



Chemical cues, 3-D structure, and social experience in contests between similarly sized juvenile black Midas cichlids, *Amphilophus* sp. 'short'

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ABSTRACT

Juvenile Midas cichlids are not territorial or remarkably aggressive under natural conditions but become extremely aggressive when placed in small aquaria. The potential effects of prior experience with 3-D structure, recent social interaction, and chemical cues on determining the outcome of contests between juvenile Midas cichlids were tested under laboratory conditions. Fish with a clay pot in their pre-test tanks defeated opponents without such prior experience when test tanks contained an identical pot. Experience in a small group of conspecifics had no significant effect on contest outcome, although fish that held lower size ranks tended to lose contests. Conspecific chemical cues did not affect the outcome of contests. Thus, although juvenile Midas cichlids are not typically aggressive they are sufficiently plastic not only to behave aggressively under certain conditions, but to adjust aggressive behavior according to prior experience with environmental structure as do some animals that are naturally territorial.

INTRODUCTION

Prior experience with the local or social environment may alter the probability that an individual will defeat an opponent. A prior-residence effect is an agonistic advantage to animals fighting in familiar locales. Prior social experience in a subordinate role generally results in a decreased probability of attaining dominance in subsequent contests, while prior experience in a dominant role usually has little or no effect [Francis, 1983]. Fishes that are not especially aggressive in their natural environments may nevertheless behave aggressively when space or number of competitors are limited [Grant, 1993], as they may be under captive conditions. It is unknown whether such fishes adjust social behavior according to prior experiences as do some fishes that typically behave aggressively. Under natural conditions Midas cichlids behave aggressively only while defending breeding territories [Barlow, 1976]. Juvenile *Amphilophus* cf. *citrinellus* have been observed in Lake Apoyo, Nicaragua not to be attached to specific sites and performing only modest levels of aggression [Oldfield et al., 2006]. However, under captive conditions that limit available space and numbers of competitors they become extremely aggressive [Oldfield, 2007].

Hypotheses:

Prior Residence-

- (1) familiar chemical cues will cause fish to defeat naïve opponents
- (2) the presence of a familiar structure will cause fish to defeat naïve opponents

Prior Social Experience-

- (1) recent dominant experience will not affect future contests
- (2) recent subordinate experience will cause fish to be defeated by naïve opponents



Adult male *Amphilophus* sp. 'short', caught in Lake Apoyo, Nicaragua, that fathered the offspring used in this study.

MATERIALS AND METHODS

Two broods of Midas cichlids from a strain recently identified as *Amphilophus* sp. 'short' [McKaye et al., 2002] were produced at the University of Michigan Museum of Zoology from one male and one female collected in Lake Apoyo, Nicaragua. Fish were sedated in MS-222, weighed, measured, and branded with silver wire that had been cooled with dry ice. Fish were pair-matched for body size based on body mass and standard length (SL) and placed individually in 38 l pre-test aquaria for 2-4 days. One member of each pair was assigned the role of subject and the other designated as its opponent.

Control

After the pre-test period, each subject and its opponent were placed simultaneously into a third aquarium identical to the pre-test tanks.

Prior Residence

Chemical cue experiment: The two fish were netted from their tanks and both fish were simultaneously released back into the tank from which the subject had been taken.

3-D structure experiment: The pre-test tank of each subject contained a clay pot, while the pre-test tank of each subject's opponent did not possess a pot. The fish were netted out of their pre-test tanks and placed into a test tank that contained a pot identical to the pot in the subject's tank.

Body size in subjects. Standard length (mean±SE) was not different between winners and losers within each treatment (t-test). In addition, of the pairs in each treatment in which the subject and its opponent were slightly mismatched for size, the number of winners that were larger than their opponents was not significantly different than expected by chance (binomial test).

Treatment	n	SL (g), winners	SL (g), losers	t	p	# unequally sized pairs	# where winner was larger	p
Control	10	5.7±0.2	5.7±0.2	0.031	0.976	5	2	1.000
Chemical	10	5.6±0.2	5.6±0.2	0.227	0.823	5	0	0.063
Clay pot	12	6.4±0.3	6.4±0.3	0.042	0.967	5	2	1.000
Dominant	12	6.8±0.2	6.8±0.1	0.120	0.905	11	6	1.000
Subordinate	12	5.7±0.3	5.6±0.3	0.194	0.848	10	8	0.109

RESULTS

Numbers of trials in which the subject defeated its naïve opponent, and significance as determined by the binomial test. Also included are summary statistics for the latencies to initiate aggression and the contest durations for each treatment. For these measures, significant differences between each experimental group and the control group were tested with a non-parametric multiple comparisons procedure [Zar, 1999].

Treatment	n	# won by subject	p	latency, min. (mean±SE)	p	duration, min. (mean±SE)	p
Control	10	6	0.754	1.71±0.26	NA	20.59±5.00	NA
Chemical	10	6	0.754	4.68±2.13	>0.50	41.89±6.63	0.50
Clay pot	12	12	<0.001	12.98±4.56	0.02>p>0.01	7.97±2.33	0.20>p>0.10
Dominant	12	5	0.774	4.14±0.70	0.20>p>0.10	20.75±6.09	>0.50
Subordinate ¹	12	3	0.146	5.41±1.55	0.20>p>0.10	24.91±8.66	>0.50

¹ All three of the subordinate winners had held the rank as the third largest fish in their respective groups. A post hoc analysis restricted to the eight groups in which the test fish was smaller than most of its group-mates (size rank 4, 5, or 6 in a group of 6) showed that all eight subjects were defeated by isolates (binomial test: p = 0.008).

Prior Social Experience

The subject of each pair was held in a pre-test tank with five or six other fish while its opponent was held in isolation. All fish in each social group had been weighed and measured so that the relative size of each group-held subject was known. In the dominant social experience experiment, each subject was the largest member of its group. In the subordinate social experiment, each subject was smaller than the largest fish in its group. No effort was made to position subjects at any particular subordinate rank. After the pre-test period, each subject and its opponent were placed simultaneously into a third aquarium identical to the pre-test tanks.



A juvenile *Amphilophus* sp. 'short' used in this study.



Laboratory at the University of Michigan Museum of Zoology in which the experiments were performed.

CONCLUSIONS/DISCUSSION

Experience with a pot caused subjects to win contests. This is consistent with studies on other species involving 3-D structure [Nijman and Heuts, 2000]. Chemical signals were expected to cause a prior residence effect, but our null finding is consistent with Bronstein's [1985] tests involving *Betta splendens*. Recent social experience did not significantly affect an individual's ability to overtake competitors, although experience as a relatively small member of a group suggested reduced dominance potential.

There was extreme variability within experiments in latency to initiate aggression and in contest duration. The increased latency observed in the ceramic pot treatment may have been due to the pot blocking visual contact [Bronstein, 1983]. Durations involving pots were not significantly different than in controls, but the lower mean might be a result of an aggression asymmetry between opponents.

Animals that are not remarkably aggressive under natural conditions may have the ability not only to behave aggressively under certain conditions, but to modify aggression according to prior experiences, as do some animals that are typically aggressive in nature. The increased chance of winning an aggressive contest after experience with a ceramic pot suggests that subjects may have identified an identical pot as a resource to be defended.

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