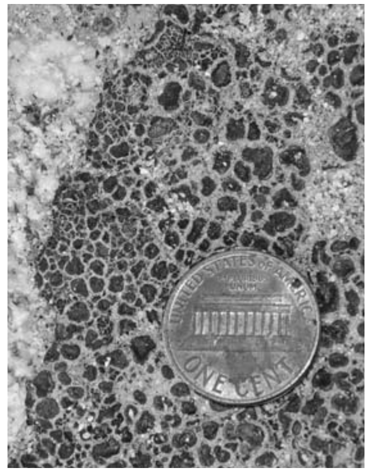
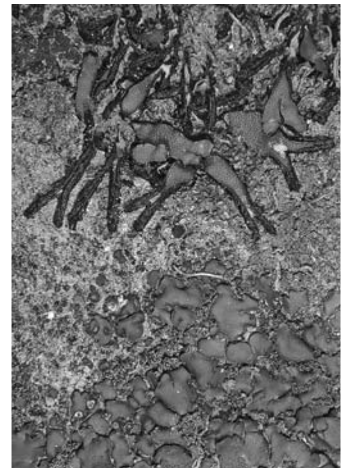
Cryptobiotic Crusts: Enabling NativePlants

by Wayne P. Armstrong

Cryptobiotic crust along Travertine Palms Wash in northeastern San Diego County. The dark crust is mostly the squamulose soil lichen Placidium lacinulatum.



Close-up view of the soil lichen Placidium lacinulatum. The thallus is composed of dark, scalelike squamules. The common name of "brown stipplescale" refers to the color and pitted squamules where the fungal spores are released.



The slender black threads with forked branching are the rolled-up, desiccated thalli of a liverwort in Palm Canyon. The hydrated green thalli in lower part of photo have unrolled into their characteristic flattened,scalelike structure.

Arid desert regions where vegetation is sparse often have miniature communities of spore-bearing "plants" called cryptogams living together on the soil surface. They include colonies of lichens, mosses, liverworts and cyanobacteria. Unlike true vascular plants, their plant body is called a thallus and they have no flowers or seeds. These unique associations and their by-products form a crust of soil particles bound together by organic materials. They are commonly referred to as biological soil crust or cryptobiotic crust, and are readily distinguished from nonbiological features, such as salt crusts on desert playas. The name is derived from "crypto" (hidden) and "biotic" (life), and literally refers to a layer of hidden life on the soil surface. Cryptobiotic crust is well developed and widespread in Anza-Borrego Desert State Park. It forms a dark, thin layer on sun-baked soils of the badlands, ancient riverbeds, and parched mountain slopes. To appreciate these marvelous organisms, you really need to get down on your knees, preferably with a good hand lens or magnifying glass.

Cryptobiotic crusts are important to desert ecosystems throughout the world because they hold soils in place and protect the underlying sediments from wind and water erosion. Members of the cryptobiotic crust stabilize soil particles with intertwining cellular strands and intricate, root-like extensions called rhizoids and rhizines. All of these organisms promote soil water retention which is vital to seed germination and the survival of seedlings. Cryptobiotic crusts are an important pioneer stage in plant succession, thus enabling native grasses and herbs to become established in an otherwise hostile environment.

Cryptobiotic soil crusts are fragile and easily damaged or destroyed by crushing and trampling. This includes hikers and horseback riders, not to mention off-road vehicles and the clearing of land for agriculture and housing. In range lands of the western United States, well-developed crust communities flourish only where cattle are excluded. It is very important to stay on designated trails and roads. Even when you are examining this remarkable desert phenomenon, it is important to tread lightly and not allow your shoes to penetrate the fragile crust. Like the Arctic tundra, once this delicate community of cryptogams has been damaged, it may take years to grow back. Large areas of crust damaged by human activities may never recover. Areas where cryptobiotic crusts have been stripped away are vulnerable to wind and water erosion, flooding, dust storms and the invasion of naturalized weeds that thrive on disturbed soil.

Cyanobacteria consist of microscopic filaments of cells with sticky polysaccharide sheaths that adhere to soil particles. They were once called blue-green algae; however, they share more characteristics with bacteria than true algae and are now placed in the kingdom Monera. Two filamentous species *Microcoleus vaginatus* and *Scytonema myochrous* are listed as important soil binders by Rosentretor, Bowker and Belnap (2007) in their beautifully illustrated book *A Field Guide to Biological Soil Crusts of Western U.S.* Drylands which is available on-line as a pdf file (see bibliography). *Scytonema* species have an amazing worldwide distribution, including black, fibrous, felt-like layers on the surface of rocks and soil. They are one of the primary reasons why ancient Maya pyramids in Guatemala appear black. Another valuable contribution by cyanobacteria is nitrogen fixation, a remarkable bacterial skill in which inert atmospheric nitrogen gas is converted into ammonia, thereby making the vital element nitrogen available to the roots of higher plants

In the Anza-Borrego Desert region, several genera of lichens produce visible soil crust that covers many miles of undisturbed soils. Lichens are a very successful life form resulting from the merging of genomes from two diverse kingdoms, the Fungi and Protista. They contain fungal hyphae and photosynthetic algal cells living together in a mutualistic relationship. Since the main body of the lichen is composed of fungal tissue, they are usually referred to as lichenized fungi. In some species, the photosynthetic symbiont is cyanobacteria rather than algae. Lichens can survive in some of the most inhospitable environments on earth, where neither symbiont could survive on its own. In fact, lichens are an excellent

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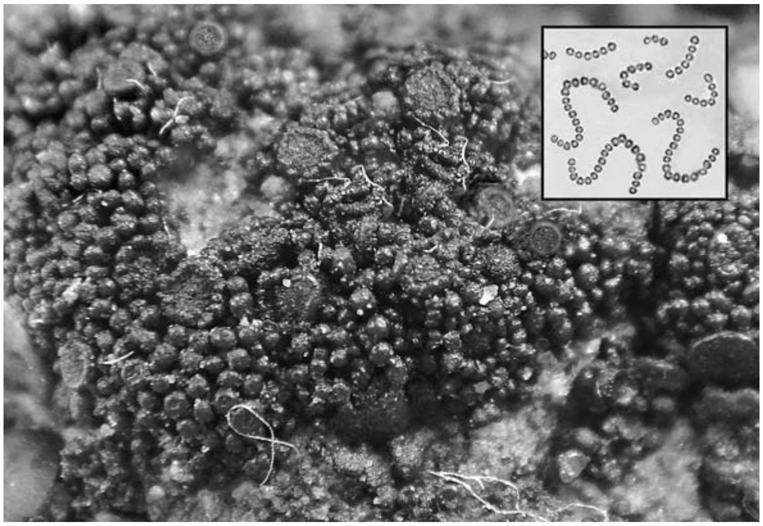

Close-up view of the dark soil lichen called tarpaper lichen. The thallus is composed of numerous spherical granules called isidia, each capable of growing into a new colony. Several disk-shaped fungal fruiting bodies (called apothecia) are also visible. The inset shows a greatly magnified view of the photosynthetic partner of this lichen, cellular filaments of the cyanobacterium Nostoc.

example of synergism, because the whole is truly greater than the sum of its parts. The algal and fungal components develop into a unique body form with morphological features quite different from either symbiont. The fungal component typically produces its characteristic reproductive body consisting of a spore-bearing cup-like structure (apothecium) or a vase-shaped perithecium lined on the inside with spores. These same structures are also produced by non-lichenized fungi in forested areas.

It is not surprising that lichens form an important component of cryptobiotic crust in desert regions. Some species are extremely drought resistant and survive for many months in a desiccated, dormant state. In fact, some lichens may lose up to 98 percent of their water content. When a lichen is wetted by an occasional rain, it quickly imbibes water like blotting paper, and photosynthesis within its algal symbiont is revived for a while. The body (thallus) of two common species in Anza Borrego Desert State Park is composed of overlapping, scalelike lobes called squamules. The foliose soil lichen *Placidium lacinulatum* is fairly widespread in the Park. The dark brown squamules contain microscopic pores (pits) that open into spore-bearing perithecia embedded in the thallus. Its common name of "brown stipplescale" refers to the color and pitted squamules. When wet the thallus turns olive green. *Psora decipiens* has larger, pinkish-tan squamules with several black, spore-bearing apothecia along the margins. Because of its distinctive reddish-tan color, this species is called "blushing scale." The photosynthetic symbiont (photobiont) for both of these soil lichens is a unicellular green alga.

Another widespread soil lichen in Anza-Borrego Desert is *Collema coccophorum*. The granular black thallus resembles a thin layer of tar or dried oil and is the derivation of the common name "tarpaper lichen." When wet the thallus imbibes water, swells and becomes gelatinous and shiny olive-green to greenish-black. In this condition it fits another common name of "jelly lichen." Like *Psora*, the fungal component produces a minute disk-shaped apothecium, although it is often difficult to spot because it blends in with the thallus. Unlike *Placidium* and *Psora*, the photosynthetic partner of *Collema* is *Nostoc*, a microscopic cyanobacterium. *Nostoc* is a widespread genus that is found in freshwater ponds and creeks, and as a symbiont in cavities within the leaves of the water fern (*Azolla*) and the coralloid surface roots of many cycads. It is also the primary ingredient of "fat choy" (*Nostoc flagelliforme*) in Chinese cuisine, an important member of the soil crust in northern China. Under high magnification the cells occur in filaments resembling minute strings of beads. Several species of *Collema*, *Placidium* and *Psora* are listed in *Lichen Flora of the Greater Sonoran Desert Region* by Tom Nash, et al. (2004), so undoubtedly additional species occur in the Anza-Borrego Desert.

Liverworts and mosses belong to the Division Bryophyta within the kingdom Plantae. They are small, spore-bearing, nonvascular plants without cones, flowers or seeds. They are fairy common in wet meadows and along the banks of mountain streams; however, they are also found in desert habitats as a component of cryptobiotic crust. In the Anza-Borrego Desert they grow in mountain canyons where they receive some shade and rain. Liverworts have a green, flattened, branched thallus that superficially resembles a foliose lichen. The underside is black, and when the thallus becomes desiccated, it rolls up into tiny black cylinders resembling black threads. This strategy reduces the surface area of the delicate thallus exposed to the sun and dry air. Desert liverworts are practically unrecognizable at this stage. The closely-related desert mosses also lose water and dry up. Their bright green leaves wither and fade to brown or pale greenish-white.

The cryptobiotic crust is certainly not as showy as fields of desert ephemeral wildflowers or the lush creosote bush scrub in full bloom. Nonetheless, it plays an important role in the desert ecosystem by stabilizing vital soils necessary for the perpetuation of native seed-bearing species.

References

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