Schooling Behavior of *Thayeria obliqua* and *Pristella maxillaris*

Nicole Shrestha

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Abstract

This project tested schooling preferences of two species, *Thayeria obliqua* and *Pristella maxillaris*. The study used two 15-gallon aquariums, two screw-top jars, and twelve individuals of each species. Two vertical lines were drawn on the front of one aquarium, separating it into three equal sections. Fish were placed in jars at opposite ends of the aquarium, a test fish was released in the center of the tank, and movements were recorded over a fifteen minute period. Each test was replicated five times with individuals of each species. Only *T. obliqua* showed a significant preference for schooling with conspecific groups. Neither species showed a significant preference for the size of the group. *Thayeria obliqua* may occur in open water habitat where schooling would be adaptive. *Pristella maxillaris* lives in swampy, vegetative habitats where cover from predators does not require schooling.

Introduction

Research has shown that fish schools increase predator avoidance and foraging efficiency (Griffiths and Magurran 1997). A fish school is classified as a group in which all individuals swim together at the same speed (Wilson and Wilson 1985), and usually includes individuals of the same size and species (Marshall 1966). Fish schools afford protection from predators and maximize the individual's fitness (Barber and Ruxton 2000). Individuals prefer to join groups of familiar conspecifics instead of groups with which they have no experience (Barber and Ruxton 2000). The probability of mixed-species schooling increases the closer the phylogenetic relationship of the two species (Ward et al. 2003). Barber and Ruxton (2000) demonstrated that sticklebacks kept jointly in schools for a six week period maintained cohesive schools when later permitted to freely interact with other schools. Ward et al. (2003) found that juvenile chub (*Leuciscus cephalus* and *Phoxinus phoxinus*) assembled preferentially with familiar fishes, regardless of whether or not they were conspecifcs. When presented with two non-familiar schools, the preference for conspecifics over heterospecifics disappeared when

the heterospecifc school was composed of individuals familiar to the test fish (Ward et al. 2003).

Krause et al. (1998) noted that group size influences foraging success and protection against predation. The evolutionary costs and benefits of schooling may depend on the size of the fish school (Krause et al. 1998). A comparison of school size choice by Threespine Stickleback (*Gasterostreus aculeatus*) and the Creek Chub *(Semolitus atromaculatus)*, revealed that because of their spines and bony lateral plates, sticklebacks were less inclined to actively select foraging groups (Krause et al. 1998). Creek Chub were more vulnerable and responded to slight school-size differences, quickly choosing the larger of two schools. Species that are more susceptible to predation responded to differences in the size of conspecific schools (Krause et al. 1998). The purposes of this study was to test whether or not a single test fish preferred to school with heterospecifics or conspecifcs and to test how the number of fish in the school affected these decisions.

Methods and Materials

The methods followed those developed by Keenleyside (1968). Two 15-gallon aquariums and twelve individuals each of *Thayeria obliqua* (Penguin Tetra) and *Pristella maxillaris* (Gold Tetra) were used in the experiment. On the front of each aquarium, two vertical lines were drawn, separating it into three equal sections. To test for heterospecificity versus conspecificity, six to eight fish of each species were placed into separate screw-top jars (~ 4L). A jar of each species was placed at each end of the aquarium. A single test fish of one of the two species was carefully released in the center of the aquarium. Over a fifteen minute period, the time the test fish spent in each of the

three areas of the tank was recorded. The test fish was then removed, and the position of the jars was reversed to test for any left/right tendencies. The same test fish was then returned to the aquarium and the recording procedure was repeated. Five replicates of this procedure were conducted with five different test fish of each species.

To test for school size preference in *P. maxillaris*, the same aquarium and a similar set up was used. Two jars, one containing four conspecifics and one with only two conspecifics, were placed in opposite ends of the aquarium. An individual *P. maxillaris* was released in the center of the aquarium. The time this fish spent in each of the three areas was recorded over a fifteen minute period. The test fish was then removed, the positions of the jars reversed, and the test fish returned to the tank to test for any left/right tendencies. Five replicates of this test were performed. For the tests involving *T. obliqua*, five conspecifics were placed in one jar and three in the other. Five replicates were performed with this species following the same protocol used on *P. maxillaris*. Data were analyzed using analysis of variance (ANOVA) and Tukey post hoc tests.

Results

During a 15 minute test for preference between conspecific or heterospecific groups, *P. maxillaris* spent an average of 310 seconds (± 250 SD) in the area with conspecifics. In the area of the tank without fish, *P. maxillaris* spent an average of 338 seconds (± 263 SD), and in the area with heterospecifics they spent an average of 213 seconds (± 285 SD.)(Fig. 1).

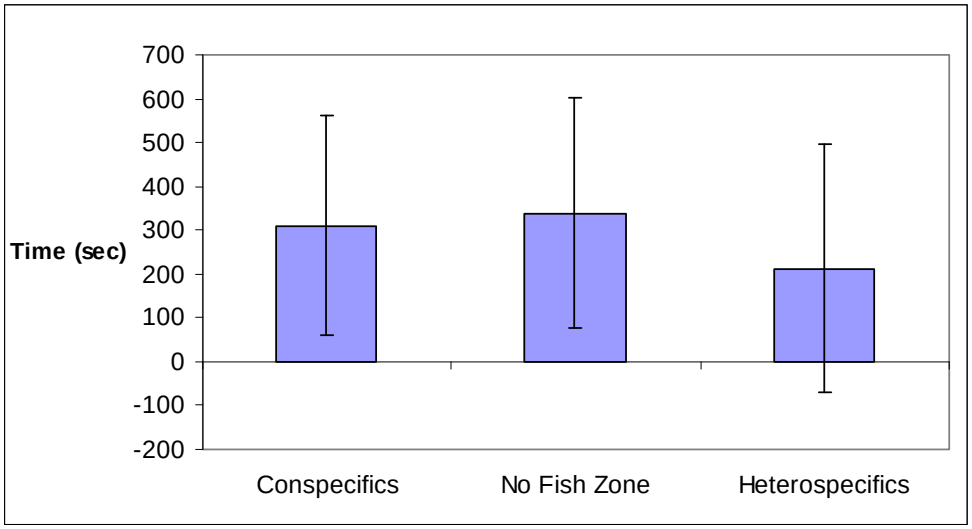

Figure 1 - The average time spent in each area of the tank by *Pristella maxillaris* when tested for species preference, including standard error bars.

Differences between observations for each group were then analyzed for significance using an ANOVA test, with a resulting p-value >0.05, which indicated no significance. *Thayeria obliqua* was also tested for preference between conspecific and heterospecfic groups. They spent an average of 755 seconds (± 190 SD) out of the 15 minute test period in the area with conspecifics. In the area without fish they spent an average of 85 seconds (± 119 SD) and in the area with heterospecifics they spent an average of 17 seconds (± 22 SD)(Fig. 2). These differences were significant (p-value <0.05). A Tukey post hoc test showed a significant difference ($p < 0.05$) between the mean of time spent in the area with conspecifics and the means of the other two areas (Fig. 3).

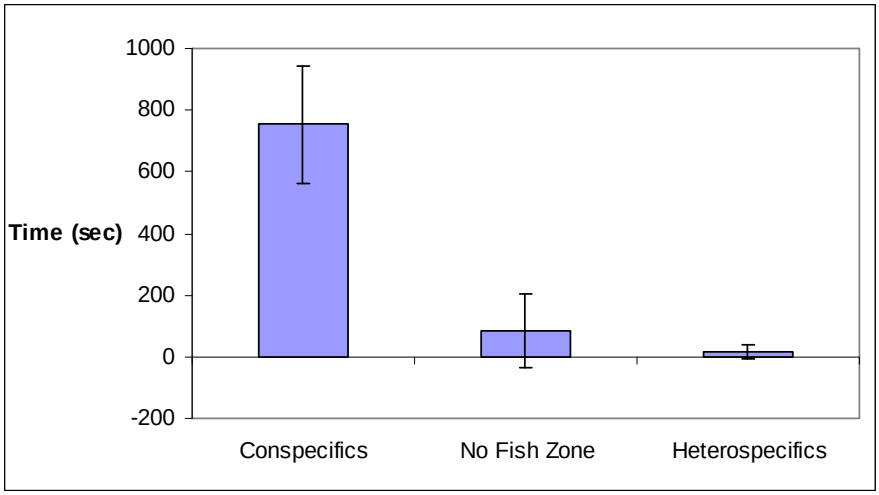

Figure 2 - The average time spent in each area of the tank by *Thayeria obliqua* when tested for species preference, with standard error bars shown.

Figure 3 - The results from a Tukey test performed with the data from *Thayeria obliqua*'s tests for preference between conspecfics and heterospecifics. Mean 1 represents the area of the tank with conspecifics, mean 2 represents the area of the tank without fish, and mean 3 represents the area of the tank with heterospecifics.

Cell No.	Var1	{1} 755.17	{2} 84.833	{3} 16.833
1	1	-	0.000178	0.000178
2	2	0.000178	-	0.645700
3	3	0.000178	0.645700	-

When tested for group size preference, *P. maxillaris* spent an average of 345 seconds (± 164 SD) out of a 15 minute period in the area with four conspecifics. In the no fish zone, they spent an average of 253 seconds (± 94 SD). In the area with two conspecifics, they spent an average of 233 seconds (± 249 SD) (Fig. 3).

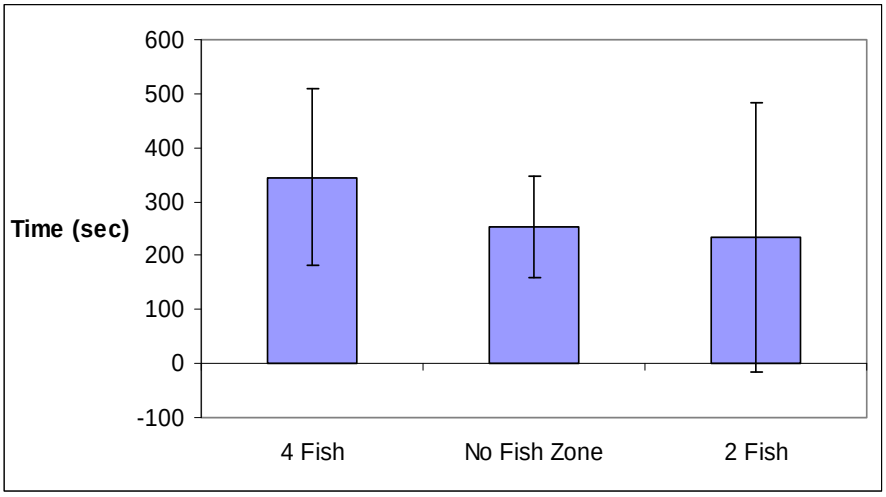

Figure 3 - *Pristella maxillaris*'s average time spent in each area of the tank when tested for group size preference, including standard error bars.

These data were not significant ($p < 0.05$). *Thayeria obliqua* was also tested for group size preference and spent an average of 420 seconds (± 357 SD) in the area with five conspecifics. In the no fish zone, they spent an average of 135 seconds (± 104 SD). In the area with three conspecifics, they spent an average of 319 seconds (± 347 SD)(Fig. 4). These data were not significantly different from each other ($p > 0.05$).

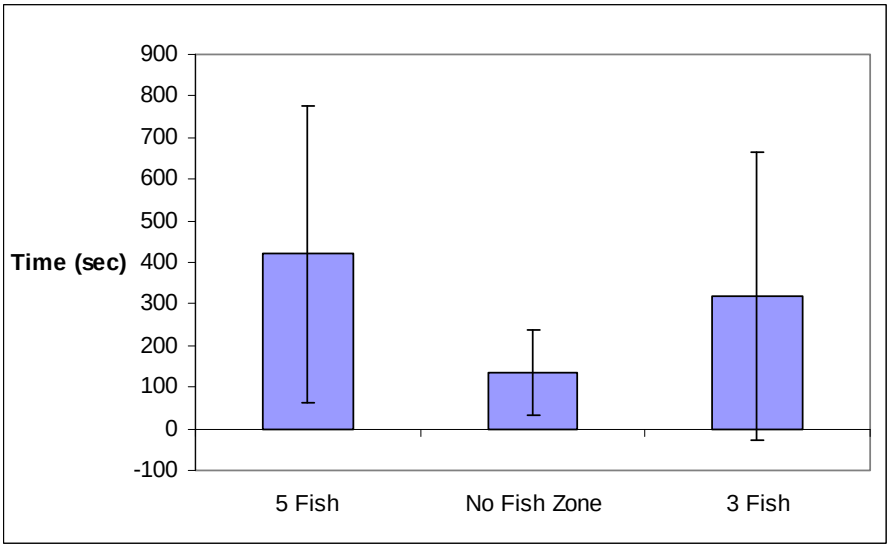

Figure 4 - The average time spent in each area of the tank by *Thayeria obliqua* when tested for group size preference, with standard error bars.

Discussion and Conclusions

When the two species were tested for preference between conspecifics and heterospecifics, only *T. obliqua* demonstrated a significant preference for conspecifics. *Pristella maxillaris* showed no preference for any area of the tank. The difference between the two species' preferences for certain areas of the tank was most likely due to the habitats where the fish naturally occur. Boujard et al. (1997) notes that *P. maxillaris* are commonly found in calm coastal waters and in swamps with dense vegetation throughout the Amazon, Orinoco, and Guianas river basins. It is possible that because *P. maxillaris* are found in areas with dense vegetation, they use the vegetation as a method of predator evasion. If this is true, there would be less selection pressure to form schools. Lima et al. (2003) note that *T. obliqua* are found throughout the middle Amazon, middle Tocantins, and Guaporé river basins. The literature does not reveal whether *T. obliqua* is an open water fish in these regions, but if it is, this would explain its inclination to school as do many other open water fish.

When tested for group size preference, neither species showed a significant preference for any area of the tank. The results from the first experiment indicate that *P. maxillaris* do not have strong schooling tendencies, so it is understandable why there was no significant preference for group size. However, explaining *T. obliqua*'s lack of preference is more difficult. One possible explanation is that as long as other fish are near, an individual may not be able to differentiate between group sizes. Another explanation could be that the difference between the two groups was not large enough to have an effect on an individual's behavior.

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