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Feeding Ecology of the Grey Mullet, *Rhinomugil corsula* (Hamilton) from the River Yamuna, North India

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Abstract

Qualitative and quantitative analyses of the gut content of the grey mullet *Rhinomugil corsula* (Hamilton) from the River Yamuna, North India, were made. Anatomical modifications in the gut, the presence of a high percentage of decayed organic matter, mud, detritus, benthic or-ganisms, algae and zooplankton indicate that the species is illiophagous and omnivorous in its feeding habits. Feeding intensity was maximal in winter and declined towards the monsoon. Sea-sonal variations in feeding intensity were determined by the percentage of empty guts.

Introduction

A knowledge of food and feeding habits of various fish species is advantageous in their proper management and exploitation. Accounts of diverse views expressed on the food of the grey mullets by various authors have been previously reported (Sarojini 1951; Pillay 1953; Luther 1962; De Silva 1980; Gupta 1981; Tandel et al. 1986; Wijeyaratne and Costa 1987). Authors have variously described the mullets as plankton feeders, herbivores, slime feeders, foul feeders, bottom feeders, etc. Despite extensive records on the subject on this group of fish, there are no accounts on grey mullet *Rhinomugil corsula* (Ham.). Because *R. corsula* is a preferred food fish, the present study was carried out to investigate its food and feeding behavior as a prelude to the management of its fishery in freshwater environments.

Materials and Methods

Monthly samples of 80-100 fish of all sizes (90-350 mm) were collected during daylight hours for a period of one year from the River Yamuna, North India, using cast nets (mesh size 2 cm) and gill nets (mesh size 5 cm). Gill nets were laid for about 8 h between 0800-1600 h. The fish were dissected in the field, and the viscera fixed in 5% formaldehyde solution and brought to the laboratory. Each fish was measured, weighed and sexed. State of maturation was determined based on the classification used by Fatima and Khan (1993). After noting the length of the alimentary tract, a 0.2 ml sample of gut content was introduced onto a Sedgewick-Rafter slide and examined under the microscope qualitatively and quantitatively. The gut content containing food material from all parts of the alimentary tract of each sampled fish was treated individually, and the proportion of various food items determined. The percentages of decayed organic matter, mud, sand grains and detritus were estimated by eye.

The intensity of feeding was studied by determining the Gret Fullness Index (GFI) using the following formula:

$$GFI = \frac{\text{Total weight of gut containing food (g)}}{\text{Total weight of fish (g)}} \cdot 100$$

Results

Gross Morphology of Buccopharynx and Alimentary Canal

Structural modifications in the buccopharynx of *R. corsula* are shown in Fig. 1. The mouth is V-shaped, inferior in position, and the gape is moderate. The jaws have a single row of fine teeth. The lower jaw has a prominent symphyseal knob in the center and, corresponding to it in the upper jaw, there is a deep pit to receive it when the mouth is closed (Figs. 1A and B). The maxillaries are slightly curved and hook-like, while the premaxillaries bear a flattened dorsal process. These dorsal processes are united edge to edge except for a small portion in the middle and for a semicircular projection in the middle of the premaxillary with the deep notch dorsally. This gape is covered

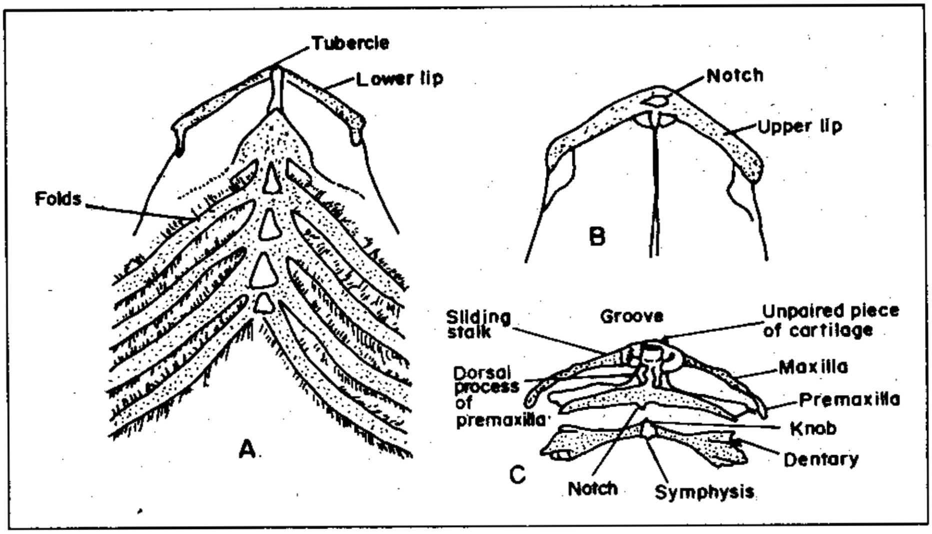

Fig. 1. Buccopharynx of *Rhinomugil corsula*.

by a boat shaped unpaired piece of cartilage (Fig. 1C). The mouth leads into a triangular dorso-ventrally compressed buccal cavity and then into the pharynx followed by a muscular esophagus, a stomach with a posterior distal muscular round sac (gizzard), and a duodenum and ilium that open to the exterior through the anus.

Gut Content Analysis

Food composition and its variation with season in the gut of *R. corsula* is given in Table 1 and the average percentage of food items in the gut is presented graphically in Fig. 2.

Intensity of Feeding

Figs. 3A and B show fluctuations in the rate of feeding in relation to season, rainfall, maturity, growth and sex. Empty guts were also noted in different months of the study and in various stages of maturity (Figs. 3A and B).

Discussion

In *R. corsula*, the terminal, inferior position of the mouth and the presence of a snout help the fish extract food from the mud. Such a position of the mouth has also been reported in other bottom feeders like *Mugil tade*, *Cirrhina mrigala* and *Labeo dero* (Pillay 1953; Khan 1972; Saxena 1980). It is believed that the incisor-like structures in the lower jaw of *R. corsula* help it nibble on the aufwuchs on the banks. The structure of maxillaries and premaxillaries provide a protractile mechanism to the mouth which also helps in the bottom feeding habit of the fish. These findings corroborate those of Pillay (1953) and Gupta (1981) that the maxillary and premaxillary processes can be termed as a "sliding stalk" on which the protractile mechanism works. When the lower jaw is pulled down, the premaxillaries hang down, the thick upper jaw with maxillaries is drawn forward and become twisted in the form of an inferior oval opening. *R. corsula* can be said to be an omnivorous fish as it possesses a long coiled gut. A modified muscular gizzard-like structure which makes it capable of rapidly mixing, crushing and grinding food, compensates for the lack of a masticatory apparatus as the fish grazes at the bottom, sucking in mud and prefering soft decayed organic matter. The stomach, with a muscular gizzard, and the long coiled intestines are features common to mullets and shads (Pillay 1953; Sarojini 1954; Marais 1980; Mundahl and Wissing 1988).

Nature of Food and Feeding

A review of the diet clearly shows that the fish obtains its food, consisting mainly of fresh and decaying plant matter mixed a with considerable amount of mud and detritus, from the iliotrophic layer of the substratum. The predominant occurrence of diatoms, green algae, blue-green algae, desmids, fragments of

Table 1. Monthly variation in percentage composition of different food organisms in the gut of *Rhinomugil corsula*.

	Months											
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Phytoplankton												
Diatoms	17.88	10.45	8.71	15.59	18.78	29.70	33.64	25.02	20,82	26.28	18.96	26.56
Navicula	12.69	13.19	2.24	3.01	3.74	8.06	15.34	12.03	6.50	8.61	9.73	15.32
Cyclotella	0.17	0.22	-	-	0.71	0.32	-	-	-	-	0.54	2.76
Synedra	0.93	1.27	0.93	1.12	2.05	2.61	1.34	4.12	1.02	2.02	0.67	1.78
Melosira	0.77	2.87	1.10	2.06	2.15	4.01	2.36	0.91	1.85	1.61	0.36	0.51
Amphora	0.47	0.54	0.82	1.07	1.27	2.01	1.37	0.59	1.00	0.77	1.61	1.81
Diatoma	1.76	1.59	1.15	2.00	2.01	2.21	2.52	1.11	2.50	3.34	1.56	1.08
Nitzschia	0.69	0.45	1.05	1.31	2.16	3.33	3.41	3.59	2.41	2.11	0.93	0.69
Gyrosigma	0.17	-	0.52	0.66	0.83	1.37	2.75	0.48	2.02	1.27	1.51	0.76
Cymbella	0.69	-	0.08	0.07	0.39	0.59	0.55	0.25	0.05	0.66	-	1.01
Fragilaria	0.08	-	-	-	-	-	-	-	0.80	-	-	0.44
Stauroneis	0.34	0.09	0.12	2.25	2.52	4.83	2.42	1.71	1.97	1.01	0.63	-
Asterionella	0.38	-	0.70	0.64	-	0.36	0.71	0.08	0.45	-	0.41	0.32
Pinnularia	-	0.23	-	1.00	0.76	-	0.89	0.15	0.25	0.76	-	0.08
Tabellaria	0.76	-	-	0.40	0.20	-	-	-	-	3.12	1.01	-
Green algae	15.96	9.08	3.05	4.30	10.74	20.00	17.37	14.38	12.58	15.90	16.00	8.60
Pediastrum	1.19	1.00	0.07	-	6.23	2.05	1.57	0.92	1.05	2.31	1.01	-
Scenedesmus	2.54	2.38	0.45	0.43	1.52	3.03	2.88	2.73	2.49	3.08	2.36	2.52
Ankistrodesmus	4.58	2.09	1.03	1.89	-	4.50	3.07	1.12	2.56	2.77	1.56	0.43
Selenastrum	1.39	0.46	-	0.14	0.91	0.72	-	0.52	-	-	2.39	-
Ulothrix	1.01	1.00	-	-	2.17	1.01	1.52	1.07	1.03	1.39	2.33	1.21
Protococcus	3.78	1.00	0.50	0.59	2.68	2.57	3.10	2.76	2.35	2.11	1.88	1.12
Spirogyra	0.97	0.35	0.43	0.23	1.19	1.45	2.05	1.37	1.76	1.11	0.57	0.51
Microspora	-	0.07	-	0.35	0.90	2.10	2.00	2.09	1.31	1.31	2.02	1.07
Actinastrum	-	0.20	0.02	0.01	0.56	0.29	0.71	0.64	0.13	-	-	1.23
Ophiocytium	-	-	-	0.05	-	0.32	-	0.34	-	-	-	-
Hydrodictyon	0.50	0.23	-	-	-	0.10	-	-	-	1.01	0.96	-
Zygnema	-	0.30	0.55	0.61	0.68	1.80	0.47	0.82	-	0.81	1.00	0.51

Continued.

Table 1. Continuation.

	Months											
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Blue-green algae	10.09	8.79	2.02	2.22	0.50	0.67	2.85	3.60	1.04	6.67	5.33	8.05
Anacystis	8.80	8.79	1.02	1.92	0.29	0.59	0.95	1.40	0.75	2.61	3.12	1.55
Tetrapedia	-	-	-	-	-	0.09	0.32	0.63	-	-	0.23	2.19
Spirulina	-	-	0.20	-	-	-	0.31	0.01	-	1.21	1.32	-
Merispocedia	-	-	0.30	0.12	-	-	0.30	-	0.25	1.43	-	4.48
Phoraldina	-	-	-	-	-	-	0.40	0.06	0.04	0.92	0.08	-
Nostoc	-	-	-	-	-	-	0.25	-	-	-	-	0.53
Anabaena	0.53	-	0.25	0.17	-	-	-	0.42	-	-	-	-
Oscillaboris	0.17	-	0.25	0.01	0.21	-	0.32	1.08	-	0.50	0.53	-
Desmids	0.76	0.72	0.54	1.45	4.86	2.20	5.01	4.12	2.73	2.53	2.62	1.48
Closterium	0.76	0.72	0.54	1.45	2.78	2.20	2.50	2.31	2.00	2.58	2.42	1.29
Staurastrum	-	-	-	-	1.57	-	1.25	1.08	0.13	-	0.20	-
Cosmarium	-	-	-	-	-	-	0.43	0.03	0.20	-	-	-
Desmidium	-	-	-	-	0.43	-	0.32	0.54	-	-	-	0.12
Decidica	-	-	-	-	0.08	-	0.51	0.16	0.40	-	-	-
Euglenophyceae	0.55	0.51	0.03	-	-	2.15	0.23	4.32	-	0.07	0.31	-
Euglena	0.08	0.51	-	-	-	1.00	0.06	1.24	-	-	0.31	-
Phacys	0.47	-	0.03	-	-	1.15	0.87	3.08	-	0.07	-	-
Zooplankton	0.70	1.46	1.41	0.25	0.01	2.72	2.23	2.44	1.21	1.31	7.37	3.73
Cladocerans	0.32	0.75	0.61	0.15	-	-	-	1.03	0.45	0.43	4.27	1.98
Copepods	-	0.19	0.13	-	-	1.40	1.00	1.40	0.61	0.44	-	0.76
Rotifers	0.30	0.46	-	0.10	0.01	1.12	0.62	0.01	0.15	0.44	3.10	0.99
Ostracods	0.08	0.06	0.67	-	-	0.20	0.41	-	-	-	-	-
Eggs and nauplii	-	-	0.05	0.19	0.37	-	0.20	0.01	-	-	-	-
Benthic organisms	-	0.112	0.150	0.129	0.095	0.025	0.005	0.101	0.002	-	0.012	0.125
Miscellaneous matter	5.50	6.75	8.64	5.00	6.07	1.78	2.24	0.69	1.50	3.00	2.95	2.32
Decayed organic matter	15.50	20.50	25.50	25.25	24.00	21.50	20.20	25.60	30.50	25.00	32.00	20.50
Mud, sand and detritus	30.55	25.01	50.50	46.02	35.25	18.50	16.50	20.00	30.52	20.50	15.00	30.00

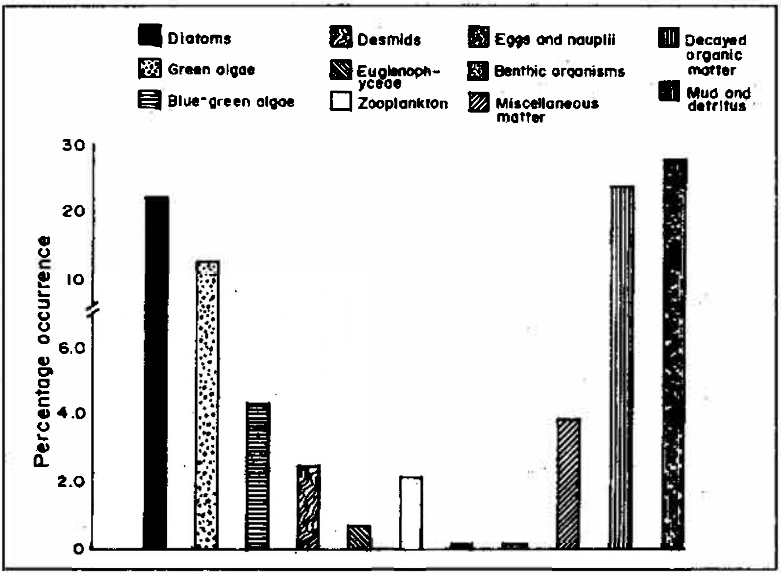

Fig. 2. Average percentage of food items in the gut of *Rhinomugil corsula*.

macrovegetation and semi-digested parts of crustaceans, rotifers, larvae of oligochaetes, nematodes and dipterans in the guts strongly suggest the possibility of *R. corsula* being omnivorous. Findings of the present study agree with those of Marais (1980) for *Liza dumerilli* that a large amount of sand particles probably help the gizzard-like stomach to mechanically break up diatoms.

Seasonal variations and the maturity stages also affect the intensity of feeding in *R. corsula*. In monsoon months, high percentages of mud, sand and detritus were observed (Table 1). It appears that during the rainy season, the bottom flora in the environment are generally disturbed by flood waters which

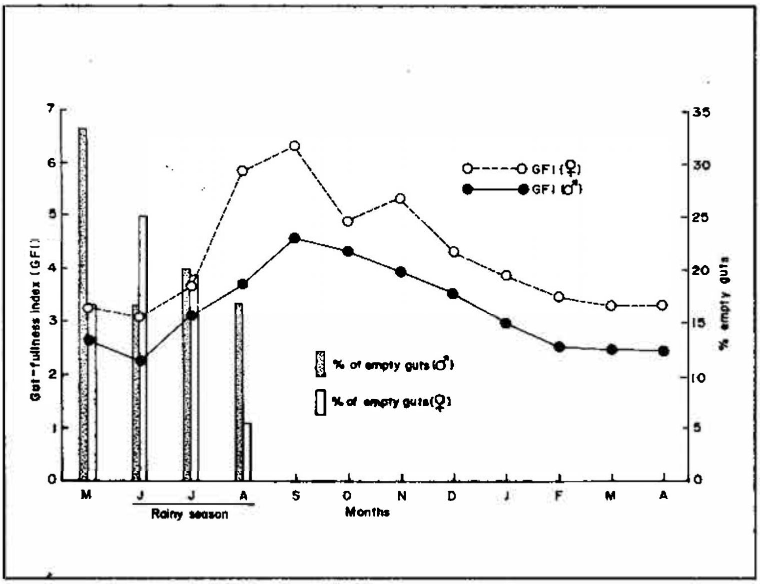

Fig. 3A. Seasonal variations in the intensity of feeding and percentage of empty guts in *Rhinomugil corsula*.

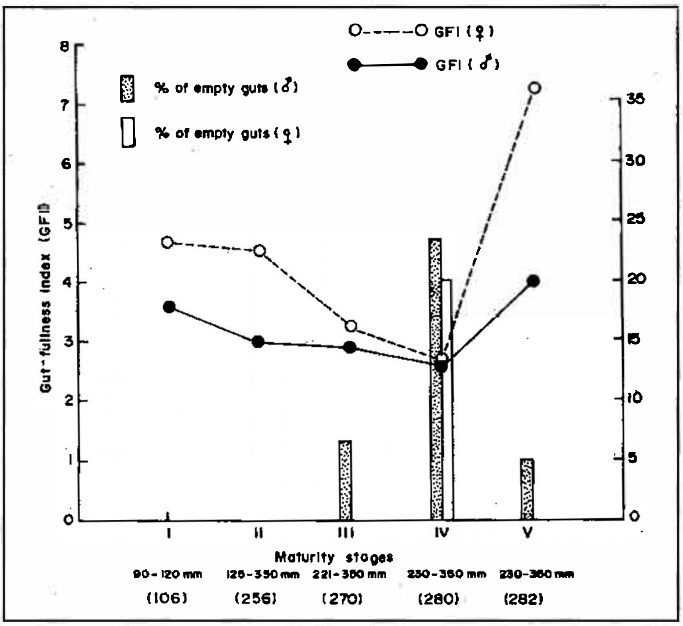

Fig. 3B. Variations in the intensity of feeding and percentage of empty guts with different maturity stages in *Rhinomugil corsula*.

hamper growth of planktonic food. The highest incidence of empty guts were recorded in May, June and July coinciding with the breeding season of the species. Just after spawning, from August onward, when the largest number of spent individuals were encountered, feeding intensity increased considerably. Low feeding activity was observed in sexually ripening (III) and ripe (IV) stages during February-June. Observations based on high feeding intensity in spent fish may be suggestive of high food requirements for building up of the gonads.

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