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Marine microorganisms as a promising and sustainable source of bioactive molecules

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ABSTRACT

There is an urgent need to discover new drug entities due to the increased incidence of severe diseases as cancer and neurodegenerative pathologies, and reducing efficacy of existing antibiotics. Recently, there is a renewed interest in exploring the marine habitat for new pharmaceuticals also thanks to the advancement in cultivation technologies and in molecular biology techniques. Microorganisms represent a still poorly explored resource for drug discovery. The possibility of obtaining a continuous source of bioactives from marine microorganisms, more amenable to culturing compared to macro-organisms, may be able to meet the challenging demands of pharmaceutical industries. This would enable a more environmentally-friendly approach to drug discovery and overcome the over-utilization of marine resources and the use of destructive collection practices. The importance of the topic is underlined by the number of EU projects funded aimed at improving the exploitation of marine organisms for drug discovery.

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1. Introduction

Oceans cover nearly 70% of the earth surface and host a huge ecological, chemical and biological diversity (Argulis and Schwartz, 1982; Pomponi, 1999; Jimeno et al., 2004; Kijjoo and Swangwong, 2004). The first living organisms appeared in the sea more than 3500 million years ago (Macdougall, 1996; Argulis and Schwartz, 1982) and evolutionary processes have equipped many marine organisms with the appropriate mechanisms to survive in a hostile milieu in terms of extreme temperatures, changes in salinity and pressure, and attack by bacteria and viral pathogens (Jimeno et al., 2004). The harsh chemical and physical conditions of the sea have also favored the production of a great variety of novel molecules in marine organisms that are unique in terms of diversity, and structural and functional features with respect to compounds isolated from terrestrial plants (Kathiresan et al., 2008) and represent a reservoir of new bioactive compounds with a great pharmaceutical potential (Reen et al., 2015). Nevertheless, the marine habitat

is still poorly explored. It is estimated that, in spite of 250 years of taxonomic classification and over 1.2 million species already catalogued in a central database, some 91% of species in the ocean still await description (Mora et al., 2011). The microbiota appears to be a promising and endless source for new drug development (Gerwick and Fenner, 2013) with new chemotherapeutants, especially novel antibiotics to combat diseases and drug-resistant pathogens that are becoming a significant threat to public health (Xiong et al., 2012). Currently, 16 of 20 marine antitumor compounds in clinical trials are derived from microbial sources and many more are expected to enter in the drug discovery pipeline (Xiong et al., 2013). For this reason there is a renewed interest in exploring the marine environment, especially as concerns the microorganisms that live in the oceans, with the aim of identifying novel chemical entities as sources for new lead compounds.

In this review we give a general overview on drug discovery in recent years, focusing in particular on microorganisms, including sponge-associated bacteria and marine photoautotrophs such as microalgae and cyanobacteria. We also present some of the innovative approaches being developed in this field, such as new cultivation methods and molecular biology tools that may help in disclosing the huge potential of marine microorganisms.

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