

Measuring aggression and threat-sensitive behavior in juvenile cod differing in size and nutritional state

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Absolute and relative differences in size and nutritional state may influence the social behavior and decision-making of individuals within a group. In the present study, individual feeding and swimming behaviors as well as aggressive interactions between two Atlantic cod, *Gadus morhua*, individuals of varying size and nutritional status were quantified. The aim of the study was to compare the relative influence of a change in nutritional status due to food deprivation (intrinsic factor), of absolute and relative size differences, and of nutritional state of the opponent (extrinsic factors) on aggression and threat-sensitive behavior in cod during the vulnerable juvenile stage. Aggressive behaviors, feeding incidence and swimming behaviors were scored and collected using the manual event recorder The Observer Video-Pro [1] and the automatic tracking system EthoVision [1].

The study was performed at the Tromsø Aquaculture Research Station (70° N), northern Norway. The behavioral effects of one to four days of food-deprivation and size differences (25 to 80 % relative weight difference) were investigated in pair-wise interactions with juvenile (0.7- 1.7 g) hatchery-reared Atlantic cod. The effects on behavior of food-deprivation in the smaller fish, food-deprivation of the larger opponent and the relative size differences were examined in thirteen different trial combinations where opponents varied in size and nutritional state. A total of 221 trials were conducted, testing 442 fish during the experimental period from 11 December to 23 December 2003.

Eight pair-wise trials were performed simultaneously in eight small aquaria (15.3 × 28.7 cm). Four cameras were mounted above the tanks, each recording fish in two aquaria. The walls and bottom of the aquaria were covered with non-reflective plastic film, reducing surface reflection. A white sheet surrounding the aquaria reduced the outside disturbance. The water inlet and outlet was on one short side of the aquaria, with a mesh preventing access to this area, and a plastic tube was positioned on the opposite side, extending down to 0.5 cm above the bottom from outside the white sheet. Feed could be delivered through the tube during the trials, keeping it in a specific area defined as the food zone of the trial arena in Ethovision. The food zone (15.3 x 10.0 cm) was one third of the trial arena. Prior to the trials the fish to be tested were carefully transferred to separate rearing tanks, and were not fed. Trials were run on four subsequent days allowing one or both of the contestants to be fed or food-deprived for either

one, two, three or four days. Two fish, one large and one small, were introduced into each aquarium, and the fish were filmed continuously for 90 minutes. Food was supplied 60 minutes after trial initiation. At termination of the trial, weight and length was measured for each fish.

A fifteen-minute sub-sample of each trial recording was analysed, including the five minutes prior to supplying feed and the ten minutes after feeding. Individual aggressive and feeding behavior were manually scored using The Observer. Feeding and aggressive behaviors were recorded, pooling the aggressive behaviors charge, chase and bite [2], as were the receivers reactions to these behaviors (flee, hide, no reaction). The performer and receiver of aggressive behaviors were identified. Behavioral data on percentage of total available time spent in the food zone, frequency in the food zone, distance between the large and small fish, and swimming behavior were collected by use of EthoVision. Swimming behaviors include mean swimming speed, and time spent approaching and approach speed towards the small fish by the large fish.

The study suggests that large, dominant fish were consistently far more aggressive than smaller, subordinate fish, and foraged more frequently when food-deprived. Food deprivation did not increase the feeding frequency of small fish, but food-deprived small fish spent more time in the food zone than their larger, fed opponents. This suggests an increased interest in food and a change in threat-sensitive behavior. Food-deprivation of up to four days had no effect on the frequency of performed aggressive behavior and few effects on swimming behavior of either opponent. The results suggest that differences in size between opponents are a stronger influence on threat-sensitive behavior in juvenile cod than nutritional state. The benefit of risk-prone behavior in small, subordinate cod that has been food-deprived for up to four days is overruled by the cost of performing such behavior when the opponent is relatively larger.

References

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