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FOOD AND FEEDING HABITS OF SOME FISH SPECIES IN OGUN STATE COASTAL ESTUARY, OGUN STATE, NIGERIA

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ABSTRACT

The food and feeding habits of eight (8) fish species *Elops lacerta, Chrysichthys auratus, Schilbe mystus, Sardinella maderensis, Synodontis schall, Hepsetus odoe, Tilapia zillii* and *Mugil cephalus* in Ogun estuary, Ogun State, Nigeria were studied and estimated for six months, between February and July, 2014. A total of 470 fishes were randomly collected from the commercial fishermen during the study. Results from the stomach contents analysed using frequency of occurrence and numerical methods showed that *S. mystus*, *E. lacerta*, *S. maderensis*, *H. odoe*, *S. schall*, *T. zillii, M. cephalus* and *C. auratus* were predators, piscivores, herbivores, piscivores, omnivores, herbivores, herbivores and omnivores respectively while *H. odoe* and *S.mystus* partly fed on *E. lacerta* and *T. zillii* respectively. The Diet Breadth (D) ranged from 0.76 to 0.88 and the percentage Gut Repletion Index (GRI), a reflection of frequency of feeding, ranged between 60-100%.

Keywords: Ogun estuary, gut repletion index, food and feeding habit, Ogun state

INTRODUCTION

The study of some of the biology of some fish species with preference to their diet composition is an important aspect in fish biology. Fish digestive system varies with their feeding habits which include; carnivorous, omnivorous, and herbivorous. Fish food varies from seasons to seasons because seasonal changes in temperature influence food consumption as well as the available food organisms, and from species to species. Fish diet has been found to be an important factor governing fish growth, condition factor, fecundity and migration patterns (Rao, 1974; Adeyemi *et al*., 2009a).

Feeding habits of fish provide essential information on bionomics of single species. The analysis of stomach contents in fish is a common method for investigating the diet of fish, and thus describing food chains and webs shared by different species. Such studies also reveal interactions among species (Kenneth *et al*., 2004). Accurate quantification of fish diets is an important aspect of fisheries management (Quinton *et al*., 2007)

Extensive studies have been done on diet composition and trophic ecology of the fish species from different water bodies especially reservoirs, lakes and lagoons. These include: diet and dietary habits of the fish

Schilbe mystus (Siluriformes: Schilbeidae) in two artificial lakes in Southwestern Nigeria by Ayoade *et al*. (2008). Lawson and Aguda (2010) worked on the diet composition ten ten pounder, *E. lacerta* from Ologe lagoon, Lagos, Nigeria. Offem *et al.* (2009) also studied the trophic ecology of commercial fishes in the Cross River, Calabar, Nigeria. The dietary habit of fishes, based on stomach analyses, is widely used in fish ecology as an important method to investigate trophic relationships in aquatic communities. There is dearth of information concerning the diet composition and trophic relationship among fishes in Ogun estuary which may be useful in multispecies ecosystem model, therefore the need for this study. This study was carried out to investigate the diet composition in the stomachs of fishes in the estuary. Information from this study will be useful in defining the predator-prey relationship that exists in this estuarine environment and for identification of stable food preferences.

MATERIALS AND METHODS

The study was carried-out in Ogun State coastal estuary, located between Ogun Waterside and Ijebu-East Local Government Areas of Ogun State, Nigeria. It is situated between 4^{0} 15' E–4^{0} 30' E and 6^{0} 20' N 6^{0} 45' N and bounded in the east by Lekki lagoon and south by Bight of Benin (Figure 1). The lack of direct access to the Atlantic Ocean coupled with the discharge of Rivers Osun, Mosafejo and Oni into the water makes it essentially freshwater (Abdul *et al.,* 2010). Fishing activities are carried out with canoes (motorised and non-motorised). The fishing gears include; gillnet, seine net, cast net, non-return valve traps, brush park fish aggregator and Bamboo traps. Several species of fish are found in the water body and these includes; *Barracuda spp., Hepsetus odoe, Tilapia spp., Sarotherodon galilaeus, Caranx hippo, Parachanna obscura, polypterus, Gymnarchus niloticus, Mormyrus spp., Polupterus spp., Papyrocranus afer, Alestes spp.* and Clupeids.

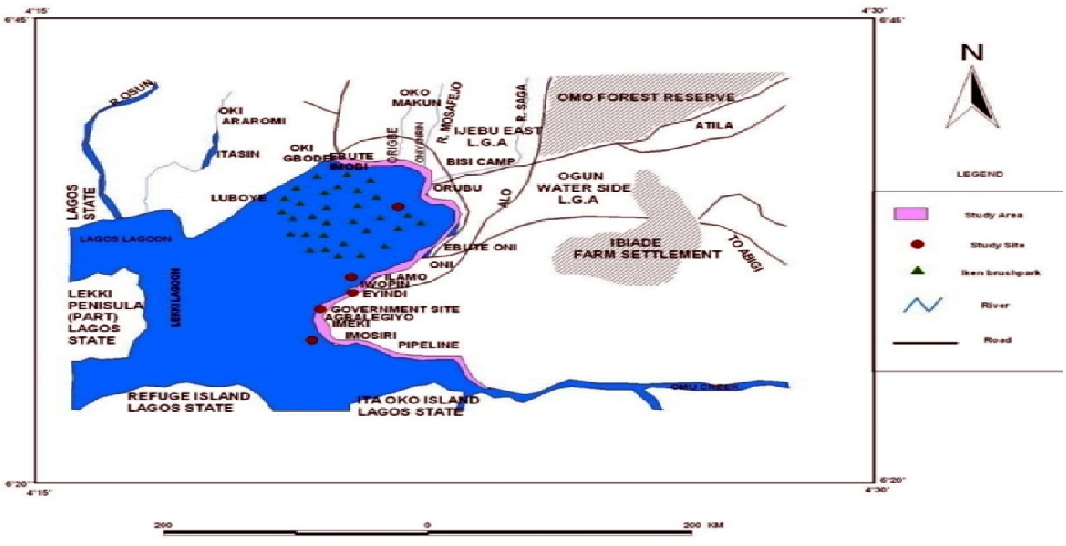

Figure 1: Map of Ogun State coastal estuary
Source: Abdul *et al*. (2010)

Samples collection

A total of 470 fishes were randomly selected from commercial fishermen at four landing sites (Agbalegiyo, Ilamo, Fishery and Wharf). On each occasion, sampling was between 06.45 am and 2.00 pm Fish identification was carried out following the field guide of Nigerian freshwater fishes by Olaosebikan and Raji (1998).

Sample measurements and gut content analysis

Fish total length (beginning of snout to end of tail) (Schineider, 1990) was taken to the nearest 0.1 cm by the use of a measuring board and were recorded for each species. The wet weight of each individual was taken with a weighing balance (Citizen model electronic balance) to the nearest 0.1 g. Fish gut was carefully extracted by opening the abdominal portion of the fish with the aid of a pointed nose pair of scissors. The gut tip of oesophagus to the end of the rectum was carefully removed by use of forceps and weighed. The guts were stored in containers containing 5% formalin and transported to the Department of Aquaculture and Fisheries Management, Federal University of Agriculture, Abeokuta. The preservation of the gut in 5% formalin enhanced the coagulation of the diet components for ease of identification (Longhurst, 1957; Haroon, 1998; Job, 2006).

Analyses of stomach Content

The analyses done on this present study were: Gut Repletion Index, i.e. number of non-empty guts divided by total number of guts examined multiplied by 100. Frequency of occurrence of each food object was obtained by expressing the number of stomach each food item occurred as percentage of total number of stomach. Numerical method in which the number of individual of each food type in each stomach is counted and expressed as a percentage of the total number of food items in the sample studied. Diet Breadth; a measure of the food spectrum as determined by Simpson's diversity index (Simpsons, 1949)

Simpson's index: $D = 1 - \frac{\Sigma n (n - 1)}{N (N - 1)}$

Where N = the total number of occurrence of all food items (in a stomach) and n = the number of occurrence of a food item.

Statistical Analysis

Data collected were subjected to cluster analysis to test the similarity in the feeding habit of the fish species.

RESULTS AND DISCUSSION

The stomach contents of the fishes are presented in Table 1. The categories of food items include, blue-green algae, green algae, diatoms, desmids, rotifer, crustaceans, fish, detritus, insects (Ephemeroptera Nymphs, Megaloptera larvae and Odonata), plant tissue, molluscs. Fingerlings of *Elops lacerta*, *Tilapia zillii* and *Sierrathrissa leonensis* were the fish species fed on by some of the fishes.

The stomach contents of *Chrysichthys auratus* were made of eleven categories which were blue-green algae, green algae, diatoms, desmids, rotifers, crustaceans, fish eggs, fish larvae, detritus, insects, plant tissues and molluscs. Out of the 70 stomachs examined, blue-green algae were the most important food items accounting for 19.51% and 17.67% by numerical and occurrence methods while diatoms were next in abundance with 15.56% and 16.69% by numerical and occurrence method. Therefore, with the result of this investigation, *C. auratus* can be said to be an omnivorous fish species due to the wide range of food consumed. *Chry-*

sichthys species has been regarded as omnivorous detritivores by (Oronsaye and Nakpodia, 2005; Offem *et al.,* 2008 and Yem *et al*., 2009). The morphology of *Chrysichthys* is adapted for bottom feeding although stomach contents may prove otherwise as the variety of food items contained in the stomach of fishes often reflect the ability of fishes to obtain food from different locations. The presence of fish eggs and larvae might be due to the location of the fish, although *Chrysichthys* has been regarded as a carnivore that feeds throughout the water column (Ajani, 2001). The stomach contents of *E. lacerta* were blue-green algae, green algae, diatoms, desmids, rotifer, crustaceans, fish, and unidentified food mass. Fish was the most important food item by numerical method (20.57%) and so also the most frequently consumed food items by frequency of occurrence method (14.54%). Green algae constituted 17.55% and 18.69% by numerical method and frequency of occurrence method respectively. *Sierrathrissa leonensis* and fingerlings of *E. lacerta* were the main food consumed, though *S. leonensis* was more dominant. It is concluded that *E. lacerta* from this study is an opportunistic piscivorous that does not only feed on single fish species. Fagade and Olaniyan (1973) grouped the *E. lacerta* among piscivorous fish that feeds on juveniles of other fish species and crustaceans. Lawson and Aguda (2010) also observed that the fish feed mainly on fish and crustacean (penaeid shrimps), while other food items such as unidentified fish, plant material and juvenile of threadfin fish are in small proportion. Crustaceans and unidentified food items were also observed in this present study, but the presence phytoplankton surpassed as observed in the two methods used. The presence of phytoplankton in their stomachs presumably could be as a result of the fish species consumed and the environment in which they feed. *Synodontis schall* fed on ten major categories of food items. These were blue-green algae, green algae, diatoms, desmids, rotifer, crustaceans, protozoa, insect parts, plant tissue and detritus. Diatoms were the most important food items by both methods 21.57% and 20.49% (Numerical and frequency of occurrence method respectively). From this, it can be inferred that *S. schall* is an omnivorous fish species due to the wide range of food items found in its stomach. Hassan (2007) observed that *S. schall* in the Nile was an omnivorous bottom feeder, where sand, mud and fish remains were present in the stomach. Nnaji *et al.* (2007) emphasized that *S. schall* usually lived on the bottom feeding on molluscs, crustaceans, annelid worms and to lesser extent on algae, fish scales, mud, sand or other things available. Laléyé *et al.* (2006) made similar observation on *S. schall* and *S. nigrita* in Ouémé River, Benin. The fish also exhibits an overlapping food and feeding habits in order to avoid inter- and intra-specific competition for available food. This study indicates that phytoplankton is the most preferred food species in Ogun estuary as it constituted 50% of its stomach content of *S. schall*. *S. schall* does not only subsist on phytoplankton feeder, but it also feeds on a little quantity of zooplankton, like rotifers and crustaceans. The ingestion of detritus has earlier been observed by Patrick-Dempster *et al*. (1993) for *Tilapia* species and carp, indicating that part of the ingested materials came from the bottom of the river. Protozoans that are typical of the estuary bottom fauna were found in the digestive tract of *S. schall* (Olojo *et al.* 2003). The stomach contents of *Mugil cephalus* were blue-green algae, green algae, diatoms, desmids, rotifer, sand particles, plant tissue and detritus. Green algae were the most important food items by numerical method (38.37%) and also were the frequently consumed food items by occurrence method (29.17%). Thus, the fish species is a herbivore considering the large amount of phytoplankton found in its stomach. *M. cephalus* feeds all year round; they are not affected by seasonal changes. Adult striped mullet has been described as herbivorous, detritivorous and "interface" feeders. The diet and feeding behaviour of mullet may vary with location, but their major foods are epiphytic and benthic microalgae, macrophyte, detritus, or inorganic sediment particles (Collins, 1985). Sand grains were also ingested by the fish during feeding as found in the stomach of the fish, and these were also in abundance by frequency of method next to detritus. Thompson (1966) as cited by Wells (1984) agreed that sand grains were found throughout the alimentary canal of mullets, and aided trituration of food in the gizzard-like pyloric stomach. Only trace amounts of rotifers were found in the stomach of this fish species, the presence which presumably might be due to the environment in which they feed.

The stomach contents of *Hepsetus odoe* were made up of six food categories. These were blue-green algae, green algae, diatoms, desmids, rotifers and fish species. Fish species (33.33% and 13.51%) were the most important food items by respective methods (Table 1). This implies that the fish is a piscivorous that feeds on fish. Planktonic organisms encountered in the stomach might probably be the foods of the prey which the fish consumed. This result is in correlation with the work of Adebisi (1981) on analyses of the stomach contents of the piscivorus fishes of the Upper Ogun River. In the study of Elakhame and Sikoki (2003) on this fish in Epie creek floodplain, Niger Delta, Nigeria, 61.6% by numerical count for fish, and fish were dominant while crustaceans and insects followed by 28.9% and 9.5% respectively. This is contrary to this study where fish constituted only 33% of the stomach content. The stomach contents of *Schilbe mystus* comprised of blue-green algae, green algae, diatoms, desmids, rotifers, insect, fish and plant tissue. Insect dominated 29.29% and 25.17% (numerical and frequency of occurrence method respectively). This was followed closely by blue-green algae 20.00% and 19.93% respectively. According to Fagade (1983), fishes that feed on one group of animals other than plant materials or detritus are predators. Therefore, *S. mystus* can be referred to as predator. The presence of fish in the stomach of *S. mystus* might be due to the predatory nature of the fish. The fish feeds mainly on insects; Odonata, Megaloptera larvae, Ephemeroptera, nymphs and other planktonic organisms. The percentage of fish (majorly *T. zillii*) in their stomach is relatively small in proportion (2.81%). Adebisi (1981) found in the diet of the species in Upper Ogun River to be mostly terrestrial insects and *Barbus* spp. Fagade (1983) similarly found that the species fed on odonata nymph, diptera larvae, fish and crustacean in Lower River Benue.

Examination of the gut contents of *Sardinella maderensis* revealed that the species fed mostly on diets from plant origin. This is not in correlation with the study of Curry and Fontana (1988) that described *S. maderensis* as a pelagic species that feed on zooplankton. Kagwade (1963) described *S. longiceps* as chiefly a phytoplankton feeder with diatoms, dinoflagellates and zooplankton appearing in its food throughout the year. The diet components encountered in the gut of *S. maderensis* during the study period include blue-green algae, green algae, diatoms, desmids, rotifers, plant tissue and detritus. From the seven different diet components that were encountered in the gut of the species during the investigation, rotifers and plant tissues had low percentage abundance and phytoplankton dominated the stomach.

The stomach contents of *T. zillii* were made up of eight major food items. These were blue-green algae, green algae, diatoms, desmids, rotifers, crustaceans, plant tissue and detritus. However, green algae were the most important food 44% and 41.42% numerical and frequency of occurrence method respectively items consumed. The high proportion of green algae was as a result of their increase during the rainy season. The preference of *T. zillii* for algae and vegetative matter may be attributed to its ability to secrete mucus from the gills that traps plankton; however, their ability to digest filamentous algae and aquatic macrophytes is through the mechanism of physical grinding of vegetative matter between the two pharyngeal plates of fine teeth and acidic nature (pH < 2) of the stomach which ruptures the cell walls of algae and bacteria (Ugwumba, 1988). Various authors studied the feeding habits of *T. zillii* in different parts of African water bodies and reported its herbivorous feeding nature (Krariman and Nadhan, 2009; Agbabiaka, 2012). The contribution of crustaceans and rotifers were generally low both in percentage by number and in occurrence. Agbabiaka (2012), from his study in River Otamiri categorized that *T. zillii* is an omnivorous fish with dietary preference for algae, vegetative matter, detritus and aquatic invertebrates larvae such as *Chaoborus* larvae *and Chironomid* larvae for juveniles and adult tilapia respectively. The fish utilize various materials found in the aquatic environment, thus can live as herbivore, predator, detritivore as well as planktivore (Brown, 1986). A number of factors are attributable to changes in the feeding habits of fish species. Fryer and Iles (1972) and Jobling (1981) listed the size of the fish, sex, season, water temperature, habitat and competition as some of these factors. Morphological changes in the feeding apparatus of the fish as a result of age may also lead to a change in the feeding habits. As a result of the feeding habits, members of *T. zillii* have been variously classified as plankton feeders, higher plant and algae feeders or macrophagous as well as mud suckers (Fagade, 1971; Brown and Colgan, 1984).

Cluster analysis (Figure 2) showed that *E. lacerta* and *C. auratus*, and *M. cephalus* and *S. maderensis* shared the same feeding arena at high (86%) similarity level. The similarity in food items consumed by *H. odoe*, *E. lacerta* and *C. auratus* was 80% while that which existed among *M. cephalus, S. maderensis* and *T. zillii* was 80%. The food consumed by *S. schall* was 72% similar to what was consumed by *H.odoe, E. lacerta* and *C. auratus,* and it was 68% similar to the food consumed by *M. cephalus, T. zillii* and *S. maderensis*. Least level of similarity was found between *S.mystus* and others, in terms of food and feeding habit. Meanwhile, when numerical data were used (Figure 3), the similarity between *M. cephalus* and *T. zillii* (>90%) was highest followed by that of *E. larcera* and *C. auratus* (85%). The cluster group of *M. cephalus, T. zillii* and *S. maderensis*. had a similarity of 80%, while that of *H. odoe, E. lacerta* and *C.auratus* was between 75-80%. *S. schall* was more similar (70%) to the latter cluster group than *S. mystus* (between 60-65%). The least similarity was observed between the latter cluster group and the cluster group that comprised of *M. cephalus, T. zillii* and *S. maderensis*.

Diet breath is the extent or measure of how broad or wide the food items in the fish are. It measures the distribution of food items available to the fish. The Simpson's index of diversity (1-d) is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. The value ranged between 0 and 1. The greater the value, the greater the sample diversity. The wider food spectrum exhibited by *C. auratus* (D = 0.88), *E. lacerta* (0.86), *S. schall* (0.88), *T. zillii* (0.76), *M. cephalus* (0.83), *H. odoe* (0.83), *S. mystus* (0.83) and *S. maderensis* (0.82) (Table 2) revealed their trophic flexibility (Wooton, 1979; Offem *et al.* 2009). This situation is similar to the observation of Offem *et al.* (2009) where wider food spectra were exhibited by *C. anguillaris* (D = 0.88), *C. nigrodigitatus* (0.86), *Synodontis amias* (0.77) and *O. niloticus* (0.76) in Cross River estuary of Nigeria. Due to high diversity, fishes can switch from one category of food to another in response to fluctuation in their abundance. Another advantage is the ability of the species to utilize many varieties of food effectively (Offem *et al.* 2009).

The Gut Repletion Index (GRI) of 100% (high proportion of the non-empty stomach) was observed in *H. odoe* (Figure 4). This indicates intense feeding activity due to the abundance of food they consumed. King *et al*. (1991) reported that 100% GRI means that the fish are frequent feeders and have higher energy requirement to sustain this level of feeding intensity. High feeding intensity was also observed in other species, *T. zillii* (81%), *S. schall* (86%) and *E. lacerta* (87%), *M. cephalus* (80%), *S. maderensis* (79%), during this study. Others like; *C. auratus* (59%) and *S. mystus* (60%) exhibited moderate feeding intensity. The species relative divergence in feeding intensity among the freshwater fishes reduces interspecific competition for food resources and this is seen to sustain large population of the fish species (King *et al*, 1991; Akpan, 1994). The present information is not in agreement with reports of Offem *et al.* (2009) who observed the 100% GRI in *C. auratus* in Cross river estuary of Nigeria. The low % GRI exhibited by two fishes might also be from their inability to switch diets due to low abundance of food items. Ogbeibu and Ezenuara (2005) reported that seasonal diversity of food items could influence food habits, diet and feeding intensity of fish. This, invariably, calls for close monitoring of the populations of *C. auratus* and *S. mystus* in Ogun estuary for sustainability. Low GRI (%) might also be as a result of inverse relationship between feeding activity and nutrient storage which according to Vaitilingon *et al.* (2003) is dependent on gonadal growth. High food consumption is usually observed during post spawning period when most energy accumulated has been used up for gonad growth and low feeding habit occurs when a sufficient amount of energy is accumulated in gut tissues, the time corresponding to initiation of gonadal growth. That is, physiological state of fish governs its feeding activity. Also, according to Fernandez and Boudouresquel (1997), fish are capable of changing their gut morphology in response to available food resources and demonstrate high degree of plasticity.

Table 1: Stomach content of some fishes in Ogun estuary, Nigeria

	Chrysichthys auratus		Elops lacerta		Synodontis schall		Mugil cephalus		Hepsetus odoe		Schilbe mystus		Sardinella maderensis		Tilapia zillii	
Food items	%No	%Oc	%No	%Oc	%No	%Oc	%No	%Oc	%No	%Oc	%No	%Oc	%No	%Oc	%No	%Oc
Blue-green algae	19.51	17.67	12.83	12.17	16.93	14.15	15.56	13.69	17.57	21.62	20	19.93	11.91	11.19	14.63	16.04
Green algae	14.75	13.29	17.55	18.69	13.9	10.49	38.37	29.17	17.12	22.3	18.33	17.83	27.72	24.93	44	41.42
Diatoms	15.56	16.69	16.98	20.47	21.57	20.49	20.15	16.67	11.71	18.24	14.29	17.13	23.41	20.87	16.23	16.6
Desmids	11.5	12.32	10.75	11.57	14.26	12.2	18.07	16.86	11.26	14.19	6.43	7.34	26.28	19.85	15.08	9.14
Rotifer	4.99	5.67	5.09	6.23	10.16	10.24	3.26	3.96	9.01	10.14	3.57	4.2	2.26	2.55	3.77	3.93
Crustaceans	9.87	9.89	9.06	9.5	8.56	8.05									1.6	1.49
Fish/fish eggs/ larvae	16.96	13.13	20.57	14.54					33.33	13.51	3.33	2.81				
Insects/ insect parts	2.56	2.43			5.88	6.83					29.29	25.17				
Unidentified food mass			7.17	6.83												
Detritus		4.21				10.48		8.93						11.45		6.53
Plant tissue	2.21	2.27			3.21	2.68	4.59	5.16			4.76	5.59	8.42	9.16	4.69	4.85
Molluscs	2.09	2.43														
Sand particles								5.56								
Protozoa					5.53	4.39										

%No: Percentage Number, %Oc: Percentage occurrence

Table 2: Gut repletion index and diet breadth of some fish species in Ogun estuary

Fish specie	Number of guts	Non-empty guts	GRI (%)	DB
Tilapia zillii	70	57	81.43	0.76
Chrysichthys auratus	70	41	58.57	0.88
Elops lacerta	70	61	87.14	0.86
Schilbe mystu	50	30	60.00	0.83
Mugil cephalu	70	56	8000	0.83
Sardinella maderensis	70	55	78.57	0.82
Hepsetus odoe	20	20	100.00	0.83
Synodontis schall	50	43	86.00	0.88

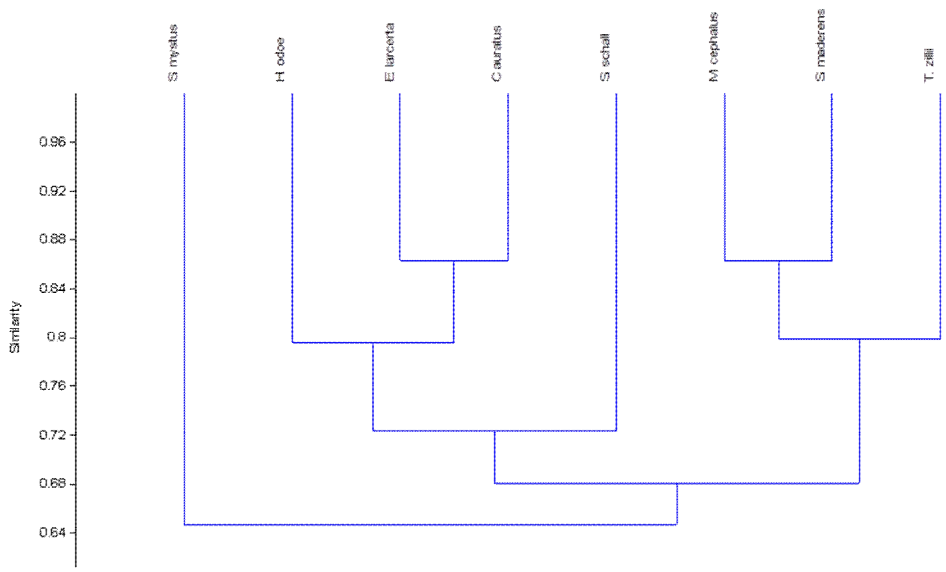

Figure 2: Cluster analysis of fish feeding habits using frequency of occurrence data

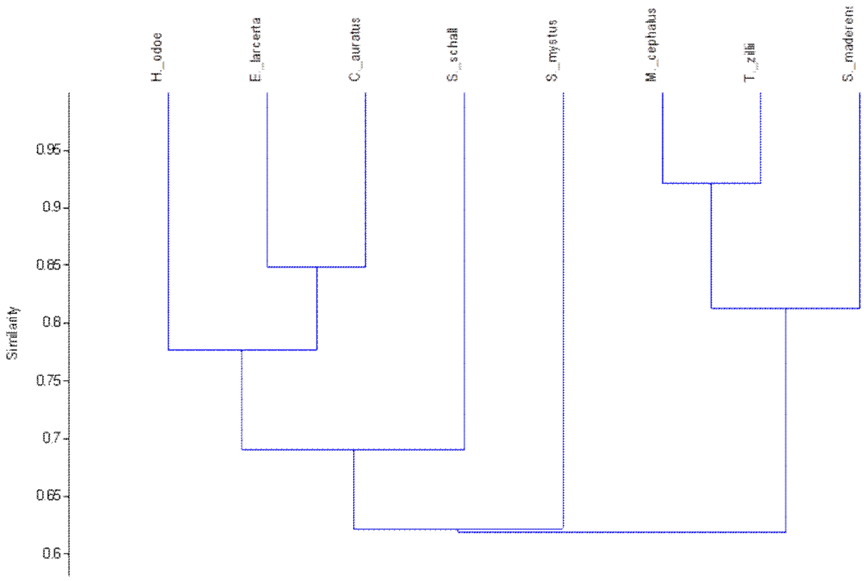

Figure 3: Cluster analysis of fish feeding habits using numerical data

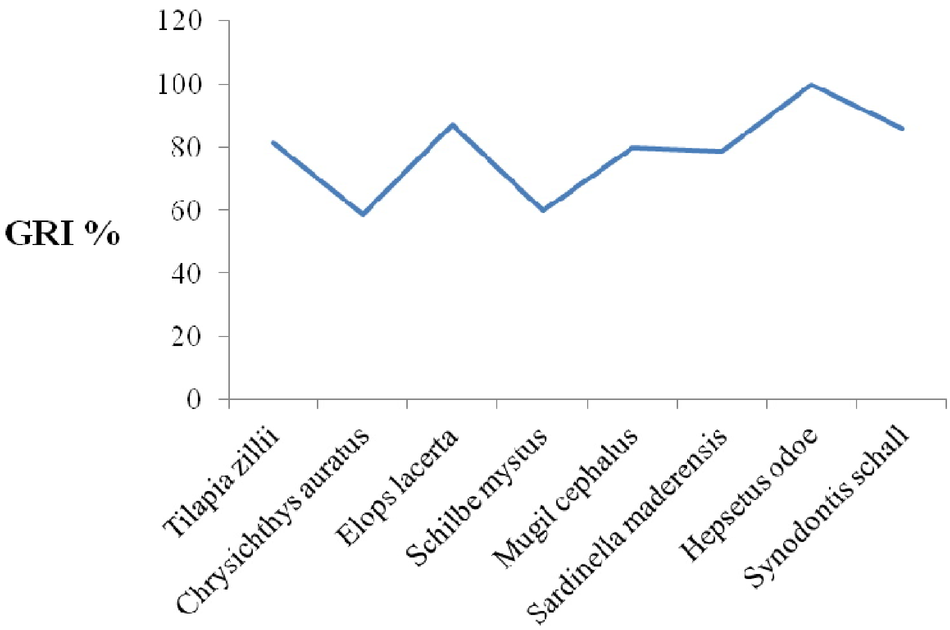

Figure 4: Gut repletion index of some fish species in Ogun State coastal estuary

CONCLUSION

The stomach contents of some fish species caught in the Ogun State coastal estuary, Nigeria showed that two fish species are piscivorous (*H. odoe, E. lacerta*). *T. zillii, S. maderensis, M. cephalus* are herbivores, *S. schall* and *C. auratus* are omnivorous fish species and *S. mystus* is a predator. The study further called for close monitoring of two fish stocks *C. auratus* and *S. mystus,* in the water body for sustainable management.

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