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Biology of Antarctic Microorganisms and Plants

edited by Ludger Kappen and Peter Hirsch

FOREWORD

The Antarctic region, known for harboring the harshest climate on Earth, is not conducive to the evolution of a great diversity of microorganisms or plants. One would expect, therefore, that comprehensive knowledge of the terrestrial biota is within easy reach. Yet, after almost a century of Antarctic research, recent discoveries revealed an unexpected variety of species and habitats, raising more questions than what could be answered.

Due to its remoteness and inaccessibility, Antarctica was visited by only a limited number of scientists. This situation improved in the last three decades and recent expeditions, particularly in marine science, glaciology, meteorology and geosciences resulted in a spectacular progress in these fields. Terrestrial biology was lagging behind, confined to limited activities of individual scientists, and very much dependent on other programs and existing facilities. Exceptions are the group of researchers of the British Antartic Survey and the ACME (Antarctic Cryptoendolithic Microbial Ecosystem) research group, established about seven years ago by Prof. E. I. Friedmann in Tallahassee, USA.

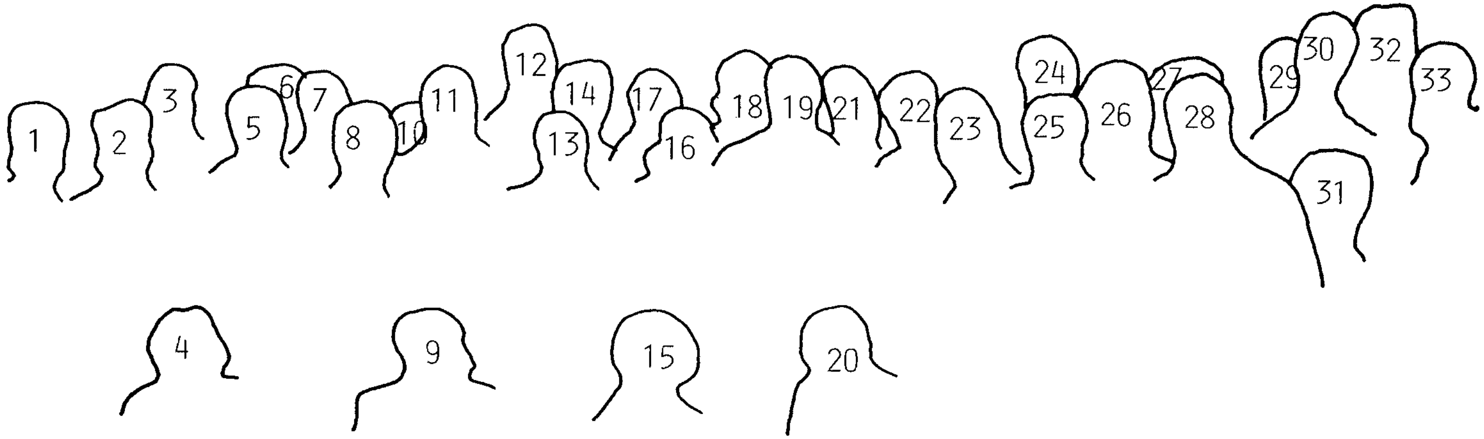
The fact remains that Antartic terrestrial scientists in most countries are still working isolated and it is apparent that there ist a need for closer communication between them. Thus, taxonomists working on Antarctic plants paid little attention to Arctic floras. Due to rapid progress in technology, an ever increasing variety of experimental designs became available for physiologists with the result that today it becomes more and more difficult to compare data of different scientists.

Antarctic terrestrial habitats are scattered over an entire continent and its islands, and scientists of different nations work in their respective Antarctic stations using different facilities. However, the major unifying aim of Antarctic terrestrial biology is to produce comparable results in order to obtain a comprehensive picture of the structure and function of the Antarctic biota.

With this in mind, we have invited Antarctic researchers from various countries for a meeting specifically devoted to terrestrial microorganisms and plants.This meeting was held at the University of Kiel between 7 and 11 September 1987 and attracted more than 50 participants. The British Antarctic Survey was particularly well represented and the ACME group combined its annual meeting with the present one, greatly contributing to the success of the Kiel symposium. Most of the funding for this international symposium was generously supplied by the Deutsche Forschungsgemeinschaft, which is gratefully acknowledged here. The generosity of the editors of the „Polarforschung" to publish this volume is greatly appreciated.

We are taking this opportunity to document the present state of art in Antarctic terrestrial biology, with 25 papers collected in this volume. The papers deal with three main subjects: (1) Taxonomy and classification (2) Temperature- and water relations, photosynthesis and growth of Antarctic microorganisms and plants and (3) Habitat conditions and structure of Antarctic biota.

(1) The incomplete state of our taxonomic knowledge is reflected by a study of Antarctic crustose lichens (1.1). One major problem in extreme environments is the great number of morphotypes within a single species (1.2). At the same time, extremely dry habitats seem to select for particular generic characters in organisms such als yeasts (1.3). Much taxonomic work is still needed in prokaryotes (1.4). Obviously, quantitative studies based on the number of species of cryptogams and microorganisms are at present still somewhat limited by the availability of data.



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(2) The answer to the old question of the survival of microorganisms and plants under the extreme environmental conditions of Antarctica depends on physiology, on applying physiological methods to ecological studies, and on development of technology suitable to Antarctic field conditions. Also, it much depends on the logistic facilities for experimental work. Rapid changes have taken place in all these areas during the last two decades.

In polar regions, light may be a limiting factor for autotrophic organisms. However, in the vicinity of ice masses, radiation can reach extremely high values, also in the UV range. This effect may intensify with the decrease of the ozone layer. Most lichens are highly tolerant to strong light, but some algae and bacteria are not and are confined to sheltered habitats (2.1). Most Antarctic organisms are well adapted to survive extremely low temperatures and are active below the freezing point of water as shown in endolithic algae (2.2). Yet, both cyanobacteria and algae living in this environment have higher temperature optima for growth than can be measured under natural conditions (2.3). The essential and limiting role of water has been studied in mosses and lichens from the maritime and continental Antarctic (2.4, 2.5, 2.7 and 2.8).

In the moist climate of the subantarctic region, macrolichens may still find almost optimal conditions for metabolic activity. In contrast, conditions in the maritime and continental Antarctic appear to be less than optimal for lichens and mosses that are active at temperatures close to the freezing point of water (2.6, 2.7 and 2.8). In dry areas, where periods of photosynthetic activity are restricted by water availability, endolithic lichens may benefit from inorganic carbon fixation by the fungal component (2.9). Attempts have been made to calculate the carbon production of maritime Antarctic lichens (2.8) and the cryptoendolithic biota (2.10). While the former reaches a maximum monthly rate similar to those of hot desert species of the same genus, the latter shows the lowest figures of productivity so far known on Earth. Radiocarbon dating indicated that these slow-growing organisms may stay alive over a few thousands of years (2.11).

(3) The third section is devoted to habitat conditions and to structure of Antarctic biota. Weathering processes in rocks are relevant particularly for epi- and endolithic biota (3.1), but the biological rate of rock weathering by endolithic organisms may exceed the physico-chemical processes. Nitrogen is not a limiting factor for the cryptoendolithic biota (3.2), but nitrogen and phosphorus are limiting the primary production in Antarctic lakes and ponds (3.3). Mineral salts affect the lower water potential of soils in the Dry Valleys, a habitat for psychrophilic yeasts (3.4).

New methods make it possible to quantify microbial communities of Antarctic soils (3.5). In the apparently "sterile" Dry Valleys, life is present in rocks and soils with a surprisingly great variety of species and communities (3.6, 3.7 and 3.8). In Antarctic terrestrial cryptogamic communities, competition seems to be of little relevance. However,it is suggested that allelopathic effects exist in bryophyte-algal communities (3.9). Lichen species were found to be capable of growing on moss, and niche separation of *Usnea* correlated well with anatomical differences in thalli (3.10).

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We sincerely hope that the collection of papers presented in this volume will become an inspiration for more intensive and coordinated research in Antarctic terrestrial biology.

Ludger Kappen and Peter Hirsch

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