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Bryozoan diversity in the Marzamemi (SE Sicily, SW Ionian Sea) and Mediterranean coralligenous habitats.

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Abstract

Although Coralligenous is considered a priority habitat for conservation within European directives largely considering its complex 3D structure promoting spatial and ecological heterogeneity and related high biodiversity, detailed information on species richness and composition is still scant, at least for some taxonomic groups, including bryozoans, notwithstanding their ecological relevance within the habitat. Focusing on the bryozoan community associated with six build-ups sampled between 33 and 37 m depth offshore Marzamemi (SE Sicily, SW Ionian Sea) this study contributes to improve knowledge on coralligenous bryozoan biodiversity, from a locality in the still understudied eastern Mediterranean. A total of 127 species were recorded, raising to 145 and 257 the coralligenous bryozoan diversity currently known for Marzamemi and the entire Mediterranean, respectively, the latter representing a high proportion (44%) of the overall Mediterranean bryozoan diversity (588). Heterogeneity was detected at small spatial scale, among build-ups in the Marzamemi area, and at the Mediterranean scale through comparison with the scant existing literature, which mostly focused on the western basin. Facies differentiation and related ecological heterogeneity, rather than geographic distance, are considered the main drivers. Finally, our results emphasise the critical importance of microscopic and SEM examination of specimens for species detection.

Introduction

Coralligenous habitat, resulting from the constructional activity of skeletonised benthic organisms thriving in the Circalittoral zone along continental shelves (Ballesteros 2006: UNEP-MAP-RAC/SPA, 2008; 2016) represents one of the most important marine habitats in the Mediterranean Sea. Coralligenous build-ups, forming either discrete bioconstructions or tabular banks *sensu* Bracchi et al. (2017), contribute to change the seascape, also influencing local circulation, and to create complex 3D structures that enhance habitat complexity and increase biodiversity (e.g., Ballesteros 2006). For these reasons, Coralligenous has been included in protection plans (Habitat Directive 92/43/CE) and in monitoring programs, such as the Marine Strategy Framework Directive (MSFD 2008/56/EC) (Ballesteros 2003), in the frame of the Integrated Monitoring and Assessment Program (IMAP) of the Barcelona Convention Ecosystem Approach and subsequent updates (UN Environment/MAP, 2019; Montefalcone et al. 2021). Actions are especially required for Coralligenous and other bioconstructions as priority habitats but, notwithstanding European and national efforts, information is still fragmentary (e.g., Kipson et al., 2022) and usually scattered in scientific literature.

Monitoring especially relies on rapid assessments finalised at obtaining estimates of coralligenous structure and biodiversity using non-destructive protocols based mostly on seascape morphology and the presence/absence of particular macrobenthic species detected by photographic surveys (e.g., Kipson et al. 2011; Piazzi et al. 2019; Di Camillo et al. 2023; Astruch et al. 2025, and references therein). However, such an approach is unable to capture the actual biodiversity, especially for bryozoans. In fact, photographic surveys typically record only a few large-sized species, especially those forming erect colonies several centimetre-to-decimetre in size, such as *A. calveti*, *M. truncata*, *P. fascialis*, *Reteporella*

spp., *S. cervicornis* and *T. avicularis*, that can be recognised based on colony colour and morphology, especially branch shape and branching pattern. Only a few further taxa, such as large encrusters forming both membraniporiform and celleporiform colonies, are usually only hardly and tentatively recognisable at genus level (e.g., *Schizomavella*), with a few possible exceptions including *C. caminata* (e.g., Casoli et al. 2020, Çinar et al. 2020; Pinna et al. 2021, Astruch et al. 2025, Gimenez et al. 2025). However, even if these species can be detected through photo/video surveys or scuba diving assessments, only sufficiently large colonies located on the exposed outer surfaces of the Coralligenous can be reliably distinguished. Nevertheless, almost all species grow in small colonies, the majority thriving within cavities and therefore remaining completely unapparent or hidden inside the bioconstruction. Colonies are usually undetectable even when attached to the outer surfaces because of the variably dense canopy, largely consisting of sciaphilous fleshy algae, which prevents the observation of the underlying substrate. Moreover, colonies growing on the canopy itself often remain not detectable, as they commonly occupy the lower canopy layer. Colonies are hardly or completely undetectable even when photogrammetry is performed after build-ups collection and the detachment of the canopy developed on coralligenous surface, as demonstrated by the comparison between data obtained for two build-ups by Bracchi et al. (2022) and those from sample examination under stereomicroscope on one of those build-ups by Rosso et al. (2023) and Donato et al. (2024).

Actually, a large portion of bryozoan colonies (and biodiversity) can be overlooked if not specifically addressed when analysing Coralligenous, due to its peculiar small-scale complexity and microhabitat diversification. This structural heterogeneity allows several different assemblages to coexist in a reduced space. Indeed, the 3D growth of coralline algae, the main coralligenous constructors, creates external surfaces that host relatively photophilic organisms (typical of shallow waters), together with variably sized, sheltered and darkish cavities. These cavities often contain accumulations resulting from both autochthonous bioclastic production and the baffling of allochthonous sediment, providing suitable conditions for circalittoral and deep-water communities that may even shift upwards (Hong 1980, UNEP-MAP-RAC/SPA, 2008). The coexistence of such distinct communities has recently been demonstrated for molluscs by Bracchi et al. (2025).

Bryozoans are known to play a relevant role in the Coralligenous being among the most common and important animal constituents (e.g., Ballesteros 2006). Following Ferrigno et al. (2024), with 31 occurrences bryozoans represent the third most reported group from the Coralligenous in a set of 339 papers published in the time interval 1965–2022. Pérès and Picard (1964) had already remarked on the importance of bryozoans in the Coralligenous, and Hong (1980) highlighted that they represent the main animal group contributing to the edification of the bioconcretion and the filling of empty spaces. However, quantitative information on their actual contribution is absent. The only available estimate is provided by True (1970), who found that, in the Marseille area, bryozoans accounted for merely 0.6-5% of the total biomass (estimated at 500–1000 g/m^2 dry weight), but contributed a remarkable 5–33% of the carbonate production, totalling 1300–6250 g/m^2.

Data on biodiversity are less so scant, but mostly restricted to western Mediterranean localities, and especially to its northwestern part (Hong 1980, 1982, 1983; Laubier 1966; Harmelin 1976, 2017; Ballesteros et al. 1993) with a few more recent information on the Adriatic Sea (Novosel et al. 2004; RAC/SPA – UNEP/MAP 2014) and partly on the northeastern Ionian Sea (Mercurio et al. 2024; Corriero et al. 2025). Some data is also available for southwestern Ionian Sea (e.g., Rosso and Sanfilippo 2009; Rosso et al. 2023; Donato et al. 2024) whereas main gaps exist for the Aegean and the Levantine Sea (e.g., Çinar et al. 2020).

Coralligenous is currently one of the most endangered habitats, prone to environmental changes including direct anthropogenic impact with physical disturbance and degradation produced by human-related activities such as fishing, recreational scuba diving, waste discharge and industrial pollution, as well as to climate change and related increasing temperatures and acidification all producing threats to its biodiversity. For this reason, a quantification of this biodiversity is needed to add information useful to highlight possible spatial differences and to establish a suitable baseline for future monitoring and protection actions.

In this context, the present paper aims to: 1. describe the bryozoan community associated with coralligenous build-ups off Marzamemi, in order to improve the understanding of coralligenous bryozoan diversity in the area; and 2. compare this bryozoan diversity with that of other coralligenous communities, in order to detect possible spatial/ecological variability within the Mediterranean Sea.

Materials and Methods

The studied build-ups originate from an area off Marzamemi (southeastern Sicily, western Ionian Sea) situated between 33.5 and 37.2 m depth (Fig. 1, Table 1) below the local distribution of the *P. oceanica* meadow, which was preliminarily surveyed through the CRESCIBLUREEF ROV_290621_06 (see Varzi et al. 2023). The landscape is characterized by loosely to closely spaced discrete columnar coralligenous bioconstructions emerging from a biogenic coarse-grained seafloor of living maerl rhodoliths, and locally grading into the hybrid bank coralligenous morphotype (Fig. 2). All build-ups already analysed from the area showed coralline algae as the main organism bioconstructors followed by serpulids and bryozoans, a remarkable primary and secondary porosity offering surfaces for bryozoan colonisation, and the occurrence of micrite infills (Di Geronimo et al. 2002; Bracchi et al. 2022; Cipriani et al. 2024; Bazzicalupo et al. 2025).

Sampling activities were carried out during the second field survey of the project, in early August 2021. Two entire coralligenous build-ups were collected and additional eight scraped samples, obtained manually by scuba diving, by detaching a surface layer of the bioconstruction as uniformly as possible. The two build-ups were obtained from areas with distinct coralligenous morphotypes: one from the hybrid banks (build-up C, sometimes reported as sample 7c; e.g., Bracchi et al., 2022, 2025) and one from the discrete build-ups (build-up E, sometimes reported as sample 21c; e.g., Bracchi et al., 2022, 2025). The scraped samples were collected from four build-ups—one from the area with discrete build-

ups (build-up A) and three from the area with hybrid banks (build-ups B, D, and F)—by scraping two 400 cm² surfaces, one from the upper and one from the lower part of each build-up. Bryozoans were detected, often separated and identified under Zeiss Discovery 8 stereomicroscopes with different magnification configurations at the Paleontology Laboratory of the Department of Biological, Geological and Environmental Sciences (DSBGA). Selected colonies were examined untreated and/or cleaned from their organic tissues, but uncoated under a Tescan Vega 2 LMU, Low Vacuum Scanning Electron Microscopy (SEM) at the Microscopical Laboratory of the same Department. Images were generated using back-scattered electrons. For the present study, only bryozoan colonies that were still attached to their substratum—either to the skeletons and skeletonised organisms forming the bioconstruction, or to organisms of the canopy—and were alive at the time of sampling, i.e., contained soft tissues in at least some zooids, were considered. Colonies were scored only if they included the ancestrula and/or the periancestrular area. Detached/broken fragments were considered when including alive modules and scored one only when no further colony of the same species was present in the sample. All species are listed (Supplementary Table 1) and synthetic information per build-up is provided in Table 2. Authorities are provided in the text only for species not reported in the tables. To provide a synthetic indication of bryozoan diversity, the Shannon-Wiener index was calculated for each examined build-up.

Material is housed in the Palaeontological Museum (PMC) of the DSBGA, University of

Catania, in the CBR Rosso bryozoan collection. Catalogue numbers are reported for several of these species illustrated with SEM photos. All species names provided in the tables (Supplementary Table 1, Table 3) are reported in the text without authority, that is reported only for a few additional/synonym species not included there.

Analysis of bryozoan diversity in the Mediterranean Coralligenous is based on main monographs reporting bryozoan species associated with coralligenous habitats, as well as on previous papers dealing with overall coralligenous biodiversity and listing bryozoan species (Table 2 and references therein). Constructing a comprehensive and reliable list of all bryozoan species reported for this habitat was challenging especially taking into consideration the relevant changes in taxonomy and species concept fostered by technological advances, including the use of SEM observations during the last six decades (see for instance comments in Harmelin and Rosso, 2023, Rosso et al. 2025). Therefore, taxonomy was largely updated using indications about synonymies already reported in the checklists for Italian and Mediterranean bryozoans (Rosso et al. 2010; Rosso and Di Martino 2016, 2023), and/or in some particular papers published in the last years (see results). The bryozoan web page (https://bryozoa.net/, accessed several times during August 2025) and the WoRMS-World Register of Marine Species (https://www.marinespecies.org/, accessed in the same period) were also checked.

Results

Bryozoan diversity of the Marzamemi coralligenous build-ups

A total of 127 bryozoan species (Tables 2, 3, Supplementary Table 1), some of which figured (Figs. 4–11), were detected thriving in and/or on the examined build-ups, including 24 cyclostomes, 6 ctenostomes and 97 cheilostomes accounting for 18.9%, 4.7% and 76.4%, respectively. However, species richness is remarkably lower when looking at single build-ups with a range between 52 (build-up A) and 85 (build-up E) species. Cheilostomes always dominate (70.4–78.8%) being represented by 39–41 species in the less diversified build-ups (C, D and A) up to 65 species in the build-up E with intermediate numbers (50 and 52 species) in the B and F build-ups, respectively (Fig. 3; Table 2). Cyclostomes follow with 8–18 species (and percentages ranging from 15.4 to 25.5) whereas ctenostomes are decidedly subordinate with only 1–5 species per build-up and ranges of 1.9–5.9%.

A core group of 20 species (15.7% of the total assemblage) was shared by all build-ups. These include five cyslostomes, i.e., *C. fistulosa*, *C. ramosa*, *D. obelius*, *D. hispida* and *M. delicatula*, the only ctenostome *A. delicatula* and well 14 cheilostomes, i.e., *A. truncata*, *C. caminata*, *C. siphuncula*, *C. brongniartii*, *C. planum*, *E. vulgaris*, *M. cereoides*, *M. mesogeia*, *M. bicollaris*, *M. modesta*, *P. mediterraneum*, *P. cheilostoma*, *P. gattyae*, and *S. delilii*. Many other species occurred in 3–5 build-ups (46 species = 36.2%) but a relevant number were restricted to only 2 build-ups (23 species, accounting for 18.1%) or even a single one (38 species, accounting for 29.9%). This last group almost entirely consists of cheilostomes, with 34 species. However, when looking at the number of colonies, although limited in number, the most frequent species account for a large part of the assemblage (56.7%). In contrast, the colony abundance of almost half the species (61) occurring only sporadically, with frequency values of 1 or 2, represent only a subordinate part of the assemblage (overall 7.7%). Although with differences between build-ups, the cheilostomes *C. caminata* and *S. delilii* are the species with the highest abundances, followed by the cyclostomes *M. delicatula* and *C. ramosa* as well as by the cheilostomes *A. truncata, C. planum* and *M. cereoides*, all exceeding one hundred colonies out of the almost 3900 found. Values of the Shannon-Wiener index range from 3.33–3.35 for build-ups D and A, respectively, and increase to 3.59–3.61 for build-ups E and B, respectively, with intermediate values of 3.45 for C and 3.52 for F.

All bryozoans found were almost unapparent when looking at collected samples. Indeed, except for a few species, such as *M. cereoides*, *M. truncata* and *Reteporella* spp., which can grow in large colonies, easily recognizable to the naked eye and sometimes even from underwater videos and imaging, colonies are small sized, usually not exceeding a few to several square millimetres. Except for *M. cereoides* on build-up E (see also Rosso et al. 2023), even large-sized species often occurred with small colonies, rarely a couple of cm in height and/or in diameter. From a morphological point of view, species with encrusting growths largely prevail with 84 species. These mainly consist of “membraniporiform” colonies, i.e., unilaminar, variably outlined patches, and spots (71 species) and to a much lesser extent of celleporiforms (13 species), i.e., thick colonies formed by irregularly superimposed or piled-up autozooids producing knobby to hemispheric or globular morphologies usually on 2-and 3-D substrata, respectively. Whereas a plethora of species belonging to several genera constitute the former group, the latter mostly consists of species of the families Celleporidae (*Celleporina* and *Turbicellepora*) and Phidoloporidae (*Rhynchozoon*) and Bitectiporidae (*Scizomavella*). Species with erect colonies are less numerous. They are especially represented by flexible species (26), usually dichotomously branched

bushes consisting of articulated, variably long internodes. Many of them are biserial (species of the cyclostome genera *Crisia* and *Filicrisia* and some cheilostomes such as *Caberea*, *Cradoscrupocellaria*, *Scrupocellaria*) but a few are pauciserial (*Cellaria*, *Margaretta*). Few species, such as most ctenostomes and the cheilostome genera *Beania*, *Bugulina*, and *Synnotum*, have very slightly mineralised, variably arranged zooids. Erect rigid species (14) are either reteporiform, i.e. possess a reticulate colony such as species of the genera *Reteporella* and *Hippellozoon*, or vincularian, with small poorly branched, thee-shaped colonies. These latter include some cyclostomes (e.g., *Idmidronea*, and some colonies of *Annectocyma* and *Platonea* and also colonies of *M. delicatula* typically growing as a single or two-to-three, basally branched, short diverging rods) and the cheilostomes *M. truncata* and *S. solanderia*.

Except for 10 species and 18 colonies, almost all species and colonies were found still attached to their own substratum in the collected samples. Out of these 117 species, 38 were exclusively found encrusting on the carbonate frame, whereas 20 occurred on fleshy algae and other elements of the canopy, including the erect articulated bryozoan *M. cereoides* (see details in Rosso et al. 2023 for the build-up E). Most of them usually showed low frequency values and colony numbers, except for a few ones, including the ctenostome *A. delicatula* and, to a lesser extent, the ctenostome *W. tuberosa*, and the cheilostomes *Haplopoma* cf. *impressum* and *P. setosa* among those found in the canopy, and a group of nine cheilostome species (*C. rugosa, C. radiata, C. fagei, P. inerma, S. fissa, E. gautieri, H. punlchra, P. curvirostris* and *S. solanderia*) for those restricted to the frame. However, an almost similar number of species (59) have been found on both the mineralised framework and elements of the canopy, usually with a higher number of colonies in the latter. Only a few species show a significantly higher number of colonies in the frame, i.e., the cyclostome *D. obelius*, and the cheilostomes *B. hirtissima, Escharina vulgaris, M. patellaria* and *O. marioni* as well as *M. truncata* that was found in the canopy with a single small colony. Further two cheilostomes (*C. venusta* and *M. mesogeia*) both occurred with a double number of colonies in the frame rather than in the canopy. It could also be remarked that unmineralised or slightly mineralised species, including ctenostomes and a few cheilostomes, essentially grew in the canopy. Besides being flexible, species in the canopy often occurred with relatively small colonies and were mostly localised on the more robust and persistent substrata. These included the few mineralised elements, such as *M. cereoides* and partly skeletonised algae, such as peyssonneliaceans, as well as thick thalli of *Osmundaria volubilis* (Linnaeus) R.A. Norris, and particularly the stems of *Flabellia petiolata* Turra (Nizzamudin), as also reported for the build-up E in Rosso et al. (2023). In the frame, colonies directly encrust corallinae algae or other skeletonised organisms including other bryozoans or the tubes of serpulids and rare vermetids. Bryozoans occur either on the outer surface of the build-ups, sometimes with colonies being several cm wide (e.g., the few ones belonging to *H. pulchra*) or within small and large cavities, usually with small colonies.

Bryozoan diversity of the Mediterranean Coralligenous

To compile a comprehensive updated list (Table 3) illustrating the bryozoan diversity of the Coralligenous in the Mediterranean Sea, we selected nine key publications. These included the general

bryozoan papers by Gautier (1962), Harmelin (1976) and Zabala (1986), which focused on the western Mediterranean and the Sicily Strait, the Provence and the Catalonia regions, respectively. Additional data were extracted from inventories for particular areas, such as Ballesteros et al. (1993) for Cabrera Island (Balearic Archipelago), and Novosel et al. (2004) and the RAC/SPA - UNEP/MAP (2014) also compiled by Novosel for the Croatian coast (northeastern Adriatic Sea). We also examined the studies specifically addressing Coralligenous biodiversity published by Laubier (1966), Hong (1980, 1982) as well as Corriero et al. (2025) and Mercurio et al. (2024). The first two focused on northwestern Mediterranean (Les Albères and Marseille areas, respectively) while the last two addressed the same Apulian bioconstructions (southern Adriatic and northern Ionian seas). A few additional papers were examined, specifically dealing with coralligenous bryozoans from selected facies around Port Cros and Bagaud Isles, Provence region (Harmelin, 2017) and from the Marzamemi area, southeastern Sicily, Ionian Sea (Rosso and Sanfilippo 2009; Rosso et al. 2023 and Donato et al. 2024). Data from the last three papers from the very same area studied here were reported together in column R + of Table 3 and the R + donut chart of Fig. 12. In contrast, papers dealing with animal-dominated mesophotic habitats and the so-called animal forests were not taken into consideration.

In compiling the list for Mediterranean Coralligenous, we omitted some species. The most relevant examples include *Buffonellaria divergens* (Smitt, 1873), *Crassimarginatella crassimarginata* (Hinks, 1880), *Fenestrulina malusii* (Audouin & Savigny, 1826), *Hincksina flustroides* (Hincks, 1877), *Microporella ciliata* (Pallas, 1766), *Schizomavella auriculata* (Hassal, 1862) *Schizomavella discoidea* (Busk, 1859), *Scrupocellaria reptans* (Linnaeus, 1758), *Turbicellepora avicularis* (Hincks, 1860), all commonly reported, and further few ones, *i.e.*, *Carbasea carbasea* (Ellis & Solander, 1786), *Collarina balzaci* (Audouin, 1826), and *Hemicyclopora multispinata* (Busk, 1861), that were only occasionally reported. In doing this, we considered that some of these species were synonymised with other species, and hence we replaced them in the list with their currently accepted synonyms. This is the case for *S. auriculata*, here reported as *S. cornuta* (see Rosso et al. 2010, 2023; Rosso and Di Martino 2016,) and for *T. avicularis*, here reported with the corresponding senior synonym *T. incrassata* (see Rosso et al. 2020). For other species, an extra-Mediterranean distribution has been recognized and their previous records from the Mediterranean Sea are now considered to result from misidentifications or to correspond to different recently described species. This applies to records of *C. carbasea* possibly corresponding to *Chartella papyrea* (Rosso and Di Martino 2016), *H. multispinata*, represented in the studied area by *H. neatonensis* (Harmelin and Rosso 2023), and *C. crassimarginata* and *S. discoidea* possibly fully corresponding to *C. matildae* and *S. blancae*, respectively (Pica et al. 2022).

In contrast, and regardless they are still considered as occurring or not in the Mediterranean, some nominal species have been split into two or more taxonomic entities potentially thriving in different areas and/or habitats, many described as new, but usually based on restricted examples of examined material, either physical or illustrated (photographed). In these cases, it is impossible to ascertain which new species (among the two or more new ones occurring in the Mediterranean) is hidden under “old” species names without examination of original material. Consequently, we reported *Buffonellaria* sp. instead of *B. divergens* (see Berning and Kukliński, 2008), *Collarina* sp. instead of *C. balzaci* (see Harmelin et al. 2019),

Fenestrulina sp. instead of *F. malusii* (see Rosso et al. 2025), *Hincksina* sp. instead of *H. flustroides* (see Berning et al. 2021), *Microporella* sp. instead of *M. ciliata* (see Di Martino and Rosso 2021), *Cradoscrupocellaria* sp. instead of *S. reptans* (see Vieira et al. 2013). We also considered *Celleporina caminata* instead of *C. mangnevillana* (Lamouroux, 1816) and *C. hassalli* instead of *C. caliciformis* (Lamouroux, 1816) notwithstanding the synonymy proposed by d'Hondt (2001) which has not yet achieved unanimous acceptance and still await formalconfirmation supported by SEM images of type specimens. Finally, for all species usually reported under the authority of Audouin, 1826, we adopted instead the authority Audouin & Savigny, 1826, following insights of Di Martino and Rosso (2021: on *Microporella*) and Rosso et al. (2025: on *Fenestrulina*) to recognize Savigny's merit in drawing all species that Audouin later simply named, often even without information about their origin (see Rosso et al. 2025).

The resulting species list counts 257 species (Table 3) including 45 cyclostomes, 11 ctenostomes and a large dominance of cheilostomes species (201). However, only a few number of species are frequent, i.e. occurs in many areas. In particular, only 5 species (*B. mediterranea, C. boryi*, *C. caminata*, *C. radiata* and *M. truncata*), accounting for 1.9%, are present in all the 10 considered areas and further four, i.e. *E. coccinea*, *M. patellaria*, *P. fascialis* and *S.* (*S.*) *cornuta* (1.6%) occur in 9 of them. This means that only nine out of the overall reported 257 species (representing 3.5% of the whole diversity) are very frequent. In contrast, 72 species (28%) occur in only one area. In general, most species, i.e. 203 species, accounting for 79% of the total diversity, show frequency values ranging 1–5, whereas the remaining 54 (21%) were found in 6–10 areas.

The total number of species per area is highly variable from 31 to 145. However, cyclostomes and also ctenostomes are not always examined, as it is the case for Gautier (1962) only focusing on cheilostomes, or Corriero et al. (2025) citing the occurrence of cyclostomes but not distinguishing individual species. In contrast, Harmelin (1976) focused on cyclostomes but also listed all found cheilostomes. In papers dealing with all orders, cheilostomes are always dominant ranging from at least more that 71% up to almost 89% (Fig. 12). Cyclostomes are subordinate representing from almost 10 to almost 27%, whereas ctenostomes are always negligible representing usually less than 4.5% except for almost 8% in a single area.

Discussion

Bryozoan diversity of the Marzamemi coralligenous build-ups

Bryozoans from the coralligenous build-ups off Marzamemi examined here substantially increase the bryozoan biodiversity previously reported for the same area. Previous knowledge was based on Di Geronimo et al. (2001) who detected only a dozen species from a build-up collected at about 32 m depth, in the same area of this study. Rosso and Sanfilippo (2009) later found 64 species with a prevalence of cheilostomes (47 species) over cyclostomes (17 species) and no ctenostomes examining coralligenous

fragments from fishermen's nets coming from 35–55 m depth range. Whereas 44 species are shared between present build-ups and deep algal fragments studied by Rosso and Sanfilippo (2009), some species represent new records raising diversity for the Marzamemi Coralligenous to 145 species (see Table 3 and Bryozoan diversity of the Mediterranean Coralligenous).

Values of Shannon-Wiener indexes calculated for individual build-ups sampled for the current study, are always higher than 3 and up to 3.61, and point to a high biodiversity, indicating the occurrence of an elevated number of species with an evenly distribution in each sample. This data, so far unavailable in literature, represent a first indication for future comparisons.

The total number of species found (127) is likely to increase with further samples, because a pool of additional species represented by recently dead colonies was observed, suggesting that they may still occur alive on other build-ups. These species include one cyclostome, *Plagioecia inoedificata* (Jullien, 1882) and six cheilostomes, i.e., *Cribellopora simplex* Gautier, 1957, *Distanseschar*ella *seguenzai* Cipolla, 1921, *Gregarinidra gregaria* (Heller, 1867, *Schizobrachiella sanguinea* (Norman, 1868), *Setosella rossanae* Rosso, Di Martino & Gerovasileiou, 2020 and *Trypostega venusta* (Norman, 1868). Most of them (*P. inoedificata, C. simplex, D. seguenzai, S. rossanae* and *T. venusta*) are even additional to the above mentioned 145 species representing the total diversity so far known for Coralligenous in SE Sicily. All these dead species are possibly rare constituents in the community, whose colonies can be however preserved in the dead assemblage (or thanatocoenosis) owing to their mineralised skeletons. Like molluscs in the same coralligenous structures (Bracchi et al. 2025), and presumably more reliably than for soft-bottom assemblages (*e.g.*, Rosso 1996 for bryozoans in the same area; Kidwell 2013 and Bracchi et al. 2025, for molluscs), these species provide complementary knowledge on the potential overall bryozoan variability within the Marzamemi Coralligenous. Moreover, owing to their *in situ* preservation, they also offer insights into the recent history of these build-up communities.

Differences among build-ups (Supplementary Table 1), involving both the total number of species and colonies as well as the species composition showing only a limited number of species shared by all samples and many species restricted to single or a few build-ups, support the idea of a high spatial variability of Coralligenous at small scale (*e.g.*, Ballesteros 2006 for a review). Literature has widely and repeatedly highlighted the high complexity of this habitat, in which constructional (or frame-building) skeletonised organisms (also including some bryozoans) form a 3D structure that provides a wide range of microhabitats with varying environmental conditions which can be exploited by a variety of species exhibiting specific adaptations (*e.g.*, Hong 1980; and Harmelin 1976 and Zabala 1986, specifically for bryozoans). A differentiation in species composition can be envisaged between the outer surfaces of the studied build-ups and the variably sized cavities of the bioconstruction resembling cave habitats and particularly semi-dark caves, as indicated by Zabala (1986). Surfaces are usually wide and directly exposed to the surrounding marine environment in large cavities, where erect or large-sized, presumably fast-growing competitive encrusters (*e.g.*, *H. pulchra*, even detectable in photogrammetric analyses: Bracchi et al. 2022) occur. In contrast, small and deep micro-cavities are characterised by a range of light and water flux attenuation possibly leading to a reduction in food availability and lower competition

allowing colonization by small-sized, less demanding species adapted to such conditions (such as *C. rugosa, E. protecta, G. pedunculata* and *S. subsolana*), some only detectable under a microscope. Further variability derives from the development and composition of the canopy, which provides bryozoans with a wide range of substrata for colonization — from ephemeral to persistent, filiform to laminar, flexible to hard, and smooth to rough surfaces. These substrata host a variety of species developing unmineralised or slightly mineralised colonies. Some are erect and flexible, attached by numerous rhizoids; others are small, erect and poorly branched, with limited encrusting parts, and still others are unilaminar, consisting of loosely jointed autozooids that allow a certain degree of flexibility, as already highlighted by Rosso et al. (2023). Consequently, a high small-to-large scale variability is also expected at the canopy level, as shown for *Cystoseira* s.l. communities by Piazzi et al. (2018). In our case, while the present study confirmed the known small-scale heterogeneity in species richness, colony abundance and species composition, it did not investigate the underlying factors driving these patterns. Nevertheless, this variability is evident even within a restricted area and bathymetric range, where different coralligenous types — namely discrete build-ups and hybrid banks *sensu* Bracchi et al. (2017) — develop, as documented by Varzi et al. (2023). Further targeted investigation is required to clarify the role of environmental parameters and their interplay with primary and secondary porosity (*sensu* Cipriani et al. 2024), as well as with biotic interactions. In the absence of a possible depth gradient (and related temperatures) usually indicated as one of the main drivers of coralligenous biodiversity (e.g., Pinna et al. 2021), local hydrodynamic conditions could play a role. Slight differences in sediment smothering, presumably related to the onset of individual build-ups on more or less elevated sea-floor areas, either connected or not to a submarine channel, were assumed by Bazzicalupo et al. (2024) as an additional driver of variation, as also suggested for bryozoan communities by Harmelin (1976) and Zabala (1986) and for bryozoans compared to algae by Balata et al. (2005). Sedimentation is also reported as a dissimilarity driver in “coralligenous platforms” by Piazzi et al. (2022, and references therein). Moreover, small-scale variations in sediment deposition could also be influenced by the morphology and spatial arrangement of elevated build-ups, which interact with local hydrodynamic fluxes similarly to cold-water-coral colonies in deep-sea settings (see Bartzke et al. 2025). Such environmental and structural variability is reflected in the composition and abundance patterns of the associated bryozoan fauna.

Frequent species are usually abundant pointing to their ability to proliferate in the Coralligenous whereas rare species are occasional, thus representing a negligible fraction in the assemblage. A comparable structure was reported by Gautier (1962, Fig. 90) who showed that the four most abundant species he recorded (*i.e.*, *T. incrassata*, as *Schismopora avicularis*, *S. cornuta*, as *S. auriculata*, *P. fascialis* as *Hippopleurifera fascialis* and *C. fistulosa*) represented half of the assemblages he examined, whereas 46 species accounted for the remaining half. Analogously, Hong (1982) remarked that 45% of bryozoan species were occasional in the build-ups he analysed, with frequency of 1–2 in his more than 50 samples, each consisting of scraped volumes of 400 cm^2 surfaces by 10 cm thickness.

However, these frequent species are not restricted to the coralligenous assemblage; in fact, most of them seem to be relatively flexible, typically showing a wide ecological distribution. In contrast, at least some of the infrequent and rare species occurring with few colonies are likely to be more typical

representatives of the Coralligenous. However, the identification of species indicative of the coralligenous habitat is challenging due to its internal complexity (produced by constructional organisms) and the interplay of physico-chemical (especially edaphic) parameters and biotic drivers. These factors generate a plethora of facies, each comprising a multiplicity of microhabitats which can be exploited by a surprisingly large number of bryozoan species, each characterized by particular adaptations and often also by intraspecific plasticity (e.g., Harmelin, 1976). Usually, only species lists (or lists of recurrent species) are provided, traditionally divided according to the "coralligenous type", including 1) a precoralligenous aspect, characterised by dominant fleshy algae such as *F. petiolata* and *H. tuna*; 2) a coralligenous on sub-horizontal surfaces, typically with *Eunicella cavolini* (Koch, 1887); 3) one on shallow-water vertical walls, characterized by *Paramuricea* species; 4) a coralligenous developed on cliffs, within microcavities and at cave entrances; and 5) a deep-water coralligenous (*e.g.*, Harmelin 1976; Zabala 1984, 1986). However, distinction among these types is not clear-cut, and more comprehensive, detailed analyses are required to identify potential indicator species for each assemblage (if any), also including measurements of environmental parameters.

Bryozoan diversity of the Mediterranean Coralligenous

The bryozoan diversity associated with Mediterranean Coralligenous is remarkable, comprising 257 species (Fig. 12, Table 3). The analysis of the coralligenous build-ups off Marzamemi adds 24 species (2 cyclostomes, 2 ctenostomes and 19 cheilostomes) to the 219 species reported by Rosso and Di Martino (2016). Among these, *C. occidentalis*, *A. capriensis*, *C. pallasiana*, *E. mamillata*, *H. ambita* and *R. elegans* represent new records for the Coralligenous. In addition, five species (i.e., ?*Stomatopora* sp. A, *Celleporina* sp. A cf *C. canariensis*, *Celleporina* sp. B, *Celleporina* sp. C and *Schizomavella* sp. A) are still undescribed and are likely new species to be described in future studies. Further records pertain to species recently erected from the Mediterranean or even the same or neighbouring areas. They include *Amathia delicatula* (Souto et al. 2010), *C. siphuncula* (Hayward and McKinney 2002), *H. neatonensis* (Harmelin and Rosso 2023), *M. bicollaris* (Di Martino and Rosso 2021), *Schizomavella* (*S.*) *subsolana* (Hayward and McKinney, 2002), and *S.* (*S.*) *tubulata* (Reverter-Gil et al. 2016). All these species are therefore absent from the examined papers (see above and Table 3) because largely published in previous years. Additional taxa at subspecies rank also contribute to the observed diversity. Their apparent absence from previous lists is difficult to verify, as subspecies are not always explicitly recognised and may have been reported under the nominal species name (see asterisks in Table 3, marking nominal subspecies when an additional one, not previously mentioned, was recognised from the Marzamemi material). Finally, it is not possible to understand if our taxa *Disporella* sp. A and *Patinella* cf. *mediterranea* correspond to any of the taxa previously referred to as undetermined lichenoporids or left in open nomenclature (e.g., Hong 1980, 1982).

Scantiness of species shared among papers (only nine species reported in 9–10 papers, accounting for merely 3.5% of the entire diversity of 257 species) even exceed data obtained from the comparison of the Marzamemi build-ups, where 20 species were shared by all build-ups, accounting for ca 15%. This paucity of shared species, together with the concomitant increase in the number and percentage of rare

species within the total observed biodiversity seemingly results from both geographical and ecological factors. However, no clear geographic distribution pattern emerges from our review and individual species can be even found alternatively in the western Mediterranean, the Ionian and/or the Adriatic Sea. The genus *Escharella*, by contrast, appears restricted to the western Mediterranean, where it is represented by as many as five species (Table 3). A similar pattern also occurs in photo-quadrat biodiversity assessments. When examining the total biodiversity of 313 species (including 20 bryozoans) associated with Coralligenous from far apart Mediterranean regions in the Gulf of Lions, western Ionian Sea and north-eastern Aegean Sea (clustered together for France, Greece and Turkey) Féral et al. (2016) found that species shared by the three areas were about 46% and that differences among groups existed with bryozoans more diversified in the French region. Geographical differences at the Mediterranean scale are expected not necessarily only in relation to geographic distance and the highest number of shared species was found by Féral et al. (2016) between France and Turkey. Rather, differences may relate to different environmental parameters, particularly temperature ranges and water circulation patterns. Pinna et al. (2021) considered thermal conditions and hydrodynamics as the main possible drivers of spatial variability in structuring assemblages associated with coralligenous cliffs along a depth gradient (18–38 m) in different sectors of western and eastern Sardinia. Similarly, even at a smaller scale within the Tyrrhenian Sea, Piazzi et al. (2023) found that latitudinal and continental-to-island gradients were the main factors influencing assemblages associated with coralligenous cliffs along the Tuscany coast. Besides focusing on different geographical areas (sometimes based on isolated samples from wide areas in the western Mediterranean, such as Gautier 1962), papers examined for the present overview also include different depth ranges from very shallow settings (c 10 m) in the Adriatic and Marseille areas (Novosel et al. 2004 and Hong 1980, 1982, respectively) to intermediate depths of c 60 m (SE Sicily, Ionian Sea: Rosso and Sanfilippo 2009) and down to 75 m (Harmelin 1976: Marseille region) and even 95 m (Ballesteros et al. 1993: Cabrera, Balearic Islands).

Accordingly, the marked variability observed among regions also reflects differences in the vertical distribution of species, which remain best known from shallow-water settings (e.g., Harmelin 1976; Ferdeghini et al. 2000; Balata et al. 2006). In line with this variability, different coralligenous facies are reported in the examined papers, although usually not explicitly indicated. Establishment of these facies in a given area is also influenced by depth and light penetration together with the geological and physiographic nature of substrata, and by local hydrodynamic and other environmental conditions. In this respect, whereas large-sized bryozoan colonies, exclusively consisting of *Reteporella* species, were only observed through ROV inspections at greater depths off Marzamemi, the absence of large-sized bryozoans (such as *S. cervicornis*, *P. fascialis*, *A. calveti* and *T. magnevillana* = *T. avicularis*) which are generally considered as indicators of healthy coralligenous communities (e.g., Gatti et al., 2015), or their occurrence with very small, even cryptic colonies (such as *M. truncata*), could simply represent a distinctive feature of the studied coralligenous. As remarked by Pinna et al. (2021), the absence of an elevated bryozoan (and gorgonian) layer does not necessarily indicate the occurrence of environmental alterations but could also be typical of pristine conditions in particular areas, which we expected to be

the case for the Coralligenous of Marzamemi. However, several species are sensitive to environmental parameters and Hong (1983) documented a remarkable species loss along a pollution gradient.

Furthermore, in each facies, the intrinsic 3D-complexity produced by the growth of coralligenous bio-constructors (or frame-builders), jointed with the particular development of the canopy contribute to small-scale spatial heterogeneity and the diversification of microhabitats furtherly promoting biodiversity. Interestingly, several facies at different depths are included in the list by Harmelin (1976) reported in Table 3 which documents as many as 128 species from the Marseille area, when including in the coralligenous also the so-called precoralligenous and coralligenous concretions.

The total of 257 bryozoan species so far reported for the coralligenous habitat largely outnumbers the 170 species indicated in Ballesteros (2006) and the 219 species (40 cyclostomes, four ctenostomes and 175 cheilostomes; Fig. 5) considered by Rosso and Di Martino (2016). The present total diversity accounts for almost 44% of the overall bryozoan diversity of 588 species currently known for the Mediterranean Sea (Rosso and Di Martino 2023) and even overcomes the 40% previously reported by Rosso and Di Martino (2016) based on a total number of 556 bryozoan species known at that time. However, this number is expected to increase further in the future taking into account that species presently known only from recently dead colonies could likely be found alive, and probably some of them such as *C. simplex* could seemingly already have been found although possibly confused with the better known, more widespread, congener *C. trichotoma*. Furthermore, the discovery of new species is plausible once biodiversity studies focused on coralligenous bioconstructions are extended to still understudied areas, such as some of eastern and southern sectors of the Mediterranean and especially the Aegean and Levantine seas where Coralligenous is possibly less studied for its deeper location owing to elevated water transparency and more oligotrophic conditions.

The high detected figures of bryozoan diversity, however, can only be achieved through detailed, small-scale sampling and laboratory analyses of collected material. In situ visual surveys alone, even when supported by underwater photography or ROV imagery, remain insufficient to capture the full extent of bryozoan diversity, although often used to assess the status of coralligenous habitat and regional biodiversity variations (e.g., Casoli et al. 2020, 2024). Most species are minute, encrusting, or cryptic, and their identification relies on microscopic examination of zooidal and skeletal features (see Donato et al. 2024, and references therein) that are invisible in standard images. Consequently, photographic and video-based studies mainly record few (usually 4–5) large, erect, or morphologically distinctive taxa (e.g., *Reteporella* spp.), while overlooking the vast majority of smaller species that dominate coralligenous assemblages.

Integrating targeted sampling with in situ documentation therefore represents the only effective strategy to obtain a realistic picture of bryozoan diversity within coralligenous habitats across the Mediterranean.

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Tables

Tables 1 to 3 are available in the Supplementary Files section.

Figures



Figure 1

Location of the investigated area off Marzamemi, SE Sicily, western Ionian Sea within the Mediterranean, and enlarged in the inset.

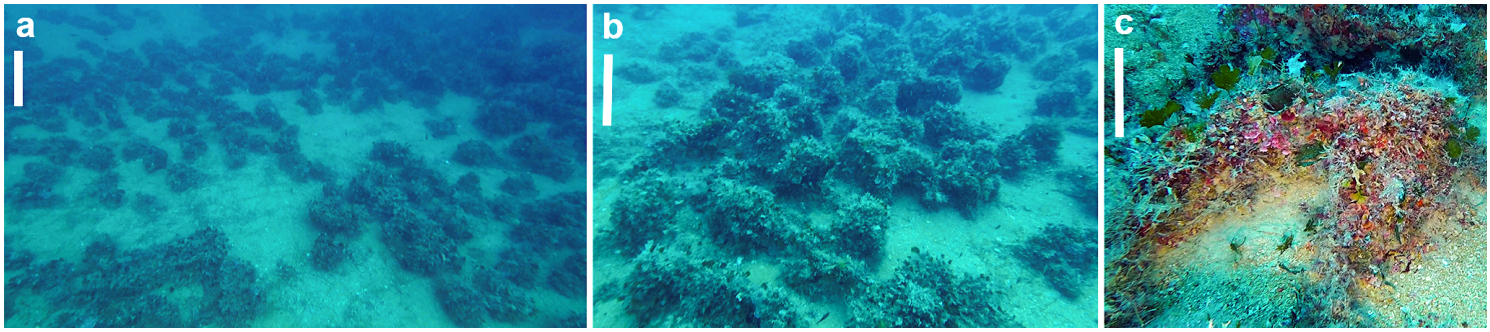


Figure 2

The seascape at the sampling site at ca 36 m depth. **a** general aspect showing differently clustered build-ups; **b**cluster of closely spaced build-ups; **c** close-up of a build-up with a dense canopy mostly consisting of fleshy algae. Scale bars: 1 m (**a**, **b**); 10 cm (**c**).

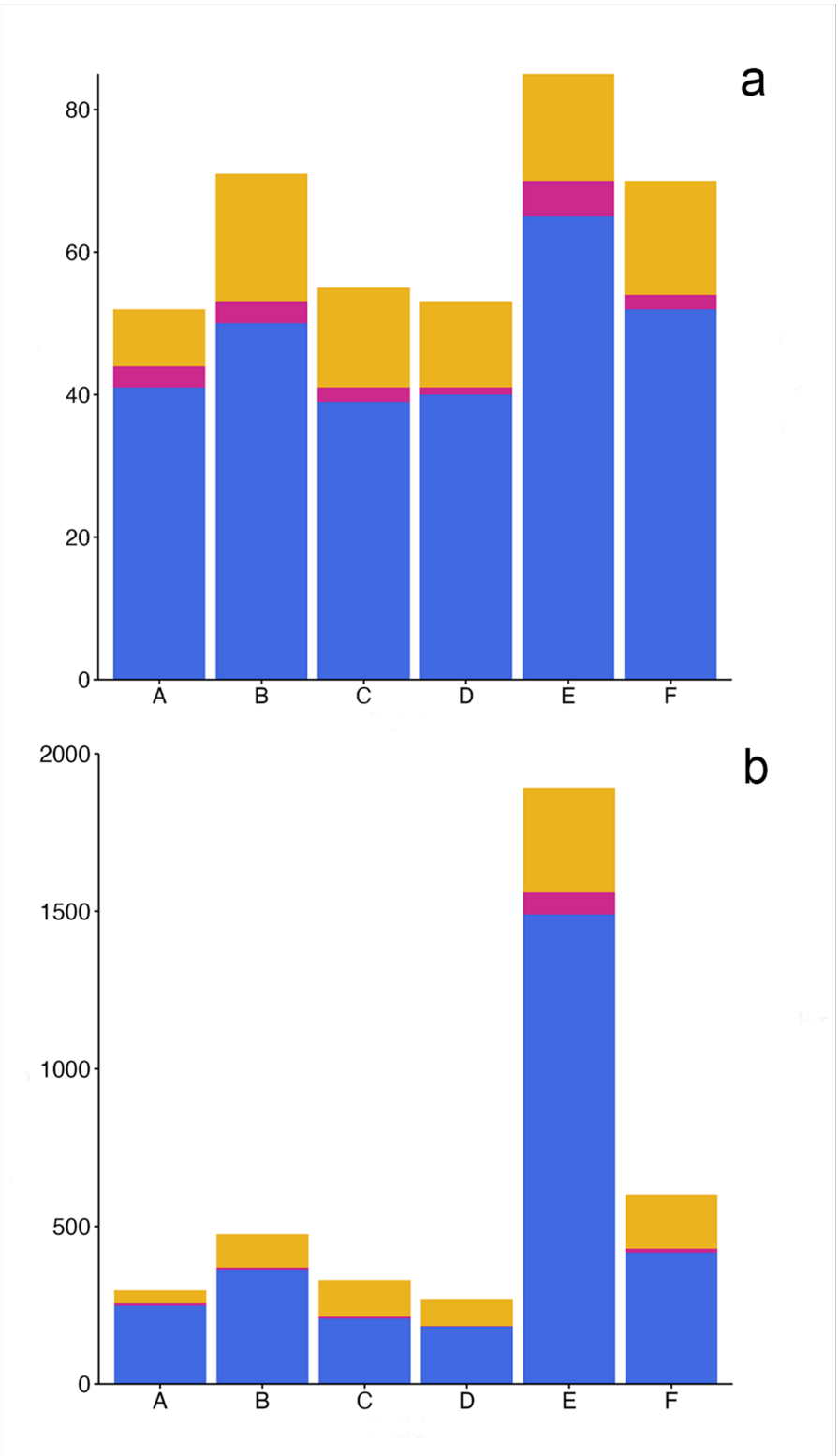


Figure 3

Histograms showing bryozoan diversity in the six examined build-ups, indicated with the letters A-F. **a** number of species; **b** number of colonies. Cyclostomes (orange); ctenostomes (purple); cheilostomes (blue).

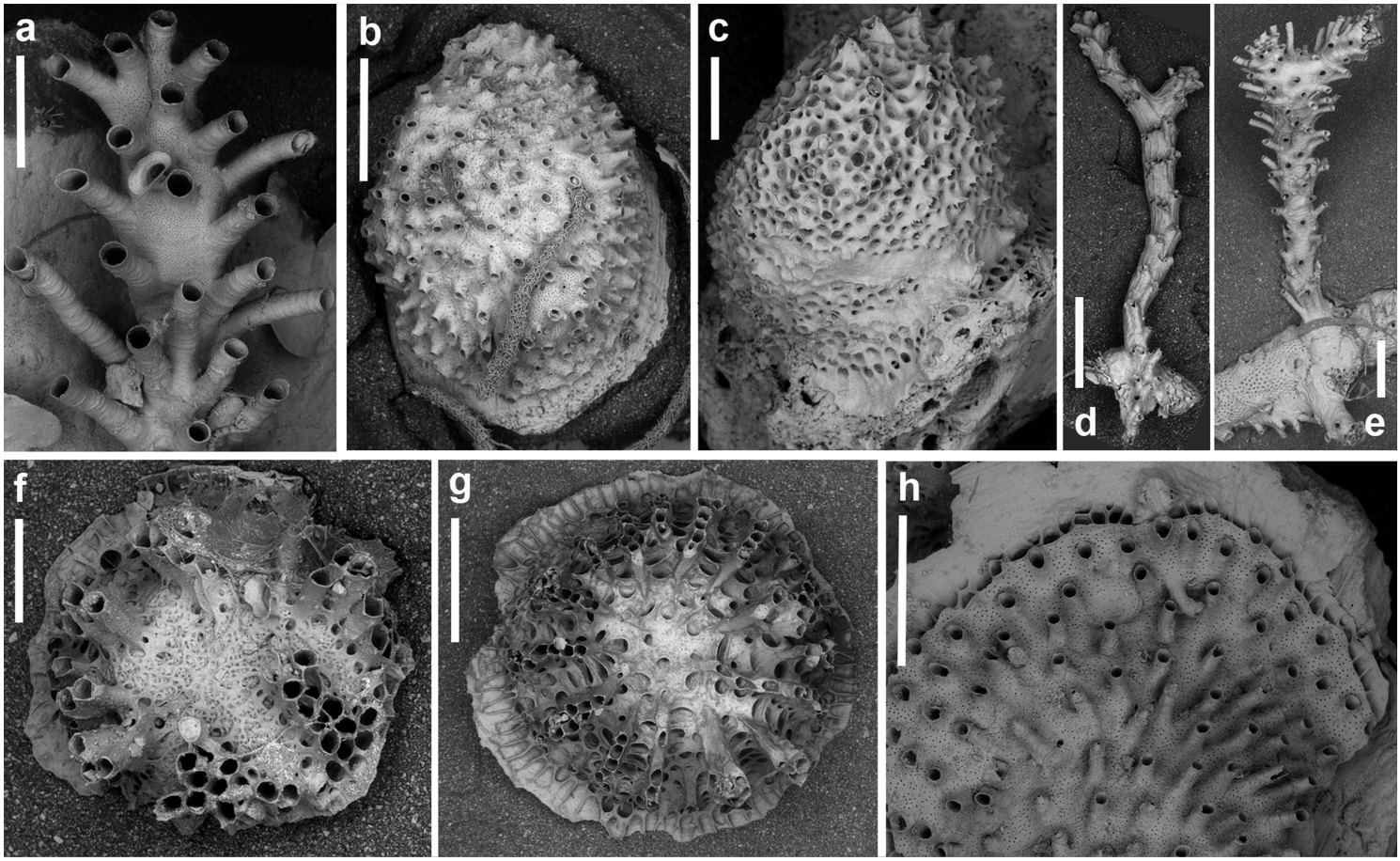


Figure 4

Selected cyclostome species (1) from the Coralligenous off Marzamemi (SE Sicily, Ionian Sea). **a** *Annectocyma major*, PMC Rosso-Collection I. H. B.161.a; **b** *Diplosolen obelius*, PMC. R.I.H. B-12.b; **c** *Disporella*sp. A, PMC Rosso-Collection I. H. B.164.a; **d** *Idmidronea triforis*, PMC Rosso-Collection I. H. B.165.a; **e** *Mecynoecia delicatula*, PMC Rosso-Collection I. H. B.50.b; **f** *Patinella mediterranea*, PMC Rosso-Collection I. H. B.166.a; **g** *Patinella radiata*, PMC Rosso-Collection I. H. B.55.b; **h** *Plagioecia sarniensis*, PMC Rosso-Collection I. H. B.49.b. Scale bars: 1 mm (**a**, **b**, **d**, **e**, **g**, **h**); 500 mm (**c**, **f**).

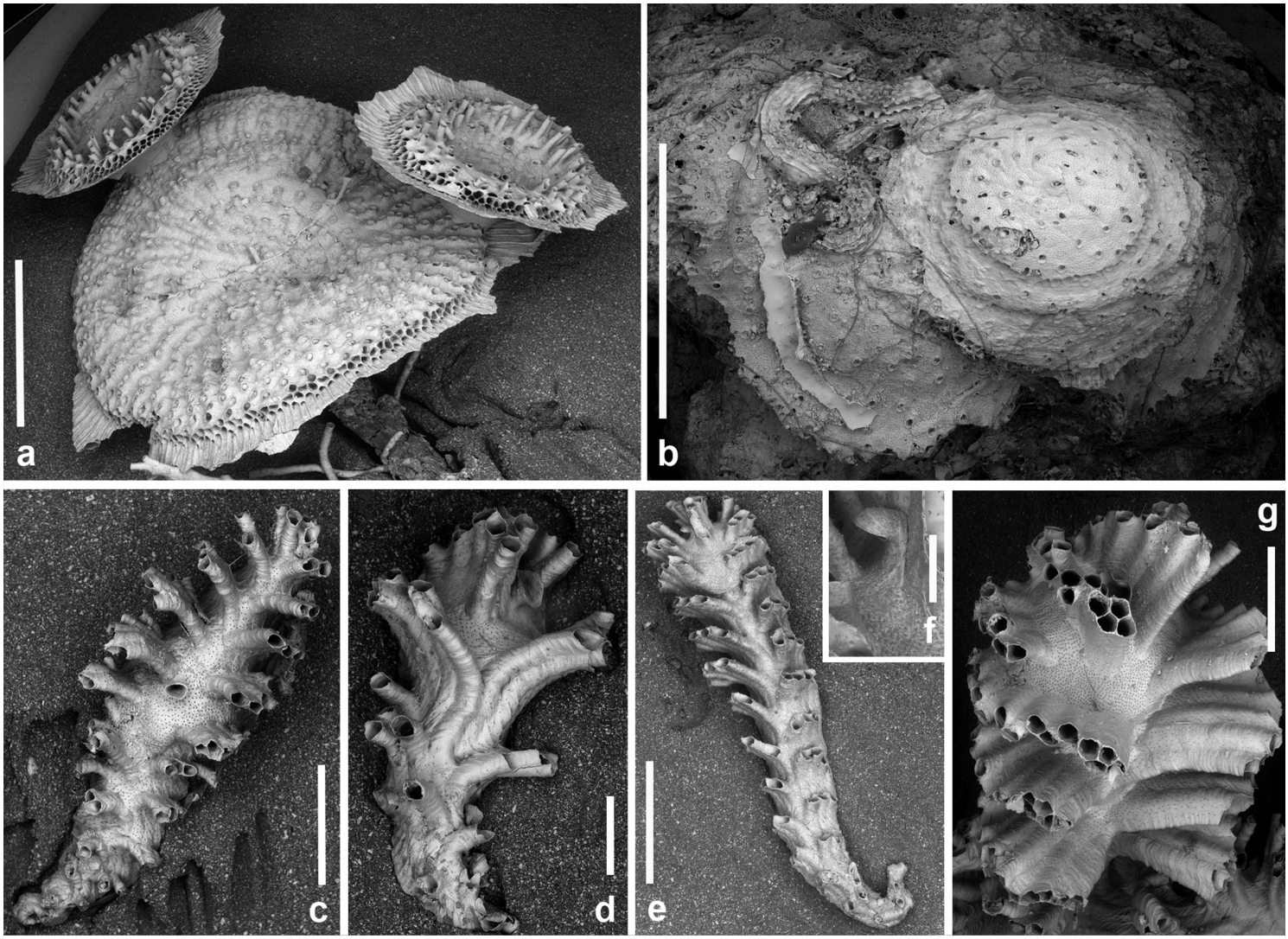


Figure 5

Selected cyclostome species (2) from the Coralligenous off Marzamemi (SE Sicily, Ionian Sea). **a** *Plagioecia patina*, PMC Rosso-Collection I. H. B.102.a; **b** *Plagioecia platydiscus*, PMC Rosso-Collection I. H. B.167.a; **c** *Platonea stoechas*, PMC Rosso-Collection I. H. B.168,a; **d** *Tubulipora aperta*, PMC Rosso-Collection I. H. B.169.a; **e**, **f** *Tubulipora liliacea*, PMC Rosso-Collection I. H. B.170.a; **g** *Tubulipora plumosa*, PMC Rosso-Collection I. H. B.171.a. Scale bars: 5 mm (**a**, **b**); 1 mm (**c**, **e, g**); 500 mm (**d**); 200 mm (**f**).

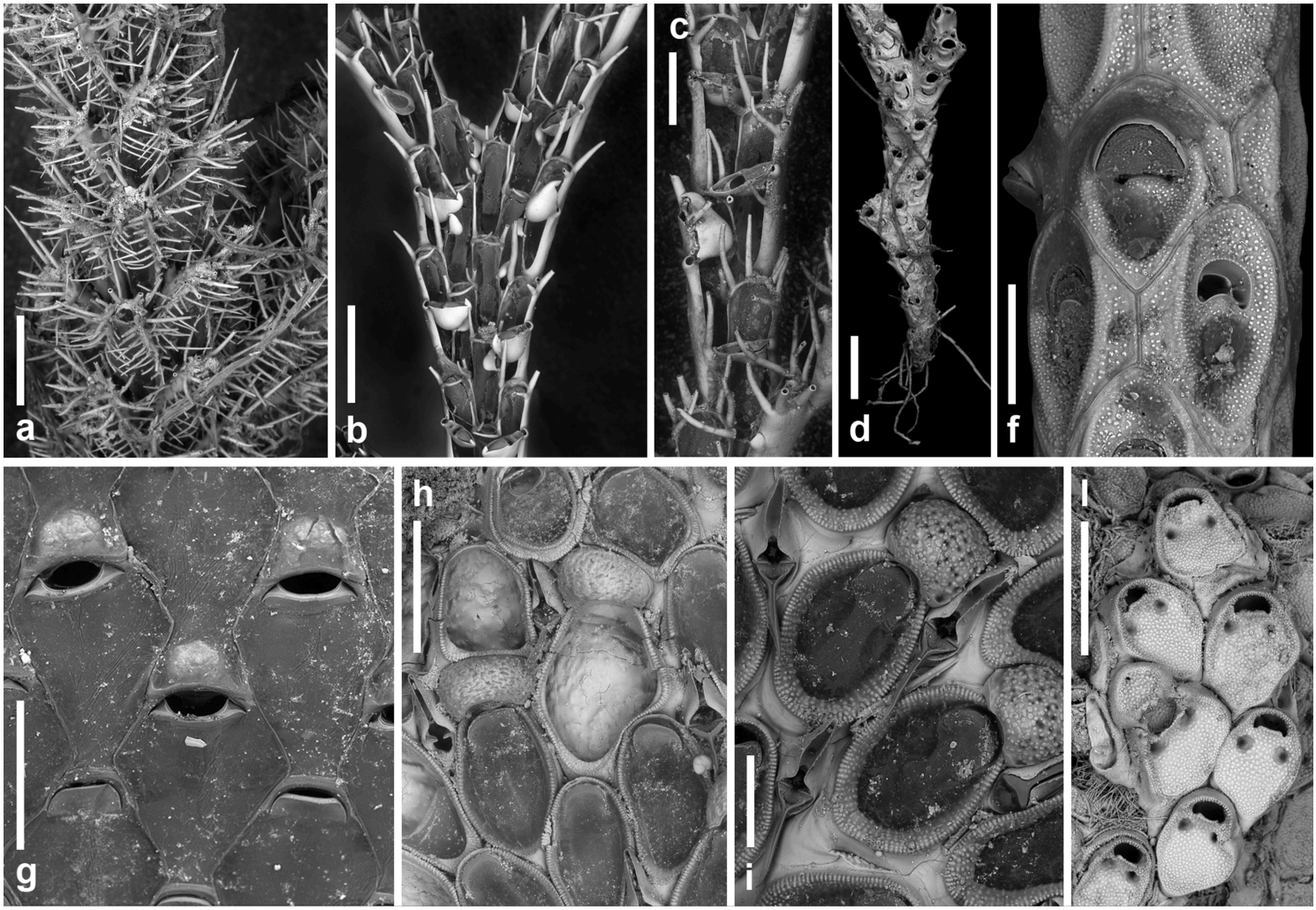


Figure 6

Selected anascan-grade cheilostome species (1) from the Coralligenous off Marzamemi (SE Sicily, Ionian Sea). **a** *Beania cylindrica*, PMC Rosso-Collection I. H. B.101.a; **b** *Bugulina calathus calathus*, PMC Rosso-Collection I. H. B.65.b; **c** *Bugulina* cf. *fulva*, PMC Rosso-Collection I. H. B.103.a.; **d** *Caberea boryi*, PMC Rosso-Collection I. H. B.66.b.; **e** *Cellaria salicornioides*, PMC Rosso-Collection I. H. B.172.a; **f** *Chartella papyrea*, PMC Rosso-Collection I. H. B.173.a; **g** *Copidozoum planum*, PMC Rosso-Collection I. H. B.174.a; **h** *Copidozoum tenuirostre*, PMC Rosso-Collection I. H. B.62.b; **i** *Coronellina fagei*, PMC Rosso-Collection I. H. B.175.a. Scale bars: 500 mm (**a**, **b**, **f**, **g**, **i**); 200 mm (**c**-**e, h**).

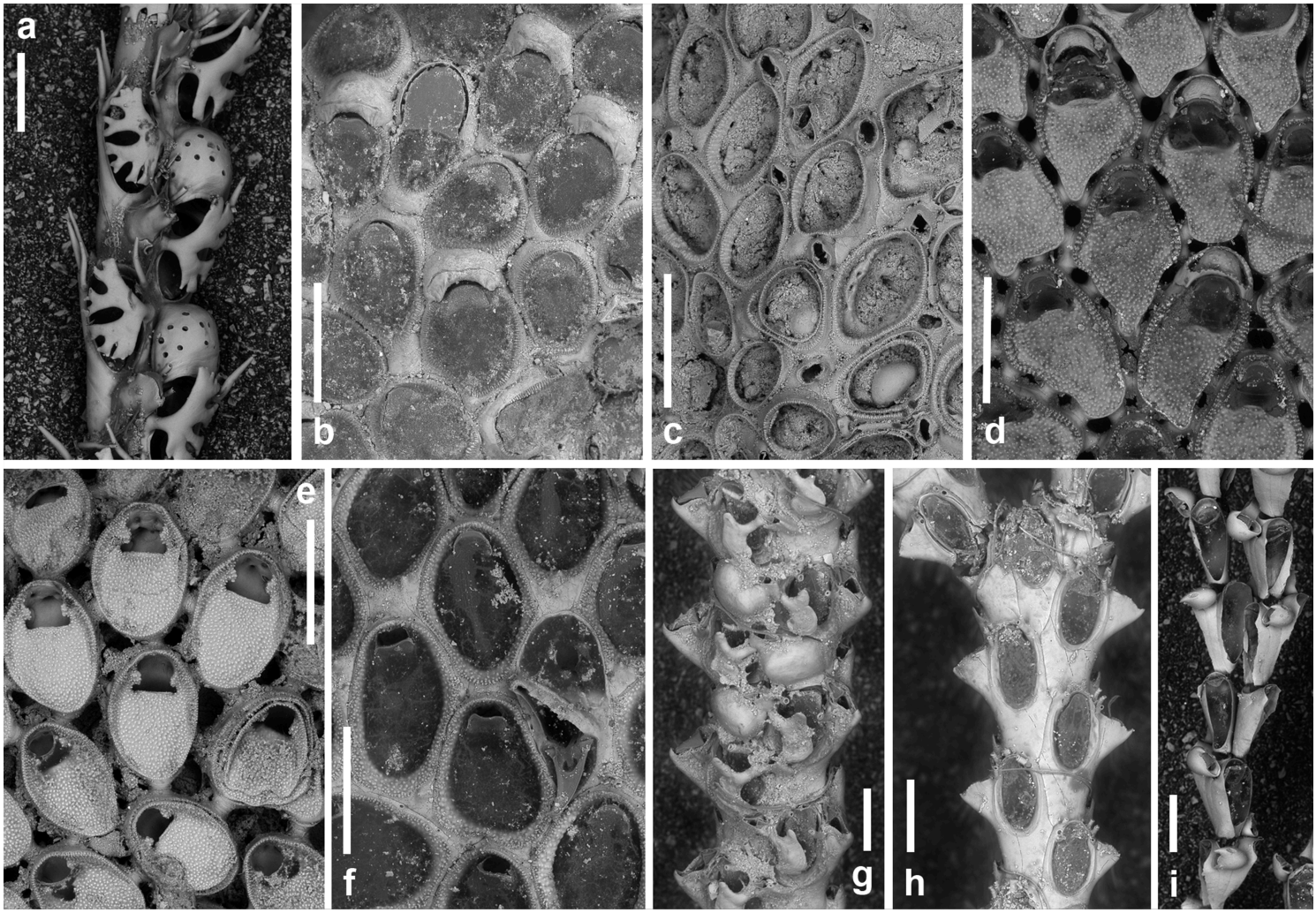


Figure 7

Selected anascan-grade cheilostome species (2) from the Coralligenous off Marzamemi (SE Sicily, Ionian Sea). **a** *Cradoscrupocellaria macrorhyncha*, PMC Rosso-Collection I. H. B.67.b; **b** *Crassimarginatella solidula*, PMC Rosso-Collection I. H. B.176.a; **c** *Ellisina gautieri*, PMC Rosso-Collection I. H. B.177.a; **d** *Mollia circumcincta*, PMC Rosso-Collection I. H. B.178.a; **e** *Mollia patellaria*, PMC Rosso-Collection I. H. B.179.a; **f** *Parellisina curvirostris*, PMC Rosso-Collection I. H. B.180.a; **g** *Scrupocellaria delilii*, PMC Rosso-Collection I. H. B.107.a; **h** *Scrupocellaria scruposa*, PMC Rosso-Collection I. H. B.106.a; **i** *Synnotum aegiptiacum*, PMC Rosso-Collection I. H. B.181.a. Scale bars: 200 mm (**a**, **g**-**i**); 500 mm (**b**-**f**).

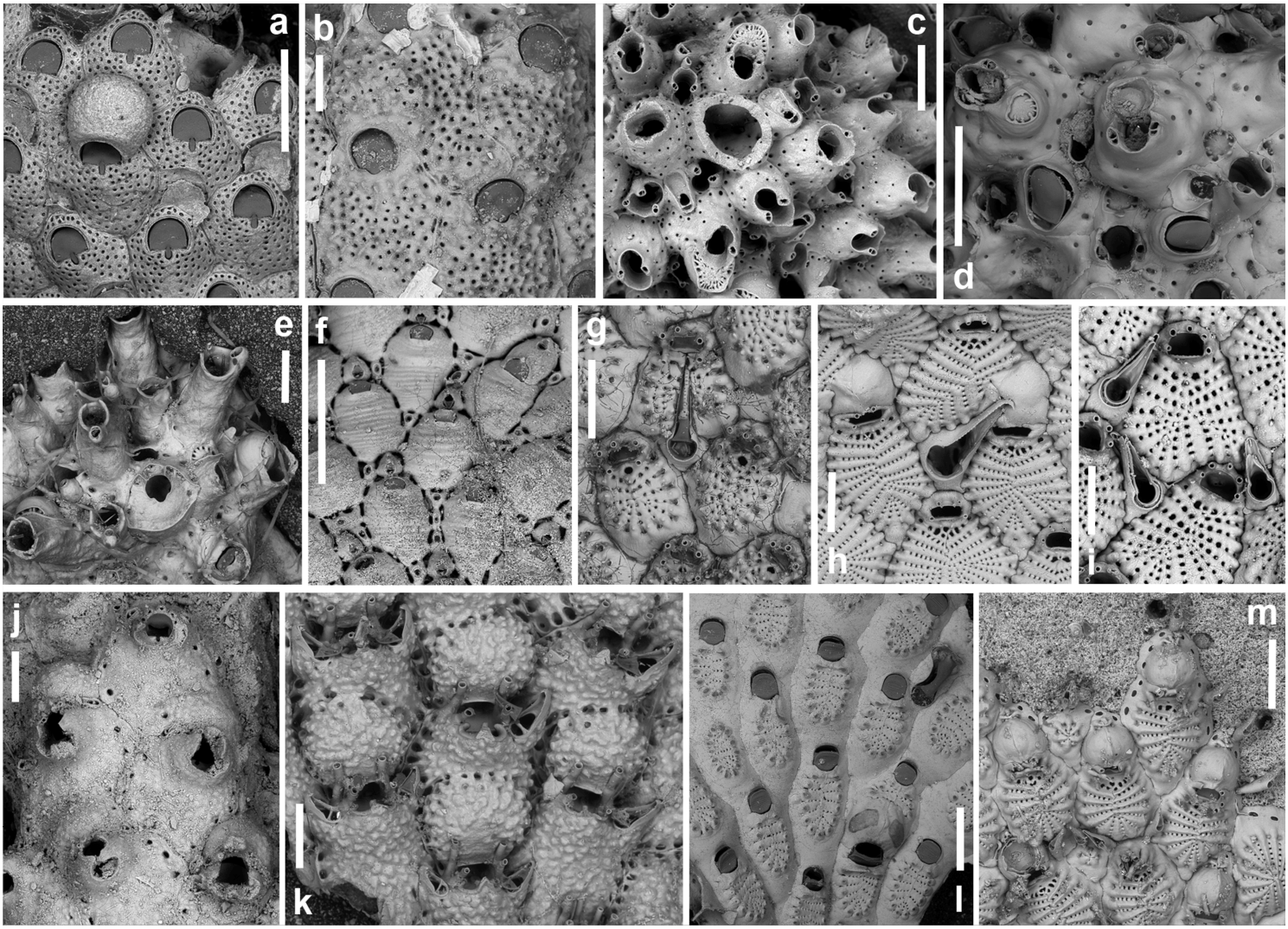


Figure 8

Selected ascophoran-grade cheilostome species (1) from the Coralligenous off Marzamemi (SE Sicily, Ionian Sea). **a** *Arthropoma cecilii*, PMC Rosso-Collection I. H. B.100.a; **b** *Calyptotheca rugosa*, PMC Rosso-Collection I. H. B.114.a; **c** *Celleporina caminata*, PMC Rosso-Collection I. H. B.98.a.; **d** *Celleporina* sp. A cf. *C. canariensis*, PMC Rosso-Collection I. H. B.182.a; **e** *Celleporina siphuncula*, PMC Rosso-Collection I. H. B.183.a; **f** *Chorizopora brongniartii*, PMC Rosso-Collection I. H. B.99.a; **g** *Cribrilaria hincksi*, PMC Rosso-Collection I. H. B.70.b; **h** *Cribrilaria radiata*, PMC Rosso-Collection I. H. B.184.a; **i** *Cribrilaria venusta*, PMC Rosso-Collection I. H. B.185.a; **j** *Escharina protecta*, PMC Rosso-Collection I. H. B.186.a; **k** *Escharoides mamillata*, PMC Rosso-Collection I. H. B.109.a; **l** *Figularia figularis*, PMC Rosso-Collection I. H. B.71.d; **m** *Glabrilaria pedunculata*, PMC Rosso-Collection I. H. B.81.b. Scale bars: 500 mm (**a**, **c**, **d, f**, **l**); 200 mm (**b**, **e**, **g**-**k**, **m**).

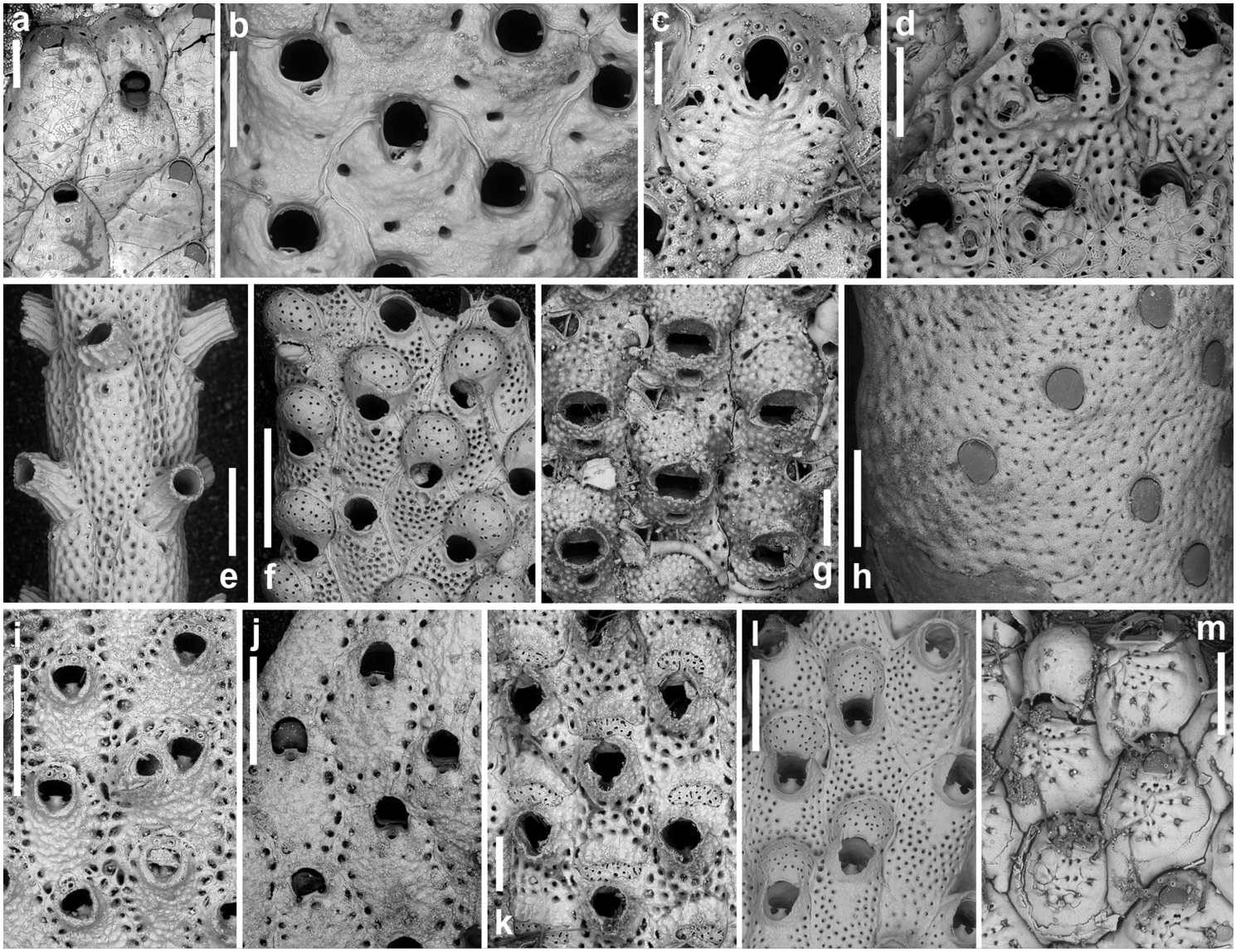


Figure 9

Selected ascophoran-grade cheilostome species (2) from the Coralligenous off Marzamemi (SE Sicily, Ionian Sea). **a** *Haplopoma impressum*, PMC Rosso-Collection I. H. B.110.a; **b** *Hippellozoon mediterraneum*, PMC Rosso-Collection I. H. B.187.a; **c** *Hippomenella mucronelliformis*, PM PMC Rosso-Collection I. H. B.188.a; **d** *Hippopleurifera pulchra*, PMC Rosso-Collection I. H. B.189.a; **e** *Margaretta cereoides*, PMC Rosso-Collection I. H. B.190.a; **f** *Metroperiella mesogeia*, PMC Rosso-Collection I. H. B.95a; **g** *Microporella bicollaris*, PMC Rosso-Collection I. H. B.96.a; **h** *Myriapora truncata*, PMC Rosso-Collection I. H. B.191.a; **i** *Parasmittina raigii*, PMC Rosso-Collection I. H. B.192.a; **j** *Porella concinna*, PMC Rosso-Collection I. H. B.193.a; **k** *Prenantia cheilostoma*, PMC Rosso-Collection I. H. B.194.a; **l** *Prenantia inerma*, PMC Rosso-Collection I. H. B.195.a; **m** *Puellina gattyae*, PMC Rosso-Collection I. H. B.105.a. Scale bars: 200 mm (**a**-**c**, **g**, **k**, **m**); 500 mm (**d-f, h**, **j**, **l**).

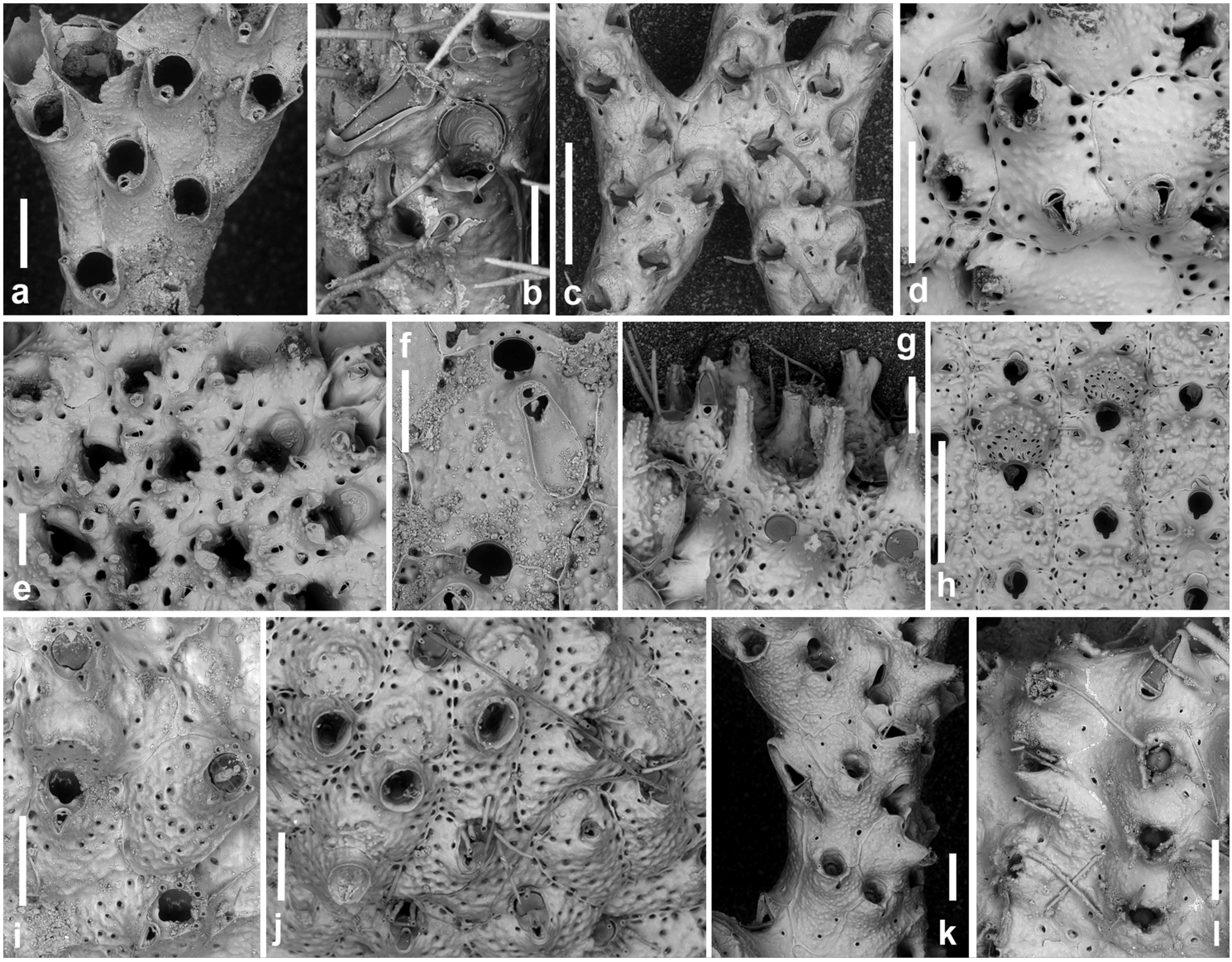


Figure 10

Selected ascophoran-grade cheilostome species (3) from the Coralligenous off Marzamemi (SE Sicily, Ionian Sea). **a** *Reteporella aporosa*, PMC Rosso-Collection I. H. B.196.a; **b** *Reteporella grimaldi*, PMC Rosso-Collection I. H. B.197.a; **c** *Reteporella sudbournensis*, PMC Rosso-Collection I. H. B.198.a; **d** *Rhynchozoon neapolitanum*, PMC Rosso-Collection I. H. B.199.a; **e** *Rhynchozoon pseudodigitatum*, PMC Rosso-Collection I. H. B.200.a; **f** *Schizomavella* (*S.*) cf. *halimedae* (Gautier, 1955), PMC Rosso-Collection I. H. B.201.a; **g** *Scizomavella* (*S.*) *hastata*, PMC Rosso-Collection I. H. B.202.a; **h** *Schizomavella* (*S.*) *linearis*, PMC Rosso-Collection I. H. B.104.a; **i** *Schizomavella* (*S.*) *subsolana*, PMC Rosso-Collection I. H. B.203.a; **j** *Schizomavella* (*S.*) *tubulata*, PMC Rosso-Collection I. H. B.204.a; **k** *Schizoretepora solanderia*, PMC. Rosso-Collection R.I.H. B-14b; **l** *Schizotheca fissa*, PMC Rosso-Collection I. H. B.205.a. Scale bars: 200 mm (**a**, **b**, **e**-**g**, **i**-**l**); 500 mm (**c, d**, **h**).

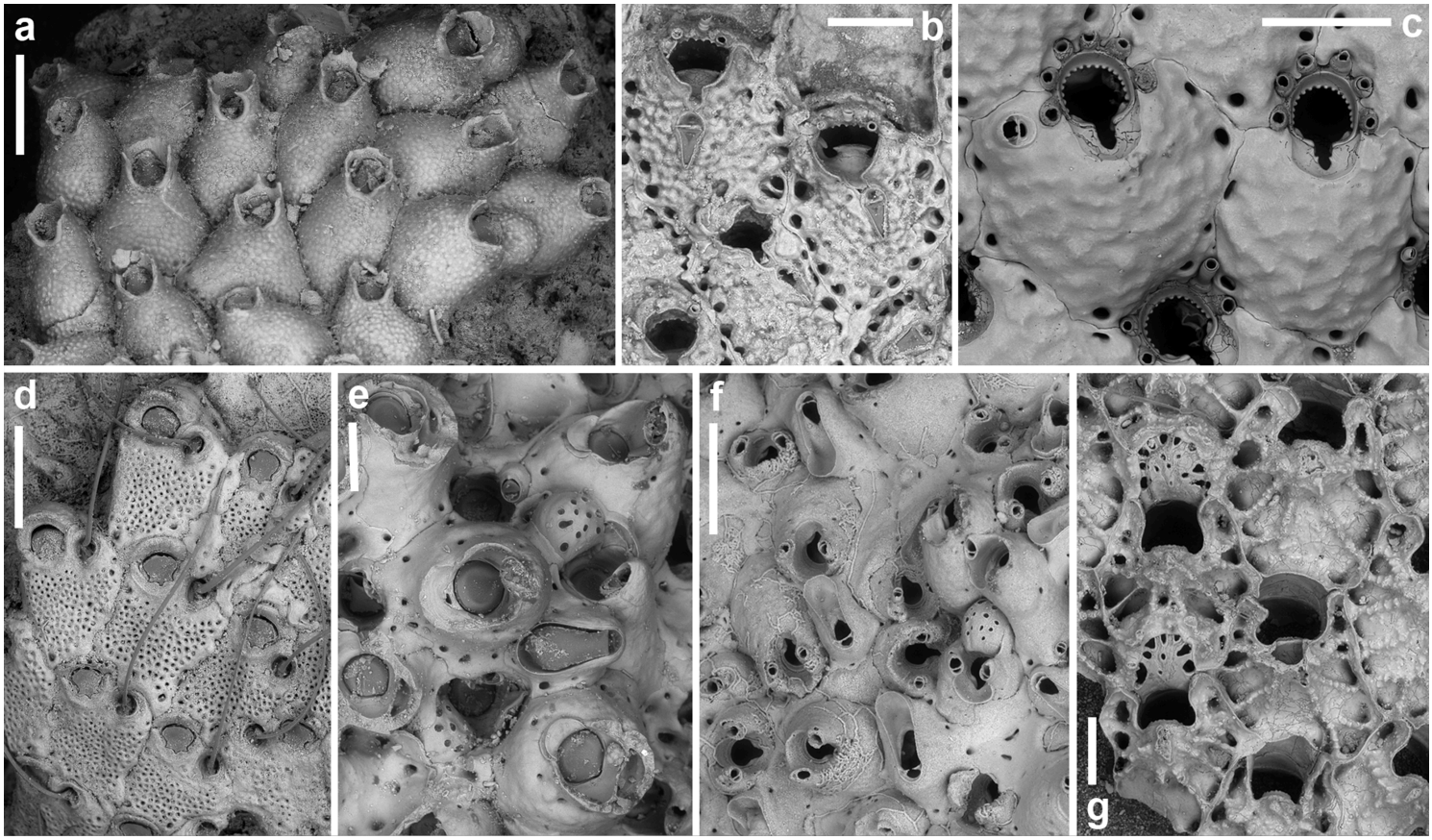


Figure 11

Selected ascophoran-grade cheilostome species (4) from the Coralligenous off Marzamemi (SE Sicily, Ionian Sea). **a** *Scutocyclopora dentata*, PMC Rosso-Collection I. H. B.93.d; **b** *Smittoidea reticulata*, PMC Rosso-Collection I. H. B.206.a; **c** *Stephanollona armata*, PMC Rosso-Collection I. H. B.207.a; **d** *Therenia rosei*, PMC Rosso-Collection I. H. B.4c; **e** *Turbicellepora coronopus*, PMC Rosso-Collection I. H. B.208.a; **f** *Turbicellepora coronopusoida*, PMC Rosso-Collection I. H. B.209.a; **g** *Umbonula ovicellata*, PMC Rosso-Collection I. H. B.210.a. Scale bars: 500 mm (**a**, **d**, **f**); 200 mm (**b, c**, **e**, **g**).

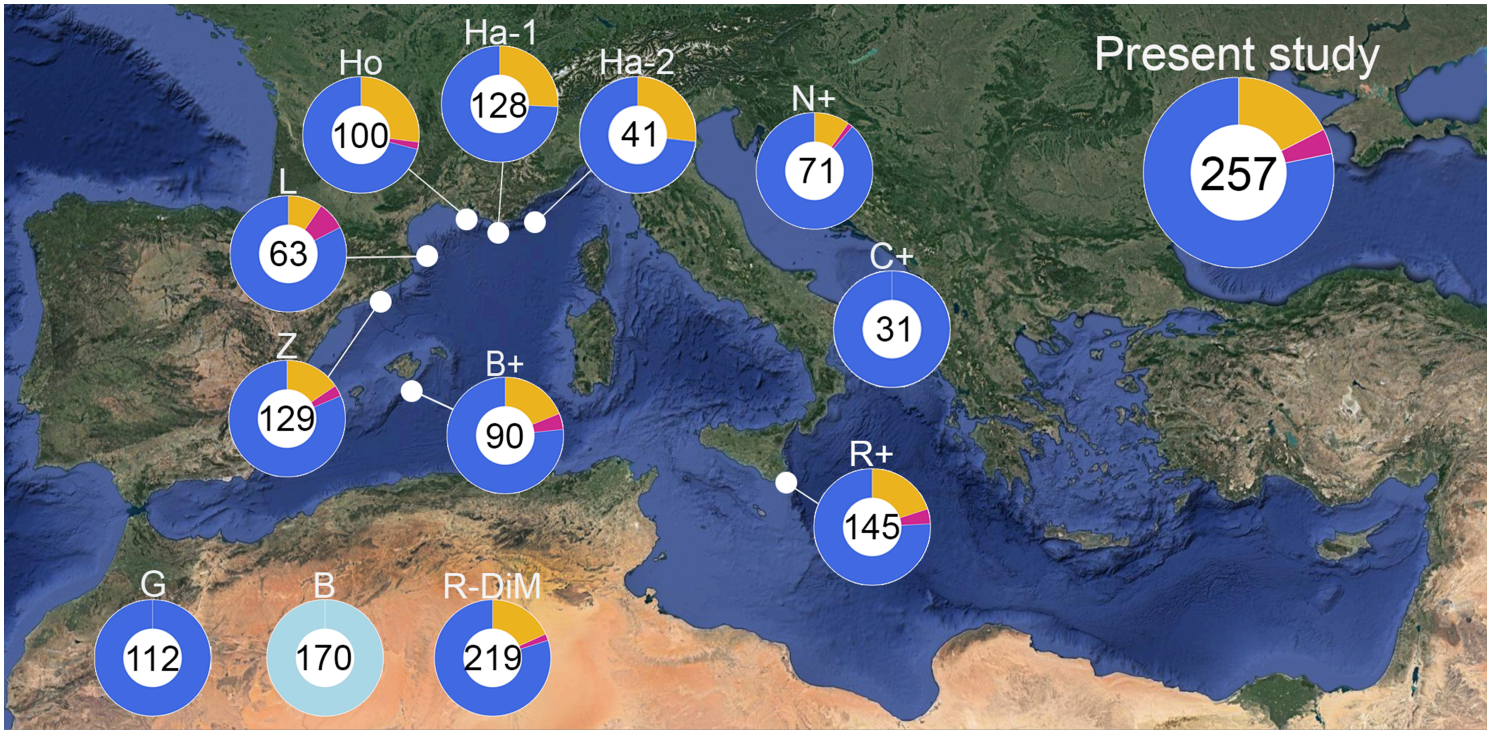


Figure 12

Bryozoan biodiversity in the Mediterranean Coralligenous from main monographies on particular areas derived from: B+: Ballesteros et al. (1993); C+: Corriero et al. (2025); H-1: Harmelin (1976); H-2: Harmelin (2017); Ho: Hong (1980, 1982); L: Laubier (1966); N+: Novosel et al. (2004) + RAC/SPA – UNEP/MAP (2014); R+: Rosso et al.: present paper for the Marzamemi area, also including data in Rosso and Sanfilippo (2009), Rosso et al. (2023) and Donato et al (2024); Z: Zabala (1986), also including data in Zabala (1984) and comprehensive papers on the entire Mediterranean including: B Ballesteros (2006); G: Gautier (1962); R-DiM: Rosso and Di Martino (2023). Donuts' colours: Cyclostomes (orange); ctenostomes (purple); cheilostomes (blue). Absence of ctenostomes in Ha-1 and Ha-2 and of ctenostomes and cyclostomes in C+ and G indicate that these groups were not reported in those papers. Pale blue in B refers to all three bryozoan orders.

Supplementary Files

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- Table1.xlsx
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- Table3.xlsx
- Suppl1.xlsx