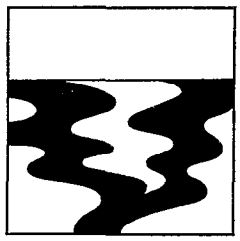

Seasonal fluctuations of Copepod populations in lake Dom Helvécio (Parque Florestal, Rio Doce, Minas Gerais, Brazil)

Takako MATSUMURA-TUNDISI (1), W. Y. OKANO (2)

ABSTRACT

Seven species of Copepoda were recorded from monomictic tropical lake Dom Helvécio (Parque Florestal, Rio Doce, Minas Gerais) during 1978. Of these two species, "Diaptomus" corderoi *and* Thermocyclops minutus *were the most abundant species, dominating the copepod fauna for most of the year.*

The lake shows a thermal and chemical stratifications during most of the year, with a short period of isothermy during winter when a total mixing occurs, causing enrichment in the whole water column. The seasonal variation of the standing-stock of several species of Copepoda is caused by the association of physical and chemical dynamic processes in the lake and competition avoidance mechanisms between species.

KEY WORDS : Lake — Water level — Precipitation — Thermal stratification — Copepoda — Seasonal fluctuations — Brazil.

RÉSUMÉ

FLUCTUATIONS SAISONNIÈRES DES POPULATIONS DE COPÉPODES DANS LE LAC DOM HELVÉCIO (PARQUE FLORESTAL, RIO DOCE, MINAS GERAIS, BRÉSIL)

Sept espèces de Copépodes ont été recensées en 1978 dans le lac Dom Helvécio, tropical et monomictique. Deux espèces, « Diaptomus » corderoi *et* Thermocyclops minutus, *étaient plus particulièrement abondantes tout au long de l'année.*

Le lac présente une stratification thermique et chimique la plus grande partie de l'année, avec une courte période d'isothermie durant l'hiver au cours de laquelle il y a mélange des eaux et enrichissement de toute la colonne d'eau. Les variations saisonnières de biomasse de plusieurs espèces de Copépodes sont la conséquence de la dynamique des facteurs physico-chimiques et des mécanismes de compétition interspécifiques.

saisonnières — Brésil.

INTRODUCTION

Lake Dom Helvécio is one of a series of natural lakes located in Minas Gerais State between parallels 19°45′ S to 19°50′ S latitude and 42°35′ W to 42°40′ W longitude at an altitude of 300 m (River Doce Valley Lake System). According to PFLUG (1969) these lakes were formed during the quaternary period in the middle course of the Rio Doce by the damming of small valleys. The damming itself was caused by elevation of the river bed through the deposition of an accumulation terrace. At present

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the lakes are situated about 20 m above the river and some are surrounded by dense tropical rainforest (Mata Atlantica type).

Previous work carried out in Lake Dom Helvécio (Tundisi *et al.*, 1978) has revealed a thermal stratification during most of the year, and the total mixing during the winter.

The purpose of this paper is to describe and discuss the fluctuation in density of copepod populations between January and November 1978, in relation to the pattern of thermal stratification.

As the seasonal cycle of environmental factors in the lake studied is characterized by a long period of strong stratification (November to March) and a short period of weak instability (June-July) it was considered that collections every two months were sufficient to follow the seasonal cycle of zooplankton communities.

MATERIAL AND METHODS

Lake Dom Helvécio, is one of the biggest and deepest lake of the River Doce Valley Lake System. It has a dendrictic shape (fig. 1) and the following morphometric charasteristics:

Surface area : 6.8 km².
Volume : 831×10^5 m³.
Perimeter : 45.0 km.
Mean depth : 12.0 m.
Maximum depth : 31.0 m.
Altitude : 300.0 m.

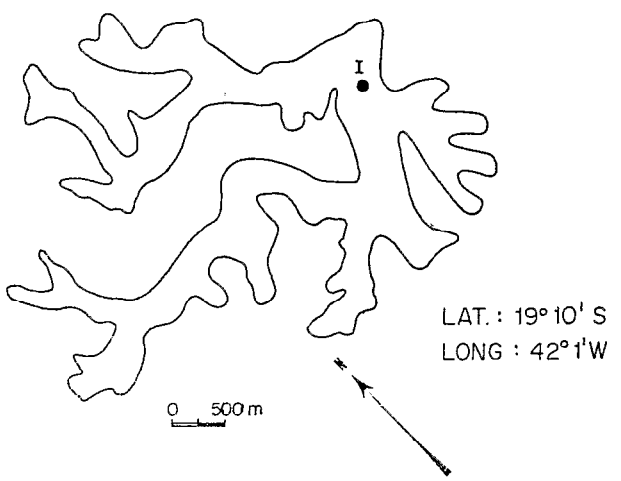

FIG. 1. — Map of Lake Dom Helvecio showing the shape and location of the sampling station.

Zooplankton sampling was made at one fixed station in the deepest point of the lake, at bimonthly intervals from surface to bottom. A suction pump was used to collect material every five meters. From each depth about 200 liters of water were filtered through a 68 μm plankton net. The material was preserved in 4 % formalin and analyzed in the laboratory under a stereomicroscope of 100 X magnification. When densities of organisms in the total samples were more than 1 000, we sub-sampled the material before counting.

The density of the copepod population, separated into adults and nauplii stages, was calculated by summing all the data which were obtained from the different depths each month.

Environmental variables such as temperature and oxygen were taken simultaneously with zooplankton sampling.

Temperature was measured with a thermistor (Dentam), and the dissolved oxygen concentration was determined by Winkler titration.

RESULTS

Temperature

The temperature measured during 1978 showed a similar pattern to that obtained in earlier years (TUNDISI *et al.*, 1978) with a stratification from September till May (Fig. 2). The thermocline,

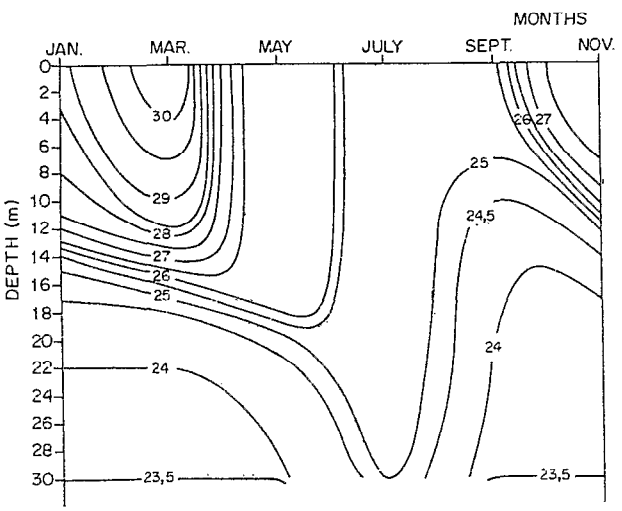

FIG. 2. — Isoclines of temperatures (°C) at Lake Dom Helvecio obtained during 1978.

located between 11.0 to 15.0 meters in January, decreases in the subsequent months to between 17.0 and 21.0 meters in May. In November the thermocline was located betwwen 6.0 and 11.0 meters.

In winter (June, July, August) a total mixing occurred in the lake, establishing isothermy in the water column and this is due to a gradual surface

cooling rather than to wind action (TUNDISI & MATSUMURA-TUNDISI, 1980).

The range in temperatures in the water column at the warmest period was from 30.0 °C on the surface to 25.0 °C at the bottom.

Oxygen

The vertical distribution of dissolved oxygen during the year showed a very close relation with the thermocline. As can be seen in fig. 3, no oxygen occurred below the thermocline during stratification. The surface oxygen value in this period was about 8.0 mg.l^{-1}. At the thermocline layer it was reduced till 2.0 mg.l^{-1} with a total anoxia in the hypolimnion. In the short period of circulation the concentration of dissolved oxygen was about 7.0 mg.l^{-1} over the whole water column.

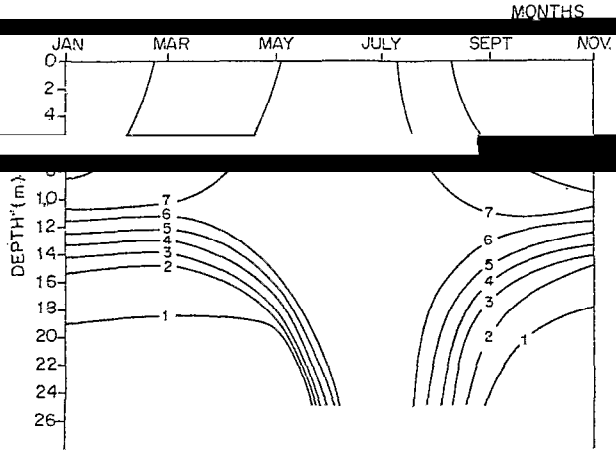

FIG. 3. — Isoclines of dissolved oxygen (mg.l^{-1}) at the Lake Dom Helvecio obtained during 1978.

Copepod fauna

The copepod fauna of lake Dom Helvécio is composed of seven species, two of which belong to the Calanoïda: *Argyrodiaptomus furcatus* (Sars) and *"Diaptomus" corderoi* Wright. *"Diaptomus" corderoi* was much more abundant than *Argyrodiaptomus furcatus*. Three species belong to the Cyclopoïda: *Thermocyclops minutus* (Lowndes), *Tropocyclops prasinus meridionalis* Kiefer, *Mesocyclops longisetus* (Thiebaud), and from these species *T. minutus* was the most abundant species. One Harpacticoïd *Atheyella sp* and one parasitic copepod *Ergasilus sp* were also found.

This environment shows a dominance of Cyclopoïda over Calanoïda considering adult and nauplii

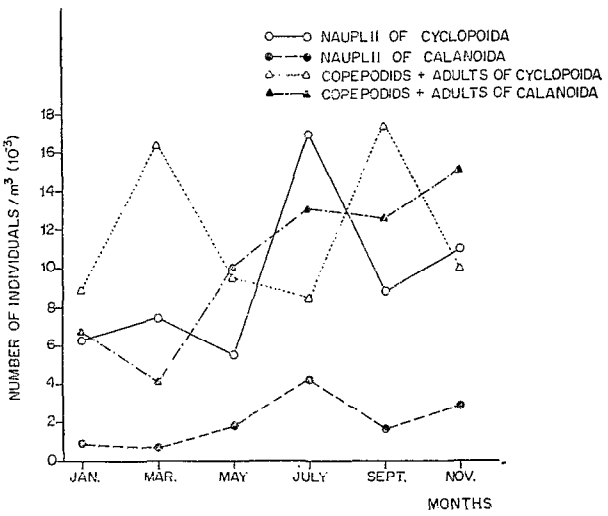

FIG. 4. — Seasonal variation in the density of calanoids and cyclopoids in the stages of nauplii and copepodids+adults at Lake Dom Helvecio (MG) during 1978.

forms. Only in July the density of adult Calanoïda [illegible] in July, indicating that this was probably the main period breeding. Calanoïd nauplii showed also a slight increase in numbers at this time. However, they occurred in much lower density, and were always less numerous than their adults.

Fig. 5 shows the seasonal fluctuation of four species of copepods. Two of them *"Diaptomus" corderoi* (Calanoïda) and *Thermocyclops minutus* (Cyclopoïda) showed their fluctuations associated with the overturn period i.e. the occurrence of high density after mixing of water column (July). *Tropocyclops prasinus* was abundant only in March staying with a low density in the other months. *Argyrodiaptomus furcatus* remained at low density around the year.

DISCUSSION

It has been pointed out by some authors working in tropical and subtropical regions that rainfall is one of the main controlling factors of seasonal fluctuations in the standing-stock of the zooplankton. This direct influence of rainfall has been observed by BURGIS (1969) in Lake George and by MATSUMURA-TUNDISI (1976), ROCHA *et al.* (in press) in "Broa" reservoir (Brazil). In the natural lakes of Brazil, this effect depends on the hydrographic system considered. In Amazon River Lakes, high numbers of the zooplankton are related to low water levels of the river

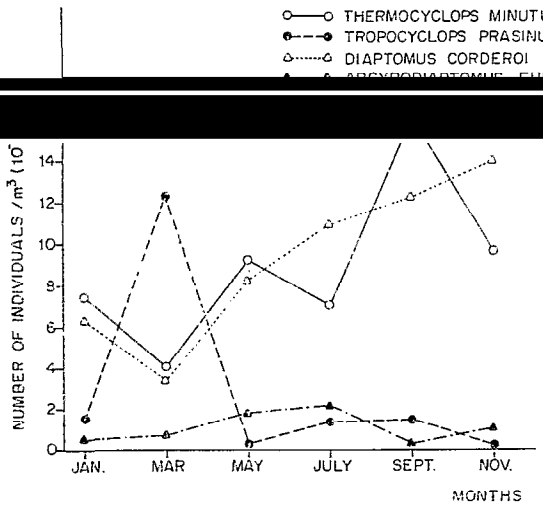

FIG. 5. — Seasonal fluctuation patterns of the main species of copepods from Lake Dom Helvecio during 1978.

[redacted] and the lakes. This coincides with periods of high rainfall (PRATEGEE & ANDRADE, 1979). However [redacted] dance of zooplankton during low water, but this water, when the lakes are enriched with the material in decomposition introduced during high water.

In lake Dom Helvécio, probably because of its location in a relatively deep valley unconnected to rivers, it seems that precipitation does not exercise any direct role on the numerical fluctuation of copepod populations. In this system the overturn caused by decreasing air temperatures is responsible for the enrichment of the system, and consequently, a higher production of phytoplankton and zooplankton [redacted] occurs often that period. Consequently for [redacted] fluctuations are not similar. This fact is likely due to factors like competition and predation. Many workers (POULET, 1978; PENNAK, 1957; SANDERCOCK, 1967; MATSUMURA-TUNDISI & HARDY, in press) have reported that zooplankton species have several mechanisms to avoid inter-specific competition, as to exploit the food resource of the environment most efficiently.

The Cyclopoïda species from lake Dom Helvécio like *Thermocyclops minutus* and *Tropocyclops prasinus* have a peak of abundance in different periods of the year, suggesting that their reproduction occur at different times. Between Calanoïda species [redacted] is a smaller species, and occurs in greater number than *A. furcatus*. PENNAK (1957) state that when two species closely related are found together in the same environment one of them is almost always much more abundant than the other and according HUTCHINSON (1951) a size difference between two species of copepods in the same genus implicate in a different selectivity of food and therefore less inter-specific competition might be inferred. The ability of one species to succeed more than another one in the environment depends of its ecological requirements like temperature, alkalinity, water chemistry and food conditions. Therefore it is possible that one or several of these conditions are implied in the difference found between the abundance of these two species. This will be object of further research.

[redacted] is clear that the adults are more abundant during [redacted] than cyclopoïda. One of the possibilities to explain this fact is the predation of nauplii by other in- [redacted] density observed in the sediments of the lake D. Helvécio (FUKUHARA & HINO, unpublished data) showed an increasing of its density from littoral to limnetic region. And as is common in many species of Diaptomidae reproduction, may occur in the littoral (ROCHA *et al.*, in press), the nauplii produced in this region probably are safe from predation and thus the stock of the Calanoïda population are maintained in the lake.

Higher density of Cyclopoïda nauplii rather than Calanoïda could be due to the spatial segregation [redacted] vertical migration, the nauplii of Calanoïda distribute between 0-10 meters while the nauplii of Cyclopoïda distribute in the lower layer between 5-15 meters becoming probably less susceptible to be predated by *Chaoborus*, which comes up to the surface at the night to feed.

Manuscrit reçu au Service des Éditions de l'O.R.S.T.O.M. le 20 octobre 1982

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