THREE YEARS STUDY OF BENTHIC COMMUNITIES ON AN ARTIFICIAL REEF IN CANARY ISLANDS

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ABSTRACT

An artificial reef was constructed in the southern coast of Gran Canaria Island (Canary Islands, Spain), with the aim to increase coastal fisheries. The artificial reef complex is compossed of 84 modular concrete blocks of five different designs, which are distributed in five separated groups. The biological assessment was carried during the last three years between November 1991 and December 1994. A comparative study of associated communities was done with Scuba diving methods. Samples of benthic invertebrates, macroalgae and fishes were obtained in the artificial reef and in a close natural reef.

This study define several stages in the succesion and dynamics of benthic communities, as well as the use of the different species in each type of module. Four main succesional stages were determined: Initial colonization, Structuring stage, Bloom of sea urchin population and Stabilization stage. Although fisheries activities were prohibited during the first 3 year after deployment, the use of non-selective fisheries technics in the area interrupted the natural dynamic, modifing the community structure. During the last 13 months, a long spined sea urchin proliferation has occupied the modules, eliminating the vegetal and animal cover, changing food and refuge availability, biodiversity, etc.

INTRODUCTION

n recent years, several artificial reefs have :en constructed in the Canary Islands with the ain oibjetive of increasing the production of)astal fisheries [1]. Most of these reefs were)ne with the financial support of the European nion. Among them, one artificial reef complex ith 84 concrete modules was deployed at 20 m epth and 2.2 miles from coastline in the outhern coast of Gran Canaria Island. Before ie deposition of the concrete blocks, a ceanographical and biological assessment of the elected area was carried out between November 990 and March 1991, in order to obtain the)aseline level of the overall area [2]. After the leposition of all modules, three-years study of he benthic communities associated was done)etween Nov-'91 and Feb-'95. In this :ontribution, the main results about the succesional stages and dynamics of the major benthic communities is presented, specially those related with benthic macroinvertebrates and fishes.

2. METHODS

The conditions of the different modules were prospected using SCUBA equipments. Benthic communities of macroalgae and macroainvertebrates were sampled with respect of mean cover, density, individual size, etc. The fish communities in the modules were estimated using the visual census technique of the point-count; the number and size per specie during five minutes in an area of 100 m^2 including a module were annotated in PVC tables [3 & 4]. Qualitative data of fishes and invertebrates were also obtained with video image and underwater pictures. The analytical process of the crude data was done with CSS Statistics Package, using a 486 PC.

3. RESULTS

The process of the succession seen on the reef complex along the study period can be differentiated in fundamentally four main stages (Fig. 1) [5]:

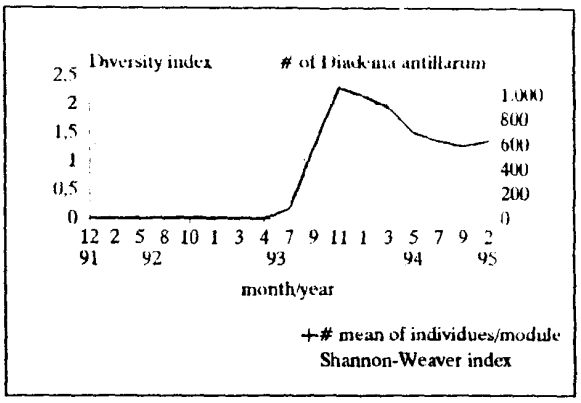

Fig.1.- Variation of the Shannon-Weaver Diversity Index of Macroinvertebrates and mean number of sea urchin (Diadema antillarum) per module along study period.

Initial stage of colonization: After placement of the blocks at the sea floor, a variaty of sessile organism began to develop on the block surfaces, starting with some crustose species of briozoans and diverse hidrozoans, and followed later by tunicates and sponges which covered most of the surfaces. These animals created a rugged substrate more suitable for the development of more complex benthic communities.

The first non-sessile macroinvertebrades arriving at the reef were generally opportunists, having good living conditions because this type of substrate offers an abundant and varied range of food, and is a place with few competitors and predadors. During this first phase, the developing communities are characterized by a low complexity, with scarce number of species, and each of these only represented by few individuals. The principal species dominating the reef in this stage, are the sea urchin D. antillarum, the polychaet Hermodice carunculata, and the crustaceans Stenorhynchus lanceolatus and Dardanus callidus.

Structuring stage: From spring '92 the arrival of new species resulted in more complex and structured benthic communities. The great abundance of macroalgae and animals on the blocks gave good living conditions resulting in great enhancement of the diversity and the number of individuals that each block was capable of supporting. The opportunists species, which were characteristics during the previous phase, were displaced by other species more specialized in using certain resources of the reef, like numerous species of mollusks and crustaceans. The development of more complex trofic relationships allowed better use of the resources of the ecosystem, providing a greater quantity of food for the different populations of fishes.

Bloom of Diadema antillarum populations stage: The communities developing after the summer '93, were completely conditioned by the exponential increase of the populations of the long-spined sea urchin D. antillarum (Phillipi, 1845) (Fig. 1). The mean number of this amphiatlantic species per block increased from approximately 6 in April '93, to 80 in July, further to 600 in September and ending at a level of more than thousand individuals per block in November the same year. This rapid development was favoured by the coincidence of three factors: Occurence of illegal over-fishing taking place on the reef eliminating many of the predators and food competitors of this sea urchin; elevated recruitment of juvenile D. antillarum that took place this summer; and the abundant algae cover giving sufficient food to sustain the growth of the newly settled individuals.

As a consequence of the increased populations of this herbivore the macroalgae cover and most of sessile invertebrates dissapeared completely, resulting in decreased primary production, which again affect all the following links in the food chain. The scarcity of food and of refuge offered by the bare blocks, provoked a disappearance of many species and a drastic decline in number of individuals of the remaining, such as Symphodus mediterraneus, Coris julis, etc.

However, the increased number of sea urchins favored population growth of some other species, by eliminating competitors and predators, such as hidrozoans, or by offering individuals refuge between the spines of the sea urchin, which many small crustaceans and juvenile of several fish species can take advantage of.

Stabilization stage: The increase of the sea urchin populations stopped at the beginning of '94, when they have eliminated completely their main food source, the macroalgae cover, and when the thin vegetable film developing on the algae free block surfaces was insufficient to maintain the elevated sea urchin biomass. Nevertheless, sea urchin densities in the order of 600 ind/block, is still so high that the growth of macroalgae is hindered as well as the development many species of invertebrates.

At the end of this study the ecosystem on the artificial reef is much alike as those observed in over-fished rocky bottoms around all the Canary Islands: the "Blanquizal". This type of communities is characterized by the dominance of D. antillarum, the practically total absence of vegetable cover, and the development of certain populations of invertebrados favored by the high densities of the sea urchin, for example the spidercrab Stenorhynchus lanceolatus. With respect to the diversity of organisms associated with the concrete modules, an average number of 26 fish species were observed in the reef area. The number of Osteichthyes species showed a strong increase compared with the preliminary study. Apart of the resident species, there are a small group of pelagic fishes, i.e. Seriola spp., Atherina presbyter and Boops boops, that are temporally aggregated around the reef area and occupied the water column. Some resident species (Chromis limbatus, Apogon imberbis and Canthigaster rostrata) and others not resident species (Atherina presbyter) utilized the modules as a nursery area.

A regular survey of the reef conditons is needed in order to determine the long-term effect of

such structure in the shallow subtidal bottom.

4. CONCLUSIONS

The module size and the variety of designs are primary parameters that seem to determine differences in the abundance and number of benthic species between modules in the beginning of the colonizations.

The increment in the number of fish species after the reef deposition is obviously related to the introduction of a hard substrate that facilitate the appearance of rocky bottom species.There are significant differences in the use of each module by fish species.

The production effect of the artificial reef complex was masked due to illegal fishing activities and the small surface ocuppied by the reef modules.

The aggregation effect was enhanced, specially for some coastal pelagic species, which were easily catch by local fishermen.

An increment in the volumen of the reef comnplex seems to be necessary to enhance its effects in coastal fisheries.

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