
Chapter I

Introduction

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At the end of the 2015 Aquatic Biodiversity and Ecosystems Conference, a day was set aside for a workshop following up on the 1990 Plant–Animal Interactions meeting and its associated Systematics Association book – *Plant–Animal Interactions in the Marine Benthos* (John et al., 1992). Talks given throughout the 2015 conference also informed the present volume and its chapters. The 2015 workshop took a comparative approach with a series of informal presentations and discussion sessions from selected participants from around the world. The general aim was to take a regionally based view of the role of interactions in setting distribution patterns, community structure and functioning of shallow-water marine ecosystems. The coverage was predominantly coastal, down to the limit of light penetration. Most contributions were from those working on rocky intertidal and subtidal habitats, reflecting the size (and willingness to contribute) of the research community coupled with the greater tradition of experimental approaches to examine interactions on more tractable hard substrata. In addition, mangroves, biofilms and the deep sea were also considered as special systems that are ubiquitous across several oceans where significant advances have been made and, therefore, warranted inclusion. Recent advances in remotely operated vehicles, for example, have increased the scope for observation and experiment in the deep sea (Johnson et al., 2013); whereas mangroves are important ecosystem

engineers which provide important ecosystem services, but are declining globally (Polidoro et al., 2010; Chee et al., 2017). Biofilms were also included as a subject given their global distribution and importance as the site of first settlement of macrobenthic organisms and as a food source for grazers (Abreu et al., 2007). While this volume does not feature any chapters specifically on artificial structures, ocean sprawl or eco-engineering, a large number of talks and posters at the conference dealt with these emerging issues, reflecting their global importance (see Firth et al., 2016; Bishop et al., 2017 and Strain et al., 2018 for reviews). A notable omission is coral reefs, which were not covered because they already have a well-established community of research workers and deserve a volume in their own right. Inevitably, there are gaps in coverage reflecting difficulties in soliciting and delivering input, especially on soft shores as well as certain geographic locations. Coverage in 1992 and 2018 is shown on the maps in Figure 1.1.

The workshop itself also provided an opportunity to reinforce the desired approach for the contribution to the invited regional reviews. Authors were asked to consider a variety of key aspects including: phylogeographic and biogeographic processes establishing the species pool in a particular region, the patterns of distribution in response to geographic and local environmental gradients (including the role of abiotic and biotic interactions in determining those patterns), the

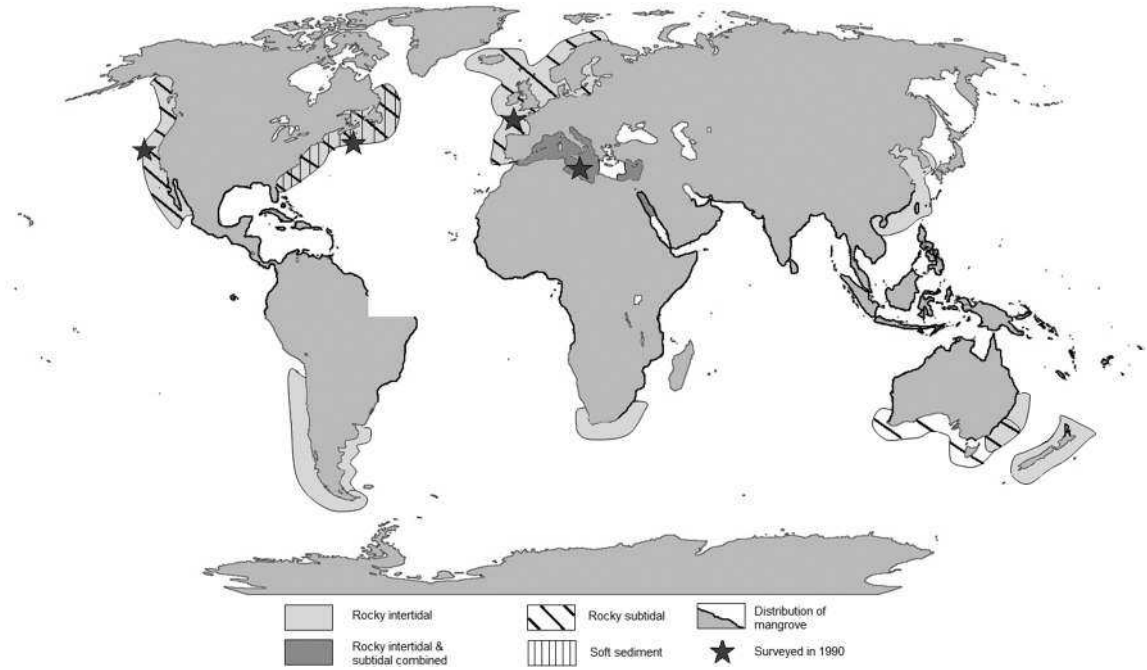


Fig. 1.1 Coverage of areas reviewed in this volume compared to John et al. (1992; indicated by a star).

role of mesoscale processes such as upwelling and coastal hydrography and morphology in setting distribution patterns and abundance, the influence of non-native invasive species, and the consequences of patterns of community structure for emergent ecosystem functioning. They were also asked to identify knowledge gaps. Accordingly, Chapter 2 led by three of the editors of the volume followed this format. The rest of the volume is a tribute to the originality and diversity of approaches adopted by the authors or, perhaps more likely, the inability of the editors to herd cats.

Chapter 2 (by Hawkins et al.) is based on the opening plenary given by Hawkins on the intertidal zone of the north-east Atlantic and provides an update to Hawkins et al. (1992). This chapter is larger than the others as it deliberately digs back into the extensive history of study of the north-east Atlantic region. The next cluster of chapters looks in turn at the subtidal zone in the north-east Atlantic (Chapter 3, by Hiscock et al.), as well as the intertidal (focussing on abiotic and biotic processes and anthropogenic effects, Chapter 4,

by Dudgeon and Petraitis) and the subtidal (Chapter 5 by Johnson et al.) rocky habitats of the north-west Atlantic. There were no specific chapters on subtidal habitats in *Plant–Animal Interactions in the Marine Benthos* (John et al., 1992), generally being subsumed in chapters focussing more on the intertidal zone; therefore, the subtidal chapters in this volume serve as a useful reference for this system. Depositing shores of the north-west Atlantic are covered in Chapter 6 (by Woodin et al.), led by a pioneer of the experimental approach on soft shores. The less-studied south-west Atlantic coast of South America is covered next (Chapter 7, by Palomo et al.), focussing on the coast of Argentina and highlighting some of the unique patterns of biodiversity on hard shores, which show higher diversity at higher latitudes in contrast to generally expected patterns. The Mediterranean Sea is then the focus of Chapters 8 and 9. In Chapter 8, Benedetti-Cecchi et al. discuss the explosion of experimental work since the late 1980s that has been conducted to untangle the important processes shaping coastal systems – a very different

approach from the classical phytosociology of the 1960s and 1970s (Ewald, 2003). Attendance at the Liverpool meeting in 1990 provided a major stimulus to the lead author (Benedetti-Cecchi) and his subsequent wider team to undertake field experiments. Chapter 9 (by Rilov et al.) then details the interactions underway in the Levant as a consequence of Lessepsian migration via the Suez canal, coupled with rapid climate warming (Rilov et al., 2018). The Levantine basin in the southeastern Mediterranean is the world's most invaded marine ecosystem (Edelist et al., 2013), and as such provides a unique opportunity not only to experimentally consider the negative impacts of non-native species (Reise et al., 2006; Zwierschke et al., 2016), but also their potential positive impacts on ecosystem functioning and emergent services (Borsje et al., 2011; Schlaepfer et al., 2011; Epstein 2017; Lemasson et al., 2017) in a highly degraded ecosystem.

Attention turns to the Pacific with chapters on the well-studied north-east Pacific coasts of North America: the intertidal zone is covered in Chapter 10 (by Fenberg and Menge), focussing on factors affecting biogeographic distributions and alteration by human impacts, while the subtidal zone is dealt within Chapter 11 (by Heery and Sebens), highlighting the interactions of biotic factors with environmental context. The south-east Pacific coast is then considered, focussing on the role of top-down and bottom-up forcing on ecological interactions along rocky shores in Chapter 12 (by Aguilera et al.). These coasts are strongly influenced by upwelling systems, which provides an overarching backdrop to the processes operating in these areas.

Focus then turns to the transition between the Atlantic and Indo-Pacific (Chapter 13, by McQuaid and Blamey) along the coasts of Southern Africa. There is a clear gap in coverage between this area and the north-west Pacific coastlines of greater China which are considered next (focussing on biogeography, phylogeography, biological processes and human impacts, Chapter 14, by Williams et al.). In addition to the reasonably well-studied shores of Hong Kong, more recent work on mainland China and Taiwan are included, giving much greater coverage, but still highlighting a lack of knowledge in this region.

The shores of Australia and New Zealand are then considered, with Schiel et al. (Chapter 15) focussing on the rocky intertidal zone, while Connell et al. (Chapter 16) review work on the kelp forests of the temperate subtidal zone, attempting to predict the future sustainability of these key ecosystems.

Specific habitats are then considered in turn: mangroves (focussing on the importance of positive interactions, Chapter 17, by Huxham et al.), biofilms (Chapter 18, by Schuster et al.) and the deep sea (Chapter 19, by Allcock and Johnson). Finally, Chapter 20 is an attempt at synthesis in part addressed by a structured questionnaire to lead authors.

We hope that the reader will see much progress since *Plant–Animal Interactions in the Marine Benthos* (John et al., 1992). The diversity of approaches by the different authors reflects differences in scientific outlook, philosophy and approach. Work in North America, which has also strongly influenced approaches in Chile, tends to progress from a theoretical perspective. This contrasts with the British school stemming from Orton, Southward and Crisp, Kitching, and Ebling (strongly influenced by the French workers Fischer-Piette and Hatton, see Hawkins et al., 2016 for review) that can be best considered as experimental natural history. Underwood has made a huge contribution in advocating logical design and experimental rigour in hard reef ecology (e.g., Underwood, 1991, 1994, 1997, 2000); and this approach has infiltrated to most corners of the world (e.g., Williams and Morritt, 1995; Benedetti-Cecchi et al., 1996; Crowe and Underwood, 1999; Airoidi, 2000; Bulleri et al., 2002; Knights et al., 2006, 2012; O'Connor et al., 2006; Firth and Crowe, 2008, 2010; Iveša et al., 2010; Marzinelli et al., 2011; Knights, 2012; Bohn et al., 2013; Jackson et al., 2013; McManus et al., 2017) from its roots in Australia. Perhaps importantly, this book also reveals regions which are poorly known, or understudied. There is, for example, very little contribution from the world's hotspot of marine biodiversity in South East Asia; nor is there the representation one would expect, given their wide distribution and large extent, for soft shore habitats. Above all, we hope that the chapters provide a thought-provoking overview of particular regions and habitat, and point the way

forwards for subsequent efforts to increase coverage in less well-studied regions.

In addition to the present book, there were a range of other outputs from this conference that were edited by members of the organising committee. A special issue of *Journal of Experimental Marine Biology and Ecology* was edited by Antony Knights, Louise Firth and Bayden Russell, and featured reviews including the effect of ocean sprawl on ecological connectivity (Bishop et al., 2017) and soft sediment habitats (Heery et al., 2017), ocean acidification impacts on ecosystem service provision in oysters (Lemasson et al., 2017), nutrient flux across the land–sea interface (Moss, 2017) and a global analysis of the role of kelp forests as biogenic habitat formers (Teagle et al., 2017). Research articles included environmental factors affecting host–parasite interactions (Firth et al., 2017), habitat complexity of artificial structures affecting biodiversity (Lavender et al., 2017, Loke et al., 2017), impacts of climate change on intertidal ectotherm behaviour (Ng et al., 2017) and larval metamorphosis in response to biofilm cues (de Brito Smith et al., 2017).

A special issue of *Oceanography and Marine Biology: An Annual Review* also stemming from the meeting was edited by Steve Hawkins, Ally Evans, Andrew Dale, Louise Firth, David Hughes and Philip Smith and featured reviews on herbivorous starfish (sea star) (Martinez et al., 2017), intertidal boulder fields (Chapman, 2017), ecological dominance on rocky shores (Rius et al., 2017), the distribution, current threats and conservation status of giant clams (Neo et al., 2017), the role of anthropogenic activities in affecting the establishment of non-indigenous species post arrival (Johnston et al., 2017) and herbivore effects on seaweed invasions (Enge et al., 2017).

We hope that this book will be of interest to marine ecologists, conservationists and managers alike, and will inspire further research where knowledge gaps have been identified.

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