

Microbial community and network responses across strong environmental gradients: How do they compare with macroorganisms?

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Abstract

The way strong environmental gradients shape multispecific assemblages has allowed us to examine a suite of ecological and evolutionary hypotheses about structure, regulation and community responses to fluctuating environments. But whether the highly diverse co-occurring microorganisms are shaped in similar ways as macroscopic organisms across the same gradients has yet to be addressed in most ecosystems. Here, we characterize intertidal biofilm bacteria communities, comparing zonation at both the “species” and community levels, as well as network attributes, with co-occurring macroalgae and invertebrates in the same rocky shore system. The results revealed that the desiccation gradient has a more significant impact on smaller communities, while both desiccation and submersion gradients (surge) affect the larger, macroscopic communities. At the community level, we also confirmed the existence of distinct communities within each intertidal zone for microorganisms, similar to what has been previously described for macroorganisms. But our results indicated that dominant microbial organisms along the same environmental gradient exhibited less differentiation across tidal levels than their macroscopic counterparts. However, despite the substantial differences in richness, size and attributes of co-occurrence networks, both macro- and micro-communities respond to stress gradients, leading to the formation of similar zonation patterns in the intertidal rocky shore.

Keywords: co-occurrence networks; epibiotic biofilms; intertidal rocky shore; stress gradients; zonation

Introduction

Understanding the mechanisms and processes responsible for patterns of abundance and distribution of species across environmental gradients is one of the main goals of community ecology (Mittelbach and McGill 2019), and one of the most striking patterns is the zonation of dominant organisms that occupy different parts of the environmental gradient. These patterns have served as the basis to test core hypotheses about the organization of communities (e.g. Whittaker 1955) and the ecological processes shaping fundamental and realized species’ niches, such as physiological tolerances and species interactions (Connell 1961a,b, Menge and Sutherland 1987). For microorganisms, the “everything is everywhere, but the environment selects” hypothesis, set forth by Lourens Baas Becking in the early 1930s, has inspired the microbial biogeographical and ecological research of the past decades

(de Wit and Bouvier 2006, O’Malley 2007, Fontaneto 2011, Hanson et al. 2012) and suggests that microbial communities are primarily determined by unlimited dispersal and secondarily by environmental selection. Microbial biodiversity is significantly influenced by environmental gradients, particularly factors that impact soil or water pH (Rousk et al. 2010, Krause et al. 2012), temperature (Logares et al. 2020) and resource availability (Follows et al. 2007). The local environment plays a critical role in selecting which microorganisms are present and, like macroscopic organisms, the patterns of abundance and composition across environmental gradients are shaped by abiotic conditions and interactions among co-occurring microbes (Fontaneto 2011, Hanson et al. 2012, Mandakovic et al. 2018). While numerous studies have examined the biogeography and macroecology of microorganisms, comparing them with macroorganisms (Astoeaga et al.

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Environmental Regulation Of Microbial Metabolism

Fems Symposium

Alireza Bahadori



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Environmental Regulation of Microbial Metabolism I. S. Kulaev, E. A. Dawes, D. W. Tempest, 2014-05-12

Environmental Regulation of Microbial Metabolism contains the proceedings of the Federation of European Microbiological Societies Symposium held in Pushchino USSR on June 1-7 1983. The symposium provided a forum for reviewing the environmental regulation of the metabolism of autotrophic and heterotrophic microorganisms, regulation of the biogenesis of cell walls and other structures in prokaryotic and eukaryotic microorganisms, and regulation of the secretion of macromolecules and transport of ions and solutes across microbial membranes. Comprised of 52 chapters, this book begins with an overview of some aspects of environmental regulation of microbial phosphorus metabolism, followed by a discussion on the role of covalent interconversion of enzymes in the regulation of microbial metabolism. Subsequent chapters explore the role and regulation of inorganic pyrophosphatase in bacteria, the central metabolism of pseudomonads degrading xenobiotics, the role of nickel enzymes in anaerobic metabolism, and the oxidation of aromatic compounds by microalgae. The book also considers carbon metabolism in phototrophic bacteria under different conditions of growth, along with the transport of solutes and metabolites in prokaryotes and eukaryotes. This monograph will be helpful to a wide range of specialists in the fields of biochemistry, physiology, molecular biology, and biotechnology. **Microbiology Abstracts**, 1991

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One-Carbon Metabolism G.A. Codd, L. Dijkhuizen, F. Robert Tabita, 2012-12-06. Autotrophic and methylotrophic microorganisms are able to grow at the expense of one carbon compounds, e.g. carbon dioxide, formaldehyde, as the principal carbon sources for the synthesis of cell material, using light, inorganic compounds, or one carbon compounds as energy sources. The study of the special adaptations required in aerobic and anaerobic microorganisms to sustain an autotrophic or methylotrophic mode of life is a fascinating field of research for scientists from various disciplines. Current research efforts not only focus on fundamental aspects, i.e. metabolic pathways and their regulation, ecology, energy conversion, and genetics, but also the possible application of these organisms in waste water treatment, degradation of xenobiotics, single cell protein production, as biocatalysts for the production of fine chemicals, draws strong attention. The aim of this series is to provide annual reviews on the biochemistry, physiology, ecology, genetics, and application of microbial autotrophs and methylotrophs. The scope of the series includes all aspects of the biology of these microbes and will deal with phototrophic and chemolithotrophic prokaryotic autotrophs, carboxydobacteria, acetogenic, methanogenic, and methylotrophic bacteria, as well as methylotrophic eukaryotes. The exciting advances made in recent years in the study of these organisms is reflected in the

chapters of this first volume which have been written by experts in the field We would like to express our sincere thanks to all the contributors for their stimulating and comprehensive chapters

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Rapid Methods and Automation in Microbiology and Immunology K.-O. Habermehl,2012-12-06 Rapid progress in molecular biology genetic engineering and basic research in immunology has opened up new possibilities for application to diagnostic procedures and to clinical research In a short period a new era of diagnosis dawned covering nearly all fields of microbiology immunology and food technology In consequence of this rapid development scientists of many disciplines are involved studying infections of humans animals and plants or working in technical microbiology The application of the newest findings of basic research to diagnostic work and to clinical research covers nearly all fields of microbiology and immunology Moreover it underlines the close relationship between diagnosis therapy and epidemiology An outstanding example of these connections is given by the recent development of hepatitis B vaccine The discovery and identification of a non cultivable agent by physicochemical and immunological methods were the heralds of a new era in the prevention of infectious diseases This book provides an up to date comprehensive review of developments and future aspects in various fields I am convinced that the authors have succeeded in furnishing a large variety of new ideas and possibilities

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Stress and Environmental Regulation of Gene Expression and Adaptation in Bacteria Frans J. de Bruijn,2016-07-01 Bacteria in various habitats are subject to continuously changing environmental conditions such as nutrient deprivation heat and cold stress UV radiation oxidative stress dessication acid stress nitrosative stress cell envelope stress heavy metal exposure osmotic stress and others In order to survive they have to respond to these conditions by adapting their physiology through sometimes drastic changes in gene expression In addition they may adapt by changing their morphology forming biofilms fruiting bodies or spores filaments Viable But Not Culturable VBNC cells or moving away from stress compounds via chemotaxis Changes in gene expression constitute the main component of the bacterial response to stress and environmental changes and involve a myriad of different mechanisms including alternative sigma factors bi or tri component regulatory systems small non coding RNA s chaperones CHRIS Cas systems DNA repair toxin antitoxin systems the stringent response efflux pumps alarmones and modulation of the cell

envelope or membranes to name a few Many regulatory elements are conserved in different bacteria however there are endless variations on the theme and novel elements of gene regulation in bacteria inhabiting particular environments are constantly being discovered Especially in pathogenic bacteria colonizing the human body a plethora of bacterial responses to innate stresses such as pH reactive nitrogen and oxygen species and antibiotic stress are being described An attempt is made to not only cover model systems but give a broad overview of the stress responsive regulatory systems in a variety of bacteria including medically important bacteria where elucidation of certain aspects of these systems could lead to treatment strategies of the pathogens Many of the regulatory systems being uncovered are specific but there is also considerable cross talk between different circuits

Stress and Environmental Regulation of Gene Expression and Adaptation in Bacteria is a comprehensive two volume work bringing together both review and original research articles on key topics in stress and environmental control of gene expression in bacteria Volume One contains key overview chapters as well as content on one two three component regulatory systems and stress responses sigma factors and stress responses small non coding RNAs and stress responses toxin antitoxin systems and stress responses stringent response to stress responses to UV irradiation SOS and double stranded systems repair systems and stress adaptation to both oxidative and osmotic stress and desiccation tolerance and drought stress Volume Two covers heat shock responses chaperonins and stress cold shock responses adaptation to acid stress nitrosative stress and envelope stress as well as iron homeostasis metal resistance quorum sensing chemotaxis and biofilm formation and viable but not culturable VBNC cells Covering the full breadth of current stress and environmental control of gene expression studies and expanding it towards future advances in the field these two volumes are a one stop reference for non medical molecular geneticists interested in gene regulation under stress

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Fundamentals of Enhanced Oil and Gas Recovery from Conventional and Unconventional Reservoirs Alireza Bahadori, 2018-08-18 Fundamentals of Enhanced Oil and Gas Recovery from Conventional and Unconventional Reservoirs delivers the proper foundation on all types of currently utilized and upcoming

enhanced oil recovery including methods used in emerging unconventional reservoirs Going beyond traditional secondary methods this reference includes advanced water based EOR methods which are becoming more popular due to CO₂ injection methods used in EOR and methods specific to target shale oil and gas activity Rounding out with a chapter devoted to optimizing the application and economy of EOR methods the book brings reservoir and petroleum engineers up to speed on the latest studies to apply Enhanced oil recovery continues to grow in technology and with ongoing unconventional reservoir activity underway enhanced oil recovery methods of many kinds will continue to gain in studies and scientific advancements Reservoir engineers currently have multiple outlets to gain knowledge and are in need of one product go to reference Explains enhanced oil recovery methods focusing specifically on those used for unconventional reservoirs Includes real world case studies and examples to further illustrate points Creates a practical and theoretical foundation with multiple contributors from various backgrounds Includes a full range of the latest and future methods for enhanced oil recovery including chemical waterflooding CO₂ injection and thermal

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Table of Contents Environmental Regulation Of Microbial Metabolism Fems Symposium

1. Understanding the eBook Environmental Regulation Of Microbial Metabolism Fems Symposium
 - The Rise of Digital Reading Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Advantages of eBooks Over Traditional Books
2. Identifying Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Environmental Regulation Of Microbial Metabolism Fems Symposium
 - User-Friendly Interface

4. Exploring eBook Recommendations from Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Personalized Recommendations
 - Environmental Regulation Of Microbial Metabolism Fems Symposium User Reviews and Ratings
 - Environmental Regulation Of Microbial Metabolism Fems Symposium and Bestseller Lists
5. Accessing Environmental Regulation Of Microbial Metabolism Fems Symposium Free and Paid eBooks
 - Environmental Regulation Of Microbial Metabolism Fems Symposium Public Domain eBooks
 - Environmental Regulation Of Microbial Metabolism Fems Symposium eBook Subscription Services
 - Environmental Regulation Of Microbial Metabolism Fems Symposium Budget-Friendly Options
6. Navigating Environmental Regulation Of Microbial Metabolism Fems Symposium eBook Formats
 - ePub, PDF, MOBI, and More
 - Environmental Regulation Of Microbial Metabolism Fems Symposium Compatibility with Devices
 - Environmental Regulation Of Microbial Metabolism Fems Symposium Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Highlighting and Note-Taking Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Interactive Elements Environmental Regulation Of Microbial Metabolism Fems Symposium
8. Staying Engaged with Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Environmental Regulation Of Microbial Metabolism Fems Symposium
9. Balancing eBooks and Physical Books Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Environmental Regulation Of Microbial Metabolism Fems Symposium
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Setting Reading Goals Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Carving Out Dedicated Reading Time

12. Sourcing Reliable Information of Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Fact-Checking eBook Content of Environmental Regulation Of Microbial Metabolism Fems Symposium
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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