

JAN TATUR-DYTKOWSKI¹ , PAWEŁ GÓRSKI² 

Anomalous interfamilial sexual behaviour of *Rhagonycha fulva* (SCOPOLI, 1763) (Coleoptera: Cantharidae) in relation to *Lepturobosca virens* (LINNAEUS, 1758) (Coleoptera: Cerambycidae)

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¹ Wąwózowa 4/17, 02-796 Warszawa, e-mail: tatur.dytkowski@gmail.com, ORCID: 0009-0006-9347-4724

² Zakład Parazytologii i Inwazyjologii, Katedra Nauk Przedklinicznych, Instytut Medycyny Weterynaryjnej, Szkoła Główna Gospodarstwa Wiejskiego, Warszawa 02-786, ul. Ciszewskiego 8, e-mail: pawel_gorski@sggw.edu.pl, ORCID: 0000-0001-7116-2072

Abstract: Unusual intergeneric and interfamilial sexual behaviour was observed between *Rhagonycha fulva* and *Lepturobosca virens*. Three copulation attempts between males of *R. fulva* and females of *L. virens* were recorded in the Bieszczady Mountains, southeastern Poland in the Smerek Valley. This is the second known observation of a mating attempt between a soldier beetle and a longhorn beetle in Poland, and the first between the red soldier beetle and the green longhorn beetle, as well as the first documented case within the subfamily Lepturinae. It is important to note that of the 20 species of Lepturinae observed only females of *L. virens* were of interest to *R. fulva* males.

Key words: extraspecific, intergeneric, interfamilial, Poland, Bieszczady Mts.

INTRODUCTION

Interspecific copulation is rarely observed phenomenon in nature. Even more infrequent are cases of copulation attempts between insects from distinct genera or even families. Interfamilial copulation between distinct families of butterflies in the natural environment was observed in the Czech Republic between *Amata phegea* (LINNAEUS, 1758) (Lepidoptera: Arctiidae) and *Zygaena filipendulae* (LINNAEUS, 1758) (Lepidoptera: Zygaenidae) (NOVOTNÝ *et al.* 2009). Crossbreeding between different genera of butterflies within the same subfamily is relatively uncommon, although it is a known phenomenon worldwide and widely discussed in literature and insect world in general. Intergeneric mating has been recorded in following butterfly families: Arctiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae and Zygaenidae (BAIDYA *et al.* 2018, NOVOTNÝ *et al.* 2009). RAY & DUTTA (2016) reported intergeneric copulation of gossamer-winged butterflies (Lepidoptera: Lycaenidae): *Anthene emolus* GODART, 1824 and *Rathinda amor* (FABRICIUS, 1775) from India. In Czech Republic an attempted interspecific copulation between *Phengaris nausithous* (BERGSTRESSER, 1779)

and *P. teleius* (BERGSTRASSER, 1779) (Lepidoptera: Lycaenidae) was observed (PILAŘOVÁ *et al.* 2024). RAMOS & FRANCINI (2014) observed an attempt of intergeneric copulation in brush-footed butterflies (Lepidoptera: Nymphalidae): *Tegosa claudina* (ESCHSCHOLTZ, 1821) and *Chlosyne lacinia saundersi* (DOUBLEDAY, 1847) in Brazil. However, most of such behaviours are observed in captivity rather than in natural conditions.

Intergeneric copulation has also been recorded within true bugs (Heteroptera: Rhopalidae): *Corizus hyoscyami* (LINNAEUS, 1758) and *Rhopalus parumpunctatus* SCHILLING, 1829 in Russia (GAPON 2019). Copulation between two closely related and widely distributed mosquito species in the tropical zone: *Aedes aegypti* (LINNAEUS, 1762) and *A. albopictus* (SKUSE, 1895) (Diptera: Culicidae) has been observed relatively frequently in nature. However, it has been determined that offspring from such pairings are not viable (BARGIELOWSKI *et al.* 2015).

In beetles, copulation between different species, genera or families is exceedingly rare and even rarer is its documentation, which is why literature on these phenomena is limited. Interfamilial copulation between weevils: *Oxystoma pomonae* (FABRICIUS, 1798) (Coleoptera: Apionidae) and *Sitona lineatus* (LINNAEUS, 1758) (Coleoptera: Curculionidae) was recorded in England (WHITEHEAD 2020). Interspecific and intergeneric copulation has been observed in ladybirds: *Coelophora inaequalis* (FABRICIUS, 1775) and *Cycloneda sanguinea limbifer* CASEY, 1899 (Coleoptera: Coccinelidae), but it has not been confirmed whether this led to fertilization (MERCADO 2023). Interspecific copulation in flea beetles (Coleoptera: Chrysomelidae) was recorded between *Chrysolina herbacea* (DUFTSCHMID, 1825) and *Chrysolina polita* (LINNAEUS, 1758) in England (GILLETT 1994). Another example of atypical sexual behaviour in insects is the frequent occurrence of copulation attempts between males. In laboratory conditions, as well as in field observations of Japanese beetles *Popillia japonica* NEWMAN, 1841 (Coleoptera: Scarabaeidae) it has been noted that such behaviours are more likely when there is a high insect density or an unusually low or high temperature (SWITZER *et al.* 2004). Moreover, at least in some insect species (genus *Drosophila*) (Diptera: Drosophilidae), homosexual behaviour may have a genetic basis (ITO *et al.* 1996).

In captivity, an attempt of interspecific copulation was observed between longhorn beetles from two distant European countries: *Anaglyptus luteofasciatus* PIC, 1905, an endemic species from the Peloponnese and *A. mysticus* (LINNAEUS, 1758) from central Poland (TATUR-DYTKOWSKI, unpublished materials). In Japan, laboratory studies were conducted on copulating *Anoplophora chinensis* (FORSTER, 1771) and *A. glabripennis* (MOTSCHULSKY, 1854) (SUNAMURA *et al.* 2022). Similar conditions in England allowed for the observation of copulation within a single genus of rove beetles: *Philonthus cephalotes* (GRAVENHORST, 1802) and *P. sordidus* (GRAVENHORST, 1802) (Coleoptera: Staphylinidae) (SUSAN & WALKER 2007).

In soldier beetles, intergeneric copulation between *Stenothemus badius* (KIESENWETTER, 1874) and *Lycocerus nigerrimus* (YAJIMA *et al.* NAKANE 1969) (Coleoptera: Cantharidae) was observed in their natural environment in Japan (NAKAMURA *et al.* 2023). Similarly, KIRIYAMA (2006) reported intergeneric copulation between *S. badius* and *Asiopodabrus yama* (NAKANE *et al.* MAKINO, 1990). Interspecific copulation between *Rhagonycha aliena* DAHLGREN, 1972 and *R. kiesenwetteri* (MARSEUL, 1864) was also observed under natural conditions in Cyprus (WHITEHEAD 2020). In addition, interspecific copulation between *Cantharis cryptica* ASHE, 1947 and *C. decipiens* BAUDI di SELVE, 1872 was observed in England (KEY 1987).

In Poland, the only known published case of intergeneric copulation between unrelated families in natural environment occurred 75 years ago between *Rhagonycha fulva* (SCOPOLI,

1763) (Coleoptera: Cantharidae) male and *Chlorophorus herbstii* (BRAHM, 1791) (Coleoptera: Cerambycidae) female (NIESIOŁOWSKI 1949). Interestingly, the described case also concerned *R. fulva* male, similarly to the discussed in this paper.

METHODS

The Western Bieszczady are the southern mesoregion of the Beskidy Lesiste macroregion, the only macroregion in Poland that belongs to the province of the Outer Eastern Carpathians (SZPARA *et al.* 2021). Observations of flower beetles were conducted with varying intensity in this area over a period of one and a half decades from 2007 to 2024. The observation sites were primarily the Smerek Valley, Smerek, Kalnica, the Niedźwiedzi Valley, Wetlina, the Wetlinka Valley and surrounding areas, as well as Duszatyn, Mików, Cisna, Dołżyca, Liszna, Roztoki Górne, Zatwarnica, and Żubracze. The phenology of individual species was recorded, and photographic documentation was simultaneously carried out without capturing the observed beetles, unless it was necessary for identification purposes.

RESULTS AND DISCUSSION

In Western Bieszczady on July 10-11 2024 in the Smerek Valley (UTM: FV04) a *Rhagonycha fulva* (SCOPOLI, 1763) male was observed attempting copulation with a female *Lepturobosca virens* (LINNAEUS, 1758) (Fig. 1). Considering the size difference between the two species (approximately 0.9 cm for *R. fulva* male and 2.4 cm for the female of *L. virens*), copulation most probably did not occur. However, the copulatory organs of the male *R. fulva* extend up to half of the body length, which is quite impressive, yet insufficient for penetration into the significantly larger female *L. virens*. A single observation of such mating attempt between different genera would be an unusual phenomenon. However, the fact that it was recorded three times over two days between individuals from distinct families is notable and interesting. The authors monitored the blossoming Apiaceae and other flowering plants in the Smerek Valley for several hours a day. Given the length of the valley and the number of flowers, documenting all the copulation attempts between *R. fulva* and *L. virens* would have been impossible. Observing this particular phenomenon three times likely represents only a fraction of all copulation attempts between *R. fulva* and *L. virens* during the flight period of both species. It is important to emphasize that the authors have been surveying the Smerek Valley for a decade during the active months of both beetle species and have never observed anything similar at this or any other monitored site. *R. fulva* is one of the most common beetle species and is regularly encountered on the flowers of Apiaceae during its appearance. This species is also commonly found in many other countries and its biology is well described. Field studies in the United Kingdom on a sample of about 1200 individuals have shown that some *R. fulva* males can live for at least 25 days and can travel up to 400 meters (RODWELL *et al.* 2018). On the other hand, *L. virens* is a local and rather rare species, although it has been regularly found in the monitored valley in June and July over the past decade, usually in small numbers. The year 2024 was a particularly good year for *L. virens*, which led to observations of at least a dozen adult beetles, including copulating pairs. During this time, *R. fulva* was the dominant species on the Apiaceae.

NIESIOŁOWSKI (1949) suggested that the choice of a female from a different species and family by *R. fulva* males might be caused by intense competition for females. In such cases a losing male may turn to an accidentally encountered female, not necessarily of its own species. It is also possible that the reduced reproductive success (or its total lack) in some males may be influenced by the presence of parasitic mites larvae of the genus *Trombidium*

(Acari: Trombidiidae). LACINY & NEMESCHKAL (2015) noticed in Austria that larger males of *R. fulva* were less infested by parasitic mites compared to smaller males. It is possible that infested males lose in mate competition to bigger individuals and may be less frequently chosen by females. Such rejected males could then attempt copulation with representatives of other species. The case of copulation between *R. fulva* and *C. herbstii* described by Niesiołowski involved beetles of similar sizes. It is intriguing why in the Bieszczady males of *R. fulva* select much larger females of *L. virens* among many other beetle species. The total number of *R. fulva* individuals during the flight period can be estimated in thousands, and in the length of a single valley, this number is practically uncountable. With such an abundant appearance, one could expect individual beetles with sexual preferences that deviate from the norm, a phenomenon that is known in animal kingdom. The observed behaviour could be amplified by the secretion of a specific pheromone by *L. virens*, somehow attractive to *R. fulva* which should be confirmed through laboratory studies.

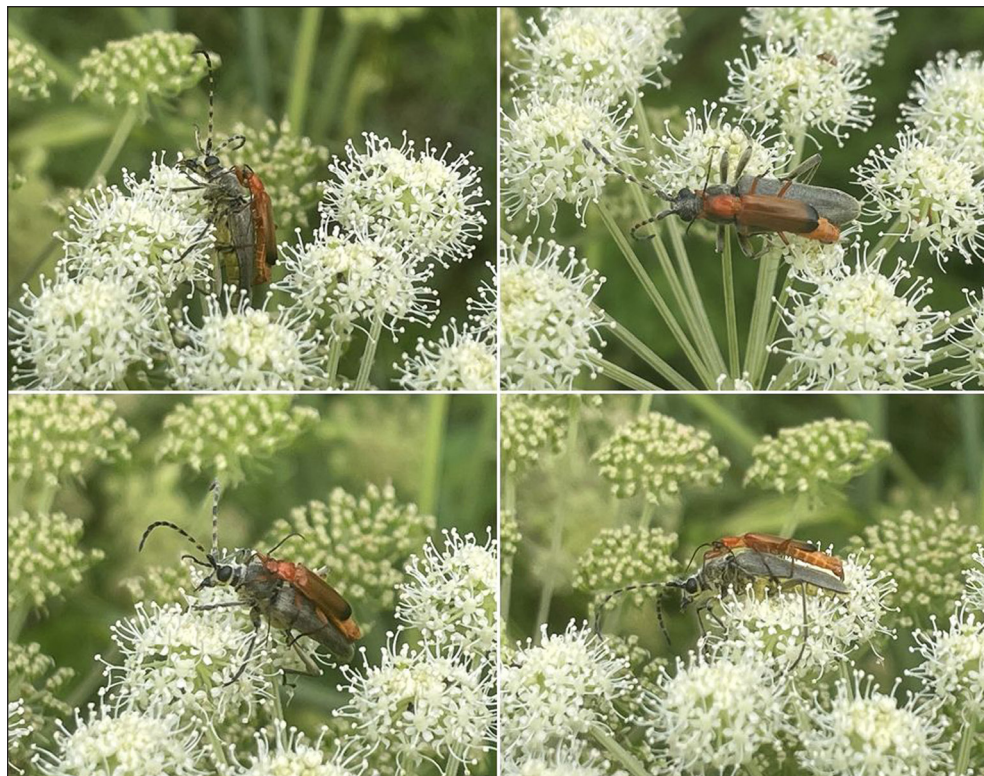


Fig. 1. *Rhagonycha fulva* male on *Lepturobosca virens* female, Smerek Valley, Western Bieszczady Mts, photos by J. Tatur-Dytkowski.

During these observations other Lepturinae species, which were not of interest of *R. fulva*, were also recorded on blossoming Apiaceae including: *Anastrangalia dubia* (SCOPOLI, 1763), *A. sanguinolenta* (LINNAEUS, 1761), *Gaurotus virginea* (LINNAEUS, 1758), *Grammoptera ruficornis* (FABRICIUS, 1781), *Leptura aethiops* PODA, 1761, *L. annularis* FABRICIUS, 1801, *L. quadrifasciata* LINNAEUS, 1758, *Nivellia sanguinosa* (GYLLENHAL, 1827), *Pachytodes cerambyciformis* (SCHRANK, 1781), *Paracorymbia maculicornis* (DE GEER, 1775), *P. tessera* (CHARPENTIER, 1825), *Pidonina lurida* (FABRICIUS, 1792), *Stenurella melanura*

(LINNAEUS, 1758), *S. nigra* (LINNAEUS, 1758), *Stictoleptura rubra* (LINNAEUS, 1758), *S. scutellata* (FABRICIUS, 1781), *Strangalia attenuata* (LINNAEUS, 1758), *Rhagium mordax* (DE GEER, 1775), *Rutpela maculata* (PODA, 1761).

Observations of intergeneric copulation and between distinct insect families are extremely rare in nature. The most recent, similar documented observation occurred 75 years ago (NIESIOŁOWSKI 1949). Insects mating with representatives of distantly related species have no chance of producing offspring. This is most likely how evolution eliminates such unusual behaviours in the animal kingdom. The behaviours described in this paper concerning *R. fulva* are particularly interesting because they are repeatable and not limited to a single occurrence. It should be emphasized that among 20 species of Lepturinae observed on flowers during the appearance of *R. fulva*, males of red soldier beetle showed interest exclusively in much larger females of *L. virens*. Considering the numerous copulating pairs and females during the mating swarm of *R. fulva*, and the fact that the males were exclusively interested in *L. virens* females, it should be ruled out that males, under the influence of high concentrations of their own species' pheromones, would randomly select females outside their family. This phenomenon warrants further investigation, including laboratory studies on the pheromones of *L. virens* and *R. fulva*. Recording and documenting such rare phenomena in nature can contribute to a thorough understanding of their causes, conditions, and mechanisms.

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