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Diversity and distribution of octocorals and scleractinians in the Persian Gulf region

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Summary

This thesis reviews available coral studies in the Persian Gulf: it discusses environmental challenges for corals in the context of climate change, it increases our knowledge of coral biodiversity and biogeography of the region, it highlights the remaining gaps in our knowledge, and it provides recommendations for further research. This is of special importance given the recent international interest in the region as a recognized natural laboratory for studying coral adaptation to climate change at a time when the impacts to the global environment, human society and the economy have started to be felt.

The first section, **Environmental conditions of the Persian Gulf and their implications for corals**, familiarises the readers with all the necessary background information about the region, with trends in current research, challenges, and the substantial changes that have taken place in marine habitats and resources over the past decade, with a description of their possible consequences to the coral ecosystem in the Gulf (**chapter 1**).

The second section, **Non-reef building octocorals**, deals with octocoral fauna of the Persian Gulf region. The first two chapters of this section (**chapters 2 and 3**) are the first comprehensive papers to be published on octocorals in the region. All of the relevant literature was reviewed in detail; a great number of new specimens as well as specimens in the available museum collections were thoroughly examined and identified. Although being unable to give names to all specimens, descriptions of numerous species are given and illustrated with SEM photographs showing the sclerite features, and *in situ* underwater pictures, and with respective distribution maps. These two studies present a foundation for octocoral work that can be built on and modified in the future. In these studies, several new species were described, some were synonymised, and many were reported for the region for the first time. The chapters that follow contain discoveries of the extensive sampling conducted by the author in the region, and describe several new species and their distribution, and so complements chapters 2 and 3. A new species of *Bebryce* (Octocorallia, Plexauridae) from the Oman with distinctive characters, i.e. tiny rosettes, led to a revision of the taxonomy of all Indo-Pacific species with similar characteristics (**chapter 4**). During fieldwork in the Persian Gulf and the Oman Sea, several new species of the genus *Trimuricea* were identified, which was unexpected given the very few records in the Indo-Pacific. However, it was impossible to determine any of the newly collected material to species level and as a result the genus was taxonomically revised, with some species synonymised and several new ones described (**chapter 5**). **Chapter 6**, was based on a study of material of the genus *Briareum* (Octocorallia, Briareidae) collected from the region. Once more our limited understanding of this genus and its species characteristics required an overview of all Indo-Pacific species leading to the description of a new species. The third section, **Reef building, scleractinian corals of the Persian Gulf**, deals with the scleractinians and other reef building corals. It discusses their taxonomy, distribution, and the consequences of environmental stresses, such as coral diseases and bleaching. **Chapter 7** reviews reef-building scleractinian corals in the Persian Gulf region in the literature. It provides a checklist of the present framework-building species and also discusses the taxonomic problems associated with some of these species. The majority of the reported species have been described, complemented with *in situ* underwater photographs and distribution maps.

In **chapter 8**, the coral health issues, bleaching, and diseases in the Persian Gulf are discussed in detail and a quantification of bleaching thresholds and all known diseases and afflictions

provided. **Chapter 9** reviews the marine conservation of the Persian Gulf through the perspective of corals. One of the direct effects of sea temperature rise is coral bleaching which have become more frequent and intense globally and which is considered to be a severe risk to the long term survival of coral reefs. The Persian Gulf, with its extreme high temperature fluctuations, has also experienced coral mortalities and bleaching events. Although, bleaching events have been recorded in the south of the Persian Gulf, equivalent information is scarce from its northern area. Since it is impossible to directly observe earlier bleaching events, hind-casting of past bleaching events was carried out. To explore the most appropriate method for hind-casting, the feasibility of using multi-temporal satellite images for detecting past bleaching events was investigated which indeed proved to be a useful tool (**chapter 10**).

The last section, **Research needs for the future**, identifies existing knowledge gaps needed to predict changes to the Persian Gulf coral reefs in light of climate change and familiarises the reader with current research concepts, their challenges and areas for further research. The results and recommendations are based on the analysis of more than 70 research questions answered by 32 researchers of various disciplines from different countries participating in the research. Therefore it amalgamates research ideas from different aspects and points of view. These questions can provide guidance for future research on coral reef ecosystems in the Persian Gulf region, and enhances the potential for assessment and effective management of future changes in this globally important and interesting region (**chapter 11**).

Appendix 1, contains a short paper, presenting the first *in situ*, shallow-water observation of the genus *Pseudothellogorgia* worldwide. This genus was considered to be exclusively a deep-water octocoral group, but during the course of this work a specimen was found in shallow waters of Daymaniyat Islands in Oman. This could indicate that the tropical monsoon system, and perhaps to some extent upwelling, plays a role in the larval dispersal of this species. **Appendix 2**, contains a short account of only the second *in situ* observation of the genus *Trimuricea* worldwide in the last century. **Appendix 3**, is a short paper on serpulid infestations on coral colonies after the extensive 2010 red tide event in the Persian Gulf that caused wide spread coral mortality. **Appendix 4**, is a short paper describing a unique and extensive coral community at an Iranian Island in the Gulf being exposed during at low tide. **Appendix 5**, is a short paper on the distribution of *Acropora* outcrops at Larak Island, in the Strait of Hormuz, demonstrating that *Acropora* has been a dominant element in the coral communities of the Persian Gulf since the Pleistocene.