THE BIOLOGY AND ECOLOGY OF LAKE VICTORIA FISHES:

THEIR DEVELOPMENT AND MANAGEMENT

(UGANDAN VERSION)

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CHAPTER 2

Biology, ecology and the fishery of Mukene *Rastrineobola argentea*

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Abstract

Food and feeding, condition factor, breeding periods, growth and size at first maturity of a small pelagic cyprinid *Rastrineobola argentea* (P.) in Lake Victoria are determined. Fishing gears and methods that have been used in the exploitation of the species and could be harmful to the fishery are outlined. Management measures leading to possible sustainable exploitation of the fishery are suggested.

Adult R. *argentea* feed on zooplankton during daytime. Juveniles feed on planktonic early instars of lakefly larvae. Although the species breeds throughout the year, two breeding peaks were observed during the drier months of August and December - January. Least breeding was observed in the rainy months of April-May and October - November. Fishes from the open water station at Bugaia showed higher numbers of breeding individuals than those from inshore areas. The mean monthly condition factor of fish from Napoleon Gulf confirmed breeding peaks as obtained from the number of fish with ripe gonads.

The species showed a mean instantaneous growth rate *(K)* of 1.75 and attains length infinity *(Lx)* of 54mm. Females of the species in these waters show a reduced size at maturity as compared to ten years ago when exploitation of the species was at minimal levels. The males have however not changed much.

Introduction

Rastrineobola argentea, a small pelagic cyprinid occurs in lakes Victoria, Kyoga and Nabugabo. Until about a decade and a half ago, Mukene was not being seriously fished. The then multi-species fishery on these lakes was based on larger table fish such as the endemic Tilapias, *Oreochromis (Oreochromis) esculentus* (G) and *Oreochromis (Nyasatilapia) variabilis* (B.). The catfishes, *Bagrus docmac* and *Clarias (Clarias) gariepinus* (B.) and the lungfish *Protopterus aethiopicus* (H.) were also common in the catches. With the successful establishment of the introduced fish species the Nile perch, *Lates niloticus* (L.) and .the Nile tilapia, *Oreochromis (Oreochromis) niloticus* (L.) in these lakes, the indigenous species have almost disappeared from the catches. Due to its current position on the food web, Mukene plays an important role in the ecosystems of the lakes in which it occurs. It transfers energy from the lower (zooplankton) to the higher (Nile perch) trophic levels. The species also remains the only endemic species of the lake under serious commercial exploitation. It is second to the Nile perch in the Ugandan waters of Lake Victoria, and holds first position at many landings on Lake Kyoga. It is however not yet being fished on Lake Nabugabo. The species is exploited for both human consumption and animal feeds manufacture.

Because of the previous little interest in the species, scientific information on *R. argentea* has been lacking. Now that the species is commercially important and its fishery is fast expanding in both lakes Victoria and Kyoga, it is necessary to understand its biology and ecology in order to manage its fishery.

This paper outlines the biology, that is: the condition factor, breeding, growth, and maturity, and the fishery of the species in Lake Victoria. When available, data from the lakes Kyoga and Nabugabo are used for comparison with the condition on Lake Victoria. This information could be useful in management, as the results given could be useful in taking management decisions necessary for proper exploitation of the fishery.

Materials and methods

Sampiing area

Sampling was done mainly in the Napoleon Gulf Pilot zone of the LVEMP, that is, the Jinja waters of Lake Victoria Fig.l. Other sampling sites included Bukungu on Lake Kyoga and the camping site at Bbale on Lake Nabugabo. On Lake Victoria, the main sampling zone the areas covered were:

a) **Napoleon Gulf**
An inshore zone, off Jinja Town, where the lake is less than 15 meters deep. There is a fishing village at Kikondo, where *Rastrineobola* is landed from the gulf waters. This area represents the inshore sheltered habitat of the lake.

b) **Buvuma Channel**

The Buvuma Channel area of the lake is between 15 and 20 meters deep. The zone represents what can be referred to as the "islands" zone. Here, numerous islands that fringe the lake on the northern shores occur. Artisanal fishing for Mukene is done in this zone because the islands protect the area. Fishing villages landing the species from this zone include Lingira, Kirongo, Itome Bay, the islands of Vuga, and Busiri and the southern portions of Buvuma Island at Kasaali.

c) Bugaia waters

The deep open waters beyond the 30-meter depth contour, outside the "islands" zone. In these waters fishing for Mukene is less intensive than the above zones due to the rough weather normally experienced in these areas. Some of the Mukene fishing villages here are Kasaali, Mubaale and Kijaka.

Specimens obtained from other parts of the lake were examined just for comparisons with those from the pilot zone. On Lake Kyoga and Lake Nabugabo samples were only obtained from commercial fishermen and by experimental fishing respectively.

Sampling methods

Experimental fishing and sampling commercial catches were the main methods employed in sample collection. Artisanal fishermen caught fish by light attraction using kerosene pressure lamps as described in Okedi (1981) and Witte and van Densen (1995). Experimental fishing involved the method as by the above fishermen, beach seining and the use of a beam trawl net. The beam trawl net was operated from the research trawler as modified in Wandera (in press). On hauling fish ashore or aboard the canoe/trawler, a random sample of approximately 0.5-kg was obtained. It was immediately preserved in 5% formaldehyde solution, and appropriately labeled for laboratory analysis. Fish recovered from the net was first weighed to determine the total catch. Different fish species were sorted out and weighed. Random samples from each of the species were taken and preserved.

Laboratory examination

In the laboratory samples were soaked in water to remove excess formaldehyde. Length frequency data were generated by measuring all the fishes (Standard Length to the nearest mm below) within the sample. From each one-mm length class 10 specimens were randomly selected for biological investigations. For every selected specimen, length and weight (to the nearest mg) were taken. The fish was cut open and sexed as in Bagenal and Braum (1978). The gut was dissected out and excess fat cleared. *R. argentea* has a tubular gut with a stomach ill-defined from the rest of the gut. The stomach was considered as the first of the three loops that constitute the gut. Its fullness was assessed by lightly displacing the contents to one end. It was then described as either less than a quarter, one-quarter, half, three-quarters and full. These degrees of fullness were respectively awarded [, 2, 4, 8 and 16 points. The gut was slit open and the contents poured onto a microscope

slide for examination. Under a dissecting microscope, food items were identified. Relative quantities of each food type were assessed by eye and expressed as percentages of the total contents.

Results

Food and feeding

Adult *R. argentea* fed on zooplankton. Copepods formed the bulk of the food in the guts of these fishes. Juveniles of the species fed on copepods and the pelagic (early instars) stages of aquatic dipterans (chaoborids and chironomids). *R. argentea* found near the water surface and very close to the shoreline fed on a variety of aquatic insects common in these zones. Such insects included Odonata (zygopterans) and ephemeropteran nymphs, trichopteran larvae, adult hemipterans (coryxids) and even adult lake flies (chaoborids and chironomids) on days when swarms of them emerged. Samples of *R. argentea* obtained from the artisanal fishermen who used light to catch them were found to have fed on lakefly larvae and pupae.
Analysis of the percentage of full stomachs covering a twenty-four-hour period revealed that Mukene fed mostly during daylight hours (Fig. 2).

Breeding periods and Condition factor

Fishes at sexual maturity stages V and VI were regarded as breeding, while III and IV and VII were considered resting and spent respectively. Breeding was observed to be taking place throughout the year in all the sampled zones. There were however peaks in breeding activities that occurred in the months of August and December/January (Fig.3). Least breeding occurred in the months of April to June and October to November.

Foulton's Condition factor *(K)* was calculated using formula:

$K = (Wx\ 100)/L^3$

Where W = weight in gm, and L = length in cm.

Only female fishes measuring 45 to 50mm SL were used in the calculation. Males were left out because male gonads (the testes) in this fish are so small that their influence on the overall weight of the fish is minimal. *Rastrineobola* longer than 50mm SL tend to be infected by a parasitic cestode *Ligula intestinalis* (Wanink 1992). The presence of the parasite could bias the condition factor of infected fish. This size was therefore left out. The majority of the fishes below 45mm SL is immature and thus contributes little to the breeding of the population.

Populations of *R. argentea* from Kikondo showed peak condition at similar times to breeding peaks that occurred in the months of August and December (Fig. 4).

Growth and size at first maturity

Length frequency analysis of populations of *R. argentea* especially from Napoleon Gulf and Buvuma Channel showed progressive increase in modal lengths (Fig.5). Using the ELEFAN computer program (Gayanilo, Soriano and Pauly 1988), growth parameters Asymptotic Length *(Lx)* Growth constant *(K)* Total and Fishing mortality (2) and *(F)* respectively were obtained as shown in Table 1 below.

Table! Growth parameters of *R. argentea* populations from Kikondo, Lingirra and Bugaia.

Fishing ground	Lx	K	Z	F
Kikondo	54.0	1.75	4.132	0.116
Lingira	54.0	1.76	4.417	0.386
Bugaia	57.9	1.14		

Fishes showing gonad sexual maturity stages I and II were considered immature while those at stages III and above were mature. Male *R. argentea* matured at 41mm SL while females matured at 42mm SL. At 45mm SL all the fishes examined were mature (Fig.5). The smallest mature female measured 37 in napoleon gulf, 39 in Buvuma Channel and 38 mm SL in the open water at Bugaia. Males from the three stations were at 39, 38 and 35 mm SL respectively.

Discussion

The main population of *R. argentea* performs diel vertical migrations together with the zooplankton it feeds on. These two stay down the water column during daytime and move to the surface waters at night. Feeding is therefore done during daytime when prey is concentrated in one layer of the water column and there is enough light to enable sight feeding. At night, zooplankton is scattered all over the top waters and feeding on this item could be difficult especially considering their sizes. Fish caught by artisanal fishermen fed on insect larvae mainly because the insects were attracted to light from the lamps. Specimens caught without light attraction were found to have mostly empty stomachs (personal observations). Juvenile R. argentea caught by light attraction still showed empty stomachs despite the abundant insects concentrated by light. These insects (later stages of chironomid and chaoborid larvae or their pupae) may be too large for Mukene predation. Breeding peaks observed occurred during the dry months of the year. The timing to breed could have been synchronized with the period of abundant food for both the brooding stock and the young. Zooplankton abundance in the Jinja waters of Lake Victoria peak around the months of July and August (Ndawula-Mwebaza 1998).

Around this time, Length frequency analysis of samples obtained show recruitment of juvenile *R. argentea* into the artisanal fishery inshore (Ogutu- Ohwayo et.aI.1998). Breeding peaks compare very well with peaks in condition factor observed above. The

open water station at Bugaia showed more individuals in breeding condition at any time than the inshore stations.

Populations of *R. argentea* from near shore waters in Napoleon Gulf and Buvuma Channel show almost similar growth parameters. The offshore population in Bugaia however shows different growth figures. These fishes grow much more slowly but attain a larger adult size. The higher asymptotic length shown by this population could be as a result of less fishing pressure exerted on Mukene in these waters. Weather conditions in the open waters at Bugaia sometimes do not permit light fishing that uses smaller canoes. Many times fishermen abandon fishing due to very rough weather. This reduces fishing pressure on the population and thus allows more fishes to grow to a larger size.

Growth parameters shown in Table I indicate that *R. argentea* in Napoleon Gulf attains sexual maturity after nine months and breeds after one year. In a heavily fished ground like Pilkington Bay at Lingira, a cohort will disappear after 15 months.

Over the last decade, commercial exploitation of Mukene in the Jinja waters of the lake has more than doubled. In 1987 Mukene was only fished at Lingira (Wandera 1992, Ogutu-Ohwayo et. a1. l998). Fishing effort was then very low. About 10 canoes were operating 2 beach seine nets of 10mm mesh size stretched, as opposed to the current number of over 30 canoes using an equal number of boat seine nets of even smaller mesh (3-5mm). The size at first maturity then was 41 and 44mmSL respectively for males and females and 100% maturity was attained at 47mm SL. Changes in size at maturity is apparently a reaction to the increased fishing pressure being exerted to the fishery. The mean adult size of the population has also been reducing with increased fishing and predation pressure. Prior to the establishment of the Nile perch, which preys on the species, *R. argentea* grew to a larger adult size than was observed during the post perch era). A sample of *R. argentea* from Lake Victoria caught in August 1970 and stored in the FIR! museum shows a mean length of 60mm SL. This size reduced to 48mm in August 1989 (Wandera 1992) and has further shrunk to the present 44mm for the same month of August. The combined effect of both predation by the Nile perch and fishing could be responsible for this gradual reduction in mean length of *Rastrineobola* populations in this lake.

Management of the fishery of *R. argentea*

Sustainable exploitation of *R. argentea* in both Lakes Kyoga and Victoria can be maintained if strict management measures are put in place. The most vital intervention points have been identified as:

a) Fishing gears and methods.

R. argentea is exploited by light attraction (Okedi 1981, Witte and van Densen 1995) The most common gears in use in the two lakes are scoop nets, beach seines, lampara (boat seines) and lift nets. Beach seine nets capture many juveniles of both Mukene and other fish species found very close to the shores (Fig.6). Mesh sizes of nets used for capture of Mukene has evolved with time. In 1988 the mesh size of beach seines in use at Lingira

stood at 10mm.With the introduction of the Lampara (boat seine) net in 1990, the mesh size was reduced to 5mm. This has further been reduced especially on Lake Kyoga to 3mm. Nets with meshes 5mm or less catch a high proportion of immature Mukene (Fig.7). Beach seine nets should therefore be discouraged as gears for Mukene fishing. Because the 5mm mesh nets are already in use and that the mean size of R. *argentea* being caught has also decreased, this size of net could still be allowed to operate. Further reduction to a smaller size should not be allowed. The 3mm nets should thus be banned.

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