Molluscan fauna from the photophilic algae of the infralittoral reef ecosystem (habitat code:1170) of Crete

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Abstract

The composition and the assemblage structure of the molluscan fauna along a depth gradient from the infralittoral hard bottom photophilic algae communities in the Cretan Sea, East Mediterranean, was studied at 2 different sites during the summers of 2007 and 2008. Samples were collected by means of SCUBA diving under the NAGISA project protocol. Examination of the material revealed 129 species, belonging to three different classes. 40 species are reported for the first time as elements of the molluscan fauna of the Cretan Sea. PERMANOVA shows that significant differences appear between the depths and years ($p < 0.05$) but not between the sites.

Keywords: reef ecosystem, mollusca, East Mediterranean, Crete, NaGISA

1. Introduction

The Mediterranean Sea is a global hotspot of marine biodiversity but habitats that are close to the coastal zone are exposed to a variety of anthropogenic pressures and the exploitation of resources (Coll et al., 2010). Seagrass meadows and the rocky shores are among the most accessible and affected by the human activities habitats, while rocky shores cover 54% of the total Mediterranean coastline (Coll et al., 2010). They are almost always covered by photophilous algae, which comprise one of the most widespread types of vegetated habitat in the Mediterranean Sea (Sales et al., 2012). Benthic herbivore invertebrates and fishes are common inhabitants of the photophilic algae and important for the structure of the shallow rocky littoral communities. Among these invertebrates, molluscs are one of the dominant taxa (Urra et al., 2013). The diversity, structure and dynamics of the molluscan assemblages in the hard bottom communities have been studied mainly in the Western Mediterranean Sea (Milazzo et al., 2000) while fewer studies have been carried out in eastern Mediterranean (Antoniadou et al. 2005). In the South Aegean and especially in Cretan Sea, molluscan assemblages have been described only from soft bottom communities (Koutsoubas et al., 1992; Koulouri et al., 2006). Crete is situated in the center of the Eastern Mediterranean Basin and is located in a representative area on the influence of the oligotrophism in the benthic ecosystem (Psarra et al., 2000). More than 65% of its coastline is constituted by rocky shores (Alexandrakis 2014). Crete is one of the selected sampling sites for the global project entitled “National Geography in Shore Areas” (NaGISA, http://nagisa.cbm.usb.ve/cms/). This study is part of the first two years of the NaGISA project, in two different locations of Crete and aims at improving the knowledge of the molluscan diversity of hard substrates in the Eastern Mediterranean, and the community structure and their bathymetric distribution on the hard bottom photophilic infralittoral zone.

2. Materials and methods

Two sites in different locations, along the north coasts of Crete Island were selected (Figure 1). The first site is Alykes in Agia Pelagia outside of Heraklion city (35.413847; 24.990866) and the second site is Elounda close to the town of Agios Nikolaos (35.249942; 25.757994).

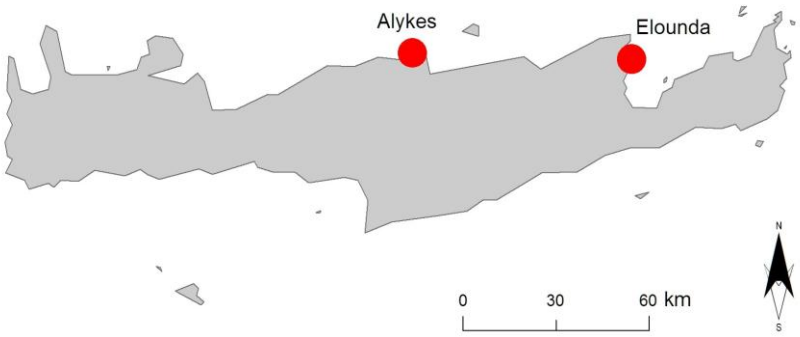

Fig. 1. The sampling locations in Crete.

Both sites were chosen for their particular location characteristics, i.e. they are both far from direct human pressures and activities, their accessibility is easy and the hard substrate is continuous with dense algal coverage (*Cystoseira* spp., *Sargassum* sp., *Corallinales* spp.), the inclination, the maximum depth (30m.) and the moderate wave exposure. At each study site, a stratified random sampling strategy has been employed, with strata representing vertical heights below low water datum. At each site, five replicate samples were taken from five stations of 1, 5, 10, 15 and 20m depth. Samples were collected in late summer of 2007 (September) and early summer of 2008 (June). At each site two vertical transects were selected and at each depth of each transect (1m, 5m, 10m, 15m, 20m) 5 replicates were collected. Samples were obtained following the NaGISA protocol (Iken et al., 2003) by means of SCUBA diving. A Plexiglas frame of 25x25 cm with a net of 0.5 mm mesh size mounted on its top side was attached to the rock with its base side. The framed surface of the substrate was hand scraped and sucked into a net-bag of 0.5 mm mesh sieve by means of a custom suction device, using an extra air tank to create the suction effect. Samples were subsequently washed through a 0.5 mm mesh sieve, fixed and preserved in 99% ethanol. Nomenclature follows WO.R.M.S classification and for each species information about the trophic group as well as the zoogeography has been compiled. Alpha diversity was measured by calculating six diversity indices [Species richness, Abundance, Shannon – Wiener H' (loge based), Pielou's evenness index J', Simpson's index 1-Lambda and Margalef's]. The permutational analysis of variance (PERMANOVA, Anderson, 2001) was applied to test for differences at two spatial scales, replicate unit and station. Factors considered were the ecological zone (depth), the sampling site (location) and the sampling period (year).

3. Results

After the examination of the collected living material, this comprised of 11042 individuals and 129 mollusc species. Gastropods are the most species-rich group, with 98 species (75.9%), followed by bivalves with 24 species (18.6%) and Polyplacophora with 7 species (5.4%). In relation to the total abundance, Gastropods were also the most numerous with 10385 individuals (94%), followed by Bivalvia with 617 individuals (5.58%) and Polyplacophora with 41 individuals (0.3%). The most frequent and abundant species in terms of individuals were the gastropods *Bittium latreilii* (adults and juveniles) with 9412 individuals, *Vexillum granum* with 108 individuals, *Alvania cimex* with also 108 individuals and the bivalve *Musculus costulatus* with 514 individuals. These are the 92.7% of the total collected individuals. Looking into the trophic groups, the 45% of the total species belong to herbivores and only 20% to carnivores. Filter feeders exist in the hard substrates and all are bivalves. Diversity indices findings were comparable to those from similar investigations in the North Aegean Sea (Antoniadou et al., 2005) and the Western Mediterranean (Milazzo et al., 2000). 40 species are new records for the malacofauna of the Cretan Sea.

PERMANOVA analysis shows that significant differences appear between the sampling depths and the years but not between the sites (Table 1).

Table 1. Results of PERMANOVA analysis on species composition and abundance of photophilic algae in Crete. Significant effects are in bold (*italics*).

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Year (Ye)	1	3869.2	3869.2	2.2796	***0.006***	999
Location (Lo)	1	2269.9	2269.9	1.47	0.143	999
Depth (De)	4	9560.2	2390	1.5803	***0.036***	995
YexLo	1	1071.9	1071.9	1.2564	0.265	996
YexDe	4	3998.8	999.7	1.1717	0.326	999
LoxDe	4	4210.4	1052.6	1.2337	0.244	999

4. Conclusions/Discussion

Even if Mollusca are considered one of the best-studied phylum in the Mediterranean (Sabelli et al. 2014), up to now the information on the spatial distribution of them as well as on the diversity in the scale of habitat in the Mediterranean is still limited if not rare. The study of the assemblages from the hard bottom photophilic algae in the infralittoral zone of Crete reveals a rich molluscan community from this important and complex habitat. In terms of numbers, 129 species have been recorded so far, 40 of them count as new elements of the Cretan marine biodiversity. The number of the recorded species is one of the highest comparing to the West Mediterranean (Urra et al. 2013 and references cited in).

Moreover, our work has the same findings as the global assessment of the NAGISA dataset (Miloslavich et al., 2013) where the analysis shows that in all regions, the assemblages of the gastropods were dominated by few species, from which the most abundant were herbivores. The highest number of abundance comes from the herbivore gastropod *Bittium latreilii*. It is one of the most abundant species that has been counted also from other studies (Pitacco et al., 2014) and this is probably related to the tridimensional form of the dominant erected algae, which serve as an excellent niche for them (Chemello & Milazzo, 2002). The shape acts as a trap for organic material and thus offers excellent conditions for the trophic needs of the species. Depth acts as a shaper for the molluscan communities. Middle depths (5, 10, 15 m.) are closer than the limit depths in the shallow (1m) and deep (20m) part of the sampling scheme. Light decrease as depth increase and thus form the composition of the photophilic algae, source of food for almost half of the species as well as shapers of microhabitats for the rest of them. Sedimentation is a natural phenomenon in the hard substrates as sediments are trapped in-between the erected algae and microhabitats are available for typical soft bottom inhabitants (Antoniadou et al., 2005). More than 15% of the species are usually found in soft substrates (e.c *Venus verrucosa*). The differences in the years are mainly associated with the periods that *Bittium latreilii* settle new cohorts (Russo et al., 2002) and thus the existence of juveniles (8500 individuals) is related to this. More than 40% of the species have been classified as members of the photophilic algae group but a significant number of species have been associated with other types of habitats. One might say that the photophilic algae communities have different roles in different periods of the year. They can act as food source during the establishment of new cohorts of species, nursery ground and protective ground from predators.

The importance of this study on the hard substrate in the East Mediterranean is denoted by the findings, as more information will come out on the diversity of the molluscs in the area as well as the factors that shape it. Our findings support the claim from previous work (Koutsoubas et al., 2000)

that the study of the marine biodiversity of Greece (the molluscs for here) is still far from being regarded as complete.

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