Zooplankton biomass, abundance and allometric patterns along an eutrophic gradient at Furnas Reservoir (Minas Gerais, Brazil).

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ABSTRACT: Zooplankton biomass, abundance and allometric patterns along an eutrophic gradient at Furnas reservoir (Minas Gerais, Brazil). The aim of this study was to describe the zooplankton composition, allometry, abundance and biomass along a trophic gradient at Furnas Reservoir. Furnas dam is located few kilometres downstream the mouth of Sapucaí River (Minas Gerais, Brazil), being one of the biggest reservoir in Brazilian Southwest (1440 Km^2, 22.6 x 10^9 m^3). Zooplankton was sampled by vertical hauls in three different campaigns along Rio Sapucaí River and Rio Grande River, with the use of a planktonic net (mesh size: 90 mm). Highest values of abundance and biomass were recorded in Rio Sapucaí River subsystem. Cladocera and Cyclopoida were more abundant in the eutrophic stations (at Rio Sapucaí River). Calanoida as Argyrodiaptomus furcatus and Notodiaptomus iheringi dominated the oligotrophic sites. Some species varied in size within the trophic gradient. There was a tendency for the appearance of proportionally bigger adults of A. furcatus in eutrophic sites. However, the Cladocera such as Diaphanosoma spp. does not seem to present important allometric alteration along the studied gradient. Finally we observed that sazonality affected the zooplankton structure. Thus, in the rainy season, biomass showed a decrease of at least 40% in all collected sites.
Key-words: Zooplankton, allometry, biomass, abundance.

RESUMO: Padrões de abundância, biomassa e alometria do zooplâncton ao longo de um gradiente trófico no reservatório de Furnas (MG, Brasil). O objetivo deste trabalho foi o de descrever a composição, alometria, abundância e biomassa da comunidade planctônica ao longo de um gradiente de trofia no reservatório de Furnas. A represa de furnas está localizada a alguns quilômetros da desembocadura do rio Sapucaí (Minas Gerais, Brasil), sendo um dos maiores reservatórios do sudeste brasileiro (1440 Km^2, 22,6 x 10^9 m^3). O zooplâncton foi amostrado através de arrastos verticais na coluna d'água em três campanhas diferentes ao longo dos rios Sapucaí e Grande, sendo usado, para isto, uma rede de plâncton de 90 mm de malha. Os maiores valores de abundância e biomassa foram encontrados no subsistema do rio Sapucaí. Cladocera e Cyclopoida foram os grupos mais abundantes nas estações eutróficas. Calanoida, como Argyrodiaptomus furcatus e Notodiaptomus iheringi dominaram as regiões mais oligotróficas. Algumas espécies variaram em tamanho ao longo do gradiente de trofia. Houve uma tendência para o aparecimento de maiores indivíduos adultos de A. furcatus em ambientes mais eutróficos. Já Diaphanosoma spp. não demonstraram importantes variações alométricas ao longo do gradiente estudado. Finalmente observamos que a sazonalidade afetou a estrutura zooplanctônica no lago, sendo os valores de biomassa durante a estação chuvosa, cerca de 40% menores do que durante a estação seca.
Palavras-chave: zooplâncton, alometria, biomassa, abundância.

Introduction

Eutrophication is a natural process in lentic ecosystems (Esteves, 1988) and basically it refers to a nutritional enrichment of water bodies, mainly with essential nutrients as phosphorus and nitrogen (Ryding & Rast, 1989). Common sources of cultural eutrophication are due to sewage, erosion of land, and even the air is a source of phosphorus input, causing continually high production that slowly changes the food web (Lampert & Sommer, 1997).

Studies about the impact of eutrophication upon zooplankton abundance and composition have a long tradition in limnology. In Brazilian reservoirs, some studies (Esteves & Sendacz, 1988; Giani, 1984; Matsumura-Tundisi & Rocha, 1983; Arcifa, 1984; Sendacz, 1984; Arcifa et al., 1992; Bini et al., 1997; Pinto-Coelho, 1998) indicated a relationship between the changes of plankton community and eutrophication processes. But, notwithstanding the large number of studies about the changes of zooplankton composition and abundance in response to trophic gradients, there are only few studies (Pace, 1986; Sendacz, 1984; Pinto-Coelho, 1987; Esteves & Sendacz, 1988; Xi He et al., 1994; Gaedke, 1993; Pinto-Coelho & Corgosinho, 1998; Rull Del Aguila, 2001, Rull Del Aguila & Pinto-Coelho, in prep.) that take into account the zooplankton biomass dynamics. Additionally, beyond nutrient availability, zooplankton can be regulated by top-down effects (Santos et al., 1994).

The aim of this paper was to describe the horizontal distribution of zooplankton abundance and biomass along an eutrophic gradient in Furnas reservoir. Additionally we analysed Argyrodiaptomus furcatus and Diaphanosoma spp. allometric patterns, attempting to find some indication of predatory or detritivory chain impact on these organisms.

Material and methods

Study Site

Located at Rio Grande River (20°40'S, 46°19'W), South of Minas Gerais state (Brazil), Furnas is the biggest reservoir of Brazilian Southeast (1,440 Km^2 of flooded area; Z_{max}: 90 m; $\overline{z}$: 13 m) being composed by two subsystems. The Rio Grande River (the central water body) receives their waters from a crystalline plateau, while Rio Sapucaí River and their tributaries run along a large area subjected to an intense agricultural activity.

Although presenting low ionic concentration and high water column transparency along most of its arms (Figueredo, 2000), the existence of sewage discharge in some of its tributaries as well as the high water residence time (160 days) contribute for a marked water quality variation along its horizontal axis (Sá, 1994).

Samples were taken in seven stations along Rio Grande and Rio Sapucaí River (Fig. 1): Rio Grande subsystem- Mangueiras- Located 3 km upstream from the dam, at the main water body of the reservoir (depth: 56.5 m); Rio Turvo- Situated between Mangueiras and the confluence between Rio Sapucaí River and Rio Grande River (depth: 32 m); Rio Grande River- Situated at Rio Grande River, before the confluence with Rio Sapucaí River (depth: 54.5 m); Rio Sapucaí subsystem- Shangrilá- Located near the confluence between Rio Grande River and Rio Sapucaí River (depth: 29.5 m); Balsa de Guapé- Situated at Rio Sapucaí River just before its confluence with Rio Grande River (depth: 33.0 m); Itaci- Located at Rio Sapucaí River between Carmo do Rio Claro and Itaci cities (depth: 22.5 m) and Fama- Situated at Rio Sapucaí River (depth = 15 m).

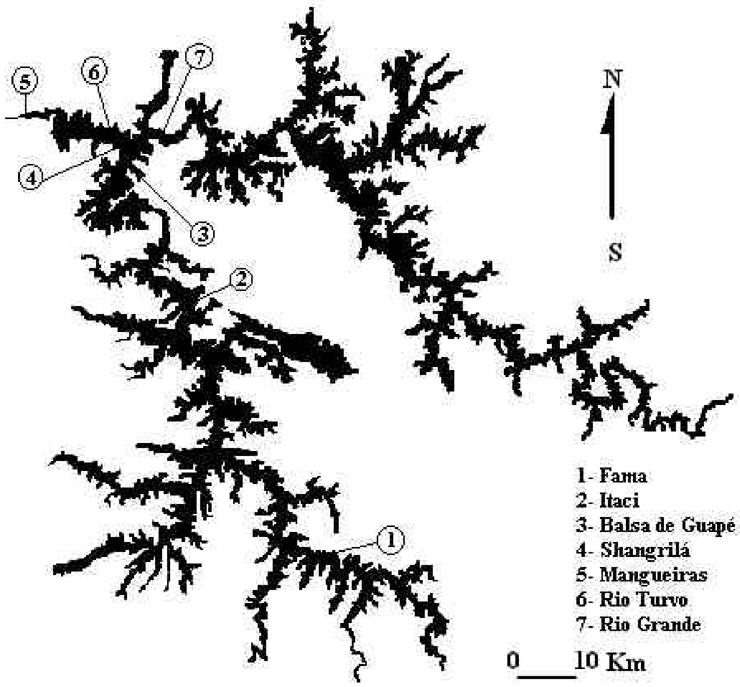

Figure 1- Distribution of the sampled sites along Furnas Reservoir (MG, Brazil).

Sampling procedures

Zooplankton samples were obtained by vertical hauls along the entire water column. During this process we used a conical net with 22 cm of diameter and 90 mm of mesh size. Samples were stored in 200 ml polyethylene bottles, stained with Bengal Rose and fixed with formalin 4%. Water transparency, temperature and dissolved oxygen at the top and bottom of the sampling sites were obtained with the use of a Secchi disk and Yellow Springs® oxymeter-thermistor equipment respectively.

At the laboratory, subsamples of 1 ml were obtained using a Hensen-Stempel pipette; 700 organisms were counted and measured (with Zeiss graduated ocular) from each sample in a reticulated Sedgwick-Rafter chamber, with the use of a Nikon microscope.

To test if the size of the zooplankton changes along an eutrophic gradient, what could be an evidence of zooplankton predation by visually oriented fishes, we measured approximately thirty to fifty adults males of A. furcatus, since the numbers per sample were sufficient. For Diaphanosoma spp. we used the values obtained from the counting process.

Biomass calculation

For each planktonic group, the biomass were calculated by the allometric equations proposed by McCauley (1984):

$B=axL^b$

where: B- Biomass in mgPs; L- Length in mm; a and b- specific allometric coefficients for each analysed taxon: Daphnia spp. (a= 6.0 and b= 3.62); Diaphanosoma spp. (a= 6.95 and b= 2.07); Bosmina spp. (a= 15.1 and b= 2.53); Ceriodaphnia spp. (a= 15.1 and b= 2.53); Cyclopoida (a= 4.18 and b= 2.64); Calanoida (a= 6.81 and b= 2.11), Nauplii (a= 1.64 and b= 0.57) and Rotifera (a= 1.2 and b= 3.0).

Data analysis

Comparisons among the Sapucaí and Rio Grande River were made by the ANOSIM test for abundance and biomass. The ordination and classification of the stations in accordance with their similarity along the studied gradient were obtained by a non-metrical multidimensional scaling (NMDS) method and by a Cluster analysis using the Bray-Curtis dissimilarity index.

For A. furcatus and Diaphanosoma spp., we also used the ANOSIM test in order to verify possible differences between the studied subsystems of the reservoir.

Results

Physical and chemical data

Isothermy was found in the water column in almost all studied sites monitored in June 1994 and July 1995. In February 1995, there was a notable thermal stratification in all stations, except for Itaci (Tab. I).

Rio Grande River subsystem presented the highest Secchi values. Dissolved oxygen patterns indicated the presence of vertical gradients along the water column, with some cases with anoxic conditions in the reservoir main axis. Rio Sapucaí River subsystem exhibited, generally, the highest values of dissolved oxygen.

Taxonomic composition

With regard to the macro (600-2000mm) and mesozooplanktonic (200-600mm) composition, Furnas reservoir presents a relatively well diversified fauna, with 10 Cladocera species, 3 species of Copepoda Cyclopoida and 4 species of Copepoda Calanoida (Tab. II).

Abundance and Biomass

The major differences between the stations located at Rio Grande and Rio Sapucaí River, observed in June 1994, were also seen in the other two periods (February 1995 and July 1995). High values of abundance and biomass were recorded for the Rio Sapucaí River subsystem (Fig. 2 A and B; Tab. III and IV). In June 1994 and July 1995 the highest abundance and biomass values were found in Fama and the lowest, in Balsa de Guapé. In February 1995, the highest abundance and biomass values decreased in the Sapucaí subsystems although there was a conspicuous increase in abundance and biomass in direction to the confluence between Rio Grande and Sapucaí River. In February 1995, there was a biomass decrease of at least 40% in all stations.

Results from the nonmetric multidimensional scaling (NMDS) and Cluster analysis (Figs. 3 and 4) confirmed the

Table I: Temperature (°C), dissolved oxygen (DO) and water transparency (Secchi) of the sampled sites in June 1994, February 1995 and July 1995 at Furnas Reservoir (MG,Brazil).

		T°			D.O (mg.L⁻¹)			Secchi (m)		
Localities		**06/94**	**02/95**	**07/95**	**06/94**	**02/95**	**07/95**	**06/94**	**02/95**	**07/95**
Fama	Top	18.00	25.00	26.00	7.50	8.50	7.63	3.00	0.50	4.00
(Zmax=15.0m)	Bottom	18.50	23.00	19.00	7.00	5.60	0.75			
Itaci	Top	20.50	26.00	22.50	7.70	8.40	7.50	3.10	1.00	3.80
(Zmax=22.5m)	Bottom	20.50	25.00	22.00	6.90	0.20	0.65			
Balsa de Guapé	Top	22.00	26.50	21.00	7.40	7.40	8.00	2.70	2.20	4.10
(Zmax=33.0m)	Bottom	20.50	21.50	21.00	0.40	0.10	0.25			
Shangrilá	Top	21.50	26.00	20.00	7.00	8.00	6.38	3.50	3.00	4.50
(Zmax=29.5m)	Bottom	20.00	23.00	20.00	0.00	0.40	0.75			
Rio Grande	Top	22.00	26.00	21.00	7.40	8.00	7.30	4.00	2.50	4.20
(Zmax=54.5m)	Bottom	20.50	20.00	20.50	0.00	0.00	0.00			
Rio Turvo	Top	20.00	26.00	20.00	7.00	7.20	6.38	7.00	3.00	4.50
(Zmax=33.0m)	Bottom	20.50	22.50	20.50	0.00	1.30	0.00			
Mangueiras	Top	22.00	25.50	20.50	7.20	7.90	7.40.	5.20	2.80	4.80
(Zmax=61.0m)	Bottom	19.50	20.00	20.00	0.00	1.10	0.00			

Table II: List of encountered species of zooplanktonic organisms along the studied period in Furnas reservoir (MG, Brasil).

Copepoda

Cyclopoida

Thermocyclops minutus Lowndes, 1934
Thermocyclops decipiens Kiefer, 1929
Mesocyclops ogunnu Onabamiro, 1957

Calanoida

Argyrodiaptomus furcatus Sars, 1901
Notodiaptomus iheringi Wright, 1935
Scolodiaptomus corderoi Wright, 1931
Notodiaptomus brandorffi Reid, 1987

Cladocera

Alona rectangula Sars, 1861
Bosmina spp.
Bosminiopsis deitersi Richard, 1895
Ceriodaphnia cornuta Sars, 1886
Ceriodaphnia spp
Daphnia spp.
Diaphanosoma spp.
Moina micrura Kurtz, 1874

Diptera

Chaoborus spp.

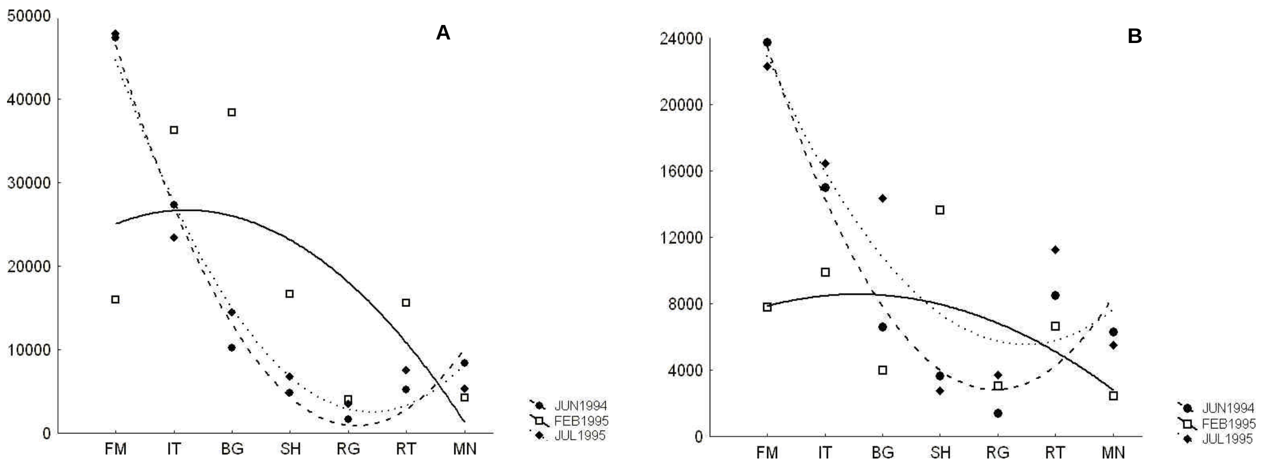

Figure 2: Zooplankton abundance (A) and biomass (B) along the studied sites in June 1994, February 1995 and July 1995 at Furnas Reservoir (MG, Brazil). FM= Fama; IT= Itaci; BG= Balsa de Guapé; SH= Shangrilá; RG= Rio Grande; RT= Rio Turvo; MN= Mangueiras.

Table III: Abundance data of zooplanktonic groups along the studied sites in June 1994, February 1995 and July 1995 at Furnas Reservoir (MG, Brazil). FM= Fama; IT= Itaci; BG= Balsa de Guapé; SH= Shangrilá; RG= Rio Grande; RT= Rio Turvo; MN= Mangueiras; ALS= All local sites; SpS= Sapucaí River sites.

Groups		FM	IT	BG	SH	MN	RT	RG	ALS	SpS
Large Cladocera	06/94	14246	1779	463	287	676	461	124	17914	16477
	02/96	1068	1494	1231	1061	443	971	312	6670	3793
	07/96	3773	2141	1488	636	607	1319	418	10281	7402
Small Cladocera	06/94	2203	1881	298	346	663	691	93	6074	4382
	02/96	1710	687	1036	2392	767	4043	219	10744	3333
	07/96	18678	1624	647	779	821	1006	642	23896	20649
Calanoida	06/94	467	368	312	180	446	722	69	2664	1137
	02/96	63	634	679	1722	264	2970	346	6668	1266
	07/96	1943	1216	1261	141	762	1287	164	6764	4420
Cyclopoida	06/94	7818	2639	2116	1210	2303	1809	291	18186	12673
	02/96	2671	2188	3691	2236	697	2471	1014	14968	8660
	07/96	2317	3218	2901	612	486	996	980	11410	8436
nauplii	06/94	8369	6629	6426	1612	2673	691	919	26109	20414
	02/96	2937	3362	3691	1722	944	2446	991	16093	9990
	07/96	3736	2818	2081	624	722	963	696	11640	8636
Rotifera	06/94	14224	14066	1691	1263	1961	818	136	34029	29871
	02/96	7491	28070	28070	7491	1124	2670	1124	76040	63631
	07/96	33440	12442	6197	4168	1869	1926	607	60639	62079
Total	06/94	47306	27362	10196	4787	8411	6182	1632	104866	84864
	02/96	16930	36236	38398	16614	4229	16671	4006	130983	90663
	07/96	47787	23369	14476	6749	6268	7496	3497	108620	86621

Table IV: Biomass data of zooplanktonic groups along the studied sites in June 1994, February 1995 and July 1995 at Furnas Reservoir (MG, Brazil). FM= Fama; IT= Itaci; BG= Balsa de Guapé; SH= Shangrilá; RG= Rio Grande; RT= Rio Turvo; MN= Mangueiras; ALS= All local sites; SpS= Sapucaí River sites; CAS= Central axis sites.

Groups		FM	IT	BG	SH	MN	RT	RG	ALS	SpS	CAS
Large Cladocera	06/94	6978	5749	1148	838	1620	928	331	17592.2	13875.1	3717.1
	02/95	1711	2806	779	2688	971	592	573	10118.9	5296.7	4823.2
	07/95	9941	6094	4082	1269	1684	3535	1110	27713.3	20116.6	7596.7
Small Cladocera	06/94	2759	1222	162	266	469	456	88	5422.2	4143.5	1278.7
	02/95	1570	604	155	1477	498	653	205	5162.6	2328.6	2834.0
	07/95	2877	1756	373	509	572	743	659	7489.3	5005.8	2483.5
Calanoida	06/94	3778	2817	1549	1002	1919	5862	367	17294.1	8143.5	9150.6
	02/95	318	3113	1029	7477	89	3897	1354	17277.6	4460.0	12817.6
	07/95	6040	5402	6993	298	2574	5535	994	27836.2	18434.9	9401.3
Cyclopoida	06/94	4874	1187	740	582	775	784	98	9040.7	6799.7	2241.0
	02/95	2166	846	492	952	300	253	347	5355.4	3504.4	1851.0
	07/95	1076	1458	1681	270	204	762	549	5898.5	4113.8	1784.7
nauplii	06/94	5334	3987	2991	949	14982	495	507	16759.5	12310.5	3449.0
	02/95	2037	2440	1457	1041	591	1261	562	9388.4	5933.6	3454.8
	07/95	2325	1746	1318	381	454	672	401	7296.5	5388.8	1907.7
Rotifera	06/94	8	21	3	3	6	1	1	42.1	32.0	10.1
	02/95	5	98	98	5	7	1	7	221.8	202.1	19.7
	07/95	32	15	11	8	8	6	4	83.7	57.9	26.8
Total	06/94	23731	14982	6591	3641	6287	8529	1391	65160.8	45304.3	19846.5
	02/95	7807	9908	4010	13640	2465	6658	3047	47524.9	21724.4	25800.5
	07/95	22291	16470	14357	2735	5496	11252	3717	76317.7	53117.8	23199.9

patterns cited above. For abundance and biomass in June 1994 and in July 1995, the eutrophic sites showed a distinct ordination along the studied gradient (Fig. 3 A and E; 4 A and E), or grouped together (Fig. 3 B and F; 4 B and F). In February 1995, the patterns were obscured by the close ordination and classification of spatially distant locations even subjected to different trophic conditions in June 1994 and July 1995 (Fig. 3 C and D; 4 C and D).

Large Cladocera (Daphnia spp, Diaphanosoma spp. and Moina micrura), small Cladocera (Bosmina spp., Bosminopsis deitersi and Ceriodaphnia spp.; except for February 1995) and Cyclopoida exhibited high values of abundance and biomass in the eutrophic stations, while Calanoida dominated the oligotrophic sites.

Another very illustrative picture can be

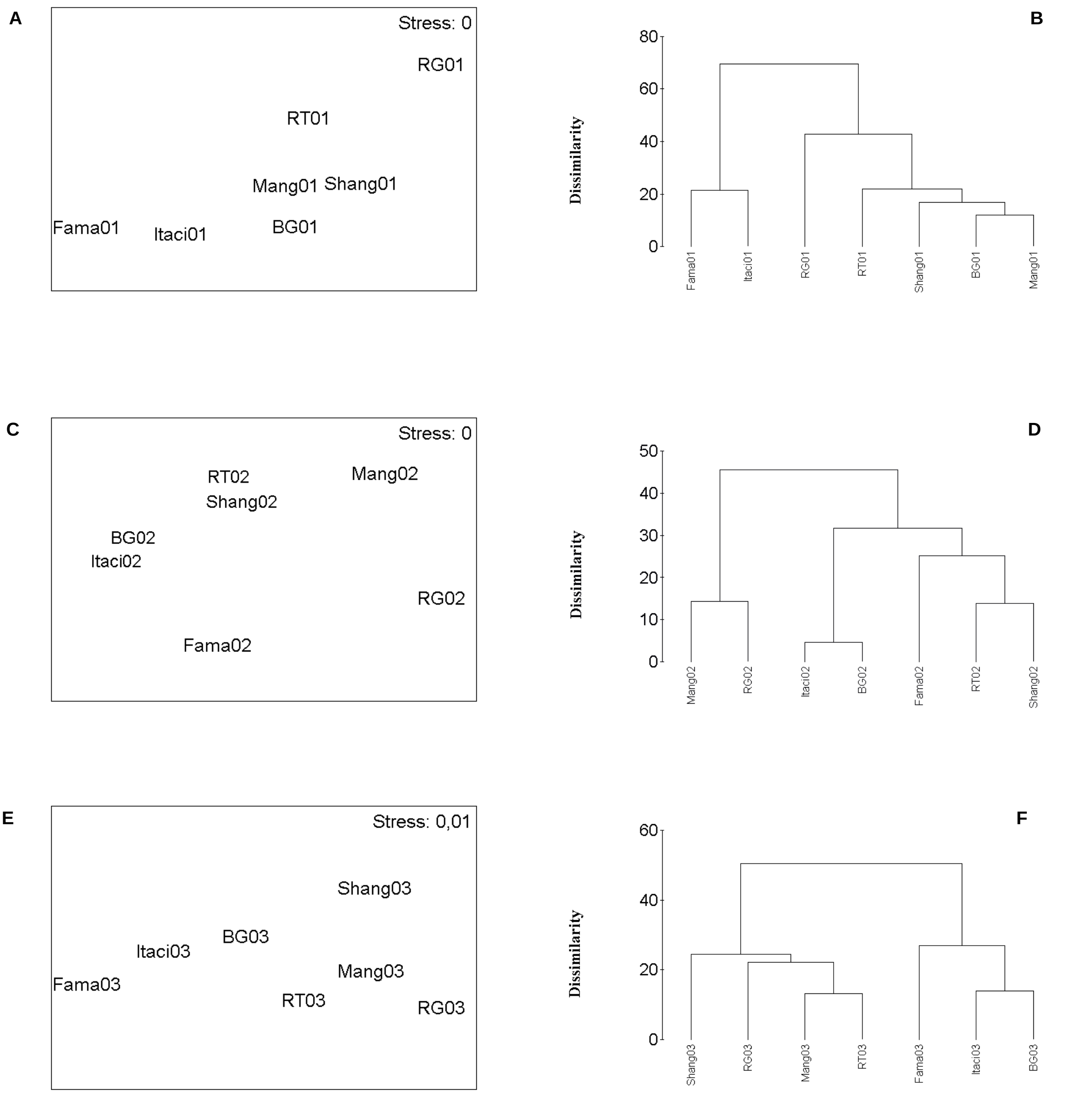

Figure 3: Ordination and classification of the studied sites (abundance data) in Furnas Reservoir. A and D= June 1994; B and E= February 1995; C and F= July 1995. BG= Balsa de Guapé; Sang= Shangrilá; RG= Rio Grande; RT= Rio Turvo; Mang= Mangueiras

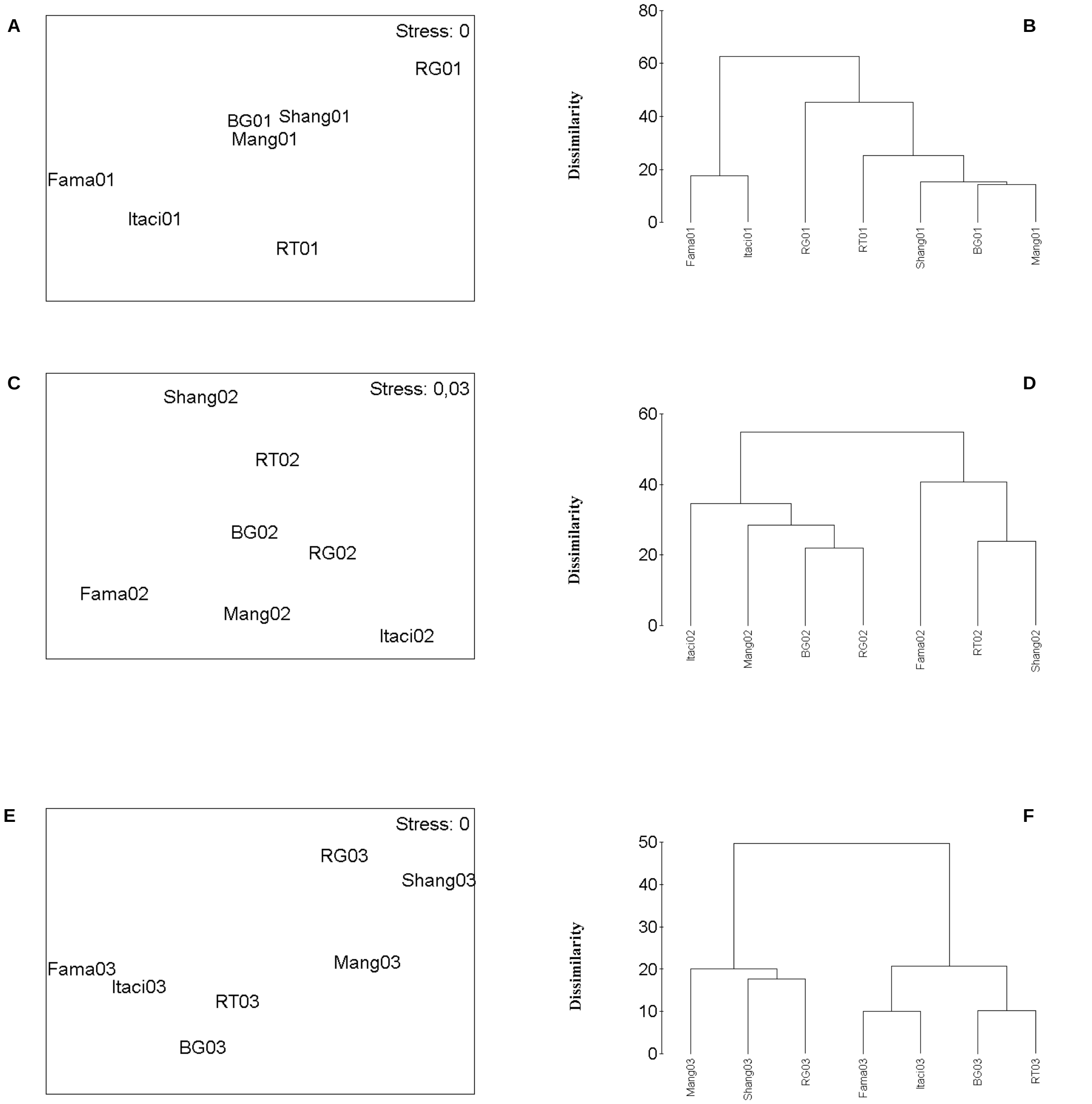

Figure 4: Ordination and classification of the studied sites (Biomass data) in Furnas Reservoir. A and D= June 1994; B and E= February 1995; C and F= July 1995. BG= Balsa de Guapé; Shang= Shangrilá; RG= Rio Grande; RT= Rio Turvo; Mang= Mangueiras

observed when we analyse the relative contribution in biomass of the most representative zooplanktonic groups. Large size herbivores (Daphnia spp., Diaphanosoma spp. and Copepoda Calanoida) contributed, with some exceptions, to more than 40% of the biomass in all locations. At Rio Sapucaí River subsystem, the Diaphanosoma spp. and Calanoida biomass was higher than 40% of the total biomass. For meso- and microzooplanktonic organisms (Bosmina spp., Ceriodaphnia spp. and nauplii), the biomass remained below 35% in almost all the stations.

Following ANOSIM results for abundance data, there was no difference between the two subsystems in February 1995, while for biomass, a significative difference was only observed in July 1995 (Tab. V).

Table V: ANOSIM results for zooplankton abundance and biomass data in June 1994, February 1995 and July 1995. R= correlation values; P= level of significance.

Variables	**June 1994**		**February 1995**		**July 1995**	
	R	**P**	**R**	**P**	**R**	**P**
Abundance	0.426	0.057	0.352	0.171	0.815	0.029
Biomass	0.259	0.171	0.037	0.543	0.630	0.057

Allometric patterns

Adults of A. furcatus seem to be proportionally bigger in eutrophic sites as Fama and Itaci (Fig. 5 A). However, Diaphanosoma spp. did not exhibited any important allometric pattern along the studied gradient.

In accordance with ANOSIM results, the allometric patterns of A. furcatus and Diaphanosoma spp. did not differ significantly between the two subsystems of the reservoir (Tab. VI).

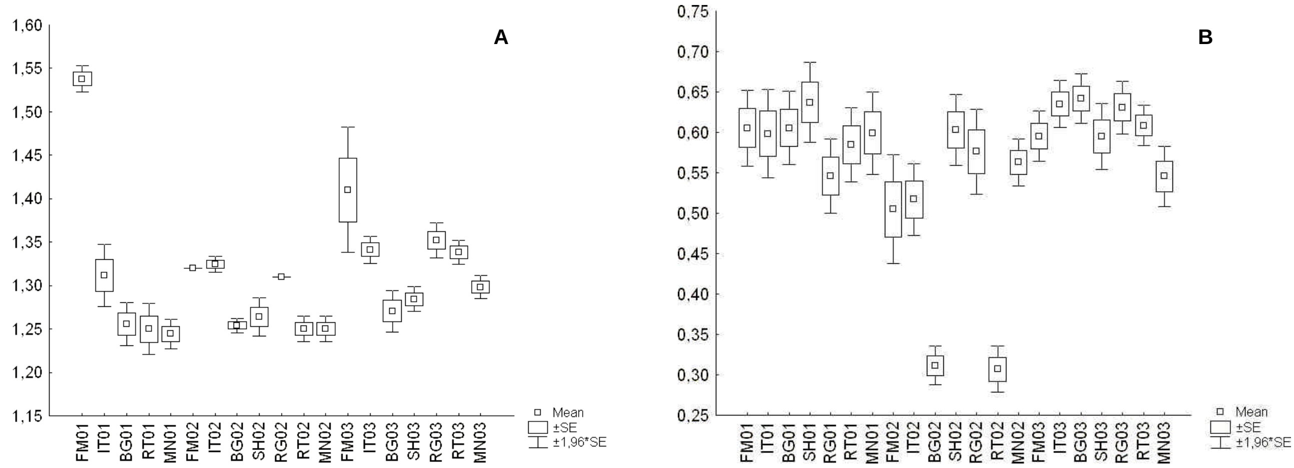

Figure 5: allometric patterns of A furcatus (A) and Diaphanosoma (B) along the studied sites in June 1994, February 1995 and July 1995 at Furnas Reservoir (MG, Brasil).

Table VI: ANOSIM results for Argyrodiaptomus furcatus and Diaphanosoma allometric data in June 1994, February 1995 and July 1995. R= correlation values; P= level of significance.

Species	**June 1994**		**February 1995**		**July 1995**	
	R	**P**	**R**	**P**	**R**	**P**
Argyrodiaptomus furcattus	0.167	0.800	0.019	0.929	0.056	0.314
Diaphanosoma spp.	0.019	0.929	0.111	0.286	0.296	0.143

Discussion

Eutrophication processes heavily affect zooplankton distribution (Bays & Crisman, 1983; Blancher, 1984; Pace, 1986; Esteves & Sendacz, 1988; Seda & Devetter, 2000). Commonly there are changes of zooplankton abundance and biomass along the evolution of lake eutrophication. In Brazilian reservoirs, some studies (Giani, 1984; Arcifa, 1984; Sendacz, 1984; Esteves & Sendacz, 1988; Arcifa et al., 1992; Bini et al., 1997; Pinto-Coelho, 1998; Pinto-Coelho & Corgosinho, 1998; Rull del Aguila, 2001) have indicated that zooplankton are affected by eutrophic processes, occurring, as we found here, an increase of abundance and/or biomass values with the increase of the eutrophic conditions.

High levels of organic matter (Patalas, 1972; Gannon & Stemberger, 1978; Pace, 1986) accelerate eutrophication processes and via a cascade effect, can promote a change in the zooplankton taxonomic composition and diversity (Hutchinson, 1967; Margalef, 1983; Esteves & Sendacz, 1988; Lampert & Sommer 1997). Some of the zooplankton changes are due to differential capacity of response exhibited by different planktonic organisms to a particular environmental properties triggered by eutrophication. For example, some authors (Sendacz & Kubo, 1982; Sendacz et al., 1984, 1985) verified the preference of Argyrodiaptomus furcatus for oligotrophic environments, while Scolodiaptomus corderoi prefer mesotrophic to eutrophic conditions (Sendacz & Kubo, 1982; Arcifa, 1984; Sendacz et al., 1985). For cyclopoid copepods, Thermocyclops decipiens is more tolerant to the eutrophication processes, occurring preferentially in meso to eutrophic water bodies (Sendacz & Kubo, 1982; Pinto-Coelho, 1983; Freitas, 1983; Giani, 1984; Sendacz et al., 1984, 1985). On the other hand, Thermocyclops minutus prefer oligotrophic sites (Hardy, 1980; Brandorf et al., 1982; Arcifa, 1984). At the studied area, Reid & Pinto-Coelho (1994) mentioned that the ecological preferences of the copepod species in Furnas Reservoir indicate a species assemblage that is typical of mesotrophic conditions, in most of the sampling sites. In accordance with these authors, an hypothetical ranking of species tolerance for productive warters in Furnas, might be: Argyrodiaptomus furcatus, Scolodiaptomus corderoi and Thermocyclos decipiens in more eutrophic regions, being followed by Notodiaptomus iheringi and Thermocyclops minutus in more oligotrophic areas. Therefore, changes of zooplankton taxonomic composition could be an indication of environmental heterogeneity (Attayde & Bozelli, 1998).

Generally speaking, Cyclopoida replaces Calanoida with the eutrophication (Pace, 1982, Rull del Aguila & Pinto-Coelho, in prep.), occurring the same in this work. But for Cladocera, our data do not completely fit those found by Rull del Aguila & Pinto Coelho (in prep.) in Furnas reservoir, where small Cladocera values were observed in sites with high trophic conditions, while large Cladocera prevailed at oligotrophic stations. This seems to be a common pattern along gradients of eutrophication and some previous studies support this tendency verified by Rull del Aguila & Pinto Coelho (in prep.). Hence, following this line of thought, oligotrophic environments would contain insufficient energy to maintain smaller zooplanktonic organisms, because of their higher rates of metabolism (Hall et al., 1976; Fenchel, 1980; Pace 1982). Nevertheless, in eutrophic environments, the higher proportion of inedible phytoplankton (Watson & Kalff, 1981) would increase the detritus accumulation, thus, enhancing the biomass of bacteria and of smaller zooplanktonic organisms. In Furnas, we did not make any effort toward the measurement of phytoplankton edibility and/ or of bacterial production and micro-mesozooplankton herbivory. However, in this work, since biomass and abundance of small and large Cladocera increased concomitantly along the eutrophic gradient, with the highest values occurring in the more eutrophic sites, thus, we believe that our data do not endorse Gannon & Stemberger (1978) hypothesis of resource allocation along eutrophic gradients, since the macrozooplankton is not substituted by meso and microzooplanctinic organisms in more eutrophic sites.

The importance of the relative densities of predator and prey in determining zooplankton abundance and allometric properties has been discussed intensively (Brooks & Dodson, 1965; Zaret & Kerfoot, 1975). Commonly, plankton taxonomic composition and allometric patterns change due to interactions with visually-oriented predators. Meanwhile, we should have caution to make such assertions in face of the zooplankton position in the trophic chain, since the size and composition of these organisms could be also structured by bottom-up effects. So before any final statement, we need to evaluate under what circumstances zooplankton is controlled by detritus chain or by direct impact by selective or non-selective predators (Bergquist et al., 1985).

Our allometric data of A. furcatus leads to two alternative hypothesis: a) High turbidity of Itaci and Fama could impose some difficulty to those predators that find and pursue their prey visually (Zaret & Kerfoot, 1975), thus favouring large body organisms; b) due to the eutrophic condition, these sites might be selecting larger and well nourished organisms. Nevertheless Pinto-Coelho & Corgosinho (1998) found high levels of lipids at the more oligotrophic sites of Furnas reservoir, probably indicating that the first hypothesis is the correct one.

It is very difficult to establish a relationship of cause and effect between an allometric pattern and a possible predation without a suitable experimental procedure. But the absence of any allometric pattern could be an indication of absence of predation pressure by vertebrates upon a given kind of prey. In this context, it is very interesting the absence of any allometric pattern in Diaphanosoma spp.

Acknowledgements

We would like to thank the national council of research (CNPq- Conselho Nacional de Pesquisa) for the financial support and to the biologists from Furnas Hatchery Station for the logistic support.

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Received: 28 March 2006
Accepted: 01 September 2006