EFFECT OF PREY SIZE SELECTION AND RATION ADDITION ON THE REARING OF PIRACANJUBA LARVAE, *BRYCON ORBIGNYANUS*

Marcelo Mattos Pedreira[1]
Lúcia Helena Sipaúba-Tavares[2]

RESUMO

Efeito da seleção do tamanho da presa e da adição da ração no cultivo de larvas de piracanjuba, *Brycon orbignyanus*.

Larvas de piracanjuba, *Brycon orbignyanus* foram cultivadas em laboratório sendo submetidas a quatro tratamentos alimentares: 1) plâncton (P) selecionado em peneira de 1.000 µm; 2) plâncton e ração (PR) selecionados em peneira de 1.000 µm, sendo a ração introduzida a partir do terceiro dia de alimentação exógena. 3) plâncton selecionado (PS) em peneira de 350 µm, até o décimo dia, a partir de quando era selecionado com peneiras de 500 µm; e 4) plâncton e ração selecionados (PSR) em peneira de 350 µm, até o décimo dia, a partir de quando eram selecionados com peneiras de 500 µm, sendo a ração introduzida a partir do terceiro dia de alimentação exógena. As variáveis limnológicas, temperatura da água, oxigênio dissolvido, pH e condutividade foram similares entre os tratamentos, estando dentro da faixa adequada para à espécie. Os resultados sugerem que a seleção de tamanho da presa está positivamente correlacionada a taxa de sobrevivência das larvas, provavelmente devido ao decréscimo da hierarquia alimentar, que atenuou a heterogeneidade de crescimento e o canibalismo por conseqüência. A ração adicionada ao alimento também foi benéfica ao cultivo das larvas.

Palavras chaves: larvas de Brycon orbignyanus, plâncton selecionado, ração.

ABSTRACT

Piracanjuba larvae *Brycon orbignyanus* were reared in laboratory and fed the following four dietary treatments: 1) plankton (P) screened in 1,000 µm sieve; 2) plankton and ration (PR) screened in 1,000 µm sieve, plus ration starting on the third day of exogenous feeding; 3) plankton (PS) screened in 350 µm sieve, for the first ten days and in 500 µm sieve in the subsequent days; and 4) plankton and ration (PSR) screened in 350 µm sieve, during the first ten days and in 500 µm sieve in the subsequent days, plus ration starting on the third day of

[1] Departamento de Zootecnia das Faculdade Federais Integradas de Diamantina. Rua da Glória, 187. Diamantina (MG), 39100–000, Brazil. e-mail: marmape@zipmail.com.br.
[2] Centro de Aqüicultura, Universidade Estadual Paulista, Jaboticabal (SP), 14870-000, Brazil.

exogenous feeding. Limnological variables, water temperature, dissolved oxygen, pH and conductivity were similar in all treatments and within the range adopted for the species. The results suggest that prey size selection correlates positively with larvae survival rates, probably due to the decrease of alimentary hierarchy, thus attenuating growth heterogeneity and consequently, cannibalism. Ration added to natural food also proved to be beneficial.

Key words: larvae Brycon orbignyanus, plankton screened, ration.

INTRODUCTION

One of the difficulties in Aquaculture is the availability of fingerlings of good quality and quantity. Weaning is the most critical period during fingerling production, which is the transition period between feeding on the food reserves from the yolk sac and the start of exogenous feeding.

In the first days of exogenous feeding, the larvae are able to capture only small organisms due to small mouth opening; however, as they develop they become more efficient due to changes in their functional, anatomic, physiological and behavioral characteristics which leads to a better performance in selecting preys (Gerking, 1994).

Hunter (1984) observed that during growth for each species there is a mouth/length relationship, and the difference is responsible for specific variations on the selection of prey size.

Brycon orbignyanus, popularly known as piracanjuba, is a herbivorous species of medium size and high commercial value. It is indigenous from Parana basin and it used to be abundant; however, with the destruction of gallery forests, pollution, dam constructions and decreasing of lakes for hydroelectric operations, the species is now rare in their natural habitat (Ceccarelli & Semhorini, 1996).

The species of the genus *Brycon* are very popular for sports fishing. But the species biggest problem is the cannibalism that occurs, generally, at the second day of life. Therefore, it is of utmost importance to supply good quality food at adequate quantity in order to diminish cannibalism and to optimize rearing of the species.

Alterations of food selectivity during development have been reported for Characiformes larvae and freshwater tropical fish. Some species are consumed preferably, selecting prey according the size and group to which they belong or using food items available in the environment.

Based on these characteristics and on the possibility of improving the performance of *B. orbignyanus* larvae in rearing systems, a diet management using two particle sizes, with and without additional ration, was evaluated.

MATERIALS AND METHODS

The piracanjuba, *Brycon orbignyanus*, larvae used in this experiment were obtained by induced reproduction at Central Eletricas de Minas Gerais (CEMIG). The one-day old

larvae weighed 1.4 mg and measured 5.29 mm (± 0.16) total length.

The larvae were kept in 50-L aquaria equipped with constant aeration and natural photoperiod, at 6 larvae/L density. Every two days waste was siphoned and 20% of the water volume was renewed. The renewal water was filtered using 3 and 5 μm porosity filters.

Feeding treatment

Two types of food were used, natural plankton collected at Centro de Aquicultura (UNESP, Jaboticabal) and concentrated using 58-μm net. In the lab, plankton was kept in 12-L vessels at room temperature, and later on distributed in the larvae tanks.

The other food, a commercial ration for fingerlings, was triturated and fractionated in two particle sizes: one fraction up to 350 μm and the second fraction between 500 and 1,000 μm. Ration composition was as follows: maximum moisture, 13%; minimum crude protein, 32%; fat, 4%; maximum fibers, 6%; maximum minerals, 12%; maximum calcium, 2.5%; and minimum phosphorus, 0.8%.

Piracanjuba larvae were fed four different treatments, with 6 replicates, consisting of: 1) natural plankton (P), fractionated using 1,000 μm screens; 2) natural plankton (PS), fractionated using 350 μm screen until the 10th day, and 500 μm after that; 3) natural plankton (PR) fractionated using 1,000 μm screen, plus ration added from the third day on after, the larvae opened their mouth; and 4) natural plankton plus ration (PSR), selected using 350 μm screens until the 10th day and later, 500 μm screen, plus ration from the third day on, after the larvae opened their mouth. Larvae were fed natural plankton ad libitum once a day and ration was fed three times a day (0800, 1400 and 1800 h).

Limnological variables

Water samples were collected daily at 0700 h to monitor quality. Dissolved oxygen and temperature were measured using a YSI 55 oxygen meter; pH and conductivity were measured using a digital Corning PS 15 and 17, respectively. Daily variations of air temperature were monitored using a thermometer of maximum and minimum, and the data were plotted.

Biological variables

Survival rates, average weight, biomass and total length were determined at the end of the experimental period.

Average weight was determined using a Scientech AS 210 balance. Larva average weight was determined dividing total biomass by the number of individuals for each replicate. Total length was determined using a stereoscopic microscope equipped with a micrometer in the eyepiece. A total of 87, 87, 86 and 90 larvae were measured for P, PR, PS and PSR treatments, respectively.

Statistical analysis

A 2 x 2 factorial, completely randomized design, with 6 replicates was used. Data were compared by analysis of variance and Tukey test, at 0.05 significance level. All statistical analysis were computed using SAS (SAS Institute Inc., Cary, North Carolina, USA).

RESULTS

Biological variables

Survival rates varied significantly among treatments with plankton fraction ($P < 0.01$) and ration addition ($P < 0.05$). Mean absolute values varied from 21.7 to 32% for PSR, 18.7 to 26.3% for PS, 17 to 22% for PR and 5.7 to 20.7% for P (Table 1).

In the aquarium where the larvae were fed only plankton (P), both alive and dead organisms accumulated on the bottom, where the weaker larvae got caught and died. In PS and PSR treatments, this phenomenon was observed later on. The waste deposited on the bottom required extra care during siphoning. This was particularly true for P treatment at the beginning of the experiment when the larvae were not able to stay in the water column, because the gas vesicle did not work yet. At this developmental stage, the larvae move vertically by sporadic pulses followed by resting moments on the bottom.

In treatments PR and PSR, with plankton and ration added, the larvae displayed positioning and capture behavior towards food particles since they were three days old.

Larger food particles, probably due to excessive hardness, were frequently captured and regurgitated. Once they were deposited on the bottom, they decomposed. Due to the initial inertia of the larva reaction to artificial food, the ration was fed in small amounts, for 20 minutes, to attract attention to the food, thus avoiding deposition on the bottom and further decomposition.

Both particle size selection and addition of ration affected positively larva survival rates. Low selection of plankton size in 1,000 μm net, resulted in reduced survival of piracanjuba larvae.

Average weight varied significantly with plankton fractionation. Average weight varied from 21.3 to 32.0 mg for PS and 23.0 to 32.8 mg for PSR, both treatments with plankton fraction. While the treatments without plankton selection, average weight varied from 41.4 to 64.1 mg for P and 29.0 to 54.1 mg for PR (Table 1).

In the treatments that displayed higher survival rates, the larvae presented lower average weight, thus average survival rate and weight were inversely proportional.

Biomass was affected positively by both plankton fractionation ($P < 0.01$) and ration addition ($P < 0.05$), the same trend was observed for the survival rates. Biomass was also higher for PSR treatment, varying from 2.71 to 3.83 g, followed by PS, 1.78 to 3.33 g; PR, 0.98 to 1.8 g and, finally P, 0.29 to 1.19 g (Table 1).

Total length varied significantly ($P < 0.05$) among treatments. Average length was lower for larvae fed selected plankton diets, PS and PSR, compared to diets without plankton selection, PR and P, it varied from 14.8 to 16.3 mm, 14.3 to 15.5 mm, 12.7 to 14.8 mm and 11.6 to 13.6 mm, respectively. An interaction ($P < 0.05$) between plankton and ration was observed, since the larvae that were fed selected plankton without ration were smaller.

Limnological variables

The limnological variables did not change significantly among different diets. During the experimental period, average water temperature varied from 19.1 to 22.4 C and air temperature oscillated between 8 and 16.5 C (Figure 1).

Due to constant aeration, dissolved oxygen levels were above 6.98 mg/L, tended to decrease from the 6th day on, increased slightly on the 11th day, 7.83 mg/L, and decreased after that. The highest and lowest levels were observed on the 4th and 2nd days, 8 mg/L and 6.98 mg/L, respectively. Oxygen concentrations were not different among treatments; however, between the 5th and 13th days there was a slight peak for treatment PS (Figure 1).

Throughout the experimental period, pH was alkaline and varied between 8.13 and 8.5 for all treatments. On the 9th and 10th day, pH was slightly lower for all treatments and between the 4th and 10th day slightly higher for treatment PS (Figure 1).

Conductivity was high and varied between 185 and 232 μS/cm throughout the experiment. Conductivity values were similar for all treatments, with the exception of PS, between the 1st and 10th day, where it was higher and varied between 218 and 232 μS/cm. In general, conductivity tended to increase between the 4th and 10th day from 204 to 216 μS/cm and decreased on the last day (Figure 1).

DISCUSSION

Data from the literature show that plankton is a very important food during the first days of life of Brycon larvae. Better rearing conditions are achieved with larger organisms and addition of artificial ration (Senhorini, 1999). In this study, the larva best performance was achieved with plankton and ration treatment compared to plankton only.

Experiments with other fish species have shown that plankton plus ration effectively improve performance of carp *Cyprinus carpio* (Lubzens *et al*., 1984) and pacu *P. mesopotamicus* (Senhorini & Fransozo, 1994). However, plankton has proven to be essential in the diet of *Brycon* larvae (Ceccarelli & Senhorini, 1996) and other indigenous species, such as pacu (Sipauba-Tavares & Braga, 1999) and tambaqui *C. macropomum* (Sipauba-Tavares & Rocha, 1993).

The necessity of natural food is related to the fact that these ingredients activate enzymatic action in the digestive tract of larvae (Ueberschar, 1995). According to Galvao *et al*. (1997) the quick assimilation of plankton by the larvae is associated to the high proteolytic activity of planktonic enzymes, which contribute to fast assimilation of the prey by the larvae. Therefore, live food should be one of the principal ingredients in the diet.

In this study, the highest survival rates and biomass of piracanjuba larvae were observed for treatments containing both plankton and ration (PR and PSR) compared to

the treatments containing exclusively plankton (P and PS). That was probably due to the fact that plankton autholysis facilitates ration assimilation by the larvae. However, in spite of P treatment lower survival rates, the larva average weight was higher. This may be the result of higher food availability and/or more space. According to Duray *et al*. (1997) in tanks with lower survival rates, the larvae tend to grow more due to less competition for food.

High variations of air temperature may have caused oscillations in the water temperature due to the small volume of the aquaria, which interfered with larva survival. According to Kamler (1992), sudden temperature variations may cause mortality of fish larvae and cause a negative impact on survival and growth.

Prey size and type

The selection of particle size had a positive effect on survival and biomass of piracanjuba larvae. Senhorini (1999) reported that three-day old piracanjuba larvae selected Cladocera positively, and they represented more than 80% of the contents in the digestive tract. Alvarez (1999) reported 29.3% survival rates, while cultivating piracanjuba larvae fed on natural plankton containing predominantly Rotifer, followed by Copepoda (dominantly nauplii) and Cladocera.

Size and availability of planktonic organisms seem to interfere with prey capture and in the success of larval rearing of Characiformes. Mouth development in piracanjuba larvae is very quick and turns possible cannibalism on the second day of life. Therefore, culture where live food is selected according to size presents the best results.

Dumont-Neto *et al*. (1997) to minimize cannibalism among piracanjuba larvae offered tambaqui larvae as initial food due to their ideal size for ingestion and reduced ability to escape. The selection of an ideal size prey is so important that the presence of another food item with different size and behavior is sufficient to increase cannibalism among *Brycon* larvae and to decrease culture efficiency (Ceccarelli, 1997).

In spite of not using other larva species to feed piracanjuba, the selected plankton treatments (PS and PSR) after 16 days, presented survival rates (23.4% ± 3.1 and 26.4% ± 4.1, respectively) higher than the values reported by: Mendonca (1994) for *B. orbignyanus* larvae, reared for 20 days, initially fed pacu larvae; Piovezan (1994) for piracanjuba larvae reared for 15 days, fed tambaqui and guaru larvae; and Lopes *et al*. (1994) for *B. cephallus*, reared for 18 days, fed plankton.

Senhorini (1999) while rearing *B. orbignyanus* larvae, for 23 days, reported higher survival rates (40.1% ± 7); however, the experiment began after the critical cannibalism phase was over (62-hour old larvae) at low stocking density (0.02 to 0.03 larvae/L) and large tanks (350 m2).

In this study, PS and PSR treatments probably supplied preys of adequate quantity and quality for larva's capturing ability during the first days of life and, therefore

diminishing cannibalism. The higher mesh used to select plankton aimed at optimizing the cost/benefit relationship, which increases as prey size decreases.

It is possible that the low results obtained when larvae were fed exclusively plankton (P) are related to plankton composition, since larva survival and growth rates depend mainly on availability and quality of food.

It is possible that the presence of carnivorous Copepoda, genus *Mesocyclops*, common in Sao Paulo state (Sendacz & Kubo, 1982) promoted competition for food against larva initial stages, thus resulting in the low survival of P treatment. Copepoda Cyclopoida, *Mesocyclops longisetus*, is extremely undesirable during initial stages (5.7 mm) of larval rearing, and its effect on the medium depends on larva developmental stage, Cyclopoida density and exposition time of the larvae to the predator (Behr *et al*., 1997).

Basile-Martins *et al*. (1987) also observed that Cyclopoida adults, present in the plankton only diet, tended to attach to the larva membranes or bodies, making movement difficult and causing the larvae to die. The same phenomenon may have occurred with piracanjuba larvae in this study, mainly during the first days of life when the larvae were less able to swim and were caught in the waste accumulated on the bottom of the tank.

Volpato *et al*. (1989) reported that larger tilapias from the same hatching, inhibit growth of the smaller ones. They eat and grow faster, and as food availability increases so does growth heterogeneity, probably due to easier access to larger amounts of food.

In this study, the diversity of prey size resulted in accelerated growth of some piracanjuba larvae, thus causing the larger larvae to predate on the smaller ones. Filial cannibalism was also observed by Ceccarelli & Senhorini (1996) for this species.

In spite of excess food being observed to cause growth heterogeneity, initially the concentration of plankton offered to the larvae aimed at increasing prey availability, which according to Duray *et al*. (1996) increases the chance of capture by the larvae and results in higher growth rate.

The impact of zooplankton predation and competition on larval rearing was not quantified, but the lower survival rate found for P treatment suggested that these events interfered in rearing performance.

The results presented here show the positive impact of particle size selection and addition of ration in the diet of piracanjuba larvae. However, more detailed studies should be conducted with respect to quantity and quality of live food and system management as well.

ACKNOWLEDGMENTS

We thank Fundação de Amparo a Pesquisa do Estado de São Paulo (FAPESP grant number 97/11812-1). Thanks are also due to Dr. Wagner Cotroni Valenti for allowing us to use the laboratory for larval rearing.

LITERATURE CITED

ALVAREZ, E. J. S. 1999. Dinâmica de algumas variáveis limnológicas em tanques de larvicultura de *Brycon orbignyanus* (Valenciennes, 1949) (Pisces Characidae) sob dois tipos de tratamentos alimentares. *Master's dissertation*, Centro de Aqüicultura da UNESP, Jaboticabal, São Paulo, Brasil.

BASILE-MARTINS, M. A., YAMANAKA, N., JACOBSEN, O. & ISHIKAWA, E C. M. 1987. Observações sobre a alimentação e a sobrevivência de larvas de pacu, *Piaractus mesopotamicus* (Holmberg, 1887) (= *Colossoma mitrei*, Berg, 1895). *B.Inst..Pesca*, 14:63-68.

BEHR, E. R., FURUYA, W. M., FURUYA, V. R. B. & HAYASHI, E C. 1997. Efeito da densidade do copépodo ciclopóide *Mesocyclops longisetus* na predação de larvas de pintado *Pseudoplatystoma corruscans*. *B.Inst..Pesca*, 24(especial):261-266.

CECCARELLI, P. S. 1997. Canibalismo em larvas de matrinxã *Brycon cephalus* (Günther, 1869). *Master's dissertation*, Instituto de Biociências da Universidade Estadual Paulista (UNESP), Botucatu, São Paulo, Brasil.

CECCARELLI, P. S. & SENHORINI, J. A. 1996. *Brycon* viabilização da produção de alevinos. *Panorama da Aqüicultura*, (6)35:10-11.

DUMONT-NETO, R., PELLI, A, FREITAS, J. L., COSTA, C. L., DE-FREITAS, A. E. & BARBOSA, E N. D. C. 1997. Reprodução induzida da piracanjuba (*Brycon orbignyanus*, Valenciennes, 1903), durante a primeira maturação sexual, cultivada em cativeiro, na estação de pesquisa e desenvolvimento ambiental de Volta Grande - CEMIG. *B. Inst. Pesca*, 24(especial):105-107.

DURAY, M. N., ESTUDILLO, C. B. & APLAZAN, L. G. 1996. The effect of background color and rotifer density on rotifer intake, growth and survival of the grouper (*Epinephelus suillus*) larvae. *Aquaculture*, 146:217-224.

DURAY, M. N., ESTUDILLO, C. B. & APLAZAN, L. G. 1997. Larval rearing of the grouper *Epinephelus suillus* under laboratory conditions. *Aquaculture*, 150:63-76.

GALVÃO, M. S. N., YAMANAKA, N., FENERICH-VERANI, N. & PIMENTEL, E C. M. M. 1997. Estudos preliminares sobre enzimas digestivas proteolíticas da tainha *Mugil platanus* Günter, 1880 (Osteichthyes, Mugilidae) durante as fases larval e juvenil. *B.Inst..Pesca*, 24:101-110.

GERKING, S. D. 1994. *Feeding Ecology of Fish*. Academic Press, New York, USA.

HUNTER, J. R. 1984. Feeding ecology and predation of marine fish larvae. Pages 33-77 in R. Lasker, editor. *Marine fish larvae: morphology, ecology, and relation to fisheries*. Washington Sea Grant Program, Washington, USA.

KAMLER, E. 1992. *Early life history of fish an energetics approach*. Chapman and Hall, London, England.

LOPES, R. N. M., SENHORINI, J. A. & SOARES, E M. C. F. 1994. Crescimento e sobrevivência de larvas de matrinxã *Brycon cephalus* Günther, 1869, (Pisces, Characidae) sob diferentes dietas alimentares. *B. Téc. CEPTA*, 7:41-48.

LUBZENS, E., SAGIE, G., MINKOFF, G., MERAGELMAN, E. & SCHNELLER, A. 1984. Rotifers (*Brachionus plicatilis*) improve growth rate of carp (*Cyprinus carpio*) larvae. *Bamidgeh*, 36(2):41-46.

MENDONÇA, J. O. J. 1994. Criação de espécies do gênero *Brycon* no CEPTA/ IBAMA. Páginas 31-48. *Anais do Seminário Sobre Criação de Espécies do Gênero Brycon*, 1. Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq, Pirassununga, Brasil.

PIOVEZAN, U. 1994. Efeito da dieta na sobrevivência de larvas de piracanjuba (*Brycon orbignyanus*) - CAUNESP. Páginas 21-24. *Anais do Seminário Sobre Criação de Espécies do Gênero Brycon*, 1. Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq, Pirassununga, Brasil.

SENDACZ, S. & KUBO, E. 1982. Copepoda (Calanoida e Cyclopoida) de reservatórios do Estado de São Paulo. *B.Inst..Pesca*, 9:51-89.

SENHORINI, J. A. 1999. Biologia larval do matrinxã *Brycon cephalus* (Günther, 1869) e do piracanjuba *Brycon orbignyanus* (Valenciannes, 1849), (Pisces Characidae) em viveiros. *Master's thesis*, Instituto de Biociências da Universidade Estadual Paulista (UNESP), Botucatu, São Paulo, Brasil.

SENHORINI, J. A. & FRANSOZO, E A. 1994. Influência da produtividade dos viveiros e a contribuição da ração na larvicultura do pacu (*Piaractus mesopotamicus*) Holmberg, 1887 (Teleostei, Characidae). *B. Téc. CEPTA*, 7:27-40.

SIPAÚBA-TAVARES L. H. & ROCHA, E O. 1993. Cultivo em larga escala de organismos planctônicos para alimentação de larvas e alevinos de peixes: I - Algas Clorophicea. *Biotemas*, 6:93-106.

SIPAÚBA-TAVARES, L. H. & BRAGA, F. M. S. 1999. Study on feeding habits of *Piaractus mesopotamicus* (pacu) larvae in fish ponds. *Naga, The ICLARM Quartely*. 22(1):24-30.

UEBERSCHÄR, B. 1995. The use of tryptic enzyme activity measurement as a nutritional condtion index: laboratory calibration data and field application. *ICES Mar. Sci. Symp*., 201:119-129.

VOLPATO, G.L., FRIOLI, P. M. & CARRIERI, E M. P. 1989. Heterogeneous growth in fishes: Some new data in the Nile tilapia *Oreochromis niloticus* and a general view about the causal mechanisms. *B. Fisiol. Anim. Univ. São Paulo*, 13:7-22.

** Distribuído em junho de 2003.*

Table 1. Mean values for survival, weight, biomass and total length of piracanjuba *Brycon orbignyanus* larvae fed the following diets: (P-plankton, PR-plankton + ration, PS- selected plankton, PSR- selected plankton + ration, and R- ration) for 16 days.

Survival (%)	PR - 0.19 Ba	P - 0.14 Bb
	PSR - 0.26 Aa	PS - 0.23 Ab
Weight (mg)	PR - 42.25 Aa	P - 52.96 Aa
	PSR - 26.68 Ba	PS - 26.57 Ba
Biomass (g)	PR - 1.37 Ba	P - 0.80 Bb
	PSR - 3.00 Aa	PS - 2.71 Ab
Length (mm)	PR - 14.99 Aa	P - 15.55 Aa
	PSR - 13.30 Ba	PS - 12.52 Ba

^{AaBb} Means followed by different letters in the same row are significantly different by Tukey test ($P < 0.05$). Means followed by different capital letters in the same column are significantly different ($P < 0.01$).

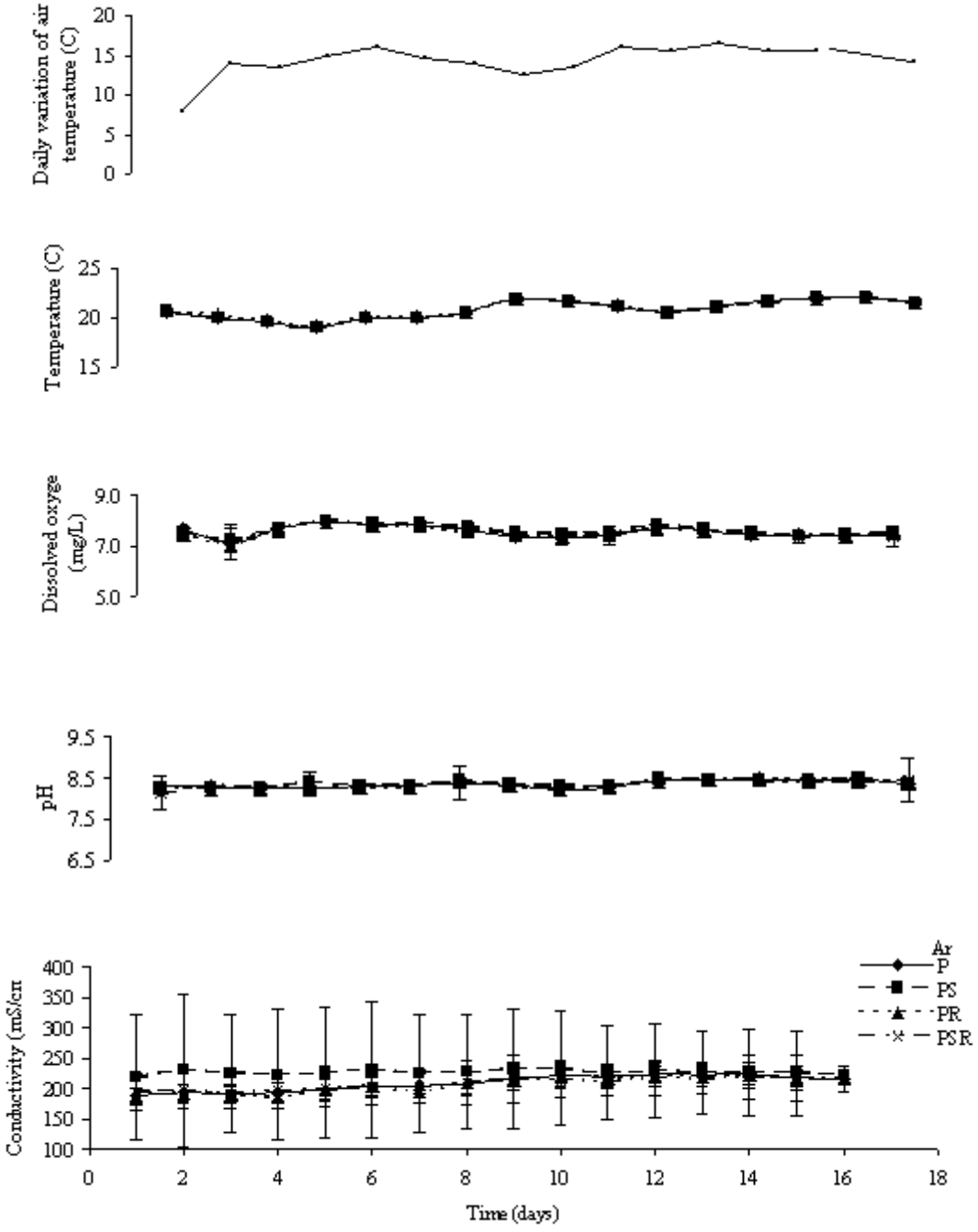

Figure 1. Absolute values of daily variation of air temperature and means (± SD) for temperature, dissolved oxygen, pH and conductivity, for the following diets: P = plankton, PS = selected plankton, PR = plankton + ration and PSR = selected plankton + ration, for 16 days rearing piracanjuba, *Brycon orbignyanus*, larvae.