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Plankton Bio-prospecting in the Ocean

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Abstract

Our planet's oceans cover most of its area and are crucial to maintaining the biosphere's balance. For instance, 50% of the oxygen we breathe comes from microscopic photosynthetic creatures, and the ocean is where we get most of our food and mineral resources. We must focus on the sea in order to identify new options for a sustainable future during this period of ecological crises and significant social change. Surprisingly, the planktonic compartment, which consists of zooplankton, phytoplankton, bacteria, and viruses, constitutes 95% of marine biomass, despite the fact that we are overusing many marine resources, especially fisheries, and the amount of its variety is still largely unknown and underutilized. As a result, plankton's promise as a bio resource for humans is mostly unrealized. Planktonic creatures have enormous prospects because of their varied evolutionary histories, including new supplies of food, medicine, and renewable energy as well as long-term approaches to reducing climate change. Numerous bioactive extracts and purified compounds have already been found in research programmes aiming to use culture collections of marine microorganisms as well as the vast riches of marine planktonic biodiversity in the oceans.

Keywords: Biosphere's balance; Microscopic photosynthetic creatures; Zooplankton; Phytoplankton; Marine planktonic biodiversity

Introduction

If we want to live longer and healthier lives while preserving our planet and its natural resources for future generations, we must be ready to tackle new difficulties as the world population ages and grows. One of the main issues raised by longer lifespans and the recent change in lifestyles is health care. On the one hand, the prevalence of genetic and lifestyle-related diseases like cardiovascular disease, ischemic stroke, diabetes, chronic respiratory disease, and some types of cancer is rising. However, despite significant advancements, infectious diseases continue to be the main causes of death worldwide. In fact, despite having a reportedly vast array of treatment options, infections remain a major cause of worry for health around the world, particularly in industrialized nations. Even though we have a relatively small number of effective treatments for lifestyle diseases, even a few small dietary changes can significantly lower the risk of developing these illnesses. However, providing over seven billion people with a balanced diet is not an easy feat. In addition to the fact that there are increasingly more people to feed, global climate change is also resulting in lower yields of some of our most popular crops, which might have disastrous consequences in developing nations [1].

We think that through bio prospecting the oceans—particularly by using the plethora of chemicals, enzymes, and genes found in mostly unstudied groups of microscopic marine organisms—new and less disruptive solutions may be discovered. The field of marine microbiology has recently experienced a boost thanks to recent developments in DNA technologies and growing public awareness of environmental problems like global warming.

Targeting plankton for bio prospecting

Life most likely began in the ocean some 3.5 billion years ago, and today, every liter of saltwater contains millions of marine bacteria. They make up more than 95% of marine biomass and can be found in a variety of habitats, such as the water column, ocean sediments, or in close proximity to other creatures. They are collectively referred to as plankton, from the Greek word "planktos," which means "drifter," because many of them drift with the currents among other minute animals like zooplankton [2]. All marine settings, even those with extreme weather, are home to planktonic species, which are also incredibly diverse in terms of their sizes, trophic levels, and taxonomic categories (representing every kingdom of life). The photosynthetic phytoplankton, bacteria, viruses, and a variety of bigger zooplankton that graze on the smaller species are all examples. With viruses often present at up to 10 billion particles/L, bacteria normally at up to 1 billion cells/L, phytoplankton typically at up to 10 million cells/L, and zooplankton typically at up to 1000 organisms/L, the number of distinct plankton varies according to size. Marine planktonic ecosystems are extremely dynamic settings that are influenced by a variety of outside influences. While some creatures, known as meroplankton, are only a component of this community when they are in a certain stage of their life cycle, typically the larval stage, others, known as zooplankton, is constitutively planktonic.

The process of collecting organisms and subsequently screening them for a particular chemical or activity of interest is known as bio prospecting. Searching for DNA sequences encoding activities of interest, either from single species or by mining metagenomic sequencing data acquired from entire plankton populations retrieved from the water column, is an alternative to directly prospecting for bioactive. Such methods can assist in avoiding several stages needed for molecular screening [3].

Marine sources of bioactive substances

The number of articles describing "marine natural products" has increased over the past 50 years but has remained much lower than those describing "plant natural products" despite numerous examples (1003 novel compounds described in 2010, more than 10,000 since the 1960s). On the other hand, a growing number of businesses are

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engaged in the production of natural products derived from plankton. Among these, Genentech and Salience are two examples of firms that specifically make items using marine plankton (see later). Microalgae in particular produce a variety of primary and secondary metabolites that are of commercial relevance. There are many other molecules of biomedical interest that have already been discovered through mining for novel molecules in planktonic communities, such as cyclopeptides from cyanobacteria that may be novel cancer drugs, demonic acid from red algae and diatoms for its anthelmintic activity [4], fucoxanthin from brown algae as a potential cancer treatment or to fight diabetes, cephalosporin P from fungi as an antibacterial agent. Whether they are primary or secondary metabolites, organisms adapted to severe conditions (temperature, pressure, pH, salinity, toxicity, etc.) seem particularly fascinating for finding compounds that would not often be encountered in the most common settings. For instance, extreme settings have allowed for the massive sampling of extremophiles bacteria, which has resulted in the discovery of a variety of unique compounds, most notably the DNA polymerases today used for the polymerase chain reaction, a molecular biology technique that is indispensable [5].

Significance of plankton in bio prospecting

Life most likely began in the ocean some 3.5 billion years ago, and today, every liter of saltwater contains millions of marine bacteria. They make up more than 95% of marine biomass and can be found in a variety of habitats, such as the water column, ocean sediments, or in close proximity to other creatures. Many of them float with the currents alongside other minute animals like zooplankton, and are commonly referred to as plankton, from the Greek word "planktos" meaning "drifter". With viruses often present at up to 10 billion particles/L, bacteria normally at up to 1 billion cells/L, phytoplankton typically at up to 10 million cells/L, and zooplankton typically at up to 1000 organisms/L, the number of distinct plankton varies according to size. Marine planktonic ecosystems are extremely dynamic settings that are influenced by a variety of outside influences [6].

Zooplankton, which includes both single-celled protests like ciliates and multicellular organisms like slaps and copepods, is a term used to describe planktonic organisms that graze on autotrophic planktonic organisms such as phytoplankton, which are autotrophic planktonic organisms that use sunlight to drive photosynthesis. Although certain organisms are capable of both autotrophy and heterotrophy at the same time or switch between the two depending on their environment, the distinction between phytoplankton and zooplankton can be hazy. Because of their mycotrophic metabolism, several functions may only be produced briefly, limiting their ability to be fully exploited [7].

Bioactive substances from marine sources

The number of articles describing "marine natural products" has increased over the past 50 years but has remained much lower than those describing "plant natural products" despite numerous examples (1003 novel compounds described in 2010, more than 10,000 since the 1960s). Articles describing "plankton natural products" are also rising in number, following a similar pattern, but there is still much work to be done because this trend only started in the late 1990s. On the other hand, a growing number of businesses are engaged in the production of natural products derived from plankton [8]. Among these, Genentech and Salience are two examples of businesses with goods made from marine plankton (more on this later). The most well-known examples come from the chlorophycaea kingdom: astaxanthin from Hematococcus pluvialis, which brought in $200 million in 2012, and -carotene from Dunaliella tertiolecta, whose market is currently projected to be worth $260 million. Undoubtedly, a species is capable of creating multiple high-value compounds simultaneously. It is also known that D. tertiolecta produces violaxanthin, a pigment with strong antiproliferative effects on MCF-7 breast cancer cells [9].

There are many other molecules of biomedical interest that have already been discovered through mining for novel molecules in planktonic communities, such as cyclopeptides from cyanobacteria that may be novel cancer drugs, domoic acid from red algae and diatoms for its anthelmintic activity, fucoxanthin from brown algae as a potential cancer treatment or to fight diabetes, cephalosporin P from fungi as an antibacterial [10].

Whether they are primary or secondary metabolites, organisms adapted to severe conditions (temperature, pressure, pH, salinity, toxicity, etc.) seem particularly fascinating for finding compounds that would not often be encountered in the most common settings. For instance, extreme settings have allowed for the massive sampling of extremophiles bacteria, which has resulted in the discovery of a variety of unique compounds, most notably the DNA polymerases that are currently used in the polymerase chain reaction, a molecular biology technique that is indispensable [11].

Oceanic bio prospecting

The fact that more than 10,000 compounds have already been reported from marine sources, even though relatively few of them have been commercialized, shows that the bio prospecting strategy is not new. Because of their evolutionary diversity and the assumption that they are rich in defense molecules with effective potencies adapted for diluted marine environments, marine bio prospecting has a tendency to target macro-organisms like corals and sponges. However, significant efforts have also targeted the deep ocean, particularly around hydrothermal vents because of the largely untapped biodiversity and unknown adaptations present in such extreme conditions. Companies like Diverse and New England Bio labs have recently gained a lot of attention in the field of marine bio prospecting. However, plankton ecosystems have received very little attention from marine bio prospectors, presumably as a result of their dynamic diverse nature or the fact that they are little understood. In spite of their great diversity in planktonic ecosystems, which is believed to number between 70,000 and 300,000 species, marine protests in particular have received very little attention. They are less common than bacteria, which makes it more challenging to gather enough biomass, which may account for the lack of interest in them [12].

Conclusion

It is clear from this succinct overview, in which we summarize the current state of the art and prospects for discovering new bio resources from marine planktonic organisms, that several success stories have already surfaced and that interest in the field is likely to increase significantly over the course of the coming years. The enormous planktonic biodiversity could be bio prospected to provide novel solutions to a lot of the world's current problems. In comparison to burning fossil fuels, employing phytoplankton as a feedstock for biofuels would have a significantly smaller impact on the carbon cycle of the earth and could one day give us sustainable liquid energy like biodiesel and possibly even hydrogen. Additionally, planktonic organisms could aid in the mass production of pharmaceutical and nutraceutical ingredients that would benefit the aging population by avoiding or treating diseases brought on by poor lifestyle choices.

Acknowledgement

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Conflict of Interest

None

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