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CULTIVATION OF *Artêmia fransciscana*, IN A CLOSED, LOW-COST CULTIVATION SYSTEM

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Abstract: The main objective of the work was to develop a methodology combining simplicity, functionality and efficiency, also measuring physicochemical parameters. A small 30-liter glass aquarium was used, as well as artificial LED lighting, a foam filter connected to an air compressor, a heater with thermostat and aragonite. A 20% water change was performed weekly, using tap water with antichlorine and salt formulated for marine aquariums. The animals were fed daily with an aqueous solution of dry yeast and dehydrated Spirulina. The first adult brine shrimp were seen on the 14th day of the experiment, with most of them already in the reproductive phase between the 22nd and 23rd day. Artemias are fully capable of developing in simplified conditions of closed systems, even in compact environments and without access to seawater. Although further investigation is needed, the cultivation of these crustaceans is not as complex as one might imagine.
Keywords: Artemia; Aquaculture; Temperature; Reproduction.

INTRODUCTION

The *Artemia franciscana* Kellogg 1906 is a microcrustacean belonging to the subphylum Crustacea, family Artemiidae (GROCHOWSKI, 1895) and genus Artemia (LEACH, 1819). It is an extremely popular live food due to its versatility: the larval stage, called nauplius, can be fed to fry of countless fish species. Furthermore, the adult stage can be used as food for small fish, including popular ornamental fish such as Betta splendens, Poecilia reticulata – among others. In addition to food for fish, corals can also be fed with these crustaceans, often constituting the only food for larvae and juveniles of numerous cultivable species (AZAD; JAINUL; LABU, 2018), such as freshwater shrimp (Macrobrachium sp.), shrimp from the Penaeidae family, lobsters (Homarus sp.), as well as crabs and countless members of the ichthyofauna.

Larvicultures of large shrimp producers (in Brazil) commonly use brine shrimp nauplii (Census of shrimp farming in the states of Ceará, Rio Grande do Norte and Piauí, 2022, p. 42) and, in a study conducted by De Souza and Cavalcante (2018), Litopenaeus schmitti shrimp fed with frozen brine shrimp showed greater weight gain compared to those fed without supplementation (p. 8).

Ornamental fish also showed higher survival rates, vigor and pigmentation when fed with live or frozen adult brine shrimp (MERCHIE, 1996), in addition to their popularity in the sector (LIM et al., 2001), with brine shrimp also being used as part of ingredient for formulated feed from numerous manufacturers, such as Alcon®, Sera®, Tetra®, Tropical® and JBL®. Artemia in the adult stage also helps to save costs (DHERT et al., 1993) and the live stage has been proven to be an excellent maturation diet for penaeid shrimp (LÉGER et al., 1987; WOUTERS et al., 1999).

The cultivation of adult brine shrimp by aquarists is still relatively uncommon, being more restricted to specialized professionals in the aquaculture sector, mainly due to the lack of knowledge about both the organism itself and the cultivation methods adopted, resulting in a scarce availability of information (CAMARA, 2020 p. 3).

The main objective of the work involved developing and analyzing a methodology for creating crustaceans, aiming for simplicity, functionality and efficiency. The specific objectives were to measure the physical-chemical parameters of the tank water.

MATERIAL AND METHODS

The work was carried out in the city of Mococa, São Paulo, between 02/20/2023 and 03/19/2023. The Artemia franciscana cysts used were from the Aquamante® brand (0.5

grams). The glass aquarium was 30 liters, filled with 5 kg of aragonite, and heated by an Aleas/Jeneca® 50W thermostat, with a temperature set at 28 ºC. A sponge filter with an air compressor was used, as well as 12 hours of photoperiod with a 4.8 W LED lamp. Tests were carried out daily for ammonia, nitrite and pH (Alcon®), salinity (with a refractometer) and temperature (using an aquarium thermometer, Boyu® brand). A partial water change was carried out weekly with a volume equivalent to 20% of the aquarium, using a fabric coffee filter so that the brine shrimp sucked into the siphon could be returned to the tank (in order to avoid losses). For replacement water, tap water was used, with Maramar® antichlorine and Veromar® salt, with a salinity of 35 g/L. Every day, the brine shrimp were fed with dry biological yeast powder (Fleischmann®) and spirulina powder (purchased at the Nutribem® store), previously dissolved in dechlorinated fresh water, in order to cause slight turbidity in the water.

Over the days, they were also visually checked to see if there were any brine shrimp exhibiting any abnormal behaviors.

Quantitative and qualitative data were analyzed, using the Microsoft® Excel Office 2019 program to organize the data and create graphs referring to physical and chemical parameters.

For photos, the Canon® PowerShot SX400 IS camera was used, as well as the Olympus® BX43 microscope, equipped with an Olympus® SC100 camera, using the program: Olympus® Cells Sens Entry™. To edit photos from the common camera, Adobe® Photoshop 2021 was used.

RESULTS AND DISCUSSION

Between 02/21 and 02/22 (2nd to 3rd day), most of the nauplii were born, with a length of 400 to 500 micrometers (instar I), as expected (SORGELOOS, 1996) (Figure 1 and Figure 2).

Figure 1. Newly hatched nauplius. Source: LANGE, 2022.

Figure 2. Detail. Source: LANGE, 2022.

The nauplii showed good acceptance of the food provided, as the water soon became clear the day after feeding. The criterion used for feeding involved causing a slight turbidity throughout the tank (Figure 3), something close to what was suggested by Dhont & Lavens (1996, p. 195), although it is not possible to use a Secchi disk to a small aquarium.

Figure 3. Slight turbidity caused by the addition of yeast previously diluted in fresh water. Source: LANGE, 2022.

On day 23 (3rd day), a large part of the population was already in the second larval stage, called instar II, when the yolk sac is consumed and the nauplii begin to feed, losing their red color and having greater swimming capacity (Figure 4 and Figure 5).

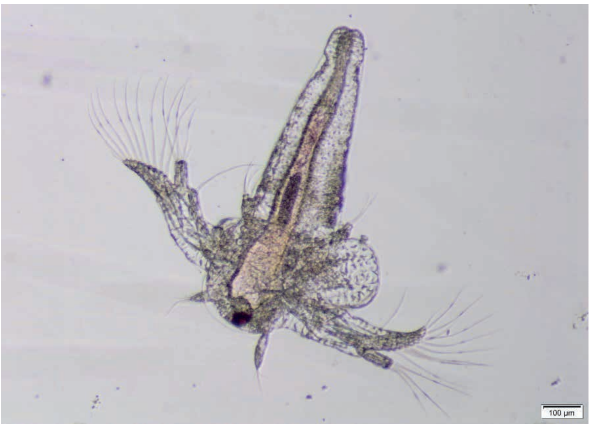

Figure 4. A nauplius of *Artemia franciscana* (possibly instar II and probably one day old). Source: LANGE, 2022.

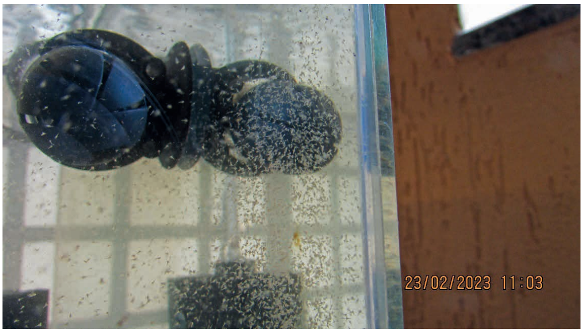

Figure 5. Nauplii aged between 1 and 2 days, without their vitelline reserves. Source: LANGE, 2023.

After a few days, the buds of future thoracopods began to emerge, with the body as a whole becoming more curved (Figure 6).

Figure 6: Nauplii aged between 5 and 6 days. Morphologically, they are more curved. In adulthood, they swim upside down, as they are attracted to light (positive phototaxis). Source: LANGE, 2023.

The first adult brine shrimp appeared on the 14th day of the experiment (03/07/2023), with the first pairs formed on the 16th day. Compared to the cultivation carried out by Sorgeloos and Personee (1975), the brine shrimp in the present experiment took a few days longer to reach full maturity. According to Piper (2018, p. 13), his first brine shrimp reached adulthood only on the 30th day. No case of black spot disease was also reported, a disease that is normally linked to poor diet (DHONT; LAVENS, 1996, p. 189; GEORGIEV et al., 2014). Furthermore, the animals were quite active, being another factor indicative of good maintenance conditions (BAERT; BOSTEELS; SORGELOOS, 1996, p. 219).

Between the 22nd and 23rd day of the experiment (03/14 and 03/15), a large part of the population was already in adulthood, with many couples formed (Figure 7). Consequently, it was possible to see numerous females already ovated (Figure 8).

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Figure 7: In the photo, you can see several adult brine shrimp. Source: LANGE, 2023.

Figure 8: Highlighted, a female with the ovisac, with numerous cysts. Source: LANGE, 2023.

At this stage, the lateral eyes are fully developed (Figure 9), as are the thoracopods (Figure 10), converging with the process described by the authors Dhont and Van Stappen (2003).

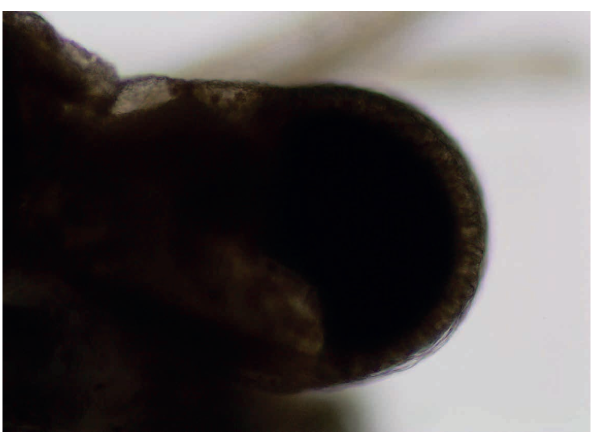

Figure 9: Detail of the lateral eye of an adult brine shrimp. Ten times magnification. Source: LANGE, 2023.

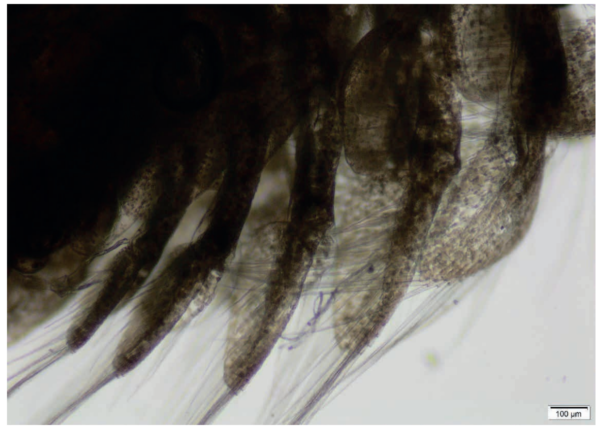

Figure 10: Detail of the thoracopods. Twenty times magnification. Source: LANGE, 2023.

It was also possible to visualize some of the main morphological aspects regarding sexual dimorphism, such as the presence of claspers in the male (Figures 11 and 12) and the ovisac in the female (Figure 11).

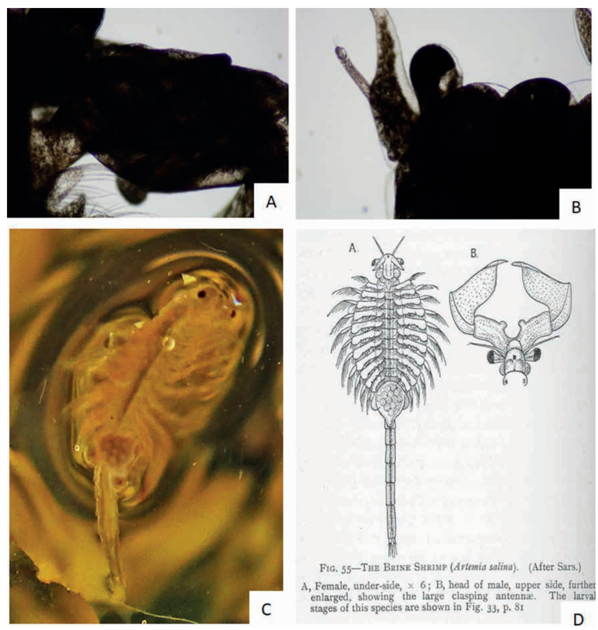

Figure 11: A – Detail of the clasper (4x magnification); B – Antenna of an adult female brine shrimp C – Adult female brine shrimp, already ovate (probably cysts); D – In Figure A, female Artemia salina, lower section (magnified by 6x). In Figure B, upper section of the head of a male brine shrimp, showing its claspers. Source: LANGE, 2023 with the exception of image D: English: Calman, W. T. (1911) Life of Crustacea, Category: New York: the MacMillan Company (public domain).

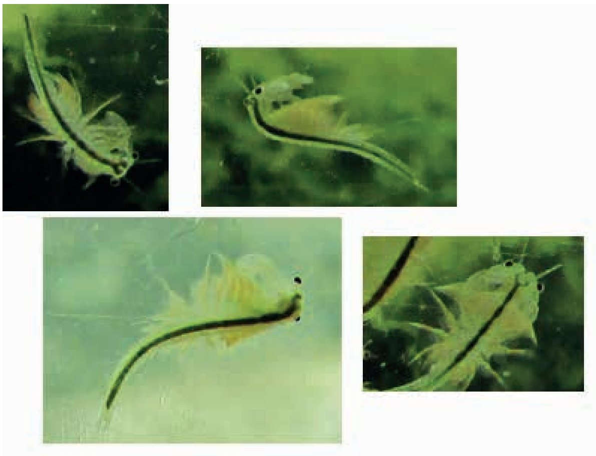

Figure 12: Montage with several photos of males. Source: LANGE, 2023.

In adult brine shrimp, it was also possible to see that the feces released were in short pellet formats (although it was not possible to view them under a microscope but with the naked eye), indicating good nutrition (BAERT; BOSTEELS, SORGELOOS, 1996).

Comparing to the experiment carried out by Taynah Câmara Araújo (2019, p. 17), whose brine shrimp died on the fifth day, it is clear to know that, throughout the author's experiment, the methodology in general was simpler: sterilized seawater was not used (rather tap water with antichlorine and a formulated salt) and the size of the tank was smaller (30 liters versus 60), also not having been developed in a specific laboratory for marine organisms. Of differences, in this experiment aragonite substrate was used, which provides calcium, essential for the ecdysis of crustaceans, in addition to providing a place for the establishment of benthic algae (Figure 13 and Figure 14), which help both in the oxygenation of the environment and as food for adult brine shrimp. Instead of aragonite, Fernando Kubitza also suggested the use of dolomite (personal communication), because the material, in addition to providing calcium, also provides magnesium, cutting costs with formulated salts.

Figure 13: First formations of benthic algae on the substrate. Source: LANGE, 2023.

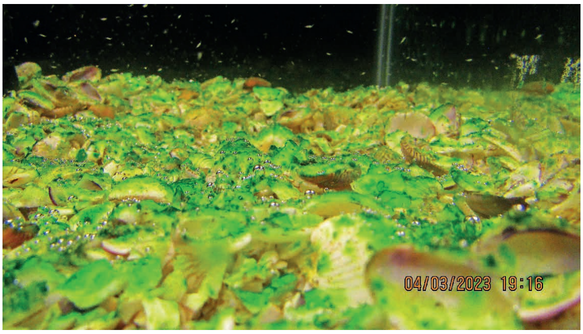

Figure 14: Numerous benthic algae. It is possible to see oxygen bubbles being generated during photosynthesis. Source: LANGE, 2023.

In the experimental project by Balachandar & Rajaram (2018), on the other hand, in just 12 days, brine shrimp managed to reach an average length of 1 cm, already sexually mature. The arrangement consisted of a series of 4-liter containers, filled with 2 liters each, using well water. In this experiment, the author carried out a total water change every two days, using live microalgae as food (genera Chaetoceros and Tetraselmis), with the salinity being 70 g/L.

FINAL CONSIDERATIONS

- Even with some basic literature on the cultivation of *Artemia sp.*, it is still possible to notice some variations in the results of these cultivated animals;
- The cyanobacteria: *Arthrospira platensis* (name of what is sold commercially as Spirulina) presents good results even

dehydrated, but its cost becomes high in large-scale productions;

- The success in reproducing brine shrimp in a 30-liter aquarium shows that it is possible to replicate them in even lower-cost arrangements (such as replacing glass aquariums with plastic boxes);

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