

Home Field Advantage in Rock Bass, *Ambloplites rupestris*, and What Doesn't Cause It.

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Abstract

Home field advantage is an evolutionarily stable strategy in which the convention of “resident will attack and intruder will flee,” is upheld in a population. The Rock Bass, *Ambloplites rupestris* is a territorial member of the centrarchid family. When intruders are introduced into the territory of a resident bass, the resident bass will show agonistic behaviors towards the intruder, and the intruder will flee. This paper focuses on determining whether there is a pheromone or chemical released into the water by a resident bass to label itself as the ‘owner’ of a territory. Our experiment found no indication of such a hormone which indicates that the home field advantage convention followed by the rock bass is established by environmental cues other than pheromones released into the water.

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Introduction

Evolutionarily stable strategies, when adopted by the majority of a population, cannot be bested by any other strategy. In common practice, the conditional strategy of, “if you are the resident, attack; if you are the intruder, retreat,” can be an evolutionarily stable strategy for a population (Dawkins, 78). In The Selfish Gene, Richard Dawkins addresses home field advantage as an evolutionarily stable strategy. Home field advantage was previously explored in the interactions between territorial wood butterflies. In these interactions, the individual with the home field advantage (the resident) removes the intruding organism (Davies, 1978). Within the infraclass Teleostei is the three-spined stickleback (*Gasterosteus aculeatus*). When a male stickleback encounters another stickleback within his territory, he will chase the intruder out, and the intruder will flee to avoid the fight (Tinbergen and Van Iersel, 1946). When the roles are switched and the intruder becomes the resident, the new resident will chase the former resident (now the intruder) from his territory (Tinbergen and Van Iersel, 1946). This indicates that the victor in these territorial interactions does not win because of physical prowess or superiority, but from following the convention of ‘if you are the resident attack, if you are the intruder flee.’

Members of the sunfish family (centrarchidae) show territoriality and agonistic behavior (Casterlin and Reynolds, 1978). Casterlin and Reynolds performed their research on the Blue Gill (*Lepomis Macrochirus*) which is a close relative of the focus of our study, the rock bass (*Ambloplites rupestris*). The question that we pursue in our experiment is, does the rock bass secrete a hormone that labels the fish the resident? Centrarchids have the ability to detect chemical cues in the water that can trigger anti-predator or foraging behavior (Goloub et al; 2005). Research is limited on agonistic interactions of rock bass and on the amount, if any, of

hormones that they secrete. Our experiment focused on determining whether rock bass secrete a pheromone into the water after establishing a territory that labels it as the resident. We hypothesized that rock bass secrete pheromones into the water that labels the aquatic region as its home field, and that the resident bass would display aggressive behavior more frequently than the intruder bass, when present in its 'home field' water.

Materials and Methods

The first step that we took in our experiment focused on determining which species of centrarchidae we wanted to observe. After observing intraspecific interactions of rock bass, bluegills and pumpkinseeds (*Lepomis gibbosus*) we decided to conduct our research using rock bass. The other centrarchid species that we observed displayed relatively limited interactions when compared to the rock bass, and because of these limited interactions, their agonistic displays were much more difficult to observe.

On 25 July, 2009 we obtained rock bass using a 100 foot purse seine in the boat well of the University of Michigan Biological Station on the southwest corner of South Fishtail Bay, and placed 15 of them into stock tanks. Of these 15 bass, 4 pairs were generated by size estimates, and separated into Aquaculture ten gallon sister tanks (e.g. labeled tank 1A and 1B, the bass within referred to by the same nomenclature). Each tank contained a bed of sand, a piece of broken clay pot, a bubbler and a filter that received air from a Second Nature Challenger II air pump. We fed our specimens twice daily with Colorfin Sinking Granule fish food.

In concordance with another experiment being carried out by a group of undergraduate researchers at the U of M biological station (Bartley F. and Saran S. unpublished), we shared experimental setup and data. When the paired sister fishes were placed into their respective tanks

they were allowed 12 hours to equilibrate before an interaction was initiated. After the equilibration period, we took one of the fish from the pair, referring to it as “intruder bass,” and placed it into the tank of the other member, referred to as the “resident bass.” The paired fishes each had an interaction as the intruder and as the resident to eliminate the possibility of having a series of fish that were simply more dominant than the other fish present.

To begin investigating the presence of a pheromone in the establishment of residency we began with the control of our experiment. We took water from Douglas Lake and filled an empty tank. We then took both bass from a pair and placed them into the third tank and observed interactions. Initially the bass would pay no attention to each other, but would focus on us as we observed them. To correct this problem we began observing them through a large sheet of cardboard with holes cut in it for us to see through. After we finished the controlled interactions we began testing for a hormonal effect. We removed both fish from their tanks, siphoned the water out of the ‘resident’ tank into the third empty tank, and then simultaneously placed both bass into the third tank, and recorded the interactions. The fish that had been equilibrated in the tank that the water came from was the resident, and the fish that was new to the water was the intruder. Criteria of agonistic interaction were thrashing motions, charges, erection of the dorsal fin (Reynolds and Casterlin, 1979) and nips, which we observed but were not referred to by Reynolds and Casterlin.

Each interaction was allowed a 10 minute duration and all interactions were paired, allowing both fish to be the “resident” and the “intruder.” After recording eight interactions on August 3rd, we realized that the filters in our tanks had activated charcoal in them which can denature hormones. We removed the filters and allowed the bass to re-equilibrate in the tanks for

an additional twelve hours to correct for this and resumed testing in the morning on August 4th, completing 10 total interactions of 5 pairs.

I generated a graph to show the differences between the interactions of the different test groups (figure 1) of tank resident, control, and water resident using the occurrence of nips, thrashes, charges and raising of the dorsal fin. Within our experimental group of water resident and intruder, I analyzed whether behavioral responses differed between test groups via X^2 analysis, looking at the number of agonistic interactions of the residents vs. the number of interactions from the intruders between test groups of tank resident, water resident, and control.

Results

The agonistic interactions observed in the tank resident experiment far outnumber the agonistic interactions of the water resident experiment (figure 1). The combined total of agonistic interactions in the 10 runs of the water resident experiment added up to 47, counting those shown by the resident and the intruder, averaging out to be 4.7 agonistic actions per interaction. The 30 runs of the tank resident experiment showed 875 agonistic interactions between the resident and the intruder, averaging out to be 29.17 agonistic displays per interaction. Of the 30 tank resident interactions recorded, 26 of them observed the resident fish showing the most agonistic displays (X^2 , $p=0.0026$. Bartley and Saran unpublished).

In our water resident experiment, one pair of rock bass accounted for 46 of the data points recorded. Of the 46, all were displayed by the bass from tank 3B. Our X^2 analysis on the data supported the null hypothesis that agonistic displays from bass in our experiment were random and not initiated by the fish that was the water resident except for fish 3b (table 2). If the values for these data are recalculated discounting the interactions of bass 3B, the test supports the

null hypothesis that interactions in the water resident experiment will be purely random and that no fish will act as the 'resident' (table 2).

Discussion

The data compared between the two experimental setups suggest that the difference between the average interactions between groups is significantly different. The tank resident experiment saw about 5 times as many agonistic displays per interaction as our water resident experiment, even when counting the 3b outlier bass. When the outlier is removed from the data, the tank resident experiment averages 29 times more agonistic displays per interaction than the water resident experiment.

The lack of interaction in the water resident experiment, when compared to the tank resident experiment, indicates that our hypothesis that, that rock bass secrete pheromones into the water that labels the aquatic region as its home field, and that the resident bass would display aggressive behavior more frequently than the intruder bass, when present in its 'home field' water, can safely be rejected. Not only did our experimental interactions differ from the observed proportion of the resident winning in 26/30 tank interactions, our fish (when discounting the outlier interactions) showed essentially no agonistic interactions. Although it is possible that our fishes had such limited interactions because they were shocked from being handled and transferred to different tanks this is unlikely. The same handling techniques were applied in the resident tank experiment, to control of any effect that handling of the resident would have on the robustness of agonistic response.

Our experiment has fairly safely eliminated the idea that there is a pheromone present in the water that rock bass release, but it leaves the question of what part of the environment

indicates which bass is the resident and which bass is the intruder. Our experiment shows that there is not a pheromone present in the water, and the resident tank experiment shows that there is home field advantage displayed by rock bass through agonistic interactions. The creation and constant secretion of a pheromone in the water would be a waste of energy and resources for a fish, because, as the environment is constantly flowing and diffusing, any pheromones in the water would be quickly diluted. Having eliminated the water as carrying a chemical that identifies a territory, there are few options as to what the bass use to identify one as the resident and the other as the intruder so faithfully.

Interestingly, in the resident tank experiment, the environments were controlled for to have nearly the exact same structural aspects. Perhaps the bass base the convention of, “if you are the resident attack, if you are the intruder flee,” on some visual cues from the environment. Possible further studies could include testing whether there is something in the waste that a bass produces that precipitates into the sand and labels a bass as the resident. Regardless of the reason for this convention, it appears as though the bass follow the evolutionarily stable strategy that the resident will attack and the intruder will flee.

Table 2.

Shows the p values of the X2 test that I performed on the data set. The highlighted values are the data points generated by bass 3b (which was responsible for 46/47 recorded data points.) When discounting the pair of the outlier pair it is clear that there is essentially no interaction between bass when placed into a third tank containing 'resident water.'

manip.	R bass	R Charge	R Dorsal	R Thrash	R Nip	I Charge	I Dorsal	R Thrash	R Nip
water	5B	0.438578	0.654721	0.215663	0.527089	0.605554	0.796204	0.465223	0.605689
water	5A	0.438578	0.654721	0.215663	0.527089	0.605554	0.796204	0.465223	0.605689
water	2B	0.438578	0.654721	0.666844	0.527089	0.605554	0.796204	0.465223	0.605689
water	5A	0.438578	0.654721	0.215663	0.527089	0.605554	0.796204	0.465223	0.605689
water	2A	0.438578	0.654721	0.215663	0.527089	0.605554	0.796204	0.465223	0.605689
water	5A	0.438578	0.654721	0.215663	0.527089	0.605554	0.796204	0.465223	0.605689
water	3B	2.12E-27	0.654721	7.57E-24	8.42E-19	0.605554	0.796204	0.465223	0.605689
water	2B	0.438578	0.654721	0.215663	0.527089	4.86E-13	0.000302	1.54E-24	4.86E-13
water	3A	0.438578	0.654721	0.215663	0.527089	0.605554	0.796204	0.465223	0.605689
water	2A	0.438578	0.654721	0.215663	0.527089	0.605554	0.796204	0.465223	0.605689

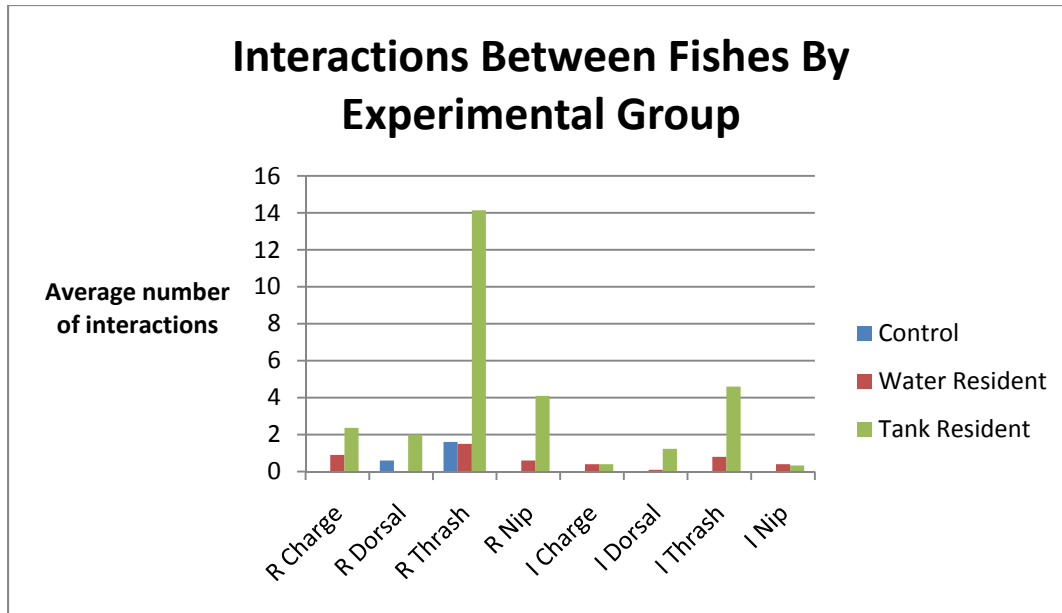


Figure 1.

Is a graphical representation comparing the various average interactions observed in the test groups. From this graph it is evident that the tank resident experiment observed many more agonistic displays than the water resident, or the control.

Citations

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3. Reynolds & Casterlin, (1979). Agonistic Displays In The Rock Bass, *Ambloplites rupestris*. *Hydrobiologia*, 65(1), 19.
4. Tinbergen, N., and J.J.A. Van Iersel. "Displacement Reactions In The 3-SPINED Stickleback." *Behavior* 1.1 (1948): 56-63. *Ingenta Connect*. Web. 13 Aug. 2009. <<http://www.ingentaconnect.com/content/brill/beh/1948/00000001/00000001/art00003?token=005219e7146f1ec4f5a666f3a7b2f7c40446f7c4774527a3f3b49264f652330434f58762f462412549>>.\
5. (Bartley F. and Saran S., Unpublished Research, 2009)