

*A homage to the past aiming at the future*

Are the oceans dying? This is a question that many people are asking themselves more and more insistently. The answer is that in no case are they dying – but they are being transformed. Deeply. Unfortunately, this transformation has changed the ocean for a worst stage in terms of overall quality. Human-induced changes across the globe affect marine more than terrestrial ecosystems. And, at sea, there is a problem: because it is not our environment, it is not easy for us to see what is happening. However, make no mistake: oceans connect all continents and have a profound impact on the terrestrial ecosystem as well. All over the world, the disappearance of large predators (whales, sharks, tuna fish, turtles, seals, swordfish, etc.), as well as the drastic reduction in many living structures on the seabed (coral reefs, algae meadows and higher plants, deep corals, etc.), has led entire ecosystems to change and achieve a new balance on the basis of abundant small organisms and accelerated life. And there is more: persistent pollution, both chemical and biological, and the “not fully understood but certain” effects of climate change may be adding to the plight of our oceans as we know them. Unfortunately, we cannot claim to know the full impact that such changes may have on the entire system, on the functioning of our planet, and on our own survival. In fact, ocean science is still dealing with several challenges to understand the largest area of the world, their needs and priorities, as well as potential solutions.

Today, no one can ignore the fact that human beings have essentially impacted every habitat in the biosphere. The biosphere that we now dominate needs to be understood regarding concepts such as ecological economics, the persistence of species, sustainable exploitation, and recoverability. The anthropogenic impacts in the ocean have large spatio-temporal variabilities, spanning from global threats, like ocean acidification and warming, to regional/local stressors, like eutrophication, deoxygenation, loss of biodiversity, among many others. This implies knowing more about population sizes, genetic flows, and the positive or negative relationships between species and the physico-chemical properties of the ocean. It also means learning to adapt our way of life (the same way of life that that has had so many impacts) and understanding our role in nature. In this list of concepts, we are undoubtedly far behind in our knowledge concerning the marine environment, as it is home to the most inaccessible and unknown habitats on Earth. The problem is partly one of focus, of perspective, of the way we understand what surrounds us. The various transformations that have taken place (and are taking place) in marine ecosystems deserve some reflection. A reflection not only as a result of specific experimentation but also from critical observation of what was once in balance; now shifted, across the globe.

The emerging Decade of Ocean Science for Sustainable Development (2021-2030) promoted by the United Nations arose from this reflection and the need to develop “the science we need for

the ocean we want”, the central phrase of the Decade. However, reaching the ocean we want is not an easy task, as there are several obstacles in the way that need to be carefully considered in terms of needs and priorities. The compartmentalization of science and equity gaps are taking us down a dangerous path, because, from a worldwide perspective, there is a great deal of data being generated, but it is sometimes difficult to interconnect them. Thus, this step towards effectively “leaving no one behind” must consider also strengthening ocean science in a collaborative way. This interdisciplinary approach can be accessed by building bridges between the four major fields of oceanography (chemical, physical, geological, and biological oceanography), without forgetting the interrelations with socio economic aspects. Also, there are other difficulties, such as basing a whole model only on what we see, ignoring many compartments of the ecosystems that certainly play important roles but are still unknown or full of unknowns. Until not so long ago, we ignored the role of bacteria and other micro organisms as the engines of life on Earth. We neglected the role of viruses, pathologies and parasites in the functioning of ecosystems, and we avoided ‘hidden’ phases of life cycles such as the existence of cysts or latent states of organisms. These are just some of the examples that lead us to the conclusion that there is a long way to go.

It is with great happiness that we present this Special Issue of *Arquivos de Ciências do Mar*, a homage to the sixtieth anniversary of the Marine Sciences Institute foundation - a homage to the past with an eclectic vision of the future. This volume is intended to gather researchers and professors from different disciplines and sensibilities, topics and questions that we have to answer in the framework of this UN Decade of the Oceans. In this Special Issue, senior and young scientists were invited to contribute on what are hot topics and challenges, concerns and threats, solutions, and plans for conservation, management, and blue growth. We had the opportunity to gather 26 different papers: opinion papers, reviews, original papers or short comments. Interestingly, the focus on the different topics made possible a polyhedric vision of the oceans, from physics to chemistry, from biology to socio-economy.

Carleial and Soares discuss the importance of understanding the way science is nowadays presented to society, and the dangers that we have to readdress to make this branch of knowledge clearer, affordable and more ethical. More than ever we need science, and the ways in which we transmit to the society its advances will be crucial for the future of an informed democracy.

We have two papers about physical ocean observations. Teixeira focuses on the importance of ocean observations to ocean modeling initiatives and presents us an overview of the past and current Brazilian programs collecting in situ near real-time data. Lentini and Mendonça in “Satellite oceanography: harnessing the technological revolution” make a historic review about Satellite Oceanography and highlight future perspectives and leading subjects on this topic. Marta-Almeida stresses the importance of ocean numerical models as a complement to the observations and also a tool for predicting the future ocean conditions and human impacts. The author presents an overview of published ocean modeling studies in Brazil. In “Dredging, mud, and Dunning-Kruger”, Schettini dives into the several aspects inherent to fine sediments dynamics with regard to coastal hydrodynamics and dredging activities. Gramcianinov and colleagues argue that the trends and future changes on the cyclone-related ocean hazards in the western South Atlantic Ocean are still difficult to access, especially in the coastal zone. The authors highlighted the need of a multi-level approach that includes the return of pure science, the use of observational data and the development of new theories and methods to better identify those trends and future changes.

A short review of the work made on the Ocean Acidification in coastal areas is described by Cotovicz Jr. and collaborators. In this paper, they make an overview of the works made in the Brazilian coasts, stressing the need to increase the information in such a diverse set of habitats,

considering the implications for future management of the biodiversity. Abril and colleagues discuss how the spreading of coastal eutrophication may be changing CO<sub>2</sub> fluxes in the tropical coastal ocean. The authors used studies from Rio de Janeiro, Brazil coast to highlight a paradoxical situation where human-impacted tropical coastal ecosystems are evolving toward marine dead zones and blue carbon reservoirs at the same time.

In the review of Havermans and collaborators, the environmental DNA as a tool to detect biodiversity, better understand the trophic ecology and explore potential stress to the ocean communities is brightly explained. They refer to the pros and cons of this methodology, a key tool to speed up management and conservation plans. Markelova and collaborators invite us in a voyage through the properties of the water, especially conscious about its fragility due to the human management of the most precious molecule for life on Earth. The need for a different policy and education is stressed in this interesting paper. The Southern Ocean also has some room in this special issue, in a perspective paper in which Isla brings us to some key factors to be considered for the future research and management of the waters surrounding the white continent. The different stressor impacting the pelagic and benthic ecosystems may alter the more pristine area on Earth.

Are jellyfish an opportunity or a hazard? This question is answered by Morandini, who explains some basic concepts and misconceptions about jellyfish, and presents cues to commercially exploit these more and more abundant organisms that take advantage of the changing oceans. Conservation is also themed in the paper of Sahm and collaborators. The authors tell how the bioprospecting of ascidian molecules of pharmaceutical value can foster conservation by telling a 20-year journey of research on bioprospecting and how it could raise awareness and foster conservation of the oceans.

The role of microbes in the future of the oceans and of humanity is depicted in the paper by Tavares. She explains why we should be interested in microbes, and how these shape the biosphere. With clear examples, she put us in perspective of key aspects like the study of the holobiome, their role in fighting contaminants or as essential part of the coral reef functioning, among other things to illustrate how microbes are excellent tools to help us through Anthropocene's challenges. With no doubt, microalgae are one of the more promising alternatives for energy. Gàrate-Osuna and collaborators describe in an extensive review the possibilities offered, and also the potential restraints that you have to consider for these tiny organisms. The paper is especially focused in the multi-product possibilities of these photosynthetic organisms. Also focusing on the power of the invisible, Bezerra et al. explore the communities of Bacteria associated with one of the most conspicuous mangrove trees of the Americas, *Rhizophora mangle*. Through this research article, the authors highlight how this baseline knowledge could be used for future monitoring projects and for providing microbial-based tools to protect and restore mangroves in the face of increasing anthropogenic threats and climate change. In "Potential and realized diversity of coastal plankton: the role of resting stages in ecosystem functioning", Belmonte and Rubino highlight the importance of resting stages as a strategy for plankton species to avoid the variability of environmental conditions. The authors also present a research perspective on the theme. On the importance of the tiny and invisible, Garcia and colleagues discuss the importance of plankton and how we can use the Decade of Ocean Science to rediscover this essential fraction of aquatic life. Through research and ocean literacy, the authors make an invitation to understand plankton and share the relevance of this "invisible world" to people of all ages, cultures, and education levels.

Guarnieri and De Leo highlight the necessity of a brave plan for marine coastal restoration, demonstrating that the tools are available, we have to apply them. A serious plan of restoration will be a winning solution together with the already existing marine protected areas and maritime

spatial planning that have been developed during decades. Within the hot topic of marine restoration, Reimer and collaborators make important questions about the methods used in the Coral Triangle. They show the importance of different approaches and the implication of research groups in the coral reef regeneration process. Expanding the theme of restoration, Rossi makes a simplified example in which an hypothetical restoration plan in the Canary Islands is applied. He highlights the possibility to optimize the distribution, density and growth of the transplanted organisms to strengthen the carbon immobilization, as well as gardening of soft and hard bottom species with the help of adapted artificial reefs. Ferreira and Lacerda discuss methods and governance decisions to promote rehabilitation/restoration of mangrove ecosystems as a globally mitigation/adaptation strategy to climate change. They argued that mangrove restoration can mitigate the climate change by sequestering carbon in biomass and sediments for long periods of time, in addition to increasing shore protection against sea level rise and extreme climate events. Matos and collaborators discuss the aspects of the integrated coastal zone management of the Northeast Brazil states from the Economy, Law and Sustainability perspectives. They identified the economic activities, directly and indirectly related to Blue Economy in this region. The authors discuss the lack of a broader democratic participation in the decision-making processes with regards to planning the coastal zone sustainable use and occupation.

The global change threats to long-lived species are analyzed by Santangelo. His explanation about the importance to apply demographic models for the conservation of these organisms is extensively explained, with key species examples that help to elucidate what could be the future roadmap for the conservation of these species. The multicriteria approach used by Montiel and collaborators opens the door to a different approach in terms of conservation. The authors made a clear case study showing the importance of having a quantitative method to select key organisms that may be useful for the application of management measures in coastal areas.

The on-board training of qualified professionals in the field of Marine Science in Brazil is the main subject explored by Calazans. In the manuscript "Floating teaching laboratory: practice as a teaching qualification", the author presents and discusses the recent construction of four new vessels in Brazil characterized as Floating Teaching Laboratories to attend the practical teaching of data collection of students of courses in Marine Science.

In this Special Issue, different authors made contributions on various topics related to the challenges faced by the oceans. Bringing a broad view of the subject, one can see the multitude of themes related to ocean sciences and the size of the challenge that we face as scientists in building a future with a gentler and more attentive look at the sea. On the occasion in which we pay tribute to the founding Institution of this journal, we took the opportunity to look to the future through the vision of the scientists that contributed to this Special Issue.

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