

Evolution and History of Giant Sequoia¹

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Abstract: Ancient ancestors of the giant sequoia (*Sequoiadendron giganteum* [Lindl.] Buchholz) were widespread throughout much of the Northern Hemisphere during the late Mesozoic Period. Climatic conditions changed, forcing the more recent ancestors of present giant sequoia into the southwestern United States. The native range is now restricted to the west slope of the Sierra Nevada. Although seen in 1833 the effective date of discovery by the Europeans was 1852. Soon after that specimen trees were cut, and then extensive logging removed about a third of the big trees. Preservation of groves started in 1864 and gained momentum in 1890 with creation of Sequoia and Yosemite National Parks. Numerous scientific studies have been conducted during the last century from paleobotany to genetics of these great trees, but much is still unknown.

EVOLUTION

The earliest close relatives of the giant sequoia (*Sequoiadendron giganteum* [Lindl.] Buchholz) were present in the Cretaceous Period (late Mesozoic) throughout much of the Northern Hemisphere (Chaney 1951). Because they appear to differ significantly from the present giant sequoia, they are not considered their immediate ancestors (Axelrod 1959). The oldest sequoia fossil (*Sequoiadendron chaneyi*) that is probably the lineal ancestor of the present giant sequoia is from the Miocene Epoch about 10 to 20 million years ago. The sequoia fossil not only resembles the modern giant sequoia, but the plants associated with the fossil are similar to those in present sequoia communities (Axelrod 1964).

During the late Miocene Epoch, the giant sequoia's ancestors were in what is now western Nevada. As conditions became cooler and drier, along with the rise of the Sierra Nevada, the survivors managed to prosper at the southwestern edge of the mountain range. Eventually they migrated to the western slope of the relatively low incipient Sierra Nevada and may have existed as isolated groves or as a continuous belt about 300 miles (482.2 km) long (Harvey and others 1981). Although the disjunct groves at present are genetically distinct, no firm conclusions can be drawn regarding the duration of genetic isolation (Fins and Libby 1982). And thus it remains unknown whether the giant sequoia followed isolated routes across the mountains or if it advanced on one broad front to be dissected into widely separated groves in the northern part of its present range.

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DISCOVERY

The earliest human encounters with giant sequoia probably occurred shortly after the first Native Americans arrived in North America tens of thousands of years ago. According to Hartesveldt (1975), in 1877 Powers recorded "that the people of the Mokelumne Tribe referred to the sequoia as 'woh-woh-nau,' which in the Miwok tongue was a word supposedly in the imitation of the hoot of an owl, the guardian spirit of the great and ancient trees." The interactions between people and the giant sequoia were thus benign for millennia.

When Europeans arrived on the scene things changed. In the mid 1800's the giant sequoia were first discovered by Europeans, even though colonization of the West had begun a century earlier and explorers had visited California two centuries before that. Two dates---1833 and 1852---are noted by Hartesveldt (1975) as landmarks. The Walker Party in late autumn 1833 crossed the Sierra Nevada and described "trees of the Redwood species, incredibly large---some of which would measure from 16 to 18 fathoms round the trunk at the height of a large man's head from the ground" (Hartesveldt 1975). In other words, at about 6 feet (1.8 m) up the trunk the diameter was estimated at over 30 feet (9.1 m). Probably it was crudely measured by counting people with outstretched arms as each equal to a fathom, and being on a slope possibly would account for such large estimates.

In the summer of 1852 Dowd, a hunter of meat for a water company, discovered giant sequoias in the vicinity of a lumber camp in the Sierra Nevada. As the story goes he returned to camp and told his incredulous tale of gigantic trees. But no one accepted his story, so he made one up that he needed help to bring back a giant grizzly bear that he had shot. The lumberjacks responded to that, and followed him to what is now known as the North Calaveras Grove (Harvey 1978). In June 1852 the *Sonora Herald* reported Dowd's discovery and the news travelled fast throughout the world (Harvey and others 1981). Then followed two reactions---one benign, the other malignant.

Several people claimed to have discovered the trees at an earlier date than did Dowd. But a mystery still unresolved is why no one from the Walker Party recalled their apparently valid earlier claim to fame. All those that did step forward claiming earlier discovery were suspect, for they reported dates later than 1852.

The other reaction was more dramatic and more significant in the history of the giant sequoia. To show the world that California really did have such huge trees, selected trees were stripped or cut down. The first to go was augered down in the North Calaveras Grove in 1852. It took a crew of 25 men working 10 days to drill enough holes to send it crashing down. The next tree to go in the North Calaveras Grove was one called "Mother of the Forest." It was stripped of its bark to about 120 feet (36.5 m) up from the ground and died several years later. This whole procedure upset John Muir who was reported to remark that it was "as sensible a scheme as skinning our great men would be

to prove their greatness" (Hartesveldt and others 1975). In 1891 the Mark Twain tree, a fine specimen, was cut down and sections sent to the American Museum of Natural History in New York City and to the British Museum in London where they are still on view (Harvey and others 1981). At least some interest in natural history was generated by the exhibition of portions of these great trees, but the destruction of individual trees soon expanded into logging.

LOGGING

Logging of giant sequoias was begun in 1856 and continued intermittently until the 1950's (Hartesveldt and others 1975). Some modest use of large downed trees and the clearing of a few smaller ones continues to date. The logging of Whitakers Forest from 1873 to 1879 produced devastating conditions that at first were deplored, but second-growth sequoias eventually provided comparative stands with old growth. Not all mature sequoias were logged so that esthetically the Forest was not as devastated as later was Converse Basin (Biswell and others 1966).

The Converse Basin Grove was once one of the largest groves of giant sequoias known in the Sierra Nevada. About 3 miles north of Grant Grove thousands of mature giant sequoias grew in a basin covering several square miles. During its 20 years of operation (1888-1908) the Sanger Lumber Co. cut an estimated 8,000 giant sequoias in the basin (Johnston 1973). Two ironic features of the logging were that not one cent of profit was realized, and that the largest tree was left and named after the logging supervisor Frank Boule.

The reasons for the lack of profit were numerous but paramount was the loss of timber shattered beyond salvaging on falling (Johnston 1973). In addition, trees over 8 feet (2.4 m) in diameter were augered and then sometimes blasted in two. Also, the lumber and time needed to build the over 30 miles (48.3 km) of flume from Millwood in the Sierra Nevada to Sanger in the Central Valley ate into the hoped-for profits. The flume, when extended to Hume Lake, was reputedly the longest in the world (Johnston 1973).

Knowledge of several fascinating sequoia attributes was salvaged from the devastation at Converse Basin. Douglass counted rings on several cut sequoia stumps of which one (D-21, about 50 yd. north of the Chicago stump) had 3,200 rings and thus is to date, the oldest known giant sequoia. (The snag that John Muir claimed was about 4,000 years old is only about a mile northeast of D-21.) Less than a quarter of a mile north of D-21 is a stump from which a section was removed by Libby to serve as a yardstick for carbon-14 dating. Shortly after the logging the rings of about 100 giant sequoia stumps were counted by E. Huntington and his graduate students. Those data have been used to correlate diameter with age (Harvey 1980).

Logging moved from Converse Basin to the east when the Hume-Bennett Lumber Co. took over. They operated from 1908 to 1926 cutting giant sequoias in groves near Hume Lake where the mill was located and from which the flume ran to Sanger. Although Mather, the first Director of the National Park Service,

attempted to include these sequoia lands in an enlarged park, his efforts fell short.

The impact of the destruction of specimen trees and logging of giant sequoias produced backlash of conservation and preservation. As early as 1873 a State law was enacted that no tree over 16 feet (4.9 m) in diameter could be cut in Fresno, Tulare, or Kern Counties. There is no evidence of the law being enforced (Johnston 1973).

PRESERVATION AND RESEARCH HISTORY

The first outright preservation of sequoia land had begun almost a decade before the State law was enacted, when in 1864 the Federal government deeded the Mariposa Grove to the State of California (Hartesveldt and others 1975). In 1890 Sequoia, General Grant and Yosemite National Parks were created thus protecting considerable sequoia acreage. Over a million signatures on a petition to President Roosevelt spurred a bill in 1909 creating Calaveras Bigtree National Forest including the North and South Calaveras Groves. They later became part of the State park system: the North Grove in 1931 and the South Grove in 1954. Most of the largest sequoia grove, Redwood Mountain Grove, was finally added to Kings Canyon National Park in 1940. On the basis of acreage, giant sequoia lands are presently largely in public ownership with almost 70 percent in National Parks and an additional almost 25 percent under other public agencies. With the protection afforded the giant sequoia, attention was directed toward managing this great natural resource. The history of managing giant sequoia is described in other papers in these proceedings (Benson 1986, Parsons and Nichols 1986, Rogers 1986).

The history of the scientific inquiry into giant sequoia grades into its natural history as well. It is difficult to separate the two and indeed it's probably not worth attempting to do so in the first place. The interest and effort put into investigating the many aspects of these unique trees vary, and the time spent ranges from a few days to several years. Due to restrictions of time and space only a few of those studies best known to the author are mentioned here with apologies for those overlooked. One may also consult the literature cited in works by Axelrod, Biswell, Fins, Hartesveldt, Harvey, Kilgore, Piirto, Rundel, and Stark (nee Beetham).

Among the first to write extensively about the giant sequoia was John Muir. He devoted a chapter to the big trees in his book on Yosemite (Muir 1912), and wrote articles on giant sequoia as early as 1876. In the 1920's Fry and White (1930) studied the natural history of giant sequoias.

In the 1930's Buchholz studied cone development in the sequoias, and though there are some questions about his work, the scientific name (*Sequoiadendron giganteum*) proposed by him is currently widely accepted. From the 1940's to 1960's Axelrod provided considerable information on the paleobotany of the giant sequoia. Also starting in the 1940's Meyer expressed concern for the survival of the giant sequoia. Hartesveldt began studies in 1956 that eventually led to further investigations on giant sequoia ecology (Hartesveldt 1962). Hartesveldt, Harvey, Shell-

hammer, and Stecker studied sequoia reproductive responses to fire and predation over a decade (Harvey 1980). In the 1960's and 1970's, Biswell along with several fine graduate students contributed to further understanding of fire and the giant sequoia (Biswell 1961), and Rundel contributed basic information on the distribution and ecology of the giant sequoia (Rundel 1969, 1971, 1972). The extensive work of Stark (1968a, 1968b) on seed germination and seedling tolerances has enlightened many "students" of the sequoias ever since. Also starting in the 1960's Kilgore studied breeding bird populations in giant sequoia forests. In the 1970's he continued work on the role of fire (Kilgore 1972, 1975, 1976).

A significant investigation during the 1970's by Piirto (1977) did much to clarify the role of fungi in association with tree failure in giant sequoias. Also in the 1970's spatial patterns and succession in the giant sequoia ecosystem was studied by Bonnicksen (1975). Genetic patterns of variation were investigated by Fins (1981).

Although much has been learned about the giant sequoia in its natural ecosystem, much still remains to be discovered. For example, little is known about the role of fungi during seedling development under natural forest conditions. Almost all the research mentioned above led to more questions than they started with, and perhaps that's the way it ought to be.

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