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PARASITISM OF CERATOPOGONIDAE (DIPTERA) BY THE WATER MITE *TYRRELLIA CIRCULARIS*

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Species of the water mite genus *Tyrrellia* inhabit primarily seepage areas and the moist substrate bordering standing and running waters (Cook 1974). Recently larvae of *Tyrrellia* have been found associated with ceratopogonid flies of the genera *Atrichopogon, Bezzia, Culicoides,* and *Dasyhelea* (Grogan and Navai 1975, Smith and Oliver 1976), but specific determinations of the mite species involved were not made. This report confirms the association between Ceratopogonidae and *Tyrrellia* with observations on the parasitism of *Dasyhelea grisea* and *D. mutabilis* by *Tyrrellia circularis* Koenike.

Field observations were made at Lake Alice, Gainesville, Florida, in late 1968 and 1969, a period when the lake was virtually covered with water hyacinths, *Eichhornia crassipes.* Decaying hyacinths added a tremendous amount of organic matter to the shores, and many larvae of several species of Ceratopogonidae were found associated with this material. At this time, the water mite also was extremely abundant. Since then, the water hyacinths have been controlled in much of the lake, and both ceratopogonid and mite densities have been observed to drop sharply.

The mite was identified by comparing the morphological characteristics of collected adults with descriptions and figures of *T. circularis,* a North American species, in Koenike (1895) and Marshall (1940) and of *T. noodti,* a South American species, in Besch (1962). These 2 species are the only described species with single anterior and posterior dorsal plates in the adult stage, a characteristic shown by the mite species included in the present study. Identified females were matched with larvae by rearing larvae from eggs laid by isolated females. Larvae were matched with nymphs by allowing engorged larvae that detached from field-collected hosts to metamorphose to the nymphal stage. Finally, nymphs were matched with adults by rearing them to the adult stage. In this way the association between the identified stage and the other stages in the life cycle could be established.

The larvae of *T. circularis* were found in the same microhabitat as the adults—the moist mats of rotting vegetation along the shore. As many as 20 unattached larvae were found per sample (453 cm^3 of substrate passed through sieves). Larvae were also found attached to the pupae of several species of Ceratopogonidae, 2 of which were identified as *Dasyhelea mutabilis* and *D. grisea.* Other Ceratopogonidae, e.g. *Atrichopogon fusculus* and *Stilobezzia antennalis* were collected from the study area but harbored no mites.

The commonest attachment site observed was the anterior end of the pupa although some larvae were found posteriorly. The number of mite larvae per pupa sometimes reached 12. The number of *D. mutabilis* pupae with different mite loads is illustrated in Figure 1 on the basis of a collection made on January 10, 1969. The significant departure ($p < .001$) of this distribution from a random one (the Poisson distribution in Figure 1) is caused by the greater number of both unparasitized and heavily parasitized hosts in the observed distribution—a common pattern in parasite-host associations (Williams 1964).

The larvae transfer from the pupa to the adult fly at ecdysis and attach primarily to the venter of the first abdominal segment. In captivity at 23°C, larvae remained attached to their hosts for 4 to 9 days. The engorged larvae, which ranged in length from 0.30 to 0.40 mm, (sample size of 8) detached from the host before metamorphosing to the nymphal stage. Since unengorged larvae are only 0.18 mm long, there is an appreciable increase in size during the period of attachment.

The size of the nymph immediately after metamorphosis averaged 0.33 mm and ranged from 0.30 to 0.40 mm (sample size of 6) in captivity. Nymphs and adults were found in the same microhabitat and were observed in the field to feed on the same foods—pupae of various species of Ceratopogonidae, including *Dasyhelea* spp. Pupae observed being held by mites in the field were kept in separate vials with the mites until they could be checked more carefully in the laboratory for mite-induced injury to confirm that they were being preyed upon. In addition, mites were fed larvae and pupae of several species of Ceratopogonidae in the laboratory. A large adult *T. circularis* is capable of consuming the

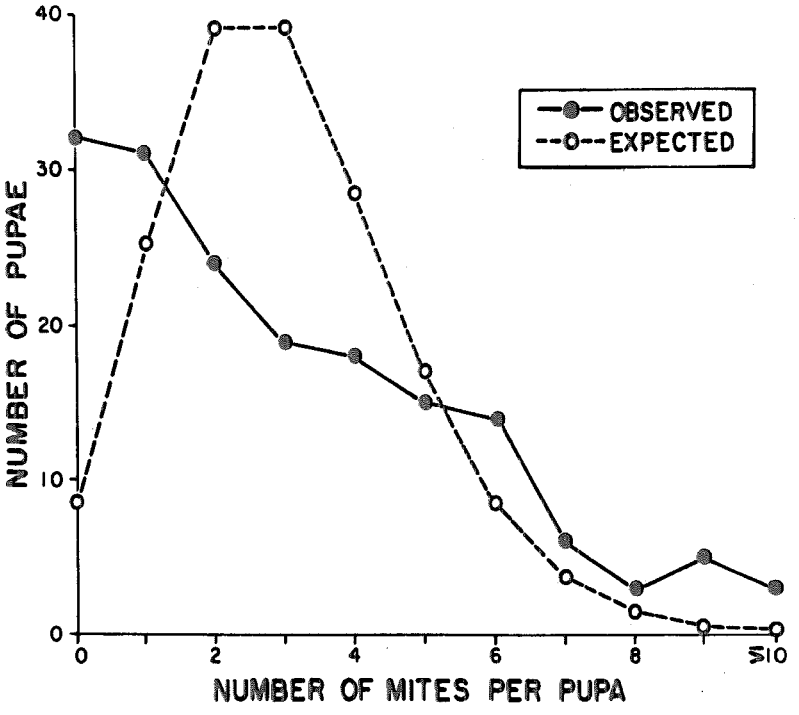

Figure 1. The observed distribution of 511 mite larvae of *Tyrrellia circularis* on 170 pupae of *Dasyhelea mutabilis* compared with the expected distribution if the mites were distributed randomly. The expected distribution is a Poisson distribution with the same mean (3.01 mites per host) as the observed distribution.

entire body contents of smaller instars of the prey. The feeding of a predatory stage of a water mite on the same species as used by the parasitic stage has been observed also in *Thyas barbigera*, a parasite and predator of the mosquito *Aedes stimulans* (Mullen 1975), and in *Hydrachna conjecta*, a parasite and predator of the corixid *Sigara striata* (Davids 1973).

Field collected nymphs averaged 0.58 mm and ranged from 0.35 to 0.85 mm in length (sample size of 37). The length of nymphs at the final metamorphic stage, the teleiochrysalis, was observed to be 0.97 mm (sample size of 3).

Adult females averaged slightly larger (1.14 mm) than males (1.00 mm) although the maximum length of collected females (range from 0.70 to 1.60 mm, sample size of 71) was much greater than that of males (range from 0.70 to 1.30 mm, sample size of 49). All females that oviposited in captivity produced small masses of red eggs, averaging only 7 eggs per mass, and this corresponded closely to the average size (6 per mass) of egg masses collected in the field. Field-collected females as small as 0.80 mm in length were observed to contain developed eggs, but the smallest collected adult female of 0.70 mm in length contained none. The number of eggs carried at one time per female increased gradually as body length increased so that an average of 62 eggs per female of 1.30 mm in length was attained. The 2 largest females (1.40 mm in length) dissected were devoid of eggs.

Field-collected egg masses were most often found in the sediment, and as many as 115 eggs in small masses were found per sample of sediment (453 cm^3). The identity of several samples of mite eggs was determined by allowing the eggs to hatch and then by comparing

the larvae with larvae associated with adult female *T. circularis*. In all cases the eggs proved to be those of *T. circularis*. No other mite eggs were found in the sediment. Eggs deposited in the laboratory also were buried in the substrate, and they hatched in about 10 days at 23°C.

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A RELEASE CAGE FOR THE MASS DISTRIBUTION OF FLIES AND OTHER INSECTS

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The stable fly, *Stomoxys calcitrans* L., is an aggressive biting insect that must be handled carefully by personnel charged with releasing large numbers for dispersal studies or sterile male releases. The flies seek the nearest blood source, including man, and once free inside release vehicles can be so distracting and annoying they can possibly cause vehicular accidents. In the conduct of the sterile-male release program on St. Croix, U.S. Virgin Islands, we attempted to develop holding and release containers that would assure some degree of protection to personnel. These releases were conducted either at fixed locations where large numbers of flies were required (ca. 12,000) or at mobile locations which required a smaller number of flies (ca. 4,000+).

In the releases involving the larger number of insects the flies were freed from a fixed station which consisted of a wood frame, plastic-screened cage (29 x 55 x 43 cm) with a solid plywood door. The door was hinged on the bottom and a coiled spring installed on one side of the cage to insure its opening when tripped. After a cage was loaded with anesthetized flies, the door was secured by a simple bolt pin latch attached to a length of nylon line. Thereafter the cage was placed on the stationary platform ca. 2 m above the ground (to protect the cage from cattle) and secured, the door could be opened by pulling the nylon line. This cage is similar to other types already described in the literature, whereas the cage used at the mobile location, which is described

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