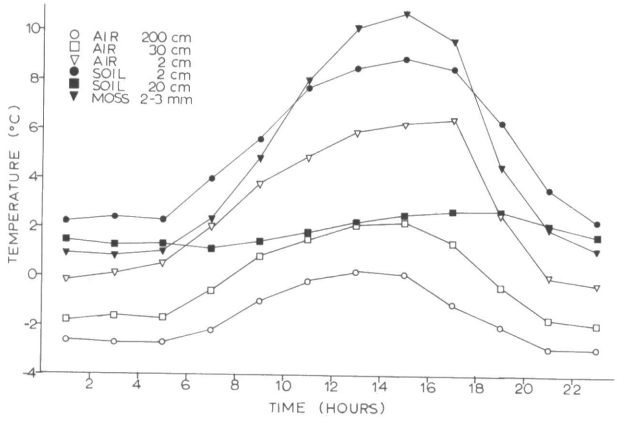
Table 2. Mean temperatures and percentages of readings within the ranges indicated (°C.), for a vertical temperature profile at Cape Armitage.

Position of probe		Air 200 cm	Air 30 cm	Air 2 cm	Soil 2 cm	Soil 20 cm	Moss 2-3 mm
Mean daily		−1.7	−0.1	+2.6	+5.2	+1.8	+4.6
Mean daily maximum		+2.1	+4.2	+10.0	+12.0	+3.2	+13.9
Mean daily minimum		−4.6	−3.3	−2.1	+1.3	+1.0	+0.1
Percentage of readings between the limits shown	13.0 and 17.5	—	—	0.2	0.2	—	5.4
	8.0 and 12.5	—	—	6.4	25.4	—	22.1
	3.0 and 7.5	2.7	11.0	36.9	45.0	13.1	23.5
	0.0 and 2.5	23.5	38.3	34.1	29.4	86.9	45.0
	−0.5 and −2.5	42.7	37.9	21.4	—	—	4.0
	−3.0 and −7.5	31.0	12.7	0.8	—	—	—

Based on readings at 15-minute intervals during a five day period beginning at 1600 hrs on 28 December, 1971.



Mean temperatures recorded during twelve 2-hour time intervals each day for a vertical temperature profile at Cape Armitage, based on readings at 15-minute intervals for a 5-day period beginning at 1600 hours on December 28, 1971.

were lower than during the period covered by table 2.

It is hoped that this approach will enable the microclimate data to be related meaningfully to experimentally determined relationships between environmental factors and the rates of plant metabolic processes, such as those already reported for an antarctic population of *Bryum argenteum* by Rastorfer (1970). Following the present field studies, living material of this species was returned successfully to Canada and established in pure culture. This material will be used in further experiments designed to compare the environmental relationships of polar, temperate, and tropical populations of this widely distributed moss.

This work was supported logistically by the United States Antarctic Research Program and financially by the National Research Council of Canada. I am most grateful to Mr. E. Koenig for his care in facilitating my work in the biological laboratory at McMurdo Station, and to Drs. G. C. C. Robinson, E. D. Rudolph, and W. C. Steere for identification of algae, lichens, and bryophytes respectively.

References

Bowra, G. T., M. W. Holdgate, and P. J. Tilbrook. 1966. Biological observations in Tottanfjella and central Heimefrontfjella. *British Antarctic Survey. Bulletin,* 9: 63–70.

Gimingham, C. H., and R. I. L. Smith. 1970. Bryophyte and lichen communities in the maritime Antarctic. In: *Antarctic Ecology,* 2, M. W. Holdgate (ed.). London, Academic Press. 752–785.

Longton, R. E. 1967. Vegetation in the maritime Antarctic. *Philosophical Transactions of the Royal Society,* Series B, 252: 213–235.

Longton, R. E. 1972. Growth and reproduction in northern and southern hemisphere populations of the peat forming moss *Polytrichum aspestre* with reference to the estimation of productivity. *Proceedings of the 4th International Peat Congress,* Otaniemi, Finland, 1:259–275.

Perkins, J. E. 1945. Biology at Little America III, the West Base of the United States Service Expedition, 1939–41. *American Philosophical Society. Proceedings,* 89(1): 270–284.

Rastorfer, J. R. 1970. Effects of light intensity and temperature on photosynthesis and respiration in two east antarctic mosses, *Bryum argenteum* and *Bryum antarcticum. Bryologist,* 73(3): 544–556.

Rudolph, E. D. 1963. Vegetation of Hallett Station area, Victoria Land, Antarctica. *Ecology,* 44(3): 585–586.

Shacklette, H. T. 1965. Element content of bryophytes. *U.S. Geological Survey. Bulletin,* 1198-D. 21 p.

Siple, P. A. 1938. The Second Byrd Antarctic Expedition—Botany I. Ecology and geographical distribution. *Missouri Botanical Garden. Annals,* 25: 467–514.

Soil microbiology studied *in situ* in the dry valleys of Antarctica

Wolf V. Vishniac *and* Stanley E. Mainzer
Department of Biology
University of Rochester

In contrast to previous studies, which determined the presence or absence, and frequency, of bacteria in the soil of the dry valleys by culturing microorganisms from soil samples, we attempted to study microbial ecology *in situ*. The purpose was to determine whether microorganisms under highly adverse conditions, especially in environments in which water was the most important limiting factor, were dormant or

whether they underwent active growth. The area chosen for this study was the valley that lies to the east of Obelisk Mountain and Mount Odin and debouches in the north on to Wright Valley. We established a series of stations from the mountain crests surrounding Odin Valley, along the adjacent valley floor, and descending the northern slope of the Asgard Range to the floor of Wright Valley. The wet environment of the Onyx River was our positive control against which we compared our findings from all other stations. While eight different types of experimental approaches were used, they can be put into four classes:

1. Growth *in situ*. Clean sterile glass slides were inserted into soil and examined after 14 days for the appearance of microcolonies that would adhere to the glass only if bacteria had grown in contact with the glass slide in the soil. Several modifications of this approach also were used.

2. Chemical activity *in situ*. The soil was inoculated with microcuries of carbon-14-labelled simple organic compounds, both in the presence and absence of potassium cyanide. Labelled carbon dioxide was trapped in filter paper soaked with barium hydroxide.

3. Growth on culture medium. Soil particles from each station were scattered on a variety of solid media. Detectable growth was eventually transferred and studied in the laboratory.

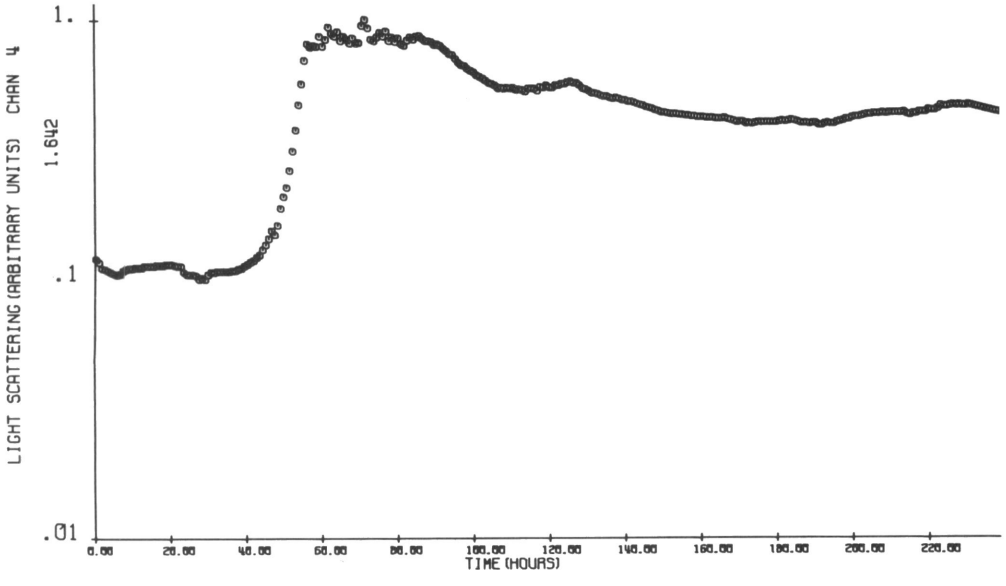
4. Growth in liquid suspension. Soil particles were placed in a dilute medium (3 grams of trypticase-soy powder per liter). Growth was observed by light scattering under field conditions.

After return from the field, soil samples were prepared for electron microscopy by fixing and staining soil films obtained by flotation. The appearance of bacterial sheets, clumps, filaments, or other colonial forms was taken as evidence for organisms having grown *in situ*.

The results demonstrate the presence and active growth of bacteria at all of the stations examined. They further demonstrate the utility of using a variety of independent techniques in examining the microecology of the soil. No single technique proved convincingly for bacterial growth at each locality, but the combined evidence from these experiments demonstrated active microbial life in all the antarctic soils examined. The figure is an example of bacterial growth as measured by light scattering. This latter technique also was used to examine the vertical distribution of bacteria in permafrost. The highest concentration occurred at the very surface of the soil and in the top centimeter of the permafrost (10 centimeters down). Bacteria in decreasing amounts were found to a depth of 40 centimeters in the permafrost. Lower layers were not examined.

Cultures of bacteria are being examined by Mrs. Gladys Welty, University of Rochester. The field kit for the use of labelled substrates and the measurements of radioactivity were prepared and carried out by Dr. Gilbert Levin and Dr. Patricia Stratt, Biospherics, Inc., Rockville, Md. Electron micrographs were taken by Dr. John Waid, Department of Botany, University of Canterbury, Christchurch, New Zealand.

This research was supported by the National Aeronautics and Space Administration. International travel and field logistics were provided under National Science Foundation grant GV-30412.



Bacterial growth in antarctic dry valley soils as measured by light scattering.