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Short communication

Larviculture of a carnivorous freshwater catfish, *Lophiosilurus alexandri*, screened by personality type

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ABSTRACT

Considering that each personality type in animals presents distinct physiological and behavioural responses, this study evaluated the efficiency of the Novel Environment test to classify larvae of *Lophiosilurus alexandri* into bold and shy individuals, which were then investigated for growth, cannibalism and mortality in larviculture of pure and mixed groups. Larvae with an average weight of 24.0 ± 1.7 mg and length of 14.1 ± 0.4 mm, were subjected to a Novel Environment test to classify their personality type (bold and shy larvae). After the larvae were classified according to personality type, they were subjected to larviculture for 15 days. Three treatments were tested: only bold larvae, only shy larvae, and a mixed treatment (bold larvae + shy larvae) at a density for 16 larvae/L, which were fed 3 times a day with *Artemia* nauplii. After larviculture, there were no differences in the final lengths of larvae of the bold, shy, and mixed treatments (26.9 ± 0.76 mm, 26.7 ± 1.00 mm, and 26.8 ± 1.24 mm, respectively); however, shy larvae possessed weighed less (0.22 ± 0.01 g) than the bold and mixed treatments, which did not differ significantly (0.25 ± 0.02 g and 0.27 ± 0.02 g, respectively). The bold and mixed treatments had the highest cannibalism rate (11.2 ± 5.1% and 23.1 ± 12.3%, respectively). Overall survival was lowest in the mixed treatment (62.5 ± 13.0%), while that of the bold and shy treatments were similar (82.5 ± 9.2% and 86.2 ± 9.2%, respectively). The separation of *L. alexandri* larvae by traits can ensure a decrease in cannibalism and hence, more productive larviculture.

1. Introduction

The personality type refers to individual level differences in behaviour and is consistent across the time and/or situations (Réale et al., 2007). Boldness can be defined as the tendency of an individual to take risk (Wilson et al., 1994). Along the shy-bold axis, individuals vary from being extremely bold (reacting to novel stimuli by becoming actively exploratory) to extremely shy or timid (reacting to novel stimuli by retreating or becoming vigilant) (Wilson et al., 1994). Individuals of the same species exhibit concise patterns of responses to danger (Øverli et al., 2007), mating, foraging, habitat use, exploration, antipredator behaviour (Dingemanse and Réale 2005; Réale et al., 2007; Wilson and Godin 2009a); these patterns are also known as the personality type (Bell, 2007). In order to classify the personality type, tests were developed to separate bold and shy individuals. They include, for example, the New Object test (Frost et al., 2007; White et al., 2013), willingness to approach a predator (Godin and Dugatkin, 1996), social dominance (Vaz-Serrano et al., 2011), and the Novel Environment test (Mesquita et al., 2016; Yoshida et al., 2005). Combining exploratory behaviour with the latency to leave a safe area to explore a potentially hazardous area has been accepted as an assessment of personality in fish (Moscicki and Hurd, 2015; Toms et al., 2010).

Individuals classified as bold are characterized as aggressive, use fight or flee as a behavioural strategy and spend more energy exploring the environment (Sih et al., 2004; Wilson and Godin 2009b). Furthermore, bold individuals have higher metabolic rates than shy individuals (Huntingford et al., 2010; Killen et al., 2011), because of this, they ingest more food (Jolles et al., 2016). In contrast, shy individuals are not aggressive, may reduce swimming and exploratory activities when they face a stressful or dangerous situation and tend to save energy (Mesquita, 2011).

Understanding the traits in fish is of great interest, not only from an evolutionary perspective but also in practical situations, such as aquaculture. The traits may be a useful model to understand an indiviual's adaptive capacity and vulnerability to stress-related illnesses (Koolhaas et al., 1999). Moreover, the different traits in fish can have negative

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consequences for aquaculture, causing aggressive behaviour among individuals, impacting production and compromising fish well-being and it has been suggested that the behavioural differences between individuals may be partially responsible for the heterogeneous growth rates observed in production systems (Huntingford and Adams, 2005).

The "pacamã" *Lophiosilurus alexandri,* is a freshwater siluriforme fish. It is carnivorous with sedentary behaviour, batch spawning, and a preference for lentic environments in stony or sandy-bottomed areas (Travassos, 1959). However, cannibalism in the early stages of breeding has been reported as one of the challenges for successful breeding of juveniles (Cordeiro et al., 2016; López and Sampaio, 2000).

So far, attempts to decrease cannibalism among carnivorous fish larvae have focussed mainly on lot size, quality and quantity of food offered and on how weaning is carried out (Król et al., 2014). However, studies evaluating the effect of personality types on cannibalistic behaviour are still few.

The aim of this study was to perform the Novel Environment test to separate *L. alexandri* into bold and shy larvae and examine differences in their performance in larviculture.

2. Methods

Two experiments were conducted in the "Laboratório de Aquacultura da Universidade Federal de Minas Gerais, Brazil".

2.1. Experiment 1 – risk taking in group

The Novel Environment test was adapted from Ibarra-Zatarain et al. (2015) and was performed in order to classify individual fish according to personality type (Fig. 1). A closed, dark chamber (20 × 28 × 20 cm) was placed at one end of a 98 × 28 × 20 cm tank (41.16L) using a 2cm-thick 28 × 20 cm styrofoam partition covered with black contact paper in order to separate a dark and a light environment. Catfish is a river bottom fish and has preference for darkness (Britz and Pienaar, 1992; Almazán Rueda, 2004; Okomoda et al., 2017). The partition had a centrally located 5 × 5 cm opening at its base with a door for sealing. The top of the chamber was closed with black plastic to ensure the environment was totally dark. The tank was filled to a height of 8 cm (total volume 21.9L). There was a fluorescent light (670 Lux) and a heater at the other opposite end of the tank (according to Fig. 1). During tests, the water temperature was kept at 28.6 ± 0.2 °C and the oxygen concentration at >5 mg/L. We used only the Novel Environment test to screening animals, according to Mesquita et al. (2015).

The Novel Environment test was performed with larvae at seven days after hatching, with an average initial weight of 24.0 ± 1.7 mg and total length of 14.1 ± 0.4 mm. The test was performed prior to the larvae receiving their first exogenous feeding and involved the placement of 40 larvae into the dark chamber, which was replicated 16 times for a total of 640 larvae. The larvae were kept in total darkness in the dark chamber for 20 min in order for them to acclimate to the environment (Mesquita et al., 2015). Next, the door opened and, twenty minutes later, closed. The larvae that remained in the dark chamber were classified as shy, and the larvae that left the chamber were classified as bold. The water was changed after each test and maintained at the same temperature inside and outside of dark chamber.

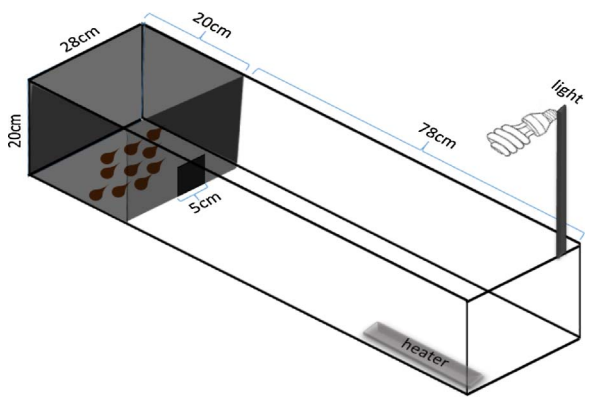

Fig. 1. Scheme of Novel Environment test.

2.2. Experiment 2 – larviculture

After the Novel Environment test, the classified larvae were immediately subjected to larviculture that lasted 15 days. Larvae were stocked in 17 tanks with 1 L of water at a density of 16 larvae/L, divided as follows: 5 tanks only received larvae classified as bold, 5 tanks received larvae only classified as shy and 7 tanks received 8 larvae classified as bold and 8 classified as shy, for a total of 16 individuals per tank, in a completely randomized design. Each tank was provided with aeration (dissolved oxygen >5 mg/L) and was kept in a thermostat controlled bath at a temperature of 28.2 ± 0.9 °C.

Cysts of *Artemia* nauplii were hatched daily to feed the larvae. The cysts were subjected to 1 h of hydration in fresh water and decapsulation with bleach, after which they were hatched in an incubator with a volume of 30 g of salt/L, constant aeration, and at a temperature of 28 °C. After 24 h, the nauplii were collected and stored in containers with salt water and aeration to serve as food for the *L. alexandri* larvae throughout the day. Feeding of the larvae occurred three times a day (8:00, 12:00 and 16:00 h) at a daily concentration of 1600 nauplii per larvae for the first five days, 2400 nauplii per larvae from the sixth to the tenth day, and 3200 nauplii per larvae from the eleventh to the fifteenth day (Santos et al., 2015). These daily amounts were equally divided among the three daily feedings. After 40 min of food distribution, 75% of the water in each tank was removed and renewed, keeping the temperature at 28 °C, but prior to the change of water, incidences of cannibalism and natural death were evaluated. Animals found dead with a wound or damaged body part, or animals that completely disappeared from the beaker, were classified as cannibalized. Animals found dead but intact were classified as having succumbed to natural death. At the end of 15 days, survival rate was determined, total length was measured with digital callipers (accuracy of ± 0.02 mm King-Tools), and the larvae were weighed using an analytical precision scale (Mars AD5002, d = 0.01 g).

2.3. Statistical analysis

Data relating to survival, mortality, cannibalism, and performance were submitted to the Shapiro-Wilks test for normality and for homoscedasticity by the Cochran test. Data that was not normal were log transformed for statistical analyses. At a later stage, the data were submitted to ANOVA and Tukey's test using a 5% probability for significance. Analyses were performed using Infostat software.

3. Results

3.1. Novel environment test

A total of 194 larvae were classified as bold and 446 as shy. Larvae started to leave the new environment at 204 ± 37 s, after which the larvae left the dark chamber one by one in a constant flow until the end of the twenty minutes.

3.2. Larviculture

Data relating to larviculture are shown in Table 1. The survival rate was similar ($P > 0.05$) between treatments containing only bold individuals and those containing only shy individuals, but it was significantly lower ($P < 0.05$) in treatments with animals of both personality type in the same tank. This was also reflected in the