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PRESENCE OF *CORALLIUM RUBRUM* ON CORALLIGENOUS ASSEMBLAGES BELOW 50 M ALONG CALABRIAN COAST (SOUTH ITALY)

ABSTRACT

The presence of red coral, Corallium rubrum *(Coralliidae, Gorgonacea) was reported during a monitoring study on biodiversity of hard bottom substrata along the coast of Calabria. A total of 52 transects at depths ranging between 50 and 200 m were surveyed by means of a Remotely Operated Vehicle (ROV). The ROV was equipped with a digital camera and with two laser pointers placed 10 cm apart and used as metric scale. We found colonies in 20% of the surveyed areas. Red coral is endemic to the Mediterranean Sea and it is one of the key engineering species of coralligenous assemblages. Due to its high commercial value it has been long overexploited and it is now a protected species. Although mixed-gas diving systems can extend the SCUBA range to slightly more than 100 m, there were very little quantitative information on populations deeper than 50 m. Quantitative data on the spatial distribution and population structure of the red coral along the southern Tyrrhenian and Ionian coasts of Calabria were collected. Colonies have been photographed and filmed. Presence, patch frequency, density, and parameters describing colony morphology were recorded. Red coral was observed between 70 and 130 meters depth. On rare occasions the presence of larger colonies (about 20 cm high) was recorded. More often we found smaller colonies (about 1 - 6 cm high), which showed only rudimentary branching patterns (primary and secondary branches). The presence of some dead colonies was also recorded.* C. rubrum *colonies were generally single or grouped in small patches of 3 – 4 specimens. Only in the southernmost area we found that this species was the dominant component of the coralligenous zone with a maximum density of ~ 90 colonies/m^2.*

KEY-WORDS: *Corallium rubrum*, coralligenous, ROV, Southern Tyrrhenian and Ionian Sea.

INTRODUCTION

Octocorals play an important role in marine ecosystems as they add three dimensional complexity to the habitat and consequently increase biodiversity (Thrush & Dayton, 2002). The Mediterranean red coral (*Corallium rubrum*, L. 1758) is a characteristic gorgonian living in the coralligenous assemblages, even if belonging to the semi dark caves biocoenosis (Ros *et al.;* 1985). It is a sessile cnidarian whose polyps formed arborescent colonies, which can reach a height of 50 cm (Garrabou & Harmelin, 2002). This long-lived species has been commercially harvested (for the use of its red calcium carbonate skeleton in the jewelry industry) since ancient times (Tescione, 1973), and during the last decades it has become evident that it was overexploited (Santangelo & Abbiati, 2001; Cicogna *et al*., 1999). Due to its commercial and ecological value, the biological information on the species increased noticeably during the last decades, but its ecolological information was still limited (Santangelo & Abbiati, 2001). Although it was well known that red coral was an eurybathic species dwelling between 5 m (within caves) down to 400 m depth (Zibrowius *et al*., 1984; Chintiroglou & Dounas-Koukouras, 1989), there was little quantitative information on distribution and population structure deeper than 50 m. (Rossi *et al.*, 2008). Few ecological studies of these deep-water environments have been conducted because of the logistical difficulty of working at greater depths (Genin *et al.*, 1992; Spalding *et al*., 2003). Most coral reef science was performed well within the depth limit of recreational scuba diving (Kahng & Kelley, 2007). The recent use of enriched air Nitrox SCUBA to extend sampling time at 50 m and the advent of Remotely Operated Vehicles (ROVs) with high-resolution images and the capability to collect samples, provided an opportunity for controlled sampling in situ and detailed observation of specific deep-water habitats. (Mortensen & Mortensen, 2004; Spalding *et al.*, 2003).

This study was part of a marine biodiversity monitoring project on hard bottom macrozoobenthos in the 50-200 m depth range conducted by ICRAM in the coastal waters of Calabria (South Italy) by means of a ROV. The lack of studies on deeper populations limited our understanding of coral ecology and the possibility of proposing a realistic management plan for harvesting this species (Rossi *et al.*, 2008). Thus the objective of this study was to increase the knowledge on the, distribution and ecology of red coral, giving information about presence, density, and morphometry of red coral colonies below 50 m.

MATERIALS AND METHODS

Twelve sites along Tyrrhenian and Ionian coast of Calabria were investigated by means of ROV during summer 2007 and 2008. A total of 52 ROV transects on hard substrate were realized between 50 and 200 m depth. Data were carried out by a photographic sampling along random transects. Every distinct group of colonies (patch) encountered were photographed by the ROV's digital camera (Nikon D80, 10 megapixel). In the case of patches larger than 1 square meter (visual estimation) more replicates were taken. The number of photos collected was proportional to the number and extension of patches. The photos were processed with Image J software (http://*rsbweb.nih.gov/nih-image*), using as scale reference two red laser dots distant 10 cm apart, to describe colony density and morphometric characters, basal diameter, height width and branching pattern, as described by Tsounis (Tsounis *et al.*, 2006a). Furthermore, the orientation (0°, 45°, 90°, 135°, 180°) of the colonies was recorded following the scheme suggest by Rossi (Rossi *et al.*, 2008) (Fig. 1). This method allowed us to obtain an extensive set of data in a non-destructive way. Although it provided only limited precision, this method was found to be suitable for the scope of this study. The number of colonies with a diameter of more than 7 mm (Tsounis *et al.*, 2006a) was also determined, as well as the number of colonies taller or shorter than 10 cm (Tsounis *et al.*, 2006b).

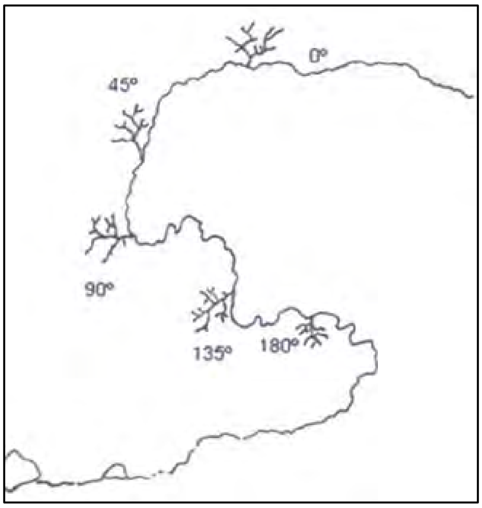


Fig. 1: Colony orientation (modified from Rossi *et al.*, 2008)

RESULTS

The presence of red coral was recorded in 12 transects, located in three different areas (Fig. 2), two in the Tyrrhenian Sea and one in the Ionian Sea. These areas were characterized by different environmental conditions and associated fauna.

- Area A**:** within Lamezia Gulf, was characterized by banks or boulders of 1 to 5 m height separated by soft substrata, water depth between 70 and 130 m. During winter, terrigenous input from rivers was present in the area. Hard substrata was colonized by encrusting red algae, bryozoans and sponges. Depending on depth, different gorgonians took up the three dimensional space: *Paramuricea clavata* (until 80 m), *Acanthogorgia cf. hirsuta, Eunicella sp.* and *Callogorgia verticillata.* Here the red coral colonies often were sparse and we observed that ~ 16 %

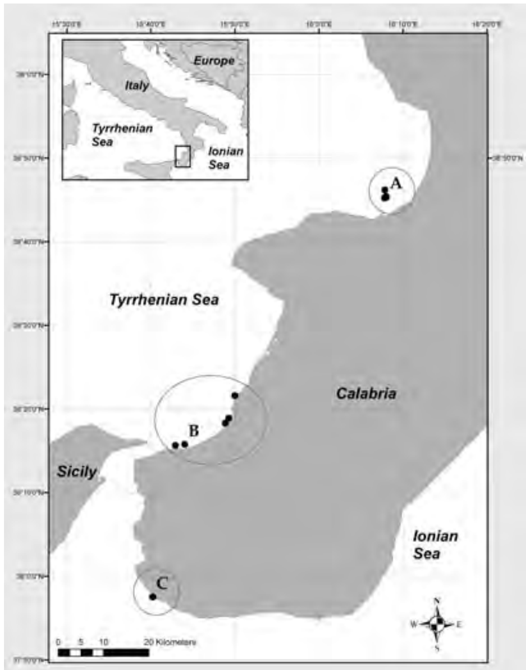


Fig. 2: Study area

(generally larger size) were dead.

- Area B: Coastal area from Palmi to Scilla, where vertical cliffs from the surface down to the sea-floor were influenced by the strong currents of the Messina Strait. Here the assemblages were constitutes by sponges, echinoderms (*Hophidiaster hophidianus, Hacelia attenuata)*, sea-urchins of genus Cidaridae and gorgonians (*Eunicella cavolinii* and *P. clavata*). Only 1.5 % of the colonies were dead.

- Area C: Capo dell'Armi, along the Calabrian coast of the Messina Strait. This area was characterized by just a little slope with south exposition that reached the soft bottom at 105 m depth. Here coralligenous biocenoses were formed by facies of *C. rubrum*. The number of colonies was very elevated, but they were restricted and brittle.

Table 1 summarized the data collected and the differences among sites.

Tab. 1: Data collected

Area	Number of transetcs	Total lengh of transects (km)	N° of photos analysed	Photos 100 m^{-1} mean ± SD	Density (col m^{-2}) mean ± SD
A	5	2.7	14	5.9 ± 2.5	6.42 ± 4.6
B	5	2.9	32	13.6 ± 16	18.04 ± 23.6
C	2	0.4	17	60 ± 69	96.57 ± 7.5

Areas with similar sampling effort (2.7-2.9 km) were compared using an F test. The difference between means of number of photos (related to coral patch frequencies) was significative (F=40.7; p<0.01).

The density of colonies was estimated for each area (Tab.1, Fig. 3). Minimum and maximum density values for all surveyed areas (1 to 101.8 colonies m^{-2}) underlined high density variability between areas.

Table 2 reported the values of the morphometric parameters. Differences among measure (diameter, height and width of colonies) for each area (A, B, C) were graphically described in Fig. 4 (Box PLOT).

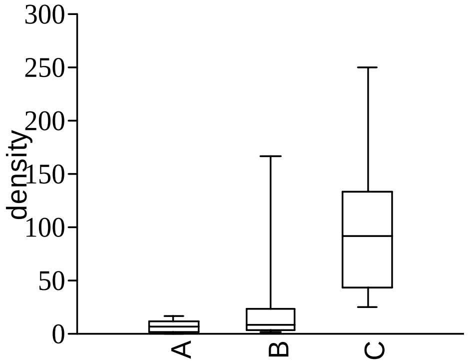


Fig. 3:Mean density (colonies m-2)

Tab. 2: mean (σ± SD), maximum and minimum values of diameter, height, width and number of branches of colonies

	n		height	width	diameter	branch
A	20	σ ± SD	9.14 ± 6.6	7.25 ± 5.3	0.64 ± 0.3	2.44 ± 1.3
		min	0.7	0.45	0.22	0
		max	21.8	17.5	1.38	6
B	162	σ ± SD	5.52 ± 4.2	6.21 ± 3.5	0.65 ± 0.4	1.86 ± 1.2
		min	0.3	0.9	0.18	0
		max	27	23.4	2.88	6
C	14	σ ± SD	3.27 ± 1.9	4.73 ± 1.7	0.44 ± 0.1	2.14 ± 1.1
		min	0.4	2.6	0.28	0
		max	6.3	7.5	0.65	4

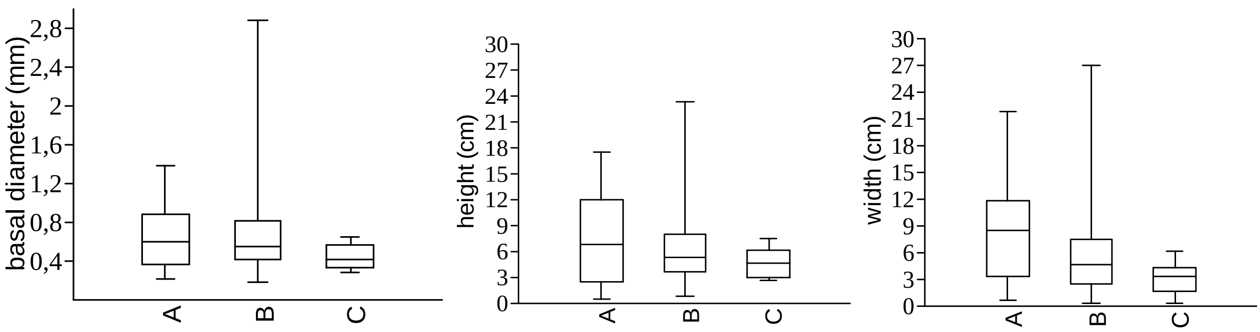
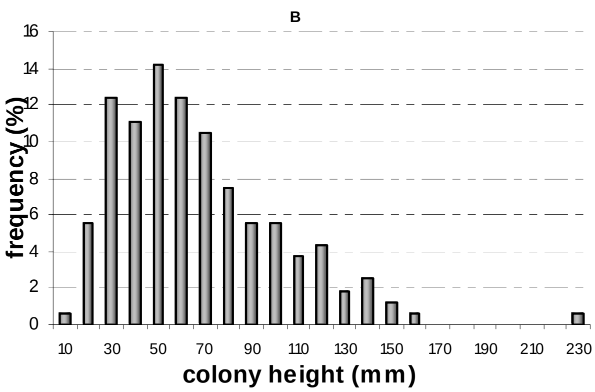


Fig. 4: Box PLOT for each area (A, B, C) of basal diameter, height and width of colonies

Highest number of measured colonies in B, respect to the other areas, allowed us to calculate the frequency distributions of the height and basal diameter of the colonies in this site. Both distributions showed a positively skewed curve (Fig. 5a, b), with average values of 6.22 ± 3.5 SD cm of height (2.79 mode, 5.34 median) and respectively 6.5 ± 3.8 SD mm (4.4 mode, 5.5 median) of basal diameter.



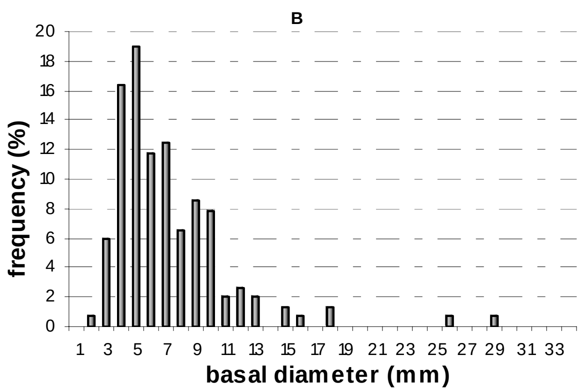


Fig. 5a: Frequency distribution of height of colonies **Fig. 5b: Frequency distribution of basal diameter**

Colony frequencies were divided in 2 size classes for both height and basal diameter (Figs. 6-7).

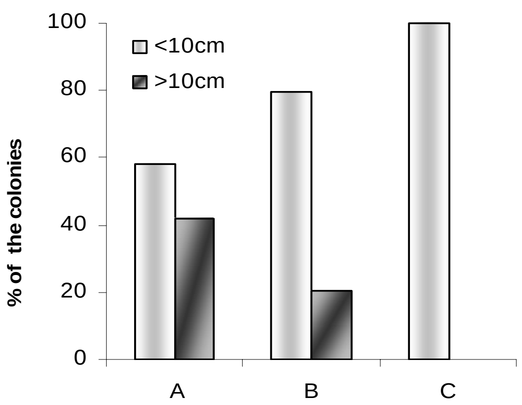


Fig. 6: Percentage of colonies bigger and smaller than 10 cm height

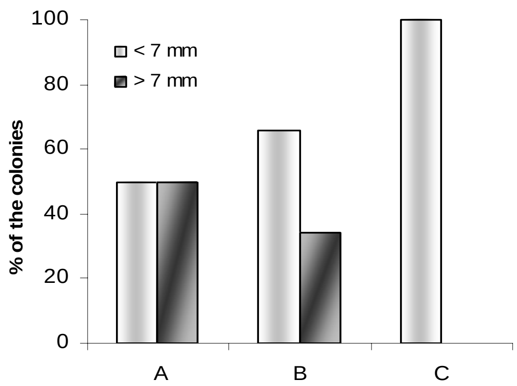


Fig. 7: Percentage of colonies bigger and smaller than 7 mm diameter

The number of colonies with a height more than 10 cm was determined, as well as the number of colonies with diameter greater or smaller than 7 mm. In all areas (A, B, C) more than 50% of the

colonies measured were smaller than 10 cm in height (Fig. 6). Our results indicated that the proportion of colonies larger than 10 cm were slightly higher in A than in B.
In area A the colonies higher than 10 cm were more than 40 % respect to area C where their were absence. We can observe a similar trend for the colonies with a smaller or larger than 7 mm basal diameter, the legal harvesting size (fig 7).

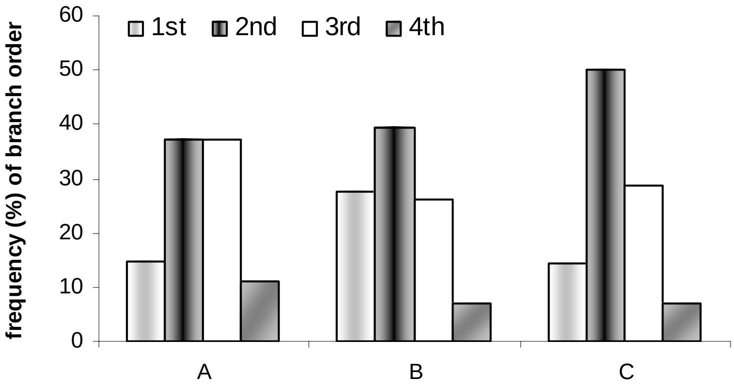


Fig. 8: Frequency distribution of number of branches for each area

Two branches colonies were the commonest typology of red coral we encountered (Fig. 8). For each area we recorded the orientation of the colonies respect to the inclination of the substratum. In area A most part of the colonies were perpendicular to the hard bottom or 45°/90° respect to the vertical cliffs. In the other sites more than 80% of colonies were hanging upside-down in the crevices or with a clear orientation tzowards the inside part of the crevice (Fig. 9).

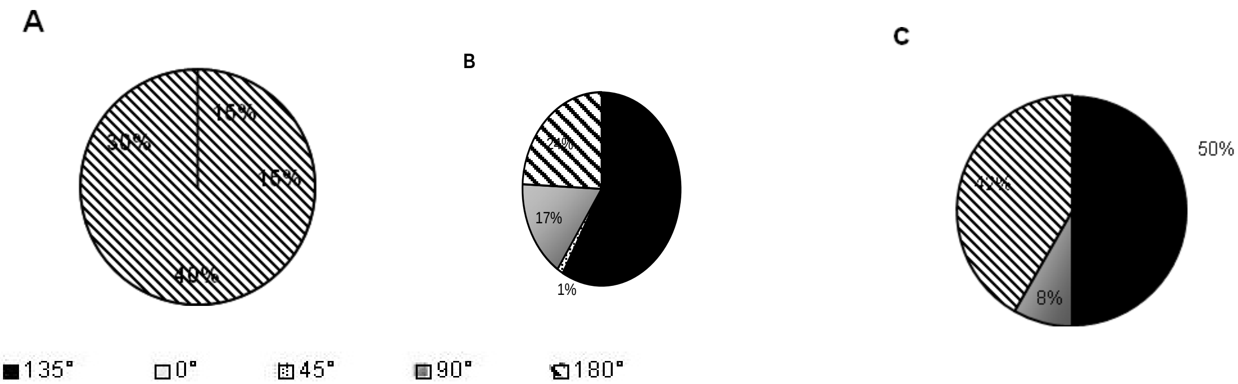


Fig. 9: percentage of colonies for each orientation (0°, 45°, 90°, 135°, 180°) for all areas (A, B, C)

DISCUSSION AND CONCLUSIONS

Enormous difference between study areas given by dissimilar environmental conditions (rate of sedimentation, light attenuation, currents) and type of substrata (boulders, slopes or cliffs) remarkably influence benthonic assemblages.
Greater density of colonies is in area C. Here the greatly sloping cliff and the strong currents, that keep high sedimentation rates, allow a more homogeneous pattern of the red coral growing. In this area, characterized by very rag bioconcretion rock, the colonies found never exceeded 10 cm in height. In area A, where red coral grows on boulders, surrounded by mud, we find lowest patches frequency and density. Nevertheless, the colonies are larger in size if compared to the other two areas. Morphometric measures and branching order confirm this trend, highlighting an inverse relationship with density. B area, characterized by vertical cliff, shows a strong variability in the colony distribution. From one transect to another, patch distribution varies from very lower values to points with elevated concentration. Density reflects the same trend. The number of small size (< 10 cm height and < 7 mm basal diameter) colonies is extremely high. Even if bigger colonies (never exceeded 20 cm height) are present, our results indicate a higher level of harvesting in this area, being already well known as situ of professional harvest.

Red coral, being a sciaphilic species, prefers dimly lit crevices and cave entrances. Light intensity limits not only density but also orientations of colonies. In the area A, where water turbidity influences the amount of light intensity, colonies grow in less sheltered conditions with more upright orientation (0°-90°). The extremely clear water of the other two surveyed areas (B and C), determinates, on the contrary, a different colony orientation (135°-180°).

The data collected in the three areas, even if the areas aren't comparable, highlight the presence of red coral from 70 m depth and a decreasing trend of patch frequency and average density with depth, which is in accordance with data available in literature. For all areas there is an inverse relation between density and size of colonies.

Overall, in the surveyed areas density values aren't high respect to other areas of the Mediterranean. Moreover, dominance of smaller size red coral colonies is probably due to over- exploitation of this species.

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