Diet and dietary habits of the fish *Schilbe mystus* (Siluriformes: Schilbeidae) in two artificial lakes in Southwestern Nigeria

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Abstract: Diet and dietary habits of African Butter Catfish *Schilbe mystus* (Linne, 1766), an economically important fish in Oyan and Asejire lakes (Southwest Nigeria) were examined between July 2000 and December 2001. Stomach contents were analysed using the numerical, frequency of occurrence and points methods. The fish is predatory but the diet differs among lakes and seasons. Insects were more important in the diet of small (<than 18 cm) fish. There were also differences in the quantity of food encountered in the stomachs of male and female *S. mystus* in both habitats. The pattern of food selection and consumption in this species differed between the two lakes. Rev. Biol. Trop. 56 (4): 1847-1855. Epub 2008 December 12.

Key words: diet, *Schilbe mystus*, Oyan Lake, Asejire Lake, Southwest Nigeria.

Asejire and Oyan lakes are artificial lakes constructed on Osun and Ogun River respectively and these rivers are the main rivers in the basin of Southwestern Nigeria. There are indications of decline in catch of fishes of commercial importance qualitatively and quantitatively in both coastal and inland water systems due to overexploitation and environmental degradation (Jamu and Ayinla 2003). Studies on the aspects of biology of fin fishes such as growth pattern, reproduction, nutrition are necessary as they would furnish relevant information for the formulation of fisheries management policies (Everhart *et al*. 1975).

Schilbeids are found in African and Asian freshwaters (Greenwood 1957). Workers such as Whitehead (1969), Olatunde (1979a), Hickley and Bailey (1987), Merron and Mann (1995), Omondi and Ogari (1994), Ogari *et al.* (1995) had reported on food habits of members of family Schilbeidae in various African rivers/lakes. Previous works on the biology of the fish species in Asejire and Oyan lakes/rivers include that of (Fagade and Adebisi 1979, Adebisi 1981, 1987, Elliot 1986, Olurin 1994). All these reported on food and feeding habits of several species, so there is no detailed work on *Schilbe mystus* which is the only member of family Schilbeidae in both lakes. The species serves as delicacy for many low income earners as it is cherished for its taste and affordable price since it does not attain large size and its of considerable commercial importance (Reed *et al*. 1967). This paper describes the diet and dietary habits of *S. mystus* in Asejire and Oyan lakes, highlighting effects of size, season and sex on feeding.

MATERIALS AND METHODS

Study Site: Oyan lake lies within (07°15′-07°26′ N, 03°06′-03°16′ E). The dam is sited 20 km northwest of Abeokuta on Oyan River and it covers an area of 40 km^2, with a maximum depth of 63m. The lake has a maximum length of 27 km and a maximum width of 6 km.

Lake Asejire is constructed on River Oshun at about 30 km east of Ibadan, Nigeria. The lake lies on (04°07′ E–07°21′ N) at an altitude of 137 m above sea level. The entire length of the lake is 19.5 km.

Collection and Laboratory Examination of Specimen: Fish were caught using surface gill nets of 50-55 mm mesh size from Asejire and Oyan Lakes between July 2000 to December 2001. Identification of the species was performed according to Leveque *et al.* (1990, 1992). The fish were kept chilled in an ice chest immediately after capture and brought to the laboratory for post-mortem examination. Specimens were measured (±0.5 cm), weighed (±0.5 g) and sex was determined externally by the presence of genital papilla which are conelike projections of the genital aperture of the males and are absent in females. The stomachs were taken out, opened and contents were emptied on absorbent paper for removal of excess water and weighed to the nearest 0.01 g. An index of fullness (total mass of stomach contents as a percentage of total mass of each predator; Arnauld and Hureau 1966) was estimated. Student t-test (Sokal and Rohlf 1987) was used to test the significance of the difference of mean fullness index values between seasons, size groups and sex. An index of stomach vacuity (V) was estimated as the percentage of the empty stomachs to the total number of stomachs analyzed. The stomach contents were poured into Petri dish and observed with unaided eyes. Then, random samples of the contents were taken and dropped on slides with aid of a dropping pipette and observed under a light microscope.

The contents of the stomach were identified to the species level where possible and analysed by the frequency of occurrence, numerical (Bagenal 1978) and point's methods as described by Hynes (1950). Since each of these methods emphasizes the importance of different categories of food items, the relative importance index of each food item based on the absolute importance index (AI) (George and Hadley 1979, Hyslop 1980) was calculated as follows.

$$RI = 100\frac{AI}{\sum_{i}^{n} AI}$$

where;
RI = relative importance index
AI = absolute importance index;
AI = % occurrence + % total numbers + % total point (substituted for % total volumes
n = number of different food items.

The specimens examined were divided into two size groups, smaller specimens (9-17.9 cm) and larger sized specimens (18-24 cm) in order to establish if there were changes in the types of food items consumed in relation to size.

RESULTS

Fullness of Stomach

Oyan Lake: Out of 1 540 specimens of *S. mystus* examined, 8% of their stomachs were fully filled with food. There were more specimens with empty stomachs in dry season (68.3%), larger size group (81.7%) and females than wet season (53.6%), small size group (50%) and males (42.5%) respectively (Table 1). The mean stomach fullness index of the smaller size group (9-17.9 cm) is significantly different from the 18-24 cm group (t-test, $p>0.05$). Between sex (t-test, $p>0.05$) and seasons (t-test, $p>0.05$) there is no significant difference. However, more food was encountered in the stomachs of males and during the dry season.

Asejire Lake: 8.4% of specimens examined had their stomach fully filled with food. The stomachs that lacked food were 44.2%, 57.1%, 56.8% and 26.2%, for 9-17.9 cm, 18-24 cm males and females respectively (Table 1). More empty stomachs were encountered in wet season (51.9%) than dry period (43.6%). The mean stomach fullness index of larger size group is significantly different from smaller size group (t-test, $p>0.05$). There is no

TABLE 1
Variation in percentage stomach vacuity index (V) and mean stomach fullness index (B ± S.E) with season, size and sex of Schilbe mystus in Asejire and Oyan Lakes, Southwestern Nigeria

Parameter	V%		B±S.E	
	Asejire Lake	Oyan Lake	Asejire Lake	Oyan Lake
Season				
Dry	43.55	68.28	2.50 ± 0.47	2.76 ± 0.46
Wet	51.88	53.59	2.56 ± 0.40	2.12 ± 0.28
Size (cm)				
9 – 17.9	44.15	50.00	*2.67 ± 0.38	*2.46 ± 0.25
18 – 24	57.14	81.65	1.29 ± 0.32	1.48 ± 0.29
Sex				
Male	56.76	42.53	1.45 ± 0.41	2.76 ± 0.19
Female	26.24	53.70	1.96 ± 0.53	1.98 ± 0.34

* - significantly different at p>0.05.

significant difference between sex and seasons (t-test, p>0.05).

Qualitative Assessment of Food Items: *S. mystus* fed on the same group of food items in both lakes, although some differences occur in the type/species. Food items from plant sources are diatoms, blue green algae, green algae, colonial algae (Table 2). Diatoms occurred more frequently in stomachs of species examined in Asejire (38.9%) than Oyan lakes (14.7%) but by numerical and points methods, diatoms are more important as food of the species in Oyan (20.1% and 2.4%) respectively than in Asejire lake (6.6% and 1.1%) respectively. Navicula was not included in the contents of stomachs of the species in Asejire Lake. Blue green algae were encountered more in stomachs examined in Oyan Lake than Asejire Lake. *Coelospharium* the dominant blue green algae in diet of this species in Oyan lake was not encountered in stomachs examined in Asejire Lake. *Spirulina* is common in stomach content of species in both lakes. Colonial algae were encountered frequently in diet of *S. mystus* in both lakes. Higher plant parts, were only encountered in the stomachs examined in Asejire Lake.

Both invertebrates and vertebrate animals were also included in the diet of *S. mystus* in both lakes. Insects and their appendages were encountered more frequently in contents of stomachs of *S. mystus* in both lakes than any other food items. Lepidoptera larvae, Odonata and Orthoptera were the least utilized insect food by the species in Asejire Lake and they were not encountered in the stomach of species in Oyan Lake. Crustaceans encountered in the diet of species in Asejire lake were *Macrobrachium* and *Cladocera*, while in Oyan lake Ostracods were also included in the diet. More fish species (Mormyrid and *Hyperopsusus bebe occidentalis* (Gunther), *Oreochromis niloticus*, and catfish) could be identified in the stomach of *S. mystus* in Oyan Lake. Partly digested fish were encountered frequently in stomach content of the species in both lakes. Sand particles and unidentified organic matter were also included in the contents of the stomach of the species in both lakes.

Food in relation to size for *Schilbe mystus*

Oyan Lake: Table 3 indicates that RI values for insects and rotifers were higher in smaller size group (33% and 1.9%) respectively than in the larger size group (24.5% and 0%) respectively. For fish food items and crustaceans, the larger size group had higher RI of 20.2% and 5.3%, while smaller size group

TABLE 2
Summary of the stomach contents of Schilbe mystus in Oyan and Asejire Lakes, Southwestern Nigeria

	Asejire lake			Oyan lake		
Food Items	% Number	% Point	% occurrence	% Number	% Point	% Occurrence
Diatom						
Cyclotella	2.36	0.24	20.83	4.03	0.79	2.25
Synedra	2.88	0.86	12.5	11.76	1.04	2.25
Eunotia	1.35	<0.01	3.47	4	0.41	5.88
Melosira	0.03	0.02	2.08	0.13	0.06	2.67
Navicula	0.00	0.00	0.00	0.18	0.14	1.6
Blue green algae						
Spirulina	0.02	0.03	2.08	<0.01	<0.01	0.53
Coelospharium	0.00	0.00	0.00	1.99	3.59	4.81
Green algae						
Spirogyra	0.03	0.27	2.78	0.51	0.26	6.42
Colonial algae	86.4	22.34	34.7	60.31	22.58	36.36
Higher Plant Parts	0.32	1.72	0.46			
Rotifer						
Notholca	0.57	0.04	6.25	0.83	1.08	2.14
Insecta						
Insect appendages	2.29	14.25	72.92	5.94	22.35	83.95
Diptera larvae (maggot, *Chaoborus*)	0.76	4.69	11.89	<0.01	0.03	1.07
Lepidoptera larvae	<0.01	0.16	0.69	0.00	0.00	0.00
Ephemeroptera Nymph	0.03	0.72	2.08	0.02	0.44	2.14
Hemiptera	0.02	0.95	5.56	0.01	0.3	2.67
Coleoptera	0.06	6.81	9.72	0.04	2.06	5.88
Orthoptera	1.29	0.16	0.69	0.00	0.00	0.00
Isoptera	0.21	5.03	3.47	0.06	7.52	8.56
Odonata	<0.01	0.30	0.69	0.00	0.00	0.00
Crustacea						
Crustacean appendages	0.03	0.62	1.39	0.00	0.00	0.00
Crayfish/Prawn (partly digested)	<0.01	2.26	1.39	<0.01	2.43	1.07
Cladocera (*Daphnia*)	0.04	0.62	2.08	0.68	0.35	1.60
Copepod	0.00	0.00	0.00	0.03	0.41	4.28
Nematode	<0.01	0.02	1.39	0.00	0.00	0.00

TABLE 2 (Continued)
Summary of the stomach contents of Schilbe mystus in Oyan and Asejire Lakes, Southwestern Nigeria

	Asejire lake			Oyan lake		
Food Items	% Number	% Point	% occurrence	% Number	% Point	% Occurrence
Pisces						
Unidentified fish	0.02	10.18	9.03	1.89	19.75	26.72
Fish Parts	0.59	4.19	16.67	0.00	0.00	0.00
Tilapia sp (Fry)	0.03	18.71	7.64	<0.01	1.43	0.53
H. bebe occidentalis (fry)	0.00	0.00	0.00	<0.01	1.43	0.53
Oreochromis niloticus(fry)	0.00	0.00	0.00	<0.01	1.42	0.53
Catfish (Fry)	0.00	0.00	0.00	<0.01	1.70	1.07
Fish larvae	0.00	0.00	0.00	0.03	0.06	0.53
Sand particle	0.00	0.33	2.08	0.00	2.25	8.02
Unidentified material	0.38	4.06	18.06	5.93	5.74	69.52

TABLE 3
Variation in relative importance indices (RI %) of food items with sex, size, and season in Schilbe mystus from Oyan and Asejire Lakes, Southwestern Nigeria

Food items	Oyan Lake						Asejire Lake					
	Size		Season		Sex		**Size**		**Season**		**Sex**	
	S	**L**	**D**	**W**	**M**	**F**	**S**	**L**	**D**	**W**	**M**	**F**
Diatom	20.5	18.8	15.9	13.0	22.0	20	8.1	3.9	12.3	5.1	8.8	13.4
Blue green algae	3.4	0.9	0.1	1.3	0.0	0.9	0.0	4.4	1.1	1.5	0.0	0.5
Green algae	2.6	0.9	2.3	5.0	2.6	0.9	0.5	0.0	0.4	0.5	0.0	0.7
Colonial algae	16.8	23.5	28.4	25.1	20.0	16.7	45.1	46	25.3	15.5	41.6	33.2
Plant parts	1.8	2.0	5.1	6.8	1.7	3.9	2.2	3.5	5.4	4.2	1.6	3.7
Crustacean	3.5	5.3	3.1	0.0	0.9	3.7	0.5	4.4	1.0	4.4	4.7	1.3
Rotifer	1.9	0.0	1.7	3.3	0.9	2.5	1.0	0.3	2.3	3.7	0.0	1.5
Nematode	0.00	1.3	1.5	1.8	1.9	0.8	0.1	0.0	0.5	0.0	0.0	1.8
Insecta	33.0	24.5	22.1	23.9	42.1	25.3	23.7	11.7	25.2	44.0	20.0	11.6
Fish	14.0	20.2	18.6	10.6	3.5	23.3	15.5	23.5	20.2	8.8	23.3	30.0
Detritus	1.3	1.3	0.0	2.3	2.5	0.4	0.0	0.0	0.0	1.9	0.0	0.5
Sand	0.0	0.2	0.0	1.4	0.0	0.0	0.0	0.0	2.3	2.0	0.0	0.4
Unidentified material	1.2	1.1	1.2	5.5	1.9	1.6	3.3	2.3	4.0	8.4	0.0	1.4

S – 9 -17.9 cm, **L** – 18 – 24cm, **D** – Dry, **W**- Wet, **M** – Male, **F** - Female.

had 14% and 3.5% respectively. RI values for unidentified organisms, detritus and plant parts were the lowest and together constituted not up to 7% for both size groups.

Asejire Lake: For smaller size group, insect food items (23.7%) were of more relative importance than fish food items (15.5%) (Table 3). However, for larger sized specimen, fish food items (23.5%) were relatively more important than insects (11.7%). The RI values for crustacean and rotifers (Zooplankton) were 0.5% and 0.97% respectively for 9–17.9 cm size group and 4.4% and 0.3% for 18–24 cm size group. The RI values of phytoplankton (diatom, blue green algae, green algae, and colonial algae) were high in groups, 53.8% in 9–17.9 cm and 54.3% in 18–24cm.

Seasonal variation in the composition of the diet of *Schilbe mystus*

Oyan Lake: The food items selected were found to vary seasonally. The variation occurred in differences in intensity in which various food items were consumed in different seasons. Insects were relatively more important in wet season than dry season, while fish food items had higher RI values during dry season (Table 3). Crustaceans were not encountered in the stomach during rainy season. Other items encountered in the stomach like phytoplankton, rotifers and nematodes did not show much seasonal variation in quantity, however, plant parts and unidentified materials are more important during rainy season.

Asejire Lake: Table 3 shows that variation occurred in the quality of food items consumed by *S. mystus* with season. Insects' food items were more important in rainy season than dry season, while fish food items had higher RI values in dry season than wet season. Zooplanktonic organisms (crustaceans, rotifers), and detritus were relatively more important in wet season while phytoplankton, nematode and plant part were more important during dry season.

Feeding in relation to sex for *Schilbe mystus*

Oyan Lake: The relative importance indices (RI) for insects were higher in the male (42.1%) than female (25.3%), while the RI value for fish food items is higher in female (23.3%) than male (3.5%). The RI values of zooplanktonic organisms were higher in females (6.2%) than in males (1.8%). The RI values of phytoplanktonic organisms were high in the sexes, 38.5% in female and 44.6% in male (Table 3).

Asejire Lake: The RI values of insect food items were higher in male (20%) than in female (11.7%). For fish food items, females (30%) had higher RI values than males (23.8%). The relative importance indices for phytoplanktonic organisms were high for females (47.8%) and males (52%). The RI values for zooplanktonic organisms were less than 10% for both sexes (Table 3).

DISCUSSION

In both study sites, the low percentage of specimens encountered with fully filled stomach could be due to nature of food consumed by this species which are mainly proteins and digestion of protein starts in the stomach. Generally, more empty stomachs were encountered in Oyan Lake than Asejire Lake except in males (Table 1). This may suggest less availability of food of this species due to probably oligotrophic nature of Oyan dam. Vassilopoulou (2006) also suggested that empty stomachs found in a lower percentage of four spotted megrims in Western Mediterranean waters was possibly due to the less oligotrophic character of the area relative to the eastern part and to particular environmental characteristics of the sampling sites, such as their proximity to more productive coastal areas. The higher stomach fullness recorded for smaller group in both locations could be associated to the increased energetic needs of small specimens displaying highest growth rates during the first year of their life (Vassilopoulou and Ondrias

1999). In Oyan lake, higher stomach fullness were recorded in males and dry season, while in Asejire lake more food were found in stomachs of this species in females and wet season. These differences further show that habitat affect pattern of food selection and consumption in fish.

Fishes that feed on one group of animal other than on plant materials or detritus are predators (Fagade 1983). Thus, *S. mystus* from Oyan and Asejire lakes can be classified as predator since the food items consisted of three major groups, fish, insects and crustacean. Planktonic organisms especially colonial algae encountered in the stomach were probably the food of the prey consumed by *S. mystus*. Imevbore and Bakare (1970) also reported presence of algae in food of *S. mystus* from Kainji reservoir. The food habits of *S. mystus* in Oyan and Asejire lakes agreed with observations of Olatunde (1979), who found the species to feed mainly on fish materials and organisms of insect origin in Kainji lake. Adebisi (1981) found the diet of the species in upper Ogun River to be made up mostly of terrestrial insects and fish of the *Barbus* spp. Fagade (1983) similarly found that the species fed on odonata nymph, diptera larvae, fish and crustacean in lower river Benue. According to Olurin (1994), this species fed on ephemeroptera nymph, coleoptera, orthoptera, *Tilapia* species in Oyan Lake. This present investigation on the diet of *S. mystus* highlights some differences in food habits of the species in two lakes which previous work had not done. The observed variations (lepidoptera larvae, orthoptera (terrestrial insects) and odonata in stomach of *S. mystus* in Asejire lake and also *H. bebe occidentalis, O. niloticus* and catfish in stomach of *S. mystus* in Oyan lake) could be due to differences in habitat reflected as pertaining to food availability or due to the fact that fishes are not rigid as to the particular type of food they eat and will utilize most readily available items.

The changes in composition of food of *S. mystus* with size recorded in the two locations may simply be a functional response to changes in fish size and/or metabolic needs (Singer 1985) or it might reflect a combination of increasing mouth size and an improved ability to handle prey and to swim faster (Gerking 1994, Platell and Potter 1988). This may give an indication of low degree intraspecific competition of food among various size groups of the fish. Many investigators have reported changes in diet of fish species as they grow. Fagade and Olaniyan (1972) observed this relationship in the West African Shad *Ethmalosa fimbriata*, which was studied in Lagos lagoon. Bhatt (1970, 1972) studied the food of Indian catfish, *Mystus seenghala* (Sykes) and *Mystus vittatus* (Bloch) and found that their diets changed with size of fish. Olatunde (1978) observed this phenomenon in Butterfish *Eutropius niloticus* (Ruppell) in Kainji Lake. Ikomi (1996) noted similar occurrence in the mormyrid *Brienomyrus longianalis* in the upper Warri River.

In Oyan Lake, fish species such as *T. zillii* and *H. bebe occidentalis* could only be identified in stomach contents of small specimens and this is probably because they have been digested more in larger size specimen thereby making identification not easy.

Variation in diet of *S. mystus* with season in both study sites agreed with the observations of several workers in different fish species (Murdoch 1967, Cornell 1976, Hume and Northcote 1985, Davidson 1986, Ugwumba and Adebisi 1992, Vassilopoulou and Papaconstantinou 1993). This variation occurred due to the fact that as the density of particular prey type declines, a predator may switch to another prey which is more abundant. According to Vassilopoulou (2006), temporal variations in diet are due to ontogenetic transformation, mainly connected to morphological adjustments that accompany growth of a fish, as well as seasonal changes in food availability. The latter may be caused by changes in the habitats available for foraging, changes due to the life history patterns of food organisms and changes caused by the feeding activities of the fishes themselves. Sexual differences observed in the diet with fish food item been relatively more important to females and insects more

important to males could probably be due to the differences in sizes between males and females. Most males fell into the small size group (9.5-19.6 cm in length) while most females were in larger size group (14.6-25 cm) and as a result of changes in food consumption with sizes reported earlier, there was also corresponding changes in food consumed with sex.

From the present results, the trophic features of the African Butter catfish in the two lakes showed that it was a predator. The prey type consumed by this species in each location seemed to be determined by their availability. Changes occurred in food habits of this species with size, season and sex in both locations.

RESUMEN

La dieta y los hábitos alimenticios de *Schilbe mystus* (Linne, 1766), un pez de importancia comercial en los lagos de Oyan y Asejire (Nigeria), fueron examinados desde diciembre del 2000 a diciembre del 2001. Se realizaron análisis de contenido estomacal utilizando métodos numéricos, de frecuencia de presencia y puntuales. Existe variación estacional en los organismos seleccionados para alimento y los insectos son más importantes para peces pequeños (<18 cm). También hay diferencias en la cantidad de alimento encontrado en los estómagos de machos con respecto a las hembras de *S. mystus* en ambos hábitats. El patrón de selección y consumo de alimento en estas especies es distinto en los dos lagos.

Palabras clave: alimento, dieta, *Schilbe mystus*, Lago Oyan, Lago Asejire, Suroeste de Nigeria.

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