frontiers | Frontiers in Earth Science

TYPE Editorial
PUBLISHED 28 November 2022
DOI 10.3389/feart.2022.1090091

Editorial: Crustose coralline red algae frameworks and rhodoliths: Past and present

Ana Cristina Rebelo[1,2,3,4,5]*, Sebastian Teichert[6], Valentina A. Bracchi[7], Michael W. Rasser[5] and Daniela Basso[7]

[1]Divisão De Geologia Marinha, Instituto Hidrográfico, Lisboa, Portugal, [2]CIBIO–Centro De Investigação Em Biodiversidade e Recursos Genéticos, InBio Laboratório Associado, Ponta Delgada, Portugal, [3]BIOPOLIS–Program in Genomics, Biodiversity and Land Planning, CIBIO, Vairão, Portugal, [4]MPB–Marine Palaeontology and Biogeography Lab, University of the Azores, Ponta Delgada, Portugal, [5]SMNS–Staatliches Museum für Naturkunde Stuttgart, Stuttgart, Germany, [6]GeoZentrum Nordbayern, Department Geographie und Geowissenschaften, Naturwissenschaften Fakultät, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany, [7]Department of Earth and Environmental Sciences, University of Milano-Bicocca, Milano, Italy

Check for updates

OPEN ACCESS

EDITED AND REVIEWED BY
Bruce S. Lieberman,
University of Kansas, United States

*CORRESPONDENCE
Ana Cristina Rebelo,
acfurtadorebelo@gmail.com

SPECIALTY SECTION
This article was submitted to Paleontology,
a section of the journal
Frontiers in Earth Science

RECEIVED 04 November 2022
ACCEPTED 21 November 2022
PUBLISHED 28 November 2022

CITATION
Rebelo AC, Teichert S, Bracchi VA, Rasser MW and Basso D (2022), Editorial: Crustose coralline red algae frameworks and rhodoliths: Past and present.
Front. Earth Sci. 10:1090091.
doi: 10.3389/feart.2022.1090091

KEYWORDS

calcareous algae, algal lithofacies, bioconstructions, palaeobiogeography, palaeoenvironments, maerl, coralline framework, ecosystem engineers

Editorial on the Research Topic
Crustose coralline red algae frameworks and rhodoliths: Past and present

Crustose Coralline red Algae (CCA) have a long and vast fossil record and continue to be significant components in recent ecosystems (Bosence, 1983). They can produce extensive carbonate sediments, either as simple crusts, free-living forms known as rhodoliths, as entire reef frameworks, or on break down, as coralline algal sands and gravels (Bosence, 1983; Rasser and Piller, 2004; Basso and Granier, 2012). CCA are autogenic ecosystem engineers, providing living space for other organisms, particularly in areas where other habitat providers, such as corals, are lacking. At microscopic scale CCA build crusts and branches providing substratum for microborers, encrusters and several other invertebrates. At macroscopic scale they form successive crusts as well as rhodoliths and their accretions, providing shelter for larger invertebrates and vertebrates, such as nurseries for fishes (Steneck, 1986; Foster, 2001). Furthermore, at a megascale CCA can form entire reef bodies, rhodolith beds and maerl megadunes, controlling extensive marine areas (Adey, 1986; Steneck, 1986; Rasser and Piller, 2004; Bracchi et al., 2015). The longevity of CCA, together with their ecological restrictions and plasticity of growth-forms in relation to environmental parameters, makes them excellent ecological indicators for recent and palaeo-environments (Bosence, 1991; Basso, 1998; Barattolo et al., 2007 and references therein). Regardless of the abundance and ecological importance in time and space, CCA frameworks and rhodoliths are still poorly understood.

Several subjects are covered by the nine research articles of this Research Topic which add greatly to advance our scientific knowledge on CCA.

Abundance and richness of the macrofauna (>500 µm) associated with a rhodolith bed at Isla del Coco National Park in Costa Rica was studied by Solano-Barquero et al. This study showed that moderate aggregation in rhodolith beds favours a greater diversity of associated taxa, as the different physical aggregation levels and morphological characteristic variation of the rhodoliths influence the faunal communities. This adds evidence to the role of rhodolith beds in providing background heterogeneity suitable for a myriad of organisms. Solano-Barquero et al. manifest the importance of rhodolith beds for biodiversity and highlight the need to preserve such ecologically relevant habitats.

Another assessment of rhodolith diversity was done by Richards et al. on the Northwestern Gulf of Mexico, including the description of a new species of *Sporolithon* (Sporolithales, Rhodophyta) and three new species of *Roseolithon* (Hapalidiales, Rhodophyta). The northwestern Gulf of Mexico is a hotspot for CCA and this study stresses the continuation of assessment in the identification and description of new species which are of critical importance to conservation efforts in the region.

Mills et al. provide an update of the CCA diversity of Guam (Mariana Islands) based on a recent DNA barcoding effort where taxa is compared to 1) the most current species inventories for Guam based on morphological identifications and 2) similar floristic accounts of CCA from other regions. Phenotypic plasticity and convergent morphologies of corallines complicate taxonomic identification. For this reason CCA have often been overlooked by phycologists and ecologists, despite their abundance and ecological importance on reefs. This study contributes to a better understanding of Guam's CCA diversity and highlights the importance of DNA-based identification in examining corallines.

Rebelo et al. report on the distribution of rhodolith-forming species and consider the factors controlling rhodolith beds around the shores of Fuerteventura Island (Canary Islands, Spain). Their study adds to a better understanding of insular rhodolith formation and deposition. They also highlight the importance of preserving rhodolith beds as biodiversity hotspots and call for a conscientious effort in the protection and maintenance of these valuable biological resources.

In the Mediterranean, Del Río et al. give a detailed analysis of the structure and morphospecies composition of a shallow rhodolith bed at Punta de la Mona, Granada (southern Spain). The rhodolith bed extends for 16,000 square meters from 9 to 24 m water depth in oligotrophic waters off Almuñecar in the Alborán Sea. While *Lithophyllum incrustans* and *Lithophyllum dentatum* dominate at shallow depths (9–12 m), *Lithothamnion valens* is the dominant species at intermediate and greater depths. This study also contradicts the common assumption in the geological literature that rhodolith beds are indicative of oligophotic environments with high nutrient levels.

Continuing in the Mediterranean, Bracchi et al. use image analysis and computed axial tomography to distinguish and quantify the different components both on the surface and inside of a Coralligenous framework. Coralligenous (reefs made of red algae) are considered the most important ecosystems in the Mediterranean Sea due to their extent, complexity, and heterogeneity, supporting very high levels of biodiversity. Their study confirms the primary role of CCA as major builders in the Mediterranean and also confirms matching evidence from the Quaternary fossil record. Their study also emphasizes the importance of monitoring, maintenance, and restoration.

Basso et al. assess the contribution of calcareous autogenic engineers to the present-day Ligurian Coralligenous on rocky walls vs. sub-horizontal substrates, to define its age and mean accumulation rate, and to explore the response of Coralligenous structural composition and major calcareous bio-engineers to Holocene climate and oceanographic changes recorded in the build-ups. Our knowledge on Coralligenous accumulation rate and age, although very fragmentary, suggests that present-day exposed algal build-ups require thousands of years to form, depending on favourable combinations of carbonate precipitation by algal engineers, persistence of compatible oceanographic conditions, and sedimentation rate, in turn controlled by the overarching geological setting. The correct temporal and spatial frame has important implications for our understanding of the history and fate of marine temperate/cold biogenic habitats under ongoing human impacts, ocean warming, and acidification (Basso et al.).

Moving on to the fossil rhodoliths Braga and Aguirre describe a cross-bedded rhodolith limestone, up to 20 m thick, which forms a mesa on which the Roman town of Acinipo was settled. This limestone is part of the infill of the Ronda Basin, a Neogene basin at the southern margin of the Atlantic-linked Guadalquivir Basin in southern Spain. This study shows how rhodoliths grew on submarine dunes in a sheltered bay episodically affected by storms.

Lastly, a study on fossil rhodoliths and coralline algal debris by Aguirre and Braga examines the Serravallian limestones at the southern margin of the Guadalquivir Basin that crop out in the vicinity of Jimena, Bedmar, and Jódar (Jaén Province, SE Spain). The coralline algae are major biotic components in these carbonates, occurring in densely packed rhodolith beds and as dispersed fragments together with other bioclasts. Here rhodoliths and coralline algal debris are preserved *in situ* or very close to their growth habitats (autochthonous–parautochthonous assemblages) and also as reworked remains (allochthonous assemblages).

This study is a key to understand the significance of this type of deposit in carbonate production within the western Mediterranean.

In summary, this Research Topic focuses on the diverse scientific questions on the crustose coralline red algae frameworks and rhodoliths through different time slices, the factors controlling species distribution and the reconstruction of their palaeoenvironments. The research developed in this Research Topic helps advance on scientific knowledge of CCA and their sensitivity to ecological parameters.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

AR was supported by a Post-doctoral grant SFRH/BPD/117810/2016 from the Portuguese Science Foundation (FCT) and project NORTE-01-0246-FEDER-000063, supported by Norte Portugal Regional Operational Programme (NORTE2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF).

Acknowledgments

We thank all the contributing authors, reviewers, editors and the Frontiers in Marine Science Editorial staff for their support in producing this Research Topic. AR acknowledges research support from National Funds through FCT - Foundation for Science and Technology under the project UIDB/50027/2020 and through DRCT under the project ACORES-01-0145_FEDER-000078 - VRPROTO: Virtual Reality PROTOtype: the geological history of "Pedra-que-pica, and under DRCTM1.1.a/005/ 519 Funcionamento-C-/2016 (CIBIOA) project. DB and VB acknowledge the research funding provided by MIUR FISR2019-04543.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Adey, W. H. (1986). "Coralline algae as indicators of sea-level," in *Sea-level research*. Editor O. van de Plassche (Dordrecht: Springer). doi:10.1007/978-94-009-4215-8_9

Barattolo, F., Bassi, D., and Romano, R. (2007). Upper Eocene larger foraminiferal–coralline algal facies from the Klokova Mountain (southern continental Greece). *Facies* 53, 361–375. doi:10.1007/s10347-007-0108-2

Basso, D., and Granier, B. (2012). Calcareous algae and global change: from identification to quantification/Algues calcaires et changement global : de l'identification à la quantification. *Geodiversitas* 34 (1), 1–12. Available at: https://sciencepress.mnhn.fr/en/periodiques/geodiversitas/34/1

Basso, D. (1998). Deep rhodolith distribution in the pontian Islands, Italy: A model for the paleoecology of a temperate sea. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 137, 173–187. doi:10.1016/s0031-0182(97)00099-0

Bosence, D. W. J. (1983). Coralline algae from the miocene of Malta. *Palaeontology* 26, 147–173.

Bosence, D. W. J. (1991). Coralline algae: mineralization, taxonomy, and palaeoecology," in *Calcareous Algae and Stromatolites*. Editor R. Riding. Berlin, Heidelberg: Springer doi:10.1007/978-3-642-52335-9_5

Bracchi, V., Savini, A., Marchese, F., Palamara, S., Basso, D., and Corselli, C. (2015). Coralligenous habitat in the Mediterranean Sea: A geomorphological description from remote data. *Italian J. Geosci.* 134, 32–40. doi:10.3301/ijg.2014.16

Foster, M. S. (2001). Rhodoliths: between rocks and soft places. *J. Phycol.* 37, 659–667. doi:10.1046/j.1529-8817.2001.00195.x

Rasser, M. W., and Piller, W. E. (2004). Crustose algal frameworks from the eocene alpine foreland. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 206, 21–39. doi:10.1016/j.palaeo.2003.12.018

Steneck, R. S. (1986). The ecology of coralline algal crusts: convergent patterns and adaptative strategies. *Annu. Rev. Ecol. Syst.* 17, 273–303. doi:10.1146/annurev.es.17.110186.001421