The role of *Caridina nilotica* (Roux) in the Lake Victoria fisheries with reference to *Lates niloticus* (L.)

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Abstract: *Caridina nilotica* (Roux) (Decapoda: Atyidae) was investigated over a period of four months in three zones of Lake Victoria. Abundances were estimated by vertical net sampling. The importance of *C. nilotica.* in the diet of the three commercial fish species was investigated. *Caridina nilotica* is a primary food for *Lates niloticus* (L.), *Oreochromis niloticus* (L.) and *Rastrineobola argentea* (Pellegrin). A quantitative study of *C. nilotica* in the fishing areas indicated high biomass which can support the Lake Victoria fisheries.

Introduction

Caridina nilotica (Roux) is an atyid shrimp typically found in benthic habitats and amongst aquatic weeds; it grows to a length of about 25 mm TL. *Caridina nilotica* feeds on bottom debris (Fryer 1960) and is distributed in the tropical and subtropical zones of eastern and southern Africa. In Lake Victoria, *C. nilotica* occurs throughout the lake and is extremely abundant in the littoral region wherever there are weed beds. Fryer (1960) observed two species *C. nilotica* and *C. africana* and two forms of *C. nilotica* in Lake Victoria, one in the vegetation in the littoral waters and another with an epibenthic distribution in the sublittoral and deep waters.

Following the introduction of the Nile perch, *Lates niloticus* (L.), in the 1950s, dramatic changes in the Lake Victoria environment have occurred. The disappearance of haplochromines in the 1980s was coupled with a shift in the diet of Nile perch towards *C. nilotica*, *Rastrineobola argentea* (Pellegrin) and juvenile *L. niloticus* (Hughes 1986; Ogari & Dadzie 1988; Ligtvoet & Mkumbo 1990; Ogutu-Ohwayo 1990). The rapid depletion of the main prey items (haplochromines) did not induce a corresponding decrease in the predator population because *L. niloticus* opportunistically switched to *R. argentea* and *C. nilotica.* Stocks of these two species appear to have greatly contributed to the maintenance of the predator population and its high catch rates.

In the early 1980s, only a few shrimps were occasionally observed in the bottom trawl catches in Mwanza Gulf, but after 1986 trawl catches for fish frequently contained thousands of shrimps (Witte *et al.* 1992). In February 1992, a small trawl (cod end 5 mm) shot for 10 minutes recorded about 100 000 individuals of *C. nilotica.* Tweddle & Bassa(1999) recorded 40 kg of *C. nilotica* in a 30 minutes frame trawl. Othina and Osewe-Odera (unpublished data) reported 3180 t of *C. nilotica* were landed in the Kenya waters of Lake Victoria in 1995. This was 1.84% of the total landings. The reason for this increase is probably that the predation pressure on juvenile shrimps has diminished.

The formerly abundant haplochromines were potentially predators of juvenile shrimps where and whenever they became available. Their demise has relieved predation pressure on the juveniles of *C. nilotica.* The current potential predators, i.e. small *L. niloticus,* however, mainly live inshore and are not abundant throughout the year (Katunzi unpublished data).

The commercial fisheries of Lake Victoria consist mainly of piscivorous *L. niloticus*, algivorous *Oreochromis niloticus* (L.) and zooplanktivorous *R. argentea*.

Caridina nilotica consume the equivalent of 2.2% of annual lake primary production. Present net annual secondary production by the shrimp is estimated to be an order of magnitude greater than the present fishery yield of the lake (Ignatow *et al.* 1996). However, the demographic status and absolute stock size of *C. nilotica,* and its role in the food web of the lake is unknown. Thus it is important to determine the shrimp biomass available to *L. niloticus*, and the population biology (biomass, growth, mortality, recruitment, reproduction) and distribution of *C. nilotica.*

The feeding habits of important fish species is also needed to understand the dynamics of the fishery and lake ecosystem as a whole. Recent studies have shown juvenile *L. niloticus*, haplochromines, *R. argentea*, *C. nilotica* and Odonata were the main food items of *L. niloticus* in order of importance in both the Speke and Mwanza gulfs (TAFIRI 1996). There is also evidence that *L. niloticus* exhibits ontogenic shifts in diet (Mkumbo& Ezekiel 1999) and spatial variation in foods eaten (Owili 1999); all aspects that need further study if the role of *C. niloticus* is to be elucidated.

The main objectives of this study are to improve our understanding of the population biology of *C. nilotica* in relation to limnological factors of Lake Victoria and the role of the shrimp in the food web.

The specific objectives are:

- to determine the spatial and temporal distribution and abundance of *C. nilotica,* and relate these to key environmental parameters.
- to study the population dynamics of *C. nilotica* (growth rates, mortality rates)
- to determine the importance of *C. nilotica* to the diet of the major commercial fish species

Material and methods

Caridina nilotica were sampled daily with a vertical net with a metal frame of 1 m x 1 m mouth opening to elucidate the temporal and spatial distribution in the three zones of the Tanzanian sector of Lake Victoria used for the trawl survey (Mkumbo & Ezekiel 1999). It was planned to take several samples at each station and, if possible, at different depths. However this was not possible because of logistical problems. Other sampling techniques such as lift net and a frame (box) trawl net will be used in the future, especially in deep waters around the thermocline.

From this regular sampling programme on *C. nilotica*, data will be collected on abundance, standing stock, length-frequency distribution (and consequently growth and mortality rates), sex ratios, reproductive biology and production. Furthermore, by sampling over a 24-hr period, diurnal movements of the shrimps will be determined.

Stomach samples from *L. niloticus* were collected from trawl catches carried out by the RV Lake Victoria Explorer in the three zones between March and June 1999. The length of the fish, index of fullness and volume of each food item present in these stomachs were recorded. These data provided quantitative information on the relative importance (as compared to the other prey species) of *C. nilotica* as a food source for different sizes of *L. niloticus* at several localities.

Results

Only one form of *C. nilotica*, which occurs both in the littoral waters and in deep waters at the thermocline (inhabiting the transition zone from oxygen-rich to oxygen poor conditions around the thermocline) was found. Offshore populations of *C. nilotica* were mainly planktonic rather than benthic, and they exhibit diel vertical migrations into near surface waters at night.

The density of *C. nilotica* at three stations in area A for the month of June, 1999 was 2004 ind. m^{-2} at Kibara (6.75 m depth), 1295 ind. m^{-2} at Kimbu (19.85 m depth) and 714 ind. m^{-2} in Ukerewe (22 m depth). In terms of wet weight, it was 120 g m^{-2}, 100 g m^{-2} and 80 g m^{-2} for Kibara, Kimbu and Ukerewe, respectively.

The carapace length distribution indicated one mode at 5 mm CL (Fig. 1). The modal length of *C. nilotica* in the stomachs of *L. niloticus* was also at 5 mm CL.

Caridina nilotica was the predominant food item in the stomachs of Nile perch, being found in approximately 50% of all fish in all sites (Table 1). The number of *C. nilotica* in the stomachs of *L. niloticus* ranged from 4 individuals for a fish of 47.2 cm TL to 227 for a fish of 49.8 cm TL. The importance of *C. nilotica* to the diet of *L. niloticus* declined with increasing size of fish (Table 2). Few fish >50 cm had *C. nilotica* in their stomachs whereas the stomach contents of small fish <10 cm were almost exclusively shrimps.

Discussion

Much of our current understanding of the autecology, production and ecological role of fish population is derived from studies of the diet based on analysis of stomach contents (Windell & Bowen, 1978). *Caridina nilotica* is an important component of the diet of many fish species such as *L. niloticus*, *O. niloticus*, *Schilbe intermedius* Rüppell, *Brycinus* spp, *Bagrus docmak* (Forsskål), *R. argentea* and haplochromines, and thus supports fish production. *Caridina nilotica,* being a primary consumer grazing on algae and also a carnivore and detritivore, therefore plays a vital role in the aquatic food web by transferring energy from the lower to the higher trophic levels.

- Although basically a diatom eater, Nile tilapia can eat and digest cyanobacteria, insects and crustaceans (Greenwood 1966; Welcomme 1968). Recently the diet has become more diverse, including zooplankton and macrobenthos, e.g. the shrimp *C. nilotica* (Gophen *et al.* 1995; Balirwa 1998).

Haplochromines were the main prey of *L. niloticus* until their demise, when *C. nilotica*, *R. argentea* and juvenile *L. niloticus* became the most important species (Gee 1969; Okedi 1971; Hughes 1986, 1992; Ligtvoet & Mkumbo 1990; Ogutu-Ohwayo 1990a; Mkumbo & Ligtvoet 1992; Ogari & Dadzie 1988).

Rastrineobola argentea is a zooplanktivore, eating mainly planktonic crustaceans (Graham 1929; Corbet 1961; Hoogenboezem 1985). In addition to zooplankton, which was the basic food during daytime, *R. argentea* take lakefly larvae (chironomids and chaoborids) and *C. nilotica* whenever these are abundant in the water column. At night, adult lake flies are taken whenever they swarm.

The percentage of *L. niloticus* containing *C. nilotica* declined from 60-85% for fish between 5 and 40 cm TL, to less than 10% for fish larger than 80 cm in length (Hughes 1986). *Caridina nilotica* decreased and fish increased in importance as the predator increased in size. The same trend was shown in the present study. *Lates niloticus* <10 cm TL ate exclusively *C. nilotica*, but it only represented 17% of the food intake for the 71-80 cm size class.

For the period of January to August 1997, small *L. niloticus* less than 40 cm, 20 cm and 30 cm TL from Speke Gulf, Mwanza Gulf and Ukerewe waters respectively contained *C. nilotica* in their stomachs, constituting over 90% of the diet. These findings differ from those reported earlier (TAFIRI report 1996), where juvenile Nile perch was the major item of this length group. They also differ from those reported by Mkumbo & Ligtvoet (1992) who found haplochromines were the major food item in the Mwanza Gulf.

Further observations revealed that fish between 40-100 cm, 20-60 cm and 30-80 cm TL from Speke Gulf, Mwanza Gulf and Ukerewe waters, respectively, consumed a variety of food items including *C. nilotica*, juvenile *L. niloticus* haplochromines, *R. argentea*, fish remains, Odonata, snails and *Barbus profundus* Greenwood.

The food web structure of Lake Victoria presently includes two major pathways:

- *Trophic pathway based on new algal production*: This pathway flows from primary producers (phytoplankton) directly to fish (*O. niloticus*) and also to zooplankton. Phytoplankton are also consumed by zooplankton which are preyed upon by juvenile *O. niloticus*, *Chaoborus*, and *R. argentea*. Zooplankton, and perhaps *Chaoborus*, are consumed by *R. argentea*.

- *Trophic pathway based on detritus*: Non-utilized phytoplankton sink to deeper layers where they decompose. These degraded products are consumed by *C. nilotica* and other invertebrates, which are consumed by juvenile and adult *L. niloticus*. Adult *L. niloticus* also prey on young *L. niloticus*. Nile perch is the top consumer of this pathway. In the present food web, *L. niloticus* is the top predator, feeding mainly on the shrimp *C. nilotica* (primary consumer) and on *R. argentea* and juvenile *L. niloticus* (both secondary consumers). The main pathways of energy are:

  -via *Caridina* to *Lates;*

  -via *Caridina* and juvenile *Lates* to *Lates;*

-via insect larvae and juvenile *Lates* to *Lates;*

-via zooplankton to *R. argentea* and juvenile *Lates* to *Lates;*

- via *Caridina* to *O. niloticus;*

- directly to *O. niloticus.*

Conclusion

Recruitment is a key factor in determining the strength of cohorts. Since fish depend on *C. nilotica* for their animal food component at early stages of their life, the quantity of *C. nilotica* is critical to survival. Thus *C. nilotica* availability is an important factor determining the relative survival of juvenile fishes.

These findings represent the preliminary output of a much wider study on the role of *C. nilotica* in the fish production of Lake Victoria. This work will be intensified and expanded to include information on production of *C. nilotica*, diel migration patterns and spatial and temporal shifts in the diet of the major commercial fish species of the lake.

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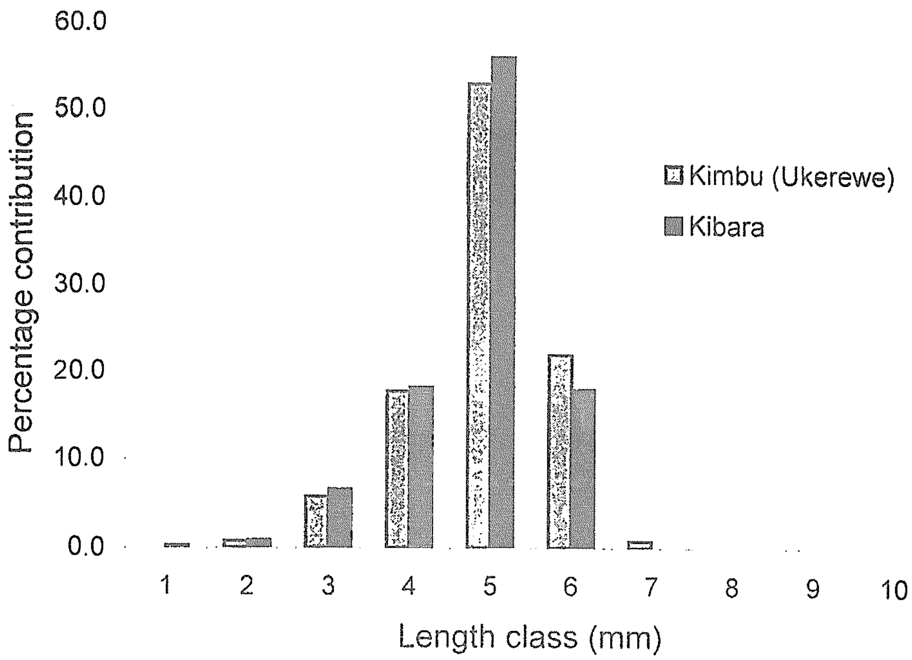

Fig. 1. Size distribution of *Caridina nilotica* from two zones of Lake Victoria in Tanzania

Table 1. Occurrence of *C. nilotica* as a food item in the stomachs of *L. niloticus* between March and June 1999.

Date	No of fish examined	No with food	No with *C. nilotica* in the stomach	No with extruded stomachs	No with empty stomachs
March 1999	244	176		34	34
April 1999	476	313	181	142	21
May 1999	293	92	38	163	21
June 1999	354	138	68	170	48

Table 2. Percentage occurrence of *C. nilotica* in stomachs of *L. niloticus* in 10-cm size groups from areas A, B and C of the Tanzania sector of Lake Victoria.

	Zone B	Zone C	Zone A	
Length group (cm)	April	May	June	March
1-10	100	100	100	20
11-20	96	74	74	30
21-30	83	67	68	14
31-40	68	0	32	0
41-50	48	11	26	19
51-60	42	0	25	11
61-70	20	0	14	0
71-80	17	0	0	0
81-90	0	0	0	0
91-100	0	0	0	0
>101	0	0	0	0