AMAZONIANA	IX	1	43 – 52	Kiel, Dezember 1984

About the relationship between the zooplankton and fluctuating water levels of Lago Camaleão, a Central Amazonian várzea lake

by

E.R. Hardy*, B. Robertson*, W. Koste**

*Instituto Nacional de Pesquisas da Amazônia, Manaus-Amazonas, Brasil
**Ludwig-Brill-Straße 5, Quakenbrück, F.R.G.

Abstract

A two-year study of the composition and abundance of the zooplankton was conducted in an Amazonian várzea lake, Lago Camaleão. Rotifers were dominant in terms of both species numbers and density. The extremely low standing-stock observed during the high water period is attributed to prevailing poor oxygen conditions and, during extreme floods, current. The species associations of rotifers also reflect the flooding regime and its consequences.

Keywords: **Zooplankton, Rotifera, Amazonian várzea lake, water level fluctuation.**

Introduction

During the course of the year Central Amazonian floodplain lakes are subjected to significant changes in size, depth, macrophyte cover, water chemistry and primary production (JUNK 1980; FURCH et al. 1983) on account of expressive fluctuations in water level. Studies of the zooplankton in these lakes are few and fewer still take into consideration the "seasonal" nature of the flooding regime. This paper presents the results of a two year survey of the composition and standing-stock of the zooplankton in an Amazonian várzea lake.

Study Area

Descriptions of the study area can be found in JUNK et al. (1983) and KOSTE & ROBERTSON (1983), among others. Nevertheless, a few points should be emphasized.

Lago Camaleão, a relatively long and very narrow lake, is located on the Ilha de Marchantaria, an island of the Solimões-Amazonas River system (Fig. 1). Lago Camaleão

0065-6755 / 1984 / 043 / © MPI für Limnologie, AG Tropenökologie, Plön; INPA, Manaus

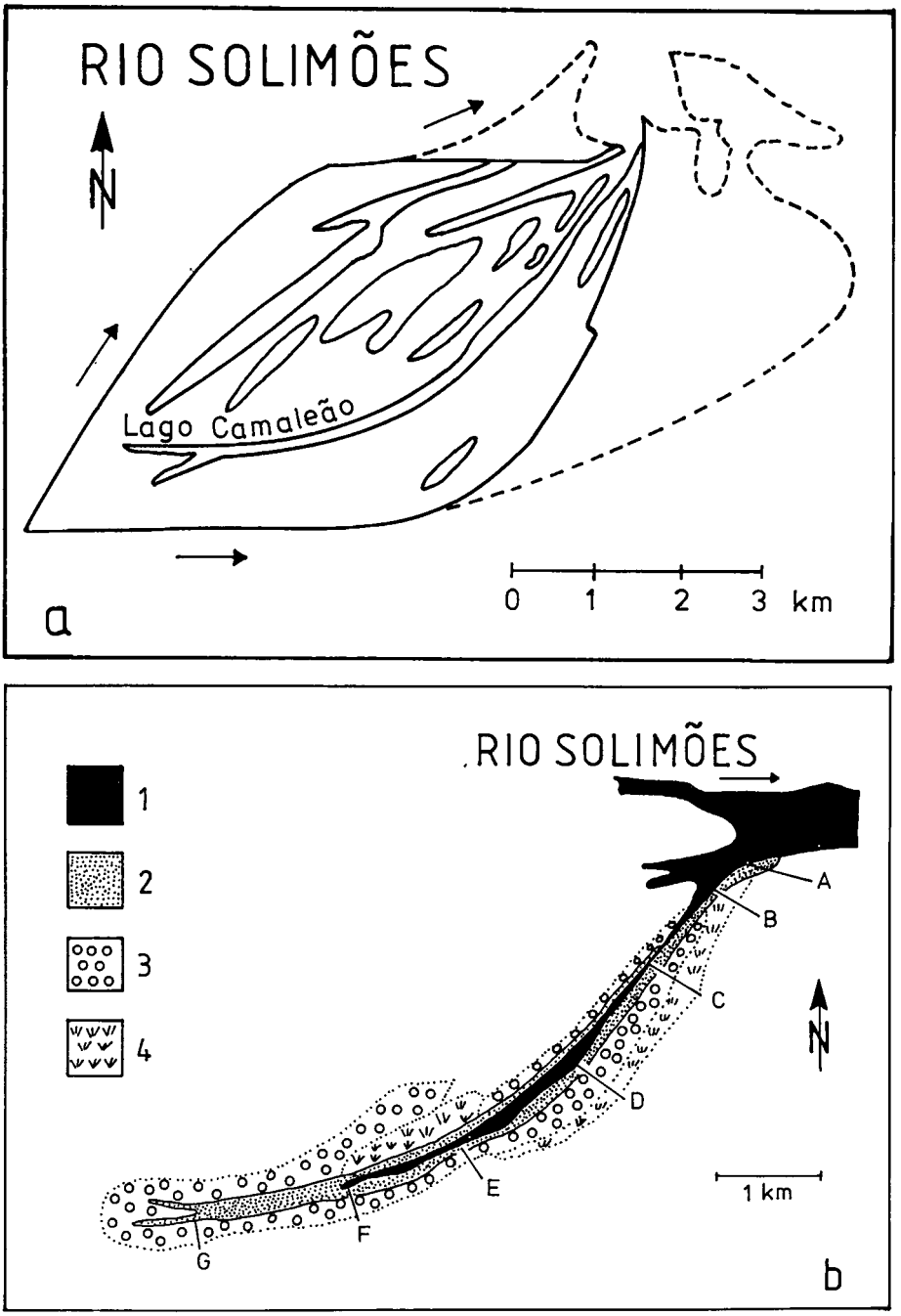

Fig. 1:
a) Ilha de Marchantaria and Lago Camaleão. **b)** Sampling stations (A - G) in Lago Camaleão.
1 – Water surface area (mid-water level); 2 – aquatic grasses; 3 – forest; 4 – semiaquatic grasses.
(Modified from FURCH et al. (1983).

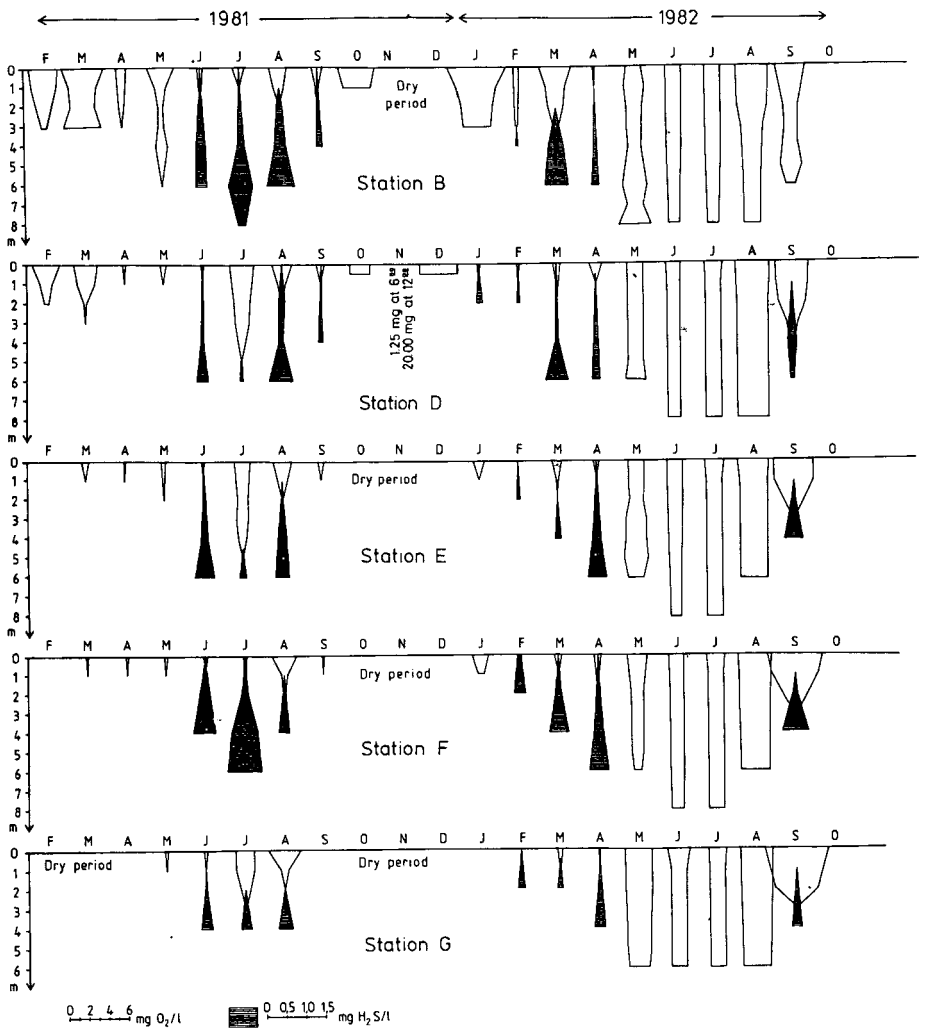

Fig. 2:
Oxygen and H_2S profiles at stations B, D, E, F and G. H_2S measurements initiated in June 1981.
In: JUNK et al. (1983)

suffers significant water level fluctuations during the year. In 1981, for example, the difference between the highest and the lowest water level was 9.6 meters, and in 1982, 11.7 meters. During the dry season, when the lake basically dries up, the exposed lake basin is rapidly colonized by semi-aquatic and terrestrial plants. During the rising water period this vegetation is flooded, eventually dies, and on decomposing, causes strong oxygen depletion in the water column (Fig. 2). At the same time, aquatic macrophytes propagate and cover most of the surface of the lake.

Material and Methods

Zooplankton samples were collected in Lago Camaleão from January 1981 to October 1982 at six stations (B - G, Fig. 1). However, due to the interference of the aquatic macrophytes during the rising and high water periods and the drying of the lake during the low water period, it was rarely possible to collect at all sampling sites.

Fifty liters was the usual volume of water collected at 0.5 m depth with the aid of a hand pump. All the samples were collected with a 55 μm plankton net and fixed at the collecting site with formalin: final concentration 6 %.

When total counts were impractical, counts were made of 5 ml subsamples taken with a Stempel Pipette. All the animals were identified to species when possible. Trophi analysis of the rotifers were executed with Eau de Javelle.

A reference collection of almost all the zooplankton species found in Lago Camaleão is deposited at the Instituto Nacional de Pesquisas da Amazônia's collection, Manaus, Amazonas, Brazil.

Results and Discussion

A total of one hundred and seventy five (175) rotifer species, which corresponds to approximatly 60 % of the known Amazonian species, were identified in our samples. This rich fauna permitted a number of interesting taxonomical studies written up in KOSTE & ROBERTSON (1983) and KOSTE et al. (1984). In contrast to the rotifers, the Crustacean fauna, Cladocera and Copepoda, occurred with few representatives, approximatly fourteen (14) and seven (7) species respectively (Table I).

The relative abundance of the three main groups of zooplankton occurring in Lago Camaleão during the study period is shown in Table II. Rotifers are the dominant group, often contributing with greater than 70 % of the standing-stock. The Crustacean fauna is usually very much reduced. In this respect Lago Camaleão differs from other várzea lakes such as Lago Jacaretinga, and Lago Grande, where crustaceans, particularly copepods, were found to be dominant (BRANDORFF 1977; CARVALHO 1981). Nevertheless, a closer examination of the development of the standing-stocks is illustrating.

In Lago Camaleão the standing-stock of rotifers has two peaks during the year (Fig. 3). One, the greatest, occurs during the extreme dry season. The other, much lower, occurs at the beginning of the rising water period. After this the standing-stock declines markedly. This pattern was repeated in two consecutive years despite the flooding regime being different.

Table I: Composition of the Crustacean fauna in Lago Camaleão (1981 - 1982)

CLADOCERA

Bosminidae

Bosmina sp.
Bosminopsis deitersi
Bosminopsis sp.

Daphnidae

Ceriodaphnia cornuta
Ceriodaphnia reticulata

Moinidae

Moina minuta
Moina reticulata
Moinodaphnia macleayi

Sididae

Diaphanosoma spinulosum
Diaphanosoma spp.
Latonopsis fasciculata

Macrothricidae

Macrotrix sp.
Illyocryptus spinifer

Chydoridae

COPEPODA

Calanoida

Notodiaptomus amazonicus
Notodiaptomus coniferoides
Notodiaptomus kieferi
Dactylodiaptomus pearsi

Cyclopoida

3 spp (cf).

Table II: Relative Abundance (%) of Rotifera, Copepoda, and Cladocera, in Lago Camaleão (Stations B - G)

Sampling date	Rotifera	Copepoda		Cladocera
		adult.	juv.	
1981				
07.01.81	72.4	2.4	23.7	1.3
26.02.81	74.3	1.4	10.8	14.0
04.06.81	96.1	0.0	3.7	0.2
01.07.81	74.9	0.0	22.5	1.6
28.07.81	80.2	0.0	19.8	0.0
01.10.81	97.0	0.0	2.9	0.0
03.11.81	99.8	0.0	0.0	0.2
1982				
07.01.82	97.2	0.1	2.5	0.4
03.02.82	99.3	0.0	1.1	0.0
03.03.82	92.7	0.0	5.5	2.4
05.05.82	53.4	0.3	44.1	2.3
02.06.82	61.3	0.0	23.4	15.2
07.07.82	56,3	1.5	22.9	19.1
04.08.82	50.4	0.6	26.6	22.4
01.09.82	36.6	11.2	48.2	4.0
07.10.82	45.7	31.8	47.7	6.7

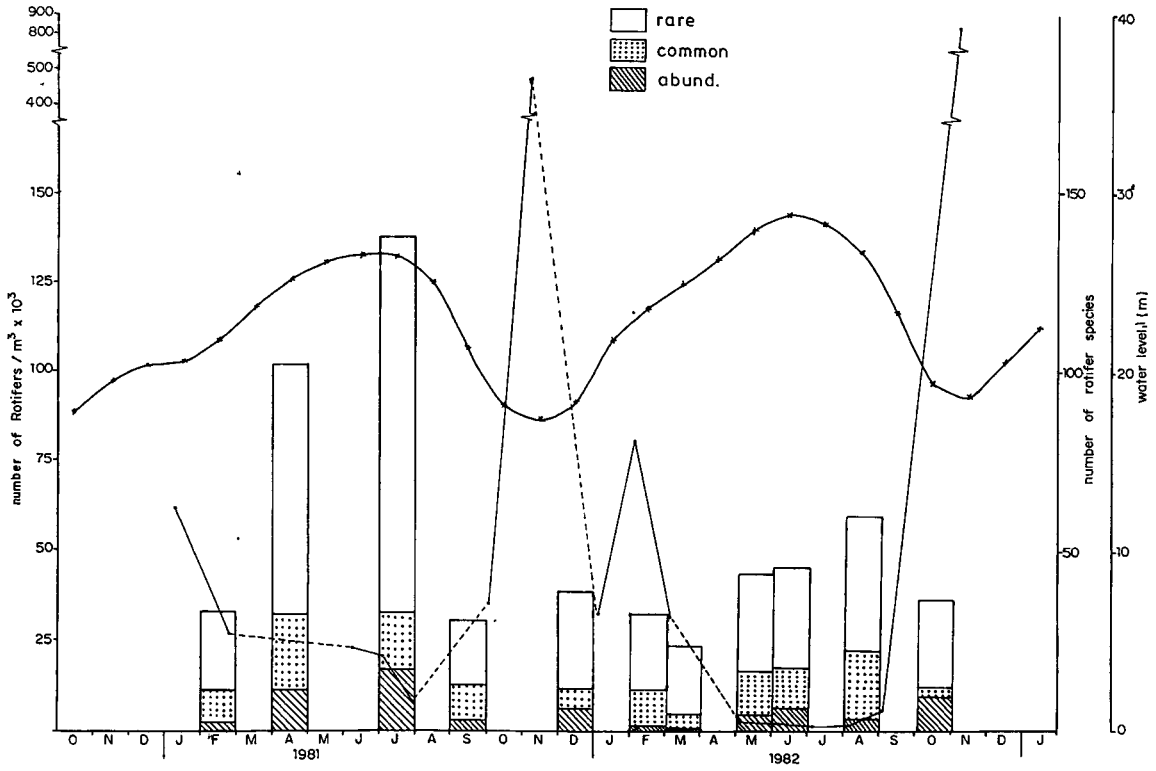

Fig. 3:
Standing-stock of rotifers in Lago Camaleão (· ——·); total number of species divided into rare, common and abundant categories and river water level (x ——x)

During the rising water period, river water enters the lake through the north east channel. Depending on the intensity of the flood, however, river water can also flow over the levee, entering the lake from the upstream end of the island. This occurred in 1982 and a strong current, 30 - 100 cm sec^{-1}, was observed in the lake from May to August (JUNK et al. 1983). Thus, in 1982, the very low standing-stock observed during the high water period can most probably be accounted for by the flood, which was accompanied by currents strong enough to sweep out even the aquatic macrophytes.

In 1981 the flood was much less intense, and the river water entered the lake only through the north east channel. The low standing-stock observed at this time is probably due primarily to the prevailing poor oxygen conditions and the presence of H_2S (Fig. 2).

The rotifer species associations tend to reinforce these hypotheses. As was first observed by KOSTE & ROBERTSON (1983), and confirmed by the 1982 analysis, species richness tends to increase with rising water levels. At the beginning of the rising water period planktonic and sessile forms are abundant while the inhabitants of the periphyton are conspicuously absent. They probably survive this period in the form of resting eggs or, like the Bdelloidea, in an anabiotic stage at the bottom of the lake. Around April, or late during the rising water period, besides the semi-planktonic forms, there also occurs a typical "rotten mud" assemblage composed of species such as *Brachionus patulus patulus, Br. patulus macracantus, Dicranophorus claviger, D. caudatus braziliensis, Lepadella rhomboides, Mytilina acantophora, M. bisulcata, M. unguipes, Rotatoria neptunia, R. rotatoria, R. tardigrada,* inclusive other Bdelloidea and *Testudinella patina.*

During the peak high water period, the semi-planktonic forms, the swimming-creeping forms of the periphyton, and the sessile species reach their maxima. During the falling water phase and into the peak dry season, the high July diversity decreases significantly. At this time we observe a taxocenosis which is composed of residual populations of planktonic (*Brachionus zahniseri gessneri, Filinia longiseta, F. saltator, Keratella americana, K. lenzi, Polyarthra vulgaris, Trichocerca similis*), and semi-planktonic forms (*Brachionus bidentata, B. falcatus, B. quadridentata, B. caudatus, Epiphanes clavulata, E. macrourus*), but most of the inhabitants of the decomposing aquatic vegetation (*Brachionus patulus, Cephalodella*-species, *Lecane*-species, *Lepadella rhomboides, Rotatoria rotatoria, Testudinella patina, T. mucronata haueriensis*). At last we have again the rotifer fauna of the rotten mud period.

Compared to the rotifer assemblage in general, which admitedly includes non-planktonic forms, the planktonic crustaceans seem to be particularly sensitive to the low oxygen conditions of the lake as is suggested by the limited development of the Cladocera and Copepoda, especially in 1981. In 1982 (Fig. 4) the crustaceans begin to be more expressive during the latter part of the year. This could be due to the combined effect of "invaders" coming in with the flood and the better oxygen conditions in the lake. However, it is interesting to note that the initial increase in the crustacean component is due almost entirely to the young stages of Copepoda, particularly nauplii. Prior to this the adults were scarce or not present in the environment. According to HOLDEN & GREEN (1960), the presence of nauplii in the absence of adults can indicate that the nauplii are hatching from resting eggs rather than the active eggs carried by adult females. Thus, the first copepod peak observed in Lago Camaleão could be due to nauplii hatching from resting eggs rather than a selective "invasion" of the animals coming in with the flood. Further studies are being undertaken to elucidate this question.

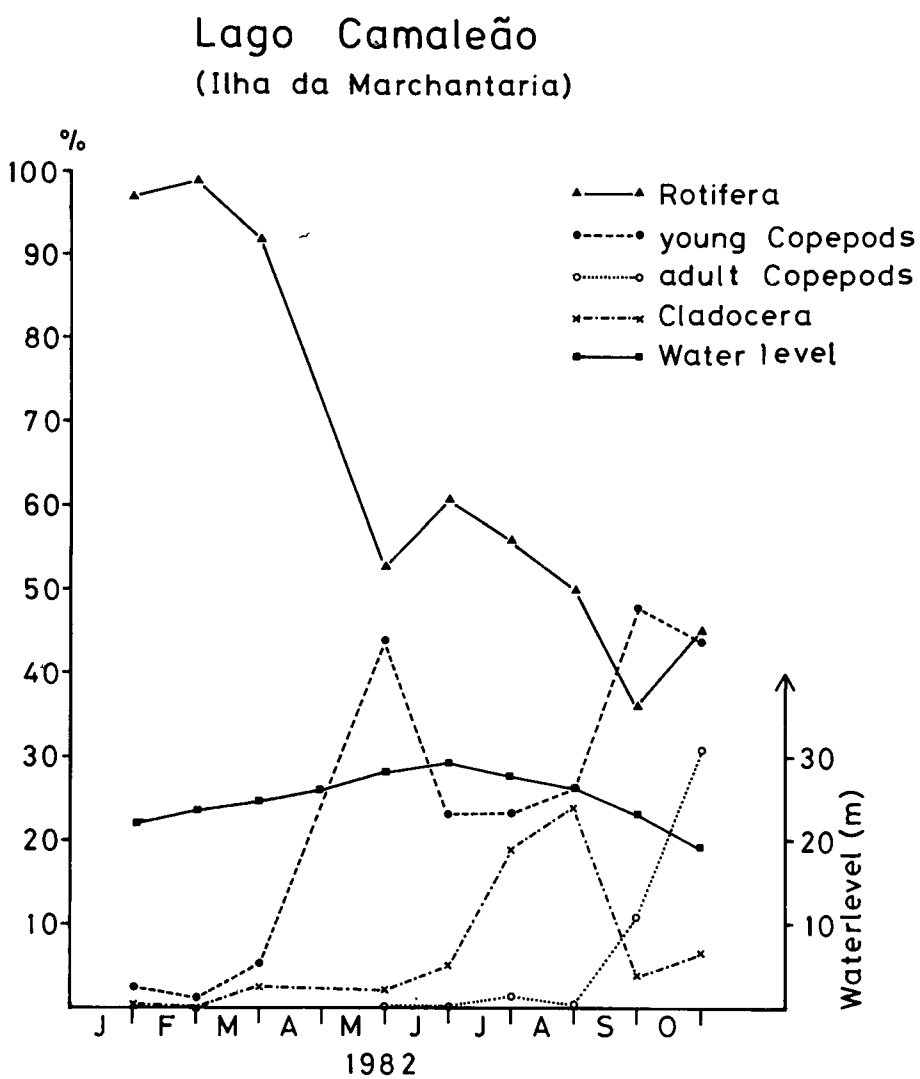

Fig. 4:
Relative abundance of Rotifera and Crustaceans in Lago Camaleão

In summary, one of the striking features of the Lago Camaleão zooplankton is the rich rotifer fauna and the poor crustacean fauna. A similar situation has been recorded by DUNCAN (1983) in Parakrama Samudra, Sri Lanka. DUNCAN, however, attributes the "virtual absence of the crustaceans" to the scarcity of macrophyte refuge in face of heavy young fish predation. This is not the case in Lago Camaleão which actually is a macrophyte dominated environment for the better part of the year. The limited crustacean development in Lago Camaleão can be attributed to the combined effect of poor oxygen conditions and, during extreme floods, strong currents.

Also, the standing-stock development pattern observed in Lago Camaleão is similar to that observed in other várzea lakes (BRANDORFF & ANDRADE 1978; CARVALHO 1981). It appears then that, different from other tropical regions, where "no regular seasonality of any groups of zooplankton is evident" (FERNANDO & RAJAPAKSA 1983) in Amazonian floodplain lakes the zooplankton does exibit marked seasonality.

Summary

Throughout 1981 and 1982 a study of the composition and abundance of the three main groups of zooplankton, Rotifera, Copepoda, and Cladocera, was conducted in Lago Camaleão, an Amazonian floodplain lake. Rotifers are dominant both in terms of species numbers and abundance. Rotifers exibit two standing-stocks peaks during the year. One, during the extreme dry season, and another at the beginning of the rising water period. The species associations of rotifers also reflect the flooding regimes and its consequences. The extremely low standing-stock observed during the high water season is attributed mainly to prevailing poor oxygen conditions during normal floods and current during extreme floods.

Resumo

Durante 1981 e 1982 estudos da composição e abundância dos tres principais grupos de zooplancton, Rotifera, Copepoda e Cladocera foram realizados no Lago Camaleão, um lago de várzea da Amazônia Central. Rotifera é o grupo dominante em número de espécies e abundância. Dois picos de abundância foram observados para os rotíferos: Um maior na estação seca e um menor no início da enchente. As associações de espécies de rotifera refletem o regime de flutuação no nível d'água. A escassez do zooplancton na cheia é atribuído principalmente às baixas concentrações de oxigênio durante uma enchente normal e fortes correntezas durante enchentes extremas.

Acknowledgments

This study is part a project being undertaken under the auspices of the bilateral cooperation between the Instituto Nacional de Pesquisas da Amazônia (INPA) and the Max-Planck-Institute. The authors would like particularly to thank Dr. W. J. Junk for providing the opportunity for the authors to work together in Plön, Germany.

References

BRANDORFF, G.-O. (1977): Untersuchungen zur Populationsdynamik des Crustaceen-planktons im tropischen Lago Castanho (Amazonas, Brasilien).- Doctoral thesis, Kiel, Germany: 108 pp.

BRANDORFF, G.-O & E.R. ANDRADE (1978): The relationship between the water level of the Amazon river and the fate of the zooplankton population in Lago Jacaretinga, a varzea lake in the Central Amazon.- Studies on Neotropical Fauna and Environment **13**: 63 - 70.

CARVALHO, M.L. (1981): Alimentação do tambaqui jovem (*Colossoma macropomum* CUVIER, 1818) e sua relação com a comunidade zooplanctônica do Lago Grande-Manaquiri, Solimões, Am.- Masters thesis, INPA/FUA, Manaus, Amazonas: 90 pp.

DUNCAN, A. (1983): The composition, density, and distribution of the zooplankton in Parakrama Samudra. In: SCHIEMER, F. (ed.) Limnology of Parakrama Samudra-Sri Lanka.- Dr. W. Junk Publishers, The Hague: pp. 85 - 94.

FERNANDO, C.H. & R. RAJAPAKSA (1983): Some remarks on long-term and seasonal changes in the zooplankton of Parakrama Samudra. In: SCHIEMER, F. (ed.) Limnology of Parakrama Samudra-Sri Lanka.- Dr. W. Junk Publishers, The Hague, pp. 77 - 84.

FURCH, K., JUNK, W.J., DIETERICH, J. & N. KOCHERT (1983): Seasonal variation in the major cation (Na, K, Mg, and Ca) content of the water of Lago Camaleão, an Amazonian floodplain lake near Manaus, Brazil.- Amazoniana 8 (1): 75 - 89.

HOLDEN, M.J. & J. GREEN (1960): The hydrology and plankton of the river Sokoto.- J. Anim. Ecol. **29**: 65 - 84.

JUNK, W.J. (1980): Áreas inundáveis – Um desafio para a limnologia.- Acta Amazonica **10** (4): 775 - 795.

JUNK, W.J., SOARES, G.M. & F.M. CARVALHO (1983): Distribution of fish species in a lake of the Amazon river floodplain near Manaus (Lago Camaleão), with special reference to extreme oxygen conditions.- Amazoniana 7 (4): 397 - 431.

KOSTE, W. & B. ROBERTSON (1983): Taxonomical studies of the rotifera (Phylum Aschelminthes) from a Central Amazonian varzea lake, Lago Camaleão (Ilha de Marchantaria, Rio Solimões, Amazonas, Brazil).- Amazoniana 8 (2): 225 - 254.

KOSTE, W., HARDY, E. & B. ROBERTSON (1984): Further taxonomical studies of the Rotifera from Lago Camaleão, a Central Amazonian varzea lake (Ilha de Marchantaria, Rio Solimões, Amazonas Brazil).- Amazoniana 8 (4): 555 - 576.

Authors' addresses:

M. Sc. Elsa R. Hardy
243 St. Leonards Road
Windsor, Berkshire
SL4 3DR
England

M. Sc. Barbara Robertson
Instituto Nacional de Pesquisas da Amazônia
(INPA)
C.p. 478
69.000 Manaus-Amazonas
Brazil

Dr. Walter Koste
Ludwig-Brill-Straße 5
D - 4570 Quakenbrück
F.R.G.

Accepted for publication in October 1984