

tends toward complacency with a few well-marked deficient rings that serve well from cross-dating. Number M-143 is also a Douglas fir extending from 90 to 358 A. D. and relatively free from injuries, and yet it has several narrow zones of reinforced rings that probably mean some special strain or injury in another part of the tree. Three pinyons, however, give us more detailed information regarding this interval, M-159, MLK-110, and MLK-153. M-159 is a core one inch in diameter, and therefore gives only a small part of the original circuit of the tree. Its record extends to a little before the year 200, but some disturbances in the rings, probably omissions, make its inner parts rather uncertain as a guide. MLK-153, however, gives an excellent record all through the 200's, and back to 150 A. D. (see cut), and while its rings become microscopic in ring size near the center, it has been possible to compare opposite radials of the tree and find a very satisfactory correspondence upon which considerable reliance can be placed. This dependability has been verified by MLK-110, a pinyon which has a reliable record after 235, giving a good account of features we know are there. It gives in addition an excellent record back to 199 A. D., judged by its agreement with MLK-153. The rings are smaller and A. D. 210, 214, 221, 225 and 229, which are small in MLK-153, are locally absent; 210 is taken as absent.

There are differences between pinyons and Douglas firs in their manner of record, but in following the pinyon we are probably getting much nearer the actual climatic sequence than if we limited ourselves to the two more complacent firs, and we have the advantage of the fairly complete circuits of the sections. In order to place these early rings on record a half-tone photograph is presented, made through a Zeiss epi-condenser with side illumination on a 45° cut across the grain.

AN EFFECT OF STARVATION ON PINE TREES

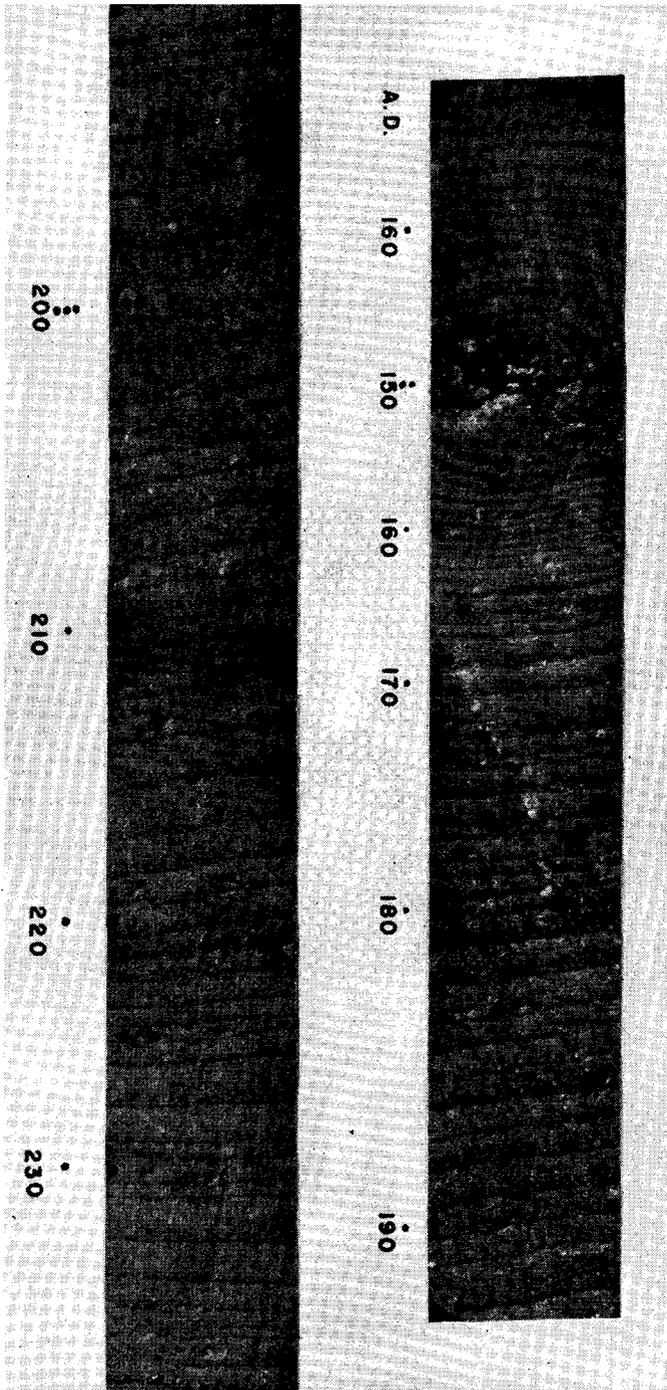
L. F. BRADY

The material on which this paper is based was observed and collected in the course of an unfinished investigation of the effect of plant growth in the disintegration of the dacite boulders at the foot of Elden Mountain near Flagstaff, Arizona.

Five dwarfed pine trees (*Pinus ponderosa*) were found growing in small holes in these boulders, (see cut) and all of them proved, as was expected, to be unusually old for their size; although, owing to the probability of the presence of double or even multiple rings, it is not possible to give their actual age until further microscopic examination of their rings has been completed.

The rock on, or in, which the trees in question grew is a hypersthene-soda dacite, and its surface is characterized by cavities, often with overhanging edges, ranging in capacity from a few hundred cubic centimeters upward, and in depth up to 50 cm. These cavities, only the smaller of which contain much soil and vegetation, appear to be due to the weathering of portions of softer, "drusy" layers in the rock, which may represent old flow surfaces. The soil in the cavities consists largely of unaltered fragments of the rock with about 60% of rock-dust and humus—the former resembling closely that found under the lichens which cover much of the surface of the boulders and being probably due to their action.

As the growing level of the trees was in every case 50 cm. or more above the ground, there is very little probability of any water being available to the roots by capillarity from below through so massive a rock as dacite. As a result the trees were dependent for moisture on the rain

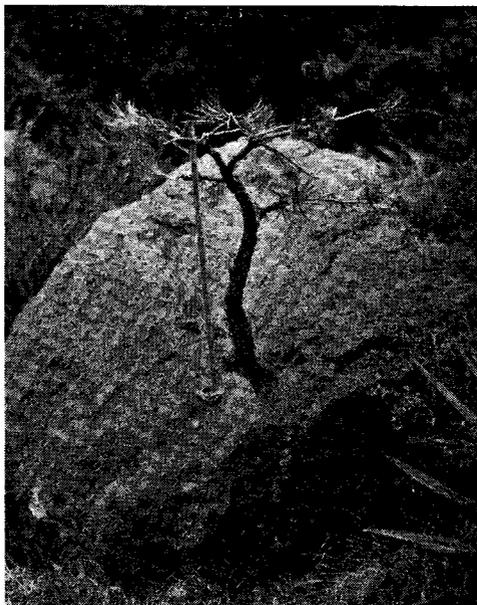


MLK-153, Pinyon, Obelisk Cave, Red Rock Valley, Northeastern Arizona. Magnification about 14 diameters.

which fell on the actual rock surface—and in all probability only a small part of that soaked into the soil pockets in which the trees could reach it. Examination showed that within a few days after a shower the soil in these cavities was “dust dry,” so that one might expect a careful exami-

nation of the rings to show that many of them are multiple, representing growth during several wet periods within a single year and cessation of growth during the intervening droughts.

After each tree was cut at the ground level, the cavity was washed out as completely as possible with a portable pressure pump, the larger rock fragments picked out, and the volume of the pocket measured roughly by filling it to the original soil level with water from a graduated vessel.



A twenty-five year old Western Yellow Pine growing in a natural rock cavity near Flagstaff.

Where possible the boulder was then split with chisel and wedge, and search made for penetrating roots.

Portions of these specimens have been sent to Dr. A. E. Douglass for further examination.

The following field notes will give an idea of the growing conditions of the five specimens:

No. 1. Marked as "seedling," August 1933. Resembled a two year old tree when collected in June, 1937. Volume of soil, 400 cc.; area of drainage, large.

No. 2. About 30 cm. high; no measurable increase in height in the last two years. Volume of soil, 1100 cc.; area of drainage, 1300 square cm. Age 12+ years. Diameter (without bark) 14 mm.

No. 3. No previous observation; shows spiral thickening of rings. Height 25 cm.; volume of soil, 500 cc.; area of drainage about 2000 square cm. Diameter, 12 mm. Age ? 20+ years.

No. 4. Extreme case of starvation; foliage much reduced. Volume of soil, 350 cc.; area of drainage, 500 square cm. Age 10-12 years. Diameter 5 mm.

No. 5. No change in size or appearance since first seen in 1934. Volume of soil, 850 cc.; area of drainage, 4500 square cm., (but most of the rain must have overflowed the soil area). Foliage about 25% of normal tree of similar size. Diameter 33 mm., height 60 cm. Age, 25+ years.

These trees were obviously growing under extremely unfavorable conditions as regards soil and moisture—in effect they were “pot-grown” specimens—and their abnormally slow growth may be due partly to recurrent drought and partly to a deficiency of nitrogen and sulphur, neither of which are present in the dacite. The amount of these elements supplied by the humus formed by wind-deposited vegetable matter might well be insufficient for normal growth, even with an adequate water supply. Only one of the specimens showed any considerable penetration of the rock by roots. Tree No. 5 had a few roots penetrating the felsitic ground-mass of the rock to a maximum depth of 25 cm. Below the bottom of the cavity in which its main root system was, the material having been partly hydrated by percolating rain water.

The illustration of Tree No. 5 shows its strong resemblance to the pot-grown Japanese trees, which by careful and studied starvation are kept alive and apparently healthy to a great age, although completely dwarfed. The amount of soil in which this tree grew to an age of at least 25 years is less than that contained in a five inch flowerpot.

DATES FROM KING'S RUIN

GORDON C. BALDWIN

King's Ruin is located about 35 miles northwest of Prescott, Arizona, in Yavapai county. The ruin lies nine miles northwest of Midway Station on the property of the King brothers. This site was excavated during the summer of 1932 by an expedition from the Arizona State Museum under the direction of Dr. Byron Cummings.

The ruin stands on the west bank of Chino Creek, one of the headwaters of the Verde, at an elevation of about 4500 feet. House remains consist of 12 rooms, representing an original group of eight rooms with four additional rooms having been built later along the eastern and southern sides. Wall construction was massive, being of clay with a central core of river boulders, averaging two feet in thickness. From the amount of wall debris in the rooms and from the present height of the walls, from three to six feet, at least a part of the structure was originally two stories in height.

About 100 yards to the east of this group was a large refuse mound in which 55 burials were uncovered, together with the floor of a large oval pithouse and the remains of a second such structure.¹

The wall construction and ground plan of the village indicate a late Pueblo II or early Pueblo III period of culture, and this is borne out by the pottery. Ninety-five percent of the pottery is plain ware, chiefly Prescott Gray Ware, with a very little intrusive Elden Corrugated and Deadman's Fugitive Red.²

The five percent of decorated ware is mainly local Verde Black-on-gray and Verde Black-on-brown. Intrusive decorated pottery consists of Walnut Black-on-white, the most abundant type, Deadman's Black-on-white (this possibly is Holbrook Black-on-white), a few sherds of Wupatki Black-on-white from the later section, and a few sherds of Citadel and Kayenta Polychromes. Thus the dated pottery types range from Pueblo II through Pueblo III, from about 1000 to 1300 A. D. The

1. For complete details concerning the site see Spicer, E. H., and Caywood, L. R., *Two Pueblo Ruins In West Central Arizona*. University of Arizona, Social Science Bulletin No. 10, 1936.
2. See Colton, H. S., and Hargrave, L. L., *Handbook of Northern Arizona Pottery Wares*. Museum of Northern Arizona, Bulletin 11, 1937, for a complete description of the various pottery types listed above.