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A preliminary study on habitat characteristics and substrate preference of coral species distributed in the Dardanelles.

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ABSTRACT

The present study aims to investigate the characteristics of living substrata of two scleractinian corals in the Dardanelles by performing the ecologic and petrographical analyses. The Mediterranean originated *Caryophyllia smithii* and *Balanophyllia europaea* are frequent coral species in the Dardanelles and the studied area between 11 and 25 m depth is known as highly distributed zone of the species. In situ, the spreading area was searched by scuba technique and the ecological characteristics of species have been measured. For the purpose of petrographical analyses, six coral individuals were collected with the associated rock samples. According to the obtained data it was determined that the rock samples are mainly composed of sandstone, micritic limestone and rhyolithic tuff. Additionally it was found that porosity in rock structure has a positive effect on coral settlement and the habitat choice in *B. europaea* and *C. smithii* can differ based on the rock structure. Ecological, biological and zoogeographical features of Anthozoan species distributed in the Turkish coasts are still poorly known. However the available data about coral distribution in the specific habitats such as the Dardanelles and the Bosphorus (Turkish Straits System, Marmara Sea) are very few and need to be increased for updating the ecological situation of species globally.

Introduction

Rocky surfaces, typically referred to as hard bottoms, are one of the most diversified ecosystems in marine life (Wahl, 2009). Contrary to soft bottom communities, these habitats constitute both more suitable living areas for various marine organisms such as corals, sponges, algae, bryozoans, crustaceans, tunicates and create a breeding, feeding or sheltering spot for fish fauna which are commercially important (Bianchi et al. 2004; Chintiroglou et al. 2005; Kendall et al. 2009). Among those species, scleractinians can be defined as the common group living on rocks, stones, gravel floors or coralligenous communities (Veron 2000; Ballesteros 2006).

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Caryophyllia smithii and *Balanophyllia europaea* are known as solitary hard coral species of the rocky substrates living throughout the Mediterranean Sea (Zibrowius, 1980; Goffredo et al. 2002). *B. europaea* is zooxanthellate, non-constructional, ahermatypic and mostly found around the shallow-waters interacted with sunlight (Goffredo and Telo 1998), whereas *C. smithii* is temperate, non-zooxanthellate and typically observed in much deeper depths than *B. europaea* (Zibrowius, 1983). *C. smithii* may also be found around the colonial invertebrates (Bell and Turner 2000) in marine habitat. In some researches the communities of *B. europaea* were recorded from the roots of Mediterranean endemic seagrass *Posidonia oceanica* (Gambi and Morri, 2008), while there was no data from such these adaptations for *C. smithii*.

When searched in detail, it can be seen that *C. smithii* and *B. europaea* are the most surveyed coral communities in the entire Mediterranean basin (Zibrowius, 1980; Fowler

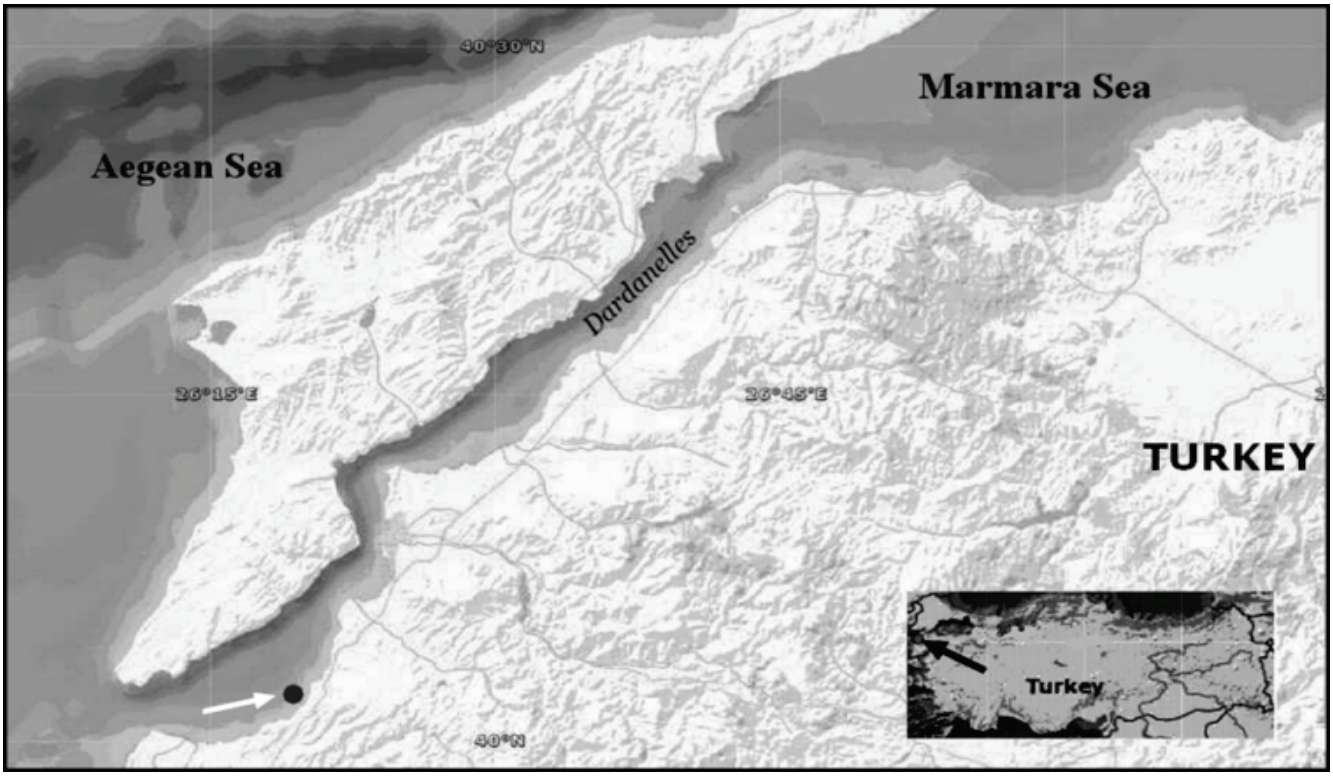

Figure 1. Sampling site in the Dardanelles.

and Laffoley, 1993; Mittelmeer, 2001; Bell, 2002; Terron Sigler and Lopez-Gonzales, 2005; Taviani et al. 2010; Caroselli et al. 2011; Goffredo et al. 2011; McCulloch et al. 2012). Although several studies have been carried out in the Levantine Basin of Turkey (Çinar et al. 2006), the Northern Aegean Sea (Çinar, 2003; Öztürk, 2004) and the Turkish Straits System, Marmara Sea (Artüz, 1990; Özalp and Alparslan, 2009, 2011; Özalp, 2012), ecology of Anthozoan fauna around the Turkish seas and the characteristics of substrate type are still poorly known. Additionally, the rock type with coral existence has not been investigated previously. In this study we primarily intended to develop the knowledge about the ecological and zoogeographical patterns of two scleractinians for the Dardanelles area. Secondarily, the present research aims to investigate the petrographical and mineralogical properties of rock samples with coral, as the structural feature of hard surfaces are crucially important for coral settlement and their latter vital activity in marine life.

In this case, rocks with coral taken from the study area have been separated into three different rock types. These are sandstone, micritic limestone and rhyolithic tuff. Sandstone is a clastic sedimentary rock composed mainly of sand-sized minerals and rock grains. Limestone is another sedimentary rock composed largely of the minerals calcite and aragonite, which are different crystal forms of calcium carbonate ($CaCO_3$). Many limestones are composed from skeletal fragments of marine organisms such as coral or foraminifera. However, rhyolithic tuff is a type of rock consisting of consolidated volcanic ash ejected from vents during a volcanic eruption.

Although several marine researches on invertebrate biodiversity and physicochemical properties around the Dardanelles with its associated habitats have been performed previously (Koçum, 2005, Büyükateş and İnanmaz, 2010, Akbulut et al. 2010), ecological patterns of

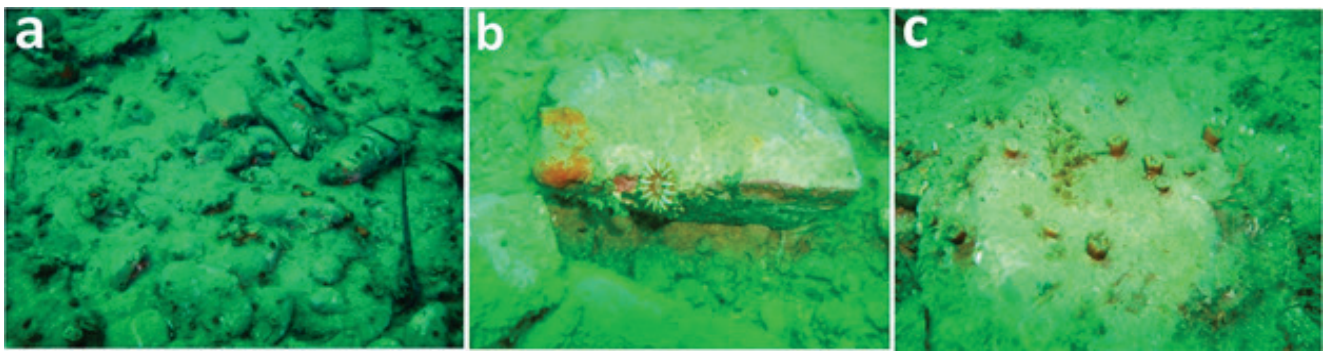

Figure 2. Coral species in situ. a: Bottom structure in the area, b: *Caryophyllia smithii*, c: *Balanophyllia europaea*.

Figure 3. Photographs of rock samples with *C. smithii* out of the water.

coral communities living in the strait are still scarce. This study focuses on enhancing the lack of knowledge on Anthozoan biology by comparing the site characteristics, environmental parameters and living adaptations of two substantial Mediterranean corals in a Marmara Sea ecosystem.

Material and methods

The rock materials were collected at the depth of 21 m by Scuba diving from the station Karanlık Liman (Güzelyalı) in the southern part of Dardanelles, Marmara Sea (40°02'103"N, 26°19'475"E) (Figure 1). For finding the more suitable rock with coral, an area of 300 m^2 between the depth of 15 and 25 m was surveyed and 12 scientific dives were performed for observation and sampling. The surface current in the area is mild (< 0.1 m/s) and stable all year round. On the substratum which is mainly comprised of sandy and muddy structure, there are many small stones with live corals covering an area of 117 m^2 between 19 and 21 m depths, and here is known as one of the largest spreading site for *B. europaea* and *C. smithii* in the strait (Özalp, 2012).

Due to the slime bottom type, a standard measuring stick was embedded to the substrata about 2 m. Three rock samples for each species (Figure 2) were photographed in situ and out of the water (Figure 3, 4) via an underwater camera, cleaned of epibionts and transferred to the laboratory for petrographical analyses. A total of six rock samples of varying weights within the study area were prepared for petrographical analyses and then examined under the polarized microscope (Olympus BX51P). Rock samples were broken into a small size enough to cut on diamond saw. Holding it tightly, the rocks were cut into a rectangular block with dimensions smaller than a slide. After that, it was cleaned and grinded with fine grit to make a very smooth and flat rock sample surface. Samples were washed and set it on the hot plate for a while. After sample is dry, a large drop of mixed epoxy was put on the center of the slide and watched to see that the bubbles come out of it as it warms. Then much of the rock sample was cut off from the slide. Holding the rock side down with a few fingers in the center of the back of the slide, the sample was grinded thinly using 400 grit. Entire samples were formed exactly 30 µm of thickness.

In addition to data, the physico-chemical factors of the sampling site were measured in different depths (0, 5, 10, 20, 30 and 40 m). The parameters determined for the studied area represent November 2011 only.

Results

The habitat choice in *B. europaea* and *C. smithii* can differ based on the rock structure. The existence of these corals is known in another 45 stations in the strait but, although the rock type in the other areas varies by volume, width, height and structural pattern, there has not been much density similarly with the current station. These species are mainly observed around the coastal areas between the depths of 11 m and 25 m. The study site is known with the highest spreading rate regarding these two scleractinians around the coastal areas of the Dardanelles. In this area, the maximum density was measured by using the 20 cm × 20 cm quadrat as 275 individuals for BE and 100 individuals for *C. smithii* per m^2. Replicate 1 represents the *B. europaea* whereas the Replicate 2 shows the density of *C. smithii*. The maximum individual diameter for *B. europaea* was 6.2 cm; while *C. smithii* was 2.3 cm.

Figure 4. Photographs of rock samples with *B. europaea* out of the water.

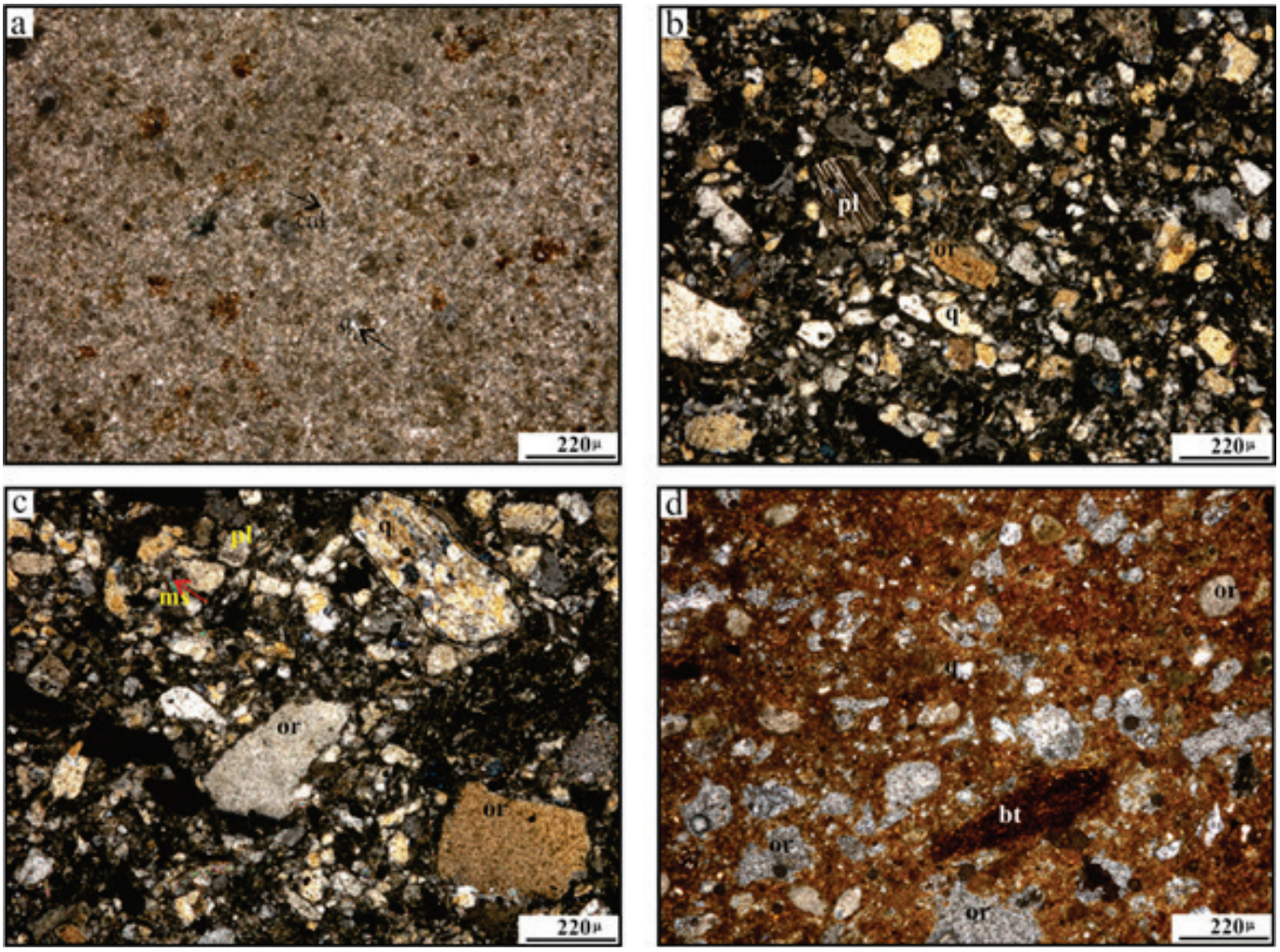

Figure 5. Microphotographs of rock samples with coral. Plane polarized light. Bar scale in the photographs. a) micritic limestone, b-c) quartz sandstone, d) rhyolithic tuff, cal: calcite, q: quartz, pl: plagioclase, or: orthoclase, ms: muscovite, bt: biotite.

Replicate 1: a, 8 × 25 = 200; b, 11 × 25 = 275, c, 7 × 25 = 175 (three repetitive replicate)
Replicate 2: a, 0 × 25 = 0; b, 3 × 25 = 75; c, 4 × 25 = 100 (three repetitive replicate)

The site characteristics are written as follows. According to the results (Table 1), it can be stated that the salinity values in the area showed the general Mediterranean feature other than the Marmara Sea. Although the surface waters of Dardanelles and the associated coastal areas are represented by the Marmara Sea, the strait habitat is under the influence of the physicochemical characters of the Northern Aegean Sea as well.

Around the area with about 120 m^2 there were many small rock pieces with coral existence (Figure 2, 3 and 4). In comparison with *C. smithii*, the number of *B. europaea* comprises much higher level in the spreading area. Because of this character, the sampling site can be defined as the only zone with highest density of *B. europaea* in the Dardanelles.

Characteristic and mineralogical properties of rock samples with coral have been examined under the Polarizan microscope. Based on petrographical investigations, three different types of rocks have been separated. These are micritic limestone, quartz sandstone and Rhyolitic tuff. Micritic limestone is mainly composed of calcite, quartz and opaque minerals (Figure 5a). Calcite is the most abundant mineral in the micritic limestone.

Quartz sandstone is mainly made up of quartz, orthoclase, plagioclase, biotite, muscovite, chlorite and epidote (Figure 5b). Quartz, orthoclase and plagioclase are the main composition of sandstone.

Rhyolitic tuff is mainly composed of quartz, orthoclase, biotite and glassy fragments (Figure 5c). These rocks are highly siliceous and contain abundant quartz phenocrysts. The phenocrysts are typically 1-7 mm in size and constitute about 15% of rock. The groundmass has been widely altered, with Fe oxide alteration most abundant giving it a reddish color.

As indicated in the paragraphs above, *B. europaea* and *C. smithii* in the current station show a widest distributional characteristic (117 m^2) by comparison with the other biotopes with these coral existence around the Dardanelles. That the common feature of these rocks with living coral is to have porosity indicating the difference between the rocky areas among other zones in this region.

Based on the characteristic properties of rocks, *B. europaea is* achieves growth on the type of micritic limestone which contains 98 % of calcite, whereas *C. smithii* grows on the type of quartz sandstone (60 % quartz) and rhyolithic tuff (15 % quartz and orthoclase). The

Table 1. Physico-chemical data at five different water columns in the study site.

Parameters	Depths				
	5 m	10 m	20 m	30 m	40 m
Temperature (°C)	10.3	10.4	14.2	14	10
Salinity (‰)	33.2	33	38.1	38.9	33.1
Dissolved Oxygen (mg/lt)	9	8,91	7	9.04	9.72
pH	7.78	8	8.1	7.9	7.7

common property of these rocks with coral is to have porosity. A similar study focusing on the different materials for coral life has been made on the special stone settlement sticks with small holes in Japan. According to this research, three coral species were observed growing on this artificial habitats and extending outside the holes of the sticks in the water at the Sekisei lagoon site (Okamoto et al. 2005).

Discussion

This preliminary study carried out using further data about the ecological parameters and petrographical analyses was conducted for the first time in the Dardanelles. With reference to the mineralogical investigations on coral-associated rock samples it can be stated that these representative species can be easily grown on rocks having porosity and this character provides positive effects on coral improving. In addition to data, the physicochemical parameters in the studied site were given and the distributional information about the scleractinian corals for the Dardanelles was enhanced. According to the rock properties it can be seen that the micritic limestone with *B. europaea* contains 98 % of calcite, whereas *C. smithii* grows on quartz sandstone and rhyolithic tuff material comprising 60 % of quartz and 15 % of a mixture of quartz and orthoclase.

The research area on Anthozoans is very new for the Turkish scientists. Although there has been some limited ecological and zoogeographical surveys on scleractinians and soft coral communities living in the Northern Aegean and the Marmara Sea (Dardanelles, Marmara Islands and Bosphorus), the further investigations on bio-ecological characteristics of Anthozoans need to be implemented due to the lack of knowledge in this field.

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