Distribution of Predatory Insects in Ponds Stocked with Tilapia and *Macrobrachium rosenbergii*

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ABSTRACT

A study was conducted in three aquaculture ponds stocked with *Macrobrachium rosenbergii* and tilapia to identify the most conspicuous insect predators there and to observe some aspects of population dynamics regarding these insects. Two of the ponds had the additional characteristic of being infested with muskgrass (*Chara* sp.; *Chlorophyta*), a freshwater algae, while the third pond had no weed growth. Samples of insects were taken in the three ponds, and fourteen taxa were identified. The bare-bottomed pond contained abundant swimming predators (notonectids). The ponds with *Chara* were dominated by odonatan nymphs. A positive correlation was found between the weight of *Chara* and the abundance of predatory insects.

INTRODUCTION

Insects are among the most abundant predators in freshwater habitats. They have developed a huge number of adaptations to cope with their feeding habits. The most commonly found aquatic insect predators are members of the orders Coleoptera, Hempitera, and Odonata. Odonatan nymphs have varied predatory habits; some stalk the prey while others remain motionless until the prey comes within easy reach (Merrit and Cummins, 1978). Most odonatans hang from vascular plant structures or climb along underwater substrates such as aquatic weeds and rocks (Pennak, 1978). Many coleopterans, *e.g.*, the Dytiscidae, swim on the surface, and when they see an appropriate prey underwater, they dive to make the capture (Borror and Delong, 1973). Total numbers of predators in water bodies are usually relatively low (Needham and Westfall, 1975). Individual hemipterans are usually found in large numbers in aquatic environments, though the total number of species may not be so large (Borror and DeLong, 1973; Pennak, 1978).

Even though insect predators are conspicuous, the effects of these on shrimp populations in man-made ponds is one problem which remains to be studied thoroughly. There have been various reports concerning attacks by odonatan nymphs and aquatic hemipterans on shrimp (Pennak, 1978, Witzig *et al.*, 1980), and some preliminary work has been done on the population dynamics in shrimp ponds.

Two main objectives were established for this project:

1. The identification of the most common insect predators in man-made *Macrobrachium* ponds, with the exclusion of borrowers.
2. A simple analysis of population distribution.

MATERIALS AND METHODS

The Aquaculture Field Station, Department of Marine Sciences, University of Puerto Rico was the site of the experiment. Ponds B7, C7, and C8 had surface areas of 1200, 700 and 700 square meters, respectively. Average depths were 0.33 to 1.33 m for ponds B7 and C7, respectively, and 0.33 to 1.67 m for pond C8. Pond B7 was used as a broodstock pond for the freshwater shrimp *Macrobrachium rosenbergii*. On June 12, 1984, 641 females and 188 males of *M. rosenbergii* were stocked. Also, 125 *Tilapia nilotica* were stocked to control aquatic weed growth. On June 26, 1985, 2000 postlarvae were added to the pond. Ponds C7 and C8 were stocked with 1050 postlarvae on August 27, 1985 and August 10, 1985. Additionally, hybrid red tilapia and *T. nilotica* were stocked on September 4 and October 30, 1985. Each of the ponds received an unknown number of recruit tilapia during a rainstorm which flooded adjacent ponds on October 7, 1985.

Part I

Ponds B7 and C7 were chosen because pond B7 had a bare bottom while pond C7 had an abundant covering of muskgrass (*Chara* sp.; *Chlorophyta*), over most of the pond bottom. This variability offered the opportunity to compare predatory insect diversity and abundance in two different habitats.

Since the depths varied in the ponds, the ponds were divided into two equal parts by an imaginary line to obtain a shallow half and deep half. A series of quadrats were established in the ponds to compare samples of the shore (which had vegetation), the open water, and the shallow and deep water (each end of the pond). Figure 1 indicates the location of each square meter quadrat. The quadrats included the entire water column and surface area of the pond bottom. Quadrat depths were 0.3, 0.7, 1.0, and 1.3 m for quadrats 1 (shallow end), 2-4 (shallow half, sides and open water), 5-7 (deeper half, sides and open water), and 8 (deep end), respectively.

Sampling was done with a dip net having a mouth of approximately 0.16 m x 0.33 m, with a 0.3 mm deep bag of 2 mm mesh netting. Each quadrat was sampled three consecutive times per sampling date, and the total number of insects caught was divided by three and rounded to the nearest integer. Samples were preserved in glass bottles containing a mixture of absolute ethanol and glycerol in a proportion of 95:5 and taken to the laboratory to be identified.

FIGURE NOT RECEIVED FROM AUTHOR AT PRESS TIME

Statistical analyses were done with the methodology described by Sokal and Rohlf (1981). Mean density was used as an abundance indicator because it allowed data comparisons in time, and raw data, by itself, did not allow this comparison. The chi-square test was used to determine significance in variability at the 0.05 level. The Kolmogorov-Smirnov test was used simultaneously with chi-square to determine significance in difference of the means. A two sample t-Test for unpaired data was used to determine differences between the abundance of Notonectidae at both ponds because only the Notonectidae appeared in both lists of the three most common taxa per pond.

Part II

Ponds C7 and C8 were chosen to observe population distribution because both had their bottom floors infested with *Chara*, thus allowing comparisons in two similar habitats. Figure 2 indicates the locations of one square meter quadrats established as transects across the shallow and deep ends of the ponds. Transect depths were 0.7, 1.0, 0.5, 1.2 m for transects 1, 2, 3, and 4, respectively. Transects 1 and 2 were in pond C7, while transects 3 and 4 were in pond C8.

Sampling in the water column of each quadrat was similar to Part I. In addition, all *Chara* within the quadrat were collected. The predatory insects were removed, identified, and added to those sampled in the water column. The *Chara* was then weighed.

Statistical analyses were done with the methodology described by Sokal and Rohlf (1981). Since many natural populations do not have normal distributions, we analyzed the data using the variance mean ratio (Poisson Distribution). A correlation test was used to determine if there was a relation between mass of *Chara* and predatory insect abundance.

RESULTS

Part I:

In Pond B7 the most abundant order was the Hemiptera, with 89.4% of the total number of individuals sampled (Table 1), while the Odonata was the most diversified with five taxa represented. The family Notonectidae was the single most abundant taxon with 88.1% of the total number of samples.

In pond C7, the most abundant and diversified Order was the Odonata with 79.5% of the total sampled divided among nine taxa. The single most abundant taxon was the genus *Pantala* with 66.35% of the total sampled.

Changes in mean density per date of sampling (Table 2) for the three most abundant taxa in Pond B7 (Notonectidae, *Laccophilus* sp., and Calopterygidae) were non-significant using the chi-square test, but were significant (0.05 level) for the Kolmogorov-Smirnov test. Changes in mean density per quadrat (Table

FIGURE NOT RECEIVED FROM AUTHOR AT PRESS TIME

Table 1. Taxa present in samples from ponds B7 and C7.

	Pond B7		Pond C7	
	Total	% of Total	Total	% of Total
Class Insecta	826	100.0	835	100.0
Order Coleoptera	31	3.8	60	7.2
Family Dytiscidae				
Genus *Laccophilus*	29	3.5	53	6.4
Genus *Laccodytes*	0	0.0	7	.8
Family Hydophilidae				
Genus *Hydrophilus*	2	0.2	0	0.0
Order Odonata	54	6.5	664	79.5
Suborder Anisoptera	13	1.6	608	72.8
Family Libellulidae				
Genus *Pantala*	10	1.2	554	66.4
Genus *Libellula*	3	0.4	55	6.6
Genus *Ladona*	0	0.0	10	1.2
Family Aeshnidae				
Genus *Aeshna*	0	0.0	4	0.5
Genus *Anax*	0	0.0	12	1.4
Family Gomphidae				
Genus *Gomphus*	0	0.0	23	2.8
Suborder Zygoptera				
Family Coenagriidae				
Genus *Amphiagrion*	14	1.79	11	1.3
Family Lestidae				
Genus *Lestes*	1	0.1	20	2.4
Family Calopterygidae	26	3.15	25	3.0
Order Hemiptera				
Family Notonectidae	728	89.4	61	7.3
Family Naucoridae				
Genus *Pelocoris*	10	1.2	2	0.2

3) showed non-significance in chi-square for the Notonectidae and Calopterygidae, but was significant for *Laccophilus*. Kolmogorov-Smirnov was again significant.

Changes in mean density per date of sampling (Table 2) for the three most abundant taxa in pond C7 (*Pantala* sp., *Libellula* sp., and Notonectidae) were non-significant with chi-square, and Kolmogorov-Smirnov showed non-significance for *Pantala* sp. only. Changes in mean density per quadrat were significant for Kolmogorov-Smirnov, but chi-square showed significance

Table 2. Mean density for each day of sampling for the three most common taxa in ponds B7 and C7.

	Mean Density (per m2) Pond B7	Pond C7
Order Coleoptera		
Family Dytiscidae		
Genus *Laccophilus*	0.6	—
Order Odonata		
Family Libellulidae		
Genus *Pantala*	—	11.5
Genus *Libellula*	—	1.2
Family Calopterygidae	0.6	—
Order Hemiptera		
Family Notonectidae	15.2	1.2

Table 3. Mean density for each quadrat for the three most common taxa in each pond.

	Mean Density per quadrat (m2) Pond B7			Pond C7		
Quadrat	**Taxon A**	**Taxon B**	**Taxon C**	**Taxon 1**	**Taxon 2**	**Taxon 3**
1	18.0	2.7	1.7	7.5	1.3	2.0
2	16.5	0.5	0.2	8.8	0.7	7.5
3	11.3	0.0	0.0	15.8	2.8	0.0
4	13.0	0.0	0.0	11.3	0.2	0.8
5	15.0	0.5	0.8	11.3	0.0	0.5
6	13.2	0.0	0.0	18.3	1.3	0.0
7	15.8	0.2	0.3	9.5	1.8	1.0
8	18.0	1.2	1.3	9.7	1.0	3.8

Taxa: A=Notonectidae
B=*Laccophilus*
C=Calopterygidae
1=*Pantala*
2=*Libellula*
3=Notonectidae

only for Notonectidae.

The Notonectidae was one of the three most abundant taxa in both ponds, but its densities per date of sampling and per quadrat were significantly lower (0.001 level) in Pond C7 than in B7 as confirmed by a two sample t-test for unpaired data.

Part II:

For the four transects (Table 4) the variance:mean ratios resulted in values greater than 1, indicating an aggregated distribution. The correlation tests between wet weight of *Chara* sp. and number of insect predators gave significant coefficient values in transects 1, 2, and 4, but was non-significant for transect 3.

Table 4. Sampling results of part II.

Transect	s2/X*	Correlation Index (R)
1	3.26	0.8067**
2	1.57	0.8635**
3	5.19	0.3935
4	8.88	0.8153**

*=Poisson Distribution
**=Significant (p=0.05)

DISCUSSION

The presence on underwater substrates (*Chara* sp., in this case) may influence the abundance, diversity, and distribution of predatory insects present in a shrimp pond. In B7, a pond with bare bottom, predators that depend on substrate, like odonatan nymphs, were less abundant, less diversified and common only on the shore, where leaves and roots of terrestrial plants that enter into the water offered them shelter from being eaten by the fish and shrimp in the pond. In the open areas of such a pond, swimming predators like notonectids, were more abundant. Apparently, they were able to avoid the fish and shrimp.

On the other hand, C7, a pond with an abundance of *Chara* sp. at the bottom, was dominated by Odonatan nymphs, particularly those in the genus *Pantala* (Sub-order Anisoptera). The density of notonectids in C7 was significantly lower than in B7, suggesting a displacement by competing predatory odonatans in that first-mentioned, *Chara* -infested pond.

In both C7 and C8, predatory insects were distributed in a aggregated pattern, probably due to differences within the transects in the distribution of the biomass of *Chara*, though it is necessary to study population distribution of prey species to get a clearer idea. Highlighting the importance of substrate and shelter to non-swimming predators in the ponds, the positive correlation between *Chara* biomass and abundance of predatory insects suggests a close relation between those two factors .

Since odonatan nymphs are abundant where shelter and substrate are non-limiting, keeping pond bottoms free of aquatic weeds, rocks, etc. should be an effective method for their control. However, predatory insects similar to notonectids which swim after their prey may require other types of control.

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