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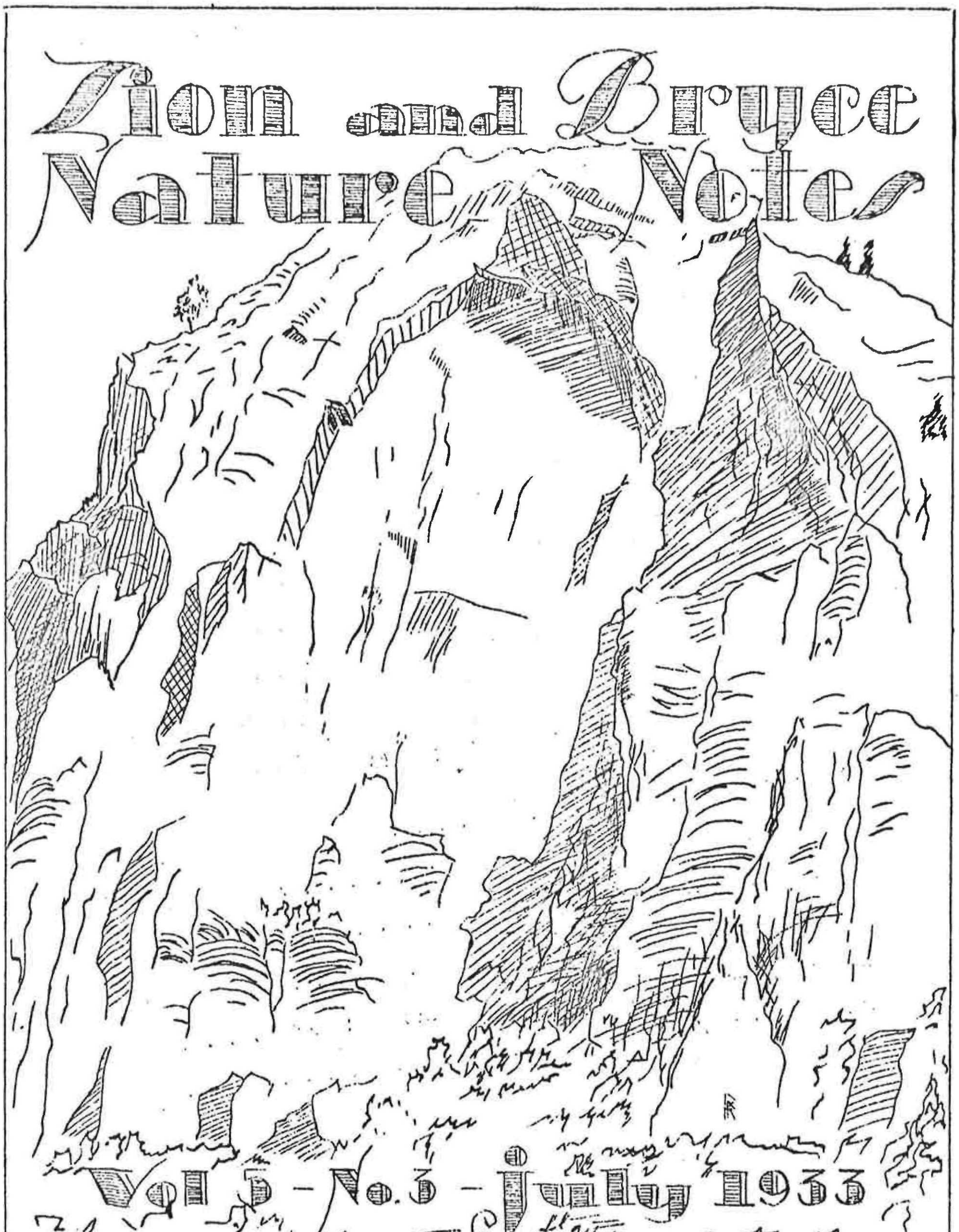

U. S. DEPARTMENT OF THE INTERIOR
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This bulletin is issued monthly for the purpose of giving information to those interested in the natural history and scientific features of Zion and Bryce Canyon National Parks. Additional copies of these bulletins may be obtained free of charge by those who can make use of them by addressing the Superintendent, Zion National Park, Utah. PUBLICATIONS USING THESE NOTES SHOULD GIVE CREDIT TO ZION-BRYCE NATURE NOTES.

P. P. Patraw, Superintendent | C. C. Presnall, Park Naturalist

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TO GREET YOU

With this issue of Nature Notes the new park naturalist assumes his duties in Zion and Bryce Canyon National Parks - and so I might continue to fill this page with similarly stilted and formal phrases were it not for the fact that I would much rather greet each one of you face to face in an easy, friendly manner. Hence this is both a greeting and an invitation; an invitation to visit our Rainbow Canyons, to renew the acquaintances which some of you made on previous visits, and to give me an opportunity to act as your host. In the short month that I have been here the canyons have proved so keenly interesting that I feel like taking each one of you on a personally conducted tour of the region. Some readers of Nature Notes will be unable to accept this invitation, and to you I promise the best possible substitute, through the pages of Nature Notes.

It is a happy coincidence that my greeting should appear just when a portion of the International Geological Congress is about to visit Bryce and Zion. To this group of visiting scientists we inscribe the current issue of Nature Notes.

Clifford Presnall

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"SLAB EROSION" IN WIDENING ZION CANYON

By A M Woodbury, Ranger-Naturalist

(Editor's Note: The following article is a resume of certain phases of a manuscript "The Carving of Zion Canyon", the publication of which has been delayed.)

Zion Canyon is about 15 miles in length and Parunuweap Canyon something less than 10 miles. Each one is exceedingly narrow at the upper end where the walls stand but a few rods apart. Each one gradually widens down-stream until at the lower end the walls are separated by more than two miles. Below the junction of the two the West Temple and the Smithsonian Butte, which are the farthest remnants of the walls, stand more than six miles apart. Beyond these remnants the Navajo Sandstone walls have been entirely obliterated as far downstream as the Hurricane Fault, a distance of 12 to 15 miles.

The Navajo Sandstone, sometimes referred to as a canyon-maker, is here nearly 2500 feet thick. The removal of such a thick layer of sandstone from an area estimated at 150 to 200 square miles in the region under consideration is a result of the multitude of natural forces at work enlarging the river valleys, collectively known as erosion.

There is little doubt that running water is here the principal and most important agent of erosion, and perhaps the most important form of running water is that produced by torrential rains that bring streams of water from every declivity to concentrate in rushing torrents in the bottom of all the major watercourses. Such floods carry heavy loads of sediment derived from the network of declivities or small channels through which the water has run in collecting together. The streams work by dissolving materials, by picking up and carrying small particles that make the water muddy, by rolling sand, gravel, rocks or boulders along the bed of the stream, by grinding these substances as they roll or by breaking up the larger pieces as they bump into one another. The permanent streams tend to follow up the work of such torrents and are auxiliary factors in the transportation of such materials.

These streams tend to degrade their beds and work downward from the top, making gorges with vertical walls. Larger ones, especially those that are permanent, tend to work faster than the smaller ones. The permanent streams of the main canyons deepened their gorges faster than the small intermittent "torrential rain" streams could follow, and hence many such "hanging" canyons pour water over the cliffs.

Such gorges cut in the Navajo sandstone are widened largely by other processes of erosion. Due to the peculiarities of this canyon-making sandstone, the gorges tend to maintain perpendicular walls even as the canyons widen. This is due primarily to undermining at the foot of the cliffs, which allows great slabs of the cliff face to fall off and leave a vertical wall behind. This type of rock fall, which may be referred to as slab erosion, is one of the principal and primary agencies in the widening of the gorges.

Other factors such as plants, frost, heat, oxidation, evaporation, soaking by rains, etc., play a part in surface disintegration, but their work is principally at or near the surface and they do not play a primary part in helping the great force of gravity cut off the vertical slabs when the support is removed by undermining.

Such undermining is produced principally by two different forces working either independently or together; (1) underground water, and (2) gravity in the guise of pressure from the weight of enormous masses of rock in the cliff face. In many places, where the Navajo sandstone rests upon Chinle shales, the footing of the cliff is impaired by faster weathering or by flowage movement in the shale, thus allowing gravity to pull down a slab of cliff.

Where the support at the foot of the cliff is adequate, then the resistance at the foot to the tremendous weight above results in an outward pressure near the foot which tends to flake off thin pieces of rock known as spalls. Repeated spalling tends to undermine the cliff. It is the cement which binds the sandgrains together which weakens under the strain and permits spalling. Without cement between the sand grains, the cliff would settle down into a steep, sandy slope. Without friction between the sand grains on such a slope, the sand would flatten out like water. The immense weight of the cliff is always tending to flatten it out. Slowly the cement yields where the strain is greatest and the spalls are the result.

Spalling alone is a slow process, but where it is aided by underground seeping water, the combined action of the two is comparatively rapid. The underground water is derived from melting snows and from rains, not all the water from which runs off in floods. The Navajo sandstone is porous and capable of absorbing about 12 per cent of its own volume of water. Some of this absorbed water is held by capillarity, but the balance tends to be pulled downward by gravity and seeps out at the foot of the cliff, or underneath isolated boulders. Wherever such seeping water occurs, it assists in the undermining of the cliff.

In some places the water seeps or drips from the face of the porous sandstone. In others it emerges in well defined channels as springs. In still other places the quantity of water is so small that it evaporates at the surface. In each case it weakens the sandstone and causes undermining. Three theories have been advanced to account for this weakening: (1) simple leaching; (2) crystallization; and (3) chemical oxidation and hydration.

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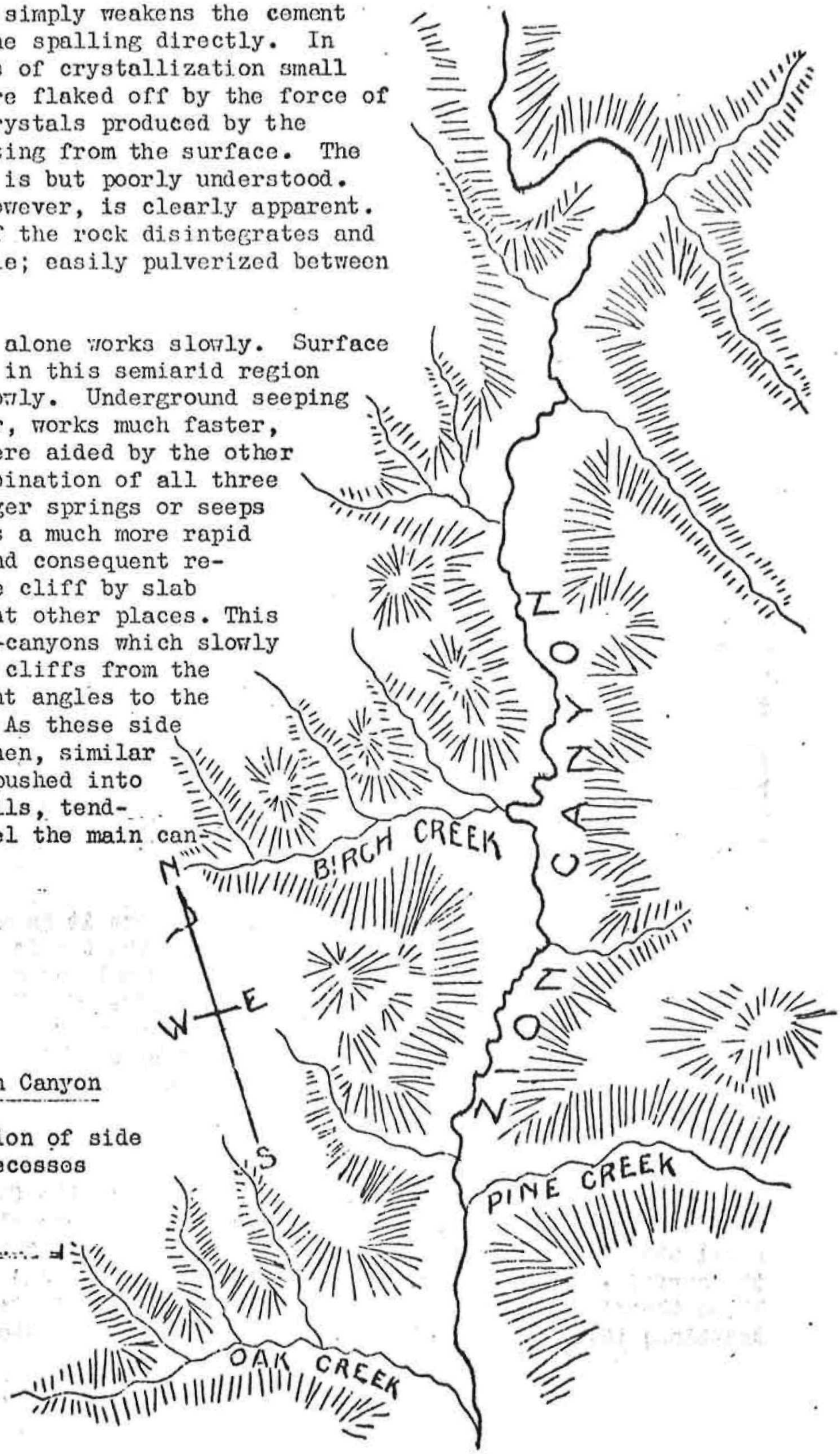
Leaching simply weakens the cement and assists the spalling directly. In observed cases of crystallization small thin scales are flaked off by the force of the growing crystals produced by the water evaporating from the surface. The third process is but poorly understood. The result, however, is clearly apparent. The surface of the rock disintegrates and becomes friable; easily pulverized between the fingers.

Spalling alone works slowly. Surface erosion alone in this semiarid region also works slowly. Underground seeping water, however, works much faster, especially where aided by the other two. The combination of all three where the larger springs or seeps occur produces a much more rapid undermining and consequent recession of the cliff by slab erosion than at other places. This produces side-canyons which slowly work into the cliffs from the bottom at right angles to the main canyon. As these side canyons lengthen, similar branches are pushed into their side-walls, tending to parallel the main canyon.



Sketch of Zion Canyon

Showing location of side canyons and recesses

One mile

It thus results that while spalling and surface erosion are at work all over the faces of the cliffs, wherever the effects of seeping water are added, the recession of the cliff is materially hastened, especially where larger quantities of seeping water concentrate into springs or streams. Such unequal recession results in an irregular outline of the faces of the canyon walls, producing deep recesses in the sides where streams of water have concentrated, and leaves projecting points between the side-canyons due to their slower recession where but little if any of the underground water emerges.

It thus appears that slab erosion is the major factor operating to widen the walls of Zion Canyon. Some slabs that fall are of tremendous size, but others grade down in size to very small pieces. In some places undermining lets the whole cliff face down at once; in other places it falls down a piece at a time, making arches which work their ways up the face of the cliffs to the top. In either case it results in widening the canyon.

Many such falls of large size are known, some of them in historic time. The latest one to date occurred on July 4, 1933, at 6:10 A.M. just opposite the Wylie Grove where I was living. Besides the noise of rolling rocks, the large cloud of dust was seen.

The oldest one historically fell from the big red arch near the Great White Throne about 1880-81 (see cover page). The rock mostly pulverized and built up the sandy slope back of the museum that is not yet fully covered with vegetation.

A huge mass fell from the east side of the West Temple on May 12, 1926. It mostly pulverized. Another large slab fell from the south side of the East Temple in July, 1929, and pulverized on the bare rock below. The sand poured over the cliff and formed a cone in Pine Creek Canyon just opposite the middle windows in the Zion Tunnel. The known falls of smaller slabs in the last few years are so numerous that there is no space to list them.

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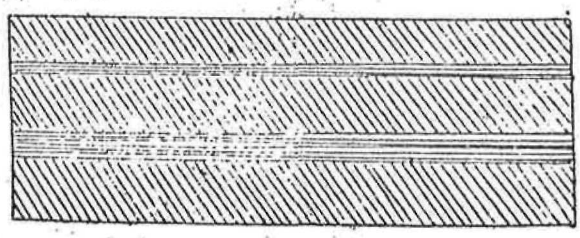
CROSS-BEDDING IN NAVAJO SANDSTONE

By Gordon Y. Croft, Ranger-Naturalist

In many sedimentary deposits, such as sandstone and conglomerate, the beds are oblique to the main stratification. This structure is called cross-bedding. It is very common throughout the Navajo sandstone. It is due to such lamination that the Checkerboard Mountain, Rock Candy Mountain and Pancake Hill derive their names.

There is much speculation as to the conditions under which the Navajo sandstone originated. A great bulk of the sedimentary deposit was laid down in water, but some was blown together by wind. The sedimentary rock which forms the precipitous cliffs of Zion Canyon is in all probability a combination of both. The evidences from the types of cross-bedding would infer as much.

The lower red-beds of the Navajo exhibit typical torrential cross-bedding. In torrential cross-bedding fine horizontally laminated strata alternate with uniformally cross-bedded strata composed of coarser material. The cross-bedding meets the horizontal beds at an acute angle both below and above. This type of bedding is believed to originate under arid conditions with concentrated rainfall and playa lake deposition. The cross-bedded layers are built forward by temporary streams where they debouch upon the playa lake, and the horizontal layers are materials which settle from suspension from the water of the playa lakes.



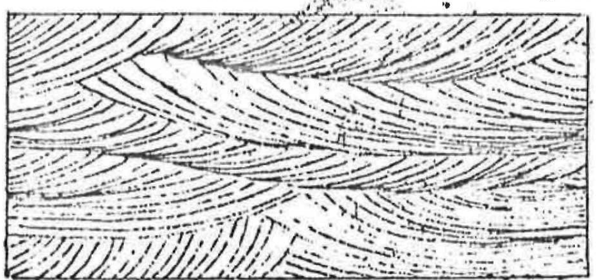
Torrential cross-bedding

This type of bedding is much in evidence along the Narrows Trail and is by far the most common in Zion Canyon proper. A microscopic examination of the particles show typical water-rounded grains of sand.

The upper portion of the Navajo is marked by cross-bedding of extreme irregularity which is typical of wind construction. This is due to the repeated shifting in the direction of the winds. The cross-laminae of a growing sand dune are of two sets: (1) the lee slope which dips at an angle of 30 degrees or the repose of dry sand, (2) and the windward side having an average dip of from 5 to 10 degrees. In typical dune cross-bedding the dip of the lee side decreases down the slope so that the layers concave upward.

Along the Zion-Mt. Carmel Highway typical wind or eolin cross-bedding is displayed with the lee side curved upward as a result of eddies in the wind. A microscopic examination of the sand grains shows well rounded particles, the result of long handling by air currents. As compared with water-worn particles of torrential cross-bedding, the eolin sands are smaller and more rounded.

Along the West Rim Trail another type of cross-bedding is in evidence. It resembles compound foreset bedding which is very prominent in deltas. In this type of bedding each set of laminae is truncated by the next overlying set. But to date no delta structure has been found in the Navajo sandstone, and further study may throw more light on this type of cross-bedding. A microscopic study of the sandgrains may show it to be eolin bedding which resembles compound foreset deposits.



Eolin cross-bedding

NEW PUBLICATION ISSUED

Scientists will be interested in a recent publication "Biotic Relationships of Zion Canyon" prepared by Dr. A. M. Woodbury, published in the April, 1933, issue of Ecological Monographs, and now available in pamphlet form from the Zion-Bryce Natural History Association at 50¢ per copy.

In 92 pages of well-written text and admirable illustrations, Dr. Woodbury has recorded a most scholarly survey of the ecology of Zion Canyon, and has included a surprising amount of detail for so brief a treatise. The geological, botanical and zoological interrelationships are dealt with in such a way as to give a lucid picture of the effects of geological processes in modifying the desert climate so as to produce a great variety of habitats. A closing chapter on succession and food cycles completes the picture. The bibliography includes many valuable references on local fauna and flora.

Copies may be obtained by addressing the Park Naturalist, Zion National Park, Utah.

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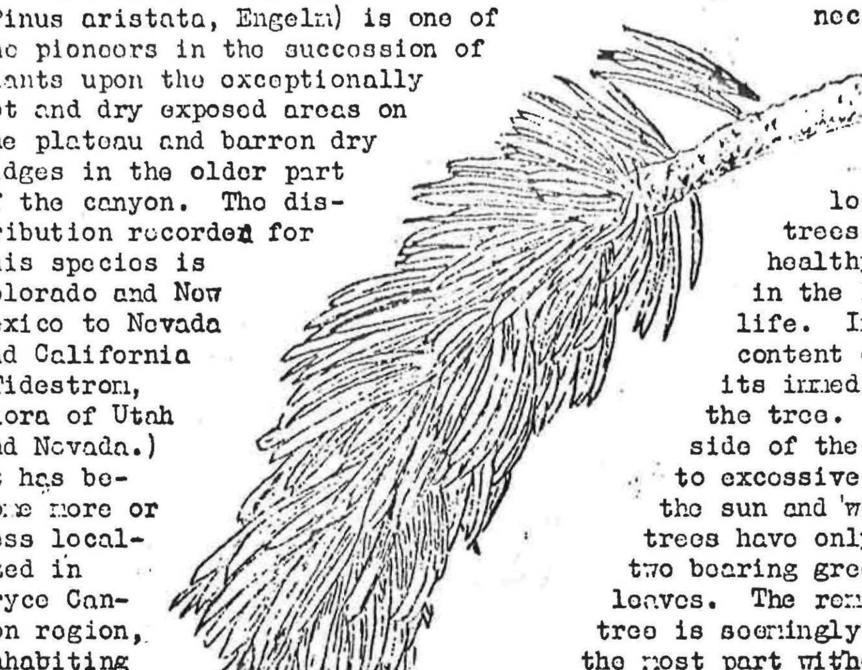
THE BRISTLE-CONE PINE IN BRYCE CANYON NATIONAL PARK

By K. F. Weight Ranger-Naturalist



The Bristlecone or Foxtail Pine (Pinus aristata, Engelm) is one of the pioneers in the succession of plants upon the exceptionally hot and dry exposed areas on the plateau and barren dry ridges in the older part of the canyon. The distribution recorded for this species is Colorado and New Mexico to Nevada and California (Tidestrom, Flora of Utah and Nevada.) It has become more or less localized in Bryce Canyon region, inhabiting only the more unfavorable locations in connection with the "Bad Lands" of the park.

On these localized areas trees vary from healthy ones to those in the last stages of life. Increased water content of the soil has its immediate effect upon the tree. On the exposed side of the ridge, subject to excessive dessication of the sun and wind, most of the trees have only a branch or two bearing green and healthy leaves. The remainder of the tree is seemingly dead, and for the most part without a bark covering.

The success of this species is apparently due to its very efficient transportation tissue in furnishing water and food for roots and leaves, its ability to withstand excessive wind and high temperature, its power to withstand root exposure after the soil has been removed by wind and rain water, and its power of starting growth in areas where the soil contains a low per cent of moisture, humus and bacteria.

ALONG NATURES HIGHWAY

A gray rock squirrel was observed by Dr. Woodbury on July 28, sitting in a hackberry tree picking leaves bearing round or spherical stem galls about one-half inch in diameter, and carefully eating the gall and dropping the balance of the leaf. The galls, which are very common on the hackberry (Celtis reticulata), are produced by minute insects, many of them in each gall. The question arose whether the squirrel ate the gall to get the insects or whether the gall itself possessed some special appetizing property since the squirrel did not eat either stem or leaf on opposite sides of the gall. A.M.W.

The finding of two nests of Rough-winged Swallows along the Narrows Trail on July 19 marks another addition to the list of birds known to nest in Zion Canyon. Previous observations of these birds in Zion indicated that they might nest here, but no nests had been found until this year. The nests were in small holes in the sandstone cliffs about 40 feet above the river. C.C.P.

Recently while sitting with my son near the door of our tent, my attention was attracted to two robins, evidently a mother and one of her progeny. They were running over the loose sand, stopping at intervals and picking into the sand as if to secure food. I have often seen robins with the same movement, running across a garden plot picking up worms, but what type of food could they possibly secure from the dry sand?

We observed with care their stopping places and proceeded to investigate. Each stop had been made at the funnel-shaped crater of the Ant Lion larva, popularly known as the Doodle Bug. They were running from crater to crater picking out the Ant Lion that lay hidden at the bottom of each one.

We continued to observe the robins until we were satisfied that they were feeding upon the Doodle Bugs, but we were still in doubt as to how the robin first learned that the bug lay hidden at the bottom of the crater. H.L.R.