A ONE-YEAR STUDY OF THE EFFECTS OF A HYPERHALINE DISCHARGE FROM A DESALINATION PLANT ON THE ZOOBENTHIC COMMUNITIES IN THE USTICA ISLAND MARINE RESERVE (SOUTHERN TYRRHENIAN SEA)

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Abstract

Sampling of the soft-bottom zoobenthic communities living near a hyperhaline discharge from a desalination plant was taken from November '96 to November '97 using a van Veen grab. The three stations being investigated showed significant differences in abundance. Major effects were recorded on polychaetes, crustaceans and molluscs decreasing in numbers at the diffuser site and on echinoderms which disappeared.

Key-words: zoobenthos, salinity, thermal pollution, Tyrrhenian Sea

Introduction

Since the end of November 1996, a desalination plant located in the Ustica Island (Southern Tyrrhenian Sea) has been furnishing potable water to the inhabitants. The plant operates through a thermal compression process: heated sea water flows through a pipe-line into an evaporator where a pressure of 0.185 bar maintains the boiling-point at less than 65°C, producing vapour (condensing in potable water) and discharging brine (70 ppt salinity, up to 3°C warmer than intake temperature) at a rate of 30.000 kg/h. The effects on benthic organisms near a brine disposal vary from changes in species composition and diversity (1, 2) to the total destruction of benthic communities (2). Various effects on marine organisms by discharge of heated effluents have also been reported (3, 4). The aim of this study was to assess the effects of the discharge on the zoobenthic communities surrounding the diffuser over a period of one year.

Materials and methods

The discharge diffuser is located at a depth of 50 m on a soft bottom characterised by strong currents. Three sampling stations were investigated: A) around the diffuser; B) 20-30 m away from the diffuser downstream; C) control site. Samples were collected in November '96, just before the plant was activated, and in July and November '97, following brine discharge. Five samples were taken at each station with a 0.1 m^2 van Veen sediment grab (5); the samples were washed on a 0.5 mm sieve and preserved in 5% formalin. Animals were identified to species and counted. Statistical analyses included comparison of sites (treatments) by analysis of variance, using total richness (R) and abundance (N) (5) computed for separate taxa (blocks: polychaetes, crustaceans, molluscs, echinoderms, sipunculans and others); ANOVA-test was repeated three times both for R and for N considering each sampling period; in order to get the observations homogeneous, R and N were weighed to one litre of sediment analysed. Shannon-Weaver diversity index (H') and evenness (J) were calculated for all stations (6). Summer and winter monitoring of temperature and salinity took place at the diffuser site, using a multiparameter probe IM 51 Idromar, before and after brine discharge was initiated. Particle grain size analysis was performed for all stations, expressed on the phi (ϕ) scale, where $\phi = -\log_2 (x)$ where x = particle size in millimetres.

Results

Mean temperatures and salinities at all stations, prior to hyperhaline discharge, were: 16-17°C and 37.9 ppt in summer; 13°C and 36.9 ppt in winter. Readings at station A, following discharge, were: 18-19°C and 49.6 ppt in summer; 16°C and 47.4 ppt in winter. The bottom was mainly composed of medium sand and characterised by the presence of encrusted Melobesiae, biodetrital and volcanic clasts, with the typical species of the biocoenosis of detritic sediments (7). A total of 310 taxa and 11.366 individuals have been recorded. In November '96 polychaetes were the most abundant group in terms of both N (43.1%) and R (48.1%), followed by crustaceans (23.3% and 30.3% respectively). Other groups were represented by low N and R values, except for sipunculans. The sipunculid *Aspidosiphon muelleri* Diesing was the dominant species at all stations; the polychaete *Lysidice ninetta* Audouin & Milne-Edwards was also well represented. During '97 summer and winter seasons, main differences were found at station A with the lowest values being recorded for all groups examined, whereas stations B and C showed closer indexes values. In July '97, echinoderms were absent at station A and the dominant species were *L. ninetta* and *A. muelleri*. In November '97, the station A was dominated by the polychaete *Pisione remota* (Southern) (18.5%) whereas *A. muelleri*, dominating the other two stations, nearly disappeared (2.3%) and occurrence of *L. ninetta* decreased at all sites. Prior to the activation of the plant, all stations recorded quite similar H' values (H'= 3.8); after its activation, station A showed the lowest value (H'= 3.2) whereas the other sites mainteined the initial value. Evenness resulted similar at all sites and seasons (J= 0.7-0.8). ANOVA-test computed for N during winter '96 showed no relevant differences among sites: the observed value (F= 1.99) is less than critical value ($F_{2,10}$= 4.1) for $p \leq 0.05$. On the contrary, major differences were recorded both in summer '97 (F= 9.27) and in winter '97 (F= 25.4). Few differences were noted among sites for R: statistical test values were very close to critical value, for $p \leq 0.05$.

Discussion

Analysis of benthic communities showed that, after one year, the hyperhaline and heated plume affected the organisms living near the diffuser. Major effects were recorded on abundance that decreased at the discharge site for all the groups examined; particularly, crustaceans, molluscs and echinoderms nearly disappeared. Although statistical analysis computed for richness did not differ significantly among sites, it should be remarked that very few species were found near the active diffuser, especially among crustaceans which decreased in numbers during both summer and winter seasons, compared to those recorded at other sites. Differences in H' values were very low; furthermore, the high values of J at all sites indicated a good distribution of the individuals among species. No relevant effects on benthic communities were noted at station B as the hyperhaline plume dilutes itself in a very few meters from the discharge mouth. The most represented polychaete *L. ninetta* seemed not to be directly affected by salinity changes. Its presence is related to that of Melobesiae in which the species lives (7). Moreover, this species has been found living inside *Posidonia oceanica* scales (8), suggesting this borer's ability to adapt to particular conditions. The dominance of *P. remota* confined only to the diffuser site in winter '97 could suggest this species suits well to the high salinity and temperature being here recorded.

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