Article

Management of the First Feeding of *Dorada Brycon sinuensis* with Two Species of Cladocerans

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Abstract: The management of the first feeding is a critical stage in the viability of the larvae and fingerling rearing. So far, the first feeding of the bryconids record the best results when fed with forage larvae; thus, the aim was to evaluate two species of cladocerans as live prey in the first feeding of dorada *Brycon sinuensis* and to evaluate their effects on the control of cannibalism. Larvae (1.2 ± 0.15 mg and 5.9 ± 0.4 mm initial weight and total length) were fed *Moina minuta* (Mm), *Macrothrix elegans* (Me) or a mixture (50:50) of cladocerans (Mix) at a rate of 20 prey mL⁻¹, once for 24 h. Another dorada larvae group were fed newly hatched larvae of *Piaractus brachipomus* (4.5 ± 0.9 mm) as forage larvae (F_L) in a ratio of 2:1 (prey:predator). The larvae were stocked to 50 L⁻¹ in aquaria with 5 L of useful volume (12 per treatment). The growth, survival, stress resistance, cannibalism mortality, and the number of prey in the gut contents were analyzed. Dorada larvae fed F_L showed higher growth, but those fed Mm showed the highest survival rate ($76.1 \pm 6.6\%$) and the lowest cannibalism mortality ($16.8 \pm 3.7\%$) ($p < 0.05$). The use of the cladocerans allowed high survival and stress resistance ($95.3 \pm 2.4\%$), and *M. minuta* proved to be a suitable prey for cannibalism control in the management of the first feeding of dorada larvae.

Keywords: cannibalism; live food; larval feeding; fish larvae

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1. Introduction

Dorada Brycon sinuensis is an endemic species of fish of the Sinú River Basin (Córdoba, Colombia), threatened by the deterioration of its natural environment [1]. Like other bryconids, this species presents characteristics desirable for fish farming, including rapid growth, acceptance of artificial diets, easy adaptation to captivity, resistance to handling, and omnivorous diet [2]. The management of first feeding is done for only 24 h because this is the critical period of intensive larviculture of this species. This technique allows the larvae to be viable for the next stages of the production process and reduces cannibalism during this critical stage [2,3]. The bryconids' life cycle is characterized by a fast embryonic stage (12–14 h to 26–28 °C); the larvae begin the exogenous feeding between 22 and 24 h after hatching (hae); management of first feeding is short (24 h). During this phase the maximum mouth opening is estimated at 20–25% of total length (5 to 6 mm); there is a short larval period (7 days); and like other bryconids, *Brycon sinuensis* shows strong cannibalism at the beginning of the exogenous feeding [2,4–8]. This behavior causes low survival rates and heterogeneity in larval size [2,7,9]. To reduce cannibalism in bryconids, larvae of another fish species (forage larvae) are often supplied as an initial live feed to increase survival and control cannibal behavior in this stage of larviculture. The rearing of fingerlings of dorada has advanced in the use of forage larvae with the first feeding management [2]; however, this method increases the production costs of fingerlings, so it is

necessary to look for alternatives with zootechnical potential as an initial live food source for the production of fingerlings without the use of forage larvae.

A possible alternative for managing bryconids' first feeding and cannibalism control is the use of cladocerans selected and grown under controlled conditions. The potential of cladocerans as a biotech food alternative for the performance of fish of aquaculture interest is well known. During rearing, dorada culture (nearly 15 days) shows selectivity for zooplankton groups, copepods, and ostracods [10]. Still, no studies evaluated the use of cladocerans in the first feeding of dorada larvae.

The biochemical composition of cladocerans is important for fish larvae because it contains most of the nutritional requirements for the survival and adequate development of the larvae [11,12]. Furthermore, due to their content of essential fatty acids [13–17] and high levels of excellent quality protein [18], cladocerans are an essential source of the vitamins, minerals [19], and enzymes necessary for larval growth and survival [20–22].

Most fish larvae require planktonic organisms as their first feed and record better growth and survival rates when fed these organisms rather than artificial diets [5,10,23–26]. Several factors explain these results: the structure and digestibility of the protein, presence of exogenous enzymes, chemical stimuli, adequate size, and slow movements of the prey that facilitate its ingestion and digestion, characteristics that meet the requirements of the larva [27]. Another feature that justifies the use of cladocerans in fish larviculture is the predatory visual stimulus provided to larvae due to the natural motility of the plankton [28].

Despite the lack of information on the management of the first feeding of *B. sinuensis* with selected cladocerans, the described characteristics make this zooplankton an interesting option to be evaluated as prey in larviculture. As stated in the 2021 Shanghai Declaration: Aquaculture for food and sustainable development, diversification is presented as an option or key to sustainable development. The diversification of aquaculture production implies new investment alternatives for both the industrial and artisanal sectors, and the first step is to expand the variety of species offered by aquaculture.

This study may support this strategic priority and help the sustainability of Colombian aquaculture and reduce non-native species. Specifically, the aquaculture of the bryconids will be strengthened through the management of larviculture, which contributes to the availability of seed for the next stage in the production process, offering natural prey recognized by the species, in this case, the cladocerans. Simultaneously, it contributes to sustainability, avoiding dependence on expensive inputs such as *Artemia* and eutrophication of the effluent due to the death of unnatural prey used in the process, thus reducing the production of nitrogen compounds. Consequently, the process is more environmentally friendly. Therefore, the study aimed to assess two species of cladocerans as prey during the onset of exogenous feeding of dorada and to evaluate their effects on the control of cannibalism.

2. Materials and Methods

The study was conducted at the Fisheries Research Institute of the University of Córdoba (CINPIC), located in Montería (Colombia). Cladocerans *Moina minuta* (length $690.2 \pm 10.2 \mu\text{m}$ and width $416.1 \pm 11.7 \mu\text{m}$) and *Macrothrix elegans* (length $492.9 \pm 3.0 \mu\text{m}$ and width $293.7 \pm 2.7 \mu\text{m}$) were isolated following the methodology of Prieto-Guevara, et al. [29] from zooplankton samples collected in the CINPIC ponds with a conical net of $250 \mu\text{m}$ of mesh. Identification of the cladocerans was carried out using the taxonomic keys described by Sars [30]. The initial strains and inoculum, which were maintained in the Living Food Laboratory of the CINPIC, were placed in 200-mL glass bottles, in water filtered through a $20\text{-}\mu\text{m}$ mesh, kept in a photoperiod 10:14 h (light:darkness) and 30% of the water volume was renewed every 48 h to remove organic matter from the bottom. Daily feeding was based on a mixture of the microalgae *Ankistrodesmus* sp. and *Scenedesmus* sp., at a concentration of $4 \times 10^5 \text{ cell mL}^{-1}$, determined by cell counting in a Neubauer chamber. The increase in

the biomass of the cladocerans was obtained using successive inoculations and the serial volume method [29].

The larvae of dorada and *Piaractus brachipomus* were obtained by reproduction induced with carp pituitary extract (5 mg/kg of live weight), applied in two doses of 20% and 80% at an interval of 12 h [2]. Incubation of the fertilized eggs was performed in 60-L cylindrical-conical upflow incubators; after hatching (70%), the dorada larvae were transferred to circular fiberglass tanks with a useful volume of 1000 L. At the beginning of exogenous feeding (22 hae), 4000 dorada larvae were distributed in 16 aquaria of 5 L of useful volume, at a density of 50 larvae L⁻¹. In addition, a sample of 100 larvae was fixed in 1% buffered formalin to measure the initial weight (1.2 ± 0.15 mg) and total length (5.9 ± 0.4 mm). The larvae were fed treatments, with four replicates each, *M. minuta* (Mm), *M. elegans* (Me), and a mixture of these cladocerans (50:50) (Mix). The cladocerans were offered at the rate of 20 prey mL⁻¹, once for 24 h, and another group was fed freshly hatched larvae of *Piaractus brachipomus* (FL) (4.5 ± 0.9 mm) in a 2:1 ratio (prey:predator) [2]. This group was considered the control treatment. The proximal composition of the different prey offered to the dorada larvae was analyzed according to the AOAC official methods [31].

After 24 h, the survival, natural mortality, cannibalism mortality, stress resistance test, growth, and gut contents were evaluated. The survival (S) was assessed using the formula $S = (N_F/N_O) \times 100$, where N_F was the final number of live larvae, and N_O was the initial number of larvae. Larval quality was evaluated by stress resistance test (S_R), which was considered an indicator of the management; from each experimental unit, the larvae were removed ($n = 10$) with a mesh of 400 μ m and maintained for six minutes in conditions of severe hypoxia; then they were returned to the experimental units, and after 15 min the larvae that survived the test were counted. The S_R was assessed using the formula $S_R = N_{AL}/N_T \times 100$, where N_{AL} was the number of alive larvae, and N_T was the total number of larvae treated to the severe hypoxia conditions [2].

The mortality for cannibalistic behavior (C_M) was assessed by counting the dead larvae that showed mutilation or bite under an inverted microscope (Carl Zeiss, Stemi 2000-C, Jena-Germany). It was estimated using the formula $C_M = (\text{cannibalized larvae}/\text{total initial larvae}) \times 100$. The natural mortality (N_M) was calculated by counting the dead larvae that did not show signs of mutilation or bite, and was assessed using the formula $N_M = (\text{total of dead larvae} - \text{dead larvae by cannibalism})/\text{total initial larvae} \times 100$ [2]. In addition, the stomach contents ($n = 15/\text{replicate}$) were assessed to verify cladoceran species ingested (microdissection) and cannibalism with an inverted microscope (Carl Zeiss, Stemi 2000-C, Jena, Germany).

In a sample of dorada larvae ($n = 20$) fixed in 1% buffered formalin, the total length of larvae was measured using an inverted microscope Stemi 2000-C (Carl Zeiss, Jena, Germany) and an image analyzer Axiovision 4 (Carl Zeiss, Gottingen, Germany). The fresh weight (the excess moisture was removed with blotting paper) was recorded using an analytical balance Adventurer (Ohaus, Shanghai, China, ± 0.001 g). The length gain (L_G), weight gain (W_G), and the specific rate of growth (G) were assessed using the formulas [32]:

$L_G = L_F - L_O$, where L_F and L_O were, respectively, the total final and initial length of the larvae;

$G_W = W_F - W_O$, where W_F and W_O correspond, respectively, to the final and initial weight of the larvae

$G = [\ln(W_F/W_O)]/T \times 100$, where T correspond to the larviculture time (day) and Ln to the natural logarithm.

The quality of the water in the experimental units registered dissolved oxygen (4.7 ± 0.2 mg L⁻¹), pH (8.0 ± 0.4), temperature (28.0 ± 0.9 °C), NH₃ ($<0.12 \pm 0.06$ mg L⁻¹), alkalinity (36.1 ± 1.9 mg L⁻¹), and total hardness (64.6 ± 1.9 mg L⁻¹); parameters within the normal range for the dorada larviculture [2].

The experimental design was completely randomized. All variables evaluated were first assessed to normality (Shapiro–Wilk test) and homogeneity of variance (Levene's test). Where necessary, arcsine-square root or logarithmic transformation was performed before

analysis. One-way ANOVA was used to determine significant differences among treatments. Tukey's test was performed as the mean separation procedure. A statistical probability of $p < 0.05$ was accepted as significant. All data are expressed as mean $\pm$ standard deviation (SD). The analysis was performed with the statistical software R (version 3.0.2).

3. Results

The S and S_R of dorada larvae after 24 h are presented in Figure 1. The highest S was recorded in larvae fed with Mm ($76.1 \pm 6.6\%$) ($p < 0.05$), but did not differ significantly ($p > 0.05$) from those fed with F_L ($64.0 \pm 13.5\%$) or with Mix ($64.1 \pm 8.5\%$). Survival of the dorada larvae S_R test ranged between $92.5 \pm 5.0\%$ (Me) and $95.3 \pm 2.4\%$ (Mm), with no significant difference observed between the treatments ($p > 0.05$).

Figure 1. Survival (S) and stress resistance (S_R) of dorada *Brycon sinuensis* larvae fed different live prey. Different letters indicate a significant difference ($p < 0.05$). Forage larvae of *Piaractus brachypomus* (F_L); *Moina minuta* (Mm); *Macrothrix elegans* (Me); mixture (50:50) of the *Moina minuta* and *Macrothrix elegans* (Mix).

Mortality due to cannibalism (C_M) and natural mortality (N_M) at 24 h is presented in Figure 2. The highest C_M in the dorada larvae was observed when feeding with Me ($39.6 \pm 6.7\%$) but without a significant difference ($p > 0.05$) from those fed F_L ($27.6 \pm 11.3\%$) and Mix ($29.7 \pm 6.6\%$). The N_M of dorada larvae ranged between those fed with Mix ($6.2 \pm 2.3\%$) and those fed with Me ($8.8 \pm 6.4\%$) without a significant difference being observed between the treatments ($p > 0.05$).

The W_G , L_G and G of the dorada larvae after 24 h are presented in Table 1, and proximate composition of prey is presented in Table 2. The W_G of the dorada larvae fed the F_L (1.5 ± 0.4 mg) was significantly higher ($p < 0.05$), although it was not different from those fed Mm (0.5 ± 0.1 mg). The L_G of the dorada larvae fed the F_L (1.6 ± 0.1 mm) was significantly higher ($p < 0.05$). However, this gain was not significantly different from that of the larvae fed the mixture of cladocerans (1.0 ± 0.3 mm). The G of the dorada larvae fed the F_L forage larvae ($3.2 \pm 0.4\%/h$) was significantly higher than those fed cladocerans ($p < 0.05$).

Figure 2. Mortality of larvae of dorada *Brycon sinuensis* fed different live prey. Different letters indicate significant difference ($p < 0.05$). Forage larvae of *Piaractus brachypomus* (FL); *Moina minuta* (Mm); *Macrothrix elegans* (Me); mixture (50:50) of the *Moina minuta* and *Macrothrix elegans* (Mix).

Table 1. Weight gain (W_G), length gain (L_G), and specific growth rate (G) of dorada *Brycon sinuensis* larvae after receiving different feeding prey for 24 h. Forage larvae of *Piaractus brachypomus* (FL); *Moina minuta* (Mm); *Macrothrix elegans* (Me); mixture (50:50) of the *Moina minuta* and *Macrothrix elegans* (Mix).

Parameters	Treatments			
	FL	Mm	Me	Mix
W_G (mg)	1.5 ± 0.4 a	0.5 ± 0.1 ab	0.3 ± 0.1 b	0.4 ± 0.0 b
L_G (mm)	1.6 ± 0.1 a	0.9 ± 0.2 b	0.9 ± 0.3 b	1.0 ± 0.3 ab
G (%/h)	3.2 ± 0.4 a	1.3 ± 0.2 b	0.8 ± 0.2 b	1.1 ± 0.1 b

Different letters in the same row indicate a significant difference ($p < 0.05$).

Table 2. The proximate composition of prey: Forage larvae of *Piaractus brachypomus* (FL); *Moina minuta* (Mm); *Macrothrix elegans* (Me); mixture (50:50) of the *Moina minuta* and *Macrothrix elegans* (Mix).

Proximate Analysis *	Treatments			
	FL	Mm	Me	Mix
Crude protein	52.3 ± 0.1 e	57.9 ± 0.1 c	80 ± 0.1 a	60.7 ± 0.1 b
Crude lipid	66.9 ± 0.1 a	32.1 ± 0.1 e	37.4 ± 0.1 d	40.3 ± 0.1 c
Moisture	77.4 ± 0.1 d	89.5 ± 0.1 b	89.6 ± 0.1 b	90.3 ± 0.1 a
Ash	0.8 ± 0.01 b	0.6 ± 0.01 c	0.6 ± 0.01 c	0.8 ± 0.01 b

Different letters in the same row indicate a significant difference ($p < 0.05$). * Dry matter.

The prey present in the stomach contents of the dorada larvae after 24 h is illustrated in Figure 3. All prey supplied at the first feeding was found in the stomach contents of the dorada larvae. However, the lowest number of prey in the stomach contents was observed in the larvae fed on forage larvae (0.8 ± 0.0 prey). In contrast, the highest number of prey was presented when fed Mm (3.7 ± 0.0 prey).

Figure 3. The number of prey in the stomach contents of dorada *Brycon sinuensis* fed different live prey. Different letters indicate a significant difference ($p < 0.05$). Forage larvae of *Piaractus brachypomus* (F_L); *Moina minuta* (Mm); *Macrothrix elegans* (Me); mixture (50:50) of the *Moina minuta* and *Macrothrix elegans* (Mix).

4. Discussion

Dorada larvae fed the cladoceran *M. minuta* at the beginning of exogenous feeding presented the highest survival in contrast with fed the *M. elegans*. The distribution and availability of the cladocerans in the water column could be suggested to explain this difference. *M. minuta* showed homogeneous distribution and sporadic movements in the entire water column making them more available and visible for capture by the dorada larvae. At the same time, *M. elegans* was distributed towards the aquarium walls (direct observation). The behavior registered of the cladoceran *M. elegans* coincides with observations in its natural environment. This cladoceran prefers substrates for its feeding and or as a protection mechanism against predators. Sousa and Elmoor-Loureiro [33] observed that the family Macrothricidae lives at the bottom or near vegetation and consider these cladocerans as phytophile organisms, which live mainly in association with roots and leaves of submerged macrophytes in the coastal zone. Diniz, et al. [34] studied the composition of the seasonal lakes of the semiarid regions of Pernambuco (Brazil). They registered that the cladocerans *Macrothrix superaculeata* and *M. elegans* were found to be associated with macrophytes. In the larviculture of the *Perca eurasia* the distribution of live food (*Artemia nauplii* and *Barchionus plicatilis*) was studied, and it was found that the feeding response was affected by the low density of live prey and its patterns of space utilization, which were very different from that of the larvae [35]. Some authors suggested that food availability and quality are the most critical factors that govern the establishment of hierarchies of dominance, growth, survival, and cannibalism, particularly in larvae of the genus *Brycon* [2,4,36].

In the present study, adequate survivals ($64.0 \pm 13.5\%$) were recorded when fed with forage larvae at a ratio of 2:1. Atencio-García, et al. [2] found that the best survival in the management of the first feeding for dorada was recorded by offering two (84.2%) and four (86.7%) forage larvae (larvae of newly hatched *Prochilodus magdalenae*); in addition, a higher

survival rate in *Brycon amazonicus* larvae (70.0%) was reported after *Piaractus brachypomus* forage larvae (larvae newly hatched) were provided in a greater proportion (4:1) for 24 h [3]. In larvae fed the cladoceran mixture, survival did not show a significant difference from the other treatments, showing that although *M. minuta* only corresponds to half the prey density in this treatment (10 prey mL⁻¹), that amount was sufficient to maintain survival at adequate values (64.1 ± 8.5%).

The dorada larvae presented similar results for the different treatments in the test of stress resistance. This result indicates that the prey offered an adequate nutritional quality to the larvae and allowed them to acquire high resistance against handling and transport. Prieto-Guevara, et al. [37] claimed that the stress resistance test allows the estimation of quality and viability of larvae according to the type of food used; thus, a best survival in this test indicates a better condition of the larva and therefore a better nutritional quality of the food offered in association with the management conditions. Atencio-García, et al. [2] stated that stress resistance due to anoxia conditions for *B. sinuensis* larvae is a valuable tool for determining the animal's physiological status before being sent to the nursery ponds. The responses to stress generally allow us to know how adaptive fish can be when faced with changes in their environment. These responses significantly impact survival during the early stages of fish life [38,39]. The results of stress resistance in the present study suggest that the larvae of *B. sinuensis*, fed the different live prey evaluated, were in good condition for handling and transfer to the next phase of rearing culture.

Mortality due to cannibalism was registered in all treatments but was higher when *M. elegans* (39.6 ± 6.7%) was offered. This result suggests that cannibalism in this treatment was related to the cladoceran distribution (*M. elegans*) in the experimental units, which reduced the feeding availability for dorada larvae in this treatment. Atencio-García, et al. [2] established that cannibalism in *B. sinuensis* is a feeding strategy associated with food availability. When the availability of prey decreases, the search for food increases; this implies an increase in energy expenditure [40]. Therefore, when fed *Macrothrix elegans*, the dorada larvae increased their cannibalism.

The adequate prey densities for the larvae is critical for increasing their intake. Different densities of zooplankton have been successfully used in other studies to reduce cannibalism and obtain satisfactory survival rates in the larval stage. In larvae with cannibalism similar to *B. sinuensis*, the following prey densities were found: 0.2 prey mL⁻¹ (*Artemia franciscana*) [36], 0.5 prey mL⁻¹ (*Moina* sp., *Diaphanosoma* sp., *Artemia salina*, *Diaptomus*) [9,41], 10 prey mL⁻¹ (*Diaptomus* sp., *Diaphanosoma* sp., *Moina* sp. and *Moinodaphnia* sp.) [37], and 0.1 prey mL⁻¹ (*Brachionus plicatilis*, *Ceriodaphnia reticulata*, *Apocyclops dengizicus*) [42]. The density of cladocerans used in this study (20 prey mL⁻¹) was higher than those reported in previous studies, suggesting that a homogeneous distribution of prey must accompany a high density to reduce cannibalism because it reduces the period of searching for prey and increases predator-prey encounters.

The natural mortality recorded in the present study was low and similar to the report of Atencio-García, et al. [2], who found natural mortality of less than 10% in the management of first feeding of dorada when fed forage larvae (*Prochilodus magdalenae*). Thus, the results of the present study suggest that cannibalism is the main cause of mortality in the management of the first feeding of dorada. In all treatments, mortality due to cannibalism was higher than natural mortality, but in larviculture worked with *M. minuta* this behavior was reduced to its minimum rate (20%), which was less than half of the mortality observed with the other offered prey.

The highest LG, WG, and G values were recorded when the dorada larvae were fed with forage larvae (*P. brachypomus*). This result is possible because larger prey allows greater energy efficiency for larvae than small prey. According to the optimal foraging theory, predators select prey that provide a high energy gain per unit of effort [40]. These authors claim that cannibalistic juveniles of *Lates calcarifer* choose smaller conspecifics when given a range of different sizes as prey. This behavior characterizes those cannibalistic predators that obtain high energy gain with the prey of similar or smaller size. Likewise,

Atencio-García, et al. [3] found higher values of L_G and W_G for *B. amazonicus* when fed forage larvae (*P. brachypomus*) compared to zooplankton, and they attributed this increase of growth to the lower energy expenditure in the capture of the forage larvae.

The appropriate size of the prey allows the predator to save more energy in catching and ingestion than a larger number of smaller organisms. Some authors consider that the density of prey defines growth and that the size of the food may be even more critical. A widely recorded pattern is the increase in growth rate and efficiency caused by increased prey size [43]. In some species of fish studied, bioenergetic alterations are the result of varying prey size or density that is predominantly driven by foraging activity, and when the prey is large and/or more abundant, predators tend to be less active [44,45], which leads to less energy spent on hunting and more growth [43].

Stomach contents of dorada fed different cladocerans as live prey reflect higher consumption of *M. minuta* (3.7 ± 0.0 prey per stomach), followed by cladoceran mixture (3.4 ± 0.1 prey per stomach), and finally by *M. elegans* (1.1 ± 0.1 prey per stomach). Notably, feeding with the mixture revealed greater food selectivity towards *M. minuta* (2.6 ± 0.0 prey per stomach) over *M. elegans* (0.8 ± 0.0 prey per stomach), suggesting the importance of the distribution and availability and movements of prey. Accordingly, *M. minuta* presents desirable characteristics for the feeding of dorada larvae, such as size, shape, color, locomotion, and distribution.

Among cladocerans, the genus *Moina* is one of the most used in recent years for the first feeding of fish larvae. For example, the genus has been employed in the larvae of *Pterophyllum scalare* [46], *Sorubim cuspicaudus* [37], *Leiopotherapon plumbeus* [47], *Oreochromis niloticus* [48], and the crustacean *Macrobrachium rosenbergii* [49] because it features many of the desired characteristics for feeding aquatic organisms, thereby ensuring larval growth [50]: adequate size, slow movement, high availability, appearance, chemical stimulation, minimum nutritional requirements, and easy ingestion.

As previously described, the cladoceran *M. elegans* was distributed near the walls, with short shifts near the surface of the walls of the experimental units. This natural behavior gives this genus of cladocerans low visibility for consumption by the dorada larvae. Therefore, its potential as prey for dorada larvae is limited by its natural habit of being associated with aquatic substrates [33,34]. This behavior is considered an adaptive strategy of some zooplankton organisms to prevent predation. da Silva, et al. [5] observed that in the stomach contents of hybrid catfish larvae (*Pseudoplatystoma corruscans* x *P. reticulatum*) kept in a previously fertilized pond, the food item *Macrothrix* sp. (0.44%) was the least consumed live prey, attributed mainly to them being organisms typical of benthic regions that may be captured only by larvae that exhibit this benthic behavior.

Therefore, *M. minuta*, presented with a homogeneous distribution in the water column, was a more visually attractive prey. Sampaio [27] found a higher selection of cladocerans in the different items offered to larvae *Brycon amazonicus*. This preference was attributed to a set of morphological characteristics that confer greater visibility to the larvae (size, shape, and pigmentation), and associated with this. In addition, their interrupted movements were an important factor that influenced food selection by visual predators. Botero [51] argued that size, shape, mobility, and contrast are the most important stimuli visual predators use in prey selection. In addition, the movement of the prey serves to differentiate the animate from the inanimate, which inclines the attention of the predator to a possible prey and increases the visibility of the same. On the other hand, [28] observed in larvae of *Piaractus mesopotamicus* that the type of stimulus coming from *Artemia* nauplii showed superior values of capture when they were compared with those stimuli coming from the inert diet; the authors indicated that the mobile prey induced tactile and visual responses and that the immobile prey escaped more easily from the attention of the predators.

Dorada, as well as other bryconids, can be considered a visual predator [8,52–54] because its eyes are well developed and pigmented; it has a wide mouth armed with pointed teeth at the beginning of exogenous feeding, as observed during the present study.

In particular, for *B. amazonicus*, the rapid development of the eye was also visualized in the early larval stages, indicating the vision to be a fundamental ability in this period [55].

This study may support sustainable development and enhance fisheries' productivity through culture-based fisheries, and as appropriate, encouraging the production of endangered species and native species with potential for aquaculture. In the present study, it can be concluded that the cladoceran *Moina minuta* present desirable characteristics as live food, allowing high survival, adequate performance, and resistance to the stress of dorada larvae. Thus, is a viable prey for reducing cannibalism in managing the first feeding of dorada.

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