Modulation of Aggression in Betta spendens

Photos of displaying male Siamese Fighting Fish

Siamese Fighting Fish (Betta splendens) have been bred in southeast Asia for centuries for aggressive confrontations; consequently, males must be housed individually. Females are smaller and less colourful and can be housed in groups. They are air-breathers, and perhaps that is why they can inhabit murky freshwater irrigation channels and agricultural marshes of Thailand and other warm places in southeast Asia.

Modulation of males' display toward other males who are either “winners” or “losers”.

Males vary in intimidatory and fighting ability. Since fighting can be very costly even for the winner, one might anticipate that male Betta splendens would modulate their aggressivity in response to evidence of the likelihood of winning or losing an aggressive confrontation with another male. A recent study, “Know thine enemy: fighting fish gather information from observing conspecific interactions”, Proc. Royal Society of London 1997, has shown that male Bettas do display differently toward a male they have observed “win” versus “lose” in an encounter with another male.

Very little is known about the behaviour of Betta splendens in the wild. There are two reasons why we might anticipate that the males would be quite territorial in the wild: (1) they are very aggressive toward other males, (2) males build bubble nests for the fertilized eggs and subsequently protect and care for the young until they leave the bubble nest. Fights between male Bettas can be prolonged and deadly so information about your prospects of winning is valuable in deciding to challenge another male.

We will test the hypothesis developed in the Oliveira et al. (1997) paper that observing the outcome of an encounter between two males will modulate our test male's aggressiveness toward the "winner" versus the "loser".

Here are four hypotheses to test:

1. Observer males will spend more time within 5 cm of the clear divider -- watching the interacting males -- than in other parts of the tank.
2. When the observer male encounters one of the fish he has just observed his latency to make an aggressive display toward the "winner" will be longer than the latency to display toward the "loser".
3. Furthermore, the intensity of the observer's display (number of aggressive lunges, total time showing gill erection, bites at the divider) toward the loser will be greater than toward the winner.
4. When the observer fish is "matched" for aggressivity with the aggressivity of the stimulus fish (winner or loser) then the subsequent aggressive challenge will continue longer than if the observer fish is clearly more aggressive or clearly less aggressive.

Methods
The Betta splendens males are individually housed in 1 L bowls where the temperature is maintained at 26-27°C and the lights are on a 14:10 light:dark cycle. They are fed daily with a pinch of Tetramin Betta food. Females are maintained in the same manner but they are housed in groups of 8 in 37 L tanks.

The behavioural testing tanks are 37 L tanks divided into thirds with the end compartments divided in half again. The partitions are made of clear Plexiglas with removable opaque dividers. Small lamps are used to make the end compartments brighter than the center compartment and thereby reduce the visibility of the observer fish to the stimulus fish.

Our procedure will entail three parts:

1. Prior to choosing which fish will be assigned the role of observer or stimulus fish, we should assess the aggressive inclinations of all potential subjects in our study. This will be done by placing a small mirror in front of the Betta bowl for 2 minutes and recording (a) the latency to respond to the reflected image with a gill erection, (b) the total number of seconds that the gills were erected facing the reflection. These data will be used to rank the males according to our aggressivity indices. We will pair males who differ substantially in rank in order to assure we will have a "winner" and a "loser". We can either choose males for test subjects (observer males) who rank in the middle, or use males who are likely to be as aggressive as the winner or the loser. This mirror assessment is unlikely to predict winners and losers perfectly, but it should work better than body size as adult male Bettas available from suppliers do not vary much in size.

2. The second part of our experimental procedure involves the test fish observing the interacting stimulus fish for 10 minutes. First, we'll let all three fish acclimatize for 20 minutes to the tank. Opaque partitions will prevent them from seeing each other. These opaque partitions are removed for the observation period of 10 minutes. Remove the barrier between the two stimulus fish before removing the observer male's barrier to ensure that the stimulus fish attend to each other. For the stimulus fish, you will record (a) the latency of each stimulus fish to respond to the other with gill erection, and the latency to approach although these two measures may occur simultaneously, (b) the total time the gills were erect, (c) the number of lunges toward the opponent fish (usually making contact with the Plexiglas partition), (d) the total time spent within 3 cm of the Plexiglas separating the opponent fish, (e) which fish withdraw from the other male (more than 5-6 cm) for at least 1 minute. For the observer fish, you will record the total time spent within 3 cm of the Plexiglas separating the interacting fish, as well as the observer fish's behavior. Three researchers will be needed to record these results simultaneously.

3. The third part of our experimental procedure involves testing our observer fish's response to the "winner" and the "loser" in 5-minute trials. The observer fish and one of the stimulus fish will be placed in the two compartments at the other end of the tank and allowed to acclimatize for 5 minutes behind the opaque partitions. The order of testing of "winner" and "loser" stimulus fish has to be counterbalanced. Again, the same measures of latency to gill erection, total gill erection time, total number of lunges, and total time within 3 cm of the partition will be recorded for the test fish and the stimulus fish (only 2 observers are required).

4. A control condition would replicate the experience of the stimulus interacting fish as described for Part 2, above, but the observer fish would not be allowed to see them. Then, the test fish would again be paired against the winner and the loser (counterbalance the order) but would not have had any prior opportunity to acquire information about the aggressivity of the male he is encountering while the stimulus fish have had the same kind of experience. All other aspects of the procedure would be the same.

In addition to computing descriptive statistics, data analyses will include paired t-tests or Wilcoxon match-pairs signed-ranks test to compare the responses and latencies of the observer fish toward the "winner" vs. the "loser". In the experimental condition, we should see a statistically significant difference in behavior toward winner vs. loser, but not in the control condition. We could also use a repeated measures MANOVA procedure where our independent or predictor variables are winner vs. loser and experimental vs. control and our dependent measures would be latency to respond, total gill erection duration, number of lunges, time within 3 cm of divider.
Non-paired or independent t-tests can be used to compare the responses of the two interacting fish to determine whether the responses of winners and losers were different; this can be done for both the experimental and the control conditions. We can also correlate (a) the responses of our test fish with the responses of the stimulus fish, (b) the mirror scores with the responses during the observed encounter and with the responses in the test encounter, (c) the responses during the observed encounter with the responses in the test encounter.

Questions and Issues to Consider:
What other factors are likely to affect the intensity of aggressivity a male Betta might display toward another male? What effects of body size or “territory” ownership or “presence” of gravid females might you anticipate with respect to “winning” or “losing” a confrontation with another male?

References