sunfish fry had been utilized as food were separated in pairs, and one green sunfish was offered to each pair of hybrid carp. Fry in two aquaria were consumed on three consecutive days. Further separation and feeding trials led to the conclusion that only two hybrid carp were utilizing green sunfish fry. This represents only 11% of the total number of hybrid carp which were originally included in the study. The hybrid carp which had taken the green sunfish fry did not feed on fry when hydrilla was placed in an aquarium containing the hybrid carp and 25 green sunfish fry. After 1 wk, the hydrilla had been eaten and all fry were still alive. Although some hybrid carp utilized animal tissues when present as the only source of food, plants were preferred when both plants and animals were offered at the same time.

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LITERATURE CITED

1. Avault, J. W. 1965. Preliminary studies with grass carp for aquatic weed control. Prog. Fish-Cult. 27:207-209.
2. Bailey, W. M. and R. L. Boyd. 1971. A preliminary report on spawning and rearing of grass carp (*Ctenopharyngodon idella*) in Arkansas. *In*: Tech. Rept. on Herbivorous Fish for Aquatic Plant Control. Appendix C. Interagency Res. Adv. Comm. Aquatic Plant Control Prog., Dept. of the Army. 16 pp.
3. Correll, D. S. and H. B. Correll. 1972. Aquatic and wetland plants of the southwestern United States. U. S. Gov't Print. Off., Washington, D. C. 1777 pp.
4. Doroshev, S. I. 1963. The survival of the white amur and tolstobik fry in Sea of Azor and Aral Sea water of varying salinity. p. 144-149. *In*: Symp. Probl. Fish. Exploit. of Plant Eating Fishes in the Water Bodies of the U.S.S.R. Ashkhabad Acad. Sci. Turkmen U.S.S.R.
5. Greenfield, D. W. 1970. An evaluation of the advisability of the release of the grass carp (*Ctenopharyngodon idella*) into the natural waters of the United States. Dept. of Biol. Sci., Northern University, DeKalb, Ill. 11 pp.
6. Grizzell, R. A. Jr. and W. W. Neely. 1962. Biological controls for water-weeds. Trans. N. Amer. Wildl. Conf. 27:107-113.
7. Penzes, G. and I. Tolg. 1966. Study of the growth and feeding of grass carp (*Ctenopharyngodon idella*) in Hungary. Bull. fr. Piscia 39(233):70-76.
8. Shell, E. W. 1962. Herbivorous fish to control *Pithophora* sp. and other aquatic weeds in ponds. Weeds 10:326-327.
9. Sills, J. B. 1970. A review of herbivorous fish for weed control. Prog. Fish.-Cult. 32:158-161.
10. Steel, R. G. D. and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Company, Inc., New York, N. Y. 481 pp.
11. Swingle, H. S. 1957. Control of pondweeds by use of herbivorous fishes. Proc. So. Weed Conf. 10:11-17.

Determination Of The Feeding Mechanism Of The Waterhyacinth Mite[1,2]

E. S. DEL FOSSE, H. L. CROMROY and D. H. HABECK

Graduate Student, Department of Entomology and Nematology, Institute of Food and Agricultural Sciences, University of Florida, Gainesville 32611; and Professors, Department of Entomology and Nematology, IFAS, University of Florida, Gainesville.

ABSTRACT

The waterhyacinth mite (*Orthogalumna terebrantis* Wallwork) is often found feeding on waterhyacinth [*Eichhornia crassipes* (Mart.) Solms] in wounds created by other animals. A radioisotope, ^{134}Cs, was used to determine the relative feeding of this mite on injured and uninjured waterhyacinth. No difference in feeding by mites was noted between injured and uninjured waterhyacinth pseudolaminae after the first 2 weeks. It was determined that the mite can enter waterhyacinth with its mouthparts, although it will use any damage on the pseudolaminae for feeding initiation.

INTRODUCTION

The waterhyacinth mite is one of more than 70 species of arthropods that attack waterhyacinth (3). Although it has apparently been present in the United States and South America for many years, it was not described as a new species until 1965 (4). Its biology and specificity have been studied (3) as has its ovipositional specificity and feeding habits (1, 2). Cordo and De Loach (1) commented that waterhyacinth mite adults fed little or not at all on an unbroken surface of a waterhyacinth pseudolamina, but they could readily penetrate the pseudolaminae for oviposition.

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[1] Acarina: Galumnidae

[2] Cooperative research conducted in Gainesville by Agricultural Research Service, U.S. Department of Agriculture and the University of Florida, Gainesville, Florida. Approved as Journal Series No. 5733.

In assessing the potential value of any arthropod species for biological control of a plant, consideration must be given to the way feeding damage is inflicted upon the plant; i.e. its feeding mechanism. The purpose of these studies were to determine the characteristics of the feeding mechanism of the waterhyacinth mite.

METHODS AND MATERIALS

In the first series of experiments 50 μCi of Cesium-134 (specific activity 2mCi/0.5cc) were placed with a hypodermic syringe into plastic tubs containing 10 liters of tap water. Seven uninjured waterhyacinth plants, washed free of all arthropods and other invertebrates, were placed into each of the tubs. Tubs were placed into a chemical hood that was approved for isotope use.

Hairclip traps were designed to fit snugly around a pseudolamina, and confine an aliquot of mites. These traps consisted of two large hairclips (ca. 9 cm long) and two pieces of clear acetate (3.5 by 4.0 cm) covered on one side by felt. One piece of felt had a window (1.75 by 2.0 cm) cut out of it for viewing the mites.

Traps containing ten mites each were placed on washed pseudolaminae of seven injured waterhyacinth and seven uninjured plants. Injured pseudolaminae had a 1.5 cm incision made in the center of their dorsal surfaces. Traps containing mites were then positioned so that the window covered the incision, allowing easy observation of feeding activities. Approximately 200 ml of 0.5% Hoagland's solution were added to the water every 4 days. Light and heat were provided by five 100-watt incandescent bulbs, which were on ca. 12 hours per day. This normally resulted in temperatures from 26 to 32 C.

In later experiments a smaller approved hood had to be used, which would accommodate one 12-liter tub. Nine each of injured and uninjured waterhyacinths were used, and 70 mites per trap were placed on each plant.

A ^{134}Cs trap was designed to remove ^{134}Cs from the air. A fan pulled the ^{134}Cs-laden air out of the hood and forced it through 1.77 cm diameter Tygon® tubing into a 0.95-liter glass jar containing 0.1N HCl. The ^{134}Cs combined with Cl, forming a precipitate, ^{134}CsCl. Air free of ^{134}Cs was then returned to the hood.

Radioactivity of pseudolaminae, mites, and background radiation were taken every 7 days during the experimental period. A pseudolamina-trap unit was removed for both injured and uninjured plants per sampling day. The pseudolaminae and mites were then placed into a Geiger-Meuller Counter and the radioactivity determined. The samples were then removed and washed with 0.1N Na_2HPO_4 buffer solution to remove the adhered ^{134}Cs. The radioactivity was determined again for mites and pseudolaminae, with all measurements converted to counts per minute (cpm).

In addition, the morphological adequacy of the mite to enter the plant was unknown, so scanning electron microscope micrographs were taken of the mouthparts of the waterhyacinth mite.

RESULTS AND DISCUSSION

Background counts were generally higher at the beginning of the sampling day than at the end. This indicates that little or no ^{134}Cs was deposited on the interior of the counter during the measurements of radiation on mites, pseudolaminae, or traps.

The amount of ^{134}Cs present in the pseudolaminae of the injured and uninjured plants was essentially equal (Figure 1). The injured plants had a slightly higher level of ^{134}Cs than did the uninjured plants, but the amount picked up by the mites was not correlated with this difference, so it was disregarded.

The amount of ^{134}Cs present in the waterhyacinth mites after feeding was higher initially with injured than with uninjured waterhyacinth plants (Figure 2). This was due to easier and faster entrance into the plant by mites when injury was present. A week later the trend reversed, possibly due to a combination of penetration and feeding by the waterhyacinth mite on uninjured plants, and desiccation of the tissue around the wound on injured plants. From 1 to 5 weeks after the start of the experiment, the amount of ^{134}Cs ingested by the waterhyacinth mite was approximately equal on both groups of plants, indicating comparable levels of feeding by mites on both classes of plants. At the 5th week, a rise in ^{134}Cs ingested by the mites was observed. This may be due to increased feeding by both groups of mites.

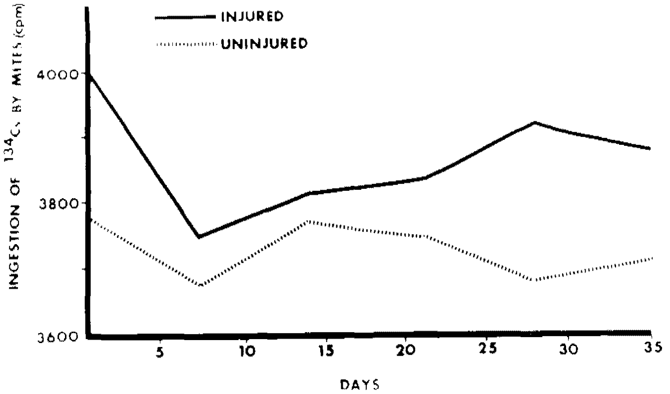

Figure 1. Amount of ^{134}Cs in Injured and Uninjured Waterhyacinth Pseudolaminae.

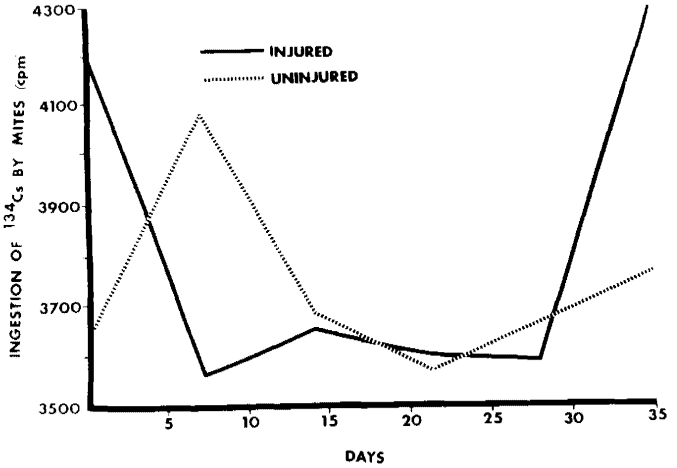

Figure 2. Feeding of the Waterhyacinth Mite on Injured and Uninjured Waterhyacinth Pseudolaminae Labelled with ^{134}Cs.

No difference was observed between the amount of ^{134}Cs ingested by mites on injured and uninjured plants. Likewise, computer-fitted regression lines showed no statistical difference in feeding capabilities. The level of feeding was initially high on injured plants, decreased slightly, then increased again (Figure 3). The sigmoid curve in Figure 3 shows the trend described above for uninjured plants. Both regression analyses and analyses of variance also indicated no difference in the amount of ^{134}Cs ingested by mites on injured and uninjured plants.

Scanning electron microscope micrographs were taken of the morphology of the waterhyacinth mite to show the position of the gnathosoma and other mouthparts (Figure 4a-c). Rutella are quite heavily armed (Figure 4c) and can penetrate waterhyacinth tissue.

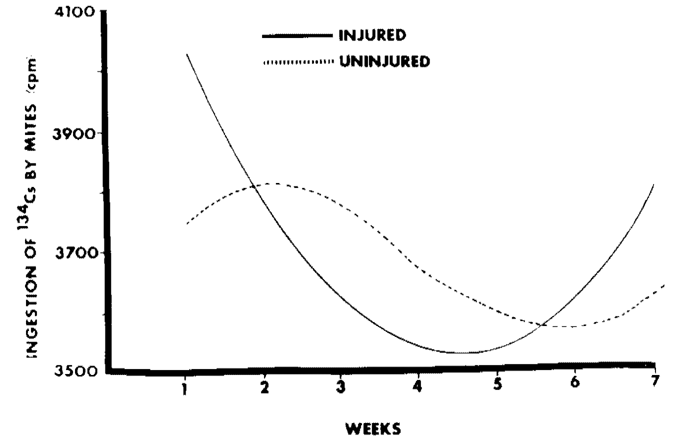

Figure 3. Computer-fitted Regression Lines of the Feeding Response of the Waterhyacinth Mite on Injured and Uninjured Waterhyacinth Pseudolaminae Labelled with ^{134}Cs.

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LITERATURE CITED

1. Cordo, H. and C. J. De Loach. 1975. Ensayo de especificidad de hospedero del acaro *Orthogalumna terebrantis* Wallwork, con notas sobre su Biologia. Soc. Entomol. Argentina. (In press).
2. Perkins, B. David. 1973. Preliminary studies on a strain of the waterhyacinth mite. Proc. II Int. Symp. Biol. Contr. Weeds. 179-84.
3. Perkins, B. David. 1974. Arthropods that stress waterhyacinth. Pans 20(3):304-14.
4. Wallwork, J. A. 1965. A leaf-boring Galumnid mite (Acari: Cryptostigmata) from Uruguay. Acarologia 7: 758-64.

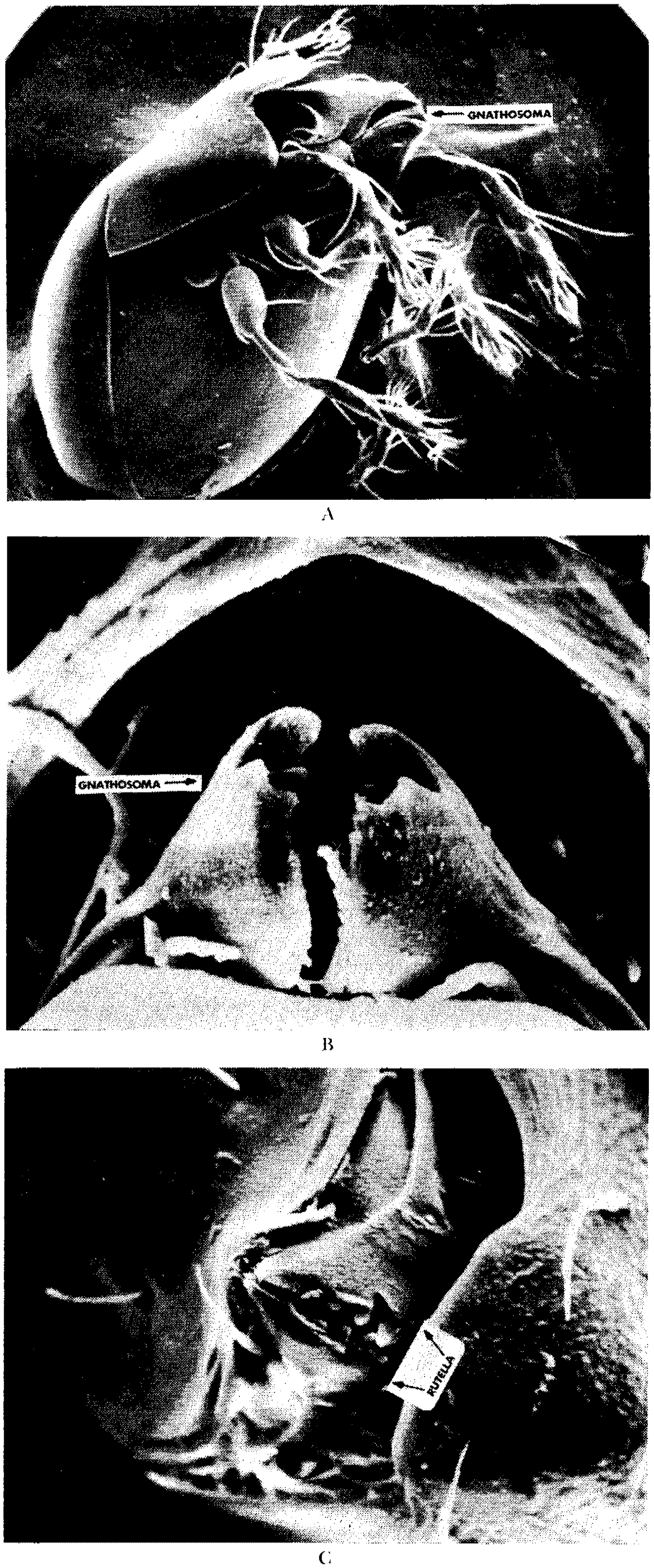

Figure 4. Scanning Electron Microscope Micrographs of the Waterhyacinth Mite Showing (a) Position of Gnathosoma in Lateral View of the Mite (142 X), (b) Frontal View of Gnathosoma (2000 X), and (c) Frontal View of Rutella (960 X).