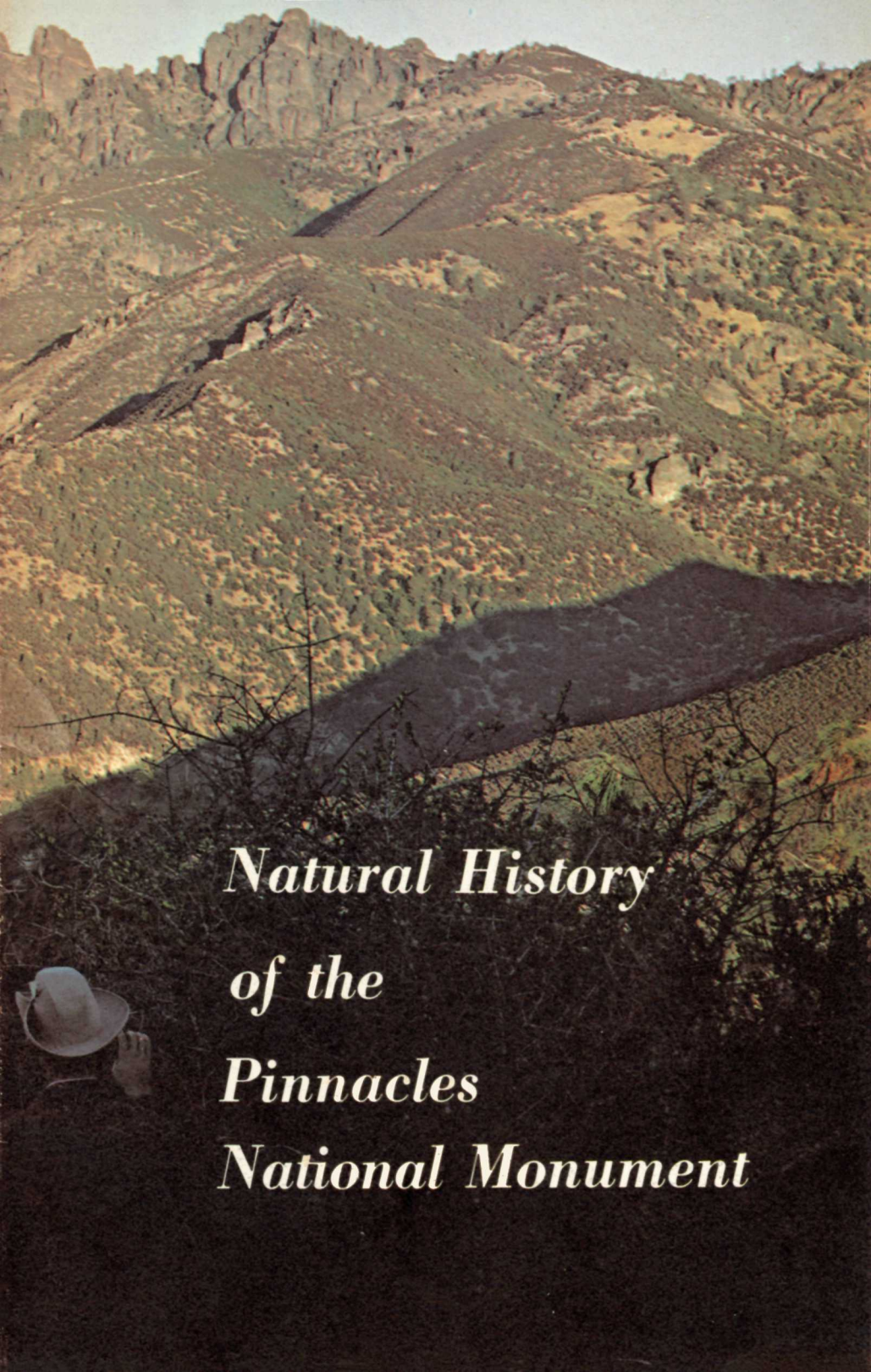


Natural History of the Pinnacles National Monument

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San Benito County, California

EDITED BY
RALPH C. WEBB

Published
— by —
PINNACLES NATURAL HISTORY ASSOCIATION

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ACKNOWLEDGEMENTS

This book is the result of the efforts of many people. It is based entirely on a manuscript by Peter S. Bennett which was the result of his original research on this area. I have reorganized it and rewritten some parts of it to suit our present needs. The illustrations consist of N.P.S. photos and drawings made by the editor. The geologic history drawings are adapted from some previously done by former Pinnacles naturalist Robert Zinc. Here I wish to thank Pinnacles superintendent Gordon K. Patterson for making available the large amount of time needed for this undertaking. My thanks also go to regional publications officer George Downes who proofread the manuscript and made many helpful suggestions.

Ralph C. Webb, Editor
September, 1969

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PREFACE

Ecology is a word that frightens many people when they first meet it. Like many other fears, though, it is revealed to be without foundation when examined in the light of day. The word was coined almost a century ago from two Greek words and means, "a study of the home". It deals with the interrelationships of the rocks, soils, plants, animals, and weather of this planet.

There are three main spheres of influence upon the earth. They are called the *atmosphere,* the *hydrosphere,* and the *biosphere.* Each is related to and dependent upon the other two spheres of influence.

We are all familiar with the atmosphere. It is the envelope of air surrounding our planet. From it plants obtain carbon dioxide and animals obtain oxygen, two most important items for the maintenance of life. The atmosphere also creates our weather. It regulates the rainfall, wind, temperature, and other elements of our various climates. It also serves as a screen against the rays of the sun. Without the atmosphere, life as we know it could not survive.

The hydrosphere is composed of all the water on this planet. Seas, lakes, rivers, underground water, and the moisture in the air. Water is not only necessary for life but also shapes the features of the earth through the actions of rain, snow, frost, glaciers, and running water. Were it not for the hydrosphere the mountains might last forever but the surface of the earth would be as sterile as that of the moon.

The biosphere contains all forms of life on earth, including you. It is likely you have regarded all this as though you were on the outside looking in but that idea is far from true. You are no transient stranger on this planet, you belong to it and are a natural part of it. In fact, you are one of the most important parts of it since only the human animal is capable of changing its entire environment to suit itself.

In the following story an attempt has been made to show you the workings of a very thin slice of earth's ecology, a part not too much influenced by humans. As you read, try to make comparisons with your own personal ecology; your home and city, your means of getting food and shelter, and how you and others depend upon one another to survive. We hope when you are through you will have a greater awareness of the real meaning of a place such as Pinnacles National Monument, or any other natural area for that matter. Perhaps you will also find a little more meaning in your own life, especially when it comes to hard problems such as air pollution, water pollution, noise pollution, and the vanishing wilderness.



A small flat lizard with horns on its head is possibly one of the most intriguing animals small boys and girls will find when they visit the Pinnacles. The Horned Lizard is harmless, feeding on ants and other small crawling insects. Their wicked looking spines are used to help them bury themselves in the sand and escape the heat of the noonday summer sun.

CHAPTER I

WHAT IT'S ABOUT

One day, not long ago, one of our visitors was describing to a ranger a small flat lizard with horns on its head which his boy had found on a hike.

"Was the weather very hot down at Chalone Creek?," the ranger asked; Surprised, the man asked, "How in the world did you know where we were?"

"I wasn't absolutely certain", the ranger smiled, "but I do know Chalone Creek is one of the few places in the monument where the coast horned lizard lives, so that was a pretty good guess".

"Do they bite?", was the camper's next question.

"No, horned lizards are harmless and aren't interested in people", the ranger chuckled. "They live mostly on ants and other small crawling insects.

"I wonder if you could spare a minute to explain that to my wife? She was afraid it might hurt the boy."

"Surely, I'd be glad to. Part of my job is to answer questions."

Once reassured, the visitors became interested in the animal and asked how the horned lizards could stand to be on such hot sand.

The ranger then explained that the ability to withstand high temperatures for a little while is one of the adaptations which allows this reptile to survive in the habitat it occupies. The horned lizard can't bear the full heat of the sun, however, for more than half-an-hour. In order to escape the sun's full fury he has another adaptation: his flat body, covered with horns and scales, allows him to bury himself quickly in the loose sand with a minimum of effort. There, just a little way below the surface, he can find a comfortably cool spot on the hottest days.

The flatness of the horned lizard's body serves another purpose too. His low profile does not cast revealing shadows which attract the attention of his enemies. Other adaptations include long toes for running and walking on the sand with ease, and a leathery skin which helps keep him from drying out.

For the horned lizard, water is a special problem: obtaining it in the first place and retaining it thereafter. There may be a great deal of water deep in the sand but it is too far down for him to reach. All through the centuries the horned lizard's system has adapted itself to getting along on the water in his insect food and that which results from his own metabolic processes.

The ranger was quick to point out to his fascinated listeners that the very same adaptations which fit the horned lizard for life in his hot, dry, sandy environment also prevent him from leaving it. If he were to venture into the grassland, for example, he would find it very hard to move through the closely growing grass stems. His wide flat body would make digging in the hard soil, to escape from heat, almost impossible. The protective coloration on his back would be sadly out of place in the dark rich grassland soil.

The horned lizard is limited by his adaptations, then, to one kind of habitat. Most other plants and animals are limited in like manner. You may have noticed along Chalone Creek, in the horned lizard's habitat, the trees all have large leaves and grow best in the streambed. These two facts are related since the large leaves allow much water to evaporate (A large sycamore may lose as much as 75 gallons/day). Such trees as willows, cottonwoods, and sycamores must be located near a permanent source of water. In the summertime the stream may be dry on the surface but these *hydrophyllic* (water-loving) trees are able to send their roots down into the streambed where water still flows underground. These roots then enable them to draw up the abundant cool moisture from below. Thus they are assured a supply of water which makes possible their rapid growth.

You can see, then, both plants and animals are limited in their choice of habitat by temperature, soil type, amount of water, and other conditions in their environment. The ecologist calls these things *limiting factors* since they control the distribution and limit of all living things. The limiting factors vary from species to species but you may be sure all plants and animals from California poppies to mountain lions have a definite set of limiting factors controlling their distribution.

By looking carefully, you will see plants or animals in any given place have many characteristics in common. Since they are all living together they all must have similar limiting factors and similar adaptations to enable them to deal successfully with their common environment.

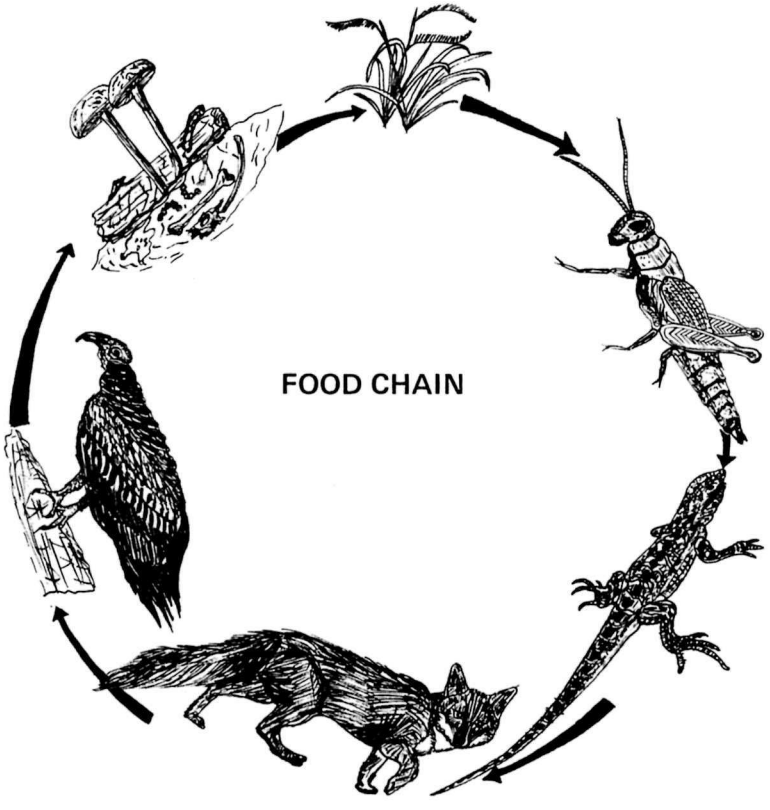
Most plants and animals in a given habitat are mutually dependent on each other for food and shelter, much as a butcher and carpenter need each other's services. Man calls his collection of stores and homes a *community* and, for the same reasons, biologists call groups of similar mutually dependent species of plants and animals *biotic communities.*

The mountain lion and deer are two important members of one biotic community. The mountain lion must depend on deer for food. The deer, in turn, depend on the lion to destroy sick and unfit members of their species to prevent overpopulation and starvation. Deer also depend on green plants for food and shelter, while plants depend on bacteria and fungi to return dead animals and plants to the soil so they may be used again.

Observation plus a little imagination will show, even in a small area, that these relationships, though exceedingly complex, form definite and rather fixed patterns. For example; gopher snakes feed on small rodents who eat grasses and seeds, red-tailed hawks kill and eat gopher snakes, the red-tailed hawk then dies and vultures eat his remains. After death, the vulture's body is decomposed by microscopic bacteria and fungi thus releasing chemicals into the soil so they may be used by plants to start the cycle again. This type of relationship is called a *food chain.* All living things are involved in food chains of some sort.

Although some animals may provide food for other animals, plants are the only form of life that actually produces food. All animals rely directly or indirectly on plants for their food. Therefore plants are called *producers* and all animals are called *consumers.* Animals feeding directly on plants, such as mice and deer, are *primary consumers.* Mountain lions and bobcats who eat mice and deer are *secondary consumers.* Nature's garbage man, the vulture, may feed on secondary consumers and is then termed, as you may guess, a *tertiary consumer.*

At Pinnacles you can easily see there are fewer bobcats than mice and fewer foxes than quails, the food supply of these animals. Why should this be so? In a sense everybody knows the answer but has probably never put it into words. Each time one animal eats another it is able to use only a small percentage of the food eaten for body building, the rest is lost as heat and waste. So a fox must eat many pounds of quail to make a pound of fox and a vulture must eat many pounds of fox to make a pound of vulture. The tertiary consumer, the vulture, thus gets about .01% of the energy from eating meat that would be otherwise available if he could eat grass directly. Generally speaking then, there are more primary consumers than secondary and more secondary than tertiary consumers.



FOOD CHAIN – Grasshoppers feed on grass which obtains its nutrients from the soil and converts them into food with the help of the sun, lizards eat grasshoppers and are eaten by foxes, the foxes die and vultures eat their remains, the vultures die and their carcasses are converted into plant nutrients by the action of bacteria and fungi. This entire relationship is called a FOOD CHAIN and all living organisms are involved in food chains of some sort.

Today we so often hear the term "balance of nature" the phrase tends to become meaningless. Nature is never balanced, in the same way a scale is balanced, it is in dynamic equilibrium; often swinging from one extreme to another – changing yet in harmony.

This continuous fluctuation is most obvious in animals. A few years ago the monument had a herd of about 600 deer and no resident mountain lions. Soon after 2 or 3 lions moved into the area and hunted extensively, reducing the herd to about 400 animals. As the number of deer decreased the lions worked harder to find food until they eventually went to hunt in another area. As soon as they

left the herd began to increase in size and as it got larger the lions were attracted back again.

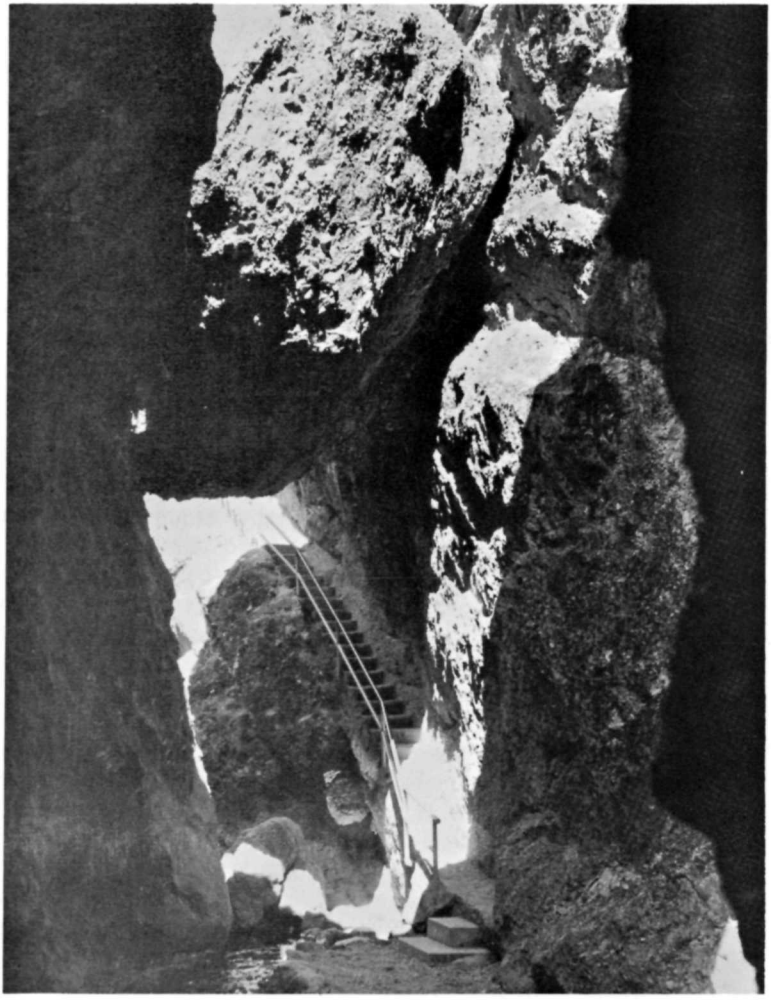
When there is a large increase of rodents, for some reason, in an area where there are few bobcats the same thing occurs. The increase in bobcat food supply allows more kittens to mature and hunt down the rodent population. When food becomes less abundant there is no longer enough to go around and some bobcats either move or die of starvation. Here again you can see nature moving from one extreme to another; want or plenty – feast or famine.

Generally speaking, predators breed and increase in numbers much more slowly than their prey. A California pocket mouse has its first litter when it is a month old; a bobcat has its first litter when it is 1½ years old. The mouse has 7 young in its litter 4 or 5 times a year; the bobcat has only 3 in a litter once a year. This means the pocket mouse gets a headstart in numbers on the bobcat and it takes a fair amount of time for the larger animal to catch up. Likewise the cat population decreases more slowly and lags behind the mice. This difference between the rate of rise and fall of predator and prey populations is typical of ecosystems left undisturbed by humans. It might be best to think of animal populations in nature as functioning like a clock pendulum; swinging from side to side, never static, never the same.

This complex type of relationship was investigated about 100 years ago. The great English naturalist Charles Darwin noticed the pasturage for cattle was of much better quality around villages than elsewhere due to the greater abundance of red clover. Acting on a hunch he decided to see if this situation had been influenced by man's presence. The results of the investigation were startling. Darwin knew red clover was pollinated by a certain species of bumblebee. (Other bees are not heavy enough to depress the petals and expose the pollen.) These bumblebees build their nest in the ground and fill it with honey. When mice find the honey they eat it and destroy the nest. Around the villages, however, the people keep cats as pets; the cats eat the mice; the bumblebees prosper in their undisturbed nests; the red clover is pollinated. This then produces plenty of seed and makes fine pasturage for cows. Therefore, in a way, the supply of milk in Darwin's day depended on the domestic cat!

The effects of change, or variation, in one species, or one consumer level, often has a surprising effect on an entire community. Not long ago some of the people working at Pinnacles noticed a sudden increase in the number of gray foxes at the headquarters area. Investigation revealed the large number of these animals was due to the presence of mountain lions, in part. This is probably the way it worked: lions mean fewer deer which results in more vegetation of the type needed by quails for food and shelter. This, in turn,

encouraged more quails followed by a corresponding increase in fox population. There is probably no other food at Pinnacles a fox more highly prizes than quails. So, you see, the sudden appearance of 2 or 3 large predators may greatly affect the lives of hundreds of small animals. An understanding of these principals will make your visit to Pinnacles National Monument, or other natural areas, more enjoyable because you will understand more of what you see.



The Bear Gulch and Old Pinnacles "Caves" are not true caves at all, but merely narrow canyons roofed over with huge rocks which fell from above. Little light penetrates these canyons and they remain dark and cool on the hottest days of summer.

CHAPTER II

WHAT YOU SEE NOW

During your visit to Pinnacles National Monument you are apt to be immediately struck by the spectacular rock formations. It was to preserve their beauty for your enjoyment this area was set aside in 1908. Most of the interest centers around the monument's volcanic rocks; formed more than 30 million years ago. Later volcanic action, shifts of the earth's crust, and the eroding forces of wind and water through the centuries have shaped the rugged crags and spires dominating the Pinnacles scene today. Most of the remains of this ancient volcano lie in an area 7 miles north and south by 5 miles east and west, the extent of the preserved area.

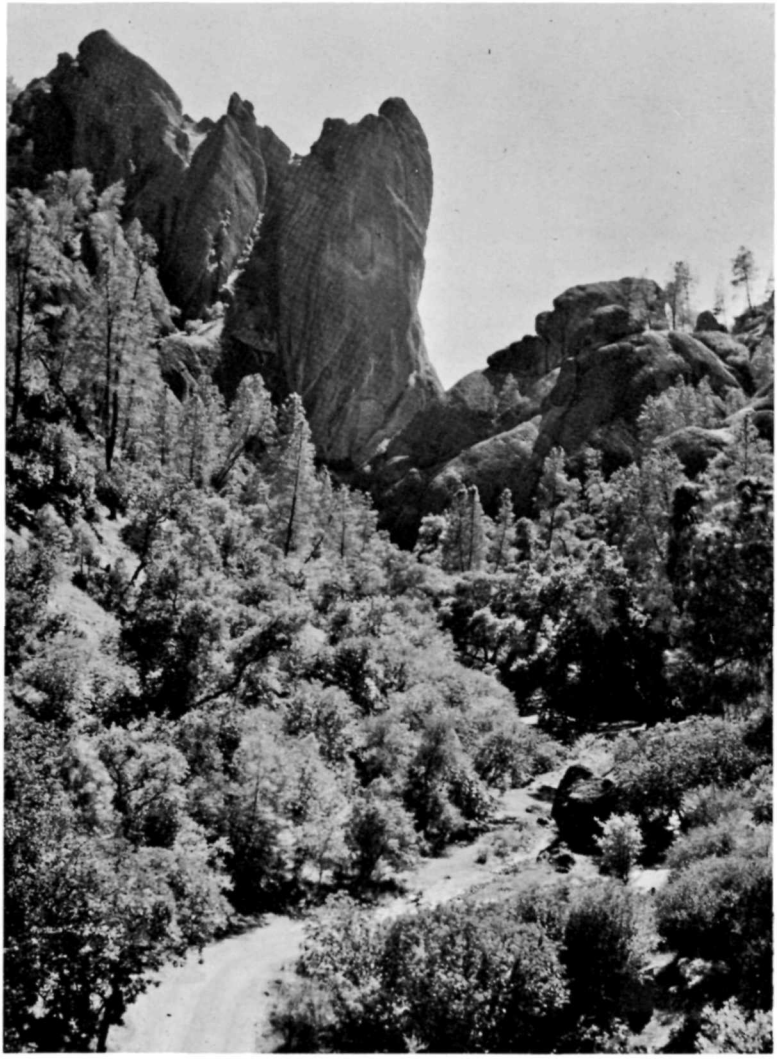
Do you think of lava as being black? It isn't always. The volcanic rocks making up the Pinnacles are a light colored non-porous material called *rhyolite.* Quartz and feldspar are the two most important rock components which accounts for the gray to light green color range.

Nearly everyone takes the short self-guiding trail past Moses Spring in Bear Gulch. Many people also explore the Bear Gulch "Caves" and clamber from Chaparral Campground through Old Pinnacles "Caves" and to reach the east side of the monument. Neither feature is a true cave at all; both consist of narrow canyons roofed over by huge rocks which fell from above and became tightly wedged between the canyon walls. Little light thus penetrates most of the area. Flashlights are necessary when going through either of the caves.

As you pause for rest at the reservoir, or at the west side campground, you will have an opportunity to observe a second outstanding feature of the monument. The vegetation manteling the slopes before you is infrequent in the National Park System. Pinnacles, along with Santa Monica Mountains National Recreation Area contains the *only* large expanse of the *Broad-leaf Chaparral,* a collective term for a community of drought resistant shrubs which form dense brushland. It survives well on poor gravelly soils. Other communities in the monument are: the *Foothill Woodland,* a

collection of oaks and grasses in a parklike arrangement; the *Riparian,* associated with water in the canyon bottoms; and the *Xeric* (bare rock). Each of these communities has developed distinctive life forms and relationships which will be described in more detail later.

The most noticeable adaptations of the Chaparral are the various ways evolved to deal with a shortage of water since the monument



Machete Ridge is one of many spectacular rock formations which caused the Pinnacles to be set aside in 1908 as a national monument.

features a Mediterranean climate of winter rains and hot dry summers. Many of the woody plants survive by conserving their moisture. Two evergreen perennials, chamise and wedgeleaf ceanothus, have small wax-covered leaves which allow little evaporation from their surfaces. The California buckeye, on the other hand, thwarts the hot dry weather by dropping its large leaves in July, leaving the branches bare and apparently lifeless until the next spring. The small annual wildflower "clarkia" avoids the hot weather. It sprouts, blooms, and seeds during the relatively short time the weather is warming up, but not yet hot, and the soil is not yet dried out. When the hottest weather arrives the parent plants die; leaving the seeds which lie dormant until the warmth and moisture of the following spring causes them to sprout and begin the life cycle once more.

Animals also adapt to the climate by frequently changing their behaviour patterns to fit the weather. Thus deer may often be seen moving about during the daylight hours during cool weather, but in the heat of July and August they are content to remain in their "beds" all day and feed mainly at night.

You will likely have neither the time nor the opportunity to see more than a fraction of the teeming life here since the monument contains about 20 species of reptiles, 30 species of mammals, 130 species of birds, and more than 1,500 species of insects! Why are there so many animal species in this relatively small area? The answer, at least in part, is the Chaparral and Foothill Woodland communities produce a greal deal of food of many types. It is not surprising then that with many kinds of food available there are many kinds of animals. Another reason is the animals are relatively undisturbed by people in Pinnacles National Monument.

The monument's meat eating animals, called *carnivores*, range in size from the 6 to 8 foot long mountain lion down to gall wasps which may be so small 50 of them lined up head to tail would measure an inch.

Plant-eating animals, called *herbivores*, are present in greater variety and numbers than carnivores. Although deermice are rarely seen, because they are most active at night, they are undoubtedly the most common animal of the monument. Pinnacles may contain as many as 280,000 deermice. That number seems small, however, when compared with the number of insects. The ladybird beetle, not extremely abundant, is estimated to number in excess of 1 million individuals at the headquarters alone during the fall swarming period.

Thus because of abundant food, and carefully maintained natural conditions, the monument has not only a great variety but also a great number of wild animals; and it all began hundreds of centuries ago.

CHAPTER III

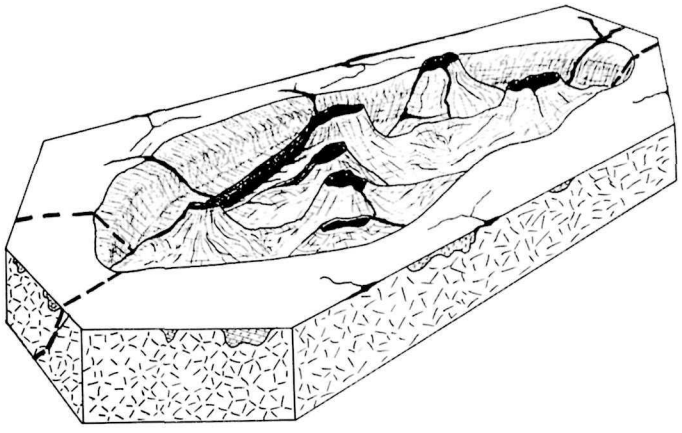
Part 1 – Geology

The changes in the continents during the past 60 million years have been so great as to stagger the imagination. It was during this period of time (Cenozoic era) the Alps and the Himalayas arose from the floor of the sea and most of the mountains of the earth reached their present size. This era was also the time the continents took the form we see today. Great ice sheets ground their way over much of the United States and most of the plants and animals we know today first made their appearance at that time. The Cenozoic, then, was a time of great change and unrest.

It was during this time the Pinnacles landscape began to evolve. At the dawn of the era erosion had reduced California to a broad stretch of low relief lands. The granite bedrock was overlain by a thin veneer of gravel. Tremendous pressures developed in the crust of the earth causing the mass of granite to begin rising. Numerous cracks developed in this bedrock and allowed intrusion of molten rock from below.

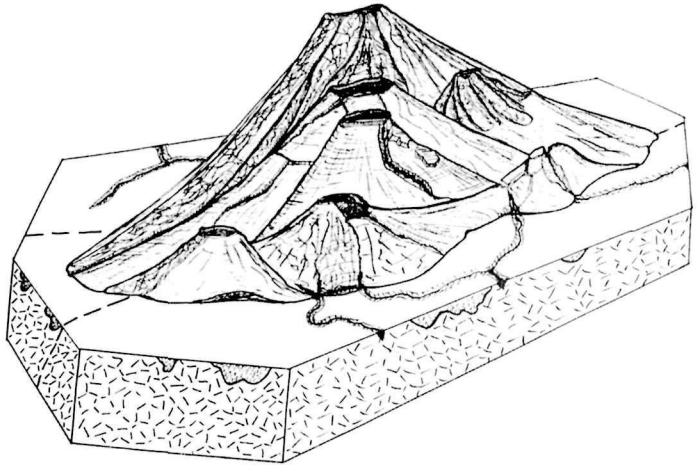
By the middle of the Miocene epoch, a part of the Cenozoic era, about 20 million years ago, this molten rock began to pour out over the surface of the land. The main kind of rock formed by these early flows was rhyolite. Layer after layer was deposited, forming a mass of considerable thickness.

One of the fissures from which the lava issued extended in a north-south direction. During the last stages of the flow the lava apparently became thick and pasty. This plugged most of the fissure, leaving a small number of vents from which several volcanic cones developed. (We know today where at least 5 of these vents are located). The resulting cones enlarged and merged to form an elongate, steep sided volcano. More lava flows and a series of violent explosions scattered tremendous amounts of molten rock and rock fragments over the landscape. These explosive erruptions marked the end of the volcanic building period in the Pinnacles area.



A large north-south fissure developed in the early stages of the Pinnacles formation. The lava issuing forth plugged most of the cracks but left a few open vents from which several volcanic cones developed.

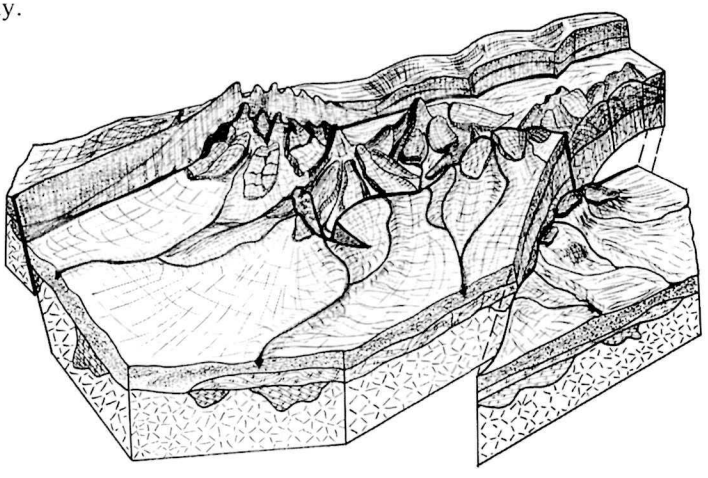
The length of time needed for these gigantic fireworks to do their job is not definitely known. It must have been a long time since these explosively derived materials accumulated to depths as great as 4,500 feet. In fact, this volcanic mountain stood an estimated 8,000 feet above mean sea level; nearly a mile higher than 3,305 foot North Chalone Peak, the highest point in the monument today.



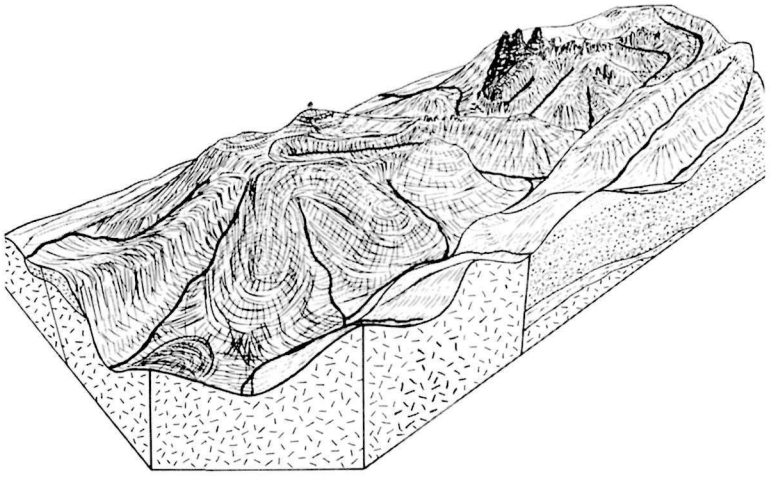
Over a long period of time intermittent lava flows and a series of explosive eruptions caused the small volcanic cones to enlarge and merge with one another. From these an elongate, steep-sided mountain [measuring some 5 miles wide, 15 miles long, and 8,000 feet high] was formed.

At the close of the volcanic activity an event took place that proved of great importance in the development of the present geologic scene. Two north-south trending faults were formed, one on each side of the present monument. The block between the faults slowly began to sink; faster on the east than on the west side, which left the block lying in a pocket with protective bulwarks on either side. The bulwarks, being higher and more exposed than the central block, were worn away first. This left the massive block exposed and tilted slightly to the east. The more steeply tilted eastern slope allowed water running from the top of the mountain to cut downward more quickly on the east side than on the west which produced a more rugged terrain on the eastern slope. During the faulting and lowering of the land, the rocks were fractured by uneven movements. The resulting cracks and joints allowed water to enter and widen them. The rapid erosion of the eastern side produced deep narrow canyons. Continuing erosion along many of the other joints eventually separated the remaining mass of rock into the vertical columns and spires that give the Pinnacles its name.

During the last stages of the volcano's formation chemical changes were taking place in the great accumulation of rock and dust thrown from the vents. Water seeping down from the surface contained chemicals that dissolved some of the minerals in the rock. Pressures from the weight of the overlying rock mass and the cementing action of water borne minerals formed a type of rock called *breccia.* This is the rock that forms the high peaks and caves today.



At the close of volcanic activity two north-south faults developed. The block between these faults slowly subsided and tilted to the east. Thus the features of this central block were well shielded from the elements by a protective bulwark of rock on either side.



The protective bulwarks eventually wore away. The elements attacked the now unshielded rock in full force. Water running down the steeply tilted eastern slope cut two deep narrow gorges into the rock to form the upper end of Bear Gulch and the West Fork of Chalone Creek. The cracks between the rocks were widened until the Pinnacles we know today were shaped and poised upon the skyline; alone among the rolling hills.

Erosion naturally takes place in soft rock more rapidly than in hard. Where a layer of softer rock underlies a layer of harder rock, unusual formations may result; balancing rocks, ledges, and anvils. The "fern chamber" and numerous other smaller cavities due to this phenomena are inhabited by the animals of the monument.

Another effect of the faulting and tilting is the formation of the "caves". Huge rocks sliding down into the deep narrow canyons became tightly wedged between their walls. The caves were formed below these "jammed" boulders; actually roofed canyons.

A mountain's awesome majesty may delude us into regarding it as indestructable and timelessly enduring. So it is, in relation to a single human lifetime or the time of humanity on earth, but mountains age year by year – like people. They wear away fragment by fragment; always changing. Only remnants of this ancient volcano remain. All that is left today lies between the Pinnacles and Chalone Creek faults. Had the faulting not occured the Pinnacles might not exist today.

The process that created the Pinnacles millions of years ago still occurs today in other parts of the earth. The volcanic chapter of the Pinnacles history would seem to be closed but the erosive forces that formed the high peaks are still active. No one can say for sure the

Pinnacles will not totally disappear leaving nothing but a flat plain or that some day volcanic activity will start again and build another 8,000 foot mountain.

Geology is not only a study of the earth and its rocks, but also an important part of the earth's biology. It has a great influence on the distribution of most living things. There are ways in which the area's geology determines the kind of plants found there. Plants are often sensitive to naturally occuring minerals in the soil, as every gardener knows. The presence or absence of just one mineral may have considerable effect on the types of plants, and consequently on the animals, found in the area. In an aerial photograph of Pinnacles small patches of soil derived from limestone are easy to locate by the kinds of plants growing there. If you look down from the High Peaks Trail toward Chalone Creek you can see a line of water loving trees such as oak, cottonwood, and willow growing along the base of the mountain opposite you. These trees mark part of the Chalone Creek fault. Water flowing underground meets an impermiable barrier at this point. This causes the water to well upward and reach the surface of the ground as a series of seeps and springs. Were it not for the springs the trees could not grow where they do and the entire mountainside would be as sparsely vegetated as it now is above and below the springs.

Actually, in one way or another, most living things are dependent upon rocks, minerals, air, and water – GEOLOGY – the foundation of life.



If you look down from the High Peaks Trail toward Chalone Creek you can see a line of water-loving trees such as oak, cottonwood, and willow growing along the base of the mountain opposite you and to the north. These trees mark a portion of the Chalone Creek Fault.

Part 2 – Paleobotany

The plants we see around us today at Pinnacles are the result of hundreds of thousands of years of change, adaptation, and evolution. They are the result of profound changes that occurred during the Cenozoic era; even in part a result of the ice age.

Early in the Cenozoic, about 65 million years ago, the vegetation of North America could be divided into two types, subtropical and temperate. Plant fossils found in California, Arizona, and New Mexico show us an area once covered with subtropical forests of wild fig, persimmon, and other trees now found in Central America. The fossil record shows this forest spread inland without interruption. The mountain ranges we know today had not yet been formed. The climate was very warm and humid with rainfall probably exceeding 100 inches per year. The rest of North America, covered by temperate forests, was also moist but cooler. In the western half of the continent the trees were mainly fir, pine, poplar, and redwood. Chestnut, maple, beech, birch, and oak made up the eastern forests.

During the Cenozoic era, from the Miocene onward, the great mountain ranges we know today began to rise above the plains. In the western United States the uplift of the Sierra Nevada and Cascade ranges cut off much of the moisture from the interior of the continent. Thus gradual drying, plus a cooling trend, spelled doom for many of the temperate species. The gingko, or maidenhair tree, now found in the Orient and the dawn redwood now found only in China were two native casualties. The subtropical forest retreated southward into what is now Mexico.

As the mountains continued their slow uplift the drying and cooling trend continued until it was climaxed in the Pliestocene epoch by great glaciers slowly grinding down from the north and from the tops of mountain ranges, even in the southwest. The fossil record indicates the forest drew back before these fingers of cold. Coast redwoods, for instance, are known to have grown as far south as Santa Barbara, California; 200 miles south of their present range.

In the southwest and Mexico some of the retreating subtropical and temperate species became adapted to the dry climate which was beginning to prevail. In addition, many of these plants became adapted to conditions developing on the west coast; winter rains and summer drought. Eventually this new type vegetation gave rise to the Chaparral and other communities now found at the Pinnacles.

After the ice age, as the climate began to warm, most of the plant life returned to the approximate area of its origin. Today we again find broad-leaved forests in the east and coniferous forests in the west. The chaparral, however, spread north far beyond its point of origin covering much of the lower half of California.

Most chaparral species are resistant to the effects of fire. This resistance may, in part, explain why chaparral is so successful in the California foothills where it has survived repeated burning for thousands of years. Plants not able to withstand repeated burning were eliminated and replaced by chaparral.

So far, we have only mentioned the origin of the plants at the Pinnacles. Animals followed a similar pattern of dispersal. Since all animals are dependent upon plants, it follows that if plants migrate



TREE POPPY – One of many flowering plants of the chaparral, this bright yellow poppy is unusual in that it is not an herbaceous plant but a woody shrub which leafs out and blooms each spring.

the animals dependent upon them must also move or adapt to a new environment. If plants become modified, animals must also be modified to keep pace. The plant-animal relationship, however, is not one of follow the leader. Animals also exert an influence on the plants in their surroundings.

Closely linked relationships of plants and animals are clearly seen when we examine relationships between flowers and their pollinators. Plants are usually pollinated by wind or animals. The oaks, pines, and grasses are wind pollinated. Most other flowering plants are pollinated by animals, mostly insects. It has been said that without insects the only food available to man would be nuts and grass.

Wind pollinated plants must produce great quantities of pollen. A mature Digger pine often produces 3 pounds of pollen. When the pollen is ripe it is released from the plant into the air depending on the wind to blow and scatter it about, hit or miss, until it lands upon the right flower and produces seed. Insect pollinated species, on the other hand, produce little pollen and rely on their tiny helpers for efficient transfer of pollen to other flowers. These plants can then expend more energy in the production of seed. It is noticeable the seeds and fruits of insect pollinated species are often much more elaborate than those of wind pollinated plants.

The study of plant fossils and the insects that pollinated them showed their rise to dominance was parallel. This is not surprising in view of the known facts of mutual dependence.

Highly developed flowers such as monkey flower, beeplant, mimulus, and hedgenettle have special structures which act as insect lures. They provide perches and places for insects to alight, colored lines and other structures to guide them to the nectar, and attractive scents. Modifications may be very specific, as in the case of Indian Warrior – a species pollinated by hummingbirds. In the area of Pinnacles the flower is red with purple overtones, closely matching the brilliant red gorget of the male Anna's hummingbird, its local pollinator. In the Sierra Nevada the pollination of Indian Warrior is performed by the Rufous hummingbird and there the flowers resemble the orange-red gorget of that species. In these cases the animals tend to pollinate the species having modifications that attract them most, thus making them more common and more successful.

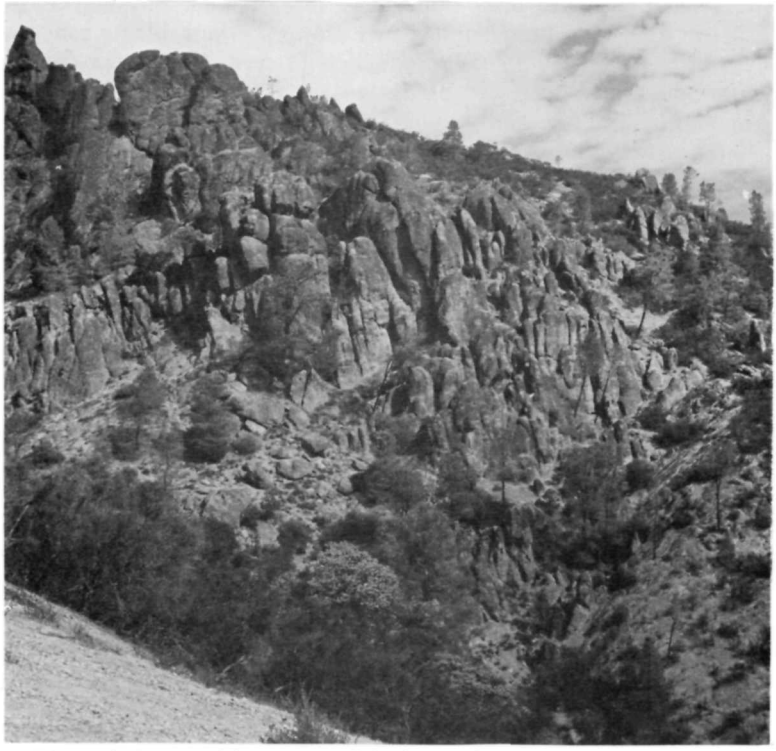
It would be a mistake to think about this kind of adaptation in terms of the plant changing itself to attract pollinators. The color of each plant is predetermined when the seed from which it sprouts is formed. The plants displaying a desireable color, or shape, are more likely to be pollinated, reproduce, and propagate more plants with this characteristic. As the process continues those strains unable to attract pollinators are eliminated.

CHAPTER IV
BIOTIC COMMUNITIES

Wind, water, and earth movements are not the only forces responsible for breaking down the rocks. Many of the plants occurring in the 4 major biological communities at Pinnacles are partially responsible for the transformation of rock into soil.

Part 1 – Xeric Communities

The *Xeric* (bare rock) communities are one of the major communities found at Pinnacles. Xeric (ZEE-RICK) means extreme aridity or dryness. This name is particularly appropriate for these



The Xeric Communities are one of the four major plant communities at the Pinnacles. Xeric means arid or dry and is very appropriate for the bare rock outcrops where these communities exist.

communities. The plants of this community all help weaken and decompose the rock, causing it to crumble into little pieces; thus forming sand which is carried away by wind and water for still other plants to work on. Thus these hard working little pioneers are seldom ever able to profit much from their labors.

Rock retains little significant moisture. Such soil as is found in the xeric community retains little more since it is coarse, raw, thin, and dries out soon after the winter rains have ceased. The only time water is not scarce in the xeric community is when rain is actually falling. Some plant and animal species, of course, have evolved adaptations which fit them to these circumstances. The plants living in this community must be able to take immediate advantage of water when it is present and have some means of surviving during long dry spells. Animals of this community must either travel to water, store it for long periods, or make their own.

To many the xeric communities seem to be barren unrelieved waste. One irate visitor once demanded the return of his entrance fee since he saw nothing but "a pile of rocks". Those visitors who have acquired even a smattering of ecologic understanding will usually find this community one of the most interesting. Relationships between organisms and their limiting factors are easily seen because they are so simple. The most important factors are the lack of water, high summer temperatures, rapid drying conditions, and poor thin soil. For many animals, especially predators, the terrain is ideal. The rocks abound with caves and cavities suitable for dens and nesting while the precipitous topography offers protection and concealment to a degree not found elsewhere in the monument. The plants here must struggle to the utmost for survival and, as a consequence, are greatly modified to deal with these conditions.

The first plants to appear on barren rock are lichens. Many people fail to recognize these patches, scales, or spots as being plants. They may be called moss or a variety of other, and often incorrect, names. Lichens, however, are living growing plants. During much of the year they are completely dry and brittle but when it rains they suddenly come to life, soften up, and grow.

Lichens are not just one plant but 2 (a fungus and an alga growing together and mutually interdependent). The algae are small one-celled green plants that produce food as their more complex flowering plant cousins do. The fungi produce no food but are efficient at gathering and storing water and nutrient materials which are then converted into food by the algae and shared with the fungi. This is a symbiotic relationship similar to one we will mention further on between chamise (greasewood) and its root fungi.

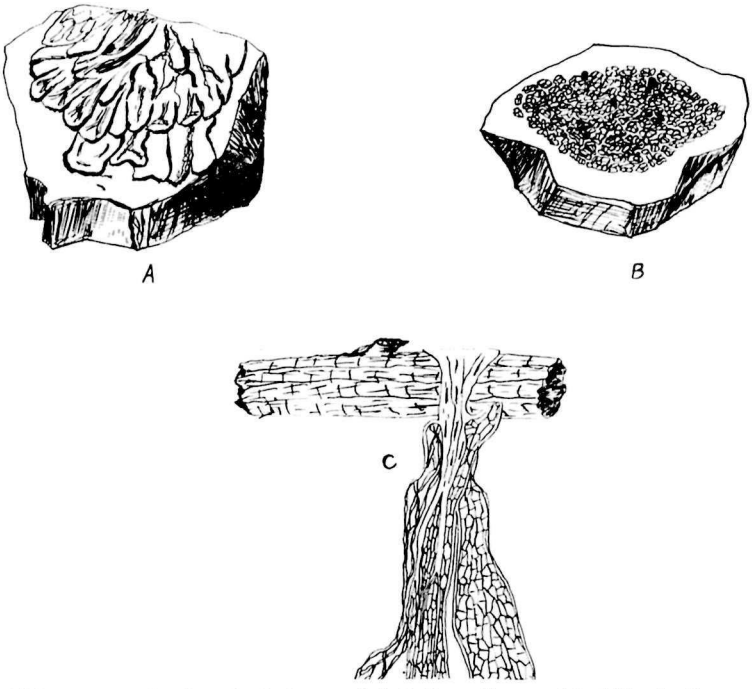
Very little is actually known about lichens. Biologists would like to know how the fungi and algae find each other. We do know algae

are able to live alone on tree trunks, in the soil, or in similar moist places but the lichen fungi are not often found growing alone.

Another question is why only certain fungal species associate with only certain species of algae.

You might not expect plants resulting from this combination to assume definite shapes or characteristics since neither of the separate species do. The shape of each species of lichen, however, consistently assumes a regular form and biologists who study them can tell at a look what algae and fungi are present.

Lichens occur in 3 basic forms: *fruticose,* erect or hanging branched structures often found on trees, (examples – staghorn lichen and the old man's beard growing on oak trees); *foliose,* flattened leaf-like bodies such as lettuceleaf lichen; and *crustose,* which form the common hard granular crusts on the rocks. The latter 2 types are of most concern to us since they are the forms most frequently seen in the xeric communities.



Lichens occur in three basic forms: [a] Foliose, flattened leaf-like bodies such as lettuce leaf lichen; [b] Crustose, which form the common hard granular crusts on rocks; [c] Fruticose, erect or hanging branched structures often found on trees, such as "grandfather's beard".

We have mentioned lichens help decompose rock as a first step in the manufacture of soil. Since there is no soil from which these plants may draw minerals required for life, they extract them directly from the rocks. Lichens secrete various acids to convert rock minerals into a water soluble form. You can easily see this by testing a damp lichen with a piece of litmus paper from a child's chemistry set. This paper turns red in an acid medium – which it does on damp lichen. Thus you can see how lichen aids in the decomposition of rock.

If you look closely, you will see the surface of lichens is covered with pores or cup-shaped bodies. The structures are the reproductive parts of the fungus. Periodically very small one-celled structures similar to the seeds of higher plants (spores) are formed here then carried away by the wind. When these spores alight in a suitable place fungus plants sprout from them, somehow acquire a few algae, and start another lichen plant.

Lichens grow very slowly. After all, they can't grow too fast on dry rock. Lichen plants may take 20 or 30 years to cover a square inch. Along trails where rocks have been exposed by blasting lichen activity may not show for 10 to 30 years, depending upon the moisture available. When you hike over the High Peaks Trail take a little time to look for, and observe, these wonderful plants struggling for existence where no other living thing can grow.

The sand and rock manufactured by lichens is passed down the hill by gravity to the mosses. Many people associate moss with the moist rocks of shady streams. Moss does need water to grow but some kinds can withstand drying. If you would like to test this statement for yourself, you can easily do so. Walk along the Moses Spring nature trail during the month of August until you find some dry, brown, apparently lifeless moss on the rocks along the trail. Pour a little water from your canteen over these plants and watch them turn as lush and green as any moss you have ever seen, in just a matter of minutes.

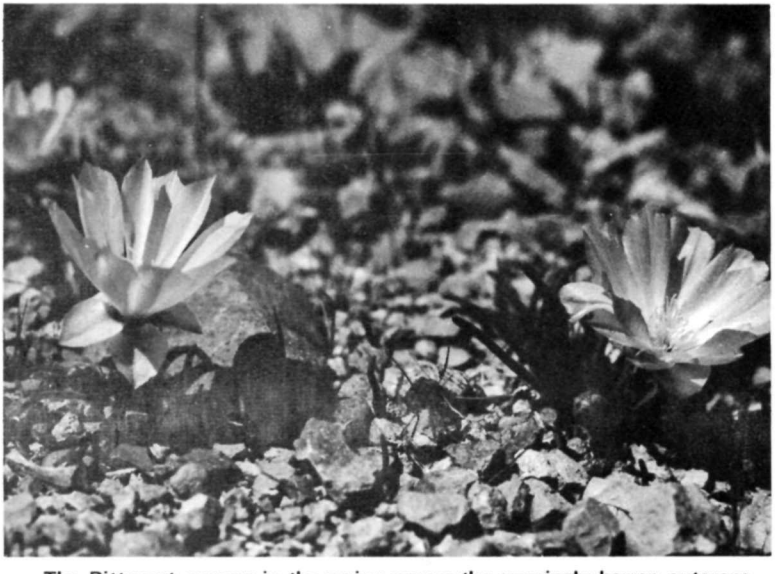
Mosses grow more rapidly than lichen. First, mosses do not have to go to as much trouble as lichens to obtain nutrients, thanks to the lichen's previous activities. Secondly, they have some soil (often provided by lichens) into which they can sink their rootlike structures. The thin but important soil can be seen if you gently part the moss stems down to their bases. This soil is then modified and improved by the mosses, thus paving the way for the next series of plants to follow. Because of this sequence, grasses are more frequently associated with mosses than are lichens. This is an example of *plant succession.*

Mosses, being more complex than lichens, have more complex life histories. They begin as tiny seedlike structures similar to the fungal spores of a lichen. When these fall in a suitable place they

germinate to form moss plants. The plants so formed, however, are tiny and unlike the moss we recognize. When these plants mature, male and female plants are formed, somewhat as in flowering plants. Since mosses have no true flowers, insects do not convey the male cells to the female cells. These plants make the best of a bad situation by having male cells able to swim to female cells in drops of water. The little embryo then grows into a typical moss plant.

The flowering plants in the xeric communities are not remarkably different from those found in the rest of the monument. They are all annuals, except for the woody plants from the chaparral or foothill woodland communities which can occasionally find a moist spot. The chief differences are the leaves which tend to be small so less water is lost by transpiration, and the stems are shorter. Short stems require less time and water to grow thus allowing the plants to get on with the vital phases of flowering and seed production prior to the onset of the dry season.

A comment is often made that flowers growing in rock habitats are brighter in color than those growing in other places. This is likely not true. Their colors seem more vivid in contrast with their drab surroundings. A list of the flowering plants found in this community can be obtained at the visitor center for the asking.



The Bitteroot appears in the spring among the seemingly barren outcrops of rock around the High Peaks. Its color appears to be an exceedingly bright pink; more so than that of any other pink flower in the monument. It is likely its colors only seem more vivid in contrast to its drab surroundings.

The turkey vulture is the most prominent large bird seen in the monument. It is a carrion eater by necessity since it is not equipped to kill prey. Unfortunately, this habit causes the bird to be regarded with disgust and abhorence by many people. Without the aid of such scavengers in removing dead animals the world would soon become a very unpleasant place. Turkey vultures eat only flesh of dead or dying animals and have few natural enemies, a combination of facts placing them at the end of the line or top of the trophic level in many food chains, a distinction shared by humans.

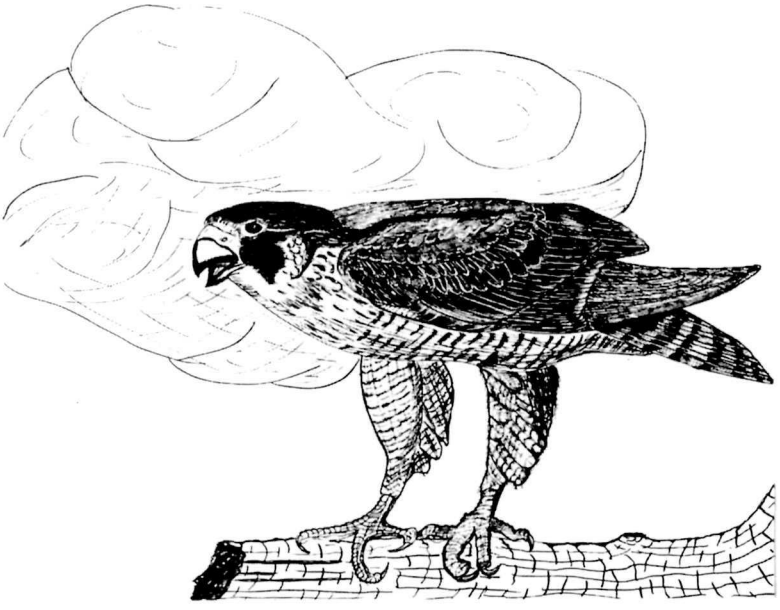
The soaring of vultures readily attracts attention and has been the subject of much study. Notice that soaring birds frequently hover at the heads of steep canyons or over ridges and mountain tops. Wind is forced upward in these places and helps provide the necessary lift for sustained soaring. Rising currents of air from the warmed surface of the earth also provide favorable conditions for soaring. At such times the vultures may soar for several hours without a single wingbeat.

By looking closely you may be able to see how vultures control their flight. Slots in the end wing feathers are opened or closed, possibly to increase or decrease the lift of the wind. The bird uses his tail as a rudder, tipping it from side to side as he banks and turns. The turkey vulture may be easily distinguished in flight from the golden eagle. The vulture curves his wing tips upward as he soars. He also appears headless when soaring high overhead.

No one really knows whether vultures find their food by sight, smell, or a combination of these senses. Experiments have proved inconclusive since it is hard to stage an experiment which maintains its scientific controls yet presents the bird with a situation it would normally face.

Vultures roost at night in trees or on the crags in the xeric communities. The vulture is a late riser. The winds do not blow as hard in the early morning and helpful air currents generated by rising heat have not yet appeared. The vulture finds it difficult to soar aloft without these aids.

The vulture need never be in a hurry since his food is already dead, or dying, and cannot escape him. The opposite is true of the peregrine falcon. This predacious bird lives almost exclusively on other birds. Its prey includes fast flying ducks, doves, pigeons, and swifts. Capturing his prey on the wing presents no problem to him since he is the fastest of all American flying birds. Estimates of as high as 175 miles an hour seem unbelieveable. One such estimate was made with a stop watch which lends credibility to these stories. Another report was made by the pilot of a small pursuit plane. While executing a dive at 175 miles per hour, he was astonished to see one of these birds flash past him and kill one of a flock of ducks below!



The Peregrine Falcon lives almost exclusively on other birds. Its prey includes fast -flying ducks, doves, and swifts. Capturing his prey on the wing is no problem to him since he is the fastest of all American flying birds and has been clocked in dives at speeds up to 175 miles per hour.

The peregrine falcon's maneuverability does not match its stupendous speed. It sometimes overshots and misses its mark. How does it stop its dives ? A ranger at Pinnacles was able to observe this feat near the Balconies in the spring of 1962. The bird was making a very fast steep dive, using rapid wingbeats. When about 15 feet above the ground, it opened its wings completely to act as brakes and flew away near the ground at very high speed. The noise created by this maneuver was reported to be very loud, resembling that produced by the rapid tearing of very heavy canvas.

The peregrine falcon is never very abundant at any location and Pinnacles is no exception. In some years, there are about 1 or 2 nesting pairs high in the rocks of the Balconies.

Undoubtedly the rarest thrill of all for the visitor to Pinnacles would be to see a mountain lion. Such an opportunity is not likely to be yours since only 2 or 3 of these magnificent cats have been seen in the monument area during the past several years. Here one realizes the importance of the National Park Service providing a refuge for all forms of wildlife, preserved and protected in a natural state.

The imagination of man has always been excited by the unknown. Especially in regard to large, strong, secretive beasts of

prey. This excitement has not worked to the advantage of the mountain lion and exaggerated stories of its characteristics and habits have given the animal a reputation which has nearly led to its extinction.

These exaggerated ideas are easily understood by a monument ranger who flashed his light along the Bear Gulch road one night at a bulk in the dark which he took to be a deer. Instead, the light revealed a full grown mountain lion about 30 feet away. Man and beast were equally surprised and both abruptly left the scene in opposite directions. In the dark the animal seemed huge. Later examination of the tracks indicated it was only a middleweight, as lions go; about 6 feet long and weighing less than 100 pounds.

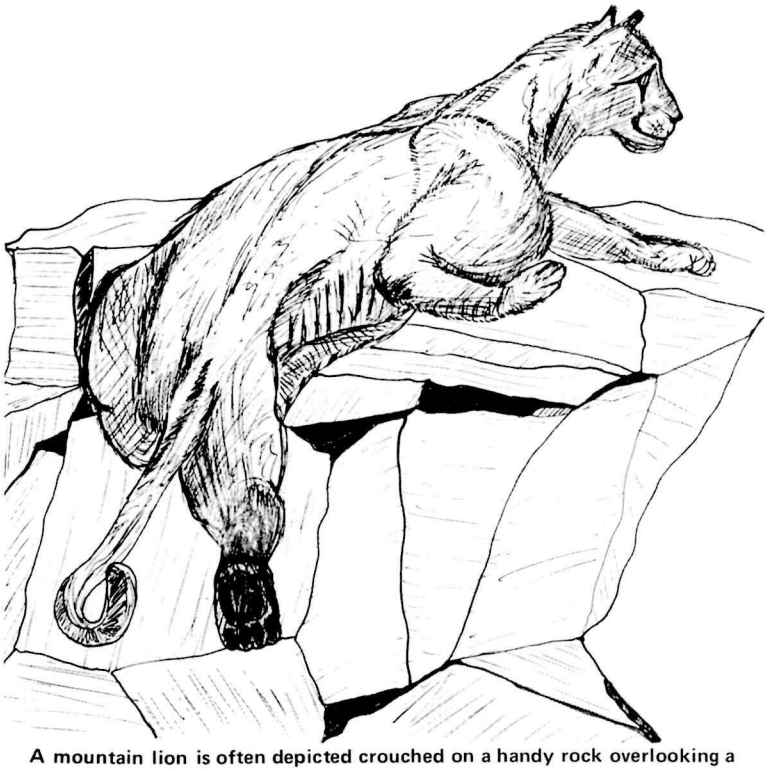
If you are both lucky and observant you might find a mountain lion's tracks on one of the monument trails. They resemble those of a large dog but can be distinguished by the difference of features of the dog and cat families. The former usually leave distinct claw marks, while the cats always travel with claws retracted. In addition, the pad of a dog's hind foot has only 2 bulges on it while those of cats have 3.

Besides his tracks, the lion leaves other characteristic sign. The "scats" are readily identified since they always contain a great deal of deer hair and often have chips of bone and/or hooves. They are about an inch in diameter and are often covered with a little dirt by the animal when they are deposited. Again, this behaviour is typical of cats.

Lions also frequently stretch by extending their forefeet forward and, while crouching, draw their back feet toward the body leaving short scratch marks about 4 inches wide and 12 inches long. The claw marks may or may not show. If trees are handy they may sharpen their claws on them; using the tree as a scratching post just as house cats do.

Male mountain lions hunt and travel along the ridges while the females usually hunt and prowl in the canyon bottoms. In saddles, and at the heads of canyons, the male and female trails often cross. In such places the males establish "scent posts", places where they frequently urinate. Such places are marked by much scratching and disturbance of the ground cover. To the human nose these areas reek with an acrid odor reminiscent of the smell of a mature alley cat. One such area has been established right beside the hiking trail to the High Peaks above the reservoir. Before the trail ascends in a series of switchbacks up to the peaks themselves it traverses a long and nearly level ridge marking the divide between Bear Gulch and the head of Condor Gulch. Here the males running the ridge cross paths with the females traveling from one drainage to the other.

Such scent posts are of great practical value to the lions.....Since



A mountain lion is often depicted crouched on a handy rock overlooking a deer trail. When his victim comes along he is supposed to make a mighty leap onto its back and kill it. This type of hunting is NOT typical and seldom resorted to except by sick or lame animals incapable of hunting in the usual way.

mountain lions have no regular mating season, the females alone know when they are receptive. They will then leave a calling card at a scent station and wait nearby for a male to show up. This greatly simplifies the problem of males and receptive females getting together at the right time in their almost trackless territories.

Hunting lions travel in large circuits, sometimes with a radius 100 miles or more, taking 30 days and over to complete the trip and arrive at the beginning again. They often make these rounds with great regularity, arriving at a given point within an hour or two year in year out.

One park ranger had an opportunity to observe this regularity. In the spring of 1963 a female, accompanied by 2 kittens, crossed the monument entrance station area on 4 consecutive Sundays between 1 and 2 o'clock in the afternoon. The time to traverse the circuit was 7

days, in this case, but this is an exception rather than the rule. Mountain lions, of course, do not operate on a 7 day week.

The kittens are born any time of the year in lairs sought out by the mother. A typical litter is composed of 2 or 3 but up to 4 are occasionally reported. The high peaks area is a favorite place for the rearing of young. It is well protected and seldom visited by man but not far from abundant game or water. It is an ideal location. The rocky areas around Chalone peak may also be used.

Although the "balance of nature" is an inaccurate and discredited term, it is very tempting to use it in describing the relationship between mountain lions and deer. The 2 species need each other; deer must rely, in part, on the lion to hold their population in check, while the mountain lion depends on deer for its principal food. The lion's anatomy and habits are directed to this end.

A mountain lion is often depicted as crouching on a handy rock overlooking a deer trail, waiting for his dinner to come along at which time he makes a mighty leap to the back of his victim and kills it. This type of hunting is *not* typical. It may be rarely resorted to by sick or lame animals no longer capable of hunting in the ordinary way. Mountain lions typically hunt on the move walking rapidly, looking from side to side, and pausing occasionally to test the wind. Strangely enough deer do not seem to be alarmed if they see a lion. They are much more alarmed if they can smell him but cannot see him. Lions are commonly allowed to come quite close before the deer run. Tracks found in the Foothill Woodland community one day dramatically illustrate this point. Tracks of a lion were found in the short dry grasses which offered no concealment. He walked along openly while approaching a doe, which was probably browsing, until he was within 50 yards of her. No cover was available and the deer *must* have seen him. When he felt he was within striking range he put on a terrific burst of speed which was revealed by the "skid marks" left in the soft soil. The deer at last became aware of her danger and attempted to bound away. She was too late and was captured about 60 yards further on.

While a mountain lion is capable of putting on terrific bursts of speed, running at least twice as fast as the deer in this case, it is doubtful such a pace could be maintained for any great distance. If the doe had fled at the first appearance of her enemy she could probably have saved her life. Deer remains are frequently found which tell the same story, the lion was allowed to approach closely enough to reach his prey with a final sprint.

The mountain lion's body is superbly adapted for short bursts of blinding speed. The most unusual modification occurs in the shoulders and back. The lion does not have a regular ball and socket

joint as do humans. His shoulder blade is loosely connected to the body by muscle and tendon. When he runs the shoulder blades slide forward throwing the forelegs ahead and adding several inches to his stride. The structure of his back also serves to lengthen his running stride. When the hind legs are on the ground making contact for the next step, the back is highly arched; unlike that of a horse which remains rigid as it runs. As the hind legs thrust backward the back straightens. These modifications give the lion the extreme speed needed to overtake and kill its prey.

Is the death of the deer inevitable, once he has been chosen as a lion's victim? Far from it! Like the perigrine falcon, the lion has speed at the expense of maneuverability. When a black tailed deer is alarmed it speeds off in a series of erratic jumps with abrupt changes in direction thus presenting an elusive target for the onrushing cat. Some estimates give the lion 1 kill in every 16 attempts; suggesting he often goes hungry.

Do mountain lions kill enough deer to ruin hunting for sportsmen? The hunter who fails to get his buck may feel better blaming his lack of success on mountain lions but California Fish and Game Department figures do not support his suspicions. Outside Pinnacles National Monument the Gavilan herd numbers about 16 deer per square mile, including about 6 huntable bucks. Less than 1 buck per square mile is killed during hunting season, 5 others survive. There does seem to be enough deer to go around for all hunters, man and beast.

Stockmen often feel mountain lions pose a threat to their livestock and should be wiped out of grazing areas. A cow is in far more danger of being mistaken for a deer by a human hunter than by a lion. Of 34 stomachs analyzed, only one lion's stomach contained the flesh of a domestic animal and there is no way of knowing if the lion had killed it or eaten a carcass dead from some other cause.

In spite of the lack of evidence against him, the mountain lion was for many years, judged a vicious creature whose destruction was desireable. From 1907 to 1947 more than 10,000 bounties were paid by the state of California alone. The decrease has steadily continued since that time through slaughter and the reduction of his range through expansion of man's civilization.

What has been the result of this unremitting campaign? Overpopulation of deer and overbrowsing of vegetation, for one thing. With this, a consequent weakening of the herds through malnutrition, starvation, and a greater susceptibility to disease.

Another loss may be even greater but it is not one easily measured. What is a species worth? Are Californians proud of having eliminated the grizzly bear from their state? Must the mountain lion share that fate? The 1963 legislature took a first step by removing

the $50.00 bounty which encouraged lion hunting. Eventually the animal may be protected so a rich and interesting feature of California fauna will continue to enjoy its natural habitat.

The most important contribution of the xeric communities in the Pinnacles ecology is undoubtedly that of providing vital refuge for the large predators. The monument area is not sufficient to offer complete protection to these wide-ranging animals and greater public understanding of their place in nature is to be hoped for.

Part 2 – Riparian Communities

Take a few minutes to look around your camp, or picnic site, and you can learn a great deal about the Riparian communities. You will remember our earlier mention of the various biotic communities. The Riparian communities are another of the 4 major types of communities found at Pinnacles and are a collection of plants and animals which live in or near an abundant source of water. You may well protest there isn't any water in the streambeds, they are as dry as a xeric community. It's true the Pinnacles streams may dwindle to small standing pools during the dry season, or even disappear altogether. The water for a Riparian communitie's needs doesn't have to appear on the surface but must be close enough so the water loving (hydrophyllic) plants can send roots down to reach it. A stream alone does not mean a Riparian community will exist there. Water must be available to support a permanent collection of plants and animals, thus excluding from consideration streams flowing over bedrock during and just after rainstorms, as in the High Peaks area.

Plants and animals in this community are bound together by their common need of water. Riparian species have little tolerance for dry conditions. You might say, instead, water is the limiting factor in the Riparian communities.

Since moisture favors the growth of trees, Riparian communities are often shaded. The cool shade harbours plants too delicate to grow in full sunlight or high temperatures. Since the trees tend, in this way, to control the distribution and type of vegetation beneath them they are called a *dominant species.*

Dominant plants vary from place to place. Near headquarters, in Bear Gulch, the dominant plants near the streambed are Digger pine, sycamore, willow, and coast live oak. Those on the nearby hillsides are blue elderberry and California buckeye. Near the entrance station, on Chalone Creek, where the canyon bottom is wider and less protected we find plants more tolerant of direct hot sunlight. Cottonwood, coast live oak, valley oak, and Digger pine are dominant here.

A change in dominant plant types causes corresponding changes in understory types. Sheltered situations with shade are favorable to rushes, rose, hedgenettle, chainfern, gooseberry, and blackberry. Where the habitat is more exposed, and dominants more widely scattered, these understory species are replaced by grasses and flowering annuals which tolerate more sunlight and drier conditions.

Riparian communities are homesites of many monument birds. One attraction, of course, is the abundance and variety of food for both seed eating and insect eating birds. Vegetation is usually dense, affording the birds good protection and a choice of nesting sites. *The effect of human presence may be observed in the Bear Gulch picnic area where safety precautions and heavy use have eliminated the entire vegetative understory with a consequent reduction in bird numbers.*

One of the common and colorful birds of the Riparian communities is the black-headed grosbeak. The male is easily recognized by his black head, orange breast, and white wing-spots. The female is drably dressed in shades of brown and tan. The male is a brilliant songster, the peer of any of his sparrow relatives. He is also an excellent and a devoted parent, assuming an equal share of the nesting season labors. A capable forager, he consumes almost anything edible. Although his bill is primarily adapted for shucking and cracking seeds, he also eats great quantities of insects which are harmful to the monument's vegetation. The sight of this appealing bird, flitting through the trees, may be one of your most vivid memories of Pinnacles.

The acrobat of birds in the Riparian communities is the white-breasted nuthatch. You are most likely to see him in his characteristic pose, head down, on the large limb or trunk which he is busily searching for insects. This droll, earnest, little bird is not an important songster but he is entertaining to watch as he seriously proceeds about his business.

In May or early June house finches, or linnets, may be seen building their nests and caring for their young in the headquarters area. House finches are mainly seed eaters, about 80% of their diet coming from this source. No seed is so small it escapes their attention. Later in the summer their menu is varied when the blackberries and elderberries ripen. When these fruits ripen early enough the parents take the whole family out to dinner. The youngsters, still with their short stubby tails, gorge themselves on fresh berries until their bills and faces are smeared with juice, causing them to resemble small boys who have stolen mom's blackberry pie.

The life of a songbird is not always a happy one. From the time the eggs are laid until the chicks are almost full grown the scrub jay is a real menace. Jays frequently eat the eggs, destroy the nests, and

devour the young birds. Later, when the young leave the nest, many are soon killed by sparrow hawks. This is as it should be. If we were able to protect all songbirds from their predators, their species would become overabundant and many would die from disease and starvation.

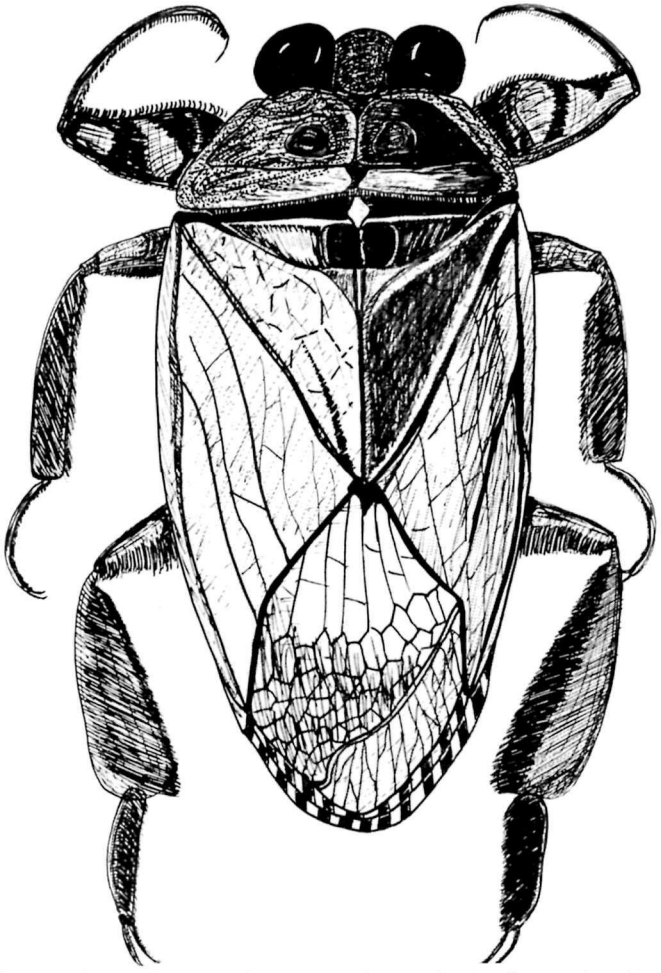
Anna's hummingbird, important as a pollinator, makes its nest on ferns and in branches overhanging the water. Less than 2 inches in diameter, these nests are a marvel of construction. The downy fuzz of sycamore trees forms the foundation and the lining is composed of willow down. When protecting the nest these birds are absolutely fearless. It is almost unbelieveable to see huge ravens, which have ventured too near, frantically flapping and dodging to get away from these tiny dynamos defending their homesite.

Woodpeckers are a valuable asset to any community where there are mature trees. Woodpeckers are often seen in the riparian communities. They construct their nests in tree trunks by hollowing out cavities far above the ground. After the woodpeckers have raised their families the nest hole is often used by nuthatches, red-shafted flickers, sparrow hawks, and screech owls. Woodpeckers live on the insects and larvae that live on or under tree bark. When one locates a tree likely to contain food he gives a few taps and pecks here and there, listening critically. When he locates an insect in this manner he makes the chips fly with his bill. He seems to rarely "bark up the wrong tree". When the end of the burrow is reached, he extends his long arrow shaped tongue into the hole and spears his dinner, much as you would pick an olive out of a jar with a toothpick. In this manner many destructive insect species are kept under control.

The riparian community is especially rich in insect life. There are forms so small they can hardly be seen with the naked eye, such as springtails helping decompose dead leaves lying on the ground. Large forms, such as the giant wood-boring beetle weighing up to 1½ ounces, are not uncommon.

The most interesting water insects are often noticed and appreciated by the younger visitors who play in and among the streams. Water striders attract immediate attention as they scamper about the surface of the water on their brush-like feet. They have only this unusual ability to "skate" and cannot swim. Should their specially designed feet become wet, they will sink and drown if they fail to reach a place where they can climb out and dry off.

Wading children need to be taught to recognize and avoid the giant water bug, or toe-biter. This insect can be easily identified since it reaches a length of about 1½ inches. It normally feeds on pollywogs, other insects, and even small fish such as the stickleback. It also inflicts a painful bite on careless humans when disturbed. The male has an unusual appearance in the spring. The female lays her



The most interesting water insects are often noticed and appreciated by the younger visitors playing in the streams and pools. One of these is the Giant Water Bug, or "Toe Biter", which reaches a length of about 1½ inches and normally feeds on pollywogs, other insects, and even small fish such as the Stickleback. It can also inflict a painful bite on careless humans when disturbed.

eggs on his back where they will be safely kept until they hatch.

These few examples can only hint at the rich and varied insect life of Pinnacles. Undisturbed by concentrated pesticides, each species plays its ancient role as predator, or prey, or both in the life of its community.

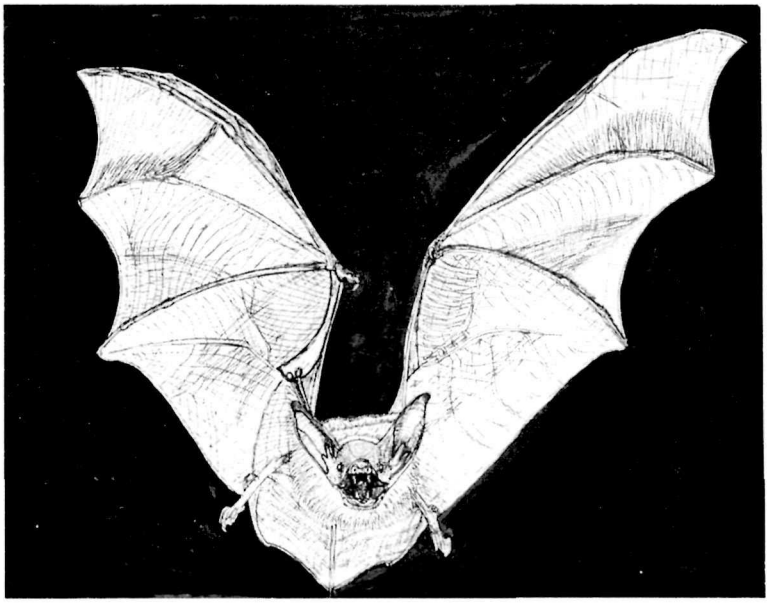
Mammals are also an important part of the Riparian



The raccoon often manages to get a share of a camper's food by guile or outright theft. Usually this is because unthinking people have fed them in the past and they have come to regard this food as their due. When on their own, however, they forage for insects, eggs, mice, and fruit; and fish for water animals such as the red-legged frog.

communities. Some such as raccoons, shrews, and ground squirrels make their homes here. Many more must visit at least once a day for water.

The king of the campground is the raccoon. This crafty animal often manages to get a share of a camper's food by guile or outright theft. When on their own, however, they fish for frogs and other water animals. Raccoons are fond of water and seldom wander very far from it. Most of their activities take place near the water. They do not always wash all their food before eating it, contrary to popular opinion. Some observations indicate they dip food into water to soften it rather than wash it. Raccoons are rarely seen in the daytime since that is when they loaf, or sleep, in trees and other inaccessible places. They come out to hunt after dark. A raccoon will eat anything. His natural forage includes insects, frogs, eggs, birds, mice, fish, and fruit. He will also help himself to any unguarded food supply in the campground; devouring fried chicken, pickled pig's feet, shrimp, and chocolate cake with equal relish. Unfortunately the appearance of a raccoon is deceptive. Far from being the cute and friendly little fellow he seems, he is actually very strong and possesses



This little brown bat, like the other three species of bats in the monument, is one of the most misunderstood animals here. It does not cast spells, suck blood, or snarl women's hair. It does consume enormous quantities of insects, most of which are captured on the wing with the aid of a built in animal SONAR. He is not blind, but can see about as well as any animal his size. His SONAR is an added advantage.

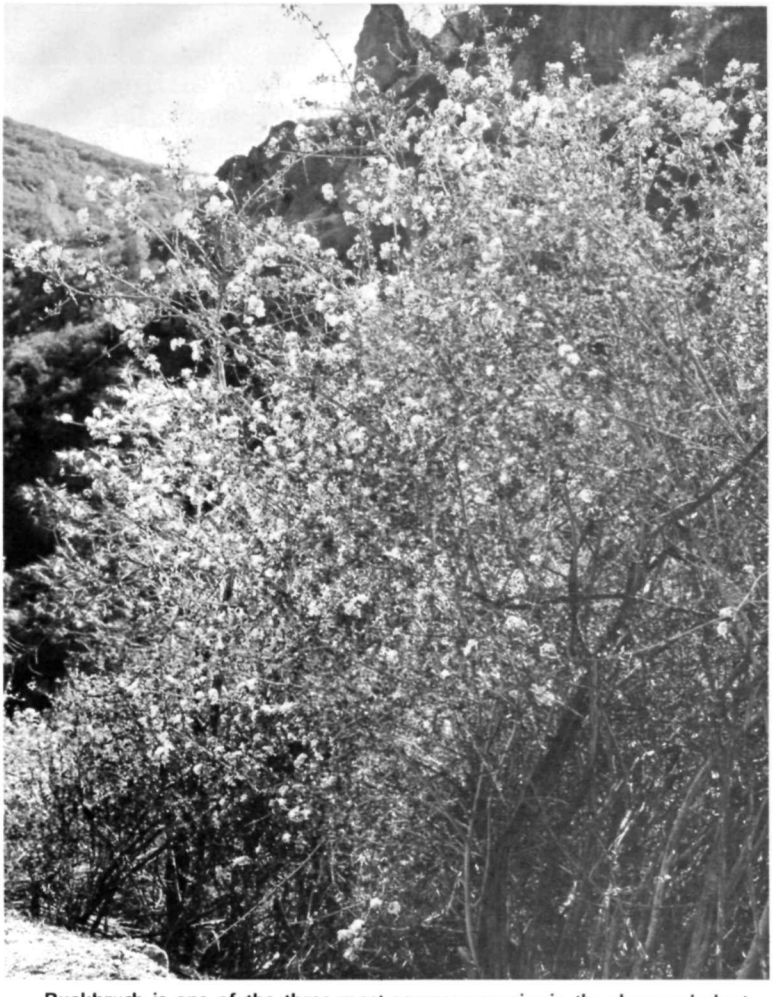
a vicious temper. For these reasons he should never be approached or touched in any way.

The Riparian communities also harbour one of the most misunderstood animals, the bat. None of the 4 species found here is detrimental to humans or his interests. They do not cast spells, suck blood, or snarl women's hair. They do consume enormous quantities of insects, most of which they capture on the wing. Bats emit high pitched squeaks while flying. These sounds bounce back from obstacles in their path and help them navigate in the same manner ships use SONAR. These squeaks are also used to help them locate prey. There is evidence certain species of moths can also hear these sounds and are able to evade the pursuing bat.

Merriam's chipmunk is the neighborhood scold. These little seed eaters are often seen teetering far out on the branch of a tree, scolding an unwitting intruder in a voice not unlike that of a hoarse bird. Like ground squirrels, to which they are closely related, chipmunks have cheek pouches for carrying food. When these pouches are full, the animal takes the food to his storehouse and

covers it with dirt. He doesn't always remember where he puts it, though, and many of the seeds buried in this manner are never found again but germinate and grow into trees.

The Riparian communities in Pinnacles are small in extent, but large in effect. Many species of plants and animals make their homes here and all animals that drink water must visit them frequently. They are the nerve center, the focus, of the monument's ecology.



Buckbrush is one of the three most common species in the chaparral plant community. In early spring it is heavy with blossoms and fills the air with a very sweet and distinctive odor.

Part 3 – Chaparral Communities

(Moist Phase)

Start up the High Peaks Trail from the Chalone Creek Campground and, within a few minutes, you will find yourself in one of the Chaparral communities. Pause and look back at the Riparian community you just left. Compare it with your present surroundings. Can you see the differences? Can you guess their causes?

The dense brush and scarcity of trees distinguishes the moist phase of the chaparral. The temperatures here are higher and the communities are more exposed to drying winds. The moisture retained in the soil is lower, especially during the summer. As you are sure to predict by now, the plants and animals of this community have adaptations which suit them to life in these hot relatively dry conditions.

We are all rightly terrified at the thought of a forest or brush fire. The words usually bring to mind a vision of pain, waste, and destruction. It may then come as a surprise to learn fire has been a *limiting factor* in the development of the Chaparral communities. For centuries, or even hundreds of centuries, fiercely burning fires of highly combustible chaparral have been a feature of the California landscape. As a result, species of plants totally destroyed by burning were gradually eliminated from the scene. True, non-resident species could spread from unburned areas but before they could become well established another fire would come along and the slow process would start over again. For this reason most plant species we see in the chaparral today have some means of resisting fire.

Manzanita, buckbrush, and chamise are the 3 most common species in the chaparral. Many gardeners, to their dismay, have tried to start manzanita in their home gardens from seed. The results are usually disappointing, even with good fresh seed and the best of care. The gardener waits and waits, but nothing happens. The secret lies in the fact manzanita germinates best when the seeds have been lightly burned. Buckbrush germinates in like manner. A fire may kill the parent plant but the seeds, lying on the soil beneath fallen and decayed leaves, are ready and waiting for a fire to come along and give them a chance to sprout. Chamise has a different method of survival. After a fire it sprouts from roots which go far enough below ground level to resist all but the very hottest fires.

Other adaptations of the chamise to its habitat are also interesting. Looking at the plant, you would never guess it to be a member of the rose family which also includes blackberries, peaches, pears, apples, and almonds. Chamise apparently evolved during the

pleistocene epoch about 1 million years ago somewhere between California and southern Mexico. The pleistocene, you will recall, was the time the Sierra Nevada was being raised to its present position and the great ice sheets were moving down from the arctic regions. Under the severe dry conditions that prevailed here at that time, the plant's ancestors developed tiny needlelike leaves covered with a heavy protective wax layer. Small leaves have much less surface exposed to the drying air, in relation to their volume, than broad, thin, flat ones. Additional protection from water loss is given by the wax in the same manner boot grease protects leather and keeps it from drying out.

(Dry Phase)

The dry phase Chaparral communities are found generally on the south and west facing slopes or where the soil is thin and does not retain much moisture. The plants in this community must be very resistant to drying. Some of the plants found in the moist phase Chaparral can survive here but the broadleafed ones are not adapted to this degree of drought and are usually absent. Chamise and buckwheat have small enough leaves to share this community. Annual flowers and grasses also manage since their life cycles are completed before the soil dries out in the summer.

Again, as all through the monument, moisture is the limiting factor dividing these 2 communities. It would be a mistake to think anything in nature is quite that simple, though. There is also a sharp difference in the types of soil in the 2 Chaparral communities. The soils of the moist phase are often finer in texture and contain higher levels of organic matter than the soils found in the dry phase. Why should this be so? Were the soils different to start with? Probably not. We find coarse, almost sterile, soils exist wherever moisture is lacking most of the year.

The rock and mineral of the soil are broken down into forms plants can use by the action of bacteria and fungi. These microscopic plants secrete chemicals that not only break down the rocky material but also decompose the dead leaves, stems, and roots from the plants of previous generations. These processes of decomposition and decay release organic material which makes finer textured soil. This soil holds moisture better than raw coarse soil. Since bacteria and fungi need moisture for activity, the number of these important organisms is much lower in the hot dry areas of dry phase chaparral, giving rise to the coarse soil found there.

Some kinds of soil bacteria are especially valuable to plants since they are able to convert nitrogen gas in the air to a water soluble

form that can be absorbed by plant roots. These "nitrogen-fixing" bacteria are an important source of nitrogen in some soils low in nutrients.

Thus the limiting factor of soil moisture has a double barreled effect. It determines which plants are able to grow in the community and it controls the soil fertility and texture. Relationships in nature are often more fascinating than they would seem to be.

While we are talking about microscopic plants in the soil let us examine an interesting relationship between fungi and some of the chaparral plants. We often think a fungus infection causes plants and animals to decay and die. This is not always true. Chamise roots are often invaded by vast numbers of fungus strands called *hyphae;* so much so, the roots often appear to be covered with a cottony mass. These shrubs, when so affected, do not sicken and die; they prosper. The fungal hyphae spread throughout the soil, extracting raw chemicals and water. These materials are then transferred to the roots where they are exchanged for food manufactured by the chamise plant. Because the fungus strands are small enough to penetrate every nook and cranny of the soil, they are far more efficient than the relatively coarse roots of the chamise could ever be alone. This cooperation for mutual benefit between 2 different species is called *symbiosis.* The symbiotic relationship between the chamise and fungus may account for the presence of chamise in habitats so hot and dry other perennial plants without this advantage, cannot survive.

Since the moist and dry phases of chaparral differ as to amount of moisture in the soil and, to some extent, the plants of each community; do we also find different animals in each? Surprisingly no. Animals are able to move about and are less restricted in their choice of habitat than are plants. When one side of a hill gets too hot animals simply move to a cooler spot. For this reason the animals in moist and dry phase chaparral are nearly the same.

Possibly the most characteristic bird of the chaparral is the wren-tit. This bird is rarely seen since it is limited to the west coast in its range, in its habitat to chaparral or thick brush, and it avoids open places. Even where it is common the wrentit is best located by its voice. When hiking along a trail through the chaparral you may be startled by its sudden ringing call from a nearby bush. This song is so characteristic that once identified it is never forgotten. (pit—pit—pit—-pit— pit-pit-tr-r-r-r-r-r-r-r-r, all with the same pitch but accelerating tempo.) Because of this distinctive song the wrentit is called the voice of the chaparral.

These little sprites are best seen by crawling a few feet off the trail and, while sitting quietly, making squeaking noises. Soon, overcome with curiosity, a pair of birds will appear to see who has invaded their territory. The wrentit is very territorial and will allow



Possibly the most characteristic bird of the chaparral is the Wrentit. Its sudden ringing call from a nearby bush, one heard, is never forgotten. Because of his distinctive song he is sometimes called the voice of the chaparral.

no other bird of the same species to invade the area it has claimed for its own. A territory, once established, is maintained for life during all seasons of the year.

One may easily read a good deal of human behaviour into the wrentit's activities. These birds mate for life and, once paired, seldom separate. An elaborate set of low-pitched calls is used for communication between the 2 as they hop about in the thickets. They constantly keep in touch with each other. Frequently a male and female will preen one another, especially on areas of the body that can only be reached with difficulty. At night the pair roosts side by side on the same perch somewhere within their territory. The body feathers are spread, fluffed, and interlaced until, when they tuck their heads over their wings, they appear to be one fluffy ball from which legs and wings protrude. Such roosting is not accidental but is consistantly done for warmth and protection. The male is a devoted husband and father, sharing tedious chores of nesting and rearing the young with his mate.

Great ingenuity is used in the construction of the nest. Usually built in a secluded spot and screened on all sides by dense foliage, the nest is well concealed from the prying eyes of would-be preda-

tors. The shredded bark of chamise and manzanita are carefully bound together with spiderwebs gathered nearby. The cup is lined with animal hair, fine grasses, and the soft fibrous covering of soap plant bulbs. As a final touch these skilled architects may cover the outside of the nest with scraps of lichen for added camouflage and concealment.

Although wrentits are capable of making long flights, they seldom do so. Flights of more than a few feet, especially across open ground, are seldom undertaken unless the bird feels forced to do so. Usually these spry little fellows get about in their dense, trackless, tangled habitat by hopping from one twig to another while balancing expertly with tail and wings. The speed with which they travel through seemingly impenetrable thickets is astonishing.

Crawling insects are the staple diet of the wrentit supplemented by berries in season. Seeds are rarely eaten. Insects are gleaned from bark, twigs, and the underside of leaves. Wrentits are frequently seen hanging upside down, performing all manner of acrobatics, to reach a choice morsel. Small insects are eaten on the spot. Larger ones are carried away to a stout branch where they are firmly held under the foot and the beak is then used to pull the victim apart into bite sized pieces. Poison oak is sometimes spread by this bird since it eats the berries with relish and discards the seeds, some of which sprout and propagate new plants.

An important adaptation possessed by this bird is its low requirement for water. It may drink frequently, when water is available, but is able to go for several weeks without drinking during the dry season.

A typical member of the Chaparral communities, the wrentit is well adapted to its harsh environment. Once you have made its acquaintance, you will listen for its call each time you return to the chaparral. When you hear it you will feel you have been welcomed back by an old friend.

The California thrasher, unlike the wrentit, is a ground feeder. Not a strong flyer, it must rely on the dense chaparral for protection and concealment. The thrasher's long bill is well suited for securing its diet of ground spiders, wasp larvae, crickets, and grubs. Little conical holes and piles of dirt are signs of the diligent food gathering of the thrasher. Being a close relative of the mocking bird, the California thrasher is a brilliant songster during mating season. The remainder of the year, however, its call is a sharp *churk!* which gives no true indication of his singing ability.

Another brown colored bird commonly seen in the chaparral is the brown towhee. Armed with a strong bill, he is an efficient seed eater. Not distinguished in appearance, the towhee is best identified

by his behaviour as he scratches noisily about in dead leaves looking for seeds on the ground.

The principal predatory birds of the chaparral are the scrub jay, sharp-shinned hawk, and sparrow hawk. (The larger hawks such as the red-tailed hawk are too big to operate effectively in the heavy brush.)

The chaparral community is a good place to see many of the reptiles of the monument. The dry leathery skin of most lizards and snakes protects them against excessive water loss, an adaptation to this dry habitat. The most feared and misunderstood reptile at Pinnacles is the Northern Pacific rattlesnake. To be sure, the hiker should be wary and cautious when in rattlesnake country but he need not be overly fearful. Rattlesnakes eat rodents. They only bite people in fear and self-defense. Generally rattlesnakes prefer to retreat when they can do so. Their venom is used only for capturing prey and for defense.

Rattlesnakes possess 2 organs, called *loreal pits*, located just below and in front of the eyes. These are heat sensing organs which detect heat radiating from warm blooded animals and aid the snake in directing his strike in poor light, or at night, which is his normal hunting period. The rattlesnake uses his long hollow fangs as hypodermic needles for efficient dispatch of his prey. Venom is stored in sacs on each side of the head below and behind the eyes. He lies very still when hunting, until his prey comes within striking distance, usually one-third to one-half his body length. With a powerful thrust of his body he then drives home his fangs. He eats small rabbits, rats, mice, frogs, ground squirrels, and lizards helping hold these rapidly breeding animal populations in check. If you own a vacation cabin and are fortunate enough to have a rattlesnake living in the foundation, you will never be troubled by mice or rats, so effective are these predators.

When young rattlers are born they have a single rattle, a button. A new button is added each time a snake sheds his skin. A well fed rattlesnake may shed its skin several times a year. The buttons, or rattles, do not indicate age but the number of times the skin has been shed. Rattlesnakes, like cats and many other animals with good night vision, have vertical pupils. All other snakes at Pinnacles have round pupils and, likely, poor night vision.

The common kingsnake, famous for eating rattlesnakes, is another member of the chaparral community. Many believe kingsnakes prey exclusively on rattlesnakes but they are probably not captured any more often than any other snake. Kingsnakes kill their prey by wrapping their bodies tightly around their victim and crushing, or constricting, it to death. Snakes and lizards are first seized by the neck then, once a hold is secured, slowly squeezed to death. When a rattler knows he has been spotted by a kingsnake he holds his head

and neck close to the ground while attempting to escape. If retreat is impossible his head and neck are often hidden beneath the coiled body. If, however, he is touched by the kingsnake a lively fight is sure to follow. The kingsnake is immune to the rattlesnake's venom and often wins the fight.

A less well known, but frequently encountered, reptile of the chaparral is the whiptailed lizard. The dust on the hiking trails may be covered with small footprints and peculiar drag marks made by the tails of these animals. On a warm day the whiptail is undoubtedly the fastest animal in the monument. It moves so fast an observer is not conscious of seeing its body, only the flying leaves or puff of dust which marks its passage. When just loafing along the whiptail runs on all fours. When real "burn-up- the-road-speed" is needed he runs only on his hind legs, body elevated, leaning forward. He needs to move fast since he is eaten by most snakes, hawks, and roadrunners. He must also be constantly alert, being the staple of so many diets. Sampling the breeze, by tasting the air with his tongue, the whiptail is acutely aware of what goes on in his habitat. he is at attention all the time and difficult to catch unaware. His sense of smell seems to be acute since he is unerring in digging up buried insects which make up his diet; spiders, caterpillars, ant-lion larvae, ants, and beetles.

The California legless lizard is another interesting inhabitant of the chaparral. This little fellow, who makes his home in piles of fallen chamise leaves, is highly adapted for digging. He lacks all emcumberances to burrowing, including legs. His smooth glossy scales allow him to glide with a minimum of effort through loose sand and leaves. His nostrils are closed by tiny valves and his mouth is so constructed it closes tightly enough to prevent the entrance of dirt and dust.

How does one tell a legless lizard from a snake? If you look closely you will find lizards have moveable eyelids which snakes do not have. They also have small scales underneath instead of the large transverse scales on the belly of a snake.

No discussion of the animals of the chaparral at Pinnacles would be complete without mentioning the big-eared kangaroo rat. If the term cute could be applied to any rodent it is certainly this one. Lloyd Glen Ingles, in his excellent books, "Mammals of California," states: "How unfortunate is the term rat when it is applied to the kangaroo rat! Clean, graceful, interesting, and beautiful; in fact almost everything a Norway rat is not are these little known, but frequently abundant, nocturnal gnomes of the arid places."

Possibly one reason these small animals are so little known is that they are active at night. This behaviour is an adaptation to the dry climate since the temperature is not only lower at night but also

the relative humidity is higher. Both factors help the animal reduce water loss by evaporation. Like the horned lizards, kangaroo rats rely mainly on their own metabolic water for moisture and are rarely seen to drink.

The kangaroo rat has another good reason for his nocturnal habits. Evasive actions are his only protection from his enemies. He even dislikes venturing out in bright moonlight. When pursued by a predator, he dashes for his burrow in a series of irregular leaps and bounds, changing direction frequently, thus making it difficult to capture him. His long hind legs are used to further advantage in foiling potential predators by kicking sand at any strange object appearing in his habitat. Such kicking may spring lightly set mouse traps or discourage a hungry rattlesnake.

Although the hind legs and tail account for his name, the kangaroo rat is not a close relative of the Australian kangaroo. Instead, it is related to the pocket gopher. Like this relative the kangaroo rat digs burrows, stores large amounts of plant food for winter use, and has big external cheek pouches.

Though rarely seen, the kangaroo rat is fairly common at Pinnacles. If you wish to get a glimpse of one try driving slowly along one of the monument roads on a dark night before the moon comes up. You might see one as it scurries off the road toward its burrow.

One enemy of the kangaroo rat is the bobcat; another is the rattlenake. Pinnacles is fortunate to have so many bobcats in their native habitat. Sometimes they are so bold they are seen walking around the headquarters area searching for ground squirrels in broad daylight. Normally, however, this champion rodent exterminator is a nocturnal hunter.

Bobcats are often mistaken for housecats which they resemble at a distance. Closer observation shows the legs are longer, giving him speed and agility. His ears are larger than those of a domestic cat and, as a final identifying mark, he has a short stubby tail which gives him his name. Much still remains to be learned about these cats. One interesting question, to which biologists presently have no answer, is why the bobcat lost his tail and what advantage is there in having a diminished tail?

Pinnacles is a good refuge for these cats since they prefer the protection and seclusion offered by the rocks and cliffs. Where wide cracks or cavities in the rocks are available a cat will choose one in which to establish a lair. Lacking such ideal spots, he will choose very dense clumps of chaparral.

Hunting habits of the bobcat are very interesting. They can climb quickly and well, even to a height of 50 or 60 feet in a large tree, when pursued by men or dogs. Most of their hunting is done on the ground since their diet consists mainly of rodents. Rabbits are taken

with regularity, especially brush rabbits and cottontails which are both slower than jackrabbits. Gophers must be a highly prized item if we may judge by the number of tracks found around gopher holes.

Neither fawns nor quails are very important in the bobcat's diet. On rare occasions a large bobcat will kill and eat a sick or weakened fawn but even these are often too large for him to handle. Quails are an agreeable variation to the steady diet of rodents but the bobcats do not seem to hunt them, perhaps finding it more efficient to pursue game that falls easier prey.

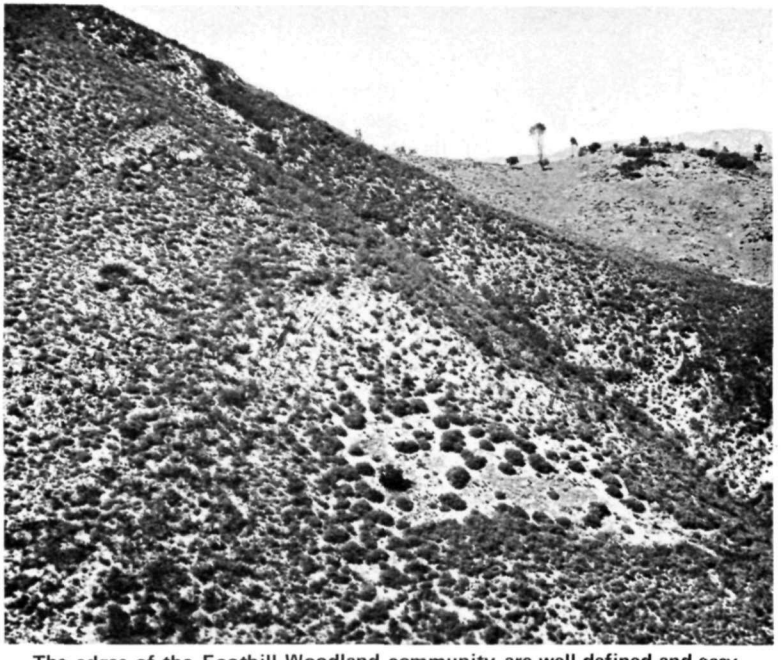
Man might well emulate the bobcat when he goes hunting. The bobcat instinctively practices good game management. Rather than hunt one area intensively, he follows a 15 to 20 mile circuit and returns to the starting point every 4 or 5 days. This avoids depletion of his food by leaving a few animals every time to repopulate an area. When hunting on the circuit the bobcat follows a definite itinerary by stopping to rest and drink at the same places on each trip, covering 4 or 5 miles a day. As we have seen, when discussing the mountain lion, this mode of life is typical of hunting cats.

The young are born in April before the onset of hot weather and the usual litter is three kittens. The young remain in the nest for several weeks and the parents take turns hunting. Kittens are trained not to leave the lair or venture forth beyond a given distance. If they disobey they are soundly cuffed back into place by one of the parents. In the world of nature careless mistakes usually mean death and the need for caution must be instilled early.

When the kittens are old enough they are taken out for hunting lessons. On warm summer evenings, just before dark, the adults may be seen bringing the kittens down to drink prior to starting off for the night.

Bobcats are more frequently seen by man than any other North American cat, probably because they are one of the few carnivores that hunt at all during the daylight hours. They will often tolerate the approach of a man to within 50 feet before fleeing. They are in no wise tame, however, and it is not safe to walk toward or annoy one. There are several recorded instances of females launching vicious attacks on men who approached the place where their kittens were hidden.

Hundreds of these animals are destroyed annually in organized predator drives, their carcasses being left to rot. Indiscriminate poisoning campaigns for reduction of so-called pests kill many more when a cat eats the bait or eats a poisoned animal. This misguided slaughter is a pity since the bobcat doesn't destroy game, rarely destroys domestic animals, and is beneficial by holding rodents in check. Those who believe control is necessary might well remember the bobcat has lived in California thousands of years without causing



The edges of the Foothill Woodland community are well defined and easy to detect. The tangled brush of the chaparral simply stops, giving way to tracts of grassland dotted with trees.

damage to the ecology and there is no reason to believe he is a source of damage now.

Importance of the Chaparral Communities to the Monument Ecology

In terms of size alone the two Chaparral communities, moist and dry, are the most important ecological units at Pinnacles. They constitute more than three-fourths of the monument area; 12,500 of 16,000 acres. To the casual viewer looking at the scrubby brush growing on sandy soil, size would seem to be the only consideration. The barren appearance is deceptive, however. The chaparral communities provide most of the food for all the animals in the monument.

Every year the chaparral produces 692,000 pounds of forage to support more than 300 deer. The community's berries, seeds, and insects feet many birds. Its stems, shoots, and leaves support myriads of insects. Its rodents feed snakes, bobcats, foxes, hawks, and eagles. If the Riparian communities are the monument's water troughs, the Chaparral communities are its breadbasket.

What is the secret of this surprising productivity under such adverse conditions? Adaptation! Through the process of natural selection of the most appropriate plants and animals, survival of the fittest, every living organism found here has reached a state of development which suits it to its dry environment.

Part 4 – Foothill Woodland Community

If you have tried to identify the ecological communities so far described, you may have had some difficulty telling where one stops and another starts. the trouble lies in the fact one community usually blends gradually into the next with no sharp dividing line. Areas where two communities intermix are called *ecotones* and are of special interest to the ecologist. Overlapping areas contain not only species from the adjacent communities but also some distinct species of their own.

The Foothill Woodland Communities at Pinnacles are the exception to this general rule. Their edges are well defined and easy to detect. The tangled brush of the chaparral simply stops, giving way to tracts of grassland dotted with trees. These communities often occupy areas of gentle relief, most often on north and east facing slopes. The foothill woodland is a little drier than the chaparral but water is not the only limiting factor. The soil in this community is rich and fine, but shallow, in contrast to that of the chaparral. Lets examine the results of that difference.

In the Foothill Woodland communities the soil is rarely more than two feet deep. It cannot retain enough moisture to sustain plant life the year around. All the monument's soils are underlain by bedrock at varying depths. Where the bedrock is far below the surface the soil can act as a sponge, holding rainwater throughout the year. Where the bedrock is too close to the surface the soil is too shallow to perform in this fashion. Thus much less water is absorbed and it cannot be retained throughout the year's dry season. Grasses and other annuals do very nicely on shallow soil since they grow and produce seed early in the season, before hot weather comes. They complete their life-cycles in mid-summer when the soil has dried out but before the plant dies short of producing seed.

How do any trees manage to live in these conditions? Blue oaks and Digger pines, species common to the foothill woodlands, are both very drought resistant. They send extremely long roots, which follow cracks in the bedrock, far below the surface to reach permanent water.

Grassland communities are usually invaded by the surrounding shrubs until the shrub species eventually take over and become the dominant species. Chaparral species lack the adaptations which would guarantee their success in the foothill woodlands. Unlike grasses, they



A typical Foothill Woodland community consists primarily of grasses, blue oaks, and Digger pines. Though the soil is rich, it is not deep and is incapable of retaining water throughout the year. The plants living here are therefore highly resistant to drought.

need water all year long. Unlike the trees just mentioned, they do not have roots of sufficient length to reach permanent water. Water is then a limiting factor which prevents the chaparral from invading the Foothill Woodland communities.

The soil found in this community is unique in the monument. The type of vegetation that grows on a soil is dependent upon the soil type. However, plants are able to change the nature of the soil for their own benefit. After all, it is chiefly the action of plants that turns the fine rock particles into soil. Grasses, for example, modify the soil in such a way it is chemically and physically good for them. The soil in the Foothill Woodland communities is best suited to the plants that grow there; not brush, not mosses, and not most trees.

Plants foreign to the community occasionally sprout from seeds dropped by birds or blown in by the wind. Few of these volunteers survive long. Their leaves become discolored and pale and their stems are sickly. Such effects might well indicate the soil is chemically unsuited to them; that the proper elements for growth and nutrition are absent. When this happens at home special fertilizers are spread in

the garden to restore the plant to health. In the winderness there is no such artificial aid. Plants unsuited to the soil where they sprout must perish.

This finer richer soil seems to cause chaparral seedlings to damp-off during the winter. Damping-off, or rotting of the roots, seems to affect manzanita and buckbrush more severely than chamise (greasewood). In fact, occasional clumps of chamise sometimes do find a spot favorable for growth here. Soil and water then represent two important limiting factors which help the Foothill Woodland communities maintain their identities and keep out intruding species.

Since much of the Foothill Woodland communities are dominated by grasses, this is a good time to talk about some of their life histories. Little is known about when or where grasses originated. They suddenly appear in the Cenozoic era in very much the same form we know today. Many thousands of years of evolution must have been required to develop such complex plants. Unfortunately we have little evidence of the process. One thing we do know, though, is the fact that grasses are very important to the present ecology of the earth. Most of the more highly developed land animals we see today are in some way dependent on the grasses for food. This is especially true of we humans. Many food chains start with grass as the *producers.* (An example of a typical food chain is found on page 5.) For this reason it is fortunate few places in the world lack grasses native to the area. The dairy, poultry, and breakfast food industries depend upon them directly and the bulk of the wildlife at Pinnacles is no less closely tied to them. Not only animals but also other plants are dependent upon grasses. The first plants to appear on a burned or devastated land are usually the grasses. Did you ever wonder why trees are seldom among the first forms of plantlife to grow on new soil? This is because the soil is not yet ready to support this type of vegetation. Grasses may be thought of as pioneers, the first settlers in a vegetational wilderness. After the grasses have modified the soil with nutrients and chemicals and have provided some protection and shade, taller forms of plantlife will eventually invade the area, providing the area is otherwise suitable, and form brushland. The brushland is then invaded by tree species if conditions become right. Such a vegetational sequence is called *succession.* When you hike in the High Peaks region of Pinnacles notice that grass is invariably found on new soil which crumbles from weathering rocks.

If grasses are so widely spread and found in so many different habitats and communities you would naturally suppose them to be very adaptable. We know this to be true, that grasses are evolving very rapidly even today. There are at least 1,100 species of grasses in the United States alone. About 24 species are found at Pinnacles.

We previously noted that grasses are self, or wind, pollinating



Grass flowers may not be as colorful and striking as a rose or daisy but they are interesting. A small hand lens will show you they are made much the same as any other flower. They have both stamens and pistils. In addition, the top of the flower often has an "awn", or long filament, and papery bracts covered with stiff backward pointing bristles. The lower end of the flower often hardens into a sharp point able to penetrate fur or clothing. Seeds may be carried many miles Ithis way before they drop off, thus insuring good dispersal. The awns often help bury the seeds and the barbed papery bracts and spines discourage seed-eating animals. The flower may not be beautiful, but it is certainly beautifully efficient.

rather than being dependent upon insects. Self pollination is most often associated with plants that have not evolved, or are not evolving, at a rapid rate; plants not often highly adaptable. Yet during the catastrophic changes that took place in the Cenozoic era grasses were not eliminated from the scene, on the contrary, they prospered. Great and rapid changes in climate impel equally great and rapid modifications in species. How then are these plants we so often think of as primitive able to be so widely adaptive? They have a built-in mechanism for change.

You may know genes make wild oats different from oats grown by farmers. The genes, little protein packets (DNA) in the cells of all

living things, control the size, shape, and other characteristics of these organisms. If a gene changes in character the organism containing it also changes. Some plants and animals undergo gene changes more readily than others. They are therefore more apt to show more new traits than those having more stable genes. These gene changes are called *mutations.*

Grasses are quite susceptible to mutations which cause different plants of the same species to vary slightly from their neighbors. Often these mutations are more harmful than beneficial but they do give living things a chance to experiment. We must not think of this process in terms of a plant attempting to improve itself in a logical manner, though. Not, "The weather is becoming drier so I am going to become more drought resistant." Rather, a mutation may occur in one of the many genes governing a characteristic. If the change is beneficial the plant will be more likely to survive and produce plants also more apt to survive than other plants. After many generations there will be more plants with the mutant genes than there are without them. In this manner a species becomes adapted to changing conditions. The changes themselves are haphazard, a hit or miss process in which there are many more misses than hits. The misses die out, the hits survive and reproduce. Darwin called this *natural selection.*

The seeds of different grasses have wonderful modifications to insure they are spread around for the maintainence of the species. The "stickers" in your socks are made of grass seed and a flower. The seed may be seen by pulling away the dry papery flower. The papery parts are often covered with stiff backward pointing bristles, much like the barbs of a hunting arrow. The lower end of a flower often hardens into a sharp point capable of penetrating an animal's fur. When the flower and seed have penetrated the fur, or clothing, they cling tightly by the stiff bristles. Seeds may be carried miles before they drop off. This insures good dispersal for the species. The same mechanisms may help the seed penetrate the soil so there is good germination when the rains come.

What would happen to the grass if there was just enough rain to cause the seeds to sprout but not enough for them to grow to maturity? The seedlings would die, of course, without producing any new seeds. Would the area then be entirely barren of grass the following spring? No! The grasses, and other kinds of plants too, have intricate timing mechanisms which prevent all the seeds from germinating at the same time.

Let's see how this system works. If we mark off a square yard of grassland and water it, seedlings will soon appear. Now we cut off the sprouts at the ground and water again. Soon new sprouts appear and the process can be repeated. We may do this again and again. In fact,

new sprouts will appear long after the experimenter gives up and goes home. Enough seed is stored in the soil to keep replacing the killed plants for a long time to come. This remarkable regulation of the sprouting time of seeds prevents the death of an entire species in the event of unusual weather, fire, or other natural disaster. How different our mountains would look if all the seeds sprouted at once, or even during the same season.

In addition to providing grass seeds with a means of dispersal, its dry flower helps discourage seed eating animals. Seeds may be covered with hairs, bristles, or long awns which make them hard to swallow. These protective devices may be so effective that animals, such as deer, may receive fatal injuries through their mouths or digestive tracts when they eat them. One of the common grasses at Pinnacles is so notorious in this respect it is called "ripgut." Seed eaters are equipped to deal with this kind of obstacle. Grass seeds which are high in protein and starch content are an important food source for wildlife.

Another important source of food in the Foothill Woodland communities is the blue oak. This tree shares, with the Digger pine and grasses, the distinction of being a characteristic species of these communities. Not a stately tree, the blue oak shows the scars and wounds of a constant battle against the elements. Its trunk is always bent or leaning. The branches are short, heavy, and gnarled. Because the wood grows very slowly it is tough, hard, and quite heavy. The maximum age attained by these trees is not known since they almost always suffer from heart-rot. The center of the trunk rots away leaving the outer shell of living wood. The disease does no immediate damage to the tree but it does destroy the inner growth rings needed to determine the tree's age. They probably live in excess of 300 years.

Unfortunately for the interested visitor the blue oak is hard to identify since the shape of the leaves and acorns is highly variable from tree to tree. The easiest method for distinguishing it from other oaks is to look for the blue-green cast of its foliage, as contrasted with the bright green of the valley oak or the dark green of the coast live oak.

The blue-green coloration gives us a clue to the success of trees in very dry habitats. The leaves are actually a dull green. The blue-green illusion is caused by the combination of the true leaf color and the whitish color of the minute hairs covering the surface of the leaf. The hairy surface tends to trap air, retarding evaporation of water from the leaves. As is the case with chaparral plants these leaves are thick, leathery, and covered with wax and/or hairs. The functions are the same, to cut down on the loss of water from the leaves.

The blue oak acorns mature in the fall of their first year. They

do not germinate well in the shade and are said to be *intolerant* of shade. The need for full sunlight and heat is a limiting factor which prevents the species from doing well in the brushy chaparral where it is rarely seen. The open foothill woodland provides optimum conditions for germination and is the tree's most favorable habitat. Here the intolerance of shade is an advantage for the species. Young trees are shaded out and cannot compete with the parent for scarce moisture.

Another adaptation to the dry habitat is shown when the acorn first sprouts. Little growth seems to take place at first, but that is only the above ground appearance. The little plant must first establish the long roots necessary for it to capture water. This root growth takes place at the expense of the stem. When the roots are well established the trunk will then begin to show good growth. Small trees, less than one foot high, have been found with roots over 10 feet long. These long roots not only keep the tree from dying from lack of water but also protect them from the ravages of fire. If the little trunk is burned and killed the still living roots will quickly send up a new one.

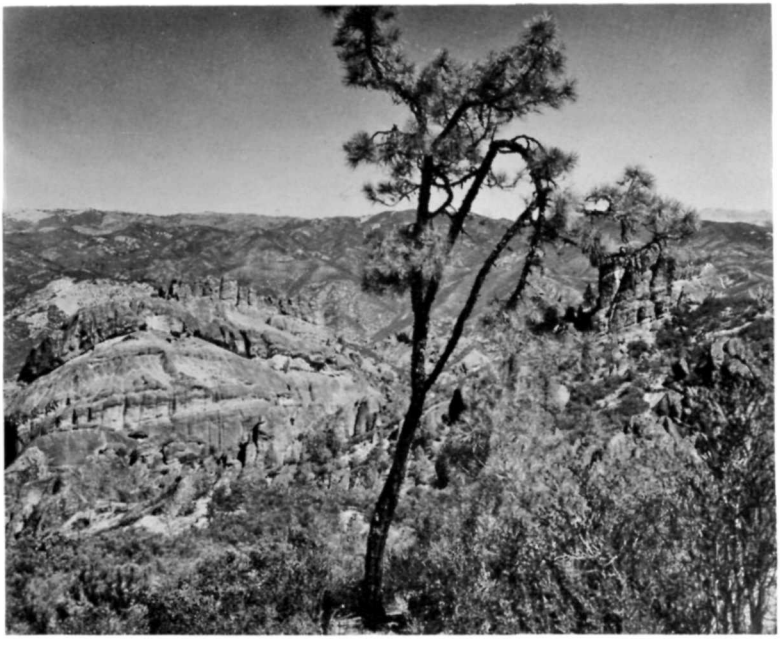
The blue oak is periodically a good seeder. Its acorns are sought by ground squirrels, woodpeckers, jays, mice, deer, rats, and insects. Rodents and woodpeckers pack them off to add to their larders against the winter months. This helps disperse the new seeds and plant new trees.

The Digger pine is closely associated with the blue oak. It meets similar environmental conditions in a slightly different way. Evaporative losses are reduced by having the leaf pores set down in deep pits. Rows of these pits form the whitish lines you see running the length of the needles. The leaf is also covered with a waxy coat.

You may envision pines as moisture loving plants dependent upon the mountain snows. As a matter of fact, pines manage very well on little moisture. The Digger pine is a champ among champs when it comes to living in dry habitats. There is no other woody plant at Pinnacles that consistantly grows in drier places with less soil. They remain unaffected even when the chamise and manzanita are dying from lack of water. Where little moisture is available on the surface, long strong roots are sent down to reach water. Often a distance of 150 feet! The roots of such a tree may be seen on the Moses Spring nature trail. Some 40 feet below the tree they are still over 4 inches in diameter.

The Digger pine is an advanced species, as pines go, highly modified to insure its success in inhospitable climates. The trunk, branches, cones, and needles are well supplied with pitch to discourage insect attack and seal wounds.

The cones vie with those of the Coulter pine for the distinction



The Digger pine is a champ among champs when it comes to living in such dry habitats as this one overlooking the Balconies. It often sends its roots down as much as 150 feet to a permanent source of water. When most other plant-life is wilting from drought, it thrives.

of being the largest and heaviest of almost any pine in the world. A mature cone may weigh as much as 3 pounds. The seeds are proportionately large and well supplied with nourishment for the young plants to draw on during the first year of growth. The cone scales are hard and armed with long, stout, wicked talons which help protect the unripe seeds from destruction by rodents. When the cone ripens the seeds are gradually released over a period of several months, falling to the ground beneath the tree.

Unlike some others, the seedwings of the Digger pine are short, heavy, and do not aid in spreading the seeds. Animals do the job and, as usual, the rodents who carry off the seeds and bury them in underground caches do not find and dig up all their treasures during the winter. In the spring these neglected seeds sprout and grow into new trees. The animals act as gardeners for the tree in return for the seeds they eat.

One of the most interesting harvesters in the Foothill Woodland communities is the California quail. Although never hunted in the monument these birds are exceedingly shy and reluctant to show off

their handsome plumage of cool grays and warm browns. The manner in which quails peck and scratch when foraging for seeds will, at a distance, remind the visitor of barnyard chickens. Like the chicken, to whom they are related, quails prefer to run rather than fly. They run with impressive speed, dodging in and out of bushes, and present an elusive target for would be predators. The quail's language is made of an elaborate system of calls. Most frequently heard in the evenings is the assembly call sounded by males to gather the covey together: *ka-RA-ho* or *chi-CA-go.* When disturbed or anxious the males emit a metallic *pwit-pwit-pwit-pwit-pwit----.* At the sound of this alarm call, the covey either flies or gets ready to do so. If chicks are present they will immediately "freeze" and crouch flat against the ground, becoming exceedingly hard to see.

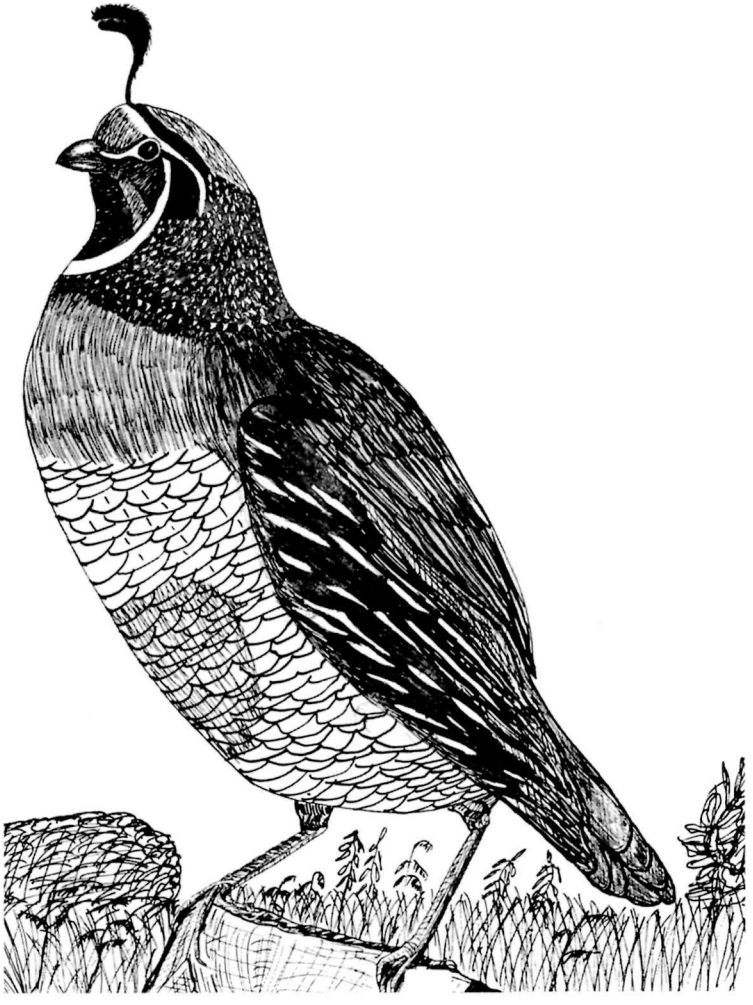
Quails feed extensively along the margins of the Foothill Woodland community. Seeds and greens are their main fare but they eat an occasional insect when it is handy. Areas that are open and provide a good view of the sky yet are close to dense brush are the preferred feeding spots. When feeding, usually in family groups, a male mounts guard on a vantage point to warn of impending danger. Apparently having good eyesight, the sentinal usually sounds an alarm when danger is still a long way off.

During the heat of the day, when not feeding, the coveys gather under the shade of the brush at the edge of the feeding areas, near water if possible, to loaf and preen their plumage. Such sites are often marked by cleared patches of dusty ground where the birds take dust baths, possibly to discourage their skin parasites. When loafing quail do not usually post sentries but the resting birds choose the site with care and enemies are usually spotted before they get near.

Red-tailed hawks, gray fox, and bobcats are the principal enemies of quails. During the day the appearance of this hawk, even at a considerable distance, sends the birds into a "state". They fall prey most easily when at roost for the night, usually in a tall bush. Bobcats and foxes are rather adept at climbing or jumping to pull them down. Foxes seem to be especially fond of quails and will spend a lot more time than a bobcat trying to get one.

The nest, an unpretentious affair, is built on the ground. A small hollow lined with grasses and leaves, concealed by tall grass will do. In such nests the young fall prey to raccoons, jays, snakes, and ravens. Where these predators are common, egg and chick loss may be rather high. This high mortality is partially offset by the large clutch size, usually 12 to 16 eggs.

Water must be present in the quail habitat. Adult birds can go several days without water, if need be, but the hatchlings must have water at least twice a day. The young birds are unable to travel more



The California quail is one of the monument's most beautiful birds. A stout-hearted little fellow, he wins the respect and admiration of all.

than a few hundred yards and will all die if the nest is too far from water. Traveling to and from water exposes the covey to predator attacks and great vigilance is exercised by the parents. The male usually goes first to inspect the "lay of the land". If all seems to be in order and safe, he utters a low guttural note to indicate the coast is clear. The mother and chicks then rush down to drink while he stands guard. He soon relinquishes his post to the female in order to obtain his own

drink. Sometimes a similar procedure is followed when the family crosses a road. The parents and chicks show great caution when approaching but when the "all clear" is given they rush across pell mell.

Quails are one of the monument's most beautiful birds. Most visitors, if they go looking, should be able to see them. A stout hearted little fellow, he wins the respect and admiration of all.

The bird lover should not be dismayed about quails having enemies such as the gray fox; this is the scheme of things. If surplus birds are not killed they are forced to live in unsuitable places where they eventually die in a pitiable condition from thirst and hunger. The gray fox, at least, is a swift and merciful killer.

Besides helping control quail populations the gray fox is instrumental in the control of rodents, his staple diet. Woodrats and rabbits are esteemed so much he often goes to great trouble to dig them out. Since he is a night prowler his prey species are also most active at dusk and at night, another example of the manner in which lives of different animals interact.

The fox, whose name has long been connected with wisdom and cunning, is seldom seen by man even where he is common. When walking along a path upon which a man is approaching he will simply step to one side behind a handy bush allowing the intruder to barge on past before he continues his journey. In areas where he is heavily trapped much more caution is shown. In these places a fox will not step on a place where the earth has been disturbed or a depression scraped.

The gray fox is almost the only member of the dog family that will climb trees, a skill very handy to master for one who likes birds. At least one case is recorded where foxes reared their young in the hollow of a tree, far above the ground.

When the kits are old enough to travel the entire family hunts together. The youngsters are given a thorough indoctrination in woodlore. Imagine the delight of the sharp-nosed youngsters when they catch their first deermouse.

Fox tracks, resembling those of a small fox terrier, may be often seen in the soft dust of the monument trails. The number of gray foxes in the area is large in relation to other carnivores. This prevalence is probably due to several factors. Foxes are small, their prey reproduces rapidly and, in the case of rodents, the year around. They also supplement their diets or can subsist entirely, if necessary, on berries and insects.

The chief enemies of the gray fox are the golden eagle, domestic dogs gone wild, and humans. Ranchers are understandably unhappy when they lose several chickens in one night. On the whole, though, foxes benefit the farmer because of their taste for rodents.

The black-tailed, or mule, deer is the most frequently seen mammal at Pinnacles. It plays an important role in the monument's ecology and

is the principal food source of the monument's largest carnivore, the mountain lion. Of greater importance, it affects the lives of many small creatures because of its effect on the vegetation.

The danger of overpopulation is a permanent problem of the deer herd at Pinnacles. Deer have no built-in self-limiting instincts as many other animals do. Many rodents, for example, become anti-social when their populations build up too greatly. They lose interest in breeding, the mothers abandon the young, or the young may be killed by adults. Deer do not show this type of behaviour. They will crowd together in such numbers the vegetation is completely stripped and many then die of starvation. When weakened by poor nutrition deer are much more susceptible to disease and parasites such as ticks, which may then spread to other animals. The effect of deer on the ecology of the monument is greatly heightened by this overpopulation. A browsing deer will eat only the tender young shoots of the vegetation. These are found on the ends of the branches and on seedlings, the points where the plant's flowers and leaves are formed. Under the impact of heavy browsing the affected plants will put forth smaller amount of seed, which is so important to birds and rodents, or they may die.

Most persons are aware deer shed their antlers every winter but do you know anything about the interesting way antlers grow? A cow's horns grow in much the same way your fingernails do but deer antlers grow like bones. Like bones, the new antlers are covered with a skin, called velvet. During growth the antlers and velvet are well supplied with blood vessels and nerves. Sensitive to the touch, they are not used for combat at this time since they are easily injured.

By the onset of breeding season the antlers have hardened and are used for fighting. A visitor is often heard remarking they must inflict terrible wounds. No doubt they would if used often, or seriously, for that purpose. Usually the combat of male mule deer is more ceremonial than deadly nature without intent to inflict much bodily injury.

When a deer is frightened or angered he does not attack with only his antlers. What would the antlerless doe do for defense? She uses her hooves. They are formidable weapons; small, sharp, and capable of cutting viciously. Many cases have been recorded where coyotes have been reduced to a pulp by such an onslaught. Deer not only kick like horses and mules but also balance on their hind legs and slash with their front hooves. It is quite dangerous to feed deer since you are placed in striking distance and position in front of them where any alarm could frighten them into attacking you.

Fawns are born between the end of May and the end of July. Usually only one fawn is born each year but twins also occur on good ranges. Born with camouflaging spots and almost scentless, they are difficult for predators to find. When danger threatens the fawns lie very still with their chins and necks flat on the ground. In the dappled shade

under bushes their spots make them very hard to see, especially since almost all predators are color blind. (Except for birds, they see only shades of black and white.) The formerly competitive bucks tend to band together after the fawns are born, leaving the does to raise the young.

Deer must rely on predators to weed out the sick, aged, and disabled animals to prevent overpopulation. At Pinnacles the most important deer predator is the mountain lion. When the lion's numbers are reduced deer population becomes a problem. Bobcats and golden eagles are the most often seen enemies of fawns. Golden eagles will attack sick fawns and eat dead ones but have never been observed flying off with one. Many deer are killed by ticks, tapeworms, lungworms, bot-flies, eye worms, skin infections, and malnutrition. Sportsmen often wish to kill deer enemies, thinking such measures will improve hunting, but the results of such efforts are often undesireable. Alter all, the deer and his enemies have lived side by side for centuries. The pioneers found enough game to support themselves in spite of predation. Difficulties started with the introduction of humans to the scene. What is required is less intervention on our part.

The Foothill Woodland communities comprise less than 7 per cent of the total area within the monument. Its chief contribution is as a home and feeding site for those species of animals eating grass or grass seed. Rabbits, quails, deermice, squirrels, and deer abound. While these areas are not large, they are reasonably productive producing about 61,300 pounds of forage a year to support about 40 head of deer. Rodents and rabbits are quite numerous, if the number of hawks and other predators visiting these communities are any indication. Large animals do not find enough concealment to make their homes here but many small ones do.

CHAPTER V

THE IMPORTANCE OF ECOLOGY

Ecology is the science that brings together facts about plants, animals, and the physical sciences such as geology, chemistry, and meteorology. From the viewpoint of ecology man is able to know what is happening in the world around him; he is becoming aware of his environment. Since humans are physically a part of the animal kingdom, this environmental awareness will help us understand our correct place in the scheme of things, just where we fit and how we can best coexist with the rest of the life of the world.

The purpose of this booklet has been to enrich your visit to Pinnacles National Monument by explaining the ecology of the area. We hope added awareness will bring you pleasure in this and other natural areas you may visit.

Ecology has many other purposes too, including many practical uses and the basis for management decisions. Once decisions have been made ecologists and other environmental specialists can find ways to carry them out. So far most attempts by humans to control their environment have been a process of trial and error without much rhyme or reason, often yielding unsatisfactory results.

Certainty of results is especially important to those people who must directly rely on the land for their income, farmers and ranchers. Millions of dollars have been spent on ineffective insect control programs. Unwise use of chemicals has made the land and sea produce harvests contaminated so badly they were unfit for human consumption. Because chemicals have been inadvertantly introduced into the water supply tons of wildlife are accidentally killed each year and wild animal populations are further reduced by destroying their habitats and breeding places.

No one yet knows with certainty what the long term results of these haphazard programs will be. This much is already known; the insects we are trying to control are almost as widespread today as they were before the introduction of chemical pest controls. The most successful programs, to date, have been those based on the principals of ecology: the introduction of natural enemies, such as the ladybird beetle, and other biological controls of insects. The ladybird beetle was first introduced into this country from Australia before the turn of the century and even today is the most successful insect control measure we have ever attempted.

Ecological research can show where we are going wrong in our fight to protect our food. Another use of ecologic study is the maintenance of our natural areas. Year by year, as the population grows and camping and hiking become more popular, our outdoor recreation facilities receive more use. How much expansion and (IMPROVEMENT?) can such an area tolerate without destroying its purpose? Ecologists can help find an answer.

In the final analysis humans will be required to consider their place in the total scheme of things or face the fate of the dinosaur. Should we destroy whatever happens to inconvenience us? Should we change the world to make our own life as effortless as possible? Should we preserve and protect only that which seems commercially valuable? Many of us hope not since we can see beauty in all creation including so-called useless swamps, sand dunes, and deserts. We find all forms of nature equally interesting and worthy of preservation. With you becoming aware of your environment we hope you do too.

Pinnacles National Monument is one such preserve of ecology. Help us protect it for your own enjoyment and that of your friends and neighbors. Help protect it for the generations yet to come.

POSTSCRIPT

To show you how environmental awareness works, I have set forth, in part, the thoughts of one of Pinnacle's perrenial visitors as he wrote them and gave them to me. It is a shame this man had to wait until old age was upon him to really become aware of his environment. I hope you, and those around you, will make time and take the initiative to explore, think about, then experience your own personal environment while you are still young so your life may be more satisfying and richer in quality. Perhaps this could even inspire you enough to make you want to do something about the mess we humans are making of our environment. To those of you who are no longer young, may you be as well off as the man who wrote the following words: (Editor)

THE CANYON TRAIL

Doyle S. Peckham

The canyon trail winds upward through the ragged chaparral of the inner coast range. I have come to think of it, in a peculiar way, as my trail.

On weekends and holidays its peace and wildness are destroyed by chanting lines of girl scouts and groups of nervous, scrambling, short-cutting boys whose leaders, or parents, seem to have forgotten they need discipline and control. If, by chance, I am there the spell is broken; and I resent them. I am tempted to the bitter plaint of fellow natives who bemoan the fact that once beautiful California has become a glut of noisy, insensitive people.

I knew California when people were scarce and the coastal mountains were as wild as wild can be. As a boy, with my father and friends, I hunted and fished and camped out in the mountains. We threw our cans around and left litter; and we broke the sounds of the wilderness with our rifle shots, for we were keen on hunting. As boys, we were as callous as the moderns. We had no sense of communion, no deep feeling for nature. We were just active kids playing a game in a way that is no longer playable; for then there were so few of us and now there are so many. As for the adults..... I should guess that, with a few rare exceptions, they were much the same. They were westerners, just one step beyond the conquest of raw nature.

As I think of my canyon trail today, when age is upon me and the need of communion has grown greater, I experience a feeling of mingled sadness and amusement. The irony of it. The abundance of

wilderness when I did not need it; the wilderness over-run with people now that I need it so much.But I refuse to succumb to bitterness. I must learn . . . .I have learned . . . .to live with it, as with many other things in life.

My canyon trail is still my canyon trail . . . .if I will just get up a little earlier in the morning or go there when the city folk and their noisy young are busy at home.

At sunrise the campground beneath the live oaks (Chalone Creek) is in shadow and the air is sharp. I have a quick cup of coffee and a couple of crackers in our little trailer house. I hold a brief conference with my still recumbent wife regarding the approximate hour of my return (I usually run considerably beyond the alloted time!). Then, with binoculars around my neck, Field Guide to Western Birds in my hip pocket, and jacket buttoned close I walk briskly across the wide arroyo that separates the campground from the foot of the trail.

The beginning of the trail is a tunnel through a thick covering of live oak and chamise. The cool still air pierces my light jacket and I hunch my shoulders involuntarily and quicken my step. But I come to a sudden halt. Ahead in the gloom at the edge of the trail a small bird is working. I focus the glasses and see that he has the gray head, rusty tail, and arrow-head breast spots of the fox sparrow.

Unlike many other birds he seems to seek the shade for his food gathering. Perhaps it is because he is so frantically active. He will hardly move out of one spot for 10 or 15 minutes at a time, and all the while his little body is constantly in motion.... hop forward, kick back (body off the ground and both legs flying), sharp eyes on the lookout for the uncovered morsel. He works hard for his food. Only occasionally, perhaps once in a half-dozen oscillations, does he break his frantic rhythm with a quick stroke downward of head and bill, and then the interruption is for the tiniest fraction of a second.

It must take a lot of bugs to fuel that tiny, racing engine where so much of the energy is consumed in the process of refueling! He never needs to take a walk to whet his appetite to digest a meal!

As I emerge from the leafy tunnel and round the first bend, I have gained enough altitude so that the sun, breaking over the eastern hills, envelopes me in welcome warmth. I climb briskly for a few dozen yards, then pause to catch my breath and allow the sun to penetrate my jacket and warm my back and shoulders. I raise my arms and take a deep breath, savoring the moment. I glance down and see a small brown lizard flattened on a rock by the trail-side warming his cold blood for the activities of the day. How different he is from the active bird in the cool shade. He reminds me of the old Model-T that required a kettle of boiling water poured over the motor to start it on a cold morning. He can't make himself warm by action; he must be warmed up to run.

The canyon trail winds upward. In the narrow rocky gulch to my

left a ragged, stunted, thick-butted juniper huddles alone, the oldest of its kind on the mountain; a relic of the ancient past. The sparse gray pines dotted over the hillside, protected now from fire, may eventually supplant the chaparral; the juniper is a symbol of a day that may not return.

I pause a moment, lost in reflection. There is a flick of movement in the brush and a small gray fox emerges from behind the juniper, slipping smoothly and gracefully, trotting not running, toward the spot where the trail crosses the gulch. In his mouth is a small furry animal, probably a young ground squirrel. He carries it gently, cross-wise, like a soft-mouthed retriever. It will be breakfast for the pups.

I have seen this fox before, farther up the trail, on another morning. He sat in the trail and let me look at him . . . . .a truly beautiful animal. Through the binoculars I could see the sharp little nose, the round eyes, the small pointed ears, the features outlined in bright red-orange that extended down his throat, along his front legs, and over his chest and belly. The bushy gray tail lay flat on the ground behind him. He sat there for perhaps two minutes, then trotted off across the canyon and disappeared among the rocks of the distant hillside.

The trail crosses the canyon where the fox and his prey have disappeared. Momentarily I am in the shade again. I hurry my steps a bit, making silent footfalls on the damp earth. I flush a spotted towhee working among the leaves and shadows. I raise my glasses, but he is too quick for me as he dives for the thick undergrowth.

I emerge into the sun again and, as I do so, three sharp notes and a stuttering trill sound from across the canyon. Immediately the call is answered from the chaparral above me, on my side. That is the wren-tit . . . . . .a nervous, furtive, brown ball of feathers with a slender bill, round head barely separated from the body, long brown tail cocked like a wren's. The dark pupil of his round eye is ringed by a band of yellow, not the common feathery eye-ring of some birds, but within the eye itself. You are lucky if you catch a glimpse of this active, nervous, little bird; still luckier if he will hold still long enough for you to see the light ring in his eye.

For many years I had heard, especially just at dusk, those echoing calls from the hillsides of dense chaparral, but whose they were I did not know. Then a ranger told me and lent me a book. I learned that a wren-tit is a permanent resident, that he mates for life. . . . .one husband, one wife. . . . ., and that the call is not a territorial warning but communication between spouses. At night husband and wife sit side by side on a limb as close as they can get. Each pulls up a leg and one bird wraps a wing about the other. That is what the account says, and it is the result of a careful 4 year study. A perfect domestic life. . . . .I don't see how they get along without T.V! Observation for women: These drab little brown birds never heard of make-up or the beauty parlor!

Sex enters their lives for only a few busy practical weeks in the nest building season. I wonder what the Madison Avenue boys would do for copy? Or the modern novelist for subject matter?

The canyon trail winds on upward in the sun. The air is fresh and clear. It is spring and there has been unusual rain. Grass is green along the trail sides. There are a few early flowers: toothwort and golden wallflower, an occasional cluster of purple shooting stars translucent in the sun. In the shady corners of the switchbacks there are delicate maidenhair fern and woodland star and rich green and brown mosses. And everywhere on the rocks are lichen patterns. . . . . intricate combinations of red and orange and green and gold. Patterns. . . . .,. .patterns are everywhere.,. . . . .in the flowers, in the mosses, in the lichen, in the leaves, on the insects, on the birds, on the animals. Balance. Design. There is very little in nature that is lopsided, off balance, inharmonious.

Once in the late spring when the grass was dry along the trail-side and the chamise was festooned with the creamy-white fluff balls of clematis, I came upon a mariposa lily lifting its beautifully patterned chalice above the dried grasses, each tinted petal perfect, from its delicate curving lip to the deep vermillion at the bottom of the cup. On each petal, just below the lip, was a splash of color as if the artist in a last burst of inspiration had dipped his brush in crimson and touched each surface lightly. Chance? Accident? Mutation? Natural selection? Survival of the fittest? Surely not entirely and exclusively. Somewhere in the process the hand of the artist had sketched the design and dipped his brush in color to set the pattern. Accident. . . . .that is the three-legged chicken, the two-headed calf, the monstrous doubled lily. They do not reproduce their kind; they do not persist. Only that which is harmonious survives. Who invented harmony? And why does it work?

The canyon trail winds upward in the sun. I remove my wool jacket and tie the sleeves about my waist. And let the healing warmth penetrate my light shirt and flood my back and shoulders. Ahead, a beautifully marked blue-and-white jay glides down into the brush, as silent as only a jay can be when it serves his purpose. Above the trail a pair of hermit thrushes scurry along the edge of a clearing. Courtship antics? Hope flares that it might be. Except in mating season the hermit thrush is the most silent bird in the forest. But when the creative urge is upon him, he breaks out in those mellow flute-like notes that are the most beautiful of all birdsong. If he is mating here in the chaparral, there could be. .,. . . .should be. . . . .song. But no. Neither on this day nor any other day have I heard his song among the oaks and chaparral. Only in the cathedral shade of the dense conifers has he ever sung for me. He may court his future mate in the chaparral, but he will spend his honeymoon in the deep forests of the high mountains. And he won't sing until then.

The following day I looked for the thrushes in that clearing, but there was no sign of them anywhere in the canyon. Perhaps if the blood runs warm enough they will find a chapel in the coastal redwoods and a minister to marry those who cannot wait for the melting of the snow on the sierras!

The narrow path winds upward, zigzagging back and forth, sometimes touching the rocky bottom of the widening canyon. I pass beneath a manzanita whose red branches arch across the trail like a trajectory of flame. I come to the end of a switchback, high on the side of the mountain, and pause for a look around. I have crossed the altitude line into the country of the canyon wrens, and from distant rock piles and spires their descending trills remind me of the cascading silver droplets of a tiny waterfall.

I look back down the canyon, my eye following the broken line of the zigzagging trail. The chaparral is alive this year. On the canyon sides the ceanothus (mountain lilac, except that here it is almost white) is in full bloom and fills the air with its faint, sweet perfume. Gray-leafed manzanita, its limbs hidden by foliage, is scattered among the dark hollyleaf cherry and still darker chamise. The creamy blossoms of the climing clematis ride the tops of cherry and chamise, contrasting brightly with their dark hosts. In the burgeoning life of the chaparral, the chamise and hollyleaf cherry are laggards. But in a few weeks they will take their places in the rising tide. Then the four-petaled clematis will have begun its metamorphosis into the feathery puff-balls of summer and its place will be taken by the creamy masses of cherry plume and the bright green tips of the reviving chamise. Beneath its bloom the hollyleaf cherry will exchange its dull and prickly foliage for a new coat of shining green.

Far back down the trail, where the path leaves the valley floor, a narrow band of dark asphalt shows between the oaks, and a yellow toy-like park truck passes by. I am more than half-way to the top, perhaps a mile from my starting place and a thousand feet above it. I resume my upward climb.

On a distant hillside a California thrasher, rough mountain cousin of the mockingbird, is practicing his repertory for the ardors of spring, as yet not quite sure of himself, but he'll have song, never fear, come mating time. On top of a chamise, with that ugly curved bill chopping the air, you wouldn't think he could be a musician; but he is, and a good one too.

The trail winds upward in the sun, criss-crossing the flattening head of the canyon. Chamise and hollyleaf cherry give way to scattered blue oak and gray Digger pine. Here the mountainside takes the full brunt of the sun's heat. There are already yellow spots among the grasses, and the shooting stars are past their prime. In a few weeks the solitary

mariposas will rise among the dried grass stalks, lifting their handsome painted corollas to the sun.

Off to my left, in the direction of the heavier growth, a startled doe, sleek and fat in her spring coat, jumps to her feet and stands nervously watching me. Through the binoculars I return the compliment. Nose, eyes, ears are focused upon me, scanning my presence. I see the twitching nostrils, the greatstaring eyes, the ears pricked forward... three keen and powerful senses combing to size me up, to estimate the danger. Suddenly she turns and starts to run, climbing upward, finally disappearing into the brush. Somewhere in the delicate mechanism of her brain the signals of sight, smell, and hearing tipped a balance and a decision was made. Curiosity held her for a moment; then she lost her nerve. I wonder how much conscious thought, if any, went into that decision.

The canyon trail winds upward in the sun. I can feel the beads of sweat beneath my hatband. In the thin shade of a Digger pine I remove my hat to allow the gently moving air to evaporate the perspiration and cool my brow. In the morning it is often warmer at the top of the hills than it is in the canyons and valleys below. But the heat this early spring morning is not oppressive. I drink deep of the invigorating freshness.

The canyon trail winds still upward in the sun. I do a zig and a zag, and on the westward tack I meet an old friend, the lichen rock, a great yellow-brown monument rising sheer 20 feet above the trail. I pause to greet my friends. . . . .I always do. . . for it is a marvel of color, especially this year after the generous rains. Red, yellow, orange, gray, black . . . . .these brilliant hues are mixed and patterned on the face of the neutral rock like colors in an abstract painting. I yearn to capture it on color film, but the light is never quite right and the rock is too high. And the only way I could get back far enough would be to slide down the steep slope below the trail, and then I could get only a squinting upward shot even if I could find a firm place to stand. Perhaps, after all, it is best the way it is. I stop to marvel and enjoy whenever I pass. The beauty registers in my mind and memory. For once I am not a packrat photographer. If you want to see my rock, you will have to climb up there with me.

The canyon trail winds upward in the sun. I move toward an approaching summit. A jay sails out in level flight from the rim of the mesa above, soaring for a moment in the updraft before dropping into the pine below me. A pair of sparrow hawks settle on a dead branch at the rim's edge, emitting their strident mating cried. The sun is warm, very warm, but above me I can see and hear the long gray needles of the pines rustling in the breeze. This is the neutral meeting place of sun and summit breeze and canyon updraft. Momentarily I am too hot for

comfort. I hurry on in quest of relief. This the last switchback before the end.

At last I round the bend and there before me is the grassy, oak-studded meadow. The Spaniards generally called such flat summit land a *mesa* (table), but in the coastal mountains they had a warmer, more specific, more domestic name for it. They called it a *potrero* (colt pasture). *Potro* is a colt; *potrero* is a good place to keep colts.

I am at the end of my climb. There is a bit of chill in the free air at the top and I put on my jacket. From the mesa come the songs of the migrating linnets and the faint "jew's-harp" "tonk-tonk" of the western bluebird. In a nearby tree I hear the sharp "chip-chip" of an Audubon's warbler. I scan the meadow with my glasses, but there is no animal life abroad this morning. Once on the mesa the largest coyote I have ever seen came within 50 yards of me before he caught my scent and loped away. I have seen many deer there. My hope is some day to catch a mountain lion trotting home from his early morning hunt. Somehow I always think of lions when I come up on this high mesa. To me, it seems like lion country.

Having scanned the meadow, I turn aside and climb a grassy knoll that tops the rim to my left. From there I look back down the canyon and out across the rolling grassy ranges to the east. As far as I can see there are mountains and more mountains. For the most part they are sparsely timbered, but on the most distant ridge stands a line of ragged conifers like Paddy's beard.

For the moment I am on top of the world. I put my hat upon the ground and lay my binoculars carefully upon it. I raise my arms and fill my lungs almost to bursting. It is good to be alive, here on top of the world. It is good to have escaped, for the moment at least, the syndrome of fear and confusion, the sense of submergence and drowning. A new perspective emerges; Man is essentially good; life can be good if only man will try harder. High places are good for the soul!

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GLOSSARY

ATMOSPHERE – all the air surrounding the earth.

BIOSPHERE–that portion of the earth and its environment in which all forms of life are manifested.

BIOTIC COMMUNITY–plants and animals consistantly living together in specific kinds of areas as determined by soil, water, temperature, altitude, latitude, and other factors.

BRECCIA – rock consisting of sharp, angular fragments (often of glacial or volcanic origin) cemented together by sand, clay, or lime.

CARNIVORE – a flesh eating organism, such as a lion or venus fly-trap.

CENOZOIC – pertaining to the fourth and latest of the geologic eras extending from 60 million years ago to the present day. It is characterized by the appearance and development of the mammals.

CHAPARRAL – shrubs of various kinds (usually with thick, stiff, leathery, and evergreen leaves) found in hot, dry environments.

COMMUNITY – different species of plants and animals consistantly living together in discrete areas determined by temperature, water, altitude, latitude, and other climatic factors.

CONSUMER – a living organism that consumes food to satisfy its needs but does not produce food through its own metabolism by synthesis of mineral matter.

COROLLA – collectively the petals, or inner leaves, of a flower.

CRUSTOSE – crust like, or forming a crusty covering.

DOMINANT SPECIES – said of the species which is the most prominent in, or controls, a plant and/or animal community.

ECOLOGY – the branch of biology dealing with the relationships between living organisms and their environment.

ECOTONE – a zone where two different plant communities vie for dominance; a transition area between two kinds of plant communities.

EDAPHIC – ecological factors pertaining to, or referring to, the soil and its influence on plants and animals.

FOLIOSE – closely clothed with leaves or leaf-like structures.

FOOD CHAIN – the cycle, or succession, from producers to consumers to the soil and back to the consumers.

FOOTHILL WOODLAND–a savanna type vegetative community consisting mostly of grasses, blue oaks, and Digger pines.

FRUITICOSE – having a shrub-like appearance, or nature.

GORGET – a bird's throat patch which has a distinctive color or texture.

HERBIVORE – a plant eating organism; one depending on plants for its food.

HYDROPHYLLIC–attracted to water; water loving.

HYDROSPHERE–all the water, both salt and fresh, on the surface of the earth and the mosture of the atmoshpere enveloping the earth.

HYPHAE – long threadlike branching bodies constituting the mycelia of fungi.

INTOLERANCE – inability to endure given ecological conditions.

LIMITING FACTOR – a factor restricting the presence of given species to specific ecologic communities or environments.

LOREAL PIT – a depression, or pit, between the eye and nostril of certain snakes which contains heat sensing organs.

MIOCENE – the third epoch of the tertiary period in the Cenozoic era which is characterized by the development of today's large mountain ranges.

MUTATIONS – sudden transmissable variations in plants or animals resulting from gene and/or chromosome changes.

NATURAL SELECTION–the process by which individuals of a species possessing characteristics that help them become adapted to their environment tend to

survive and pass these characteristics on while those less able to do so tend to die out [survival of the fittest].

PLANT SUCCESSION – a series of different kinds of plants succeeding each other in a definite order; one kind growing first followed by another until a stable, or climax, plant population is achieved.

PLEISTOCENE – the first half of the quartenary period of the Cenozoic era which began about 1 million years ago. It is characterized by the great ice ages of Europe, North American, and northern Asia.

PRIMARY CONSUMER – a living organism unable to synthesize its own food which subsists on plants (producers). Deer, squirrels, and quails are of this kind.

PRODUCER – a plant, or other living organism, which possesses chlorophyll and is able to synthesize its food from water, minerals, and sunlight.

RHYOLITE – rock similar to granite but which has a much finer crystalline texture and appearance.

RELICT – a survivor; especially of a vanishing race, type, or species: belonging to a nearly extinct class.

RIPARIAN – pertaining to plants and animals living on a river bank; plant and animal communities living only where there is abundant water.

SECONDARY CONSUMER – living organisms subsisting on primary consumers. Bobcats, hawks, and foxes are of this type.

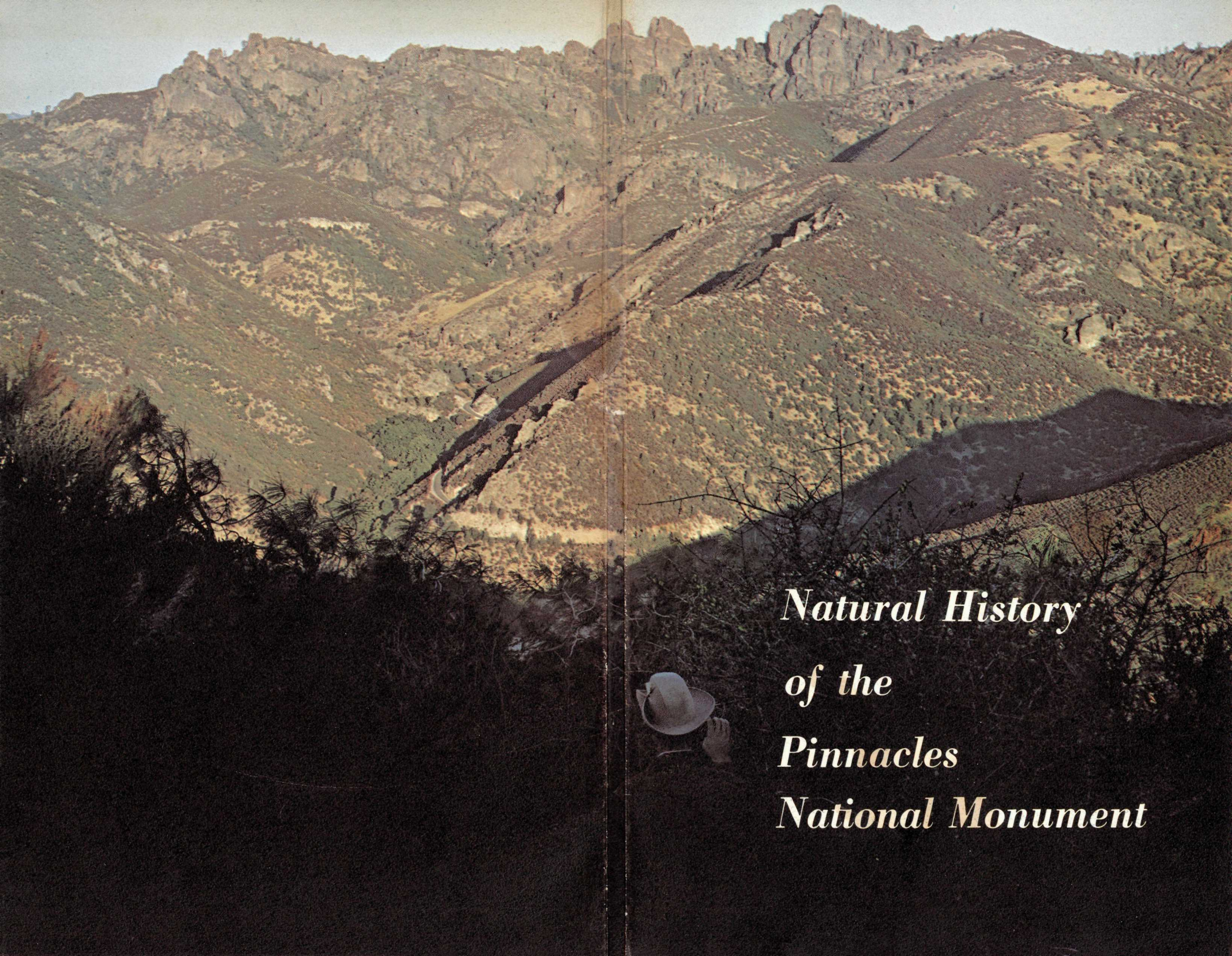
SPORE – a single cell, simple and primative when compared with a seed, that gives rise to a new plant as does a seed.

SYMBOSIS – a mutually advantageous partnership of dissimilar organisms such as the algae and fungi in lichen.

TERTIARY CONSUMER – living organisms subsisting on secondary consumers. Vultures are the best example of this type.

XERIC – pertaining to, or adapted to, conditions of extreme aridity or dryness.





Natural History of the Pinnacles National Monument