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FOOD AND FEEDING HABITS OF THE CATFISH, *BAGRUS DOCMAK* (FORSSKAL, 1775) (PISCES:BAGRIDAE) IN LAKE CHAMO, ETHIOPIA

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ABSTRACT: The natural food of the catfish *Bagrus docmak* was studied from February 1995 to February 1996 in Lake Chamo, Ethiopia. The stomach contents of a total of 534 fish samples, ranging in size from 33–99 cm fork length (L_F) and 500–17400 g in total weight (W_T) were investigated. The diet of *B. docmak* was composed of insects (larvae, nymphs and adults), aquatic snails and different fish species such as *Synodontis schall, Labeo horie, Oreochromis niloticus, Barbus sp.* and *Hydrocynus forskalii*. Juvenile *B. docmak* (< 40 cm L_F) ingested more insects than fish while older fish were largely piscivorous, with fish constituting more than 98% of their diet by weight. *S. schall* was the most important prey and occurred in more than 81% of all the stomachs of large *B. docmak*. The prey:predator (*S. schall*:*B. docmak*) length ratio varied between 1:2 and 1:6. The feeding habit of *B. docmak* in Lake Chamo is compared with that of other tropical African lakes that have similar ichthyofauna.

Key words/phrases: ***Bagrus docmak*, Ethiopia, Lake Chamo, prey:predator ratio, *Synodontis schall***

INTRODUCTION

The bagrid catfishes (Bagridae of the Order Siluriformes) are widely distributed in Asian and African freshwaters. Lowe-McConnel (1987) states that about 100 species of bagrid catfishes occur in African freshwaters and Ajai (1987) reported the occurrence of *Bagrus* species with other bagrids in Lake Kainji, Nigeria. Golubstov *et al.*, (1995) reported the presence of bagrids in the basins of the Gambia, Chad, Niger, Senegal and Volta in Africa. In Ethiopia, *B. docmak* (local name "kerkero") occurs in the two southern lakes Abaya and Chamo (Shibru Tedla, 1973), in the Gambela region (Golubstov *et al.*, 1995) and in the Tekezzie valley (Elias Dadebo, Personal communication).

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The food and feeding habits of *B. docmak* were earlier investigated by several workers (Corbet, 1961; Chilvers and Gee, 1974; Lowe-McConnel, 1987; Okach and Dadzie, 1988; Khallaf and Authman, 1992). It was noted by these workers that the feeding habit of *B. docmak* varies with age and size of the fish.

Bagrus species are predominantly predatory bottom-dwellers and feed on invertebrates and/or other fish. Various workers pointed out that the major diet of *B. docmak* in Lake Victoria is haplochromine cichlids (Corbet, 1961; Gee and Gilbert, 1967). Chilvers and Gee (1974) reported the feeding similarities between *B. docmak* and Nile perch, *Lates niloticus*. Both species feed predominantly on invertebrates when young and shift to piscivorous habit as adult. However, Okach and Dadzie (1988) noted that the two fish are mutually exclusive in their bathymetric distribution and have different preferences for water temperature and conductivity.

The catfish are of special importance as food because they have few intramuscular bones in their flesh and are readily accepted as valuable food fish. The commercial importance of *B. docmak* has been well documented by different workers who concluded that *B. docmak* and *Clarias gariepinus* were the major food source for the human population around Lake Victoria (Bendá, 1979; Marten, 1979). Elias Dadebo (1988) also noted that *B. docmak* is of some commercial importance for the fishermen around Lake Chamo, Ethiopia.

In recent years, as a result of the increasing fishing pressure on the major commercial fish in Lake Chamo, the Nile perch stock has declined to the level of being uncommon in landings. Fishermen have started looking at alternative fishery options such as tilapia (*Oreochromis niloticus*) and catfish, *B. docmak*. Piscivorous fish like *B. docmak* and Nile perch are very sensitive to high fishing pressure and hence biological information is needed on *Bagrus* for proper scientific and management purposes before it becomes rare like the Nile perch. Thus this study was initiated with the objective to investigate the food and feeding habits of *B. docmak* in Lake Chamo, so as to provide baseline information on the ecology of this fish for proper management guidelines. This is the first study on the feeding of *B. docmak* in Lake Chamo and other papers dealing with its reproductive biology and condition factor are reported elsewhere (Hailu Anja *et al.*, unpublished data).

Study area: Lake Chamo

Lake Chamo lies in the southern part of the Ethiopian Rift Valley at an altitude of 1233 m. It lies within the less intensely faulted basin of the rift floor and to the east of the lake rises the remarkable Precambrian block of the Amaro Mountains (Mohr, 1962). Lake Chamo is fed principally by the Kulfo river entering from the north and the less important feeders, the Sile and Sego rivers from the west (Fig. 1). During the study period, the water level was lower than the outlet channel and hence the lake had no surface outlet.

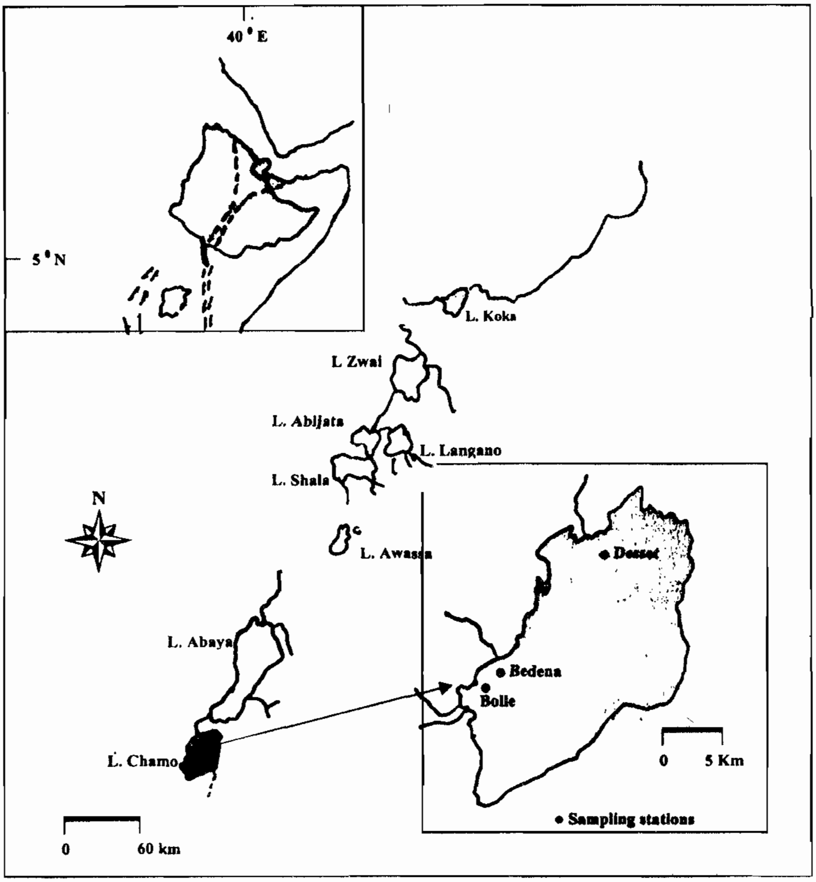

Fig. 1. Location of Lake Chamo in the Ethiopian Rift Valley. Right inset shows the three sampling stations.

The climatic condition of Lake Chamo consists of one dry and one rainy season per year. The rainy months are contiguously distributed from March to October (Fig. 2) and total annual rainfall varies between 600 and 1000 mm. The air temperature during the study year 1995 was slightly higher than that of previous years.

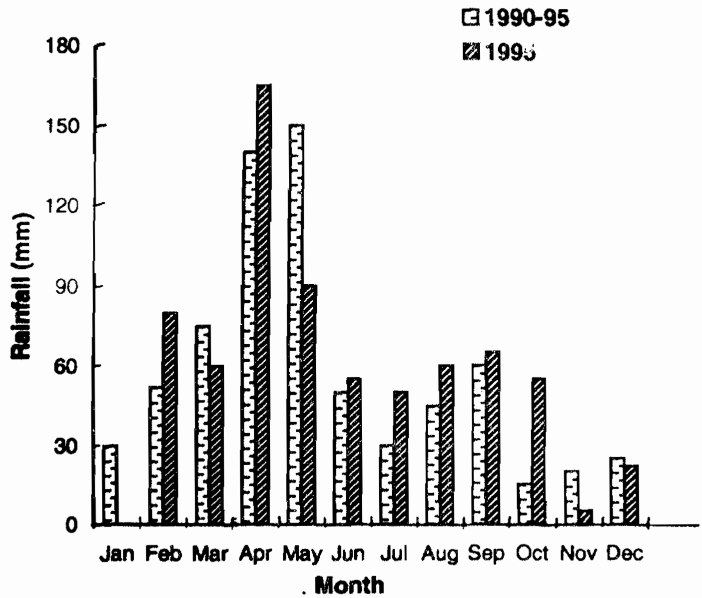

Fig. 2. Mean monthly average rainfall for 1990–1995 and the monthly rainfall during the study year (1995) for the Lake Chamo area.

Based on the level of nutrients, Chlorophyll *a* (89 $\mu g l^{-1}$) and a Secchi depth of 65 cm, Lake Chamo can be categorized as a productive lake (Elizabeth Kebede *et al.*, 1994). Algal blooms with concomitant fish kills have been reported (*e.g.*, Amha Belay and Wood, 1982). Zooplankton consist mainly of rotifers, cladocerans such as *Daphnia magna* and copepods such as *Mesocyclops ogunnus* (Defaye, 1988; Green and Seyoum Mengistou, 1991). The benthos is dominated by oligochaetes, chironomids and gastropods (Tudorancea *et al.*, 1989), all of which are important food items for *B. docmak* in Lake Chamo.

The ichtyofauna of Lake Chamo and Lake Abaya is of the Soudanian type and is dominated by six species with a thriving fishery of economic importance. These are *O. niloticus, L. niloticus, B. docmak, L. horie, C. gariepinus* and *Barbus sp.* in decreasing order of fishery importance. The small catfish *S. schall* is very abundant and is the main prey item for *B. docmak*. *L. horie* also serves as food for the nearby crocodile farm. Other fish of less economic importance are *Mormyrus cashive* (Mormoryidae), *Hydrocynus forskalii* (Characidae), *Barbus bynni* and *Labeo niloticus* (Cyprinidae), *Schilbe sp.* (Schilbeidae) and the minnow *Aplocheilichthys sp.* (Cyprinodontinae).

According to FAO (1992), the sustainable fish yield from Lake Chamo is between 3,000 and 5, 500 tonnes /year, yet the estimated catch for the year 1994–1995 was only 1,814 tonnes (LFDP, 1995). All fishermen at Lake Chamo use wooden rafts ("Ogolo") constructed from *Aeschynomene elaphroxylon*. Gillnets were introduced in the lake in 1988 (Hermann, 1993) and constitute the major fishing gear at the moment. The catfish are mostly caught by hooks and longlines.

MATERIALS AND METHODS

a) Sampling and morphometric measurements

Samples of *B. docmak* were collected using stationary longlines from three sites (Desset, Bedena and Bolle, Fig. 1) for a period of thirteen months between February 1995 and February 1996. In addition, the commercial catch was also sampled. Five stationary longlines each with 100 similar-sized hooks (№ 1, 2, 3, 4,or 5) and 200 m long were used. The hooks were baited with *S. schall* and were set approximately 0.5 m below the surface of the water during the afternoon and lifted the next morning. Sampling was done for 5 days each month.

The fork length (L_F) of all fish were measured to the nearest 1 mm. The total weight (W_T) of fish under 1000 g were taken to the nearest gram, those between 1000 and 2000 g were taken to the nearest 5 g, and fish over 2000 g were weighed to the nearest 50 g. Each fish was dissected and the entire stomach contents were preserved in 5% formaldehyde solution to be examined in the laboratory. The food items were identified and quantitatively analysed using standard methods.

Stomach contents were analysed using the frequency of occurrence method as described in Windell and Bowen (1978) and the percent composition by number method of Hyslop (1980) and Bowen (1983). The first method records the number of stomachs in which a given food item occurred, irrespective of its size or abundance, while the second methods describe the relative numerical importance of each food item in the diet.

In addition, the weight of food items in each food type was expressed as percentage of the total weight of ingested food in the stomach to determine its percent composition by weight (Bowen, 1983). If the prey fish were only slightly digested, they were weighed directly. If prey were partially digested, the method of "reconstructed weights" was used to estimate their weight at ingestion (Pearre, 1980). In this procedure, the length of the indigestible hard part, *i.e.*, the dorsal spine of the most important prey fish

(*S. schall*) was measured. Weight of prey was then estimated from the relationship between the length of the dorsal spine and the weight of the prey fish. Other prey fish were weighed and the weight before ingestion was estimated according to the degree of digestion. The weight of invertebrate prey were obtained from the average weight of invertebrate prey collected from the lake.

b) Fish size–food relationship

Percentage composition by number and by weight were arbitrarily classified into six fish length groups: 30–40, 40–50, 50–60, 60–70, 70–80 and > 80 cm. The relative importance of each food item for fish belonging to each length group was determined following the method outlined in Fagade and Olaniyan (1972). The relationship of feeding habit and fish size was then determined.

c) Predator and prey relationship

Relationship between the size of *B. docmak* and size of its most important prey (*S. schall*) was determined. The L_F of the prey was estimated depending on the degree of digestion. If the prey was digested slightly, the L_F was measured directly whereas the L_F of digested prey was estimated indirectly using a relationship established between the size of an indigestible body part (*i.e.*, dorsal spine, L_{SP}) and L_F of the prey sampled from the water (Ajayi, 1987; Fig. 6).

RESULTS

***Diet composition of* B. docmak**

Out of a total of 534 fish caught in this study, 280 (52.4%) contained food items in their stomachs. The diet of *B. docmak* consisted of insects, molluscs and different fish species such as *H. forskalli, Barbus sp. L. horie, O. niloticus* and *S. schall*, and some unidentifiable fish (Table 1). Mostly, larvae and nymphs of four insect groups were observed. For food analysis, the food items were categorised into eight groups, namely, five fish species, two invertebrates (*i.e.*, insects and molluscs) and unidentified fish remains.

The most important food items were *S. schall* and *L. horie* among fish, and insects among invertebrates. Based on the frequency of occurrence method, the main food items in descending order of importance were *S. schall* (81.1%), insects (20%) and *L. horie* (17.1%) (Fig. 3.). Except for insects (in the gravimetric method), the same order of importance was observed with the numerical and gravimetric methods. The minor food items constituted only

17.5% (occurrence) and 10.9% (numerical and gravimetric) of the total food items.

Table 1. Food items identified in the gut of *B. docmak* from Lake Chamo.

Insecta	
	Chironomid larva
	Odonata nymphs
	Coleoptera
	Hemiptera
Molluska	
	Gastropoda
Pisces	
	Synodontis schall
	Labeo horie
	Oreochromis niloticus
	Barbus sp.
	Hydrocynus forskalii
	Unidentified fish remains

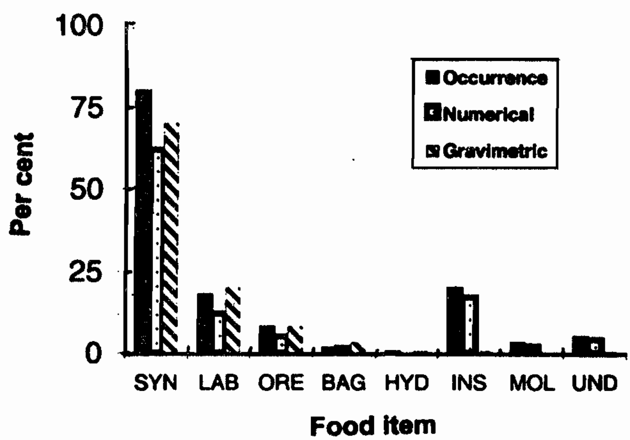

Fig. 3. The relative percent importance of foods in the diet of *B. docmak* determined by three methods (Abbreviations are: SYN, *Synodontis*; LAB, *Labeo*; ORE, *Oreochromis*; BAG, *Bagrus;* HYD, *Hydrocynus*; INS, Insects; MOL, Mollusks and UND, Unidentified).

The weight of partially digested *S. schall* was estimated using the equation derived from dorsal spine length vs body weight: Log $_{10}$ W_T= -3.60+3.36 Log $_{10}$ L_{SP} (r^2 =0.77, $p<0.05$, n=81) (Fig. 4), where W_T is total weight of *S. schall* and L_{SP} is dorsal spine length. A total of 281 (63%) *S. schall* weighing 23.68 kg (69.2%) were recorded in comparison with all other food items combined. *S. schall* constituted most of the amount and bulk of the food of *B. docmak.*

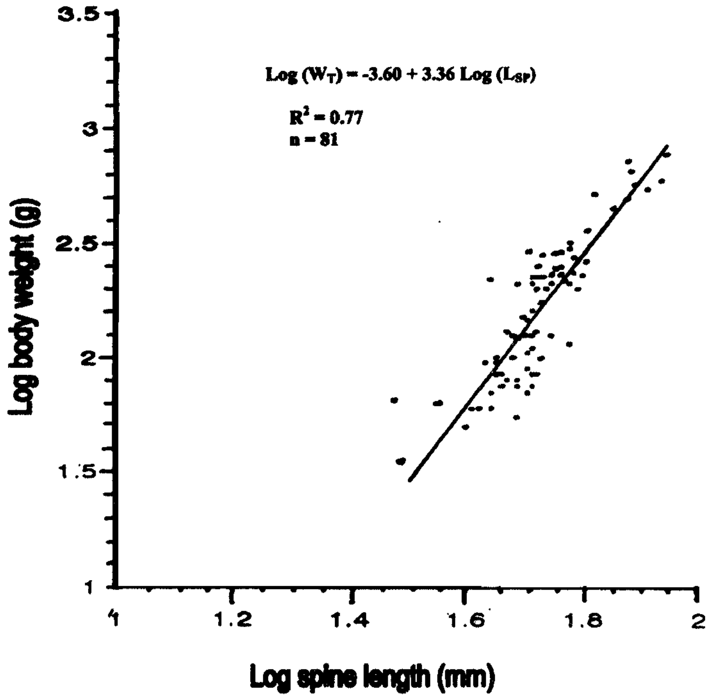

Fig. 4. Relationship between $\log_{10}$ dorsal spine length and $\log_{10}$ body weight of *S. schall* in Lake Chamo. This linear equation was used to reconstruct the weight of *S. schall* ingested by B. *docmak.*

B. docmak *size and its feeding habit*

Larger *B. docmak* fed only on fish and smaller ones fed on invertebrates, and insects in particular (Fig. 5). Invertebrates constituted by number 43.8% of the diet of *B. docmak* between 30.0 and 39.9 cm, but the values decreased to less than 2.5% in fish larger than 80.0 cm L_F (Fig. 5). Based on the gravimetric method, insects constituted 4.4% by weight of the food of *B. docmak* ranging in size between 30.0 and 39.9 cm, and this decreased to < 0.1% in fish larger than 80.0 cm (Fig. 5). Fish prey contributed 56.2% by number and 95.6% by weight of *B. docmak* between 30.0 and 39.9 cm, and this increased to 97.6% by number and 99.9% by weight in fish larger than 80.0 cm. *S. schall* showed increasing importance both in number and weight in the diet of *B. docmak* with increasing size of predator fish (Fig. 5). The relative numerical importance of *S. schall* increased from 25% in the 30-39.9 cm length group to 76.6% in fish larger than 80 cm and its relative weight increased from 39% in the 30-39.9 cm up to 82.1% in larger length groups (Fig. 5).

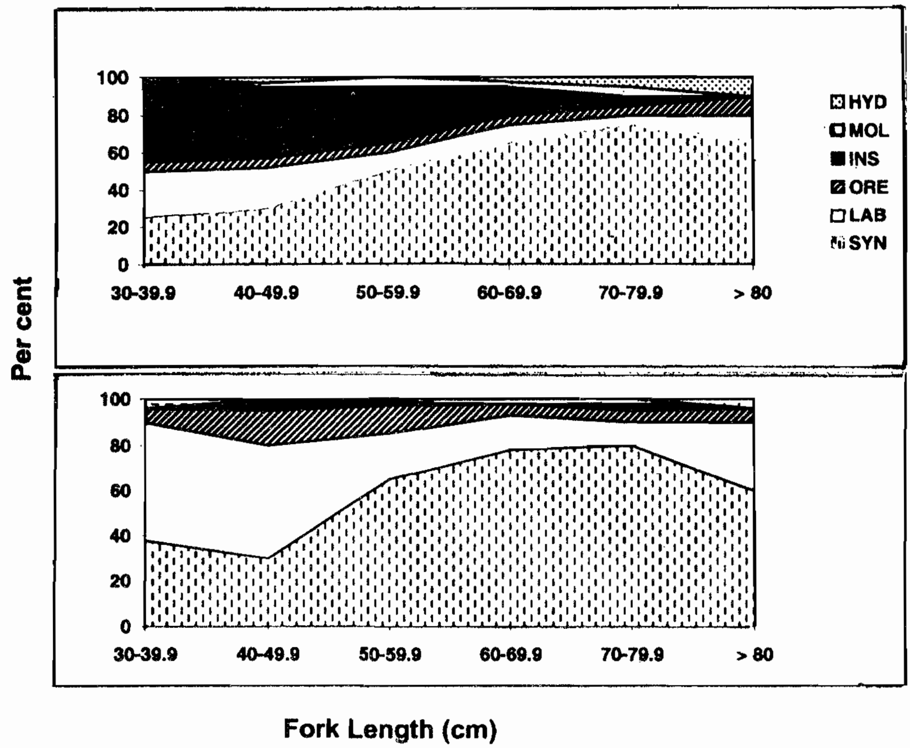

Fig. 5. The diet composition of *B. docmak* in relation to size (fork length, cm) determined with the numerical (upper) and gravimetric (lower panel) methods. Abbreviations same as for Figure 3.

The prey fish *L. horie* and *O. niloticus* showed a similar trend of increasing importance with predator size up to 50 cm, followed by decreasing importance afterwards. The two less important prey fish, namely - *Barbus sp.* and *H. forskalii* were encountered in the stomachs of larger *B. docmak* (>65 cm). *Barbus sp.* were recorded from three individual *B. docmak* of 65.6, 73.0 and 73.5 cm LF. Only one *H. forskalii* was found in the stomach of an 80.2 cm *B. docmak*. Those fish found in very low frequency, such as *Barbus* *spp.* (1.07%) and *H. forskalii* (0.36%) were most likely swallowed accidentally by *B. docmak.*

Predator-prey relationship

S. schall was the most important prey of *B. docmak* in Lake Chamo (Figs 3 and 5) and therefore predator-prey size relationship was analysed only for *S. schall.* The L_F of *S. schall* was estimated from the dorsal spine length using the following relationship as in Fig. 6.

$$L_F = -2.92 + 0.46\ L_{SP}\ (r^2 = 0.86,\ p<0.05,\ n=80)$$

where L_F is fork length of *S. schall* and L_{SP} is dorsal spine length.

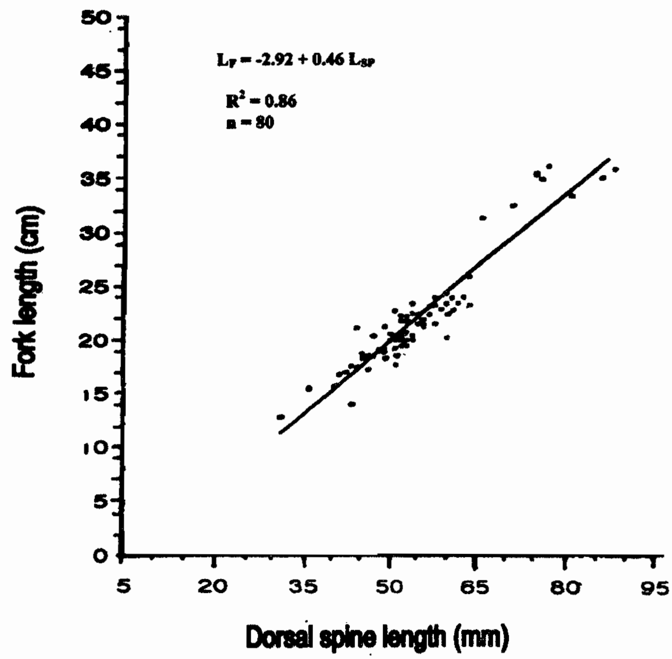

Fig. 6. Relationship between dorsal spine length and fork length of *S. schall* prey. The regression equation was used to estimate the fork length of *S. schall* from spine length collected from the gut of *B. docmak.*

The length of *S. schall* ingested by *B. docmak* ranged from 9.0 to 23.2 cm and the length of *B. docmak* that had consumed *S. schall* ranged from 36.1 to 98.4 cm. Hence the overall prey-predator ratio ranged from 1:2 to 1:6. However, most prey:predator size ratios were found to lie between 1:3 and 1:5 (Fig. 7). This indicates that *B. docmak* feeds on *S. schall* that are between 20.0 and 33.3% of its length. The prey-predator ratio relationship varied with the length of *B. docmak* (Fig. 7). Thus the ratio was 1:2 for *B. docmak* below 40.0 cm LF and decreased to 1:4 and 1:5 for larger *B. docmak*, and can be taken to be 1:4 on average for larger predator fish.

The maximum absolute size of *S. schall* eaten showed a fairly linear increase up to 23.3 cm LF with increase in predator size up to 85 cm LF. Beyond this, it decreased with increasing predator length.

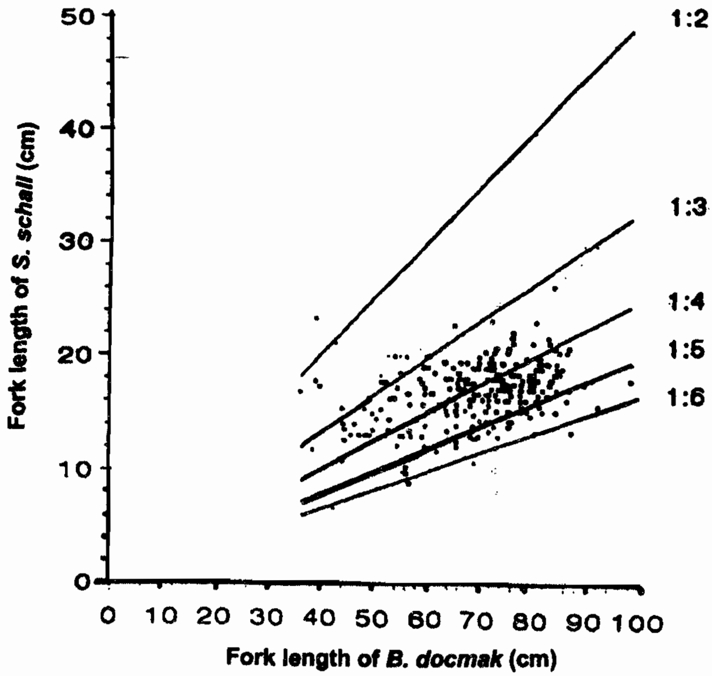

Fig. 7. Relationship between prey and predator size (*S. schall*: *B. docmak*) in Lake Chamo.

DISCUSSION

The proportion of *B. docmak* with empty stomachs was high (about 48%). Since the longlines were set overnight, regurgitation and/or digestion might have taken place. Corbet (1961) observed a high regurgitation rate for *B. docmak* from Lake Victoria. Generally, piscivorous fish in the tropics feed throughout the year as the water temperature does not inhibit feeding (Whitefield and Blaber, 1978). Thus, the high occurrence of *B. docmak* with empty stomachs does not imply that feeding is seasonally inhibited in Lake Chamo.

The three different methods used showed different results on the feeding behavior of *B. docmak*. For example, insects comprised 20% of the diet of *B. docmak* when analysed by frequency of occurrence but only 0.67% when analysed by weight (Fig. 3). Several workers have also suggested that the relative importance of food items can best be gauged by two or more methods in conjunction (Whitefield and Blaber, 1978; Hyslop, 1980). Thus consideration of only one method of stomach content analysis may not give a true impression about the importance of food items and the feeding behaviour of fish.

This study showed that *S. schall* was the most important prey fish for *B. docmak* in Lake Chamo. In other lakes, other fish prey were reported as major food for *B. docmak*. Khallaff and Authman (1992) reported that in the Nile canal of Egypt, numerically 90% of the diet of *B. docmak* were tilapia. In addition Haplochromines were reported to contribute over 90% by number of the total food of *B. docmak* in the Kenyan waters of Lake Victoria (Corbet, 1961; Chilvers, 1969; Chilvers and Gee, 1974; Okach and Dadzie, 1988). In Lake Kainji, Nigeria, *B. docmak* feeds on the catfish *Chrysichtys auratus* supplemented with *Tilapia spp.* (Ajai, 1987). It appears that one factor for selection of food by *B. docmak* is the ease of availability of prey fish. But, it was also observed that other fish were equally abundant and available in Lake Chamo, such as *L. horii* and *O. niloticus*. However, both were not as important as *S. schall* as food for *B. docmak* (Fig. 5). Thus, the vertical distribution of *B. docmak* and *S. schall* might be the more important factor for the preference and selection of the latter by the former, since both are bottom dwellers (Cyrus and Blaber, 1983; Ofari-Danson, 1992; Demeke Admassu, Personal communication).

Other than the overlap in the distribution of the predator and prey species, there is another possible reason why *B. docmak* prefers *S. schall* more than other prey fish. This could be because *S. schall* is a very difficult fish to predate due to its pectoral and dorsal spines. When challenged, *Synodontis* erects these spines which require a large mouth and strong jaws for swallowing - qualities possessed by *B. docmak*, but not by other predators such as Nile perch. The latter usually go for less armoured but fast swimming prey fish such as tilapia. It is possible that in Lake Chamo, the two predator fish, *B. docmak* and *L. niloticus* have evolved different preferences to different prey species or that *B. docmak* has evolved unique adaptation to attack an armoured fish and survive successfully.

The diet composition of *B. docmak* varies with its size, being directly related with fish prey and inversely with invertebrate prey (Fig. 5). Similar observations were documented by Okach and Dadzie (1988) for *B. docmak* in Lake Victoria. Other workers also noted the importance of insects in the diet of small-sized *B. docmak* (Corbet, 1961; Munro, 1967; Lowe-McConnel, 1987). The present work did not confirm the ontogenic diet preferences of *B. docmak* because small-sized fish could not be sampled.

The prey:predator ratio of *B. docmak* varied with the length of the predator (Fig. 7). The prey:predator ratio for smaller *B. docmak* was 1:2 and for large *B. docmak* it was 1:4 to 1:6. In addition, the prey fish of large *Bagrus* were not always contained in the stomach but the caudal peduncles often projected forwards into the buccal cavity. This phenomenon was rare in small *Bagrus*. It may be deduced that the maximum volume to which the stomach can be distended is relatively greater in small *B. docmak*. This could be because of the absence of mature gonads and large quantities of fat, and the presence of a large coelomic space in small *Bagrus*. Chilvers and Gee (1974) and Olatunde (1986) have noted that predator gape, volume of the buccal cavity, stomach distension and prey length are the major factors influencing prey-predator ratio in the Bagridae and Schilbeidae.

S. schall has a well-developed anti-predatory defense. The triangle-shaped erect spines makes it difficult to be easily preyed. A Nile perch was found dead with one *S. schall* jammed into its throat (Demeke Admassu and Zenebe Tadesse, Personal communication), however, *B. docmak* readily manages to swallow *S. schall*. Chilvers and Gee (1974) and Ajayi (1987) found that *B. docmak* swallowed its prey head first. Such whole fish head-first ingestion seems advantageous to the process of maneuvering the chocking dorsal and pectoral spines of *S. schall* during ingestion. *B. docmak* may be effective in catching its prey on a face to face attack and the possession of small prehensile teeth may avoid damage by the prey's pectoral and dorsal spines.

At present, the vast population of *S. schall* in lake Chamo is not exploited commercially. The presence of *B. docmak* may be an added asset in that it provides a major link between man and the currently unexploited large stock of *S. schall* in the lake. Hence more work is essential to study the biology of *B. docmak* in Lake Chamo in order to pinpoint its trophic position and its trophic role in the system, so as to devise optimal strategies for its proper utilisation and conservation in this ecosystem.

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REFERENCES

1. Ajayi, T.O. (1987) The food and feeding habits of, and the predation on the family Bagridae (Pisces:Siluroidea) in Lake Kainji, Nigeria. *Arch. Hydrobiol.* **109**(4):583-600.

2. Amha Belay and Wood, R.B. (1982). Limnological aspects of an algal bloom on Lake Chamo in Gamo Goffa Administrative region of Ethiopia in 1978. *SINET: Ethiop. J. Sci.* **5** (1):1-19.

3. Benda, R.S. (1979). Analysis of catch rate data from 1968 to 1976 from nine fishlandings in the Kenyan waters of Lake Victoria. *J. Fish Biol.* **14**:385-388.

4. Bowen, S.H. (1983). Quantitative description of the diet. **In**: *Fisheries Techniques*, pp. 325-336, (Nielson, L.A. and Johnson, D.L., eds). Southern Printing Company. Blacksburg, Virginia.

5. Chilvers, R.M. (1969). A method of age estimation from length frequency data for large fish with reference to *Bagrus docmak*. Report East Afr. Freshwater. Fish. Res. Org. 1968, pp. 32-38.

6. Chilvers, R.M. and Gee, J.M. (1974). The food of *Bagrus docmak* (Pisces: Siluriformes) and its relationship with *Haplochromis* (Pisces:Cichlidae) in Lake Victoria. *J. Fish. Biol.* **6**:483-505.

7. Corbet, P.S. (1961). The food of non-cichlid fishes of Lake Victoria basin, with remarks on lacustrine conditions. *Proc. Zool. Soc. Lond.* **136**:1-101.

8. Cyrus, D.P. and Blaber, S.J.M. (1983). The food and feeding ecology of Gerreidae in the estuaries of Natal. *J. Fish. Biol.* **22**:373-393.

9. Defaye, D. (1988). Contribution a la connaissance des crustaces copepodes d'Ethiopie. *Hydrobiologia* **164**:103-147.

10. Elias Dadebo (1988). Studies on the biology and commercial catch of *Clarias mossambicus* Peters (Pisces:Claridae) in Lake Awassa, Ethiopia. Unpublished M.Sc. Thesis. Addis Ababa University, 73 pp.

11. Elizabeth Kebede, Zinabu Gebre-Mariam and Ahlgren, I. (1994). The Ethiopian Rift Valley lakes: Chemical characteristics of a salinity-alkalinity series. *Hydrobiologia* **288**:1-12.

12. Fagade, S.O. and Olaniyan, C.I.O. (1972). The biology of the West African shad, *Ethmalosa fimbiata* in the Lagos lagoon, Nigeria. *J. Fish Biol* **4**:519-533.

13. FAO (1992). Rift Valley Lakes Basin Integrated Natural Resource Development Master Plan. Food and Agriculture Organization. ETH/88/001. Vol. 4 pp. 1-54.

14. Gee, J.M. and Gilbert, M.T. (1967). The establishment of a commercial fishery for *Haplochromis* in the Uganda waters of Lake Victoria. Part I. *East. Afr. Freshwat. Fish. Res.* Org. Occasional Paper. No.5.

15. Golubstov, A.S., Darkov, A.A., Dgebuadze, Y.Y. and Mina, M.V. (1995). *An artificial key to fish species of Gambella Region.* Joint Ethio-Russian Biological Expedition. Artistic Printing, Addis Ababa, 84 pp.

16. Green, J. and Seyoum Mengistou (1991). Specific diversity and community structure of Rotifera in a salinity series of Ethiopian inland waters. *Hydrobiologia.* **209**:95–106.

17. Hermann, J. (1993). Current situation, recent developments and prospects for Lake Ziway, Awassa, Abaya and Chamo. Paper presented at a national seminar on fisheries policy and strategy session. 22–25 June, 1993, Addis Ababa.

18. Hyslop, E.J. (1980). Stomach contents analysis: a review of methods and their Application. *J. Fish Biol.* **17**:411–429.

19. Khallaf, E.A and Autman, M.N. (1992). Changes in diet, prey size and feeding habit in *Bagrus bayad,* and possible interactions with *Bagrus docmak* in a Nile canal. *Env. Biol. Fish.* **34**:425–431

20. LFDP (1995). Fisheries statistical bulletin No. 2. Working paper No. 19. Lake Fisheries Development Project, Ministry of Agriculture, Addis Ababa.

21. Lowe-McConnel, R.H. (1987). *Ecological studies in tropical fish communities.* Cambridge University Press, London, 382 pp.

22. Marten, G.G. (1979). Predator removal: effect on fisheries yield in Lake Victoria. *Science* **203**:646–648.

23. Mohr, P.A. (1962). The Ethiopian Rift system. *Bull. Geophys. Obs.* **3**(1):33–62.

24. Munro, J.L. (1967). The food of a community of East African freshwater fishes. *J. Zool. Lond.* **151**:389–415.

25. Ofari-Danson, P.K. (1992). Ecology of some species of catfish, *Synodontis,* in the Kpong Headpond in Ghana. *Env. Biol. Fish.* **35**:49–61.

26. Okach, J.O. and Dadzie, S. (1988). The food, feeding habits and distribution of a Siluroid catfish, *Bagrus docmak,* in the Kenya waters of Lake Victoria. *J. Fish Biol.* **32**:85–94.

27. Olatunde, A.A. (1986). The food and feeding habits of *Physalia pellucids* and *Schilbe uranoscopus* (Family Schilbeidae) in Lake Kainji, Nigeria. *Freshwat. Biol.* **9**:183–190.

28. Pearre, S.J. (1980). The copepod width-length relations and its utility in food chain research. *Can. J. Zool.* **58**:1884–1891.

29. Shibru Tedla (1973). *Freshwater fishes of Ethiopia.* Hailesellasie I University, Addis Ababa, 101 pp.

30. Tudorancea, C. Baxter, R.M. and Fernando, C.H. (1989). A comparative limnological study of zoobenthic associations in lakes of the Ethiopian Rift Valley. *Arch. Hydrobiol.* (Suppl.) **83**(2):121–174.

31. Whitefield, A.K. and Blaber, S.J.M. (1978). Food and feeding ecology of piscivorous fishes of Lake St. Lucia, Zululand. *J. Fish. Biol.* **13**:675–691.

32. Windell, J.T and Bowen, S.H. (1978). Methods for a study of fish diets based on analysis of stomach contents. **In:** *Methods for the Assessment of Fish Production in Freshwaters*, 3rd. ed. pp. 219–226, (Bagenal, T.B., ed.) Oxford, Blackwell.