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FIELD NOTES ON ZOOPLANKTON

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 of 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 buildup of effective coordination mechanisms to ensure full collaboration between the Governments concerned.

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GCP/RAF/271/FIN PUBLICATIONS

Publications of the project are issued in two series:

* Series of **technical documents (GCP/RAF/271/FIN-TD)** related to meetings, missions and research organized by the project.

* Series of **field guides and manuals (GCP/RAF/271/FIN-FM)** related to training and field work activity conducted in the framework of the project.

For both series, reference is further made to the document number **(01)**, and the language in which the document is issued: English **(En)** and/or French **(Fr)**.

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1. INTRODUCTION

In the project “Research for the Management of the Fisheries on Lake Tanganyika” (LTR), the zooplankton subcomponent provides information of the pelagic zooplankton community, which consists mainly of three groups: protozoans (*Vorticella*), calanoid copepods (*Tropodiaptomus simplex*[1]) and cyclopoid copepods (dominant species *Mesocyclops aequatorialis aequatorialis*[2]). Caridean shrimps and medusa *Limnocnida tanganyicae* may be important locally. The manual for zooplankton sampling (Vuorinen, 1993) summarizes the research objectives concerning pelagic zooplankton community, its interactions with pelagic fish and predator–prey relationships.

These field notes present the procedures for weekly regular and intensive zooplankton sampling, both on board of a vessel and in the laboratory. Identification keys and figures for nauplius, copepodid and adult stages of Calanoida and Cyclopoida copepoda are also given.

2. ZOOPLANKTON CHARACTERISTICS

Planktonic animals are dominated by three major groups: the Rotifera and two subclasses of the Crustacea, i.e. Cladocera and Copepoda. Only Copepoda are truly pelagic. In Lake Tanganyika the pelagic zooplankton composition is simple; *Tropodiaptomus simplex* is the only representative of Calanoid copepods and of Cyclopoid copepods the dominant species is *Mesocyclops aequatorialis aequatorialis. Microcyclops cunningtoni*[3]*, Tropocyclops tenellus*[4] and *Thermocyclops oblongatus* are rare but can also be found in pelagic zone (Coulter, 1991). Medusa *(Limnocnida tanganyicae)* and Atyidae *Limnocaridina* (Caridean shrimp) can be occasionally found in the pelagic waters as well as protozoa *Vorticella* spp.

The zooplankton can be divided into three groups according to the body size:

Formerly called:

[1] *Diaptomus simplex*
[2] *Cyclops leuckarti*
[3] *Cyclops cunninqtoni*
[4] *Cyclops tenellus*

a) **microzooplankton**: nauplius-stages of copepods and protozoans, body size 10—50 µm along the major axis;

b) **mesozooplankton**: copepodid and adult stages of copepods, body size 0.5-5.0 mm; and

c) **macrozooplankton**: medusae and shrimps, body size 1—2 cm.

Listed below are the key characteristics of different zooplankton groups:

Rotifera

Body shape of a rotifer is elongated and regions of the head, trunk and foot are usually distinguishable. Some 70 species of Rotifera (five endemic) have been recorded in Lake Tanganyika, all from its littoral zone (Wetzel, 1983).

Cladocera

Head is distinct and the body is covered by a bivalve cuticula carapace. Light sensitive organs usually consist of a large, compound eye and a smaller ocellus. The second antennae are large swimming appendages and constitute the primary organs of locomotion. The mouthparts consist of: (1) large chitinized mandibles that grind food particles; (2) a pair of smaller maxilles, used to push food between mandibles; and (3) a median labrum that covers the other mouthparts. Twenty four cladoceran species belonging to 19 genera have been recorded from Lake Tanganyika. All the species are well known and have a wide distribution; none of them is endemic. Cladocera are not present in pelagic water zones (Wetzel, 1983).

Copepoda

The free-living copepods can be divided into three distinct groups: the suborders **Calanoida, Cyclopoida** and **Harpacticoida**. They can be distinguished from each other by the general structure of the first antennae, urosome and the fifth leg.

The body consists of the anterior metasome (**cephalothorax**), which is divided into head region, bearing five pairs of appendages representing antennae and mouthparts, and the thorax, with six pairs of swimming legs. The posterior urosome consists of abdominal segments, and terminal caudal rami (**furca**) bearing setae.

The Harpacticoid copepods are almost exclusively littoral. None of them have been reported from the open water of the lake. Cyclopoida copepods are primarily littoral benthic but

4 out of 31 species have been found in the pelagic waters of Lake Tanganyika, the most abundant being *Mesocyclops aequatorialis aequatorialis.* Pelagic *Tropodiaptomus simplex* is the only representative of the Calanoida copepods in the lake (Wetzel, 1983).

3. SAMPLING PROCEDURES ON THE LAKE

3.1 Time and location

(A) Weekly regular sampling

Zooplankton sampling is done weekly, on Tuesday at 9 a.m. (Burundi time), together with limnology subcomponent sampling. The site is indicated as location A.

(B) Intensive sampling

Twenty—four hours intensive sampling is done every six weeks following the phase of the moon. Every second intensive sampling takes place during the full moon and every second sampling during the new moon. Samples are taken every six hours starting at 12 a.m. (Burundi time) and ending the next morning at 6 a.m. (Burundi time). Sampling method is quantitative; the Limnos tube sampler is not selective but all the specimens in the sampled water should be trapped. Sampling is done at least at eight depths and together with limnology subcomponent sampling.

3.2 Equipment needed

The equipment must be prepared the day before the sampling takes place. The following equipment is used:

(A) for weekly regular sampling

* plankton net with **100 µm** mesh aperture and with at least **110 m** rope; some weight may be necessary to add to the lower end of the net;
* 40 % formalin and syringe;
* one bucket;
* labelled plastic sample bottle of volume 250 ml
  label: **Z/country code/A/date/mesh aperture/sampled depth**

(B) for intensive sampling

* **7.4 litre** Limnos tube sampler with at least **140 m** rope;
* plankton net with **50 µm** mesh aperture;
* two buckets with capacity of 15-20 litres each;
* 40% formalin and syringe;
* labelled plastic sample bottles of volume 100 ml label: **Z/country code/B/date/mesh**

aperture/hour/depth/sampled water volume

3.3 Lake sampling procedures

(A) Weekly regular sampling

(1) Clean the plankton net before using it to get rid of dust and dirt which may disturb sampling and filtering by clogging the net. Make sure the hose pipe at the lower end is closed.

(2) Release the rope and the plankton net to 100 m depth and try to get the net and the rope in as vertical position as possible. Verticality can be increased by attaching weight with string to the plankton container (the small bottle with hose pipe at lower end of the net). Tow the net back at a speed of 0.5 m/s. That means from 100 m depth towing time is almost three and half minutes.

(3) Open the hose pipe and drain the contents of the plankton container in the sample bottle. Rinse the net six times in the bucket which must be filled with water. Dip the net in the water and lift it up and empty the container into the sample bottle. **Don't let the rim of the net go under the surface of the water otherwise you may catch zooplankters which don't originate from the sampled water column**. Add 10 ml of 40% formalin to the sample bottle.

(B) Intensive sampling

(1) Before starting sampling rinse the net properly so that no dust or dirt is attached to the net because it disturbs both filtering and counting of zooplankton. Make sure the tube sampler is clean.

(2) Start sampling from the surface. Open the sampler and check carefully that the lid at the lower end is properly opened and the hose pipe is closed. Keep the messenger in your hand when letting the sampler to sink. When the sampler is at the desired depth and rope in vertical position send the messenger. Once you feel a "kick" in your hand the messenger has reached the sampler and the lids have closed. One messenger is travelling at the speed of **5-6 sec/10 m** thus for **100 m** travelling time is about **one minute** and for **300 m** about **three minutes**.

(3) Lift the sampler to deck. Keep the sampler only from the ends but not from the tube itself and in vertical position because otherwise the water will run out.

(4) Using the hose pipe which is attached to the tube first take water sample for limnology (1l for analysis in lab and 400 ml for measuring conductivity and pH on board). Let the overflow (when filling the water sample bottle) run to the bucket and then the remainder through the pipe or from the lower opening

of the sampler.

(5) From the same depth take a second water sample and empty the whole tube into the bucket where there is already the water from the first tube. Duplicate sampling is done to increase the number of individuals in the sample in order to get more reliable results. (Ideally sampling twice from the same depth should be done at the same time to avoid mixing of the sampled water column).

(6) Filter the water by pouring it **gently** and at **low pressure** through the net to the other bucket. Gently filtering is important to avoid damage to the fragile organisms or their forced passage through the mesh (Downing and Rigler, 1984). Drain the contents of the plankton container into the small sample bottle. Rinse the net in the water twice or more depending on the size of the sample bottle, add the formalin — 7 ml for 100 ml - to the sample and close and put in a safe place. Repeat the same for all the depths.

4. COUNTING OP ZOOPLANKTON

4.1 Subsampling

Before proceeding to subsampling record the volume of sample by weighing the bottle and remember to deduct the weight of an empty bottle (12.9 g for a 100 ml bottle and 28.9 g for a 250 ml bottle).

(A) Weekly regular sampling

Usually the sample is concentrated with small zooplankters and therefore subsampling is done to reduce the number of counted individuals without losing reliability in results. As a general guideline counting of 100 individuals from one sample is enough.

Micro—and mesozooplankton:

Subsampling with the **micropipette** is done as follows: cut the plastic tip of the pipette so that diameter of opening is at least **4 mm** (Downing and Rigler, 1984). Then adjust the volume of the pipette, mix the sample properly by turning the sample bottle up and down gently for **two minutes**, take subsample with pipette (most of the time 0.5-1 ml subsample is enough because zooplankters are so abundant in the sample), eject to the counting chamber (10 ml), adjust the volume to 10 ml with distilled water and proceed as instructed in the LTR Field Manual 06 (Vuorinen, 1993)

Macrozooplankton:

Most of the time you have not to subsample medusae, shrimps and ovigerous females: if there are in total less than 300

specimens in the whole sample, count them all. If there are more than 300 specimens in the whole sample, subsample with Folsom splitter.

(B) Intensive sampling

First have a look at the sample bottle to get an idea of the number of zooplankters in the sample and adjust subsampling according to the abundance of the specimens in the sample:

Micro– and mesozooplankton: prepare the subsample as instructed in Field Manual No. 7. Use 10, 25, 50 ml counting chambers and/or combination of them when counting micro– and mesozooplankton.

Macrozooplankton: idem as for weekly regular sampling (see above).

4.2 Counting and identification

Start counting micro– and mesozooplankton, then shift to macrozooplankton. While counting nauplii, copepodites and adults you may encounter macroscopic animals as well. Keep a record of them too.

Count micro– and mesozooplankton using the inverted microscope (Leitz Labovert FS) and objective 10/0.25 (magnification 100:1). For macrozooplankton use the counting wheel and dissecting microscope. Usually magnification 16x is enough. Use the electronic counter for recording. Indicate for each identification unit a separate channel in the counter.

Taxonomic identification keys for Cyclopoida and Calanoida orders are reported at the end of this manual. The Figures (Annexes 2–5) show the life stages of these two orders (Kiefer, 1978). One has to differentiate and count Calanoida and Cyclopoida copepods and within each order identify nauplius- and copepodid– stages, adult males and females and ovigerous females. The fifth and adult stage of Cyclopoidae should be kept as one unit. Some protozoa, mainly *Vorticella* sp., can be also present.

Record the counts in the counting form (Annex 11) add the required information and file it.

Store the **weekly regular** samples in good order in a dry, cool and dark place (but no refrigeration is needed!).

5. DATABASE

The final results are expressed as number of individuals per cubic meter for both weekly and intensive sampling. The correct formula has been entered in the Excel worksheet datafile. It takes into consideration the sampled water volume, the counts from the subsample and the multiplying factor.

(A) Weekly regular sampling

One year data are entered in one Excel worksheet file. The first part in the file, called **form** (Annex 10), is for entering **the counts** according the identification units. Information as date, country, hour, sample volume and subsample volume are entered as well. On the second part of the file, called **table**, the number per cubic meter for different categories are calculated automatically. This information will be used for further data analysis.
The file names are as follows:

ZA93A.XLS, where **Z** = zooplankton
3A93B.XLS **A** = regular sampling
ZA93C.XLS **93**= year
3A93D.XLS **A** Burundi, **B** = Tanzania,
C = Zambia , **D** = Zaïre

(B) Intensive sampling

Results from each intensive sampling are stored in separate files.

Below is an example of the name of an intensive sampling datafile:

ZB9308A.XLS, where **Z** = zooplankton
B = intensive sampling
93 = year
08 = month
A = Burundi

6. IDENTIFICATION KEYS FOR CALANOIDA AND CYCLOPOIDA

6.1 CALANOIDA

nauplius larva stages (N1-N6)

- body shape is elongated
- between first antennae (**Al**) is a distinct nose
- first antenna (**Al**) is longer than second antenna (**A2**) and both antennae have two branches
- the tip of **Al** is wide and flattened
- caudal hairs are strong and pointing directly backwards

copepodid stages (C1-C5)

— resemble adult specimens
- metasome is wide and more than two times longer than abdomen
— first antennae (**Al**) are very long (longer than metasome)
— number of segments increases in each moulting: stage **Cl:6** segments — stages **C4**, **C5** (female): **9** segments and male stage **C5:1O** segments
— swimming appendages are in pairs: C**1:2 — C3-C5:4**
- **P5** (fifth swimming appendage) in the stages **C4** and **C5** is developing and strong
— **P5** are in same pairs in female but different from each other in male

adult, male

— metasome is wide and more than two times longer than narrow abdomen
— first antennae (**Al**) are very long (longer than metasome)
- right **Al** is jointed
— number of body segments is **11**
- swimming appendages (in pairs) are **4**
- **P5** (fifth swimming leg) is strong and legs are different from each other

adult, female

— metasome is wide and more than two times longer than narrow abdomen
— first antennae (**Al**) are very long, longer than metasome and identical
— number of body segments is **9**
— first segment in abdomen is swollen genital segment
- swimming appendages (in pairs) are **4**
- **P5** (fifth swimming leg) is strong and in same pairs
— gravid female has got one egg sac

6.2 CYCLOPOIDA

nauplius-larva stages (N1-N6)

- body shape in round-oval, not flattened
— first antenna (**Al** one—branched) shorter than second antenna (**A2** two—branched)
— tip of the first antenna is narrow
- caudal hairs are weak and short and pointing slightly outwards

copepodid-stages

— resemble adult specimens
— metasome is wide and more than **1.3** times longer than narrow abdomen
— first antennae (**Al**) are long but shorter than metasome
— number of segments increases in each moulting: stage **Cl:5** segments — stage **C5:9** segments
- the last segment (**4**.) of the abdomen before furca is long
- swimming appendages are in same pairs **Cl:2-C3—C5:4**
- in stages **C4** and **CS P5** is developing, but is stunted and in same pairs

adult, male

— metasome is wide and more than **1.3** times longer than narrow abdomen
— first antennae (**Al**) are long but shorter than metasome
— first antennae are jointed for copulating
- number of body segments is **10**
- the last segment (**5**.) of the abdomen before furca is short
— swimming appendages (in same pairs) are four
— **P5** is stunted and in same pairs

adult, female

— metasome is wide and more than **1.3** times longer than narrow abdomen
— first antennae (**Al**) are long and in same pairs but shorter than metasome
— number of body segments is **9**
— first segment in abdomen is swollen genital segment
— **4.** segment in abdomen is short
— swimming appendages (in same pairs) are **4**
— **P5** gravid female has got two egg sacs

7. REFERENCES

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Wetzel, R.G. Limnology. Second Edition. Philadelphia: Saunders
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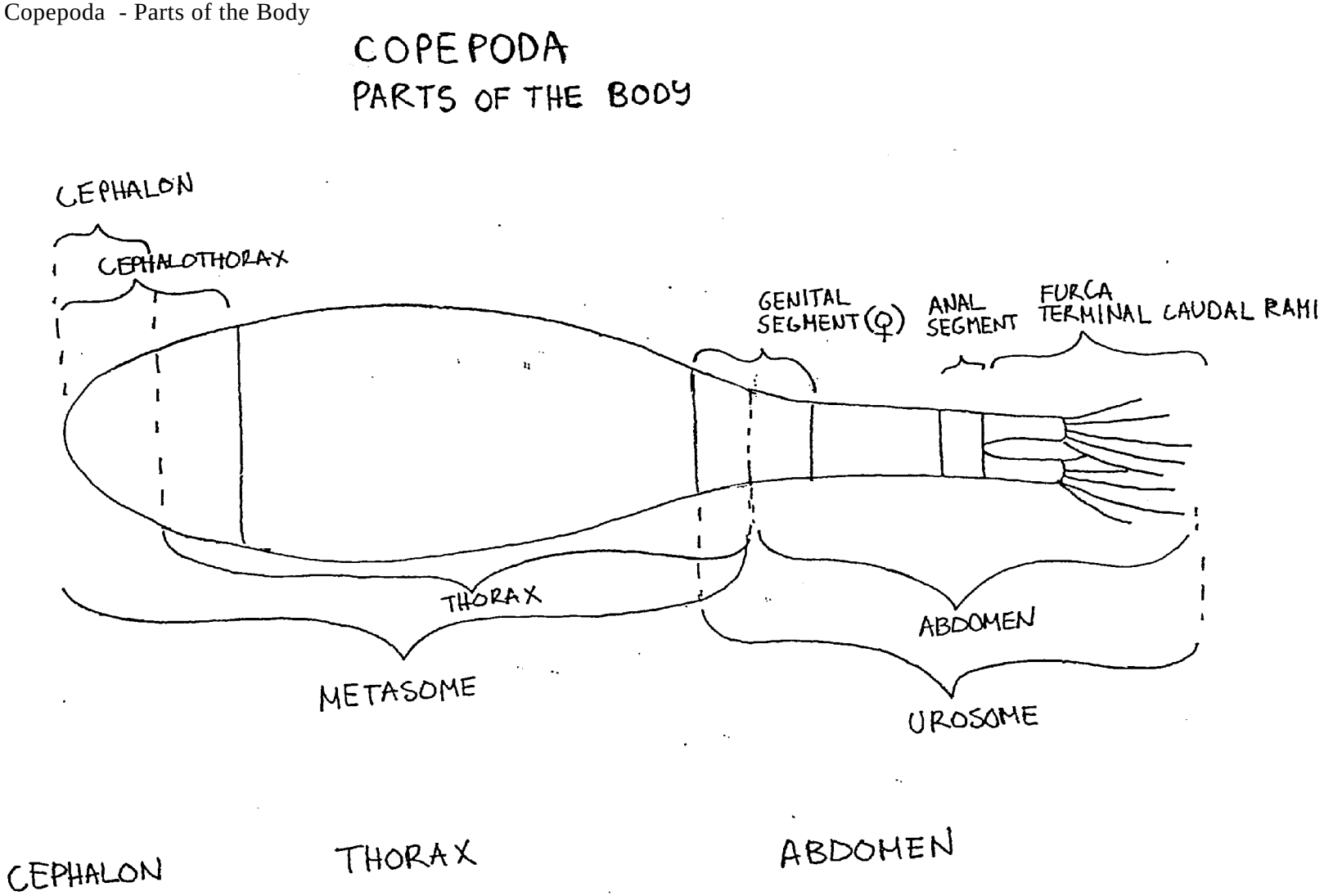
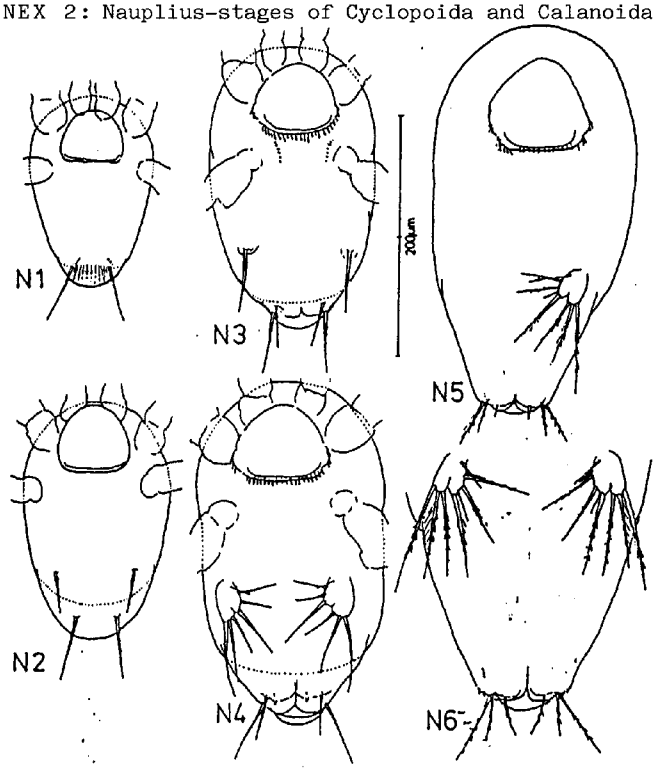
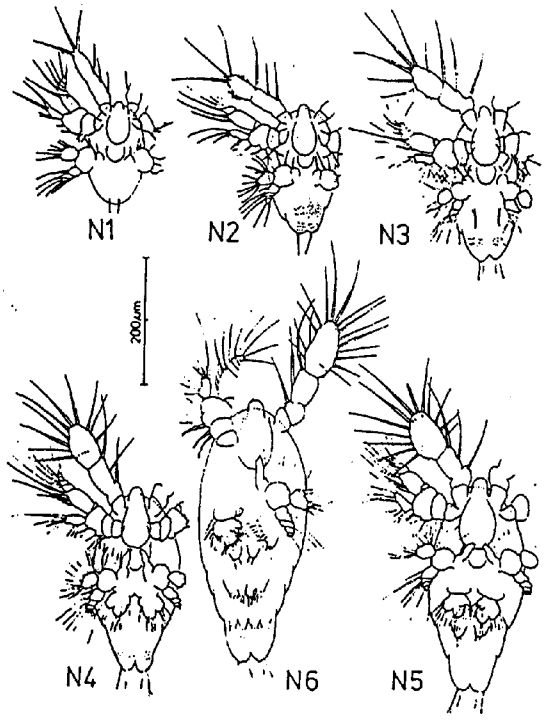
Annex 1 : Copepoda - Parts of the Body



ANNEX 2: Nauplius-stages of Cyclopoida and Calanoida

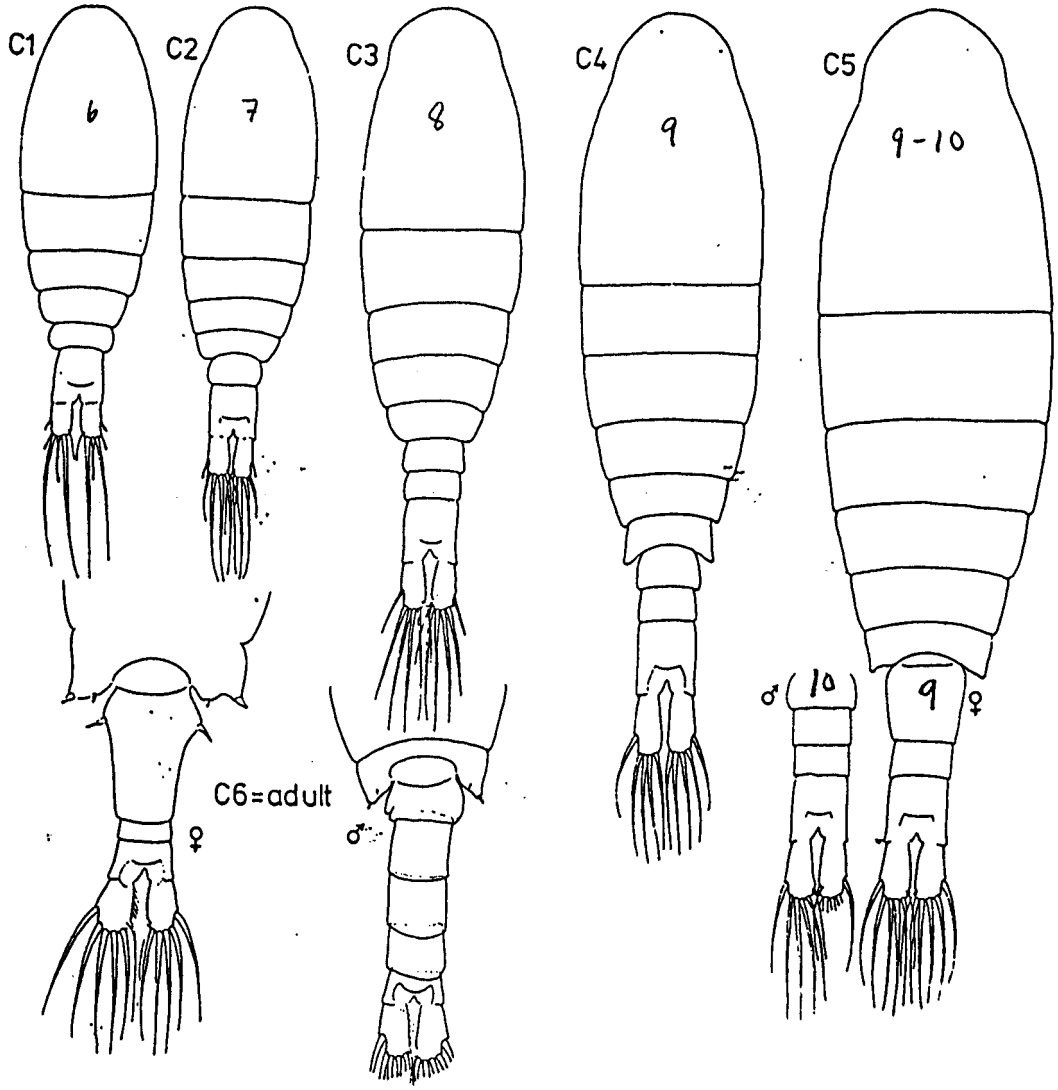


Cyclopoida

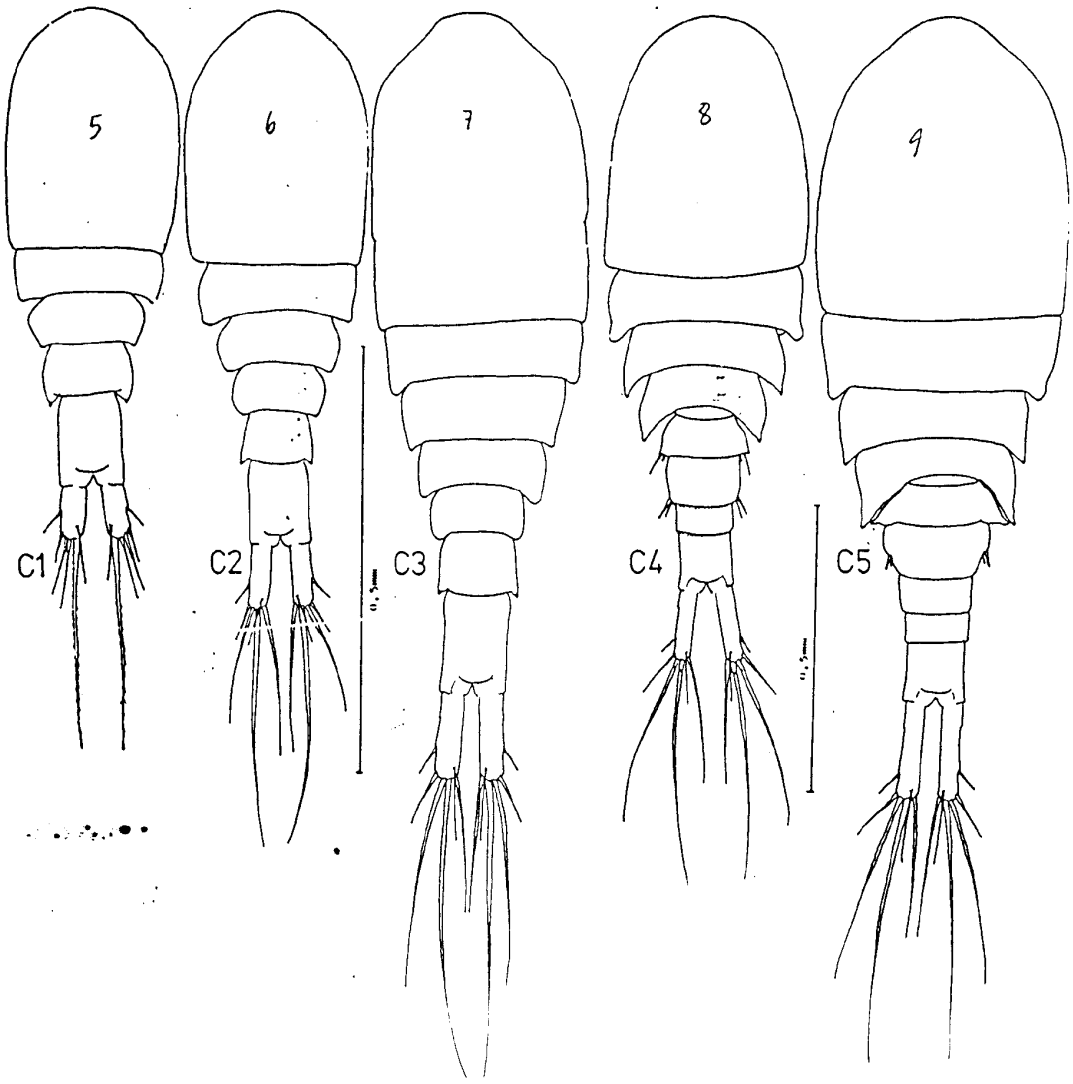


Calanoida

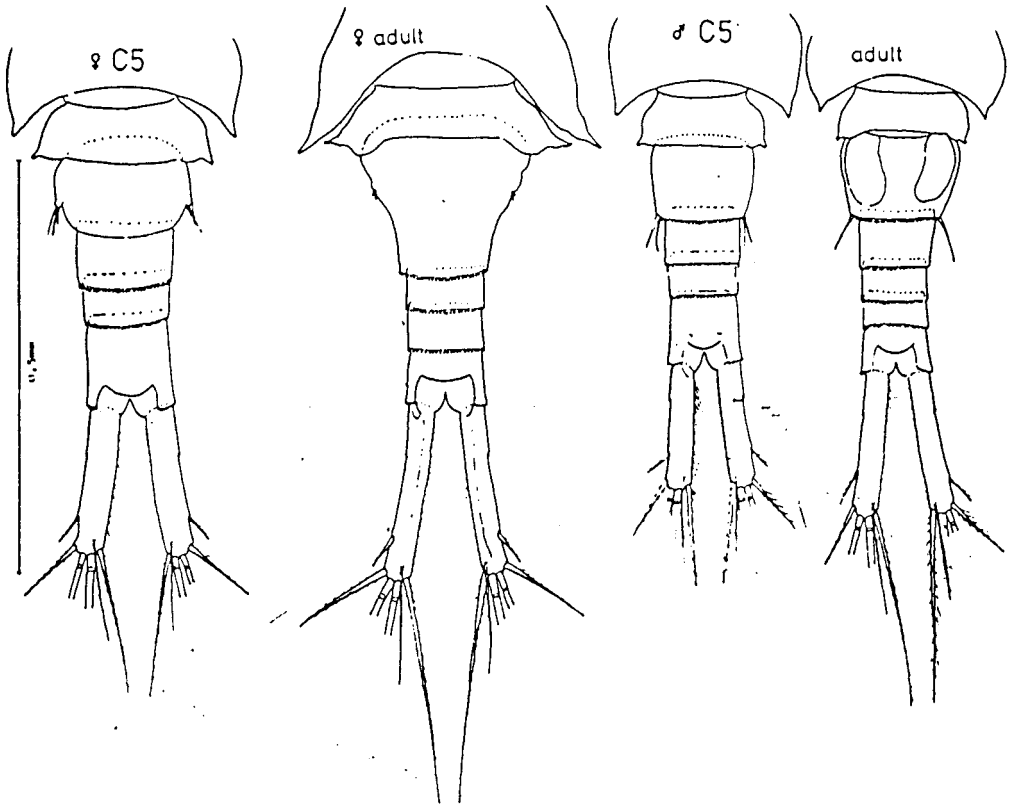
ANNEX 3: Copepodid-stages of Calanoida

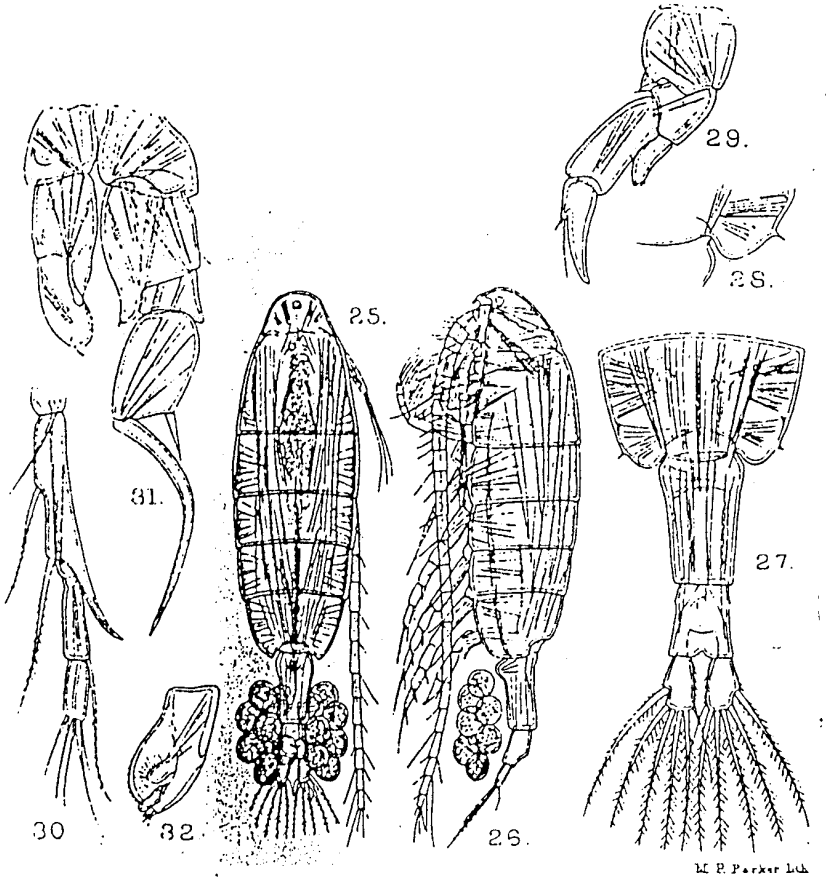


ANNEX 4: Copepodid-stages of Cyclopoida



ANNEX 5: Urosome of adult Cyclopoida, male and female



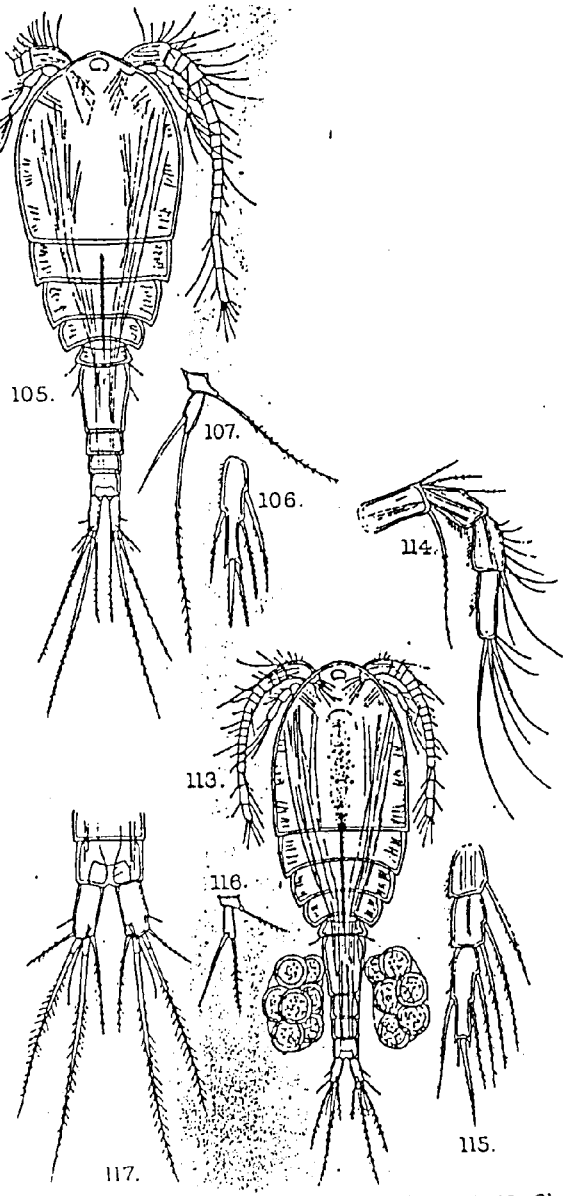


25-32. DIAPTOMUS SIMPLEX. G. O. Sars.

Diaptomus simplex G. O. Sars.

Fig. 25. Adult ovigerous female, dorsal view.
26. Same, viewed from left side.
27. Urosome together with posterior part of metasome, dorsal view.
28. Right lateral part of last segment of metasome, somewhat more magnified.
29. Leg of last pair.
30. Outer three joints of right anterior antenna of male.
31. Last pair of legs of same.
32. Outer ramus of left leg, viewed from the anterior face, and more highly magnified.

ANNEX 7: Mesocyclops aequatorialis aequatorialis
(former Cyclops leuckarti)



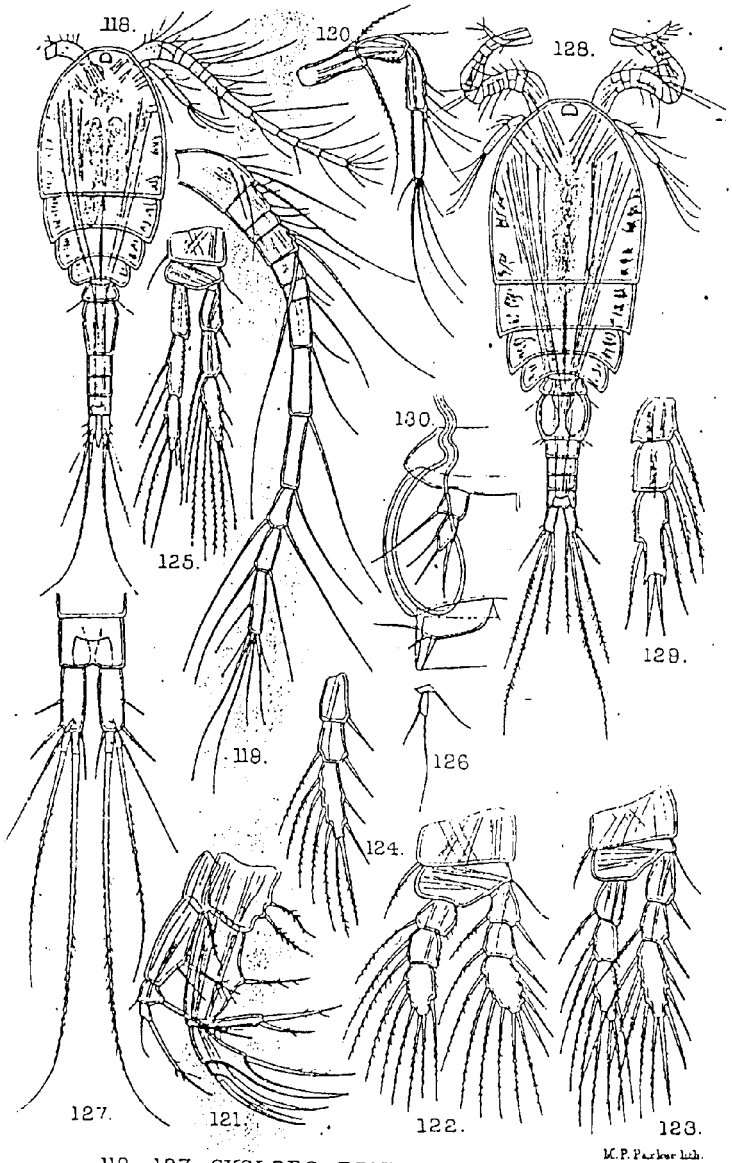
105-107. CYCLOPS LEUCKARTI. Claus
113-117. CYCLOPS NEGLECTUS, G. O. Sars.

Cyclops leuckarti Claus.

105. Adult female, dorsal view.
106. Terminal joint of inner ramus of a leg of 4th pair.
107. Leg of last pair.

Cyclops neglectus G. O. Sars.

113. Adult ovigerous female, dorsal view.
114. Posterior antenna.
116. Inner ramus of a leg of 4th pair.
116. Leg of last pair.
117. Extremity of urosome, with the caudal rami, dorsal view.



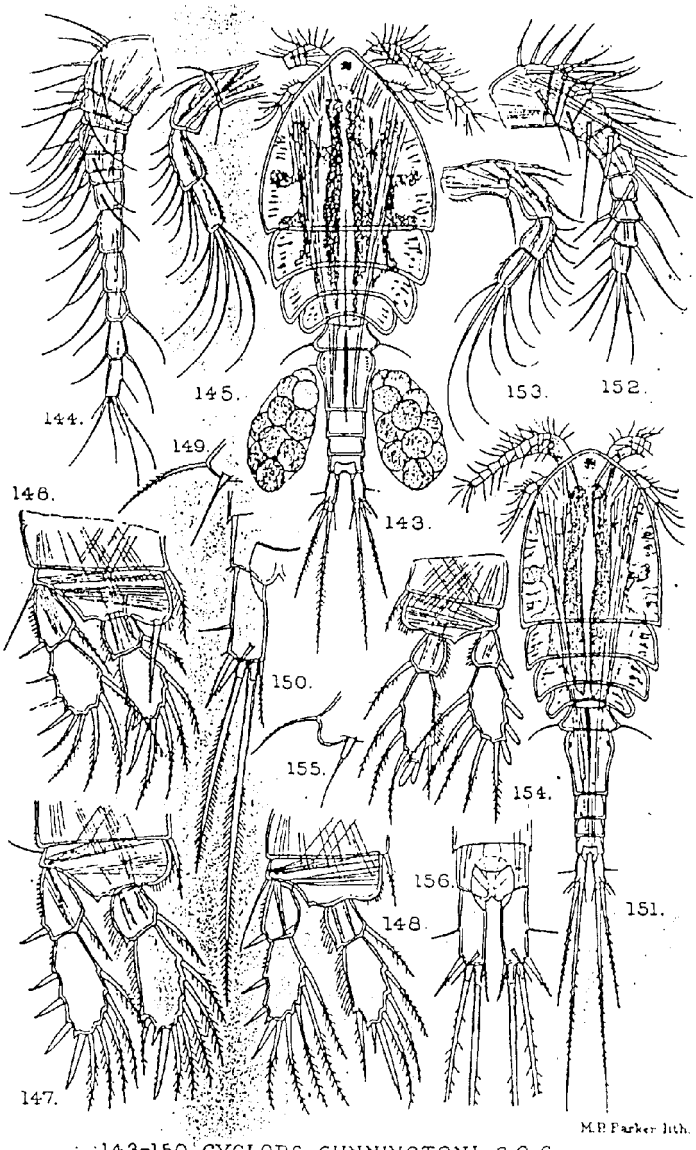
118-127, CYCLOPS TENELLUS, G. O. Sars.
128-130, CYCLOPS ALBIDUS. (Jurine).

Cyclops tenellus G. O. Sars.

118. Adult female, dorsal view.
119. Anterior antenna.
120. Posterior antenna.
121. The two maxillipeds on left side.
122. Leg of 1st pair.
123. Leg of 2nd pair.
124. Outer ramus of a leg of 3rd pair.
125. Leg of 4th pair.
126. Leg of last pair.
127. Extremity of urosome with the caudal rami, dorsal view.

Cyclops albidus (Jurine).

128. Adult male, dorsal view.
129. Inner ramus of a leg of 4th pair.
130. Right half of the last pedigerous segment and of the genital segment viewed from the ventral face, exhibiting the corresponding leg of last pair and genital lamella, as also an enclosed spermatophore.



143-150, CYCLOPS CUNNINGTONI, G.O. Sars.
151-156, CYCLOPS PACHYCOMUS, G.O. Sars

Cyclops cunningtoni G. O. Sars.

143. Adult ovigerous female, dorsal view.
144. Anterior antenna.
146. Posterior antenna.
146. Leg of 1st pair.
147. Leg of 3rd pair.
148. Leg of 4th pair.
149. Lateral part of last pedigerous segment, with the corresponding rudimentary leg.
150. Left caudal ramus, with adjoining part of urosome, dorsal view.

Cyclops pachycomus G. O. Sars.

151. Adult female, dorsal view.
152. Anterior antenna.
153. Posterior antenna.
154. Leg of 4th pair.
155. Lateral part of last pedigerous segment, with the corresponding rudimentary leg.
156. Extremity of urosome, with the caudal rami, dorsal view.

Research for the Management of the Fisheries on Lake Tanganyika (B)

Zooplankton 24 hour intensive sampling with 50 µm net

start from row 7

								counts												
								Diaptomidae					Cyclopidae							
Date	H	C.	Depth	SV	CV	k1	k2	M	F	Ov	Cop	Naup	M	F	Ov	Cop	Naup	Lim.	At	oth.

Annex 11: Zooplankton counting form

Research for the management of the fisheries on lake Tanganyika

Zooplankton counting form

Date: Mesh: Sampled Sample volume:
Hour: Depth: water volume: Team counting:

	CV	MDi	FDi	OvDi	CopDi	NDi	MCy	FCy	OvCy	CopCy	NaupCy	Limno	Shrimp	Vort	Fr eggs	Other
total																

remarks:

Date: Mesh: Sampled Sample volume:
Hour: Depth: water volume: Team counting:

	CV	MDi	FDi	OvDi	CopDi	NDi	MCy	FCy	OvCy	CopCy	NaupCy	Limno	Shrimp	Vort	Fr eggs	Other
total																

remarks:

Date: Mesh: Sampled Sample volume:
Hour: Depth: water volume: Team counting:

	CV	MDi	FDi	OvDi	CopDi	NDi	MCy	FCy	OvCy	CopCy	NaupCy	Limno	Shrimp	Vort	Fr eggs	Other
total																

remarks:

Date: Mesh: Sampled Sample volume:
Hour: Depth: water volume: Team counting:

	CV	MDi	FDi	OvDi	CopDi	NDi	MCy	FCy	OvCy	CopCy	NaupCy	Limno	Shrimp	Vort	Fr eggs	Other
total																

remarks: