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SHORT COMMUNICATIONS

MALE SUBSTRATE USE IN RELATION TO AGE AND SIZE IN *HETAERINA CRUENTATA* (RAMBUR) (ZYGOPTERA: CALOPTERYGIDAE)

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Males perch on substrates of different heights (rock = 5-15 cm, grass = 30-40 cm and tree = more than 1 m) in reproductive areas. In order to look for the possibility of male exclusion in these places, an analysis was made using male age and size. Older males were more aggressive and dominant in grass. These males had longer wings than younger ones, but no significant differences prevailed in abdominal and total length. This suggests a possible exclusion of younger males by older males.

INTRODUCTION

Hetaerina cruentata (Ramb.) is a sexually-dimorphic damselfly in size (total length $\bar{x}$ ± STD error, ♂ 4.579 ± 0.097 cm, ♀ 3.953 ± 0.200 cm) and color. The territorial behavior of *H. cruentata* is similar to those species of the same family (see PAJUNEN, 1966; WAAGE, 1973; ALCOCK, 1982; EBERHARD, 1986). The influence of size in intramale competition in territorial odonates has been rarely documented (however see MILLER, 1983; FINCKE, 1984; TSUBAKI & ONO, 1986, 1987). Such influence on body size potentially can affect several factors related to female access. It is very probable that spatial distribution can be one of these factors, but this has not been studied yet.

In *H. cruentata*, males perch at different heights in oviposition areas. Since substrate height influences the opportunity to capture receptive females (CORDOBA-AGUILAR, 1994a), I analyzed the substrate use in relation to age and length of three phenotypic characters. My aim was to look for a possible competition in the use of such substrates by males.

METHODS

Data were collected in the Rio Sordo in Xalapa, Veracruz, Mexico (19°30'N 96°95'W) from 3 to 24 September, 1992. The river has a mean width of 3 m. Non-marked individuals were daily marked. I took the following data per marking: individual number (in order to follow their age and/or color changes), sex, relative age, phenotypic lengths (total, abdominal and wing), and type of substrate. Measurements were made using a caliper to the nearest 0.001 cm. Visual census was done once daily. By each census, I recorded the individual number and substrate used. Age was divided into four classes related to physical semi-discriminant characteristics (following CORDOBA-AGUILAR, 1994b): (1) Teneral (T). Recently emerged individuals of soft consitution. These males do not possess the color of older individuals and their flight is very irregular ("zig-zagging"). — (2) Juvenile mature (JM). At this age the color is intense and brilliant, and wing transparency is high. — (3) Old mature (OM). Wing transparency and brilliant body colors are less intense than JM. Sometimes these individuals show broken or damaged wings. A fourth type, intermediate in age between JM and OM, is the mature (M). These individuals preserve characteristics of both classes.

Perching substrates were classified into three types: grass, rocks and trees. This division is related to the real composition of the habitat (mostly constituted by these factors) with their different heights from the ground. Rocks had a variation of height between 5-10 cm ($\bar{x}=8$), grass 30-40 cm ($\bar{x}=35$) and trees more than one meter ($\bar{x}=105$ cm).

In order to measure male aggression by substrate, I made some focal observations using several individuals randomly chosen along the day. These observations were taken from 8 to 20 of September, 1992. I recorded the number of aggressive flights carried out against other males. I paid special attention to the substrate that these males used, the hour of day and the outcome of each aggression.

RESULTS

Since individuals of age-class T were mostly dispersed, comparisons were made only among JM, M and OM males. Figure 1 shows individual abundance by substrate. OM males were significantly more abundant in the three substrates than the other two ages Grass $\chi^2 = 97.5$, Rocks $\chi^2 = 46.9$, Tree $\chi^2 = 22.5$; all d.f. = 2, $P < 0.001$). Even comparing the frequencies of OM and M males, the former were significantly more abundant (Grass $\chi^2 = 25.2$, $P < 0.0001$; Rocks $\chi^2 = 4.9$, $0.02 < P < 0.05$; Tree $\chi^2 = 4.4$, $0.02 < P < 0.05$; all d.f. = 1).

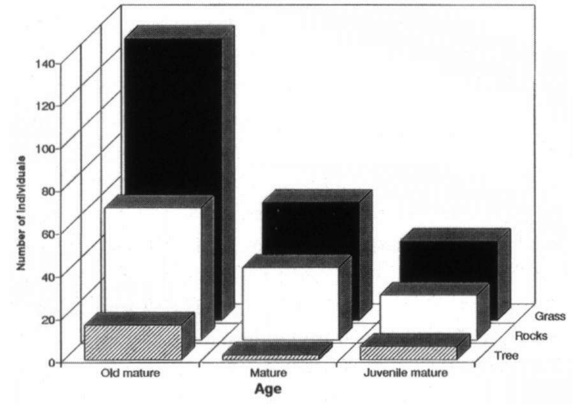

Fig. 1. Male abundance of *Hetaerina cruentata* according to age and type of substrate used.

Table I

Size lengths (mean ± STD error) in males of *Hetaerina cruentata*, in relation to age. – [OM = old mature, – M = mature, – JM = juvenile mature]

Age	Total length[1]	Abdominal length[2]	Wing length[3]	n
OM	4.599 ± 0.001	3.651 ± 0.001	2.766 ± 0.001	123
M	4.591 ± 0.002	3.645 ± 0.001	2.071 ± 0.001	88
JM	4.585 ± 0.002	3.653 ± 0.002	2.732 ± 0.023	61

[1] Anova $p > 0.05$
[2] Anova $p > 0.05$
[3] Anova $p = 0.05$

Table II

Male aggression by substrate and age measured as the average (X ± STD error) number of flights carried out against any male along the day. – [OM = old mature, – M = mature, – JM = juvenile mature]

Age	Grass	Rocks	Tree
OM	67.56 ± 2.39	45.25 ± 1.32	20.75 ± 1.33
M	43.37 ± 1.5	37.75 ± 1.19	16.66 ± 1.19
JM	41.13 ± 1.37	28.75 ± 3.92	17.75 ± 1.89
Kruskal-Wallis ANOVA	15.728[1]	5.051[2]	4.242[3]

[1] $p < 0.0001$
[2] $p > 0.05$
[3] $p > 0.05$

According to size measurements, there were no differences among the three age-classes in abdominal and total lengths. However there was a significant difference in wing size, where OM males were longer in this character than the other ages (Two-way ANOVA P = 0.05; Tab. I).

The average number of aggressive flights carried out by different males in distinct substrates showed a different pattern by substrate, being OM males the more aggressive in grass than in the other places (Tab. II).

DISCUSSION

EBERHARD (1986) distinguished different activities in males perching at two distinct heights in *H. occisa*. Those closer to the water surface were more aggressive than the others. ALCOCK (1982) observed the same in *H. vulnerata*. In *Mnais pruinosa*, there were similar results where *esakii* males (territorials) were closer to the water than *strigata* males (non-territorials) (NOMAKUCHI & HIGASHI, 1985). In *Calopteryx virgo*, territorial males perched at an average height of 4.8 cm, while non-territorial males perched at more than 30 cm (PAJUNEN, 1966). Therefore, differences in substrate use seem to be a regular pattern, where more aggressive males use lower substrates (for a possible interspecific case of exclusion see BICK & BICK, 1972). In *H. cruentata*, this difference was clear, and it is further shown that age and size have an influence in the use of these places. Although the "rock" substrate is the one closest to the water surface, the only significant difference in substrate use among the different age classes was in grass. Besides, OM males were more aggressive in grass. These results contrast with other studies where more aggressive males were more abundant in substrates closer to the water. Nevertheless, it shall be noted that this study is based primarily on the height differences. It is possible that a different substrate composition (higher rocks or lower grass) could change these results. An other factor that might have affected the data is the abundance of each substrate which I did not measure.

Each territory of *H. cruentata* is aggressively defended by one male. On most occasions more than two non-territorial males are present in a territory (CORDOBA-AGUILAR, 1994a). As in other species, these non-territorial males do not interact or lose most contests with owner males. The reasons for these distinct behavioral patterns are still not clear in Odonata (however see FORSYTH & MONTGOMERIE, 1987), although it is a common pattern in several species (CAMPANELLA & WOLF, 1975; WAAGE, 1973, 1979; WALTZ & WOLF, 1984; TSUBAKI & ONO, 1986; FINCKE, 1992; among others). Each flight by a non-territorial male is followed by an interaction with a territorial male. It is possible that height differences can reduce important energetic expenses in non-territorial males with a minor number of interactions.

FORSYTH & MONTGOMERIE (1987) and TSUBAKI & ONO (1986, 1987) have indicated that male reproductive tactics depend on the age and size. Despite this not being an extensive study, these analyses suggest that older and longer-winged males displaced other males. It would be interesting to observe the male distribution in habitats where there are no differences in perching heights.

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