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MOLLUSCS
OF THE MARINE PROTECTED AREA "SECCHE DI TOR PATERNO"

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Esame finale anno 2011

to Ilaria and Chiara,
my daughters

This PhD thesis is the completion of a long path from childhood amateur conchology to scientific research.

Many people were involved in this journey, but key characters are three.

Luca Marini, director of "Secche di Tor Paterno" Marine Protected Area, shared the project idea of field research on molluscs and trusted me in accomplishing the task. Without his active support in finding funds for the field activities this project would have not started. It is no exaggeration saying I would not have even thought of entering the PhD without him.

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Key-words: Mollusca, ecology, biodiversity, conservation, *Posidonia oceanica*, coralligenous, detritic pools, Secche di Tor Paterno

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2 Executive summary

This thesis was aimed at describing the molluscan biodiversity of the infralittoral off-shore reefs in the "Secche di Tor Paterno" marine protected area. Off-shore reefs are a rather common feature of the Mediterranean Sea submarine landscape constituted by outcrops of hard substratum emerging from wide open soft substrata.

Four biocoenoses were sampled by SCUBA diving: *Posidonia oceanica* leaves and rhizomes, coralligenous concretions and detritic pools. The malacofauna of each biocoenosis was studied in detail. Moreover, comparison data sets from other localities and depths were used as comparison material to further understand the patterns of diversity. Polychaeta, Pleocyemata (Crustacea) and Brachiopoda were studied at different degrees of detail with the final aim to understand to which extent different taxonomic groups worked well as descriptors of biocoenoses and therefore if molluscs were a reasonable or optimal choice.

The thanatocoenoses near the biocoenoses were sampled too to assess the agreement between the death and life assemblages.

The main conclusions of this thesis are given in the following paragraphs.

2.1 The molluscan diversity

The high habitat heterogeneity of the reefs allows the establishment of a highly diverse mollusc assemblage: 162 species were found alive and a good number of them live exclusively in given biocoenoses. The sampled fauna is 9% of the Italian fauna and 15% of the fauna of the biogeographic sector 2. These numbers are very high considering the geographic restrictness of the area, the narrow depth interval which implies that several biocoenoses are not present (e.g. photophilous algae, deep water corals), the lack of true soft substrata, the single season and single year sampling and that a 1 mm sieve was used (so missing some tiny species like Pyramidellidae). Moreover, biodiversity estimators suggest that the total richness of species may reach 236 species (second order Jackknife 2 estimator).

The coralligenous proved to be the richest biocoenosis both in terms of total number of species (123) and species living exclusively there (53). The *Posidonia* rhizomes are the second richest biocoenosis (88 species). The *Posidonia* leaves were rather poor with just 14 species and the detritic pools host 22 species. However, these two biocoenoses contributed with a good share of species not found elsewhere. This is particularly remarkable for the detritic pools: 13 species (59.1%) were found in this biocoenosis only. The reefs host 4 species of conservation interest: *Erosaria spurca* and *Luria lurida* (Gastropoda: Cypraeidae), *Lithophaga lithophaga* (Bivalvia: Mytilidae), *Pinna nobilis* (Bivalvia: Pinnidae). No alien species were found on the reefs.

The high habitat and species diversity of these reefs, the presence of species of conservation interest and the lack of alien species, pooled with their distance from the coastline which implies less intense anthropogenic impacts suggest the need of a greater effort for the protection and conservation of this kind of submarine structures.

2.2 Biocoenoses characterization

The a priori choice of molluscs as descriptors of biocoenoses was confirmed by their good behaviour in discriminating even similar biocoenoses like the coralligenous and *Posidonia* rhizomes since the molluscan assemblages of the biocoenoses are significantly different (PERMANOVA, $p<0.05$). Errant Polychaeta, Pleocyemata (Crustacea) and Brachiopoda did not show significantly different communities in these two biocoenoses.

The power of molluscs may be in their high species diversity and low vagility. Despite this analysis has some limitations due to samples preservation and taxonomic challenges of polychaetes and crabs, this is the first attempt of such a comparison in Mediterranean complex hard substratum environments.

2.3 Analysis of the Posidonia *leaves species assemblage*

Despite the *Posidonia* leaves fauna has been studied several times, information about deep water meadows (below 15 m) is scarce.

In “Secche di Tor Paterno” the *Posidonia* leaves species assemblage is characterized by its poorness. Only 14 species were collected. Moreover, species which usually thrive in this biocoenosis were found in very limited quantity (e.g. *Bittium latreillii*, *Jujubinus exasperatus*, *Rissoa auriscalpium*, the latter however prefers shallower meadows) or were absent (e.g. *Smaragdia viridis*, a few specimens were found in the rhizomes). The leaves stratum hosts however some interesting species due to their spotty distribution (*Chauvetia* aff *brunnea*) or restricted range (*Alvania settepassii*). No significant differences could be recognized between assemblages living on *Posidonia* settled on different substrata (soft *vs* hard) and this is consistent with the lack of significant differences of shoot density which is the main *Posidonia* bed structure parameter. Most of the characteristic species described by Pérès & Picard (1964) are present (e.g.: *Jujubinus exasperatus*, *Rissoa auriscalpium*, *Rissoa violacea*, *Pusillina philippi*, *Bittium latreillii*, *Ocinebrina aciculata* and *Chauvetia* aff. *brunnea*).

This community is dominated by microalgae herbivores both in terms of number of specimens and species. However, carnivores may be a very important component being present up to 83.3% of the total number of specimens within a single replicate as already described for other deep water .

Comparison with data sets from other localities suggest that deep water (below 15 m) communities are significantly different from shallower water ones in terms of species composition and abundance. Due to this issue, the variation of the community across geographic gradients couldn’t be investigated satisfactorily.

2.4 Analysis of the Posidonia *rhizomes species assemblage*

The malacocoenosis of the *Posidonia* rhizomes is rich and diversified. Eighty-eight species were collected. Several species are rare and of deep water affinity like *Hanleya hanleyi*, *Obesula marisnostri*, *Mathilda gemmulata*. Almost a third of the community is composed by carnivores and 24.1% of the species are specialized carnivores on preys without mobility (Fissurellidae, Triphoridae, Cerithiopsidae, Eulimidae, Pyramidellidae) and this enhances diversification and rarity. Microalgae herbivores are a fourth of the assemblage and another fourth is made by filter-feeders.

Posidonia oceanica settles in the Secche di Tor Paterno reefs on two different substrata: hard coralligenous concretions and small sedimentary pools. The two assemblages are not significantly different, however those living on soft substratum have an high presence of infaunal species.

Comparison with other data-sets further supports the hypothesis that the rhizome layer of *Posidonia* hosts a rich molluscan community, much richer than the leaves stratum, and with reduced dominance phenomena. Despite the ubiquitous *Bittium latreillii* dominates 60% of studied samples, the other 40% show a wide array of dominant species.

To maximize the sampling success in this environment both defoliation and a wide area (1 m^2) is suggested.

2.5 Analysis of the coralligenous species assemblage

In terms of species diversity, the coralligenous hosts the richest species assemblage with 123 species, 77.4% of the whole Secche di Tor Paterno fauna. The richness of the coralligenous is due to the richness of niches and interactions. The mixture of hard substrata and soft enclaves, the richness of sessile species (sponges, gorgonians,…), the sciaphilous conditions help creating the most suitable conditions for boosting molluscan diversity. Several species are rare or of deep water affinity: *Danilia tinei*, *Obesula marisnostri*, *Cerithiopsis nofronii* and *Typhinellus labiatus*. *Lima lima* and *Manupecten pesfelis*, both considered characteristic species of the biocoenosis in the literature were found here too.

The coralligenous stations seem to host a rather homogeneous assemblage without significant differences between samples and stations. The biocoenosis is dominated by microalgae herbivores, but carnivorous are an important part of the community and one of the reasons for such a high diversity.

Comparison with other data sets is biased by the great difference in the sampling technique. However, right on this issue it is possible to draw some conclusions. The air-lift sampler performed very well when the number of species and specimens intercepted is concerned. However, it does not manage to sample cemented species (e.g.: Vermetidae, Chamidae, Spondylidae) and may undersample species firmly attached to the substratum (e.g. *Striarca lactea*, *Hiatella arctica*, Brachiopoda). Scraping allowed to sample these taxa, but its representation of the biodiversity is lower and the damage to the substratum much higher. Moreover, the air-lift sampler manages to sample better the sediment enclaves in the coralligenous.

2.6 Analysis of the detritic species assemblage

Detritic pools within the reefs may be ascribed to the coastal detritic biocoenosis (DC; Pérès & Picard, 1964). The detritic pools host a poor species assemblage, 22 species, however most of them are exclusive of these soft substrata and these samples have added several species to the knowledge of the malacofauna of the reefs. The only typical molluscan species cited by Pérès & Picard (1964) for this biocoenosis and sampled in the Secche di Tor Paterno pools is *Crassopleura maravignae*.

Specialized carnivores contribute to the biodiversity with a high number of species, up to 40%. Remarkably, bivalves and filter feeders are not dominant despite soft substrata are usually a suitable environment for them.

The comparison with data sets from the soft substrata around the reefs and within the boundaries of the Marine Protected Area show that the two assemblages are remarkably different. However, when the analysis is run to understand differences between biocoenoses, the coastal detritic station sampled by Università Tor Vergata is the only without statistically significant differences from the detritic pools confirming the hypothesis that this peculiar environments belong to this biocoenosis, despite it probably represents a different and still to be described facies.

2.7 Agreement between death and living assemblages

The analysis of the agreement between death and living assemblages is of interest both in paleoecological reconstruction and in biodiversity conservation, since it could allow the assessment of the biodiversity of an area with a reduced effort and with the advantage of analyzing a time-averaged assemblage which sums up the contribution of several seasons and years.

The study has been carried out by a qualitative comparison of samples from the death and living assemblages, with standard metrics and multivariate techniques. The minimum volume for a meaningful analysis has been evaluated in 1 liter of sediment. The analysis was carried out both with the complete data set and with a reduced one with only those species which contribute more than 1% to the overall abundance.

The comparison between living and death assemblages showed that there is a high representativeness of sediments in respect of nearby biocoenoses as a result of low bottom transport. It is important to specify that the spatial scale is in the meters or a few tens of meters. This is supported by:

- the neat differentiation of the death assemblages nearby different biocoenoses both by a taxonomic and quali-quantitative point of view, despite being spatially close to other biocoenoses
- the taxonomic composition of sediments which is strongly influenced by the living communities (e.g. reduced presence of species of the coralligenous endobenthos in the *Posidonia* assemblage)
- The decrease in the values of some fidelity metrics if the full biocoenoses data set is considered instead of only data from the stations nearest to the sediment collection sites

Sediments contain some allochthonous species which thrive in the soft substrata around the reefs (mainly bivalves) and some species which couldn't be intercepted in the biocoenoses survey due to the little destructive sampling techniques used (e.g. endobenthos species, cementing species). When evaluating the biodiversity of the area, the former should be put apart while the latter are an important addition to the knowledge of the area.

Fidelity metrics suggest a good agreement between the living and death assemblages when species richness and taxonomic composition are considered. However, metrics values have to be evaluated in the context of highly diverse molluscan assemblages with little dominance phenomena quite different from those proper of soft substrata which were studied in a number of cases in literature and also different from the few hard substratum cases in literature which focus on a small number of species due to the choice to select only species above 1 or 2 cm in size.

The study suggests that fidelity is lower when considering the species dominance where important differences are described between the living and death assemblages. These differences could be associated to the trophism of species and possibly to the species life span.

The interpretation of recent and fossil thanatocoenoses is seriously affected by the lack of appropriate knowledge on molluscs life histories. Detailed in formation on diets, seasonality, pluriennial variability of populations and information on life spans of species are keys for a full comprehension of biocoenoses dynamics and their contribution to death assemblages. Reversely, fossil death assemblages need this information for their interpretation in a paleoecological perspective.

The study results will help in a better interpretation of paleontological data and foresee good potentialities for the monitoring of biocoenoses using nearby death assemblages. When the latter is considered, the limited diving bottom time required to sample sediments in respect to biocoenoses and the limited field time for treating samples after collection and before laboratory would allow faster surveys and/or greater spatial resolution of sampling. Moreover, the time-averaging effect allows a better description of the fauna, which can be surrogated only by multi-season, pluriennal biocoenoses surveys. However, dead specimens tend to loose important diagnostic characters and may require more skilled personnel for sorting and identification. Another evident drawback of this technique is the limitation to taxa leaving post-mortem remains. Mollusca, however, is the most diverse benthic phylum and therefore allows a good description of the biocoenoses.

3 Introduction

3.1 The studied area

The Marine Protected Area "Secche di Tor Paterno" lies in the Central Tyrrhenian Sea, off the coasts of Lazio (Fig. 1). It is an off-shore reef 12 miles off the coast. The top of the reef is at -18 m, its maximum depth is around -70 m where muddy substratum is found.

It is part of a wider set of off-shore reefs (Fig. 2), made of three main reefs. The "Secche di Terra" are the nearest to the coast and the most shallow, ranging in depth from a few metres to 18-20 metres. The "Secche di Mezzo" are those within the borders of the Marine Protected Area. The "Secche di Fuori" lie on a bottom of a hundred meters deep.

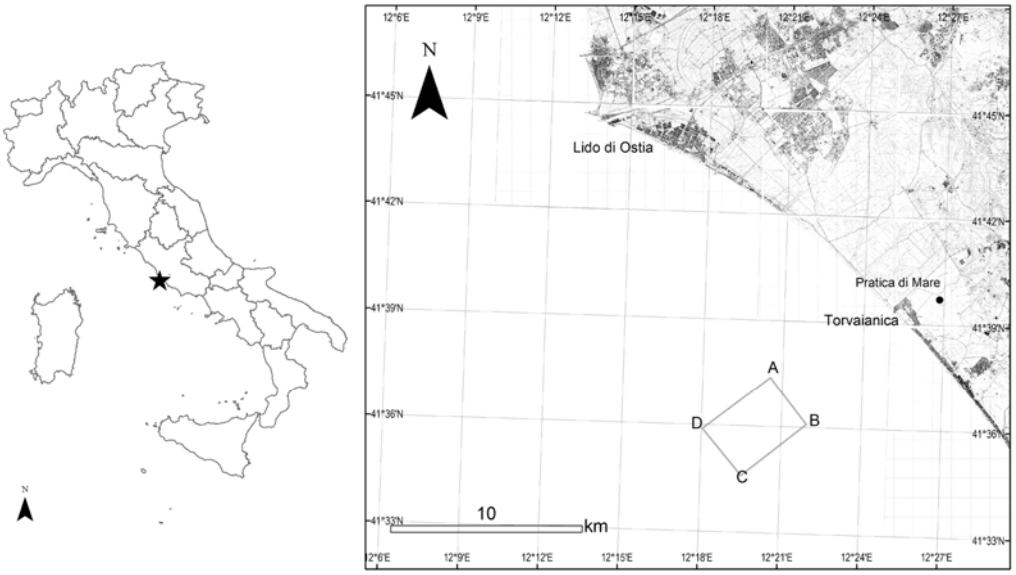


Fig. 1 – Location of the Marine Protected Area "Secche di Tor Paterno" in the Central Tyrrhenian Sea. Lido di Ostia is just south of the river Tevere estuary, which flows through Rome.

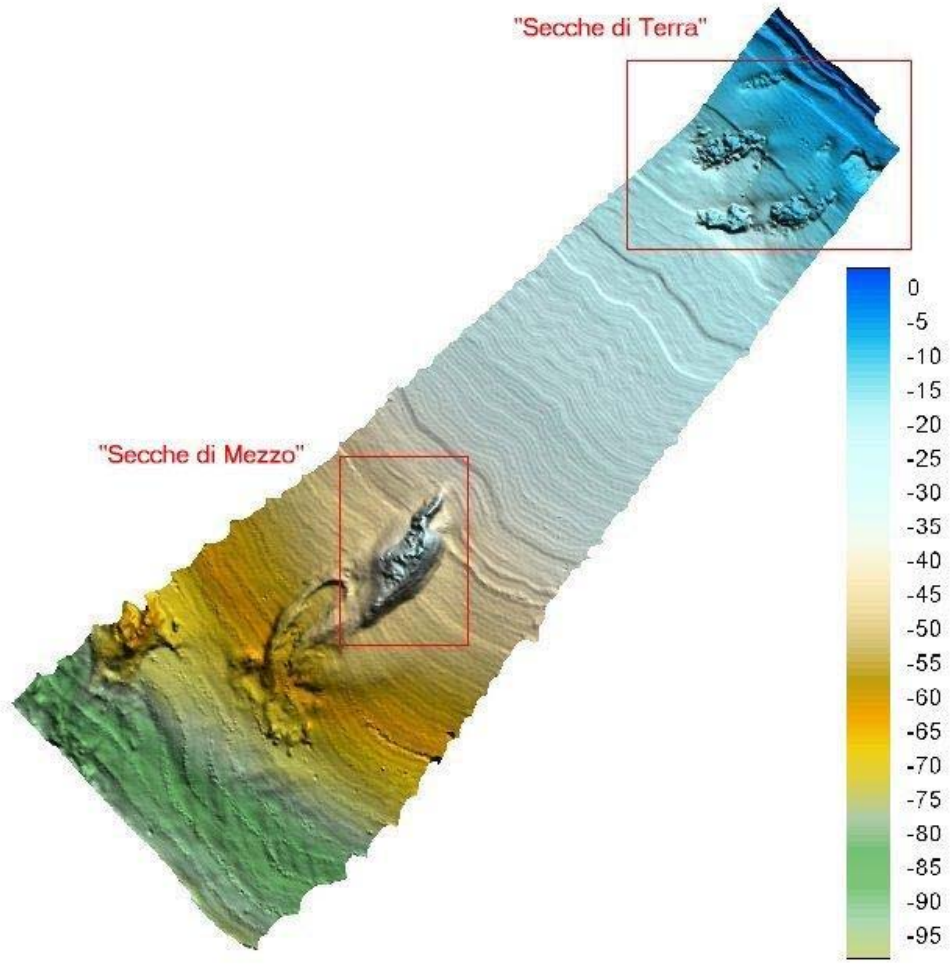


Fig. 2 – Bathimetry of the area. The "Secche di Fuori" are too off-shore to be illustrated here. The image is orientated northwards, different shades of colour represent different depths. (courtesy Nautilus Società Cooperativa)

This area is of great conservation interest for several reasons.

First, it is the only Italian marine protected area totally off-shore, without any coastal zone. It is therefore a peculiar conservation experiment and its fauna and biology may be representatives of other off-shore reefs which do not enjoy any kind of protection.

Secondly, it hosts two important benthic biocoenoses: the coralligenous and *Posidonia* meadows.

The former are calcareous formations of biogenic origin typical of Mediterranean benthic environments, produced by the accumulation of encrusting algae growing in dim light conditions which host several associations and facies. This habitat is considered important for conservation by the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention. Relini (2002) considers most of the associations and facies of the coralligenous remarkable or extremely important for conservation purposes.

The latter consists in meadows of the endemic Mediterranean seagrass *Posidonia oceanica* ((L.) Delile, 1813). It is an habitat enlisted in Annex I of the Council Directive 92/43/EEC "on the conservation of natural habitats and of wild fauna and flora" of the European Union. Annex I lists the "natural habitat types of Community interest whose conservation requires the designation of special areas of conservation". Moreover, *Posidonia* beds (*Posidonion oceanicae*) (code 1120) are marked as priority habitats for conservation. Due to this presence, the Marine Protected Area "Secche di Tor Paterno" is a site of Community importance of the Natura 2000 network (code IT6000010). The site is 27 hectares, with a maximum depth of –25 m (lower depth at which *Posidonia* patches are found) and its *Posidonia* cover is extimated at 5% (Ministero dell'Ambiente e della Tutela del Territorio, 2002). *Posidonia* is rarely present as

a meadow *sensu stricto*: it is more often present as patches in the coralligenous substratum. Small meadows are present where a large enough sedimentary area is present.

3.2 Why sampling in a marine protected area?

Reasons for such a work in a marine protected area lies in the field of conservation, ecology and biodiversity.

I stronlgy agree with Giangrande's view (2003) that inventories of the biodiversity of protected areas are essential. They allow the production of taxonomic lists for the characterization of the different biotopes inside the area and the production of a data set for future comparison. Giangrande discusses this topic about areas proposed for protection, but it applies to already established protected areas too if the basic information is lacking. The main objective of this work was exactly to be a starting point for the study of the biodiversity of the "Secche di Tor Paterno" Marine Protected Area. Despite it is mostly limited to molluscs, its level of detail is far above previous studies. Not only faunistic lists are provided, but different biotopes are characterized and studied on their own and some ecological issues are treated too.

The results of this work will be useful for the management of the area especially if further study will be funded in order to have a comparable set of data in a few years. A marine protected area is expected to protect a pristine habitat. Off-shore reefs are a common feature of the Italian coast-line and the results of the analysis of Tor Paterno reefs can be a bench-mark for the analysis of further reefs elsewhere in Italy and in the whole Mediterranean Sea.

Last, monitoring of European Union priority habitats like the *Posidonia* fields is required by law and this can be a contribution towards the fulfillment of these duties.

3.3 The molluscan fauna

This study has been focused on the *phylum* Mollusca.

Mollusca is one of the most diverse marine *phyla*. The number of estimated described marine species is roughly 53,000 with a yearly increment of 350 new species (Bouchet, 2006). The Mediterranean Sea alone hosts almost 2,000 species (Chiarelli in his 1999 annotated check-list recorded 1,792 species, new species have been described and new lessepsian migrants and aliens have been reported since then). The Mediterranean fauna is one of the best known in the world since it has been studied since the 19th century by many scholars. Despite difficult groups still exist and the taxonomy is often complicated by a pletora of unclear taxa and poor comparison with paleontological material, we can assess that most species can be identified to the genus level and a very good percentage to the species level.

Molluscs are recognized as excellent descriptors of benthic biocoenoses (Gambi et al., 1982). Moreover they are worldwide recognized as good descriptors of biodiversity (Wells 1998; Mikkelsen & Cracraft 2001; Gladstone 2002; Smith 2005).

Most molluscs have a calcareous shell which does not easily dissolve after the death of the animal. Therefore, shells represent an important part of thanatocoenoses and the study of recent biocoenoses allows comparisons with recent and fossil thanatocoenoses.

Most Molluscs retain in the adult shell the larval one, allowing inference about the their type of development (planktotrophic vs non-planktotrophic). This has important consequences on the study of the dispersal of species, colonization phenomena and biogeography.

The malacofauna of the Secche di Tor Paterno was poorly studied in the past.

The most relevant study was carried out by the La Sapienza University in Rome in early '90s (1993). The study was aimed at describing the environmental characteristics and fishery resources of the area and covers different biocoenoses and animal and vegetal groups. Molluscs are covered in good detail and a check-list of 445 species is provided. This list is the result of several years of study by University scholars and other researchers from all biocoenoses of the area: from shallow water (a few meters deep) "Secche di Terra" to the deep water (more than a hundred meters) "Secche di Fuori". The material which allowed to compile this list was obtained in several ways from fishermen's nets to divers' samplings, from thanatocoenoses analysis to net sampling on *Posidonia* leaves. This check-list reports many species from these shallow and deep water environments which nowadays are not within the Marine Protected Area. This study has also been based on benthic samplings by brushing hard substrata on 20×20 centimeters squares from 21 to 37 meters deep,

collecting 449 specimens and 40 species. This technical report is poorly known and had little distribution while its synthesis was published a few years later (Ardizzone *et al.,* 1998).

The University Tor Vergata in Rome carried out two surveys of the area (Ministero dell'Ambiente, 1998; Cataudella, 2005). Both these surveys have a wider environmental point of view and information on molluscs is limited to the most common species. However, data on coralligenous and *Posidonia* meadows are given and help to have a better view of these habitats in this area.

A few publications have taxonomical interest. In 1984 Amati & Nofroni described a new species of gastropod from the Secche di Tor Paterno (*locus typicus*): *Alvania settepassii* (Gastropoda, Rissoidae). In 1987 Amati described two new species from the Mediterranean Sea: *Cerithiopsis nofronii* (Gastropoda, Cerithiopsidae) and *Chrysallida moolenbeeki* (Gastropoda, Pyramidellidae). Both these species have a wider Tyrrhenian Sea distribution, however paratypes were selected from the Secche di Tor Paterno.

Smaller contributions were made by Oliverio & Villa (1981, 1983). These two papers do not deal specifically with the fauna of the Secche di Tor Paterno, but with the fishermen's nets samples from boats harboured in Fiumicino (Rome). However, vessels from this town went to the Secche di Tor Paterno area so can indirectly give information on the fauna, especially of the deeper water soft substrata around the rocky reefs.

Last, Nicolay & Angioy (1993) illustrate a couple of gastropods: *Clathromangelia quadrillum* (Gastropoda, Conidae) and *Typhinellus sowerbyi* (Gastropoda, Muricidae). Despite these are well known Mediterranean species, this paper is one of the very few which illustrates specimens from the area.

Despite the survey by La Sapienza University yelds a lot of information and a rich check-list is provided, the malacofauna of the protected area has never been studied in the detail presented here. As better described in chapter 4, most samplings have been made by SCUBA diving with efficient techniques. The huge number of living specimens found has allowed to have a clearer idea of the living malacofauna in the protected reefs and to analyse in detail many local ecological issues. Moreover, the great amount of data allowed to draw general conclusions on the ecology of these biocoenoses.

The samplings were so effective that many other *phyla* were sampled. Research is going on and Brachiopoda has been studied in detail (Evangelisti *et al*., in print). Brachiopoda were not treated in any other study on this area.

3.4 Abbreviations

In graphs and tables the sampled biocoenoses are often indicated by the following abbreviations:

COR: coralligenous;

FOP: foliar layer of *Posidonia oceanica*;

RIP: rhizome layer of *Posidonia oceanica*;

DET: detritic substratum.

4 Materials and methods

4.1 Field activity

Sampling took place from late May to late June 2007 and was carried out by a SCUBA diving team composed by 4 people from a diving boat.

Three different sampling techniques were used:

1. The most used was suction sampling by way of two diver-operated air-lift suction samplers. The airlift consisted of a PVC tube of a minimum length of 120 cm and of 6**.**5 cm diameter, with a scuba cylinder supplying air, fitted at 10 cm above the mouth of the tube. The other end of the tube was affixed to a 0**.**5 mm mesh nylon bag that could be removed, closed and replaced underwater.
2. On *Posidonia* leaves a net was used. The net had a rectangular metal frame, 20 × 40 cm in size. A 0.5 mm plastic bag was attached to the frame and the nets were tightly closed after sampling before being taken to the surface to avoid losing specimens.
3. Last, sediment samples were collected by hand with cloth bags.

Sampling took place in four different habitats which represent all biocoenoses at the infralittoral depths of the reefs:

1. The coralligenous. This was the most sampled environment because it covers most of the reefs and because it is less studied than soft-substrata and *Posidonia*.

   Sampling was carried out on a 1 m × 1 m square frame. Particular care was placed in sampling crevices, pools and underside of rocks which were present in the sampling area. Three replicates per each station were carried out.
2. The *Posidonia oceanica* patches at the foliar layer.

   This habitat was sampled with the rectangular net. Three replicates were carried out at each station and 20 strokes were given at each replicate along a path which was later sampled at the rhizome layer. Since *Posidonia* is mostly present in small patches, it was not possible to sample the 60 strokes per replicate as usually done (Buia *et al.,* 2003). However, a total of 60 strokes per each station was.
3. The *Posidonia oceanica* patches at the rhizome layer.

   The area sampled at the foliar layer was then defoliated (taking care about cutting leaves and not rhizomes) to maximize sampling efficacy (Bonfitto *et al.,* 1998). Then suction sampling was carried out on a 1 m × 1 m square frame. At each station 3 replicates were carried out.
4. The detritic pools in the reefs.

   The pools were sampled on a 1 m × 1 m square frame. At each station 3 replicates were carried out.

   Hand-collected sediments from the detritic pools were collected without replicates.

In the *Posidonia oceanica* stations the rhizome density was evaluated on a 25 × 25 cm frames as leaves length, width and number per each rhizome.

Station	Samples	Buoy [1]	Latitude	Longitude	Biocoenoses	Habitat details	Depth	Sampling method	Date [dd/mm/yy]
1	**S1 S2 S3**	7	41° 36' 21" N	12° 20' 28" E	Coralligenous	Horizontal hard substratum with *Eunicella* spp.	-25 m	Suction sampler	21/05/2007
2	**S4 S5 S6**	8	41° 36' 18" N	12° 20' 30" E	Coralligenous	Vertical wall with *Eunicella* spp. and *Paramuricea clavata*	-27 m	Suction sampler	25/05/2007

[1] The stations were placed near buoys to moor boats installed to protect benthic substrata from anchorage.

Station	Samples	Buoy [1]	Latitude	Longitude	Biocoenoses	Habitat details	Depth	Sampling method	Date [dd/mm/yy]
3	**S7 S8 S9**	8	41° 36' 18" N	12° 20' 30" E	Coralligenous	Horizontal hard substratum with *Eunicella* spp.	-25 m	Suction sampler	25/05/2007
4	**S10 S11 S12**	6	41° 36' 15" N	12° 20' 29" E	Coralligenous	Horizontal hard substratum with *Eunicella* spp.	-26 m	Suction sampler	07/06/2007
5	**S13 S14 S15**	6	41° 36' 15" N	12° 20' 29" E	Detritic	Detritic pools in coralligenous substratum	-28 m	Suction sampler	07/06/2007
10	**S16 S17 S22**	1	41° 36' 13" N	12° 20' 30" E	Coralligenous	Horizontal hard substratum with rare *Eunicella* spp.	-20 m	Suction sampler	20/06/2007
11	**S18[2] S19 S20 S21**	4	41° 36' 07" N	12° 20' 20" E	Coralligenous	Horizontal hard substratum with *Eunicella* spp.	-25 m	Suction sampler	21/06/2007
-	**R1 R2 R3[3]**	1	41° 36' 13" N	12° 20' 30" E	*Posidonia oceanica*	*Posidonia* patches on hard substratum – foliar layer	-24m	Net	21/05/2007
6	**R4 R5 R6**	7	41° 36' 21" N	12° 20' 28" E	*Posidonia oceanica*	*Posidonia* patches on hard substratum – foliar layer	-26 m	Net	08/06/2007
8	**R7 R8 R9**	1	41° 36' 13" N	12° 20' 30" E	*Posidonia oceanica*	*Posidonia* field on soft substratum – foliar layer	-26 m	Net	20/06/2007
7	**SP1 SP2 SP3**	7	41° 36' 21" N	12° 20' 28" E	*Posidonia oceanica*	*Posidonia* patches on hard substratum – rhizome layer	-26 m	Suction sampler	08/06/2007
9	**SP4 SP5 SP6**	1	41° 36' 13" N	12° 20' 30" E	*Posidonia oceanica*	*Posidonia* field on soft substratum – rhizome layer	-26 m	Suction sampler	20/06/2007
-	**D1 Substratum sediment**	1	41° 36' 13" N	12° 20' 30" E	*Posidonia oceanica*	Thanatocoenoses nearby small *Posidonia* meadow	-25 m	Hand collected	20/06/2007
-	**D2 Substratum sediment**	8	41° 36' 18" N	12° 20' 30" E	Coralligenous	Thanatocoenoses at the base of a wall with *Eunicella* spp. and *Paramuricea clavata*	-27m	Hand collected	25/05/2007

Tab. 1 - Station list, Marine Protected Area "Secche di Tor Paterno", Central Tyrrhenian Sea, Italy

[2] Replicate S18 was excessively poor because a suction sampler got stucked with rocks. This replicate was not used for the following studies, except for the qualitative information on collected species. Another sampling was done in the same station, S21, to maintain the three replicates per station rule.

[3] Replicates R1, R2 and R3 were originally sampled as a test of the sampling equipment and not intended for further analysis. However, since the fauna of the foliar layer of *Posidonia oceanica* proved to be very poor, these replicates were retained in order to use all the information available.

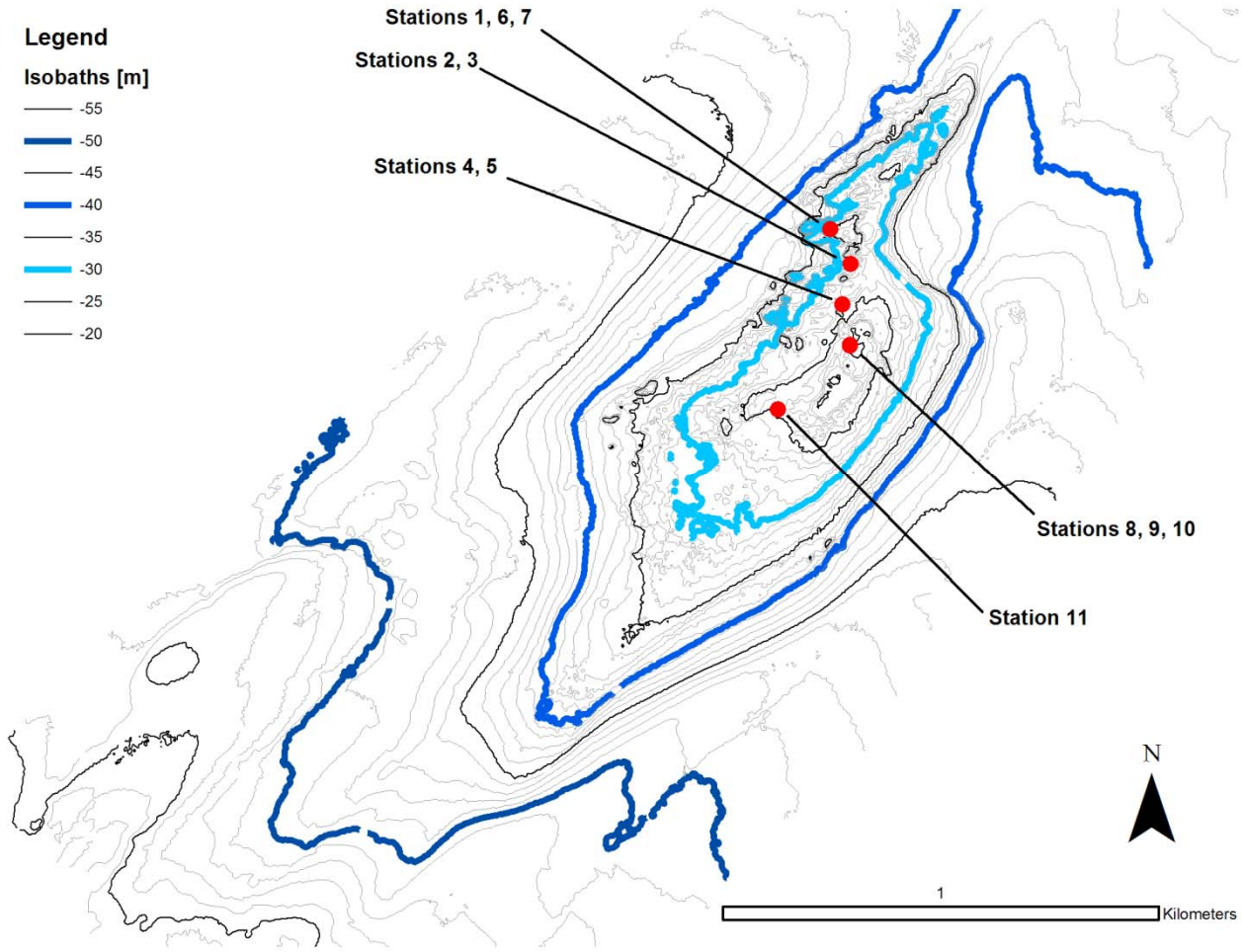


Fig. 3 – Location of stations on the reefs

Sampling was difficult because of occasional poor visibility, depth and strong currents.

Samples were sieved and the coarsest part was discarded in the field. Live collected specimens were hand-picked and placed in sea water for photography of the living animal. Some small specimens were taken to the labs in the University of Bologna for photography of the living animal under stereomicroscope.

All hand-picked specimens were then placed in ethanol 95% as it was done with bulk samples after further sieving with meshes 1 mm, 3 mm and 5 mm wide.

4.2 Laboratory sorting

Samples were analyzed in the lab, picking live collected specimens up. These were counted and identified at the species level whenever possible. Dead specimens were also picked up and identified. Non-shelled Mollusca were retained but not counted and identified.

All live collected specimens are preserved in ethanol 95%. Specimens belonging to other *Phyla* than Mollusca are preserved in ethanol 95% for further study.

4.3 Data analysis techniques

Several statistical techniques were used to treat data. Multivariate data are represented by input matrices of *p* rows (usually species) and *n* columns (usually samples). Most computing was done with the software PRIMER-E versions 5 and 6 (Clarke & Gorley, 2006). Accumulation curves and biodiversity estimations were carried out with EstimateS (Colwell, 2006). Most other computing was done with Microsoft Excel.

The description below is taken from a few statistical manuals (e.g.: Clarke & Warwick, 2001; Soliani, 2005) and has the aim to shortly describe the data analysis techniques. A short comment about the technique results or parameters choices is usually included so that choices in the analysis can be fully understood.

4.3.1 Standardisation

Prior to subsequent analysis, multivariate data were sometimes standardised.

This means that instead of using the absolute quantities, e.g. of specimens found for each species, relative numbers were used and each data input matrix entry is divided by its column total and multiplied by 100.

$$y_{ij}^{s} = \frac{y_{ij}}{\sum_{i=1}^{p} y_{ij}} \cdot 100$$

where:

y_{ij} is the data matrix entry

y_{ij}^{s} is the standardised matrix entry

p is the total number of rows of the data matrix entry

Standardisation was used whenever the volume of samples differed much which was often evidenced by great variation in the total number of specimens for each sample.

In this way, the percentage composition of the sample is considered.

4.3.2 Transformation

Another treatment of raw data before further computing was transformation.

Transformation of data applies a mathematical formula to each data matrix entry. Depending on the formula used the effect on data differs as follows:

- No transformation. This will imply that only the common species contribute to the similarity.
- The less severe transformation is the root transform ($\sqrt{y}$). It has the effect of down-weighting the importance of the highly abundant species, so that similarities between samples depend not only on their values but also those of less common ("mid-range") species.
- A more severe transformation is the 4th root transform ($\sqrt{\sqrt{y}}$). This transformation takes the down-weighting of highly abundant species further, allowing not only the mid-range but also the rarer species to exert some influence on the calculation of similarity between samples.
- An alternative severe transformation with very similar effect to the 4th root is the *log* transform. To avoid the occurrences of log 0 computing, the formula used is:

  $$y_{ij}^{t} = \log_e(1 + y_{ij})$$

  where:

  y_{ij} is the data matrix entry

  y_{ij}^{t} is the transformed matrix entry

  In this way transformed values are always greater than 0 when y_{ij} is greater than zero too and 0 when y_{ij} is 0.
- The most severe transformation is a reduction of the quantitative data to *presence/absence*. This can be thought of the ultimate transformation in down-weighting the effects of common species.

4.3.3 Similarity matrix

Most multivariate data analysis techniques use the concept of similarity (*S*) between any pair of samples (or more generally of arrays in an input matrix). This brings to the construction of a similarity lower triangular matrix.

To compute the similarity between arrays many methods have been suggested over the years. The Bray-Curtis coefficient (Bray & Curtis, 1957) was mostly used in this work.

The similarity between the j^{th} and k^{th} samples, S_{jk}, has the following definition:

$$S_{jk} = 100 \cdot \left\{ 1 - \frac{\sum_{i=1}^{p} |y_{ij} - y_{ik}|}{\sum_{i=1}^{p} (y_{ij} + y_{ik})} \right\}$$

where:

S_{jk} is the similarity between the j^{th} and k^{th} samples

y_{ij} represents the entry in the i^{th} row and j^{th} column of the data matrix

y_{ik} represents the entry in the i^{th} row and k^{th} column of the data matrix

S_{jk} is 0 if the two samples have no species in common while S_{jk} is 100 if two samples are identical.

A property of this coefficient is that similarity depends on species which are present in one or other (or both) samples, and not on species which are absent from both.

4.3.4 One-way ANalysis Of VARiance (ANOVA)

The univariate analysis of variance was computed by the F-test using the following formula:

$$F = \frac{variance\ of\ the\ group\ means}{mean\ of\ the\ within-group\ variances}$$

or, more accurately:

$$F = \frac{s_B^2}{s_w^2}$$

where:

s_B^2 is the variance between groups, computed with:

$$s_B^2 = \frac{SS_B}{\nu_B}$$

SS_B is the sum of squares of the mean of each group and the mean of the whole mean value of all groups:

$$SS_B = \sum_{j=1}^{p} n_i \left(\bar{X}_j - \bar{\bar{X}} \right)^2$$

with:

n_i is the number of data of the i^{th} group

$\bar{X}_j$ is the mean of each group

$\bar{\bar{X}}$ is the whole mean value of all groups

ν_B is the degrees of freedom between groups

$$\nu_B = p - 1$$

with p the number of groups

and:

s_w^2 is the variance within groups, computed by:

$$s_w^2 = \frac{SS_w}{\nu_w}$$

SS_w is the sum of squares of differences between each element of a group and the group mean:

$$SS_w = \sum_{j=1}^{p} \sum_{i=1}^{n_i} \left(X_{ij} - \bar{X}_j \right)^2$$

with:

n_i is the number of data of the i^{th} group

X_{ij} is the element of the group

$\bar{X}_j$ is the mean of each group

ν_w is the degrees of freedom between groups

$$\nu_w = n - p$$

with *n* the total number of elements of all groups and *p* the number of groups.

Statistical significance is tested for by comparing the F test statistic to the F-distribution.

The null hypothesis is rejected when the test statistic is greater than the tabled value.

Significance level was usually fixed at α=0.05.

The F-test can be used as a global test and as a pairwise test between the different types of samples. However, in this case the risk of type I errors (detecting a difference when it does not exist) will cumulate. Therefore the Bonferroni correction may be applied and the significance level is reduced to

$$\alpha' = \frac{\alpha}{n}$$

where *n* is the number of pairwise comparisons, despite the increase of risk of type II errors (not detecting a difference when one exists).

Please note that the meaning of indices (*i*, *j*) and other simbols (*n*, *p*, etc) used here is different from those used when treating data matrices for multivariate analysis.

4.3.5 Mann–Whitney U test

The Mann–Whitney U test is a non-parametric test for assessing whether two independent samples of observations come from the same distribution. It is virtually identical to performing an ordinary parametric two-sample t-test on the data after ranking over the combined samples.

This test has been used every time the hypothesis of normality needed for a t-test was not supported.

4.3.6 Cluster analysis

Cluster analysis aims to find natural groupings of samples such that samples within a group are more similar to each other, generally, than samples in different groups. It may be useful to see whether replicate samples within a site form a cluster that is distinct from replicates within other sites and can be an overview of differences between type of sites. It is a method that can be used in cases where the samples are expected to divide into well-defined groups, while it is not appropriate when samples are expected to respond to a more continuous gradient of variation.

The clustering technique used here is the hierarchical agglomerative method which takes the similarity matrix as its starting point and successively fuse the samples into groups and the groups into larger clusters creating a dendrogram.

The process involves the iterative construction of similarity matrices by successive fusing of samples. The combination of similarity values may follow three methods:

- Single linkage,
- Complete linkage,
- Group-average link.

Single link clustering has a tendency to produce chains of linked samples, with each successive stage just adding another single sample onto a large group. Complete linkage will tend to have the opposite effect, with an emphasis on small clusters at the early stages. Group-average link tends to stay in the middle between these two extremes.

4.3.7 Non-metric Multi-Dimensional Scaling (MDS)

This is an ordination procedure first introduced by Shepard (1962) and Kruskal (1964). It constructs a map of the samples in a specified number of dimensions. Its starting point is a similarity or dissimilarity matrix. Its interpretation is in terms of the relative values of similarity to each other and the ranks of the similarities are the only information used by a successful non-metric MDS ordination.

However, there will be some distortion between the similarity rankings and the corresponding distance rankings in the ordination plot and the degree of this distortion is called stress. Stress can be thought of the as measuring the difficulty involved in compressing the sample relationships into (usually) two dimensions. Stress values can be evaluated in this way:

- Stress <0.05 gives an excellent representation;
- Stress <0.1 corresponds to a good ordination;
- Stress <0.2 still gives a potentially useful 2-dimensional picture;
- Stress >0.3 indicates that the points are close to being arbitraly placed in the 2-dimensional ordination space.

To ascertain whether the final result is reliable, the procedure is repeated several times from a different starting point. If the same (lowest stress) solution re-appears from a number of different starts then there is a strong assurance, though never a total guarantee, that this is indeed the best solution. So the number of restarts is a measure of the strength of the final plot.

4.3.8 Multivariate ANalysis Of SIMilarities (ANOSIM)

ANOSIM is a simple non-parametric permutation procedure applied to the similarity matrix underlying the ordination of samples. It tests whether there are statistically significant differences among different multi-variate samples. It was described by Clarke *et al* (1988).

The starting point of its procedure is computing a test statistic reflecting the observed differences between sites contrasted with differences among replicates within sites. The test is based on the rank similarities between samples in the underlying triangular similarity matrix.

The test statistic *R* is computed by:

$$R = \frac{(\overline{r_B} - \overline{r_W})}{\frac{1}{2}M}$$

where:

$\overline{r_B}$ is the average of rank similarities arising from all pairs of replicates between different sites

$\overline{r_W}$ is the average of rank similarities among replicates within sites

and

$$M = \frac{n(n-1)}{2}$$

with *n* the total number of samples under consideration.

R has the following properties:

- It belongs to the range (-1,1) and usually fall between 0 and 1;
- It is equal to 1 only if all replicates within sites are more similar to each other than any replicates from different sites;
- It is approximately zero if the null hypothesis is true, so that similarities between and within sites will be the same on average (differences are due to casuality and not to sites properties);
- It is below zero when similarities across different sites are higher than those within sites and it is highly unlikely.

The second step of the procedure is recomputing the statistic under permutations. If the null hypothesis is true that there are no differences across sites, then there will be little effect on the value of *R* if the labels identifying which replicates belong to which sites are arbitraly rearranged. Since the number of possible

permutations grows quickly with the increase in the number of samples, the full set of permutations is randomly sampled (usually with replacement) to give the null distribution of *R*.

The last step of the procedure is to calculate the significance level by referring the observed *R* value to its permutation distribution. If the null hypothesis is true, the likely spread of values of R is given by the random rearrangements, so that if the true value of *R* looks unlikely to have come from this distribution there is evidence to reject the null hypothesis. The level of significance can be computed by:

$$\alpha = \frac{t+1}{T+1}$$

where:

t is the number of simulated *R* values as large or greater than the observed *R*;

T is the total number of simulated values.

It is therefore important to highlight that the interpretation of the value of *R* is strongly related to its distribution and that the possibility of having a significant permutation depends on the number of replicates which has not to be too low.

4.3.9 SIMilarity PERcentage breakdown (SIMPER)

The SIMPER routine was first described by Clarke (1993). It is an exploratory analysis to locate which species are the greatest contributors to differences between sites or, on the other hand, which species contribute most to similarities within replicates from the same sites.

The average dissimilarity between all pairs of inter-group samples is broken down into separate contributions from each species δ_i. The average contribution of the i^{th} species to the dissimilarities $\overline{\delta_i}$ is usually contributed by many pairs of samples. Therefore its standard deviation SD(δ_i) is informative too.

If $\overline{\delta_i}$ is large and SD(δ_i) small the ratio $\overline{\delta_i}/SD(\delta_i)$ is large too, then the i^{th} species not only contributes much to the dissimilarity between groups 1 and 2 but it also does so consistently in inter-comparisons of all samples in the two groups. It is thus a good discriminating species.

The results of the SIMPER routine are placed in a table like the following:

Species	Group COR Average Abundance	Group FOP Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity %
Chauvetia aff *brunnea*	0.44	1.75	6.27	1.17*	6.94	6.94
Bittium latreillii	23.67	6.00	6.02	1.67*	6.66	13.60
Nassarius incrassatus	8.94	0.00	4.27	2.39*	4.72	18.33

Tab. 2 – Example of the results of a dissimilarity analysis between groups with the SIMPER routine

The columns contain the following data:

- "Group *X* Average Abundance": average relative abundance of the species in the *X* biocoenosis;
- "Average Dissimilarity": average contribution of the species to dissimilarity;
- "Diss/SD": ratio between the average contribution of the species to dissimilarity and the standard deviation of the contribution of the species to dissimilarity, if this ratio is high the species is likely to be a good discriminating one;
- "Contribution to dissimilarity %": percentage contribution of the species to dissimilarity;
- "Cumulations of contributions to dissimilarity%": cumulation of the percentage contribution of the species to dissimilarity.

In much the same way, the contribution each species makes to the average similarity within a group $\overline{S_i}$ can be examined. The more abundant a species is within a group, the more it will contribute to the intra-group similarities. It typifies that group if it is found at a consistent abundance throughout so that the standard eviation SD(S_i) is low and the ratio $\overline{S_i}$/SD(S_i) high.

The results of the similarity analysis by the SIMPER routine are placed in a table like the following:

Species	Group COR Average Abundance	Average Similarity	Sim/SD	Contribution to similarity %	Cumulations of contributions to similarity%
Bittium latreillii	23.67	7.88	2.13*	16.95	16.95
Nassarius incrassatus	8.94	4.61	2.26*	9.93	26.88
Pollia scabra	4.56	3.31	2.23*	7.11	33.99

Tab. 3 – Example of the results of a similarity analysis within a group with the SIMPER routine

The columns contain the following data:

- "Group COR Average Abundance": average relative abundance of the species in the *X* biocoenosis;
- "Average Similarity": average contribution of the species to similarity within the biocenosis;
- "Sim/SD": ratio between the average contribution of the species to similarity and the standard deviation of the average contribution of the species to similarity; the higher it is, the more the species is typical to the biocoenosis; however, this does not mean the species is typical *only* of one biocoenosis, but it can typify more than one;
- "Contribution to similarity": percentage contribution of the species to similarity;
- Cumulations of contributions to similarity%": cumulation of the percentage contribution of the species to similarity.

4.3.10 PERmutational Multivariate ANalysis Of VAriance (PERMANOVA)

PERMANOVA is a computer program for testing the simultaneous response of one or more variables to one or more factors in an ANOVA experimental design on the basis of any distance measure using permutation methods (Anderson, 2005). The method is described in detail in Anderson (2001) and McArdle & Anderson (2001).

PERMANOVA can be applied to the values of similarity matrices or to their ranks alike, this being a difference from ANOSIM (pag. 19) in the one-way case.

When the number of possible permutations is too low, the program uses Monte Carlo sampling to construct the asymptotic permutation distribution for the entire *F* statistic (Anderson *et al.,* 2003). This helps resolving problems of level of significance higher than desired because of the small number of samples.

4.4 Biodiversity indices

Biodiversity indices were used to synthetize the information hidden in samples both using them without further computing or using them in statistical tests (e.g. analysis of variance).

The following biodiversity indices were used.

4.4.1 Number of species (S)

This index is just the total number of species present. The more species there are, the more diverse the sample.

However, this index has to be used with care since its use in non comparable samples may mislead the analysis. For example, it strictly depends on the sampling effort (the bigger the sample, the more species are likely to be).

For this reason, in this thesis it has been mainly used to compute more complex indexes, like Margalef species richness.

4.4.2 Number of specimens (N)

This index is not a true diversity index, but it is an abundance index.

It gives information on the quantity of specimens per sample and when used in relation to the area sampled can describe the density of living specimens in the different samples.

4.4.3 Margalef's species richness (d)

Since the number of species is sample dependent, it is not suitable when different sampling techniques are used or when there are doubts that sampling has been carried out with the same efficacy.

Margalef's species richness index is based on the number of species, but incorporates the total number of individuals too:

$$d = \frac{S - 1}{\log N}$$

Where:

S is the number of species;

N is the number of specimens.

4.4.4 Shannon index (H')

This is the most commonly used diversity index and is computed by:

$$H' = -\sum_{i=1}^{S} p_i \cdot \log_e p_i$$

where:

p_i is the proportion of the total count arising from the i^{th} species:

$$p_i = \frac{n_i}{N}$$

The higher the value of the index, the more diverse is the sample.

Note that the natural logarithm is used.

The Shannon index can be sensitive to the degree of sampling effort and should be compared across equivalent sampling desings.

4.4.5 Equitability (J')

This index expresses how evenly the individuals are distributed among the different species. It is referred as Pielou's evenness index too. It is computed by:

$$J' = \frac{H'}{H'_{max}} = \frac{H'}{\log_e S}$$

This index is close to 1 when all species are equally abundant. It is close to 0 when the sample is highly dominated by a few species.

4.4.6 Simpson index (λ)

This is another commonly used index which has a number of forms. Here two forms are used:

$$\lambda = \sum_{i=1}^{S} p_i^2$$

$$1 - \lambda = 1 - \sum_{i=1}^{S} p_i^2$$

where:

p_i is the proportion of the total count arising from the i^{th} species:

$$p_i = \frac{n_i}{N}$$

The index λ has a natural interpretation as the probability that any two individuals from the sample, chosen at random, are from the same species. λ is always ≤1.

It is a dominance index, in the sense that its largest values correspond to assemblages whose total abundance is dominated by one, or a very few, of the species present. Its complement 1- λ is thus an equitability or evennes index, taking its largest value when all species have the same abundance.

4.5 Biodiversity estimators

Accumulation curves were drawn with EstimateS 8 (Colwell, 2006) with 50 randomizations. Biodiversity estimations were done using the Bootstrap non-parametric first order estimator (Smith *et al.*, 1984) and the Jackknife non-parametric second order estimator (Burnham *et al.*, 1979). The first order estimators take into consideration singletons only, while the second order estimators take into consideration doubletons too.

Singletons are defined by Novotny & Basset (2000) as species represented by a single specimen in the sample. Doubletons are those represented by two specimens in the sample. Species found as a single individual in component communities are called "local singletons", those found as a single individual in the combined data set are called "unique singletons".

4.6 Trophic groups and feeding guilds

Trophic information for all species was mined from the literature. A great effort in citations was placed for every species, the reference is given as a foot note. The following priorities were followed:

1. Specific literature about the species;
2. Specific literature about species of the same genus within the same biogeographic province;
3. Specific literature about species of the same genus or systematically closely related outside the biogeographic province;
4. General references on the supra-specific group.

It has been decided (arbitrarily) to use the same classification of feeding modes and guilds used by Rueda *et al.* (2009) (Tab. 4) for the sole reason that it allows comparison with a work with a similar approach but on a different biocoenosis (*Zostera marina* beds) in a different geographical area (Alboran Sea).

Code	Feeding guild description	Examples
SC	Scavengers	Nassariidae
AG	Herbivores of macroalgae and epiphytes	*Williamia*
MG	Microalgae herbivores	Most Trochidae, Cerithiidae, Rissoidae
SG	Seagrass-feeding herbivores	*Smaragdia*
D	Deposit feeders	*Nucula*, *Nuculana*, Tellinidae, Semelidae
F	Filter feeders	Most bivalves, with the exception of deposit feeders
SY	Symbiont-bearing species	A few bivalves (*Solemya*, Lucinidae, Thyasiridae, *Xylophaga*)
E	Ectoparasites and carnivores on preys without mobility	Triphoridae, Cerithiopsidae, Eulimidae, Epitoniidae, Coralliophilinae, Pyramidellidae, some opisthobranchs
C	Carnivores on mobile prey	Turridae, most Muricidae, some opisthobranchs
O	Egg and spawn feeders	*Mitrella minor*

Tab. 4 – Feeding modes

4.7 The role of species in describing biocoenoses

When describing the fauna of biocoenoses, species can be ascribed to three different categories:

- Characteristic species: these species are typical of a biocenosis, meaning that they are usually found in it notwithstanding their abundance which can be high (constant species) or low (sporadical species). This group can be divided in two further groups: the exclusive species which can be found only in a given biotope or the species which *prefer* the biocoenosis, meaning that in that biotope they are significantly more abundant than in others.
- Accompanying species: these species are normally present in the given biocoenosis as in others. These species may appear at the given depth level, or can be indicators of edaphic conditions or may have wide ecological tolerance and are usually ubiquitarian.
- Accidental species: these are species characteristic of other biocoenoses but occasionally found in the given biotope where they experience limited success (reduced life span, increased predation, inability to reproduce,…).

Particular attention should be given in classifying species which are parasites, symbiontic, commensals or are species-specific epibiontic. Their attitude towards biocoenoses will depend by their host and not by themselves, of course.

Another issue to be considered in general, but which is probably of low interest in benthic molluscs, is that some species may have a different affiliation to biocoenoses in different stages of their development.

5 Sampling results and efficacy

Two main sampling techniques were used in this survey: the hand-net on *Posidonia* leaves and a suction air-lift sampler on other biocoenoses. Both of them were used by SCUBA divers.

The use of hand-nets on *Posidonia* leaves is a technique described in several studies and recently standardised (Buia *et al.,* 2003): sixty strokes per replicate are required. However, this method is thought for 'true' *Posidonia* fields, while in the Tor Paterno reefs we had to face small patches of *Posidonia* or very scattered fields because plants grow on hard coralligenous substratum. For this reason we had to use only 20 strokes per replicate, however taking care of making three replicates per station to have the 60 strokes for each station for being able to compare data with those collected by other scholars. This is a semi-quantitative technique.

On the other hand, the sampling technique for the rhizomes, the coralligenous and the detritic pools is less standardised.

The vagile fauna of the rhizomes of *Posidonia* is sampled in many ways (Buia *et al.,* 2003), but the most efficient and least destructive is the diver-operated suction sampler. It is a quantitative technique. However, there is not a standardisation of this method. One square meter sampled areas are reported in literature (Russo *et al.,* 1986; Giangrande, 1985) too as 40 centimeter squares (Buia *et al.,* 2003).

When it comes to the coralligenous, direct sampling techniques for hard substrata are usually brushing and air-lift suction sampling (Bianchi *et al.,* 2003). Since the investigated area is protected, the suction sampler was preferred because it is less destructive. However, boring endobenthos (e.g. *Lithophaga*, *Gastrochaena*) is difficult to obtain in this way and the analysis of thanatocenoses is useful to have a more complete view of the biodiversity of this complex biocoenosis. Boring endobenthos is present in thanatocoenosis due to the periodic erosion of the bioherms. The issue of the mimimum area to sample is not resolved yet (Bianchi *et al.,* 2003). Due to the complex structure of the coralligenous any two-dimensional size does not describe accurately the quantity of "useful surface" for organisms since this environment is rich in crevices, stones and biohermatic species which greatily augment the surface used by animals and molluscs in particular.

Soft substrata are usually surveyed by indirect techniques like grabs and dredges (Castelli *et al.,* 2003). However, the soft substrata in the reefs are detritic pools of limited extension. The largest pools may be a few tens of meters wide. It is therefore necessary to use a direct technique. Since the main interest were molluscs which usually are buried in the first centimeters of sediment, the air-lift suction sampler was tested here. No standardisation exists for this particular technique in this environment. A 1 m^2 area per replicate was sampled.

5.1 Results

Sampling brought 2,495 living specimens of shelled molluscs. The number of species and specimens for each species are summarized in the following tables.

Station	**1**			**2**			**3**			**4**			**10**			**11**		
Replicate	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21
Specimens	173	25	70	90	126	27	119	113	37	126	123	49	159	62	153	118	122	101
Species	53	11	26	33	34	14	40	33	13	29	35	25	43	25	42	39	44	37

Tab. 5 – Quantitative results for the replicates in the coralligenous

Station	**-**			**6**			**8**		
Replicate	R1	R2	R3	R4	R5	R6	R7	R8	R9
Specimens	24	6	25	6	3	19	0	6	5
Species	5	3	5	2	2	7	0	5	3

Tab. 6 – Quantitative results for the replicates in the *Posidonia oceanica* leaves

Station	**7**			**9**		
Replicate	SP1	SP2	SP3	SP4	SP5	SP6
Specimens	74	94	100	152	70	63
Species	34	33	30	54	31	27

Tab. 7 – Quantitative results for the replicates in the *Posidonia oceanica* rhizomes

Station	**5**		
Replicate	S13	S14	S15
Specimens	24	7	25
Species	16	5	10

Tab. 8 – Quantitative results for the replicates in the detritic pools

The number of specimens per replicate was sometimes very variable (e.g. coralligenous) and this may be dependant to some extent on the different experience of the divers (Tab. 9).

Biocoenosis	n° of samples	Specimens		Species	
		mean	standard deviation	mean	standard deviation
Coralligenous	18	99.6	45.2	32.0	11.4
Posidonia leaves	9	10.4	9.5	3.6	2.1
Posidonia rhizomes	6	92.2	32.6	34.8	9.7
Detritic pools	3	18.7	10.1	10.3	5.5
Total	36	69.3	53.3	23.6	16.0

Tab. 9 – Mean and standard deviation of the samples

Each biocoenosis contributed to the number of species as reported in Tab. 10.

	***Posidonia* leaves**	***Posidonia* rhizomes**	**Coralligenous**	**Detritic pools**
Number of species	14	88	123	22
	Leaves and rhizomes combined: 92			

Tab. 10 – Number of species of each biocoenosis

To evaluate the efficacy of sampling accumulation curves were drawn and biodiversity estimators of the first order (Bootstrap) and second order (Jackknife 2) were used.

The overall sampling in all biocoenoses (Fig. 4) shows that saturation is not achieved. Estimators suggest the expected number of species is between 182 (+14.5%) and 236 (48.4%).

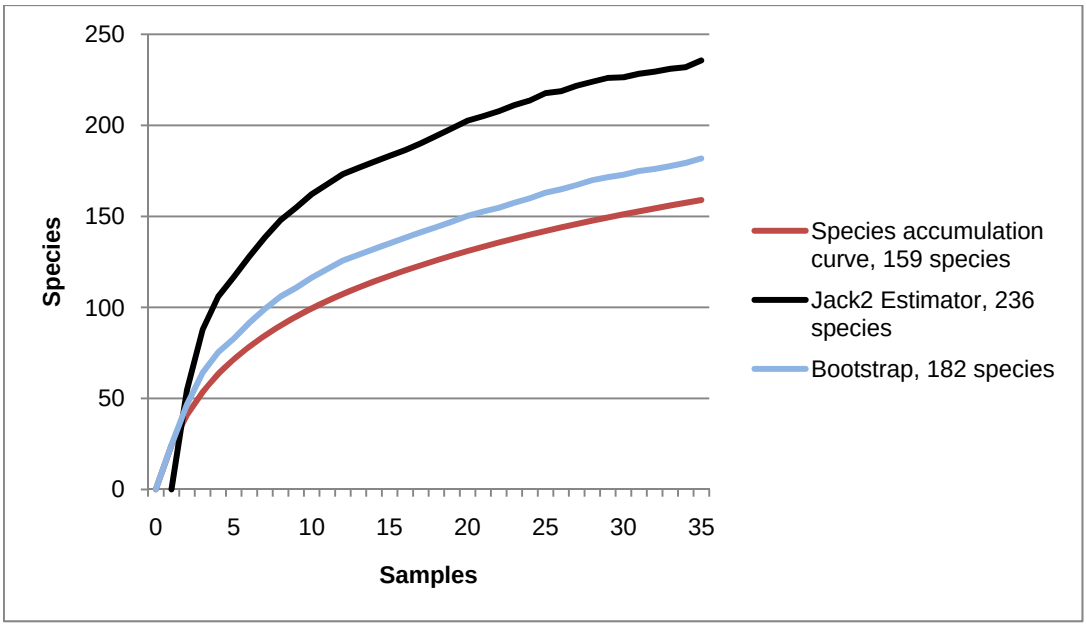


Fig. 4 – Measured and estimated species accumulation curves of the Secche di Tor Paterno (all samples)

The analysis has been performed for every single biocoenosis.

The samples in the *Posidonia* leaves show again lack of saturation (Fig. 5). The estimated number of species ranges between 17 (21.4%) to 26 (+85.7%).

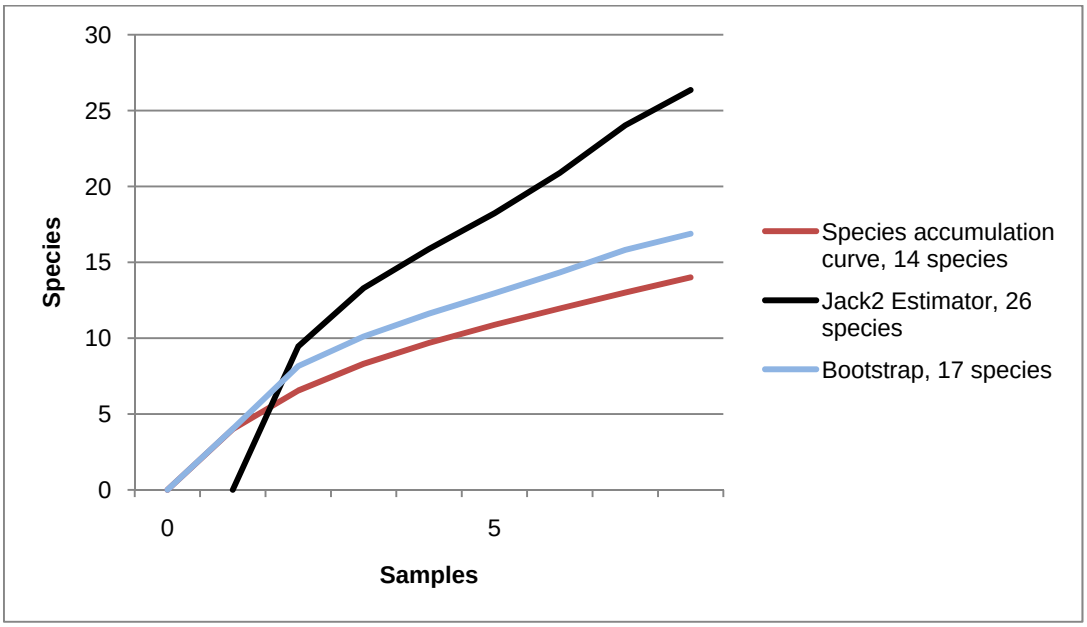


Fig. 5 – Measured and estimated species accumulation curves of the *Posidonia* leaves

The samples in the *Posidonia* rhizomes perform slightly better than the leaves (Fig. 6). The estimated number of species is between 103 (+17.1%) and 137 (+55.7%).

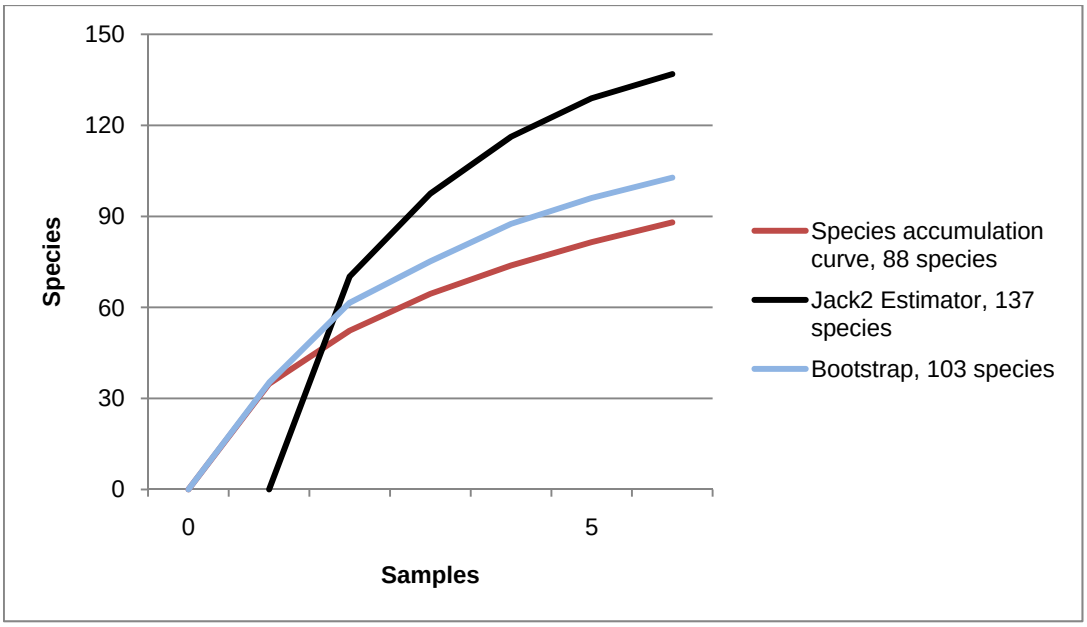


Fig. 6 - Measured and estimated species accumulation curves of the *Posidonia* rhizomes

The coralligenous showed the best saturation (Fig. 7). The estimated number of species is between 141 (+14.6%) and 186 (+ 51.2%).

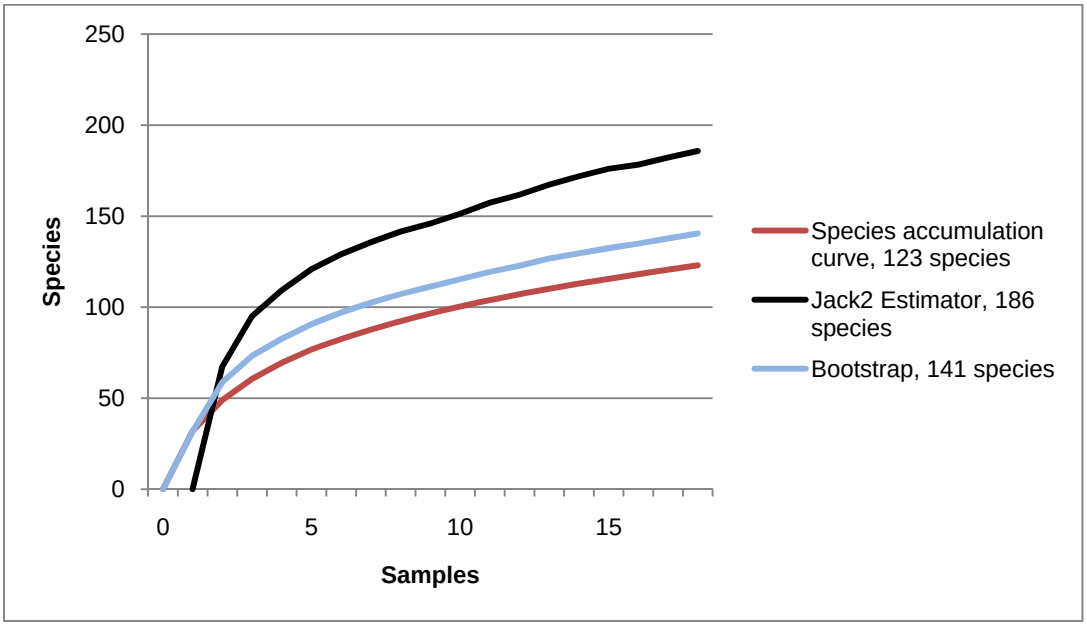


Fig. 7 - Measured and estimated species accumulation curves of the coralligenous

The detritic pools did not achieve any saturation (Fig. 8). The estimated number of species spans from 27 (+22.7%) to 36 (+63.6%).

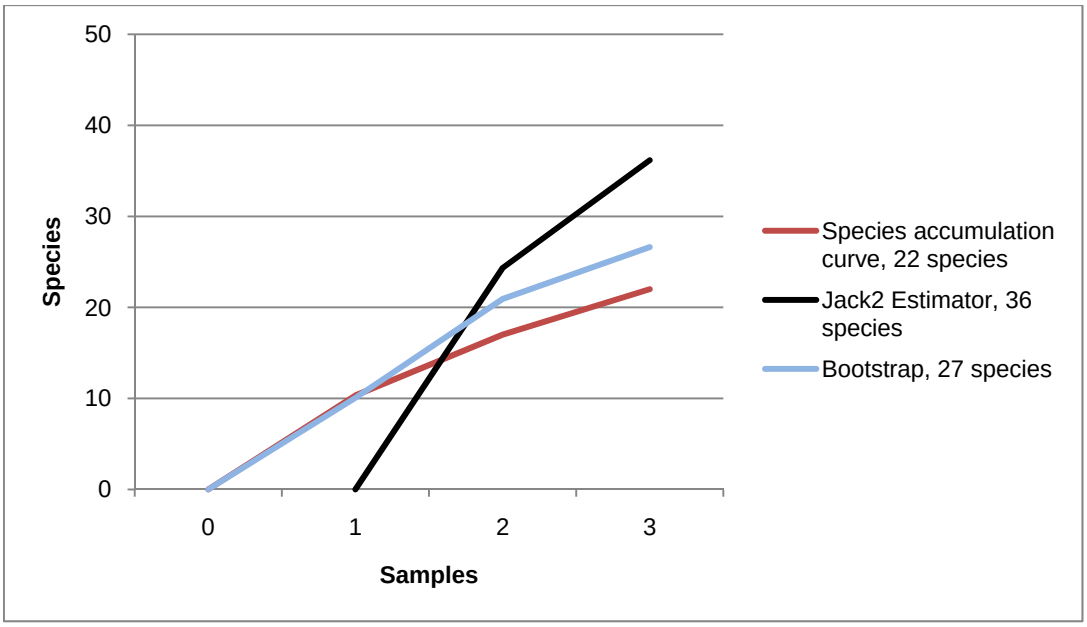


Fig. 8 - Measured and estimated species accumulation curves of the detritic pools

5.2 Discussion

Overall, the saturation results were under expectations since we thought that 12 stations and 36 samples could be adquate to describe the biodiversity of a restricted area (22 Ha circa within the 30 m isobath). The lack of flattening of the accumulation curves and the wide gap between the actual number of species and the estimates means that a greater sampling effort should have been deployed in such an heterogenous area.

The variability of samples in terms of number of specimens may be due to two causes: the heterogeneity of the community and the experience of the diver. Both certainly had an influx in the present case.

The diver experience is one of the most concerning issues, since if it is not enough it does not allow to have a adequate description of the sampled community. The high variability observed in the coralligenous, for example, is certainly due to divers' experience too. In this environment, specimens hide in holes and crevices and skill and expertise is needed to sample efficiently. On the other hand, sampling in the *Posidonia* rhizomes gave much more uniform results. There, specimens mostly hide in the rhizomes grooves and in the sediment and their capture is much easier. Establishing a standard number of air atmospheres from the cylinders to be used in each replicate (at the same depth) can be a method to standardize the samping effort.

On soft substrata like in the reefs detritic pools, the main trouble with the samples was efficiently sorting them in the field discarding the fine sediment and retaining only the right size of sediment and specimens. In this case, sampling on smaller surfaces per replicate may help in having a lower amount of sediment to sort and so in being able to do it better. In this case, the number of replicates per station should be increased. A lower volume also helps the diver: the samples with one square meter areas were very heavy and hard to swim with.

The *Posidonia* leaves sampling technique enjoys the best standardisation. Our results are not satisfying however, this may enforce the need of at least 60 strokes per replicate.

6 The molluscan diversity

6.1 Results

6.1.1 Faunal list

The sorting of live collected material brought to the discovery of 2,495 specimens representing 159 species of shelled molluscs. The following table contains the list of species in taxonomic order with the quantity of specimens in each biocoenosis.

Taxonomy follows CLEMAM - Taxonomic Database on European Marine Mollusca" (http://www.somali.asso.fr/clemam/index.php, last access for compiling this list June 10th, 2009).

N°	CLASS	FAMILY	GENUS	SPECIES	COR	POS	RIP	DET
1	POLYPLACOPHORA	Leptochitonidae	*Lepidopleurus*	*cajetanus* (Poli, 1791)	2	0	0	0
2	POLYPLACOPHORA	Hanleyidae	*Hanleya*	*hanleyi* (Bean in Thorpe, 1844)	0	0	1	0
3	POLYPLACOPHORA	Ischnochitonidae	*Callochiton*	*septemvalvis* (Montagu, 1803)	35	0	1	0
4	POLYPLACOPHORA	Chitonidae	*Chiton*	*corallinus* (Risso, 1826)	15	0	2	0
5	POLYPLACOPHORA	Acanthochitonidae	*Acanthochitona*	*crinita* (Pennant, 1777)	2	0	0	0
6	POLYPLACOPHORA	-	Polyplacophora	sp.	1	0	0	0
7	GASTROPODA	Fissurellidae	*Diodora*	*graeca* (Linné, 1758)	8	0	0	0
8	GASTROPODA	Fissurellidae	*Diodora*	sp.	3	0	1	0
9	GASTROPODA	Fissurellidae	*Emarginula*	*octaviana* Coen, 1939	3	0	0	0
10	GASTROPODA	Fissurellidae	*Emarginula*	*punctulum* Piani, 1980	3	0	1	0
11	GASTROPODA	Fissurellidae	*Emarginula*	*rosea* Bell T., 1824	1	0	0	0
12	GASTROPODA	Fissurellidae	*Emarginula*	*sicula* Gray, 1825	1	0	1	0
13	GASTROPODA	Fissurellidae	*Emarginella*	*huzardii* (Payraudeau, 1826)	3	0	0	0
14	GASTROPODA	Scissurellidae	*Scissurella*	*costata* d'Orbigny, 1824	7	0	1	1
15	GASTROPODA	Haliotidae	*Haliotis*	*tuberculata lamellosa* Lamarck, 1822	5	0	0	0
16	GASTROPODA	Trochidae	*Clanculus*	*corallinus* (Gmelin, 1791)	15	0	0	0
17	GASTROPODA	Trochidae	*Clanculus*	*cruciatus* (Linné, 1758)	5	0	0	0
18	GASTROPODA	Trochidae	*Jujubinus*	*exasperatus* (Pennant, 1777)	5	1	9	0
19	GASTROPODA	Trochidae	*Jujubinus*	*striatus* (Linné, 1758)	2	0	1	0
20	GASTROPODA	Calliostomatidae	*Calliostoma*	*conulus* (Linné, 1758)	3	0	1	0
21	GASTROPODA	Calliostomatidae	*Calliostoma*	*laugieri* (Payraudeau, 1826)	0	1	0	0
22	GASTROPODA	Chilodontidae	*Danilia*	*tinei* (Calcara, 1839)	8	0	0	0
23	GASTROPODA	Turbinidae	*Bolma*	*rugosa* (Linné, 1767)	7	0	10	0
24	GASTROPODA	Turbinidae	*Homalopoma*	*sanguineum* (Linné, 1758)	8	0	11	0
25	GASTROPODA	Phasianellidae	*Tricolia*	*tenuis* (Michaud, 1829)	0	0	3	0
26	GASTROPODA	Neritidae	*Smaragdia*	*viridis* (Linné, 1758)	0	0	3	0
27	GASTROPODA	Cerithiidae	*Cerithium*	*vulgatum* Bruguière, 1792	9	1	0	1
28	GASTROPODA	Cerithiidae	*Bittium*	*latreillii* (Payraudeau, 1826)	426	48	86	0
29	GASTROPODA	Cerithiidae	*Bittium*	sp. 1	15	4	6	0
30	GASTROPODA	Cerithiidae	*Bittium*	sp. 2	0	0	1	0
31	GASTROPODA	Cerithiidae	*Bittium*	sp. 3	4	0	0	0
32	GASTROPODA	Siliquariidae	*Petalopoma*	*elisabettae* Schiaparelli, 2002	2	0	0	0

N°	CLASS	FAMILY	GENUS	SPECIES	COR	POS	RIP	DET
33	GASTROPODA	Turritellidae	*Turritella*	*turbona* Monterosato, 1877	5	0	15	1
34	GASTROPODA	Triphoridae	*Marshallora*	*adversa* (Montagu, 1803)	29	0	10	0
35	GASTROPODA	Triphoridae	*Monophorus*	*erythrosoma* (Bouchet & Guillemot, 1978)	20	0	2	0
36	GASTROPODA	Triphoridae	*Monophorus*	*perversus* (Linné, 1758)	5	0	1	0
37	GASTROPODA	Triphoridae	*Monophorus*	*thiriotae* Bouchet, 1985	6	0	0	0
38	GASTROPODA	Triphoridae	*Obesula*	*marisnostri* Bouchet, 1985	1	0	1	0
39	GASTROPODA	Triphoridae	*Pogonodon*	*pseudocanaricus* (Bouchet, 1985)	0	0	2	0
40	GASTROPODA	Triphoridae	*Similiphora*	*similior* (Bouchet & Guillemot, 1978)	1	0	0	0
41	GASTROPODA	Triphoridae	*Metaxia*	*metaxae* (Delle Chiaje, 1828)	47	1	7	0
42	GASTROPODA	Cerithiopsis	*Cerithiopsis*	*nana* sensu Auctores non Jeffreys, 1867 [4]	8	1	7	0
43	GASTROPODA	Cerithiopsis	*Cerithiopsis*	*nofronii* Amati, 1987	1	0	0	0
44	GASTROPODA	Cerithiopsis	*Cerithiopsis*	sp. 1	12	0	7	0
45	GASTROPODA	Cerithiopsis	*Cerithiopsis*	sp. 2	0	0	1	0
46	GASTROPODA	Cerithiopsis	*Cerithiopsis*	sp. 3	0	0	1	0
47	GASTROPODA	Cerithiopsis	*Dizoniopsis*	*coppolae* (Aradas, 1870) [4]	1	0	0	0
48	GASTROPODA	Eulimidae	*Parvioris*	*ibizenca* (Nordsieck, 1968)	0	0	3	0
49	GASTROPODA	Eulimidae	*Sticteulima*	*jeffreysiana* (Brusina, 1869)	1	0	1	0
50	GASTROPODA	Eulimidae	*Vitreolina*	*incurva* (Bucquoy, Dautzenberg & Dollfus, 1883)	0	0	0	1
51	GASTROPODA	Rissoidae	*Rissoa*	*auriscalpium* (Linné, 1758)	0	2	0	0
52	GASTROPODA	Rissoidae	*Rissoa*	*violacea* Desmarest, 1814	0	6	2	0
53	GASTROPODA	Rissoidae	*Pusillina*	*inconspicua* (Alder, 1844)	4	1	1	0
54	GASTROPODA	Rissoidae	*Pusillina*	*philippi* (Aradas & Maggiore, 1844)	1	1	0	0
55	GASTROPODA	Rissoidae	*Pusillina*	sp.	3	0	0	0
56	GASTROPODA	Rissoidae	*Alvania*	*cancellata* (da Costa, 1778)	93	0	3	0
57	GASTROPODA	Rissoidae	*Alvania*	*cimex* (Linné, 1758)	1	0	0	0
58	GASTROPODA	Rissoidae	*Alvania*	*discors* (Allan, 1818)	2	0	0	0
59	GASTROPODA	Rissoidae	*Alvania*	*geryonia* (Nardo, 1847)	2	0	0	0
60	GASTROPODA	Rissoidae	*Alvania*	*hispidula* (Monterosato, 1884)	22	0	2	0
61	GASTROPODA	Rissoidae	*Alvania*	*lineata* Risso, 1826	11	0	0	0
62	GASTROPODA	Rissoidae	*Alvania*	*settepassii* Amati & Nofroni, 1985	25	2	2	0
63	GASTROPODA	Rissoidae	*Alvania*	*tenera* (Philippi, 1844)	6	0	0	0
64	GASTROPODA	Rissoidae	*Crisilla*	*beniamina* (Monterosato, 1884)	1	0	0	0
65	GASTROPODA	Rissoidae	*Manzonia*	*crassa* (Kanmacher, 1798)	7	0	0	0
66	GASTROPODA	Rissoidae	*Rissoina*	*bruguieri* (Payraudeau, 1826)	2	0	0	0
67	GASTROPODA	Caecidae	*Caecum*	*armoricum* de Folin, 1869	0	0	0	3
68	GASTROPODA	Caecidae	*Caecum*	*clarkii* Carpenter, 1859	0	0	0	4
69	GASTROPODA	Caecidae	*Caecum*	*subannulatum* de Folin, 1870	1	0	0	0
70	GASTROPODA	Caecidae	*Parastrophia*	*asturiana* de Folin, 1870	1	0	0	0
71	GASTROPODA	Calyptraeidae	*Crepidula*	sp.	1	0	1	0
72	GASTROPODA	Triviidae	*Trivia*	*arctica* (Pulteney, 1799)	1	0	0	0

[4] Cfr. Giannuzzi-Savelli et al., 1999

N°	CLASS	FAMILY	GENUS	SPECIES	COR	POS	RIP	DET
73	GASTROPODA	Cypraeidae	*Erosaria*	*spurca* (Linné, 1758)	0	0	1	0
74	GASTROPODA	Cypraeidae	*Luria*	*lurida* (Linné, 1758)	1	0	0	0
75	GASTROPODA	Naticidae	*Euspira*	*pulchella* (Risso, 1826)	1	0	6	2
76	GASTROPODA	Naticidae	*Payraudeautia*	*intricata* (Donovan, 1804)	0	0	1	0
77	GASTROPODA	Muricidae	*Dermomurex*	*scalaroides* (de Blainville, 1829)	1	0	3	0
78	GASTROPODA	Muricidae	*Ocinebrina*	*aciculata* (Lamarck, 1822)	9	11	12	0
79	GASTROPODA	Muricidae	*Muricopsis*	*aradasii* (Poirier, 1883)	4	0	12	0
80	GASTROPODA	Muricidae	*Muricopsis*	*cristata* (Brocchi, 1814)	89	0	40	0
81	GASTROPODA	Muricidae	*Typhinellus*	*labiatus* (de Cristofori & Jan, 1832)	1	0	0	0
82	GASTROPODA	Muricidae	*Coralliophila*	*meyendorffii* (Calcara, 1845)	8	0	1	0
83	GASTROPODA	Mitridae	*Mitra*	*cornicula* (Linné, 1758)	23	0	2	0
84	GASTROPODA	Costellariidae	*Vexillum*	*ebenus* (Lamarck, 1811)	2	0	1	0
85	GASTROPODA	Costellariidae	*Vexillum*	*savignyi* (Payraudeau, 1826)	17	0	3	0
86	GASTROPODA	Costellariidae	*Vexillum*	*tricolor* (Gmelin, 1791)	18	0	6	0
87	GASTROPODA	Buccinidae	*Euthria*	*corneum* (Linné, 1758)	1	0	0	0
88	GASTROPODA	Buccinidae	*Chauvetia*	aff *brunnea* (Donovan, 1804)	8	14	26	0
89	GASTROPODA	Buccinidae	*Chauvetia*	*recondita* (Brugnone, 1873)	5	0	6	0
90	GASTROPODA	Buccinidae	*Pollia*	*dorbignyi* (Payraudeau, 1826)	1	0	0	0
91	GASTROPODA	Buccinidae	*Pollia*	*scabra* Locard, 1892	82	0	7	0
92	GASTROPODA	Nassariidae	*Nassarius*	*incrassatus* (Ström, 1768)	161	0	26	0
93	GASTROPODA	Columbellidae	*Columbella*	*rustica* (Linné, 1758)	2	0	0	0
94	GASTROPODA	Columbellidae	*Mitrella*	*coccinea* (Philippi, 1836) [5]	2	0	0	0
95	GASTROPODA	Columbellidae	*Mitrella*	*gervillii* (Payraudeau, 1826)	1	0	2	0
96	GASTROPODA	Columbellidae	*Mitrella*	*minor* (Scacchi, 1836)	0	0	6	0
97	GASTROPODA	Columbellidae	*Mitrella*	*scripta* (Linné, 1758)	42	0	3	0
98	GASTROPODA	Fasciolariidae	*Fusinus*	*pulchellus* (Philippi, 1844)	38	0	16	0
99	GASTROPODA	Conidae	*Comarmondia*	*gracilis* (Montagu, 1803)	0	0	0	1
100	GASTROPODA	Conidae	*Mitromorpha*	*karpathoensis* (Nordsieck, 1969)	0	0	1	0
101	GASTROPODA	Conidae	*Clathromangelia*	*granum* (Philippi, 1844)	5	0	2	0
102	GASTROPODA	Conidae	*Mangelia*	*scabrida* Monterosato, 1890	18	0	5	0
103	GASTROPODA	Conidae	*Mangelia*	*stossiciana* Brusina, 1869	2	0	2	0
104	GASTROPODA	Conidae	*Mangelia*	*vauquelini* (Payraudeau, 1826)	14	0	0	0
105	GASTROPODA	Conidae	*Raphitoma*	*concinna* (Scacchi, 1836)	2	0	1	0
106	GASTROPODA	Conidae	*Raphitoma*	*leufroyi* (Michaud, 1828)	5	0	1	0
107	GASTROPODA	Conidae	*Raphitoma*	*linearis* (Montagu, 1803)	69	0	20	1
108	GASTROPODA	Conidae	*Raphitoma*	sp. 1	1	0	4	0
109	GASTROPODA	Conidae	*Raphitoma*	sp. 2	1	0	1	0
110	GASTROPODA	Conidae	*Raphitoma*	sp. 3	1	0	0	0
111	GASTROPODA	Conidae	*Raphitoma*	sp. 4	0	0	2	0
112	GASTROPODA	Drilliidae	*Crassopleura*	*maravignae* (Bivona Ant. in Bivona And., 1838)	0	0	0	3

[5] Cfr. Giannuzzi-Savelli et al., 2003

N°	CLASS	FAMILY	GENUS	SPECIES	COR	POS	RIP	DET
113	GASTROPODA	Architectonicidae	*Pseudotorinia*	*architae* (Costa O.G., 1841)	0	0	0	1
114	GASTROPODA	Mathildidae	*Mathilda*	*gemmulata* Semper, 1865	0	0	1	0
115	GASTROPODA	Pyramidellidae	*Chrysallida*	*excavata* (Philippi, 1836)	1	0	0	0
116	GASTROPODA	Pyramidellidae	*Chrysallida*	*suturalis* (Philippi, 1844)	2	0	0	1
117	GASTROPODA	Pyramidellidae	*Odostomella*	*doliolum* (Philippi, 1844)	14	0	1	0
118	GASTROPODA	Pyramidellidae	*Ondina*	sp.	0	0	1	0
119	GASTROPODA	Pyramidellidae	*Turbonilla*	*gradata* Bucquoy, Dautzenberg & Dollfus, 1883	1	0	0	0
120	GASTROPODA	Pyramidellidae	*Turbonilla*	*striatula* (Linné, 1758)	0	0	0	1
121	GASTROPODA	Amathinidae	*Clathrella*	*clathrata* (Philippi, 1844)	1	0	0	0
122	GASTROPODA	Retusidae	*Retusa*	*mamillata* (Philippi, 1836)	0	0	0	20
123	GASTROPODA	Retusidae	*Cylichnina*	*crebrisculpta* Monterosato, 1884	0	0	0	1
124	GASTROPODA	Haminoeidae	*Haminoea*	sp.	1	0	0	0
125	GASTROPODA	Haminoeidae	*Weinkauffia*	*turgidula* (Forbes, 1844)	1	0	0	0
126	GASTROPODA	Philinidae	*Philine*	sp.	0	0	0	1
127	GASTROPODA	Siphonariidae	*Williamia*	*gussonii* (Costa O.G., 1829)	17	0	1	0
128	BIVALVIA	Nuculidae	*Nucula*	sp.	18	0	2	1
129	BIVALVIA	Arcidae	*Barbatia*	*barbata* (Linné, 1758)	13	0	7	0
130	BIVALVIA	Noetidae	*Striarca*	*lactea* (Linné, 1758)	52	0	26	3
131	BIVALVIA	Mytilidae	*Gregariella*	*semigranata* (Reeve, 1858)	12	0	2	0
132	BIVALVIA	Mytilidae	*Lithophaga*	*lithophaga* (Linné, 1758)	6	0	0	0
133	BIVALVIA	Mytilidae	*Dacrydium*	*hyalinum* (Monterosato, 1875)	0	0	1	0
134	BIVALVIA	Mytilidae	*Modiolula*	*phaseolina* (Philippi, 1844)	0	0	3	0
135	BIVALVIA	Pectinidae	*Chlamys*	*flexuosa* (Poli, 1795)	2	0	0	0
136	BIVALVIA	Pectinidae	*Chlamys*	*glabra* (Linné, 1758)	1	0	0	0
137	BIVALVIA	Pectinidae	*Crassadoma*	*multistriata* (Poli, 1795)	13	0	0	0
138	BIVALVIA	Limidae	*Lima*	*lima* (Linné, 1758)	15	0	2	0
139	BIVALVIA	Limidae	*Limaria*	*hians* (Gmelin, 1791)	7	0	0	0
140	BIVALVIA	Limidae	*Limaria*	*tuberculata* (Olivi, 1792)	3	0	0	0
141	BIVALVIA	Galeommatidae	*Galeomma*	*turtoni* Sowerby G.B. I in Turton, 1825	8	0	0	0
142	BIVALVIA	Kelliidae	*Kellia*	*suborbicularis* (Montagu, 1803)	1	0	0	0
143	BIVALVIA	Leptonidae	*Hemilepton*	*nitidum* (Turton, 1822)	0	0	0	2
144	BIVALVIA	Montacutidae	*Montacuta*	sp.	1	0	0	0
145	BIVALVIA	Montacutidae	*Kurtiella*	sp.	0	0	1	0
146	BIVALVIA	Carditidae	*Pteromeris*	*corbis* (Philippi, 1836)	0	0	0	5
147	BIVALVIA	Cardiidae	*Parvicardium*	*scriptum* (Bucquoy, Dautzenberg & Dollfus, 1892)	7	0	5	0
148	BIVALVIA	Cardiidae	*Papillicardium*	*papillosum* (Poli, 1791)	18	0	20	1
149	BIVALVIA	Tellinidae	*Tellina*	*tenuis* da Costa, 1778	1	0	1	0
150	BIVALVIA	Tellinidae	*Arcopagia*	*balaustina* (Linné, 1758)	3	0	3	0
151	BIVALVIA	Psammobiidae	*Gari*	*costulata* (Turton, 1822)	0	0	1	0
152	BIVALVIA	Semelidae	*Abra*	sp.	2	0	0	0
153	BIVALVIA	Veneridae	*Venus*	*verrucosa* Linné, 1758	2	0	5	0

N°	CLASS	FAMILY	GENUS	SPECIES	COR	POS	RIP	DET
154	BIVALVIA	Veneridae	*Clausinella*	*fasciata* (da Costa, 1778)	0	0	0	1
155	BIVALVIA	Veneridae	*Gouldia*	*minima* (Montagu, 1803)	9	0	34	0
156	BIVALVIA	Hiatellidae	*Hiatella*	*arctica* (Linné, 1767)	4	0	4	0
157	BIVALVIA	Thraciidae	*Thracia*	*distorta* (Montagu, 1803)	1	0	4	0
158	BIVALVIA	-	Bivalvia	sp (broken shell)	1	0	0	0
159	SCAPHOPODA	Dentaliidae	*Antalis*	*vulgaris* (da Costa, 1778)	0	0	1	0

Tab. 11 – List of shelled molluscan species found during the field survey

A few other species were observed alive in their natural habitat during sampling activities, but they were not collected in the samples. They are:

- *Neosimnia spelta* (Linné, 1758);
- *Coralliophila brevis* (de Blainville, 1832);
- *Pinna nobilis* (Linné, 1758).

These species are relevant to the description of the biodiversity of the area, but they are not included in the quali-quantitative matrix on which the biocoenoses analysis has been carried out which is reported in Annex I.

The richness of the area evaluated at different taxonomic levels is the following:

	Order	Family	Genus	Species
Taxa	18	65	113	162

Tab. 12 – Taxonomic richness of "Secche di Tor Paterno" Marine Protected Area (shelled Mollusca only)

Species of family Triphoridae, one of the most interesting families of gastropods found in the MPA, are illustrated in plates 1 and 2.

6.1.2 Biocenotic preferences

Species were assigned to different groups according to their frequency in one or more biocoenoses.

Eighty-eight species were found in a single biocoenosis only (Tab. 13). Of these, 53 were found in the coralligenous only (53% of the species found in the coralligenous and 33.3% of the whole fauna), 2 were found in the *Posidonia* leaves only (14.3% of the species found in this biocoenosis and 1.3% of the whole fauna), 20 species were found in the *Posidonia* rhizomes only (22.7% of the species found in this biocoenosis and 12.6% of the whole fauna) and 13 species were found in detritic pools only (59.1% of the species found in this biocoenosis and 8.2% of the whole fauna.

Biocoenosis	n°	% (whole fauna)	Total n° species biocoenosis	% (single biocoenosis)
Coralligenous only	53	33.3%	123	43.1%
Posidonia leaves only	2	1.3%	14	14.3%
Posidonia rhizomes only	20	12.6%	88	22.7%
Detritic pools only	13	8.2%	22	59.1%
Total	88			

Tab. 13 – Number and share of species exclusive of a single biocoenosis

The species found in the coralligenous only are:

- *Lepidopleurus cajetanus*
- *Acanthochitona crinita*
- Polyplacophora sp.
- *Diodora graeca*
- *Emarginula octaviana*
- *Emarginula rosea*
- *Emarginella huzardii*
- *Haliotis tuberculata lamellosa*
- *Clanculus corallinus*
- *Clanculus cruciatus*
- *Danilia tinei*
- *Bittium* sp. 3
- *Petalopoma elisabettae*
- *Monophorus thiriotae*
- *Similiphora similior*
- *Cerithiopsis nofronii*
- *Dizoniopsis coppolae*
- *Pusillina* sp.
- *Alvania cimex*
- *Alvania discors*
- *Alvania geryonia*
- *Alvania lineata*
- *Alvania tenera*
- *Crisilla beniamina*
- *Manzonia crassa*
- *Rissoina bruguieri*
- *Caecum subannulatum*
- *Parastrophia asturiana*
- *Trivia arctica*
- *Luria lurida*
- *Typhinellus labiatus*
- *Euthria corneum*
- *Pollia dorbignyi*
- *Columbella rustica*
- *Mitrella coccinea*
- *Mangelia vauquelini*
- *Raphitoma* sp. 3
- *Chrysallida excavata*
- *Turbonilla gradata*
- *Clathrella clathrata*
- *Haminoea* sp.
- *Weinkauffia turgidula*
- *Lithophaga lithophaga*
- *Chlamys flexuosa*
- *Chlamys glabra*

- *Crassadoma multistriata*
- *Limaria hians*
- *Limaria tuberculata*
- *Galeomma turtoni*
- *Kellia suborbicularis*
- *Montacuta* sp.
- *Abra* sp.
- *Bivalvia* sp. (broken shell)

The species found in the *Posidonia* leaves only are:

- *Calliostoma laugieri*
- *Rissoa auriscalpium*

The species found in the *Posidonia* rhizomes only are:

- *Hanleya hanleyi*
- *Tricolia tenuis*
- *Smaragdia viridis*
- *Bittium* sp. 2
- *Pogonodon pseudocanaricus*
- *Cerithiopsis* sp. 2
- *Cerithiopsis* sp. 3
- *Parvioris ibizenca*
- *Erosaria spurca*
- *Payraudeautia intricata*
- *Mitrella minor*
- *Mitromorpha karpathoensis*
- *Raphitoma* sp. 4
- *Mathilda gemmulata*
- *Ondina* sp.
- *Dacrydium hyalinum*
- *Modiolula phaseolina*
- *Kurtiella* sp.
- *Gari costulata*
- *Antalis vulgaris*

The species found in the detritic pools only are:

- *Vitreolina incurva*
- *Caecum armoricum*
- *Caecum clarkii*
- *Comarmondia gracilis*
- *Crassopleura maravignae*
- *Pseudotorinia architae*
- *Turbonilla striatula*
- *Retusa mamillata*
- *Cylichnina crebrisculpta*
- *Philine* sp.
- *Hemilepton nitidum*
- *Pteromeris corbis*

- *Clausinella fasciata*

Remarkably, species found in two biocoenoses are the exception rather than the rule (Tab. 14). Only one species is in common between the coralligenous and *Posidonia* leaves (*Pusillina philippi*), one between the coralligenous and the detritic pools (*Chrysallida suturalis*, whose presence is influenced by its host since it is a parasite), one between *Posidonia* leaves and rhizomes (*Rissoa violacea*, and this is quite surprising and marks the difference between these two layers; moreover, it can't be excluded that the two specimens of this species found in the rhizomes were crawling on the leaves and fell down during the sampling of the leaves but were not intercepted by the net). However, 51 species (32.1% of the whole fauna) were found both in the coralligenous and in the *Posidonia* rhizomes.

Biocoenoses	**n°**	**% (whole fauna)**
coralligenous-*Posidonia* leaves	1	0.6%
coralligenous-*Posidonia* rhizomes	51	32.1%
coralligenous-detritic pools	1	0.6%
Posidonia leaves-*Posidonia* rhizomes	1	0.6%
Posidonia leaves-detritic pools	0	0.0%
Posidonia rhizomes-detritic pools	0	0.0%

Tab. 14 - Number and share of species in common between two biocoenoses

The species found both in the coralligenous and in the *Posidonia* rhizomes are:

- *Callochiton septemvalvis*
- *Chiton corallinus*
- *Diodora* sp.
- *Emarginula punctulum*
- *Emarginula sicula*
- *Jujubinus striatus*
- *Calliostoma conulum*
- *Bolma rugosa*
- *Homalopoma sanguineum*
- *Marshallora adversa*
- *Monophorus erythrosoma*
- *Monophorus perversus*
- *Obesula marisnostri*
- *Cerithiopsis* sp. 1
- *Sticteulima jeffreysiana*
- *Alvania cancellata*
- *Alvania hispidula*
- *Crepidula* sp.
- *Dermomurex scalaroides*
- *Muricopsis aradasii*
- *Muricopsis cristata*
- *Coralliophila meyendorffii*
- *Mitra cornicula*
- *Vexillum ebenus*

- *Vexillum savignyi*
- *Vexillum tricolor*
- *Chauvetia recondita*
- *Pollia scabra*
- *Nassarius incrassatus*
- *Mitrella gervillii*
- *Mitrella scripta*
- *Fusinus pulchellus*
- *Clathromangelia granum*
- *Mangelia scabrida*
- *Mangelia stossiciana*
- *Raphitoma concinna*
- *Raphitoma leufroyi*
- *Raphitoma* sp. 1
- *Raphitoma* sp. 2
- *Odostomella doliolum*
- *Williamia gussonii*
- *Barbatia barbata*
- *Gregariella semigranata*
- *Lima lima*
- *Parvicardium scriptum*
- *Tellina tenuis*
- *Arcopagia balaustina*
- *Venus verrucosa*
- *Gouldia minima*
- *Hiatella arctica*
- *Thracia distorta*

A few species are almost ubiquitarian, being found in three biocoenoses (Tab. 15).

Biocoenoses	**n°**	**% (whole fauna)**
Coralligenous-*Posidonia* leaves-*Posidonia* rhizomes	9	5.7%
Coralligenous-*Posidonia* leaves-Detritic pools	1	0.6%
Coralligenous-*Posidonia* rhizomes-Detritic pools	7	4.4%
Posidonia leaves-*Posidonia* rhizomes-Detritic pools	0	0%

Tab. 15 - Number and share of species in common between three biocoenoses

The species found in the coralligenous, in the *Posidonia* leaves and rhizomes are:

- *Jujubinus exasperatus*
- *Bittium latreillii*
- *Bittium* sp. 1
- *Metaxia metaxae*
- *Cerithiopsis nana*
- *Pusillina inconspicua*
- *Alvania settepassii*

- *Ocinebrina aciculata*
- *Chauvetia* aff *brunnea*

A single species was found in the coralligenous, the *Posidonia* leaves and the detritic:

- *Cerithium vulgatum*

The species found in the coralligenous, the *Posidonia* rhizomes and the detritic are:

- *Scissurella costata*
- *Turritella turbona*
- *Euspira pulchella*
- *Raphitoma linearis*
- *Nucula sp.*
- *Striarca lactea*
- *Papillicardium papillosum*

6.2 Discussion

6.2.1 Biodiversity of the malacofauna and its interest for conservation

The sampled fauna in the reefs accounts for 162 species. This number is certainly going to rise as the work will continue on the analysis of organogenous sediments and the smallest fractions.

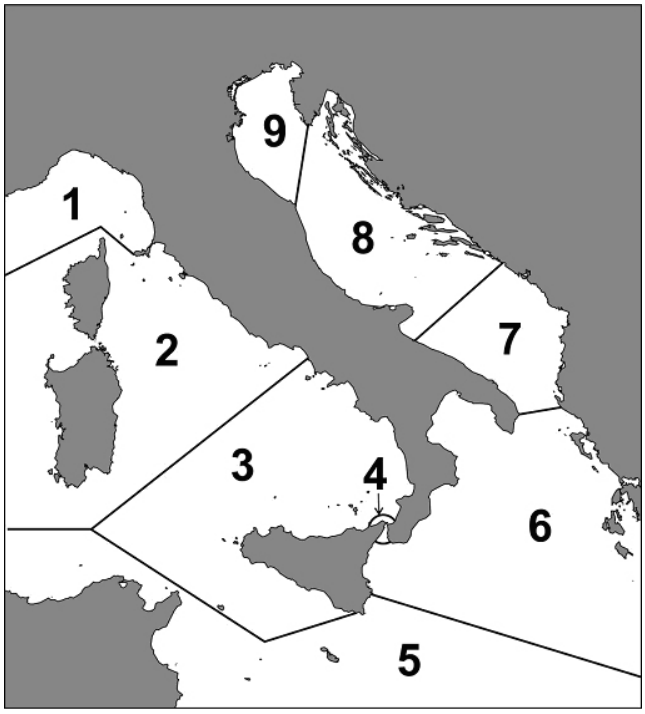


Fig. 9 – Biogeographic sectors around Italy (Relini, 2009)

The Italian checklist of fauna and flora of Italian seas (Relini, 2009) lists 1,792 species of shelled molluscs (Polyplacophora, Monoplacophora, Gastropoda excluding Order Nudibranchia, Bivalvia and Scaphopoda) and 1,085 species for the biogeographic sector 2 which covers the Central Tyrrhenian Sea, Corse and Sardinia, being one of the widest around Italy. This means that the sampled fauna is 9% of the Italian fauna and 15% of the fauna of sector 2. These numbers are very high considering the geographic restrictness of the area, the narrow depth interval which implies that several biocoenoses are not present (e.g. photophilous algae, deep water corals), the lack of true soft substrata, the single season and single year sampling and that a 1 mm sieve was used (so missing some tiny species like Pyramidellidae). Moreover, the use of non destructive sampling devices implied that some endobenthos species may have been missed (e.g.

Vanikoridae, boring bivalves, epibionts like *Pteria hirundo* or species which hide in deep crevices like *Manupecten pesfelis* which were observed dead in the sediment pools).

Group	n° of species in the Mediterranean Sea [6]	n° of species in Italy	n° of species in sector 2	Representativeness of Secche di Tor Paterno fauna		
				n°	% Italy	% Sector 2
Polyplacophora	36	40	25	6	15.0%	24.0%
Monoplacophora	1	1	1	0	0%	0%
Gastropoda Prosobranchia	858	890	501	108	12.1%	21.6%
Gastropoda Heterobranchia		189	132	9	4.8%	6.8%
Gastropoda Pulmonata		12	6	1	8.3%	16.7%
Gastropoda Opisthobranchia [7]		287	136	5	1.7%	3.7%
Bivalvia	376	523	272	32	6.1%	11.8%
Scaphopoda	13	20	12	1	5.0%	8.3%
TOTAL	**1284**	**1792**	**1085**	**162**	**9.0%**	**14.9%**

Tab. 16 – Number of shelled molluscs in the Mediterranean Sea (WoRMS), in Italy, in biogeographic sector 2 (both: Relini, 2009) and in Secche di Tor Paterno

Moreover, no alien molluscan species were recorded.

The survey allowed to extend the known range of some species along the Italian coastline. The following are species not previously recorded in biogeographic sector 2:

- *Cylichnina crebrisculpta* Monterosato, 1884 (previously recorded for sector 3 only, the southern Tyrrhenian Sea)
- *Gregariella semigranata* (Reeve, 1858) (previously recorded for the more southern sectors 3, 5 and 6)
- *Chlamys glabra* (Linné, 1758) [8] (this species is recorded in the check-list for all sectors except the central and northern Tyrrhenian Sea (sectors 1 and 2), however some records in literature were already available, e.g. Terreni, 1981 for Toscana)
- *Parvicardium scriptum* (Bucquoy, Dautzenberg & Dollfus, 1892) (previously recorded for sector 5, the southernmost coasts of Sicily and of the Sicily Channel)

Moreover, knowledge on the Secche di Tor Paterno area has been greatly improved by 28 new records. The reference work is the study of University La Sapienza (1993) which treated a wider area both geographically, bathimetrically and biocoenotically pooling research carried out by several means in 12 years. Therefore, new records have particular value. New records are:

- *Smaragdia viridis* ((Linné, 1758)
- *Petalopoma elisabettae* Schiaparelli, 2002 [9]
- *Monophorus erythrosoma* (Bouchet & Guillemot, 1978)

[6] As downloaded from the WoRMS database accessed December 29th, 2010, however it is a work in progress.

[7] Order Nudibranchia excluded.

[8] Only juvenile species found, so identification is tentative.

[9] It is likely that this species was already listed as *Tenagodus obtusus* (Schumacher, 1817)

- *Monophorus thiriotae* Bouchet, 1985
- *Obesula marisnostri* Bouchet, 1985
- *Pogonodon pseudocanaricus* (Bouchet, 1985)
- *Caecum armoricum* De Folin, 1869
- *Caecum clarkii* Carpenter, 1859
- *Chauvetia recondita* (Brugnone, 1873)
- *Pollia scabra* Locard, 1892
- *Mitrella coccinea* (Philippi, 1836)
- *Mitromorpha karpathoensis* (Nordsieck, 1969)
- *Raphitoma concinna* (Scacchi, 1836)
- *Pseudotorinia architae* (Costa O.G., 1841)
- *Mathilda gemmulata* Semper, 1865
- *Turbonilla gradata* Bucquoy, Dautzenberg & Dollfus, 1883
- *Clathrella clathrata* (Philippi, 1844)
- *Cylichnina crebrisculpta* Monterosato, 1884
- *Gregariella semigranata* (Reeve, 1858)
- *Modiolula phaseolina* (Philippi, 1844)
- *Chlamys flexuosa* (Poli, 1795)
- *Chlamys glabra* (Linné, 1758)
- *Limaria tuberculata* (Olivi, 1792)
- *Hemilepton nitidum* (Turton, 1822)
- *Tellina tenuis* Da Costa, 1778
- *Gari costulata* (Turton, 1822)
- *Clausinella fasciata* (Da Costa, 1778)
- *Antalis vulgaris* (Da Costa, 1778)

More new records may hide in groups with difficult taxonomy like *Bittium*, Cerithiopsidae, *Mangelia*, *Raphitoma*, which couln't be assigned to a taxon with certainty.

It is important to highlight the presence of the following species of conservation interest:

- *Erosaria spurca* (Linné, 1758) (Gastropoda: Cypraeidae)

  This species is a member of the family Cypraeidae, much sought after by collectors. For this reason, all Mediterranean autoctonous species of this family are protected. This species is enlisted in Appendix II "Strictly protected fauna species" of the Bern Convention and in Annex II to the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention which is devoted to endangered species.

  A single adult living specimen has been found. A few other dead specimens were found, but the species looks to be very rare in the Area while it is more common in the southern Mediterranean Sea.

- *Luria lurida* (Linné, 1758) (Gastropoda: Cypraeidae)

  This species belongs to the same family as *Erosaria spurca* and enjoys the same degree of protection. It is enlisted in Appendix II "Strictly protected fauna species" of the Bern Convention and in the Annex II to the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention too.

  A single living juvenile specimen has been found. A few dead specimens were collected. Again the species is rare in the Area, while it is usually more common in the shallows in coastal waters of most of the Mediterranean Sea, with the exception of its coldest parts (e.g.: North-Eastern Adriatic Sea).

- *Lithophaga lithophaga* (Linné, 1758) (Bivalvia: Mytilidae)

The vernacular name of this species is “dattero di mare” and it is considered a delicacy all around the Mediterranean Sea. However, it lives deeply bored into rocks and the only way to extract them is breaking the substratum destroying and removing both endolithion and epilithion. Full recovery is expected in a time frame of several tens of years if not hundreds of years (Russo et al., 1992).

For this reason, fishing of this species is forbidden in Italy since 1988 (DM 401, 20/08/1988).

In the Marine Protected Area the species bores the superficial layers of the coralligenous and all collected specimens are juveniles. However, the sampling technique with suction airlift is not appropriate to the sampling of adults since they live too deep into the hard substratum.

This is one of the few marine molluscs species enlisted in the Habitat Directive in Annex IV “Animal and plant species of Community interest in need of strict protection”. Moreover, *L. lithophaga* is enlisted in Appendix II “Strictly protected fauna species” of the Bern Convention and in the Annex II to the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention too.

- *Pinna nobilis* (Linné, 1758) (Bivalvia: Pinnidae)

  This is a very big bivalve which can reach 100 cm and more in length. For this reason, the species has not been found in our samples, but several specimens were observed during dives, especially in the *Posidonia oceanica* patches. A big specimen of approximately 50 centimeters in length has been found.

  It is enlisted in the Habitat Directive in Annex IV “Animal and plant species of Community interest in need of strict protection” and in the Annex II to the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention.

Since this legislation often overlap, a summary of the appliable protection is given in Tab. 17:

Species	Bern (1979) Appendix II	Bern (1979) Appendix III	Habitat Directive (1992) Annex II	Habitat Directive (1992) Annex IV	Barcelona (1995) Annex II
Erosaria spurca	×				×
Luria lurida	×				×
Lithophaga lithophaga	×			×	×
Pinna nobilis				×	×

Tab. 17 – Summary of international legislation on protected species

The Council of Europe Convention on the Conservation of European Wildlife and Natural Habitats - also known as the Bern Convention - was adopted on September 1979 in Bern (Switzerland) and came into force on 1 June 1982. The aims of the Convention are "to conserve wild flora and fauna and their natural habitats, especially those species and habitats whose conservation requires the co-operation of several States, and to promote such co-operation. Particular emphasis is given to endangered and vulnerable species, including endangered and vulnerable migratory species." The Convention lists protected species on three Appendices: Appendix I lists strictly protected flora species , appendix II lists strictly protected fauna species, Appendix III lists protected fauna species.

The Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean was adopted on 10 June 1995 and came into force on 12 December 1999. It is an amendment to the 1976 Barcelona Convention for Protection against Pollution in the Mediterranean Sea. The aims of the protocol are to “protect, preserve and manage in a sustainable and environmentally sound way areas of particular natural or cultural value, notably by the establishment of specially protected areas” and to “protect, preserve and manage threatened or endangered species of flora and fauna”. The Protocol lists protected species two annexes: Annex II is a “List of endangered or threatened species”, Annex III enlists species whose exploitation is regulated.

The Habitats Directive (more formally known as Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) is a European Union directive adopted in 1992 as an EU response to the Berne Convention. It aims to protect some 220 habitats and approximately 1000 species listed in the directive's Annexes. These are species and habitats which are considered to be of European interest, following criteria given in the directive. The directive lists protected species in three annexes: Annex II covers "Animal and plant species of community interest whose conservation requires the designation of special areas of conservation", Annex IV covers "Animal and plant species of community interest in need of strict protection", while Annex V lists species "of community interest whose taking in the wild and exploitation may be subject to management measures".

Moreover, Secche di Tor Paterno were the source of material which lead to the description of a few species of shelled molluscs:

- *Cerithiopsis nofronii* Amati, 1987 (Gastropoda: Cerithiopsidae)

  The *locus typicus* of this species is Bocche di Bonifacio. Two lots coming from the Tor Paterno reefs were designated as paratypes of this species.

  A single, but living, specimen has been found in the survey. A few other dead specimens were found in the sorting of thanatocoenosis samples collected before the survey.

  It seems to be a very rare species in the investigated area. It may prefer deeper waters.
- *Alvania settepassii* Amati & Nofroni, 1985 (Gastropoda: Rissoidae)

  The *locus typicus* of this species is the Marine Protected Area.

  This species is common in the thanatocoenosis sediments, but it is uncommon alive. However, 29 living specimens were found, both juveniles and adults, confirming the presence of a population in the area.

  This species is present in other parts of the Tyrrhenian Sea and specimens tentatively assigned to this *taxon* are reported from the Jonian coasts of Puglia (Trono, 2006).

6.2.2 Biocenotic preferences

The number of species exclusive of a single biocoenosis is remarkably high. However, only a few species are known for being restricted to the biocoenosis in literature. Several species (Triphoridae, Cerithiopsidae, Pyramidellidae) are parasites or extremely specialized predators and are expected where their host lives. However, for most species the host is not known.

Between the species characteristic of the coralligenous there are *Danilia tinei* (Palazzi & Villari (2001) cite specimens from the rhizomes of dense *Posidonia* meadows and caves, but these records are occasional in literature), *Alvania tenera* (cfr. Piani, 1979), *Mitrella coccinea*. The coralligenous host a good number of exclusive species (19, 35.8%) which feed on microalgae and therefore depend on light, despite dim, for survival (e.g. Polyplacophora, Trochidae, Rissoidae).

Rissoa auriscalpium is a characteristic and exclusive species of *Posidonia* leaves and it is more common in shallow and sheltered water.

Between the species found in the rhizomes only, most are carnivorous or parasites (11, 55.5%). Between the few species which feed on microalgae there are *Tricolia tenuis* and *Smaragdia viridis* which are usually associated to the leaves. Their presence can be justified with the nictemeral migrations on the plant axis which is already described in literature for *T. pullus* (Russo *et al.*, 1984).

Several species were exclusively found in the detritic pools. These pools are a markedly different habitat from the others and this justifies the high percentage of species found only in them. The main consequence is that sampling these pools, which at first sight seem lifeless, brought an important addition on the knowledge of the biodiversity of Secche di Tor Paterno. Between these, some are *Comarmondia gracilis* and *Crassopleura maravignae*, two predators which hide in the sediment.

The remarkable high number of species in common between the coralligenous and the *Posidonia* rhizomes are peculiarly polarized towards parasites and carnivorous species: 31 species, 60.7%! These species are usually pretty vagile and probably find adequate prey or host in both sciaphilous environments.

Between the almost ubiquitarian species present in three biocoenoses, two main groups are recognizable. The first is the group of species affiliated to light both because they eat microalgae (e.g. *Bittium*, Rissoidae) or because they are vagile species not strictly sciaphilous (e.g. Muricidae). This group thrives in the coralligenous and *Posidonia* leaves and rhizomes. The second is a group of mainly infaunal species associated to soft substrata which thrives not only in the detritic pools, but in the coralligenous and rhizomes too where small pockets of sediment are present.

The only species found in the three most diverse biocoenoses, coralligenous, *Posidonia* leaves and detritic pools, *Cerithium vulgatum*, should be considered dubious since morphological evidence suggest the species found in the detritic pools may not be *C. vulgatum* but a different species.

7 Biocoenoses characterization

Sampling was carried out in the infralittoral level of the reefs which is characterized by biocoenoses which are installed on rock emerging from the surrounding circalittoral soft substrata.

At this level, the reefs host four different biocoenoses:

- Biocoenosis of the *Posidonia oceanica* meadows ("HP", Pérès & Picard, 1964), which is characterized in its definition by the foliar layer species assemblages;
- Biocoenosis of the rhizomes epifauna of *Posidonia oceanica*, which can be identified as a particular form of the Coralligenous biocoenosis ("C", Pérès & Picard, 1964) due to its sciaphilous conditions and that can be related to the precoralligenous;
- Biocoenosis of the coralligenous ("C", Pérès & Picard, 1964), in its typical aspect, which hosts a few different facies;
- Biocoenosis of the Coastal Detritic ("DC", Pérès & Picard, 1964).

A few issues have to be highlighted.

First, water turbidity is very variable due to the estaury of the Tevere river a few kilometers northwards often causes low water transparency, especially during floods. In periods of low rainfall visibility can be good (up to 20 meters) and affected by turbidity brought by bottom currents. This issue combined with the depth (reef tops are at 18 meters and rapidly decrease to lower depths) allow biocoenoses with different light requirements to live one close to each other. On the reefs the conditions allow the existence of *Posidonia oceanica* and of the coralligenous side to side and this brings to the existence of ecotones and ecoclines which add much to the richness of the area.

Second, the *Posidonia oceanica* meadows are a "carrefour biocenotique" (Bianchi et al. 1989) and we have investigated two different levels: the leaves and the rhizomes. The former is a photophilous environment while the latter is a sciaphilous environment with encrusting coralline algae and has some characters of an enclave of coralligenous in the *Posidonia oceanica* meadow (Pérès and Picard 1964).

Last, the *Posidonia* rhizomes are characterized by the presence of fine sediment which may allow the settlement of species with affinity to soft substrata. The quantity of sediment depends upon whether *Posidonia* settles on hard or soft substrata, but it is anyway much higher than in the coralligenous. This can be mostly related to the effect of the foliar layer which reduces water hydrodynamism. A similar effect can be found in small crevices of the coralligenous but it is much more random distributed.

The data analysis was therefore aimed at understanding to which extent these biocoenoses host different molluscan species assemblages and which *taxa* make the difference. This is the basis for further analysis of each biocoenosis and comparison with other data sets.

7.1 Results

One of the main problems was to verify to which extent the molluscan assemblages differed in any way between biocoenoses. In other words: do the biocoenoses host typical molluscan assemblages? Then to answer to the question the data were treated with two different approaches:

1. Analysis of data with an univariate approach, using diversity indices to describe each sample;
2. Analysis of data with a multivariate approach, using the full quali-quantitative data matrix shown in Annex I.

7.1.1 Univariate approach

The computed indices were (see chapter 4.4 "Biodiversity indices" for details):

- Indices of species richness:
  - S, number of species;
  - d, Margalef's species richness;
- Indices of diversity:
  - H', Shannon index;
  - λ, Simpson index.

- Indices of evenness:
    - J', equitability or Pielou's evenness;
    - 1- λ, another form of the Simpson index.

Results are summarized in Tab. 18.

	Species richness		Diversity		Equitability	
Replicate[10]	**S**	**d**	**H'**	**λ**	**J'**	**1- λ**
S1-COR-01	53	10.091	3.250	0.075	0.818	0.925
S2-COR-01	11	3.107	2.000	0.203	0.834	0.797
S3-COR-01	26	5.884	2.950	0.074	0.905	0.926
S4-COR-02	33	7.111	3.107	0.060	0.889	0.940
S5-COR-02	34	6.823	2.879	0.108	0.816	0.892
S6-COR-02	14	3.944	2.375	0.119	0.900	0.881
S7-COR-03	40	8.160	3.073	0.100	0.833	0.900
S8-COR-03	33	6.769	3.031	0.077	0.867	0.923
S9-COR-03	13	3.323	1.705	0.343	0.665	0.657
S10-COR-04	29	5.799	2.640	0.123	0.784	0.877
S11-COR-04	35	7.065	2.754	0.144	0.775	0.856
S12-COR-04	25	6.167	2.897	0.083	0.900	0.917
S16-COR-10	43	8.286	3.111	0.074	0.827	0.926
S17-COR-10	25	5.815	2.755	0.105	0.856	0.895
S22-COR-10	42	8.150	2.998	0.099	0.802	0.901
S19-COR-11	39	7.965	2.836	0.149	0.774	0.851
S20-COR-11	44	8.951	3.370	0.049	0.891	0.951
S21-COR-11	37	7.800	2.850	0.139	0.789	0.861
R1-FOP---	5	1.259	0.682	0.701	0.424	0.299
R2-FOP---	3	1.116	1.011	0.389	0.921	0.611
R3-FOP---	5	1.243	1.015	0.498	0.631	0.502
R4-FOP-06	2	0.558	0.451	0.722	0.650	0.278
R5-FOP-06	2	0.910	0.637	0.556	0.918	0.444
R6-FOP-06	7	2.038	1.441	0.335	0.740	0.665
R8-FOP-08	5	2.232	1.561	0.222	0.970	0.778
R9-FOP-08	3	1.243	0.950	0.440	0.865	0.560
SP1-RIP-07	34	7.667	3.261	0.049	0.925	0.951
SP2-RIP-07	33	7.043	2.904	0.096	0.831	0.904
SP3-RIP-07	30	6.297	2.616	0.146	0.769	0.854
SP4-RIP-09	54	10.550	3.532	0.045	0.885	0.955
SP5-RIP-09	31	7.061	3.176	0.054	0.925	0.946
SP6-RIP-09	27	6.275	2.907	0.079	0.882	0.921

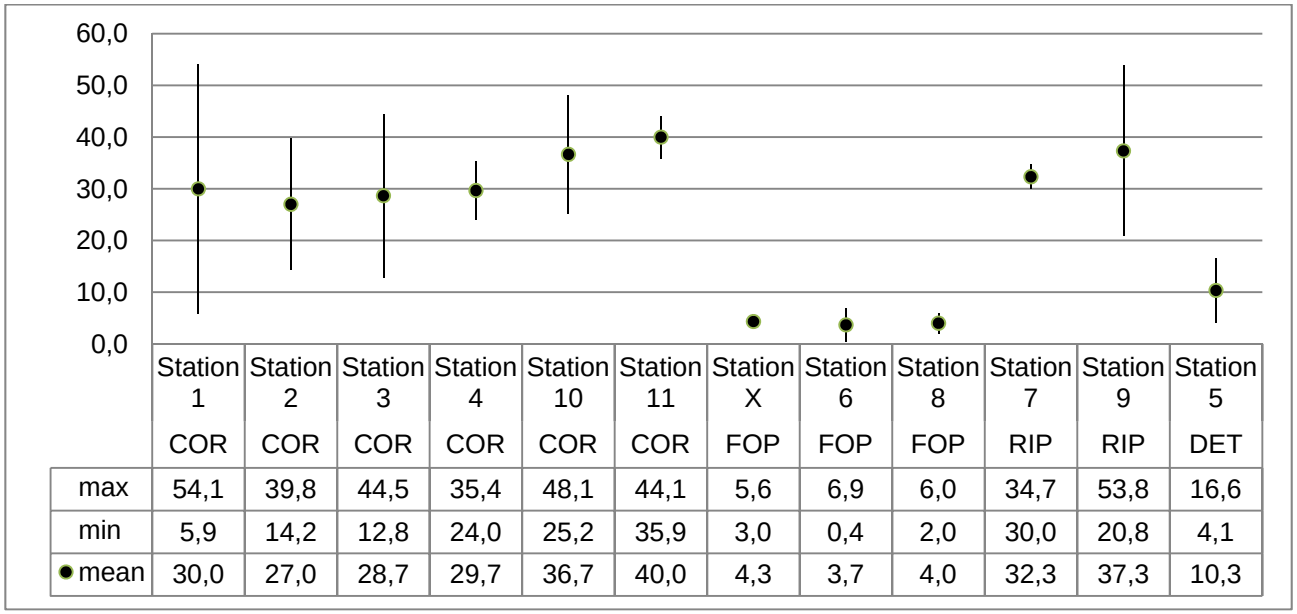
[10] Here replicates are coded in this way: first the replicate code, then the biocoenosis code and last the station code. For example, sample S1-COR-01 is the sample S1 collected in the coralligenous biocoenosis in station 01

	Species richness		Diversity		Equitability	
Replicate[10]	**S**	**d**	**H'**	**λ**	**J'**	**1- λ**
S13-DET-05	16	4.720	2.590	0.094	0.934	0.906
S14-DET-05	5	2.056	1.475	0.265	0.917	0.735
S15-DET-05	10	2.796	1.609	0.341	0.699	0.659

Tab. 18 – Indices values for all samples

The values of each index for each station were then computed averaging the values of the different (usually three[11]) samples in each station.

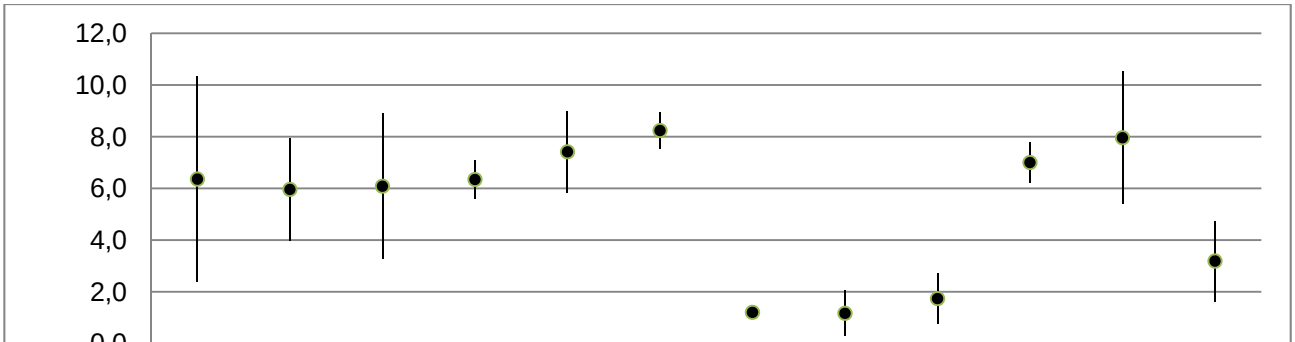
The indices values for each station and their 95% confidence intervals are figured below with comments.



	Station 1 COR	Station 2 COR	Station 3 COR	Station 4 COR	Station 10 COR	Station 11 COR	Station X FOP	Station 6 FOP	Station 8 FOP	Station 7 RIP	Station 9 RIP	Station 5 DET
max	54,1	39,8	44,5	35,4	48,1	44,1	5,6	6,9	6,0	34,7	53,8	16,6
min	5,9	14,2	12,8	24,0	25,2	35,9	3,0	0,4	2,0	30,0	20,8	4,1
● mean	30,0	27,0	28,7	29,7	36,7	40,0	4,3	3,7	4,0	32,3	37,3	10,3

Fig. 10 – 95% confidence intervals of the species richness (S) for each station

[11] The only exception is station 8 (foliar layer of *Posidonia oceanica*) where a sample was empty and so only two samples were retained for computation.



	Station 1 COR	Station 2 COR	Station 3 COR	Station 4 COR	Station 10 COR	Station 11 COR	Station X FOP	Station 6 FOP	Station 8 FOP	Station 7 RIP	Station 9 RIP	Station 5 DET
max	10,340	7,941	8,902	7,081	8,989	8,943	1,294	2,043	2,708	7,779	10,537	4,747
min	2,382	3,978	3,266	5,607	5,845	7,535	1,118	0,294	0,768	6,226	5,388	1,634
mean	6,361	5,960	6,084	6,344	7,417	8,239	1,206	1,169	1,738	7,003	7,962	3,190

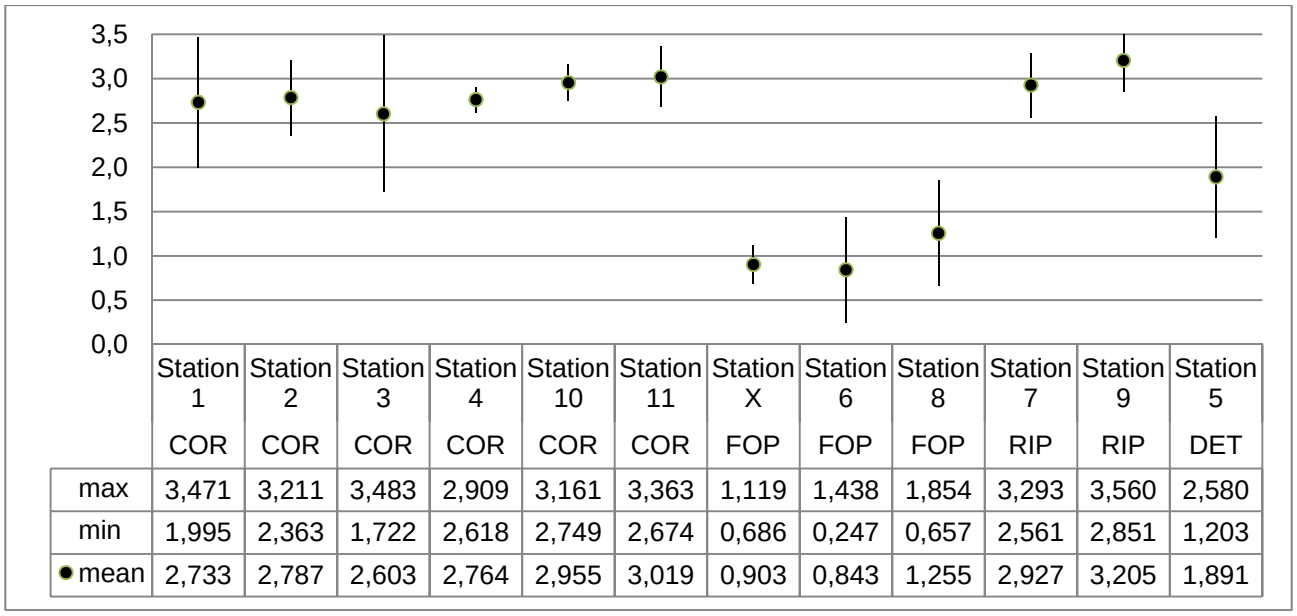
Fig. 11 – 95% confidence intervals of the Margalef's species richness index (d) for each station

Species richness indices show great variability among stations. 95% confidence intervals are wide even within the same biocoenosis and this is probably due to the different sampling efficacy which was observed. Since these indices depends in various degrees upon the sampling effort, they are not the best to characterize the stations and the biocoenoses.

In any case, a few observations can be done:

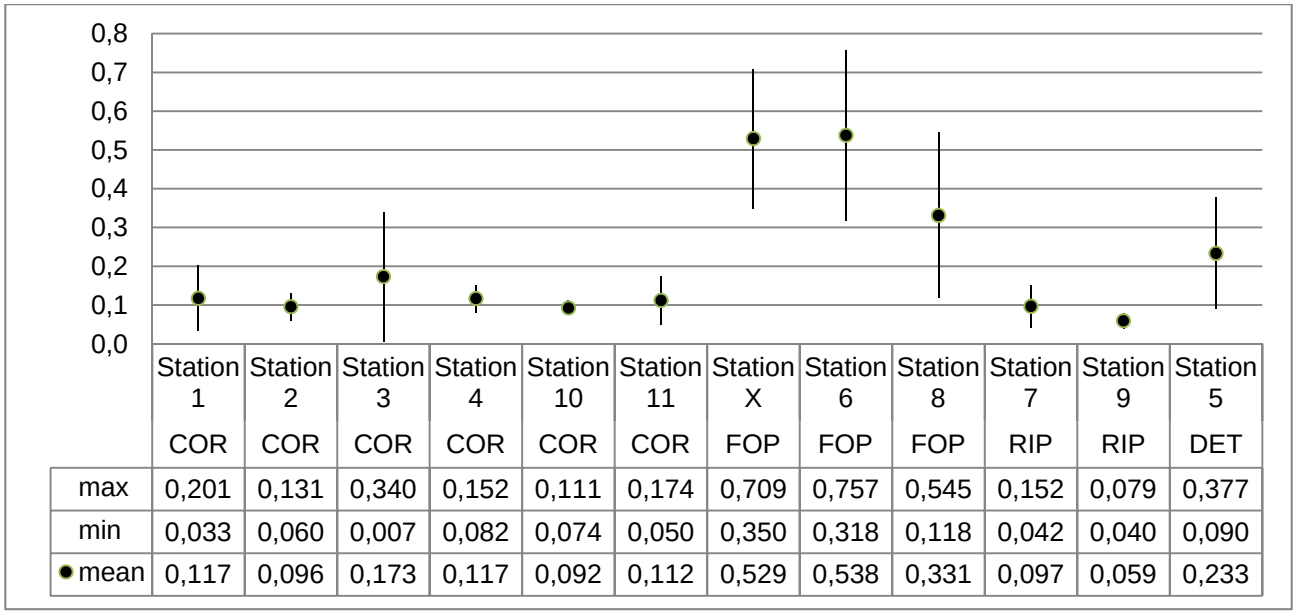
- The coralligenous and rhizome layer of *Posidonia oceanica* are the richest biocoenoses in terms of number of species, hosting a mean value of 30 species per sample but reaching over 50 species in the richest samples;
- The detritic biocoenosis is poor in species, with a mean value of the single station of 10;
- The foliar layer of *Posidonia oceanica* is particularly poor in species with a mean value of 3.7 to 4.3 species per station.

If the richness of the coralligenous and rhizome layer and the poorness of the detritic pools were expected, the extreme poorness of the foliar layer of *Posidonia oceanica* was a surprise and is commented upon in greater detail in chapter 8.



	Station 1 COR	Station 2 COR	Station 3 COR	Station 4 COR	Station 10 COR	Station 11 COR	Station X FOP	Station 6 FOP	Station 8 FOP	Station 7 RIP	Station 9 RIP	Station 5 DET
max	3,471	3,211	3,483	2,909	3,161	3,363	1,119	1,438	1,854	3,293	3,560	2,580
min	1,995	2,363	1,722	2,618	2,749	2,674	0,686	0,247	0,657	2,561	2,851	1,203
mean	2,733	2,787	2,603	2,764	2,955	3,019	0,903	0,843	1,255	2,927	3,205	1,891

Fig. 12 – 95% confidence intervals of the Shannon index (H') for each station

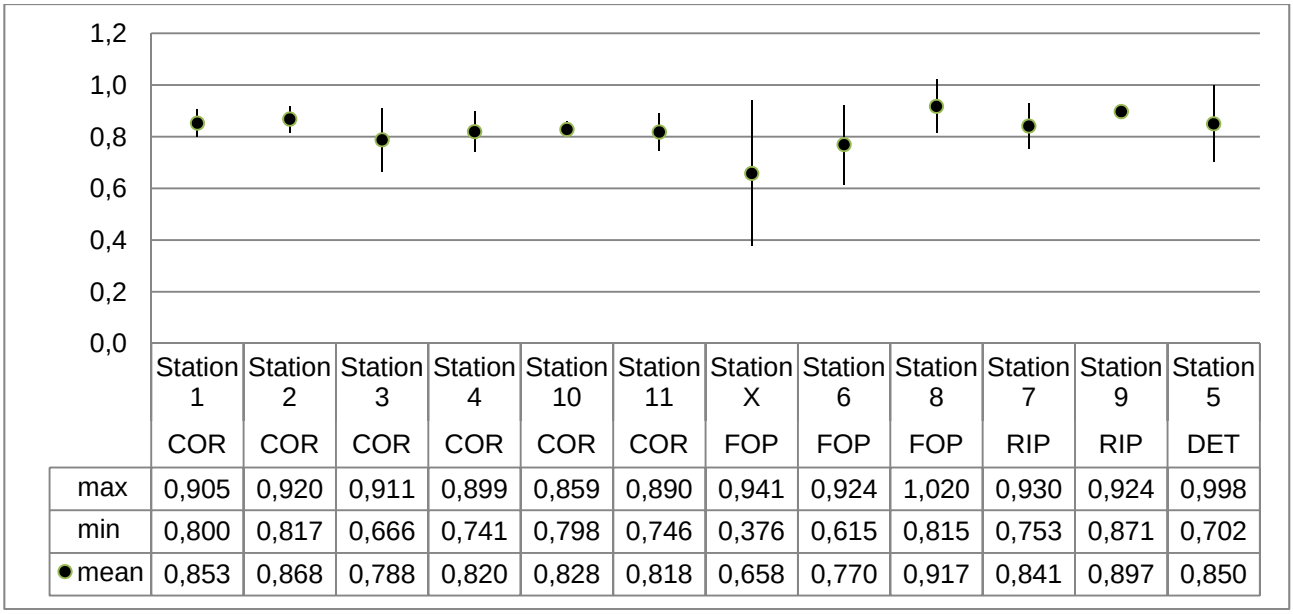


	Station 1 COR	Station 2 COR	Station 3 COR	Station 4 COR	Station 10 COR	Station 11 COR	Station X FOP	Station 6 FOP	Station 8 FOP	Station 7 RIP	Station 9 RIP	Station 5 DET
max	0,201	0,131	0,340	0,152	0,111	0,174	0,709	0,757	0,545	0,152	0,079	0,377
min	0,033	0,060	0,007	0,082	0,074	0,050	0,350	0,318	0,118	0,042	0,040	0,090
mean	0,117	0,096	0,173	0,117	0,092	0,112	0,529	0,538	0,331	0,097	0,059	0,233

Fig. 13 – 95% confidence intervals of the Simpson index (λ) for each station

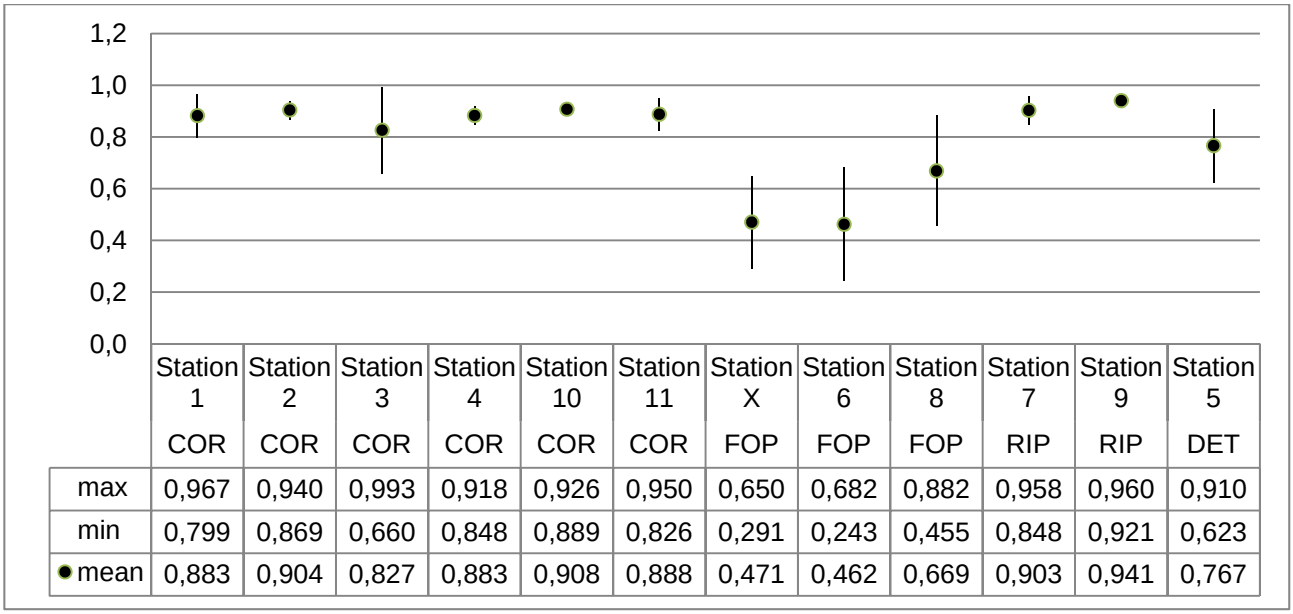
Shannon and Simpson (λ) diversity indices give different results. Where one is low the other is high and vice versa. However, this difference is due to the fact that the Shannon index is a "true" diversity index, while Simpson index is a dominance index in the sense that its largest values correspond to assemblages whose total abundance is dominated by one, or a very few, of the species present. For this reason, despite the foliar layer of *Posidonia oceanica* can be regarded as a poor assemblage in terms of specimens and species collected, its high Simpson index values are due to the presence of a few dominant species (*Bittium latreillii*, *Chauvetia* aff *brunnea*, *Ocinebrina aciculata*, see chapter 8 for further details). Something similar happens in the detritic biocoenosis, whose samples are dominated by a few species (*Pteromeris corbis* and *Retusa mamillata*). The coralligenous and rhizome layer of *Posidonia oceanica* have low Simpson index values because specimens are more distributed among species.

The Shannon index describes the coralligenous and rhizome layer of *Posidonia oceanica* as the richest with values near or above 3. The detritic biocoenosis is poorer with a mean value of 1.891 while the foliar layer of *Posidonia oceanica* is the poorest with Shannon index values between 0.843 and 1.255.



	Station 1 COR	Station 2 COR	Station 3 COR	Station 4 COR	Station 10 COR	Station 11 COR	Station X FOP	Station 6 FOP	Station 8 FOP	Station 7 RIP	Station 9 RIP	Station 5 DET
max	0,905	0,920	0,911	0,899	0,859	0,890	0,941	0,924	1,020	0,930	0,924	0,998
min	0,800	0,817	0,666	0,741	0,798	0,746	0,376	0,615	0,815	0,753	0,871	0,702
mean	0,853	0,868	0,788	0,820	0,828	0,818	0,658	0,770	0,917	0,841	0,897	0,850

Fig. 14 – 95% confidence intervals of the evenness (J') index for each station



	Station 1 COR	Station 2 COR	Station 3 COR	Station 4 COR	Station 10 COR	Station 11 COR	Station X FOP	Station 6 FOP	Station 8 FOP	Station 7 RIP	Station 9 RIP	Station 5 DET
max	0,967	0,940	0,993	0,918	0,926	0,950	0,650	0,682	0,882	0,958	0,960	0,910
min	0,799	0,869	0,660	0,848	0,889	0,826	0,291	0,243	0,455	0,848	0,921	0,623
mean	0,883	0,904	0,827	0,883	0,908	0,888	0,471	0,462	0,669	0,903	0,941	0,767

Fig. 15 – 95% confidence intervals of the Simpson index (1-λ) for each station

The evenness (J') index has pretty high values for all stations. While the evenness index has a pretty constant value across stations belonging to the same biocoenosis (mean value ranging from 0.788 to 0.897), the foliar layer of *Posidonia oceanica* has the most variable pattern with the lowest (0.658) and highest (0.917) mean index value across all stations and with wide confidence intervals. This is probably due to the poorness of the samples which affect computing.

The Simpson index (1-λ) is the most sensitive to the different equitability of the biocoenoses. It has a high value for the coralligenous and rhizome layer of *Posidonia oceanica* (mean values from 0.827 to 0.941), slightly lower values for the detritic pools (mean 0.767) and the lowest values for the *Posidonia* leaves (mean values from 0.462 to 0.669).

It has to be remembered that the different confidence intervals are the result of different sampling efficacy and replicates homogeneity. This is particularly true for the foliar layer of *Posidonia*, which host 3 to 24 specimens *per* replicate only with great variability between samples, but it happened in the coralligenous stations 1 and 3 too, where samples have up to 173 specimens, but with great variation between samples

(station 1 has 25 to 173 specimens, station 3 has 37 to 119 specimens). The number of species has a similar pattern but values are smaller and less variable.

To statistically test differences of the indices values between the biocoenoses, an ANOVA (one-way analysis of variance, cfr. 4.3.4) with F-test was performed. However, variances were too variable between all stations for most diversity indices. Therefore, transformation of data was needed before testing to stabilise variance. A severe transformation was chosen, using 4^{th} root transform.

The transformed data are in the following table.

	Species richness		**Diversity**		**Equitability**	
	√√S	**√√d**	**√√ λ**	**√√H'**	**√√J'**	**√√(1- λ)**
S1-COR-01	2.698	1.782	0.523	1.343	0.951	0.981
S2-COR-01	1.821	1.328	0.671	1.189	0.956	0.945
S3-COR-01	2.258	1.557	0.521	1.311	0.975	0.981
S4-COR-02	2.397	1.633	0.494	1.328	0.971	0.985
S5-COR-02	2.415	1.616	0.573	1.303	0.951	0.972
S6-COR-02	1.934	1.409	0.588	1.241	0.974	0.969
S7-COR-03	2.515	1.690	0.563	1.324	0.955	0.974
S8-COR-03	2.397	1.613	0.526	1.319	0.965	0.980
S9-COR-03	1.899	1.350	0.765	1.143	0.903	0.900
S10-COR-04	2.321	1.552	0.593	1.275	0.941	0.968
S11-COR-04	2.432	1.630	0.616	1.288	0.938	0.962
S12-COR-04	2.236	1.576	0.537	1.305	0.974	0.979
S16-COR-10	2.561	1.697	0.521	1.328	0.954	0.981
S17-COR-10	2.236	1.553	0.569	1.288	0.962	0.973
S22-COR-10	2.546	1.690	0.561	1.316	0.946	0.974
S19-COR-11	2.499	1.680	0.621	1.298	0.938	0.961
S20-COR-11	2.576	1.730	0.470	1.355	0.971	0.988
S21-COR-11	2.466	1.671	0.610	1.299	0.943	0.963
R1-FOP---	1.495	1.059	0.915	0.909	0.807	0.739
R2-FOP---	1.316	1.028	0.790	1.003	0.980	0.884
R3-FOP---	1.495	1.056	0.840	1.004	0.891	0.842
R4-FOP-06	1.189	0.864	0.922	0.819	0.898	0.726
R5-FOP-06	1.189	0.977	0.863	0.893	0.979	0.816
R6-FOP-06	1.627	1.195	0.761	1.096	0.928	0.903
R8-FOP-08	1.495	1.222	0.687	1.118	0.992	0.939
R9-FOP-08	1.316	1.056	0.814	0.987	0.964	0.865
SP1-RIP-07	2.415	1.664	0.469	1.344	0.981	0.988
SP2-RIP-07	2.397	1.629	0.556	1.305	0.955	0.975
SP3-RIP-07	2.340	1.584	0.618	1.272	0.936	0.961
SP4-RIP-09	2.711	1.802	0.461	1.371	0.970	0.989
SP5-RIP-09	2.360	1.630	0.482	1.335	0.981	0.986
SP6-RIP-09	2.280	1.583	0.530	1.306	0.969	0.980
S13-DET-05	2.000	1.474	0.553	1.269	0.983	0.976
S14-DET-05	1.495	1.197	0.718	1.102	0.978	0.926

	Species richness		Diversity		Equitability	
	√√**S**	√√**d**	√√ **λ**	√√**H'**	√√**J'**	√√**(1- λ)**
S15-DET-05	1.778	1.293	0.764	1.126	0.914	0.901

Tab. 19 – Fourth root transformed indices values for all samples

The question to be answered is:

- are there any significant differences in terms of richness, diversity and equitability between the sampled stations?

To answer to this question, a few steps were followed:

- first, a total test of differences, seeing whether there were statistically significant differences between the stations;
- then, a test within biocoenoses to see to which extent stations displayed the same indices values within the same biocoenosis;
- last, a pair-wise test between biocoenoses to see to which extent the indices differed.

So the first test is a test of differences between all stations. It is a preliminary test to see whether it has sense to go deeper testing differences between biocoenoses.

An F-test was performed for all indices and results are summarized in Tab. 20. The null hypothesis is that the differences between stations are due to casuality. Therefore the null hypothesis is that there are not statistically significant differences between stations. The null hypothesis is rejected if the calculated F value is greater than the F tabled value. If the null hypothesis is rejected, then there are significant differences between stations.

Biodiversity index		F value	Test results (α=0.05)
Species richness	S	10.554	There are significant differences
	d	11.653	There are significant differences
Diversity	H’	11.520	There are significant differences
	λ	7.016	There are significant differences
Equitability	J’	1.187	There are NOT significant differences
	1- λ	6.380	There are significant differences

Tab. 20 – Results of F-test between all stations using all diversity indices (degrees of freedom of the numerator: 11, degrees of freedom of the denominator: 23, F tabled value p=0.05: 2.236)

A few observations are straight-forward:

- Most indices clearly show there are statistically significant (p=0.05) differences between stations
- The Pielou’s evenness index does not show any statistically significant (p=0.05) difference between stations; the qualitative description of the indices confidence intervals already highlighted that this index was not very variable between stations

The same test was then performed within each biocoenosis to test whether the differences of the diversity indices values between stations are significant or not.

Diversity index		Differences within coralligenous stations F value	Differences within *Posidonia* leaves stations F value	Differences within *Posidonia* rhizomes stations F value
Species richness	S	0.527	0.239	0.242
	d	0.590	0.697	0.426

Diversity index		Differences within coralligenous stations F value	Differences within *Posidonia* leaves stations F value	Differences within *Posidonia* rhizomes stations F value
Diversity	H'	0.347	0.741	1.170
	λ	0.312	1.231	1.406
Equitability	J'	0.591	1.184	1.385
	1- λ	0.517	0.894	1.575
Tabled F value (p=0.05)		3.106	5.786	7.709
Numerator degrees of freedom		5	2	1
Denominator degrees of freedom		12	5	4
Test results (p=0.05)		There are NOT significant differences	There are NOT significant differences	There are NOT significant differences

Tab. 21 – Results of F-test between stations placed in the same biocoenosis using all diversity indices

All diversity indices do not show significant differences between stations of the same biocoenosis (p=0.05). This time Pielou's evenness J has the same behaviour of other indices as could be expected since it does not show any significant differences between all stations.

This is an important first result, because it means that stations belonging to the same biocoenosis have an homogenous fauna in terms of species richness, diversity and equitability.

Now what has to be verified is whether these indices have different values in different biocoenoses. So a pairwise F-test was computed. Due to the risk of increase of type I errors in a pairwise test like this, the Bonferroni correction is applied and the significance level is reduced to 0.01 (which is approximately 0.05/6).

Diversity index		COR vs FOP	COR vs RIP	COR vs DET	FOP vs RIP	FOP vs DET	RIP vs DET
Species richness	S	11.095	*0.517*	*2.581*	29.931	*2.472*	11.116
	d	12.515	*0.633*	*2.276*	27.297	*3.632*	*9.405*
Diversity	H'	12.324	*0.568*	*1.884*	15.742	*3.009*	*7.187*
	λ	7.811	*0.730*	*0.910*	17.676	*2.629*	*4.335*
Equitability	J'	*1.205*	*0.858*	*0.361*	*1.539*	*1.144*	*0.355*
	1- λ	6.319	*0.733*	*1.160*	*5.898*	*2.178*	*3.882*
Tabled F value (p=0.01)		**3.791**	**4.026**	**4.456**	**6.422**	**8.451**	**10.925**
Numerator degrees of freedom		8	7	6	4	3	2
Denominator degrees of freedom		17	16	14	9	7	6

Tab. 22 – Results of F-test between stations placed in different biocoenosis using all diversity indices (values in *italics* are below the tabled F value, meaning there are not significant differences, while values in red are above the tabled F value, p=0.01)

The coralligenous and the foliar layer of *Posidonia oceanica* biocoenoses are different in terms of species richness, species diversity and equitability as far the Simpson index is concerned. There are not significant differences in the Pielou's evenness J' values.

The coralligenous and the rhizome layer of *Posidonia oceanica* biocoenoses are not different in terms of species richness, species diversity and equitability.

The coralligenous and the detritic biocoenoses are not different in terms of species richness, species diversity and equitability and this is quite surprising. The number of species, for example, is usually the double in a coralligenous station than in a detritic one. This may be a result of the 4^{th} root transform which may have flattened too much indices values in this case.

The foliar and the rhizome layer of *Posidonia oceanica* show quite marked differences in terms of species richness and species diversity. Equitability indices do not differ significantly.

The foliar layer of *Posidonia oceanica* and the detritic biocoenoses are not different in terms of species richness, species diversity and equitability.

Last, the rhizome layer of *Posidonia oceanica* and the detritic biocoenoses are different in terms of species richness when the number of species is concerned. The other indices do not show significant differences.

7.1.2 Multivariate approach

The analysis of the full multivariate data was performed using the quali-quantitative matrix in Annex I. Data were standardized because the sampling efficacy (e.g. number of specimens per replicate) was variable as could be observed in the field.

The analysis followed these steps:

- Transformation;
- Computing of the similarity matrix;
- Cluster analysis;
- Non-metric Multi-Dimensional Scaling (MDS);
- ANOSIM procedure;
- SIMPER routine;
- PERMANOVA.

A transformation was applied to avoid that the similarities were excessively influenced by common species only since the species assemblages are rich and diversified. The square root transform was chosen bringing the right equilibrium between down-grading the importance of common species and not over-grading the rare species one. A similarity matrix was computed using the Bray-Curtis coefficient. The cluster analysis was performed using the hierarchical agglomerative method and using group-average linkage for the combination of similarity values. The factor used for every replicate was the biocenosis the sample was caught in.

Results are illustrated in Fig. 16 and Fig. 17.

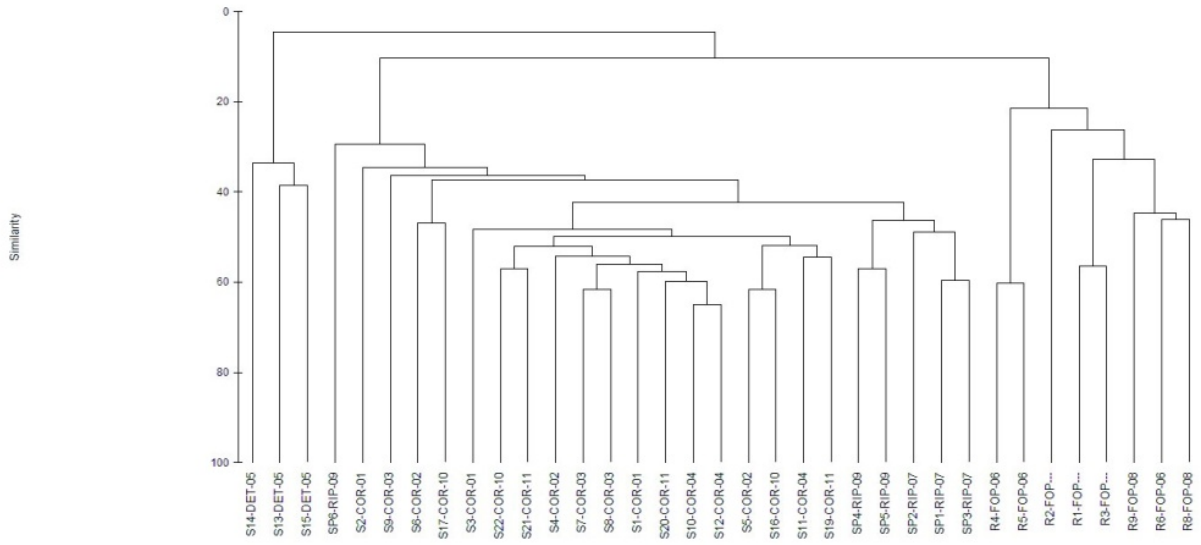


Fig. 16 – Dendrogram for hierarchical clustering of all replicates from all stations (standardized data, square root transform, Bray-Curtis similarity coefficient, group-average linkage); replicates labels are evidenced

In the dendrogram in Fig. 16 it is possible to notice that in some cases replicates from the same station are grouped together.

This is the obvious case of the detritic replicates from the single station, but it is also the more interesting case of the foliar layer of *Posidonia*. Replicates R4 and R5 from station 6, R1 and R3 from the unnumbered test station (see chapter 4.1), R8 and R9 both belonging to station 8 form clusters. Replicates R2 and R6 are the exception to this rule. Since stations were placed in areas where *Posidonia* grow in different environmental conditions (e.g. station 6 is patches of *Posidonia* in a coralligenous substratum, station 8 is a small field in a sedimentary area, the unnumbered test station is again patches on hard substratum) the overall clustering attitude of these replicates may indicate that faunal assemblages in *Posidonia* leaves differ according to the substratum where the plant settles (see chapter 8).

In the rhizome layer of *Posidonia* this clustering can be observed again: replicates SP1, SP2 and SP3 (station 7) cluster together as SP4 and SP5 (station 9) do. SP6 (station 9) is a problematic replicate which is considered different from the whole coralligenous-rhizomes group. This may be associated to the substratum where *Posidonia* settles even better than the foliar layer replicates and even more intuitively. Station 7 is the rhizome layer corresponding station of foliar layer station 6 and is patches of *Posidonia* in a coralligenous substratum. Station 9 is the corresponding of station 8 and here *Posidonia* settles in one of the few truly sedimentary areas in the reefs. Rhizomes in the coralligenous and in the sediment are clearly different habitats the latter having much more sediment and being able, e.g., to host more sediment dwellers like bivalves while the former having more the characteristics of the coralligenous species assemblage.

In the coralligenous, replicates are occasionally clustered by pairs (S7 and S8 from station 3, S10 and S12 from station 4), but they are more often mixed up. This behaviour may be explained in two ways: or it indicates a very uniform species assemblage across stations, or an inadequate sampled area per replica. The former hypothesis seems the most reliable in this case, see chapter 10.

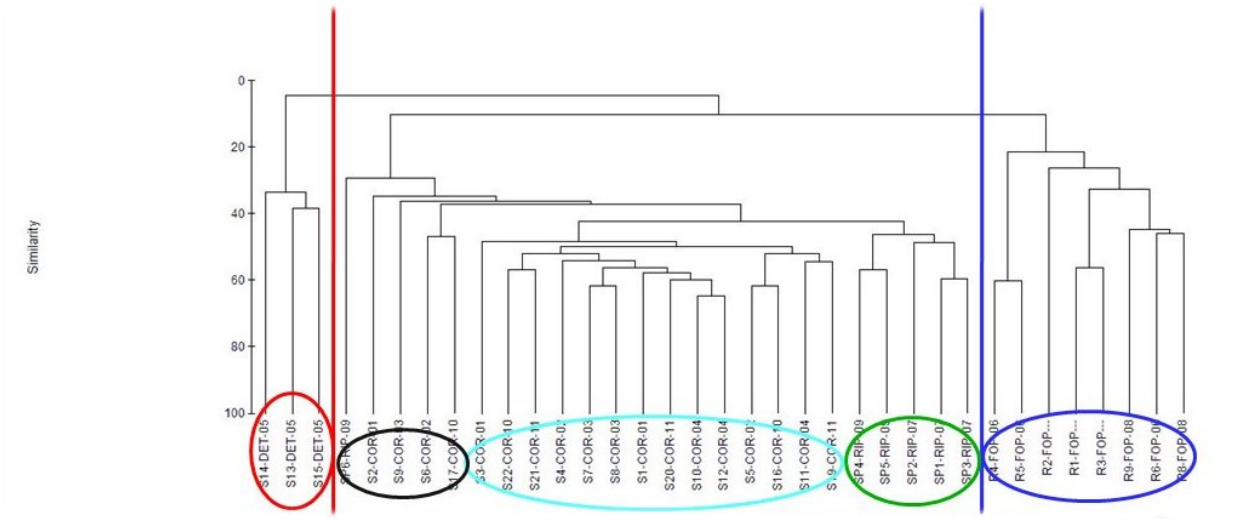


Fig. 17 – Dendrogram for hierarchical clustering of all replicates from all stations (standardized data, square root transform, Bray-Curtis similarity coefficient, group-average linkage); colours mark clusters belonging to the same biocoenosis: blue (foliar layer of *Posidonia oceanica*), green (rhizome layer of *Posidonia oceanica*), light blue (coralligenous), red (detritic pools), black (problematic replicates)

The analysis of the dendrogram at a lower level of similarity is easier looking at Fig. 17.

Here two species assemblages are clearly recognizable. First, the replicates belonging to the single station in the detritic pools (in red), then the replicates belonging to the foliar layer of *Posidonia oceanica* (in blue). In the middle there are replicates from the coralligenous and *Posidonia* rhizomes where two main clusters can be recognized: the cluster of the rhizomes (in green) and that of most coralligenous replicates (in light blue). Five replicates escape these clusters (four belonging to the coralligenous, S2, S6, S9 and S17, and one to the rhizomes, SP6). The rhizome replicate SP6 is particularly problematic because it was sampled on rhizomes in a sedimentary area (station 9), so it is expected to host a species assemblage different from hard substrata but it is not clustered with the other replicates from the same station.

A Non metric Multi-Dimensional Scaling was then performed for a further analysis of data.

A two-dimensions plot was drawn computing the MDS with 10 restarts and is figured in Fig. 18 (plots with up to 30 restarts were drawn too without any difference in stress and overall geometry). A stress value of 0.1 was obtained and considered satisfactory for interpretation. A three-dimensions plot was drawn too, but it is much less intuitive to look at and therefore its interpretation more difficult. MDS was also computed on 4th root transformed data but the overall geometry and stress values were the same.

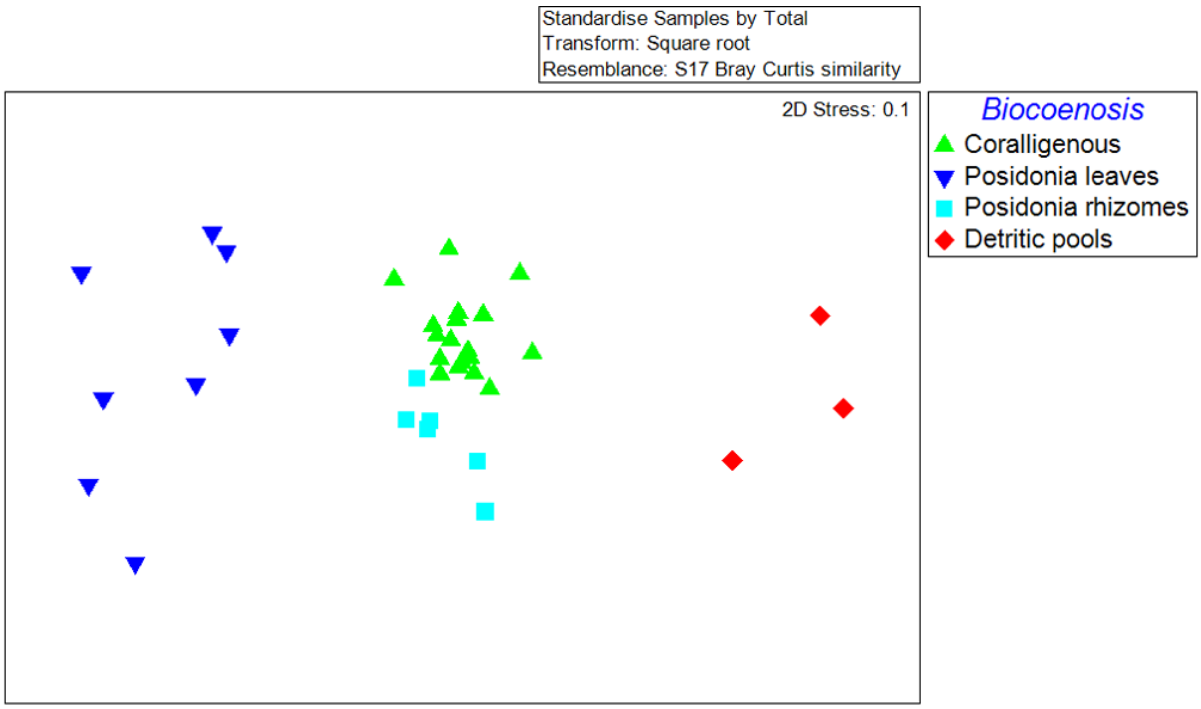


Fig. 18 – Non metric Multi-Dimensional Scaling plot of all replicates (10 restarts), different symbols and colours represent different biocoenoses

The plot shows a group of replicates belonging to the detritic biocoenosis (roars in red) and another group belonging to the foliar layer of *Posidonia oceanica* (blue triangles) on the sides. In the middle, there are all other replicates belonging to the coralligenous (green triangles) and the rhizomes (light blue squares).

While these three main groups are clearly distinguished with relative distances higher than those within the biocoenoses, the group of replicates within the central group are not put aside so clearly. Despite they are put in two different groups, they are very close to each other meaning that differences are much less important than in the distinction from the detritic and foliar replicates.

The overall pattern of the cluster analysis is therefore supported by the MDS.

When it comes to a finer interpretation, we can observe that those "problematic replicates" in the cluster analysis are here at the edges of the central group of coralligenous-rhizomes replicates confirming their difference from the overall pattern. If the number of species and specimens of these "problematic replicates" is analysed it can be easily seen that they are unusually poor replicates in terms of number of specimens and species and this is likely to cause their outlying position.

Similarities between stations were tested by the ANOSIM test. A single factor was tested: the biocoenosis to which the station belongs. A global ANOSIM test was conducted first to analyse the overall differences between groups. The test was conducted using the similarity ranked matrix of standardized data, square root transformed in order to have data fully comparable with the most satisfying clustering and MDS-plotting described above.

The resulting *R* distribution is the following:

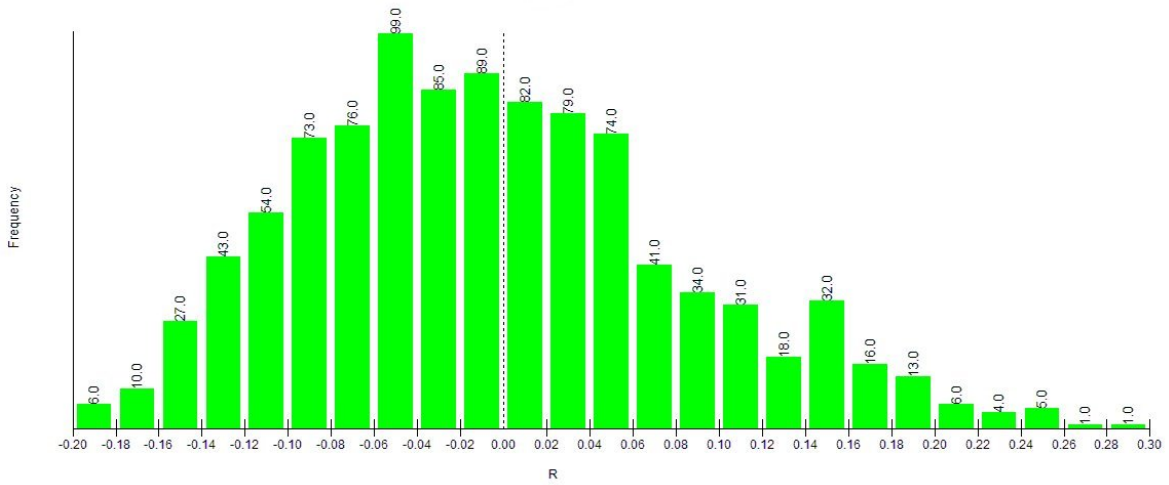


Fig. 19 – Simulated distribution of the test statistic *R* calculated through permutations of the replicates (999 permutations)

The value of *R* calculated on the sample (*R*=0.805) is much higher than any other value of *R* calculated through permutations. This allows to assess that there are significant differences between replicates (computed p is 0.001, but level of significance was p=0.05).

A pairwise test was then conducted to understand where these differences lied. Results are summarized in Tab. 23.

Groups	***R* statistic**	**Significance level %**	**Possible permutations**	**Actual permutations**	**Number of *R* values ≥ observed *R***
COR, FOP	0.951	0.1	1562275	999	0
COR, RIP	0.51	0.2	134596	999	1
COR, DET	1	0.1	1330	999	0
FOP, RIP	0.782	0.3	3003	999	2
FOP, DET	0.933	0.6	165	165	1
RIP, DET	1	1.2	84	84	1

Tab. 23 – Results of ANOSIM pairwise test (maximum 999 permutations where done)

Since the overall significance level is kept at p=0.05, the level of significance of every single pairwise test is lower since the Bonferroni correction is applied. Therefore, the level of significance of every single pairwise test is 0.05/6 and so 0.008 (0.8%).

A low number of possible permutations can affect the maximum significance level. Despite the number of possible permutations for comparison between the foliar layer of *Posidonia* (POS) and the detritic is lower than the fixed number (999), the level of significance (p=0.006) is still satisfactory. On the other hand, the level of significance of the test between the *Posidonia* rhizomes (RIP) and the detritic pools (DET) is just 0.012, higher than the Bonferroni corrected fixed level. However, since the number of replicates is low the maximum level of significance possible was 0.011. A quick look at the quali-quantitative data of the two biocoenoses do not leave doubts about the difference in the species assemblage. Also the high value of the *R* statistic and fact that just a single value of simulated distribution of the *R* statistic is above the sample *R* value suggest that the two assemblages are substantially different. These problematic pairwise comparisons will be later tested again with more powerful tools (PERMANOVA and Monte Carlo sampling).

The other pairwise tests suggest there are statistically significant differences between the other biocoenoses (p<0.008). Of particular interest it is the statistically significant difference between the coralligenous and the rhizome layer of *Posidonia* since this was not at all clear after the cluster analysis (Fig. 17) and was still

subject to interpretation in the MDS (Fig. 18). It is interesting to highlight the marked difference between the rhizome layer and the foliar layer of *Posidonia oceanica* too.

To further check the similarities between stations and biocoenoses, a PERMANOVA was performed on the similarity matrix. The global test shows that there are significant differences between samples ($p<0.05$). The permutational test has a level of significance of 0.001, extremely low enforcing the existence of considerable differences. The pairwise test shows again there are significant differences between biocoenoses ($p<0.008$) as reported in Tab. 24. Where the number of permutations is too low for meaningful permutational tests (FOP vs DET and RIP vs DET), Monte Carlo values of the level of significance were considered (Anderson & Robinson, 2003). In the cases with few possible permutations, the observations of raw quali-quantitative data further support the existence of different species assemblages, as previously discussed when the ANOSIM results are reported.

	Significance level %	**Possible permutations**	**Significance level % (with Monte Carlo sampling)**
COR, FOP	0.001	998	0.001
COR, RIP	0.001	993	0.001
COR, DET	0.003	706	0.001
FOP, RIP	0.001	860	0.001
FOP, DET	0.01	165	0.002
RIP, DET	0.02	84	0.001

Tab. 24 – Results of PERMANOVA pairwise test

A SIMPER analysis was carried out to locate which species are the greatest contributors to differences between biocoenoses. Again the input matrix was a dissimilarity and a similarity matrix computed with Bray-Curtis distances on standardized, square root transformed data.

Since the number of species is high, the computing was stopped when the cumulation of contributions to dissimilarity reached 60%. In the similarity analysis, the computing was stopped when the cumulation of contributions to similarity reached 90% because the role of some species had to be investigated.

Results are given in the tables below. First tables with the breakdown of similarity within each biocoenosis are given and then tables with the breakdown of dissimilarity between biocoenoses. Comments for each biocoenosis comparison are then given and within this comment similarity results will be discussed too in order to compare the species which typify biocoenoses with those that discriminate them. Last, comments are given again on similarity results to compare the typifying species between biocoenoses.

Species	**Group COR Average Abundance**	**Average Similarity**	**Sim/SD**	**Contribution to similarity %**	**Cumulations of contributions to similarity%**
Bittium latreillii *	23.67	7.88	2.13	16.95	16.95
Nassarius incrassatus *	8.94	4.61	2.26	9.93	26.88
Pollia scabra *	4.56	3.31	2.23	7.11	33.99
Raphitoma linearis *	3.83	2.90	2.07	6.24	40.23
Muricopsis cristata *	4.94	2.82	1.56	6.08	46.31
Striarca lactea	2.89	1.89	1.02	4.07	50.38
Callochiton septemvalvis	1.94	1.88	1.28	4.04	54.42
Alvania cancellata	5.17	1.87	0.91	4.03	58.45
Fusinus pulchellus	2.11	1.67	1.07	3.60	62.05
Metaxia metaxae	2.61	1.48	1.11	3.17	65.22
Marshallora adversa	1.61	1.40	1.05	3.02	68.24

Species	Group COR Average Abundance	Average Similarity	Sim/SD	Contribution to similarity %	Cumulations of contributions to similarity%
Mitrella scripta	2.33	1.26	0.83	2.71	70.95
Mitra cornicula	1.28	1.03	0.98	2.21	73.16
Alvania settepassii	1.39	0.78	0.69	1.69	74.85
Monophorus erythrosoma	1.11	0.75	0.73	1.61	76.46
Alvania hispidula	1.22	0.70	0.60	1.52	77.97
Chiton corallinus	0.83	0.63	0.59	1.35	79.33
Vexillum tricolor	1.00	0.59	0.53	1.26	80.59
Mangelia stossiciana	1.00	0.57	0.62	1.23	81.82
Papillicardium papillosum	1.00	0.55	0.62	1.19	83.01
Mangelia vauquelini	0.78	0.52	0.52	1.11	84.12
Williamia gussonii	0.94	0.48	0.51	1.04	85.16
Gregariella semigranata	0.67	0.48	0.50	1.02	86.18
Nucula sp.	1.00	0.46	0.52	0.98	87.16
Bittium sp. 1	0.83	0.44	0.44	0.95	88.11
Cerithiopsis sp. 1	0.67	0.44	0.55	0.94	89.05
Vexillum savignyi	0.94	0.40	0.53	0.85	89.91
Chlamys multistriata	0.72	0.39	0.44	0.84	90.75

Tab. 25 – Results of the SIMPER analysis representing the breakdown of average similarity within the coralligenous

Species	Group FOP Average Abundance	Average Similarity	Sim/SD	Contribution to similarity %	Cumulations of contributions to similarity%
Chauvetia aff *brunnea*	1.75	11.97	0.83	40.06	40.06
Bittium latreillii	6.00	6.21	0.48	20.79	60.85
Rissoa violacea	0.75	5.39	0.66	18.06	78.91
Ocinebrina aciculata	1.38	4.30	0.44	14.39	93.30

Tab. 26 – Results of the SIMPER analysis representing the breakdown of average similarity within the foliar layer of *Posidonia oceanica*

Species	Group RIP Average Abundance	Average Similarity	Sim/SD	Contribution to similarity %	Cumulations of contributions to similarity%
Bittium latreillii *	14.33	5.18	3.72	11.22	11.22
Muricopsis cristata *	6.67	4.26	4.30	9.23	20.45
Gouldia minima *	5.67	3.34	2.71	7.23	27.68
Raphitoma linearis *	3.33	2.73	2.45	5.90	33.59
Fusinus pulchellus *	2.67	2.60	4.73	5.63	39.21
Chauvetia aff *brunnea*	4.33	2.37	1.21	5.13	44.34
Nassarius incrassatus	4.33	2.36	1.28	5.11	49.45
Striarca lactea *	4.33	2.21	2.54	4.79	54.24
Murexsul aradasii *	2.00	2.13	7.68	4.61	58.85

Species	Group RIP Average Abundance	Average Similarity	Sim/SD	Contribution to similarity %	Cumulations of contributions to similarity%
Bolma rugosa	1.67	1.56	1.29	3.37	62.22
Ocinebrina aciculata	2.00	1.52	1.32	3.29	65.52
Cerithiopsis sp. 1	1.17	1.36	1.35	2.95	68.47
Papillicardium papillosum	3.33	1.27	0.70	2.74	71.21
Turritella turbona	2.50	1.01	0.75	2.18	73.39
Marshallora adversa	1.67	0.94	0.78	2.03	75.42
Metaxia metaxae	1.17	0.82	0.78	1.78	77.20
Homalopoma sanguineum	1.83	0.81	0.69	1.75	78.95
Barbatia barbata	1.17	0.80	0.79	1.73	80.68
Cerithiopsis nana	1.17	0.80	0.78	1.72	82.40
Parvicardium scriptum	0.83	0.79	0.74	1.70	84.11
Bittium sp. 1	1.00	0.77	0.79	1.67	85.77
Mangelia stossiciana	0.83	0.69	0.76	1.50	87.27
Venus verrucosa	0.83	0.52	0.48	1.13	88.41
Mitrella minor	1.00	0.45	0.48	0.98	89.38
Raphitoma sp. 1	0.67	0.44	0.48	0.95	90.33

Tab. 27 – Results of the SIMPER analysis representing the breakdown of average similarity within the rhizome layer of *Posidonia oceanica*

Species	Group DET Average Abundance	Average Similarity	Sim/SD	Contribution to similarity %	Cumulations of contributions to similarity%
Retusa mamillata *	6.67	14.04	9.49	39.92	39.92
Pteromeris corbis *	1.67	7.05	6.56	20.05	59.97
Caecum clarkii	1.33	4.75	0.58	13.51	73.47
Striarca lactea	1.00	3.21	0.58	9.11	82.59
Euspira pulchella	0.67	2.04	0.58	5.80	88.39
Crassopleura maravignae	1.00	2.04	0.58	5.80	94.20

Tab. 28 – Results of the SIMPER analysis representing the breakdown of average similarity within the detritic pools

Species	Group COR Average Abundance	Group FOP Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity %
Chauvetia aff *brunnea* *	0.44	1.75	6.27	1.17	6.94	6.94
Bittium latreillii *	23.67	6.00	6.02	1.67	6.66	13.60
Nassarius incrassatus *	8.94	0.00	4.27	2.39	4.72	18.33
Ocinebrina aciculata	0.50	1.38	4.06	0.89	4.49	22.82
Rissoa violacea	0.00	0.75	3.47	1.04	3.84	26.66
Pollia scabra *	4.56	0.00	3.28	1.82	3.63	30.29
Muricopsis cristata *	4.94	0.00	3.02	1.69	3.34	33.64

Species	Group COR Average Abundance	Group FOP Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity %
Raphitoma linearis *	3.83	0.00	2.72	2.53	3.00	36.64
Bittium sp. 1	0.83	0.50	2.59	0.94	2.87	39.51
Alvania cancellata	5.17	0.00	2.53	1.24	2.80	42.30
Striarca lactea	2.89	0.00	2.35	1.35	2.60	44.90
Metaxia metaxae	2.61	0.13	2.15	1.37	2.37	47.28
Callochiton septemvalvis	1.94	0.00	1.98	1.75	2.19	49.46
Fusinus pulchellus	2.11	0.00	1.97	1.51	2.17	51.64
Alvania settepassii	1.39	0.25	1.91	1.00	2.12	53.75
Marshallora adversa	1.61	0.00	1.77	1.22	1.96	55.71
Mitrella scripta	2.33	0.00	1.73	1.25	1.91	57.62
Cerithiopsis nana	0.44	0.13	1.54	0.52	1.71	59.33
Mitra cornicula	1.28	0.00	1.26	1.45	1.39	60.72

Tab. 29 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the coralligenous and foliar layer of *Posidonia oceanica* (the asterisk marks discriminating species on the basis of the Diss/SD value)

Species	Group COR Average Abundance	Group RIP Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity%
Gouldia minima *	0.50	5.67	2.18	1.87	3.48	3.48
Bittium latreillii	23.67	14.33	1.99	1.35	3.18	6.66
Chauvetia aff *brunnea* *	0.44	4.33	1.79	1.71	2.86	9.51
Pollia scabra	4.56	1.17	1.68	1.44	2.68	12.19
Alvania cancellata	5.17	0.50	1.49	1.28	2.39	14.58
Papillicardium papillosum	1.00	3.33	1.47	1.16	2.35	16.92
Nassarius incrassatus	8.94	4.33	1.32	1.13	2.11	19.04
Striarca lactea	2.89	4.33	1.25	1.21	2.00	21.03
Turritella turbona	0.28	2.50	1.24	1.10	1.97	23.01
Callochiton septemvalvis *	1.94	0.17	1.21	1.69	1.93	24.93
Murexsul aradasii *	0.22	2.00	1.18	2.47	1.88	26.81
Muricopsis cristata	4.94	6.67	1.09	1.12	1.74	28.55
Mitrella scripta	2.33	0.50	1.05	1.26	1.67	30.22
Ocinebrina aciculata *	0.50	2.00	1.01	1.53	1.62	31.85
Bolma rugosa *	0.39	1.67	1.00	1.54	1.60	33.44
Homalopoma sanguineum	0.44	1.83	0.99	1.15	1.59	35.03
Metaxia metaxae	2.61	1.17	0.92	1.23	1.47	36.50
Jujubinus exasperatus	0.28	1.50	0.90	0.84	1.43	37.93
Marshallora adversa	1.61	1.67	0.86	1.16	1.37	39.30
Alvania settepassii	1.39	0.33	0.85	0.97	1.36	40.66
Alvania hispidula	1.22	0.33	0.80	1.04	1.29	41.95
Raphitoma linearis	3.83	3.33	0.80	1.34	1.28	43.23
Vexillum tricolor	1.00	1.00	0.79	1.12	1.26	44.48

Species	Group COR Average Abundance	Group RIP Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity%
Barbatia barbata	0.72	1.17	0.78	1.23	1.24	45.73
Venus verrucosa	0.11	0.83	0.78	1.00	1.24	46.97
Fusinus pulchellus	2.11	2.67	0.75	1.25	1.19	48.16
Bittium sp. 1	0.83	1.00	0.75	1.31	1.19	49.35
Euspira pulchella	0.06	1.00	0.73	0.93	1.17	50.53
Parvicardium scriptum	0.39	0.83	0.73	1.23	1.17	51.70
Mitra cornicula	1.28	0.33	0.73	1.31	1.16	52.86
Cerithiopsis nana	0.44	1.17	0.72	1.27	1.16	54.01
Chiton corallinus	0.83	0.33	0.72	1.04	1.15	55.17
Mangelia stossiciana	1.00	0.83	0.71	1.23	1.14	56.30
Cerithiopsis sp. 1	0.67	1.17	0.69	1.26	1.10	57.40
Gregariella semigranata	0.67	0.33	0.68	0.99	1.09	58.50
Nucula sp.	1.00	0.33	0.67	0.99	1.08	59.57
Raphitoma sp. 1	0.06	0.67	0.67	0.98	1.08	60.65

Tab. 30 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the coralligenous and rhizome layer of *Posidonia oceanica* (the asterisk marks discriminating species on the basis of the Diss/SD value)

Species	Group FOP Average Abundance	Group RIP Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity%
Bittium latreillii *	6.00	14.33	5.30	2.05	6.06	6.06
Chauvetia aff brunnea	1.75	4.33	4.69	1.27	5.35	11.41
Ocinebrina aciculata	1.38	2.00	3.80	1.14	4.34	15.75
Muricopsis cristata *	0.00	6.67	3.74	4.34	4.27	20.02
Gouldia minima *	0.00	5.67	3.46	2.30	3.95	23.97
Rissoa violacea	0.75	0.33	3.17	1.07	3.63	27.60
Raphitoma linearis *	0.00	3.33	2.72	2.36	3.11	30.71
Striarca lactea	0.00	4.33	2.72	1.48	3.10	33.81
Nassarius incrassatus *	0.00	4.33	2.67	1.81	3.05	36.86
Bittium sp. 1	0.50	1.00	2.46	1.05	2.81	39.67
Papillicardium papillosum	0.00	3.33	2.34	1.07	2.68	42.34
Fusinus pulchellus *	0.00	2.67	2.29	5.31	2.61	44.96
Cerithiopsis nana	0.13	1.17	1.96	0.84	2.24	47.19
Murexsul aradasii *	0.00	2.00	1.91	4.93	2.18	49.37
Turritella turbona	0.00	2.50	1.84	1.09	2.10	51.47
Bolma rugosa *	0.00	1.67	1.71	1.93	1.96	53.43
Metaxia metaxae	0.13	1.17	1.61	1.14	1.84	55.27
Homalopoma sanguineum	0.00	1.83	1.51	1.08	1.72	57.00
Cerithiopsis sp. 1 *	0.00	1.17	1.40	2.06	1.60	58.60
Marshallora adversa	0.00	1.67	1.36	1.37	1.56	60.15

Tab. 31 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the foliar and rhizome layer of *Posidonia oceanica* (the asterisk marks discriminating species on the basis of the Diss/SD value)

Species	Group COR Average Abundance	Group DET Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity%
Retusa mamillata *	0.00	6.67	6.94	2.86	7.36	7.36
Bittium latreillii *	23.67	0.00	6.22	2.23	6.59	13.96
Pteromeris corbis	0.00	1.67	4.85	1.42	5.14	19.09
Nassarius incrassatus *	8.94	0.00	3.66	2.40	3.88	22.98
Caecum clarkii	0.00	1.33	3.38	1.35	3.58	26.56
Pollia scabra *	4.56	0.00	2.81	1.84	2.98	29.54
Muricopsis cristata *	4.94	0.00	2.60	1.70	2.76	32.30
Striarca lactea *	2.89	1.00	2.33	1.58	2.47	34.76
Alvania cancellata	5.17	0.00	2.17	1.24	2.30	37.07
Crassopleura maravignae	0.00	1.00	2.01	1.35	2.14	39.20
Raphitoma linearis	3.83	0.33	1.85	1.49	1.96	41.16
Philine sp.	0.00	0.33	1.82	0.69	1.93	43.09
Callochiton septemvalvis *	1.94	0.00	1.69	1.75	1.79	44.89
Hemilepton nitidum	0.00	0.67	1.69	1.36	1.79	46.67
Fusinus pulchellus	2.11	0.00	1.68	1.51	1.79	48.46
Euspira pulchella	0.06	0.67	1.67	1.37	1.77	50.23
Metaxia metaxae	2.61	0.00	1.60	1.43	1.70	51.92
Marshallora adversa	1.61	0.00	1.51	1.24	1.60	53.52
Mitrella scripta	2.33	0.00	1.49	1.24	1.57	55.10
Caecum armoricum	0.00	1.00	1.37	0.69	1.45	56.55
Alvania settepassii	1.39	0.00	1.15	0.91	1.22	57.77
Nucula sp.	1.00	0.33	1.14	1.07	1.21	58.99
Papillicardium papillosum	1.00	0.33	1.13	1.18	1.20	60.18

Tab. 32 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the coralligenous and the detritic pools (the asterisk marks discriminating species on the basis of the Diss/SD value)

Species	Group FOP Average Abundance	Group DET Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity%
Retusa mamillata *	0.00	6.67	11.53	2.91	11.57	11.57
Chauvetia aff *brunnea*	1.75	0.00	9.16	1.14	9.19	20.76
Pteromeris corbis	0.00	1.67	8.28	1.35	8.30	29.06
Bittium latreillii	6.00	0.00	7.49	0.89	7.51	36.57
Caecum clarkii	0.00	1.33	5.81	1.35	5.82	42.40
Ocinebrina aciculata	1.38	0.00	5.75	0.81	5.77	48.17
Rissoa violacea	0.75	0.00	4.96	1.03	4.97	53.14
Striarca lactea	0.00	1.00	4.93	1.22	4.95	58.09
Bittium sp. 1	0.50	0.00	3.25	0.68	3.26	61.34

Tab. 33 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the foliar layer of *Posidonia oceanica* and the detritic pools (the asterisk marks discriminating species on the basis of the Diss/SD value)

Species	Group RIP Average Abundance	Group DET Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity%
Retusa mamillata *	0.00	6.67	6.54	2.98	7.04	7.04
Pteromeris corbis	0.00	1.67	4.55	1.43	4.90	11.94
Bittium latreillii *	14.33	0.00	4.45	2.35	4.79	16.74
Muricopsis cristata *	6.67	0.00	3.24	4.12	3.49	20.23
Caecum clarkii	0.00	1.33	3.16	1.35	3.41	23.64
Gouldia minima *	5.67	0.00	2.99	2.24	3.23	26.86
Chauvetia aff *brunnea*	4.33	0.00	2.32	1.76	2.50	29.36
Nassarius incrassatus	4.33	0.00	2.31	1.78	2.49	31.85
Striarca lactea	4.33	1.00	2.29	1.82	2.47	34.33
Fusinus pulchellus *	2.67	0.00	1.98	4.78	2.14	36.46
Crassopleura maravignae	0.00	1.00	1.90	1.34	2.05	38.52
Papillicardium papillosum	3.33	0.33	1.90	1.06	2.04	40.56
Raphitoma linearis	3.33	0.33	1.90	1.55	2.04	42.61
Philine sp.	0.00	0.33	1.71	0.68	1.84	44.44
Murexsul aradasii *	2.00	0.00	1.65	4.44	1.78	46.23
Hemilepton nitidum	0.00	0.67	1.59	1.36	1.72	47.94
Turritella turbona	2.50	0.33	1.56	1.13	1.68	49.63
Ocinebrina aciculata	2.00	0.00	1.50	1.90	1.62	51.25
Bolma rugosa	1.67	0.00	1.49	1.88	1.60	52.85
Euspira pulchella	1.00	0.67	1.36	1.27	1.46	54.31
Homalopoma sanguineum	1.83	0.00	1.31	1.06	1.41	55.72
Caecum armoricum	0.00	1.00	1.30	0.68	1.40	57.12
Cerithiopsis sp. 1	1.17	0.00	1.22	2.01	1.31	58.43
Marshallora adversa	1.67	0.00	1.18	1.33	1.28	59.71
Metaxia metaxae	1.17	0.00	1.05	1.29	1.14	60.85

Tab. 34 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the rhizome layer of *Posidonia oceanica* and the detritic pools (the asterisk marks discriminating species on the basis of the Diss/SD value)

In the following analysis of discriminating species between biocoenoses, an arbitrary level of 1.5 for the Diss/SD ratio was chosen. Species with a ratio value above it were considered discriminating species. The few exceptions will be pointed out.

The average dissimilarity between the coralligenous and the foliar layer of *Posidonia oceanica* (Tab. 29) is 90.4, very high. Of this, 6.27 is contributed by *Chauvetia* aff *brunnea* and a further 6.02 by *Bittium latreillii*, respectively 6.94% and 6.66% of the overall value of 90.4. On the basis of the ratio between the average contribution of the species to dissimilarity and the standard deviation of the contribution of the species to dissimilarity (Diss/SD), discriminating species are *Chauvetia* aff *brunnea*, which is present mostly on *Posidonia* leaves, *Bittium latreillii*, *Nassarius incrassatus*, *Pollia scabra*, *Muricopsis cristata* and *Raphitoma linearis*, which are present mostly in the coralligenous. The latter group of species is also the group of the most typical species in the coralligenous in the similarity analysis (they all have an high Sim/SD value). Similarly, *Chauvetia* aff *brunnea* is a species which gives a great contribution to similarity within the foliar layer of *Posidonia oceanica* but it has a low Sim/SD value, mainly because of an high standard deviation. This result may be influenced by the low number of specimens collected in this biocoenosis. A total of 24 species account for the two-thirds of the dissimilarity and 58 species account for the 90% of the distinction.

The average dissimilarity between the coralligenous and the rhizomes is 62.58. An high value. Of this, 2.18 is contributed by *Gouldia minima* and a further 1.99 by *Bittium latreillii*, respectively 3.48% and 3.18% of the overall value of 62.58, cumulating to 3.48% and 6.66%. Dissimilarity here is mainly the responsibility of the filter feeder *Gouldia minima*, which is a typical species of the rhizomes and not of the coralligenous. *Bittium latreillii* is present in both kind of samples, but it is more abundant in the coralligenous. Its presence in both environments implies a low Diss/Sd value and therefore it is not considered a discriminating species. Consistently, the within biocoenosis similarity analysis identifies *B. latreillii* as typical of both. On the basis of the Diss/SD ratio, discriminating species are *Gouldia minima*, *Chauvetia* aff *brunnea* and *Murexsul aradasii* which are mostly present in the rhizomes, *Callochiton septemvalvis* which is mostly present in the coralligenous. *Bolma rugosa* and *Ocinebrina aciculata* have a Diss/SD ratio a little above 1.5, but their low abundance do not allow to consider them discriminating species. A total of 42 species account for the two-thirds of the dissimilarity and 81 species account for the 90% of the distinction. It seems that differences between these biocoenoses cannot be attributed to a few species, but are due to a wider set of species and probably to different abundance ratios in the two biocoenoses.

The average dissimilarity between the foliar and rhizome layer of *Posidonia oceanica* is 87.52, very high again. Of the 87.52 average dissimilarity, 5.30 is contributed by *Bittium latreillii* and 4.69 by *Chauvetia* aff *brunnea*, respectively 6.06% and 5.35% of the overall value, cumulating to 6.06% and 11.41%. Differences are mainly due to two factors. First, to *Bittium latreillii* which is present in both kind of stations but it is definitely more abundant in the rhizomes. Second, to a set of species which are not abundant, but which are present in the rhizomes only: *Muricopsis cristata*, *Gouldia minima*, *Raphitoma linearis*, *Nassarius incrassatus*, *Fusinus pulchellus*, *Murexsul aradasii*, *Bolma rugosa*, *Cerithiopsis* sp. 1. *Chauvetia* aff *brunnea* gives a good contribution to dissimilarity but it has a low Diss/SD value, probably because it is not present in all the replicates in the foliar layer. A total of 24 species account for the two-thirds of the dissimilarity and 57 species account for the 90% of the distinction.

The average dissimilarity between the coralligenous and the detritic is 94.32, very high. Of this, 6.94 is contributed by *Retusa mamillata* and a further 6.22 by *Bittium latreillii*, respectively 7.36% and 6.59% of the overall value of 94.32, cumulating to 7.36% and 13.96%. Discriminating species on the basis of the Diss/SD ratio are *Retusa mamillata*, *Bittium latreillii*, *Nassarius incrassatus*, *Pollia scabra*, *Muricopsis cristata*, *Striarca lactea* but here the list would be longer but it has been stopped at a Diss/SD value of 2. In this case, discriminating species are those which live on one or the other biocoenosis, with the only exception of *Striarca lactea* which lives in both. A total of 29 species account for the two-thirds of the dissimilarity and 63 species account for the 90% of the distinction.

The average dissimilarity between the foliar layer of *Posidonia oceanica* and the detritic pools is 99.69, extremely high. Of this, 11.53 is contributed by *Retusa mamillata* and a further 9.16 by *Chauvetia* aff *brunnea*, respectively 11.57% and 9.19% of the overall value of 99.69, cumulating to 11.57% and 20.76%. The most discriminating species is *Retusa mamillata* which is also typical of (and present only in) the detritic biocoenosis. Many more species are present in only one of the two biocoenoses, but their Diss/SD ratio is low. Maybe here the low number of specimens in these replicates may have influenced the analysis. A total of 10 species account for the two-thirds of the dissimilarity and 25 species account for the 90% of the distinction.

The average dissimilarity between the rhizomes of *Posidonia* and the detritic pools is 92.79, very high. Of this, 6.54 is contributed by *Retusa mamillata* and a further 4.55 by *Pteromeris corbis*, respectively 7.04% and 4.90% of the overall value of 92.79, cumulating to 7.04% and 11.94%. Discriminating species are *Retusa mamillata*, *Bittium latreillii*, *Muricopsis cristata*, *Gouldia minima*, *Fusinus pulchellus*. The first is typical of the detritic pools, the other species live in the coralligenous. It is remarkable the complete lack of *Gouldia minima* from the detritic pools, probably because of preferences toward finer sediment sizes. A total of 30 species account for the two-thirds of the dissimilarity and 63 species account for the 90% of the distinction.

Back to the analysis of similarities within biocoenoses, it is possible to highlight which their typical species are (on the basis of an arbitrary chosen value of Sim/SD>1.5).

Foliar layer of *Posidonia oceanica*	Rhizome layer of *Posidonia oceanica*	Coralligenous	Detritic
Chauvetia brunnea (Sim/SD = 0.83)	*Bittium latreillii* *Muricopsis cristata* *Gouldia minima* *Raphitoma linearis* *Fusinus pulchellus* *Striarca lactea* *Murexsul aradasii*	*Bittium latreillii* *Nassarius incrassatus* *Pollia scabra* *Muricopsis cristata* *Raphitoma linearis*	*Retusa mamillata* *Pteromeris corbis*

Tab. 35 – Typical species of the biocoenoses on the basis of the Sim/SD ratio (species above 1.5 are considered "typical"), underlined species are those in common between the rhizomes and the coralligenous

The detritic pools have typical species present only there: *Retusa mamillata* and *Pteromeris corbis*. The former is a carnivorous species while the latter is a filter feeder.

The foliar layer of *Posidonia oceanica* has as a typical species *Chauvetia* aff *brunnea* which is also sometimes present in the rhizomes despite there it has not a typifying role. *Chauvetia* are carnivorous.

The rhizomes and the coralligenous have three typical species in common: *Bittium latreillii*, *Muricopsis cristata* and *Raphitoma linearis*. The first one is a microalgae herbivore, while the others are carnivorous. The rhizomes have as typical species also *Gouldia minima* and *Striarca lactea*, filter feeders, *Fusinus pulchellus* and *Murexsul aradasii* which are carnivorous. The coralligenous has as further typical species two carnivores: *Nassarius incrassatus* (which is a scavenger) and *Pollia scabra*.

7.1.3 Analysis with other phyla

The samples contained a wealth of specimens belonging to other phyla. Crustaceans and polychaetes were particularly abundant, but also brachiopods, pantopods, sipunculids and several other groups were present.

Therefore, it is interesting to see to which extent other groups describe biocoenoses. Unfortunately, sampling and sorting techniques were optimal for molluscs, but not for other groups. This induced a bias in the analysis which will be discussed.

All the following analyses were based on standardised and square-root transformed data, using the Bray-Curtis similarity coefficient.

7.1.3.1 Errant Polychaeta

The most diverse group after molluscs is polychaetes (Anellida: Polychaeta). In particular, errant polychaetes will be considered. Due to the taxonomic difficulties of this group, specimens were segregated to morphospecies on the basis of morphological characters (e.g. head, segments, setae, buccal mass,…) but no identification was attempted. Ethanol is not the optimal fixative for this group and several specimens broke in segments or were not well fixed and therefore an high percentage of specimens couldn't be identified (see Tab. 36, Tab. 37, Tab. 38 and Tab. 39) with a mean value of 35% per sample.

This induced the following bias: first, the morphospecies segregation was not carried out by a specialist. The group is very difficult. To overcome this bias, whenever there was a doubt about conspecificity a new morphospecies was segregated. This may have resulted in an oversplitting, which implies emphasizing differences. Second, the high number of unidentified specimens implies a distortion in the results, probably biased towards the smallest or more fragile species which will relatively be less represented in the data.

Polychaetes were particularly well represented in the coralligenous and in the *Posidonia* rhizomes. They were very rare in the *Posidonia* leaves and not recorded in the detritic pools. Therefore, the analysis was concentrated on testing differences between the first two biocoenoses, which are indeed the most interesting for their strong similarity. The full data matrix is in Annex 12.

Overall, 347 specimens were assigned to 85 morphospecies.

	S1	S2	S3	S4	S5	S6	S7	S8	S9
Identified			89.5%	76.3%	82.6%	4.5%	55.9%	61.5%	100.0%
Not identified			10.5%	23.7%	17.4%	95.5%	44.1%	38.5%	0.0%
N° of specimens	0	0	19	59	23	22	93	39	1

Tab. 36 – Percentage of identified specimens of errant Polychaeta, Secche di Tor Paterno, coralligenous samples part I

	S10	S11	S12	S16	S17	S22	S19	S20	S21
Identified	75.0%	30.8%	75.9%	100.0%	65.8%	47.6%	56.7%	55.8%	60.0%
Not identified	25.0%	69.2%	24.1%	0.0%	34.2%	52.4%	43.3%	44.2%	40.0%
N° of specimens	8	13	29	11	38	42	30	52	25

Tab. 37 – Percentage of identified specimens of errant Polychaeta, Secche di Tor Paterno, coralligenous samples part II

	R1	R2	R3	R4	R5	R6	R8	R9
Identified						100.0%		
Not identified						0.0%		
N° of specimens	0	0	0	0	0	1	0	0

Tab. 38 – Percentage of identified specimens of errant Polychaeta, Secche di Tor Paterno, *Posidonia* leaves samples

	SP1	SP2	SP3	SP4	SP5	SP6
Identified	50.0%	53.3%	50.0%	48.0%		90.0%
Not identified	50.0%	46.7%	50.0%	52.0%		10.0%
N° of specimens	6	15	12	25	0	10

Tab. 39 – Percentage of identified specimens of errant Polychaeta, Secche di Tor Paterno, *Posidonia* rhizomes samples

A multivariate analysis of data was performed in a way similar to what was done for molluscs. The MDS plot in Fig. 20 shows there is not a clear separation between biocoenoses, and this is especially significant for coralligenous and *Posidonia* rhizomes which have a good representation in terms of number of samples.

The statistical analysis evidenced there are not statistically significant differences between the coralligenous and *Posidonia* rhizomes samples (ANOSIM, $p<0.05$).

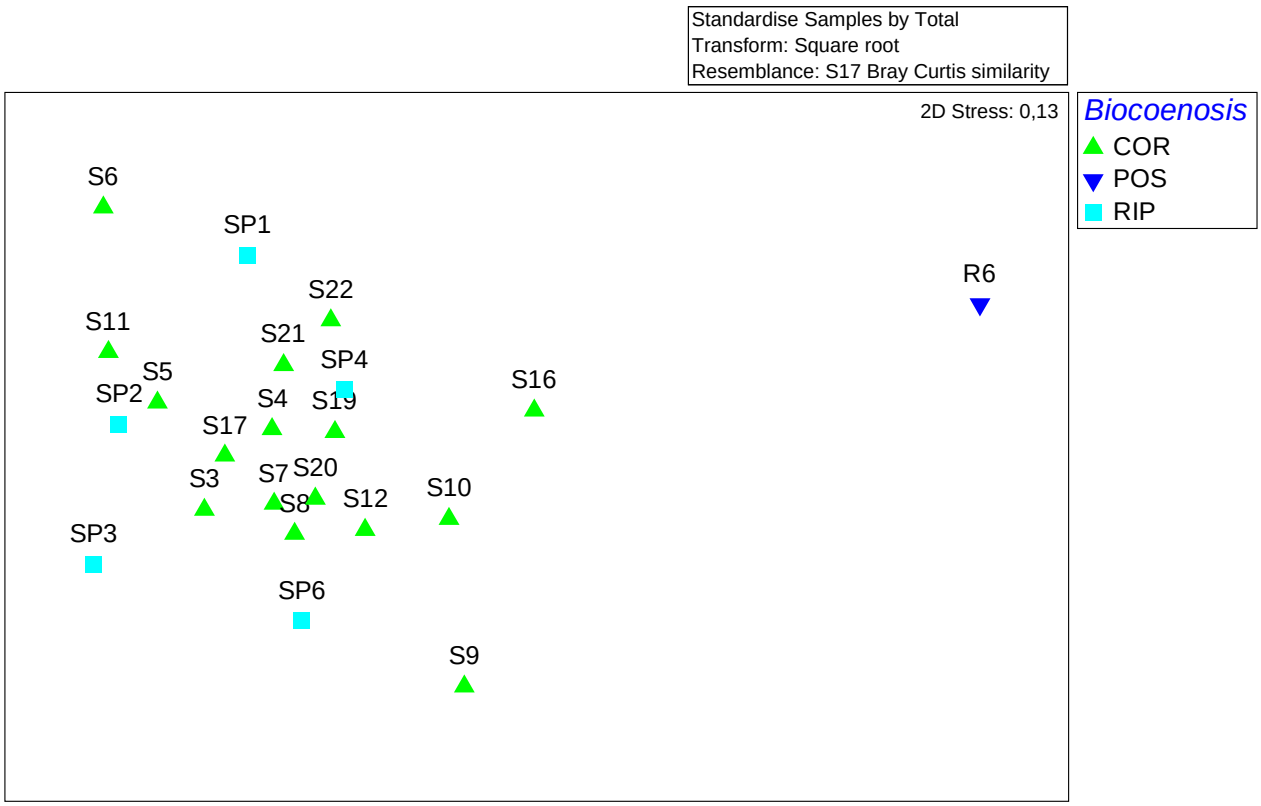


Fig. 20 – Non metric Multi-Dimensional Scaling of errant Polychaeta in Secche di Tor Paterno

7.1.3.2 Crustacea: "crabs" (suborder Pleocyemata)

Another group proved to be extremely prolific both qualitatively and quantitatively: Crustacea. However, due to the already described problem of preservation, only a few groups preserved well, those with harder body parts. Therefore, the identification was carried out only on crabs, hermit crabs and a few other groups belonging to the suborder Pleocyemata. Segregation and identification was carried out by Bruno Sabelli and Carlo Froglia. The full data matrix is in Annex 11.

Here the bias is mainly in the preservation conditions which did not allow identification of all specimens, especially the most juvenile. No data are present from the detritic pools.

The analysis is based on 123 specimens belonging to 46 species.

The MDS plot (Fig. 21) shows that there is some clustering of samples according to biocoenosis, however, there are not significant differences between the assemblages of coralligenous and *Posidonia* rhizomes (ANOSIM, $p<0.05$). The result of the comparison between the *Posidonia* leaves and other biocoenoses is unclear, since there are significant differences with the rhizomes but there are not with the coralligenous (both ANOSIM, $p<0.05$). However, the leaves samples are so poor that conclusions cannot be definitive.

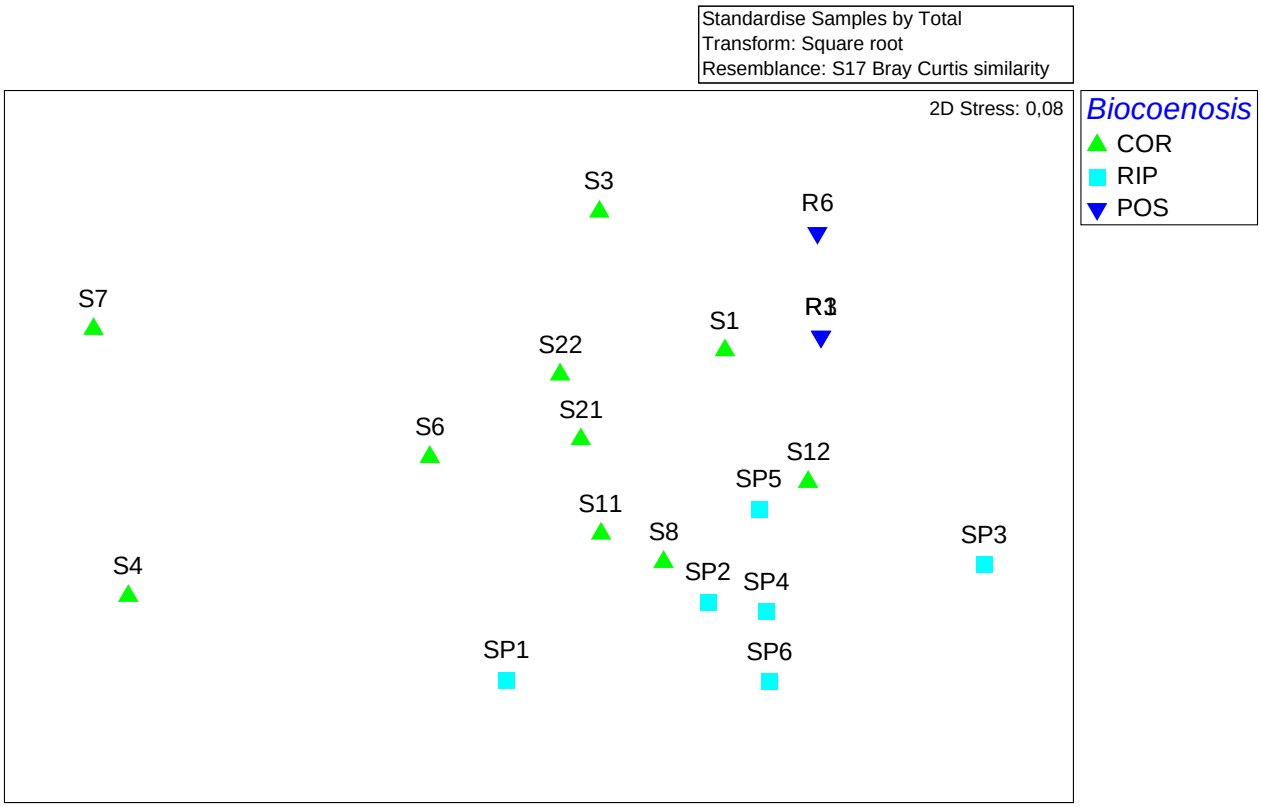


Fig. 21 – Non metric Multi-Dimensional Scaling of Pleocyemata (Crustacea) in Secche di Tor Paterno [12]

7.1.3.3 Brachiopoda

Brachiopods were poorly represented in the samples, despite an important element of thanatocoenoses (Evangelisti *et al.*, in print). The few living specimens were all identified at the species level by Francesca Evangelisti (Tab. 40). The analysis is based on 9 specimens belonging to 2 species and is here proposed for sake of completeness, despite the reduced number of species and specimens does not alllow to draw any robust conclusion.

Species	S8	S19	S20	SP1	SP2	SP3
Joania cordata	0	1	0	3	2	1
Argyrotheca cuneata	1	0	1	0	0	0

Tab. 40 – Quali-quantitative data of brachiopods in Secche di Tor Paterno

Here the main bias is the lack of proper sampling. Brachiopods live attached by a peduncle to the substratum, often in crevices and other sheltered micro-environments The air-lift suction sampler is not likely to detach them from the substratum but just to catch hard objects were they settled (other shells, coralligenous fragments, rhizome fibres, etc). A proper sampling method would have considered keeping all boulders and big objects found (which were discarded in the field after a fast inspection for molluscs), brushing or observing them under a microscope. Therefore our samples are not representative of the true brachiopod communities.

The MDS plot (Fig. 22) shows that stations are kept aside in two distinct groups, but that relative distances do not match the biocoenoses differences since S19 is much nearer to SP3 than to any other coralligenous sample. The two assemblages does not show any significant difference (ANOSIM, $p<0.05$).

[12] Sample S2 was removed from the plot because it was an outlier, having a single species not found in other samples

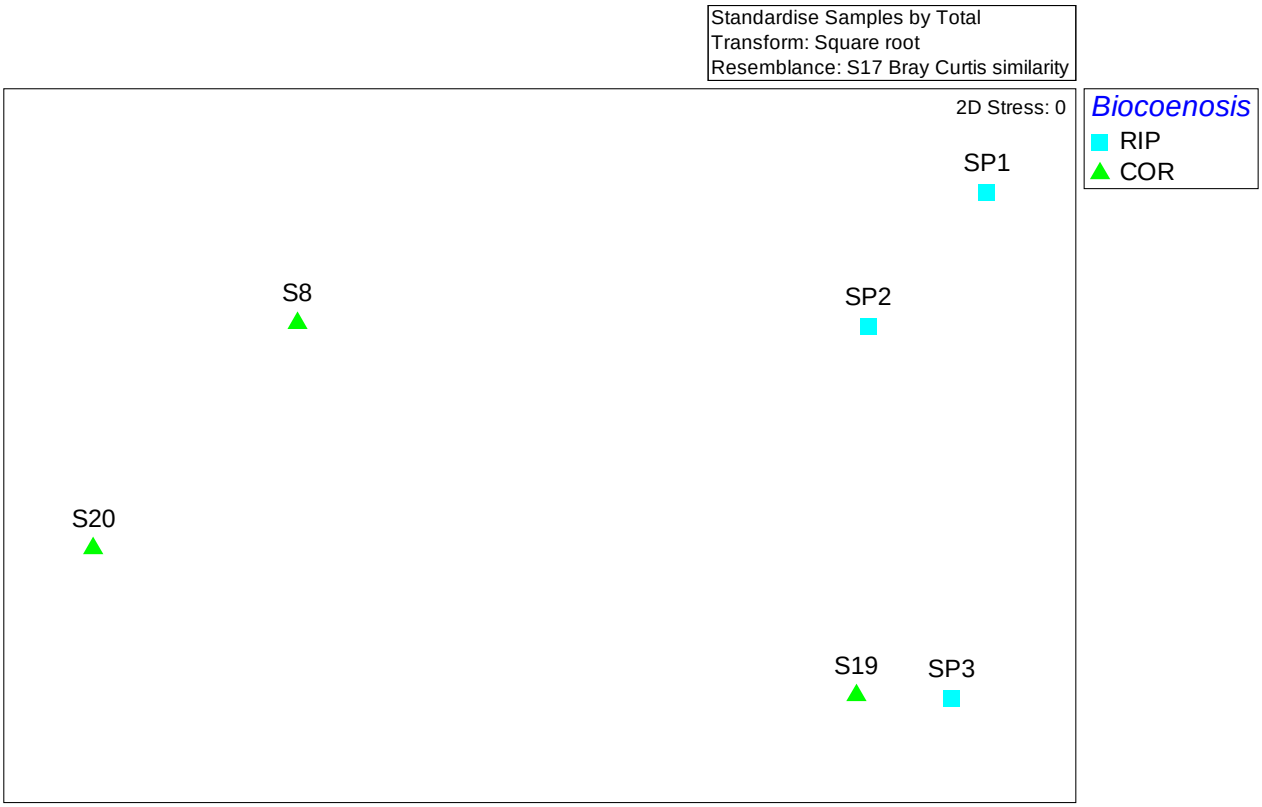


Fig. 22 – Non metric Multi-Dimensional Scaling of Brachiopoda in Secche di Tor Paterno

7.2 Discussion

7.2.1 Molluscs

The univariate approach uses a few indices of species richness, diversity and equitability to characterize stations and so biocoenoses.

Most indices have statistically significant ($p<0.05$) differences between all stations, with the notable exception of Pielou's evenness J' which implies the lack of important dominance phenomena in all biocoenoses.

All indices does not have statistically significant ($p<0.05$) differences between stations belonging to the same biocoenosis. This means that species richness, diversity and equitability are constant within the biocoenosis, notwithstanding the different sampling efficacy which was observed. This information is also a first test of adequacy of the sampling method and areas.

The most interesting information given by the univariate analysis is that the coralligenous and rhizome layer of *Posidonia oceanica* are the richest and the most diversified biocoenoses, with the highest equitability values. This information is of conservation interest. The *Posidonia ocanica* fields enjoy strong protection by the European Union Habitat Directive (92/43/EEC) as an habitat of community interest whose conservation requires the designation of special areas of conservation. The coralligenous biocoenosis is not protected by the Habitat Directive; despite it is considered important for conservation by the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention, this protocol has little operational consequences and the coralligenous does not enjoy true protection according to the European Union and Italian laws.

The foliar layer of *Posidonia oceanica* has a poor species assemblage in terms of species richness and diversity and it is the only assemblage to show considerably low equitability values due to heavy dominance patterns; dominance can be seen in the behaviour of the Simpson index λ too. As it is better commented upon in chapter 8, this is an unusual assemblage for this habitat and its poor characters may be due to depth and fragmentation of *Posidonia* into patches.

The detritic pools have a poor species assemblage too. This was predictable, and is confirmed by the values of the species richness indices and the diversity indices. However, the moderately high equitability indices show little dominance of any species.

The comparison of indices between the different biocoenoses gave contrasting results depending on the index used and biocoenoses considered. Indices fail to evidence statistically significant differences between the biocoenoses in a consistent way and therefore if they are important descriptors of the species assemblages they are not useful for biocoenosis discrimination.

The multivariate techniques manage to handle full quali-quantitative data matrices. Moreover, the techniques used do not need to reduce the number of variables (like PCA – Principal Component Analysis does). All the information is retained and the picture is more reliable.

Clustering, Non metric Multi-Dimensional Scaling and similarity tests all confirm that four distinct species assemblages can be recognized with statistical significance ($p<0.05$): the detritic pools, the foliar and rhizome layers of *Posidonia oceanica*, the coralligenous. These assemblages usually have different typical species.

The detritic is the most different biocoenosis whose typical species are not present elsewhere (*Retusa mamillata* and *Pteromeris corbis*).

The foliar layer of *Posidonia* is well distinguishable too. Its most typical species (*Chauvetia* aff *brunnea*) is present also in the rhizomes. It has to be pointed out that nictemeral migrations from leaves to rhizomes and back have been documented in the *Posidonia* fields (Russo *et al.*, 1984) and that our observations refer only to day-time assemblages. However, the day time species assemblage is the most typical of the leaves (Pérès & Picard, 1964).

The rhizome layer of *Posidonia* is well distinguishable from its corresponding foliar level. It is a rich and diversified assemblage of species. Between its typical species there are filter feeders (e.g. *Gouldia minima*), proof of the importance of sedimentary enclaves between the rhizomes due to the action of the foliar layer which reduces water hydrodinamism.

The coralligenous is rich and diversified too. Despite small sedimentary enclaves can be found here too, they are certainly most scattered and rare and the typical species are all microalgae herbivores (*Bittium latreillii*) or carnivorous (*Nassarius incrassatus*, *Pollia scabra*, *Muricopsis cristata*, *Raphitoma linearis*) gastropods.

The rhizome layer and the coralligenous have close species assemblages and they have three typical species in common (*Bittium latreillii*, *Muricopsis cristata* and *Raphitoma linearis*).

Pérès & Picard (1964) already highlighted that the foliar layer and the rhizome layer of *Posidonia* host two different biocoenoses and that the rhizome layer one is a sciaphilous community very similar to the coralligenous. Moreover, Bianchi *et al* (1989) suggest that the *Posidonia* meadows host four different and independent compartments (leaves, rhizomes, rhizomes infauna, vagile fauna). These approaches are confirmed by our data.

With the main exception of the filter feeders *Gouldia minima* and *Striarca lactea* in the rhizomes, typical species are often carnivorous. The typifying role of carnivores in the biocoenoses is less easy to interpret. It may be due to high predation specialization, e.g. turrids are specialized for polychaetes. However, if carnivores are typifying species it may imply that their prey are not molluscs.

Parasites never characterize any biocoenosis, notwithstanding their overall relative abundance (e.g. Triphoridae alone account for almost 100 specimens on 2700, 3.7%). This may be due to the fact that their host do not characterize biocoenoses. Triphoridae tend to be more frequent in the coralligenous, Cerithiopsidae in the rhizomes. Eulimidae and Pyramidellidae are not even present in the SIMPER results because their contribution is really marginal. This may be due to their rarity (especially for Eulimidae) and for their small size (Pyramidellidae, they may have been discarded in the sieving).

The indices discussed at the beginning of this paragraph are able to describe characters of the assemblages and tell us to which extent assemblages from different biocoenoses have different characters. To answer the

question whether different biocoenoses host typical molluscan assemblages, the univariate approach is not useful. Multivariate approach has to be used since it values the information given by each single species in the assemblage. A striking example of this is that the foliar layer of *Posidonia oceanica* and the detritic biocoenoses are not different in terms of species richness, species diversity and equitability while these are clearly different on the basis of the analysis of the entire quali-quantitative data. This result shows clearly that indices are not suitable for discriminating between species assemblages, but they are only useful to further describe species assemblages or to compare samples from the same biocoenosis.

7.2.2 Other phyla

Notwithstanding the several biases in the analyses described above, the result is somehow interesting and it is one of the very first carried out on such heterogeneous complex hard substrata.

Concentrating our attention on the coralligenous vs *Posidonia* rhizomes differentiation, since they are the most similar environments with the most quantitatively significant samples, no other group shows neat and statistically significant differences like molluscs.

As long as decapod crustaceans are concerned, this was already observed by García-Raso *et al.* (1996) despite in much shallower environments: they concluded that "these biotopes represent part of the habitat of the same decapod crustacean community" despite they host "differing quantitative species compositions" with "the high dominance of a small number of and different species".

Remarkable is the lack of differences in a very diverse group like polychaetes. It is important here to highlight that the result is potentiated by the bias induced by the splitting attitude in morphospecies segregation since this emphasizes differences in samples.

The lack of significance of the differences of polychaetes and crustaceans may be due to their high vagility while molluscs are much less mobile animals.

Brachiopods are too few in species and specimens to offer any conclusive remark, however, the lack of discriminating potential is probably due to the fact that both the coralligenous and the rhizomes offer the micro-environments needed by this group to settle and grow.

These results are in accordance with what was already carried out on soft substrata (Gambi *et al.*, 1982) where molluscs proved to be excellent descriptors.

8 Analysis of the *Posidonia* leaves species assemblage

Posidonia oceanica is a marine plant endemic of the Mediterranean Sea where it is distributed quite evenly with the exception of the extreme western part near Gibraltar and the extreme eastern part (Egypt east of the Nile Delta, Palestine, Israel and Lebanon, where it is absent probably because of excessively high temperatures). It is not present in the Marmara Sea and Black Sea due to their low salinity.

Posidonia meadows are one of the most productive ecosystems on Earth. Its production has two origins: first, the plant production itself, second, the production of the leaves epiphytes. *Posidonia* meadows have also a key role in the oxigenation of water.

Posidonia oceanica is considered a key-species of the ecosystem and host a rich and diversified community. It is estimated it hosts 400 species of plants and thousands of animal species (Boudouresque *et al.,* 2006). Moreover, it is a nursery of several species.

Posidonia leaves can generally grow up to 80 cm, but leaves up to 156 cm were measured (Boudouresque *et al.,* 2006). This is a photophile habitat and leaves are attractive for herbivores, which feed on the leaves theirselves (rarely) or on the epyphites.

The *Posidonia oceanica* meadow found within the reefs represent the homonimous biocoenosis (HP, Pérès & Picard, 1964). This biocoenosis is considered a "carrefour biocoenotique" by Bianchi *et al.* (1989) and two main layers are recognizable: the leaves and the rhizomes.

The typical molluscan species cited by Pérès & Picard (1964) in the leaves are "*Propeamussium hyalinum* [*Flexopecten hyalinus* (Poli, 1795)], *Cantharidus exasperatus* [*Jujubinus exasperatus* (Pennant, 1777)], *Phasianella speciosa* [*Tricolia speciosa* (von Mühlfeldt, 1824)], *Phasianella pulla* [*Tricolia pullus* (Linné, 1758)], *Smaragdia viridis* [(Linné, 1758)], *Rissoa variabilis* [(von Mühlfeldt, 1824)], *Rissoa ventricosa* [Desmarest, 1814], *Rissoa auriscalpium* [(Linné, 1758)], *Rissoa violacea* [Desmarest, 1814], *Rissoa decorata* [Philippi, 1846], *Rissoa radiata* [*Pusillina radiata* (Philippi 1836)], *Rissoa dolium* [*Pusillina philippi* (Aradas & Maggiore, 1844)], *Alvania* spp. and especially *Alvania cimex* [(Linné, 1758)], *Alvania montagui* [*Alvania discors* (Allan, 1818)] and *Alvania lineata* [Risso, 1826], *Rissoina bruguieri* [(Payraudeau, 1826)], *Bittium reticulatum* [probably misidentification of *Bittium latreillii* (Payraudeau, 1826)], *Ocinebra aciculata* [*Ocinebrina aciculata* (Lamarck, 1822)], *Chauvetia minima* [*Chauvetia brunnea* Donovan, 1804], *Persicula clandestina* [*Granulina marginata* (Bivona Ant., 1832)], *Persicula miliaria* [*Gibberula miliaria* (Linné, 1758)]."

This habitat exists in the Mediterranean Sea only and it is of conservation concern due to its biodiversity and the heavy anthropogenic pressures the Mediterranean coastal environments experience. The habitat is considered within the 1120* "*Posidonia* beds" habitat of the Directive 92/43/CE "Habitat" and therefore sites with this habitat can be considered for inclusion in the Natura 2000 network (European Commission – DG Environment, 2007). Moreover, this plant is considered endangered and the habitat a priority for conservation by the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention.

Posidonia meadows are one of the most studied benthic biocoenoses in the Mediterranean and the foliar molluscan community assemblage has been studied in several works despite a thorough comparison of data sets along geographic gradients is still lacking.

This is the first quantitative survey on the molluscan fauna of the *Posidonia* leaves of Secche di Tor Paterno.

8.1 Results

8.1.1 *Posidonia oceanica* bed structure and morphometry

In the "Secche di Tor Paterno" Marine Protected Area *Posidonia oceanica* is present in a scattered way. In a few cases it settles in sedimentary pools forming small but omogeneous meadows (station 8, Fig. 23, samples R7, R8, R9). It is more often present as patches (unnumbered station, samples R1, R2, R3) or settled on hard substratum (station 6, Fig. 24, samples R4, R5, R6).

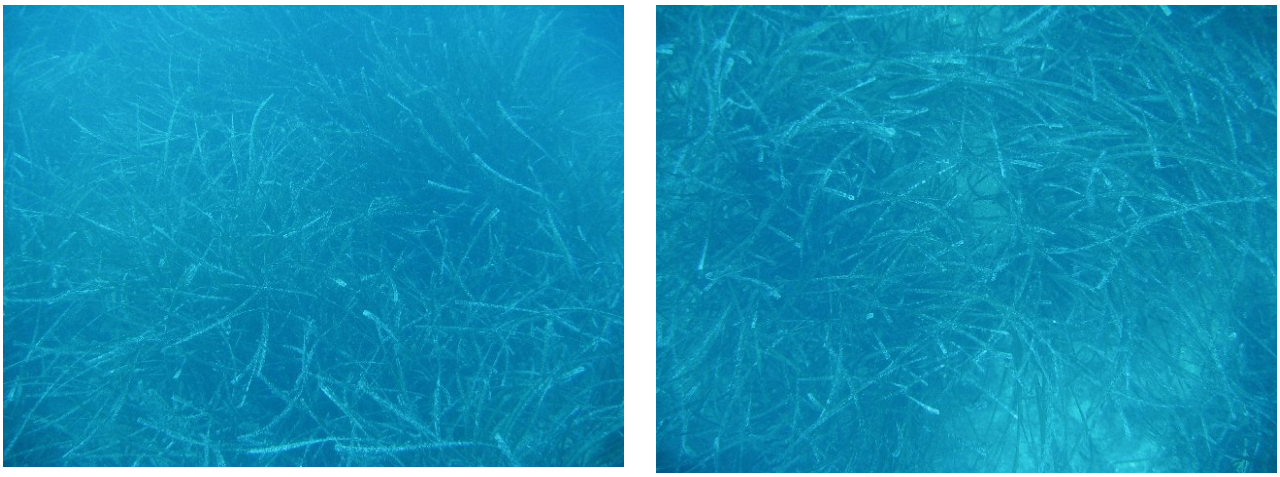


Fig. 23 – *Posidonia oceanica* meadow in a sedimentary pool (station 8)

Fig. 24 – *Posidonia oceanica* meadow on coralligenous (station 6)

Posidonia oceanica bed structure and morphometry data are contained in Tab. 41. These data were not recorded for the station where samples R1, R2 and R3 were taken.

At station 8 the mean shoot density of the meadow is 389 ± 144 shoots/m^2, while at station 6 it is 368 ± 162. The high standard deviation may be due both to environmental heterogeneity and sampling anomalies. Shoot density at the two stations are not statistically different (Mann-Whitney U = 4, $n_1 = n_2 = 3$, p = 0.05). These density values would fall in the third class according to the classification of Giraud (1977), low density meadows with sparse shoots are associated to this class; moreover they are considered as meadows in regression or in dynamic equilibrium. However, Giraud's classification does not consider the depth factor which is very important for this plant. For this reason, Pergent *et al* (1995) suggest a new classification which considers density *and* depth. This classification implies that the *Posidonia* of the "Secche di Tor Paterno" have a normal density.

The mean number of leaves per shoot at station 8 is 5.8 ± 2.2 leaves/shoot while at station 6 is 5.4 ± 1.2 leaves/shoot. The distributions at the two stations differed significantly (Mann–Whitney U = 2045.5, $n_1 = 73$, $n_2 = 69$, p = 0.05).

The mean leaves length is 434 ± 204 mm at station 6 while it is 413 ± 185 mm at station 8. The distributions at the two stations do not differ significantly (Mann–Whitney U = 60161, $n_1 = 338$, $n_2 = 383$, p = 0.05).

	station 6			station 8		
Replicates	1	2	3	1	2	3
N° shoots	14	21	34	25	15	33
Shoot density *per* m^2	224	336	544	400	240	528
Station mean shoot density	368			389		
Station shoot density standard deviation	162			144		
Mean n° leaves/shoot	4.2	6.3	6.2	5.6	5.7	5.0
N° leaves/shoot standard deviation	1.5	2.0	2.2	1.6	1.1	0.9
Station mean n° leaves/shoot	5.8			5.4		
Station n° leaves/shoot standard deviation	2.2			1.2		
Mean leaves length [mm]	569	364	468	408	375	436
Leaves length standard deviation	87	195	202	178	209	175
Station mean leaves length	434			413		
Station leaves length standard deviation	204			185		

Tab. 41 – *Posidonia oceanica* bed structure and morphometry

8.1.2 The molluscan community

The species collected in the *Posidonia* leaves and their abundance are given in Tab. 42.

		Diet	Station --			Station 6			Station 8		
			R1	R2	R3	R4	R5	R6	R7	R8	R9
1	*Jujubinus exasperatus*	MG [13]	0	0	0	0	0	1	0	0	0
2	*Calliostoma laugieri*	MG [14]	1	0	0	0	0	0	0	0	0
3	*Cerithium vulgatum*	MG [15]	1	0	0	0	0	0	0	0	0
4	*Bittium latreillii*	MG [16]	20	0	17	0	0	10	0	1	0
5	*Bittium* sp. 1 (*reticulatum* species group)	MG [17]	0	0	0	0	0	1	0	2	1
6	*Metaxia metaxae*	E [18]	0	0	0	0	0	0	0	1	0
7	*Cerithiopsis nana*	E [19]	0	0	0	0	1	0	0	0	0
8	*Rissoa auriscalpium*	MG [20]	0	0	2	0	0	0	0	0	0

[13] Fretter *et al*., 1977.

[14] *Calliostoma* are usually considered carnivorous species eating hydroids, gorgonians, anemones. *Calliostoma occidentale* Mighels & Adams, 1842, an amphiatlantic northern species, is associated to coelenterates (Perron *et al.*, 1978). The only information on Lusitanian species is for *C. zizyphinum* (Linné, 1758): Fretter *et al*., 1977 hypothesize it both eats detritus matter and polyps, assessing that scraping is the commoner mode. Moreover, Holmes *et al.* (2001) showed that *C. zizyphinum* wipes its shell with its foot gathering any matter (mainly microalgae) that has adhered to the pedal mucus present on the surface of its shell. In this way, it contributes to approximately one-fifth of its daily energetic requirement. Therefore, we consider it a microalgae herbivore and for *C. laugieri* we follow the same hypothesis.

[15] Houbrick, 1992, for congeneric Indo-Pacific species.

[16] Russo *et al*., 2002.

[17] Fretter *et al*., 1981.

[18] Bouchet, 1984.

[19] Fretter *et al*., 1982 for the congeneric *Cerithiopsis tubercularis* (Montagu, 1803).

[20] Fretter *et al*., 1978 for the congeneric *Rissoa violacea* Desmarest, 1814.

		Diet	Station --			Station 6			Station 8		
			R1	R2	R3	R4	R5	R6	R7	R8	R9
9	*Rissoa violacea*	MG [21]	1	2	1	1	0	0	0	1	0
10	*Pusillina inconspicua*	MG [21]	0	0	0	0	0	1	0	0	0
11	*Pusillina philippi*	MG [22]	0	0	1	0	0	0	0	0	0
12	*Alvania settepassii*	MG [23]	0	1	0	0	0	1	0	0	0
13	*Ocinebrina aciculata*	C [24]	0	3	4	0	0	1	0	0	3
14	*Chauvetia* aff *brunnea*	C [24]	1	0	0	5	2	4	0	1	1
	TOTAL NUMBER OF SPECIMENS		24	6	25	6	3	19	0	6	5

Tab. 42 – Quali-quantitative data of the *Posidonia* leaves samples, Secche di Tor Paterno

The dendrogram in Fig. 25 and the MDS in Fig. 26 show that replicates do not cluster together neatly. Replicates do not have significant differences nor stations have (ANOSIM, $p<0.05$).

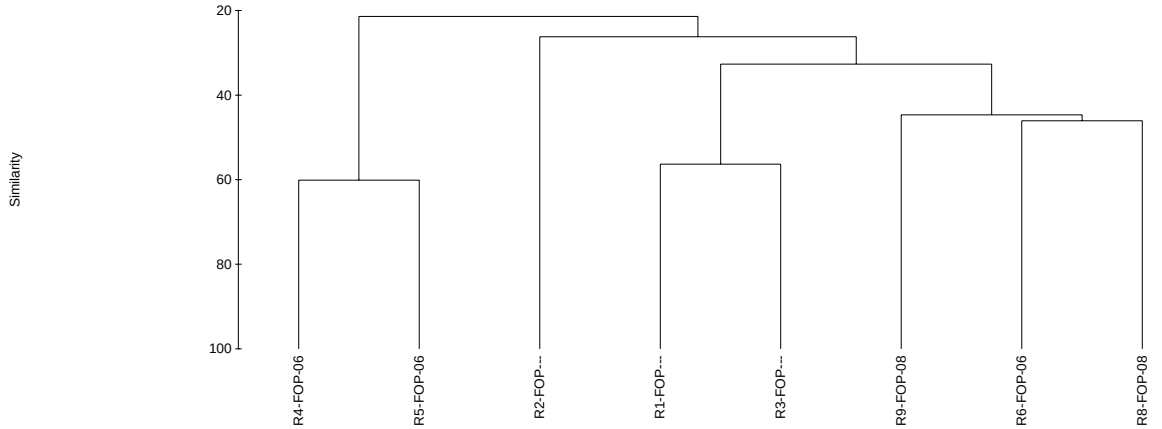


Fig. 25 - Dendrogram for hierarchical clustering of all replicates from *Posidonia* leaves stations (standardized data, square root transform, Bray-Curtis similarity coefficient, group-average linkage), Secche di Tor Paterno

[21] Fretter *et al*., 1978.

[22] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[23] Fretter *et al*., 1978 for all congeneric species.

[24] Fretter *et al*., 1984.

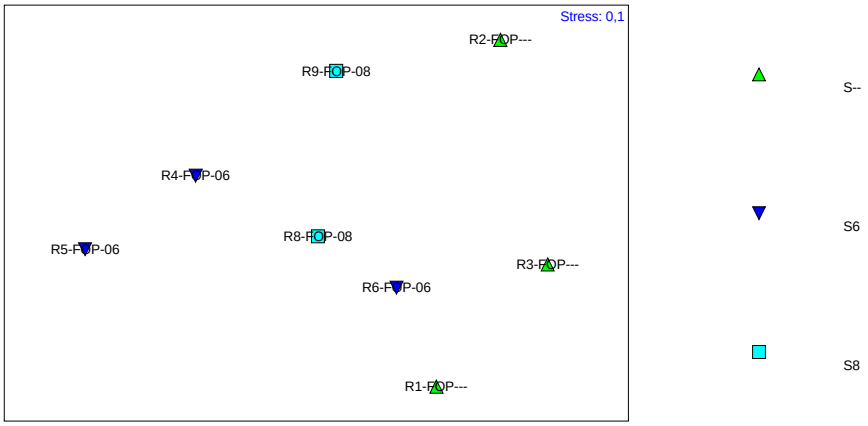


Fig. 26 – Non metric Multi-Dimensional Scaling plot of foliar layer of *Posidonia oceanica* replicates (10 restarts), different symbols and colours represent different stations, Secche di Tor Paterno

8.1.3 Mollusca community structure

By a population structure point of view, species richness along replicates varies from 2 to 7, Shannon diversity index (H') ranges from 0.451 to 1.441 and evenness (J') ranges from 0.424 to 0.921 (Tab. 43).

Replicate[25]	S	H'	J'
R1-FOP---	5	0.682	0.424
R2-FOP---	3	1.011	0.921
R3-FOP---	5	1.015	0.631
R4-FOP-06	2	0.451	0.650
R5-FOP-06	2	0.637	0.918
R6-FOP-06	7	1.441	0.740
R8-FOP-08	5	1.561	0.970
R9-FOP-08	3	0.950	0.865

Tab. 43 – Biodiversity indices values for *Posidonia* leaves samples, Secche di Tor Paterno

Diversity and equitability indices are influenced by dominance phenomena (Tab. 44). Replicates R1, R3, R6 and R8 see as dominant species *Bittium latreillii*. Stations R2 and R9 show *Ocinebrina aciculata* as dominant species while stations R4 and R5 have *Chauvetia* aff *brunnea* as dominant species.

		Diet	Station --			Station 6			Station 8	
			R1	R2	R3	R4	R5	R6	R8	R9
1	*Jujubinus exasperatus*	MG	-	-	-	-	-	5%	-	-
2	*Calliostoma laugieri*	MG	4%	-	-	-	-	-	-	-
3	*Cerithium vulgatum*	MG	4%	-	-	-	-	-	-	-
4	*Bittium latreillii*	MG	83%	-	68%	-	-	53%	17%	-

[25] Here replicates are coded in this way: first the replicate code, then the biocoenosis code and last the station code. For example, sample S1-COR-01 is the sample S1 collected in the coralligenous biocoenosis in station 01

		Diet	Station --			Station 6			Station 8	
			R1	R2	R3	R4	R5	R6	R8	R9
5	*Bittium* sp. 1 (*reticulatum* species group)	MG	-	-	-	-	-	5%	33%	20%
6	*Metaxia metaxae*	E	-	-	-	-	-	-	17%	-
7	*Cerithiopsis nana*	E	-	-	-	-	33%	-	-	-
8	*Rissoa auriscalpium*	MG	-	-	8%	-	-	-	-	-
9	*Rissoa violacea*	MG	4%	33%	4%	17%	-	-	17%	-
10	*Pusillina inconspicua*	MG	-	-	-	-	-	5%	-	-
11	*Pusillina philippi*	MG	-	-	4%	-	-	-	-	-
12	*Alvania settepassii*	MG	-	17%	-	-	-	5%	-	-
13	*Ocinebrina aciculata*	C	-	50%	16%	-	-	5%	-	60%
14	*Chauvetia* aff *brunnea*	C	4%	-	-	83%	67%	21%	17%	20%

Tab. 44 – Species dominance in the *Posidonia* leaves samples, Secche di Tor Paterno

Feeding guilds analysis (Tab. 45) highlights that in replicates R1, R3, R6 and R8 microalgae herbivore species dominates the community. In these cases *Bittium* spp. are responsible for this pattern. In replicates R2, R4, R5 and R9 carnivorous species dominates. Here the pattern is more diversified since this dominance is given by two species: *Ocinebrina aciculata* and *Chauvetia* aff *brunnea*. The ratio between carnivorous and microalgae herbivores is ranges from 0 to 5. It is remarkable that many samples have this ratio equal to or greater than 1.

		Station --			Station 6			Station 8	
		R1	R2	R3	R4	R5	R6	R8	R9
SC	Scavengers	-	-	-	-	-	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	-	-	-	-	-
MG	Microalgae herbivores	95.8%	50.0%	84.0%	16.7%	0.0%	73.7%	66.7%	20.0%
SG	Seagrass-feeding herbivores	-	-	-	-	-	-	-	-
D	Deposit feeders	-	-	-	-	-	-	-	-
F	Filter feeders	-	-	-	-	-	-	-	-
SY	Symbiont-bearing species	-	-	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	16.7%	0.0%
C	Carnivores on mobile prey	4.2%	50.0%	16.0%	83.3%	66.7%	26.3%	16.7%	80.0%
O	Egg and spawn feeders	-	-	-	-	-	-	-	-
Carnivorous/ microalgae herbivores ratio		0.0	1.0	0.2	5.0	1.0	0.4	0.3	4.0

Tab. 45 – Trophic groups dominance in the samples, Secche di Tor Paterno

		Station --			Station 6			Station 8	
		R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R8**	**R9**
SC	Scavengers	-	-	-	-	-	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	-	-	-	-	-
MG	Microalgae herbivores	4	2	4	1	0	5	3	1
SG	Seagrass-feeding herbivores	-	-	-	-	-	-	-	-
D	Deposit feeders	-	-	-	-	-	-	-	-
F	Filter feeders	-	-	-	-	-	-	-	-
SY	Symbiont-bearing species	-	-	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	0	0	0	0	1	0	1	0
C	Carnivores on mobile prey	1	1	1	1	1	2	1	2
O	Egg and spawn feeders	-	-	-	-	-	-	-	-

Tab. 46 – Number of species *per* feeding guilds in the *Posidonia* leaves samples, Secche di Tor Paterno

8.1.4 Comparison with other data sets

Data from Secche di Tor Paterno have been compared with other data sets (Tab. 47).

N°	**Locality**	**Depth**	**Sampling technique**	**Date**	**Data source**
1	Secche della Meloria (Livorno)	-4 m	Hand net, 60 strokes per replicate	October 1988	Castriota, 1989
2	Elba Isl., Baia di Fetovaia	-5 m and -12 m	Hand net, 20 strokes per replicate	June 2002	B. Sabelli unpublished data
3	Giglio Isl, Campese	-9 m	Hand net, 60 strokes per replicate	March 1992	Bonfitto *et al*., 1998
4	Ischia Isl., Lacco Ameno d'Ischia, near Punta Vico	Several depth steps from -1 m to -30 m	Hand net, 40 strokes per replicate	Autumn 1979	Idato *et al*., 1983
5	Croatia, Hvrgada Isl.	-4 m and -11 m	Hand net, 60 strokes per replicate	July 2000	Solustri *et al*., 2002

Tab. 47 – Data sets for comparison of Secche di Tor Paterno *Posidonia* leaves assemblage

Fig. 27 – Location of comparison data sets (cfr. Tab. 47)

These data sets represent several stations at different latitudes in the same Tyrrhenian basin of Secche di Tor Paterno (Secche della Meloria, Elba, Giglio, Ischia) and in the Adriatic Sea (Croatia, Hvrgada Isl.).

Samples were collected at different depths: shallow water stations at -4/5 m were sampled in Secche della Meloria, Elba Isl., Ischia Isl. and Croatia; moderately deep water stations at -9/12 m were sampled at Elba Isl., Giglio Isl., Ischia Isl. and Croatia, while deep water stations at -25 m like Tor Paterno were sampled in Ischia Isl. only. The samples from Ischia Isl. are remarkable because a depth transect from shallow to deep water was sampled at the following depths: -1 m, -2 m, -3 m, -4 m, -6 m, -8 m, -10 m, -12 m, -15 m, -19 m, -25 m and -30 m. Comparison between these depth levels showed that the molluscan assemblage changes with depth (see Idato *et al*. (1983) for details). In this work, only the station at -25 m will be considered and discussed.

The sampling technique was the same in terms of devices used, a hand-operated net, but different in terms of sampling intensity: 20 strokes per replicate were used in Elba Isl (like in Secche di Tor Paterno), 40 strokes per replicate were used in Ischia Isl. and 60 strokes per replicate were used in Secche della Meloria, Giglio and Croatia. This different sampling intensity may affect the samples in terms of quantity of collected specimens. To overcome this bias, when 20 strokes per replicate were used (Secche di Tor Paterno, Elba Isl) data will be analysed per station pooling replicates to achieve the 60 strokes per sample. This adjustment can't be done for Ischia Isl, were 40 strokes per replicate were sampled.

Samples were collected in different periods of the year: Giglio was sampled in spring, Elba and Croatia in summer, Secche della Meloria and Ischia in autumn. The different seasons may affect the sampled species assemblage both qualitatively (because of species seasonality) and quantitatively (different recruitment periods). However, Russo *et al*. (1984) suggest that the molluscan species assemblages of *Posidonia* leaves

are under the control of climatic factors related to depth and apparently independent of the season. Therefore, data collected in different seasons are comparable.

In all localities *Posidonia* is settled on a sedimentary substratum.

Data sets are reported in annexes 2 to 6. Taxonomy has not been updated, unless useful for discussion.

8.1.4.1 Secche della Meloria (Livorno)

The species collected in the *Posidonia* leaves and their abundance are given in Tab. 48. All replicates come from a meadow at 4 m deep. Sampling was carried out by hand-net with 60 strokes per replicate in October 1988.

		Diet	R_H	R_I	R_J	R_L
1	*Jujubinus exasperatus*	MG [26]	2	5	1	10
2	*Gibbula umbilicaris*	MG [27]	0	0	0	4
3	*Calliostoma laugieri*	MG [14]	1	0	1	1
4	*Tricolia speciosa*	MG [28]	0	1	0	0
5	*Rissoa auriscalpium*	MG [29]	8	0	1	1
6	*Rissoa guerinii*	MG [30]	2	3	0	1
7	*Rissoa variabilis*	MG [29]	9	4	3	1
8	*Pusillina dolium* [31]	MG [32]	4	0	0	0
9	*Pusillina radiata*	MG [32]	0	6	2	5
10	*Alvania discors*	MG [33]	0	0	1	0
11	*Alvania pagodula*	MG [33]	2	0	0	0
12	*Bittium reticulatum* [34]	MG [35]	349	469	87	215
13	*Bittium jadertinum*	MG [36]	0	6	5	8
14	*Cerithiopsis minima*	E [37]	0	0	0	1
15	*Marshallora adversa*	E [38]	1	0	0	0
	TOTAL NUMBER OF SPECIMENS		378	494	101	247

Tab. 48 – Quali-quantitative data of the *Posidonia* leaves samples, Secche della Meloria (Livorno)

By a population structure point of view, species richness along replicates varies from 7 to 10 with Shannon diversity index (H') ranging from 0.285 to 0.642 and evenness (J') ranging from 0.147 to 0.309 (Tab. 49).

[26] Fretter *et al*., 1977.

[27] Fretter *et al*., 1977 for all congeneric species.

[28] Fretter *et al*., 1977 for *Tricolia pullus* (Linné, 1758).

[29] Fretter *et al*., 1978 for other congeneric species.

[30] Fretter *et al*., 1978.

[31] = *Pusillina philippi* (Aradas & Maggiore, 1844)

[32] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[33] Fretter *et al*., 1978 for all congeneric species.

[34] Misidentification of *Bittium latreillii* Payraudeau, 1826.

[35] Russo *et al*., 2002.

[36] Fretter *et al*., 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778).

[37] Fretter *et al*., 1982 for the congeneric *Cerithiopsis tubercularis* (Montagu, 1803).

[38] Bouchet, 1984.

Replicate	S	H'	J'
R_H	9	0.407	0.185
R_I	7	0.285	0.147
R_J	8	0.642	0.309
R_L	10	0.619	0.269

Tab. 49 – Biodiversity indices values for *Posidonia* leaves samples, Secche della Meloria

Diversity and equitability indices are influenced by dominance phenomena (**Errore. L'origine riferimento non è stata trovata.**). All replicates see as dominant species *Bittium latreillii* with a strong dominance ranging from 86.1% to 94.9%.

		Diet	R_H	R_I	R_J	R_L
1	*Jujubinus exasperatus*	MG	0.5%	1.0%	1.0%	4.0%
2	*Gibbula umbilicaris*	MG	-	-	-	1.6%
3	*Calliostoma laugieri*	MG	0.3%	-	1.0%	0.4%
4	*Tricolia speciosa*	MG	-	0.2%	-	-
5	*Rissoa auriscalpium*	MG	2.1%	-	1.0%	0.4%
6	*Rissoa guerinii*	MG	0.5%	0.6%	-	0.4%
7	*Rissoa variabilis*	MG	2.4%	0.8%	3.0%	0.4%
8	*Pusillina dolium*	MG	1.1%	-	-	-
9	*Pusillina radiata*	MG	-	1.2%	2.0%	2.0%
10	*Alvania discors*	MG	-	-	1.0%	-
11	*Alvania pagodula*	MG	0.5%	-	-	-
12	*Bittium reticulatum* (=*B. latreillii* [34])	MG	92.3%	94.9%	86.1%	87.0%
13	*Bittium jadertinum*	MG	-	1.2%	5.0%	3.2%
14	*Cerithiopsis minima*	E	-	-	-	0.4%
15	*Marshallora adversa*	E	0.3%	-	-	-

Tab. 50 – Species dominance in the *Posidonia* leaves samples, Secche della Meloria

Feeding guilds analysis (Tab. 51) highlights the dominance of microalgae herbivores along all replicates. This pattern is given by the dominance of *Bittium latreillii*. The ratio between carnivorous and microalgae herbivores is always zero since no carnivorous species were collected.

		R_H	R_I	R_J	R_L
SC	Scavengers	-	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	-
MG	Microalgae herbivores	99.7%	100%	100%	99.6%
SG	Seagrass-feeding herbivores	-	-	-	-
D	Deposit feeders	-	-	-	-
F	Filter feeders	-	-	-	-
SY	Symbiont-bearing species	-	-	-	-

		R_H	R_I	R_J	R_L
E	Ectoparasites and carnivores on preys without mobility	0.3%	-	-	0.4%
C	Carnivores on mobile prey	-	-	-	-
O	Egg and spawn feeders	-	-	-	-
Carnivorous/ microalgae herbivores ratio		0	0	0	0

Tab. 51 – Trophic groups dominance in the samples, Secche della Meloria

		R_H	R_I	R_J	R_L
SC	Scavengers	-	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	-
MG	Microalgae herbivores	8	7	8	9
SG	Seagrass-feeding herbivores	-	-	-	-
D	Deposit feeders	-	-	-	-
F	Filter feeders	-	-	-	-
SY	Symbiont-bearing species	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	1	0	0	1
C	Carnivores on mobile prey	-	-	-	-
O	Egg and spawn feeders	-	-	-	-

Tab. 52 – Number of species *per* feeding guilds in the *Posidonia* leaves samples, Secche della Meloria

8.1.4.2 Elba Isl.

The species collected in the *Posidonia* leaves and their abundance are given in Tab. 48. All replicates come from two stations at -5 m and -12 m deep. Sampling was carried out by hand-net with 20 strokes per replicate in June 1992. For comparison with other stations, data will be provided both as single replicates and joining replicates in stations to reach the 60 strokes per station used by other scholars. However, since at 5 m deep 4 replicates were sampled, the station data will be composed only by replicates 1 to 3.

		Diet	R1-5	R2-5	R3-5	Station -5m[39]	R4-5	R1-12	R2-12	R3-12	Station -12m
1	*Jujubinus exasperatus*	MG [40]	6	7	2	15	1	2	11	6	19
2	*Calliostoma laugieri*	MG [14]	0	0	0	0	0	0	1	0	1

[39] Pooling replicates R1-5, R2-5, R3-5 only.

[40] Fretter *et al*., 1977

		Diet	R1-5	R2-5	R3-5	Station -5m[39]	R4-5	R1-12	R2-12	R3-12	Station -12m
3	*Tricolia pullus*	MG [41]	2	0	0	2	3	1	5	1	7
4	*Tricolia speciosa*	MG [42]	5	6	1	12	2	3	1	0	4
5	*Smaragdia viridis*	SG [43]	1	0	0	1	0	0	0	0	0
6	*Bittium jadertinum*	MG [44]	7	9	17	33	1	5	6	4	15
7	*Bittium latreillii*	MG [45]	45	58	88	191	9	299	494	126	919
8	*Rissoa auriscalpium*	MG [46]	21	32	65	118	13	60	70	37	167
9	*Rissoa decorata*	MG [47]	0	0	1	1	0	0	0	0	0
10	*Rissoa guerini*	MG [48]	1	0	0	1	0	0	1	0	1
11	*Rissoa similis*	MG [47]	0	0	0	0	0	0	0	1	1
12	*Rissoa variabilis*	MG [47]	0	1	1	2	0	0	0	0	0
13	*Rissoa ventricosa*	MG [47]	19	26	25	70	5	20	20	17	57
14	*Rissoa violacea*	MG [49]	3	4	3	10	1	13	10	7	30
15	*Alvania lineata*	MG [50]	3	1	0	4	0	0	1	1	2
16	*Alvania montagui*	MG [50]	0	2	2	4	0	0	4	4	8
17	*Pusillina radiata*	MG [51]	0	1	7	8	1	19	19	8	46
18	Triphoridae [52]	E [53]	0	0	1	1	0	0	0	0	0
19	*Pusia tricolor*	C [54]	0	0	0	0	0	1	0	0	1
	TOTAL NUMBER OF SPECIMENS		113	147	213	473	36	423	643	212	1278

Tab. 53 – Quali-quantitative data of the *Posidonia* leaves samples, Elba Isl.

By a population structure point of view, species richness along replicates varies from 9 to 13 with Shannon diversity index (H') ranging from 0.944 to 1.793 and evenness (J') ranging from 0.368 to 0.798 (Tab. 54). The shallow water station has higher diversity (both in terms of number of species and Shannon index) than the deeper water one. Moreover, it shows an higher evenness.

Replicate	S	H'	J'
R1-5	11	1.793	0.748
R2-5	11	1.710	0.713
R3-5	12	1.541	0.620

[41] Fretter *et al*., 1977.

[42] Fretter *et al*., 1977 for *Tricolia pullus* (Linné, 1758).

[43] Rueda *et al*., 2007.

[44] Fretter *et al*., 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778).

[45] Russo *et al*., 2002.

[46] Fretter *et al*., 1978 for the congeneric *Rissoa violacea* Desmarest, 1814.

[47] Fretter *et al*., 1978 for other congeneric species.

[48] Fretter *et al*., 1978.

[49] Fretter *et al*., 1978.

[50] Fretter *et al*., 1978 for all congeneric species.

[51] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[52] It is likely to be *Marshallora adversa* (Montagu, 1803), since a note states its animal is white coloured.

[53] Bouchet, 1984.

[54] Beesley *et al.*, 1998 for Costellariidae

Replicate	S	H'	J'
Station -5m	16	1.713	0.618
R4-5	9	1.754	0.798
R1-12	10	1.054	0.458
R2-12	13	0.944	0.368
R3-12	11	1.379	0.575
Station -12m	15	1.075	0.397

Tab. 54 – Biodiversity indices values for *Posidonia* leaves samples, Elba Isl.

Diversity and equitability indices are influenced by dominance phenomena (Tab. 55). Two species dominate most: *Bittium latreillii* and *Rissoa auriscalpium*. However, their dominance changes significantly with depth: for example *B. latreillii* has a 40.4% dominance at the station at -5 m deep, while it has a 71.9% dominance at -12 m. On the contrary, *R. auriscalpium* dominance decreases from 24.9% (station at -5m) to 13.1% at 12 m.

		Diet	R1-5	R2-5	R3-5	Station -5m [39]	R4-5	R1-12	R2-12	R3-12	Station -12m
1	*Jujubinus exasperatus*	MG	5.3%	4.8%	0.9%	3.2%	2.8%	0.5%	1.7%	2.8%	1.5%
2	*Calliostoma laugieri*	MG	-	-	-	-	-	-	0.2%	-	0.1%
3	*Tricolia pullus*	MG	1.8%	-	-	0.4%	8.3%	0.2%	0.8%	0.5%	0.5%
4	*Tricolia speciosa*	MG	4.4%	4.1%	0.5%	2.5%	5.6%	0.7%	0.2%	-	0.3%
5	*Smaragdia viridis*	SG	0.9%	-	-	0.2%	-	-	-	-	-
6	*Bittium jadertinum*	MG	6.2%	6.1%	8.0%	7.0%	2.8%	1.2%	0.9%	1.9%	1.2%
7	*Bittium latreillii*	MG	39.8%	39.5%	41.3%	40.4%	25.0%	70.7%	76.8%	59.4%	71.9%
8	*Rissoa auriscalpium*	MG	18.6%	21.8%	30.5%	24.9%	36.1%	14.2%	10.9%	17.5%	13.1%
9	*Rissoa decorata*	MG	-	-	0.5%	0.2%	-	-	-	-	-
10	*Rissoa guerini*	MG	0.9%	-	-	0.2%	-	-	0.2%	-	0.1%
11	*Rissoa similis*	MG	-	-	-	-	-	-	-	0.5%	0.1%
12	*Rissoa variabilis*	MG	-	0.7%	0.5%	0.4%	-	-	-	-	-
13	*Rissoa ventricosa*	MG	16.8%	17.7%	11.7%	14.8%	13.9%	4.7%	3.1%	8.0%	4.5%
14	*Rissoa violacea*	MG	2.7%	2.7%	1.4%	2.1%	2.8%	3.1%	1.6%	3.3%	2.3%
15	*Alvania lineata*	MG	2.7%	0.7%	-	0.8%	-	-	0.2%	0.5%	0.2%
16	*Alvania montagui*	MG	-	1.4%	0.9%	0.8%	-	-	0.6%	1.9%	0.6%
17	*Pusillina radiata*	MG	-	0.7%	3.3%	1.7%	2.8%	4.5%	3.0%	3.8%	3.6%
18	Triphoridae	E	-	-	0.5%	0.2%	-	-	-	-	-
19	*Pusia tricolor*	C	-	-	-	-	-	0.2%	-	-	0.1%

Tab. 55 – Species dominance in the *Posidonia* leaves samples, Elba Isl.

Feeding guilds analysis (Tab. 56, Tab. 57) highlights the dominance of microalgae herbivores along all replicates. This pattern is given by the dominance of *Bittium latreillii* and of *Rissoa* spp.. The signal given by the seagrass-feeding herbivores is due to the presence of *Smaragdia viridis*. The ratio between carnivorous and microalgae herbivores is always zero since almost no carnivorous species were collected.

		R1-5	R2-5	R3-5	Station -5m [39]	R4-5	R1-12	R2-12	R3-12	Station -12m
SC	Scavengers	-	-	-	-	-	-	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	-	-	-	-	-	-
MG	Microalgae herbivores	99.1%	100%	99.5%	99.6%	100%	99.8%	100%	100%	99.9%
SG	Seagrass-feeding herbivores	0.9%	-	-	0.2%	-	-	-	-	-
D	Deposit feeders	-	-	-	-	-	-	-	-	-
F	Filter feeders	-	-	-	-	-	-	-	-	-
SY	Symbiont-bearing species	-	-	-	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	-	-	0.5%	0.2%	-	-	-	-	-
C	Carnivores on mobile prey	-	-	-	-	-	0.2%	-	-	0.1%
O	Egg and spawn feeders	-	-	-	-	-	-	-	-	-
Carnivorous/ microalgae herbivores ratio		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Tab. 56 – Trophic groups dominance in the samples, Elba Isl.

		R1-5	R2-5	R3-5	Station -5m [39]	R4-5	R1-12	R2-12	R3-12	Station -12m
SC	Scavengers	-	-	-	-	-	-	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	-	-	-	-	-	-
MG	Microalgae herbivores	10	11	11	14	9	9	13	11	14
SG	Seagrass-feeding herbivores	1	-	-	1	-	-	-	-	-
D	Deposit feeders	-	-	-	-	-	-	-	-	-
F	Filter feeders	-	-	-	-	-	-	-	-	-
SY	Symbiont-bearing species	-	-	-	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	-	-	1	1	-	-	-	-	-
C	Carnivores on mobile prey	-	-	-	-	-	1	-	-	1
O	Egg and spawn feeders	-	-	-	-	-	-	-	-	-

Tab. 57 – Number of species *per* feeding guilds in the *Posidonia* leaves samples, Elba Isl.

8.1.4.3 Giglio Isl.

The species collected in the *Posidonia* leaves and their abundance are given in Tab. 58. The sample was collected at 9 m deep. Sampling was carried out by hand-net with 60 strokes in March 1992.

		Diet	R-B
1	*Tricolia tenuis*	MG [55]	1
2	*Jujubinus exasperatus*	MG [56]	4
3	*Jujubinus striatus*	MG [57]	16
4	*Bittium jadertinum*	MG [58]	2
5	*Bittium latreillii*	MG [59]	14
6	*Rissoa auriscalpium*	MG [60]	1
7	*Rissoa decorata*	MG [61]	9
8	*Rissoa ventricosa*	MG [61]	11
9	*Rissoa violacea*	MG [62]	4
10	*Alvania discors*	MG [63]	8
11	*Alvania lineata*	MG [63]	1
12	*Pusillina radiata*	MG [64]	1
	TOTAL NUMBER OF SPECIMENS		72

Tab. 58 – Quali-quantitative data of the *Posidonia* leaves samples, Giglio Isl.

By a population structure point of view, the sample contained 12 species and its Shannon index is 2.102 while its evenness is 0.846 (Tab. 59).

Replicate	S	H'	J'
R-B	12	2.102	0.846

Tab. 59 – Biodiversity indices values for *Posidonia* leaves samples, Giglio Isl.

Diversity and equitability indices are influenced by dominance phenomena (Tab. 60). Two species dominate most: *Jujubinus striatus* (22.2%) and *Bittium latreillii* (19.4%).

		Diet	R-B
1	*Tricolia tenuis*	MG	1.4%
2	*Jujubinus exasperatus*	MG	5.6%
3	*Jujubinus striatus*	MG	22.2%
4	*Bittium jadertinum*	MG	2.8%
5	*Bittium latreillii*	MG	19.4%
6	*Rissoa auriscalpium*	MG	1.4%

[55] Fretter *et al*., 1977 for *Tricolia pullus* (Linné, 1758).

[56] Fretter *et al*., 1977.

[57] Peduzzi, 1987

[58] Fretter *et al*., 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778).

[59] Russo *et al*., 2002.

[60] Fretter *et al*., 1978 for the congeneric *Rissoa violacea* Desmarest, 1814.

[61] Fretter *et al*., 1978 for other congeneric species.

[62] Fretter *et al*., 1978.

[63] Fretter *et al.*, 1978 for all congeneric species

[64] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

		Diet	R-B
7	*Rissoa decorata*	MG	12.5%
8	*Rissoa ventricosa*	MG	15.3%
9	*Rissoa violacea*	MG	5.6%
10	*Alvania discors*	MG	11.1%
11	*Alvania lineata*	MG	1.4%
12	*Pusillina radiata*	MG	1.4%

Tab. 60 – Species dominance in the *Posidonia* leaves samples, Giglio Isl.

Feeding guilds analysis (Tab. 61, Tab. 62) highlights that this community is composed by microalgae herbivores species only. Therefore, also the ratio between carnivorous and microalgae herbivores is always zero since no carnivorous species were collected.

		R-B
SC	Scavengers	-
AG	Herbivores of macroalgae and epiphytes	-
MG	Microalgae herbivores	-
SG	Seagrass-feeding herbivores	100%
D	Deposit feeders	-
F	Filter feeders	-
SY	Symbiont-bearing species	-
E	Ectoparasites and carnivores on preys without mobility	-
C	Carnivores on mobile prey	-
O	Egg and spawn feeders	-
Carnivorous/ microalgae herbivores ratio		0.0

Tab. 61 – Trophic groups dominance in the samples, Giglio Isl.

		R-B
SC	Scavengers	-
AG	Herbivores of macroalgae and epiphytes	-
MG	Microalgae herbivores	-
SG	Seagrass-feeding herbivores	12
D	Deposit feeders	-

		R-B
F	Filter feeders	-
SY	Symbiont-bearing species	-
E	Ectoparasites and carnivores on preys without mobility	-
C	Carnivores on mobile prey	-
O	Egg and spawn feeders	-

Tab. 62 – Number of species *per* feeding guilds in the *Posidonia* leaves samples, Giglio Isl.

8.1.4.4 Ischia Isl.

The species collected in the *Posidonia* leaves and their abundance are given in Tab. 63. Only replicates from -25 m deep were considered since they are the only ones truly comparable to the Secche di Tor Paterno ones as long as depth is concerned. Sampling was carried out by hand-net with 40 strokes per replicate in Autumn 1979.

Abundance data for *Turboella radiata* (*Pusillina radiata*) were given for both adults and juveniles in distinct rows in the paper by Idato *et al*.. These data have been pooled to have a single abundance data for the species, since all other localities did not have any splitting between adults and juveniles.

		Diet	R-25A	R-25B	R-25C
1	*Jujubinus exasperatus*	MG [65]	1	1	0
2	*Jujubinus striatus*	MG [66]	1	0	0
3	*Tricolia speciosa*	MG [67]	1	1	0
4	*Rissoella* sp.	MG [68]	6	4	0
5	*Microsetia cossurae*	MG [69]	0	1	0
6	*Turboella radiata*	MG [70]	14	13	12
7	*Turboella lineolata*	MG [70]	2	3	2
8	*Apicularia guerinii*	MG [71]	0	1	1
9	*Apicularia violacea*	MG [71]	6	5	6
10	*Alvania discors*	MG [72]	0	1	1
11	*Alvania lineata*	MG [72]	4	1	5
12	*Turritella communis*	F [73]	0	0	1

[65] Fretter *et al*., 1977.

[66] Peduzzi, 1987

[67] Fretter *et al*., 1977 for *Tricolia pullus* (Linné, 1758)

[68] Fretter *et al.*, 1978 for *Rissoella* spp.

[69] Fretter *et al*., 1978 for *Cingulopsis fulgida* (J. Adams, 1797) [= *Eatonina fulgida*], congeneric of Microsetia cossurae (Calcara, 1841) [= *Eatonina cossurae*]

[70] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[71] Fretter *et al*., 1978.

[72] Fretter *et al.*, 1978 for all congeneric species

[73] Fretter *et al.*, 1981

		Diet	R-25A	R-25B	R-25C
13	*Bittium reticulatum* [74]	MG [75]	8	3	5
14	*Balcis devians*	E [76]	1	0	0
15	*Naticarius millepunctatus*	C [77]	1	0	0
16	*Muricopsis cristata*	C [78]	1	0	0
17	*Phyllonotus trunculus*	C [79]	0	1	0
18	*Ocinebrina aciculata*	C [80]	0	0	4
19	*Buccinulum corneum*	C [81]	0	0	1
20	*Fusinus pulchellus*	C [82]	1	0	0
21	*Gibberula philippii*	C [83]	2	0	3
22	*Gibberulina clandestina*	C [83]	2	5	1
23	*Lissopecten hyalinus*	F [84]	1	3	0
24	*Anomia ephippium*	F [84]	1	0	1
	TOTAL NUMBER OF SPECIMENS		53	43	43

Tab. 63 – Quali-quantitative data of the *Posidonia* leaves samples, Ischia Isl.

By a population structure point of view, species richness along replicates varies from 13 to 17 with Shannon diversity index (H') ranging from 2.206 to 2.371 and evenness (J') ranging from 0.837 to 0.860 (Tab. 64).

Replicate	S	H'	J'
R-25A	17	2.371	0.837
R-25B	14	2.253	0.854
R-25C	13	2.206	0.860

Tab. 64 – Biodiversity indices values for *Posidonia* leaves samples, Ischia Isl.

Diversity and equitability indices are influenced by dominance phenomena (Tab. 65). Two species dominate most: *Turboella radiata* and *Bittium latreillii*. However, their dominance is not as strong as could be observed in shallower stations in Ischia Isl and therefore there is a high diversity and high evenness.

		Diet	R-25A	R-25B	R-25C
1	*Jujubinus exasperatus*	MG	1.9%	2.3%	0.0%
2	*Jujubinus striatus*	MG	1.9%	0.0%	0.0%
3	*Tricolia speciosa*	MG	1.9%	2.3%	0.0%

[74] It is probably a misidentification of *Bittium latreillii* (Payraudeau, 1826).

[75] Russo *et al*., 2002.

[76] Waren, 1983

[77] Fretter *et al.*, 1981 for all Naticidae.

[78] Fretter *et al*., 1981 for all Muricidae *sensu stricto* (excluding, for example, Coralliphilinae)

[79] Peharda *et al.*, 2006

[80] Fretter *et al*., 1984.

[81] Fretter *et al*., 1984 for all Buccinidae.

[82] Beesley *et al*., 1998 for Fasciolariidae

[83] Beesley *et al*., 1998 for "marginellids" (Marginellidae and Cystiscidae)

[84] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

		Diet	R-25A	R-25B	R-25C
4	*Rissoella* sp.	MG	11.3%	9.3%	0.0%
5	*Microsetia cossurae*	MG	0.0%	2.3%	0.0%
6	*Turboella radiata*	MG	26.4%	30.2%	27.9%
7	*Turboella lineolata*	MG	3.8%	7.0%	4.7%
8	*Apicularia guerinii*	MG	0.0%	2.3%	2.3%
9	*Apicularia violacea*	MG	11.3%	11.6%	14.0%
10	*Alvania discors*	MG	0.0%	2.3%	2.3%
11	*Alvania lineata*	MG	7.5%	2.3%	11.6%
12	*Turritella communis*	F	0.0%	0.0%	2.3%
13	*Bittium reticulatum* [85]	MG	15.1%	7.0%	11.6%
14	*Balcis devians*	E	1.9%	0.0%	0.0%
15	*Naticarius millepunctatus*	C	1.9%	0.0%	0.0%
16	*Muricopsis cristata*	C	1.9%	0.0%	0.0%
17	*Phyllonotus trunculus*	C	0.0%	2.3%	0.0%
18	*Ocinebrina aciculata*	C	0.0%	0.0%	9.3%
19	*Buccinulum corneum*	C	0.0%	0.0%	2.3%
20	*Fusinus pulchellus*	C	1.9%	0.0%	0.0%
21	*Gibberula philippii*	C	3.8%	0.0%	7.0%
22	*Gibberulina clandestina*	C	3.8%	11.6%	2.3%
23	*Lissopecten hyalinus*	F	1.9%	7.0%	0.0%
24	*Anomia ephippium*	F	1.9%	0.0%	2.3%

Tab. 65 – Species dominance in the *Posidonia* leaves samples, Ischia Isl.

Feeding guilds analysis (Tab. 66Tab. 51) highlights the dominance of microalgae herbivores along all replicates. However, carnivorous species represent a good share of the community. Parasites and filter-feeders are present too. The latter mainly for the presence of a few bivalves and *Turritella communis*, whose presence on the foliar layer of *Posidonia* is rather unusual. The ratio between carnivorous and microalgae herbivores ranges from 16.3% to 28.1%.

		R-25A	R-25B	R-25C
SC	Scavengers	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-
MG	Microalgae herbivores	81.1%	79.1%	74.4%
SG	Seagrass-feeding herbivores	-	-	-
D	Deposit feeders	-	-	-
F	Filter feeders	3.8%	7.0%	4.7%
SY	Symbiont-bearing species	-	-	-

[85] It is most probably a misidentification of *Bittium latreillii* (Payraudeau, 1826).

		R-25A	R-25B	R-25C
E	Ectoparasites and carnivores on preys without mobility	1.9%	0.0%	0.0%
C	Carnivores on mobile prey	13.2%	14.0%	20.9%
O	Egg and spawn feeders	-	-	-
Carnivorous/ microalgae herbivores ratio		16.3%	17.6%	28.1%

Tab. 66 – Trophic groups dominance in the samples, Ischia Isl.

		R-25A	R-25B	R-25C
SC	Scavengers	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-
MG	Microalgae herbivores	9	11	7
SG	Seagrass-feeding herbivores	-	-	-
D	Deposit feeders	-	-	-
F	Filter feeders	2	1	2
SY	Symbiont-bearing species	-	-	-
E	Ectoparasites and carnivores on preys without mobility	1	-	-
C	Carnivores on mobile prey	5	2	4
O	Egg and spawn feeders	-	-	-

Tab. 67 – Number of species *per* feeding guilds in the *Posidonia* leaves samples, Ischia Isl.

8.1.4.5 Hvrgada Isl, Croatia

The species collected in the *Posidonia* leaves and their abundance are given in Tab. 68. Replicates come from two stations at -4 m and -11 m deep. Sampling was carried out by hand-net with 60 strokes per replicate in July 2000.

		Diet	R4	R11
1	*Smaragdia viridis*	SG [86]	0	6
2	*Calliostoma laugieri*	MG [14]	0	1
3	*Jujubinus striatus*	MG [87]	13	2
4	*Tricolia tenuis*	MG [88]	9	4

[86] Rueda *et al.*, 2007

[87] Peduzzi, 1987

[88] Fretter *et al*., 1977 for *Tricolia pullus* (Linné, 1758).

		Diet	R4	R11
5	*Bittium jadertinum*	MG [89]	5	0
6	*Bittium latreillii*	MG [90]	75	10
7	*Rissoa labiosa*	MG [91]	2	0
8	*Rissoa monodonta*	MG [91]	1	0
9	*Rissoa splendida*	MG [91]	6	0
10	*Rissoa variabilis*	MG [91]	3	0
11	*Rissoa ventricosa*	MG [91]	0	4
12	*Pusillina philippi*	MG [92]	1	0
13	*Granulina marginata*	C [93]	0	1
14	*Modiolarca subpicta*	F [94]	0	1
15	*Lissopecten hyalinus*	F [94]	0	2
	TOTAL NUMBER OF SPECIMENS		115	31

Tab. 68 – Quali-quantitative data of the *Posidonia* leaves samples, Hvrgada Isl., Croatia

By a population structure point of view, all replicates have 9 species with Shannon diversity index (H') ranging from 0.865 to 1.263 and evenness (J') ranging from 0.394 to 0.575 (Tab. 69). The shallow water station has higher Shannon diversity than the deeper water one. Moreover, it shows an higher evenness.

Replicate	S	H'	J'
R4	9	1.263	0.575
R11	9	0.865	0.394

Tab. 69 – Biodiversity indices values for *Posidonia* leaves samples, Hvrgada Isl., Croatia

Diversity and equitability indices are influenced by dominance phenomena (Tab. 70). A species dominates in all replicates: *Bittium latreillii*. In the shallower sample, the second most abundant species is *Jujubinus striatus*, while in the deeper one it is *Smaragdia viridis* (which is absent in the shallower sample).

		Diet	R4	R11
1	*Smaragdia viridis*	SG	0.0%	19.4%
2	*Calliostoma laugieri*	MG	0.0%	3.2%
3	*Jujubinus striatus*	MG	11.3%	6.5%
4	*Tricolia tenuis*	MG	7.8%	12.9%
5	*Bittium jadertinum*	MG	4.3%	0.0%
6	*Bittium latreillii*	MG	65.2%	32.3%
7	*Rissoa labiosa*	MG	1.7%	0.0%
8	*Rissoa monodonta*	MG	0.9%	0.0%

[89] Fretter *et al*., 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778).

[90] Russo *et al*., 2002.

[91] Fretter *et al*., 1978 for other congeneric species.

[92] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[93] Beesley *et al*., 1998 for "marginellids" (Marginellidae and Cystiscidae)

[94] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

		Diet	R4	R11
9	*Rissoa splendida*	MG	5.2%	0.0%
10	*Rissoa variabilis*	MG	2.6%	0.0%
11	*Rissoa ventricosa*	MG	0.0%	12.9%
12	*Pusillina philippi*	MG	0.9%	0.0%
13	*Granulina marginata*	C	0.0%	3.2%
14	*Modiolarca subpicta*	F	0.0%	3.2%
15	*Lissopecten hyalinus*	F	0.0%	6.5%

Tab. 70 – Species dominance in the *Posidonia* leaves samples, Hvrgada Isl., Croatia

Feeding guilds analysis (Tab. 71, Tab. 72) highlights the dominance of microalgae herbivores along all replicates. In the shallower replicate microalgae herbivores are the only present. In the deeper one, seagrass-feeding herbivore species represent 19.4% of the community (with the only species *Smaragdia viridis*) and filter-feeders and carnivores are present too. The ratio between carnivorous and microalgae herbivores is zero in the shallower station and 0.05, very low, in the deeper one.

		R4	R11
SC	Scavengers	-	-
AG	Herbivores of macroalgae and epiphytes	-	-
MG	Microalgae herbivores	100%	67.7%
SG	Seagrass-feeding herbivores	-	19.4%
D	Deposit feeders	-	-
F	Filter feeders	-	9.7%
SY	Symbiont-bearing species	-	-
E	Ectoparasites and carnivores on preys without mobility	-	-
C	Carnivores on mobile prey	-	3.2%
O	Egg and spawn feeders	-	-
Carnivorous/ microalgae herbivores ratio		0.0	0.05

Tab. 71 – Trophic groups dominance in the samples, Hvrgada Isl., Croatia

		R4	R11
SC	Scavengers	-	-
AG	Herbivores of macroalgae and epiphytes	-	-
MG	Microalgae herbivores	15	5

		R4	R11
SG	Seagrass-feeding herbivores	-	1
D	Deposit feeders	-	-
F	Filter feeders	-	2
SY	Symbiont-bearing species	-	-
E	Ectoparasites and carnivores on preys without mobility	-	-
C	Carnivores on mobile prey	-	1
O	Egg and spawn feeders	-	-

Tab. 72 – Number of species *per* feeding guilds in the *Posidonia* leaves samples, Hvrgada Isl., Croatia

8.1.4.6 Comparison between localities

Comparative tables of the main features of the communities in different localities are reported in the following tables.

	Secche della Meloria				Elba Isl. [95]		Giglio Isl.	Secche di Tor Paterno [96]			Ischia Isl.			Hvrgada Isl, Croatia	
Station/ sample	**R_H**	**R_I**	**R_J**	**R_L**	**-5m**	**-12m**	**R-B**	**--**	**6**	**8**	**A**	**B**	**C**	**R4**	**R11**
Depth	-4 m				-5 m	-12 m	-9 m	-24 m	-26 m	-28 m	-25 m			-4m	-11m
N	378	494	101	247	473	1278	72	55	28	11	53	43	43	115	31
S	9	7	8	10	16	15	12	9	9	6	17	15	14	9	9

Tab. 73 – Comparative table of abundance and species richness of different localities

	Secche della Meloria				Elba Isl. [95]		Giglio Isl.	Secche di Tor Paterno [96]			Ischia Isl.			Hvrgada Isl, Croatia	
Station/ sample	**R_H**	**R_I**	**R_J**	**R_L**	**-5m**	**-12m**	**R-B**	**--**	**6**	**8**	**A**	**B**	**C**	**R4**	**R11**
Depth	-4 m				-5 m	-12 m	-9 m	-24 m	-26 m	-28 m	-25 m			-4m	-11m
H	0.407	0.285	0.642	0.619	1.713	1.075	2.102	1.204	1.568	1.673	2.371	2.416	2.383	1.263	0.865
J	0.185	0.147	0.309	0.269	0.618	0.397	0.846	0.548	0.714	0.934	0.837	0.892	0.903	0.575	0.394

Tab. 74 – Comparative table of Shannon diversity and Pielou's evenness of different localities

[95] See chapter 8.1.4.2 for how replicates were pooled into stations.

[96] Since replicates were obtained with 20 strokes and three replicates per station were carried out, replicates were pooled to have a sample obtained with 60 strokes.

	Secche della Meloria				Elba Is.		Giglio Is.
	Sample H -4m	**Sample I -4m**	**Sample J -4m**	**Sample L -4m**	**Station -5m**	**Station -12m**	**-9m**
1st dominant species	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Jujubinus striatus* (MG)
2nd dominant species	*Rissoa variabilis* (MG)	*Pusillina radiata* (MG)	*Bittium jadertinum* (MG)	*Jujubinus exasperatus* (MG)	*Rissoa auriscalpium* (MG)	*Rissoa auriscalpium* (MG)	*Bittium latreillii* (MG)

Tab. 75 – Comparative table of dominant species at different localities (part one)

	Secche di Tor Paterno MPA			Ischia Is.			Hvrgada Isl (HR)	
	Trial station -24m	**Station 6 -26m**	**Station 8 -26m**	**-25m A**	**-25m B**	**-25m C**	**-4m**	**-11m**
1st dominant species	*Bittium latreillii* (MG)	*Chauvetia* aff *brunnea* (C)	*Bittium sp. 1* (MG)	*Pusillina radiata* (MG)	*Pusillina radiata* (MG)	*Pusillina radiata* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)
2nd dominant species	*Ocinebrina aciculata* (C)	*Bittium latreillii* (MG)	*Ocinebrina aciculata* (C)	*Bittium reticulatum* (MG)	*Rissoa violacea* (MG)	*Rissoa violacea* (MG)	*Jujubinus striatus* (MG)	*Smaragdia viridis* (SG)

Tab. 76 – Comparative table of dominant species at different localities (part two)

	Secche della Meloria				Elba Isl. [95]		Giglio Isl.	Secche di Tor Paterno [96]			Ischia Isl.			Hvrgada Isl, Croatia	
Station/ sample	**R_H**	**R_I**	**R_J**	**R_L**	**-5m**	**-12m**	**R-B**	**--**	**6**	**8**	**A**	**B**	**C**	**R4**	**R11**
Depth	-4 m				-5 m	-12 m	-9 m	-24 m	-26 m	-28 m	-25 m			-4m	-11m
SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MG	99.7%	100%	100%	99.6%	99.6%	99.9%	100%	85.5%	53.6%	45.5%	81.1%	79.1%	74.4%	100%	67.7%
SG	-	-	-	-	0.2%	-	-	0%	0%	0%	0.0%	0.0%	0.0%	-	19.4%
D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	0.3%	-	-	-	0.2%	-	-	0%	3.6%	9.1%	1.9%	0.0%	0.0%	-	9.7%
SY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	0.4%	-	-	-	85.5%	53.6%	45.5%	3.8%	7.0%	4.7%	-	0.0%
C	-	-	-	-	-	0.1%	-	14.5%	42.9%	45.5%	13.2%	14.0%	20.9%	-	3.2%
O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carnivorous/ microalgae herbivores ratio	0	0	0	0	0	0	0	0.17	0.80	1.00	0.16	0.18	0.28	0	0.05

Tab. 77 – Comparative table of trophic groups of different localities

	Secche della Meloria				Elba Isl. [95]		Giglio Isl.	Secche di Tor Paterno [96]			Ischia Isl.			Hvrgada Isl, Croatia	
Station/ sample	**R_H**	**R_I**	**R_J**	**R_L**	**-5m**	**-12m**	**R-B**	**--**	**6**	**8**	**A**	**B**	**C**	**R4**	**R11**
Depth	-4 m				-5 m	-12 m	-9 m	-24 m	-26 m	-28 m	-25 m			-4m	-11m
SC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MG	8	7	8	9	14	14	-	7	6	3	9	11	7	15	5
SG	-	-	-	-	1	-	12	-	-	-	-	-	-	-	1
D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-	-	2	1	2	-	2
SY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	1	0	0	1	1	-	-	-	1	1	1	-	-	-	-
C	-	-	-	-	-	1	-	2	2	2	5	2	4	-	1
O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Tab. 78 – Comparative table of trophic groups of different localities (species counts)

Moreover, a multivariate analysis of the assemblages, pooling them into a single abundance matrix, was carried out. To achieve this, the taxonomy of the different data sets was updated. However, it was not possible to sort again samples to check any misidentifications.

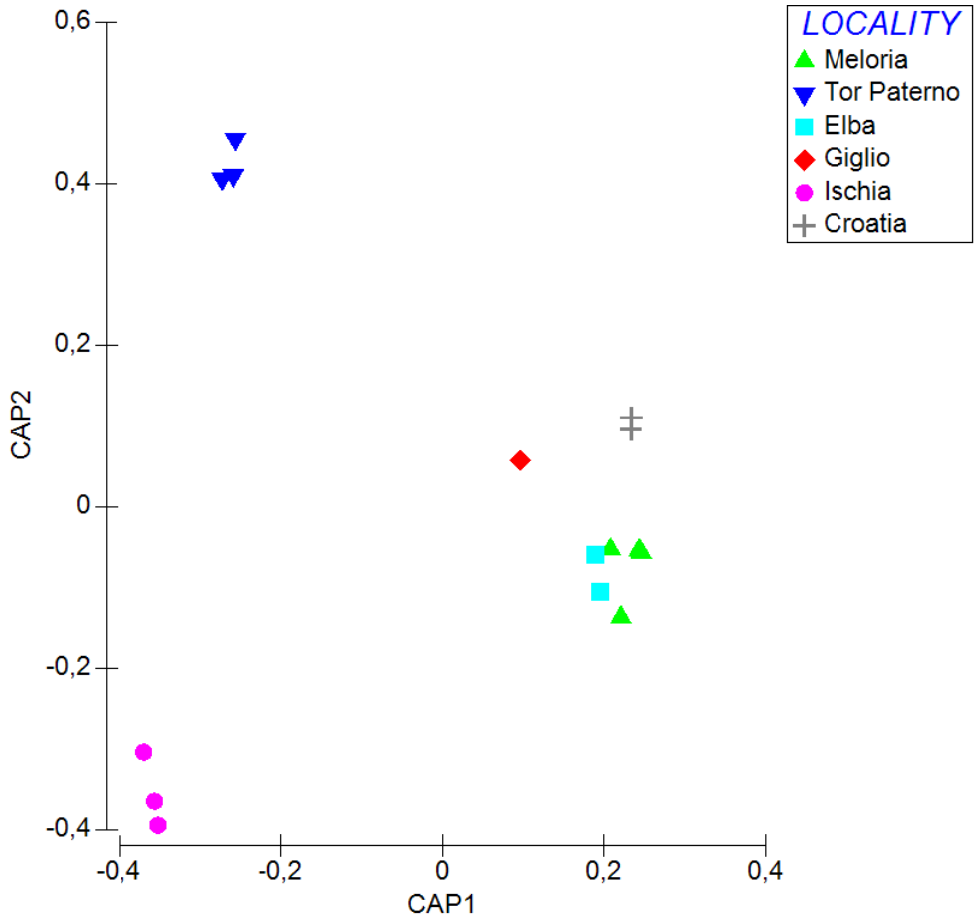


Fig. 28 – Canonical analysis on principal coordinates, factor: locality

Due to samples heterogeneity data were standardised. Moreover, they were square-root transformed for a more balanced relationship between rare and common species. The Bray-Curtis similarity coefficient was used.

Canonical analysis on principal coordinates gave plot in Fig. 28. The graphical representation indicates that the deep water assemblages are distant from all the shallow water ones. Moreover, it stresses the uniqueness of Secche di Tor Paterno assemblages. However, when statistically tested (PERMANOVA, $p<0.05$, with Monte Carlo simulations due to the low number of permutations) differences are not so neat. Secche della Meloria assemblages are considered different from all other localities. Secche di Tor Paterno assemblages are considered different from Ischia ones, but no significant differences are detected with Giglio Isl. assemblages. Elba Isl. assemblages are different from Ischia, Secche di Tor Paterno and Secche della Meloria but not significantly different from Giglio Isl. and Croatia. Ischia Isl assemblages are considered different from most others except Giglio Isl.. Croatian assemblages are considered different from most others except Giglio Isl.. However, since there is no obvious reason why Giglio Isl. should be different from most other stations while Croatian assemblages aren't much different from deep water Ischia ones or shallow water Secche della Meloria ones, this analysis shows that it is difficult to draw conclusions on difference based on geographical localisation of the stations and may suggest that there are not true differences in the *Posidonia* leaves assemblages across a geographical transect.

A further analysis was carried out defining a factor in relation to the basin where stations lie. Two levels were selected: one for the Tyrrhenian Sea stations and the other for the Adriatic Sea one. No statistically significant differences are detected (PERMANOVA, $p<0.05$, with Monte Carlo simulations due to the low number of permutations).

The same analysis was carried out defining a factor in relation to the depth of the station. Shallow water stations were defined when above 5 m, intermediate from 6 to 15, deep below 15.

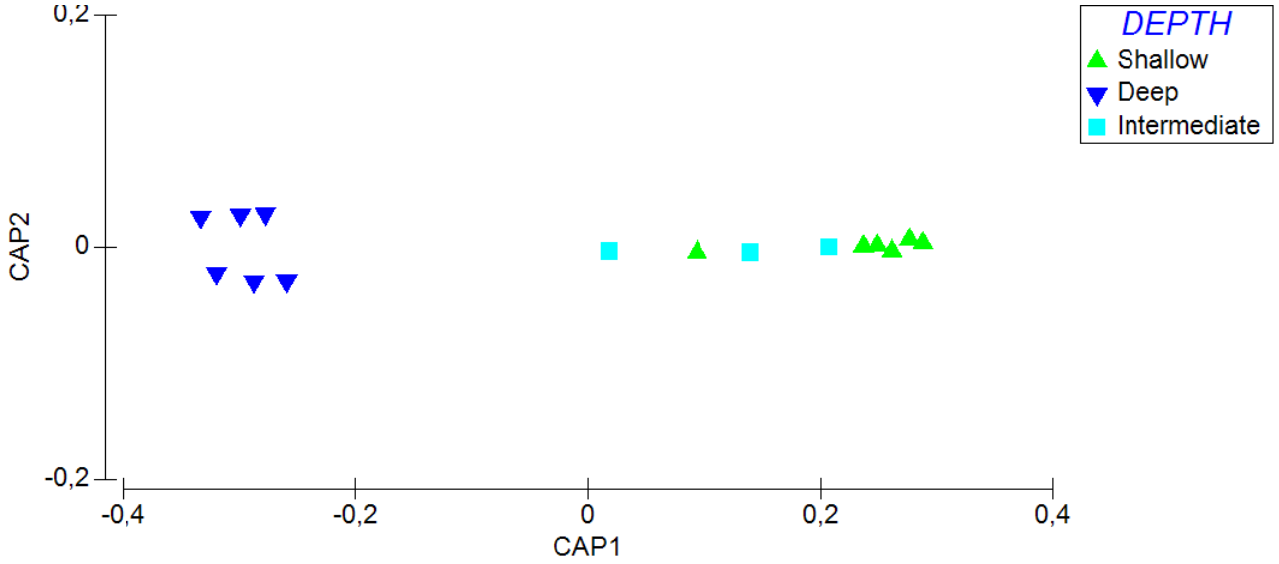


Fig. 29 - Canonical analysis on principal coordinates, factor: locality

Canonical analysis on principal coordinates gave plot in Fig. 29 which shows how deep water stations are different from shallow water and intermediate ones. Shallow water and intermediate ones are not clearly put aside. Consistently, PERMANOVA ($p<0.05$, with Monte Carlo simulations for the low number of permutations) suggests that the deep water stations are different from the others, while the shallow and intermediate levels are not significantly different. Therefore, depth seem to be an important factor in defining the species assemblages of *Posidonia* leaf stratum but only in deep water (below 15m) (as suggested by previous authors, e.g. Idato *et al*., 1983).

8.2 Discussion

8.2.1 Secche di Tor Paterno community

The two *Posidonia* areas which were sampled do not significantly differ as long as the shoot density and the mean leaves length are considered. On the contrary, the number of leaves per shoot is significantly different in the two stations. Mean leaves length is slightly greater in the meadow in the sedimentary area than in the shoots growing on hard substratum, but these differences are not statistically significant.

Scardi *et al* (2005) sampled *Posidonia* in the same area in July 2004 (Tab. 79) and reported data of a survey in 1998. Data collected in 2004 come from two stations, which are near our station 8. Data collected in 1998 do not bear station details except depth.

	Coordinates	Depth	Date	Notes
Station P1	-	-27m	1998	
Station P2	-	-23m	1998	
Station P3	-	-28m	1998	
Station P4	-	-23m	1998	
Station P5	-	-24m	1998	
Station P6	-	-22m	1998	
Station 1	41°36.141'N - 012°20.477'E	-25m	27/07/2004	Site "La Grotta"
Station 2	41°36.144'N – 012°20.470'E	-23m	27/07/2004	Site "Il Cappello"

Tab. 79 – Stations data of Tor Vergata University survey (Scardi *et al.,* 2005)

Comparative results are given in Tab. 80.

	Mean density [shoots/m^2]	Giraud (1977) class	Pergent *et al* (1995) evaluation
Station P1 Tor Vergata 1998	164	IV	Normal density
Station P2 Tor Vergata 1998	165	IV	Sub-normal density
Station P3 Tor Vergata 1998	155	IV	Normal density
Station P4 Tor Vergata 1998	225	IV	Normal density
Station P5 Tor Vergata 1998	172	IV	Normal density
Station P6 Tor Vergata 1998	249	IV	Normal density
Station 1 Tor Vergata 2004	53.8 ± 50.3	V	Sub-normal density
Station 2 Tor Vergata 2004	151.3 ± 16.2	IV	Sub-normal density
Station 6 survey 2007	368 ± 162	III	Normal density
Station 8 survey 2007	389 ± 144	III	Normal density

Tab. 80 – Density data in the Secche di Tor Paterno *Posidonia* surveys

It is difficult to draw conclusions on data in Tab. 80 because it could not be reconstructed to which extent samples were taken in the same spots and this has great importance due to the heterogenity of the area substrata. However, it seems clear that most samples would classify the meadows in the lower limit of a normal condition or in the upper of a sub-normal condition and that this condition does not see significant changes in the considered time-frame, despite some oscillation could be hypothesized.

Only 14 species were collected, all of them are gastropods as usual for this biocoenosis. Moreover, the limited quantity of *Rissoa auriscalpium* and the lack of *Smaragdia viridis* are striking since these species are often associated to this plant. Even common species like *Bittium latreillii* or *Jujubinus exasperatus* are present in limited quantities. This is a poor species assemblage. It is interesting to underline the presence of *Chauvetia* aff *brunnea* and of *Alvania settepassii* not found in the other stations used for comparison (see below).

The lack of any significant difference between replicates and stations shows that the different substrata on which *Posidonia* has settled does not influence the leaves molluscan assemblage. This is consistent with the lack of significant differences of shoot density which is the main *Posidonia* bed structure parameter.

This community is dominated by microalgae herbivores both in terms of number of specimens and species. The analysis of feeding guilds (Tab. 45) also shows that at this depth carnivorous species have a key role in the community being present up to 83.3% of the total number of specimens within a single replicate.

When comparing the fauna with the typical species described by Pérès & Picard (1964) most of the species are present: *Jujubinus exasperatus*, *Rissoa auriscalpium*, *Rissoa violacea*, *Pusillina philippi*, *Bittium latreillii*, *Ocinebrina aciculata* and *Chauvetia* aff. *brunnea*.

Tricolia tenuis (closely related to *T. speciosa* and *T. pullus*) and *Smaragdia viridis* were found in the rhizomes and their lack from leaves may be due to the nictemeral migrations along the plant axis (Russo *et al.*, 1984).

Granulina marginata, *Persicula miliaria* and *Flexopecten hyalinus* are probably absent from the biocoenosis since just a few dead specimens have been found in the sediment samples to date. The Rissoidae are present despite with an impoverished assemblage.

8.2.2 Comparison with other data sets

Other data sets give interesting information to compare the assemblages of Secche di Tor Paterno.

By a qualitative point of view, the key taxa of the foliar layer of *Posidonia oceanica* are present in all stations. This is especially true for *Bittium latreillii*, which is often the dominant species in the shallow water samples, Rissoidae and Trochidae. The shallow water samples (Secche della Meloria, Elba Isl. at -5 m, Giglio Isl. and Hvrgada Isl. at -4 m) are dominated by those taxa and other species are very rare. On the contrary, deeper water samples see the presence of different families like Muricidae, Costellariidae, Cystiscidae. The presence of filter-feeders like *Lissopecten hyalinus* and *Anomia ephippium* which were found in Ischia Isl. but not elsewhere may be influenced by the strokes strength since these species live firmly attached to the substratum (*Lissopecten* by byssum, *Anomia* is attached by a calcified byssum). *Chauvetia* aff *brunnea* which can be dominant in Secche di Tor Paterno is not present elsewhere. Despite this species is widespread in the Mediterranean Sea, it is a localized one, probably due to its non-planktotrophic development type. *Alvania settepassii* is not found elsewhere too. This may be due to several reasons: first, it is a lower infralittoral species and therefore couldn't be found in shallow water stations; second, it is more strongly associated to the coralligenous; last, its distribution still has to be understood properly (e.g.: are morphologically similar specimens form the Jonian Sea the same species or is *Alvania settepassii* restricted to the Central Tyrrhenian Sea?).

The quantitative richness of the samples in terms of number of specimens (Tab. 73) varies greatily in accordance to location and depth. Elba Isl. has the most abundant samples with up to more than 1200 specimens per station (at -12 m). Also Secche della Meloria (-4 m) are rich with hundreds of specimens per station. Deep water stations show much poorer assemblages: both Secche di Tor Paterno and Ischia have around 50 or less specimens per station. Also the Croatian station at -11 m shows a remarkably poor assemblage with just 31 specimens.

When the number of species is considered, stations within the same locality are less variable than the number of specimens. Numbers are anyway pretty low since richness varies from 7 to 17 specimens. The most diverse stations are Elba Isl (-5 m) with up to 16 species and Ischia Isl. (-25 m) with up to 17 species. In this case, Secche di Tor Paterno and Ischia Isl have a different pattern, Ischia being considerably much richer than Secche di Tor Paterno. Since the two localities are in the same biogeographic area of the Mediterranean and have the same depth, the main reason may lie in the different structure of the meadow. Ischia has a continuous meadow which starts below the low tide line while Secche di Tor Paterno have small meadows or patches on hard substratum. Fragmentation of the habitat may influence the recruiting ability of *Posidonia* leaves.

Shannon diversity (Tab. 74) is at its highest at Ischia Isl (2.371-2.416). Secche di Tor Paterno have moderately high values of this index 1.204-1.673, lower than Ischia, but generally higher than most shallower water stations with the striking exception of Giglio Isl. (2.102). Pielou's evenness is very high at Ischia Isl. because of the lack of a single dominant species (the dominant one is just one order of magnitude more abundant than others, while in other stations like Secche della Meloria or Elba Isl. the dominant one is two orders of magnitude more abundant than others). The same pattern can be found in Secche di Tor Paterno, especially at station 8 (small, but continuous meadow on soft substratum) while evenness decreases at station 6 (meadow on hard substratum) and on isolated patches (unnumbered station).

Bittium latreillii is often the dominant species (Tab. 75, Tab. 76) and usually present by the hundreds in shallow water stations (above -15 m) with the only exception of Giglio Isl where it is the second dominant species anyway. Deeper water stations have a clearly different dominance pattern which is much less standardized: at Ischia Isl. the dominant species is *Pusillina radiata* while at Secche di Tor Paterno every station has a different dominant species: *Bittium latreillii*, *Chauvetia* aff *brunnea* and *Bittium* sp. 1. Secche di Tor Paterno have also the characteristic of having between the two most abundant species always a carnivore.

The analysis of species feeding guilds (Tab. 77) highlights a well known pattern in *Posidonia* leaves molluscan assemblages. In shallow water stations microalgae herbivore species dominate or are the only present. In deeper water assemblages, carnivorous species play an important role being present from 13.2% to 20.9% in Ischia and up to 45.5% in Secche di Tor Paterno. Carnivorous have a negligible presence in stations above -15 m. Quoting Gambi *et al.* (1992) "the greater abundance of carnivores at deep stations is due to the diversity of prey too as to habitat stability and heterogeneity, which allows for a multiplicity of niches and interactions". This pattern may be better described by the carnivorous/microalgae herbivores ratio (Fig. 30) which shows the general trend of high presence of carnivores in the deeper stations and the

strikingly high values of Secche di Tor Paterno. Filter-feeders, parasites and sea-grass or macroalgae feeding herbivores are occasional everywhere.

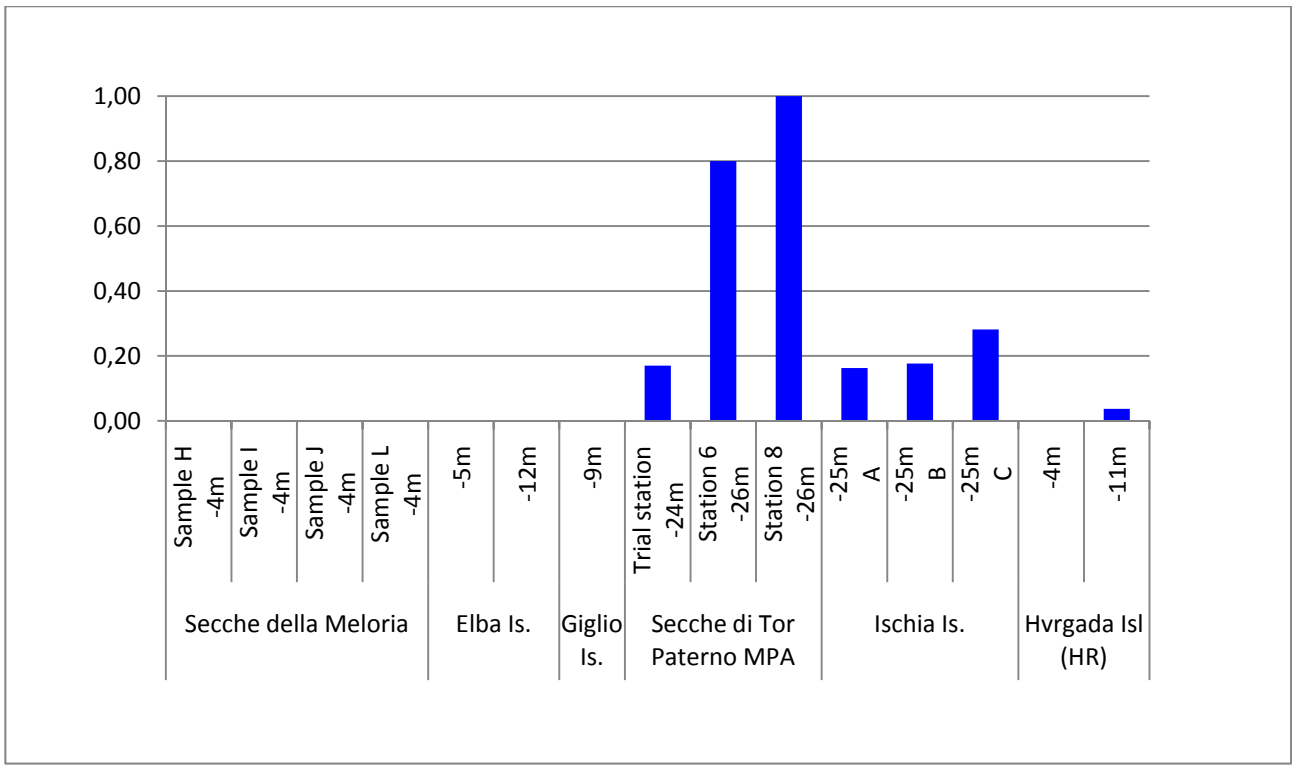


Fig. 30 – Carnivorous/ microalgae herbivores ratio in all stations

As a last consideration, croatian stations at moderate depths (-11 m) show some features of much deeper stations in the Central Tyrrhenian Sea, for example the number of specimens is very low, the presence of carnivores low but markedly above zero. It would be interesting to study whether the species assemblages in the two basins show significant differences with a wider data set and which environmental conditions are the main drivers.

9 Analysis of the *Posidonia* rhizomes species assemblage

General aspects of *Posidonia oceanica* meadows are treated in chapter 8 (page 74).

It is here important to highlight that *Posidonia* rhizomes allow the establishment of meadows in both soft and hard substrata. Rhizomes can be plagiotropes (spreading horizontally) or orthotropes (spreading vertically) building a complex three-dimensional structure which has a significant sediment component but also a hard part constituted by the rhizomes themselves and their epibiontic species (coralline algae, bryozoans, …). The rhizomes, the roots and the sediment within constitue a "matte".

The sediment in the rhizomes is both of autochtonous and allochtonous origin. The former is the residuals of organisms which live in the meadows (shells, coralline weeds, etc), the latter is the sediment which is trapped by the leaves which act reducing water hydrodynamism. In this way rhizomes are a diversified environment which can host species associated to coralline weeds, to hard substrata (the rhizomes themselves) and to soft substrata (the sediment). Due to the protective leaves action, this is a sciaphilous habitat and Pérès & Picard (1964) suggested it could be considered an enclave of the coralligenous (cfr. chapter 10, page 148).

Moreover, the rhizomes are considered part of that "carrefour biocoenotique" of *Posidonia oceanica* described by Bianchi *et al.*, 1989.

Knowledge on the fauna of this layer is scant. A few works deal with the fauna of the matte (e.g.: Harmelin, 1964; Vaccarella *et al.*, 1981) but research on the rhizomes and their "coralligenous" assemblages are even rarer. García Raso *et al*. (1996) studied the crustacean communities of this environment comparing it to true coralligenous communities, concluding that the crustacean community is not significantly different. However, no specific work on the molluscs of the rhizomes was found.

This is the first survey on the molluscan fauna of the *Posidonia* rhizomes of Secche di Tor Paterno.

Our sampling was not aimed at the endobenthos of the mattes, however, the upper layer of this level was certainly sampled and it is therefore useful to cite that Harmelin (1964) consider among the characteristic and exclusive molluscan species of this layer: "*Venus verrucosa* [Linné, 1758], *Lima hians* [*Limaria hians* (Gmelin, 1791)], *Lima inflata* [*Limaria tuberculata* (Olivi, 1792)], *Woodia digitaria* [*Digitaria digitaria* (Linné, 1758)], *Lepton squamosum* [(Montagu, 1803)], *Galeomma turtoni* [Sowerby G.B. I in Turton, 1825]". Characteristic species which preferentially live in this level are: "*Cardita trapezia* [*Glans trapezia* (Linné, 1767)], *Psammobia vespertina* [*Gari depressa* (Pennant, 1777)] and *Tapes pullastra* var. *geographicus* [*Venerupis senegalensis* (Gmelin, 1791)]".

The coralligenous biocoenosis of which the rhizome layer is considered a close relative hosts some characteristic mollusc species. Pérès & Picard (1964) cite in detail just two: *Chlamys pes-felis* [*Manupecten pesfelis* (Linné, 1758)] and *Lima squamosa* [*Lima lima* (Linné, 1758)].

Despite care was placed in the sampling efficacy of the leaves, some specimens may have fallen in the rhizomes because of the retraction of the animal in response to sampling disturb. Therefore, the fauna of the rhizomes may contain specimens which were crawling on the leaves.

9.1 Results

9.1.1 *Posidonia oceanica* bed structure and morphometry

The description of the bed structure is given in detail in par. 8.1.1 at page 74.

It is here important to highlight that two stations were sampled in this survey:

1. station 7 (samples SP1, SP2, SP3) where *Posidonia* is on a hard substratum; rhizomes are therefore in the coralligenous substratum;
2. station 9 (samples SP4, SP5, SP6) where *Posidonia* is in a more typical sedimentary area; rhizomes are therefore in the soft substratum.

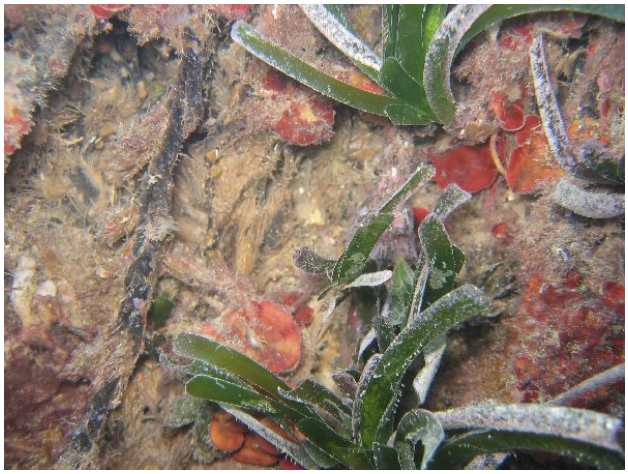



Fig. 31 – The *Posidonia* rhizomes habitat (Monte Argentario, Grosseto)

9.1.2 The molluscan community

The species collected in the *Posidonia* rhizomes and their abundance are given in Tab. 81.

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
1	*Hanleya hanleyi*	MG [97]	0	0	0	1	0	0
2	*Callochiton septemvalvis*	MG [97]	0	0	0	1	0	0
3	*Chiton corallinus*	MG [97]	0	0	2	0	0	0
4	*Diodora* sp.	E [98]	0	0	0	1	0	0
5	*Emarginula punctulum*	E [99]	0	0	0	1	0	0
6	*Emarginula sicula*	E [99]	0	0	1	0	0	0
7	*Scissurella costata*	MG [100]	0	0	1	0	0	0
8	*Jujubinus exasperatus*	MG [101]	1	0	0	1	7	0
9	*Jujubinus striatus*	MG [102]	0	0	0	0	0	1
10	*Calliostoma conulum*	MG [14]	1	0	0	0	0	0
11	*Bolma rugosa*	MG [103]	1	0	1	4	2	2
12	*Homalopoma sanguineum*	MG [104]	3	6	1	1	0	0
13	*Tricolia tenuis*	MG [105]	0	0	0	1	0	2
14	*Smaragdia viridis*	SG [106]	0	0	0	0	1	2

[97] Dell'Angelo *et al.*, 2001

[98] Fretter *et al.*, 1976 for *Diodora apertura* (Montagu, 1803) [= *Diodora graeca*]

[99] Fretter *et al.*, 1976 for all congeneric species

[100] Fretter *et al.*, 1976 for the congeneric *Anatoma crispata* (Fleming, 1828) [*Scissurella*]

[101] Fretter *et al.*, 1977

[102] Peduzzi, 1987

[103] Beu *et al.*, 1979

[104] Due to the absence of specific references, it is hypothesized the same feeding guild of *Bolma rugosa*, despite they belong to different subfamilies, Colloniinae and Turbininae respectively, within Turbinidae.

[105] Fretter *et al.*, 1977 for *Tricolia pullus* (Linné, 1758)

[106] Rueda *et al.*, 2007

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
15	*Bittium latreillii*	MG [107]	6	19	34	20	4	3
16	*Bittium* sp. 1	MG [108]	1	1	1	3	0	0
17	*Bittium* sp. 2	MG [108]	0	1	0	0	0	0
18	*Turritella turbona*	F [109]	0	1	0	4	8	2
19	*Marshallora adversa*	E [110]	0	2	0	6	1	1
20	*Monophorus erythrosoma*	E [110]	0	0	1	1	0	0
21	*Monophorus perversus*	E [110]	0	0	0	0	0	1
22	*Obesula marisnostri*	E [110]	1	0	0	0	0	0
23	*Pogonodon pseudocanaricus*	E [110]	0	2	0	0	0	0
24	*Metaxia metaxae*	E [110]	1	0	1	3	2	0
25	*Cerithiopsis nana*	E [111]	2	1	1	3	0	0
26	*Cerithiopsis* sp. 1	E [111]	1	2	1	2	1	0
27	*Cerithiopsis* sp. 2	E [111]	0	0	0	1	0	0
28	*Cerithiopsis* sp. 3	E [111]	0	1	0	0	0	0
29	*Parvioris ibizenca*	E [112]	0	2	0	1	0	0
30	*Sticteulima jeffreysiana*	E [112]	0	0	0	1	0	0
31	*Rissoa violacea*	MG [113]	0	0	0	2	0	0
32	*Pusillina inconspicua*	MG [113]	1	0	0	0	0	0
33	*Alvania cancellata*	MG [113]	2	0	1	0	0	0
34	*Alvania hispidula*	MG [114]	2	0	0	0	0	0
35	*Alvania settepassii*	MG [114]	0	0	0	2	0	0
36	*Crepidula* sp.	F [115]	1	0	0	0	0	0
37	*Erosaria spurca*	E [116]	0	0	0	1	0	0
38	*Euspira pulchella*	C [117]	0	0	0	2	3	1
39	*Payraudeautia intricata*	C [117]	0	0	0	0	1	0
40	*Dermomurex scalaroides*	C [118]	0	0	2	0	0	1
41	*Ocinebrina aciculata*	C [119]	3	2	1	5	1	0
42	*Muricopsis aradasii*	C [118]	1	1	1	6	2	1
43	*Muricopsis cristata*	C [118]	8	4	7	13	2	6

[107] Russo *et al.*, 2002

[108] Fretter *et al.*, 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778)

[109] Fretter *et al.*, 1981 for the congeneric *Turritella communis* Risso, 1826.

[110] Bouchet, 1984.

[111] Fretter *et al.*, 1982 for the congeneric *Cerithiopsis tubercularis* (Montagu, 1803)

[112] Waren, 1983

[113] Fretter *et al.*, 1978

[114] Fretter *et al.*, 1978 for all congeneric species

[115] Fretter *et al.*, 1981 for the congeneric *Crepidula fornicata* (Linné, 1758) ”microphagous mucous feeder”

[116] Doneddu *et al.*, 1993 for *Luria lurida* (Linné, 1758)

[117] Fretter *et al.*, 1981 for all Naticidae.

[118] Fretter *et al*., 1981 for all Muricidae *sensu stricto* (excluding, for example, Coralliphilinae)

[119] Fretter *et al.*, 1984

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
44	*Coralliophila meyendorffii*	E [120]	0	1	0	0	0	0
45	*Mitra cornicula*	C [121]	1	0	1	0	0	0
46	*Vexillum ebenus*	C [122]	0	0	0	0	0	1
47	*Vexillum savignyi*	C [122]	0	0	0	1	2	0
48	*Vexillum tricolor*	C [122]	0	1	0	3	2	0
49	*Chauvetia* aff *brunnea*	C [119]	5	6	8	6	0	1
50	*Chauvetia recondita*	C [123]	0	1	2	3	0	0
51	*Pollia scabra*	C [124]	0	2	5	0	0	0
52	*Nassarius incrassatus*	SC [125]	5	2	9	7	3	0
53	*Mitrella gervillii*	C [126]	0	1	0	1	0	0
54	*Mitrella minor*	O [127]	0	2	0	3	1	0
55	*Mitrella scripta*	C [126]	0	0	0	1	2	0
56	*Fusinus pulchellus*	C [128]	3	3	1	6	2	1
57	*Mitromorpha karpathoensis*	C [129]	0	1	0	0	0	0
58	*Clathromangelia granum*	C [129]	1	1	0	0	0	0
59	*Mangelia scabrida*	C [129]	1	0	1	1	2	0
60	*Mangelia stossiciana*	C [129]	0	0	0	1	1	0
61	*Raphitoma concinna*	C [129]	0	0	0	0	1	0
62	*Raphitoma leufroyi*	C [129]	0	0	0	1	0	0
63	*Raphitoma linearis*	C [129]	4	1	6	3	1	5
64	*Raphitoma* sp. 1	C [129]	2	1	0	0	0	1
65	*Raphitoma* sp. 2	C [129]	0	0	0	1	0	0
66	*Raphitoma* sp. 4	C [129]	0	0	0	1	1	0
67	*Mathilda gemmulata*	E [121]	0	0	0	1	0	0
68	*Odostomella doliolum*	E [130]	0	0	1	0	0	0
69	*Ondina* sp.	E [130]	0	0	0	1	0	0
70	*Williamia gussonii*	AG [131]	0	0	0	0	0	1
71	*Nucula* sp.	D [132]	1	0	0	1	0	0

[120] Oliverio, 1989

[121] Beesley *et al.*, 1998 for Mitridae

[122] Beesley *et al.*, 1998 for Costellariidae

[123] Fretter *et al.*, 1984 for the congeneric *Chauvetia brunnea* (Donovan, 1804)

[124] Fretter *et al*., 1984 for all Buccinidae.

[125] Fretter *et al*., 1984

[126] Kantor *et al.*, 1991 for *Mitrella burchardi* (Dunker, 1877), Japan Sea

[127] Rueda *et al.*, 2009

[128] Beesley *et al*., 1998 for Fasciolariidae

[129] Fretter *et al*., 1984 for all "Turridae" *sensu lato*

[130] Fretter *et al.*, 1986 for Pyramidellacea

[131] Beesley *et al*., 1998 for Siphonariidae

[132] Beesley *et al*., 1998 for Nuculidae

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
72	*Barbatia barbata*	F [133]	1	3	1	2	0	0
73	*Striarca lactea*	F [133]	1	18	1	1	3	2
74	*Gregariella semigranata*	F [133]	1	0	0	0	0	1
75	*Dacrydium hyalinum*	F [133]	0	0	0	1	0	0
76	*Modiolula phaseolina*	F [133]	0	1	0	1	1	0
77	*Lima lima*	F [133]	0	2	0	0	0	0
78	*Kurtiella* sp.	F [134]	1	0	0	0	0	0
79	*Parvicardium scriptum*	F [135]	0	0	2	1	1	1
80	*Papillicardium papillosum*	F [135]	5	0	0	2	3	10
81	*Tellina tenuis*	D [136]	0	0	0	1	0	0
82	*Arcopagia balaustina*	D [136]	0	0	0	0	1	2
83	*Gari costulata*	D [136]	0	0	0	0	0	1
84	*Venus verrucosa*	F [137]	2	0	0	0	1	2
85	*Gouldia minima*	F [137]	3	1	3	10	7	10
86	*Hiatella arctica*	F [138]	1	0	2	1	0	0
87	*Thracia distorta*	F [139]	0	1	0	3	0	0
88	*Antalis vulgaris*	C [140]	0	0	0	0	0	1
	TOTAL NUMBER OF SPECIMENS		74	94	100	152	70	63

Tab. 81 – Quali-quantitative data of the *Posidonia* rhizomes samples, Secche di Tor Paterno

In terms of species diversity, the rhizomes host a great deal of species compared to the foliar layer. Finding species of the foliar layer in the rhizomes can also be due to the disturb of the sampling activity which makes molluscs retract into their shells and fall in the rhizomes.

The dendrogram in Fig. 32 shows that replicates in station 7 (SP1, SP2, SP3) cluster together, replicates SP4 and SP5 in station 9 cluster together too while replicate SP6 is different from all the others. The MDS in Fig. 33 gives a less clear view of the situation, despite replicate SP6 is again at the edges of the plot.

[133] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[134] Beesley *et al*., 1998 for Galeommatoidea

[135] Beesley *et al*., 1998 for the whole family Cardiidae

[136] Beesley *et al*., 1998 for the whole family Tellinidae, Psammobiidae (with the exception of the Eastern Pacific *Nuttallia nuttallii* (Conrad, 1837))

[137] Beesley *et al*., 1998 for the whole family Veneridae

[138] Gofas, 2009a

[139] Beesley *et al*., 1998 for Thracioidea

[140] Reynolds, 2002: "The Scaphopoda are marine infaunal carnivores that feed on foraminiferans and other microorganisms selected and manipulated by their unique feeding tentacles or captacula"

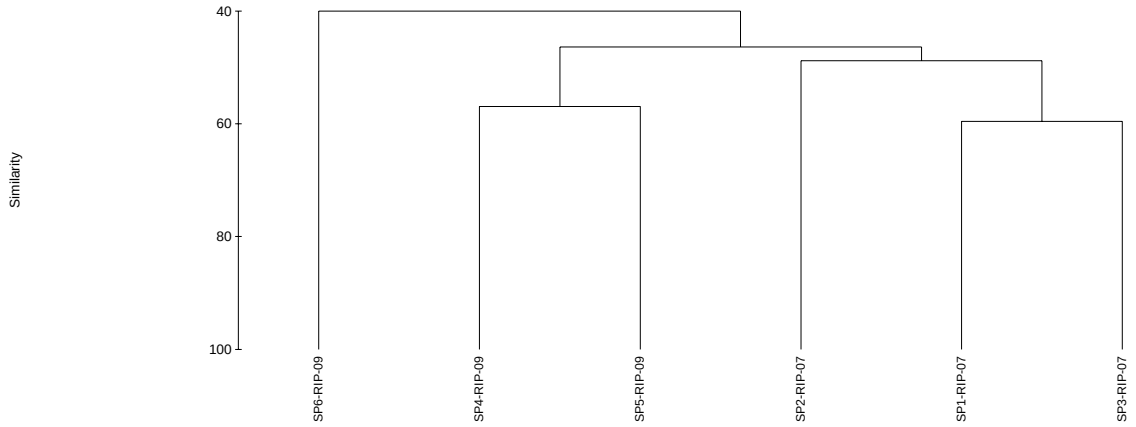


Fig. 32 – Dendrogram for hierarchical clustering of all replicates from rhizome layer of *Posidonia oceanica* stations (standardized data, square root transform, Bray-Curtis similarity coefficient, group-average linkage); replicates labels are evidenced

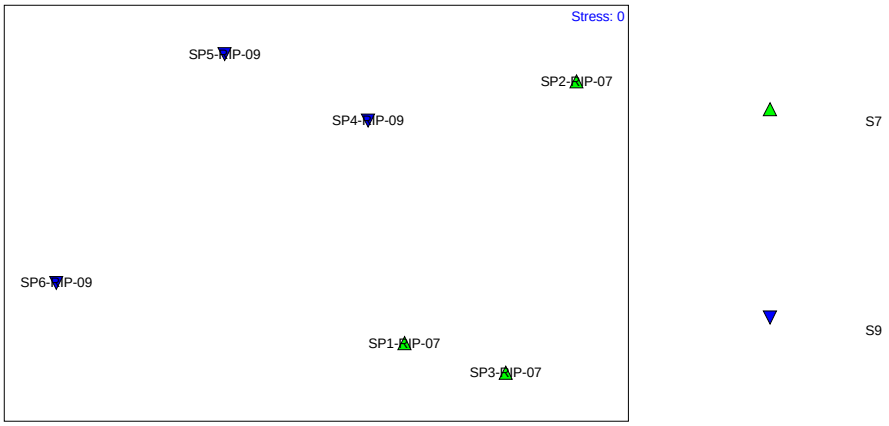


Fig. 33 - Non metric Multi-Dimensional Scaling plot of rhizome layer of *Posidonia oceanica* replicates (10 restarts), different symbols and colours represent different stations

Nor ANOSIM nor PERMANOVA (with Montecarlo simulations due to the low number of samples) tests indicate the two stations assemblages are statistically different ($p>0.05$).

Anyway, the analysis of data by the SIMPER routine confirms there are slight differences in the two stations (average dissimilarity 56.85) and helps in understanding which species contribute most to these differences (Tab. 82).

Species	**Station S7 Average Abundance**	**Station S9 Average Abundance**	**Average Dissimilarity**	**Diss/SD**	**Contribution to dissimilarity %**	**Cumulations of contributions to dissimilarity %**
Papillicardium papillosum *	0.87	2.40	1.95	1.44	3.43	3.43
Turritella turbona *	0.34	2.26	1.85	1.86	3.25	6.68
Bittium latreillii	4.39	2.73	1.81	1.40	3.18	9.87
Gouldia minima *	1.59	3.24	1.61	1.95	2.83	12.70
Chauvetia aff *brunnea* *	2.65	1.08	1.53	1.71	2.70	15.40

Species	Station S7 Average Abundance	Station S9 Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity %
Homalopoma sanguineum *	1.85	0.27	1.52	1.93	2.67	18.06
Euspira pulchella *	0.00	1.49	1.43	3.10	2.52	20.59
Striarca lactea	2.18	1.55	1.31	1.23	2.31	22.90
Jujubinus exasperatus	0.39	1.32	1.23	0.99	2.16	25.05
Nassarius incrassatus	2.35	1.41	1.23	1.22	2.16	27.21
Pollia scabra	1.23	0.00	1.21	1.23	2.12	29.33
Marshallora adversa	0.49	1.48	1.03	1.76	1.81	31.14
Tellina balaustina	0.00	0.99	1.00	1.24	1.76	32.90
Smaragdia viridis	0.00	0.99	1.00	1.24	1.76	34.65
Barbatia barbata	1.32	0.38	0.95	1.51	1.68	36.33
Bolma rugosa	0.72	1.70	0.94	1.74	1.65	37.98
Cerithiopsis nana	1.23	0.47	0.91	1.77	1.60	39.58
Venus verrucosa	0.55	0.99	0.89	1.17	1.57	41.15
Vexillum tricolor	0.34	1.03	0.86	1.33	1.51	42.67
Tricolia tenuis	0.00	0.86	0.84	1.05	1.48	44.15
Alvania cancellata	0.88	0.00	0.83	1.25	1.47	45.61
Bittium sp. 1	1.06	0.47	0.81	2.08	1.42	47.03
Raphitoma linearis	1.94	1.81	0.80	1.50	1.41	48.44
Parvicardium scriptum	0.47	1.09	0.79	1.83	1.39	49.83
Mitrella scripta	0.00	0.83	0.78	1.09	1.38	51.21
Vexillum savignyi	0.00	0.83	0.78	1.09	1.38	52.59
Ocinebrina aciculata	1.49	1.00	0.77	1.22	1.36	53.95
Metaxia metaxae	0.72	1.03	0.76	1.40	1.34	55.28
Raphitoma sp. 1	0.89	0.42	0.75	1.23	1.32	56.60
Hiatella arctica	0.86	0.27	0.75	1.28	1.31	57.92
Mitrella minor	0.49	0.87	0.73	1.15	1.28	59.20
Chauvetia recondita	0.82	0.47	0.72	1.14	1.27	60.47

Tab. 82 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the two stations in the rhizomes (the asterisk marks discriminating species on the basis of the Diss/SD value)

The species which most contribute to the dissimilarity are *Papillicardium papillosum*, *Turritella turbona*, *Gouldia minima* and *Euspira pulchella* which are more abundant in station 9. These are all infaunal species which find in the sediment where *Posidonia* settles in station 9 a more suitable environment than the hard substratum of station 7.

Also *Chauvetia* aff *brunnea* and *Homalopoma sanguineum* contribute to the dissimilarity, being species mainly found in station 7 where *Posidonia* is settled on a hard substratum.

Remarkably, the average similarity within stations is higher in station 7 (52.40) than in station 9 (48.90) despite the hard substratum where *Posidonia* is settled would have suggested a more heterogeneous habitat and therefore less homogeneity. This is consistent with the cluster diagram and MDS plot seen above and the responsibility of this pattern shall be searched for in replicate SP6.

So why SP6 is so out-lying? Replicate SP6 is the poorest sample (63 specimens). However, SP5 has 70 specimens and SP1 74, therefore the quantity of specimens collected is not the key here. The SIMPER ruoutine is of help for a qualitative discrimination analysis (Tab. 83, Tab. 84). It highlights that SP6 is

discriminated by a higher proportion of *Papillicardium papillosum*, *Arcopagia balaustina* and *Venus verrucosa* and the lack of *Nassarius incrassatus* and several other rare species like *Metaxia metaxae*, *Mitrella minor*, *Mitrella scripta*, *Vexillum tricolor*, etc. The presence of more bivalves may indicate a higher proportion of sediment in the sampled spot which is consistent with the lack of those rare species which are more typical of hard substrata. The absence of *Nassarius incrassatus* may be explained by its feeding guild: being a scavenger it concentrates in places where there is dead remnants for food.

Species	Station S7 Average Abundance	Station S9 Average Abundance	Average Dissimilarity	Diss/SD [141]	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity %
Papillicardium papillosum	1.15	3.98	2.50	-	4.10	4.10
Nassarius incrassatus	2.15	0.00	1.89	-	3.10	7.21
Ocinebrina aciculata	1.81	0.00	1.60	-	2.62	9.83
Tellina balaustina	0.00	1.78	1.57	-	2.58	12.40
Venus verrucosa	0.00	1.78	1.57	-	2.58	14.98
Smaragdia viridis	0.00	1.78	1.57	-	2.58	17.56
Bittium latreillii	3.63	2.18	1.28	-	2.09	19.65
Gouldia minima	2.56	3.98	1.25	-	2.05	21.70
Raphitoma linearis	1.40	2.82	1.25	-	2.04	23.74
Thracia distorta	1.40	0.00	1.24	-	2.03	25.77
Bittium sp. 1	1.40	0.00	1.24	-	2.03	27.80
Cerithiopsis nana	1.40	0.00	1.24	-	2.03	29.83
Chauvetia recondita	1.40	0.00	1.24	-	2.03	31.87
Metaxia metaxae	1.40	0.00	1.24	-	2.03	33.90
Mitrella minor	1.40	0.00	1.24	-	2.03	35.93
Vexillum tricolor	1.40	0.00	1.24	-	2.03	37.96
Gregariella semigranata	0.00	1.26	1.11	-	1.82	39.78
Psammobia costulata	0.00	1.26	1.11	-	1.82	41.60
Dermomurex scalaroides	0.00	1.26	1.11	-	1.82	43.42
Jujubinus striatus	0.00	1.26	1.11	-	1.82	45.25
Monophorus perversus	0.00	1.26	1.11	-	1.82	47.07
Raphitoma	0.00	1.26	1.11	-	1.82	48.89
Vexillum ebenus	0.00	1.26	1.11	-	1.82	50.71
Williamia gussonii	0.00	1.26	1.11	-	1.82	52.53
Dentalium vulgare	0.00	1.26	1.11	-	1.82	54.35
Barbatia barbata	1.15	0.00	1.01	-	1.66	56.01
Alvania settepassii	1.15	0.00	1.01	-	1.66	57.67
Cerithiopsis sp. 1	1.15	0.00	1.01	-	1.66	59.33
Rissoa violacea	1.15	0.00	1.01	-	1.66	60.99

Tab. 83 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the replicates SP4 and SP6 of station 9

[141] This analysis couldn't be performed because the analysis was done defining a factor with a level for each replicate.

Species	Station S7 Average Abundance	Station S9 Average Abundance	Average Dissimilarity	Diss/SD [142]	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity %
Jujubinus exasperatus	3.16	0.00	3.17	-	6.44	6.44
Nassarius incrassatus	2.07	0.00	2.08	-	4.21	10.65
Papillicardium papillosum	2.07	3.98	1.92	-	3.90	14.55
Tricolia tenuis	0.00	1.78	1.79	-	3.63	18.17
Mangelia sp. 1	1.69	0.00	1.69	-	3.44	21.61
Metaxia metaxae	1.69	0.00	1.69	-	3.44	25.05
Mitrella scripta	1.69	0.00	1.69	-	3.44	28.50
Vexillum savignyi	1.69	0.00	1.69	-	3.44	31.94
Vexillum tricolor	1.69	0.00	1.69	-	3.44	35.38
Raphitoma linearis	1.20	2.82	1.63	-	3.30	38.68
Turritella turbona	3.38	1.78	1.60	-	3.25	41.93
Muricopsis cristata	1.69	3.09	1.40	-	2.84	44.77
Gregariella semigranata	0.00	1.26	1.26	-	2.56	47.34
Psammobia costulata	0.00	1.26	1.26	-	2.56	49.90
Chauvetia aff *brunnea*	0.00	1.26	1.26	-	2.56	52.47
Dermomurex scalaroides	0.00	1.26	1.26	-	2.56	55.03
Jujubinus striatus	0.00	1.26	1.26	-	2.56	57.60
Monophorus perversus	0.00	1.26	1.26	-	2.56	60.16

Tab. 84 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the replicates SP5 and SP6 of station 9

9.1.3 Mollusca community structure

By a population structure point of view, species richness along replicates varies from 27 to 54. Shannon diversity index (H') ranges from 2.616 to 3.532 and evenness (J') ranges from 0.769 to 0.925 (Tab. 127).

Replicate[143]	S	H'	J'
SP1-RIP-07	34	3.261	0.925
SP2-RIP-07	33	2.904	0.831
SP3-RIP-07	30	2.616	0.769
SP4-RIP-09	54	3.532	0.885
SP5-RIP-09	31	3.176	0.925
SP6-RIP-09	27	2.907	0.882

Tab. 85 – Biodiversity indices values for *Posidonia* rhizomes samples, Secche di Tor Paterno

Diversity and equitability indices are influenced by dominance phenomena (Tab. 86, see Tab. 87 for a synthesis). The high values of the Shannon index and of the evenness index suggest there are not strong dominance phenomena. The analysis of species dominance confirm this.

[142] This analysis couldn't be performed because the analysis was done defining a factor with a level for each replicate.

[143] Here replicates are coded in this way: first the replicate code, then the biocoenosis code and last the station code. For example, sample S1-COR-01 is the sample S1 collected in the coralligenous biocoenosis in station 01

Only *Bittium latreillii* attains a dominance of 34.0% in a single sample (SP3), but in the other replicates its dominance decreases to 20.2% (SP2), 13.2% (SP4) and the below 10% (SP1, SP5, SP6). *B. latreillii* is the dominant species in only 3 replicates.

Some filter-feeder bivalves have high dominance values in sample SP6: *Papillicardium papillosum* and *Gouldia minima*, both with 15.9%.

The predator species *Muricopsis cristata* is the dominant species in sample SP1 (10.8%) and it is also present in good percentage in samples SP4 (8.6%) and SP6 (9.5%).

Remarkably, the dominant species across samples varies widely both taxonomically and by a trophic point of view. This is consistent with an environment characterized by high species diversity and habitat heterogeneity. Moreover, samples SP5 and SP6 have a high percentage of species typical of soft substrata (*Turritella turbona*, *Papillicardium papillosum*, *Gouldia minima*) while samples SP1, SP2 and SP3 have a higher percentage of species usually associated to firm substrata like *Bittium latreillii*, *Muricopsis cristata*, *Striarca lactea*. This supports the idea that the rhizome environment hosts heterogeneous populations and that some differences depend on the substratum where *Posidonia* is settled.

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
1	*Hanleya hanleyi*	MG	-	-	-	0.7%	-	-
2	*Callochiton septemvalvis*	MG	-	-	-	0.7%	-	-
3	*Chiton corallinus*	MG	-	-	2.0%	-	-	-
4	*Diodora* sp.	E	-	-	-	0.7%	-	-
5	*Emarginula punctulum*	E	-	-	-	0.7%	-	-
6	*Emarginula sicula*	E	-	-	1.0%	-	-	-
7	*Scissurella costata*	MG	-	-	1.0%	-	-	-
8	*Jujubinus exasperatus*	MG	1.4%	-	-	0.7%	10.0%	-
9	*Jujubinus striatus*	MG	-	-	-	-	-	1.6%
10	*Calliostoma conulum*	MG	1.4%	-	-	-	-	-
11	*Bolma rugosa*	MG	1.4%	-	1.0%	2.6%	2.9%	3.2%
12	*Homalopoma sanguineum*	MG	4.1%	6.4%	1.0%	0.7%	-	-
13	*Tricolia tenuis*	MG	-	-	-	0.7%	-	3.2%
14	*Smaragdia viridis*	SG	-	-	-	-	1.4%	3.2%
15	*Bittium latreillii*	MG	8.1%	20.2%	34.0%	13.2%	5.7%	4.8%
16	*Bittium* sp. 1	MG	1.4%	1.1%	1.0%	2.0%	-	-
17	*Bittium* sp. 2	MG	-	1.1%	-	-	-	-

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
18	*Turritella turbona*	F	-	1.1%	-	2.6%	11.4%	3.2%
19	*Marshallora adversa*	E	-	2.1%	-	3.9%	1.4%	1.6%
20	*Monophorus erythrosoma*	E	-	-	1.0%	0.7%	-	-
21	*Monophorus perversus*	E	-	-	-	-	-	1.6%
22	*Obesula marisnostri*	E	1.4%	-	-	-	-	-
23	*Pogonodon pseudocanaricus*	E	-	2.1%	-	-	-	-
24	*Metaxia metaxae*	E	1.4%	-	1.0%	2.0%	2.9%	-
25	*Cerithiopsis nana*	E	2.7%	1.1%	1.0%	2.0%	-	-
26	*Cerithiopsis* sp. 1	E	1.4%	2.1%	1.0%	1.3%	1.4%	-
27	*Cerithiopsis* sp. 2	E	-	-	-	0.7%	-	-
28	*Cerithiopsis* sp. 3	E	-	1.1%	-	-	-	-
29	*Parvioris ibizenca*	E	-	2.1%	-	0.7%	-	-
30	*Sticteulima jeffreysiana*	E	-	-	-	0.7%	-	-
31	*Rissoa violacea*	MG	-	-	-	1.3%	-	-
32	*Pusillina inconspicua*	MG	1.4%	-	-	-	-	-
33	*Alvania cancellata*	MG	2.7%	-	1.0%	-	-	-
34	*Alvania hispidula*	MG	2.7%	-	-	-	-	-
35	*Alvania settepassii*	MG	-	-	-	1.3%	-	-
36	*Crepidula* sp.	F	1.4%	-	-	-	-	-
37	*Erosaria spurca*	E	-	-	-	0.7%	-	-
38	*Euspira pulchella*	C	-	-	-	1.3%	4.3%	1.6%
39	*Payraudeautia intricata*	C	-	-	-	-	1.4%	-
40	*Dermomurex scalaroides*	C	-	-	2.0%	-	-	1.6%
41	*Ocinebrina aciculata*	C	4.1%	2.1%	1.0%	3.3%	1.4%	-
42	*Muricopsis aradasii*	C	1.4%	1.1%	1.0%	3.9%	2.9%	1.6%
43	*Muricopsis cristata*	C	10.8%	4.3%	7.0%	8.6%	2.9%	9.5%
44	*Coralliophila meyendorffii*	E	-	1.1%	-	-	-	-
45	*Mitra cornicula*	C	1.4%	-	1.0%	-	-	-
46	*Vexillum ebenus*	C	-	-	-	-	-	1.6%
47	*Vexillum savignyi*	C	-	-	-	0.7%	2.9%	-
48	*Vexillum tricolor*	C	-	1.1%	-	2.0%	2.9%	-
49	*Chauvetia* aff *brunnea*	C	6.8%	6.4%	8.0%	3.9%	-	1.6%
50	*Chauvetia recondita*	C	-	1.1%	2.0%	2.0%	-	-
51	*Pollia scabra*	C	-	2.1%	5.0%	-	-	-
52	*Nassarius incrassatus*	SC	6.8%	2.1%	9.0%	4.6%	4.3%	-
53	*Mitrella gervillii*	C	-	1.1%	-	0.7%	-	-
54	*Mitrella minor*	O	-	2.1%	-	2.0%	1.4%	-
55	*Mitrella scripta*	C	-	-	-	0.7%	2.9%	-
56	*Fusinus pulchellus*	C	4.1%	3.2%	1.0%	3.9%	2.9%	1.6%
57	*Mitromorpha karpathoensis*	C	-	1.1%	-	-	-	-
58	*Clathromangelia granum*	C	1.4%	1.1%	-	-	-	-
59	*Mangelia scabrida*	C	1.4%	-	1.0%	0.7%	2.9%	-

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
60	*Mangelia stossiciana*	C	-	-	-	0.7%	1.4%	-
61	*Raphitoma concinna*	C	-	-	-	-	1.4%	-
62	*Raphitoma leufroyi*	C	-	-	-	0.7%	-	-
63	*Raphitoma linearis*	C	5.4%	1.1%	6.0%	2.0%	1.4%	7.9%
64	*Raphitoma* sp. 1	C	2.7%	1.1%	-	-	-	1.6%
65	*Raphitoma* sp. 2	C	-	-	-	0.7%	-	-
66	*Raphitoma* sp. 4	C	-	-	-	0.7%	1.4%	-
67	*Mathilda gemmulata*	E	-	-	-	0.7%	-	-
68	*Odostomella doliolum*	E	-	-	1.0%	-	-	-
69	*Ondina* sp.	E	-	-	-	0.7%	-	-
70	*Williamia gussonii*	AG	-	-	-	-	-	1.6%
71	*Nucula* sp.	D	1.4%	-	-	0.7%	-	-
72	*Barbatia barbata*	F	1.4%	3.2%	1.0%	1.3%	-	-
73	*Striarca lactea*	F	1.4%	19.1%	1.0%	0.7%	4.3%	3.2%
74	*Gregariella semigranata*	F	1.4%	-	-	-	-	1.6%
75	*Dacrydium hyalinum*	F	-	-	-	0.7%	-	-
76	*Modiolula phaseolina*	F	-	1.1%	-	0.7%	1.4%	-
77	*Lima lima*	F	-	2.1%	-	-	-	-
78	*Kurtiella* sp.	F	1.4%	-	-	-	-	-
79	*Parvicardium scriptum*	F	-	-	2.0%	0.7%	1.4%	1.6%
80	*Papillicardium papillosum*	F	6.8%	-	-	1.3%	4.3%	15.9%
81	*Tellina tenuis*	D	-	-	-	0.7%	-	-
82	*Arcopagia balaustina*	D	-	-	-	-	1.4%	3.2%
83	*Gari costulata*	D	-	-	-	-	-	1.6%
84	*Venus verrucosa*	F	2.7%	-	-	-	1.4%	3.2%
85	*Gouldia minima*	F	4.1%	1.1%	3.0%	6.6%	10.0%	15.9%
86	*Hiatella arctica*	F	1.4%	-	2.0%	0.7%	-	-
87	*Thracia distorta*	F	-	1.1%	-	2.0%	-	-
88	*Antalis vulgaris*	C	-	-	-	-	-	1.6%

Tab. 86 – Species dominance in the *Posidonia* rhizomes samples, Secche di Tor Paterno

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
8	*Jujubinus exasperatus*	MG	1.4%	-	-	0.7%	10.0%	-
15	*Bittium latreillii*	MG	8.1%	20.2%	34.0%	13.2%	5.7%	4.8%
18	*Turritella turbona*	F	-	1.1%	-	2.6%	11.4%	3.2%
43	*Muricopsis cristata*	C	10.8%	4.3%	7.0%	8.6%	2.9%	9.5%
49	*Chauvetia* aff *brunnea*	C	6.8%	6.4%	8.0%	3.9%	-	1.6%
52	*Nassarius incrassatus*	SC	6.8%	2.1%	9.0%	4.6%	4.3%	-

		Diet	Station 7			Station 9		
			SP1	SP2	SP3	SP4	SP5	SP6
63	*Raphitoma linearis*	C	5.4%	1.1%	6.0%	2.0%	1.4%	7.9%
73	*Striarca lactea*	F	1.4%	19.1%	1.0%	0.7%	4.3%	3.2%
80	*Papillicardium papillosum*	F	6.8%	-	-	1.3%	4.3%	15.9%
85	*Gouldia minima*	F	4.1%	1.1%	3.0%	6.6%	10.0%	15.9%

Tab. 87 – Species dominance in the *Posidonia* rhizomes samples, Secche di Tor Paterno, synthesis of the most dominant species (maximum dominance near to or over 8%)

	Station 7			Station 9		
	SP1	SP2	SP3	SP4	SP5	SP6
1st dominant species	*Muricopsis cristata* (C)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Turritella turbona* (F)	*Papillicardium papillosum* (F) *Gouldia minima* (F)
2nd dominant species	*Bittium latreillii* (MG)	*Striarca lactea* (F)	*Nassarius incrassatus* (SC)	*Muricopsis cristata* (C)	*Jujubinus exasperatus* (MG) *Gouldia minima* (F)	*Muricopsis cristata* (C)

Tab. 88 – Comparative table of dominant species in different replicates

The analysis of feeding guilds (Tab. 89) shows a balanced pattern between the most abundant groups: carnivores on mobile prey, microalgae herbivores and filter-feeders. They have all high percentages and are between the dominant guilds in all samples. Remarkably, in the samples SP5 and SP6 filter-feeders are the dominant group while microalgae herbivores have low abundance, confirming that the spots were strongly influenced by a higher percentage of soft substratum. It is important to highlight the high frequency of ectoparasites and carnivores on preys without mobility. None of these species have a high frequency, but all together they represent a high percentage of the community. This is due to their feeding specialization and constitute an important element of the biodiversity of the community representing up to 24.1% of the species richness (Tab. 91). If both types of carnivores are pooled, they would represent the dominant group in most samples with the exception of SP6 where the soft substratum conditions allow a higher proportion of filter feeders.

Other feeding guilds whose presence is not negligible are scavengers which are up to 9% of the community (sample SP3). Their presence is scattered and connected to a single species: *Nassarius incrassatus*. Egg and spawn feeders are present with the only species *Mitrella minor* and abundance up to 2%. Deposit feeders have a more balanced presence in the samples (4 have them) but with low abundance (from 1.3-1.4% in 3 samples while the sample SP6 has a 4.8%, again confirming the soft substratum affinity of the spot of this replicate).

Negligible the presence of herbivores of macroalgae (present in two replicates, 3.6% in SP6) and of seagrass (again present in two replicates up to 3.2%).

No symbiont-bearing species were found in this environment, which is surprising since these species are infaunal bivalves (Lucinidae, Thyasiridae) which may find in the sediment enclaves of this biocoenosis a suitable habitat, while they are present in the coralligenous.

\		Station 7			Station 9		
		SP1	SP2	SP3	SP4	SP5	SP6
SC	Scavengers	6.8%	2.1%	9.0%	4.6%	4.3%	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	-	-	1.6%

\		Station 7			Station 9		
		SP1	**SP2**	**SP3**	**SP4**	**SP5**	**SP6**
MG	Microalgae herbivores	24.3%	28.7%	41.0%	23.7%	18.6%	12.7%
SG	Seagrass-feeding herbivores	-	-	-	-	1.4%	3.2%
D	Deposit feeders	1.4%	-	-	1.3%	1.4%	4.8%
F	Filter feeders	21.6%	28.7%	9.0%	17.1%	34.3%	44.4%
SY	Symbiont-bearing species	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	6.8%	11.7%	6.0%	15.1%	5.7%	3.2%
C	Carnivores on mobile prey	39.2%	26.6%	35.0%	36.2%	32.9%	30.2%
O	Egg and spawn feeders	-	2.1%	-	2.0%	1.4%	-
	1st dominant guild	C	MG, F	MG	C	F	F
	2nd dominant guild	MG	C	C	MG	C	C
	1st dominant guild if C and E guilds are pooled	C+E	C+E	C+E, F	C+E	C+E	F
Carnivorous/ microalgae herbivores ratio		1.6	0.9	0.9	1.5	1.8	2.4

Tab. 89 – Feeding guilds dominance in the *Posidonia* rhizomes samples, Secche di Tor Paterno

\		Station 7			Station 9		
		SP1	**SP2**	**SP3**	**SP4**	**SP5**	**SP6**
SC	Scavengers	2.9%	3.0%	3.3%	1.9%	3.2%	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	-	-	3.7%
MG	Microalgae herbivores	26.5%	12.1%	23.3%	18.5%	9.7%	14.8%
SG	Seagrass-feeding herbivores	-	-	-	-	3.2%	3.7%
D	Deposit feeders	2.9%	-	-	3.7%	3.2%	7.4%
F	Filter feeders	26.5%	21.2%	16.7%	18.5%	22.6%	25.9%
SY	Symbiont-bearing species	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	11.8%	21.2%	2-	24.1%	9.7%	7.4%
C	Carnivores on mobile prey	29.4%	39.4%	36.7%	31.5%	45.2%	37.0%
O	Egg and spawn feeders	-	3.0%	-	1.9%	3.2%	-

Tab. 90 – Number of species *per* feeding guilds in the *Posidonia* rhizomes samples, Secche di Tor Paterno

9.1.4 Comparison with other data sets

Data from Secche di Tor Paterno have been compared with other data sets.

	Locality	Depth	Sampling technique	Date	Data source
1	Secche della Meloria (Livorno)	-4 m	Air-lift suction sampler, 0.25 × 0.25 m per replicate, without defoliation	October 1988	Castriota, 1989
2	Elba Isl., Baia di Fetovaia	-5 m and -12 m	Air-lift suction sampler, 1 m^2 per replicate, with defoliation	June 2002	B. Sabelli unpublished data
3	Giglio Isl, Campese	-9 m	Air-lift suction sampler, 1 m^2 per replicate, with defoliation	March 1992	Bonfitto *et al.*, 1998
5	Croatia, Hvrgada Isl.	-4 m and -11 m	Air-lift suction sampler, 1 m^2 per replicate, with defoliation	July 2000	Solustri *et al.*, 2002

Tab. 91 – Data sets for comparison of Secche di Tor Paterno *Posidonia* rhizomes assemblage

Fig. 34 – Location of comparison data sets (cfr. Tab. 91)

These data sets represent several stations at different latitudes in the same Tyrrhenian basin of Secche di Tor Paterno (Secche della Meloria, Elba, Giglio) and in the Adriatic Sea (Croatia, Hrvgada Isl.). Unfortunately,

unlike in the case of the foliar layer, there is not a work on rhizomes comparable to the one by Idato *et al.* (1983) on leaves with samples along a depth gradient.

Samples were collected at different depths: shallow water stations at -4/5 m were sampled in Secche della Meloria, Elba Isl., and Croatia; moderately deep water stations at -9/12 m were sampled at Elba Isl., Giglio Isl., and Croatia, while there are no samples taken at the same depth of Secche di Tor Paterno.

The sampling technique was the same in terms of devices used, an air-lift suction sampler, but different in terms of the sampled area: 1 m^2 in Elba Isl., Giglio Isl., Croatia and Secche di Tor Paterno, while in Secche della Meloria a considerably smaller area was sampled for each replicate: 0.25 m^2. Data of the latter locality will be discussed considering this bias.

Another important factor about sampling is whether the area was defoliated or not before air-lift sampling since Bonfitto *et al.* (1998) showed that results are different in the two cases (and richer with defoliation). The sampled area was defoliated in Secche di Tor Paterno, Elba Isl., Giglio Isl. (sample S-B) and Croatia while it was not defoliated in Secche della Meloria, Giglio Isl. (sample S-A).

Samples were collected in different periods of the year: Giglio was sampled in spring, Elba and Croatia in summer, Secche della Meloria in autumn. The different seasons may affect the sampled species assemblage both qualitatively (because of species seasonality) and quantitatively (different recruitment periods). Russo *et al*. (1984) suggest that the molluscan species assemblages of *Posidonia* leaves are under the control of climatic factors related to depth and apparently independent of the season, however there are not similar studies for the rhizome layer and therefore the bias cannot be evaluated.

In all localities *Posidonia* is settled on a sedimentary substratum while in Secche di Tor Paterno station 9 only is on a sedimentary area while station 7 is on hard substratum covered by coralligenous concretions.

Data sets are reported in annexes 2, 3, 4 and 6. Taxonomy has not been updated, unless useful for discussion.

9.1.4.1 Secche della Meloria (Livorno)

The species collected in the *Posidonia* rhizomes and their abundance are given in Tab. 92. All replicates come from a meadow at 4 m deep. Sampling was carried out by air-lift suction sampler on a 0.25 × 0.25 m area per replicate without defoliation in October 1988.

		Diet	S_A	S_B	S_C
1	*Jujubinus exasperatus*	MG [144]	5	1	4
2	*Gibbula umbilicaris*	MG [145]	2	0	0
3	*Calliostoma laugieri*	MG [14]	2	0	0
4	*Tricolia pullus*	MG [146]	0	1	0
5	*Rissoa auriscalpium*	MG [147]	1	1	0
6	*Rissoa guerinii*	MG [148]	0	1	0
7	*Rissoa similis*	MG [47]	0	0	1
8	*Alvania cimex*	MG [149]	4	0	0
9	*Alvania geryonia*	MG [149]	1	0	0
10	*Alvania pagodula*	MG [149]	1	0	0
11	*Bittium reticulatum* [150]	MG [151]	4	8	1

[144] Fretter *et al*., 1977

[145] Fretter *et al*., 1977 for all congeneric species.

[146] Fretter *et al*., 1977

[147] Fretter *et al*., 1978 for the congeneric *Rissoa violacea* Desmarest, 1814.

[148] Fretter *et al*., 1978.

[149] Fretter *et al*., 1978 for all congeneric species.

[150] Misidentification of *Bittium latreillii* Payraudeau, 1826.

		Diet	S_A	S_B	S_C
12	*Nassarius incrassatus*	SC [152]	11	1	1
13	*Limea loscombi*	F [133]	1	0	0
14	*Mysella bidentata*	F [153]	0	1	0
15	*Cardita calyculata*	F [154]	1	2	0
16	*Glans trapezia*	F [154]	0	2	0
17	*Venericardia antiquata*	F [154]	5	0	0
18	*Parvicardium ovale*	F [155]	3	1	0
19	*Plagiocardium papillosum*	F [155]	1	1	0
20	*Venus verrucosa*	F [156]	2	1	0
21	*Gouldia minima*	F [156]	1	0	0
22	*Hiatella arctica*	F [157]	0	1	0
23	*Thracia distorta*	F [158]	0	1	0
	TOTAL NUMBER OF SPECIMENS		45	23	7

Tab. 92 – Quali-quantitative data of the *Posidonia* rhizomes samples, Secche della Meloria (Livorno)

By a population structure point of view, species richness along replicates varies from 4 to 16 with Shannon diversity index (H') ranging from 1.154 to 2.451 and evenness (J') ranging from 0.832 to 0.884.

Replicate	S	H'	J'
S_A	16	2.451	0.884
S_B	14	2.292	0.868
S_C	4	1.154	0.832

Tab. 93 – Biodiversity indices values for *Posidonia* rhizomes samples, Secche della Meloria

Diversity and equitability indices are influenced by dominance phenomena (Tab. 94). Sample A has *Nassarius incrassatus* as dominant species with 24.4% of specimens. Sample B has *Bittium latreillii* as dominant species with 34.8% of specimens. Sample C is a very poor sample with only 7 specimens and the dominant species is *Jujubinus exasperatus* with 57.1%.

		Diet	S_A	S_B	S_C
1	*Jujubinus exasperatus*	MG	11.1%	4.3%	57.1%
2	*Gibbula umbilicaris*	MG	4.4%	-	-
3	*Calliostoma laugieri*	MG	4.4%	-	-
4	*Tricolia pullus*	MG	-	4.3%	-
5	*Rissoa auriscalpium*	MG	2.2%	4.3%	-

[151] Russo *et al*., 2002.

[152] Fretter *et al*., 1984

[153] Beesley *et al*., 1998 for Galeommatoidea

[154] In the absence of specific references we assume the typical feeding guild of bivalves: filter-feeding.

[155] Beesley *et al*., 1998 for the whole family Cardiidae

[156] Beesley *et al*., 1998 for the whole family Veneridae

[157] Gofas, 2009a

[158] Beesley *et al*., 1998 for Thracioidea

		Diet	S_A	S_B	S_C
6	*Rissoa guerinii*	MG	-	4.3%	-
7	*Rissoa similis*	MG	-	-	14.3%
8	*Alvania cimex*	MG	8.9%	-	-
9	*Alvania geryonia*	MG	2.2%	-	-
10	*Alvania pagodula*	MG	2.2%	-	-
11	*Bittium reticulatum* [159]	MG	8.9%	34.8%	14.3%
12	*Nassarius incrassatus*	SC	24.4%	4.3%	14.3%
13	*Limea loscombi*	F	2.2%	-	-
14	*Mysella bidentata*	F	-	4.3%	-
15	*Cardita calyculata*	F	2.2%	8.7%	-
16	*Glans trapezia*	F	-	8.7%	-
17	*Venericardia antiquata*	F	11.1%	-	-
18	*Parvicardium ovale*	F	6.7%	4.3%	-
19	*Plagiocardium papillosum*	F	2.2%	4.3%	-
20	*Venus verrucosa*	F	4.4%	4.3%	-
21	*Gouldia minima*	F	2.2%	-	-
22	*Hiatella arctica*	F	-	4.3%	-
23	*Thracia distorta*	F	-	4.3%	-

Tab. 94 – Species dominance in the *Posidonia* rhizomes samples, Secche della Meloria

	S_A	S_B	S_C
1st dominant species	*Nassarius incrassatus* (SC)	*Bittium latreillii* (MG)	*Jujubinus exasperatus* (MG)
2nd dominant species	*Jujubinus exasperatus* (MG) *Venericardia antiquata* (F)	*Cardita calyculata* (F) *Glans trapezia* (F)	All other 4 species

Tab. 95 – Comparative table of dominant species in different replicates

Feeding guild analysis (Tab. 96) suggests that microalgae herbivores are the dominant group (from 44.4% in sample A to 85.7% in sample C) but filter feeders are very well represented too with 31.1% in sample A and 43.5% in sample B, however, they are absent from sample C. Scavengers represent the last group with dominance ranging from 4.3% in sample B to 24.4% in sample A. The ratio between carnivores and microalgae herbivores is zero since no carnivores are present.

In terms of number of species (Tab. 97), the pattern is similar with a dominance of microalgae herbivores, a good number of filter feeders and scavengers as the last group.

		S_A	S_B	S_C
SC	Scavengers	24.4%	4.3%	14.3%
AG	Herbivores of macroalgae and epiphytes	-	-	-

[159] Misidentification of *Bittium latreillii* Payraudeau, 1826.

		S_A	S_B	S_C
MG	Microalgae herbivores	44.4%	52.2%	85.7%
SG	Seagrass-feeding herbivores	-	-	-
D	Deposit feeders	-	-	-
F	Filter feeders	31.1%	43.5%	-
SY	Symbiont-bearing species	-	-	-
E	Ectoparasites and carnivores on preys without mobility	-	-	-
C	Carnivores on mobile prey	-	-	-
O	Egg and spawn feeders	-	-	-
	1st dominant guild	MG	MG	MG
	2nd dominant guild	F	F	SC
	1st dominant guild if C and E guilds are pooled	MG	MG	MG
Carnivorous/ microalgae herbivores ratio		0	0	0

Tab. 96 – Feeding guilds dominance in the *Posidonia* rhizomes samples, Secche della Meloria

		S_A	S_B	S_C
SC	Scavengers	6.3%	7.1%	25.0%
AG	Herbivores of macroalgae and epiphytes	-	-	-
MG	Microalgae herbivores	50.0%	35.7%	75.0%
SG	Seagrass-feeding herbivores	-	-	-
D	Deposit feeders	-	-	-
F	Filter feeders	43.8%	57.1%	-
SY	Symbiont-bearing species	-	-	-
E	Ectoparasites and carnivores on preys without mobility	-	-	-
C	Carnivores on mobile prey	-	-	-
O	Egg and spawn feeders	-	-	-

Tab. 97 – Number of species *per* feeding guilds in the *Posidonia* rhizomes samples, Secche della Meloria

9.1.4.2 Elba Isl.

The species collected in the *Posidonia* rhizomes and their abundance are given in Tab. 98. Two stations were sampled at -5 m and -12 m, with three replicates each. Sampling was carried out by air-lift suction sampler on a 1 m^2 area per replicate with defoliation in June 2002.

		Diet	S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
1	*Lepidopleurus cajetanus*	MG [160]	1	0	0	0	0	0
2	*Scissurella costata*	MG [161]	1	0	0	0	0	0
3	*Emarginula pustula*	E [162]	0	0	0	0	1	0
4	*Gibbula umbilicaris*	MG [163]	0	0	0	0	0	1
5	*Jujubinus exasperatus*	MG [164]	8	3	8	20	11	14
6	*Clanculus corallinus*	MG [165]	0	0	0	2	0	0
7	*Clanculus jussieui*	MG [165]	0	0	0	1	0	0
8	*Calliostoma laugieri*	MG [14]	0	0	1	0	0	0
9	*Tricolia pullus*	MG [166]	40	25	38	37	10	9
10	*Tricolia speciosa*	MG [167]	18	19	9	6	4	3
11	*Bittium jadertinum*	MG [168]	4	3	4	5	3	2
12	*Bittium latreilli*	MG [169]	103	72	98	259	39	24
13	*Rissoa auriscalpium*	MG [170]	51	32	22	13	20	10
14	*Rissoa ventricosa*	MG [171]	0	0	1	0	1	1
15	*Rissoa violacea*	MG [172]	0	0	0	0	0	1
16	*Alvania cimex*	MG [173]	18	9	45	101	14	0
17	*Alvania lineata*	MG [173]	10	5	25	0	0	0
18	*Alvania montagui*	MG [173]	4	4	15	2	1	0
19	*Pusillina radiata*	MG [174]	1	1	3	1	0	2
20	*Rissoina bruguierei*	MG [175]	0	0	1	3	0	0
21	*Polinices nitida*	C [176]	0	0	0	2	0	1

[160] Dell'Angelo *et al.*, 2001

[161] Fretter *et al.*, 1976 for the congeneric *Anatoma crispata* (Fleming, 1828) [*Scissurella*]

[162] Fretter *et al.*, 1976 for all congeneric species

[163] Fretter *et al*., 1977 for all congeneric species

[164] Fretter *et al*., 1977

[165] Beesley *et al*., 1998 for Trochinae

[166] Fretter *et al*., 1977

[167] Fretter *et al*., 1977 for *Tricolia pullus* (Linné, 1758)

[168] Fretter *et al.*, 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778)

[169] Russo *et al*., 2002.

[170] Fretter *et al*., 1978 for the congeneric *Rissoa violacea* Desmarest, 1814.

[171] Fretter *et al*., 1978 for other congeneric species.

[172] Fretter *et al*., 1978.

[173] Fretter *et al*., 1978 for all congeneric species.

[174] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[175] Beesley *et al*., 1998 for Rissoidae

[176] Fretter *et al.*, 1981 for all Naticidae

		Diet	S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
22	*Eulima* cfr. *subulata*	E [177]	0	1	0	0	0	0
23	*Parvioris ibizenca*	E [177]	0	0	1	3	1	1
24	*Vitreolina philippii*	E [178]	0	1	0	0	0	0
25	Triphoridae	E [179]	0	1	1	12	1	0
26	*Phyllonotus trunculus*	C [180]	0	0	1	0	0	0
27	*Typhis sowerbyi*	C [181]	2	3	0	0	0	0
28	*Nassarius incrassatus*	SC [182]	2	0	11	15	1	1
29	*Pusia tricolor*	C [183]	0	0	1	0	0	0
31	*Gibberula miliaria*	C [184]	1	0	1	4	3	1
32	*Haedropleura secalina*	C [185]	0	0	0	0	0	1
33	*Mangilia albida*	C [185]	1	1	0	0	0	0
34	*Mangilia* sp 1	C [185]	0	0	0	0	0	1
35	*Mangilia* sp 2	C [185]	0	0	0	0	1	0
36	*Raphitoma bicolor*	C [185]	0	0	0	3	0	1
37	*Raphitoma linearis*	C [185]	0	0	0	3	3	1
38	*Leufroya leufroyi*	C [185]	0	0	0	0	2	0
39	*Chrysallida dolium*	E [186]	0	0	1	0	0	0
40	*Chrysallida excavata*	E [187]	0	0	0	1	0	0
41	*Odostomia conoidea*	E [187]	0	0	1	1	0	0
42	*Turbonilla scalaris*	E [187]	0	0	0	1	1	0
43	*Turbonilla rufa*	E [188]	0	0	0	0	2	1
44	*Nucula nucleus*	D [189]	0	0	0	0	0	1
45	*Navicula noae*	F [190]	0	0	3	2	0	0
46	*Barbatia barbata*	F [190]	0	0	1	2	0	0
47	*Striarca lactea*	F [190]	3	1	1	23	4	3
48	*Musculus subpictus*	F [190]	1	0	2	1	1	0
49	*Cardita trapezia*	F [191]	14	12	10	29	8	8

[177] Waren, 1983

[178] Fretter *et al.*, 1982; Mifsud, 1991

[179] Bouchet, 1984

[180] Peharda *et al.*, 2006

[181] Fretter *et al*., 1981 for all Muricidae *sensu stricto* (excluding, for example, Coralliphilinae)

[182] Fretter *et al*., 1984

[183] Beesley *et al.*, 1998 for the entire family

[184] Beesley *et al*., 1998 for "marginellids" (Marginellidae and Cystiscidae)

[185] Fretter *et al*., 1984 for all "Turridae" *sensu lato*

[186] Fretter *et al.*, 1986 for Pyramidellacea

[187] Fretter *et al.*, 1986

[188] Fretter *et al.*, 1986 for Pyramidellacea

[189] Beesley *et al*., 1998 for Nuculidae

[190] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[191] In the absence of specific references we assume the typical feeding guild of bivalves: filter-feeding.

		Diet	S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
50	*Plagiocardium papillosum*	F [192]	0	0	0	0	0	1
51	*Ctena decussata*	SY [193]	1	0	1	1	3	0
52	*Divaricella divaricata*	SY [193]	0	0	1	0	0	0
53	*Gouldia minima*	F [194]	3	3	3	2	5	3
54	*Venus verrucosa*	F [194]	0	0	0	0	1	0
55	*Lajonkairea lajonkairii*	F [195]	0	0	1	0	1	0
56	*Tellina balaustina*	D [196]	0	0	0	0	1	0
57	*Hiatella arctica*	F [197]	0	0	1	0	0	0
58	Bivalve gen sp ind	F [198]	0	0	0	2	0	0
	TOTAL NUMBER OF SPECIMENS		287	196	312	557	143	92

Tab. 98 – Quali-quantitative data of the *Posidonia* rhizomes samples, Elba Is.

To assess whether there are significant differences between the stations at different depth, data were standardized, square root transformed and a similarity matrix was computed with the Bray-Curtis coefficient. Despite the Non metric Multi-Dimensional Scaling plot (Fig. 35) would suggest two different groups, these differences are not statistically significant (ANOSIM, $p>0.05$). The lack of differences may be due to the presence of leale and therefore the fact that this biocoenosis is sciaphilous and with low water movement regardless of the depth.

[192] Beesley *et al*., 1998 for the whole family Cardiidae

[193] Taylor *et al*., 2000 for Lucinidae

[194] Beesley *et al*., 1998 for the whole family Veneridae

[195] Beesley *et al*., 1998 for the superfamily Veneroidea

[196] Beesley *et al*., 1998 for the whole family Tellinidae, Psammobiidae (with the exception of the Eastern Pacific *Nuttallia nuttallii* (Conrad, 1837))

[197] Gofas, 2009a

[198] The most common feeding guild in bivalves

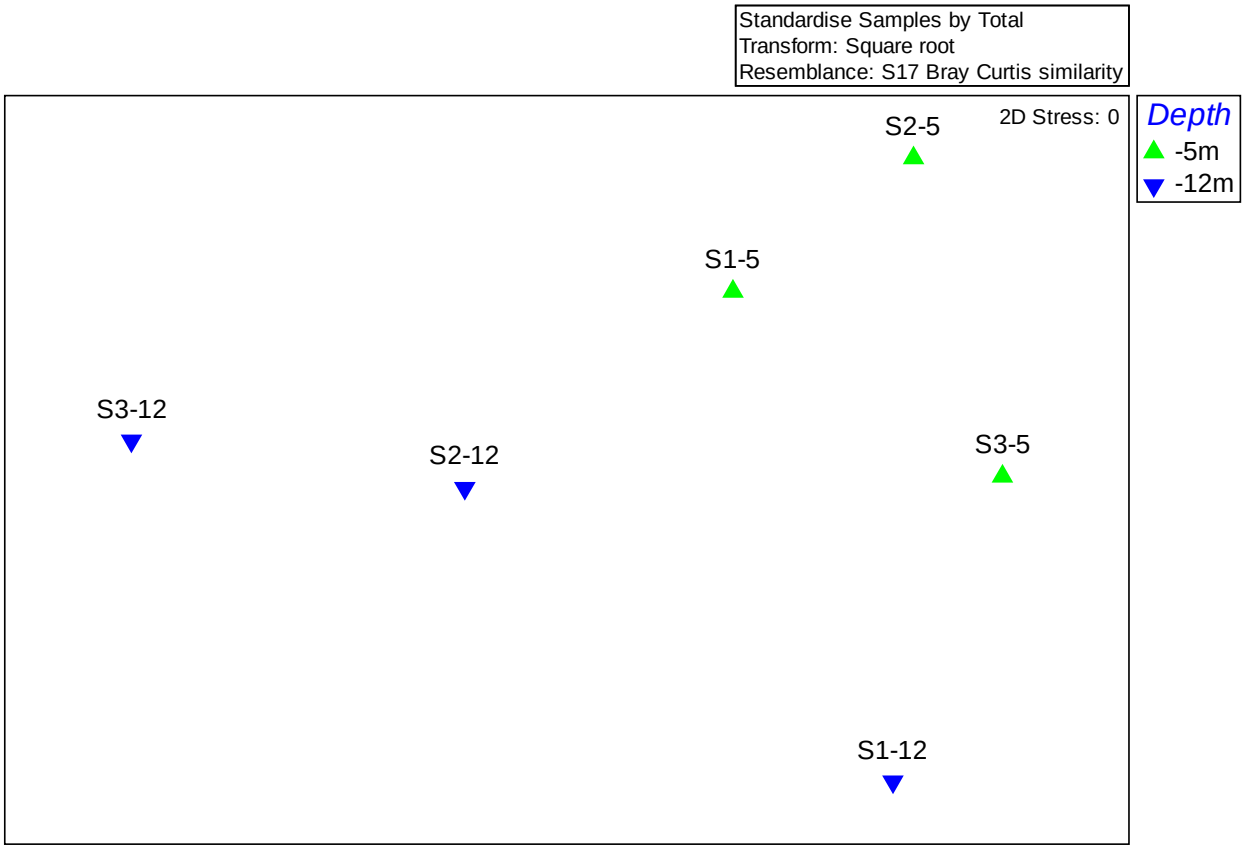


Fig. 35 – Non metric Multi-Dimensional Scaling plot of the *Posidonia* rhizomes samples from Elba Isl.

By a population structure point of view, species richness along replicates ranges from 18 to 31. Shannon diversity index (H') ranges from 1.978 to 2.579 and evenness from 0.582 to 0.789 (Tab. 99). The station in deeper water has higher Shannon diversity (mean 2.172 at -5 m while 2.355 at -12 m). On the contrary, evenness differs slightly since it has a mean value of 0.483 at -5 m and 0.499 at -12 m.

Replicate	S	H'	J'
S1-5	21	2.083	0.684
S2-5	18	2.056	0.711
S3-5	31	2.376	0.692
S1-12	30	1.978	0.582
S2-12	27	2.579	0.783
S3-12	24	2.507	0.789

Tab. 99 – Biodiversity indices values for *Posidonia* rhizomes samples, Elba Isl.

Diversity and equitability indices are influenced by dominance phenomena (Tab. 100, Tab. 101). *Bittium latreillii* is the dominant species in every sample with dominance ranging from 26.1% to 46.5%. *Rissoa auriscalpium* is the second dominant species in samples S1-5 (17.8%), S2-5 (16.3%) and S2-12 (14%) while *Alvania cimex* is the second dominant species in samples SS3-5 (14.4%) and S1-12 (18.1%). *Jujubinus exasperatus* is the second dominant species in sample S3-12.

		Diet	S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
1	*Lepidopleurus cajetanus*	MG	0.3%	-	-	-	-	-
2	*Scissurella costata*	MG	0.3%	-	-	-	-	-
3	*Emarginula pustula*	E	-	-	-	-	0.7%	-
4	*Gibbula umbilicaris*	MG	-	-	-	-	-	1.1%
5	*Jujubinus exasperatus*	MG	2.8%	1.5%	2.6%	3.6%	7.7%	15.2%
6	*Clanculus corallinus*	MG	-	-	-	0.4%	-	-
7	*Clanculus jussieui*	MG	-	-	-	0.2%	-	-
8	*Calliostoma laugieri*	MG	-	-	0.3%	-	-	-
9	*Tricolia pullus*	MG	13.9%	12.8%	12.2%	6.6%	7.0%	9.8%
10	*Tricolia speciosa*	MG	6.3%	9.7%	2.9%	1.1%	2.8%	3.3%
11	*Bittium jadertinum*	MG	1.4%	1.5%	1.3%	0.9%	2.1%	2.2%
12	*Bittium latreilli*	MG	35.9%	36.7%	31.4%	46.5%	27.3%	26.1%
13	*Rissoa auriscalpium*	MG	17.8%	16.3%	7.1%	2.3%	14.0%	10.9%
14	*Rissoa ventricosa*	MG	-	-	0.3%	-	0.7%	1.1%
15	*Rissoa violacea*	MG	-	-	-	-	-	1.1%
16	*Alvania cimex*	MG	6.3%	4.6%	14.4%	18.1%	9.8%	-
17	*Alvania lineata*	MG	3.5%	2.6%	8.0%	-	-	-
18	*Alvania montagui*	MG	1.4%	2.0%	4.8%	0.4%	0.7%	-
19	*Pusillina radiata*	MG	0.3%	0.5%	1.0%	0.2%	-	2.2%
20	*Rissoina bruguierei*	MG	-	-	0.3%	0.5%	-	-
21	*Polinices nitida*	C	-	-	-	0.4%	-	1.1%
22	*Eulima* cfr. *subulata*	E	-	0.5%	-	-	-	-
23	*Parvioris ibizenca*	E	-	-	0.3%	0.5%	0.7%	1.1%
24	*Vitreolina philippii*	E	-	0.5%	-	-	-	-
25	Triphoridae	E	-	0.5%	0.3%	2.2%	0.7%	-
26	*Phyllonotus trunculus*	C	-	-	0.3%	-	-	-
27	*Typhis sowerbyi*	C	0.7%	1.5%	-	-	-	-
28	*Nassarius incrassatus*	SC	0.7%	-	3.5%	2.7%	0.7%	1.1%
29	*Pusia tricolor*	C	-	-	0.3%	-	-	-
31	*Gibberula miliaria*	C	0.3%	-	0.3%	0.7%	2.1%	1.1%
32	*Haedropleura secalina*	C	-	-	-	-	-	1.1%
33	*Mangilia albida*	C	0.3%	0.5%	-	-	-	-
34	*Mangilia* sp 1	C	-	-	-	-	-	1.1%
35	*Mangilia* sp 2	C	-	-	-	-	0.7%	-
36	*Raphitoma bicolor*	C	-	-	-	0.5%	-	1.1%
37	*Raphitoma linearis*	C	-	-	-	0.5%	2.1%	1.1%
38	*Leufroya leufroyi*	C	-	-	-	-	1.4%	-
39	*Chrysallida dolium*	E	-	-	0.3%	-	-	-
40	*Chrysallida excavata*	E	-	-	-	0.2%	-	-
41	*Odostomia conoidea*	E	-	-	0.3%	0.2%	-	-
42	*Turbonilla scalaris*	E	-	-	-	0.2%	0.7%	-
43	*Turbonilla rufa*	E	-	-	-	-	1.4%	1.1%
44	*Nucula nucleus*	D	-	-	-	-	-	1.1%

		Diet	S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
45	*Navicula noae*	F	-	-	1.0%	0.4%	-	-
46	*Barbatia barbata*	F	-	-	0.3%	0.4%	-	-
47	*Striarca lactea*	F	1.0%	0.5%	0.3%	4.1%	2.8%	3.3%
48	*Musculus subpictus*	F	0.3%	-	0.6%	0.2%	0.7%	-
49	*Cardita trapezia*	F	4.9%	6.1%	3.2%	5.2%	5.6%	8.7%
50	*Plagiocardium papillosum*	F	-	-	-	-	-	1.1%
51	*Ctena decussata*	SY	0.3%	-	0.3%	0.2%	2.1%	-
52	*Divaricella divaricata*	SY	-	-	0.3%	-	-	-
53	*Gouldia minima*	F	1.0%	1.5%	1.0%	0.4%	3.5%	3.3%
54	*Venus verrucosa*	F	-	-	-	-	0.7%	-
55	*Lajonkairea lajonkairii*	F	-	-	0.3%	-	0.7%	-
56	*Tellina balaustina*	D	-	-	-	-	0.7%	-
57	*Hiatella arctica*	F	-	-	0.3%	-	-	-
58	Bivalve gen sp ind	F	-	-	-	0.4%	-	-

Tab. 100 – Species dominance in the *Posidonia* rhizomes samples, Elba Isl.

	S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
1st dominant species	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)
2nd dominant species	*Rissoa auriscalpium* (MG)	*Rissoa auriscalpium* (MG)	*Alvania cimex* (MG)	*Alvania cimex* (MG)	*Rissoa auriscalpium* (MG)	*Jujubinus exasperatus* (MG)

Tab. 101 – Comparative table of dominant species in different replicates

Feeding guilds analysis (Tab. 102) highlight the strong dominance of microalgae herbivores, their presence ranging from 72% to 90.2%. Despite being dominant in all replicates, they tend to be slightly less abundant in the deeper water station at -12 m: their mean dominance is 88.3% in the station at -5 m while it is 75.2% in the station at -12 m. This group is represented mainly by *Bittium latreillii* and Rissoidae.

The second dominant feeding guild is filter feeders due to the presence of bivalves. Their presence ranges from 7.1% to 16.3%. Remarkably, despite the rhizomes usually host sediments suitable for infaunal species, the most common species here are *Striarca lactea* and *Cardita trapezia*, both live attached by byssus to firm substrata.

Carnivores on mobile prey are a few, from 1% to 6.5%. The ratio between carnivores and microalgae herbivores is therefore very low ranging from 0.01 to 0.09. Ectoparasites are even less and range from absent to 4.2%. Scavengers are present in even smaller numbers and deposit feeders are occasionally present with 0.7% to 1.1% dominance.

As already observed in the foliar layer, in the deeper station carnivores tend to be more abundant than in the shallower station.

In terms of number of species (Tab. 125) the described pattern does not differ much.

		S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
SC	Scavengers	0.7%	-	3.5%	2.7%	0.7%	1.1%
AG	Herbivores of macroalgae and epiphytes	-	-	-	-	-	-

		S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
MG	Microalgae herbivores	90.2%	88.3%	86.5%	80.8%	72.0%	72.8%
SG	Seagrass-feeding herbivores	-	-	-	-	-	-
D	Deposit feeders	-	-	-	-	0.7%	1.1%
F	Filter feeders	7.3%	8.2%	7.1%	11.0%	14.0%	16.3%
SY	Symbiont-bearing species	0.3%	-	0.6%	0.2%	2.1%	-
E	Ectoparasites and carnivores on preys without mobility	-	1.5%	1.3%	3.2%	4.2%	2.2%
C	Carnivores on mobile prey	1.4%	2.0%	1.0%	2.2%	6.3%	6.5%
O	Egg and spawn feeders	-	-	-	-	-	-
	1st dominant guild	MG	MG	MG	MG	MG	MG
	2nd dominant guild	F	F	F	F	F	F
	1st dominant guild if C and E guilds are pooled	MG	MG	MG	MG	MG	MG
Carnivorous/ microalgae herbivores ratio		0.02	0.02	0.01	0.03	0.09	0.09

Tab. 102 – Feeding guilds dominance in the *Posidonia* rhizomes samples, Elba Isl.

		S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
SC	Scavengers	0.7%	-	3.5%	2.7%	0.7%	0.9%
AG	Herbivores of macroalgae and epiphytes	-	0.5%	0.6%	0.5%	2.6%	4.5%
MG	Microalgae herbivores	90.2%	87.8%	85.4%	81.7%	67.3%	60.9%
SG	Seagrass-feeding herbivores	-	0.5%	0.6%	0.5%	2.6%	4.5%
D	Deposit feeders	-	-	-	-	0.7%	0.9%
F	Filter feeders	7.3%	8.1%	7.0%	11.1%	13.1%	13.6%
SY	Symbiont-bearing species	0.3%	-	0.6%	0.2%	2.0%	-
E	Ectoparasites and carnivores on preys without mobility	-	0.5%	0.6%	0.5%	2.6%	4.5%
C	Carnivores on mobile prey	1.4%	2.0%	0.9%	2.2%	5.9%	5.5%
O	Egg and spawn feeders	-	0.5%	0.6%	0.5%	2.6%	4.5%

Tab. 103 – Number of species *per* feeding guilds in the *Posidonia* rhizomes samples, Elba Isl.

9.1.4.3 Giglio Isl.

The species collected in the *Posidonia* rhizomes and their abundance are given in Tab. 104. The sample was collected at -9 m after defoliation (S-B). Sampling was carried out by air-lift suction sampler on a 1 m^2 area in March 1992.

		Diet	S-B
1	*Callochiton septemvalvis euplaeae*	MG [199]	3
2	*Smaragdia viridis*	SG [200]	3
3	*Emarginula pustula*	E [201]	2
4	*Clanculus jusseui*	MG [202]	1
5	*Jujubinus gravinae*	MG [203]	1
6	*Jujubinus striatus*	MG [204]	10
7	*Tricolia pullus pullus*	MG [205]	10
8	*Tricolia tenuis*	MG [206]	1
9	*Cerithium alucaster*	MG [207]	1
10	*Cerithium vulgatum*	MG [207]	2
11	*Bittium jadertinum*	MG [208]	28
12	*Bittium latreillii*	MG [209]	165
13	*Rissoa decorata*	MG [210]	4
14	*Rissoa ventricosa*	MG [210]	2
15	*Alvania cimex*	MG [211]	3
16	*Alvania discors*	MG [211]	23
17	*Alvania geryonia*	MG [211]	1
18	*Alvania lineata*	MG [211]	1
19	*Alvania pagodula*	MG [211]	4
20	*Pusillina radiata*	MG [212]	1
21	*Rissoina bruguierei*	MG [213]	2
22	*Natica dillwynii*	C [214]	2

[199] Dell'Angelo *et al.*, 2001

[200] Rueda *et al.*, 2007

[201] Fretter *et al.*, 1976 for all congeneric species

[202] Beesley *et al*., 1998 for Trochinae

[203] Fretter *et al.*, 1977 for other *Cantharidus* [*Jujubinus*] species

[204] Peduzzi, 1987

[205] Fretter *et al*., 1977

[206] Fretter *et al*., 1977 for *Tricolia pullus* (Linné, 1758)

[207] Houbrick, 1992, for congeneric Indo-Pacific species.

[208] Fretter *et al.*, 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778)

[209] Russo *et al*., 2002.

[210] Fretter *et al*., 1978 for other congeneric species.

[211] Fretter *et al*., 1978 for all congeneric species.

[212] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[213] Beesley *et al*., 1998 for Rissoidae

[214] Fretter *et al.*, 1981 for all Naticidae

		Diet	S-B
23	*Marshallora adversa*	E [215]	7
24	*Epitonium commune*	E [216]	1
25	*Melanella polita*	E [217]	2
26	*Nassarius incrassatus*	SC [218]	36
27	*Columbella rustica*	AG [219]	1
28	*Vexillum tricolor*	C [220]	1
29	*Gibberula miliaria*	C [221]	1
30	*Granulina marginata*	C [221]	8
31	*Fasciolaria lignaria*	C [222]	2
32	*Mangelia vauquelini*	C [223]	2
33	*Raphitoma linearis*	C [223]	4
34	*Eulimella* sp.	E [224]	1
35	*Odostomia acuta*	E [225]	1
36	*Turbonilla lactea*	E [225]	1
37	*Turbonilla striatula*	E [224]	1
38	*Arca noae*	F [226]	5
39	*Striarca lactea*	F [226]	64
40	*Gregariella petagnae*	F [226]	4
41	*Modiolula phaseolina*	F [226]	1
42	*Ctena decussata*	SY [227]	4
43	*Chama gryphoides*	F [228]	1
44	*Neolepton sulcatulum*	F [229]	1
45	*Glans trapezia*	F [230]	59
46	*Venus verrucosa*	F [231]	14
47	*Gouldia minima*	F [231]	5

[215] Bouchet, 1984

[216] Fretter *et al.*, 1982 for *Epitonium clathrus* (Linné, 1758)

[217] Waren, 1983

[218] Fretter *et al*., 1984

[219] deMaintenon, 1999 for most Columbellinae

[220] Beesley *et al.*, 1998 for the entire family

[221] Beesley *et al*., 1998 for "marginellids" (Marginellidae and Cystiscidae)

[222] Beesley *et al*., 1998 for Fasciolariidae

[223] Fretter *et al*., 1984 for all "Turridae" *sensu lato*

[224] Fretter *et al.*, 1986 for Pyramidellacea

[225] Fretter *et al.*, 1986

[226] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[227] Taylor *et al.*, 2000 for Lucinidae

[228] Beesley *et al*., 1998 for Chamidae

[229] No specific information was found on this species and its family. It is here supposed to be a filter-feeder like most other bivalves.

[230] In the absence of specific references we assume the typical feeding guild of bivalves: filter-feeding.

[231] Beesley *et al*., 1998 for the whole family Veneridae

		Diet	S-B
48	*Hiatella arctica*	F [232]	3
	TOTAL NUMBER OF SPECIMENS		500

Tab. 104 – Quali-quantitative data of the *Posidonia* rhizomes samples, Giglio Is.

By a population structure point of view, species richness is 48 while Shannon diversity index (H') is 2.565 and evenness 0.663.

Replicate	S	H'	J'
S-B	48	2.565	0.663

Tab. 105 – Biodiversity indices values for *Posidonia* rhizomes samples, Giglio Isl.

Diversity and equitability indices are influenced by dominance phenomena (Tab. 106). *Bittium latreillii* is the dominant species with 33.3% of specimens. The second most abundant species is *Striarca lactea* (12.8%).

		Diet	S-B
1	*Callochiton septemvalvis euplaeae*	MG	0.6%
2	*Smaragdia viridis*	SG	0.6%
3	*Emarginula pustula*	E	0.4%
4	*Clanculus jusseui*	MG	0.2%
5	*Jujubinus gravinae*	MG	0.2%
6	*Jujubinus striatus*	MG	2.0%
7	*Tricolia pullus pullus*	MG	2.0%
8	*Tricolia tenuis*	MG	0.2%
9	*Cerithium alucaster*	MG	0.2%
10	*Cerithium vulgatum*	MG	0.4%
11	*Bittium jadertinum*	MG	5.6%
12	*Bittium latreillii*	MG	33.0%
13	*Rissoa decorata*	MG	0.8%
14	*Rissoa ventricosa*	MG	0.4%
15	*Alvania cimex*	MG	0.6%211
16	*Alvania discors*	MG	4.6%
17	*Alvania geryonia*	MG	0.2%
18	*Alvania lineata*	MG	0.2%
19	*Alvania pagodula*	MG	0.8%
20	*Pusillina radiata*	MG	0.2%
21	*Rissoina bruguierei*	MG	0.4%
22	*Natica dillwynii*	C	0.4%
23	*Marshallora adversa*	E	1.4%
24	*Epitonium commune*	E	0.2%
25	*Melanella polita*	E	0.4%
26	*Nassarius incrassatus*	SC	7.2%

[232] Gofas, 2009a

		Diet	S-B
27	*Columbella rustica*	AG	0.2%
28	*Vexillum tricolor*	C	0.2%
29	*Gibberula miliaria*	C	0.2%
30	*Granulina marginata*	C	1.6%
31	*Fasciolaria lignaria*	C	0.4%
32	*Mangelia vauquelini*	C	0.4%
33	*Raphitoma linearis*	C	0.8%
34	*Eulimella* sp.	E	0.2%
35	*Odostomia acuta*	E	0.2%
36	*Turbonilla lactea*	E	0.2%
37	*Turbonilla striatula*	E	0.2%
38	*Arca noae*	F	1.0%
39	*Striarca lactea*	F	12.8%
40	*Gregariella petagnae*	F	0.8%
41	*Modiolula phaseolina*	F	0.2%
42	*Ctena decussata*	SY	0.8%
43	*Chama gryphoides*	F	0.2%
44	*Neolepton sulcatulum*	F	0.2%
45	*Glans trapezia*	F	11.8%
46	*Venus verrucosa*	F	2.8%
47	*Gouldia minima*	F	1.0%
48	*Hiatella arctica*	F	0.6%

Tab. 106 – Species dominance in the *Posidonia* rhizomes samples, Giglio Isl.

	S-B
1st dominant species	*Bittium latreillii* (MG)
2nd dominant species	*Striarca lactea* (F)

Tab. 107 – Dominant species in the sample

Feeding guild analysis (Tab. 125) highlights the dominance of microalgae herbivores with 52.6%. Filter feeders are the second most abundant feeding guild (31.4%). Scavengers are the third group (7.2%) due to the abundant presence (36 specimens) of a single species (*Nassarius incrassatus*). Carnivores (4%) and ectoparasites (3.2%) are present in small numbers while herbivores on macroalgae are negligible.

In terms of number of species (Tab. 109) the role of carnivores emerges being 14.6% of species. Ectoparasites are even more: 16.7%, accounting all together for 31.3% being the second most represented group. These samples had therefore a good species diversity of carnivores despite being rare species.

		S-B
SC	Scavengers	7.2%
AG	Herbivores of macroalgae and epiphytes	0.2%

		S-B
MG	Microalgae herbivores	52.6%
SG	Seagrass-feeding herbivores	0.6%
D	Deposit feeders	-
F	Filter feeders	31.4%
SY	Symbiont-bearing species	0.8%
E	Ectoparasites and carnivores on preys without mobility	3.2%
C	Carnivores on mobile prey	4.0%
O	Egg and spawn feeders	-
	1st dominant guild	MG
	2nd dominant guild	F
	1st dominant guild if C and E guilds are pooled	MG
Carnivorous/ microalgae herbivores ratio		0.08

Tab. 108 – Feeding guilds dominance in the *Posidonia* rhizomes samples, Giglio Isl.

		S-B
SC	Scavengers	2.1%
AG	Herbivores of macroalgae and epiphytes	2.1%
MG	Microalgae herbivores	39.6%
SG	Seagrass-feeding herbivores	2.1%
D	Deposit feeders	-
F	Filter feeders	20.8%
SY	Symbiont-bearing species	2.1%
E	Ectoparasites and carnivores on preys without mobility	16.7%
C	Carnivores on mobile prey	14.6%
O	Egg and spawn feeders	-

Tab. 109 – Number of species *per* feeding guilds in the *Posidonia* rhizomes samples, Giglio Isl.

9.1.4.4 Hvrgada Isl., Croatia

The species collected in the *Posidonia* rhizomes and their abundance are given in Tab. 110. Two samples were collected at -4 and -11m, both after defoliation. Sampling was carried out by air-lift suction sampler on a 1 m^2 area per replicate in July, 2000.

		Diet	S4	S11
1	*Jujubinus striatus*	MG [233]	8	0
2	*Tricolia tenuis*	MG [234]	87	1
3	*Cerithium vulgatum*	MG [235]	0	2
4	*Bittium jadertinum*	MG [236]	3	0
5	*Bittium latreillii*	MG [237]	35	0
6	*Rissoa splendida*	MG [238]	21	0
7	*Rissoa variabilis*	MG [238]	5	0
8	*Rissoa ventricosa*	MG [238]	0	2
9	*Rissoa violacea*	MG [239]	0	4
10	*Alvania cimex*	MG [240]	2	0
11	*Alvania discors*	MG [240]	43	0
12	*Alvania geryonia*	MG [240]	5	0
13	*Alvania pagodula*	MG [240]	5	0
14	*Pusillina radiata*	MG [241]	0	1
15	*Caecum trachea*	MG [242]	1	0
16	*Polinices nitida*	C [243]	0	1
17	*Melanella boscii*	E [244]	0	1
18	*Granulina marginata*	C [245]	2	1
19	*Bela* sp	C [246]	0	1
20	*Mangelia* sp1	C [246]	0	3
21	*Mangelia* sp2	C [246]	0	2
22	*Odostomia acuta*	E [247]	0	1
23	*Nucula nucleus*	D [248]	4	0

[233] Peduzzi, 1987

[234] Fretter *et al*., 1977 for *Tricolia pullus* (Linné, 1758)

[235] Houbrick, 1992, for congeneric Indo-Pacific species.

[236] Fretter *et al.*, 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778)

[237] Russo *et al*., 2002.

[238] Fretter *et al*., 1978 for other congeneric species.

[239] Fretter *et al*., 1978

[240] Fretter *et al*., 1978 for all congeneric species.

[241] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[242] Fretter *et al*., 1978 for *Caecum imperforatum* (Kanmacher, 1798) [=*Caecum trachea*]

[243] Fretter *et al.*, 1981 for all Naticidae

[244] Waren, 1983

[245] Beesley *et al*., 1998 for "marginellids" (Marginellidae and Cystiscidae)

[246] Fretter *et al*., 1984 for for all "Turridae" *sensu lato*

[247] Fretter *et al.*, 1986

[248] Beesley *et al*., 1998 for Nuculidae

		Diet	S4	S11
24	*Modiolarca subpicta*	F [249]	2	0
25	*Pododesmus patelliformis*	F [249]	0	1
26	*Thyasira flexuosa*	SY [250]	7	0
27	*Mysella bidentata*	F [251]	2	0
28	*Parvicardium exiguum*	F [252]	5	1
29	*Venus verrucosa*	F [253]	0	8
30	*Gouldia minima*	F [253]	12	2
31	*Callista chione*	F [253]	0	1
	TOTAL NUMBER OF SPECIMENS		249	33

Tab. 110 – Quali-quantitative data of the *Posidonia* rhizomes samples, Hvrgada Is., Croatia

The shallow water sample has a much higher abundance of specimens, with a difference of an order of magnitude (249 vs 33).

By a population structure point of view (Tab. 105), species richness is almost the same at the two stations but with a low percentage of shared species (12.9%). Shannon diversity index (H') is lower in shallow water (2.123) than in deep water (2.556) and the same trend is shown by evenness (0.734 in shallow water and 0.902 in deep water).

Therefore, the assemblage at the two depths is different both in terms of species composition, faunal abundance and diversity indices.

Replicate	S	H'	J'
S4	18	2.123	0.734
S11	17	2.556	0.902

Tab. 111 – Biodiversity indices values for *Posidonia* rhizomes samples, Giglio Isl.

Diversity and equitability indices are influenced by dominance phenomena (Tab. 112, Tab. 113). *Tricolia tenuis* is the dominant species in the shallow water station (34.9%) while *Venus verrucosa*, a filter feeding venerid clam, is the dominant species in the deeper water station (24.2%). The second dominant species is *Alvania discors* (17.3%) in shallow water and *Rissoa violacea* (12.1%) in deep water.

These differences further support the hypothesis that the two stations host different species assemblages. Moreover, the deeper water one probably has a greater percentage of sediment since the dominant presence of an infaunal filter feeder.

		Diet	S4	S11
1	*Jujubinus striatus*	MG	3.2%	-
2	*Tricolia tenuis*	MG	34.9%	3.0%
3	*Cerithium vulgatum*	MG	-	6.1%
4	*Bittium jadertinum*	MG	1.2%	-
5	*Bittium latreillii*	MG	14.1%	-

[249] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[250] Dias Passos *et al.*, 2007

[251] Beesley *et al*., 1998 for Galeommatoidea

[252] Beesley *et al*., 1998 for the whole family Cardiidae

[253] Beesley *et al*., 1998 for the whole family Veneridae

		Diet	S4	S11
6	*Rissoa splendida*	MG	8.4%	-
7	*Rissoa variabilis*	MG	2.0%	-
8	*Rissoa ventricosa*	MG	-	6.1%
9	*Rissoa violacea*	MG	-	12.1%
10	*Alvania cimex*	MG	0.8%	-
11	*Alvania discors*	MG	17.3%	-
12	*Alvania geryonia*	MG	2.0%	-
13	*Alvania pagodula*	MG	2.0%	-
14	*Pusillina radiata*	MG	-	3.0%
15	*Caecum trachea*	MG	0.4%	-
16	*Polinices nitida*	C	-	3.0%
17	*Melanella boscii*	E	-	3.0%
18	*Granulina marginata*	C	0.8%	3.0%
19	*Bela* sp	C	-	3.0%
20	*Mangelia* sp1	C	-	9.1%
21	*Mangelia* sp2	C	-	6.1%
22	*Odostomia acuta*	E	-	3.0%
23	*Nucula nucleus*	D	1.6%	-
24	*Modiolarca subpicta*	F	0.8%	-
25	*Pododesmus patelliformis*	F	-	3.0%
26	*Thyasira flexuosa*	SY	2.8%	-
27	*Mysella bidentata*	F	0.8%	-
28	*Parvicardium exiguum*	F	2.0%	3.0%
29	*Venus verrucosa*	F	-	24.2%
30	*Gouldia minima*	F	4.8%	6.1%
31	*Callista chione*	F	-	3.0%

Tab. 112 – Species dominance in the *Posidonia* rhizomes samples, Hvrgada Isl., Croatia

	S4	S11
1st dominant species	*Tricolia tenuis* (MG)	*Venus verrucosa* (F)
2nd dominant species	*Alvania discors* (MG)	*Rissoa violacea* (MG)

Tab. 113 – Comparative table of dominant species in the two samples

Feeding guild analysis (Tab. 114) highlights the strong dominance of microalgae herbivores in shallow water (86.3%). Filter feeders attain an 8.4% dominance while other groups are negligible. On the contrary, the deep water station has a much more balanced pattern: the dominant guild is filter feeding with 39.4%, microalgae herbivores are 30.3% and all carnivores (those on mobile prey, 24.2%, pooled with ectoparasites, 6.1%) are 30.3%. The ratio between carnivores and microalgae herbivores is very low in shallow water (0.01) and much higher in deeper water (0.8), a pattern already observed both in the foliar layer and in the rhizomes.

In terms of number of species (Tab. 126), the overall pattern is maintained. However the dominance of microalgae herbivores in shallow water is slightly reduced (61.1%) while the other more diversified guilds have slightly higher percentages. In deep water, the three main guilds (microalgae herbivores, filter feeders

and carnivores on mobile prey) are equal but if all carnivores are pooled together they become the dominant group with 41.2% of species, testifying the higher diversity of carnivores due to increased specialization.

		S4	S11
SC	Scavengers	-	-
AG	Herbivores of macroalgae and epiphytes	-	-
MG	Microalgae herbivores	86.3%	30.3%
SG	Seagrass-feeding herbivores	-	-
D	Deposit feeders	1.6%	-
F	Filter feeders	8.4%	39.4%
SY	Symbiont-bearing species	2.8%	-
E	Ectoparasites and carnivores on preys without mobility	-	6.1%
C	Carnivores on mobile prey	0.8%	24.2%
O	Egg and spawn feeders	-	-
	1st dominant guild	MG	F
	2nd dominant guild	F	MG
	1st dominant guild if C and E guilds are pooled	MG	F
Carnivorous/ microalgae herbivores ratio		0.01	0.80

Tab. 114 – Feeding guilds dominance in the *Posidonia* rhizomes samples, Hvrgada Isl., Croatia

		S4	S11
SC	Scavengers	-	-
AG	Herbivores of macroalgae and epiphytes	-	-
MG	Microalgae herbivores	61.1%	29.4%
SG	Seagrass-feeding herbivores	-	-
D	Deposit feeders	5.6%	-
F	Filter feeders	22.2%	29.4%
SY	Symbiont-bearing species	5.6%	-
E	Ectoparasites and carnivores on preys without mobility	-	11.8%

		S4	S11
C	Carnivores on mobile prey	5.6%	29.4%
O	Egg and spawn feeders	-	-

Tab. 115 – Number of species *per* feeding guilds in the *Posidonia* rhizomes samples, Hvrgada Isl., Croatia

9.1.4.5 Comparison between localities

Comparative tables of the main features of the localities are reported in the following tables.

	Secche della Meloria			Elba Isl.						Giglio Isl.	Secche di Tor Paterno						Hvrgada Isl, Croatia	
Sample	**S_A**	**S_B**	**S_C**	**S1-5**	**S2-5**	**S3-5**	**S1-12**	**S2-12**	**S3-12**	**R-B**	**SP1[254]**	**SP2[254]**	**SP3[254]**	**SP4[255]**	**SP5[255]**	**SP6[255]**	**R4**	**R11**
Depth	-4 m			-5m			-12m			-9 m	-26 m						-4m	-11m
N	45	23	7	287	196	312	557	143	82	500	74	94	100	152	70	63	249	33
S	16	14	4	21	18	31	30	27	24	48	34	33	30	54	31	27	18	17

Tab. 116 – Comparative table of abundance and species richness of different localities

	Secche della Meloria			Elba Isl.						Giglio Isl.	Secche di Tor Paterno						Hvrgada Isl, Croatia	
Sample	**S_A**	**S_B**	**S_C**	**S1-5**	**S2-5**	**S3-5**	**S1-12**	**S2-12**	**S3-12**	**R-B**	**SP1[254]**	**SP2[254]**	**SP3[254]**	**SP4[255]**	**SP5[255]**	**SP6[255]**	**R4**	**R11**
Depth	-4 m			-5 m			-12 m			-9 m	-26 m						-4m	-11m
H	2.451	2.292	1.154	2.083	2.056	2.376	1.978	2.579	2.507	2.565	3.261	2.904	2.616	3.532	3.176	2.907	2.123	2.556
J	0.884	0.868	0.832	0.684	0.711	0.692	0.582	0.783	0.789	0.663	0.925	0.831	0.769	0.885	0.925	0.882	0.734	0.902

Tab. 117 – Comparative table of Shannon diversity and Pielou's evenness of different localities

	Secche della Meloria			Elba Is.						Giglio Is.
	S_A	**S_B**	**S_C**	**S1-5**	**S2-5**	**S3-5**	**S1-12**	**S2-12**	**S3-12**	**-9m**
1st dominant species	*Nassarius incrassatus* (SC)	*Bittium latreillii* (MG)	*Jujubinus exasperatus* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)
2nd dominant species	*Jujubinus exasperatus* (MG) *Venericardia antiquata* (F)	*Cardita calyculata* (F) *Glans trapezia* (F)	All other 4 species	*Rissoa auriscalpium* (MG)	*Rissoa auriscalpium* (MG)	*Alvania cimex* (MG)	*Alvania cimex* (MG)	*Rissoa auriscalpium* (MG)	*Jujubinus exasperatus* (MG)	*Striarca lactea* (F)

Tab. 118 – Comparative table of dominant species at different localities (part one)

[254] On hard substratum.

[255] In a sedimentary pool.

	Secche di Tor Paterno						Hvrgada Isl (HR)	
	SP1^{254} -26m	**SP2^{254} -26m**	**SP3^{254} -26m**	**SP4^{255} -26m**	**SP5^{255} -26m**	**SP6^{255} -26m**	**-4m**	**-11m**
1st dominant species	*Muricopsis cristata* (C)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Turritella turbona* (F)	*Papillicardium papillosum* (F) *Gouldia minima* (F)	*Tricolia tenuis* (MG)	*Venus verrucosa* (F)
2nd dominant species	*Bittium latreillii* (MG)	*Striarca lactea* (F)	*Nassarius incrassatus* (SC)	*Muricopsis cristata* (C)	*Jujubinus exasperatus* (MG) *Gouldia minima* (F)	*Muricopsis cristata* (C)	*Alvania discors* (MG)	*Rissoa violacea* (MG)

Tab. 119 – Comparative table of dominant species at different localities (part two)

	Secche della Meloria			Elba Isl.						Giglio Isl.	Secche di Tor Paterno						Hvrgada Isl. Croatia	
Sample	**S_A**	**S_B**	**S_C**	**S1-5**	**S2-5**	**S3-5**	**S1-12**	**S2-12**	**S3-12**	**R-B**	**SP1^{254}**	**SP2^{254}**	**SP3^{254}**	**SP4^{255}**	**SP5^{255}**	**SP6^{255}**	**R4**	**R11**
Depth	-4 m			-5 m	-5 m	-5 m	-12 m	-12 m	-12 m	-9 m	-26 m						-4m	-11m
SC	24.4 %	4.3%	14.3 %	0.7%	-	3.5%	2.7%	0.7%	1.1%	7.2%	6.8%	2.1%	9.0%	4.6%	4.3%	-	-	-
AG	-	-	-	-	-	-	-	-	-	0.2%	-	-	-	-	-	1.6%	-	-
MG	44.4 %	52.2 %	85.7 %	90.2 %	88.3 %	86.5 %	80.8 %	72.0 %	72.8 %	52.6%	24.3 %	28.7 %	41.0 %	23.7 %	18.6 %	12.7 %	86.3 %	30.3 %
SG	-	-	-	-	-	-	-	-	-	0.6%	-	-	-	-	1.4%	3.2%	-	-
D	-	-	-	-	-	-	-	0.7%	1.1%	-	1.4%	-	-	1.3%	1.4%	4.8%	1.6%	-
F	31.1 %	43.5 %	-	7.3%	8.2%	7.1%	11.0 %	14.0 %	16.3 %	31.4%	21.6 %	28.7 %	9.0%	17.1 %	34.3 %	44.4 %	8.4%	39.4 %
SY	-	-	-	0.3%	-	0.6%	0.2%	2.1%	-	0.8%	-	-	-	-	-	-	2.8%	-
E	-	-	-	-	1.5%	1.3%	3.2%	4.2%	2.2%	3.2%	6.8%	11.7 %	6.0%	15.1 %	5.7%	3.2%	-	6.1%
C	-	-	-	1.4%	2.0%	1.0%	2.2%	6.3%	6.5%	4.0%	39.2 %	26.6 %	35.0 %	36.2 %	32.9 %	30.2 %	0.8%	24.2 %
O	-	-	-	-	-	-	-	-	-	-	-	2.1%	-	2.0%	1.4%	-	-	-
Carnivorous/ microalgae herbivores ratio	0	0	0	0.02	0.02	0.01	0.03	0.09	0.09	0.08	1.6	0.9	0.9	1.5	1.8	2.4	0.01	0.80

Tab. 120 – Comparative table of trophic groups of different localities (species abundance)

	Secche della Meloria			Elba Isl.						Giglio Isl.	Secche di Tor Paterno						Hvrgada Isl. Croatia	
Sample	**S_A**	**S_B**	**S_C**	**S1-5**	**S2-5**	**S3-5**	**S1-12**	**S2-12**	**S3-12**	**R-B**	**SP1^{254}**	**SP2^{254}**	**SP3^{254}**	**SP4^{255}**	**SP5^{255}**	**SP6^{255}**	**R4**	**R11**
Depth	-4 m			-5 m	-12 m	-5 m	-5 m	-5 m	-12 m	-12 m	-12 m						-4m	-11m
SC	6.3%	7.1%	25.0 %	0.7%	-	3.5%	2.7%	0.7%	0.9%	2.1%	2.9%	3.0%	3.3%	1.9%	3.2%	-	-	-
AG	-	-	-	-	0.5%	0.6%	0.5%	2.6%	4.5%	2.1%	-	-	-	-	-	3.7%	-	-
MG	50.0 %	35.7 %	75.0 %	90.2 %	87.8 %	85.4 %	81.7 %	67.3 %	60.9 %	39.6%	26.5 %	12.1 %	23.3 %	18.5 %	9.7%	14.8 %	61.1 %	29.4 %
SG	-	-	-	-	0.5%	0.6%	0.5%	2.6%	4.5%	2.1%	-	-	-	-	3.2%	3.7%	-	-
D	-	-	-	-	-	-	-	0.7%	0.9%	-	2.9%	-	-	3.7%	3.2%	7.4%	5.6%	-

	Secche della Meloria			Elba Isl.						Giglio Isl.	Secche di Tor Paterno						Hvrgada Isl. Croatia	
Sample	**S_A**	**S_B**	**S_C**	**S1-5**	**S2-5**	**S3-5**	**S1-12**	**S2-12**	**S3-12**	**R-B**	**SP1^{254}**	**SP2^{254}**	**SP3^{254}**	**SP4^{255}**	**SP5^{255}**	**SP6^{255}**	**R4**	**R11**
Depth	-4 m			-5 m	-12 m	-5 m	-5 m	-5 m	-12 m	-12 m	-12 m						-4m	-11m
F	43.8 %	57.1 %	-	7.3%	8.1%	7.0%	11.1 %	13.1 %	13.6 %	20.8%	26.5 %	21.2 %	16.7 %	18.5 %	22.6 %	25.9 %	22.2 %	29.4 %
SY	-	-	-	0.3%	-	0.6%	0.2%	2.0%	-	2.1%	-	-	-	-	-	-	5.6%	-
E	-	-	-	-	0.5%	0.6%	0.5%	2.6%	4.5%	16.7%	11.8 %	21.2 %	2-	24.1 %	9.7%	7.4%	-	11.8 %
C	-	-	-	1.4%	2.0%	0.9%	2.2%	5.9%	5.5%	14.6%	29.4 %	39.4 %	36.7 %	31.5 %	45.2 %	37.0 %	5.6%	29.4 %
O	-	-	-	-	0.5%	0.6%	0.5%	2.6%	4.5%	-	-	3.0%	-	1.9%	3.2%	-	-	-

Tab. 121 – Comparative table of trophic groups of different localities (species counts)

A multivariate analysis of the assemblages, pooling them into a single abundance matrix, was carried out. To achieve this, the taxonomy of the different data sets was updated. However, it was not possible to sort again samples to check any misidentifications. Moreover, sometimes pooling of abundance data into the same species would have been tentative due to the use of generic assignments only or outdated taxonomy. In a few cases, this may have resulted in an oversplitting of the species.

Due to sample heterogeneity, data were standardised. Moreover, they were square-root transformed for a more balanced relationship between rare and common species. The Bray-Curtis similarity coefficient was used.

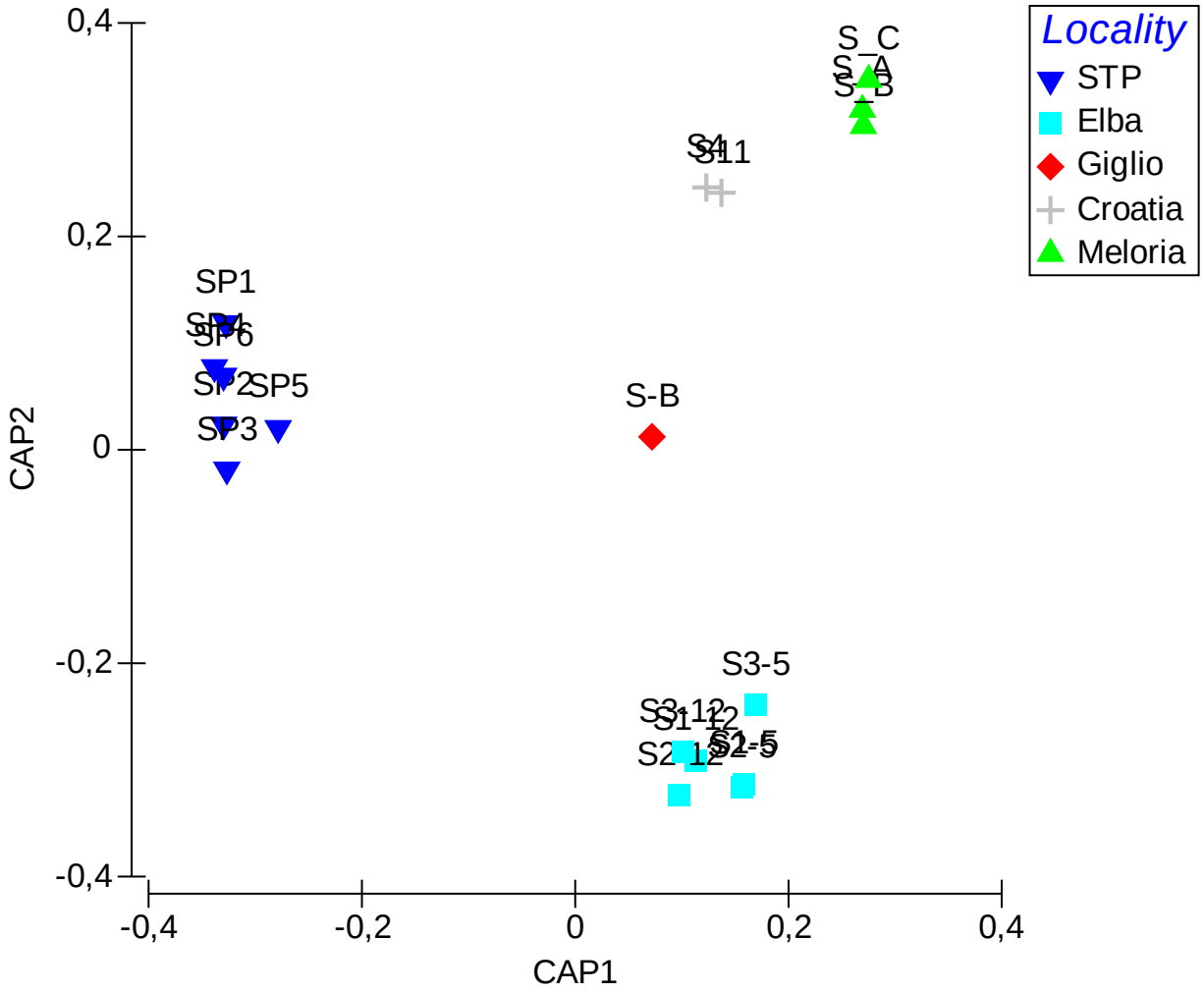


Fig. 36 – Canonical analysis on principal coordinates, factor: locality

Canonical analysis on principal coordinates gave plot in Fig. 36. It is clear that assemblages from different localities group together and are distant from others. In this scenario, the Secche di Tor Paterno samples are well apart.

However, these differences are statistically significant (PERMANOVA, $p<0.05$, with Monte Carlo simulations due to the low number of permutations) in most cases, but not always. The assemblage of Giglio Isl. is not statistically different from the others, but this may be due to the absence of replicates (and therefore the low number of replicates which influence the analysis). Giglio Isl assemblage is significantly different from Elba Isl. ones only, but this may be due again to the unbalancement in terms of stations and replicates between the two localities. Secche di Tor Paterno and Elba Isl. assemblages are significantly different from all other stations (except Giglio Isl.), while Hvrgada Isl. and Secche della Meloria assemblages do not show statistically significant differences. This is quite surprising since dominant species are different and shared species between the two stations are 14.1%

This pattern suggests there are not true differences in the *Posidonia* rhizomes assemblages across a geographical transect.

	Tor Paterno	Meloria	Elba Isl.	Giglio Isl.	Ischia Isl.
Tor Paterno	-	Yes	Yes	No	-
Meloria	Yes	-	Yes	No	-
Elba Isl.	Yes	Yes	-	Yes	-
Giglio Isl.	No	No	Yes	-	-
Ischia Isl.	-	-	-	-	-
Hvrgada Isl.	Yes	No	Yes	No	-

Tab. 122 – Significant differences (PERMANOVA, $p<0.05$) between rhizome layer assemblages

	Tor Paterno	Meloria	Elba Isl.	Giglio Isl.	Ischia Isl.
Tor Paterno	-	Yes	Yes	No	Yes
Meloria	Yes	-	Yes	Yes	Yes
Elba Isl.	Yes	Yes	-	No	Yes
Giglio Isl.	No	Yes	No	-	No
Ischia Isl.	Yes	Yes	Yes	No	-
Hvrgada Isl.	Yes	Yes	No	No	Yes

Tab. 123 – Significant differences (PERMANOVA, $p<0.05$) between foliar layer assemblages (cfr. cap. 8.1.4, pag. 80)

The pattern of statistical significances is not the same of the foliar layer (Tab. 122, Tab. 123) with the only exception of Secche di Tor Paterno. This may imply that the two layers have independent assemblages.

The same analysis was performed analysing the influence of depth. Stations were assigned to the following depth levels: shallow water down to 5 m, intermediate from 6 to 15 m, deep below 15. Canonical analysis on principal coordinates using the depth factor (Fig. 37) clearly groups samples according to depth. However, these differences are statistically significant only between the deep water (Secche di Tor Paterno) and the other depth layers, while they are not statistically significant between the shallow and intermediate layers. This pattern is the same found for the foliar layer assemblage (cfr cap. 8.1.4.6, pag. 96). This suggests that the assemblage of Secche di Tor Paterno is highly peculiar, probably because of depth, but maybe also because of the hard substratum where *Posidonia* settles type of substratum being the main driver of diversification of communities.

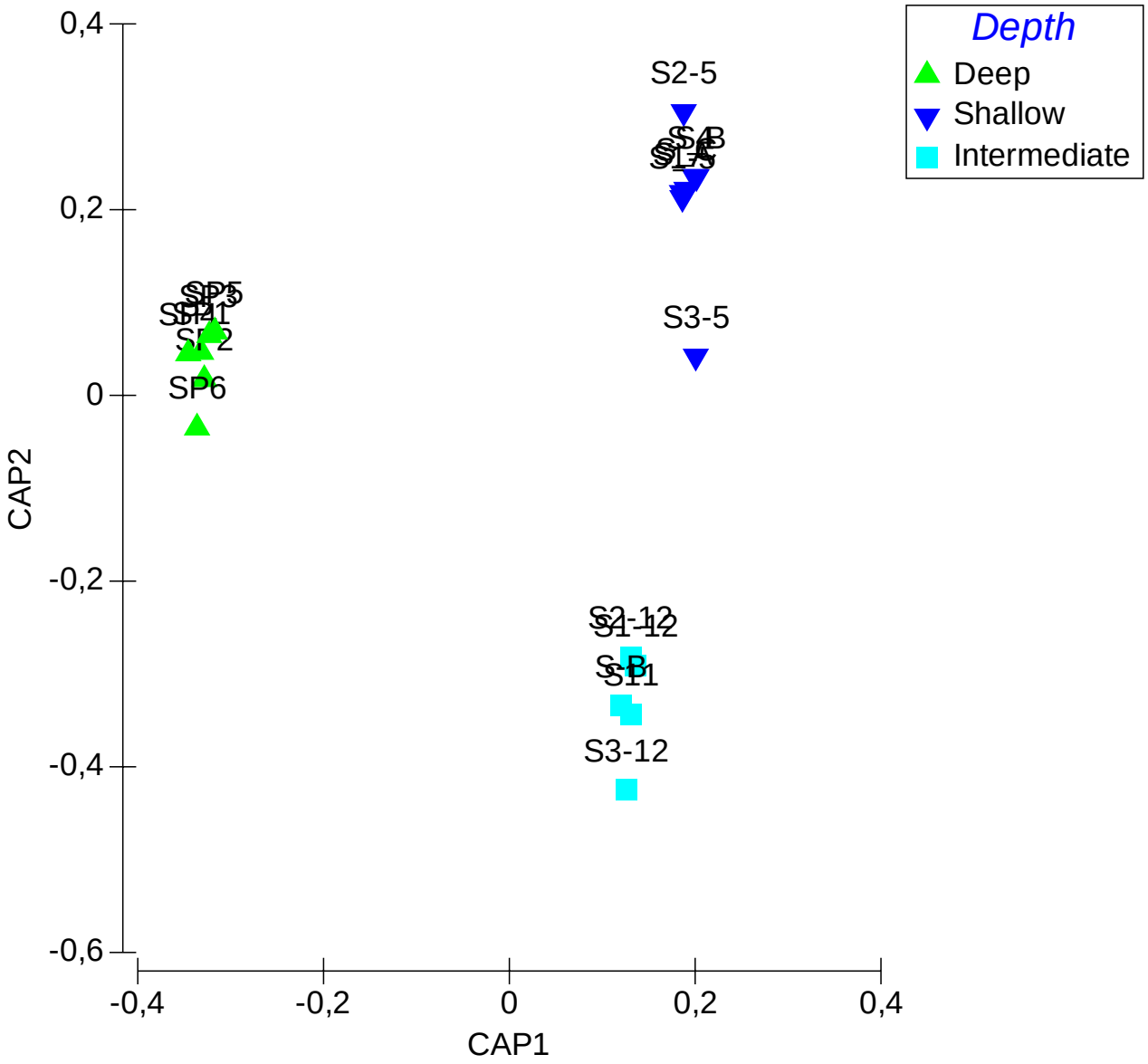


Fig. 37 - Canonical analysis on principal coordinates, factor: depth

A last analysis was performed to test whether there were any significant differences among the different basins: the Tyrrhenian and Adriatic seas (Fig. 38). These differences are statistically significant ($p<0.05$, PERMANOVA and ANOSIM). The SIMPER routine was run to understand which species most contributed to the differences. *Tricolia tenuis* is the greatest contributor and it is an extremely abundant species in Croatia, especially in the shallower water sample, while it is much less frequent and abundant in the Tyrrhenian stations. The second greatest contributor is *Bittium latreillii*, which is relatively less abundant in the Adriatic stations rather than in the Tyrrhenian ones. Then there are *Venus verrucosa* (relatively more common in the Adriatic Sea than in the Tyrrhenian Sea), *Jujubinus exasperatus* (absent in the Adriatic Sea, but frequent in the Tyrrhenian Sea) and *Alvania discors* (which is a dominant species in the Adriatic Sea and unfrequent in the Tyrrhenian Sea). The full output of the SIMPER routine is reported in Tab. 124.

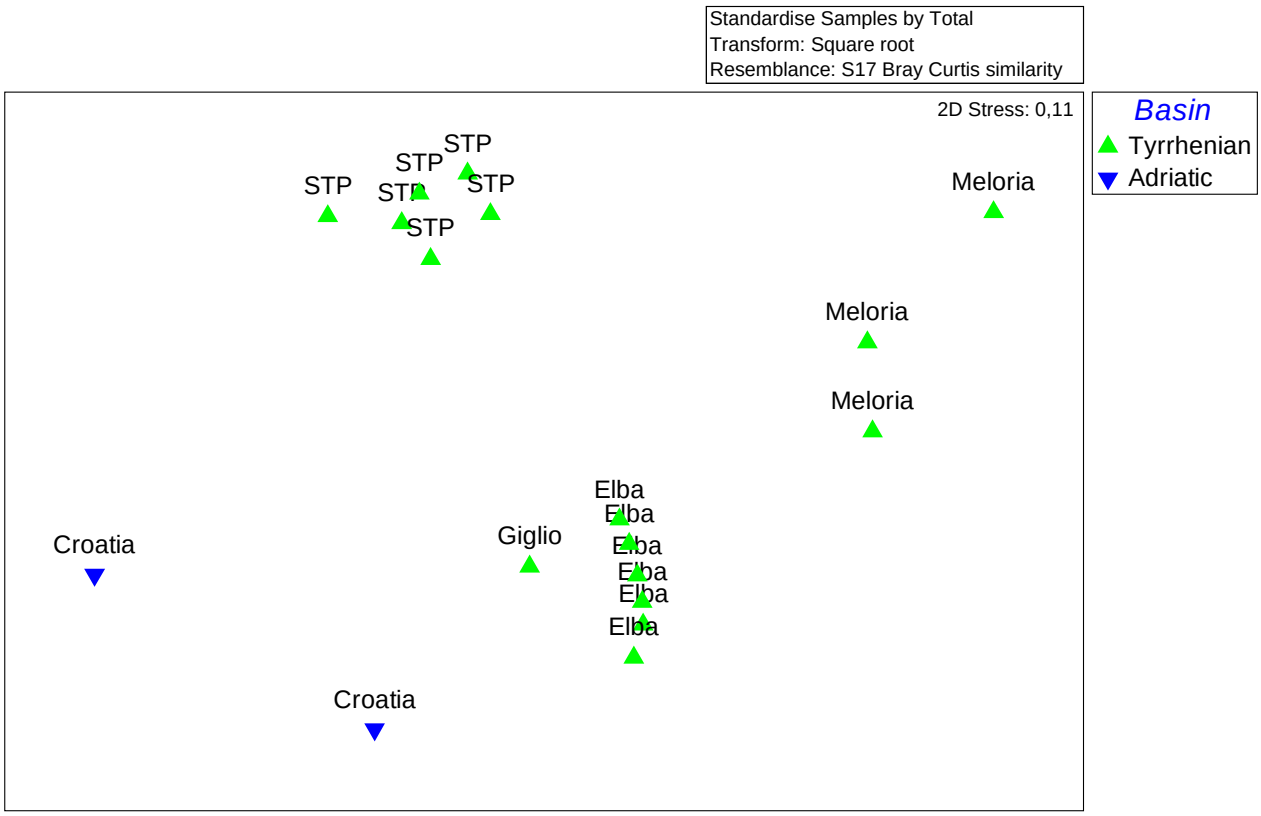


Fig. 38 – Non metric Multi-Dimensional Scaling plot of *Posidonia* rhizomes samples from Tor Paterno and comparison localities

Species	Tyrrenhian stations Average Abundance	Adriatic stations Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity %
Tricolia tenuis	0.19	3.83	4.75	1.56	5.42	5.42
Bittium latreillii	3.87	1.87	3.77	1.40	4.30	9.72
Venus verrucosa	0.71	2.46	3.09	1.20	3.52	13.24
Jujubinus exasperatus	1.95	0.00	2.75	0.84	3.13	16.37
Alvania montagui	0.52	2.08	2.71	1.15	3.09	19.46
Nassarius incrassatus	1.93	0.00	2.52	1.31	2.87	22.32
Rissoa violacea	0.14	1.74	2.17	1.01	2.48	24.80
Parvicardium exiguum	0.00	1.58	2.02	6.04	2.30	27.09
Rissoa auriscalpium	1.44	0.00	1.95	0.87	2.22	29.31
Rissoa splendida	0.00	1.45	1.91	0.96	2.17	31.49
Tricolia pullus	1.42	0.00	1.90	0.90	2.16	33.65
Mangelia sp1	0.00	1.51	1.88	0.97	2.14	35.79
Alvania cimex	1.23	0.45	1.70	1.01	1.94	37.73
Striarca lactea	1.41	0.00	1.70	1.22	1.93	39.66
Cardita trapezia	1.28	0.00	1.69	0.96	1.92	41.58
Granulina marginata	0.08	1.32	1.61	2.58	1.83	43.41
Rissoa ventricosa	0.19	1.23	1.54	1.08	1.75	45.17
Cerithium vulgatum	0.04	1.23	1.53	0.99	1.75	46.92

Species	Tyrrenhian stations Average Abundance	Adriatic stations Average Abundance	Average Dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulations of contributions to dissimilarity %
Mangelia sp2	0.00	1.23	1.53	0.97	1.75	48.66
Gouldia minima	1.53	2.33	1.53	1.46	1.75	50.41
Bittium reticulatum	0.79	0.00	1.20	0.45	1.36	51.77
Jujubinus striatus	0.17	0.90	1.17	1.00	1.34	53.11
Euspira pulchella	0.38	0.87	1.12	1.10	1.27	54.38
Raphitoma linearis	0.96	0.00	1.12	1.02	1.27	55.66
Thyasira flexuosa	0.00	0.84	1.10	0.96	1.25	56.91
Pusillina radiata	0.29	0.87	1.09	1.18	1.25	58.16
Muricopsis cristata	0.98	0.00	1.09	0.73	1.24	59.40
Melanella boscii	0.00	0.87	1.08	0.97	1.24	60.64

Tab. 124 – Results of the SIMPER analysis representing the breakdown of average dissimilarity between the Tyrrhenian and the Adriatic stations

9.2 Discussion

9.2.1 Secche di Tor Paterno community

The rhizome layer of the *Posidonia oceanica* meadows and patches is a rich and biodiverse environment. The biocoenosis hosts in Secche di Tor Paterno 88 species of shelled molluscs (55.4% of the whole diversity) and the mean number of species per sample is 35 and this suggests a high heterogeneity to highlight that the sorting technique discarded specimens below 1 mm. This implies that some diverse but minute groups like Pyramidellidae may be under-represented and global richness under-estimated.

A high contribution to the biodiversity of this community is given by specialized carnivores. This group accounts for up to 24.1% of the species richness. This group is characterized by *taxa* like Fissurellidae, Triphoridae, Cerithiopsidae, Eulimidae, Pyramidellidae. Triphoridae in particular is represented by 6 species, a high percentage of the overall infralittoral Mediterranean fauna. In this environment some very rare species were found like *Hanleya hanleyi*, *Obesula marisnostri*, *Mathilda gemmulata* which may find in the sciaphilous condition of the rhizomes an habitat similar to the deeper water one where these species are usually found.

The richness of the rhizome layer can be due to several factors:

- The sciaphilous habitat which is the most suitable to most molluscs;
- The heterogeneity of the substratum of the Secche di Tor Paterno, were hard substratum covered by the coralligenous is intermixed with pure rhizome habitat;
- The greater habitat heterogeneity which allows for a multiplicity of niches and interactions bringing to a more complex community.

The two stations which were sampled have *Posidonia oceanica* settled on different substrata. Station 7 has *Posidonia* settled on a hard substratum mostly covered by coralligenous concretions, while station 9 has *Posidonia* settled in a sedimentary pool. Despite no statistical significant differences were found between these two stations (ANOSIM, PERMANOVA, $p>0.05$), an in-depth analysis of the community suggests that there are differences in terms of dominant species and feeding guilds: species typical of soft substrata (which are also filter feeders) dominate in station 9 like *Turritella turbona*, *Papillicardium papillosum* and *Gouldia minima* while species usually associated to hard substrata dominate in station 7 like *Bittium latreillii*, *Muricopsis cristata*, *Striarca lactea* which show more diverse feeding guilds. The further dominance of

species of soft substratum affinity may also justify the outsiding of replicate SP6 in the cluster diagram (Fig. 32) and MDS plot (Fig. 33).

The richness of carnivores is sustained by a rich diversity of other species. For example, polychaetes represent a good share of the community and are the probable food of Turridae which are here represented by 10 species (11% of the whole rhizomes diversity).

Comparison with the characteristic species cited in literature (Harmelin, 1964 for the mattes; Pérès & Picard, 1964 for the coralligenous) shows little consistency. Only *Venus verrucosa* is present as typical species of the mattes and *Lima lima* as characteristic of the coralligenous.

9.2.2 Comparison with other data sets

The diversity of species can achieve remarkable numbers in the rhizomes with peaks of 54 species per sample in Secche di Tor Paterno. This is a special case however, since the *Posidonia* patches lay in a coralligenous substratum which certainly help enriching the rhizomes community due to the presence of ecoclines. Most other samples have a species abundance between 15 and 30 species per sample.

Shannon diversity is at its highest in Secche di Tor Paterno where values are all above 2.6 and 50% of samples have it above 3. Again this is probably the result of an ecoclinal gradient towards the coralligenous. In any case, most other samples have Shannon index above 2. The foliar layer had significantly lower values (pag. 101) and a much lower equitability due to more significant cases of species dominance.

The dominant species in the rhizome layer is often *Bittium latreillii*: 11 samples on 18, 61.1%. The other samples show a great heterogeneity of dominant species, since every sample has a different one. The presence of dominants doesn't seem to be correlated with depth. Considering the feeding guilds, dominant species are often microalgae herbivores, but also scavengers (*Nassarius incrassatus* in Secche della Meloria), carnivores on mobile prey (*Muricopsis cristata* in Secche di Tor Paterno) and filter feeders (*Turritella turbona*, *Papillicardium papillosum* and *Gouldia minima* in Secche di Tor Paterno, *Venus verrucosa* in Hrvgada Isl.).

Moreover, microalgae herbivores are present in all samples, filter-feeders in all but one (94.4%), carnivores on mobile prey in 15 samples (83.3%), ectoparasites in 13 (72.2%), scavengers in 14 (77.8%). The other feeding guilds are present less frequently. Remarkable that despite the rhizome layer is suitable for infaunal bivalves a very low frequence and abundance of detritus feeders is present.

Quantitatively, the rhizome layer hosts a higher number of specimens than the foliar layer. However, the ability to sample this abundance is strictly dependand on the sampling technique. If the leaves are removed the effectiveness of sampling in the rhizomes is much higher and all localities where defoliation was carried out show a higher number of specimes in the rhizomes than in the leaves (Secche di Tor Paterno, Giglio Isl, Hrvgada Isl.). Secche della Meloria samples are particularly poor (7 to 45 specimens, 4 to 16 species) which is an anomaly in the context of very shallow stations, however, the very small sampling area (0.25 × 0.25 m) has certainly played a role.

The carnivorous/microalgae herbivores ratio increases with depth and shows a pattern similar to the foliar layer. This ratio is usually below 0.1 above -15 m while it grows to 2.4 at -25 m. This is probably the result of lower light irradiance. Remarkably, the station in Croatia at -11 m has a 0.8 ratio which is in the order of magnitude of deeper stations of the Tyrrhenian Sea. As already observed for the foliar layer, the rhizome layer in Croatia shows the presence of deeper water characters in shallower levels, and this may be due to reduced water transparency or other environmental factors which would deserve further study.

10 Analysis of the coralligenous species assemblage

The coralligenous biocoenosis (C, Pérès & Picard, 1964) is a typical biocoenosis of hard substrata and is characterized by two conditions:

1. The availability of hard substrata, either rocky or concretionary;
2. The sciaphilous environment and algal dominance.

Two characteristic mollusc species are cited by Pérès & Picard (1964): *Chlamys pes-felis* [*Manupecten pesfelis* (Linné, 1758)] and *Lima squamosa* [*Lima lima* (Linné, 1758)].

The coralligenous habitat is a hard substratum of biogenic origin that is mainly produced by the accumulation of calcareous encrusting algae growing in dim light conditions (Ballesteros, 2006). One of the main characters of this environment is therefore to be sciaphilic. The bioherm of coralline algae is a very complex three-dimensional structure which host living algae in the illuminated upper part of the concretions, suspension feeders in the lower part of the concretions, wall cavities and overhangs, borers inside the concretions and soft-substratum fauna in the sediment deposited in cavities and holes. Therefore, coralligenous habitat has a high microspatial heterogeneity making difficult a quantitative sampling approach. Moreover, each niche can have great variation in environmental factors (e.g. light, water movement and sedimentation rates) adding to the great heterogeneity of the assemblage.

Coralligenous extends from -15/20 m to the deeper circalittoral (120 m circa). In Secche di Tor Paterno samples come from shallow water compared to the bathymetric tolerance of the habitat since samples come from -20/27 m.

Fifteen facies are described for this biocoenosis (Giaccone et al., 2009). Three are encountered in the Secche di Tor Paterno:

- association with *Eunicella singularis* (Esper, 1791), on horizontal and sub-horizontal substrata;
- association with *Eunicella cavolinii* (Koch, 1887) on the walls and underside of boulders;
- association with *Paramuricea clavata* (Risso, 1826) on the reef drop-offs below 30 m.

This habitat exists in the Mediterranean Sea only and it is of conservation concern due to its biodiversity and the heavy anthropogenic pressures the Mediterranean coastal environments experience. The habitat is considered within the 1170 “Reefs” habitat of the Directive 92/43/CE “Habitat” and therefore sites with this habitat can be considered for inclusion in the Natura 2000 network (European Commission – DG Environment, 2007). Moreover, it is considered important for conservation by the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention. Moreover, this habitat is reported to be the second most important hot spot of species diversity in the Mediterranean Sea after the *Posidonia oceanica* meadows (Boudouresque, 2004) which have enjoyed much more research.

Most of the published literature on this habitat is from the north-western Mediterranean: Banyuls-sur-Mer (Laubier, 1966), Marseille (Hong, 1980), Islas Medas (Gili & Ros, 1984). Some further work has been carried out on the very peculiar North Adriatic coralligenous outcrops called “tegnue” (see Casellato & Stefanon, 2008 for a review). The Tyrrhenian Sea coralligenous assemblages were not studied much. Virgilio *et al.* (2006) analyzed the spatial and temporal variations of epibenthic assemblages at Calafuria, south of Livorno, but biodiversity reports lack.

The molluscan assemblages in particular were studied in the Mediterranean France locations (Laubier, 1966; Hong, 1980; Huelin & Ros, 1984), in Mediterranean Spain (Martin *et al*., 1990, Salas & Hergueta, 1986) but no similar works are available for infralittoral coralligenous reefs in the Tyrrhenian Sea.

Sampling of the coralligenous biocoenosis in Secche di Tor Paterno was carried out in September 1992 by Università La Sapienza (1993) by scraping of 20 × 20 cm area in 5 stations between 21 and 37 meters deep. Forty species (2 were nudibranchs) and 449 specimens (2 nudibranchs) were recorded alive.

10.1 Results

10.1.1 Habitat description

The coralligenous biocoenosis was the most studied since it covers most of the reefs. Eighteen replicates belonging to 6 stations were done. Most stations have the same kind of horizontal coralligenous substratum with *Eunicella* spp. at depths from -20 to -27m. A single station, number 2 (replicates S4-5-6), was placed on a vertical wall with *Eunicella* spp. and *Paramuricea clavata*.

Every single 1 m^2 sampling area may have a pretty different effective surface because of the extremely variable presence of crevices, stones, holes which characterize the coralligenous.

10.1.2 The molluscan community

The species collected in the coralligenous and their abundance are given in Tab. 125 (stations 1, 2, 3) and Tab. 126 (stations 4, 10, 11).

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
1	*Lepidopleurus cajetanus*	MG [256]	0	0	0	0	0	0	0	0	0
2	*Callochiton septemvalvis*	MG [256]	1	0	3	0	2	1	1	3	1
3	*Chiton corallinus*	MG [256]	1	0	0	2	0	0	3	1	1
4	*Acanthochitona crinita*	MG [256]	0	0	0	0	0	0	0	0	0
5	*Polyplacophora* sp.	MG [256]	1	0	0	0	0	0	0	0	0
6	*Diodora graeca*	E [257]	1	0	0	0	2	0	1	0	0
7	*Diodora* sp.	E [257]	0	0	0	0	0	0	3	0	0
8	*Emarginula octaviana*	E [258]	1	0	0	0	0	0	0	1	0
9	*Emarginula punctulum*	E [258]	0	1	0	0	0	0	0	0	0
10	*Emarginula rosea*	E [259]	0	0	0	0	0	0	1	0	0
11	*Emarginula sicula*	E [258]	0	0	0	0	0	0	0	0	0
12	*Emarginella huzardii*	E [258]	0	0	0	1	0	0	0	0	0
13	*Scissurella costata*	MG [260]	1	2	3	0	0	0	0	0	0
14	*Haliotis tuberculata lamellosa*	AG [261]	0	0	1	0	0	0	0	0	0
15	*Clanculus corallinus*	MG [262]	0	0	2	2	0	0	0	0	0
16	*Clanculus cruciatus*	MG [262]	0	0	0	0	0	0	0	0	0
17	*Jujubinus exasperatus*	MG [263]	0	0	0	0	0	0	0	0	0
18	*Jujubinus striatus*	MG [264]	1	0	1	0	0	0	0	0	0
19	*Calliostoma conulum*	MG [14]	1	0	0	1	1	0	0	0	0

[256] Dell'Angelo *et al.*, 2001

[257] Fretter *et al.*, 1976 for *Diodora apertura* (Montagu, 1803) [= *Diodora graeca*]

[258] Fretter *et al.*, 1976 for all congeneric species

[259] Fretter *et al.*, 1976

[260] Fretter *et al.*, 1976 for the congeneric *Anatoma crispata* (Fleming, 1828) [*Scissurella*]

[261] Fretter *et al.*, 1976

[262] Beesley *et al*., 1998 for Trochinae

[263] Fretter *et al*., 1977

[264] Peduzzi, 1987

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
20	*Danilia tinei*	MG [265]	0	0	0	0	0	0	1	2	0
21	*Bolma rugosa*	MG [266]	2	0	1	1	0	0	0	0	0
22	*Homalopoma sanguineum*	MG [267]	0	0	1	0	0	0	1	3	0
23	*Cerithium vulgatum*	MG [268]	1	0	0	0	0	0	2	0	0
24	*Bittium latreillii*	MG [269]	35	10	14	9	35	2	34	24	21
25	*Bittium* sp. 1	MG [270]	1	0	0	0	0	0	0	0	1
26	*Bittium* sp. 3	MG [270]	0	0	0	0	0	0	0	0	0
27	*Petalopoma elisabettae*	F [271]	0	0	0	0	0	0	0	0	0
28	*Turritella turbona*	F [272]	0	0	0	0	0	0	2	2	0
29	*Marshallora adversa*	E [273]	3	2	0	2	2	1	1	1	0
30	*Monophorus erythrosoma*	E [273]	2	0	0	1	3	0	3	1	0
31	*Monophorus perversus*	E [273]	1	0	0	0	0	0	0	0	0
32	*Monophorus thiriotae*	E [273]	2	0	0	0	1	0	0	0	0
33	*Obesula marisnostri*	E [273]	0	0	0	0	0	0	1	0	0
34	*Similiphora similior*	E [273]	0	0	0	0	0	0	0	0	0
35	*Metaxia metaxae*	E [273]	5	0	1	9	2	0	6	3	0
36	*Cerithiopsis nana*	E [274]	2	0	0	0	1	0	1	0	0
37	*Cerithiopsis nofronii*	E [274]	0	0	0	0	0	0	0	0	0
38	*Cerithiopsis* sp. 1	E [274]	0	0	0	1	0	0	1	1	0
39	*Dizoniopsis coppolae*	E [274]	0	0	0	0	0	0	0	0	0
40	*Sticteulima jeffreysiana*	E [275]	0	0	0	0	0	0	0	0	0
41	*Pusillina inconspicua*	MG [276]	0	0	0	0	2	0	0	0	0
42	*Pusillina philippi*	MG [277]	0	0	0	0	1	0	0	0	0
43	*Pusillina* sp.	MG [277]	0	0	3	0	0	0	0	0	0
44	*Alvania cancellata*	MG [278]	5	2	4	0	5	0	4	5	0
45	*Alvania cimex*	MG [279]	0	0	0	0	0	0	0	0	0
46	*Alvania discors*	MG [279]	1	0	0	0	0	0	0	0	1

[265] Fretter *et al*., 1977 for the systematically close Trochidae

[266] Beu *et al.*, 1979

[267] Due to the absence of specific references, it is hypothesized the same feeding guild of *Bolma rugosa*, despite they belong to different subfamilies, Colloniinae and Turbininae respectively, within Turbinidae.

[268] Houbrick, 1992, for congeneric Indo-Pacific species.

[269] Russo *et al*., 2002.

[270] Fretter *et al.*, 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778)

[271] Schiaparelli, 2002

[272] Fretter *et al.*, 1981 for the congeneric *Turritella communis* Risso, 1826.

[273] Bouchet, 1984

[274] Fretter *et al.*, 1982 for the congeneric *Cerithiopsis tubercularis* (Montagu, 1803)

[275] Waren, 1983

[276] Fretter *et al.*, 1978

[277] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[278] Fretter *et al.*, 1978

[279] Fretter *et al.*, 1978 for all congeneric species

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
47	*Alvania geryonia*	MG [279]	0	0	0	0	2	0	0	0	0
48	*Alvania hispidula*	MG [279]	2	0	0	0	3	1	1	0	1
49	*Alvania lineata*	MG [279]	0	0	0	0	0	0	1	0	0
50	*Alvania settepassii*	MG [279]	2	0	2	0	2	0	1	1	3
51	*Alvania tenera*	MG [279]	0	0	0	0	1	0	0	0	0
52	*Crisilla beniamina*	MG [280]	0	0	0	0	0	0	0	0	0
53	*Manzonia crassa*	MG [281]	0	0	0	0	4	0	0	0	0
54	*Rissoina bruguieri*	MG [282]	2	0	0	0	0	0	0	0	0
55	*Caecum subannulatum*	MG [283]	1	0	0	0	0	0	0	0	0
56	*Parastrophia asturiana*	MG [284]	0	0	0	0	1	0	0	0	0
57	*Crepidula* sp.	F [285]	0	0	0	0	0	0	0	0	0
58	*Trivia arctica*	E [286]	0	0	0	0	0	0	0	1	0
59	*Luria lurida*	E [287]	0	0	0	0	0	0	0	0	0
60	*Euspira pulchella*	C [288]	0	0	0	0	0	0	0	0	0
61	*Dermomurex scalaroides*	C [289]	0	0	0	0	1	0	0	0	0
62	*Ocinebrina aciculata*	C [290]	1	0	0	0	0	0	0	1	0
63	*Muricopsis aradasii*	C [289]	0	0	0	2	0	0	0	1	0
64	*Muricopsis cristata*	C [289]	17	0	4	8	6	5	4	10	0
65	*Typhinellus labiatus*	C [289]	0	0	0	0	0	0	0	0	0
66	*Coralliophila meyendorffii*	E [291]	1	0	0	2	0	0	2	3	0
67	*Mitra cornicula*	C [292]	2	0	2	1	2	0	1	3	0
68	*Vexillum ebenus*	C [293]	0	0	0	0	0	0	0	0	0
69	*Vexillum savignyi*	C [293]	1	0	0	1	0	0	1	1	0
70	*Vexillum tricolor*	C [293]	2	1	0	0	0	0	0	3	0
71	*Euthria corneum*	C [294]	0	0	0	1	0	0	0	0	0

[280] Fretter *et al.*, 1978 for the congeneric *Crisilla semistriata* (Montagu, 1808) (referred as *Cingula semistriata*)

[281] Fretter *et al.*, 1978 for *Alvania crassa* [= *Manzonia crassa*]

[282] Beesley *et al*., 1998 for Rissoidae

[283] Fretter *et al*., 1978 for the congeneric *Caecum trachea* (Montagu, 1803) [referred as *Caecum imperforatum* (Kanmacher, 1798)]

[284] Supposed to be a detritus feeder like *Caecum trachea* (Montagu, 1803) (see note 283), despite belonging to the other subfamily Ctiloceratinae (see note 283) (Montagu, 1803))

[285] Fretter *et al.*, 1981 for the congeneric *Crepidula fornicata* (Linné, 1758) "microphagous mucous feeder"

[286] Fretter *et al.*, 1981

[287] Doneddu *et al.*, 1993

[288] Fretter *et al.*, 1981 for all Naticidae

[289] Fretter *et al*., 1981 for all Muricidae *sensu stricto* (excluding, for example, Coralliphilinae)

[290] Fretter *et al.*, 1984

[291] Oliverio, 1989

[292] Beesley *et al.*, 1998 for Mitridae

[293] Beesley *et al.*, 1998 for Costellariidae

[294] Fretter *et al*., 1984 for all Buccinidae.

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
72	*Chauvetia* aff *brunnea*	C [295]	7	0	0	0	0	0	0	0	0
73	*Chauvetia recondita*	C [296]	0	0	0	1	1	0	2	0	0
74	*Pollia dorbignyi*	C [294]	0	0	0	0	0	0	0	0	0
75	*Pollia scabra*	C [294]	7	0	4	6	4	6	3	7	1
76	*Nassarius incrassatus*	SC [297]	19	3	5	8	14	3	5	6	0
77	*Columbella rustica*	AG [298]	0	0	0	0	0	0	0	0	0
78	*Mitrella coccinea*	C [299]	1	0	0	0	0	1	0	0	0
79	*Mitrella gervillii*	C [299]	0	0	0	0	0	0	0	0	0
80	*Mitrella scripta*	C [299]	5	0	0	0	0	0	2	5	1
81	*Fusinus pulchellus*	C [300]	4	0	2	6	0	1	4	7	1
82	*Clathromangelia granum*	C [301]	2	0	0	0	1	0	0	0	0
83	*Mangelia scabrida*	C [301]	2	0	0	1	1	0	0	0	0
84	*Mangelia stossiciana*	C [301]	1	0	0	0	0	0	0	0	0
85	*Mangelia vauquelini*	C [301]	1	1	1	2	0	0	0	0	0
86	*Raphitoma concinna*	C [301]	0	0	0	0	0	0	0	0	0
87	*Raphitoma leufroyi*	C [301]	2	0	0	0	0	0	0	0	0
88	*Raphitoma linearis*	C [301]	9	1	2	2	7	0	6	4	1
89	*Raphitoma* sp. 1	C [301]	0	0	0	0	0	0	0	0	0
90	*Raphitoma* sp. 2	C [301]	0	0	0	0	0	0	0	0	0
91	*Raphitoma* sp. 3	C [301]	0	0	0	0	0	0	0	0	0
92	*Chrysallida excavata*	E [302]	0	0	0	0	0	0	0	0	0
93	*Chrysallida suturalis*	E [302]	2	0	0	0	0	0	0	0	0
94	*Odostomella doliolum*	E [303]	2	0	0	1	8	0	1	0	0
95	*Turbonilla gradata*	E [303]	1	0	0	0	0	0	0	0	0
96	*Clathrella clathrata*	E [303]	0	0	0	0	0	0	1	0	0
97	*Haminoea* sp.	MG [304]	0	0	0	0	0	0	0	0	0
98	*Weinkauffia turgidula*	MG [305]	0	0	0	0	0	0	0	0	0
99	*Williamia gussonii*	AG [306]	1	0	2	0	0	0	0	1	0

[295] Fretter *et al.*, 1984

[296] Fretter *et al.*, 1984 for the congeneric *Chauvetia brunnea* (Donovan, 1804)

[297] Fretter *et al*., 1984

[298] deMaintenon, 1999 for most Columbellinae

[299] Kantor *et al.*, 1991 for *Mitrella burchardi* (Dunker, 1877), Japan Sea

[300] Beesley *et al*., 1998 for Fasciolariidae

[301] Fretter *et al*., 1984 for all "Turridae" *sensu lato*

[302] Fretter *et al.*, 1986

[303] Fretter *et al.*, 1986 for Pyramidellacea

[304] Boulch-Bleas, 1983 for *Haminoea hydatis* (Linné, 1758); Malaquias *et al.*, 2004 for the congeneric lusitanic species *Haminoea orbignyana* (de Férussac, 1822)

[305] Beesley *et al*., 1998 for Haminoeidae

[306] Beesley *et al*., 1998 for Siphonariidae

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
100	*Nucula* sp.	D [307]	1	0	4	0	1	0	3	0	0
101	*Barbatia barbata*	F [308]	0	0	0	0	0	0	3	0	1
102	*Striarca lactea*	F [308]	0	1	1	8	3	1	4	3	3
103	*Gregariella semigranata*	F [308]	1	1	0	1	2	1	1	0	0
104	*Lithophaga lithophaga*	F [308]	0	0	0	1	0	1	0	0	0
105	*Chlamys flexuosa*	F [308]	0	0	1	0	0	0	1	0	0
106	*Chlamys glabra*	F [308]	1	0	0	0	0	0	0	0	0
107	*Crassadoma multistriata*	F [308]	0	0	0	1	0	2	3	1	0
108	*Lima lima*	F [308]	0	0	4	1	2	0	0	1	0
109	*Limaria hians*	F [308]	0	0	0	0	2	0	0	0	0
110	*Limaria tuberculata*	F [308]	1	0	0	1	0	0	0	0	0
111	*Galeomma turtoni*	F [309]	0	0	0	0	0	1	0	4	0
112	*Kellia suborbicularis*	F [310]	0	0	0	0	0	0	0	0	0
113	*Montacuta* sp.	F [311]	1	0	0	0	0	0	0	0	0
114	*Parvicardium scriptum*	F [312]	0	0	0	2	0	0	0	2	0
115	*Papillicardium papillosum*	F [312]	1	0	0	3	1	0	1	0	0
116	*Tellina tenuis*	D [313]	0	0	0	0	0	0	0	0	0
117	*Arcopagia balaustina*	D [313]	0	0	1	0	0	0	2	0	0
118	*Abra* sp.	D [314]	0	0	1	0	0	0	0	0	0
119	*Venus verrucosa*	F [315]	0	0	0	0	0	0	0	0	0
120	*Gouldia minima*	F [315]	2	0	0	0	0	0	0	0	0
121	*Hiatella arctica*	F [316]	0	0	0	0	0	0	0	1	0
122	*Thracia distorta*	F [317]	0	0	0	0	0	0	0	0	0
123	Bivalvia sp. (broken shell)	F [318]	0	0	0	1	0	0	0	0	0
	TOTAL NUMBER OF SPECIMENS		173	25	70	90	126	27	119	113	37

Tab. 125 – Quali-quantitative data of the coralligenous samples, Secche di Tor Paterno (Part I – Stations 1, 2, 3)

[307] Beesley *et al*., 1998 for Nuculidae

[308] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[309] Beesley *et al*., 1998 for Galeommatidae

[310] Beesley *et al*., 1998, considered within Galeommatidae

[311] Beesley *et al*., 1998 for Galeommatoidea

[312] Beesley *et al*., 1998 for the whole family Cardiidae

[313] Beesley *et al*., 1998 for the whole family Tellinidae, Psammobiidae (with the exception of the Eastern Pacific *Nuttallia nuttallii* (Conrad, 1837))

[314] Hughes, 1973 for *Abra tenuis* (Montagu, 1803)

[315] Beesley *et al*., 1998 for the whole family Veneridae

[316] Gofas, 2009a

[317] Beesley *et al*., 1998 for Thracioidea

[318] The most common feeding guild in bivalves

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
1	*Lepidopleurus cajetanus*	MG	0	0	0	2	0	0	0	0	0
2	*Callochiton septemvalvis*	MG	3	2	1	4	2	0	6	3	2
3	*Chiton corallinus*	MG	2	0	1	0	2	1	0	1	0
4	*Acanthochitona crinita*	MG	0	1	0	1	0	0	0	0	0
5	*Polyplacophora* sp.	MG	0	0	0	0	0	0	0	0	0
6	*Diodora graeca*	E	0	0	0	2	1	0	0	0	1
7	*Diodora* sp.	E	0	0	0	0	0	0	0	0	0
8	*Emarginula octaviana*	E	0	0	0	0	0	1	0	0	0
9	*Emarginula punctulum*	E	0	0	0	0	0	0	1	1	0
10	*Emarginula rosea*	E	0	0	0	0	0	0	0	0	0
11	*Emarginula sicula*	E	0	0	0	0	0	0	1	0	0
12	*Emarginella huzardii*	E	0	0	0	0	0	0	1	0	1
13	*Scissurella costata*	MG	1	0	0	0	0	0	0	0	0
14	*Haliotis tuberculata lamellosa*	AG	1	0	0	0	1	0	1	1	0
15	*Clanculus corallinus*	MG	2	0	3	0	0	4	0	0	2
16	*Clanculus cruciatus*	MG	0	0	0	0	0	3	2	0	0
17	*Jujubinus exasperatus*	MG	0	0	2	0	1	0	0	1	1
18	*Jujubinus striatus*	MG	0	0	0	0	0	0	0	0	0
19	*Calliostoma conulum*	MG	0	0	0	0	0	0	0	0	0
20	*Danilia tinei*	MG	0	4	0	0	0	0	1	0	0
21	*Bolma rugosa*	MG	0	1	0	0	0	1	0	1	0
22	*Homalopoma sanguineum*	MG	0	1	1	0	0	0	0	0	1
23	*Cerithium vulgatum*	MG	0	0	0	0	0	4	0	1	1
24	*Bittium latreillii*	MG	32	43	11	26	0	37	43	15	35
25	*Bittium* sp. 1	MG	2	3	2	4	1	0	1	0	0
26	*Bittium* sp. 3	MG	0	2	0	1	0	0	0	0	1
27	*Petalopoma elisabettae*	F	0	0	0	0	0	0	0	1	1
28	*Turritella turbona*	F	0	0	0	0	1	0	0	0	0
29	*Marshallora adversa*	E	2	5	1	1	0	3	4	1	0
30	*Monophorus erythrosoma*	E	2	2	1	0	0	2	1	2	0
31	*Monophorus perversus*	E	0	1	0	2	0	0	0	1	0
32	*Monophorus thiriotae*	E	0	0	0	1	0	0	1	1	0
33	*Obesula marisnostri*	E	0	0	0	0	0	0	0	0	0
34	*Similiphora similior*	E	0	1	0	0	0	0	0	0	0
35	*Metaxia metaxae*	E	2	2	3	1	0	4	5	3	1
36	*Cerithiopsis nana*	E	0	1	0	1	0	1	0	0	1
37	*Cerithiopsis nofronii*	E	0	0	0	0	0	0	1	0	0
38	*Cerithiopsis* sp. 1	E	1	1	0	3	1	0	0	2	1
39	*Dizoniopsis coppolae*	E	0	0	0	1	0	0	0	0	0
40	*Sticteulima jeffreysiana*	E	0	0	0	0	0	0	0	0	1
41	*Pusillina inconspicua*	MG	0	0	0	2	0	0	0	0	0
42	*Pusillina philippi*	MG	0	0	0	0	0	0	0	0	0

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
43	*Pusillina* sp.	MG	0	0	0	0	0	0	0	0	0
44	*Alvania cancellata*	MG	24	10	0	16	0	3	5	9	1
45	*Alvania cimex*	MG	0	1	0	0	0	0	0	0	0
46	*Alvania discors*	MG	0	0	0	0	0	0	0	0	0
47	*Alvania geryonia*	MG	0	0	0	0	0	0	0	0	0
48	*Alvania hispidula*	MG	2	2	0	7	0	1	2	0	0
49	*Alvania lineata*	MG	1	5	0	0	0	1	1	0	2
50	*Alvania settepassii*	MG	1	5	0	5	0	0	2	1	0
51	*Alvania tenera*	MG	0	1	0	4	0	0	0	0	0
52	*Crisilla beniamina*	MG	0	0	0	1	0	0	0	0	0
53	*Manzonia crassa*	MG	0	0	0	3	0	0	0	0	0
54	*Rissoina bruguieri*	MG	0	0	0	0	0	0	0	0	0
55	*Caecum subannulatum*	MG	0	0	0	0	0	0	0	0	0
56	*Parastrophia asturiana*	MG	0	0	0	0	0	0	0	0	0
57	*Crepidula* sp.	F	0	0	0	0	0	0	0	0	1
58	*Trivia arctica*	E	0	0	0	0	0	0	0	0	0
59	*Luria lurida*	E	0	0	0	0	0	1	0	0	0
60	*Euspira pulchella*	C	0	0	0	0	0	0	0	0	1
61	*Dermomurex scalaroides*	C	0	0	0	0	0	0	0	0	0
62	*Ocinebrina aciculata*	C	0	0	1	0	1	4	0	0	1
63	*Muricopsis aradasii*	C	0	0	1	0	0	0	0	0	0
64	*Muricopsis cristata*	C	7	1	2	4	4	5	3	7	2
65	*Typhinellus labiatus*	C	0	0	0	0	0	0	1	0	0
66	*Coralliophila meyendorffii*	E	0	0	0	0	0	0	0	0	0
67	*Mitra cornicula*	C	1	1	0	3	1	3	0	1	2
68	*Vexillum ebenus*	C	0	0	0	0	0	1	0	1	0
69	*Vexillum savignyi*	C	0	1	0	1	0	3	0	4	4
70	*Vexillum tricolor*	C	2	2	1	0	0	0	1	4	2
71	*Euthria corneum*	C	0	0	0	0	0	0	0	0	0
72	*Chauvetia* aff *brunnea*	C	0	0	0	1	0	0	0	0	0
73	*Chauvetia recondita*	C	0	0	0	0	0	1	0	0	0
74	*Pollia dorbignyi*	C	0	1	0	0	0	0	0	0	0
75	*Pollia scabra*	C	5	3	4	5	8	6	3	8	2
76	*Nassarius incrassatus*	SC	9	7	3	19	16	25	4	8	7
77	*Columbella rustica*	AG	0	0	0	0	0	1	0	1	0
78	*Mitrella coccinea*	C	0	0	0	0	0	0	0	0	0
79	*Mitrella gervillii*	C	0	0	0	0	0	0	0	1	0
80	*Mitrella scripta*	C	2	0	1	2	4	9	3	3	5
81	*Fusinus pulchellus*	C	3	2	2	1	1	0	1	3	0
82	*Clathromangelia granum*	C	0	0	0	0	0	1	1	0	0
83	*Mangelia scabrida*	C	2	1	1	1	0	0	3	4	2
84	*Mangelia stossiciana*	C	0	0	0	0	0	0	1	0	0

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
85	*Mangelia vauquelini*	C	2	0	1	1	0	3	0	2	0
86	*Raphitoma concinna*	C	0	0	0	0	1	0	0	0	1
87	*Raphitoma leufroyi*	C	1	1	0	0	0	1	0	0	0
88	*Raphitoma linearis*	C	10	4	2	2	2	1	2	9	5
89	*Raphitoma* sp. 1	C	0	0	1	0	0	0	0	0	0
90	*Raphitoma* sp. 2	C	0	0	0	0	0	0	0	1	0
91	*Raphitoma* sp. 3	C	0	0	0	0	0	0	1	0	0
92	*Chrysallida excavata*	E	0	0	0	1	0	0	0	0	0
93	*Chrysallida suturalis*	E	0	0	0	0	0	0	0	0	0
94	*Odostomella doliolum*	E	0	0	1	1	0	0	0	0	0
95	*Turbonilla gradata*	E	0	0	0	0	0	0	0	0	0
96	*Clathrella clathrata*	E	0	0	0	0	0	0	0	0	0
97	*Haminoea* sp.	MG	0	0	0	1	0	0	0	0	0
98	*Weinkauffia turgidula*	MG	0	0	0	1	0	0	0	0	0
99	*Williamia gussonii*	AG	1	0	0	0	2	3	3	1	3
100	*Nucula* sp.	D	0	3	0	2	2	0	1	1	0
101	*Barbatia barbata*	F	0	0	0	2	0	3	1	1	2
102	*Striarca lactea*	F	0	0	1	18	3	1	0	4	1
103	*Gregariella semigranata*	F	0	0	0	2	0	1	0	2	0
104	*Lithophaga lithophaga*	F	0	0	0	0	1	1	0	0	2
105	*Chlamys flexuosa*	F	0	0	0	0	0	0	0	0	0
106	*Chlamys glabra*	F	0	0	0	0	0	0	0	0	0
107	*Crassadoma multistriata*	F	0	1	0	0	2	1	0	0	2
108	*Lima lima*	F	0	0	0	0	1	2	3	0	1
109	*Limaria hians*	F	0	0	0	1	2	1	1	0	0
110	*Limaria tuberculata*	F	0	0	0	0	0	0	0	1	0
111	*Galeomma turtoni*	F	0	0	0	1	1	1	0	0	0
112	*Kellia suborbicularis*	F	0	0	0	0	0	0	1	0	0
113	*Montacuta* sp.	F	0	0	0	0	0	0	0	0	0
114	*Parvicardium scriptum*	F	0	1	0	0	0	0	0	1	1
115	*Papillicardium papillosum*	F	1	0	1	0	0	2	3	4	1
116	*Tellina tenuis*	D	1	0	0	0	0	0	0	0	0
117	*Arcopagia balaustina*	D	0	0	0	0	0	0	0	0	0
118	*Abra* sp.	D	0	0	0	0	0	0	0	1	0
119	*Venus verrucosa*	F	0	0	0	0	0	1	1	0	0
120	*Gouldia minima*	F	0	0	0	0	0	4	1	2	0
121	*Hiatella arctica*	F	0	0	0	1	0	1	0	1	0
122	*Thracia distorta*	F	0	0	0	0	0	0	0	1	0
123	Bivalvia sp. (broken shell)	F	0	0	0	0	0	0	0	0	0
	TOTAL NUMBER OF SPECIMENS		125	123	49	159	62	153	118	122	101

Tab. 126 – Quali-quantitative data of the coralligenous sampels, Secche di Tor Paterno (Part II – Stations 4, 10, 11)

In terms of species diversity, the coralligenous hosts the richest species assemblage with 123 species, 77.4% of the whole Secche di Tor Paterno fauna.

The richness of the coralligenous is due to the richness of niches and interactions. The mixture of hard substrata and soft enclaves, the richness of sessile species (sponges, gorgonians,…), the sciaphilous conditions which are the most suitable to molluscs help boosting molluscan diversity.

The dendrogram in Fig. 39 fails to cluster together more than two replicates from the same station (e.g. S7 and S8, S10 and S12) while many replicates from different stations are pooled together. The MDS in Fig. 39 confirms this confused pattern and the lack of statistically significant differences within the biocoenosis described in par 7.1.2 is confirmed (ANOSIM, $p<0.05$). The MDS stress is not low, but the high dimensionality of the original data constrained in a two dimensional plot is probably the main cause of this. However, the cross-check with the cluster dendrogram confirms the overall conclusions.

The samples of station 2 (S4, S5, S6) which is the only station on a vertical wall rather than on a horizontal reef are spread around too and this does suggest their species assemblage is not different from the others.

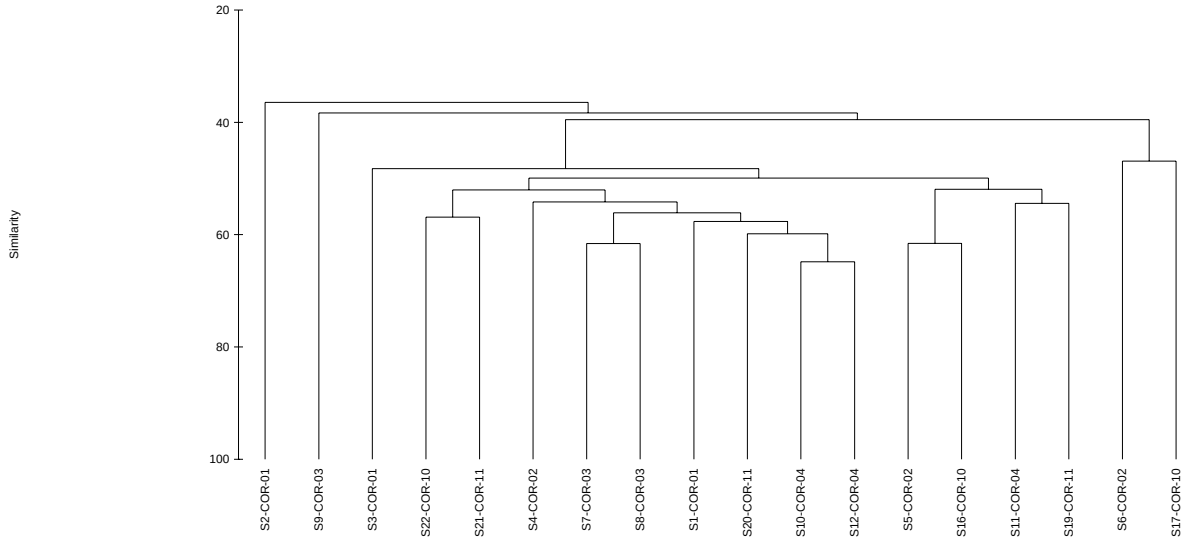


Fig. 39 – Dendrogram for hierarchical clustering of all replicates from coralligenous stations (standardized data, square root transform, Bray-Curtis similarity coefficient, group-average linkage); labels are replicates codes

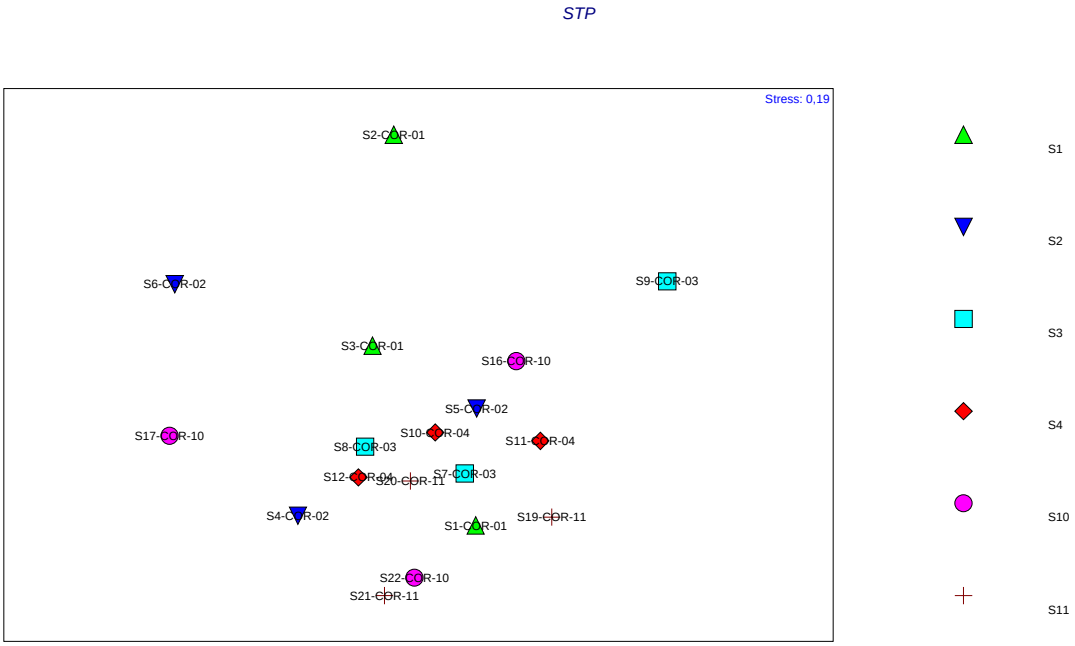


Fig. 40 - Non metric Multi-Dimensional Scaling plot of coralligenous replicates (10 restarts), different symbols and colours represent different stations

10.1.3 Mollusca community structure

By a population structure point of view, species richness along replicates varies from 11 to 53, with a mean of 32 species per sample. Shannon diversity index ranges from 1.705 to 3.370 and evenness (J') ranges from 0.665 to 0.905.

Replicate[319]	S	H'	J'
S1-COR-01	53	3.250	0.818
S2-COR-01	11	2.000	0.834
S3-COR-01	26	2.950	0.905
S4-COR-02	33	3.107	0.889
S5-COR-02	34	2.879	0.816
S6-COR-02	14	2.375	0.900
S7-COR-03	40	3.073	0.833
S8-COR-03	33	3.031	0.867
S9-COR-03	13	1.705	0.665
S10-COR-04	29	2.640	0.784
S11-COR-04	35	2.754	0.775
S12-COR-04	25	2.897	0.900
S16-COR-10	43	3.111	0.827
S17-COR-10	25	2.755	0.856
S22-COR-10	42	2.998	0.802

[319] Here replicates are coded in this way: first the replicate code, then the biocoenosis code and last the station code. For example, sample S1-COR-01 is the sample S1 collected in the coralligenous biocoenosis in station 01

Replicate[319]	S	H'	J'
S19-COR-11	39	2.836	0.774
S20-COR-11	44	3.370	0.891
S21-COR-11	37	2.850	0.789

Tab. 127 – Biodiversity indices values for coralligenous samples, Secche di Tor Paterno

Diversity and equitability indices are influenced by dominance phenomena (Tab. 128 and Tab. 129, see Tab. 130 Tab. 131 for a synthesis). The high values of the Shannon index and of the evenness index suggest there are not strong dominance phenomena. The analysis of species dominance confirm this.

Only *Bittium latreillii* attains a dominance of 56.8% in a single sample (S9), but in the other replicates its dominance decreases down to 7.4% (S6) with a mean of 24.4%. Accordingly, S9 is the sample with the lowest Shannon and evenness indices. However, *B. latreillii* is the dominant species in 16 replicates. In the two samples where it is not the dominant species, *Nassarius incrassatus* and *Pollia scabra* substitute it. *Metaxia metaxae* attain the same dominance of *B. latreillii* in sample S4. *N. incrassatus* is the second most abundant species in 8 samples while *Alvania cancellata*, *Raphitoma linearis* and *Striarca lactea* occasionally show up as the second most abundant species.

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
1	*Lepidopleurus cajetanus*	MG	-	-	-	-	-	-	-	-	-
2	*Callochiton septemvalvis*	MG	0.6%	-	4.3%	-	1.6%	3.7%	0.8%	2.7%	2.7%
3	*Chiton corallinus*	MG	0.6%	-	-	2.2%	-	-	2.5%	0.9%	2.7%
4	*Acanthochitona crinita*	MG	-	-	-	-	-	-	-	-	-
5	*Polyplacophora* sp.	MG	0.6%	-	-	-	-	-	-	-	-
6	*Diodora graeca*	E	0.6%	-	-	-	1.6%	-	0.8%	-	-
7	*Diodora* sp.	E	-	-	-	-	-	-	2.5%	-	-
8	*Emarginula octaviana*	E	0.6%	-	-	-	-	-	-	0.9%	-
9	*Emarginula punctulum*	E	-	4.0%	-	-	-	-	-	-	-
10	*Emarginula rosea*	E	-	-	-	-	-	-	0.8%	-	-
11	*Emarginula sicula*	E	-	-	-	-	-	-	-	-	-
12	*Emarginella huzardii*	E	-	-	-	1.1%	-	-	-	-	-
13	*Scissurella costata*	MG	0.6%	8.0%	4.3%	-	-	-	-	-	-
14	*Haliotis tuberculata lamellosa*	AG	-	-	1.4%	-	-	-	-	-	-
15	*Clanculus corallinus*	MG	-	-	2.9%	2.2%	-	-	-	-	-
16	*Clanculus cruciatus*	MG	-	-	-	-	-	-	-	-	-
17	*Jujubinus exasperatus*	MG	-	-	-	-	-	-	-	-	-
18	*Jujubinus striatus*	MG	0.6%	-	1.4%	-	-	-	-	-	-
19	*Calliostoma conulum*	MG	0.6%	-	-	1.1%	0.8%	-	-	-	-
20	*Danilia tinei*	MG	-	-	-	-	-	-	0.8%	1.8%	-
21	*Bolma rugosa*	MG	1.2%	-	1.4%	1.1%	-	-	-	-	-
22	*Homalopoma sanguineum*	MG	-	-	1.4%	-	-	-	0.8%	2.7%	-
23	*Cerithium vulgatum*	MG	0.6%	-	-	-	-	-	1.7%	-	-
24	*Bittium latreillii*	MG	20.2%	40.0%	20.0%	10.0%	27.8%	7.4%	28.6%	21.2%	56.8%
25	*Bittium* sp. 1	MG	0.6%	-	-	-	-	-	-	-	2.7%
26	*Bittium* sp. 3	MG	-	-	-	-	-	-	-	-	-

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
27	*Petalopoma elisabettae*	F	-	-	-	-	-	-	-	-	-
28	*Turritella turbona*	F	-	-	-	-	-	-	1.7%	1.8%	-
29	*Marshallora adversa*	E	1.7%	8.0%	-	2.2%	1.6%	3.7%	0.8%	0.9%	-
30	*Monophorus erythrosoma*	E	1.2%	-	-	1.1%	2.4%	-	2.5%	0.9%	-
31	*Monophorus perversus*	E	0.6%	-	-	-	-	-	-	-	-
32	*Monophorus thiriotae*	E	1.2%	-	-	-	0.8%	-	-	-	-
33	*Obesula marisnostri*	E	-	-	-	-	-	-	0.8%	-	-
34	*Similiphora similior*	E	-	-	-	-	-	-	-	-	-
35	*Metaxia metaxae*	E	2.9%	-	1.4%	10.0%	1.6%	-	5.0%	2.7%	-
36	*Cerithiopsis nana*	E	1.2%	-	-	-	0.8%	-	0.8%	-	-
37	*Cerithiopsis nofronii*	E	-	-	-	-	-	-	-	-	-
38	*Cerithiopsis* sp. 1	E	-	-	-	1.1%	-	-	0.8%	0.9%	-
39	*Dizoniopsis coppolae*	E	-	-	-	-	-	-	-	-	-
40	*Sticteulima jeffreysiana*	E	-	-	-	-	-	-	-	-	-
41	*Pusillina inconspicua*	MG	-	-	-	-	1.6%	-	-	-	-
42	*Pusillina philippi*	MG	-	-	-	-	0.8%	-	-	-	-
43	*Pusillina* sp.	MG	-	-	4.3%	-	-	-	-	-	-
44	*Alvania cancellata*	MG	2.9%	8.0%	5.7%	-	4.0%	-	3.4%	4.4%	-
45	*Alvania cimex*	MG	-	-	-	-	-	-	-	-	-
46	*Alvania discors*	MG	0.6%	-	-	-	-	-	-	-	2.7%
47	*Alvania geryonia*	MG	-	-	-	-	1.6%	-	-	-	-
48	*Alvania hispidula*	MG	1.2%	-	-	-	2.4%	3.7%	0.8%	-	2.7%
49	*Alvania lineata*	MG	-	-	-	-	-	-	0.8%	-	-
50	*Alvania settepassii*	MG	1.2%	-	2.9%	-	1.6%	-	0.8%	0.9%	8.1%
51	*Alvania tenera*	MG	-	-	-	-	0.8%	-	-	-	-
52	*Crisilla beniamina*	MG	-	-	-	-	-	-	-	-	-
53	*Manzonia crassa*	MG	-	-	-	-	3.2%	-	-	-	-
54	*Rissoina bruguieri*	MG	1.2%	-	-	-	-	-	-	-	-
55	*Caecum subannulatum*	MG	0.6%	-	-	-	-	-	-	-	-
56	*Parastrophia asturiana*	MG	-	-	-	-	0.8%	-	-	-	-
57	*Crepidula* sp.	F	-	-	-	-	-	-	-	-	-
58	*Trivia arctica*	E	-	-	-	-	-	-	-	0.9%	-
59	*Luria lurida*	E	-	-	-	-	-	-	-	-	-
60	*Euspira pulchella*	C	-	-	-	-	-	-	-	-	-
61	*Dermomurex scalaroides*	C	-	-	-	-	0.8%	-	-	-	-
62	*Ocinebrina aciculata*	C	0.6%	-	-	-	-	-	-	0.9%	-
63	*Muricopsis aradasii*	C	-	-	-	2.2%	-	-	-	0.9%	-
64	*Muricopsis cristata*	C	9.8%	-	5.7%	8.9%	4.8%	18.5%	3.4%	8.8%	-
65	*Typhinellus labiatus*	C	-	-	-	-	-	-	-	-	-
66	*Coralliophila meyendorffii*	E	0.6%	-	-	2.2%	-	-	1.7%	2.7%	-
67	*Mitra cornicula*	C	1.2%	-	2.9%	1.1%	1.6%	-	0.8%	2.7%	-
68	*Vexillum ebenus*	C	-	-	-	-	-	-	-	-	-

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
69	*Vexillum savignyi*	C	0.6%	-	-	1.1%	-	-	0.8%	0.9%	-
70	*Vexillum tricolor*	C	1.2%	4.0%	-	-	-	-	-	2.7%	-
71	*Euthria corneum*	C	-	-	-	1.1%	-	-	-	-	-
72	*Chauvetia* aff *brunnea*	C	4.0%	-	-	-	-	-	-	-	-
73	*Chauvetia recondita*	C	-	-	-	1.1%	0.8%	-	1.7%	-	-
74	*Pollia dorbignyi*	C	-	-	-	-	-	-	-	-	-
75	*Pollia scabra*	C	4.0%	-	5.7%	6.7%	3.2%	22.2%	2.5%	6.2%	2.7%
76	*Nassarius incrassatus*	SC	11.0%	12.0%	7.1%	8.9%	11.1%	11.1%	4.2%	5.3%	-
77	*Columbella rustica*	AG	-	-	-	-	-	-	-	-	-
78	*Mitrella coccinea*	C	0.6%	-	-	-	-	3.7%	-	-	-
79	*Mitrella gervillii*	C	-	-	-	-	-	-	-	-	-
80	*Mitrella scripta*	C	2.9%	-	-	-	-	-	1.7%	4.4%	2.7%
81	*Fusinus pulchellus*	C	2.3%	-	2.9%	6.7%	-	3.7%	3.4%	6.2%	2.7%
82	*Clathromangelia granum*	C	1.2%	-	-	-	0.8%	-	-	-	-
83	*Mangelia scabrida*	C	1.2%	-	-	1.1%	0.8%	-	-	-	-
84	*Mangelia stossiciana*	C	0.6%	-	-	-	-	-	-	-	-
85	*Mangelia vauquelini*	C	0.6%	4.0%	1.4%	2.2%	-	-	-	-	-
86	*Raphitoma concinna*	C	-	-	-	-	-	-	-	-	-
87	*Raphitoma leufroyi*	C	1.2%	-	-	-	-	-	-	-	-
88	*Raphitoma linearis*	C	5.2%	4.0%	2.9%	2.2%	5.6%	-	5.0%	3.5%	2.7%
89	*Raphitoma* sp. 1	C	-	-	-	-	-	-	-	-	-
90	*Raphitoma* sp. 2	C	-	-	-	-	-	-	-	-	-
91	*Raphitoma* sp. 3	C	-	-	-	-	-	-	-	-	-
92	*Chrysallida excavata*	E	-	-	-	-	-	-	-	-	-
93	*Chrysallida suturalis*	E	1.2%	-	-	-	-	-	-	-	-
94	*Odostomella doliolum*	E	1.2%	-	-	1.1%	6.3%	-	0.8%	-	-
95	*Turbonilla gradata*	E	0.6%	-	-	-	-	-	-	-	-
96	*Clathrella clathrata*	E	-	-	-	-	-	-	0.8%	-	-
97	*Haminoea* sp.	MG	-	-	-	-	-	-	-	-	-
98	*Weinkauffia turgidula*	MG	-	-	-	-	-	-	-	-	-
99	*Williamia gussonii*	AG	0.6%	-	2.9%	-	-	-	-	0.9%	-
100	*Nucula* sp.	D	0.6%	-	5.7%	-	0.8%	-	2.5%	-	-
101	*Barbatia barbata*	F	-	-	-	-	-	-	2.5%	-	2.7%
102	*Striarca lactea*	F	-	4.0%	1.4%	8.9%	2.4%	3.7%	3.4%	2.7%	8.1%
103	*Gregariella semigranata*	F	0.6%	4.0%	-	1.1%	1.6%	3.7%	0.8%	-	-
104	*Lithophaga lithophaga*	F	-	-	-	1.1%	-	3.7%	-	-	-
105	*Chlamys flexuosa*	F	-	-	1.4%	-	-	-	0.8%	-	-
106	*Chlamys glabra*	F	0.6%	-	-	-	-	-	-	-	-
107	*Crassadoma multistriata*	F	-	-	-	1.1%	-	7.4%	2.5%	0.9%	-
108	*Lima lima*	F	-	-	5.7%	1.1%	1.6%	-	-	0.9%	-
109	*Limaria hians*	F	-	-	-	-	1.6%	-	-	-	-
110	*Limaria tuberculata*	F	0.6%	-	-	1.1%	-	-	-	-	-

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
111	*Galeomma turtoni*	F	-	-	-	-	-	3.7%	-	3.5%	-
112	*Kellia suborbicularis*	F	-	-	-	-	-	-	-	-	-
113	*Montacuta* sp.	F	0.6%	-	-	-	-	-	-	-	-
114	*Parvicardium scriptum*	F	-	-	-	2.2%	-	-	-	1.8%	-
115	*Papillicardium papillosum*	F	0.6%	-	-	3.3%	0.8%	-	0.8%	-	-
116	*Tellina tenuis*	D	-	-	-	-	-	-	-	-	-
117	*Arcopagia balaustina*	D	-	-	1.4%	-	-	-	1.7%	-	-
118	*Abra* sp.	D	-	-	1.4%	-	-	-	-	-	-
119	*Venus verrucosa*	F	-	-	-	-	-	-	-	-	-
120	*Gouldia minima*	F	1.2%	-	-	-	-	-	-	-	-
121	*Hiatella arctica*	F	-	-	-	-	-	-	-	0.9%	-
122	*Thracia distorta*	F	-	-	-	-	-	-	-	-	-
123	Bivalvia sp. (broken shell)	F	-	-	-	1.1%	-	-	-	-	-

Tab. 128 – Species dominance in the coralligenous samples, Secche di Tor Paterno (part I, stations 1, 2, 3)

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
1	*Lepidopleurus cajetanus*	MG	-	-	-	1.3%	-	-	-	-	-
2	*Callochiton septemvalvis*	MG	2.4%	1.6%	2.0%	2.5%	3.2%	-	5.1%	2.5%	2.0%
3	*Chiton corallinus*	MG	1.6%	-	2.0%	-	3.2%	0.7%	-	0.8%	-
4	*Acanthochitona crinita*	MG	-	0.8%	-	0.6%	-	-	-	-	-
5	*Polyplacophora* sp.	MG	-	-	-	-	-	-	-	-	-
6	*Diodora graeca*	E	-	-	-	1.3%	1.6%	-	-	-	1.0%
7	*Diodora* sp.	E	-	-	-	-	-	-	-	-	-
8	*Emarginula octaviana*	E	-	-	-	-	-	0.7%	-	-	-
9	*Emarginula punctulum*	E	-	-	-	-	-	-	0.8%	0.8%	-
10	*Emarginula rosea*	E	-	-	-	-	-	-	-	-	-
11	*Emarginula sicula*	E	-	-	-	-	-	-	0.8%	-	-
12	*Emarginella huzardii*	E	-	-	-	-	-	-	0.8%	-	1.0%
13	*Scissurella costata*	MG	0.8%	-	-	-	-	-	-	-	-
14	*Haliotis tuberculata lamellosa*	AG	0.8%	-	-	-	1.6%	-	0.8%	0.8%	-
15	*Clanculus corallinus*	MG	1.6%	-	6.1%	-	-	2.6%	-	-	2.0%
16	*Clanculus cruciatus*	MG	-	-	-	-	-	2.0%	1.7%	-	-
17	*Jujubinus exasperatus*	MG	-	-	4.1%	-	1.6%	-	-	0.8%	1.0%
18	*Jujubinus striatus*	MG	-	-	-	-	-	-	-	-	-
19	*Calliostoma conulum*	MG	-	-	-	-	-	-	-	-	-
20	*Danilia tinei*	MG	-	3.3%	-	-	-	-	0.8%	-	-
21	*Bolma rugosa*	MG	-	0.8%	-	-	-	0.7%	-	0.8%	-
22	*Homalopoma sanguineum*	MG	-	0.8%	2.0%	-	-	-	-	-	1.0%
23	*Cerithium vulgatum*	MG	-	-	-	-	-	2.6%	-	0.8%	1.0%
24	*Bittium latreillii*	MG	25.6%	35.0%	22.4%	16.4%	-	24.2%	36.4%	12.3%	34.7%
25	*Bittium* sp. 1	MG	1.6%	2.4%	4.1%	2.5%	1.6%	-	0.8%	-	-

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
26	*Bittium* sp. 3	MG	-	1.6%	-	0.6%	-	-	-	-	1.0%
27	*Petalopoma elisabettae*	F	-	-	-	-	-	-	-	0.8%	1.0%
28	*Turritella turbona*	F	-	-	-	-	1.6%	-	-	-	-
29	*Marshallora adversa*	E	1.6%	4.1%	2.0%	0.6%	-	2.0%	3.4%	0.8%	-
30	*Monophorus erythrosoma*	E	1.6%	1.6%	2.0%	-	-	1.3%	0.8%	1.6%	-
31	*Monophorus perversus*	E	-	0.8%	-	1.3%	-	-	-	0.8%	-
32	*Monophorus thiriotae*	E	-	-	-	0.6%	-	-	0.8%	0.8%	-
33	*Obesula marisnostri*	E	-	-	-	-	-	-	-	-	-
34	*Similiphora similior*	E	-	0.8%	-	-	-	-	-	-	-
35	*Metaxia metaxae*	E	1.6%	1.6%	6.1%	0.6%	-	2.6%	4.2%	2.5%	1.0%
36	*Cerithiopsis nana*	E	-	0.8%	-	0.6%	-	0.7%	-	-	1.0%
37	*Cerithiopsis nofronii*	E	-	-	-	-	-	-	0.8%	-	-
38	*Cerithiopsis* sp. 1	E	0.8%	0.8%	-	1.9%	1.6%	-	-	1.6%	1.0%
39	*Dizoniopsis coppolae*	E	-	-	-	0.6%	-	-	-	-	-
40	*Sticteulima jeffreysiana*	E	-	-	-	-	-	-	-	-	1.0%
41	*Pusillina inconspicua*	MG	-	-	-	1.3%	-	-	-	-	-
42	*Pusillina philippi*	MG	-	-	-	-	-	-	-	-	-
43	*Pusillina* sp.	MG	-	-	-	-	-	-	-	-	-
44	*Alvania cancellata*	MG	19.2%	8.1%	-	10.1%	-	2.0%	4.2%	7.4%	1.0%
45	*Alvania cimex*	MG	-	0.8%	-	-	-	-	-	-	-
46	*Alvania discors*	MG	-	-	-	-	-	-	-	-	-
47	*Alvania geryonia*	MG	-	-	-	-	-	-	-	-	-
48	*Alvania hispidula*	MG	1.6%	1.6%	-	4.4%	-	0.7%	1.7%	-	-
49	*Alvania lineata*	MG	0.8%	4.1%	-	-	-	0.7%	0.8%	-	2.0%
50	*Alvania settepassii*	MG	0.8%	4.1%	-	3.1%	-	-	1.7%	0.8%	-
51	*Alvania tenera*	MG	-	0.8%	-	2.5%	-	-	-	-	-
52	*Crisilla beniamina*	MG	-	-	-	0.6%	-	-	-	-	-
53	*Manzonia crassa*	MG	-	-	-	1.9%	-	-	-	-	-
54	*Rissoina bruguieri*	MG	-	-	-	-	-	-	-	-	-
55	*Caecum subannulatum*	MG	-	-	-	-	-	-	-	-	-
56	*Parastrophia asturiana*	MG	-	-	-	-	-	-	-	-	-
57	*Crepidula* sp.	F	-	-	-	-	-	-	-	-	1.0%
58	*Trivia arctica*	E	-	-	-	-	-	-	-	-	-
59	*Luria lurida*	E	-	-	-	-	-	0.7%	-	-	-
60	*Euspira pulchella*	C	-	-	-	-	-	-	-	-	1.0%
61	*Dermomurex scalaroides*	C	-	-	-	-	-	-	-	-	-
62	*Ocinebrina aciculata*	C	-	-	2.0%	-	1.6%	2.6%	-	-	1.0%
63	*Muricopsis aradasii*	C	-	-	2.0%	-	-	-	-	-	-
64	*Muricopsis cristata*	C	5.6%	0.8%	4.1%	2.5%	6.5%	3.3%	2.5%	5.7%	2.0%
65	*Typhinellus labiatus*	C	-	-	-	-	-	-	0.8%	-	-
66	*Coralliophila meyendorffii*	E	-	-	-	-	-	-	-	-	-
67	*Mitra cornicula*	C	0.8%	0.8%	-	1.9%	1.6%	2.0%	-	0.8%	2.0%

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
68	*Vexillum ebenus*	C	-	-	-	-	-	0.7%	-	0.8%	-
69	*Vexillum savignyi*	C	-	0.8%	-	0.6%	-	2.0%	-	3.3%	4.0%
70	*Vexillum tricolor*	C	1.6%	1.6%	2.0%	-	-	-	0.8%	3.3%	2.0%
71	*Euthria corneum*	C	-	-	-	-	-	-	-	-	-
72	*Chauvetia* aff *brunnea*	C	-	-	-	0.6%	-	-	-	-	-
73	*Chauvetia recondita*	C	-	-	-	-	-	0.7%	-	-	-
74	*Pollia dorbignyi*	C	-	0.8%	-	-	-	-	-	-	-
75	*Pollia scabra*	C	4.0%	2.4%	8.2%	3.1%	12.9%	3.9%	2.5%	6.6%	2.0%
76	*Nassarius incrassatus*	SC	7.2%	5.7%	6.1%	11.9%	25.8%	16.3%	3.4%	6.6%	6.9%
77	*Columbella rustica*	AG	-	-	-	-	-	0.7%	-	0.8%	-
78	*Mitrella coccinea*	C	-	-	-	-	-	-	-	-	-
79	*Mitrella gervillii*	C	-	-	-	-	-	-	-	0.8%	-
80	*Mitrella scripta*	C	1.6%	-	2.0%	1.3%	6.5%	5.9%	2.5%	2.5%	5.0%
81	*Fusinus pulchellus*	C	2.4%	1.6%	4.1%	0.6%	1.6%	-	0.8%	2.5%	-
82	*Clathromangelia granum*	C	-	-	-	-	-	0.7%	0.8%	-	-
83	*Mangelia scabrida*	C	1.6%	0.8%	2.0%	0.6%	-	-	2.5%	3.3%	2.0%
84	*Mangelia stossiciana*	C	-	-	-	-	-	-	0.8%	-	-
85	*Mangelia vauquelini*	C	1.6%	-	2.0%	0.6%	-	2.0%	-	1.6%	-
86	*Raphitoma concinna*	C	-	-	-	-	1.6%	-	-	-	1.0%
87	*Raphitoma leufroyi*	C	0.8%	0.8%	-	-	-	0.7%	-	-	-
88	*Raphitoma linearis*	C	8.0%	3.3%	4.1%	1.3%	3.2%	0.7%	1.7%	7.4%	5.0%
89	*Raphitoma* sp. 1	C	-	-	2.0%	-	-	-	-	-	-
90	*Raphitoma* sp. 2	C	-	-	-	-	-	-	-	0.8%	-
91	*Raphitoma* sp. 3	C	-	-	-	-	-	-	0.8%	-	-
92	*Chrysallida excavata*	E	-	-	-	0.6%	-	-	-	-	-
93	*Chrysallida suturalis*	E	-	-	-	-	-	-	-	-	-
94	*Odostomella doliolum*	E	-	-	2.0%	0.6%	-	-	-	-	-
95	*Turbonilla gradata*	E	-	-	-	-	-	-	-	-	-
96	*Clathrella clathrata*	E	-	-	-	-	-	-	-	-	-
97	*Haminoea* sp.	MG	-	-	-	0.6%	-	-	-	-	-
98	*Weinkauffia turgidula*	MG	-	-	-	0.6%	-	-	-	-	-
99	*Williamia gussonii*	AG	0.8%	-	-	-	3.2%	2.0%	2.5%	0.8%	3.0%
100	*Nucula* sp.	D	-	2.4%	-	1.3%	3.2%	-	0.8%	0.8%	-
101	*Barbatia barbata*	F	-	-	-	1.3%	-	2.0%	0.8%	0.8%	2.0%
102	*Striarca lactea*	F	-	-	2.0%	11.3%	4.8%	0.7%	-	3.3%	1.0%
103	*Gregariella semigranata*	F	-	-	-	1.3%	-	0.7%	-	1.6%	-
104	*Lithophaga lithophaga*	F	-	-	-	-	1.6%	0.7%	-	-	2.0%
105	*Chlamys flexuosa*	F	-	-	-	-	-	-	-	-	-
106	*Chlamys glabra*	F	-	-	-	-	-	-	-	-	-
107	*Crassadoma multistriata*	F	-	0.8%	-	-	3.2%	0.7%	-	-	2.0%
108	*Lima lima*	F	-	-	-	-	1.6%	1.3%	2.5%	-	1.0%
109	*Limaria hians*	F	-	-	-	0.6%	3.2%	0.7%	0.8%	-	-

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
110	*Limaria tuberculata*	F	-	-	-	-	-	-	-	0.8%	-
111	*Galeomma turtoni*	F	-	-	-	0.6%	1.6%	0.7%	-	-	-
112	*Kellia suborbicularis*	F	-	-	-	-	-	-	0.8%	-	-
113	*Montacuta* sp.	F	-	-	-	-	-	-	-	-	-
114	*Parvicardium scriptum*	F	-	0.8%	-	-	-	-	-	0.8%	1.0%
115	*Papillicardium papillosum*	F	0.8%	-	2.0%	-	-	1.3%	2.5%	3.3%	1.0%
116	*Tellina tenuis*	D	0.8%	-	-	-	-	-	-	-	-
117	*Arcopagia balaustina*	D	-	-	-	-	-	-	-	-	-
118	*Abra* sp.	D	-	-	-	-	-	-	-	0.8%	-
119	*Venus verrucosa*	F	-	-	-	-	-	0.7%	0.8%	-	-
120	*Gouldia minima*	F	-	-	-	-	-	2.6%	0.8%	1.6%	-
121	*Hiatella arctica*	F	-	-	-	0.6%	-	0.7%	-	0.8%	-
122	*Thracia distorta*	F	-	-	-	-	-	-	-	0.8%	-
123	Bivalvia sp. (broken shell)	F	-	-	-	-	-	-	-	-	-

Tab. 129 – Species dominance in the coralligenous samples, Secche di Tor Paterno (part II, stations 4, 10, 11)

		Diet	Station 1			Station 2			Station 3		
			S1	S2	S3	S4	S5	S6	S7	S8	S9
13	*Scissurella costata*	MG	0.6%	8.0%	4.3%	-	-	-	-	-	-
24	*Bittium latreillii*	MG	20.2%	40.0%	20.0%	10.0%	27.8%	7.4%	28.6%	21.2%	56.8%
29	*Marshallora adversa*	E	1.7%	8.0%	-	2.2%	1.6%	3.7%	0.8%	0.9%	-
35	*Metaxia metaxae*	E	2.9%	-	1.4%	10.0%	1.6%	-	5.0%	2.7%	-
44	*Alvania cancellata*	MG	2.9%	8.0%	5.7%	-	4.0%	-	3.4%	4.4%	-
50	*Alvania settepassii*	MG	1.2%	-	2.9%	-	1.6%	-	0.8%	0.9%	8.1%
64	*Muricopsis cristata*	C	9.8%	-	5.7%	8.9%	4.8%	18.5%	3.4%	8.8%	-
75	*Pollia scabra*	C	4.0%	-	5.7%	6.7%	3.2%	22.2%	2.5%	6.2%	2.7%
76	*Nassarius incrassatus*	SC	11.0%	12.0%	7.1%	8.9%	11.1%	11.1%	4.2%	5.3%	-
88	*Raphitoma linearis*	C	5.2%	4.0%	2.9%	2.2%	5.6%	-	5.0%	3.5%	2.7%
102	*Striarca lactea*	F	-	4.0%	1.4%	8.9%	2.4%	3.7%	3.4%	2.7%	8.1%

Tab. 130 – Species dominance in the in the coralligenous samples, Secche di Tor Paterno, synthesis of the most dominant species (maximum dominance near to or over 8%) (part I, stations 1, 2, 3)

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
13	*Scissurella costata*	MG	0.8%	-	-	-	-	-	-	-	-
24	*Bittium latreillii*	MG	25.6%	35.0%	22.4%	16.4%	-	24.2%	36.4%	12.3%	34.7%
29	*Marshallora adversa*	E	1.6%	4.1%	2.0%	0.6%	-	2.0%	3.4%	0.8%	-
35	*Metaxia metaxae*	E	1.6%	1.6%	6.1%	0.6%	-	2.6%	4.2%	2.5%	1.0%
44	*Alvania cancellata*	MG	19.2%	8.1%	-	10.1%	-	2.0%	4.2%	7.4%	1.0%
50	*Alvania settepassii*	MG	0.8%	4.1%	-	3.1%	-	-	1.7%	0.8%	-
64	*Muricopsis cristata*	C	5.6%	0.8%	4.1%	2.5%	6.5%	3.3%	2.5%	5.7%	2.0%

		Diet	Station 4			Station 10			Station 11		
			S10	S11	S12	S16	S17	S22	S19	S20	S21
75	*Pollia scabra*	C	4.0%	2.4%	8.2%	3.1%	12.9%	3.9%	2.5%	6.6%	2.0%
76	*Nassarius incrassatus*	SC	7.2%	5.7%	6.1%	11.9%	25.8%	16.3%	3.4%	6.6%	6.9%
88	*Raphitoma linearis*	C	8.0%	3.3%	4.1%	1.3%	3.2%	0.7%	1.7%	7.4%	5.0%
102	*Striarca lactea*	F	-	-	2.0%	11.3%	4.8%	0.7%	-	3.3%	1.0%

Tab. 131 – Species dominance in the in the coralligenous samples, Secche di Tor Paterno, synthesis of the most dominant species (maximum dominance near to or over 8%) (part II, stations 4, 10, 11)

	Station 1			Station 2			Station 3		
	S1	S2	S3	S4	S5	S6	S7	S8	S9
1st dominant species	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG) *Metaxia metaxae* (E)	*Bittium latreillii* (MG)	*Pollia scabra* (C)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)
2nd dominant species	*Nassarius incrassatus* (SC)	*Nassarius incrassatus* (SC)	*Nassarius incrassatus* (SC)	*Nassarius incrassatus* (SC) *Muricopsis cristata* (C) *Striarca lactea* (F)	*Nassarius incrassatus* (SC)	*Muricopsis cristata* (C)	*Raphitoma linearis* (C)	*Muricopsis cristata* (C)	*Alvania settepassii* (MG) *Striarca lactea* (F)
	Station 4			**Station 10**			**Station 11**		
	S10	S11	S12	S16	S17	S22	S19	S20	S21
1st dominant species	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Nassarius incrassatus* (SG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)
2nd dominant species	*Alvania cancellata* (MG)	*Alvania cancellata* (MG)	*Pollia scabra* (C)	*Nassarius incrassatus* (SC)	*Pollia scabra* (C)	*Nassarius incrassatus* (SC)	*Metaxia metaxae* (E) *Alvania cancellata* (MG)	*Alvania cancellata* (MG) *Raphitoma linearis* (C)	*Nassarius incrassatus* (SC)

Tab. 132 – Comparative table of dominant species in different replicates

The analysis of feeding guilds (Tab. 133 and Tab. 134) shows that microalgae herbivores are often the dominant feeding guild (12 samples over 18) followed by carnivores on mobile prey (the remaining 6 samples). However, microalgae herbivores often show much higher percentages. Moreover, the pooling of all carnivores (C+E) reach dominance only in 6 samples, with a strikingly different pattern than in the rhizomes. In any case, ectoparasites and carnivores on preys without mobility are a remarkable element of the community. Scavengers (with the only representative *Nassarius incrassatus*) and filter-feeders (mostly bivalves) are an important component of the community since they are present in most samples with abundances ranging from 3.4% to 25.8% for scavengers and 0.8% to 22.2% for filter feeders.

Herbivores of macroalgae are a negligible component of the community, never attaining a trophic group dominance of more than 5%. No symbiont-bearing nor egg and spawn feeder species are present and of course no seagrass-feeding herbivores neither. *Mitrella minor* is therefore confined to the *Posidonia* rhizomes where it probably finds its favourite preys or the sediment fraction suitable for its survival.

In terms of number of species (Tab. 135 and Tab. 136) the importance of specialized carnivores (E) is even greater as usual for this group with high feeding specialization. The relative importance of microalgae herbivores (MG) is reduced while the importance of carnivores (C) is substantially the same.

\		Station 1			Station 2			Station 3		
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
SC	Scavengers	11.0%	12.0%	7.1%	8.9%	11.1%	11.1%	4.2%	5.3%	-
AG	Herbivores of macroalgae and epiphytes	0.6%	-	4.3%	-	-	-	-	0.9%	-
MG	Microalgae herbivores	33.5%	56.0%	48.6%	16.7%	46.8%	14.8%	41.2%	34.5%	78.4%
SG	Seagrass-feeding herbivores	-	-	-	-	-	-	-	-	-
D	Deposit feeders	0.6%	-	8.6%	-	0.8%	-	4.2%	-	-
F	Filter feeders	4.0%	8.0%	8.6%	21.1%	7.9%	22.2%	12.6%	12.4%	10.8%
SY	Symbiont-bearing species	-	-	-	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	13.3%	12.0%	1.4%	18.9%	15.1%	3.7%	18.5%	9.7%	-
C	Carnivores on mobile prey	37.0%	12.0%	21.4%	34.4%	18.3%	48.1%	19.3%	37.2%	10.8%
O	Egg and spawn feeders	-	-	-	-	-	-	-	-	-
	1st dominant guild	C	MG	MG	C	MG	C	MG	C	MG
	2nd dominant guild	MG	SC, E, C	C	F	C	F	C	MG	F, C
	1st dominant guild if C and E guilds are pooled	C+E	MG	MG	C+E	MG	C	MG	C+E	MG
Carnivorous/ microalgae herbivores ratio		1.1	0.2	0.4	2.1	0.4	3.3	0.5	1.1	0.1

Tab. 133 – Feeding guilds dominance in the coralligenous samples, Secche di Tor Paterno (part I, stations 1, 2, 3)

\		Station 4			Station 10			Station 11		
		S10	**S11**	**S12**	**S10**	**S11**	**S12**	**S10**	**S11**	**S12**
SC	Scavengers	7.2%	5.7%	6.1%	11.9%	25.8%	16.3%	3.4%	6.6%	6.9%
AG	Herbivores of macroalgae and epiphytes	1.6%	-	-	-	4.8%	2.6%	3.4%	2.5%	3.0%
MG	Microalgae herbivores	56.0%	65.9%	42.9%	49.1%	9.7%	35.9%	53.4%	26.2%	45.5%
SG	Seagrass-feeding herbivores	-	-	-	-	-	-	-	-	-
D	Deposit feeders	0.8%	2.4%	-	1.3%	3.2%	-	0.8%	1.6%	-
F	Filter feeders	0.8%	1.6%	4.1%	15.7%	17.7%	12.4%	9.3%	14.8%	11.9%
SY	Symbiont-bearing species	-	-	-	-	-	-	-	-	-

\		Station 4			Station 10			Station 11		
		S10	**S11**	**S12**	**S10**	**S11**	**S12**	**S10**	**S11**	**S12**
E	Ectoparasites and carnivores on preys without mobility	5.6%	10.6%	12.2%	8.8%	3.2%	7.8%	12.7%	9.0%	5.9%
C	Carnivores on mobile prey	28.0%	13.8%	34.7%	13.2%	35.5%	24.8%	16.9%	39.3%	26.7%
O	Egg and spawn feeders	-	-	-	-	-	-	-	-	-
	1st dominant guild	MG	MG	MG	MG	C	MG	MG	C	MG
	2nd dominant guild	C	C	C	F	SC	C	C	MG	C
	1st dominant guild if C and E guilds are pooled	MG	MG	C+E	MG	C+E	MG	MG	C+E	MG
Carnivorous/ microalgae herbivores ratio		0.5	0.2	0.8	0.3	3.7	0.7	0.3	1.5	0.6

Tab. 134 – Feeding guilds dominance in the coralligenous samples, Secche di Tor Paterno (part II, stations 4, 10, 11)

\		Station 1			Station 2			Station 3		
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
SC	Scavengers	1.9%	9.1%	3.8%	3.0%	2.9%	7.1%	2.5%	3.0%	-
AG	Herbivores of macroalgae and epiphytes	1.9%	-	7.7%	-	-	-	-	3.0%	-
MG	Microalgae herbivores	30.2%	27.3%	38.5%	15.2%	35.3%	21.4%	25.0%	21.2%	53.8%
SG	Seagrass-feeding herbivores	-	-	-	-	-	-	-	-	-
D	Deposit feeders	1.9%	-	11.5%	-	2.9%	-	5.0%	-	-
F	Filter feeders	11.3%	18.2%	11.5%	27.3%	14.7%	35.7%	17.5%	21.2%	15.4%
SY	Symbiont-bearing species	-	-	-	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	22.6%	18.2%	3.8%	21.2%	20.6%	7.1%	30.0%	21.2%	-
C	Carnivores on mobile prey	30.2%	27.3%	23.1%	33.3%	23.5%	28.6%	20.0%	30.3%	30.8%
O	Egg and spawn feeders	-	-	-	-	-	-	-	-	-

Tab. 135 – Number of species *per* feeding guilds in the coralligenous samples, Secche di Tor Paterno (part I, stations 1, 2, 3)

\		Station 1			Station 2			Station 3		
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
SC	Scavengers	3.4%	2.9%	4.0%	2.3%	4.0%	2.4%	2.6%	2.3%	2.7%
AG	Herbivores of macroalgae and epiphytes	6.9%	-	-	-	8.0%	4.8%	5.1%	6.8%	2.7%
MG	Microalgae herbivores	34.5%	40.0%	28.0%	34.9%	16.0%	21.4%	23.1%	18.2%	24.3%
SG	Seagrass-feeding herbivores	-	-	-	-	-	-	-	-	-
D	Deposit feeders	3.4%	2.9%	-	2.3%	4.0%	-	2.6%	4.5%	-
F	Filter feeders	3.4%	5.7%	8.0%	14.0%	28.0%	28.6%	17.9%	22.7%	24.3%
SY	Symbiont-bearing species	-	-	-	-	-	-	-	-	-
E	Ectoparasites and carnivores on preys without mobility	13.8%	20.0%	16.0%	23.3%	8.0%	14.3%	20.5%	15.9%	16.2%
C	Carnivores on mobile prey	34.5%	28.6%	44.0%	23.3%	32.0%	28.6%	28.2%	29.5%	29.7%
O	Egg and spawn feeders	-	-	-	-	-	-	-	-	-

Tab. 136 – Number of species *per* feeding guilds in the coralligenous samples, Secche di Tor Paterno (part II, stations 4, 10, 11)

10.1.4 Comparison with other data sets

Data from Secche di Tor Paterno have been compared with other data sets.

	Locality	**Depth**	**Sampling technique**	**Date**	**Data source**
STP	Secche di Tor Paterno	-21 (a), -29 (b), -37 (c), -26 (d), -21 (e)	Scraping of a 20 × 20 cm square area	Settembre 1992	Università La Sapienza, 1993
1	Capo San Marco, Sciacca (Agrigento)	-12m	Scraping of a 30 × 30 cm square area	August 1989	Gillone, 1990
2	Riserva Orientata dello Zingaro, Scopello (Trapani)	-24m	Scraping of a 30 × 30 cm square area	August 1989	Gillone, 1990

Tab. 137 – Data sets for comparison of Secche di Tor Paterno coralligenous assemblage

Fig. 41 – Location of comparison data sets (cfr. Tab. 137)

Luckily, a very interesting comparison data set is the one obtained by Università La Sapienza (1993) during a survey of the area. The collecting technique is different since they used scraping instead of the suction sampler, but the depth interval is similar with a station in deeper water at -37m. The sampled fauna is rather poor compared to the present work, just 40 species. Samples were taken in late summer, September 1992. Samples contained also 2 nudibranchs (*Pandorisindecora*, *Tritonia striata*) which were not considered in the analysis since the 2007 sampling concentrated on *shelled* molluscs. Stations are in different places than this study (despite station "a" is remarkably near station 11), however they are spread over the same bathymetric interval with a single deeper water station ("c") (Fig. 42).

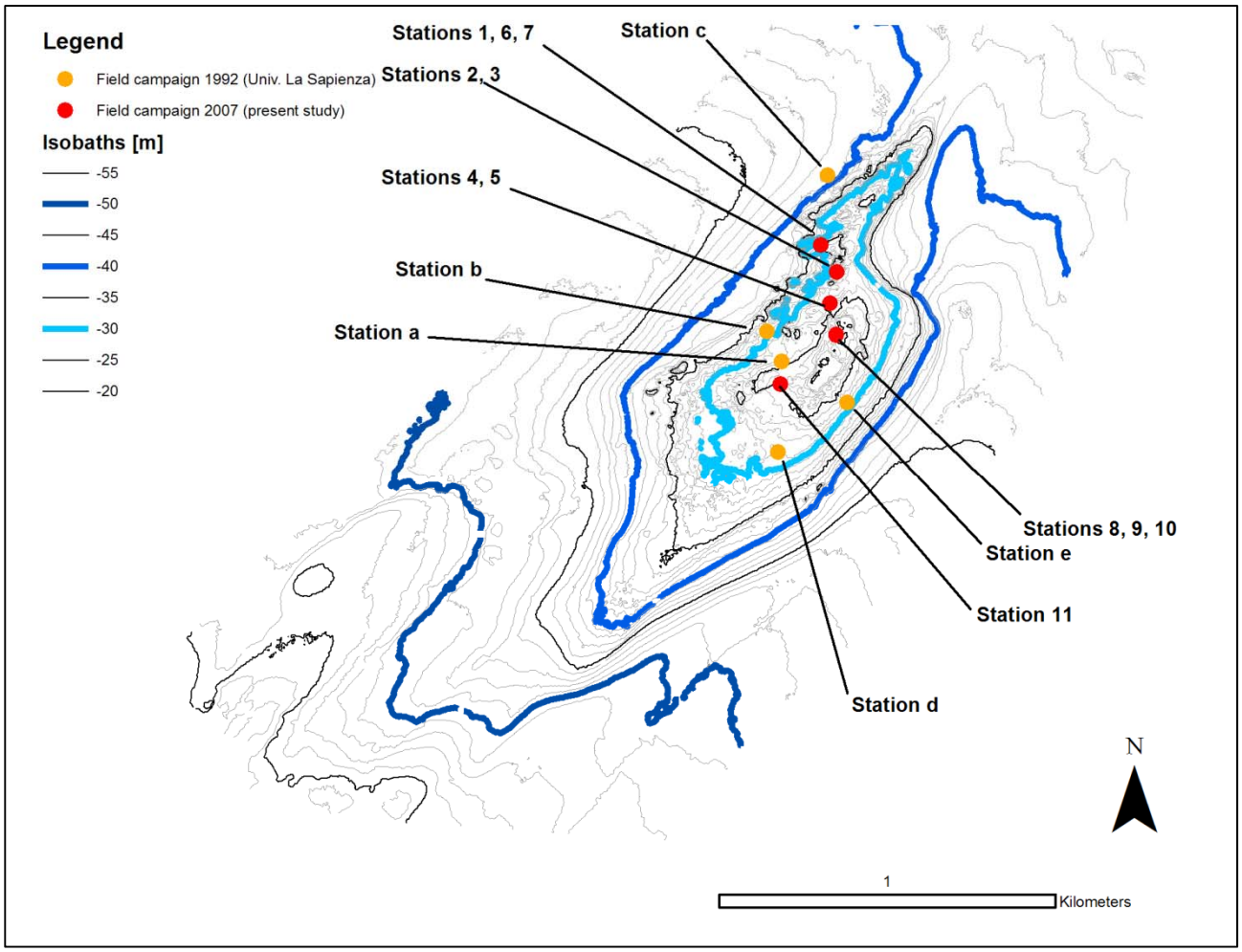


Fig. 42 – Comparison of the location of stations in surveys 1992 (Università La Sapienza) and 2007 (present study)

It has been remarkably difficult to locate further data sets for this biocoenosis from other localities for a geographical comparison.

Two data sets have been found and both come from Sicily despite in different geographic areas. The first one derives from samplings in Sciacca, on the southern shores of Sicily facing the Strait of Sicily. The second comes from the north-western part of Sicily near Scopello. It is important to highlight that the Sciacca sample was collected in a locality without any form of protection, while the Scopello sample comes from a nature reserve. Samples were collected at different depths: the Sciacca sample at -12 m while the Scopello one at -24 m, which is therefore the bathymetrically closest to the Secche di Tor Paterno samples. Both samples were collected on vertical walls, therefore being station 2 at Tor Paterno the most similar in terms of morphology of the substratum. The sampling technique is different too, since while in Secche di Tor Paterno we used the air-lift suction sampler on a 1 m^2 area the samples from Sicily come from scraping a 30 × 30 cm square area. Samples in Sicily were collected in August, while those in Secche di Tor Paterno from late May to early July.

Using scraping may imply both a difference in the quantity of material collected due to the different area sampled and both in the qualitative composition of the species because scraping allow the sampler to obtain borers (e.g. *Gastrochaena*), sessile species (e.g. *Arca*, *Barbatia* which settle by byssum or Chamidae which is cemented) or species which live deeply embedded in the coralligenous formation (e.g. Vanikoridae). This bias will be evaluated both in the statistical treatment of data (standardising samples) and in the discussion of results.

The different month of the year when sampling was carried out should not affect the analysis of the assemblage, since temporal variations on a seasonal scale in the coralligenous assemblages are reported to be low (Ballesteros, 2006; Virgilio *et al.*, 2006).

Data sets are reported in annexes 7, 8 and 9. Taxonomy has not been updated, unless useful for discussion.

10.1.4.1 Secche di Tor Paterno

The species collected in the coralligenous and their abundance are given in Tab. 138. Five samples were collected between 21 and 37 m scraping the surface of the substratum in a 20 × 20 cm square without replication. Sampling was carried out in Septemebr 1992.

		Diet	a	b	c	d	e
1	*Acanthochitona crinita*	MG [320]					2
2	*Acanthochitona fascicularis*	MG [320]		2			
3	*Callochiton septemvalvis*	MG [320]				1	
4	*Chiton phaseolinus*	MG [320]		1		1	
5	*Alvania cimex*	MG [321]	1				
6	*Alvania lineata*	MG [321]					2
7	*Bolma rugosa*	MG [322]				1	
8	*Buccinulum corneum*	C [323]					1
9	*Diodora graeca*	E [324]					1
10	*Emarginella huzardii*	E [325]		1		3	
11	*Emarginula rosea*	E [326]		1			1
12	*Haliotis tuberculata lamellosa*	AG [327]				1	
13	*Haminoea hydatis*	MG [328]		3			
14	*Homalopoma sanguineum*	MG [329]		1			
15	*Muricopsis cristata*	C [330]	2				
16	*Ocinebrina aciculata*	C [331]			1		
17	*Rissoa violacea*	MG [332]					1
18	*Weinkauffia turgidula*	MG [333]	1				
19	*Anomia ephippium*	F [334]			2	2	
20	*Barbatia barbata*	F [335]		1			

[320] Dell'Angelo *et al.*, 2001

[321] Fretter *et al.*, 1978 for all congeneric species

[322] Beu *et al.*, 1979

[323] Fretter *et al*., 1984 for all Buccinidae.

[324] Fretter *et al.*, 1976 for *Diodora apertura* (Montagu, 1803) [= *Diodora graeca*]

[325] Fretter *et al.*, 1976 for *Diodora apertura* (Montagu, 1803) [= *Diodora graeca*]

[326] Fretter *et al.*, 1976

[327] Fretter *et al.*, 1976

[328] Boulch-Bleas, 1983 for *Haminoea hydatis* (Linné, 1758); Malaquias *et al.*, 2004 for the congeneric lusitanic species *Haminoea orbignyana* (de Férussac, 1822)

[329] Due to the absence of specific references, it is hypothesized the same feeding guild of *Bolma rugosa*, despite they belong to different subfamilies, Colloniinae and Turbininae respectively, within Turbinidae.

[330] Fretter *et al*., 1981 for all Muricidae *sensu stricto* (excluding, for example, Coralliphilinae)

[331] Fretter *et al*., 1984.

[332] Fretter *et al*., 1978.

[333] Beesley *et al*., 1998 for Haminoeidae

[334] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[335] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

		Diet	a	b	c	d	e
21	*Chama gryphoides*	F [336]			1		
22	*Chlamys multistriata*	F [336]	2	1	1	1	
23	*Divaricella angulifera*	SY [337]					1
24	*Galeomma turtoni*	F [338]		2			
25	*Gouldia minima*	F [339]		2			
26	*Gregariella petagnae*	F [340]		1	1		
27	*Hiatella arctica*	F [341]	41	30	62	43	32
28	*Kellia suborbicularis*	F [342]				1	
29	*Lima exilis*	F [340]		2			
31	*Lima lima*	F [340]	2	3		3	
32	*Lithophaga lithophaga*	F [340]	4	3		3	5
33	*Modiolarca subpicta*	F [340]			13		
34	*Modiolus barbatus*	F [340]	1	2			
35	*Musculus costulatus*	F [340]	3	1			
36	*Nuculoma tenuis*	D [343]		2	2		
37	*Pseudochama gryphina*	F [336]	1	4			
38	*Striarca lactea*	F [340]	23	27	28	29	23
39	*Thracia distorta*	F [344]		2	5	4	
	TOTAL NUMBER OF SPECIMENS		81	92	116	93	69

Tab. 138 – Quali-quantitative data of the coralligenous samples, Secche di Tor Paterno (Università La Sapienza, 1993)

By a population structure point of view, species richness along samples ranges from 10 to 21. Shannon diversity index ranges from 1.363 to 2.172 and evenness from 0.592 to 0.714 (Tab. 139).

Sample	S	H'	J'
a	11	1.464	0.611
b	21	2.172	0.714
c	10	1.363	0.592
d	13	1.563	0.609
e	10	1.425	0.619

Tab. 139 – Biodiversity indices values for coralligenous samples at Secche di Tor Paterno (Università La Sapienza, 1992)

Diversity and equitability indices are influenced by dominance phenomena (Tab. 140, Tab. 141). Remarkably, all samples have *Hiatella arctica* and *Striarca lactea* as dominant species. Moreover, together

[336] Beesley *et al*., 1998 for Chamidae

[337] Taylor *et al.*, 2000 for Lucinidae

[338] Beesley *et al*., 1998 for Galeommatidae

[339] Beesley *et al*., 1998 for the whole family Veneridae

[340] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[341] Gofas, 2009a

[342] Beesley *et al*., 1998, considered within Galeommatidae

[343] Beesley *et al*., 1998 for Nuculidae

[344] Beesley *et al*., 1998 for Thracioidea

they cover 62-80% of the whole assemblage. With the only exception of *Modiolarca subpicta* in sample "c" all other species have negligible relative abundance. *Striarca lactea* and *Hiatella arctica* are bivalves which settle on hard substratum with their byssum. Truly infaunal species of soft substratum which exploit the sediment pools in the coralligenous are very limited in these samples.

		Diet	a	b	c	d	e
1	*Acanthochitona crinita*	MG	-	-	-	-	2.9%
2	*Acanthochitona fascicularis*	MG	-	2.2%	-	-	-
3	*Callochiton septemvalvis*	MG	-	-	-	1.1%	-
4	*Chiton phaseolinus*	MG	-	1.1%	-	1.1%	-
5	*Alvania cimex*	MG	1.2%	-	-	-	-
6	*Alvania lineata*	MG	-	-	-	-	2.9%
7	*Bolma rugosa*	MG	-	-	-	1.1%	-
8	*Buccinulum corneum*	C	-	-	-	-	1.4%
9	*Diodora graeca*	E	-	-	-	-	1.4%
10	*Emarginella huzardii*	E	-	1.1%	-	3.2%	-
11	*Emarginula rosea*	E	-	1.1%	-	-	1.4%
12	*Haliotis tuberculata lamellosa*	AG	-	-	-	1.1%	-
13	*Haminoea hydatis*	MG	-	3.3%	-	-	-
14	*Homalopoma sanguineum*	MG	-	1.1%	-	-	-
15	*Muricopsis cristata*	C	2.5%	-	-	-	-
16	*Ocinebrina aciculata*	C	-	-	0.9%	-	-
17	*Rissoa violacea*	MG	-	-	-	-	1.4%
18	*Weinkauffia turgidula*	MG	1.2%	-	-	-	-
19	*Anomia ephippium*	F	-	-	1.7%	2.2%	-
20	*Barbatia barbata*	F	-	1.1%	-	-	-
21	*Chama gryphoides*	F	-	-	0.9%	-	-
22	*Chlamys multistriata*	F	2.5%	1.1%	0.9%	1.1%	-
23	*Divaricella angulifera*	SY	-	-	-	-	1.4%
24	*Galeomma turtoni*	F	-	2.2%	-	-	-
25	*Gouldia minima*	F	-	2.2%	-	-	-
26	*Gregariella petagnae*	F	-	1.1%	0.9%	-	-
27	*Hiatella arctica*	F	50.6%	32.6%	53.4%	46.2%	46.4%
28	*Kellia suborbicularis*	F	-	-	-	1.1%	-
29	*Lima exilis*	F	-	2.2%	-	-	-
31	*Lima lima*	F	2.5%	3.3%	-	3.2%	-
32	*Lithophaga lithophaga*	F	4.9%	3.3%	-	3.2%	7.2%
33	*Modiolarca subpicta*	F	-	-	11.2%	-	-
34	*Modiolus barbatus*	F	1.2%	2.2%	-	-	-
35	*Musculus costulatus*	F	3.7%	1.1%	-	-	-

		Diet	a	b	c	d	e
36	*Nuculoma tenuis*	D	-	2.2%	1.7%	-	-
37	*Pseudochama gryphina*	F	1.2%	4.3%	-	-	-
38	*Striarca lactea*	F	28.4%	29.3%	24.1%	31.2%	33.3%
39	*Thracia distorta*	F	-	2.2%	4.3%	4.3%	-

Tab. 140 – Species dominance in the coralligenous samples at Secche di Tor Paterno (Università La Sapienza, 1992)

	a	b	c	d	e
1st dominant species	*Hiatella arctica* (F)	*Hiatella arctica* (F)	*Hiatella arctica* (F)	*Hiatella arctica* (F)	*Hiatella arctica* (F)
2nd dominant species	*Striarca lactea* (F)	*Striarca lactea* (F)	*Striarca lactea* (F)	*Striarca lactea* (F)	*Striarca lactea* (F)

Tab. 141 – Comparative table of dominant species in different replicates

Feeding guild analysis (Tab. 142) shows that filter feeders dominate the sample as could be supposed by the species dominance analysis. This is the same in all samples at all depths. Microalgae herbivores play a secondary role, their presence is 2.5-7.6% of the assemblage. The other groups have a negligible presence.

In terms of number of species (Tab. 143) the dominance of filter feeders highlights that other bivalve species are common in this environment, not only *Striarca lactea* and *Hiatella arctica*. However, the species analysis highlights the species diversity of other trophic groups like microalgae herbivores, ectoparasites and carnivores.

		a	b	c	d	e
SC	Scavengers	-	-	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	1.1%	-
MG	Microalgae herbivores	2.5%	7.6%	-	3.2%	7.2%
SG	Seagrass-feeding herbivores	-	-	-	-	-
D	Deposit feeders	-	2.2%	1.7%	-	-
F	Filter feeders	95.1%	88.0%	97.4%	92.5%	87.0%
SY	Symbiont-bearing species	-	-	-	-	1.4%
E	Ectoparasites and carnivores on preys without mobility	-	2.2%	-	3.2%	2.9%
C	Carnivores on mobile prey	2.5%	-	0.9%	-	1.4%
O	Egg and spawn feeders	-	-	-	-	-
	1st dominant guild	F	F	F	F	F
	2nd dominant guild	MG – C	MG	D	MG - E	MG

		a	b	c	d	e
	1st dominant guild if C and E guilds are pooled	MG – C	MG	D	MG – E	MG
Carnivorous/ microalgae herbivores ratio		1	0	-	0	0.2

Tab. 142 – Feeding guilds dominance in the coralligenous samples at Secche di Tor Paterno (Università La Sapienza, 1992)

		a	b	c	d	e
SC	Scavengers	-	-	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-	7.7%	-
MG	Microalgae herbivores	18.2%	19.0%	-	23.1%	30.0%
SG	Seagrass-feeding herbivores	-	-	-	-	-
D	Deposit feeders	-	4.8%	10.0%	-	-
F	Filter feeders	72.7%	66.7%	80.0%	61.5%	30.0%
SY	Symbiont-bearing species	-	-	-	-	10.0%
E	Ectoparasites and carnivores on preys without mobility	-	9.5%	-	7.7%	20.0%
C	Carnivores on mobile prey	9.1%	-	10.0%	-	10.0%
O	Egg and spawn feeders	-	-	-	-	-

Tab. 143 – Number of species *per* feeding guilds in the coralligenous samples at Secche di Tor Paterno (Università La Sapienza, 1992)

10.1.4.2 Capo San Marco, Sciacca (Agrigento)

The species collected in the coralligenous and their abundance are given in Tab. 144. Three samples were collected at -12 m scraping the surface of the substratum in a 30 × 30 cm square. The sampled area lied on a little illuminated vertical wall, with a fraction of mud. Sampling was carried out in August 1989.

		Diet	G1	G2	G3
1	*Lepidopleurus cajetanus*	MG [345]		1	
2	*Callochiton septemvalvis euplaeae*	MG [345]	3	2	12
3	*Chiton corallinus*	MG [345]	2		
4	*Acanthichitona crinita*	MG [345]	1		
5	*Emarginula adriatica*	E [346]	1		

[345] Dell'Angelo *et al.*, 2001

[346] Fretter *et al.*, 1976 for all congeneric species

		Diet	G1	G2	G3
6	*Scissurella costata*	MG [347]			1
7	*Haliotis tubercolata lamellosa*	AG [348]	1	1	
8	*Clanculus corallinus*	MG [349]			1
9	*Clanculus cruciatus*	MG [349]		1	
10	*Bittium jadertinum*	MG [350]			1
11	*Bittium latreillii*	MG [351]			3
12	*Alvania cingulata*	MG [352]	22	2	36
13	*Alvania semistriata*	MG [353]			7
14	*Manzonia crassa*	MG [354]	2		1
15	*Pusillina philippi*	MG [355]			1
16	*Caecum subannulatum*	MG [356]		1	
17	*Parastrophia asturiana*	MG [357]			1
18	*Trivia monacha*	E [358]		1	
19	*Marshallora adversa*	E [359]		1	
20	*Monophorus perversus*	E [359]			1
21	*Monophorus thiriotae*	E [359]		1	
22	*Metaxia metaxae*	E [359]			2
23	*Muricopsis cristata*	C [360]		1	7
24	*Ocinebrina edwardsii*	C [360]	1	2	
25	*Ocinebrina hybrida*	C [360]			2
26	*Chauvetia* sp.	C [361]			3
27	*Chauvetia lefebvrei*	C [361]		1	1
28	*Pollia dorbignyi*	C [362]		1	
29	*Pollia scabra*	C [362]			5
31	*Fasciolaria lignaria*	C [363]			1

[347] Fretter *et al.*, 1976 for the congeneric *Anatoma crispata* (Fleming, 1828) [*Scissurella*]

[348] Fretter *et al.*, 1976

[349] Beesley *et al*., 1998 for Trochinae

[350] Fretter *et al.*, 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778)

[351] Russo *et al*., 2002

[352] Fretter *et al.*, 1978 for all congeneric species

[353] Fretter *et al.*, 1978

[354] Fretter *et al.*, 1978 for *Alvania crassa* [= *Manzonia crassa*]

[355] Fretter *et al*., 1978 for the congeneric *Pusillina inconspicua* (Alder, 1844).

[356] Fretter *et al*., 1978 for the congeneric *Caecum trachea* (Montagu, 1803) [referred as *Caecum imperforatum* (Kanmacher, 1798)]

[357] Supposed to be a detritus feeder like *Caecum trachea* (Montagu, 1803) (see note 283), despite belonging to the other subfamily Ctiloceratinae (see note 283) (Montagu, 1803))

[358] Fretter *et al.*, 1981

[359] Bouchet, 1984

[360] Fretter *et al*., 1981 for all Muricidae *sensu stricto* (excluding, for example, Coralliphilinae)

[361] Fretter *et al.*, 1984 for the congeneric *Chauvetia brunnea* (Donovan, 1804)

[362] Fretter *et al*., 1984 for all Buccinidae.

[363] Beesley *et al*., 1998 for Fasciolariidae

		Diet	G1	G2	G3
32	*Nassarius incrassatus*	SC [364]	3		2
33	*Columbella rustica*	AG [365]	1		1
34	*Mitrella scripta*	C [366]			1
35	*Gibberula caelata*	C [367]			2
36	*Conus mediterraneus*	C [368]		1	
37	*Bela* sp.	C [369]	1		
38	*Mangeliella taeniata*	C [369]			1
39	*Raphitoma purpurea*	C [369]			1
40	*Raphitoma leufroyi*	C [369]			2
41	*Folinella excavata*	E [370]		2	
42	*Williamia gussonii*	AG [371]		1	2
43	*Nucula nucleus*	D [372]	1		
44	*Arca noae*	F [373]			1
45	*Barbatia barbata*	F [373]	4	1	2
46	*Striarca lactea*	F [373]	19	5	2
47	*Glycymeris* sp.	F [373]	2		
48	*Musculus costulatus*	F [373]			1
49	*Rhomboidella prideauxi*	F [373]			2
50	*Lithophaga lithophaga*	F [373]	1		2
51	*Modiolula phaseolina*	F [373]	2		1
52	*Ctena decussata*	SY [374]	1		
53	*Chama gryphoides*	F [375]	2	1	3
54	*Pseudochama gryphina*	F [375]	1		2
55	*Galeomma turtoni*	F [376]			1
56	*Kellia suborbicularis*	F [377]	2	1	5
57	*Parvicardium ovale*	F [378]			2
58	*Plagiocardium papillosum*	F [378]	1		

[364] Fretter *et al*., 1984

[365] deMaintenon, 1999 for most Columbellinae

[366] Kantor *et al.*, 1991 for *Mitrella burchardi* (Dunker, 1877), Japan Sea

[367] Beesley *et al*., 1998 for "marginellids" (Marginellidae and Cystiscidae)

[368] Taylor, 1987

[369] Fretter *et al*., 1984 for all "Turridae" *sensu lato*

[370] Fretter *et al.*, 1986

[371] Beesley *et al*., 1998 for Siphonariidae

[372] Beesley *et al*., 1998 for Nuculidae

[373] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[374] Taylor *et al.*, 2000 for Lucinidae

[375] Beesley *et al*., 1998 for Chamidae

[376] Beesley *et al*., 1998 for Galeommatidae

[377] Beesley *et al*., 1998, considered within Galeommatidae

[378] Beesley *et al*., 1998 for the whole family Cardiidae

		Diet	G1	G2	G3
59	*Abra alba*	D [379]	2		4
60	*Chamelea gallina*	F [380]		1	
61	*Gastrochaena dubia*	F [381]	3		
62	*Hiatella rugosa*	F [382]	8	3	24
	TOTAL NUMBER OF SPECIMENS		87	32	150

Tab. 144 – Quali-quantitative data of the coralligenous samples, Capo San Marco, Sciacca (Agrigento)

By a population structure point of view, species richness along replicates ranges from 22 to 40. Shannon diversity index ranges from 2.561 to 2.941 and evenness from 0.796 to 0.951 (Tab. 145).

Replicate	S	H'	J'
G1	25	2.561	0.796
G2	22	2.938	0.951
G3	40	2.941	0.797

Tab. 145 – Biodiversity indices values for coralligenous samples at Sciacca (Agrigento)

Diversity and equitability indices are influenced by dominance phenomena (Tab. 146, Tab. 147). Remarkably, *Alvania cingulata* is the dominant species in samples G1 (25.3%) and G3 (24%), *Striarca lactea* is dominant in G2 (15.6%) and the second most abundant species in G1 (21.8%) while *Hiatella rugosa* is the second dominant species in G2 (9.4%) and G3 (16%). *Bittium latreillii* which is usually a very common species is absent (G1 and G2) or present in very limited numbers (G3, only 3 specimens, 2%).

Striarca lactea and *Hiatella rugosa* are bivalves which settle on hard substratum with their byssum. Truly infaunal species of soft substratum which exploit the sediment pools in the coralligenous are very limited in number in these samples.

		Diet	G1	G2	G3
1	*Lepidopleurus cajetanus*	MG	-	3.1%	-
2	*Callochiton septemvalvis euplaeae*	MG	3.4%	6.3%	8.0%
3	*Chiton corallinus*	MG	2.3%	-	-
4	*Acanthichitona crinita*	MG	1.1%	-	-
5	*Emarginula adriatica*	E	1.1%	-	-
6	*Scissurella costata*	MG	-	-	0.7%
7	*Haliotis tubercolata lamellosa*	AG	1.1%	3.1%	-
8	*Clanculus corallinus*	MG	-	-	0.7%
9	*Clanculus cruciatus*	MG	-	3.1%	-
10	*Bittium jadertinum*	MG	-	-	0.7%
11	*Bittium latreillii*	MG	-	-	2.0%
12	*Alvania cingulata*	MG	25.3%	6.3%	24.0%
13	*Alvania semistriata*	MG	-	-	4.7%

[379] Hughes, 1973 for *Abra tenuis* (Montagu, 1803)

[380] Beesley *et al*., 1998 for the whole family Veneridae

[381] Beesley *et al*., 1998 for the whole family Gastrochaenidae

[382] Gofas, 2009b

		Diet	G1	G2	G3
14	*Manzonia crassa*	MG	2.3%	-	0.7%
15	*Pusillina philippi*	MG	-	-	0.7%
16	*Caecum subannulatum*	MG	-	3.1%	-
17	*Parastrophia asturiana*	MG	-	-	0.7%
18	*Trivia monacha*	E	-	3.1%	-
19	*Marshallora adversa*	E	-	3.1%	-
20	*Monophorus perversus*	E	-	-	0.7%
21	*Monophorus thiriotae*	E	-	3.1%	-
22	*Metaxia metaxae*	E	-	-	1.3%
23	*Muricopsis cristata*	C	-	3.1%	4.7%
24	*Ocinebrina edwardsii*	C	1.1%	6.3%	-
25	*Ocinebrina hybrida*	C	-	-	1.3%
26	*Chauvetia* sp.	C	-	-	2.0%
27	*Chauvetia lefebvrei*	C	-	3.1%	0.7%
28	*Pollia dorbignyi*	C	-	3.1%	-
29	*Pollia scabra*	C	-	-	3.3%
31	*Fasciolaria lignaria*	C	-	-	0.7%
32	*Nassarius incrassatus*	SC	3.4%	-	1.3%
33	*Columbella rustica*	AG	1.1%	-	0.7%
34	*Mitrella scripta*	C	-	-	0.7%
35	*Gibberula caelata*	C	-	-	1.3%
36	*Conus mediterraneus*	C	-	3.1%	-
37	*Bela* sp.	C	1.1%	-	-
38	*Mangeliella taeniata*	C	-	-	0.7%
39	*Raphitoma purpurea*	C	-	-	0.7%
40	*Raphitoma leufroyi*	C	-	-	1.3%
41	*Folinella excavata*	E	-	6.3%	-
42	*Williamia gussonii*	AG	-	3.1%	1.3%
43	*Nucula nucleus*	D	1.1%	-	-
44	*Arca noae*	F	-	-	0.7%
45	*Barbatia barbata*	F	4.6%	3.1%	1.3%
46	*Striarca lactea*	F	21.8%	15.6%	1.3%
47	*Glycymeris* sp.	F	2.3%	-	-
48	*Musculus costulatus*	F	-	-	0.7%
49	*Rhomboidella prideauxi*	F	-	-	1.3%
50	*Lithophaga lithophaga*	F	1.1%	-	1.3%
51	*Modiolula phaseolina*	F	2.3%	-	0.7%
52	*Ctena decussata*	SY	1.1%	-	-
53	*Chama gryphoides*	F	2.3%	3.1%	2.0%
54	*Pseudochama gryphina*	F	1.1%	-	1.3%
55	*Galeomma turtoni*	F	-	-	0.7%
56	*Kellia suborbicularis*	F	2.3%	3.1%	3.3%
57	*Parvicardium ovale*	F	-	-	1.3%

		Diet	G1	G2	G3
58	*Plagiocardium papillosum*	F	1.1%	-	-
59	*Abra alba*	D	2.3%	-	2.7%
60	*Chamelea gallina*	F	-	3.1%	-
61	*Gastrochaena dubia*	F	3.4%	-	-
62	*Hiatella rugosa*	F	9.2%	9.4%	16.0%

Tab. 146 – Species dominance in the coralligenous samples at Sciacca (Agrigento)

	G1	G2	G3
1st dominant species	*Alvania cingulata* (MG)	*Striarca lactea* (F)	*Alvania cingulata* (MG)
2nd dominant species	*Striarca lactea* (F)	*Hiatella rugosa* (F)	*Hiatella rugosa* (F)

Tab. 147 – Comparative table of dominant species in different replicates

Feeding guild analysis (Tab. 148) highlights the dominance of filter feeders in samples G1 (51.7%) and G2 (37.5%), mainly due to the presence of *Striarca lactea* and *Hiatella rugosa*, and of microalgae herbivores in G3 (42.7%) due to *Alvania cingulata*, other rissoids and *Callochiton septemvalvis*.

The second dominant feeding guild is microalgae herbivores in G1 (34.5%) and G2 (21.9%) and filter feeders in G3 (32%).

Carnivores on a mobile prey are negligible in G1 (2.3%) while they are an important component of the community in G2 (18.8%) and G3 (17.3%). This is due to a wide array of species which are present in low numbers and therefore none attains any significant dominance. Ectoparasites have a negligible presence in G1 (1.1%) and G3 (2%) remarkably high presence in G2 (15.6%) and the pattern is the same as described above for carnivores: many species in low numbers.

Herbivores of macroalgae and epiphytes are a constant presence in small numbers (2% to 6.3%). Deposit feeders, symbiont-bearing species and scavengers are occasional groups while no seagrass-feeding herbivores and egg or spawn feeders are present.

The ratio between carnivorous and microalgae herbivores is very variable ranging from 0.07 (G1) to 0.86 (G2).

In terms of number of species (Tab. 149) filter feeders are dominant in all samples (from 27.3% in G2 to 44% in G1). Microalgae herbivores range from 20% (G1) to 25% (G3). As usual due to the high diversity of the group, the dominance role of carnivores on mobile prey and ectoparasites is higher when species are considered. Carnivores range from 8% (G1) to 27.5% (G3) and ectoparasites from 4% (G1) to 18.2% (G2).

		G1	G2	G3
SC	Scavengers	3.4%	-	1.3%
AG	Herbivores of macroalgae and epiphytes	2.3%	6.3%	2.0%
MG	Microalgae herbivores	34.5%	21.9%	42.7%
SG	Seagrass-feeding herbivores	-	-	-
D	Deposit feeders	3.4%	-	2.7%
F	Filter feeders	51.7%	37.5%	32.0%

		G1	G2	G3
SY	Symbiont-bearing species	1.1%	-	-
E	Ectoparasites and carnivores on preys without mobility	1.1%	15.6%	2.0%
C	Carnivores on mobile prey	2.3%	18.8%	17.3%
O	Egg and spawn feeders	-	-	-
	1st dominant guild	F	F	MG
	2nd dominant guild	MG	MG	F
	1st dominant guild if C and E guilds are pooled	F	F	MG
Carnivorous/ microalgae herbivores ratio		0.07	0.86	0.41

Tab. 148 – Feeding guilds dominance in the coralligenous samples at Sciacca (Agrigento)

		G1	G2	G3
SC	Scavengers	4.0%	-	2.5%
AG	Herbivores of macroalgae and epiphytes	8.0%	9.1%	5.0%
MG	Microalgae herbivores	20.0%	22.7%	25.0%
SG	Seagrass-feeding herbivores	-	-	-
D	Deposit feeders	8.0%	-	2.5%
F	Filter feeders	44.0%	27.3%	32.5%
SY	Symbiont-bearing species	4.0%	-	-
E	Ectoparasites and carnivores on preys without mobility	4.0%	18.2%	5.0%
C	Carnivores on mobile prey	8.0%	22.7%	27.5%
O	Egg and spawn feeders	-	-	-

Tab. 149 – Number of species *per* feeding guilds in the coralligenous samples at Sciacca (Agrigento)

10.1.4.3 Riserva Orientata dello Zingaro, Scopello (Trapani)

The species collected in the coralligenous and their abundance are given in Tab. 144. Three samples were collected at -24 m m scraping the surface of the substratum in a 30 × 30 cm square area on a vertical wall

with many crevices. The area had strong currents and water visibility was very good. Little sediment was present on the substratum. Sampling was carried out in August 1989.

		Diet	G4
1	*Bittium jadertinum*	MG [383]	5
2	*Bittium latreillii*	MG [384]	2
3	*Alvania cingulata*	MG [385]	2
4	*Alvania beniamina*	MG [386]	2
5	*Rissoina bruguierei*	MG [387]	2
6	*Barleeia unifasciata*	MG [388]	1
7	*Muricopsis cristata*	C [389]	1
8	*Chauvetia* sp.	C [390]	1
9	*Volvarina mitrella*	C [391]	1
10	*Granulina clandestina*	C [391]	1
11	*Musculus costulatus*	F [392]	1
12	*Rhomboidella prideauxi*	F [392]	1
13	*Kellia suborbicularis*	F [393]	1
14	*Hiatella rugosa*	F [394]	1
	TOTAL NUMBER OF SPECIMENS		22

Tab. 150 – Quali-quantitative data of the coralligenous samples, Riserva Orientata dello Zingaro, Scopello (Trapani)

By a population structure point of view, species richness is low (14), but Shannon diversity index is relatively high 2.473 and evenness very high with 0.937 (Tab. 151).

Replicate	S	H'	J'
G4	14	2.473	0.937

Tab. 151 – Biodiversity indices values for coralligenous samples at Scopello (Trapani)

Diversity and equitability indices are influenced by dominance phenomena (Tab. 152, Tab. 153). The dominant species is *Bittium jadertinum* (22.7%). Then four species share the second place: *Bittium latreillii*, *Alvania cingulata*, *Alvania beniamina* and *Rissoina bruguierei* (9.1% each).

[383] Fretter *et al.*, 1981 for the congeneric *Bittium reticulatum* (Da Costa, 1778)

[384] Russo *et al*., 2002

[385] Fretter *et al.*, 1978 for all congeneric species

[386] Fretter *et al.*, 1978 for the congeneric *Crisilla semistriata* (Montagu, 1808) (referred as *Cingula semistriata*)

[387] Beesley *et al*., 1998 for Rissoidae

[388] Fretter *et al.*, 1978

[389] Fretter *et al*., 1981 for all Muricidae *sensu stricto* (excluding, for example, Coralliphilinae)

[390] Fretter *et al.*, 1984 for the congeneric *Chauvetia brunnea* (Donovan, 1804)

[391] Beesley *et al*., 1998 for "marginellids" (Marginellidae and Cystiscidae)

[392] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[393] Beesley *et al*., 1998, considered within Galeommatidae

[394] Gofas, 2009b

		Diet	G4
1	*Bittium jadertinum*	MG	22.7%
2	*Bittium latreillii*	MG	9.1%
3	*Alvania cingulata*	MG	9.1%
4	*Alvania beniamina*	MG	9.1%
5	*Rissoina bruguierei*	MG	9.1%
6	*Barleeia unifasciata*	MG	4.5%
7	*Muricopsis cristata*	C	4.5%
8	*Chauvetia* sp.	C	4.5%
9	*Volvarina mitrella*	C	4.5%
10	*Granulina clandestina*	C	4.5%
11	*Musculus costulatus*	F	4.5%
12	*Rhomboidella prideauxi*	F	4.5%
13	*Kellia suborbicularis*	F	4.5%
14	*Hiatella rugosa*	F	4.5%

Tab. 152 – Species dominance in the coralligenous samples at Scopello (Trapani)

	G4
1st dominant species	*Bittium jadertinum* (MG)
2nd dominant species	*Bittium latreillii* *Alvania cingulata* *Alvania beniamina* *Rissoina bruguierei* (all MG)

Tab. 153 – Summary of dominant species

Feeding guild analysis (Tab. 154) highlights the strong dominance of microalgae herbivores (63.6%) mainly due to *Bittium* and rissoids. Then filter feeders (18.2%) and carnivores on mobile prey (18.2%) follow.

If the number of species is considered (Tab. 155) the pattern is the same with an even higher relative weight of microalgae herbivores (75%).

		G4
SC	Scavengers	-
AG	Herbivores of macroalgae and epiphytes	-
MG	Microalgae herbivores	63.6%
SG	Seagrass-feeding herbivores	-
D	Deposit feeders	-
F	Filter feeders	18.2%

		G4
SY	Symbiont-bearing species	-
E	Ectoparasites and carnivores on preys without mobility	-
C	Carnivores on mobile prey	18.2%
O	Egg and spawn feeders	-
	1st dominant guild	MG
	2nd dominant guild	F, C
	1st dominant guild if C and E guilds are pooled	MG
Carnivorous/ microalgae herbivores ratio		0.29

Tab. 154 – Feeding guilds dominance in the coralligenous samples at Scopello (Trapani)

		G4
SC	Scavengers	-
AG	Herbivores of macroalgae and epiphytes	-
MG	Microalgae herbivores	75.0%
SG	Seagrass-feeding herbivores	-
D	Deposit feeders	-
F	Filter feeders	12.5%
SY	Symbiont-bearing species	-
E	Ectoparasites and carnivores on preys without mobility	-
C	Carnivores on mobile prey	12.5%
O	Egg and spawn feeders	-

Tab. 155 – Number of species *per* feeding guilds in the coralligenous samples at Scopello (Trapani)

10.1.4.4 Comparison between localities

Comparative tables of the main features of the localities are reported in the following tables.

	Sciacca (Agrigento)			Scopello (Trapani)	Secche di Tor Paterno 1992				
Sample	G1	G2	G3	G4	a	b	c	d	e
Depth	-12m			-24m	-21m	-29m	-37m	-26m	-21m
N	87	32	150	22	81	92	116	93	69
S	25	22	40	14	11	21	10	13	10

Tab. 156 – Comparative table of abundance and species richness of different localities (part I)

	Secche di Tor Paterno 2007																	
Sample	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21
Depth	-25m			-27m			-25m			-26m			-20m			-25m		
N	173	25	70	90	126	27	119	113	37	125	123	49	159	62	153	118	122	101
S	53	11	26	33	34	14	40	33	13	29	35	25	43	25	42	39	44	37

Tab. 157 – Comparative table of abundance and species richness of different localities (part II)

	Sciacca (Agrigento)			Scopello (Trapani)	Secche di Tor Paterno 1992				
Sample	G1	G2	G3	G4	a	b	c	d	e
Depth	-12m			-24m	-21m	-29m	-37m	-26m	-21m
H	2.651	2.938	2.941	2.473	1.464	2.172	1.363	1.563	1.425
J	0.796	0.951	0.797	0.937	0.424	0.496	0.411	0.423	0.430

Tab. 158 – Comparative table of Shannon diversity and Pielou's evenness of different localities (part I)

	Secche di Tor Paterno 2007																	
Sample	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21
Depth	-25m			-27m			-25m			-26m			-20m			-25m		
H	3.250	2.000	2.950	3.107	2.879	2.375	3.073	3.031	1.705	2.640	2.754	2.897	3.111	2.755	2.998	2.836	3.370	2.850
J	0.818	0.834	0.905	0.889	0.816	0.900	0.833	0.867	0.665	0.784	0.775	0.900	0.827	0.856	0.802	0.774	0.891	0.789

Tab. 159 – Comparative table of Shannon diversity and Pielou's evenness of different localities (part II)

	Sciacca (Agrigento)			Scopello (Trapani)	Secche di Tor Paterno (1992)				
	G1	**G2**	**G3**	**G4**	**a**	**b**	**c**	**d**	**e**
1st dominant species	*Alvania cingulata* (MG)	*Striarca lactea* (F)	*Alvania cingulata* (MG)	*Bittium jadertinum* (MG)	*Hiatella arctica* (F)	*Hiatella arctica* (F)	*Hiatella arctica* (F)	*Hiatella arctica* (F)	*Hiatella arctica* (F)
2nd dominant species	*Striarca lactea* (F)	*Hiatella rugosa* (F)	*Hiatella rugosa* (F)	*Bittium latreillii* *Alvania cingulata* *Alvania beniamina* *Rissoina bruguierei* (all MG)	*Striarca lactea* (F)	*Striarca lactea* (F)	*Striarca lactea* (F)	*Striarca lactea* (F)	*Striarca lactea* (F)

Tab. 160 – Comparative table of dominant species at different localities (part I)

	Secche di Tor Paterno (2007)								
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
1st dominant species	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG) *Metaxia metaxae* (E)	*Bittium latreillii* (MG)	*Pollia scabra* (C)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)
2nd dominant species	*Nassarius incrassatus* (SC)	*Nassarius incrassatus* (SC)	*Nassarius incrassatus* (SC)	*Nassarius incrassatus* (SC) *Muricopsis cristata* (C) *Striarca lactea* (F)	*Nassarius incrassatus* (SC)	*Muricopsis cristata* (C)	*Raphitoma linearis* (C)	*Muricopsis cristata* (C)	*Alvania settepassii* (MG) *Striarca lactea* (F)

Tab. 161 – Comparative table of dominant species at different localities (part II)

	Secche di Tor Paterno (2007)								
	S10	**S11**	**S12**	**S16**	**S17**	**S22**	**S19**	**S20**	**S21**
1st dominant species	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Nassarius incrassatus* (SG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)	*Bittium latreillii* (MG)
2nd dominant species	*Alvania cancellata* (MG)	*Alvania cancellata* (MG)	*Pollia scabra* (C)	*Nassarius incrassatus* (SC)	*Pollia scabra* (C)	*Nassarius incrassatus* (SC)	*Metaxia metaxae* (E) *Alvania cancellata* (MG)	*Alvania cancellata* (MG) *Raphitoma linearis* (C)	*Nassarius incrassatus* (SC)

Tab. 162 – Comparative table of dominant species at different localities (part III)

	Sciacca (Agrigento)			Scopello (Trapani)	Secche di Tor Paterno (1992)				
Sample	G1	G2	G3	G4	a	b	c	d	e
Depth	-12m			-24m	-21m	-29m	-37m	-26m	-21m
SC	3.4%	-	1.3%	-	-	-	-	-	-
AG	2.3%	6.3%	2.0%	-	-	-	-	1.1%	-
MG	34.5%	21.9%	42.7%	63.6%	2.5%	7.6%	-	3.2%	7.2%
SG	-	-	-	-	-	-	-	-	-
D	3.4%	-	2.7%	-	-	2.2%	1.7%	-	-
F	51.7%	37.5%	32.0%	18.2%	95.1%	88.0%	97.4%	92.5%	87.0%
SY	1.1%	-	-	-	-	-	-	-	1.4%
E	1.1%	15.6%	2.0%	-	-	2.2%	-	3.2%	2.9%
C	2.3%	18.8%	17.3%	18.2%	2.5%	-	0.9%	-	1.4%
O	-	-	-	-	-	-	-	-	-
Carnivorous/ microalgae herbivores ratio	0.07	0.86	0.41	0.29	1	0	-	0	0.2

Tab. 163 – Comparative table of trophic groups of different localities (species abundance) (part I)

	Secche di Tor Paterno (2007)																	
Sample	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S16**	**S17**	**S22**	**S19**	**S20**	**S21**
Depth	-25m			-27m			-25m			-26m			-20m			-25m		
SC	11.0%	12.0%	7.1%	8.9%	11.1%	11.1%	4.2%	5.3%	-	7.2%	5.7%	6.1%	11.9%	25.8%	16.3%	3.4%	6.6%	6.9%
AG	0.6%	-	4.3%	-	-	-	-	0.9%	-	1.6%	-	-	-	4.8%	2.6%	3.4%	2.5%	3.0%
MG	33.5%	56.0%	48.6%	16.7%	46.8%	14.8%	41.2%	34.5%	78.4%	56.0%	65.9%	42.9%	49.1%	9.7%	35.9%	53.4%	26.2%	45.5%
SG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	0.6%	-	8.6%	-	0.8%	-	4.2%	-	-	0.8%	2.4%	-	1.3%	3.2%	-	0.8%	1.6%	-
F	4.0%	8.0%	8.6%	21.1%	7.9%	22.2%	12.6%	12.4%	10.8%	0.8%	1.6%	4.1%	15.7%	17.7%	12.4%	9.3%	14.8%	11.9%
SY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	13.3%	12.0%	1.4%	18.9%	15.1%	3.7%	18.5%	9.7%	-	5.6%	10.6%	12.2%	8.8%	3.2%	7.8%	12.7%	9.0%	5.9%
C	37.0%	12.0%	21.4%	34.4%	18.3%	48.1%	19.3%	37.2%	10.8%	28.0%	13.8%	34.7%	13.2%	35.5%	24.8%	16.9%	39.3%	26.7%
O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carnivorous/ microalgae herbivores ratio	1.1	0.2	0.4	2.1	0.4	3.3	0.5	1.1	0.1	0.5	0.2	0.8	0.3	3.7	0.7	0.3	1.5	0.6

Tab. 164 – Comparative table of trophic groups of different localities (species abundance) (part II)

	Sciacca (Agrigento)			Scopello (Trapani)	Secche di Tor Paterno (1992)				
Sample	**G1**	**G2**	**G3**	**G4**	**a**	**b**	**c**	**d**	**e**
Depth	-12m			-24m	-21m	-29m	-37m	-26m	-21m
SC	4.0%	-	2.5%	-	-	-	-	-	-
AG	8.0%	9.1%	5.0%	-	-	-	-	7.7%	-
MG	20.0%	22.7%	25.0%	75.0%	18.2%	19.0%	-	23.1%	30.0%
SG	-	-	-	-	-	-	-	-	-
D	8.0%	-	2.5%	-	-	4.8%	10.0%	-	-
F	44.0%	27.3%	32.5%	12.5%	72.7%	66.7%	80.0%	61.5%	30.0%
SY	4.0%	-	-	-	-	-	-	-	10.0%
E	4.0%	18.2%	5.0%	-	-	9.5%	-	7.7%	20.0%
C	8.0%	22.7%	27.5%	12.5%	9.1%	-	10.0%	-	10.0%
O	-	-	-	-	-	-	-	-	-

Tab. 165 – Comparative table of trophic groups of different localities (species counts) (part I)

	Secche di Tor Paterno (2007)																	
Sample	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S16**	**S17**	**S22**	**S19**	**S20**	**S21**
Depth	-25m			-27m			-25m			-26m			-20m			-25m		
SC	1.9%	9.1%	3.8%	3.0%	2.9%	7.1%	2.5%	3.0%	-	3.4%	2.9%	4.0%	2.3%	4.0%	2.4%	2.6%	2.3%	2.7%
AG	1.9%	-	7.7%	-	-	-	-	3.0%	-	6.9%	-	-	-	8.0%	4.8%	5.1%	6.8%	2.7%

	Secche di Tor Paterno (2007)																	
Sample	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S16**	**S17**	**S22**	**S19**	**S20**	**S21**
Depth	-25m			-27m			-25m			-26m			-20m			-25m		
MG	30.2%	27.3%	38.5%	15.2%	35.3%	21.4%	25.0%	21.2%	53.8%	34.5%	40.0%	28.0%	34.9%	16.0%	21.4%	23.1%	18.2%	24.3%
SG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	1.9%	-	11.5%	-	2.9%	-	5.0%	-	-	3.4%	2.9%	-	2.3%	4.0%	-	2.6%	4.5%	-
F	11.3%	18.2%	11.5%	27.3%	14.7%	35.7%	17.5%	21.2%	15.4%	3.4%	5.7%	8.0%	14.0%	28.0%	28.6%	17.9%	22.7%	24.3%
SY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	22.6%	18.2%	3.8%	21.2%	20.6%	7.1%	30.0%	21.2%	-	13.8%	20.0%	16.0%	23.3%	8.0%	14.3%	20.5%	15.9%	16.2%
C	30.2%	27.3%	23.1%	33.3%	23.5%	28.6%	20.0%	30.3%	30.8%	34.5%	28.6%	44.0%	23.3%	32.0%	28.6%	28.2%	29.5%	29.7%
O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Tab. 166 – Comparative table of trophic groups of different localities (species counts) (part II)

A multivariate analysis of the assemblages was carried out. Data sets were pooled into a single abundance matrix. However, it was not possible to sort again samples to check any misidentifications. Moreover, sometimes pooling of abundance data into the same species would have been tentative due to the use of generic assignments only or outdated taxonomy. In a few cases, this may have resulted in an oversplitting of the species.

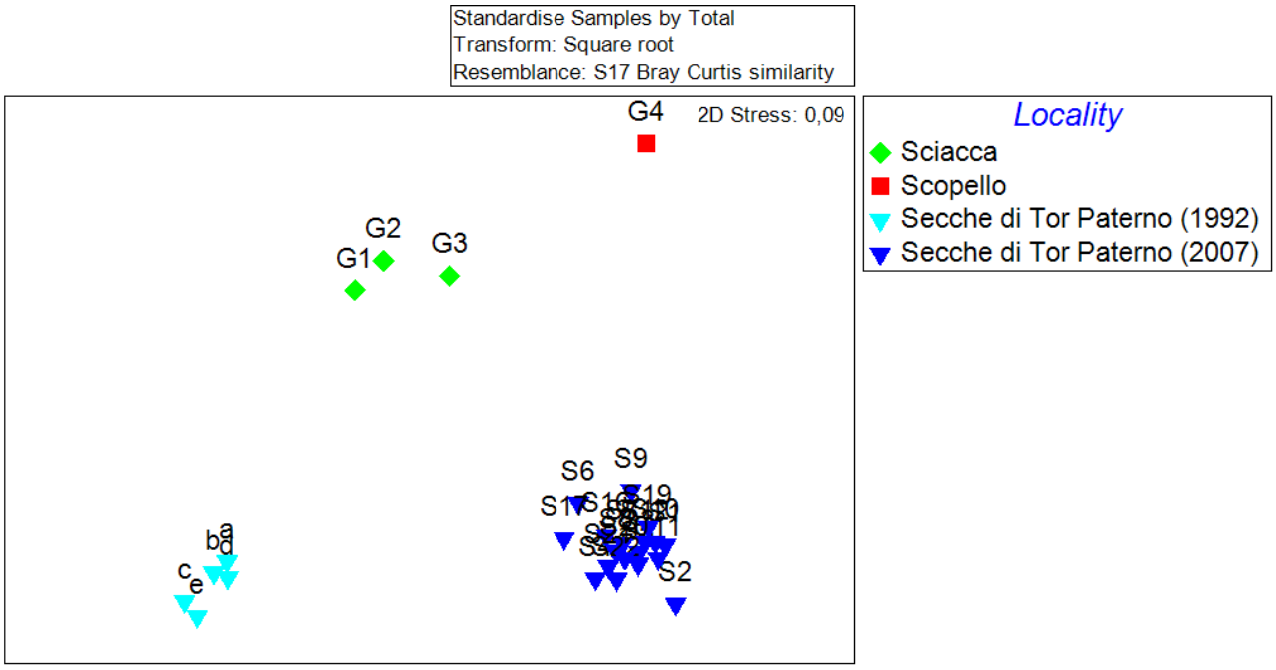


Fig. 43 – Non metric Multi-Dimensional Scaling plot of all coralligenous data sets combined

Non metric Multi-Dimensional Scaling plot is reported in Fig. 43. The graphical representation clearly shows that all the data sets group together and are distant from other data sets. However, Sciacca and Scopello assemblages are not significantly different (PERMANOVA, $p<0.05$, with Monte Carlo simulations).

10.2 Discussion

10.2.1 Secche di Tor Paterno community

The coralligenous biocoenosis resulted in the richest community in terms of species diversity. It hosts 123 species, 77.4% of the whole Secche di Tor Paterno fauna. Also the rhizomes host a high species diversity, 88 species (55.4% of the whole area). Both biocoenoses have been greatily neglected in literature but this is the evidence for giving more attention to so rich environments. Again, like for the rhizomes of *Posidonia*, it is important to highlight that the sorting technique discarded specimens below 1 mm. This implies that some diverse but minute groups like Pyramidellidae may be under-represented and global richness under-estimated.

A high contribution to the biodiversity of this community is given by specialized carnivores. This group accounts for up to 30% of the species richness. This group is characterized by *taxa* like Fissurellidae, Triphoridae, Cerithiopsidae, Eulimidae, Pyramidellidae. Triphoridae in particular is here represented by 7 species, a high percentage of the overall infralittoral Mediterranean fauna. In this environment some peculiar or rare species were found like *Danilia tinei*, *Obesula marisnostri*, *Cerithiopsis nofronii* and *Typhinellus labiatus*.

The richness of the coralligenous can be due to several factors:

- The sciaphilous habitat which is the most suitable to most molluscs;
- The greater habitat heterogeneity which allows for a multiplicity of niches and interactions bringing to a more complex community.

The biocoenosis resulted hosting a rich but rather homogeneous assemblage without significant differences between samples and stations (ANOSIM, $p<0.05$).

By a feeding guilds point of view, The richness of microalgae herbivores and its relative higher frequency than in the rhizomes may be due to the fact that the coralligenous at these depths is less sciaphilous than the rhizomes where the foliar layer blocks most sunlight. Despite the depth, the light which reaches the exposed coralligenous evidently allows the growth of microalgae film, for example on *Lithothamnion*, where most herbivores are expected to feed. The richness in carnivores is probably due to the overall animal richness of the community and abundance and diversity of preys, while the relative abundance of scavengers may be due to the amount of dead animal material which is consistent with a rich community. The frequency of filter-feeders and deposit-feeders is very variable but their presence is dependant also on the availability of soft substratum enclaves for the settlement of bivalves (e.g. Cardiidae, Veneridae), despite most species are usually attached to hard substrata by byssum (e.g. Arcidae, Noetidae, Pectinidae which are all families well represented).

Two species are considered typical of this biocoenosis by Pérès & Picard (1964): *Lima lima* and *Manupecten pesfelis*. Both are present in the Secche di Tor Paterno despite only the former was intercepted in the samples. The latter was observed dead, probably predated by octopus. It is a large species (4-8 cm) usually lives deep in crevices and so difficult to catch.

10.2.2 Comparison with other data sets

The two data sets from Secche di Tor Paterno are remarkably different (PERMANOVA, $p<0.05$, with Monte Carlo simulations). This may be due to the sampling method. Scraping (collected in 1992) and air-lift sampler (2007) are highly different in the way they sample the substratum: scraping manages to eradicate all sessile species (e.g.: *Hiatella arctica* and *Striarca lactea*) which proved to be the most common species in 1992 samples. This method caught also cemented species like Chamidae which were not collected with the air-lift suction sampler. On the other hand, the latter device allows to sample on a wider area without harming so much the environment, to better intercept species in sediment pools (e.g. *Turritella turbona*, Cardiidae and Tellinidae which were collected in the 2007 survey). The number of species censued for the coralligenous in 2007 is three times those collected in 1992. Of course, it can't be excluded a major change in the assemblages, but this seems unlikely since no causes can be traced of such a phenomenon.

Sicilian data sets from Sciacca and Scopello were obtained by scraping too and they confirm the greater ability of this technique to intercept sessile or cemented species, but also to give poor results in terms of number of species intercepted. This may be mostly due to the small area sampled which is not representative

of the heterogeneity of the environment. The biodiversity evaluated by scraping is remarkably different as can be seen from the value of the Shannon index in Secche di Tor Paterno: its mean value in 1992 is just 1.597 while in 2007 it reaches 2.810! This may also evidence that despite sessile or cemented species are a part of the biodiversity in the coralligenous, the greatest share of species is vagile.

In any case, the extreme dominance of *Hiatella arctica* and *Striarca lactea* in 1992 samples in Secche di Tor Paterno is remarkable and unregistered in other samples.

11 Analysis of the detritic species assemblage

The detritic pools found within the reefs are enclaves of the coastal detritic (DC) biocoenosis (Pérès & Picard, 1964) in the coralligenous.

The typical molluscan species cited by Pérès & Picard (1964) are "*Lima loscombei* [*Limaria loscombi* (Sowerby G.B. I, 1823)], *Propeamussium incomparabile* [*Palliolum incomparabile* (Risso, 1826)], *Chlamys flexuosa* [*Flexopecten flexuosus* (Poli, 1795)], *Laevicardium oblongum* [(Gmelin, 1791)], *Cardium deshayesi* [*Acanthocardia deshayesii* (Payraudeau, 1826)], *Tellina donacina* [Linné, 1758], *Eulima polita* [*Melanella polita* (Linné, 1758)], *Drillus maravignae* [*Crassopleura maravignae* (Bivona Ant. in Bivona And*.,* 1838)]".

The biocoenosis has some typical facies: the "praline" facies, the facies of *Halarachnion spatulatum*, the facies of *Ophiura texturata*, the nullipore facies, the facies of compound-ascidians, the facies of *Vidalia volubilis*, the facies of free Squamariaceae. None of these facies was recognizable in the Secche di Tor Paterno.

By a conservation point of view, this biocoenosis is not considered a priority. However, it experiences serious pressures by trawling.

This is the first survey on the molluscan fauna of the detritic pools of Secche di Tor Paterno. The work by Università Tor Vergata (2005) analysed the soft substrata around the reefs, belonging to the biocoenosis of the muddy detritic bottoms (DE) and of the terrigenous mud (VTC).

No other works could be found in the literature specifically dealing with this particular facies of the coastal detritic biocoenosis.

11.1 Results

11.1.1 Habitat description

A station was positioned within the wide sedimentary pools which are present within coralligenous hard substrata. This sediment is mainly composed of the remnants and fragments of coralline algae, shells and other living beings with hard parts.

The size of the pools is very variable since they fill the cavities of the reef. They vary in diameter from less than a meter to more than 10 meters. The samples here analyzed were taken in one of the widest pools found at -28 m.

Sampling was carried out by a diver operated suction sampler even here, despite soft substrata are usually sampled by more rigidly quantitative devices (e.g. box corers). The suction sampler allowed sampling of a wider area, but also gave great problems because of the high volume of sediment collected and the weight of the samplers both during sampling and when bringing them along the sea floor and then up on the boat.

11.1.2 The molluscan community

The species collected in the detritic pools and their abundance are given in Tab. 167.

		Diet	Station 5		
			S13	S14	S15
1	*Scissurella costata*	MG [395]	0	0	1
2	*Cerithium vulgatum*	MG [396]	1	0	0
3	*Turritella turbona*	F [397]	1	0	0
4	*Vitreolina incurva*	E [398]	0	0	1

[395] Fretter *et al.*, 1976 for the congeneric *Anatoma crispata* (Fleming, 1828) [*Scissurella*]

[396] Houbrick, 1992, for congeneric Indo-Pacific species.

[397] Fretter *et al.*, 1981 for the congeneric *Turritella communis* Risso, 1826.

[398] Waren, 1983

		Diet	Station 5		
			S13	S14	S15
5	*Caecum armoricum*	MG [399]	3	0	0
6	*Caecum clarkii*	MG [399]	0	1	3
7	*Euspira pulchella*	C [400]	1	0	1
8	*Comarmondia gracilis*	C [401]	1	0	0
9	*Raphitoma linearis*	C [401]	1	0	0
10	*Crassopleura maravignae*	C [401]	2	0	1
11	*Pseudotorinia architae*	E [402]	1	0	0
12	*Chrysallida suturalis*	E [403]	0	0	1
13	*Turbonilla striatula*	E [404]	1	0	0
14	*Retusa mamillata*	C [405]	5	1	14
15	*Cylichnina crebrisculpta*	C [406]	1	0	0
16	*Philine* sp.	C [407]	0	1	0
17	*Nucula* sp.	D [408]	1	0	0
18	*Striarca lactea*	F [409]	2	1	0
19	*Hemilepton nitidum*	F [410]	1	0	1
20	*Pteromeris corbis*	F [411]	1	3	1
21	*Papillicardium papillosum*	F [412]	1	0	0
22	*Clausinella fasciata*	F [413]	0	0	1
	TOTAL NUMBER OF SPECIMENS		24	7	25

Tab. 167 – Quali-quantitative data of the detritic pools samples, Secche di Tor Paterno

In terms of species diversity, the detritic pools offer only 22 species, 13.8% of the whole fauna. However, many species are unique of this environment (e.g.: *Comarmondia gracilis*, *Crassopleura maravignae*, *Pseudotorinia architae*, *Retusa mamillata*, *Pteromeris corbis*) and these samples have therefore added great value to the description of the biodiversity of the area.

[399] Fretter *et al*., 1978 for the congeneric *Caecum trachea* (Montagu, 1803) [referred as *Caecum imperforatum* (Kanmacher, 1798)]

[400] Fretter *et al.*, 1981 for all Naticidae

[401] Fretter *et al*., 1984 for all "Turridae" *sensu lato*

[402] Melone *et al.*, 1982

[403] Fretter *et al.*, 1986

[404] Fretter *et al.*, 1986 for Pyramidellacea

[405] Berry, 1988

[406] Beesley *et al*., 1998 for Retusidae

[407] Morton *et al.*, 1990 for the congeneric *Philine orientalis* A. Adams, 1854

[408] Beesley *et al*., 1998 for Nuculidae

[409] Beesley *et al*., 1998 for Pteriomorphia (Mytiloida, Arcoida, Pterioida, Limoida and Ostreoida)

[410] Beesley *et al*., 1998 for Galeommatoidea

[411] In the absence of specific references we assume the typical feeding guild of bivalves: filter-feeding.

[412] Beesley *et al*., 1998 for the whole family Cardiidae

[413] Beesley *et al*., 1998 for the whole family Veneridae

11.1.3 Mollusca community structure

By a population structure point of view, species richness along replicates varies from 5 to 16, with a mean of 10.3 species per sample. Shannon diversity index varies from 1.475 to 2.590 and evenness (J') ranges from 0.699 to 0.934.

Replicate	S	H'	J'
S13	16	2.590	0.934
S14	5	1.475	0.917
S15	10	1.609	0.699

Tab. 168 – Biodiversity indices values for detritic samples, Secche di Tor Paterno

Diversity and equitability indices are influenced by dominance phenomena (Tab. 169, Tab. 170). In sample S13 *Retusa mamillata* is the dominant species, but with 20.8% of specimens and consequently the Shannon index and the evenness are the highest in the station. Sample S14 shows a dominant presence of *Pteromeris corbis*, with 42.9% of specimens, influencing the indices: S14 has the lowest Shannon index. Evenness is not low, but the small number of specimens of the sample may have an influence on this. S15 shows a very high dominance of *Retusa mamillata*, with 56% of specimens. As a consequence, both the Shannon index and the evenness are quite low.

Remarkably, bivalves are rarely dominant in the samples despite soft substrata are usually a very suitable habitat. Caecidae, a family of tiny gastropods, have a remarkable abundance. They probably find a very suitable environment in the interstices of the substratum.

		Diet	Station 5		
			S13	S14	S15
1	*Scissurella costata*	MG	0.0%	0.0%	4.0%
2	*Cerithium vulgatum*	MG	4.2%	0.0%	0.0%
3	*Turritella turbona*	F	4.2%	0.0%	0.0%
4	*Vitreolina incurva*	E	0.0%	0.0%	4.0%
5	*Caecum armoricum*	MG	12.5%	0.0%	0.0%
6	*Caecum clarkii*	MG	0.0%	14.3%	12.0%
7	*Euspira pulchella*	C	4.2%	0.0%	4.0%
8	*Comarmondia gracilis*	C	4.2%	0.0%	0.0%
9	*Raphitoma linearis*	C	4.2%	0.0%	0.0%
10	*Crassopleura maravignae*	C	8.3%	0.0%	4.0%
11	*Pseudotorinia architae*	E	4.2%	0.0%	0.0%
12	*Chrysallida suturalis*	E	0.0%	0.0%	4.0%
13	*Turbonilla striatula*	E	4.2%	0.0%	0.0%
14	*Retusa mamillata*	C	20.8%	14.3%	56.0%
15	*Cylichnina crebrisculpta*	C	4.2%	0.0%	0.0%
16	*Philine* sp.	C	0.0%	14.3%	0.0%
17	*Nucula* sp.	D	4.2%	0.0%	0.0%
18	*Striarca lactea*	F	8.3%	14.3%	0.0%
19	*Hemilepton nitidum*	F	4.2%	0.0%	4.0%
20	*Pteromeris corbis*	F	4.2%	42.9%	4.0%
21	*Papillicardium papillosum*	F	4.2%	0.0%	0.0%
22	*Clausinella fasciata*	F	0.0%	0.0%	4.0%

		Diet	Station 5		
			S13	S14	S15
	TOTAL NUMBER OF SPECIMENS		24	7	25

Tab. 169 – Species dominance in the detritic samples, Secche di Tor Paterno

	Station 5		
	S13	S14	S15
1st dominant species	*Retusa mamillata* (C)	*Pteromeris corbis* (F)	*Retusa mamillata* (C)
2nd dominant species	*Caecum armoricum* (MG)	- [414]	*Caecum clarkii* (MG)

Tab. 170 – Comparative table of dominant species in different replicates

The analysis of the feeding guilds (Tab. 171) shows that carnivores on mobile prey are often the dominant feeding guild (samples S13 and S15, and the second most abundant in S14), followed by filter-feeders and microalgae herbivores. Deposit feeders (4.2% in S13) and ectoparasites (maximum 8.3% in S13) are present but in small numbers. Pooling all carnivores (on mobile prey and ectoparasites) does not change this pattern.

In terms of number of species (Tab. 172) carnivores on mobile prey and filter feeders still are the dominant feeding guilds but their relative weight is almost equal.

The abundance of carnivores implies abundance of preys. For example Turridae, which are present in this substratum with some species not found elsewhere and of big size (e.g. *Comarmondia gracilis*, *Crassopleura maravignae*) are polychaete specialized hunters. Polychaete worms are expected to be an important component of the community in soft substrata.

		Station 5		
		S13	S14	S15
SC	Scavengers	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-
MG	Microalgae herbivores	16.7%	14.3%	16.0%
SG	Seagrass-feeding herbivores	-	-	-
D	Deposit feeders	4.2%	-	-
F	Filter feeders	25.0%	57.1%	12.0%
SY	Symbiont-bearing species	-	-	-
E	Ectoparasites and carnivores on preys without mobility	8.3%	-	8.0%
C	Carnivores on mobile prey	45.8%	28.6%	64.0%

[414] Due to the low number of specimens, all other species show the same dominance and it is therefore of little value in the analysis.

		Station 5		
		S13	**S14**	**S15**
O	Egg and spawn feeders	-	-	-
	1st dominant guild	C	F	C
	2nd dominant guild	F	C	MG
	1st dominant guild if C and E guilds are pooled	C	F	C
Carnivorous/ microalgae herbivores ratio		2.8	2.0	4.0

Tab. 171 – Feeding guilds dominance in the detritic samples, Secche di Tor Paterno

		Station 5		
		S13	**S14**	**S15**
SC	Scavengers	-	-	-
AG	Herbivores of macroalgae and epiphytes	-	-	-
MG	Microalgae herbivores	12.5%	20%	20%
SG	Seagrass-feeding herbivores	-	-	-
D	Deposit feeders	6.3%	-	-
F	Filter feeders	31.3%	40%	30%
SY	Symbiont-bearing species	-	-	-
E	Ectoparasites and carnivores on preys without mobility	12.5%	-	20%
C	Carnivores on mobile prey	37.5%	40%	30%
O	Egg and spawn feeders	-	-	-

Tab. 172 – Number of species *per* feeding guilds in the detritic samples, Secche di Tor Paterno

11.1.4 Comparison with other data sets

Data from Secche di Tor Paterno detritic pools have been compared with other data sets of soft substrata around the reefs and within the Marine Protected Area sampled in a survey by Università Tor Vergata (2005).

Locality	Depth	Sampling technique	Date	Data source
Secche di Tor Paterno	Tab. 174	Van Veen grab, sampled area: 0.1 m^2, sampled volume 17 l; 2 samples per station	9-10/12/2004	Università Tor Vergata, 2005

Tab. 173 – Data sets for comparison of Secche di Tor Paterno coralligenous assemblage

Data sets are reported in annex 10. Taxonomy has not been updated, unless useful for discussion.

11.1.4.1 Secche di Tor Paterno 2004 (Univ. Tor Vergata)

The survey carried out by Università Tor Vergata (2005) in december 2004 addressed the faunal composition of the soft substrata around the reefs and inside the Marine Protected Area. Samples were collected by a van Veen Grab with 2 grabs for each station. The grab had a sampled area of 0.1 m^2 and a sampled volume of 17 liters. The survey sampled 26 stations in the MPA (Tab. 174) and 3 stations outside the MPA as comparison data (not considered in this re-analysis).

Abundace data are given in Tab. 175.

Station	Depth [m]	Biocoenosis
1	-39	Biocoenosis of the terrigenous mud (VTC)
2	-38.5	Biocoenosis of the terrigenous mud (VTC)
3	-37	Biocoenosis of the terrigenous mud (VTC)
4	-33	Biocoenosis of the terrigenous mud (VTC)
5	-40	Biocoenosis of the coastal detritic (DC)
6	-42	Biocoenosis of the terrigenous mud (VTC)
7	-41	Biocoenosis of the muddy detritic bottoms (DE) (impoverished)
8	-46	Biocoenosis of the terrigenous mud (VTC)
9	-47	Biocoenosis of the muddy detritic bottoms (DE)
10	-48	Biocoenosis of the muddy detritic bottoms (DE)
11	-53	Biocoenosis of the muddy detritic bottoms (DE)
12	-55	Biocoenosis of the muddy detritic bottoms (DE) (impoverished)
13	-55	Biocoenosis of the muddy detritic bottoms (DE) (impoverished)
14	-55	Biocoenosis of the muddy detritic bottoms (DE)
15	-55	Biocoenosis of the muddy detritic bottoms (DE)
16	-53	Biocoenosis of the muddy detritic bottoms (DE)
17	-54	Biocoenosis of the muddy detritic bottoms (DE)
18	-55	Biocoenosis of the muddy detritic bottoms (DE)
19	-50	Biocoenosis of the muddy detritic bottoms (DE) (impoverished)
20	-50	Biocoenosis of the muddy detritic bottoms (DE) (impoverished)
21	-50	Biocoenosis of the muddy detritic bottoms (DE) (impoverished)

Station	Depth [m]	Biocoenosis
22	-47	Biocoenosis of the muddy detritic bottoms (DE) (impoverished)
23	-47	Biocoenosis of the muddy detritic bottoms (DE) (impoverished)
24	-41	Biocoenosis of the terrigenous mud (VTC)
25	-41	Biocoenosis of the terrigenous mud (VTC)
26	-41	Biocoenosis of the terrigenous mud (VTC)

Tab. 174 – List of stations of the Università Tor Vergata survey on soft substrata in 2004

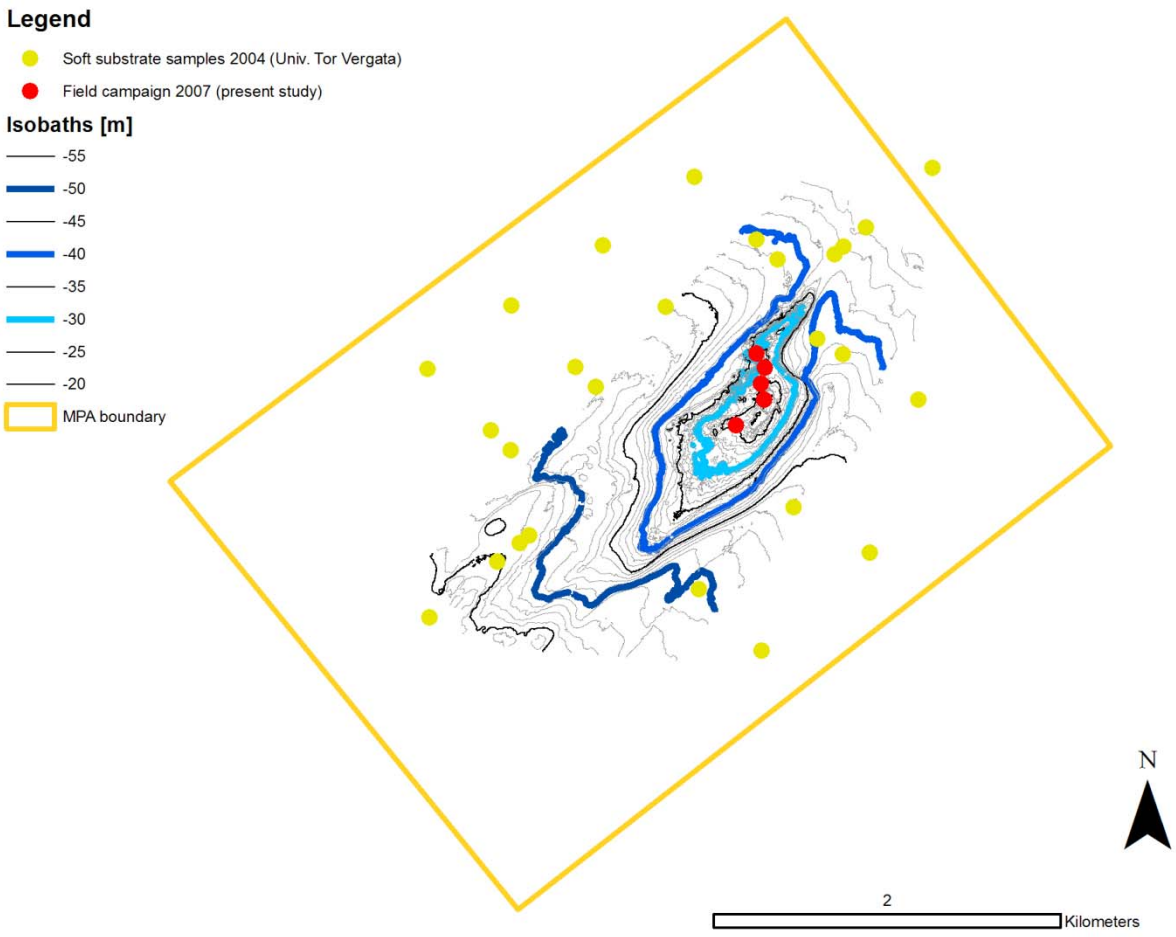


Fig. 44 – Location of stations on soft substratum sampled by Università Tor Vergata in 2004

Species	Trophic group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Turritella communis	F [415]	1			42						1												3				
Turritella turbona	F [416]					1																					
Hyala vitrea	MG [417]		2								2												2		2		
Aporrhais pespelecani	MG [415]					1																					
Calyptraea chinensis	F [415]	1									1						1										
Polinices fusca	C [415]					1																					
Polinices nitida	C [418]								1																		
Tectonatica filosa	C [418]				1																						
Nassarius pygmaeus	SC [419]				2		1										1										
Odostomia conoidea	E [420]		1																								
Pyramidellidae indet.	E [420]						1																1				
Cylichna cylindracea	C [421]																	1									
Nucula nucleus	D [422]					2				1	1	1															
Nucula sulcata	D [422]				1													2		1	1						
Nuculana commutata	D [422]					3					1						1										
Diplodonta brocchi	F [423]														1				1				1				
Mysella bidentata	F [424]		1	1		1	2		9	1		1	2	3	2		2		7				1				
Parvicardium scabrum	F [425]					3					2						1										
Plagiocardium papillosum	F [425]															1											
Phaxas adriaticus	F [426]									1							1	1			1	1				1	1
Tellina serrata	D [136]					1										1											
Abra alba	D [427]							1															1	2			
Abra nitida	D [427]		2		1	1		1	2									2				1	2		2	4	1
Clausinella brogniartii	F [428]					1																					
Timoclea ovata	F [428]					10								1												1	
Mysia undata	F [429]																	1									
Corbula gibba	F [430]					1			10		2	2	1		1		2	4	1								
Dentalium inaequicostatum	C [431]								2					2		4	1	1								1	
TOTAL NUMBER OF SPECIMENS		2	6	1	47	26	4	2	24	3	10	4	3	6	4	6	10	12	9	1	2	2	11	2	4	7	2

Tab. 175 – Quali-quantitative data of the soft substratum samples around the reefs (Università Tor Vergata, 2005)

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[415] Fretter *et al.*, 1981

[416] Fretter *et al.*, 1981 for the congeneric *Turritella communis* Risso, 1826.

[417] Fretter *et al.*, 1978

[418] Fretter *et al.*, 1981 for all Naticidae

[419] Fretter *et al.*, 1984

[420] Fretter *et al.*, 1986 for Pyramidellacea

[421] Thompson & Brown, 1976

[422] Beesley *et al.*, 1998 for Nuculidae

[423] Jackson, 1973 for *Diplodonta* spp. from *Thalassia* communities in Jamaica, West Indies

[424] Beesley *et al.*, 1998 for Galeommatoidea

[425] Beesley *et al.*, 1998 for the whole family Cardiidae

[426] WoRMS, 2010

[427] Hughes, 1973 for *Abra tenuis* (Montagu, 1803)

[428] Beesley *et al.*, 1998 for the whole family Veneridae

[429] Gofas, 2010a

[430] Gofas, 2010b

[431] Reynolds, 2002: "The Scaphopoda are marine infaunal carnivores that feed on foraminiferans and other microorganisms selected and manipulated by their unique feeding tentacles or captacula"

By a population structure point of view, species richness along samples varies from 1 to 12. Shannon diversity index ranges from 0 to 2.066 and evenness from 0.299 to 1 (Tab. 168).

Sample	S	H'	J'
1	2	0.693	1.000
2	4	1.330	0.959
3	1	-	-
4	5	0.481	0.299
5	12	2.066	0.831
6	3	1.040	0.946
7	2	0.693	1.000
8	5	1.279	0.795
9	3	1.099	1.000
10	7	1.887	0.970
11	3	1.040	0.946
12	2	0.637	0.918
13	3	1.011	0.921
14	3	1.040	0.946
15	3	0.868	0.790
16	8	2.025	0.974
17	7	1.792	0.921
18	3	0.684	0.622
19	1	-	-
20	2	0.693	1.000
21	2	0.693	1.000
22	7	1.846	0.949
23	1	-	-
24	2	0.693	1.000
25	4	1.154	0.832
26	2	0.693	1.000

Tab. 176 – Biodiversity indices values for soft substratum samples, Secche di Tor Paterno (Univ. Tor Vergata, 2005)

Diversity and equitability indices are influenced by dominance phenomena (Tab. 177, Tab. 178). Samples are characterized by a small number of species (mean 3.7) and therefore dominances are often very strong in terms of relative abundance but not much meaningful in terms of absolute number of specimens.

Mysella bidentata is often the dominant species in the biocoenosis of muddy detritic bottoms (DE) (40% of samples), the biocoenosis of the terrigenous mud (VTC) has a variable assemblage of dominant species with *Turritella communis*, *Mysella bidentata* and *Abra nitida* being the ones dominant in at least two samples and the coastal detritic (DC) has dominant species different from other biocoenoses (*Timoclea ovata*, *Nuculana commutata* and *Parvicardium scabrum*). As could be expected in this environment, most dominant species are filter-feeders.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Turritella communis	F	50.0%	-	-	89.4%	-	-	-	-	-	10.0%	-	-	-	-	-	-	-	-	-	-	-	27.3%	-	-	-	-
Turritella turbona	F	-	-	-	-	3.8%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyala vitrea	MG	-	33.3%	-	-	-	-	-	-	-	20.0%	-	-	-	-	-	-	-	-	-	-	-	18.2%	-	50.0%	-	-
Aporrhais pespelecani	MG	-	-	-	-	3.8%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calyptraea chinensis	F	50.0%	-	-	-	-	-	-	-	-	10.0%	-	-	-	-	-	10.0%	-	-	-	-	-	-	-	-	-	-
Polinices fusca	C	-	-	-	-	3.8%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polinices nitida	C	-	-	-	-	-	-	-	4.2%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tectonatica filosa	C	-	-	-	2.1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassarius pygmaeus	SC	-	-	-	4.3%	-	25.0%	-	-	-	-	-	-	-	-	-	10.0%	-	-	-	-	-	-	-	-	-	-
Odostomia conoidea	E	-	16.7%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyramidellidae indet.	E	-	-	-	-	-	25.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.1%	-	-	-	-
Cylichna cylindracea	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3%	-	-	-	-	-	-	-	-	-
Nucula nucleus	D	-	-	-	-	7.7%	-	-	-	33.3%	10.0%	25.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nucula sulcata	D	-	-	-	2.1%	-	-	-	-	-	-	-	-	-	-	-	-	16.7%	-	100%	50.0%	-	-	-	-	-	-
Nuculana commutata	D	-	-	-	-	11.5%	-	-	-	-	10.0%	-	-	-	-	-	10.0%	-	-	-	-	-	-	-	-	-	-
Diplodonta brocchi	F	-	-	-	-	-	-	-	-	-	-	-	-	-	25.0%	-	-	-	11.1%	-	-	-	9.1%	-	-	-	-
Mysella bidentata	F	-	16.7%	100%	-	3.8%	50.0%	-	37.5%	33.3%	-	25.0%	66.7%	50.0%	50.0%	-	20.0%	-	77.8%	-	-	-	9.1%	-	-	-	-
Parvicardium scabrum	F	-	-	-	-	11.5%	-	-	-	-	20.0%	-	-	-	-	-	10.0%	-	-	-	-	-	-	-	-	-	-
Plagiocardium papillosum	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.7%	-	-	-	-	-	-	-	-	-	-	-
Phaxas adriaticus	F	-	-	-	-	-	-	-	-	33.3%	-	-	-	-	-	-	10.0%	8.3%	-	-	50.0%	50.0%	-	-	-	14.3%	50.0%
Tellina serrata	D	-	-	-	-	3.8%	-	-	-	-	-	-	-	-	-	16.7%	-	-	-	-	-	-	-	-	-	-	-
Abra alba	D	-	-	-	-	-	-	50.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.1%	100%	-	-	-
Abra nitida	D	-	33.3%	-	2.1%	3.8%	-	50.0%	8.3%	-	-	-	-	-	-	-	-	16.7%	-	-	-	50.0%	18.2%	-	50.0%	57.1%	50.0%
Clausinella brogniartii	F	-	-	-	-	3.8%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timoclea ovata	F	-	-	-	-	38.5%	-	-	-	-	-	-	-	16.7%	-	-	-	-	-	-	-	-	-	-	-	14.3%	-
Mysia undata	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3%	-	-	-	-	-	-	-	-	-
Corbula gibba	F	-	-	-	-	3.8%	-	-	41.7%	-	20.0%	50.0%	33.3%	-	25.0%	-	20.0%	33.3%	11.1%	-	-	-	-	-	-	-	-
Dentalium inaequicostatum	C	-	-	-	-	-	-	-	8.3%	-	-	-	-	33.3%	-	66.7%	10.0%	8.3%	-	-	-	-	-	-	-	14.3%	-

Tab. 177 – Species dominance in the soft substratum samples around the reefs (Università Tor Vergata, 2005)

Sample	1st dominant species	2nd dominant species	Biocoenosis
1	*Turritella communis* (F)	*Calyptraea chinensis* (F)	VTC
2	*Hyala vitrea* (MG)	*Abra nitida* (F)	VTC
3	*Mysella bidentata* (F) [432]	-	VTC
4	*Turritella communis* (F)	*Nassarius pygmaeus* (SC)	VTC
5	*Timoclea ovata* (F)	*Nuculana commutata* (F) *Parvicardium scabrum* (F)	DC
6	*Mysella bidentata* (F)	*Nassarius pygmaeus* (SC) Pyramidellidae indet (E)	VTC
7	*Abra alba* (F) *Abra nitida* (F) [433]	-	DE (impoverished)
8	*Corbula gibba* (F)	*Mysella bidentata* (F)	VTC
9	*Nucula nucleus* (D) *Mysella bidentata* (F) *Phaxas adriaticus* (F) [434]	-	DE
10	*Hyala vitrea* (MG) *Parvicardium scabrum* (F) *Corbula gibba* (F) [435]	-	DE
11	*Corbula gibba* (F)	*Nucula nucleus* (D) *Mysella bidentata* (F)	DE
12	*Mysella bidentata* (F)	*Corbula gibba* (F)	DE (impoverished)
13	*Mysella bidentata* (F)	*Dentalium inaequicostatum* (C)	DE (impoverished)
14	*Mysella bidentata* (F)	*Diplodonta brocchi* (F) *Corbula gibba* (F)	DE
15	*Dentalium inaequicostatum* (C) [435]	-	DE
16	*Mysella bidentata* (F) *Mysia undata* (F) [435]	-	DE
17	*Corbula gibba* (F)	*Nucula sulcata* (D) *Abra nitida* (F)	DE
18	*Mysella bidentata* (F)	*Diplodonta brocchi* (F) *Corbula gibba* (F)	DE
19	*Nucula sulcata* (D) [432]	-	DE (impoverished)
20	*Nucula sulcata* (D) *Phaxas adriaticus* (F) [433]	-	DE (impoverished)
21	*Phaxas adriaticus* (F) *Abra nitida* (F) [433]	-	DE (impoverished)
22	*Turritella communis* (F)	*Abra nitida* (F)	DE (impoverished)

[432] 100% dominance.

[433] 50% dominance each.

[434] 33.3% dominance each.

[435] Due to the low number of specimens, all other species show the same dominance and it is therefore of little value in the analysis.

Sample	1st dominant species	2nd dominant species	Biocoenosis
23	*Abra alba* (F) [432]	-	DE (impoverished)
24	*Hyala vitrea* (MG)	*Abra nitida* (F)	VTC
25	*Abra nitida* (F) [435]	-	VTC
26	*Phaxas adriaticus* (F) *Abra nitida* (F) [433]	-	VTC

Tab. 178 – Comparative table of dominant species in different samples

Feeding guild analysis (Tab. 179) confirms that filter feeders are the dominant feeding guild (20 samples on 26, 77%) followed by detritus feeders (8 samples, 31%, sometimes this guild is codominant with filter feeders). Other feeding guilds are only occasionally dominant.
In terms of number of species (Tab. 180) filter feeders are still the dominant feeding guild (20 samples on 26, 77%) followed by detritus feeders (8 samples, 31%, sometimes this guild is codominant with filter feeders). Other feeding guilds are only occasionally dominant. Despite the low number of species, this means that filter feeders and detritus feeders find in these substrata a suitable environment for several species.

Sample	SC	AG	MG	SG	D	F	SY	E	C	O	1st dominant guild
	Scavengers	Herbivores of macroalgae and epiphytes	Microalgae herbivores	Seagrass-feeding herbivores	Deposit feeders	Filter feeders	Symbiont-bearing species	Ectoparasites and carnivores on preys without mobility	Carnivores on mobile prey	Egg and spawn feeders	
1	-	-	-	-	-	100%	-	-	-	-	F
2	-	-	33.3%	-	33.3%	16.7%	-	16.7%	-	-	D – MG
3	-	-	-	-	-	100%	-	-	-	-	F
4	4.3%	-	-	-	4.3%	89.4%	-	-	2.1%	-	F
5	-	-	3.8%	-	26.9%	65.4%	-	-	3.8%	-	F
6	25.0%	-	-	-	-	50.0%	-	25.0%	-	-	F
7	-	-	-	-	100%	-	-	-	-	-	F
8	-	-	-	-	8.3%	79.2%	-	-	12.5%	-	F
9	-	-	-	-	33.3%	66.7%	-	-	-	-	F
10	-	-	20.0%	-	20.0%	60.0%	-	-	-	-	F
11	-	-	-	-	25.0%	75.0%	-	-	-	-	F
12	-	-	-	-	-	100%	-	-	-	-	F
13	-	-	-	-	-	66.7%	-	-	33.3%	-	F
14	-	-	-	-	-	100%	-	-	-	-	F
15	-	-	-	-	16.7%	16.7%	-	-	66.7%	-	C
16	10.0%	-	-	-	10.0%	70.0%	-	-	10.0%	-	F
17	-	-	-	-	33.3%	50.0%	-	-	16.7%	-	F
18	-	-	-	-	-	100%	-	-	-	-	F
19	-	-	-	-	100%	-	-	-	-	-	D
20	-	-	-	-	50.0%	50.0%	-	-	-	-	F – D
21	-	-	-	-	50.0%	50.0%	-	-	-	-	F – D
22	-	-	18.2%	-	27.3%	45.5%	-	9.1%	-	-	F
23	-	-	-	-	100%	-	-	-	-	-	D
24	-	-	50.0%	-	50.0%	-	-	-	-	-	D

Sample	SC	AG	MG	SG	D	F	SY	E	C	O	1st dominant guild
	Scavengers	Herbivores of macroalgae and epiphytes	Microalgae herbivores	Seagrass-feeding herbivores	Deposit feeders	Filter feeders	Symbiont-bearing species	Ectoparasites and carnivores on preys without mobility	Carnivores on mobile prey	Egg and spawn feeders	
25	-	-	-	-	57.1%	28.6%	-	-	14.3%	-	D
26	-	-	-	-	50.0%	50.0%	-	-	-	-	F – D

Tab. 179 – Feeding guilds dominance in the soft substratum samples around the reefs (Università Tor Vergata, 2005)

Sample	SC	AG	MG	SG	D	F	SY	E	C	O	1st dominant guild
	Scavengers	Herbivores of macroalgae and epiphytes	Microalgae herbivores	Seagrass-feeding herbivores	Deposit feeders	Filter feeders	Symbiont-bearing species	Ectoparasites and carnivores on preys without mobility	Carnivores on mobile prey	Egg and spawn feeders	
1	-	-	-	-	-	100%	-	-	-	-	F
2	-	-	25.0%	-	25.0%	25.0%	-	25.0%	-	-	-
3	-	-	-	-	-	100%	-	-	-	-	F
4	20.0%	-	-	-	40.0%	20.0%	-	-	20.0%	-	D
5	-	-	8.3%	-	33.3%	50.0%	-	-	8.3%	-	F
6	33.3%	-	-	-	-	33.3%	-	33.3%	-	-	-
7	-	-	-	-	100%	-	-	-	-	-	D
8	-	-	-	-	20.0%	40.0%	-	-	40.0%	-	F
9	-	-	-	-	33.3%	66.7%	-	-	-	-	F
10	-	-	14.3%	-	28.6%	57.1%	-	-	-	-	F
11	-	-	-	-	33.3%	66.7%	-	-	-	-	F
12	-	-	-	-	-	100%	-	-	-	-	F
13	-	-	-	-	-	66.7%	-	-	33.3%	-	F
14	-	-	-	-	-	100%	-	-	-	-	F
15	-	-	-	-	33.3%	33.3%	-	-	33.3%	-	-
16	12.5%	-	-	-	12.5%	62.5%	-	-	12.5%	-	F
17	-	-	-	-	28.6%	42.9%	-	-	28.6%	-	F
18	-	-	-	-	-	100%	-	-	-	-	F
19	-	-	-	-	100%	-	-	-	-	-	D
20	-	-	-	-	50.0%	50.0%	-	-	-	-	F – D
21	-	-	-	-	50.0%	50.0%	-	-	-	-	F – D
22	-	-	14.3%	-	28.6%	42.9%	-	14.3%	-	-	F
23	-	-	-	-	100%	-	-	-	-	-	D
24	-	-	50.0%	-	50.0%	-	-	-	-	-	D – MG
25	-	-	-	-	25.0%	50.0%	-	-	25.0%	-	F
26	-	-	-	-	50.0%	50.0%	-	-	-	-	F

Tab. 180 – Number of species *per* feeding guilds in the soft substratum samples around the reefs (Università Tor Vergata, 2005)

11.1.4.2 Comparison between localities

Since only two data sets are compared, data about diversity indices and trophic groups will not be repeated and pooled in tables as it was done for other biocoenoses. Results will concentrate on the multivariate analysis.

The Non metric Multi-Dimensional Scaling plot in Fig. 45 evidences that the two data sets group together. The two kind of species assemblages show significant differences (ANOSIM, $p<0.05$).

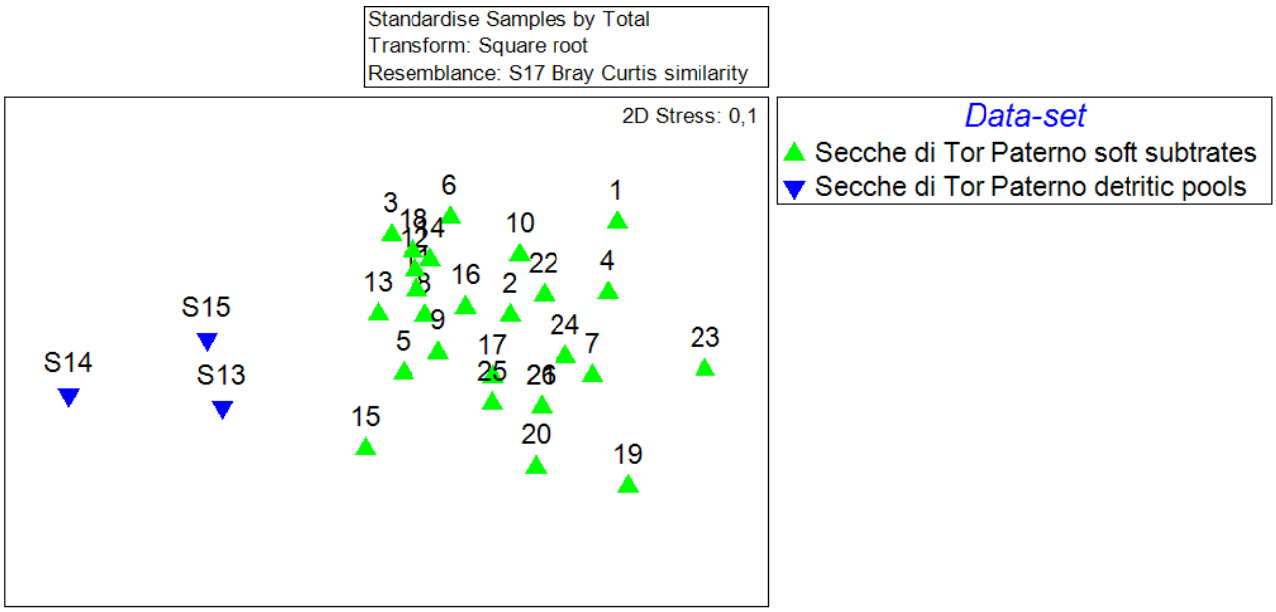

Fig. 45 – Non metric Multi-Dimensional Scaling plot of soft substrata and reef detritic pools in Secche di Tor Paterno, factor: data set

If the analysis is repeated adding a factor about the biocoenosis, then the pattern is more complicated. Again, the MDS plot (Fig. 46) shows that points which represent the detritic pools are distant from all the others which appear well mixed. However, detritic pools are statistically different from all the soft substratum biocoenoses investigated by Università Tor Vergata with the only exception of the coastal detritic station (n° 5) and this is consistent in considering the pools belonging to this biocoenosis (PERMANOVA, $p<0.05$, Tab. 181). The low number of species in the Tor Vergata samples, however, demand care in the interpretation of these results.

Biocoenoses	t	p (perm)	Unique perms	p (Monte Carlo)
VTC, DC	1.1044	0.187	10	**0.306**
VTC, DE (poor)	0.91293	**0.582**	962	0.512
VTC, DE	1.4772	**0.04**	978	0.056
VTC, DC (pools)	1.9254	**0.007**	215	0.007
DC, DE (poor)	1.0395	0.451	9	**0.354**
DC, DE	1.0794	0.336	9	**0.358**
DC, DC (pools)	1.6643	0.259	4	**0.149**
DE (poor), DE	1.4111	**0.045**	931	0.09
DE (poor), DC (pools)	1.7673	**0.007**	165	0.014
DE, DC (pools)	2.2232	**0.009**	164	0.001

Tab. 181 – Output of the PERMANOVA analysis (bold character evidences the p values taken into consideration in the analysis)

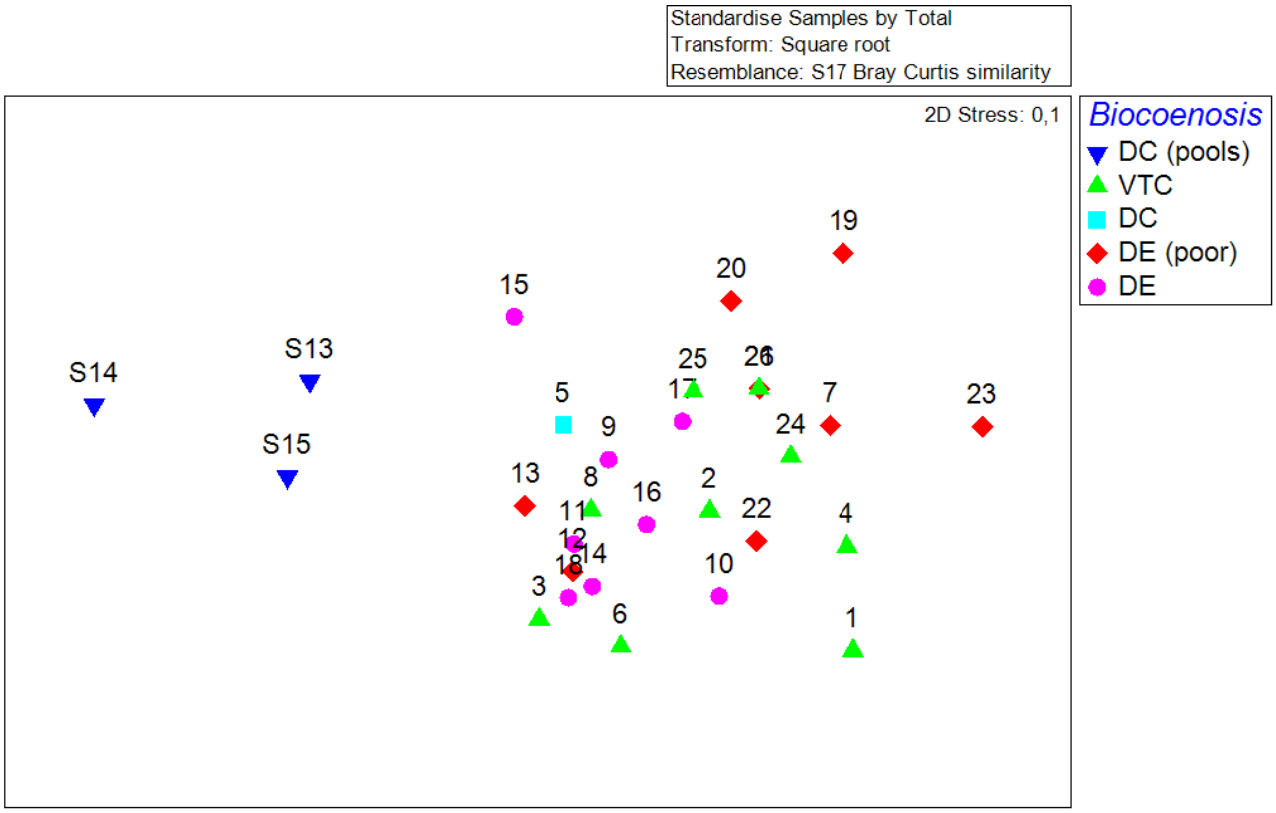

Fig. 46 – Non metric Multi-Dimensional Scaling plot of soft substrata and reef detritic pools in Secche di Tor Paterno, factor: biocoenosis

11.2 Discussion

11.2.1 Secche di Tor Paterno community

The detritic pools host a poor species assemblage, however many species found there are exclusive of soft substrata and these samples have added several species to the overall malacofauna of the reefs.

Specialized carnivores contribute to the biodiversity with a high number of species, up to 40%. Remarkably, despite soft substrata are usually a suitable environment for bivalves and filter feeders, these groups are not dominant.

The only typical molluscan species cited by Pérès & Picard (1964) for this biocoenosis and sampled in the Secche di Tor Paterno pools is *Crassopleura maravignae*. This is an element which marks the peculiarity of this soft substratum.

11.2.2 Comparison with othet data sets

The comparison with data sets from the soft substrata around the reef and within the boundaries of the Marine Protected Area show that the two assemblages are remarkably different. However, when the analysis is run to understand differences between biocoenoses, the coastal detritic station sampled by Università Tor Vergata is the only without statistically significant differences ($p<0.05$) from the detritic pools confirming the hypothesis that this peculiar environments belong to this biocoenosis, despite they probably represent a different and still to be described facies.

This highlights the interest of the detritic pools which host typical species assemblages and add much to the richness of the reefs at infralittoral depths.

12 Agreement between death and living molluscs assemblages

The study of the agreement between death and life assemblages has two main fields of interest. First, palaeoecological reconstruction of benthic communities is based on the ability to evaluate how accurately death assemblages preserve the composition and structure of the original community. Second, the evaluation of biodiversity of an area is a basic requirement for any conservation activity. Biodiversity surveys require time in order to sample enough all the biocoenoses and would require multiple surveys in different seasons and years to fully intercept all the organisms living in the area which is generally not done due to financial and operational constraints. Since death assemblages accumulate and preserve specimens of several seasons and years due to the phenomenon of "time-averaging", they may describe the biodiversity of an area in a more complete way and with a reduced effort. Moreover, this would be a virtually totally non-destructive monitoring of the communities since the living specimens in small volumes of sediment are very few. Therefore, it is interesting to evaluate to which extent death assemblages give us information about these issues and with which bias and limitations.

Of course, taxa which allow a thorough dead-live comparison are those which produce hard skeletal parts which accumulate after the death of the animal and therefore molluscs perform excellently since most species have a calcareous shell and it is the most diverse animal benthic phylum (in the Mediterranean Sea almost 2,000 species are listed at present; 53,000 have been described worldwide with a yearly increment of 350 species (Bouchet, 2006)). Other groups have calcareous skeletons, but their low diversity in present day communities (e.g. Brachiopoda) or their limited geographic distribution (e.g. corals) render their use on a wide scale of lower interest or limited to specific geographic areas.

Study of the dead-live agreement for palaeoecological purposes has been mainly carried out on soft substrata. Cadée (1968) compared molluscan biocoenoses and thanatocoenoses in the Ria de Arosa (Galicia, NW Spain); there species found in the biocoenoses were always found in the thanatocoenosis but there was little quantitative correlation between the two.

Kidwell (2001) re-analyses 17 molluscan data sets with several conclusions of general interest:

- Species that are not present in the death assemblages are virtually all numerically rare and small and/or fragile;
- Death assemblages are preferentially composed of species that are known to live locally, those which do not may be exotics or relicts; however, in case of discordances the main reason may be undersampling of the living community;
- The rank order of dominance is generally well preserved in death and life assemblages;
- The species richness of a death assemblage is generally 2 or 3 times that of the living fauna.

Very few studies have been carried out on molluscs assemblages on hard substrata. Zuschin *et al.* (2000) studied the issue on coral reef associated hard substrata in the northern Red Sea. Between their main conclusions the good agreement in the taxonomic composition of the death and living assemblages, the observation of strong differences regarding dominating taxa, due to being rapidly over-grown by corals and coralline algae and due to post-mortem transport. Zuschin & Oliver (2003) analyzed this issue on sublittoral hard substrata around granitic islands of the Seychelles. Among their main conclusions there are they support the use of a reduced data set without the quantitatively unimportant species (taxa which contribute less than 1% to either the live or dead mollusc content of all samples); they observe strong differences in the abundance of co-occurring living and dead molluscs mainly due to the phenomenon of post-mortem out-of-habitat transport, which reduces the in-situ abundances, and pagurization, which increases abundances. Among its limitations, the low number of considered taxa, 49 in the full data set, due to sampling strategy which considered only species above 1 cm in size, and the low taxonomic resolution since some groups were identified at the supra-specific level only due to lack of adequate taxonomic knowledge on tropical molluscs (e.g. some bivalves like Chamoidea, Spondylidae, Ostreoidea) and for the difficulties of identify them in the field (e.g. *Conus*).

A single paper was found dealing specifically with the comparison of a quaternary molluscs (gastropods) assemblage from a *Posidonia oceanica* meadow with a recent living community in the same locality (Russo *et al.*, 1989). Operating with multivariate analysis, they observed time-related differences in the population

structure which however are not in contrast with the overall resemblance between the fossil and extant communities especially at determined depth levels and in determined sheltering conditions.

The main purpose of the present study in this context is to evaluate:

- To which extent the death assemblage describe the living community and to which extent death assemblages are originated from the nearby community rather than more distant ones in a complex highly heterogeneous reef environment
- The dead-live agreement using a set of standard metrics
- The ecological agreement according to a few indices like dominance or trophism dominance

The previous issues will be analyzed in the context of highly diversified communities (in the order of magnitude of 100 species) with a great effort to cover the small sized fauna which is dominant in these environments (the 1-6 mm size range is considered).

The potential of death assemblages for conservation purposes is an even less common issue in literature. Warwick & Light (2002) compared death and life assemblages in the intertidal sands of St Martin's Flats, Isles of Scilly (United Kingdom) using a taxonomic distinctness index. They find that in order to extrapolate regional biodiversity of any group of organisms from a death assemblage at one location, that assemblage must have been constituted by processes which randomize the species composition from a wide range of habitats at that location to avoid the over-representation of taxa (bivalves in the paper) which are proper of the substratum.

A common question is:

- Which is the minimum death assemblage sediment volume for a meaningful analysis? In the context of palaeoecological reconstruction it may be of interest reasoning on a reduced data set which eliminates the rarest species while for a biodiversity survey the richness of rare species is a very interesting element to evaluate since they usually contribute highly to biodiversity

These issues will be addressed analysing the data obtained from the field study on the biocoenoses of Secche di Tor Paterno described in the previous chapters and comparing them with organogenous sediments collected in the same area at the same time nearby the sampled biocoenoses.

12.1 Materials and methods

12.1.1 Material studied

Sediment samples were collected at two stations representing the two most important biocoenoses in the reefs. Sample 1 comes from a thanatocoenosis nearby a small *Posidonia oceanica* meadow at -25m in a sedimentary pool. The nearby biocoenosis was sampled both at the foliar (station 8, samples R7, R8, R9) and rhizome layer (station 9, samples SP4, SP5, SP6). Sample 2 comes from a thanatocoenosis at -27m at the base of a coralligenous wall with facies of *Eunicella singularis* and *Paramuricea clavata*. Its biocoenosis was sampled right on the wall (station 2, samples S4, S5, S6) and above the wall on sub-horizontal coralligenous with *Eunicella singularis* (station 3, samples S7, S8, S9). Samples were collected in order to be at least 1 liter each: the *Posidonia* sample was 1.05 liters while the coralligenous sample was 1.8 liters. Samples were collected during the operations for the biocoenoses survey: sample 1 was collected on June 20th, 2007, sample 2 on May 25th, 2007, the same day of the biocoenoses samplings.

12.1.2 Sediment analysis

The sediment was rinsed in fresh water and dried. Then it was sieved with meshes of the same size used for the biocoenosis in order to have the same size class of shells. The smaller mesh was 1 mm while the bigger was 6 mm. The whole volume was divided into subsamples of 50 ml.

All subsamples were sorted under a binocular microscope and shells extracted and selected. Not all shells were kept for the analysis. Selection was carried out in order to keep specimens which have the main diagnostic characters present and could be identified by a trained but junior taxonomist. When shells get worn they tend to loose some diagnostic characters like colour, sculpture features, protoconch. Nonetheless, these specimens may be identified by a senior malacologist expert of the local fauna. However, the aim was

to test a method for wide use and applicable by trained personnel but who is not specialist of the taxonomic group. The following rules for specimens selection were used. These criteria shall be met to repeat the experiment in the same condition.

All classes:

- the first layer of the shell should be fully preserved, it may be worn but not broken
- even if more than half of the shell is present, it should not have major holes or breaks (e.g. crab predated specimens may retain the full length of the shell but may have lost most of the whorls)

Gastropoda:

- at least half shell present (this is not easy to determine if only the apical half is present)

Bivalvia:

- at least half valve present with hinge (the hinge area is the most informative for identification)

Polyplacophora:

- all valves should be retained unless sculpture is excessively worn to render the valve almost flat

An example of application of the rules is given in Fig. 47.

Pelagic species were removed from the analysis since they couldn't be found in the benthic biocoenoses. Then all specimens were identified at the species level and counted separately for each subsample. When identification was difficult because species belonged to little known taxonomic groups (e.g. Turridae, Pyramidellidae) then specimens were compared with the biocoenosis samples to identify them in the same way. To render the specimens count fully comparable to the biocoenoses data, the number of bivalves loose valves was divided by two while the number of polyplacophorans loose valves were divided by eight. Moreover, when in the biocoenosis morphospecies of difficult groups were recognized on the basis of animal morphology (e.g. *Bittium reticulatum*) species group) data were pooled into a single morphospecies.

Final quali-quantitative data matrices are in Annexes 14 and 15.

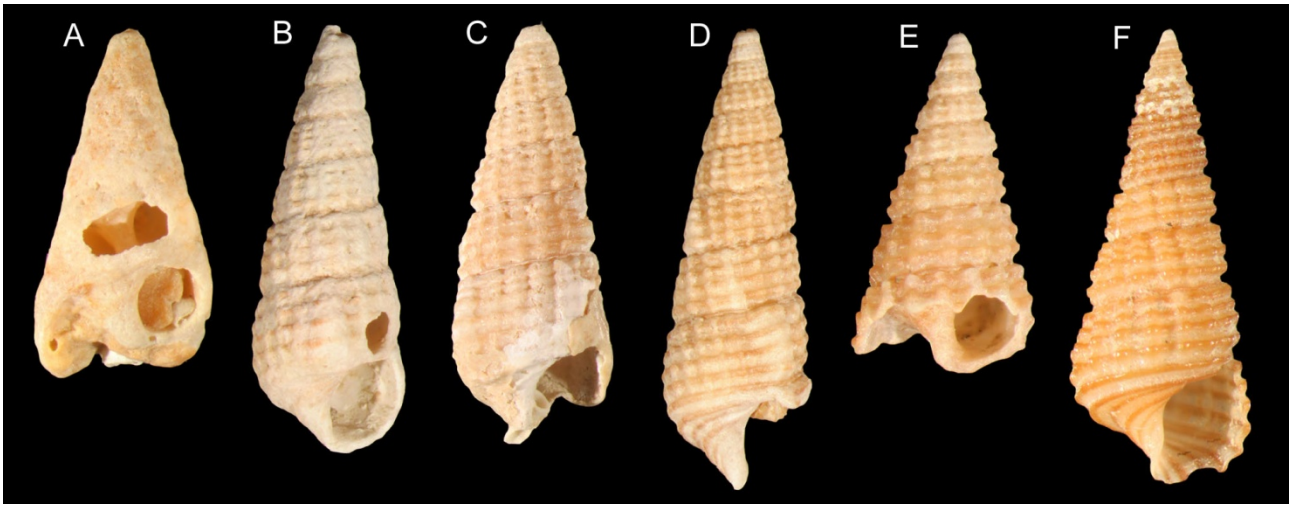

Fig. 47 – *Bittium latreillii*, different degrees of quality of the specimens. A-B-C. Discarded specimens. A. Poorest quality, the specimen can be identified only by an experienced malacologist well acquainted with the local fauna. B. The specimen is very worn. The first layer of the shell which owns the sculpture details is lost. C. The specimen has some post mortem encrustations, protoconch and peristome are missing, sculpture is worn. This is a border line case. D-E-F. Retained specimens. D. The specimen lacks the peristome, but the sculpture is preserved and identification is straightforward. E. The specimen lacks most of the teleoconch, however it was supposed that at least half of the shell was present. Sculpture condition allowed identification easily. F. Specimen in very good condition. Identification can be carried out by an untrained biologist on the basis of reference books. (size range: 3.7-8.5 mm)

12.1.3 Biocoenoses data adjustments

Biocoenoses data needed to be slightly adjusted before being compared with thanatocoenoses data. The first adjustment related to size. Biocoenoses samples kept specimens of any size above 1 mm, while the sediments were sieved with meshes up to 6 mm. Therefore, all specimens above 6 mm were removed from the data set. This selection deleted only 75 specimens of the complete biocoenoses data set, just 3%. In the

Posidonia samples used in this analysis only 18 specimens (again 3%) and 2 species (2.3%) were removed. In the coralligenous 14 specimens (2.7%) and 3 species (4.1%) were removed. This testifies that these molluscan communities are dominated by small sized species.

	Coralligenous samples		***Posidonia oceanic* samples**	
	whole size range (>1 mm)	**1-6 mm size range**	**whole size range (>1 mm)**	**1-6 mm size range**
Species	73	70	88	86
Specimens	512	498	592	574

Tab. 182 – Number of species and specimens in the biocoenoses samples before and after the size range correction

The final quali-quantitative data matrix is in Annex 13.

Since the sediment coming from the vicinities of *Posidonia oceanica* pooled specimens of the foliar and rhizome layer, data of samples coming from the two layers of the biocoenosis were pooled together.

12.1.4 Data analysis

Data analysis was carried out by two main methods. The first is with techniques commonly used in benthic ecology, namely non-parametric multivariate analysis carried out with PRIMER-E 6 (Clarke & Gorley, 2006). Statistical tests were performed with ANOSIM (Clarke & Green, 1988). In pairwise tests the Bonferroni correction was applied and the proportionately reduced level of significance was considered. The SIMPER routine (Clarke, 1993) was then used to locate which species are the greatest contributors to differences between groups or, on the other hand, which species contribute most to similarities within replicates from the same group.

When mean data are given, the standard deviation is specified in the notation mean±SD. The statistical analysis of mean values was performed with the Student's t-test.

12.1.5 Metrics to evaluate the fidelity between the death and living assemblages

To assess the fidelity between the living and death assemblages with respect to species richness and taxonomic composition five information were retrieved from the data sets (Kidwell & Bosence, 1991, but notation was changed adopting the symbol *S* for the number of species and *N* for the number of individuals as usual in ecological studies):

- the number of species found living only (S_L),
- the number of species found dead only (S_D),
- the number of species found both living and dead (S_{LD}),
- the number of specimens of species found dead only (N_D)
- the number of specimens of species found living and dead (N_{LD}).

Then, three metrics were computed (Kidwell & Bosence, 1991):

- the percentage of species found living which are also found dead:

$$S_{LvsD}\% = \frac{S_{LD}}{S_L + S_{LD}} \times 100$$

- the percentage of species found dead which are also found living:

$$S_{DvsL}\% = \frac{S_{LD}}{S_D + S_{LD}} \times 100$$

- the percentage of dead individuals from species found alive:

$$N_{DvsL}\% = \frac{dead\ N_{LD}}{dead\ N_D + N_{LD}} \times 100$$

To assess the fidelity with respect to species dominance three metrics were computed for the samples (Kidwell & Bosence, 1991):

- Number of top six taxa in the death assemblage that are also among the six most abundant taxa in the living community
- Percentage of dead individuals that come from the top six taxa in the living community
- Number of top six taxa that occur in the same rank order in both death assemblage and living community
- Percentage of dead individuals that come from taxa ranked identically both dead and alive.

12.2 Results

12.2.1 Experiment repeatability

To see to which extent the rules which were established to select specimens (cfr. par. 12.1.2) worked in obtaining the same results even if different researchers carried out the sorting of specimens, the coralligenous samples were sorted out by two people with different skills. Most of the subsamples (26 over 36) were sorted out by a researcher (Paolo G. Albano) with senior experience with Mediterranean molluscs and who worked out the biocoenoses samples, being therefore well acquainted with the local fauna. Further 10 subsamples were sorted out by a biologist (Eimi Ailen Font) with no knowledge of the Mediterranean molluscs fauna and at her first task of this kind. After some identification corrections, it resulted that the younger operator tended to keep more specimens (mean 183.8±30.8) than the senior operator (mean 164.3±35.8) representing more species (respectively 40.8±4.1 and 40.2±5.7), however both these differences are not statistically significant (Student's t-test, $p=0.05$, unequal sample sizes, unequal variance). Moreover, no significant differences could be recognized between the two sets of data by multivariate analysis (ANOSIM, $p<0.05$). The identification by the younger operator needed some review due to the small size, high diversity and frequency of taxonomically difficult groups.

12.2.2 Sediment minimum volume

The separation of the sediment into subsamples was done to progressively analyse the sediment and evaluate which is the minimum volume of it needed for a meaningful analysis. Subsamples were reasonably homogeneous in the number of specimens (*Posidonia* 205.9±24.1, coralligenous 169.7±35.2) and species (*Posidonia* 44.9±4.5, coralligenous 40.4±5.3).

The species accumulation curves (Fig. 48) do not reach the asymptote. However, their slope is progressively lower and stabilizes after 10 samples which represent 109 species in the *Posidonia* sediment (80.7% of the whole sample) and 105 in the coralligenous sediment (67.7% of the whole sample). However, since the slope is still positive, the initial hypothesis of a 1 liter volume was maintained and therefore 20 subsamples were considered operationally adequate for analysis. Twenty subsamples represented 133 species (98.5%) of the whole fauna found in the *Posidonia* sediment and 130 species (83.9%) of the coralligenous fauna.

The same analysis was performed on a reduced data set with only those taxa which contribute more than 1% to the mollusc content of the sample (in accordance to what was done by Zuschin *et al.*, 2000 and Zuschin & Oliver, 2003, where "the 1% limit was chosen due to the properties of proportion statistics, where the influence of smallest proportions could bias statistical treatment"). In the *Posidonia* samples 120 species (88.9%!) were discarded but the reduced data set of 15 species comprises 82% of the individuals. In the coralligenous samples 139 species (89.7%!) were discarded but the reduced data set of 16 species comprises 82.5% of the individuals. This important reduction in the number of species allows the fast reaching of the asymptote (Fig. 49) despite discards an important part of the biodiversity.

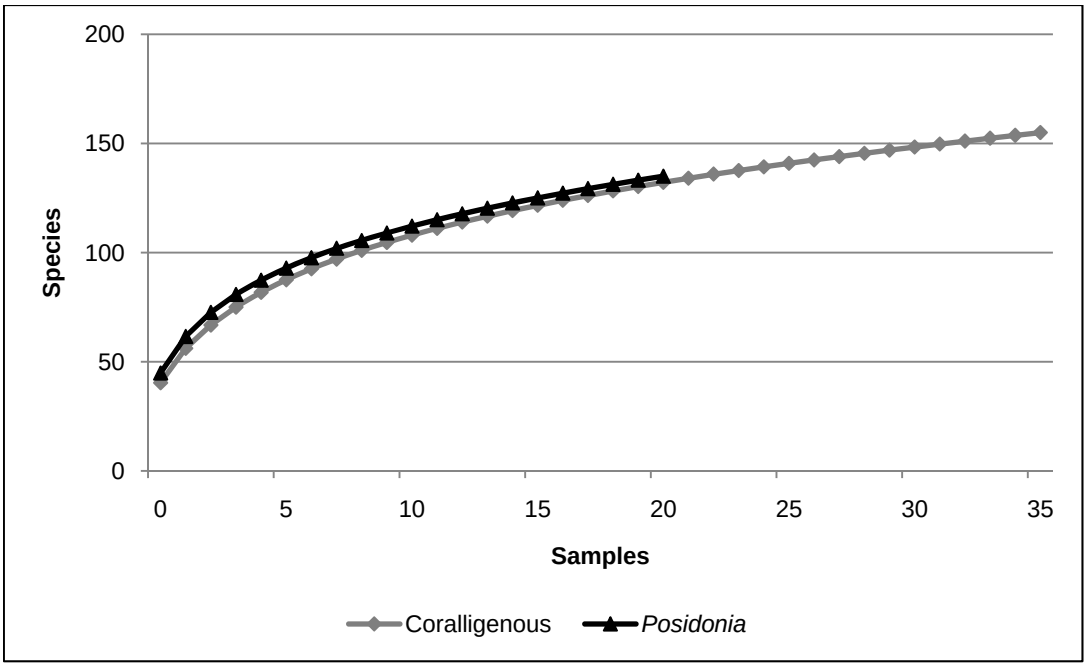

Fig. 48 – Species accumulation curves of the two sediments (full data set)

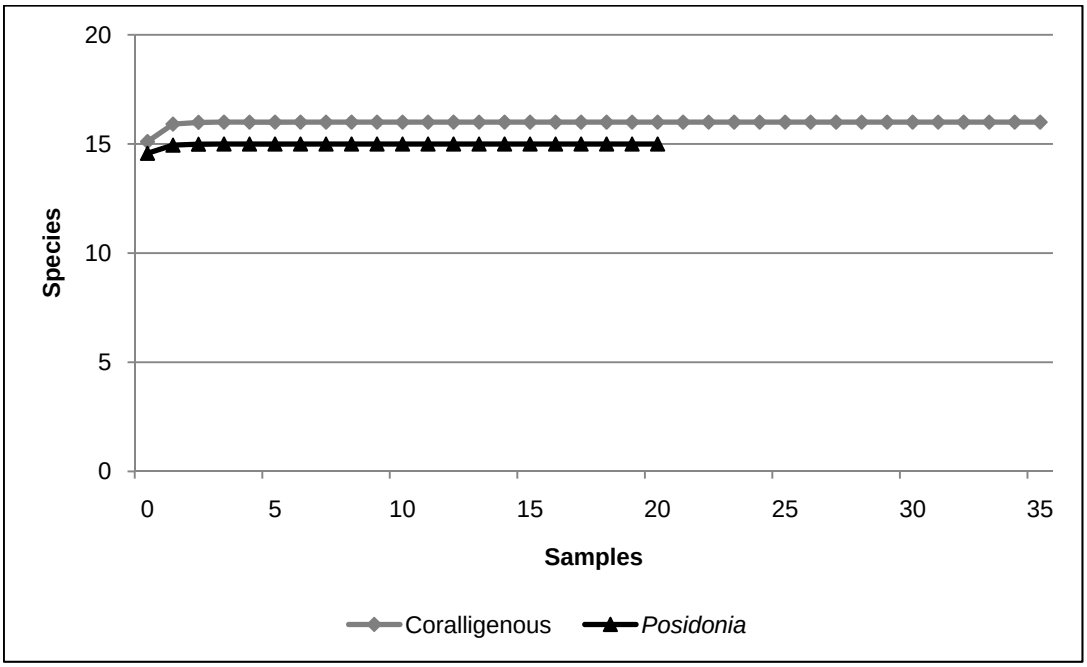

Fig. 49 – Species accumulation curves of the two sediments (reduced data set)

12.2.3 Sediments species composition

The *Posidonia oceanica* sample contained 135 species of shelled molluscs. This is 46.7% more than those found in the biocoenosis where 92 species were identified (cfr. par. 8.1.2 and 9.1.2). The coralligenous sample contained 155 species, 26% more than the biocoenosis where 123 species were identified (cfr. par. 10.1.2).

Some species in both sediments clearly are not typical of any biocoenosis on the reefs but are most likely larvae coming from the soft substrata around the reefs which settled and developed in their sediment enclaves: 14 species in *Posidonia* sediment and 14 species in the coralligenous one. The most common of these allochthonous species were *Turritella communis* Risso, 1826 and *Timoclea ovata* (Pennant, 1777). Despite some differences in the species composition, these soft substratum species are present quite evenly

in the two samples and this is consistent with the hypothesis of an occasional colonization of unsuccessful settlers. The most remarkable exception is the presence of several specimens of a young unidentified *Glycymeris* in the coralligenous, but it can't be excluded that the detritic substrata at the base of coralligenous walls may host this species steadily.

Other species which were not found in the biocoenosis are those typical of the endobenthos like *Gastrochaena dubia* (Pennant, 1777) or those which live cemented on hard substratum (Vermetidae, *Spondylus*, Anomiidae, Chamidae). Remarkably, the presence of these species is markedly higher in the coralligenous (8 species) than in the *Posidonia* (3 species) probably due to the fact that such species find a much more suitable habitat in this biocoenosis. This is a first element which suggest that sediments quite strictly reflect the main characters of the nearby biocoenoses (*Posidonia oceanica* is fully surrounded by the coralligenous in the reefs but this evidently affected the species composition less than the meadow itself).

The two data sets were analysed by non-parametric multivariate techniques to verify to which extent they were different. Since samples were rather homogeneous in the number of specimens, no standardisation was performed, but data were square root transformed for a more balanced weighting between common and rare species. The plot in Fig. 50 shows how the two sediments subsamples group together. Points are very close one to each other with a pattern very similar to the one observed between the biocoenoses (cfr. par. 7.1.2). The stress value is high. The 3-dimensional plot performed better with a 0.2 stress, but since it is less readable and the point can be described with the 2-dimensional too, the latter is here presented. The cluster analysis (Fig. 51) further support this splitting grouping most *Posidonia* subsamples in a single cluster with a level of similarity of approximately 65%. A single *Posidonia* subsample clusters with the coralligenous ones and a single coralligenous subsample clusters with the *Posidonia* ones. It is important to highlight that the differences between these two groups are statistically significant (ANOSIM, $p<0.05$). These differences lie in the different proportions of the abundance of some species rather than in disjuncted species pools as suggested by the output of the SIMPER routine (Tab. 183). For example, *Chauvetia* aff. *brunnea*, *Striarca lactea*, *Rissoina bruguieri* and *Mitrella scripta* are more common in the *Posidonia* sediment while *Jujubinus striatus* and *J. exasperatus* are more common in the coralligenous sediment.

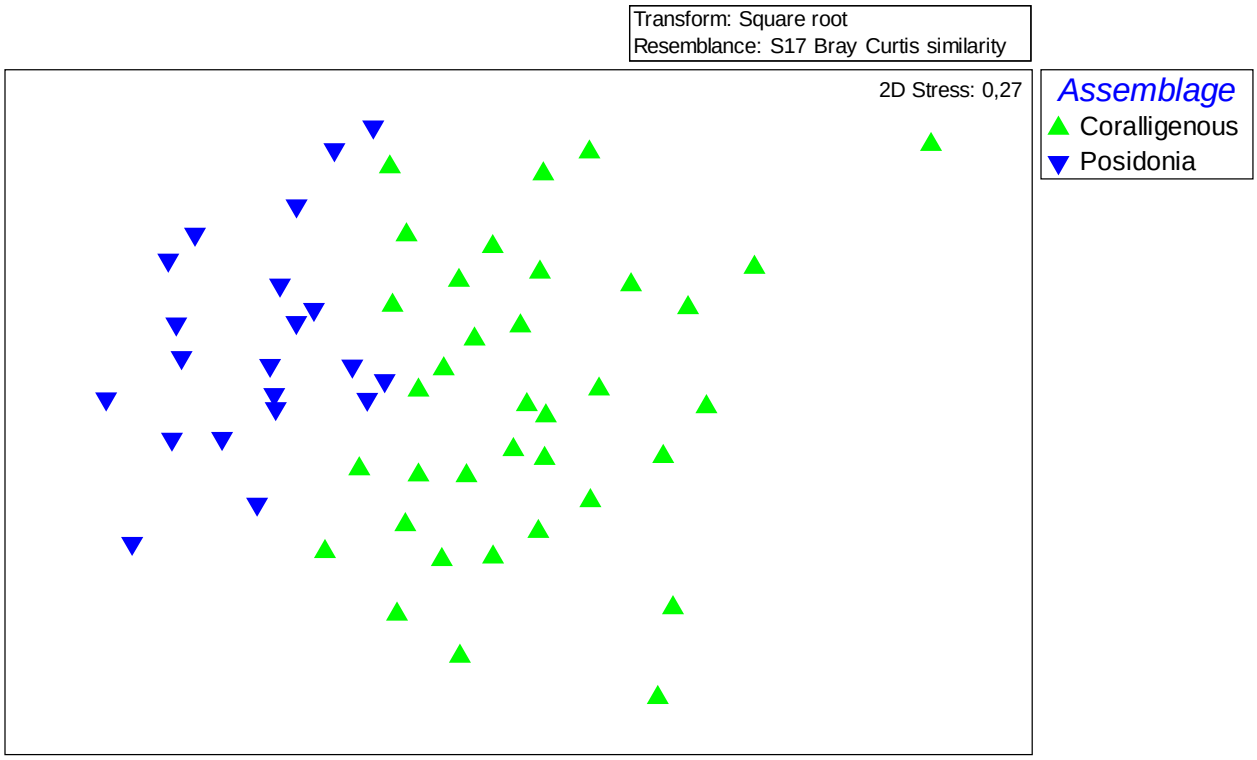

Fig. 50 – Non metric Multi-Dimensional Scaling plot of thanatocoenoses samples, full data set

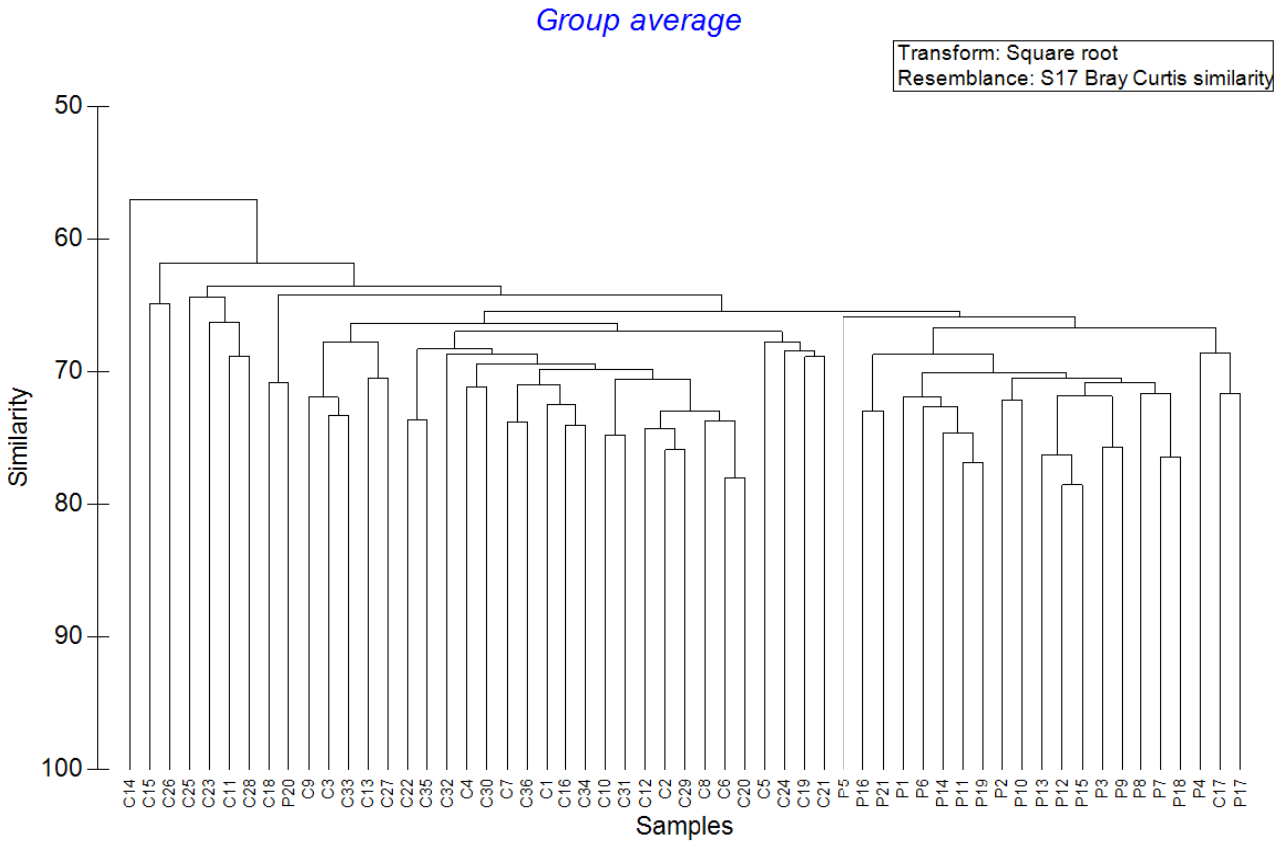

Fig. 51 – Cluster analysis of thanatocoenoses samples, full data set

Species	Coralligenous average abundance	*Posidonia* average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %
Bittium latreillii	7.30	8.47	0.98	1.45	2.76	2.76
Chauvetia aff *brunnea*	0.23	1.34	0.83	1.77	2.33	5.08
Striarca lactea	3.81	4.88	0.82	1.69	2.29	7.37
Alvania lineata	1.78	2.56	0.74	1.25	2.08	9.45
Alvania settepassii	2.61	3.02	0.67	1.23	1.89	11.34
Rissoina bruguieri	0.42	1.17	0.67	1.38	1.86	13.20
Mitrella scripta	0.13	0.96	0.65	1.45	1.83	15.04
Jujubinus striatus	3.64	3.18	0.59	1.35	1.65	16.68
Bolma rugosa	1.14	1.24	0.58	1.21	1.62	18.30
Muricopsis cristata	0.38	1.05	0.58	1.32	1.62	19.92
Alvania geryonia	1.50	1.69	0.58	1.23	1.61	21.53
Raphitoma linearis	0.56	0.80	0.53	1.20	1.49	23.02
Petalopoma elisabettae	1.49	1.12	0.53	1.28	1.49	24.51
Emarginula punctulum	0.82	0.54	0.53	1.17	1.47	25.98
Clanculus corallinus	1.33	1.05	0.52	1.17	1.44	27.42
Jujubinus exasperatus	2.96	2.71	0.51	1.34	1.44	28.86
Gouldia minima	1.45	2.08	0.51	1.23	1.42	30.28
Alvania cancellata	2.80	2.41	0.51	1.35	1.41	31.69

Species	Coralligenous average abundance	*Posidonia* average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %
Bittium sp. *"reticulatum"*	2.06	2.11	0.50	1.17	1.40	33.10
Pteromeris corbis	0.87	0.41	0.48	1.30	1.35	34.45
Turritella turbona	0.95	0.77	0.48	1.16	1.35	35.80
Nassarius incrassatus	0.85	1.26	0.48	1.18	1.35	37.15
Emarginella huzardii	0.33	0.61	0.47	1.02	1.31	38.46
Pollia scabra	0.78	0.75	0.47	1.17	1.30	39.76
Nucula nucleus	1.21	1.60	0.46	1.17	1.30	41.06
Danilia tinei	0.78	0.62	0.46	1.12	1.29	42.36
Ocinebrina aciculata	0.22	0.65	0.45	1.12	1.27	43.63
Fusinus pulchellus	0.76	0.86	0.45	1.19	1.27	44.90
Emarginula sicula	0.76	0.38	0.45	1.14	1.27	46.17
Homalopoma sanguineum	2.85	3.03	0.45	1.22	1.26	47.42
Marshallora adversa	0.41	0.63	0.44	1.11	1.24	48.66
Crassadoma multistriata	0.66	0.20	0.44	1.28	1.23	49.89
Metaxia metaxae	0.47	0.48	0.43	1.02	1.21	51.11
Calliostoma conulum	0.49	0.50	0.43	1.05	1.20	52.31
Calliostoma laugieri	0.30	0.55	0.43	1.00	1.20	53.50
Diodora graeca	0.59	0.55	0.42	1.10	1.18	54.69
Mangelia stossiciana	0.33	0.63	0.42	1.08	1.18	55.87
Rissoa violacea	0.28	0.56	0.42	1.06	1.16	57.03
Tectura virginea	0.36	0.43	0.41	0.89	1.13	58.17
Hiatella arctica	0.55	0.25	0.37	1.13	1.04	59.21
Parvicardium scriptum	0.74	0.49	0.37	1.26	1.03	60.23

Tab. 183 - Output of the SIMPER routine representing the breakdown of average dissimilarity between the coralligenous and *Posidonia* sediments (full data set)

The reduced data sets are composed by 15 species for the *Posidonia* sample and 16 species for the coralligenous one. The overlap is very high since if the two samples are merged a list of 17 species comes out and 14 species (82.4%) are in common between the two biocoenoses. All the species not proper of the biocoenoses but of the soft substrata around the reefs and those living in the endobenthos or cemented are missing since they contribute less than 1% each to the total abundance.

A non-parametric multivariate analysis was carried out on the reduced data set too with the same procedure described above for the full data set. The plot in Fig. 52 shows that the two biocoenoses are well separated, even more neatly than with the full data set. The stress value is much lower than with the full data set but this is induced by the great reduction in the number of variables. Stress is adequate for interpretation. The cluster analysis (Fig. 53) shows a higher level of similarity than with the full data set. Apart for the outlier subsample C14, most coralligenous samples cluster together while the *Posidonia* ones have two coralligenous subsamples (C17 and C18) within them at a level of similarity of approximately 83%. The differences between biocoenoses are statistically significant (ANOSIM, $p<0.05$). The SIMPER routine clearly shows that the species most contributing to the differences between samples are mainly those which occur in a single sample only, namely *Petalopoma elisabettae* and *Clanculus corallinus* which occur in the coralligenous sample and *Chauvetia* aff. *brunnea* which occurs in the *Posidonia* sample only. Further differences are in the different proportions of the species abundance in the two samples.

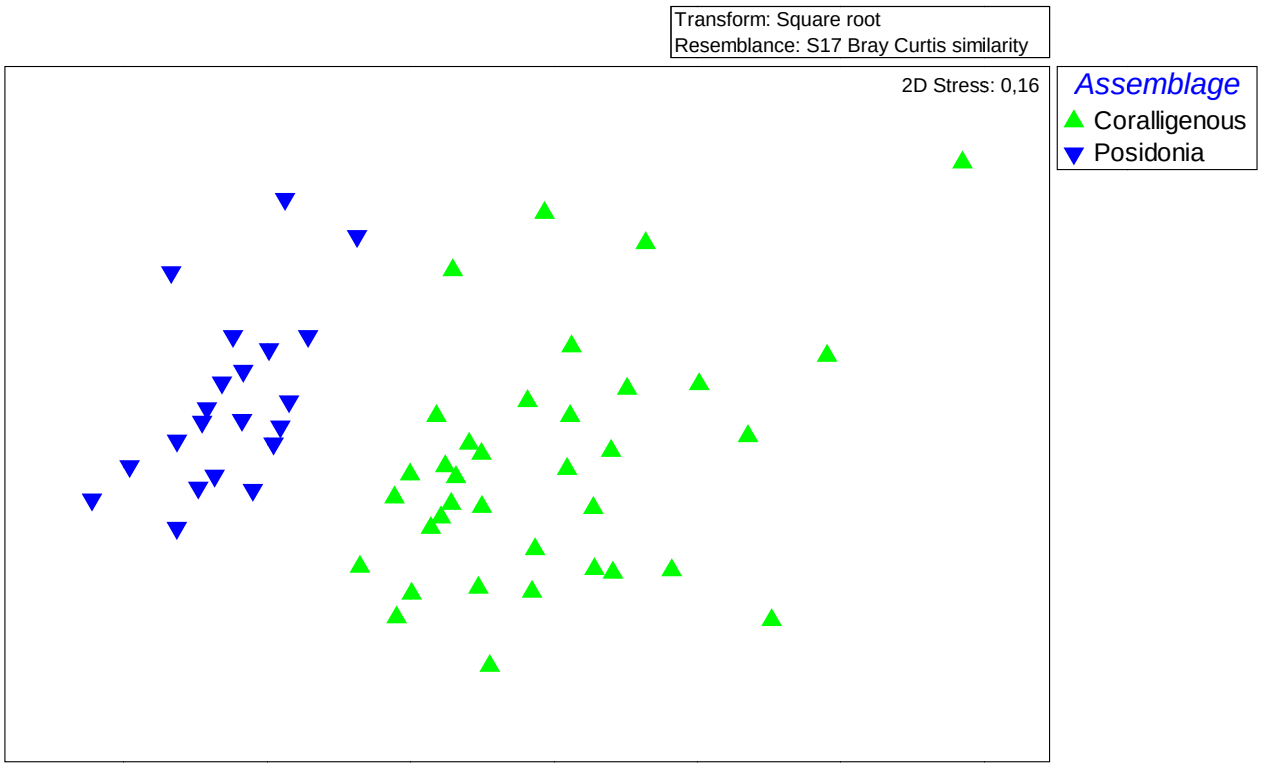

Fig. 52 – Non metric Multi-Dimensional Scaling plot of thanatocoenoses samples, reduced data set

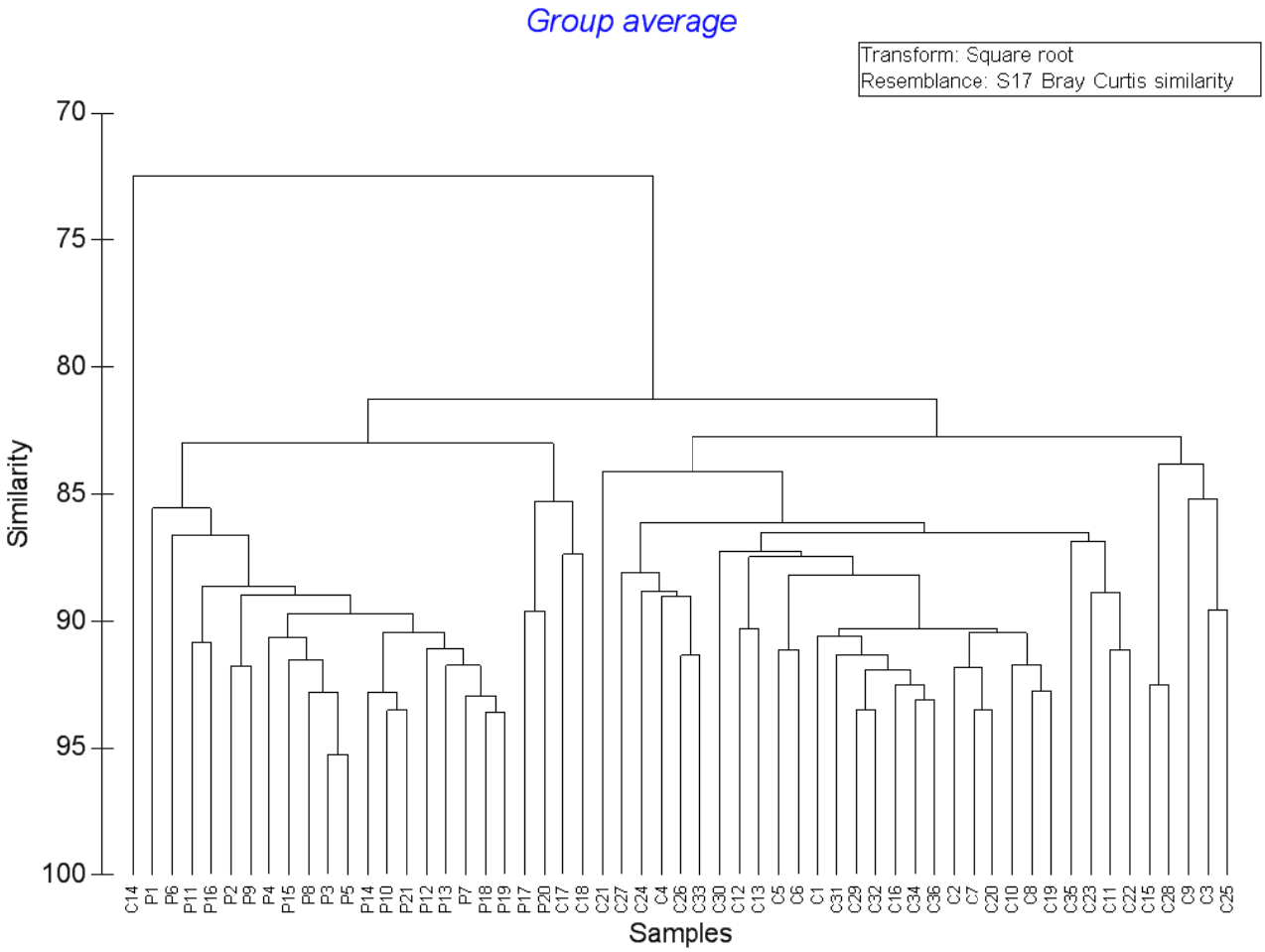

Fig. 53 – Cluster analysis of thanatocoenoses samples, reduced data set

Species	Coralligenous average abundance	*Posidonia* average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %
Petalopoma elisabettae	1.49	0.00	1.82	2.29	9.47	9.47
Bittium latreillii	7.30	8.47	1.70	1.44	8.83	18.30
Chauvetia aff *brunnea*	0.00	1.34	1.64	2.31	8.55	26.84
Clanculus corallinus	1.33	0.00	1.63	2.53	8.47	35.31
Striarca lactea	3.81	4.88	1.41	1.67	7.33	42.63
Alvania lineata	1.78	2.56	1.28	1.26	6.63	49.27
Alvania settepassii	2.61	3.02	1.16	1.22	6.05	55.32
Jujubinus striatus	3.64	3.18	1.01	1.35	5.25	60.57
Bolma rugosa	1.14	1.24	0.99	1.22	5.16	65.73
Alvania geryonia	1.50	1.69	0.99	1.24	5.14	70.87
Jujubinus exasperatus	2.96	2.71	0.88	1.35	4.58	75.45
Gouldia minima	1.45	2.08	0.87	1.23	4.53	79.98
Bittium sp. *"reticulatum"*	2.06	2.11	0.87	1.17	4.50	84.48
Alvania cancellata	2.80	2.41	0.86	1.37	4.49	88.97
Nucula nucleus	1.21	1.60	0.80	1.16	4.16	93.13

Tab. 184 - Output of the SIMPER routine representing the breakdown of average dissimilarity between the coralligenous and *Posidonia* sediments (reduced data set)

12.2.4 Comparison between biocoenoses and thanatocoenoses

12.2.4.1 Qualitative biodiversity comparison

The first comparison between the biocoenoses and the thanatocoenoses is in terms of species diversity and faunal list. This analysis is performed on the estimated optimal volume of 1 liter of sediment. Since subsamples were randomly taken from the bulk sample, the first 20 subsamples have been considered, in the hypothesis that they are an unbiased excerption from the sampled volume.

Nothwithstanding the volume correction, the molluscs found in the sediment samples are more than those found in the biocoenosis. The *Posidonia* sediment contains 132 species, 43.5% more than the biocoenosis. Remarkably, not only the biocoenosis lacks some species found in the thanatocoenosis, but the reverse is true too. Polyplacophora account all together for 7 species, but only 1 was found in both samples, *Callochiton septemvalvis*. The other three species are equally distributed between the thanatocoenosis and the biocoenosis. The class Gastropoda is represented by 107 species, 87 present in the thanatocoenosis and 65 in the biocoenosis. Twenty species found in the biocoenosis (30.1%) were not found in the thanatocoenosis. Between the remarkable absences: *Smaragdia viridis* which despite rare in the biocoenosis has a tick shell which should guarantee permancence in the thanatocoenosis record, 5 species of Triphoridae and Cerithiopsidae which may be underestimated in the sediments because their shell soon looses important diagnostic characters (especially protoconch and peristome), a few Turridae and Pyramidellidae probably due to their overall rarity or to extreme cases of low frequence seasonality. Among the species which are present in the thanatocoenosis but absent from the biocoenosis there are species which belong to soft substratum biocoenoses around the reefs as discussed in par. 12.2.3 and species which are not proper of this biocoenosis but are found in nearby ones like *Danilia tinei* (which however has some occasional records in literature for *Posidonia* rhizomes too, see Palazzi & Villari, 2001), *Petalopoma elisabettae*, *Mitrella coccinea* which are more frequently found in the coralligenous or *Crassopleura maravignae* which lives in detritic pools. The class Bivalvia is represented all together by 45 species, but only 17 were found in the biocoenosis and 41 in the thanatocoenosis. Of the former group, 4 species (23.5%) were not found in the

thanatocoenosis, while 28 species (68.3%) were found in the sediments and not in the biocoenosis. For this class, species coming from soft substrata around the reefs are particularly important since 10 species, more than a third, belong to this group. Other 5 species are expected to be present in the nearby biocoenoses since they are species of the endobenthos (*Lithophaga*) or which live cemented on hard substrata (*Spondylus*, Chamidae). Scaphopoda is represented by a single species found only in the biocoenosis.

The coralligenous sediment contains 132 species, 7.3% more than the biocoenosis. The class Polyplacophora is represented by 6 species: 2 are in common between the thanatocoenosis and the biocoenosis (*Callochiton septemvalvis* and *Lepidopleurus cajetanus*), and 2 are exclusive of the two specimen sources. The class Gastropoda is represented by 120 species, 92 in the biocoenosis and 82 in the thanatocoenosis. Thirty-eight species (41.3%) are present in the biocoenosis and not in the thanatocoenosis. Of these, 7 species are Triphoridae and Cerithiopsidae, which are highly diversified families but with fine interspecific differences and can't be identified if specimens are worn or loose their protoconch and peristome as it is often the case after death. For most of the other species it is not easy to understand why they lack from the thanatocoenosis. Twenty-eight species (34.1%) of the thanatocoenosis are not found in the biocoenosis. Five of these species are typical of the soft substrata around the reefs or live cemented on hard substrata and therefore couldn't be found in the biocoenosis due to the sampling technique. Five other species are typical of other biocoenoses, especially of *Posidonia oceanica* like *Tricolia speciosa*, *T. tenuis*, *Rissoa ventricosa*, *R. violacea*. The class Bivalvia is represented by 50 species, 46 are present in the thanatocoenosis and 23 in the biocoenosis. Only 5 species (21.7%) of the biocoenosis were not found in the thanatocoenosis and they are mostly species identified at the genus level because belonging to taxonomically difficult groups. Their presence in the thanatocoenosis may be therefore underevaluated due to the loss of diagnostic characters. Twenty-eight species (60.9%) of the thanatocoenosis were not found in the biocoenosis. Half of these are species typical of the soft substrata around the reefs or live cemented on hard substrata. *Manupecten pesfelis* was observed alive during dives but was missing from the biocoenosis samples probably due to its life habit in deep crevices. A single Scaphopoda was found and only in the thanatocoenosis.

12.2.4.2 Fidelity with respect to species richness and taxonomic composition

The metrics listed in par. 12.1.5 were computed for both the minimum volume and sampled volume and reduced data set and complete data set and results are in the following tables.

Metric	Minimum volume (1 l)		Complete volume (1.05 l)	
	Complete data sets	Reduced data sets	Complete data sets	Reduced data sets
S_L	18	16	18	16
S_D	83	6	86	6
S_{LD}	49	9	49	9
N_D	761.1	792.5	802.6	832
N_{LD}	3604.6	2684.5	3772.6	2817.5
S_{LvsD}%	73.1%	36%	73.1%	36%
S_{DvsL}%	37.1%	60%	36.3%	60%
N_{DvsL}%	82.6%	77.2%	82.5%	77.2%

Tab. 185 – Fidelity with respect to species richness and taxonomic composition in the *Posidonia* environment

Metric	Minimum volume (1 l)		Complete volume (1.8 l)	
	Complete data sets	Reduced data sets	Complete data sets	Reduced data sets
S_L	18	18	16	18
S_D	80	11	101	11
S_{LD}	52	5	54	5
N_D	896.8	534	1575.1	960.5

Metric	Minimum volume (1 l)		Complete volume (1.8 l)	
	Complete data sets	Reduced data sets	Complete data sets	Reduced data sets
N_{LD}	2964.1	1902	5000.9	3298
S_{LvsD}%	74.3%	21.7%	77.1%	21.7%
S_{DvsL}%	39.4%	31.3%	34.8%	31.3%
N_{DvsL}%	76.8%	78.1%	76.1%	77.5%

Tab. 186 – Fidelity with respect to species richness and taxonomic composition in the coralligenous environment

If we take into consideration the issue of the potential undersampling of the living assemblages, its influence could be here tested using as data for the biocoenosis not only the replicates strictly near the site where sediments were collected but all replicates for the same biocoenosis. Therefore, for the coralligenous all the 6 coralligenous stations (18 replicates) can be evaluated and for the *Posidonia* the 4 stations (12 replicates). In the case of the coralligenous, this of course means averaging the assemblage on a wider area but since stations were selected in a narrow bathymetric interval and with scant differences in the biocoenosis facies then the comparison may be interesting to evaluate the sampling bias. When the *Posidonia* samples are concerned, the bias between the stations near the sediment collection site and the other stations may be greater because *Posidonia* settles on different substrata in the two sites (soft sediment in the first case, hard substratum in the second) and this certainly influences the community composition especially in the rhizomes (see par. 9.1.2 at page 105). Results are given in Tab. 187 for the *Posidonia* samples and Tab. 188 for the coralligenous samples.

Metric	Minimum volume (1 l)		Complete volume (1.05 l)	
	Complete data sets	Reduced data sets	Complete data sets	Reduced data sets
S_L	28	17	28	17
S_D	74	6	77	6
S_{LD}	58	9	58	9
N_D	576.1	792.5	608.6	832
N_{LD}	4062.6	2834.5	4239.6	2967.5
S_{LvsD}%	67.4%	34.6%	67.4%	34.6%
S_{DvsL}%	43.9%	60%	43.0%	60%
N_{DvsL}%	87.6%	78.2%	87.5%	78.1%

Tab. 187 – Fidelity with respect to species richness and taxonomic composition in the *Posidonia* environment, considering all stations for the living assemblage survey

Metric	Minimum volume (1 l)		Complete volume (1.8 l)	
	Complete data sets	Reduced data sets	Complete data sets	Reduced data sets
S_L	48	11	43	11
S_D	60	15	78	15
S_{LD}	72	5	77	5
N_D	212.3	1024.5	359.4	1831.5
N_{LD}	4768.6	2380	7352.6	3280.5
S_{LvsD}%	60%	31.3%	64.2%	31.3%
S_{DvsL}%	54.5%	25%	49.7%	25%
N_{DvsL}%	95.7%	64.2%	95.3%	64.2%

Tab. 188 – Fidelity with respect to species richness and taxonomic composition in the coralligenous environment, considering all stations for the living assemblage survey

12.2.4.3 Species assemblages comparison

Full data sets (all species, full volume) were pooled into a single abundance matrix and then analysed with classical methods of benthic ecology with non-parametrical multivariate statistics. Data were standardised, due to the differences in total abundance of single samples, transformed both with square root and presence/absence, and then an MDS plot was drawn.

These plots (Fig. 54, Fig. 55) show that all data sets group together and that distances within living and death samples are lower than those between them. However, if the presence/absence transform is used, the distances between groups become relatively lower than those within groups. This suggests that differences are more due to the relative abundance of species rather than the species composition itself. In any case, differences between all groups are statistically significant ($p<0.05$).

To further test this hypothesis, data sets were modified deleting those species which were typical of soft substrata around the reefs or which live cemented on hard substratum and therefore couldn't be intercepted during the sampling of living material. Further MDS plots were drawn (Fig. 56, Fig. 57) without noticing any significant difference in the patterns nor in the statistical significance of differences (ANOSIM, $p<0.05$).

Differences between living and death assemblages were analysed with the SIMPER routine to locate which species made the difference (Tab. 189, Tab. 190). The full species list was used. The species which most contribute to differences between death and living coralligenous assemblages are *Jujubinus striatus*, *J. exasperatus* and *Homalopoma sanguineum* which are remarkably more common in the death assemblage, *Nassarius incrassatus*, *Muricopsis cristata*, *Pollia scabra* which are more common in the living assemblage. The species which most contribute to differences between death and living *Posidonia* assemblages are *Bittium latreillii*, *J. striatus*, *Striarca lactea*, *Alvania settepassii* and *A. lineata* which are more common in the death assemblage, *Muricopsis cristata* and *Chauvetia* aff *brunnea* which are more common in the living assemblage. All these species are present in both samples, but it is their relative abundance which makes the difference.

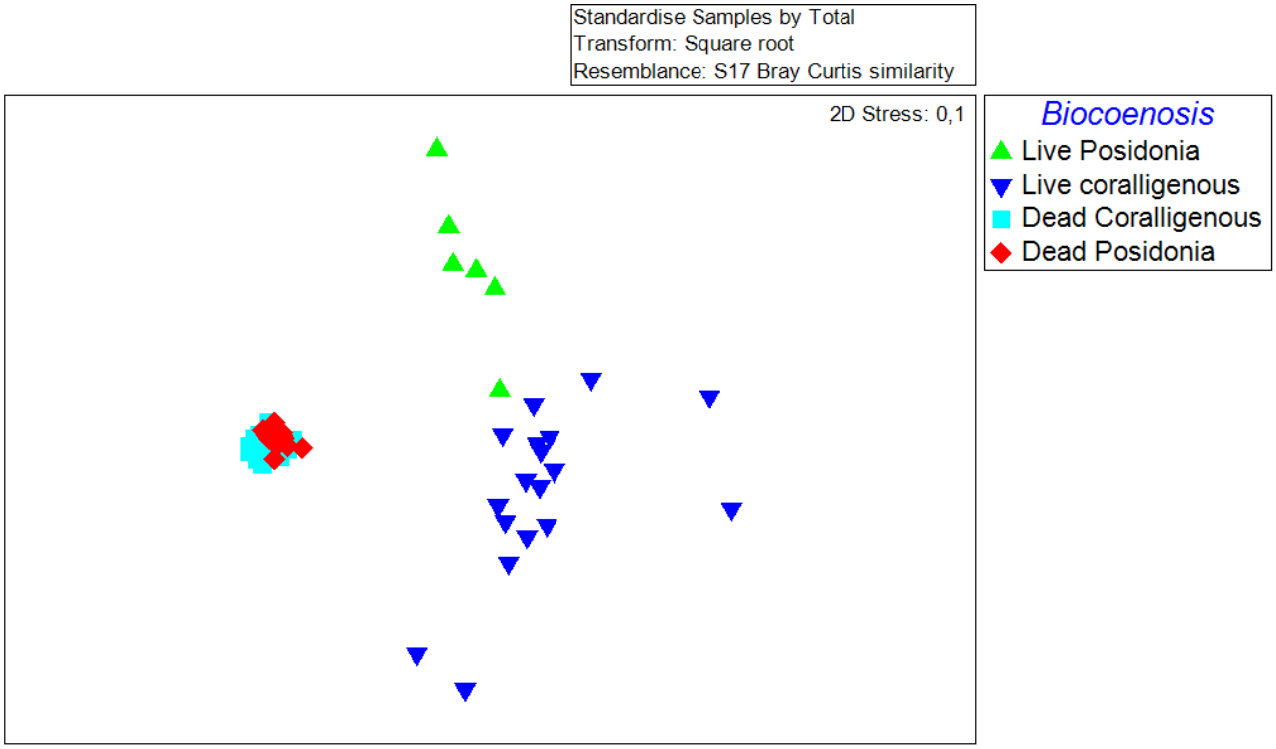

Fig. 54 – Non metric Multi-Dimensional Scaling plot comparing living and death samples, square root transform

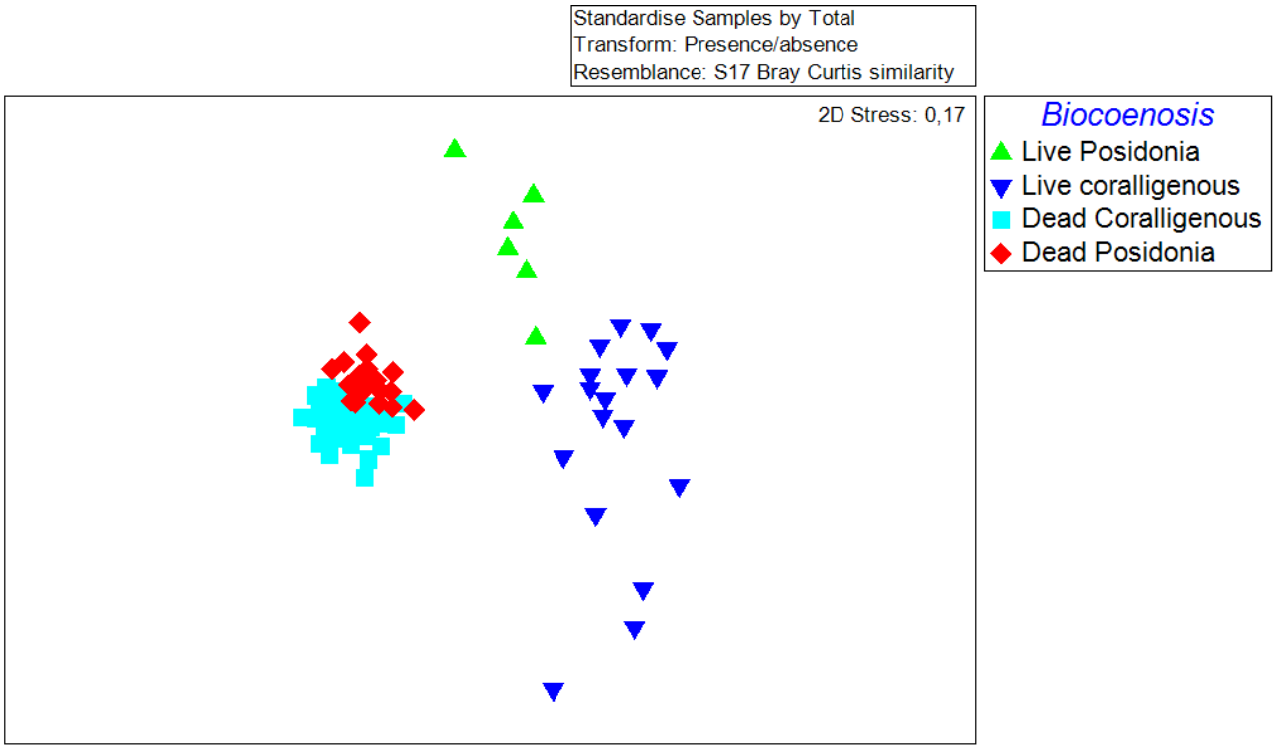

Fig. 55 – Non metric Multi-Dimensional Scaling plot comparing living and death samples, presence/absence transform

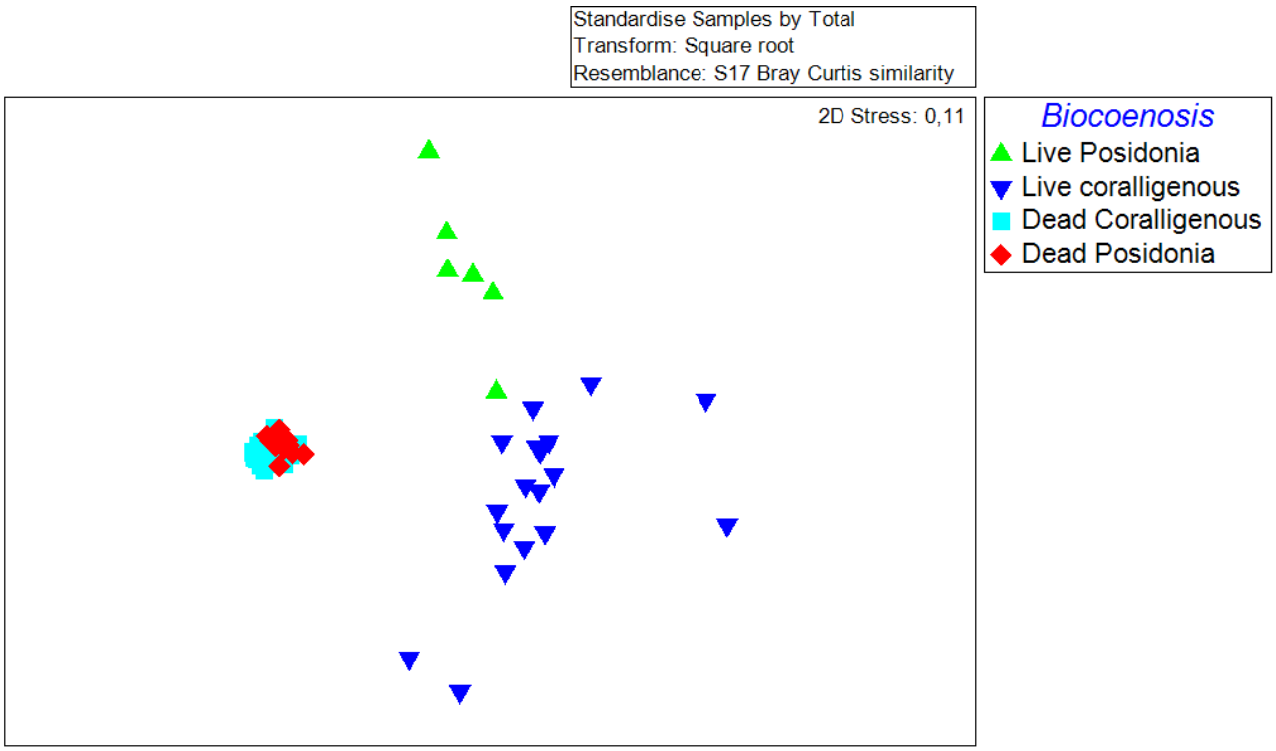

Fig. 56 – Non metric Dimensional Scaling plot comparing living and death samples where soft substratum and cemented species were removed from the data set, square root transform

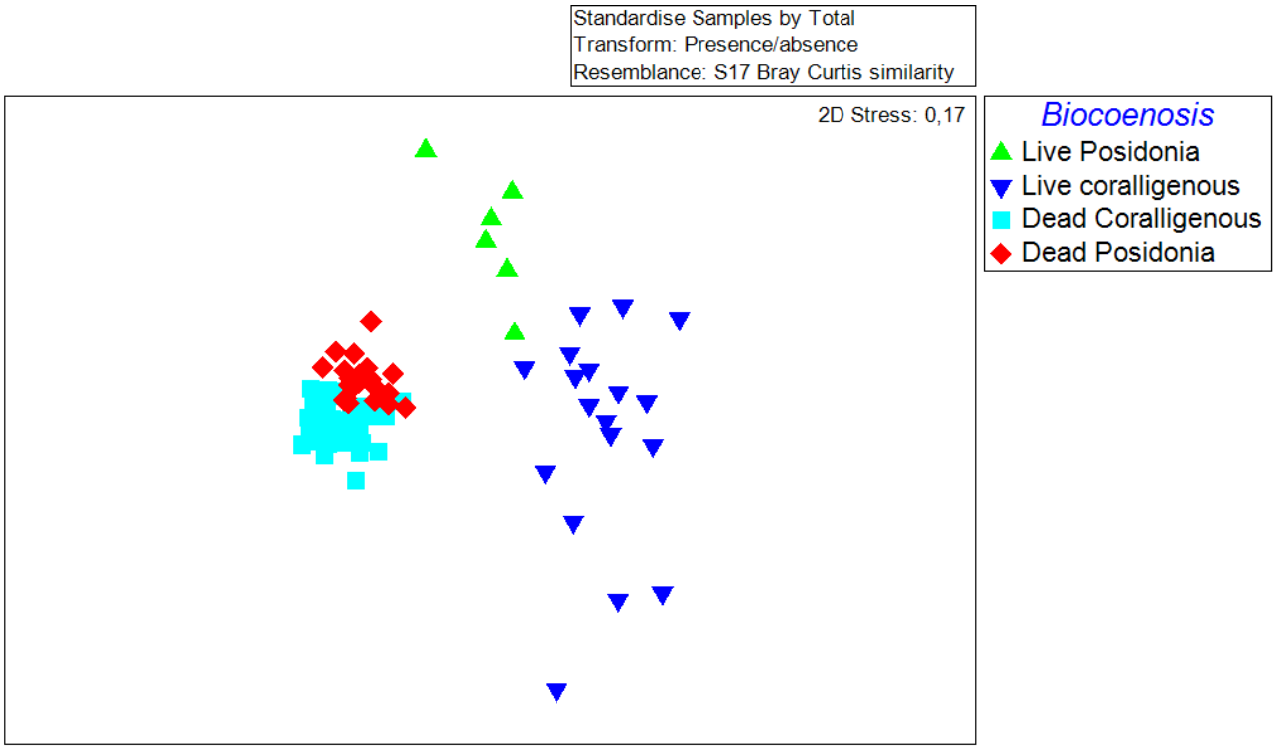

Fig. 57 – Non metric Dimensional Scaling plot comparing living and death samples where soft substratum and cemented species were removed from the data set, presence/absence transform

Species	Living coralligenous average abundance	Death coralligenous average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %	Feeding guild
Jujubinus striatus	0.11	2.81	2.79	4.47	4.20	4.20	MG
Nassarius incrassatus	2.87	0.65	2.36	2.10	3.56	7.76	SC
Jujubinus exasperatus	0.29	2.29	2.07	2.74	3.12	10.88	MG
Homalopoma sanguineum	0.40	2.20	1.88	2.41	2.83	13.71	MG
Muricopsis cristata	2.07	0.30	1.87	1.67	2.83	16.54	C
Pollia scabra	2.16	0.61	1.68	1.60	2.54	19.07	C
Striarca lactea	1.50	2.95	1.54	1.64	2.32	21.39	F
Raphitoma linearis	1.82	0.44	1.47	1.97	2.22	23.61	C
Bittium latreillii	4.73	5.63	1.42	0.97	2.14	25.75	MG
Callochiton septemvalvis	1.31	0.01	1.34	1.81	2.03	27.78	MG
Alvania settepassii	0.88	2.00	1.32	1.59	1.99	29.77	MG
Alvania cancellata	1.71	2.15	1.18	1.26	1.79	31.55	MG
Mitrella scripta	1.18	0.10	1.17	1.27	1.76	33.31	C
Alvania lineata	0.39	1.36	1.15	1.76	1.73	35.04	MG
Bittium sp. *"reticulatum"*	0.65	1.57	1.15	1.58	1.73	36.77	MG

Species	Living coralligenous average abundance	Death coralligenous average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %	Feeding guild
Alvania geryonia	0.07	1.14	1.14	1.95	1.72	38.49	MG
Metaxia metaxae	1.31	0.37	1.12	1.38	1.68	40.17	E
Petalopoma elisabettae	0.11	1.14	1.10	1.96	1.66	41.83	F
Marshallora adversa	1.14	0.31	1.03	1.25	1.55	43.37	E
Fusinus pulchellus	1.30	0.59	1.03	1.48	1.55	44.92	C
Gouldia minima	0.28	1.11	0.99	1.93	1.49	46.41	F
Nucula nucleus	0.00	0.92	0.95	1.89	1.43	47.83	D
Clanculus corallinus	0.53	1.02	0.92	1.80	1.39	49.22	MG
Mitra cornicula	0.90	0.00	0.89	1.45	1.34	50.57	C
Papillicardium papillosum	0.63	1.17	0.85	1.49	1.29	51.85	F
Bolma rugosa	0.18	0.87	0.82	1.49	1.24	53.10	MG
Alvania hispidula	0.78	0.32	0.78	1.12	1.18	54.27	MG
Barbatia barbata	0.42	0.86	0.75	1.94	1.13	55.41	F
Turritella turbona	0.05	0.74	0.75	1.40	1.12	56.53	F
Vexillum tricolor	0.72	0.27	0.74	1.07	1.12	57.65	C
Chiton corallinus	0.71	0.01	0.74	1.00	1.11	58.76	MG
Monophorus erythrosoma	0.76	0.12	0.73	1.22	1.10	59.86	E
Emarginula punctulum	0.21	0.63	0.70	1.12	1.05	60.91	E

Tab. 189 – Output of the SIMPER routine representing the breakdown of average dissimilarity between the death coralligenous sediments and the coralligenous biocoenosis

Species	Living *Posidonia* average abundance	Death *Posidonia* average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %	Feeding guild
Bittium latreillii	3.64	5.91	2.24	1.85	3.59	3.59	MG
Jujubinus striatus	0.21	2.21	1.92	3.22	3.08	6.68	MG
Striarca lactea	1.84	3.41	1.78	2.77	2.86	9.54	F
Alvania settepassii	0.35	2.12	1.74	2.37	2.80	12.33	MG
Alvania lineata	0.00	1.78	1.71	3.69	2.74	15.07	MG
Muricopsis cristata	2.50	0.73	1.70	2.72	2.73	17.81	C
Chauvetia aff *brunnea*	2.43	0.93	1.46	1.67	2.35	20.16	C
Jujubinus exasperatus	1.01	1.89	1.27	2.07	2.04	22.20	MG
Alvania cancellata	0.42	1.69	1.25	2.02	2.00	24.21	MG
Raphitoma linearis	1.83	0.55	1.24	1.57	1.99	26.20	C

Species	Living *Posidonia* average abundance	Death *Posidonia* average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %	Feeding guild
Papillicardium papillosum	1.55	1.05	1.19	1.64	1.92	28.11	F
Homalopoma sanguineum	1.03	2.11	1.19	1.55	1.91	30.02	MG
Muricopsis aradasii	1.34	0.10	1.17	2.96	1.88	31.91	C
Ocinebrina aciculata	1.65	0.45	1.15	2.17	1.84	33.75	C
Alvania geryonia	0.00	1.19	1.14	2.44	1.84	35.59	MG
Nassarius incrassatus	1.77	0.88	1.14	2.14	1.84	37.42	SC
Nucula nucleus	0.00	1.12	1.08	4.46	1.73	39.15	D
Gouldia minima	2.39	1.45	1.05	1.25	1.69	40.84	F
Turritella turbona	0.98	0.54	0.93	1.11	1.49	42.33	F
Fusinus pulchellus	1.52	0.61	0.86	1.76	1.38	43.71	C
Cerithiopsis nana	0.89	0.00	0.84	1.35	1.36	45.07	E
Cerithiopsis sp. 1	0.97	0.18	0.82	1.82	1.32	46.38	E
Marshallora adversa	0.99	0.45	0.79	1.56	1.27	47.65	E
Rissoina bruguieri	0.00	0.82	0.78	1.71	1.26	48.91	MG
Metaxia metaxae	0.93	0.34	0.78	1.29	1.25	50.15	E
Petalopoma elisabettae	0.00	0.79	0.76	1.89	1.22	51.38	F
Pollia scabra	0.58	0.52	0.74	1.27	1.18	52.56	C
Euspira pulchella	0.75	0.17	0.71	1.03	1.15	53.71	C
Mangelia scabrida	0.76	0.03	0.71	1.23	1.14	54.85	C
Clanculus corallinus	0.00	0.74	0.71	1.43	1.14	55.99	MG
Bolma rugosa	0.91	0.88	0.70	1.37	1.12	57.10	MG
Vexillum tricolor	0.69	0.24	0.65	1.15	1.04	58.15	C
Mitrella minor	0.68	0.35	0.64	1.33	1.03	59.18	C
Parvicardium scriptum	0.76	0.35	0.63	1.61	1.02	60.20	F

Tab. 190 – Output of the SIMPER routine representing the breakdown of average dissimilarity between the death *Posidonia* sediments and the *Posidonia* biocoenosis

The analysis was re-run using both the death and living assemblage with only those species which contribute at least 1% to the overall richness. The non metric MDS in Fig. 58 shows that the thanatocoenoses samples strictly group together while the biocoenoses samples are far and well disjuncted. Comparing this picture with the respective one with the full data sets (Fig. 54) the thanatocoenoses samples are much nearer one to each other. Evidently reduction homogeneized them more than did with the biocoenoses samples.

The SIMPER routine evidences that the differences between the death and living assemblages of the same biocoenoses are mainly due to species which are absent from one of the two. In the coralligenous samples (Tab. 189) *Pollia scabra*, *Muricopsis cristata*, *Nassarius incrassatus*, *Fusinus pulchellus*, *Raphitoma linearis*, *Metaxia metaxae* are present in the living assemblage only, while *Jujubinus striatus*, *J. exasperatus*, *Homalopoma sanguineum*, *Bittium* sp. "*reticulatum*" and *Alvania lineata* are present only in the death assemblage. In the *Posidonia* samples (Tab. 190) exactly the same happens: *Muricopsis cristata*, *Raphitoma linearis*, *Nassarius incrassatus*, *Ocinebrina aciculata*, *Fusinus pulchellus* and *Muricopsis aradasii* are present only in the living assemblage while Jujubinus striatus, *Alvania settepassii*, *A. lineata* and *A. cancellata* are present in the death assemblage only. In this habitat a great contributor to differences is also

the different frequence of *Bittium latreillii*, which is more common in the death assemblage than in the living one. It can be easily seen that these groups of species have different trophic guilds. The group present in the living assemblage being composed by carnivores or scavengers while the group present in the death assemblage composed by microalgae herbivores.

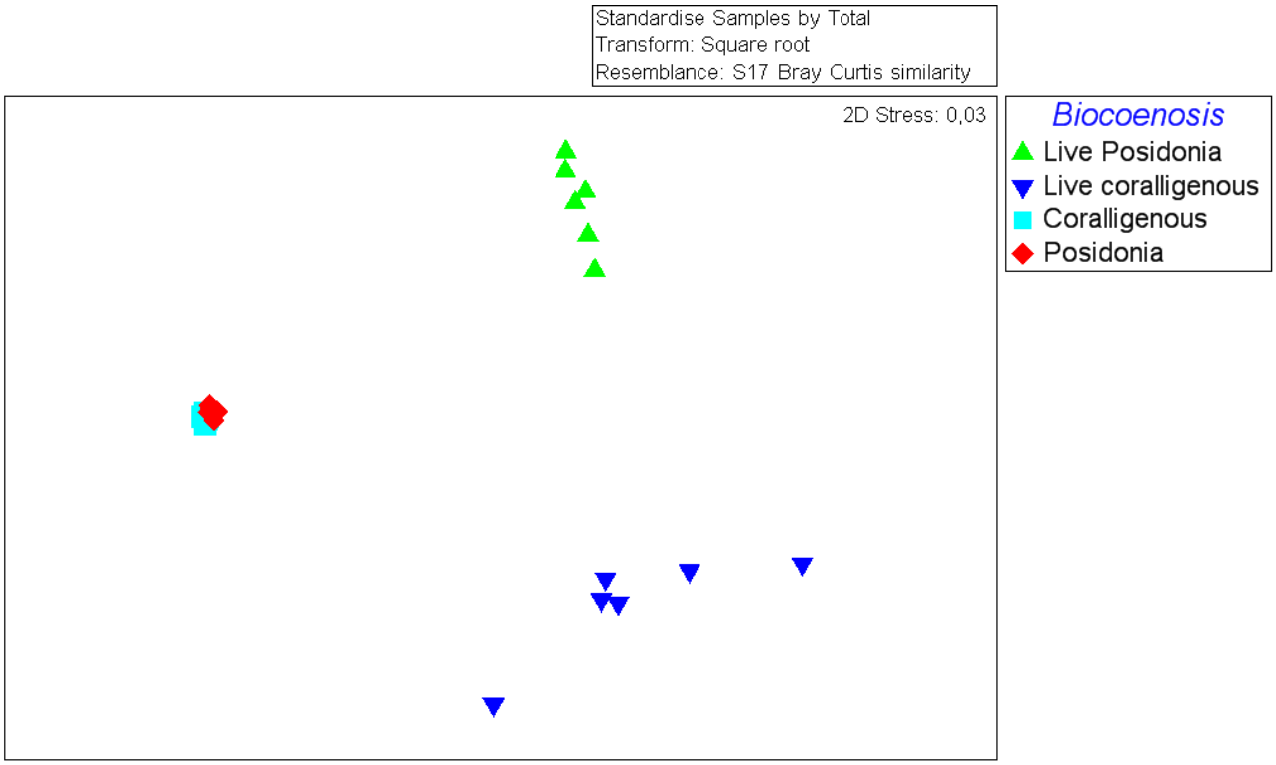

Fig. 58 - Non metric Dimensional Scaling plot comparing living and death samples with reduced data sets containing only species contributing at least 1% to the overall abundance, square root transform

Species	Living coralligenous average abundance	Death coralligenous average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %	Feeding guild
Jujubinus striatus	0.00	3.10	4.53	6.21	6.34	6.34	MG
Pollia scabra	2.65	0.00	3.87	2.50	5.42	11.76	C
Muricopsis cristata	2.65	0.00	3.79	1.76	5.30	17.06	C
Nassarius incrassatus	2.60	0.00	3.71	1.98	5.20	22.26	SC
Jujubinus exasperatus	0.00	2.53	3.70	5.24	5.18	27.43	MG
Homalopoma sanguineum	0.00	2.43	3.56	4.65	4.98	32.41	MG
Fusinus pulchellus	1.93	0.00	2.80	2.09	3.93	36.34	C
Raphitoma linearis	1.78	0.00	2.57	2.08	3.60	39.94	C
Bittium sp. *"reticulatum"*	0.00	1.73	2.52	3.01	3.53	43.46	MG
Bittium latreillii	5.25	6.21	2.33	1.36	3.26	46.72	MG
Alvania lineata	0.00	1.51	2.20	2.50	3.08	49.80	MG
Metaxia metaxae	1.56	0.00	2.17	1.20	3.04	52.84	E
Alvania cancellata	1.11	2.37	2.07	1.25	2.90	55.74	MG
Alvania settepassii	1.08	2.20	2.02	1.88	2.83	58.57	MG

Species	Living coralligenous average abundance	Death coralligenous average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %	Feeding guild
Callochiton septemvalvis	1.35	0.00	2.00	1.88	2.80	61.37	MG

Tab. 191 – Output of the SIMPER routine representing the breakdown of average dissimilarity between the death coralligenous sediments and the coralligenous biocoenoses, reduced data sets

Species	Living *Posidonia* average abundance	Death *Posidonia* average abundance	Average dissimilarity	Diss/SD	Contribution to dissimilarity %	Cumulation of contributions to dissimilarity %	Feeding guild
Muricopsis cristata	2.82	0.00	3.93	3.85	6.20	6.20	C
Bittium latreillii	4.04	6.53	3.51	1.84	5.53	11.73	MG
Jujubinus striatus	0.00	2.44	3.39	5.04	5.34	17.07	MG
Alvania settepassii	0.00	2.34	3.25	3.19	5.12	22.19	MG
Raphitoma linearis	2.06	0.00	2.90	2.38	4.57	26.76	C
Striarca lactea	2.05	3.77	2.79	2.57	4.40	31.16	F
Alvania lineata	0.00	1.96	2.72	3.75	4.28	35.45	MG
Nassarius incrassatus	1.97	0.00	2.71	1.90	4.26	39.71	SC
Ocinebrina aciculata	1.86	0.00	2.59	3.71	4.08	43.79	C
Alvania cancellata	0.00	1.87	2.59	4.41	4.08	47.87	MG
Chauvetia aff brunnea	2.72	1.03	2.40	1.71	3.77	51.65	C
Fusinus pulchellus	1.71	0.00	2.34	3.99	3.69	55.34	C
Muricopsis aradasii	1.51	0.00	2.07	3.84	3.26	58.60	C
Jujubinus exasperatus	1.13	2.09	2.02	2.02	3.19	61.78	MG

Tab. 192 – Output of the SIMPER routine representing the breakdown of average dissimilarity between the death *Posidonia* sediments and the *Posidonia* biocoenoses, reduced data sets

12.2.4.4 Fidelity with respect to species dominance

The metrics listed in par. 12.1.5 were computed for both the minimum volume and sampled volume and reduced data set and complete data set. Moreover, the distribution of species abundances was verified to see to which extent it is comparable to the observations of Kidwell & Bosence (1991).

Metric	Complete data sets			Reduced data sets		
	%	N (total)	S (total)	%	N (total)	S (total)
Posidonia living assemblage	44.8%	574	86	55.7%	461	26
Posidonia death assemblage	65.1%	4113.8	132	79.3%	3373	15
Coralligenous living assemblage	52.7%	498	70	63.9%	410	23
Coralligenous death assemblage	63.7%	3402.9	132	77.7%	2790.5	16

Tab. 193 – Percentage of individuals belonging to the top 6 most abundant species with the minimum volume of sediments; N = number of specimens; S = number of species

Metric	Complete data sets			Reduced data sets		
	%	N (total)	S (total)	%	N (total)	S (total)
Posidonia living assemblage	44.8%	574	86	55.7%	461	26
Posidonia death assemblage	65%	4323.3	135	79.3%	3545.5	15
Coralligenous living assemblage	52.7%	498	70	63.9%	410	23
Coralligenous death assemblage	63.7%	6110	155	77.3%	5038	16

Tab. 194 – Percentage of individuals belonging to the top 6 most abundant species with the full volume of sediments; N = number of specimens; S = number of species

Metric	Minimum volume (1 l)		Complete volume (1.05 l)	
	Complete data sets	Reduced data sets	Complete data sets	Reduced data sets
N° top 6 dead taxa that are also among top 6 living taxa	2	2	2	2
% dead individuals from top 6 living taxa	51.4%	60.8%	51.5%	60.9%
N° top 6 taxa in the same rank order in death and living assemblages	1	1	1	1
% dead individuals from taxa ranked the same in death and living assemblages	36.9%	42.7%	35.1%	42.8%

Tab. 195 – Fidelity with respect to species dominance in the *Posidonia* environment

Metric	Minimum volume (1 l)		Complete volume (1.8 l)	
	Complete data sets	Reduced data sets	Complete data sets	Reduced data sets
N° top 6 dead taxa that are also among top 6 living taxa	2	2	2	2
% dead individuals from top 6 living taxa	42.8%	49.9%	42.5%	49.2%
N° top 6 taxa in the same rank order in death and living assemblages	1	1	1	1
% dead individuals from taxa ranked the same in death and living assemblages	31.6%	38.5%	31.8%	38.6%

Tab. 196 – Fidelity with respect to species dominance in the coralligenous environment

When dealing with the minimum volume, the list of the top 6 most abundant species have been listed in Tab. 197 and Tab. 198.

	Living assemblage	Death assemblage
1	*Bittium latreillii*	*Bittium latreillii*
2	*Chauvetia* aff *brunnea*	*Striarca lactea*
3	*Muricopsis cristata*	*Jujubinus striatus*
4	*Gouldia minima*	*Alvania settepassii*

	Living assemblage	Death assemblage
5	*Striarca lactea*	*Homalopoma sanguineum*
6	*Nassarius incrassatus*	*Jujubinus exasperatus*

Tab. 197 – Top 6 most abundant species in the living and death assemblage in the *Posidonia* samples

	Living assemblage	Death assemblage
1	*Bittium latreillii*	*Bittium latreillii*
2	*Nassarius incrassatus*	*Striarca lactea*
3	*Muricopsis cristata*	*Jujubinus striatus*
4	*Pollia scabra*	*Jujubinus exasperatus*
5	*Striarca lactea*	*Homalopoma sanguineum*
6	*Raphitoma linearis*	*Alvania cancellata*

Tab. 198 – Top 6 most abundant species in the living and death assemblage in the coralligenous samples

12.3 Discussion

12.3.1.1 Experiment repeatability

The selection of specimens from the sediment samples is the very first step of the procedure here suggested and is particularly critical because different approaches may lead to very different results. However, the few basic rules defined were well interpretated both by a senior malacologist and by a young biologist bringing to comparable data.

12.3.1.2 Sediment minimum volume

The need to find a minimum volume for meaningful results arises to render the method operational. Time for sorting out and analysing a single sample should be reasonable to sustain a survey with several stations and samples. One liter of sediment allows a thorough description of the biodiversity. If the reduced data set is considered, the volume would be much less, probably just 150-200 ml, however the loss of species in the reduced data set is so high that the description of biodiversity would be highly deformed. Therefore, it seems more adequate to use the 1 liter sample and then analyse the data in different ways (e.g. using the full and reduced data sets).

12.3.1.3 Sediment species composition

The first element which made us confindent that sediments could bring interesting information on the nearby biocoenoses which produced those organogenous remains is the fact that the two sediments contained clearly distinguishable (despite very similar) species assemblages nothwithstanding the proximity and often sovrapposition of the biocoenoses in the heterogeneous and complex environment of the reefs. This means that transport in the reefs is not enough for bringing shells far from where they lived and this may be due also to the complex morphology of the reefs where sediment settles in pools which are surrounded by coralligenous concretions and by *Posidonia* leaves which can be an obstacle for transport. This is particularly important both for paleoecological reconstruction and for non-destructive biodiversity monitoring methods.

12.3.1.4 Comparison between biocoenosis and thanatocoenosis

Understanding the faunal composition of a site without harming the living populations may be a first important result of the thanatocoenosis analysis. Thanatocoenoses contain a higher number of species than the biocoenoses. However, this does not simply mean that the thanatocoenoses represent a richer assemblage of species, containing the species of the biocoenosis at any given time and those living there in other seasons or years. There is indeed a remarkable number of species which were found in the biocoenoses and were absent from the thanatocoenoses. These species do not usually have particularly fragile shells which could justify their fast disruption and their absence may be looked for in occasional populations of species which

do not find truly suitable living conditions in the reefs or in seasonal, annual and long term fluctuations of others. However, data on the life histories of molluscs are extremely scarce, especially for those tiny uncommon species which here constitute most of the diversity. However this suggests that multi-season multi-year samplings of the biocoenoses are needed to better understand their cycles and further study of the species autoecology are necessary to understand better the outcome of such biocoenotic studies. The analysis of thanatocoenosis allows to trace the existence of species which may be missed by some sampling techniques, especially those which aim at be little distructive of the substratum which may not intercept the endobenthos and species living cemented on the substratum. On the other hand, thanatocoenosis contains species which are occasionally present in the reefs due to transport of larvae which do not manage to settle and develop consistent populations due to the unsuitability of the environment. This was particularly clear with species which are typical of the soft substrata around the reefs (e.g. biocoenoses of the terrigenous mud and of the muddy detritic bottoms (Pérès & Picard, 1964)). The presence in the thanatocoenoses of species typical of other reef biocoenoses is however rare and does not affect the overall comprehension of the fauna.

An interesting result of the comparison between the species assemblages is that there seems to be a general pattern where carnivorous species are more common (and therefore make more the difference) in the living assemblages while non-carnivorous (e.g. microalgae herbivores - MG, filter feeders - F) are more common in the death assemblages. In the coralligenous this is true up to the 50% of the cumulated contribution to dissimilarity (26 species) and in the *Posidonia* up to 40% (17 species). As carnivorous it has to be intended in this case both species which prey on mobile species (C) and on animals without mobility (E). Despite the latter are at lower levels of contribution to differences, probably due to their overall low frequency. Moreover, scavengers (SC) are considered in this group too.

Despite again we hit against poor information on molluscs life histories and especially their life span, this pattern may be correlated with the length of life. For example, *Bittium latreillii* has a 18 months estimated life span (Russo *et al.*, 2002). *Rissoa* are probably annuals (Fretter & Graham, 1978) since Wigham (1975) showed that *Rissoa parva* has a life span of 8-9 months or only 3-4 months depending on the time of settlement. Warén (1996) studying reproduction in *R. parva*, *R. membranacea* (Adams, 1800) and *R. lilacina* Récluz, 1843, observed that all three species seemed to die after spawning, which took place after less than one year from hatching.

Fretter & Graham (1984) suggest for *Nassarius incrassatus* a life span of at least 5-6 years based on a literature review. No specific literature could be traced for the other species, however some European Muricidae have multi-year life spans (e.g. more than 7 years for *Hexaplex trunculus* (Linné, 1758) (Vasconcelos *et al.*, 2006), at least 4 years for *Nucella lapillus* (Linné, 1758), *Urosalpinx cinerea* (Say, 1822) up to 14 years as reported by Fretter & Graham, 1984).

These data support the view that carnivores may have a longer life span than non carnivores when molluscs are considered, despite it is a very preliminary consideration due to the lack of data on a significant number of species. Short life spans mean that more frequently scheletons are added to the thanatocoenoses and therefore these species are relatively more abundant in the sediments as already discussed by Cadée (1968). However, recently Kidwell & Rothfus (2010) analysed the influence of life span on the live-dead agreement in soft substratum bivalve coenoses concluding that "variation in population turnover among species is not a major source of taphonomic bias in time-averaged death assemblages among bivalves […]: bias must arise largely from other factors". This issue is therefore very open to further study.

12.3.1.5 Fidelity with respect to species richness and taxonomic composition

T The analysis of the metrics employed in the fidelity computation evidences a few clear facts. First, differences in their values between the complete volume and minimum volume are minimal. This is quite obvious in the case of the *Posidonia* samples since there was a small difference in the two volumes. It is more striking that there are not great differences even in the coralligenous samples where the complete volume was 180% the minimum volume. The metric which shows the main differences is S_D which increases with the complete data set from 80 to 101 species. However, if the reduced data sets are considered, this difference disappears since analyzing a greater volume of sediment mainly adds rare species with little influence on the overall evaluation. This further supports the idea of a standardized 1 liter volume for analysis of the death assemblage.

Then, the percentage of species found alive which are also found dead is reasonably high (73.1% in the *Posidonia*, 74.3-77.1% in the coralligenous) if the complete data sets are considered but it drastically drops if

the reduced data sets are used (36% in the *Posidonia*, 21.7% in the coralligenous). The values of the complete data sets are in or near the range estimated by Kidwell and Bosence (1991) for soft substrata and above the values found for coral reef habitats by Zuschin *et al.* (2000) (maximum for a specific habitat: 66.7%). However, in this latter work it is evident an increase in the metrics if the reduced data sets are used while here right the opposite happens. This means that if only common species are considered, the number of species found alive which are also found dead decreases as a consequence of little dominance phenomena in the investigated biocoenoses as suggested by a thorough analysis of the living communities (cfr. par. 9.1.3 at page 112 for *Posidonia* rhizomes and par. 10.1.3 at page 158 for the coralligenous). Little dominance implies that common and rare species are not well separated by a quantitative point of view causing this marked decrease in the fidelity metric.

If the percentage of species found dead which are also found alive is considered, values are different for the two biocoenoses. In *Posidonia* the percentage is 36.3-37.1% in the complete data set (depending on the volume of sediment analyzed) and it increases to 60% in the reduced data set. If the coralligenous is considered, the percentage is 34.8-39.4% (higher with the minimum volume which does not include some rarities) in the complete data set and 31.3% in the reduced data set. The values for the complete data sets are within the range estimated by Kidwell and Bosence (1991) for soft substrata but markedly lower than the values found for coral reef habitats by Zuschin *et al.* (2000) (study area: 61.9%). Low fidelity here means that relatively few species from the death assemblage were found in the living one and this may be a result of the time-averaging effects which may be particularly remarkable in communities with low dominance and several rare species like these ones. In the *Posidonia* data, however, this metric increases markedly with the reduced data set implying that the common species associated to this plant have a more steady presence in the different seasons and years. Especially the leaf stratum is known to host the most typical species assemblage. On the contrary, in the coralligenous this metric is even lower with the reduced data set: again this is evidence of a community with poor dominance phenomena where the most common species do not necessarily well describe its complexity and diversity.

Last, the percentage of dead individuals from species found alive is generally high with a narrow range (77.2-82.6%) in the *Posidonia* samples in the different cases and a wider range (78.1-87.6%) in the coralligenous. These values are in the range estimated by Kidwell and Bosence (1991) for soft substrata. Data for coral reefs (Zuschin *et al.*, 2000) are more variable (45.8-96.3% depending on the habitat). This means that in these environments species not sampled alive tend to be represented by few dead individuals probably due to their being allochthonous (e.g. isolated specimens hatched from larvae originated in the soft substrata around the reefs), or forming occasional populations due to seasonality and overall rarity.

These metrics and especially the percentage of species found dead which are also found alive may however be influenced by the sampling intensity of the life assemblage (Kidwell and Bosence, 1991). Sampling in the biocoenoses was in a single season and single year.

If we consider all samples available from the biocoenoses, the percentage of species found alive which are also found dead decreases with complete data sets both in the *Posidonia* and in the coralligenous assemblages. With reduced data sets it increases in the coralligenous and decreases in the *Posidonia*. The decrease with the complete data sets is mostly due to the increase in the number of species found alive only (S_L) which may be due to the increased survey data which cover different areas of the reef and in the lower representativeness of the sediment samples in relation to the whole reefs. This further supports the hypothesis of low transport, low mixing and therefore high representativeness of sediments in respect to nearby life assemblages. The increase with the reduced data set in the coralligenous is probably due to the effect of the few selected species which are also the most widespread and common in the different sites of the reefs and therefore the reduction of the number of species found alive only (S_L). The decrease with the reduced data set in the *Posidonia* is very limited and it could be due to the fact that enlarging the live data set with stations of *Posidonia* settled on a different substratum and with a slightly different community composition adds living species (even quantitatively important) which are not proper of the site and therefore are not found in the death assemblage.

The percentage of species found dead which are also found live increases in the *Posidonia* samples of a 5-6 points if full data sets are considered. No differences are found working with the reduced data sets. In the coralligenous, this metric shows much higher values in this case with a range of 49.7-54.5% rather than 34.8-39.4% (both evaluated with complete data sets). If reduced data sets are considered, this percentage is still markedly low and even lower than in the previous comparison due to the rarity and localization of a good

part of the malacocoenosis. The behavior of this metric supports the point of view of Kidwell & Bosence (1991) about the importance of adequate surveys of living assemblages for comparison with the death ones. However, the *Posidonia* reduced data set suggests that the common species in this biocoenosis allow a thorough comparison regardless of the sampling intensity and the coralligenous reduced data set further supports the affinity between a living assemblage and its spatially close death one in so diverse communities.

The percentage of dead individuals of species found alive increases if the complete data sets are considered in both biocoenoses, despite the increase is much higher in the coralligenous than in the *Posidonia*. This may be due to the increased species richness of the live data set. Results with the reduced data sets are markedly lower in the coralligenous while almost the same in the *Posidonia* and this is due to the low dominance of taxa which concentrates less than in other localities and environments specimens in a few abundant species.

The performance of the comparison between the death assemblage and the living assemblage considering all the available stations for the biocoenoses in the survey carried out evidences that in the coralligenous fidelity results increase more than in the *Posidonia.* This may be due, as said above, to the fact that the two sites where *Posidonia* was sampled are not truly equal due to the different substratum on which the plant settles which influences the community composition especially of the rhizome layer and to the higher diversity and lower dominance phenomena in the coralligenous.

12.3.1.6 Species assemblages comparison

Non-parametric multivariate analysis of data suggest that the death assemblages are quite different from the living ones and that this is due mainly to the different abundance of species. This is showed by the different topology of the MDS plots which clearly show that the analysis run after the presence/absence transform put points closer one to each other, meaning that samples are considered more similar one to each other than with the square root transform.

The remarkable result of the MDS plot with the reduced data sets where the distances between the death and the living assemblages are greater than with complete data sets highlight the deformation of the assemblages with the death of individuals.

12.3.1.7 Fidelity with respect to species dominance

Both the distribution of species abundance and the metrics to evaluate the fidelity in respect to species dominance do not change much whether the complete or minimum (1 liter) volume is considered. The only exception is the percentage of dead individuals from taxa ranked the same in death and living assemblages which is slightly lower when working with complete data sets rather than with the 1 liter volume (35.1% vs 36.9%). This can be easily explained since after the first liter (and probably even well before) further sediment examination adds as new only rare species which do not alter the dominance ratios. The following discussion will be therefore based on the data computed for the 1 liter volume.

The distribution of species abundance (Tab. 193, Tab. 194) clearly shows that in these biocoenoses we deal with a high number of species with low dominance phenomena. The representativeness of the top 6 most abundant species is just 44.8% for the living *Posidonia* assemblage which grows to 55.7% if the reduced data set is considered. This percentage is 52.7% in the coralligenous and it grows to 63.9% if the reduced data set is considered. The high increase of these percentages if the reduced data set is considered is a further element that supports the low dominance pattern of these assemblages. These values are very far from those cited by Kidwell & Bosence (1991) for soft substrata and mark the difficulties in dealing with highly diverse heterogeneous hard substratum assemblages. They are even lower than those found by Zuschin *et al.* (2000) in Red Sea coral reefs and by Zuschin & Oliver (2003) in the Seychelles reefs, despite in those cases the decision not to take into consideration specimens below 2 cm and 1 cm in size respectively has certainly biased the study greatly reducing the evaluated diversity which dominates the smallest size classes (see for tropical biota Bouchet (2009) and Albano *et al.* (submitted) for evaluation on two of the most speciose gastropod families, respectively Pyramidellidae and Triphoridae, whose species are mostly below 1 cm).

In the death assemblages the top 6 most abundant species represent 65.1% of specimens in *Posidonia* environment (79.3% with the reduced data set) and 63.7% of specimens in the coralligenous (77.7% with the reduced data set). This marked increase in respect to the living assemblages may be due to the fact that the most abundant species have a short life-span. This is true for *Bittium latreillii* for example, which lives approximately 18 months. Most other abundant species are herbivores which are expected to have a shorter life span than carnivores. Further discussion of this point is in par. 12.3.1.4.

When it comes to the metrics, the number of top six taxa in the death assemblage that are also among the six most abundant taxa in the living community are 2 both in the *Posidonia* and in the coralligenous samples and are remarkably the same: *Bittium latreillii* and *Striarca lactea*. The other top 4 species in the living *Posidonia* assemblages are mainly carnivores (*Chauvetia* aff *brunnea*, *Muricopsis cristata* and the scavenger *Nassarius incrassatus*), the last being the filter feeder bivalve *Gouldia minima*. In the coralligenous all the other top 4 species are carnivores (*Pollia scabra*, *Raphitoma linearis*, *Muricopsis cristata* and the scavenger *Nassarius incrassatus*). Therefore, as further discussed in par. 12.3.1.4, their reduced abundance in the death assemblage may be due again to their probable longer life span than the herbivores which dominate the other top 4 species in the sediments: *Jujubinus exasperatus*, *J. striatus*, *Homalopoma sanguineum* in both kind of samples, then *Alvania settepassii* in the *Posidonia* samples and *Alvania cancellata* in the coralligenous samples.

The percentage of dead individuals that come from the top six taxa in the living community is 51.4% (60.8% if the reduced data set is considered) in the *Posidonia* samples and 42.8% (49.9% if the reduced data set is considered). These values are slightly lower than those reported by Kidwell & Bosence (1991) as mean values (57%) despite they suggest a wide range is possible (20-99%). In this case, the reason should be searched again in the different trophic composition of the death and living assemblage since in the living assemblages carnivores are half or more of the top 6 most abundant species while they totally lack from the top 6 most abundant species in the death assemblage.

The number of top six taxa that occur in the same rank order in both death assemblage and living community is remarkably low, just 1, in both the *Posidonia* and coralligenous community and it is always the same species: the hyper-abundant and ubiquitous *Bittium latreillii*. Then, as already discussed, the other ranks are occupied by different species with different ecological roles. This is consistent with the observations of Kidwell & Bosence (1991).

Last, the percentage of dead individuals that come from taxa ranked identically both dead and alive is again low and strictly associated to the abundance of *Bittium latreillii*. The values are slightly higher (*Posidonia* 36.9-42.7%, coralligenous 31.6-38.5%) than those reported by Kidwell & Bosence (1991) for soft substrata where about one third of all individuals in the death assemblage belong to species rakned identically in both the death and living assemblages.

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PLATES

EXAMPLES OF THE MOLLUSCAN BIODIVERSITY OF SECCHE DI TOR PATERNO

Plate 1. Family Triphoridae. a-c) *Marshallora adversa* (Montagu, 1803), height 4.9 mm, sample S11 (coralligenous). d) *Marshallora adversa* (Montagu, 1803), height 6.3 mm, sample S6 (coralligenous). Form with the first spiral cord white. e-f) *Monophorus erythrosoma* (Bouchet & Guillemot, 1978), height 8.8 mm, sample S10 (coralligenous). g-h) *Monophorus erythrosoma* (Bouchet & Guillemot, 1978), height 7.7 mm, sample S4 (coralligenous). i-j) *Monophorus perversus* (Linné, 1758), height 10.8 mm, sample S16 (coralligenous). k-l) *Monophorus perversus* (Linné, 1758) juvenile, height 6.5 mm, sample S11 (coralligenous). m-o) *Monophorus thiriotae* Bouchet, 1985, height 6.4 mm, sample S5 (coralligenous).

Plate 2. Family Triphoridae. a-c) *Obesula marisnostri* Bouchet, 1985, height 7.7 mm, sample S7 (coralligenous). d-f) *Similiphora similior* (Bouchet & Guillemot, 1978), height 9.4 mm, sample S11 (coralligenous). g-h) *Obesula marisnostri* Bouchet, 1985, height 4.9 mm, sample SP1 (*Posidonia* rhizomes). i-j) *Pogonodon pseudocanaricus* (Bouchet, 1985), height 4.9 mm, sample SP2 (*Posidonia* rhizomes). k-l) *Pogonodon pseudocanaricus* (Bouchet, 1985) juvenile, height 3 mm, sample SP2 (*Posidonia* rhizomes).

ANNEX 1

QUALI-QUANTITATIVE RESULTS OF THE MOLLUSCA SAMPLED IN SECCHE DI TOR PATERNO

Annex 1 - Quali-quantitative data matrix, Secche di Tor Paterno

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6	S13	S14	S15
Lepidopleurus cajetanus	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hanleya hanleyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Callochiton septemvalvis	1	0	3	0	2	1	1	3	1	3	2	1	4	2	0	6	3	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Chiton corallinus	1	0	0	2	0	0	3	1	1	2	0	1	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Acanthochitona crinita	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyplacophora sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diodora graeca	1	0	0	0	2	0	1	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diodora sp.	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Emarginula octaviana	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emarginula punctulum	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Emarginula rosea	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emarginula sicula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Emarginella huzardii	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scissurella costata	1	2	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Haliotis tuberculata lamellosa	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clanculus corallinus	0	0	2	2	0	0	0	0	0	2	0	3	0	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clanculus cruciatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jujubinus exasperatus	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	1	1	0	0	0	0	0	1	0	0	1	0	0	1	7	0	0	0	0
Jujubinus striatus	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Calliostoma conulum	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Calliostoma laugieri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danilia tinei	0	0	0	0	0	0	1	2	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bolma rugosa	2	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	4	2	2	0	0	0
Homalopoma sanguineum	0	0	1	0	0	0	1	3	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	6	1	1	0	0	0	0	0
Tricolia tenuis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0
Smaragdia viridis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
Cerithium vulgatum	1	0	0	0	0	0	2	0	0	0	0	0	0	0	4	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Bittium latreillii	35	10	14	9	35	2	34	24	21	32	43	11	26	0	37	43	15	35	20	0	17	0	0	10	1	0	6	19	34	20	4	3	0	0	0
Bittium sp. 1	1	0	0	0	0	0	0	0	1	2	3	2	4	1	0	1	0	0	0	0	0	0	0	1	2	1	1	1	1	3	0	0	0	0	0
Bittium sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Bittium sp. 3	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petalopoma elisabettae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turritella turbona	0	0	0	0	0	0	2	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	8	2	1	0	0
Marshallora adversa	3	2	0	2	2	1	1	1	0	2	5	1	1	0	3	4	1	0	0	0	0	0	0	0	0	0	0	2	0	6	1	1	0	0	0
Monophorus erythrosoma	2	0	0	1	3	0	3	1	0	2	2	1	0	0	2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Monophorus perversus	1	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Monophorus thiriotae	2	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Obesula marisnostri	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Pogonodon pseudocanaricus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Similiphora similior	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metaxia metaxae	5	0	1	9	2	0	6	3	0	2	2	3	1	0	4	5	3	1	0	0	0	0	0	0	1	0	1	0	1	3	2	0	0	0	0
Cerithiopsis nana	2	0	0	0	1	0	1	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0	2	1	1	3	0	0	0	0	0
Cerithiopsis nofronii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerithiopsis sp. 1	0	0	0	1	0	0	1	1	0	1	1	0	3	1	0	0	2	1	0	0	0	0	0	0	0	0	1	2	1	2	1	0	0	0	0
Cerithiopsis sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Cerithiopsis sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Dizoniopsis coppolae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parvioris ibizenca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Sticteulima jeffreysiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Vitreolina incurva	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Rissoa auriscalpium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rissoa violacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	0	0	1	0	0	0	0	2	0	0	0	0	0
Pusillina inconspicua	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Pusillina philippi	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pusillina sp.	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Annex 1 - Quali-quantitative data matrix, Secche di Tor Paterno

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6	S13	S14	S15
Alvania cancellata	5	2	4	0	5	0	4	5	0	24	10	0	16	0	3	5	9	1	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Alvania cimex	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alvania discors	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alvania geryonia	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alvania hispidula	2	0	0	0	3	1	1	0	1	2	2	0	7	0	1	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Alvania lineata	0	0	0	0	0	0	1	0	0	1	5	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alvania settepassii	2	0	2	0	2	0	1	1	3	1	5	0	5	0	0	2	1	0	0	1	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
Alvania tenera	0	0	0	0	1	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crisilla beniamina	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manzonia crassa	0	0	0	0	4	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rissoina bruguieri	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caecum armoricum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Caecum clarkii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Caecum subannulatum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parastrophia asturiana	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crepidula sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Trivia arctica	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erosaria spurca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Luria lurida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euspira pulchella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	3	1	1	0	1
Payraudeautia intricata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Dermomurex scalaroides	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0
Ocinebrina aciculata	1	0	0	0	0	0	0	1	0	0	0	1	0	1	4	0	0	1	0	3	4	0	0	1	0	3	3	2	1	5	1	0	0	0	0
Muricopsis aradasii	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	6	2	1	0	0	0
Muricopsis cristata	17	0	4	8	6	5	4	10	0	7	1	2	4	4	5	3	7	2	0	0	0	0	0	0	0	0	8	4	7	13	2	6	0	0	0
Typhinellus labiatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coralliophila meyendorffii	1	0	0	2	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mitra cornicula	2	0	2	1	2	0	1	3	0	1	1	0	3	1	3	0	1	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Vexillum ebenus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Vexillum savignyi	1	0	0	1	0	0	1	1	0	0	1	0	1	0	3	0	4	4	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
Vexillum tricolor	2	1	0	0	0	0	0	3	0	2	2	1	0	0	0	1	4	2	0	0	0	0	0	0	0	0	0	1	0	3	2	0	0	0	0
Euthria corneum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chauvetia aff brunnea	7	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	5	2	4	1	1	5	6	8	6	0	1	0	0	0
Chauvetia recondita	0	0	0	1	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0
Pollia dorbignyi	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pollia scabra	7	0	4	6	4	6	3	7	1	5	3	4	5	8	6	3	8	2	0	0	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0
Nassarius incrassatus	19	3	5	8	14	3	5	6	0	9	7	3	19	16	25	4	8	7	0	0	0	0	0	0	0	0	5	2	9	7	3	0	0	0	0
Columbella rustica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mitrella coccinea	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mitrella gervillii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Mitrella minor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1	0	0	0	0	0
Mitrella scripta	5	0	0	0	0	0	2	5	1	2	0	1	2	4	9	3	3	5	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0
Fusinus pulchellus	4	0	2	6	0	1	4	7	1	3	2	2	1	1	0	1	3	0	0	0	0	0	0	0	0	0	3	3	1	6	2	1	0	0	0
Comarmondia gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mitromorpha karpathoensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Clathromangelia granum	2	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Mangelia scabrida	2	0	0	1	1	0	0	0	0	2	1	1	1	0	0	3	4	2	0	0	0	0	0	0	0	0	1	0	1	1	2	0	0	0	0
Mangelia stossiciana	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Mangelia vauquelini	1	1	1	2	0	0	0	0	0	2	0	1	1	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Raphitoma concinna	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Raphitoma leufroyi	2	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Annex 1 - Quali-quantitative data matrix, Secche di Tor Paterno

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6	S13	S14	S15
Raphitoma linearis	9	1	2	2	7	0	6	4	1	10	4	2	2	2	1	2	9	5	0	0	0	0	0	0	0	0	4	1	6	3	1	5	1	0	0
Raphitoma sp. 1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	0
Raphitoma sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Raphitoma sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Raphitoma sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Crassopleura maravignae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Pseudotorinia architae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mathilda gemmulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Chrysallida excavata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chrysallida suturalis	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Odostomella doliolum	2	0	0	1	8	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ondina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Turbonilla gradata	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turbonilla striatula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Clathrella clathrata	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retusa mamillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	14
Cylichnina crebrisculpta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Haminoea sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weinkauffia turgidula	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philine sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Williamia gussonii	1	0	2	0	0	0	0	1	0	1	0	0	0	2	3	3	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Nucula sp.	1	0	4	0	1	0	3	0	0	0	3	0	2	2	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0
Barbatia barbata	0	0	0	0	0	0	3	0	1	0	0	0	2	0	3	1	1	2	0	0	0	0	0	0	0	0	1	3	1	2	0	0	0	0	0
Striarca lactea	0	1	1	8	3	1	4	3	3	0	0	1	18	3	1	0	4	1	0	0	0	0	0	0	0	0	1	18	1	1	3	2	2	1	0
Gregariella semigranata	1	1	0	1	2	1	1	0	0	0	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Lithophaga lithophaga	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dacrydium hyalinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Modiolula phaseolina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
Chlamys flexuosa	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlamys glabra	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crassadoma multistriata	0	0	0	1	0	2	3	1	0	0	1	0	0	2	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lima lima	0	0	4	1	2	0	0	1	0	0	0	0	0	1	2	3	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Limaria hians	0	0	0	0	2	0	0	0	0	0	0	0	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limaria tuberculata	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galeomma turtoni	0	0	0	0	0	1	0	4	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kellia suborbicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemilepton nitidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Montacuta sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kurtiella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Pteromeris corbis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1
Parvicardium scriptum	0	0	0	2	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0
Papillicardium papillosum	1	0	0	3	1	0	1	0	0	1	0	1	0	0	2	3	4	1	0	0	0	0	0	0	0	0	5	0	0	2	3	10	1	0	0
Tellina tenuis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Arcopagia balaustina	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
Gari costulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Abra sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Venus verrucosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	2	0	0	0
Clausinella fasciata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Gouldia minima	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	2	0	0	0	0	0	0	0	0	0	3	1	3	10	7	10	0	0	0
Hiatella arctica	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0
Thracia distorta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0
Bivalvia sp. (broken shell)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antalis vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
TOTAL NUMBER OF SPECIMENS	173	25	70	90	126	27	119	113	37	125	123	49	159	62	153	118	122	101	24	6	25	6	3	19	6	5	74	94	100	152	70	63	24	7	25

ANNEX 2

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN *POSIDONIA OCEANICA* IN SECCHE DELLA MELORIA (BOTH LEAVES AND RHIZOMES, CASTRIOTA, 1989)

Annex 2 - Quali-quantitative data matrix, Secche della Meloria (Livorno), Sabelli*et al* (unpublished)

	S_A	S_B	S_C	R_H	R_I	R_J	R_L
Lepidopleurus cayetanus	0	0	0	0	0	0	0
Chiton olivaceus	0	0	0	0	0	0	0
Acanthochitona fascicularis	0	0	0	0	0	0	0
Diodora graeca	0	0	0	0	0	0	0
Diodora italica	0	0	0	0	0	0	0
Patella caerulea	0	0	0	0	0	0	0
Jujubinus exasperatus	5	1	4	2	5	1	10
Jujubinus gravinae	0	0	0	0	0	0	0
Jujubinus striatus	0	0	0	0	0	0	0
Gibbula philberti	0	0	0	0	0	0	0
Gibbula varia	0	0	0	0	0	0	0
Gibbula umbilicaris	2	0	0	0	0	0	4
Calliostoma laugieri	2	0	0	1	0	1	1
Clanculus cruciatus	0	0	0	0	0	0	0
Clanculus jussieui	0	0	0	0	0	0	0
Astraea rugosa	0	0	0	0	0	0	0
Tricolia pullus	0	1	0	0	0	0	0
Tricolia speciosa	0	0	0	0	1	0	0
Nodulus contortus	0	0	0	0	0	0	0
Rissoa auriscalpium	1	1	0	8	0	1	1
Rissoa guerinii	0	1	0	2	3	0	1
Rissoa similis	0	0	1	0	0	0	0
Rissoa variabilis	0	0	0	9	4	3	1
Pusillina dolium	0	0	0	4	0	0	0
Pusillina radiata	0	0	0	0	6	2	5
Alvania cimex	4	0	0	0	0	0	0
Alvania aspera	0	0	0	0	0	0	0
Alvania cancellata	0	0	0	0	0	0	0
Alvania discors	0	0	0	0	0	1	0
Alvania geryonia	1	0	0	0	0	0	0
Alvania lanciae	0	0	0	0	0	0	0
Alvania lineata	0	0	0	0	0	0	0
Alvania pagodula	1	0	0	2	0	0	0
Alvania subcrenulata	0	0	0	0	0	0	0
Alvania semistriata	0	0	0	0	0	0	0
Alvania carinata	0	0	0	0	0	0	0
Alvania sp	0	0	0	0	0	0	0
Manzonia crassa	0	0	0	0	0	0	0
Rissoina bruguierei	0	0	0	0	0	0	0
Bittium reticulatum	4	8	1	349	469	87	215
Bittium jadertinum	0	0	0	0	6	5	8
Cerithium vulgatum	0	0	0	0	0	0	0
Cerithiopsis minima	0	0	0	0	0	0	1
Cerithiopsis nicephorus	0	0	0	0	0	0	0
Cerithiopsis scalaris	0	0	0	0	0	0	0
Cerithiopsis sp	0	0	0	0	0	0	0
Metaxia metaxa	0	0	0	0	0	0	0
Monophorus sp	0	0	0	0	0	0	0
Parvíorís microstoma	0	0	0	0	0	0	0
Vitreolina philippi	0	0	0	0	0	0	0
Muricopsis cristata	0	0	0	0	0	0	0
Cantharus dorbignyi	0	0	0	0	0	0	0
Chauvetia minima	0	0	0	0	0	0	0

Annex 2 - Quali-quantitative data matrix, Secche della Meloria (Livorno), Sabelli*et al* (unpublished)

	S_A	S_B	S_C	R_H	R_I	R_J	R_L
Columbella rustica	0	0	0	0	0	0	0
Nassarius incrassatus	11	1	1	0	0	0	0
Marshallora adversa	0	0	0	1	0	0	0
Gíbberula miliaria	0	0	0	0	0	0	0
Conus ventricosus	0	0	0	0	0	0	0
Haedropleura septangularis	0	0	0	0	0	0	0
Chrysallida doliolum	0	0	0	0	0	0	0
Odostomia conoidea	0	0	0	0	0	0	0
Turbonilla striatula	0	0	0	0	0	0	0
Nucula nucleus	0	0	0	0	0	0	0
Arca noe	0	0	0	0	0	0	0
Striarca lactea	0	0	0	0	0	0	0
Mytilus galloprovincialis	0	0	0	0	0	0	0
Musculus costulatus	0	0	0	0	0	0	0
Modiolus barbatus	0	0	0	0	0	0	0
Modiolula phaseolina	0	0	0	0	0	0	0
Chlamys multistriata	0	0	0	0	0	0	0
ChIamys varia	0	0	0	0	0	0	0
Anomia ephippium	0	0	0	0	0	0	0
Limea loscombi	1	0	0	0	0	0	0
Ctena decussata	0	0	0	0	0	0	0
Chama gryphoides	0	0	0	0	0	0	0
Lepton squamosum	0	0	0	0	0	0	0
Mysella bidentata	0	1	0	0	0	0	0
Cardita calyculata	1	2	0	0	0	0	0
Glans trapezia	0	2	0	0	0	0	0
Venericardia antiquata	5	0	0	0	0	0	0
Parvicardium ovale	3	1	0	0	0	0	0
Plagiocardium papillosum	1	1	0	0	0	0	0
Venus verrucosa	2	1	0	0	0	0	0
Gouldia minima	1	0	0	0	0	0	0
Irus irus	0	0	0	0	0	0	0
Venerupis aurea	0	0	0	0	0	0	0
Venerupis senegalensis	0	0	0	0	0	0	0
Venerupis lucens	0	0	0	0	0	0	0
Petricola lajonkairii	0	0	0	0	0	0	0
Gastrochaena dubia	0	0	0	0	0	0	0
Hiatella arctica	0	1	0	0	0	0	0
Thracia distorta	0	1	0	0	0	0	0
TOTAL NUMBER OF SPECIMENS	45	23	7	378	494	101	247

ANNEX 3

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN *POSIDONIA OCEANICA* IN ELBA ISLAND (BOTH LEAVES AND RHIZOMES, B. SABELLI UNPUBLISHED DATA)

Annex 3 - Quali-quantitative data matrix, Elba Isl., Sabelli *et al* (unpublished)

	R1-5	R2-5	R3-5	R4-5	R1-12	R2-12	R3-12	S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
Lepidopleurus cajetanus	0	0	0	0	0	0	0	1	0	0	0	0	0
Scissurella costata	0	0	0	0	0	0	0	1	0	0	0	0	0
Emarginula pustula	0	0	0	0	0	0	0	0	0	0	0	1	0
Gibbula umbilicaris	0	0	0	0	0	0	0	0	0	0	0	0	1
Jujubinus exasperatus	6	7	2	1	2	11	6	8	3	8	20	11	14
Clanculus corallinus	0	0	0	0	0	0	0	0	0	0	2	0	0
Clanculus jussieui	0	0	0	0	0	0	0	0	0	0	1	0	0
Calliostoma laugieri	0	0	0	0	0	1	0	0	0	1	0	0	0
Tricolia pullus	2	0	0	3	1	5	1	40	25	38	37	10	9
Tricolia speciosa	5	6	1	2	3	1	0	18	19	9	6	4	3
Smaragdia viridis	1	0	0	0	0	0	0	0	0	0	0	0	0
Bittium jadertinum	7	9	17	1	5	6	4	4	3	4	5	3	2
Bittium latreilli	45	58	88	9	299	494	126	103	72	98	259	39	24
Rissoa auriscalpium	21	32	65	13	60	70	37	51	32	22	13	20	10
Rissoa decorata	0	0	1	0	0	0	0	0	0	0	0	0	0
Rissoa guerini	1	0	0	0	0	1	0	0	0	0	0	0	0
Rissoa similis	0	0	0	0	0	0	1	0	0	0	0	0	0
Rissoa variabilis	0	1	1	0	0	0	0	0	0	0	0	0	0
Rissoa ventricosa	19	26	25	5	20	20	17	0	0	1	0	1	1
Rissoa violacea	3	4	3	1	13	10	7	0	0	0	0	0	1
Alvania cimex	0	0	0	0	0	0	0	18	9	45	101	14	0
Alvania lineata	3	1	0	0	0	1	1	10	5	25	0	0	0
Alvania montagui	0	2	2	0	0	4	4	4	4	15	2	1	0
Pusillina radiata	0	1	7	1	19	19	8	1	1	3	1	0	2
Rissoina bruguierei	0	0	0	0	0	0	0	0	0	1	3	0	0
Polinices nitida	0	0	0	0	0	0	0	0	0	0	2	0	1
Eulima subulata ?	0	0	0	0	0	0	0	0	1	0	0	0	0
Parvioris ibizenca	0	0	0	0	0	0	0	0	0	1	3	1	1
Vitreolina philippii	0	0	0	0	0	0	0	0	1	0	0	0	0
Triphoridae bianco	0	0	1	0	0	0	0	0	0	0	0	0	0
Triphoridae	0	0	0	0	0	0	0	0	1	1	12	1	0
Phyllonotus trunculus	0	0	0	0	0	0	0	0	0	1	0	0	0
Tiphys sowerbyi	0	0	0	0	0	0	0	2	3	0	0	0	0
Nassarius incrassatus	0	0	0	0	0	0	0	2	0	11	15	1	1
Pusia tricolor	0	0	0	0	1	0	0	0	0	1	0	0	0
Gibberula miliaria	0	0	0	0	0	0	0	1	0	1	4	3	1
Haedropleura secalina	0	0	0	0	0	0	0	0	0	0	0	0	1
Mangilia albida	0	0	0	0	0	0	0	1	1	0	0	0	0
Mangilia sp 1	0	0	0	0	0	0	0	0	0	0	0	0	1
Mangilia sp 2	0	0	0	0	0	0	0	0	0	0	0	1	0
Raphitoma bicolor	0	0	0	0	0	0	0	0	0	0	3	0	1
Raphitoma linearis	0	0	0	0	0	0	0	0	0	0	3	3	1
Leufroya leufroyi	0	0	0	0	0	0	0	0	0	0	0	2	0
Chrysallida dolium	0	0	0	0	0	0	0	0	0	1	0	0	0
Chrysallida excavata	0	0	0	0	0	0	0	0	0	0	1	0	0
Odostomia conoidea	0	0	0	0	0	0	0	0	0	1	1	0	0
Turbonilla scalaris	0	0	0	0	0	0	0	0	0	0	1	1	0
Turbonilla rufa	0	0	0	0	0	0	0	0	0	0	0	2	1
Nucula nucleus	0	0	0	0	0	0	0	0	0	0	0	0	1
Navicula noae	0	0	0	0	0	0	0	0	0	3	2	0	0
Barbatia barbata	0	0	0	0	0	0	0	0	0	1	2	0	0
Striarca lactea	0	0	0	0	0	0	0	3	1	1	23	4	3
Musculus subpictus	0	0	0	0	0	0	0	1	0	2	1	1	0
Cardita trapezia	0	0	0	0	0	0	0	14	12	10	29	8	8

Annex 3 - Quali-quantitative data matrix, Elba Isl., Sabelli *et al* (unpublished)

	R1-5	R2-5	R3-5	R4-5	R1-12	R2-12	R3-12	S1-5	S2-5	S3-5	S1-12	S2-12	S3-12
Plagiocardium papillosum	0	0	0	0	0	0	0	0	0	0	0	0	1
Ctena decussata	0	0	0	0	0	0	0	1	0	1	1	3	0
Divaricella divaricata	0	0	0	0	0	0	0	0	0	1	0	0	0
Gouldia minima	0	0	0	0	0	0	0	3	3	3	2	5	3
Venus verrucosa	0	0	0	0	0	0	0	0	0	0	0	1	0
Lajonkairea lajonkairii	0	0	0	0	0	0	0	0	0	1	0	1	0
Tellina balaustina	0	0	0	0	0	0	0	0	0	0	0	1	0
Hiatella arctica	0	0	0	0	0	0	0	0	0	1	0	0	0
Bivalve gen sp ind	0	0	0	0	0	0	0	0	0	0	2	0	0
TOTAL NUMBER OF SPECIMENS	113	147	213	36	423	643	212	287	196	312	557	143	92

ANNEX 4

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN *POSIDONIA OCEANICA* IN GIGLIO ISLAND (BOTH LEAVES AND RHIZOMES, BONFITTO *ET AL.*, 1998)

Annex 4 - Quali-quantitative data matrix, Giglio Isl., Bonfitto *et al* , 1998

	S-B	R-B
Callochiton septemvalvis euplaeae	3	0
Smaragdia viridis	3	0
Emarginula pustula	2	0
Clanculus jusseui	1	0
Jujubinus exasperatus	0	4
Jujubinus gravinae	1	0
Jujubinus striatus	10	16
Tricolia pullus pullus	10	0
Tricolia tenuis	1	1
Cerithium alucaster	1	0
Cerithium vulgatum	2	0
Bittium jadertinum	28	2
Bittium latreillii	165	14
Rissoa auriscalpium	0	1
Rissoa decorata	4	9
Rissoa ventricosa	2	11
Rissoa violacea	0	4
Alvania cimex	3	0
Alvania discors	23	8
Alvania geryonia	1	0
Alvania lineata	1	1
Alvania pagodula	4	0
Pusillina radiata	1	1
Rissoina bruguierei	2	0
Natica dillwynii	2	0
Marshallora adversa	7	0
Epitonium commune	1	0
Melanella polita	2	0
Nassarius incrassatus	36	0
Columbella rustica	1	0
Vexillum tricolor	1	0
Gibberula miliaria	1	0
Granulina marginata	8	0
Fasciolaria lignaria	2	0
Mangelia vauquelini	2	0
Raphitoma linearis	4	0
Eulimella sp.	1	0
Odostomia acuta	1	0
Turbonilla lactea	1	0
Turbonilla striatola	1	0
Arca noae	5	0
Striarca lactea	64	0
Gregariella petagnae	4	0
Modiolula phaseolina	1	0
Ctena decussata	4	0
Chama gryphoides	1	0
Neolepton sulcatulum	1	0
Glans trapezia	59	0
Venus verrucosa	14	0
Gouldia minima	5	0
Hiatella arctica	3	0
TOTAL NUMBER OF SPECIMENS	500	72

ANNEX 5

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN *POSIDONIA OCEANICA* IN ISCHIA ISLAND (LEAVES STRATUM, IDATO *ET AL.*, 1983)

Annex 5 - Quali-quantitative data matrix, Ischia Isl., Idato*et al*, 1983

	R-25A	R-25B	R-25C
Jujubinus exasperatus	1	1	0
Jujubinus striatus	1	0	0
Tricolia speciosa	1	1	0
Rissoella sp.	6	4	0
Microsetia cossurae	0	1	0
Turboella radiata (juv)	14	10	8
Turboella radiata (ad)	0	3	4
Turboella lineolata (juv)	2	3	2
Apicularia guerinii	0	1	1
Rissoa violacea	6	5	6
Alvania discors	0	1	1
Alvania lineata	4	1	5
Turritella communis	0	0	1
Bittium reticulatum	8	3	5
Balcis devians	1	0	0
Naticarius millepunctatus (juv)	1	0	0
Muricopsis cristata	1	0	0
Phyllonotus trunculus	0	1	0
Ocinebrina aciculata (juv)	0	0	4
Buccinulum corneum (juv)	0	0	1
Fusinus pulchellus	1	0	0
Gibberula philippii	2	0	3
Gibberulina clandestina	2	5	1
Lissopecten hyalinus	1	3	0
Anomia ephippium	1	0	1
TOTAL NUMBER OF SPECIMENS	53	43	43

ANNEX 6

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN *POSIDONIA OCEANICA* IN HVRGADA ISLAND, CROATIA (BOTH LEAVES AND RHIZOMES, SOLUSTRI *ET AL.*, 2002)

Annex 6 - Quali-quantitative data matrix, Vrgada (Croazia), Solustri*et al*, 2002

	R4	R11	S4	S11
Smaragdia viridis	0	6	0	0
Calliostoma laugieri	0	1	0	0
Jujubinus striatus	13	2	8	0
Tricolia tenuis	9	4	87	1
Cerithium vulgatum	0	0	0	2
Bittium jadertinum	5	0	3	0
Bittium latreillii	75	10	35	0
Rissoa labiosa	2	0	0	0
Rissoa monodonta	1	0	0	0
Rissoa splendida	6	0	21	0
Rissoa variabilis	3	0	5	0
Rissoa ventricosa	0	4	0	2
Rissoa violacea	0	0	0	4
Alvania cimex	0	0	2	0
Alvania discors	0	0	43	0
Alvania geryonia	0	0	5	0
Alvania pagodula	0	0	5	0
Pusillina philippi	1	0	0	0
Pusillina radiata	0	0	0	1
Caecum trachea	0	0	1	0
Polinices nitida	0	0	0	1
Melanella boscii	0	0	0	1
Granulina marginata	0	1	2	1
Bela sp	0	0	0	1
Mangelia sp1	0	0	0	3
Mangelia sp2	0	0	0	2
Odostomia acuta	0	0	0	1
Nucula nucleus	0	0	4	0
Modiolarca subpicta	0	1	2	0
Lissopecten hyalinus	0	2	0	0
Pododesmus patelliformis	0	0	0	1
Thyasira flexuosa	0	0	7	0
Mysella bidentata	0	0	2	0
Parvicardium exiguum	0	0	5	1
Venus verrucosa	0	0	0	8
Gouldia minima	0	0	12	2
Callista chione	0	0	0	1
TOTAL NUMBER OF SPECIMENS	115	31	249	33

ANNEX 7

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN THE CORALLIGENOUS IN SECCHE DI TOR PATERNO (UNIVERSITÀ LA SAPIENZA, 1993)

Annex 7 - Quali-quantitative data matrix, Secche di Tor Paterno, Univ. La Sapienza, 1993

	a	b	c	d	e
Acanthochitona crinita					2
Acanthochitona fascicularis		2			
Callochiton septemvalvis				1	
Chiton phaseolinus		1		1	
Alvania cimex	1				
Alvania lineata					2
Bolma rugosa				1	
Buccinulum corneum					1
Diodora graeca					1
Emarginella huzardii		1		3	
Emarginula rosea		1			1
Haliotis tuberculata lamellosa				1	
Haminoea hydatis		3			
Homalopoma sanguineum		1			
Muricopsis cristata	2				
Ocinebrina aciculata			1		
Rissoa violacea					1
Weinkauffia turgidula	1				
Anomia ephippium			2	2	
Barbatia barbata		1			
Chama gryphoides			1		
Chlamys multistriata	2	1	1	1	
Divaricella angulifera					1
Galeomma turtoni		2			
Gouldia minima		2			
Gregariella petagnae		1	1		
Hiatella arctica	41	30	62	43	32
Kellia suborbicularis				1	
Lima exilis		2			
Lima lima	2	3		3	
Lithophaga lithophaga	4	3		3	5
Modiolarca subpicta			13		
Modiolus barbatus	1	2			
Musculus costulatus	3	1			
Nuculoma tenuis		2	2		
Pseudochama gryphina	1	4			
Striarca lactea	23	27	28	29	23
Thracia distorta		2	5	4	
TOTAL NUMBER OF SPECIMENS	81	92	116	93	69

ANNEX 8

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN THE CORALLIGENOUS IN SCIACCA (SICILY) (GILLONE, 1990)

Annex 8 - Quali-quantitative data matrix, Sciacca (Agrigento) Gillone, 1990

	G1	G2	G3
Lepidopleurus cajetanus		1	
Callochiton septemvalvis euplaeae	3	2	12
Chiton corallinus	2		
Acanthichitona crinita	1		
Emarginula adriatica	1		
Scissurella costata			1
Haliotis tubercolata lamellosa	1	1	
Clanculus corallinus			1
Clanculus cruciatus		1	
Bittium jadertinum			1
Bittium latreillii			3
Alvania cingulata	22	2	36
Alvania semistriata			7
Manzonia crassa	2		1
Pusillina philippi			1
Caecum subannulatum		1	
Parastrophia asturiana			1
Trivia monacha		1	
Marshallora adversa		1	
Monophorus perversus			1
Monophorus thiriotae		1	
Metaxia metaxae			2
Muricopsis cristata		1	7
Ocinebrina edwardsii	1	2	
Ocinebrina hybrida			2
Chauvetia sp.			3
Chauvetia lefebvrei		1	1
Pollia dorbignyi		1	
Pollia scabra			5
Fasciolaria lignaria			1
Nassarius incrassatus	3		2
Columbella rustica	1		1
Mitrella scripta			1
Gibberula caelata			2
Conus mediterraneus		1	
Bela sp.	1		
Mangeliella taeniata			1
Raphitoma purpurea			1
Raphitoma leufroyi			2
Folinella excavata		2	
Williamia gussonii		1	2
Nucula nucleus	1		
Arca noae			1
Barbatia barbata	4	1	2
Striarca lactea	19	5	2
Glycymeris sp.	2		
Musculus costulatus			1
Rhomboidella prideauxi			2
Lithophaga lithophaga	1		2
Modiolula phaseolina	2		1
Ctena decussata	1		
Chama gryphoides	2	1	3
Pseudochama gryphina	1		2
Galeomma turtoni			1
Kellia suborbicularis	2	1	5

Annex 8 - Quali-quantitative data matrix, Sciacca (Agrigento) Gillone, 1990

	G1	G2	G3
Parvicardium ovale			2
Plagiocardium papillosum	1		
Abra alba	2		4
Chamelea gallina		1	
Gastrochaena dubia	3		
Hiatella rugosa	8	3	24
TOTAL NUMBER OF SPECIMENS	87	32	150

ANNEX 9

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN THE CORALLIGENOUS IN SCOPELLO (SICILY) (GILLONE, 1990)

Annex 9 - Quali-quantitative data matrix, Scopello (Trapani), Riserva Orientata dello Zingaro, Gillone, 1990

	G4
Bittium jadertinum	5
Bittium latreillii	2
Alvania cingulata	2
Alvania beniamina	2
Rissoina bruguierei	2
Barleeia unifasciata	1
Muricopsis cristata	1
Chauvetia sp.	1
Volvarina mitrella	1
Granulina clandestina	1
Musculus costulatus	1
Rhomboidella prideauxi	1
Kellia suborbicularis	1
Hiatella rugosa	1
TOTAL NUMBER OF SPECIMENS	22

ANNEX 10

QUALI-QUANTITATIVE RESULTS OF THE SAMPLING IN THE SOFT SUBSTRATA AROUND SECCHE DI TOR PATERNO (UNIVERSITÀ TOR VERGATA, 2005)

Annex 10 - Quali-quantitative data matrix, soft substrate stations, Secche di Tor Paterno (Univ. Tor Vergata, 2005)

	1	2	3	4	5	6	7	8	9	10	11	12	13
Abra alba							1						
Abra nitida		2		1	1		1	2					
Aporrhais pespelecani					1								
Calyptraea chinensis	1									1			
Clausinella brogniartii					1								
Corbula gibba					1			10		2	2	1	
Cylichna cylindracea													
Dentalium inaequicostatum								2					2
Diplodonta brocchi													
Hyala vitrea		2								2			
Mysella bidentata		1	1		1	2		9	1		1	2	3
Mysia undata													
Nassarius pygmaeus				2		1							
Nucula nucleus					2				1	1	1		
Nucula sulcata				1									
Nuculana commutata					3					1			
Odostomia conoidea		1											
Parvicardium scabrum					3					2			
Phaxas adriaticus									1				
Plagiocardium papillosum													
Polinices fusca					1								
Polinices nitida								1					
Pyramidellidae indet.						1							
Tectonatica filosa				1									
Tellina serrata					1								
Timoclea ovata					10								1
Turritella communis	1			42						1			
Turritella turbona					1								
TOTAL NUMBER OF SPECIMENS	2	6	1	47	26	4	2	24	3	10	4	3	6

Annex 10 - Quali-quantitative data matrix, soft substrate stations, Secche di Tor Paterno (Univ. Tor Vergata, 2005)

	14	15	16	17	18	19	20	21	22	23	24	25	26
Abra alba									1	2			
Abra nitida				2				1	2		2	4	1
Aporrhais pespelecani													
Calyptraea chinensis			1										
Clausinella brogniartii													
Corbula gibba	1		2	4	1								
Cylichna cylindracea				1									
Dentalium inaequicostatum		4	1	1								1	
Diplodonta brocchi	1				1				1				
Hyala vitrea									2		2		
Mysella bidentata	2		2		7				1				
Mysia undata				1									
Nassarius pygmaeus			1										
Nucula nucleus													
Nucula sulcata				2		1	1						
Nuculana commutata			1										
Odostomia conoidea													
Parvicardium scabrum			1										
Phaxas adriaticus			1	1			1	1				1	1
Plagiocardium papillosum		1											
Polinices fusca													
Polinices nitida													
Pyramidellidae indet.									1				
Tectonatica filosa													
Tellina serrata		1											
Timoclea ovata												1	
Turritella communis									3				
Turritella turbona													
TOTAL NUMBER OF SPECIMENS	4	6	10	12	9	1	2	2	11	2	4	7	2

ANNEX 11

QUALI-QUANTITATIVE RESULTS OF THE PLEOCYEMATA (CRUSTACEA) SAMPLED IN SECCHE DI TOR PATERNO

Annex 11 - Quali-quantitative data matrix, Pleocyemata (Crustacea), Secche di Tor Paterno

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19
Achaeus cfr gordonae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Achaeus cranchii	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Achaeus gracilis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Alfeide	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Alphaeus dentipes	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Alphaeus dentipes ?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anapagurus ?	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Anapagurus euridactylus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Athanas nitescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Athanas sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bathynectes longipes	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Calcinus tubularis	0	0	0	0	0	1	0	0	0	0	6	0	0	0	1	0
Cestopagurus timidus	3	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Ebalia edwardsi	0	0	0	0	0	0	0	4	0	0	2	3	0	0	0	0
Ebalia nux	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethusa mascarone	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurynome aspera	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0
Eurynome spinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eutynome cfr spinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galathea bolivari	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Gnathophyllum elegans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Herbstia condyliata juv	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Hippolite inermis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilia nucleus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liocarcinus arcuatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liocarcinus corrugatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysmata seticaudata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macropodia czerniavski	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macropodia rostrata	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pagurus anachoretus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Pagurus chevreuxi	3	0	0	0	0	1	0	1	0	0	3	0	0	0	0	0
Pagurus cuanensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Pagurus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Palemon xyphias	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parthenope massena	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Periclimenes sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pilumnus sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Pinnoteres pisum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisidia bluteli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisidia longimana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisidia sp.	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Processa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scyllarus pygmaeus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synalphaeus gamberelloides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thoralus cranchii ?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Xantho pilipes	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0
Not identified			2	14	4	21	41	15		2	9	7		13	22	13
TOTAL NUMBER OF SPECIMENS	12	1	11	16	4	28	43	22	0	2	21	11	0	13	27	13

Annex 11 - Quali-quantitative data matrix, Pleocyemata (Crustacea), Secche di Tor Paterno

	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6
Achaeus cfr gordonae	0	0	0	0	0	0	0	0			0	0	0	0	0	1
Achaeus cranchii	0	0	0	0	0	0	0	0			0	1	0	0	0	0
Achaeus gracilis	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Alfeide	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Alphaeus dentipes	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Alphaeus dentipes ?	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Anapagurus ?	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Anapagurus euridactylus	0	0	0	0	0	0	0	0			0	0	0	0	0	1
Athanas nitescens	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Athanas sp.	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Bathynectes longipes	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Calcinus tubularis	0	1	0	0	0	0	0	0			0	0	0	1	0	0
Cestopagurus timidus	0	0	1	0	1	0	0	0			0	0	0	0	1	0
Ebalia edwardsi	0	0	0	0	0	0	0	0			0	2	0	5	2	2
Ebalia nux	0	0	0	0	0	0	0	0			4	0	0	0	0	0
Ethusa mascarone	0	0	0	0	0	0	0	0			0	0	1	0	0	0
Eurynome aspera	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Eurynome spinosa	0	0	0	0	0	0	0	0			0	0	0	1	0	1
Eutynome cfr spinosa	0	0	0	0	0	0	0	0			1	0	0	0	0	0
Galathea bolivari	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Gnathophyllum elegans	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Herbstia condyliata juv	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Hippolite inermis	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Ilia nucleus	0	0	0	0	0	0	0	0			0	0	0	0	1	0
Liocarcinus arcuatus	0	0	0	0	0	0	0	0			0	0	0	1	0	0
Liocarcinus corrugatus	0	0	0	0	0	0	0	0			0	0	0	0	1	0
Lysmata seticaudata	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Macropodia czerniavski	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Macropodia rostrata	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Pagurus anachoretus	0	1	1	0	1	0	0	1			0	0	0	0	1	0
Pagurus chevreuxi	0	3	0	0	0	0	0	0			1	2	0	0	1	0
Pagurus cuanensis	0	2	0	0	0	0	0	0			0	0	0	0	0	1
Pagurus sp.	0	0	0	0	0	0	0	0			0	2	2	3	4	1
Palemon xyphias	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Parthenope massena	0	0	0	0	0	0	0	1			0	0	0	0	0	0
Periclimenes sp.	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Pilumnus sp.	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Pinnoteres pisum	0	0	0	0	0	0	0	0			0	0	0	1	0	0
Pisidia bluteli	0	0	0	0	0	0	0	0			0	0	1	0	0	0
Pisidia longimana	0	0	0	0	0	0	0	0			0	1	0	0	0	0
Pisidia sp.	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Processa sp.	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Scyllarus pygmaeus	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Synalphaeus gamberelloides	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Thoralus cranchii ?	0	0	0	0	0	0	0	0			0	0	0	0	0	0
Xantho pilipes	0	1	0	0	0	0	0	0			0	0	0	0	0	0
Not identified	23	10									3	7	6	13		1
TOTAL NUMBER OF SPECIMENS	23	18	2	0	2	0	0	2	0	0	9	15	10	25	11	8

ANNEX 12

QUALI-QUANTITATIVE RESULTS OF THE ERRANT POLYCHAETA SAMPLED IN SECCHE DI TOR PATERNO

Annex 12 - Quali-quantitative data matrix, errant Polychaeta, Secche di Tor Paterno

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6
P01							6	2				1	1	1				1														1
P02													1											1								
P03							1						1																			
P04													1																			
P05				1			1						2																			
P06													1																			
P07				1									1				1															
P08				3						1		1	1		5	2		1												1		
P09				2									1																			
P10													1																			
P11														2																		
P12			1	1	2		1							1														1				
P13			1				2	1						1																		
P14			1	5			1	3		4		5		1		4	6															
P15				2	2		3	1			1			3	2	2	3	3										2		1		
P16														1																		
P17			2	1										2		3	3										1	1	1	1		
P18														1																		
P19														1																		
P20							1							1																		
P21														1		1																
P22				1			3	3						1			2															
P23				2	1		1							1														1				
P24														1																		
P25			1	1	6		2	3			1			2				1														
P27														1		1																
P28														1																		
P29							1							1																1			
P30																1																
P31			2													1																
P32															1	1																
P33				2	1		1	3				2		1		1		1														1
P34				2			1										2												1			
P35							7	1	1			3					4													1		1
P36			1				3	1				1					3															
P37								1		1		2					1															
P38			1	4	2		4					1					2													4		
P40																	1															
P42																		1														
P43				1														1														
P44							3											1												1		
P45			1	3		1									2			2														
P46				1			1								6			2									1			1		
P47																		1														
P48			1	1			2								1																	1
P49															1																	
P50					1										1																	
P51															1																	2
P52																											1					
P53																												2				2
P54												1																1		0		
P55																														1		
P56																														1		

Annex 12 - Quali-quantitative data matrix, errant Polychaeta, Secche di Tor Paterno

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6
P57								1																					1			
P58								1																					2			
P59																																1
P60			1				1										1															
P61			1																													
P62			1																													
P63			1	2																												
P64			1																													
P65				1																												
P66				1																												
P67				2																												
P68				1																												
P69				3				1																								
P70				1																												
P71					1																											
P72					1																											
P73					1																											
P74					1																											
P75							1					1																					
P76												3																					
P77												1																					
P78											2																						
P79							1																									
P80							1																									
P81							1																									
P82							1																									
P83							1																									
P84								1																								
P85								1																								
Not identified			2	14	4	21	41	15		2	9	7		13	22	13	23	10									3	7	6	13		1
TOTAL NUMBER OF SPECIMENS	0	0	19	59	23	22	93	39	1	8	13	29	11	38	42	30	52	25	0	0	0	0	0	1	0	0	6	15	12	25	0	10

ANNEX 13

QUALI-QUANTITATIVE RESULTS OF THE MOLLUSCS SAMPLED IN SECCHE DI TOR PATERNO SIZE RANGE 1-6 MM FOR LIVE-DEAD COMPARISON

Annex 13 - Quali-quantitative data matrix, Secche di Tor Paterno, without specimens bigger than 6 mm for live-death assemblages fidelity analysis (yellow cells have been changed from the original data set)

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6	S13	S14	S15
Lepidopleurus cajetanus	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hanleya hanleyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Callochiton septemvalvis	1	0	3	0	2	1	1	3	1	3	2	1	4	2	0	6	3	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Chiton corallinus	1	0	0	2	0	0	3	1	1	2	0	1	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Acanthochitona crinita	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polyplacophora sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diodora graeca	1	0	0	0	2	0	1	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diodora sp.	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Emarginula octaviana	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emarginula punctulum	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Emarginula rosea	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emarginula sicula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Emarginella huzardii	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scissurella costata	1	2	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Haliotis tuberculata lamellosa	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clanculus corallinus	0	0	1	2	0	0	0	0	0	2	0	3	0	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clanculus cruciatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jujubinus exasperatus	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	1	1	0	0	0	0	0	1	0	0	1	0	0	1	7	0	0	0	0
Jujubinus striatus	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Calliostoma conulum	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Calliostoma laugieri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danilia tinei	0	0	0	0	0	0	1	2	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bolma rugosa	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	4	0	2	0	0	0
Homalopoma sanguineum	0	0	1	0	0	0	1	3	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	6	1	1	0	0	0	0	0
Tricolia tenuis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0
Smaragdia viridis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0
Cerithium vulgatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bittium latreillii	35	10	14	9	35	2	34	24	21	32	43	11	26	0	37	43	15	35	20	0	17	0	0	10	1	0	6	19	34	20	4	3	0	0	0
Bittium sp. 1	1	0	0	0	0	0	0	0	1	2	3	2	4	1	0	1	0	0	0	0	0	0	0	1	2	1	1	1	1	3	0	0	0	0	0
Bittium sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Bittium sp. 3	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petalopoma elisabettae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turritella turbona	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	7	0	1	0	0
Marshallora adversa	3	2	0	2	2	1	1	1	0	2	5	1	1	0	3	4	1	0	0	0	0	0	0	0	0	0	0	2	0	6	1	1	0	0	0
Monophorus erythrosoma	2	0	0	1	3	0	3	1	0	2	2	1	0	0	2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Monophorus perversus	1	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Monophorus thiriotae	2	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Obesula marisnostri	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Pogonodon pseudocanaricus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Similiphora similior	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metaxia metaxae	5	0	1	9	2	0	6	3	0	2	2	3	1	0	4	5	3	1	0	0	0	0	0	0	1	0	1	0	1	3	2	0	0	0	0
Cerithiopsis nana	2	0	0	0	1	0	1	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0	2	1	1	3	0	0	0	0	0
Cerithiopsis nofronii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerithiopsis sp. 1	0	0	0	1	0	0	1	1	0	1	1	0	3	1	0	0	2	1	0	0	0	0	0	0	0	0	1	2	1	2	1	0	0	0	0
Cerithiopsis sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Cerithiopsis sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Dizoniopsis coppolae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parvioris ibizenca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Sticteulima jeffreysiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Vitreolina incurva	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Rissoa auriscalpium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rissoa violacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	0	0	1	0	0	0	0	2	0	0	0	0	0
Pusillina inconspicua	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Pusillina philippi	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pusillina sp.	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Annex 13 - Quali-quantitative data matrix, Secche di Tor Paterno, without specimens bigger than 6 mm for live-death assemblages fidelity analysis (yellow cells have been changed from the original data set)

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6	S13	S14	S15
Alvania cancellata	5	2	4	0	5	0	4	5	0	24	10	0	16	0	3	5	9	1	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0
Alvania cimex	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alvania discors	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alvania geryonia	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alvania hispidula	2	0	0	0	3	1	1	0	1	2	2	0	7	0	1	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Alvania lineata	0	0	0	0	0	0	1	0	0	1	5	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alvania settepassii	2	0	2	0	2	0	1	1	3	1	5	0	5	0	0	2	1	0	0	1	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
Alvania tenera	0	0	0	0	1	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crisilla beniamina	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manzonia crassa	0	0	0	0	4	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rissoina bruguieri	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caecum armoricum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Caecum clarkii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Caecum subannulatum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parastrophia asturiana	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crepidula sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Trivia arctica	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erosaria spurca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Luria lurida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euspira pulchella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	3	1	1	0	1
Payraudeautia intricata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Dermomurex scalaroides	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0
Ocinebrina aciculata	1	0	0	0	0	0	0	1	0	0	0	1	0	1	4	0	0	1	0	3	4	0	0	1	0	3	3	2	1	5	1	0	0	0	0
Muricopsis aradasii	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	6	2	1	0	0	0
Muricopsis cristata	17	0	4	8	6	5	4	10	0	7	1	2	4	4	5	3	7	2	0	0	0	0	0	0	0	0	8	4	7	10	2	6	0	0	0
Typhinellus labiatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coralliophila meyendorffii	1	0	0	2	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mitra cornicula	2	0	2	1	2	0	1	3	0	1	1	0	3	1	3	0	1	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Vexillum ebenus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Vexillum savignyi	1	0	0	1	0	0	1	1	0	0	1	0	1	0	3	0	4	4	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
Vexillum tricolor	2	1	0	0	0	0	0	3	0	2	2	1	0	0	0	1	4	2	0	0	0	0	0	0	0	0	0	1	0	3	2	0	0	0	0
Euthria corneum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chauvetia aff brunnea	7	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	5	2	4	1	1	5	6	8	6	0	1	0	0	0
Chauvetia recondita	0	0	0	1	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0
Pollia dorbignyi	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pollia scabra	7	0	4	6	4	5	3	7	1	5	3	4	5	8	6	3	8	2	0	0	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0
Nassarius incrassatus	19	3	5	8	14	3	5	6	0	9	7	3	19	16	25	4	8	7	0	0	0	0	0	0	0	0	5	2	9	5	3	0	0	0	0
Columbella rustica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mitrella coccinea	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mitrella gervillii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Mitrella minor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1	0	0	0	0
Mitrella scripta	5	0	0	0	0	0	2	5	1	2	0	1	2	4	9	3	3	5	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Fusinus pulchellus	4	0	2	6	0	1	4	7	1	3	2	2	1	1	0	1	3	0	0	0	0	0	0	0	0	0	3	3	1	6	1	1	0	0	0
Comarmondia gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mitromorpha karpathoensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Clathromangelia granum	2	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Mangelia scabrida	2	0	0	1	1	0	0	0	0	2	1	1	1	0	0	3	4	2	0	0	0	0	0	0	0	0	1	0	1	1	2	0	0	0	0
Mangelia stossiciana	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Mangelia vauquelini	1	1	1	2	0	0	0	0	0	2	0	1	1	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Raphitoma concinna	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Raphitoma leufroyi	2	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Annex 13 - Quali-quantitative data matrix, Secche di Tor Paterno, without specimens bigger than 6 mm for live-death assemblages fidelity analysis (yellow cells have been changed from the original data set)

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S16	S17	S22	S19	S20	S21	R1	R2	R3	R4	R5	R6	R8	R9	SP1	SP2	SP3	SP4	SP5	SP6	S13	S14	S15
Raphitoma linearis	9	1	2	2	7	0	6	4	1	10	4	2	2	2	1	2	9	5	0	0	0	0	0	0	0	0	4	1	6	3	1	5	1	0	0
Raphitoma sp. 1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	0
Raphitoma sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Raphitoma sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Raphitoma sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Crassopleura maravignae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Pseudotorinia architae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mathilda gemmulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Chrysallida excavata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chrysallida suturalis	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Odostomella doliolum	2	0	0	1	8	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ondina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Turbonilla gradata	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turbonilla striatula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Clathrella clathrata	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retusa mamillata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	14
Cylichnina crebrisculpta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Haminoea sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weinkauffia turgidula	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philine sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Williamia gussonii	1	0	2	0	0	0	0	1	0	1	0	0	0	2	3	3	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Nucula sp.	1	0	4	0	1	0	3	0	0	0	3	0	2	2	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0
Barbatia barbata	0	0	0	0	0	0	3	0	1	0	0	0	2	0	2	1	0	1	0	0	0	0	0	0	0	0	1	3	1	2	0	0	0	0	0
Striarca lactea	0	1	1	8	3	1	4	3	3	0	0	1	18	3	1	0	4	1	0	0	0	0	0	0	0	0	1	18	1	1	3	2	2	1	0
Gregariella semigranata	1	1	0	1	2	1	1	0	0	0	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Lithophaga lithophaga	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dacrydium hyalinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Modiolula phaseolina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0
Chlamys flexuosa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlamys glabra	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crassadoma multistriata	0	0	0	1	0	1	3	0	0	0	1	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lima lima	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Limaria hians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limaria tuberculata	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galeomma turtoni	0	0	0	0	0	1	0	4	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kellia suborbicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemilepton nitidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Montacuta sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kurtiella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Pteromeris corbis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1
Parvicardium scriptum	0	0	0	2	0	0	0	2	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	0
Papillicardium papillosum	0	0	0	3	1	0	1	0	0	1	0	1	0	0	1	3	4	1	0	0	0	0	0	0	0	0	5	0	0	2	3	8	1	0	0
Tellina tenuis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Arcopagia balaustina	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Gari costulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Abra sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Venus verrucosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0
Clausinella fasciata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gouldia minima	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	2	0	0	0	0	0	0	0	0	0	3	1	3	10	7	10	0	0	0
Hiatella arctica	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0
Thracia distorta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0
Bivalvia sp. (broken shell)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antalis vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
TOTAL NUMBER OF SPECIMENS	170	25	63	88	123	25	114	111	37	125	122	49	158	56	142	114	119	97	23	6	25	6	3	19	6	5	74	94	100	146	63	58	23	7	24

ANNEX 14

QUALI-QUANTITATIVE DATA OF THE *POSIDONIA OCEANICA* DEATH ASSEMBLAGE IN SECCHE DI TOR PATERNO

Annex 14 - Quali-quantitative data matrix, coralligenous thanatocoenosis, Secche di Tor Paterno (loose valves divided by 2 for bivalves and by 8 for polyplacophorans)

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21
Lepidopleurus africanus										0.13											
Lepidopleurus cajetanus					0.13																
Acanthochitona fascicularis	0.13	0.13	0.13				0.13											0.13	0.25		
Callochiton septemvalvis					0.13																
Tectura virginea	2	2					1			1				3	2				1		
Diodora graeca		2			1	1	1		1	2	3		1					1	1		
Emarginula octaviana								1			1		2	1					1		
Emarginula punctulum							2	1	1				2	1	1	1		1		1	2
Emarginula sicula		1		1				1				1			1		1	1		1	
Emarginella huzardii	2			2		1						1	1	1	2				1	3	3
Clanculus corallinus	3	2				3	2	3	1	1	2	1	4	3	3		2	1		3	
Jujubinus exasperatus	20	10	5	10	8	14	6	10	10	4	9	4	7	6	7	4	5	3	7	9	5
Jujubinus striatus	2	10	16	9	17	13	8	19	16	15	11	9	8	6	15	7	6	8	10	9	8
Gibbula fanulum					1																1
Calliostoma conulum			3		1					2					1	1	1	2	1		1
Calliostoma laugieri	3		1			2			1		1	1	1	2		1			1		
Danilia tinei		1	1				1	1	1	1	1	1	1	1	1			1		1	
Bolma rugosa	4		2	3	5	1	3	4			1	3	2		4	2	4	2	4	1	
Homalopoma sanguineum	6	13	10	11	10	6	12	12	12	12	4	7	8	11	13	6	5	12	10	5	13
Tricolia pullus								1		1		1				1		1			
Tricolia speciosa	2		1						2			1			1				1		1
Cerithium vulgatum		1	2		1			1					1					1	1		
Bittium latreillii	70	93	92	74	81	80	71	85	64	68	78	75	52	59	72	60	52	67	71	77	75
Bittium sp. "reticulatum"	4	6	5	4	5	7	5	6	11	4	4	3	3	4	6	4	1	6	6	1	4
Petalopoma elisabettae	1		1	3		1	1	1	1		3	3	2	2	1	4	1	1	3	3	1
Turritella communis					1					1							1				1
Turritella turbona		1	1	1		1		1	1		2	1	1	2	2	1	2		2		
Marshallora adversa	2			1				1		1	1			1		1	2	1	1	2	1
Monophorus erythrosoma				1				1													
Monophorus perversus					1		1	1													
Monophorus thiriotae								1			1									1	
Metaxia metaxae	2				3			1	1	1		1		1						1	1
Cerithiopsis sp. "scalare"							1	1	2		1									1	
Epitonium commune						1															
Melanella boscii (cfr)																		1			
Sticteulima jeffreysiana		1																			
Rissoa guerinii		1								1				1				1			
Rissoa ventricosa																			1		
Rissoa violacea	2	2				1	1	1		1		1	1	1	1	1					
Pusillina sp.			1																		
Alvania cancellata	7	7	3	2	2	6	7	4	7	6	8	6	7	11	6	6	3	11	9	4	6
Alvania cimex-mamillata							1				1										
Alvania geryonia		1	2	6	2	4	2	3	4	3	7	1	1	2	2	8	4	5	2	4	6
Alvania hispidula								1	1				1					1		2	
Alvania lineata	6	16	8	4	9	15	2	5	9	4	10	6	3	10	6	10	3	6	7	1	9
Alvania settepassii	12	15	11	11	7		16	11	14	6	8	5	9	11	3	12	15	10	8	16	8
Rissoina bruguieri	4	5	3		1	1	1		2	1		2	1	2	1		4	3	2	3	2
Calyptraea chinensis						1															
Crepidula unguiformis				1																	
Luria lurida																					1
Euspira pulchella			1		1			1						1			1				
Dermomurex scalaroides									1												
Ocinebrina aciculata			1	1	2		2	1			1	1	1	2				2	1	1	
Muricopsis aradasii																1		1			1
Muricopsis cristata	5	1	2		2	1	2	1	1	2	1	1	1		1	2		1	1	3	1
Typhinellus labiatus												1									
Coralliophila meyendorffii																1			1		
Mitra cornicula							1											1		1	
Vexillum ebenus				1											1						1
Vexillum tricolor		2	1		1			1	1	1										1	
Vexillum savignyi		1		1	1	1	1	1							1				1		
Chauvetia aff brunnea	1	2	4	2	4	2	4	2	5	1		1	2	1	4	1	2	4	2		1

Annex 14 - Quali-quantitative data matrix, coralligenous thanatocoenosis, Secche di Tor Paterno (loose valves divided by 2 for bivalves and by 8 for polyplacophorans)

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21
Chauvetia mamillata	2	1	2						2				1								
Chauvetia recondita		1					1		1							1	1	1	1		1
Pollia scabra		3		2		1			1	2		1	1		3	1		1	1	2	1
Nassarius pygmaeus					1																
Nassarius incrassatus	1	3	1	1	2	2	1	4	2	2	2	2	2	1	1		1	1	3	2	3
Columbella rustica				1										1						1	
Mitrella coccinea				1																	
Mitrella minor	1	1				1	1	1			1			1				1	3		1
Mitrella scripta	1	1	2			2	2	1	1	3	2			1		4	2	1	2	1	1
Fusinus pulchellus	1		2	1	2	1	2			1	1	2	1	1	1		1	1	1	2	
Mitromorpha mediterranea								1													
Clathromangelia granum	1					1								1					1		1
Mangelia sp. 1 "giallina"	1		1	1		2			1	1	1	1	1		2	2					1
Mangelia sp. 2 "scura"												1									
Mangelia sp. "multilineolata"		1																			
Mangelia vauquelini		2	1					1	1	1										1	
Raphitoma concinna						1		1										1			
Raphitoma leufroyi		1		1		1	1										1				
Raphitoma linearis	2	2	4			2		2	1	1	2			1		1	1		2	2	
Raphitoma sp. 1					1																
Raphitoma sp. "bicolor"	1							1										1			2
Raphitoma sp. X														1							
Crassopleura maravignae																	1				
Euparthenia humboldti					1			1													
Turbonilla jeffreysii				1													1				
Turbonilla striatula																				1	
Clathrella clathrata														1							
Ringicula conformis										1											
Umbraculum umbraculum			1								1										
Williamia gussonii			2				1		1									1		1	
Nucula nucleus	4.50	2.00	5.00	4.50	2.00	4.00	2.00	2.00	2.00	3.00	3.50	2.50	1.50	3.00	1.00	1.50	3.50	3.00	3.50	5.00	3.00
Arca noae						0.50					0.50									0.50	
Arca tetragona								0.50													
Barbatia barbata	1.50	2.00	2.00	2.00	3.00	1.50	2.00	1.50	2.00	1.50	1.50	3.00	2.00	0.50	3.00	1.00	2.00	3.00	1.50	1.00	2.50
Striarca lactea	20.00	30.50	26.00	17.50	22.50	25.00	24.50	26.50	28.50	48.00	27.50	30.50	27.00	49.00	20.00	26.50	18.00	29.00	22.00	13.50	27.50
Glycymeris sp.	0.50	1.50		0.50	0.50		0.50	0.50	3.00		0.50	0.50		0.50	1.00						
Lithophaga lithophaga			0.50						0.50												
Gregariella semigranata													0.50			0.50					
Modiolus sp.												0.50	0.50								
Aequipecten opercularis																			0.50		
Lissopecten hyalinus										0.50		0.50									
Crassadoma multistriata					0.50				0.50					0.50				2.00	0.50		
Chlamys varia				0.50																	
Spondylus gaederopus																		0.50			
Lima lima			1.00	0.50		0.50	0.50	0.50	1.00		1.00	0.50		1.00	1.00				1.00	0.50	
Lima hians							0.50						0.50								
Limaria tuberculata		0.50																			
Ctena decussata		0.50														0.50					
Galeomma turtoni		0.50							0.50		0.50		0.50	0.50		0.50		0.50			
Kellia suborbicularis					0.50																
Diplodonta apicalis		0.50																			
Chama gryphoides							0.50	1.00	2.00		0.50			0.50	0.50		0.50	0.50	0.50	0.50	
Pseudochama gryphoides				0.50		1.50								0.50							
Glans trapezia																0.50					
Pteromeris corbis	1.00	0.50	0.50			0.50				0.50		1.50	0.50	1.00		0.50		0.50		1.00	
Astarte sp.							0.50														
Gonilia calliglypta					0.50							0.50									
Parvicardium scriptum			0.50			0.50			0.50	0.50		1.00	0.50	0.50	0.50	0.50	0.50	0.50		0.50	2.00
Papillicardium papillosum	1.50	2.00	3.00	2.50	3.00	2.50	1.50	0.50	3.00	2.00	2.50	3.00	2.00	2.00	5.00	4.50	1.00	2.00	2.00	1.50	3.50
Spisula subtruncata						0.50		0.50													
Tellina balaustina				0.50							1.00										
Tellina donacina																					0.50

Annex 14 - Quali-quantitative data matrix, coralligenous thanatocoenosis, Secche di Tor Paterno (loose valves divided by 2 for bivalves and by 8 for polyplacophorans)

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21
Psammobia costulata						0.50			0.50			0.50								0.50	
Abra sp.																					1.00
Venus verrucosa		1.00			0.50			0.50	0.50			0.50			0.50						
Chamelea gallina																				0.50	
Timoclea ovata	1.50	2.50	0.50	0.50	1.50		1.00	0.50	1.00	1.50	0.50		0.50	1.00	1.50	0.50		1.00	0.50		2.00
Gouldia minima	3.50	4.50	6.00	5.50	6.00	5.50	6.00	4.50	7.50	3.00	4.00	3.50	7.50	4.00	3.50	3.00	2.00	5.00	5.00	3.00	5.00
Pitar rudis			1.00				0.50														
Paphia aurea																				0.50	
Corbula gibba			0.50							1.00			0.50						0.50		
Hiatella arctica	0.50					0.50			0.50		1.00						0.50		0.50		0.50
Thracia distorta					0.50																

ANNEX 15

QUALI-QUANTITATIVE DATA OF THE CORALLIGENOUS DEATH ASSEMBLAGE IN SECCHE DI TOR PATERNO

Annex 15 - Quali-quantitative data matrix, coralligenous thanatocoenosis, Secche di Tor Paterno (loose valves divided by 2 for bivalves and by 8 for polyplacophorans)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33	C34	C35	C36
Lepidopleurus cajetanus															0.13																					
Lepidopleurus africanus																																0.13	0.13			
Acanthochitona crinita																														0.13			0.13			
Acanthochitona fascicularis				0.13	0.13	0.13		0.13										0.13				0.13	0.25		0.13	0.13						0.25				
Chiton corallinus																																		0.13	0.13	
Callochiton septemvalvis			0.13																																	
Tectura virginea			1	1	1					1	4							1						2	1						1	2				1
Diodora graeca	1	1	1			1	1	1	1			1	1		1				1	2	1			1		1	1		1		1	1	1	1		
Emarginula octaviana	1	2	1										1		1										1	2	1									
Emarginula punctulum	1				1	4	1		1	2				2			1	1	4	4	3	1		1	2			2	2	3	1			2	1	2
Emarginula sicula	3	2		1		1	1	1		1	1	1	1		3	3		1	1		1		1		1			1	2	1		1	1	1		2
Emarginella huzardii							2								1		1	1	4				1	1		1				2						1
Clanculus corallinus	2	3	1	4		2	2	2	1	1	1	3	4	1	2	2	3	2	2	1		2	2		1	2	2	2	1	8	2	1	3	3	3	3
Jujubinus exasperatus	15	13	6	7	11	12	9	13	6	12	5	6	13	4	9	7	10	8	16	9	3	10	12	7	7	9	8	11	6	18	7	9	5	8	12	5
Jujubinus striatus	22	14	11	18	14	3	19	18	8	11	15	14	11	10	7	18	17	15	13	15	14	19	20	14	10	8	8	10	14	17	12	13	11	15	12	19
Gibbula guttadauri															1				1																	
Calliostoma conulum	1		2	1	1		2		1				2						1	1			1		1						1	1	2	1	1
Calliostoma laugieri	1							2								1	2							1		2	1				1			2		
Danilia tinei		1		1	2	1	3	2		2		1				1		2	1		2	1		2	6	1		1	2	2		1			2	1
Bolma rugosa	3		2	2	3	2	2	2		2				2		3	5	3	4	1	2		1	3	2	1	2		3	2	1	1	1	2	3	3
Homalopoma sanguineum	10	11	12	12	12	8	9	9	6	8	7	6	4	1	11	8	3	4	11	7	6	11	10	8	8	6	15	8	9	9	7	12	9	10	9	7
Tricolia pullus																																				1
Tricolia speciosa		1					1								2	2			3					1												1
Tricolia tenuis	1	1	1	4			1				1		1	1		2				1		4	1							1		1	1			1
Cerithium vulgatum		2	1			1		2				1			2								1									2			1	
Bittium latreillii	86	59	42	42	45	41	68	60	42	68	51	51	40	33	33	58	74	53	64	65	37	57	51	50	37	41	54	42	62	47	65	74	44	72	65	72
Bittium sp. "reticulatum"	7	4	3	1	3	3	4	6	2	6	5	9	7		6	7	7	1	4	4	4	4	5	1	3	1	6	5	8	9	2	12	1	7	4	12
Petalopoma elisabettae	5	1	4	6	3	2	1	4		4	1	5	2	1	3	2			4	2	3	1		3	1	4	2	3	4	3	5	3	3	2	3	5
Turritella communis				1						1																		1			3			1		
Turritella turbona	1	4	2	2		2	2	2	3	2	1	1	2		1		5	1			1	1		2	1		1		1	3			2	1	2	2
Marshallora adversa		2			2		1		1		1		1			1	2				1			1					2				1	1		
Monophorus erythrosoma			1	1									1										1					2							
Metaxia metaxae			1	1		1	1						1	1				2		1						2		2	3			2			2	1
Cerithiopsis sp. "scalare"									1										1		1														1	
Cerithiopsis jeffreysii					1																															
Parvioris microstoma							1																													
Rissoa ventricosa																				1																
Rissoa violacea	1				2		2					2										1				1	1		1					1		
Pusillina consimilis																1	1															1				
Pusillina philippii																1																				
Alvania cancellata	14	10	5	4	10	10	9	13	5	7	6	7	7	2	7	8	5	6	7	11	6	8	4	9	3	9	9	4	12	5	14	12	12	12	8	14
Alvania cimex-mamillata		1						1	1	1			1											1												
Alvania geryonia	9	5		1	4	3	3	1	1	3	3	4	3	3	1	8	4	4	1	2	3		2	1		1	1	2	3	6	6	1	2	5		6
Alvania hispidula				2	2	2	1								1	1		1	1				2		1			1		1						1
Alvania lineata	3	3	2	4	6	3	4	4	2	7	1	5	5	2		8	3	4	4	2	7	1	1	2	3	4	4		3	8	5	5	7	4		7
Alvania settepassii	6	9	4	9	6	5	9	7	5	7	5	7	4	1	8	11	11	5	8	4	13	6	15	4	3	1	8	9	11	10	6	10	4	11	6	12
Crisilla semistriata																					1															
Rissoina bruguieri	1	1		1	2								1								1	1	1	2	1		1			2	1			1		
Vermetus granulatus																			1																	
Serpulorbis arenaria (cfr)																																			1	
Megalomphalus azonus													1																							
Calyptraea chinensis																			1				1													
Crepidula gibbosa																		1																		
Crepidula unguiformis																1																				
Luria lurida											1																									
Euspira pulchella										1				1			1	1													1	4				
Dermomurex scalaroides					1																															
Ocinebrina aciculata			1							1				1				2		1											2		1			
Muricopsis aradasii			3				1		1									1							1	1						1	1			1
Muricopsis cristata		2	1		1				1	1					1	1		1											2		1		1	1	1	
Coralliophila meyendorffii																			1																	
Vexilum ebenus																											1							1		

Annex 15 - Quali-quantitative data matrix, coralligenous thanatocoenosis, Secche di Tor Paterno (loose valves divided by 2 for bivalves and by 8 for polyplacophorans)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33	C34	C35	C36
Vexillum tricolor		2			1			1				2			1			1		1				1		2							1	1		
Vexillum savignyi																			1			1		1		1							1		1	
Chauvetia aff brunnea	2			1	1							1	1														1	1						1		
Chauvetia mamillata																	1													1	1					
Chauvetia recondita			1		1			2		2					1									1				1			1					1
Pollia scabra	2		2		1	1	3	1	1		2		1		1	2		2			1	1		1	1	1		1	1			2	2	2	1	1
Nassarius pygmaeus					1																															
Nassarius incrassatus	2		1	3	1		1			1	2	2		1		3	2	1	2		1	2	2		3	3	1				1	3		1	1	1
Mitrella coccinea		1																	1									1								
Mitrella minor	1									1																			1							
Mitrella scripta				1									2				1										2									
Fusinus pulchellus	1	2	1	1		3		2	1	2		1	1	1	1	2		1		2		1				2	3		2	2	3	1				
Comarmondia gracilis																																		1		
Clathromangelia granum		1			1		3	1							1	1							1			1							2	1		
Mangelia sp. 1 "giallina"			1		1	1					1						1		1		1			1	1			1				1				1
Mangelia sp. 2 "scura"													1			1											1		1				1			1
Mangelia vauquelini										1																										
Raphitoma concinna		1			1														1			1														
Raphitoma leufroyi																							1									3				1
Raphitoma linearis			3	1				1	1		2			1		1	1	1						1			2	1	2	2	5					2
Raphitoma sp. "bicolor"	1			1	1		1				1	1							1																	
Raphitoma sp. 3																										1										
Raphitoma sp. "mai vista prima"																							1													
Heliacus fallaciosus																			1					1												
Odostomella doliolum					1																															
Euparthenia humboldti	1										1					1																				
Euparthenia bulinea																												1								
Turbonilla jeffreysii																1	1	2				1								1						
Turbonilla striatula							1																													
Clathrella clathrata																				1																2
Ringicula conformis	1															1																				
Haminoea sp.				1						1		1							1					1									1		1	
Umbraculum umbraculum		1			1		1	1						1															1							1
Berthellina sp.												1																								
Williamia gussonii		1	1		1	1		1						1	1			1	1	2		2											2		1
Nucula nucleus	2.00	3.00		2.50	4.50	3.00	1.50		1.00	2.00	3.00		2.50			3.50	3.50	7.00	0.50	2.00	1.50	2.00	0.50	1.00	0.50	3.00	2.50	0.50	2.50	0.50	4.50	1.00	2.00	8.50	2.50	3.00
Arca noae			0.50	0.50											0.50						0.50															
Arca tetragona									0.50																					0.50				0.50		
Barbatia barbata	1.00	0.50	1.50	1.50	1.50	2.50	2.50	2.00	1.00	1.00	0.00	1.00	0.50	0.50	1.00	2.00	1.50	2.50	1.00	1.50	3.00	2.50	0.50	0.50	0.50	0.50	1.00	1.00	1.50	2.00	0.50	3.00	3.00	2.00	0.50	1.00
Striarca lactea	23.00	18.50	11.50	13.00	22.50	19.00	23.50	14.00	8.00	15.00	16.00	17.50	13.50	10.50	11.00	22.00	16.00	9.50	19.50	23.00	18.00	12.00	16.50	11.00	6.50	13.00	12.00	10.50	18.50	17.50	15.50	17.00	12.50	13.50	11.50	14.00
Glycymeris sp.		2.00	1.00	1.00	1.00	0.50	0.50			0.50		0.50	0.50		0.50	0.50			1.00	0.50	0.50	0.50				0.50	0.50		1.50				1.00			
Lithophaga lithophaga		0.50																																		
Gregariella semigranata														0.50			0.50							0.50		0.50				0.50		0.50			0.50	
Musculus costulatus										0.50																										
Modiolarca subpicta																										1.00										
Propeamussium fenestratum																													0.50							
Aequipecten opercularis																					0.50															
Lissopecten hyalinus																														0.50						
Palliolum incomparabile																																	0.50			
Crassadoma multistriata	1.00	1.00	0.50		3.00		0.50		1.00	2.00	1.50	1.00	0.50					0.50	1.00	1.50		0.50		0.50		1.00	0.50	1.50	1.00	1.00	0.50	0.50	1.50	0.50	0.50	
Chlamys flexuosa					0.50																											0.50				
Chlamys glabra							0.50												0.50					0.50	0.50											
Chlamys pesfelis																0.50														0.50						
Spondylus gaederopus																		0.50																		
Anomia sp.																											1.00			0.50						0.50
Pododesmus patelliformis		0.50								0.50			1.00														0.50									
Lima lima	0.50	1.00	0.50		0.50	1.00	1.50					1.00	0.50	0.50	0.50				1.00	0.50			1.00	0.50		0.50	1.50	1.00				1.00	0.50			0.50
Lima hians							0.50						0.50				0.50									0.50										
Limaria tuberculata																					0.50															
Ctena decussata															0.50																					
Galeomma turtoni				1.00				0.50		1.00	0.50									0.50					1.00					0.50	0.50			0.50	
Kellia suborbicularis					0.50																						0.50								

Annex 15 - Quali-quantitative data matrix, coralligenous thanatocoenosis, Secche di Tor Paterno (loose valves divided by 2 for bivalves and by 8 for polyplacophorans)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33	C34	C35	C36
Kelliopsis jozinae							0.50																													
Diplodonta apicalis	0.50																																			
Chama gryphoides														0.50							0.50					1.00					1.50				
Pseudochama gryphoides	0.50			0.50			0.50																													
Pteromeris corbis		1.50	0.50	4.00	1.00	0.50	1.00	0.50	1.50	1.50		3.50		1.00		1.50	3.00	0.50	1.00		1.00	1.00	1.00		0.50		0.50		1.00	4.00	3.00	4.00	1.00	4.00	1.00	
Astarte sp.		0.50															0.50						1.00													
Gonilia calliglypta					1.50					1.00	0.50	0.50	0.50			0.50			0.50		0.50							0.50								
Parvicardium roseum		0.50																																1.50		
Parvicardium scriptum	1.00	1.50		0.50	1.00	1.00		0.50	0.50	2.00	0.50	1.00	1.00		1.50	1.00	1.50	0.50	0.50	1.00	1.00	0.50	1.00	0.50		0.50		0.50		0.50	1.50	2.00		1.50	1.00	
Papillicardium papillosum	2.00	2.50	1.50	2.00	3.50	4.50	3.50	2.50	1.00	5.00	3.50	2.50	2.00	2.00	4.00	3.00	4.00		1.00	2.50		3.50	2.50	1.50	3.50	2.50	2.50	3.00	2.00	7.00	2.50	2.50	1.00	2.50	1.50	2.00
Spisula subtruncata							0.50																					0.50				0.50				
Gastrana fragilis																											1.50									
Arcopagia balaustina					0.50					0.50		0.50															1.00			0.50						
Arcopagia crassa							2.00																													
Tellina donacina											0.50																			1.50						0.50
Tellina tenuis																		0.50					0.50													
Tellina sp.																										0.50										
Psammobia costulata															0.50			0.50												0.50						
Solecurtus sp.	0.50																																			
Coralliophaga lithophagella																								0.50					0.50							
Venus verrucosa													0.50			0.50		0.50				0.50	0.50							0.50		0.50	0.50		0.50
Chamelea gallina																			0.50																	
Timoclea ovata	0.50	0.50	1.50	1.50		1.00	0.50	4.00	1.00	1.00	0.50	1.00	1.00	3.50		1.50	2.50		2.00	1.00	1.50		0.50	1.50	1.50		0.50		0.50	0.50	0.50		2.50	1.00	1.00	0.50
Gouldia minima	4.00	4.00	1.00	3.00	2.00	2.50	6.50	2.50	3.00	3.00	2.50	3.50	4.00	0.50	1.00	5.00	2.00	1.00	4.00	3.50	3.50	2.50	2.00	2.50		0.50		3.50	3.00	2.00	4.00	3.50	1.00	1.50	3.00	3.50
Pitar rudis	2.00							0.50																											1.00	
Corbula gibba								2.00					2.00			2.00		2.00				2.00									2.00					
Gastrochaena dubia											2.00																									
Hiatella arctica		0.50			0.50	1.50	0.50	1.50		2.50		0.50				1.00	1.50		0.50	2.50				0.50	2.00				1.00	1.50	1.00	1.00		1.00	0.50	1.00
Thracia distorta	0.50																																			
Antalis vulgaris								1.00																												
Biv indet (Scacchia elliptica?)																								1.50												