EFFECTS OF OCEAN ACIDIFICATION ON THE PRECIOUS MEDITERRANEAN RED CORAL (CORALLIUM RUBRUM)

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Abstract
Corallium rubrum is an octocoral endemic to the Mediterranean Sea. Slow growing and long living, it has been harvested since ancient times determining overexploitation due to the high economic value of axial skeleton. Moreover the Mg rich calcite skeleton make it vulnerable to ocean acidification. To understand the effects of elevated pCO_2, colonies of *C. rubrum* were maintained for 314 days in aquarium tanks at 2 pH levels (8,16 and 7,84). Buoyant weight, biochemical balance (protein, carbohydrates and lipids) and spicules morphology were measured. Buoyant weight increment was significantly different between controls and acidified treatment. Aberrant spicule shapes were observed only in acidified treatments. Total organic matter was higher in acidified treatments while no difference was found in carbohydrates, lipids and proteins contents

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Introduction: Mediterranean Sea is is considered one of the world's most sensitive regions to Ocean Acidification (OA) [1]. OA is a threat for calcifying organisms and can also have regional socio-economic effects related with the reduction in the harvest of high commercial interest species [2]. Red coral, *Corallium rubrum* is a long-lived, slow-growing gorgonian endemic to the Mediterranean Sea, where it dwells between 10 and 600 m depth. The high economic value of the skeleton used for jewelry, determined overexploitation [3]. The axial skeleton and the sclerites, coated with living tissue, are both composed of Mg-rich calcite [4] which solubility is greater than that of aragonite or calcite [5], moreover the seawater saturation state with respect to carbonate minerals decreases with increasing latitude [6]. Thus *C. rubrum* is expected to be highly susceptible to OA. We evaluated the effects of OA on $CaCO_3$ deposition, sclerites morphology and biochemical balance.

Methods. 48 colonies of *C. rubrum* (from 40 m depth) were distributed among 6 aquaria, further subdivided into 2 treatments (3 replicates): control (~8.10) and low pH (~7.81), simulating, respectively, seawater in equilibrium with ~380 and ~800 ppm CO_2 (current and projected levels for year 2100). Seawater pH was adjusted by bubbling CO_2 and monitored by glass electrodes connected to a pH controller. Additionally, total alkalinity was analyzed by potentiometric titration and pH using spectrophotometry. Buoyant weight, sclerites morphology, organic matter (OM) content and biochemical balance were measured quarterly during 314 days (Time 0 to Time 3). At the end of the experiment, specific microdensity and porosity were estimated on 6 colonies (1 from each aquarium). Sclerites (photographed at SEM) were categorized in 3 morphological types (I, II and aberrant) and the ratio area/perimeter, width/height and circularity were calculated and analysied by PERMANOVA. OM content was determined as the difference between dry and ash weight. Total carbohydrates, protein and lipid content were quantified colorimetrically and results analysed by ANOVA.

Results and discussion. No significant differences were observed, neither in microdensity nor on porosity, indicating that the structural material composition of skeleton was not affected by treatment. Calcification rates in low pH treatment was significantly lower (59%) with respect to control, confirming the expected detrimental effect on skeletal formation. Sclerites morphology was significantly different at Time 3, and aberrant shapes were detected only in low pH treatments. According to [7] the main function of sclerites is the mechanical protection, although [4] suggested a role in $CaCO_3$ temporary stocks. Therefore, in the long term, OA should affect *C. rubrum* compromising the $CaCO_3$ stocking capacity and skeleton biomechanical properties. OM content was significantly higher in the low pH treatment with stable values through time while changed in control treatments from T0 to T3. According to [8] metabolism is affected under low pH conditions and the energetic cost of calcification is higher. Therefore we hypothesize that *C. rubrum* respond to low pH by increasing the formation of OM, consequently decreasing calcification rates. Total protein, carbohydrate and lipid content were not different between treatments but the Coefficient of Variation (CV) was lower in low pH treatments indicating a more dimmed seasonal trend, probably due to endogenous processes or dormancy activated to save energy. A decrease in calcification rate together with a metabolic depression could have negative rebounds on the economy of the jewellery industry linked to this species leading to a price deflation. Furthermore some populations may suffer local extirpation due to the combined effects of climate and athropogenic threats. Projections of population structure under OA scenarios based on our results can be used to give advices for management and conservation [9] to preserve *C.rubrum* with the associated biodiersity and the economy linked to its exploitation.

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