Aggressive behavior and territorial availability in *Orconectes rusticus*

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Abstract: Aggressive behavior is important in resource access and determination of fitness in many species. In the rusty crayfish, *Orconectes rusticus,* limited availability of shelter leads to aggressive bouts of dominance. We tested the effects of reduced territory on crayfish aggression by examining fights in two habitats of different sizes. We found that aggressive behavior was significantly higher when available territory was reduced.

Introduction: Aggressive behavior plays an important role in many species in determining access to limited resources such as food, territory, or mates. Aggressive behavior is commonly seen in *Orconectes rusticus,* the rusty crayfish. Crayfish use a variety of aggressive techniques to obtain dominance, including aggressive displays and physical combat with claws and antennae. A number of factors are important in determining individual crayfish dominance, including body size (Klar & Crowley, 2012), chemical cues in urine (Breithaupt & Eger, 2002), and shelter availability (Klar & Crowley, 2012). Bergman and Moore (2005) report that aggression was more intense over limited shelter than in fights over limited food, indicating that shelter is a resource of higher priority in crayfish. We tested the effects of space availability on aggressive displays in crayfish by observing aggressive displays in male crayfish in tubs of two different sizes. Our hypothesis was that the frequency of aggressive displays in crayfish would increase as the amount of available space decreased.

Methods: Seven male crayfish were captured in nets from Lake Itasca over a three day period. Males were housed in 50L tubs filled with lake water. Each crayfish was given a number identification, then weighed and measured for length from head to tail. Testing for aggressive behavior occurred over a three day period. Crayfish were first tested for aggressive behavior in a large control tub that had sufficient room for crayfish to avoid each other (surface area= 1816.5 cm^2). After this round of tests, crayfish were tested in the same order in a small tub to simulate reduced available territory (surface (area= 518.5 cm^2). Twenty-one fights occurred in each tub size, with 42 total fights being observed. Each test proceeded by filling the tub to a depth of approximately 8 cm with lake water, which was sufficient for all crayfish to remain fully submerged. Each crayfish was then placed in the tub on opposite sides with a physical barrier present to avoid early contact. After 2 min of separation, the barrier was removed, and the crayfish were observed for 5 min. Aggressive behavior was observed and scored using a rating system from Breithaupt & Eger (2002, Table 1). Each occurrence of an aggressive or defensive behavior was counted and then added using the weighted scores from the previous study. Test order was systematically predetermined to ensure that each crayfish had the longest resting period possible while the tests were run continuously. The water in the tub was changed between each trial to dispose of potential chemical cues.

Table 1. Definition of agonistic levels, adapted from Breithaupt & Eger (2002).

Score	Description	Behavioral Elements
-2	Fleeing	Fast walking backwards, fast walking away, tail-flipping
-1	Avoidance	Walking backwards slowly, walking away slowly, turning away
1	No physical contact (within 1 body length)	Approaching, turning towards, following opponent
2	No physical contact (threat display)	High on legs, meral spreading
3	Physical contact (claws not used to grasp)	Antenna touching, whipping; claw touching, pushing, tapping
4	Physical contact (claws used to grasp)	Clamping of chela(e) onto opponents body

Results: In analyzing the correlation between crayfish mass and levels of aggression, no significant correlation was observed (R^2=0.115; Fig 1).

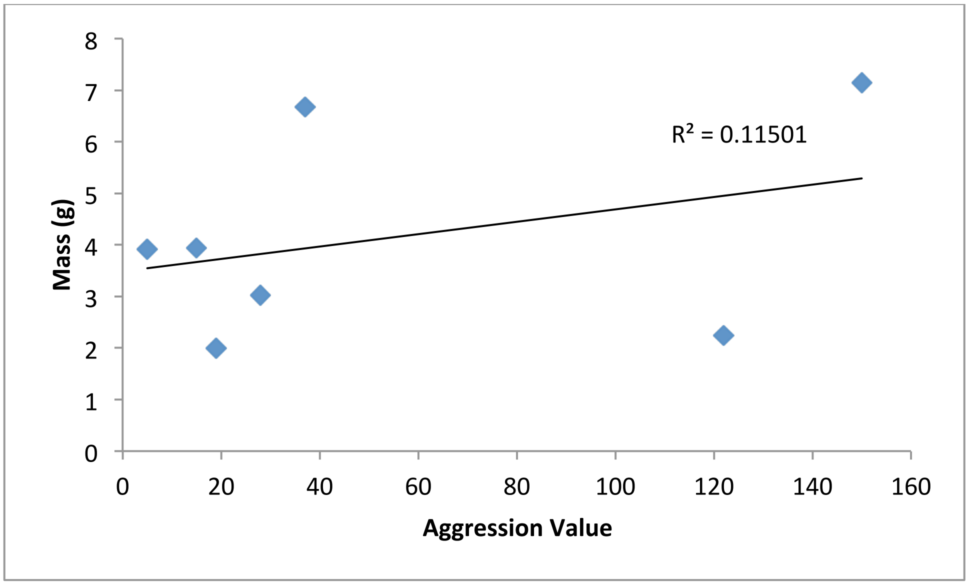

Figure 1: Correlation of crayfish mass compared to total level of aggression displayed in competitive bouts.

Analysis of correlation between the mass of the crayfish and the total number of wins in bouts also showed no significant correlation (R^2=0.165; Fig 2). Wins were determined by summing the quantitative aggression value observed during bouts and marking the crayfish with the larger aggression value as the winner.

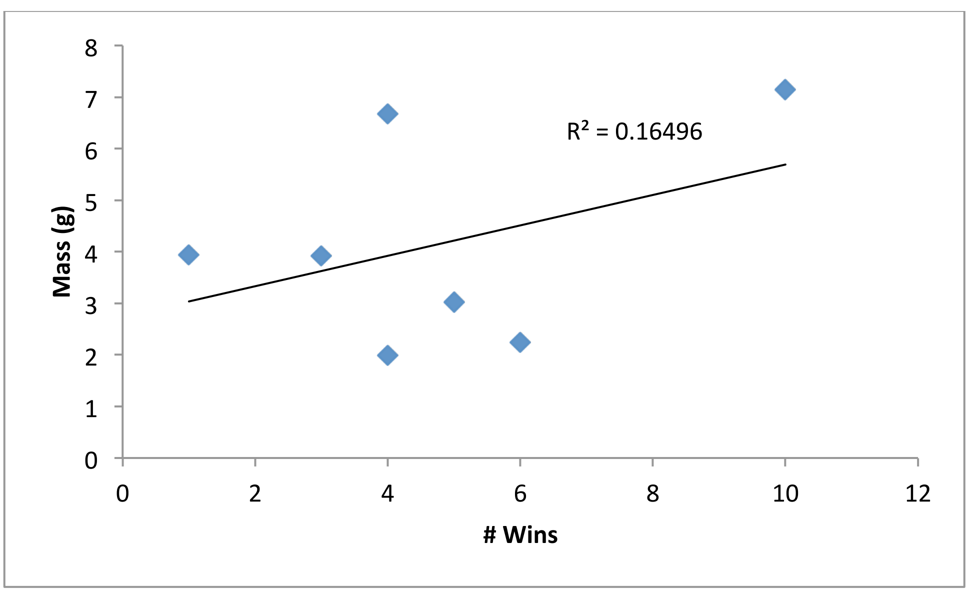

Figure 2: Correlation of crayfish mass to the total number of wins observed in competitive bouts.

Analysis of the habitat size in comparison to the aggression level of each bout showed there was a significant difference between aggression values in each arena size (t=2.02, df= 41, P=0.0181; Fig 3).

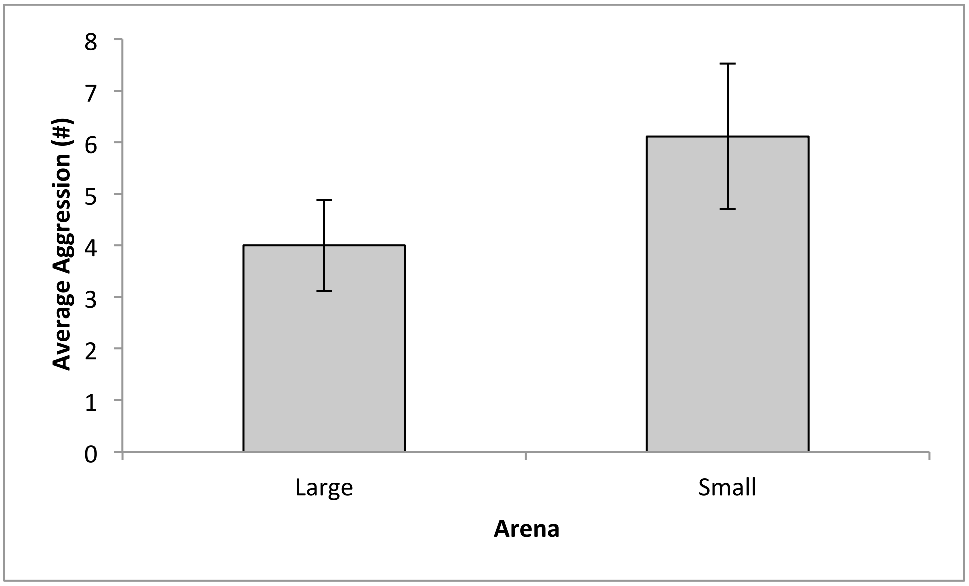

Figure 3: Mean (± 1 SE) aggression levels of crayfish compared to arena size. The large arena was the large tub with surface area of 1816.5cm^2, and the small arena was small tub with surface area of 518.48cm^2.

Discussion: Since a significant difference was seen in the varying territory sizes for the rusty crayfish, it can be concluded that aggression levels increase when available territory is reduced. These results support our original hypothesis, as well as the results of Bergman & Moore (2005). However, the outcome of these bouts relies on more than size. No significant correlation was found between crayfish mass and overall aggression or number of wins. As with many other organisms, other chemical and physical factors affect the competitive behavior of crayfish, such as chemical cues and previous competitive outcome (Moore & Bergman, 2005). These variables play crucial factors in the determination of dominance, especially when territory is limited, and might explain why no correlation was found between body size and aggression scoring. The access to such resources is a key factor in the survivability of organisms, establishing social dominance and increasing overall fitness (Klar & Crowley, 2011). Still, with all the present variables such as resource availability and levels of activity, it is difficult to accurately predict territorial behavior. Possible future studies could analyze how time of day affects crayfish levels. Crayfish are known to be nocturnal and sensitive to olfaction (Breithaupt & Eger, 2002). It is possible that a difference in aggression will be seen at night when crayfish are most active.

Literature Cited:

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