Preliminary Studies of a Strain of the Waterhyacinth Mite[1] from Argentina [2]

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Abstract

The mite Orthogalumna terebrantis Wallwork is a promising biological control agent of waterhyacinth, Eichhornia crassipes (Mart.) Solms, because the immature forms produce major damage to the weed by mining the leaves parallel to the laminae. Field populations emanating from a few overwintering adults reach high levels with the advent of hot summer weather. Populations of the mite exist in Argentina and in Florida, but the differences in the feeding behavior of the 2 strains indicate that the Argentine strain might be useful in the United States. Field and laboratory studies were therefore made in Argentina to determine the population dynamics and biology of the mite; also, tests were made with 17 species of plants to determin the feeding specificity of the Argentine strain to waterhyacinth. The Argentine strain was found only on waterhyacinth.

Waterhyacinth, Eichhornia crassipes (Mart.) Solms, is among the most troublesome weeds of the world. Since it is a free-floating aquatic plant, it can block waterways and irrigation canals, can completely cover lakes and reservoirs, and can even invade rice paddies. Where its population is dense, the plant also increases water loss through evapotranspiration. In the United States, waterhyacinth occurs mostly in the southeast from Texas to Florida, where it is a serious problem. Herbicides (e.g., 2,4-D) can kill it, but regrowth is so rapid and chemicals so expensive that biological means of control are desirable.

The plant originated somewhere in South America (Bock 1966); thus, the biological control agents specific to the weed would be most likely to occur there. A. Silveira Guido[4] therefore investigated the interesting arthropods found attacking the plant in Uruguay and made the first study of the waterhyacinth mite, Orthogalumna terebrantis Wallwork (1965). After his initial observations, the USDA Biological Control of Weeds Laboratory in Hurlingham, Argentina began more detailed studies. Meanwhile, Dr. Fred D. Bennett of the Commonwealth Institute of Biological Control, Trinidad, discovered the same species of mite on waterhyacinth in Florida (Bennett 1970). However, studies revealed at least two obvious differences in the feeding behavior of the two strains. The Florida strain feeds on pickerelweed, Pontederia cordata L. (Gordon and Coulson 1971); the Argentine strain has been found to feed only on waterhyacinth. Also, the feeding galleries (larval mines made parallel to the leaf laminae) formed by the Florida strain were somewhat more concentrated than those of the Argentine strain; However, this concentration did not produce any notable increase in the damage caused by the Florida strain. The studies subsequently conducted at the laboratory in Argentina between 1968 and 1971 of the population dynamics, biology, and behavior of the Argentine strain are reported here. Also, an investigation was made of the damage produced and the specifity of the mite to waterhyacinth so a decision could be made concerning the desirability of introducing this strain of the mite into the population already present in Florida.

Field Population Studies

Field populations of the mite were studied in Tigre, Campana, and Santa Fe, Argentina. The adult mites were found throughout the year, but during cooler weather, the numbers diminish, and the few that do survive feed only slightly until optimum high summer temperatures recur. When these temperatures are reached, the populations increase at such a rapid rate that few leaves remain unattacked in a lake full of plants. This eruption can take place in as little as three weeks when conditions are optimum, even when the initial number of adults is extremely small. A heavily attacked waterhyacinth leaf has 25 to 50 feeding tunnels in an 2-cm^2 area of leaf, that is, 250-500 tunnels per leaf.

Thus, a square meter of waterhyacinth in a lake area could bear 20,000 or more mites, both adults and immature forms, within a month after reproduction begins.

The damage is usually done to all but the new leaves. The older, larger leaves average more than 500 tunnels per leaf and usually become brown and dried after such an attack because of the dehydrating effect of the sun on the mite galleries. Mite damage can usually be discerned at a distance by the appearance of these older, dead, brown leaves.

The Florida strain of mites apparently tends to restrict itself to shady areas where waterhyacinth grows (Gordon and Coulson 1971). This is not the case in Argentina; plants are equally heavily attacked in sun or shade. However, the plants in sunlight deteriorate much more rapidly, and the immature forms are therefore trapped and killed inside the leaves as the tunnels dry.

Biology

The adults O. terebrantis oviposit in separate laminae as they move across a leaf; an egg is inserted every fourth or so lamina. Generally, the larval mites begin tunneling apically, but sometimes they tunnel towards the petiole (counts indicated 2 to 7 apically-directed tunnels for each tunnel directed toward the petiole). The tunnels reach an average length of 5 mm before the adult emerges. This development from the egg to adult requires about 10 days. Once the adult emerges, it may feed at a spot where the plant has been injured, or it may again enter a tunnel to feed. Indeed, adults were often found feeding individually or in small groups in a sunken feeding scar caused by insect enemies of E. crassipes. However, the greatest damage to waterhyacinth is caused by the tunneling of the immature mites since the number they form far surpasses the number formed by adults alone, so much so, that the number of adult tunnels is negligible in comparison. Dissection of the tunnels of four leaves, and counts of the stages inside during a heavy midsummer attack in 1969-70 revealed a ratio of 1 adult to 5 nymphs to 10 larvae. Thus, most tunnels are occupied by a single larva or nymph. Also, most adults disperse after emerging from their tunnels. The abandoned tunnels can be spotted easily since the tunnel ends in a large adult emergence hole which is easily seen when a leaf is held to the light. Likewise, the tunnels with developing larvae and numphs or an unemerged adult can be recognized by the absence of an emergence hole. In an inhabited tunnel, the developing immature form or adult will be found at the outer end of the tunnel. These numerous aging tunnels amplify many times the drying effect of the sun and thus cause the death of the older leaves of waterhyacinth.

Orthogalumna terebrantis exhibits no sexual dimorphism, which makes mating studies difficult. However, an investigator can combine two randomly chosen virgin mites in a clamp cage (obtained by selecting unemerged mites from the tunnels) and achieve some success in such studies. Also, the number of generations a year is difficult to determine because of the rapid reproductive rate, but it is definitely dependent on the number of days of high temperature in the field.

In Argentina, no natural enemies of the waterhyacinth mite other than general predators, for example, predaceous mites, were found. Summertime adult mortality is high, but the population diminishes only little because the high reproductive rate offsets this mortality. The heat of the sun seems to be the major cause of death: adult mites exposed to high temperatures and sunlight outside the tunnels or exposed to artificial light in the laboratory succumbed within a day in the absence of moisture.

Overwintering occurs in the adult stage and often lasts from May to January in the Buenos Aires area of Argentina.

Laboratory Host Specificity Testing

Testing in Hurlingham for specificity to waterhyacinth was conducted with the plant species listed in Table 1.

The tests were made inside the laboratory at average daily temperatures ranging from 25 to 32° C. The mites were confined on a test plant in a cage constructed from a wooden, spring-type clothespin, as follows. The two clothespin halves were separated. Then a 1/4-in. hole was drilled in one, and the hole was sealed to the outside by gluing on half a gelatin capsule. Then the clamping surfaces of the clothespin were trimmed down and lined with felt, and the clothespin was reassembled. Twenty field-collected, active adult mites could be placed in each capsule. Then the clothespin was clamped to the test plant, and observations were made over a period of 11 days.

The only plant attacked by the Argentine strain of the mite during these tests (three tiny feeding nicks were made on *Lactuca sativa*) was *E. crassipes*. This negligible damage to *L. sativa* was not surprising because of its fleshy, aqueous nature, but the lack of damage to *P. cordata* and *E. azurea* was surprising. In Florida, observations in the field established that *Pontederia* was attacked by the Florida strain and even appeared to be preferred over *E. crassipes* in some areas (Gordon and Coulson 1971).

Subsequently, field observations of *P. cordata* and *E. azurea* were made to substantiate the results of the laboratory tests. Thus, a dozen of each ~~species of~~ plant was placed in the laboratory garden pool among *E. crassipes* ~~that~~ were heavily infested with *O. terebrantis*. However, during the remainder of the summer, no mite damage was observed on either *P. cordata* or *E. azurea*. In addition, plants of *E. azurea* observed growing among a thick fringe of *E. crassipes* along the border of a lake in Campagna, Argentina were undamaged despite a heavy infestation of the mite on the waterhyacinth. Also, a large stand of *P. cordata* that occurred along a river near the lake and about 50 yards from the infested waterhyacinth bore no evidence of mite damage (the mite could easily have been transported this short distance by wind). Thus, the absence of damage in Argentina to plants of the family Pontederiaceae other than *E. crassipes* seems to be confirmed.

From the results of the preliminary tests, the Argentine strain of *O. terebrantis* is a candidate for introduction into the United States as a biological control agent for waterhyacinth. However, before the introduction can take place, more evidence is needed to show that there would be some benefit from its introduction, or, perhaps, that the Florida and Argentine strains are two rather than one species. The mites from Florida and from Argentina have been identified by entomologists in the United States and Argentina as belonging to the same species, but cross-breeding experiments with mites from the two populations are needed and are planned to verify this. Thus, a population of the Florida strain has recently been introduced into quarantine in Argentina and will be used for both cross-mating and comparative specificity studies.

Table 1. Test plants used in host-specificity studies of *Orthogalumna terebrantis* in Argentina.

Pontederiaceae	Amaranthaceae
Eichhornia crassipes (Mart.) Solms (control)	*Alternanthera bettzickiana* (Reg.) Standl.
Eichhornia azurea (Sw.) Kunth	*Alternanthera philoxeroides* (Mart.) Griseb.
Pontederia cordata L.	*Iresine herbstii* Hook.
Commelinaceae	Onagraceae
Tradescantia crassifolia Cav.	*Ludwigia repens* Forst.
Commelina coelestis Willd.	Cruciferae
Commelina virginica L.	*Nasturtium officinale* R. Br.
Zebrina pendula Schnizl.	Compositae
Liliaceae	*Lactuca sativa* L.
Agapanthus africanus (L.) Hoffm.	Gramineae
Allium sativum L.	*Saccharum officinarum* L.
Bromeliaceae	
Ananas comosus (L.) Merr.	

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Footnotes

1/ *Orthogalumna terebrantis* Wallwork; Acari; Cryptostigmata: Galumnidae

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4/ Silveira Guido, A. 1965. Natural enemies of weed plants. Final report (unpublished report, Department Sanidad Vegetal, Univ. de La Republic, Montevideo, Uruguay).