The Benthos Study of
Lake Awasa

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By
Tilahun Kibret
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ABSTRACT

Exploratory benthic studies were carried out throughout Lake Awasa at 17 stations for 10 months. Bottom samples were collected by using an Ekman grab and the fauna of the macrophytes from the littoral region was sampled using a fine standard hand net. For determination of total organic matter of the profundal mud an oven and a muffle furnace were used.

Communities of benthic fauna were reported from the Lake in relation to the types of bottom substrates and aquatic macrophytes. The profundal mud was analysed with respect to its total organic matter and texture.

Conditions in the mouth of Tikur Wuha (the main inflow) as a small control area was compared to the main lake with regard to its chemical, vegetations and bottom types.

The fauna of open littoral, weed beds, the mouth of Tikur Wuha and seasonally flooded areas were identified and their distribution in the lake was mapped. The ostracods were found to be the most numerous of all benthic communities (mean number 48,751/m^2). Other benthic crustaceans such as cyclopoid copepods and Cladocera were also reported.

Chironomids were also found to be among the most dominant benthic forms. 27 genera of chironomids were reported from the lake. Nilodorum spp. seem to be the dominant littoral midges in the vegetation. Cladotanytarsus and Procladius species are the dominant bottom midges in the mud below the vegetation and under open water.

Other macroinvertebrates including Ephemeroptera (Caenis and Cloeon spp), Odonata nymphs (Anisoptera and Zygoptera), Heteroptera, Coleoptera, caddis fly larvae (mainly Leptoceridae), gastropod snails and some others were mainly found from the macrophyte zone. Some parasitic and semi-parasitic forms were also collected.

In the littoral zone fauna numbers decreased with increasing depth. In the profundal region, benthos was absent. This seems to be due to the flocculant nature of the bottom mud. Water level fluctuations did not seem to affect faunal distribution.

Seasonal variations of the benthic organisms of the lake were tested for their significance using students t-test and most of the benthos were found to be unaffected by wet and dry seasons. Only the mayfly Cloeon spp and the chironomids Procladius spp were found to be significantly affected by seasonal variations.

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1. INTRODUCTION

The importance of the benthic or "bottom dwelling" fauna of lakes has been stressed by many authors, some of whom are listed in chapter 2. This fauna, consisting largely of small arthropods and oligochaetes, shares with the zooplankton the task of converting photosynthetic plants, algae and detritus into food suitable for many species of fish.

During the last 50 years or more there have been extensive studies on the benthos of temperate lakes, mainly in the northern hemisphere, but far fewer on that of tropical lakes. Most of the tropical research has been carriedout in Central Africa (eg. Munro 1966, McLachlan 1974) but so far, there have been no studies on the benthos of Ethiopian lakes. This is inspite of the fact that much work has been done on the physical properties of Rfit Valley lakes (eg. Talling, Wood, Prosser and Baxter 1973; Wood, Prosser and Baxter 1976; Wood, Prosser and Baxter 1978; Amha and Wood 1982). There would, therefore, seem to be some urgency on making a start on benthic research.

According to the report of the National Revolutionary Development Campaign and Central Planning Supreme Council (1983) Lake Awasa is one of the six Rift Valley Lakes which are chosen for fishery development in the ten year development plan. Annual production of 260 to 700 tons is expected from Lake Awasa between the years 1983 - 1994. A total of 10,000 tons of fish yield is expected from the six lakes by the year 1994 with 700 tons from Lake Awasa.

The aim of the project reported on here is to identify and map the communities of benthic fauna in Lake Awasa in relation to the types of bottom substrate and the distribution of aquatic macrophytes.

2. LITERATURE REVIEW

2.1 The Benthos

According to Brinkhurst (1974) the benthos is defined as being that assemblage of animals living in or on the sediment and dependant upon the decomposition cycle for most not for all of its basic food supply. Hence he considers the benthos as the true "infauna" especially that inhabiting substrates ranging from sand through mud to silt.

However, McLachlan (1979) does not restrict the concept to the sediments only. He uses the term benthos for animals living on solid substrata of any kind in lake, a swamp as well as in the ocean. Accordingly there are generally two substrata of interest in lakes: the mud and the surface of the aquatic vascular plants.

The benthos may be artificially divided into two major groups: macrobenthos and microbenthos. Macrobenthos consists of organisms retained by a No. 30 unit series seive (Lind, 1974), the rest are microbenthos.

Macrobenthos and meiobenthos (the middle sized group) are organisms visible to the naked eyes (Brinkhurst, 1974). The meiobenthos according to McIntyre (1969) can be separated from larger macrobenthos by seives of about 1 or 0.5 mm mesh size.

Benthic organisms play important roles in the aquatic community. First, they are involved in the mineralization and recycling of organic matter produced in the open water above or brought in from external sources, second, they are important second and third links in trophic sequence of aquatic communities (Hayes, McCarter, Cameron and Livingstone

1952; Marlier 1958; Lenhard, Ross and Duplooy 1962; Oppenheimer 1963; McLachlan 1970 and 1971; Boyd 1970). According to Fryer (1959), Macan (1965 and 1976), Hilsonhoff (1967), Petr (1967), Kaushik and Hynes (1968), McIntyre (1969), McCormack (1970), Cummins (1973), Kugler (1978), Gophen, Drnner and Vinyard (1983), many benthic insect larvae form are major food source for fish.

On the other-hand, Ali and Fowler (1983) point out that massive emergence of aquatic insects, such as, chironomid midges, from lake areas may create serious nuisances and economic problems for residents. Such problems include severe annoyance, clogging of air conditioning units, defacing of properties and traffic hazards. Adult midges are also associated with allergic symptoms, Cranston, Gad El Rab, Rosmary and Kay (1983).

2.2 FACTORS AFFECTING DISTRIBUTION AND ABUNDANCE OF THE BENTHOS

2.2.1 Substrate Type

Among the factors affecting the distribution and abundance of benthic fauna, substrate characteristics have much significance. According to McLachlan (1969) the physical properties of substrate particles are of considerable importance and may under certain circumstances be the primary factor affecting fauna presence. For instance he found that coarse sand was avoided by Nilodorum brevibucca which favoured fine particle sediments. Meadows and Campbell (1972) found that the larvae of may fly Hexagenia can only burrow easily in mud. McLachlan (1970) reported that in Lake Kariba, Zimbabwe, the following species were specific to submerged macrophytes: the Chironomids Polypedilum bipustulatum and Nilodorum brevibucca, mayfly Povila adusta and the caddisfly Amphipsyche senegaliensis.

The association of tube builders, including most chironomids, with substrate particles of particular size is usually related to the tube construction requirements of the species. McLachlan (1976) has shown that a preference for large pit particles for tube construction was a factor in the restriction of Glyptotendipes paripes, a chironomid larvae, to a small area near exposed shore of Lake Blaxter in England.

According to Chapman and Trevarthen (1953) the distribution of organisms in sandy shores is a function of the nature of the substrate which controls such factors as drainage, aeration and penetrability. Salinity and turbidity (Harrison and Farina, 1965) are also important factors.

A study by Cuppen (1983) shows that ecological distribution of Hygrotus spp., Dytiscidae, is determined mostly by the water type (depth and size) and the abundance and structure of plant growth. In this case habitat structure and presence of plants and their morphology play a greater role than chemical factors in influencing habitat selection.

McLachlan and McLachlan (1971) working in Lake Kariba showed that faunal biomass was positively correlated with the amount of organic matter in the profundal zone and inversely associated with the quantity of coarse sand in the littoral zone. Faunal biomass decreased with increasing depth and in general littoral mud supported larger number of species than profundal mud.

Morphological and physiological adaptations are also important as shown by Madson (1968) in a study on the mayfly nymphs, Heptagenia sulphura (Mull) and Heptagenia fuscogrisea (Retz). H.sulphura nearly always selects a habitat of stones and gravels whereas H.fuscogrisea is exclusively found on vegetation.

Faunal association with macrophytes was discussed by McLachlan (1966) on the variety and abundance of benthic fauna. The effect of floating plants and of rooted macrophytes on the fauna and the habitat offered by the plants themselves is important for the presence of the fauna. According to his observation, the presence of aquatic plants result in an increase in the biomass of the mud fauna and in the appearance of several new species.

Nevertheless, some aquatic macrophytes may have a negative influence on the distribution of benthic fauna. According to Hobbs and Molina (1983) the presence of the aquatic fern, Salvinia auriculata is detrimental to the production of Anopheles albimanus. In fact, mats of Salvinia had a marked inhibitory effect on anopheline breeding. The plant can be an oviposition barrier to gravid Anopheles albimanus. McLachlan (1966) reported that samples taken in association with S.auriculata mats revealed a total depression of all mud fauna under a permanent mat.

2.2.2 Climatic factors

Climatic factors, especially wind direction and velocity at time of emergence and oviposition, appeared to be very important in determining the distribution and abundance of aquatic insects in lakes (Hilsonhoff, 1967).

Oviposition and site selection by adults appears to have little importance upon the final distribution of larvae within a lake. Reproduction behaviour can be seriously affected by wind which disrupts swarming and hence successful mating, this may also mean that eggs are not laid in suitable sites.

Nevertheless, Davis (1976) has shown that wind induced water currents can counteract these effects; they can lead to concentration of eggs within lakes but also act as dispersal agents for first instar larvae, allowing them to find and settle in more favorable conditions.

2.2.3 Seasonal variations

Seasonal variations which have a bearing on oxygen distribution (Serruya, 1978; Kugler, 1978), change in temperature and salinity (Swanson, 1983) play a role in benthos abundance and distribution. According to Spence (1983) seasonal variations also affect development of aquatic vegetation and patterns of food availability which may in turn affect individual faunal growth and survival.

Environmental factors such as a rise and fall of water level may control the distribution, abundance and even absence of some species. This is associated with chemical changes and reduction in oxygen content (McLachlan, 1970).

2.2.4 Water depth

According to Demeneer, Depauw and Waegeman (1978) shallower zones of lakes support larger fauna population and this is attributed to appropriate conditions such as better oxygenation, suitable substrate or better food supplies; they found that the mean biomass along the edges was 5.2 times higher than in the central parts of a "water sport baan" at Ghent, the Netherlands.

According to Serruya (1978) spatial distribution of benthic fauna is also controlled by the presence of oxygen and the depth of water body. Swanson (1983) pointed out that the restriction of the habitable zone by meromixis (permanent stratification) with accompanying loss of mobile first and second instars also controls faunal presence. Zone of good habitat, that is areas of dense macrophyte or benthic algae growth is seen with high production of invertebrates.

2.2.5 Chemical nature of the mud and pollution

Occurence of the benthos is also affected by the chemical nature of the mud. Hilsonhoff and Narf (1968) reported that the occurence of *Procladius* larvae and ostracoda was positively correlated with a high pH of mud and negatively correlated with the amount of organic matter in the mud in fourteen Wisconsin lakes.

According to the studies of Nalepa and Robertson (1981) and Saraka and Paasivirta (1972) on the vertical distribution of zoobenthos in the substrate, more than 50% of the community occurs in the top centimetre. The upper community includes naidids, chironomids, cyclopoids, cladocera and gastropods. The deeper community consist of tubificids, stylodrilus, nematodes and tardigrades. The vertical distribution of the fauna within the benthic communities has an important influence on circulation of organic matter and the availability of benthic fauna to predators.

According to Saraka and Paasivirta (1972) in the more polluted areas of lakes the macrofauna lives deeper in the sediment than in clear parts. It is suggested that here redox potential is less favourable near the surface of the sediment than in the deeper layers. The influence of human activities such as the wood processing industry and agriculture can also affect the distribution and abundance of both macro and meiofauna.

2.2.6 Competition

Benthic organisms are also restricted in their distribution by inter and intra specific competitions. Generally, feeding patterns, aerobic requirements, methods of locomotion, body shape and presence or absence of competition restrict the majority of zoobenthos to the upper few centimeters regardless of sediment type (Nalepa and Robertson, 1981).

According to Thut (1969) the depth distribution of two Chironomus spp. and two Polypedilum spp and three species of predatory Procladius suggest that competition may play a role in determining the spatial distribution of benthic animals. The inverse correlation between numbers of chironomidae and depth may be due to competitive interaction with oligochaeta.

Fish predation, microsporidial and unknown viruses, fungi and bacteria are found to be the most important regulators of some aquatic insects like for example *Chironomus plumosus* (Hilsonhoff, 1967; Swanson, 1983).

2.2.7 Behavioural adaptations

Behavioural adaptations are also among the factors controlling benthic faunal distribution in aquatic habitats. According to Oliver (1968) species of *Procladius* in the Canadian Arctic require three or more years of larvae development. Here there is overwintering and no emergence occurred before the habitats were clear of ice and snow. The annual emergence was closely synchronized in each of the species investigated.

Such behavioural tactics as recuction to aquatic stages, is a characteristic adaptive value of some tropical midges, *Chironomus imicola*. According to McLachlan (1983) the adaptive value of the life styles of *Chironomus imicola* is quite different from *Polypedilum vanderplanki*, another pool dweller which has a long larvae life and is able to survive desiccation.

2.3 THE LITTORAL BENTHIC FAUNA

According to Wetzel (1975) the littoral region consists of an interface zone between the land of the drainage basin and the open water of lakes and is divisible into a number of rather distinct transitional zones from the shore to the deepest point. The epilotoral zone lies entirely above the water level and is uninfluenced by spray. The supralittoral zone also lies entirely above the water level, but is subject to spraying by waves. The eulittoral zone encompases that shoreline region between the highest and the lowest seasonal water levels and is often influenced by the disturbances of breaking waves. The eulittoral zone and the next zone, the infralittoral, collectively constitute the littoral zone. The infralittoral zone is subdivided into three sub zones: the upper infralittoral or zone of emergant or floating leaved, rooted vegetation; and lower infralittoral or zone of submersed rooted or adnate macrophyte.

According to Williams and Lenton (1975) there is evidence that the largest numbers of zooplankton are found near periphery of lakes and there are active faunal migrations towards it. For example, each year Clarias mosambicus Peter and Barbus paludinosus Peter, which account 70% of the fish in Lake Chilwa move from the open lake into littoral zone.

According to Williams and Lenton (1975) the littoral zone has the following roles:

1. it provides a diverse habitat for animals.
2. it acts as a sieve and a trap for allochtonous and autochtonous material.

3. the nutrient pump effect of emergent vegetation often results in higher concentration of elements in the littoral water than in that of the lake itself.
4. it often contributes a major portion of the autotrophic production of a lake of which detritus forms a major energy source.

According to Munro (1966) therefore, the littoral region undoubtedly plays a large part in the provision of food for fish.

During exploratory studies on the invertebrates in Lake McIwaine, Zimbabwe, Munro (1966) collected along transects running from shallow littoral to profundal waters; his samples show that the greatest abundance of all types of invertebrates occured in 2-5 meters in the upper sub-littoral. Below this the levels of abundance declined.

According to McLaohlan (1970) the oviposition of Chironomid females is determined by immersed vegetation. Therefore, macrophytes of the littoral zone have important roles in the spatial distribution of aquatic fauna. It seems likely therefore, that the standing crop of fauna on immersed vegetations may be inversely proportional to the distance from the littoral zone.

According to Boyd (1970) most macrophytes are good sources of minerals, carbon,proteins, nitrogen, sulphur and potassium. The amino acids, proteins and caloric contents of vascular aquatic plants were studied by Boyd (1970) and his findings indicated that the amino acid composition of proteins in aquatic macrophytes is relatively constant; for example the protein level in Typha latifolia was found to be 4g/100g dry weight, in Nymphea odozata 14.6, in Ceratophylum demersum 17.1 and

Lake Awasa is fringed by an extensive macrophyte zone which may extend out into the water for 150m or more in some places and to a depth of 4-5m. This zone is stratified into sub-zones dominated by different plant species more or less according to the depth. At the littoral margin, extending to about 20-40m offshore (to ?m) is a sub-zone of mixed species, mainly patches of Cyperus spp, water lilies (Nymphea caerulea) and Potomogeton spp., a number of isolated patches of Typha angustifolia were noted close inshore. Then follows a sub-zone of grass, Paspalidium geminatum about 50 - 100m wide to a depth of 3 or 4m. The rhizomes grow up from the bottom and the upper stems are hollow and float, the growing shoots with leaves and fruiting bodies emerge into the air. This plant is the dominating macrophyte of the lake. In places there are limited patches of Potomogeton sp. just beyond the Paspalidium sub-zone, and on the bottom of a patch of open water within this zone Chara sp was found growing.

At the mouth of the Tikur Wuha River the vegetation is quite different consisting of large patches of Cyperus papyrus, Ludwigia stolinfera, Lemna minor, Wolfia arrhiza, and grasses not found elsewhere. This difference in flora is attributed to the lower content of sodium in the river water.

A list of some aquatic macrophytes of Lake Awasa is given on Table 18.

The lake water is rich in phytoplankton mainly the algae Botryococcus sp. which colours the water a green to brownish-green colour for all of the year.

The bottom of the lake consists mainly of hard pumice and quartz sand. This is visible on the few sandy beaches, mainly on the western shore where cattle are watered. It extends, however, under the macrophyte zone where it is covered with a thin layer of mud. This type of bottom extends up to 1500m from the western shore but to a lesser distance from the other shores, but always to about 500m beyond the macrophyte zone and to a depth of about 6(?)m. Beyond this the hard sand is covered with a layer of ostracod shells mixed with a little mud to a depth of about 6-8m(?).

At about 8m or slightly deeper the bottom is covered with a layer of very soft, brown flocculant mud. This extends to the maximum depth of the lake, 22m (Fig. 2).

4. MATERIALS AND METHODS

Bottom samples were taken by using an Ekman grab which has a capacity of 5,175 cubic centimeters. Fauna of littoral region from macrophytes was sampled using a fine standard hand net which has a mesh size of 0.20mm. Samples were taken from 25.4.83 to 12.2.84 for ten months at intervals of thirty days.

The samples were collected from littoral, profundal regions of the lake, seasonally flooded areas and from temporary water collections around the margins of the lake. The samples were collected from 17 sampling stations (Fig. 3).

The collected samples were then preserved in 5% formalin solution and were transported in polythene plastic bags to our laboratory in Addis Ababa. In the laboratory the samples were washed through the same mesh size net as that used in the field. Bigger organisms were sorted out against the white background of an enamel dish and then were identified using keys of Pennack (1953) and Ward and Whipple (1959). Smaller ones were counted using a multiple channel counter and analyzed under a dissecting microscope. For detailed identification a compound microscope was used.

For the determination of total organic matter an Imperial II radiant heat oven, UL type, and an electric muffle furnace were used. The mud content was dried at 80°C and the dried samples were burnt in the furnace at 550°C. An electric Mettler balance was used for weighing the samples and total organic matter was calculated from the weight difference of the dried and burnt samples.

When the samples were large in size for analysis and counting, subsamplings, Edmondson (1971), were used for processing and developing data. The sample was poured into a beaker and was thoroughly stirred with a glass rod in an irregular manner to achieve a random distribution of organisms. Stirring was done in such a way as to avoid vortices that serve to concentrate organisms in one portion of the container. While the sample was being stirred, the sub-sample was taken using wide mouth pipette.

Remarks on Figure 3

Different sites were chosen around the lake as sampling stations. These stations are marked on Fig. 3.

Station

I = Boat landing site
II = Infront of police station
III = Near veternary clinic
IV = Tulu
V = Jara, southern part of lake, rocky shore
VI = Korate, south western part of the lake
VII = Dore
VIII = Shalfo
IX = South of Rima
X = Rima
XI = Cheleleka northern part of the lake
XII = Mouth of Tikur Wuha
XIII = Back water near Relief and Rehabilitation office
XIV = Seasonally flooded area
XV = Ogowa, back water
XVI = Off the mouth of Tikur Wuha
XVII = Off Tulu

Most of the stations were visited more than two times during the study periods. Samples were taken from the coast upto the margin of the flocullant mud.

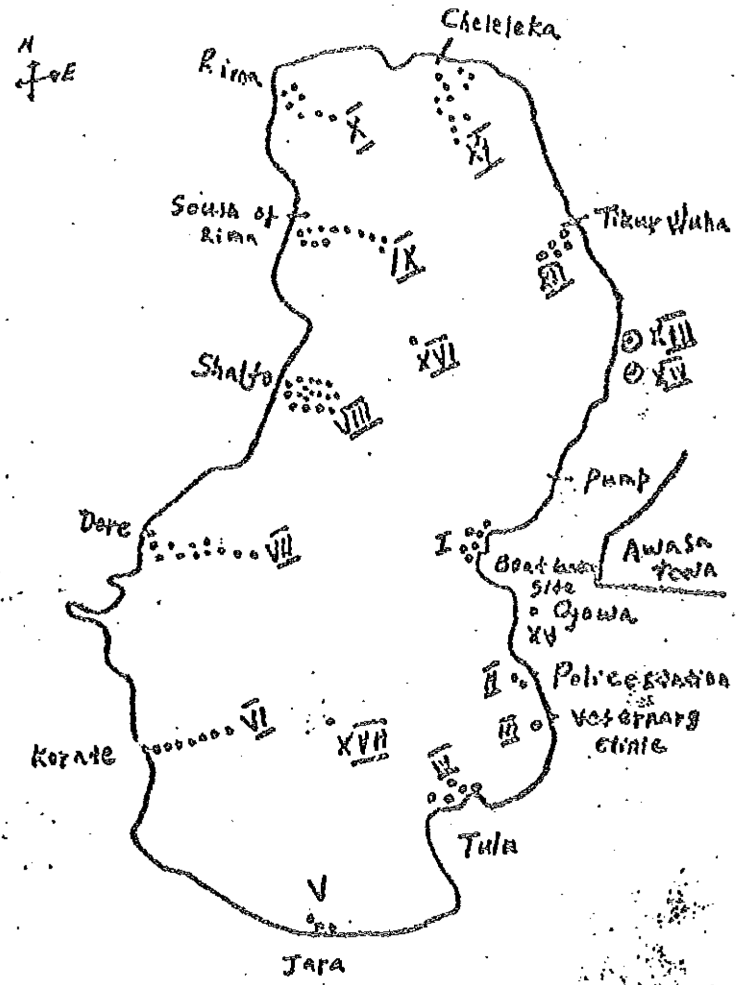

Fig 3 Lake Awasa Sampling Stations

5. RESULTS

Benthic fauna

5.1 The profundal mud of Lake Awasa

The profundus of the lake is composed of mainly very soft floculant brown mud and detritus below a depth of 6-8 meters. Thus mud is so soft that benthic fauna find it difficult or impossible to live on it and burrowing animals cannot construct tubes through it. A number of samples were taken with the Ekman grab but very few or no macroinvertebrates were collected in each sample. The macrophyte zone and the adjacent littoral regions are, however, rich in fauna.

The total organic matter of of this mud content of the lake has been found to be one third of the dry weight 30.59% (Table 1) of the mud. After burning the residue was found out to be composed of hard siliceous crystalized substance which was insoluble in water and hydrochloric acid. No ostracod shell or any other benthic skeletal remains were found. The presence of the silicious substance in the profundal mud suggests that the bottom of lake may be sandy pumice throughout covered by organic detritus; water seepage upward through this sandy pumice bottom may carry siliceous particles into the mud.

TABLE 1

Total organic matter of profundal mud of Lake Awasa (below a depth of 6-8 meters).

Experiment	Dry weight gm	Ash weight gm	Total organic matter gm	% Total organic matter
1	5.527	3.917	1.61	29.13
2	7.828	5.120	2.71	34.61
3	6.850	4.452	2.40	35.04
4	10.03	7.156	2.87	28.61
5	8.783	6.268	2.52	28.69
6	7.401	5.372	2.030	27.43
Average				30.59

5.2 Fauna of open littoral

Starting from the margin of the macrophyte zone and stretching deep into the open water for at least 500 meters is found large zone with a bottom consisting largely of ostracod shells; this is inhabited mainly by five species of benthic ostracodes (Table 3-4). In addition, oligochaeta, mainly *Limnodrilus* sp, Epehmeroptera (*Caenis* and *Cloen* spp) and chironomid larvae are present.

Oligochaeta *Limnodrilus*, Naididae (*Nais spp*) and Ephemeroptera each had population running into hundreds per square meter and ostracods, copepods and chironomid larvae were measured in thousands per square meter. Hydracarina, Odonata nymphs, Trichoptera and mollusca had relatively small numbers (Table 2). High standard deviations indicate a patchy distribution for all organisms.

5.3 Fauna of weed beds

The benthos of the weed bed of Lake Awasa is stratified in the lake in the following way: in the littoral region benthic organisms are found both at the bottom and in the weed bed. It was observed that the weed beds harbour the majority of the many invertebrates. Ostracoda mostly Limnocytherinae Gomphocythere *angulata* and Darwinulidae Darwinula *stevensoni*, Oligochaeta mainly *Nais* spp, Hydracarina, Ephemeroptera (*Cloeon* and *Caenis* spp) and chironomid larvae were also present. Benthic nematodes, copepods (mainly cyclopoid spp), Cladocerans, Odonata nymphs (Zygoptera, Coenogrionidae, and Anisoptera), Trichoptera, Heteroptera (Corixidae *Micronecta* spp, Gerridae, Nepidae, Naucoridae *Laccocoris* spp Notonectidae *Anisops* spp, Mesoveliidae, Plea, Veliidae), Homoptera, Coleoptera (Curculionidae, Dytiscidae, *Berosus* spp, Gyrinidae, Hydrophil

Scarabidae), Ceratopogonidae, Stratiomyiidae, gastropod snails, amphibians (tadpoles) and fish fry were also found around the macrophyte zone of the littoral region.

In addition to the sedentary aquatic animals, certain terresterial forms which may be accidental or visitors were often seen around the macrophyte zone. In this group are included terresterial dipterans (Syrphidae), lepidopterans, hymenopterans, orthopterans and coleopterans. Their appearances may be for feeding, egg laying or it may be accidental. For instance some lepidopterans caterpillars were found in the stems of the grass Paspalidium, Cyperus, spp and other types of vegetations.

5.4 Fauna of Tikur Wuha River

The water is slightly turbid and brown in color. The bottom substrate which is mainly sandy pumice has a larger particle size than the main lake.

Samples from Tikur Wuha have different fauna from the rest of the lake and the midge Chironomus sp was found to be dominant at the mouth of the stream on June 1983 samplings (Appendix V'). Besides, Stratiomyiid Ceratopogonidae, caddisfly larvae and pupa and other dipterans larvae such as Culicidae were found in large numbers at the mouth of the stream. Snails, however, were not collected from this site. Some of the Ostracod collected in the mouth of the stream were different in their sizes, shapes and color compared to those found in the main lake.

The bottom samples from the mouth of the river were poor in their fauna type and number (Appendix W').

5.5 Fauna of flooded area

The organisms collected from more recently flooded areas and from the main lake were found to be similar (Table 2,6,11) and unlike those of Lake Chilwa, Lancaster (1979), Cantrel (1979). Water level fluctuations seem to have no significant effect on faunal distribution in Lake Awasa.

The most important groups of benthic organisms of the lake are the following:

1. Nematoda

The nematods collected were small, transparent and were rare in their occurence. Most of the nematods were collected from the bottom of the lake using the Ekman grab. The largest numbers of nematodes were collected from sandy bottom between the grass *Paspalidium geminatum* and *Cyperus* sp at station IX (Table 4.). Very few nematods were collected using hand net from and around the weed bed. It may be suggested that most of the nematods may be burrowing forms at the bottom of the lake. It should be noted that many small nematods could have escaped through the mesh of the net or laboratory sieve net.

2. Oligochaeta

Two families of Oligochaetes, naididae and tubificidae, were collected from the lake. These are represented by Nais and Limnodrilus spp respectively. 86% of the collected Limnodrilus were from the bottom of the lake, collected by an Ekman grab. The weed bed harbours about 11% of Limnodrilus in the community. The rest 3% were collected from back waters of the lake and the feeder stream Tikur Wuha. Most of the naidids were from the weed bed. But some Nais spp were also found at the bottom of the lake but with less frequency and abundance. Only 10% of the Nais population was found to be bottom dwellers.

3. Hirudinae

Few hirudines were collected from the lake throughout the study. Most of the leeches were from the Tikur Wuha. These predatory Annelids were also present in the weed bed, at the bottom of the lake in the littoral region and back water of the lake.

4. Orbatid mite

These benthic organisms comprise 6% of the benthic community and were mainly found in back waters, flooded areas and shallow water of the lake. Few orbatid mites were collected from the main lake in the weed bed. The largest numbers of orbatid mites were collected from shallow water at station III (Appendix Q') in association with charophytes.

5. Hydracarina (water mites)

The hydracarina were collected from the weed bed (Table 6), bottom of the lake (Table 2), in the mouth of Tikur Wuha (Table 12), back waters, seasonally flooded areas and shallow water (Table 11). Hydracarina were also collected from the bottom of the lake under the weed beds (Table 4). The largest number of these organisms were collected from the weed bed using a hand net. Among the macrophytes the water lilies, Nymphea sp, (Table 8) harbour the largest number of Hydracarina.

6. Crustaceans

More than 70% of the benthic fauna of Lake Awasa were crustaceans. These organisms were sampled in the lake from the weed bed, bottom of the lake, mouth of the stream, Tikur Wuha River, back waters, flooded area and shallow water of the lake.

6.1 Cladocera

The list of benthic Cladocera of Lake Awasa is given in (Table 15). More than four genera of cladocerans are reported from the lake. These benthic organisms constitute about 5% of the benthos. They were found mainly in the weed bed.

The cladocerans Diaphnosoma excisum, Alona sp cf. quadrangularis, Alona, sp, Alona davidi and Macrothrix spinosus were collected from the grass Paspalidium geminatum using a hand net at different stations IV-XI from the lake (Appendices E,F,I,K,N). Diaphnosoma excisum, Macrothrix sp and Alona davidi were also collected from Nymphea sp at stations I and X (Appendices K,F'). Moina micrura and Alona davidi were also collected from Cyperus at station IX using a hand net (Appendix J').

Macrothrix spp were collected from the bottom of the lake using an Ekman grab at station VIII (Table 5).

Alona pulchela, Macrothrix spinosus and Macrothrix triserials were collected from seasonally flooded grass infront of hotel at station XIV (Appendix T'). Also Moinodapnia macleary and other cladocerans were collected from temporary water near Relief and Rehabilitation Commission Office at station XIII (Appendix S').

6.2 Copepoda (cyclopoids)

Copepods are a substantial component of the benthos of Lake Awasa. In addition to the limnetic forms, many are benthic forms and constitute about 22% of the benthic fauna of Lake Awasa. Most of the benthic cyclopoids were found in the weed bed (Table 6). They were also found in small numbers at the bottom of the littoral and a mean of 2,941 per m^2 were found; they were third in density behind the ostracod and the chironomid larvae. Nevertheless, cyclopoids were the dominant benthic organisms in the weed bed and constitute 50% of the benthic organisms in this part of the lake. More than five genera of cyclopoids (Table 16) were reported from different stations in the lake. The sites of collection were from the weed bed, bottom of the lake, shallow water of the lake, in mouth of Tikur Wuha, back waters and seasonally flooded grass.

Accordingly cyclopoid copepods were the cominant group. These were collected from the grass Paspalidium geminatum in different parts of the lake including stations I and V (Appendices D,E). One cyclopoid species, Mesocyclops aequaterialis similis, was also collected from water lilies (Nymphae sp) from station I in the eastern side of the lake (Appendix D).

Cyclopoid Copepods, some of which with eggs, were collected from stations VII and VIII using an Ekman grab from the bottom of the littoral (Table 3,5).

Ectocyclops spp were sampled from shallow water at station III (Appendix Q') and Mesocyclops aequatorialis similis were also collected from station XIII in temporaty water collections (Appendix S'). Cyclopoid copepods including Afrocyclops spp were collected from the mouth of Tikur Wuha (Appendix V').

6.3 Branchiura: Argulus spp

These parasitic copepods (Pennack, 1953) were found in the lake but with less frequency. They are usually attached to their hosts which may include fishes and amphibians Prasad (1980). The branchiuran copepods were collected from the bottom of the lake at littoral region and the macrophyte zone by using an Ekman grab and a hand net respectively (Table 2,6).

Argulus spp were accordingly collected from Southern tip of the lake, station V at the edge of the grass Paspalidium geminatum by using an Ekman grab (Appendix A). Argulus spp were also collected from the bottom of the lake 100 meters from grass under the mud of open water at station IX, (Table 4). These parasitic Copepods were also collected from stations I and V around the grass Paspalidium geminatum (Appendices E.G), in Nymphae, from flooded area infront of hotel at station XIV (Appendices R,T'), from station XI in the grass Paspalidium (Appendix I) and in the mouth of Tikur Wuha (Appendix Y') by using a hand net.

6.4 Ostracoda

These groups of organisms were the most numerious of all benthic forms. They constitute about 87% of the benthic community at the bottom

(Table 2). It was noted that these forms were mainly bottom dwellers. Ostracods were found at the bottom of the littoral region under vegetation cover extending upto 1000 meters into deep water (Table 5). The ostracods had their highest density about 50 meters distance from the outer margin of the grass Paspalisium geminatum under open water.

The ostracods collected at the bottom were mainly Limnocytherinae (rough surface 95.82%) and in addition smooth surface forms 4.18%, Darwinulidae, were also collected.

Ostracods were also found in the macrophyte zone and the mouth of Tikur Wuha but relatively in less numbers (Table 6,12) than the bottom population. In addition ostracods were also present in back waters and seasonally flooded area of the lake (Table 11).

7. Ephemeroptera

Two families of mayflies were commonly found in the lake. These were Caenidae and Baetidae, represented by Caenis spp and Cloeon spp. The Ephemeroptera constituted about 2% of the whole benthic community. These mayfly nymphs were collected from the bottom of the lake, weed bed, shallow water of the lake, mouth of Tikur Wuha, back waters and seasonally flooded area.

Caenis spp were predominantly found at the bottom where they were fifteen times denser than Cloeon spp (Table 2). Caenis and Cloeon spp were collected from the bottom of the lake from stations VI, VII, VIII and IX at different times of samplings (Table 3,4,5) and(Appendix C).

The Ephemeropterans were also collected from the weed bed; here the Cloeon spp were about ten times more numerous those of Caenis spp. In the weed bed the mayflies were collected from stations I,IV,V,VI,VII, IX and X in the grass Paspalidium (Appendices D,E,G,H,K,L,N,Q). Mayfly nymphs were also collected from stations IV,VII,VIII,Xand XI in Nymphae (Appendices W.Y,B',C',E') and here too the Cloeon spp were more dominant than the Caenis spp (Table 8). Samples collected from Tikur Wuha (Table 12), shallow water of the lake and flooded area (Table 11) showed mayflies and there too the Cloeon spp were more dominant than Caenis spp.

Adults of Cloeon collected at lights at night indicated that there was one common species of Cloeon and two rare species. Flying adults of Caenis caught at the lake shore appeared to belong to only one species.

8. Heteroptera

During the year 1944-46 while travelling widely in Ethiopia, Kenya and Somalia Hynes (1955) had collected aquatic heteropterans. One of the collections made was in Lake Awasa on open sandy beach and in the same Lake Awasa at inflow. Micronecta scutellaris stal, Mesovelia vittigera were collected in the main lake where leaves of water lilies broke the surface or where there are emergent vegetation. Gerris severinin Kirkaldy, Microveliia gracillima Reuteur, Microvelia awasai Poison, Hydrometra somaliensis Poison, Mesovelia vittigera Horvath, Micronecta scuttellaris stal, Micronecta isis, Sigara sexilineata Reuter, Laccocoris limigenus stal, Sphaerodema grassei Poison were collected from the inflow. Nevertheless, the family Nepidae, Notonectidae, Pleidae, Herbidae and Rantaridae were not collected from the stream.

The family corixidae Micronecta denticulata Hutchinson, Gerridae, Naucoridae Laccocoris spp, Notonoctidae Anisops spp, Mesoveliidae, Plea, Veliidae and Homoptera were collected from lake Awasa (Table 6) mainly from the weed bed. Corixidae Micronecta denticulata Hutchinson and notonectidae Anisops spp were the dominant heteropterans.

The heteropterans collected at the mouth of Tikur Wuha (Table 12) were similar to those found in the main lake around the macrophyte zone. In addition, Nepidae Ranatra cf. parvipes, Belostomatidae Sphaerodema cf grassie were collected from seasonally flooded grass (Appendix U').

9. Coleoptera

Many larva and adult coleopterans were collected from Lake Awasa from the Weed bed through-out the study period (Table 6). Dytiscidae were the dominant coleopterans. In this group are included Hydrophorium and Notorini spp. Hydrophilidae were also another important family collected. Other coleopterans such as Gyrinidae, Curculionidae, Scarbidae and many other aquatic and some terresterial colleopterans were found in the lake.

Coleopterans collected from Tikur Wuha (Table 12), seasonally flooded grass, shallow water of the lake and back waters (Table 11) were similar to those found in the main lake and most of the beetles collected were predators.

10. Diptera

10.1 Chironomidae

A total of twenty seven genera of chironomid larvae were reported from the lake (Table 17). These midges constitute about 10% of the benthic community of the lake. Most of these dipterans were littoral and very few were profundal forms. The majority of the chironomids were found at all times of samplings and few showed seasonality (Table 13-14). Apart from the main lake, chironomids were also collected from the mouth of Tikur Wuha (Table 12) back waters of the lake and seasonally flooded areas (Table 11) and all of them were found to be similar to those found in the main lake.

Most of the chironomid larvae in the littoral zone bore into the stems of such macrophytes as Paspalidium geminatum and Cyperus spp and pupate there. Some of the chironomids (eg. Nilodorum and Cricotopus spp) can also construct their tubes from detritus and dead algae specially of Botriococcus spp.

Nilodorum spp seem to be the dominant littoral midges (Table 6). Other midges such as Cricotopus scottae, Procladius spp and Tanytarsus spp were also found in large numbers in littoral region. Ablabesmyia, Cladotanytarsus, Cryptochironomus, Polypedilum, Procladius and Tanytarsus species were mainly bottom dwellers. Species diversity and faunal number of chironomid larvae collected from the bottom of the open water decreased with the progress of the depth of the lake. The habitats of the bottom dwellers extend from the macrophyte zone deep into the bottom [illegible] of the open water to the margin of the flocculant mud. Such bottom dwelling midges as the Ablabesmyia, Cryptochironomus, Polypedilum Tanytarsus and Xenochironomus were mainly found in the littoral regions under the vegetation cover . Nevertheless, Cladotanytarsus and Procladius were the only midges which extended onto the bottom of the deep water (Table 4-5). According to Thut (1969) Procladius spp do not build or construct mud tubes but actively move about the substrates searching for food. They are also one of the chironomids whose larvae are found in open water.

Unlike Lake Kinneret, Kugler (1978) from which chironomid larvae were reported from the depth of 42.5 meters of the profundals, the chironomids from Lake Awasa reach only maximum depth of 8 meters. Here, the benthic organisms are restricted to the littoral regions. Similarly Lake Chilwa McLachlan (1979) harbours most of its chironomids in the macrophyte regions.

Some of the midges were not strict littoral or mud dwellers. There were chironomid larvae which were common to both habitats. These types of larvae include the *Ablabesmyia*, *Cladotanytarsus*, *Procladius*, *Cricotopus scottae*, *Dicrotendipes*, *Parachironomus*, *Polypedilum*,*Cladotanytarsus* and *Tanytarsus* species (Table 4-5).

Orthocladini, *Corynoneura* and *Nanocladius* were found only in the weed bed (Table 6). On the other hand *Clinotanypus* and *Xenochironomus* were strict bottom dwellers (Table 2).

The chironomid larvae which were found at the mouth of Tikur Wuha (Table 12) were similar to those living in the main lake. But the *Chironomus* spp were mainly found at the mouth of Tikur Wuha. They were very rare in the main lake. In addition, *Cricotopus albitibia*, *Nilodorum* spp, *Parachironomus*, *Polypedilum*, *Cricotopus scottae* and *Parametriocnemus* were collected at the mouth of Tikur Wuha near vegetation *Papyrus.* The bottom of the river had relatively fewer chironomids. *Procladius*, *Dicrotendipes*, *Nilodorum* and *Parachironomus* spp were collected five meters from the mouth of Tikur Wuha.

Chironomids collected from 25.4.83-12.2.84 (Table 7) in the grass *Paspalidium geminatum* consisted *Nilodorum* spp and *Cricotopus scottae* in large numbers. These midges constituted more than half (0.77) of the whole chironomid community collected. *Tanytarsus* spp, *Polypedilum*, *Parachironomus*, *Cricotopus albitibia* and *Nanocladius* were found in small numbers. The chironomid larvae were 14% of the whole benthic community found in the grass.

Chironomids collected in the lake around *Nymphea* were fairly abundant and constituted 25.5% of the benthic community in this region (Table 8). *Nilodorum* spp were the dominant midges. They constituted half the population of chironomids. *Procladius* species were the second dominant group followed by *Cricotopus* spp.

In *Cyperus*, unlike the grass and water lilies (*Nymphea* spp), only a few kinds of chironomid larvae were collected. *Cricotopus scottae*, *Nanocladius* and *Nilodorum* species were the dominant group (Table 9).

The bottom samples collected from the lake using the Ekman grab consisted mainly of the Chironmids *Cladotanytarsus* and *Procladius*. Other chironomids such as *Nilodorum*, *Polypedilum*, *Xenochironomus* and *Cryptochironomus* were also found (Table 2). These midges were mainly present at the bottom of the littoral region. Nevertheless the *Cladotanytarsus* and *Procladius* spp were not restricted to the littoral region; they were found deep under the open water mud. Larval abundance was, however, greater up to the distance of 50 meters from the grass *Paspalidium geminatum* zone (Table 3,4,5).

10.2 Other dipterans

Such dipterans larvae as Ceratopogonidae *Bezzia* spp, Culicidae and stratiomyiidae were also collected in the lake (Table 6). Some other dipterans adults were also found. These were mainly collected from the weed bed using a hand net. All the dipterans collected from the bottom of the lake belong to the family chironomidae (Table 2). Most of the Stratiomyiidae were collected in the weed bed and some were found in the mouth of Tikur Wuha. Most of the biting midges, Caratopogonidae Bezzia spp and Culex spp were collected from the mouth of Tikur Wuha stream near Cyperus papyrus using hand net (Appendix Z').

11. Mollusca

Mollusca (gastropos snails) were collected from different stations in the lake. The molluscs were found in the macrophyte zone, bottom of the lake, back waters and seasonally flooded areas. No snails were collected in the mouth of Tikur Wuha river.

The snails Bulinus truncatus, Afrogyrus coretus and Gyraulus costulatus were collected from the grass Paspalidium geminatum at different times and different stations - I, III, IV and XI (Appendices D.G.O,P,Q). Bulinus truncatus, Bulinus forskali and Afrogyrus coretus were also collected in Nymphea at stations I, IV, VIII, X and XI (Appendices R,S, V, C', D', F', G').

Few Bulinus truncatus were also collected using a hand net at station IX (Appendix J'). They were also collected from Potamogeton at station XI (Appendix O').

Bulinus truncatus and Gyraulus costulatus were collected from the bottom of the lake at littoral from stations VII, VIII, XI using Ekman grab (Table 3,4,) (Appendices B.C.). The snails Gyraulus costulatus were sampled at site VIII between Cyperus and the grass Paspalidium from hard bottom where the vegetation Chara was dominant.

Bulinus truncatus, Gyraulus costulatus and Lymnea natalensis were collected in shallow water at station III (Appendix Q') and the snails Biomphalaria sudanica, Bulinus forskali and Bulinus spp. were collected from station XIV (Appendix U').

12. Fish fry and minnows

Most of the fish fry were collected from the weed bed (Table 6) and Potamogeton (Table 10) by using a hand net. These were Oreochromis niloticus, Barbus spp and small cyprinidont minnows. Oreochromis niloticus and Barbus spp are important with respect to their abundance and economic uses.

13. Seasonal distribution of the benthos

The presence of the benthos of Lake Awasa was not much governed by seasonal variations. Both the weed bed and bottom samples had to a lesser extent differences in their faunal composition at different seasons.

According to Daniel Gemechu (1977) the type of rainfall regimes of the lake region in the southern Rift Valley are characterized by one rainy season, that is, the rainy months are contiguosly distributed. This also means that there is only one dry season. There are eight rainy months from March to October and there are no "small rains".

The seasonal distribution of the benthos of Lake Awasa is given on table 13-14. Compared to wet season, the benthis organisms were found relatively in larger numbers in dry season. For instance the oligochaetae Limnodrilus spp were collected in the weed bed in dry season only. On the otherhand naididae(Nais spp) were dominant in the weed bed during wet season. Copepods constituted 49.75% of the number of the benthos community in the dry season and their number was reduced to 13.43% in the wet season. Hetropterans on the other hand had their largest numbers during wet season. Trichopterans and molluscs had their highest numbers during the dry season.

TABLE 2 (Cont'd.)

Date 25.5.83- 10.2.84	Benthic Organisms	No.	Mean No. n = 30	S.D.	No./m^2	%
	Cricotopus Scottae	3	* 0.004			
	Parachironomus Sp$_2$	1	* 0.0014			
	Chironomus sp	1	* 0.0014			
	Criptochironomus	17	* 0.023			
	Dicrotendipes	1	* 0.0014			
	Nilodorum	74	* 0.1			
	Parachironomus	1	* 0.0014			
	Polypedilum	32	* 0.044			
	Xenochironomus	27	* 0.037			
	Cladotanytarsus pseudomancus	366	* 0.492			

* Proportions of Chironomidae

TABLE 2 (Cont'd.)

Date 25.5.83–10.2.84	Benthic Organisms	No.	Mean No. n = 30	S.D.	No./m^2	%
	Tanytarsus	2	*0.003			
	Chironomid pupa	11	0.37	0.85	486	0.03
	Clinotanypus	1	0.033		2	
	Clinotanypus brevitarsis	2	0.067		3	
	Nilodorum brevipalpis	5	0.17		7	
	Parachironomus sp	1	0.033		2	
	Cladotanytarsus	2	0.067		3	
	Mollusca Gastropod snails	22	0.73	26	32	0.058
	Bulinus sp	1	0.033		2	
	Bulinus truncatus	7	0.23		10	
	Gyraulus costulatus	14	0.47		21	
	TOTAL	37961	1265.37		56,182	100.00

* Proportions of Chironomidae

TABLE 3

Benthic Organisms of Lake Awasa Collected from Shalfo using an Ekman grab

Date 10.9.83	Benthic Organisms	Water-lilies Nymphea	Cyperus	in grass	edge of grass	50m from grass	Mean No. n = 5	No./m^2	%
	Oligochaeta								
	Naididae			14			2.8	124	0.14
	Limnodrilus				154	51	41.0	1820	2.09
	Ostracoda	26		321	5186	3026	1711.8	76004	
	Darwinulidae			72	173	112	71.4	3170	3.63
	Limnocytherinae			249	5013	2914	1635.2	72603	83.47
	Copedoda	14			67	281	72.4	3215	3.68
	Cladocera			1	1	14	3.2	142	0.16

TABLE 3 (Cont'd.)

Date 10.9.83	Benthic Organisms	Water-lilies Nymphae	Cyperus	in grass	edge of grass	50m from grass	Mean No. n = 5	No./m^2	%
	Ephemeroptera	46	6	6	3	4	13	577	0.66
	Cloeon spp	3	1	-	1	-			
	Caenis spp	43	5	6	2	4			
	Odonata								
	Anisoptera		2				0.4	18	0.02
	Trichoptera			1	4		1	44	0.05
	Chironomid larvae	38	37	81	276	156	117.6	5221	5.98
	Ablabesmyia		*0.02		*0.02	*0.08			
	Procladius	*0.46	*0.03	0.33	*0.32	*0.38			
	Cryptochironomus				*0.04				
	Dicrotendipes		*0.02						
	Nilodorum	*0.54	*0.93						
	Polypedilum				*0.02	*0.05			

*Proportions of Chironomidae

TABLE 3 (Cont'd.)

Date 10.9.83	Benthic Organisms	Water-lilies Nymphea	Cyperus	in grass	edge of grass	50m from grass	Mean No. n = 5	No./m^2	%
	Cladotanytarsus			*0.33	*0.6	*0.5			
	Tanytarsus			*0.33					
	Chironomid pupa		2	1	4		1.4	62	0.07
	Nilodorum brevipalpis		2	1	4				
	Mollusca								
	Bulinus truncatus		5				1	44	0.05
	TOTAL	124	52	425	5696	3532	1965.8	87282	100.00

*Proportions of Chironomidae

TABLE 4

Benthic Organisms collected from South of Rima using Ekman grab

Date 9.2.84	Benthic Organisms	Between grass & Cyperus	Within grass	Inner edge of grass	Outer edge of grass	Distance from grass in meter				Mean No. n=8	No./m^2	%
						50	100	200	500			
	Nematoda	128		52	4					23	10212	0.95
	Oligochaeta											
	Naididae			6	122					16	710	0.66
	Limnodrilus	66	42	6		21	9	42	5	23.88	1060	0.98
	Copepoda	24	20	9	35	16	130	42	5	35.13	1560	1.45
	Argulus						1			0.125	6	0.006
	Ostracoda	2779	1054	659	4059	3113	967	4670	16	2165	96109	89.23
	Hydracarina	1		2						0.375	17	0.02
	Ephemeroptera *Caenis*	33	10	14	3					7.5	333	0.31

TABLE 4 (Cont'd.)

Date 9.2.84	Benthic Organisms	Between grass & Cyperus	With-in grass	Inner edge of grass	Outer edge of grass	Distance from grass in meter 50	100	200	500	Mean No. n=8	No./m^2	%
	Trichoptera	18	1	10	1					3.75	167	0.16
	Chironomid larvae	338	132	252	154	137	*0.67	123	70	151	6704	6.22
	Ablabesmyia	*0.03	*0.07		*0.03	*0.06		*0.03				
	Clinotanypus							*0.03				
	Procladius	*0.03	*0.07		*0.06	*0.11	*0.33	*0.48	*0.94			
	Parachironomus sp.								0.06			
	Cryptochironomus	*0.05	*0.03		*0.06	*0.01		*0.14				
	Polypedilum	*0.09	*0.07	0.29	*0.16							
	Xenochironomus	*0.09	*0.37	0.06		*0.23						
	Cladotanytarsus	*0.71	*0.40	0.65	*0.69	*0.63		*0.32				

*Proportions of Chironomidae

TABLE 4 (Cont'd.)

Date 9.2.84	Benthic Organisms	Between grass & Cyperus	Within grass	Inner edge of grass	Outer edge of grass	Distance from grass in meter				Mean No n=8	No./m^2	%
						50	100	200	500			
	Chironomidpupa					1		1		0.25	11	0.01
	Clinotanypus							1				
	Parachironomus					1						
	Mollusca-*Bulinus* sp								1	0.125	5	0.004
	TOTAL	3387	1259	1010	4378	3289	1109	4878	97	2426	107709	100

TABLE 5

Benthic Organisms collected from Dore using Ekman grab

Date 9.2.84	Benthic Organisms	Between grass & Cyperus	Within grass	Edge of grass	Distance from grass in meters					Mean No. n=8	No./m^2	%
					50	100	200	500	1000			
	Oligochaeta *Limnodrilus* spp	13		31	17	7				8.5	377	1.53
	Ostracoda	857	420	409	969	305	222	32	160	421.75	18726	75.77
	Copepoda	199	100	3	131	43	60	91		78.38	3480	14.08
	Cladocera	15			7	2	5	12		5.13	228	0.92
	Hydracarina	1	20							2.63	117	0.47
	Ephemeroptera- *Caenis* spp.	55								6.68	305	1.23
	Trichoptera	1		1	4					0.75	33	0.13

TABLE 5 (Cont'd)

Date 9.2.84	Benthic Organisms	Between grass & Cyperus	Within grass	Edge of grass	Distance from grass					Mean No.8	No./m^2	%
					50	100	200	500	1000			
	Chironomid larvae	46	30	59	69	10	9	3	30	32	1421	5.75
	Ablabesmyia	*0.03										
	Procladius	*0.31	*0.67	*0.32	*0.21	*0.86	*0.14		*0.5			
	Cricotopus - *scottae*	*0.06										
	Cryptochironomus			*0.05								
	Nilodorum		*0.13									
	Parachironomus sp_2	*0.03										
	Polypedilum			*0.05								
	Cladotanytarsus	*0.56		*0.58	*0.79	*0.14	*0.86	*0.67	*0.5			

*Proportions of Chironomidae

TABLE 5 (Cont'd.)

Date 9.2.84	Benthic Organisms	Between grass & Cyperus	Within grass	Edge of grass	Distance from grass in meters					Mean No. n=8	No./m^2	%
					50	100	200	500	1000			
	Chironomid pupa											
	Cladotanytarsus pseudomancus	18		1						0.125	6	0.024
	Mollusca											
	Gyraulus - costulatus	4								0.5	22	0.09
	TOTAL	1191	570	504	1197	367	296	138	190	556.63	24714	100.00

TABLE 6

Benthic Organisms of Lake Awasa collected from weed bed using a hand net

Date 25.5.83-10.2.84	Benthic Organisms	Range	Mean No. n=44	%
	Nematoda	0-6	0.16	0.019
	Oligochaeta			
	Naididae	0-204	25.11	3.01
	Limnodrilus	0-65	1.5	0.18
	Hirudinea	0-1	0.068	0.008
	Orbatid mite	0-2371		
	Hydracarina	0-214	11.96	1.43
	Ostracoda	0-730	44.73	5.36
	Cladocera	0-808	59.39	7.12
	Copepoda	0-2208	293.82	35.24
	Branchiura *Argulus* sp	0-2	0.205	0.025
	Odonata nymphs	0-10	3.96	0.47
	Anisoptera	0-4		
	Zygoptera	0-6		
	Ephemeroptera	0-94	39.98	4.79
	Cloeon spp	0-75		
	Caenis spp	0-19		
	Orthoptera	0-5	0.205	0.025

TABLE 6 (cont'd.)

Date 25.5.83- 10-2-84	Benthic Organisms	Range	Mean No. n = 44	%
	Heteroptera	0-776	98.84	11.85
	Micronecta denticulata	0-499		
	Gerridae	0-39		
	Nepidae	0-2		
	Naucoridae *Laccocoris*	0-75		
	Notonectidae *Anisops*	0-77		
	Mesoveliidae	0-5		
	Plea	0-6		
	Veliidae	0-772		
	Homoptera (terresterial)	0-28	7.18	0.86
	Coleoptera	0-60	13.61	1.63
	Curcurlionidae	0-1		
	Dytiscidae larvae	0-45		
	Dytiscidae adult	0-8		
	Gyrinidae	0-3		
	Hydrophylidae larvae	0-3		
	Hydrophylidae adult	0-3		
	Scarabidae (terresterial)	0-7		

TABLE 6 (cont'd)

Date 25.5.83- 10.2.84	Benthic Organisms	Range	Mean No. n = 44	%
	Coleoptera spp larvae	0-6		
	Coleoptera spp adult	0-5		
	Trichoptera	0-12	1.09	0.13
	Chironomid larvae	3-425	88	10.55
	Ablabesmyia	0-1		
	Procladius	0-61		
	Corynoneura	0-2		
	Cricotopus albitibia	0-7		
	Cricotpus scottae	0-42		
	Nanocladius	0-6		
	Nanocladius albitibia	0-1		
	Dicrotendipes	0-5		
	Nilodorum	0-212		
	Nilodorum brevibucca	0-6		
	Nilodorum brevipalpis	0-87		
	Parachironomus sp_1	0-1		
	Parachironomus sp_2	0-16		
	Polypedilum	0-2		
	Tanytarsus sp	0-50		
	Tanytarsus nigricornis	0-18		
	Cladotanytarsus	0-1		

TABLE 6 (cont'd.)

Date 25.5.83-10.2.84	Benthic Organisms	Range	Mean No. n=44	%
	Chironomid pupa	0-17	2	0.24
	Procladius	0-1		
	Procladius brevipetiolatus	0-2		
	Orthocladini	0-1		
	Corynoneura	0-1		
	Cricotopus scottae	0-7		
	Nanocladius vittelinus	0-1		
	Nilodorum brevipalpis	0-10		
	Tanytarsus nigricornis	0-4		
	Diptera larvae culicidae	0-1	0.068	0.0081
	Diptera larvae	0-160	5.046	0.61
	Stratiomyiidae	0-37	0.93	0.11
	Ceratopogonidae *Bezzia* sp	0-2	0.14	0.016
	Diptera pupa	0-10	0.66	0.079
	Diptera adults	0-12	2.11	0.25
	Hymenoptera	0-10	5.77	0.69
	Lepidoptera caterpillar	0-7	0.61	0.074
	Mollusca	0-36	6.73	0.81
	Afrogyrus coretus	0-2		
	Biomphalaria sudanica	0-34		
	Bulinus sp	0-4		

TABLE 6 (cont'd.)

Date 25.5.83- 10.2.84	Benthic Organisms	Range	Mean No. n = 44	%
	Bulinus forskali	0-22		
	Bulinus truncatus	0-13		
	Gyraulus costulatus	0-34		
	Fish fry	0-41	1.46	0.17
	Tadpole	0-278	6.86	0.82

TABLE 7

Benthic Organisms of Lake Awasa collected from grass *Paspalidium geminatum* using a hand net

Date 25.4.83-10.2.84	Benthic Organisms	No.	Mean No. n = 14	%
	Oligochaeta			
	Naididae	443	31.64	3.66
	Limnodrilus	1	0.07	0.0083
	Hirudinea	2	0.14	0.017
	Copepoda	5554	396.71	45.85
	Branchiura *Argulus* sp	4	0.29	0.033
	Ostracoda	298	21.29	2.46
	Cladocera	1787	127.64	14.75
	Orbatidmite	5	0.36	0.04
	Hydracarina	61	4.36	0.50
	Ephemeroptera	184	13.4	1.52
	Cloeon spp	108	7.71	
	Caenis spp	61	4.36	
	Odonata	23	1.64	0.19
	Anisoptera	-		
	Zygoptera	11		
	Heteroptera	1707	121.93	14.1
	Corixidae *Micronecta denticulata*	616	44	
	Gerridae	21	1.5	

TABLE 7 (cont'd.)

Date 25.4.83-10.2.84	Benthic Organisms	No.	Mean No. n = 14	%
	Nepidae	1	0.071	
	Mesoveliidae	5	0.36	
	Naucoridae Laccocoris	84	6	
	Notonectidae Anisops	115	11.07	
	Plea	2	0.14	
	Veliidae	808	57.71	
	Homoptera	35	2.5	
	Coleoptera	36	2.57	0.29
	Dytiscidae larvae	17	1.21	
	Dytiscidae adult	6	0.43	
	Hydrophilidae adult	4	0.29	
	Coleoptera spp larvae	2	0.14	
	Coleoptera spp adult	2	0.14	
	Scarabidae	7	0.5	
	Trichoptera	29	2.07	0.24
	Chironomid larvae	1797	128.36	14.83
	Ablabesmyia	2	*0.0027	
	Procladius	19	*0.026	
	Cricotopus albitibia	16	*0.022	
	Cricotopus scottae	210	*0.29	
	Corynoneura	7	*0.0096	

* = Proportions of Chironomidae

TABLE 7 (cont'd.)

Date 25.4.83-10.2.84	Benthic Organisms	No.	Mean No. n = 14	%
	Nanocladius	12	*0.016	
	Dicrotendipes	8	*0.01	
	Nilodorum brevipalpis	361	*0.495	
	Parachironomus sp_2	16	*0.022	
	Polypedilum	15	*0.021	
	Einfeldia	1	*0.0014	
	Tanytarsus	42	*0.058	
	Tanytarsus nigricornis	18	*0.025	
	Chironomid pupa	56	4	0.46
	Corynoneura	1	*0.033	
	Orthocladini	1	*0.033	
	Cricotopus scottae	12	*0.4	
	Nilodorum brevipalpis	12	*0.4	
	Tanytarsus nigricornis	4	*0.13	
	Diptera larvae	2	0.14	0.017
	Diptera larvae culex	1	0.071	0.0083
	Ceratopogonidae *Bezzia* sp	2	0.14	0.017
	Stratiomyiidae	1	0.071	0.0083
	Diptera pupa	4	0.29	0.033
	Diptera adult	19	1.36	0.16
	Hymenoptera	13	0.93	0.11
	Lepidoptera larvae	8	0.57	0.066
	Mollusca	28	2	0.23
	Bulinus spp	27	1.93	
	Gyraulus costulatus	1	0.071	
	Fish fry	13	0.93	0.11
	TOTAL	12113	865.21	100.00

*Proportions of Chironomidae

TABLE 8

Benthic Organisms collected in
Nymphea caerulea using a hand net

Date 25.4.83- 12.2.84	Benthic Organisms	No.	Mean No. n = 17	%
	Nematoda	6	0.35	0.092
	Oligochaeta			
	Naididae	557	32.76	8.56
	Ostracoda	225	13.24	3.46
	Cladocera	221	13	3.39
	Copepoda	1642	96.59	25.23
	Branchiura *Argulus* sp	2	0.12	0.03
	Orbatidmite	8	0.47	0.12
	Hydracarina	357	21	5.49
	Ephemeroptera	231	13.59	3.55
	Cloeon spp	132	7.77	
	Caenis spp	18	1.06	
	Odonata	28	1.65	0.43
	Anisoptera	10	0.59	0.015
	Zygoptera	14	0.82	0.22
	Orthoptera	1	0.059	0.015
	Heteroptera	1439	84.65	22.12
	Corixidae *Micronecta-denticulata*	608	35.76	

TABLE 8 (cont'd.)

Date 25.4.83-12.2.84	Benthic Organisms	No.	Mean No. n=17	%
	Gerridae	89	5.24	
	Nepidae	2	0.12	
	Mesoveliidae	1	0.059	
	Plea	2	0.12	
	Naucoridae Laccocoris	151	8.88	
	Notonectidae Anisops	153	9.00	
	Veliidae	166	9.77	
	Homoptera	3	0.18	0.015
	Coleoptera	133	7.82	2.044
	Dytiscidae larvae	83	4.88	
	Dytiscidae adult	4	0.24	
	Hydrophylidae larvae	2	0.12	
	Hydrophylidae adult	2	0.12	
	Scarabidae (terresterial)	17	1	
	Coleoptera spp larvae	17	1	
	Coleoptera spp adult	10	0.59	
	Trichoptera	16	0.94	0.25
	Chironomid larvae	1463	86.06	22.48
	Ablabesmyia	1	*0.0013	
	Procladius	117	*0.152	
	Procladius brevipetiolatus	2	*0.0026	

* Proportions of Chironomidae

TABLE 8 (cont'd.)

Date 25.4.83-12.2.84	Benthic Organisms	No.	Mean n = 17	%
	Cricotopus albitibia	5	*0.0065	
	Cricotopus scottae	57	*0.074	
	Nanocladius	7	*0.091	
	Dicrotendipes	2	*0.0026	
	Nilodorum brevibucca	6	*0.0078	
	Nilodorum brevipalpis	477	*0.62	
	Parachironomus sp_1	5	*0.0065	
	Parachironomus sp_2	17	*0.022	
	Tanytarsus	71	*0.092	
	Cladotanytarsus	2	*0.0026	
	Chironomid pupa	16	0.94	0.25
	Procladius	1	*0.077	
	Procladius brevipetiolatus	2	*0.15	
	Cricotopus scottae	1	*0.077	
	Nanocladius vitellinus	1	*0.62	
	Nilodorum brevipalpis	8	*0.62	
	Diptera larvae stratiomyiidae	3	0.18	0.046

* Proportion of Chironomidae

TABLE 8 (cont'd.)

Date 25.4.83- 12.2.84	Benthic Organisms	No.	Mean No. n = 17	%
	Diptera larvae	2	0.12	0.31
	Diptera Ceratopogonidae - *Bezzia* sp	4	0.24	0.062
	Diptera adult	19	1.12	0.29
	Diptera pupa	17	1	0.26
	Hymenoptera	16	0.94	0.25
	Leipidoptera larvae	16	0.94	0.25
	Mollusca	67	3.94	1.029
	Afrogyrus coretus	2	0.12	
	Biomphilaria	3	0.18	
	Bulinus forskali	12	0.71	
	Bulinus truncatus	47	2.76	
	Gyraulus costulatus	2	0.12	
	Fish fry	7	0.41	0.11
	Tadpoles	8	0.47	0.12
	TOTAL	6507	382.76	100.00

TABLE 9

Benthic organisms collected in Cyperus
of the lake using a hand net

Date 10.9.83-10.2.84	Benthic Organisms	No.	Mean No. n = 6	%
	Oligochaeta			
	Naididae	61	10.17	2.33
	Orbatid mite	16	2.67	0.61
	Hydracarina	35	5.83	1.34
	Cladocera	74	12.33	2.83
	Copepoda	1904	317.3	72.87
	Ostracoda	24	4	0.92
	Odonata	7	1.17	0.27
	Zygoptera	5		
	Ephemeroptera	32	5.33	1.23
	Cloeon spp	18		
	Caenis spp	11		
	Heteroptera	27	4.5	1.03
	Corixidae *Micronecta* - *denticulata*	5		
	Gerridae	1		
	Naucoridae *Laccocoris* sp	1		
	Notonectidae *Anisops* spp	15		

TABLE 10 (cont'd.)

Date 25.4.83	Benthic Organisms	No.	Mean No. n = 2	%
	Chironomid larvae	8	4	1.95
	Nilodorum	7	3.5	
	Diptera adult	12	6	2.93
	Mollusca	5	2.5	1.22
	Bulinus truncatus	4		
	Fish fry	41	20.5	10.0%
	Tadpole	275	137.5	67.0%
	TOTAL	410	205	100.0%

TABLE 11

Benthic Organisms collected from Shallow water of the lake, seasonally flooded areas and back waters.

Date 27.5.83-22.10.83	Benthic Organisms	No.	Mean No. n = 5	%
	Oligochaeta			
	Naididae	22	4.4	0.14
	Limnodrilus	65	13	0.42
	Hirudinea	1	0.2	0.01
	Ostracoda	1446	289.2	9.37
	Cladocera	531	106.2	3.44
	Copepoda	4700	940	30.46
	Branchiura Argulus sp	3	0.6	0.019
	Orbatidmite	4883	976.6	31.65
	Hydracarina	82	16.4	0.53
	Ephemeroptera	741	148.2	4.8
	Cloeon spp	727	145.4	
	Caenis spp	14	2.8	
	Odonata	118	23.6	0.77
	Anisoptera	3	0.6	
	Zygoptera	113	22.6	
	Orthoptera	8	1.6	0.05

TABLE 11 (cont'd.)

Date 27.5.83- 22.10.83	Benthic Organisms	No.	Mean No. n = 5	%
	Heteroptera	1132	227.8	7.38
	Corixidae _Micronecta-denticulata_	7	1.4	
	Gyrinidae	14	2.8	
	Naucoridae _Laccocoris_	96	20.6	
	Nepidae	14	2.8	
	Notonectidae _Anisops_	831	166.2	
	Plea	53	10.6	
	Veliidae	127	25.4	
	Homoptera	227	55.4	1.47
	Coleoptera	427	85.4	2.77
	Curculionidae adult	1	0.2	
	Dytiscidae larvae	157	31.4	
	Dytiscidae adult	188	37.6	
	Gyrinidae	3	0.6	
	Hydrophylidae larvae	1	0.2	
	Coleoptera spp? larvae	21	4.2	
	Coleoptera spp? adult	56	11.2	
	Diptera larvae culex	2	0.4	0.013
	Diptera larvae?	218	50.2	1.41

TABLE 11 (cont'd.)

Date 27.5.83- 22.10-83	Benthic Organisms	No.	Mean No. n = 5	%
	Chironomid larvae	225	45	1.46
	Ablabesmyia	*0.06		
	Dicrotendipes	*0.02		
	Nilodorum	*0.87		
	Polypedilum	*0.04		
	Stratiomidae larvae	37	7.4	0.24
	Chironomid pupa	6	1.2	0.04
	Diptera pupa	8	1.6	0.05
	Diptera adult	42	8.4	0.27
	Hymenoptera	225	45.0	1.46
	Lepidoptera larvae	3	0.6	0.02
	Mollusca gastropod snails	200	40.00	1.29
	Biomphilaria sudanica	67	13.4	
	Bulinus sp	4	0.8	
	Bulinus forskali	1	0.2	
	Bulinus natalensis	3	0.6	
	Gyraulus costulatus	34	6.8	
	Fish fry	4	0.8	0.026
	Frog tadpole	16	3.2	0.1
	TOTAL	15429	3089	100.00

* Proportions of Chironomidae

TABLE 12

Benthic Organisms collected in the mouth of Tikur Wuha, inlet of Lake Awasa

Date 25.6.83-10.2.84	Benthic Organisms	No.	Mean No. n = 6	%
	Nematoda	2	0.33	0.079
	Oligochaeta			
	Naididae	221	36.83	8.7
	Limnodrilus	13	2.17	0.51
	Hirudinea	46	7.67	1.81
	Ostracoda	182	30.33	7.17
	Cladocera	55	9.17	2.17
	Copepoda	1009	168.17	39.72
	Branchiura *Argulus* sp	1	0.17	0.039
	Hydracarina	67	11.17	2.64
	Orbatid mite	2	0.33	0.079
	Ephemeroptera	201	33.5	7.91
	Cloeon spp	180	30	
	Caenis sp	2	0.33	
	Odonata	7	1.77	0.28
	Anisoptera	2	0.33	
	Zygoptera	5	0.83	

TABLE 12 (cont'd.)

Date 25.6.83-10.2.84	Benthic Organisms	No.	Mean No. n = 6	%
	Heteroptera	200	33.33	7.87
	Corixidae *Micronecta denticulata*	76	12.67	
	Gerridae	3	0.5	
	Nacuoridae:*Loccorcoris* spp	2	0.33	
	Nepidae	34	5.67	
	Notonectidae *Anisops* spp	36	6.00	
	Plea	47	7.83	
	Veliidae	2	0.33	
	Homoptera	2	0.33	0.079
	Coleoptera	71	11.83	
	Dytiscidae larvae	44	7.33	
	Dytiscidae adult	21	3.5	
	Hydrophilidae *Berosus* adult	1	0.17	
	Coleoptera spp? larvae	1	0.17	
	Coleoptera spp? adult	4	0.66	
	Trichoptera	83	13.83	

TABLE 12 (cont'd.)

Date 25.6.83-10.2.84	Benthic Organisms	No.	Mean No. n = 6	%
	Chironomid larvae	177	29.5	6.97
	Ablabesmyia	*0.02		
	Procladius	*0.03		
	Cricotopus albitibia	*0.31		
	Cricotopus scottae	*0.03		
	Parametriocnemus	*0.02		
	Chironomus sp	*0.14		
	Dicrotendipes sp$_1$	*0.02		
	Dicrotendipes sp$_2$	*0.09		
	Nilodorum spp	*0.14		
	Parachironomus sp$_1$	*0.03		
	Parachironomus sp$_2$	*0.08		
	Polypedilum	*0.09		
	Chironomid pupa	12	2	0.47
	Diptera larvae			
	Culicidae larvae	19	3.17	0.75
	Ceratopogonidae *Bezzia* sp	163	27.17	6.42
	Stratiomyiidae	5	0.83	0.19
	Diptera adult	1	0.17	0.039
	Hymenoptera	1	0.17	0.039
	TOTAL	2540	423.33	100.00

*Proportions of Chironomidae

TABLE 13

Benthic Organisms collected from the bottom at differnet seasons

Benthic Organisms	Dry Season November - February					Wet Season March - October				
	No.	Mean No n=26	S.D	No./m^2	%	No.	Mean No n=12	No./m^2	S.D.	%
Nematoda	186	7.15		318	0.65	-	-	-	-	-
Oligochaeta										
Naididae	133	5.12	23.9	227	0.47	16	1.33	59	3.2	0.16
Limnodrilus spp	294	11.31	16.3	502	1.03	205	17.08	759	30.4	2.01
Hirudinea						2	0.17	7		0.019
Hydracarina	27	1.04		46	0.094	-	-	-	-	-
Ostracoda	24977	960.65	1182.2	42653	87.46	8732	728	32308	1023.7	85.36
Cladocera	42	1.62		72	0.15	30	2.5	111		0.29
Copepoda	955	36.73		1631	3.34	510	42.5	1887		4.99
Branchiura *Argulus* sp	1	0.039		2	0.004	2	0.17	7		0.019
Odonata Zygoptera	2	0.077		4	0.008	2	0.17	7		0.019

TABLE 13 (cont'd.)

Benthic Organisms	Dry Season November–February					Wet Season March – October				
	No.	Mean No. n=26	S.D.	No./m^2	%	No.	Mean No. n=12	No./m^2	S.D.	%
Ephemeroptera	129	4.96	10.9	220	0.45	81	6.78	300	8.9	0.79
Cloeon spp	–	–	0	–	–	10	0.83	37	1.99	
Caenis spp	129	4.96	10.9	220		45	3.75	167	5.5	
Trichoptera	36	1.39		62	0.13	6	0.5	22		0.058
Chironomid larvae	1753	67.42	89.3	2994	6.14	625	52.03	2312	50.3	6.11
Ablabesmyia	*0.04					*0.03				
Clinotanypus	*0.002					–	–	–		
Procladius	*0.23		3.71			*0.28			8.7	
Cricotopus scottae	*0.007					–	–	–		
Chironomus spp	*0.002					–	–	–		
Cryptochironomus	*0.03					*0.02				
Dicroptendipes Sp$_1$						*0.003				
Nilodorum	*0.005					*0.24				
Parachironomus sp$_2$	*0.005					–	–	–		
Polypedilum	*0.06					*0.02				

*Proportions of Chironomidae

TABLE 13 (cont'd.)

	Dry Season November – February					Wet Season March – October				
	No.	Mean No. n=26	S.D.	No./m^2	%	No.	Mean No. n=12	No./m^2	S.D.	%
Xenochironomus	*0.06					–	–	–		
Cladotanytarsus	*0.56					*0.41				
Chironomid pupa	5	0.19		9	0.019	8	0.67	30		0.079
Nilodorum – *brevipalpis*	2	0.077		4		*0.43				
Parachironomus sp$_1$	1	0.039		2		–	–	–		
Cladotanytarsus – *pseudomancus*	2	0.77		4		*0.57				
Diptera pupa						3	0.25	11		0.029
Mollusca	17	0.65		29	0.053	6	0.5	22		0.058
Bulinus spp	3	0.12		5		6	0.5	22		
Gyraulus costulatus	14	0.54		24		–	—			
TOTAL	28557	1098.35		48767	100	10229	852.42	37847		100

*Proportions of Chironomidae

TABLE 14

Benthic Organisms collected from macrophytes using a hand net at different seasons.

Benthic Organisms	Dry Season November – February			Wet Season March – October		
	No.	Mean No. n=26	%	No.	Mean No. n=19	%
Nematoda	8	0.31	0.044	1	0.053	0.012
Oligochaeta						
Naididae	1076	41.39	5.93	2307	121.42	28.65
Limnodrilus spp	14	0.54	0.077	–	–	–
Hirudinae	48	1.85	0.26	–	–	–
Orbatid mite	4	0.15	0.022	27	1.42	0.34
Hydracarina	175	6.73	0.96	634	33.37	7.87
Ostracoda	702	27	3.87	52	2.74	0.65
Cladocera	1520	58.46	8.38	635	33.42	7.89
Copepoda	9029	347.27	49.75	1081	56.90	13.43
Branchiura *Argulus* spp	3	0.12	0.017	4	0.21	0.05

TABLE 14 (cont'd.)

Benthic Organisms	Dry Season November-February			Wet Season March-October		
	No.	Mean No. n=26	%	No.	Mean No. n=19	%
Odonata	41	1.58	0.23	24	1.26	0.30
Anisoptera	6	0.23		-	-	-
Zygoptera	18	0.69		18	0.95	
Ephemeroptera	481	18.5	2.65	171	9	2.12
Cloeon Spp	419	16.12		82	4.32	
Caenis spp	47	1.81		37	1.95	
Heteroptera	1999	76.88	11.01	1374	72.32	17.06
Corixidae *Micronecta denticulata*	1315	50.57		163	8.58	
Gerridae	24	0.92		90	4.74	
Hydrometridae	5	0.19				
Naucoridae *Laccocoris* spp	120	4.62		165	8.68	
Notonectidae	373	14.35		52	2.74	
Mesovelliidae				1	0.052	
Plea	54	2.077		1	0.052	
Veliidae	89	3.42		892	46.95	

TABLE 14 (cont'd.)

Benthic Organisms	Dry Season Novermber - February			Wet Season March - October		
	No.	Mean No. n=26	%	No.	Mean No. n=19	%
Homoptera	38	1.46	0.21	2	0.11	0.03
Coleoptera	176	6.77	0.97	77	4.05	0.96
Dytiscidae larvae	113	4.35		34	1.79	
Dytiscidae adult	4	0.15		8	0.42	
Hydrophilidae larvae	2	0.077		3	0.16	
Hydrophilidae adult	6	0.23		2	0.11	
Scarabidae adult	23	0.89				
Coleoptera spp. larvae	2	0.077		23	1.21	
Coleoptera spp adult	8	0.31		6	0.32	
Trichoptera	124	4.77	0.68	7	0.37	0.068
Chironomid larvae	2291	88.11	11.62	1205	63.42	14.97
Ablabesmyia	*0.001			*0.004		
Procladius	*0.08			-		
Corynoneura	*0.003			*0.004		
Cricotopus albitibia	*0.01			*0.04		

TABLE 14 (cont'd.)

Benthic Organisms	Dry Season November - Feb.			Wet Season March - October		
	No.	Mean No. n=26	%	No.	Mean No. n=19	%
Cricotopus scottae	*0.40			*0.09		
Nanocladius	*0.01			*0.025		
Parametriocnemus	*0.0006			-		
Chironomus spp				*0.02		
Dicrotendipes sp$_1$	*0.004			*0.01		
Nilodorum spp	*0.35			*0.8		
Nilodorum brevibucca	*0.004			-		
Nilodorum brevipalpis	*0.007			-		
Parachironomus sp$_1$	*0.003			*0.002		
Parachironomus sp$_2$	*0.02			*0.002		
Polypedilum	*0.01			*0.004		
Cladotanytarsus	*0.001			-		
Tanytarsus	*0.08			-		

*Proportions of Chironomidae

TABLE 14 (cont'd.)

Benthic Organisms	Dry Season November–February			Wet Season March – October		
	No.	Mean No. n=26	%	No.	Mean No. n=19	%
Chironomid pupa	67	2.58	0.37	15	0.79	0.19
Procladius	*0.03			–	–	
Procladius brevipetiolatus	–			*0.25		
Orthocladini	*0.03			–		
Nanocladius vittelinus	–			*0.25		
Corynoneura	*0.03			–		
Cricotopus scottae	*0.36			*0.125		
Nilodorum brevipalpis	*0.42			*0.38		
Tanytarsus nigricornis	*0.13			–	–	
Diptera larvae culicidae	19	0.73	0.11	1	0.052	0.012
Diptera larvae				4	0.21	0.049
Straticmyiidae	6	0.23	0.03	3	0.16	0.037
Ceratopogonidae	169	6.5	0.93	–	–	

*Proportions of chironomidae

TABLE 14 (cont'd.)

Benthic Organisms	Dry Season November–February			Wet Season March–October		
	No.	Mean No. n=26	%	No.	Mean No. n=19	%
Diptera pupa	15	0.58	0.08	18	0.95	0.22
Diptera adult	17	0.65	0.09	35	1.84	0.44
Hymenoptera	12	0.46	0.07	19	1	0.24
Lepidoptera larvae	19	0.73	0.11	6	0.32	0.075
Mollusca	78	3	0.43	22	1.16	0.27
Afrogyrus coretus	3	0.12		–	–	
Biomphilaria sudanica	2	0.77		1	0.052	
Bulinus spp	12	0.46		6	0.32	
Bulinus forskali	21	0.81		–	–	
Bulinus truncatus	41	1.58		13	0.66	
Gyraulus costulatus	1	0.039		2	0.11	
Fish fry	8	0.31	0.04	52	2.74	0.65
Tadpole	9	0.35	0.05	278	14.63	3.45
TOTAL	18148	698.00	100	8055	423.24	100

TABLE 15

List of benthic cladoceras of Lake Awasa

1. *Alona davidi* King
2. *Alona* cf. *quadrangularis* Muller
3. *Alona* sp.
4. *Alona pulchella* King.
5. *Diaphnosoma excisum* Sars.
6. *Macrothrix* sp.
7. *Macrothrix spinosus* King
8. *Macrothrix* of *triserialis*
9. *Moina micrura* Kurz
10. *Moinodaphnia macleayi* King.

TABLE 16

List of benthic copepod of Lake Awasa

1. *Afrocyclops* spp
2. *Cyclopoid* spp
3. *Ectocyclop* spp
4. *Mesocyclops*(*aequatorialis*) *similis*
5. *Mesocyclops* spp

TABLE 17.

List of chironomids collected from Lake Awasa
and its surroundings

1.	*Clinotanypus claripennis* Kieffer	+
2.	*Procladius brevipetiolatus* Goetghebeur	+++
3.	*Ablabesmyia nilotica* Kieffer	+
4.	*Ablabesmyia freemani* Harrison	+++
5.	*Tanypus gutatipennis* Goetghebeur	+
6.	*Cricotopus scottae* Freeman	++
7.	*Cricotopus albitibia* Walker	++
8.	*Nanocladius vitellinus* Kieffer	+
9.	*Corynoneura dewulfi* Goetghebeur	+
10.	*Parametriocnemus* spp	+
11.	*Nilodorum brevipalpis* Kieffer	++++
12.	*Nilodorum brevibucca* Kieffer	++
13.	*Dicrotendipes fusconotatus* Kieffer	++
14.	*Dicrotendipes 14-punctatus* Goetghebeur	+
15.	*Chironomus calipterus* Kieffer	+
16.	*Chironomus transvalensis* Kieffer	+
17.	*Cryptochironomus lindneri* Freeman	+
18.	*Parachironomus* (*Littare*) *acutus* Goetghebeur	++

TABLE 17 (cont'd.)

19.	*Parachironomus dewalfianus* Goetghebeur	++
20.	*Polypedilum abyssiniae* Kieffer	++
21.	*Polypedilum deletam* Goetghebeur	+
22.	*Einfeldia imicola* Kieffer	+
23.	*Xenochironomus* sp	+
24.	*Cladotanytarsus psedomancus* Goetghebeur	++++
25.	*Tanytarsus bifurcatus* Freeman	+
26.	*Tanytarsus horni* Goetghebeur	+
27.	*Tanytarsus nigricornis* Goetghebeur	+

\+ = Rare

++ = Common

+++ = Very common

++++ = Abundant

TABLE 18

A list of some important macrophytes collected from Lake Awasa and in the mouth of Tikur Wuha river. (+).

1. *Ceratophyilum demersum* L.
2. *Cyperus exalatus* Rotz.
*3. *Cyperus papyrus* L.
*4. *Lemna minor* L.
*5. *Ludwigia stolinfera* (Guillem and Peroth) Roven.
6. *Nymphea caerulea* Sav.
7. *Paspalidium geminatum* (Forsk) Stapf.
8. *Polygonum senegalense* Meisn.
9. *Potamegoton schweinfurthii* A. Benn.
10. *Pycreus nitidus* (Lam.) Raynal
11. *Scirpus brachyceras* Host ex. A. Rich
12. *Typha angustifolia* Conn.
13. *Urticularia inflexa* Forsk.
*14. *Wolffia arrhiza* (Hirk.) ex Wim (New to Ethiopia)

* Collected only in mouth of Tikur Wuha river.

\+ The above aquatic macrophytes have been identified by Ato Getachew Aweke and partially by Kew Garden Herbarium.

TABLE 19

Lake Awasa, temperature and Oxygen profiles

Depth meters	9 Dec. 1983		10 Feb. 1984		28 Apr. 1984		26 May 1984	
	°C	Oxygen mg/l	°C	Oxygen mg/l	°C	Oxygen mg/l	°C	Oxygen mg/l
0	24	7.4	20.6	7.2	27	6.3	28.4	6.3
1	22	8.2	19.8	7.2	25	6.6	25.0	7.15
2	22	7.5	19.6	7.1	24	7.1	24.7	7.11
3	21.8	6.5	19.5	7.15	23	6.15	24.5	6.6
4	21.5	6.4	19.4	7.0	23	6.15	24.4	6.0
5	21.5	6.2	19.4	6.95	23	5.8	24.4	5.8
6	21.0	6.0	19.4	6.9	–	–	24.3	5.29
7	21.0	6.3	19.4	6.9	–	–	24.3	5.65
8	21.0	6.2	19.4	6.85	–	–	24.0	5.28
9	21.0	5.8	19.4	6.85	–	–	23.8	3.65
10	21.0	5.6	19.4	6.80	22.0	2.1	23.8	3.20
11	21.0	5.6	19.4	6.80	–	–	23.7	3.20

TABLE 19 (cont'd.)

Depth meters	9 Dec. 1983		10 Feb. 1984		28 Apr. 1984		26 May 1984	
	°C	Oxygen mg/l	°C	Oxygen mg/l	°C	Oxygen mg/l	°C	Oxygen mg/l
12	21.0	5.6	19.4	6.75	-	-	23.6	2.65
13	21.0	5.5	19.4	6.55	-	-	23.5	2.40
14	-	5.0	19.3	6.5	-	-	22.2	2.20
15	-	4.9	19.1	6.25	-	-	23.2	1.90
16	-	4.2	19.0	5.8	-	-	-	-
17	-	-	19.0	5.6	-	-	-	-
18	-	-	19.0	5.3	-	-	-	-
19	-	-	19.0	5.45	-	-	-	-
20	-	-	19.0	5.35	-	-	-	-
21	-	-	19.0	5.35	-	-	-	-

TABLE 19 (cont'd.)

	15 June 1984		25 Aug. 1984		11 Sept. 1984		24 Sept. 1984		25 Oct. 1984	
Depth meters	°C	Oxygen mg/l	°C	Oxygen mg/l	°C	Oxygen mg/l	°C	Oxygen mg/l	°C	Oxygen mg/l
0	23.5	6.6	23	10.5	23.3	7.1	23.8	9.5	26	9
1	23.0	6.5	22.2	10.6	22.6	7.2	22.4	9.35	23	11
2	22.6	6.4	22	10.4	22.4	7.1	22.2	8.8	22.6	10.4
3	22.6	6.1	22	10.4	22.3	6.4	22.2	8.2	22.3	9.4
4	22.5	5.4	22	10.2	22.3	6.5	22.2	8.1	22.2	8.5
5	22.5	5.8	22	10.0	22.3	6.45	22.0	8.0	22.2	8.5
6	22.5	5.7	22	9.7	22.3	6.4	22.0	7.9	22.2	8.6
7	22.5	5.8	22	9.5	22.3	6.35	22.0	8.0	22.2	8.4
8	22.4	5.8	22	9.2	22.3	6.3	22.0	7.85	22.2	7.87
9	22.3	5.8	22	8.4	22.2	5.9	22.0	7.8	22.2	7.4
10	22.3	5.7	22	8.3	22.2	5.1	22.0	7.8	22.2	6.9
11	22.3	5.7	22	8.2	22.1	4.95	22.0	7.6	22.2	6.2

TABLE 19 (cont'd.)

Depth meters	15 June 1984 °C	15 June 1984 Oxygen mg/l	25 Aug. 1984 °C	25 Aug. 1984 Oxygen mg/l	11 Sept. 1984 °C	11 Sept. 1984 Oxygen mg/l	24 Sept. 1984 °C	24 Sept. 1984 Oxygen mg/l	25 Oct. 1984 °C	25 Oct. 1984 Oxygen mg/l
12	22.3	5.6	22	7.7	22.0	4.3	21.90	6.4	22.0	5.5
13	22.0	4.9	22	7.6	21.9	3.1	21.60	3.2	22.0	3.25
14	21.8	1.0	21.1	2.0	21.8	1.5	21.4	1.55	21.9	1.95
15	21.5	0.6	21.0	1.7	21.7	1.75	21.0	1.25	21.78	0.8
16	-	-	21.0	1.4	21.7	1.8	-	-	-	-
17	-	-	21.0	1.2	21.7	0.7	-	-	-	-
18	-	-	21.0	1.2	21.6	0.3	-	-	-	-
19	-	-	-	-	21.5	0.25	-	-	-	-
20	-	-	-	-	21.4	0.2	-	-	-	-
21	-	-	-	-	21.3	0.2	-	-	-	-

6. DISCUSSION

The benthic organisms in Lake Awas are both abundant and diverse in species and form an important part of the rich fauna of the lake.

6.1 Fauna of the macrophytes

The different vegetation habitats in the lake such as the grass *Paspalidium geminatum*, *Nymphea Caerulea*, *Cyperus exalatus*, *Potamogeton schweinfurthii*, *Cyperus papyrus* and other vegetation types support most of the benthos.

The species composition of the vegetation fauna was different from those of the mud; at least seventy two genera being present as compared to thirty two genera in the mud. As far as density is concerned the total numbers in the mud were almost entirely due to the presence of Ostracods and chironomid larvae, whereas the faunal numbers in the aquuatic plants were due to other groups. The mud under the vegetation had rather a mixed fauna due, to some extent, to invasion by fauna from vegetation.

Compared to the other forms of vegetation, the grass *Paspalidium geminatum* supports larger numbers of organisms. According to Scheffer, Achterberg and Beltman (1984) the penetrability of the vegetation and physical and chemical conditions within the plant stands may be important factors affecting the distribution of macroinvertebrates in their habitats. For instance, compared to the grass, the numbers of chironomids supported by *Nymphea* and *Cyperus* spp were smaller. This may be due to light penetration and density of plants. According to McLachlan (1969) the largest chironomid population was present in Lake Kariba where light penetration was good, while the smallest population was present under the densely packed vegetation.

Most heteropterans and coleopterans species were found also in the Paspalidium geminatum and Nymphea caerulea. In Cyperus spp heteropterans and coleopterans appear to be particularly rare.

In Potamogeton copepods, ostracods, hemipteras, coleopteras and chironomids appeared to be rare. Nevertheless, tadpoles and fish fry were found in large numbers. The scarcity of the macroinvertebrates may be due to predation.

In lakes, ponds and ditches the habitat preference of macroinvertebrates seem to be influenced by vegetation. It has been found by Scheffer, Achterberg and Beltman (1984) that the vegetation pattern is probably the main factor in determining the spatial distribution of macroinvertebrates. Different vegetation types differed considerably in total faunal density. Species that are taxonomically related tend to have a similar distribution.

It was clearly seen that most benthic fauna of Lake Awasa were mostly concentrated in the littoral region in association with macrophytes. The nurseries of fishes are also seen in this region and the macrophyte zone can therefore be considered as a site of good habitat and breeding ground for macroinvertebrates and fishes. It would appear clear that the benthos in this region is an important food source for fishes. It can be projected that adverse actions such as cutting and burning of macrophytes will probably affect faunal existence and this will even lead to fish depletion.

6.2 Fauna of the littoral mud

In Lake Awasa it was interesting to note that the major chironomid species under the open water mud were Pracladius brevipetiolatus and Cladotanytarsus pseudomancus. The former species appear to be predators

Pennak (1953). The species of Odonata, benthic copepods and Hirudinea (glossiphonids) collected from the mud are also generally accepted as being predaceous (Pennak, 1953). The mud therefore supports many predators feeding on the detritus feeders, *Cladotanytarsus pseudomancus*, *Limnodrilus* spp, Ostracods and *Cloeon* spp.

6.3 Fauna of the profundus

The profundic mud does not support any macrobenthos. According to McLanchlan (1969) the physical properties of the substrate particles themselves are of considerable importance and may under certain circumstances be the primary factor affecting substrate selection. The physical and chemical nature of the mud can obviously limit the presence of benthic fauna.

Percentage carbon (g/100g dry mud) in surface deposits of some tropical African lakes were compared with temperate lakes by McLachlan (1974). It has been found that most African lakes have lower carbon values than from temperate lakes. Nevertheless the presence of high percentage carbon value in the mud of the profundal zone of Lake Awasa did not help to the presence of macroinvertebrates. The floculant texture of the mud is therefore considered to be a limiting factor, as in Lake Chilwa McLachlan (1979).

6.4 Benthic Curustaceans

The crustaceans which include Cladocera, Copepoda, Branchiura *Argulus* spp, and Ostracoda are widely distributed in Lake Awasa. Unlike Lake Kinneret, Isreal, Serruya (1978) the list of benthic crustacea from Lake Awasa does not include Amphipods, Isopods and Decapods which are mainly the characterstics of most temperate lakes. Nevertheless, crustaceans from Lake Chilwa, Malawi, Kalak (1979) and Lake Awasa (Table 15) are similar. For example the Cladoceras Diaphnosoma excisum, Moina micrura and Alona spp are found in both lakes.

It may be due to their opportunistic feeding habit and wide tolerance of different environmental conditions (Pennak, 1953; Meglitsch, 1972) that ostracods are found to be the dominant group of all the benthic organisms of Lake Awasa. According to Pennak (1953) ostracods are ominivorous scavengers and their food consists mostly of bacteria, algae, fine detritus and dead animals. It was clearly seen that ostracods were the true benthic "infauna" at the bottom of the lake and this may be associated to high fallouts of detritus and presence of other benthic animals at the bottom.

6.5 Benthic Chironomids

The chironomids found in the lake are among the dominant benthic organisms. Their distribution in the lake was patchy and this may be due to the patterns of availability of food and oxygen. Depth is also another factor which regulates chironomid presence in lakes. It was found in Lake Awasa that most of the benthic chironomids were concentrated in the littoral zone down to four meters depth where vegetation is abundant. Temperature seems to have no significant effect as there was very little seasonal difference (Table 19).

The majority of the littoral midges were found to be tube constructors and they use the available substrata as stems of macrophytes, detritus, littoral mud and fine sand for tube construction. It was noted that most of the chironomids in Lake Awasa belong to the sub-family chironominae (Nilodorum, Dicrotendipes, Chironomus, Cryptochironomus, Parachironomus, *Polypedilum* and *Einfeldia*) and according to Pennak (1953) they have herbivorous and macrophagus characteristics, and also build flimsy tubes of organic detritus algae or small sand grains and silt.

Procladius brevipetiolatus which are found on the bottom down to a depth of eight meters are found freely on the surface of mud. According to Pennak (1953) *Procladius brevipetiolatus* do not build cases, are predaceous and other insect larvae form a large portion of their diet. Tube building *Cladotanytarsus pseudomancus* is common in the same region as *Procaldius brevipetiolatus*.

6.6 Molluscs

Gastropod snails which are the other important components of the benthic fauna of Lake Awasa are both of medical and biological importances. Brown (1980) reported twelve genera of gastropod snails from and around Lake Awasa. In this study, however, seven genera are reported.

According to Kloos and Lemma (1977) and McCullough (1965) *Lymnea truncatula* and *L. nataliensis* are found to be host snails of *Fasciola hepatica* and *Fasciola gigantica* and the authors reported that these snails are also transmitters of *Schistosoma bovis* in Ethiopia. Lo and Lemma (1975) have pointed out that one of the endemic areas of *Schistosoma bovis* is Awasa and the *Fasciola* infection rate in Awasa was 60%. According to Brown and Wright (1974) *Bulinus truncatus* is also considered as a potential intermediate host for *Schistosoma haematobium*. However, it appears that many of the snails found by the previous authors were found in smaller water bodies and swampy regions around the lake. The common planorbid in the lake is *Bulinus truncatus* which does not appear to host human schistosomes.

Compared to the main lake, the scarcity of gastropod snails in the mouth of Tikur Wuha may be due to the absence of large floating macrophytes (Nymphea spp) and other suitable substrates from the mouth of the stream. The river itself contained Biomphalaria sp which did not appear to survive when it was washed into the lake.

6.7 Parasitic and predator fauna

Some of the benthic fauna of Lake Awasa have parasitic modes of life at least in one of their life cycles. In this group are included Branchiura Argulus sp and Hydracarina. Coleoptera larvae such as Dytiscidae and Hydrophilidae larvae are predaceous. The Dytiscidae group, according to Pennak (1953), are exclusively carnivorous and they feed on all kinds of aquatic metazoa including dragonfly nymphs, tadpoles and even small fish. Biting midge larvae such as Certatopogonidae Bezzia spp are even nuisance to higher vertebrates.

According to Bottger (1976) Heteroptera, Coleopters, Odonata, Plecoptera, Trichoptera and Chironomid pupa are attacked by some larvae of water mites (Acari, Hydrachnellae). It was also observed in Lake Awasa that water mites were seen attached to the body of Nepidae.

The effect of bird predation is also considerable. Lake Awasa is noted for the wide range of fish eating birds: Coromorants, pelicans and herons are common all over the lake. Big lizards, Varanus sp which were seen once in the southern tip of the lake near a rocky shore may also prey upon fishes.

It has been shown by Dogiel, Petrushevski and Polyanski (1961) that Branchiura, Argulus spp, leeches and other blood sucking parasites might act as vectors of diseases of fishes. By damaging the surface of the body and internal organs of fishes and producing various wounds and ulcerations, parasites favor the penetration of other pathogenic organisms mainly fungi and bacteria.

The extent of parasitism and fish predation by birds and other animals were not determined. Nevertheless, it can be infered that productivity may be affected by these parasites and predators and further studies are therefore important.

7. CONCLUSION AND RECOMMENDATIONS

In this study the distribution of the benthos of Lake Awasa was mapped. The lake harbours most of its macrobenthos in the macrophytes at the littoral. The macrophytes appeared to be the most important sites of interactions among the benthos. The profundal zone, however, is devoid of any macrobenthos.

It has become apparent that most of the benthic fauna of the lake are important sources of food for fishes. In addition to this some benthic fauna have parasitic and predatory habits.

The extensive macrophytes which fringe the lake in all directions not only provide habitats to the many invertebrates and young fish but also serve as important food sources for the different fauna of the lake. It is important that care should be taken to maintain the integrity and health of the macrophytes, otherwise the lake may probably be barren in macrobenthos and fish fauna if anything disaster occurs to the vegetation.

Because of the very soft and flocculant nature of the profundal mud, introduction of such fish as the carp may drastically increase turbidity and consequently productivity of phytoplankton can be greatly altered. Introduction of fish must therefore be carried out after having assessed the behaviour, yield and commercial value of fish and their effects on the present valuable commercial fish *Oreochromis niloticus*.

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9. APPENDICES

APPENDIX A

Benthic Organisms collected from the bottom of Lake Awasa Southern Tip of the Lake Using Ekman Grab.

Date 25.5.83	Benthic Organisms	Edge of grass	No./m^2	%
	Oligochaeta Naididae	3	133	1.036
	Ostracoda	173	7681	59.86
	Copepoda	43	1909	14.88
	Argulus	2	89	0.69
	Cladocera	14	621	4.84
	Ephemeroptera	17	751	5.85
	Cloeon spp	7		
	Caenis spp	10		
	Chironomid larvae	37	1643	12.80
	Procladius	*0.78		
	Nilodorum	*0.14		
	Cladotanytarsus	*0.14		
	TOTAL	289	12832	100.00

* Proportion of Chironomidae

APPENDIX B

Benthic Organisms collected from Cheleka using Ekman grab

Date 9.12.83	Benthic Organisms	Middle of Grass	Distance from grass in meter			Mean No. n = 4	No./m^2	%
			50	100	250			
	Nematoda	2				0.5	22	0.11
	Oligochaeta							
	Naididae	5				1.25	56	0.27
	Limnodrilus		7			1.75	78	0.38
	Ostracoda	205	1395	138		434.5	19292	93.85
	Copepoda	6		6		3	133	0.65
	Chironomid larvae	24	56	1	4	21.25	944	4.59
	Ablabesmyia	* 0.5	*0.03					
	Procladius	* 0.25	*0.31		3			
	Cricotopus Scottae	*0.25						
	Chironomus sp		*0.03					
	Polypedilum		*0.06					
	Cladotanytarsus		*0.55		1			

* Proportions of Chironomidae

APPENDIX B (Cont'd.)

Date 9.12.83	Benthic Organisms	Middle of grass	Distance from grass in meter			Mean No. n = 4	No./m^2	%
			50	100	250			
	Chironomid pupa							
	Nilodorum brevipaplis	1				0.25	11	0.054
	Mollusca							
	Bulinus truncatus	2				0.5	22	0.11
	TOTAL	245	1458	145	4	463	20557	100.00

APPENDIX C

Benthic Organisms collected from Cheleleka using Ekman grab

Distance 10.2.84	Benthic Organisms	Inner edge of grass	Distance from grass in meters		Mean No. n = 3	No./m^2	%
			50	1000			
	Oligochaeta *Limnodrilus*	26		2	9.33	414	0.99
	Ostracoda	1143	1353	58	851.33	37799	91.18
	Copeopda	3	16	16	11.66	581	1.25
	Hydracorina	3			1.00	44	0.11
	Ephemeroptera *Caenis* spp	10	4		4.66	207	0.499
	Odonata nymph						
	Anisoptera	2			0.66	29	0.069
	Chironomid larvae	126	17	11	51.33	2279	5.49
	Ablabesmyia	*0.07					
	Procladius	*0.1	*1	*0.71			

*Proportion of Chironomidae

APPENDIX C (Cont'd.)

Date 10.2.84	Benthic Organisms	Inner edge of grass	Distance from grass in meters		Mean No. n = 3	No./m^2	%
			50	1000			
	Cladotanytarsus sp			*0.29			
	Cladotanytrsus- pseudomancus	*0.76					
	Chironomid pupa						
	Cladotanytarsus- pseudomancus		1		0.33	15	0.036
	Mollusca						
	Gyraulus costulatus	10			3.33	148	0.36
	TOTAL	1323	1391	87	933.67	41455	100.00

* Proportion of Chironomidae

APPENDIX D

Benthic Organisms collected from boat landing site in grass Paspalidium using a hand net.

Date 25.4.83	Benthic Organisms	No./handnet	%
	Cladocera	7	4.38
	Ostracoda	3	1.88
	Copepoda	118	73.75
	Ephemeroptera		
	Cloen Sp.	1	0.63
	Heteroptera		
	Naucoridae Laccoris	15	9.38
	Chironomid larvae	11	6.88
	Cricotopus albitibia	*0.33	
	Nilodorum sp	*0.66	
	Mollusca		
	Bulinus truncatus	2	1.25
	Fish fry	3	1.88
	TOTAL	160	100.00

* Proportions of Chironomidae

APPENDIX E

Benthic Organisms collected from Southern tip, Jara in grass Paspalidium using hand net.

Date 27.5.83	Benthic Organisms	No./hand net	%
	Copepoda	2	3.08
	Branchiura Argulus sp	1	1.54
	Hydracarina	6	9.23
	Ephemeroptera		
	Cloeon spp	22	33.85
	Odonata		
	Zygoptera	1	1.54
	Heteroptera	6	9.23
	Corixidae Micronecta - denticulata	2	
	Gerridae	1	
	Notonectidae Anisops	3	
	Coleoptera		
	Dytiscidae larvae	1	1.54
	Chironomid larvae	26	40.00
	Cricotopus scottae	*0.06	
	Dicrotendipes	*0.06	
	Nilodorum	*0.81	
	Polypedilum	*0.06	
	TOTAL	65	100.00

* Proportions of Chironomidae

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