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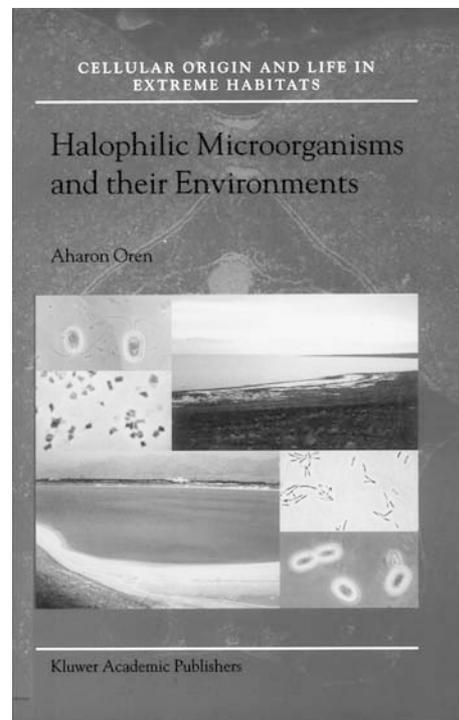
Aharon Oren: Halophilic microorganisms and their environments

Kluwer Academic, Dordrecht, 2002. 575 pp. 24.5×16.5 cm (ISBN 1-4020-0829-5) US\$ 197.00

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Microorganisms live everywhere, or almost everywhere. Our habit to believe only in what we see has led us to think that habitats where our bare eye is not able to detect life forms are lifeless. With the growing importance given to the microbial world and the new methods developed to detect microbial life, it is now possible to state that almost all environments on Earth contain life. Even the most inhospitable places harbor organisms that obligate us to broaden the spectrum of conditions at which we suppose life exists. Extremely high or low temperatures, even above or below the limits at which water remains at its liquid state at atmospheric pressure, salt concentrations near saturation point, hydrostatic pressures of up to 1,000 atmospheres, nothing can stop life. This confronts scientists with amazing challenges, and Kluwer Academic Publishers has decided to dedicate a whole book series to extreme habitats (Cellular Origin and Life in Extreme Habitats). The book reviewed here is the fifth (and latest) published in the series. The books published before were *Enigmatic microorganisms and life in extreme environments* (Joseph Seckbach, 1999), *Journey to diverse microbial worlds* (Joseph Seckbach, 2000), *The new science of astrobiology* (Julian Chela-Flores, 2001) and *Symbiosis* (Joseph Seckbach, 2002).

The author of this book, Aharon Oren, from the Hebrew University of Jerusalem, is a worldwide leading expert in halophilic microorganisms; consequently, this book will surely become a main reference text for anyone studying or active in this field. As the author states, in the last few years genomics has drastically changed all fields of biology, making older books in need of revision. However, contemporary research seems to have forgotten the relevance of advances made more than a few decades ago. Fortunately, this book has devoted an entire section (Sect. 1, “An historical survey”) to the origins of the study of halophilic organisms. One of the



first scientists to presume that some organisms could live in hypersaline environments was Charles Darwin, who, at the sight of a salt lake in Patagonia during his travels on the *H.M.S. Beagle* wrote: “How surprising it is that any creatures should be able to exist in a fluid, saturated with brine, and that they should be crawling among crystals of sulfate of soda and lime!”. He also observed the reddish color of the water in this lake and made the assumption that it was caused by some “infusorial animalcula”. Section 1 of *Halophilic microorganisms* also recounts the first descriptions of *Archaea*, *Bacteria* and *Eukarya* in hypersaline environments.

Section 2 (“Halophilic microorganisms and their properties”) is the longest one, comprising ten chapters and more than 350 pages. Chapter 2, the first in this

section, reviews the taxonomy of halophilic microorganisms. Chapter 3 deals with their cellular structure. Extreme halophiles show a variety of different shapes, some of which are surprising, but all of which are adapted to the environment. Metabolism and physiology is the subject of Chap. 4, which discusses some unique pathways and reactions found only in these organisms. One of the most striking properties of salterns and other hypersaline environments is their red color at certain times. This is due to the pigments produced by the microorganisms living there. These pigments are described in detail in Chap. 5. The ability to cope with high salt concentrations is dealt with in Chap. 6, which describes ion metabolism, while the properties of halophilic proteins are explained in Chap. 7. In order to resist the high osmotic pressure outside their cells, halophiles have to maintain a high intracellular concentration of solutes. These solutes, however, have to be compatible with enzyme action and other cellular functions. Chapter 8 reviews a wide variety of the compatible solutes used by these organisms for this purpose. Chapter 9 includes two separate topics: halophilic bacteriophages (viruses affecting halophilic *Bacteria* and *Archaea*) and halocins (small antibiotic molecules excreted by halophilic *Archaea*). Although halocins were expected to regulate interactions between microbial populations, they have not been proven to play any important ecological role in hypersaline environments. Genetics at last appear in Chap. 10, where the author gives an exhaustive account of the latest advances made in this field. The last chapter of this second section, Chap. 11, focuses on the biotechnological applications of halophilic microorganisms. The structure of the ten chapters in this section is similar, dealing separately with halophilic *Archaea*, *Bacteria*, and *Eukarya*, which reminds us that these organisms have adapted separately to this kind of extreme environment. For readers interested in expanding their knowledge about halophiles, each chapter includes a long list of references.

Section 3 (“Hypersaline environments and their biota”) gives an account of the most widely known (or most studied) hypersaline environments in the world. The author describes the different features of the Great Salt Lake in Utah (Chap. 12), the Dead Sea (Chap. 13), man-made solar salterns (Chap. 14), alkaline hypersaline lakes in Africa and Asia (Chap. 15), and Mono Lake in California and Big Soda Lake in Nevada (Chap. 16). The last chapter of this section (Chap. 17) is an overall review of all hypersaline environments that were been considered in the other chapters, including Antarctic hypersaline lakes, Solar Lake in Sinai, and deep-sea brines.

Section 4 discusses halophiles from a drastically different point of view. The title of the only chapter in this section, “Evolution of halophiles and survival of halophiles on Earth and in space”, is clear enough. The origin (or origins) of extreme halophiles is discussed, as is also the possibility that the first organisms on Earth belonged to this group, although the last discoveries seem to refute this hypothesis. Halophiles have also been considered to be able to remain viable for long periods of time inside salt crystals. The author reviews all the evidences for and against this interesting possibility. The chapter ends with a short comment on the possibility that halophiles could exist on other planets. The last part of this book (Sect. 5, “Supplement”) includes a short discussion on cultivation and handling of halophilic microorganisms, a short glossary on limnological terms, and several indexes.

Scientists studying halophilic microorganisms and even microbiologists working in other fields will find this book of great interest, as it can be considered the state of the art in this field, including a discussion of the latest advances and plenty of additional information. The author, well-known microbiologist Aharon Oren, has shown with this book that he is not only an excellent researcher and writer but also that he can also communicate to everyone his sweet love for salt-loving microorganisms.