



Climate change and microbial ecology

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“Ecosystem” is the term coined by the English botanist Arthur Tansley (1871–1955), in 1935, to name an organized unit that comprises the total array of living beings present in a defined area, together with the accompanying physico-chemical environmental factors.

The study of biodiversity in a particular ecosystem (a forest, a lake, a sea) would be incomplete without the inclusion of microorganisms, since they are essential contributors to the global functioning of the planet and thus to the sustainable development of the biosphere, because the primary role of microbes in the biosphere is as a catalysts of biogeochemical cycles. Microorganisms are essential components of all ecological systems integrated into the biosphere. In fact, at one time, when they were the only inhabitants of the planet, prokaryotes were the “founders” of ecosystems during the early Archaean eon (3850–3500 million years ago).

The effort to define comprehensively the place of bacteria in the living world was the leitmotif of the Delft School, with an emphasis on the ecological aspects related to biochemistry. Delft is a small city in the Netherlands, well-known for its characteristic blue and white porcelain and for being the birthplace of the painter Jan Vermeer. But Delft also played a significant role in the history of microbiology. There, microbes (first, protists in 1674, and then bacteria, in 1683) were discovered by Antonie van Leeuwenhoek (1632–1723), the founding father of microbiology. It was also in Delft that Martinus W. Beijerinck (1851–1931) established the scientific principles of prokaryotic physiology and ecology. His successor in the chair of microbiology was Albert J. Kluyver (1888–

1956). Kluyver’s disciple, Cornelis B. van Niel (1897–1985), transmitted the ideas of the Delft School to the USA, following his move to that country in 1929. Lourens G.M. Baas Becking (1895–1963), was a student at the Delft University and attended van Niel’s courses in Pacific Grove, California. Baas Becking was strongly influenced by Beijerinck’s work, which established the basis for a general view of the role of bacteria in the cycle of nutrients in the biosphere, and thus highlighting the importance of the interactions between life and Earth. Baas Becking invoked the name of Gaia more than 30 years before James Lovelock proposed his Gaia hypothesis. Baas Becking proposed that any bacteria could be isolated from nature if the adequate culture conditions were provided. He summarized this idea stating that “everything is everywhere, but the environment selects,” thus pioneering the modern studies of the biogeography of microorganisms and the assembly of natural communities.

Multiauthored book (edited by Jürgen Marxsen) *Climate change and microbial ecology* masterly shows the current knowledge on how microorganism are affected by global climate change and vice versa, how microorganisms affect the development of global climate change, by discussing the topic from the perspective of the different groups of microorganisms, such as bacteria (chapters 1, 2), protozoa (chapter 3), fungi (chapter 4), and viruses (chapter 5). But also, the book exposes the viewpoint of the influence of different ecosystems on microbial communities. The studied ecosystems discuss aquatic (rivers, lakes, and groundwater, chapters 6, 8, 9), and soil environments (chapters 7, 10, 11, 12).

Water pollution derived of anthropogenic origin in addition to the effects of climate change, are major impact within aquatic ecosystems. Climate change may act over long periods of time, leading to slight but continuous alteration. Pollution may have an immediate effect. Presence of pollutants and nutrients into aquatic systems significantly disrupts the structure and function of natural microbial assemblages, leading to reduced species diversity, increased heterotrophy and rises in the numbers of potentially virulent/toxic microbes (Chapter 1, 2). Protists influence the abundance and taxonomical bacterial distribution in aquatic systems. Changes in proportion of protists due to variations in temperature may impact in bacterial population and thus the regulation of carbon and nutrient transfer in those ecosystems (Chapter 3). Chapter 4 focus direct and indirect effects of climate change on the community composition, growth, reproduction, metabolism and decomposing activity of aquatic hyphomycetes and terrestrial macromycetes. Response of ectomycorrhizal fungi to global changes are difficult to address because these fungi depend on their host plants and cannot be dissociated from them. Changes in water temperature affect microbial growth, respiratory rates and carbon assimilation. Thus, temperature impact likely on the interaction between viruses and their host. Clearly, an improved understanding of viral responses to those environmental alterations would enhance our chances to predict potential consequences of such changes (Chapter 5).

The perception that most microorganisms live as complex communities that are attached to surfaces has profoundly changed microbiology over the past decades. Most, if not all, bacteria can form biofilms. The term “biofilm,” coined by Bill Costerton in 1978, refers to heterogeneous structures comprising different populations of microorganisms surrounded by a matrix (mostly of exopolysaccharides) that allows their attachment to inert (e.g., rocks, glass, plastic) or organic (e.g., skin, cuticle, mucosa) surfaces. Current research indicates common mechanism of shifts in biofilm community composition, structure and functioning due to increasing temperature

or suffering from desiccation episodes and other environmental perturbations. Different communities may have different sensitivity to a disturbance. Further research is needed in order to link the community composition to the metabolic changes. Measurements of carbon and nitrogen budgets are needed to quantify the effects of biofilm metabolism on ecosystem nutrient cycling (Chapters 6-12).

Recently, we are aware that symbiotic microbiota is an integral part of a human being. The diverse microbiota that colonizes the human body contributes to gut maturation, host nutrition and pathogen resistance. Microbes also directly interact with human host by regulating intestinal epithelial proliferation, fat storage and inflammatory responses. Microbiota perturbations (dysbiosis) were found to be associated with periodontal disease and obesity, allergies and asthma are linked to childhood antibiotic use which may alter intestinal microbiota. Similarly microorganisms are critical components of all ecological systems integrated into the biosphere. Earth health depends on the correct functioning of their microbiota. Dysbiosis due to climate changes may lead to “biosphere disease” that can affect ecosystems macroscopically, with profound changes in the fauna and flora of ecosystems inhabitants, leading to the extinction of some species of animals or plants.

Climate change and microbial ecology reviews significant topics in climate change related to microbial ecology. Chapters describe different Earth ecosystems and their associated microbiota with respect to diversity and functionality in the cycles of matter. This book is essential for microbial ecologist and everyone that are interesting in global climate change. 🌍

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