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This Bulletin is issued monthly for the purpose of giving information to those interested in the natural history and scientific features of the Grand Canyon National Park. Additional copies of these bulletins may be obtained free of charge by those who can make use of them, by addressing the Superintendent, Grand Canyon National Park, Grand Canyon, Arizona.

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Pauline Mead, Ranger Naturalist.

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Mr. Edwin D. McKee, who resigned as Park Naturalist on November 30, 1930, in order that during the winter months he could continue his university studies leading to a doctorate, will be reinstated and resume his duties about April 1, 1931.

During his absence Mr. McKee prepared and published an illustrated handbook entitled "Ancient Landscapes of the Grand Canyon Region". The book comprehensively, yet in simple language, outlines the geologic story of the Zion, Bryce, Petrified Forest, Painted Desert and Grand Canyon formations, and will be found of considerable interest and value by the visitor to these regions.

-- P. P. Patraw --

FOSSIL FOOTPRINTS OF THE COCONINO
By Edwin D. McKee.

Recently while reviewing literature in connection with the preparation of a paper on the Coconino formation (not yet published), the writer was greatly impressed with the wealth of interesting material accumulated by Dr. C. W. Gilmore in his three bulletins on the fossil footprints of that formation. Since these publications are already out of print and are probably unknown to many of those interested in the wonders of Grand Canyon, a brief review of their contents together with a few personal observations are here presented.

The tracks of the Coconino sandstone were first brought to scientific attention in 1915 when Prof. Charles Schuchert of Yale University made a small collection along the Hermit Trail. A study of these and the description of several of them was undertaken by Prof. Lull. In 1924 an extensive study of the Coconino footprints by Dr. C. W. Gilmore of the U. S. National Museum was made possible through the interest of Dr. John C. Merriam and was continued for several years. The results of this splendid work were published in the Smithsonian Miscellaneous Publications 2832, 2917, 2956.

All of the Coconino footprints are considered to be those of quadrupedal animals though they vary extremely in size and character. Some appear to have been made of animals not larger than small lizards; others apparently were formed by creatures having large feet and strides nearly a yard in length. Some indicate short-limbed, heavy, widebodied animals, while other tracks suggest animals having long slender limbs and narrow bodies.

Dr. Gilmore states that the tracks of the backboned animals in the Coconino sandstone suggest a correlation with the rocks of Permian age in Texas where occur skeletons of many kinds of extinct creatures some of which had the right proportion of foot, limb and body to have made imprints similar to those found at Grand Canyon. It seems fair to assume that such animals formerly also inhabited the Arizona region. If these deductions are correct, then the tracks represent primitive crawling reptiles and amphibians all of which were unlike any creatures living today. Trails made by invertebrates, and burrows probably formed by worms also occur in the Coconino.

In summing up the fauna of the Coconino sandstone, Dr. Gilmore states that it is, "Carboniferous (age) in aspect as shown by the relatively small size of the animals, all of which are quadrupedal, as contrasted with the considerable number of very large forms and many three-toed bipedal animals of the Triassic (period). Taken as a whole, this fauna which now consists of 15 genera and 22 species, seems to have closer relationships to the ichnite fauna from the Middle Coal Measures of Kansas described by Marsh than to the more extensive fauna from the Coal Measures of Nova Scotia made known by Dawson and Matthew. The predominating species is *Laoporus noblei* which apparently is present wherever Coconino tracks are found."

The footprints occur preserved on the upper surfaces of inclined bedding planes. Many of them are beautifully distinct and the courses of animals can often be traced for considerable distances. Regarding the lack of organic remains, Prof. Schuchert considers that this is "probably due to the originally loose and repeatedly reworked sands, a most unfavorable habitat for animals".

A peculiar feature of the occurrence of the Coconino tracks is summed up by Gilmore in the following statement, "The trend of nearly all of the tracks and trails was in one direction, that is, up the slope of the crossbedded sandstones -- and the examination of many additional hundred square feet of track-covered surface verifies this original observation. In all of the hundreds of trails seen, only three exceptions were found." At another place Dr. Gilmore refers to this feature as suggestive of "an old trail leading to the water, or possibly -- a great migration of animal life such as is occasionally known to take place among the animals of the present time."

The geographical range of the footprints of the Coconino sandstone is essentially the same as that of the formation itself. In the Grand Canyon region, the writer has personally found Coconino tracks near Seligman and Flagstaff, and along the Tanner, Hance, Grand View, Yaki, Kaibab, Bright Angel, Hermit and Bass trails, and he has seen specimens from near Pine, in the University of Arizona collections, thus showing a very widespread and general occurrence.

The vertical range of footprints in the Coconino is described by Gilmore as, "confined to the basal 150 feet of the formation of which the lowermost 20 are barren", and again, "so far as known, (tracks) are found only in the lower half". The only exception to this that has come to the writer's attention is on the Yaki Trail where tracks occur in places at least midway in the upper half. Footprints appear to be most abundant about the 150-foot level, but apparently occur at almost every level from there down.

The only definite correlation of the Coconino tracks suggested by Dr. Gilmore is the following: "Recognition has been made of generically-like if not specifically similar tracks found in the Coconino sandstone of Grand Canyon and the Lyons sandstone of Colorado". It also seems worthy to note that Dr. Gilmore found none of the genera of the Coconino represented in the two underlying, track-bearing formations of Grand Canyon, namely the Hermit and Supai.

SEDIMENTARY ROCKS
By Clyde C. Searl, Acting Park Naturalist.

A common question brought up by conversations and lectures at the Yavapai observation station concerns the difference between various types of rock. As the lecturer explains that the rock which forms the walls of the inner gorge are igneous, and that the colored rocks which appear above the inner gorge and extend to the top, are chiefly organic and sedimentary, it is not often clear to the listener just what the differences are between the types of rock.

The term "igneous" does not accurately describe the rocks of the inner gorge. Literally, the word means "fiery" and has long been in use to include all rocks which have actually been melted within the earth, or which have been thrown out on the surface by volcanos. In short, igneous rocks owe their origin to some of the effects of the internal heat of the earth far beneath the surface.

In the February issue of Nature Notes, an article dealt almost entirely with the formation of organic rocks. Only a few brief statements describing that type of rock will be given here. Since leaves, branches and stems of plants, and the shells or other remains of animals, are scattered so abundantly through ordinary dirt and sand, it is easy to understand that some times they may occur in such quantity as to form great deposits of themselves. We may term them organic rocks, or organically-derived rocks, because they owe their origin to the accumulation of what are called organic remains, the remains of plants and animals.

Sedimentary rocks, the type with which this article will deal, are just as interesting as are the organic rocks with their countless number of animal skeletons, but it must be admitted that the interest of the sedimentary rock is increased by the presence of many organic remains. Such is the case in the sedimentary rocks of the walls of Grand Canyon. Briefly, sedimentary rocks are made up, as the name implies, of gravel, sand and mud. How these materials have been gathered together and hardened into solid stone is a question that bothers many people who are getting their first lesson or taste of geology at the Yavapai Station. It is easily explained by the things that can be pointed out directly to the interested party.

It is easily demonstrated that the Colorado River at the point below Yavapai is a very muddy stream and by reference to the data of the United States Geological Survey gathered by daily readings taken at the various gauging stations along the river, that the sediment transported by the river reaches enormous quantities. Then by the aid of photographs and of models on display in the exhibit rooms of the building up of the river's delta at the Gulf of California, it becomes easy by the example to make clear how many of the layers of rock in the walls of Grand Canyon were built up in ages past.

It is true that a large quantity of the material passing through Grand Canyon will become deposited along the way, but so long as a current of water is moving swiftly, it keeps the gravel, sand, and mud from settling to the bottom. A very rapid current will carry along not only gravel and sand and mud, but even much larger bodies of rock. A stream does not have to increase its velocity many times to enable it to carry huge boulders by rolling them over and over. As the current's speed decreases the heavy rocks will cease to roll; gravels will sink to the bottom as sediment; next the sand will settle, and the mud, being lighter, will be carried much farther until it, too, will settle to the bottom. Assuming that the crustal movement of the earth, which is going on in numerous places today, should cause a slow dropping of the surface of the earth at the mouth of a river, it can readily be seen that thick layers of mud will gradually be built thicker. In time the pressure, with the always accompanying heat and the natural cementing qualities in the mud, will turn it into stone. Such was the story in the Grand Canyon. At times the region was the mouth of the river, and the crustal movement of the earth resulted in a gradual sinking, until great layers many hundreds of feet thick came into existence.

If one stands on the suspension bridge which spans the river at a point visible from Yavapai, it will be noticed that branches of trees, logs, and occasionally the body of some animal are carried by in the stream. These dead animals and the other debris are carried far down the stream and buried in the mud. And if one goes to the delta region of the river, tracks of animals can be seen on the wet banks, or on the beach exposed at low tide. Some of the impressions will harden before other silt is placed on top, and in this way the imprints will be sealed until brought to light again by the forces of erosion or the interest of man. Then coming back up the trail from the bridge, the quarries where fossil ferns lie superimposed one above the other, and the footprints of animals exposed by the blasting of the trails, take on a deeper meaning.

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During a warm spell the first part of the month of March, two lizards of the genus *Uta* were seen daily disporting themselves on the walk of Yavapai Observation Station. Both were very young lizards and it is highly possible that experience had not yet taught them that it was indiscrete to come out until warm weather was surely with us. The present cold spell has taught them that two or three warm days do not mean that Summer is here.

THE ROCK LOVING ALUM ROOT
By Ranger-naturalist Pauline Mead.

Two species of allum root
(*Heuchera rubescens* and *Heuchera novomexicana*) which are both unique to the

Southwest, and rather rare, occur at the Grand Canyon, one on the North Rim and one on the South Rim. They are closely related and appear very much alike, having lobed, bristle-tipped, basal leaves and a slender flower stalk from which hangs small bell-shaped flowers. The petal-like calyx is responsible for the color of the flower, since the true petals are small and white and are usually hidden. The alum roots are perennial herbs having very stout root stalks.

The South Rim alum root species (*Heuchera rubescens*) has a purplish-red flower tipped with green. The long slender stamens extend beyond the flower cup giving it a feathery appearance. The flower stalk is the shorter and the leaves are the smaller of the two. It grows in beautiful mats on protected rocks along the canyon rim. In the fall the leaves turn a rich purple-red.

The North Rim alum root (*Heuchera novomexicana*) has a yellow-white flower, the stamens of which are hidden. It is found about the meadows of the Kaibab forest, particularly on rocky slopes.

The alum root belongs to the saxifrage family, a family in which many taxonomists include the sweet syringa and the gooseberry and the currant. The saxifrage family is considered by most botanists to be somewhat more primitive than the rose family.

Heuchera rubescens
South Rim

Heuchera novomexicana
North Rim

OFFICIAL REPORT ON STOCKING CANYON STREAMS WITH FISH
By Chief Ranger J. P. Brooks.

The trout stocking program for the Grand Canyon was concluded on February 28. Five streams are stocked; two of them with rainbow, one with loach and rainbow, one with brook and one with blackspotted.

Bright Angel Creek: (Rainbow and Loch Leven trout) Was first stocked by the Park Service in 1923 with 20,000 rainbow fry. In 1924 Loch Leven was introduced by a stock of 50,000 eggs. Restocking of this stream with rainbow and Loch Leven was carried on in 1924 and again in 1930. Efforts were made to stock this stream prior to 1923 with brook and rainbow fry but the success of the plants are doubtful. This stream is now well stocked, both species thriving. Occasional restocking will be necessary, depending on the extent fished.

Shinumo Creek: (Blackspotted trout) First stock of 50,000 black-spotted eggs introduced in 1925; the eggs were planted in White Creek, an intermittent tributary to Shinumo Creek. The plant was unsuccessful. Restocked in 1930 with 50,000 blackspotted eggs. This stream is now well stocked. A recent stream check disclosed young trout measuring from 4" to 4½" long. Restocking will not be necessary until fished to some degree.

Clear Creek: (Brook trout) First stocked in 1928 with 50,000 brook trout eggs. Restocked in 1931 with 25,000 eggs. This stream is well stocked and will not need restocking until fished to some extent. The trout of this stream are exceptionally thrifty.

Havasus Creek: (Rainbow trout) First plant of 10,000 brook trout fry made in June 1927. This plant was a failure. Stocked in 1931 with 25,000 rainbow eggs. The eggs were hatched in the vicinity of the creek in troughs and 18,000 fry released in the stream. This stream is now stocked and will not need restocking until fished to some extent.

Tapeats Creek (Thunder River) (Rainbow trout) Stocked in March 1922 by Forest Service; 5,000 rainbow eggs introduced. A recent inspection of this stream disclosed a well-stocked trout stream.

Garden Creek: (Loach Leven trout) 4,000 Loch Leven Eggs introduced in 1930. Will not need restocking. This is a small stream and will not support many trout. The object of the plant was for novelty rather than for fishing.

This concludes the trout stocking for the canyon streams that will support fish. Restocking will not be necessary except where a stream is heavily fished. Stream conditions for natural propagation, food supply and growth are ideal in these waters and tho the obstacles encountered in making the plants were greater than elsewhere the efforts are justified by the results obtained.

THE RACCOON OF HAVASUPAI
By Ranger Chester R. Marklev.

Havasupai, the land of sky-blue water, roaring cataracts, spectacular waterfalls, majestic rock formations and romantic vistas, here lives the Havasupai Indian - isolated by fifteen miles of rough canyon trail that meanders through picturesque canyon scenery - a quiet, peace-loving people, satisfied to sit beside their hogans and bask in the warm sunshine of perpetual summer when not repairing irrigation ditches and tilling the soil, and performing other homely tasks.

Havasu (Cataract) Creek flowing through the five hundred acres of fertile land, turns it into a blooming valley. Possessing atmospheric conditions typical of the Lower Sonoran Life Zone, the valley refuses to conform to its zoning where an abundance of water counteracts a natural arid condition and pushes back the cat's-claw, mesquite and cactus, making way for a profusion of cottonwood, willow, and even hickory. Man has introduced many fruit trees; peach, plum, apricot, apple, fig and other fruit trees in bloom at this season of the year giving to the valley an Easter dress of gorgeous coloring.

Here lives the Pallid Raccoon (*Procyon lotor pallidus*). When and how he came to be in Havasu Canyon is an unsolved puzzle. The closest neighbor of this species is reported along the Colorado River near Needles, over two hundred miles away. Lacking an important article of diet - fish, - the little animal has turned to the natural food of fish that abounds along Cataract Creek - insects and insect larvae. During the winter month he subsists chiefly on helgramites, the larvae of the Dobson fly. The raccoon is known as a carnivore, but the cur dogs of the Indians being wilder and more voracious, hunting by night as well as by day has forced the raccoon to turn to the pursuit of less conspicuous animals. Evidence indicates that during the summer and early fall his diet includes wild grapes, berries, and corn from the outlying fields. In the spring and summer small birds and eggs undoubtedly are taken and devoured by the coons during their nightly raids along the banks of the stream.

The raccoon has been known for his remarkable ability to climb trees; yet, although trees well over three feet in diameter, and sixty to eighty feet high are available, he shows little tendency to climb them, preferring to scale precipitous walls, where are located his dens, high above the flood waters which periodically sweep down the canyon from drainage areas many miles away. This habit of climbing perpendicular walls, entering man-made caves, mine shafts, and natural openings, may be for numerous reasons, such as preying on bats, but the primary reason is for a place of safety from the Indian dogs which are their only enemy other than the Indian who may kill a few coons to save his little patch of corn.

The Indian regards the coon as an enemy to his crops, kills a few, but otherwise allows him to go his way in peace. During a conversation with an old Indian, the writer asked him if the Indians ever ate coon. He answered, "White man eat coon, Indian no eatum". Evidently they were good enough for the whiteman but not good enough for an Indian. Later while talking with a young Indian buck, I asked him the same question, and he replied, "Coon no good eatum, stink, smell bad". Yet, he went on to say that the Indian relished roasted wildcat, coyote, and rock squirrels, - animals that the whiteman would hesitate to eat.

The writer took one adult specimen for scientific purposes, and found the flesh very palatable, to the extent of being delicious, equal to that of eastern woodchuck and better than rabbit.

Specifications of Procyon lotor pallidus:

Date: - February 15, 1931.
Locality: - Havasu Canyon
Sex: - Adult female,
Length: - 34.5 inches
Tail vertebrae: - 13.5 inches
Tail tuff: - 1.5 inches
Hind foot: - 5.7 inches
Weight: - 12 pounds
Condition: - Very fat
Fur: - Density good, hide prime.
Stomach contents: - Dobsonfly larva exclusively.

During the month of February, I planted Cataract Creek with Rainbow fry which were strong and healthy five days after planting. If conditions remain favorable, the raccoon may in the future acquire that item of their diet which has been lacking, * fish.



EDITORIAL NOTE:

Since the preparation of this article, Chief Ranger James P. Brooks, and party have returned from a trip to Tapeats Creek and vicinity where they observed numerous signs presumably of raccoons, altho no raccoon was actually seen. No such signs have been observed in the many other side streams in the Grand Canyon which have been explored, except in Havasu Canyon.

FOURTH REPORT ON THE GERMINATION OF NATIVE WILD-FLOWER SEEDS

By Ranger-naturalist Pauline Mead

The wild flower seedlings that had been started in germinating trays in the greenhouse (see previous reports on germination experiment), were transplanted to the hot-bed on March 2. All of the seedlings had developed lateral roots and were therefore old enough for transplanting.

It was interesting to note the relative hardness of the seedlings after transplanting. New Mexican Locust (*Robinia neomexicana*) proved to be the most delicate of the seedlings; soon after they were taken to the hot-bed all of the locust died. It is supposed that the reason for this may have been too much exposure to sunlight. A new set of locust seeds was planted and the seedlings from this set will be given more shade, to determine whether or not excess sunshine was the cause of the death of the first set. Seedlings of Indian paint brush (*Castilleja linariaefolia*) are also delicate. All except three of the plants died and those three are growing but slowly.

It will be remembered that the seeds of Western Virgin's bower (*Clematis ligusticifolia*) showed the highest percentage of germination. The seedlings, however, are slow-growing and several died after transplanting. In general those in the sun do better than those placed in the shade. Pentstemon seeds (*Pentstemon glaber* and *Pentstemon torreyi*) showed a low percentage of germination but the seedlings are hardy and are growing quite rapidly. The seedlings of blue bonnet (*Lupinus barbiger*) globe mallow (*Sphaeralcea marginata*) and prickly aster (*Machaeranthera angustifolia*) are also hardy and fast growing. Mountain mahogany (*Cercocarpus montanus*), cliff rose (*Cowania stansburiana*) and apache plume (*Fallugia paridoxa*) seedlings are hardy but slow growing. The seedlings of cat's claw (*Acacia greggii*) and trefoil (*Lotus wrightii*) appeared delicate at first. One lotus seedling wilted after transplanting. In a few days, however, they straightened up and when last observed, March 29, appeared healthy.

On March 3 a new set of seeds was planted in the hot-bed. Up to date two seedlings of red bud are all that have come up of this set.

Following are the species of seeds planted March 3:

- Gambel's Oak (*Quercus gambelii*)
- Wild Buckwheat (*Eriogonum racemosum*)
- Columbine (*Aquilegia* sp.)
- Thistle Poppy (*Agemone platycenas*)
- Red Bud (*Cercis occidentalis*)

Fishhook Cactus (*Neomammillari* sp.)
Jimsonweed (*Datura meteloides*)
Sagebrush (*Artemisia tridentata*)
Goldenrod (*Solidago trinervata*)

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On Saturday, February 7, I witnessed a short battle between a raven and a hawk. I was walking on the Bright Angel Trail, about 600 feet below the South Rim, when I heard a raven's raucous voice, more noisesome even than usual. Rounding a short point, I saw ahead of me a raven and a hawk circling in the air. The raven would repeatedly gain the vantage point at the rear of and above the hawk, and then dive after the hawk. The hawk seemed easily to elude his pursuer after no more than momentary contact and apparently without injury. After a half-dozen attacks the raven tired and circled wider; the hawk began to climb on an air current, without movement of wing; the raven in pursuit. In a few spirals the hawk gained the level of the rim and was soon only a moving speck against the gray winter sky, the raven still in pursuit but constantly losing "ground".

I was reminded of the air fights I had seen during the war, but the apparent unconcern of the hawk for his adversary made this battle much less interesting.

-- P. P. Patraw --

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The first Indian paint brush bloom (*Castilleja angustifolia*) seen this spring was found on March 27 on the east side of Maricopa Point.

Another of the earliest spring flowers of the rim is the purple milkvetch (*Astragalus diphysus*) which was found in bloom east of Hermit's Rest on March 29.

-- Pauline Mead --

In these pages during the last few months you have read of field trips, wild flower seed germination experiments and many interesting and carefully compiled reports by Ranger-naturalist Pauline Mead. How could you guess that between the very lines of these technically worded articles Cupid, fully armed, stalked his prey?

On these important field trips Mr. P. P. Patraw, our Assistant Superintendent often accompanied Miss Mead and in the collection of seeds and specimens he was of great assistance - - using his strong left arm, while with the right, thoroughly pricked by Cupid's arrows (but none the less capacitated), he lead her to the rim of the abyss, the Abyss of Matrimony. There he pictured for her a trail so smooth and adventures so enticing that our wonderful Grand Canyon slipped into second place in her heart.

We hope that when they go down into this new Canyon, which is said to be greater than ours, they may see always the beautiful coloring, hear always the song of the birds and pick always the flowers of Spring. May they never look back to the Rim with regret.

