Tactics of Host Exploitation by a Thermophilic Water Mite

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The water mites are an ecological assemblage of organisms from several independent evolutionary lines. Each line, however, is thought to be derived from some terrestrial trombidiid ancestor; thus all lines began with the basic trombidiid life cycle in common. Eggs hatch into six-legged, parasitic larvae. After engorgement on a host, the larvae detach and enter a dormant stage called the nymphochrysalis, which incorporates the protonymph. The deutonymph is the only active nymphal stage, and is called the nymph. Nymphs enter another transformation stage, the teliochrysalis, which incorporates the tritonymph, and emerge as adults. Adults and nymphs are free-living.

In his analysis of water mite evolution Mitchell (1957) suggested that progressive alterations of the primitive host-parasite relationship have led to the diversity of water mite life cycles seen today. These alterations involved either an increase in the number of developmental stages spent on the host, or a progressive suppression of the parasitic stages until, ultimately, free-living nymphs hatch from the eggs. Identifying 4 major evolutionary lines on the basis of larval and adult characters, Mitchell noted that the same kinds of life cycle alterations have occurred independently in different lines. This convergence suggests that certain ecological problems in mite-host relations impose similar selective pressures on mite varying widely in morphology and behavior. Identification of such powerful evolutionary forces is of interest, but progress has been hindered by problems in studying the highly mobile free-living aquatic stages and the difficulty of assessing the problems larvae have in finding hosts. Consequently, most investigations have relied on inferences from data on parasitic loads on hosts (for example, Efford 1963, Mitchell 1969). Studies of a water mite from hot springs, to be presented here, allow more direct identification of the variables important in determining the life history parameters of parasitic mites.

THE ORGANISMS

Hosts of the mite considered here are brine flies (Diptera, Ephydridae) which feed on the algal-bacterial mat in the effluent channels of alkaline hot springs in Yellowstone National Park. Their exploitation of the mat is part of a cyclic pattern of mate destruction and regrowth in any one location. When the mat is young and thin it cannot be exploited by flies because it is covered by hot water. As it grows thicker it diverts the water flow until it becomes exposed to the air and cools to temperatures below 40°C. Adult flies rapidly invade newly exposed areas to feed and lay eggs. Their activity in a given patch lasts only a few days because newly-hatched fly larvae convert the algae into a stagnant soup that is unattractive to adults. The larval feeding weakens the mat that diverts the water flow, and eventually hot water flows back into the area, washing out debris, killing the unemerged fly larvae, and allowing resumption of algal growth (see Wiegert and Mitchell 1973, for further details). A spring outflow consists of many small patches of algae in different stages of this cycle. Adult flies are constantly shifting their activity as new patches of algae become available and old ones fade out.

Adults of the mite *Partnuniella thermalis* Viets (Protziidae, Hydrachnellae) feed primarily on the eggs of the host springs brine flies. The adult mites lay eggs in the algal-bacterial mat or the silaceous gravel beneath it in the effluent channels. Larvae hatch 11–20 days later, move through the air-water interface, and wait on islands of algae for their adult brine fly hosts. If a fly walks over a larva, the mite jumps onto the fly's body. If the mite is not removed by fly grooming, it attaches, feeds, and remains in place until the host dies. It then detaches, reenters the water, and begins the nymphochrysalis stage. After emergence the nymphs, like the adults, feed primarily on brine fly eggs.

The pattern in space of resources for both parasitic and free-living stages of the mite will be a mosaic of high and low density patches with few patches of intermediate density. A sedentary mite in a given patch would experience inputs of resources interspersed with long periods of very low resource density. To the degree that the mites can search more than one patch or store energy from one period of abundance to the next, they can convert this discontinuous resource into the continuous one necessary for survival. *Partnuniella* has evidently achieved this end while retaining the primitive trombidiid-like association with its host. Other members of its evolutionary line (Mitchell's thyasid line) have extended the parasitic association with the host through the nymphochrysalis and into the nymphal stage. Still others have evolved non-parasitic larvae. I will attempt to explain why neither of these alternatives would be successful in the hot spring environment and to point out some of the ecological factors which help to influence the behavior and longevity of adult and larval water mites.

METHODS

The problems in the mite life cycle were initially identified by construction of a survivorship curve for a field population. Data were obtained by har-