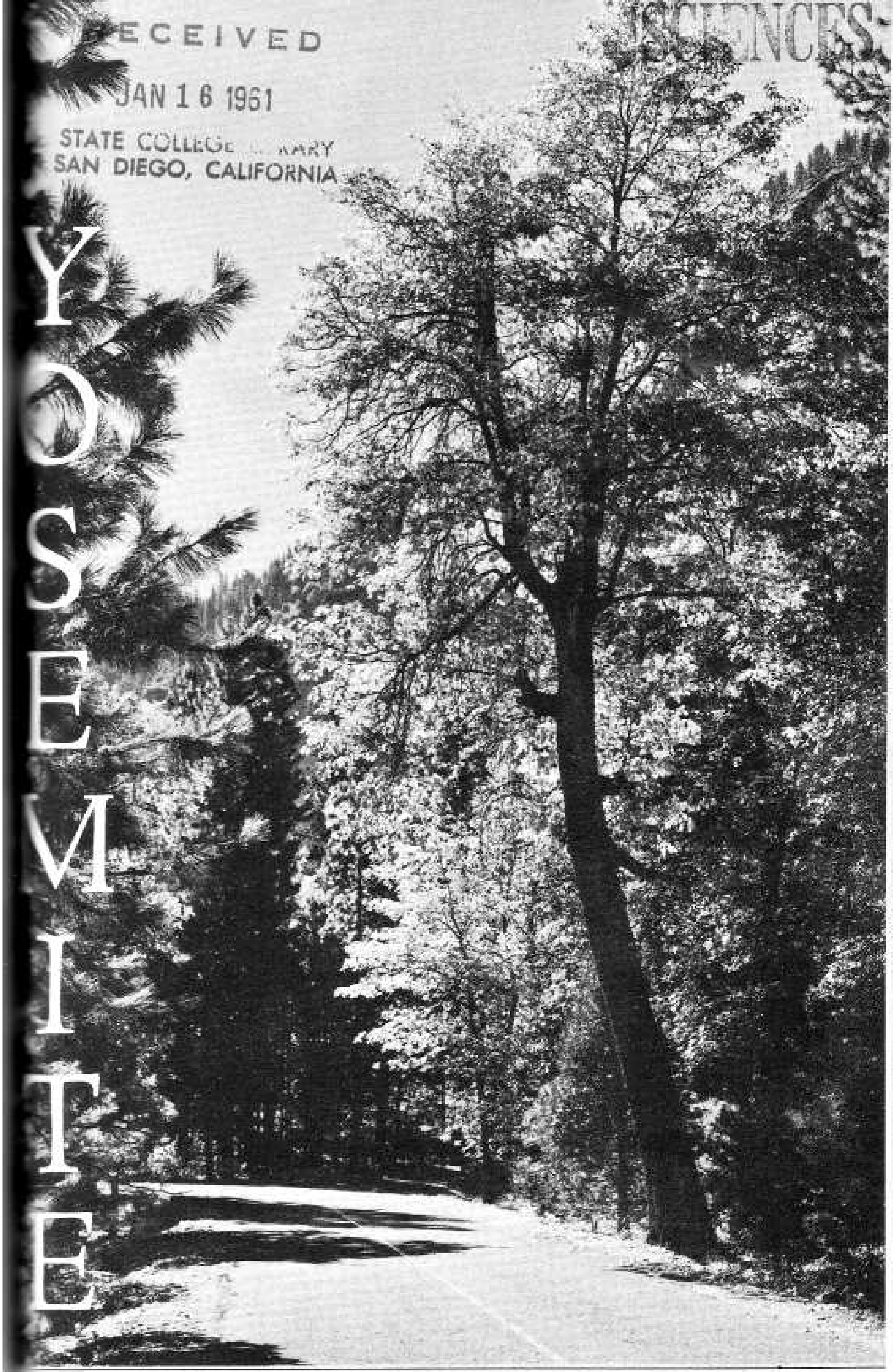
YOSEMITE



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NATURE NOTES

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EXPERIMENT IN INDIVIDUALISM
THE NATIONAL PARK AS AN OUTDOOR LABORATORY

Paul J. Sage, Museum Aid

We are all probably familiar with the two primary functions of the National Park — to provide, in its primeval state, areas for the recreation, enjoyment, and inspiration of the people, and to hold these areas inalienable for all time, preserving them as the priceless heritage of the American people. There is yet another function of great significance which the National Park serves, but we often fail to appreciate this function when we come to look, enjoy and then hurry back to the hustle of everyday life. The National Parks serve to stimulate and encourage serious scientific research in many fields including biology, geology, and archeology. It is the role of Yosemite, particularly in regard to biological research, which is the concern of this article.

It is and always has been the policy of the administration in Yosemite to foster serious research and to aid the trained scientist, offering him natural and sometimes artificial facilities that are of inestimable value. The National Park Service asks only that the work carried on have sufficient potential significance to justify the use of the natural features and that the results of the work be preserved in such a way that they shall always be available for the examination and use of the public. This latter requirement is one of the ideals of true scientific endeavor.

The natural attributes of the Yosemite area are made to order for the investigation of the relationships between the organism and the environment—the study of ecology. From the lower dry western slopes in the Upper Sonoran Zone, through the more lush coniferous and broadleaf forests of the Transition zone, the stately pines and firs of the Canadian zone, the hardy and tenacious pines and hemlock of the Hudsonian zone, and up into the diminutive flora and hardy fauna of the Arctic Alpine zone the massive block that is the Sierra, soars. More than 360 kinds of animals live unmolested by man in a myriad of associational communities in this great and beautiful outdoor laboratory.

In addition to the outstanding natural facilities a small but highly selective research library, a herbarium containing a collection of the local flora, and a fine collection of study skins are housed in the museum. Both the trained scientist and the interested layman are encouraged to make free use of these facilities, with a minimum of restrictions.

The Yosemite area has been the scene of several ecological studies that we may justifiably call classics. A classical experiment is a study that is so beautifully conceived, so precisely performed, and so carefully interpreted that it is truly unique. It is more than just an experiment; it is in a sense a work of art whose form is so fine that it may serve as a model and guide for further study. Such a study was the one that began in 1922. In that year Jens Clausen, David Keck, and William Hiesey began to study the plants of California.

The problem with which Clausen, Keck, and Hiesey were dealing was a very old one and if we are to appreciate the significance of their labors we must delve briefly into the past — into the story of an argument that traces its origin to the beginning of the nineteenth century. Jean Lamarck was a French biologist. When he looked about at the wonderful world of nature he was amazed. He was amazed by the marvelous adaptation each plant and animal showed to its particular way of life. Why did the giraffe have such a long neck? Why didn't the mouse? Obviously, Lamarck thought, it was because the giraffe, living in the arid African plains where food could be obtained only from tall trees, continually stretched his neck in his attempt to obtain food; his neck, therefore, grew longer and longer. The mouse, on the other hand, since he lived in meadows where he fed on the ripe grain that fell to the ground, rarely found it necessary to stretch his neck and therefore never developed an unreasonably long one. This then was the essence of Lamarck's theory: the organism by its habits - habits that are determined largely by the way it lives - can alter its own and its offspring's structure and physiology to correspond with the demands placed on them by the environment. Acquired characters, in other words, were inherited.

Until exactly one hundred years ago this theory went unproved but practically unchallenged. It was in 1859, eight years after the discovery of Yosemite, that an English gentleman — Charles Darwin — offered a new theory to account for the adaptation of the organism to its environment. He noted that in nature there was great competition. The young pine tree growing in the forest in only one among hundreds. What determines that one seedling rather than another shall become a titan of the forest? Darwin suggested that the individual that was innately superior would succeed more often than individuals that were inferior. He also suggested that the adaptive traits that characterize superior individuals might arise by chance. In the successful pine tree, for example, occasionally some small shortcut might be found which would make the long chemical process by which the tree manufactures food more efficient. If the seedlings produced by this tree could also take advantage of the shortcut, more of them might be expected to survive the rigorous competition of youth than would those seed ngs which had to depend on the old nefficient method of food manufacure. In this way, Darwin suggested, daptive traits that arose by chance ight be perpetuated.

Whenever two opposing theories e presented to the scientific world any scientists turn their attention the task of evaluating them to dermine which is more useful. Gaston nnier, a French botanist, began a udy in 1884 which he hoped would of great use in evaluating the two eories. He worked in the Pyrenees d in the Alps. He chose species of nts that grew over a range from foothills to the high peaks. The nts had rather distinctively differt forms at high and low altitudes d from a single seedling many nnected but rooted plants would velop. This type of growth is lled clone growth; a common exple of clone growth is seen in the glish Ivy. All members of a clone ne from the same seed and have same hereditary characteristics. Bonnier obtained clones at low aldes, divided them in half, left one f at the low altitude and took the er to the higher altitudes where other form of the species grew. re he found a high altitude clone he same species but of the high tude form, dug it up, left one half high altitude, and next to it he nted the half of the low altitude n. He then took the other half of high altitude type and carried it wn to the lowlands where he plantt next to the remaining half of the altitude form. This technique is own as reciprocal transplanting. rovided an ideal method of comring the Lamarckian theory with t of Darwin. Lamarck would have ected the high altitude form to rend to the new environment by nging into the low altitude form en they were carried down to the low altitudes and, conversely, the low altitude form to change into the high altitude type when it was carried up the mountain. Darwin, on the other hand, would have predicted no such radical change. He would have expected the transplanted individuals to retain their individualities when moved into the new environments.

Bonnier's results were quite spectacular. Over a period of thirty-five years he reported that almost all the low altitude plants that had been moved to the high altitude were transformed into the high altitude types. It appeared that Lamarck's expectations had been fulfilled and that his theory was quite valid. There were, however, a few small problems regarding the results of Bonnier's study that were quite difficult to explain. While the low altitude forms of the plants studied were readily transformed into the high altitude types, the opposite conversion—of high altitude types into low—was rarely successful. Bonnier also found it quite difficult to explain the fact that transformations were successful only when the transplants were made within the range of the species. If, for example, a lowland form was moved into an alpine area in which the high altitude form was not found, the lowland plant retained its particular characteristics.

Problems like these together with important theoretical considerations which are outside the scope of our discussion greatly interested Clausen, Keck, and Hiesey in the problem of the relationship between the species and its environment. They carefully studied Bonnier's results and found that, surprisingly enough, the French botanist had preserved no evidence against which his results could be checked. They also learned that he had made no attempt to care for his gardens over the years. This information suggested the possibility that none of the transformations Bonnier reported had actually occurred. Instead, it was possible that during the long period of thirty-five years most of his transplants died and were then replaced by seedlings of the forms native to the areas. If this were indeed the case it would explain why transformations succeeded only within the range of the species. Outside the range there would be no seeds to provide replacements. Determined to investigate this possibility by conducting reciprocal transplant experiments of their own, Clausen, Keck, and Hiesey obtained financial support from the Carnegie Institution and began to search for appropriate species and a suitable area in which to conduct their investigations.

In California they found a number a species that appeared to be ideal for their study. Gland cinquefoil, *Potentilla glandulosa,* and yarrow, *Achillea* spp., were among the most interesting. Both of these species were widely distributed, perennial, and had different forms in different environments. Yarrow was found from the coast all the way across California into the desert regions of Nevada. Cinquefoil had almost as wide a distribution, ranging from the coast to the crest of the Sierra. The perennial habit made it possible to continue observation over many years. Both also had the clone habit of growth we talked about earlier. It was possible, therefore, to have one individual in several different places at the same time by simply dividing up the clone and planting the several parts in different environments. In addition to possessing different forms in different habitats both species had different growth and flowering cycles in different places. The species that grew high in the Sierra where the summer lasted only two months, for example, grew and flowered rapidly with the onset of warm weather and then became dormant during the winter. Forms of the species that grew on the hot dry inner coast ranges, on the other hand, were almost dormant during the summer but grew and flowered during the mild moist winter and spring when the Sierran forms were deeply buried in the snow.

Having found appropriate species of plants to investigate the scientists turned their attention to finding appropriate places from which to obtain plants — places in which the plants grew in unalienated environments — and to finding suitable gardens in which the plants could be grown and studied. The natural attributes of the Yosemite area which we discused earlier here came into prominence. Collections were made and small experimental gardens were established in the Sierra near Mather, White Wolf, Porcupine Flat, Snow Flat, Tuolumne Meadows and Mount Dana. On the east side of the Sierra at Mono Lake and Benton. Collections were also made around Yosemite Creek and Tenaya Lake and the plants were moved to nearby gardens. Pi-ants were obtained also on the coast and in the San Joaquin Valley, and a large experimental garden was established at the Carnegie Institution's Department of Plant Biology on the campus at Stanford University.

To avoid the pitfalls that led to criticism of Bonier, great care was taken in the selection of garden sites. All possible precautions were taken to insure that the environment within each garden was uniform. To determine if the gardens were in fact uniform they were tested by growing pure strains of an annual species of tarweed and then comparing all the plants to see if they were essentially identical. When the scientists were sure that the conditions in each garden were uniform they planted the experimental plants and began their study.

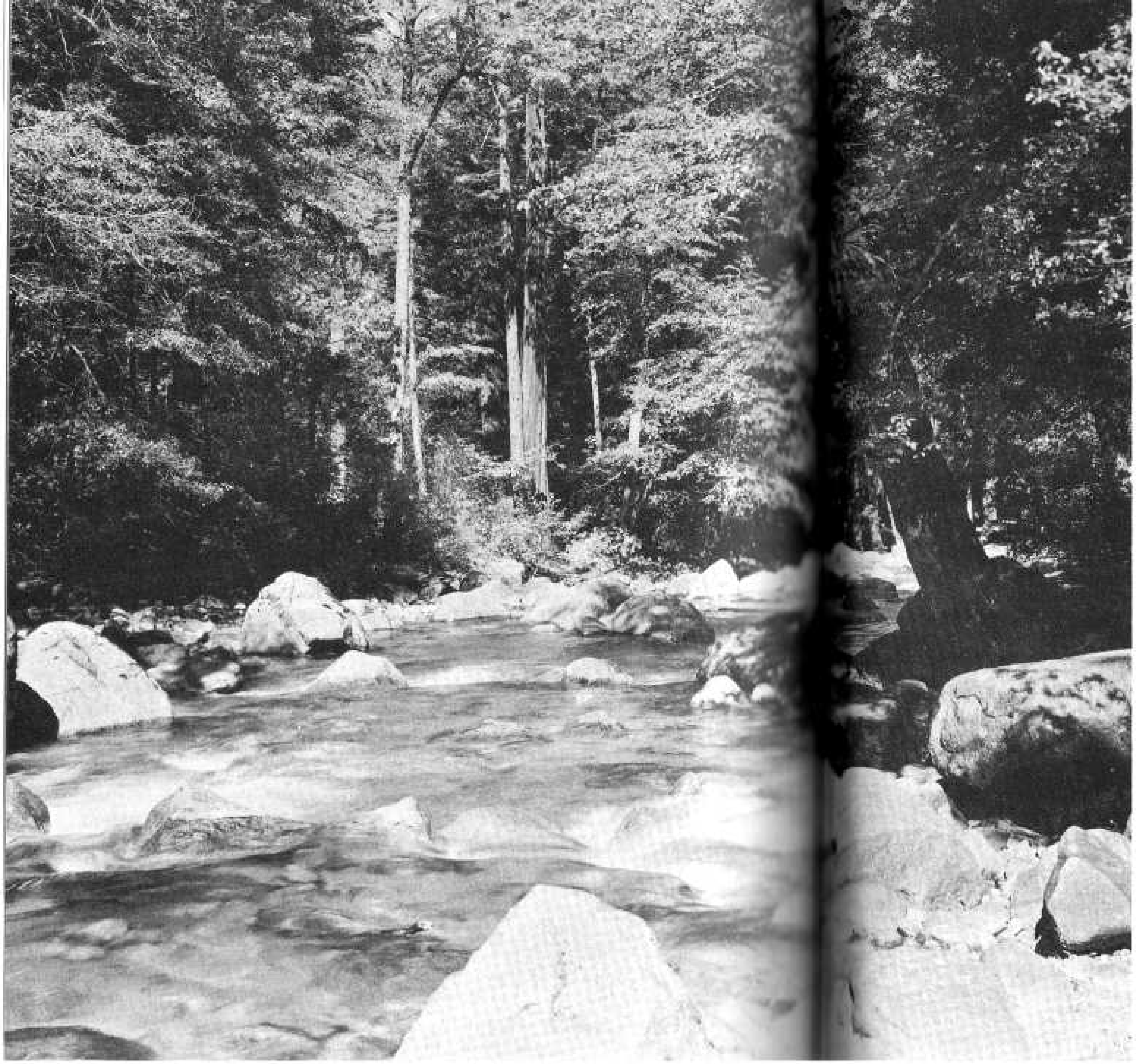
As the study progressed and its scope increased it became necessary to consolidate and centralize operations. In 1929, seven years after the inception of the study, three principal stations were developed and the plants that had been at other stations were carefully transplanted to the new gardens. The large garden at Stanford was retained, another was developed at Mather, and a third was established at timber line adjoining the eastern boundary of Yosemite.

The climate at the Stanford station was typically coastal; the weather was mild and conditions were favorable for year around growth. Rain came mostly during the winter and spring. At the Mather station spring began in early April. Summers were mild with warm days and cool nights and the winter was reasonably mild with the snow rarely reaching a depth of more than two feet. The timber line station was nestled high in the crest of the Sierra at an elevation of 10,000 feet surrounded by soaring peaks and small ice fields. The climate here is rigorous and the environment demanding. The growth season never exceeds two months.

With the three gardens established, each in a different environment, the team could study the individual plants from two different viewpoints. They could compare the effect of a given environment on plants that had originally come from different environments simply by growing them side by side in one of the gardens. They could also study the effect of different environments on one individual by comparing the portions of any one clone that had been grown in the different environments.

Clausen, Keck and Hiesey's results are most interesting and I'm sure many will want to consult a few of the references listed at the end of this article. I would, however, like to discuss briefly a few of the more significant and general conclusions that came from the scientist's work. Their results were quite the opposite of those of Bonnier. Individuals of any given type retained their identity regardless of where they were grown. In no case was one form transformed into another. The flowering and growth cycle remained particularly constant in each form and the external appearance changed but little. When plants from many different environments were grown in the garden at Stanford, each plant retained the individual form which was characteristic of its type even though all were grown under exactly the same conditions. The plants are not just single exceptional individuals. Rather, they represent the mean calculated from the comparison of many many individual plants.

The keynote of the work of Clausen, Keck, and Hiesey was care. Each year during the study they took notes on each of their plants. They also preserved one herbarium specimen from each plant each year. Often they took photographs of the individual plants for study and comparison. All these records and specimens have been carefully preserved in order that any competent scientist may check on the validity of their results. In addition to careful records, great care was taken of the gardens themselves. A watch was kept for weeds and particularly for seedlings of the plants under study. If any were found they were removed at once. The plants themselves were spaced far enough apart



Merced River In Yosemite Valley

While the National Parks serve in an important sense as recreation areas, their primary use extends far into that fundamental education which concerns real appreciation of nature. Here beauty in its truest sense receives expression and exerts its influence along with recreation and formal education. To me the parks are not merely places to rest and exercise and learn. They are regions where one penetrates the veil to meet the realities of nature — and to appreciate more fully the unfathomable power behind it.

—John C. Merriam

so they would receive a fair share of water, light, and minerals. Not satisfied with the results from their hundreds of transplants the team went on to make further study of the individual plants. Experimental crossing of forms was employed and extensive microscopic examination of the cells was carried on. In all cases the results substantiated those obtained from the field studies. It is this great care that Clausen, Keck, and Hiesey gave to all details that sets their work apart as extraordinary — as classical.

The work of this team of scientists—over a period of more than twenty years—has been acknowledged as among the truly significant research that has been performed during this century. To the biologist it represents a classical defeat of the Lamarckian argument. It represents the finest techniques in the new approach to the study of the nature of the species and the organism.

While we can no longer abide his argument, it is important that we do not condemn Lamarck himself. We must recognize him, and for that matter Bonier, as serious, well intentioned scientists — men who were wrong but who were original in their thoughts and in their work. Indeed, these men stimulated the very research that proved them wrong. At the same time we must not accept the theory of Darwin and the conclusions of Clausen, Keck, and Hiesey as representing some absolute and unalterable law. These ideas should be considered nothing more or less than tools — tools to help mankind achieve an understanding of the perfection and beauty of the natural world.

The function of the National Park in stimulating and aiding serious research is easily justified. It is on the basis of the results of such endeavor that we find the bedrock upon which we may build our interpretive program — a program that aims to acquaint the visitor with the perfection of the world of nature and of man and that is designed to help him experience the delight and the inspiration that such acquaintance engenders.

FOR FURTHER READING

Clausen, J., *Stages in the Evolution of Plant Species.* Cornell U. Press, Ithaca, N.Y., n.d.

Clausen, J., D. Keck, and W. Hiesey, *Experimental Studies on the Nature of Species, I, Effect of Varied Environment on Western North American Plants.* Carnegie Inst. of Washington, Publication No. 520, Wash., D.C., 1940.

Darwin, C., *The Origin of Species.* John Murray, London, 1900.

Grinnell, J. and T. I. Storer, *Animal Life in the Yosemite.* U. of Calif. Press, Berkeley, Calif., 1924.

So we see that national parks are really national museums. Their purpose is to preserve, in a condition as unaltered as is humanly possible, the wilderness that greeted the eyes of the first white men who challenged and conquered it. It is to insure that the processes of nature can work, without artifice, upon all the living things, as well as the earth forms, within their boundaries. It is to keep intact in the wilderness areas all the historic and prehistoric evidences of occupation by our predecessors. And in doing these things, the extra reward of recreational value emerges. —FREEMAN TILDEN

NOTES FROM MY JOURNAL

William L. Neely, Ranger-Naturalist

I've just been out to the gravelly lace to watch the pussypaws. When they have been captured, ried, pressed, and locked safely way in an herbarium, then, I supose, a more academic name for hem is *Spraguea umbellata*. They have basal rosette of dark green leaery leaves and on long pedicels hey raise several paws of pink ower-clusters. You'll find them long the roadsides, especially in e middle and higher regions of osemite wherever there are dusty ravelly flats with plenty of sun.

I made some experiments with hem this summer. There is a whole arden of them outside my tent. For everal years I've noticed that when he sun is high they raise their pink aws up from the ground, until at oon when the sun is directly overead, they are nearly vertical. By vening the flower stalks droop, and y night they flop down on the round as though worn out.

Is this a response to sunlight or varmth? Many arctic and alpine lants seem to cling or clump togeher close to the ground or to the ocks to take advantage of the reained heat. The skyland (alpine) wilow will grow in a fringe around the unny side of a glacial boulder, hugging it for its warmth. Its very name, *Salix petrophila*, the "rock-loving" wilow testifies to this. The Brewer mounainheath (red heather) and *Cassiope* will do the same.

I put a gallon-size tin can over one of the pussypaws one cold morning when it was flat on the ground. This should keep it in the dark. If the response is to sunlight then at noon it should still be flat. It wasn't. It was

—*M. V. Hood*

Pussypaws

up with the others. But that following night under its tin can it didn't go down with the others. Maybe the can made warmer conditions, so next I cut holes in the can in such a way to keep out light but permit ventilation and equal temperatures with the outside. It rose and declined with the others, except that at night it still half-heartedly kept one foot raised.

Next I built a little rock wall on one side to make partial shade, but allowing free air movements. The plant persisted in raising its flower pedicels higher than the rest at noon and refusing to lie down at night for a week after.

Possibly we are seeing a mechanism to insure fertilization rather than a heat or sun movement . . . the plant raising the flowers high when insects are about. Or perhaps the pedicels droop at night when photosynthesis stops and the accumulated sugars in the green cells of the stalk change to starches, the cells becoming less turgid and the stalks relaxing, only to grow full again in daylight when the products of photosynthesis fill the cells.

Or it may be a method of slowing down water-loss. Pussypaws usually grow in hot-dry exposed dirt or fine gravel where evaporation from the leaves is critical if not protected in some way or by some mechanism. I've noticed that at midday the flowers are up and make an umbrella over the leaves, casting a delicate shadow pattern. Morning or late afternoon when sun is not so severe the flowers decline and don't shade the food-producing leaves. Most likely the flower movements are the result of several of these factors combined.

BIRD COURTSHIP IN YOSEMITE

Douglass H. Hubbard, Park Naturalist

In all of Nature, few experiences are more rewarding than an opportunity to observe courtship activities of birds. These seem as varied as birds themselves.

On a Sunday, in mid-May, I watched the noisy, rough-and-tumble mating activities of a pair of robins, then the strutting of an irridescent male Brewer blackbird who, puffed out and with wing tips dragging, walked up and down in front of an unimpressed female of the same species on a sandy shore of the Merced River. Obviously unimpressed, she watched for a few minutes, then flew off across the river, the eager male in close pursuit.

But the prize actor was a black-headed grosbeak. His plumet to earth beside my window attracted my eye. Then I heard a soft, muted song, barely audible but not too different from the regular grosbeak song. As I looked carefully from the window to the ground I could see the handsome male, wings extended slightly, and fluttering. His soft, lilting song was punctuated at intervals with the characteristic single notes, so soft they could scarcely be heard. As I watched, the female, which I had not seen before, flew up from near the male. She paused on the branches of a small bush, then flew away. His love-song thus interrupted the male grosbeak flew away too, perhaps to add his unwanted song to those of his comrades, which fill Yosemite Valley's summer days with music.

The annual Christmas Bird Count is printed in detail each year in YOSEMITE NATURE NOTES, published by the YOSEMITE NATURAL HISTORY ASSOCIATION, INC., BOX 545, YOSEMITE NATIONAL PARK, CALIFORNIA. A subscription for you or gift subscriptions for your friends will bring you the Yosemite Story twelve times a year for only $2.00.

A LARGE LODGEPOLE PINE

Howard H. Cofer, Ranger-Naturalist

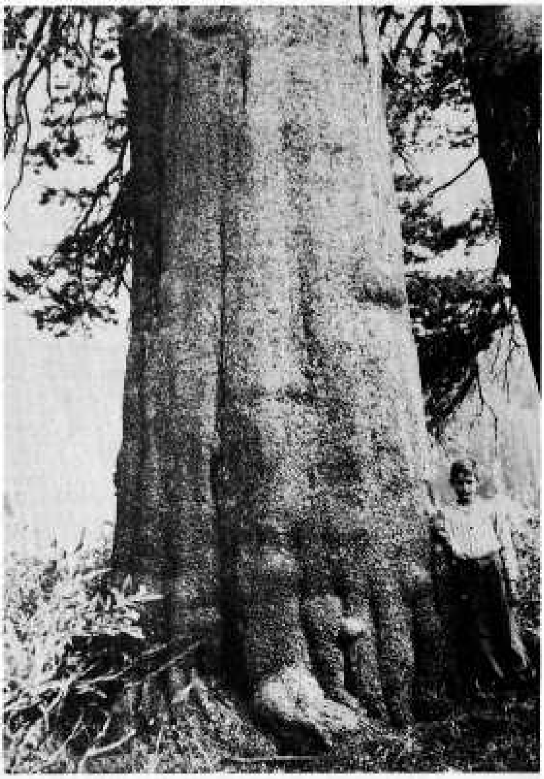
While hiking to Harden Lake, an unusually large specimen of lodgepole pine attracted my attention. Measurement showed it to be 16 feet 5 inches in circumference with an average diameter of 62.7 inches at breast height. Measurement above the swollen region at the base showed 17 feet 11 inches in circumference and an average diameter of 68.4 inches. The cross sectional diameter is greater in one direction than in the other since the trunk is rather elliptical in shape. The diameters given above were calculated from the circumference and so represent an average diameter.

Yosemite Nature Notes, Special Issue, on "The Cone Bearing Trees of Yosemite," gives reference to a lodgepole with a diameter of 62 inches growing near Moraine Meadows. This same reference indicates that trees with trunks 2 or 3 feet in diameter are good sized lodgepole pines. The majority of lodgepoles found in the vicinity of our tree are about 2 feet in diameter. However, these same trees are about the same height as the Harden Lake tree, about 120 feet. This greatly exceeds the average height of the mature lodgepole which runs about 60 feet.

This tree must be from 200 to 300 years of age, which is a maximum for these trees and this one certainly appears to be "on its last legs." The majority of limbs are dead and I could count only fifteen primary branches which are alive. There are no cones in evidence. Although the pure stands of lodgepole pines in the Tuolumne area are infested with the needleminer, an insect which usually kills the tree, apparently the trees in this area are not infested. The top one-fourth of the tree has died since last year and several of the top branches have dead needles still attached. Two large fungi are

One of Yosemite's record lodgepoles - 16 feet in circumference - just west of Benson Pass.

—*Ernst, NPS*



on the north side of the tree at about 18 and 35 feet above the base and this area of the tree definitely appears to be dying. One large fungus is on the south side of the tree about 25 feet up and there is a great deal of sap all the way down from it to the base. Staghorn lichens are present on a few of the lower dead branches on the north side.

At one time this old tree undoubtedly had a forked trunk from about the 55 foot mark on the north side, however, it has been broken out, apparently many years ago. The bark is off the trunk in sort of a V-shape for several feet below this area and much of this dead portion is filled with holes made by woodpeckers. At a point a few feet below where this major fork had been, and one-quarter way around the trunk to the west, a new branch has grown horizontally for about four feet and and then has made a sharp right angle turn to grow straight up for 25 to 30 feet. This type of response often occurs when a major terminal bud is broken out of a tree, but this one apparently never did become dominant. It sticks out rather like a third arm.

There are no other trees around for a radius of 25 to 30 feet. The other trees in the area are mostly red fir with white fir and lodgepole pine scattered about. Jeffrey pines, with a few aspen, are on the rise above the flat. The elevation in this area is about 7500 feet and the site is on a flat. The tree in the Moraine Meadow area is at an elevation of over 8000 feet. Lodgepole pines occur from sea level to elevations of 10,000 feet here in the Sierra but attain their maximum size in the 7000 to 8500 feet range.

If you stay in the White Wolf campground or hike to Harden Lake, you can find this tree about 150 yards beyond the junction of the trail with the fire road. It is on the right or east side and not five feet away from the edge of the road.

I have found it interesting during the last two summers to observe this old veteran struggle to stay alive. It surely won't be able to hold on for many more summers. In the meantime, we hope to keep watching.

EDITOR'S NOTE: The largest recorded lodgepole pine is 19 feet in circumference at 4½ feet above the ground. Found by Harold S. Coons, in Sierra National Forest, it is 160 feet high.

FULL MOON IN YOSEMITE

Ted R. McVey, Ranger-Naturalist

Yosemite seems to take on new beauty with each full moon.
A glorious storm preceded the moon's coming and clouds were flitting from
peak to peak as silently as passing ghosts.
Then the moon's gentle beams began to caress the canyon walls.
A new concept of beauty reached out to fill me with everlasting joy as the
changing light danced from cliff to cliff.

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All mail orders should be addressed to, and remittances made payable to, YOSEMITE NATURAL HISTORY ASSOCIATION, YOSEMITE NATIONAL PARK, CALIFORNIA. Prices include postage, insurance, and on proper items, California State Sales Tax 3%, plus 1% County Tax.

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