verbreitung der Art für die Region der adriatischen Küste skizziert. In Bosnien und Herzegowina wurde *C. tenellum* an sieben Orten gefunden. Die Art bevorzugt Lebensräume mit einer dichten und vielfältigen Vegetation und strö-

mendem Wasser. Dieser Befund wird in Bezug auf die Verbreitung und die Habitate der Art entlang der östlichen Adria und in Europa diskutiert. Abschließend werden Gefährdungsursachen und Schutzstatus der Art auf dem Balkan dargestellt.

Introduction

The genus *Ceriagrion* Selys occurs mainly in the warm regions of Africa and Asia. In Europe, it is represented by only two species, *C. tenellum* (de Villers, 1789) and *C. georgifreyi* Schmidt, 1953, both preferring warm microhabitats (Dijkstra & Kalkman 2012). The distribution range of *C. tenellum* includes South and West Europe and North Africa. Although the species is common and widespread in large parts of West Europe and the western Mediterranean, populations are very rare in the Balkans and known only from a narrow belt along the Adriatic coast and Greece (Kalkman 2005; Boudot et al. 2009). In the western Balkans the species is found in Albania (Kalkman 2005), Bosnia and Herzegovina (Kulijer 2012; Kulijer et al. 2013), Croatia (Belančić et al. 2008; Vinko 2011b), Montenegro (Gligorović & Pešić 2007) and Slovenia (Kotarac 1997; Ferletić 2007; Vinko 2008, 2011a). All known localities of the species are situated in the Mediterranean region, or in the areas influenced by the Mediterranean climate through the river valleys (Dijkstra & Lewington 2006; Boudot et al. 2009; Kulijer et al. 2012, 2013).

The first and for a long time the only known locality of the species in Bosnia and Herzegovina was Boračko Lake. This record is based on the specimens kept in the entomological collection of the National Museum of Bosnia and Herzegovina (Adamović 1948; Kulijer et al. 2013). This is the most significant dragonfly collection from the country and one of the first in the Balkans with some of the oldest specimens from the region (Kulijer & Marinov 2010; Kulijer & Boudot 2013). Several recent field surveys resulted in collection of additional records from the Mediterranean region of the country (Kulijer et al. 2012, 2013).

In this paper the first observation of a population of *C. tenellum* from the Danube catchment area in Bosnia and Herzegovina and the Balkans is reported.

Locality and observations

The Đol Lake (Veliki Đol or Large Đol) is a 2 ha small, oval shaped lake situated at 44°19’32’’N, 17°09’30’’E, and at an altitude of 431 m above sea level, in the valley of Pliva River, app. 80 m from the main channel of the river and 3.5 km southwest from the Veliko Plivsko Lake (120 ha) (Fig. 1). One small permanent stream enters the lake on the east side, and one outflow connects the lake and the Pliva River. The Pliva River is one of the largest tributaries of the Vrbas River. It flows to the north and belongs to the Sava/Danube catchment and the Black Sea basin without connection to the Adriatic. The study area is located in the central part

of the Dinaric Alps and the Alpine biogeographical region of Bosnia and Herzegovina. The main vegetation of the area is Oak-Hornbeam forests.

The area is influenced by continental and Pannonian climate from the north through the Vrbas River valley. Climate data were available for the Jajce town, 9 km from the Đol Lake (Federal Institute for Hydrometeorology Sarajevo pers. comm.). The climate of this area is temperate continental with average annual temperature of 9.9°C and average annual precipitation of 900 mm. The lowest winter average is in January with -0.8°C. The average annual temperature in a period 2008-2012 was 11°C. Extremely low temperatures were recorded in February 2012 when the month average was -4°C and for 10 days the average daily temperature was below -10°C. The number of days with temperature below the freezing point during the winter months (December-February) in the period 2008-2012 ranged from 6 to 18 days per month. The maximum of 50 days below 0°C in the past five years was in the winter of 2011-2012.

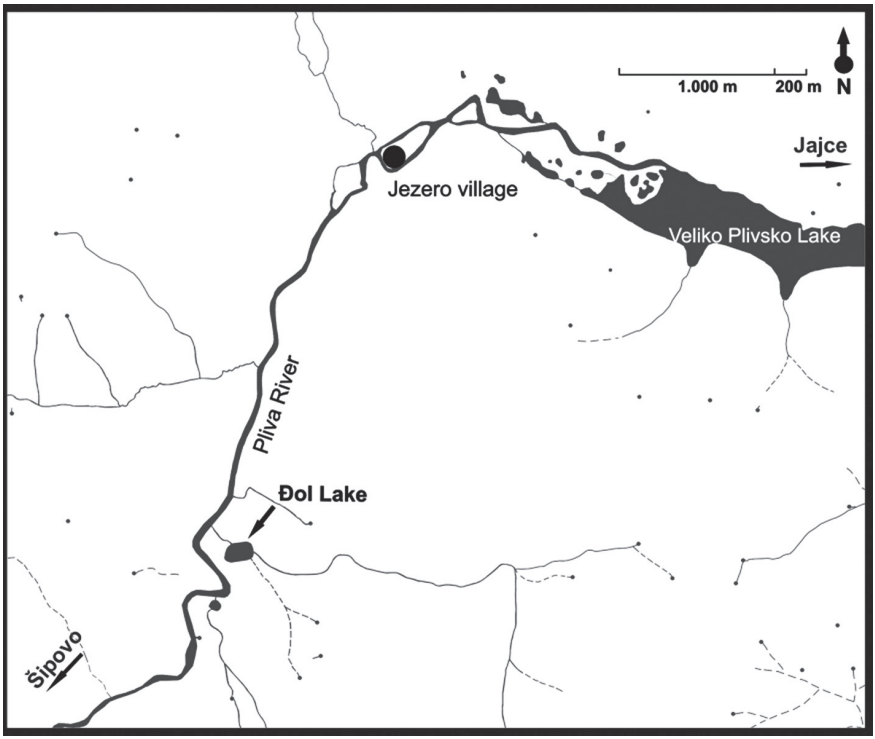

Figure 1. Map of the Đol Lake area. – Abbildung 1: Karte des Đol See-Gebietes.

At the lake (Fig. 2) a narrow reed belt of *Phragmites australis* and *Typha* spp. dominates on the southern margin , while vegetation on the other parts of the lake is much scarcer. Few *Salix* spp. and *Alnus glutinosa* trees and shrubs are present along the western and northern border. The lake is used for fishing and swimming by the local population and is partly surrounded by cultivated fields. A local road runs along the western margin of the lake.

Dragonfly records from this region are scarce. The oldest data available can be found in the entomological collection of the National Museum of Bosnia and Herzegovina. All the records originate from the Plivska lakes, the two lakes located in the vicinity of the Đol Lake. Several field surveys were recently conducted at these lakes by DK, which resulted in 22 recorded species, but *Ceriagrion tenellum* was not found. Both lakes are richly vegetated, especially the western part of the Veliko Plivsko Lake.

The first specimens of *C. tenellum*, two males, were found and photographed by GT at Đol Lake on 21 July 2011 at the south-western lake margin (Fig. 3). In order

Figure 2. Overall view of the habitat of *Ceriagrion tenellum* at the Đol Lake (03-vi-2012). – Abbildung 2: Übersicht über den Lebensraum von *Ceriagrion tenellum* am Đol See (03.06.2012). Photo: GT

to investigate this interesting finding the locality was surveyed on 3 June 2012 by DK on which occasion more than 20 tenerals were counted at the north-north-western margin of the lake, in a meadow vegetation and *Salix* spp. shrubs.

The tenerals were found only near the outflow, at the north-northwestern margin of the lake. Stream and the lake bankside vegetation in this part were dominated by *Juncus* spp. and *Carex* spp.

During the second visit the weather was warm and sunny, but moderate wind made it hard to find the specimens that were well hidden and inactive in the meadow vegetation in an area a few meters wide along the lake border.

Apart from *C. tenellum*, in 2011 only three additional species were observed: *Enallagma cyathigerum*, *Platycnemis pennipes* and *Orthetrum coerulescens*.

During the survey in 2012, the following dragonfly species were found at the Đol Lake: *Calopteryx virgo* (5 individuals), *Coenagrion puella* (> 100), *Ischnura elegans* (50), *Pyrrhosoma nymphula* (60), *Platycnemis pennipes* (20), *Aeshna isoceles* (5), *Anax imperator* (3), *Cordulia aenea* (8), *Libellula depressa* (1), *Libellula fulva* (50), *Orthetrum albistylum* (1), *Orthetrum cancellatum* (2), *Orthetrum coerulescens* (2).

Figure 3. Male of *C. tenellum* at the Đol Lake (21-vii-2011). – Abbildung 3: Männchen von *C. tenellum* am Đol See (21.07.2011). Photo: GT

Discussion

The discovery of the population of *Ceriagrion tenellum* in an area so far and isolated from the Adriatic coast is very interesting. The present finding is the first observation of a population of this species in the Danube River basin in the Balkans.

The reported locality is situated 105 km from the Adriatic coast (as the crow flies) and separated from the coastal region by mountain ranges. The closest population known in Bosnia is the one from Boračko Lake (Kulijer et al. 2013), the only other known locality in the Alpine biogeographical region in the western Balkans, but its position in the valley of the Neretva River gives a connection to the Adriatic Sea and the region is influenced by the climate of the Mediterranean (Fig. 4).

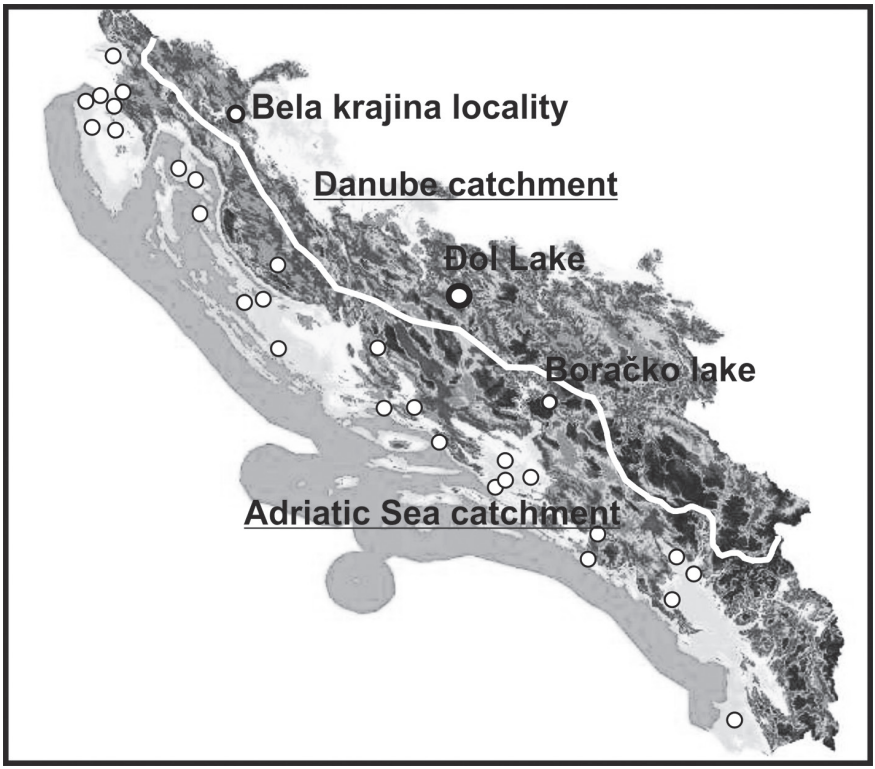

Figure 4. The distribution of *Ceriagrion tenellum* in the Dinaric Region in the eastern Adriatic (white dots), the white line marks the border between the Adriatic and the Danube catchment. – Abbildung 4: Die Verbreitung von *Ceriagrion tenellum* in der Dinarischen Region und der östlichen Adria (weiße Punkte), die weiße Linie markiert die Grenze zwischen dem Adria- und dem Donau-Einzugsgebiet.

In Slovenia a single male of *C. tenellum* was observed at a fish pond in the village of Hrast pri Vinici in the Bela krajina region in 2008 (Vinko 2008; Fig. 4). This area is a part of the Kolpa River basin and also belongs to the Danube drainage. It is located far from any other known locality of the species in Slovenia or Croatia. Later investigation failed to confirm presence of the species in the area (Šalamun 2011). Therefore, the record presented here is the only autochthonous population of *C. tenellum* in the Danube catchment area in the Balkans.

The dragonfly species encountered at the study site correspond to the expected community assemblage in this habitat type in this region. When we compare the species composition of seven known localities of *C. tenellum* in Bosnia and Herzegovina, we found that only *Ischnura elegans* and *Orthetrum coerulescens* were recorded at all of them. Other common species were *Platycnemis pennipes* (6 localities); *Coenagrion puella*, *Aeshna isoceles*, *Libellula fulva* and *Orthetrum cancellatum* (5); *Calopteryx splendens*, *Calopteryx virgo*, *Anax imperator* and *Sympetrum sanguineum* (4). The majority of these species are common in slow running waters in the country. According to Kotarac (1997), *O. coerulescens* is the species found most frequently together with *C. tenellum* in Slovenia.

At the Đol Lake tenerals of *C. tenellum* were found together with *P. nymphula*, and this is the only locality in the country where both species were recorded. In contrast to this, both species were found together at most of the *C. tenellum* habitats in the coastal region of Slovenia (Ferletić 2007). In Bosnia and Herzegovina *P. nymphula* is mostly present in central, mountainous regions and scarce in the south, in contrast to the Mediterranean distribution of *C. tenellum*.

The habitat of the species in Europe seems to be highly diverse. A wide range of stagnant or slow flowing waters are reported as habitats of *C. tenellum* and the published information indicates that in different regions the species favours different habitat types. According to Dijkstra & Lewington (2006) in Europe *C. tenellum* mainly inhabits small streams, seepages, bogs and heathy lakes. Askew (1988) reports that the species inhabits marshes, ponds, peat bogs and slow running canals. In Lower Saxony (Germany) the species is recorded at many different habitats, but prefers bogs and predominantly acidic and nutrient poor waters (Clausnitzer 2007a; Jödicke 2007).

Kotarac (1997) mentioned that in Slovenia *C. tenellum* is restricted to the coastal area, but is not picky in terms of habitat type, inhabiting both standing and flowing waters. A similar situation is also reported from Croatia (Belančić et al. 2008).

Buchwald (1994) reports that springs and permanent water flow are important for *C. tenellum*. According to Strange et al. (2007) in England the main habitat requirements of the species include permanent water supply and abundant emergent vegetation. The species is more sensitive to low winter temperatures in habitats without water current (Clausnitzer 2007a, b).

At most of the *C. tenellum* localities in Bosnia and Herzegovina both running and stagnant waters are present. The main characteristic of all habitats is rich and diverse emergent vegetation at the water margins. At the Boračko Lake the species is mainly found at the southern part of the lake and along the margin of a small river flowing out of the lake. This is similar to observations from the Đol Lake. At the Trebižat River the species was found at a small pond between the two stretches of the river with a wide belt of dense *Juncus* spp. and *Carex* spp. In the same region at the Mlade River it was also found at a small pond, as well as in the vegetation along the river (Kulijer et al. 2012). In the Nature Park Hutovo Blato an abundant population was found at the richly vegetated north-western margin of Škrka Lake, where only a few small and temporary springs may be present.

Knowledge of the ecology and the habitat requirements of *C. tenellum* in the Balkan region is insufficient. The adults are found in streams and flowing canals, as well as ponds and lakes. The adults at surveyed localities in Bosnia and Herzegovina prefer water margins with rich and diverse vegetation and the presence of running water. At Boračko Lake the species was never found at the stream flowing into the lake. As the larvae of the species, especially in mountain regions, require relatively high water temperatures, the proximity of cold karst springs and cold water is probably not favourable and they prefer outflows, where rich water vegetation is developed. The slow flowing water possibly provides environmental conditions necessary for development of the habitat structure and the rich and diverse vegetation that is important for development of the larvae of *C. tenellum*. As all observations were only of adults, details about the habitat are still insufficiently known. Further work on larval habitat should give more data on the ecology and habitat preferences of the species in the Balkans.

Although the Đol Lake is located in the mountainous region of the Dinaric Alps and isolated from the Adriatic, it is possible that the species will be found at more localities in this area as dragonfly fauna of the region is still largely unknown. It is also possible that the species lives in similar habitats in other areas of the mountain region, as is the case with the Boračko Lake in the Adriatic catchment area. In some cases microhabitats with warmer climate occur in river valleys and canyons further inland, in the mountainous region of the country, with the local environmental conditions that fulfil the ecological requirements of *C. tenellum*. It is possible that strong isolation of similar habitats in some areas of central and north Bosnia could be the reason for the species' absence.

Microclimate conditions of habitats may strongly limit the distribution of *C. tenellum;* the low winter temperature in particular negatively affects the larvae (Clausnitzer et al. 2007a, b; Strange et al. 2007). Multiple evidence exists regarding the influence of climate change on the Odonata (Hassall et al. 2007; Jödicke 2007; Dingemanse & Kalkman 2008; Ott 2010), but these effects are not easy to interpret and can vary between years and geographical areas (Dingemanse & Kalkman 2008). Besides temperature, other factors such as weather conditions

are important elements that influence dragonfly distribution (Dingemanse & Kalkman 2008). Unfortunately, historic data from the region are very scarce and do not allow comparison with the species' range in the past.

The population from the Đol Lake is on the upper altitudinal limit of the species' distribution in the Balkans (431 m). Although it is known that in other areas, especially in the Mediterranean, some populations can be found at an altitude of 1,000 or even 2,000 m above sea level (Jacquemin 1994; Gander & Maddalena 2005; Grand & Boudot 2006; Boudot & De Knijf 2012), the Balkan populations are mainly distributed in the lowland coastal area. The main reason is probably the cold alpine climate of the Dinaric Alps, even in the mountains in coastal areas, in combination with the lack of suitable habitats in the mountain areas. Due to the geological compositions consisting mainly of carbonates, the mountain areas are often very dry and permanent freshwater habitats are rare, particularly in the Mediterranean area.

Recent discovery of several new localities in Bosnia and Herzegovina (Kulijer et al. 2012; Kulijer et al. 2013) suggests that the species is more common in the region than it was previously thought and that more localities will probably be discovered (Kulijer et al. 2013). The knowledge of the species distribution in the region is still insufficient. Recent surveys in several karst fields in north Herzegovina and south Bosnia, the karst mountain area that separates Mediterranean from the region where this population was found, did not yield any data on the species presence in that region (Kulijer 2012; DK unpublished data). Further investigation is needed in order to provide a better insight into the ecology and habitat requirements of this species at the western edge of its distribution. Future research will probably give us more information about the origin of this population and the species' status in the area, as well as its potential presence in other habitats in the continental region.

Conservation concerns

In the West Balkan region the species is rare and therefore of special interest in terms of conservation. On the Slovenian Red List the species is classified as «Endangered» (EN) (Bedjanič 2002) and in Croatia as «Vulnerable» (VU) (Belančić et al. 2008) while in the other countries of the region Red Lists for dragonflies still do not exist. Based on current distribution and status, Kulijer et al. (2013) consider *Ceriagrion tenellum* as potentially threatened in Bosnia and Herzegovina.

The main threat for the species is destruction of habitats due to regulation of watercourses. The status of the species in the Mediterranean region will probably deteriorate in future due to numerous hydroelectric power plant projects, other infrastructure projects, water usage for tourism development and desiccation of habitats as a consequence of the climate change.

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