BIOLOGICAL STUDIES ON *MACROSEIUS BISCUTATUS* (ACARINA:PHYTOSEIIDAE)[1, 2]

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INTRODUCTION

Macroseius biscutatus Chant, Denmark, and Baker (1959) was described from males, females, and immatures taken from pitcher plant leaf cups, *Sarracenia* sp., in Alachua County by R. E. Woodruff and H. A. Denmark. A new subfamily and genus were erected for the species because of its large size, divided dorsal scutum, and five pairs of dorsal setae (excluding the vertical and clunal setae). The unique characteristics of this mite have been recognized by Chant (1959), Muma (1961, 1963), Wainstein (1962), Pritchard and Baker (1962), and Schuster and Pritchard (1963) in maintaining for it a separate subfamily or tribe. Chant (1965), however, expanded and reevaluated the family and synonymized the subfamily and tribe within the Phytoseiinae.

Since all workers prior to Chant (1965) considered the species to be morphologically distinctive, the present authors initiated biological studies in late 1961 to determine whether the species was biologically distinct. Special attention was directed toward determination of its ecological requirements, life cycle, and food habits.

METHODS

Since *M. biscutatus* lives inside of the leaf cups of *Sarracenia minor* Walt. (Fig. 1) where it cannot be observed, most of the studies were conducted in the laboratory. Leaf cups (Fig. 2) were collected at several locations, placed in paper or plastic sacks, and maintained in an upright position during transportation and storage. The leaf cups were cut open after refrigeration for varying lengths of time, and the number, location, and activity of the mites recorded. The mites were then removed and isolated singly or in groups in shell vials, test tubes, stender dishes, syracuse dishes, petri dishes, glass tubings plugged with cotton and plaster of paris, or glass reconstructions of leaf cups. Substrates included leaf pieces, insect fragments collected from leaf cups, frass of the pitcher plant infesting noctuid, *Exyra semicrocea* (Gn.), white plaster of paris, plaster of paris mixed with charcoal, agar, blotting paper, and filter paper. Offered foods included clean leaf cup pieces, untreated and autoclaved insect fragments and noctuid frass, miscellaneous living, injured, or dead collembola from leaf cups, agar reared collembola, collembola and mushrooms, *Anoetus hughesi* Hunter and Hunter from leaf cups, undetermined Acaridae, *Panagrolaimus* sp. from leaf cups, *Panagrellus redivivus* (Linné), rotting potatoes, undetermined fungus cultures on agar, and clean agar.

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All laboratory observations, tests, and rearings were conducted at room temperatures that ranged from 75° F to 85° F. Humidities during feeding and life cycle studies were maintained at near saturation levels by regular addition of water to the isolation cages. In a few instances, cages were allowed to dry out in order to test survival of mites under low humidities.

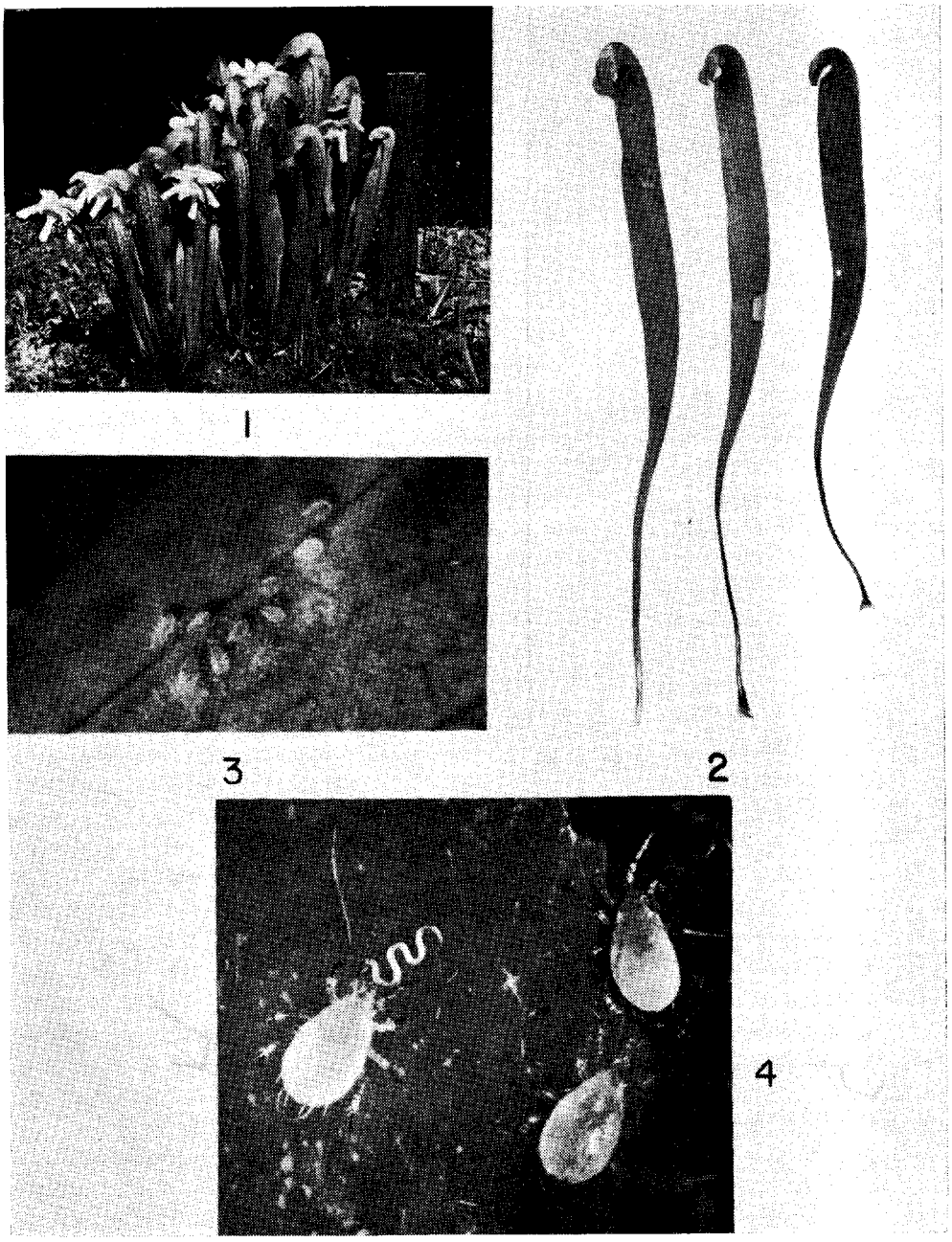

PLATE LEGEND

Fig. 1. Large plant of *Sarracenia minor* Walt. Fig. 2. Leaf cups of *S. minor*, one-half life size. Fig. 3. Cluster of *Macroseius biscutatus* Chant, Denmark, and Baker on inside surface of leaf cup, 24X. Fig. 4. Female *M. biscutatus* and *Panagrellus redivivus* (L.), 54X.

Ecological Requirements

M. biscutatus has been collected from Florida, Georgia, and North Carolina. In Florida, it has been recorded from Alachua, Baker, Osceola, Polk, and Putnam Counties. Its distribution probably coincides with that of *Sarracenia minor* Walt. No *Sarracenia purpurescens* Linné or *Sarracenia flava* Linné were examined during the study.

With the exception of a single male found on asparagus fern, *Asparagus plumosus* Baker, by C. R. Roberts, 14 February 1966 at Fern Park, Florida, all specimens have been taken from the inside of pitcher plant leaf cups. Several samples of ground litter around and between pitcher plants have produced no specimens. Beating of grasses and bushes in pitcher plant localities has also failed to produce specimens. Hibernation and mite migration were not observed during this study, but mites obviously must survive winter conditions when plant foliage is killed. The mites probably move from plant-to-plant during the spring and summer, perhaps by some form of phoresy.

The mites on which the original description was based were collected from leaf cups infested with *E. semicrocea* larvae and seemed to be associated with the larval frass. In recent collections populations varied from 1 to 20 individuals per leaf cup. Although mites were found in clean cups, insect-filled cups, noctuid-injured cups, and anoetid-infested cups, large clusters (Fig. 3) were found primarily in insect-filled cups. No mites were found in dead cups or in living cups from which the hood had been removed by insect injury, livestock grazing, or mowing.

The mites apparently remain active during all seasons of the year in Florida. Collections have been made in every month except August, and this lack is one of omission rather than failure to collect. Abundance of the mites at any given location apparently is governed more by leaf cup condition than by season as is shown in Table 1.

Life Cycle

The life cycle of *M. biscutatus* was obtained by using the nematodes, *Panagrolaimus* sp. and *Panagrellus redivivus* (Linné), as food. Mites did not complete a life cycle on any of the other offered foods except the scavenger mite, *Anoetus hughesi* Hunter and Hunter. When nematodes were used as food, mite reproduction, development, and population increases were obtained in test tubes, stender dishes, and petri dishes. Table 2 represents a summary of data with three series of mites.

Eggs were of the typical obovate phytoseiid form. In the laboratory, they were most frequently laid on the sides of the tubes or dishes. They were found on the sides of the leaf cups under natural conditions. Eggs usually hatched in 2 to 6 days.

Larvae for the most part did not feed, but an occasional specimen was observed feeding on immature nematodes. Larvae usually completed development in less than one day.

Pronymphs and deutonymphs moved around and fed in the same deliberate manner as adults. Nymphs usually completed development in 6 to 12 days.

Adults walked slowly and deliberately over the various substrates,

TABLE 1.—RELATIVE ABUNDANCE OF *Macroseius biscutatus* CHANT, DENMARK, AND BAKER IN *Sarracenia* LEAF CUPS AT THREE LOCATIONS, TWO IN POLK COUNTY AND ONE IN ALACHUA COUNTY, FLORIDA BETWEEN JANUARY AND DECEMBER 1966.

Locality	Date	No. cups	No. mites	Condition of leaf cups
Polk City	1/12/66	10	0	Most young and clean
	2/21/66	10	25	All insect-filled
	3/22/66	10	46	All insect-filled
	5/17/66	10	7	5 damaged, 5 insect-filled
	6/16/66	10	5	5 damaged, 5 young
	7/25/66	10	58	Most insect-filled
11 miles north of Polk City	1/12/66	10	9	Most damaged or dead
	2/21/66	10	31	Most insect-filled
	3/22/66	10	0	All damaged
	5/17/66	10	30	Most insect-filled
	6/16/66	10	42	Most insect-filled
	7/25/66	10	0	All young and clean
Orange Heights, Alachua County	1/23/66	10	27	All damaged—partially insect filled
	2/16/66	10	32	All damaged—partially insect filled
	3/20/66	10	41	7 damaged, 3 young and clean, 2 damaged, insect-filled
	4/24/66	10	68	8 young and partially insect-filled
	5/18/66	10	100+	All almost mature, insect-filled
	6/20/66	10	100+	All mature, insect-filled
	7/24/66	10	100+	All mature, insect-filled
	9/18/66	10	100+	All mature, insect-filled, 3 damaged
	10/22/66	10	62	All damaged, insect-filled
	11/24/66	10	46	All damaged, insect-filled
	12/17/66	10	34	All damaged, partially insect-filled

picked up nematodes in their chelicerae, and fed readily (Fig. 4). When two or more adults were isolated together, they usually remained in a group except when feeding. Adults and nymphs also clustered together, but cannibalism of nymphs was occasionally observed. Adults were not

observed cannibalizing each other. Mating was accomplished in the usual phytoseiid manner with the male clinging to the venter of the female and with both oriented in the same direction. Females produced eggs 10 to 14 days after mating and survived from 14 to 126 days with a mean of 93 days. Unmated females produced no eggs, but unmated males and females survived from 72 to 93 days with a mean of 81 days.

Food Habits

Since Chant (1959), Chant and Fleschner (1960), McMurtry (1963), and others have demonstrated that some phytoseiid species can survive

TABLE 2.—Life cycle of three series of *Macroseius biscutatus* Chant, Denmark and Baker when fed two different nematodes.

Food Stage	Number mites	No. days to complete development			
		Minimum	Maximum	Mean	Mode
Panagrellus redivius (L.)	24				
Egg		4.00	10	6.00	6.00
Larva		0.75	1	0.86	0.75
Pronymph		4.00	7	5.10	5.00
Deutonymph		5.00	8	6.10	6.00
Totals		13.75	26	18.06	17.75
Panagrolaimus sp.	25				
Egg		2.00	3	2.40	2.00
Larva		0.75	1	0.86	0.75
Pronymph		3.00	5	4.00	4.00
Deutonymph		3.00	6	4.40	4.00
Totals		8.75	15	11.66	10.75
Panagrolaimus sp.	27				
Egg		2	6	4.3	4
Larva		1	6	1.7	1
Pronymph		3	5	3.5	3
Deutonymph		3	4	3.3	3
Totals		9	21	12.8	11

and reproduce on more than one kind of food, *M. biscutatus* was offered a wide variety of food materials that existed in its environmental niche and some that did not. Results of these feeding tests were evaluated using survival, reproduction, and development as criteria for food suitability. The results are presented in Table 3.

M. biscutatus apparently can survive for varying lengths of time up to 3 months on water and offered dead animal materials. However, among

TABLE 3.—SURVIVAL, REPRODUCTION, AND DEVELOPMENT OF *Macroseius biscutatus* CHANT, DENMARK AND BAKER WHEN FED VARIOUS KINDS OF FOOD.

Offered food*	No. mites	Days survival	Repro-duction	Development
Water	33	6-37	None	None
Leaf cups	24	5-61	None	None
Noctuid frass—in leaf cup	24	112	None	None
Noctuid frass—in test tube	15	13-90	None	None
Noctuid frass boiled —in test tube	15	13-90	None	None
Insect fragments	10	12-37	None after 3rd day	None beyond pronymph
Insect fragments	15	13-90	None	None
Insect fragments boiled	15	30-90	None after 3rd day	None beyond pronymph
Insect fragments auto-claved	10	10-40	None	None
Citrus litter	6	30-31	None after 3rd day	None beyond pronymph
Collembola	10	119-126	Limited	None beyond pronymph
Injured Collembola	17	3-35	Limited	None beyond pronymph
Collembola and insect fragments	10	37-40	Limited	None beyond pronymph
Collembola and mushrooms	24	119-126	Limited	None beyond pronymph
Agar reared Collembola	16	60-70	None	None
Unidentified acarids	10	40-86	None	None
Unidentified acarids	5	10-13	None after 3rd day	None beyond deutonymph
Anoetus hughesi H. & H.	20	11-104	Limited	A few adults produced
Anoetids and *Panagrolaimus*	18	36-101	Good	Many adults produced
Panagrellus redivivus (L.)	48	?	Good	Many adults produced
Panagrolaimus sp.	40?	?	Good	Many adults produced
Panagrolaimus sp.	10	14-101	Good	Many adults produced

*When an offered food appears twice in the table, both authors tested it.

all the food materials offered, it can reproduce only on collembola, anoetids, or nematodes, and it can complete development only on anoetids or nematodes. Present data indicate that of these two, nematodes are probably preferred.

Discussion

Biological data accumulated to date indicate that *M. biscutatus* is largely restricted to an ecological niche encompassed by the leaf cups of *S. minor*. Its abundance within the niche is limited by leaf cup condition, its life cycle is longer than that reported for other phytoseiids, and its preferred food is nematodes. Such is not the case, however, with most phytoseiids which are ubiquitous, limited in abundance by temperature and available food, have a short life cycle, and feed primarily on mites, pollen and honeydew.

Since *M. biscutatus* seems to be as distinctive biologically as it is morphologically, it would seem that its retention in the montotypic sub-family Macroseiinae Chant, Denmark, and Baker is justified.

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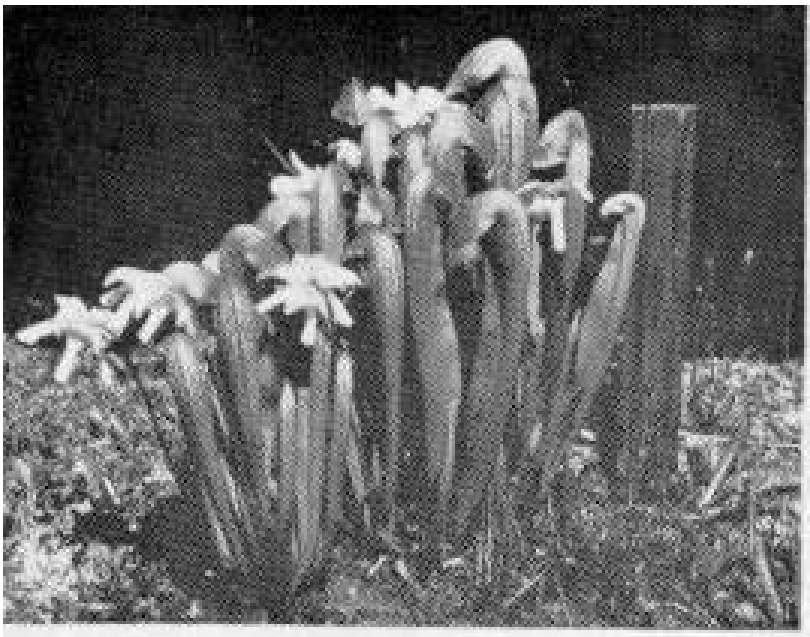

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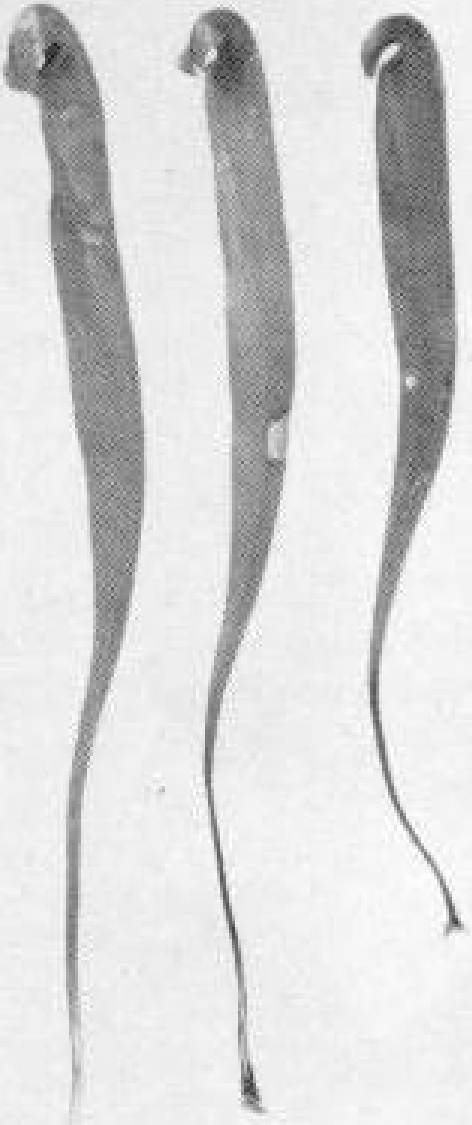

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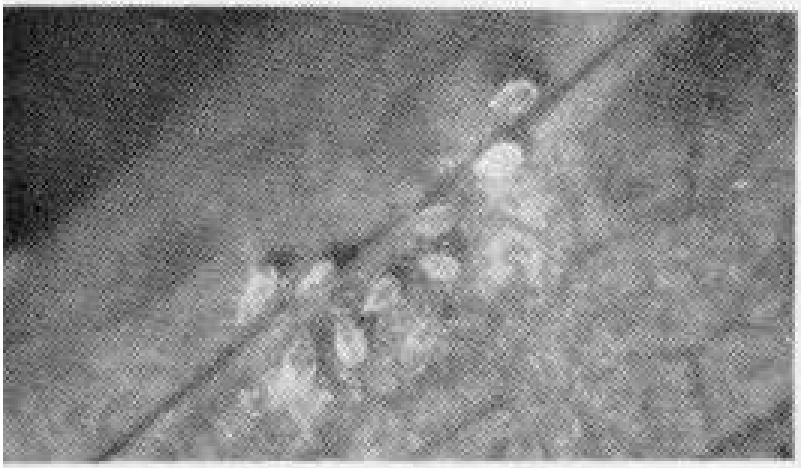

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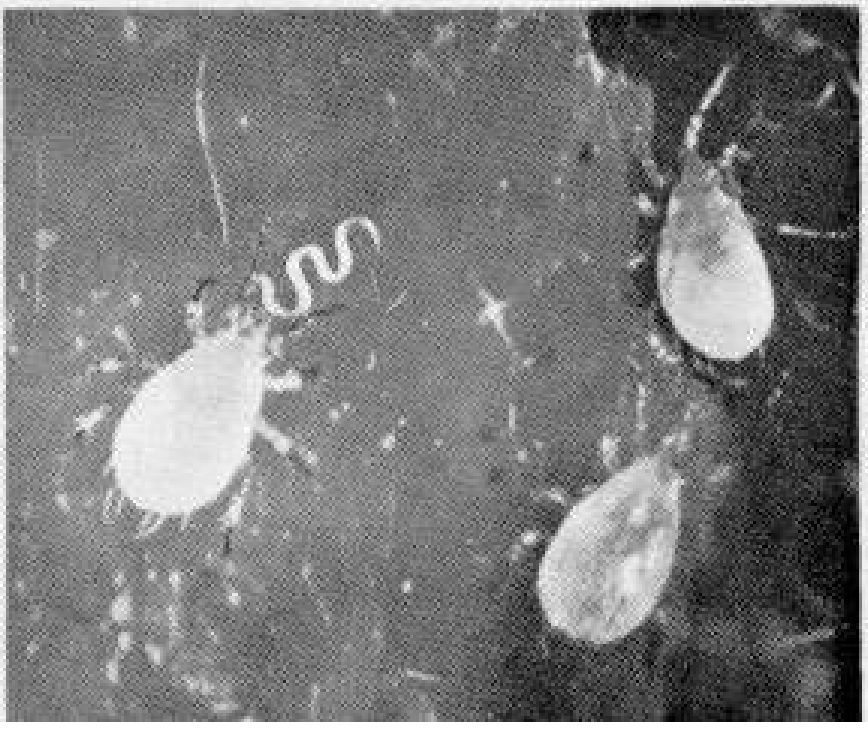

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