J. Fish Biol. (1988) **32**, 571–577

The food of the Nile perch, *Lates niloticus* (L.), after the disappearance of the haplochromine cichlids in the Nyanza Gulf of Lake Victoria (Kenya)

J. OGARI* AND S. DADZIE†

**Kenya Marine and Fisheries Research Institute, P.O. Box 1881, Kisumu, Kenya and*
†Department of Zoology, University of Nairobi, P.O. Box 30197, Nairobi, Kenya

(Received 30 June 1987, Accepted 28 August 1987)

After the disappearance of the haplochromine species in the Nyanza Gulf of Lake Victoria as a result of predation by *Lates niloticus*, the latter has turned its attention to aquatic invertebrates and other fish. Changes in the diet of the Nile perch with increase in its size have been observed: young *L. niloticus* preyed mostly on invertebrates, including crustaceans and various small aquatic insects; large, immature *L. niloticus* supplemented the invertebrate diet with both young and small fish; adults above 80 cm total length were mainly piscivorous. *L. niloticus* feeds on fish prey of about one third its own length.

The tendency of *L. niloticus* to switch from one prey item to another, depending on availability, is reported; e.g., in the Nyanza Gulf, the prey diet has shifted from the haplochromine to *Caridina nilotica* and *L. niloticus* juveniles.

I. INTRODUCTION

Lates niloticus (L) is a predatory freshwater fish which is economically important both in East and West Africa. Although the species is endemic in Lakes Albert and Turkana in East Africa, it was introduced into Lakes Kyoga and Victoria in the early 1950s and 1960s, respectively (Gee, 1969). It is, at present, the most widespread single species in Lake Victoria where, in the Kenya waters, it forms the backbone of the commercial fishery, constituting over 50% of the total annual landing (Government of Kenya, 1985).

Lates niloticus was introduced into Lake Victoria so that it might use the large stocks of haplochromine fishes which were regarded as ' trash fish ' (Gee, 1969). Kudhongania & Cordone (1974) stated that at least 80% of the demersal ichthyomass in Lake Victoria was composed of the haplochromine cichlids. Benda (1981) reported that the haplochromines were the major stocks within each depth strata in the Kenya waters of Lake Victoria. Muller & Benda (1981) indicated that from 1969/1970 to 1977 these species had declined by 1·3 times within the Nyanza Gulf, and Okemwa *et al.* (1982) observed low catch rates of less than 0·01 kg ha^{-1} in the Nyanza Gulf.

Hamblyn (1966), Gee (1969), Okedi (1970) and Okemwa (1983) reported haplochromines as the main component of the diet of *L. niloticus* in Lake Victoria. The present study was undertaken in order to assess the food and feeding habits of *L. niloticus* after the disappearance of the haplochromines in the Nyanza Gulf of Lake Victoria (Kenya).

II. MATERIALS AND METHODS

Samples of *L. niloticus* were obtained by both beach seining and bottom trawling from 16 sampling sites in the Nyanza Gulf (Fig. 1) during January–July 1982. The specimens were

0022–1112/88/040571+07 $03.00/0

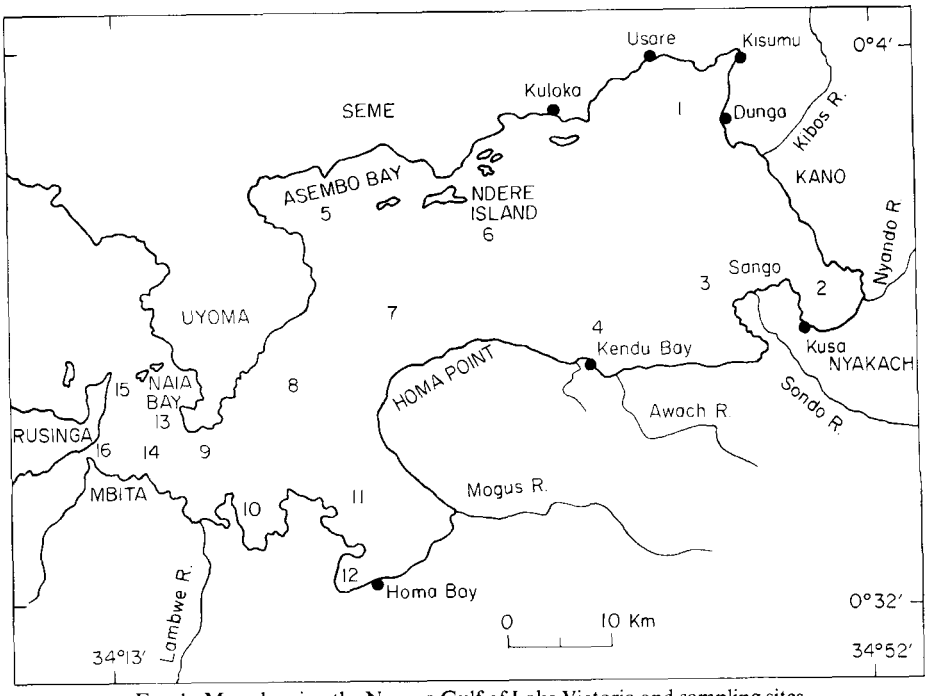

FIG. 1. Map showing the Nyanza Gulf of Lake Victoria and sampling sites.

measured to the nearest cm, dissected, sexed and stomach contents noted. *L. niloticus* juveniles of less than 15 cm total length (T.L.) were preserved in 5% formalin for subsequent examination in the laboratory using a low power microscope. The identification of prey, particularly those in varying stages of digestion, was enhanced by comparing the prey eaten with the fish and invertebrate samples collected in the trawl. The food items were classified as far as possible to the species level. Total lengths and numbers of fish prey were recorded whenever possible.

The recording of the food items was based on the occurrence method (Hynes, 1950). During the study, the stomachs of 1614 specimens ranging from 1·0–170·0 cm were examined.

III. RESULTS

Figure 2 shows the food of *L. niloticus* in the Nyanza Gulf, January–July 1982. Crustaceans, particularly *Caridina nilotica* (Roux) and *L. niloticus*, were the most important food types in the diet. Insects occurred frequently, with Odonata, *Povilla adusta* (Navas), being the commonest. Molluscs were also included in the diet.

Changes in the diet with increasing size of the predator were also noticed. There was a decline in the importance of invertebrates and an increase in the importance of fish as the predator grew in size (Figs 2, 3). Zooplankton, especially cladocerans, chironomids, copepods and *Povilla adusta*, composed the food of *L. niloticus* under 5 cm total length. As the juveniles increased in size from 5 cm, the zooplanktonic food was replaced with insects (mainly Odonata), crustaceans (dominated by *C. nilotica*) and fish prey (with *Rastrineobola argentea* (Pellegrin) as the principal species). *Caridina nilotica* formed the main food of juvenile *L. niloticus*, with *R. argentea* as secondary diet. The change from a predominantly invertebrate diet to

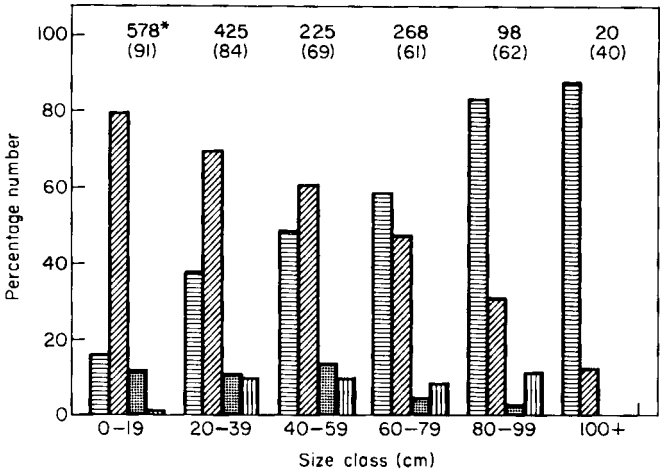

FIG. 2. The contribution of fish, ▤, crustaceans, ▨, insects, ▥ and molluscs, ▦ to the diet of *Lates niloticus* of different size classes, January–July 1982. *Number of fish examined, and, in parentheses, percentage of fish found feeding.

one dominated by fish occurred when the predator reached about 80 cm T.L. The larger *L. niloticus* fed almost exclusively on a diet of fish, with immature Nile perch being the most important constituent, followed by *R. argentea*. Haplochromines, *Oreochromis niloticus* (L), *Clarias mossambicus* (Peters), *Xenoclarias* sp., *Alestes* sp., *Synodontis* sp., *Protopterus aethiopicus*, *Barbus* sp. and *Labeo victorianus* (Boulenger) were eaten less frequently.

A scatter plot of the total length of each of the three fish prey (*L. niloticus*, *O. niloticus* and *Haplochromis* sp.) against the total length of the predator is presented in Fig. 4. At 95% confidence limit, the ranges of sizes eaten were 6·17–9·67 cm T.L. for *O. niloticus*, 6·81–8·49 cm for *Haplochromis* and 9·24–10·64 cm T.L. for *L. niloticus*. The results further indicate that most of the food items were less than a third of the predator size. Only in two stomachs did the length of prey approach 50% of the predator length; a specimen of 167·0 cm T.L. and another of 68·0 cm T.L. had eaten *Clarias mossambicus* of 85·0 cm and *L. niloticus* of 34·5 cm, respectively.

The number and variety of food prey encountered in individual stomachs indicated that the Nile perch is a voracious carnivore, especially on small species, e.g. *R. argentea*, haplochromines, immature *L. niloticus* and crustaceans (*Caridina nilotica*). The maximum number of prey per stomach tended to increase with increase in predator size; maxima of 7 individuals of *O. niloticus*, 21 of immature *L. niloticus* and 105 of *R. argentea* were counted in the stomachs of nile perch of 80 cm T.L. and above. The number of *Haplochromis* spp. found in the stomachs in which that prey occurred showed no increase with predator size, probably due to the scarcity of haplochromines in the gulf. The results further revealed a tendency for the number of large prey to be fewer than the number of small prey in every stomach examined.

IV. DISCUSSION

Lates niloticus seems to have fulfilled the main purpose of its introduction, especially in the Nyanza Gulf of Lake Victoria. Haplochromines were originally

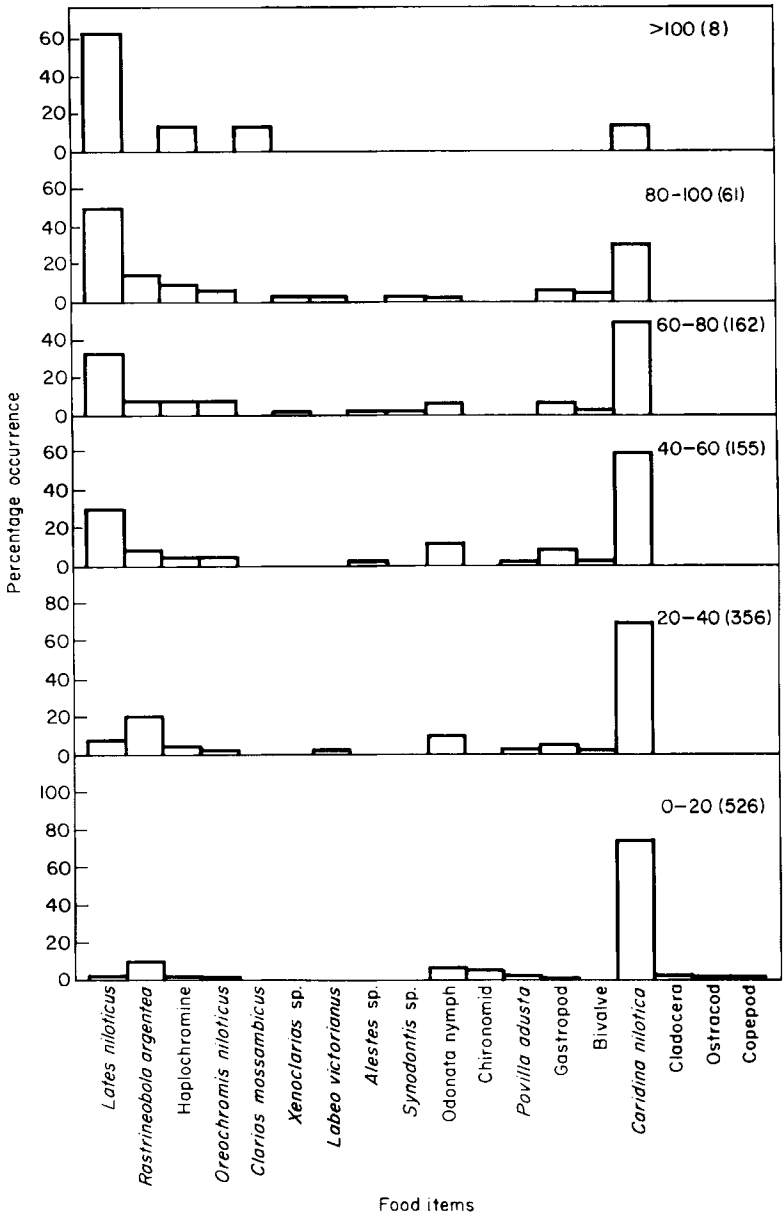

FIG. 3. The diet of *Lates niloticus* in 20-cm length groups. Figures in parentheses indicate sample size.

reported as the dominant prey item of *L. niloticus* in Lake Victoria (Hamblyn, 1966; Gee, 1969; Okedi, 1970; Okemwa, 1983). However, the results of the present investigations reveal low numbers of those species and a switch to other prey items. The present results concur with those of Gee (1969) and Hopson (1972) who, in Lakes Kyoga and Chad, respectively, described *L. niloticus* as a carnivore, not restricted to feeding specifically on any one species of fish or invertebrate. Gee (1969), Hamblyn (1966), Okedi (1970) and Hopson (1972) studied the food of

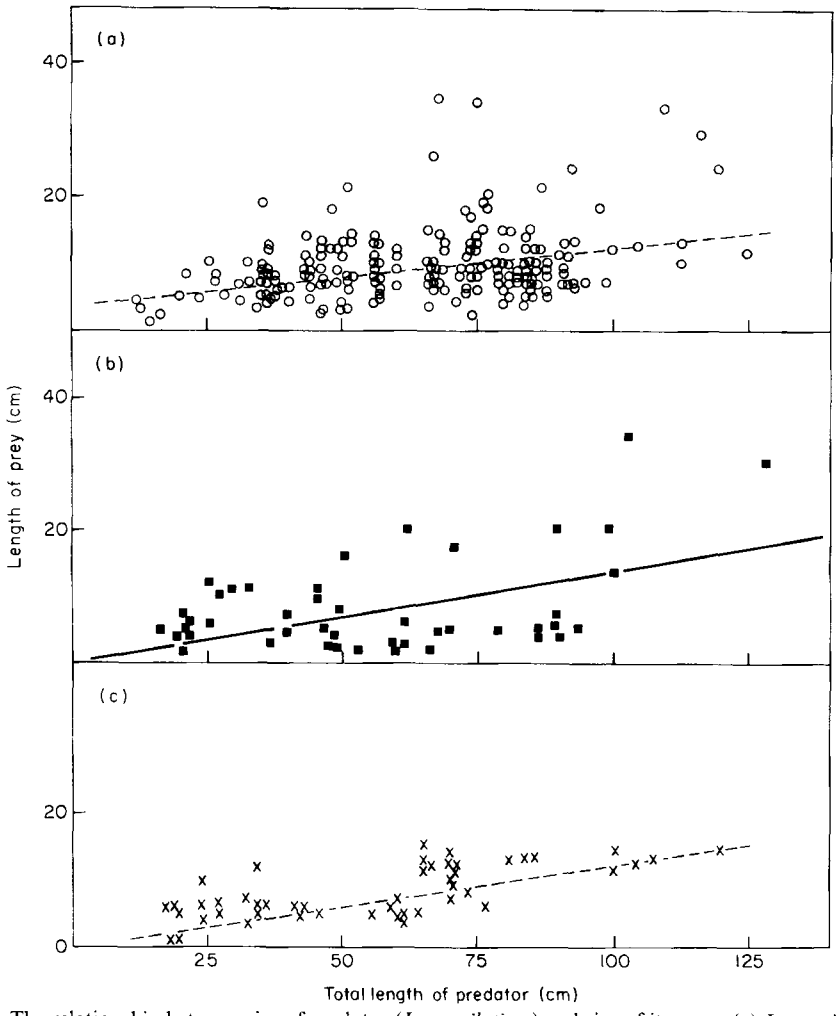

FIG. 4. The relationship between size of predator (*Lates niloticus*) and size of its prey. (a) *Lates niloticus*; (b) *Oreochromis niloticus*; (c) *Haplochromis* spp.

juvenile *L. niloticus* in various lakes apart from Lake Victoria, and noted that the dominant prey item was planktonic crustaceans.

The transition in food selection with increase in predator size found in the present study is in agreement with the results of Hamblyn (1966) who, in Lake Albert, observed that invertebrates dominated in the stomach of *L. niloticus* of less than 60 cm T.L. but that, with increase in predator size above 60 cm, it became piscivorous.

Hamblyn (1966), Gee (1969), Okedi (1970) and Coulter (1976) observed that the proportion of prey body-length to predator body-length was often in the region of 20–25, 25–30, 35·6 and 35%, respectively. Most of the fish-prey eaten in the present study were under 20 cm T.L., which agrees with the finding of Gee (1969) that the greatest impact of *L. niloticus* predation on prey species occurs when they are 3–17·5 cm S.L. Thus, it would appear that the haplochromine cichlids with total

lengths of less than 20 cm were the main target prey. This is probably one of the factors contributing to the sudden decline of the haplochromine stocks in Nyanza Gulf of Lake Victoria.

Hamblyn (1966), Gee (1969), Okedi (1970) and Ogutu-Ohwayo (1984) observed that, with the decline of the preferred fish prey, adult *L. niloticus* in Lake Kyoga switched from one species to another, initially preferring mormyrids and haplochromines and later *O. niloticus* and immature *L. niloticus*. The shift of predation from haplochromines to *Caridina nilotica* and juvenile *L. niloticus*, with the decline in haplochromines, has been observed in the present study.

Coulter (1976) reported that selection of prey is governed more by availability than by preference for a particular species. Hopson (1972) noted that cannibalism may result partly from a scarcity of alternative food source. He further observed that cannibalism is clearly a matter of opportunity and probably occurs in the Nile perch whenever smaller individuals of the same species happen to be the most readily available food source. The changes in *L. niloticus* diet observed in the present study may be related to the availability, relative abundance and convenient size of the prey species in the gulf. Changing from one food item as the dominant prey in *L. niloticus* diet to another will probably continue until the predator reaches a balance with its prey species in Lake Victoria.

This work was supported by the Director, Kenya Marine and Fisheries Research Institute (Mr S. O. Allela). We are grateful to the Master fisherman, Mr H. O. Okolo, and the crews of the research vessels, for making the cruises successful.

We thank the technician, J. A. Olondo, for his assistance in the collection and processing of the samples, and Mrs M. L. Odongo for typing the manuscript.

References

Benda, R. S. (1981). A comparison of bottom trawl catch rate in the Kenya waters of Lake Victoria. *J. Fish Biol.* **18,** 609–613.

Coulter, G. W. (1976). The biology of *Lates* species (Nile perch) in Lake Tanganyika and the status of the pelagic fishery for *Lates* species and *Luciolates stappersii* (Blgr.). *J. Fish Biol.* **9,** 235–259.

Gee, J. M. (1969). A composition of certain aspects of the biology of *Lates niloticus* (L) in endemic and introduced environments in East Africa. In *Man-made Lakes; The Accra Symposium* (L. E. Obeng, ed.), pp. 251–260. Ghana University Press.

Government of Kenya (1985). *Fisheries Department Statistical Bulletin*: 1985. Ministry of Tourism & Wildlife (mimeo).

Hamblyn, E. L. (1966). The food and feeding habits of Nile perch *Lates niloticus* (L) (Pisces: Centropomidae). *Rev. Zool. Bot. Afr.* **74,** 1–28.

Hopson, A. J. (1972). *A Study of the Nile Perch* Lates niloticus *(L) in Lake Chad.* Foreign and Commonwealth Office, Overseas Development Admin. Overseas Res. Publ. No. 19, p. 23. London: HMSO. 93pp.

Hopson, A. J. (1982). *Lake Turkana. A Report on the Findings of the Lake Turkana project, 1972–1975*, Vol. 1. London: Overseas Development Administration. 348 pp.

Hynes, H. B. N. (1950). The food of freshwater sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in studies of the food of fishes. *J. Anim. Ecol.* **19,** 36–58.

Kudhongania, A. W. & Cordone, A. J. (1974). Bathospatial distribution pattern and biomass estimates of major demersal fishes in Lake Victoria. *J. Trop. Hydrobiol. Fish.* **3,** 15–31.

Muller, R. G. & Benda, R. S. (1981). A comparison of bottom trawl stock densities in the inner Kavirondo Gulf of Lake Victoria. *J. Fish Biol.* **19,** 339–401.

Ogutu-Ohwayo, R. (1984). The effects of predation by Nile perch *Lates niloticus* (Linne), introduced into Lake Kyoga (Uganda) in relation to the fisheries of Lake Kyoga and Lake Victoria. *CIFA, FAO, Fish. Rep.* **335,** 18–41.

Okedi, J. (1970). Further observation on the ecology of the Nile perch *Lates niloticus* (Linne) in Lake Victoria and Kyoga. *Ann. Rep. E. Afr. Freshwat. Fish. Res. Org.* 1970, 42–55.

Okemwa, E. N. (1983). The food of Nile perch *Lates niloticus* (Linne) (Pisces: Centropomidae) in relation to the disappearance of *Tilapia* spp. in Nyanza Gulf of Lake Victoria. *E. Afr. Agric. For. J.* **49,** 21–26.

Okemwa, E. N., Ogari, J. & Kibaara, D. (1982). Fisheries research findings in Nyanza Gulf of Lake Victoria. *Proc. Workshop Water Quality Management and Pollution Control*, 13–27. Kisumu, Kenya: Lake Basin Development Authority.