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Feeding Habits of the African Bagrid, *Chrysichthys filamentosus* in a Nigerian Lake

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Abstract The feeding ecology of *Chrysichthys*, a commercially important freshwater bagrid in Nigeria, is described from a southeastern lake. Over a year period, 779 stomachs were examined. The main food items were chaoborid and chironomid larvae, ostracods, copepods and detritus. Larger fish fed mostly on insect larvae and detritus while the smaller individuals consumed mostly microcrustacea. Feeding intensity was lowest during the height of the flood. There was little diel change in the amount of food consumed. The fish are morphologically pre-adapted for their benthic omnivorous feeding habits.

Bagrid fishes of the genus *Chrysichthys* are widely distributed in freshwater systems of tropical Africa, within latitudes 25°N and S, and between Tanzania in the east and Senegal in the west (Jayaram, 1966). Over 40 species have been described, although there are some problems in their taxonomy and systematics (Vanderpuye, 1981). They support thriving commercial fisheries of many West African waters such as the River Niger/Benue system (Motwani, 1970), freshwaters of Ivory Coast, Lagos and Lekki lagoons (Ikusemiju and Olaniyan, 1977), Kainji Lake (Turner, 1970), River Ogun (Sydenham, 1977) and Oguta Lake (this study).

Apart from its importance in the capture fisheries, *Chrysichthys* is increasingly attracting attention as a potentially culturable fish in West Africa (Ajayi, 1972; Ezenwa, 1982).

The ecology and biology of composite species in southwestern Nigeria are virtually unknown. Available information is restricted to the southwestern and northern Nigerian waters. Examples of such studies are those of Ikusemiju (1975) on the biology of *C. nigrodigitatus* in Lagos and Lekki lagoons; distribution, reproduction and growth of *C. walkeri* in the Lekki lagoon (Ikusemiju, 1976) and that of Ikusemiju and Olaniyan (1977) on the food and feeding habits of *C. walkeri*, *C. filamentosus* and *C. nigrodigitatus* also in Lekki lagoon. Other studies based on southwestern waters are those of Fagade (1980) on the age of *C. nigrodigitatus* of Lake Asejire using the otoliths, Ezenwa and Ikusemiju (1981) on the age and growth of the Lagos lagoon samples of the same species using dorsal spines and Fagade and Adebisi (1977) on the fecundity of *C. nigrodigitatus* in Lake Asejire, Ibadan. In the northern part of the country, the available studies are those of Ajayi (1972) and Imevbore and Bakare (1970) on the *Chrysichthys* of Lake Kainji and River Niger (Kainji area) respectively.

This paper is therefore an attempt to describe the food of this important group of fish in southeastern Nigeria. It specifically describes the feeding ecology and food habits of *C. filamentosus* in Oguta Lake, the largest (though small, 1.79 km^2) natural lake in the Anambra/Imo River basin of the Niger Delta system. The chemical hydrology of the lake has been studied in detail by Nwadiaro and Umeham (1985) and Nwadiaro (in press a). While the physical features are summarised in other publications such as Nwadiaro and Okorie (1985a, b). The biological features so far studied are the phytoplankton productivity (Nwadiaro and Oji, 1985) and the unusual, macroscopic, algal jellies (Nwadiaro, in press b).

Materials and methods

The fish were obtained with the aid of fishermen, with gill nets, of various mesh sizes, ranging from 2.1 to 18 cm (1–7 inches), cast nets, wire and basket traps, multiple long lines and single rod and hooks (size No. 3–15). This combination of capture methods was employed to reduce size selection. Sampling was carried out at various day periods in the various areas of the small lake, every month from December 1982 to November 1983.

The samples taken were killed immediately in ice, stomachs dissected out and stored in 10% formalin, in separate, labelled specimen bottles, bearing the sex, length and weight of the fish. In the laboratory, the stomach contents of individuals were examined and the food items identified as far as possible. Analyses of stomach contents were by the frequency of occurrence and volumetric index methods. The merits and demerits of these methods have been reviewed by Hyslop (1980).

The degree of repletion or stomach fullness was estimated based on an arbitrary scale of 0–4 where

0=empty stomach
1=$\frac{1}{4}$ full
2=$\frac{1}{2}$ full
3=$\frac{3}{4}$ full
4=100% full

An empty stomach was one with little or nothing in its stomach as ascertained by physical handling or pressing the excised stomach. A stomach 100% full is one stuffed completely with food items. The mean index of repletion for all specimens taken per month was calculated and used to ascertain feeding intensity.

In order to obtain an idea of the feeding adaptations of the species, the structure of the mouth, their position and gape, were studied. The alimentary tract of some individuals was removed, unravelled and their length measured, and expressed as the relative gut index (RGI). This index is a ratio of the gut length to the standard length.

Results

Species composition of *Chrysichthys* In Oguta Lake, *C. filamentosus* constituted over 98% of the genus caught. A total of 779 specimens was examined. These comprised 349 males and 433 females in the size range 9–24 cm total length and 11–24 g total weight. The only other species is *C. nigrodigitatus*. The biometric features of *C. filamentosus* have been described by Nwadiaro and Okorie (1985a).

Food spectrum and importance. Table 1 shows the food of *C. filamentosus* examined with the indices of importance. The dominant food items were insect larvae, ostracods, copepods, cladocerans and detritus. Chaoborid larvae occurred in 36% of the stomachs examined and contributed 25% of the total volume of stomach contents recovered. The bloodworms (chironomid larvae) accounted for 24.9% and 16.5% by the frequency of occurrence and volumetric indices respectively.

Table 1. Summary of the food items of 779 *Chrysichthys filamentosus* from Oguta Lake.

	Frequency method		Volumetric method	
	Number	Percent	Volume (cm^3)	Percent
Detritus	264	33.9	10.5	24.5
Sand	56	7.2	0.9	2.1
Diatoms	71	9.1	—	—
Vegetable matter	104	13.4	4.2	9.8
Nematodes	100	12.8	0.6	1.5
Crustacea				
Copepoda	223	28.6	1.2	2.8
Cladocera	140	18.0	0.9	2.1
Ostracoda	263	33.8	3.2	7.5
Insecta				
Chironomid larva	194	24.9	7.1	16.5
Chironomid pupa	5	0.6	0.1	0.2
Chaoborid larva	273	36.0	10.8	25.2
Trichoptera larva	79	10.1	1.1	2.5
Odonata nymph	46	5.9	0.9	2.0
Ephemeroptera nymph	38	4.9	0.6	1.5
Pisces				
Fish bone	7	0.9	0.2	0.5
Fish scales	30	3.9	0.3	0.8
Fish eggs	8	1.0	0.2	0.4
Unidentified	7	0.9	0.05	0.1

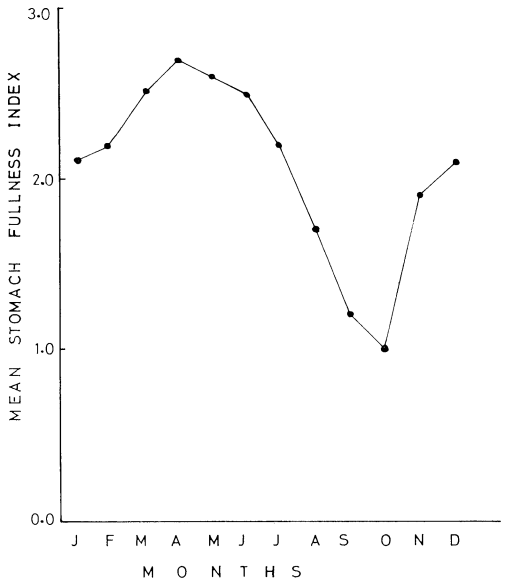

Fig. 1. Monthly variation in the mean stomach fullness index of *Chrysichthys filamentosus* taken from Oguta Lake in 1983.

Ostracods followed these insect larvae occurring in 33.8% of the stomachs but making up only 7.5% of the volume of food eaten. Copepods and waterfleas (cladocerans) were the next most important animal components in the diet.

Detritus was of considerable importance in the diet. It occurred in 33.9% of the stomachs and made up 24.5% by volume of the food. Vegetable matter was also of some importance (13.4% occurrence and 9.8% by volume), so were nematodes 12.8% occurrence.

Fish remains, caddisfly larvae (trichoptera), odonatan (dragonfly) and ephemeropteran (mayfly) nymphs made minor contributions to the diet of *C. filamentosus* in Oguta Lake. Naviculoid diatoms and sandgrains occurred incidentally and may have been picked up while foraging for the main food items.

Dietary changes with fish size. The specimens of *C. filamentosus* caught were divided into two size groups in order to ascertain any ontogenetic changes in food habits. These were the small fish of 8–14 cm total length and the large fish group 15–24 cm total length. The frequency of occurrence method alone was chosen for this comparison since the volumetric method incorporated all the size groups taken in each month of sampling.

The result of the comparison (Table 2) shows that there were distinct differences in the food habits of small and large sized fishes. The larger fish consumed by far more detritus and insect larvae than the younger ones, indicating that they were largely bottom-feeders. On the other hand, the smaller ones consumed more ostracods, copepods, cladocera and vegetable matter than the bigger fish.

Seasonal variation in the feeding intensity and food type. Figure 1 shows the monthly variation in the indices of stomach fullness of *C. filamentosus*. Approximately 20% of the population sampled had empty stomachs and the incidence of fish in this category was much higher (22.5%) from July to October. The mean stomach fullness rose from 2.1 in January to 2.7 in April and thereafter fell progressively to a minimum of 1.0 in October. As shown by Nwadiaro and Umeham (1985) peak height of water occur in October (major flood) while July has the highest rainfall. The feeding intensity was therefore maximal during the non-spate period.

From the data on Table 3 and Fig. 2, a seasonal variation in the composition of the diet of *C.*

Table 2. The percentage occurrence of food items in two size groups of *Chrysichthys filamentosus* in Oguta Lake.

Total length No. examined	8–14 cm 318	15–24 cm 461
Detritus	7.1	27.1
Sand grains	1.3	5.9
Diatoms	2.4	6.7
Vegetable matter	8.5	4.9
Nematodes	1.7	11.2
Crustacea		
Copepoda	19.0	9.6
Cladocera	11.7	7.6
Ostracoda	23.0	10.8
Insecta		
Chironomid larva	4.4	20.9
Chironomid pupa	0.1	0.5
Chaoborid larva	4.7	29.0
Trichoptera larva	1.7	8.5
Odonata nymph	4.5	1.4
Ephemeroptera nymph	3.9	1.0
Pisces		
Fish bone	0.8	0.3
Fish scales	3.1	0.8
Fish eggs	1.0	0
Unidentified	0.6	0.3

filamentosus in Oguta Lake is discernible. For example, although ostracods were consumed throughout the year, their percentage occurrence was higher between December and April (relatively drier period) than between May and October (Fig. 2). Occurrence of chironomid and chaoborid larvae in the stomachs was lower in the June-October period while there were distinct peaks (April, July and November) in the monthly occurrence of detritus in the diet. On the other hand, dragonfly and mayfly nymphs occurred in fairly equal proportions throughout the year. Vegetable matter was consumed more between August and November which is the flood period, during which period, the bank vegetation are drowned and so become more available. The incidence of fish eggs in the stomachs was higher during this period when most tropical fish spawn (Daget, 1954).

Diurnal variation in feeding intensity and dietary composition. Of the 107 fish taken during the day (6 a.m.–6 p.m.), 21 (19.6%) had empty stomachs compared to 17 out of 104 (16.3%) caught at night (6 p.m.–6 a.m.) with empty stomachs. Feeding activity was therefore only slightly higher at night period.

As shown on Table 4, there was no remarkable difference in the quality of the diet consumed either at night or day. Based on the frequency of occurrence method, the type of food were virtually the same except that the proportions of ostracods,

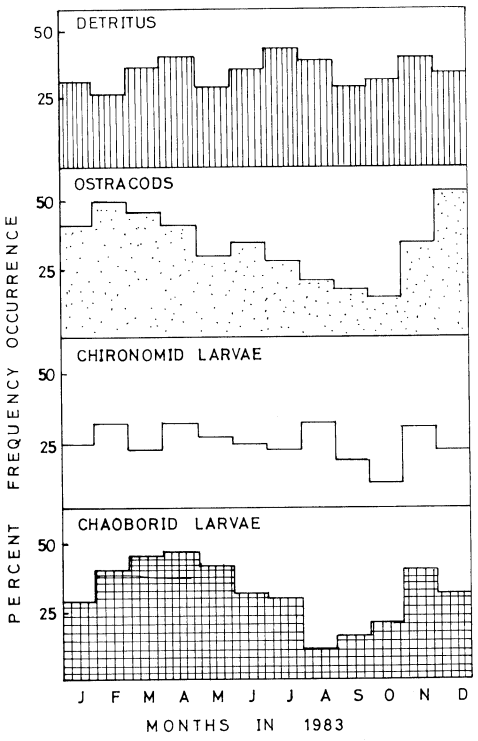

Fig. 2. Seasonal variation in the frequeney of occurrence index of major food items in the stomach of *Chrysichthys filamentosus* from Oguta Lake in 1983.

Table 3. Monthly percentage volumes of food items in *Chrysichthys filamentosus* from Oguta Lake.

	J	F	M	A	M	J	J	A	S	O	N	D
Detritus	26	19.5	21	27.5	21.5	24.5	26.7	29.6	26.5	28.5	22.2	26.5
Sand	3.6	1.8	1.1	2.1	4.2	1.0	6.0	5.1	8.2	5.2	2.0	3.5
Diatoms	—	—	—	—	—	—	—	—	—	—	—	—
Vegetable matter	9.8	1.5	5.5	6.9	8.8	8.7	9.8	14.5	12.1	10.5	14.5	8.9
Nematodes	2.2	1.2	11.0	1.5	1.4	1.8	2.2	1.1	2.6	1.6	1.6	1.0
Copepoda	3.4	4.2	4.8	3.0	2.7	2.6	2.4	2.0	1.3	1.4	2.9	4.9
Cladocera	2.3	3.0	3.6	2.5	2.5	1.7	1.5	0.5	2.0	0.8	2.2	2.1
Ostracoda	8.6	10.0	11.3	7.5	7.4	7.2	4.0	7.2	5.2	4.6	7.2	9.4
Chironomid larva	19	24	10.1	18.5	16	19.5	17.3	23.2	16.7	15.7	16.5	17.4
Chironomid pupa	0	0	1.6	0	3.2	0	0	0	0	0	0	0
Chaoborid larva	19.5	28.1	27.2	25.5	25.5	25	24.6	12.1	20.5	24.4	21.2	22.5
Trichoptera larva	0.8	1.0	6.2	2.8	1.5	1.5	1.2	2.5	1.2	2.2	3.0	1.0
Odonata nymph	2.0	2.1	3.4	2.5	2.6	2.3	1.6	1.5	0.8	2.6	1.5	1.6
Ephemoptera nymph	2.1	2.3	2.4	2.3	1.5	1.6	1.6	0.5	2.2	0	2.0	0.6
Fish bone	0	0.2	0	0.4	0.4	0.4	0.2	0	0	0	0.8	0
Fish scales	0.5	0.5	0.8	0	0.5	1.0	0.5	0.2	0.2	1.5	0.5	0.5
Fish eggs	0	0	0	0	0	0	0	0	0.5	1.0	0.2	0
Unidentified	0.2	0.2	0	0	0	0.2	0.3	0	0	0	0.2	0

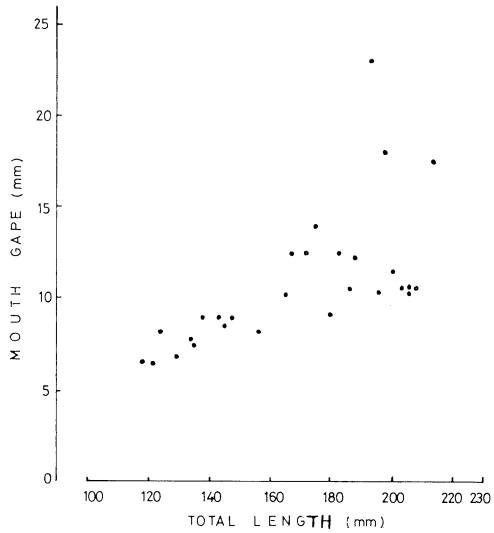

Fig. 3. The relationship between gape size and total length in the *Chrysichthys filamentosus* population from Oguta Lake.

bloodworms and fish eggs differed.

Feeding structures and adaptation. The head of *C. filamentosus* is relatively large with a width of 14.9–22.4% of standard length and large protruding, bulbous eyes. The pectoral fins are anterior and ventral, allowing the fish to hover over the substrate while feeding as suggested by Keast and Webb (1966) for fish with such pectoral fins. The mouth is ventro-terminal and more suitable for a bottom feeder. The mouth gape is moderately narrow in the younger fish but become wider in the bigger ones (Fig. 3). Younger fish feed more on microcrustaceans while the adult exploit the detritus using their shovel-like mouth to explore the substratum (pers. observ.). Although a few of the anterior gill rakers are short and widely spaced. The rest are stiff, filamentous and closely set, especially in the smaller specimens. This forms an efficient sieve typical of plankton/detritus feeders (Suyehiro, 1941) and serves to retain very small food items.

The relative gut index (RGI) of *C. filamentous* from Oguta Lake was in the range 1.4–2.3 (mean 1.9) for fish of 8.6–19.3 cm standard length.

The RGI is typical of an omnivore. Piscivores have low RGI (0.6–1.0) while herbivores have larger values of 2.9–8.1 (Odum, 1968). *C. filamentosus* in Oguta Lake appears adequately preadapted for the omnivorous/bottom feeding habits which it shows.

Table 4. Diurnal variation in the frequency of occurrence of the stomach contents of *Chrysichthys filamentosus* from Oguta Lake. Total sampled=212, Day=107, Night=105.

	Number		Percent	
	Day	Night	Day	Night
Detritus	43	40	40.2	38.5
Sand	5	7	4.7	6.7
Diatoms	5	9	4.7	8.7
Vegetable matter	10	14	9.3	13.5
Nematodes	11	11	10.3	10.6
Crustacea				
Copepoda	30	26	28	25
Cladocera	13	22	12	21.2
Ostracoda	41	30	38.3	28.8
Insecta				
Chironomid larva	28	35	26.2	33.7
Chironomid pupa	2	1	1.8	0.9
Chaoborid larva	43	42	40.2	40.4
Trichoptera larva	18	7	16.8	6.7
Odonata nymph	6	7	5.6	6.7
Ephemeroptera nymph	6	8	5.6	7.7
Pisces				
Fish bone	2	1	1.9	0.9
Fish scales	3	4	2.8	3.8
Fish eggs	1	0	0.9	0
Unidentified	1	1	0.9	0.9

Discussion

Insect larvae, detritus, crustaceans, molluscs, vegetable matter and young fish have been variously reported as major food items of *Chrysichthys* in many African and Nigerian freshwater systems. Although the diet had a lot of animal component and some other items like diatoms were probably fortuitous, the *C. filamentosus* of Oguta Lake is an omnivore. Such a habit has been reported by some previous workers on the genus, e.g. Petr (1972), Turner (1970), and Ajayi (1972). A few workers like Fagade and Olaniyan (1973) and Bakare (1970) suggest a more restricted food spectrum for *Chrysichthys*. Sandon and Tayid (1953) reported the food of *C. auratus* as consisting mainly of young fish and vegetable matter in the River Nile, while in the River Niger Imevbore and Bakare (1970) found that bivalve molluscs (Sphaeridae) and caddisfly larvae (Trichoptera) were the major food items of the same species. Fagade and Olaniyan (1973) found mainly bivalve and gastropod molluscs as food of *C. nigrodigitatus* in Lagos lagoon; a system which has a rich molluscan fauna in its macrobenthic community (Oyenekan, 1975). Ajayi (1972) described *C. auratus* of Lake Kainji as an omnivore incorporating a wide variety of food items such as detritus, ostracods, chironomid larvae and mayfly nymphs into its diet. In the same study, *C. nigrodigitatus* was reported to feed mainly on detritus, trichopteran nymphs, bivalve molluscs and chironomid larvae. For the only available study which is based on *C. filamentosus*, Ikusemiju and Olaniyan (1977) found mostly ostracods, cladocerans and chironomids in their diet in Lekki lagoon; closely resembling the result reported in this study.

The picture emerging from the above review, is that nearly all the *Chrysichthys* so far reported are basically bottom feeders. The presence or predominance of a food item is more of a function of their occurrence in the benthos than of the preference or selectivity by these bagrids. Noteworthy about the Oguta Lake *C. filamentosus* is the absence of molluscs. This component is completely absent in the profundal benthos of the lake (personal observation). In the brackish waters of Buguma, in the southeastern limit of the Lower Niger Delta, the food of *C. nigrodigitatus* consists mainly of molluscs, big decapod crustaceans (*Sesarma* crabs) and nereid polychaetes (Erondu, 1984, unpublished report). These food items are the most obvious benthic fauna in brackish waters of coastal Nigeria.

The change in diet associated with increase in size has been reported in *Chrysichthys* (Ajayi, 1972; Ikusemiju and Olaniyan, 1977). According to Ajayi (1972), young *C. auratus* relied on fish remains, copepods and ostracods while the adults consumed large quantities of detritus, bivalves and vegetable matter. Ikusemiju and Olaniyan (1977) however, reported no differences in the diet associated with increase in size in *C. nigrodigitatus* in Lekki lagoon but noted that the young consumed more crustaceans than the adults. This size differentiation in the degree of exploitation of a range of food resources is of immense advantage in the reduction of intra-specific competition in the population.

The seasonality associated with feeding in this study is also a feature of *C. auratus* in Lake Kainji (Ajayi, 1972). Several reasons can be advanced for the decline in feeding intensity observed from August to October. This is a period when many tropical species, including *Chrysichthys* spawn (Daget, 1954; Reed *et al.*, 1967; Welcomme, 1969). Spawning activities and probably, eventual parental care leaves little time for feeding. Another related explanation has to do with the physical space in the body cavity available for the stomach at the spawning period. In females, the large ovaries may only leave a little space for food in the stomach. Willoughby (1974) also reported decreased feeding intensity in *Synodontis schall* (Mochokidae) in Lake Kainji during the breeding season.

The variability in the composition of the diet in the *Chrysichthys* in Oguta Lake appears to be dictated by changes in food availability than by mere seasonality of preference as discussed in the first paragraph of this discussion. For instance, vegetable matter showed high coccurrence in the diet during the flood season when the bank macrophytes are drowned. In addition, most of the animal components may probably become more difficult to detect due to increased turbidity and larger water volume during this period. This reasoning is more plausible for the younger *C. filamentosus* than for the larger fish.

It may be concluded that the feeding habits of *C. filamentosus* in the southeastern Nigerian lake are similar to those of the same genera in the

southwestern and northern Nigerian freshwater ecosystems. They are largely omnivorous, bottom-feeding fish with a large proportion of animal component and detritus in their diet, and they are adequately pre-adapted for this habit. The composition of the benthic community of the aquatic system is a major determinant in the food spectrum of these bagrids in Oguta Lake as in other systems.

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ナイジェリアのギギ科魚類 *Chrysichthys filamentosus* の食性

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ナイジェリア南部の湖に生息するギギ科魚類 *Chrysichthys filamentosus* の食性を調べた．1 年間に 779 個の胃を調べた結果，主に食べていたのはケヨソイカ科とユスリカ科の幼虫，貝形虫類，橈脚類およびデトリタスであった．大形の個体は昆虫の幼虫を食べていたが，小形の個体は微小な甲殻類を食べていた．湖の水量が多いときには，食べる量は少なかった．食べる量の日変化は殆ど見られなかった．本種は底性の雑食性に形態的に前適応していると考えられる．