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Plankton identified in Stomach contents of *Oreochromis nilotics* (Pisces, CICHLIDAE) and the water system of Lakes Edward, George, and Kazinga channel - Uganda

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INTRODUCTION

Lake Edward (Fig. 1) is connected to Lake George by Kazinga Channel. The commercial fisheries of this water system are dominated by *Oreochromis niloticus* and *Bagrus docmak.* However, *O. niloticus* is on the decline in commercial catches and yet the water system may be rich in phytoplankton, the common food for *O. niloticus.*

LOWE-MCCONNELL (1958) reported phyto-plankton and diatoms as the major food items identified in *O. niloticus* stomachs for fish caught by gill nets on Lake Edward while on Lake George, it was reported that *O. niloticus* fed on phytoplankton as well as bottom deposits. Green lake algae were observed by Poll (1939) as filling up the stomachs and intestines of *O. niloticus* in L. George. FISH (1955) stated that the fish fed on bottom deposits and on some zooplankton in L. George. GANF (1972) and MORIARTY and MORIARTY (1973) noted that *O. niloticus* from L.Geoge fed mostly on phytoplankton species, 70% being blue-green algae dominated by *Microcystis aaeruginosa, M. flos- aquae* and *Anabaenopsis* species. Other food items of lesser importance were zooplankton dominated by copepods.

On the other hand, WORTHINGTON (1932) noted that *O. niloticus* ingested a wide range of food material in Lake Edward, George and Albert and WORTHINGTON and RICARDO (1936) found crustacea, chironomids and algae in the stomachs of fish from these habitats but only phytoplankton in fish from L.victoria. Other observations on the *O. niloticus* stomach contents carried out on Lake Rudolf (Turkana) (HARBOTT, 1975) using a seine net showed that the dominant algae were the blue-greens such as *Spirulina laxissima S. terebrifoemis, Anabaena spiroides* and *Chrooccus* spp with a few *Microcystis* spp colonies. The diatoms identified were of *Navicula* spp, *Achnanthes* spp and *Cymbella* spp. Zooplankton and Protozoa were scarce.

LOWE-MCCONNELL (1958) summarised the composition of the food contents found in stomachs of *O. niloticus* of East African Great Lakes as primarily algae however, in Lake Victoria for example several studies have shown changes in feeding habits of fish following species introduction there. BALIRWA (1990) found the major food items of *O. niloticus* from trawl catches on L. Victoria to be detritus, invertebrates and phytoplankton. WELCOMME (1967) identified phytoplankton and bottom deposits in fish stomachs from L. Victoria gill net catch samples, GETABU (1994) identified blue-green algae, diatoms and aquatic invertebrates in the Nyanza Gulf, L. Victoria while BALIRWA (1998) observed that detritus material and insects especially chironomid larvae, *Caridina,* molluscs were the most important items regularly ingested by *O. niloticus* caught from trawl catches in shallow littoral zone habitats of Nothern portion of Lake Victoria making up to 50% - 65% mean volume of stomach contents. Phytoplankton and higher plant remains made up less than 15% of mean

volume of the stomach contents. Among the phytoplankton, the dominant taxa were blue-green algae e.g. *Microcystis, Anabaena, Merismopedia, Lyngbya* spp and Diatoms were *Nitzchia, Melosira* and *Navicula* spp.

In Lakes George, Edward and Kazinga Channel, there has been no similar detailed and follow up studies on the major food items ingested by *O. niloticus* in more than two decades and yet there are some changes especially in the commercial fishery of the species. Though the samples anlayzed in this study were not very many, the several organisms identified in the water samples and in the stomach contents of the fish will add to the pool of the existing knowledge especially on the phytoplankton and open avenues for detailed investigations in the food and feeding habitats of the species.

MATERIALS AND METHODS

The samples were collected from Lake Edward at Rwenshama, Kisenyi and Katwe, and from Lake George at Mahyoro, Kashaka and Kasenyi and in Kazinga Channel at Katunguru. The water system and stations are indicated in Figure 1. Water samples and *O. niloticus* stomach contents were collected during March to May 1991. Sampling was carried out before midday. The water samples were collected from depths ranging from 0.1m to 1.8m using a Van Dorn sampler. *O. niloticus* stomachs were removed from fish caught by experimental beach seine in positions where water samples were obtained. Only 10 fish ranging from 10 - 35 cm in total length were examined from each station.

Each individual sample of water or stomach contents was preserved in 5% formalin for subsequent analysis. 5ml of each of a well shaken sample, one ml of sub-sample was drawn and transferred on to a slide and covered with a cover slip. The organisms, cell or colonies and other materials present were identified under a binocular microscope. Estimates were based on the point mehtod (HYNES, 1950).

Stomach content analysis: A point method similar to that in water sample analysis was used. The sub-samples were scanned under a binocular microscope to identify the organisms and other materials. The different organisms and material were allocated points and these points for each food item or materials were summed up and scaled down to percentage composition on a decreasing order of abundance.

Points were allocated as follows:

\+ = one organism, colony, cell or material observed.

++ = two to five items

+++ = six to nine items

++++ = ten and above items - abundant

RESULTS

Water sample analysis

The organisms identified from the water samples obtained irrespective of station or depth were mainly the phytoplankton (diatoms, blue-green algae and green algae). Of the phytoplankton, blue green-algae were the most abundant both in quantity and number of species especially in L. George (Table 1). In order of importance were *Microcystis* spp, *Planktolyngbya* spp and *Anabaenopsis* spp were the dominant blue greens. Diatoms and green algae were present but less abundant.

Stomach sample analysis

The estimated proportions of different types of phytoplankton identified in *O. niloticus* stomach contents (Table 2) indicate that blue-green algae were the most abundant followed by the diatoms and green algae. However, some of the blue-green algae such as *Chroococcus, Oscillatoria* and *Closterium*, the diatoms *Synedra, Rhopalodia, Flagilaria, Stephanodiscus* spp; the green algae, *Cosmarium, Rhophidium, Staurastrum, Tetraedron* spp identified in the stomach contents were not obeserved in the water samples. The pennate form of diatoms encountered in the water samples were not identified in stomach contents.

Of the blue green algae identified in the stomach contents *Microcystis* contributed 60%, *Lyngbya* 14% and *Merismopedia* 8%. Diatoms were *Surirella* 31%, *Navicula* 21% and *Nitzchia* 18%. Green algae were mostly of *Scenedesmus* 40%, Filamentous algae 16% and *Pediastrum* 10%. The various estimated proportions of phytoplankton identified in *O. niloticus* stomach contents are shown in Table 3. Other items found in the stomach contents but estimated separately from phyroplankton included in order of importance: unidentified higher plant remains, rotifers, unidentified insect remains, chironomids, copepods, detrital material and sand grains.

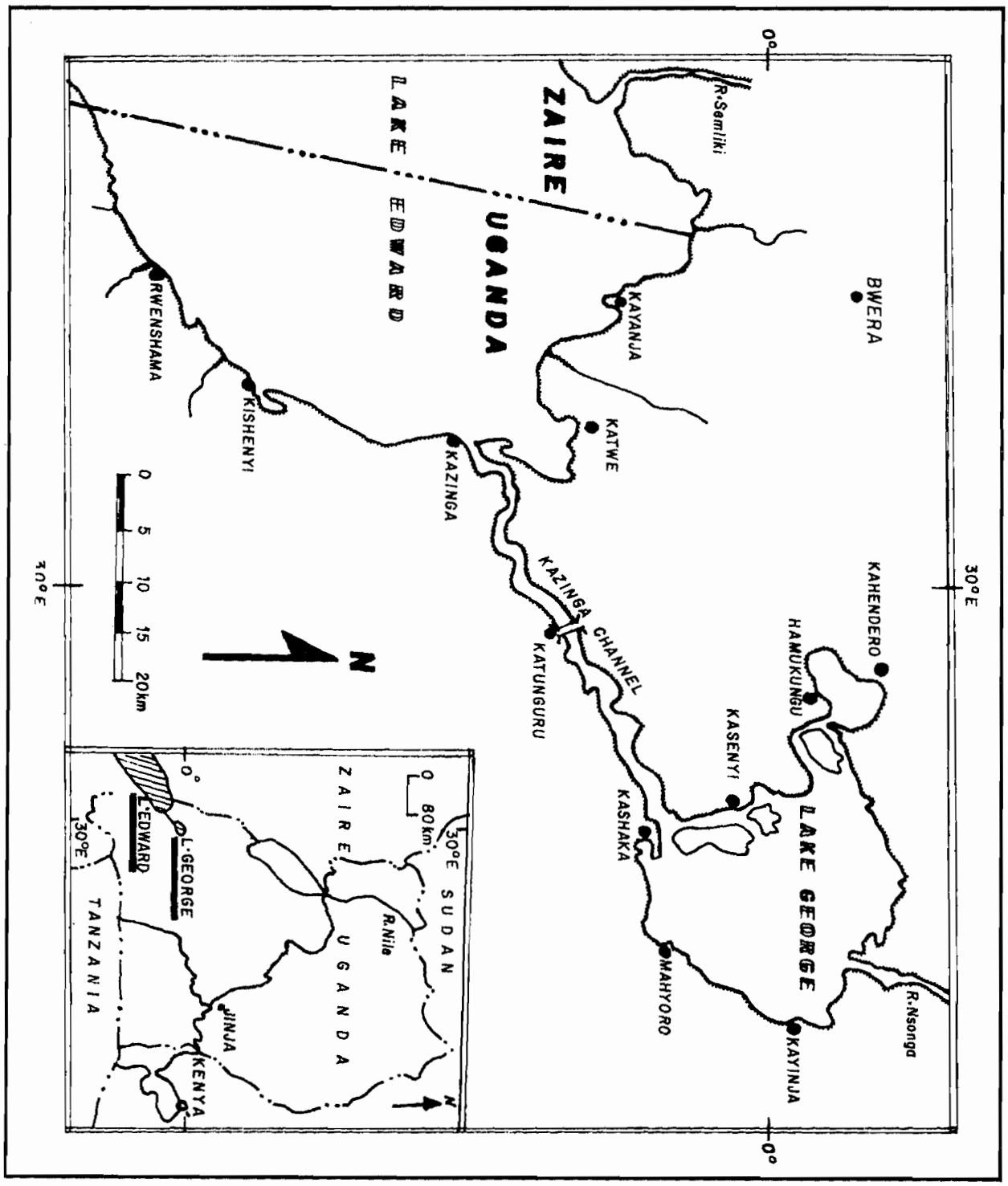

Fig. 1. Location of sampling sites on Lake Edward, George and Kazinga Channel

Table 1: Phytoplankton taxa identified at different depths from water samples of Lakes Edward, George and Kazinga Channel (March-May 1991). N/S means not sampled.

Depth (m)	L. Edward	L. George	Kazinga Channel
		Diatoms	
0.1 m	*Pennate form* *Nitzschia*	*Pennate form*	*Melosira* *Navicula* *Pennate form* *Nitzschia* *Surirelia*
0.5 m	*Nitzschia*		*Nitzschia*
1.0 m	N/S	N/S	*Nitzschia*
1.8 m	N/S	N/S	*Melosira*
		Blue green algae	
0.1 m	*Microcystis* *Planktolyngbya* *Anabaenopsis*	*Microcystis* *Planktolyngbya* *Lyngbya* *Cylindrospermum* *Merismopedia* *Anabaenopsis*	*Microcystis* *Anabaena* *Anabaenopsis* *Planktolyngabya* *Lyngbya*
0.5 m	*Microcystis* *Planktolyngbya* *Anabaenopsis*	*Microcystis* *Planktolyngbya* *Lyngbya* *Cylindrospermum* *Merismopedia* *Anabaenopsis*	*Microcystis* *Planktolyngbya* *Anabaenopsis*
1.0 m	N/S	N/S	*Anabaena* *Microcystis* *Planktolyngbya*
1.8 m	N/S	N/S	*Planktolyngbya* *Anabaenopsis* *Anabaena*
		Green algae	
0.1 m	N/S	*Scenedesmus* *Ankistrodesmus*	*Scenedesmus*
0.5 m	*Pediastrum* *Scenedesmus*	*Ankistrodesmus* *Scenedesmus*	*Pediastrum* *Scenedesmus*
1.0 m	N/S	N/S	*Scenedesmus* *Pediastrum*
1.8 m	N/S	N/S	*Pediastrum* *Scenedesmus*

Table 2: Estimated proportions of different types of phytoplankton identified in the stomachs of *O. niloticus* from Lakes Edward, George and Kazinga Channel

Phytoplankton	L. Edward	L. George	Kazinga Channel
Diatoms	40%	25%	28%
Blue-green	44%	62%	54%
Green algae	16%	13%	18%

Table 3. Estimated proportions of different phytoplankton taxa (% composition in samples) in the diet of *O. niloticus* of lakes Edward, George and Kazinga Channel.

	L. Edward	L. George	Kazinga Channel
		Diatom spp%	
Surirelia	34	25	43
Navicula	26	37	29
Nitzschia	16	21	21
Melosira	9	4	0
Flagilaria	7	4	7
Stephanodiscus	5	7	0
Rhopalodia	1	1	0
Synedra	2	0	0
		Blue green algae spp%	
Microcystis	50	64	70
Lyngbya	21	11	19
Merismopedia	12	7	4
Chroococcus	1	9	7
Oscillatoria	3	1	0
Anabaenopsis	0	2	0
Anabaena	0	1	0
Closterium	0	0.4	0
Cylindrospermum	13	6	0
Scenedesmus	69	13	56
		Green algae spp%	
Pediastrum	10	8	22
Filamentous algae	10	21	22
Cosmorium	0	19	0
Rhophidium	0	25	0
Staurastrum	12	2	0
Tetraedron	0	4	0
Ankistrodesmus	0	8	0

DISCUSSION AND CONCLUSION

The point method (Hynes, 1950) was used because it was easy and rapid to apply and required no special apparatus. Food items identified in stomach contents but not in water samples indicate that *O. niloticus* in their water bodies feeds in several different habitats and at various water depths even though some habitats were not covered by the sampling techniques used. The gear used to sample the fish could also influence the types of food ingested by the fish. Only the beach seine was used during the study and in day time close to the shore line. Seasonal sampling was not taken into consideration nor were the individual size groups of fish. The pennate form of diatoms identified in the water samples but not in fish stomach contents could be due to sampling methodologies or the type of the diatoms are not preferred by the fish. Though *O. niloticus* is known mainly to be a herbivorous fish in the water system (Moriarty 1973), it was observed to supplement its diet with invertebrates. For example in the Northern part of Lake Victoria Balirwa (1998) observed that the *O. niloticus* does not exhibit the same feeding habits (i.e. herbivorous diet) as had been reported by several previous studies on the food of this species, but also feeds on Molluscs, Chironomids, *Caridina* and higher plant material etc. The species feeding mainly during

the day was reported earlier (Moriarty and Moriarty, 1973) for Lake George. Therefore, the time of capture could have influenced the types of food recorded as ingested by the fish during this study. Allen (1942) used the results of the point method (availability factor) in studies of the food of the fish as a measure of availability of each food to the fish. The presence of detritus material indicates that the fish can also feed near or on the lake bottom. Though generally the fish is a filter feeder mainly on phytoplankton, it can also actively chase its prey especially the invertebrates like crustaceans.

The phytoplankton abundace in the water system and their presence in the food of *O. niloticus* seem to suggest that the phytoplankton are still readily available to the fish. The phytoplankton therefore are readily available to the fish in the water system. Though phytoplankton were more important in the diet of fish, the fish can be generally described as omnivorous and the importance of other food items should not be under valued as the methodological limitations of sampling, time, habitats sampled, sampling gear and limited samples could lead to under estimation in the present study. The food of *O. niloticus* in the water system is still readily available and the feeding habits of the fish has not changed much. However, the feeding habits may vary depending on items available for ingestion.

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