ASPECTS OF THE ECOLOGY OF THE CRUSTACEAN ZOOPLANKTON IN THE SANYATI BASIN, LAKE KARIBA

LAKE KARIBA FISHERIES RESEARCH INSTITUTE

PROJECT REPORT NO. 35

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JUNE 1980

DEPARTMENT OF NATIONAL PARKS AND WILDLIFE MANAGEMENT

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INTRODUCTION

Since its introduction into Lake Kariba in 1967, the Lake tanganyika clupeid Limnothrissa miodon (Boulenger) has become the most important commercial species in the Lake (Marshall and Langerman 1979 : Marshall 1979). It occupies the open waters of the Lake and feeds principally on the crustacean zooplankton, of which Bosmina longirostris (O.F. Muller) and Mesocyclops leuckarti (Claus) are the most important (Begg 1974 a : Cochrane 1978). These two species make up over 80% of their diet whilst others such as Ceriodaphnia dubia Sars and Diaphanosoma excisum Sars make up most of the remainder. This report deals almost entirely with Bosmina and Mesocyclops as the other species were rare, and is part of a broader programme investigating components of the sardine food chain and factors affecting their productivity.

Previous work on zooplankton in Kariba has been centred on the Mwenda river estuary and the Sanyati basin. Bowmaker (1973) and Mills (1977) produced general surveys of plankton in the Mwenda area, whilst more detailed studies there have dealt with jellyfish (Mills 1973) and Chaoborus (Mitchell 1974 : Mills 1976). The abundance of zooplankton in relation to thermal stratification in the Sanyati basin was described by Begg (1974 b) who also investigated the relationship between the diurnal movements of zooplankton and Limnothrissa (Begg 1976). Cochrane (1978) also studied zooplankton in relation to sardines in the Sanyati basin.

METHODS

The programme was carried out in the Sanyati basin (Fig. 1) and two main investigations took place. In the first a weekly sample was taken at the sampling station nearest Kariba dam wall (Fig. 1). The sample was integrated from subsamples taken at 5m depth intervals in order to give an indication of the total zooplankton abundance and to overcome the effects of diurnal movements. The samples for each month were combined to give mean monthly abundance and the programme lasted from January - December 1979.

The second part of the programme was an attempt to assess the horizontal distribution of the zooplankton and the effects on them of the tributary rivers. Integrated samples from the whole water column were taken from 15 stations (Fig. 1) at four different times. The first was in August 1979 when the lake was isothermal whilst river flows were low, whereas in February 1980 river flows had increased slightly. The last samples were taken in April 1980 when the tributary rivers were flooding strongly after a prolonged period of heavy rain.

Zooplankton samples were taken with a 25mm diameter hose attached to an electric pump with an approximate pumping rate of 8l min^{-1}. The hose was lowered to a maximum of 60m and samples were taken at every 5m to the surface. Fewer samples were taken at shallow stations but the total quantity of water sampled was never less than 75l. The water was pumped into a vertical column and passed through a bolting silk screen of 7,8 meshes mm^{-1} (64mm between parallel threads). The screen was removed after sampling and stored in 10% formalin.

In the laboratory the screens were washed and the sample reduced to 10 or 15ml. Counts were made in a 1ml Sedgewick - Rafter cell and numbers were converted to no. $m^{-3} \times 10^3$ and expressed as such throughout this report.

RESULTS

Zooplankton abundance was principally influenced by the thermal regime of the lake and by the inflowing rivers (Fig. 2). Rainfall from five stations in the Sanyati catchment was used as an index of river flow as flow data were not available. Surface and bottom temperatures are shown to indicate turnover which occurred from June - September.

Bosmina numbers were particularly influenced by turnover and they were most abundant during the period June - August when the water was coldest. Phytoplankton numbers also increased during this period (I.H. Beattie, pers. comm.) following nutrient release from the hypolimnion and both *Bosmina* and *Mesocyclops* responded to this. *Mesocyclops* also showed a peak in the rainy season which was probably caused by nutrients brought in by the inflowing rivers. The water was very much warmer during this period and this may be the reason why *Bosmina* numbers showed no increase.

Nauplii were abundant in the latter part of the rainy season (January - March) but in the winter and early rains (October - December) the post-nauplii were more numerous. This may be a result of predation pressure from *Limnothrissa* which increased steadily from January - August (Fig. 3). From August - December sardine numbers in the open water decreased and predation on the zooplankton was reduced. This probably enhances the survival of the post-nauplii stages of *Mesocyclops*.

Few other crustacean zooplankton were found and in all cases their populations were very low (usually $< 25m^{-3}$). In January a few *Diaphanosoma* were recorded, and a small unidentified cladoceran occurred in March, May, June and July.

The horizontal distribution of *Bosmina* and *Mesocyclops* is shown in Figs. 4 - 6. The only period in which *Bosmina* was abundant was in August and their numbers were lowest in February (Fig. 4). They were generally most common in the river mouths, particularly the Naodza, Sanyati and Gache Gache, and least common in the shallow areas east and west of the Sanyati and in the area between Antelope Island and the mainland.

Mesocyclops nauplii were most abundant in the eastern part of the basin in August and November but these areas were less productive in February and April (Fig. 5). The central and south western areas of the basin became more important during these periods. Thus in August the greatest density was in the Gache Gache bay in shallow water, but by April they were more numerous in the deep water north of the Sanyati mouth.

The post-naupliar stages of Mesocyclops were usually commonest in deeper water (Fig. 6). In August, November and February numbers were highest in the centre of the basin from the Sanyati mouth to the dam wall area and in the Naodza - Gache Gache area. In April, however, the southern half of the basin was generally unproductive except off the Sanyati. Centres of high density occurred in open water south of the dam wall and in the Naodza estuary whilst the shallow water in the Antelope Island - Charara mouth area was unproductive.

Once again few other species were recorded in this programme. In August some Diaphanosoma were found to the west of the Naodza ($1872m^{-3}$) whilst a small population of Daphnia ($89m^{-3}$) occurred in Gache Gache bay. In November some Diaphanosoma were recorded at the Charara river mouth but in February no other species were taken. Small populations of Diaphanosoma were recorded at three stations in April and they were most abundant at the Sanyati mouth ($1370m^{-3}$).

DISCUSSION

The basic seasonal pattern found in this study is similar to that noted by Begg (1974 b) and Cochrane (1978). Both workers found that Bosmina were most abundant in the winter months from June to August, but there was some variation in Mesocyclops abundance. Begg found that both nauplii and post-nauplii were abundant during the latter part of the 1970/71 rainy season (January - March 1971). There was, however, no increase in the early part of the 1971/72 rainy season. Cochrane recorded the rainy season peak for Mesocyclops but found no large increase in numbers in winter.

The horizontal distribution showed no definite patterns although there was a tendency for zooplankton to be more abundant in the riverine areas. This is similar to the pattern shown in the Mwenda estuary (Bowmaker 1973 : Mills 1977). In general the eastern portion of the basin appeared to be most productive but the reasons for this are not clear. It may be that the nutrient levels in rivers such as Charara, Naodza and Gache Gache are high or else this is an effect of currents and wind patterns.

The relationship between the zooplankton and Limnothrissa is of interest. Sardine catches follow the cycle of plankton abundance to some degree in that they are highest soon after overturn. However, they are low during the rainy season when Mesocyclops is most numerous and this appears to be related to the breeding cycle of the fish. Cochrane (1978) showed that they breed from September to February in shallow marginal areas and that there is a migration into deeper waters as they grow in size. This accounts for the steadily increasing catches from January to August. Mature fish (i.e. approx 1 yr. old) are thus in the open waters at overturn and are able to take advantage of the plankton increase that occurs. Following this there is a period of food stress when there is apparently considerable mortality amongst the fish. However, there must also be a migration back to shallow water to breed and these two factors account for the drop in catch that occurs at this time.

Some evidence of the impact of predation on the zooplankton is available. Data from the open water station at the Mwenda estuary, collected in 1967/68 before the sardine had become established, are given by Bowmaker (1973). He found that the zooplankton was dominated by larger animals, principally Ceriodaphnia (26%), Diaptomids (24%), and Diaphanosoma (12%), The post-nauplier stages of Mesocyclops made up 19% of the total whilst nauplii and Bosmina were only 11% and 5% respectively.

By contrast this study found that Ceriodaphnia, Diaphansoma and the diaptomids had been almost completely eliminated. Bosmina and nauplii now made up 38% and 32% of the total plankton respectively. Size selective predation on zooplankton by fish has been shown to eliminate the larger crustacea (Brooks and Dodson 1965) and Limnothrissa appears to have had this effect in Lake Kariba.

Quantitative changes are less easy to detect as Bowmaker's data are expressed as dry weight and he gives no indication of numbers. No figures exist for Kariba to enable the present data to be converted to dry weight. However, the biomass of zooplankton is likely to be the same although mortality and production rates may be considerably higher.

ACKNOWLEDGEMENTS

Mark Collinge, Peter Jokonya, Charles Makoni and the crew of "Pelican" assisted with field sampling, whilst Mark Collinge and Peter Jokonya also undertook a large proportion of the counting required.

REFERENCES

Begg, G.W. (1974 b) Investigations into the biology and status of the Tanganyika sardine Limnothrissa miodon (Boulenger) in Lake Kariba. Lake Kariba Fisheries Research Institute Proj. Rept. 19 : 1-151 (cyclostyled).

Begg, G.W. (1974 b) The influence of thermal and oxygen stratification on the vertical distribution of plankton at the mouth of Sanyati gorge, Lake Kariba. Kariba Studies (4) : 60-67.

Begg, G.W. (1976) The relationship between the diurnal movements of some of the zooplankton and the sardine Limnothrissa miodon in Lake Kariba. Limnol. Oceanogr. 21 : 529-539.

Bowmaker, A.P. (1973) An hydrobiological study of the Mwenda river and its mouth. Ph.D. thesis, University of Witwatersrand.

Brooks, J.L. & Dodson, S.I. (1965) Predation, body size and composition of plankton. Science 150 : 28-35.

Cochrane, K.L. (1978) Seasonal fluctuations in the catches of Limnothrissa miodon (Boulenger) in Lake Kariba. Lake Kariba Fisheries Research Institute, Proj. Rept. 29 : 1-163 (cyclostyled).

Marshall, B.E. (1979) Fish populations and the fisheries potential of Lake Kariba, S. Afr. J. Sci. 75 : 485-488.

Marshall, B.E. & Langerman, J.D. (1979) The Tanganyika sardine in Lake Kariba, Rhod. Sci. News 13 : 104-105.

Mills, M.L. (1973) The "explosive" occurrence of the freshwater medusa Limnocnida tanganyicae Gunter in Lake Kariba during 1972. Arnoldia, Rhod. 6 (14) : 1-8.

Mills, M.L. (1976) The Chaoborus (Diptera : Chaoboridae) component of the invertebrate drift of the Mwenda river, Lake Kariba, Central Africa. Hydrobiologia 48 : 247-250.

Mills, M.L. (1977) A preliminary report on the planktonic micro-crustacea of the Mwenda bay area, Lake Kariba. Trans. Rhod. Sci. Ass. 58 : 28-37.

Mitchell, S.A. (1975) The biology of central African Chaoboridae and their distribution over selected areas of Lake Kariba. M.Phil. thesis, University of London.

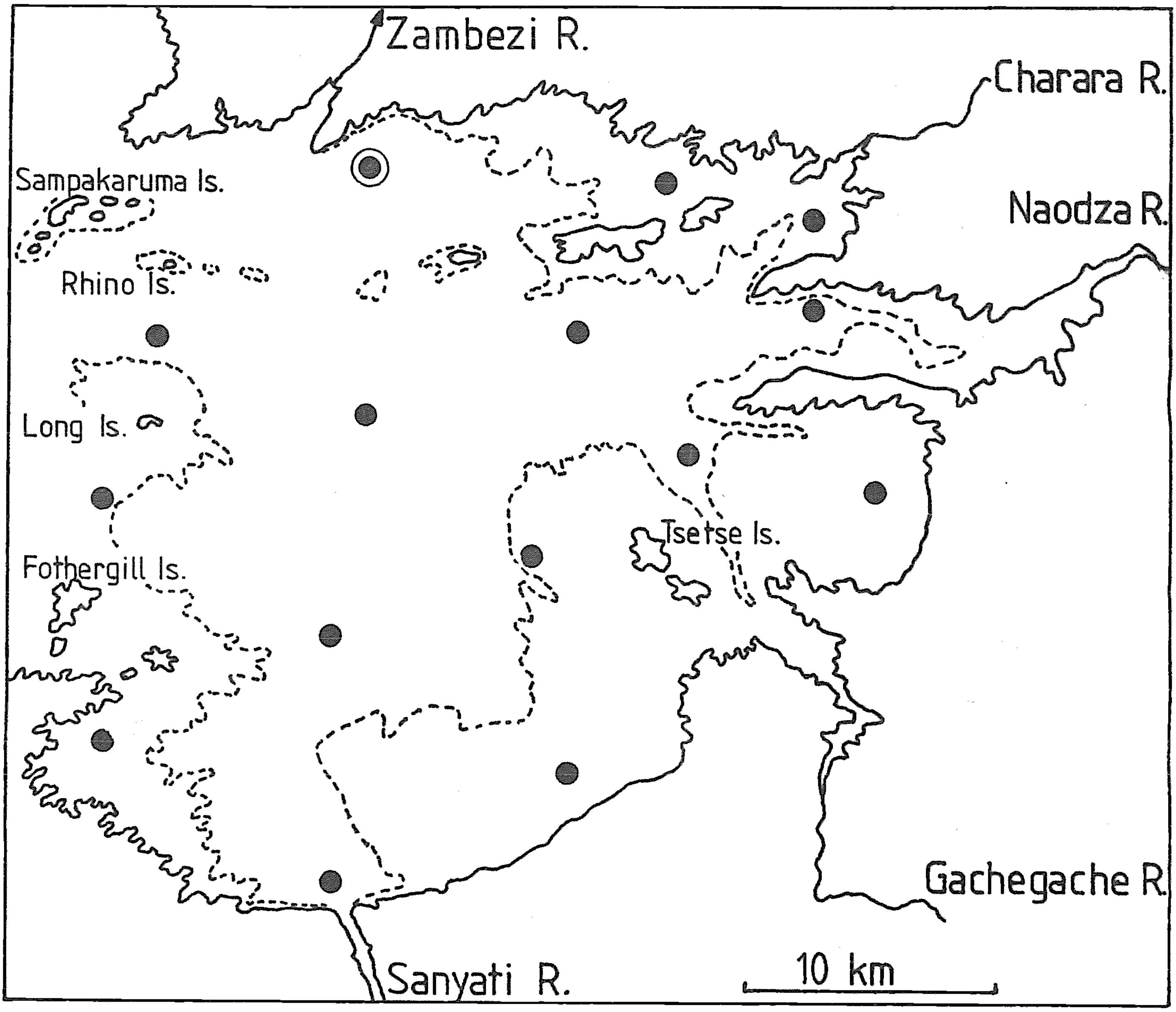

Fig. 1 : Main features of the Sanyati Basin, Lake Kariba. The western boundary of the basin is Fothergill Is. - Long Is. - Rhino Is. - Sampakaruma Is. The broken line is the approximate 20m depth contour and the 15 sampling stations are shown thus ● . The weekly sampling station is shown thus ◉

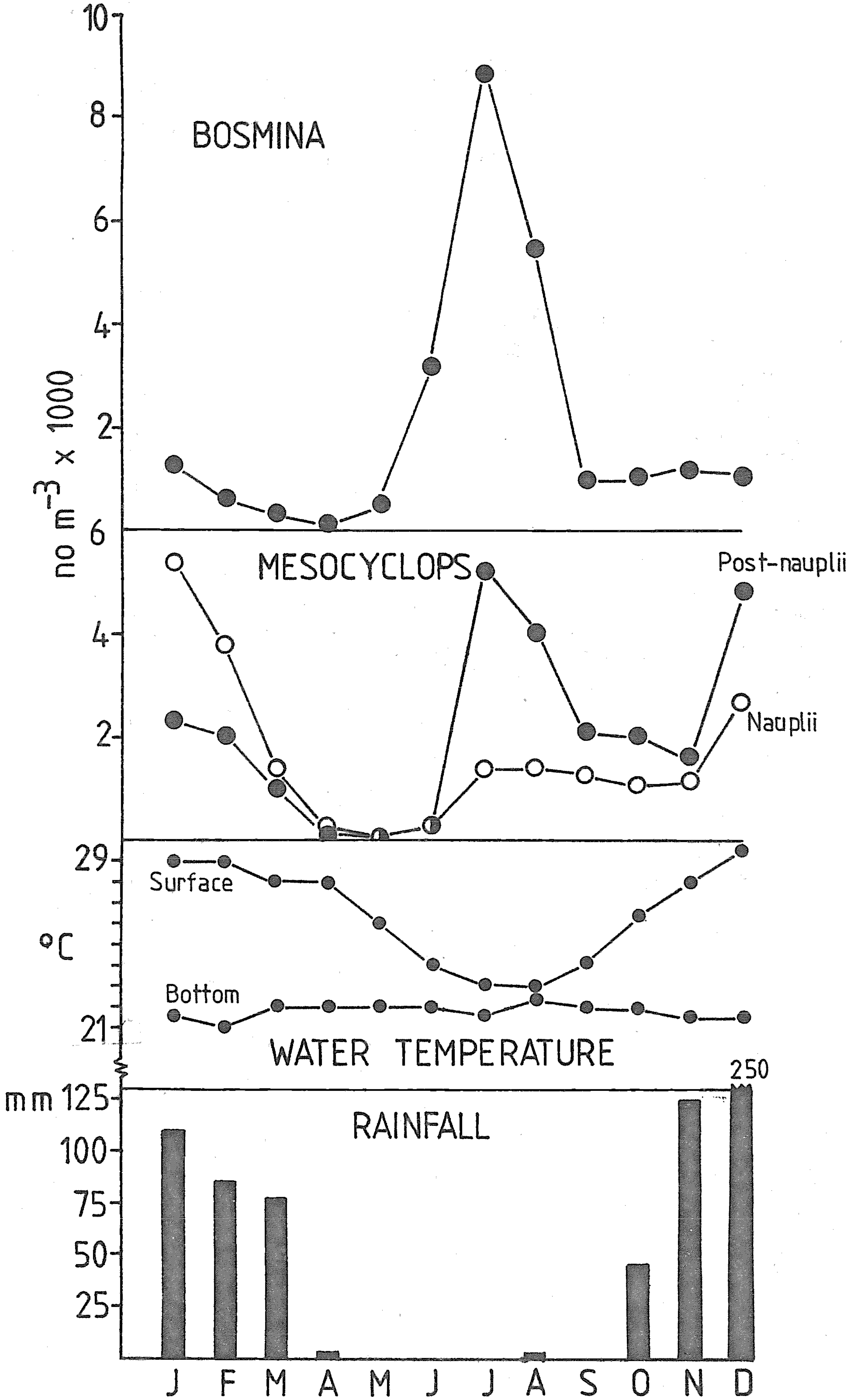

Fig. 2 : The abundance of Bosmina and Mesocyclops in relation to water temperature and rainfall in 1979.

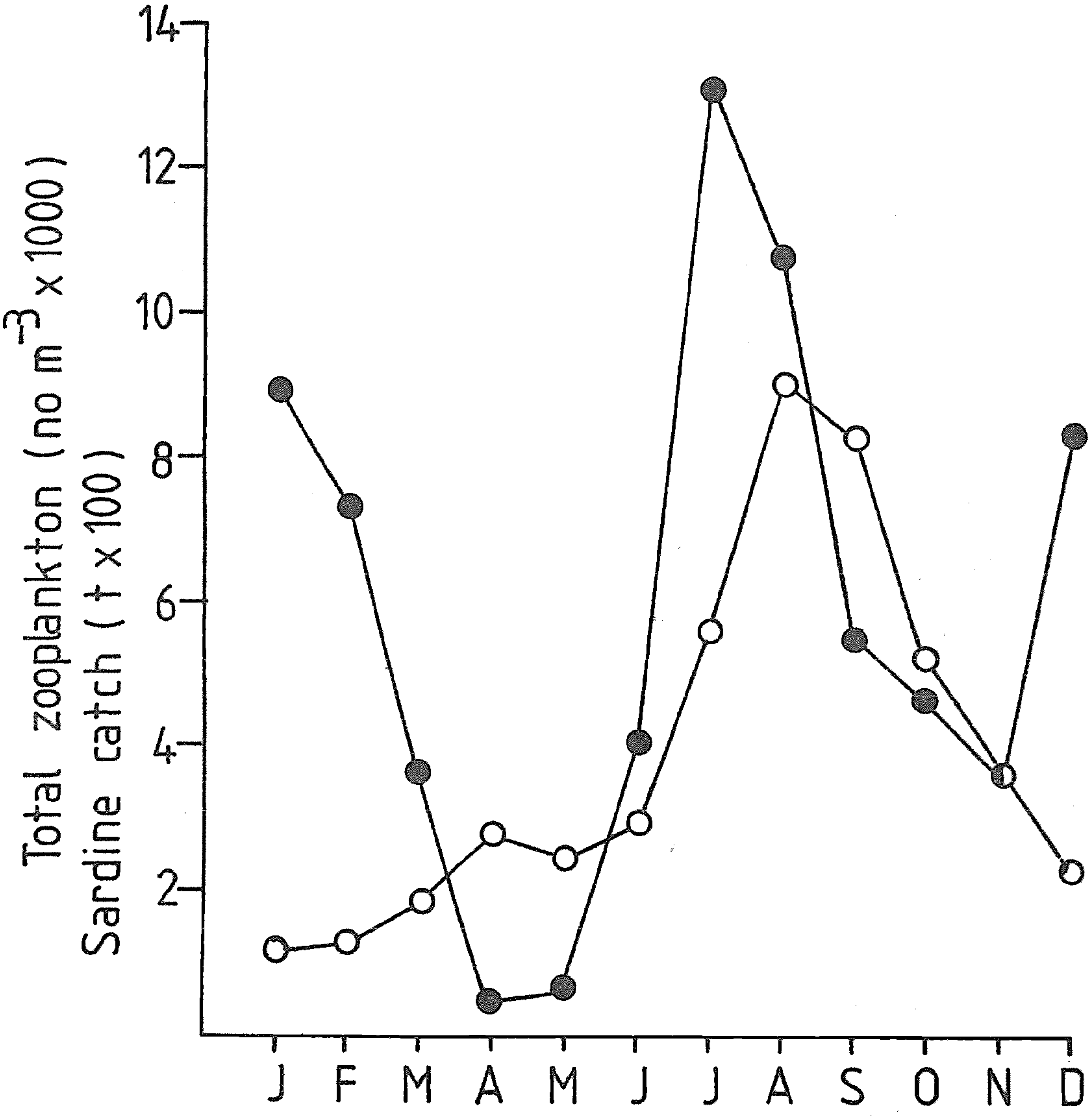

Fig. 3 : The relationship between sardine catches and zooplankton abundance in 1979 ●, zooplankton abundance ○, sardine catches.

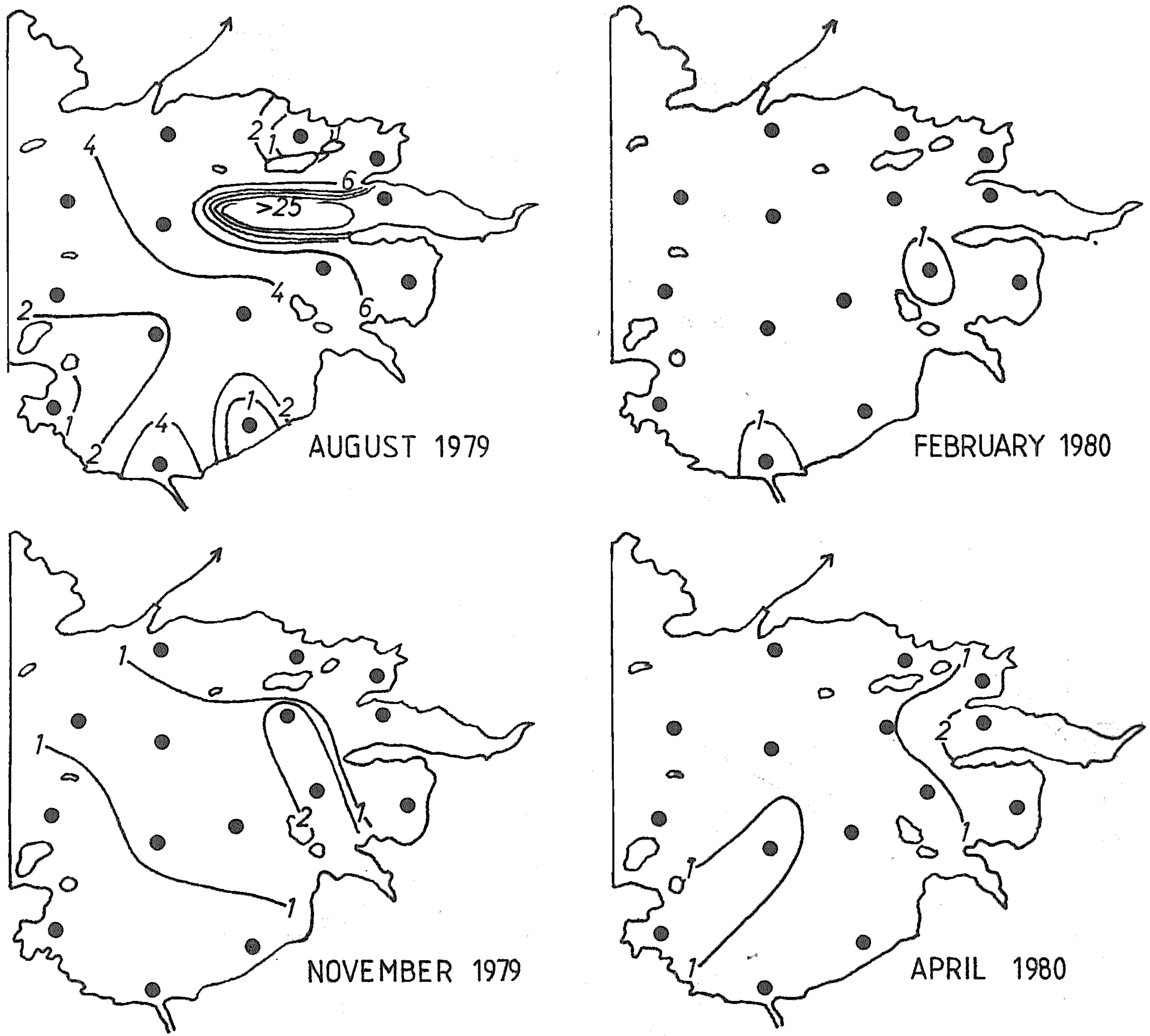

Fig. 4 : The horizontal distribution of Bosmina in the Sanyati basin.