is the first time that they have been associated with the inscriptions mentioned by Kendrick in his 1889 diary. It is also important, I feel, that a record was made of these names and dates before they are completely erased by time and the weather.

Cryptobiotic Crust Holding the Place in Place

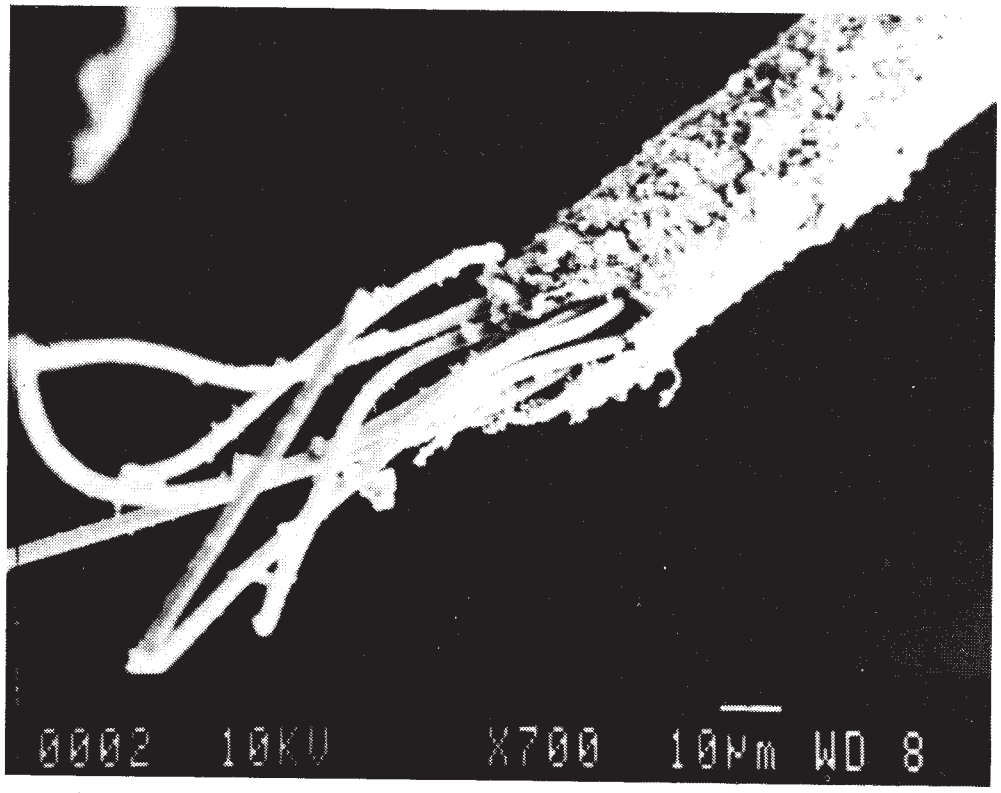
by Jayne Belnap

Living soil crusts are found throughout the world, from the hottest deserts to polar regions. In arid regions, these soil crusts are dominated by cyanobacteria, and also include soil lichens, mosses, green algae, microfungi, and bacteria. These crusts play many important roles in the ecosystems in which they occur. In the cold deserts of the Colorado Plateau region (parts of Utah, Arizona Colorado, and New Mexico), these crusts are extraordinarily well-developed, often representing over 70% of the living ground cover.

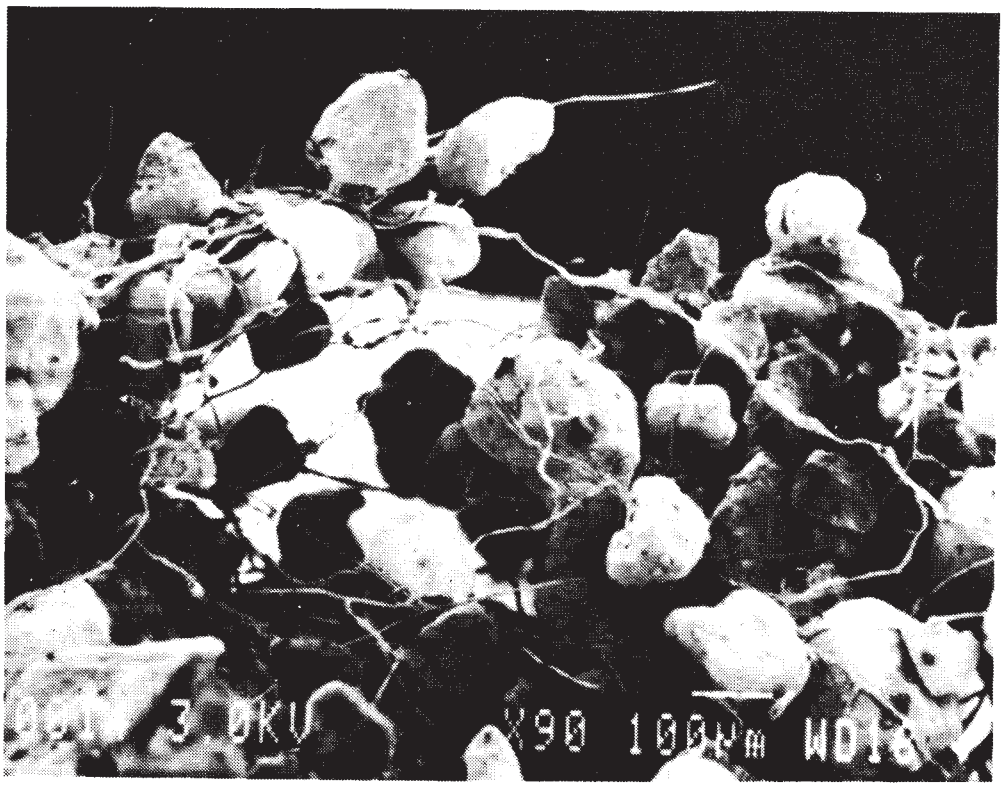
Cyanobacteria, previously called blue-green algae, are one of the oldest forms of life known. It is thought that these organisms were one of the early colonizers of earth's land masses and integral in the formation and stabilization of the earth's first soils. Some of the earliest fossils found, called stromatolites and dating more than 3.9 billion years old, are extremely thick mats of cyanobacteria. These mats are believed to have played an important role in converting the earth's original carbon dioxide-rich atmosphere into the oxygen-rich atmosphere necessary for the evolution of life as we know it today.

Cyanobacteria occur as single cells or as filaments. The most common form found in desert soils are the filamentous type. The cells or filaments are surrounded by sheaths that are extremely persistent in these soils. When moistened, the cyanobacterial filaments become active, moving through the soils and leaving a trail of the sticky, mucilaginous sheath material behind. This sheath material sticks to surfaces such as rock or soil particles, forming an intricate webbing of fibers in the soil. In this way, loose soil particles are joined together, and otherwise unstable and highly erosion-prone surfaces become resistant to both wind and water erosion. The soil-binding action is not dependent on the presence of living filaments: layers of abandoned sheaths, built up over long periods of time, can still be found clinging tenaciously to soil particles at depths greater than 15 cm in sandy soils. This provides cohesion and stability in these loose sandy soils even at depth.

The crusts have other functions as well. They are important in the interception of rainfall. When moistened, the sheaths absorb up to ten times their volume of water. The roughened surface of the crusts slows precipitation



Crust in sandy soils. The visible fibers are Microcoleus vaginatus. Note how Microcoleus connects the otherwise loose sand grains together, thus preventing wind and water erosion.



Microcoleus vaginatus, the dominant organism in the crust. Microcoleus is important in enhancing water and nutrient relations within the soil, as well as increasing soil stability.

QUOTE

"An adventure is a poorly planned trip."

Mark Twain

QUOTE

"We do not remember days; we remember moments."

Cesare Pavese

runoff and increases water infiltration into the soil. This is especially important in arid areas with sporadic, heavy rainfall. Vascular plants growing in crusted areas have higher levels of many essential nutrients than plants growing in areas without crusts. Electron micrographs of sheaths show them covered with fine clay particles to which cling essential nutrients, keeping these nutrients from being leached out of the upper soil horizons or becoming bound in a form unavailable to plants. In addition to the functions of stabilizing surfaces and increasing water harvesting, crustal organisms also contribute nitrogen and organic matter to ecosystems. This is especially important in desert ecosystems, where nitrogen levels are low, and often limiting to the systems' productivity.

Unfortunately, many activities of man are incompatible with the presence and well-being of these cyanobacterial crusts. The cyanobacterial fibers that confer such tensile strength to these crusts are no match for the compressional stress placed on them by footprints (cows or people) or machinery, especially when the crusts are dry and therefore brittle. Crushed crusts contribute less nitrogen and organic matter to the ecosystem. Impacted soils are left highly susceptible to both wind and water erosion. Raindrop erosion is increased, and overland water flows carry detached material away. This is especially a problem when the destruction is in a continuous strip, as with vehicular or bicycle tracks. These are highly susceptible to water erosion as channels are quickly formed, especially if on slopes. Wind blows pieces of the pulverized crust away; it also blows the underlying loose soil around, covering nearby crusts. Since crustal organisms need to photosynthesize, burial can mean death. When large sandy areas are impacted in dry periods, previously stable areas can become a series of moving sand dunes in a matter of only a few years.

Large areas that are impacted may never recover. Under the best circumstances a thin veneer may return in five to seven years. Even a single footprint has a long-lasting effect: nitrogen fixation stops, and underlying sheath material is crushed. Damage done to the abandoned sheath material underneath the surface cannot be repaired since the living organisms are only on the surface. Instead, sheaths must build up slowly as a result of many years of cyanobacterial growth.

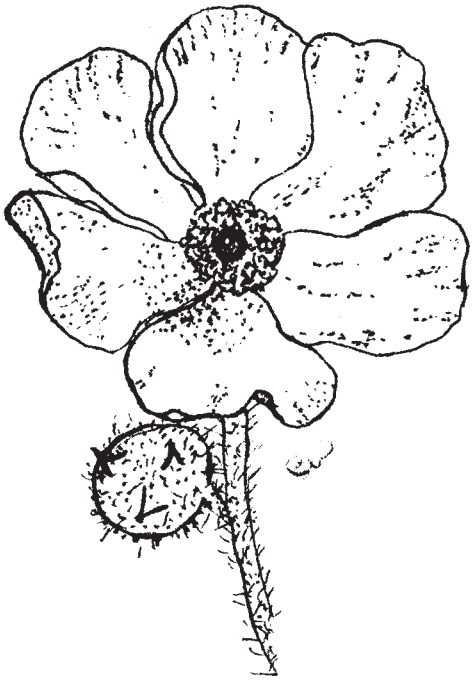
It is critical that we take care of the soil crusts around us, as they are an essential part of the ecosystem. They are the topsoil of the desert. Stay on trails or try to walk only in washes or on rock when possible. Help us keep the place in place!

What About that Cryptogamic Stuff?

Cryptobiotic crusts were formerly called cryptogamic crusts since the majority of the organisms in the crust were once considered cryptogams. Cryptogam, meaning "hidden marriage" in Latin, is used to refer to non-vascular plants that include the mosses, green algae, and other such organisms that do not have true flowers.

Cyanobacteria, the dominant group of organisms in the crusts, were at one time considered to be part of the cryptogam group, thus making the crusts almost entirely cryptogamic species. Since then, however, cyanobacteria have been reclassified, and are now considered to be either their own kingdom, or of the kingdom Monera, which also includes true bacteria.

The name "cryptobiotic crusts" was chosen since it was easy to remember, and carries no taxonomic implications. "Cryptobiotic" means "hidden life", and thus covers all the organisms found in the complex universe of these crusts.



QUOTE

"Once a journey is designed, equipped and put in process, a new factor enters and takes over. A trip, a safari, an expedition is an entity, different from all other journeys. It has personality, temperament, individuality, uniqueness. A journey is a person in itself, no two are alike. And all plans, safeguards, policing and coercion are fruitless.

We find after years of struggle that we do not take a trip, a trip takes us. Tour masters, schedules, reservations, brass bound and inevitable, dash themselves to wreckage on the personality of the trip. Only when this is recognized can the blown-in-the-glass bum relax and go along with it. Only then do the frustrations fall away. In this a journey is like marriage. The certain way to be wrong is to think you control it.

I feel better now, having said this, although only those who have experienced it will understand it."

John Steinbeck