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Food and feeding habits and condition factor of fish species in Qua Iboe River estuary, Akwa Ibom State, southeastern Nigeria

Imaobong E. Ekpo, Mandu A. Essien-Ibok and Joseph N. Nkwoji

Abstract
Food and feeding habits of 187 fish specimens made up of 17 species from Qua Iboe River estuary were studied from July – October 2008. Specimens with food were more (141; 75.40%) than those without food (46; 24.60%). Highest condition factor was obtained in *Chrysichthys nigrodigitatus* (2.71) while the least was found in *Sarotherodon barracuda* (0.37). Gastrosomatic index showed highest (100%) in eight species whereas the lowest occurred only in *Trachinotus teraia* (4.35%). The highest relative frequency of food items was observed in fish and sediments (10; 15.63%) while the lowest occurred in annelids, molluscs and unidentified foods (1; 1.56%). Others were crustaceans and detritus (8; 12.50%), algae and plant materials (7; 10.94%), nematodes (5; 7.80%) and protozoans and insects (3; 4.69%). Variation in food richness ranged from 1 food item (0.54%) in three species (*Bathygobius soporator, Epinephelus aeneus* and *T. teraia*) to 36 food items (19.67%) observed in *Liza falcipinnis.* In view of these diets, the fishes were subdivided into planktophaguous, herbivorous, predatory and detritivorous species. However, overlaps existed; fishes were found to feed on more than one type of food item which reduced competition and encouraged coexistence.

Keywords: Fish species, diet composition, gastrosomatic index, feeding intensity, Qua Iboe, River estuary

1. Introduction
The diet of cultured fish species does not provide precise and reliable information on the food and feeding habits and condition factor of such species [1]. Hence, most studies which are aimed at obtaining such information are based on the analysis of gut contents of fish caught from their natural habitats [1, 2, 3, 4]. The study of the food and feeding habits of fish species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management programmed on fish capture and culture [5] and because the aquatic ecosystem is dynamic. The gut content is a reflection of the water quality, all other factors being constant.
The natural habitats offer a great diversity of organisms that are used as food by fish, which differ in sizes (microscopic and macroscopic) and taxonomy groups [6]. The dietary analysis of fish in their natural habitats enhances the understanding of the growth, abundance, productivity and distribute on of organisms [7, 8]. Condition factor is used as an index of growth and feeding intensity and decrease with increase in length [9]. It influences the reproductive cycle in fish [10] and it is an important fishery management tool in estimating the relative well–being of a fish population in a particular river system.
The fishes in Qua Iboe River estuary are exposited under subsistence and artisanal fisheries. In spite of the presence and abundance of important economic and commercial fish species in this estuary, there is scanty record on their food and feeding habits [8, 11, 12, 13, 14] and dearth of information on the trophic biology of these multi-species. The knowledge of the food and feeding habits of fishes provide answers to practical problems which arise in relation to human exploitation. Therefore, the present study on the food and feeding habits of common fish species in Qua Iboe River estuary was conducted to make available this important information.

2. Materials and methods
2.1 Study area
The study was carried out in the estuarine water of Qua Iboe River in Ibeno Local Government

Area in Akwa Ibom State, Nigeria (4° 49′ 02.88″N; 7° 56′ 51.09″E) (Fig. 1). It is one of the three major hydrographic features in Akwa Ibom State, Nigeria. It is located in the tropical belt with an equatorial climate regime characterized by dry (November - March) and wet (April - October) seasons [15, 16]. The southern-most part of the river basin which constitutes the estuarine zone which consists of sandy coastal beach ridges covering an area of C.560 km^2 [15]. It has a distance of approximately C.40 km from Eket to Ibeno where it empties into the Atlantic Ocean. The nature of the substratum consists of fine sand, salty and muddy deposits. The estuary consists of tidal creeks, small brackish water lagoons and fringing mangrove swamps. Hence, the shoreline is characterized by muddy/marshy edges. The channel morphology is characterized by very wide channel and very deep pools [16].

The vegetation of the mangrove swamps comprises predominantly the red mangroves (*Rhizophora harrisonii, R. mangle* and *R. racemosa*), white mangroves (*Avicenna africana*) and black mangroves (*Laguncularia racemosa*), stands of *Nypa fruticans*, *Phoenix reclinata* and *Acrostichum aureum* also grow in some places. The study area has been described in more detailed elsewhere [17].

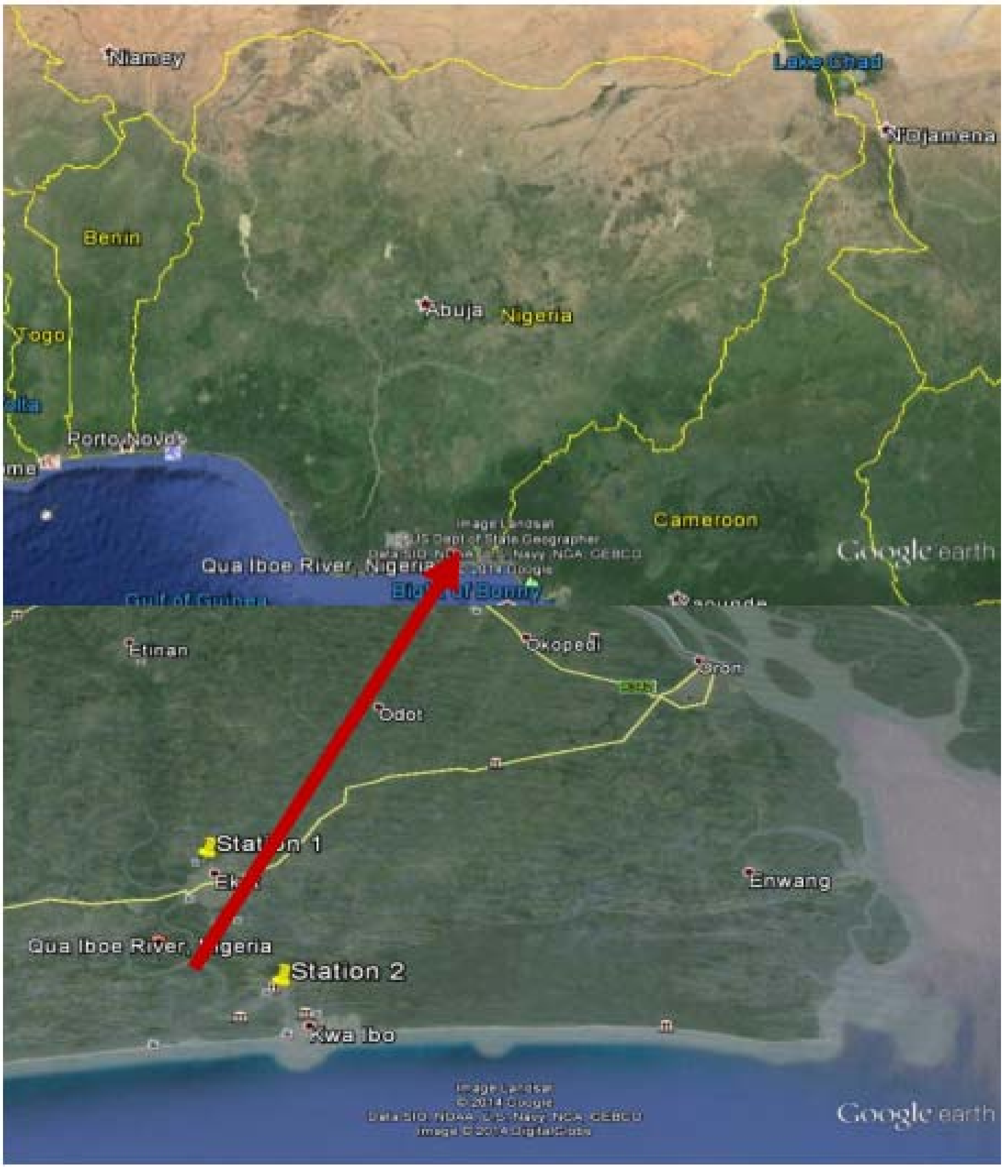

Fig 1: Map of Qua Iboe River estuary in Akwa Ibom State showing sampling stations. Insert: Map of Nigeria showing the location of Akwa Ibom State, Nigeria (Source: Google earth, [18]).

2.2 Fish sampling, preservation and measurement

Fish sampling was conducted with the help of local fishermen using traditional fishing gear such as hook and line, set gillnets and basket traps from July – October 2008. A combination of these fishing methods was necessary since all of them were selective in one way or the other [19]. Pending examination, the specimens were preserved for not more than five days in a deep freezer or in 10% formalin to reduce post humus digestion to the minimum [20]. Fish caught were identified with the aid of as [21, 22, 23]. Each specimen was measured to the nearest 0.1 cm total length (TL) using a 1-50 cm (range) measuring board and weighed to the nearest 0.1 cm total weight (WT) on a top loading Sartorius 'PT' 600 balance. Each specimen was later dissected and the stomach slit open to remove its contents which were weighed to the nearest 0.1 g, using a top loading mettle 'Ps 165' electron balance after blotting out excess fluid.

2.3 Gut contents analyses

Each slit stomach was assigned a number of points proportional to its degree of fullness according to an arbitrary 0-20 point scale [24]. In this method, 0, 5, 10, 15 and 20 points were scored for empty, ¼ full, ½ full, ¾ full and full stomachs respectively. Intermediary points were also allotted where necessary according to the proportion of food in the stomach. Stomach contents were sorted out into categories using [25] and analyzed using Relative Frequency (%RF) methods [24, 26, 27]:

$$RF = \frac{F_i}{F_i} \times 100 \quad (1)$$

Whereas,
F_i = Frequency of item i; F_i = Frequency of the n^{th} item i.e. number of all F_i.

All RF values sum up to 100%. RF is unweighted by the actual amounts of items in the stomachs but is responsive to the frequency of each in relation to the frequencies of all others.
The integrated importance of each food item was then expressed as an Index of Food Dominance (IFD) [15] according to the formula:

$$IFD = \frac{RF.\,PP}{\Sigma RF.PP} \times 100 \quad (2)$$

Whereas,
RF = % Relative Frequency of food item;
PP = % Point Percentage

This index ranges from 0-100%. Food items with IFD ≥10% were arbitrarily considered as primary diets; those with IFD between 1-9.9% as secondary diets and those with IFD<1% as incidental food items. The use of IFD to establish overall food preponderance is adequate as it incorporates the RF and PP data, thus minimizing the bias characteristic of cases in which results from different analytical methods are independently interpreted [15].
The Gastrosomatic Index (GSI) was calculated to show the trends in the feeding activity of the fish according to the formula [28]:

$$GSI = 100Wf/Wt \quad (3)$$

Whereas, Wf = Weight (g) of food in the gut; Wt = Total weight (g) of the fish

The Gut repletion index (GRI) was calculated using the formula:

$$GRI = \frac{\text{Number of non-empty guts}}{\text{Total number of specimens examined}} \times 100 \quad (4)$$

In the point method, the points previously assigned to each stomach were shared among the various contents or food items, taking account of the relative proportions by volume. The mean points gained by each food item were determined. The mean total points gained by each food item was computed and expressed as percentage of the grand total points (PP) gained by all stomach contents. Mean points per stomach were then computed to give the Average Gut Fullness (AGF) [26] as:

$$AGF = \frac{\Sigma P}{\Sigma PP} \times 100 \quad (5)$$

Fish condition factor was calculated as:

$$k = 100TW/L^3 \quad (6)$$

The condition factor of a fish is regarded as the fitness or relative well-being of the fish and it indicates the general metabolism of the fish [29]. Condition factor depends on how well a fish feeds and generally, it is believed that small-sized individuals feed more than the larger ones. Therefore, fishes with condition factor values greater than one (≥1) were considered as high while those <1 were low.
For fishes without stomachs, the anterior ends of the intestine were opened and the contents removed for analyses.

3. Results

A total of 187 specimens comprising 11 families and 17 species were examined for food and feeding habits (Table 1). The species, sample size and records on food availability are depicted also in Table 1. The largest sample size was recorded in Mugilidae with four species (109 specimens; 58.30%) while those with a single specimen (1; 0.53%) (Serranidae and Sphyraenidae) were the least. The percentage of specimens with food was higher (141; 75.40%) than specimens with empty stomachs (46; 24.60%).

3.1 Size variation

Table 2 indicates the mean sizes (TL, cm and Wt, g), mean condition factor, gut repletion index (GRI, %), average gut fullness (AGF) and mean gastrosomatic (GSI, %). The largest fish was *S. barracuda* (23.20 cm) whereas *P. peroteti* (8.40 cm) was the smallest fish in terms of their mean length. The heaviest fish in terms of mean weight was *S. melanotherodon* (72.10 g) while *P. peroteti* was the lightest fish (4.90 g).

3.2 Condition factor

Highest well-being was obtained in *C. nigrodigitatus* (2.71) but the least was found in *S. barracuda* (0.37) as illustrated in Table 3. Low condition factor values were observed in 10 species: *S. melanotherodon* (1.97), *E. aeneus* (1.24), *T. guineensis* (2.11), *T. teraia* (1.13), *P. jubelini* (1.20) and *B. soporator* (1.52) while the others were high 7 species: *E. fimbriata* (0.93), *L. dumerili* (0.77), *L. falcipinnis* (0.82), *L. grandisquamis* (0.90), *M. curema* (0.87), *P. quadrifilis* (0.70), *P. peroteti* (0.83), *P. elongatus* (0.80) and *T. goreensis* (0.73).

3.3 Feeding intensity

GRI (%) showed highest in eight species (*S. melanotherodon, E. aeneus, T. guineensis, L. dumerili, L. falcipinnis, P. peroteti. S. barracuda* and *T. goreensis*) of fish having 100% whereas the lowest occurred in *T. teraia* (4.35%) as shown in Table 3. AGF occurred highest in *E. aeneus* (20.00) while the lowest was observed in *T. teraia* with 0.09.
GSI showed highest in *P. peroteti* (10.0%) whereas the least was in *T. teraia* (0.0%).
Based on their feeding intensity, eleven species of fish were considered active feeders (*S. melanotherodon, T. guineensis, E. fimbriata, L. dumerili, L. falcipinnis, L. grandisquamis, P. peroteti, E. aeneus, P. elongatus, S. barracuda* and *T. goreensis*) whereas six were shown to be non-active feeders (*C. nigrodigitatus, B. soporator, M. curema, P. quadrifilis, P. jubelini* and *T. teraia*) as shown in Table 2.

Table 1: Sample size, specimens without food and specimens with food of the fishes in of Qua Iboe River estuary, Nigeria.

Fish family/species	Sample size / %RF	Records on food availability	
		Food present	Food absent
Cichlidae			
Sarotherodon melanotheron (Ruppell)	2	2	-
Tilapia guineensis (Bleeker, 1862)	1	1	-
Total Cichlidae	**3 (1.60)**		
Clarotidae			
Chrysichthys nigrodigitatus (Lacepede, 1803)	5	3	2
Total Clarotidae	**5 (2.67)**		
Clupeidae			
Ethmalosa fimbriata (Bowdich, 1825)	15	12	3
Total Clupeidae	**15 (8.02)**		
Gobiidae			
Bathygobius soporator (Valenciennes)	2	1	1
Total Gobiidae	**2 (1.07)**		
Mugilidae			
Liza dumerili	21	21	-
L. falcipinnis (Valenciennes, 1836)	31	31	-
L. grandisquamis (Valenciennes, 1836)	52	45	7
Mugil curema (Linnaeus, 1758)	5	2	3
Total Mugilidae	**109 (58.30)**		
Polynemidae			
Polydactylus quadrifilis (Cuvier, 1830)	2	1	1
Total Polynemidae	**2 (1.07)**		
Pomadasidae			
Pomadasys jubelini (Cuvier, 1830)	7	4	3
P. peroteti (Cuvier, 1830)	1	1	-
Total Pomadasidae	**8 (4.28)**		
Serranidae			
Epinephelus aeneus	1	1	-
Total Serranidae	**1 (0.53)**		
Sciaenidae			
Pseudotolithus elongatus (Bowdich, 1825)	17	13	4
Total Sciaenidae	**17 (9.09)**		
Sphyraenidae			
Sphyraena barracuda (Peters, 1844)	1	1	-
Total Sciaenidae	**1 (0.53)**		
Trachinidae			
Trachinotus goreensis (Cuvier, 1832)	1	1	-
T. teraia (Cuvier, 1832)	23	1	22
Total Trachinidae	**24 (12.84)**		
Grand total	**187**	**141 (75.40)**	**46 (24.60)**

Table 2: Mean size variation, condition factor and feeding intensity of the fish species of Qua Iboe River estuary, Nigeria.

Fish species	Mean TL(cm)	Mean Wt (g)	Mean K	GRI (%)	AGF	Mean GSI (%)	Feeding intensity
Sarotherodon melanotheron	14.60	72.10	1.97	100	6.00	0.62	Active feeder
Tilapia guineensis	14.20	60.40	2.11	100	16.00	0.66	„
Chrysichthys nigrodigitatus	21.94	63.44	2.71	60	8.60	0.40	Non-active
Ethmalosa fimbriata	16.10	35.81	0.93	80	11.60	0.30	Active feeder
Bathygobius soporator	9.45	13.85	1.52	50	5.00	0.26	Non-active
Liza dumerili	14.66	26.89	0.77	100	12.62	1.36	Active feeder
L. falcipinnis	13.15	20.44	0.82	100	14.48	3.88	„
L. grandisquamis	14.49	30.31	0.90	86.54	11.04	1.02	„
Mugil curema	14.78	28.88	0.87	40	5.80	0.25	Non-active
Polydactylus quadrifilis	20.30	58.75	0.70	50	4.00	0.90	„
Pomadasys jubelini	13.01	26.71	1.20	57.14	8.57	1.41	„
P. peroteti	8.40	4.90	0.83	100	15.00	10.00	Active feeder
Epinephelus aeneus	15.20	43.40	1.24	100	20.00	0.32	„
Pseudotolithus elongatus	16.03	37.09	0.80	76.47	7.82	0.23	„
Sphyraena barracuda	23.20	46.60	0.37	100	15.00	1.80	„
Trachinotus goreensis	9.80	6.90	0.73	100	9.00	0.80	„
T. teraia	7.70	5.30	1.13	4.35	0.09	0.00	Non-active

3.4 Fish diet composition

The trophic spectra of the 17 fish species were illustrated in Table 3. Twelve major dietary compositions were identified in the fish stomachs (Fig. 2). The highest relative frequency was observed in fish and sediments (10; 15.63%) while the lowest occurred in annelids, molluscs and unidentified foods (1; 1.56%). Others were crustaceans and detritus (8; 12.50%), algae and plant materials (7; 10.94%), nematodes (5; 7.80%) and protozoans and insects (3; 4.69%). These dietaries were of plant (phytoplankton and macrophytes), animal (zooplankton, protozoans, annelids, insects, crustaceans, nematodes, molluscs and fish), non-living matter (detritus and sediments) and unidentified food origins (Table 3).

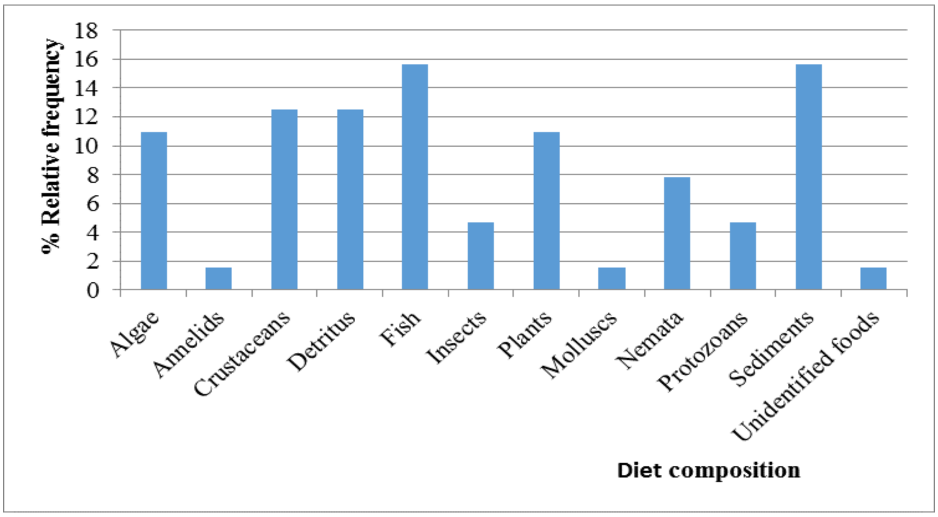

Fig 2: Relative frequency of dietary composition of fish species in Qua Iboe River estuary, Nigeria.

The food richness of the estuarine fish species showed that there were 183 food occurrences (Table 3). Variation in food richness ranged from 1 (0.54%) in three species (*B. soporator*, *E. aeneus* and *T. teraia*) to 36 food items (19.67%) observed in *L. falcipinnis*. It was also the highest among mugilid species, followed by *L. grandisquamis* (31; 16.94%), then *L. dumerili* (25; 13.66%) and lastly *M. curema* (13; 7.10%). Among those with only one food item, fish was the only food item found in the gut except in *T. teraia* which had sediments.

Table 3: Size ranges and primary dietary composition based on %IFD of fish species in Qua Iboe River estuary, Nigeria.

Fish species	N	Total length, TL (cm)		Total weight, WT (g)		Primary dietary composition (%IFD)	Food richness (%N)
		Min	Max	Min	Max		
Sarotherodon melanotheron	2	10.7	18.5	25.1	119.1	Algae (28.94), plants (42.10), nemata (10.53) & sediment (15.79)	8(4.37)
Tilapia guineensis	1	14.2		60.4		Algae(75.76) & plant (15.16)	10(5.46)
Chrysichthys nigrodigitatus	5	19.7	27.8	51.5	72.4	Crustacean (62.29), fish (13.20) & molluscs (20.75)	6(3.28)
Ethmalosa fimbriata	15	13.2	17.8	25.9	56.0	Algae (65.82) & crustaceans (16.16)	25(13.66)
Bathygobius soporator	2	8.0	10.9	7.6	20.1	Fish (100)	1(0.55)
Liza dumerili	21	10.1	23.5	8.1	98.2	Algae (19.06), detritus (11.58), plants (10.65) & sediments (57.95)	25(13.66)
L. falcipinnis	31	8.5	20.0	0.8	60.6	Algae (11.33), detritus (15.21) & sediments (67.38)	36(19.67)
L. grandisquamis	52	10.9	23.7	11.3	129.1	Algae (10.91), detritus (14.15), plants (10.18) & sediments (63.34)	31(16.94)
Mugil curema	5	10.9	16.8	11.9	35.8	Algae (49.53) & sediments (39.71)	13(7.10)
Polydactylus quadrifilis	2	20.0	20.6	55.8	61.7	Crustaceans (77.78) & fish (22.22)	2(1.09)
Pomadasys jubelini	7	11.8	15.1	19.4	39.3	Annelida (11.40), crustaceans (54.17) & fish (32.28)	7(3.83)
P. peroteti	1	8.4		4.9		Fish (86.67) & detritus (13.33)	3(1.64)
Epinephelus aeneus	1	15.2		43.4		Fish (100)	1(0.55)
Pseudotolithus elongatus	17	11.4	21.5	10.4	74.8	Crustaceans (49.96) & fish (46.77)	9(4.92)
Sphyraena barracuda	1	23.2		46.6		Fish (93.33)	3(1.64)
Trachinotus goreensis	1	9.8		6.9		Crustaceans (88.89) & sediments (11.11)	2(1.09)
T. teraia	23	6.2	9.5	2.9	9.0	Sediments (100)	1(0.55)
Grand total	**187**						**183**

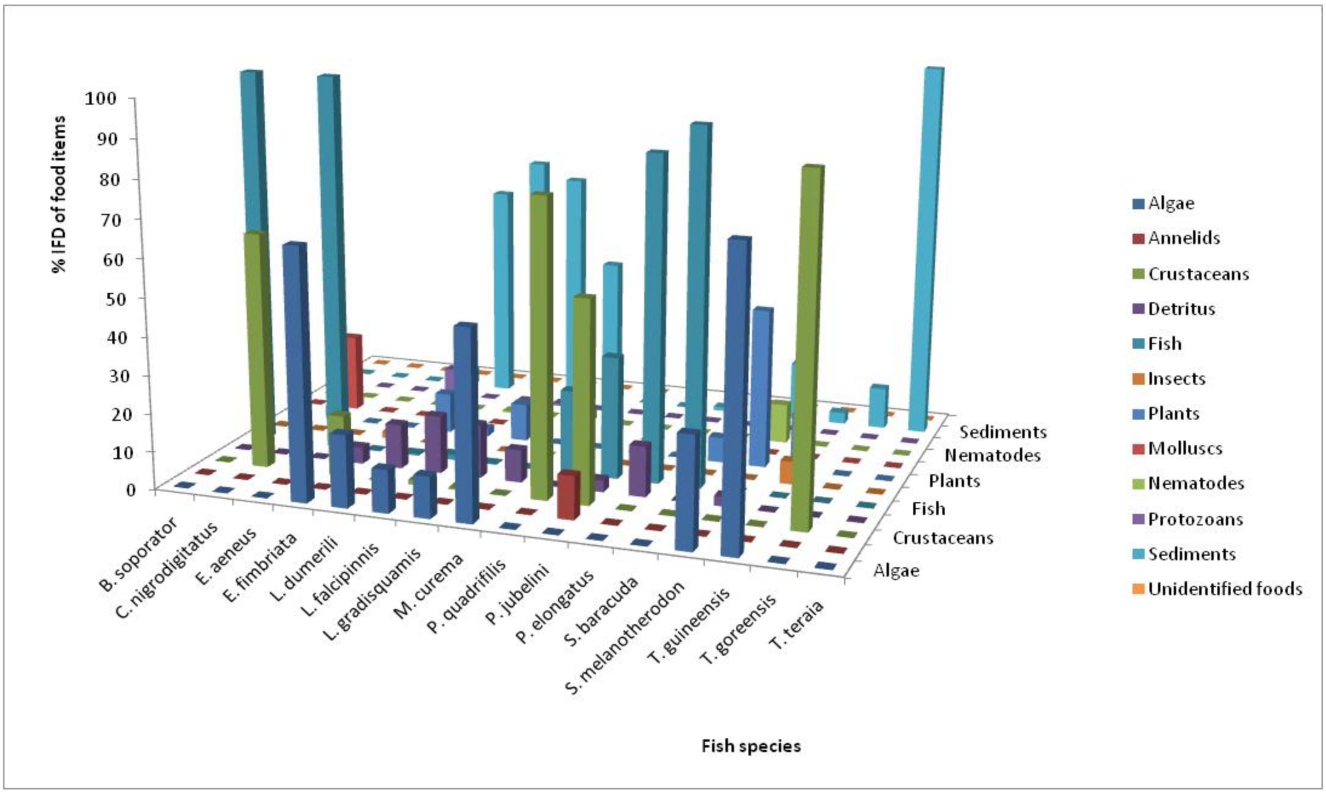

Fig 3: Dietary composition using % IFD of the fish species in Qua Iboe River estuary, Nigeria.

3.5 Trophic relationship among fish species

The trophic relationship among species of fish was illustrated in Fig. 4. Three species (*T. teraia, E. aeneus* and *B. soporator*) were found to ingest only one major food item; four ingested two (*T. goreensis, P. peroteti, P. quadrifilis and S. barracuda*) while others fed on more than two major food items. Thus, each species depended on more than one food source apart from the few.

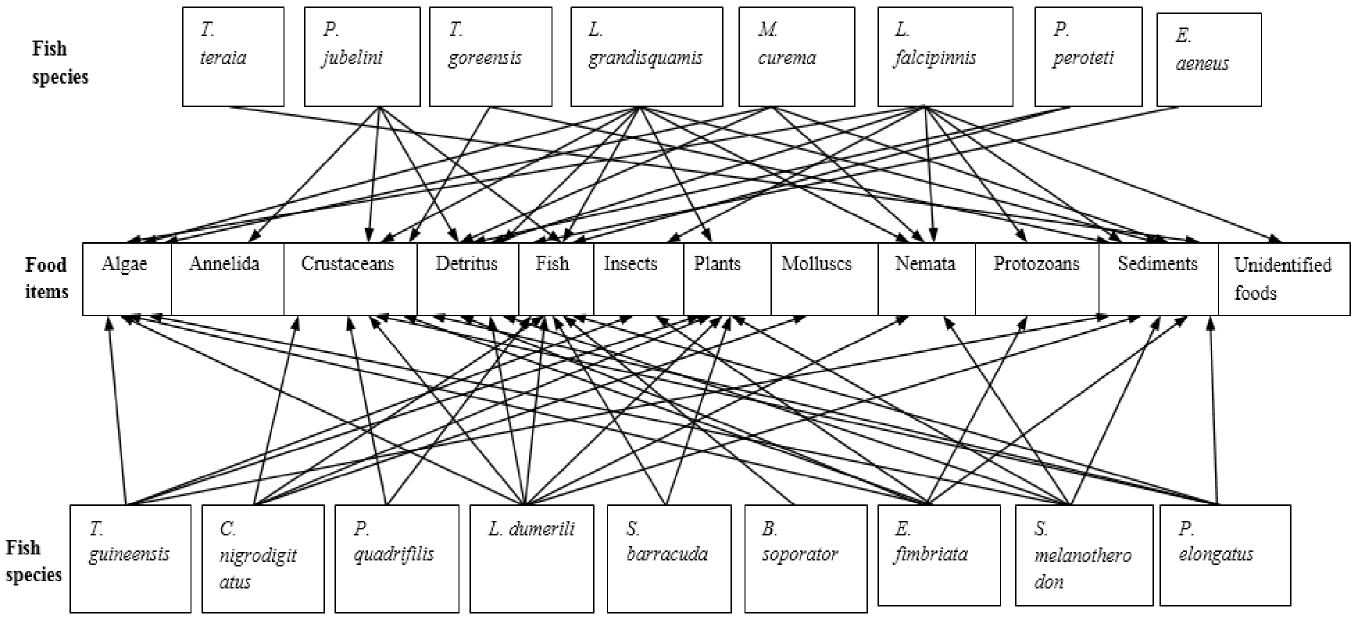

Fig 4: Trophic relationship of estuarine fish species in Qua Iboe River estuary, Nigeria.

4. Discussion

Fish species have been classified based on stomach contents. This grouping varies depending a number of factors, such as type and part of water body the fish were caught, region, season, month, hydrological cycle, developmental stage of the fish, researcher, adopted methods, among others. Hence, there seems to appear overlaps, where one species may be described in more than one way based on the gut content identified. For instance, *Tilapia* species have been reported to be plankton, plant, animal and/or deposit feeders [30, 31, 32, 20, 33, 34, 35, 36].

Twelve major dietary compositions constituted the food of the studied fish in Qua Iboe River estuary. The wide variety of items occurring the stomachs of all the fish species show that they are non-selective in feeding and it appears that each species is capable of utilizing many sources of food. Shep *et al.*, [37] observed that such feeding on a wide range of food organisms that makes them euryphagous feeding with a food base comprising both plants and animals. Index of food dominance enables these fishes to be categorized into 4 broad groups: planktophaguous, herbivorous, predators and detritivores.

Planktophaguous fish ingest large quantities of algae and planktonic crustaceans as their foods. Three major species occurred as planktivore: *E. fimbriata* (65.82%), *T. guineensis* (75.76%) and *M. curema* (49.53%). Fagade and Olaniyan [20] showed that *E. fimbriata* preys on both phytoplankton (algae e.g. *Coscinodiscus, Biddulphia* sp) and zooplankton (copepods and bivalves) as obtained in this study; although bivalves did not appear among their dietaries. In *Tilapia guineensis*, diatoms and algal filaments gained high percentages of IFD as shown in [31] and [20]. However, [38] noted that cichlids are generally plankton feeders. Fagade and Olaniyan, [20] noted that diatoms occurred in the food of *M. curema*. High percentage of detrital materials also occur in the diet of *M. curema*, hence they had been described as iliophagous (detritus feeders) [39, 20, 31]. Isangedighi *et al.,* [40] reported that *M. cephalus*' high feeding intensity could be a reflection of the abundance of requisite food resources while Odum [41] noted that this species is a diurnal and opportunistic feeder. Contrasting with the obtained result, [37] reported that *T. guineensis* in Ayame man-made lake are non-selective (both plant and animal materials) in feeding, thus classifying it omnivore.

The only species found to ingest large quantities of plant materials (herbivore) was *S. melanotheron* (42.10%) together with algae (28.94%). It could be possible that while browsing the macrophytes, the attached algae (aufwuchs or periphytons) have also been ingested or the other way round. This finding conflicts with that of [42] in which the food of this species was dominated by mud. This difference may be attributable to the number of specimens sampled, duration of the study, fishing methods and season.

The animal feeding fishes (predatory) can be categorized into 2 main sub-groups: piscivorous (preying on fish) and non-piscivorous (preying on other macroscopic animals other than fish) species. However, overlap was observed which helped to reduce competition and encouraged coexistence.

Piscivorous species were *E. aeneus* (100%), *B. soporator* (100%), *S. barracuda* (93.33%) and *P. peroteti* (86.67%). These species include whole fish and/or fish parts in their diets. Fagade and Olaniyan [20] reported that the piscivorous species of Lagos lagoon include *E. fimbriata* in their diet. The piscivorous species also ingest some items of other food sources e.g. crustaceans. This ability to exploit varying areas of food supply by these piscivorous will no doubt reduce rate of competition, hence confer survival value of their species. Fish is a common sight in the study area since as a beach, it is also a landing site for boats which buy 'trash' from offshore vessels. Most sorting and washing are carried out here, where the unwanted components are thrown back into the water. Hence, any fish could pick incidentally.

Non-piscivorous species include *C. nigrodigitatus* (62.29%), *T. goreensis* (88.89%), *P. jubelini* (54.17%), *P. quadrifilis* (77.78%) and *P. elongatus* (49.96%). These species either feed on adult crustaceans or mollusks. Some also include polychaetes (annelids) in their diet, example, *P. jubelini* while others take in nematodes. *C. nigrodigitatus* feeds on mainly crustaceans (shrimps and crabs) and mollusks (bivalves and gastropods). The results show that the non-piscivorous predators feed on a wide variety of animals leading to considerable overlapping as was seen in *C. nigrodigitatus*. It was however, reported that this species utilizes varying sizes of prey and this helps to reduce competition [20]. *P. elongatus* and *P. jubelini* included juvenile fish and some detrital matter in their diet. Thus, they were flexible in their diet which will reduce possible competition for food. Confirming the present finding, Abowei *et al.,* [43] reported that *P. elongatus* in Bonny estuary is a predator feeding on invertebrates such as penaeid shrimps, mantis shrimps, *Macrobrachium* sp, hermit crabs, small fish and crabs.

Bottom feeders include *L. grandisquamis* (63.34%), *L. falcipinnis* (67.38%), *L. dumerili* (57.95%), *M. curema* (39.71%), and *T. teraia* (100%) which fed mainly on bottom deposits. These mullet species feed by stirring up the bottom and filtering the particles brought into suspension with their gill rakers [20]. The diets of the mullet species are dominated by detritus, algae and sediments which agrees with [26] in which *L. falcipinnis* was described as a "detritivore – algivore – deposit feeder" and *L. grandisquamis* as a "detritivore" [39]. Again, [44] described *M. cephalus* in terms of food and feeding habits as phytophagus and benthic, having fed on ostracods (1.26%), nemata (0.01%), pisces scales (0.14%), Chlorophyceae (2.64%) and diatoms (95.94%) with a mean K = 0.946. They exhibited food preferences according to their habitats [45]. Abujam *et al.*, [46] illustrated that intensity of feeding declined when fish become mature/ripe and were ready for spawning and completely reduced to its lowest level in spent fish.

In view of the food and feeding habits of these fishes, the trophic relationship can be established as in Fig. 4. The dietary components are much diversified. The planktophaguous species include other dietaries in their diet while the predators have a wide spectrum of food items which include insects, crustaceans, nematodes and fish. The deposit feeders include some crustaceans, algae and some macrophyte materials in their diet. They depended mainly on autochthonous food items. Estuaries have been shown to be very productive in terms of biota especially planktons, arthropods, molluscs, protozoans, etc; hence, they have been described as spawning, nursery, and feeding grounds. The partitioning of the food resources among these estuarine species may have favored their coexistence.

Offem *et al.,* [47] observed that the ecological advantage of this is that it enables a fish to switch from one category of food to another in response to fluctuation in their abundance. This leads to the ability of the species to utilize many different food objects effectively. Despite the wide food overlaps, the competition for food is probably minimal, because all the fish species feed on a wide range of dietaries and also because of the abundance of main preys. In a similar study, [37] reported that the studied fishes exhibited a general feeding strategy, hence, the occurrence of overlap even to a high degree does not necessarily mean that competition is present, if the resources are not limited.

5. Summary and Conclusion

The food and feeding habits of the commonly occurring fishes in the Qua Iboe River estuary show a great diversity in pattern and have been grouped into planktophaguous, predatory and deposit feeding. Overlaps exist which ensures reduced competition among the fishes and ensures a wider spectrum of dietaries. The planktophaguous species feed mainly on phytoplankton and zooplankton. The predators have been sub-divided into insectivorous and piscivorous species while the deposit feeders feed on the bottom sediment and detritus. From the tropic relationships established, it can be concluded that the fish species in the Qua Iboe River estuary utilize more than one source of food. They depended mainly on autochthonous food items. In view of the numerous species of economic importance and commercially exploited species in the Qua Iboe River particularly in the estuarine zone, it is therefore my recommendation that the fish stock in the river should be assessed properly and the extent of pollution in the estuary should be determined to know what management strategies and control measures are to be taken.

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