Bangladesh J. Zool. **48**(2): 243-251, 2020 ISSN: 0304-9027
eISSN: 2408-8455

# STUDIES ON MIGRATION OF *TENUALOSA ILISHA* IN BANGLADESH WATERS USING PARASITES AS BIOLOGICAL TAG

Md. Aminul Islam Bhuiyan* and Zannatun Nahar Jhinu

*Department of Zoology, University of Dhaka, Dhaka, Bangladesh*

**Abstract:** The study was aimed at following the movement of adolescent *Tenualosa ilisha* from nursery grounds to feeding and spawning grounds or other type of movements in Bangladesh waters. To accomplish this, data on metazoan endoparasites were used as biological tags for detection of migratory route. A total of 2667 host fishes were collected from eleven sites covering the three different ecological habitats of Bangladesh. Initial selection of parasites as biological tags was executed by using established criteria, primarily on the basis of different level of infection in different habitats. The role of incidental parasites as tags is also discussed. Overall fourteen species under eleven genus of endohelminths were identified from alimentary canal and associated organs of host, only three species of them had satisfied the criteria of being as biological tag. These are cestode parasite *Ilisha parthenogenetica* and acanthocephalan parasite *Acanthosentis indica* and *Acanthosentis hilsai*. Higher prevalence of these parasites at respective sites and the trend of prevalence of infection in size class of host fish demonstrated host's anadromous nature and reinforced the belief that the *T. ilisha* as a whole, migrates from the sea to the rivers via the estuaries and vice versa.

***Keywords:*** Migration, Biological tag, Parasite, *Tenualosa ilisha*

## INTRODUCTION

To meet the biological demand, *Tenualosa ilisha* (Hilsa shad, the national fish of Bangladesh) perform genetically determined or occasionally environmentally influenced rhythmic movements from sea to freshwater through estuarine habitat and vice versa during entire life (Margolis *et al.* 1982). Such migration validates its anadromous nature, which occurs mainly for spawning or feeding purpose and are generally time oriented (Lagler *et al.* 1962). Though Hilsa shad lives in the sea for most of its life, however migrates at least 1200-1300 km upstream from estuarine region for spawning purpose and it also found about 250 kilometer distance from coastal region (Halder and Islam, 2008). Generally two types of migratory pattern have been observed in Hilsa shad depending on various factors in Bangladesh, these are- south west monsoon

*Author for corresponding: < aminul_zool@du.ac.bd >
 **DOI: https://doi.org/10.3329/bjz.v48i2.52366**

migration and winter migration (Lagler *et al.* 1962). During such migrations fishes are accompanied by their parasites, so that the colonization of new areas may lead to the loss of their initial parasites or the acquisition of new parasite species, either by host capture or speciation of the original species (Mosquera *et al*. 2000). To be considered as tag, parasites should have significantly different levels of infection in the subject host in different parts of the study area. This is based on the premise that each site has its own characteristic parasite community which a migrant host may acquire or lose as it travels. The biological tag studies are usually based on differences in prevalence of infection between samples (Mackenzie 1987).

The economic value of this species has led to the use of parasites as biological marker for precise identification and definition of fish stocks as well as knowledge of the parasitic fauna and the spatial distribution of both parasite and fish population (Mosquera *et al.* 2000). As *T. ilisha* is one of the flagship species of Bangladesh, which sector contributes 11% of the total fish production and 1% of the national GDP in the country (Department of Fishery, 2016), conservation of this species is indeed needed. Therefore, knowledge on migratory pattern and route of this species demand more attention to boost cognizance and enhance the efficient conservatory practices for them in Bangladesh.

## MATERIAL AND METHODS

This study looks at the movement of *T. ilisha* in Bangladesh waters using data on gut endohelminths as biological tags for detection of migratory route. Initial selection of parasites as biological tags was accomplished by using established principles and then inferences were drawn.

*General selection criteria of tag parasite to study fish migration route:* Sets of criteria for selecting appropriate tag parasites have been proposed and discussed by Kabata (1963), Sindermann (1961, 1983), Mackenzie (1983, 1987), Lester (1990) and Moser (1991). Later Mackenzie (1998) proposed a more flexible general guideline avoiding some unnecessarily restrictive criteria from earlier ones. Criteria proposed by Mackenzie (1998) seem to be appropriate in selecting parasite tags for anadromous fish like *T. ilisha* in Bangladesh. The most important of these guidelines are as follows.

- The parasite should have significantly different levels of infection in the target host in different parts of the study area.
- The parasite should have a long life span in the target host.

- The parasite should be easily detected and identified; otherwise time can become a limiting factor.
- Finding the parasite should involve the minimum of dissection. Site specific parasites are time savers.
- The parasite should have no marked pathological effects, which might change the behavior of the host.

*Variable:* Prevalence is considered to be a most useful parameter as it is less variable and represents the entire data set (both infested and non-infested fish) that is used as an indicatory variable for tagging in this study (Margolis *et al.* 1982).

*Sample collection:* A total of 2667 host fish, *Tenualosa ilisha* were collected from three different ecological habitats of Bangladesh waters, to be more specific 1565 host fishes from the rivers in Chandpur (23°14.40 N 90°40.73 E), Aricha (23°46.10 N 89°46.83 E), Paksey (24°04.46 N 98°02.15 E), Sherpur 24°37.65 N 91°40.82 E); 609 host fishes from estuaries in Patuakhali (22°21.42 N 90°21.10 E), Barguna (22°09.45 N 90°07.61 E), Bhola (22°43.10 N 90°40.53 E), Barishal (22°42.23 N 90°22.49 E) and Sandwip (22°30.56 N 91°42.78 E); 493 host fishes from the sea in Cox's Bazar (21°25.09 N 91°59.97 E) and Kuakata (21°48.97 N 90°07.32 E).

*Data processing:* After collecting the data, both morphometric and meristic characteristics of the host fishes were analyzed such as the weight, length and sex of each fish were recorded. The viscera and organs (cardiac stomach, pyloric caeca, stomach, intestine and mesenteries) were removed individually through simple dissection and kept in 10% formalin in polyethylene bags with a label inside. Laboratorial analysis was performed at Parasitology laboratory, Department of Zoology, University of Dhaka, Dhaka, Bangladesh. Extensive search was made for helminth parasites infecting the fish using microscope. Parasites from each organ were sorted, cleaned and counted which was followed by preservation in 70% alcohol. Berland's method was used for staining and mounting.

*Statistical analysis:* As parasite counts were not normally distributed, nonparametric ANOVA using ranked scores (SAS PROC GLM procedure) was performed to accomplish multivariate analysis among samples of different habitat. Square root transformation of parasite numbers was done to bring frequency distribution close to normal for ANOVA. All statistical tests were done by SAS version-6. Only the data on component parasites (prevalence > 10%) were used in calculation (Bush *et al.* 1990).

## RESULTS AND DISCUSSION

A rich and diverse parasitic fauna have been found in *Tenualosa ilisha* in the present study. Overall 14 species under 11 genuses of endohelminths have been collected and identified from alimentary canal and associated organs (mesenteries and caeca). These are five species of trematodes: *Aphanurus stossichi*, *Faustula brevichrus, F. gangetica, F. ilishii, Lecithaster indicus;* two species of cestode parasites: *Ilisha parthenogenetica* (plerocercoid) and *Otobothrium ilisha* (plerocercoid); five species of nematodes: *Goezia bangladeshi* (adult and larvae), *Camallanus* sp. (larvae), Po*rrocaecum* sp. (larvae), *Capillaria* sp. (larvae) and *Hysterothylacium* sp. (larvae) and two acanthocephalan species: *Acanthosentis indica and A. hilsai.* All of them were present in freshwater, brackish and salt water stock indicating a remarkable spatial stability. A number of nematodes could not be identified up to species level because they were found in their larval stages. Three species of *Faustula* were counted together and referred as *Faustula* spp. and two species of *Acanthocentis* were counted together and referred as *Acanthosentis* spp. Prevalence of different parasites in *Tenualosa ilisha* from three different habitats such as freshwater, brackish water and marine water bodies are shown in Table 1.

**Table 1. Prevalence (%) of different parasite species in different habitats with statistical significance (ANOVA) in Hilsa shad (*Tenuasa ilisha)***

| Group | Parasites | Freshwater | Brackish water | Marine | *P* |
|---|---|---|---|---|---|
| Trematoda | *Aphanurus stossichi* | 77.45 | 94.80 | 91.70 | > 0.05 NS |
| | *Faustula* spp | 49.13 | 77.89 | 67.17 | > 0.05 NS |
| | *Lecithaster. indicus* | 17.16 | 58.72 | 29.43 | < 0.05* |
| Cestoda | *Otobothrium ilisha* | 1.92 | 0.00 | 1.51 | > 0.05 NS |
| | *Ilisha parthenogenetica* | 4.02 | 38.23 | 11.32 | < 0.01** |
| Nematoda | *Goezia bangladeshi* | 34.76 | 31.80 | 34.34 | > 0.05 NS |
| | *Camallanus* sp. | 1.00 | 0.00 | 0.38 | > 0.05 NS |
| | *Capillaria* sp. | 1.40 | 0.61 | 0.75 | > 0.05 NS |
| | *Porroceacum* sp. | 1.00 | 0.00 | 0.75 | > 0.05 NS |
| | *Hysterothylacium* sp. | 10.20 | 2.75 | 1.51 | >0.05NS |
| Acanthocephala | *Acanthosentis* spp. | 8.37 | 3.36 | 4.91 | < 0.01** |

*NS, not significant; * significant at 5% level and ** significant at 1% level. Three species of Faustula were counted together and referred as Faustula spp. And two species of Acanthocentis were counted together and referred as Acanthosentis spp.*

of the parasites only nine species of parasite had the status of component parasite (prevalence above 10%) (Bush *et al.* 1990). These are *Aphanurus stossichi, Lecithaster indicus, Faustula brevichrus, F. gangetica, F. ilishii, Ilisha* *parthenogenetica, Goezia Bangladeshi* and *Acanthosentis*. Prevalence of the following named *Lecithaster indicus*, *Ilisha parthenogenetica* and *Acanthosentis* spp. were distinctly different from the above mentioned parasites which were statistically significant. However, short life span (< 1 year) of *L. indicus* (adult digenean) in the alimentary canal of fish limited their use as biological tags. Therefore *Ilisha parthenogenetica* and *Acanthosentis indica and A. hilsai* were appeared to be satisfied with the selection criteria for the use of parasites as tags to study migration due to their long survival (several years) often for the life of the fish. It can be compared with the work of Stanley (1992), in which study only 2 parasites were found out of 25 and Boje *et al.* (1997), in which study only 6 parasites out of 21 were found to satisfy the criteria of tag parasite.

Parasites have been chosen as tags on the basis of differences in the level of infections in different sites of different ecological habitats. The role of incidental parasites as tags is also discussed. Prevalence of helminth infection in each sampling sites were observed and showed in Figure 1.

It is evident that (Figure 1), among the component parasites the prevalence of *Faustula* spp., *A. stossichi, L. indicus* and *Goezia bangladeshi* did not vary considerably between sites, however *I. parthenogenetica* and *Acanthosentis* spp. varied between sites. Cestode parasite, *I. parthenogenetica* had higher prevalence in brackish water species respectively in Barguna, (54.74%), Barishal (42.65%) and Sandwip (37.14%). Conversely, *Acanthosentis* spp. had higher prevalence in freshwater species respectively in Sherpur (22.03%), Paksey (15.90%), Aricha (8.36%) and Chandpur (4.83%). Though the prevalence of infection by nematodes was very low, they occurred more or less in almost all the sites.

To exemplify, it has been depicted how the tag parasites were distributed in different sized groups of the hilsa in Table 2. Host size was equated with age as it was performed at Miah *et al.* (1997). All the three parasites were found to infect hilsa at an early age and remained identifiable in the mature fish. Prevalence of *I. parthenogenetica* and *Acanthosentis* spp. was measured in respect of the body length of host fishes that can be resemble with their age or life stages.

Host fishes were divided into nine arbitrary groups according to their length which ranges between 17.2 cm and 58 cm.

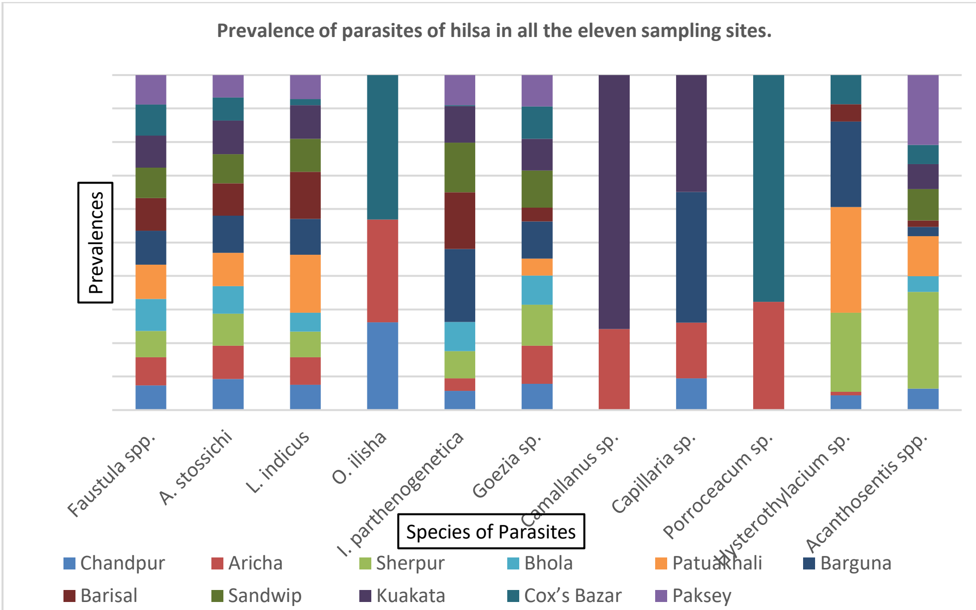


Fig. 1. Prevalence of parasites of *Tenualosa ilisha* in all the eleven sampling sites

**Table 2. Prevalence of infection by tag parasites in different length groups of T. ilisha**

| Class No | Size classes (cm) | Freshwater | | Brackish water | | Marine | |
|---|---|---|---|---|---|---|---|
| | | *Ilisha. parthenogenetica* | *Acanthosentis* spp. | *Ilisha. parthenogenetica* | *Acanthosentis* spp. | *Ilisha .parthenogenet ica* | *Acanthosentis* spp. |
| 1 | 15 - 20 | 22.73 | 22.73 | - | - | - | - |
| 2 | 20 – 25 | 8.52 | 5.68 | 33.33 | 0 | 20 | 0 |
| 3 | 25 - 30 | 16.46 | 6.1 | 39.62 | 4.76 | 17.65 | 0 |
| 4 | 30 – 35 | 11.56 | 4.76 | 41.9 | 7.46 | 5 | 3.33 |
| 5 | 35 - 40 | 13.91 | 11.3 | 34.33 | 3.03 | 13.86 | 6.93 |
| 6 | 40 - 45 | 15.46 | 13.4 | 60.61 | 0 | 8.93 | 3.57 |
| 7 | 45 – 50 | 12.5 | 6.25 | 14.29 | 0 | 21.43 | 7.14 |
| 8 | 50 – 55 | 16.67 | 13.89 | 22.73 | 0 | 11.11 | 11.1 |
| 9 | 55 - 60 | 0 | 0 | 50 | 0 | 0 | 1 0 |

* The fish were divided into 9 class sizes. No fish fell in the 1st length class in brackish water and marine samples.

The results on distribution of parasites in size classes indicate that *I. parthenogenetica* had highest prevalence (22.73%) in the smallest size class of hilsa in freshwater. In brackish water the prevalence of *I. parthenogenetica* was relatively higher than the freshwater and it showed conformity in 2nd to 5th size classes (33.33%-41.9%) that was followed by fluctuations in the larger classes (6th to 9th classes) ranging 14%-60.61%. The higher prevalence of *I. parthenogenetica* in brackish water sites indicates that this cestode was recruited in brackish water sites after or before the hilsa migrated to the other sites. In marine habitats, prevalence of *I. parthenogenetica* did not show any pattern with regard to the size class of host fish and no *I. parthenogenetica* could be found in the smallest and the largest classes (Table 2).

Similarly, *Acanthosentis* spp. showed the highest prevalence in the smallest size class and infected all classes size except largest class while in brackish water and marine samples no fish were found infected in smaller size classes (1st and 2nd groups). In brackish water, *Acanthosentis* spp. infection was found only in the middle classes (3rd to 5th classes). In marine sample, *Acanthosentis* spp. was found in the middle and larger groups (4th to 8th size classes) (Table 2). The higher prevalence of *Acanthosentis* spp. in freshwater sites indicates that this parasite was recruited in the freshwater habitats before or after migrating to sea or estuary.

Therefore, the results on distribution of parasites in size classes specify that the hilsa acquired infection of *Acanthosentis* spp. in the freshwater habitats of Chadpur, Aricha, Sherpur and Paksey at a very tender age whereas, infection of *Acanthosentis* spp. was found in middle classes in brackish water and in middle and larger size classes in marine samples. This trend of *Acanthosentis* spp. infection supports the assumption that as the hilsa become larger they move to the marine region of Kuakata and Cox's Bazar. *Tenualosa ilisha* was infected by *I. parthenogentica* in brackish water habitats of Bhola, Patuakhali, Barguna, Barisha and Sandwip in Bangladesh in a tender age (Table 2). Higher prevalence of *I. parthenogenetica* in brackish water especially in middle size class indicates that the cestode parasite was acquired from estuary and the host fish (hilsa) spent there much time for feeding. Both the prevalence in size classes and in different sites supports the assumption that *Acanthosentis* spp. was recruited in freshwater and *I. parthenogenetica* was recruited in brackish water habitats.

So, the consistent prevalence of parasites which are not site specific (trematodes) and higher prevalence of parasites at respective sites which are site specific (*Acanthosentis* spp. and *I. parthenogenetica*) and the trend of prevalence of infection in size class of hilsa reinforced the belief that the hilsa, as a whole, migrates from the sea to the rivers via the estuaries and vice versa.

Except for *Acanthosentis* spp. and *I. parthenogenetica* infection, there was little difference in the rest of the parasite fauna of *T. ilisha* captured in freshwater, brackish water and salt water. Several salt water parasites (notably all the trematodes and nematodes) were common in fish captured in freshwater and brackish water, illustrating the ability of these parasites to survive in their host during movement into estuarine and freshwater conditions. The scarcity of freshwater parasites in the 'hilsa shad' suggests that although they do enter freshwater, most probably they do not spend extended periods of time feeding there.

Prevalence of *Goezia bangladeshi* did not vary widely in size classes of freshwater 'hilsa shad' and it ranged from 29.88%-50%. In brackish water *T. ilisha*, prevalence of *Goezia bangladeshi* was almost similar in 2nd to 6th class. Prevalence varied greatly in the larger size classes (7th – 9th classes). In marine *T. ilisha* stock, higher prevalence was observed in intermediate to larger size class.

Moreover, the presence of some larval nematodes (incidental parasites) that have sea mammals (cetaceans) as their definitive hosts and which were found in all the habitats indicated that *T. ilisha* served as an intermediate host of those parasites and travel from sea to freshwater through the estuary. No other published information is available on *T. ilisha* movement based on parasitological data which has limited the scope of direct comparison.

## LITERATURE CITED

BERLAND, B. 1982. Basic techniques involved in helminth preservation. In proceeding of workshop on "Technology as applied to museum parasite collections." ICOP A V- Toronto, Canada: 1-15.

BOJE, J., RIGET, F. and KOIE, M. 1997. Helminth parasites as biological tags in population studies of Greenland halibut (*Reinharditus hippoglossoides* (Walbaum)), in the North-West Atlantic. *ICES Journal of Marine Science* **54:** 886-895.

BUSH, A. O., AHO, J.M. AND KENNEDY, C. R. 1990. Ecological verses Phylogenetic determinants of helminth parasite community richness. *Evolutionary Ecology* **4**: 1-20.

HALDER, G. C. and ISLAM, M.R. 2008. *Ilish Mach Sangrakhan abong Unnoun Babasthapona koushal* (Hilsa fisheries conservation development and management techniques, In Bangla). Department of Fisheries (DoF), Dhaka, Bangladesh. pp. 1-40.

KABATA, Z. 1963. A new species of *Clavella* (Copepoda, Lernaeopodidae) from the South Atlantic. *Crustaceana* **5:** 257-262.

LAGLER, K. F., BARDACH, J. E and MILLER, R. R.1962. *Ichthyology*. John Wiley and Sons, Inc., New York. 203p.

LESTER, R.J.G. 1990. Reappraisal of the use of parasites for fish stock identification. *Aus. J. Mar. Fresh. Res.* **41:** 855-864.

MACKENZIE, K. 1983. Parasite as biological tags in fish population studies. *Adv.Appl.Biol*.**7:** 251-331.

MACKENZIE, K. 1987. Parasite as indicators of host populations. *Int. J. Parasitol.* **17:** 345-352.

MACKENZIE, K. and ABAUNZA, P. 1998. Parasite as biological tags for stock discrimination of marine fish: a guide to procedures and methods. *Fisheries Research* **38**: 45-56.

MARGOLIS L., ESCH, G. W., HOLMES, J.C., KURIS, A.M. and SCHAD, G.A. 1982. The use of ecological terms in parasitology. Report of an ad hoc committee of the American Society of Parasitologists. *J. Parasitol.* **68**(1): 131-133.

MOSER, M.1991. Parasite as biological tags. *Parasitol. Today* **7**(7): 183-186.

MOSQUERA, M.J., GOMEZ-GESTEIRA and PEREZ-VILLAR. 2000. Using Parasites as Biological Tags of Fish Populations: A Dynamical Model. Bulletin of Mathematical Biology **62**: 87-99.

SINDERMAN, C. J. 1961. Parasites tags for marine fish. *J. Wild l. Manage.* **25:** 41-47.

STANLEY, R. D., LEE, D.L. and WHITAKER, D. J. 1992. Parasites of yellowtail rockfish, *Sebastes flavidus* from the Pacific coast of North America as potential biological tags for stock identification. *Can. J. Zool.***70:** 1086-1096.

*(Manuscript received on 20 September, 2020 revised on 25 December, 2020)*