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Chapter 2 - Prospection, Collection, and Preservation of Marine Samples

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 10.1016/B978-0-444-63359-0.00002-1 ↗

Abstract

Organisms thriving in the marine environment, living under unique conditions of temperature, pressure, and even chemical surroundings are responsible for the presence of countless bioactive compounds with commercial potential. Bioprospecting can be defined as the collection of such biological materials, as well as the analysis of its properties and contents, with the purpose of developing a commercial product. Thus, the present chapter will focus on the different sampling strategies that have to be taken into account to ensure the appropriate collection of micro- and macroorganisms from natural marine environments. Also, bioprospecting in extreme environments will be addressed due to their peculiar characteristics, together with the preservation of samples.

Keywords

Bioactive compounds; bioprospecting; sample collection; marine environment; extreme habitats

Previous chapter in this volume Next chapter in this volume

Introduction

Although there is a lack of uniformity in the definition of bioprospecting, it can be defined as the collection of biological material and the analysis of its material properties, or its molecular, biochemical, or genetic content for the purpose of developing a commercial product (as defined by the New Zealand government).

Therefore, bioprospecting can be considered as a tool for biodiversity conservation if conducted in an environmentally responsible way. In fact, the International Society of Chemical Ecology has proposed the Biorational Approach to “narrow the field of search to manageable proportions and increase the likelihood of discovering a useful natural product, bridging bioprospecting with biodiversity conservation” [1], [2], [3]. There is a global interest in conservation, with nondestructive use of

natural resources to avoid losses due to overexploitation and even species extinction accompanying habitat destruction. Thus, bioprospecting will contribute greatly to increase scientific knowledge on natural marine ecosystems, regardless of whether the target compound will lead to financial returns or not. Furthermore, from an economical point of view, these actions can promote innovation, scientific research increase, and potentiate aquaculture production of target organisms, which will in turn, generate wealth. However, special care must be given to ethical issues in bioprospecting and conservation policies: research must respect host institutes and organizations regarding new discoveries, including new localities of rare and endangered species. Also, prospecting raises issues of environmental disturbance during the extractive process. For instance, the movement of vessels can cause pollutants to be released or lead to a disruption of currents that may cause unwanted movement of organisms. Moreover, discarding scientific samples can act as a source of biological contamination [3], [4]. Therefore, mitigation measures to reduce the impact to a minimum must be undertaken. Also, special care must be given in protecting traditional knowledge on natural products regarding the rights of indigenous people and local communities, safeguarded by the Rio Declaration and the United Nations Convention on Biological Diversity [4], [5].

Traditionally, the greatest contributors of bioactive compounds have come from terrestrial habitats and include plants, bacteria, and fungi [6], [7]. With the search extending into the marine environment, new groups have surfaced as sources of bioactive substances, including algae and invertebrates.

The definition of marine microorganisms refers to all microscopic species found in salt water, which is in fact an ecological designation rather than a taxonomic classification [8]. The vast biological diversity of marine microorganisms includes archaea, bacteria, viruses, diatoms, yeasts, and fungi [9], but has been explored only to a very limited extent. Nonetheless, the diversity of secondary metabolites produced by these communities is expected to be equally diverse and abundant [7], [2], [10]. Current estimates point to hundreds of millions of marine species representing over 90% of total marine biomass [8]. For fungi alone, despite the fact that only about 465 species are described, the most realistic approach estimates the existence of 1.5 million [7], [10]. Marine bacteria represent about 10% and are found mainly in sediments, but also in endophytic/symbiotic associations with other marine organisms [7], [11]. It is assumed that all marine organisms are associated with microorganisms, which can constitute in some cases up to 40% of total biomass. In fact, in some cases, bioactive compounds primarily attributed to invertebrates were later found to be produced by bacteria or fungal species.

As mentioned before there is a long-lasting tradition of exploring plants and plant extracts in the search for bioactive compounds. Even now the estimates point to 25% of all currently administered drugs having originated from plants. As it happens with marine microorganisms, marine plants include various taxonomic categories and again are an ecologically based classification composed of microalgae, macroalgae (seaweeds), and flowering plants. Also, when compared to terrestrial species, research on bioactive compounds has yet to reach the same level [7].

Finally, macroorganisms constitute another important source of bioactive compounds. This is also a diverse taxonomic group representing several trophic levels of the food web and includes both invertebrate and vertebrate animal species. Among the ascidians, sponges and mollusks have gained importance due to the number of substances with bioactivity being discovered [12]. Research has focused on sessile invertebrates, because they possess no means of physical defense but have evolved powerful chemical substances as defense mechanisms for themselves and to protect egg masses against predation, among other effects [12], [13], [14].

Also, common to all the chemical compounds released in the aquatic environment where dilution would constitute a problem, these substances are usually very potent.

Section snippets

Bioprospecting in extreme environments

Marine organisms living in the deep sea, polar regions, and other extreme environments are exposed to severe conditions in terms of temperature, light, pressure, oxygen, salinity, and even chemical toxicity [15], [16], [17]. Such extremophile organisms developed unique biochemical properties in order to survive under these circumstances, and therefore they are promising sources of unique bioactive compounds [18], [19], [20]. Nevertheless, shallow temperate and tropical habitats have been the …

Collection of marine samples

In order to have a full and unequivocal natural compound evaluation and in that sense, to assure the properties discovered can in fact be attributed to the organism collected, several factors must be considered. The safety and quality of a given compound is influenced by both intrinsic and extrinsic factors (see Table 2.1) [14], [41]. As we will discuss further, specimens obtained from local suppliers will be more easily accessible to bioactive compounds, especially if larger amounts are …

Sustainable production of bioactive compounds

With the intensification of oceans exploration, a notable and growing number of bioactive natural products are being isolated from a variety of marine organisms. However, despite the great potential of such bioactive compounds, their steady production is a key limiting factor that may hold back the development of commercial processes [52], [53], [54]. Bioprospecting of some marine compounds usually depends on wild specimens harvesting. Wild harvest only satisfies the demand partially and …

Preservation of marine samples

Preservation of organism samples is a prerequisite for field studies in remote areas or when there are impediments to return the samples to the laboratory in due time. The collection of marine organisms for the study of bioactive compounds is many times performed in open sea, where immediate tests and analyses are often impossible [79]. One problem arising in the case of microorganisms as producers for bioactive compounds is that host macroorganisms obtained during collection, in some cases, …

Final considerations

With more than 70% of the world's surface and with the least known habitats and species, the ocean plays a critical role in the search for new solutions to ancient problems related to human health, as it is an important source of bioactive compounds with enormous potential for fighting disease. Bioprospecting and biodiversity conservation have progressed closely in this quest for new substances. Collection and preservation techniques play a crucial role in guaranteeing the discovery of new …

Acknowledgements

The authors are grateful to the EMEPC – Estrutura de Missão para a Extensão da Plataforma Continental, Escola Superior de Turismo e Tecnologia do Mar – Polytechnic Institute of Leiria, André Horta, Celso Alves, Luana Granada, Marco Lemos, Nádia Sousa, Nuno Vasco Rodrigues and Sílvia Jesus for kindly providing the photos used in this chapter. …

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