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Observations on Experimental Artificial Reef Constructed at Tuticorin

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ABSTRACT

An experimental artificial reef was constructed in the break-water of Tuticorin Harbour during July-August, 1989 at a depth of 6 m using discarded lorry tyres. A total number of 23 modules, consisting of 69 tyres and fabricated in three different designs, were used for the reef construction. The reef occupied a bottom area of approximately 50 sq.m. with a height of 0.8 to 1 m. Within a period of one month from the time of construction, autotrophic community dominated by red algae and heterotrophic community dominated by cirripedes, in addition to colonization by various groups of invertebrate organisms, were observed on the reef structure. The inhabitation by fish was observed during the third month. The behaviour of fish and shellfish in the artificial reef was observed by SCUBA diving.

INTRODUCTION

Floating bamboo bundles and piles of stones kept on the sea bottom have long been used as fish-gathering devices by traditional fishermen in various parts of the world (Turner *et al.*, 1969; Stone, 1982; Vik, 1982; Grove and Sonu, 1983; Chang, 1985). These objects attract fishes as they provide living space, shelter or protection from predators, thus serving as a habitat. The algae and other organisms which attach to the objects serve as food for fishes, especially for young ones. They also act as a base for 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 and artificial reefs have been constructed mostly on the floor of the sea for enhancing the coastal fishery (Sheehy, 1982). Although artificial reefs are being constructed extensively in many countries, particularly in the South-east Asian countries on a commercial scale as a Government sponsored programme, work on these lines is only at a preliminary stage in India. As experimental observations are required prior to large-scale construction of artificial reefs in the open sea, an experimental artificial reef using cheap materials was constructed at Tuticorin during the year 1989, the congregation of fish and shell-fish in the vicinity of the artificial reef was studied and the results presented in this communication.

MATERIAL AND METHODS

Discarded lorry tyres were used as the reef blocks for the construction of the artificial reef. Three designs of modules were fabricated on board the Research Vessel, Cadalmin IV. Each module consisted of three tyres which were fastened together with polypropylene rope of 6 mm thickness. Design 1 was in the form of a tripod with the tyres standing vertically (Fig. 1). Each module of this design was provided with maximum inter-space between the blocks and the module occupied a floor area of approximately 2.3 m. A total number of 13 modules of this design were fabricated and released in the break-water of Tuticorin harbour at a depth of 6 m. during July, 1989. Design 2 was fabricated in the form of a cylinder with no inter-space between the blcoks, but with provision for free flow of water from one end to the other. Design 3 was in the form of a well with no inter-space between the blocks and the water in the module attaining more or less a stagnant condition. The bottom area covered by each module in Design 2 and 3 was less than 1 sq.m. These modules were fabricated and released in the same area during August, 1989. The height of the structure was about 1 m in the case of Designs 1 and 2 and 0.8 m in the case of Design 3. The modules were carefully released with the help of the winch of the vessel and their position on the bottom was set right by SCUBA diving. The artificial reef thus constructed covered an area of approximately 50 sq. m. After the construction of the reef was over, observations were made every fortnight, either by snorkelling or by diving with SCUBA. The important fauna and flora associated with the reef and the congregation of fish and shellfish and their behaviour were studied. In order to assess the nature and extent of invertebrate colonization on the reef structures, tyre pieces measuring a size of 100 cm^2 were tied along with the modules at the time of construction of the reef and these were periodically removed and observed. Experimental fishing was carried out during every observation using either hook and line or a perch trap. The perch trap was made up of fibres of Acatia wood and had a length of 1 m, width of 0.5 m and height of 0.3 m. The fishes caught by the hook and line and the perch trap were sorted out, identified and their sizes recorded. In the case of fish, the total length was measured (from snout to caudal tip), whereas in the case of the crab, width of the carapace was recorded.

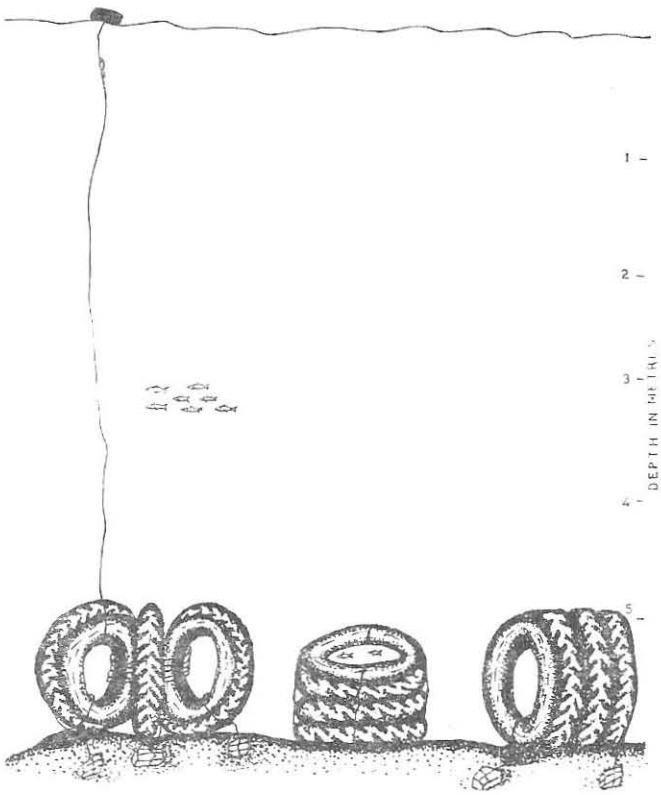

Fig. 1. Schematic diagram of the reef modules showing the inhabitation by fish in the well-type module as observed by underwater diving with SCUBA

Results and Discussions

Within a period of one month from the time of construction of the artificial reef, good growth of algae was observed on the reef structures including the tyre pieces. The maximum length of the algal filament was 27 mm when observed after 15 days. This increased to 48 mm 37 days following the construction of the reef. The algae belonged to two classes *viz.*, Rhodophyceae and Phaeophyceae and were mainly represented by three species namely, *Acanthophora* sp. *Gracilaria* spp. and *Padina* sp. In addition to the algae, growth of sea grass was also observed. The animal community was represented by various groups of invertebrate organisms. However, the animals belonging to the groups Porifera, Bryozoa, Polychaeta, Isopoda, Amphipoda and Cirripedia were found to have colonized the reef structures in large numbers. It was observed that the colonization by polychaetes and cirripedes was very rapid. Initially, the composition of both the polychaetes and cirripedes was almost in equal proportion. However, as the period advanced, the settlement of barnacles on the reef structures increased at a faster rate.

Underwater observations on the biotic community of the artificial reef were carried out by SCUBA diving and the inhabitation and the behaviour of fish and shellfish were studied. The inhabitation by fish was recorded for the first time during the third month *i.e.* in October. Thereafter, the inhabitation could be noticed during every observation. *Serranus* sp. preferred to live within the crevices of the reef structures, whereas *Lutianus* spp. preferred to swim in the stagnant water body of the well-type module without touching the reef structures. *Caranx* spp. and *Selar malam* were observed to hover in large numbers about 2 m above the reef structures. Apparently, these fishes were taking shelter in the lee waves produced by the reef structures. The blennids, *Dasson* sp. and *Petroscirtes lienardi* were observed in the sub-surface and found to cling to the marker rope, whereas crabs *(Portunus pelagicus)* were found to live on the marker float, hiding themselves under the seaweeds grown on the float. Thus, four distinct groups of fishes were recognized based on their attraction to the reef structures.

Experimental fishing carried out in the vicinity of the artificial reef has shown that three species of carangids namely, *Caranx carangus, C. sansun* and *Selar malam* were taking shelter in the mid-water column, whereas the perches, *Lutianus vitta, L.fulviflamma, Lethrinus nebulosus, Serranus boenack* and *Lates calcarifer* occupied the bottom area closely interacting with the reef structures. During January 1990, *i.e.* six months after the construction of the reef, only two species *viz., C. carangus* and *Selar malam* were recorded. But, during February, two species of *Caranx* and three species of *Lutianus* were observed. The composition of the species collected from the artificial reef further increased in March when two species of crabs *viz., Portunus pelagicus* and *Charybdis* sp. and ten species of fish were recorded. The size ranges of the different species of fish and crabs collected during different months are given in Table 1. The analysis of the size-frequency distributions of *L. nebulosus* and *L. vitta* showed that the former ranged between 138 and 199 mm with a mode at 136-140 mm, and the latter from 122 to 172 mm with a mode at 121-125 mm.

Reports of artificial reefs attracting distinct groups of fishes are available in literature. Change (1985) observed four distinct groups of fishes in an artificial reef constructed at a depth of 18 m. According to Nakamura (1985), the optimum height of a reef structure to cause a lee wave is approximately 10% of the water depth. In the present investigation, the depth of the water was only 6 m and the height of the reef was between 0.8 and 1 m. Though the height was more than what has been recommended, congregation of fish could be observed above the structures indicating the formation of lee waves. Observations on the behaviour of fish in the vicinity of the artificial reef suggest that the design of the structure plays an important role in attracting fish. In the present investigation, the relationship between the reef design and the behaviour of fish was studied from two angles the behaviour of fish

Table 1. Size range of fishes and crabs collected from the artificial reef

Month	Species	Size range (mm) (min)	(max)	No. of specimens collected
August, 89	*Portunus pelagicus*	---	25	1
October, 89	*Portunus pelagicus*	32	33	2
January, 90	*Caranx carangus*	157	252	2
	Selar malam	149	192	4
February, 90	*C.sansun*	---	189	1
	Selar malam	135	182	3
	Lutianus fulviflamma	---	132	1
	L. vitta	153	166	2
	Lutianus sp.	---	240	1
March, 90	*Portunus pelagicus*	---	44	1
	Charybdis sp.	76	86	2
	Dasson sp.	---	86	1
	Petroscirtes lienardi	---	37	1
	Callyodon bataviensis	---	210	1
	Siganus oramin	119	142	2
	Serranus boenack	---	223	1
	Lethrinus nebulosus	138	199	13
	Lethrinus sp.	139	210	18
	Lutianus vitta	122	172	23
	Lates calcarifer	201	248	4
	Chaetodontops collaris	---	83	1

towards a single unit of the reef and the entire arrangement of the reef. It was observed that out of the three designs used, the well-type design was more effective. *Lutianus* spp. were found to swim within the 'well' indicating its preference to swim in stagnant water bodies. On the other hand, when the entire reef was considered, it was found to be effective in attracting the pelagic resources, particularly the carangids. It has been reported that in Japan about 150 species of fish exhibit distinct response to reefs (Nakamura, 1985). Although some reports are available on the construction of artificial reef in Indian waters, information on the behaviour of fish in the artificial reef is lacking (CMFRI, 1988; Anon. 1989). The results of the present investigation clearly show that certain groups of fishes, particularly the lutianids exhibit distinct response to the artificial reef, which will be very useful in designing suitable concrete structures for artificial reefs in the open sea for exploitation of this commercially important group.

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