Applied Animal Behaviour Science 157 (2014) 146–151

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Aggressiveness and locomotion activity related to hatching time in Matrinxã, *Brycon amazonicus* (Spix and Agassiz, 1829)

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ARTICLE INFO

Article history:
Accepted 29 May 2014
Available online 6 June 2014

Keywords:
Aggressive behavior
Aquaculture
Swimming
Survival
Fish

ABSTRACT

Since agonistic interaction has been a major obstacle for fish hatchery and represents great economic losses for fish farmers, aggressiveness during the different post-hatching stages of the matrinxã, *Brycon amazonicus*, is analyzed and compared. Each group of three larvae was observed at six different sessions: 12, 24, 36, 48, 60 and 72 ± 2 h after hatching (HAH) for 20 min, with 10 repetitions for each treatment. Aggressive behavior and motor activity were described by an ethogram: approach, attack, chase, flight, frontal display, mouth fight, mouth opening, threat, circular and linear swimming, contact and Ω-posture. Biometric measurements have indicated an increase in total length and mass ($P < 0.001$). Number of aggressive behaviors (12 HAH: 95.80 ± 14.68; 24 HAH: 53.40 ± 20.99; 36 HAH: 12.40 ± 9.44; 48 HAH: 22.80 ± 18.89; 60 HAH: 35.20 ± 17.57 and 72 HAH: 92.40 ± 28.54, $P < 0.001$) and duration of motor activity (12 HAH: 1446.70 ± 160.70; 24 HAH: 453.10 ± 184.95; 36 HAH: 100.50 ± 42.18; 48 HAH: 22.8 ± 110.30; 60 HAH: 99.10 ± 23.83 and 72 HAH: 822.90 ± 361.28, $P < 0.001$) in the group was higher at 12 and 72 HAH. Results suggest that lower motor activity reduced the probability of encounters between larvae and, therefore, social interactions between group members of *B. amazonicus*.

1. Introduction

Aggressive predatory interactions may cause injuries or may result in partial or total intake (cannibalism) of conspecific fish (Folkvord, 1997; Kestemont et al., 2003). The behavior has been recorded in several species of fish under natural and/or artificial conditions (Hseu et al., 2003; Smith and Reay, 1991) and it has a significant impact on survival during the early stages of the animals' lives (Leonardo et al., 2008; Urbinati et al., 2008). High rates of aggressive behavior may cause injuries, trigger stressful conditions, increase pathogens, and lead to high mortality rates (Huntingford et al., 2006). According to Pickering and Christie (1981), stress in fish farming should be carefully taken into account because social interactions are more intense due to limited space, and are harmful for fish health.

Several factors, such as environmental parameters, animals' size, feeding rates and population density, modulate the frequency and intensity of fish mortality (Baras et al.,

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http://dx.doi.org/10.1016/j.applanim.2014.05.009
0168-1591/

2011; Ostrowski et al., 1996). In fact, the species *Seriola dumerili* tends to raise cannibalism rates in denser populations (Miki et al., 2011). The frequency of cannibalism in *Dicentrarchus labrax* and *Seriola quinqueradiata* is inversely related to feeding rate and size differences among individuals in the group (Katavic et al., 1989; Sakakura and Tsukamoto, 1998). Several strategies were adopted in an attempt to minimize cannibalism in captivity. They included different types and sizes of food (Lopes et al., 1995), thyroid hormones (Leonardo et al., 2008; Urbinati et al., 2008), different shapes and colors of the aquariums (Pedreira et al., 2006) and different stocking densities (Miki et al., 2011). However, the onset of agonistic behavior, which implies cannibalism as an outcome, during larval development in tropical freshwater fish species, is unknown.

Although featuring cannibalistic behavior, *Brycon amazonicus* (Spix and Agassiz, 1829), commonly known as matrinxã, is a species of high commercial interest for fish farming (in several regions of Brazil) because it grows fast, has good acceptance of artificial feed and presents high quality meat (Gomes and Urbinati, 2010). Under natural conditions, *B. amazonicus* may reduce the display of agonistic interactions because of the space available in the environment and dispersion of specimens. However, under artificial conditions, such as fish farms, the aggressive behavior increases, possibly because of overcrowding and confinement.

The larval development of matrinxã is extremely fast when compared to that of other freshwater South American teleost fish species. According to Romagosa et al. (2001), the matrinxã's embryonic differentiation is quick, with a short larval stage, and metamorphosis practically ends 36 h after fertilization.

Matrinxã's hatching has substantial technological barriers since larvae loss may reach 90% due to aggressiveness and cannibalism at this stage (Parazo et al., 1991), which hampers farming and causes huge liabilities. Although evidence indicates that aggressive behavior of matrinxã begins at the larval stage (e.g. Senhorini et al., 1998), there are no studies which describe and compare the agonistic interaction during different post-hatching stages of *B. amazonicus*. The identification of the display period of high aggressiveness will forward knowledge on the management of biotic and abiotic factors (e.g. temperature and luminosity) to reduce this behavior and therefore high fish mortality. Thus, ethological results will provide information that may be used to improve hatchery methods and thereby increase the efficiency of commercial farming of the species.

2. Materials and methods

2.1. Rearing conditions

The study was conducted at the Aquaculture Centre of the Experimental Farm of University of Amazonas, Manaus, Brazil. The crude carp pituitary extract, as described by Romagosa et al. (2001), was employed to achieve larval production from artificial propagation. After extrusion, fertilized eggs were placed in 35 L-incubators, with constant water exchange, temperature at 26.9 ± 0.5 °C, pH 7.45 ± 0.6, density 1 g of egg/L of water (~1 larvae/mL) and a 12 h light/dark-cycle photoperiod, starting at 0700.

Table 1
Ethogram of aggressive behavior for *Brycon amazonicus.*

Aggressive events	Description
Approach	An animal swims toward the opponent, without threat or physical contact
Attack	The aggressor strikes with the head of the opponent's body
Chase	One fish follows the opponent that swims (move more than one body length) in opposite direction
Flight	The attacked or chased fish moves away from the contest place
Frontal display	Both fish approach frontally each other, but without physical contact
Mouth fight	Both fish approach frontally each other with their mouths opened and bite the opponent's mouth. Their mouths are kept tightly together while one fish displaces the opponent backwards
Mouth opening	The larvae performs opening and closing movements of the jaw
Threat	The fish approaches the opponent, preparing for attack, but its opponent moves away

2.2. Experimental design

Experimental design comprised six observation sessions: 12, 24, 36, 48, 60 and 72 ± 2 h after hatching (HAH), each repeated 10 times. Zero time was considered the moment 50% of larvae was hatched (Romagosa et al., 2001). For each experimental treatment, three specimens were collected from the incubator and transferred (with 3 mL plastic pipettes) to a 2 cm × 1.5 cm glass bowl previously filled with 3 mL of water so that conditions could be maintained similar to the incubator (density 1 larvae/mL).

2.3. Behavioral observations

Larvae were acclimatized for 10 min and their agonistic behavior was video-recorded for 20 min. An ethogram was developed to describe and quantify (number of interactions) aggressive behavior (see Section 3; Table 1). The locomotion rate was quantified by the time taken by the animal moving around during each observation (Olla et al., 1978; Sabate et al., 2008). A graph paper was placed under each glass bowl to improve the analysis method. In addition, the type of motor activity was taken into account: circular swimming – larvae move from one place to another in a circle; linear swimming – animals move from one square to another in a straight line; contact – animals touch each other during locomotion; Ohm-(Ω) posture – larvae bend their body posture at different angles. The sum of all aggressive interactions, with the exception of flight (total contest), and total motor activity – sum of swimming and contact, were also taken into account. Intra and inter-rater reliability for the observers were determined by Spearman correlation (intra: $R > 0.92$ and inter: $R > 0.85$).