CANYONS & CAVES

A Newsletter from the Resource Management Offices
Carlsbad Caverns National Park

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Preserving America's Natural and Cultural Heritage for future generations!

Edited by Dale L. Pate

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RESOURCE NEWS

SPRING AND SUMMER WEATHER – Hot and dry would describe the spring and early summer weather experienced at the park. There were a total of 19 days that topped 100°F from May to the end of June. Temperatures rose over 100°F eleven days in a row, from June 20 to June 30. The hottest temperature was 107°F recorded on June 28. The rest of the days in that period were in the high 90's. The monsoon season started in July and helped to moderate temperatures. **Rainfall** was down for the entire period. In April there was .11 inches received, in May there was no rainfall, and in June there was .14 inches received. Even with the monsoons beginning, in July there was only .40 inches of rain received while in August 1.67 inches fell. From mid-March through August the park received a total of 2.32 inches of rain. For the same time period in 1997, the park received 8.75 inches of rain.

Compiled by Lorie Hardin

THANKS TO LANCE MATTSON for reporting suspicious activities from a visitor group in the park. Four individuals were fined for entering a park cave without a permit. Lance received a Fast-Track Award for his observations and report.

HISTORIC ITEMS – Items of a historical nature continue to be moved around in Lower Cave and Slaughter Canyon Cave. When items are moved, they are taken out of context and information concerning their placement is lost. Moving an item also impacts the item and the cave floor. Please **DO NOT** move any historic item found in any cave.

WELCOME to Steven Bekedam, a new SCA for Surface Resources. Steven EOD's Oct. 1.

WHAT'S HAPPENING IN SURFACE RESOURCES

- Mountain Lion Transects begin again in October. The dates for the transects are in the Calendar of Events. Contact David Roemer, ext. 373, if you'd like to participate.
- The week of October 5 begins the field work to delineate the active and historic wetlands boundaries at Rattlesnake Springs (see write up)
- Renée Beymer and Diane Dobos-Bubno will attend two back-to-back conferences in Albuquerque this November: one focuses on vegetation management and one on riparian habitat and water use issues.

CAVE RESOURCES VOLUNTEERS – Adios and thanks to Gosia Roemer and Jed Holmes for all the hard work they did this summer. Gosia returns to Poland while Jed is in the band at Carlsbad High School. Look for Jed spraying algae in Carlsbasd Cavern on weekends this fall and winter.

During a summer storm, lightning strikes the Rattlesnake Canyon area.
© Dale L. Pate

THE MYSTERY OF THE SCATTERED PEARLS

by Paula Bauer

Usually people think of pearls as products of deep-water creatures, hidden treasures from the depths. Yet another kind of pearl lies visible in shallow pools deep underground. Cave pearls intrigue and delight those who see them. They seem to form mysteriously, lying loose in the cave not attached to anything, such as a cave wall, ceiling, or floor. Their mysterious nature is to many what makes them so extraordinary.

Cave pearls, also known as marbles and hailstones among other names, form when water drips into a shallow cave pool creating a small "nest" or "cup". A grain of sand, a piece of bat bone or soda straw, or any other foreign object may become the nucleus for the pearl growth. As layer upon layer of crystals adhere to the nucleus in "onion-like layers"; the developing pearl is continually moved due to the constant drip of water or the forces of crystal growth itself. Thus, the pearl remains unattached to the floor of the pool.

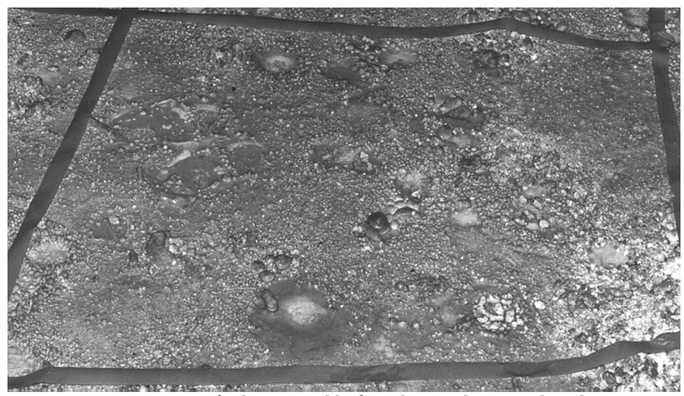
Cave pearls are generally believed to be relatively young, fast-growing speleothems. Through experimental demonstration, cave pearls can grow "up to 5 mm in diameter in less than 10 years". Though they form in the same manner, throughout the world, cave pearls vary in size, color, mineral composition, and shape. The smallest "pearls" are merely a single calcite crystal of 0.1 millimeter while the biggest are "as large as billiard balls". Cave pearls are not always smooth and spherical. They can be cigar-shaped and even cubical "stacked like so many sugar cubes in a box".

In Carlsbad Cavern, one may see a great number and diversity of cave pearls on the floor of the Rookery in Lower Cave. Here, some pearls are seemingly perfectly rounded; others are more misshapen like pebbles, while others look like stubs of white cigars. Some sit neatly in their "nests" while others appear scattered about like chicken feed. Because they are not attached, the pearls could easily have been picked up, handled, and unheedingly tossed back to the floor. Or perhaps there is more to this mystery.

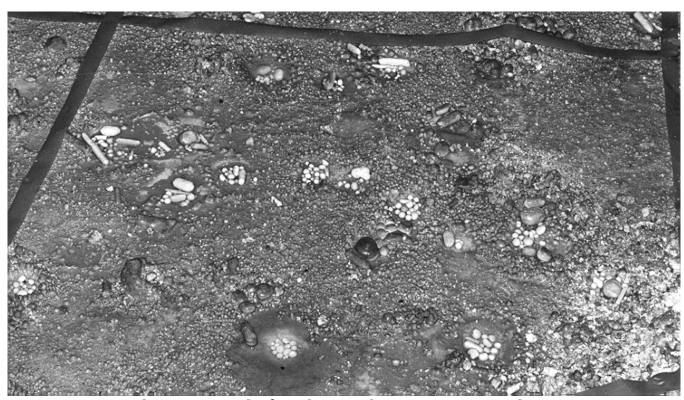
Through the years, stories have persisted as to the treatment of pearls by park employees. One story claims that pearls seemed so numerous in earlier years that rangers commonly handed them out to park visitors as souvenirs. Another asserts that the park's first superintendent kept some handy in his office to hand out at will. In fact, there is no documentation to support any of these claims. They are possibly just stories. Perhaps individual rangers/guides acting on their own initiative freely allowed pearls to be taken. However, one would hope that the accounts are false. And when one examines the statements, policies, and acts of the early leaders of the park, one can witness the concern for the conservation of the cave and its fragile and limited formations.

Another tale involves a whole bucket of cave pearls. One variation of the story goes that someone found a bucket full of pearls in the cave. The finder scattered the pearls in the Rookery in an effort to return the pearls to their proper place if not their precise "nests". Is this the source of the mystery of the scattered pearls? Carlsbad Caverns' former Cave Specialist, Ron Kerbo, has the answer to this question.

Kerbo recalled the situation as follows. Sometime about 1983 or '84 geologists Carol Hill and Michael Queen were working in Lower Cave, examining cave features as part of their research. Hill found the "bucket" tucked behind a "wall" of broken cave formations. She immediately notified Kerbo in his office and he returned with the cavers to the location in Lower Cave. He said that the pearls were stained with rust and had obviously sat undisturbed for a long time in the "bucket", an aged and rusted, large-sized coffee can. They removed the can and gently cleaned the cave pearls in water. Afterward, they carefully returned them to the Rookery where Kerbo and a few volunteers tried their best to match the pearls in size and shape to appropriate nests. The entire process was documented with photographs and each pearl's new location was marked on the maps of the cave. Unfortunately, since this event most of the documentation has been lost or misplaced. The Cave Resource Office has only a handful of unlabeled photographs of the meticulous process of returning the pearls to their nests.



One section of a larger grid before the pearls were placed.



The same grid after the pearls were put into place.

Since this portrays the actual incident, why then do the pearls in the Rookery look scattered and not painstakingly placed? Perhaps they have been handled, moved, stepped on, and jostled since the time that the pearls in the coffee tin were replaced. Perhaps some of the pearls had been placed in the Rookery by some earlier misguided if well-meaning cave re-decorator. Perhaps the pearls have always been there like that. Pearls do not always form in clearly delineated "cups".

The Rookery cave pearls alone will guard the truth to their history. We are left with our imaginations, speculations, and facts. But, as long as people can wonder at their size, shape, and their odd nature compared to the other speleothems around them, people will continue to find them fascinating and retain the sense of mystery.

All scientific explanations were taken from Carol Hill's and Paolo Forti's, Cave Minerals of the World, 1986. Account of discovery of the "bucket of pearls" from Ron Kerbo via a telephone conversation on September 18, 1998.

EDITOR'S NOTE: Documentation found with a few photos indicates that the pearls were placed back in their nests in the Fall of 1983.

IDENTIFYING WETLANDS AT RATTLESNAKE SPRINGS

byDiane Dobos-Bubno

(from an interview with Leslie Krueger, NPS Water Resources Division, Fort Collins, CO)

Cool, clear, flowing water on a hot, dry desert day--this is just one reason that Rattlesnake Springs is such a draw to visitors. This same water source provides a habitat enticing birds, mammals and plant life. Though protected at Carlsbad Caverns National Park, Rattlesnake Springs might be considered an endangered habitat. Estimates indicate that only 10% of the pre-Anglo American riparian habitat remain in the Southwest, a dramatic loss in the last 100 years.

The Clean Water Act protects wetlands from certain activities. In addition to these protections, Secretary of Interior Bruce Babbitt formally adopted strict standards for classifying wetlands. Under his watch, wetland protection has become an important focus. And for good reason. The roles of wetlands are diverse, from clearing particulate matter in water to providing refuges for wildlife of all sizes. As wetlands disappear, so does the biological diversity in both the plant and animal kingdoms.

It is the water source and resulting stream course that initially categorize parts of Rattlesnake Springs as a wetland. However, the wetland classification extends past the obvious water pathways since a wetland is defined as being under influence of water. Unfortunately, the actual wetland boundaries of Rattlesnake Springs are unknown. No wetland delineation has ever been done to determine either the current or the historic extent of the wetland.

This will be rectified during the week of October 5 when Rattlesnake Springs will be the site of a wetland classification and delineation. A team of experts will gather field data so that the boundary of the wetland can be drawn. In addition, we hope that soil pits will help determine the historic extent of the wetland. This understanding will direct future wetland restoration projects at Rattlesnake Springs.

Delineating a wetland is a three-parameter approach. Field evidence is gathered on vegetation, soil types, and hydrology. The vegetation evident with a wetland is called hydrophytic vegetation meaning plants that grow in or are adapted to aquatic or very wet environments. Since wetland environments tend to be water-saturated during various times of the year, the existence of hydrophytic plants is a good clue to the existence of a wetland.

The prominent presence of water, whether surface or subsurface, creates changes in the soil structure which differentiates these soil types from soils not exposed to constant wet conditions. With water saturation, so-called hydric soils are exposed to anaerobic (without oxygen) conditions that precipitate out characteristic iron and concretions. The result is a sticky, bluish-gray clay layer with orange coloration in the soil matrix and along plant roots. Should the wetland dry out, these clues can be found decades later. It is these reminders of the past that may allow us to determine the historic boundaries of the wetlands at Rattlesnake Springs. If this evidence is found there, it will provide us with a better understanding of the unrecorded extent of those wetlands.

The third parameter in the process is to evaluate the wetland hydrology, that is, the conditions that support a wetland today. Though all three of these parameters—vegetation, soils, and hydrology—are considered jointly, in some cases, a wetland can be classified with only one parameter apparent. An example of this might be a beach, a reef or a mudflat where the sole existence of hydrologic forces, wave action in this case, classify the wetland.

Past water and land disturbances at Rattlesnake Springs may prevent a true picture of the past. However, as with a jigsaw puzzle, it is the accumulation of the little pieces that will provide with a better understanding of our park resources.

BARITE "STALACTITES" IN LECHUGUILLA

by Harvey DuChene

I received the analysis results for the yellowish green "stalactites" recently found in Lechuguilla by Peter Bosted, Dick LaForge, Paul Fowler, et al. The mineral is barite with a trace of calcite. My understanding is that the stalactites were found in a newly discovered area called "Frostworks" which is located beneath the Keel Haul area of the Western Borehole. Other than the blue barite in bedrocck at the lip of the entrance pit, this is the first confirmation of barite from Lech, and definitely the first barite speleothem from the cave. In fact, based on the new edition of Cave Minerals of the World, barite stalactites are rare, and when they do occur, are found in caves associated with economic mineral deposits (mines).

I believe that there is one other occurrence of barite "stalactites" in Lech, and it is in the Chandelier Graveyard. This example is solitary, whereas the Frostworks has several "stalactites."

I have put the term "stalactite" in quotations because I do not yet know if the Lech barite speleothems have a central canal that would suggest that they form similarly to calcite stalactites. I plan to cut a thin-section of the sample and examine it under a petrographic microscope to see if I can find clues to internal structure and perhaps the mode of origin.

Suffice to say, the barite is beautiful stuff. It consists of pale yellow-green, tabular crystals and looks (superficially) like it may be monocrystalline. The crystals have high luster and reflectivity and are partly coated with a white mineral, probably calcite, but possibly gypsum. I haven't identified the accessory mineral yet, but the study suggests calcite.

BANNER-TAILED KANGAROO RAT
(*Dipodomys spectabilis*)
by Ken Geluso

As Banner-tailed kangaroo rats excavate their underground burrow systems, conspicuous mounds of dirt form on the surface of the ground. These dome-shaped mounds may contain numerous openings eight centimeters or larger in diameter. Well-traveled trails radiate from these burrow entrances that are currently occupied by a kangaroo rat. These characteristic mounds are quite distinctive and easy to locate in areas inhabited by this species.


Banner-tailed Kangaroo Rat (Photo by Ken Geluso)

At Carlsbad Caverns National Park, I located mounds of bannertails only in the flat lowlands of the seabed along the base of the escarpment. Mounds were present in the desert scrubland, arid grassland, and juniper plains, and these were also the only habitats in which I captured bannertails. Although there was one specimen of a bannertail from Rattlesnake Springs collected in 1964, I failed to locate any mounds or catch any animals of this species on this parcel of land. Bailey (1929) mentioned that during his survey, *Dipodomys spectabilis* were abundant "on the high limestone ridges all around the Carlsbad Cavern." During my study, I found no evidence that bannertails live in any habitats of the reef. Banner-tailed kangaroo rats trapped in my study were captured at elevations ranging from 3,640 to 4,330 feet; the one caught in 1964 was taken somewhere between 3,620 to 3,670 feet in elevation.

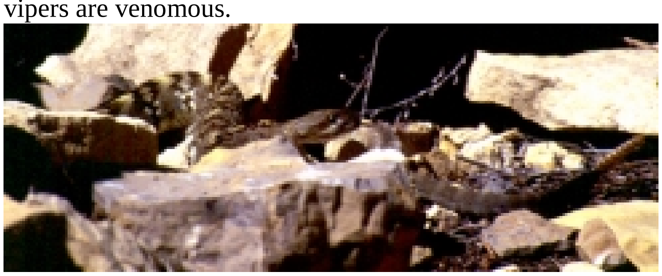
The highest density of mounds constructed by bannertails on park property was in open areas of desert scrubland containing little grass and silty soil intermixed with small stones. Sometimes mounds were located near rocky areas containing lechuguilla, but the mounds themselves were built in areas where the ground surface was relatively smooth. Within the scrubland, I never located a mound or captured a bannertail in the grassy areas.


Typical mound constructed by the Banner-tailed Kangaroo Rat.
(Photo by Ken Geluso)

This article was taken from a report titled "Rodents of Carlsbad Caverns National Park" by Ken Geluso which was completed in 1992.

BLACK-TAILED RATTLESNAKE
(Crotalus molossus)
by Dale Pate

Out of six species of rattlesnake found in Carlsbad Caverns National Park, the Northern Black-tailed Rattlesnake is one of the most commonly seen. There are three subspecies of *Crotalus molossus*, the only one in New Mexico is *Crotalus molossus molossus*. This species is a "pit viper" which refers to a deep pit on each side of the head that is lined with sensory organs and are used to detect heat from their prey. All pit vipers are venomous.


Black-tailed Rattlesnake in Last Chance Canyon © Dale L. Pate

The black-tailed rattlesnake is found from west-central Texas through the lower two-thirds of New Mexico to northern and western Arizona and then south into Mexico down as far as the state of Oaxaca. It is also found on two islands in the Gulf of California. In the United States, *Crotalus molossus* has been measured at 126 cm long (slightly over four feet), while in Mexico the longest measures up to 130 cm (four and one-quarter feet).

The black-tailed rattlesnake is found in many different habitats from high conifeous forest to riparian areas, lava flows, and desert creosotebush areas. In New Mexico, blacktails are found in areas ranging from 1000 meters (3,280 feet) to 3150 meters (10,330 feet) in elevation. In general, blacktails are mild-mannered, but will become aggressive if provoked or startled. At times they have been found several meters above the ground in trees. Their diet consists of pocket mice, woodrats, birds, squirrels, rabbits, chipmunks, kangaroo rats, gophers, deer mice, and lizards.

Information concerning the Northern Black-tailed Rattlesnake has been taken from Amphibians and Reptiles of New Mexico by William Degenhardt, Charles Painter, and Andrew Price which was published in 1996.

HELICTITES AND SUBAQUEOUS HELICTITES
by Dale Pate

HELICTITE is a word first used in 1886 to describe a contorted speleothem, which twists in any direction, seemingly in defiance of gravity. It comes from the Greek root "helick" which means to spiral. As early as 1655, investigators were beginning to understand how helictites form. It was not until 1940 however, when L. Huff was able to grow helictites in his laboratory, that anyone was able to study their growth first-hand. He concluded that hydrostatic pressure and capillarity (defined as the interaction between contacting surfaces of a liquid and a solid that distorts the liquid) were the main forces that create helictites. In 1954, G. G. Moore explained the ways in which helictites curve. These factors combined with others such as evaporation, airflow,

Helictites grow from a soda straw in Lechuguilla Cave. (NPS photo by Dave Bunnell)

impurities, water supply, and intracrystalline seepage affect helictite growth. In general, water seeps through an opening on the floor, wall, or even the side of a soda straw, and a central tube forms that the water keeps pushing through as crystals form at the tip of this tube. Factors such as the shape of the crystals, evaporation, air-flow patterns, and impurities cause the helictite to spiral or to bifurcate (split into more than one tube). There are four major types of helictites which won't be discussed here, but they all formed by these same forces. An excellent and more detailed description of helictites is found in "Cave Minerals of the World" by Carol Hill and Paolo Forti on pages 42-46. The information presented here is taken from this publication.

SUBAQUEOUS HELICTITES – Until the discovery of helictites that appeared to be growing underwater in Lechuguilla Cave, helictites were known only from subaerial (air-filled) origins. To date, more than 20 locations of subaqueous helictites have been discovered in Lechuguilla Cave. Their discovery has not confused or clouded the factors that have made normal helictites grow. These processes are understood quite well. In fact, subaqueous helictites have some similar characteristics. They are formed much like normal helictites in that crystals form around a central tube and growth occurs mainly at the tip or end of the helictite. They are different though in that they do not bifurcate or split, but remain one single tube. Subaqueous helictites share several common traits. They are all associated with a present or former pool level, form narrow central canals or tubes, and are all 1 to 2 meters downslope from a significant gypsum deposit. All pools that contain subaqueous helictites that are growing are located in a wet flowstone surface only a short distance from partially dissolved blocks of gypsum. As water flows through the gypsum dissolving it away, this water becomes supersaturated with calcite from the gypsum. As this supersaturated water enters the pool by seeping through pores or as narrow streamlets, subaqueous helictites are formed. Many begin to form at the pool level and angle downward, but some form from water seeping through pores in the pool walls. Obviously, the processes involved are quite complex. Since the discovery of subaqueous helictites actually growing in Lechuguilla Cave, it is thought that some helictites in Wind Cave, South Dakota may have formed underwater also. For a more detailed account, please read an article titled "Extraordinary Subaqueous Speleothems in Lechuguilla Cave, New Mexico" by Donald Davis, Art Palmer, and Peggy Palmer. This was published in the NSS Bulletin, No. 52, pp 70-86. The information presented here has been gleaned from this article.

AND THE TIMES, THEY ARE A CHANGE'N
by Jason Richards

Recently, I was reading some old *Southwest Cavers*, the Newsletter for the Southwest Region of the National Speleological Society (NSS). I guess I was just taking a walk down old memory lane. But while doing so, I reflected on conservation ethics and how they've changed over the years. The real scary part is, I realized I've been caving for all but 14 years of my life, considering I'm 25 almost (for the second time that is).

At the beginning of my caving career, I did a lot of caving in the Roswell area but when my father retired from the military, we moved to Albuquerque. My biggest interest was caving……I just couldn't get enough of it. So I sought out the local caving group which turned out to be the Sandia Student Grotto, at the University of New Mexico (a chapter of the NSS). Perhaps this was the wisest move I ever made in my caving career, as my mentors turned out to be people like, Harvey DuChene, Carol Hill, and Dave Jagnow, I was quite lucky in that aspect.

Conservation and preservation of caves has always been the main goal of the National Speleological Society, and conservation ethics was always taught and stressed through the Grottos of the NSS. The Sandia Grotto was no different and I soon learned that you,"took only pictures, left nothing but footprints, and killed nothing but time", and that was the way it was, and stressed.

Through the 60's and early 70's thoughts on cave conservation changed very little. In fact, some of the big names in caving routinely brought their dogs….*in…* the caves. Without mentioning names of the owners, I can think of *Crooked Thumb* and *Suzie*. I caved with *Crooked Thumb*, a German Shepherd and a mix with something else, in Cottonwood Cave, and *Suzie*, a Welsh Corgie, in Fort Stanton Cave. I'm sure *Ole Crook* hiked his leg on several stalagmites thinking they were fireplugs.

We would routinely go anywhere we wanted to in the caves as long as there was nothing fragile to break, not thinking about the footprints and boot marks we were leaving behind. The boots we wore had high carbon "Vibrum" soles that marked anything we walked on. Those same boot marks in some caves are calcified over on flowstone, there, forever as a token to our ignorance.

Carbide lamps were the main source of light. Carbide was cheap, readily available and batteries were expensive and didn't last long. Consequently, disposal of spent carbide was always a problem. Usually, we would carry two fully charged bottoms for our lamps, and if we needed to recharge the bottoms in the cave, we would dump the spent carbide into plastic sandwich bags. Try as you might, accidents did happen and carbide was spilled in the cave. Carbide dumps in the cave were not real common. However, there were those that didn't have a clue when it came to conservation ethics and would dump spent carbide in the cave.

The discovery of new caves was always exciting, and still is today, however, the approved methods of exploration were quite different. Scoop Booty!! Explore as much as possible, take pictures and see what you can. Surveying the cave as you go was unheard of, and the impact on caves was great. Most of the main caves in the Lincoln National Forest, caves such as *Madonna, Hell Below, Three Fingers* and *Virgin* were totally scooped before they were considered for survey. Perhaps, today, those caves would not have been closed had they been properly surveyed and trails established when they were discovered.

Today, things are quite different, even the motto of cavers has changed; "Take nothing but pictures, leave nothing but carefully placed footprints and kill nothing but time". It's pretty exciting to be involved on the leading edge of conservation. Much of the more recent views on conservation have been the direct result of exploration in Lechuguilla Cave. A survey as you go policy has been established, double flagged trails are common, restoration projects in caves throughout the United States are the "in" thing.

Even microbes, thought to be little, insignificant critters, have been brought to light and their importance realized by scientists such as Diana Northup and Dr. Larry Mallory. I'm sure that someday, perhaps 34 years from now, some cave specialist will be sitting in this same office saying, "I can't believe they used to do those things".

YES, WE HAVE ALGAE!

by Renée Beymer

…and not just in the water. Terrestrial algae, in our desert. Everywhere I go in the deserts I see them (I studied them in college, so I look for them). Even in our driest deserts, even in Death Valley, there are dried-out black or brown or white crusts on the soil surface. These crusts are living organisms, composed of various algae, lichens, and mosses—all of which photosynthesize. Also associated with them are microscopic algae, fungi, and bacteria. They usually don't look like much, but when it rains they come out of dormancy quickly. They absorb moisture, develop deeper pigments (especially greens), and start photosynthesizing and transpiring and reproducing.

Microphytic crust in Carlsbad Caverns National Park.

These crusts used to be called 'cryptogamic' (meaning 'primitive' organisms). Now, some researchers prefer more scientifically correct terms, such as 'microphytic' (tiny plants) or 'microbiotic' (tiny organisms).

This summer I got a call from Dr. Jeffrey Johansen of John Carroll University (Ohio). Dr. Johansen and three colleagues are conducting a three-year study of microbiotic crusts across the western U.S. and Canada, funded by the National Science Foundation. He wanted to know if CCNP had any crusts they could include in the study. I said, "Yes, we have algae (and lichens…)!" Dr. Johansen came to the park in July, conducting field work at two sites. He took data and samples for further study. We won't have final results for a while, but preliminarily he commented that we have very interesting crusts.

Maybe you've never noticed them here. Lots of people don't. You probably wonder: who cares? What are these crusts and why are they important? The following is taken mostly from Dr. Johansen's study proposal and from my own master's research on crusts at Grand Canyon National Park. As always, if you want to see more articles or more color pictures, be sure to let me know.

OVERVIEW

Microphytic crust is an important component of arid and semi-arid ecosystems. Crusts consist of nonvascular plants, primarily algae, lichens and mosses, that live on the soil surface. They are called plants because they contain chlorophyll *a* and photosynthesize (they manufacture carbohydrates out of water and sunlight). They are nonvascular because they don't have systems of internal transport within the plant; they don't transport water from roots to leaves like trees do. They also don't make flowers and seeds, reproducing slightly differently.

Crusts impart many direct advantages to the ecosystems in which they occur. Preventing soil erosion is one important benefit. This happens two ways. First, the filaments of algae, rhizines [root-like structures] of lichens and rhizoids [also root-like] of mosses aggregate the soil particles, binding them together. This often creates an irregular soil surface, or "pinnacled" microtopography, which interrupts wind patterns, reducing wind erosion and trapping wind-borne soil particles. Second, the crusts physically protect the soil by covering it with their thalli ['bodies'], thereby reducing rain-caused erosion and the accompanying loss of sediment.

Crusts also improve the moisture content of soils. The presence of crusts increases the depth of water penetration and total soil moisture content. One study has suggested that crusts may decrease evaporation from the soil surface, enhancing the significantly higher infiltration rates already found in crusted soils. Other studies [including Dr. Johansen's] have shown that crusts enhance seed germination and seedling development, presumably by providing a stable soil substrate and extra nutrients.

The effects of algae on soil fertility have been studied extensively. Nitrogen content was found to increase 400 percent in crusted soils with abundant algal growth. Nitrogen-fixing components of the crust include blue-green algae, lichens, and certain nitrogen-fixing bacteria associated with cryptogams. All three groups of crusts organisms exhibit extreme resistance to desiccation [drying]. The increased longevity afforded by this resistance to desiccation prolongs their potential contribution of nutrients to a semi-arid environment.

THE CURRENT STUDY

Despite their putative importance, crusts have been spottily studied. They are best known from the soils of the Colorado Plateau and Great Basin, where they can easily make up the dominant form of plant cover. The crusts of the Chihuahuan Desert are relatively unstudied. Dr. Johansen and his colleagues are attempting to determine the biogeography of western microbiotic crust species, including this desert. This information will benefit the park because it will enhance the biological inventories going on throughout the park. It will add to our knowledge of biological diversity. New species of cryptogams (microphytes) may even be discovered here.

This study is significant because for the first time a team of specialists in soil cyanobacteria [blue-green algae], eukaryotic algae ['higher' algae], lichen [symbiotic associations of algae and fungi], and moss taxonomy is collecting soils from 30 sites throughout the West. They are isolating, identifying, and archiving all microbiotic species found within these groups. This work has never been done for any site in the Chihuahuan Desert, Mojave Desert, or Sonoran Desert. In addition to CCNP, other Chihuahuan Desert sites in this study include Fort Bliss, Halloman Air Force Base, the Jornada Long-Term Ecological Research (LTER) site, the Sevilleta LTER, White Mesa, and possibly White Sands National Monument.

Objectives of the study include identifying all crust species, determining soil chemistry and texture characteristics, and developing a website to show pictures of the algae, methods used, and results. The many National Park Service units occurring in these three deserts will benefit greatly from this new information.

EFFECTS OF DISTURBANCE

A number of studies describing re-establishment of crusts following disturbances have been reported. In one study in Utah, the most pronounced recovery of the crust organisms occurred between 14 to 18 years following protection from heavy grazing. Elsewhere in Utah, a "diverse and well-developed soil crust flora" was found after 20 years.

Compaction caused by the hooves of cattle and other livestock has a negative impact on physical properties of soil and soil crusts. In Utah, areas ungrazed for 14 to 38 years were compared with adjacent grazed areas. They found 10 times greater moss cover, three times greater lichen cover, and twice as much algal cover inside the exclosures than outside. Significantly greater concentrations of phosphorus, potassium, and organic matter have been found on ungrazed over grazed sites. At least one national park studied the effects of hikers on crust cover. They found that boot type and number of passes over an area were important factors in impacting crusts.

In Utah studies of crust recovery after fire damage, Dr. Johansen found considerable re-establishment of algae five years after burning, while mosses and lichens were only beginning to reinvade. He found an unburned area had much greater algal biomass than an area burned five years earlier.

SOIL ORGANIC MATTER

While the crusts' role in increasing soil nutrients has been repeatedly proven, the contribution of organic matter [carbon compounds] to soils had been generally assumed and indirectly demonstrated. Direct demonstration of the contribution of carbohydrate to the soil from the crust organisms was demonstrated in my research.

It has been shown that many algae release (or "leak") from 1 to 25 percent of the organic carbohydrates that they produce during photosynthesis. The algae that occur within lichens have been shown to excrete up to 80 percent of their carbon, probably an important part of the symbiotic relationship within lichens. The lichen body itself has been shown to lose membrane integrity during the wetting and drying cycles it experiences in nature, thus increasing its loss of carbon compounds to the soil. This has even been shown in Antarctic cryptogams, probably from frost damage. Soils in Antarctica were shown to have a very high carbohydrate content in spring thaw, and the carbohydrates were the same types as those found in nearby cryptogams.

Translocation of carbohydrates from the crust to the underlying soils was demonstrated exposing intact crust samples to an atmosphere wherein all the carbon dioxide (CO^2) was radioactively labeled with ^{14}C, giving $^{14}CO^2$. When the soils beneath these crusts were sampled over time, ^{14}C showed up in soil organic matter. The crusts had accumulated labeled C during photosynthesis, and the underlying soils showed accumulations over time. The source of this increase in radiation in the soil below the crust layer is attributable to carbohydrates generated by the crust during photosynthesis in the labeled atmosphere.

REFERENCES

Johansen, Jeffrey R., Valerie R. Flechtner, Louise A. Lewis, and Larry L. St. Clair. 1998. Isolation and identification of microbiotic crust algae, lichens, and mosses from Carlsbad Caverns NP. Research proposal on file in CCNP Resource Management office.

Beymer, R.J., and J.M. Klopatek. 1991. Potential contribution of carbon by microphytic crusts in pinyon-juniper woodlands. Arid Soil Research and Rehabilitation 5:187-198.

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CALENDAR OF EVENTS

Oct. 2	Mountain Lion Transects Training
Oct. 13 – 16	Mountain Lion Transects
Oct. 19	Mountain Lion Transects
Oct. 24 – Nov. 1	LEARN Survey Expedition in Lechuguilla Cave
Nov. 4 – 5	Mountain Lion Transects
Nov. 7 – 15	Survey Expedition in Lechuguilla Cave led by Steve Reames
Nov. 21 – 25	Survey Expedition in Carlsbad Cavern led by Joe Sumbera
Nov. 26 – 29	CRF Survey and Restoration Activities in Carlsbad Cavern
Dec. 12 – 20	Survey Expedition in Lechuguilla Cave led by Peter and Dave Jones