Food and Feeding Habits of *Distichodus* Species (Osteichthyes: Distichodontidae) in Anambra River Basin, Nigeria

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Abstract

The food and feeding habits of *Distichodus rostratus, D. brevipinnis* and D. *engycephalus* in Anambra river were studied over a period of 12 months. The stomach contents of 499 specimens were analysed using percentage number (%N) and percentage relative frequency (%RF) methods. The three species are omnivorous bottom and surface water feeders, feeding more on plant materials (seeds, fruits, grasses and filamentous green algae) than on food of animal origin (ants, insects and fish). The stomach fullness analysis showed that 57.3 ± 2.9% (53.8 – 59.5%) of the stomachs examined had food while 42.8 ± 2.9 % (40.8 – 46.2%) were empty. The species fed on the same kinds of food items in slightly varying degrees of % N and % RF. Raabe's coefficient factor (R = 81.0%, %RF; 60.7%, %N) indicated a high degree of similarity in the food preference of the species. The percentage full stomach and partially full stomachs were significantly higher in the rainy season than in the dry season ($P<0.05$) for all the species considering combined sex, male and female respectively, indicating seasonal variation in the feeding pattern of the species.

Key words: Distichodus species, food and feeding, Anambra river

Introduction

Distichodus species are widely distributed in Nigeria, Nilo-sudan, Niger, Volta, Chad and Nile basins (Teugels *et al* 1992). They are used extensively in aquaculture on account of their seeds being readily available in the wild for stocking, good adaptation to climate, ability to support high population densities and to feed on grasses and weeds in ponds (Satia, 1990).

Socio-culturally, "dried" Distichodus fish are widely used in Nigeria to prepare special delicacies used during marriage, naming ceremonies, cultural festivals and entertainment of special quests. The fish are commercially important and are often seen in piles of smoke-cured fishes for sale (Teugels, *et al.* 1992).

Bakare (1968), Imevbore and Bakare (1970) investigated the food and feeding of non-cichlid fishes of River Niger and reported that *Distichodus* species are herbivorous, feeding on algae and higher plant materials. In lake Kainji, Nigeria the species fed on aquatic and terrestrial plants and algae (Aromowo, 1982). In other tropical water bodies, *Distichodus* species are also reported to be herbivorous in Nile river (Sandon and Tayib, 1953) and in lake Kariba (Bowmaker, 1970). But there have been no studies on the food and feeding habits of *Distichodus* species in Anambra river, inspite of their economic importance. *Distichodus* species constitute important fishery in Anambra river basin and they are widely used in aquaculture. One of the factors that tend to limit the rapid growth of aquaculture in Nigeria is lack of appropriate feed for specific cultured species. Appropriate feeds cannot be formulated without sufficient scientific information on the natural food of the species. The present study is to contribute to the knowledge on the food and feeding habits of *Distichodus rostratus* Gunther, *D. brevipinnis* Gunther, and D. *engycephalus* Gunther in Anambra river, Nigeria, the information of which could be useful in the formulation of appropriate feed for the species in aquaculture.

Materials and Methods

Study area: Anambra river, the study area, is located between latitude 6^0 10' and 7^0 35' and longitude 7^0 40' (Figure 1). The river flows southwards and discharges into Niger river close to Onitsha. The main river channel has a total length of about 207km (Azugo, 1978). The mean temperature during the study period was 26.5^0C (range 25.5 – 31.0^0C). The vegetation in the basin is derived Guinea savannah, but the lentic water bodies in the basin are often fringed with macrophytes *(Pterocarpus spp, Dalbergia spp;*

Jussiaea spp; Vassia cuspidata, Pennisetum spp; Cynodon spp).

The climate comprises a rainy season from April to September with a mean annual rainfall of 180 ± 30 cm (Ilozumba, 1980) and a dry season (October – March). From December to January/February the area is influenced by harmattan (cold, dry North-East trade wind blowing southwards). Our sampling stations were at Otuocha and Ogurugu at the Anambra river (Fig. 1).

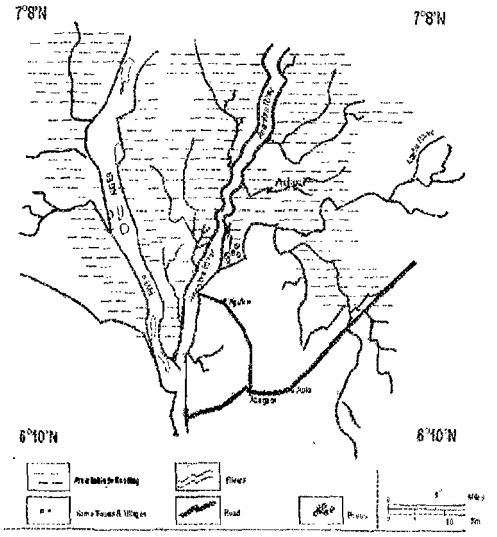

Fig. 1: Map of Anambra river basin showing sampling locations

Sample collection and handling: Fish specimens were collected monthly at Otuocha and Ogurugu between November, 1999 and October, 2000 using set gill nets (2.8, 6.4, 7.8 and 10 cm knot to knot mesh sizes, drag net (3.8 cm mesh size), surface drift net (10.2 cm mesh size) and cast nets (3.8 cm and 5.0 cm mesh sizes). Baskets, traps and hook and line (No. 10 hook) were also used. The gill nets and traps were set between 15.00 and 17.00 hours and inspected the following morning between 07.00 and 09.00 hours. The drift and drag nets, baskets and the hook and line were used during the day (11.00 – 14.00 hours). In addition, fish specimens certified to have been caught from Anambra river were bought from the local fishermen at Otuocha and Ogurugu landing sites. Fish that were not dead at collection were killed in 10% benzocaine solution. The total length (TL, cm), body weight (BW, g), gear and depth of catches were recorded before they were preserved in 10% formalin. For large specimens, 10 ml of 10% formalin was also injected into their guts for better preservation. The fish samples were then taken to Zoology Laboratory at the University of Nigeria, Nsukka for analysis.

In the laboratory, the fish were dissected to remove their stomach. Each stomach was split open, and its contents emptied into the petri-dish to which a small amount of water or 10 ml alcohol was added to disperse the stomach contents. Using a dissecting microscope, the food items were sorted into categories and identified to species level where possible. Relative frequency method (Windel & Bowen, 1978) and numerical method (Hyslop, 1980) were used to analyse the stomach contents. The percentage relative frequency (%RF) was expressed as %RF = 100 $\left(\frac{a_i}{\sum^{n} A}\right)$ (King, 1988). Where RF = relative frequency index, a = frequency of a particular food item and A = frequency of the n^{th} food item. In the numerical method, the number of food types in each stomach was expressed as a percentage of the total number of food items in all the stomachs containing food.

The degree of each stomach's fullness was estimated by visual observation of the stomach's contents (Awachie, 1965), and categorized on a 20 point scale. 20 points for full stomach, 15 points for $^3/_4$ full, 10 points for $^1/_2$ full, 5 points for $^1/_4$ full and 0 point for empty stomach. Partial stomach fullness was obtained as the sum of the $^3/_4$, $^1/_2$ and $^1/_4$ stomach fullness. Raabe's coefficient factor (R) was used to compare the food similarity and preference of the species (Hallowell, 1978) and was calculated as R = ∑min (a, b, c ..... n), where R = Raabe's coefficient factor, min (a, b, c...n) = minimum % of food common to all the species. Students't-test was used to compare the monthly and seasonal levels of stomach fullness of the species (Sachs, 1972).

Results

Stomach fullness: Table 1 shows the overall stomach fullness in the three species of *Distichodus* studied. Of the169 *D. rostratus* (120 – 330 mm TL) examined, 26 (15.39%) had full stomachs (FS), 65 (38.46% had partially-filled stomachs (PS) and 78 (46.15%) had empty stomachs (ES). For 167 *D. brevipinnis* (125 – 264 mm TL) examined for food, 31(18.56%) had FS, 66(39.52%) PS and 70(41.92%) had ES. On the other hand, the 163 *D. engycephalus* (95-85 mm TL) stomachs examined, 26(15.92%) were full (FS), 71(43.59%) were partially-filled, and 66(40.49%) were empty.

Table 1: Stomach fullness of *Distichodus* species of Anambra river

	D. rostratus	*D. brevipinnis*	*D. engycephalus*
Full stomach (FS)	26 (15.39%)	31 (18.56%)	26 (15.92%)
Partial stomach fullness (PS)	65 (38.46%)	66 (39.52%)	71 (43.59%)
Empty stomach (ES)	78 (46.15%)	70 (41.92%)	66 (40.49%)
Number examined	169	167	163

Table 2: Food of *Distichodus* spp by percentage number (%N) and percentage relative frequency (%RF)

Food item	*D. rostratus*		*D. brevipinnis*		*D. engycephalus*	
	%N	%RF	%N	%RF	%N	%RF
Animal components						
Fish scale	4.30	6.0	2.70	4.0	6.77	3.8
Ants	3.30	5.5	4.43	6.4	7.35	6.4
Insect parts	2.05	4.2	3.56	4.0	7.96	7.0
Coleoptera	0.98	2.1	3.04	3.7	3.05	3.0
Plant components						
Fruits & seeds	10.95	14.2	15.12	15.6	20.46	10.2
Ceratophylum	-	8.9	-	8.8	-	7.2
Oryza Longiostaminata	20.57	10.9	34.75	15.8	27.23	18.8
Echinoclea spp	51.63	16.5	30.75	14.3	14.98	17.7
Spirogyra spp	4.33	11.8	3.30	6.4	7.64	9.3
Zygnema spp	1.82	20.0	2.25	21.0	4.61	16.6
Total	**1317**	-	**1151**	-	**694**	-
Number examined	**169**	**169**	**167**	**167**	**163**	**163**
Number with empty stomach	**78**	**78**	**70**	**70**	**66**	**66**
Number with food in stomach	**91**	**91**	**97**	**97**	**97**	**97**
Food categories		**10**		**10**		**10**
Raabe's coefficient factor (R) = 60.7% (%N); 81.0% (%RF)						

Seasonal variation in stomach fullness: Figure 2 shows the seasonal variation in the stomach fullness of the three *Distichodus* species. The percentage empty stomach (%ES) was significantly higher (P>0.05) in the dry season (October – March) than in the rainy season (April – September) for all the species considering combined sex, male and female respectively. Similarly, the percentage full stomach (%FS) both in the combined sex, male and female specimens in all the species was significantly higher (P<0.5) in the rainy season than in the dry season (Fig. 2). Furthermore, the percentage of partially-filled stomach (%PS) for the combined sex individuals in the rainy season was not different from that in the dry season in *D. brevipinnis* and *D. engycephalus* but in *D. rostratus* the % PS was higher in the rainy than in the dry season. In male *D. rostratus* and *D. brevipinnis* the %PS was higher (P<0.05) in the rainy season than in the dry season, while in *D. engycephalus* there was no significant difference. Females of *D. brevipinnus* and *D. engycephalus* showed no significant difference in %PS between the seasons, while in the females of *D. rostratus* the %PS was higher (P<0.05) in the dry season than in the rainy season (Fig 2).

Food composition: The major food items consumed by *Distichodus* species are presented in Table 2 as percentage number (%N) and percentage relative frequency (%RF). A total of 1317 food items were recorded in the stomachs of *D. rostratus*. Of this, food of plant origin accounted for 89.2% by percentage number (%N) and 82.17% by percentage relative frequency (%RF), while food of animal origin accounted for 10.8% (%N) and 10.6% (%RF) (Table 2). The most numerous food items among the plant materials recorded by percentage number were *Echinoclea spp* (51.63%), *Oryza longiostaminata* (20.57%), fruits and seeds (10.95%) and *Spirogyra spp* (4.33%). Considering percentage relative frequency analysis, these food items were recorded as 16.5%, 0.90%, 14.2% and 11.80% respectively. The food items of animal origin encountered were fish scales 4.3% (%N) and 6.0% (%RF), ants 3.30% (%N) and 5.5% (%RF), insect parts 2.05% (%N) and 4.2% (%RF) (Table 2). *Distichodus brevipinnis* fed more on food of plant origin 86.19% (%N) and 78.5% (%RF) than on food of animal origin 13.81% (%N) and 18.1% (%RF) (Table 2).

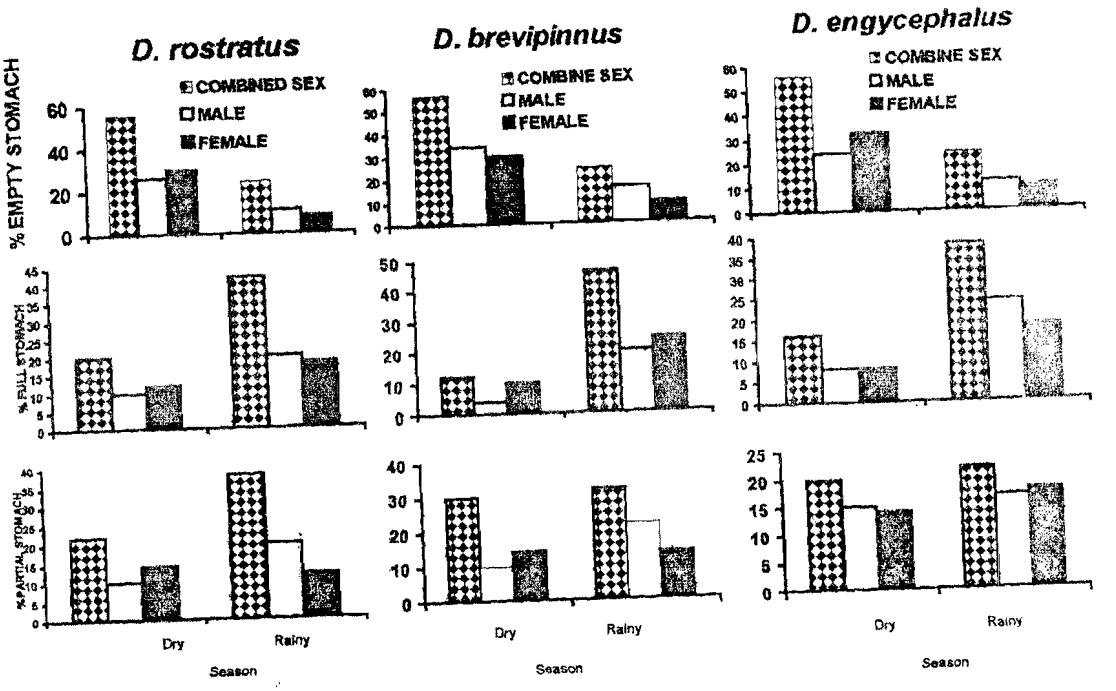

Fig. 2: Seasonal variation in feeding intensity of *Distichodus* species.

The common plant materials recorded were Oryza *longiostaminata* (34.75%, %N) accounting for 15.8% by %RF, *Echinoclea spp.* (30.75%, %N; 14.3%, %RF), fruit and seeds (15.12%, %N; 15.60%, %RF) while *Zygnema spp* occurred the least in terms of %N (2.25%) but was the most frequently encountered food item (21.0%) in the diet of the species. Ants dominated the animal component of the food items both in %N (4.43%) and %RF (6.4%) followed by insect parts (3.56%, %N; 4.0%, %RF) while fish scales had 4.0% (%RF) and 2.7% (%N) (Table 2).

Food of plant origin dominated the diet of *D. engycephalus* (74.92%, %N; 79.8%, %RF) while food of animal origin accounted for only 25% (%N) and 20.2% (%RF). Among the plant materials, Oryza *longiostaminata* had the highest %N (27.23%), while *Echinoclea spp* were the most frequently encountered food items (17.7%). Fruits and seeds had 20.46% (%N) and 10.2% (%RF). Insect parts were the dominant animal components in the diet of the species both in %N (7.96%) and %RF (7.0%) followed by ants (7.35%, %N; 6.4%, %RF) and fish scales (6.77%, %N' 3.8%, %RF) (Table 2).

Competition for food among the *Distichodus* species: It was observed from the analysis of the stomach contents that the three species of *Distichodus* fed almost on the same food items with slightly varying degrees in number and frequency. The number of food categories was 10 in all the species. The high values of Raabe's coefficient factor (R=81.0%, %RF and R=60.7% (%N) suggest a strong similarity in the food preferences of the three species in Anambra river (Table 2).

Discussion

Distichodus species of Lake Kainji are surface water dwellers (Aromowo, 1982) whereas in River Niger they are, bottom dwellers (Bakare, 1968). In the present study the fish were caught in the cast nets and surface drift nets as well as in deep set gill nets, drag nets and in traps indicating that they inhabit the bottom as well as the surface water of Anambra river. They are omnivores, feeding predominantly on plant materials. Seasonal variation in the stomach fullness among the studied species indicated a higher feeding activity during the rainy season than in the dry season. During the rainy season allochthonous food materials and minerals are washed from the adjoining land into the system by flood. This tends to increase the feeding propensities of many fishes (King, 1989).

Aromowo (1982) noted some seasonal variation in the food preference of *Distichodus* species of lake Kainji with respect to high water level (September -April) and low water level in the lake. *D. rostratus* fed more on grass during

high water and more on decaying plant materials and epiphytic algae at low water. *Distichodus brevipinnis* exhibited a similar seasonal variation in its diet. It fed mainly on submerged grass, leaves and stems during high water and on grass mixed with epiphytic algae during low water. However, Ezenwaji and Inyang (1998) did not observe any seasonal difference ($P<0.05$) in the feeding intensity of another teleost, *Clarias agboyiensis* Sydenham inhabiting Anambra flood river system, Nigeria. On the other hand, Nwadiaro and Okorie (1987) observed peak feeding intensity in *Chrysichthys filamentosus* Daget of Oguta lake during the months of March to May (dry season). Olatunde (1978) noted that the highest feeding intensity in *Eutropius niloticus* Rupell in lake Kainji, Nigeria, was between November and December. These findings suggest that the feeding intensities of fishes vary according to species and the environment in which the species live. *Distichodus* in River Niger fed on aquatic and terrestrial plant materials and algae (Reed *et al* 1967, Bakare, 1968, Imevbore and Bakare, 1970 and Welcomme, 1985). These reports agree with our findings on the food of *Distichodus* species of Anambra river. Although Aromowo (1982) reported that *Distichodus* species of lake Kainji were exclusively herbivorous, and Satia (1990) noted that the species feed on grasses and weeds in ponds, the present study shows that *Distichodus* species of Anambra river are omnivorous; apart from feeding on plant materials, they also fed on food of animal components (ants, insects and fish scales). This observation agrees with the report of Medani (1988) that *Distichodus* species of Jabel-Aulia lake, Sudan, also fed on fish scales, ants and insects. Daget (1953) reported that *D. engycephalus* is the least vegetarian among other *Distichodus* species by feeding on ants and Tilapia fish scales. In the present study *D. engycephalus* was found to feed on slightly more food of animal origin than the other two species (Table 2).

Analysis of the stomach fullness indicated that 57.2 ± 2.9% (range 53.8 – 59.5%) of the stomachs examined had food items, while 42.8 ± 2.9% (range 40.5 – 46.2%) were empty. A number of factors could account for a high percentage of empty stomachs in a population. It could be attributed to the feeding pattern of the fish and the time of their capture. Fish captured during their non-feeding period may have a high percentage of empty stomachs. It could be as a result of a high rate of digestion between the feeding and harvest time. It could also be as a result of non-availability of food resource in the environment.

Most of the specimens for the present study were caught in the set gill nets and traps at night and in the cast and drift nets during the day. The high percentage of the empty stomachs (42.8 ± 2.9%) observed could be attributed to the feeding pattern of the fish. According to Aromowo (1982), *Distichodus* species of Lake Kainji did not feed at night. They fed more in the evening until dusk and less during the day. This may probably explain the high percentage of empty stomachs observed in the present study.

The high values of Raabe's coefficient factor (R=81%, %RF; 69.7%, %N) indicated a strong similarity in the diet of the three species studied. A strong similarity in the diet of two or more species in an area could give rise to inter-specific competition and this in turn could generate diversification in the food items eaten by the competing species as a response to the competition. In the present study, there was no marked diversification in the food items consumed by the three species (10 food categories in each species) (Table 2). The non-diversification in the food items of the species could suggest that the fish might not have competed keenly for the rich and abundant fish food in Anambra river basin (Ezenwaji, pers. comm.).

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