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Food and feeding habits of *Gnathonemus petersii* (Osteichthyes: Mormyridae) in Anambra River, Nigeria

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Abstract

The food and feeding habits of *Gnathonemus petersii* (Osteichthyes: Mormyridae) were investigated for a period of 18 months in the Anambra river. Fish samples were collected monthly at Otuocha and Ogurugu river ports along the Anambra River using multiple fishing gears. The most dominant food group was Insecta (IFS = 48.23) followed by detritus (IFS = 31.07) while the least was Arachnida (IFS = 0.20). Variation in the stomach fullness condition showed that 64 (19.10%) of the studied stomach were empty, 71 (21.19%) were full, while 200 (59.70%) were partially (1/2, 1/4 and 3/4) filled. Stomachs were generally full during the rains when feeding intensity was high while partially filled stomachs predominated in the dry season. Whereas the IFS of five (5) food categories were higher in females, only three (3) were higher in the males (*t*-test, $P < 0.05$ in all cases). Other food categories were not sex dependent. Food richness and diet breadth showed no significant difference between the sexes but not seasons. The trophic variations in *G. petersii* in relationship with the physiochemical parameters of the river are discussed.

Keywords: *Gnathonemus petersii*, Food, Feeding habits, Anambra River, Nigeria

Introduction

Gnathonemus pertesii (Günther, 1862) is one of the mormyrid species inhabiting fresh waters of Nigeria like Ogun, Lower Niger, Benue, Cross and Anambra rivers. Imevbore and Bakere (1970) reported that *Gnathonemus deboensis, G. pictus, G. senegalensis* and *G. tamandua* fed almost exclusively on the larvae of benthic insect families such as larvae of *Chironomidae, Ephemeropterae, Ceratopogonidae, Chaoboridae* and *Trichoptera*. Blake (1977) reported that the mormyrid fishes of Lake Kanji fed heavily on *Povilla species* and Chironomidae larvae. Tuegels et al. (1992) reported that *Gnathonemus petersii* of Cross River basins fed heavily on benthic insects predominantly midge larvae and cadis fly larvae (Chironomidae and Trichoptera respectively).

Other reports on food and feeding habits of some mormyrid species in Nigeria include Hyslop (1986) on Mormyridae from the flood plain pools of the Sokoto River basin, King (1989) on *Brienomyrus brachyistus* (Gill 1862) in a Nigerian rainforest stream, Teugels et al. (1992) on the mormyrids of the Cross River Basin, Ikomi (1996) on the growth pattern, feeding habits and reproductive characteristics of the Mormyrid *Brienomyrus*

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longianalis (Boulenger 1901) in the Upper Warri River, Nigeria, Kouamelan et al. (2000) on the effects of a man-made lake on the diet of the African electric fish, *Momyrus rume*, Nwani (2004) on the biology of Morymyrids (Osteichthyes: Mormyridae) in Anambra River, Nwani et al. (2006 a,b) on the food and feeding habits of *Campylomormyrus tamandua* and *Hyperopisus bebe* respectively among others. Notwithstanding its enormous importance, knowledge on the food and feeding habits of *Gnathonemus petersii* in Anambra River is scarcely known. This study is an attempt to fill this information gap and focuses on feeding intensity, diet composition, sex and seasonal variation in the diet of *G. petersii.*

Description of the study area

The Anambra River has its source from Ankpa highlands of Kogi State of Nigeria. It lies between latitude $6^{\circ}10'N^{-}$ and $7^{\circ}10'N^{-}$ and longitude $7^{\circ}40'E^{-}$ East of river Niger. The climate is characterized by a rainy season (April – September/October) and a dry season (November – March). The ranges of some physicochemical parameters of the water are: water temperature 21.19 – 28.40 $^{\circ}C$, transparency 0.40–1.40 m, and water depth 4.70 – 6.67 m. The vegetation in the basin is guinea savanna but the lentic water bodies are often fringed with macrophytes like *Pterocarpus sp., Jussiaea sp., Eupatorum sp., Pennisetum sp., Cyndon sp,* and, in some areas, *Raphia hookeri*.

Materials and methods

Fish specimens were collected monthly around Otuocha and Ogurugu river ports along the Anambra River from October 2004 to March 2006 using gill nets of mesh sizes 38.1mm, 63.5 mm, 76.2 mm, 101.6 mm and 177.8 mm, traps, hook and lines. Fish collected were preserved in ice and transported to the laboratory for analysis. Identification of fish specimen was done using the keys of Holden and Reed (1972), Lowe-McConnell (1972), Teugels et al. (1992) and Olaosibekan and Raji (1998). The stomach of each fish was dissected out and its degree of fullness estimated by arbitrary 0–20 points scale thus 0, 5, 10, 15, and 20 points, representing empty, 1/4, 1/2, 3/4 full and fully distended stomachs respectively. The percentage of empty stomachs (ES), full stomachs (FS), partially filled stomachs (PS) i.e. (1/4, 1/2 and 3/4 full) was used to evaluate patterns of feeding activity. Stomach contents were sorted out into categories and analyzed using relative frequency (RF) methods (Hyslop 1980; King 1988). Thus:

$$\%RF = (a_i/n)\ \Sigma A_{i=1}$$

Where, a_i = frequency of item a
A = sum of all a_i values
n = number of stomachs examined

For the percentage point (%PP) scheme, each stomach was allotted 20 points regardless of the fish size and these were shared amongst the various categories of food taking into account their relative proportion by volume. The points gained by each food item in all stomachs examined were computed and expressed as a percentage of the total points of all food items. The %RF and %PP were then used to compute the index of food significance as follows:

$$IFS = \frac{\%RF \times \%PP}{\sum \%RF \times \%PP} \times \frac{100}{1}$$

Where RF = relative frequency, PP = percentage point.

IFS ≥ 8 was regarded as primary, IFS ≥ 3 but < 8 as secondary whereas food with IFS < 3 was incidental. The IFS data was used to compute diet breadth based on Shannon–Weiner function (H) as follows:

$$H\ (IFS) = -\sum (n_i/N) \ln (n_i/N)$$

Where ni = IFS of each food item, N = total IFS of all food items.

Food richness was defined as the number of food items in the diet (King et al. 1988). Seasonal variation in stomach fullness condition was evaluated by one way analysis of variance (ANOVA). Differences were considered significant at 5% level of probability.

Results

Feeding intensity

The overall stomach fullness condition showed that out of the 335 samples of *G. petersii* stomachs examined, 64 (19.10%) were empty, 71 (21.19%) were full and 200 (59.70%) were partially filled. Among the partially filled stomachs 70 (20.90%) were 1/4 full, 63 (18.81%) were 1/2 full while 67 (20.00%) were 3/4 full. The monthly variation in the stomach fullness condition (Fig. 1) indicates that the peaks of full stomachs (FS) were in September

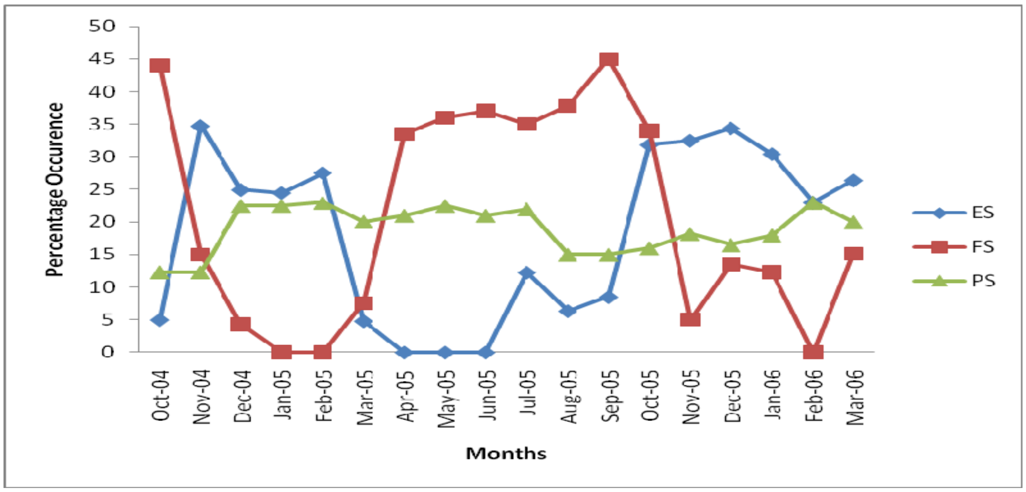

Fig. 1. Monthly variations in the stomach fullness condition of *Gnathonemus petersii* in Anambra River

Table 1. Trophic spectrum of the diet of all sizes of *Gnathonemus petersii* in Anambra River

Dietaries		%RF	%PP	IFS
Algae:	Filamentous algae	5.70	4.45	4.26
	Colonial algae	2.47	2.16	0.90
Unicellular algae	Diatoms	2.80	2.20	1.04
	Desmids	0.02	0.03	0.20
	Euglenids	3.21	2.70	1.26
Benthic invertebrates:				
	Chironomid larvae and pupae	14.91	20.80	26.89
	Unid dipteral larvae	4.01	3.85	2.59
Odonata	Anisoptera larvae	3.76	2.80	1.77
	Ephemeropteran larvae	4.75	5.07	4.05
	Trichoptera larvae	4.20	5.00	3.53
Crustacea	Ostracoda	2.20	2.75	1.28
Arachnida	Hydracarina	0.15	0.14	0.20
Allochthonous invertebrates				
Hymenoptera	Formiicidae imagines	5.50	8.01	7.40
	Lepidopteran larvae	4.02	3.25	2.20
Diplopoda	Polydesmida	0.03	0.01	0.40
Miscellaneous invertebrates		4.30	4.77	3.25
Zooplankton				
Crustacea - Cyclopod Copepods		3.06	1.89	0.97
Cladocera -	Bosmina	1.99	1.50	0.50
Rotifer -	Keratella	2.04	0.80	0.27
Macrophyte materials				
	Leaf fragments	6.20	5.94	6.19
	Seeds	0.30	0.08	0.20
Detritus				
Coarse particulate organic matter		6.60	750	10.32
Fine particulate organic matter		5.30	4.95	4.41
Mud/Sand		11.04	9.35	16.34

and October (rainy season). These months corresponded to the periods (April to October) when the empty stomachs (ES) were lowest. Partially filled stomachs (PS) were highest after the rains particularly in February.

With respect to seasonal variation in stomach fullness condition, empty stomachs (ES) and 1/4 full stomachs were dominant during the dry season while full stomach (FS) was dominant during the wet season (Fig. 1). There was also significant dry season increase in empty stomachs ($P < 0.05$) and ¼ full stomach ($P < 0.05$). There was no significant difference between the seasons in 3/4 full ($P > 0.05$) and ¼ full ($P > 0.05$) stomachs respectively.

Diet composition

Twenty-four food items were recorded in the diet of *G. petersii* (Table 1), these include, mud/sand (%RF = 11.04), Chironomid larvae (%RF = 8.90) and coarse particulate organic matter (%RF = 6.60). Chironomid larvae contributed the highest value (14.20%) in the percentage point (%PP) whereas mud/sand (%PP = 9.35) and Formicidae imagines (%PP = 8.01) followed respectively. The least value was recorded in Polydesmida (%PP = 0.01). Considering the value for the index of food significance (IFS) of each food group, benthic invertebrates were the most dominant group (IFS = 40.31%) followed by mud/sand (IFS = 16.34%). Food of primary importance (IFS ≥ 8) was coarse particulate organic matter, mud/sand and Chironomid larvae and pupa. Eight food categories were of secondary importance (IFS ≥ 3 ≤ 8) while fourteen others were of minor incidental importance (IFS < 3). Other food items were of minor (incidental) importance (IFS < 3).

Table 2. Seasonal variation in the IFS of *Gnathonemus petersii* in Anambra River

Dietaries		Dry season	Rainy season	P*
Algae	Filamentous algae	1.64	1.27	NS
	Colonial algae	-	0.56	
Unicellular algae	Diatoms	1.05	1.60	NS
	Desmids	-	1.30	
	Euglenids	1.92	2.41	NS
Benthic invertebrates				
	Chironomid larvae and pupae	14.67	21.44	<0.05
	Unid dipteral larvae	6.47	4.29	NS
Odonata	Anisoptera larvae	-	2.63	
	Ephemeropteram larvae	6.59	7.40	NS
	Trichoptera larvae	10.52	5.06	<0.05
Crustacea	Ostracoda	1.05	1.31	NS
Arachnida	Hydracarina	1.55	1.16	NS
Allochthonous invertebrates				
Hymenoptera	Formiicidae imagines	2.10	6.30	<0.05
	Lepidopteran larvae	4.41	4.59	NS
Diplopoda	Polydesmida	-	0.08	
Miscellaneous invertebrates		6.85	4.48	NS
Zooplankton				
Crustacea - Cyclopod Copepods		2.70	1.26	NS
Cladocera -	Bosmina	2.56	0.72	NS
Rotifer -	Keratella	-	0.14	
Macrophyte materials				
	Leaf fragments	2.29	5.73	<0.05
	Seeds	2.63	7.94	<0.05
Detritus:				
Coarse particulate organic matter		13.40	8.00	<0.05
Fine particulate organic matter		5.83	2.42	<0.05
Mud/Sand		12.79	9.09	<0.05
Food richness		19	24	
Diet breadth		2.75	2.83	

* = Probability at 0.05, NS = No significant difference ($P > 0.05$).

Seasonal variation in the diet

The seasonal variation in the diet of *G. petersii* (Table 2) shows that food richness, diet breadth and qualitative food composition were all season dependent. While four (4) food items (Chironomid Larvae and pupae, Trichoptera larvae, Coarse particulate Organic matter and Mud/Sand) were of primary importance (IFS ≥ 8) in the dry season, three (3) items (Chironomid Larvae and pupae, Coarse particulate Organic matter and Mud/Sand) were of primary importance in the rainy season. The IFS of five (5) food items were higher in the dry season ($P < 0.05$), whereas three (3) were higher in the rainy seasons ($P < 0.05$). The IFS of other food categories were not season dependent. Diet breadth and food richness were both higher in the rainy than dry season.

Sex variation in the diet

The sex variation in the qualitative food composition in *G. petersii* is presented in Table 3. Whereas the IFS of five (5) food categories were higher in females ($P < 0.05$), only three (3) were higher in the males ($P < 0.05$). Other food categories were not sex dependent. Three (3) food categories each were of primary importance in both the males and females. Food richness and diet breadth were both higher in the males than females ($P < 0.05$).

Table 3. Sex dependent variation in IFS of *Gnathonemus petersii* in Anambra River

Dietaries		Male	Female	P*
Algae	Filamentous algae	4.26	4.65	NS
	Colonial algae	2.84	-	
Unicellular algae	Diatoms	0.83	1.25	NS
	Desmids	-	0.09	
	Euglenids	1.49	1.50	NS
Benthic invertebrates				
	Chironomid larvae and pupae	26.68	32.82	<0.05
	Unid dipteral larvae	2.33	2.32	NS
Odonata	Anisoptera larvae	5.24	0.40	<0.05
	Ephemeropteram larvae	2.01	5.07	<0.05
	Trichoptera larvae	3.43	2.46	NS
Crustacea	Ostracoda	1.19	2.27	NS
Arachnida	Hydracarina	-	0.69	
Allochthonous invertebrates				
Hymenoptera	Formiicidae imagines	10.60	4.10	<0.05
	Lepidopteran larvae	2.04	5.37	<0.05
Diplopoda	Polydesmida	0.19	-	
Miscellaneous invertebrates		3.43	2.50	NS
Zooplankton				
Crustacea - Cyclopod Copepods		0.60	1.87	NS
Cladocera -	Bosmina	0.34	-	
Rotifer -	Keratella	0.91	-	
Macrophyte materials				
	Leaf fragments	8.34	2.40	<0.05
	Seeds	0.24	-	
Detritus				
Coarse particulate organic matter		7.00	11.63	<0.05
Fine particulate organic matter		5.73	4.31	NS
Mud/Sand		10.30	14.30	<0.05
Food richness		22	19	
Diet breadth		2.70	2.47	

* = Probability at 0.05, NS = No significant difference ($P > 0.05$).

Discussion

The major food items of *G. petersii* in Anambra River were found to be Chironomid larvae and pupae, mud/sand and coarse particulate organic matter and these were found in all stomach containing food. The mud/sand was probably ingested along with food items during feeding. *G. petersii* is thus basically a bottom feeder as evidenced by the significant contribution of the bottom dwelling food items such as coarse particulate organic matter, mud/sand and other dipteran insects like Chironomid larvae and pupae to the total diet of the fish. Bottom feeding habit of other mormyrids have been reported by Lewis (1974), Olatunde and Moneke (1985), Ikomi (1996), Kouamelam et al. (1999), Fawole (2002), Nwani (2004) and Nwani et al. (2006, ab). *G. petersii* also fed substantially on food items of plant origin; this and other food items meet the carbohydrate needs of the fish, variations in feeding habits showed an increase in the stomach fullness during the rainy season and decrease in the dry season. The proportion of empty stomachs was higher in the dry season.

This may be due to a wide variety and abundance of food during the rains as a result of run-off and increase in volume of water and a dwindling of food supply during the dry season due to decrease in the volume of water. The food richness and diet breadth were higher in the rainy season than the dry season. This finding deviated form the optimal foraging theory (King et al. 1989) which stated that diet breadth expands during the time of scarcity and contracts during the period of plenty. This report however is in consonance with the reports of Lowe-McConnell (1972) and Welcomme (1979, 1985) that many tropical fresh water fishes have a broader trophic spectrum during the rainy (flood) season. Although there was no significant variation in the qualitative composition of the food of *G. petersii* in relation to the sexes, the relative proportion of the various food categories differed. Males fed more on leaf fragments, Anisoptera larvae and on formicoid hymenoptera whereas females ingested more coarse particulate organic matter, mud/sand, Chironomid larvae and pupae, Ephemeroptera larvae and Lepidoptera larvae.

Conclusion

In general, the large amount of detritus in the diet of both sexes of *G. petersii* is a survival strategy as it could be derived from the surrounding aquatic and terrestrial habitats. The high trophic flexibility exhibited by *G. petersii* in the feeding behavior thus, enables it to thrive in most riverine ecosystems of Nigeria.

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