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Food and feeding of brown-stage eels of *Anguilla bicolor* in the Bolgoda Estuary

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Abstract

Live samples of brown- stage eels of *Anguilla bicolor* were collected from the Bolgoda Estuary. The samples were grouped as <300mm, 300-400mm, 400-500mm, 500-600mm and >600mm total length. The stomachs were injected with 10% formalin and the contents examined. The food of eels was assessed by the volume displacement method and the frequency of occurrence method. Gastrosomatic index was determined and the number of empty stomachs were recorded. The similarity among the diets of different size groups and that at different seasons were also determined. The results indicate that *Anguilla bicolor* change its feeding habits markedly as it grows. They feed mainly on invertebrates when small and become more piscivorous as they grow. No seasonal variation in the feeding habits was observed. It was also observed that the fish did not feed at the same intensity throughout the year. A high feeding intensity occurred from August to December.

Keywords : *Anguilla bicolor*, food, feeding, size class

1. Introduction

There have been many studies on the feeding biology *of Anguilla anguilla* (European eel), *Anguilla japonica* (Japanese eel), *Anguilla rostrata* (American eel), *Anguilla australis* and *Anguilla reinhardtii* (Australian eels) and *Anguilla dieffenbachia* (Newzealand eel) (Frost, 1946; Sinha and Jones, 1967; Moriarty, 1972,1973; Shafi and Maitland, 1972; Biro, 1974; Moore and Moore, 1976; Ezzat and El-Seraffy, 1977; Wenner, 1972; Cairns, 1942; Cadwallader, 1975; Burnet, 1969; Beumer, 1979; Ryan, 1986; Usui, 1979; Dorner and Benndorf, 2003; Schulze et al, 2004).

But no such records are found on the Indian Ocean eels *(Anguilla bicolor* and *Anguilla nebulosa).* In this study, investigations concerning the food and feeding habits of *Anguilla bicolor* in a brackish water system, the Bolgoda Estuary, were carried out.

2. Materials and Methods

Live samples of brown-stage eels were collected from 1994 to 1997 from the catch of beach seine, stream weir, fyke net and long line from the North Bolgoda lake, South Bolgoda lake and Panadura river of the Bolgoda Estuary system. After collection the fish were killed by immersion in water containing ethyl 4-amino benzoate. A total of 579 eels were examined. The samples were subjected to the measurement of total length and weight and were grouped as <300mm, 300-400mm, 400-500mm 500-600mm and >600mm total length (TL). TL values that fell on the class boundaries were always tabulated in the higher class.

Each stomach was opened and the wet weight of the stomach contents were recorded to the nearest 0.1 mg and expressed as a percentage of the total weight of the fish to represent gastrosomatic index. If there was a delay in the examination of the stomach contents the stomach was injected with 10% formalin to prevent digestion of the contents and preserved in 10% formalin for later analysis. Food items were sorted, and where possible each food organism was identified to the species level. The volume to the nearest 0.5ml of each taxonomic category was measured by the volume displacement method.

The proportion of the population that feed on a particular food item (frequency of occurrence) was expressed as the percentage number of stomachs in which a species occurs. The number of empty stomachs was also noted and expressed as a percentage. The similarity among the diets of different size groups and that at different seasons were determined by the method described by Schoener (1970).

3. Results

The food items present in the stomach contents of brown-stage eels *of Anguilla bicolor* were as follows.

Crustacea
Cladocera
Copepoda
Caridenae
Xanthidae
Metapenaeus ensis
Metapenaeus dobsoni
Penaeus monodon

Insecta
Hemiptera spp.

Annelida
Oligochaeta spp.
Polychaeta spp.

Mollusca
Gastropoda spp.

Osteichthyes
Zenachopterus disper
Ambasis commersoni
Ehirava fluviatilis

Miscellaneous
Macrophytes
Algae
Sand particles

Assessment of the food of eels by the volume displacement method (fig. 1) reveal that the food of the <300mm TL (total length) group consist solely of crustaceans and insects, each being equally important. The 300-400mm TL and 400-500mm TL groups fed on three more categories, namely annelids, mollusks and fish (Osteichthyes) in addition to crustaceans and insects, which still remained the predominant food. The 500-600mm TL and the >600mm TL groups fed on only two categories, namely crustaceans and fish.

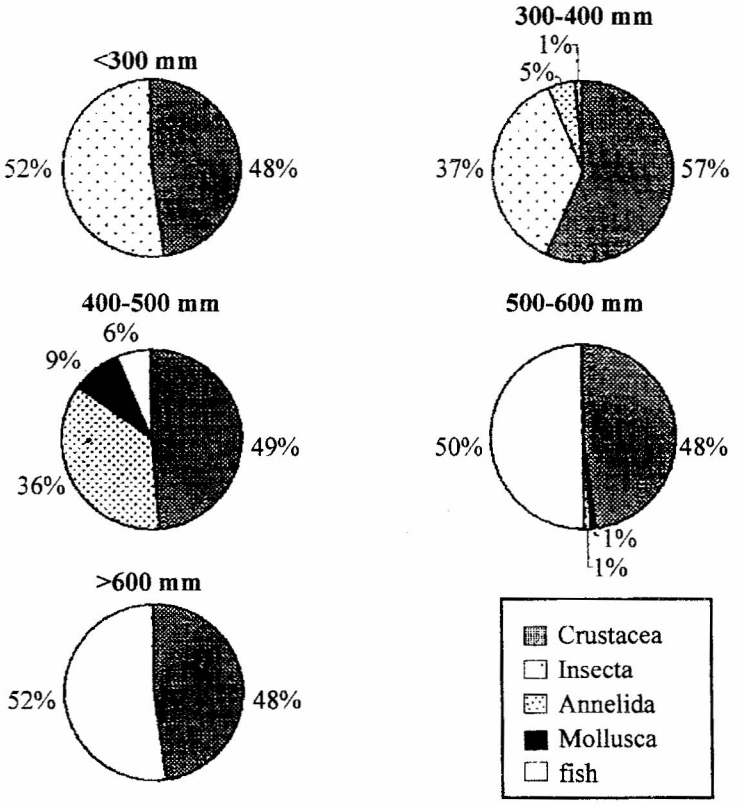

Figure 1: Percentage of food items in each size class (determined by the volume displacement method)

Table 1 shows the frequency of occurrence of prey species in the different size groups. In the 300-400mm TL group 36% of all stomachs examined contained the crustacean species *Penaeus monodon.* In the 400-500mm TL group 30% of the stomachs examined contained the fish species *Ambasis commersoni.* In the 500-600mm TL group no significant preference for any particular species was observed. 50% of all stomachs in the >600mm TL group contained the fish species *Ambasis commersoni.*

Table 1: Percentage frequency of occurrence of prey species in the stomach contents of *Anguilla bicolor* of different size classes.

Food Item	300-400 mm (%)	400-500 mm (%)	500-600 mm (%)	>600mm (%)
Crustacea				
Cladocera		3.03		
Copepoda	2.12			
Caridenae	19.15	15.15	25	25
Xanthidae	29.78	21.21		
M. ensis	23.4	24.24		
M. dobsoni	25.53	21.21	25	
P. monodon	36.17	18.18		
Insecta				
Hemiptera	4.25	3.03		
Annelida				
Oligochaeta	2.12			
Polychaeta	4.25	3.03		
Mollusca				
Gastropoda	2.12	3.03		
Fish				
Zenarchopterus Disper		12.12	16.16	
Ambasis Commersoni	6.38	30.30	16.16	50
Ehirava fluviatilis	25.53	27.27	8.33	37.50

Similarity indices among the diets of different size groups is given in table Similarity indices among the diets of different size groups varied from 57.95% (300-400mm / 400-500mm size groups) to 4.41% (300-400mm />600mm size groups). These results indicate that *Anguilla bicolor* change its feeding habits markedly as it grows.

Table 2 : Percent similarity of diets in the different size classes

	300-400 mm	400-500 mm	500-600 mm	>600mm
300-400 mm	100	57.95	22.63	4.41
400-500 mm		100	36.75	25.57
500-600 mm			100	47.92
>600mm				100

The percent similarity of diet in each month of the year is given in table 3. The similarity indices showed arbitrary variation and generally remained on the high side.

Table 3 : Percent similarity of diets in each month of the year

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Jan	100	54.38	74.56	77.5	40	66.7	52.5	62.5	60	76.15	68	62.5
Feb		100	64.38	63.13	39.88	65.23	46.88	52.2	55.63	57.53	64.13	59.83
Mar			100	82.52	54.54	79.42	71.14	78.81	68.2	72.87	8.91	74.31
Apr				100	42.5	74.75	65	74.2	82.5	36.35	80.5	65.1
May					100	46.65	42.5	46	30	32.1	43	60.7
June						100	60.9	74.5	76.6	69	81	68.9
July							100	70	57.5	53	61	61.3
Aug								100	67.4	67.4	72.35	67.1
Sep									100	75.65	72	52.1
Oct										100	75.9	59.1
Nov											100	74.85
Dec												100

Seasonal variation of GSI and percentage of empty stomachs are shown in fig. 2. A peak value for GSI and a drop in the % of empty stomachs was recorded around October, indicating an increase in feeding intensity around October. A drop in the salinity of the estuary water was observed during this time. GSI was found to be negatively correlated with the salinity of the estuary water (r = -0.69).

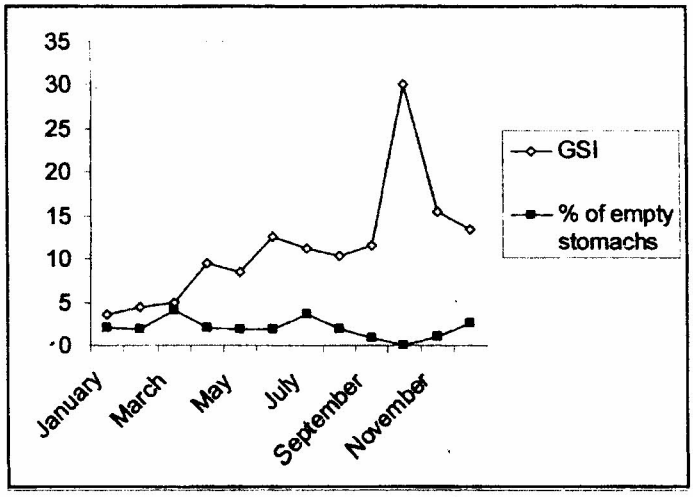

Figure 2: Seasonal variation in GSI and percentage of empty stomachs

4. Discussion

Assessment of the food of *Anguilla bicolor* by the volume displacement method, frequency of occurrence method and determination of similarity indices indicate that *Anguilla bicolor* change its feeding habits markedly as it grows. *Anguilla bicolor* of less than 300mm total length (TL) fed exclusively on crustaceans and insects. In the 300-500mm TL group they fed on crustaceans, insects, annelids, mollusks and fish. The 500-600mm TL group fed primarily on crustaceans and fish. Other studies on the feeding habits of eels present somewhat contradictory results. Frost (1946) working *on Anguilla anguilla* in the Windermere catchment, Sinha and Jones (1967) working on *Anguilla anguilla* in Wales, and Beumer (1979) working *on Anguilla australis* and *Anguilla reinhardii* in Australia found no change in the diet as eels grew. Frost (1946) examined the stomachs of 180 eels of various sizes from the Windermere catchment and found that mollusks were the most important food item. Fish were found in very few stomachs. Sinha and Jones (1967) studied the stomachs of about 5000 eels from rivers in Wales and concluded that fish did not constitute a major portion of the eel diet. Beumer (1979) working on *Anguilla australis* from a lake in Victoria, noted that teleosts and insects formed the most abundant food items. However, he found no evidence to show that *Anguilla australis* change its feeding habits markedly as it grows.

Hartley (1940) working *on Anguilla anguilla,* Cairns (1942) working *on Anguilla dieffenbachia* and *Anguilla australis* and Ryan (1986) working on *Anguilla australis* found as in this study, that eels change their diet as they grow. They fed primarily upon invertebrates when small and become more piscivorous as they grew.

In this study no seasonal variation in the feeding habits of *Anguilla bicolor* in the Bolgoda Estuary was observed. Beumer (1979) working on *Anguilla australis* from a lake in Victoria, did not find differences in diet between seasons except between Autumn and Winter. Ryan (1986) working *on Anguilla australis* in a lake in New Zealand observed the most obvious seasonal differences in the <40cm and 40.1-50cm size classes only. In the present study the result was based on pooled size classes. However, if individual size classes had been examined differences may have been revealed.

Seasonal variation of GSI and % occurrence of empty stomachs indicate *that Anguilla bicolor* in the Bolgoda Estuary do not feed at the same intensity throughout the year. A high feeding intensity occurred from August to December with a peak in October.

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