Preface

Why a functional approach to marine biology?

Upon opening this book, you are about to embark on a trip into the world's oceans that may lead you from a familiar sandy beach to the far reaches of the open ocean and the deep sea, on a fascinating journey studying marine life and how living creatures, from giant whales to tiny microbes, interact with the environment in which they thrive. There are many possible approaches to the study of a certain subject in the life sciences, and when it comes to a complex, interdisciplinary subject such as Marine Biology, the approaches can be even more challenging. Biology has traditionally put an emphasis on structure over function. Taxonomy and systematics have played a significant role in the development of Marine Biology as a discipline, especially in the 19th and 20th century, following the Linnean tradition established amidst the Romantic Naturalism movement.[1]

Are Marine Biology and Biological Oceanography the same thing? No. Marine Biology is the study of the biological aspects of marine organisms, meaning that the focus is put in the biota itself rather than the marine environment which they inhabit. On the other hand, Biological Oceanography is the branch within the science of oceanography that focuses on the processes mediated by the biota, which have implications for the oceans. Traditionally, scientists who go on cruises look into distribution patterns of biota and relate them to environmental properties are considered biological oceanographers, and those who explore the biological functioning of organisms, e.g., conducting laboratory experiments, consider themselves marine biologists. *Are these two disciplines too far apart from each other?* No, not necessarily. In fact, they only differ in their focuses, while they have many points of contact and overlap. As it has been proposed, the combination of the two disciplinary approaches briefly sketched above leads to a better understanding of the ecology of the oceans.[2] In that sense, this book tries to "reconcile" (for lack of a better term) these two seemingly different disciplines, in the sense that we believe the study of marine organisms may be incomplete, and even limited, without considering them in the context of the environment that they thrive in, and how they interact and modify it through their metabolic, behavioral and reproductive processes.

Undoubtedly, the 20th century saw the advent and consolidation of Ecology as a new discipline in the biological sciences, drawing much of its conceptual framework from experimental developments in marine systems (e.g., island biogeography experiment by MacArthur and Wilson,[3] the concept of keystone species and bottom-up *vs.* top-down controls elegantly introduced by Robert Paine[4] through rocky-shore communities). *Can we separate the study of marine organisms from their environment?* No. The study of Marine Biology necessarily requires an ecological approach; it is even implicit in the very term (*Marine* refers to the environment, *Biology* refers to the life that thrives in and alters such environment). Remember that the term *ecology* was coined by the German zoologist Ernst Haeckel, after the Greek term οἶκος, meaning "house". That is enough reason for us to have primed an ecological approach to the treatment of each chapter in this book.

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[1] Larson, J.L. 1967. Goethe and Linnæus. J. Hist. Ideas 28(4): 590–596.

[2] Kiørboe, T. 2008. A Mechanistic Approach to Plankton Ecology. Princeton University Press, Princeton, NJ. 209 pp.

[3] MacArthur, R.H. and E.O. Wilson. 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, NJ. 203 pp.

[4] Paine, R.T. 1966. Food web complexity and species diversity. Am. Nat. 100: 65–75.

So why focus on function over structure? In its early stages, the blooming science of Ecology heavily relied on the characterization of communities from a structural point of view; the Braun-Blanquet cover-abundance scale[5] for the analysis of plant communities is perhaps the most remarkable example of such disciplinary approach, and this approach was imprinted into many ecological studies throughout the 20th century. More recently, the "ecosystem service" framework, introduced some 15 years ago,[6] emphasized the (economic) value that the natural functioning of ecosystems provides not only to the biosphere, but also to mankind. It has since been successfully adopted in academic and environmental management circles. What would be the economic costs of clearing a tidal prism of suspended particles in an enclosed embayment if we should need to resort to engineering devices rather than relying on benthic suspension feeders? On a closer look, the ecosystem service framework is inherently linked to ecosystem functioning rather than structure. The Anthropocene has witnessed many changes in the way biogeochemical processes and rates work at a planetary scale. As such, it is the functioning of marine ecosystems that is being compromised.[7] The case of an invading seagrass in the Caribbean Sea, mentioned in Chapter 8, is one example of how ecosystem functioning may be altered, while the structure might remain quite the same.

The field of Marine Biology certainly is not new; in fact, there are some excellent textbooks on the matter that have become classics over the decades since their publication. For our book, we have strived to seek the contributions of renowned and up-and-coming professionals in the different fields of Marine Biology, aiming to produce a fresh text for the new audiences of students and young academics. This was done in our hopes to deliver consolidated knowledge and contribute new perspectives to the young actors that will make a difference in the way we study, make use and preserve our oceans in the future. This book was conceived as an introduction to Marine Biology, for a new generation of scientists, teachers and academics interested in the world's oceans. Of course there are many remarkable Marine Biology textbooks out there, which paved the way for the enlargement of this discipline, and we hope this book measures up to the legacy of renowned authors who conceived those wonderful books.

The book is organized into three sections, namely, an introductory part separated into two chapters and providing a general background to the marine environment; a mid-section consisting of 10 Chapters, which delve into the functional biodiversity of marine organisms (this represents the core of the book); and finally two closing chapters that focus on current topics of special interest such as climate change.

We hope to have produced a high-quality text that will appeal both to upper-level undergraduate and first-year graduate students, professors teaching those courses, and members of the scientific community. For such endeavor, we have taken special care contacting renowned specialists on different topics, which is reflected in the diversity of institutions around the world that are represented among the authors included in this book. With contributions from authors from North and South America, Europe and Japan, we made a conscious effort as editors for the book to be appealing to a broad audience of readers from around the world. We are thankful to the authors who produced high-quality material, mostly based on primary literature sources (i.e., publications from specific scientific journals), covering examples from all major ocean basins and coastal seas on Earth. We are also thankful to those researchers who contributed original photographs and illustrations to enrich the text (credits are given where appropriate).

This is a peer-reviewed book, meaning that all chapters have been evaluated by experts in each field, on the basis of their scientific quality, innovative approaches and potential contributions to each sub-discipline within Marine Biology. Accordingly, this preface would not be complete without the acknowledgement of the superb job carried out by the many reviewers who contributed their expertise and insight to the improvement of each chapter and the book as a whole. They come from broad areas of academia, scientific research, conservation charities, NGOs, and environmental business and technology. They are:

N. Aberle-Malzahn: Department of Biology, Norwegian University of Science and Technology

M. Ahrens: Universidad de Bogotá Jorge Tadeo Lozano

[5] Braun-Blanquet, J. 1932. Plant Sociology (Transl. G.D. Fuller and H.S. Conrad). McGraw-Hill, New York. 539 pp.

[6] Millenium Ecosystem Assessment. 2005. Ecosystems and Human Well-Being: Biodiversity Synthesis. World Resources Institute, Washington DC.

[7] Margalef, R. 1963. On certain unifying principles in ecology. Am. Nat. 97: 357–374.

J.M. Bedmar: Argentinian Geological Service (SEGEMAR)
C.F. Berghoff: National Institute for Fisheries Research and Development - Argentina (INIDEP)
G.S. Blanco: Marine Organismal Biology Institute (IBIOMAR)
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G. Cavieres P.: Center of Applied Ecology and Sustainability, Pontificia Universidad Católica de Chile
G. Cepeda: National Institute for Fisheries Research and Development - Argentina (INIDEP) & IIMyC
R.R. Christian: East Carolina University
G. Giardino: Marine and Coastal Research Institute (IIMyC)
S. Gonçalves Leles: University of Southern California
A. Jordi: Jupiter Intelligence
R. McBride: NOAA Fisheries, Northeast Fisheries Science Center
A.C. Morandini: Center for Marine Biology (CEBIMar) & Zoology Dept., Universidade de São Paulo
V. Reyes: Whale and Dolphin Conservation UK & Fundación Cethus
A.F. Rosenthal: Asociación Naturalistas Geselinos-NGO
V. Segura: INIDEP
I. Sunesen: CONICET, Phycology Division at La Plata Museum

Some others have opted to remain anonymous. Through their contributions, they have made this book much more sound and robust; of course they are not liable for any inaccuracies and errors that may remain in the text.

Last but not the least, we would like to express our gratitude to our families and support systems, without whose help the road leading up to the completion of this project would have been even longer and more winding. JP would especially like to thank his twins, Lena and Braulio, for being understanding, encouraging and patient whenever their Daddy had to take time off to work on this book, and also for being the best help on field trips. PP wants to mention the inspiring questions of her son Ulises, a 10-year-old super explorer of the beautiful oceans.

The final stages of writing and editing for this book took place during the COVID-19 pandemic, a time when most of humankind halted their daily lives and had to take a step aside. During this time, a deep collective conscience on the impacts we have created on our planet started to arise, and many people, perhaps millions who have never given a thought to such matters, noticed their magnitude and importance for the first time. Ours is a pivotal time for the care and preservation of the Earth's oceans, and we hope this is collectively embraced among other new paradigms; as such we hope to have made a small contribution with this book.

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