Hidden Life

Biological Soil Crusts at Tule Springs Fossil Beds National Monument

FIGURE 1: Lichen species part of the biocrust at TUSK.

FIGURE 2: Biocrust (dark spots) under a desert shrub.

Tule Springs Fossil Beds National Monument (TUSK) is an urban park that tells the story of an ever-changing environment. Once a lush Ice Age wetland, now eroded badlands, TUSK is a treasure trove of fossils and a refuge for the desert's smallest lifeforms. Look at the ground, and you may see a microlandscape quietly shaped over centuries by some of the oldest organisms on the planet. This community, known as biological soil crust, forms the foundation of our ecosystem (Figures 1 and 2).

What is biological soil crust?

Biological soil crusts, or "biocrusts," are communities of cyanobacteria, lichens, fungi, algae, and mosses living on the surface of soils in terrestrial environments. They cover about 12% of the Earth's land surface[1] and over 70% of the living ground cover in many drylands[2].

At TUSK, biocrusts make life possible for other desert species.

Why is biocrust important?

Cyanobacteria are among the oldest known photosynthetic life forms on Earth, dating back over 3 billion years — they are the reason we have oxygen in our atmosphere. When rain hits the soil surface, desert cyanobacteria become active and move through the soil, leaving behind filaments and Extracellular Polymeric Substances (EPS), sticky protective layers of complex sugars and proteins, that hold the soil crust together like a matrix (Figure 3).

DRI

All photos taken by DRI.

FIGURE 3: Close-up of cyanobacteria filaments.

FIGURE 4: Biocrust interspersed between calcium carbonate rubble.

FIGURE 5: Different lichen species make up the biocrust at TUSK.

As biocrusts grow, they:

- Prevent wind and water erosion.
- Trap dust before it enters the atmosphere, improving air quality.
- Retain and slowly release water, supporting desert plants and wildlife.
- Add nitrogen and organic matter to the soil, increasing nutrients.

Without biocrust, desert ecosystems would lose stability, fertility, and resilience.

How easily are they damaged?

Living in the top few millimeters of soil, biocrusts only grow when conditions are moist. In the Mojave Desert, biocrusts are especially slow growing, as rainy days are few and far between. Because they are so thin and fragile, a single footstep or tire track can crush centuries of growth. Biocrusts in sandy areas are particularly vulnerable; if broken, previously stable areas can become moving sand dunes in just a few years[2].

Once damaged:

- Soil remains vulnerable to erosion for 20 years or more[2].
- Full recovery can take anywhere from 5 to 250 years, depending on rainfall and soil type[2].
- In some cases, the crust never fully recovers.

Protecting biocrusts helps keep the entire desert ecosystem intact.

Biocrust in TUSK

Biocrust can be found across TUSK in different soil types and plant communities (Figures 4, 5, 6, and 7). Gypsum soils, which are notably rich in calcium, are a distinctive soil type at TUSK. The unique conditions of gypsum soil foster a diverse community of plants and biocrust organisms, including widespread southwestern lichens. For example, Figures 1, 2, 5, 6, and 8 all contain or focus on *Collema* lichens. These lichen species have a high nitrogen fixation capacity, playing an important role in the ecosystem.

FIGURE 6: Biocrust amongst desert pavement at TUSK.

FIGURE 7: Biocrust amongst desert pavement at TUSK.

The same species of lichen can take on different outward appearances depending on the soil they are living in. At TUSK, for example, biocrust can be found scattered between chunky calcium carbonate rubble left behind from ancient marshes (Figure 4). Biocrusts are also interspersed within desert pavement, a cobblestone cover of pebbles and rocks created from the bedload of ancient streams after finer sediments have blown away (Figures 6 and 7).

How can we identify biocrusts?

Biocrust appearance can vary in height and shape based on its ecosystem and maturity level. Mature biological soil crusts are often the easiest to identify, as they can have darker, developed lichen and be up to several centimeters, in the form of pinnacles and mounds. Newer biocrust, on the other hand, is commonly overlooked as it appears to be flat to the ground and is similar in color to the soil. Species richness and total cover (the absence of bare spaces) are also good indicators of maturity. Typically, the darker and more abundant lichens coincide with higher cyanobacteria biomass and erosion resistance (Figure 12). In other words, the older the crust, the more stable that soil will be (Figures 8 and 9).

FIGURE 8: Active cyanobacteria (green tint) and lichen after rainfall, part of a mature biocrust at TUSK.

It is important to note that lichens on rock surfaces are not considered biocrust and serve a different function than lichens on soil surfaces (Figure 10). While soil lichens stabilize and fertilize the soil, rock lichens break down materials.

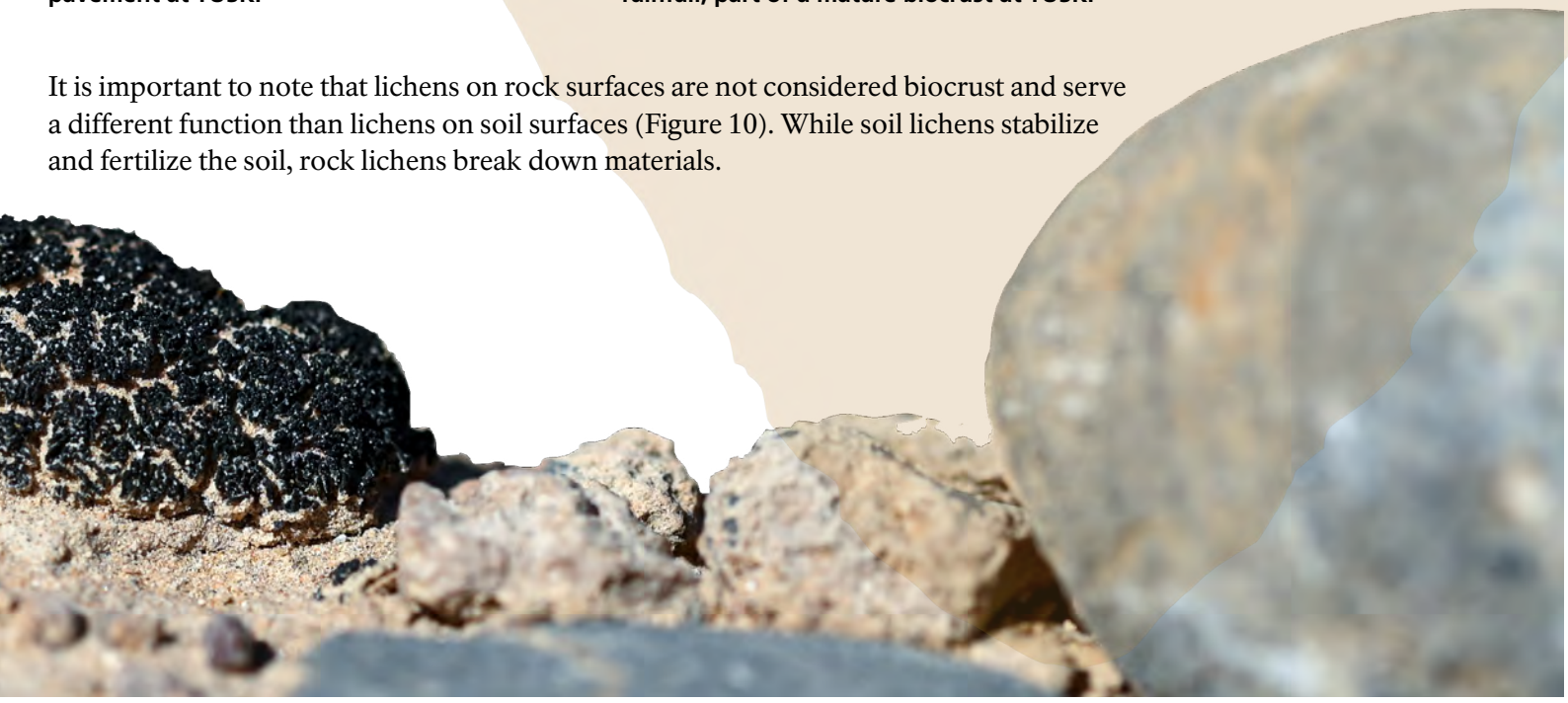

FIGURE 9: Mature biocrust at TUSK.

FIGURE 10: Species of rock lichen at TUSK on calcium carbonate remnants.

FIGURE 11: Species of rock lichen on tufa at TUSK.

FIGURE 12: Active cyanobacteria (green tint), part of the biocrust, after rainfall.

At Tule Springs, rock lichens gradually weather away tufa (Figure 11, a porous limestone left over from Ice Age springs) but do not provide the soil-binding or moisture-holding benefits of biocrust. When identifying biocrust, we solely look for soil surface organisms.

Being a good steward:

You can help protect the biocrust by following these simple steps:

1. **Stay on the trail!** Established trails and rocky washes are best to walk on when possible as they are not home to biocrust.
2. **Do not walk, bike, or drive on the biocrust.** These activities can cause permanent damage and destroy hundreds of years' worth of biocrust growth.
3. If you are in a group and you are surrounded by biocrust, walk along any pathway, big or small, created by waterflow. If there is absolutely no route that avoids the crust, take your time to find the path that best minimizes damage. On flatter land, your group should stay in a single file line, but if you are on steep terrain, it is best to disperse and avoid creating paths prone to erosion.
4. **Spread the word:** Tell your friends and family about biocrust and how they can protect it, too!

Citations

1. Bowen, L., & Dr. Reed, S. (2020, February 27). *Growing biocrust in Utah*. The Nature Conservancy. Retrieved December 1, 2025, from https://www.nature.org/en-us/about-us/where-we-work/united-states/utah/stories-in-utah/growing-biocrust-in-utah/
2. Belnap, J. (2020, January 7). *Cryptobiotic soils: holding the place in place*. GeoChange Global Change Data. Retrieved December 1, 2025, from https://www.mesaprietapetroglyphs.org/uploads/4/2/3/9/42390305/cryptobiotic_soils__holding_the_place_in_place.pdf

iNaturalist

To help protect our biological soil crusts, scan the QR code and join our iNaturalist TUSK project! Uploading photos of the biocrust (and other organisms) you see allows us to better protect and monitor their ecosystems.

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Remember, DON'T BUST THE CRUST!