

The Effect of Size Asymmetry on the Expression of Territoriality in Northern Crayfish (*Orconectes virilis*)

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Abstract

Territoriality in female northern crayfish, *Orconectes virilis*, was studied through the observation of resident-intruder crayfish pair interactions based on size asymmetry. Resident-intruder pairings were chosen among 18 crayfish, with a total of 51 asymmetric interactions observed. Resident crayfish were allowed to establish themselves immediately within shelters, followed by the placement of intruder crayfish within the territory of the resident. One of three possible interactions was noted for each resident-intruder pair and shelter, including resident eviction, resident-intruder union, or resistance of intruder. It was found that resident-intruder pairs having high percent size asymmetry resulted in high eviction rates of small residents by large intruders.

Introduction

Territoriality is a phenomenon that is often exhibited in scenarios of competition (i.e., limited resources, mates), aggressive dominance between same- or opposite-sex individuals, and prior ownership of a resource (i.e., shelter), leading to aggressive interactions and either loss or preservation of ownership in many cases (Capelli & Hamilton 1984; Vorburger & Ribi 1999; Usio et al. 2001). Analysis of various interactions among animals that exhibit territoriality reveals another related phenomenon known as the “prior residence effect”, in which the owner of a shelter has an advantage over an intruder (Braddock 1949). This related phenomenon has been demonstrated in several decapod crustaceans, including lobsters, prawns, crabs, and crayfish. Studies focused on territoriality, specifically in terms of shelter competition, of crayfish have shown that the importance of shelter for crayfish is well known, as shelter possession directly

influences individual survival, especially through decreased risk of inter- and intra-specific predation (Figler et al. 1999). Furthermore, obtaining and retaining possession of a shelter typically involves aggressive competition, and one of the most reliable predictors of such competition is relative size, where larger individuals will win aggressive encounters against smaller individuals except when the size difference is minimized (Figler et al. 1999). In addition to size asymmetry, it has also been shown in crayfish that the initial resident of a shelter has a social dominance advantage over a subsequent intruder, which defines the prior residence effect (Braddock 1949; Peeke 1995). The purpose of this study was to analyze territoriality by determining the percent size asymmetry for which resident-intruder interactions would result in the highest probable eviction rates of resident crayfish.

Materials and Methods

Female crayfish were caught from Lake Itasca (Clearwater County, MN) using hand held nets, with 21 total crayfish kept for the purpose of this study. All crayfish were fed moist dog food and housed for 15 h in a holding tank (39 cm wide x 55 cm long x 29 cm deep) containing four small clay flower pots, various rocks, and freshwater from Lake Itasca. Measurements of carapace length (cm) for each individual female were taken and recorded, and all crayfish were individually marked with unique symbols using nail polish. Resident-intruder pairings were chosen among 18 of the 21 available crayfish, creating 51 pairings that resulted in 10 ranges of size asymmetries varying from 4% to 109%. Four 5-gal buckets (28.5 cm diameter) were set up for observing resident-intruder interactions, each containing one shelter (Styrofoam[®] cup measuring 6 cm wide x 6.4 cm long x 2.9 cm tall) and a depth of 1 in of freshwater. Female resident crayfish were individually placed directly in front of a shelter, allowing for immediate establishment of residency. Intruder crayfish were individually placed in front of the shelter of

their resident match, and immediate resident-intruder interactions were observed. One of three possible interactions was recorded for each pair: resident crayfish was evicted from shelter, both crayfish joined together in same shelter, or resident crayfish resisted intruder. Data for resident evictions were combined and compared against data for no resident evictions, and average percent asymmetry for each of these groups was also calculated. These data were analyzed using a statistical t-test, and a graph comparing evictions versus no evictions based on average percent asymmetry was created. Further analysis of our data included a graph comparing cumulative eviction rates based on percent asymmetry.

Results

We found that there is a statistically significant difference between size asymmetry of female crayfish when resident evictions occur versus instances when no resident evictions take place ($t = 2.01$, $df = 49$, $p = 0.0435$; Fig. 1). On average, it was found that resident crayfish were evicted from shelters when size asymmetry was 63.7% between resident-intruder pairs, while both resident and intruder crayfish joined one another in a shelter (no evictions) when size asymmetry was 45.3% between pairs.

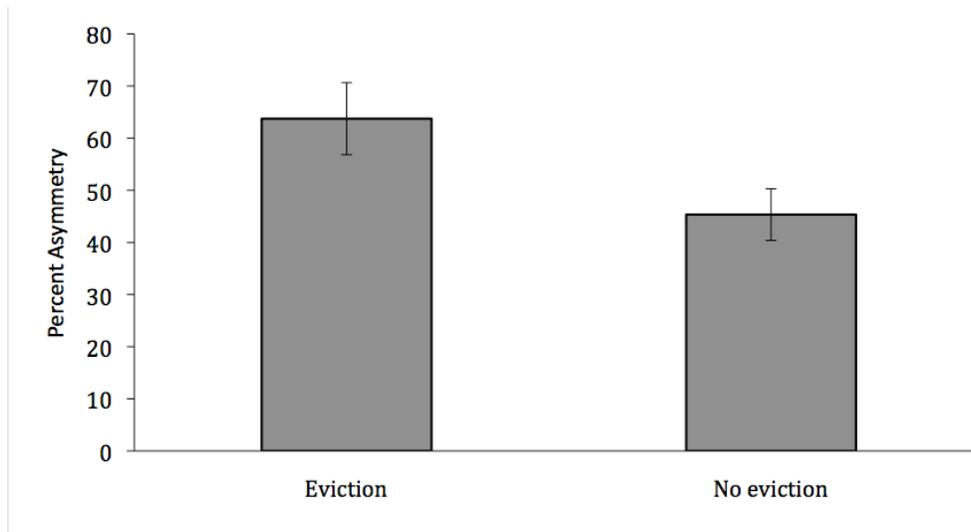


Fig. 1: Mean (± 1 S. E.), percent asymmetry for evictions and no evictions

Analysis of cumulative eviction rates for resident-intruder pairs was determined by calculating the sum of all resident evictions throughout all 51 resident-intruder pair interactions, and then using these sums to calculate the rate for which resident evictions occurred. We found that no resident evictions occurred between pairs differing by 4% to 21% size asymmetry, and that resident eviction rates took place most often when resident-intruder pairs differed by more than 67% size asymmetry. (Fig. 2).

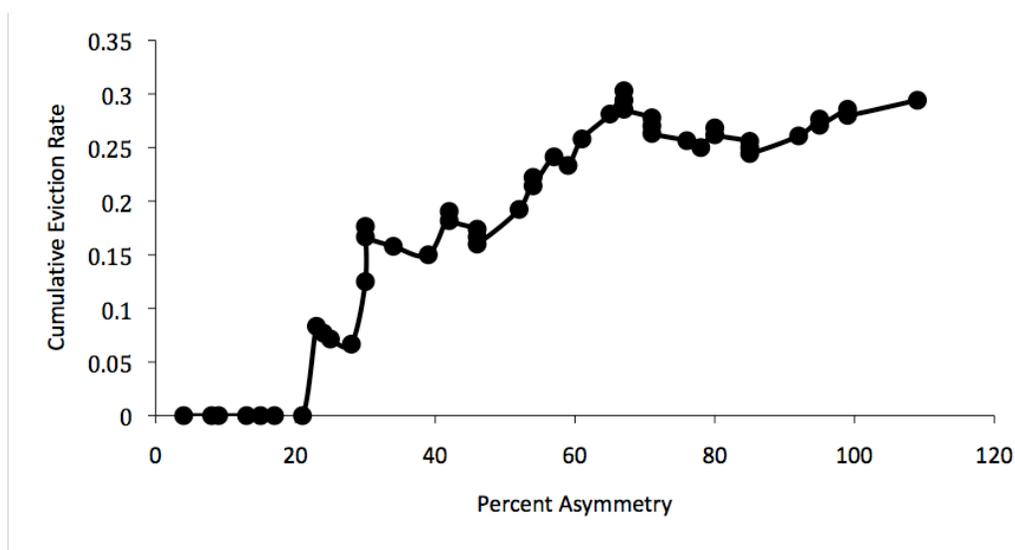


Fig. 2: Cumulative eviction rate based on resident-intruder percent asymmetry

Discussion

We found that resident-intruder pairs having high percent size asymmetry resulted in high eviction rates of small residents by large intruders in comparison to similar-sized resident-intruder pairs. Similar results in regards to resident-intruder pairs with high percent size asymmetries and resident evictions were noted in another study among juvenile red swamp crayfish (*Procambarus clarkii*), in which relative size was significantly related to contest outcomes (Figler et al. 1999). Among resident red swamp crayfish that were the same size as intruders, residents won a significantly higher proportion of encounters in comparison to residents that were smaller than intruders (Figler et al. 1999). Although our study did not find significant data supporting resident victories over similar sized intruders, we did find that small resident crayfish were more likely to be evicted upon intrusion of a large crayfish. Rather, our data showed that a minimum percent size asymmetry of 21% was required for resident evictions, and that resident eviction rates were shown to increase steadily over a percent size asymmetry range of 21% to 67%. Furthermore, high resident eviction rates were found to take place over a percent size asymmetry range of 67% to 109%. Aside from size asymmetry, prior ownership of a shelter is also known to be a determining factor of territoriality and contest outcomes, as a size disadvantage has been shown to be well-compensated for by actual possession of a shelter (Usio et al. 2001). Also, in regards to contest outcomes and prior ownership, it has been proposed that, when fighting costs are high relative to the payoff from winning, prior ownership should determine the outcome (Usio et al. 2001). Using prior residence effect to understand territoriality has shown, however, that true territoriality strengthens the position of an individual holding an area as time passes, while the effect of prior residence lessens over time (Braddock 1949). Furthermore, there are other factors that have been shown to predominate in situations of

resident-intruder interactions as the intruder becomes more familiar with the resident's territory, including the gender(s) being tested, hunger state, time of season (i.e., breeding), and molting (Braddock 1949). Taking these factors into consideration, as well as the time frame for which resident-intruder interactions took place within our study, it would be interesting to examine how resident territoriality varies with an extended time period of acclimation for resident crayfish. Combining resident acclimation time with an extended time period of resident-intruder interactions, it would be interesting to note how or if the number of shelter defenses (intruder evictions) or losses (resident evictions) by resident crayfish would be affected. Because we only tested the effect of size asymmetry and territoriality for females, conducting the same study for male northern crayfish would allow us to compare the percent size asymmetry needed for females versus males in regards to predicting resident eviction rates.

References

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