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ENVIRONMENTAL DESCRIPTION OF AN ARTIFICIAL REEF SITE IN GRAN CANARIA (CANARY ISLANDS, SPAIN) PRIOR TO REEF PLACEMENT

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ABSTRACT

An artificial reef complex was built on the southern coast of Gran Canaria Island (Canary Islands), with the financial support of the Archipelago Autonomous Government. This artificial reef is composed of five separated units, each of them with different types of modular concrete blocks. Between November 1990 and March 1991, before the deposition of the concrete blocks, an oceanographic and biological assessment of the selected area was carried out which included oceanographic and SCUBA sampling at the artificial reef site, the coastal rocky bottom and a nearby sublittoral natural reef. The results obtained allowed us to make a bionomical chart of that coast and to characterize the entire area as oligotrophic, in the oceanographic and biological sense. Nutrient concentrations were low. Benthic communities were composed of different species of green algae and few live invertebrates were observed. The ichthyofauna was diverse, but with a low biomass.

With the financial support of the Canarian Archipelago Autonomous Government, an artificial reef complex was constructed on the southern coast of Gran Canaria Island. This artificial reef is comprised of 82 modular concrete blocks, with different designs of 1.2–5 mt in weight, 0.8–2.00 m in height and grouped in five separate units.

Before the deposition of the concrete blocks, a environmental evaluation of the selected area was carried out by an inter-disciplinary team. The study included oceanographic and SCUBA sampling in the artificial reef area, on the coastal rocky bottom and on a nearby sublittoral natural reef.

We present the data collected, both oceanographical and biological, to obtain a baseline level of the overall area for future comparative purposes. Until now, the area studied was characterized by typical soft bottom communities.

METHODS

The study area is located near the southern point of Gran Canaria Island (Faro Maspalomas) (Fig. 1). The area climate is very dry with sparse rain runoff. The topographic profile was obtained with a FURUNO echo sounder that revealed a flat platform of organic sand-sediments between 17 and 21 m depth. Water samples were taken in triplicate at different depths (0, 5 and 15 m) with Niskin bottles provided with a manual device for nutrients and planktonic samples. Collections were made in January and February 1991. Nutrient samples were stored in polyethylene bottles, previously cleaned with 0.1 M HCl and analyzed after filtration with 0.45 μm filters. Nitrate, nitrite, phosphate and silicate were spectrophotometrically measured using conventional methods (Grasshoff et al., 1983) with 10 cm cells. The isoconcentration lines of nutrients were obtained using a computer numeric program (SURFER vs. 4.11) for both type samples. Light penetration profiles were obtained twice with a LICOR underwater spherical sensor (192SA) and a datalogger both in December 1990 and March 1991.

Three main habitats can be distinguished: (1) the rocky coastal area (0–6 m depth) with an intertidal zone rich in tide-pools and a sublittoral zone with big boulders; (2) the sandy bottom (6–40 m depth), composed of organic white sand; and (3) an isolated natural reef (16–20 m depth) close to the artificial reef site, which is made of a rocky platform that protrudes 2–3 m above the sandy bottom.

The communities surveyed with SCUBA in these habitats included benthic and demersal populations of fishes, invertebrates and marine plants. The SCUBA samples were taken monthly between December 1990 and March 1991. Fish populations were estimated using a line transect method of 10

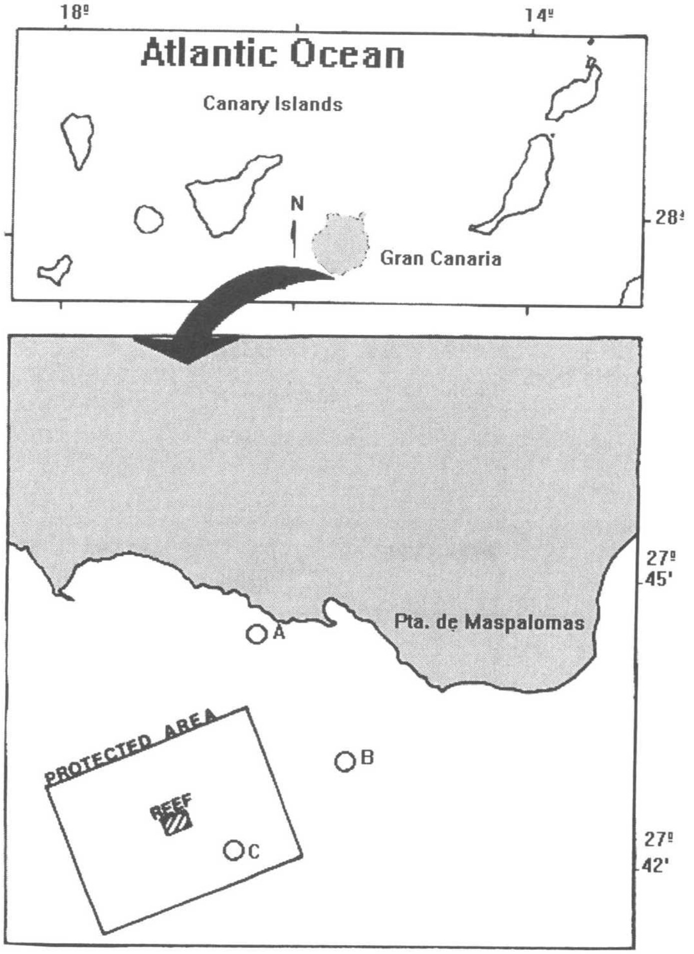

Figure 1. Location of the study area. (A) coastal zone; B) natural reef zone; (C) sandy bottom zone.

min duration in an area of 100 m^2 (Bortone et al., 1986; Bortone et al., 1989). Fish sizes were sorted in three classes: small (postlarva stage), medium (juvenile stage), and large (adult stage). Invertebrates were identified and collected in the different habitats randomly along linear transects. Sediment samples of 5 cm thickness were taken with a PVC core tube (10 cm diameter) every 3 min in a linear transect 50 m in length. Marine plants were mainly identified in situ and a voucher sample of each species was collected (Taylor, 1960; Børgesen, 1925–1930; Afonso-Carrillo and Sansó-Acedo, 1989). Percentage coverage of plants was calculated from a 25 × 25 cm square used randomly.

Presence-absence data of fishes and invertebrates were also obtained with video image and underwater pictures.

RESULTS

The bottom where the artificial reef will be placed is uniform in depth (18–20 m); the substrate is organic white sand, rich in detritus of mollusc shells, echinoderm skeletons, and coralline calcareous boulders. The topographic profile remains almost unchanged up to several miles from the coast, where an underwater cliff marks the end of the island platform.

Figure 2 shows the surface distributions of nitrate, phosphate and silicate, as

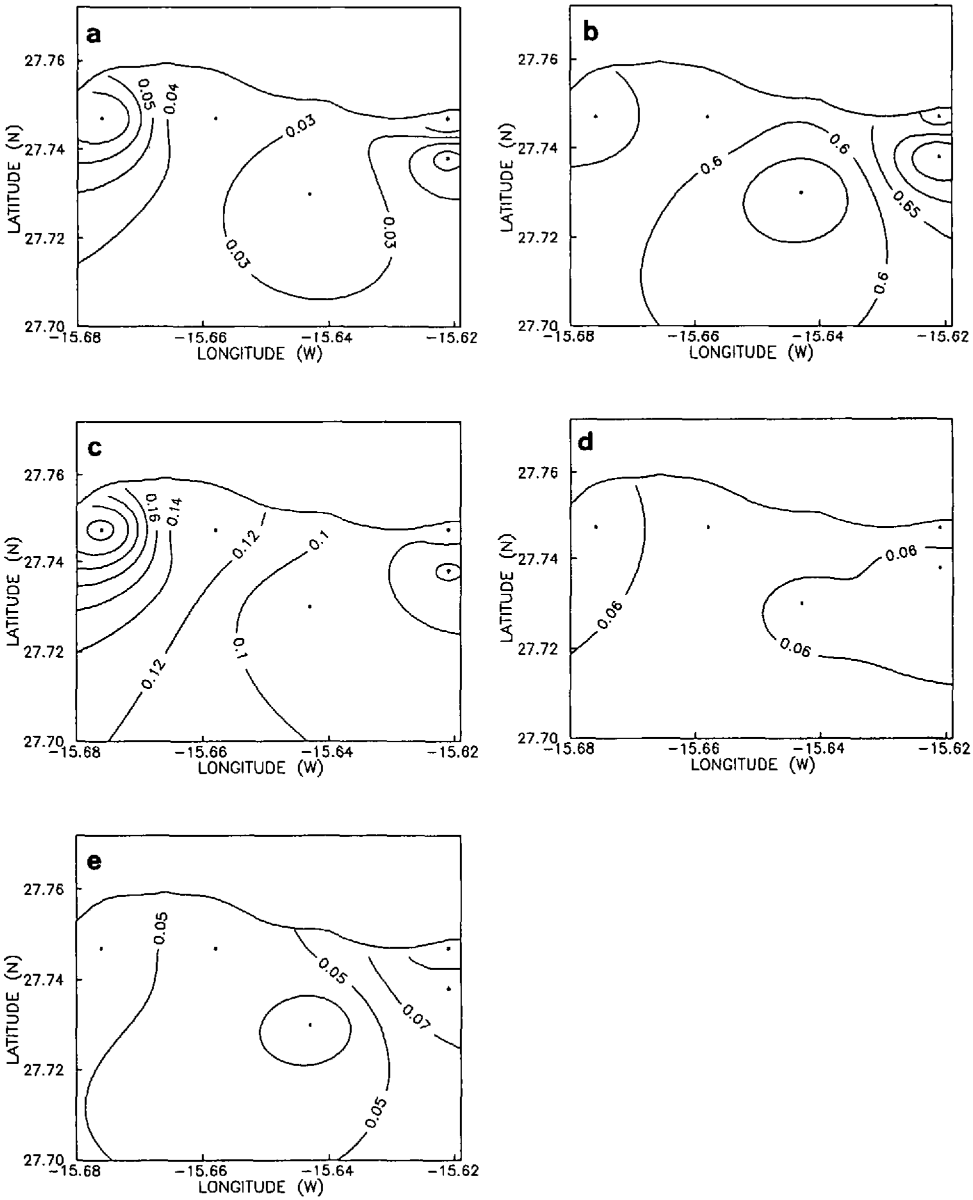

Figure 2. Nutrient distributions in the study area. a) Phosphate in surface; b) Silicate in surface; c), d) and e) Nitrate in surface, 5 and 15 m depth respectively.

well as nitrate distribution at 5 and 15 m depths. Concentrations of all nutrients were low, typical of clean oligotrophic waters. Ranges varied between 0.009–0.25 μM for nitrate, 0.47–0.7 μM for silicate, 0.0083–0.08 μM for phosphate and 0.017–0.035 μM for nitrite.

Light profiles obtained in December and March were quite similar (Fig. 3). PAR attenuation in the study area is very low, reflecting the high transparency of the coastal waters. These profiles indicated that in December the PAR attenuation

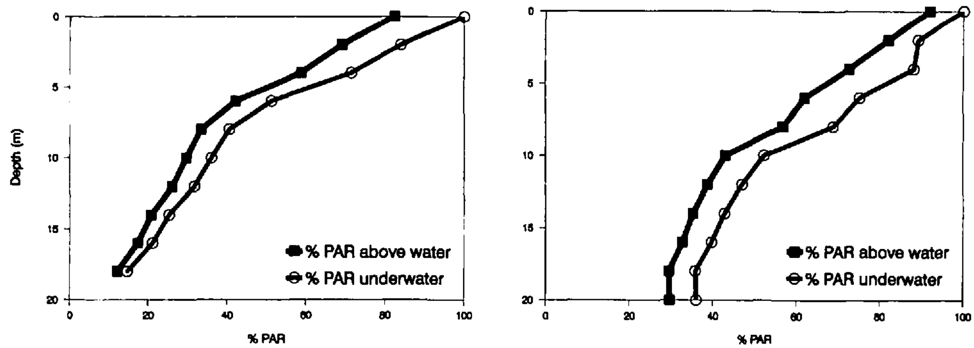

Figure 3. Light penetration profile in the study area (PAR = Photosynthetic Active Radiation). Left: December 1990; Right: March 1991.

was more pronounced as the consequence of higher particulate matter concentration in the water column.

Figures 4 and 5 show the number of species of macroalgae and invertebrates, respectively, present in the different habitats. With respect to marine plants, seagrass was only observed at the artificial reef site, whereas red algae were dominant in the coastal zone.

Finally Table 1 lists the ichthyofauna observed during the line transects.

Discussion

The depth distributions of different nutrients are similar. Input of particulate material from the Island did not appear to influence concentrations of nutrients of this zone. Some sampling stations close to land showed limited influence from anthropogenic nutrient sources of urban sewage (see Fig. 2 for $PO^{-3}{}_4$, $NO^-{}_3$). In spite of these small inputs, there was no general enrichment in the studied area. Results indicate that nutrients are used quickly by organisms and algae in the area, remaining at low levels in the water masses. From these observations, it would be advantageous to increase the primary production in the reef vicinity by artificial fertilization.

The low levels of phytoplanktonic biomass and the comparatively high levels of zooplanktonic biomass characterize the waters around the Canary Islands, especially in the lee side of the islands (Hernández-León and Miranda-Rodal, 1987).

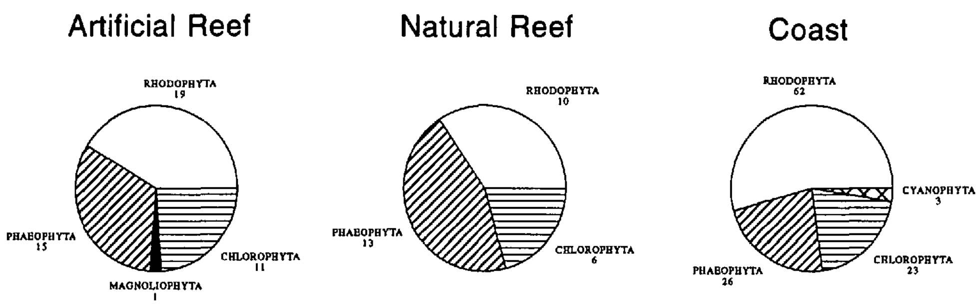

Figure 4. Abundance of marine plants, grouped by divisions, in the different habitats. The number of species observed is quoted below each division.

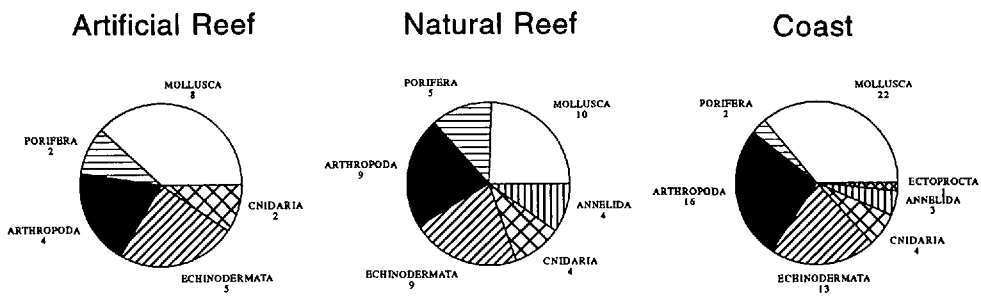

Figure 5. Abundance of invertebrates, grouped by phylum, in the different habitats. The number of species observed is quoted below each phylum.

The secondary consumers exert a strong grazing pressure on primary productivity and, therefore, the values of chlorophyll and other pigments remain rather low.

The comparison of the species lists among the habitats surveyed, shows a rich soft bottom infauna at the artificial reef site, typical of sandy substrates, in which the equinodermata *Ophiopsila aranea* represents a new record for the Canarian Archipelago. The high diversity of invertebrate organisms observed in both the coastal zone and the natural reef zone indicates the potential benthic communities that would develop on the nearby artificial substrate.

The number of macroalgae present in the study area is more diverse in the coastal zone, whereas the two sublittoral zones are dominated by few species. In the coastal zone, the availability of different habitats (tide pools, hard and soft substrates) may enhance the growth of more green, brown and red algae than the sublittoral environment. The organic substrate of the artificial reef site is more suitable for the growth of green algae, mainly species of Siphonales; the rocky bottom of the natural reef zone is colonized by few red and green algae. Light profiles revealed that sufficient amounts of PAR reach the sandy bottom to sustains the growth of macroalgae, but the absence of available substrate limit their presence.

With reference to the composition of fish species, the class Osteichthyes has the highest species diversity in the area of the natural reef compared to the coastal zone and the artificial reef site, which is the least diverse presumably due to the low availability of food and/or refuge. However, the hard bottom ecosystems of this area, when compared with similar ones, show the absence of some characteristic species of the families Sparidae and Serranidae, probably due to overfishing for these species. On the other hand, fishes of the class Chondrichthyes show a great diversity in the artificial reef site, higher than in the natural reef, and were not observed close to the shore.

It seems that the main factor that controls the size structure of the fish populations in the area is seasonality. During late winter and early spring, juveniles of some Sparidae species are located in shallow water close to the shore, associated with the characteristics of the available food and water temperature.

The proposed reef site is characterized as an oligotrophic area with very few planktonic and benthic species. The benthic communities are better represented in the coastal zone presumably due to the availability of different habitats.

The construction of an artificial reef may enhance the bloom of planktonic communities as well as concentrate the dispersed ichthyologic biomass. A survey program will be needed to evaluate the effect of the artificial reef construction.

Table 1. List of fishes present/absent in the different habitats prospected. S = small (postlarvae); M = medium (juvenile); L = large size (adult), and – = Absence.

	Coastal zone	Natural reef zone	Artificial reef zone
Class Chondrichthyes			
Fam: Rajidae			
Raja sp.	–	–	L
Fam: Dasyatidae			
Taeniura grabata	–	L	–
Fam: Myliobatidae			
Myliobatis aquila	–	–	L
Fam: Squatinidae			
Squatina squatina	–	–	L
Fam: Triakidae			
Mustelus mustelus	–	–	L
Class Osteichthyes			
Fam: Apogonidae			
Apogon imberbis	L	M, L	–
Fam: Blennidae			
Ophioblennius atlanticus	L	–	–
Fam: Bothidae			
Bothus podas	–	–	L
Fam: Congridae			
Heteroconger longissimus	–	–	L
Fam: Labridae			
Centrolabrus trutta	L	–	–
Thalassoma pavo	L	L	–
Xyrichthys novacula	–	–	S, M, L
Fam: Monacanthidae			
Stephanolepis hispidus	–	L	L
Fam: Muraenidae			
Gymnothorax maderensis	–	L	–
Muraena augusti	–	L	–
Fam: Pomacentridae			
Abudefduf luridus	L	S, M, L	–
Chromis limbatus	L	M, L	–
Fam: Scorpaenidae			
Scorpaena maderensis	M	L	–
S. scrofa	–	L	–
Fam: Scaridae			
Sparisoma cretense	S	S, M, L	–
Fam: Serranidae			
Serranus atricauda	L	L	L
Fam: Soleidae			
Solea vulgaris	–	–	L
Fam: Sparidae			
Boops boops	L	L	L
Diplodus vulgaris	M	L	–
D. cervinus cervinus	M	–	–
D. sargus cadenati	M	L	–
Lithognathus mormyrus	S, M	–	–
Spondyliosoma cantharus	–	L	L
Fam: Sphyraenidae			
Sphyraena viridensis	–	L	–
Fam: Synodontidae			
Synodus saurus	L	–	L
S. synodus	–	L	–
Fam: Tetraodontidae			
Canthigaster rostrata	S	S, L	–
Sphoeroides spengleri	L	L	L
Fam: Trachinidae			
Trachinus draco	–	–	L

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