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The Effect of Sea Cucumber *Holothuria tubulosa* (G., 1788) on Nutrient and Sediment of Aegean Sea Shores

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Abstract: The effects of sea cucumber, *Holothuria tubulosa*, on sediment of hypereutrophic conditions were investigated. Research was designed as two groups with 3 replicates. And data determined from sea cucumber groups were compared to that of the control. Water samples and sediment samples were analyzed three times in a week with respect to nitrogenous materials and organic carbon. The differences between the initial and final concentrations of % C, ammonium, nitrate and nitrite were significant ($p<0.05$) at the end of the 84 days of experiment. The data from the present study showed that sea cucumber played an important role in the refreshing of sea water. Therefore, it can be suggested that sea cucumbers might be successfully used for the improvement of coastal regions especially in the areas with fish farming.

Key words: *Holothuria tubulosa*, nutrient, sediment, organic carbon, pollution

INTRODUCTION

Ahlgren (1998) reported that sea cucumbers consumed fouling debris with assimilation of amino acids and other organic matter at a rate of two to three folds more efficiently than their natural sediment diet and cleaned surface area on the nets. Therefore holothurians have been accepted as suitable model organisms for the study of feeding and nutrient recycling of sediment feeders (Uthicke, 1999). Moriarty *et al.* (1985) and Uthicke (1999) reported that benthic microalgal production and biomass might be reduced by high holothurian densities, feeding activity in natural densities was also beneficial for the sediment microalgal community due to the ammonium and small amounts of phosphate excreted from the holothurians (Uthicke and Klumpp, 1997; Mukai *et al.*, 1989; Uthicke, 2001a, b). Similarly, it was showed that enhancement of microalgal communities was caused by ammonium level excreted from holothurians (Uthicke, 2001a; Uthicke and Klumpp, 1997).

Kitano *et al.* (2003) reported that feeding and movements of sea cucumbers on the sea bottom recovered the bottom conditions and increased the number of diversity of species by inhibition of anaerobic conditions. It was also reported that extirpation of sea cucumbers caused hardening sea floor, eliminating habitat for other benthic and infaunal organisms (Bruckner *et al.*, 2003).

It is known that intensive aquaculture farming has negative effects on the production environments such as depletion in oxygen rate by fouling debris and algal bloom due to high nutrients results in eutrification in enclosed seas (Nixon, 1995; Yank and Atamanalp, 2001). Therefore, this study was conducted to investigate the effects of *Holothuria tubulosa* on nutrient concentration in water column and organic carbon (C %) in sediment collected from shores of Aegean Sea under laboratory conditions.

MATERIALS AND METHODS

Holothuria tubulosa (Gmelin, 1788) with 65.41±0.20 g was collected from Izmir Bay in November 2004 in Turkey. Sea cucumber samples were transferred to the Marine Laboratory of Fisheries Faculty of Ege University. After one week acclimatization period, experiments were performed in glass aquaria sized as 73×32×30 cm with three replicates for 84 days. The aquaria were laid with organically rich sediment namely black sediment with 5 cm height and lighted 12 h intervals. Sediments were sieved by using a 1 mm mesh to remove large particles. Aquaria were supplied with 180 L filtered sea water and air stones. Each aquarium included four sea cucumbers and its pH, salinity, dissolved oxygen and temperature was monitored daily. Control aquaria did not included sea cucumbers. Sea cucumbers were weighted with the 0.01 sensitivity. Sediment samples and water samples were taken three times in a week. In figures measures were showed as mean value. Organic carbon (C%) of sediment was analyzed according to Gaudette *et al.* (1974). Chlorophyll-a concentration with flourometer; salinity with Mohr-Knudsen method; nutrient determination with manual spectrophotometric method were performed on water samples (Strickland and Parsons, 1972; Egemen and Sunlu, 1996). Percentage

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saturation was calculated by DO, pH and temperature parameters (Benson and Krause, 1984).

Statistical analyzes: Data were recorded and analyzed on Microsoft Excel and SPSS 11.0 software. Goodness of feet was applied for normal distribution. Mann-Whitney U-test was performed for statistica evaluation.

Regression analysis using least square method was performed on the data has exponential variations in the graphs of C % against t (time) to calculate organic matter consumption rate.

RESULTS

Wet weight of sea cucumbers were increased from 65.41±0.20 g to 69.16±0.23 g. Mean water dissolved oxygen, temperature, salinity and pH values from the aquaria with sea cucumber and without sea cucumber 6.95±0.30, 5.84±0.51 mg L^{-1}, 20.91±0.27, 20.92±0.28°C, 38.88±1.91 and 38.89±1.95 ppt, respectively.

Significant differences were determined between aquaria with respect to % saturation, pH and chlorophyll-a ($p<0.05$) (Fig. 1).

In control aquaria, ammonium concentration decreased for the first 21 days of the experiment but after that stabilized. Nitrite concentration increased during 14 days, but decreased slightly after first two weeks and stabilized starting from end of 4th week. Nitrate concentration was always under the limits (Fig. 2a).

In aquarium containing sea cucumber, ammonium concentration significantly decreased ($p<0.05$) and stabilized the second half of experiment period. While ammonium concentration was rapidly decreasing, nitrite concentration was increasing vice versa. Similarly, nitrite concentration was rapidly decreasing; nitrate concentration was increasing (Fig. 2b).

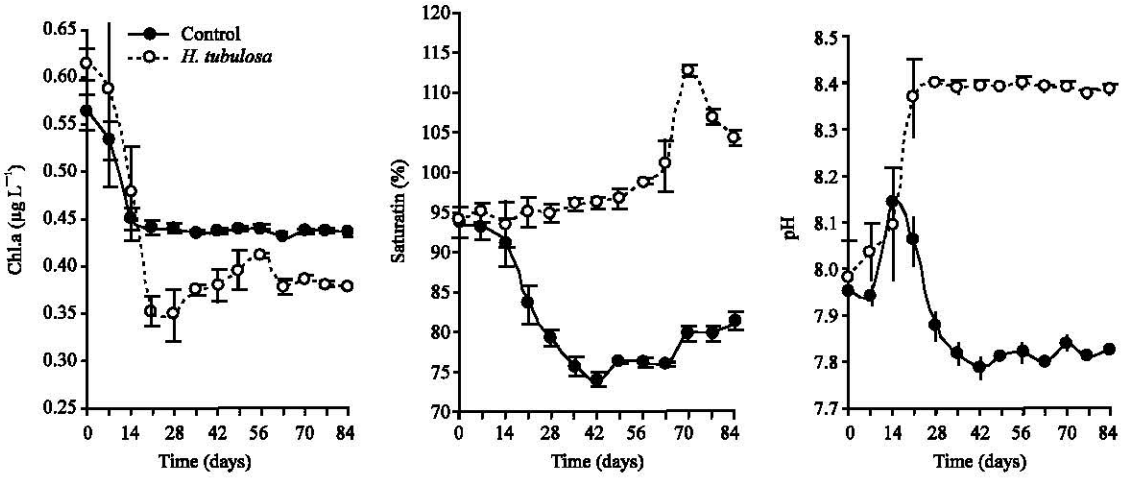

Fig. 1: Changes in chlorophyll-a, saturation and pH (mean±SD) values of a hypereutrophic medium during the 84 days of the experiment

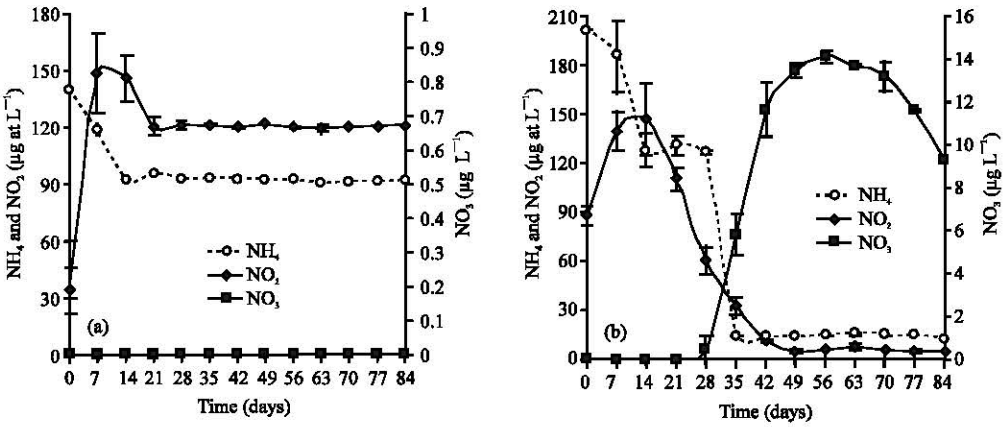

Fig. 2a, b: Changes in ammonium, nitrite and nitrate (mean±SD) values of a hypereutrophic medium during the 84 days of the experiment. (a) without sea cucumber and (b) with sea cucumber

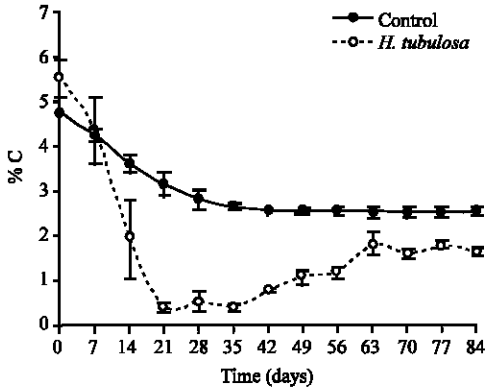

Fig. 3: Changes in organic carbon (mean±SD) values from sediment of hypereutrophic medium during the 84 days of the experiment

Organic matter of sediments (%C) of both aquaria showed significant differences ($p<0.05$). There was remarkable decrease in aquarium with sea cucumber in aspects of %C values. It decreased from 5.52% to below 0.5% (Fig. 3). Consumption rate of organic carbon was calculated as 0.211 day^{-1} ($R^2 = 0.9518$). It changed from 4.74 to 2.51% in control aquarium (Fig. 3). Consumption rate of organic carbon was recorded as 0.0192 day^{-1} ($R^2 = 0.928$).

DISCUSSION

Saturation and pH values were higher in aquarium containing sea cucumber than that of the control. The reason for this could be the movement and feeding of the sea cucumbers in the aquaria. On the other hand low saturation may be caused by the decomposition of organic matter in the control aquaria at the present study. It was reported that sea cucumbers were essential organisms of marine ecosystem which recover 90% of sea bottom biomass because of their detritus feeding activity (Higgins, 2000). Similarly, it was reported that the sea cucumbers prevented the formation of anaerobic conditions (Uthicke, 2001b; Kitano *et al*., 2003) by consuming high amount of organic matter inside the sediment (Moriarty, 1982).

Low chlorophyll-a content may be caused by their consumption by sea cucumbers. Moreover, it was observed that sea cucumber caused a reduction in the ammonium level by consuming organic matter of the sediment, by this way it was also able to prevent the excess production of algae by stabilizing chlorophyll a concentration. Unlikely, Uthicke (2001a) reported that one sea cucumber may enhance ammonium concentration for a short period of time over an area of nearly 0.2 $m^2 h^{-1}$ in an oligotrophic environment.

However, Uthicke and Klumpp (1998) reported that increase in ammonium concentration caused to 34% enhancement in gross and net production of the microalgal community. Since there were fluctuations in the nitrite and nitrate concentrations in the present study, increase of nitrite followed by ammonium increase may refer that there was nitrification in the environment. Decrease of nitrate concentration may refer that there was denitrification. Although, controversial results were reported, for instance, Uthicke and Klumpp (1998) reported that ammonium nitrogen increased in the oligotrophic areas with sea cucumber, Uthicke (2001a) reported that there were no significant contribution on the total nitrogen in the areas with *H. atra* and *S. chloronotus*. Therefore, *H. tubulosa* may accelerate nitrification by increasing ammonium and could decrease ammonium concentrations in hypereutrophic environment at the present study. Podamo (1975) reported that denitrification was the dominant process for muddy zones. Organic carbon was low compared to control in the aquarium with sea cucumber and increased after 35 days of the experiment. Organic matter consumption in control aquarium was only performed by bacteria.

Increasing of % C in aquarium containing sea cucumber may be coming from their sediment patch selectivity of *H. tubulosa* (Amon and Herndl, 1991; Scheiblauer and Reinthaler, 1998). Kitano *et al*. (2003) has emphasized that TOC (total organic carbon) has quietly decreased until 42nd day in the aquarium with sea cucumbers and it has increased in reversed trend after 84th day compared to the aquarium without sea cucumber.

Observing reductions in ammonium concentrations and accelerating nitrification and denitrification process with preventing formation of anaerobic conditions in hypereutrophic environment by *H. tubulosa*, it can be concluded that sea cucumbers can be successfully used for the improvement of coastal regions with fish farming. In other words, *Holothuria tubulosa* may both remove biological pollution and improve water quality in such areas. Therefore, a polyculture of fish and sea cucumber might be realized in future. However, considering the present data, further studies will be needed for the density determination in the natural environments.

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