

Observation of heterospecific mating attempt by blue chaser *Libellula fulva* Müller, 1764 and broad-bodied chaser *L. depressa* Linnaeus, 1758 (Odonata: Libellulidae)

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Abstract. A successful copula formation between a *Libellula fulva* male and a *L. depressa* female was documented photographically on 23. 6. 2022 along a small stream at the Natura 2000 site Ličenca pri Poljčanah in NE Slovenia. This represents the first record of an anomalous mating attempt with copula formation between the species involved. Their distribution in Slovenia as well as syntopic and syntemporal observations in the country are presented and briefly discussed, as are the site-specific factors and aged female colouration that may have contributed to the described rare attempt of heterospecific mating.

Key words: Odonata, dragonflies, mating, copulation, wheel position, syntopic occurrence

Izvleček. Opazovanje poskusa heterospecifičnega parjenja črnega ploščca *Libellula fulva* Müller, 1764 in modrega ploščca *L. depressa* Linnaeus, 1758 (Odonata: Libellulidae) – Dne 23. 6. 2022 je bila ob manjšem potočku v območju Natura 2000 Ličenca pri Poljčanah v SV Sloveniji foto dokumentirana uspešna formacija paritvenega koleslja med samcem črnega ploščca *Libellula fulva* in samico modrega ploščca *L. depressa*. To je prvi zapis o poskusu parjenja s formacijo paritvenega koleslja med vpletenima vrstama. Na kratko so predstavljena in obravnavana njuna razširjenost v Sloveniji ter prostorsko in časovno prekrivajoča se opazovanja v državi, prav tako pa so obravnavani specifični dejavniki na mestu opazovanja in obarvanost postarane samice, ki bi lahko prispevali k opisanemu redkemu poskusu heterospecifičnega parjenja.

Ključne besede: Odonata, kačji pastirji, parjenje, kopulacija, paritveni koleselj, sintopično pojavljanje

Introduction

Dragonflies (Insecta: Odonata) have a unique mode of reproduction among insects with indirect insemination and delayed fertilization. In order to reproduce, sexually mature dragonflies must encounter a conspecific of the opposite sex, recognize it and mate with it. Prior to copulation, sperm is transferred from the male's primary genitalia at the tip of the abdomen to his secondary genitalia at the base of the abdomen, and during the formation of the heart-shaped copula or mating wheel, it is transferred to female's genitalia. The eggs are not fertilized until they are laid. Recognition of sex and species in most odonates is primarily based on visual



characteristics such as size, body shape, flight style, colour and colour pattern (Corbet 1999; Wildermuth & Martens 2019).

Reports of anomalous mating attempts between different dragonfly species are not extremely rare, and comprehensive reviews on this topic have been presented by e.g. Bick & Bick (1981), Utzeri & Belfiore (1990), and Corbet (1999). They include both observations of homosexual heterospecific male tandems, as well as heterosexual heterospecific pairing attempts. The latter usually include observations of interspecific tandems within the same genus (e.g. Heidemann 1982; Miller & Fincke 2004; Chovanec 2022), less frequently combinations between representatives of different genera (e.g. Bedjanič 2006; Wildermuth 2015), or even between different families within the same suborder (e.g. Corbet 1999; Kosterin et al. 2001; Tamm et al. 2015). In most instances, the anomalous mating attempt ends in the tandem stage, before the contact of male's secondary copulation organ and female's genitalia and thus prior to actual sperm transfer. Less commonly, the heterospecific mating wheel is formed, which is an obligatory stage in the functional framework for potential insemination and subsequent fertilization. The reports of subsequent oviposition after heterospecific copulation are much rarer (e.g. Kunz 2010), while reports on confirmed interspecific hybrids in dragonflies are only occasional (Corbet 1999; Futahashi & Hayashi 2004, Okude & Futahashi 2022; Solano et al. 2018).

Within the family Libellulidae, heterospecific mating errors were most frequently reported in *Sympetrum* species, either as intrageneric pairs (e.g. Bick & Bick 1981; Rehfeldt 1993; Kornová et al. 2022) or more rarely heterogeneric pairs (e.g. Rehfeldt 1993; Richardson & Smith 2012; Wildermuth 2015). In other libellulid genera, such as *Leucorrhinia* (e.g. Utzeri & Belfiore 1990) and *Orthetrum* (e.g. Khelifa 2013; Chovanec 2022; Thio & Ngiam 2023), reports are sparser. Nevertheless, with rare exceptions (e.g. Kunz 2010), the great majority of reports only documents tandem formation, without actual copulation, i.e. without the formation of a mating wheel. In the genus *Libellula*, individual cases of heterospecific copulation have been reported in the Nearctic (Bick & Bick 1981) and Oriental species (Utzeri & Belfiore 1990), while only a few scattered reports are known for European representatives of the genus – e.g. Seggewiße (2008) documented an apparently unsuccessful attempt of copula formation between a *L. fulva* male and a *L. quadrimaculata* female, while Wildermuth & Martens (2019) briefly mention exceptional cases of anomalous mating attempts between *L. depressa* and *L. quadrimaculata*. A further observation of heterospecific copulation between a *L. fulva* male and a *L. depressa* female, not previously reported in the literature, is added in this article.

Materials and methods

The observations described in the sequel were made on 23. 6. 2022 at the Natura 2000 site Ličenca pri Poljčanah in NE Slovenia. The locality is a small right tributary of the Ličenca stream at the bridge of the Ponevnik–Zgornje Laže side road, 200 meters N of the settlement of Zgornje Laže (WGS 84 Lat./Long.: 46.3223 °N, 15.5396 °E). The aforementioned small tributary of the Ličenca stream is less than 1 meter wide, the water current is slow and the richly overgrown riparian vegetation almost completely covers the water surface. On the upstream side of the

bridge, a small widening is present, forming a shallow 1.5×0.5 m wide pool, overgrown with *Sparganium* sp. and some clumps of *Carex* sp. and *Iris pseudacorus*, but still with some open water surface. The surrounding landscape is an open mosaic agricultural land, upstream of the bridge on one side there is a regularly mown semi-intensive meadow, while the other side is bordered by a field. Along the stream there is a narrow, unmown belt of vegetation with a few small *Salix* shrubs.

The observations on site were made from the road bridge. In the afternoon, between 15:15 and 15:25 p.m. (Central European Summer Time), the weather was predominantly sunny with 25°C, very light cloud cover and no wind. Photographs were taken with the Sony Cyber-Shot RX10 IV digital camera. The precise time of each individual photograph was subsequently determined at home using the automatically saved image properties.

Results and discussion

On arrival at the site, already known from previous visits, regular rapid dragonfly inventory was carried out from the road bridge. Soon, a somewhat strange, restlessly flying tandem was spotted, and only seconds later I realized that it consisted of a *L. fulva* male and a *L. depressa* female. Apparently, the female was trying to free herself from the grasp of male's appendages, but was unsuccessful. The pair in tandem was restless, the potential mates repeatedly settled down for a few seconds and then flew off again and changed position. After observing this behaviour for about a minute and being unable to take a photo, the first observed copula was formed at around 15:19:40 (Fig. 1a) and lasted less than 15 seconds. Then the copula disbanded and the pair still remained in tandem at the same location. From above, at a distance of a few centimetres and without any contact, it was harassed for a few seconds by a flying *L. depressa* male (Fig. 1b). After changing position and flying around at short intervals, the pair successfully formed the second copula at around 15:20:25, whereupon several successful photos were taken (Fig. 1c, d). The pair in the copula changed position on *Sparganium* leaves once or twice, but remained in the copula at least until 15:22:12, when the last photo was taken. After that, visual contact with the pair was lost, and they did not return to the same location for the next two or three minutes before I left. Other dragonfly specimens observed during my brief visit to this locality were: *Calopteryx splendens* 2♂, 1♀, *Coenagrion ornatum* 2♂, 1♀, *C. puella* 1♂, *Platycnemis pennipes* 3♂, 1♀, *Orthetrum brunneum* 3♂, *O. coerulescens* 4♂, 1 copula and *Libellula depressa* 2♂.

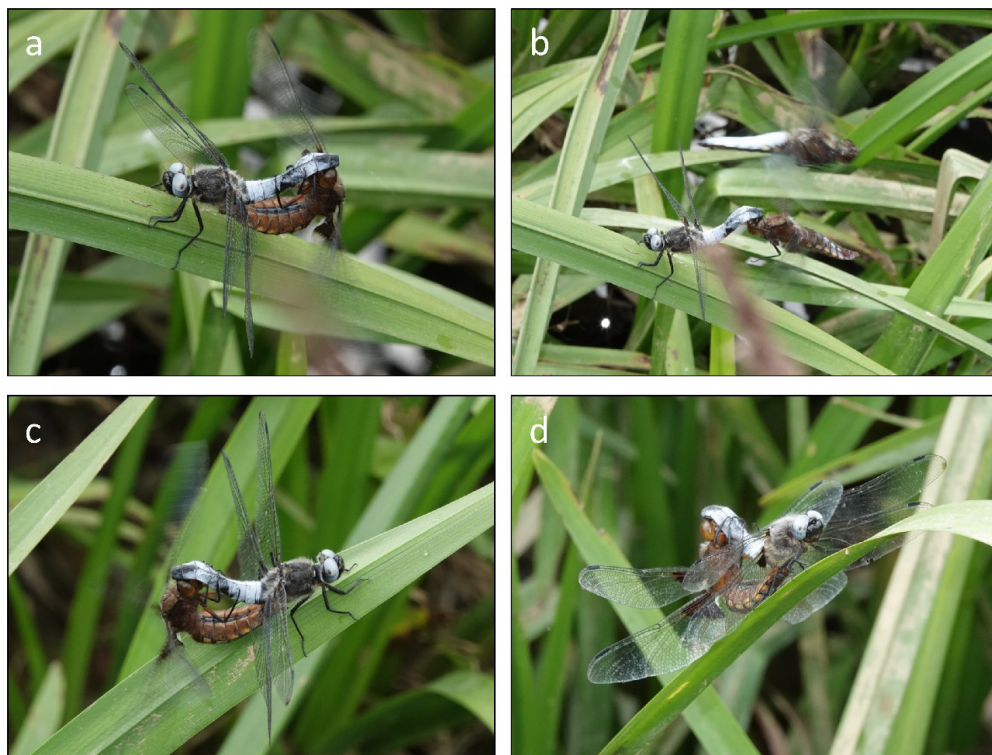


Figure 1. Temporal sequence of successful copula formation between a Blue Chaser *Libellula fulva* male and a Broad-bodied Chaser *L. depressa* female: (a) first successful copula formation (15:19:52 p.m.), (b) copula breaking up, pair remains in tandem, harassed by a Blue Chaser *L. depressa* male from above (15:20:00 p.m.), (c) second successful copula formation (15:21:00 p.m.), (d) after changing the resting place the pair still remains in second successful copula formation (15:21:34 p.m.) (photo: M. Bedjanič, Ličenca pri Poljčanah, 23. 6. 2022).

Slika 1. Časovno zaporedje uspešne formacije paritvenega koleslja med samcem črnega ploščca *Libellula fulva* in samico modrega ploščca *L. depressa*: (a) prva uspešna formacija paritvenega koleslja (15:19:52), (b) razpad paritvenega koleslja, par ostane v tandemu, ki ga od zgoraj nadleguje samec modrega ploščca *L. depressa* (15:20:00), (c) druga uspešna formacija paritvenega koleslja (15:21:00), (d) po spremembi počivališča par še vedno vztraja v drugi uspešni formaciji paritvenega koleslja (15:21:34) (foto: M. Bedjanič, Ličenca pri Poljčanah, 23. 6. 2022).

The basic prerequisite for potential heterospecific sexual interaction is clearly the simultaneous occurrence of adult dragonflies in space and time. Regarding the known occurrence of both species in Slovenia, the database of the Slovene Dragonfly Society and the Centre for Cartography of Fauna and Flora (as of October 2023) contains 571 localities with 937 faunistic data for *L. fulva*, while *L. depressa* is much more common with 2,200 known localities and 3,768 faunistic data (Fig. 2). More importantly, both species were recorded at the same locality in 337 cases with 814 faunistic data. Their co-occurrence on the same date was recorded at 279 localities for which 375 such faunistic data are available, the latter meaning the simultaneous observation of both species at the same location and on the same date.

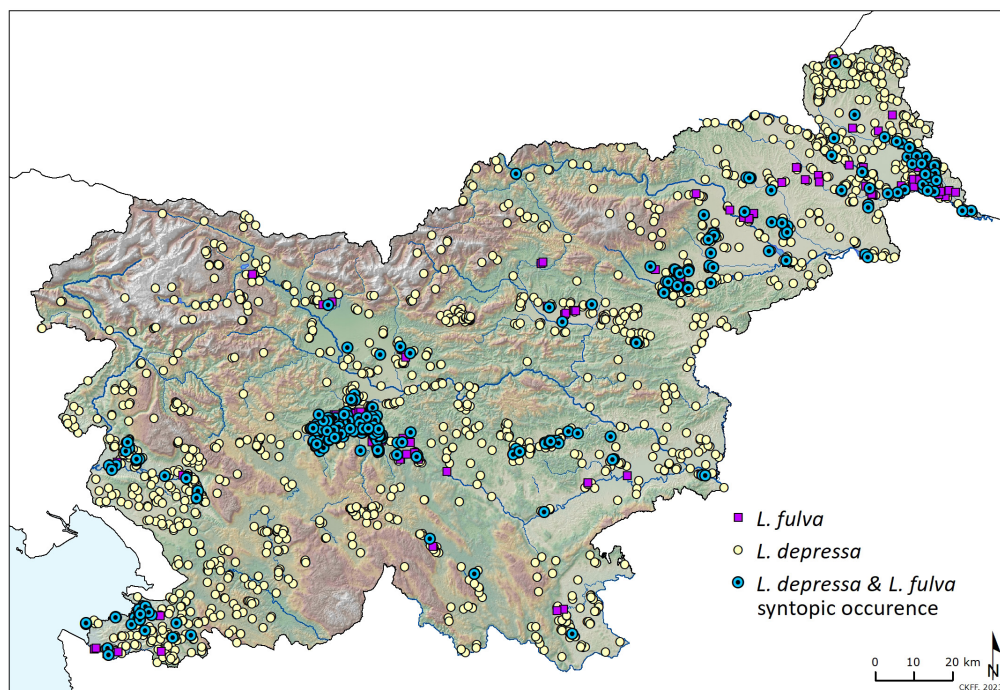


Figure 2. Distribution of broad-bodied chaser *Libellula depressa* and blue chaser *L. fulva* in Slovenia, with indicated localities of syntopic occurrences of both species (source: database of the Slovene Dragonfly Society and the Centre for Cartography of Fauna and Flora, October 2023)

Slika 2. Razširjenost modrega ploščca *Libellula depressa* in črnega ploščca *L. fulva* v Sloveniji, z označenimi lokalitetami sintopičnega pojavljanja obeh vrst (vir: podatkovna zbirka Slovenskega odonatološkega društva in Centra za kartografijo favne in flore, oktober 2023)

As for the observations of mating activity of both species, considering conspecific pairs with copula or tandem formation, the above-mentioned database contains 164 data for *L. depressa* and 147 for *L. fulva*, but with an inverse ratio of only 220 individual conspecific pairs observed in the former and 471 pairs observed in the latter. Regardless of the commonness of *L. depressa*, the above numbers are not surprising due to the different mating behaviour. In *L. fulva*, copulation usually lasts between 10–15 minutes, with the pair usually settling in a sunny place after a short zigzag flight, while in *L. depressa*, copula formation is very short and copulation completed in flight usually lasts only 4–30 seconds (Sternberg 2000; Sternberg et al. 2000; Wildermuth & Martens 2019). However, the presented data from Slovenia show that the observations of conspecific mating attempts extracted from all faunistic data of the species are not rare, but nevertheless much more frequent in *L. fulva* (15.7 %) than in *L. depressa* (4.4 %).

Other factors that may have contributed to the rare anomalous mating attempt are the specifics of the microlocality, where the road bridge and overgrown upstream section direct the adult dragonflies to concentrate around a small shallow pool and stream section with some open water surface only a few square meters in size. In such small-size environment, conspecific and heterospecific interactions are more likely to occur. It should also be noted that the end of June falls towards the end of flight period for both species, which means that the individuals are

already old, and have much less vivid colour patterns, as evident from the dull brownish coloration of the *L. depressa* female, which has also developed a slight light blue pruinescence on the dorsum of the middle abdominal segments (Fig. 1b). Neglecting considerably broader abdomen and the larger dark basal spots on the fore and hind wings, this colouration somewhat resembles the colouration of old *L. fulva* females and may have contributed to the observed mating confusion.

As the Slovenian odonatological records clearly show, it is obvious that *L. fulva* and *L. depressa* occur together spatially and temporally and that they often share the same habitats at the same time. The situation is probably similar in many other parts of their range in Central Europe at least. It is therefore surprising that the present observation is only the first evidence of an anomalous mating attempt with copula formation between the species involved. In the present case, the locality specifics and the older age colouration of the involved *L. depressa* female could have been the decisive factors. In any case, the complete lack of similar reports from elsewhere suggests that the mate recognition and other mechanisms that prevent heterospecific mating attempts between the two species are apparently very effective.

Povzetek

Poročila o heterospecifičnih poskusih parjenja pri kačjih pastirjih niso skrajno redka (Bick & Bick 1981; Utzeri & Belfiore 1990; Corbet 1999). Tudi znotraj družine ploščcev (Libellulidae) so bili poskusi heterospecifičnega parjenja, ki so posledica napačne prepoznavne samice s strani samca, opazovani že velikokrat (npr. Bick & Bick 1981; Rehfeldt 1993; Wildermuth 2015; Kornová et al. 2022; Chovanec 2022). Velika večina poročil pa temelji le na opazovanjih tandemov samca in samice, brez dejanske kopulacije. Opazovanja heterospecifičnih paritvenih kolesljev so mnogo redkejša (npr. Kunz 2010). Za vrste ploščcev (*Libellula* spp.), ki se pojavljajo v Evropi, je znanih le nekaj primerov heterospecifične kopulacije (npr. Seggewiße 2008; Wildermuth & Martens 2019). V pričujočem članku je predstavljeno opazovanje heterospecifične kopulacije med samcem črnega ploščca *L. fulva* in samico modrega ploščca *L. depressa*, o čemer v literaturi še ni bilo poročil.

Konec junija 2022 je bila ob manjšem potočku v območju Natura 2000 Ličenca pri Poljčanah v severovzhodni Sloveniji prvič fotografirana uspešna formacija paritvenega koleslja omenjenih vrst (Sl. 1a–d). Samec črnega ploščca in samica modrega ploščca sta po nemirnem spreletavanju v tandemu prvič oblikovala paritveni koleselj le za nekaj sekund (Sl. 1a), po razpadu katerega sta ostala v tandemu (Sl. 1b) in vnovič tvorila paritveni koleselj za poldrugo minuto (Sl. 1c, d), potem pa odletela in ju ni bilo več na spregled.

Sočasno pojavljanje odraslih kačjih pastirjev v prostoru in času je predpogoj za morebitno heterospecifično spolno interakcijo. Predstavljena razširjenost črnega in modrega ploščca v Sloveniji (Sl. 2) kaže na številna prostorsko prekrivajoča se opazovanja. Podobno velja tudi za časovni vidik – obe vrsti sta bili zabeleženi hkrati na isti datum na 279 lokalitetah, za katere je znanih 375 favnističnih podatkov. K opisanemu redkemu poskusu heterospecifičnega parjenja so morda prispevali tudi specifični dejavniki na majhnem zaraščenem odseku potočka z le nekaj odprte vodne površine. Podobno velja za obarvanost postarane samice modrega ploščca (Sl. 1b), ki je kljub znatno širšemu zadku in večjim temnim lisam na bazi sprednjih in zadnjih kril, s prevladujočo rjavkasto obarvanostjo in rahlim sivkastim voskastim poprhom na zadku, nekoliko spominjala na obarvanost starih samic črnega ploščca.

Glede na pogostost črnega in modrega ploščca v Sloveniji in Evropi preseneča, da poskusi heterospecifičnega parjenja med njima doslej še niso bili zabeleženi. Ustrezno prepoznavanje potencialnih paritvenih partnerjev in drugi mehanizmi, ki preprečujejo heterospecifične poskuse parjenja, so pri obeh vpletenih vrstah očitno zelo učinkoviti.

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