Ascospore cultures of lichen phycobionts from the antarctic desert

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During the 1983–1984 austral summer, cultures of lichen phycobionts were isolated from ascopores in fruiting bodies of fertile stages. The lichens are cryptoendolithic, chasmoendolithic, and epilithic forms collected in the mountainous areas of the Ross Desert (*Acarospora* sp., *Buellia grisea* Dodge & Baker, *Buellia pallida* Dodge & Baker, *Lecidea capsulata* Dodge & Baker, *Lecidea phillipsiana* R. Filson, *Lecanora* sp., and *Rinodina* sp.). The isolation method of Ahmadjian (1961) was followed with minor modifications: portions of mature apothecia from freshly collected samples were affixed with petroleum jelly to the inside of the cover of a Gelman Tissue Culture Dish which contained sterile solid nutrient medium. Several standard mycological media were used with equal success. The attached ascocarps were wetted with a drop of sterile double distilled water and the dish inverted so that the cover with the ascospores was at the top. As the ascocarps absorb moisture, the spores are forcibly discharged onto the underlying medium. During this time, cultures were kept at 4°C.

As soon as the spores were released, each dish was sealed with parafilm as drying of the agar medium inhibits ascospore germination. Upon germination, small blocks of agar with a few (preferably single) spores were cut out aseptically and transferred to fresh medium. Cultures were maintained at 10°C ± 1°C.

One hundred and twenty strains were isolated and are being maintained in the culture collection of microorganisms from extreme dry environments in the Department of Biological Science, Florida State University.

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Continuous temperature measurements in the cryptoendolithic microbial habitat by satellite-relay data acquisition system

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Ecological research in Antarctica is hampered by the difficulty of obtaining field data over the entire year. The logistical difficulties of supporting year-round field parties and the desire to minimize disturbance of the unique ecosystems of the Antarctic suggest that automatic data acquisition systems could play a key role in field research in areas away from the main winter-over stations.

Previous studies of the physical ecology of the cryptoendolithic microbial communities of the antarctic cold desert have been limited to data collected during field work (Friedmann 1977; Kappen, Friedmann, and Garty 1981; McKay and Friedmann in press). In this paper we present temperature data acquired with a satellite-relay data acquisition system. The data set considered here is only the first section of a continuous data log extending throughout the summer and winter months (Friedmann, McKay, and Nienow in preparation).

The satellite-relay system employed is based on the antarctic automatic weather stations of Stearns and Savage (1981) and Stearns (1982). The satellite transmission and power systems and the range of sensors developed for measurements in the cryptoendolithic habitat are described in McKay et al. (1983).

Temperature is measured with a semiconductor sensor. The active device is a National Semiconductor (Santa Clara, California) LM134-3 current source packaged in a hermetically sealed cylindrical metal can, approximately 4 millimeters in both height and diameter. The sensor current is directly proportional to absolute temperature. This device is an ideal remote temperature sensor because it does not lose accuracy over long wire runs. The sensor current is passed through a precision resistor with a low temperature coefficient, and the voltage across this resistor is the output signal. Calibration of the LM134-3 consists of slope adjustment only, and since the output extrapolates to 0 at O°K, it is independent of any initial inaccuracy. Pre-conditioning of the input signals is handled by custom manufactured electronics (National Research and Technology, Tallahassee, Florida).

Data are processed by an Argos Data Acquisition Platform (ADAP, manufactured by Polar Research Laboratories, Santa Barbara, California). The ADAP is a self-contained, portable data system designed for remote areas. Each unit is capable of sampling 32 channels in the form of analog ground-referenced voltages from 0 to 5 volts. In operation, the ADAP completes a sampling sequence once every 200 seconds. In each sampling sequence, the unit samples all 32 channels for more than a 1-second interval and then stores, digitizes, and transmits the data to the TIROS/NOAA series satellites. When the satellite's orbit places it within the view of a platform, the transmissions are received and relayed to the ARGOS center (*Centre Spatial*) in Toulouse, France. The fact that the satellites are in polar orbits makes this system particularly well suited for use in Antarctica where data transmission to geostationary satellites is often impossible. The total number of satellite passes over a given platform averages about seven a day at the equator and up to 28 per day at the poles. Currently there are two satellites active in this series, TIROS 7 and 8, in sun-synchronous polar orbits with periods of about 100 minutes. Three additional spacecraft in this series are under construction and are scheduled for launch in 1984, 1985, and 1986–1987.

The major problem in the design of a ground station in Antarctica is ensuring survival throughout the austral winter. For our system, power is supplied by eight 12–volt 40-ampere-hour lead-acid gel batteries (Power Sonic, Redwood City, California) recharged during the summer months by an array of solar cells. The average power requirement of the system, including ADAP, ancillary electronics and sensors is about 0.6 watts. This load can be sustained for over 8 months with the battery supply. All electronic components are rated or tested to -40°C.

Temperature variations of the air and of the surface of two Beacon sandstone outcrops are reported here. Air temperature was measured at a distance of about 1 meter from the rock sensors and at a height of about 70 centimeters above the surface, screened from direct solar radiation by a polished metal cylinder. The site of the "colonized rock" is a sandstone outcrop, colonized by cryptoendolithic microorganisms. The crust is brown from the accumulation of iron compounds. The orientation of the measured face is vertical, and it faces the sun directly in the morning hours. This is the same rock boulder measured earlier by Kappen, Friedmann, and Garty (1981) and McKay and Friedmann (in press). The location of the sensor is the same as "site *a*" in McKay and Friedmann (in press). The "uncolonized rock" is a horizontal Beacon sandstone surface with no iron incrustation and without microbal colonization. It is not in the shadow of any other rock boulder and during the observation period it received nearly continuous sunlight.

Figure 1 shows temperature variations over a 16.3-day period beginning 21 December 1983, each profile being based on over 1,300 data points.

Figure 2, parts a, b, and c, show the cumulative time histograms for the data in figure 1. The cumulative time is the sum of all the time intervals during which the temperature is within the limits of the histogram step. The algorithm that calculates the cumulative time distributions (developed by T. Lung at the National Aeronautics and Space Administration) assumes linear interpolation between events. As an example for the use of the cumulative time graph, we note that the uncolonized rock spent a total of about 1 day at temperatures between 0.0°C and 2.0°C during the 16.3-day interval. The total areas in each of the cumulative time histograms are the same and equal the total period of measurements (16.3 days). Figure 2d shows the fraction of the total time that temperature exceeded a specified level for each of the three profiles. This was calculated by summing all cumulative time values for the intervals exceeding the specified level and dividing by the total time interval.

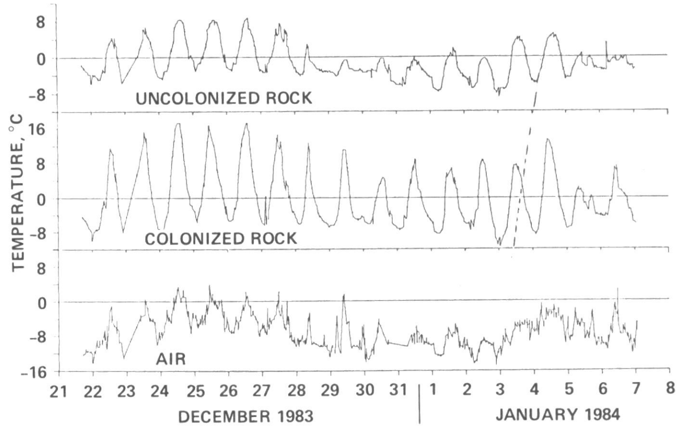

Figure 1. Temperatures of air and of two rock surfaces between 22 December 1983 and 7 January 1984, recorded by satellite transmission. Each graph represents 1303 data points without averaging or smoothing.

Both rock surfaces were considerably warmer than the air with a temperature differential between the air and the colonized rock face of about 15°C during the day. The maximum rock surface termperature observed was 17.3°C. In addition, the air temperature showed considerably more short-term variations than the temperature of either rock surface (figure 1). The biological importance of such variations has been discussed by McKay and Friedmann (in press).

A comparison of the solid and dotted lines in figure 2d shows that both the "uncolonized" rock and the "colonized" rock reached temperatures exceeding -2°C for the same time period. Experimental data indicate (Kappen and Friedmann 1983; Vestal, Federle, and Friedmann, *Antarctic Journal*, this issue) that biological activity takes place at this temperature. However, the "colonized" rock reaches biologically significant, higher temperature levels for considerably longer time periods than the "uncolonized" rock. For example, the total time that the temperature exceeds 4°C (figure 2d) during the period of measurements is 3.60 days for the "colonized" rock, 1.85 days for the "uncolonized" rock, and 0.0 days for the air.

At this time, available experimental biological data are still too fragmentary to determine the cumulative time/temperature threshold for microbial colonization of rocks. The year-round satellite-mediated microclimatological measurements are designed to provide the physical basis for such studies.

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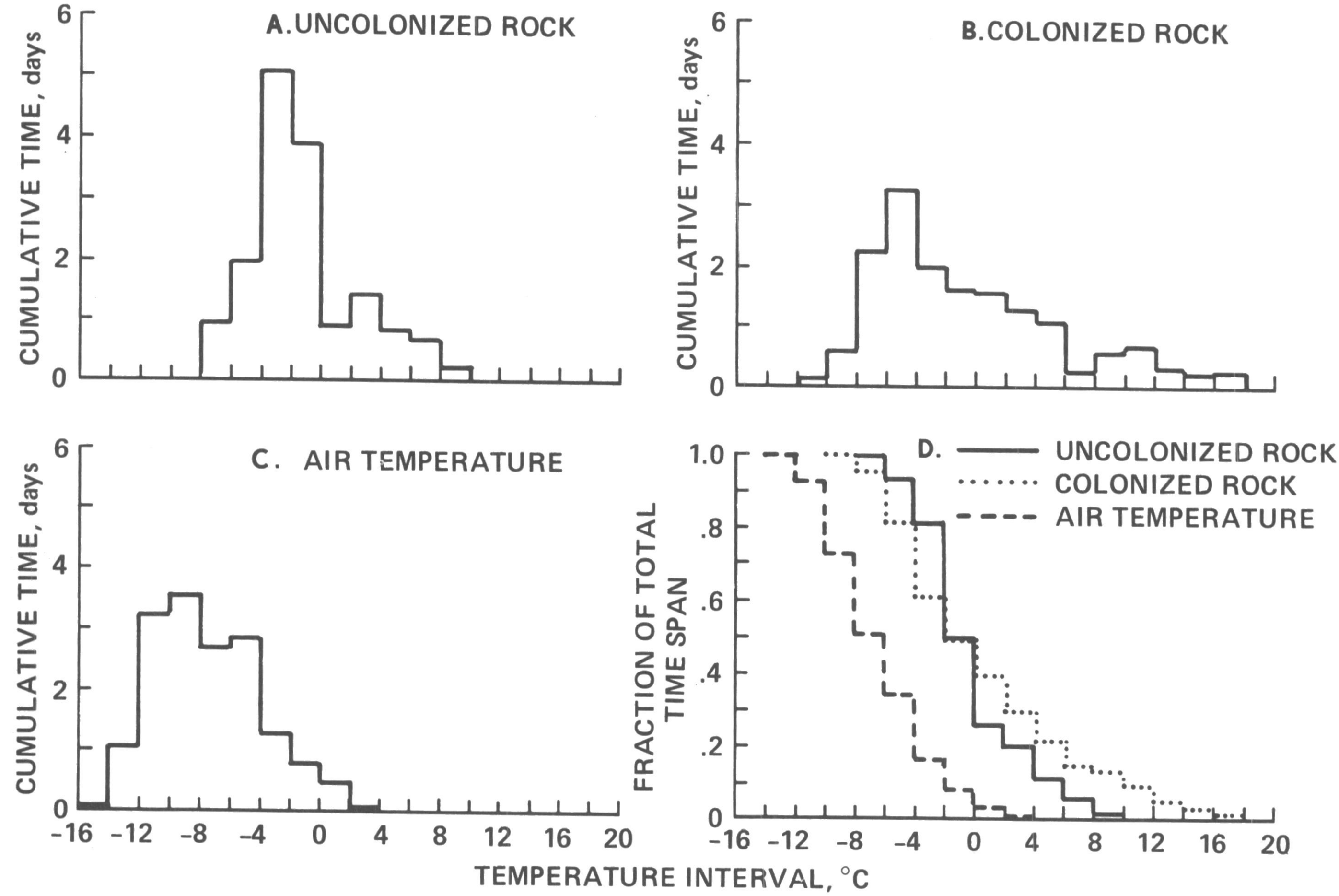

Figure 2. a, b, c: Cumulative time histograms for temperatures of "uncolonized" rock, "colonized" rock and air shown in figure 1. d: Fractions of total time span that the temperature exceeded the specified value. Actual lengths of time can be calculated by multiplying this fraction with the total time period of the measurements (16.3 days).

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