Mara River and Associated Wetland as a Refuge of Threatened Indigenous Tilapiines of Lake Victoria, Tanzania

A. I. Chande*
Tanzania Fisheries Research Institute, P. O. Box 90, Kigoma, Tanzania.
E-mail: abdichande@yahoo.com

Abstract

A study was carried out in Mara River and Lake Kirumi in January/February, 2005 to investigate the importance of the wetland as a refuge site for indigenous cichlids particularly tilapiines which have either disappeared from Lake Victoria or threatened. Fish samples were obtained using experimental gillnets whose stretched mesh sizes ranged from 25.4 to 101.6 mm. The nets were set in the evening and retrieved early in the following morning. The catch was sorted into different species and their proportions according to number and weight was calculated. Gonadal maturity status was determined, and gut content was also analysed. Parallel to fish sampling, environmental parameters which included dissolved oxygen, conductivity, pH, concentration of silicon and phytoplankton composition were recorded. The results showed that Mara River recorded a higher (11 species types) fish species composition than Lake Kirumi (6 species types). The most dominant fish species in Lake Kirumi was Oreochromis niloticus which constituted 63.59% by weight followed by O. esculentus (15.39%), which is an indigenous cichlid in Lake Victoria and has completely disappeared from the lake. The occurrence of O. esculentus is a result of the dominance of its preferred food item in the environment, the diatom, Aulacoceira nyassensis which has disappeared from Lake Victoria. The diatom also dominated in the gut content of the fish species.

Keywords: Fisheries, Plankton, Nutrients, Macrophytes, Management

Introduction

Lake Victoria catchment has diverse forms of water bodies surrounded by a variety of wetland vegetation. Recent studies have ascertained that these ecosystems, including small lakes (satellite lakes), rivers, ponds, dams and wetlands around Lake Victoria catchment are faunal reservoirs for endangered fish species (Katunzi and Kishe, 2004). In addition, wetlands and inland water systems have undergone ecological changes due to direct and indirect contamination of water by agricultural chemicals, sewage and other organic materials. All these inputs have exceeded the natural purification capacity of the aquatic ecosystems and have caused changes in the environmental parameters.

Fringing vegetation comprising *Cyperus, phyragmites, Typha, Vossia, Lemna, Pistia, Nymphaea* and *Ceratophylum* species just to mention a few occupy most of the wetlands. All these varieties of emergent, floating and submerged vegetation provide nourishment to a variety of fish species and other organisms found in the water bodies. The biological diversity of these water bodies and wetlands is high and requires concerted efforts for their preservation and utilization. The vegetation also acts as microhabitats that serve as nursery grounds and shelter of fish from predators. These reservoirs of biological diversity could be of great value ranging from scientific, cultural as well as recreational point of view and therefore the justification for their conservation.

Research in wetlands lags behind and therefore there is an urgent need for more attention in order to furnish information that will contribute to the effective conservation and sustainable utilization of the available natural resources in the wetlands. This survey aimed at investigating the role of Lake Kirumi (an ox-lake) and Mara River wetland as a refuge site of

*Corresponding author

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threatened indigenous cichlids of Lake Victoria, Tanzania.

Materials and Methods

Sample and Data collection

Fisheries Data

Fish samples were obtained using gillnets from Lake Kirumi and Mara River. The gillnets ranged from 25.4mm to 101.6mm stretched mesh size which were set in the evening and hauled in the following morning. A total of 14 nets were set in Lake Kirumi while in Mara River only 12 nets were set. Experimental fishing was done for four days in Lake Kirumi and seven days in Mara River. There were no fishing activities in the lake by fishermen surrounding the wetland because the lake was closed from fishing to allow the regeneration of the fish stocks. The fish catch was separated into different species and their weight and number were recorded. The following parameters were also recorded; gonadal maturity and food items taken according to Hyslop (1980).

Zooplankton

Three stations were sampled in Mara River and two stations in Lake Kirumi. Samples were collected with a plankton net of 40μm mesh size having an opening of 29 cm diameter and 1 meter in length. The net was lowered close to the bottom without disturbing the sediment and slowly hauled to allow the water to be filtered. The net was rigged with weight to enhance vertical sinking. Three replicates of samples at each station were combined to make a composite sample. The collected samples were immediately preserved in 4% sugar formalin. In the laboratory each sample was diluted, and a known volume sub sampled and examined. Taxonomic identification was done using available keys (Ruttner-Kolisko, 1974; Korinek, 1984; Boxshall & Braide, 1991; Maas 1993; Korovchinsky, 1993). Counting was done under a microscope at x40 magnification and percent species composition calculated.

Phytoplankton

Phytoplankton samples for species diversity were collected from the same stations as zooplankton samples. Samples were collected by towing Plankton net (10 μm mesh size) at low boat speed for 15 minutes at the water surface. Three vertical hauls were also made to collect samples for species diversity in each water body. 100ml concentrated sample was preserved for laboratory analysis by using 0.7% Lugol's solution and 2.5% formalin. That is 0.7ml. of Lugol's solution was added to 100ml sample and after one hour, 2.5 ml of formalin was added to the very sample. In the laboratory samples were examined using an inverted microscope at x40 magnification. Identification of phytoplankton species was done by using the available keys (John *et al.* 2002). The counts made from the samples were calculated as percentage composition.

Physical and Chemical parameters

Temperature, dissolved oxygen, pH and conductivity were measured *in situ* using the hydrolab. Transparency was measured with a 25 cm diameter secchi disc painted black and white. The disc was lowered along the side of the boat away from the direct sunlight and the depth of disappearance was recorded.

Nutrients

One-litre capacity water sampler was used to collect water samples and stored in 1litre plastic bottles for nutrient determination. Surface and bottom water samples were taken in Mara River at three stations while in Lake Kirumi only two water samples were collected from two stations. Each bottle was thoroughly washed and rinsed with water before sample collection. The sample was filtered through 47 μm GF/C filter papers. The filtrates were kept for analysis of dissolved nutrients including silica (SRSi) using atomic absorption spectrophotometric standard methods as outlined in APHA (1992).

Results

Fisheries

Fish species Composition and Catch Rates

Tables 1 and 2 present percent fish species composition and catch rate (g/net/day) from gillnet catches in Lake Kirumi and Mara River respectively. The results show that the highest species diversity was recorded in Mara river (11 species), haplochromines consitituted a taxon because identification was not possible. Lake Kirumi recorded the least (6 species). The most dominant species in Mara River was *Lates niloticus* which constituted 58.03% by weight, followed by *Oreochromis niloticus* (15.86%). In Lake Kirumi *O. niloticus* was the most (63.59%) dominant, species followed by *O. esculentus* (15.39%). Regarding the relative abundance or catch rates of the different fish species the results show that generally the catch rates were very low for all species. For example, in Lake Kirumi *O. niloticus* recorded the highest catch rate of 200.71g/net/day while in Mara river the highest catch rate of 162.68 g/net/day was recorded by *L. niloticus*. The catch rates for the different species differed significantly for both Lake Kirumi and Mara River as shown by Wilcoxon signed rank test, (W) = 21.00, p=0.031 and (W) = 66.00, p=0.001 respectively.

Table 1: Percent (by No. & Wt.) fish species composition and catch rate (g/net/day) of Lake Kirumi during January/February 2005

Fish species	No	% by No	Wt (g)	% by Wt.	Catch rate (g/net/day)
Oreochromis niloticus	114	21.84	11240	63.59	200.71
O. esculentus	172	32.95	2720	15.39	48.57
Propterus aethiopicus	2	0.38	1290	7.30	23.04
Haplochromines	182	34.87	1810	10.24	32.32
Clarias alluadi	2	0.38	27	0.15	0.48
Barbus altianalis	50	9.58	590	3.34	10.54
Total	**522**	**100**	**17677**	**100**	**315.66**

Table 2: Percent (by No. & Wt.) fish species composition and catch rate (g/net/day) of Mara River during January/February 2005

Fish species	No	% by No	Wt. (g)	% by Wt.	Catch rate (g/net/day)
O. niloticus	9	4.46	3735	15.86	44.46
O. leucostictus	1	0.50	65	0.28	0.77
Lates niloticus	125	61.87	13665	58.03	162.68
Schilbe intermedius	15	7.43	690	2.93	8.21
Synodontis afrofischeri	19	9.41	670	2.85	7.98
S. victoriae	4	1.97	205	0.87	2.44
Tilapia zillii	3	1.48	455	1.93	5.42
Brycinus sadleri	5	2.48	180	0.76	2.14
Protopterus aethiopicus	5	2.48	2625	11.15	31.25
Clarias gariepinus	2	0.99	1025	4.35	12.20
Haplochromines	14	6.93	235	0.99	2.80
Total	**202**	**100**	**23550**	**100**	**280.36**

Maturity stages

Results of maturity stages of *O. niloticus* and *O. esculentus* in Lake Kirumi show that there were more mature individuals (stages 4-6) than immature ones (stages 2 and 3) in the case of *O. niloticus* for both males and females. Mature individuals constituted about 65% for males and 74% for females. Immature individuals dominated for both males (70.5%) and females (70.6) while in the case of *O. esculentus*. The smallest mature individuals encountered for *O. niloticus* were 14.5cm (females) and 17.5cm (males) while in the case of *O. esculentus* , the smallest size were 8.0cm (females) and 13.3cm (males). In the case of Mara River, the most dominant species was *L. niloticus* and all individuals were immature of gonadal maturity stage 1.

Stomach contents of fish species

Stomach contents of juvenile *Lates niloticus*, *Tilapia zilii*, *Oreochromis niloticus* and *Orecochiromis esculentus* were analysed. The results show that almost all fish species had taken both zooplankton and phytoplankton except *L. niloticus* which exclusively consumed zooplankton. The quantity of food taken depended on the availability of food items in the environment (Phytoplankton and zooplankton). For example *O. niloticus* consumed a lot of *Brachionus species* both in Lake Kirumi and Mara River which was also abundant in the environment. Likewise the stomach content of *O. esculentus* was dominated by the phytoplankton, *Aulacoseira nyassensis* in Lake Kirumi which was dominant in the waters.

Zooplankton and Phytoplankton Species Composition

The zooplankton community comprised two groups, copepoda and rotifera in Lake Kirumi. A total of 11 genera and 15 species were identified and copepoda contributed four species while rotifera contributed 11 species. *Brachionus* was the most common genus and contributed four species, the most common one was *Brachionus calyciflorus* which on average constituted 92.45% numerically. In Mara River three groups of zooplankton were encountered namely; cladocera, copepoda and rotifera, *Brachionus calyciflorus* was the most common and constituted 25%. Regarding the species composition of phytoplankton, a total of 34 species were encountered from Lake Kirumi. *Aulacoseira nyassensis* was the most common, (47.20%), followed by *Microcystis flos aquae* (8.60%).

Physical and Chemical Parameters

Lake Kirumi was more turbid than Mara River, Secchi disk readings were 0.25 m and 1.23 m respectively. The waters of Mara River were cooler than those of Lake Kirumi whereby on average temperatures recorded were 23.2 °C and 25.9 °C respectively. The levels of dissolved oxygen (DO) ranged from 1.9 to 4.2 mg/L in Mara River while in Lake Kirumi ranged between 3.6 mg/L and 4.3 mg/L in the bottom and surface respectively. Generally the pH values were stable ranging from 6.0 to 7.2, the lowest being in Lake Kirumi (6.0) and the highest (7.2) value was in Mara river downstream. Conductivity ranged from 132.7 to 641.3 μScm^{-1} with the least (132.7 μScm^{-1}) in Mara river and the highest was 641.3 in Lake Kirumi. Regarding silica concentration, higher values were recorded in Lake Kirumi (ranged between 0.028 and 0.116 mg/L) than in Mara river (ranged between 0.012 and 0.063 mg/L.).

Discussion

The results show that the common fish species in the wetland are the endangered ones in the main lake. For example in Mara river anadromous species dominated which include; *Synodontis afrofischeri* which constituted 20.3% by number and *Schilbe intermedius* (10.9%). The occurrence of these species was also reported by Katunzi (2003). Surprisingly the contribution of *Lates niloticus* in the catch was higher (61.0% by weight) than that reported by Katunzi (2003) which was only 8.17%. This implies that *Lates niloticus* explores upstream to search for its prey items which have taken refugee in the riverine system. If proper management measures in the ox-bow lake (Lake Kirumi) are not taken the ecological conditions might change and give way to the predator to prey on the indigenous species including *Oreochromis esculentus* which is virtually absent in the main lake and has taken refugee into the Lake Kirumi. The species was second to the haplochromines in the lake, constituting 33.1% by number followed by *O. niloticus* (21.9%). The dominance of *O. esculentus* in Lake Kirumi could be attributed to the high abundance of the diatoms (*Aulacoseira nyassensis*) its preferred food item which constituted 47.2% in the environment. The importance of *Aulecoseira* species in the diet of *O. esculentus* is reflected in the gut content analysis whereby its constitution was about 50% (Table 4). The diatom has completely disappeared from the main lake which led to the disappearance of the indigenous tilapiines particularly *O. esculentus* and *O. variabilis*. *Aulacoseira* species flourish well in the presence of silicon which was recorded relatively in high (0.028 – 0.116 mg/L) concentrations in Lake Kirumi while in Mara river the concentration ranged from 0.012 to 0.063 mg/L.

The present study has shown a decrease in species diversity in Lake Kirumi. Previous surveys (Katunzi 2003) showed that almost all tilapiines were common in Lake Victoria where as this survey only two species; *O. esculentus* and *O. niloticus* were encountered. This could be attributed to a combination of factors including; over-fishing by using illegal fishing gears such as small meshed nets and the destruction of the surrounding habitat (macrophytes). During the survey, part of the vegetation cover was burnt down in an attempt to procure space for agricultural activities. Burning alters the ecological configuration and destroys the habitat for many fish species.

These small lakes which are within the Lake Victoria basin normally known as satellite lakes are rich in biodiversity. This is a result of the macrophytic cover which has a buffering capacity (Carter, 1995). The areas are characterized by low oxygen due to the decomposition of organic matter, the vegetation also forms a physical barrier and obscure the predator, *Lates niloticus* which is a high oxygen demanding species. More over, ox-bow lakes are supposed to have a high biodiversity due to their association with rivers and main lake. There is a continuous replenishment of the stocks and water levels as a result of their being connected to the river (Katunzi, 2003).

The results have shown that many individuals of *O. niloticus* were mature which implies that the species breeds during this period. The results on sizes in present study differ from what was reported in the main lake whereby the size at first maturity for *O. niloticus* ranged from 28 to 30cm TL for females and 32-34cm TL for males (van Oijen, 1995). The population in the ox-bow lake (Lake Kirumi) attained maturity at a smaller size than in the main lake.

The attaining of gonadal maturity at a smaller size and the stunted growth of the individuals in Lake Kirumi could be attributed to several factors including; limitation of food resources and space which lead to competition. This is supported by the gut content analysis whereby both *O. niloticus* and *O. esculentus* consumed a limited number of food items including zooplankton and phytoplankton. The most common zooplankton preferred by fish are the cyclopoids (crustacean) which were in a very low abundance in Lake Kirumi. This is an indication of low levels of food for fish. Crustacean zooplankton is large in size that is why they are preferred as food items for fish. The gut contents showed that the rotifers which dominated are small in size, this could be the reason of attaining gonadal maturity at a smaller size.

Conclusion

It is concluded the Mara river and the small lake under study are good refuges for endangered tilapia. There are great variability in the biodiversity of both fish species and their food sources in the three areas of study. It is recommended that more studies be carried out to come out with firm conclusions as the sample size in the present study was small. It would also be of importance to find out monthly variations in the type of fish in these areas.

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