Underwater survey of rocky reefs of Muttom, Tamil Nadu: possible tsunami impacts

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Abstract

Rocky reef sites offshore of Muttom, Tamil Nadu were surveyed using SCUBA in 2002 and 2005. Over ninety percent of the benthos was found to be from four categories: fine turfing algae, rubble, sponge and barnacles. The relative abundance of these four categories shifted dramatically between the survey period with the decrease in sponge and barnacle cover matched by an increase in fine turfing algae and rubble. The changes to this site are consistent with tsunami damage. However, due to the lack of data just prior to the tsunami, the changes cannot be conclusively attributed to tsunami damage.

Introduction

The December 26th, 2004 tsunami devastated many coastal regions of the Indo-Pacific. Studies of tsunami-impacted marine habitats have shown varying effects (Tun et al., 2005). In Southeast Asia, the tsunami wave itself did not impact reefs as much as the resultant backwash and debris left on the reefs subsequent to the wave passing (Tun et al., 2005). However, in Sri Lanka scientists found that the reefs offshore of Trincolamee were severely damaged by wave impact resulting in almost complete destruction of the coral reef

(UNEP, 2005). In Southeast Asia, coral reef fish fauna did not appear to be affected by the tsunami and intact and healthy reefs provided a measure of protection for the coastal areas which unhealthy reefs did not (Tun et al., 2005; UNEP, 2005). NARA (2005) reports that large coral reef fish were not impacted in Sri Lanka, but smaller fishes were less abundant in heavily damaged coral reefs. Damage to reefs on the west coast of Sri Lanka was limited (Tamelander, 2005).There did not appear to be damage to reefs in the Gulf of Mannar (NARA, 2005; Patterson Edwards, 2005).

We surveyed rocky reefs offshore of Muttom, Tamil Nadu several years prior to the tsunami and undertook a resurvey of these areas post-tsunami. Using identical methods and surveyors, we were able to examine changes at this site and try to determine if the tsunami impacted these marine habitats.

Methods

Rocky habitat offshore of Muttom, Tamil Nadu was surveyed for benthic percent coverage in January 2002 and May, 2005. This marine habitat consists of two rocky structures located approximately 1 km offshore. The area above the waterline was approximately circular with a diameter of 15-20 m and a height of 3-5 m above the water surface reaching to a depth of 15 m.

Line intercept transects were used to calculate the percent cover of both living and non-living benthos (Table 1). In 2002, six 25 m transects were lain in representative areas of the substrate and in 2005, twelve transects were completed. One observer (RDS) examined the bottom underneath points at 25 cm intervals along the transect, giving a total of 100 possible points per transect. Some transects contained less than 100 points due to diving related issues. Percent cover was calculated as the total number of points for each benthic category divided by the total number of points for that transect.

Data were compared using a t-test. Data that are percentages are known to follow a binomial distribution, rather than a normal distribution (Zar 1984). When proportions are known, rather than simply percentages, the modified Freeman and Tukey (1950) transformation has been shown to be most effective, especially when small proportions are abundant, as is the case with the data. Thus the transformation $p' = \frac{1}{2}[\arcsin \sqrt{(x/n+1)} + \arcsin \sqrt{((x+1)/(n+1))}]$was used to meet the assumption of normality for using a t-test (Zar 1984), where x = the number of points per transect of a particular category and n = the total number of points in the transect. As there were no significant differences in the mean percent cover of any benthic category between the two rocky sites ($P>0.05$) data were combined for comparison by benthic category between years.

Results

Most benthic taxons were rare, occupying less than 1% of the space surveyed by transect lines (Table 1). The dominant categories in 2002 were: barnacles (42%), fine turfing algae (22.3%), sponges (14. 4%) and rubble (11.7%). In 2005 the dominant categories were similar, but in a different order of ranking: fine turfing algae (59.7), rubble (25.6) and sponge (6.2). Live barnacles were not observed in 2005. The four most dominant categories in 2002 contributed 90.4 percent of the total area occupied under transects, while in 2005 the top three categories contributed a similar amount (91.5%). Table 1 shows that between 2002 and 2005, barnacles and sponges decreased and fine turfing algae and rubble increased. We could not test the significance of the change in barnacle cover as there were none observed in 2005. However, it is obvious that a decrease of 44% barnacle cover is significant.

Discussion

The benthos found at Muttom, Tamil Nadu has changed significantly between January 2002 and May 2005. Over ninety percent of the benthos was occupied by only four categories: fine turfing algae, rubble, sponge and barnacles. However, there were significant shifts in the relative abundance of these categories between the years. It appears that the decrease in barnacle and sponge cover was accounted for by an increase in fine turfing algae and rubble. If space became available in this area, fine turfing algae would be among the first to colonize as it grows fast and can withstand both heavy wave action and sedimentation. The dead barnacles would then become rubble. Much of the sponge cover at this site was encrusting (R. Sluka personal observation).

The December 26, 2004 tsunami had varying impacts on marine environments throughout the Indian Ocean region (Tun et al., 2005). While we cannot conclusively state that the changes observed at Muttom, Tamil Nadu are directly due to tsunami impacts, they are consistent with damage that the tsunami would inflict on this environment. Barnacles are not harvested from this region so this factor can be ruled out as a cause of the decrease in barnacle cover. Another possible cause would be sedimentation. Barnacles are filter feeders and could have been smothered by the silty sediments in this region. With limited wave action, much silt and sand are swept into the water column. This smothering effect could have caused the barnacles to have died. However, while we did not observe live barnacles under transect lines, there were small patches of dead barnacles covered with various encrusting organisms such as ascidians and sponges or covered in fine turfing algae. The percent coverage of rubble increased significantly and much of this rubble was formed by dead barnacles (R. Sluka personal observation). It is not clear why sponge cover would decrease, but like barnacles, sponges are filter feeders. Sponges may also have been negatively affected by sedimentation prior to the tsunami.

We were not able to make observation on fish abundance due to low visibility. However, groups of large parrotfish (*Scarus ghobban* and *S. rubroviolaceus* > 50cm), surgeonfish (*Acanthurus bariene* >30 cm) and snapper (*Lutjanus argentimaculatus* > 50 cm) were observed at these sites. Fishermen report that catches are lower at this site, but this could not be verified with landing data. In other studies of tsunami impacted reefs, fish abundance and diversity were not affected (Tun et al. 2005), with the exception of small ornamental reef fish in heavily impacted reefs of Sri Lanka (Nara, 2005).

This site appears similar to rocky subtidal sites found in temperate latitudes. In rocky subtidal regions one of three types of communities usually predominate: seaweeds, mussels or encrusting communities (coralline algae, ascidians and sponges) (Nybakken, 2001). The Muttom site, though, is dominated by a cover of fine turfing algae. However, in and amongst this fine turfing algae exists an encrusting community. The mechanisms for maintaining this encrusting community are currently unknown, but are likely due to grazing pressures. Herbivores are numerous at this site (parrotfish, surgeonfish and sea urchins). Similarly, the Muttom area is well known for its abundance of starfish which are predators on mussels (Gaymer and Himmelman, 2002). Herbivores are likely cropping any macroalgae or seaweeds which grow at this site. Additionally, mussels may be limited by the abundant starfish population. This would result in space available for the encrusting community to persist in abundance despite these species' lower competitive ability (Nybakken, 2001).

This study clearly indicates the need for monitoring of this area. Until recently this was not possible due to lack of scientists trained in SCUBA. However, IERSE and MRDS have collaborated on a project to develop a reef research team based in southwest India that now has the training and expertise to conduct these types of surveys.

Further research should focus on how sedimentation affects this reef and a monitoring program initiated. In particular, the various mechanisms, biotic and abiotic, which shape community abundance and structure at this site should be investigated.

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Table 1: Summary of benthic cover (percent ± 1 SE) by site. n=number of transects per site. Significance indicates the results of a two-tailed t-test on arcsin transformed data. Ns = not significant p >0.05, * = p< 0.05, ** = p<0.01, *** = p<0.001 and n/a indicates that for one year this category was not observed within transect limits and thus a t-test could not be performed.

Benthos	Muttom 2002	Muttom 2005	Significance	t value
n	6	12		
Habitat	offshore	offshore		
Lat N/Lon E	8.11/77.29	8.11/77.29		
Total hard coral	0.7 (0.5)	0.4 (0.3)	ns	0.635
Total octocoral	---	---		
Anemones	---	0.1 (0.1)	n/a	
Zoanthids	---	0.3 (0.3)	n/a	
Corallimorphs	---	---		
Hydroid	---	---		
Tunicates/ascidians	---	0.6 (0.4)	n/a	
Sponges	14.4 (3.2)	6.2 (1.3)	**	3.166
Total algal cover	24.5 (3.6)	63.2 (4.4)	***	-7.174
Fine turf	22.3 (3.4)	59.7 (4.2)	***	-6.784
Thick turf	0.5 (0.5)	---	n/a	
Crustose coralline	1.5 (0.5)	2.3 (0.9)	ns	-0.415
Brown frondose	---	---		
Green frondose	---	0.1 (0.1)	n/a	
Red frondose	0.2 (0.2)	0.3 (0.1)	ns	-0.761
Barnacle	42.0 (6.0)	---	n/a	
Mussel	4.1 (2.2)	0.9 (0.5)	ns	1.508
Polychaete	---	---		
Bare space	0.9 (0.6)	1.0 (0.3)	ns	-0.546
sand	1.2 (0.8)	---	n/a	
Sand on hard-bottom	0.7 (0.3)	0.3 (0.3)	ns	1.626
Silt on hard-bottom	---	---		
Rubble	11.7 (2.5)	25.6 (4.3)	*	-2.307