Summary
Estuarine systems are among the most productive and valuable ecosystems on Earth (Costanza et al., 1997). Scientific interest is increasingly focusing on the effects of major natural or human perturbations on estuarine ecosystems. Estuaries consist of a complex mixture of distinctive habitats and their importance, dynamics, functions and ecological connectivity are still poorly understood (Elliott and Hemingway, 2002).

Intertidal mudflats are a dominant habitat in many estuaries, often covering a considerable part of the total estuarine area. This particular type of habitat has been recognized to be of key importance for the estuarine food web due to its high productivity when compared to subtidal areas (Elliott and Dewailly, 1995). Fishes that occupy the intertidal and the upper subtidal zones of estuaries have proven to be difficult to classify in terms of their habitat use. Some species spend most of their life therein, others descend to deeper waters as they grow larger, and still others enter this zone only during high tide periods. The Sunderbans mudflats (Banerjee, 1998; Bose, 2004) are found at the estuary and on the deltaic islands where low velocity of river and tidal current occurs. The flats are exposed in low tides and submerged in high tides, thus being changed morphologically even in one tidal cycle. The interior parts of the mudflats are magnificent home of luxuriant mangroves. The Sunderbans mudflats control the food chain in the estuarine ecosystem. However, no systematic approach towards studying the ichthyofaunal diversities of different habitats of Indian Sundarbans for conservation purpose has been attempted so far.

Studies of resource requirements by various species have been used in attempts to understand factors controlling the distribution and abundance of organisms (Ross, 1986). In addition, studies on food habits of organisms utilizing each habitat help to illustrate the role of the latter in the ecology of several organisms. The study of feeding habits of fishes from the mudflats of Sundarbans is unique, since the environmental changes require continuous adjustments at all levels of the biological organization (Val and Almeida-Val, 1995; López-Vásquez et al., 1995; López-Vásquez et al., 1995).
Although, no studies on the feeding habits of fishes within such assemblages in Sundarbans mudflats have been conducted, few have been made in temperate regions only (Edgar and Shaw, 1995; Horinouchi and Sano, 2000).

Digestive enzymes however, may be a complementary tool useful for determining which dietary components are most effectively metabolized (Bréthes et al., 1994). Documented information on the digestive enzymes of fishes with different feeding habits is relatively rare although several workers have reviewed the physiology of digestion of fishes (Barrington, 1957; Kuźmina and Kuźmina, 1991).

The present study was aimed to characterize the nekton assemblage of a mudflat area of the Indian Sundarbans and to assess its structure and seasonal distribution patterns in its high tidal and low tidal conditions, to determine dietary preferences for each of the fish species so as to understand the survival strategies of fish with regard to nutritional profiling correlated with availability of food in unique mudflat habitat in estuarine system and lastly to quantify the activities of a range of digestive enzymes in each fish species to determine the utilization of various food sources available to the fishes.

In the present study, 31 fish species belonging to 22 families and 9 orders were collected during high tide, whereas only 12 were recorded during low tide. In terms of numbers of species per family, Gobiidaes was the most diverse followed by Engraulidae, Congridae and Muraenidae in submerged mudflats. All the diversity indices showed marked seasonal and inter-annual variations. Temporal variations were also found in fish assemblage structure in both the tidal conditions. Estuarine species (ES) was the most important ecological guild of the mudflats of Sundarbans both during high and low tides. CCA showed that among all abiotic variables examined, salinity, pH and nutrients were the most important influencing fish assemblage during high tide. TDS, water temperature and salinity were significant during low tide. Considering the importance of mudflats in supporting fish diversity,
the present study emphasizes the increased efforts for conservation of such habitat in Indian Sundarbans.

Analysis of feeding guild may show differences in trophic structure and ecosystem dynamics, and therefore may have implications for the management of fisheries (Koslow, 1997). Overall, twelve carnivorous, eleven plankti-benthivorous, one omnivorous, one strictly herbivorous and six detritivorous species were found in the present study. The values of standardized niche breadth and trophic diversity obtained in this study pointed to an adaptation of resource use towards environment availability. *O. apicalis* and *T. jarbua* presented high values for standardized niche breadth among carnivores, utilizing a diverse range of aquatic macro-invertibrates, their consumption being lower than their environmental availability. Among plankti-benthivorous guild, *G. chapra* reflected maximum trophic diversity but comparatively lower niche breadth. Maximum niche breadth was obtained for *G. giuris* under this guild. Omnivorous *S. panijus*, on the other hand, represented high niche breadth as well as high trophic diversity. However, *M. gulio* and *L. parcia* respectively showed highest niche breadth and trophic diversity amongst the detritivorous.

High degree of interspecific dietary overlap between carnivorous fishes may reflect concentration and competition for the same food. The omnivorous *S. panijus* reflected significant niche overlap with the carnivorous species *O. apicalis*, *M. gulio*, *T. chatareus* and maximum with *T. jarbua*. This omnivorous species also showed significant niche overlap with three plankti-benthivorous species (*S. strongyrula*, *B. mcclellandi* and *S. argus*), though no niche overlap was found with detritivorous species. This low overlap verified within the community and the field observations that indicated habitat segregations among overlapping species, suggest that food partitioning mechanisms may occur at different levels. Among detritivores, although food overlap was 100% among species, *L. parcia* showed highest niche breadth with *M. raitaborua*. 

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In the present study, significantly low levels of α-amylase activity was detected in the digestive tract in *U. marmoratus, B. butis* (cranchi-piscivorous), *S. argus, T. gangeticus, U. lepturus* (generalized carnivorous) and in *S. sathete* (obligatory hyper carnivore) among carnivorous feeding guild. Regarding cellulose activity, maximum enzyme activity was observed in *C. neglecta*, a carnivore fish. Invertase activity, on the other hand, was found to be highest in *U. lepturus*, a generalized. Higher digestive enzyme activity in detritivorous fishes is an adaptation to extract high nutrient levels from detritus, which represents a poor nutrient source. This adaptation may be species specific and be used extensively by fishes to survive specific environmental conditions. The activity of alkaline protease was maximum in *H. limbatus* (planktibenthivorous) and *C. lingua* (detritivorous) followed by *O. apicalis* (generalized carnivorous). By contrast, in spite of having higher proportion of detritus in the stomach, *B. butis* showed the lowest activity of proteolytic enzymes (alkaline proteinases and pepsin) in this study. The highest activity of pepsin was observed in *M. bagio* (cranchi-piscivorous) followed by *C. neglecta* (stomach and intestine) (cranchi-piscivorous) and *M. raitaborua* (detritivorous). This could be a digestive strategy adopted by *Coilia* to maximally utilize the low protein content in its natural diet. Thus, it might be summarized from this study that the food preference and digestive physiology was always incomplete in fish communities. No such relationship could be established in the fishes in the mudflat belonging to different feeding guilds through present study possibly because of incomplete segregation of food niches in fishes. It is, therefore, concluded that phylogeny rather than adaptation to trophic resources played a determinant role for their digestive physiology.

On the whole, these results also point out that two tidal conditions and seasonal fluctuations are relevant in structuring the fish assemblages of the mudflat habitat of Indian Sundarbans due to different ecological reasons. The inundated mudflats during post monsoon sustain high diversity because habitats come under
strong influence of the communication channels with open sea. The marine influence contributes significantly to increase species diversity in the lagoonal systems supporting the confinement theory (Guelorget and Perthuisot, 1983). On the other hand, many of the species captured seem to benefit from the advantages of the intertidal habitat, particularly the high availability of food (Chaudhuri et al., 2012a). Lower ichthyofaunal diversity in the exposed mudflat can be reasoned from the said fact of hydrological connectivity. Therefore, the sustainability of diversified fish assemblage in mudflats depends on a constant monitoring and conservation efforts of this unique habitat. With hardly anything known about the aquatic fauna of the region (some of the species are yet to be described), much of the fauna in these adjoining habitats could be lost forever even before they are known to us. The future of the Sundarbans will depend upon the management of freshwater resources as much as on the conservation of its biological resources.