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Ecology

Widespread colonization by polar hypoliths

High-latitude polar deserts are among the most extreme environments on Earth. Here we describe a large and previously unappreciated habitat for photosynthetic life under opaque rocks in the Arctic and Antarctic polar deserts. This habitat is created by the periglacial movement of the rocks, which allows some light to reach their underside. The productivity of this ecosystem is at least as great as that of above-ground biomass and potentially doubles previous productivity estimates for the polar desert ecozone.

The underside of rocks in climatically extreme deserts acts as a refugium for photosynthetic microorganisms (defined as 'hypoliths') and their community (the 'hypolithon')[1]. Here, the organisms are protected from harsh ultraviolet radiation[2] and wind scouring, and trapped moisture can provide them with a source of liquid water[3]. Colonization also usually requires the rocks to be sufficiently translucent to allow for the penetration of light — all hypoliths reported so far have been found under quartz, which is one of the most common translucent rocks[4,5].

We examined 850 randomly selected opaque dolomitic rocks, without regard to the local patterns of periglacial rock sorting, on Cornwallis Island and Devon Island in the Canadian high Arctic. These are regions typical of extreme polar desert, where vegetation cover was measured to be 1.2% or less[6]. On Devon Island, 95% of rocks were found to be colonized, and on Cornwallis Island, 94% were colonized. The photosynthetic organisms form a well defined green band on the underside of the rocks. The mean (±s.d.) band width of these communities was 3.1±1.9 cm and 3.0±1.6 cm on Devon Island and Cornwallis, respectively.

The Arctic hypoliths are dominated by cyanobacteria. Species found include *Gloeocapsa* cf. atrata Kützing, *Gloeocapsa* cf. punctata Nägeli, *Gloeocapsa* cf. kuetzingiana Nägeli and *Chroococcidiopsis*-like cells; unicellular algal chlorophytes were also present[7].

We investigated the colonization of well developed polygons, which are just one manifestation of a diversity of linear and circular features caused by the long-term action of periglacial processes[8]. In the Arctic, we found colonization on 68% of rocks within polygons, with a mean (±s.d.) band width of 0.7±0.8 cm, where the rocks are surrounded by fine soil sorted into their centres. At the edges, where the cracks around the rocks are larger, we found 100% colonization with a mean (±s.d.) band width of 3.6±1.4 cm (Fig. 1).

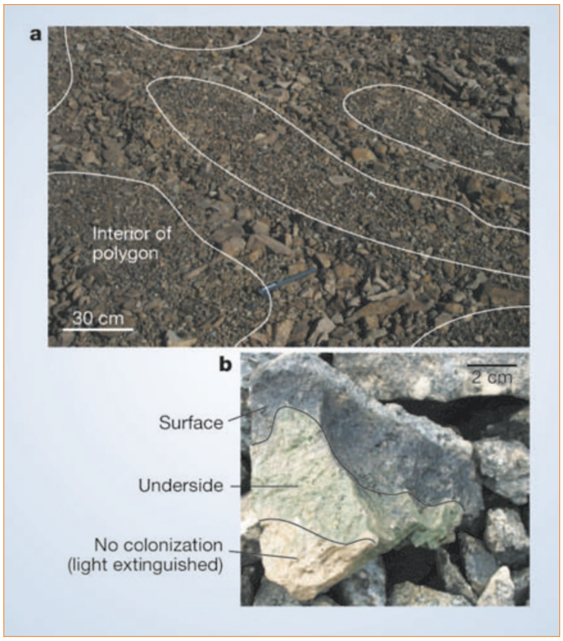

Figure 1 Colonization by polar hypolithon. **a,** Hypolithic colonization is enhanced by rock sorting which, among other factors, increases light penetration to the underside of rocks, shown here at the edges of polygonal terrain (white lines indicate polygon edges). **b,** Opaque rocks are colonized on their underside by well defined bands of photosynthetic communities, seen here on an excavated rock.

We studied similar polygonal terrains at Mars Oasis on Alexander Island in the Antarctic Peninsula, a location where hypolithic colonization occurs. The percentage colonization was 5% within polygons and 100% on the edges of polygons, with mean (±s.d.) band widths of 0.7±0.1 and 2.1±0.3 cm, respectively. We propose that rock sorting by periglacial action, including that during freeze–thaw cycles, improves light penetration around the edges of rocks, one factor that might account for the widespread colonization of the underside of opaque rocks.

We estimated the productivity of the Arctic communities by monitoring the uptake of ^{14}C-labelled sodium bicarbonate (for methods, see supplementary information). Assuming no carbon uptake from other sources, a conservative estimate of mean (±s.d.) productivity is about 0.8 ± 0.3 g m^{-2} yr^{-1}. Given that the estimated mean (±s.d.) productivity from plants, lichens and bryophytes on Devon Island is 1.0 ± 0.4 g m^{-2} yr^{-1} (ref. 6), the polar hypolithon may be just as important in sequestering carbon, at least doubling previous estimates of the productivity of the rocky polar desert.

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Corrigendum: Does gut hormone PYY$_{3-36}$ decrease food intake in rodents?

M. Tschöp, T. R. Castañeda, H. G. Joost, C. Thöne-Reineke, S. Ortmann, S. Klaus, M. M. Hagan, P. C. Chandler, K. D. Oswald, S. C. Benoit, R. J. Seeley, K. P. Kinzig, T. H. Moran, A. G. Beck-Sickinger, N. Koglin, R. J. Rodgers, J. E. Blundell, Y. Ishii, A. H. Beattie, P. Holch, D. B. Allison, K. Raun, K. Madsen, B. S. Wulff, C. E. Stidsen, M. Birringer, O. J. Kreuzer, M. Schindler, K. Arndt, K. Rudolf, M. Mark, X. Y. Deng, D. C. Withcomb, H. Halem, J. Taylor, J. Dong, R. Datta, M. Culler, S. Craney, D. Flora, D. Smiley, M. L. Heiman

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