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Research article

MARINE JETTIES AS ARTIFICIAL REEFS (ARS) – A STUDY ON THE FISH ASSEMBLAGE STRUCTURE FROM PORT BLAIR, SOUTH ANDAMAN

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ABSTRACT: Artificial Reefs (ARs) are those manmade structures (including marine jetties) which can support a number of native populations both moving and sessile in marine ecosystem. The present study investigated the fish assemblage structure in the marine jetties at Marina Park (MP), Panighat (PG), Chatham (CT) and Dundus Point (DP) around Port Blair, South Andaman coast. The most number of pillars in the water was found in CT (26) and MP (22) while the longest marine jetties in length were MP and PG (60m). The average temperature ranged between 32 to 35 ˚C while average salinity varied from 30 to 33psu. The average pH was found to be alkaline (8.43 to 8.60), whereas the dissolved Oxygen (ml/l) varied from 4.42 - 5.78 and Biological Oxygen Demand (ml/l) was found to be highest in Dundus Point i.e. 1.07 and lowest was in Panighat (0.75). Sedentary organisms like oysters, barnacles, chiton, gastropods, algae etc. were recorded in all the stations, while soft corals were present only in Marina Park and Panighat. A total of 1971 individuals of fishes belonging to 38 species, 29 genera and 22 families were observed during the study. Lutjanids, Pomacentrids and Chaetodontids were the abundant in all the jetties. The diversity indices viz. Shannon Weaver's species diversity index, Margalef's species richness index, Simpson's species evenness index and Pielou Species evenness index have shown that Marina Park Jetty is more diverse as well as abundant in fish species (1.82, 4.27, 0.72, and 0.54 respectively) even though the anthropogenic activities like tourism were observed very high compared to other jetties, while the lowest in diversity and abundance was Dundus Point Jetty (0.71, 0.74, 0.37, and 0.44 respectively). The percentage of plastic waste was maximum in all the study sites i.e. 61.1 (MP), 15.5 (PG), 71.4 (CT) and 54.5 (DP). While the minimum percentage was found to be of fishing nets i.e. 2.7 (MP), 3.8 (PG), 1.8 (DP) and Nil in Chatham. The other waste items included glass bottles, footwear, polythene covers and clothes. The results of the present study have shown that the abundance and species diversity of fishes is related mostly to the length of the jetty as well as number of pillars in the water which can act as an artificial habitat.

Key words: Artificial Reefs, Marine Jetty, fish assemblage, South Andaman.

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INTRODUCTION

The concept of artificial reef (AR) defines a group of activities that aim to remodel the marine ecosystem by offering new habitats (Seaman, 2000). Oceanic platforms, docks, dikes, jetties and sea walls are some of the environments that fit this definition and that essentially functions as artificial rocky coasts (Pickering et al. 1998). A jetty is a stony structure built on the edge of the sea and is used to get on and off from boat and are hence considered as an area of high human activities which puts it under a lot of stress due to high pollution levels.

The water around the jetties is home to a wide variety of marine flora and fauna. Though a lot of organisms cannot survive under polluted conditions, quite a number have adapted to live under these conditions. But any marine structures, whether manmade or natural have a recognized potential to attract and concentrate fish (Rounsefell, 1972, Wyche, 1984, Collins and Mallinson, 1984, Bohnsack and Suther land, 1985, Potts and McGuigan, 1986, Bohnsack, 1989, 1991, Ambrose and Swarbrick, 1989, DeMartini et al. 1989, Bohnsack et al. 1991, Collins et al. 1991) and to enhance the stocks. Productivity in real terms in relation to AR relies on the assumption that AR provide additional critical habitat which increases the environmental carrying capacity and thereby the abundance and biomass of reef biota. (Polovina, 1994, Bortone et al. 1994). The AR potentially provides: substrata for benthic fauna and there by additional food and increased feeding efficiency; shelter from predation or tidal currents (Collins et al. 1991, Spanier, 1996); Artificial structures introduced to intertidal and sub tidal habitats may replace natural hard substrata or soft sediment. Therefore, the creation of such habitats has the potential to alter the distribution, diversity and abundance of organisms in these environments (McDonell and Pickett, 1990; Conell and Glasby, 1999), although the degree to which they alter biodiversity will depend on the type of natural habitat most affected (Bulleri, 2005). Extreme environmental conditions can influence fish distribution and abundance (Johnson et al. 2010). Shallow rocky reef fish communities are known to be influenced by geographical variables (different degree of oceanographic regimes) and depths. Irregular substrate seemed to promote greater abundance and habitat and may be characterized mainly due to the mixture of species typical of pelagic offshore habitats or/and coastal habitats and high abundances of small pelagic and predator species (Afonso et al. 2002).

Artificial reef habitats have several benefits including: providing food, shelter, protection, and spawning areas for fish and marine life, as well as, relieving natural reefs from user pressure by providing alternative recreational areas. From an aquacultural point of view, the artificial reefs can increase fish catch tremendously and are now employed in over 40 countries and it is ongoing (Matthews, 1985; Ambrose and Swarbrick, 1989; Bayle Sempere et al. 1994; Baine, 2001; Lance et al. 2005). AR’s provide an ideal tool for investigating the effect of habitat complexity of fishes. Fishes occupy many different ecological niches, are highly mobile, and can respond quickly to environmental changes or manipulations. There has been an increasing frequency of world-wide use of artificial structures in effort to increase fish abundance and diversity, improve catch rates of targeted species, manipulate habitats and restore damaged coral reefs (Bohnsack and Sutherland, 1985; Bohnsack, 1990; Bohnsack et al. 1991; Seaman, 1997; Spieler et al. 2001).Unlike natural reefs, they can be replicated and precisely located and can also be used to increase the productivity and fishery potential of relatively barren and unproductive areas. Reefs when properly located and structured not only concentrate fishes but also increase the biological productivity of the area. The fish assemblage structure at marine jetties around South Andaman along with their habitat structure and pollution status was analysed during the present study.

MATERIALS AND METHODS

The study was conducted between December 2013 to March 2014 at four marine jetties around South Andaman (Fig. 1) viz.

1. Marina Park (MP) is located at 11˚40’18.32’’N latitude and 92˚44’58.85’’E longitude with average length of 60m and depth of 6m and the bottom is covered with sand and rubble, and the structure is supported by 22 pillars.
2. Panighat (PG) is located at 11˚41’52.07’’N latitude and 92˚43’50.50’’E longitude, with average length of 60m and the structure is supported by 16 pillars with an average depth of 10m.
3. Chatham (CH) is located at 11˚41’08.53’’N latitude and 92˚43’23.43’’E longitude, with average length of 40m and the structure is supported by 26 pillars with an average depth of 10m.
4. Dundus Point (DP) is located at 11˚40’15.31’’N latitude 92˚42’32.43 E longitude, it has an area of about 45m and the structure is supported by 22 pillars and have an depth of about 12m.

At all the study stations, fish abundance was observed visually using stationary point counts within different areas of the jetties; under pilings and in the open water by snorkelling following rover diving technique(Schmitt and Sullivan 1996) that involves visually counting the fishes in a defined area for a definite period of time. Fishes were counted 5m either side of the diver. Surface counts were done from the surface to a depth of maximum 5m.

All individual species of fishes were recorded and identified by standard identification keys (Allen et al. 2003; Rao, 2009). Fish diversity and abundance has been calculated by using diversity indices like Shannon-Wienner index of diversity (Shannon 1948) Simpson's species richness index (Simpson 1949) Margalef's species richness index (Clifford and Stephenson, 1975) and Pielou's species evenness index (Pielou 1966). Along with fishes, presence of other sedentary organisms has also been observed from all the study sites.
To understand the relationship and effect of habitat structure on fish assemblage, physico-chemical parameters like water temperature (by Celsius Thermometer), salinity(by Salinometer), Dissolved Oxygen and Biological Oxygen Demand(by Wrinkler's method) along with the pollution status of marine jetties has been analysed from all the study sites

RESULT AND DISCUSSION

A properly constructed artificial reef can transform itself into convenient fishing ground in short span of time. These ARs attracts algae, fishes along with other organisms which attach to the objects serve as food for the fishes, especially for the young ones. They also act as base for the attachment of eggs in some cases. Based on this principle, artificial habitats for fishes are being constructed in many countries either on the floor or on the sub surface of the sea. Various structures have been designed using different materials including concrete manufactured products, steel hulled vessels, aircrafts(crashing at sea), railroad, subway and street cars and other designed structures (Ronald and Carrie 2004) . The artificial reefs are constructed mostly in the floor of the sea for enhancing coastal fishery (Sheehy, 1982). Artificial reef has been recognised as one of the tool to aggregate fish and to improve the income of artisanal fisherman (Bergstrom, 1983; Philipose et val. 1995; Devraj and Vivekanandan, 1999). In present study a total of 1971 individuals belonging to 38 species, 29 genera, and 22 families were observed. Among all the marine jetties Marina Park jetty showed more abundance compared to other jetties (Fig. 2). Species belonging to the families Lutjanidae and Pomacentridae were more dominant in Marina Park (Fig.2) while Chaetodontids were plentiful in Panighat marine jetty. Chatham and Dundus Point have shown least abundance of fishes.

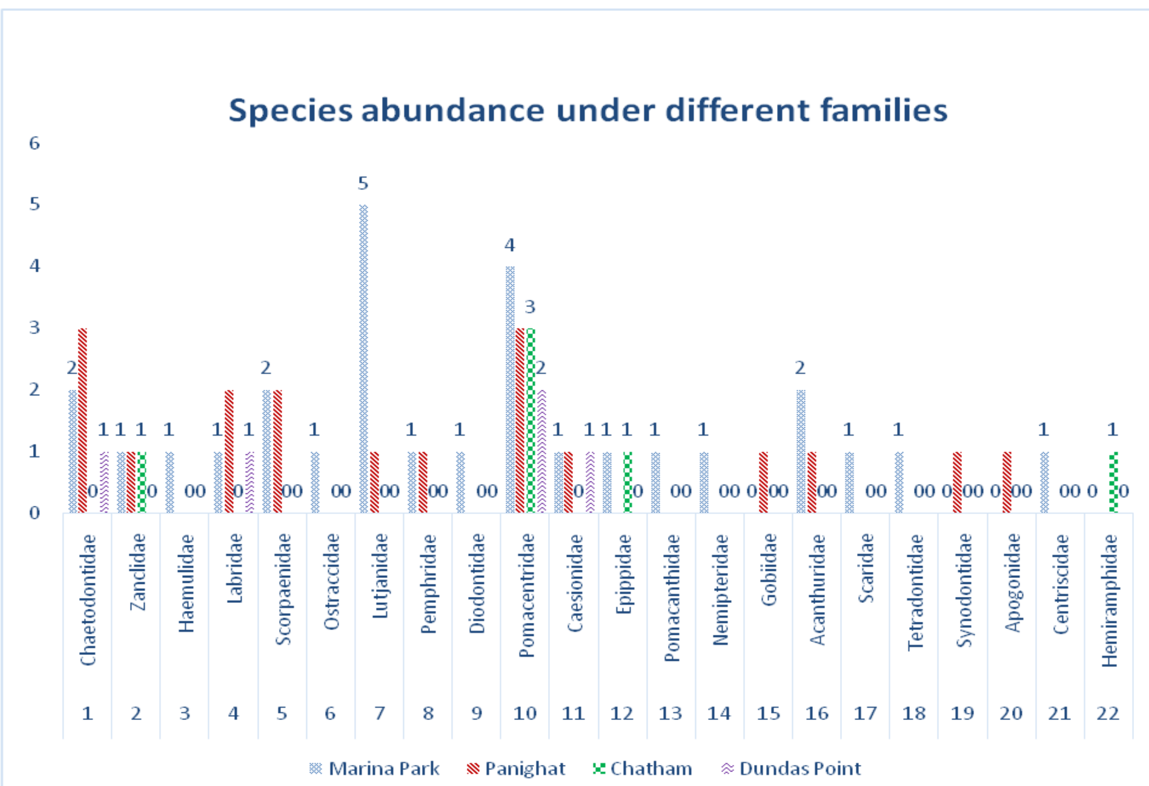


Figure 1. Showing the number genera and species recorded from each station

The diversity indices have shown highest values for Marina Park jetty indicating the suitability of the habitat for fishes (Fig. 3). The Margalef's species richness, Shannon- Weinner diversity indices and Simpson's species richness index showed the lowest in Dundus Point Jetty indicating least preferred habitat for the fishes. The spatial variation in the fish assemblage associated with jetties and marinas clearly indicated that fishes were responding to the presence of various structures with in the marinas. Different types of structures, in this instance, pontoons and pilings, and different types of marinas, those built with pontoons and those built with jetties, however, did not differ with respect to their associated fish assemblages (Clynick 2007).

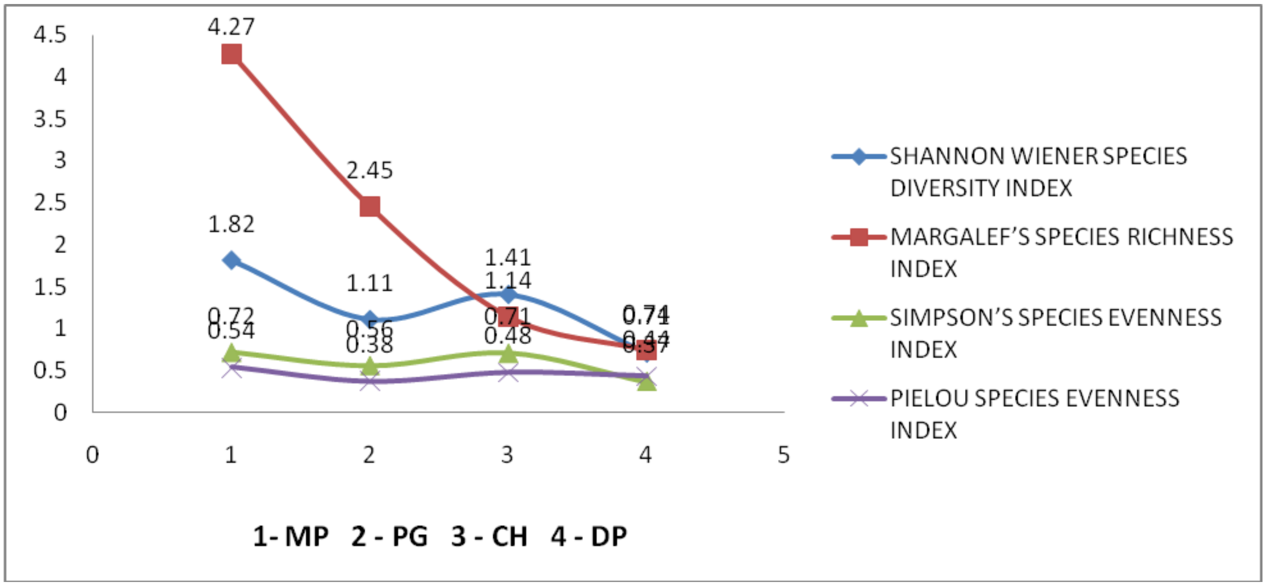


Figure 2. Showing various diversity indices at all the study stations

As jetties are generally built over sand, they replace soft sediments with hard substrata, so it will not be possible to preserve the natural patterns of distribution of organisms (Bulleri, 2005). It has been found that in each type of structure - pontoons, pilings, seawalls, is inhabited by a distinct assemblage of organisms (Glasby, 1999; Glasby and Connell, 2001; People, 2006). The results of the present study have shown that the assemblage of different marine organisms, like oysters, barnacles, chiton, algae and gastropods that were found to be associated with all marine jetties, while soft corals were found only in Marina Park and Panighat jetty and the presence of sea urchins were only observed in Marina Park jetty.

Table-1. Organisms associated with all jetties

Organisms	MP	PG	CH	DP
Oysters	+	+	+	+
Barnacles	+	+	+	+
Chiton	+	+	+	+
Algae	+	+	+	+
Soft coral	+	+	-	-
Gastropods	+	+	+	+
Sea Urchins	+	-	-	-

(MP: Marina Park, PG: Panighat, CH: Chatham, DP: Dundus Point)

Spatial and temporal variation in fish community structure is influenced both by habitat structure and environmental structures. Habitat structures and substrate complexity (Luckhurst and Luckhurst 1978), variation in depth (Harmelin 1990; Dufour *et al.* 1995; Garcia-Charton and Perez-Ruzafa 1998), climatic differences (Holbrook *et al.* 1997), and current flow and exposure (Williams 1982) have been reported to influence directly or indirectly the community structure. Also the physical and chemical parameters like temperature, salinity, pH, DO, BOD, and pollution status also have an influence on the community structure.

The average water temperature plays an important role which influences the Chemical, Biochemical and Biological characteristics of water bodies and it have shown a range of 32 -35˚C during the period of study with amaximum recorded at Chatham jetty (Table 2). Salinity ranged from 30-33psu from all the study area. The highest was recorded from Chatham 33 psu and lowest 30 psu was from Panighat jetty. The pH value oscillates from 8.4 to 8.6 indicating the alkaline nature of the water. Observed dissolve oxygen values ranges from 4-6 ml/l indicating the slightly polluted condition of water, while the biological oxygen demand of all the stations was below 1.5(ml/l).

Table-2: Station wise physico-chemical parameters

Stations	Water Temperature(°C)	Salinity (psu)	pH	Dissolved Oxygen (mg/l)	Biological Oxygen Demand (mg/l)
Marina Park	34	30	8.56	5.18	0.91
Panighat	34	33	8.49	4.42	0.75
Chatham	35	33	8.43	5.78	0.89
Dundas Point	32	32	8.58	5.23	1.07

Solid waste recorded from all the stations shows that the non-degradable plastic waste items were dominant overall than the other item and least were the fishing nets (Fig. 4).

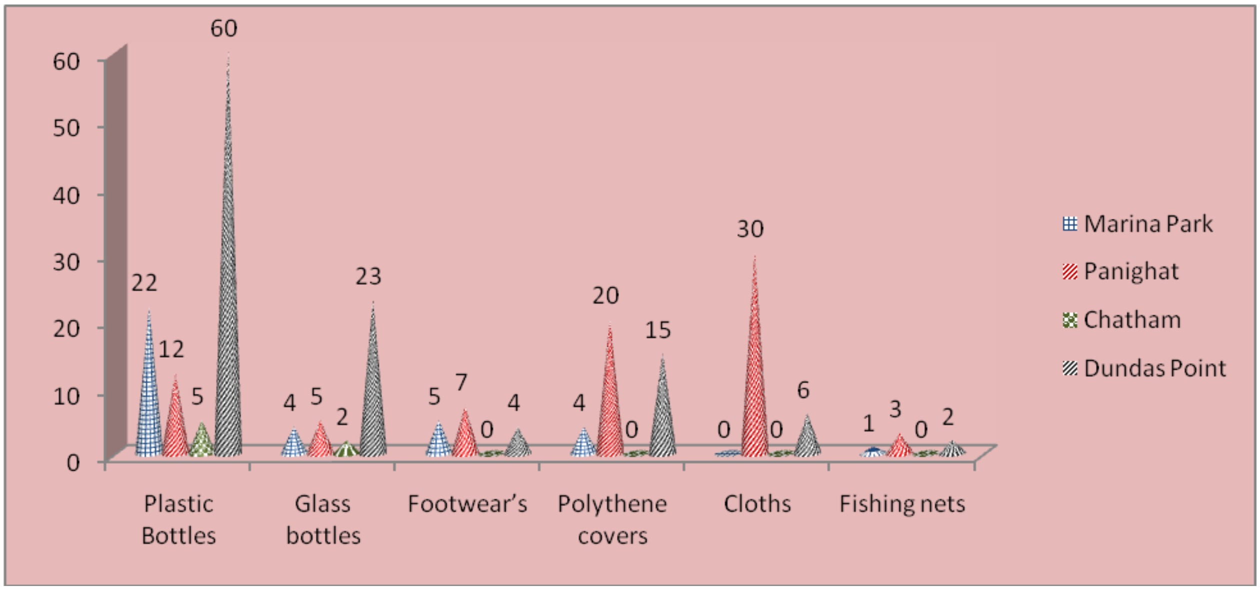
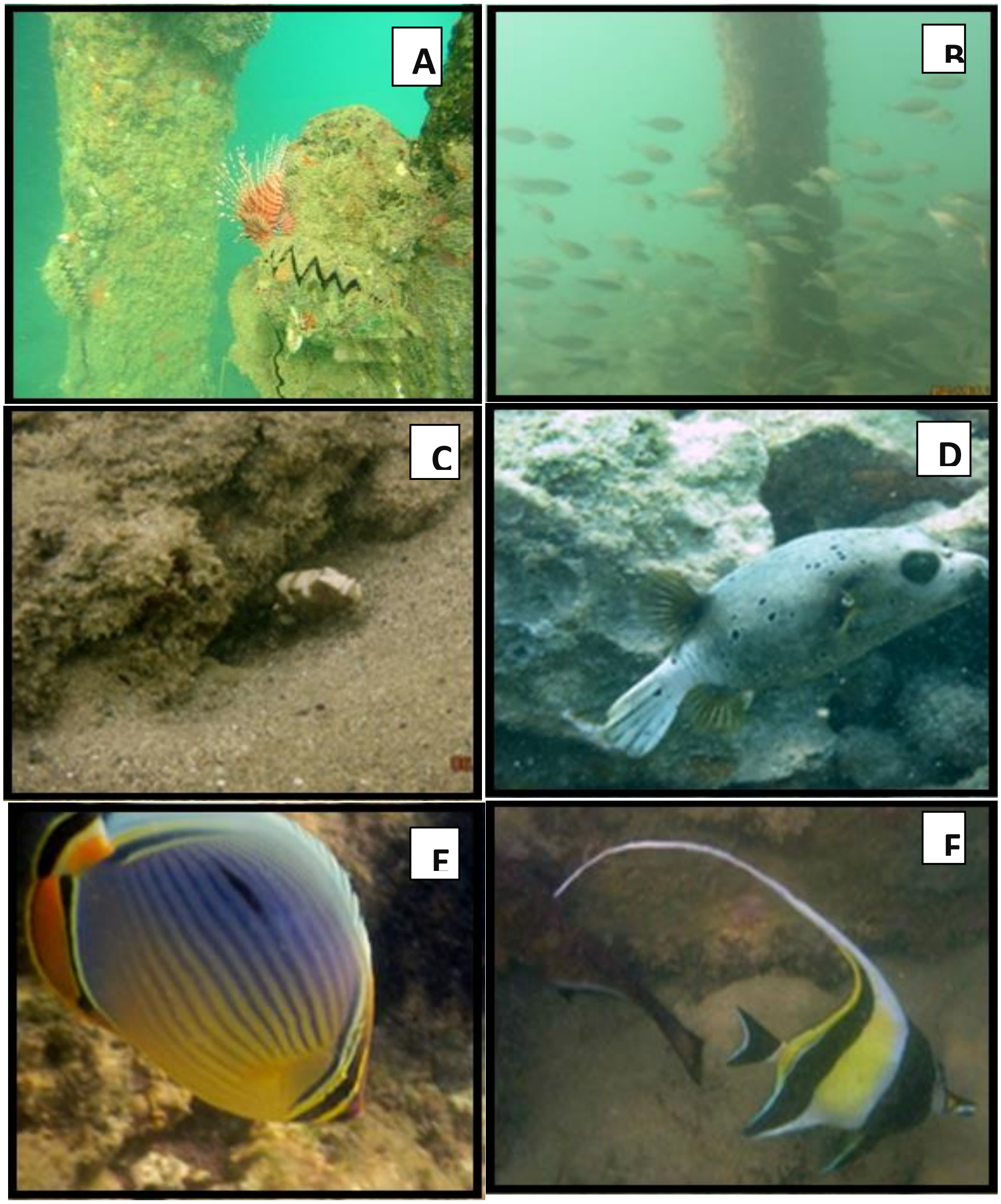


Figure 3.Percentage composition of solid waste

Habitat structure plays an important role in the assemblage of fishes. The analysis of different features in the jetties studied such as structures, construction, area, depth, bottom topography, human activities, associated organisms and status of pollution by analysing solid waste and physical parameters have shown that the habitat structure has a main role in the abundance of organisms. The pillars and walls present in the jetties were occupied by a diverse group of organisms such as barnacles, oysters, macro algae and corals. Fishes of family Chaedontidae feeds on coral polyps while members of Pomacentridae feeds on algae so they are mostly associated with the pillars and other walls. The large crevices between the concrete blocks effectively provided shelters that are utilized by fishes belonging to the families of Pomacanthidae and Pomacentridae which were amongst the most abundant fishes on these artificial habitats. Depth and bottom topography is another limiting factor which limits the assemblage of fishes. The Marina Park and Panighat jetties have shown high diversity and abundance of fishes because the average depth of the jetty was less than 10 m with very less turbidity. Bottom topography of Marina Park was composed of rocks, concrete blocks and sand. Dundas Point and Chatham jetty have more depth and the water was more turbidwith less diversity of fishes.



A - *Pteroisvolitans;* B - *Synodus sp.;* C -*Cryptocentrus sp.;*D - *Arothronnigropunctuatus;* E - *Chaetodontrifasciatus;*F –*Zancluscornatus*

Plate 1. Major fish species associated with marine

Pollution was found to be a major aspect that influences the fish assemblage at all the study sites. Even though Andaman and Nicobar Islands are said to be non-polluted, the analysis of water quality and solid waste dispersal had revealed that Dund as Point and Panighatjetties are dumped with a lot of plastic material and other pollutants. These pollutants are non-bio degradable and reduce the water quality and that can be major aspect behind the reduced abundance of fishes, as the results shows only six families of fishes were observed in Chatham and five in Dundus point jetty, while in Marina Park, richness in fish families were observed with a total 28 families and this fact can be attributed to the better environmental conditions. The present study revealed that the habitat has an important role in fish assemblages. The high structural complexity of large artificial reef or man-made structure unit have found to be an important character in species richness, abundance and biomass. The increased habitat complexity induced significant changes in the entire community structure, particularly in terms of greater species richness.

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