

Coral reefs transplantation and restoration experience in Pirotan Island, Marine National Park, Gulf of Kachchh, India

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Massive corals planted over long lasting artificial reefs like concrete triangles have proven to be useful for the transplantation and restoration. A total of 215 artificial triangles were deployed with 1569 coral fragments at a small tide drain channel in Pirotan Island, Marine National Park, Gulf of Kachchh. The overall survival rate of transplanted corals was 77.57%, 7.84% of corals found detached from the triangles, 12.17% of corals bleached and 2.42% of corals dead. In addition, coral fragments overcame the impairment of the water current, sedimentation, algae cover and wave actions. Present preliminary study evident this transplantation methodology as a successful way for coral restoration in a most stressful ecosystem like the Gulf of Kuchchh.

[Keywords: Artificial reef, Restoration, Transplantation, Marine National Park, Jamnagar, Gulf of Kachchh, Gujarat]

Introduction

Coral reefs are diverse and vulnerable ecosystem characterized by a complex interdependence of plants and animals. These coral reefs are massive limestone structures built up through the constructional cementing processes and depositional activities of animals of the class Anthozoa (Order Scleractinia) as well as all other calcium carbonate secreting animals and calcifying algae¹. Nowadays world wild coral reef ecosystems are declining continuously due to over fishing, pollution and other anthropogenic and natural disturbances²⁻³ and regional level^{1,4-10}.

Restoration of degraded reefs is considered as one of the major coral reef conservation techniques to mitigate the negative effects of anthropogenic activities on the reef ecosystem. Most of the alternative methods range from extinct coral species reintroduction and transplantation to the enhancement of recruitment potential and artificial reefs¹¹⁻¹³. Reef restoration has been employed in various situations created by

fundamentally different causes, and restoration activities must consider the actual causes of coral reef degradation. However the restoration defined goal of returning an ecosystem, as nearly as possible to its original condition¹⁴⁻¹⁶.

The present study was to investigate the status of coral nubbins on transforming artificial cement triangle structures. The objective of this study is to evaluate the survival rare, attachment and stability of the transplanted massive coral species on the cement triangle structure, which may leads to improve the resilience ability of the reef ecosystem of Pirotan Island, Gulf of Kachchh Marine National Park.

Material and Methods

The Gulf of Kachchh is one of the world richest Marine Biospheres, occupies an area of 7350 sq. km which encompassing 42 coral reef islands. These islands' premises are home to a very interesting heterogeneous group of fauna and

flora. Due to its rich diversity, the Government of Gujarat in 1983 declared an area of about 457.92 sq.km as the Marine Sanctuary and 162.89 sq km as Marine National Park. Pirotan Island is an important island in the Marine National Park located along the Jamnagar district of Gujarat state, India. It has an area of 3 sq km and is located 22 km off the coast, consisting of mangroves, coral reef, seagrass, algae, invertebrates and low tide beaches. The experimental coral restoration was carried out from February to June, 2014 in Pirotan Island (Lat. 22°35.073 N; Long. 069°57.515 E), Marine National Park area of Gulf of Kachchh (Figure 1).



Figure 1. Coral restoration site in Pirotan Island, Gulf of Kachchh, India

Each artificial triangle was prepared using three concrete plates with holes (70cm height X 42cm width X 3cm thickness). It is made up of cement, gravels, sand and iron rods. Iron ropes and plastic tags were used for strapping 3 triangles together; each plate has 10 kg weight and each triangle has 30 kg (Figure 2). Total 215 triangles were prepared and deployed in the channel of Pirotan Island. The structures were transported to the study site with the support of the local fisher folk community.

For selecting the donor sites, the Line intersect transect (LIT) method¹⁷ was followed to assess the present status of corals and availability

of coral species like frequently observed, rarely observed, very rare species and extinct species in different sites of the reef plates. Reviewing the literatures inferred that the presence of 49 scleractinian corals from this region¹⁸ and another report evident 31 species of live corals from the Marine National Park, Gulf of Kachchh¹⁰. Based on these, donor sites and suitable local coral species were selected for the transplantation and restoration study.

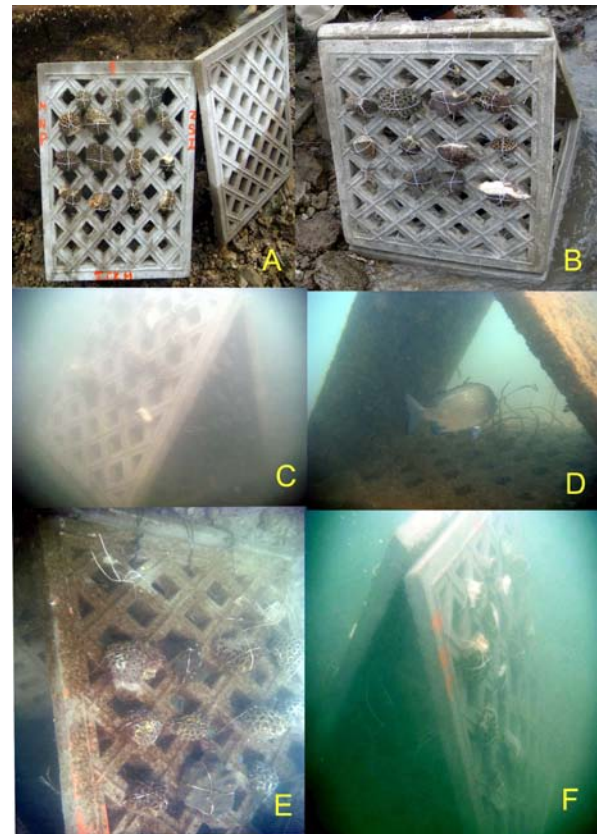


Figure 2. Artificial concrete triangles used for restoration in Pirotan Island (A – Single cement plate; B, C – Artificial concrete triangle; D – Fishes on artificial triangles; E, F – transplanted corals on this structures)

During the collection the transplant fragments from the donor colonies, some important criteria were followed to reduce the stress to the donor mother colonies. One or two fragments were collected from single donor colonies and care was taken to avoid severe damage to the donor and coral fragments while using underwater cutter, hammer and chisel.

Based on the previous reports, large size fragments have a higher survival rate. Coral fragments of different size (< 12 cm) were collected from local donor coral colonies from Pirotan Island, Kalubhar Island, Mithapur reef and Laku Point. Most of those colonies collected had

been found unattached over the coral bed and those were exposed during low-tide. The samples were transported by buckets filled with seawater and aerator to the transplantation sites.

The collected coral samples were fixed to the artificial triangle using underwater cement (Carboline A and B) after tied with copper wires.

Results

A total of 1569 coral samples under 8 genera were transplanted in the unexposed channel, Pirotan Island even during low-tides. The overall survivorship of transplanted coral fragments for four months after transplantation is

Among the transplanted species, maximum survivorship was shown by *Favia* sp. (41.56%) followed by *Siderastrea* sp. (8.67%), *Porites* sp. (5.93%), *Goniopora* sp. (5.29%), *Goniastrea* sp. (3.19%), *Favites* sp. (2.68%), *Turbinaria* sp. (0.70%), and *Acanthastrea* sp. (0.38%) respectively (Table 2). These preliminary studies indicate a very successful survival rate for this triangle methodology, which may overcome the strong water current, heavy deposition of sedimentation and bio-foulants on the transplants of these triangles.

TABLE 1. Number of transplanted colonies per scleractinian genus and survival rate during the study period

Genus	No of samples Transplanted (Feb-14)	No of samples detached	No of samples Bleached	No of samples Dead	No of samples (Jun-14)
<i>Favia</i>	850	48	139	11	652
<i>Porites</i>	115	8	12	2	93
<i>Favites</i>	70	12	10	6	42
<i>Goniastrea</i>	68	10	4	4	50
<i>Goniopora</i>	95	12	0	0	83
<i>Siderastrea</i>	175	15	14	10	136
<i>Acanthastrea</i>	8	2	0	0	6
<i>Turbinaria</i>	13	2	0	0	11
<i>Cyphastrea</i>	175	14	12	5	144
Total	1569	123	191	38	1217

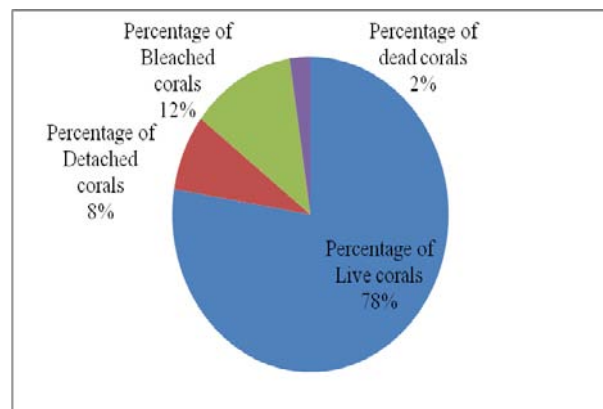


Figure 3. Survivorship rate (%) of the transplantations depending on the duration of survival.

given in Table 1. A sum of 77.57% transplants were live corals, bleaching fragments 12%, dead coral fragments were 2% and fragments found detached from the frames due to wave action estimated 8%, were noticed during this study period (Figure 3).

Discussion

During the study period, it is observed that 4.94% of coral fragments were found detached due to water current and wave action. Losses of coral fragment on artificial substrates were reported from a number of previous transplantation studies¹⁹⁻²⁰. A maximum of 77.57% of live corals observed during this study period. The concrete artificial structures will also serve as a good substrate for a newly recruiting coral plan for settlement if they persist for a long period of time (minimum 10 to 15 years). Long term observation of corals on artificial substratum from Molasses Reef was analysed by²¹.

The result indicates a very successful rate for this triangle structure methodology. This method has widespread application potential for enhancing the recovery of damaged coral reefs and considering to rebuilding of new coral reefs in suitable sites. During the present study, the collection of coral samples from the donor site for

Genus	Live coral samples (%)	Samples detached (%)	Bleached samples (%)	Dead corals (%)
<i>Favia</i>	41.56	3.06	8.86	0.70
<i>Porites</i>	5.93	0.51	0.76	0.13
<i>Favites</i>	2.68	0.76	0.64	0.38
<i>Goniastrea</i>	3.19	0.64	0.25	0.25
<i>Goniopora</i>	5.29	0.76	0.00	0.00
<i>Siderastrea</i>	8.67	0.96	0.89	0.64
<i>Acanthastrea</i>	0.38	0.13	0.00	0.00
<i>Turbinaria</i>	0.70	0.13	0.00	0.00
<i>Cyphastrea</i>	9.18	0.89	0.76	0.32

transplantations and its effects on natural populations was done in a responsible manner. Number of quantitative assessment and experimental observations of the team in the Gulf of Kachchh have identified numerous young once and small coral colonies recruiting in the areas of extremely shallow some time exposed during minus low-tide. These juveniles are exposed to the extreme sun light during the daily daytime low-tides.

This extreme situation would be affected the long-term survival of these coral juveniles and many of these corals were weakly attached to the reef bottom and could therefore be tilted and transported by strong water currents to deeper muddy region. The exposed coral samples have been bleached due to temperature and sunlight during the summer season. These kinds of coral colonies offer a potential opportunistic source for transplantation and restoration.

The triangle structures are used to construct artificial reefs for fishing ground, this structure also support to the small invertebrates and corals to attach²². During the present investigation also, number of associated fishes found to use these triangles as their habitat (Fig. 2D). In India, corals recruitments on a 20 years old sunken shipwrecks from Gulf of Mannar was assessed¹³, after 20 years of observation, 23% of live coral colonies have recruited on the shipwreck and these provide shelter to many reef fishes and reduce overexploitation of marine resources in this region. Establishment of artificial reefs may create new patchy reef in unsuitable sites and it will support new recruitments of corals also. Eventually, the rate of recovery of the reefs would be increased gradually.

Conclusion

The present experimental transplantation and restoration were tried on Pirotan Island, Gulf of Kachchh and 78 % of coral survival was noted on artificial triangle substrates. The coral transplantation is a major tool for securing the restoration and conservation of endangered coral species²³. A success of coral transplantation depends on the study site, coral species, the sample size, structure of substrates, environmental condition and also the frequency of monitoring. The present study proved to be a success in the coral restoration initiative and hence it is recommended that coral restorations are suitable for large scale transplantations in future at Marine National Park, Gulf of Kachchh.

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