

**INTRASPECIFIC PREDATION IN IMMATURE *COENAGRION
PUELLA* (L.): A SWITCH IN FOOD SELECTION?
(ZYGOPTERA: COENAGRIONIDAE)**

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Observations on cannibalism in outdoor insectaries are presented. The behavioural interactions are described. Cannibalism (in both sexes) occurred only during periods of cold weather. It is hypothesised that intraspecific predation is a switch in food selection due to bad weather conditions.

INTRODUCTION

FOX (1975) reviewed intraspecific predation in general and proposed five factors affecting cannibalism, viz. starvation, density, victim behaviour, stress, and victim availability. Whereas cannibalism is a well-known phenomenon in natural populations (CROWLEY & HOPPER, 1994), especially in odonate larval populations (JOHNSON, 1991), the evidence in adult dragonflies is scanty. UTZERI (1980) presented a review of intraspecific predation in adult Zygoptera and suggested that cannibalism occurs when the intraspecific communication fails. CORDERO (1992) supported this hypothesis, but restricted it to the females only. In addition, he discussed sexual cannibalism as a widespread phenomenon, for example in spiders (ELGAR & NASH, 1988). However, this does not explain the fact that, in case of cannibalism, most damselflies attack much bigger prey than usual. Cannibalism, as a mechanism of density regulation in damselfly larvae, is not yet known in adults.

The aim of this paper is to show the behavioural patterns of intraspecific predation in *C. puella*, and to discuss the possible reasons of cannibalism in adult damselflies.

MATERIAL AND METHODS

The study was carried out at a small pond on the edge of a forest, 15 km E of Braunschweig (Germany, Lower-Saxony, 52°18'20"N, 10°46'20"E), between 28 May and 10 June 1995. The damselflies were caught on the day of emergence and kept in outdoor cages (1 × 1 × 1,5 m), at a maximum density of 50 individuals per cage. The cages were placed in a meadow close to the ponds, in an area used by *C. puella* as a foraging habitat. A cage was made of four wooden posts, extended with a mosquito net (mesh 2 mm), as described by LANGENBACH (1993). The food, supplied daily, consisted of midges and flies (caught in the wild) and of cultured *Drosophila*. The damselflies were inspected for two hours per day. Every morning they were counted and the dead individuals were checked for signs of cannibalistic attacks.

Table I

Number and injuries of the *Coenagrion puella* individuals involved in intraspecific predation from 28 May to 10 June 1996, in freeland-cages

Date	Predator	Prey	Wing damaged	Prey's death	N
28-V	♀	♂		†	1
	♂	♂		†	2
		♂	+	†	3
3-VI	♀	♀		†	1
4-VI		♀	+		3
		♂	+		1
5-VI		♀	+		1
7-VI		♂		†	1
10-VI		♂	+		1

OBSERVATIONS

Sixteen individuals showed signs of intraspecific attacks (Tab. I). Additionally, we noticed a few attacks that were answered successfully by the prey, causing no injuries. There were also two successful attacks by teneral *C. puella* females on teneral *C. hastulatum* (male and female). Most cannibalistic interactions took place during a long-lasting period of

cold weather. Figure 1 shows the daily mean temperatures as compared to the daily 1961-1990 average.

When a conspecific approached a perching individual, males as well as females showed a refusal display. A scheme of the different steps during an attack is given

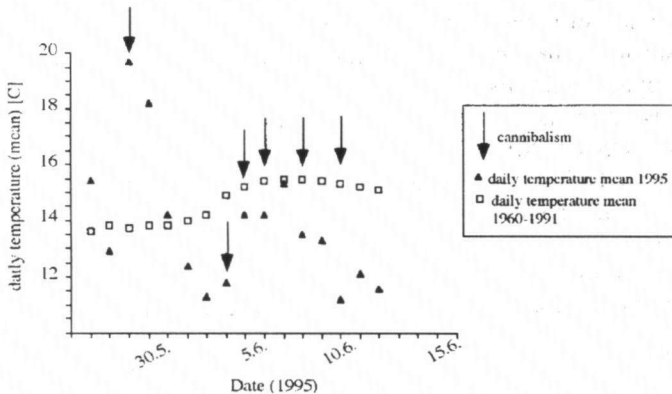


Fig. 1. Daily average temperature in 1995 in comparison with the 1961-1990 daily average temperatures for the period when cannibalism occurred.

in Figure 2. The wings are spread in an angle of 45°. First the predator bites into the wing near the nodum, subsequently it tries to land on the prey's thorax or abdomen. This is followed by abdominal waving of the prey. When the predator starts feeding, prey's defense movements cease.

DISCUSSION

Eight out of the 16 intraspecific attacks led to the prey's death. The refusal display showed the same patterns as described in detail by UTZERI (1988). Whether

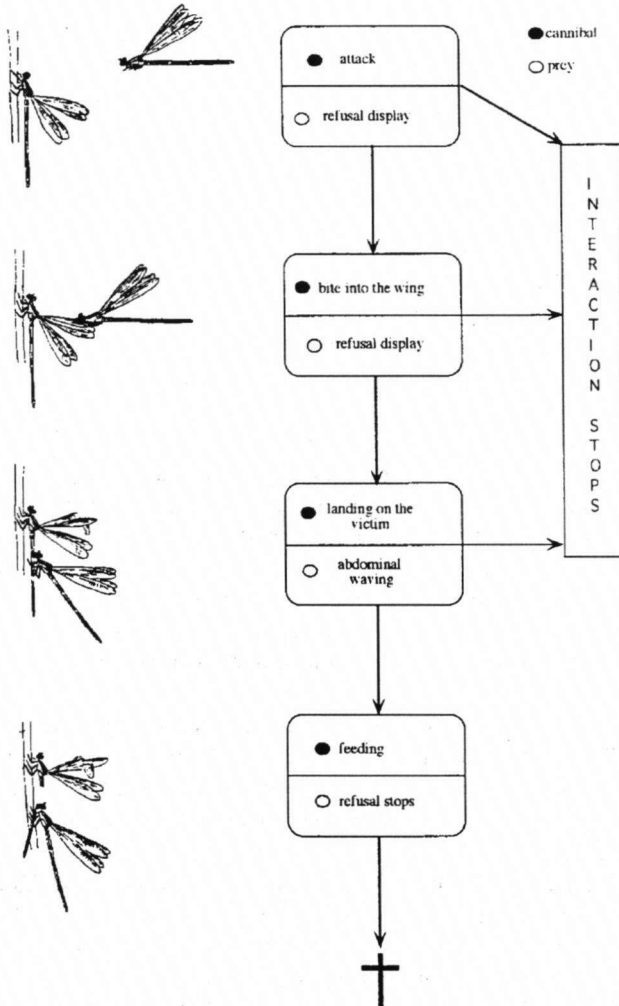


Fig. 2. Behavioural patterns of intraspecific predation in *Coenagrion puella*.

or not an attack was abandoned depended on the intensity of the prey's refusal and on predator's motivation. Presumably, this is a kind of predator's optimization strategy (McFARLAND, 1977). Species-recognition probably does not occur, since the observed individuals were not fully coloured. Furthermore some behavioural patterns are not fully developed in the teneral individuals.

Out of the five causes of intraspecific predation as postulated by FOX (1975), it is likely that only a single one operated in the observed case. The density could be disregarded, since during the periods of cannibalism, 20-40 individuals were within a cage. At the end of June, when the weather became better and warmer, up to 60 individuals were in the same cage and no interspecific predation could be detected. Also starvation may not have occurred, as the food was provided daily and in an adequate supply (cf. FORBES & LEUNG, 1995; LANGENBACH, 1993). The victim's behaviour only plays a role, when the predator has already decided to attack. Therefore it seems that in teneral *C. puella* the availability of the victims is the main condition triggering cannibalism.

The coenagrionid prey (e.g. Diptera and sometimes spiders and aphids) is usually much smaller than the damselflies (CORBET, 1962; PARR & PARR, 1972; PRITCHARD, 1964). Only *Ischnura* species are known to prey on organisms up to their own size. Most evidence on coenagrionid cannibalism comes from various *Ischnura* species (UTZERI, 1980; CORDERO, 1992).

Cannibalistic behaviour occurred mostly during and after the period of cold weather. No foraging took place then and the damselflies starved side by side with the potential prey, as the temperature was too low for foraging. It seems, as far as intraspecific predation in teneral *C. puella* is concerned, the need to avoid a severe negative energy balance during cold weather periods may trigger a switch in prey selection to bigger prey items with a longer handling time on the one hand, and a bigger energy content on the other. The conspecifics were the largest prey available to the individuals in our cages. Mostly males were attacked, which may be due to their smaller size. This interpretation is supported also by observations on the feeding of *Aeshna grandis*. Mr M. Gasse (pers. comm.) reported on an individual preying, after a period of several cold days, on adult Anisoptera, though small Diptera are the usual food of this species.

We have also observed a few successful attacks by *C. puella* on teneral *C. hastulatum*. This may suggest that cannibalism in *C. puella* is not an intraspecific interaction but rather a change in food selection. Inasmuch the term, "intraguild predation", well known in damselfly larvae (JOHNSON, 1991), may be introduced in adults as well.

The information on food uptake, foraging and mortality during the odonate maturation is meagre (CORBET, 1980). Due to experimental difficulties, the estimates and analyses of energy and food uptake in dragonflies are restricted to mature, territorial adults (FRIED & MAY, 1983; MAY, 1984).

CORDERO's (1992) hypothesis of sexual cannibalism could be weakened by

our evidence on intraspecific predation in immature adults. The refusal display was identical in both sexes, and both sexes acted as predators and served as prey.

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REFERENCES

- CORBET, P.S., 1962. *A biology of dragonflies*. Witherby, London.
- CORBET, P.S., 1980. Biology of Odonata. *Annu. Rev. Ent.* 25: 189-217.
- CORDERO, A., 1992. Sexual cannibalism in the damselfly *Ischnura graellsii* (Odonata: Coenagrionidae). *Entomol. gener.* 17: 17-20.
- CROWLEY, H.P. & K.R. HOPPER, 1994. How to behave around cannibals: a density-dependent dynamic game. *Am. Nat.* 143: 117-154.
- ELGAR, M. & D. NASH, 1988. Sexual cannibalism in the garden spider *Araneus diadematus*. *Anim. Behav.* 36: 1511-1517.
- FORBES, M.R.L. & B. LEUNG, 1995. Pre-fabricated dining shelters as outdoor insectaries: an assessment using *Enallagma ebrium* (Hagen) (Zygoptera: Coenagrionidae). *Odonatologica* 24: 461-466.
- FRIED, C.S. & M.L. MAY, 1983. Energy expenditure and food intake of territorial male *Pachydiplax longipennis* (Odonata: Libellulidae). *Ecol. Ent.* 8: 283-292.
- FOX, L., 1975. Cannibalism in natural populations. *Annu. Rev. Ecol. Syst.* 6: 87-106.
- JOHNSON, D.M., 1991. Behavioral ecology of larval dragonflies and damselflies. *Trends Ecol. Evol.* 6: 8-13.
- LANGENBACH, A., 1993. Time of colour change in female *Ischnura pumilio* (Charpentier) (Zygoptera: Coenagrionidae). *Odonatologica* 22: 469-477.
- MAY, M.L., 1984. Energetics of adult Anisoptera with special reference to feeding and reproductive behavior. *Adv. Odonatol.* 2: 95-116.
- McFARLAND, D.J., 1977. Decision making in animals. *Nature, Lond.* 269: 15-21.
- PARR, M.J. & M. PARR, 1972. Survival rates, population density and predation in the damselfly, *Ischnura elegans* (Vander Linden) (Zygoptera: Coenagrionidae). *Odonatologica* 1: 137-141.
- PRITCHARD, G., 1964. The prey of adult dragonflies in northern Alberta. *Can. Ent.* 96: 821-825.
- UTZERI, C., 1980. Considerations on cannibalism in Zygoptera. *Notul. odonatol.* 1: 100-102.
- UTZERI, C., 1988. Female "refusal display" versus male "threat display" in Zygoptera: is it a case of intraspecific imitation? *Odonatologica* 17: 45-54.