Post tsunami recovery of fauna and flora of the Barberyn reef, Beruwala, Sri Lanka

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Abstract

Barberyn reef, a reef situated on the South-west coast of Sri Lanka at 6° 26' N and 79° 58' E, which was denuded by the tsunami, 2004, was studied to monitor the recovery of flora and fauna. The site was visited immediately after the tsunami and at periods of 6 months, 1 year and 2 years. A line transect was laid parallel to the shore along the reef and triplicate quadrate samples were taken from 16 sampling locations at 50 m intervals. Positions of the locations were accurately noted using a hand held GPS. Percentage cover of sea weeds and abundance of invertebrates were recorded. The reef was observed to be almost bare immediately after the tsunami. A considerable increase of abundance and diversity of seaweeds and invertebrates was observed from January to June, 2005 and full recovery was observed by June 2005. Species richness increased from 2% in January 2005 to 12% in June 2005 while average percent cover of sea weeds increased from 2% in January 2005 to 23.44± 1.56% in 2005 and to 77.81± 27.62% in 2006. Species richness of invertebrates was 0 in January 2005 and increased to 5.22±3.42%, 2.81±1.68% and 10.56±3.69% respectively in June 2005, December 2005 and December 2006. Fourteen species of seaweeds under eleven families dominated by *Turbinaria, Caulerpa, Ulva, Jania, Gelidium, Gracilaria* and *Sargassum* and twenty-seven species of invertebrates consisting of 11 species of polychaetes, 9 species of gastropods, 16 species of crustaceans, 2 species of echinoderms were recorded during the present study. It was also observed that the abundance of invertebrates increased significantly ($r = 0.89$, $p<0.05$) with the increase of percent cover of seaweeds in the reef.

Keywords: Barberyn reef, Sea weeds, Invertebrates, Tsunami

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Introduction

The plant life of the shore below the splash zone is chiefly represented by the diverse forms of algae ranging from microscopic unicellular diatoms to large multicelluler sea weeds. The rock pools near the sea shore which get exposed at low tide are usually covered with large areas of sea weeds.

As regards the distribution of marine algae in Sri Lanka, most of the red algae are found growing in the southern and western parts while the shallow shores of the northern coast are abundant with Chlorophyceae and Pheophyceae (Durairatnum 1961). Some Rhodophytes occur in the eastern coast during the South-west monsoons, but disappear during the south east monsoons (Durairatnum 1961). Eighty four species of Chlorophytes, 65 species of Phaeophytes and 166 species of Rhodophytes adding up to a total of 315 species of algae have been recorded from Sri Lanka (Durairatnum 1961). Silva *et al.*, (2002) have recorded 440 species and Mallikarachchi (2004) has recorded 125 macroalgal species, of which 11 are new records, belonging to 65 genera and 34 families (from the South-west coast). With these findings, the total algae recorded from Sri Lanka increases to 451 species.

Barberyn reef, situated on the South-west coast of Sri Lanka, in the Kalutara district, approximately half a mile south of Beruwala town at 6° 26' N and 79° 58' E, is a diverse ecosystem and a living laboratory which is often used by academics in the Universities and scientists from other Institutes to teach their students and sub-ordinates. The reef is also used by local fishermen for extraction of bait and bait fishing and by tourists for recreational purposes.

According to earlier records, the flora of the reef consisted of 13 species of marine algae belonging to 11 families (Goonatilake *et al.*, 1995). The fauna of the reef however, have not yet been reported in the literature but NARA has recorded the fauna of the reef as part of ongoing surveys. According to these data, collected prior to the tsunami, the reef fauna was represented by 34 species consisting of 8 species of polychaetes, 9 species of mollusks, 2 species of echinoderms, and 15 species of decapods (Personal observations).

The tsunami in 2004 devastated the coastal area and severely affected and denuded the reef. In view of the importance of the diversity in the reef, this study was carried out to evaluate the time taken for recovery of fauna and flora of the reef and to find out the changes in the diversity.

Materials and methods

The study was carried out during the period from December 2004 to December 2006 starting immediately after the tsunami and at periods of 6 months, 1 year and 2 years. A line transect was laid parallel to the shore along the reef and percentage cover of sea weeds and abundance of invertebrates was determined using a quadrat of 25 cm x 25 cm in size at 16 sampling locations which were at 50 m distance from each other. Sampling was done in triplicate. Positions of the locations were accurately noted using a hand held Global Positioning System (Magalan model) at each point.

The samples of seaweeds and invertebrates were fixed immediately in 70% alcohol and transported to the laboratory for further analysis. The samples were sorted, identified up to the lowest possible taxonomic level and counted. Species richness of algae and invertebrates were calculated as the number present at each point. Diversity of invertebrates and seaweeds was determined at each site using Shannon Weiner diversity index (H') given below (Zar 1995).

$$H1=\sum_{ial}^{n} P_i \log (P_i)$$

Where, P_i is the proportion of the total count arising from the i^{th} species

The relationship between abundance of invertebrates and percentage cover of sea weeds was calculated by regression analysis.

Results

Fourteen species of seaweeds belonging to eleven families, dominated by *Turbinaria*, *Caulerpa*, *Ulva*, *Jania*, *Gelidium*, *Gracilaria* and *Sargassum,* were recorded during the study. Table 1 shows the list of algal species recorded during the period of study.

Table 1. Species of algae recorded from the Barberyn reef during the period of study.

Order	Family	Species
Ulvales	Ulvaleae	*Ulva fasciata*
Siphonales	Codiaceae	*Halimeda opuntiq*
	Caulerpaceae	*Caulerpa racemosa*
Siphonocladales	Valoniaceae	*Valonia* sp
Dictyotales	Dictyotaceae	*Padina* sp
		Dictyota citiata
Fucales	Sargassaceae	*Turbinaria ornate*
		Sargassum sp
Nemelionales	Chaetangiaceae	*Scinaia furcellata*
Gelidiales	Gelidiaceae	*Gelidium* sp
Crypotomenniales	Corallinaceae	*Jania* sp
Gigartinales	Gracilariaceae	*Gracilaria* sp
Cermiales	Rhodomelaceae	*Acanthophora* sp

Changes in species richness of the algae at each of the 16 sampling points at 6 months, 12 months and 2 years after the tsunami are given in Table 2. There was no significant difference between the species richness of June 2005 and December 2006 ($F = 1.63$, $p>0.05$) but significant differences were observed between species richness of June and December in the year 2005 ($F = 11.04$, $p< 0.05$) and December 2005 and December 2006 ($F = 12.62$, $p<0.05$) respectively.

Table 2. Changes in species richness at 16 sampling points during four sampling occasions

Sampling Point	Jan 2005 (a week after tsunami)	June 2005 (after 6 months)	Dec 2005 (after 1 year)	Dec 2006 (after 2 years)
1	0	4	1	3
2	0	3	1	4
3	0	2	1	3
4	0	5	3	4
5	0	6	3	7
6	0	4	2	3
7	0	3	3	5
8	0	3	2	4
9	0	2	1	3
10	0	3	2	4
11	0	4	4	4
12	1	9	3	7
13	1	8	4	9
14	0	3	2	4
15	0	2	1	3
16	0	2	1	1

Average values for percent cover of sea weeds immediately after tsunami, at periods of 6 months, 1 year and 2 years are shown in Table 3.

Table 3. Average percent cover of sea weeds immediately after tsunami, after 6 months, 1 year and 2 years.

Sampling time	**Average percent cover of sea weeds**
January 2005 (a week after tsunami)	2 ±0.24%
June 2005 (after 6 months)	18 ±0.82%
December 2005 (after 1 year)	23.44± 1.56%
December 2006 (after 2 years)	23.44± 1.56%

During the first visit, small emerging plants of *Ulva lactuca* were found at sampling points 12 and 13. Thereafter, a clear increasing trend in the percent cover of sea weeds was observed.

The reef was found to be denuded at the visit made just after the tsunami and no animal species were observed. During the latter period of the study 38 species of invertebrates consisting of 11 species of polychaetes including nereids and nephtyds, 9 species of mollusks including 7 species of gastropods, a limpet and *Saccostrea* sp., 16 species of crustaceans consisting of 8 species of gammerids, 6 brachyuran crabs, 1 anomuran crab, and *Balanus* sp., and 2 species of echinoderms were recorded. The polychaetes were always found among the roots or holdfast of the sea weeds, most among the holdfast of *Gelidium*. Crustaceans, especially the amphipods and crabs were mostly found among the green sea weeds such as *Acanthophora*.

Table 4. Abundance of fauna recorded during the study (number/m^2).

Species	**January 2005 (a week after tsunami)**	**June 2005 (after 6 months)**	**December 2005 (after 1 year)**	**December 2006 (after 2 years)**
Polychaetes				
Nereidae	-	-	+	++
Nephtyidae	-	-	+	+++
Other species	-	+	++	+++
Mollusks				
Gastropoda	-	++	+	+++
Bi-valvia	-	+	+	+++
Crustaceans				
Brachyura	-	-	+	++
Anomura	-	-	+	+
Amphipoda	-	++	+++	+++
Cirripedia	-	+	++	++
Echinoderms				
Echinus sp.	-	+	++	+++
Sea anemone	-	-	++	+++

+ - < $2/m^2$, ++ - $2<x<5/m^2$, +++ - $5</m^2$

Table 5 shows the diversity of invertebrates in sampling sites during the four visits. It is evident that the diversity of sampling sites 1, 2, 5, 6, 11, 12 and 15 were comparatively higher than that of the other sites. It is also evident that the diversity in June 2005 is similar to that of December 2006.

Table 5. Shannon Weiner Diversity index (H') of invertebrates at each site during the period of study.

Sampling Point	January 2005	June 2005	December 2005	December 2006
1	0	2.083	1.282	2.098
2	0	1.363	0.683	1.502
3	0	1.112	0.000	1.229
4	0	1.905	0.000	1.922
5	0	1.799	1.264	1.726
6	0	1.900	1.101	1.958
7	0	1.353	0.000	1.405
8	0	1.481	0.000	1.440
9	0	2.170	0.613	2.133
10	0	2.200	0.613	2.245
11	0	2.260	1.379	2.239
12	0	2.197	1.040	2.086
13	0	1.562	0.780	1.613
14	0	1.990	0.854	1.970
15	0	2.358	1.567	2.367
16	0	1.026	0.598	1.013

Table 6. Species richness of fauna immediately after tsunami, and at periods of 6 months, 1 year and 2 years

Sampling time	**Species richness**
January 2005 (a week after tsunami)	0
June 2005 (after 6 months)	5.22±3.42
December 2005 (after 1 year)	2.81±1.68
December 2006 (after 2 years)	10.56±3.69

Average species richness of invertebrates immediately after tsunami, after 6 months, after 1 year and after 2 years is shown in Table 6. A clear increasing trend of species richness is evident.

The correlation coefficient (r) between percent cover of seaweeds and abundance of invertebrates was 0.89 and this was significant at the 5% level of confidence. It is evident that the abundance of invertebrates increases significantly with the increase of percent cover of seaweeds on the reef.

Discussion

The devastation caused by the tsunami (26th December 2004) to the coastal habitats in the region has been assessed by many authors. However, assessments of the impact on the shallow reef habitats were scanty. Mantri (2006) has collected baseline data on biomass availability and distribution of benthic intertidal seaweed species on the coast of India immediately after the tsunami and assessed the level of damage on the sea weed habitats. The present study assesses the time taken for recovery of a reef which was denuded by the tsunami and observed that the reef habitat had fully recovered by 6 months. This was confirmed by the facts that the diversity and species richness in December 2006 are also similar to those in June 2005. Durairatnam (1961) has shown that the monsoons play an important role in the algal flora of Sri Lanka and the decrease of diversity and species richness in December 2005 may be attributed to the severe monsoonal rains that occur at that time. The huge waves that break on the edges of the

reef may have impacted the diversity and species richness. According to Mallikarachchi (2004) April-June season has a positive impact on seaweeds and the speedy recovery of the seaweed ecosystem in Barberyn reef may also be due to the favourable season that followed after tsunami in late December which influenced the proliferation of both fauna and flora.

It is also interesting to note that the abundance of invertebrates increased significantly ($r = 0.89$, $p<0.05$) with the increase in the percent cover of seaweeds on the reef. Algae provide shelter and oxygenated water for animals to thrive (Littler and Littler, 1994) and also serves as a refuge for invertebrates. With the increase of sea weed cover, the invertebrates have more areas for proliferation and may be the reason for their proliferation with the increase of sea weeds. The Barberyn reef is an interesting coastal habitat which could be used for detailed studies on sea weeds and associated fauna.

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