THE EFFECT OF AVAILABLE SPACE ON CRAYFISH AGGRESSION

K. Larson and M. Greenfield
University of Minnesota Lake Itasca Biological Station
Animal Behavior

Abstract:

Scientific literature has shown that crayfish are aggressive creatures and that aggression manifests itself in various situations where resources such as space or food are limited. The experiment was designed to test the possibility that a decrease in available space for the crayfish *Orconectes virilis* would increase the amount of agonistic behavior between the observed crayfish. By studying crayfish from Lake Itasca, the goal was to determine if a decrease in space was a situation that caused crayfish to be more aggressive to each other. Using a fish tank and a movable wall, the amount of space given to the two crayfish is decreased by ten centimeters twice, thus giving three separate space increments of behavior to observe. The results showed a significant difference in the behavior frequency between the first and third space increments.

Introduction:

Agonistic behavior is one of the basic behaviors in the lives of most animals. Whether mammal or insect, bird or fish, nearly every species has its own way of presenting its aggression to others, and the amount of literature on the subject is massive. Animals of all types have evolved tools to further assist them when this agonistic behavior shows itself, and crustaceans—such as crayfish—are a prime example.

Literature today has shown that crayfish are aggressive, a conclusion usually drawn by observation of the use of their infamous pincers. It is a common occurrence for

crayfish to avoid each other, however when they do meet it is almost always in an aggressive manner (Bovbjerg 1948). This agonistic behavior causes crayfish to create a dominance hierarchy when forced to be around other crayfish (Bovbjerg 1948). This hierarchy is largely affected by the size of the crayfish competing, causing those with larger body masses to be higher up in the hierarchy (Rubenstein and Hazlett, 1974). Most studies focusing on crayfish, especially on their agonistic behavior, tend to use crayfish of similar body size due to this hierarchy system (Huber et al., 2002).

The agonistic behavior of crayfish has been greatly studied and is influenced by many factors, including resources (Bergman and Moore, 2003), gender, age (Bovberg, 1948), and various other things. Habitat can also play a role in how aggressive crayfish are: more complexity in habitat leads to less aggression (Corkum and Cronin, 2004).

Our study looked to see if available space for the crayfish *Orconectes virilis* would also be a factor in how aggressive they were towards each other in a given period of time, while simultaneously eliminating some of the factors that affect agonistic behavior for clearer data.

Methods:

The crayfish in our study were obtained from the north arm of Lake Itasca near the University of Minnesota Biological Station. The method used to gather the crayfish was seining in the littoral zone. The crayfish were then isolated in glass jars filled with lake water in order to prevent any dominance hierarchies from developing if all crayfish were placed in one tank. If they were kept more than one day in the jars, they were fed small pieces of celery until we were able to perform the observations.

The observations were performed indoors in a 30x60 cm tank with 15 cm of water from Lake Itasca. A red plastic folder was used to shorten the length of the tank from 60 cm to 30 cm, thus increasing the amount of interaction between the two observed crayfish regardless of their potential size. Each pair of observed crayfish were of similar length. The length of the observed crayfish ranged from 3.4 cm to 9.0 cm. Some algae from the lake remained in the tank to make it seem more natural, however no rocks or sand were placed in the bottom in order to prevent burrowing and avoidance of each other.

After the initial isolation of the crayfish, they were again isolated for five minutes on either side of the folder in the tank in order to allow for the crayfish to become acclimated to the new environment. The observations began both crayfish were placed on the same side of the folder in a 30x30 cm space of tank, where they remained for five minutes. The given space was then reduced by 10 cm (to 20x30 cm space) by moving the folder towards the opposite wall and again observed the crayfish for five minutes. This process was repeated, reducing the given space by 10 cm (to 10x30 cm space) and observing for five minutes. At each interval the crayfish remained on one side while the folder was moved, but they were then separated in order to prevent ongoing aggression from continuing into the next section of the trial.

Each crayfish was measured at the end of its trial by placing it on top of a flat ruler and measuring from the tip of its nose to the end of its tail. When each series of trials was over, the crayfish were returned to Lake Itasca in an area south of where they were obtained to prevent duplicates.

Results:

The results from the experiment show greater mean behavior frequencies for both the claw raise and the combat to be significantly higher in the 30 cm and 10 cm space increments (Fig. 1). Within the claw raise behavior frequency, the 10 cm space is significantly higher than both the 30 cm and 20 cm increments in addition to the control increment. Also, within this behavior the 30 cm space standard error bar falls directly between the 10 and the 20 cm spaces which is also indicative of significance. The combat behavior was not observed in the control group. Also, between the three spatial increments in this behavior there is little statistical difference between error bars. Thirdly, within the retreat behavior the two increments that are statistically significant based on the standard error bars are the 30 and the 10 cm bars. The rest of the data is not statistically different.

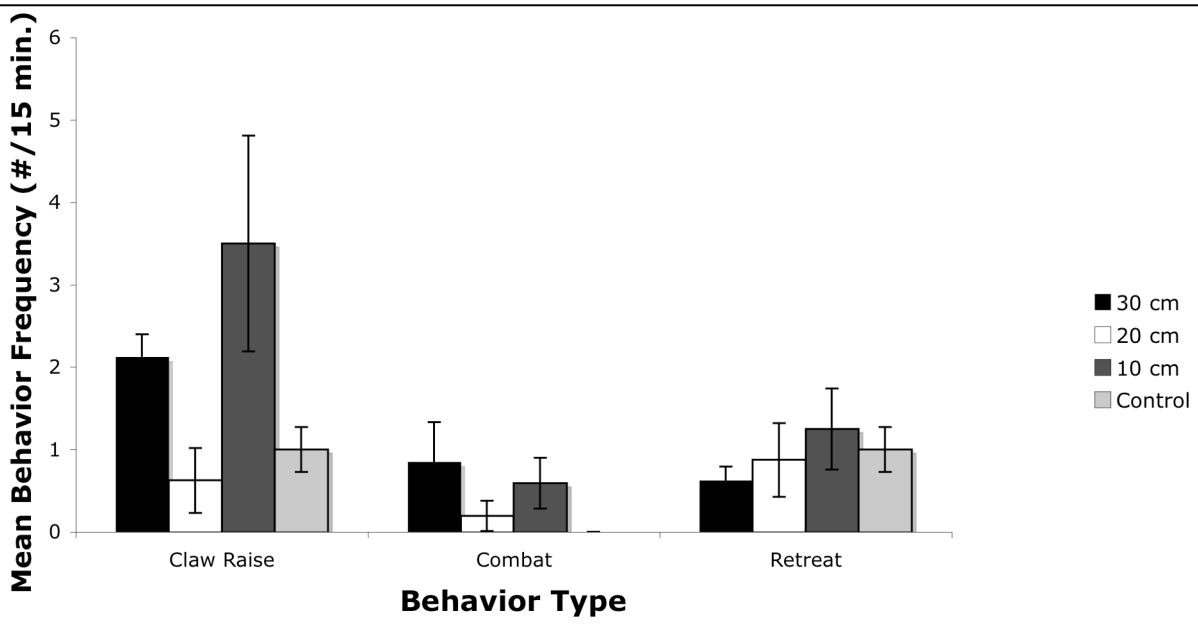

Figure One. The mean (± S.E.) of the behavior frequencies for each spacing increment, including the control where no increments were present.

Discussion:

From the results, it can be concluded that the most significant difference in behavior frequency occurred between the 10 cm and the 30 cm space increments within the claw raise behavior. The first increase in claw raise behaviors that occurred within the 30 cm space could be accounted for by the initial introduction aggression. It is the first time the crayfish have been introduced and aggression generally occurs at this time. The greatest mean frequency in the claw raise behaviors within the 10cm space is in accordance with the hypothesis stating that the aggressive behavior frequencies will increase with a decrease in space. The combat behavior was very similar between the 10 cm and the 30 cm spaces, while occurring slightly less in the 20 cm space. All frequencies were relatively low in comparison to the frequencies of the claw raise behaviors. This decrease in behaviors could be accounted for by the mere fact that a combat is much more energy costly to the crayfish and a less active behavior may be just as useful. The number of retreats in all treatments was relatively similar with the most significant difference occurring within the 10 cm and 30 cm regions. The 10 cm retreat frequency could be accounted for by a decreased amount of space that allowed for the crayfish to see each other and establish a two-crayfish hierarchy within the time spent in the tank.

One trend that stands out within all three treatments is the increase in agonistic behaviors within the both the 30 cm and the 10 cm space, compared to the behaviors within the 20 cm space. The increase in aggression with the crayfish are in the 30 cm space could be caused by an increase in behaviors to establish dominance when the two

crayfish are initially introduced. The second increase in agonistic behaviors occurring in the 10 cm space increment is in accordance with the given hypothesis that states the crayfish will increase their agonistic behavior when the spaced they are within decreases.

Future implications of the findings that agonistic behavior increases with decreases space can be applied to the study of territoriality in crayfish. This suggests that crayfish may have a space requirement necessary for their territory and that they will exhibit aggressive behavior if this requirement is not met. More information and significant data is necessary to confirm this phenomenon however. One aspect of the experiment that could have been improved was the sample size. A sample size of eight was used due to the limitations given by the lack of survival of the crayfish in the lab. Seining was performed many times which may not have totally standardized the sample as well. A second aspect that could be improved was the likeness of the experimental setup to the natural environment of the crayfish *Orconectes virilis.* Lake water from Lake Itasca was used which resembled the natural aquatic nature of the surroundings, however the tank had a glass bottom with little to no cover which could have also affected the behavior of the crayfish.

Future directions for the experiment involve some minor changes to the current setup. The first change would be sample size. A much greater sample size is necessary in order to draw a conclusion about the behavior. A second change would be a more realistic tank setting which appeared more like the natural setting for the crayfish. An additional direction to follow would be to try and gauge this behavior when a specific resource is present such as a shelter or a food source.

References:

Bergman, D.A. and Moore, P.A. 2003. Field observations of intraspecific agonistic behavior of two crayfish species, *Orconectes rusticus* and *Orconectes virilis*, in different habitats. *Biological Bulletin*, 205: 26-35

Bovberg, R.V. 1948. Some factors affecting aggressive behavior in crayfish. *Cerebral Cortex*, 19: 127-136

Corkum, L.D. and Cronin, D.J. 2004. Habitat complexity reduces aggression and enhances consumption in crayfish. *Journal of Ethology*, 22: 23-27

Huber, R., Daws, A.G., Tuttle, S.A., and Panksepp, J.B. 2002. Quantitative behavioral techniques for the study of crustacean aggression. *The Crustacean Nervous System*, 186-201

Rubenstein, D.I. and Hazlett, B.A. 1974. Examination of the agonistic behavior of the crayfish *Orconectes virilis* by character analysis. *Behaviour*, 50: 193-216