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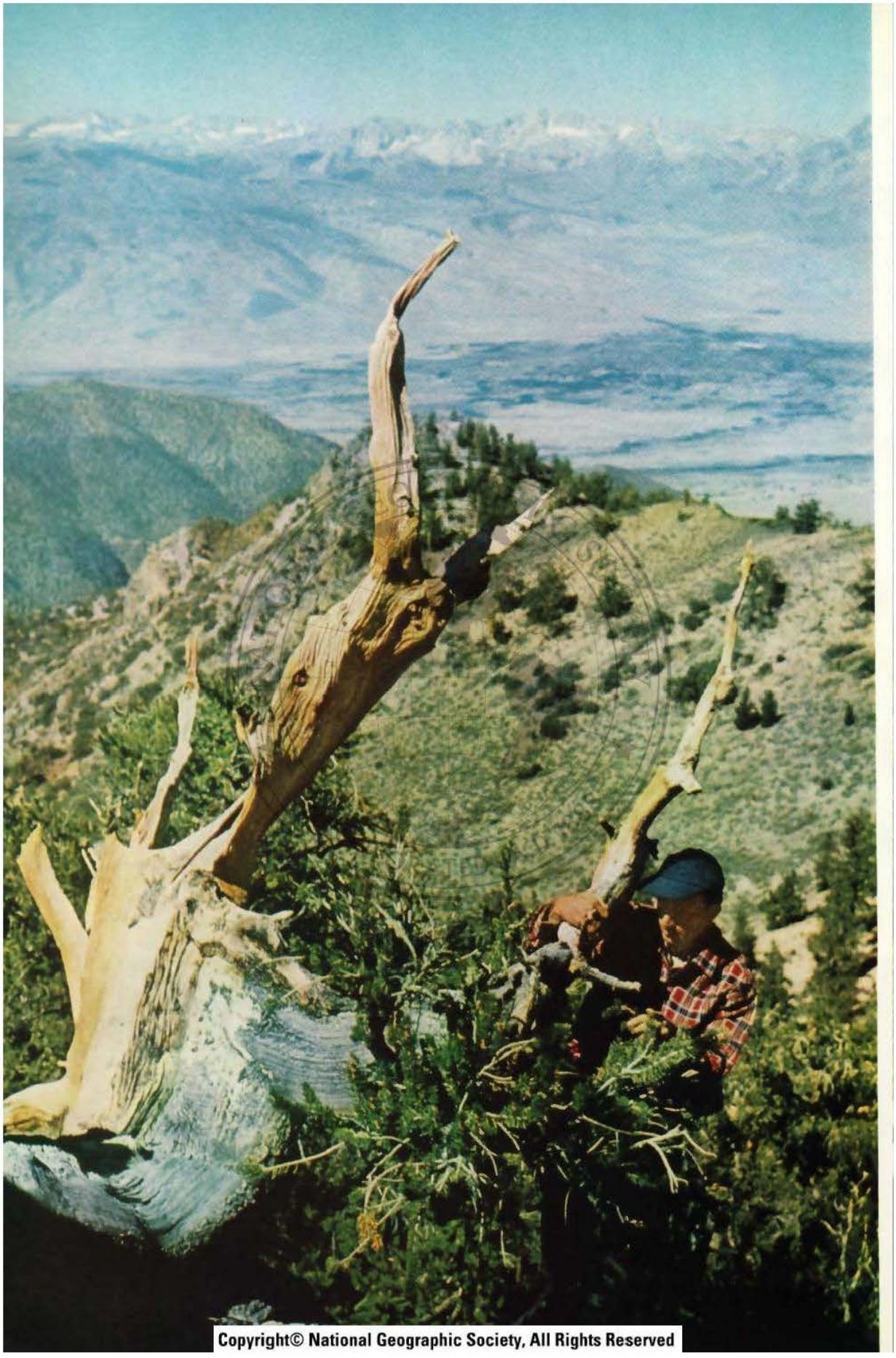


Bristlecone Pine, Oldest Known Living Thing

By Edmund Schulman

Dendrochronologist, Laboratory of Tree-Ring Research, and Associate Professor of Dendrochronology, University of Arizona, Tucson

With Photographs by W. Robert Moore, National Geographic Staff

ONLY recently we have learned that certain stunted pines of arid highlands, not the mammoth trees of rainy forests, may now be called the oldest living things on earth.

Microscopic study of growth rings reveals that a bristlecone pine tree found last summer at nearly 10,000 feet began growing more than 4,600 years ago and thus surpasses the oldest known giant sequoia by many centuries (page 364).

California continues to hold the championship, for the newly discovered world's oldest tree also grows in the Golden State. It stands in the Inyo National Forest, in the White Mountains of east-central California (map, page 361).

Many of its neighbors are nearly as old; we have now dated 17 bristlecone pines (*Pinus aristata*) 4,000 years old or more, all in the White Mountains and 9 of them in the area we came to call Methuselah Walk (page 356).

Ancient Dwarfs Look Their Age

These oldest pines are now but living ruins. Their trunks, 10 to 30 feet high, are little more than eroded stumps. Yet each possesses its life line, a few inches wide, of bark-covered growing tissue leading from partly bare roots to a thin crown of branches. And each still is able to produce cones occasionally, as it has for well over 4,000 years.

After studying a photograph of one of these trees, a friend of mine remarked enthusiastically, "Don't you wish we could all live to be that old?"

To this his wife replied, "Who wants to be 4,000 years old, if she looks like that!"

But beauty is as beauty does, and to me as a climatologist the bristlecones look good indeed. The history preserved in their annual layers of growth should eventually give us a unique record of past climatic changes.

Potentially of far greater importance is the fact that the capacity of these trees to live so fantastically long may—when we come to understand it fully—perhaps serve as a guidepost on the road to the understanding of longevity in general.

20 Years' Research Led to Discovery

But how had we come to find Methuselah Walk and the other groves of four-millennium trees? How could we be certain they were really so ancient and so full of significant tales about the climates of the past?

The story really begins some two decades ago, when I began hunting long-lived trees in the course of climatic research at the University of Arizona. There Dr. A. E. Douglass long ago had found that trees of certain species show marked variation in ring width, reflecting wet and dry years. This is especially true of the Rocky Mountain Douglas fir and some of the pines.

When cores are taken with a simple instrument (page 370) and growth rings are carefully checked against those in many neighboring trees, it is possible to trace the missing rings, extra rings, and other irregularities in growth and so to date the rings exactly.

By matching the pattern of wide and narrow rings in the inner part of old trees with corresponding patterns in timbers cut by prehistoric Indians, the scientist can determine when these ancient peoples built their pueblos.

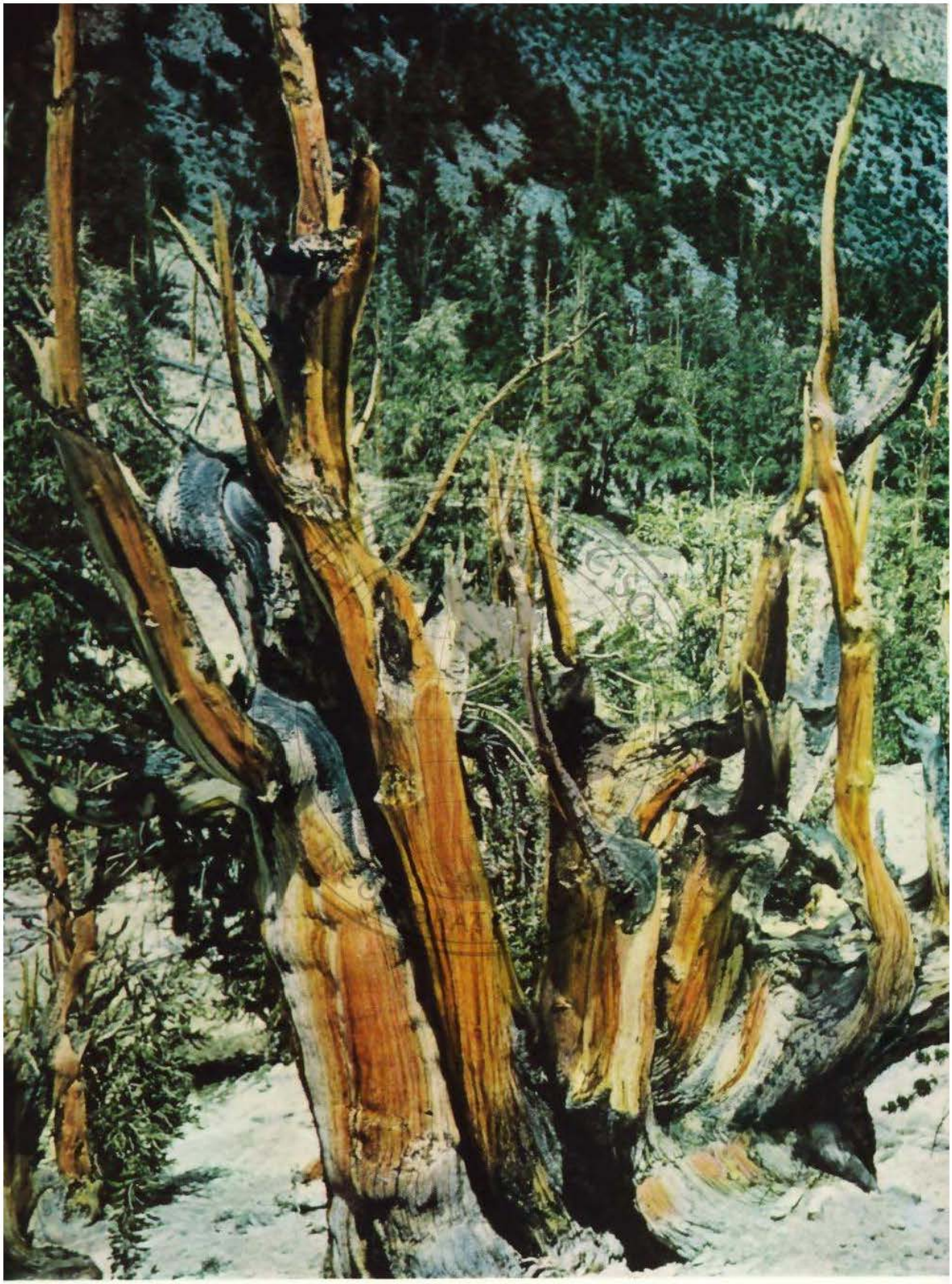
Thus, in the 1920's, three notable National Geographic Society expeditions led by Dr.

Bristlecone Pine, 40 Centuries Old, Sustains Life amid Its Own Ruin

Abraham walked the earth when this tree was thrusting its first tender roots into a rocky crevice two miles high and rearing a slender stem. Racked by wind and erosion, the pine trembled on the brink of death. Yet it endured, recording time and weather with its annual growth rings.

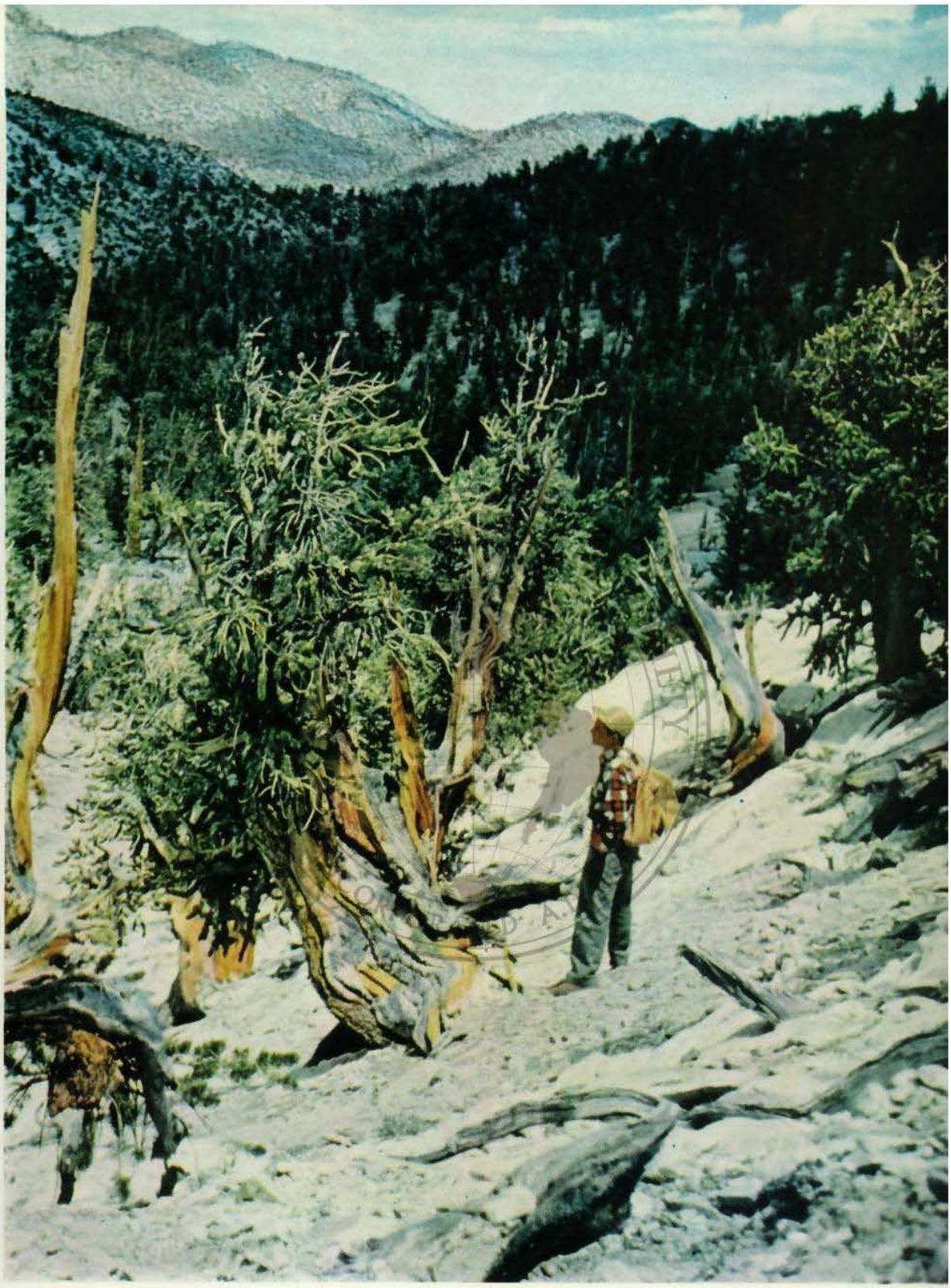
Here, in California's White Mountains, the author's assistant, M. E. Cooley, examines this bristlecone's one living branch. At its base a single narrow strip of bark protects growing tissue. Erosion has polished the dead wood. Distant snow peaks of the Sierra Nevada wall off Pacific Ocean moisture from Owens Valley and the White Mountains.

Kodachromes by W. Robert Moore, National Geographic Staff © N.G.S.



Living Monuments on Methuselah Walk Rival the Great Pyramid in Age

Pinus aristata, the bristlecone pine, seems to survive because of adversity. All the older individuals in the White Mountains are found near 10,000 feet in a dry, rocky wilderness. Denied spurts of youthful growth,



such trees cautiously add no more than an inch to their girth in a century. With so little tissue to nourish, they can afford to shut up shop almost entirely during lean years. In such times they may produce no cones and lay down no rings except on narrow strips of the stem. Dr. Schulman gave the name Methuselah Walk to this part of the White Mountains after discovering here the oldest known living trees.

Douglass determined the age of Pueblo Bonito, New Mexico, in what is now Chaco Canyon National Monument. These expeditions pushed back the Southwest's historical horizon to more than 800 years before Columbus.*

The Indians naturally preferred tall, straight young trees for building timbers. They rarely bothered with the gnarled veterans that here and there clung to a dry sandstone ledge.

Driven, however, by an entirely different need, we began sampling such "worthless" veterans. We were looking for old trees whose growth rings might give us a longer and more sensitive history of past droughts.

Underprivileged Trees Live Longest

At once it became evident that precisely under such difficult living conditions trees not only showed the expected high sensitivity to rainfall, but were able to live far beyond the normal life span of more "fortunately" located individuals of the species.

There came a day when we could point, for example, to an inconspicuous Douglas fir clinging to a narrow ledge near Mesa Verde National Park headquarters and say:

"That slender tree only 20 feet high began its life about A. D. 1375. It has seen several generations of Douglas firs, like those now bordering the creek bed below, grow to magnificent size and then rot and die, while it remains sound to the core."

And later it was a thrilling experience to find, sample, and date a cliff tree in Navajo Canyon near by with a life span reaching back to the time of the cliff dwellers of Mesa Verde, abandoned forever about A. D. 1290.

An 860-year ponderosa pine in Bryce Canyon National Park, a 975-year piñon pine in central Utah, and other grand veterans gave us continuous tree-ring histories of annual rainfall much longer than we had once thought possible. But after many years of hunting and sampling old trees throughout the semiarid West, it began to seem that we were approaching the absolute age limits for rain-sensitive dwarf trees in this region.

Then, at the very end of the summer field season of 1952, an entirely unexpected find opened up new possibilities. Sampling a stand of old Douglas firs above Sun Valley, Idaho, we found an alpine-type limber pine with one side completely dead. The core from this tree could not reach center but seemed to have an unusual number of rings.

That night with the aid of a flashlight at our camp below, I cut a surface on the sample and examined it more closely. I was astonished to find that the 16-inch core contained some 1,400 years of datable growth rings. Later we found that this limber pine was almost exactly 1,650 years old.

But it was in the 1953 field season that the dazzling possibilities of new and fantastically long records of year-by-year rainfall in alpine trees became apparent.

Prof. Frits W. Went, of the Earhart Plant Research Laboratory at the California Institute of Technology, joined me on another visit to the unusually old pines of Sun Valley, and we spent most of one day in cutting down, for detailed laboratory analysis, the 1,650-year pine discovered the preceding year. The next day, with the help of the Forest Service, we piled much of it into our truck and took off for Pasadena, where I was working at Caltech on a year's leave from the University of Arizona.

On our homeward drive we detoured into the White Mountains of California, to check on a rumor that old trees existed there. Often such rumors had turned out to be unfounded. But not this one!

"Patriarch" a Mere 1,500 Years Old

In this portion of the Inyo National Forest a multiple-stemmed bristlecone pine tree some 37 feet in over-all circumference near the base had been reported some years earlier by the local ranger, A. E. Noren, who had named it the Patriarch (page 362). We sampled the Patriarch and found it to be about 1,500 years old, but with the typically insensitive ring growth of upper timberline.

More exciting was our discovery that on drier sites near by lived 1,500-year-old bristlecones—upper-timber-zone trees—which were better recorders of drought years than even the Sun Valley limber pines.

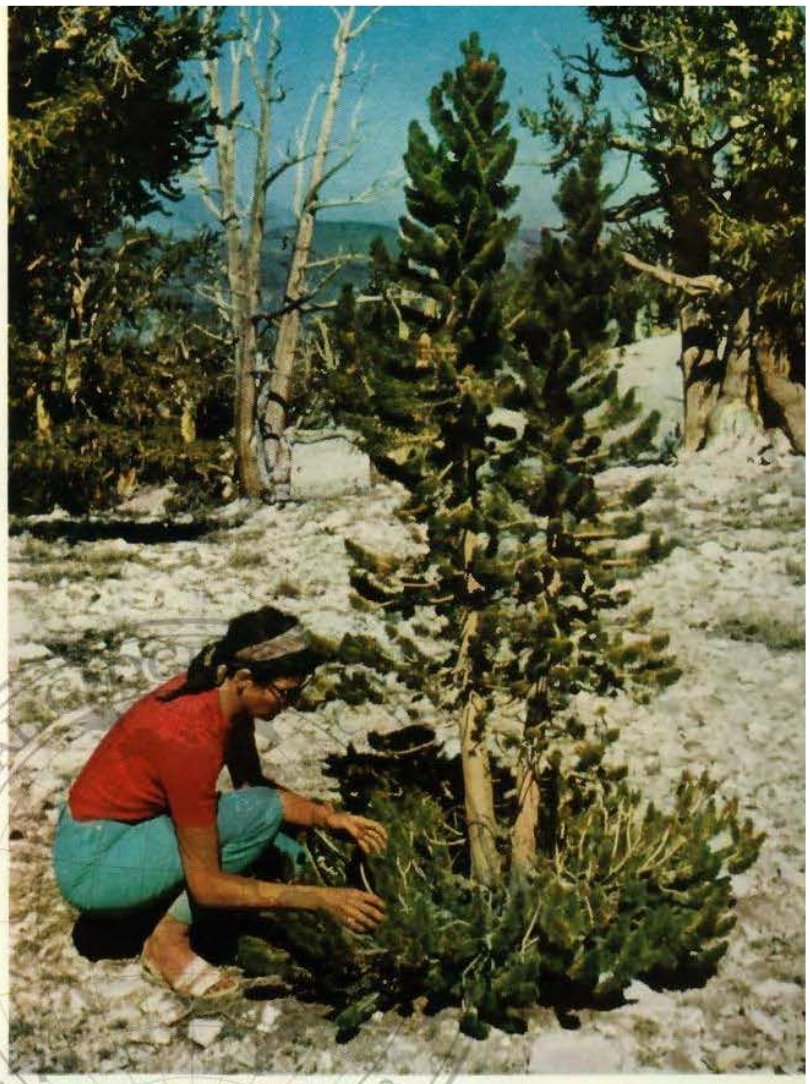
Sampling the stem of a very old bristlecone pine, however, proved quite a problem, for many of them are completely unorthodox in shape. Instead of the familiar circular cross section, these trees are distorted so greatly that often it is a major puzzle to locate the early portion of the stem. The strip of living tissue in an old, eroded stem may now be growing in a direction at right angles to its direction a millennium ago.

How was I to get a complete sample from bark to center in such a tree? The available borers were not designed to go around a bend!

* See "Secret of the Southwest Solved by Talkative Tree Rings," by Andrew Ellicott Douglass, NATIONAL GEOGRAPHIC MAGAZINE, December, 1929.

Green Wreath Encircles a Youngster of 50 Years

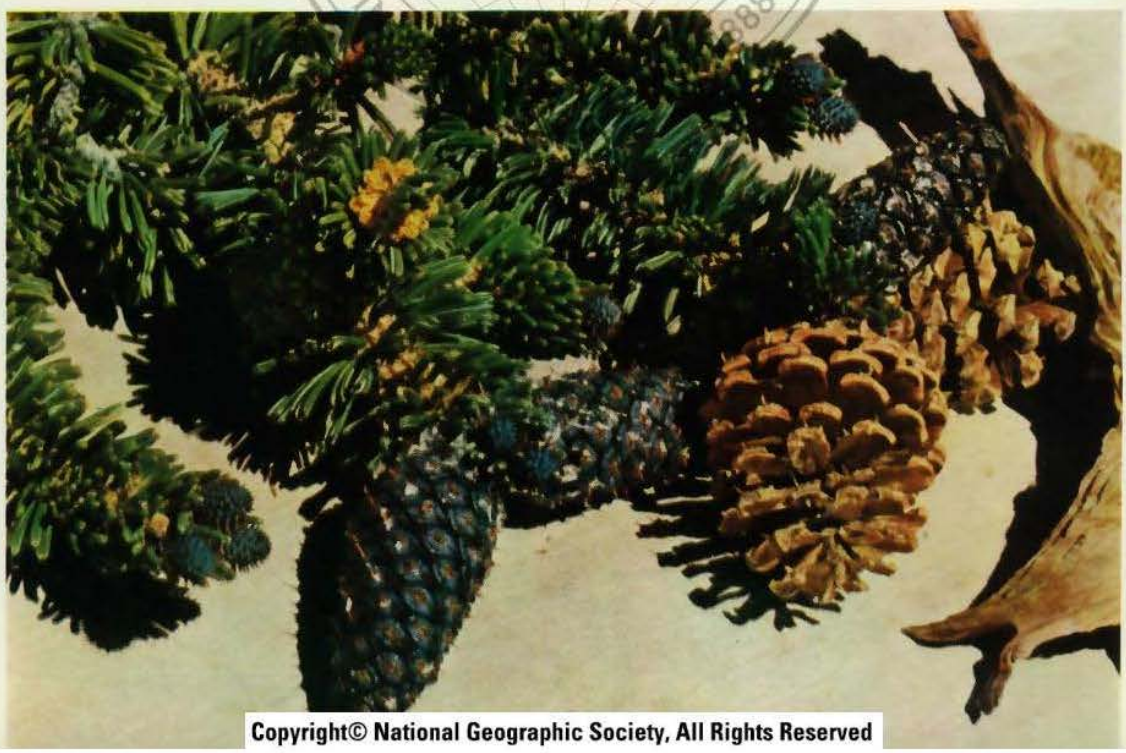
Two stems vigorously compete for the lion's share of the tree's nourishment. During drought the branches growing at the base may be first to wither; next the weaker of the two stems may die. The stronger may finally drop all except one limb to sustain a thin trickle of life. Or all may live on for centuries and produce a grove-like cluster such as the Patriarch (page 362).

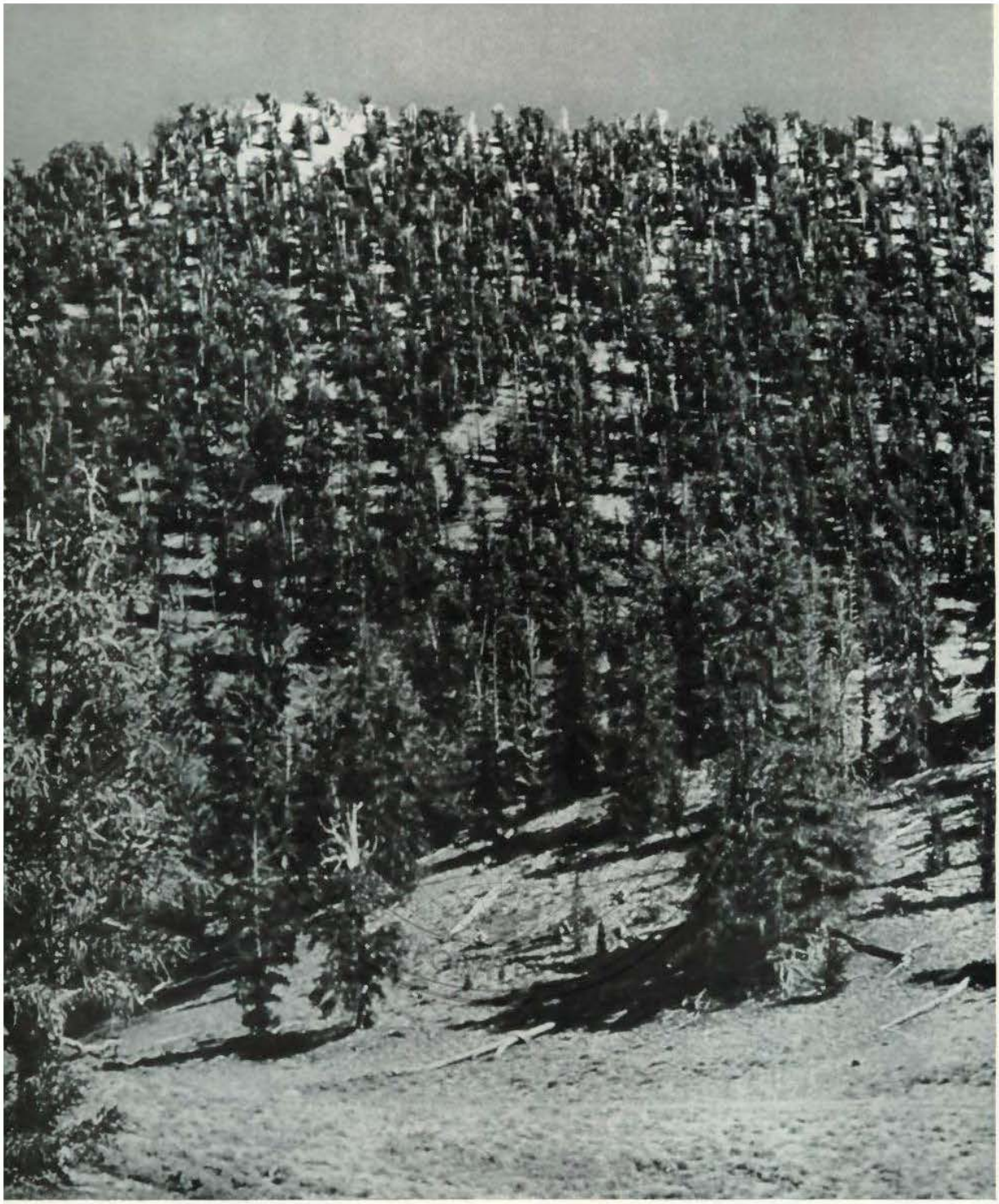


Three Crops of Cones Ensure Fresh Progeny

Dry brown fruit are last year's issue. This season's purple cones stand within a month of maturity. Creamy male cones at branch ends will pollinate young female cones for next year's offspring.

Bristle-tipped scales of the fruit give the tree its name.

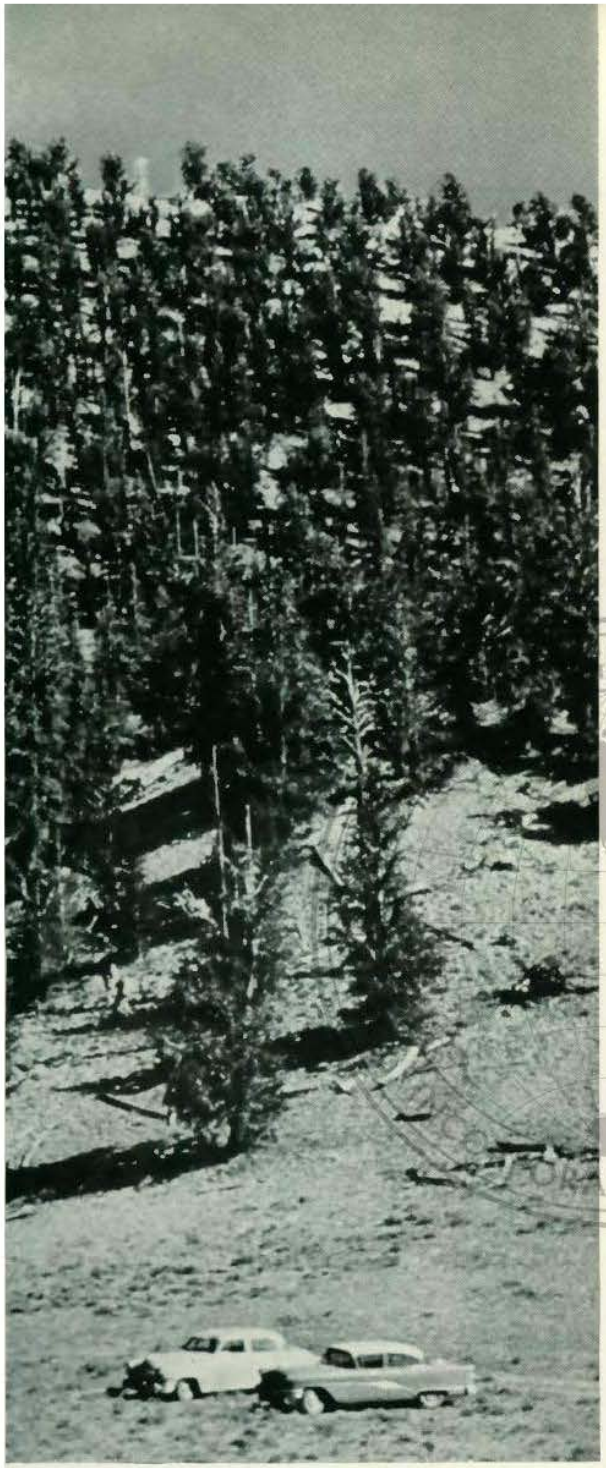




California's Arid White Mountains, Home of the New-found Methuselah Trees; Bristlecone

The tree itself offered the solution, for we could get a *series* of borings around the stem, first through the bark and then through successively older parts of the eroded area. In the long dead and dry but very resinous wood our live-tree borers worked! These cores were consistent enough in ring-width patterns to be dated by overlap matching, just as the rings in the pueblo beams were matched and dated against rings in living trees.

Laboratory study of the collection of drill cores obtained in 1953 soon convinced me it would be desirable to sample representative stands of bristlecone pines all the way from



Pines Grow Only in the American Southwest

California to Colorado, and this was done. By 1956 we knew for a fact that we had here trees in the 4,000-year-plus class, incredible though it seemed. We also knew that bristlecone pine trees were able to reach highest ages and greatest growth sensitivity at the western limit of their range. Nowhere have trees yet been sampled which approach the top ages of more than 4,500 years found in the White Mountains region of the Inyo National Forest.

In the more extensive groves of bristlecone pine in that range, trees of all ages can be found, but on the driest and most adverse sites it is easier to find a very old tree than a very young one! Even the slender little stem which looks like a sapling may show several hundred annual rings on the few inches of core from bark to center (page 365).

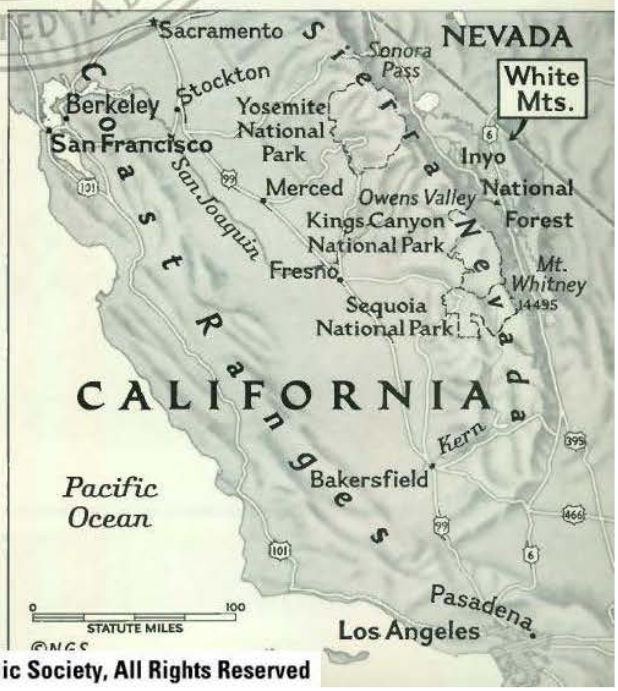
In 1956 we sampled what we thought would be plenty of White Mountain bristlecones to get our precise dating back into the earlier millenniums; we had already carried it back to A. D. 250. But we picked up only about 200 years during the following winter's laboratory work, and could go no farther. We had hit what we began calling the "B. C. barrier."

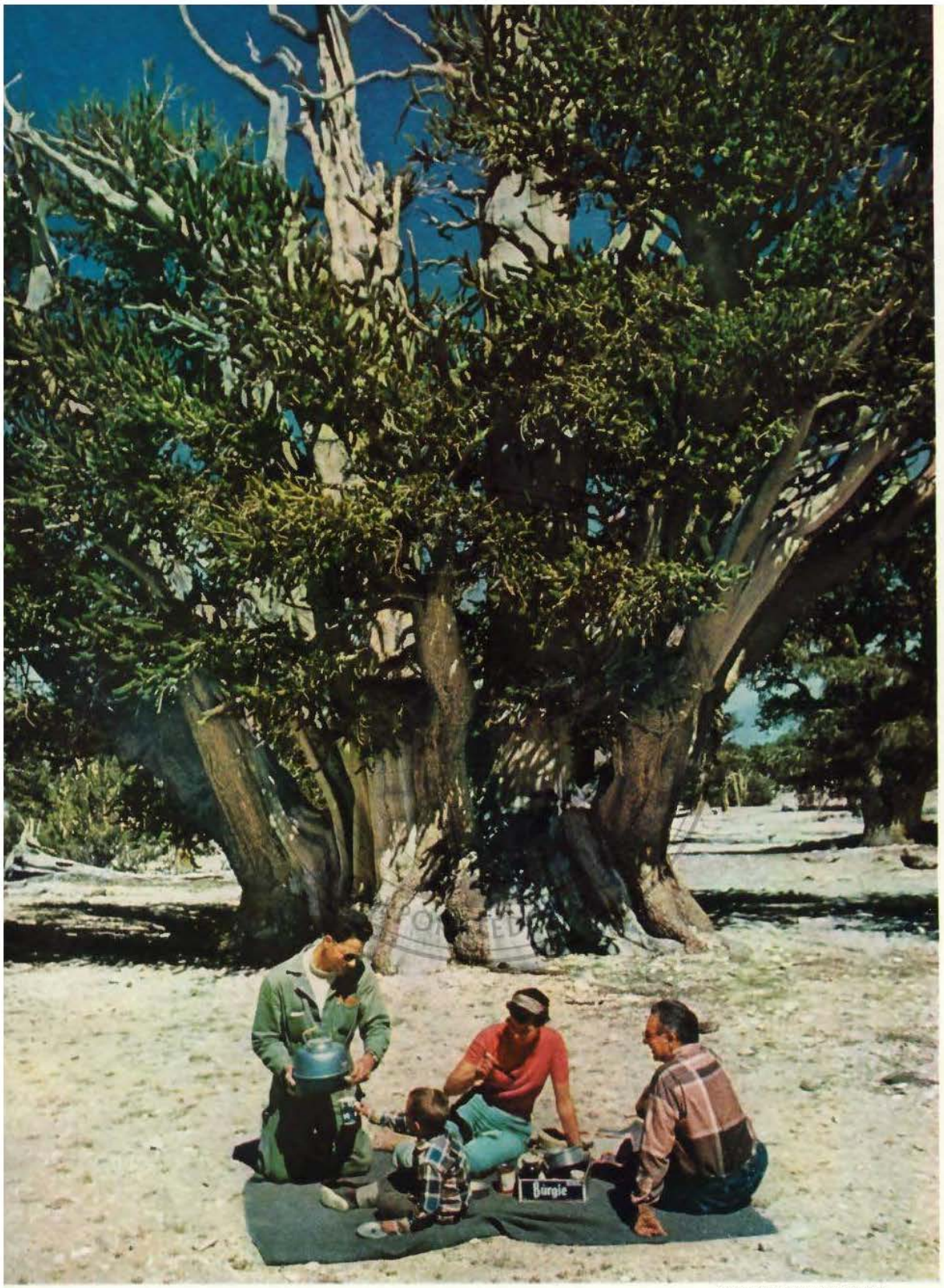
Methuselah Walk Found in '57

Many more samples were needed, and thus we planned a major field survey for the entire summer of 1957 in the driest parts of the White Mountain bristlecone forest.

As in 1956, this was made possible by a grant from the National Science Foundation. I had the valuable assistance of geologist M. E. Cooley, nicknamed "Spade," and just where we had hoped to find it, we came upon Methuselah Walk.

Here was a marvelous combination of the conditions apparently favorable to the great longevity we were looking for: the farthest limit of the dry forest edge, outcroppings of calcareous rock, and little rainfall—probably





Largest Bristlecone Combines a Grove of Trees with One Root System

The Patriarch is not the oldest pine in Inyo National Forest; its age is a mere 1,500 years. Favorable conditions allowed it to attain a circumference of 37 feet, yet the top failed from starvation. The author (right) and friends break their tree study with a picnic.

no more than 10 inches a year. These were just the trees we needed to date the bristlecone chronology of rainfall well into B. C. times.

After weeks of work along Methuselah Walk we found ourselves thinking of these oldest individuals as tending to belong to one of three rough types, or forms. There was the "massive slab" type, like Pine Alpha (page 371). There were many of the "eagle's aerie" type, with numerous spreading snags. And, finally, there was the "pickaback" type, which we have found nowhere else.

The pickaback is a type of old bristlecone pine which can usually be sampled almost or right to its heart in a straight line through the small strip of remaining bark, if one starts low in the stem. Yet above this, near eye level, there are several separate stems. These are joined in what seems to be pickaback fashion, and it is easy to see three such stems as a Junior-Dad-Granddad sequence.

Microscopic examination of the first cores from one of these trees, which we soon got to calling the Great-granddad Pickaback, was another of those exciting events which this rich species can so bountifully provide.

Great-granddad Proves Oldest of All

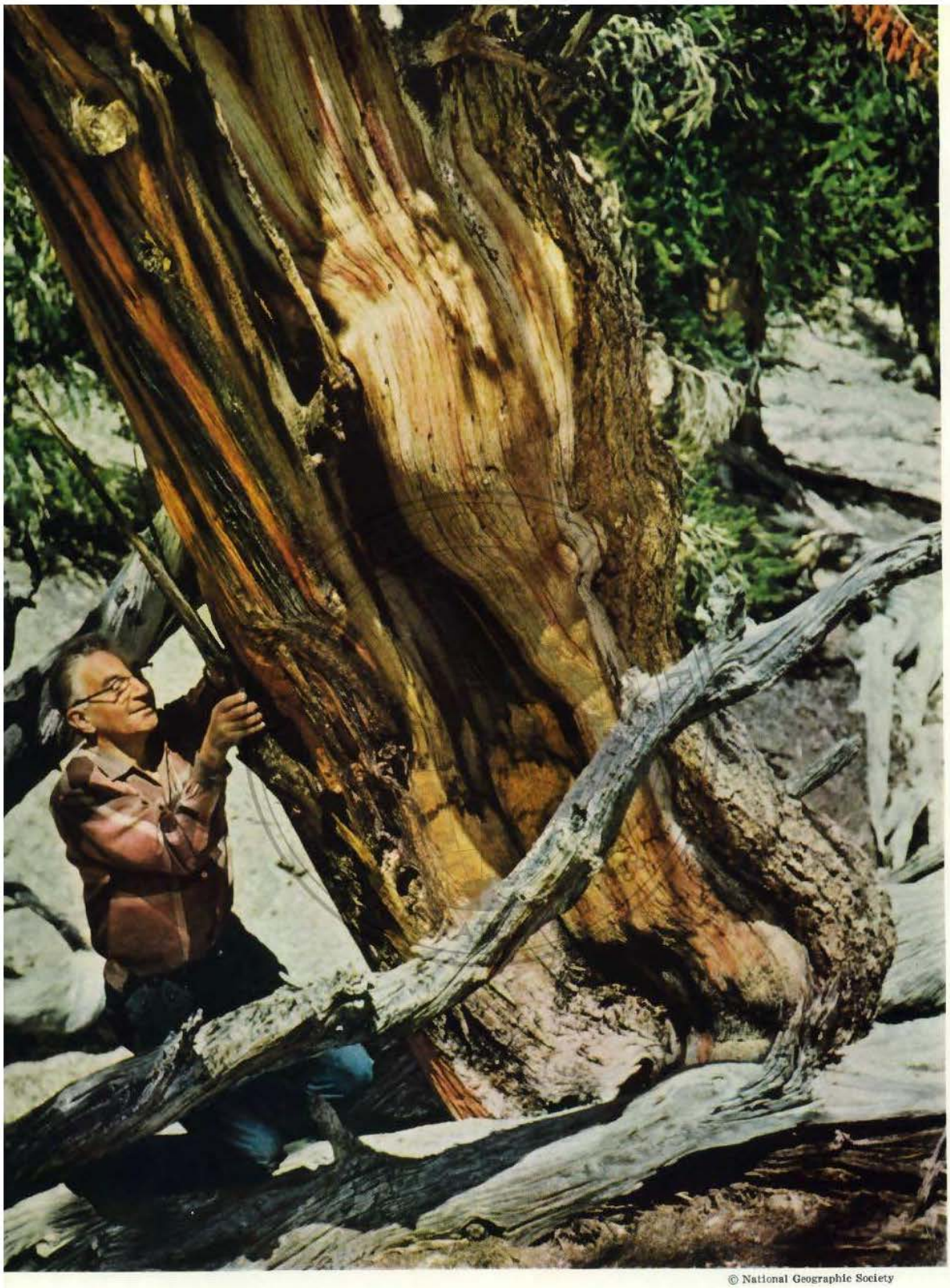
We had broken our lonely camp, an hour by foot from Methuselah Walk, and driven along the plateau some miles to the White Mountain Research Station, now principally under the direction of the University of California at Berkeley. Here were good companions, welcome bunks—and a well-stocked freezer!—at over 10,000 feet.

That evening I had our long cores from Great-granddad under the lens, and as I dated

Four Thousand Years March Across the Face of This "Pickaback" Pine

As a sapling, about 2000 B. C., the tree formed the ring near the point numbered 1. Point 2 indicates growth about 500 B. C., when the Persian Darius was mobilizing to fight the Greeks. Charlemagne's survivors were quarreling over the pieces of his Holy Roman Empire when the bristlecone laid down the ring at point 3, now precisely dated A. D. 828. The outermost ring at 4 grew in 1957, the year the tree was cut for study. This is part of the tree from Methuselah Walk (page 366); its lower surface shows an unbroken series of rings.

Tree-Ring Laboratory



A Short Spike Marks the Heart of the Oldest Known Living Tree

This pine has survived more than 4,600 years; missing rings make precise dating difficult. Dr. Schulman calls it a pickaback tree because new growth has mounted the old through the ages. Here he grasps "Great-granddad," the primary stem. "Granddad" (center) shows a hollow. "Dad," the next layer, is dying. Bark-covered "Junior" (right) keeps the tree alive.

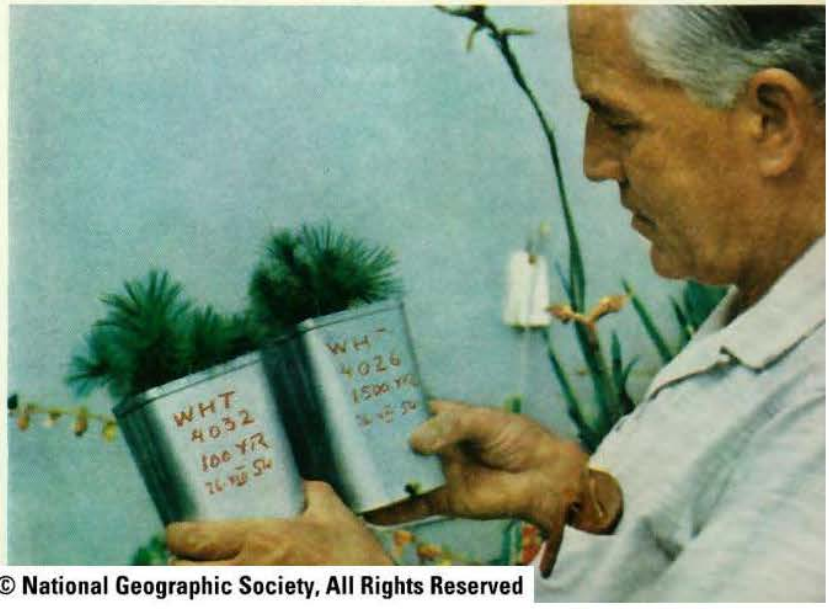
Coring Tool Extracts Capsuled History from a 700-year-old Dwarf

Surrounded by larger trees, this bristlecone pine ekes out a meager living. Three-inch-thick trunk and three-foot height are all it has to show for centuries of struggle. Dr. Schulman's corer will leave no permanent hole in the bark; the tree's resin heals such wounds.

Seed from an Old Pine Grows as Vigorously as That from a Youngster

Dr. Frits W. Went, in charge of the Earhart Plant Research Laboratory at California Institute of Technology, holds baby pines he grew from the cones of a 100-year-old and a 1,500-year-old tree.

By varying growth conditions artificially, Dr. Went hopes to learn whether old bristlecones differ basically from young ones.



the outer centuries of rings and then went on to a quick count of the earlier rings, unusually crowded even for bristlecone, I felt excitement rise, for we were rapidly piling up the centuries. And when I got to within one inch of the inner end of our cores, I fairly shouted at my colleague working across the table.

"Spade, we've got a 4,000-plus tree with the center present!"

This was the first of all our four-millennium trees which had not eroded past the center.

More exact work later showed that the Great-granddad Pickaback had begun growth more than 4,600 years ago. Thus it stands right now as the oldest known living thing (page 364).

To determine the life history of this strange pickaback form of tree, we hardened our hearts and, at the very end of the field season, cut down a similar but somewhat younger specimen for detailed study. Spade and I lugged the bulky logs out of the canyon on a stretcher. After a five-hour struggle, we got them to our car and headed for home.

With polished surfaces to study, we found that Junior, the youngest stem, was not at all a direct low branch of Dad. On the contrary, for far more than a millennium one of Dad's primary branches remained suppressed near the ground, its twigs producing offshoots which in turn produced others in an innumerable succession.

At last, about A. D. 800, one of the newest offshoots was freed, perhaps by the dying away of Dad's branches above, and it soon became the dominant and eventually the sustaining stem-branch of the tree. And this was how Dad got started, too, some 1,500 years after the birth of Granddad, the original seedling, about 2000 B. C.

"But Don't Touch General Sherman!"

Of course, *Sequoia gigantea*—the "big tree" of California—has long been considered the oldest living thing. Its tall relative, the coast redwood, *Sequoia sempervirens*—despite its ever-living name—attains ages only roughly half or two-thirds as great, with a maximum around 2,200 years.

More than 45 years ago the rings on hundreds of giant sequoia stumps throughout the heavily lumbered Sierra Nevada forests were measured by Ellsworth Huntington and his crew of woodsmen. Three thousand or more annual rings could be counted on four of the stumps.

Later, more exact ages were derived after a detailed cross-comparison of the rings in these trees by Dr. Douglass. On the oldest one, which had been cut down in 1892, the earliest ring dated at 1307 B. C. This oldest precisely dated sequoia must have sprouted about 1320 B. C.; it was 3,212 years old.

But what about that burned-out old sequoia snag on which John Muir counted some 4,000 rings, back around the 1880's? Alas, no one could later find the stump and verify the count. Muir himself emphasized that the rings were very distorted in many places. And in his day the science of precise ring dating was still undeveloped. One hesitates to question that grand observer, yet there is a disturbing gap in age as compared with the oldest exactly dated sequoias.

And what of the large standing sequoias?

Some years ago I got permission from Col. John R. White, then superintendent of Sequoia National Park, to take increment borings in living sequoia trees. "You're welcome to sample any other tree in the park," he said, "but don't touch General Sherman!"

Since the standard borer is barely long enough to get through the General's bark, this was not a serious restriction. Besides, Dr. Douglass had studied this tree's growth by sampling burned areas in it decades ago, and had estimated its age at possibly 3,500 years.

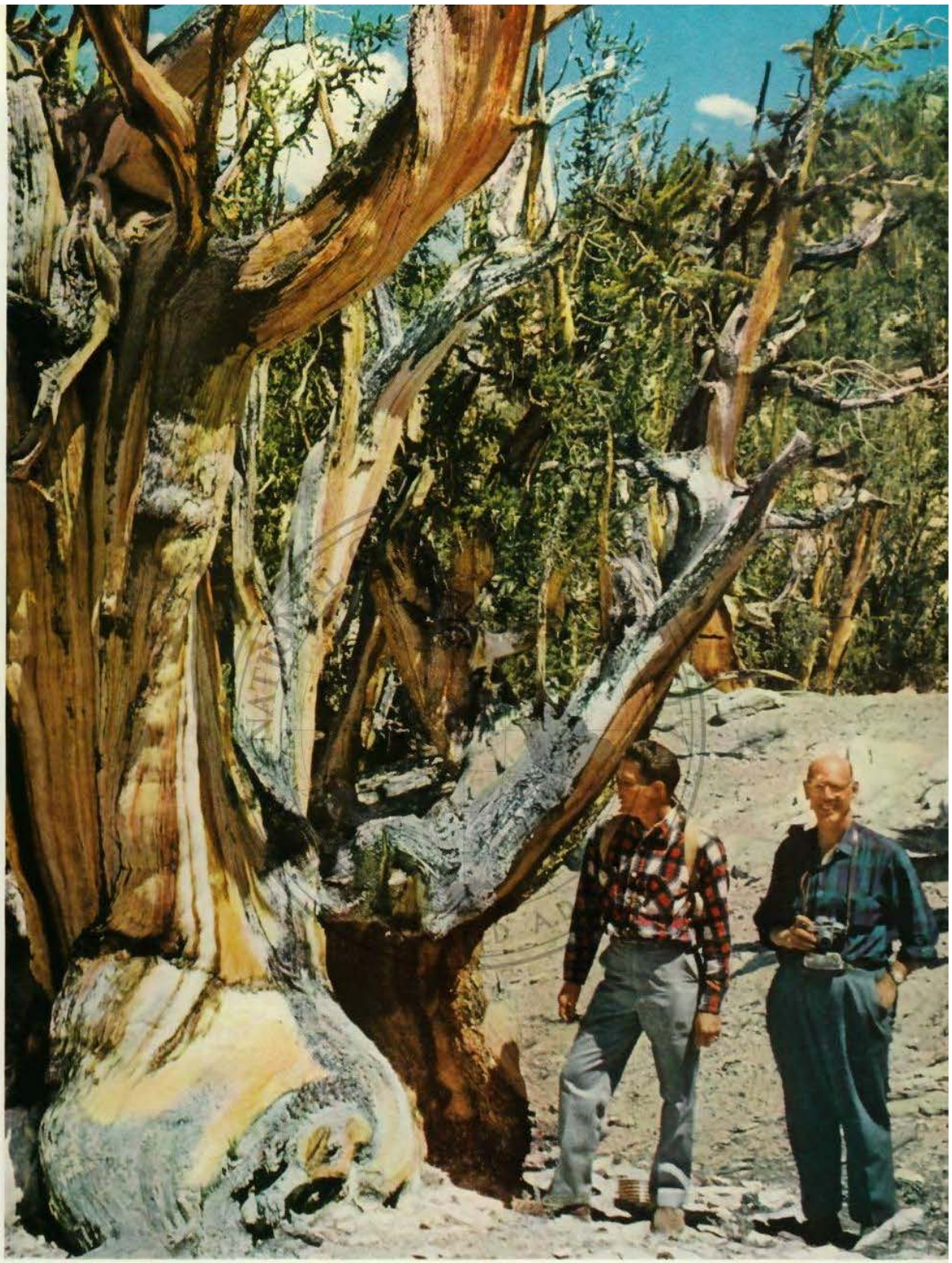
Sequoia May Win in the End

Our borings indicated that in this species the biggest trees are likely to be the oldest. Until deep borings are made in the biggest ones, we will not know whether any living sequoia is older than the oldest that have been cut.

In *potential* life span the giant sequoia seems to come back into first place, for the General Sherman Tree and most other mammoth sequoias appear to have little or no decay. Barring accidents like out-of-balance toppling or a series of great fires, mature sequoias living now could well be living still, in their protected parks, in A. D. 5000.

By that time the oldest living bristlecone pines will surely have long since gone. For these oldest pines have in a certain sense been dying for two millenniums or more. They now possess only a narrow strip of their once complete bark and the growing tissue beneath it. True, the dying-back of this life line is exceedingly slow, and several of them seem good for at least five centuries still. But they probably cannot live much more.

It is curious, and perhaps significant, that the oldest bristlecone pines and the oldest giant sequoias are neighbors separated by



Kodachrome by Edmund Schulman © National Geographic Society

Wind-blown Sand and Ice Give Dead Wood the Luster of a New Board

Among trees of the upper timber zone, the bristlecone shares with the limber pine the only known ability to record rainfall by the size of its rings. This 3,000-year-old added rings so faithfully and accurately that Dr. Schulman uses it as a key to date other trees. The forest is so resinous that its exudations gummed the camera lenses of W. Robert Moore (right), veteran chief of the National Geographic Society's Foreign Editorial Staff.

only a few score airline miles. About the same distance away, in Yosemite National Park, stand millenniums-old trees of still another species, the western juniper. John Muir, before the turn of the century, put the age of the gnarled giants above Yosemite's Tenaya Lake at 2,000 years, and our own studies of these and the junipers near Sonora Pass not far to the north suggest a maximum age of at least 2,500 years. Does California have a kind of maximum-age monopoly?

Although trees of various other species throughout the world have been estimated to reach ages in the thousands of years, none has yet been definitely verified by careful study to be in the 3,000-year class.

In 1943 I had a chance to see the magnificent cypress in the churchyard of Santa María del Tule near Oaxaca, Mexico. It inspires enthusiastic overestimates of age. But if we judge by the growth on a wind-felled branch, measurements of increase in girth of the stem, and the plentiful underground water supply, an age estimate of 1,500 years is probably very optimistic, even if this is not the triplet tree it is believed to be.

Mere Size Does Not Mean Age

During a forest sampling survey in the southern Andes some years ago, I made an effort to find the oldest *Fitzroya*, locally called "alerce," a wet-forest tree very similar to our coast redwood. Some of the alerce we sampled were found to be in the 2,000-year class—a respectable age, certainly, but only about half the reputed maximum.

One is tempted to suggest a general rule: if a very large tree, anywhere in the world, grows in a flattish area and its roots tap very moist soil most of the time, then it probably does not have the age to which its size seems to entitle it.

It appears that there exist throughout the world two general categories of very old trees. One consists of the giants favored by plenty of water. In the other are battered dwarfs managing to eke out a minimum living in a very adverse environment. And the oldest dwarfs outlive the oldest giants, at least today in the American West.

Can the bristlecone pines tell us something about the causes of great longevity in trees? We do not yet know, but there are promising leads.

In an open grove of old bristlecone pines many of the trees are full of heart rot and some are only shells. But here and there is one that is almost or entirely sound, and it is older than the others. Always this sound tree is extremely resinous. Perhaps the chemistry of the resin in the oldest individuals is different from that in the average bristlecone. Or it may be merely the especially heavy concentration of resin that has enabled the tree to ward off decay.

In the oldest bristlecones, growth has been exceedingly slow almost from the very first year, in contrast to larger but younger pines, which show fairly fast growth in the early decades of life. Does this indicate anything more than the fact that the oldest pines are found only on the most difficult sites?

Would the seeds from an eroded old bristlecone pine tree germinate? Near such an old pine stood a slender but tall young tree we found to be just over a century old. Perhaps it was a descendant of the old one. We collected cones from both. Later, Professor Went processed seeds from these trees in his controlled-environment laboratory. And sturdy though tiny seedlings from the old as well as the young trees appeared (page 365).

Some of the old trees have been adding only an inch or less of rings per century throughout their long lives. There is something a little fantastic in the persistent ability of a 4,000-year-old tree to shut up shop almost everywhere throughout its stem in a very dry year, and faithfully to reawaken to add many new cells in a favorable year.

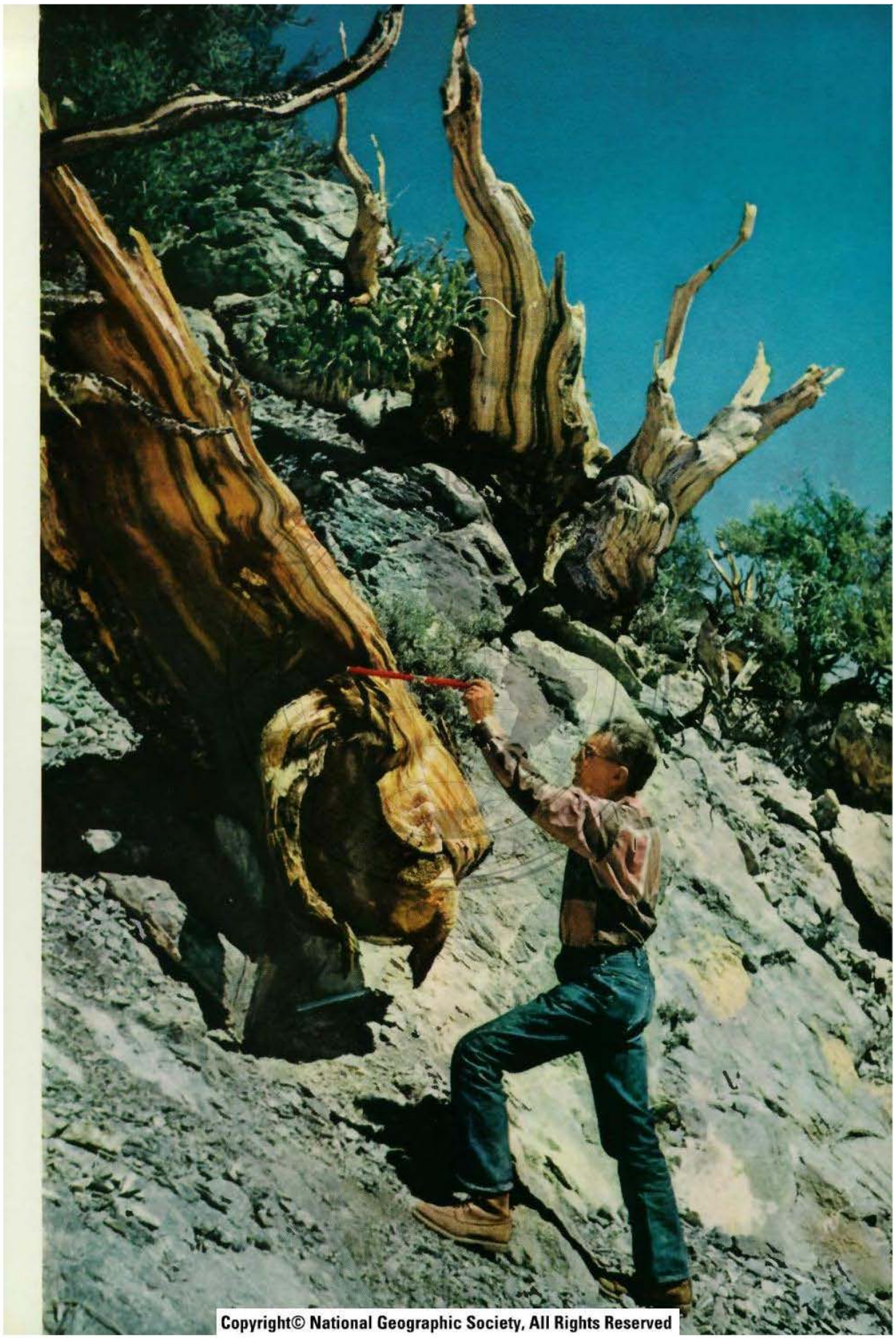
Like a brief visit of a reporter to a new country, our sampling of a thousand bristlecone pine trees is far from enough to get the whole story. And with each field trip these very rich trees have given us more questions than answers.

Maybe we cannot hope to find bristlecone pine trees very much older than those we have found already, for the days of the oldest studied are obviously numbered. But when research has been carried far enough in these Methuselah pines, perhaps their misshapen and battered stems will give us answers of great beauty.

Like Battered Derelicts on a Beach, Living Driftwood Clings to a Cliff

These two bristlecones have been neighbors more than 40 centuries. The author's corer points to the spot where earth once covered the roots of one. Erosion cut away the limestone, leaving the exposed base to die. Roots on the upper side of the slope keep the tree alive. Another face of the far pine appears on page 354; green branch testifies that sap still flows.

All Kodachromes by W. Robert Moore, National Geographic Staff © N.G.S.

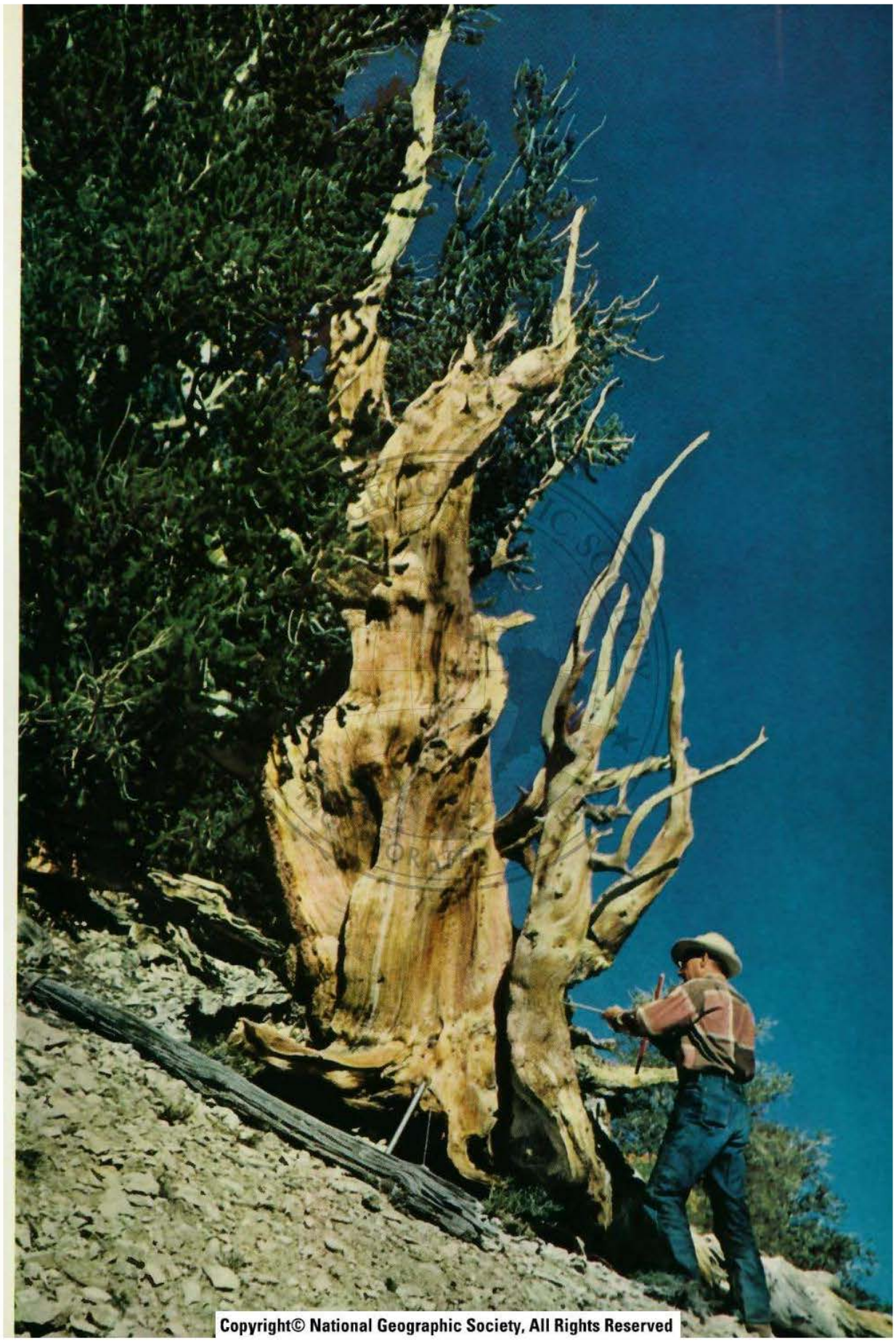


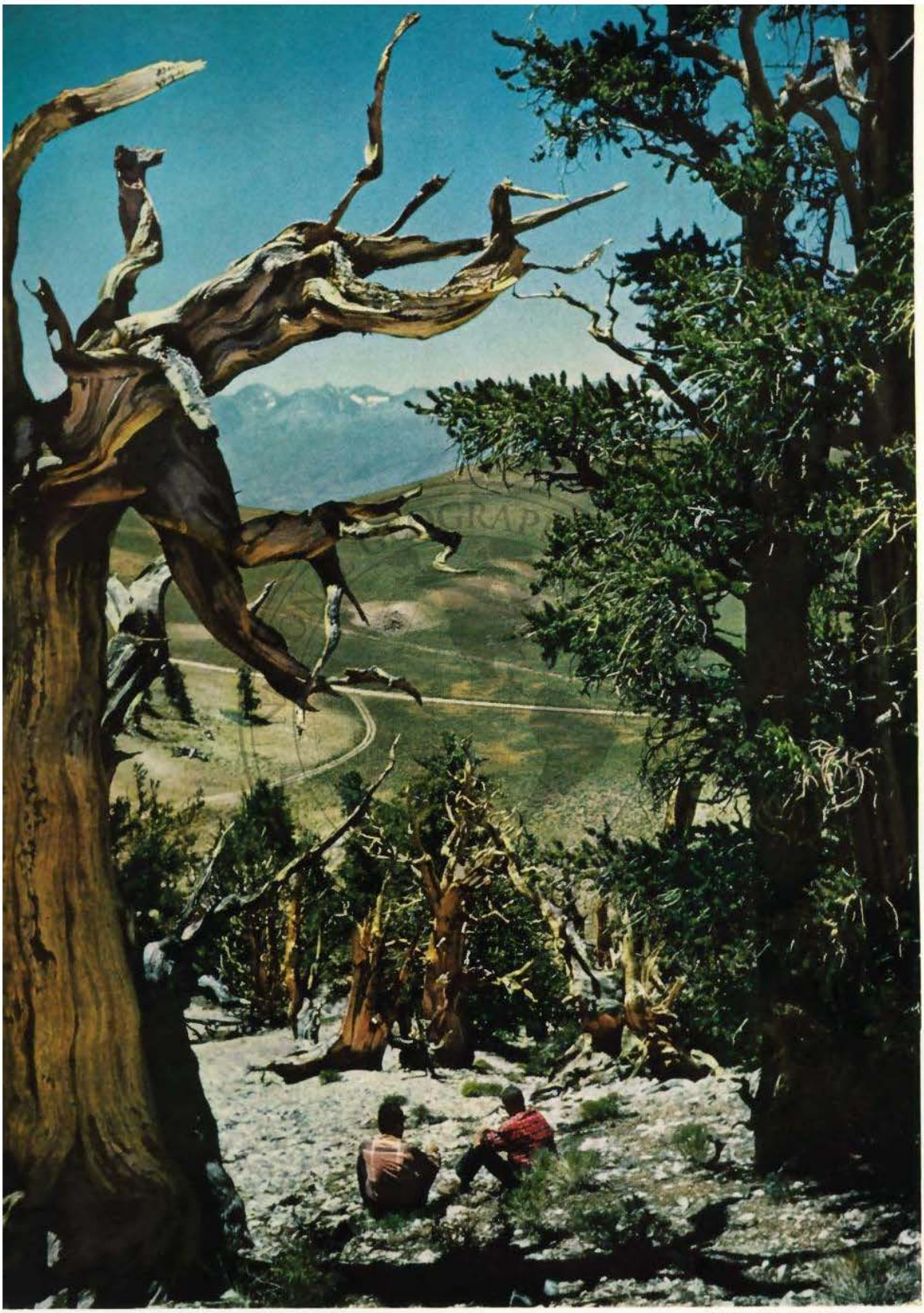
Dr. Schulman reads history with a microscope. His assistant glues and ties a pencil-slim tree core into a troughed stick. When the glue hardens, the mounted core will be shaved with a razor and swabbed with kerosene to make its rings distinct under the lens.

Swedish borer cuts an unbroken core from the heart of a tree. Crosspiece is used to twist the thread-tipped instrument into the wood. Dr. Schulman withdraws the core remover, retrieving the sample intact. Some bristlecone pines require special borers up to 40 inches long.

Pine Alpha Yields Another Core to Solve the Enigma of Its Life

This bristlecone is named for the initial letter in the Greek alphabet because it was the first certified to be older than 4,000 years. Many chapters in its story still await revelation. Its distorted growth precludes the simple sampling—a single core from bark to heart—possible with most trees. Scientists had to take cores at different angles and match rings in parts of cores that overlapped one another.





A Ghost of the Forest Lifts Bony Fingers to the Sky. Sierra Nevada Rises in Distance