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CRITICISM

Life in Ancient Ice. Ed. Castello, J.D. and Rogers, S.O. Princeton University Press, Princeton, 2005, 328 pp. 20 halftones, 51 line illus., 27 tables

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This collection of papers offers a unique survey of the most important investigations of microorganisms in ancient ice and permafrost soils. The book is based on materials of a symposium held in summer 2001 (June 30 to July 3) in Oregon, USA. The meeting was sponsored by the National Science Foundation, USA, and organized by the renowned scientists John D. Castello and Scott O. Rogers of Michigan University, USA.

The symposium brought together experts who study ice and permafrost soils, the preservation of different forms of live organisms under such conditions, and their evolution. The symposium's goal was to appraise the state of current knowledge and the prospects of this branch of biology. It is well known that viruses, bacteria, spores of fungi, and pollen of plants are carried by the wind around the Earth. Having been trapped in ice in the Polar Regions, they can be conserved for hundreds and thousands of years. Some of the organisms are merely preserved for a long time under such conditions, while others are able to carry out their life cycle.

Thirty-five key specialists from Australia, Germany, Denmark, Israel, Canada, Russia, and the United States took part in the symposium. The reviewed edition, containing 20 chapters, presents the reports presented at the meeting, as well as contributions by other researchers.

The major subjects to the volume are as follows:

consideration of the data suggesting the existence of life in ancient ice and permafrost soils;

evaluation of the validity of these data;

evaluation of the importance of the obtained evidence on life in ancient ice to the understanding of modern life processes;

determination of the most important directions of future studies and elaboration of guidelines.

The book consists of an Introduction (Chapter 1), written by Castello and Rogers, and 19 more chapters. Chapter 2 outlines recommendations on how contamination can be avoided when studying samples and identifying isolates in ancient ice cores. Chapter 3 presents evidence on perennial ice in an Antarctic lake as a habitat of cyanobacteria. The development of prokaryotes in Antarctic sea ice and their role in the communities of ancient ice are considered in Chapter 4. Chapter 5 concerns the discovery of diatoms in ice cores extracted from the Antarctic ice cover. Chapter 6, containing evidence on the nature and likely sources of biogenic particles found in the ancient ice of Antarctica, is the last in the block of chapters devoted to microorganisms found in the ice, water, and atmosphere of the Polar Regions.

The life of microorganisms in permafrost soil at temperatures below the freezing point is the subject of Chapter 7. The authors claim to have obtained both direct and circumstantial evidence that, even at such low temperatures, microorganisms are capable of metabolic activity by virtue of being surrounded by overcooled water.

The next block of chapters (8–16) describes the microorganisms found in permafrost soils (Chapters 8–10) and glaciers (Chapters 11–16), with special attention given to fungi. Chapter 8 contains data on yeasts isolated from permafrost soil. Thus, *Cryptococcus saitoi, C. victoriae, C. antarcticus* var. *circumpolaris*, and *Rhodotorula creatinivora* were isolated from permafrost soil samples from Kolyma (Northeast Siberia). Chapter 9 is devoted to fungi discovered in ancient permafrost soil deposits in the Arctic and Antarctic regions. The list of the mycelial fungi found is quite long and comprises 14 species of the genus *Penicillium*, 5 species of *Aspergillus*, 4 species of *Cladosporium*, 2 species of the genus *Arthrinium*, and also 23 species of 23 other genera belonging to the classes *Ascomycetes* and *Zygomycetes* and the group of Anamorphic fungi. In addition, the authors obtained isolates of a fungus belonging to the group of *Mycelia sterilia* that was not identified to the species level. Chapter 11 deals with mycelial fungi found in glaciers by studying ice cores from Greenland and subglacial Lake Vostok in Antarctica. A total of 217 strains were isolated and assigned to 16 species based on morphological features and molecular-genetic evidence. Fungi of the genera *Penicillium, Aspergillus, Cladosporium, Alternaria, Fusarium*, and *Ulocladium* were identified in ice samples by morphological features, which parallels the data of Chapter 9 on fungi in permafrost soils. Using molecular-genetic methods, *Dactylella lobata, Multiclavula corynoides, Pleurotus pulmonarius*, and *Tricholoma robustum* were identified, belonging to the classes *Ascomycetes* and *Basidiomycetes* (the latter

fungi are difficult or even impossible to determine by their morphological features in a culture).

Chapter 12 presents data on yeast fungi found in Greenland's ice cover. The isolates were assigned to *Rhodotorula mucilaginosa, R. larynges,* and *Rhodotorula* sp.

Some of the fungi mentioned in the chapters reviewed above are commonplace in the Arctic and Antarctic regions, while others were undoubtedly brought in here from temperate and even tropical zones. The latter also applies to many bacterial species mentioned in Chapters 10, 15, and 16 and holds both for glaciers close to and quite far from temperate zones. For example, in Chapter 10, cyanobacteria are described that are able to survive and metabolize in permafrost soil in the absence of sunlight. This fact shows that most of viable microorganisms in permafrost soil and ice are able to survive under widely different conditions, including extreme ones.

Chapters 13 and 14 are devoted to viruses. Chapter 13 presents findings on bacteriophages discovered in bacteria isolated from polar ice cores. The same authors previously isolated viruses of plants from an ancient glacier. Taken together, these findings demonstrate two possible ways for viruses to be preserved in glaciers: in the form of intact virus particles (or particle fragments) and by incorporating into the bacterial chromosomes and thus becoming prophages. Chapter 14 discusses the disappearance and reemergence of viruses; glaciers are considered as possible sites of the preservation of viruses. The authors claim that this issue will become a main theme of many research projects. The diversity of organisms described in these chapters, the extreme conditions of the environment these organisms were found in, and the mechanisms of their propagation call for a revision of previous concepts of where and how microbes are able to survive.

The concluding chapters outline the results of more recent studies. Chapter 17 summarizes all available evidence related to studies of cores extracted from the ice cap covering subglacial Lake Vostok in Antarctica. Chapter 18 describes a robot specially designed to carry out a wide range of missions, including the search for microorganisms in extreme environments, such as subglacial Lake Vostok. Chapter 19 discusses the relevance of using the results of biological studies of permafrost soils and glaciers to model astrobiological explorations.

Chapter 20 sums up the most significant and important results of the studies reported in the book. It also outlines the methodological aspects of forthcoming scientific studies devoted to this problem.

The arrival of this volume is very timely and helpful. It is clear from its materials that Russian scientists have made and are making a significant contribution to life exploration in ancient ice. Until now, their works had seldom appeared in English-language editions. This is one of the reasons why overseas specialists were generally weakly acquainted with the works by our researchers. This gap has now been bridged. The jacket of this book carries words by Lloyd Burckle, Lamont-Doherty Earth Observatory at Columbia University, USA, stating that, for the first time, the leading experts in the field have been brought together in one book to discuss the key issues of life studies in permafrost. Among these experts, Burckle makes a special mention of the Russian scientist S.S. Abyzov as a one of the founding fathers of this branch of science. Such high appraisal is, beyond any doubt, well deserved.

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