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Editorial: Scientific approaches for the conservation and sustainable use of precious coral resources

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Editorial on the Research Topic
Scientific approaches for the conservation and sustainable use of precious coral resources

Precious corals: resources threatened by fisheries

The history of the human use of precious corals finds its origins in the Mediterranean region. Based on studies of Neolithic sites in Italy, Switzerland and Spain, it is hypothesised that the Mediterranean red coral *Corallium rubrum* (Linnaeus, 1758) was already in use by the end of the 6th millennium BC (Borrello et al., 2012). Furthermore, a ship containing precious coral fragments dating back to the late 6th century BC was excavated at a site in Marseille, France, indicating that ship-based coral fishing was practised at that time (Pomey, 2000). In modern times, coral fishing began in Japanese waters in the 1870s, in Taiwanese waters in the 1920s, and around Midway and the Hawaiian Islands in the late 1960s (Iwasaki, 2010). Today, coral fisheries are present in the Mediterranean Sea and Japanese and Taiwanese waters. Until recently, coral fisheries have repeatedly sought out new fishing grounds, exhausted them and moved on to the next one. This primitive exploitation strategy has led to a decline in resources, resulting in the listing of *C. rubrum* as Endangered (EN) on the IUCN Red List of Anthozoans in the Mediterranean Sea and the Japanese red coral, pink coral and white coral as Near Threatened (NT) on the Red List of the Ministry of the Environment in Japan. In addition, Chinese precious corals are listed in Appendix III of CITES.

With precious coral resources currently under increasing fishing pressure due to rising prices, the management and restoration of resources are urgent issues. However, the scientific knowledge needed to address these problems is lacking. This Research Topic, entitled "*Scientific Approaches for the Conservation and Sustainable Use of Precious Coral Resources*" was conceived as an opportunity to consolidate biological and ecological knowledge on this subject. Contributing researchers Kise et al. conducted a population genetic analysis using genome-wide single-nucleotide polymorphisms (SNPs) of Japanese red coral *C. japonicum* (Kishinouye, 1903) in Japanese waters and showed that gene flow was widely maintained in the geographic range. However, larval dispersal simulations revealed the existence of populations with limited interactions with other populations. Yamada et al. estimated the growth rates of *C. japonicum*, pink coral *Pleurocorallium elatius* (Ridley, 1882) and white coral *P. konojoi* (Kishinouye, 1903) using the ^{210}Pb method and found that their radial growth rates (diameter) were 0.21–0.36 mm/year, 0.36 mm/year, and 0.36–0.60 mm/year, respectively. The knowledge needed to manage coral resources in Japan is scarce, and resource management lags behind that in the Mediterranean Sea (Iwasaki, 2019). These results can therefore contribute to the understanding of population dynamics, resource management and extinction risk assessment for Japanese precious coral populations.

New threats

In an age of global changes, precious corals and the environment they live in are facing new threats. Mass mortalities of *C. rubrum* due to ocean heatwaves have already occurred in shallow waters in the Mediterranean Sea (Cerrano et al., 2000; Garrabou et al., 2001; Garrabou et al., 2009). Multiple climatic hazards (increased sea temperatures, acidification, decreases in oxygen and POC flux) affect the seamount ecosystems and slope ecosystems where precious corals are distributed. These hazards are expected to diminish the habitat quality of cold-water corals in seamount ecosystems. Moreover, an expansion of oxygen minimum zones due to oxygen decrease is expected to affect the biodiversity and distribution of organisms in slope ecosystems (Bindoff et al., 2019). Due to the high solubility of their high-magnesium calcite skeleton, precious corals are susceptible to acidification. Experiments rearing *C. rubrum* in acidified seawater showed a decrease in biocalcification, growth rates and polyps' feeding activity (Bramanti et al., 2013; Cerrano et al., 2013; Le Goff et al., 2017).

In this Research Topic, Toma et al. analysed data from 624 ROV dives conducted at depths of 40–1825 m in the waters around Italy. They reported that *C. rubrum* populations were exposed to stressful situations throughout the study area and that mortality in mesophotic zones was mainly due to mechanical entanglement by non-selective fishing gear, used not only in the past but also, illegally, today (Cattaneo-Vietti et al., 2017). They also reported the occurrence of recent mass mortality events at depths of 70–200 m, raising the issue of determining the cause of death. Giordano et al. studied in detail the skeletogenesis in the early stages of *C. rubrum* and found that the first sclerites appear at least 12 days after larval settlement, which is associated with a high $CaCO_3$ production rate, and that sclerites are formed in 3–4 days. Since ocean acidification affects the early life stages of species (Kurihara, 2008; Cohen et al., 2009), this study is a significant contribution to understanding the potential effects of future pH changes. Finally, Yoshimura et al. conducted high-precision Sr isotope measurements on the skeletons of several precious corals at depths of 30–1500 m in the Pacific Ocean and found that the stable isotope ratio of Sr (δ^{88}Sr) remained almost constant regardless of the locality and depth of the coral and was not affected by changes in the partition coefficient (K_d), i.e., the skeletal and seawater Sr/Ca ratios. These results demonstrate a pathway to accurately reconstructing past seawater stable Sr isotope ratios and provide fundamental insight into marine environmental variability and the incorporation of trace elements into the carbonate skeletons of precious corals.

Future issues

While research on the effects of the above-mentioned fishing impact and multiple climatic threats on the occurrence, abundance and resilience of precious coral resources is vital, exploratory studies are still essential to fully ascertain the distribution of precious coral species in the oceans, particularly in deep waters. With the development of various offshore activities (oil and gas extraction, mining, construction, etc.), research on precious corals and the conservation of these representative inhabitants of vulnerable marine ecosystems are increasingly important issues. The demand for precious corals and the prices they command as jewelry will affect the collection and, consequently, the fate of these species. These factors highlight the importance of the institution of Marine Protected Areas (MPAs) not only along coastal waters but also at mesophotic and bathyal depths, where many coral populations are found. In this regard, with over twenty years of protection in the Portofino MPA (Ligurian Sea, Mediterranean Sea), the shallow-water red coral populations have shown a clear recovery (Bavestrello et al., 2015).

Not only natural scientific research but also sociological and economic research on precious corals as marine products is essential. In addition, research on the actual situation of commercial distribution and trade controls is necessary for the effective implementation of CITES regulations. Furthermore, precious corals, which have been used worldwide since prehistoric times for ornaments, jewelry and medicines, provide a rich subject for research on material culture (Lacey, 2016; Iwasaki, 2021). The editors hope this Research Topic will spark the interest of a wide range of researchers and inspire ongoing studies of precious corals.

Author contributions

NI: Writing – original draft. GB: Writing – review & editing. MB: Writing – review & editing. HH: Writing – review & editing. YT: Writing – review & editing.

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