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Rapid assessment on diversity and community structure of macroalgae before and after the 2004 Tsunami at Talibong Island, Trang Province, Thailand,

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Key words: Diversity, Community, Macroalgae, Tsunami, Talibong island, Thailand

Running Title: Diversity and community of macroalgae before and after the 2004 tsunami

Abstract

The diversity and community of macroalgae were investigated at 3 sites at Talibong Island, Trang Province, Thailand, from April 2004 to May 2005. Preliminary studies revealed a high diversity of macroalgae on the west coast of the island. Therefore, it was decided that these were good sites to set up fifteen of 0.5 m X 0.5 m permanent plots to monitor macroalgae community changes. Physical factors such as salinity, seawater temperature, NO_3^-, NO_2^- and PO_4^{3-} were also measured. Eighteen species of macroalgae were found. *Sargassum stolonifolium* and *Laurencia composita* were the most abundant species, covering 90% and 39%, respectively, on the rocky substrate. *Padina sanctae-crucis* and *Caulerpa taxifolia* were the most dominant species on the sandy substrate. Thirteen species varied among the sites and seasons. Eleven species were strongly influenced by the 26 December, 2004 tsunami. *L. composita* and *Padina sanctae-crucis*, for example, were washed up to the shores by the strong tsunami wave, and clearly resulted in a decrease in percentage cover. In addition, many permanent plots were covered by sediment causing anoxic conditions. Multivariate analysis revealed that most macroalgae and sites were randomly spread out on the axis before the tsunami; but they were grouped after the tsunami hit these sites. We have not found any seasonal pattern or recovery of macroalgae after 5 months after the tsunami.

Introduction

Talibong Island, a protected non-hunting area, is the biggest island in Trang Province, Thailand. The island has recently been designated as Ramsar site No. 1182 with connection to Had Chao Mai Marine National Park and the Trang River Estuaries (http://www.ramsar.org). These are interconnected wetland ecosystems with riverine, estuarine, and coastal wetlands, including mangroves, sand beach and rocky marine shores, mud flats, coral reefs and seagrass beds. The island supports various marine organisms, including migrating seabirds at Leam Chu Hoi and an important endangered species of dugong (*Dugong dugon*). Fifty three dugongs were observed n the seagrass beds in the southeast of the island (Hines, 2002). Talibong is also known to have the healthiest and most richly diverse seagrass ecosystem in Thailand. Eight of the twelve known species reported in Thailand are found there (Changsang and Poovachiranon, 1994, Poovachiranon and Changsang, 1994). Also various corals such as *Porites*, *Favites*, *Turbinaria* and *Acropora*, cover an area of 2.38 km^2 along the west to the south coasts of island (Pongsuwan, 1999). Indeed, the island is very rich in marine habitats and organisms. However, very little is known about the diversity and ecology of seaweeds.

Under the Japanese Society for the Promotion of Science (JSPS) multilateral programs for marine science, the macroalgae diversity group has chosen Talibong island as a representative area for the Andaman sea along with Samui Island as a representative of Gulf of Thailand . Preliminary studies have shown that 3 sites on the west coast of Talibong have the richest diversity of macroagae (Prathep and Tantiprapaj, 2003) Site No. I was dominated by *Caulerpa taxifolia* on the sandy substrate in the shallow subtidal bay. Site No. II was dominated by *Laurencia compostia* and *Padina sanctae-crucis* with rocky and sandy substrates. Those macroalgae were found in shallow subtidal habitats, at similar depths Site No. III was dominated by *Sargrassum stolonifolium* on the rocky substrate habitat in a sheltered bay.

We have described the diversity and community of macroalgae at these chosen sites since April 2004. Talibong was hit by the 26 December 2004 tsunami. Therefore, we have some baseline data by which the effect of the tsunami on macroagal diversity and community can be evaluated. This is the first report of the effect of the tsunami on macroalgae,in Thailand.

Study sites and Material and Methods

Preliminary survey around the island during 2-5 May 2003, showed that there was a high diversity and abundant macroalgae at the west coast of Talibong Island (Prathep and Tantiprapaj, 2003). Fifteen permanent plots, 0.5 m X 0.5 m, were randomly set up at 3 different sites along the west coast (Fig. 1), 5 plots at each site. Each plot was marked using GPS, GARMIN GPS 76; and fluorescence tape was used to mark at the corner of each plot. Percentage cover of macroalgae at each plots were estimated at the sites from April 2004 - May 2005 using (Saito and Atobe, 1970). Most macroalgae specimens were brought back to laboratory and preserved in 4% seawater formalin or herbarium sheets. They were deposited at herbarium at PSU National History Museum, Prince of Songkla University, Thailand.

The island is influenced by the Southwest Monsoon from May-October which represents a rainy season; and by the Northeast Monsoon from November-April, a dry season. Field collections were made in April 2004, at the beginning of September 2004, at the end of November and at the beginnings of January, March and May 2005. Strong wave conditions did not allow access to the sites from April to August. However, our data covers both dry and rainy seasons. Physical data such as salinity, seawater temperature, NO_3^-, NO_2^- and PO_4^- were investigated, 5 replications at each site. Water samples were collected at the sites, kept in dark cool conditions and brought back to laboratory for further analyses.

Statistical Analysis

Analyses of variance (ANOVA) were employed to test the effect of 1) sites and seasons and 2) sites and tsunami on abundance of macroaglae using STATISTICA version 5.0. If necessary, data were transformed to meet the assumptions of the parametric test. Friedman ANOVA was employed if there was no homogeneity of data after a series of transformations. Multiple comparisons were made following Zar (1984) when there were significant differences between treatments. Statistical results were presented based on the transformed analyses, but for clarity graphical output was based on the untransformed means.

We used a canonical correspondence analysis (CCA) to illustrate the differences in the physicochemical characteristics of sites and seasons on macroalgae community using PCORD version 4.0. The analysis were done using the dataset (18 species, 75 samples), which included 1) salinity, 2) seawater temperature, 3) NO_3^-, 4) NO_2^-, 5) PO_4^- and 6) tsunami. The CCA procedure was used with a Monte Carlo test with 499 permutations, to determine which environmental variables were important in explaining the variation in the species in each data set

Results

There were variations in diversity and the community of macroalgae among sites and seasons. Eighteen species were found in this study: 7 species of red algae, 5 species each of brown and green algae and only one species of blue green algae (Table 1). The highest diversity was found at site No. I during April 2004, eleven species of macroalgae. Only four species were observed in January shortly after the tsunami hit these sites.

Laurencia composita, Lynbya majuscula, Padina sanctae-crucis and *Gelidella acerosa* occurred at all 3 sites, while *L. composita* and *P. sanctae-crucis* were the most common algae found in this study (Table 1). Filamentous red algae such as *Polysiphonia, Gelidiopsis* sp., *Symploca* sp. and *Valonia pachynema* were recorded only once in our study.

Thirteen species showed significant differences in percentage cover with respect to sites, seasons and their interactions (Table 2). While, eleven species showed significant differences in percentage cover with respect to sites, before/after the tsunami and their interactions (Table 2). The percentage cover of both *L. composita and P. sanctae-crucis* dropped significantly in January after the tsunami hit the sites (Fig. 2).The percentage cover of *L. composita* was only 3% in January. The brown alga, *Padina sanctae-crucis* disappeared. In addition, we observed these algae including some seagrasses floating in water column and washed up on the shore, 5 days after the tsunami hit *S. stolonifolium* also was influenced by the tsunami, the percentage cover dropped by 26 %, with some shortened fronds observed. Fronds presumably snapped off during the strong wave action.

Canonical correspondence analysis (CCA) (Fig. 3) documented that the distribution of species was influenced with respect to the four environmental variables: salinity, seawater temperature, NO_3^- and PO_4^- ($P<0.05$). All species were rather spread out on all axes (Eigen values of first two axes: 0.39 and 0.26), *S. stolonifolium* was the nearest species plotted near the centre of the graph, suggesting it was less influenced by any physical factors. Although, the physical factors significantly influenced the algal community, but most species were further out from physical factors vectors and from the centre of the graph.

In addition, the sites could be divided into before and after the tsunami data. All sites were rather spread out before the tsunami hit; but then crushed together after the tsunami (Fig. 4). This suggested that all sites had similar species and physical variables after being hit by the tsunami, which we observed as lesser diversity and percentage cover. Moreover, many permanent plots were buried by sediment 5 days after.

Discussion

The variations of diversity of macroalgae at the Talibong island might be the result of differences in substrates and wave exposure. Sites No. 1and No. 2 have exposed sandy and rocky substrates; while Site No. 3 has sheltered rocky substrates. The complexity of substrates are known to influence the greater diversity of algae and marine benthic organisms (Dean and Connell, 1987), thus we found a higher diversity of macroalgae at Site No. 1 during April, when there was less effect of wave exposure.

The differences in dominant species of each site might therefore be due to the nature of the substrates, *Caulerpa*, for example, was a dominant species at Site No.1, which has a sandy substrate, allowing stolons and rhizoids to grow into the sand. *Sargassum* dominated at site No. 3, which has a rocky substrate, allowing the discoid holdfast to attach. After the monsoon season, macroalgae dropped more than 50%. This might be the result of the high wave energy, which could stir up the sediment and cover the crust of small algae such *Gelidella*. While, *Laurencia*, a fragile red alga, would be broken by the strong wave action, which we found many floating fronds in the water column.

These post-monsoon patterns are similar to the post-tsunami, which had a stronger effect on the marine benthic organisms such as seagrasses, sponges, corals, and molluscs. All sites showed similar post- tsunami, patterns: decreased in both diversity and abundance of macroalgae. The effects of tsunami on algae and other marine organism could be divided into 1) direct impacts and 2) indirect impacts.

The direct impact of severe wave energy on shallow nearshore habitats (including coral reef ecosystems, seagrasses and mangroves) could be extensive but also dependent on the amount of wave energy these ecosystems are normally exposed to. Areas normally exposed to significant wave energy from large swells or tropical storms are less likely to be severely impacted. On the other hand, shallow bays typically protected from high wave action could have suffered more extensive damage such as at site 3.

Damage by wave energy is also species specific. Some species of coral, algae and other marine invertebrates are extremely delicate and cannot withstand turbulent high energy environments as seen in *Laurencia* and *Padina*. As a result, these species would be particularly susceptible to the damaging wave energy generated by this tsunami. Although, wave forces and current are known to influence recruitment, dispersal, community structure and dislodgement of the algae and marine benthic organisms (Ballantine, 1961, Lewis, 1964, Norton, 1991, Denny, 1995), only recently, which pointed that what influence break or dislodge of macroalgae is still little known (Thomsen and Wernberg, 2005). Thus, more studies are still needed to understand what cause the dislodgment of macroagale.

A major indirect impact of the tsunami on nearshore marine ecosystems includes sedimentation from extreme runoff and the churning up of coastal silt, sand and organic matter. Some ecosystems could have been buried by sediments flushed into shallow nearshore environments. For areas normally exposed to high wave energy or strong currents, this sedimentation will probably be washed away over several weeks or months, depending on the degree of sedimentation. In more protected areas (not typically exposed to significant wave energy or currents), it could take years or decades for the ecosystem to recover. Most small benthic algae were found buried in our first survey after the tsunami and have not been found yet after five months of the monitoring.

This powerful tsunami could have substantially altered some shallow water benthic habitats, reducing their effectiveness as nurseries and shelters for fish and benthic organisms — organisms living on, attached to, or burrowing in the sediment of the ocean floor. As a result, some nearshore fisheries could be impacted by very low recruitment success over the next few years. Unfortunately, such impacts could ripple through the entire food chain for decades, however, they will not be likely to cause lasting impacts. Extensive damage to nearshore estuaries, mangrove and seagrass habitats — many of which could have been completely torn free of their roots.

This was the first tsunami in Thailand, which caused various damages to marine ecosystem in Southern Thailand including macroalgae community. Although, this research was a first report on the effect of tsunami on macoralgae community but further investigation is still needed to understand such recovering of macroagale community after the tsunami. This would provide further information to understand various ecological theories such as natural disturbance, succession and recruitment.

Acknowledgements

We are very much grateful for all the help and hearts from our team, "seaweeds and seagrass research unit, CBITP, PSU". Thanks to Professor Larry B. Liddle for manuscript improvement. KNIT, UNOCAL and PSU for funding; and JSPS and Professor Hisao Ogawa for the wonderful program.

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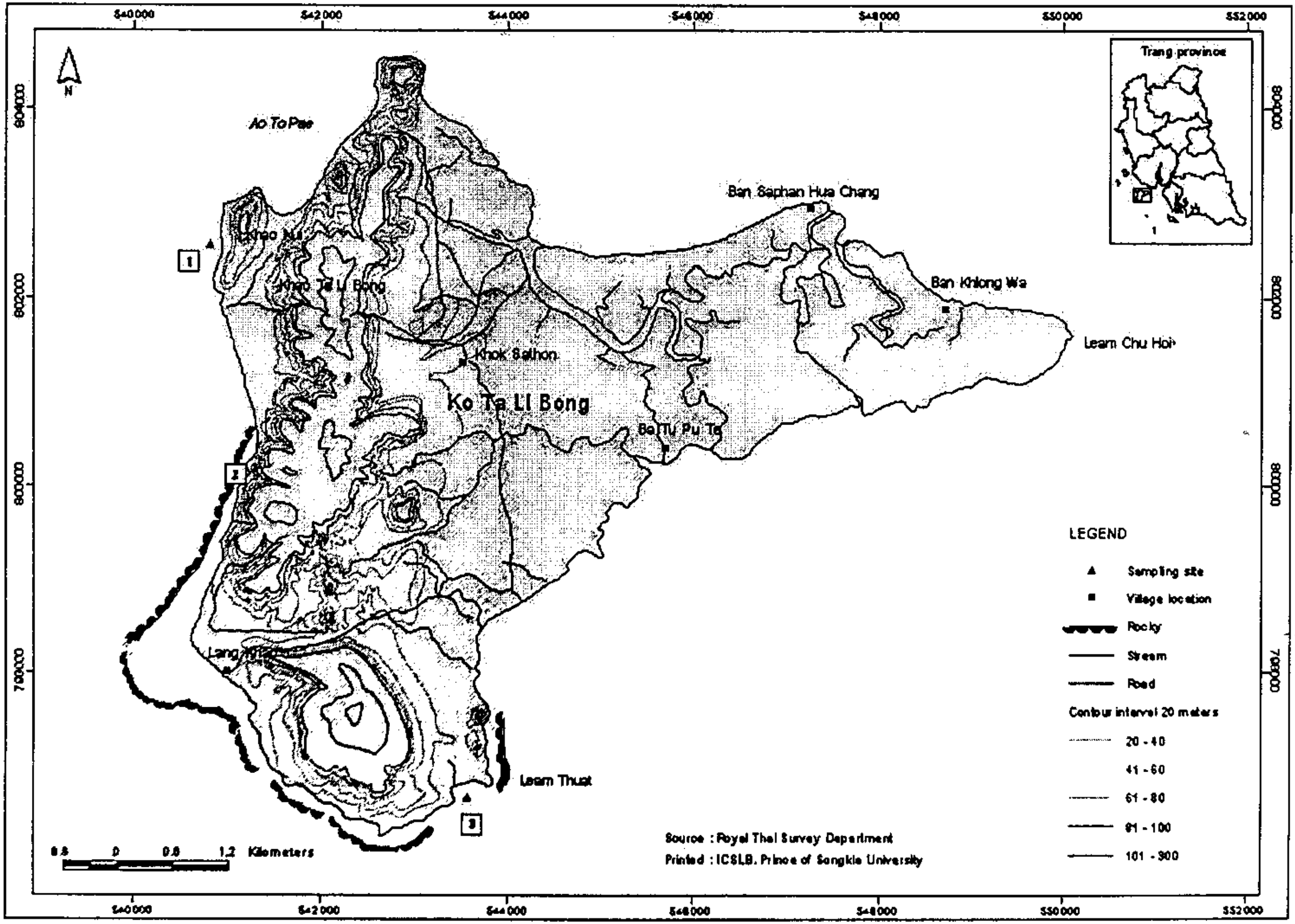
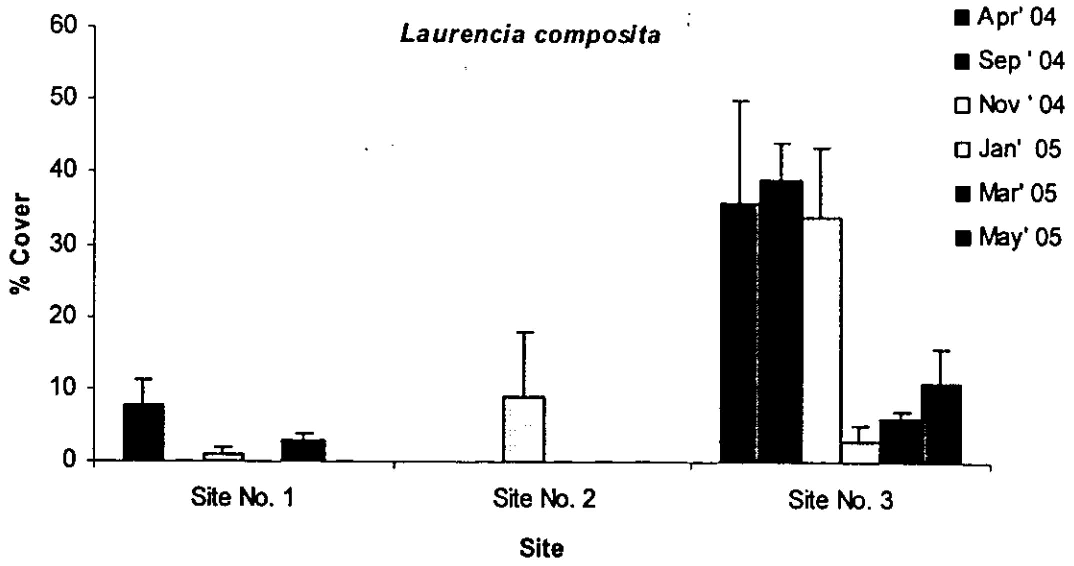


Figure 1 Permanent plots were set and monitored at each site and the coastal line of Talibong island, Trang Province, Southern Thailand.



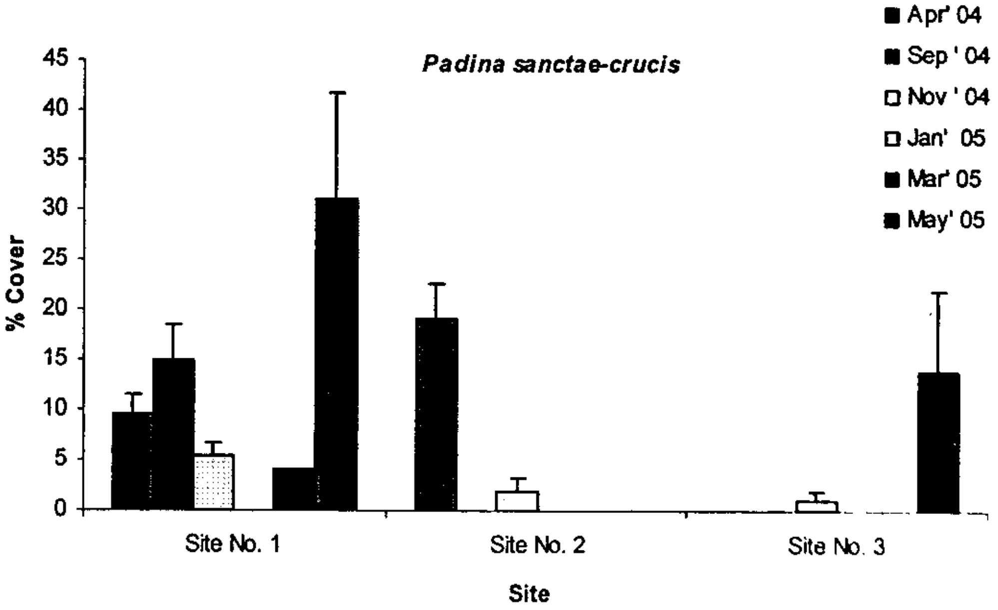


Figure 2 Effect of sites and seasons on % cover of some macroalgae: *Laurencia composita, Padina sanctae-crucis*

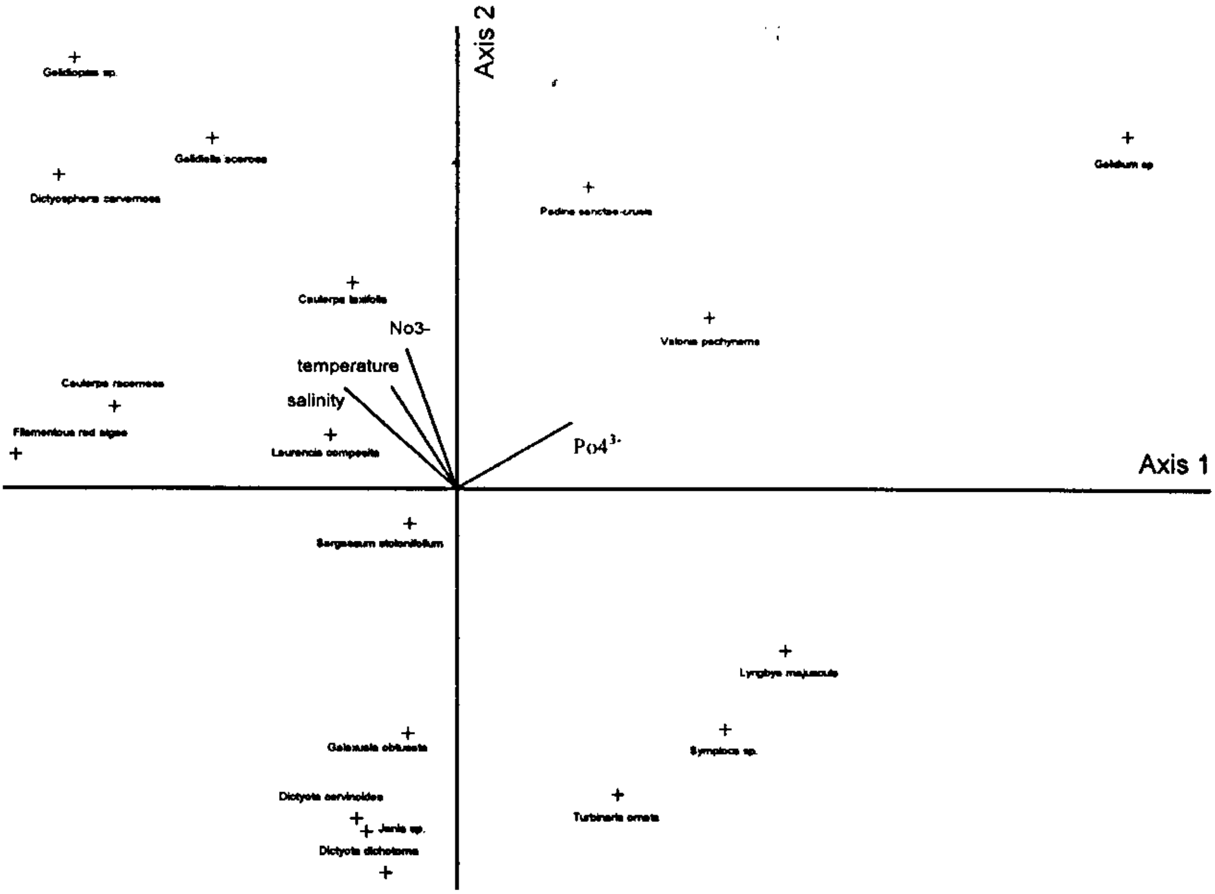


Figure 3 CCA result showing distribution of macroaglae and relationship between macroalgae and environmental conditions

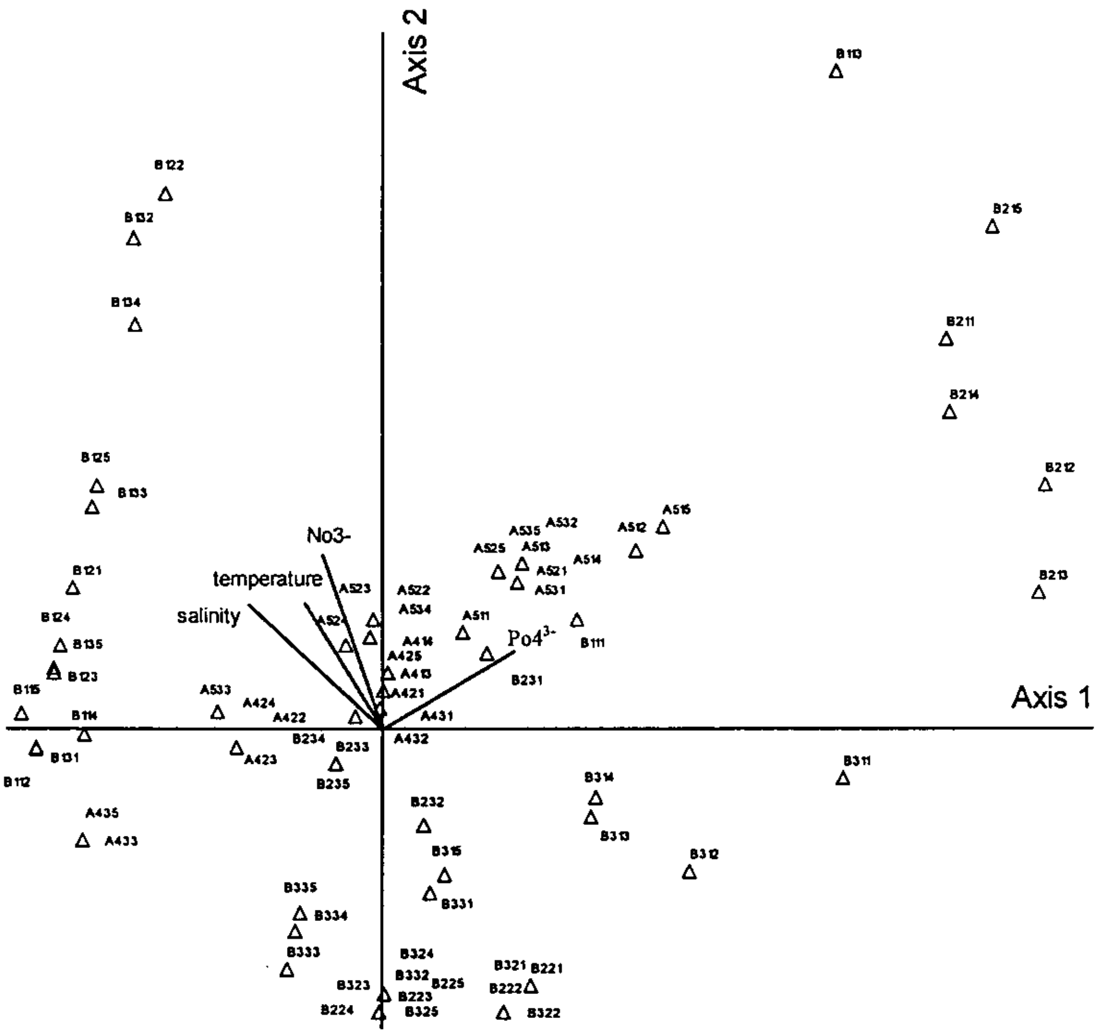


Figure 4 CCA result showing distribution of before(B) and after(A) tsunami sample sites and relation between sample site and environmental Conditions.