# Comparative study of the zooplankton composition of two lacustrine ecosystems in Southwestern Amazonia

**Erlei Cassiano Keppeler**

*Universidade Estadual Paulista e Universidade Federal do Acre. Centro Aquicultura, Rodovia Carlos Tonanni, s/n., Jaboticabal, 14870-00; São Paulo, Brasil. email: erlei@caunesp.unesp.br*

**ABSTRACT. Comparative study of the zooplankton composition of two lacustrine ecosystems in Southwestern *Amazonia*.** The zooplankton communities of two lacustrine ecosystems in southwestern *Amazonia* (*Lago Amapá* and *Lago Pirapora*) were studied based on samples collected over an 11-month period. The general aim of the present work was to contribute to the knowledge of the zooplankton fauna in southwestern *Amazonia*, by studying the occurrence of certain species; and to improve the knowledge of the *Rio Acre* tributaries. The total number of taxa included 38 species of rotifers, 6 cladocerans and 7 copepods. Most of the species were from the rotifer family Brachionidae. Jaccard´s similarity index was similar for the two lakes at 0.6964 The constancy index defined the species *Keratella cochlearis, Filinia* cf. *terminalis*, *Filinia opoliensis, Hexarthra intermedia braziliensis, Ceriodaphnia cornuta, Moina minuta, Diaphanosoma spinulosum*, and immature forms (nauplii and copepodites) as the constant in these lakes. The presence of zooplankton with higher number of species occupying the middle depths, during morning and night periods.

**Key words:** zooplankton, composition, *Amazonia*.

**RESUMO. Estudo comparativo da composição do zooplâncton de dois ecossistemas lacustres da Amazônia Sul-Ocidental.** A comunidade zooplanctônica de dois ecossistemas lacustres localizados na Amazônia Sul-Ocidental (*Lago Amapá* e *Lago Pirapora*) foi estudada, com base em amostras coletadas, durante 11 meses. O objetivo geral do presente trabalho foi contribuir com o conhecimento da fauna do zooplâncton na Amazônia Sul-Ocidental, estudando particularmente a ocorrência de certas espécies nos tributários do Rio Acre. Foi registrado o total de taxas: 38 rotíferos, 6 cladóceros e 7 copépodos. O índice de Jaccard, para comparar a similaridade entre os dois lagos, foi 0,6964. Brachionidae foi a família com o maior número de espécies. O índice de constância definiu as espécies *Keratella cochlearis*, *Filinia* cf. *terminalis*, *Filinia opoliensis*, *Hexarthra intermedia braziliensis*, *Ceriodaphnia cornuta*, *Moina minuta*, *Diaphanosoma spinulosum*, e ainda as formas imaturas (náuplios e copepoditos) como constantes nos lagos estudados. Observou-se o maior número de espécies ocupando o meio da coluna da água, durante o período da manhã e noite.

**Palavras-chave:** zooplâncton, composição, Amazônia.

## Introduction

River-floodplain systems show marked temporal variation in physical, chemical, and biotic factors, associated with variations in the flood and dry phases, influenced by the hydrological regime of the principal river. According to Junk *et al.* (1989), most large or medium-sized rivers have adjacent areas subject to flooding and which, together with the main stream, constitute the river-floodplain systems.

Almost all Amazonian waterbodies and wetlands are subject to varying degrees of water-level fluctuation. Fluctuations are widest in the main rivers and their adjacent floodplains. These floods are regular annual events, resulting in a well defined high-water and low-water period each year (Junk and Howard-Williams, 1984).

Aquatic communities are influenced by these flood pulses. The zooplankton community has been investigated, mainly Cladocera, Copepoda and Rotifera, in order to better understand how these temporal changes influence the composition of these communities.

Zooplankton in tropical aquatic systems has been investigated in Venezuela by Michelangelli *et al.*

(1980), Twombly and Lewis (1987), Saunders and Lewis (1988), Zoppi de Rôa *et al.* (1990), and Lopez and Ochoa (1995), among others. In Brazil, the studies carried out by Espíndola *et al.* (1996), Bonecker *et al.* (1998), Branco *et al.* (2000), and Sampaio and Lopez (2000) are among the most important ones. The structure of the zooplankton community has been intensively studied on the Rio Paraná floodplain, principally in the 1990s, by several investigators: Lansac-Tôha *et al.* (1992, 1993, 1999), Bonecker *et al.* (1994, 1996, 1998), Bonecker and Lansac-Tôha (1996), Campos *et al.* (1996), and Lima *et al.* (1998).

In Amazonian bodies of water, approximately 250 species of Rotifera (including sessile and illoricate forms) are known nowadays. The composition of the limnetic Cladocera of various lakes and rivers, excluding the Macrothricidae and Chydoridae, has a species number in the range of 20. The limnetic Copepoda found in these environments has a species number in the range of 40, the majority being calanoid copepods (Robertson and Hardy, 1984).

In the Central Amazon floodplain, where faunistic surveys are more numerous, the most important zooplankton studies include those of Brandorff (1973), Brandorff and Andrade (1978), Koste and Robertson (1983), Carvalho (1983), Hardy (1980); Hardy *et al.* (1984), Robertson and Hardy (1984), Santos-Silva *et al.* (1989), Bozelli (1992, 1994), and Waichman *et al* (2002). The only study of this community in southwestern Amazonia was made by Sendacz and Melo-Costa (1991), along the *Rio Acre* and lakes (*Lua Nova, Nova Andirá*, and *Lago Amapá*). These authors studied the composition and species richness in these waterbodies, finding 46 species of rotifers, 7 cladocerans, 7 cyclopoid copepods, and 3 calanoid copepods. This diverse fauna is similar to that of central Amazonia, with some widely distributed species, and some are endemic to Amazonia.

The general aim of the present work is to contribute to our knowledge of the zooplankton fauna in southwestern Amazonia, studying the occurrence of certain species; and to improve the knowledge of the Rio Acre tributaries.

## Material and methods

### Study area

In the areas of the Amazonia lowlands, the character of the Andean rivers, instead of showing depth erosion, develop strong lateral incisions, resulting in meandering. After passing their cones of coarse rubble, deposited when leaving the mountainous section of their courses, the rivers carry a bottom-load of sand, which forms sandbanks, and their water becomes turbid, because of their load of suspended fine particles. The meanders migrate down the rivers, old ones are cut off and transformed into oxbow-lakes, new ones are formed, and the whole land adjacent to the rivers is in a constant and rapid process of dismantling and rebuilding, a process which can be observed on a time-scale of a few decades (Sioli, 1984). The lakes studied are environments situated in the Amazon Basin. *Lago Amapá* is situated in the Municipality of *Rio Branco*, and *Lago Pirapora* is located in *Porto Acre*, in the State of *Amazonas*, with the geographic co-ordinates 10°02'36"S; 67°50'24" W and 9°27'21"S; 67°31'39"W , respectively (Figure 1). Both meander lakes are affluents of the Rio Acre, characterized according Sioli (1984) as whitewater rivers, of turbid, more or less ochre-colored water. This type of river is known in the pre-Andean zone as southwestern. One of the main characteristics of the lakes studied is the fluctuation of the water level, which is distinguished by two phases: high water and low water. They are directly influenced by the hydrological regime of the River *Acre*, especially during high water periods. These lakes are abandoned meanders. The minimum and maximum depths for *Lago Amapá* are respectively 2.7 and 4.5m and for *Pirapora* 4.5 and 13m.

According to Salati *et al.* (1978), the Amazon basin hydrological complex is formed by thousands of small rivers and probably has been, together with the exuberant forest, in dynamic equilibrium for millenia. The lakes studied are situated south of the equator, beyond parallel 65°W, with a minimum amount of precipitation in June/July (Sioli, 1984).

Being in the hydrographic basin of the *Rio Acre*, to which they are permanently linked, *Lago Amapá* and *Lago Pirapora* are considered white-water lakes according to Sioli (1968). The lakes are surrounded by forest, which is inundated during high water and, as a consequence, there is a great input of organic matter from the forest into the lake.

Zooplankton was collected from both lakes. Sampling was carried out monthly, for a period of 11 months. Complete characterization of the community was carried out by two methods. The first was by horizontal and vertical hauls using a net of 55-$\mu$m mesh size. In the second method, water was collected with a Van Dorn bottle at various depths, and then filtered through a 55-$\mu$m mesh plankton net, during the morning and at night, in the littoral zone at the surface and bottom, and in the pelagic zone at the surface, middle and bottom depths. Details of the vertical distribution and abundance density in that stratum as diurnal variations have been studied by Keppeler (2003). The samples were preserved with formalin solutin (4%).

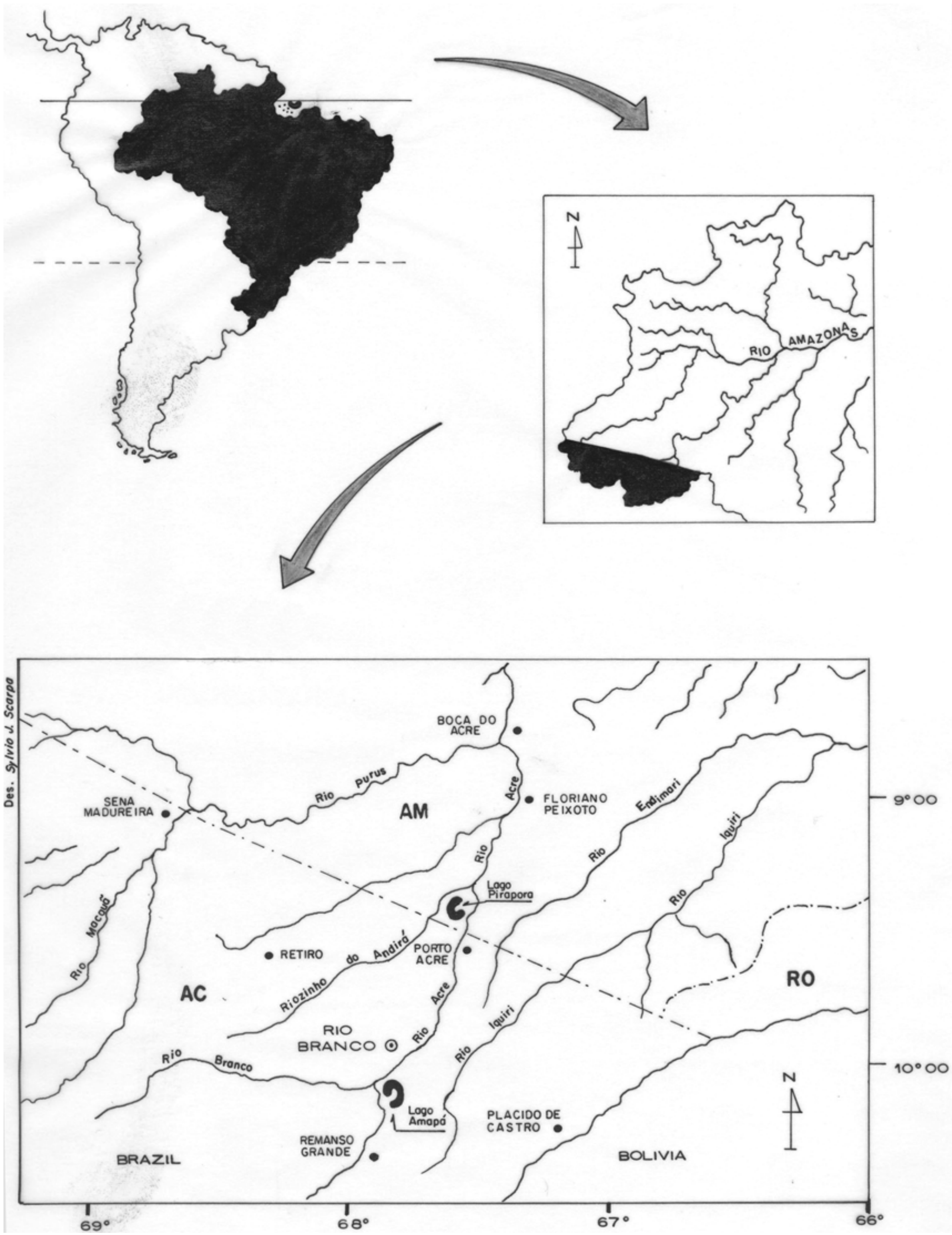


**Figure 1.** Location of the *Amapá* and *Pirapora* lakes.

Water depth was measured by means of a marked and weighted rope. Transparency was determined using a Secchi disc. Water samples for physical and chemical analyses were collected with a Van Dorn bottle. Temperature was measured with a mercury thermometer. Electrical conductivity and pH were determined with conductivimeter and pH meters. Dissolved oxygen was determined according to the Winkler method modified according to Golterman *et al.*

(1978) and APHA (1992). Turbidity was measured with turbidimeter.

Qualitative analysis was carried out using stereoscopic and compound microscopes. The following references were used to identify species: Koste (1978), Reid (1985), Santos-Silva *et al.* (1989), Segers *et al.* (1993), Segers (1995), and Battistoni (1995), among others.

The constancy index of each zooplankton group at the sampling stations was determined using the following expression (Dajoz, 1972):

C = n x 100/N

where n = number of collections containing the group or species; and N = total number of collections.

The species groups were considered constant when they were recorded as more than 50% of the samples, accessory when present as 25 to 50% of the samples; and accidental when recorded as less than 25% of the samples.

The qualitative similarity between the populations of the different collection locations was calculated using Jaccard's Index (Krebs, 1989), as:

Cj = a/a+b+c

where C is the index, a is the number of species present in both locations, b is the number of species present only in location A, and c is the number of species present only in location B. The presence of a species in a collection location was scored as 1, and its absence was scored as 0.

## Results

Figure 2 shows the rainfall during the period studied. Figure 3 presents data for certain limnological characteristics of the lakes (Marques-Lopes, 2001). The minimum temperature was 22.65°C in June, and the maximum was 30.40°C, in *Lago Amapá*. The mean temperature for both lakes was 27°C. Higher transparency levels occurred during the low water period. The transparency levels ranged, during this period, from 0.30m in August to 1.40m in September, with an average of 0.63m in *Lago Amapá*. For *Lago Pirapora* the average transparency level for the low water period was 0.39m, ranging from 0.30m in September/ October to 0.60 in May. For dissolved oxygen, during the low water period, the minimum was 3.15mg.L$^{-1}$ (*Lago Amapá*) in March, while the maximum was 11.96 mg.L$^{-1}$, also for *Lago Amapá*, resulting in an overall average of 6.80 mg.L$^{-1}$ for *Lago Amapá* and 4.74 for *Lago Pirapora*. The values for electrical conductivity oscillated for *Lago Amapá* between 28.83 and 56.73$\mu$S.cm$^{-1}$, and for *Lago Pirapora* 35.90-140$\mu$S.cm$^{-1}$. The minimum value for turbidity was 13.40NTU during the low water period (*Lago Amapá*) and the maximum 88.30NTU (*Lago Pirapora*).

Table 1 shows the species and/or main groups of zooplankton. The main taxonomic groups were Rotifera and Crustacea (Cladocera and Copepoda). The group that included most of the taxa was Rotifera, with 38 species. Brachionidae had most species, followed by Filinidae. Most species were found in both lakes: *Anuraeopsis* sp., *Asplanchna sieboldi, Asplanchna brightwelli, Brachionus falcatus, Brachionus caudatus, Brachionus calicyflorus, Brachionus calyciflorus* for *anuraeformis, Brachionus mirus* for *reductus, Keratella americana, Keratella cochlearis, Trichocerca bicristata, Filinia* cf. *terminalis, Filinia opoliensis, Filinia pejleri, Filinia longiseta, Hexarthra intermedia braziliensis, Hexarthra* sp., *Testudinella patina, Testudinella* sp., *Diaphanosoma spinulosum, Bosminospsis deitersi, Moina minuta, Moina reticulata, Ceriodaphnia cornuta, Daphnia gessneri, Mesocyclops meridianus, Microcyclops* sp., *Thermocyclops* sp., *Neutrocyclops brevifurca*, *Notodiaptomus coniferoides,* and *Calodiaptomus perelegans*.

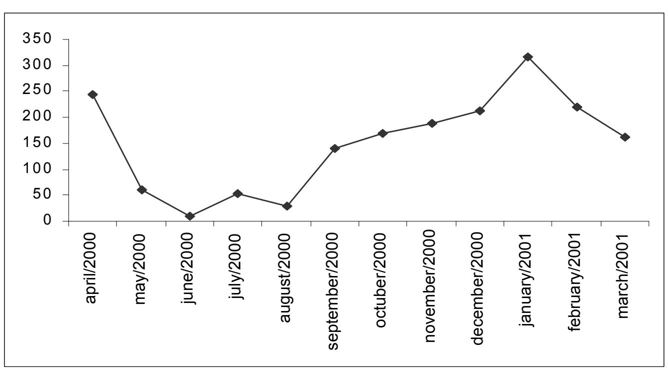


**Figure 2.** Rainfall during the period of April, 2000 to February, 2001. Source: Federal University of Acre, Department of Agrarian Sciences, Meteorological Station, Bulletin of Meteorological Data of the Municipality of Rio Branco.

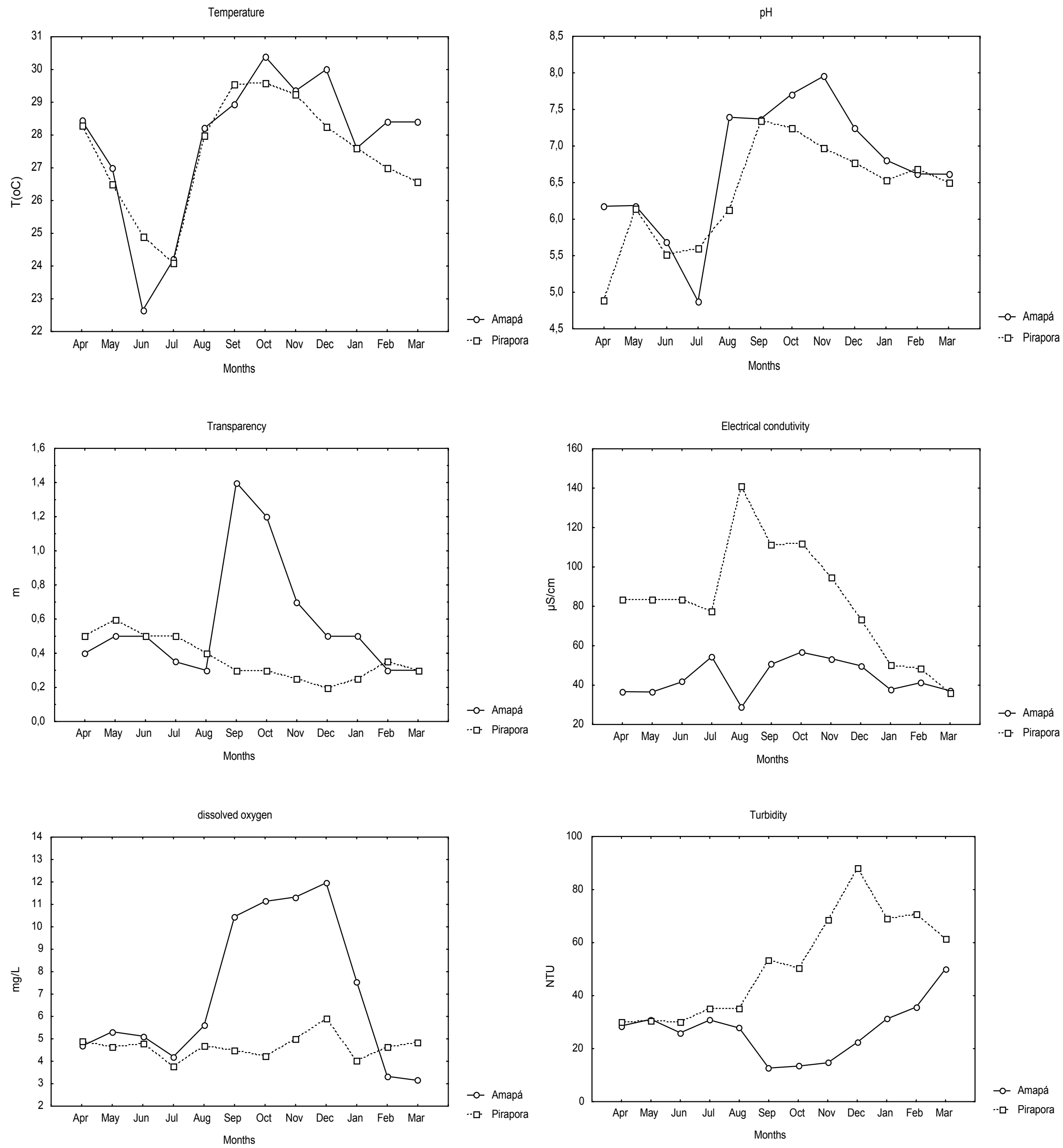


**Figure 3.** Physical-chemical parameters of *Lago Amapá* and *Lago Pirapora* during April/2000 to March/2001

In *Lago Pirapora*, the constant species were *Brachionus falcatus*, *Keratella cochlearis*, *Polyarthra vulgaris*, *Filinia* cf. *terminalis*, *F. opoliensis*, *F. longiseta*, *Hexarthra intermedia braziliensis*, *Diaphanosoma spinulosum*, *Ceriodaphnia cornuta*, copepodites, and nauplii. In *Lago Amapá*, *K. cochlearis*, *Filinia* cf. *terminalis*, *F. opoliensis*, *Hexarthra intermedia braziliensis*, *D. spinulosum*, *Moina minuta*, *C. cornuta*, copepodites, and nauplii were constant. (Figure 4). Jaccard´s similarity index was similar for the two lakes at 0.6964. Table 2 shows the species present in the surface, middle and bottom depths. *Moina minuta* was found to be common in all the compartments of the water column throughout the period of study.

**Table 1.** Zooplankton taxa recorded in the *Amapá* and *Pirapora* lakes over an 11-month period (A* = *Amapá*, P* = *Pirapora*, X = occurrence of taxon on collection date).

| | 04 | | 05 | | 06 | | 07 | | 08 | | 09 | | 11 | | 12 | | 01 | | 02 | | 03 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zooplankton taxon** | A* | P* | A | P | A | P | A | P | A | P | A | P | A | P | A | P | A | P | A | P | A | P |
| **ROTIFERA** | | | | | | | | | | | | | | | | | | | | | | |
| Asplanchnidae | | | | | | | | | | | | | | | | | | | | | | |
| *Anuraeopsis* sp. | X | X | | | | | | | | | | | | | | | | | | | | X |
| *Ascomorpha* sp. | | | X | | | | | | | | X | | | | | | | | | | | |
| *Asplanchna sieboldi* | X | | | X | | | | | | | | | | | X | | X | | X | X | | X |
| *Asplanchna brightwelli* | X | | | X | | | | | | | | X | | X | | | | | | X | | |
| Brachionidae | | | | | | | | | | | | | | | | | | | | | | |
| *Brachionus falcatus* | X | X | X | X | X | X | | X | | X | X | X | | | | | | | | | X | |
| *Brachionus caudatus* | | X | X | X | X | | | | | | | X | | | | | | | | | | |
| *Brachionus dolabratus* | | | | | | | | | | | | | | | X | | | | | | | |
| *Brachionus calicyflorus* | | | X | | | | | | | | | | | | X | X | X | | X | | | |
| *Brachionus calicyflorus* fa. *anuraeformis* | | | | X | | | | | | | | | | | | | X | | | X | | |
| *Brachionus havanaensis* | | | | X | | | | | | | | | | | | | | | | | | |
| *Brachionus mirus* fa. *reductus* | X | | X | X | | X | | X | | X | | | | | | | | X | | | | |
| *Brachionus quadridentatus* | | X | | | | | | | | | | | | | | | | | | | | |
| *Keratella americana* | X | | X | | X | | | | | X | | X | | | | | X | | | | | |
| *Keratella cochlearis* | X | X | X | X | X | X | | X | X | X | X | X | | X | X | | | | X | X | | X |
| *Keratella cochlearis* var. cf. *hispida* | X | | | | | | | | | | | | | | | | | | | | | |
| *Platyonus patulus* fa. *macrodactyla* | | | | | | | | | | X | | | | | | | | | | | | |
| Trochosphaeridae | | | | | | | | | | | | | | | | | | | | | | |
| *Trochosphaera aequatorialis* | | | | X | | | | | | | | | | | | | | | | | | X |
| Epiphanidae | | | | | | | | | | | | | | | | | | | | | | |
| *Epiphanes macrourus* | | | | X | | | | | | | | | | | | | | | | | | |
| *Epiphanes* sp | | | X | | | | | | | | | | | | | | | | | | | |
| Lecanidae | | | | | | | | | | | | | | | | | | | | | | |
| *Lecane curvicornis* | X | | | | | | | | | | | | | | | | | | | | | |
| *Lecane elsa* | | X | | | | | | | | | | | | | | | | | | | | |
| *Lecane lunaris* | | X | | | | | | | | | | | | | | | | | | | | |
| Trichocercidae | | | | | | | | | | | | | | | | | | | | | | |
| *Trichocerca bicristata* | X | X | | X | | | | | | | | | | | X | | X | | | X | X | |
| *Trichocerca similis* | X | | X | X | X | | | X | | | | | | | X | X | X | | | X | | |
| *Trichocerca* sp. | X | | | | | | | | | | | | | | | | | | | | X | |
| Notommatidae | | | | | | | | | | | | | | | | | | | | | | |
| *Cephalodella gibba* | | | | | | | | | | | | X | | | | | | | | | | |
| Colurellidae | | | | | | | | | | | | | | | | | | | | | | |
| *Lepadella* sp. | | | X | | | | | | | | | | | | | | | | | | | |
| Synchaetidae | | | | | | | | | | | | | | | | | | | | | | |
| *Polyarthra* sp. | X | X | X | | | X | | | | | | | | | | | | | | | | |
| *Polyarthra vulgaris* | X | X | | X | X | X | X | X | | | X | X | | X | | | X | | | X | | X |
| Filinidae | | | | | | | | | | | | | | | | | | | | | | |
| *Filinia limnetica* | | | | X | | X | | | | | | | | | | | | | | | | |
| *Filinia* cf. *terminalis* | X | | X | | X | X | X | X | X | X | | X | | | | | X | X | X | X | X | X |
| *Filinia opoliensis* | X | | X | X | | X | X | | | X | X | X | X | X | X | X | X | | X | | | |
| *Filinia pjeleri* | | | | | | X | | X | | | | | | | | | | | X | | | |
| *Filinia longiseta* | X | X | | X | | X | | X | | | | | | | | | | | X | X | X | X |
| Hexarthridae | | | | | | | | | | | | | | | | | | | | | | |
| *Hexarthra intermedia braziliensis* | X | | X | X | X | X | | X | | X | X | X | X | | X | | | | | | | X |
| *Hexarthra* sp. | X | X | X | | | | | | | | | | | | | | | | | | | |
| Testudinellidae | | | | | | | | | | | | | | | | | | | | | | |
| *Testudinella patina* | | | | | | | | | | | | | | | | | | | X | | | X |
| *Testudinella* sp. | | X | X | | | | | | | | | | | | | | | | | | | |
| **CLADOCERA** | | | | | | | | | | | | | | | | | | | | | | |
| Sididae | | | | | | | | | | | | | | | | | | | | | | |
| *Diaphanosoma spinulosum* | X | | X | X | X | X | X | X | X | X | X | X | X | | X | | X | | | X | | |
| Bosminidae | | | | | | | | | | | | | | | | | | | | | | |
| *Bosminopsis deitersi* | X | | | | | | | | | X | X | | | | | | | | | | | |
| Moinidae | | | | | | | | | | | | | | | | | | | | | | |
| *Moina minuta* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | X |
| *Moina reticulata* | | X | X | X | X | X | | | | | X | | | | | X | | | | | | |
| Daphnidae | | | | | | | | | | | | | | | | | | | | | | |
| *Ceriodaphnia cornuta* | X | | X | X | X | X | X | X | | X | | X | X | | X | X | X | | | | | |
| *Daphnia gessneri* | X | | X | | | | | | | | | | | | | | | | | | | |
| **COPEPODA** | | | | | | | | | | | | | | | | | | | | | | |
| **CYCLOPOIDA** | | | | | | | | | | | | | | | | | | | | | | |
| Cyclopidae | | | | | | | | | | | | | | | | | | | | | | |
| *Mesocyclops meridianus* | X | | X | X | | X | X | X | | X | X | | X | | | | | X | | | | |
| *Microcyclops* sp. | | | | X | X | | X | X | | | X | X | | | | | | | | | | |
| *Thermocyclops sp.* | X | | | X | X | | | | | | | | X | X | | | X | | X | | | |
| *Neutrocyclops brevifurca* | | | | | | X | X | | | | | | | | | | | | | | | |

**Cont. Table 1.** Zooplankton taxa recorded in the *Amapá* and *Pirapora* lakes over an 11-month period (A* = *Amapá*, P* = *Pirapora*, X = occurrence of taxon on collection date).

| | 04 | | 05 | | 06 | | 07 | | 08 | | 09 | | 11 | | 12 | | 01 | | 02 | | 03 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zooplankton taxon** | A* | P* | A | P | A | P | A | P | A | P | A | P | A | P | A | P | A | P | A | P | A | P |
| **CALANOIDA** | | | | | | | | | | | | | | | | | | | | | | |
| Diaptomidae | | | | | | | | | | | | | | | | | | | | | | |
| *Notodiaptomus* coniferoides | X | X | X | | | | X | | | | | | | | | | | | | | | |
| *Calodiaptomus perelegans* | | | | | | X | X | | | | | | | | | | | | | | | |
| *Calodiaptomus* sp. | | | | | | X | | | | | | | | | | | | | | | | |
| Copepod larval forms | | | | | | | | | | | | | | | | | | | | | | |
| Copepodites of cyclopoida and calanoida | X | X | X | X | X | X | | X | X | | | | X | X | X | | X | X | | | | X |
| Nauplii | X | X | X | X | X | X | X | X | X | X | X | | X | X | X | X | X | X | X | X | | X |

**Table 2.** Vertical distribution of the frequency of zooplankton species in *Lago Amapá* and *Lago Pirapora* during the period of April, 2000 to February, 2001.

| | | April | | | | May | | | | June | | | | July | | | | August | | | | September | | | | November | | | | December | | | | January | | | | February | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | | P | | A | | P | | A | | P | | A | | P | | A | | P | | A | | P | | A | | P | | A | | P | | A | | P | | A | | P | |
| Species | Diurnal period | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N | M | N |
| *B. mirus* fa. *reductus* | S | + | | | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | M | | + | + | | | | + | | | | + | + | | | + | + | | | | | | | | | | | | | | | | | | | | | | | | |
| | B | | | + | | | | + | + | | + | + | + | | | + | | | | + | | | | | | | | | | | | | | | | | | | | | |
| *P. vulgaris* | S | + | + | + | | | | + | + | + | | + | | + | + | | | | | | | + | | | | | | | | | | | | | | | | | | | |
| | M | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | B | + | | + | | | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *F.* cf. *terminalis.* | S | | | | | + | | | + | | + | | + | | + | + | | | | | + | | | | | | | | | | | | | | | + | | | + | + | |
| | M | + | + | + | | | + | + | | | + | + | + | | + | | | | | | | | | | | | | | | | | | | | | | | + | | + | |
| | B | | + | + | | + | + | | | + | + | | + | | + | | | | | | + | | | | | | | | | | | | | | | | + | | + | | + |
| *D. spinulosum* | S | + | | | | | | | | | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | + |
| | M | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | + |
| | B | + | | | | | | | | + | + | | + | + | + | | | | + | | | + | + | | | + | + | | | + | + | | | + | + | | | | | | |
| *M. minuta* | S | + | + | + | | + | + | + | + | + | | | + | + | + | + | + | | | | + | + | | | + | + | | + | + | + | + | + | | | + | | + | | | | + |
| | M | + | + | | | | | + | + | | | + | + | | + | + | | | | | + | + | | | | | + | + | | + | | + | | + | | + | | | | | + |
| | B | + | + | + | | + | + | + | + | + | + | | + | + | + | + | | | + | + | + | + | + | + | | | + | + | + | + | + | + | + | + | | + | | | | | + |
| *C. cornuta* | S | | | | | + | + | | | + | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | |
| | M | + | | | | + | | | + | + | | | | | + | | | | | | | + | | | | | | | | | | | | | | | | | | + | |
| | B | + | + | | | + | + | | | + | | | | + | + | | | | | | | + | + | | | | | | | + | | | | + | + | | | | | | + |
| *M. meridianus* | S | | | | | | + | | + | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | M | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | |

A= *Lago Amapá*; P= *Lago Pirapora*; M= at morning; N= at night; S= surface; M=middle; B=bottom

## Discussion

During the high-water period, after November, transparency was reduced, especially in *Lago Amapá*. For both lakes studied, temperature, pH and turbidity increased, while electrical conductivity and dissolved oxygen diminished, possibly affecting species diversity under these environmental changes. These changes were increased after flooding (Figure 2), as reported by Hardy *et al.* (1984), who observed a deficiency of zooplankton during flooding, attributed principally to the low concentrations of oxygen during a normal rise in the level of Lago Camaleão in Central Amazônia.

Dissolved oxygen in *Lago Pirapora* had an average of 4.74mg/L, while *Lago Amapá* showed a higher average level (6.80mg.L$^{-1}$). Zooplankton species tended to be more distributed throughout the water column of the latter lake, especially *Ceriodaphnia cornuta* and *Moina minuta.*

The zooplankton composition in these lakes included a number of taxa similar to the results obtained by Sendacz and Melo-Costa (1991), in *Amapá* Lake and other floodplain habitats of the Rio Acre. The zooplankton species found are common in Amazonian environments, and also in the region of the Lower, Middle, and Upper *Paraná* River, as recorded by Bonecker *et al.* (1994).

The Rotifera was the group with most species identified in the different aquatic environments from this part of the Amazon basin. In the same basin, this group also showed the highest species diversity in studies by Koste and Robertson (1983), Hardy (1980), Hardy *et al.* (1984), Robertson and Hardy (1984), Sendacz and Melo-Costa (1991), and Bozelli (1992), as well as in other environments (Lansac-Tôha *et al.*, 1999 and Sharma and Sharma, 2001).

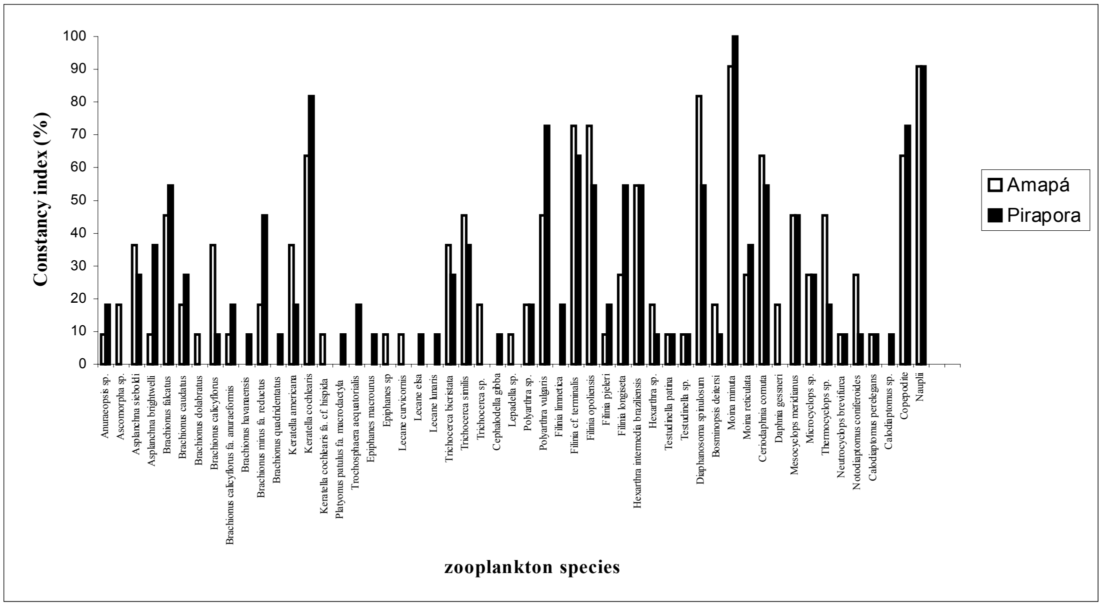


**Figure 4.** Constancy indices of the different zooplankton groups during an 11-month period in *Lago Amapá* and *Lago Pirapora*.

The large species number of this group is considered to be opportunistic species in different environments. The lakes studied are subject to the successive changes that occur in floodplain areas, with the result that r-strategists, which reproduce rapidly under conditions of stress, are common. Birky and Gilbert (1971) suggested that there is a series of advantages in the rotifers system of reproduction, which could favor the participation of most of these animals in an opportunistic, colonizing lifestyle. Opportunistic organisms show wide fluctuations in population, being adapted to reproduce in relatively limiting conditions, but extremely rapidly under favorable circumstances.

The rotifer family Brachionidae showed the highest number of species (12), mainly in the genera *Brachionus* and *Keratella* with 8 and 2 species, respectively, plus 1 variety of *Keratella*, followed by the Filinidae (6 species), with 5 species of the genus *Filinia*. The high species richness of these families was also found by Sendacz and Melo-Costa (1991), Lansac-Tôha *et al.* (1992), and Frutos (1998). The family Brachionidae predominates in tropical environments, and was also dominant in the study of Carvalho (1983) in Central Amazonia.

The dominant rotifer species in *Lago Pirapora* were Brachionus falcatus, Keratella cochlearis, Polyarthra vulgaris, Filinia cf. terminalis, Filinia longiseta, Filinia opoliensis, and Hexarthra intermedia braziliensis. The most frequent species in *Lago Amapá* were *K. cochlearis*, *F.* cf. *terminalis*, and *F. opoliensis*. In the study by Lansac-Tôha et al. (1993) carried out in *Porto Rico*, state of *Paraná*, and *Nova Andradinha*, state of *Mato Grosso*, on the *Rio Paraná* floodplain, *K. cochlearis*, *Polyarthra* spp. and *B. falcatus* were also dominant. Higher species frequency, mainly of rotifers, occurred during the dry season than during flood season, in both studies.

Microcrustaceans, especially calanoids, were poorly represented. Cyclopoids were represented by four genera: *Thermocyclops*, *Mesocyclops, Microcyclops*, and *Neutrocyclops*. The species of *Thermocyclops* is new to science, according to Sendacz and Melo-Costa (1991). Of this genus, the species *Thermocyclops minutus* and *T. decipiens* were common in two lakes, Fechada and *Pousada das Garças*, in *Paraná* (Lansac-Tôha *et al.*, 1993). *Neutrocyclops brevifurca* was present, especially in *Amapá* Lake. According to Reid (1993), this species also occurs in the Cerrado region of Brazil. *Mesocyclops meridianus* was infrequent during the entire study period.

The cladocerans *Bosminopsis deitersi, Ceriodaphnia cornuta, Diaphanosoma spinulosum*, and *Moina minuta* were recorded. These species were also found either in great abundance or frequently in the *Rio Paraná* in Argentina (Paggi, 1979; Paggi and José de Paggi, 1990), and in Amazonia (Robertson and Hardy, 1984; Bozelli, 1992). Most of the cladoceran species recorded in the lakes were found in Lago Castanho, central Amazonia: *Diaphanosoma spinulosum, Daphnia gessneri, Ceriodaphnia cornuta, Moina minuta*, and *Moina reticulata*. *Moina minuta* was very frequent in both *Amapá* and *Pirapora* lakes. This genus is common in South America, particularly in floodplain lakes, but its distribution is poorly known (Hardy and Duncan, 1994; Lima, *et al.,* 1998). *Daphnia gessneri* was infrequent during the entire study, occurring only in two collections in *Lago Amapá*. The cladocerans *Bosminopsis deitersi, Ceriodaphnia cornuta* and *Moina minuta* were very frequent in Lago Batata, an Amazon lake impacted by bauxite tailings, with low transparency of 0.5 to 2.5m (Bozelli, 1992), similar to the transparencies of 0.30 to 1.40m in *Amapá* and *Pirapora*.

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