Marine microbial ecology and bioreactors

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Introduction

The oil spill in the Gulf of Mexico in 2010, where the equivalent of 4.9 million barrels of oil was released into the environment, attracted a lot of attention among policy makers and civil society. However, the impacts on the ecosystem turned out to be less catastrophic than expected due to marine microbes digesting the oil spill, even though there are signs of permanent damage.[1] This is a clear example of the adaptive properties of bacteria and the wide range of compounds they can feed on.[2] Microbes also have a very diverse range of substances they can produce and are at the base of healthy, stable, ecosystems all over the world. Marine Microbial Ecology, while still a relatively new field of research, is rapidly uncovering the importance of microbial life in nutrient availability in ecosystems. This is no different for marine environments in which, for example, processes such as nitrification[3] and CO_2-fixation[4] are mainly regulated by microorganisms. Seeing as how over 90% of the ocean's biomass is estimated to be microbial life[5], it is no surprise that their role is crucial in ecosystems. However, because this field has only become an important topic in the last 10 years or so[6], in-depth research is still lacking and only general findings exist in terms of marine biodiversity[7] or in relation to human health.[8]

Marine microbial ecology and bioreactors: facts & figures
• Over 90% of marine biomass consists of microbial life. • An estimated 50-80% of all biomass is found under the ocean surface. • Microbial phytoplankton makes up the basis of the marine food chain and is responsible for producing 50% of the world's oxygen. • Microorganisms are also the main drivers behind nutrient availability in marine ecosystems. • However, microbial community dynamics are still poorly understood.
Source: authors' compilation.

Scientific Debate

Within the scientific community there is still debate on the determination of microbial species due to having only small amounts of genetic material to work with [9] In addition, one of the difficulties is determining marine microbial biodiversity, as the sheer number of species is very high and the data of different areas is not properly integrated.[10] There are also the technical difficulties of measuring a large area like the ocean, which naturally comes forth from the trade-off of either covering a large area or getting a detailed description.[10] However, it is becoming clearer clear that a large microbial biodiversity is not necessarily the main reason for a healthy ecosystem. Rather, the composition of a certain microbial community may be a stronger indicator than biodiversity [11] and microbial community dynamics change when influenced by other factors, such as an increase in CO_2-levels.[12] As such, a change in a microbial community might have a big effect on the ecosystem's nutrient cycles[13] and, due to this, on the other organisms living there as well.

There have been suggestions of connecting the current assessments of marine biodiversity into a single global assessment on marine biodiversity. Such a systems approach is needed in order to establish the importance and function of microbial communities in ecosystems. If this is known this knowledge can possibly be applied in increasing ecosystem resilience or assisting in ecosystem restoration, such as the oil spill.[14] This would not only help in improving the current assessments on marine life but also in linking the data on marine ecosystem health at all different levels "*from microbes to whales, […] to entire ecosystems*".[10]

Where on the one hand microbial communities are to be studied and researched in order to determine their interactions with the ecosystem, on the other hand there is an ever growing interest in the scientific community in bioreactors. A bioreactor is a machine that optimizes a natural environment for growth of specific microbial species and communities. The marine bioreactors focus on microbial life that needs such specific living conditions (high salt concentrations, high pressure, etc.), that they cannot be cultured in a laboratory.[15] By positioning the bioreactor off the coast on the sea floor, the bioreactor's microbial life is able to thrive under its natural conditions. These bioreactors could even lead to a system in which the ocean is used in the sustainable production of medicine or other chemical substances, clean energy, or even food.[15] Moreover, increased use of bioreactors could lead to production of energy or biological compounds in a sustainable manner without damaging the ecosystem where the bioreactor is positioned.

In short, more efficient research into microbial communities and their interactions with the environment can be attained through biodiversity assessments. This could lead to better utilization of bioreactor technology. Finally, a better understanding of microbial ecology can help us in many fields, from ecosystem resilience and restoration to even a higher yield in seafood production.[16]

Food for thought on marine microbial ecology and bioreactors
• Microbial communities, while not yet completely understood, are at the base of a healthy ecosystem.
• A global biodiversity assessment network helps in understanding the dynamics in microbial communities.
• A good understanding of microbial community dynamics can lead to new ways of ecosystem restoration and resilience.
• Bioreactors combine the 'special talents' of certain microbial species with the native marine environment to produce chemicals and energy without damaging the ecosystem.
• Stimulation of use of bioreactors can lead to enhanced a use of ocean for sustainable production.

Source: authors' compilation.

Issues for further consideration

The following issues were suggested by the team of young researchers for consideration by policy makers:

- Establishment of a global assessment on marine biodiversity, with special attention to microbial biodiversity
- Stimulation and promotion of research in application of bioreactors in marine environments
- Improved understanding and functioning of marine microbial communities

Notes

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