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Competitive Interaction and Foraging Speed in the Invasive Shrimp, Palaemon Macrodactylus, and Three Species of Native Palaemon Shrimp in New Jersey Waters

Invasive species can have an ecological impact on native species and potential economic impact on commercially important species. Competitive interactions and foraging speed were observed in four estuarine grass shrimp, *Palaemon* species. Three species of shrimp were native to New Jersey waters (*P. pugio, P. vulgaris, P. intermedius*), while the fourth species was an invasive species originating from Japan (*P. macrodactylus*). A Kruskal-Wallis H test was used to determine whether the mean ranks for these times were significantly different between the four species. For this series of trials, the times to reach the food source increased by species from *P. vulgaris* (mean rank = 34.00), *P. pugio* (mean rank = 36.18), *P. macrodactylus* (mean rank = 39.19), to *P. intermedius* (mean rank = 50.40). However, the differences between species were not statistically significant, $\chi^2(3) = 7.072$, $p = 0.070$. During observation records it was found that *P. macrodactylus* were more aggressive toward their competitors and were the only species in the experiment to guard food and attack other shrimp. This suggests that the invasive species may have a favorable advantage controlling food sources.

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Acknowledgments: ***Rutgers University Marine Field Station***

Competitive interaction and foraging speed in the invasive shrimp, Palaemon macrodactylus, and three species of native Palaemon shrimp in New Jersey Waters

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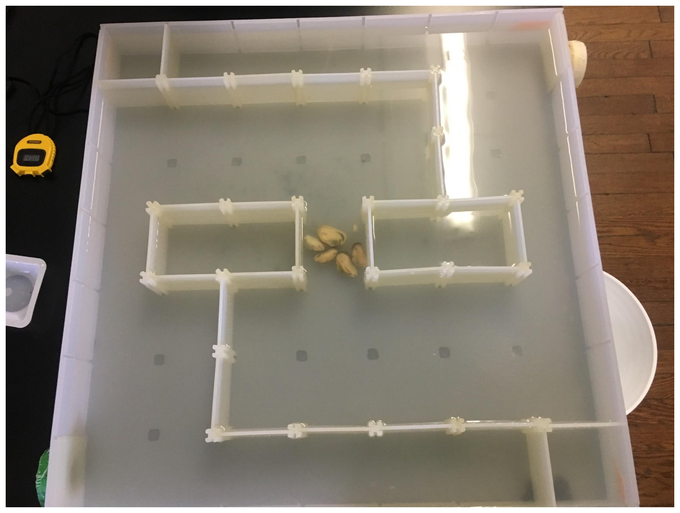
Abstract

Competitive interactions and foraging speed were observed in four estuarine grass shrimp, Palaemon species. Three species of shrimp are native to New Jersey waters (P. pugio, P. vulgaris, P. intermedius), while the fourth species was an invasive species originating in japan (P. macrodactylus). Since invasive species can have an economic and ecological impact on native species, they are important organisms to study. It was hypothesized that the invasive would be more aggressive and faster at finding food than the native species due to their larger average body size. Two shrimp were placed in a maze to run separate, but identical courses to reach a common food source. Two different food sources, mussels and clams were used as bait for this experiment and, for each shrimp, the time to locate and reach the food source was measured. For each food source, a Kruskal-Wallis H test was used to determine whether there were significant differences, between the four species. When mussels were used as bait, the times to reach the food source were not significantly different between groups, $X^{2(3)}$=7.072, p=0.070. When clams were used as bait, the times to reach the food source, the differences between groups was not significantly different, $X^{2(3)}$=2.506, p=0.474. After reaching the food source, the shrimp were allowed to remain in the area of the bait and their interactions were observed and recorded. P. macrodactylus were more aggressive toward their competitors, suggesting that this invasive species may have a favorable advantage controlling food sources.

Introduction

There are many different species of shrimp and more specifically grass shrimp. The four species that were used in this study include Pugio, Vulgaris, Macro, and Intermedius. The pugio were the smallest and had no color to very few stripes on their egg sacks. The vulgaris were the second smallest and had very dark stripes on their abdomen as well as their egg sacks. The Macros were the largest species and had bright orange bands on their legs and feeder claws. The intermedius were the second largest and had blue – green segments on their front legs. Each species was carefully identified by their color and if there was any question, they were put under a microscope and identified by the amount of spikes on their rostrums. The four sites that were sampled included Tuckerton, Sandy Hook, Red Bank, and Parlin. Tuckerton is a marine field sampling station run by Rutgers, Sandy Hook in a bay in the state park that was sampled with a sand net walking through the bay, Red Bank and Parlin were both marinas that had moderate boat traffic in and out. The purpose of this experiment was to see the different food sources that each species prefers to eat from, to ultimately see if all of the species are going after the same food sources.



Methods

Field Collection

- *P. Macrodactylus* have distinct orange bands on their legs, racing stripes down their back, and are larger
- *P. Pugio* will sometimes have stripes on their eggs but do not have stripes on their legs or abdomen and are rather small
- *P. Intermedius* have blue green segments on their legs and are larger than the *P. Pugio* and *P. Vulgaris* but smaller than the *P. Macrodactylus.*
- *P. Vulgaris* are larger than the *P. Pugio* and have stripes on their abdomen and on their eggs.

Maintenance in Lab

- Shrimp were fed Aqueon Tropical Flakes
- Tanks were cleaned every 3 weeks
- Filters were cleaned twice a week
- Shrimp were fed every other day unless they were placed on a hold for experimental purposes

Laboratory Experiments

- Shrimp were food deprived for a minimum of 48 hours
- One shrimp was placed at each end of the maze and had to navigate through identical pathways to a common food source
- Mussels were used as the food source and four species of shrimp were used
- Time was recorded to see how long it took each shrimp to navigate the maze
- Interactions between species were also recorded

Results

For this series of trials, a mussel was used as the food source in the maze and the time it took for a shrimp to navigate the maze and reach the food source was recorded. The time for each shrimp, in a sample comprised of four species of shrimp, *Palaemon macrodactylus* (*n* = 16), *Palaemonetes vulgaris* (*n = 20*), *Palaemonetes pugio* (*n* = 20) and *Palaemon intermedius* (*n* = 24), was recorded. A Kruskal-Wallis H test was used to determine if there were significant differences in these times (sec.) between the four species of shrimp. The time distributions across species were not similarly shaped, as assessed by visual inspection of comparative boxplots of the distributions. For this sample of shrimp, the times to reach the food source increased by species from *Palaemonetes vulgaris* (mean rank = 34.00), to *Palaemonetes pugio* (mean rank = 36.18), to *Palaemon macrodactylus* (mean rank = 39.19), and finally to *Palaemon intermedius* (mean rank = 50.40). However, the differences between groups was not significantly different, $\chi^2(3) = 7.072$, $p = 0.070$. The distributions of the times across species were not similarly shaped, as assessed by visual inspection of comparative boxplots of the distributions

Discussion

Based on the data collected, and my experience of working in the field and in the lab, the *Palaemon macrodactylus* are larger, more aggressive, and faster. The can find food faster and will attack other species that are trying to eat from the same food source. The data had showed very close rankings between the macros, vulgaris, and pugios, but the noted reactions during the lab had shown that the macros are aggressive towards any other organism. The macros will attack other macros and any other species that they come in contact with. The fastest record time recorded was set by a macro which was 33 seconds. This showed that the macros were able to figure out the maze very fast which means they are very smart species and can figure out how to achieve and finish tasks faster than the native species.

Ranks

	Species	N	Mean Rank
time (sec)	Macro	16	39.19
	Vulgaris	20	34.00
	Pugio	20	36.18
	Intermedius	24	50.40
	Total	80	

Figure 1. Ranking of species
Comparison of the number of each species tested, and the mean rank of each species

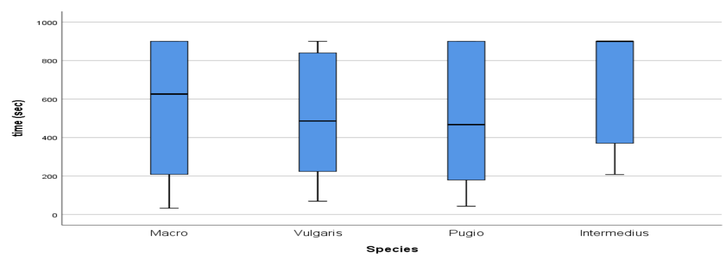


Figure 2. Average time by species
Comparison of the four species in a box and whisker plot showing the interquartile range along with maximum times and minimum times.

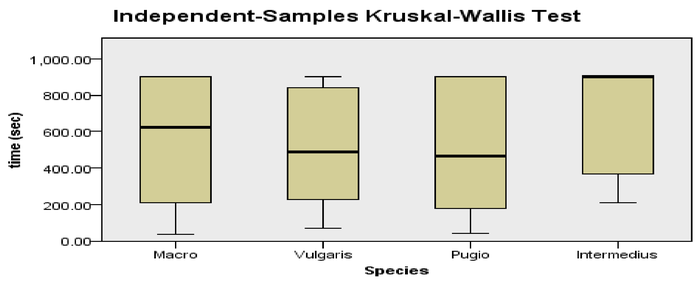


Figure 3. Kruskal-Wallis Test
Comparison of the four species in the Kruskal-Wallis test run as independent samples based off of the times for each individual shrimp species.

Acknowledgements:
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Selected References

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