JSR Publications

Available Online

J. Sci. Res. **6** (1), 169-174 (2014)

JOURNAL OF SCIENTIFIC RESEARCH

www.banglajol.info/index.php/JSR

Mouth Morphometry and Architecture of Freshwater Cat Fish *Mystus vittatus* Bloch (1974) (Siluriformes, Bagridae) in Relation to its Feeding Habit

S. Chattopadhyay, S. Nandi, and S. K. Saikia[1]

Aquatic Ecology and Fish Biology Laboratory, Department of Zoology, Visva Bharati University, Santiniketan, West Bengal, India, Pin-731235

Received 9 September 2013, accepted in final revised form 1 December 2013

Abstract

Mouth morphology and architecture of a freshwater cat fish *Mystus vittatus* was studied in relation to its food and feeding habits. The fish has small mouth and predates mainly on small sized preys. It possesses terminal mouth, equipped with villiform teeth on both lower and upper jaw. Lower jaw also bears molariform teeth in addition to villiforms teeth to grasp and prevent the escape of prey. Lack of papilliform teeth and prominent microridges suggest its plankton feeding habits and poor test sensation on captured preys.

Keywords: Dentition; Carnivorous; Molariform; Villiform

doi: http://dx.doi.org/10.3329/jsr.v6i1.16369 J. Sci. Res. **6** (1), 169-174 (2014)

1. Introduction

Mystus vittatus is a common fresh water fish that dwells in canals, ditches, rivers, ponds, lakes etc and has wide distribution throughout India, Bangladesh, Pakistan, Sri Lanka and Thailand. The body of the fish looks silver in colour with golden tinge and oriented with 5 narrow black bands, above and below the lateral line, and a black distinct shoulder spot on each side of the body. Mouth is small and terminal with 4 pairs of barbels. The fish dwells mainly in muddy bottoms rich in macro zooplanktonic food, insect larvae etc. Like other catfishes, its mouth morphology and architecture play significant role in searching, capturing and collecting food into the alimentary canal. Mouth morphology of few cat fishes like *Ictalurus punctatus* [1], *Clarius gariepinus* [2], two African catfishes *Andersonia* (Amphiliidae) and *Siluradon* (Schilbeidae) [3], and *Rita rita* [4] were well studied. Recently, Gamal et al. [5] performed scanning electron microscopic studies on the

[1] *Corresponding author*: surjyasurjya@gmail.com

morphological adaptation of buccal cavity of the omnivorous cat fish *Clarias gariepinus* in relation to its feeding habits.

Recent studies indicate that there exists strong relationship between mouth architecture and feeding habits in fish. Herbivorous fish like *Oreochromis niloticus*, surgeonfishes have mouth architecture which correlates with their feeding habits [6, 7]. However, mouth morphology and architecture of *M. vittatus* has hardly received any attention. The present study, therefore, aims to examine the mouth morphology and architecture of *M. vittatus* to have better understanding on its feeding habits.

2. Materials and Method

2.1. *Collection of fish and morphometric analysis*

M. vittatus (n = 35) were collected from fresh water ponds in and around Bolpur, West Bengal, India throughout February 2013 and preserved in 10% formalin solution. Morphometric analysis was performed in the laboratory using standardized scale and digital balance (Table 1). Vertical and horizontal mouth openings were measured and mouth area (M_A) was calculated [8].

2.2. *Condition factor*

The condition factor (K) was determined to verify the relative condition of fishes. Mathematically, $K = (W/L^3) \times 100$, (where W, weight in g; L, length in cm).

2.3. *Scanning electron microscopic (SEM) study*

Freshly collected *M. vittatus* (n = 2) were washed with 1M phosphate buffer (p^H = 7.4) and treated with 0.1M sucrose solution for 15 - 20 minutes to remove mucus contents. After repeated washing, the samples were kept in 2.5-3% gluteraldehyde in cacodylate buffer for 4 hours at 4^0C. Thereafter, samples were dehydrated through graded series of ethanol followed by critical point drying, sputtering with gold and then examined under scanning electron microscope.

Table 1. Definition of morphometric measures recorded for *M. vittatus.* (All lengths in cm).

Measures	Code	Definition
Total length	TL	Distance between tip of snout and caudal fin lobe
Standard length	SL	Distance between tip of snout and base of caudal fin
Head length	HL	Distance on a straight line between the anterior most part of snout and posterior most edge of the opercular bone

Table 1 (*contd.*)

Head depth	HD	Distance between the occiput and the ventral side of the head
Head width	HW	The horizontal distance between two opercular starting points
Upper jaw length	UJL	Total length of upper jaw
Lower jaw length	LJL	Total length of lower jaw
Snout length	SnL	Distance on straight line between the anterior most part of the snout and anterior margin of the orbit
Vertical mouth opening	VMO	Fully expanded vertical mouth opening
Horizontal mouth opening	HMO	Fully expanded horizontal mouth opening
Weight	W	Weight of fish in g

3. Result

3.1. *Mouth morphology*

The mean mouth morphometric measures of *M. vittatus* (with K values ranging between 0.55-1.18) were presented in Table 2. The mean HL and HD of the fish was 1.94 cm and 1.1 cm, respectively. The mean lengths of upper and lower jaws were indifferent (0.60 cm). It has a slightly protruding snout of 0.70 cm in length. The mouth bears four pairs of unequal barbels viz. maxillary (5.44 cm), long mandibular (2.29 cm), short mandibular (1.48 cm) and nasal (1.08 cm). VMO and HMO were almost of equal lengths (0.737 cm and 0.783 cm, respectively).

Table 2. Morphometric measures of *M. vittaus* (n = 35). For abbreviations, see Table 1.

Morphometric parameters	HL	HD	UJL	LJL	Mx	Mdl	Mds	Ns	VMO	HMO
cm	1.9	1.1	0.6	0.6	5.4	2.3	1.5	1.1	0.74	0.78
SD (±)	0.25	0.12	0.07	0.07	0.75	0.34	0.23	0.16	0.09	0.12

Mx, Maxillary barbel; Mdl, Mandibular (long) barbel; Mds, Mandibuluar (short) barbel; Ns, Nasal barbell

3.2. *Mouth architecture*

Fig. 1 shows details of SEM studies from mouth of the fish. The upper lip is thick and more prominent than lower lip. Upper jaw bears numerous needle like long and conical villiform teeth, while lower jaw is equipped with a combination of villiform and molariform teeth.

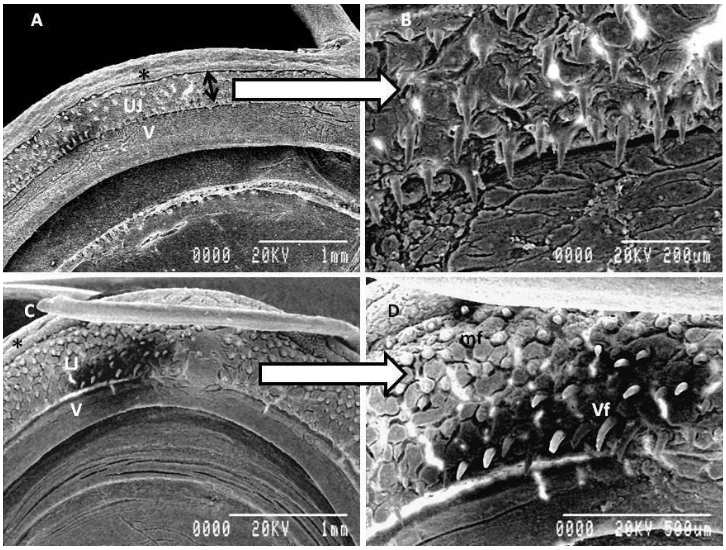

Fig. 1. Scanning electron micrograph of mouth architecture of *M. vittatus.* (A) Dentition in upper jaw. The black star indicates upper lip; V, vellum; double headed black arrow focuses villiform dentition, (B) Magnified portion from upper jaw to show villiform dentition, (C) Dentition in lower jaw. The black star indicates lower lip; (D) Magnified portion from lower jaw to show villiform and mollariform dentition; mf, molariform teeth; Vf, villiform teeth.

4. Discussion

The fish has a dorsoventrally flattened head with head length nearly 2 cm and head depth half of the head length. The average total length of the fish was 8.8 cm, and maxillary barbel extended upto 60% of total length of the fish. In general, barbels in fish are out growths of gustatory (taste) system and the ratio of total length to barbel length is important as it indicates searching ability of the fish through gustatory arrangements in the body. This ratio was constant in *M. vittatus* throughout all sizes, indicating its continuous tactile feeding behavior throughout its growth. McCormick [9] on tropical goat fish, *Upen eustragula* (Mallidae) found that food availability influences the relationship between barbel length and fish size. Slower growing fishes have longer barbels relative to their body length. In that case *M. vittatus* is moderately growing fish. Presence of four pairs of barbels indicates its strong gustatory ability in searching food at the bottom.

The edges of jaws in *M. vittatus* end in fleshy and blunt cartilaginous lips. It has strong upper and slightly wider lower jaws, intended for preliminary crushing of hard armature of its prey. A flattened sub-terminal mouth with narrow vertical and horizontal openings results smaller mouth area ($0.453cm^2$) that describes limited feeding regimes of this fish on smaller preys.

Most catfishes have either cardiform or villiform teeth. However, *M. vittatus* has numerous strong, small and sharp teeth found in the lower mandibular and upper maxillary jaws. The presence of teeth on jaws is required to hold or grasp prey items and to prevent them escaping from the mouth. The maxillary teeth in *M. vittatus* are sharp, pointed and straight. The mandibular teeth are formed by villiform and molariform types and located on the curved band of the jaw, not on the palatine. Exclusive carnivorous fishes bear teeth on jaws, tongue, roof of the mouth and pharynx [4]. All these help in seizure, grasping and grinding of prey. Interestingly, *M. vittatus* has no canine and vomer teeth on jaws. Further, absence of papilliform teeth on jaws confirms that *M. vittatus* does not feed by seizure. Restriction of molariform and villiform teeth only to jaw regions helps in catching and grasping activity and therefore describes moderate carnivorous filter feeding nature of *M. vittatus* on zooplanktons. In addition, edentulous palatine (Figure 1) describes *M. vittatus* feeding on soft bodied food or if on shelled organisms, not on too hardy shelled (e.g. mollusc). Azadi et al. [10] reported that *M. vittatus* is a plankton feeder and feeds on copepods, cladocerans, rotifers, ostracods, insect larvae, oligochaetes, chlorophyceae, bacillariophyceae and debris. By food composition, it is 43% zooplankton feeder with majority from calanoid and copepod in the stomach. Zoobenthos contributes 22% to its diet with insect larvae as major component [11]. By composition, it prefers crustacea (24%), protozoa (13%) and insect (11%) [12]. Shafi and Quddus [13] also reported algae (22%) along with zooplankton (27%) in its gut. None of these workers reported mollusc-like food in its gut.

M. vittatus bears poorly distributed microridges on its mouth. The functional significance of microridges has been considered to serve as a secretory source of lubricant, facilitating movement of materials over a cell surface and protecting the plasma lemma from damage by abrasion, especially from hard food substances. As *M. vittatus* has feeding regimes limited to soft shelled zooplanktonic organisms, microridges are not an essential architectural structure in the mouth for feeding activity. Lack of prominent or compact microridges further suggests its inability to adopt taste based (gustatory) foraging on selected prey items. As in most freshwater fishes, presence of traces of microridges may be an evolutionary remark, but without prominent functions.

The mouth morphometry and architecture describe functional ecology and ethology of the feeding regimes of fish [14, 15]. The shape of the body and mouth, dentition system and barbels in *M. vittatus* confirm its carnivorous feeding on small preys, like zooplanktons without strong taste sensation and poor predation on hardy prey items.

Acknowledgement

The authors are highly indebted to CAS Programme (Phase II) (UGC, New Delhi), Department of Zoology, Visva Bharati University, Santiniketan for providing all material support to complete this work.

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