

# SEXUAL RECOGNITION IN ADULT *ERYTHEMIS SIMPLICICOLLIS*<sup>1</sup>

(ODONATA: ANISOPTERA)

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## ABSTRACT

This research was conducted primarily to determine if male dragonflies of the dimorphic species *Erythemis simplicicollis* reacted differently towards the different sexes, and, if so, to find out what sexual differences served as stimuli for the various behavioral patterns. Altogether thirty-five experiments were conducted in the marsh of Ebaugh Pond, Denison University, utilizing St. Quentin's fishing-line technique (1934) to simulate natural conditions. The experimentation involved altering the physical appearance of both live and dead dragonflies of both sexes and observing the reaction of free males towards these specimens. It was concluded that the visual recognition in this dimorphic species involved stimulation by perception of body coloration, and did not include any recognition of variation in flight pattern or any other subtle difference in behavior.

## INTRODUCTION

This research was conducted primarily to determine if male dragonflies of the species *Erythemis simplicicollis* reacted differently towards the different sexes and, if so, to discover which parts of the anatomy served as stimuli for the different behavioral patterns. Attempts were also made to determine which senses were used in this recognition or "selection," as it is sometimes called, and whether or not the recognition was reciprocal. This has long been a subject of great controversy, and the references consulted in the research were, in many cases, found to directly contradict one another. Research was done in Ebaugh Pond of Denison University, using 52 different dragonflies.

In 1952, N. W. Moore showed the clashes of males of the ten species of dragonflies to be sexual rather than aggressive. His experiments strongly suggested that "either the males of the species considered were unable to distinguish between the males and females of their own species, or that the suboptical stimulus provided by a male was normally sufficient to elicit sexual behavior." Authors of other references disagreed with this conclusion and stated that the males of a given species treated other males "aggressively" and females "sexually." Authors of all references consulted believed that sight was the only sense used in recognition. Johnson (1962c) stated it was improbable that any olfactory stimulus was used for selection because attempts at tandem, the second stage of sexual behavior between dragonflies of opposite sex (fig. 2C), had actually been made with dried models preserved in moth balls. It had been thought that sexual recognition among dragonflies was reached not only by differences in color patterns, but also by "possible delicate behavioral differences" (Ito 1960). According to Corbet (1962), two types of visual recognition existed: unilateral, in which the male alone was stimulated by the female, and reciprocal, in which two-way stimulation occurred.

## PROCEDURE

*Erythemis simplicicollis* Say (Odonata: Anisoptera) was used in this research for three reasons: no previous work on sexual recognition with this species had been conducted; the species is relatively abundant at Ebaugh Pond, Denison University, where the observations were made; and it is a sexually dimorphic species, the sexes having conspicuously different body colorations. The adult

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male *Erythemis simplicicollis* is light blue with perhaps a green thorax and becomes entirely pruinose blue with age. The female, on the other hand, is a bright yellow-green with brown abdominal stripes. Both male and female have green faces and, completely clear wings, except for the stigma on the leading edges of fore- and hind-wings common to all dragonflies. The teneral or immature *Erythemis simplicicollis* has a green body and brown abdominal markings, closely resembling the mature female, but it is incapable of any extended flight. Because this species is sexually dimorphic, it is my belief that visual recognition of body colors is most important in its sexual recognition.

Experimentation could best be conducted under natural conditions using the fishing-line technique first employed by St.-Quentin in 1934. Dragonflies were caught, placed in protective cellophane bags, and cooled in a refrigerator. Light cotton thread was then tied around the dragonfly's thorax behind the second pair of legs and the first pair of wings (figure 1). After tying the other end of the thread to a five-foot pole, the dragonfly's flight could be induced simply by removing the substratum and, with practice, its general flight could be controlled.

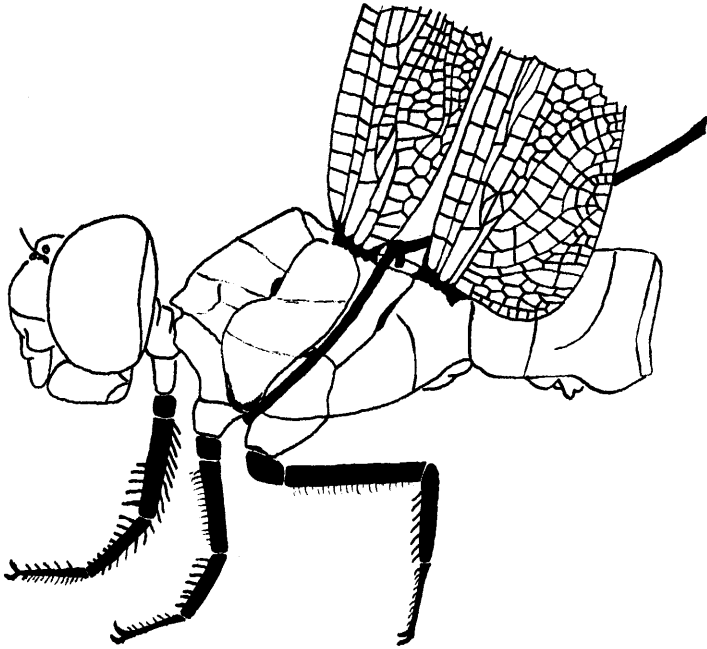


FIGURE 1. Cotton thread on dragonfly.

A difference in reaction of a free male toward live males and females on threads was first tested. Several live adult females were flown on lines before free males. In each case the free male immediately flew onto the female's thorax, moved his abdomen forward, and went into tandem position, which was followed shortly by copulation. The cotton thread around the female's thorax evidently did not prevent tandem. This behavioral pattern (figure 2) has also been observed quite frequently between free males and females in nature whenever a female would venture out to the marsh and open water from the dense brush of dry land inhabited primarily by females and tenerals. Each time a live adult male was flown in the same manner before a free male, however, an entirely different reaction took place. The free male hovered around the tied male and chased it wherever

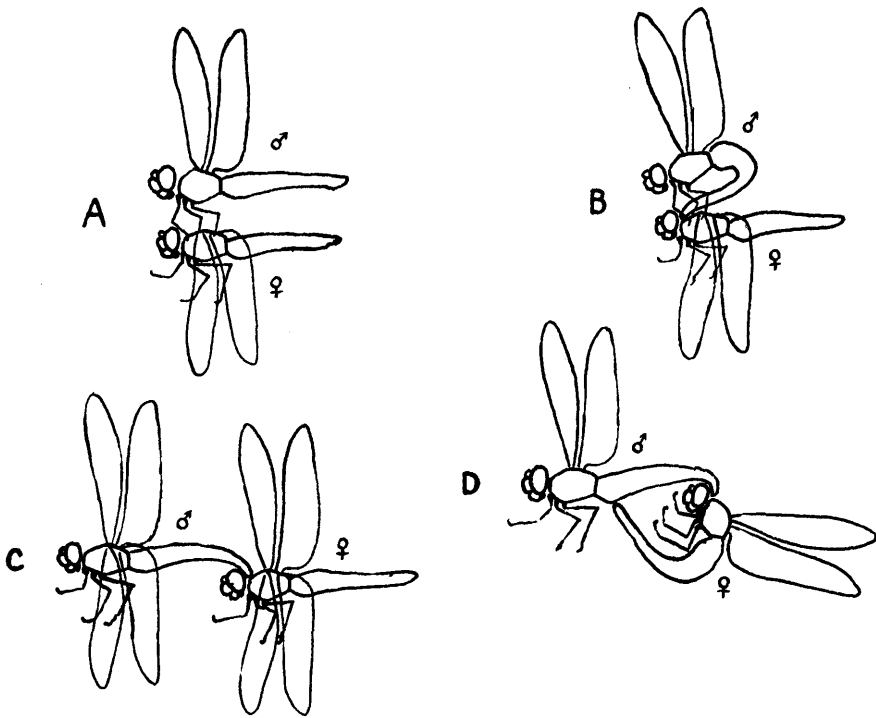


FIGURE 2. Sexual behavioral pattern.

- A. Pre-tandem (clash involving physical contact).
- B. Pre-tandem (female must support flight)
- C. Tandem.
- D. Copulation.

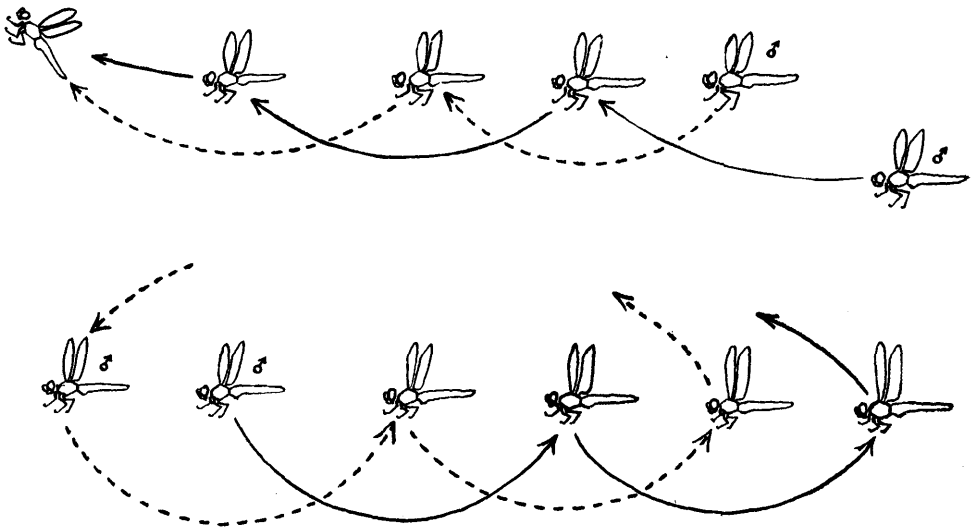


FIGURE 3. Aggressive behavioral pattern. (No physical contact involved).

it went, while the male on the thread tried continually to escape or to land. This greatly resembled and probably was an attempt to duplicate what I term the "leap-frog pattern" or aggressive behavior of this species, the peculiar flight pattern often observed under purely natural conditions among only *Erythemis simplicicollis* males (figure 3). Throughout this paper the term "sexual behavior" will be used in referring to the normal reaction of a male towards a female (figure 2) and the term "aggressive" in reference to the normal behavior between two males of this species (figure 3).

To find if life was necessary for "recognition," or more properly to elicit a response from the free males of the pond area, be it sexual or aggressive behavior, dead dragonflies of both sexes were moved on lines before free males. Motion was found to be necessary to induce any type of reaction. Free males clashed with the dead females on threads, a response interpreted as the physical contact of pretandem (figures 2A, 2B), but the tandem position was never actually achieved, because the females were not actually in flight. Free males hovered around the dead males on threads and chased them wherever they were moved, but of course no "leap frog" pattern resulted because even the inhibited cooperation of the tied dragonfly was impossible with the dead insects.

To find if motion or flight was necessary for recognition, dead dragonflies of both sexes were placed on natural perches around the swamp. These were completely ignored by the free males, and one male went so far as to rest briefly on one of the "decoys." It had been previously noticed that females had always been picked up into tandem while in flight, and that male aggression had always occurred in the air a few feet above the water surface.

Two experiments were conducted with *Erythemis simplicicollis* females to find if the head or copulatory organs held any release value. A dead female whose head had been removed was clashed with, but only the pre-tandem position was reached. A live female whose copulatory organs, located at the tip of the abdomen, had been removed was treated sexually and a free male achieved tandem position with it.

The next series of experiments dealt with wings as a possible stimulus for "selection." First, the entire wing tips with the dark markings or stigma were clipped off a live female. This specimen was treated sexually, including copulation by the free males. Next, a live female's wings were painted entirely black. Although it attracted no *Erythemis simplicicollis* males, this female was treated sexually and clashed with by *Libellula luctuosa* males, a species whose basal wing sections are conspicuously black. In various other experiments involving wing coloration, the free males went into tandem only with females which had completely clear wings. Tied *Erythemis simplicicollis* females elicited a sexual response from free males if the females had at least two wings, one on each side of the thorax; similarly, tied males with only one wing missing from each side were treated aggressively.

Because body coloration was suspected to be the primary stimulus of sexual recognition in this species, most of the research was concentrated in this field. If it were true that visual "recognition" was reached on the basis of body coloration, a free male should act sexually toward another male which was painted as a female. Thus, both live (rendered inactive by refrigeration) and dead males were painted exactly like females with model airplane enamels. In all cases they were treated sexually. The physical contact of the pretandem position was attained; but tandem position was never achieved, because the tied males desperately fought off the free males, and the dead males, much the same as the dead females on threads previously, were incapable of flight or of cooperation. Likewise, live and dead females painted as males were treated aggressively, or hovered around and chased. Next, live females were painted only half blue. If a female painted blue on the dorsal side were approached by a free male from above she was treated

aggressively; if she were approached from below, however, she was treated sexually. Just the opposite reaction resulted when a female was painted blue on her ventral side, while remaining normal on her dorsal side. Both male and female teneral, which so closely resemble the adult females, were treated sexually by free males, although the tandem position was never achieved.

To find if sexual recognition required cooperation on behalf of both sexes, a live female's eyes were painted with boneblack so as to completely obscure her vision. When flown on a line before free males, she was clashed with, but tandem was never achieved. However, when the boneblack was removed from the same female's eyes, enabling her to see, she immediately went into tandem and then attained copulation with various males.

Altogether, thirty-five experiments were conducted, using fifty-two different dragonflies.

#### CONCLUSIONS

Several conclusions could be drawn from these observations. First of all body coloration of this dimorphic species is the most important stimulus to elicit either sexual or aggressive behavior. This visual recognition is apparently reciprocal and definitely requires the active cooperation on the part of both sexes. *Erythemis simplicicollis* males are apparently able to "distinguish" between sexes of their species; that is, the visual appearance of a female elicits a response entirely different from that accorded another male. They act sexually towards females and aggressively towards the males (as indicated in figures 2 and 3).

Life is not necessary for recognition, but the dragonflies must be in motion similar to that of flight in order to induce any type of reaction. Teneral are not treated sexually primarily because their wings are too weak, so that they are seldom found in open flight over the water. At least two wings are sufficient to elicit any type of reaction. The wings must be entirely clear and transparent as naturally occur in this species. The head, copulatory organs, and stigma were found to hold no release value. Finally, neither flight patterns nor any "delicate behavioral differences" seemed to play any part at all in the sexual recognition of *Erythemis simplicicollis*.

#### REFERENCES CITED

- Buchholtz, C.** 1956. Eine Analyse des Paarungsverhaltens und der dabei wirkenden Auslöser bei den Libellen *Platycnemis pennipes* (Pall.) und *Pl. dealbata* (Klug.). Zeitschrift für Tierpsychologie 13: 13-25.
- Corbet, P. S.** 1962. A Biology of Dragonflies. H. F. & G. Witherby Ltd., London. 274 p.
- Corbet, P. S., Cynthia Longfield, and N. W. Moore.** 1960. Dragonflies. Collins Clear-Type Press, London. 260 p.
- Ito, Y.** 1960. Territorialism and residentiality in a dragonfly, *Orthetrum albuistylum speciosum* Uhler (Odonata: Anisoptera). Ent. Soc. Amer. Ann. 53: 851-853.
- Jacobs, M. E.** 1955. Studies on territorialism and sexual selection in dragonflies. Ecology 36: 566-568.
- Johnson, C.** 1962a. A description of territorial behavior and a quantitative study of its function in males of *Hetaerina americana* (Fabricius), (Odonata: Agrididae). Canad. Ent. 94: 178-190.
- . 1962b. Reproductive isolation in damselflies and dragonflies (Order Odonata). Tex. Jour. Sci. 14: 297-304.
- . 1962c. A study of territoriality and breeding behavior in *Pachydiplax longipennis* Burmeister (Odonata: Libellulidae). Southwestern Nat. 7: 191-197.
- Moore, N. W.** 1952. On the so-called "territories" of dragonflies (Odonata-Anisoptera). Behavior 4: 85-100.
- Portmann, A.** 1961. Animals As Social Beings. The Viking Press, New York. p. 233.
- Saint-Quentin, D.** 1934. Beobachtungen und Versuche an Libellen in ihren Jagdrevieren. Kohowia 13: 275-282.