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Group oviposition in three platycnemidid species (Odonata: Platycnemididae)

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Abstract

The European *Platycnemis acutipennis* and *P. latipes* and the African *Mesocnemis singularis* aggregate during oviposition. Choice experiments show that, in all three species, groups develop because tandems preferentially land where conspecifics already show oviposition behaviour. Just a single motionless male in the typical vertical position of a tandem male stimulates aggregation and oviposition behaviour in conspecifics.

Introduction

In some zygopteran species, grouping of ovipositing pairs is often observed. In the platycnemidid *Platycnemis pennipes* (Pallas) and some Coenagrionidae, groups develop because tandems prefer to land close to conspecific pairs (Martens 1992, 1993). This paper demonstrates such behaviour in three more species of Platycnemididae, using a standardized experimental setup that is particularly useful in strong water currents.

Material and methods

Species and localities

Platycnemis acutipennis Selys and *P. latipes* Rambur are medium-sized Zygoptera. The bodies of the males are pale orange and white, respectively, and black markings occur on thorax and at the tip of the abdomen. Both species occur in South-Western Europe and inhabit especially running waters (Martens 1996). The reproductive behaviour of both species has been described in detail by Heymer (1966).

Choice experiments with *P. latipes* were carried out 21-25 June 1993 at the Canal de Vergières, southern France (43°34'N, 4°50'E, alt. 7 m), at a bridge on a section without water plants. This stretch of water had a width of 1.8-2.0 m and a maximum depth of 0.75 m. This canal and its dragonfly fauna are described in detail by Rehfeldt et al. (1991).

P. acutipennis was studied on 26 and 27 June 1993 at the river Lez near Montferrier, southern France (43°44'N, 3°50'E, alt. 58 m). At the study site the river was about 30 m wide and had no discernable current. *Myriophyllum* sp. was the dominant aquatic plant. Choice experiments were carried out at a 5 m long angler site, which was free of water plants, and with a steep bank leading directly to a water depth of 1.4 m.

Mesocnemis singularis Karsch is metallic black in the male with a pale blue pruinosity. It occurs from Natal to east and west equatorial Africa and inhabits rocky, fast flowing parts of streams and rivers (Pinhey 1961, 1980). Its reproductive behaviour has been briefly described by Lempert (1988). The species was studied 7-18 April 1993 at a rocky location of the Comoé River in the Comoé National Park, Ivory Coast (8°45'N, 3°47'W, alt. ca 250 m). Choice experiments took place on a 10 m long section of the river without water plants. In April 1993, at the end of the dry season, this part of the river had a width of 15 m and a maximum depth of 1.5 m.

Methods

A pair of wooden sticks were placed in the water, attached to an underwater frame. The sticks were 30 cm long by 1cm wide and fixed parallel, 30 cm apart at a distance of 0.7 to 0.9 m from the bank and at least 1 m from the nearest plants or neighbouring test systems. Generally two trials were run simultaneously, occasionally three.

Dead specimens which were captured and prepared just before the experiments commenced were used as models. After about 3 h their body colours became noticeably dull and darkened and they were then discarded. Models were fixed to one of each pair of sticks with insect pins. First a simulated ovipositing pair was attached; females were placed in an egg-laying position, while males were fixed at the level of the prothorax of the female in a vertical position. Secondly, the model was reduced to only the vertical male.

When a tandem pair landed on one of the sticks, duration of stay and behaviour of the pair were recorded. If a female touched the stick with her abdomen this was considered to be an attempt at oviposition and the whole sequence was interpreted as choice of oviposition site. After the tandem had flown off, the sticks were taken out of the water and the model changed from one stick to the other. All experiments were statistically tested for the homogeneity of the two observed distributions – landings on the stick with a model versus landings on the paired stick without a model.

Results

Platycnemis acutipennis

Tandems which passed the study site generally approached the prepared substrates. On 92.5% of all landings on the sticks (n = 67) the female curved her abdomen immediately on landing and touched the substrate. Contact with the stick lasted a mean

3.1 s (s.d. ± 1.3 s, n = 38). Models of both, an ovipositing tandem and a vertical male on its own, attracted conspecific tandems to land at the same stick (Table 1). Eighteen times tandems took to the air and returned to land near the model again, whereas on only two occasions did a tandem change to the stick without a model ($\chi^2 = 12.8, p < 0.001$).

Table 1. Choice of oviposition site by tandems of *Platycnemis acutipennis*. Models of conspecifics are fixed to just one of the two wooden sticks.

Model	Number of landings on substratum		χ^2	p
	with model	without model		
Ovipositing tandem	16	1	13.2	<0.001
Vertical male	22	3	14.4	<0.001

Platycnemis latipes

At the Canal de Vergières large groups of ovipositing pairs were observed (Fig. 1). The presence of an ovipositing tandem or a vertical male of its own attracted conspecific tandems searching for a breeding site (Table 2). Nine times a second tandem landed and tried to oviposit at the occupied site, while at the alternative site no tandems landed. Twenty times tandems took to the air and returned to land near the model again, and none changed to the other stick.

In 96.9% of all landings on the sticks (n = 65, Table 2) the female curved her abdomen immediately on landing and touched the substrate for an average of 9.5 s (s.d. ± 5.1 s, n = 35), which is significantly longer than *P. acutipennis* do on the identical material ($U = 106.5, z = 6.2, p < 0.001$). Neither *Platycnemis* species actually deposited eggs in the stick.

Table 2. Choice of oviposition site by tandems of *Platycnemis latipes*. Models of conspecifics are fixed to just one of the two wooden sticks.

Model	Number of landings on substratum		χ^2	p
	with model	without model		
Ovipositing tandem	20	0	20.0	<0.001
Vertical male	17	0	17.0	<0.001

Figure 1. An aggregation of ovipositing pairs of *Platycnemis latipes* at the Canal de Vergières, southern France.

Mesocnemis singularis

At the Comoé river, *M. singularis* appeared in low density in April 1993. The largest group, consisting of four tandems, was observed at one of the experimental sites. Females laid eggs into driftwood and living parts of *Polygonum* sp. During choice experiments, eight of the specimens used as models were taken by fish. Several individuals of *Brycinus macrolepidotus* Valenciennes (Characidae), with a body length of 10 to 15 cm, were observed, lurking below the surface, before darting up and taking them from its stick.

Models of an ovipositing tandems, as well as an upright male on its own, attracted conspecific tandems searching for a breeding site to land (Table 3). On 13 occasions a second tandem landed at the occupied site, while none landed at the alternative site. In 98.2% of the landings the female touched the substrate with her ovipositor for between 3 s and more than 1 min. Eggs were deposited into the wet timber.

Discussion

After copulation, tandems of the three species investigated show clear and directed aggregation behaviour. Oviposition sites already occupied by ovipositing conspecifics,

Table 3. Choice of oviposition site by tandems of *Mesocnemis singularis*. Models of conspecifics are fixed to just one of the two wooden sticks.

Model	Number of landings on substratum		χ^2	p
	with model	without model		
Ovipositing tandem	25	5	13.3	<0.001
Vertical male	22	3	14.4	<0.001

are preferred to a significant degree. As shown for *Platycnemis pennipes* (Martens 1992), a conspecific male in the vertical mate-guarding position is also quite an important stimulus for aggregation. A conspecific male in the regular perching position do not have an effect (Martens 1992).

The simple, artificial experimental setup used here is not suitable for all conditions. Particularly when distinct plant structures or sparkling reflections from the water surface play an important role in the choice of the oviposition site, as known from the coenagrionids *Pyrrhosoma nymphula* (Sulzer) and *Coenagrion mercuriale* (Charpentier), the attraction of a substrate cannot be increased simply by models of conspecifics (Martens 1993, 2000). However, running waters with strong current and/or continuous shade are poor in water plants, so that often only driftwood is available for oviposition. Such conditions are common in the tropics, and many Zygoptera species of tropical running waters use driftwood, roots, or fallen leaves for oviposition (e.g. Robertson 1982; Lempert 1988). That oviposition behaviour could be evoked in the platycnemidid species presented here by very simple artificial oviposition substrates, is an indication of the low level of selectivity in respect to substrate.

Also, such conditions expose ovipositing dragonflies to increased predation risk. Aggregation is one possibility for lowering the predation risk posed by frogs (Rehfeldt 1990, 1992). The number of fish attacks on fixed specimens of *Mesocnemis singularis* lead one to suspect that pressure by fish predation is high. Aggregation behaviour may also serve to reduce the individual predation risk from fish through the dilution effect. As a rule a predator only manages to catch one pair when it attacks a group, so that the others are able to escape.

Social attraction may lead to very uneven distribution of ovipositing pairs of dragonflies on a stretch of running water. Data on population density obtained from short sampling stretches of water do not necessarily give a reliable picture of damselfly colonization of a section of river. The census of ovipositing pairs is far easier than counting individuals on the bank. But aggregation behaviour of ovipositing pairs can lead to false conclusions in assessing and interpreting habitat preferences. To get reasonable results it is necessary to examine all potential habitat types at different times of day and on different days. Only with this procedure is it possible to eliminate random founder effects. Brief temporal and spatial checks, commonly used in monitoring studies of threatened species in landscape assessments in Central Europe as well as in many ecological research projects, may therefore have dubious value.

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