Acta Scientiarum 22(2):347-353, 2000.
ISSN 1415-6814.

Horizontal distribution patterns of testate amoebae (Rhizopoda, Amoebozoa) in plankton samples of the Corumbá reservoir area, state of Goiás, Brazil

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ABSTRACT. The purpose of this study was to discuss the horizontal variations in the testate amoebae assemblages occurring in different regions of the Corumbá reservoir. A total of 61 taxa were identified representing 8 families. Difflugiidae was the most rich. The greatest number of taxa were found in the lotic environments. The increase in the velocity of current, discharge and the washout of the marginal vegetation resulted in an increase in species richness in the lotic environments. On the other hand, the presence of many accidental species in the lacustrine and transitional zones of the reservoir might be due to the fact that these are deep and extensive regions. *Centropyxis aculeata* was constant in all regions, with the exception of lacustrine zone of the reservoir. Other taxa were constant only in lotic environments (upstream Corumbá river and tributaries) and riverine zone of the reservoir: *Arcella conica*, *A. costata*, *A. discoides*, *A. vulgaris*, *Centropyxis ecornis* and *Difflugia gramen*.

Key words: testate amoebae, zooplankton, distribution patterns, reservoir, Brazil.

RESUMO. Padrões de distribuição horizontal de tecamebas (Rhizopoda, Amoebozoa) em amostras de plâncton na área do reservatório de Corumbá, Estado de Goiás, Brasil. O objetivo deste estudo foi discutir as variações horizontais na assembléias de tecamebas em diferentes regiões do reservatório de Corumbá. Foi identificado um total de 61 taxa pertencentes a 8 famílias. Difflugiidae foi a mais rica em número de taxa. O maior número de taxa foi registrado em ambientes lóticos. O aumento na velocidade de corrente, descarga e a lavagem da vegetação marginal resultaram em um incremento na riqueza de espécies nos ambientes lóticos. Por outro lado, a presença de muitas espécies acidentais nas zonas lacustre e transicional do reservatório pode ser em razão de essas serem regiões profundas e extensas. *Centropyxis aculeata* foi constante em todas as regiões, com exceção da zona lacustre do reservatório. Outros taxa foram constantes somente nos ambientes lóticos (rio Corumbá-jusante e tributários) e zona fluvial do reservatório: *Arcella conica*, *A. costata*, *A. discoides*, *A. vulgaris*, *Centropyxis ecornis* e *Difflugia gramen*.

Palavras-chave: tecamebas, zooplâncton, padrões de distribuição, reservatório, Brasil.

Testate amoebae are essentially aquatic organisms and they occur in a variety of humid and freshwater habitats. Although more usually associated with a substrate, sediments or aquatic vegetation, they have been registered as frequent and sometimes very abundant in plankton organisms of both lentic and lotic environments (Hynes, 1976; Wetzel, 1983; Hunt and Chein, 1983; Arndt, 1993; Green, 1994; Velho *et al*., 1996; Lansac-Tôha *et al*., 1997).

In reservoirs, the zooplankton community plays an important role in energy transfer and regeneration, and transport of nutrients. The structure of this community is often the result of colonization and selection processes (Armengol, 1980).

Among the groups making up the zooplankton communities in Brazilian reservoirs and rivers little is known about the testate amoebae although they may be frequent, especially in lotic environments

(Rolla *et al.*, 1990, 1992; Neumann-Leitão *et al.*, 1991; Lopes, 1993).

The zooplankton community in the pre and post impoundment phases of the Corumbá reservoir in the state of Goiás, Brazil, offered an opportunity to study these protozoans given their numerical dominance at the lotic sampling stations which include the main river and its tributaries (Lansac-Tôha *et al*., 1999).

In this study we propose to discuss the horizontal variations in the testate amoebae assemblages occurring in different regions of the Corumbá reservoir, and in the Corumbá river itself and its tributaries.

Material and methods

Concluded in September of 1996, the Corumbá reservoir, situated in the state of Goiás, Brazil (48º31'W; 17º59'S), has the following characteristics: maximum length: 60 km; mean depth: 23 m; maximum depth: 76 m; surface area: 65 km^2, volume: 1,5 x 10^6 m^3; total theoretical water residence time: 30 days; main tributaries: rivers Peixe and Pirapetinga; and area of drainage basin: 27,800 km^2.

One of the lake's main tributaries, the Pirapetinga river, receives sewage from the city of Caldas Novas and also from a slaughterhouse.

Sampling was carried out from November 1996 to September 1998 at a total of twenty-one sampling stations. Seventeen were located in the reservoir itself, representing riverine (RES1, RES2), transitional (RES3, RES4, RES5) and lacustrine (RES6, RES7, RES8) zones, and arms (ARM1 to 9); 2 were located in the Corumbá river, 1 upstream (RIV1) and 1 downstream (RIV2) of the reservoir; and 2 in the main tributaries: Peixe river (TRI1) and Pirapetinga (TRI2) river (Figure 1).

163 samples were collected with an electric pump and a 70µm plankton net at different standardized depths of the water column (1,000 liters for sample) and fixed immediately with 4% buffered formalin.

The identification of the infrageneric taxa was based on Deflandre (1928, 1929); Gauthier-Liévre and Thomas (1958); Vucetich (1973); Ogden and Hedley (1980); Velho and Lansac-Tôha (1996); Velho *et al*. (1996) and Hardoim (1997).

The frequency of each taxon was calculated using the constancy index (Dajoz, 1973). According to this index, constant taxa were considered to be those that occurred in more than 50% of the samples, accessory taxa those occurring in 25% to 50% of the samples and accidental taxa those occurring in up to 25% of the samples.

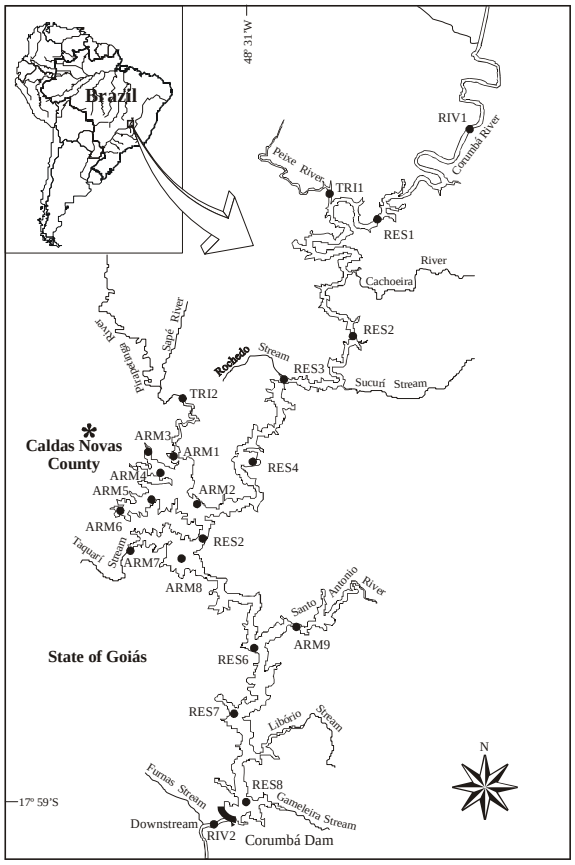

Figure 1. Study area map and sampling sites

Results

Sixty-one infrageneric taxa were identified representing 8 families (Figure 2). Diflugiidae were represented by 23 taxa, Arcellidae by 14, Centropyxidae by 9 and Hyalospheniidae by 6 taxa (Figure 3).

The greatest number of taxa, 53, were found in the lotic environments, in the upstream Corumbá river and tributaries followed by the transitional zone (50 taxa), and the riverine zone (44 taxa) (Figure 4).

The remaining stations, downstream Corumbá river, lacustrine zone and arms presented fewer taxa. It should be pointed out that the downstream Corumbá river presented the same number of taxa as that of the lacustrine zone probably because the first sampling station (downstream Corumbá river) receives an expressive contribution of the reservoir (Figure 4).

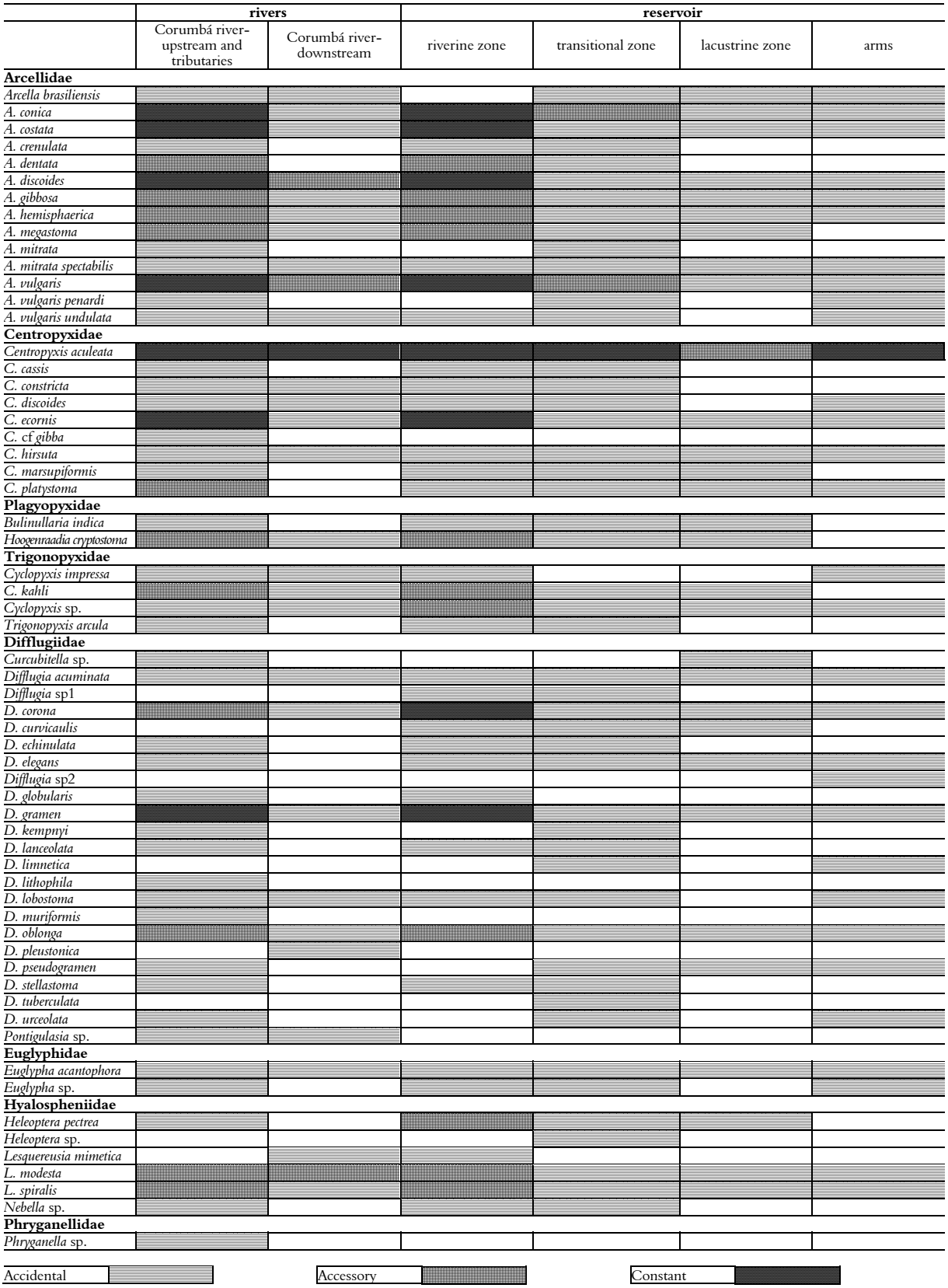

Figure 2. Occurrence and constancy index of testate amoebae taxa in different regions in the Corumbá reservoir area from November 1996 to September 1998. Constant taxa were present in more than 50% of the samples; accessory, 25% to 50% of the samples; and accidental, less than 25% of the samples

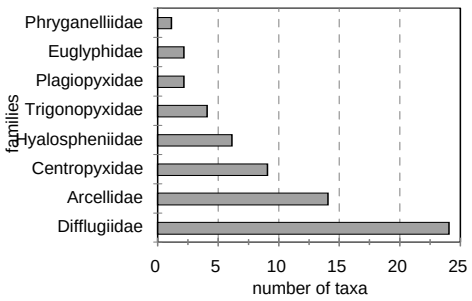

Figure 3. Number of taxa of the testate amoebae families in Corumbá reservoir area from November 1996 to September 1998

With regard to the constancy index, the lotic and the riverine environments of the reservoir presented the greatest number of constant taxa, 7 and 8 respectively (Figure 4). These two environments also presented the greatest number of accessory taxa (11). On the other hand, of the thirty taxa registered in the lacustrine zone of the reservoir, 29 were accidental and 1 was accessory.

Centropyxis aculeata was constant in all regions, with the exception of the lacustrine environment of the reservoir where it was accessory. This species was also the only constant taxon of the downstream region and in the transitional zone and arms (Figure 2).

Considering the lotic environments (upstream Corumbá river and tributaries) and the riverine zone of the reservoir, the following taxa were registered as constant, beside *Centropyxis aculeata*, *Arcella conica*, *A. costata*, *A. discoides*, *A. vulgaris*, *Centropyxis ecornis* and *Difflugia gramen*. *Difflugia corona* was constant only in the riverine zone of the reservoir (Figure 2).

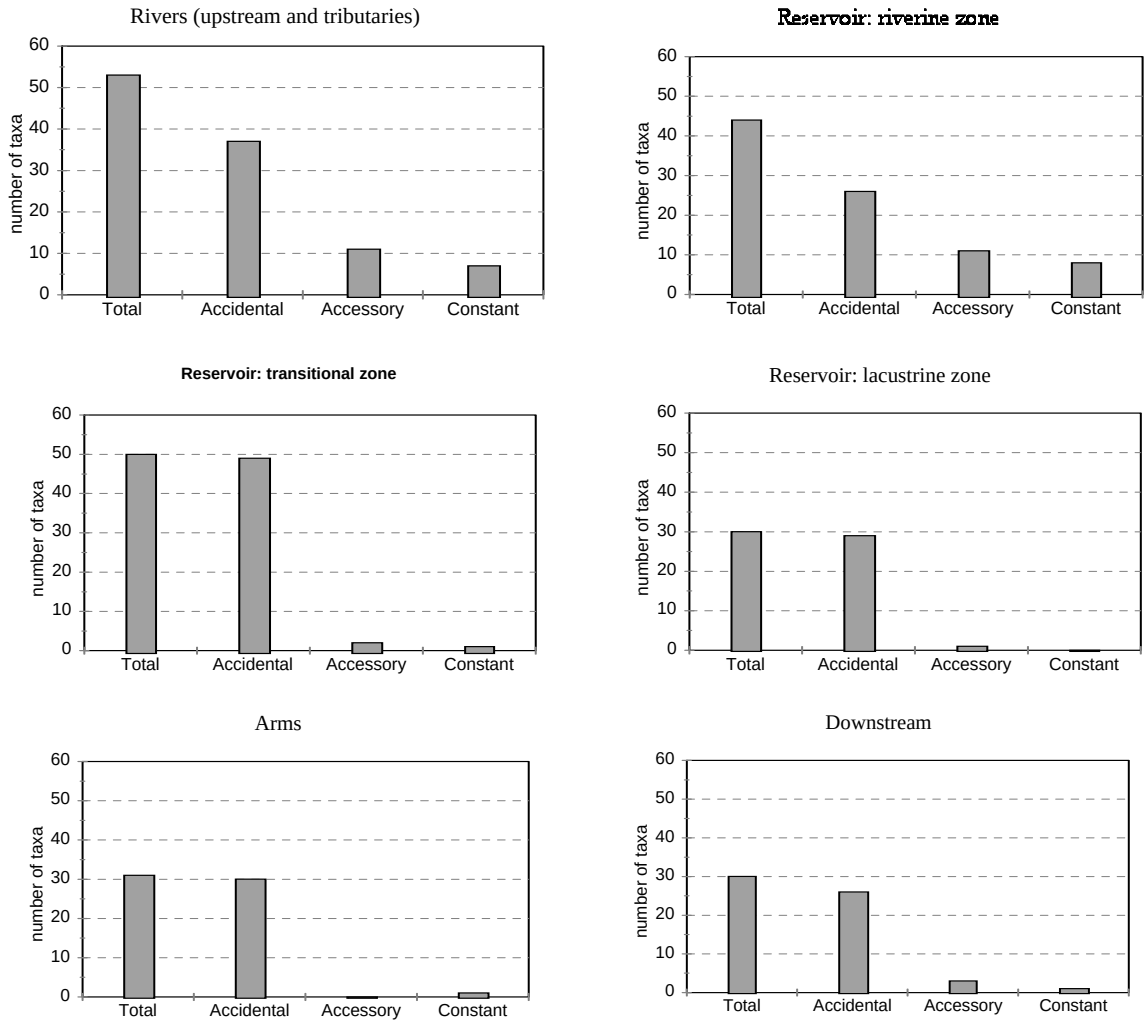

Figure 4. Total number of the testate amoebae taxa in different regions in the Corumbá reservoir area from November 1996 to September 1998 and their constancy. R = rivers (Corumbá river-upstream and tributaries); Ri = riverine zone; T = transitional zone; L = lacustrine zone; A = arms; D = Corumbá river-downstream

Some taxa were registered accidentally and at only one sampling station. In this manner, *Centropyxis* cf *gibba*, *Difflugia muriformis*, *D. lithophila*, and *Phryganella* sp. were exclusive of lotic environments. *Difflugia pleustonica* occurred only downstream the reservoir. On the other hand, *Difflugia sp.*, *D. tuberculata*, and *Heleoptera pectrea* were registered only in the transition zone, and *Curcubitella* sp. occurred only in the lacustrine region of the reservoir (Figure 2).

Discussion

Inventories of testate amoebae in Brazil are still very few; too few to furnish, as yet, a concrete idea of the number of species in Brazil. Although testate amoebae have been studied in a variety of different habitats, including sediment, aquatic macrophytes, plankton of rivers, lakes, litter, *Sphagnum* moss (Closs and Madeira, 1962, 1967; Walker, 1982; Torres and Jebran, 1994; Rhoden and Pitoni, 1999; Velho *et al.*, 1999), these studies are limited to very few geographical regions. However, in the latest years there has been an increase in the number of research projects that have included testate amoebae in their surveys scientific papers.

With regard to their occurrence in plankton, more detailed studies register a number of testate amoebae taxa ranging from 40 in marginal lagoons in the São Francisco river (Dabés, 1995) to 73 in lentic and lotic environments of the floodplain of the upper Paraná river (Lansac-Tôha *et al*., 1997; Velho, 2000). In this manner, the register of 61 taxa in the Corumbá reservoir and tributaries may be considered expressive.

The most representative family in the Corumbá reservoir, Difflugiidae, has also proven to be the most diverse in samples from other Brazilian ecosystems including plankton, sediment and macrophytes (Green, 1975; Hardoim and Heckman, 1996; Torres, 1996; Hardoim, 1997; Lansac-Tôha *et al*., 1997; Oliveira, 1999; Velho *et al*., 1999).

It should be mentioned that the other two important families in the Corumbá reservoir, Arcellidae and Centropyxidae, have also been found with high species numbers in other plankton studies (Green, 1975; Rolla *et al*., 1992; Dabés, 1995; Bonecker *et al*., 1996; Nunes *et al*., 1996; Lansac-Tôha *et al*., 1997).

Centropyxis aculeata, the most frequent taxon in the Corumbá reservoir and tributaries, also presents the highest frequency registers in Brazil (Velho *et al*., 1996, 2000; Velho, 2000).

Arcella vulgaris is the taxon of *Arcella* most frequent in the Corumbá reservoir and the most frequently found in other Brazilian ecosystems (Velho *et al*., 1996; Lansac-Tôha *et al*., 2000).

Research in rivers and reservoirs has shown that, in general, the velocity of current and discharge have been the principal factors determining the spatial and temporal patterns of testate amoebae species richness in plankton (Lansac-Tôha *et al*., 1999). The increase in the flow velocity and discharge causes a re-suspension of the organisms associated with the sediment and the washout of the marginal vegetation, carrying the amoebae to the water column, resulting in an increase in species richness.

On the other hand, the great depth, low flow velocity and low influence of the littoral zone on the pelagic zone, observed in the lacustrine and transitional regions of the reservoir, do not allow the presence of constant taxa, then leading to a higher number of accidental taxa. Bonecker *et al.* (1997), in studies of the zooplankton of a lagoon, of the Doce river in the state of Minas Gerais, suggest that the presence of testate amoebae in this lagoon is due to the reduced depth.

Acknowledgements

We thank Prof. Barbara Robertson and Dr. Luiz Carlos Gomes for assistence with the English text and suggestions. This research has been supported by Furnas Centrais Elétricas S. A.

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Received on March 24, 2000.
Accepted on May 30, 2000.