

Water quality and zooplankton in tanks with larvae of *Brycon Orbignyanus* (Valenciennes, 1949)

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Abstract

Due to the importance of water variables conditions and available food in the development and survival of fish larvae, the current research evaluates the effects of two different food treatments (ration + zooplankton and only zooplankton) and water quality in tanks with *Brycon orbignyanus* larvae. Total water transparency (45 cm) has been mainly associated with short residence time, continuous water flow and shallowness. Dissolved oxygen ranged between 1.32 and 7.00 mg.L⁻¹ in tanks with ration + zooplankton and between 1.82 and 7.60 mg.L⁻¹ in tanks with only zooplankton treatments. Nutrients were directly affected by the addition of ration in water, with the exception of nitrite. Ten Rotifera species were found represented by high densities, ranging between 8.7 × 10⁵ and 1.3 × 10⁶ org.m⁻³, throughout the experimental period (January to March/1996). Cladocera had the lowest density in the four tanks under analysis and ranged between 4.7 × 10⁴ and 2.1 × 10⁵ org.m⁻³ for the six species. *Diaphanosoma birgei* has been classified as the most frequent species. Since ration + zooplankton produced better larvae yield, this treatment is recommended for *Brycon orbignyanus* larvae.

Keywords: *Brycon orbignyanus*, larvae tanks, limnology, zooplankton.

Qualidade da água e zooplâncton em tanques de larvicultura de *Brycon orbignyanus* (Valenciennes, 1949)

Resumo

Devido à importância das condições das variáveis da água e do alimento disponível no desenvolvimento e sobrevivência das larvas de peixes, o objetivo deste estudo foi avaliar o efeito do uso de dois tratamentos alimentares (ração + zooplâncton e somente zooplâncton) e a qualidade da água, em tanques de larvicultura de *Brycon orbignyanus*. A transparência total da água (45 cm) esteve associada principalmente ao curto tempo de residência, fluxo contínuo e baixa profundidade. As concentrações de oxigênio dissolvido variaram de 1,32 a 7,00 mg.L⁻¹ no tratamento contendo ração + zooplâncton, e de 1,82 a 7,60 mg.L⁻¹ no tratamento contendo somente zooplâncton. Os nutrientes foram diretamente influenciados pela adição de ração no meio com exceção do nitrito. Rotifera apresentou a maior densidade, variando ao longo do período experimental de 8,7 × 10⁵ a 1,3 × 10⁶ org.m⁻³ entre os quatro tanques estudados, num total de dez espécies. A menor densidade foi observada para Cladocera, variando de 4,7 × 10⁴ a 2,1 × 10⁵ org.m⁻³ num total de seis espécies encontradas, sendo *Diaphanosoma birgei* a única espécie classificada como muito frequente. O uso de ração junto com zooplâncton proporcionou melhor rendimento para larvas de *B. orbignyanus*.

Palavras-chave: *Brycon orbignyanus*, tanques de larvicultura, limnologia, zooplâncton.

1. Introduction

A major problem in *Brycon orbignyanus* production is its high mortality rate during the larvae stage and during development into the fingerling stage. Feeding preference of *B. orbignyanus* larvae consists of crusta-

cean zooplankton, mainly Cladocera and insect larvae. According to Ceccarelli and Senhorini (1996), other fish larvae should be placed together with *B. orbignyanus* larvae in order to avoid cannibalism during the incuba-

tion period. After this phase *B. orbignyanus* larvae may be transported to fishponds, although culture success depends on the type and quantity of zooplankton available in the pond, larvae density and water quality.

Lopes et al. (1994) showed that supply of ration + zooplankton to *Brycon cephalus* Gunther, 1869 established higher survival rates, whereas larvae had high growth rates (length and weight) in zooplankton only treatment. This fact confirmed the importance of live plankton as a basic component for fish initial feed.

Brycon orbignyanus, commonly known as “piracanjuba”, is a species of great interest for fish farmers due to its fast growth, food habits (omnivore), easy adaptation to artificial diets, good flesh quality and for its use in sport fishing. “Piracanjuba” is an indigenous species of the river Paraná basin where it used to be found abundantly. However, due to deforestation, pollution and impounding, the species has become rare in its natural habitat (Mendonça, 1996).

Physical, chemical and biological variables regulate the functioning of larvae production tanks. Control of the environment culture conditions is currently considered to be the main factor in production improvement. Actually, the latter depends on management approaches, on water quality monitoring and on knowledge of the species' feeding habits.

Great variability in survival, growth and quality of hatchery-produced fish larvae is a common and complex problem and mass mortalities may occur (Battaglione et al., 2005). In spite of some recent encouraging results involving dispensed diets for fish larvae, the rearing of most freshwater fish species still relies on live food, at least up to metamorphosis. Zooplankton groups, such as Copepoda, Cladocera and Rotifera, are preys widely used in the rearing of fish larvae (Aragão et al., 2004).

Harvested zooplankton has regularly been used as live food for larvae of freshwater fish species. The water quality control in larvae tanks and zooplankton as live food affect variable growth and larval survival (Evjemo et al., 2003).

Given the importance of the water variables conditions and available food in the development and survival of fish larvae, the current research evaluates the effects of two different food treatments (ration + zooplankton and only zooplankton) and water quality in tanks with *Brycon orbignyanus* larvae

2. Materials and Methods

This study was undertaken at the Research Station and Environmental Development of Volta Grande (CEMIG, MG, Brazil), downstream the Volta Grande reservoir, and a water source for CEMIG tanks. Four 8.49 m² tanks were populated with *Brycon orbignyanus* larvae, at a density of 94 larvae fish/m², and were reared until the 41st day.

The tanks were left empty for 7 days before the experiments and dolomitic lime (MgCO₃) at 8 kg/tank and chicken dung (1000 g.m⁻²) at 9 kg/tank were added.

Tanks were half filled (0.23 m) and kept at the same level for 5 days. They were then completed up to 0.45 m and water was made to flow continuously through the tanks. Larvae were placed in the tanks 2 days after spawning.

B. orbignyanus larvae in the current research originated from the CEMIG breeding stock. Following protocols by Woynarovich and Horvath (1985), recently hatched tambaqui (*Colossoma macropomum* (Cuvier, 1818)) were added to the 36 hatcheries to feed the *B. orbignyanus* larvae and prevent cannibalism. Two types of food treatments were investigated: one containing ration + zooplankton (TR) and another containing only zooplankton (TN). A supplementary diet containing 19% crude protein was given to larvae in TR up to the 20th day; a pellet-shape ration, containing 20% crude protein (20 kg.d⁻¹), was given as from the next day. The experiment was conducted in duplicate (TN₁; TN₂ = only zooplankton, and TR₁; TR₂ = ration + zooplankton).

Water samples were analyzed daily, with a 1 L Van Dorn bottle during the first week and then every four days, in all of the tanks, until the end of experiment. Temperature, conductivity and pH were determined with Corning temperature meter, Micronal B330 and Metrhon Herisau E 488, respectively. Transparency was determined by Secchi disk, dissolved oxygen, nitrite, nitrate, total phosphorus and orthophosphate were measured according to Golterman et al. (1978). Ammonia, chlorophyll-*a*, alkalinity and inorganic carbon were determined according to Koroleff (1976), Nush (1980) and Mackereth et al. (1978). Residence time was measured by the speed of water entrance into the tanks, assessing time spent for 2 L water output, expressed in days, needed for the total renewal of water volume in the tanks.

For quantitative and qualitative analysis of zooplankton, samples were obtained with a 58 µm mesh plankton net and then preserved in 4% formalin. Zooplankton organisms were counted in Sedgewick Rafter Cell and examined under 100x magnification. Copepoda nauplii and copepodids of *Argyrodiaptomus furcatus* Cowgill et al. (1985) and *Notodiptomus iherinig* (Wright, 1935); were counted together; density data were expressed in abundance percentage and individuals.m⁻³. Frequency occurrence was also estimated for total zooplankton organisms, divided into four classes: class 4 (very frequent, from 76 to 100%), class 3 (frequent, between 51 and 75%), class 2 (moderately frequent, between 26 and 50%) and class 1 (low frequency, between 1 and 25%).

Ten fish larvae were measured for total length with a graded scale and weighed using a 1g-precision balance. Larvae were measured daily during the first week; later, they were measured at a four-day interval, until the end of the experiment.

Total length and weight of *B. orbignyanus* larvae were determined by minimum square methods (Santos, 1978). Growth rates compared by method of treatment were analyzed according to Gabriel's procedure (Sokal and Rohlf, 1981), using simultaneous comparisons. Density of zooplankton organisms was evaluated

by means of the non-parametric Freedman test (Siegel, 1975) and significance level for statistical test results was $p = 0.05$.

3. Results

Total transparency of 45 cm was obtained in tanks with low conductivity, which ranged from 36 to 64 $\mu\text{S.cm}^{-1}$ in TR_1 , from 28 to 60 $\mu\text{S.cm}^{-1}$ in TR_2 , from 31 to 66 $\mu\text{S.cm}^{-1}$ in TN_1 and from 33 to 66 $\mu\text{S.cm}^{-1}$ in TN_2 (Figure 1).

Dissolved oxygen was below 4 mg.L^{-1} during the period, with the exception of TN_1 treatment. A rise in con-

centration above 4.25 mg.L^{-1} occurred starting from the 11th day, (above 4.25 mg.L^{-1}) with its peak at 7.6 mg.L^{-1} on the 27th day, the highest reported value during the study period (Figure 1).

Water temperature varied from 27 to 30 °C in the four tanks under analysis. Affected by the oligotrophic conditions of the reservoir, pH remained acid, with variations between 5.7 and 6.8 in TR_1 , between 6.1 and 6.6 in TR_2 , between 6.2 and 6.8 in TN_1 and between 6.0 and 6.6 in TN_2 (Figure 1).

Free CO_2 concentrations in TR and TN treatments were high due to the acidic pH of the medium and alternated bicarbonate dominance. Alkalinity, with a standard

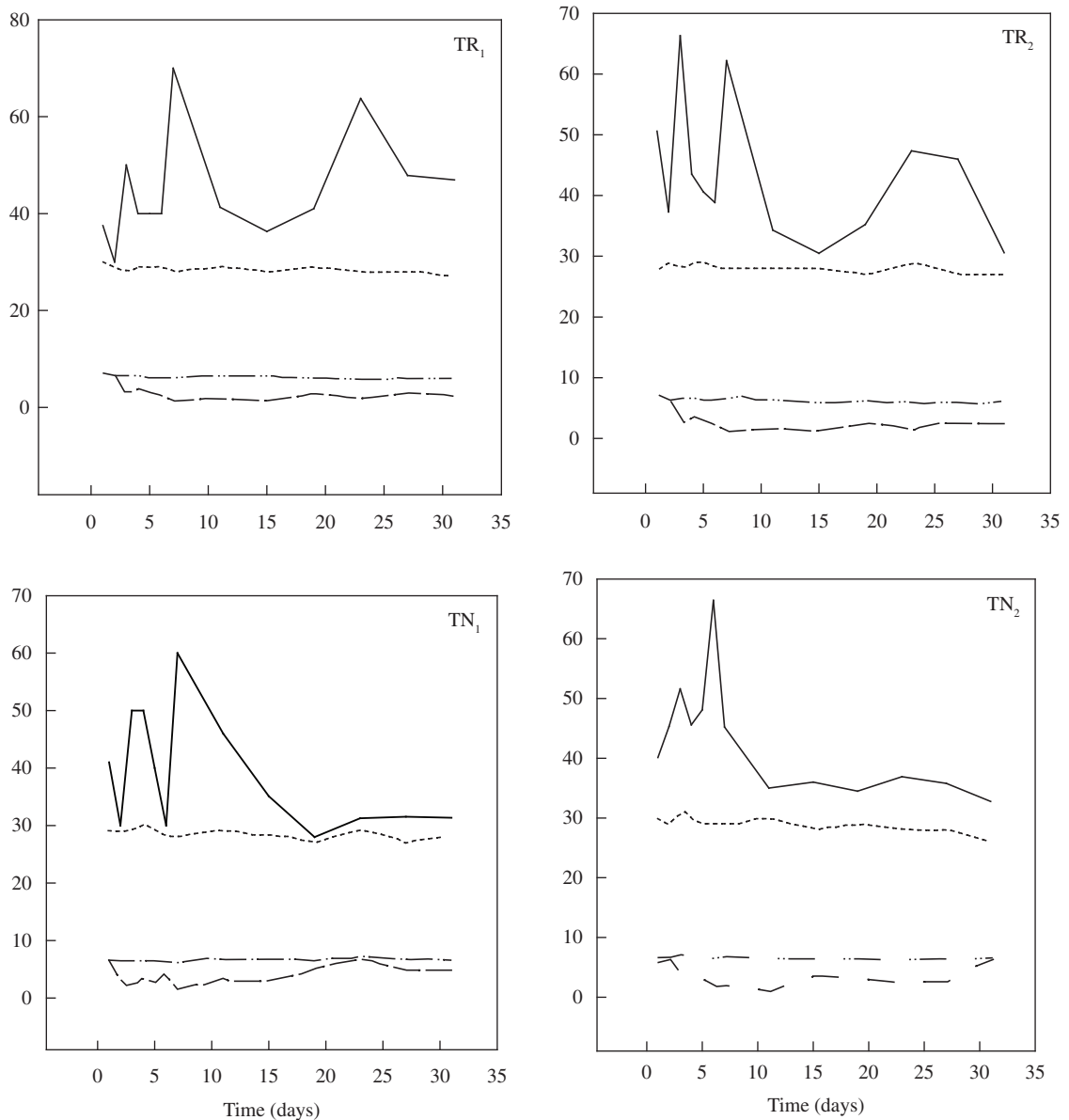


Figure 1. Fluctuation of dissolved oxygen (mg.L^{-1} , —), temperature ($^{\circ}\text{C}$,), pH (—.) and conductivity ($\mu\text{S.cm}^{-1}$, —) of the *Brycon orbignyanus* larvae tanks, where TR = ration + zooplankton and TN = only zooplankton.

variation similar to bicarbonate with higher concentrations in ration-less treatments, ranged between 11 and 23 mg.L⁻¹ in TN₁, and between 15 and 22 mg.L⁻¹ in TN₂, when compared to ration treatment with variations from 8 to 27 mg.L⁻¹ and from 6 to 22 mg.L⁻¹ for treatments TR₁ and TR₂, respectively (Figure 2).

Highest ammonium concentrations were reported in the treatment with TR₂ ration (740 µg.L⁻¹), mainly at the start of the experiment and up to the 9th day; later concentration rates were similar to nitrite and nitrate ones. Throughout the study, nitrogen compounds remained low with the exception of registered sudden ammonium peaks at the start of the experiment (Figure 3).

Although high concentrations of total phosphorus and orthophosphate were reported up till the 15th day, rates later on decreased to insignificant concentrations. Phosphorus concentrations in TR treatment were higher and reached a maximum of 847 and 935 µg.L⁻¹ in TR₁, and TR₂ tanks respectively. Chlorophyll-*a* was lower than 25 µg.L⁻¹ during the experimental period (Figure 4).

The zooplankton community consisted of 19 taxa or rather, 10 Rotifera, 6 Cladocera and 3 Copepoda. Table 1 shows their density variations. Although most taxa showed low frequencies (class 1), the short residence time restricted long life span and stimulated the short life-cycle of Rotifera. Actually, the latter constitut-

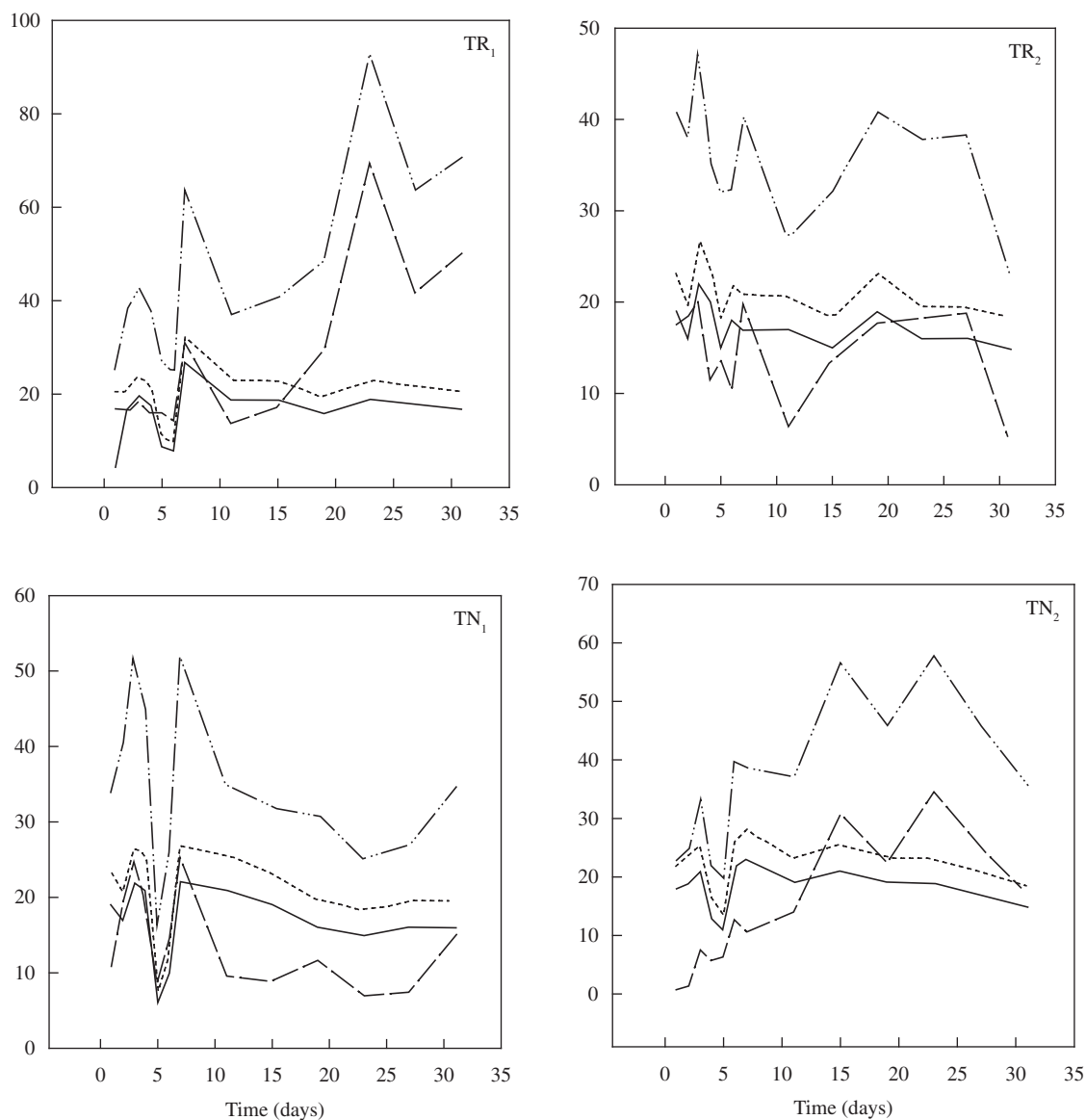


Figure 2. Fluctuation (mg.L⁻¹) of alkalinity (—), bicarbonate (....), free CO₂ (— —) and total carbon (— · —) of the *Brycon orbignyanus* larvae tanks, where: TR = ration + zooplankton and TN = only zooplankton.

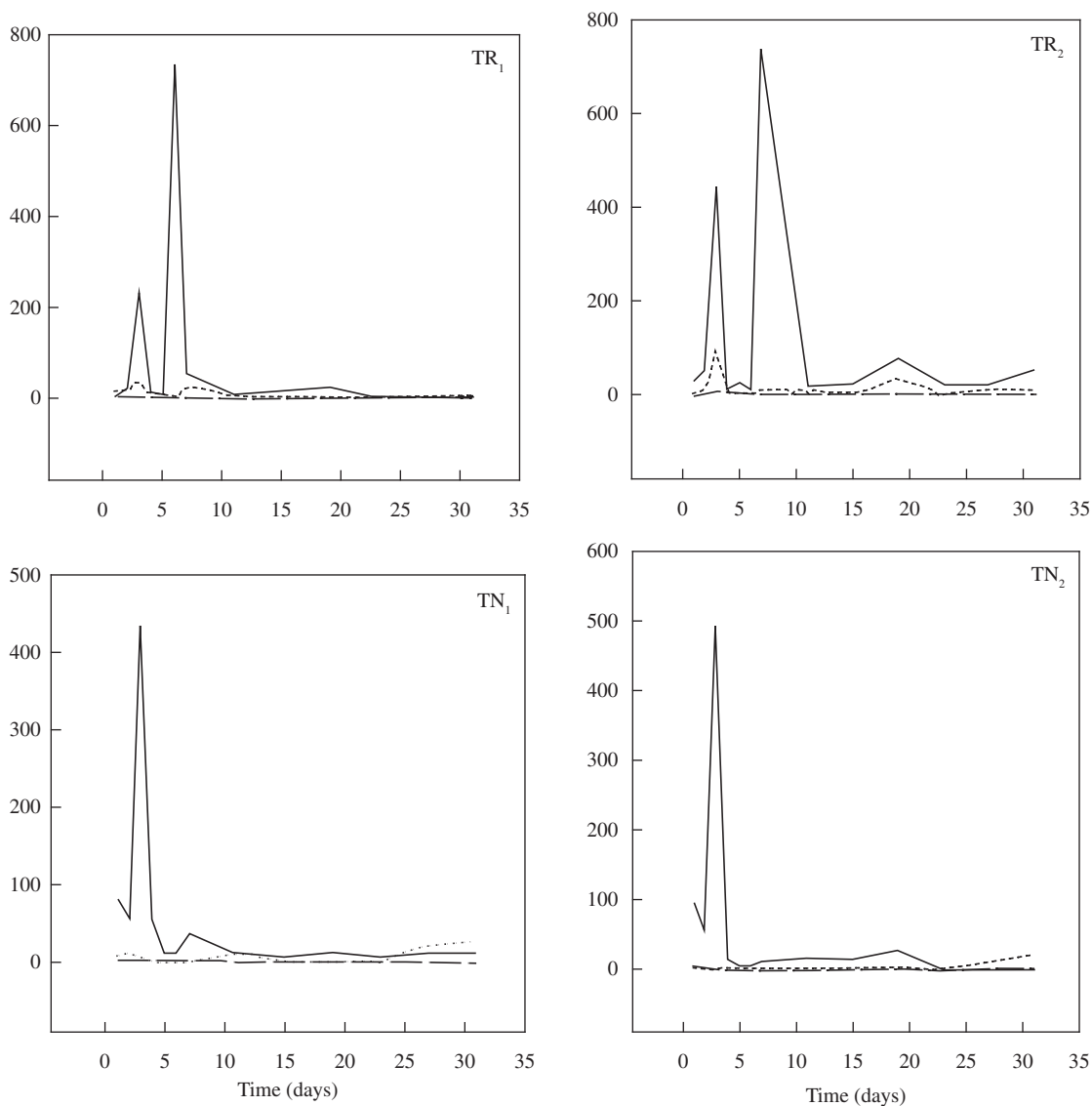


Figure 3. Fluctuation ($\mu\text{g.L}^{-1}$) of ammonia (—), nitrite (---) and nitrate (...) of the *Brycon orbignyanus* larvae tanks, where: TR = ration + zooplankton and TN = only zooplankton.

ed the largest number of species and/or genus reported (Table 2).

Rotifera were moderately frequent and were mainly represented by *Asplanchna* sp., with 1.5 to 3.8×10^5 ind. m^{-3} , and by *Epiphanes macrourus* Barrois and Dady (1894), with 3.5 to 6.0×10^5 ind. m^{-3} . Rotifera dominated the zooplankton community from the 19th day up till the end of the experiment. Copepoda were mostly represented by nauplii and copepodid, with more than 30 and 35% in TR, and 47 and 45% in TN. In TR treatment Copepoda – nauplii were considered frequent (class 3). Cladocera, the least abundant taxa, were represented mostly by the species *Diaphanosoma birgei* (Korineck, 1981), with over 54%. It was the only species classified as class 4, that is, very frequent, during the study period (Tables 1 and 2, Figure 5). Although all zooplankton spe-

cies were, as a rule, reported in treatment TR, *Bosmina tubicen* Brehm, 1953 and *Moina* sp. were not reported in TN treatment. The highest number of individuals, was reported in TR $2,010$ ind. m^{-3} (TR₁) and $2,283$ ind. m^{-3} (TR₂), was reported in TR (Table 1).

The highest survival rate (48%) has been observed for plankton treatment only (TN₁); however, the percentage was reduced to 20% for TN₂. Survival rates for TR₁ and TR₂ were 28 and 26%, respectively.

Weight-length relationship was not significantly different ($p > 0.05$) among the treatments, overlapping between intervals (Table 3). The average initial size and weight of the larvae in TR tanks were 1.21 cm and 0.02 g, respectively, and in TN tanks 1.08 cm and 0.02 g in TN tanks. During the experimental period, weights increased more quickly in tanks with ration. In fact,

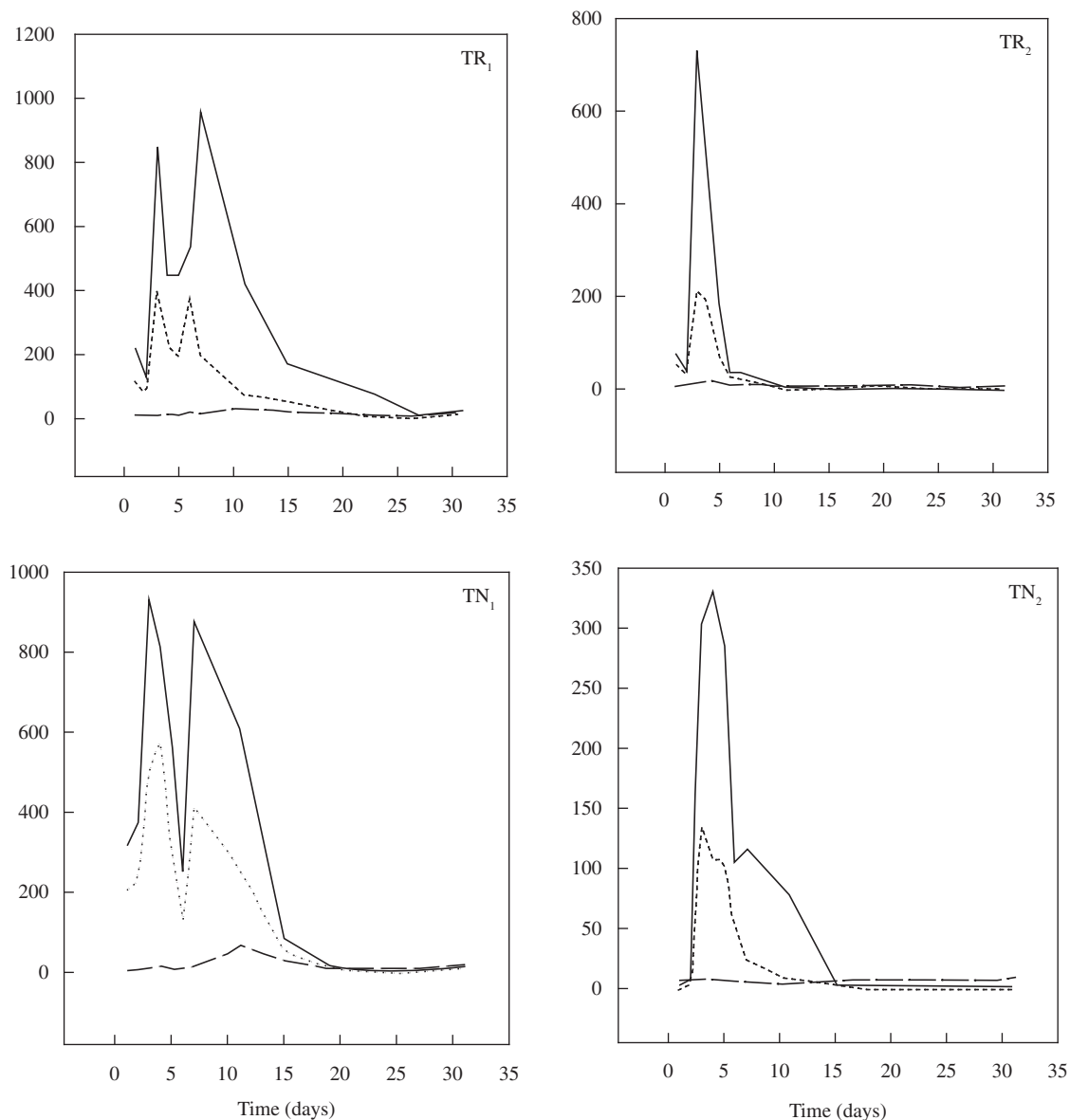


Figure 4. Fluctuation ($\mu\text{g.L}^{-1}$) of total phosphorus (—), orthophosphate (....) and chlorophyll-*a* (---) of the *Brycon orbignyanus* larvae tanks, where: TR = ration + zooplankton and TN = only zooplankton.

the larvae reached a final average weight and length of 8.58 g and 9.06 g, and 8.34 and 8.76 cm for TR₁ and TR₂, respectively. Results from ration-less tanks (TN) were lower, final average weights and lengths were 1.43 and 1.72 g and 4.91 and 5 cm, respectively.

4. Discussion

Water temperature in shallow artificial ponds is directly affected by solar radiation. During the experimental period temperature values were within normal limits suitable for the breeding of *Brycon orbignyanus*. According to Kubitza (1998), adequate temperature for tropical fish ranges between 20 and 30 °C, with its best between

28 and 32 °C. Total water transparency has been mainly associated with short residence time, continuous flow and shallowness. These factors associated to a water supply from an oligotrophic reservoir, also affected conductivity, which remained below 50 $\mu\text{S.cm}^{-1}$, frequently reported in the Volta Grande reservoir (Rolla et al., 1990).

Acid pH in tanks affected inorganic carbon compounds with significant rates of free CO₂. According to Gomes (1997), acid pH in larviculture tanks negatively affected both the survival and the development of *B. cephalus* larvae.

Nutrients in water were affected by feed treatment. Due to the feed decomposition and the consequent in-

Table 1. Total density and composition of zooplankton organisms ($\times 10^3$ org.m⁻³) in Brycon orbignyus larvae tanks, where TR = ration + zooplankton and TN = only zooplankton.

Taxa	Density ($\times 10^3$ ind.m ⁻³)			
	TR ₁	TR ₂	TN ₁	TN ₂
ROTIFERA				
<i>Asplanchna</i> sp	376	306	152	158
<i>Brachionus dolabratus</i>	92	36	32	35
<i>Brachionus falcatus</i>	42	95	36	28
<i>Epiphanes macrourus</i>	603	552	464	350
<i>Filinia longiseta</i>	12	12	40	26
<i>Keratella americana</i>	29	31	38	43
<i>Lecane</i> sp	10	5	28	66
<i>Lecane pertica</i>	28	48	32	29
<i>Ptygura</i> sp	75	46	92	75
<i>Trichocerca</i> sp	95	150	58	58
CLADOCERA				
<i>Bosmina tubicen</i>	4	2	3	-
<i>Ceriodaphnia</i> sp	8	5	5	5
<i>Ceriodaphnia cornuta</i>	10	10	4	4
<i>Daphnia gessneri</i>	2	3	2	2
<i>Diaphanosoma birgei</i>	29	171	33	191
<i>Moina</i> sp	5	2	-	4
COPEPODA				
<i>Thermocyclops decipiens</i> adult	63	47	86	48
<i>Notodiaptomus iheringi</i> adult	49	172	134	360
<i>Argyrodiaptomus furcatus</i> adult	26	187	120	66
*Copepodid	69	240	82	65
*nauplii	383	163	490	334

- not observed in the sample.

**A. furcatus* and *N. iheringi* copepodid and nauplii.

corporation of these elements into the water column by algal biomass, the concentration of nutrients in TR tanks was higher. Since movement stirred by water input and output in tanks causes more active nitrification, lower nitrite concentrations were reported when the latter were compared to nitrate and ammonia concentration rates.

Sipaíba-Tavares et al. (2000) also reported low nitrite and high nitrate concentrations in tilapia tanks with water renewal. This fact demonstrated not only absorption of the element by phytoplankton but also activities of nitrifying bacteria in fishponds.

Since higher concentrations of orthophosphate and total phosphorus occurred in TR treatments, the direct effect of inert feed on the dynamics of nutrients has been indicated. Avnimelech (1998) verified that in earthen carp ponds 20% of phosphorus and 25% of nitrogen were recovered when fish were harvested. The remaining percentage was accumulated in sediments or became available in the water column.

Water mass circulation was also affected by nutrient availability, which in turn was influenced by the continuous water flow and by the management of fish harvesting,

which triggered the re-suspension of the sediment. Furthermore, phosphorus compounds of food affect its availability in the environment: greater loss occurs when food has a low conversion. Whereas nitrogen depends on several factors, fish excretion rates depend on the food rate, digestibility and availability (Pillay, 1992).

Low chlorophyll-*a* concentration may be associated with the water short residence time which will have restricted a long permanence of phytoplankton biomass in the ponds. This fact influenced the low dissolved oxygen concentrations due to the fact that oxygen consumption and phytoplankton production were more important than diffusion processes. According to Gomes et al. (2000), *Brycon* can survive in water with low levels of dissolved oxygen.

Short residence time in ponds affected directly the zooplankton community, characterized by low species diversity. However, short life-span organisms, such as Rotifera, were ecologically better adapted to unforeseen changes of the environment and, in the long run, become dominant. Probably associated with higher availability of nutrients in culture tanks, Rotifera represented more

Table 2. Specific composition and frequency of different zooplankton taxa in *Brycon orbignyanus* larvae tanks with two treatments: ration + zooplankton (TR) and only zooplankton (TN), where: 1 = 1 to 25% frequency; 2 = 26 to 50% frequency; 3 = 51 to 75% frequency and 4 = 76 to 100% frequency.

Taxa	Frequency			
	TR ₁	TR ₂	TN ₁	TN ₂
ROTIFERA				
<i>Lecane</i> sp	1	1	1	1
<i>Brachionus dolabratus</i>	1	1	1	1
<i>Filinia longiseta</i>	1	1	1	1
<i>Brachionus falcatus</i>	1	1	1	1
<i>Lecane pertica</i>	1	1	1	1
<i>Keratella americana</i>	1	1	1	1
<i>Ptygura</i> sp	1	1	1	1
<i>Trichocerca</i> sp	1	1	1	1
<i>Asplanchna</i> sp	2	1	2	2
<i>Epiphanes macrourus</i>	2	2	2	2
CLADOCERA				
<i>Daphnia gessneri</i>	1	1	1	1
<i>Moina</i> sp	1	-	1	1
<i>Bosmina tubicen</i>	1	1	1	1
<i>Ceriodaphnia cornuta</i>	1	1	1	1
<i>Ceriodaphnia</i> sp	1	1	1	1
<i>Diaphanosoma birgei</i>	3	3	4	4
COPEPODA				
<i>Thermocyclops decipiens</i> adult	1	1	1	1
<i>Notodiaptomus iheringi</i> adult	1	1	1	2
<i>Argyrodiaptomus furcatus</i> adult	1	1	2	1
*copepodid	1	1	2	1
*nauplii	3	3	1	2

**A. furcatus* and *N. iheringi* copepodid and nauplii.

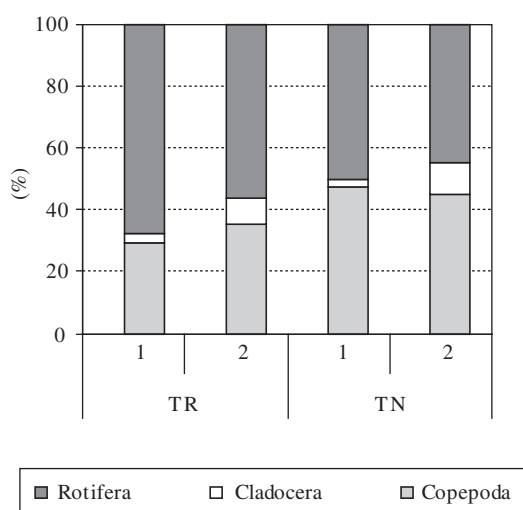


Figure 5. Relative (%) composition of zooplanktonic community found in the ponds for the two tanks, where: TR = ration + zooplankton and TN = only zooplankton.

than 50% of the organisms found in the experiment and were more abundant in TR treatment. High Rotifera density has been associated with the capacity of organisms to adapt themselves quickly to environmental disruption and perturbation. In fact, prevalence in physically unstable systems, such as fishponds, has been the trend (Sipaúba-Tavares and Colus, 1997).

According to Sendacz and Kubo (1982), Calanoida-Copepoda is more abundant than Cladocera in oligotrophic waters, a characteristic of the water supplied to the tanks. Lower abundance of Cladocera in tanks may be associated with predation by *B. orbignyanus* larvae, which prefer zooplankton crustaceans, mainly Cladocera (Ceccarelli and Senhorini, 1996). In their study on survival, growth and trophic dynamics in "piracanjuba" larvae tanks, Senhorini and Fransozo (1998) verified that Cladocera were preferentially ingested by the larvae

Coupled to predation, high water transparency, low temperatures and water flow are unfavorable factors to Cladocera in fish tanks (Sipaúba-Tavares and Colus, 1997). Cladocera were more abundant only at the start of the experimental period when water temperature was

Table 3. Data on the relationship weight / length of *Brycon orbignyanus* in two different treatments (TR = ration + zooplankton and TN = only zooplankton), where N = number of specimens; a = numerical value of interceptor in the allometric equation; b = angular coefficient rate with confidence interval, r = correlation coefficient rate.

Weight/length relationship	TR ₁	TR ₂	TN ₁	TN ₂
N	105	132	107	137
A	0.0100	0.0095	0.0096	0.0086
B	3.13 ± 0.25	3.07 ± 0.22	3.11 ± 0.26	3.18 ± 0.24
R	0.998	0.981	0.997	0.994

high. Although *Diaphanosoma birgei* was the only dominant one among Cladocera, it was also the only zooplankton species classified as frequent in the tanks.

According to Pereira et al. (2004), predominance of *Diaphanosoma birgei* in fish tanks is associated with continuous water flow, low dissolved oxygen and high phosphorus rates. High phosphorus rates in TR₂ affected the high species density observed, since it represented 88.6% of all Cladocera reported.

The water supply of the culture tanks came from an oligotrophic reservoir and directly affected the Copepoda community. In fact, the two Diaptomidae species, *Notodiaptomus iheringi* and *Argyrodiaptomus furcatus*, were the most abundant. *Thermocyclops decipiens*, characteristic of mesotrophic and eutrophic environments (Sendacz and Kubo, 1982), represented a single occurrence of a Cyclopoida species.

Zooplankton fluctuations are triggered by several factors such as temperature, light and dark periods, water quality, food availability, competition and predation. In fish hatcheries, management may also modify the reproductive cycles of these organisms and population succession (Sipaúba-Tavares and Colus, 1997).

Survival rates were low. Whereas only in treatment TN₁ a 48% survival occurred, survival rates were lower than 28% in the other tanks. Lopes et al. (1994) demonstrated that supply of zooplankton plus ration caused higher survival rates for *Brycon cephalus*.

According to Battaglione et al. (2005), Rotifera were a likely source of bacterial load to larval striped trumpeter (*Latris lineata*) in tanks. Moreover, Evjemo et al. (2003) verified that total protein in Calanoida-Copepoda was higher than 50% of dry weight than that of Rotifera. In the current experiment, Rotifera reached high densities and Copepoda, low densities. These factors may be influenced by growth and survival results of *Brycon orbignyanus* larvae. Quantity and quality of available food and the control of the culture water variations directly affected the survival and performance of fish larvae.

Since there was no difference between growth rates within the weight-length relationship, condition factors of larvae in the treatments were similar ($p > 0.05$). Condition factors showed the fish well-being within a certain environment and were associated with conditions in the allometric equation $y = ax^b$, adjusted to weight and length data (Braga, 1997).

Pronounced fluctuation of organisms in Rotifera-dominant tanks has been reported, followed by Copepoda and Cladocera. Fluctuation in shallow artificial fish culture systems are probably associated with water flow, quantity of available food, chemical and physical changes of water and biological interactions including predation and competition. Zooplankton was thus affected by short life-span water residence which favored opportunist species, such as Rotifera, and affected the survival of *B. orbignyanus* larvae in tanks.

Results indicate some management recommendations can be applied in the larvae culture station of Volta Grande (CEMIG) so that the survival of *B. orbignyanus* larvae may be increased:

- 1) Water flow decrease in tanks in order to retain phytoplankton biomass and consequently to increase the quantity and quality of zooplankton organisms; water turbidity caused by planktonic organisms increases, light penetration is reduced and dissolved oxygen in the tanks is increased.
- 2) Since the ration + zooplankton treatment (TR) showed better results, this treatment should be recommended for *Brycon orbignyanus* larvae.
- 3) Deeper ponds may be used, since these systems are directly affected by local climate.
- 4) In this study, water in the tanks was supplied by an oligotrophic reservoir characterized by low plankton densities; consequently, tank construction with the sole aim to cultivate zooplankton as a food reserve for *B. orbignyanus* larvae is recommended.

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