

**GROUP OVIPOSITION
IN *COENAGRION MERCURIALE* (CHARPENTIER)
(ZYGOPTERA: COENAGRIONIDAE)**

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Pairs aggregate during oviposition. Discrimination experiments with pairs of floating leaves of *Berula erecta* show that tandems land preferentially on leaves where a single motionless ♂ in the typical vertical position of a tandem ♂ is present.

INTRODUCTION

Coenagrion mercuriale is an endangered species distributed from northwestern Germany and southern England to the western part of North Africa. It was specified in Appendix II of the Bern Convention and in Annex II of the EC Council Directive on the Conservation of natural and seminatural Habitats (cf. GRAND, 1996). The species became a model organism in European conservation biology (e.g. RÖSKE, 1995) and further biological details are badly needed.

In its continental European range, *C. mercuriale* colonises exclusively small running waters near the spring or within the influence of ground water (BUCHWALD et al., 1989). Based on the comprehensive analysis of BUCHWALD (1989) its habitat association is well understood. The breeding habitat is marked by current, moderate vegetation density, a specific composition and structure of the herbaceous vegetation as well as ice-free conditions. CLAUSEN (1990) writes that egg-laying pairs attracted searching pairs to preferentially settle in their immediate neighbourhood.

In this paper I present field experiments that show that pairs of *C. mercuriale* perform aggregation behaviour during oviposition.

MATERIAL AND METHODS

Coenagrion mercuriale is a medium-sized damselfly with blue body and sexually dimorphic black markings. It was studied from 16-VII to 24-VII-1992 in Brittany, at a small brook near Keravec, 2.5 km north of Pouldreuzic (Département Finistère, France, 47°58'34"N, 4°20'40"W; alt. 50 m). At the study site, an unused meadow, the brook had a width of 1.4 m and a maximum depth of 0.2 m. The vegetation in the water consisted of a rich mosaic of *Callitriche* sp., *Berula erecta* (= *Sium erectum*), *Mentha aquatica*, *Sparganium erectum*, *Typha latifolia*, *Solanum dulcamara*, *Lycopus europaeus*, *Rumex* sp. and *Iris pseudacorus*.

In a section with an open bank behind a clump of *Callitriche*, a big stone was placed to form an area with less turbid flow. There, I fixed the following experimental design: two underwater leaves of *Berula erecta*, both with 7 leaflets, 9.5 and 10.0 cm long and respectively 5.0-5.5 cm wide, were pinned with their petiole to a stick 15 cm apart. The leaves floated in the water current with a minimum distance of 10 cm to the bank.

Dead damselflies were used as models which were collected and prepared just before the experiments. With an insect pin a male was fixed to the petiole on one of the two alternative sites. In view of the experience with other *Coenagrion* species (MARTENS, 1992, 1994), I refrained from a female in egg-laying position since a single male is enough to induce aggregation. In a second series, the experimental substrates were enlarged by fixing a second stick with a pair of leaves directly behind the first pair of leaves. In previous tests with damselfly models no tandem landed on substrates such as floating wooden sticks (1 × 1 × 30 cm) or leaves of *Sparganium erectum*.

When a tandem landed at one of the prepared substrates the direction of approach, landing site, duration of stay and behaviour of the pair were recorded. Whenever a female touched the plant with her abdomen, this was considered as an attempt at oviposition. After the tandem flew off, I moved the damselfly model to the opposite substrate.

To collect additional data on individuals under non-experimental conditions ovipositing pairs were filmed on a clump of *Callitriche* with a video camera on a tripod.

RESULTS

Pairs perform oviposition behaviour on floating leaves. In 54.9% of all cases ($n = 122$) oviposition behaviour lasted less than 20 s (minimum = 2 s) and in 24.6% longer than one minute (maximum = 7 min 56 s). The pairs often aggregated in groups, up to 9 tandems were close together at a dense mat of *Callitriche*.

In 40 cases tandems landed at the prepared substrates and females touched the substrate with curved abdomen (Tab. I). In the trials with smaller substrates, on two occasions females landed but held their abdomen straight. Another 6 pairs approached the sites occupied with the model and hovered, before they either landed at the alternative free site (3 ×) or flew away.

Table I

Choice of oviposition site in *Coenagrion mercuriale*. A model of a conspecific male in a vertical position was alternately fixed to one of two alternative substrates (leaves of *Berula erecta*)

Substrate	Landing on site		Difference from 1:1 χ^2	P
	with model	without model		
One leaf	22	6	9.1	<0.01
Two leaves	12	0	12.0	<0.001

Females touched the fixed leaves of *Berula erecta* with their ovipositor at the petiole and the underside of the leaflets, for 2 s to 7 min 23 s. Afterwards, eggs were found in the petiole exclusively, 27 eggs after 7 min 23 s of oviposition, and 9 eggs after 1 min 46 s. This corresponds to an egg deposition rate of 3.66 or 5.08 eggs min⁻¹, respectively. Females touching the substrate for up to 1 min 17 s laid no eggs (n = 14).

DISCUSSION

Tandems of *Coenagrion mercuriale* preferentially land on oviposition sites where conspecific pairs are already present. The experimental results agree with the observations of CLAUSEN (1990). A motionless male in the vertical position is sufficient to stimulate aggregation behaviour. Such behaviour is already known in *C. pulchellum* and *C. puella* (MARTENS, 1989, 1992, 1994).

In field experiments on social attraction, when the set-ups include a great number of alternative oviposition sites, there is the problem of micro-climatic or substrate effects causing uneven spatial distribution. During choice experiments with pairs of substrates it is important to eliminate other alternatives without destroying the habitat. During previous tests with other species I have used substrates which could be placed within the existing vegetation (MARTENS, 1989) or could effectively be isolated from other plants (MARTENS, 1994). With *C. mercuriale* the first possibility seems impracticable. Plant mats, on which pairs of *C. mercuriale* oviposit, are variable in structure and offer numerous potential oviposition sites. Only by covering parts of the plant mats would it be possible to create distinct oviposition sites. The use of isolated substrates could be limited for the following reasons:

- (1) The size of the substrate could be important in obtaining clear results (Tab. I).
- (2) Parts of soft, herbaceous water plants could not be exposed to any water current without loss of their typical form.
- (3) It is difficult to find a way of exposing parts of a substrate in running water in a manner which allows repeatable experiments because of the fine nature of the material.
- (4) For oviposition site selection the structure of the surrounding area may also be important.

The investigations of BUCHWALD (1989) demonstrate the significance of herbaceous plants and of the direct environment on the persistence of breeding populations of *C. mercuriale*. After the failure of experiments with different materials (see Material and Methods), it seems that *C. mercuriale* prefers herbaceous plants for oviposition, but it has not been proved yet. I agree with ZIMMERMANN (1975), that pairs search for useful plants by trial and error. Many of the observations of oviposition and of plants used for oviposition in the literature need to be checked. One should only speak of oviposition when eggs are actually deposited.

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REFERENCES

- BUCHWALD, R., 1989. Die Bedeutung der Vegetation für die Habitatbindung einiger Libellenarten der Quellmoore und Fließgewässer. *Phytocoenologia* 17: 307-448.
- BUCHWALD, R., B. HÖPPNER & W. RÖSKE, 1989. Gefährdung und Schutzmöglichkeiten grundwasserbeeinflusster Wiesenbäche und -gräben in der Oberrheinebene. *Natur u. Landschaft* 64: 398-403.
- CLAUSEN, W., 1990. Weitere Libellenbeobachtungen aus dem nördlichen Ostwestfalen. *Natur u. Heimat, Münster* 50: 49-53.
- GRAND, D., 1996. *Coenagrion mercuriale* (Charpentier, 1840). In: P.J. van Helsdingen, L. Willemse & M.C.D. Speight (Eds), Background information on invertebrates of the habitats Directive and the Bern Convention. Part 2: Mantodea, Odonata, Orthoptera and Arachnida, pp. 245-253. [Nature and Environment, No. 80]. Council of Europe, Strasbourg.
- MARTENS, A., 1989. Aggregation of tandems in *Coenagrion pulchellum* (Van der Linden, 1825) during oviposition (Odonata: Coenagrionidae). *Zool. Anz.* 223: 124-128.
- MARTENS, A., 1992. *Aggregationen von Platycnemis pennipes* (Pallas) während der Eiablage (Odonata: Platycnemididae). Ph.D. Diss., Techn. Univ. Braunschweig.
- MARTENS, A., 1994. Field experiments on aggregation behaviour and oviposition in *Coenagrion puella* (L.) (Zygoptera: Coenagrionidae). *Adv. Odonatol.* 6: 49-58.
- RÖSKE, W., 1995. Die Helm-Azurjungfer (*Coenagrion mercuriale*, Odonata) in Baden-Württemberg: aktuelle Bestandssituation und erste Erfahrungen mit dem Artenhilfsprogramm. *Z. Ökol. Naturschutz* 4: 29-37.
- ZIMMERMANN, W., 1975. Eine interessante Libellengesellschaft im zentralen Thüringer Becken. *Ent. Nachr.* 19: 149-155.