



## Calcareous nannoplankton inside coralligenous build-ups: the case of Marzamemi (SE, Sicily)

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**KEY WORDS** - *Coccolithophores, algal reef, bioconstruction, Ionian Sea, sediment trap.*

**ABSTRACT** - *In the Mediterranean Sea, crustose coralline algae form mesophotic reefs referred to as Coralligenous. They act as a sediment trap and may be considered as a potential source of geological information. Two coralligenous build-ups collected during the project FISR "CRESCIBLUREEF" at 36 and 37 m water depth off the coast of south-eastern Sicily reveal the presence of calcareous nannoplankton/nannofossil specimens within the sediment infilling. This novel finding reveals the occurrence of a mixed modern and reworked nannoplankton assemblage derived from marine-snow sedimentation and land weathering, respectively. The quantitative analysis of the assemblages from both build-ups shows a difference in sedimentation exposure derived from the different local environments where the build-ups were collected, highlighting the potential role of coccolithophores as a sedimentation proxy for coastal settings.*

### INTRODUCTION

The littoral zone is a region of great importance characterised by the interplay of the marine and terrestrial domains, influenced by biotic and abiotic geological processes. Its ecosystem is highly dynamic, and controlled by global and local factors (Davis & Hayes, 1984; Cattaneo & Steel, 2003; Pérez-Ruzafa et al., 2011). The most conspicuous biogenic of the Mediterranean Sea littoral zone is the Coralligenous, a complex biological reef that is predominantly formed by calcareous red algae (Pérès, 1982; Ballesteros, 2006; Basso et al., 2022).

During the Holocene, these bioconstructions have been developing following sea level advancement (Sartoretto et al., 1996; Bertolino et al., 2017, 2019), with slow accretion rates (between 0.06 to 0.27 mm per year) (Di Geronimo et al., 2001; Bertolino et al., 2019; Basso et al., 2022). Coralligenous reefs have recorded multiple environmental changes and colonised the seafloor with distinctive landforms (Bracchi et al., 2017; Varzi et al., 2023). Moreover, coralligenous structure provides habitat for diverse organisms that secondarily contribute to its formation (e.g., some serpulids and bryozoans), bioerosion (e.g., sponges), or are simply dwellers (e.g., fleshy algae, crustaceans, some bryozoans and serpulids) (Fig. 1), resulting in a biodiversity hotspot that deserves protection and monitoring (Bracchi et al., 2022).

The project CresciBluReef (CBR) aimed to study Coralligenous off the coast of Marzamemi village

(Siracusa, south-eastern Sicily) (Fig. 2). In the framework of the CBR project several investigations have been undertaken on the Marzamemi Coralligenous: to assess the spatial distribution on the seafloor (Varzi et al., 2023), to investigate its surficial biological composition and inner structure complexity (Bracchi et al., 2022), to analyse the various components of the inner and superficial fauna (Rosso et al., 2023; Sanfilippo et al., 2024) and the microbial component (Cipriani et al., 2024). Coccolithophores are unicellular haptophytes algae, extremely important for the marine carbon cycle. Their calcareous skeletal remains (or coccoliths) are largely used for paleoclimatic and paleoceanographic reconstructions (Winter & Siesser, 1994; Baumann et al., 2004). In addition, the presence of reworked specimens in the observed assemblage (namely nannofossils from different stratigraphic intervals), can help in evaluating the amount of terrigenous input in a studied basin (Ferreira et al., 2008; Incarbona et al., 2010; Cascella et al., 2019). Coccolithophores are usually found in oceanic and pelagic settings, but their presence in shallow waters is sometimes overlooked, especially as possible proxies for sedimentological features (e.g., Guerreiro et al., 2005).

The porous structure of the Coralligenous represents a geological repository where coccoliths could be considered as a paleohydrological proxy. Their presence alongside that of the benthic assemblages associated with the build-ups, can give insights on the composition and

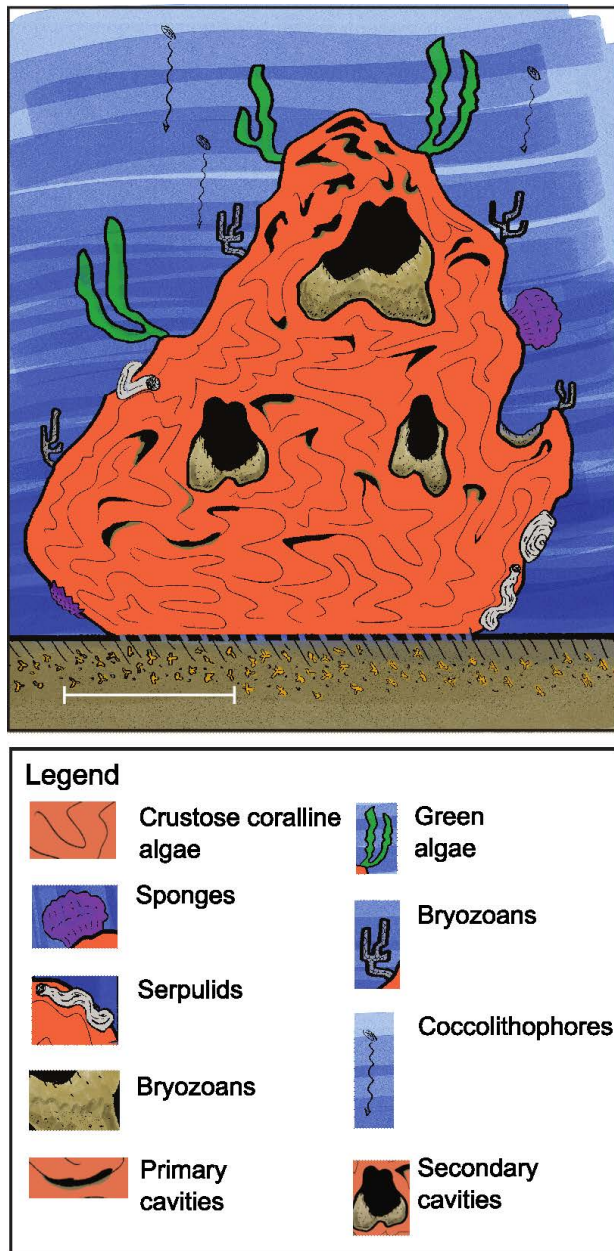


Fig. 1 - (color online) Schematic representation of a coralligenous build-up in its environment. Porosity (in black, as primary and secondary cavities of various sizes partly filled with sediments) and organisms living on its surface are shown and include sponges, bryozoans, serpulids and green algae. The black arrows show coccolithophore sedimentation from the water column. Scale bar: 10 cm.

amount of land derived sediments, the bathymetry of the area and/or the stratigraphy of the outcrops on land. We present herein, for the first time, some findings on the coccolithophore assemblages observed inside the sediment infilling of coralligenous build-ups, potentially related with the sedimentation regime of the area during the Coralligenous development. In this study, we focus on the challenges encountered during sample collection, the potential meaning of the coccolithophore assemblage composition in relation with the sediment exposure, and the hints for further investigations on this intriguing topic.

## SETTING

The study area is located off the village of Marzamemi (Siracusa, Sicily) in the south-eastern part of the Sicily Island (Fig. 2) on the southernmost Hyblean plateau. The stratigraphic succession outcropping in this area consists of carbonate sediments and local volcanic products of Cretaceous to Quaternary age (Distefano et al., 2021). The lithostratigraphy of the outcrops in the nearby area of the Marzamemi village and its drainage basin is referred to the Lower Pliocene unit of the Trubi Formation and the white-yellowish marls of the Late Pliocene. Erosional morphologies are present in these units both on land and in submerged areas. The sublittoral zones show morphological features interpreted as karst depressions (Distefano et al., 2021; Varzi et al., 2023). Marks of subaerial erosional surfaces can be detected underwater, highlighting the relative low sea level during the late Quaternary. Upper Pleistocene marine terraces are approximately 15 m above sea level (Gracia et al., 2002; Distefano et al., 2021). The subsequent evolution produced sedimentary deposition and transformed river valleys into progressively infilling estuaries. The Coralligenous extends within two main depth-ranges: from 36 to 42 m water depth where it forms hybrid banks, *sensu* Bracchi et al. (2017), with lateral continuity due to coalescence of coralligenous build-up; and from 86 to 92 m water depth, where the Coralligenous is organised as individual build-ups often clustered together (Varzi et al., 2023).

The area is characterised by a typical Mediterranean climate, with hot and dry summers and mid latitude stormy rains and cool winters (Mariotti et al., 2002; Grassa et al., 2006). The precipitation pattern reflects a strong seasonal trend with most of the rainfall occurring in winter and with very low amounts in summer. Spring and autumn experience climate conditions intermediate between the summer and winter types (Pirrone et al., 2003). High-intensity storms, such as “Medicanes”, occasionally occur in this region (Cavicchia et al., 2014; Scicchitano et al., 2020).

## MATERIALS AND METHODS

After the identification of the coralligenous site, with the use of a Remotely Operated Vehicle (ROV; Bracchi et al., 2022; Varzi et al., 2023), two discrete build-ups at 37 and 36 m water depth were collected by SCUBA divers (Fig. 2).

The first build-up, labelled CBR2\_3\_7c (hereafter referred to as 7c), was collected in an area of dense coralligenous cover, with hybrid banks of more or less distinct columns covering most of the sea bed (Bracchi et al., 2017, 2022) and the build-up itself was coalescing with some adjacent ones (Fig. 2c). The second build-up, labelled CBR2\_4\_21c (hereafter referred to as 21c), was collected in an open area with sparse coralligenous cover (Varzi et al., 2023), and it was isolated from the others build-ups (Fig. 2d). The two build-ups and associated material were analysed and deposited at the Department of Environmental and Earth Sciences of the University of Milano-Bicocca (Milan, Italy).

After the recovery, the build-ups were cut along their sagittal plane, exposing the extremely porous inside with

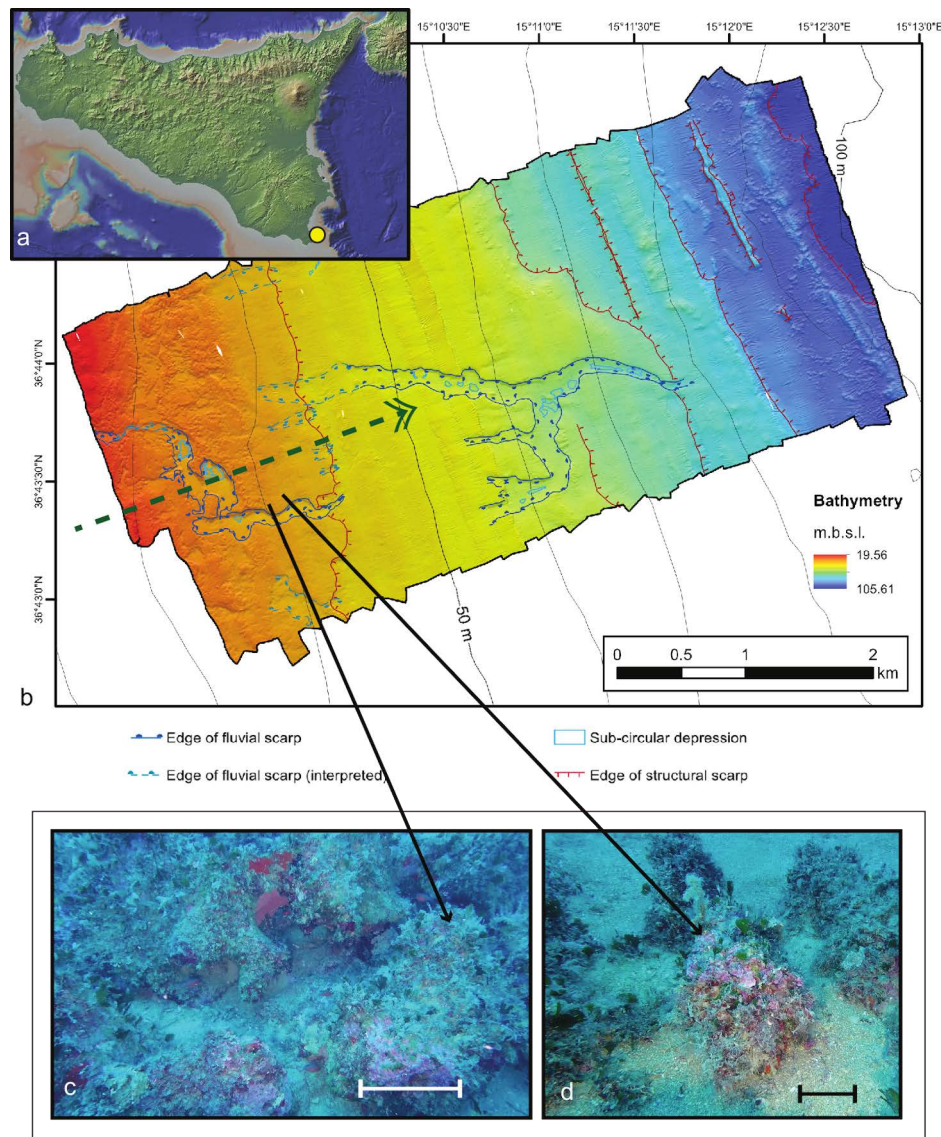


Fig. 2 - (color online) Location of the study area and sampling site. a) Map of Sicily, South-Central Mediterranean, and study area, Marzamemi marina, South-East Sicily (dot in a). b) Bathymetric map of the study area. Bathymetric lines every 10 m, green dotted line represents the drainage from land. Modified from Varzi et al. (2023). c) 7c build-up before sampling. Scale bar: 10 cm. d) 21c build-up before sampling. Scale bar: 10 cm.

cavities of various sizes filled with sediments (Fig. 3). Following Cipriani et al. (2024) two types of cavities have been observed: primary cavities (derived from gaps formed during the algal accretion) and secondary cavities (derived from bioerosion). The sediments inside the build-ups occur as loose or cemented (Cipriani et al., 2024). The loose sediment mainly occurs in the larger, centimetric cavities (Fig. 3), and shows a brownish to dark/grey colour, and silty/clayey texture (Fig. 4). It embeds a large amount of bioclasts, mostly represented by rhodolith fragments, with a minor portion composed of various, mainly carbonaceous, fragments belonging to planktonic and benthic foraminifera, serpulids, bryozoans, ostracods and molluscs. The cemented sediment occurs in the smaller cavities (few mm to 1 cm in diameter) and lacks bioclasts at a mesoscale observation (Fig. 4).

A total of twenty-three samples of loose sediment was collected from the larger cavities of the build-ups (Fig. 3). In the 7c build-up we collected the material from a series

of connected centimetre-sized cavities running from the top to the lower portion of the build-up (Fig. 3a). The samples inside the 21c build-up came from a large cavity (ca. 20 cm in diameter), filled with sediment and branching out from the centre of the structure towards the exterior (Fig. 3b). Additional samples from the 21c build-up came from sediment washed out from the build-up during its cutting. Samples for coccolith analysis were prepared with the standard smear slide technique (Young & Bown, 1998) and then observed with an Olympus BX51 microscope with polarising light at 1000 $\times$  magnification, in order to assess and count their coccolith assemblage. Coccoliths in the samples are scarce, which makes estimation of abundances extremely difficult. In particular, some samples bore an extremely low number of coccoliths, while other samples were richer. Considering these differences in abundance, we decided to limit the counting to 30 fields of view per sample.

To compare the sediment assemblage with the surrounding environment, a second set of six samples was

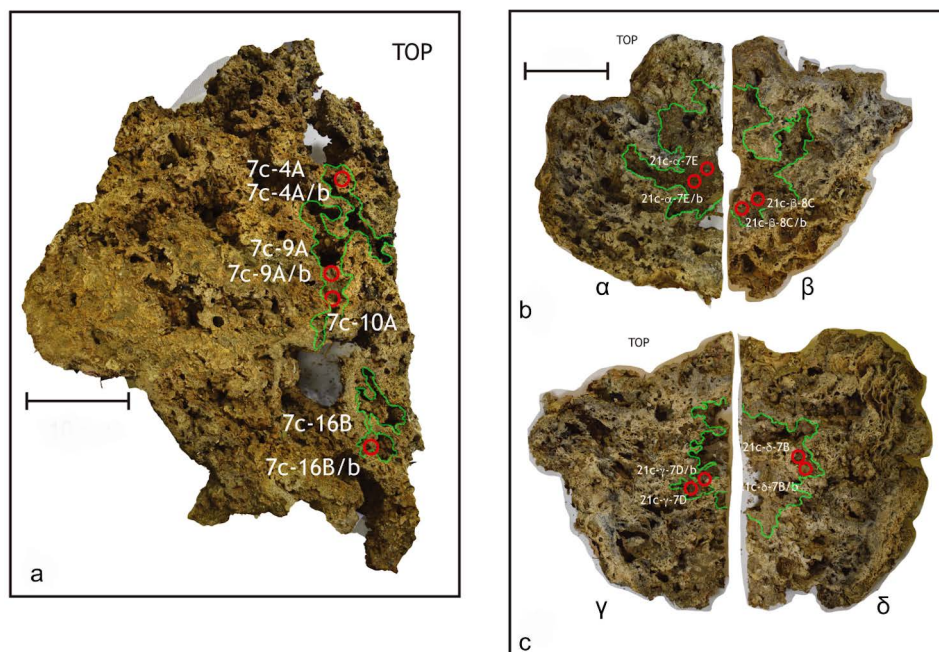


Fig. 3 - (color online) The two build-ups after being cut. a) 7c build-up was cut in two halves and one of it was subsampled (red circles). Scale bar: 10 cm. b-c) 21c build-up was cut in four pieces:  $\alpha$ ,  $\beta$  in (b) and  $\gamma$  and  $\delta$  in (c). The samples 21c AB 3, 4, 5, 6, 8, 9, 10-11, 12-13, were washed from the 21c build-up during the cutting, hence their location cannot be pinpointed on this figure. Scale bar: 10 cm. The build-ups are displayed in live position. Red circles (in b and c) indicate the subsampling samples; the cavities on both build-ups have been highlighted in green (note that the cavities are connected).

collected from the water column by the SCUBA divers. About two litres of seawater per sample was collected at around 5 meters water depth, directly above the build-ups collection site. The water samples were treated with a Lugol's iodine solution to preserve the planktonic fraction during transportation (Williams et al., 2016), and transported to the laboratory of the Department of Earth and Environmental Sciences of the University of Milano-Bicocca (Milan, Italy). The water samples were



Fig. 4 - (color online) Close up of the 21c build-up inside skeletal framework. Highlighted the two types of sediments in the cavities: cemented (red) and loose (white). Scale bar: 1 cm.

filtered on Millipore 0.45  $\mu\text{m}$  filters and then mounted on microscope slides for observation.

A third set of samples was collected from the beach in front of the build-ups collection area using the procedure described by Cachão (2022). The procedure involved the collection of a spoonful of beach sediment, adding subsequently 30-40 ml of freshwater. The suspended sample has then been poured into a vial and pipetted on the smear slide for microscope observations.

In addition to optical microscopy, two sets of observation were performed under Scanning Electron Microscopy (SEM). The first one was on selected samples of loose sediment, through a Zeiss FEG Gemini 500 at the University of Milano-Bicocca, in order to identify coccoliths morphological and preservational features. The second set of observations was performed at the University of Calabria with the Ultra High-Resolution SEM (UHR-SEM) - ZEISS CrossBeam 350. This second set of analyses was focused on the cemented portion of the sediments during the analysis of the micritic component of the coralligenous build-ups (Cipriani et al., 2024). Nannofossil recognition followed Young et al. (2003).

## RESULTS

The analysis of coccoliths from the sediment of the coralligenous build-up cavities evidenced an assemblage of mainly modern-day/Holocene coccolithophores with a reworked fraction of coccoliths from older stratigraphic intervals (namely Pliocene). The modern assemblage is more abundant in the 21c build-up (mean 111.5 coccoliths

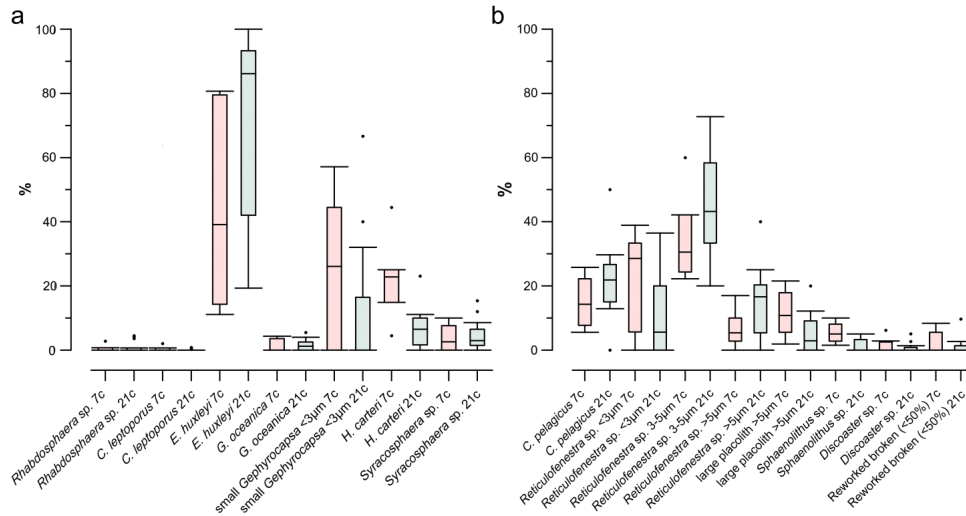


Fig. 5 - (color online) Boxplot comparison of the coccolithophore taxa percentage abundances of the modern (a) and reworked (b) assemblages inside the two build-ups. 7c build-up is indicated in red and 21c build-up in green.

per sample) than in the 7c (mean 69.8 coccolith per sample) (see Tab. S3 of the Supplementary Online Material - SOM). It is composed by: *Emiliana huxleyi* (Lohmann, 1902) Hay & Mohler in Hay et al., 1967 (47.8% of the 7c modern-day assemblage and 76.8% of 21c), small *Gephyrocapsa* spp. (24% of 7c and 10.7% of 21c), *Gephyrocapsa oceanica* Kamptner, 1943 (1.3% of 7c and 1.6% of 21c), *Syracosphaera histrica* Kamptner, 1941 (3.9% of 7c and 4% of 21c), and *Helicosphaera carteri* (Wallich, 1877) Kamptner, 1954 (22.6% of 7c and 7.13% of 21c). Rare occurrences include *Rhabdosphaera stilifera* (Lohmann, 1902) Kleijne & Jordan, 1990 (0.5% of 7c and 0.8% of 21c) and *Braarudosphaera bigelowii* (Gran & Braarud, 1935) Deflandre, 1947 (less than 0.3% of the assemblage) (Fig. 5). All these taxa have been considered as modern-day for counting purpose, regardless of their conservation status. The abundance of coccoliths in the water column is extremely scarce (less than 20 coccoliths per sample). The water column coccolith composition is consistent with the modern-day assemblage, with *E. huxleyi* (62.8% of the assemblage),

small *Gephyrocapsa* (4%), *G. oceanica* (4.8%), *S. histrica* (6.2%), *H. carteri* (5.9%) and *R. stilifera* (10.8%) (see Supp. Mat.). Cocospheres of *E. huxleyi* are present.

The reworked assemblage is more abundant in 7c build-up (a mean of 66.4 coccoliths per sample) than in 21c build-up (a mean of 51.9 coccoliths per sample) (see Tab. S3). Reworked assemblage is mainly composed by *Coccolithus pelagicus* (Wallich, 1877) Schiller, 1930 (15.3% of the reworked assemblage of 7c and 21.7% of 21c), *Reticulofenestra* specimens as follows: small *R.* (< 3µm, *R. minuta* Roth, 1970: 22.8% of 7c and 10.9% of 21c), medium *R.* (between 3 and 5 µm: 34.1% of 7c and 44.1% of the 21c) and large *R.* (> 5 µm, *R. pseudoumbilicus* [Gartner, 1967]) Gartner, 1969: 6.7% of 7c and 15.4% of 21c), large placoliths in extremely poor preservation status (> 5 µm: 11.6% of 7c and 4.8% of 21c) and *Discoaster* s.l. (2% of 7c and 0.6% of 21c) (Fig. 5).

In the 7c build-up a mean total of 136.9 coccolithophores per sample has been counted, with the modern assemblage representing around 41.5% of the counts and reworked

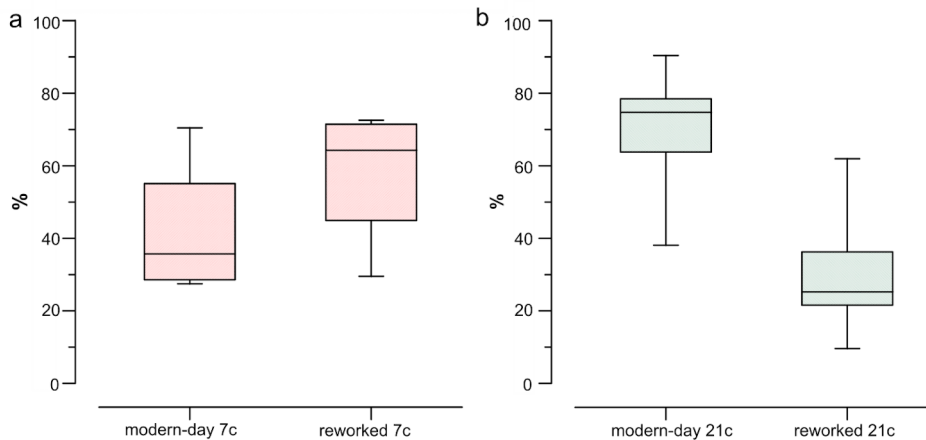


Fig. 6 - (color online) Boxplot comparison of the coccolithophore modern and reworked percentage assemblages in the two build ups: 7c build-up (a) and 21c build-up (b).

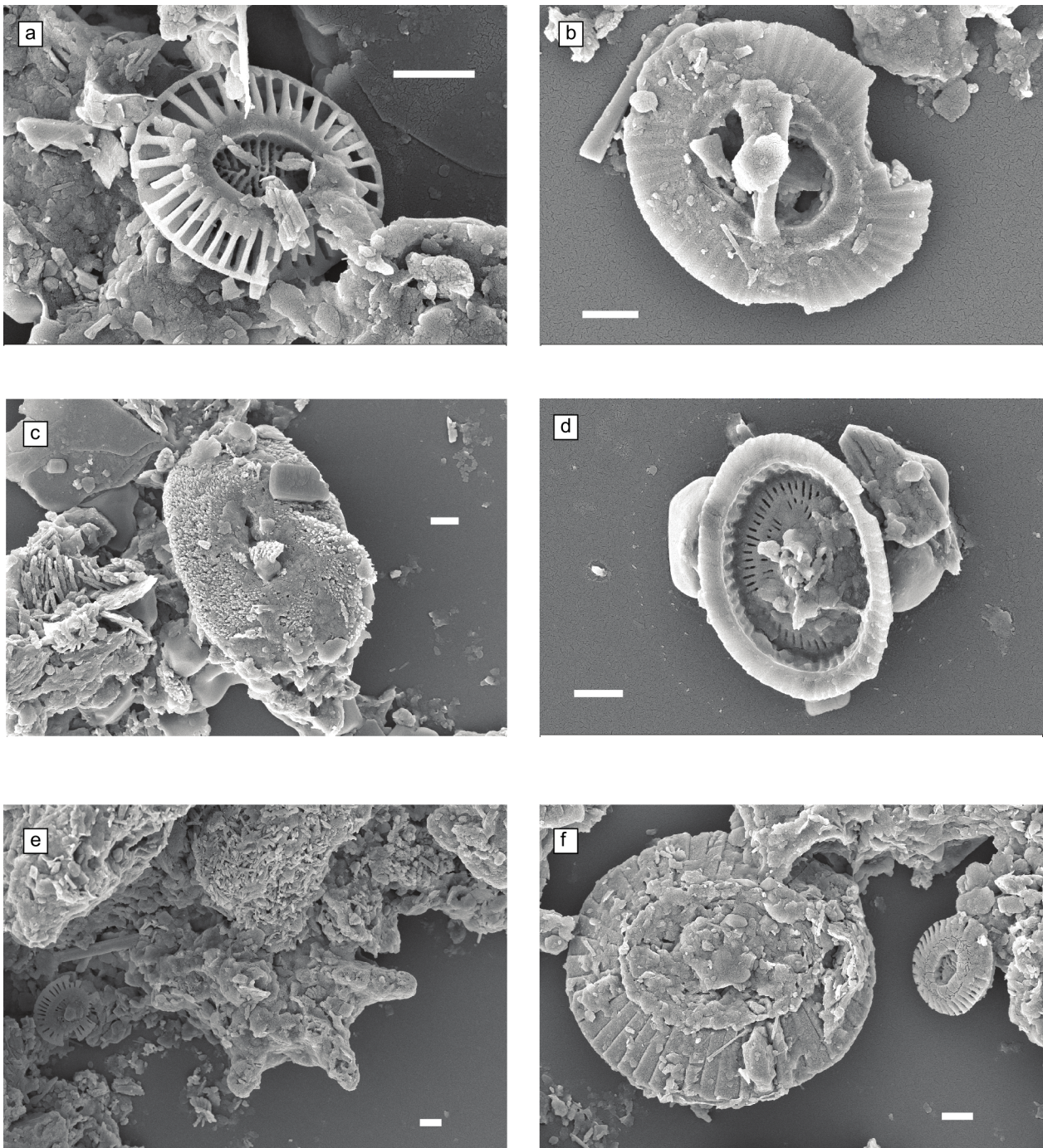


Fig. 7 - SEM photographs of the main coccolithophore taxa of the loose sediments. a) *Emiliana huxleyi* (Lohmann, 1902) Hay & Mohler in Hay et al., 1967. b) *Gephyrocapsa oceanica* Kamptner, 1943. c) *Helicosphaera carteri* (Wallich, 1877) Kamptner, 1954. d) *Syracosphaera histrica* Kamptner, 1941. e) *Discoaster* sp. f) Placoliths. Scale-bars: 1  $\mu$ m.

coccolithophores the 58.5% (Fig. 6). The 21c build-up showed a mean total of 163.4 coccolithophores per sample, with the modern assemblage representing 70% and the reworked 30.1% of the total (Fig. 6).

The observation with optical and electron microscopy revealed a variable degree of preservation of the coccoliths in the build-ups. Extant forms such as *E. huxleyi*, *G. oceanica* and *S. histrica*, are relatively well preserved. In particular, we observed that specimens of *S. histrica* show good preservation and that *G. oceanica* specimens have, in general, well-preserved bridges (Fig. 7b-d). On

the other hand, several specimens of *E. huxleyi* show broken thin radial elements of their distal shield (Fig. 7a). *H. carteri* specimens present a certain degree of etching as shown in Fig. 7c. Reworked coccoliths in the loose sediment show a high degree of etching, dissolution and recrystallisation (Fig. 7e-f). For instance, we observed fragmentation of *Discoaster*'s arms and recrystallisation of the central area of various placoliths, hampering species recognition (Fig. 7f).

In cemented sediments, coccoliths are often embedded in the matrix (Fig. 8). *Emiliana huxleyi* specimens appear

to be relatively well preserved with only some dissolution evidence (Fig. 8a). Other modern assemblage coccoliths appear well preserved, with some etching and mechanical breaks but no apparent dissolution (Fig. 8b-d). Reworked coccoliths show a higher degree of dissolution and recrystallisation for both placoliths and Discoasteraceae (Fig. 8e-f).

## DISCUSSION

The finding of modern-day coccoliths in the Coralligenous confirms their accumulation inside the build-up porosity during the build-up growth, albeit their scantiness in the shallow water column. These modern-day coccoliths are in accordance with the literature on coccolithophore assemblage in the present-day Mediterranean (Malinverno et al., 2014; Cerino et al., 2017).

Coccoliths retrieved in the loose sediment present markings of physical taphonomic processes, such as fragmentation affecting some coccoliths (as the radial elements of the distal shield of *E. huxleyi*) that are likely due to mechanical stress. The etching observed on *H. carteri* specimens, on the other hand, can be attributed to either an initial diagenesis or to dissolution of dead individuals in the water column (Andruleit, 2000). Coccoliths in the cemented sediment exhibit a high-degree of etching and dissolution. In absence of any chance to argue for sedimentation rate inside the cavities, it is not possible to assess how the coccolith sedimentation has changed throughout time. The Coralligenous presents a typical cavernous structure with cavities from mm to dm wide (Ballesteros, 2006). These cavities are the results of both the coralligenous growth (e.g., Basso et al., 2007) and bioerosion from boring organisms (e.g., sponges, mollusks) (Bertolino et al., 2014, 2017; Costa et al., 2019), and possibly the combination of both. In the studied samples, cavities were observed both on the surface and inside of the extremely porous inner structure (Bracchi et al., 2022).

The analysis of the cavity nature and genesis is beyond the scope of this work. However, given the manifold nature of the porosity we cannot rule out some degree of sediment reworking inside the cavities. It is possible that some have been filled in one single sedimentary event, such as intense flooding or tsunami (De Martini et al., 2010) whereas others could have been shielded from major sediment deposition by the curtains represented by the canopy of fleshy unmineralized organisms, abundant on the build-ups surface (Bracchi et al., 2022; Rosso et al., 2023). The analysis of the coccolith assemblage inside the build-up cavities has revealed at least two sources of accumulations: input from the water column, indicated by modern-day coccoliths, and input from land, testified by the high presence of reworked specimens produced by erosion and terrigenous discharge (Fig. 6). In particular, owing to the presence of *R. pseudoumbilicus*, *R. minuta* and *Discoaster* spp., the reworked assemblage appears to be related to the Lower Pliocene Trubi Formation well represented on land outcrops (La Rosa, 1974; Beltran et al., 2011; Distefano et al., 2021).

Sedimentation appears to be high, with elevated turbidity observed at the bottom and conspicuous

discharge events registered in geological and historical archives in the area (Scicchitano et al., 2007, 2020; De Martini et al., 2010). A geomorphological and sedimentological characterization of the area revealed that the seafloor in the sampling zones is composed of medium to coarse detrital sediments (Varzi et al., 2023). This sedimentation is documented by a thin mud veneer on the surface of the coralligenous build-ups (Bracchi et al., 2022) and in the internal accumulations as well. The examination of the coccolithophore assemblage inside the Coralligenous offers valuable insights into variations in the pattern of sedimentation within the area, shedding light on the possible contrasting levels of sediment exposure between the two build-ups, despite their nearby location at a similar water depth. A first investigation on the build-ups surface has been carried out revealing the degree of their sediment coverage (Bracchi et al., 2022). In particular, the 21c build-up showed a relatively high amount of sediment veneering the surface both before and after the removal of the fleshy unmineralized organisms. Sediments on the 21c cover ca. 22% of the build-up top surface. On the other hand, only 13% of the 7c surface is covered with sediment. This seems to indicate that the 7c, which is located inside an area of high coralligenous cover with numerous build-ups packed side by side (Fig. 2), is more shielded by normal marine sedimentation and less prone to sediment resuspension and redeposition after high-energy events. On the other hand, the 21c build-up, located in a more open area, seems much more exposed to sedimentation.

However, it is likely that, during periods of high terrigenous input, possibly related to seasonal humid periods and erosional phases or high intensity storms, both areas are equally affected by terrigenous sedimentation, given the proximity to each other and their location near a submarine channel (Fig. 2) documented by Varzi et al. (2023). This can potentially introduce a bias in sedimentation between the two build-ups. Specifically, the 7c sediment samples exhibit a relatively higher proportion of reworked coccoliths within the skeletal structure, as this build-up benefits from greater protection against normal, day-by-day marine sedimentation, while it is affected by extreme events of land weathering and sediment input. Conversely, the 21c samples display a higher percentage of modern coccoliths, which accumulate on a regular basis under normal conditions.

Unfortunately, a comparison between the coccoliths in the build-ups and those on the beach is not possible. The employed methodology for nannosampling of the coastal environment has failed to reveal coccoliths inside the collected samples. This was probably because the suspension was kept in the vials for five days, dramatically increasing coccolith dissolution. This drawback, however, suggests improvement to the current methodology, and we recommend to apply the suspension as quickly as possible on the slides to avoid dissolution. Finally, we provide some remarks on two coccolith taxa with potential ecological and stratigraphic interest: *H. carteri* and *S. histrica*.

*Syracosphaera histrica* ecology has been linked to freshwater input related to terrigenous arrival (e.g., Weaver & Pujol, 1988; Ausín et al., 2015; Bazzicalupo et al., 2020), and its presence has been confirmed in estuarine

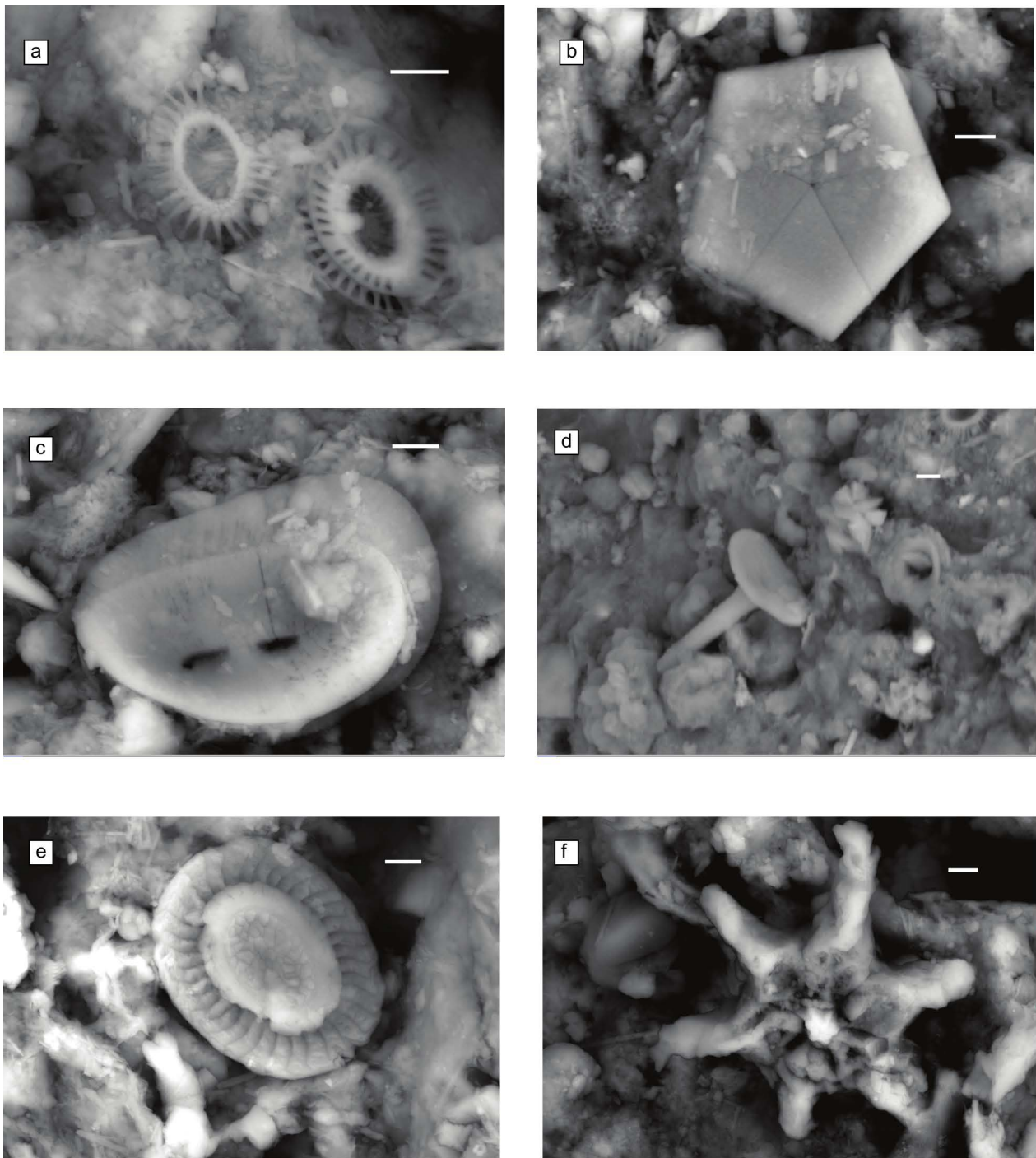


Fig. 8 - SEM photographs of the main coccolithophore taxa of the cemented sediments. a) *Emiliana huxleyi* (Lohmann, 1902) Hay & Mohler in Hay et al., 1967. b) *Braarudosphaera bigelowii* (Gran & Braarud, 1935) Deflandre, 1947. c) *Helicosphaera carteri* (Wallich, 1877) Kamptner, 1954. d) *Rhabdosphaera stilifera* (Lohmann, 1902) Kleijne & Jordan, 1990. e) Placolith. f) *Reticulofenestra* sp. Scale-bars: 1  $\mu$ m.

areas (e.g., Šupraha et al., 2016). The presence of this taxon in the studied assemblage so close to the coastal area seems to confirm its correlation with the terrigenous input.

The presence of *H. carteri* on the other hand, is more controversial. As for *S. histrica*, *H. carteri* is related to terrigenous input but it appears to be more connected to higher turbidity (Giraudeau, 1992; Flores et al., 1997; Bazzicalupo et al., 2018; Bonomo et al., 2021). Given the stratigraphic range of this taxon (late Oligocene

- present day) (Young & Bown, 1998; Beltran et al., 2011), and the preservation status of its coccoliths inside the sediment (Figs 7-8), some doubt remains whether it is to be considered in the modern-day or the reworked assemblage. In particular, if we look at the percentage of the single species, we observe that *H. carteri* (22.6% of the assemblage) is more abundant in the 7c build-up than in the 21c (7.13%). This pattern parallels that observed for all the other taxa, with reworked coccoliths



that found more abundantly inside the 7c than in the 21c. Consequently, *H. carteri* could be considered as a reworked taxon. Also, the absence of coccospheres suggests to include *H. carteri* among the reworked specimens by land weathering. A more extensive investigation of the modern coccolithophore assemblage in the water column (looking also at seasonal patterns), would shed some light on the presence of *H. carteri* in this area.

## CONCLUSIONS

This investigation on sediments from cavities of two coralligenous build-ups from Marzamemi (SE Sicily) has revealed, for the first time, the occurrence of coccoliths inside such biogenic structures. The observed assemblage showed a modern coccolith fraction, derived from marine-snow sedimentation and reworked specimens coming from land weathering and transport.

The two fractions are present (with different percentages) in both the build-ups, and give evidence of a relatively high amount of terrigenous input from land and a low amount of coccoliths from the marine snow.

Some differences found between the two build-up assemblages have been found, likely related to the differences in the exposure to sedimentation. The build-up 7c has a much higher reworked coccolith percentage (58.5%) than the 21c (30.1%). This could be explained by a sedimentation difference: the two build-ups are roughly exposed in the same way to high sedimentation events that transport a larger percentage of reworked coccolith eroded from land, whereas the 7c build-up is more shielded from day-by-day marine snow, than the 21c, which contains a proportionally higher percentage of present day coccoliths. This result supports the hypothesis of a difference in the exposure to sedimentation of the two build-ups, as already suggested by the analysis of the surface cover of the Coralligenous samples (Bracchi et al., 2022). Moreover, our observations show the potential of coccolithophore assemblage as a proxy for sedimentation on this kind of coastal environment, and potentially provide an additional tool to interpret the paleoenvironment of fossil coralligenous facies cropping out on land.

Currently ongoing analysis will be integrated with these results: 1) radiocarbon dating of the coralligenous build-ups, for assessing growth rate and the age of its various parts (as the age of its cavities); 2) analysis of sediment cored outside the Coralligenous, that can provide a stratigraphical constrain for the reconstruction of the hydrological and environmental changes occurred in the area during the Coralligenous growth. This piece of information could contribute to shed light on the various events that took place during the Late Holocene in the Marzamemi area.

## SUPPLEMENTARY ONLINE MATERIAL

Supplementary data of this work are available on the BSPI website at: <https://www.paleoitalia.it/bollettino-spi/early-access/>

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