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ROOSTING AND RESTING SITE SELECTION BY COENAGRIONID DAMSELFLIES

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Field observations on adult *Ischnura elegans*, *Coenagrion puella* and *Enallagma cyathigerum* show that plant stems are frequently adopted as roosting sites and that the species differ in the mean stem diameters selected. *Ischnura* roosts on narrower stems than *Enallagma*, and *Coenagrion* appears to prefer stems of intermediate diameter. This ranking of the species is demonstrated experimentally for both roosting and resting sites, and a relationship is shown between eye spacing and preferred stem diameter. Damselflies use supports that are sufficiently wide to conceal most of the body whilst allowing unimpeded vision.

INTRODUCTION

At night, and during daytime when temperatures are low, adult coenagrionid damselflies adopt a characteristic roosting posture on vegetation growing close to their breeding sites. They most commonly roost on more or less vertical plant stems, always with their heads uppermost and bodies parallel with and closely applied to their supports (Fig. 1). The roosting posture is distinct from the resting posture which is assumed between periods of flight activity. In the resting position (Fig. 1) the legs are more extended so that the body is held away from the plant support with the abdomen forming an angle of up to almost 90° to the stem.

The physical characteristics of roosting and resting sites selected by *Ischnura elegans* (Vander Linden), *Coenagrion puella* (L.) and *Enallagma cyathigerum* (Charpentier) were investigated in free-living and captive damselflies. Specific differences in site selection are discussed in relation to the dimensions and escape reaction of the insects.

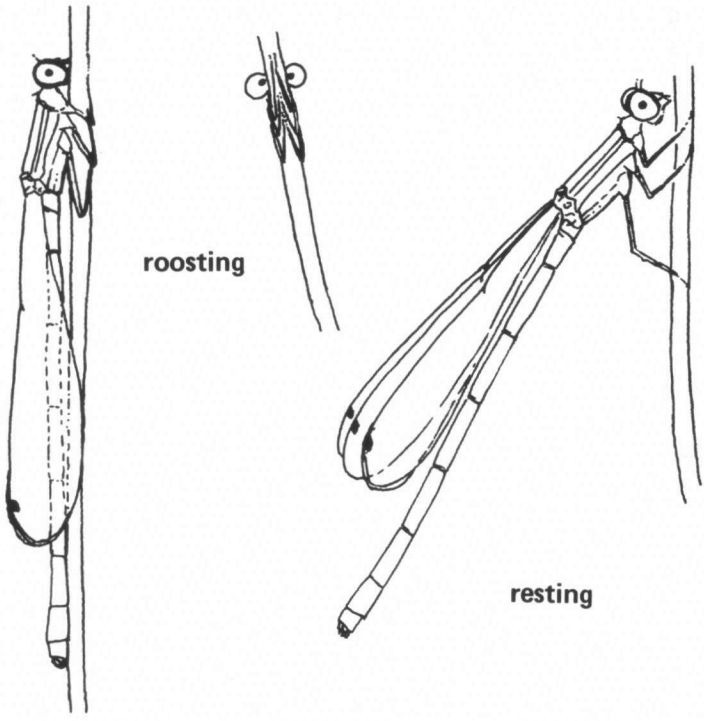

Fig. 1. Typical roosting and resting attitudes of coenagrionid damselflies.

THE STUDY AREA

The study was conducted at Woodchester Park, Gloucestershire (SO 8201), a valley in the Cotswold Hills, during late June and early July, 1978 to 1981. Field observations were made at two sites in the valley where all three species occurred on a dam holding a medium-sized lake and around the periphery of a small pond in pastureland. The behaviour of freshly captured damselflies was observed in cubic cages constructed from thin metal rods which supported nylon netting. Each edge of a cage measured 90 cm. Cages were erected on a mown lawn at Woodchester Park Field Centre.

FIELD OBSERVATIONS ON NATURAL ROOSTING SITES

Vegetation at the dam and pond was carefully searched between 20:00 and 22:30 h, a time when almost all damselflies had assumed

the roosting attitude. Vegetation was very varied at both places but most damselflies were found roosting on grasses, and wide-stemmed herbs such as *Epilobium, Eupatorium* and *Conium* seemed to be avoided (Table I). Eighty percent of the *Ischnura,* fifty-six percent of the *Enallagma* but only thirty-two percent of the *Coenagrion* were found on stems. *Coenagrion* was most commonly located on grass leaves although it occurred on a greater variety of plants than the other two species.

Table I

Numbers of *Ischnura elegans, Coenagrion puella* and *Enallagma cyathigerum* roosting on different types of vegetation

Plant	Position	*I. elegans*	*C. puella*	*E. cyathigerum*
Grass*	stem	25	5	23
	leaf	6	13	10
	inflorescence	4	3	6
Juncus	stem	6	1	
Equisetum	stem	9	3	
Urtica	leaf		1	2
Rumex	leaf		1	
Galium	inflorescence		1	

*mainly *Arrhenatherum elatius* (l.), some *Dactylis glomerata* L.

Table II

Mean diameters of stems at roosting positions of damselflies. Standard errors are shown in parentheses

	I. elegans	*C. puella*	*E. cyathigerum*
Number	40	9	23
Mean diameter (mm)	1.86 (0.07)	1.89 (0.19)	2.17 (0.13)

Ischnura	v.	*Enallagma*	$t = 2.22,\ 0.02 < P < 0.05$
Coenagrion	v.	*Enallagma*	$t = 1{,}15\ P > 0.1$ NS
Ischnura	v.	*Coenagrion*	$t = 0.17\ P > 0.5$ NS

Few female *C. puella* and *E. cythigerum* were found roosting and the majority of data for these species in Table I refer to males. The mean height above ground level of the heads of roosting insects was similar for all species (*I. elegans* 82.5 cm, *C. puella* 82.9 cm, *E. cyathigerum* 75.1 cm) and also for both sexes of *Ischnura* (males 84.1 cm,

females 80.9 cm, for sixteen individuals of each sex).

Measurements of the diameters of stems at the level of the heads of roosting insects indicate that *Ischnura* and *Coenagrion* select narrower stems than *Enallagma* although only the difference between *Ischnura* and *Enallagma* is statistically significant (Table II).

CAGE OBSERVATIONS ON ROOSTING SITES

To attempt to confirm that damselflies actively select as roosting sites supports of particular diameters, a number were confined in cages furnished with wooden sticks. Each stick was 80 cm in length, approximately round in section, and the lower 4 cm was pushed into the ground to hold the stick more or less vertical. Sticks of three different sectional diameters were used: large (*c* 4.0 mm diameter), medium (*c* 3.1 mm) and small (*c* 2.1 mm). Twenty-seven sticks, nine of each size, were placed at random inside each cage. About twenty male damselflies of one of the three species were released into each cage in the afternoon and the number of these taking up roosting positions on each size of stick was counted in the late evening (about 21:00 h). Insects roosting on the cage supports and netting were ignored. Combined data from several replicates are presented in Table III. The roosting distribution is non-random ($P<0.05$) showing that the species behave differently. All three species will roost on sticks of all provided diameters but none is evenly distributed over the three stick sizes. *Ischnura* and *Coenagrion* prefer small diameter sticks whilst *Enallagma* selects medium and small sticks ($P<0.01$ in all cases).

Table III

Numbers of male damselflies roosting on large, medium and small diameter sticks

Species	Large	Medium	Small
I. elegans	43	41	68
C. puella	7	8	18
E. cyathigerum	10	30	26

$\chi^2 = 10.20$, d.f. 4, $P < 0.05 > 0.02$

CAGE OBSERVATIONS ON RESTING SITES

Whilst conducting the observations on roosting sites described above, counts were made during daytime of the numbers of damsel-

flies using the different sizes of sticks as resting sites (Table IV). The data are more heterogeneous ($P<0.01$) than for roosting-site selection because *Ischnura* does not show its roosting preference for small sticks and rests mostly on large sticks, although not significantly so ($0.05<P<0.1$). *Enallagma* chooses medium and small sticks, as when roosting, but its distribution does not differ significantly from an even distribution ($0.05<P<0.1$). The resting distribution of only *Coenagrion* is statistically significant ($P<0.001$) showing a bias, as when roosting, for small sticks.

Table IV

Numbers of male damselflies resting on large, medium and small diameter sticks

Species	Large	Medium	Small
I. elegans	74	58	58
C. puella	5	7	20
E. cyathigerum	15	26	23

$\chi^2 = 17.71$, d.f. 4, $P< 0.01 >0.001$

In a further experiment, a number of grass stalks of varying thicknesses were pushed into a sheet of polystyrene on the bottom of the cage. The stalks were labelled and marked at 3 cm intervals. Six or seven male specimens of each species were introduced into the cage and the stalks and heights at which they rested were noted. Diameters of the resting positions were afterwards measured and the results are presented as a histogram (Fig. 2). *Enallagma* and *Coenagrion* behaved as in the first experiment with *Enallagma* resting at wider points on the stems than *Coenagrion*; *Ischnura* repeated its roosting preference for thin stems, selecting on average slightly narrower supports than *Coenagrion*.

DIMENSIONS OF THE DAMSELFLIES

Four measurements were made, using an eyepiece graticule on a stereobinocular microscope, on several freshly dead individuals of both sexes of *I. elegans*, *C. puella* and *E. cyathigerum*. The ventral surface of each specimen was viewed and the widths were measured of (a) the head between the outer margins of the eyes, (b) the separation of the pseudopupils, (c) the minimum space between the eyes, and (d) the centre of the third abdominal segment (Fig. 3). Mean values of

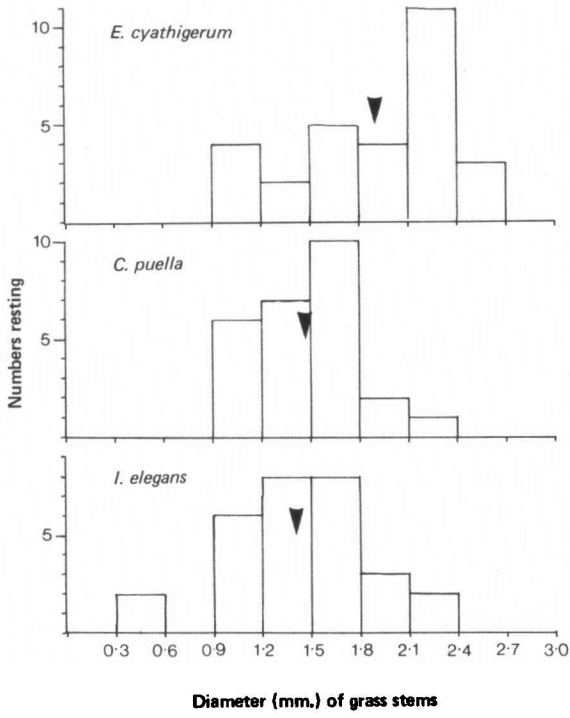

Fig. 2. Numbers of male damselflies of three species resting on grass stalks at different stem diameters. The arrowheads indicate the mean diameters selected.

these measurements are given in Table V. The size differences between the species are small and there is considerable overlap, but on average *E. cyathigerum* is the largest species and *I. elegans* the smallest. Females tend to be slightly larger than their males.

DISCUSSION

I. elegans, *C. puella* and *E. cyathigerum* commonly use plant stems as night roosting sites and frequently also as resting sites between spells of flying. Stems are not selected at random. When stems of a wide range of diameters are available, *Ischnura* prefers narrow ones, *Coenagrion* those of slightly greater diameter, and *Enallagma* selects stems that are wider than those used by the other two species. A similar but less clearly defined range of preferences was shown by caged damselflies provided with artificial supports of only three diameters.

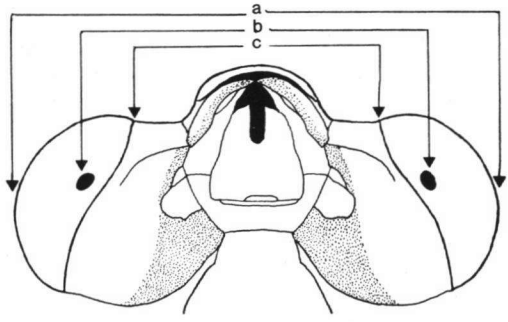

Fig. 3. Head of damselfly in ventral view showing the dimensions referred to in Table V.

Table V

Dimensions of *I. elegans*, *C. puella* and *E. cyathigerum* in mm with standard deviations in parentheses. a = maximum head width, b = separation of pseudopupils in ventral view, c = minimum ventral separation of eyes, d = width at centre of third abdominal segment

		Number	a	b	c	d
Ischnura	♂	13	3.87(0.11)	2.67(0.18	1.90(0.09)	0.60(0.07)
Ischnura	♀	12	3.87(0.09)	2.70(0.09)	1.93(0.10)	0.75(0.09)
Coenagrion	♂	11	4.10(0.12)	2;68(0.20)	1.91(0.10)	0.66(0.06)
Coenagrion	♀	10	4.28(0.24)	2.71(0.08)	2.08(0.12)	1.13(0.20)
Enallagma	♂	11	4.24(0.20)	2.94(0.11)	2.13(0.06)	0.71(0.06)
Enallagma	♀	5	4.32(0.22)	3.00(0.20)	2.13(0.12)	1.09(0.19)

Body measurements of the three species correspond to their ranking by support-diameter preference, *E. cyathigerum* being the largest and *I. elegans* the smallest species.

A settled damselfly is vulnerable. It does not fly rapidly from its support when disturbed but instead usually sidles round the stem so as to interpose it between itself and the source of disturbance. Only the damselfly's eyes project on either side of the stem so that it is able to maintain surveillance. This escape reaction will be most effective when the support is of greater width than the insect's body but no wider than the ventral separation of its eyes. Measurements of the species (Table V) suggest that optimum stem diameters for males of the species lie within the following ranges: *I. Elegans* 0.06 - 1.90 mm, *C. puella* 0.66 - 1.91 mm, *E. cyathigerum* 0.71 - 2.13 mm. For females the minimum diameters, and to a smaller extent the maximum

diameters, will exceed those for their males. The data on site selection presented in this paper agree well with these figures and it is concluded that *I. elegans, C. puella* and *E. cyathigerum* are behaviourally adapted to select roosting and resting positions that are appropriate to their particular dimensions.

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