
Preface

Environmental genomics brings together the various fields of knowledge on past and present living organisms and ecosystems, through the analysis of the sequence of genes and genomes using (meta)barcode or (meta)genomics as well as the analysis of genes and genomes expression using (meta)transcriptomics. Combined with other approaches such as (meta)proteomics, metabolomics and *in situ* observations, environmental genomics provides a wealth of information about the taxonomy and diversity of current and fossil organisms, their phylogeny and evolution, their potentialities and abilities to adapt and acclimatize, their biology, their functional traits and their interactions with the environment in its biotic and abiotic dimensions.

Next-generation DNA and RNA sequencing technologies (NGS) allow the production of structural and functional (meta)genomics data at a scale that was unimaginable just a few years ago. NGS technologies have significantly and permanently changed, not only the experimental strategies used to investigate evolution, biodiversity and the ecology of living and dead organisms and ecosystems, but also the scientific perspective on human populations. They have also profoundly changed our representation of living organisms and their intrinsic characteristics and interactions with other organisms. NGS technologies apply to all living organisms (Archaea, Eukaryotes and Bacteria and their associated viruses) and give access to previously unknown taxonomic groups and biological functions. This technological revolution opens up new scientific opportunities as it renews technical and methodological pathways. Environmental genomics is the field

that benefited and still benefits the most from this paradigm shift, as it integrates the most advanced knowledge of environmental science at all scales, whether these are biological (from the metabolite to ecosystem), spatial (from the local to the planetary level), or temporal (from the possibly very distant past to recent or current time). Harnessing these new possibilities requires specific efforts in terms of the initial and continued education of the various members of the scientific communities (biology, ecology, but also computer science and mathematics), especially those who will conduct research in the years to come.

This book is the result of a collective effort of reflection and writing of the French scientific community, involved in the research group on environmental genomics, the successor of the Réseau Thématique Pluridisciplinaire of the same name (<http://gdr3692.wix.com/gdrge>). Its intent is to present the possibilities of this emerging discipline (Introduction), to provide an overview of the issues, challenges and perspectives of environmental genomics (Chapter 1) and to present the technological revolutions brought about by the development of the new sequencing methods, identifying their possibilities and limitations (Chapter 2). The following chapters describe in more detail the state of thinking in various methodological and scientific fields: access to NGS data production and sharing (Chapter 3), NGS data quality (Chapter 4), characterization of life (Chapter 5), structure and dynamics of biodiversity (Chapter 6), study of the evolution and adaptation of genes and genomes (Chapter 7), analysis of degraded and/or ancient DNA (Chapter 8), functional and genomic ecology of populations (Chapter 9) and communities (Chapter 10). The last chapters discuss more exploratory aspects of the modeling and functioning of ecosystems (Chapter 11) as well as aspects related to the future developments of 3^d and 4th generation technologies (Chapter 12).

Let us wager that the new research possibilities enabled by environmental genomics, combined with new methods for the development and analysis of complex systems, will enable the coming generations of students and researchers to understand all dimensions of life, taking into account the complexity of the intricate interactions that occur amongst organisms, their functional relations and beyond their complex interactions with the environment which they shape and which shapes them. The reader will discover throughout the pages of this book how interdisciplinarity is at the core of this emerging research domain, as it requires skills and expertise that pertain to various fields of biology (ecology, evolution, paleobiology, taxonomy, etc.), of "hard" sciences (computer science and bioinformatics,

mathematics, biogeochemistry, physics, etc.) as well as of human and social sciences (sociology, anthropology and paleoanthropology, statistics, etc.). Reviving the naturalist approaches of the 18th century, environmental genomics is a field science that today offers an exceptional opportunity to tackle the societal issues raised by global change of natural or anthropic origin.

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