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FOOD AND FEEDING HABITS OF *DISTICHODUS ENGYCEPHALUS* (BOULENGER, 1907) OF LAKE OGUTA: SEARCH FOR A SUSTAINABLE AQUACULTURE IN THE NEW MILLENNIUM

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Abstract

Food and feeding of *Distichodus engycephalus* (Boulenger, 1907), a potential culturable fish from Lake Oguta was investigated between March 2003 and October 2004 using the frequency of occurrence and numerical methods. *D. engycephalus* was found to be a herbivorous fish. Diet comprised of organisms from seven food taxa, including filamentous green algae (31.2% by bulk), higher plants (22.0%), detritus/mud (13.0%), unicellular green algae (9.6%), diatoms (6.7%); cyanophyceae (6.0%) and rotifera (3.5%). Filamentous algae and macrophytes were the most important dietary items and occurred in 98% of the stomachs with food. Changes in feeding pattern were observed as the fish matures, with the young fish showing marked preference for diatoms (41.0%) and unicellular algae (23.0%). Feeding adaptations include muscular oesophagus, reduced stomach and elongated intestine. The implications of these in the formulation of artificial feed for cultured species and in sustainable rural aquaculture in the new millenium are discussed.

Key words: Food and feeding habits, *D. engycephalus*, sustainable aquaculture.

Introduction

Dramatic decline in capture fisheries potentials and massive campaign by the Imo State Directorate of Employment to popularize fish farming as a gainful self-employment have resulted in a shift of emphasis in resource allocation from capture fisheries to small scale aquaculture. *Distichodus engycephalus* (Pisces: Distichodontidae), a non conventional culturable fish is one of the (potential) species considered for use in rural aquaculture.

Potential attributes of the fish (Njoku, and Ejiogu, 2005) as confirmed from culture trials include availability locally, ability to reproduce in captivity, acceptance of artificial (supplementary) food, resistance to diseases and parasites and fast growth rate.

Distichodontid fishes are the most important commercially exploited stocks in Lake Oguta, comprising more than 56.01% by weight of the total gill net fishery (Nwadiaro, 1989). Distichodus species are among the fishes rated as fish grade A (Njoku, 1991) based on popularity, table size and accruable farm- gate price.

However, a successful culture of the Distichodontid fish (locally called Ota-afifia) will require a good knowledge of the food and feeding habits of the species.

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The study of food and feeding habit, according to Ayinla, (1988) and Kateyo *et al.* (2007) is important in guiding fish culturists in the choice of feedstuff to be used in compounding the artificial diets of cultured species for optimal production.

In the present study, the food and feeding habit of *D. engycephalus* of Lake Oguta is investigated using the frequency of occurrence and numerical methods. It is hoped that the resulting information will not only help in the on-going campaign to popularize fish farming as a gainful employment, but also contribute to the dietary knowledge of the potential culturable fishes for a sustainable rural development and for the attainment of the millenium development goals in food sufficiency and responsible fisheries.

Materials and method

Study area

Lake Oguta (Fig. 1) is located in Oguta Local Government Area of Imo State, Nigeria, between latitude 5°41′ and 5^0.44’ of Equator and longitude 6^0.56’ and 6^0.45’ East of Greenwich meridian. The lake is the longest natural water body in the Anambra/Imo River Basin in South Eastern Nigeria. The lake has a dry season surface area of 1.80 km at peak flood around October, and a mean depth of 5.5m. The water body which is linear in shape is fed mainly by the Njaba and Obana Rivers. The lake empties itself into the River Niger drainage system through River Orashi. The physico-chemical characteristic of the lake has already been reported (Odigi and Nwadiaro, 1988).

Fish sampling and analysis

Fish sampling was done on monthly basis. A minimum of 25 specimens comprising the various size groups of *D. engycephalus* were analyzed per month. Each Station was simultaneously fished with three categories of fishing gear, namely, cast nets, surface- set gill nets, and bottom-set gill nets. After capture, the fish were immediately identified with the aid of a combination of keys provided by Gunther (1966) and Leveque *et al.* (1996). Thereafter the specimens were transported to the laboratory in 10% formalin for analysis.

Stomach content analysis

Standard methods described by Sarker *et al.* (1980) and Adite *et al.* (2005) were adopted for stomach contents analysis. Immediately after capture, the fish were killed in ice to prevent regurgitation. They were then measured, weighed and dissected to extract the stomach which was stored in 5% formalin, or the whole fish was orally administered with 10% formalin to prevent post mortem digestion (Sarker *et al.*, 1980) and then taken to the laboratory for examination. The foods of *D. engycephalus* were evaluated both quantitatively (number of organisms) and qualitatively (types of organisms). A combination of frequency of occurrence and numerical methods were adopted in the analysis of the stomach contents. This is to eliminate the inherent bias in the use of one analysis method.

The food items were separated by taxa and identified down to species level and in some cases to higher taxonomic levels. After dissection, the contents of the stomach were placed in separately labeled Petri dish and the food item examined under the microscope and classified. Counts were made of the number of different food categories. Ward and Whipple (1959) and Prescott (1978) were used for the identification of the food organisms. A checklist of the food items encountered in the stomach was then prepared.

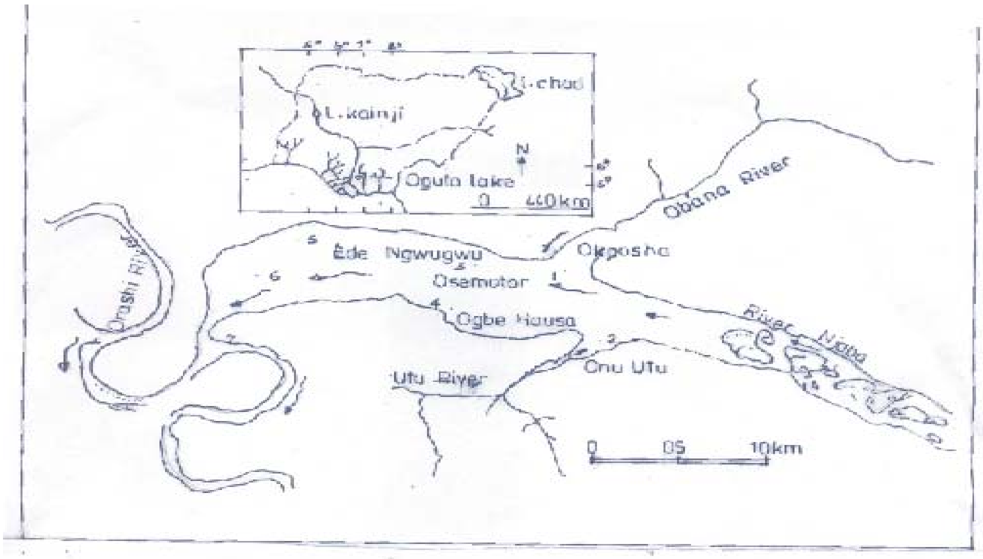

Fig. 1. Map of Lake Oguta showing the associated Rivers and sampling stations.

(i) Frequency of occurrence method: The frequency of occurrence method (Hyslop, 1980), was used in assessing the food and feeding habit of the fishes. The number of stomachs containing one or more individuals of each food category (or taxum) was recorded. This number was then expressed as a percentage of all stomachs containing food.

(ii) Numerical method: Numerical analysis followed the method described by Sarker *et al.* (1980). The stomachs were removed and the contents extracted, blotted dry and weighed on a mettler analytical balance to the nearest 0.1mg for small extracts and with Ohms triple beam balance for big samples. The stomach contents were subsequently preserved in individually labeled Petri dish containing 10 ml of 5% formalin.

For microscopic examination, the content of each Petri dish was agitated. Drops were taken out with a dropping pipette and diluted to aid identification and counting. For each sub sample (i.e. dish representing one fish), three drops were taken on a haemacytometer slide, a counting chamber with each cell or division measuring 0.2mm × 0.0025mm, and the contents examined. This procedure was repeated three times. The individual food items found in the 64 cells of the haemacytometer slide were enumerated with the aid of tally counter by counting only 25 cells and multiplying 64 by the average count of the 25 cells. The mean number of food counted (average of the 64 cells) was multiplied by the haemacytometer factor (× 4000) to obtain the equivalent number of that organism in 1ml volume of the stomach contents. The total number of the same food item (e.g. *Chlorella species*) in the 10ml food sample was consequently determined by multiplying the number of each food organism counted in 1 ml (or 1mm^3) sample by 10. Results were expressed in relative diet composition.

Dietary changes with fish size

Dietary changes with fish size of *D. engycephalus* were investigated with individuals belonging to two size groups of 6-14cm and 24-34 cm total length. The frequency of occurrence method was adopted for this evaluation in accordance with Arawomo (1976) and Adite *et al*. (2005).

The monthly variation in mean stomach repletion or fullness was determined with reference to records of stomach contents of the fish analyzed on monthly basis during the annual cycle.

The relative gut index (feeding habits)

The Relative Gut Index, RGI. (Odum, 1968) which is the ratio of the gut length to the standard length of the fish was used as an index for placing the fish in the appropriate feeding habit. The parameter was calculated as follows:

$$RGI = \frac{\text{Gut length (cm)}}{\text{Standard length (cm)}}$$

$$RGI = \text{Gut length}$$

Results

Dietary composition of *D. engycephalus*

Table 1 summarizes the results of stomach content analysis of *Distichodus engycephalus* of Oguta Lake. A total of 465 specimens were examined out of which 387 (83.2%) stomachs contained food. The dominant food were plant matter, phytoplankton, detritus, diatoms and rotifers. Plant matter was encountered in as much as 98% of the stomachs with food, contributing some 22.0% to the bulk of food consumed by the fish. Spirogyra sp. occurred in 48% of the stomachs and accounted for 10% of the diet.

Oedogonium, which was encountered in 82% of the stomachs, amounted to 10% of the fish diet; Zygnema appeared in 55% of the stomachs and contributed 7% of the total bulk of the food list. Others are Ulothrix (60% and 4.2%) in terms of frequency of occurrence and diet composition respectively; Nitzschia (0.9% and 3.80%), Closterium (12% and 3.0%), Scenedesmus (3.0% and 2.3%), Microcystis (4% and 3.0%) and Spirulina (10% and 3.0%). On the whole, *D. engycephalus* fed on organisms belonging to seven food taxa. Filamentous green algae (Chlorophyceal) was by far, the most dominant food of the species, accounting for 31.2% of the fish diet, followed by higher plants (22%), detritus (including sand and mud), 13%. Others were unicellular green algae (Chlorophyceal), 9.6%, diatoms (6.7%), blue- green algae (Cyanophyceae) 6.0%. Rotifera (3.5%) was the least contributor.

Ontogeneric variation (change with age) in dietary items

Figure 2 shows the results of the ontogeny and the dietary pattern of *D.* engyceprialus. The young (6-16cm TL) and the adult fish (24-34cm TL) fed on the available seven food categories, but the young individuals fed more on filamentous green algae (11%) than the adult fish (8%) in addition to diatoms (41%) and unicellular green algae (23%).

Feeding structures adaptations and habits

Table 2 shows the gut/ standard length ratio of *D. engycephalus* of Oguta Lake. This ratio, known as the Relative Gut Index (RGI) is a bionomic factor for assigning fish species to specific feeding habits. The observed value (3.2) was compared with data reported by Arawomo (1976) for other herbivorous fishes (Table 2).

Discussion

Diet composition of *D. engycephalus*

The findings revealed that *D engycephalus* is a herbivorous fish, feeding principally on aquatic macrophytes and algae. Other food items, such as diatoms (6.7%), rotifers (3.5%) and detritus (13.0%) are mere incidentals in the diet.

This observation is in agreement with the findings of Bakare (1970) in River Niger, Arawomo (1976, 1982) in Lake Kainji and Adite *et al.* (2005) in Benin Republic. The herbivorous feeding habit of the fish probably explains why the fish exclusively inhabits the vegetative on-shore areas of the lake (Nwadiaro, 1989) which serve as shelter and food.

Changes with age in diet and food habit

Investigations on the ontogeneric changes in foods and feeding of the species revealed that both the young fish and adults fed on the same food items grouped into seven (7) taxa, but at different degrees. Whereas the adult fish fed more on aquatic macrophytes and filamentous algae, the young fish preferred diatoms (41.0%) and unicellular algae (23.0%).

Table 1. The food items of *D. engycephalus* from Oguta Lake (No. Examined = 465).

Food Items	Frequency of occurrence method		Numerical method		
	No. of Fish (Stomachs)	Percentage Frequency	Number of Food Items (millions)	Relative Number (%)	Diet Composition (%)
SAND, MUD AND DETRITUS	147	38.0	–	13.0	13.0
HIGHER PLANTS					22.0
Dead plant matter	379	98.0	4620	22.0	22.0
BLUE- GREEN ALGAE (CHLOROPHYCEAEA)					6.0
Gleocapsa	–	–	–	–	–
Microcystis	16	4.0	308	2.0	2.0
Oscillatoria	31	8.0	154	1.0	1.0
Spirulina	39	10.0	462	3.0	3.0
UNICELLULAR GREEN ALAGE (CHLOROPHYCEAE)					9.6
Crucigenia	43	11.0	15	0.1	0.1
Scenedesmus	12	3.0	354	2.3	2.3
Chlorella	8	2.0	246	1.6	1.6
Eudorina	23	6.0	231	1.5	1.5
Closterium	46	12.0	462	3.0	3.0
Cymbella	4	1.1	15	0.1	0.1
Staurastrum	15	4.0	92	0.6	0.6
Pediastrum	19	5.0	46	0.3	0.3
Characium	8	2.0	15	0.1	0.1
					31.2
FILAMENTOUS GREEN ALGAE	232	60	647	4.2	4.2
(CHLOROPHYCEAE)	317	82	1540	10.0	10.0
Ulothrix	213	55	1078	7.0	7.0
Oedogonium	186	48	1848	12.5	12.5
Zygnema					
Spirogyra					
					6.7
DIATOMS (BACILLARIOPHYCEAE)					
Navicula	11	2.8	15	0.11	0.11
Nitzschia	3	0.9	13	0.10	0.10
Asterionella	12	3.0	39	0.30	0.30
ROTIFERA	23	6.0	323	2.1	3.5
Keratella	50	12.8	185	1.2	2.1
Branchionus					1.4
UNIDENTIFIED	76	19.6	–	–	–

* Empty stomachs = 78

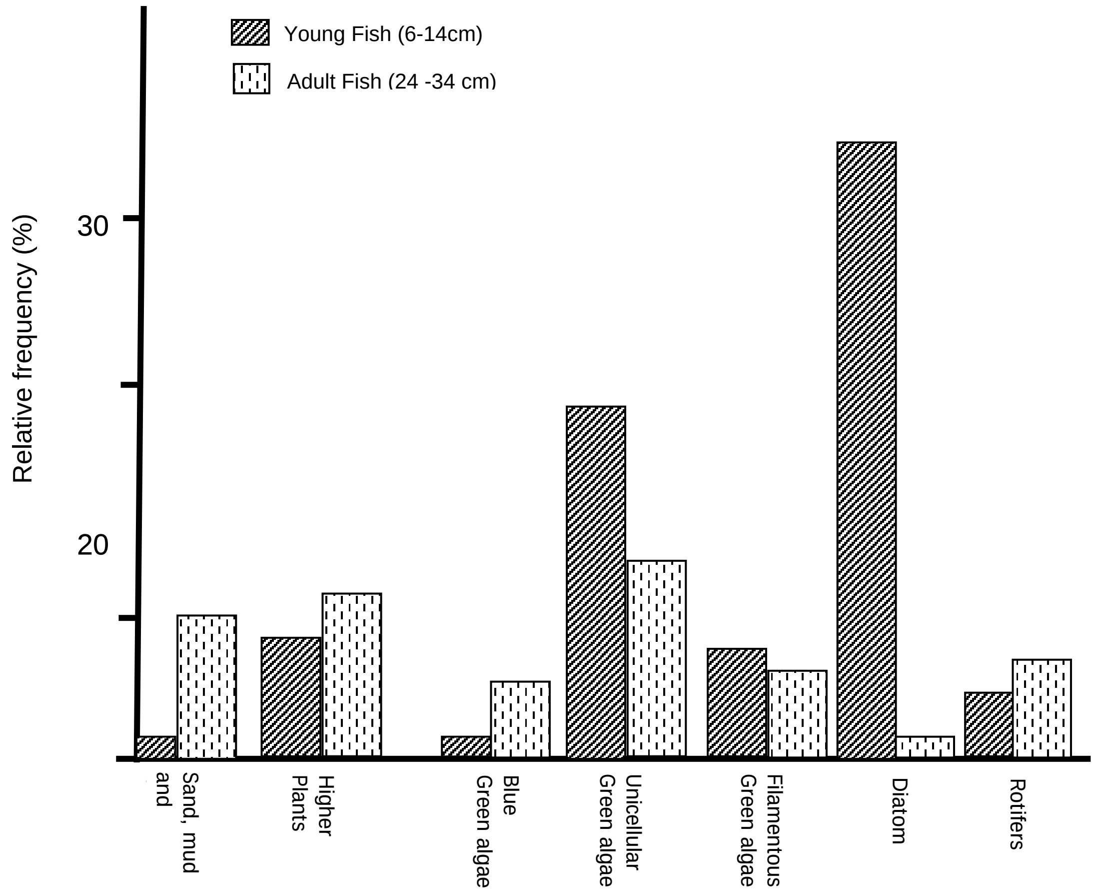

Fig. 2. Relative frequency of occurrence of food taxa in two developmental stages of *D. engycephalus* of Oguta Lake (N= 515)

Table 2. Ratio of Gut Length to Standard Length (Relative Gut Index, RGI) in *D. engycephalus* compared with Arawomo (1976) for similar species in the region

FISH SPECIES		
A: Piscivores (Carnivorous spps)	Arawomo (1976)	This study
Hydrocynus forskali	1.1	-
Lates niloticus	0.6	-
Schilbe mystus	1.2	-
B: Omnivores		
Alestes baremose	1.3	-
Alestes dentex	1.4	-
Auchenoglanis biscutatus	1.4	-
Auchenoglanis occidentalis	1.5	-
Chrysichthys auratus	2.0	-
C: Herbivores		
Distichodus engycephalus	3.0	3.2
D: Detritus and Alage Feeders		
Citharinus citharus	6.7	-
Citharinus latus	8.1	-
Citharinus distichodoides	5.5	-
Tilapia galileaus	7.5	-

Though current repots are not available for comparison, the observation agrees with Bakare (1970) on *Distichodus engycephalus* of River Niger and Campbell *et al.* (2005) on Nilotic Ichthyfauna of Uganda. The observed dietary changes with fish size in *D. engycephalus* also conform to documented reports on other species. For example Ikusemiju and Olaniyan (1977) noted that the young of *Chrysichthys auratus* fed on copepods and ostracods while the adults consumed detritus and vegetable matter. This is also true of *Malapterurus electricus* (Olatunde, 1984) in which fishes below 20.0cm standard length depended on detritus while adults above 20.0cm were mainly piscivorous.

Feeding habit and adaptations

The observed Relative Gut Index (RGL) of 3.2 further confirms *D. engycephalus* as a herbivorous fish. This value falls within the range (Odum, 1971) for herbivorous species. Arawomo (1976) recorded RGI values of 2.9 – 3.1 in similar species of Lake Kainji and concluded that they were herbivores. The observed feeding adaptations (short and muscular oesophagus, pharyngeal teeth, small stomach, and elongated intestine) have been described as dietary modifications for herbivorous feeding and agree with observations of Arawomo (1982) in Lake Kainji. Lagler *et al.* (1977) posits that the numerous pyloric caeca are devices to increase the surface area available for intestinal digestion of cellulose materials and absorption.

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