Food and Feeding Habits of the Big-eye Grunt, *Brachydeuterus auritus* (Valenciennes, 1831) in the Coastal Waters off Tema, Ghana

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Abstract

Examination of 424 stomach contents of Big-eye grunt, *Brachydeuterus auritus* from May and September to December 2016 showed four major food groups. By a decreasing order of abundance, these are: crustacea (64%), fish (35%), molluscs (0.4%) and insects (0.3%). Anchovies were the commonest prey types, with a frequency of occurrence of 53.6%, followed, among the crustaceans, by lobster larvae (34.5%) and shrimp larvae (5.3%). Crab zoe larvae and crab shell had very low frequencies (<1.0% each). Molluscs, represented by squid and juvenile cuttlefish, and insects, represented mainly by chironomid larvae, both had very low frequencies (<1.0). A low feeding intensity was recorded in October and November, a period coinciding with the highest number of fish with empty stomachs. Conversely, a greater feeding activity was recorded in May, September and December, a period coinciding with the highest number of fish with ¼, ½, ¾ and full stomachs. The proportion of crustaceans in stomach contents increased significantly with increasing size of *B. auritus*, while the proportion of fish significantly decreased with age of fish. It is recommended that stomach content analysis of this fish species be replicated to cover all seasons and other geographical areas.

Keywords: Big-eye grunt, *Brachydeuterus auritu*s, diet, feeding habits, coastal waters, Tema, Ghana

Introduction

The Big-eye grunt, *Brachydeuterus auratus* belongs to the Taxonomic Family Haemulidae. It is distributed in the tropical and sub-tropical waters of eastern Atlantic where it occurs at depths of 10 to 100 m (Ali et al., 2018; Zan-Bi et al., 2022). It is a major fishery target throughout its range, from Morocco to Angola. The species inhabits areas with sandy and muddy substrates, remaining near the bottom during the day and moving into open waters at night to feed (IUCN, 2015). In terms of conservation status, the species has been categorized as Near Threatened (NT) according to the IUCN Red List of Threatened species 2017 (www.iucnredlist.org). There are about five different species belonging to this family which occur in the coastal waters of Ghana. The Big-eye grunt, commonly called Burrito, is the smallest of all the family members, yet it is the most commercially important species of the Family in terms of abundance and quality (Ali et al., 2018; Amponsah et al., 2017). It is encountered in large quantities in catches of artisanal fishermen engaged in Ghanaian coastal fishing operations (Amponsah et al., 2016). It is exploited with a variety of fishing gears, including bottom trawls, gill nets, set nets, beach seines and purse seines. Little wonder *B. auritus* is the most exploited species of the Haemulidae Family along the coastline of Ghana (Kwei and Ofori-Adu, 2005; Aggrey-Fynn and Sackey-Mensah, 2012).

Food and feeding habits studies are helpful in identifying some of the high level trophic relations in an ecosystem (Dadzie, 2007).

From a practical standpoint, information on the quantity and quality of food consumed by fish is needed for estimating fish production (Paloheimo and Dickie. 1970; Mills and Fournier, 1979; Murphy and Willis, 1996). In addition, knowledge of the feeding ecology of commercial as well as non-commercial fish species is essential for implementing a multispecies approach to fisheries management (Gulland, 1977).
As already established, in the coastal waters of Ghana, *B. auritus* contributes to the multispecies commercial fishery. Despite its commercial importance, only scanty information exists on its food and feeding habits locally (Blay et al., 2006). Regionally, there is a similar dearth of information on this important aspect of fishery biology (Ikusemuju et al., 1979; Adebiyi, 2012; Nunoo et al., 2013). The present study was, therefore, carried out to add to the limited knowledge of the trophic niche of this species within the ecosystem. The objectives of this study were to describe: (1) food items, (2) frequency of occurrence of different food items in the stomach, (3) proportion of major prey groups in the stomach (4) feeding intensity, (5) food in relation to fish size, (6) gravimetric composition of food and (7) relative importance of food items.

Materials and Methods

Sampling site

Fresh samples of *B. auritus* were randomly collected from fishermen's catches from the Ghana coastal waters of the Gulf of Guinea, at the Tema Fishing Harbour lying at 5°40'0"N, 0°0'0"E and covering an area of 1.7 million square metres (Figure 1). The samples were collected during a 5-month period – in May, 2016 and from September to December, 2016. A total of 424 samples were transported to the laboratory on ice.

Data analyses

Upon arrival at the laboratory of the Department of Animal Biology and Conservation Science (DABCS), the total length (TLcm) and standard length (SLcm) of each fish and their corresponding body weights (g) were taken. The fish were then dissected and the degree of stomach fullness assessed according to the subjective scale described by Lebedev (1946) as empty, ¼ full, ½ full, ¾ full or full. The data were then used to calculate a monthly fullness index (FI) as follows:

$$FI = \frac{\textit{Number of stomachs with the same degree of fullness}}{\textit{Total number of stomachs examined}}$$

The gut was then excised and weighed (g) together with its contents. The stomach contents were then emptied into a Petri dish suspended in water under a microscope, and all prey items identified to the lowest possible Taxon using the identification guides of Carpenter and De Angelis (2014, 2016). Prey items that were partly or completely digested were grouped together and described as detritus/miscellaneous. The contribution of each food type to the diet and the frequency of occurrence were determined according

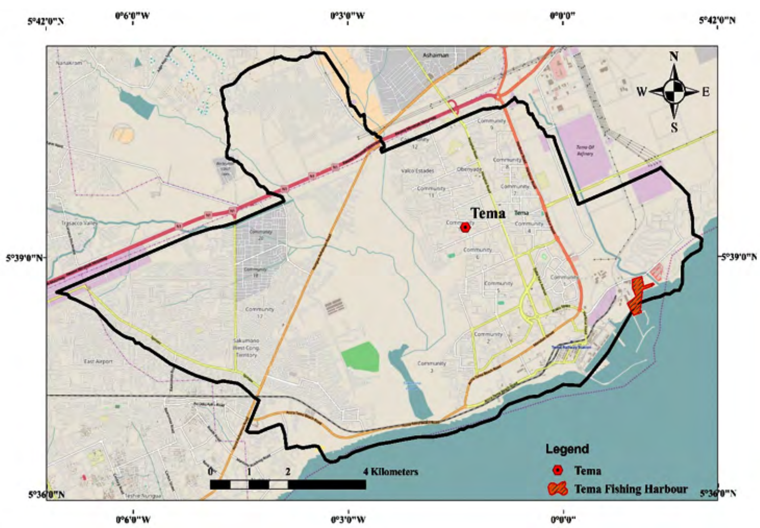

Figure 1 Map of the coastal area of Tema showing the fishing area

to Hynes (1950) as the number of stomachs in which a prey item occurred, expressed as a percentage of the total number of stomachs examined. The proportion of prey items identified in each group in May and from September to December 2016, were determined according to the number method (Bowen, 1985) as the number of food items of each food type for each fish examined expressed as a percentage of the total number of items counted.

The variation in diet with length of *B. auritus* was investigated according to Dadzie (2007) by re-grouping the fish into size classes at 3.0 cm standard length (SL) intervals and assessing the gut contents based on the major food groups with an occurrence of 10% or more in the stomachs, using the percentage occurrence data. The gravimetric composition of the major food groups was determined as the bulk weight of the food groups expressed as a percentage of the total weight of all the food groups. The Index of Relative Importance (IRI) was determined using the formula of Cortes (1997) as follows:

$$IRI = (Cn + Cw)\ \% \times FO$$

Where: Cn = Percentage composition by number of a particular food item, Cw = Gravimetric percentage composition of a particular prey item and FO = Percentage of frequency of occurrence of food

Results

Food items

The trophic spectrum of 424 stomachs of *B. auritus* analyzed were classified into four major categories: crustaceans, fish, molluscs and insects, together with data on their monthly fluctuations (Table 1). Crustaceans were represented by shrimp larvae (*Penaeus* sp.), lobster larvae, crab zoe larvae (*Callinectes* sp.) and crab shells, while fish were represented by anchovies (*Engraulis encrasicolus*) and juvenile bonga shad (*Ethmalosa fimbriata*). Of the insects, chironomid larvae, *Clunio* sp. and other unidentified insects were present, followed by molluscs which were represented by pencil squid (Loliga forbesii) and cuttlefish (Sepia hierreda).

Frequency of occurrence of different food items

The four major food categories established from the samples during the study yielded 10 Taxa, excluding detritus (Figure 2). Anchovies were the commonest food item recorded from the stomachs during the study, occurring at the highest frequency of 53.6%. Lobster larvae followed at a frequency of 34.5%, then shrimp larvae (5.3%). The rest of the food items, including other species of fish, crustaceans, molluscs and insects occurred at very low frequencies (<1.0%). The monthly frequency of occurrence did not show a

TABLE 1

Numerical and percentage frequency of occurrence of various food items of *Brachydeuterus auritus* in May and from September to December 2016

Major prey group	Food items	May		Sept.		Oct.		Nov.		Dec.	
		No.	%	No.	%	No.	%	No.	%	No.	%
Crustacea	Shrimp larvae	9	11.3	0	0	1	1.0	1	1.43	11	14.3
	Lobster larvae	59	73.8	1	1	24	24.7	21	30.0	35	45.5
	Crab zoe larvae	3	3.8	0	0	0	0	0	0	0	0
	Crab shell	0	0	0	0	1	1.0	0	0	0	0
Fish	Anchovy	20	25.0	83	83	46	47.4	19	27.1	66	85.7
	Juvenile bonga shad	0	0	0	0	1	1.0	0	0	0	0
Insect	Chironomid larvae	2	2.5	0	0	0	0	1	1.42	0	0
	Others	0	0	1	1	0	0	0	0	0	0
Mollusc	Squid	1	1.25	0	0	0	0	0	0	3	3.9
	Juvenile cuttlefish	0	0	0	0	0	0	0	0	1	1.3
Detritus		71	88.8	41	41	87	89.7	58	82.9	56	72.7
Total no. of fish examined		80		100		97		70		77	

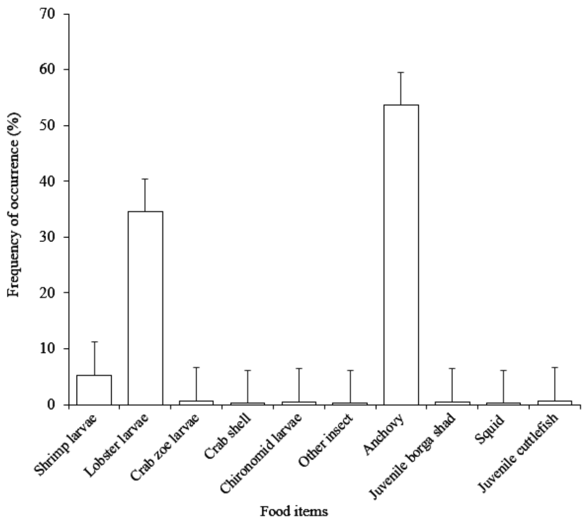

Figure 2 Frequency of occurrence of different food items in the diet of *Brachydeuterus auritus* in May and from September to December, 2016. Vertical bars indicate standard deviations

statistically significant difference as revealed by the one-way ANOVA test ($F_{calculated}$ (0.69) <$F_{critical}$ (5.32)).

Feeding intensity

The stomach fullness index revealed monthly variations (Figure 3). The highest proportions of ¼ full stomachs and ½ full stomachs were recorded in May (25%) and December (22.1%), respectively. Three-quarter full stomachs recorded their maximum proportion also in May (42.5%). The highest proportion of empty stomachs was recorded in October (54.6%), while full stomachs dominated the samples in December (54.5%). There was evidence of an increase in empty stomachs as the months progressed, except in November and December.

Gravimetric composition of food

Fish exhibited the highest gravimetric percentage composition of food (75.8%), followed by crustaceans (22.5%). Molluscs recorded a gravimetric percentage composition of 1.5%, with insects registering the lowest value of 0.2% of the stomach contents (Figure 4).

Food in relation to fish size

Only two major food groups impacted significantly in virtually all the size classes of the samples investigated. With the appearance of crustaceans in the stomach of the smallest size-class fish, the frequency of occurrence

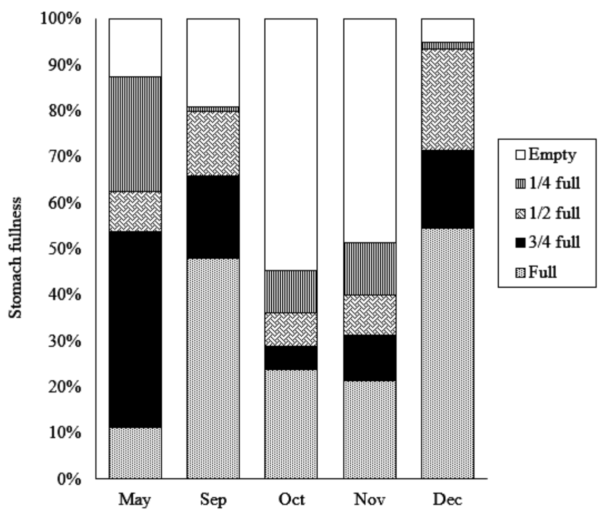

Figure 3 Monthly variations of stomach fullness of *Brachydeuterus auritus* in May and from September to December, 2016

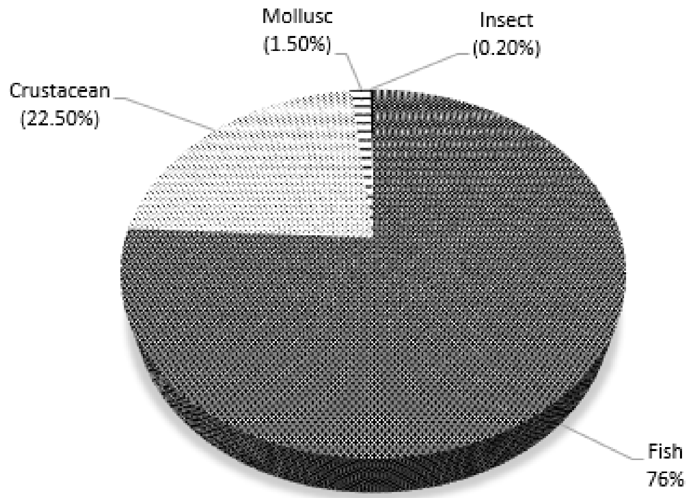

Figure 4 Gravimetric composition of the major food groups of *Brachydeuterus auritus* in May and from September to December, 2016

of this food item increased significantly with increasing fish size (r=0.952, $p<0.05$). On the other hand, the proportion of fish diet which was the highest in the smallest size group significantly increased with increasing size of fish (=-0.49, $p<0.05$) (Figure 5).

Relative importance of food items

The mean proportions of the total prey items contributed by each prey group during the entire study and their relative importance are summarized in Table 2. Crustaceans accounted

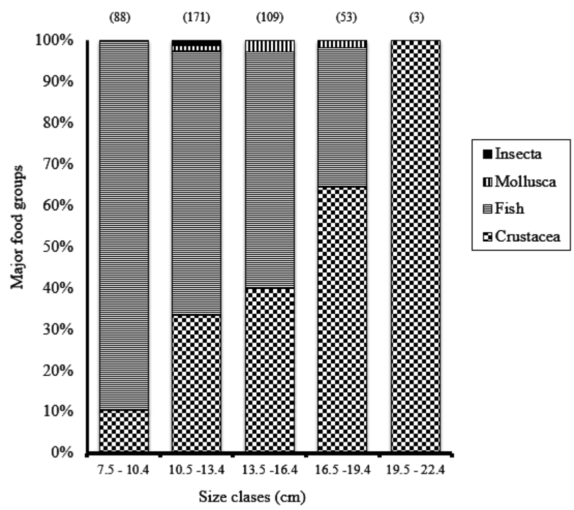

Figure 5 Composition of *Brachydeuterus auritus* among size-classes based on percentage occurrence of the major food groups. Figures in parentheses indicate sample size

TABLE 2

Relative importance of dietary items to *Brachydeuterus auritus* off the coastal waters of Ghana

Dietary items	Number (%)	Occurrence (%)	Weight (%)	IRI
Crustaceans	63.90	38.4	22.5	3317.76
Fish	35.40	55.2	75.8	6138.24
Molluscs	0.33	0.9	1.5	1.65
Insects	0.28	0.9	0.2	0.432

for 63.9% by number, 38.4% by occurrence and 22.5% by weight. Fish accounted for 35.4% by number, 55.2% by occurrence and 75.8% by weight. Other food items like molluscs accounted for 0.3% by number, 0.9% by occurrence and 1.5% by weight, while insects accounted for 0.3% by number, 0.9% by occurrence and 0.2% by weight. In terms of relative importance, fish was the most important food group with an index of relative importance of 6,138.2, followed by crustaceans (3,317.8), then molluscs (1.7) and, finally, insects (0.4).

Discussion

From the results of this study, it is evident that *B. auritus* in the coastal waters of Tema, feeds on a narrow range of food items, consisting mainly of crustaceans and fish, with molluscs and insects constituting an insignificant part. This is clear evidence of stenophagy, and is in conformity with the findings of Blay et al. (2006) in the same coastal waters of Ghana and also with those of Ikusemiju et al. (1979) and Adebiyi (2012) in waters of the Lagos coast in Nigeria. These findings suggest that the species is a highly carnivorous fish in its food habits.

There are two types of predatory fish: piscivorous predatory fish and non-piscivorous predatory fish. According to Adebiyi (2012), piscivorous predatory fish is the fish species that has fish constituting its major dietary items, whereas non-piscivorous predatory fish has other macroscopic animals other than fish as its major dietary items. The author, therefore, reported in his study on *B. auritus*, that the species could be regarded as a non-piscivorous predatory fish because crustaceans constituted its major dietary items. In contrast, in their studies on Haemulidae fishes of the North-Eastern Atlantic and the Mediterranean, Ben-Tuvia and Kay (1986), categorized *B. auritus* as a piscivorous predator. In the present study, crustaceans were the major prey items in the stomach of the species on monthly basis, in conformity with the suggestion of non-piscivory by Adebiyi (2012). However, viewed in the context of total consumption of individual food items throughout the study period, fish, specifically anchovies were the greatest food items consumed. Based on our evidence, *B. auritus* may be regarded both as piscivorous and non-piscivorous predator.

Monthly variations were observed in the patterns of feeding intensity investigated through the analyses of fluctuations in stomach fullness indices. *Brachydeuterus auritus* fed most intensively in December, recording the highest number of full stomachs. This may be due to the high availability of food during this month as a result of favourable conditions (Blay et al., 2006). However, the highest proportion of empty stomachs was observed in October. Feeding intensity varies with size, the reproductive cycle, season and the environment. Spawning activities have been synchronized with low feeding intensity (Dadzie et al., 2000; Stergiou, 1998; Kurup, 1993). This suggests that *B. auritus* probably spawns in October after which intensive feeding takes place culminating in the highest proportion of full stomachs observed in December. This is in agreement with the findings of Asabre-Ameyaw (2001) and Ali et al. (2018) that the species spawns during the upwelling seasons, that is, between July and October in Ghana. In terms of ontogenetic changes in food habits, the results of this study revealed a major shift from a piscivorous diet in the young *B. auritus*, to a diet of crustaceans as it grows in size. This observation confirms the results of earlier investigators on the subject, including those of Dadzie (2007), Lukoschek and McCormick (2001) and Dadzie et al. (2000).

Overall, the highest recorded preys in the present study were crustaceans. In terms of occurrence and gravimetric composition; however, fish had the greatest proportion. A further analysis using the Index of Relative Importance which consolidates numerical, occurrence and gravimetric methods, revealed that fish is the most important prey item to the Big-eye grunt, followed by crustaceans. Molluscs and insects were totally unimportant as they were the least in terms of indices of relative importance as compared to fish and crustaceans. These findings are in conformity with those of Blay et al. (2006) in *B. auritus* off the coast of Cape Coast, Ghana. In contrast, reports on this fish from Nigeria indicate that crustaceans are the most important prey items, followed by algae, then fish (Adebiyi, 2012). These differences in the preferred food items of the species may be accounted for by the availability of the dietary items in the environment in which the fish inhabits. It is recommended that stomach content analysis of this fish species be replicated to cover all seasons and other geographical areas. In addition, fisheries management efforts should include not only the conservation of pelagic fish species, but also the conservation of demersal species including *Brachydeuterus auritus*, which are also of commercial importance to Ghanaians.

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