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WINGCLAPPING BEHAVIOR IN *CALOPTERYX MACULATA* (P. DE BEAUVOIS) (ZYGOPTERA: CALOPTERYGIDAE)

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Previous studies have suggested that zygopteran wingclapping serves a social function; however, it may also contribute to behavioral thermoregulation. Two brief studies were performed to determine whether wingclapping rates increase in response to endogenous and exogenous heat sources. In both instances wingclapping increased as predicted, suggesting that the behavior has a cooling effect.

INTRODUCTION

Many zygopterans exhibit a behavior pattern in which the wings are spread outward to a species-typical angle and are then quickly snapped together (WALKER, 1953; JOHNSON, 1962; BICK & BICK, 1965, 1971; HEYMER, 1972). BICK & BICK (1978) suggested that this wingclapping serves the general function of territorial declaration. Comparisons among species revealed marked variation. In some coenagrionids and lestids the behavior is relatively inconspicuous and is observed only among males. In the Calopterygidae, on the other hand, wingclapping is prominent and is frequently displayed by both sexes. BICK & BICK (1978) observed *Calopteryx maculata* during oviposition episodes and suggested that the female and her guarding mate wingclap in order to communicate their presence to one another.

In two seasons of observing the feeding and mating patterns of female *C. maculata* we noticed that they wingclap in a great variety of contexts. The behavior is frequent during reproductive activities such as oviposition and copulation but also during nonreproductive activities such as feeding and grooming. Not only does it occur in the presence of males, but also in all-female feeding

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aggregations and even when a female is alone. The observations suggested that nonsocial factors also have an influence. Because the behavior seems most frequent during the warm mid-day hours of greatest activity, wingclapping might aid in heat reduction. Endogenous heat from muscle activity as well as exogenous heat accumulation from radiant sunlight might be reduced either by increasing the flow of relatively cool streamside air over the body surface and/or by pumping warm hemolymph through the cooler regions of the abdomen. If this hypothesis is correct, wingclapping should increase in response to radiation from an artificial heat source. It should also be most frequent immediately following an episode of high muscular activity.

STUDY 1

Wingclapping is most obvious on warm, sunny days. Because social activity also increases on such days, however, it is difficult to isolate the influence of radiant heat on the behavior. In this study social influences were eliminated by bringing females indoors and occluding their vision.

METHOD

Ten females were netted from the banks of Moore Creek, a tributary of the New River located in the Crackers Neck region of Grayson County, Virginia. They were brought indoors, and suspended by their wingtips from a springclip clothespin. Each eye was then covered with a droplet of enamel paint, and the female remained suspended until the paint was dry. (When *C. maculata* are suspended with legs unsupported, they do not attempt to groom the eyes during the drying period of approximately 20 min.).

For behavioral testing each female was allowed to perch on a twig. She was then alternately exposed to the beam of a sunlamp (Westinghouse 250 watt) and to shade. The testing regimen consisted of a 5-min exposure to shade followed by a 30-s exposure to the lamp (at 40 cm) followed again by 5 min of shade and so on alternately until each female had been exposed to five intervals of shade and five intervals of lamp exposure, a total of 30 minutes of testing. Wingclap frequency under the 30-s lamp exposures was compared with that during the final 30 s of the control shade intervals.

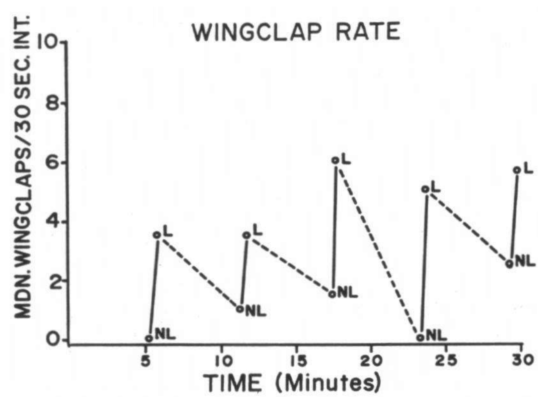

Fig. 1. Wingclapping in response to sunlamp. Female *C. maculata* were exposed to radiant heat from a sunlamp for 30 sec periods separated by five-minute non-exposure intervals. L = 30 sec. lamp exposure; NL = 30 sec control period at end of non-exposure interval.

RESULTS

In addition to exhibiting postural adjustments to minimize exposure to the heat source (as described by MAY, 1976), all females increased their wingclap frequency when exposed to brief periods of radiation from the sunlamp. Cumulative frequency counts under lamp exposure were more than twice those recorded in control periods (Medians 22.5 and 9.5 respectively; $P < .0005$; Wilcoxon one-tailed Signed-Ranks Test). Figure 1 portrays the changes in wingclap frequency over successive trials of the test.

STUDY 2

We wished to determine whether wingclapping is highest immediately following phasic bursts of activity which, presumably, result in endogenous heat production. To minimize social influences, we focused on feeding flights during the morning hours prior to the reproductive phase. *C. maculata* is a perch feeder: it captures small flying insects on the wing and returns to its perch between flights. We predicted that wingclapping would not be equally distributed throughout the interflight interval but would be concentrated in the period immediately following a flight.

METHOD

Ten male and ten female *C. maculata* were observed between 11:00 and 12:30 hours. Ambient temperature was 24° C. An observation began when an individual returned to its perch after a feeding flight, and it continued until the next feeding flight or until two minutes had passed. The distribution of wingclaps within the interval between feeding flights was noted. In order to allow time for several wingclaps to occur, interflight intervals of less than 30 seconds were discarded from the data. (This was necessary in only two instances).

RESULTS

Figure 2 depicts the distribution of wingclapping during interflight intervals of the males and females. As predicted, wingclapping was

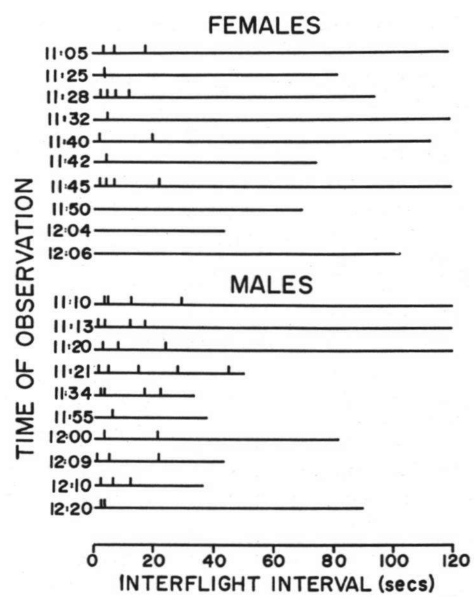

Fig. 2. Distribution of wingclapping by ten female and ten male *C. maculata* during intervals between feeding flights.

concentrated in the period immediately following a flight. Among the ten females, seven exhibited wingclapping, and all of these did so within the first half of the interflight interval. Seven of the males also performed all wingclaps in the first half of the interval.

DISCUSSION

In both studies wingclapping frequencies increased under conditions designed to increase endogenous or exogenous heat, suggesting that the behavior may have a cooling effect. We and others have noted that when *C. maculata* are chased, wingclapping does not increase as this hypothesis would predict. However, the failure to respond when chased may represent a special circumstance. We have noted that *C. maculata* ceases wingclapping when a predator is near. In 1984, while observing a cluster of several females on a particularly warm day, the large predatory dragonfly, *Hagenius brevistylus*, perched among them. All females within a radius of approximately 3 m ceased wingclapping and feeding, and they remained inactive for more than two hours while the dragonfly was present. Wingclapping and feeding resumed soon after the dragonfly departed.

Although these studies indicate that wingclapping can occur in the absence of social stimulation from conspecifics and can vary with thermal stimulation, our observations do not discount the importance of social functions nor do they provide more than indirect evidence for a cooling effect. Animals may display conspicuous social signals in order to alert others to their presence, whether those recipients are actually present or not. Moreover, the cooling effect of wingclapping can be clearly demonstrated only when changes in body temperature are recorded directly. In preliminary work we attempted to detect such changes from the surface of the thorax using a sensitive telethermometer. Five females *C. maculata* were given periodic exposure to a sunlamp as described for Study I. Although the behavioral changes were as expected, surface temperatures recorded at a large number of probe sites did not change noticeably in response to single wingclaps, though brief bursts of flight (1 s or less) did produce measurable cooling. It is possible that cooling effects are largely internal and could be measured from the flight muscles themselves. The more sensitive techniques of MAY (1976) and of SINGER (1987) for measuring internal temperatures may be useful in discriminating the contribution of thermoregulation from other factors, such as that of general arousal.

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REFERENCES

BICK, G.H. & J.C. BICK, 1965. Demography and behavior of the damselfly Argia apicalis (Say) (Odonata: Coenagriidae). *Ecology* 46: 461-472.

BICK, G.H. & J.C. BICK, 1971. Localization, behavior, and spacing of unpaired males of the damselfly, Argia plana Calvert (Odonata: Coenagrionidae). *Proc. ent. Soc. Wash.* 73: 146-152.

BICK, G.H. & J.C. BICK, 1978. The significance of wingclapping in Zygoptera. *Odonatologica* 7: 5-9.

HEYMER, A., 1972. Verhaltensstudien an Prachtlibellen. Beiträge zur Ethologie und Evolution der Calopterygidae Selys, 1850 (Odonata: Zygoptera). *Fortschr. Verhaltensf.* 11: 1-100.

JOHNSON, C., 1962. Breeding behavior and oviposition in Calopteryx maculata (Beauvois) (Odonata: Calopterygidae). *Am. Midl. Nat.* 68: 242-247.

MAY, M.L., 1976. Thermoregulation and adaptation to temperature in dragonflies. *Ecol. Monogr.* 46: 1-32.

SINGER, F., 1987. A physiological basis of variation in postcopulatory behaviour in a dragonfly Sympetrum obtrusum. *Anim. Behav.* 35: 1575-1577.

WALKER, E.M., 1953. *The Odonata of Canada and Alaska*, Vol. 1. Univ. Toronto Press, Toronto.