The Great Lakes Entomologist

Volume 17
Number 4 - Winter 1984 *Number 4 - Winter 1984*

Article 3

December 1984

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VISUAL RECOGNITION OF FEMALES BY MALE *CALOPTERYX MACULATA* (ODONATA: CALOPTERYGIDAE)

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ABSTRACT

In order to determine the function of the white wing stigma in *Calopteryx maculata*, males and females were marked or left unaltered, pinned onto a stick and presented to free ranging males. Male responses to females with blackened stigmas were minimal whereas most males responded to unaltered females, unaltered males, and altered males. It is suggested that presence of the white stigma, in combination with wing transparency, is important for male discrimination between the sexes.

Mate recognition in odonates has been the subject of a number of studies. Paulson (1973) found that species with highly colored wings have similar abdominal appendages while those with colorless wings have distinctly different genitalia. In several species with colorless wings, males cannot visually distinguish females but are prevented from mating with females of other species due to differences in external genitalia (Paulson 1974). Mate recognition does involve initial visual recognition of females by males in a number of odonates including *Platycypha caligata* (Selys) (Robertson 1982), *Enallagma* spp. (Robertson and Paterson 1982) and *Perithemis tenera* Say (Jacob 1955).

Calopteryx maculata (Beauvois) has been the subject of several studies on mating behavior (Waage 1973, 1975, 1979a,b) and, although Johnson (1962) suggested that the female white stigma might be used to guide a male in alighting on the female's thorax, the function of the white stigma has not been determined. The present study involved presentation of *C. maculata* specimens with altered and unaltered stigmas to males in the field in order to determine the role of this structure in mating.

MATERIALS AND METHODS

Adult *C. maculata* males and females were captured at Cave Hollow stream, Warrensburg, Johnson County, Missouri, on 10 July 1983. After capture, each insect was pinned through the thorax between the wing bases, attached to a touch-me-not (*Impatiens capensis* Meerb.) stem, and either marked or left unaltered. Marking involved covering a female's white stigmas with black acrylic paint and covering a male's black stigmas with white Liquid Paper®. Each test consisted of presenting an altered or unaltered male or female to a free ranging male *C. maculata* and recording that male's response. A male was recorded as responding if it alighted on the wings or body or attempted or completed tandem. A total of 40 free ranging males was tested. After a male was tested once, I continued down the stream channel to avoid testing the same male again. Each test lasted 2 min or until the male flew off. During the test, latency of response (the length of time between initial presentation and response) and duration of response (time between onset of response and termination of response) were recorded.

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RESULTS AND DISCUSSION

Male reactions to altered females were significantly different from reactions to unaltered females (Table 1), and were minimal with most males doing nothing or only touching the female's body before flying away (Fig. 1). Male reactions to altered males were not significantly different from reactions to unaltered males (Table 1). Although males responded to each of the four test subjects, they only displayed to unaltered females. Free ranging males did not make courtship displays to test males; all of these encounters were of an aggressive nature. In courtship, the female approaches a territorial male which then gives the pair forming, or cross, display (Waage 1973). If the female does not accept the male, she responds by spreading her wings (Johnson 1962). Waage (1973) found that this display only delayed mounting by the male. The results of the present study support Waage's interpretation. Unaltered females exhibited this wing spreading behavior, but most males continued to court them and even attempted tandem, which resulted in a longer duration of response to unaltered females (Fig. 1). Two males attempted tandem without preliminary courtship. Waage (1973) noted that females dislodged nonterritorial males that mounted them without any courtship display. Most males were prevented from successful tandem by the violent flapping of the female's wings. These males were possibly nonterritorial, as only one male achieved successful tandem.

Males responded to unaltered and altered males in the same general way (Fig. 1). Several males engaged in what Johnson (1962) termed aggressive encounters. During these encounters, the free ranging male would face the male test subject and rapidly vibrate its wings while in a stationary position. The male would then fly onto the wings of the specimen. Jacobs (1955) described similar results when he presented *P. tenera* normal males to other males. He observed the males pouncing repeatedly onto the introduced male's wings. When he blackened the male specimen's wings, the encountered males displayed courtship behavior and attempted coupling. In the present study, tandem was attempted once to the altered male, but it was also attempted once to the unaltered male. In both instances, tandem was prevented when the specimens aggressively flapped their wings. The results for altered males are contrary to those of Jacobs (1955). The adding of the white stigma, which is characteristic of females, appeared to have no noticeable behavioral effects on normal males.

Johnson (1962) suggested that when females' wings are folded, the white stigma serves to align the male with the female's thorax. The results of my study indicate that males could achieve successful tandem without the female's wings being folded over her back. Waage (1975) stated that sex recognition in *C. maculata* is based on wing transparency. This appeared to be true for male recognition of males, but not for male recognition of females. Males responded fully to unaltered females, while little or no response was recorded for altered females. It is suggested, therefore, that wing transparency in combination with the white stigma must be present before a male can discriminate fully between the sexes.

Table 1. Responses of free ranging males to altered females, unaltered females, altered males, and unaltered males; type of response to males and females was different (see text). G-statistics computed separately to test each sample against the 8:2 ratio hypothesis.

Test Subjects	Response	No Response	n	X^2
Unaltered Female	8	2	10	0
Altered Female	3	7	10	5.8269[a]
Unaltered Male	8	2	10	0
Altered Male	9	1	10	0.3669

[a] $P < 0.05$

DOI: 10.22543/0090-0222.1520

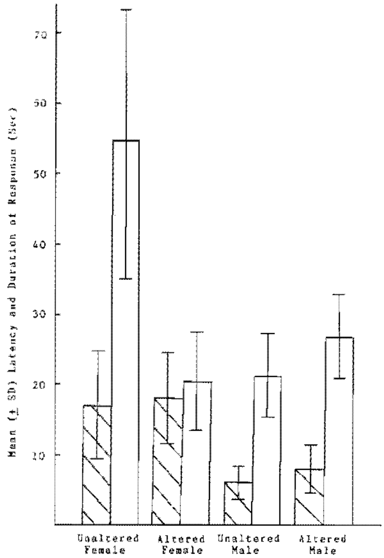

Fig. 1. Means (± SD) of latency (striped bars) and duration of response (white bars) of male *C. maculata* to females and males with altered and unaltered stigmas (n = 10).

ACKNOWLEDGMENTS

I wish to thank Drs. John F. Belshe and Jan Randall, Department of Biology, Central Missouri State University (CMSU) for their helpful suggestions and Dr. Stephen W. Wilson, CMSU, for his patience and critical review of the manuscript.

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DOI: 10.22543/0090-0222.1520