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Adaptation of the alimentary tract to feeding habits in the weed eating fish (grass carp) *Ctenopharyngodon idella* (Val.)

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The present communication is on the adaptation of the alimentary canal to feeding habit of the weed eating fish Ctenopharyngodon idella *(Val.) from Nadia District of West Bengal. The morphology of the alimentary canal, relative dimensions of different parts of the alimentary canal in the total length of the alimentary canal (morphometrics); relative length of the gut (R.L.G.) at different groups of the fish have been studied in relation to the food and feeding habit of the fish. The gut content analysis of the fish has been done at different length groups of the fish. The pattern of mucosal folds at the different regions of the alimentary canal of the fish has been described. Morphology of the alimentary canal and relative dimensions of different parts of the alimentary canal suggests its herbivorous feeding habit. The fish has been found to depend on food of animal origin at its early stages. In the juvenile stage the fish preferred food of both plant and animal origin . In the advanced stages the fish depended only on aquatic macrophytes. The R.L.G. value varied from 0.8 to 2.5. the value increased with the increase of vegetable matter in the gut content. The R.L.G. value of the adults (2.5) suggests that the gut is rather short when compared to other herbivours. The pattern of mucosal folds at different regions of the alimentary canal was found to vary for performing different functional roles. The fish has been recommended for control of aquatic weeds. Their feeding strategy could be altered by providing them with cheaper food from indigenously available raw materials of plant origin to make fishery operation more economic.*

Key words: Adaptation, alimentary tract, feeding habits, grass carp

Biological control by using herbivorous fish is probably the best for controlling the aquatic weeds. Several types of weeds can be kept under control with the help of few species of herbivorous fishes. The grass carp, *C. idella* is an important herbivorus species and voraciously feeds on most of the aquatic weeds. The grass carp are native to large rivers in Asia, ranging from the Amur River in China and Siberia south to West River in China and Thailand. It was introduced in India in 1959 by importing from Hong Kong and Japan. Normally it feeds on aquatic weeds and terrestrial grass (Napier) and in the absence of plants may feed on fish fry. It manures the fish ponds as 50 per cent of the daily consumed, which is about twice of its body weight is defecated in semidigested condition, which constitutes organic manures (Santhanam et. al., 1987). In China, the grass carp is reported to consume 40 – 70% of its own weight of grass per day and 100 fish per ha can totally eradicate weeds.

Some of the earlier works on the alimentary canal and digestion of *C. idella* are by Hickling (1966), Barry and Low (1970), Moitra and Sinha (1971), Fisher (1972), Mukhopadhyay (1977), Trewisan (1979) and Das and Tripathi (1991). The present communication is on the adaptation of the alimentary canal of *C. idella* to its feeding habit and deals with the morphology and morphometrics of the alimentary canal, pattern of the mucosal folds of the alimentary canal and gut content analysis.

MATERIALS AND METHODS

The materials for the present study (specimens of *C. idella*) were collected from different ponds located at Nadia District of West Bengal. A total of 120 specimens were collected ranging in total length from 10 mm to 400 mm. Immediately after collection, the specimens preserved in 10% formalin. Total length of the specimens was measured. The alimentary canal was removed, uncoiled and cleaned of the attached tissues.

Measurements such as length from lip to oesophagus, length of intestinal bulb, length of intestine were taken for five individuals. The Relative length of the gut (R.L.G.) was determined by dividing the length of the gut by total length of the fish. Gut content analysis was done for 120 specimens. For estimation of food organisms the 'Points method' (Hynes, 1950) was followed. Mucosal folds of the alimentary canal were studied under dissecting binocular.

RESULTS AND DISCUSSION

Morphology of the alimentary canal of *C. idella* has been shown in figure1. Mouth is terminal, not extending to anterior margin of eyes. Lips are thin without any lobes. Upper jaw is slightly longer than lower and protractile (Fig 2, D and E). Buccal cavity is edentulous. Four pairs of supra-pharyngeal teeth are present. The gill arch bears two rows of soft pointed gill rakers (Fig. 1. F). The lips and buccal cavity are papillated.

The gut is of moderate length, some what muscular and poorly differentiated. The oesophagus is short and demarcated from the intestinal bulb. The intestinal bulb is well formed. The intestine is moderately coiled and some what thick walled. Its diameter is almost same throughout. The rectum is not differentiated externally. The structure of the alimentary canal of *C. idella* conforms the description given by Das and Moitra (1956) for herbivorous fishes, supplemented by the results of gut content analysis (Table 1).

Grass carp, like other cyprinids, has a toothless mouth but has strong specialized pharyngeal teeth (Fig. 2 D and E) for rasping aquatic vegetation. These teeth occur in 2 rows, the upper consisting of 2 small teeth on either side and lower of strong comb- like teeth comprising 4 on the right and 5 on the left pharyngeal bone. In fishes of length 30 cm and below, the lower pharyngeal teeth tend to have a serrated cutting surface, while in the large fish, teeth are thicker and tend to have double and serrated cutting and rasping surfaces. The change in teeth structure is associated with the change in the feeding habit. Larger fishes are able to masticate the leaves of tough land plants and fibrous grass (Hickling, 1966).

The percentage (average) of length of different components of the alimentary canal in the total length of the alimentary canal (Fig. 2 C) is as follows: Bucco-pharynx 10.38, Oesophagus, 1.98, Intestinal bulb, 14.93, Intestine, 72.72. This percentage varies considerably with different feeding habits. The importance of these variations can be clearly understood if we consider the food taken by different species (Groot, 1971). According to Dasgupta (2002) the herbivorous and plankton feeding fishes have short bucco-pharynx to catch small sized vegetable food, no stomach at all or have intestinal bulb in place of stomach and long intestine to digest vegetable matter. The carnivorous fishes have long bucco-pharynx and long stomach for capture and storage of big sized prey, but short intestine to digest animal matter. The omnivorous fishes were found to have conditions in between.

The mean R.L.G. value has been found to increase from 0.8 to 2.5 with the increase in length of the fish and increase of vegetable matter in the gut content. The R.L.G. value of the adults (2.5) suggests that the gut is rather short when compared to other herbivours. It is evident that R.L.G. value has a closer relationship with the nature of food of fishes. In herbivorous fishes such as *Labeo rohita*, *L. gonius* (Das and Moitra,

1956, 1958, 1963) and *Labeo dero* (Das and Nath, 1965) the R.L.G. values were 12.0, 9.5 and 8.9 respectively. In omnivorous fishes such as *Puntius chonchonius*, *Barbus hexastichus*, the R.L.G. values were 3.3 and 2.3 respectively (Das and Nath, 1965). In carnivorous fishes the R.L.G. values were the lowest, e.g. *Bagarius bagarius* had 0.8 and *Notopterus chitala* had 0.4 (Das and Moitra, 1956).This is also evident from the report of Dasgupta (2004), he has reported the R.L.G. value for different freshwater fishes in relation to their food and feeding habits. The length of the intestine varies not only with the food habit, but also in relation to the size and age of the fish (Sinha, 1992). The different types of correlations between the diet and length of intestine encountered in various adult teleosts also hold good on the different life history stages (fry, fingerling and adult) of carp due to the change in dietary habit. On the other hand, it is difficult to make a generalized statement between the diet and the length of the intestine of the fish as more than one factor appears to be responsible for determining the R.L.G. (Barrington, 1957). As for example, the shortness of the gut in a fish may be compensated by the increase in complexity of its mucosal folds and also the presence of pyloric caeca occurring in some species.

The gut enzymes are: lipase, present chiefly in the anterior part of the alimentary canal, and amylase and proteases, located in the mid intestine. The food passes through the gut in less than 8 hours at 28 to 30 degree centigrade. Digestion is incomplete and about half the food material is passed out as faeces which can support directly or indirectly a large biomass of other species of fish (Hickling, 1966).

Mucosal folds of the alimentary canal of *C. idella* has been shown in figure 1 C . In the oesophageal region the folds are wavy , folds are wavy and transverse in the intestinal bulb, in the intestine the folds are straight and transverse, the rectum shows curved transverse folds. The pattern of mucosal folds in different regions of the alimentary canal is meant for conduction, retention and assimilation of the ingested food materials (Moitra and Sinha, 1971). The longitudinal folds probably help in facilitating conduction of food. The transverse pattern of folds may help partially to retard the motion of food and help in retaining the food for longer period for trituration and digestion. The irregular folds may serve intermediate functional role.

Gut content analysis of *C. idella* has been shown in Table 1. The gut content analysis reveals that the fish feeds mainly on animal matter such as microcrustaceans, rotifers, insect larvae upto the length of 30 mm, thereafter he vegetable matter increases in the gut content. In the adults (above 30 mm size) the gut contents consisted of mainly aquatic macrophytes (Table 1). In the younger stages the fish prefers zooplankton as they are easily digested than the phytoplankton. The nutritional value of zooplankton is also more than phytoplankton.

According to Nikolsky (1956), grass carp of lengths greater than 30 mm is almost exclusively a vegetarian. In the case of smaller fry, the diet may comprise rotifers, crustaceans, unicellular algae and occasionally chironomid larvae. The results of the present work are in agreement with Nikolsky (1956). Macrophyte material is first eaten at 17 to 18 mm, and at this size, the importance of rotifers in the diet declines and that of chironomids increases. In India, the fry of grass carp at 25 to 27 mm size have been observed to accept Wolfia as feed. At 27 mm length, macrovegetation forms the bulk of its diet, and from 30 mm upwards, the fish, as stated above is wholly herbivore (Jhingran, 1991).

Das and Tripathi (1991) conducted experiment on *C. idella* and obtained significant cellulose activity among other digestive enzymes, viz., amylase, protease and lipase. They suggested the need for providing cellulose as an ingredient in the diet of grass carp.Mukhopadhyay (1977) suggested that the feeding strategy could be altered by providing them with cheaper food from indigenously available raw materials chiefly of plant origin to make fishery operation more economic.

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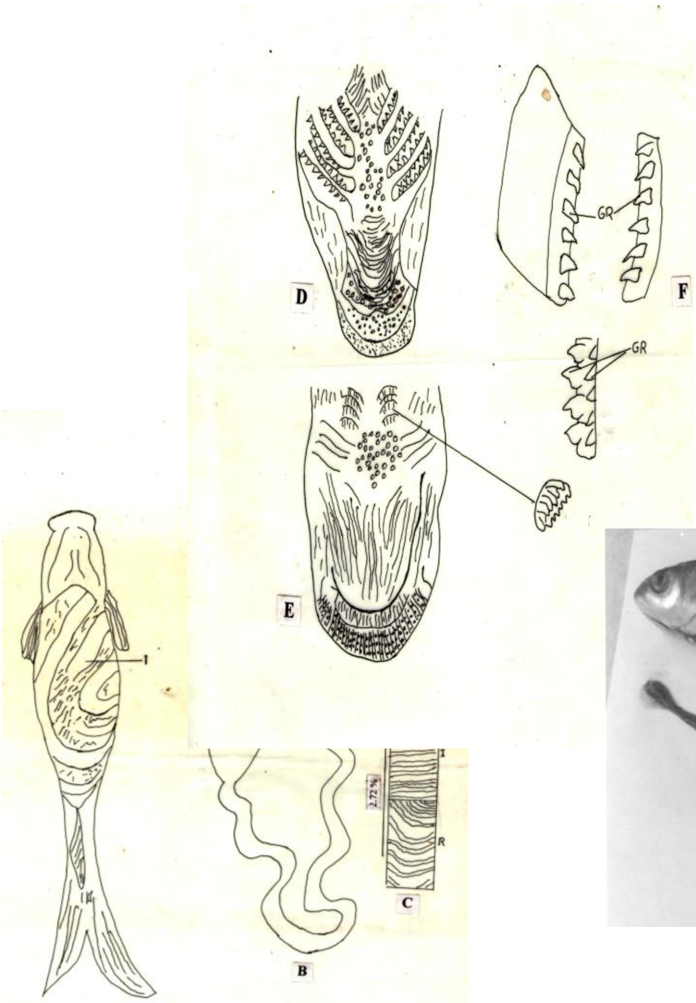

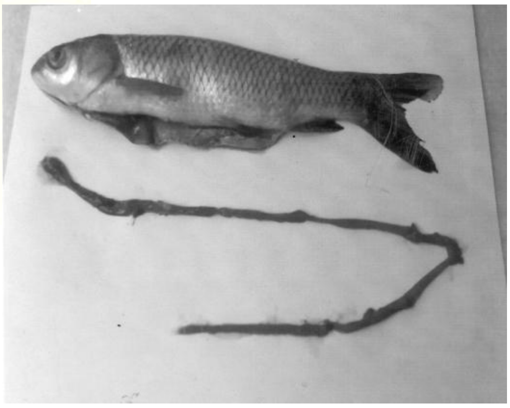

Table. 1. Gut content analysis of *C. idella*

Sl. No.	Length groups mm)	No. of fishes examined	Gut contents: Animal matter	Gut contents: Veg. Matter	Mean R.L.G.
1.	10 - 15	20	Microcrustaceans, rotifers, chironomous and mosquitol larvae (98 %)	algae (2 %)	0.8
2.	15 - 20	20	Microcrustaceans, rotifers, chironomous larvae (95 %)	algae (8 %)	0.9
3.	20 - 25	20	Chironomous Larvae, Rotifers	Unidentifiable Macrophyte Tissue, Algae	1.0
4.	25 - 30	20	Chironomous Larvae, Rotifers (90%)	Unidentifiable Macrophyte Tissue, Algae (10%)	1.2
5.	30 - 150	20	Chironomous Larvae, Roti (70%)	Unidentifiable Macrophyte Tissue, Algae (30%)	1.4
6.	150 - 250	10	Chironomous Larvae, Rotifers (40%)	Unidentifiable Macrophyte Tissue, Algae (60%)	1.58
7.	250 - 375	5		Unidentifiable Macrophyte Tissue, Algae (100%)	1.9
8.	375 - 400	5		Unidentifiable Macrophyte Tissue, Algae (100%)	2.5