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Zooplankton in the Gut Content of Indian Shad (*Tenualosa ilisha*): Case Study at the Meghna River Estuary, Bangladesh

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Research Article

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ABSTRACT

The Indian Shad or Hilsa (*Tenualosa ilisha*) is the national fish of Bangladesh. The study was conducted to identify zooplankton species in the gut content of Hilsa, collected from the Meghna river estuary in two seasons: pre-monsoon (March) and monsoon (June) in 2014. Fishes (N=80) were divided into four different groups as per their body weight (i.e. <75 g, 76-150 g, 151-225 g and >225 g). Relative length of gut (RLG) of the four groups were 1.10 ± 0.04, 1.19 ± 0.04, 1.35 ± 0.02 and 1.44 ± 0.02, respectively. The study identified twenty six (26) zooplankton species under six (6) groups comprised of copepods (50.04%), cladocerons (23.10%), protozoans (11.55%), chaetognatha (8.33%), rotifers (4.83%) and ostracods (2.15%). Zooplankton abundance was higher in pre-monsoon and lower in monsoon. However, density (individuals/100 ml) of zooplankton in gut content of the Hilsa decreased with the increase of the size. The study suggested that at the young stage of life cycle, Hilsa mainly feed on zooplankton and diverts their food habits as they grow. The study could be very helpful for the ethical and ecosystem-based management and optimum utilization of this single largest valuable Hilsa fishery in Bangladesh.

INTRODUCTION

Tenualosa ilisha is popularly known as Hilsa or *Ilish* and also called the king of fish (*Macher raja ilish*) in Bangladesh. It has a wide range of distribution and recognized as one of the important commercial fishes in Indo-Pacific region [1]. The fish forms part of anadromous species, constituting an important sector for fishery exploitation in the country [2,3]. Hilsa is considered as the largest and single most valuable fishery in the country. The diversity of species of zooplanktons varies from one region to the other. Seasonally, some species of zooplanktons are abundant whilst during some periods, tends to be limited. It is widely found in Bangladesh from the Bay of Bengal to our rivers. Bangladesh alone produces 60 percent of the Hilsa population in the world while 20 percent caught in Myanmar, 15 percent in India and the rest are found in Oman, Pakistan and Bahrain [4]. In the year 2013-14, Hilsa contributed about 11% to the country's total fish production and 1.0% of GDP [5]. About 2.5 million people directly or indirectly engaged with this fishery [6]. In Bangladesh, Hilsa is available almost throughout the year in the major rivers such as the Meghna and the Padma [7]. Spawning of Hilsa usually occurs between the months of June and July. These periods are known as "summer spawning", with spawning in February-March being termed as "winter spawning" [8]. For breeding and feeding purposes, Hilsa mainly migrate through the Padma-Meghna river system [9]. Hilsa feeds on planktons and so unlike other fish they have to be constantly on the move. Even Hilsa have to swim when other fishes sleep at night or rest [4]. The study of the feeding habits of fish based on gut content analysis is widely used in fish ecology, which is an important tool for investigating tropic relationship in the aquatic communities [10]. Hence, Knowledge on food and feeding habits has manifold advantages for the

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ecosystem-based management and exploitation of this valuable fishery [11]. It is for these reasons why the study was undertaken to study the seasonal concentration of zooplanktons in the Hilsa gut per the periods set aside in the methodology of this study.

Area of study

In Bangladesh, the Meghna river estuary is the largest estuarine ecosystem among the 20 estuaries and support diverse fish biodiversity [12]. The geographical location of the estuary is between latitude 20°30′ and 22° N and longitude 91°45′ and 92°15′ E **(Figure 1).** The area has sunny and tropical weather along with monsoon climate and greatly influenced by the seasonal monsoon winds like other parts of the country. Mean annual rainfall in the study area is 3207 mm, and mean annual temperature is 26.24°C. The entire area is tidal-influenced all year, ranges from 0.07 m during neap tide to 4.42 m during spring tide [12]. The dominant soil characteristics include muddy and sandy-clay loam texture [13]. Majority of the people are engaged with fishing and their livelihood is mostly dependent on Hilsa fishing.

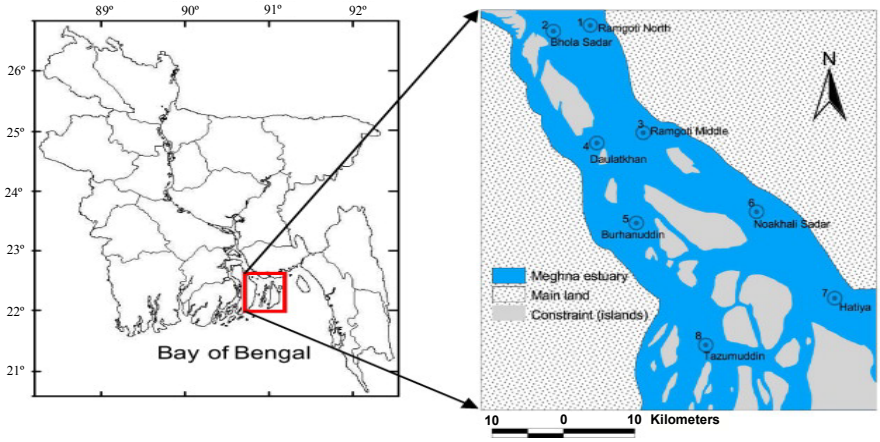

Figure 1. Geographical location of the sampling area.

Statement of the problem

In Bangladesh, the Meghna River is considered as one of the major migratory route of Hilsa [2]. Researchers from South Asia have carried out studies on the food and feeding habit of Hilsa in different water bodies from India [2,14-17]; from Bangladesh [18]; and from Pakistan[19]. However, detailed information on zooplankton species in the gut content of Hilsa is not yet available for the Meghna river estuary in Bangladesh waters. Currently in Bangladesh, no significant study has been conducted on relative length of gut and seasonal variation in density of zooplankton species in the gut content of Hilsa in the present study area.

Objectives

The principal objective of this study was to provide a quantitative estimation of the food preferences of Hilsa with a special emphasis on zooplankton feeding at the Meghna river estuary in Bangladesh. In this communication, the following objectives have been discussed:

To compare relative length of the gut in relation to size of Hilsa

To identify zooplankton species in the gut content of Hilsa in pre-monsoon and monsoon seasons

Justification of the study

The food preference of Hilsa has been attracting the attention of fisheries scientists for decades. The gut content analysis of Hilsa will help to understand the Hilsa and zooplankton interaction in the Meghna river estuary. The study will be very helpful to academic researcher's worldwide, corporate bodies, government and non-government authorities as a baseline study and also to explore more in the subject area. The study could be serving as an important tool for the ethical and ecosystem-based management of this valuable Hilsa fishery in Bangladesh for maximum sustainable yield.

RESEARCH METHODOLOGY AND APPROACH

Research strategy

The research strategy which was adapted for this was basically quantitative approach. Quantitative approach was adapted because the objectives of this study are strictly scientific and would use scientific variables and approach to establish an empirical or logical conclusion.

Sampling fraction/methodology

The sampling was done in two seasons: pre-monsoon (March) and monsoon (June) in 2014. For gut content analysis of Hilsa, samples were collected at night or early in the morning from the commercial catch in the Alaxander Bazar, Ramgoti, Lakshmipur. This period of fishing in the morning during weekly hours were carried that during that period in order to get maximum abundance

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of zooplanktons in the gut content. Fish sample (N=80) were divided into four size groups (10 fishes per group in each season) according to their body weight as <75 g, 76-150 g, 151-225 g and<226 g. Average total length (TL) was measured by measuring tape and body weight was measures by analogue kitchen scale. After dissecting fishes using sharp knife total gut length and relative length of the gut (RLG) were measured and recorded. Stomach along with their contents was removed carefully and preserved in 5% formalin **(Figure 2).**

Figure 2. Sample collection and preservation for the study.

Relative length of gut (RLG)

RLG values were calculated by using simple equation given below and then averaged.

$$\text{RLG Value} = \frac{\text{Total gut length}}{\text{Total length}}$$

Gut sample analysis and identification of zooplankton

Identification of zooplankton was conducted in the laboratory of Department of Fisheries and Marine Science. The quantitative estimation and identification of zooplankton was done by using a luminous electronic microscope (Model: XSZ21-05DN and made in China). All the species identification up to generic level was done carefully. Microsoft office tools like; Microsoft word and excel worksheet were used in preparing related tables and analysis of data.

Limitations

Sample collection required to do in the early morning. Distance in road network as well as the bad nature of roads made frequent sampling difficult. This may to some extent affect the credibility of the study but a number of sampling was done to keep this study more valid and objective. Grading and buying of fish from landing site were difficult tasks because fisherman didn't want to sell small amount of fishes in different grades. This limited the acquisition of data for this study to some extent with regards to the timing and planning for the completion of this study. The sampling size (N=10) for this study was limited because of limited funding of this research. This to some extent affected the effectiveness of the study as more funds would have enabled us to carry to do more.

RESULTS AND DISCUSSIONS

Relative gut length (RLG)

The study shows that Hilsa is predominantly microphagus in feeding habit [15,20]. Gradual increase in Hilsa size and changes in season divert feeding habit of Hilsa reported by Shafi et al., De and Datta and De et al. [15,16,21]. Increase in RLG value with the increase in size indicated that Hilsa prefers zooplankton in their early stages and shift their preference towards phytoplankton in adult stages.

Identification of zooplankton

The stomach contents as well as food tracers only indicate what the fish would feed on. Quantitatively, a total of 6 groups containing 26 species of zooplankton were identified during the gut analysis of Hilsa **(Table 1 and Table 2).** Copepods consisted of half of the total number of zooplankton. The reasons behind copecods consisting of half of the total number of zooplanktons in the stomach contents were as a result of what was available in the water, thus, the sea and what the Hilsa prefers. Level of composition of zooplankton was as copepods>cladocerons>chaetognathas>ostracods>rotifers>protozoans **(Table 3).**

Table 1. RLG value of Hilsa fish of the different size groups of two seasons.

Size group	Total length (mm)	Gut length (mm)	RLG Value
<75 g (20)	184.02 ± 6.01	204.11 ± 9.44	1.10 ± 0.04
76-150 g (20)	216.22 ± 4.59	258.67 ± 10.60	1.19 ± 0.04
151-225 g (20)	248.74 ± 6.40	336.56 ± 10.43	1.35 ± 0.02
>226 g (20)	278.16 ± 8.043	403.55 ± 11.11	1.44 ± 0.02

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Table 2. Preferred zooplankton species by Hilsa in two seasons.

Groups	Species	Pre-monsoon Indv./100 ml	Monsoon Indv./100 ml
Copepods	*Cyclops* sp.	90	75
	Calanus sp.	75	60
	Diaptomus sp.	60	35
	Bryocvamptus sp.	55	40
	Microsetella sp.	30	24
	Naupleus sp.	10	5
Cladocerons	*Bosmina* sp.	60	50
	Diaphanosoma sp.	40	35
	Moina sp.	30	18
	Macrothrix sp.	15	10
Chaetognathas	*Sagitta* sp.	80	49
Ostracods	*Cypris* sp.	60	33
Rotifers	*Brachionus* sp.	4	2
	Keratella sp.	3	1
	Polyarthra sp.	3	4
	Lecane sp.	4	1
	Filinia sp.	8	6
	Cephalodella sp.	6	3
	Rotaria sp.	3	2
	Kelicotia sp.	3	1
Protozoans	*Euglena* sp.	3	2
	Phacus sp.	3	1
	Volvox sp.	3	2
	Difflugia sp.	1	3
	Colpoda sp.	3	1
	Euglepha sp.	1	1

Table 3. Quantitative analysis of zooplankton (Indv./100 ml) in four size groups in two seasons.

Genera	<75 g	76-150 g	151-225 g	>300 g	Total Indv./100 ml	Percentage (%)
Copepods	220	159	110	70	559	50.04
Cladocerons	68	90	70	30	258	23.10
Chaetognathas	51	30	33	15	129	11.55
Ostracods	28	19	30	16	93	8.33
Rotifers	30	10	6	8	54	4.83
Protozoans	9	8	5	2	24	2.15

Copepods are the most important food items consumed by the fish in two seasons. Similar findings reported by De and Datta and Karna et al. [15,22]. Copepods, detritus, algae, mysis, molluscan larvae, diatoms, rotifers and mud and sand particles in food items of Hilsa is reported by Hasan et al., Ramkrishnaiah, Dutta et al. and Karna et al. [914,17,22]. The nature of food items in young Hilsa indicates that it mainly feed from surface and column niche of water body [15]. It is evident from the above discourse that young Hilsa mainly subsist on zooplankton while adult Hilsa are microphagous planktivores. Similar observations have been made by Hora, Hora and Nair [23,24].

The identification of zooplankton up to generic level in the gut contents of Hilsa consisted of a complete identification of the zooplankton. Number of zooplankton per 100 ml was higher in the pre-monsoon season than the monsoon season except *Diffugia* sp., *Polyarthra* sp. and *Euglepha* sp. **(Table 3)** [17] reported seasonal oscillation in intensity of feeding of Hilsa and maximum feeding intensity during the month of February and March.

CONCLUSION

The Meghna river estuary features a sunny and tropical weather along with monsoon climate. The area has been greatly influenced by the seasonal monsoon winds like other parts of the country. Hilsa uses the Meghna River as one their major migratory route. They feed mainly on zooplankton in juvenile stage of life cycles but zooplankton in adult stage. Present study was undertaken to analyze zooplankton contents in the stomach up to generic level in pre-monsoon and monsoon seasons. The study found that relative gut length of Hilsa decreased with the increase in body size. The study identified 6 different groups comprised of 26 zooplankton genera. Further research on the food and feeding ecology of Hilsa in the Meghna river estuary are warranted for the effective management of the Hilsa fishery, domestication and culture to conserve and confirm sustainability of declining Hilsa fishery.

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