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Sponge epibionts on ecosystem-engineering ascidians: The case of *Microcosmus sabatieri*

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ABSTRACT

The study of epibionts on habitat engineering ascidians is of increasing interest because changes in the population structure of the latter may affect associated communities, especially in the case of commercially exploited species. The solitary ascidian *Microcosmus sabatieri* lives on rocky cliffs in the Eastern Mediterranean and is harvested in certain Aegean areas. Its hard, wrinkled tunic is usually fouled by various epibionts both sessile and motile. Sponges are an important component of this complex and their biomass may be higher than that of the ascidian itself, strongly affecting diversity and abundance of the motile epifauna. The aim of this study was to examine in detail the structure of the epibiotic sponge assemblage on ascidians collected from their main fishing grounds in the South Aegean Sea. A rich (41 species) and taxonomically diverse sponge assemblage was found, while only eight species contributed 80% of the total sponge cover. Most of the epibiotic sponges commonly grow on the surrounding sublittoral cliffs. The encrusting sponge growth form prevailed in cover of the ascidian tunic, while two massive species dominated in terms of frequency of appearance and abundance. Ascidian dimensions, weight and volume were significantly correlated with sponge diversity, abundance and cover area, thus structuring the epibiotic sponge assemblage. Spatial patterns in sponge cover were not clear, but a general declining NW to SE trend in sponge richness, abundance and cover appeared in accordance with previous records. Sponge distribution on the ascidian tunic presented a clear pattern related with characteristic features of the ascidian: the posterior zone supported the richest and most expansive sponge fauna. The ecosystem-engineering process performed by the ascidian is enhanced by the diverse epibiotic sponge assemblage, thus further increasing habitat complexity in this space-limited, temperate, sublittoral, rocky environment.

1. Introduction

Sponges are an important component of benthic communities, playing a major role in their organization and functioning in many different ways (see Wulff, 2006; Bell, 2008). They are sessile animals highly dependent on the availability of the suitable substratum. In the Mediterranean they commonly inhabit shaded rocky bottoms along the sublittoral zone (Boury-Esnault, 1971; Uriz et al., 1992; Antoniadou et al., 2006). They have been recorded as epibionts on animal substrates, such as bivalves (Corriero and Pronzato, 1987; Burns and Bingham, 2002; Guenther and De Nys, 2006), decapods (Stachowitsch, 1980; Maldonado and Uriz, 1992), echinoids (Cerrano et al., 2009), and other sponges (Rützler, 1970; see Wulff, 2008).

The term "ecosystem engineers" was introduced by Jones et al. (1994) to describe organisms that directly or indirectly control the availability of resources to other life forms by causing physical state changes in biotic or abiotic materials. Sessile marine invertebrates often act as ecosystem engineers by adding physical structure to the environment (Wright and Jones, 2006) as do mussels and other bivalves via shells and resulting reefs (Commito et al., 2005), or by developing a living substrate for other organisms as do sponges (Koukouras et al., 1996; Ribeiro et al., 2003) and ascidians (Castilla et al., 2004; Voultsiadou et al., 2007).

Habitat engineering ascidians seem to enhance local biodiversity by providing living habitat of increased structural complexity which is colonized by both sessile and motile organisms. The study of epibionts and their relationships with the ascidians becomes of rising interest since (1) any disturbance or contamination of these biogenic habitats, as well as the bioactive compounds they secrete might effect the epibiotic communities which they support (Roberts et al., 2008); (2) some ascidians are commercially harvested species,

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collected for food or bait and their exploitation might have cascade effects on the associated communities (Coleman and Williams, 2002; Monteiro et al., 2002); (3) it has been suggested that certain groups of epibionts, such as algae and sponges, could reinforce the engineering activity of the ascidians, with important consequences on the motile epibiotic fauna (Voultsiadou et al., 2007).

Information about epibiotic sponges on ascidians hardly exists, since most studies deal exclusively with the motile fauna (Voultsiadou et al., 2007 and references therein) or refer collectively to sponges as a higher taxon (Davis and Wright, 1989; Castilla et al., 2004). Actually, there is only one paper recording the sponge species inhabiting three different ascidians in the western Mediterranean (Biblioni and Uriz, 1981).

The solitary ascidian *Microcosmus sabatieri* Roule, 1885, is a large-sized tunicate that lives firmly attached on rocky cliffs. It constitutes a gastronomic delicacy of high nutritional value (Stamatis et al., 2008). Today, its populations have collapsed at several western Mediterranean areas for unknown reasons and are under moderate fishing pressure in the Aegean Sea (Vafidis et al., 2008). Although Monniot (1965) suggested that the presence of this species in the benthic ecosystem may enhance local biodiversity, since its wrinkled, thick tunic is usually covered by epibiotic organisms, very little information exists on its associated communities. Voultsiadou et al. (2007) studying the motile peracarid epifauna of *M. sabatieri* showed that its richness, abundance and diversity was strongly dependant on the biomass of sessile epibionts, such as algae and sponges, which in some cases had a higher biomass than the ascidian itself.

The main goal of the present work was to examine in detail the structure of the epibiotic sponge assemblage on the ascidian *Microcosmus sabatieri*. This was accomplished by estimating diversity, abundance, frequency of appearance, and cover of sponges settled on *M. sabatieri* in the South Aegean, where the main fishing grounds of the species are located. The relationships of the above parameters with several biometric variables of the ascidian population were examined and the topographic distribution of the epibiotic sponge assemblage was investigated on the ascidian tunic and over the study area, in order to assess potential spatial patterns.

2. Materials and methods

Specimens of *Microcosmus sabatieri* were collected from ten sampling stations located in four islands: Kandelioussa (C1, C2), Tilos (T1, T2, T3, T4), Symi (S1, S2), and Chalki (X1, X2) of the Dodecanese Archipelago, in the South Aegean Sea (Fig. 1). At each island two kinds of habitats: (1) vertical rocky cliffs and (2) inclined rocks located on *Posidonia oceanica* meadows were sampled, with the exception of Kandelioussa in which the coastline consists exclusively of rocky walls. Sampling was carried out by scientists and sponge fishermen diving with the "nargileh" method, in depths between 30 and 50 m. By this method low pressure air is continuously provided through a compressor located on the boat, permitting divers to stay longer underwater. Ten to fifteen specimens larger than 4 cm were randomly collected by hand at each station, put in net sacs, and stored in formalin.

In the laboratory, each specimen was photographed (Fig. 2A) on both sides; then it was measured for wet weight (W) with an electronic scale to the nearest mg, and volume (V) by means of water displacement. The ascidians were cleaned of epibionts and the collected sponges were preserved separately and identified to the species level. Then, all ascidians were measured for total length (L) and maximum perimeter (P) with a caliper to the nearest mm. On the photographs of each ascidian specimen, the tunic surface was divided into five topographic zones (Fig. 2B) and the epibiotic sponges were mapped on. Using a compensating planimeter (Koizuni, TypeKP-27) the surface area of ascidians (A) and the sponge cover on them (C) were estimated. Sponges were classified according to their morphology as encrusting or massive growth forms.

The structure of sponge assemblage settled on the ascidians was analyzed by calculating species richness (S), and the following parameters for each species: (1) abundance (N) estimated as the number of sponge specimens found on the examined ascidians, (2) presence on ascidian individuals (Pa) estimated as the number of ascidians on which each sponge species was found, (3) dominance (D) estimated as the percentage species abundance, (4) cover (C), estimated as the total area in cm^2 covered on the ascidians, and (5) mean cover (mC), estimated as the mean sponge cover area. Linear regression analysis was used to estimate relationships between the ascidian biometric characteristics and sponge assemblage parameters (Sokal and Rohlf, 1987).

Analysis of variance (GLM ANOVA) was used to examine differences in abundance, species richness and cover of sponges and of each growth form (i.e. encrusting or massive) separately, among islands (4-level random factor) and sites (10-level fixed factor, nested on islands). Prior to the analyses, data were tested for normality by the Anderson–Darling test, while the homogeneity of variances was tested by Cohran's test and, when necessary, data were log-transformed (Underwood, 1997). The Fisher LSD test was used for post hoc comparisons when appropriate. ANOVAs were performed using the SPSS software package.

Multivariate analyses were used to compare the similarity of sponge assemblages settled on the ascidians. Non-metric multidimensional scaling ordination (nMDS) via Bray–Curtis distances on presence/absence, mean abundance and mean cover data was used to visualise changes in composition of the sponge fauna across sampling sites. Similarity of percentage analysis (SIMPER) was used to identify the species responsible for the spatial

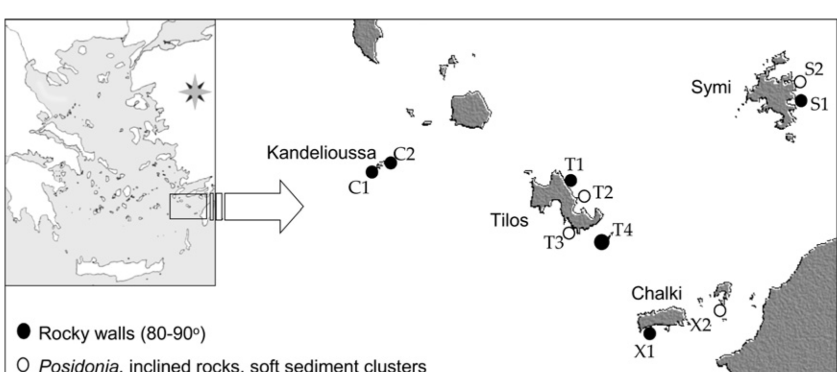

Fig. 1. Map of the Aegean Sea and the Dodecanese area, indicating the sampling stations.