

THE NATURAL HISTORY OF PETROGLYPH NATIONAL MONUMENT

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The Landscape

Petroglyph National Monument encompasses most of Albuquerque's "West Mesa." An arresting sight from within the city, its stark outlines embrace several distinct landforms, the largest of which is the "mesa top." This semi-arid grassland rises gently to the west for a mile or two above a long, undulating escarpment composed of black volcanic rock called basalt. Seen from central Albuquerque, the mesa top appears to end on the western skyline as a low north-south ridge topped by a line of at least five small volcanic cones, locally called the "volcanoes." A final landform exists at the escarpment's base, where a flat apron of sandy terrain delimits the Monument's eastern boundary with the city. The escarpment's irregularities also create a number of distinct embayments, their floors being continuous with the sandy apron. Collectively, the mesa top, the escarpment and the volcanoes, and the escarpment base with its embayments form the landscape covered in this chapter.

Together with the Rio Grande and the city-covered plain between it and the eastern Sandia Mountains, the Monument resides on the floor of the Albuquerque Basin, a great geological trough. As part of

the lengthy Rio Grande Rift, the continuously subsiding basin lies above about four miles of the same Paleozoic and Mesozoic sedimentary rock layers that cap the summit and eastern slope of the Sandias. The rock layers, in turn, are covered by over a mile of alluvial sand, silt and gravel which began to fill the subsiding basin during the Quaternary and late Tertiary periods. These processes continue in our time.

The cones and the escarpment impart a uniqueness to the Monument. Both owe their origin to eruptions, nearly 160,000 years ago, of magma along a north-south fissure some five miles in length. Over time, other eruptions in the basin also produced a variety of dark hills, cones and flows that remain prominent features in the Rio Grande Valley. From the fissure in question the magma flowed eastward toward the river valley. Six flows took place within a few months; the first were the hottest and produced broad fluid sheets of lava that may have reached the river. Subsequent flows were cooler, more viscous and less extensive. The final eruptions formed the cones. Some of the flows skirted the bases of small hills or possibly dunes. As those features eroded they left three prominent gaps, or "geological windows," where no lava ever reached. Streambeds caused the lava sheets to extend as thick fingers toward the river. In time, these became the worn and rocky "peninsulas" that give the escarpment its ribbon-like appearance.

As it cooled and hardened the ancient lava became basalt, which, during thousands of years of erosion, cracked and then broke into the boulders and smaller rocks that now stud the base of the escarpment. Most are covered with a dark crust of manganese oxide, called "desert varnish." It was on this veneer that the petroglyphs were eventually inscribed. Where the rocks are in contact with soil their undersides are white with an aeolian deposit of calcium carbonate, or "caliche." Many rocks on and within the cones are reddish, having originated from fragmented pieces of hot lava (bombs, cinders and ash) that were oxidized by escaping volcanic gases and atmospheric oxygen.

At first glance a lava field seems a sterile place; however, its tortuous topography actually makes it accessible to living organisms and organic debris. Horizontal tubes, or lava caves, in the Monument's vents and escarpment provide retreats for animals whose droppings and carcasses support additional life, and for wind- and water-borne detritus which does the same. Animal burrows, as well as the moisture-seeking roots of plants, occur in the soil beneath boulders. Because of their dark color, the rocks and boulders absorb heat. And because they are partly sunken into the substrate, seep water from rain and melting snow moistens the soil below them. Thus, the sub-rock microenvironment provides a relatively moist and thermally moderate habitat of great value to many kinds of plants and animals.

Plants and Animals of the Monument

The mesa top, the sandy base of the escarpment, and the volcanic portions of the Monument all teem with life. Much of that life, however, is beyond the immediate view of the unpracticed eye. Although patience is needed to see even a small portion of the Monument's biotic diversity, frequent unobtrusive visits will eventually reward the sensitive observer with a real appreciation of its extent. With this in mind, the more obvious representatives of the Monument's plant and animal life are now discussed. And while we start with the spatially dominant mesa top, the reader should be aware that many of that landform's plants and animals also occur in other parts of the Monument.

The Mesa Top

From a distance, the mesa top appears to be a fairly homogeneous plain, dotted by a few junipers on its higher reaches and dissected by a small number of dry water courses. These "arroyos" drain the elevated cone areas and carry storm water eastward to channels in the escarpment. In winter the mesa is a nondescript brown, except when covered by snow. By late spring it takes on a greenish tint, and in a wet summer it can appear quite lush. These changes reflect seasonal patterns of precipitation that affect the entire region.

On average, the Albuquerque area receives about two-thirds of its precipitation between early July and late September. During that period, moisture-laden air newly arrived from the Gulf of Mexico rises convectively to produce isolated thunderstorms. Mesa soils absorb much of that rain after wet winters. But after dry winters they absorb less rain and runoffs are heavy. The cooler months can in fact be very dry, especially in early fall and late spring. On the other hand, during "El Nino" years of lowered atmospheric pressure in the eastern Pacific, considerable spring moisture can be imported by westerly winds. As in other semi-arid regions, seasonal and annual variation in precipitation is high; therefore, the annual average of about eight inches (200 mm) has little biological significance in a given year.

Most of the plant biomass of the mesa top consists of perennial bunchgrasses. Typically, these grow in moderately alkaline, sandy loam soils that add a shallow covering to the underlying basalt. Black gramma (Bouteloua eriopoda) and galleta (Hilaria jamesii) are perhaps the predominant grasses, but where the soil is sandier the dropseeds (Sporobolus species) and Indian ricegrass (Oryzopsis hymenoides) are likely to dominate. The first three of these grow best in hot summer weather. Indian ricegrass, in contrast, grows best in the cool spring and accounts for the blush of green on the mesa in that season; it is especially common on the deep soil floor of the geological windows. Patches of blue gramma (B. gracilis) occur in depressions near arroyos, and sideoats gramma (B.

curtipendula) can be seen around basalt outcrops and near the water-scoured rocks of arroyo bottoms. They too are summer grasses.

Other common perennial but nonwoody vegetation on the mesa top includes broom snakeweed (Gutierrezia sarothrae), a subshrub that thrives in disturbed soils throughout western North America. Promoted by heavy livestock grazing in the past, snakeweed's tiny yellow flowers add yet another hue to the landscape in late summer and early fall. At that time of year purple aster (Machaeranthera canescens) also contributes showy heads to the scene, while along arroyos and the Monument's few old dirt roads, globe mallow (Sphaeralcea angustifolia) continues to display small orange flowers on spindly stalks.

Several species of cactus occur close to the ground, as unwary hikers in tennis shoes have learned to their discomfort after striking a low prickly pear (Opuntia polyacantha) or pincushion cactus (Coryphantha vivipara). In late spring, one is less apt to have this experience because the respective yellow and pink flowers of these species are so conspicuous. Growing on soils with a history of disturbance is another cactus, the tree cholla (Opuntia imbricata), which also produces its flowers--big magenta ones--in the spring.

Woody evergreen shrubs on the open mesa include winterfat (Eurotia lanata), which usually occurs in dispersed clusters, easily identified

in the fall by their conspicuous cottony fruits. A more solitary woody shrub in the same general habitat is four-wing saltbush (Atriplex canescens) with its characteristic masses of crossed seeds. Saltbush tends to be abundant near arroyos. Lining arroyo banks are stretches of tightly clumped Apache plume (Fallugia paradoxa), a bushy shrub that simultaneously presents white flowers and wavy purplish seed heads. Thickets of the large and densely branched squawberry (Rhus trilobata) also occur in arroyos. The red berries in the fall are probably important wildlife food. Prickly clusters of dead tumbleweed (Salsola kali)--Asia's gift to our western plains--hang up against the arroyo shrubs, and, during much of the year, lodge against virtually any object in the way of their wind-driven journey from points west. In the early spring, tumbleweed has soft green tissues which, some say, make a tolerable salad.

Truly conspicuous all year long are the one-seeded juniper trees (Juniperus monosperma), their dark foliage defining arroyo cuts below the volcanic cones. The paucity of vegetation around many of the junipers suggests how effectively, not many years ago, they shaded cows on hot days. Contrasting with the green of the junipers, particularly in late spring and early summer following adequate winter rains, are the striking white flowers of soapweed yucca (Yucca glauca). These are produced on stalks that rise above bunches of spiked leaves. Burrow entrances beneath yuccas attest to their importance as shelters to rodents. The massive roots of this yucca species stores nutrients and water for long periods--an

excellent survival strategy in areas with highly variable precipitation.

Early spring on the mesa top brings out showy flowers of quite a few herbaceous plants, perennials as well as annuals. Several low-growing bladderpod mustards (Lesquerella species) are especially common on the cones. Other mustards, such as the white flowered spectaclepod (Dithyrea wislizenii), are widespread over the mesa and may remain in flower throughout the summer. At dawn during this period, evening primroses (Oenothera species) expose their large white petals before the sun warms the air. Low splashes of purple and pink in spring and early summer reveal the presence of loco weed (Astragalus species), beautiful but toxic to cattle. In spring and summer, the large green leaves and rusty-colored flower stalks of curly dock (Rumex crispus) indicate where rodents--and in the past, cows--have disrupted the topsoil. In May, if one looks closely at the clearings around harvester ant nests, tiny white flowers of hiddenflower (Cryptantha crassisejala) reveal where seeds were inadvertently dropped by the ants the previous fall.

With the onset of summer rains, often in early July, a different floral assemblage partly replaces that of spring. Now, the elongate purple floral heads of several scorpionweeds (Phacelia species) are evident on unstable soils. Yellow-flowering plants are also readily visible in the summer. Many are composites such as perennial goldenweed (Haplopappus spinulosus) and many-headed groundsel (Senecio

multicapitatus), the latter being larger and more striking.

Conspicuous too, is low-growing wild zinnia (Zinnia grandiflora) with its tightly bunched blaze of yellow flowers. In early summer, on sandier soils, the yellow flowers of threadleaf white ragweed (Hymenopappus filifolius) wave easily in the breeze; often a pale yellow crab spider (family Thomisidae) will be waiting on a clustered flower heads for an unwary fly. Nearby may be the geometrically intriguing yellow flowers of common stickleaf (Mentzelia pumila), whose leaves do indeed stick to hiker's pants.

Large numbers of animals use the mesa top and all other parts of the Monument. Almost anywhere, one can scare up cottontails (Sylvilagus auduboni) and black tailed jackrabbits (Lepus californicus). Coyotes (Canis latrans), gray foxes (Urocyon) and kit foxes (Vulpes macrotis), which prey on these and other small mammals--and eat whatever is seasonally available besides--occur on the Monument but are far less in evidence. Large burrow entrances scattered over the grassland may have been the work of badgers (Taxidea taxus). When abandoned by these fearless but seldom seen carnivores they serve as refuges for other animals, including reptiles and a great variety of arthropods. Smaller burrow entrances are much more common, and lead to the underground retreats of small rodents. These include often locally abundant, seed- and insect-eating deer mice (Peromyscus species), partially carnivorous--on insects and other rodents--grasshopper mice (Onychomys species), as

well as seed-harvesting silky pocket mice (Perognathus species) and kangaroo rats (Dipodomys species).

Kangaroo rat excavations on the mesa top take the external form of low mounds, on and around which grow plants that thrive in disturbed soils. In contrast, piles of sticks, pieces of cholla, old cow pads and assorted debris beneath junipers or in outcrop crevices signify the presence of pack rats (Neotoma species). Some refuse heaps (middens) of these feisty rodents have been occupied in the Southwest for thousands of years. Plant and animal (including arthropod) remains within dried pack rat urine tell us much about regional climates during and since the late Pleistocene (Ice Age).

Birds using the Monument and the rest of the Rio Grande Valley can be described either as "residents" that breed and live there much of the year, or as "nonresidents" that migrate through or occasionally visit the area in summer or winter. Since species in both groups are well distributed over each of the Monument's landforms, with few exceptions the following description applies to the mesa top as well as the rest of the Monument.

Flocks of small, nondescript brown birds forage over most of the Monument, primarily in winter and during spring and fall migration. Many flocks consist of resident horned larks (Eremophila alpestris); others of several species of sparrows. In the winter, additional

flocks of the "Oregon" type of dark-eyed juncos (Junco hyemalis) from the northwest and white-crowned sparrows (Zonotrichia leucophrys) from higher latitudes make their appearance. Larger-bodied mourning doves (Zenaida macroura)--summer visitors that fly swiftly and sometimes in small groups--can startle a hiker, as can the sudden whirring rise of a covey of resident scaled quail (Callipepla squamata). Western meadowlarks (Sturnella neglecta) are common residents, too, their melodious song a fixture of the spring and summer scene.

Many species of migrating swallows, flycatchers, sparrows and other birds move through the region in spring and fall. In contrast, the loggerhead shrike (Lanius ludovicianus) stays all year, sometimes impaling its arthropod, lizard or even small avian prey on the thorns of shrubs. Another notable resident predator is the greater roadrunner (Geococcyx californianus), whose vigorous gait and heavy bill ensure it a similar diet. High overhead, a resident red-tailed hawk (Buteo jamaicensis) is likely to be eyeing the landscape below for rodents, while not far above the mesa a winter visitor, the northern harrier (Circus cyaneus), swoops with upraised wings for the same reason.

Another raptor, the prairie falcon (Falco mexicanus) is most conspicuous in winter on the Monument, where it probably nests. Its chief prey is other birds and small mammals. Raptor-like birds there also include two large and virtually indistinguishable black

species, the common raven (Corvus corax) and the Chihuahuan raven (C. cryptoleucus). Pairs of ravens are spotted on the Monument all year. Finally, a standard summer member of the regional avifauna is the turkey vulture (Cathartes aura), a bird large enough to resemble an eagle as it sails in great circles searching for its potential food: carrion and small animals.

As with the birds, most species of reptiles on the Monument are widely distributed over the landscape. Lizards, in particular, are plentiful most of the year. Even on relatively warm winter days, small annual side-blotched lizards (Uta stansburiana) and whiptails (Cnemidophorus species) emerge from their various hidden shelters and bask in the low rays of the sun. Eastern fence lizards (Sceloporus undulatus) also occur on the Monument, foraging for small arthropods beneath shrubs or wherever such prey can be caught. Camouflaged to blend in with the pale sandy substrate, several species of horned lizards (Phrynosoma) wait near the nests of ants, in season, for their special form of nutrition.

Snakes are a less visible component of the Monument's herpetofauna, so it is something of a treat to come across a slender, swiftly moving coachwhip (Masticophis flagellum) in almost any surface habitat. Fast and aggressive, these diurnal hunters prey heavily on other lizards. Another Monument inhabitant, the bullsnake (Pituophis melanoleucus sayi), also hunts in the daytime but preys mainly on small mammals, which it kills by constriction. Bullsnares are

yellow or cream colored with dark blotches; they can become quite large. More of a nocturnal forager, the prairie rattlesnake (Crotalis viridis viridis) is a small mammal specialist as well; its blotched coloration makes it difficult to see, and it may be encountered anywhere on the Monument. Snakes are an integral part of the Monument's food web, and, together with the other animals there, should be left undisturbed.

Constituting, as they do, the bulk of the animal species on earth, invertebrates naturally abound on all parts of the Monument. Yet in this brief description of the Monument's natural history, it is only reasonable to restrict our focus to a relatively few of its more representative invertebrate groups. Most of these will be arthropods. Aside from ever present grasshoppers (most in the family Acrididae), perhaps the best examples of the Arthropoda between March and November are darkling beetles (family Tenebrionidae). At least a dozen species of lumbering black tenebrionids populate the Monument in abundance. As flightless scavengers they are often seen quietly exploring accumulated litter around plants and rocks. Not being good burrowers like their subterranean larvae, adult tenebrionids tend to shelter in burrows made by vertebrate animals. This practice exposes them to predation by rodents such as grasshopper mice, which eat them head first and thus avoid ingesting the noxious rear end. When startled, many darkling species assume a head-down, tail-up position, which, together with their black color, may warn potential predators

of their unpleasant taste. Since this "headstanding" is a widespread tenebrionid trait, it presumably has survival value--despite the depredations of grasshopper mice and, on occasion, other animals such as coyotes.

To gain an impression of the tremendous arthropod diversity on the Monument, one can sweep an insect net back and forth through a patch of grass and snakeweed. The tiny flies, beetles and leafhopper bugs (family Cicadellidae) in the net will show that the diversity is indeed real. A sweep through a shrub such as Apache plume should produce a very different assortment: a few spiders, some tiny ants and shiny leaf beetles (family Chrysomelidae), a few little leaf-eating weevils (family Curculionidae) and a pollinating bee or two. Such are examples of the day-active arthropods of the mesa.

Then there are the harvester ants. Belonging to the ant genus Pogonomyrmex, harvesters forage mainly for seeds (although they also scavenge animal food) by day in spring and fall, and at all hours that are not too hot in the summer. The low dark mounds of P. rugosus, in particular, reveal the carefully selected source of its mound material. The uniformly sized grains of basalt contrast with the surrounding lighter soil and probably help to transfer heat rapidly to the nest below. In other parts of the Southwest, harvester species are known to compete with rodents and birds for

seeds. Harvesters and other ants and are felt to be significant regulators of primary (i.e., plant) production.

At night, the floor of the mesa is devoid of most flying insects other than moths. Cutworm or owlet moths (family Noctuidae) and a host of usually smaller-bodied species disperse at that time, mainly for reproductive purposes. Large numbers can be attracted to a "blacklight" (ultra-violet) on a warm summer night. The same instrument exposes the surprisingly abundant scorpion population of this semi-arid grassland. Scorpions fluoresce when exposed to UV wavelengths, appearing as small greenish-yellow jewels on the ground. Yet a flashlight shows Paruroctonus utahensis and a few other local species to be sandy in color. Setting aside the mysteries of scorpion coloration, we note the following facts about this species: its sting hurts a bit but is not normally dangerous, it is a "sit-and-wait" predator that can get along on as few as three meals a year, and it spends the daytime hours in slanting burrows that it digs in sandy soil. One of its meals could well be a camel cricket (family Rhaphidophoridae. Huge numbers of these tan, humpbacked insects move over the ground at night, eating detritus of all sorts and being eaten by a variety of predators, including other camel crickets.

The Escarpment Base

The floors of the large embayments in the sinuous escarpment support plant communities that tend to differ in composition from those of the mesa above. The southernmost of the four largest embayments lies below Mesa Prieta, the southern extension of the mesa top, and is dominated by extensive stands of sand sage (Artemisia filifolia), a composite shrub. Indian ricegrass and dropseed grasses are common there as well, as they are elsewhere below the escarpment.

Directly to the north the largest embayment, Rinconada Canyon, extends into the escarpment by over half a mile. Its plant communities are quite diverse. Divided lengthwise by an arroyo, its southern half is very sandy, especially in a hilly belt along the north-facing escarpment slope. Giant dropseed (Sporobolus giganteus) is a common grass there, and good stands of purple sage (Dalea scoparia) occur as well. The tiny purple flowers of this micro-leaved leguminous shrub appear in the summer. Purple sage is host to hordes of little Perdosa bees (family Andrenidae), whose hind legs bulge with orange pollen as they dart among the flowers. The green, photosynthesizing stems of purple sage in summer become a drab yellowish brown in the winter and spring.

To the north of the Rinconada's dividing arroyo there is less giant dropseed and the grasses are more mixed. All of the common mesa top species are represented, Indian ricegrass in particular. Stands of purple sage, sand sage and four-wing saltbush occur--the last of these often close to the arroyo. Sunflowers (Helianthus species) present their conspicuous yellow heads along low drainages in late

summer. Odd-shaped, yellow and brown ambush bugs (family Phymatidae) wait motionless on these heads for bees and flies.

The sandy soil at the escarpment base is home to the burrowing wolf spider (Geolycosa raphaelana). This nocturnal hunter constructs a silken turret at its burrow entrance, around which is a neat ring of little balls of excavated soil. Spring and fall--not summer when provisioning pompilid wasps are abundant--are the times to see these turrets. Geolycosa restricts its foraging to a small area immediately around the burrow. By contrast, hyperactive solpugids, distant relatives of spiders and scorpions, run all over the surface and even climb in vegetation in search of their arthropod prey.

Most of the vertebrates found in the embayments were discussed earlier. However, three bird species are particularly common in these places and therefore deserve special mention here. Two are summer visitors and breed in the embayments; they are the northern mockingbird (Mimus polyglottos) and the black-throated sparrow (Amphispiza biliniata). The third is a winter visitor, the sage sparrow (Amphispiza belli). Each of these birds has a distinctive song, but that of the mockingbird is legendary because of its imitating repertoire.

Petroglyph Park is situated in a small fenced embayment about halfway along the escarpment to the north. The Park preserves some

fine native grassland (lots of Indian ricegrass) and contains, at its inner end, a pocket of mixed shrubland. Bounded on the south by Unser Boulevard, this attractive reserve is protected by Albuquerque's Open Space Program.

Finally, just south of the northernmost peninsula, Piedras Marcadas Canyon becomes the last embayment. Its inner portion is known for obvious reasons as the "Alcove." Together with the "Sand Escarpment" that climbs to the top of low basalt cliffs at its southern end, the Alcove displays the topographic and biotic diversity of the Rinconada compressed into a small amount of highly varied terrain. As a result, its plant communities consist for the most part of relatively small patches of vegetation, each dominated by one or a few plant species. The Alcove and the embayments to the south may not encompass the area of the mesa top, but their plant and animal diversity must be at least as great.

The Escarpment and the Volcanic Cones

The rocky slopes of the escarpment constrain the numbers and kinds of plants that use its meager soil surface. Various grasses, including galleta, little bluestem (Andropogon scoparius) and species of three-awn (Aristida) are found there between the rocks, and four-wing saltbush puts its roots down in the same spaces, only deeper. At the inner ends of the embayments, where storm water drains from arroyos on the mesa above, squawberry and apache plume clog the

bottoms of the steep rocky canyons; debris piled against these shrubs attests to the force of occasional runoffs. On south-facing slopes, a small woody shrub, Parthenium incanum, with white woolly leaves and white flowers, is fairly common among the rocks, as is at least one species of thin-stemmed brickelbrush (Brickellia). Altogether, the vegetation of the escarpment is not especially dramatic, even though a small complement of low white, yellow, pink and purple flowers rewards the careful explorer, in season. The same can be said for the volcanic cones, which have perhaps a greater density of yellow mustards.

Mosses occur on the north sides of secluded escarpment boulders and on north-facing slopes of the larger cones. These easily overlooked plants take on a healthy green when moist, and when teased apart under a dissecting microscope exhibit a moisture-activated fauna of tiny nematodes, rotifers and tardigrades. The latter two groups are understandably foreign to non-biologists, but nematodes deserve broad appreciation. In truth, moss-bound nematodes are but a fraction of the enormous numbers of these miniature worms, as nematodes exist in all Monument soils (and in all soils everywhere). The densest populations occur beneath vegetation, where they consume bacteria, fungi, other tiny animals--and plant roots. Here it should be added that fungal spores also cover the Monument landscape, as they do the surface of the rest of the planet. One study has shown the fungal spore community of the escarpment to be very different from that of the Rinconada floor.

It is impossible to overlook the lichens that color many otherwise black basaltic rocks. These symbiotic associations of algae and fungi appear as patterned splotches on north-facing surfaces. Their yellows, greens, reds and oranges entice the photographer and challenge the painter.

What the basaltic flows lack in the way of conspicuous plants they make up for in animal life. Great horned owls (Bubo virginianus) nest in some of the inner canyons, which also provide dens for foxes--and possibly bobcats (Lynx rufus). Omnivorous white-tailed antelope squirrels (Ammospermophilus leucurus) are common on escarpment rocks throughout the year. Present, too, are rock pocket mice (Chaetodipus intermedius). The escarpment population of this poorly known rodent is one of the northernmost in the region. In warm weather, the descending trill of canyon wrens (Catherpes mexicanus) is a sound to remember. Frequently, rock wrens (Salpinctes obsoletus) flit from one boulder to another, bobbing their heads while searching for insects among the rocks. Two other rock-loving birds are the brown or canyon towhee (Pipilo fuscus) and the rufous-crowned sparrow (Aimophila ruficeps). Both are residents; the former along the entire escarpment, the latter apparently only near its southern end.

The escarpment is home to hundreds of invertebrate species, but none is more unusual than the desert millipede, Orthoporus ornatus. This large, many-legged and mahogany-colored arthropod occupies the

escarpment's southern two-thirds--why not the northern portion is anyone's guess. Where it does live, it occurs in massive numbers. The escarpment population is apparently refugial, that is, it was probably much more widespread population in a warmer, moister period some thousands of years ago. Subsequent climatic cooling and drying made millipede survival impossible on all but heat-absorbing basaltic landforms in the Rio Grande Valley north of Socorro. This may have been true for other kinds of animals as well--something only further studies will reveal.

Desert millipedes live about a decade. Normally, they spend eight or nine months in the soil under rocks, emerging only when the first rains of the summer monsoon wet the soil long enough to make emergence possible. Then, on summer mornings in early July, hundreds of newly emerged individuals can be seen nibbling on surface detritus and occasionally basking in the branches of shrubs. Later in the day they shelter in crevices or mammal burrows--or they may retreat into their small round emergence holes at the bases of boulders. Those unable to return underground by the end of summer leave their bleached skeletons where they die. Skeletons are abundant between rocks on the Rinconada's south-facing slope; some even occur in the arroyo connecting the top of that embayment with the most southern of the volcanic cones.

A final bit of natural history takes us, in fact, back to those cones. On the summits of the three big ones, in spring and

summer, a visitor can witness "hilltopping," which is characteristic of certain flying insects. The most colorful are butterflies, whose rapid, wind-buffed flights around these uppermost projections of the landscape seem to celebrate warm and breezy afternoons. But as summer draws to a close the butterflies disappear. Then, too, other elements of the regional biota make their transitions to a cooler, drier season. Such changes have been going on for many thousands of years on what is now Petroglyph National Monument. The cycle of life that we presently witness in this unique setting was undoubtedly observed by the ancients as they crafted their rock art and hopefully will be observed by future generations as well.