Food and Feeding Habits of *Epiplatys Senegalensis* (Pisces: Cyprinodontiformes; Cyprinodontidae) in a Back Water Pond in Benin City, Southern Nigeria

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Abstract

Investigations were carried out on the food and feeding habits of *Epiplatys senegalensis* (Steindachner) 1870 in a back water pond along the Ikpoba river in Benin City, Nigeria. *E. senegalensis* was found to be morphologically well adapted to surface and pelagic feeding habits. The correlation between body size and (i) gape size and (ii) food size, were significant ($P < 0.01$). This fish was found to be a generalized feeder (omnivorous), feeding mainly on dipteran larvae, other insects, other benthos, algae, zooplankton and some detritus. Feeding habits varied with food type and size. The former also varied with the seasons. Detritus was, however, found to be ubiquitous in the environment. The forage ratios of the food items also varied with the seasons. Feeding activity increased from January to June, and no significant difference ($P<0.05$) existed between the feeding activity of females and males. The condition factor of the fish increased from the dry to the rainy (wet) seasons with smaller size-classes of the fish in a better condition than the larger size–classes.

Introduction

Studies on the feeding habits of fish have received considerable attention all over the world. These investigations form the basis for the successful development of capture and culture fisheries (Blake, 1977; Adebisi, 1981; Muabe, 1992). Some of these fishes have ornamental value, and members of the genera *Lebistes, Panchax, Sarotherodon, Poecilia, Tilapia* and *Gambusia* have been used for this purpose (Cust & Bird, 1977). Others are larvivorous and some workers have attempted to use them as bio-control agents for disease vectors of aquatic larval stages such as mosquitoes (Lindberg, 1974; Menon & Rajagopalan, 1978).

The applied problem of using the correct fish species either for fish culture, ornamental purpose or larval control requires fundamental information on the feeding ecology of the fish in question. Apart from the general contribution it makes to a clearer understanding of the complex aquatic environment (Corbet, 1961), significantly important is the information on nutrition it provides to support man's efforts to propagate fish in the most efficient manner possible (Welcomme, 1979).

With the paucity of published information on such studies in the tropics, it becomes difficult to know the extent to which the existing aquatic resources are being utilized in these sub-regions. The present investigations were, consequently, designed to look at the food and feeding habits of a tropical larvivorous cyprinodont, *Epiplatys senegalensis* (Steindachner) 1870, in a back water pond in southern Nigeria.

Materials and methods

The study area is located along the Ikpoba river at Ugbowo, north-west of Benin City

in southern Nigeria (latitude 5° 30' N; longitude 5° 48' E) (Fig. 1). The geology, climate, vegetation and morphometry of the study area and study site have been described by Ogbeibu (1984) and Mathews (1985).

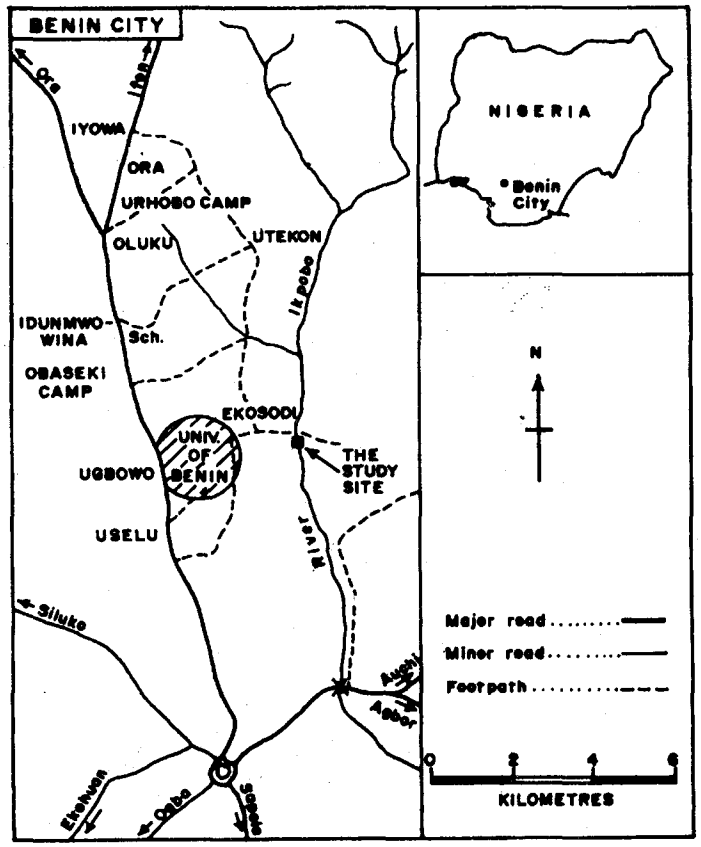

Fig. 1. The study area

Water, plankton, weed associated organisms, benthic organisms and fish samples were obtained from the field fortnightly between January and June. Air and water temperatures of the habitat were measured at the study site. Water for physico-chemical parameters was collected in polyethylene bottles and taken to the laboratory according to standard methods (APHA). *p*H and conductivity measurements were made in the field using a *p*H meter and a conductivity meter, respectively. A plankton throw net (mesh size: 154 μm) was used to sample the plankton. A short-handled scoop net (mesh size: 154 μm; length of handle: 1 m) was used to sample weed associated organisms as well as benthic samples. The 'kick technique' (Hynes, 1961) was employed for sampling the benthos. These samples were preserved in 4% formalin and examined in the laboratory microscopically. A long-handled scoop net (mesh size: 2 mm; length of handle: 1.5 m) was used for catching fish by using the method designated here as the "search and hit technique".

The collector stood in the water and searched the surface of the water for fish which could be easily recognized by the shiny spot on the head. On locating the fish, a hit was made with the swift downward stroke of the net slicing through the water underneath the fish and coming out in a smooth flowing motion. With a little practice, this method was efficient to catch *E. senegalensis* which was abundant in the habitat. Fishing lasted for 30 min on each sampling day. The fish caught were counted, preserved in 10% formalin and transported to the laboratory for gut content analysis within time duration of 2 h.

Standard length, total length and gape

size of the fish were measured in the laboratory. The Condition Factor 'K' of the fish was calculated (Lagler *et al.*, 1962). The sex of the fish was determined using morphological characteristics (Reed *et al.*, 1967). Fish were then dissected and the gut fullness was subjectively estimated by feeling it and the fullness points (4 for full, 3 for ¾ full, 2 for ½ full, 1 for ¼ full and 0 for empty guts) ranked as ordinal data (Zar, 1974). Guts were then weighed and cut open with the content of each gut washed unto a glass slide using a few drops of 4% formalin. The empty guts were then weighed and the difference in weight between the full and empty guts was recorded as the weight of gut content. No correction factor was needed for the weight loss of gut since this was negligible.

Large food organisms recognized with or without the help of a dissecting microscope were counted directly. The rest of the diluted gut content was teased to disperse aggregates. The whole sample was then examined and food items identified using the dissecting and compound binocular microscopes. Numbers were also estimated using a counting grid. The gut contents were analyzed using the Numerical, Points and Gravimetric methods (Hynes, 1950). The forage ratios of the food items consumed by the fish were also calculated (Edmondson & Winberg, 1971).

Results

Water level at the study habitat was lowest in January and February (124.50 cm) and highest in June (142.70 cm). Air and water temperatures fluctuated between 23.0 °C and 31.0 °C with a mean ± SE of 28.20 ± 0.78 °C for air and 26.30± 0.36 °C for water. Conductivity was highest in March (35.00 μmhos) and lowest in June (19.00 μmhos) with a mean ± SE of 28.30 ±1.78 μmhos. *p*H values increased from 5.40 in late February to 8.40 in late June. The total alkalinity increased from 3.0 mgl^{-1} $CaC0_3$ in January to 35.00 mgl^{-1} $CaC0_3$ in June (Fig. 2).

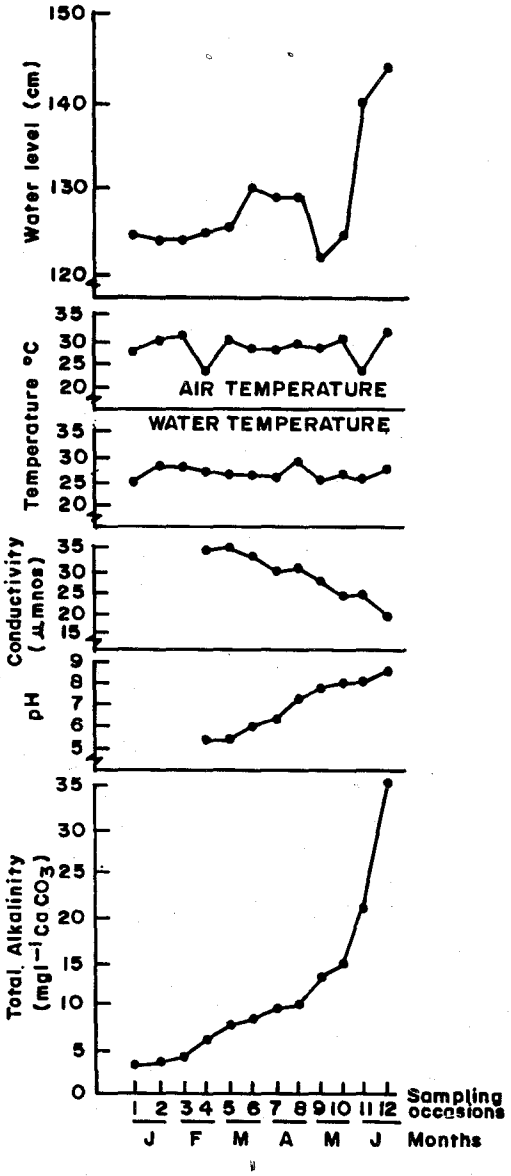

Fig. 2. Variation in the physical and chemical conditions of the study habitat

The specimens of *E. senegalensis* studied ranged in standard length from 1.00 cm to 5.40 cm. The mean gape size was 0.50 ± 0.12 cm with the buccal cavity bearing homodont maxillary and pharyngeal teeth. The relationship between body size and gape size of *E. senegalensis* showed a significant positive correlation ($r=0.87$; $P<0.01$). The regression coefficient (b = 0.11, Y = 0.003 + 0.11 X) was tested with ANOVA and found to be highly significant (F = 142.16; $P < 0.01$) (Fig. 3). A total of 336 fish; 177 females and 159 males, were caught during the study.

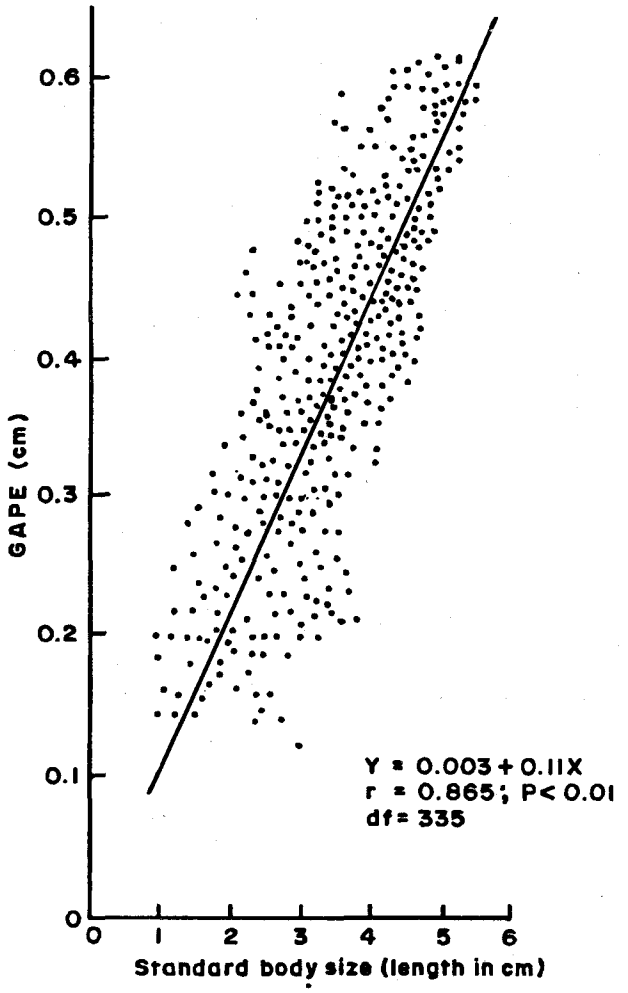

Fig. 3. Relatiopnship between the body size and the gape of *E. senegalensis*

Food was present in all the guts of *E. senegalensis* caught during the study. The mean weights of their gut contents are shown in Table 1. The food items consumed by the fish are shown in Table 2. The major food items were insects, detritus, zooplankton (such as cladocerans), other benthos (ostracoda, malacostraca, hydrachnellae, nematoda, annelida and platyhelminthes), plants and plant parts as well as miscellaneous food items (sand grains, mud pellets and fish scales).

Three size-classes of *E. senegalensis* were grouped in the study. The food composition in each size-class using the Numerical Gravimetric and Points methods are presented in Table 3. The three methods showed that dipteran larvae, other insects and zooplankton constituted major proportions in fish of sizes ranging from 3.91 to 5.40 cm standard length. Detritus was not quantifiable with the Numerical method. The Points and Gravimetric methods, however, revealed some level of significance of this food in the diet of the fish. Phytoplankton were consumed more by smaller sized fish than by larger fish. More miscellaneous items were consumed in fish of size 2.41 to 3.90 cm than in any other length group.

There was a significant positive correlation between body size (SL, cm) and the maximum

TABLE 1

Mean weights of gut contents of E. senegalensis *caught on each sampling occasion*

Sampling occasion	*Sample size (No. of fish)*	*Mean weight of gut content ± SD (g)*	*Mean fish weight ± SD (g)*
1	23	0.005 ± 0.004	0.44 ± 0.10
2	22	0.010 ± 0.004	0.55 ± 0.08
3	22	0.005 ± 0.004	0.66 ± 0.07
4	29	0.011 ± 0.010	0.66 ± 0.07
5	28	0.014 ± 0.008	0.70 ± 0.09
6	29	0.011 ± 0.006	0.52 ± 0.09
7	30	0.012 ± 0.008	0.51 ± 0.09
8	32	0.006 ± 0.007	0.41 ± 0.04
9	33	0.021 ± 0.034	0.22 ± 0.06
10	32	0.012 ± 0.008	0.47 ± 0.07
11	28	0.013 ± 0.009	0.53 ± 0.10
12	27	0.022 ± 0.007	0.72 ± 0.11

sizes of food items eaten by *E. senegalensis* (r=0.837; P<0.01). Similarly, the correlation between the standard length and the mean food size was positively significant (r = 0.575; P < 0.01). The regression slopes for both the maximum and mean food sizes *vis-a-vis* fish size were also significant (Y = 1004.20 + 346.18X; P < 0.01) for maximum food size and Y = 331.71 + 169.05X; P < 0.01 for mean food size). These relationships are shown in Fig. 4.

Fortnightly variations in the feeding habits of *E. senegalensis* estimated using both Numerical and Points methods showed that the proportion of dipteran larvae was highest in the first half of March (Numerical method, NM = 4.26%; Points method, PM = 34.38%) and decreased drastically in May (NM = 0.21%; PM = 0.83%).

The composition of zooplankton was relatively uniform throughout the sampling period with the largest percentage in late May (NM = 0.45%; PM = 2.23%). Phytoplankton were consistent in the diet with maximum consumption in late February and early March (NM = 3.40%, PM = 8.02%). Detritus, which was quantified with the Points method, had the highest value in the month of May and the lowest value in March (73.01% and 14.30% respectively). Miscellaneous food items occurred now and then in samples through out the study period. The other invertebrates were consumed through out the study with consumption decreasing as the sampling progressed (Table 4).

The Forage Ratio (FR) for algae was highest (2.60) in February and lowest (0.34) in January. FR values for zooplankton were highest (2.0) in January and least (0.50) in March. Other insect food (Ephemeroptera, Coleoptera, Hemiptera, Hymenoptera) had the highest FR value (1.20) in January and the lowest (0.26) in the last half of March. The highest positive selection (3.67) was shown for dipteran larvae in the last half of January. High FR values were also recorded for this food item in March, April and May. The other benthos were most positively selected (1.64) in January and most avoided (0.36) in the last half of February. The food items considered here were those that could easily be estimated in the environment of the fish during the study (Table 5).

The feeding activity of *E. senegalensis* expressed as mean percentage weight of food per body weight of fish was highest in late June and lowest in January (Fig. 5). There was a general increase in the quantity of food eaten from January to June. The feeding activities of females and males

TABLE 2

Food items of E. senegalensis *in the Ikpoba river*

	Method of analysis					
	Numerical		*Points*		*Gravimetric*	
Food items consumed	*Numbers*	*%*	*Points*	*%*	*Weight(g)*	*%*
Detritus	*	*	69.72	20.75	0.10	2.61
Insects						
Dipteran Larvae	2,230	1.80	67.73	20.16	0.12	3.13
Ephemeroptera (nymphs)	71	0.06	1.41	0.42	0.10	2.61
Hemiptera	499	0.40	5.00	1.49	0.11	2.87
Larval Coleoptera	127	0.10	2.52	0.75	0.11	2.87
Adult Coleoptera	431	0.35	9.67	2.88	0.54	14.10
Hymenoptera	204	0.17	4.03	1.20	0.31	8.10
Other insects	15	0.02	0.10	0.03	0.15	3.92
Insect parts	3,058	2.47	105.03	31.26	0.10	2.61
Zooplankton						
Rotifera	20	0.03	0.13	0.04	0.10	2.61
Cladocera	1,204	0.97	13.50	4.02	0.22	5.74
Copepoda	175	0.14	1.71	0.51	0.20	5.22
Other benthos						
Ostracoda	608	0.49	0.40	1.12	0.26	6.79
Malacostraca	122	0.10	2.58	0.77	0.31	8.10
Hydrachnellae	697	0.56	0.60	0.18	0.10	2.61
Nematoda	148	0.12	3.32	0.99	0.20	5.22
Annelida	101	0.08	1.68	0.50	0.20	5.22
Platyhelminthes	71	0.06	1.17	0.35	0.11	2.87
Plants						
Unicellular algae	3,728	3.02	3.19	0.95	0.05	1.31
Multicellular algae	1,077	0.87	34.13	10.16	0.10	2.16
Plant seeds	1,301	1.05	1.27	0.38	0.12	3.13
Miscellaneous						
Sand grains	1,747	1.41	1.37	0.41	0.11	2.87
Mud pellets	96	0.08	0.06	0.02	0.01	0.26
Fish scales	282	0.23	5.57	1.66	0.10	2.61

Number of whole guts examined = 336
Number of guts with food = 336
Number of empty guts = 0

* Unquantifiable with the numerical method.

were not significantly different ($t = 1.378$; $df = 11$; $P < 0.05$). The Condition Factor (K) of *E. senegalensis* varied over the months and also with fish size. The highest value (2.04 ± 0.19) was obtained in March while the other two peaks (1.72 ± 0.14 and 1.7 ± 0.16) were obtained in January and June, respectively. The lowest value of K (1.19 ± 0.05) was obtained in February (Fig. 6). Fish ranging in size from 1.41 – 1.90 cm (SL) had the highest value of mean K (1.87 ± 0.25). There was a gradual decrease in the value of K as fish increased in size from 1.91 cm to 4.90 cm (SL) with the mode in size class 2.91 – 3.40 cm SL. (1.59 ± 0.06 cm)

Discussion

In the study habitat, fluctuations in physical and chemical conditions did not significantly affect the fish population ($P < 0.05$). These fluctuations may not have been wide enough

TABLE 3

Variation in the dietary items consumed by different length groups of E. senegalensis (data in percentages: N= Numerical method, P = Points method, G = Gravimetric method)

	Length groups (cm) and number of specimens examined per group								
	1.0–2.40 (68)			*2.41–3.90 (272)*			*3.91–5.40 (54)*		
Dietary items	*N*	*P*	*G*	*N*	*P*	*G*	*N*	*P*	*G*
Detritus particules	*	21.45	1.96	*	20.35	1.49	*	29.98	2.35
Dipteran larvae	0.94	12.06	1.14	1.99	14.63	11.94	1.24	16.41	15.33
Other insects	0.15	3.32	1.96	0.52	5.49	2.71	0.38	0.91	0.47
Phytoplankton	10.47	12.73	2.77	1.58	5.20	0.95	1.15	5.16	1.10
Zooplankton	0.31	0.60	1.14	0.38	1.12	1.76	0.28	1.24	2.19
Other plant materials	1.83	0.64	3.26	0.98	1.01	5.29	0.65	0.24	1.25
Other invertebrates	0.28	1.04	5.06	0.22	0.49	2.04	0.18	0.45	2.19
Miscellaneous	7.42	48.16	82.71	8.28	51.71	73.82	6.27	45.61	75.12
Total	100	100		100	100	100	100	100	100

*Unquantifiable with the numerical method

to bring about significant changes in the abundance of the fish during the study period. Other tropical fish species, however, take advantage of favourable conditions to feed and breed and increased in biomass (Lowe-McConnel, 1975).

The feeding of any fish is often reflected in its general morphology. The general morphology of *E. senegalensis* seems to suggest that it is an efficient surface feeder. *Epiplatys senegalensis* is a gape-limited predator. This is shown by the highly significant positive correlation between the body size and the gape of the fish as well as the shift in the size of food items consumed with increasing fish size. Smaller fish (SL, 1.0 – 2.40 cm) consumed a narrow range of food items (phytoplankton) while larger fish consumed a wider range, and this variation could be attributed to gape difference. Apart from the gape, selectivity and improved searching ability of the large size-classes (SL, 4.41–5.40 cm) are also likely to influence the food and feeding habits. Ontogeneric changes in feeding habits have earlier been reported for other fresh water fish (Adebisi, 1981; Muabe, 1992). Such changes in feeding habits reduce intra-specific competition and make it possible for fish of different sizes to occupy the same habitat.

The composition of food consumed by *E. senegalensis* showed that detritus was consistently included in the diet. A large percentage of fish stomachs examined, irrespective of species, contain detritus (Groenewald, 1964). However, the interpretation of detritivory in pelagic and surface feeding fish is difficult. Various views have been expressed in the literature ranging from filter feeding (Thomas, 1966) to rather melodramatic scenario of fish struggling to escape from fish gear, consuming large quantities of detritus (Groenewald, 1964). Therefore, consumption of detritus by *E. senegalensis* could have been either intentional or accidental

TABLE 4

Fortnightly percentages of food items consumed by E. senegalensis *(Estimated using the numerical (N) and points (P) methods)*

Months	*Sampling occasion*	*Food items consumed and their percentages*															
		Detritus		*Dipteran larvae*		*Other insects*		*Algae*		*Zooplankton*		*Other plants*		*Other invert.*		*Miscellaneous*	
		N	*P*	*N*	*P*	*N*	*P*	*N*	*P*	*N*	*P*	*N*	*P*	*N*	*P*	*N*	*P*
Jan	1	*	30.78	1.21	18.74	0.74	3.50	0.71	4.56	0.44	1.35	0.35	0.17	0.27	0.85	0.29	0.87
	2	*	25.06	2.23	28.66	0.34	3.98	0.73	2.90	0.37	1.64	0.18	0.07	0.57	1.13	0.59	1.15
Feb	3	*	29.39	1.37	21.26	0.25	3.42	0.57	3.69	0.34	1.72	0.36	0.17	0.50	2.02	0.52	2.04
	4	*	17.58	2.49	24.76	0.53	5.18	3.40	5.08	0.37	0.48	0.24	0.03	1.20	1.63	1.22	1.65
Mar	5	*	14.30	4.26	34.38	0.44	4.04	3.13	8.02	0.29	0.87	0.79	0.21	0.68	0.50	0.69	0.51
	6	*	18.39	3.50	28.01	0.48	4.21	3.33	7.24	0.44	1.42	1.15	0.31	0.81	0.66	0.83	0.69
Apr	7	*	17.00	3.57	33.83	0.93	4.14	2.09	6.38	0.40	1.37	1.31	0.41	0.90	0.75	0.92	0.77
	8	*	21.17	1.16	21.20	0.58	6.41	0.42	2.59	0.29	1.19	1.77	0.50	0.57	0.53	0.59	0.55
May	9	*	26.48	1.00	13.95	0.44	5.68	1.10	3.73	0.45	2.23	1.99	0.91	0.84	0.64	0.86	0.66
	10	*	73.01	0.21	0.83	0.65	2.53	1.95	2.19	0.42	0.27	1.87	0.24	0.47	0.79	0.49	0.79
Jun	11	*	24.76	0.17	2.19	0.69	8.69	2.63	2.59	0.30	0.66	1.33	0.57	0.17	0.26	0.19	0.28
	12	*	21.00	0.10	1.11	0.76	7.87	2.50	7.54	0.47	0.31	0.50	0.20	0.25	0.47	0.27	0.49

*Unquantifiable with the numerical method

TABLE 5

Fortnightly forage ratios (FR) for some food items of E. senegalensis, *January–June*

Month	*January*		*February*		*March*		*April*		*May*		*June*	
Date	*11*	*25*	*8*	*22*	*8*	*22*	*5*	*19*	*3*	*17*	*1*	*15*
Food items												
Algae	1.11	0.34	0.95	2.60	2.05	2.14	1.37	0.36	0.38	1.68	1.81	1.74
Zooplankton (Rotifera, Cladocera, Copepoda)	0.86	2.00	1.13	0.77	0.50	0.64	0.79	1.25	1.38	1.21	0.73	1.00
Other insects (Ephemeroptera, Coleoptera, Hemiptera, Hymenoptera)	1.05	1.20	0.71	0.33	0.30	0.26	0.52	0.72	0.64	0.64	0.80	0.76
Dipteran larvae	0.67	3.67	0.96	0.91	1.48	1.35	2.67	2.91	1.63	0.43	0.33	0.17
Other benthos (Ostracoda, Malacostraca, Hydrachnellae, Nematoda, Annelida, Platyhelminthes)	1.42	1.64	1.15	0.36	0.48	0.76	0.54	1.05	1.04	0.52	0.48	0.48

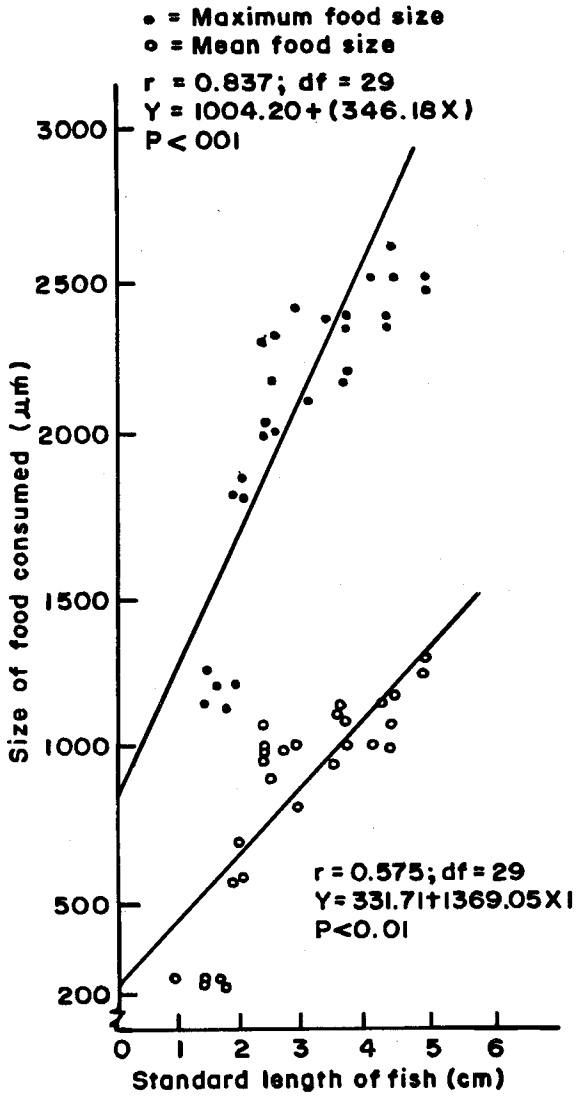

Fig. 4. Relationship between the body size and the size of food consumed by *E. senegalensis*

and needs further laboratory verification. Some authors working with piscivorous fish (Adebisi, 1981) and even bottom feeders (Ikusemiju & Olaniyan, 1977) ignore detritus as food component although it is an inevitable entity in the gut contents of fish. Irrespective of the mechanism involved, detritivory is beneficial since dead organic matter is a rich source of crude protein.

Insects generally formed a large percentage of the diet of *E. senegalensis*. Most of these were aquatic insects which were abundant amongst the submerged plants. The preference of *E. senegalensis* for insects inhabiting the weeds points to the possibility of the efficacy of using this fish in the bio-control of vectors of parasites of man and domestic animals, many of which are phytophilous. This possibility has earlier been noted for some cyprinodonts and cichlids (Hickling, 1961).

The present results show that this fish is not a strict zooplankton feeder but reduction in other food items may lead to the selective feeding on zooplankton. The above view-point supports the findings of some workers who found that zooplankton maxima in some water bodies synchronized with the aquatic insect minima (Prowse & Talling, 1958). It should, however, be noted that plankton maxima in the tropics may occur at any period of the year depending on the favourability of the physical and chemical conditions of the particular ecosystem (Egborge, 1981). Benthos were consumed to varying degrees by *E. senegalensis* although this fish is not considered to be a strict benthophage. Victor & Ndome (1988) found *E. senegalensis* to be rather a surface and mid water feeder. The occurrence of benthic organisms in its gut content could have been due to the feeding activity in the bankroot biotope as well as among aquatic macrophytes where some benthic

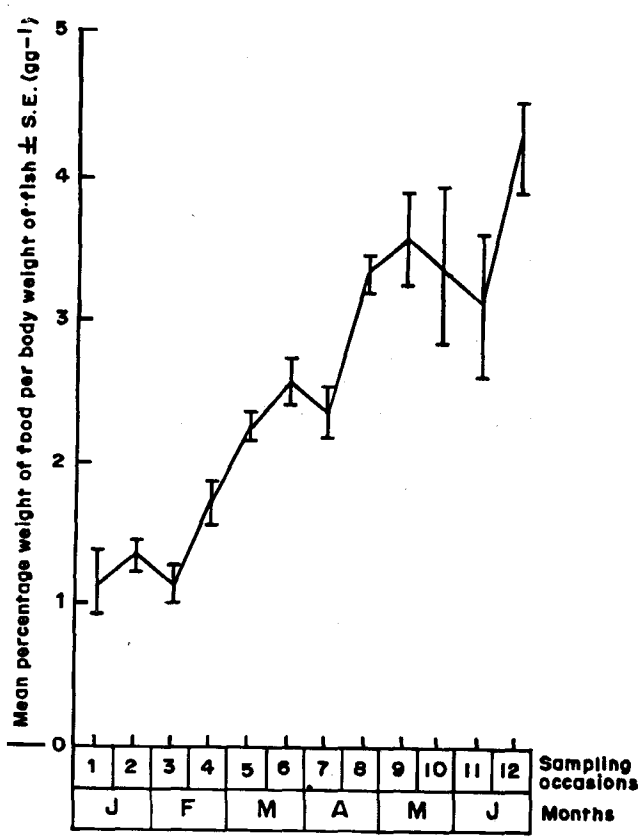

Fig. 5. Variation in the feeding activity of *E. senegalensis*

organisms such as chironomid larvae and oligochaetes abound (Dejoux *et al.*, 1969).

The quantity of phytoplankton (algae) consumed by *E. senegalensis* is not surprising as it has been reported that algae contribute largely to the diets of most fish (Jafri & Mustafa, 1977). However, the plant seeds that occurred in the gut content of this fish could likely have fallen into the water from the fringing plants and were subsequently picked up by the fish from the water surface. The occurrence of sand, mud and fish scales in the diet of *E. senegalensis* could also have resulted from the accidental uptake of these items by the fish while feeding on the bank root biotope. It is obvious that sand grains which in themselves have no nutritive value may provide some nutrients to the fish through their coating of organic material (Fagade, 1971). Similarly, mud acts as food for some fish species (Bakare, 1970). This is because it contains amino acids and other products of decay which together with saprophytic bacteria and other protozoan micro-organisms constitute a rich source of crude protein (Hickling, 1961; Bakare, 1970; Welcomme, 1979). The occurrence of fish scales in a few specimens of *E. senegalensis* and the absence of decomposing bones in the diet showed that *E. senegalensis* was not piscivorous. The fish scales are not important in the diet of the fish and their inclusion could have been as a result of 'Carrion' feeding (Bishai & Abugideiri, 1965).

The ubiquitous nature of detritus and the drastic fortnightly fluctuations of other food items eaten by *E. senegalensis* indicated that this fish was shifting in its food and feeding habits depending on the availability of various food items. Such shifts in feeding habits have been reported for some fish species (Arawomo, 1976). In flood plain rivers and associated systems, the basic feeding habits of fish is usually flexible to take advantage of any other food items as and when available (Welcomme, 1979).

The general increase in the feeding activity of *E. senegalensis* from January to June could be due to the increasing diversity and

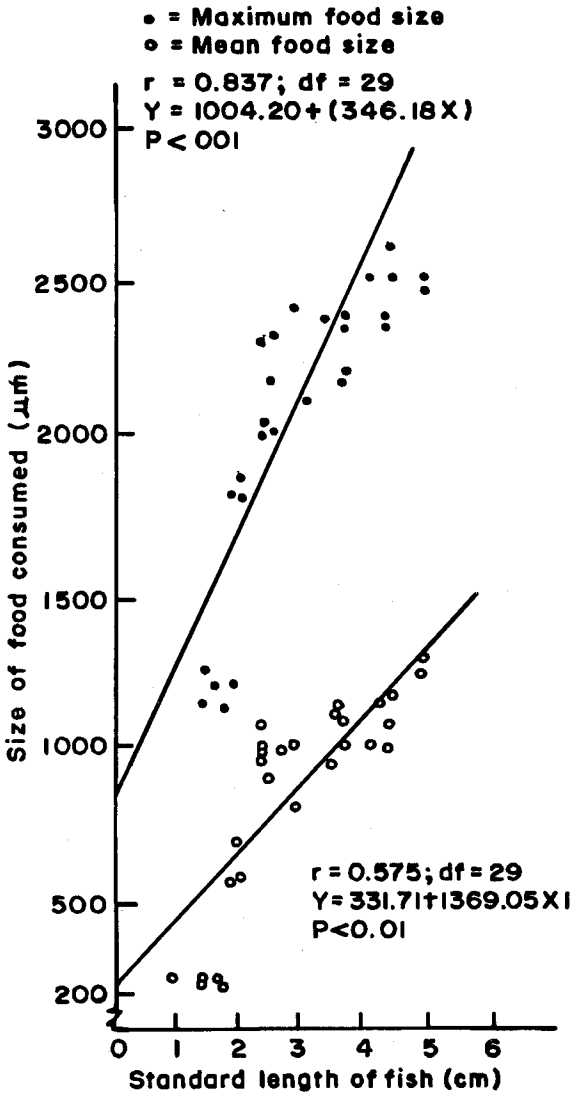

Fig. 4. Relationship between the body size and the size of food consumed by *E. senegalensis*

and needs further laboratory verification. Some authors working with piscivorous fish (Adebisi, 1981) and even bottom feeders (Ikusemiju & Olaniyan, 1977) ignore detritus as food component although it is an inevitable entity in the gut contents of fish. Irrespective of the mechanism involved, detritivory is beneficial since dead organic matter is a rich source of crude protein.

Insects generally formed a large percentage of the diet of *E. senegalensis*. Most of these were aquatic insects which were abundant amongst the submerged plants. The preference of *E. senegalensis* for insects inhabiting the weeds points to the possibility of the efficacy of using this fish in the bio-control of vectors of parasites of man and domestic animals, many of which are phytophilous. This possibility has earlier been noted for some cyprinodonts and cichlids (Hickling, 1961).

The present results show that this fish is not a strict zooplankton feeder but reduction in other food items may lead to the selective feeding on zooplankton. The above view-point supports the findings of some workers who found that zooplankton maxima in some water bodies synchronized with the aquatic insect minima (Prowse & Talling, 1958). It should, however, be noted that plankton maxima in the tropics may occur at any period of the year depending on the favourability of the physical and chemical conditions of the particular ecosystem (Egborge, 1981). Benthos were consumed to varying degrees by *E. senegalensis* although this fish is not considered to be a strict benthophage. Victor & Ndome (1988) found *E. senegalensis* to be rather a surface and mid water feeder. The occurrence of benthic organisms in its gut content could have been due to the feeding activity in the bankroot biotope as well as among aquatic macrophytes where some benthic

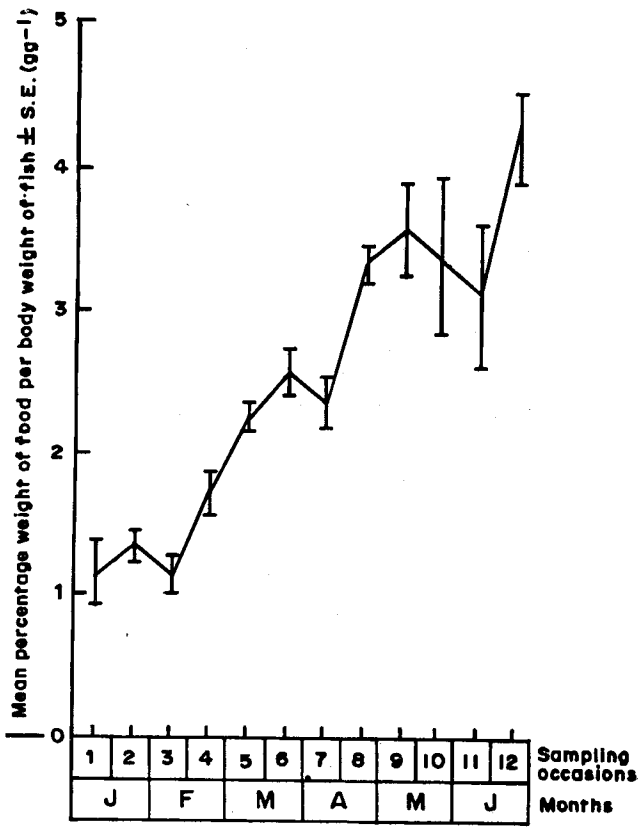

Fig. 5. Variation in the feeding activity of *E. senegalensis*

organisms such as chironomid larvae and oligochaetes abound (Dejoux *et al.*, 1969).

The quantity of phytoplankton (algae) consumed by *E. senegalensis* is not surprising as it has been reported that algae contribute largely to the diets of most fish (Jafri & Mustafa, 1977). However, the plant seeds that occurred in the gut content of this fish could likely have fallen into the water from the fringing plants and were subsequently picked up by the fish from the water surface. The occurrence of sand, mud and fish scales in the diet of *E. senegalensis* could also have resulted from the accidental uptake of these items by the fish while feeding on the bank root biotope. It is obvious that sand grains which in themselves have no nutritive value may provide some nutrients to the fish through their coating of organic material (Fagade, 1971). Similarly, mud acts as food for some fish species (Bakare, 1970). This is because it contains amino acids and other products of decay which together with saprophytic bacteria and other protozoan micro-organisms constitute a rich source of crude protein (Hickling, 1961; Bakare, 1970; Welcomme, 1979). The occurrence of fish scales in a few specimens of *E. senegalensis* and the absence of decomposing bones in the diet showed that *E. senegalensis* was not piscivorous. The fish scales are not important in the diet of the fish and their inclusion could have been as a result of 'Carrion' feeding (Bishai & Abugideiri, 1965).

The ubiquitous nature of detritus and the drastic fortnightly fluctuations of other food items eaten by *E. senegalensis* indicated that this fish was shifting in its food and feeding habits depending on the availability of various food items. Such shifts in feeding habits have been reported for some fish species (Arawomo, 1976). In flood plain rivers and associated systems, the basic feeding habits of fish is usually flexible to take advantage of any other food items as and when available (Welcomme, 1979).

The general increase in the feeding activity of *E. senegalensis* from January to June could be due to the increasing diversity and

abundance of food items in the environment as the rains and flood set in. There was no significant difference ($P > 0.05$) in the feeding activity of females and males of *E. senegalensis*. The relatively larger size (max. SL, 5.40 cm) of males over the females (max. SL, 4.90 cm) could be due to the fact that the females use most of their energy reserves for egg development.

An irregular pattern in Condition Factor (K) was observed for *E. senegalensis* in this study although there was an increase from the dry season to the rainy season during which there is usually intensive feeding and build-up of energy reserves by most fishes (Welcomme, 1979). Smaller size-classes of *E. senegalensis* were in better condition than the larger size-classes. This could be due to the fact that the algae and other small food items which were found to constitute the major food components of small fish were constantly present in the environment whereas the other food items preferred by the larger fish were constantly fluctuating in their abundance throughout the study period. Similar observations have earlier been recorded by Brown (1985) for *Synodontis* spp. and *Gnathonemus tamandua* in the Ikpoba river, Nigeria.

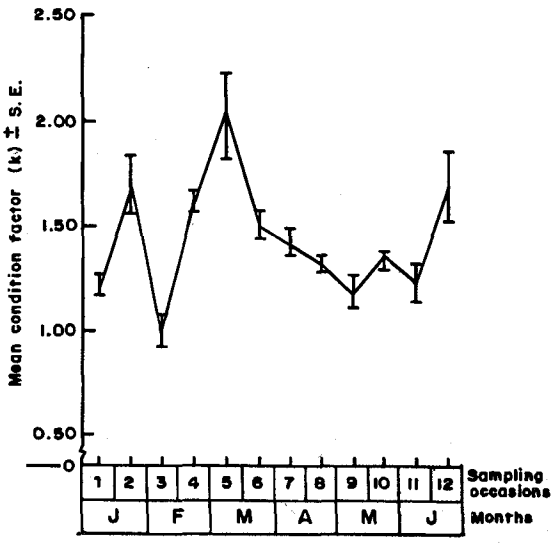

Fig. 6. Variation in Mean Condition Factor (K) for *E. senegalensis* in the study habitat

Conclusion

The present study has reviewed the feeding ecology of *E. senegalensis* in its natural habitat. The results have shown that *E. senegalensis* is distinctly larvivorous, and both small and large fish feed on dipteran larvae. This study, therefore, confirms that *E. senegalensis* could be used for the control of insect pests such as mosquitoes. Such bio-control measures are preferred to pest control since they do not cause chemical pollution in the environment. Victor & Ndome (1988) have shown that *E. senegalensis* preferred to feed on mosquito larvae and chironomid larvae over other food items offered to it in the laboratory. It may be possible to breed, rear and introduce *E. senegalensis* into mosquito breeding areas such as pools, ponds and ditches to help eliminate or reduce the abundance of mosquito larvae in these places.

Since *E. senegalensis* tolerates changes in the physical and chemical conditions of its habitat as observed in this study, it may be possible to introduce it into fairly polluted ponds and pools harbouring mosquito larvae. Further studies on *E. senegalensis* should, therefore, be conducted to understand its breeding biology and its tolerance to habitat conditions. If and when the above information is obtained, field trials should be organized to verify the use of this fish as a control agent of mosquito larvae.

fish as a control agent of mosquito larvae.

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