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New data on occurrence of thermophile Scleractinia (Cnidaria, Anthozoa) in the Phlaegrean Islands (Ischia, Procida, Vivara, Gulf of Naples), with special attention to *Astroides calycularis*

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SUMMARY

New data on occurrence and distribution of some Scleractinia (Cnidaria, Anthozoa) with thermophile affinity were presented for the area comprising the Phlaegrean islands (Ischia, Procida and Vivara, Gulf of Naples Tyrrhenian Sea). Data were obtained by means of visual census and photographic sampling in 21 sites located all around the islands on rocky cliffs, rocky banks and semi-obscure caves. Four species with thermophile affinity were recorded: *Cladocora caespitosa* (Linneo, 1767), *Madracis pharensis* (Heller, 1868), *Phyllangia mouchezii* (Lacaze-Duthiers, 1897), and *Astroides calycularis* (Pallas, 1766). Both *M. pharensis* and *P. mouchezii* were first reported for the studied area after our study. The most widespread and frequent species was *C. caespitosa*, occurring in almost all studied sites in photophilious biotopes within the first 15-20 m depth. *M. pharensis* was particularly abundant in the "Grotta Grande" of the bank "Formiche of Vivara", where it formed a large *facies* on the cave ceiling. *P. mouchezii* was the most occasional specie occurring with few colonies in three sites between 25 and 40 m depth. For *A. calycularis* a specific study on abundance pattern and population structure was performed in three stations (two inside of a semi-submersed, semi-obscure cave and one along the shadowed cliff off S. Angelo). *A. calycularis* showed very high densities in the zone 0-1 m depth, mainly consisting of young specimens (1-3 corallites). Density showed a dramatic decrease below 3 m depth in the two stations inside the cave, while in S. Angelo density started to decrease below 6-8 m depth. Inside of the cave, comparison with previous observations from an earlier ecological study performed in 1976, revealed that the species has strongly increased its abundance and coverage, extending its colonization to the entire perimeter of the cave, including a long and narrow siphon and a large inner chamber (from approx. 56 m^2 of bottom colonized in 1976 to approx. 418 m^2 in 2003).

The high frequency, and extension of *A. calycularis* in the studied area can be favored by changes in the hydrographic conditions in the southern Tyrrhenian Sea and in the Gulf of Naples. In fact, an overall slight warming of the superficial waters has been recorded in some periods in the Gulf. Longer water mass summer stratification and increase of winter minimum were occasionally recorded. This inter-annual variability, with some years or longer periods of warming of the superficial waters, may be an important factor for the reproductive success of the species, which in these periods can favor more intensive offspring production and increase successful settlement of new recruits that may lead to the increased colonization observed.

A. calycularis, especially in those areas such as the Gulf of Naples near to its northern distribution limit, should be therefore considered as a good "biological indicator" at short and medium-term scale, to reveal ongoing climatic changes.

INTRODUCTION

For the past decades, an increasing number of tropical species have been colonizing the Mediterranean Sea throughout the Suez Canal (lessepsian migration). After entering, some of these species are now expanding their distribution in the Mediterranean Sea. At the same time, also autochthonous species of the Mediterranean showing a thermophile affinity and mainly distributed in the southern and oriental basins, show a progressive expansion towards the northern part of the Mediterranean seas. This latter phenomenon is particularly evident in the Ligurian Sea and Northern Tyrrhenian Sea (Bianchi and Morri, 1993; Astraldi et al., 1995; Morri and Bianchi, 2001), where it is starting to strongly affect the local biodiversity (Bianchi and Morri, 2000), as well as along the French coast (Francour et al., 1994; Perez et al., 2000). The main reason of these phenomena, already pointed out by various studies (Bethoux et al., 1990; Astraldi et al., 1995), is the slightly increase of the surface temperature. The trend of the winter isotherm of 14 °C affects the geographic distribution of several Mediterranean species, and more often organisms sensitive to water temperature, such as gorgonians, scleractinians and bryzoans, show large and catastrophic mass-mortality events related to water warming, due to the deepening of the thermocline or to longer persistence of water stratification effects over time (Perez et al., 2000; Cerrano et al., 2000).

These observations have stimulated several studies to monitor the occurrence and distribution of some of these "sentinel" species, in order to relate their dynamics to possible ongoing climatic changes. In this context, the scleractinians represent "key" organisms since many species occurring in the Mediterranean are influenced in their distribution and reproductive biology by temperature and its year to year variability (Zibrowius, 1980). As an example, a recent study revealed that the inter-annual changes of the surface water temperature cause a differential growth of the calcareous skeleton in the scleractinian *Cladocora caespitosa* (Morri et al., 2001), while the occurrence and distribution of *Astroides calycularis* was often used in past climatic reconstruction and sea level changes (Zibrowius, 1995; Morhange et al., 1999).

Within this context, the aim of this contribution is to add new data on occurrence and distribution of some scleractinia with thermophile affinity in the areas defined by the Phlaegrean islands (Ischia, Procida and Vivara, Gulf of Naples, Tyrrhenian Sea), with some details on their extension, frequency and ecology, in order to build up a reference baseline. The species *Astroides calycularis*, in particular, has been considered as "case study" due to the fact that for this scleractinia the Phlaegrean islands, and the island of Ventotene north-west to Ischia in the Gulf of Gaeta represent the northern boundary of its distribution in the occidental basin of the Mediterranean Sea (Zibrowius, 1980; 1995). In addition, data on the distribution of this species were also available from previous studies (Cinelli et al., 1977). We used those data to make a long-term comparison with present day observations.

MATERIAL AND METHODS

The majority of data here presented have been collected in the framework of a pilot study for the institution of the Marine Protected Area "Regno di Nettuno", which includes the Phlaegrean islands of Ischia, Procida and Vivara (national law 394/91) (Dappiano et al., 2003; Gambi et al., 2003a, 2003b).

The Phlaegrean islands have a coastal development of approx. 64 km, mainly characterized by rocky cliffs, and with several "pocket beaches" interspersed. Meadows of the seagrasses *Posidonia oceanica* and *Cymodocea nodosa* form a quite continuous belt, from about 5 to 30 m depth, around the area (Fig. 1). Close to the coast and in the channel between Ischia and Procida there are several rocky banks, relatively shallow, and often colonized by *P. oceanica* patches (Gambi et al., 2003a).

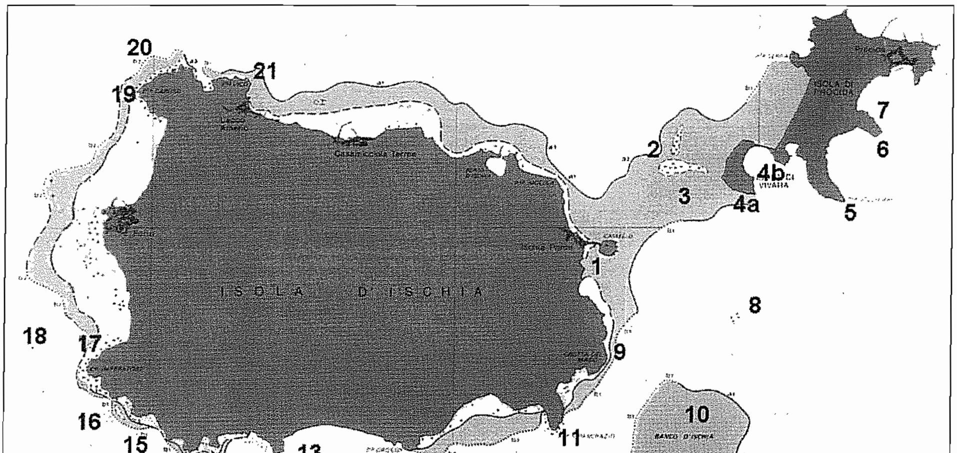

Fig. 1 - Map of the Phlaegrean Islands with location of the sites surveyed by visual census (see Tab. I for site names and depth range of visual census). The gray area indicates the distribution of *Posidonia oceanica* beds (according to Colantoni et al., 1982).

An extensive qualitative survey was performed by means of the visual census technique in order to better characterize composition, physiognomy, and extent of the main benthic assemblages of the hard bottoms, by checking distribution of the most characteristic macro- and megabenthic species. The survey was conducted by SCUBA diving in summer 2000 and early months of 2001 in 21 sites around the islands (Fig. 1 and Tab. I) and located on vertical cliffs, rocky banks, and semi-obscure cave. The depth range considered varied from 0 to about 40-50 m depth (Tab. I). At each site the frequency and extent of the studied species was evaluated by means of a semi-quantitative code: 1 = present, but not common; 2 = abundant; 3 = dominant, forming a *facies*.

Tab. I - List of the 21 sites where benthic visual census was performed (see numbers in Fig. 1 for location of sites), and of the studied species of scleractinians: 1= present but not common; 2= common; 3= dominant, forming a *facies* (see text).

Numbers as in Fig. 1	Sites of visual census	Depth range (m) of visual census	*Cladocora caespitosa*	*Madracis pharensis*	*Phyllangia mouchezii*	*Astroides calycularis*
1	Castello Aragonese (*Posidonia* and *Cymodocea* meadows)	2-5	-	-	-	-
2	Bank Formiche of Vivara (Ischia Channel) (natural arches, bank top; semi-obscure caves)	5-20	1	1-3		1
3	Bank "Faraglione" (Ischia Channel) (bank top and lateral walls)	17-25	1	1	1	-
4a-4b	Vivara island (vertical cliffs on north-east and south-west sides)	4-10	1-2	-	-	-
5	Solchiaro Point (Procida) (vertical cliff)	8-37	1	-	1	-
6	Pizzaco Point (Procida) (vertical cliff)	5-35	1	-	-	-
7	Sant'Antonio Bay (Procida) (*Cymodocea* meadow)	10-15	-	-	-	-
8	Bank "Catena-Pertuso" (Ischia Channel) (bank top)	40-25	1	-	-	-
9	Mago's Cave (walls outside the cave)	0-9	2	-	-	-
9	Mago's Cave (walls inside cave)	0-6	-	-	-	3
10	Ischia Bank (*Posidonia* and erratic rocks)	28-30	-	-	-	-
11	San Pancrazio Point (vertical cliff)	8-38	1	-	-	2
12	Cape Grosso (vertical cliff and *Posidonia*)	16-28	2	-	-	-
13	Maronti Bay (*Posidonia* meadow)	18-25	-	-	-	-
14	Sant'Angelo Point (vertical cliff)	10-50	1	-	-	3
15	Bank "La Scannella" (rocky bank)	10-26	1	-	1	-
16	Rock "La Nave" (vertical cliff, small caves)	5-25	2	-	-	1
17	Rock "Pietra Nera" (vertical cliff)	5-15	-	-	-	-
18	Bank "La Linea" (bank top and walls)	25-20	1	-	-	-
19	Cape Caruso (vertical cliff)	6-15	1	-	-	2
20	Bank "Bell'ommo e' terra" (bank top and walls)	25-18	1	-	-	-
21	Vico Point (vertical cliff)	8-10	2	-	-	-

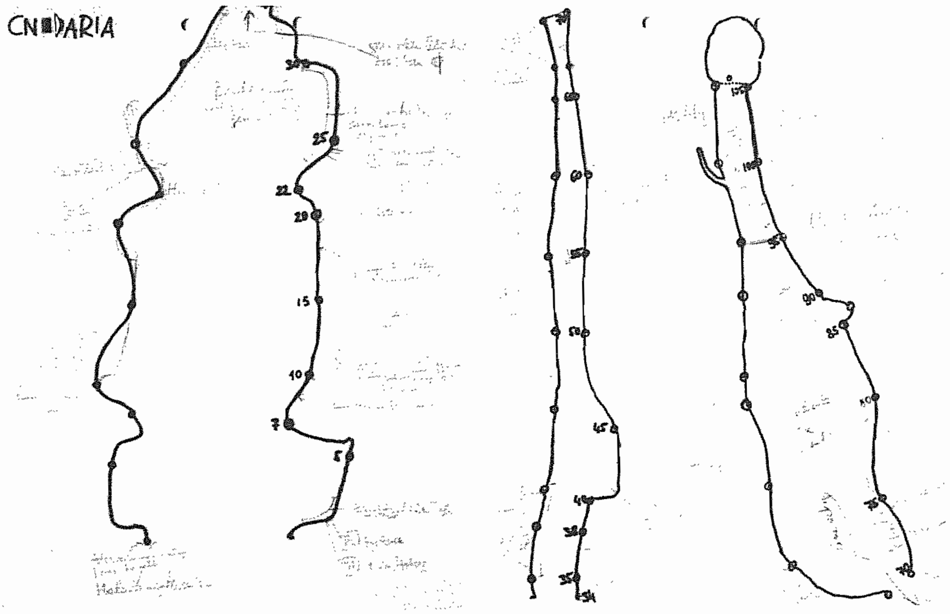

Fig. 2 - Original plastic board with the topographic mapping of the Mago's Cave, used by Dr. Armin Svoboda for visual census of Cnidaria in the Mago's Cave during the ecological survey performed in 1976 (Cinelli et al., 1977). The most important sceltactinia species are reported in different segments and depth of the cave, including *Astroides calycularis*.

For *Astroides calycularis* a specific study was conducted during spring 2003. In the island of Ischia previous records of this species were available for a large semi-submersed, semi-obscure cave named "Mago's Cave", in which *A. calycularis* occurred in limited areas between 0 and 3 m depth (Cinelli et al., 1977; Gambi M.C., pers. observ.), and for the emerged rock "La Nave" between 0 and 3-4 m depth (Gambi et al., 2003b). The visual census of the present study was extended to the entire perimeter of the cave in order to compare present observations to previous data from the ecological study by Cinelli et al. (1977), and from the accurate topographic visual census performed by Dr A. Svoboda (1976; unpublished data) (Fig. 2). In order to study the abundance pattern and the community structure of the species two stations were established within the cave: station 1 is located close to the main entrance; station 2 is further inside the cave (Fig. 3). A third station was established in a cliff off S. Angelo, in proximity of the rock called "l'elefante", an area where *A. calycularis* was found quite abundant (Dappiano et al., 2003). In all the three stations abundance and population structure (size/frequency distribution) of *A. calycularis* were checked along a depth transept at three bathymetric zones: 0-1 m, 2-3 m and 3-4 m depth. Sampling was done by means of an underwater camera (Nikonos-V), equipped with a macro-objective mounted on a 35 mm objective (frame

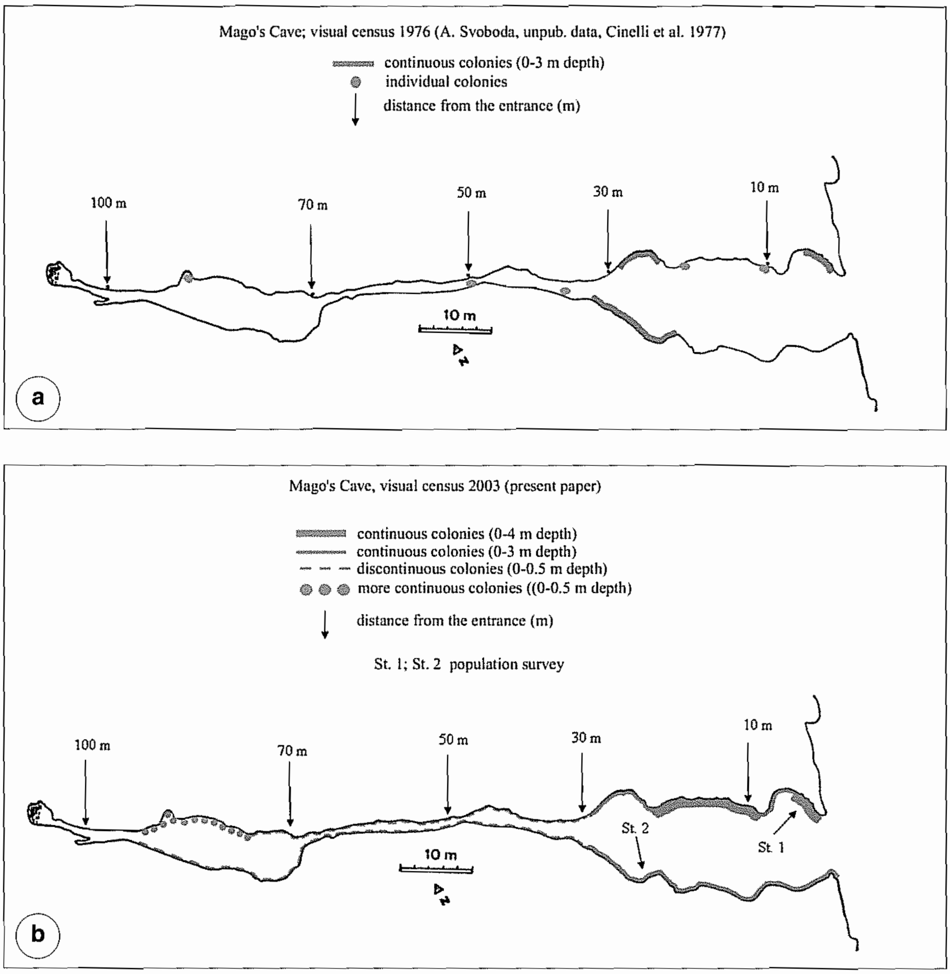

Fig. 3 - a) Map of the planimetry of the Mago's Cave (top view), with indication of distribution of *Astroides calycularis* during the visual census in 1976 (A. Svoboda, unpublished data; Cinelli et al., 1977). b) Map of the Mago's Cave, with indication of distribution of *Astroides calycularis* during our visual census in spring 2003.

dimension 18 x 12 cm, for a surface of 216 cm^2). For each bathymetric zones an horizontal transept 4 m long was established, in which three areas were randomly selected (random numbers). Each area consists of 4 photographic frames arranged to form a quadrate of total 864 cm^2 surface. The individual slides (frames) were analyzed under a stereo microscope with a micrometric ocular. Each colony was counted; very young colonies formed by 1 to 3 corallites were counted separately, while the wider diameter was measured for larger colonies. To build the size/frequency histograms, size classes were established with 1 cm interval. Each 864 cm^2 area was reconstructed by integrating the 4

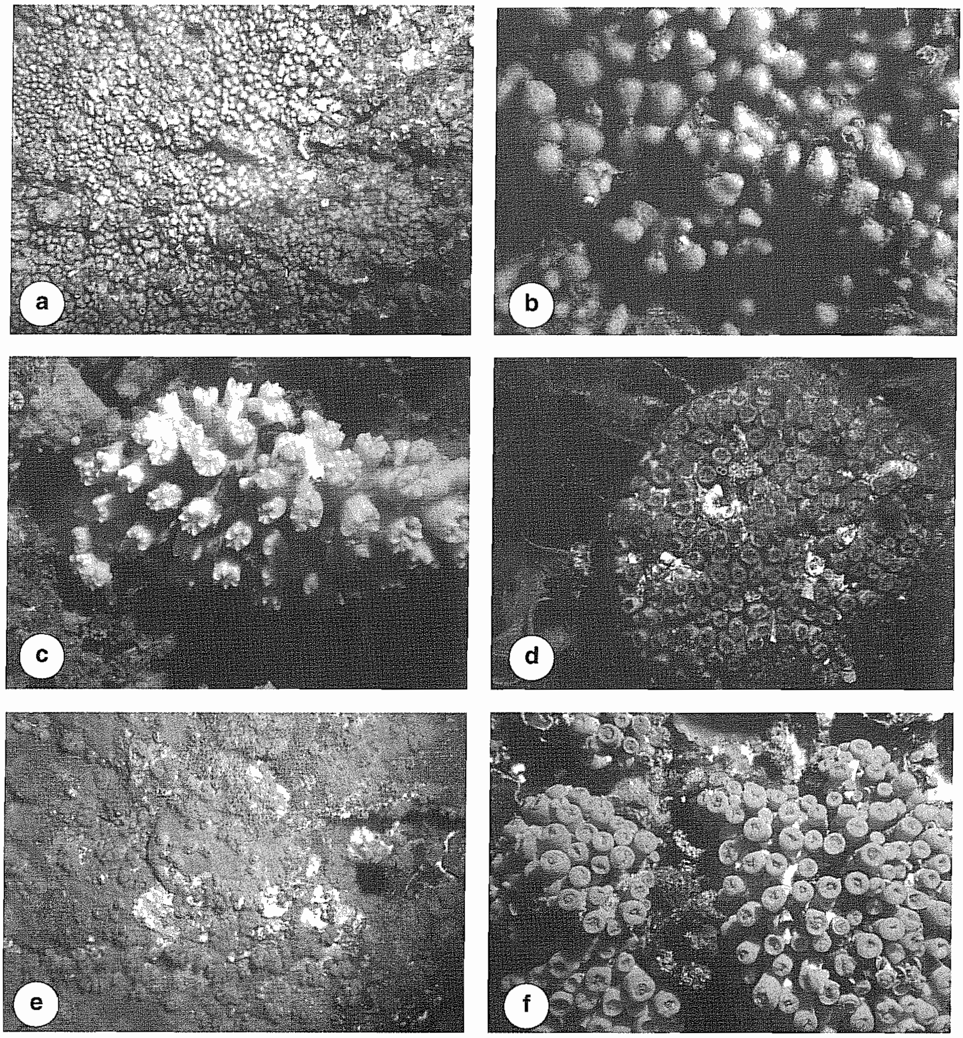

Fig. 4 - Color photographs of the studied species: a) *Madracis pharensis*, colonies forming a *facies* on the ceiling inside the "Grotta Grande" of the Formiche of Vivara (12 m depth, width about 1 m); b) *Madracis pharensis*, colonies showing the "nodular" shape (each nodule about 2-3 cm width); c) *Phyllangia mouchezii* (Scannella bank, 26 m depth, colony about 8 cm width); d) *Cladocora caespitosa* (Cape Vico 10 m depth; colony about 10 cm width); e) *Astroides calycularis* forming a *facies* inside the Mago's Cave (1 m depth); f) some colonies of *Astroides calycularis* at 5 m depth in S. Angelo (approx. 2-5 cm diameter); note the retracted polips with separate, erect corallites, and the globular shape of the colonies. (Photographs by Marco Dappiano).

colonies show the typical "nodular" morphology (Fig. 4b), and also shows some ability at forming bio-constructions, as recorded in other areas of the Mediterranean Sea (Morri et al., 2000).

frames (slides). For each station and bathymetric zone values of abundance and frequency of size classes were expressed as means (± s.d.) of the three 864 cm^2 area replicates.

RESULTS AND DISCUSSION

Between the 11 species of scleractinians recorded during the visual census (Gambi et al., 2003b) some are considered to have a thermophile affinity: *Cladocora caespitosa* (Linneo, 1767), *Madracis pharensis* (Heller, 1868), *Phyllangia mouchezii* (Lacaze-Duthiers, 1897), and *Astroides calycularis* (Pallas, 1766) (Fig. 4).

Cladocora caespitosa

This species was the most uniformly distributed around the coasts of the Phlegrean islands (see Tab. I). *C. caespitosa* was more frequent in the area outside the Mago's Cave, at the emerged rock "La Nave", at Cape Vico, at the top of the rocky bank "Formiche of Vivara" and at Pizzaco Point (island of Procida), especially within the first 15-20 m depth. As a whole the colonies were relatively small (less than 10 cm in diameter) (Fig. 4d). Larger colonies (more than 10 cm) were recorded only at Pizzaco Point at 10 m depth.

Madracis pharensis

This species, of tropical origin, shows a certain potential of bio-construction also in the Mediterranean, being an haermatypic form (Zibrowius, 1980; Morri et al., 2000). It has been recorded for the first time in the studied area during our survey (Dappiano et al., 2003). *M. pharensis* occurs only at two sites with well localized populations (Tab. I). The population at the site "il Faraglione" (a big submerged rock surrounded by *Posidonia oceanica* meadows) is represented by scarce colonies localized in small shadowed crevices on the vertical walls. The population at the large shallow rocky bank "Formiche of Vivara" consists of several extended colonies which colonize shadowed areas. Some settlements occur under two natural rocky arches at 14 m depth, while settlements with larger coverage were recorded within some semi-obscure caves, which are common biotopes of the bank. In particular, within the "Grotta Grande", a large cave with a quite complex morphology (Ferranti et al., 1994), the specie is forming a *facies* in a relatively large area (approx. 4 m^2) on the ceiling of the cave (12 m depth) (Fig. 4a). This habitat represents a typical environmental situation for the species, observed often in other marine caves along the Italian coasts (Alvisi et al., 1994; Morri and Pessani, 2003 and references herein). Inside the cave the

Phyllangia mouchezii

Also this species was first recorded in the studied area during the visual survey (Dappiano et al., 2003). *P. mouchezii* was observed in three sites (Tab. I) with a limited number of colonies between 25 m and 40 m depth (Fig. 4c).

Astroides calycularis

This species is actually distributed in different sites along the coast of the studied area and in habitats where some typical environmental conditions occur (shallow cliff shadowed and relatively sheltered, shallow caves and crevices) (Tab. I). The observed populations at some sites extend their colonization up to 8-10 m depth (e.g., Cape Caruso, S. Angelo, S. Pancrazio Point, "Formiche" of Vivara), and are often dominant on the substrate or form *facies* especially between 0 and 3-4 m depth (e.g., Mago's Cave, S. Angelo). Fig. 3 shows a comparison between present (spring 2003) and past data (1976; Svoboda A., person. observ.; Cinelli et al., 1977) in the area where the species is more abundant, the Mago's Cave. The differences between the two periods are striking; in 1976 the species was present only in three limited areas within the first chamber of the cave between 0 and max 3 m depth. *A. calycularis* was very scarce and with single individual colonies along the wall of the narrow siphon and in the final inner chamber of the cave. Bottom surface colonized by the species was estimated in approx. 56 m². The same colonization pattern was also observed during a qualitative visual survey in

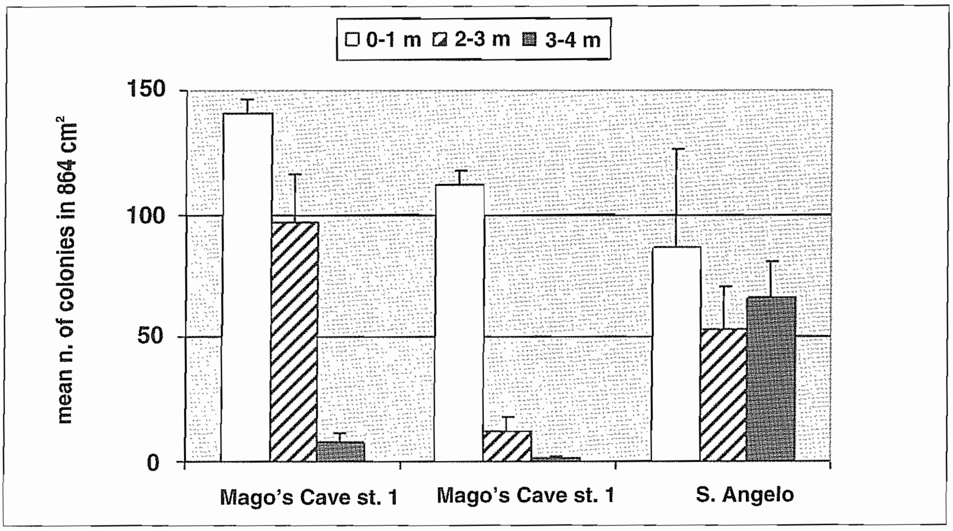

Fig. 5 - Trend of the mean abundance (n. of colonies in 864 cm²) of *Astroides calycularis* in the three studied stations and along the depth transept at 0-1, 2-3 and 3-4 m depth. Bars indicate standard deviations.

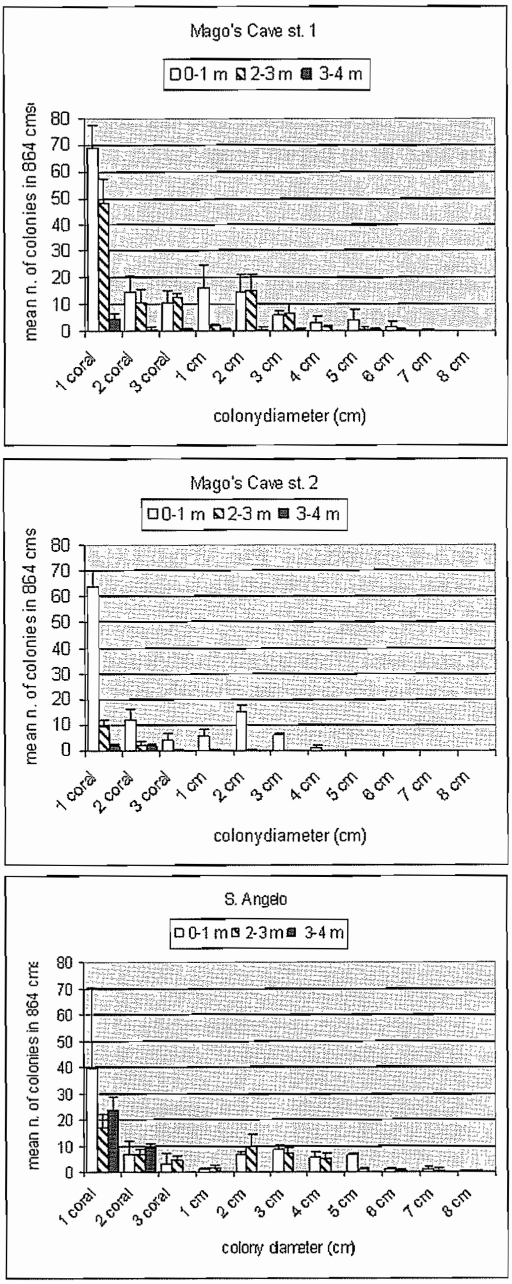

Fig. 6 - Trend of the mean abundance (n. of colonies in 864 cm^2) of *Astroides calycularis* size classes (colony diameter, cm) in the three studied stations and along the depth transept at 0-1, 2-3 and 3-4 m depth. Bars indicate standard deviations.

July 1983 (M.C. Gambi, pers. observ.). At present, the species has extended its distribution and occurs almost in the entire perimeter of the first chamber, reaching in some areas up to 4 m depth. Along the narrow siphon, several colonies are present although with a discontinuous pattern and limited to about 1 m depth. The colonization also occurred along the wall of the inner chamber, where in the northern side, the colonies form a more dense and continuous coverage, although limited to the first 0.5 m depth. Bottom surface colonized by the species was estimated in approx. 418 m^2. These observations demonstrate that during the last 25 years the species has enormously extended its coverage within the cave (approx. by a factor 7.5), as a probable consequence of particularly favorable environmental conditions and reduced competition for space with other species, being the cave poorly colonized (especially along the siphon and in the inner chamber) also in 1976 (Cinelli et al., 1977). In addition, the occurrence of *Astroides* in the inner chamber of the cave is quite unusual, since generally the innermost part of caves with low water exchange and low food supply may limit the colonization of filter feeding species (Gili et al., 1986). However, the Mago's Cave is characterized by high hydrodynamic exchanges, and limitation to colonization has been mainly attributed to the substratum type and its topography, rather then to food constraint (Cinelli et al., 1977).

Data about abundance pattern and population structure in the studied stations are shown in Figs. 5 and 6. In the stations at the Mago's Cave the density is highest at 0–1 m (more than a mean of 100 colonies) and gradually decreases with depth in st. 1, where also at 2-3 m depth the species is quite frequent, whereas density decreases more rapidly in st. 2. Below 3 m depth density is low at both stations.

In the station of S. Angelo, on the contrary, density of *A. calycularis* is more uniform at the studied depths, and an evident decrease of the species is shown only below 6-8 m depth, with some colonies being still present at 11 m depth. Depth limitation of *A. calycularis* in the Mago's Cave can be related to the relatively reduced depth of the cave (5-6 m) and to the bottom coarse sediment grain size which, when re-suspended by the relatively strong hydrodynamics of the area, can exert a strong scouring disturbance on the settled sessile organisms. On the contrary the cliff at S. Angelo is much deeper (70-80 m).

Looking at the population structure, one can observe that there are many young colonies (1-3 corallites) in all the studied stations (Fig. 6), which suggests intense settlement. This pattern is particularly evident at the two stations inside of the cave, and where the largest colonies do not overcome 3 cm in diameter. In the station of S. Angelo the colonies showed higher sizes, with maximum dimensions reaching 8 cm in diameter. The number of young colonies (1-3 corallites) is higher at 0-1 m and rapidly decreases with depth, especially at the stations within the cave, even though these young colonies represent the majority of the specimens occurring below 3 m depth in the cave (Fig. 6). Young colonies are less abundant in the S. Angelo station probably due to the competition for the substrate with the macroalgae and other sessile invertebrates which are more abundant at this site, respect to the Mago's Cave (Gambi et al., 2003b). On the whole, if not considering the peak shown by young colonies, the size/frequency distribution in the stations within the cave has a uni-modal distribution pattern, while it has a less regular pattern in the station of S. Angelo (Fig. 6).

Larger colonies showed different morphology of the corallites and structure of the colony according to the sites. Specimens of the cave have polips with fused corallites, colony with an "encrusting" growth form, compact or moderately globose, with an irregular shape to best fit the substrate topography (Fig. 4e). Specimens form S. Angelo showed polips with separated corallites often interspersed, or covered with calcareous red algae (corallinales), the colonies have a globose and erect structure (Fig. 4f), probably related to the more sheltered conditions of the area. Similar differences in morphology and also in size have been observed by other AA (Morri et al., 1995; Cirino et al., 1995), and have been related to both physical environment (e.g., water movement, bottom topography) and food supply and special trophic condition of the colonized habitat. As an example, *Astroides* populations showed larger corallites and colony dimensions (gigantism) in the innermost part of the "Grotta Azzurra" at Capo Palinuro (Southern Tyrrhenian Sea), where large food supplies are provided by chemiosynthetic sulphur bacteria (Morri et al., 1995; Benedetti-Cecchi et al., 1997), respect to other areas inside and outside the cave, where sulphur springs do not occur.

Along the Italian coast *A. calycularis* is distributed in the Southern Tyrrhenian Sea, Ionian Sea and Sicily Strait, but there is no precise information about the northern limit of its distribution. A single colony has been recorded in the Giglio island (Tuscany Archipelago) (Bianchi and Morri, 1994) and in the Pianosa island (Tuscany Archipelago) (Bedini, 2004). Our observation in summer 2002 in the island of Ventotene (Gulf of Gaeta north to Naples and near its northern limit), where the species was previously reported (E. Fresi pers. comm, in Zibrowius, 1980), revealed the occurrence of many small colonies between 0 and about 1.5 m depth in the rocks at the sides and facing the beach Cala Nave, as well as in the nearby small island of Santo Stefano (site called "molo 4"), where the species reached about 3-4 m depth. Corallite and colony morphology of the Ventotene specimens are very similar to that of the Mago's Cave.

The occurrence of *A. calycularis* in the Adriatic Sea is documented for Apulia (Salento coast, see web-site: www.iltaccod'italia.com, of the Marine Biological Station of Porto Cesareo), and Croatia, near the island of Glavat (central Adriatic Sea) (Kuzic et al., 2002; Grubelic et al., 2004). These latter records were related by the AA to changes in the circulation pattern and temperature regimes in the Eastern Mediterranean, which favored both the larval transport and settlement of this species, as well as of other thermophile organisms (Novosel et al., 2004). More recent data on the distribution and ecology of the species in marine caves along the Italian coast are available in Morri and Pessani (2003).

The high number of young colonies found in our study, coupled with the striking increase in distribution and coverage, observed at small and medium scale in the Mago's Cave and Ischia island populations from the 1976 to present days, suggest that the species has found in the last two decades favorable condition for its recruitment and expansion, and that this process is probably ongoing in the whole Tyrrhenian basin.

However, reproduction of *A. calycularis* is relatively poorly known, since the historical observation on planula larvae by Lacaze-Duthiers (1873) and on maturity and gamete emission by Lo Bianco (1909) in the Gulf of Naples. *A. calycularis* reproduces sexually from April to August. It is a monoic species, with male and female polyps in the same colony. The fertilization is intraovarian; the eggs develop into a planula stage. These few data on reproduction have been confirmed in a study conducted in the Naples public Aquarium (Cirino et al., 1995). Colonies of approx. 10-20 cm in diameter, collected in November 1990 near the Gulf of

Naples at 3-4 m depth and reared in a large tank, were observed to spawn the spermathozoa in April 1991. After two months orange planulae were observed swimming in the tank, while others were already settled on the substratum. At the end of July they were transformed into oozoids. While light seemed to have no influence on settlement, availability of rocks and progressive water temperature increase were important factors for rapid settlement and normal progression of the life cycle (Cirino et al., 1995). The most interesting results of that study was the fact that the initiation of the reproductive phase was related to the introduction of supplement food source (zooplankton) in the tank. The AA also noted that some of the specimens reached 1.5 cm height after two years in the tank, and that others clearly reproduced asexually, however it was sometimes difficult to distinguish between aggregated polyps derived by individual planulae, and colonies formed by a single corallite and its cloned blastozoids (Cirino et al., 1995).

No information is available for reproduction *in situ*, as well as for the potential of fragmentation in this species, as shown by several other clone-forming anthozoans (Russo and Vari, 1999).

The higher frequency, and extension of *A. calycularis* in the studied area can be related to changes in the overall thermal conditions, in fact, in these last years different species with a warm water affinity have spread out in the studied area, and in the Gulf of Naples in general. The introduced green alga *Caulerpa racemosa* was recorded for the fist time in the Gulf of Naples in 1997 in limited areas (Buia et al., 2001), and is now widespread with an invasive behavior in many zones around the Gulf and in the Phlegrean islands (Buia et al., 2003; Russo et al., 2003). The thermophile red alga *Asparagopsis taxifomis*, first recorded in the island of Ischia and Procida in summer 2000 (Gambi et al., 2003b), has recently shown (spring 2003) an invasive habit by covering large portion of shallow hard bottoms mixed with photophilous algae (Gambi M.C., pers. observ.). The Mediterranean parrot fish, *Sparisoma cretense*, distributed mainly in the Eastern basin and relatively rare northern to Sicily, was first observed at Ischia in autumn 1997 with few specimens, and it is now quite common in various sites (La Nave, Formiche of Vivara) (Gambi M.C., Balestrieri L., pers. observ.), while a specimen of the sub-tropical tetraodontid fish *Sphoeroides pachygaster* was recorded off Ischia in April 2002 (Dappiano M., pers. observ.). Finally, is also worth to mention a recent record in the intertidal rocks of Ischia (June 2004) of the introduced tropical crab *Percon gibbesi*, (Lorenti M., pers. comm.). All these findings suggest a general trend of climate change towards a warming of the superficial water masses. A tendency of a slight warming of the superficial waters have been highlighted in some periods in the Gulf (Mazzocchi and Ribera d'Alcalà, 1995). Longer water mass summer stratification and increase of winter minimum were also occasionally recorded, leading to a possible change also in the trophic structure of the pelagic food-web (Mangoni, 1999; Mangoni and Corato, 2002). In addition, a clear increase (about

1.5-2 °C) of both the mean maximum and minimum air temperature was evident in Naples area starting from the late '80, according to the data available in the website www.campaniameteo.com/Min%20e%20Max%20a%20Napoli.htm.

This inter-annual variability in temperature regimes and consequent hydrographic conditions (pelagic production, water mass circulation etc.), with some years or longer periods of warming of the superficial waters, may be important factors for the reproductive success of the species, which in these periods can favor more intensive offspring production, and higher successful settlement of the new recruits, that leads to an increase of the overall colonization by the species.

A. calycularis, especially in those areas such as the Gulf of Naples near to its distribution limit, should be therefore considered as a good "biological indicator" at short and medium-term scale, useful to reveal rapid climatic changes, as observed in Pleistocene populations by Zibrowius (1995), and as proposed for *C. caespitosa* in the Ligurian Sea basin (Morri et al., 2001).

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