

NEW RECORDS OF CRITICALLY ENDANGERED DAMSELFLY SPECIES *Coenagrion hastulatum* (CHARPENTIER, 1825) IN SERBIA

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ABSTRACT. This paper reports the second known locality of *Coenagrion hastulatum* (Charpentier, 1825), a damselfly species facing an extremely high risk of extinction in the Republic of Serbia. Previously known from a single locality on Mt. Golija, the species is now considered Critically Endangered (CR) and possibly regionally extinct. The last published record dates to the late 20th century, and field surveys in the past decade have failed to confirm its presence. A newly discovered population was recorded in 2021 and 2022 in a group of small ponds at the edge of the Special Nature Reserve "Park Šuma Ivlje" on Mt. Zlatar (southwestern Serbia), along with 16 other Odonata species. The extremely small habitat, its isolation, and increasing anthropogenic pressures suggest that the species is even more threatened than previously assumed, highlighting the urgent need for conservation action.

Keywords: Odonata, Spearhead Bluet, Red Data Book, habitat degradation, protection.

INTRODUCTION

Odonata (dragonflies and damselflies) are amphibiotic insects whose aquatic and terrestrial life stages make them reliable indicators of habitat quality and key links between freshwater and terrestrial ecosystems (WILLIGALLA and FARTMANN, 2012; VILENICA, 2017). Their relatively large body size, vivid coloration, active predatory behavior, and predominantly diurnal and conspicuous lifestyle, combined with their ecological importance, make them an attractive and popular group for both professional and amateur entomologists (KALKMAN *et al.*, 2008; VILENICA *et al.*, 2020). Moreover, Odonata are of great importance for freshwater conservation, being included in national Red Lists across many European countries (SAHLÉN *et*

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al., 2004; KALKMAN *et al.*, 2018), with their most significant legal protection provided by the European Union Habitats Directive 92/43/EEC (EUROPEAN UNION, 1992).

Due to its geographical position and high habitat diversity, Serbia represents an important region for odonate research. Twenty of the seventy Odonata species recorded so far in Serbia (JOVIĆ, 2025) are included in the recently published national Red Data Book of aquatic invertebrates (ŽIVIĆ, 2024). Among them is the critically endangered species *Coenagrion hastulatum* (Charpentier, 1825), for which only a few historical records exist in Serbia. Its presence was documented on two occasions in the late 20th century (25 June 1986 and 12 July 1989) at the peatbog Dajičko Jezero on Mt. Golija (ADAMOVIĆ, 1990). The same author considered *C. hastulatum* to be a glacial relict species in Serbia, characterized by a boreo-alpine distribution pattern. STERNBERG (1998) classified this species within the Eurasian faunal group, suggesting that it recolonized Central Europe via postglacial dispersal routes from both Eastern Europe (north of the Carpathians) and Southern Europe (westward from the Alps). These hypotheses are consistent with the idea that *C. hastulatum* populations may have survived the Ice Ages in southern (Mediterranean) refugia, as proposed by ADAMOVIĆ (1990). In this study, we present a new record of *C. hastulatum* in Serbia, contributing to a better understanding of its current distribution, conservation status, and biogeographical significance.

MATERIALS AND METHODS

Fieldwork was performed in June 2020, June and August 2021, and July 2022. Dragonflies and damselflies were surveyed at three small ponds at the Jezera locality (43.399647°N, 19.828344°E, approximately 1385 m a.s.l.) in the central Mt. Zlatar area (Fig 1). Ponds 1, 2, and 3 are well lit small water bodies of different sizes and varying amounts of floatant and emergent vegetation.

The locality Jezera is a mountain meadow located between the peaks of Ravna Krševa and Velika Orlovača, near the village of Drmanovići, east of the Special Nature Reserve “Park Šuma Ivlje” on Mt. Zlatar in SW Serbia. Ponds (1, 2, and 3) are well-lit small water bodies of different sizes and the amounts of floatant and emergent vegetation.

Pond 1 – covers a surface area of approximately 230 m², with a perimeter of about 50 m. The depth increases gradually, resulting in extensive emergent vegetation that provides suitable sites for perching and shelter. During the peak of the season (June-July), a large portion of the surface is covered by floating vegetation.

Pond 2 – consists of a pair of puddles at the site; the larger one covers an area of up to 20 m² and has a perimeter of approximately 16 m. Only emergent vegetation is present. During the driest part of the summer, these puddles likely dry up.

Pond 3 – covers a surface area of nearly 310 m², with a perimeter of approximately 70 m (Fig. 2). Except for the south-east edge, the depth increases sharply, so emergent vegetation is highly localized, and the best perching sites are provided by bank vegetation. At the peak of the season, however, most of the pond surface is covered by floating vegetation.

The primary method of data collection was observing the activities of adult individuals. Observations were conducted using close-focus Pentax Papilio II 8×21 binoculars, designed for observing both near and distant objects, making them ideal for studying insect behavior. Some voucher specimens were collected using standard entomological aerial nets for active collecting adults and a hand net for collecting aquatic invertebrates by sweeping aquatic vegetation, taking care to keep the habitat integrity. Sampled specimens are stored in the collection of the Natural History Museum in Belgrade (NHM600Beo 595.7333). DIJKSTRA *et al.* (2020) and AMBRUS *et al.* (2018) were used for the identification of collected material. Pond metrics were measured using Google Earth Pro (version 10.96.0.1).

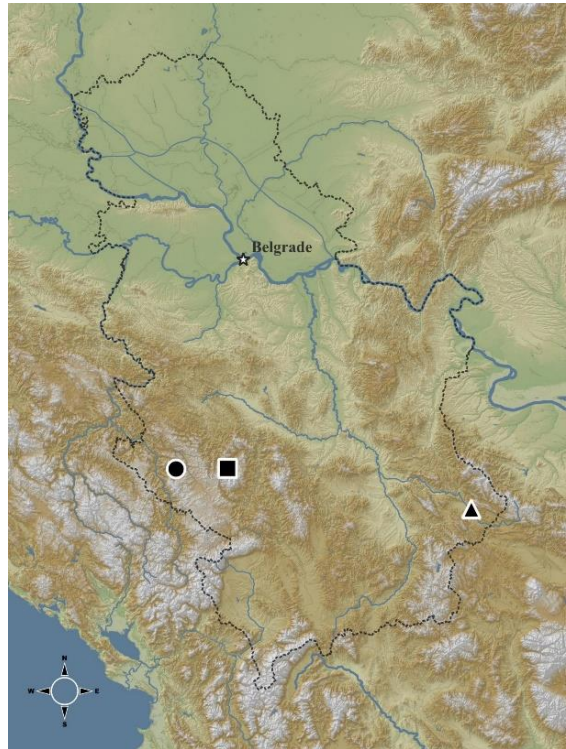


Figure 1. Map of the locations with recorded presence of *Coenagrion hastulatum* in Serbia: Jezera on Mt. Zlatar (black dot) and Dajičko Lake on Mt. Golija (black square). A possible record from the early 20th century from Krupačko Lake near Pirot (black triangle) could not be confirmed due to the poor condition of the voucher specimen (ADAMOVIĆ, 1990).

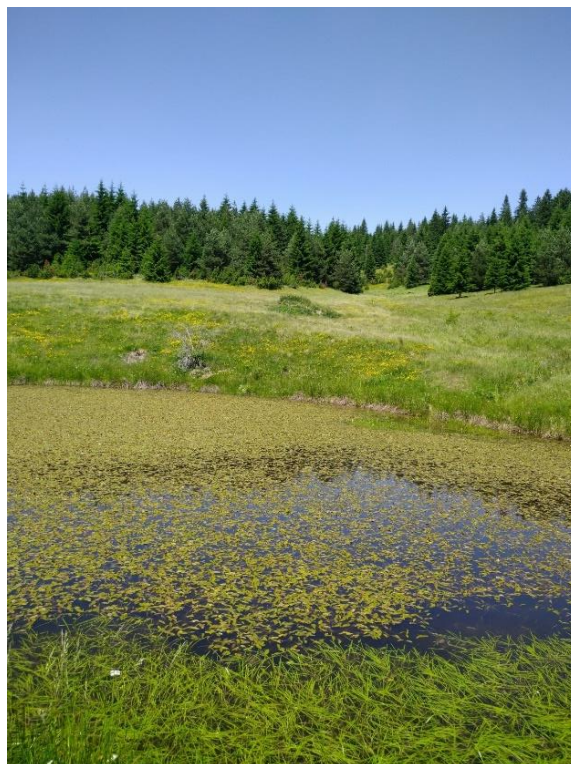


Figure 2. *Coenagrion hastulatum* habitat – Pond 3 - the largest ponds at the locality Jezera, Mt. Zlatar (photo by M. Jović, 2021).

RESULTS AND DISCUSSION

A small population of *C. hastulatum* (Fig. 3) was discovered in 2021 at a group of ponds and puddles in the Jezera locality, central Zlatar, southwestern Serbia. During two subsequent visits in 2021 and 2022, we confirmed the local presence of this critically endangered species and collected data on other Odonata species inhabiting or visiting this small and relatively isolated area. Data from a previous short visit in 2020 were also included. The complete list of recorded Odonata species is presented in Tab. 1.

Table 1. Review of data on Odonata species recorded at the locality Jezera, Mt. Zlatar. Information on dates, development stages (L – larva, E – exuvia, A – adult), behavior (C – copula) and the exact locations of the species records are accompanied by the recently assessed levels of threat (NT – Near Threatened, EN – Endangered, CR – Critically Endangered, DD – Data Deficient) in Serbia.

Species	Pond 1	Pond 2	Pond 3	Red Book of Serbia
<i>Lestes sponsa</i> (Hansemann, 1823)	A (2021-08-03)	A (2022-07-02)	A (2021-08-03)	NT (Jović, 2024b)
<i>Lestes dryas</i> Kirby, 1890	A (2021-08-03)	A (2022-07-02)	A (2022-07-02)	-
<i>Lestes barbarus</i> (Fabricius, 1798)	-	-	A (2021-06-30)	-
<i>Ischnura elegans</i> (Vander Linden, 1820)	A (2020-06-17)	-	-	-
<i>Enallagma cyathigerum</i> (Charpentier, 1840)	A (2021-06-30)	-	A (2021-08-03)	-
<i>Coenagrion pulchellum</i> (Vander Linden, 1825)	A (2021-08-03)	-	-	-
<i>Coenagrion puella</i> (Linnaeus, 1758)	A (2020-06-17, 2021-06-30, 2021-08-03, 2022-07-02); L (2020-06-17)	A (2021-06-30, 2022-07-02)	A (2021-06-30, 2021-08-03, 2022-07-02)	-
<i>Coenagrion hastulatum</i> (Charpentier, 1825)	A (2021-06-30, 2022-07-02); C (2022-07-02)	A (2021-06-30, 2022-07-02)	A (2021-06-30, 2022-07-02)	CR (Jović, 2024d)
<i>Pyrrhosoma nymphula</i> (Sulzer, 1776)	A (2022-07-02)	A, C (2021-06-30, 2022-07-02)	A (2021-06-30, 2022-07-02)	-
<i>Aeshna mixta</i> Latreille, 1805	L (2020-06-17)	-	-	-
<i>Aeshna cyanea</i> (Müller, 1764)	A (2021-08-03, 2022-07-02); L (2020-06-17)	A (2021-08-03, 2022-07-02), E (2021-08-03)	A (2021-06-30, 2021-08-03), E (2021-08-03)	-
<i>Aeshna juncea</i> (Linnaeus, 1758)	A (2021-08-03, 2022-07-02); C, E (2021-08-03)	-	A (2021-06-30, 2021-08-03, 2022-07-02)	EN (Jović, 2024c)
<i>Anax imperator</i> Leach, 1815	A (2021-06-30)	A (2021-06-30)	A (2021-06-30, 2022-07-02)	-
<i>Cordulia aenea</i> (Linnaeus, 1758)	-	-	A (2020-06-17, 2021-06-30)	-
<i>Libellula depressa</i> Linnaeus, 1758	A (2021-06-30), L (2020-06-17)	A (2021-06-30)	A (2021-06-30)	-
<i>Libellula quadrimaculata</i> Linnaeus, 1758	-	-	A (2021-06-30, 2022-07-02)	-
<i>Sympetrum pedemontanum</i> (Müller in Allioni, 1766)	-	-	A (2021-06-30)	DD (Jović, 2024a)
Number of species	13	8	14	4



Figure 3. *Coenagrion hastulatum* male on Pond 1, July 2nd, 2022, Mt. Zlatar (photo by M. Jović, 2022).

The species composition recorded at Jezera (Tab. 1) closely corresponds to that reported by ADAMOVIĆ (1990) for Mt. Golija (10 species: *Lestes sponsa*, *Pyrrhosoma nymphula*, *Coenagrion scitulum* (Rambur, 1842), *C. hastulatum*, *C. puella*, *Enallagma cyathigerum*, *Aeshna juncea*, *Cordulia aenea*, *Libellula quadrimaculata*, *Leucorrhinia dubia* (Vander Linden, 1825)) and by BEDJANIĆ (2011) for Mt. Zelengora (11 species: *L. dryas*, *C. hastulatum*, *E. cyathigerum*, *Ischnura pumilio* (Charpentier, 1825), *I. elegans*, *P. nymphula*, *Aeshna grandis* (Linnaeus, 1758), *A. cyanea*, *A. juncea*, *C. aenea*, *L. quadrimaculata*), with common species underlined. Overall, the Odonata diversity recorded at Jezera in this study (17 species) exceeds that reported in previous studies, highlighting the high regional importance of this locality for biodiversity conservation.

Coenagrion hastulatum is considered a glacial relict species in Serbia with a boreo-alpine distribution (ADAMOVIĆ, 1990). The most recent record of *C. hastulatum* from Dajičko Lake, documented by a voucher specimen (4 August 2010, leg. M. Jović), has not been previously published. Adults were observed in flight within dense shoreline vegetation, whereas subsequent surveys conducted in 2019 and 2021 failed to confirm its presence. Historically, it was recorded on two occasions in the late 1980s at the peat bog Dajičko Jezero on Mt. Golija (ADAMOVIĆ, 1990), while an earlier record from Lake Krupačko Jezero near Pirot, attributed to Kosta Marić, dates to the early 20th century (ADAMOVIĆ, 1993) (Fig. 1). The poor condition of the voucher specimen prevented verification, and it was not included in the first list of Odonata species in the collection of the Natural History Museum of the Serbian Land (present-day Natural History Museum, Belgrade) (ADAMOVIĆ, 1949). Nevertheless, ADAMOVIĆ (1990) considers that the species was previously present in Serbia.

Coenagrion hastulatum is considered a Eurosiberian faunal element with a boreo-alpine distribution (BEDJANIĆ, 2011). A review of its regional distribution in the Balkans—including a small number of mountainous lakes in Slovenia, Bosnia and Herzegovina, Montenegro, Serbia, and Bulgaria, suggests a slightly wider range, although optimal habitats remain scarce across the Balkan Peninsula (BEDJANIĆ, 2011). In general, the mountains of south-western Serbia, together with the adjacent areas of Montenegro and Bosnia and Herzegovina, are known for their rich and distinctive odonate fauna, which includes many regionally rare and, in some cases, threatened taxa, such as *Coenagrion hastulatum* (Charpentier, 1825), *Aeshna juncea*

(Linnaeus, 1758) and *Leucorrhinia dubia* (Vander Linden, 1825) (ADAMOVIĆ, 1990; ADAMOVIĆ *et al.*, 1996; BEDJANIĆ, 2011; KULIJER & MILJEVIĆ, 2017).

Recent studies on habitat requirements of *C. hastulatum* in Scotland demonstrated positive correlations between species presence and water body and sediment depth, as well as the occurrence of specific *Juncus*, *Carex*, and *Sphagnum* species, while floating and emergent vegetation showed negative correlations (DINNING *et al.*, 2022). In contrast, habitats occupied by the species in Serbia are rich in both floating and, in the case of Pond 1, emergent vegetation (Fig. 2; Fig. 4a, b).



Figure 4. Satellite images of the investigated localities through time, illustrating the land use changes: a) September 2010; b) June 2017; c) October 2023; 1-Pond 1, 2-Pond (puddles) 2, 3-Pond 3 (Images downloaded from Google Earth Pro on December 25th, 2025).

This dense vegetation near the water surface provides a suitable and safe microhabitat for larval development (JOHANSSON, 2000). CLAUSNITZER (2020) reports that *C. hastulatum* occupies a relatively wide range of freshwater habitats in the northern part of its European range, whereas in southwestern Europe it is restricted to oligotrophic to mesotrophic habitats, including swamps, pools, and peat bogs. BOUDOT *et al.* (2015) described its habitats in southeastern Europe as elevated peat bogs and oligotrophic to mesotrophic lakes and ponds,

often within or near forests and characterized by well-developed sedge belts. Our observations correspond with these descriptions.

According to the IUCN Red List of European Odonata, this species has the status of vulnerable species (VU) (DE KNIJF *et al.*, 2024). BILLQVIST *et al.* (2024) indicate a decline of the species throughout western and southern Europe because of habitat loss. The same authors list the following probable major causes: global warming, multiple drought periods, degradation caused by the livestock, and agriculture induced eutrophication.

The area where *C. hastulatum* was recorded in Serbia is unique, hosting the only autochthonous community of Scots pine (*Pinus sylvestris* L.) and spruce (*Picea abies* (L.) H. Karst.) on a limestone substrate (OSTOJIC *et al.*, 2016). Its mountainous climate and the presence of often-neglected small freshwater habitats have created a refuge for many species that are absent or extremely rare elsewhere in Serbia.

Besides the *C. hastulatum* (CR), at the locality Jezera we recorded three additional Odonata species included in the Serbian Red Data Book (ŽIVIĆ, 2024): *L. sponsa* (NT), *A. juncea* (EN) and *S. pedemontanum* (DD). However, none of these four species is legally protected in Serbia (OFFICIAL GAZETTE OF RS, 5/2010, 47/2011, 32/2016, 98/2016). This discrepancy between scientific evidence and conservation policy further increases the vulnerability of these species at the national level. Our field observations and satellite imagery (Fig. 4c) indicate that the last known population of *C. hastulatum* in Serbia is under severe anthropogenic pressure. Land-use changes, particularly the expansion of ploughland to immediate vicinity of the ponds (Fig. 3c), have resulted in critical physical habitat alteration or even destruction, accompanied by increased risk of pollution and eutrophication. Additional threats may arise from climate change, including prolonged or more frequent droughts and rising temperatures, potentially further degrading suitable habitats.

Given the narrow distribution range of *C. hastulatum* in Serbia and the increasing intensity of anthropogenic and climatic pressures on its remaining habitats, sustained field monitoring and long-term ecological studies are essential. Such efforts are crucial for evidence-based conservation planning and for aligning national protection measures with current scientific knowledge.

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