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A MID-SUMMER COMPARISON OF SIZES AND GROWTH RATES AMONG NYMPHS OF THREE SYMPATRIC MANTIDS (MANTODEA: MANTIDAE) IN TWO OLD-FIELD HABITATS

L. E. HURD AND R. M. EISENBERG

Ecology Program, School of Life Sciences, University of Delaware, Newark, Delaware 19716.

Abstract.—We compared three species of mantid nymphs in two field habitats (sites CHRY and AG), in two censuses during mid-summer 1986. *Tenodera sinensis* (Saussure) nymphs exhibited no difference between sites, either in size of nymphs, or in rate of maturation. Both *T. angustipennis* and *M. religiosa* were significantly larger in site CHRY than in site AG in August, although no such difference had been evident in July. More individuals of these two species had also matured in CHRY than in AG by the August census. These data suggest that *T. angustipennis* and *M. religiosa* were more food limited at site AG than at site CHRY during the time just prior to maturation. These results are consistent with the hypothesis that *Tenodera sinensis* is more of a habitat generalist than the other two species.

Key Words: Mantodea, Mantidae, *Tenodera, Mantis,* food limitation, sympatry, predators

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Mantids are generalist predators subject to food limitation which varies in importance during a growing season, as well as between habitats and years (Matsura et al. 1975, Hurd et al. 1978, Hurd and Eisenberg 1984, Eisenberg et al. 1981). Food limitations on newly hatched nymphs can retard development and decrease size of the imago, which in turn reduces fecundity (Eisenberg et al. 1981, Matsura and Marooka 1983, Hurd and Eisenberg 1984, Hurd and Rathet 1986). Therefore, comparing sizes of mantids collected at the same time from different habitats could provide a relative measure of the differences between habitats in terms of food limitation and fitness for a given species. We can then ask the same question of any number of mantid species found together in the same habitat to discern whether the resource level in a given field is qualitatively the same for each species.

Most ecological work on mantids has concentrated on a single species in a single habitat during either the first month of life or adulthood. Rathet and Hurd (1983) studied growth rates and habitat placement within a single field site, of nymphs of three species which commonly occur together in old fields in northern Delaware: *Tenodera sinensis* (Saussure), *T. angustipennis* (Saussure), *Mantis religiosa* (Linnaeus). These three morphologically similar species hatch at different times, differ in body size (*T. sinensis* > *T. angustipennis* > *M. religiosa*), and/or inhabit different levels of foliage within a field. These niche differences suggest to us that there may be differences in resource utilization among these species. In an exploratory study designed to detect both

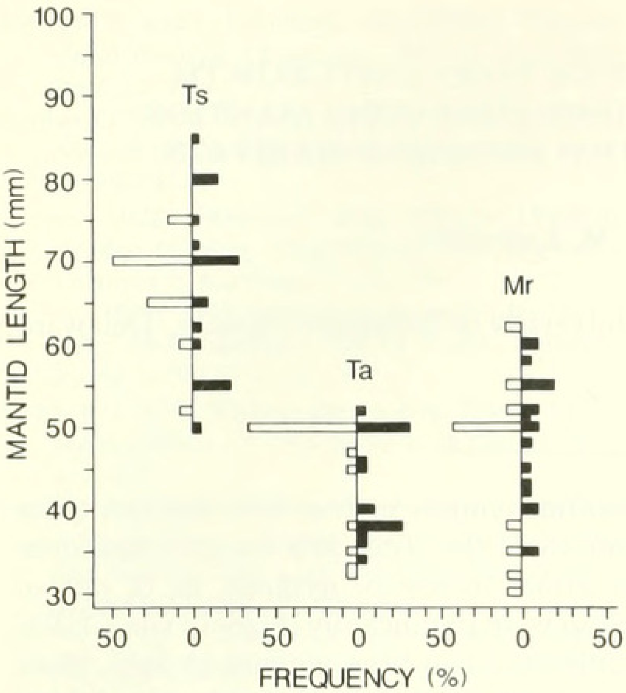

Fig. 1. Sizes of mantid nymphs in two habitats on 19 July 1986. Open bars represent frequency of nymphs of various sizes found at site AG; shaded bars are for site CHRY. Ts = *Tenodera sinensis*, Ta = *T. angustipennis*, Mr = *Mantis religiosa*. One-way ANOVA: $F = 24.945$; $df = 5, 72$; $P < 0.001$. LSD comparisons indicate *T. sinensis* is significantly larger than the other two species; no differences between sites.

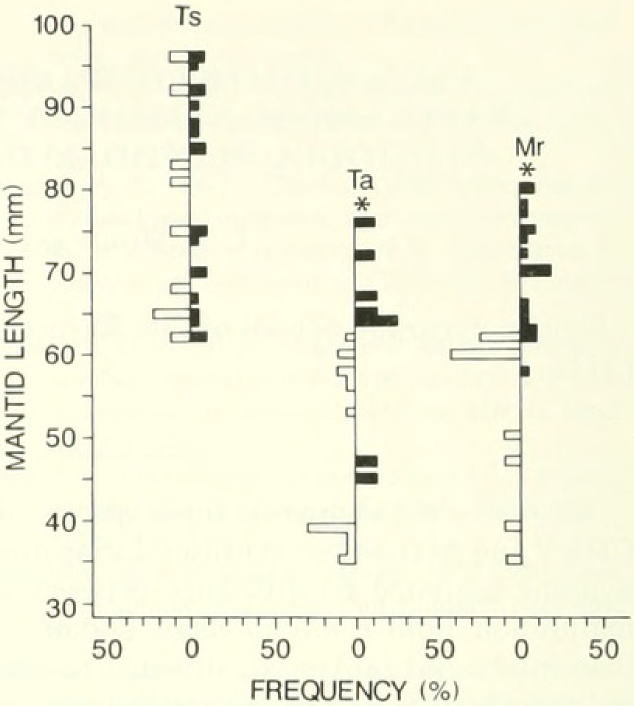

Fig. 2. Sizes of mantid nymphs in two habitats on 13 August 1986. Open bars represent frequency of nymphs of various sizes found at site AG; shaded bars are for site CHRY. Ts = *Tenodera sinensis*, Ta = *T. angustipennis*, Mr = *Mantis religiosa*. One-way ANOVA: $F = 25.714$; $df = 5, 84$; $P < 0.001$. LSD comparisons indicate *T. sinensis* is significantly larger than the other two species; site differences indicated by asterisks.

site and interspecific differences, we compared sizes and growth rates of these three mantid species in two old fields during the last nymphal stages.

Materials and Methods

The two old-field habitats in our study are in Newark, New Castle County, Delaware. They are approximately 3 km apart and have different vegetation. One field, site AG, is located on the experimental farm of the School of Agriculture, University of Delaware, and is dominated by a dense ground cover of timothy (*Phleum pratense*) and Canada bluegrass (*Poa compressa*) with patches of goldenrod (*Solidago* spp.) and thistle (*Cirsium* spp.). The other field, site CHRY, is adjacent to the Chrysler plant in Newark, and is dominated by goldenrod with a ground cover of grasses, chiefly timothy.

We censused mantids in both habitats on 19 July and 13 August 1986, which bracketed the last month of nymphal life for these species. Individuals were hand caught, identified, measured for length (front of head to tip of abdomen), and then released at the point of capture. Sex was recorded for those mantids which had matured by the second census. Lengths were compared among species and habitats on each census date with one-way ANOVA and least signifcant difference *post hoc* comparison using Statgraphics (STSC, version 2.1).

Results and Discussion

Tenodera sinensis nymphs were larger than the other two species at both sites in July (one-way ANOVA, $F = 24.945$; $df = 5, 72$; $P < 0.001$), and *M. religiosa* was not significantly different in size from *T. angustipennis* (Fig. 1). This interspecific difference was expected from earlier results

Table 1. Numbers of individuals, % adult and adult sex ratio for three mantid species in two habitats (AG and CHRY) in July and August of 1986. Mr = *Mantis religiosa*, Ts = *Tenodera sinensis*, Ta = *T. angustipennis*.

Species	Site	July *N*	August *N*	% Adult	M:F
M. religiosa	AG	12	12	75	7:2
	CHRY	20	20	100	10:10
T. angustipennis	AG	20	19	0	
	CHRY	23	8	25	2:0
T. sinensis	AG	15	9	56	1:4
	CHRY	26	22	59	7:6

(Rathet and Hurd 1983) and published size differences for adults (Gurney 1950, Helfer 1963). There were no differences in size between sites for any species at this time. Apparently, then, the sites did not differ in food limitation from egg hatch until mid-July. There were no adults of any species present in either field on 19 July.

The August census revealed a number of differences which were not apparent in July (Fig. 2). *Tenodera sinensis* was still significantly larger than the other two species at both sites (one-way ANOVA, F = 25.714; df = 5, 84; $P < 0.001$), and did not exhibit a difference between sites in size or percentage of adults (Table 1). However, both *M. religiosa* and *T. angustipennis* were significantly larger at site CHRY than at site AG (Fig. 2), and more had matured at site CHRY (Table 1). The size differences could not be attributed solely to a greater number of adults at CHRY because even the largest adults at AG were smaller than the largest adults at CHRY for both species. These data suggest that there was greater food limitation during the intervening month at site AG for these two species than at site CHRY. Some adult *M. religiosa* at CHRY were considerably larger (75–80 mm) than previously published records for this species (about 65 mm) (Gurney 1950, Helfer 1963). The sizes of the other two species (Fig. 2) were consistent with the literature.

Eisenberg et al. (1981) hypothesized that mantids could rely on insects which forage on late summer flowers (e.g. goldenrod) for a major portion of their prey when insect biomass declines in the rest of the field. Hurd (1989) found that adult female *T. sinensis* on flowers gained significantly more weight and deposited oothecae with more eggs (i.e. had greater fitness) than those on plants not in flower. We have found mostly *T. sinensis* on these flowers, which may explain why they apparently were not as food limited at site AG as the other two species. Thus, while all three species might rely on the same prey early in the season, *M. religiosa* and *T. angustipennis* could be better indicators of habitat quality in terms of resident arthropod prey availability than *T. sinensis* late in the season. A detailed examination of the diets of these species in the field is needed to test these ideas.

Acknowledgments

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PROC. ENTOMOL. SOC. WASH.
91(1), 1989, p. 54

NOTE

Ixodes downsi (Acari: Ixodidae) from Peru

Ixodes downsi Kohls was originally described from Aripo Cave, Trinidad, on the basis of a male, female, and three nymphs found on the wall of the cave, and one larva found on a bat, *Anoura g. geoffroyi* Gray in the cave (Kohls 1957. Proc. Entomol. Soc. Wash. 59: 257–264). On the basis of this scant information, Kohls (op. cit.) speculated that it might be a bat tick although he noted that oil birds, *Steatornis caripensis* Humboldt, nested in the cave and a large rat was also seen (in the cave). *I. downsi* has not been recorded since the original description.

We report a second locality for the species at a considerable distance from the type locality. An engorged female was collected from the throat of a young, fully feathered *S. caripensis* found on the floor of a cave near Tingo María, Department Huanuco, Peru, on 11 February 1975 by Baker. Bats were heard in the cave but none were seen and several unidentified parrots flew from the cave. This locality is approximately 2600 km southwest of the type locality, on the opposite side of South America. The finding of a specimen on an oil bird only confuses the issue as to whether *I. downsi* is a bat tick or a bird tick. There are no known species of *Ixodes* commonly found on both birds and bats, and additional collecting from hosts will be necessary before the true host relationships can be ascertained.

The length and width measurements of the engorged female from Peru, compared with those of the unengorged allotype female in parentheses, were 7.22 (2.53) mm and 4.07 (1.87) mm, respectively. In all other respects the Peruvian specimen agrees with the original description.

The specimen will be deposited in the Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Gainesville, Florida.

Nixon Wilson, *Department of Biology, University of Northern Iowa, Cedar Falls, Iowa 50614;* W. Wilson Baker, *Tall Timbers Research Station, Rt. 1, Box 678, Tallahassee, Florida 32312.*