

## DISCUSSION:

During the study period from January, 2013 to July - 2017, eight (8) areas are considered as study areas according to the local name of those areas viz., Paschim Gadadharpur, Udaypur, Ongaria Ghat, Jatranala Ghat, New Digha (Bat tala ghat), Hospital Ghat (Marine aquarium ghat), Sea Hawk Ghat and Digha Mohana.

During study period it is observed the total number of 54 species of bivalves belonging to 8 orders, 18 families, 35 species of gastropods belonging to 4 orders, 18 families and 4 species of cephalopods belonging to 3 orders, 3 families have been identified at Digha coast of West Bengal. All of these except cephalopods habitat (Sandy bottom) can be found in the different ghats (spots) at Digha coast. Cephalopods are caught by drag net operation.

The population studies of molluscs (benthic invertebrates) show that the high species diversity at Udaypur provides suitable substratum for molluscs population. The habitats in these localities comprise of estuary with continuous flow of fresh water and regular tidal rhythm of inflow and out flow of water. All molluscs species show abundant distribution in Mohana due to flow of fresh water of Dubda water basin but in very near future none of the molluscs species shows ample distribution in Digha mohana because of increasing fishing activities throughout the year and also for pollution in the area. In old Digha i.e. Sea hawk ghat and Hospital ghat, there was low molluscs species diversity in beginning period of my research work due to very high anthropogenic activities in this area. Old Digha shows till now very little molluscs species with moderate distribution which was due to construction of wall and cement boulder around coast provided suitable substratum of the settlement of bivalves in recent time. It is expected that the availability of molluscs species will be higher in coming future at all ghats of old Digha. The relationship between energy budgets, habitat structure, physiological parameters and population diversity has been investigated most extensively in marine bivalves.

In Jatranala ghat, Ongaria ghat, and Paschim gadadharpur ghat, the availability of molluscs is very poor due to lack of shelter and unsuitable physico-chemical parameters of soil and water but in Udaypur ghat, molluscs species richness is very high due to presence of substratum as shelter, suitable physic-chemical parameters of soil and water and peaceful environment.

This study of natural population of molluscs (*Meretrix* sp, *Paphia* sp, *Donax* sp, *Macra* sp, *Saccostrea* sp and *Macoma* sp etc) at eight study localities reveals several points of interest with respect to sustainability of the species as well as impact of different levels of anthropogenic activities in the area. As a common tropical and sub tropical marine bivalves, high densities of these species occur in the zone of inter tidal and sub tidal regions of coastal water at Digha. Besides the dominance of marine molluscs species is maximum in inter tidal zone reported in these localities, can possibly be attributed to a higher tolerance level to environmental stress like atmospheric exposure, fluctuation of salinity due to influx of fresh water, pressure induced by pollution etc. and particularly in Mohana pollution effects like fishing boat discharge, sewage and land drain. In the present study, population density of marine molluscs (benthic groups of animal) is comparatively more at Digha mohana. It is observed that in estuarine environments where changes in salinity are very large, maximum abundance of many organisms occur at exceptionally low salinities. At Digha, though the edible oyster inhabits in sub tidal region thereby remain submerged even in low tide hours, the water is mostly turbid. Due to such environment there is positive effect on the number of gametes formed, released and survival of new recruits. Such situation may be attributed to enhance by pure, eutrophic, environmental conditions prevailing in monsoon from June to August, which gave great decrease in the population density in case of molluscs species at all the localities (Diagram – 6). The decrease of population was considerably less in the other location in respect to seasons, which reveals suitability of the habitats.

Difference between populations at different locations may represent the response to different levels of stress. The differences in the densities can be accounted to the greater

number of younger individuals settled and grown. Such differences of the reproductive success are common in species that use an indirect mode of reproduction and several biotic and abiotic factors can be responsible.

It is suggested that the temperature was principal factor controlling the onset of shell growth. Further, in the view of density and size distribution of the marine bivalves, the differences in the start of the growing season observed between younger and older generations can probably be related to the presence or absence of reproductive activity and to energy allocation. The differences in the population densities at different locations under the present study can also probably be related to the presence or absence of reproductive activity and to energy allocation. However, uncoupled growth patterns of shell and soft tissue seem to be a general phenomenon in marine bivalve populations.

Mechanisms by which shell and soft tissue growth may be uncoupled are different growth rates of components, loss of weight due to spawning, and loss of tissue weight due to periods of negative energy balance. In the present study, the population shows startled growth and variations in distribution in different locations because of elevation pollution levels and exploitation by local

The 9 bivalves species such as *Crassoetrea gryphoides*, *Macra mera*, *M. violacea*, *M. plicataria*, *M. luzonica*, *M. dissimilis*, *M. cuneata*, *M. stultum* and *Saccostrea cuculata* are found at Digha coast throughout the year.

The 12 gastropods species like *Acrilla gracilis*, *Cerithidea obtuse*, *Murex tribulus*, *Natica trigrina*, *N. lineate*, *N. gualteriana*, *N. grayana*, *Polinices didyma*, *P. tumidus*, *Tonna dolium*, *T. sulcosa* and *Umbonium vestiarium* are also available at Digha coast in all months of a year.

It is observed that other available molluscs species found at Digha coast are seasonal. They are mainly found in post monsoon period in adequate numbers and pre monsoon period in little number.

According to survey in nearby coastal villages like Mandala, Padima, Mirjapur, Dattapur and Raghusardarbard, it is known that the available marine molluscs species found at Digha coast are not all suitable for human consumption because peculiar smell, toxic and harmful poisonous effect of molluscs flesh on human body. Only 12 species out of 54 numbers of bivalves, 2 species out of 35 numbers of gastropods and 4 species out of 4 numbers of cephalopods are edible. The meat of edible molluscs available at Digha coast is not properly utilized as human food. Local people consume them very little except cephalopods because they are all getting different varieties of marine fishes in low price value. But in near future the molluscs meat may be eaten by local poor people due to containing high protein in comparison with marine fishes and also scarcity of marine fishes. A little number of very poor common people takes cephalopods meat as their daily food at Digha and surrounding areas. The migratory people come in winter season to take fish and fishing activities as their occupation consume edible molluscs meat in regular basis.

In the village Padima, the population is 1458 and only 116 number of people (8% of total village population) under 23 house hold take edible molluscs meat as their food mainly cephalopods meat. In case of village Mirjapur, the picture is very poor there. The total population is 362 and only 18 people (4 % of total village population) under 5 house hold consumes molluscs meat. As per survey in the village Dattapur, 812 people live there and only 48 numbers of villagers (6% of total village population) under 12 house hold consume only cephalopods meat. The picture is very unsatisfactory in the village Mandala and Raghusardarbard. Only 3% people in this two villages consume edible molluscs meat mainly cephalopods meat where 1220 and 824 number of people live respectively.

The nine edible clam species, which are available at Digha coast are *Anadara granosa* (Linnaeus, 1758), *Anadara inequivalvis* (Bruquiere, 1789), *Anadara antiquata* (Linnaeus, 1758), *Donax incarnates* (Gmelin, 1791), *Donax scortum* (Linnaeus, 1758), *Katelsysia opima* (Gmelin, 1791), *Meretrix meretrix* (Linnaeus, 1758),

*Meretrix casta* (Gmelin, 1791) and *Solen brevis* (Gray, 1842). From the foregoing account it is cleared that clams are sought after by considerable section of poorer classes of fisher folk as a source of nutritious food.

The meat of all available three species of *Anadara* (Table - 24) is red in colour, believed to be highly nutritious. But in India the meat taste of these clams are not appreciated by people due to bad odour. The species of *Anadara* are not caught for human consumption, used industrially for lime production. The meat of available two species of *Donax* (Table - 24) is caught in India for human consumption. Meat is highly delicious and nutritious. Flesh contains high protein value. It is served as roasted, steamed, boiled or traditionally raw in Southern parts of India but the local people at Digha do not consume it due to availability of fishes and lack of awareness.

In India *Meretrix casta* popularly known as 'Matti' in South India, yellow clam *Meretrix meretrix* and the baby clam, *Katelysia opima* (Table – 24) is consumed by people as considered it as fish flesh. At Digha coast it is not considered as food at present.

The two edible species of oyster available at Digha coast are *Crassostrea gryphoides* (Scholthein, 1813) and *Saccostrea cucullata* (Born, 1778). These two species of edible oyster are used as food of human beings. Meat is highly delicious and nutritious. Southern parts of India consume the meat but the local people at Digha do not consume it due to availability of fishes and lack of knowledge.

Oysters are being utilized only to a limited extent in India. In our country the oysters are cooked in ghee or vegetable oil after mixing salt and condiments. Only in some places on the West coast people know about the nutritious shell fish and eat them. But for this, only poor people usually fishermen consume them. In Western countries where the oysters are greatly relished, oysters are eaten raw and in a variety of forms like oyster stew, smoked oyster, oyster meat canned in salad oil, oyster meat boiled in wine, breaded oysters etc.

The only available edible mussel at Digha coast is *Perna viridis* (Linnaeus, 1758). In India the value of mussels as nutritious food is not realized to a large extent. Mussels are usually consumed after cooking in the form of curry. People of poorer classes boil the mussels with pieces of roots of tapioca or cassava with a little quantity of water and when they are cooked, drain and eat them. Some people eat raw mussels but this is very rare. But at Digha coast it is not considered as food at present.

The utilization of gastropods is very much less than the bivalves as food. A small number of gastropods (Table – 25) are suitable for being utilized as food by man. The only edible gastropods, which are available at Digha coast are *Olivancillaria gibbosa* (Born, 1778) and *Umbonium vestiarium* (Linnaeus, 1758). They are fished by fishermen and poor coastal people for food usually when fish are not available. Meat of gastropods is seldom sold in the markets for being used as human food.

Cephalopods meat is well known food to consumers at Digha and surrounding villages according to the survey. There are 4 cephalopods species are found and all of them are edible (Table – 26). All portions of cephalopods are used as food except octopus. In case of octopus, the head is not eaten by consumers. Apart from the use as food, most of the cephalopods are largely used as fish bait, mainly for the bigger fishes as the seer fishes, sharks, carangids and rays. The octopus lurk in the shells and are removed and taken by the long line fishermen to fishing grounds for using them as good bait.

From the Vedic times chank (*Xancus pyrum*) came to be used in the Hindu rituals and some of the customs are shared by people of the other religions faiths. It is adored and dedicated to the temples for worship and used widely in our daily life. It has also found an important place in heraldry and royal emblems and coins in this country.

The meat of all molluscs both edible and non edible is used as feed of poultry birds, ducks etc. But it can be used as feed of all carnivorous fishes and also prawns and shrimps. It is observed that carnivorous aquatic cultivable species show faster growth rate to take molluscs meat because molluscs meat contains maximum protein values.

Molluscs fishery may be commercially viable whether edible molluscs meat can be exported to abroad. Molluscs collectors, traders, exporters and also Govt. should focus their eyes on this fishery at Digha coast. There are 4 numbers of molluscs shell processing industry on the way from Digha boarder to Talsari of Odisha. They are processed the shell in traditional way. Modern technology, advanced machinery system is not seen in such industries. A hut with straw shed is used as industry building. Government should implement a financial scheme that the small marginal industrialist can get financial support to extend their such industry & arrange a training program on molluscs meat and shell processing technology that workers can know the modern meat and shell processing technology followed in the world and set up molluscs meat processing plant to process meat.

Exporters should go there at Digha, purchase the edible molluscs meat with giving suitable market value and export the meat to foreign countries. The future development of such industry will generate employment opportunity among the un - employed young people in the society.

An industry is bound to develop for the export trade of frozen or canned meat of oyster, mussel and clam, edible gastropods and cephalopods for which the demand in countries abroad is good. This requires only a little initiative and enterprise on the part of the business circles, as the processing facilities are already available in most parts of the country. More than this, a greater demand for the shellfish food within our own country could be created by educating the people on the nutritive merits of the molluscs. By developing cultured practices of useful shellfishes substantial increase in yield could be expected.

The shell of all available molluscs is used there at Digha properly. The shells, which are available at Digha coast are used for production of lime, home decoration, preparation of garlands and conch etc. All molluscs shells, big or small, dull ones or beautifully tined ones go into the making of toys, boxes, lamp bases of shades, rings, ash-trays, knife handles etc. most of the polished shells are sold as cunios, cameos (a gem with figure

carved in relief) are carved on large shells by removal of the surface layers and exposing the deeper layers of varied colour pattern. The corridors of the temples are flooded with soaps selling such articles. Almost obsolete now are much used as the whelks for purple dye, cuttlebone for polishing furniture, sepia for drawing ink, molluscs shells are pulverized and used in poultry feed for the birds to lay eggs with thick and perfect shells.

Marine water molluscs have ability to filter water, take part in food chain as consumer and provide habitat to invertebrates is necessary to survive in water. Meat of few edible molluscs species are nutritious, delicious used as food of human beings in various parts of the world.

A huge amount of eroded sediments, fly ash along with several other industrial discharges mixed with the marine water of Bay of Bengal and have made every year this coast (Digha coast) unsuitable for living fishes, prawns, shrimps, molluscs and other biodiversity which are economically important or not but play important role in existence of human life directly or indirectly.

The water pollution is directly reflected by the steady decline of the abundance of finfish and shellfish seeds, smaller fin fishes and other nektonic forms. The data collected during last 10 years from the Department of Fishery, Government of West Bengal, relating to fish and shellfish landings at Digha and surrounding coast, reveals a rapid reduction of total landings of different fishery resources.

Operation of huge number of fishing trawlers with nylon thread gears may be considered a major factor for such down going condition. It is well known that oil and other related organic products after being discharged from different fishing trawlers, ships and other marine vessels pollute considerably both pelagic and benthic environment. Domestic sewage in small quantities is known to fertile the sea water which leads to an increase in marine productivity because of eutrophication. Waste disposal from the tourist centers of Digha and nearby fishing harbours of Sankarpur contributes pollutants into the nearby



estuaries and small marshes. We should be sincere immediately to protect the biodiversity of Digha coast in West Bengal. It is hopeful that government has taken some primary initiatives to save Digha. Beach side is concreted and very clean. There is restricted and carefully watched any untoward incident that hamper the natural and social environment of Digha.

At Digha it is seen that all ghats (spots) do not show the availability of all marine molluscs population because increasing tourism, pollution, fluctuation of water parameters throughout the year and other anthropogenic activities. It proves that marine molluscs fauna are under heavy pressure. Present study shows that Udaypur ghat (spot) and New Digha ghat (spot) is most suitable location of marine molluscs population. However Digha Mohana and other ghats (spots) are under pressure due to early mentioned causes. Maximum marine molluscs species are available at Digha coast during winter season in the month from October to February. On the other hand molluscs population is minimum during rainy season in the month from June to August in a year. Public (tourist) should be conscious about bio- diversity of all ecosystems. All of them should know how different varieties of marine molluscs species as well as other populations are beneficial and play role in existence of human life. The law CRZ (Coastal Regulation Zone) must be implemented strictly by Government both State and Central for survival of marine population.

It is also observed that, molluscs species are also being increasingly threatened at Digha coast due to uncontrolled collection of live specimen by local women for some ornamental purposes and for zoological excursions. Very often they continued their works while collecting a large number of specimens. Simultaneously, they also collected a number of species which are now rare due to destruction of their habitat and over exploitation.

In view of faunal richness which is now threatened by exploitation of marine fishery resources, tourism without eco friendly awareness and overall socio-economic development, this coastal zone demands more protective measures.

Based on studies, there are some humble recommendations for conservation of marine molluscs like an awareness program for the fishermen, tourists, collectors of zoological samples has to be undertaken, as the fishermen and also the over-enthusiastic tourists destroy the living molluscs and other marine aquatic organisms (with or without their knowledge).

Restrictions period (May and June) may be imposed on fishing activities except permissible seasons, and also on the mesh size regulation (> 90 mm) of fishing nets.

General tourists as well as excursion team often collect a lot of specimen in the first flush of enthusiasm but it is observed that most of those are finally dumped on the beach where the animals are allowed to die and rot. This habit has also to be banned immediately.

Over exploitation by repeatedly collecting the same organisms (especially the various species of live bivalve, gastropods, cephalopods and others) year after year from beach by the study team from various educational institutions for display in their museum should be restricted.

Drag net operation on intertidal areas is to be banned or restricted and selective sorting and releasing of by catch organisms in the sea before their death should be made compulsory.

In this context an alternative way might be taken as taking a number of photographs of the organisms from various angles without disturbing them and to collect only very few examples of each species, particularly of rare and poorly populated species.

Comprehensive assessment (environmental, chemical and biological) of by catch marine organisms in the light of fishery exploitation and bio-medical studies may be invited.