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ZOOPLANKTON ECOLOGY OF LAKE TANGANYIKA REPORT ON THE RESULTS OF LTR'S SCIENTIFIC SAMPLING PROGRAMME JULY 1993 - JULY 1994

by
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PREFACE

The Research for the Management of the Fisheries on Lake Tanganyika project (Lake Tanganyika Research) became fully operational in January 1992. It is executed by the Food and Agriculture Organization of the United Nations (FAO) and funded by the Finnish International Development Agency (FINNIDA) and the Arab Gulf Programme for United Nations Development Organizations (AGFUND).

This project aims at the determination of the biological basis for fish production on Lake Tanganyika, in order to permit the formulation 0f a coherent lake—wide fisheries management policy for the four riparian States (Burundi, Tanzania, Zaïre and Zambia).

Particular attention will be also given to the reinforcement of the skills and physical facilities of the fisheries research units in all four beneficiary countries as well as to the build— up of effective coordination mechanisms to ensure full collaboration between tha Governments concerned.

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1. INTRODUCTION

Lake Tanganyika has been described as an oligotrophic lake due to its high transparency, which can sometimes be up to 23.5m (measured off Kigoma on 28.6.1994). The standing crop of algae is low (Hecky and Kling, 1981) but algal growth rates and levels of primary production are extremely high (Hecky and Fee, 1981). Furthermore, the transfer efficiency from primary producers to zooplankton is efficient at approximately 17% (Hecky and Fee, 1981; Burgis, 1984). Thus, pelagic zooplankton forms a central role in the lake ecosystem transferring the energy from primary producers to the pelagic clupeids (*Stolothrissa tanganyicae* and *Limnothrissa miodon*) and juveniles of *Lates stappersii*.

The current sampling scheme aims at studying the seasonal and spatial variations in the abundance and diversity of the pelagic zooplankton community. The objective is to determine predator-prey relationships, seasonal and spatial dynamics and ecological interactions between trophic stages together with the information from other subcomponents of the Scientific Sampling Programme (hereafter SSP). The ultimate aim is to quantitatively describe the biological basis of fish production in the lake and, on that basis, to prepare a lake-wide fisheries management plan.

In this report, the differences in zooplankton composition and seasonal changes in zooplankton in the northern part (Bujumbura and Kigoma) and in the southern part (Kipili and Mpulungu) of the lake are presented and discussed. Diel vertical distribution and migration patterns at the sampling localities are also described. A brief summary of annual abundance changes of macrozooplankton is presented.

2. MATERIAL AND METHODS

The sampling schedule consisted of two parts:

1) <u>Regular weekly sampling</u> in the pelagic zone including a vertical tow from 100 meters depth to the surface in daytime using a plankton net of 100 µm mesh size and 25 cm opening.

2) <u>Six-weekly intensive sampling</u> including four series of samples during a 24-hour cycle starting at 12 hrs (in Kigoma 13 hrs) and ending the next morning at 6 hrs (in Kigoma 7 hrs). Samples were taken from certain depths, brought to the surface and sieved with a 50 µm plankton net.

The methods used are described in detail in Kurki (1993), Vuorinen (1993) and Vuorinen and Kurki (1994).

The sampling sites were selected to represent the pelagic area where the depth for regular weekly sampling was at least 120 m and for 24-hour sampling at least 320 m. In Table 1, the distances from the shore and the maximum depth at each sampling point are given.

<u>Table 1</u> : Distance from the shore and the maximum depth at the sampling site on lake Tanganyika

	regular sampling		24 hours sampling	
Station	**km**	**depth/m**	**km**	**depth/m**
Bujumbura	**5.5**	**120**	**9.0**	**>300**
Kigoma	**2.5**	**250-500**	**4.0**	**250-500**
Mpulungu	**6.5**	**120**	**4.0**	**320**
Kipili	**5.0**	**>100**	**-**	**-**

The overall number of zooplankton samples collected at each station is presented in Table 2.

<u>Table 2</u>: The number of zooplankton samples collected at each station during the first year of SSP

Station	**regular sampling**	**24 hours cycle**
Bujumbura	**28**	**260**
Kigoma	**40**	**288**
Kipili	**37**	**-**
Mpulungu	**38**	**312**

In Figure 1, the sampling sites in Bujumbura, Kigoma, Kipili and Mpulungu are presented. The letter A stands for regular sampling and letter B for 24-hour cycle.

A non-parametric Mann-Whitney U-test was run to test the differences in numbers of *Tropodiaptomus simplex* and Cyclopoida at different sampling localities using the data of the first year of SSP. The density differences between seasons were equally tested with the Mann-Whitney U-test. All the data collected during the first year of SSP was used for testing (Mann-Whitney U-test) the differences in abundances of the pelagic Copepoda between the four stations.

3. RESULTS

3.1 <u>Pelagic zooplankton composition</u>

The pelagic zooplankton was dominated by crustacean copepod *Tropodiaptomus simplex* (Diaptomidae) and Cyclopidae. Minor constituents of the pelagic zooplankton were medusae (*Limnocnida tanganyicae*), Atyidae shrimps, fish larvae and *Vorticella spp.*

In the northern end, including both Bujumbura and Kigoma waters, the pelagic zooplankton was dominated by the Cyclopoid copepods, which formed in Bujumbura 60% and in Kigoma 69% of the total number of the zooplankton during the observation period (Figures 2a and b). In the south end off Mpulungu both Cyclopoids and *Tropodiaptomus simplex* were found in equal numbers (Figure 2d). In Kipili station Cyclopoids were slightly dominating the pelagic zooplankton with the share of 57% of the total number (Figure 2c).

The Atyidae shrimps were caught regularly though their number remained low. In the southern part proportion of shrimps in the pelagic zooplankton seemed to increase with the greatest numbers in Kipili waters (Figure 2c).

According the first year results the pelagic mesozooplankton showed some variation in number between the seasons in the northern end. *Tropodiaptomus simplex* had increased abundance level during July-November compared to the season of maximum stability (December-May) in Bujumbura waters. In Kigoma area both *Tropodiaptomus simplex* and Cyclopidae had higher densitities during September - May than during June - August (Figures 4b and c). In the south basin (Kipili and Mpulungu) no change in the number between the seasons could be observed when the data was tested with the Mann-Whitney U-test of equal means (Figures 5b, c and 6b, c).

When all the data of the first sampling year was pooled together the northern part of the lake showed the highest densities of the pelagic mesozooplankton while in the south end in Mpulungu the lowest numbers were recorded (Figure 7).

3.1.1 Bujumbura waters

Cyclopidae Copepoda dominated the zooplankton in Bujumbura waters when expressed as number per m^3 ($p<0.001$) (Table 3). During the observation period, Cyclopidae formed 60% (nauplii 12%, copepodids and adults 48%) of the total pelagic zooplankton and 32% of the zooplankton consisted of *Tropodiaptomus simplex* (nauplii 13%, copepodids and adults 19%). *Limnocnida tanganyicae*, protozoan *Vorticella spp.* and other unspecified and unidentified plankters were minor constituents of the pelagic zooplankton (Figure 2a).

3.1.2 Kigoma waters

Similarly to Bujumbura, Cyclopidae formed the major part of the pelagic zooplankton in Kigoma accounting for 69% (nauplii 12%, copepodids and adults 57%) of the total zooplankton number. *Tropodiaptomus simplex* had a share of 31% (nauplii 19%, copepodids and adults 12%) of the total number of individuals (Figure 2b). The number of *Limnocnida tanganyicae* never exceeded 120 individuals per m^3 and the number of shrimps was less than 25 individuals per m^3 throughout the observation period (Figures 9a and b). Fish larvae were counted occasionally in the samples but never exceeded one individual per m^3.

3.1.3 Kipili waters

The zooplankton sampling programme started in November 1993 in Kipili substation, thus the data do not cover the whole year.

The number of Cyclopidae and *Tropodiaptomus simplex* was different ($p<0.05$) (Table 3). Cyclopidae contributed 58% (nauplii 3%, copepodids and adults 55%) of the total number of the pelagic zooplankton during the observation period.

Tropodiaptomus simplex formed 41% (nauplii 21%, copepodids and adults 20%) and shrimps accounted for 2% of the pelagic zooplankton (Figure 2c). Once during the observation period shrimps accounted for 17% (9.11.1993) of the total number of individuals. *Limnocnida tanganyicae* were found in each sample, the maximum being 100 individuals per m^3 (17.5.1994) (Figure 10a). Ergasilidae copepods were found occasionally in samples together with fish larvae.

3.1.4 Mpulungu waters

Numbers of *Tropodiaptomus simplex* and Cyclopidae were not discernible by the U-test (Table 3). When expressed as percentage values, Cyclopidae contributed 54% (nauplii 15%, copepodids and adults 39%) and *Tropodiaptomus simplex* 45% (nauplii 12%, copepodids and adults 33%) to the total number of pelagic zooplankton during the observation period (Figure 2d). *Limnocnida tanganyicae* was undetectable several times but once accounted for 4% (23.5.1994) of the total number. The number of shrimps went once above 50 specimens per m^3 (19.10.1994). Throughout the study period, shrimps were observed in the samples though in low numbers. Fish larvae were counted occasionally.

Table 3: **Mann-Whitney U-test of equal means of *Tropodiaptomus simplex* and Cyclopidae. Observation period July 1993-July 1994 (Kipili: November 1993-July 1994).**

U= test value
μ=mean
SD=standard deviation
z= normalized test value
p=risk level

Bujumbura		Kigoma		Kipili		Mpulungu	
Tropo	Cyclo	Tropo	Cyclo	Tropo	Cyclo	Tropo	Cyclo
n=28	n=28	n=40	n=40	n=37	n=37	n=38	n=38
R_1=546	R_2=994	R_1=994	R_2=2171	R_1=1176	R_2=1599	R_1=1327	R_2=1599
U=644		U=1426		U=896		U=858	
μ=392		μ=800		μ=684.5		μ=722	
SD=61.0		SD=103.9		SD=92.5		SD=96.3	
z=4.12		z=6.024		z=2.29		z=1.413	
p<0.001		p<0.001		p<0.05		p=0.15 NS	

3.2. Seasonal changes

The year was divided into three seasons according to Coulter and Spigel (1991):

Dry season:	June, July, August
Wet warming season:	September, October, November
Season of maximum stability:	December, January, February, March April, May

Strong southerly wind dominates the **dry season** and loss of heat is caused mainly by evaporative cooling. Upwelling of cooler water in the south end reinforces the horizontal temperature gradient and movement of surface water towards north under wind stress. During dry season stratification breaks down at the south end and becomes very weak throughout the south basin, but in the north basin a thermocline persists. Upper 50 meters are isothermal throughout the lake. At the beginning of **wet warming** season south wind ceases and changes mainly to northerly wind. Heat uptake by the lake is greatest in the south. At the north end isotherms rise 30 to 40 m in early September and thermocline becomes less sharp, and at the south end isotherms enter the surface steeply in late September. By the beginning of the phase of **maximum stability** in December the thermocline has reached the level at which it will remain during the wet season. There is a well established thermocline usually at about 50 m which persists until the onset of southerly winds in April/May.

Off Bujumbura, no difference in number of *Tropodiaptomus simplex* could be observed at the risk level of 0.05 between dry and wet warming season. Instead, the density of *Tropodiaptomus simplex* was higher during the wet warming season and the dry season compared to the season of maximum stability at the risk level of 0.05 (Figure 3b). The number of Cyclopidae did not change between the seasons but remained at the same abundance level (Figure 3c).

In Kigoma waters, *Tropodiaptomus simplex* was more abundant during the wet warming period and during the season of maximum stability than during the dry season (at the risk level of 0.05) but remained at the same level during the months of September - May (Figure 4b). Cyclopidae showed similar seasonal changes in abundance to the Diaptomidae (Figures 4b and c).

In Kipili the overall number of both *Tropodiaptomus simplex* and Cyclopidae did not change between the seasons but remained at the same abundance level (Figures 5b and c). Off Mpulungu, the same was observed: neither *Tropodiaptomus simplex* nor Cyclopidae showed any seasonal changes in abundance (Figures 6b and c).

3.3 Comparison of the zooplankton abundances between the sampling localities:

The overall Copepoda density (including both *Tropodiaptomus simplex* and Cyclopidae) was at its lowest level for all the stations in Mpulungu waters. The highest abundance level was maintained in Bujumbura waters. The zooplankton density was at the same level between Kigoma and Kipili but slightly less off Kigoma than off Bujumbura (Figure 7a).

The numbers of *Tropodiaptomus simplex* were at its highest level in the most northern part of the lake (in Bujumbura). In Kigoma waters and in the most southern part (in Mpulungu) *Tropodiaptomus simplex* was found in equal numbers. In Kipili, *Tropodiaptomus simplex* was found in greater numbers than in Mpulungu but in equal numbers with Bujumbura and Kigoma (Figure 7b).

The number of Cyclopidae was clearly highest in the northern basin; Bujumbura and Kigoma data showed the same density level. Similarly, Kigoma and Kipili showed the same abundance numbers. In Mpulungu waters, the number of Cyclopidae was lowest (Figure 7c).

3.4 Abundance patterns of Copepoda

3.4.1. Bujumbura waters

In Bujumbura waters the pelagic Copepoda had the highest density within the sampliny year (Figure 3a) in July 1993. Especially *Tropodiaptomus simplex* contributed to the high abundance level (Figure 3b). Cyclopoid copepods slightly increased in number in August 1993 and next time in November 1993 (Figure 3c). Diaptomid copepods showed a second abundance peak in October 1993 and third in February 1994. Cyclopoids were more abundant in April 1994.

3.4.2. Kigoma waters

In Kigoma waters two abundance maxima with both Diaptomidae and Cyclopidae was observed during the study period. *Tropodiaptomus simplex* reached their first maxima in October 1993 and Cyclopoids in November 1993 (Figure 3b and c). Both groups tended to decrease in number after their first abundance maxima, *T. simplex* reaching the second density peak in April 1994 (Figure 3b) and Cyclopidae in May 1994 (Figure 3c).

3.4.3. Kipili waters

In Kipili, which is situated in the southern basin, a regular zooplankton sampling started in November 1993. First clear abundance maxima were observed in February 1994 for both Diaptomidae and Cyclopidae (Figure 5) and second time in May 1994, Cyclopoids contributing most to the peak (Figure 5c). High desity level remained until the end of July 1994 when number of Copepoda drastically dropped.

3.4.4. Mpulungu waters

In Mpulungu regular zooplankon sampling started in middle August 1993 when the first abundance maxima of both Diaptomidae and Cyclopidae were counted (Figure 6a, b and c). Generally, the numbers seemed to decrease and then again increase reaching the second maxima in December 1993 (*T. simplex*) and January (Cyclopidae). A third maxima were in July 1994 Cyclopoids reaching the highest numbers (Figure 3c).

3.5 Macrozooplankton

Medusae (*Limnocnida tanganyicae*), shrimps (Atyidae sp.) and fish larvae were found in the pelagic zooplankton at all the sampling localities.

In Bujumbura, medusae were counted throughout the observation period showing peak abundances in October 1993, January and June 1994 (Figure 8a). Shrimps were counted in low numbers, mostly the monthly mean was below 5 individuals per m^3. In November 1993, the monthly mean reached 15 individuals per m^3 (Figure 8b).

In Kigoma waters, medusae were found regularly. The highest abundance was reached in November 1993 (Figure 9a). Atyidae shrimps were constant components of the pelagic zooplankton. Abundance maxima in October 1993, February and June 1994 were preceded by increasing numbers and followed by decreasing density (Figure 9b).

In the south basin, in Kipili, the medusae increased in number and eventually reached a peak abundance in May 1994. In June and July 1994, a decreasing trend in density was observed (Figure 10a). Shrimps had a peak abundance in February 1994, when 1000 individuals in m^3 was counted (Figure 10b).

In the south point (Mpulungu), medusae were almost absent in the samples from August 1993 to November 1993. Highest densities were reached in April 1994 followed by a decrease (Figure 11a). Atyidae were found to be constant constituents of the pelagic zooplankton though the density changed. Highest abundances were counted in August, October 1993, April and July 1994 (Figure 11b).

3.6 Vertical distribution and migration of the pelagic Copepoda during 24-hour cycle

3.6.1 Bujumbura

In Bujumbura waters, Copepoda were found in low numbers below 100 meters. Zooplankton tended to concentrate in the water layers 0-80 m, maximum density being at 20 and 40 m (Figure 12).

Vertical migration could be observed in *Tropodiaptomus simplex* copepodids and adults: density maximum was at 0 and 20 meters during sunset and at the sunrise at 100 meters (Figures 12a-d). Naupliar stages of *T.simplex* did not show diel vertical migration; vertical distribution pattern was the same throughout the day and night (Figures 12e-h). Cyclopoida copepods did not show diel vertical migration but remained at the same depths during day and night (Figures 12m-p).

At midday, zooplankton samples contained more individuals than at other hours (18 hrs, 24 hrs, 06 hrs). At midday, the mean number of zooplankton collected was 382312 individuals per m^3 (mean of 8 24-hour cycles) and at dawn 2400040 specimens per m^3. The majority of the plankters were Cyclopoida copepods accounting for 58-63% of the total Copepoda.

3.6.2 Kigoma

Copepodid and adult stages of *Tropodiaptomus simplex* showed diel vertical migration (Figures 13a-d). At midday, the abundance maximum was at 120 m and the surface was devoid of animals, by sunset plankters had ascended mostly to 20-40 m. At 7 hrs in the morning, zooplankton were found mostly below 60 m (Figures 13a-d). Naupliar stages had diel vertical migration as well: in day samples, the surface layer (0 m) had only few animals and abundance maximum was at 20 m (Figure 13e). In the evening highest abundances were counted at 0 m (Figure 13f). The following morning, water layers from 0 to 120 m were occupied by nauplii with density maxima being at 0 and 20 m (Figure 13h).

Cyclopoid copepodids and adults ascended to the surface at the sunset but descending to deeper layers at dawn was not pronounced (Figures 13i-l). At 13 hrs, the surface was lacking animals and density maxima were at 20-60 m (Figure 13i). Some individuals were found at 140 m. By 1 hr, zooplankton had concentrated above 40 m and the following morning there was no change in the distribution pattern (Figures 13k and l).

Cyclopoid nauplii did not show different distribution pattern between day and evening: abundance maxima were at 20 and 40 meters (Figure 13m and n). At midnight, the surface layer (0 m) was occupied by nauplii abundance maxima being at 0, 20 and 40 m (Figure 13o). 80 m was virtually devoid of nauplii but at 100 m some animals could be found. No migration downwards had taken place by next morning but nauplii remained at 0, 20 and 40 m (Figure 13p).

The zooplankton collected during the 24-hour cycle was dominated by Cyclopoid nauplii: at midday 76%, at sunset 75%, at midnight and at dawn 78% of the Copepoda collected were Cyclopidae nauplii (mean values of 9 24-hour cycles). *Tropodiaptomus simplex* was a minor constituent comprising 6-8% of the zooplankton collected. The total number of zooplankton collected during different hours remained at the same level: 292000-330000 individuals per m^3.

3.6.3 <u>Mpulungu</u>

In Mpulungu, zooplankters were found down to 220 m: Small proportion of Cyclopidae copepodids and adults were found at the water layers 200-220 m in the morning (Figure 14l), few Cyclopoid nauplii were at 200 m (Figure 14p) and few Diaptomidae copepodids and adults at 200-220 m layers (Figure 14d).

Zooplankton tended to avoid surface at midday, both *Tropodiaptomus* and Cyclopidae were found in low numbers at 0 m (Figures 14a, e, i and m). Copepodids and adults of both Copepoda groups had ascended closer to the surface by sunset (Figures 14b and j). Two abundance peaks could be observed, namely at 20 m and at 120 m. By midnight copepodids and adults had distributed from 0 to 140 m and 140 m showed higher density than 100 and 120 m (mean values of 8 24-hour cycles) (Figures 14c and l). At dawn, descending had taken place and plankters were found mostly at 40-140 m (Figures 14 e and m). Cyclopoid copepodids and adults showed clear abundance peaks at 140 m.

Nauplii were widely distributed but some tendency to migrate upwards at the sunset could be observed (Figures 14f and n). At midnight, few animals were found at 100 and 120 m but concentration to 140 m could be observed (Figures 14g and o).

Slightly fewer animals were collected in the evening and during the night than in daytime. The number of individuals caught varied between 183000 and 225000 animals per m^3. Cyclopidae formed 52-58% and *Tropodiaptomus simplex* 38-44% of the total Copepoda sampled.

3.6.4 <u>Comparison among the stations</u>

In Mpulungu area, zooplankton distributed deeper than in the northern part of the lake (Kigoma and Bujumbura area). In Bujumbura zooplankton was mostly found in 0-80 m and in Mpulungu the water layers up to 220 m were occupied by zooplankton.

In Kigoma area diel vertical migration was most pronounced.

Diaptomidae copepodids and adults shifted from as deep as 120 m to the surface in the night and again ascended to 60-100 m at dawn. In Bujumbura waters, only *Tropodiaptomus simplex* copepodids and adults showed diel vertical migration and in Mpulungu area the migration pattern was not clear.

4. CONCLUSIONS

The zooplankton densities were highest in the northern part of the lake (Bujumbura and Kigoma) and lowest in Mpulungu waters when all the data was pooled together. The difference found in abundance between southern and northern ends of the lake might suggest that the sampling locations are not placed in comparable manner in relation to pelagic and littoral ecosystems. Another explanation for this variance could be a real difference between planktonic ecosystems, with considerably more Cyclopoida in the northern end of the lake and lower zooplankton production in the southern end of the lake.

In the northern part of the lake Cyclopidae dominated the pelagic zooplankton but in the southern end of the lake *Tropodiaptomus simplex* were in equal numbers with Cyclopidae. Rufli (1981) reported *Tropodiaptomus simplex* to contribute 45 % to the total number of pelagic zooplankton (August 1975-July 1976) and Cyclopoida copepods 49-60% in Kigoma waters. During the current study the percentage shares in Kigoma waters were 31% for *Tropodiaptomus* and Cyclopoida 69% .

It looks like the pelagic Copepoda of lake Tanganyika have annual fluctuation pattern with two or three abundance maxima within one year depending on the copepod group and the sampling site. Yet this annual and seasonal patterns will get more clarification as more data is accrued during the second year of SSP. Twombly (1983) in lake Malawi reported seasonal changes in population sizes over a period of 2.5 years.

In Kigoma waters, the number of zooplankton fluctuated during the stratification period. From November 1993, the density decreased and high numbers were reached again in April (*Tropodiaptomus simplex*) and May 1994 (Cyclopidae). *Stolothrissa tanganyicae* catches were high in November and December 1993 and in April and May 1994 (data from fish biology sub-component) in Kigoma waters with a decreasing catch in between those months. Possibly, zooplankton were preyed upon by clupeids which caused the number of zooplankton to decrease. Low predation pressure by clupeids allowed zooplankton to build up the population which resulted in April and May 1994 abundance maxima.

Narita *et al.*, (1986) reported increased numbers of egg carrying *Tropodiaptomus simplex* in September and October and suspected high reproduction rate to be a product of the high primary production. During the current study, high numbers of egg carrying females were counted in September and October 1993 off Bujumbura and off Mpulungu. In Kigoma, a clear reproduction peak was observed in April 1994.

In Kipili waters, the average yearly number of shrimps was 15 times greater than in Mpulungu and 40 times greater than in Kigoma. In Bujumbura, the number of shrimps was lowest, the yearly mean being half that of Kigoma. Shrimps are important diet constituents of *L.stappersii* in Kigoma area and in the south in Mpulungu (information from fish biology sub-component). The zooplankton net does not catch effectively shrimps but data gives us some indication of spatial and seasonal variations of shrimp abundances.

In Kigoma area, diel vertical migration of *Tropodiaptomus simplex* copepodids and adults was clear. It can be probably explained by the predator-avoidance hypothesis (e.g. Gliwics, 1986): due to their considerably large size *Tropodiaptomus simplex* have to seek for refuge in deeper water layers in order to hide from planktivorous predators (clupeids) which are visual predators and prey mostly upon copepods (*Stolothrissa* stomachs opened in LTR Kigoma in October 1994 consisted mostly of Copepoda). At dusk, when light intensity decreases, ascending to the surface and grazing on phytoplankton takes place. Vertical distribution pattern can also be related to photoinhibition of primary production (Salonen and Sarvala, 1994).

Abundances of clupeids and zooplankton seem to be connected (according the results of the first year of SSP). The lake wide surveys will give us more insight in this relationship as the simultaneous fish and zooplankton sampling will take place and stomach content analysis of clupeids will be carried out.

Data collected up to now revealed the vital importance of regular sampling. Since August 1994, sampling has been done strictly on weekly basis and taking three replicate zooplankton samples. This should clarify the nature of short term variations and patchy distribution of the Copepoda.

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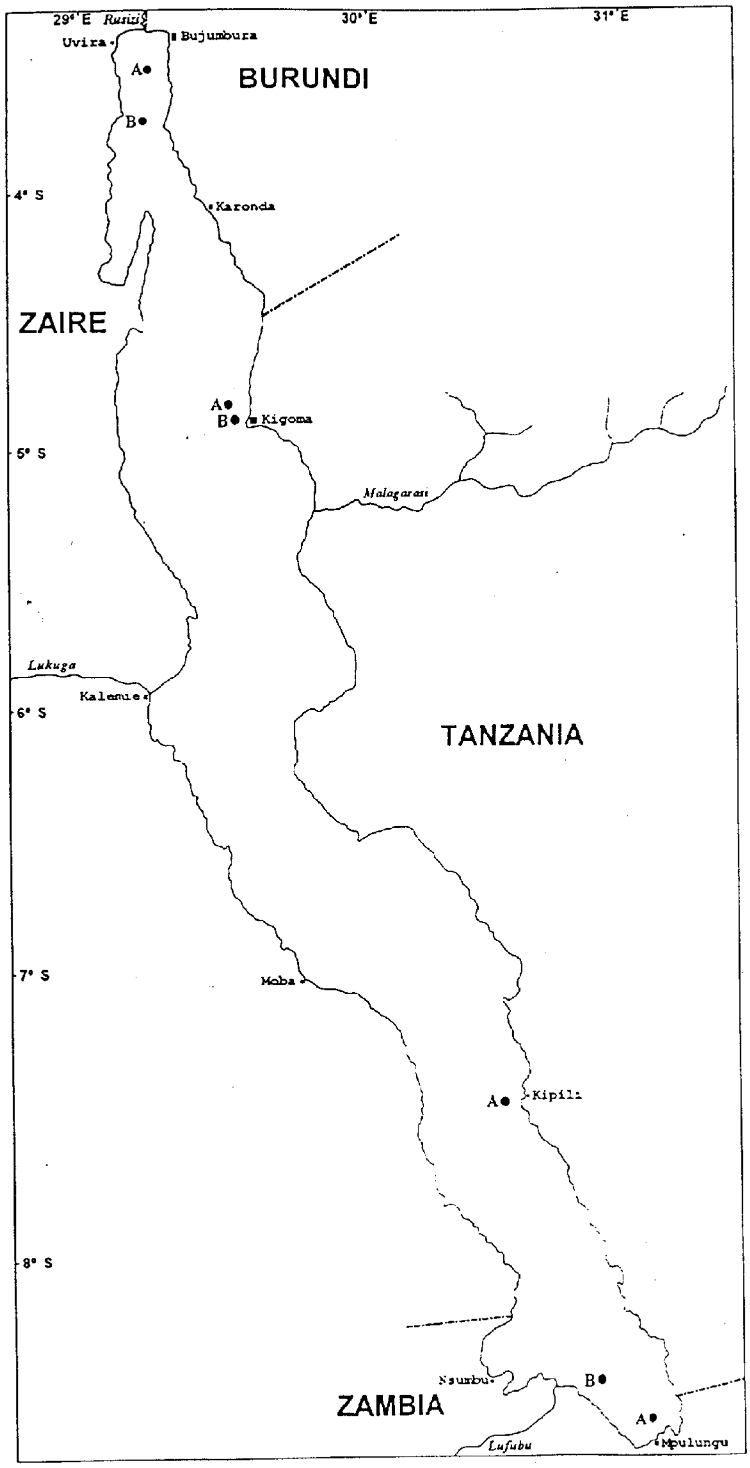

Fig. 1: LTR sampling localities (A:weekly sampling; B:24-hours cycle)

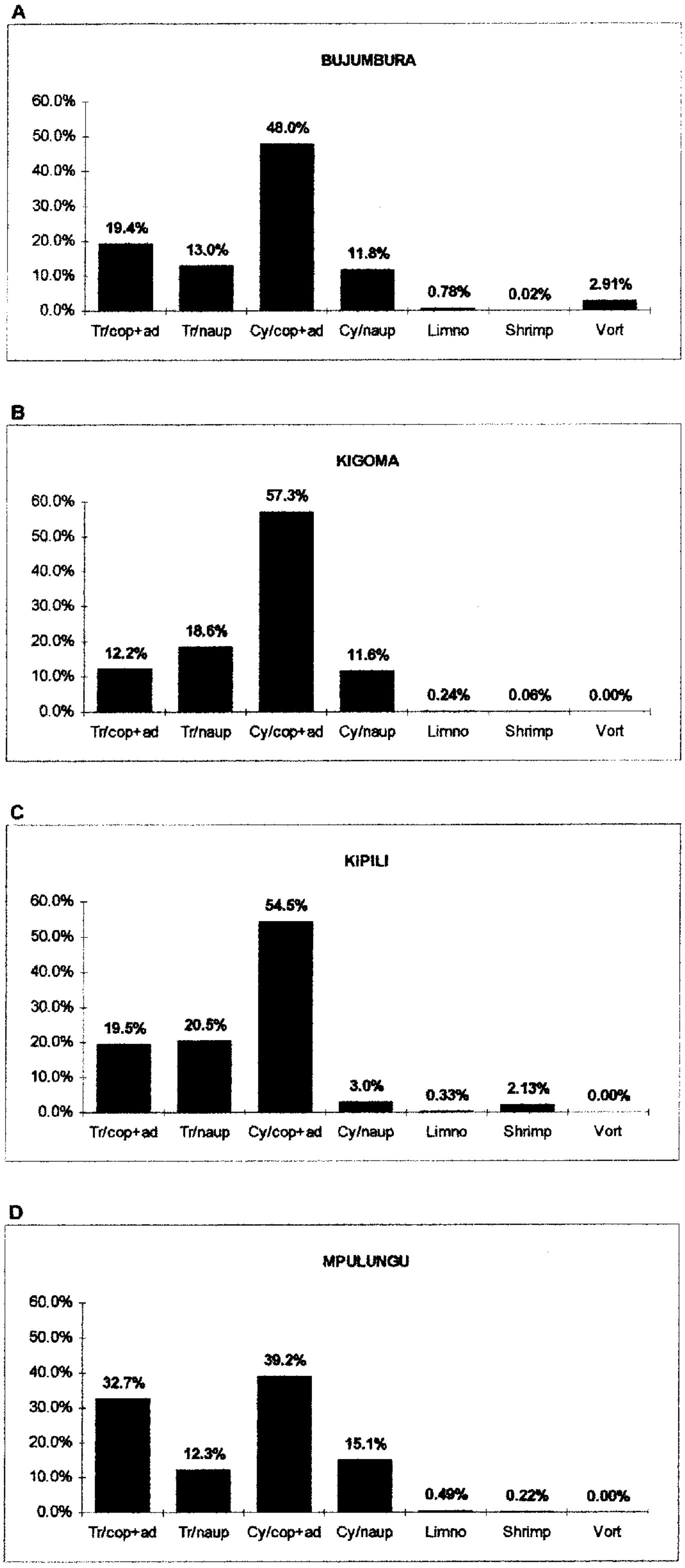

Fig 2 : Pelagic zooplankton composition in the sampling localities

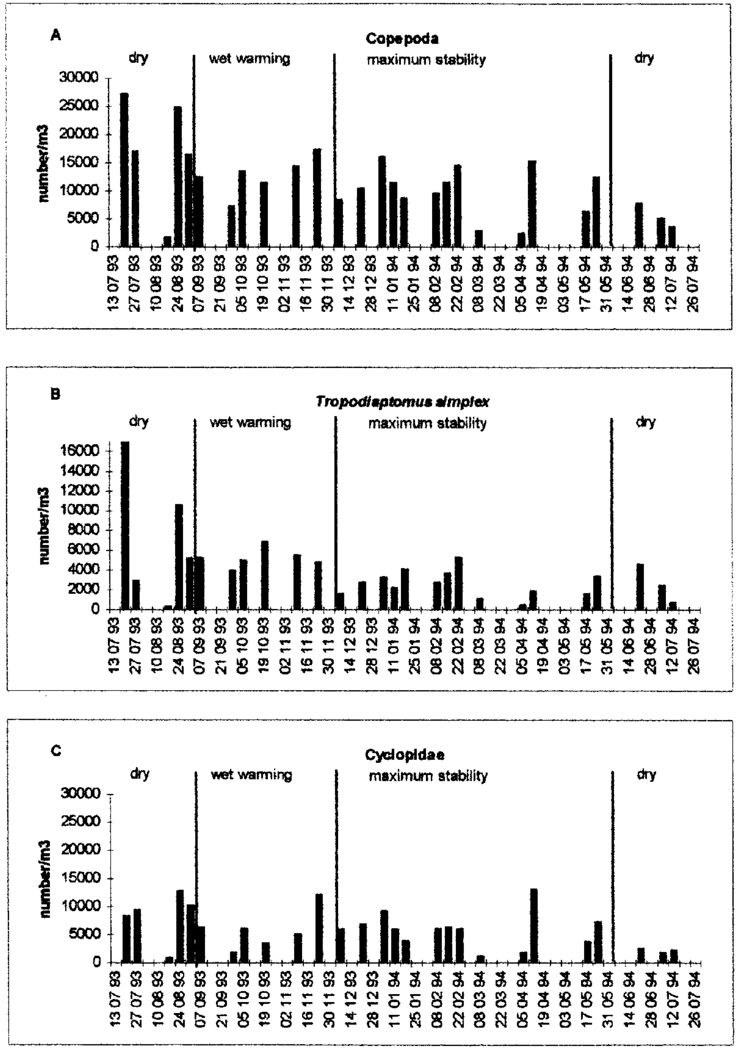

Fig 3: Abundance of the pelagic Copepoda in Bujumbura waters, Burundi.

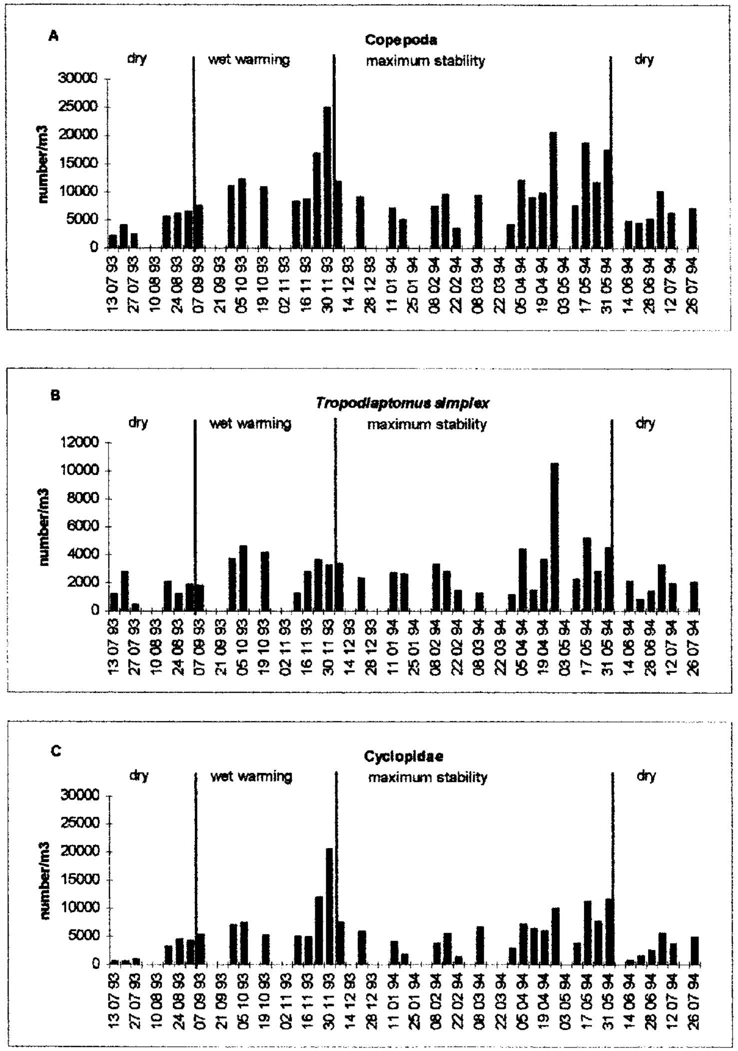

Fig 4: Abundance of the pelagic Copepoda in Kigoma waters, Tanzania.

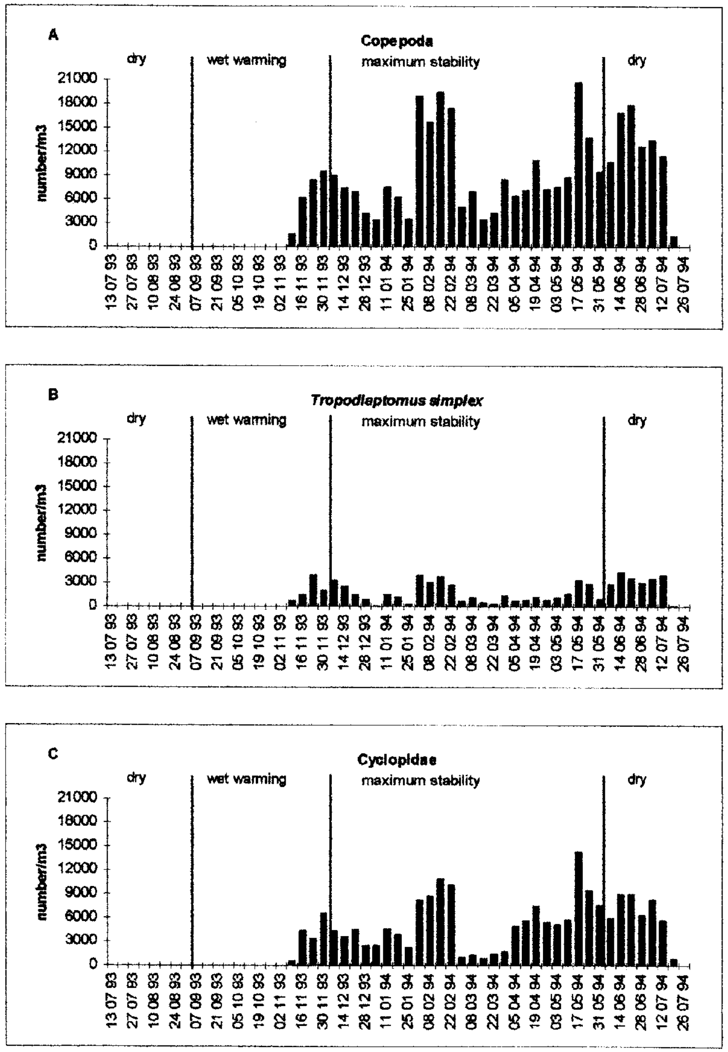

Fig 5: Abundance of the pelagic Copepoda in Kipili waters, Tanzania

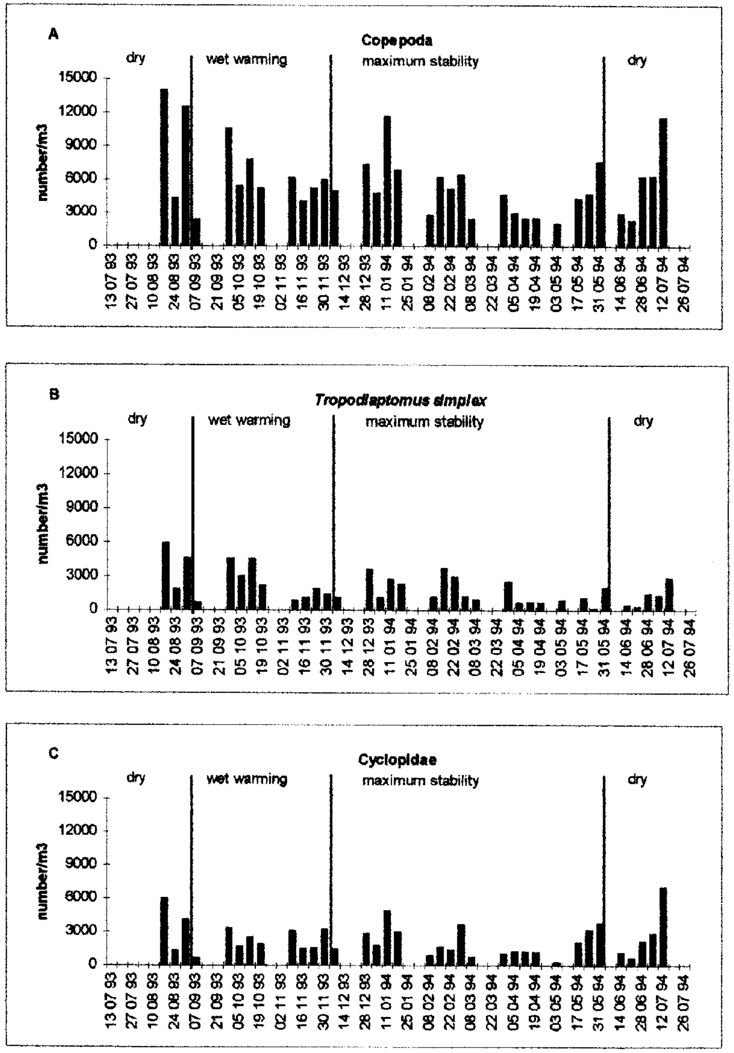

Fig 6: Abundance of the pelagic Copepoda in Mpulungu waters, Zambia

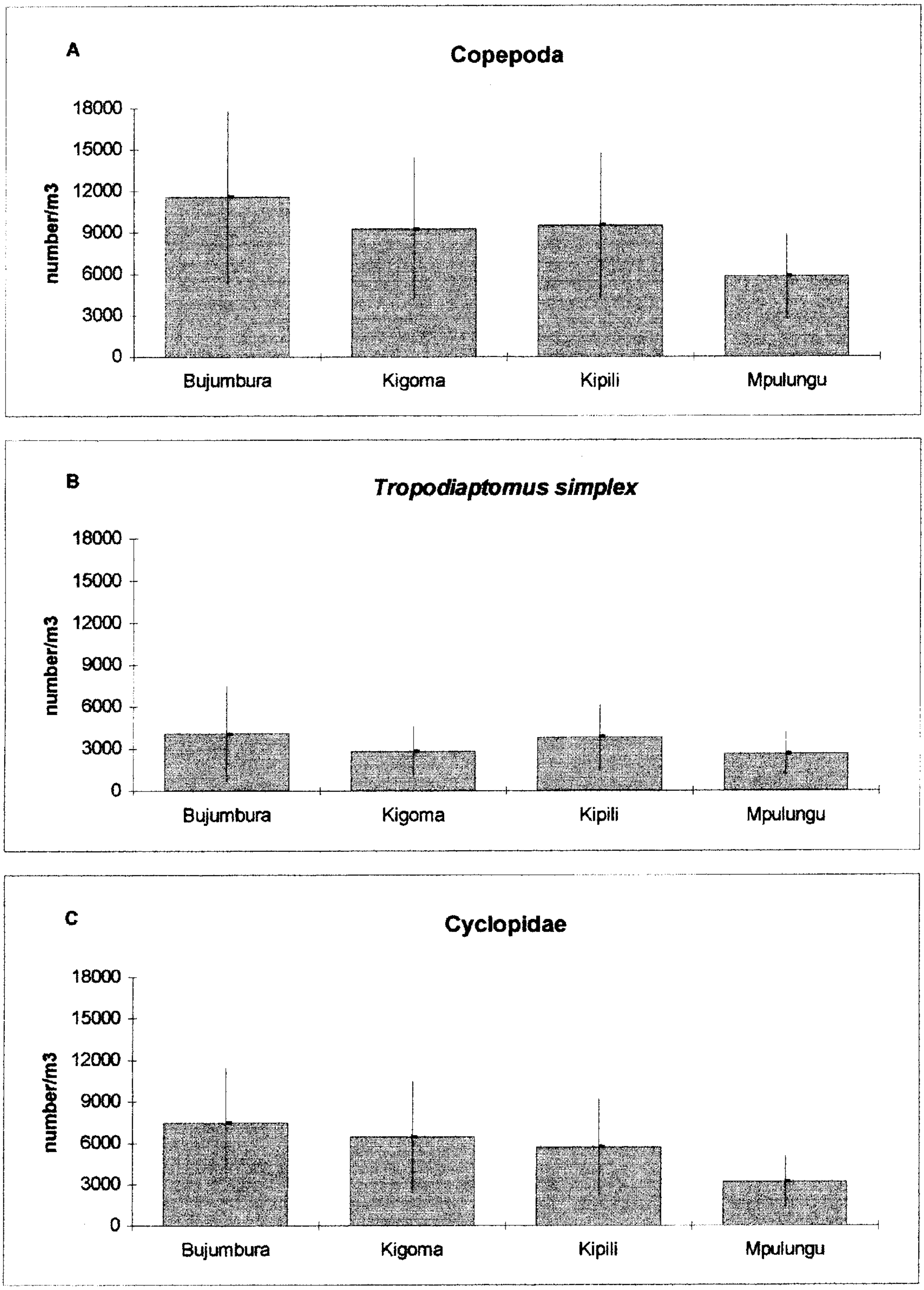

Fig 7: Mean abundances of Copepoda with standard deviations in all the sampling localities during July 1993 - July 1994

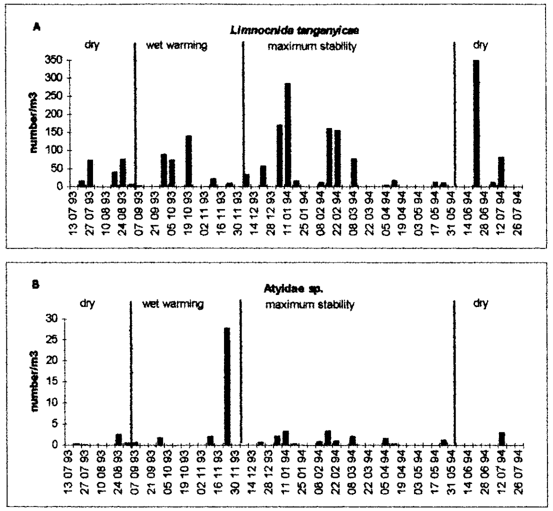

Fig 8: Pelagic macrozooplankton in Bujumbura waters, Burundi

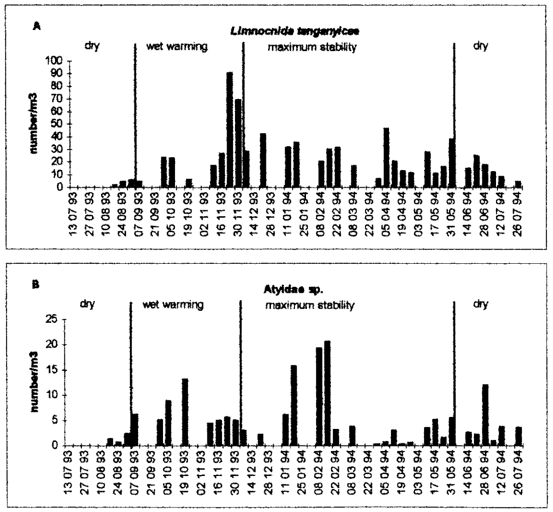

Fig 9: Pelagic macrozooplankton in Kigoma waters, Tanzania

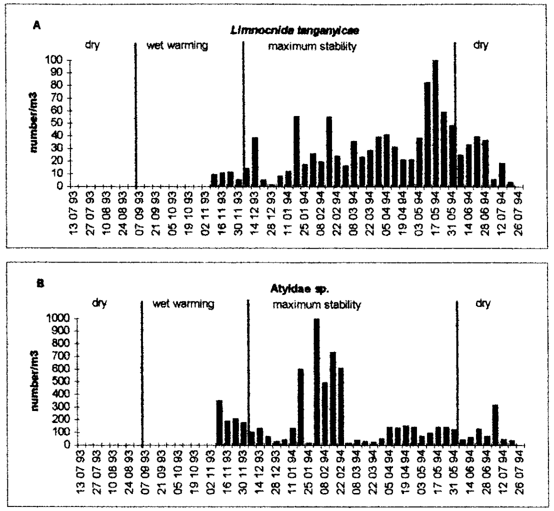

Fig 10: Pelagic macrozooplankton in Kipili waters, Tanzania

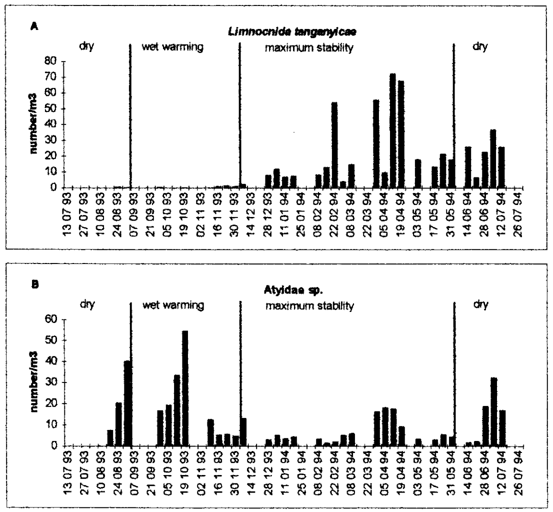

Fig 11: Pelagic macrozooplanktin in Mpulungu waters, Zambia

Fig 12: Vertical distribution of the pelagic Copepoda in Bujumbura, Burundi. Mean values and stardard deviations of eight 24-hour cycles.

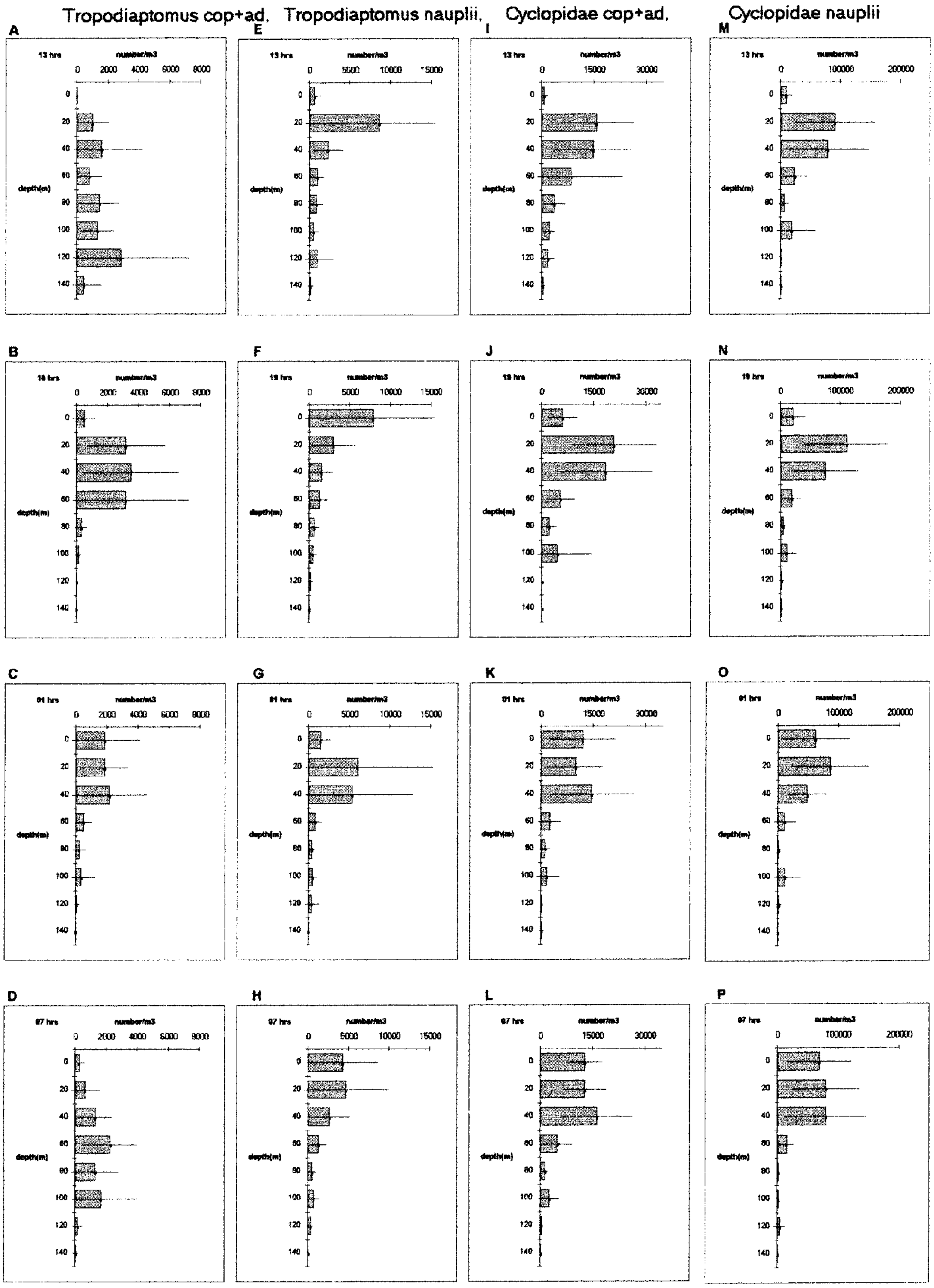

Fig 13: Vertical distribution of the pelagic Copepoda in Kigoma, Tanzania. Mean values and stardard deviations of nine 24-hour cycles.

Fig 14: Vertical distribution of the pelagic Copepoda in Mpulungu, Zambia. Mean values and stardard deviations of eight 24-hour cycles.