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PREDATION BY WATER MITES (ACARINA: HYDRACHNELLAE) ON THE IMMATURE STAGES OF MOSQUITOES[1]

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ABSTRACT. The post-larval stages of several water mites are reported for the first time as predators on the immature stages of mosquitoes. Nymphs and adults of *Thyas barbigera* and *T. stolli* were found to feed on *Aedes* eggs in the laboratory. Three types of feeding damage may result, each of which can be correlated with the age of the eggs at the time predation takes place. The nymphs and adult females of certain *Piona* spp. found in temporary woodland pools were observed to attack and kill *Aedes* larvae under both laboratory and field conditions. Predation by these mites appears to cause a progressive paralysis in the mosquito larvae, first affecting the head and associated structures and gradually extending posteriorly. A single case of a *Hydryphantes ruber* female preying on a IV-instar *Aedes stimulans* larva was observed in the laboratory.

Although mites are commonly found as ectoparasites on adult mosquitoes, few observations have been made regarding mites as predators on the immature stages of mosquitoes. Nymphs and adults of trombiculid mites, including the genera *Eutrombicula* and *Trombicula,* have been observed feeding on *Aedes aegypti* eggs in the laboratory (Jenkins, 1947). Hearle (1926) reported unidentified dark-red water mites preying voraciously on *Aedes vexans* larvae in a cottonwood swamp. To my knowledge, the only other published report of water mites preying on immature

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mosquitoes is that of Laird (1947) in which *Limnesia jamurensis* was observed feeding on the eggs and I-instar larvae of *Anopheles farauti* and *Culex pullus*.

Larvae of water mites belonging to the family Thyasidae are frequently found as parasites on adult *Aedes* mosquitoes. Nothing however has been known concerning the feeding habits of the post-larval stages of these mites. During attempts to rear thyasid mites in the laboratory, I offered as food a variety of small aquatic organisms including planarians, ostracods, copepods, oligochaetes, mayfly nymphs, active and quiescent stages of several water mites, chironomid larvae and the immature stages of various other aquatic insects of the orders Diptera and Coleoptera. Although rejecting all of these potential food sources, both nymphs and adults of *Thyas barbigera* and *T. stolli* fed on mosquito eggs.

Eggs which had been preyed upon by these mites exhibited three distinct types of feeding damage. The first was characterized by eggs with a single small, symmetrical hole approximately 40μ in diameter near the larger end. The edge of the opening was raised slightly forming an irregular rim (Fig. 1*a, b*). These eggs were greyish and were not noticeably collapsed. In the second type, the eggs bore a longitudinal slit along one side varying from 80 to 320μ in length (Fig. 1*c, d*). The cut edges were relatively smooth and curled inward. Such eggs were often partially collapsed or distorted and were usually lighter in color than normal intact eggs. The third, and most commonly observed, type of feeding damage was characterized by eggs which were torn open along one side, producing mutilated shells with very irregular, jagged edges (Figs. 1*e, f;* 3). The egg contents were completely removed leaving only the collapsed chorion and membranes. In contrast to the other two types, these eggs were black.

The types of damage appear to correlate with the age of the eggs at the time predation occurs. In Types I and II, the eggs are relatively fresh as evidenced by the lighter coloration of the chorion. A small hole or short longitudinal opening made by the mite's chelicerae is sufficient to gain access to the nutrients and undeveloped tissues within. Once the chorion has become fully sclerotized and embryonic development has progressed substantially (e.g., 4–7 days), it is necessary for the mite to tear the egg open along most of its length in order to reach the contents (Figs 2–3). This explains the fully darkened coloration and extensive feeding damage exhibited by Type III eggs.

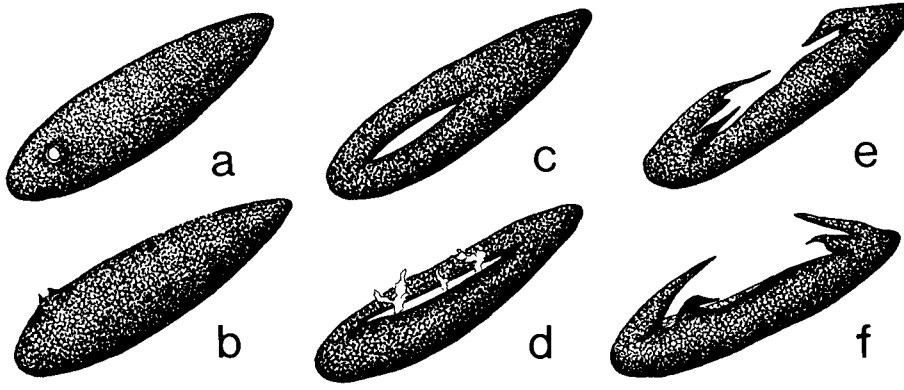
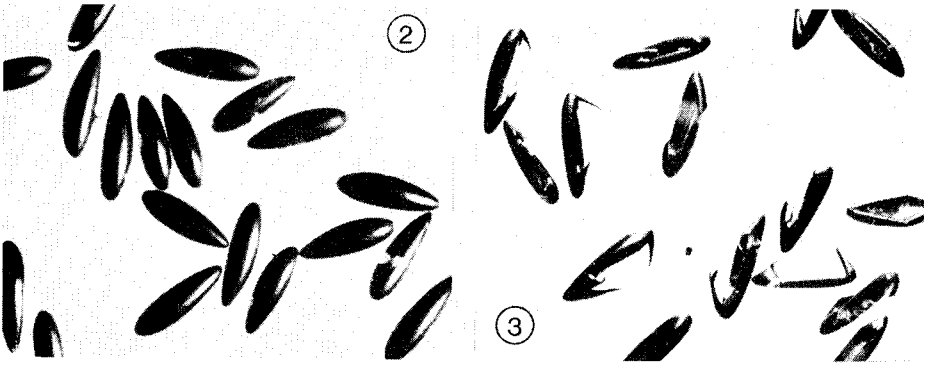


Fig. 1. Types of feeding damage exhibited by mosquito eggs preyed on by thyasid mites. *a* and *b*, Type I characterized by a circular hole with a raised rim. *c* and *d*, Type II with longitudinal slit, the margins of which are smooth and curled inward. *e* and *f*, Type III in which the egg is torn open along most of its length leaving irregular jagged edges.



Figs. 2–3. *Aedes stimulans* eggs preyed upon by *Thyas barbigera*. 2. normal eggs. 3. following predation.

To determine the number of mosquito eggs upon which a *Thyas* nymph or adult may feed, the following observations were made. Twenty vials were set up, 10 containing a single *Thyas* nymph and 10 containing a single *Thyas* adult. To each vial were added 3 *Aedes stimulans* eggs less than 48 hours old. At the end of a 26-day period, examination of the vials revealed that 7 of the nymphs (70%) and 8 of the adult mites (80%) had preyed upon 1 or more of the eggs provided. The majority of nymphs and adults (60% in both cases) had fed on 1 or 2 eggs during the test period. Only 1 nymph (10%) and 2 adults (20%) destroyed all 3 eggs. If this is indicative of the number of eggs which thyasid mites destroy under field conditions, it is unlikely that such predation has a serious impact on mosquito populations.

Since both *Thyas barbigera* and *T. stolli* typically occur in woodland pools and swamps where *Aedes* spp. breed, the eggs of these mosquitoes may indeed serve as an abundant food source for the post-larval stages of these mites. Whether such eggs represent a major item in their diet under natural conditions remains uncertain.

In addition to mosquito eggs, mosquito larvae may also serve as prey for water mites. On several occasions during April and May 1971 and 1972, adult water mites were observed clinging to late-instar *Aedes* larvae at the surface of a temporary woodland pool at the Ringwood Wildlife Preserve, Tompkins County, New York. Such larvae were best detected by their irritated behavior and the presence of an orange-to-red mite usually attached near the thorax. The mites in each case belonged to the family Pionidae.

In the laboratory, *Piona* nymphs collected from the above site were observed preying on I-instar *Aedes abserratus* larvae. Typically the mites attack the young larvae by first grasping them about the thorax or head capsule. The larva responds immediately by struggling to dislodge the mite and, if feeding near the bottom, promptly attempts to rise to the water surface as the mite pierces the integument with its chelicerae. Within 1 to 3 minutes, the mosquito's activity progressively subsides and the prey sinks to the bottom, unable to maintain itself at the surface. By this time the mouthbrushes cease to move, the antennae have curved ventrally, and the posterior-most abdominal segments are commonly bent slightly from the axis of the remainder of the body. For several minutes thereafter the only discernible movements of the larva are quivering and intermittent twitching of the anal gills and siphon. Virtually all activity ceases in 10 to 14 minutes following initial seizure by the nymphal mite.

Not uncommonly the mite will withdraw its chelicerae after the prey has been subdued, move to another part of the body,

and pierce the integument again. This action may be repeated one or more times, usually involving the cervical region and intersegmental areas between the anteriormost abdominal segments. Occasionally a mite was observed trying to drag its cumbersome prey beneath it by flailing its legs in an ineffective swimming fashion. Up to 20 minutes or more after attacking I-instar mosquito larvae, the *Piona* nymphs abruptly withdraw their mouthparts and swim off.

To determine how many I-instar mosquito larvae a *Piona* nymph might feed on per day, 6 vials, each containing 10 I-instar *Aedes* larvae, were set up. A single *Piona* nymph was placed in each of 4 of the vials with the remaining 2 serving as controls. Up to 4 larvae were killed in the test vials during the first 7 hours compared with no mortality in the controls. After 24 hours the number of dead larvae per test vial ranged from 4 to 8 whereas 3 larvae had died in each of the controls. This suggests that a single *Piona* nymph may destroy as many as 5 or more I-instar mosquito larvae per day.

On two occasions adult *Piona* females were observed preying on IV-instar *Aedes stimulans* larvae at the Ringwood Wildlife Preserve. Each had seized its prey near the junction of the thorax and abdomen. Upon collection in a dipper, the mites remained attached to their prey despite the latter's convulsive movements. Within 2 to 3 minutes the weakened larvae sank to the bottom with the mites still atached. After a lapse of several more minutes the *Piona* mites were then observed crawling over the bodies of their subdued prey, shortly after which all activity on the part of the mosquito larvae ceased. In the laboratory similar observations were made of a *Piona* female preying on a IV-instar larva of *Aedes fitchii*. No *Piona* males were observed preying on mosquito larvae.

It appears that nymphs and adults of certain *Piona* spp. may commonly prey on *Aedes* larvae occurring in the same vernal woodland pools in which they themselves often abound. Nymphs tend to prey on early-instar larvae whereas *Piona* adults can successfully subdue IV-instars. Seizure of the prey may occur either at the water surface or as the mosquito larvae are feeding near the bottom. In the latter case, upon being attacked the larvae rise to the surface where they attempt to remain until being overcome. The subsequent impairment of mobility on the part of the mosquito larva indicates a progressive paralysis induced by the attached mite which first affects the head and then gradually extends posteriorly.

Böttger's (1970) review of the feeding habits of water mites indicates that cladocerans are a common food source for *Piona* spp. with mayfly nymphs and chironomid larvae also serving as prey. The extent to which various *Piona* spp. prey on mosquito and other nematoceran larvae remains to be established.

A single case of an adult *Hydryphantes ruber* female preying on a IV-instar *Aedes stimulans* larva was observed in the laboratory. The mosquito larva was already weakened from unknown causes when the mite seized it and pierced the eighth abdominal segment just anterior to the comb scales. The larva exhibited little resistance as the mite proceeded to feed. Whether or not mosquito larvae represent a significant item in the diet of *H. ruber* under natural conditions is uncertain. Nothing else, however, is known concerning the feeding habits of this mite (Böttger, 1966).

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