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LIMNOLOGICAL STUDY OF POND WATER, SOIL AND EFFLUENTS OF GROW-OUT PONDS OF MACROBRACHIUM AMAZONICUM

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ABSTRACT

Grow-out ponds are ecosystems in the first stages of ecological succession. In the present study, a limnological evaluation on grow-out ponds of *Macrobrachium amazonicum* subjected to different feeding rates and forms of harvest management was performed. Twelve 0.01-ha earthen ponds were stocked with 20 juveniles.m^{-2}. Three of these ponds were supplied with 3%, three with 5%, and three with 7% of prawn biomass. Three remaining ponds were supplied with 5% of prawn biomass and subjected to selective harvest. Sixteen water and effluent parameters were monitored weekly, namely, dissolved oxygen, biochemical oxygen demand, pH, total alkalinity, electrical conductivity, nitrate-N, nitrite-N, ammonia-N, soluble phosphate, total phosphate, chlorophyll a, chlorophyll b, chlorophyll c, pheophytin, total dissolved solids and turbidity. Our data suggest that the different feeding rates and types of harvest do not play a significant role in pond ecology and, therefore, possibly intrinsic characteristics of each pond could be greatly influencing the quality of the water.

Keywords: Amazon river prawn; water quality; aquaculture.

RESUMO

Os viveiros de cultivo semi-intensivo de camarões de água doce são ecossistemas límnicos em fase inicial de sucessão ecológica. No presente estudo, foi realizada uma avaliação limnológica de viveiros de cultivo de *Macrobrachium amazonicum* submetidos a diferentes taxas de arraçoamento e tipos de despescas. Doze viveiros com cerca de 0,01 ha foram povoados com 20 juvenis de *M. amazonicum*.m^{-2}. Os camarões contidos em cada três viveiros foram arraçoados com 3%, 5% e 7% da biomassa dos camarões. Outros três viveiros foram arraçoados com 5% da biomassa dos camarões e submetidos à despesca mista. Semanalmente, foram determinadas as seguintes variáveis da água: temperatura, oxigênio dissolvido, demanda bioquímica de oxigênio, pH, alcalinidade total, condutividade elétrica, nitrato, nitrito, nitrogênio amoniacal, nitrogênio total, ortofosfato solúvel, fósforo total, clorofila a, clorofila b, clorofila c, feofitina, turbidez e sólidos totais suspensos. Possivelmente, as características intrínsecas de cada viveiro exercem maior efeito sobre a qualidade da água do que os níveis de arraçoamento e tipo de despesca.

Palavras-Chave: camarão da Amazônia; qualidade de água; aqüicultura.

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1. INTRODUCTION

Prawn farming occurs in earthen ponds that contain biota of nutritional value to prawns. The Amazon River prawn *Macrobrachium amazonicum* has been exploited by artisan fishing around dams (GURGEL; MATOS, 1984) and in rivers (COLLART; MOREIRA, 1993; VALENTI; MORAES-RIODADES; VALENTI, 2004; NEW, 2005). *Macrobrachium amazonicum* is a native Brazilian species that shows great potential for aquaculture (MORAES-VALENTI; VALENTI, 2007). This prawn species tolerates grow-out intensification and may be raised in both semi-intensive and intensive systems stocked at very high densities yet yielding high productivity (MORAES-VALENTI; VALENTI, 2007). However, little is known about the effects of different types of pond management, especially those that affect water quality.

The development of the Amazon River prawn culture, including all forms of its farming practiced in aquaculture, depends basically on characteristics of the ecosystems in which the prawn is introduced (VALENTI, 2000; ASSAD; BURSZTYN, 2000). In this sense, ecosystems must remain balanced to make it possible to maintain their productivity, and the preservation of the environment plays a vital role. The development of management techniques is important not only to increase productivity but also to evaluate the resulting environmental impacts (VALENTI, 2000). Grow out ponds are small and vary from of 0.1 to 5 ha. of impounded area (VALENTI; TIDWELL, 2006). Thus, to observe the variations in the medium in which the shrimp live and to be able to determine impacts caused by prawn farming in the environment, it is of great interest to evaluate the ponds and the effluents of culture ponds.

The aim of the present study was to assess the homogeneity of water ponds and the influence that different types of treatments of prawn biomass exert on water variables using grouping analysis complemented with principal components analysis (PCA) to explain the structure of variance and co-variance of the original variables (MARTEL et al., 2003).

2. MATERIAL AND METHODS

2.1. Description of culture

The study was conducted at the Crustacean Sector of the Aquaculture Center (CAUNESP) at the Universidade Estadual Paulista in Jaboticabal (21°15′22′′S and 48°18′48′′W) São

Paulo, Brazil, from December 2003 to May 2004. The climate in the study site is Cwa type according to the Koeppen classification (KOEPPEN, 1944). Twelve 100 square meters earthen ponds were stocked with 20 juveniles.m^{-2}, with individual weight average of 360 mg. Description of ponds and information about variations of stocking densities of prawns are reported in Valenti e New (2000) and New (2002).

2.2. Treatments and parameters

After introducing prawns in the 12 ponds, three of these were supplied with 3%, three with 5%, and three with 7% of prawn biomass. The animals were fed twice a day with a commercial diet of extruded 37% crude protein. Three remaining ponds were supplied with 5% of prawn biomass and subjected to selective harvest.

We selected 16 water and effluent parameters to monitor weekly, namely: dissolved oxygen; biochemical oxygen demand; pH; total alkalinity; electrical conductivity; nitrate-N; nitrite-N; ammonia-N; soluble phosphate; total phosphate; chlorophyll a; chlorophyll b; chlorophyll c; pheophytin; total dissolved solids; and turbidity. Add in sediments were monitored for carbon, phosphorus and nitrogen.

Water analyses

Each week, measurements and sampling of the pond inlet water and effluent were conducted during the morning (7:00h to 9:00h) and afternoon (15:00h to 17:00h). Temperature (surface and bottom), dissolved oxygen (bottom) and biochemical oxygen demand (BOD) were measured using a model 52 oxygen meter from YSI (whole sample). BOD was calculated as the difference between the final and initial level of dissolved oxygen during five days of incubation at 20±1 °C, with water samples diluted generally to 40% (APHA, 1992). Total alkalinity was assessed according to Boyd and Tucker (1992). The pH and electrical conductivity were determined at the bottom of the ponds using an YSI pH conductivity meter model 63.

Different forms of nitrogen and phosphorus were determined in whole samples collected from both the photic and aphotic zones following methods described by APHA (1992) for nitrate; Strickland and Parsons (1960) for nitrite; Solorzano (1969) for ammonia nitrogen; Valderrama (1981) for total nitrogen; and Adams (1990); and Boyd and Tucker (1992) for total phosphorus and soluble phosphate. Turbidity was assessed according to Wetzel and Likens (1991) by spectrophotometry, and total suspended solids by a gravimetric method as described by Boyd and Tucker (1992). The pigments chlorophyll a, model 2000 spectrophotometer was used in these analyses. All determinations were conducted twice. When the two values obtained were close, the average was taken as the result. If the values were discrepant, a third reading was taken and the extreme value was discarded.

Sediment analyses

Sampling of the sediment (about 10 cm deep) was carried out on the 18th week of culture (i.e., six weeks after selective harvest had started). Samples were obtained randomly in the ponds, using a shovel. Next, the samples were air-dried and stored in Styrofoam containers. Before the laboratory analysis, the samples were strained through a 2-mm mesh and homogenized. The South Dakota methods were used (modified) for the determination of organic matter (CANTARELLA et al., 2001). The determination of total nitrogen (N) was carried out based on the method described by Tedesco et al. (1985). This method consists basically of the digestion of the samples at a temperature up to 330 °C, in the presence of oxidants and catalysts. Subsequently, the extract was distilled in a micro Kjeldahl apparatus and N was quantified by acid-base titration. The concentrations of total phosphorus were determined based on the colorimetric method described by Kuo (1996).

Global analysis of the experiment, experimental design and statistical analysis

Hierarchical grouping analysis is a multivariate statistical analysis that aims to cluster in one group similar experimental units based on criteria of similarity. The result is a graph showing the formation of groups called a dendrogram (SNEATH; SOKAL, 1973). Simple Euclidian distance was adopted as the measure of similarity among the groups considered, along with the algorithm UPGMA (unweighted pair group method with arithmetic averages) as a grouping strategy (SNEATH; SOKAL, 1973). Principal components analysis creates latent orthogonal variables called principal components utilizing the matrix of covariance of the data. The eigenvalues of this matrix produce eigenvectors (principal components) which are linear combinations of the original variables. The orthogonal system produced by the two major eigenvalues (first and second principal components) preserve greatest amount of original information. The discriminatory power of each variable is evaluated by the formula:

$$r_{x_j}\left(CP_h\right)=\frac{a_{jh}\sqrt{\lambda_h}}{s_j}$$

where $r_{x_j}(CP_h)$ is the correlation between the variable x_j and the principal component CP_h, a_{jh} is the coefficient of the variable *j* in the *h*th principal component, and λ_h is the *h*th eigenvalue of the covariance matrix.

Both analyses were processed after normalization of the data according to the formula:

$$Z_{kj} = \frac{X_{kj} - \overline{X}_j}{s_j}$$

Where:

Z_{kj} is the normalized value,

X_{kj} is the observed value, and

$\overline{X}_j$ and s_j are the mean and standard deviation of variable *j*.

Thus, the variables tend toward a null mean and unit variance.

According to Kaiser's criterion, eigenvalues above 1 would be considered because they generate components with an important amount of information regarding the original variables (KAISER, 1958). The percentage of total variance for each component CP_h is obtained based on the formula:

$$CP_h = \frac{\lambda_h}{T(C)} 100$$

Where:

$T(C)$ is the trace of the covariance matrix ($\lambda_1 + \lambda_2 + \ldots + \lambda_h$).

All the data were analyzed using Statistica software version 7.0 from Statsoft Company (STATSOFT, 2004).

3. RESULTS

Tables 1 to 4 show the variation of the limnological variables and sediment in the treatments studied. This Tables presents the means for limnologic variables from the pond water obtained from 12th week on, pooled by treatment, in the morning and afternoon. Apparently, treatments herein studied showed the same pattern of variation along the whole culture.

Table 1 – Means (± standard deviation) of limnological variables of the pond water, obtained in the morning and afternoon in ponds with three different feeding rates studied (3%, 5% and 7% of biomass), in weeks 15 to 18. Each mean represents the pooled value obtained for the three ponds subjected to the same treatment.

Variable	Morning			Afternoon		
	3%	5%	7%	3%	5%	7%
Dissolved oxygen (%)	81.50±27.87	66.68±22.80	72.24±20.54	81.45±32.41	57.35±20.66	66.56±16.66
BOD (mg.L^{-1})	6.91±2.96	4.65±3.88	6.60±2.89	7.15±2.32	7.14±3.05	5.54±3.48
pH	7.46±0.73	7.37±0.20	7.14±0.40	8.48±0.64	8.28±0.58	7.82±0.50
Total alkalinity (mg.L^{-1} $CaCO_3$)	47.51±4.39	47.18±3.64	46.54±3.87	47.18±4.76	46.08±4.83	45.53±2.65
Electrical conductivity (µS.cm^{-1})	95±20	88±15	95±11	88±10	90±17	95±11
N-Nitrate (µg.L^{-1})	1294±1469	1492±1387	1286±1349	1191±1459	1627±1397	1418±1453
N-Nitrite (µg.L^{-1})	44±21	58±19	46±16	36±25	55±20	43±15
Ammonia nitrogen (µg.L^{-1})	167±85	198±115	225±122	110±90	132±84	150±108
Total nitrogen (mg.L^{-1})	4.77±0.31	4.10±0.56	4.64±0.55	4.54±0.37	4.98±0.07	4.97±0.04
Soluble phosphate (mg.L^{-1})	0.03±0.04	0.03±0.04	0.04±0.05	0.02±0.03	0.05±0.04	0.03±0.03
Total Phosphorus (mg.L^{-1})	0.10±0.07	0.11±0.06	0.09±0.05	0.06±0.03	0.09±0.05	0.06±0.05
Chlorophyll a (µg.L^{-1})	334±201	306±271	216±98	304±170	423±570	262±144
Chlorophyll b (µg.L^{-1})	102±123	107±93	139±137	126±111	171±176	112± 69
Chlorophyll c (µg.L^{-1})	97±149	116±124	101±78	44±41	124±141	82±72
Pheophytin (µg.L^{-1})	692±411	752±759	985±825	749±524	877±1075	970±954
Total suspended solids (mg.L^{-1})	19.16±19.04	51.50±52.41	21.03±20.84	22.64±22.36	14.87±15.52	10.03±10.73
Turbidity (UNT)	20±8	14±7	17±7	22±9	21±23	18±9

Table 2 – Means (± standard deviation) of limnological variables of the effluents, obtained in the morning and afternoon in ponds with the three different feeding rates studied (3%, 5% and 7% of biomass), in weeks 15 to 18. Each mean represents the pooled value obtained for the three ponds subjected to the same treatment.

Variable	Morning			Afternoon		
	3%	5%	7%	3%	5%	7%
Dissolved oxygen (%)	95.55±37.74	82.67±36.65	87.04±34.86	65.24±19.30	66.74±17.92	64.97±13.66
BOD (mg.L^{-1})	5.16±1.51	7.14±3.05	5.30±2.97	4.46±3.29	4.18±2.65	4.83±1.75
pH	7.90±0.57	7.61±0.53	7.29±0.51	7.86±0.63	7.67±0.35	7.70±0.57
Total alkalinity (mg.L^{-1} $CaCO_3$)	45.07±4.48	47.38±5.97	46.67±3.18	46.33±5.48	45.28±3.76	46.05±4.75
Electrical conductivity (µS.cm^{-1})	91±11	87±10	89±11	91±14	90±11	92±10
N-Nitrate (µg.L^{-1})	1209±1441	1769±1872	1353±1533	1445±1821	2052±2565	1368±1542
N-Nitrite (µg.L^{-1})	46±19	55±19	50±15	44±24	55±22	49±20
Ammonia nitrogen (µg.L^{-1})	192±157	185±139	200±202	168±86	243±153	231±179
Total nitrogen (mg.L^{-1})	4.94±0.04	4.49±0.36	4.35±0.98	5.00±0.04	5.02±0.06	4.89±0.05
Soluble phosphate (mg.L^{-1})	0.02±0.03	0.03±0.04	0.02±0.03	0.01±0.02	0.03±0.03	0.03±0.02
Total Phosphorus (mg.L^{-1})	0.07±0.03	0.06±0.02	0.08±0.04	0.07±0.03	0.05±0.04	0.09±0.09
Chlorophyll a (µg.L^{-1})	231±111	240±108	203±98	408±356	222±147	333±282
Chlorophyll b (µg.L^{-1})	69±44	97±71	90±74	158±139	122±59	138±129
Chlorophyll c (µg.L^{-1})	63±52	62±36	81±77	96±62	52±42	97±73
Pheophytin (µg.L^{-1})	598±504	618±448	650±476	990±1365	560±338	783±615
Total suspended solids (mg.L^{-1})	23.09±20.33	17.94±11.92	11.52±8.02	15.97±11.02	11.14±7.42	14.76±14.57
Turbidity (UNT)	19±9	14±6	18±12	24±8	19±7	23±11

Table 3 – Means (± standard deviation) of limnological variables of the pond water, obtained in the morning and afternoon. Each mean represents the pooled value obtained for the three ponds subjected to the same treatment.

Variable	Combined harvest (not seined) in pond water				Combined harvest (not seined) in effluent			
	Morning		Afternoon		Morning		Afternoon	
Dissolved oxygen (%)	6.30	±2.05	7.08	±2.13	5.93	±2.65	5.46	±1.57
Dissolved oxygen ($mg.L^{-1}$)	77.58	±26.05	91.29	±29.44	75.36	±27.36	64.21	±22.47
BOD ($mg.L^{-1}$)	7.02	±2.84	7.02	±3.59	5.72	±2.63	4.90	±2.41
pH	7.18	±0.40	7.94	±0.67	7.40	±0.61	7.34	±0.59
Total alkalinity ($mg.L^{-1}$ $CaCO_3$)	46.54	±4.57	44.86	±5.40	45.56	±4.48	44.21	±6.88
Electrical conductivity ($\mu S.cm^{-1}$)	95	±27	89	±9	92	±13	96	±10
N-Nitrate ($\mu g.L^{-1}$)	1059	±1332	707	±1085	1162	±130	1362	±2011
N-Nitrite ($\mu g.L^{-1}$)	45	±16	47	±21	54	±25	58	±33
Ammonia nitrogen ($\mu g.L^{-1}$)	201	±97	172	±155	215	±118	158	±121
Soluble phosphate ($mg.L^{-1}$)	0.045	±0.039	0.084	±0.073	0.059	±0.085	0.076	±0.058
Total Phosphorus ($mg.L^{-1}$)	0.086	±0.056	0.112	±0.095	0.113	±0.111	0.097	±0.096
Chlorophyll a ($\mu g.L^{-1}$)	278	±197	264	±246	247	±294	347	±304
Chlorophyll b($\mu g.L^{-1}$)	181	±304	95	±73	74	±59	109	±64
Chlorophyll c ($\mu g.L^{-1}$)	98	±84	62	±57	54	±34	88	±65
Pheophytin ($\mu g.L^{-1}$)	830	±557	712	±593	632	±729	828	±797
Total suspended solids ($mg.L^{-1}$)	0.026	±0.025	0.024	±0.028	0.018	±0.014	0.015	±0.011
Turbidity (UNT)	23	±12	25	±11	24	±13	27	±12

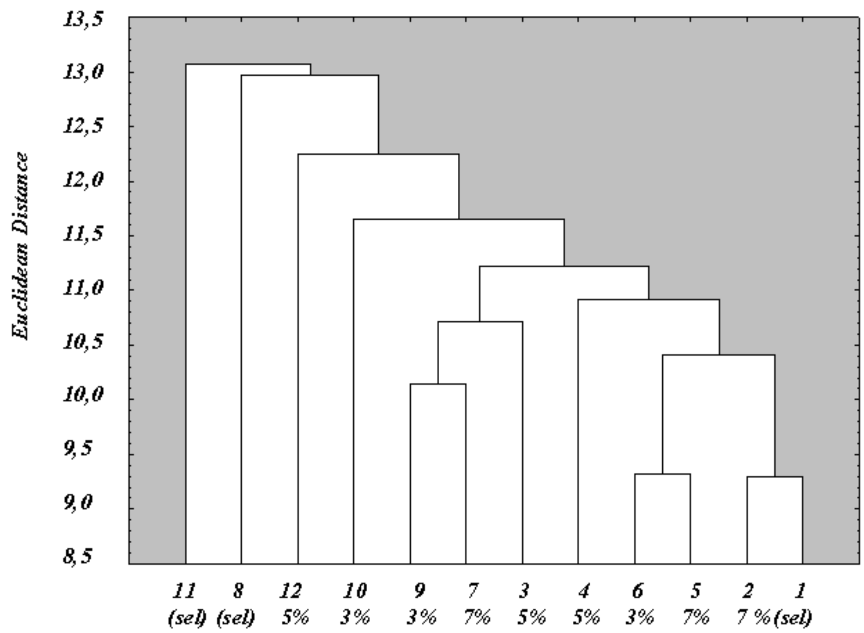
Font: Keppeler; Valenti (2006); Keppeler et al. (in prep).

Table 4 – Concentration of organic carbon, total nitrogen and total phosphorus in the sediment of ponds submitted to feeding rates of 3%, 5% and 7% of biomass and combined harvest.

	3%	5%	7%	Combined harvest
Organic carbon ($g.dm^{-3}$)	13.33±1.53	14.33±4.04	10.33±1.53	12.00± 2.00
Total nitrogen ($g.kg^{-1}$)	0.83±0.40	0.83±0.21	0.86±0.21	1.56 ± 0.50
Total Phosphorus ($g.kg^{-1}$)	1.90±0.15	1.80±0.10	1.83±0.26	1.60 ± 0.17

Font: Keppeler; Valenti, 2006; Keppeler et al., (in prep.)

Figure 1 presents the results of grouping analysis for ponds subjected to different treatments. There was no group formation for ponds when considering different feeding rates and selective harvest.



Sel = Selective; 3%, 5% and 7% correspond to the treatments tested.

Figure 1 – Dendrogram showing the grouping of ponds.
The numbers outside the parentheses identify the ponds.

The results from the principal components analysis (PCA) are represented in the scatter plot (Fig. 2), and Table 5 contains the correlation coefficients between the variable and the two first axis of the ordinance. In these, 39.01% explained the total variability of the system, 22.85% being in first axis and 16.16% in the second. Figure 2 does not suggest the existence of grouping for the ponds.

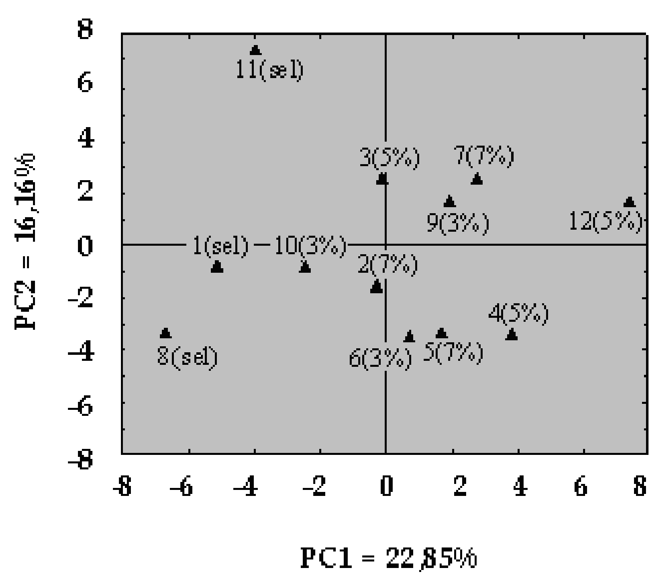


Figure 2 – Two-bidimensional plot showing the grouping of the ponds containing *Macrobrachium amazonicum* according to the first two principal components.

Table 5 – Correlation between variables analyzed and the first two principal components in water ponds of *Macrobrachium amazonicum*.

	PC1	PC2		PC1	PC2
DO%mp	-0.2649	-0.3857	**TPHOSPmp**	-0.3419	0.4681
DO%ap	-0.4233	*-0.6076	**TPHOSPap**	-0.3947	0.1875
DO%me	*-0.5868	-0.3655	**TPHOSPme**	*-0.8126	-0.0309
DO%ae	-0.0381	-0.3480	**TPHOSPae**	*-0.6216	0.3338
pHmp	-0.3539	0.0761	**TURBmp**	*-0.6214	*0.6856
pHap	0.0931	-0.0408	**TURBap**	-0.3827	*0.7078
phme	-0.1503	0.3724	**TURBme**	*-0.6029	*0.7106
phae	0.1016	0.3033	**TURBae**	-0.4733	*0.6224
CONDmp	0.1351	-0.3118	**TSOLmp**	0.2598	0.0062
CONDap	0.1879	0.2041	**TSOLap**	-0.4724	-0.1169
CONDme	-0.0226	0.0387	**TSOLme**	0.4194	0.2609
CONDae	-0.2492	*0.5817	**TSOLae**	*-0.6682	0.3225
BODmp	*-0.5830	0.4196	**CHLORmp**	*-0.7946	-0.2568
BODap	-0.4101	0.3202	**CHLORap**	-0.3176	0.1770
BOD$_5$me	*-0.5692	0.4374	**CHLORme**	*-0.8372	-0.1747
BOD$_5$ ae	-0.4551	0.3779	**CHLORae**	*-0.5281	*-0.5740
ALKALmp	0.0376	0.3078	**CHLORmp**	*-0.6716	-0.3827
ALKALap	*0.5678	*-0.5673	**CHLORBap**	-0.2763	0.3402
ALKALme	-0.2679	-0.0969	**CHLORBme**	*-0.6732	0.1281
ALKALae	0.2954	0.0266	**CHLORBae**	-0.4337	-0.2143
AMONmp	0.4215	0.3381	**CHLORCmp**	*-0.5447	*-0.5109
AMONap	-0.0232	*0.7626	**CHLORCap**	-0.2111	-0.2974
AMONme	0.1637	*0.5686	**CHLORCme**	-0.3779	0.0873
AMONae	*0.5424	0.4678	**CHLORCae**	*-0.6775	-0.2971
NITRITmp	*0.7503	0.0891	**PHEOPmp**	*-0.7187	-0.3490
NITRITap	*0.5359	0.4060	**PHEOPap**	-0.3183	0.1485
NITRITme	0.2781	0.4266	**PHEOPme**	*-0.8463	-0.2423
NITRITae	0.1862	*0.8505	**PHEOPae**	-0.4295	*-0.5103
NITRAmp	*0.7142	0.1323	**CARB$_S$**	*-0.5960	0.0605
NITRAap	*0.8553	-0.1785	**PHOSP$_S$**	-0.0187	*-0.8294
NITRAme	*0.8346	0.1823	**NITROG$_S$**	*-0.7689	-0.1712
NITRAae	0.4597	0.4104			
NITROGmp	0.0291	-0.1860			
NITROGap	-0.0282	-0.0800			
NITROGme	0.2553	0.1763			
NITROGae	0.3057	*-0.7374			
ORTHOmp	0.0492	-0.2419			
ORTHOap	0.2082	-0.5331			
ORTHOme	-0.4985	*0.7327			
ORTHOae	-0.3379	0.2416			

Legend: DO% - Dissolved oxygen in percent saturation (%); COND= electrical conductivity; BOD= biochemical oxygen demand; ALKAL= total alkalinity; AMON = ammonia nitrogen; NITRIT=N-nitrite; NITRAT=N-nitrate; NITROG= total nitrogen; ORTHO = soluble phosphate; TPHOSP = total phosphorus; TURB=turbidity; TSOL= total suspended solids; CHLOR a=chlorophyll a; CHLOR b = chlorophyll b; CHLOR c= chlorophyll c; PHEOP =Pheophytin; CARBS= organic carbon in sediment; PHOSPS= phosphorus in sediment; NITROGS = nitrogen in sediment. mp= morning and pond; ap= afternoon and pond; ae= afternoon and effluent.

4. DISCUSSION

Cluster analysis showed no trend toward grouping by treatment, which suggests that selective harvest or 3%, 5% and 7% feeding rates were not the major factors influencing water characteristics. This finding is similar to that reported by Moraes-Riodades et al. (2006) who studied different stocking densities (10, 20, 40 and 80 ind.m^{-2}). According to these authors, other factors, such as pond position, wind effects, sunlight incidence angles or soil characteristics seem to have more influence on water variables than the changes in the management and the increasing in the allochthonous material input due to treatments of 3%, 5% and 7% feeding rates.

Considering the limnologic characteristics of the effluent pertaining to the ponds subjected to the different treatments herein tested, no grouping of the ponds was observed. According to our observations, variations resulting from different feeding rates or the type of harvest seem to play a minor role in pond ecology. Thus, we believe that intrinsic characteristics of each pond likely exert more influence on the functioning of these systems than the limnologic characteristics. The effect of the treatments could have been masked due to ponds being hypertrophic ecosystems. Thus, the changes resulting from the application of different feeding rates and selective harvest were too small to significantly modify the limnologic characteristics of the water. On the other hand, it is known that ponds of the same type constructed side by side receiving the same type of management can show totally different limnologic characteristics. This is due mainly to the fact that the routes of ecological succession are determined by the organisms that are initially present in each pond (DELINCÉ, 1992), which is likely related to the heterogeneity observed among ponds.

High correlations were found for dissolved oxygen, ammonia nitrogen, total nitrogen, soluble orthophosphate, total phosphorus and chlorophyll a. In the soil, phosphorus and nitrogen showed the highest levels. This is possibly due to the large amount of ration added to the ponds. Studies conducted by Tidwell et al. (1997) showed that parameters as dissolved oxygen, chlorophyll a, ammonia-N and nitrite were affected significantly by feeding, while levels of nitrate-N were constant when studying two types of treatment: prawns in three ponds were not fed, and prawns in additional three ponds were fed a complete diet. Other studies, such as that by Moraes-Riodades and Valenti (2007), have also observed that when ponds of *Macrobrachium amazonicum* are supplied with large amounts of feed in order to maintain densities as high as 80 ind.m^{-2}, there is no harm to the levels of dissolved oxygen and ammonia-N due of this type of management. Moreover, other parameters examined in our study, including pH, electrical conductivity, nitrite and nitrate, were also not affected by high feeding rates. Altogether, these findings dampen the concern about the need for more daily regulation of pond water renewal with intensive feed management.

5. CONCLUSION

The intrinsic characteristics of each pond could be influencing more the quality of the water, than the particular feeding rate in the range of 3% to 7% of the biomass and the use of selective harvest, in view of the lack of grouping.

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