BIODIVERSITY OF LAKE VICTORIA:

ITS CONSERVATION AND SUSTAINABLE USE

[THE UGANDAN VERSION]

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CHAPTER 9
The diversity of macroinvertebrates in the Victoria and Kyoga lake basin and their relationship to ecosystem functioning

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Introduction

Aquatic macro-invertebrates encompass all those organisms that can be seen with unaided eyes. Most macro-invertebrates are categorised as semi-aquatic in that they are aquatic in early stages, but live as terrestrial organisms as adults, while others like gastropods, bivalves, Oligochaetae, Hirudinae and ostracods are exclusively aquatic. Some of them such as mayflies lay eggs in water and subsequent stages also live in water until adulthood when they emerge to live a terrestrial life. In others, eggs are laid near the water, while some like members of Tendipedidae (midges) lay their eggs on the leaves of aquatic macrophytes and after hatching their larvae creep into water.

Macro-invertebrates are economically important. They contribute, among other things, to the diet of different species of fish (Greenwood 1966, Corbet 1961, EAFRO Ann. Rep. 1954/55, 1955/56, 1958). Gastropods and bivalves, for example are important prey for *Protopterus aethiopicus;* chirnomid and chaoborid larvae are important in the diet of most demersal fishes while Ephemeroptera and Odonata nymphs contribute to the food of juvenile *L. niloticus* (OgulU-Ohwayo 1984). They thus occupy an important position in aquatic food chains, linking primary production by algae to higher trophic levels culminating into fish production.

Macro-invertebrates are also commonly used as indicators of nutrient enrichment in water bodies (eutrophication), a widely occurring phenomenon in Ugandan lakes due to negative human impacts. For the example, some chironomid communities (Saether 1979), Oligochaetes (Matagi 1996) have been shown to be of use as biological indicators of pollution. From unpublished reports and personal observations around Lake Victoria some, like *Caridina nilotica* and mollusc shells are of economic value in that they are commercially harvested, processed and incorporated into domestic animal feeds. Yet others are parasitic on other aquatic organisms, e.g. Leeches and Argulids on fish (Mbahinzireki 1977). Some Gastropods e.g. *Bulinus* spp. and *Biomphalaria* spp are vectors of *Schistosoma,* which cause bilharzia in man. Other types are scavengers on dead organisms e.g. fish and even vegetation thus helping in cleaning of the water bodies.

It is therefore important that the status of macro-invertebrates in water bodies be studied in order to understand their ecological importance and contribution to fishery production. Documented information on the biology and ecology of macro-invertebrates in Ugandan

waters is at present very scanty. of the early studies were based on analyses of stomach contents of fishes from Lake Victoria and of limited scope (EAFFRO Annual reports 1954/55; 1956/57; 1958) although some specific studies (Macdonald 1956; Corbet 1958; Tjonneland 1958a, 1958b) were also carried out. During the late 1980s and the 1990s some detailed studies were carried out largely on aspects of distribution and abundance of major macro-invertebrate groups in the northern part of the Lake Victoria (Mbahinzireki, lORC unpublished technical reports, Lehman *et al.* 1994). Despite the widely acknowledged ecological importance of these organisms in aquatic habitats, detailed information on their status and ecology is limited and virtually non-existent for many other lakes in Uganda.

Over the past three to four decades most have been greatly impacted by human activities in the catchment areas involving vegetation clearance for agriculture, overgrazing, encroachment on swampy buffer zones between wate.r and land (ecotones), release of untreated domestic and industrial wastes into waterways etc. Such impacts have been aggravated by increasing human populations in most lake basin areas and have led to influx' of excessive nutrient loads (eutrophication) and pollutants (pollution) into most water bodies. Environmental changes are considered to be the primary factors influencing changes in species richness in aquatic habitats as a direct result of differences in tolerance by the various organisms to different factors. The lakes surveyed during this study were assumed to be at different stages of nutrient enrichment (lake trophy). The aim of the study was to investigate the composition, distribution and abundance patterns of macro-invertebrates, and compare possible differences within each lake (i.e. inshore vs offshore, sediment vs macrophyte roots, sandy vs muddy sediments etc) as well as diffrences between the different lakes.

This paper presents preliminary results on the diversity of macro-invertebrates in various water bodies within the Victoria and lake (including the River Nile) and attempts to define the relationship between macro-invertebrate communities, ecosystem functioning and fish production.

Study Area

The study area covered selected water bodies within the Victoria and Kyoga lake basins namely, lakes Mburo, Kachera, Wamala, Kayanja, Kayugi, Nabugabo, Victoria, Victoria Nile, Kyoga, Nawampasa, Nakuwa, Gigati, Nyaguo, Agu , Bisina, Kawi, and Lemwa

Materials and methods

Sediment and macrophyte samples were collected from the edge (macrophyte) inshore and offshore areas (sediment) of each lake. Macrophytes were sampled using a wooden quadrat of size 0.5 X 0.5 m. Roots of the macrophytes were dislodged from surrounding vegetation using a machete. Only the roots were taken for invertebrate investigation. Root

samples were placed in labelled polythene bags. A Ponar Grab was used to collect sediment samples. hauls were taken from each sampling point and emptied into a plastic basin. The bottom type was determined by visual inspection and described from the texture of the sample. Samples were washed (concentrated) using a 500um-mesh net washing bag and the semi-processed sample placed in a labelled bottle containing 5% formalin or 45% ethanol. In the laboratory each sample was rinsed, poured on to a flat tray, individual organisms sorted and taxonomically identified as far as possible.

Results

Lakes **Mburo and Kachera**

The taxonomic composition of Lake Mburo showed higher diversity of benthos (i.e. 10 taxa) inshore compared to offshore waters (4 taxa) *Chironomus* spp and Chironominae were more abundant in inshore than offshore sediment. On the other hand, Chaoborids were more numerous in the open water than in the inshore sediment. In Lake Kachera, the two taxa: *Chironomus* spp and Chironominae showed a similar inshore-offshore gradient of abundance as in Lake Mburo. Tanypodinae had higher abundance in offshores waters in both lakes. Offshore sediments of Mburo and Kachera showed similarity in that they both contained the four cornmon taxa: *Chironomus* spp, Chironominae, Tanyponidae and Chaoboridae and supported higher diversity inshore than offshore.

From the papyrus (macrophyte) sample of Lake Mburo, a slightly higher diversity comprising II taxa was observed compared to 10 recovered in sediments. Despite their occurrence in very low densities, almost all organisms found in sediment samples were present in the papyrus samples. Markedly high densities occurred in the papyrus samples i.e. Chrionominae (10628 ind.lm^2, *Povilla* spp (2144 ind.lm^2), Coleoptera (533 ind.l m^2) etc (Table 8a) Similarly, papyrus samples of Lake Kachera supported much higher diversity of macro-invertebrates (13 taxa) than the sediments samples (7 taxa). The most abundant taxa included Chironominae, Ceratopogonidae, and Coleoptera (Table 8a). In both lakes, there were no Chaoborids in the papyrus samples in contrast to the high densities (1572 ind.lm^2) observed in the sediment samples.

L. Wamala

Eight taxa: Chaoborids, Chironominae, *Chironomus* spp, Tanypodinae, Oligochaetes, Hirudinea, Hydracarina and Ostracods were encountered. Like in most cases, inshore sediment showed more diversity (with all the above taxa) than the offshores with only five taxa. The *Chaoborus* sp. *Chironomus* spp, and Tanypodinae were the most abundant organism in both inshore and offshore sites. *Chironomus* spp contributed 57.2% inshore and 33.1% offshore, while Chaoborus sp 31.0% inshore and 52.2% offshore. Also appeared in both localities were the Chironominae, and Oligochaetes. (Table 2 a & b)

From the papyrus, a high diversity of 14 taxa were realised, with all the above taxa from sediment appearing. Chironominae-(49.9%),Coleoptera-(24.75),ostracods-(5.7%),Oligochaete-(4.2%) and *Chironomus* spp-(3.3%) were the most abundant taxa recovered. Other taxa present were *Biomphalaria* sp. *Bulinus* sp. Anisoptera, zygoptera, Coleoptera and Trichoptera whose numerical contribution were indicated in Tables II a &b.

R. Sio

Despite the sady bottom, which usually shows higher diversity of organisms, R. Sio upstream and its mouth into Victoria were apparently devoid of macroinvertebrates. However the sediment from the downstream (100m into the lake) gave bivales *(Corbicula , Sphaeria*), *Melanoides* sp ,Oligochaetes and Chironominae . From Madwa rocky, a station around, showed higher diversity of7 taxa – *Corbicula, Melanoides* sp., *Sphaeria, Chaoborus* sp. Tanypodinae, Trichoptera and Oligochaete. At both points the bivalves (mostly *Corbicula* sp.) were the most abundant (Table 2).

From the macrophytes, *Eichhornia* spp, *Biophalaria* sp. *Lymnaea* sp. Coleoptera and Trichoptera were recovered, the *Biomphalaria* being the most abundant (Tables II a & b).

Lake Kayanja

Except for *Chironomus* spp, this lake was characterised by low numbers of macro-benthic organisms compared to other lakes (Tables 3a and 3b). However, the inshore sediment showed relatively higher diversity of organisms (7 taxa) relative to the offshore sediment (4 taxa). The most abundant taxon inshore was Chironominae (81.8%) while *Povilla* sp. and Chaoborids, Anisoptera, Coleoptera, Trychotera and Ceratopogonids were much less abundant (6 to < 2 %). In the offshore sediments, all the four taxa *Chironomus,* Chironominae, Tanypodinae and *Chaoborus* occurred in relatively high densities (136, 95, 109 and 136 ind.f m^2 respectively, corresponding to 28.6%, 20.0%, 22.9% and 28.6%).

From the dominant shoreline macrophyte, *Miscathidium,* relatively low diversity of only 6 taxa was observed compared to 9 recovered from the sediment samples (Table 9a). With the exception of *Povilla spp.* and Coleoptera which occurred in both habitat types, *Miscathdium* supported somewhat different types of organisms i.e. Hemiptera *(Naucaris),* 01igochaetes, leeches and Hydracarina. *Povilla* spp. was the most abundant in the macrophyte sample with 2416 ind.fm^2 corresponding to 93.9% (Table 9b), while oligochaetes, Coleoptera, *Naucaris* and Hydracarina were generally poorly represented

Lake Kayugi

Due accessibility problems of this lake, only sediment samples were collected from the offshore area. The sample contained only 5 taxa (Table 3a). Chaoborids were the most abundant (789 ind./m^1) followed by *Chironomus* spp (571 ind./m^1), Tanyporiidae (299 ind./m^2), *Povilla* spp and Ceratopogonids (14 ind./m^1 each). The corresponding percentages were shown in Table 3b.

Lake Nabugabo

A low diversity of only 3 and 2 taxa in sediment samples from the inshore and offshore areas was observed. *Chironomus* spp contributed the highest percentage of organisms (81.4 %) in the inshore area while other minor groups were *Povilla* spp and Odonata (Anisoptera). In the offshore sediment *Chaoborus* spp was the main sediment component. Other minor groups included Tanyponidae, Coleoptera, Trichoptera, and Ceratopogonids (Tables 3a & 3b).

The macrophyte sample *(Papyrus)* also indicated generally low diversity and density of organisms (Table 9a). A part from the *Povilla* spp, which occurred in both sediment and macrophyte samples, the two substrates exhibited different organism composition. In the sediment, *Povilla* spp. (7 ind./m^2), Anisoptera (7 ind./m^2), *Chironomus* spp (61 ind./m^2), Tanyponidae (21 ind./m^1) and Chaoborids 361 ind./m^1 were recovered though in relatively low concentrations. On the other hand the macrophyte fauna comprised Ephemeroptera (32 ind./m^2), *Naucaris* (32 ind.lm^1), Chironominae (64ind./m^1) in addition to *Povilla* spp. which dominated the community (3520 ind./m^1 corresponding to 96.5%) (Tables 9a & 9b).

In general, the papyrus-macrophyte substrate supported higher density of 3648 ind./m^1 compared to the sediment with only 456 ind./m^2

Victoria Nile (Bujagali and the Nile upstream of L. Kyoga)

Samples taken from two points, one representing the shoreline area (RNB,) and another the midstream area (RNB1) exhibited relatively high diversity of organisms compared to other water bodies investigated. Gastropods (mainly *Bellamya* and *Melanoid),* Bivalves (mainly *Corbicula* and *Sphaeria),* Ephemeroptera, Ostracods, , Chironominae and Oligochaetae were represented in both shoreline and midstream sediments. On the other hand, Tanypodinae, leeches and Trichoptera were absent in the shoreline sediment, while Anisoptera, Chaoborids, Ceratopogonids and Cladocera were missing in the midstream sample. Density of organisms was higher in the shoreline sediment (2449 ind./m^1) than that from the midstream point (993 ind./m^1).

From the sediment sampled arround the river upstream of L. Kyoga, 6 taxa were recovered in each of inshore and the offshore samples. From inshore *Povilla sp.and* bivalves (Sphaeria sp.) were more dominant with 104 and 68 ind./m^1 respectively. They each contributed 54.2% and 35.4% respectively. Other taxa included *Gastropods(Pila*

sp.),Tanypodinae, Oligochaetes and Ceratopogonids .From offshore sedimets *Sphaeria* sp. contributed 82.9%. Other taxa were Gastropods *(Cabia* sp. and *Bel/amya* sp.),Biva[ves(Mulera sp. and Bysonodonta sp.) and Tanypodinae (Tables 4a & 4b).

Lake Kyoga-Iyingo

Only two taxa, Chaoboridae and Tanypodinae were encountered in samples from both inshore and offshore sites. Both taxa occurred in inshore sediment while only Chaoboridae was recovered from offshore. In the shoreline sediment, Chaoborids contributed *(541m^2)* while the rest 20.6% was constituted by Tanypodinae (14 ind.lm^2) (Tables 5a & 5b). Chaoborids exhibited higher density of (871 ind.lm^2) offshore compared to 68 ind.l m^2 in inshore sediment.

From the macrophytes *(Papyrus)* 13 taxa were encountered The more abundant taxa were Chironominae (2864 ind.lm^2 , 54.2%), *Povilla* spp (1520 ind.lm^2, 28.8%), unidentified Ephemeroptera *(320/m^2*, 6.1 %), ostracods (240 ind.lm^2, 4.5%), *Naucaris* (128 ind.lm^2, 2.4%) and *Biomphalaria* (64 ind.lm^2, 1.2%). Other minor taxa included chaoborids, Anisoptera, Coleoptera, Hydracarina, Cladocera and *Caridina niiOlica.* (Table lOa & lOb).

Lake Nawampasa

Two taxa, chaoborids and ostracods were found in sediments from both inshore and offshore areas of the lake. In the inshore sediment, only chaoborids *(271m^2)* were present. In offshore sample chaoborids constituted 60.3% of the total number, but at a low density of 40 ind.lm^2, while ostracods contributed 39.7% corresponding to a density of 27 ind.lm^2 Cfable 5a & 5b).

The macrophyte sample *(Papyrus)* showed relatively high diversity of 8 taxa. The most common taxa were Chironominae (464 ind./m^2, 45.3%), Coleoptera (320 ind.lm^2, 31.3%), Oligochaetae (128 ind.lm^2, 12.5%) and *Biomphalaria* spp (48 ind.lm^1, 4.7%) Other minor taxa included *Pila,* Lymnae, *Naucaris* and Anisoptera each with a density of 16 indlm^2 (Table lOa & lOb).

Lake Nakuwa

The diversity of organisms was lower in the inshore than offshore sediments. From the laner, 6 taxa were found compared to only 3 in the former. Chaoborids, Tanypodinae, and ostracods were present in both the offshore and inshore sediments. Chaoborids dominated the offshore sediments with 1075 ind.lm^2 corresponding to 86.8% while dominant group inshore was ostracods with 54 ind.tm^2 corresponding to 79.5%. Other taxa recovered offshore were oligochaetes, ceratopogonids and melanoids (Tables 5a & 5b).

Table 1a

Abundance (ind.1 m^2) of benthic macroinvertebrates in the Koki lakes 1999.

Taxa	Mro inshore	Mro offshore	Kra inshore	Kra offshore
Chironomids *(Chironomus* sp.)	231	23	86	86
Chironomids (Chironominae)	730	23	5	9
Chironomids (Tanypodinae)	236	921	9	231
Ceratopogonids	5		5	63
Chaoborids	5	73		3143
Ephemeropera *(Povi/la* sp.)	5			
Ephemeropera *(Caenis* sp.)	9			
Odonata (Anisoptera)			5	
Hemiptera (Corixa)	5			
Hirudinea	9			
Hyradracarina (mites)			5	
Ostracods	14			
Total	1249	1040	115	3532
No. of taxa	10	4	6	5

Table 1b

Percentage composition of benthic macroinvertebrates in the Koki Lakes· 1999.

Taxa	Mro inshore	Mro offshore	Kra inshore	Kra offshore
Chironomids *(Chironomus* sp.)	18.5	2.2	74.8	2.4
Chironomids (Chironominae)	58.4	2.2	4.3	0.3
Chironomids (Tanypodinae)	189	88.6	7.8	6.5
Ceratopogonids	0.4		4.3	1.8
Chaoborids	0.4	7.0		89.0
Ephemeropera *(Povi/la* sp.)	0.4			
Ephemeropera *(Caenis sp.)*	0.7			
Odonata (Anisoptera)			4.3	
Hemiptera (Corixa)'	0.4			
Hirudinea			4.3	
Hyradracarina (mites)	0.7			
Ostracods	1.1			
Total	100.0	100.0	100.0	100.0

Table 2a

The abundance (ind. / m^2) of benthic macroinvertebrates in lake Wamala (April & Aug.1999) and R. Asio (Oct.1999)

Taxa	Wla		R. Sio	
	inshore	offshore	0' stream	Madwa
Gastropods *(Melanoides* sp.)			41	14
Bivalves *(Sphaeria* spp)			544	68
Bivalves *(Corbicula* sp.)			3102	776
Chaoborus sp.	144	277		54
Chironomids (Chironominae)	4	3	14	
Chironomids (Chironomus sp.)	266	176		
Chironomids (Tanypodinae)	41	65		204
Trichoptera				41
Oligochaetes	3	10	136	272
Hirudinea	2			
Hydracarina	2			
Ostracods	3			
Totals	465	531	3837	1429
No. of taxa	8	5	5	7

Table 2b

The percentage composition of benthic macroinvertebrates in lake Wamala (April & Aug.1999) and R. Asio (Oct.1999)

Taxa	Wla		R. Sio	
	inshore	offshore	0' stream	Madwa
Gastropods *(Melanoides* sp.)			1.1	1.0
Bivalves *(Sphaeria* spp)			14.2	4.8
Bivalves *(Corbicula* sp.)			80.8	54.3
Chaoborus sp.	31.0	52.2		3.8
Chironomids (Chironominae)	0.9	0.6	0.4	
Chironomids (Chironomus sp.)	57.2	33.1		
Chironomids (Tanypodinae)	8.8	12.2		14.3
Trichoptera				2.9
Oligochaetes	0.6	1.9	3.5	19.0
Hirudinea	0.4			
Hydracarina	0.4			
Ostracods	0.6			
Totals	100.0	100.0	100.0	100.0

Table 3a

Abundance (indo / m^2) of benthic macroinvertebrates in different Nabugabo satelite lakes 1999.

Taxa	Kja inshore	Kja offshore	Kji offshore	Nbo inshore	Nbo offshore
Chironomids *(Chironomus* sp.)	680	136	571	122	
Chironomids (Chironominae)		95			
Chironomids (Tanypodinae)	41	109	299		41
Chaoborids		136	789		721
Ceratopogonids			14		
Ephemeroptera *(Caenis sp.)*	54				
Ephemeroptera *(Povilla* sp.)	14		14	14	
Odonata (Anisoptera)	14			14	
Trichoptera	14				
Coleoptera	14				
Totals	831	476	1687	150	762
No. of taxa	7	4	5	3	2

Table 3b

Percentage composition of benthic macroinvertebrates taxa in the Nabugabo satelite lakes, 1999.

Taxa:	Kja inshore	Kja offshore	Kji offshore	Nbo inshore	Nbo offshore
Chironomids *(Chironomus* sp.)	81.8	28.6	338	82.4	
Chironomids (Chironominae)		20.0	17.8		
Chironomids (Tanypodinae)	4.9	22.9	46.8		5.4
Chaoborids		28.6			94.6
Ceratopogonids			0.8		
Ephemeroptera *(Caenis* sp.)	6.5				
Ephemeroptera *(Povilla* sp.)	1.7			9.3	
Odonata (Anisoptera)	1.7		0.8	9.3	
Trichoptera	1.7				
Coleoptera	1.7				
Totals	100.0	100.0	100.0	100.0	100.0

4a:

Abundance *(ind.1 m²)* of benthic macroinvertebrates in Victoria nile

Taxa	Vie inshore	offshore	Kia inshore	offshore
Gastropods *(Gabia* sp.)	54	14		27
Gastropods *(Balfamya* sp.)	68	163		9
Gastropods *(Pila* sp.)			5	
Gastropods *(Melanoid* sp.)	789	68		
Bivalves *(Caa/atura* sp.)	68			
Bivalves *(Sphaen'a* sp.)	27	27	68	372
Bivalves *(Corbicu/a* sp.)	286	14		
Bivalves *(Mutera* sp.)				5
Bivalves *(Byasonodonra* sp.)				27
Ostracods	531	68		
Ephemeroptera *(Povilla* sp.)	14	27	104	
Ephemeroptera (Other sp.)	68	422		
Odonata (Anisoptera)	14			
Chironornids (Chironominae)	95	68		
Chironomids (Tanypodinae)		27	5	9
Oligochaetes	204	14	5	
Hirudinae (Leeches)		41		
Trichoptera *(Hydropsyche* sp.)		41		
Chaoborids	95			
Ceratopogonids	109		5	
Cladocera (Giant	27			
Totals	2449	993	192	449
No. of Taxa	15	13	6	6

Table 4b:

Percentage composition of benthic macroinvertebrates in Victoria nile

Taxa	Vie inshore	offshore	Kia inshore	offshore
Gastropods *(Gabia* sp.)	2.2	1.4		6.0
Gastropods *(Bellamya* sp.)	28	16.4		2.0
Gastropods *(PiJa* sp.)			2.6	
Gastropods *(Melanoid* sp.)	32.2	6.9		
Bivalves *(Caelalura* sp.)	2.8			
Bivalves *(Sphaeria sp.*)	1.1	2.7	35.4	82.9
Bivalves *(Corbicula* sp.)	11.7	1.4		
Bivalves *(MUt6fa* sp.)				1.1
Bivalves *(Byasonodonta* sp.)				6.0
Ostracods	21.7	69		
Ephemeroptera *(Povila* sp.)	0.6	2.7	54.2	
Ephemeroptera (other sp.)	28	42.5		
Odonata (Anisoptera)	0.6			
Chironomids (Chironomlnae)	39	69		
Chironomids (Tanypodinae)		2.7	2.6	2.0
Oligochaetes	83	1.4		
Hirudinae (Leeches)		4.1	2.6	
Trichoptera *(Hydropsyche* sp.)		4.1		
Chaoborids	39			
Ceratopogonids	4.4		2.6	
Cladocera (Giani *type)*	1 1			
Totals	100	100	100	100

Table Sa:

Abundance (ind. *I* m^2) of benthic macroinvertebrates in different Kyoga minor Lakes July, 1999.

Taxa	Kgo		Nsa		Nwa		Gti	
	inshore	offshore	inshore	offshore	inshore	offshore	inshore	offshore
Gastropods (Melanoids)						**14**		
Odonata (Anisoptera)								
Chironomids *(Chironomus* sp.)								
Chironomids (Tanypodinae)	**14**				95	95		
Chaoborids	54	871	27	**41**	14	1075	41	190
Ceratopogonids						14		
Oligochaetes						27		
Tricoptera							54	
Ostracods			14	27	54	14		
Totals	**68**	**871**	**41**	**68**	**163**	**1239**	**95**	**190**
No of Taxa	2	1	2	2	3	5	2	1

Table Sa continuation

Taxa	Ngo		Agu		Kwi		Lma	
	inshore	offshore	inshore	offshore	inshore	offshore	inshore	offshore
Odonata (Anisoptera)		14						
Chironomids *(Chironomus* sp.)	41	27						68
Chironomids (Tanypodinae)	327							639
Chaoborids	122		14.0			41		707
Ceratopogonids								
Oligochaetes		27						
Tricoptera								
Ostracods								
Totals	**490**	**68**	**14**	0	0	**41**	0	**1414**
No of Taxa	3	3	1	0	0	1	0	3

Table 5b:

Percentage composition of benthic macroinvertebrates in different Kyoga minor Lakes July, 1999.

	Kgo		Nsa		Nwa		Gti	
Taxa	inshore	offshore	inshore	offshore'	inshore	offshore	inshore	offshore
Gastropods *(Melanoid* sp)						1.1		
Odonata (Anisoptera)								
Chironomids *(Chiron'omus* sp.)								
Chironomids (Tanypodinae)	20.6					7.7		
Chaoborids	79.4	100.0	100.0	60.3	20.6	86.8	43.2	100.0
Ceratopogonids						1.1		
Oligochaetes						2.2		
Tricoptera							56.8	
Ostracods				39.7	79.4	1.1		
Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5b continuation

Taxa	Ngo		Agu		Kwi		Lma	
	inshore	offshore	inshore	offshore	inshore	offshore	inshore	offshore
Odonata (Anisoptera)		20.6						
Chironomids *(Chironomus* sp.)	8.4	39.7						4.8
Chironomids (Tanypodinae)	66.7					69.9		45.2
Chaoborids	24.9		100			30.1		50.0
Ceratopogonids								
Oligochaetes		39.7						
Tricoptera								
Ostracods								
Totals	100.0	100.0	100.0	0.0	0.0	100.0	0.0	100.0

Table 6

Number of taxa from sedment for varius lakes inshores and offshores

Lake		Mro	Kra	Wla	Kja	Nbo	Vie	Kle	Kgu	Kgo	Nsa	Nwa	Gti
No. of taxa	inshore'	10	8	8	7	3	18	6	18	2	2	4	2
	offshore	5	6	5	4	2	15	6	8	5	3	9	1

Table 7a

Grand totals of organims (ind. / m^2) from the inshore and offshore of the individual lakes

Lake		Mro	Kra	Wla	Kja	Nbo	Vie	Kle	Kgu	Kgo	Nsa	Nwa	Gti
No. of organisms	inshore	2264	460	465	831	150	1002	192	699	48	41	260	95
	offshore	693	2278	531	476	750	626	449	234	661	116	1043	190

Table 7b

The diversity of macroinvertebrates in both sediment and macrophyte roots from the individual lakes

Lake		Mro	Kra	Wla	Kja	Nbo	Vie	Kle	Kgu	Kgo	Nsa	Nwa	Gti
No. of taxa	Sediment	10	8	8	9	5	20	8	18	5	3	10	2
	Mcrophyte	11	23	14	6	4	13	18	18	10	10	15	2

Table Sa

The diversity and abundancy (indo *1m'*) of macroinvertebrates in sediment and macrophyte roots from the Koki lakes

Taxa	L. Mro Sediment	L. Mro Papyrus	L. Kra Sediment	L. Kra Papyrus
Gastropods *(Bulinus* sp.)		11		
Gastropods (Lymnaea)				16
Ephemeroptera *(Povilla* sp.)	3	2144		
Ephemeroptera (other spp)	5	305		16
Odonata (Anisoptera)			3	
Hemiptera (Naucarids)		139		64
Hemiptera (Corixids)	3			
Chironomids *(Chironomus* sp.)	127	39	86	20
Chironomids (Chironominae)	377	10626	7	348
Chironomids (Tanypodinae)	579	64	120	
Chaobonds	39		1572	
Ceratopogonids	3		34	592
Tabanids				32
Trichoptera				32
Syrphids				16
Oligochaetes		437		144
Hirudinae	5	341		112
Coleoptera		533		3220
Hydracanna		160	3	32
Ostracods	7			
Totals	1148	14801	1825	3144
No. of taxa	10	11	1	13

Table 8b

Percentage Composition of macroinvertebrates in sediment and macrophyte roots from the Koki lakes

Taxa	L. Mro Sediment	L. Mro Papyrus	L. Kra Sediment	L. Kra Papyrus
Gastropods *(Bulinus* sp.)		0.1		
Gastropods (Lymnaea)				0.4
Ephemeroptera *(Povilla* sp.)	0.2	145		
Ephemeroptera (other spp)	0.4	2.1		0.4
Odonata (Anisoptera)			0.1	
Hemiptera (Naucarids)		0.9		1.7
Hemiptera (Corixids)	0.2			
Chironomids *(Chironomus* sp.)	11.1	03	4.7	0.5
Chironomids (Chironominae)	32.9	71.8	0.4	9.3
Chironomids (Tanypodinae)	50.5	0.4	6.6	
Chaoborids	3.4		86.2	
Ceratopogonids	0.2		1.9	15.8
Tabanids				0.9
Trichoptera				0.9
Syrphids				0.4
Oligochaetes		3		3.8
Hirudinae	0.4	2.3		3
Coleoptera		3.6		62
Hydracarina		1.1	0.1	0.9
Ostracods	0.6			
Totals	100.0	100.0	100.0	100.0

Table 9a

The diversitv and abundancv (indo / m^2) of macroinvertebrates in

Taxa	L. Kja Sediment	L. Kja *Typhathidium*	L. Nbo Sediment	L. Nbo Papyrus
Ephemeroptera *(Povilla* sp.)	7	12416	7	3520
Ephemeroptera (Caenis sp.)	27			32
Odonata (Anisoptera)	7		7	
Hemiptera (Naucarids)		160		32
Chironomids *(Chironomus* sp.)	408		61	
Chironomids (Chironominae)	48			64
Chironomids (Tanypodinae)	75		21	
Chaoborids	68		361	
Trichoptera	7			
Oligochaetes		352		
Hirudinae		32		
Coleoptera	7	128		
Hydracarina		128		
Totals	654	13216	456	3648
No. of taxa	10	6	5	4

Table 9b

Percentage Composition of macroinvertebrates in sediment and macrophyte roots from the Nabugabo satelite lakes

Taxa	L. Kja Sediment	L. Kja *Typhathidium*	L. Nbo Sediment	L. Nbo Papyrus
Ephemeroptera *(Povilla* sp.)	1.1	93.9	1.5	96.5
Ephemeroptera (Caenis sp.)	4.1			0.9
Odonata (Anisoptera)	1.1		1.5	
Hemiptera (Naucarids)		1.2		0.9
Chironomids *(Chironomus* sp.)	62.4		13.4	
Chironomids (Chironominae)	7.3			1.8
Chironomids (Tanypodinae)	11.5		4.5	
Chaoborids	10.4		79.1	
Trichoptera	1.1			
Oligochaetes		2.7		
Hirudinae		0.2		
Coleoptera	1.1	0.1		
Hydracarina		0.1		
Totals	100.0	100.0	100.0	100.0
No. of taxa	10	6	5	4

Table 10a

Diversity and abundancy of macroinvertebrates in sediment and macrophyte roots from the Kyoga satelite lakes

	Kgo		Nsa		Nwa		Gti	
Taxa	**Sediment**	***Eichhornia***	**Sediment**	**Papyrus**	**Sediment**	**Papyrus**	**Sediment**	***Typha***
Gastropods *(Bulinus sp.*)						336		
Gastropods *(Biomphalaria* sp.)		64		48		496		
Gastropods *(Melanoid* sp.)					7	64		
Gastropods *(Lymnaea)*				*16*				
Gastropods *(Pi/a)*				*16*				
Ephemeroptera *(Povilla* spJ		1520				144		
Ephemeroptera (other spp)		320						
Odonata (Anisoptera)		16		16				
Odonata (Zygoptera)								
Hemip. (Naucaris)		128		16		160		
Hemiptera (others)		48				16		
Chironomids *(Chironomus sp.)*						64		
Chironomids (Chironominae)		2864		464		896		352
Chironomids (Tanypodinae)	7				48	16		
Chaoborus spp.	463	16	34		545		116	
Ceratopogonids					7	48		
Tabanids								
Trichoptera							27	
Syrphids								
Oligochaetes				128	7			176
Hirudinae (Leeches)						288		
Coleoptera (beetles)		32		320		448		
Hyradracarina (mites)		32						
Ostracodes		240	14		34	14432		
Cladocera (giant type)		48				16		
Caridina nilotica		16						
Totals	**470**	**5280**	**48**	**1024**	**648**	**17424**	**143**	**528**
No. of taxa	2	**13**	2	8	6	**14**	2	2

Table 11a

The diversity and abundance (ind. / m^2) of macroinvertebrates in sediment and macrophyte roots from L. Wamala & R. Sio (1999)

	Wla		**R. Sio**	
Taxa	Sed.	**Pap.**	Sed.	Pap.
Gastropods *(Biomphalaria* sp.)		20		176
Gastropods *(Bulinus* sp.)		56		
Gastropods *(Lymnaea)*				16
Gastropods *(Melanoides* sp.)			27	
Bivalves *(Sphaeria* spp)			306	
Bivalves *(Corbicula* sp.)			1939	
Odonata (Anisoptera)		4		
Odonata (Zygoptera)		4		
Ephemeroptera (Others)		180		
Hemiptera (Naucaris)		12		
Hemip(others)		8		
Chaoborus sp.	143		27	
Chironomids (Chironominae	7	1872	7	
Chironomids (Chironomus s	409	124		
Chironomids (Tanypodinae)	57	72	102	
Coleoptera		928		16
Trichoptera			20	16
Hydracarina	2	0		
Ostracods	3	212		
Oligochaetes	13	156	204	
Hirudinae	1	104		
Totals	**634**	**3752**	**2633**	**224**
No. of taxa	8	**14**	8	4

Number of taxa per square meter inshore and offshore sediment from individual lakes

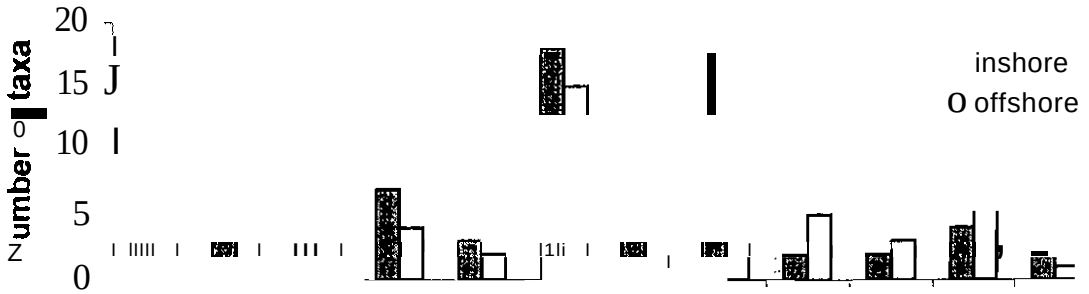


Fig. 1

Grand totals of benthos inshore and offshore sediment from the individual lakes

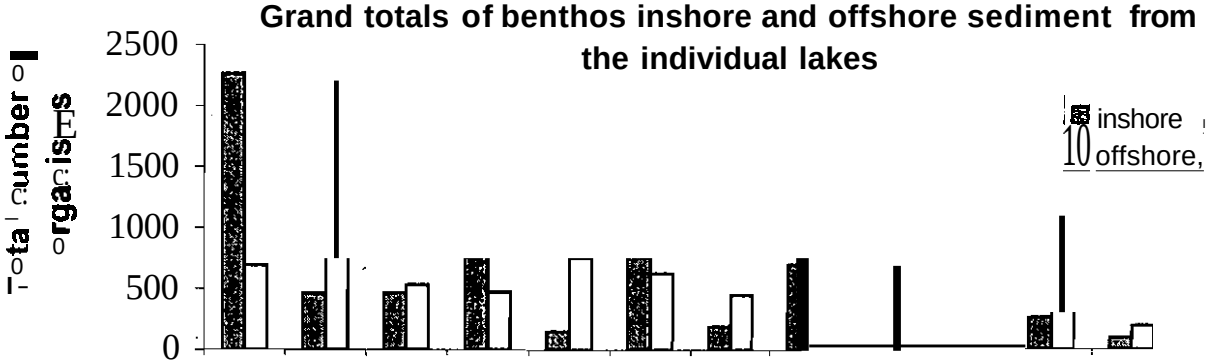


Fig. 2

Number of taxa recovered from sediment and macrophyte roots of the various lakes

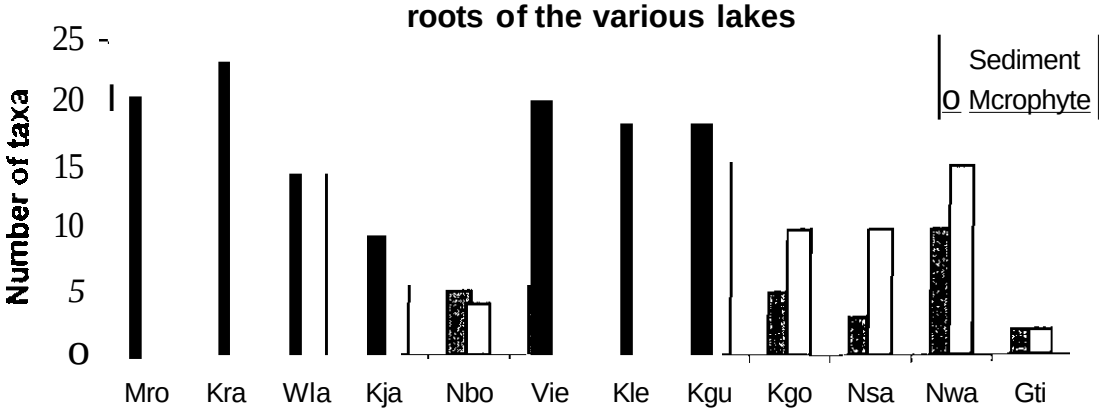


Fig. 3

Table 12

L. Kachera. Lwebiriba site (Comparison between different macrophytes sampled from the same point)

Taxa	Nile cabbage ind.1 m^2	%	Papyrus sp. ind.1 m^2	%
Coleoptera (beetles)	640	25	4000	B1.2
Hirudinae (leeches)	160	6.25	64	1.3
Hydracarina (mites)			64	1.3
Hemiptera (Naucarids)	64	2.5	64	1.3
Oligochaetes	32	'1.25	256	5.2
Chironomids (Chironominae)	2BB	11.25	44B	9.1
Tabanids (horseflies)	32	1.25	32	0.6
Ephemeroptera (Heptageniids)	32	1.25		
Tricoptera	64	2.5		
Syrphids	32	1.25		
Ceratopogonids	11 B4	46.25		
Gastropods *(Lymnaea)*	32	1.25		
Totals	2560	100	4928	100
No. of taxa	11		7	

Table 13

R. Nile up-stream of L. Kyoga (Comparison between *Eichhonia craccipes* and *Pa,*

Taxa	*E. craccipes* ind.1 m^2	%	Papyrus sp. ind.1 m^2	%
Gastropods -*Gabia* sp.	5	0.2		
Gastropods -Bellamya sp.	11	0.4		
Gastropods -*Bulinus* sp.	4B	1.6	16	0.4
Gastropods -*Biomphalaria* sp.	53	1.B	32	0.7
Hemiptera (Naucarids)	75	2.5	43	1
Hemiptera - (others)	21	0.7		
Hirudinae (leeches)	261	B.B	B21	1B.7
Coleoptera (beetles)	21	0.7	75	1.7
Ephemeroptera *(Povilla* sp.)	1979	66.9	3147	71.B
Ephemeroptera *(Caenis* sp.)	117	4.0	75	1.7
Chironomids (Chironominae)	213	7.2	53	1.2
Oligochaetes	5	0.2	21	0.5
Hidracarina (mites)	32	1.1		
Trichoptera	5	0.2	37	0.9
Tabanids	5	0.2		
Odonata (Anisoptera)	37	1.3	53	1.2
Odonata (Zygoptera)	16	0.5	5	0.1
Caridina nilotica	4B	1.6		
Ceratopogonids	5	0.2		
Bivalves		0.0	5	0.1
Totals	2957	100	4383	100
No. of taxa	19		13	

Table 10b

Percentage Composition of macroinvertebrates in sediment and macrophyte roots from the Kyoga satelite lakes

	Kgo		Nsa		Nwa		Gti	
Taxa	**Sediment**	***Eichhornia***	**Sediment**	**Papyrus**	**Sediment**	**Papyrus**	**Sediment**	***Typha***
Gastropods *(Bulinus* sp.)						1.9		
Gastropods *(Biomphalaria* sp.)		1.2		4.7		2.8		
Gastropods *(Melanoid* sp.)					1.1	0.4		
Gastropods (Lymnaea)				1.6				
Gastropods *(Pila)*				1.6				
Ephemeroptera *(Povilla* sp.)		28.8				0.8		
Ephem. (Other spp)		6.1						
Odonata (Anisoptera)		0.3		1.6				
Odonata (Zygoptera)								
Hemip. (Naucaris)		2.4		1.6		0.9		
Hemiptera (others)		0.9				0.1		
Chironomids *(Chironomus sp.*)						0.4		
Chironomids (Chironominae)		54.2		45.3		5.1		66.7
Chironomids (Tanypodinae)	1.5				7.4	0.1		
Chaoborus spp.	98.8	0.3	70.8		84.1		81.1	
Ceratopogonids					1.1	0.3		
Tabanids								
Trichoptera							18.9	
Syrphids								
Oligochaetes.				12.5	1.1			33.3
Hirudinae (Leeches)						1.7		
Coleoptera (beetles)		0.6		31.3		2.6		
Hyradracarina (mites)		0.6						
Ostracodes		4.5	29.2		5.2	82.8		
Cladocera (giant type)		0.9				0.1		
Caridina nilotica		0.3						
Totals	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table11b

The percentage composition of macroinvertebrates in sediment and macrophyte roots from L. Wamala & R. Sio (1999)

Taxa	Wla		R. Sio	
	Sed.	Pap.	Sed.	Pap.
Gastropods *(Biomphalaria* sp.)		0.5		78.6
Gastropods *(Bulinus* sp.)		1.5		
Gastropods *(Lymnaea)*				7.1
Gastropods *(Melanoides* sp.)			1.0	
Bivalves *(Sphaeria* spp)			11.6	
Bivalves *(Corbicula* sp.)			73.6	
Odonata (Anisoptera)		0.1		
Odonata (Zygoptera)		0.1		
Ephemeroptera (Others)		4.8		
Hemiptera (Naucaris)		0.3		
Hemip(others)		0.2		
Chaoborus sp.	22.5		1.0	
Chironomids (Chironominae	1.2	49.9	0.3	
Chironomids (Chironomus s	64.4	3.3		
Chironomids (Tanypodinae)	9.1	1.9	3.9	
Coleoptera		24.7		7.1
Trichoptera			0.8	7.1
Hydracarina	0.2	0.0		
Ostracods	0.4	5.7		
Oligochaetes	2.0	4.2	7.8	
Hirudinae	0.2	2.8		
Totals	100.0	100.0	100.0	100.0