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Trophic spectrum of *Pseudotolithus elongatus* (Sciaenidae: Teleostei) in Imo River estuary, Nigeria

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Abstract
The trophic spectrum of *Pseudotolithus elongatus* in Imo River Estuary was studied using the index of relative importance (IRI). This index combines three standard methods of stomach analysis namely: the point, frequency of occurrence and numerical methods. The resultant IRI was further expressed as a percentage for each food item. The major dietary categories were of two classes namely: crustacean (shrimps) and Pisces (fish) with % IRI of 51.81% and 24.34% respectively. Other items (unidentified mass of tissues, plant materials, and polychaete worms) had a total % IRI of 23.84%. The food composition showed no variation with sex and season except for the presence of plant materials occurring only in the raining season. Feeding intensity was greater in the dry than in the wet season and in females than in males. The largest size group (41-50 cm) exhibited the highest intensity of feeding but no clear ontogenic pattern in vacuity index was observed.

Keywords: Trophic spectrum, feeding intensity, *Pseudotolithus elongatus*, Nigeria

1. Introduction
The Croakers (Genus: *Pseudotolithus*) are amongst the commercially important fish in the Nigerian inshore waters [1]. They occur throughout the Atlantic coast of West Africa [2] and are exploited by both industrial and artisanal fisheries. One of the most economically important and dominant species in the Nigerian coastal waters is *Pseudotolithus elongatus* [1, 3].This species occurs in the estuaries and saline creek systems [4]
Previous reports on the Croakers in the Niger Delta area of Nigeria include Akpan and Isangedighi (2004) [5], Akpan *et al.,* (2004) [4], Isangedighi (2014) [3] and Isangedighi and Ambrose (2015) [6]. Detailed information on the trophic spectrum of *Pseudotolithus* species in Imo River estuary, Nigeria is generally lacking. The present report focuses specifically on the trophic spectrum of *P. elongatus* of the Imo River estuary. It is meant to provide more information regarding the species and assess the ecosystem within which it thrives.

2. Materials and methods
2.1 Study area
The Imo River estuary is located in the tropical rainforest belt with an equatorial climate regime. There are two seasons namely, the wet and dry seasons. The wet or rainy season which is characterized by moist winds and heavy precipitation is of longer duration. It starts from March and last until October while the dry season with hot humid winds and scanty precipitation extends from November to February. However, due to the effect of the hot humid moist air (as a result of the area's proximity to the Atlantic Ocean) rainfall lasts during much of the year (Peters *et al.,* 1994) [7]. The intertidal zone of the river is fringed by mangrove/nipa palm swamps.

2.2 Sample collection
Samples of *P. elongatus* were obtained from boat landings of artisanal fisherfolks at Uta Ewa axis of Imo river in Akwa Ibom state for twelve consecutive months. Specimens were weighed to the nearest 0.1 g after blotting dry with filter paper and measured to the nearest 0.1cm (Total length, TL)

2.3 Feeding intensity
Feeding intensity was determined by the vacuity index. This index is calculated by dividing the

number of empty stomach by the total number of stomachs and multiplying the outcome by 100 [8]. Consequently, the higher the vacuity index, the lower the feeding intensity.

2.4 Food composition

Three methods were used to assess the food composition namely: the point, frequency of occurrence and numerical methods. The stomachs were removed, slit open, and the contents displayed in petri dishes with a few drops of distilled water added to agitate them and examined microscopically and macroscopically. Prey items were identified to the lowest possible taxonomic level. In the point method, each stomach was sorted out visually, categorized as empty, one quarter, half, three quarters and full and scored 0, 5, 10, 15 and 20 respectively with intermediate scores where necessary. These points were shared among the various contents, taking account of their relative proportion by volume. Points scored by each food item was calculated and expresses as percentage of grand total point scored by all stomach contents giving the percentage point (Cp).

The percentage frequency of occurrence (F) was based on the number of stomachs in which a food item was found, expressed as a percentage of the total number of non-empty stomachs while percentage numerical abundance (Cn) was the number of each prey item in all non-empty stomachs in a sample, expressed as the percentage of the total number of food items in all stomachs [9]. The principal food items were then identified using the index of relative importance (IRI) embracing the three methods as follows:

IRI = (Cn +Cp) x F

Where IRI = Index of Relative Importance; Cn = Percentage Numerical Abundance; Cp = Percentage Point and F = Percentage Frequency of Occurrence. The IRI was further expressed as percentage viz.:

$$\%IRI = \left(\frac{IRI}{\sum IRI} \right) \times 100$$

Where ∑IRI refers to the sum of all IRI.

3. Results

3.1 Feeding intensity

The overall vacuity index was 50.37%. Figure 1 shows the monthly variation of vacuity index of *P. elongatus* in the Imo river estuary. The highest vacuity index occurred in July (84.8%) while the lowest occurred in October (23.3%). Consequently, feeding activity in *P. elongatus* reached its peak on October and was lowest in July.

3.2 Ontogenic variation in feeding intensity

Figure 2 shows the variation of vacuity index with size groups. The 31-40cm (TL) group had the highest vacuity index while the 41-50cm (TL) group had the lowest vacuity index. The ontogenic variation in vacuity index did not show any clear pattern.

3.3 Seasonal variation in feeding intensity

Wet season samples of *P. elongatus* had higher vacuity index (54.5%) than dry season samples (42.0%). This implied that feeding was more intense during the dry season than during the rainy season.

3.4 Sexual variation in feeding intensity

Feeding intensity was higher in female (VI = 54.55%) than male (VI = 64.71%)

3.5 Diet composition

The diet of *P. elongatus* in the Imo River estuary consisted mainly of crustaceans (shrimps) and Pisces (fishes).Other food items were unidentified mass of tissue, plant material (leaf/leaf stalk) and Polychaete worm. The relative importance of the different prey groups and species are shown in Table 1. Crustaceans constituted the most important prey group making up 51.81% of the IRI. Among the crustaceans, shrimp parts had the highest % IRI (41.76%) while *Parapenaeopsis atlantica* had the lowest % IRI (1.49%). Pisces (fishes) contributed the second highest dietary materials making up 24.34%. Other food items made up 23.84% of the total IRI. No difference in food composition between the sexes was observed but plant materials occurred in the stomach only during the rainy season.

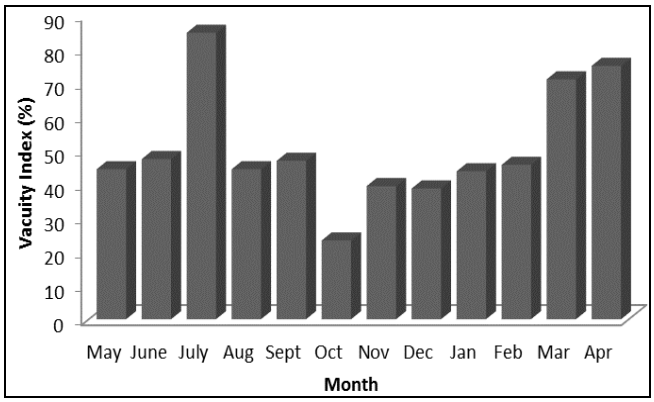

Fig 1: Monthly vacuity Index of *P. elongatus* in Imo river estuary, Nigeria

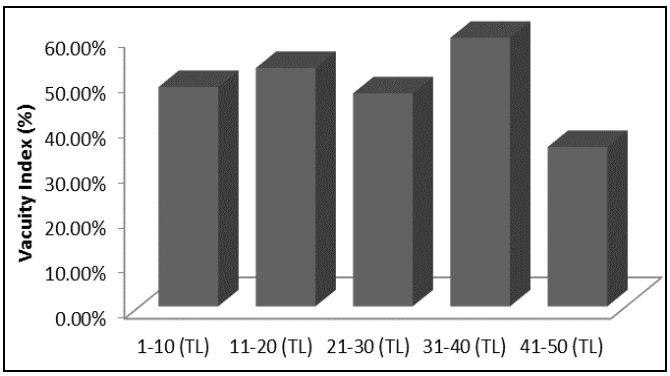

Fig 2: Variation of feeding intensity with size groups of *P. elongatus* in Imo river estuary, Nigeria

Table 1: Dietary Composition of *P. elongatus* in Imo River Estuary, Nigeria

Food Item	*Cn*	*Cp*	*F*	*IRI*	*%IRI*
Pisces					
Brachydeuterus auritus	0.81	4.90	3.03	17.30	0.32
Ilisha Africana	1.63	7.35	6.06	54.42	1.02
Unidentified partially digested fish	11.38	27.45	30.30	1176.55	21.97
Ethmalosa fimbriata	1.63	6.86	6.06	51.45	0.96
Fish scale	0.81	0.49	3.00	3.90	0.07
Total	16.26	46.56	45.45	1303.62	24.34
Crustacea (Shrimp)					
Nematopalaemon hastatus	4.07	1.23	3.03	16.06	0.3
Parapenaeopsis atlantica	4.88	8.33	6.06	80.05	1.49
Unidentified partially digested whole shrimp	10.57	10.29	21.20	442.2	8.26
Shrimp parts	45.5	11.27	39.39	2236.17	41.76
Total	65.02	31.12	69.68	2774.4	51.81
Others					
Unid.mass of tissue	-	17.16	54.55	936.0	17.48
Plant material (leaf/leaf stalk)	17.07	4.4	15.15	325.27	6.08
Polychaete worm	4.88	0.25	3.03	15.54	0.29
Total	21.95	21.81	72.73	1276.8	23.85
Number of stomachs examined	399				
Number of empty stomachs	201				
Vacuity index	50.37%				

Cn = percentage numerical abundance, *Cp*= percentage point, *F*= percentage frequency of occurrence
IRI= Index of Relative Importance

4. Discussion

Vacuity index of 50.37% in this study is higher than that reported for the species in the Lagos lagoon [10] and the Cross River estuary [3] showing a reduction in feeding activity of *P. elongatus* in Imo river estuary. This probably indicates that the requisite prey items are relatively less abundant in the station under study. While the largest size group engage in more feeding expedition than other size groups, there was no clear ontogenetic pattern in feeding intensity. Increased feeding activity in very large fish may be due to increased mouth gape. Large fish are also less vulnerable to predators during feeding and therefore indulge in greater foraging activity [3]. Bigger fish are faster and better able to handle prey [11]

Seasonal variation in vacuity index showed a higher feeding activity in the dry season than during the rainy season. Similar trend has been reported for *Brienomyrus brachyistus* [12] and *P. elongatus* of the Cross river estuary [3] The trend is an adaptation towards ensuring the availability of energy for the breeding activity of *P. elongatus* which reaches its peak in the dry season [6]. Higher foraging activity in the dry season may also be attributed to higher temperature associated with the season [13, 14] with its attendant increase in metabolic activities. Thus, the species fed more in the dry season to meet up with the increased metabolic demand linked with elevated temperature.

The overall food composition of *P. elongatus* was principally carnivorous. The narrow trophic spectrum of this species depicts a highly specialized feeder. Major dietary items were shrimps (Crustaceans) and juvenile fish (Pisces).Both categories of food items are of immense nutritional benefit. Shrimps dominates the trophic spectrum of these species probably because they are easy to capture and have a large population in the estuary.

Inspite of the high trophic specialization of this species as seen in this study, the occurrence of other minor food items such as plant materials and polychaete worms gives credence to the inherent ability of *P. elongatus* to expand its dietary spectrum to minimize competition for food between conspecifics and congeners. The occurrence of plant materials in the stomach of *P. elongatus* only during the rainy season had earlier been reported in the species caught in the Cross river estuary where they were categorized as allocthonous food materials brought in as a result of the expanded habitat of fish [3] They are of less nutritional worth than animal preys but their presence in the stomach give satiation in addition to increasing gastric evacuation rates which compensate for their low assimilation efficiency [15].The presence of Polychaete worms in the stomach of this species is worthy of note and seem unique to the Croackers of Imo river estuary as they were not observed in the species of the Cross river estuary. However, Polychaetes are known to be the main food supply of many commercial fishes and shrimps (Per. Com).

5. Conclusion

On the whole, this investigation reveals that *P. elongatus* of Imo River estuary though largely carnivorous, has the capacity to expand its dietary spectrum to reduce competition. It however subsists in an ecological setting that may be less productive than its congeners in the Cross River estuary and Lagos lagoon.

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