THE CITRUS INDUSTRY

VOLUME V
CROP PROTECTION, POSTHARVEST
TECHNOLOGY, AND EARLY HISTORY
OF CITRUS RESEARCH IN CALIFORNIA

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CHAPTER 5

The Origins of Citrus Research in California

HARRY W. LAWTON
and LEWIS G. WEATHERS

In 1987, THE CITRUS RESEARCH CENTER and Agricultural Experiment Station (CRC-AES) of the University of California, Riverside, celebrated its eightieth anniversary. Officially established in 1907 as the Citrus Experiment Station, the name was changed in 1961 to reflect an increasingly broader scope of research. Today the CRC-AES serves as the world's leading center for research in citrus and subtropical horticulture. The international reputation of the experiment station rests on scientific accomplishments in citrus and other subtropical crops in such research areas as general horticulture, plant breeding, irrigation, soils, plant nutrition, entomology (including biological control and other aspects of pest management), nematology, and the biochemistry of citrus and avocado fruits. The CRC-AES has influenced production techniques wherever citrus is grown on a commercial scale, and over the years its researchers have repeatedly solved pest and disease problems that have threatened the industry in California.

The CRC-AES is a branch of the statewide Agricultural Experiment Station of the University of California Division of Agriculture and Natural Resources, the principal agricultural research agency of the state of California. In the past 20 years, it has expanded its research expertise and emerged as one of the world's leading centers in the agriculture of arid and semiarid lands. Today, the CRC-AES has two main goals: (1) to develop knowledge of plants important to agriculture in arid and semiarid subtropical climates so as to improve the production and quality of food, fiber, ornamental, and specialty crops; and (2) to develop knowledge and ensure the efficient use of the natural resources of the geographical region, and to protect or improve the quality of the environment for human habitation and crop production. Although its goals have expanded over the years to meet increasingly diverse agricultural needs, the CRC-AES remains a prolific source of citrus research. Authorities estimate that its research on citrus alone saves the California industry more than $25 million annually—an estimate that is probably conservative (White 1982).

Citrus growers and their representatives have been credited with the vigorous lobbying that led the California State Legislature to mandate establishment of the Citrus Experiment Station in 1905 as a branch of a proposed Southern California Pathological Laboratory (Webber 1918; Boyce 1968). The fight of the citrus growers to establish an experiment station had few allies within the University at that time, although its agricultural scientists were certainly sympathetic to the need for citrus research. The University of California Agricultural Experiment Station, headquartered in Berkeley, then faced a retrenchment that had begun in 1903. Four horticultural field stations established between 1888 and 1890 were already in the process of being closed down (Shinn 1902; Stadtman 1970). The grass-roots movement to create a citrus field station succeeded mostly because of the stubborn efforts of citrus growers in southern California, then the center of the state's orange industry. In large measure, it succeeded because of the relentless energy and organizational abilities of one man, John Henry Reed, a

Riverside citrus grower who first proposed establishment of the experiment station (fig. 5-1). No buildings bear his name and no bronze plaques honor his memory. Nevertheless, Reed deserves to be remembered as the founder of the Citrus Experiment Station (Weathers and Lawton 1982; Lawton 1983). He was an exemplar both of the scientific spirit of inquiry and of those hardy pioneers who established California's citrus industry.

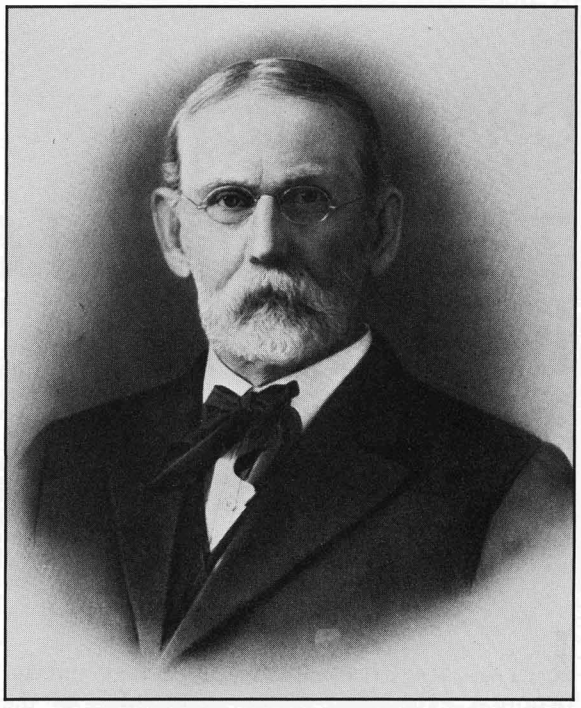


Fig. 5-1. John Henry Reed, founder of the Citrus Research Center and Agricultural Experiment Station.

Beginnings of the Citrus Industry in California

Although citrus has been grown in California from the time of the Spanish missions, it remained a minor crop until the late nineteenth century (Butterfield 1963; Webber, Reuther, and Lawton 1967). William Wolfskill, who in 1841 planted the first orange grove in Los Angeles, explored the commercial possibilities of citrus in the 1850s (fig. 5-2), obtaining his earliest trees from the garden of Mission San Gabriel; he eventually developed a 70-acre orchard (Evans 1874; Downey 1874; Wilson 1965). In 1858, a visiting committee of the California State Agricultural

Fig. 5-2. In 1841, William Wolfskill planted his first orange grove in Los Angeles. Although he was the first southern California grower to raise oranges for profit, his orchard never exceeded 70 acres. Note that the orchard was cultivated for basin irrigation. (Photo courtesy of The Bancroft Library.)

Society toured southern California ranches and found only seven citrus orchards (Anon. 1858). Even as late as 1870, there were only 8,000 orange trees in Los Angeles County and fewer than 35,000 trees in the state (Anon. 1867, 1872). In 1868, the first load of oranges—2,200 boxes—was shipped by boat from Los Angeles to San Francisco, where the fruit had difficulty competing with oranges from Tahiti and the Hawaiian Islands (Caughey 1946). While Wolfskill and a few other early growers in the Los Angeles area eventually succeeded on a modest scale, oranges were generally considered too perishable for long rail shipment, with delays in transit, and much local fruit was of poor quality until the 1880s (Van Dyke 1890; Dumke 1944).

Toward the close of the 1860s in southern California, many owners of Mexican land grants—devastated by years of drought—were forced to break up their immense cattle ranches and sell land to the growing numbers of Americans emigrating from the East (Cleland 1941). A string of colony towns, mostly developed by land and water companies, sprang up east of Los Angeles during the next two decades (Warner 1891; Guinn 1912). These irrigated settlements in a semidesert formed the foundation of a vast citrus empire, now mostly vanished, across inland southern California. The "Citrus Belt," as it came to be known, stretched for more than 70 miles along uplands bordering the San Gabriel and San Bernardino mountain ranges from Pasadena in the west to Redlands in the east (McWilliams 1946*a*). More than a million orange trees were growing in this region by 1880, and each year thereafter thousands more were planted (Dumke 1944). The rapid emergence of the interior citrus belt after 1870 was a unique phenomenon in American fruit culture (fig. 5-3).

Historians and other writers have speculated for almost a century on the factors responsible for the sudden genesis of the citrus belt. Spaulding (1885) attributed the swift increase in citrus plantings after 1870 to the stimulus of Wolfskill's efforts. While Wolfskill's groves were much admired, profitable, and an early showplace for tourists, Los Angeles newspapers of the 1860s contain only sporadic reports indicating interest in citrus and its commercial prospects. Although some hailed citrus as the coming crop, it was mostly looked upon as one of many promising specialty crops that included olives, walnuts, various deciduous fruit and nut trees, and many subtropical crops (Bartlett 1868). Moreover, throughout the 1860s the major crop interests in the

Fig. 5-3. The southern California "citrus belt" emerged in the 1870s and within two decades stretched eastward from Pasadena to Redlands beneath the foothills of the San Gabriel and San Bernardino mountain ranges. This view was taken in 1914 from Knob Hill in the Arlington Heights area of Riverside. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

southland were viticulture, grain, and cotton (which saw a brief boom), and an ill-fated craze that led speculators to plant thousands of mulberry trees (Caughey 1946; Klose 1964).

Coit (1915) suggested that the advent of the Southern Pacific Railroad was the chief factor in commercial citrus development. Orange groves of the first colony towns, however, had already come into bearing, and growers were pioneering a state market before the railroad rate wars of the mid-1880s assured the profitability of an eastern market. Joseph Wolfskill of Los Angeles did ship a single carload of oranges east in 1877, but such shipments were rare until the next decade (Spaulding n.d.). It wasn't until February 4, 1886 that the first special train loaded only with oranges left Los Angeles on an uncertain journey to St. Louis (Spaulding 1922). Caughey (1946) and Bean (1968) hypothesized that two factors other than the railroads caused citrus to forge to the front in the 1870s: The discovery that certain varieties of oranges grew best in the uplands, out of the coastal fog belt, and the introduction of the Washington navel orange. However, the advantage of planting in the uplands was perceived only gradually. Bartlett (1868), for example, believed that much of the San Bernardino Valley was unsuited to citrus, and members of the Riverside colony were widely ridiculed for trying to grow citrus on mesa lands (North 1900). As late as 1889, some Redlands citrus growers still argued that the Washington navel was an "unsatisfactory tree," and more than a million orange trees of various varieties were planted before its superiority was generally recognized throughout the citrus belt (Anon. 1889*a*).

All of these factors contributed to the cumulative expansion of the citrus belt, but neither singly nor collectively do they account for the original impulse that led the upland colony settlements in the 1870s and 1880s to concentrate on planting slow-maturing citrus trees rather than rapidly maturing crops with a ready market. The major stimulus seems to have been the initial success of citrus growing in the earliest of the upland colonies, Riverside, where the citrus industry first took root. The resourceful, cooperative character of Riverside's pioneer settlers, their abysmal ignorance of the care that must be lavished on citrus, and the confluence of several fortuitous events conspired to shape the stumbling beginnings of California's citrus industry.

Much of the history of California's citrus industry before 1900 necessarily centers on ideas and discoveries that originated in Riverside. Riverside had an edge of almost a decade on most of the other citrus-growing settlements. That was enough to place Riverside in the forefront of the major advances in California citriculture, just as it was there that the popular growers' movement originated, leading eventually to the founding of the world's first citrus experiment station.

The Riverside Colony

In the summer of 1870, Judge John W. North (fig. 5-4)—lawyer, abolitionist, and founder of Northfield, Minnesota—and a group of fellow investors purchased portions of the Jurupa and Rubidoux ranchos along the Santa Ana River about 60 miles east of Los Angeles (Patterson 1971; Klotz 1972). They incorporated as the Southern California Colony Association, laid out a townsite for the Riverside colony, and distributed circulars throughout the northern states to attract settlers (Greves 1883; North 1900). The next year an irrigation canal was completed to the dry, barren townsite mesa, where formerly only sheep had grazed (Rubidoux 1907; Hornbeck 1908).[1]

North let his imagination bloom in ballyhooing crops that might be grown in this supposedly semitropic paradise (Stonehouse 1965). The arriving settlers, mostly midwesterners unfamiliar with irrigation agriculture, planted profusely: raisin and wine grapes; alfalfa, corn, and grain; medleys of vegetables; strawberries and raspberries; almost every deciduous fruit and nut crop from apples to walnuts—more than 30 assorted crops in all, including mulberry trees, pomegranates, and opium (Roe 1932;

[1]The canal was dug and kept free of weeds by Cahuilla Indians, who had established a *rancheria* near the colony on the north slope of Mount Rubidoux (Patterson 1971). After secularization of the missions in 1834, the Indians had become the main labor force on the ranchos. They readily shifted over to the American colony settlements in the 1870s, and many became proficient at the budding and grafting of citrus. With completion of the railroads in southern California, the Indians were gradually superceded by a Chinese work force in the groves and packinghouses (Hinckley 1946; Lawton 1959; Thompson 1978; Griego 1979; Wormser 1987). Despite an extensive literature on agricultural labor in California, there has been little research on the early history of citrus workers. McWilliams (1946*a*) presented a chapter on the history of successive ethnic minorities in the citrus labor force, detailing some of the labor conflicts. Shamel (1918–1919) published a series of papers on the housing of citrus workers that reflects grower viewpoints. Fleeting references on the subject may be found in McWilliams (1939, 1946*b*), Williamson (1947), and Galarza (1964). Most of the literature relates to the period of modern agribusiness.

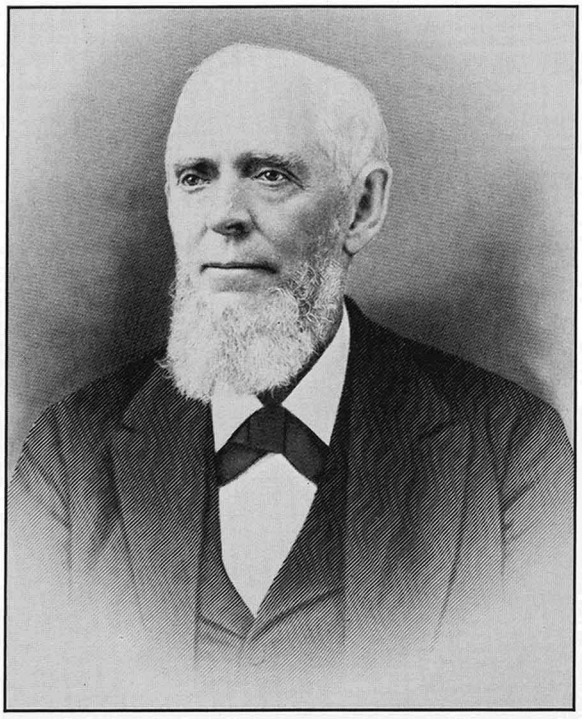


Fig. 5-4. John W. North founded Riverside, but moved on to other enterprises before the citrus industry gave the community national prominence. (Photo from Brown and Boyd 1922.)

Anon. 1901*a*). Some of the crops fared disastrously, particularly in the face of the region's fierce Santa Ana winds. Disillusioned by various setbacks, North left Riverside in 1880, eventually founding another colony (Oleander) in the San Joaquin Valley and pioneering the raisin grape industry of that region (Stonehouse 1965).

Late in 1870, several Riverside settlers visited two small orange groves planted in the 1850s and 1860s in Old San Bernardino (near present-day Redlands) by Anson Van Leuven and Capt. N. J. Pishon, respectively (Elliott 1883; North 1907; Lerch and Haenszel 1981). The prices these growers were getting locally aroused the settlers' interest, and seedlings of orange, lemon, and lime were soon obtained from Los Angeles (Holmes 1912). On March 1, 1871 Dr. K. D. Shugart, an emigrant from Belle Plaine, Iowa, planted the colony's first citrus in his yard (Anon. 1890*a*).

In 1872, D. C. Twogood established the town's first nursery for the propagation of citrus (Roe 1932). The shift away from other crops to citrus began in earnest that year with the planting of almost 7,000 trees by the colonists. These extensive plantings may have been stimulated by the publication in August 1871 of the first crude treatise on citrus culture in California by Col. J. J. Warner in the *Los Angeles Star* (Warner 1871). Further encouragement for growing citrus was lent by the publication in 1872 of Charles Nordhoff's best-selling *California: for Health, Pleasure, and Residence.* Captivated by the elegance of orange trees, Nordhoff (1872) devoted extravagant attention to citrus and its potential profits. His guide became the bible of eastern emigrants arriving in southern California throughout the 1870s. Nevertheless, an eastern market lay years in the future, and the California market was still largely undeveloped. Neighbors of the Riverside colony scoffed that the local market would soon be glutted by more plantings and that orange trees would become worthless (North 1900).

Sometime between 1873 and 1875 (a much disputed date) and reportedly at the request of Mrs. Luther Tibbets (figs. 5-5, 5-6), the U.S. Department of Agriculture in Washington, D.C. shipped two na-

Fig. 5-5. According to legend, Eliza Tibbets used her dishwater to irrigate the two parent navel orange trees obtained from the U.S. Department of Agriculture. Considerable controversy has arisen over whether Eliza or her husband, Luther, was most responsible for securing the trees, but Mrs. Tibbets gave equal credit to her husband. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

vel orange trees that it had imported from Bahia, Brazil to her Riverside home (Lummis 1929; Shamel and Pomeroy 1933).[2] There is disagreement as to when the Bahia orange came into bearing and whether its superior taste was first recognized in 1878 at an informal citrus fair held in the home of G. W. Garcelon (Holt 1879; Patterson 1971). Luther Tibbets (1887) claimed that the fruit was first exhibited in 1879 at a citrus fair in Los Angeles. The soils of the semiarid southern California citrus belt favored the Bahia orange more than did the wetter, tropical climate of its homeland in Brazil or the humid, subtropical climate of Florida. Before the end of the 1880s, Riverside growers were eagerly budding trees to this new variety (Elliott 1883). Introduction of the Bahia orange, which became known as the Washington navel because it was distributed from Washington, D.C., revolutionized citrus culture (fig. 5-7). Its gradual dominance over other varieties as a table orange led to California's leadership in the orange industry in the 1890s.

The first California citrus fruit fair, organized by A. S. White and H. J. Rudisill in 1879 in Riverside, attracted hundreds of visitors from neighboring towns and helped promote the colony's image as the

Fig. 5-6. This photograph, taken in 1898, shows the two parent Washington navel orange trees at the home of Luther and Eliza Tibbets, 4374 Central Avenue, Riverside. One tree was later transplanted to the courtyard of the Mission Inn, where it died; the other survives and bears fruit in a small park at the corner of Magnolia and Arlington avenues. (Photo by H. H. Monroe.)

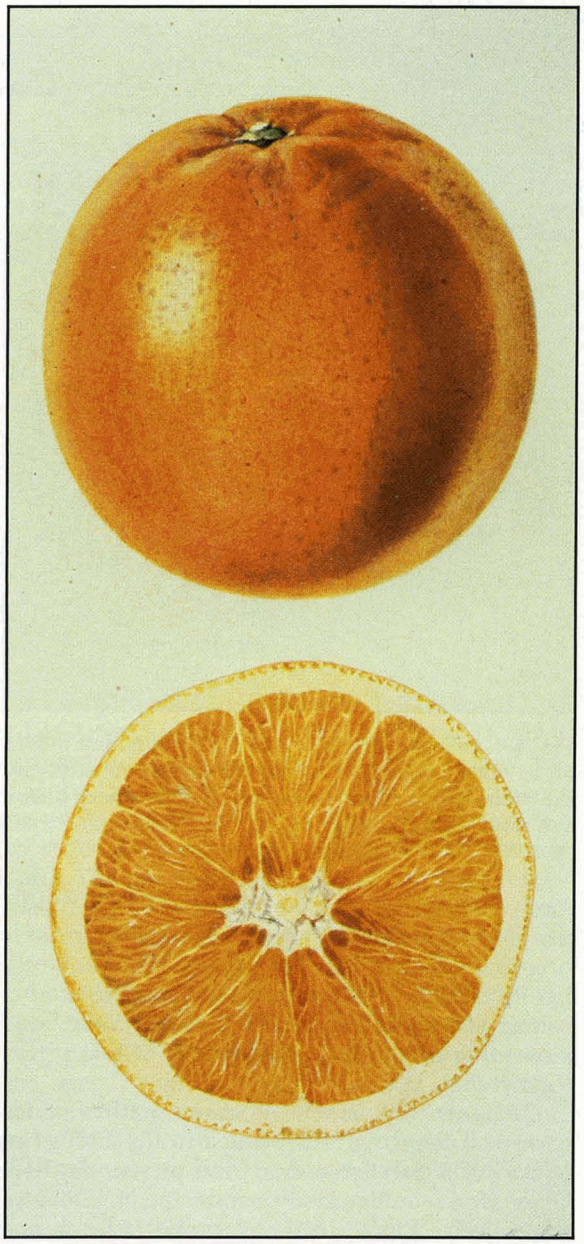


Fig. 5-7. A 1927 painting by R. C. Steadman for the U.S. Department of Agriculture shows fruit from one of the Washington navel orange trees shipped to Mrs. Eliza Tibbets in Riverside in 1873. The ridge on the top fruit is a chimera, a common abnormality in citrus. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

[2]Controversy has long existed as to whether Eliza or Luther Tibbets merits the most credit for introduction of the Washington navel (see also Van Deman 1887; Reed 1906; Pomeroy 1928; Mills 1943; Patterson 1971; Klotz 1975). In their lifetime, the couple insisted on sharing credit. Recent studies by Esther Klotz of Riverside (personal communication) suggest that only two Bahia trees were shipped from Washington to Riverside, not three as previously believed.

new orange-growing center of southern California (fig. 5-8). Papers on a variety of technical topics read by growers at the fair testified to their determination to place citrus culture on a scientific basis (Holt 1879).[3]

In 1881, citizens founded a stock company and built the first packinghouse in Riverside (Klotz 1969). By 1882 more than 200,000 citrus trees had been planted in Riverside, and many were already bearing (Roe 1932). In that same year, G. W. Garcelon and A. J. Twogood of Riverside shipped the first carload of oranges and lemons to Denver (Brown and Boyd 1922). In 1884, the statewide firm of Griffin and Skelley opened a packinghouse in Riverside and local growers shipped 25,000 boxes of fruit to San Francisco markets at $3 a box (Spaulding 1885; Klotz 1969). "When our groves come into bearing, we shall be rich as mud," one colonist exclaimed at the start of settlement in 1871, and this boast finally seemed to be coming true (Roe 1932).

As production increased, however, growers confronted formidable shipping and marketing

Fig. 5-8. In 1879, Riverside held the first Citrus Fair in California, an event that became annual and attracted many visitors from neighboring towns. This photograph was taken in 1883 in the Citrus Fair Pavilion in Riverside. (Photo courtesy of Riverside Public Library.)

[3]Novelist Helen Hunt Jackson (1919) attended the Riverside citrus fair of 1882 in the community's newly built Citrus Fair Pavilion. She described displays of oranges and lemons so colorful that the "whole place was fairly ablaze, and made one think of Arabian Nights' Tales." The city's most elaborate citrus fair was staged on February 7–9, 1888, when Riverside hosted the American Horticultural Society (Ridpath 1888). Exhibits in the pavilion included an intricate grotto built of mandarin oranges, a Chinese pagoda formed from citrus fruits, and a gigantic pyramid of Washington navels. Two distinguished USDA entomologists were guest speakers: C. V. Riley and Albert Koebele. The Citrus Fair Pavilion burned to the ground in April of that year, and the Loring Opera House was erected on the site in 1889 (Klotz 1967).

problems. Fruit often "bunched up" in warehouses or during shipment and rotted. Crooked commission agents and auction dealers found numerous ways to fleece the growers of profits (Ainsworth n.d.). Although the Southern Pacific Railroad reached Los Angeles in 1876 and completed an eastern link to New Orleans by 1883, the railroad established ruthlessly exorbitant shipping rates (Bancroft 1890; Nadeau 1948). Most of Riverside's pioneer growers therefore packed their fruit loosely in barrels and shipped it by steamer to San Francisco or sent it by wagon to the mining towns of Arizona and New Mexico (Boyd 1907; Brown and Boyd 1922). Not until completion of the rival Santa Fe line in 1885, which led to railroad rate wars, did routine shipment of citrus by rail become commercially feasible.

Emergence of the Citrus Belt

During the railroad-inspired land booms of southern California in the mid-1870s and 1880s, new waves of emigrants, primarily of the professional class, and many of them wealthy and retired, founded a succession of towns and colonies. Beginning in 1873 with Pasadena (the Indiana Colony), the settlements ran mostly along the eastbound route of the Southern Pacific between Los Angeles and the San Bernardino Valley (Guinn 1912; Dumke 1944; Lillard 1966). Inevitably, these newcomers looked to the "parent colony" of Riverside as a model, sometimes relying upon it for leadership.

The initial task of these new settlements in a semiarid desert was to solve costly, complex problems relating to water supply and water rights (Beattie 1951; Brown 1982). In some areas, ingenious water distribution systems were developed that tested the engineering skills of the period. In 1881, Canadian brothers George and William Chaffey developed a system to deliver water under pressure through concrete pipes from streams in the San Gabriel Mountains to their Etiwanda Colony—the first such system in the West (Alexander 1928; Ebeling 1979). In 1884, another Canadian, Matthew Gage (figs. 5-9, 5-10), began work on the first large-scale artesian system, constructing a 20-mile canal that brought water to the undeveloped upper plain of Riverside from the underground San Bernardino Valley basin (Anon. 1886; Kent 1890*a*). Quarrels over water rights and conflicts between suppliers and users led to demands for state water law reform (Hall 1883; Holt 1903). In 1884, the first State Irrigation Convention was held in Riverside, marking the stormy beginning of a long effort to resolve perplexing obstacles related to water rights and irrigation in California (Malone 1965; Raup 1959; Brown 1982).

Most of the new irrigation settlements, such as Covina, experimented at first with a variety of crops (e.g., Pflueger 1964). Citrus growing had a fascination, however, for these emigrants, many of whom had owned orchards in the Midwest or were descendants of horticulturists (Wickson 1909). The popular Riverside citrus fairs of the early 1880s gave them an opportunity to visit the "parent colony" and learn more about citrus culture. Then, in 1885, Riverside achieved international prominence by winning the gold medal for superiority of its oranges in international competition at the New Orleans World's Fair (Holt 1888). Other awards followed at citrus fairs in New York and Chicago (Brown and Boyd 1922; Patterson 1981*a*). The consequent growing demand for Riverside oranges in developing state and national markets and the optimism of Riverside colonists about the industry's future stampeded other citrus-belt settlements into planting more groves (Holt 1888).

The citrus belt developed rapidly as a unique region of southern California with a distinctive rural-urban lifestyle that had no parallel in America

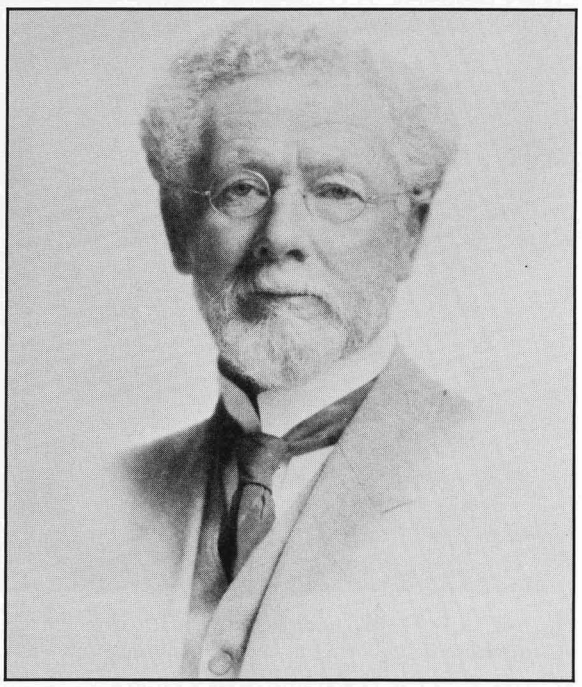


Fig. 5-9. Canadian Matthew Gage tapped artesian water sources in the San Bernardino Valley basin and engineered a canal that required the boring of more than 12 miles of tunnels to bring water to the undeveloped upper plain of Riverside. Later, enlisting the aid of British capital, he lengthened the canal to irrigate thousands of acres in Arlington Heights. (Photo courtesy of Riverside Municipal Museum.)

Fig. 5-10. In 1904, G. Harold Powell, while conducting research on fruit decay in Riverside, took this photograph of the Gage Canal in Arlington Heights. The canal made possible the extension of citrus growing to thousands of additional acres and was one of the first major irrigation achievements in southern California. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

(McWilliams 1946*a*). Here began much of the gradual evolution of farming into modern agribusiness. Here also, nestled against a broad blue sweep of foothills, communities that were the forerunners of modern suburbia developed (fig. 5-11). Homes, businesses, schools, churches, and stately green orange groves formed an interknit pattern in these citrus belt cities, closely connected in a later era by interurban Pacific Electric trolley lines "along which might be found the small orchards of the superannuated minister, the retired high school teacher, the lawyer, the doctor, as well as those drawn from other walks of life" (Coit 1915). A farm elsewhere in the United States might give one a sense of possession and domination, as Carey McWilliams (1946*b*) observed, "but to own an orange grove in Southern California is to live on the real gold coast of American agriculture."

Names of citrus-belt towns such as Pasadena, San Gabriel, Whittier, Pomona, Monrovia, Azusa, Covina, Glendora, Upland, Ontario, Etiwanda, San Bernardino, Redlands, Corona, and Riverside were to become synonymous throughout the world with citrus growing. Near the end of the century, orchards of summer-ripening Valencias were found to be best adapted to the coastal regions and were planted in Santa Barbara, Ventura, Orange, and San Diego counties.[4] Still later, the citrus industry would steadily expand into suitable lands north of the Tehachapi Mountains, where citrus had previously been grown only in small quantities (Wickson 1909). The term "Citrus Belt," however, continued to encompass only that foothill region in which the citrus industry of southern California had its origin. One might speak of a Santa Paula citrus belt or a Porterville citrus belt, but in popular parlance there was only one Citrus Belt. The region endured as one of singular charm and beauty until the end of World War II, when groves in those communities that had been created by some of the nation's first large developers began falling before the onslaught of new hordes of subdivision developers and their bulldozers.

[4]R. H. Gilman of Placentia is said to have planted the first commercial orchard of Valencia oranges in Orange County in 1880 (MacArthur 1959).

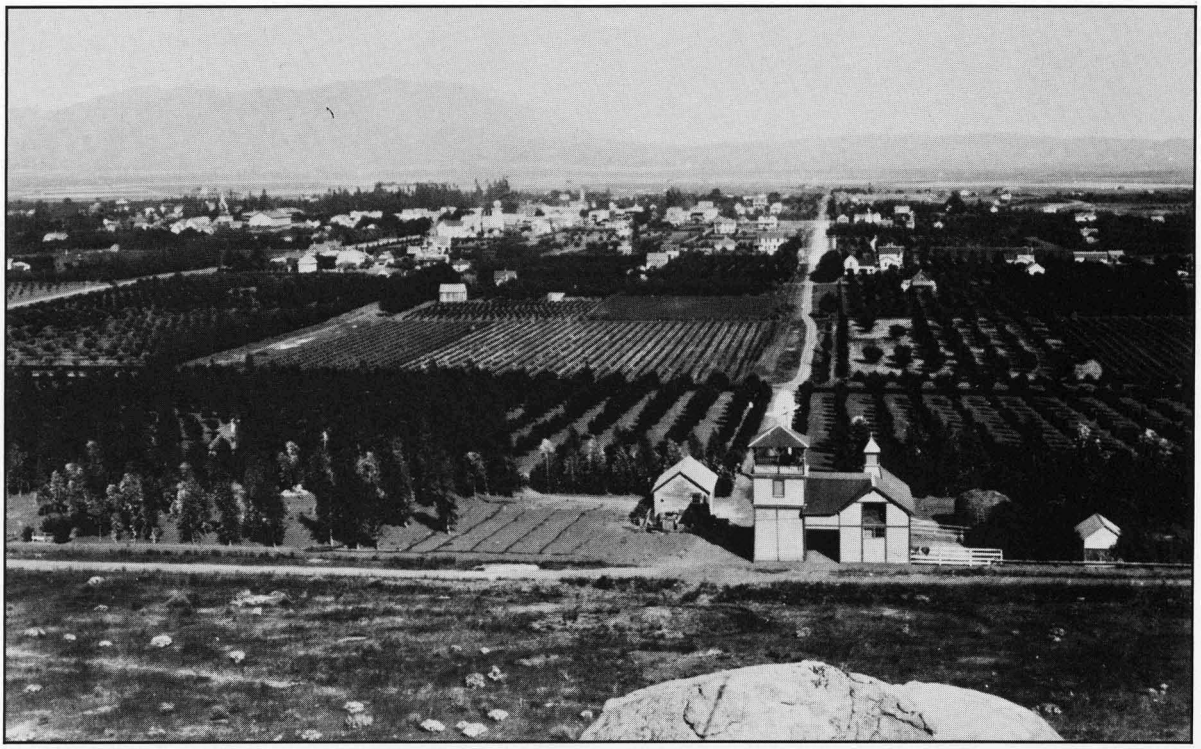


Fig. 5-11. The southern California citrus belt was well established by about 1885 when this photograph was taken of Riverside, looking down Tenth Street. *Left*, in the distance, are the Box Springs Mountains. (Photo courtesy of The Bancroft Library.)

Origins of Citrus Research in California

The development of the southern California citrus belt came just as the nation entered a golden age of agricultural science—the period from 1880 to 1890—when significant breakthroughs in the new sciences of bacteriology, virology, genetics, and botany would transform a number of older agricultural sciences (Rossiter 1979). Between 1875 and 1890, the faith of farmers, agricultural leaders, and legislators that science could produce miracles and increase crop production stimulated problem-oriented research into new disciplines and led to massive government funding of a new infrastructure serving agricultural interests.

The cornerstone of agricultural science in America was laid in 1862 with the establishment of the U.S. Department of Agriculture and the passage of the first Morrill Land-Grant Act. That year has been termed the *annus mirabilis* of American agriculture (Mayer and Mayer 1974). In 1862, Iowa became the first state to act on the grant-of-land provisions of the Morrill Act by founding the Iowa Agricultural College (True 1929). In 1868, the University of California was created as a similar land-grant institution (Ferrier 1930). The era of public education had begun—representing a sharp break with the tradition that colleges existed only as private institutions to train the sons of gentlemen in the classical professions: the law, medicine, and the ministry. With passage of the Hatch Act in 1887, which provided $15,000 annually for each experiment station, and the second Morrill Act in 1890 for the more complete endowment and support of land-grant colleges, the subsequent rise of agricultural science in the United States was assured (True 1937; Rossiter 1979).

Cooperation and Innovation

No other crop in America achieved a comparable level of technological sophistication as early as the California citrus industry (McWilliams 1946*a*). In large measure, the technology developed rapidly because of a democratic spirit of cooperation and organization that was relatively new—at least to such

an intense degree—in agriculture. The founders of the industry were mostly better-educated members of the professions or business, many of them children or grandchildren of midwestern pioneers or of families of the New England states, bringing with them much-needed capital, commercial habits, business acumen, and imagination (Coit 1915).

Most of the newcomers arrived in California ignorant even of the rudiments of classical citriculture. Many citrus growers had never put hand to plow, most faced an entirely new prospect in irrigation agriculture, and all found local lore with respect to citrus growing vague and unreliable (Spaulding 1922). In California, furrows were still being smoothed by dragging brush over them; fruit picking in the absence of clippers consisted of yanking fruit from the trees (Shoemaker 1922; Pollard 1916). Although many settlers had some farming experience or descended from farmers, particularly horticulturists, their backgrounds in business and the professions had given them a progressive attitude, a belief in technology, and urban organizational skills. More capitalists than cultivators, not bound to the conventional wisdom of the dirt farmer—indeed, having little or no knowledge of citriculture—they were capable of taking risks and open to innovation. The emigrants discovered an industry in a primitive state and they set out to organize and master it (Spaulding 1922).

The primary labor force in all phases of citriculture in southern California in the late nineteenth century was Chinese, mostly immigrants from Guangdong Province in southern China (fig. 5-12). Every important citrus belt community had its Chinatown, and Chinese were employed on most large ranches, serving as field hands, cooks, and servants, and sometimes rising to positions as overseers (McWilliams 1946*a*; Lawton 1959; Wormser 1987). Riverside's Chinatown had a permanent population by 1894 of at least 450 persons, and during the citrus harvest as many as 2,000 additional Chinese migrant workers camped in tents or crudely erected shelters throughout the community. Many Chinese were more familiar with citriculture than the American midwesterners since citrus had been grown in their region of southern China for centuries. In Riverside and other communities of the Citrus Belt, Chinese merchants organized labor contract agencies that supplied immigrant pickers, packers, and field hands to orange growers (Lawton 1987). The unsung contributions of the Chinese to citriculture in California were probably enormous, and many new techniques introduced by growers in the nineteenth century were probably first suggested by Chinese ranch overseers or workers (Wormser 1987).

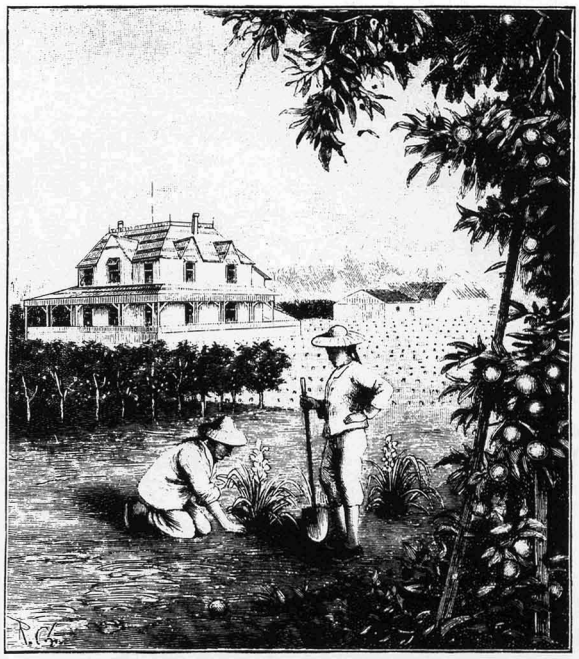


Fig. 5-12. Most early citrus growers lacked knowledge about citriculture. Their principal workers in the 1880s were Chinese immigrants, some of whom undoubtedly passed on knowledge of citrus growing techniques in China. (Photo copied from a nineteenth-century engraving courtesy of California State Department of Parks and Recreation.)

American emigrants to the citrus belt, such as Judge North, brought from the Midwest a profound respect for the Grange—the first mass movement of farmers in America (North 1877). They already knew the value of Farmers' Clubs and were familiar with Farmers' Institutes, a developing midwestern institution that got its start in 1868 at Kansas State Agricultural College and served to bring farmers and their problems into contact with agricultural scientists (True 1929).

In 1874, years ahead of the Hatch Act, the University of California Agricultural Experiment Station was founded. It is the oldest college-created experiment station in the United States (Slate 1919; Stadtman 1968). The great soil scientist Eugene W. Hilgard (fig. 5-13) was the man charged in 1875 with establishing the foundations of both the statewide experiment station and the College of Agriculture at Berkeley (Slate 1919; Jenny 1961; Horn 1974). Determined to take research knowledge directly to the farmers of the state, Hilgard added public service to the University's functions of research and teaching (Stadtman 1970). In northern California, farmers tended to be conservative and even mistrustful of new crop-growing techniques based on scientific ag-

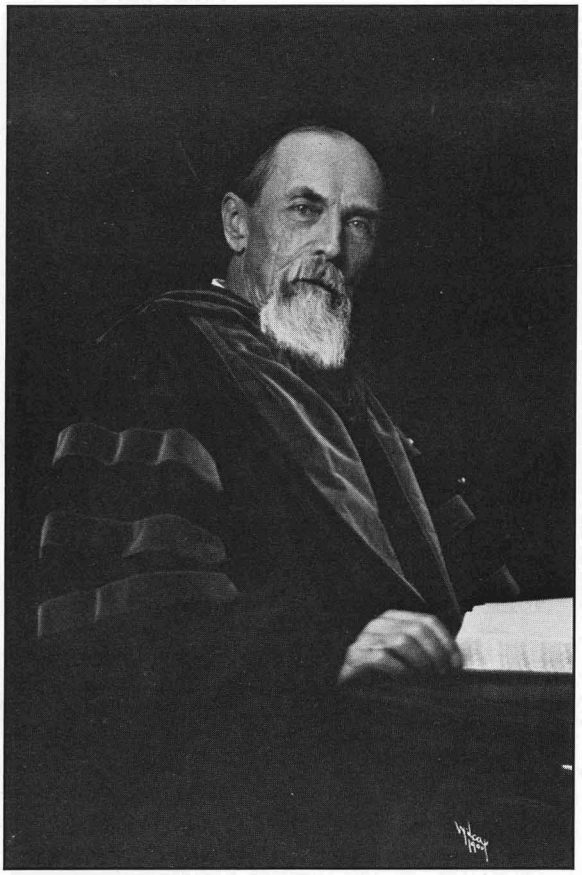


Fig. 5-13. Eugene W. Hilgard, dean of the College of Agriculture at the University of California, Berkeley, and the first director of the Statewide Agricultural Experiment Station. (Photo courtesy of The Bancroft Library.)

riculture. Slowly they were won over by Hilgard's skillful diplomacy (Horn 1974). In the southern part of the state, however, citrus growers were eager for research on their problems, and made connections very early with the University.

In the files of the Bancroft Library at Berkeley are the yellowed letters of those early citrus ranchers soliciting advice on every conceivable subject from Hilgard. In the face of grudging financial provisions for research, concern for other crops, and the need for an initial soil survey of the state, Hilgard often responded to growers with recommendations based on old-world practices. Despite a small staff and many duties during his early years at Berkeley, he patiently answered all the letters, functioning as a one-man cooperative extension service. When Matthew Gage decided to expand his Riverside canal in 1889, it was Hilgard who carefully checked his plans, guided and encouraged him, and even wrote a letter introducing him to New York financiers (Hilgard 1889*a*).

For the most part, citrus growers conducted their own trial-and-error research until the end of the nineteenth century. They were eclectics, filching valuable ideas from the past, but were just as quick to test new ideas. Although they thoughtfully perused ancient treatises on citriculture (e.g., Gallesio 1876), borrowed methods from Florida growers (e.g., Manville 1883), and during jaunts to Europe examined traditional methods in southern France, Spain, and Italy (e.g., Kham 1888*a*, 1888*b*; Anon. 1900*a*), they soon discarded many cultural practices and precedents of other citrus-producing regions. They exchanged information freely at early citrus fairs (fig. 5-14) and at statewide Fruit Growers' Conventions, the first of which was held in Sacramento in 1881 (Wickson 1903; Essig 1931). They also readily shared their discoveries through letters and articles written for agricultural journals, local newspapers, and such regional magazines as the *Southern California Horticulturist* and the *Rural Californian*.

Citrus-belt towns of the nineteenth century were keenly competitive, constantly taking potshots at each other in local newspapers. When Pomona imported a statue of the goddess Pomona from Florence, Italy, and unveiled it with great pomp, its high-flown cultural aspirations were mocked by neighbors (Anon. 1889*b*; Kent 1890*b*). Riverside, with its soon-to-be world-famous Mission Inn and ornate Loring Opera House—the richest city per capita in the United States by 1895, according to the Bradstreet Index—sneered at Pomona's statue, but was viewed by other towns as affecting haughty airs itself. Where citrus was concerned, however, rivalries usually ended, and a sharing of knowledge prevailed among these newcomers in a strange land. For this reason, it is impossible to determine the originators of many early discoveries and inventions in California orange culture.

A Los Angeles nurseryman, Thomas Garey, published the state's first book on citrus-growing, *Orange Culture in California*, in 1882. William Spaulding's highly literate *The Orange: Its Culture in California* became the first book published in Riverside. Garey was aware of the newer sciences, briefly mentioning Justus Liebig, the father of agricultural chemistry, but both books largely comprise conventional wisdom based on the experience of California orange growers. A third early work, this one emphasizing fruit varieties, is B. M. Lelong's *A Treatise on Citrus Culture in California*, published in 1888.

Flooding and, later, basin irrigation were traditionally employed in California citrus groves until

Fig. 5-14. In the 1890s, Los Angeles launched the first annual state citrus fair, building on the success of citrus fairs in Riverside and other orange-growing communities. These were lavish events as citrus belt communities competed for prizes with elaborate displays of fruit. (Photo courtesy of Pomona Public Library.)

the 1880s. For a while, subirrigation with pipes laid to trees throughout a grove was popular (Spaulding 1885). Gradually, most other systems were superseded by furrow irrigation employing flumes, which became known as the Riverside Method because it had been perfected in that community (Warner 1891). Van Dyke (1894) presented evidence that the furrow method of irrigation was derived either directly from Chinese irrigators or from Anglo observations of Chinese vegetable growing techniques. Few means of frost protection were known until the mid-1890s. W. A. Sanders, a Fresno grower, advocated piling manure beside each tree, like a haycock, and raising steam when the temperature plummeted by pouring water over each pile (Garey 1882).

In the earliest years, the citrus belt was relatively free from citrus diseases. L. M. Holt (1877) was the first to describe and alert growers to the dangers of citrus pests and diseases in California, then few in number and mostly confined to older Los Angeles orchards. Scale insects were considered the most serious pests, and they were sprayed with decoctions of tobacco, mixtures of whale oil soap and coal oil, and other remedies (Chapin 1882; Garey 1882; Cooke 1885).

Townsend Glover, the first federal entomologist, studied beneficial and injurious insects on oranges as early as 1854 in Florida (Howard 1930; Boyce 1950). The year 1880, however, marked the first milestone in scientific citrus research in California when John Henry Comstock (1881), an entomologist for the U.S. Department of Agriculture (USDA), spent 3 months in Utah and California studying scale insects, which he described in a his-

toric report (Compere 1961). In 1888, California passed the first quarantine laws in the United States, and recommendations for strengthening the act were drafted by a Fruit Growers Committee of the State Board of Horticulture led by A. S. White of Riverside (White et al. 1882). Riverside growers organized a countywide quarantine to halt the spread of red scale in 1882. When a local rancher, ignorant of the danger, imported diseased trees from the town of Orange, they held a mass meeting and subscribed $200 to burn his trees (Roe 1932).

In about 1868, cottony-cushion scale (*Icerya purchasi*) entered California from Australia, and within 15 years it threatened Los Angeles citrus orchards with extinction (Lelong 1902). Grower Joseph Wolfskill and his orchard manager, Alexander Craw, experimented with many fumigants under tents (Quayle 1929). In 1886, these two investigators were joined by Daniel W. Coquillett, a USDA entomologist, who soon determined that hydrocyanic acid was the most effective fumigant against the pest (Essig 1931; Compere 1961). Craw urged that the USDA send Coquillett to Australia to search for natural enemies of the scale to use against it. In 1887, the California State Fruit Growers met in Riverside and drafted a resolution requesting that Congress fund such a search (Doutt 1958). It was another USDA entomologist, Albert Koebele (fig 5-15), however, who was finally sent to Australia, where he discovered the Vedalia beetle (*Rodalia cardinalis*). Released in Wolfskill's orchards, this predator of the scale (fig. 5-16) provided the first scientific demonstration of biological control. In 18 months, California groves were virtually free of the pest. Other studies of biological control using pest parasites and predators continued for problems such as black and red scales, with mixed results. Such research had strong support in the 1890s from citrus growers and the California State Board of Horticulture (Compere 1961).

Except for biological control studies, however, little significant research was carried out on citrus by trained investigators in California before 1900. Hilgard's research staff in Berkeley was spread thin, and there were many general crop problems larger in magnitude than the often specialized challenges facing citrus growers. The growers themselves made many major discoveries of the period, rising magnificently to the task. They made important contributions in citrus cultivation, pruning, irrigation, and fertilization, and in harvesting, packing, and marketing for citrus (Koethen 1929). Most citrus belt towns contributed to the industry, but none remotely matched Riverside for sheer leadership and technological innovation up into the early 1900s. F. M. Reed (1929) and E. L. Koethen (1929) recorded some of the hundreds of new cultural techniques and mechanical developments spawned in this one community starting in the 1880s. Tom Patterson (1971) and Vincent Moses (1982) traced the history of citrus manufacturing equipment in Riverside. It would be misleading to suggest that all of the discoveries made in Riverside were original or unparalleled elsewhere, but they were extensive in scope and number.

In about 1879, S. B. Bliss became the first California grower to bud his trees on sour orange stock, importing rootstock seedlings from Florida (Craw 1890; Roe 1932). B. B. Barney of Sunnyslope Groves budded the first orchard of Washington navels in about 1880, and at the same time introduced the tissue-thin protective orange wrapper (Anon. 1917).

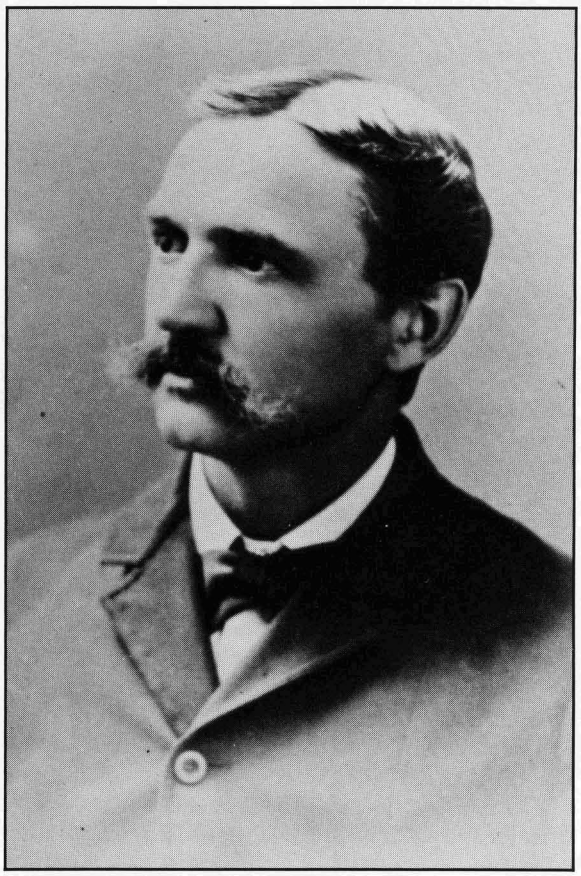


Fig. 5-15. Albert Koebele, discoverer of the Vedalia beetle in Australia, provided the first scientific demonstration of biological control. The predator was released in the Wolfskill orchards in Los Angeles where it effectively controlled cottony-cushion scale. (Photo courtesy of the Department of Entomology, University of California, Riverside.)

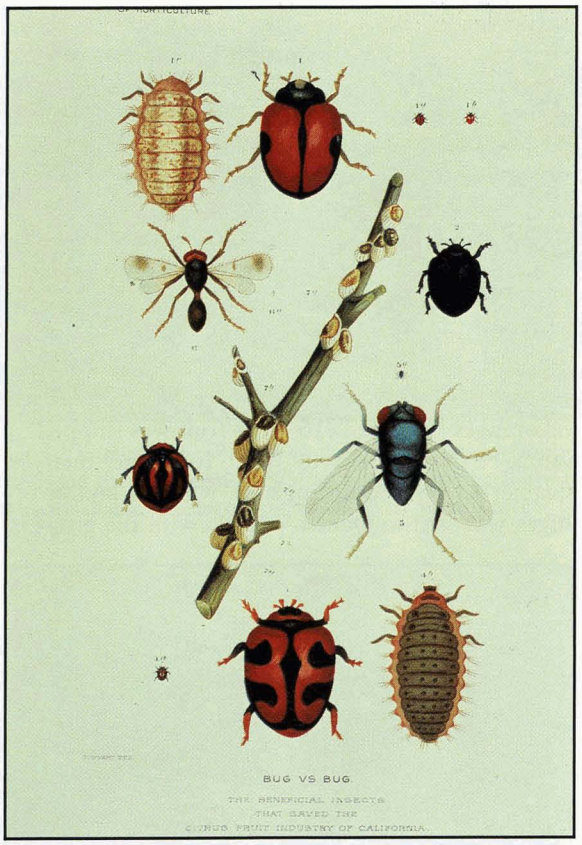


Fig. 5-16. This color plate, published by the California State Commission of Horticulture in its first biennial report (1903–1904), shows a twig infested with cottony-cushion scale and various stages in the life cycles of beneficial insects used to control the scale. Koebele's Vedalia beetle is shown at the bottom of the plate.

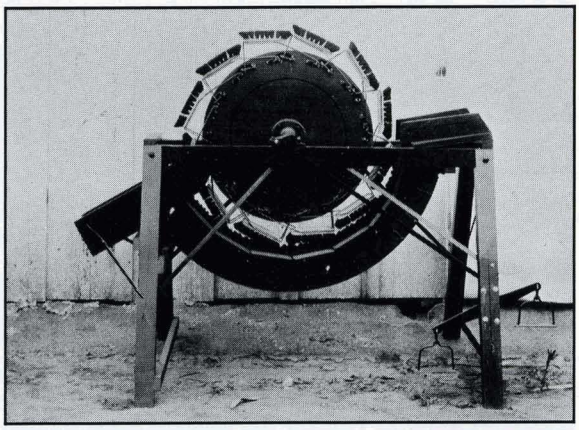


Fig. 5-17. In 1897, Harrison and Benjamin Wright, who conducted the first smudging experiments with crude oil in iron pots and lard pails, invented this citrus brusher to clean fruit after picking.

In 1887, J. W. Keeney patented the first successful orange grader used in California (Ingersoll 1904). In 1888, Harrison and Benjamin Wright conducted the first experiments with frost protection devices in southern California, burning crude oil in iron pots and lard pails (Turrell 1973). About the same time, J. K. Woodward replaced gunnysacks by inventing the standard picking sack with a prop-tree bracket (Reed 1929). In 1897, brothers Harrison and Benjamin Wright developed a brushing machine to clean fruit (fig. 5-17). The Meacham brothers and later J. L. Stevenson manufactured light, efficient ladders for the industry. Felix Haven worked out a system with ropes and ladders to suspend cyanide fumigation tents over trees (fig. 5-18). E. I. Covey manufactured lidding and strapping machines. A. M. Aldrich may have been the first grower to experiment with cover crops, planting clover between tree rows (Koethen 1929). G. W. Garcelon perfected the tray system for curing lemons (Reed 1929). Near the turn of the century, George Parker, owner of the Parker Machine Works, came up with a mechanical triumph—the automatic box-making machine (fig. 5-19). Hale Paxton later perfected more versatile versions (Moses 1982). In 1903, James Mills, Sr. installed the first private chemistry laboratory on a citrus ranch for the Arlington Heights Fruit Company (Anon. 1928*a*). About three years later, E. J. Bryan invented the clamp hand truck for releasing stacks of fruit boxes (Patterson 1982). In 1913, Frank Chase conceived the gravity water separator for frozen fruit, giving it to the industry without patent (Patterson 1981*b*). Fred Stebler invented much of what would become standard packinghouse

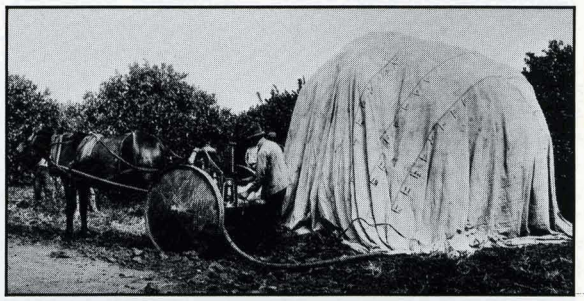


Fig. 5-18. Experiments with cyanide fumigation to control insect and scale pests were conducted in the 1880s by Joseph Wolfskill and Alexander Craw. Fumigation methods were further perfected at the Wolfskill ranch by Daniel W. Coquillet, a USDA entomologist. In 1921, Felix Havens of Riverside worked out the system of ropes and ladders to suspend cyanide fumigation tents over trees as shown here. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

equipment around the world: efficient machines to wash, grade, and process fruit (fig. 5-20) (Moses 1982). The two competing mechanical wizards, Stebler and Parker, turned Riverside into the world center for citrus machinery construction. Their firms ended years of rivalry in 1938 with a final consolidation as the Food Machinery Corporation.

Critical to development of a national market for citrus was finding a way to halt fruit spoilage during shipment. Although the first special train loaded exclusively with oranges made a successful trip from Los Angeles to St. Louis in 1886, running on an express train schedule (fig. 5-21), routine shipments of citrus with normal delays en route were often ruinous to growers because of spoilage. In 1886, while managing a citrus fair in Chicago, L. M. Holt (fig. 5-22), publisher of the *Riverside Daily Press,* learned of advances in cold storage (Anon. 1887*a*). He persuaded the Inter-Ocean Cold Storage Company to locate in Riverside, and their plant was in operation by the end of the year. In 1887, the first ventilated railcar in California was developed, and on April 4 of that year the first cold-storage shipment of Riverside navels was sold on the floor of a Boston exchange (Anon. 1887*b*). That summer J. R. Dobbins of San Gabriel shipped the first carload of Valencia oranges to Chicago (Clark 1916). The refrigerated car was first used for citrus in 1889, with ice replenishment along most eastern routes (Patterson 1971). In 1893, the Claremont California Fruit Growers Association made the first overseas shipment of navel oranges (Dreher 1916). The fruit was shipped by Santa Fe fast freight to New York and then by steamer to Liverpool, England, where a box of oranges was sent to Queen Victoria with the growers'

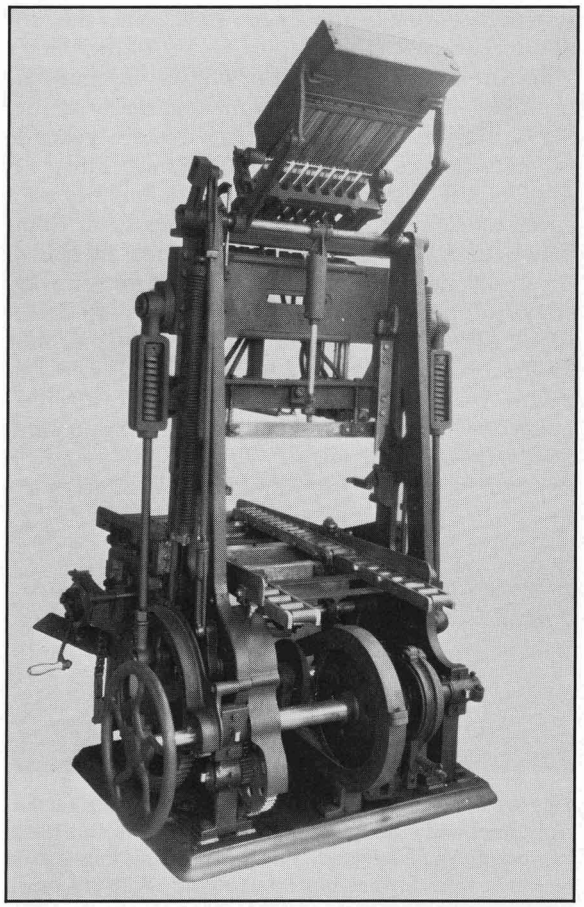


Fig. 5-19. George Parker perfected mammoth crate-nailing machines after opening the Parker Machine Works in Riverside in 1909. His lidders, one of which is shown here, dominated the world market. (Photo courtesy of Riverside Municipal Museum.)

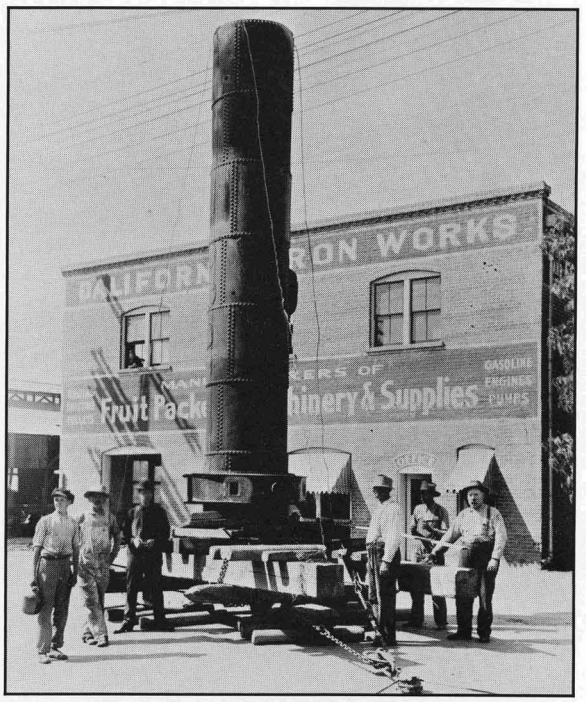


Fig. 5-20. In 1889, Fred Stebler, a mechanical wizard with only 3 months of formal schooling, arrived in Riverside, where he purchased half interest in the Crawford and Fay Machine Shop. In 1902, he became sole owner of the firm, which soon attained preeminence in the manufacture of machinery to handle and process citrus fruit. Stebler obtained about 40 patents on his inventions, which included graders, washers, dryers, clamp trucks, elevators, labelers, railroad car squeezers, separators, and fruit distributors. This photograph of his California Iron Works shows a crew preparing to install the chimney of a furnace to burn wood refuse. (Photo courtesy of Mrs. Irene Patterson.)

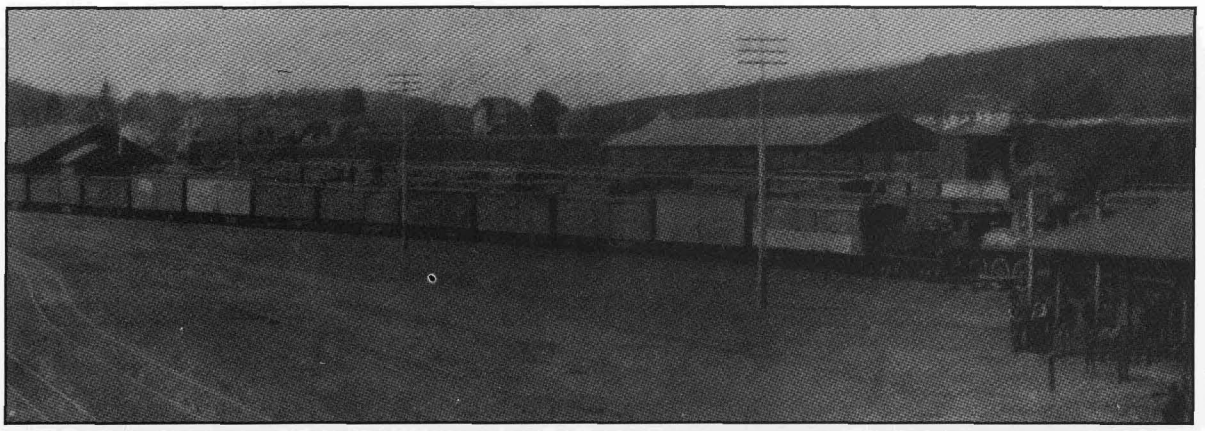


Fig. 5-21. The first special train loaded exclusively with oranges left the River Station, Los Angeles, on February 14, 1886, via the Southern Pacific and Union Pacific Railways, on express train time for the Missouri River. Shipments to more distant eastern points followed within a few years. (Photo courtesy of the Historical Society of Southern California.)

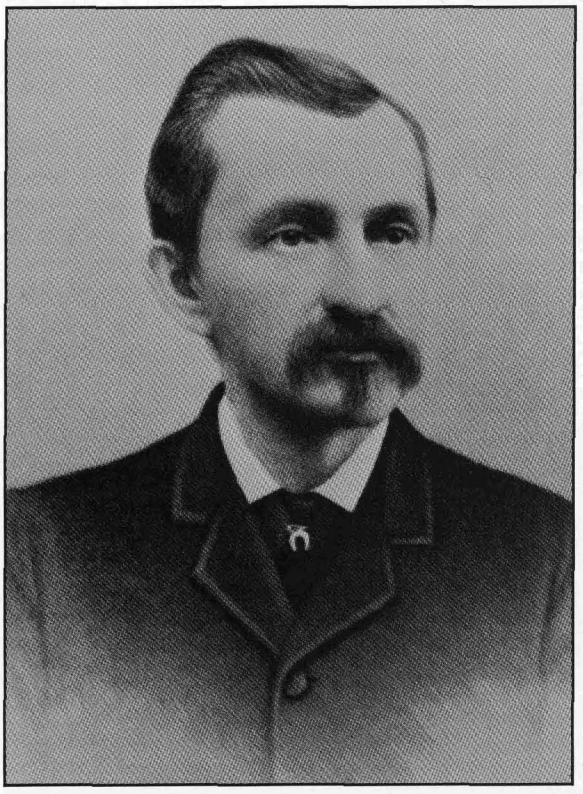


Fig. 5-22. A gifted, practical visionary of his era, L. M. Holt was publisher of the *Riverside Daily Press* and had many financial interests in southern California. He spearheaded organization of the Southern California Horticultural Society and helped develop the refrigerated rail shipment of citrus. (Photo courtesy of Riverside Municipal Museum.)

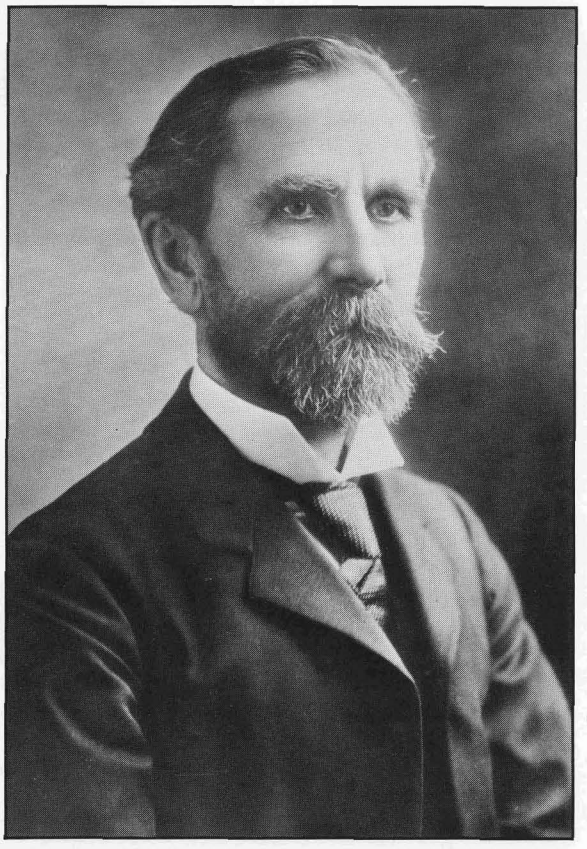


Fig. 5-23. T. H. B. Chamblin formed the first growers cooperative in Riverside to share packing and marketing expenses. He later helped organize the California Fruit Growers Exchange, now Sunkist Growers, Inc. (Photo courtesy of Sunkist Growers, Inc.)

Fig. 5-24. The first cooperative marketing of citrus in California began in about 1888, under the direction of T. H. B. Chamblin, and utilized the F. B. Devine Packinghouse shown here. Most packinghouses of the period relied on Chinese labor.

compliments. The Queen is said to have "pronounced the fruit palatable."

From the beginning, citrus growers were victimized by unscrupulous brokers, who might sell a grower's oranges at a low price in the morning and then have an accomplice resell them at a higher price by nightfall (Brown and Boyd 1922). In 1885, J. Debarth Shorb of San Gabriel organized the Orange Growers Protective Union of Southern California to curb such practices (Lynn 1969; MacCurdy 1925). The union and similar grower organizations that were founded later lacked packing facilities, however, and were unable to break the stranglehold of the packers and commission agents. One by one these groups formed by growers fell by the wayside.

The opening of eastern markets made it even harder for growers to monitor or control sellers. In about 1888, T. H. B. Chamblin (fig. 5-23) of Riverside conceived a "growers' pool" to share cooperatively the expenses of packing and marketing (Cumberland 1917; MacCurdy 1925). Chamblin banded together 11 growers as the Pachappa Orange Growers Association. It began operations through the F. B. Devine Packinghouse (fig. 5-24), later establishing its own packinghouses (fig. 5-25) (Patterson 1983). In late 1892, ranchers in the Pomona Valley, led by P. J. Dreher, formed the Claremont California Fruit Growers Association and also launched cooperative marketing (Dreher 1916; Anon. 1983).

The season of 1891–1892 was marked by a "saturnalia of reckless speculation and robbery" by shippers and brokers; the next season pushed many southern California growers to the brink of ruin (Spaulding 1922; Lloyd 1919). The Riverside and Claremont exchanges, however, had succeeded in wresting control from the packers, shippers, and brokers, and their victory was apparent in the face of industrywide losses. On August 29, 1893, a meeting of southern California growers was held in Los Angeles with Chamblin as the directing spirit. Fruit associations were organized by district along nonprofit, cooperative lines, and on October 31, 1895 the growers officially incorporated as the Southern California Fruit Growers Exchange (Cumberland

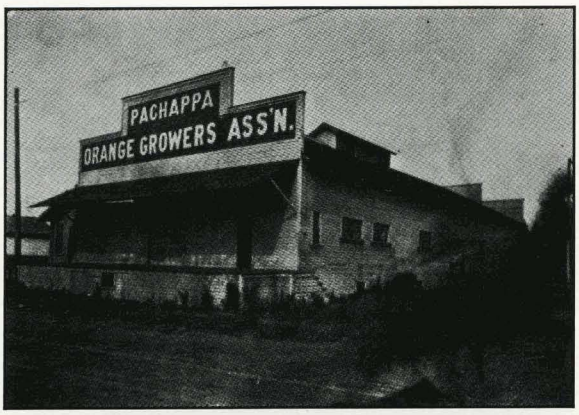
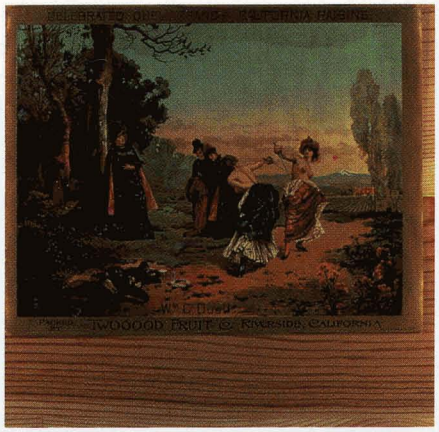


Fig. 5-25. The Pachappa Orange Growers Association, the first cooperative packinghouse, was located at Pachappa Avenue and Thirteenth Street in Riverside. It was an outgrowth of cooperative efforts begun in 1886 by a group of growers. Subsequently, they established their own packinghouses. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

1917). In 1904, the name of the organization was changed to the more impressive California Fruit Growers Exchange, which in 1952 became officially known as Sunkist Growers, Inc. (Rust and Garner 1960; Anon. 1983). Not all growers joined the exchange; at least 40 cooperative associations were formed outside of it by 1919, and there were a number of independent grower-shippers (Coit 1919). One of the most successful cooperatives was Mutual Orange Distributors, founded in 1906 in Redlands by Arthur Gregory, which exists today as Pure Gold (Horn, Chandler, and Thomason 1937; Lockabey 1955).

Cooperatives made it possible for citrus growers to organize the market systematically and to enter national and world trade before home supply had been attained—a concept that Wickson (1909) termed "unique, daring, and original." The California Fruit Growers Exchange, which very early lined up 85 percent of the growers, has been characterized as the most efficient marketing cooperative in the world (McWilliams 1946*a*). Over the years, it developed a far-flung research, advertising, and marketing network (Jacobs 1978). Beginning in 1903, it mounted an advertising campaign that within 50 years reached an annual budget of more than $8 million—a campaign that made oranges one of the most popular fruits grown. Not the least factor in promoting oranges was the orange crate label or trademark first encouraged when the Riverside Board of Trade printed labels and offered them to growers in 1889 (fig. 5-26) (Ingersoll 1904). Wolfskill had shipped a carload of oranges to St. Louis in 1877, each crate stamped with the label "Wolfskill California oranges" on the box ends, the earliest advertisement of a domestically grown fruit (Gordon and Salkin 1977). By the 1890s, orange crate labels (fig. 5-27) with their audacious art had become synonymous with California's pride in its golden fruit (McClelland and Last 1983; Evans 1984). Perhaps the best known label in the world is the familiar Sunkist brand (Anon. 1901*b*).

Fig. 5-26. The first citrus label, a 5½- by 28-inch ribbon, was pasted over the top of the citrus crate. The label was printed and distributed to growers by the Riverside Board of Trade and Riverside Orange Growers Association to promote interest in Riverside oranges. This colorful advertisement called attention to Riverside's triumphs at the New Orleans World's Fair and Cotton Exposition in 1885. The one copy of this label known to exist is in the Laurie Gordon Collection, San Francisco. (Photo courtesy of Laurie Gordon.)



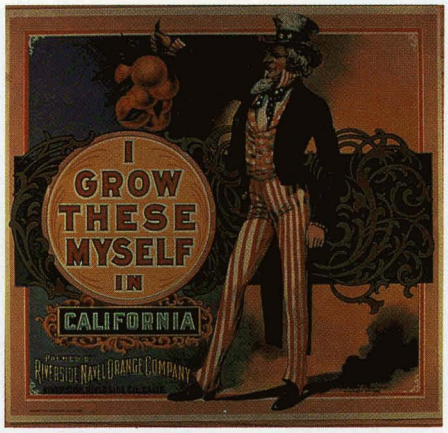


Fig. 5-27*A*. For more than a century, citrus crate labels have depicted a range of often flamboyant subjects, emphasizing grower pride in a product or region, reflecting period styles, presenting social, historical, and topical scenes, and permitting artists extravagant use of their imaginations. *Top left:* Raisin growers may have been the first to advertise their wares with labels. This image of two women dueling was highly risque for the early 1880s. (Courtesy of Lorne Allmon.) *Top right:* One of the rarest of citrus labels, bringing up to $1,000 in the collector's market, is the patriotic "Uncle Sam" design. (Courtesy of Lorne Allmon.) *Center left:* The scarce Griffin and Skelley navel orange label of 1886. (Courtesy of The Huntington Library.) *Center right:* Citrus belt landscapes were a favorite subject of orange crate artists. (Courtesy of Lorne Allmon.) *Bottom left and right:* Labels reminiscent of valentines with many flowery embellishments were popular in the Victorian period. (Courtesy of Lorne Allmon.)

Fig. 5-27*B*. Among citrus label collectors, individual labels are usually referred to by their brand names. Many brand labels were repeatedly reprinted and sometimes redesigned to catch up with changing times. *Top left, right, and center left:* These three rare labels are from the large collection of the Riverside Public Library. *Center right and bottom left and right:* These three unusual labels are from the Lorne Allmon Collection. Although names of lithographers and printers were often printed on labels, the artists rarely signed their names. The "Sombrero Brand" (*bottom right*) is one of the few labels signed by an artist. Its designer, James Swinnerton, later became famous as the creator of the "Little Jimmy" cartoon strip for the Hearst newspapers. Interest in citrus labels has led to organization of the Los Angeles-based Citrus Label Society, an international group of up to 400 members.

The Southern California Agricultural Experiment Station

After passage of the Hatch Act by Congress in 1887, Professor Hilgard and the Regents of the University of California determined that the bulk of funds from the act would not go to a central experiment station at Berkeley, but would establish outlying field stations in the state's four main climatic regions (Stadtman 1970; Nye 1983). At these four "regional culture" substations, supervisors directed by Hilgard would amass data on soils, climate, and water; conduct cultural experiments with many crops; and coordinate cooperative research between the University and private farmers (Hilgard 1890*a*).

In 1888, the University established three substations in northern California at Jackson, Tulare, and Paso Robles; each was planted with upwards of 600 varieties of crops for culture tests (Hilgard 1890*a*). Hilgard then began considering a site for a field station in southern California. In 1883, the University of Southern California had founded a branch institution, Chaffey College of Agriculture, at Ontario in the Pomona Valley (Servin and Wilson 1969). Hilgard (1888) believed that the proximity of this college would strengthen his southern field station and he entered into cautious negotiations with various Pomona business leaders for a site somewhere near Ontario (Hilgard 1889*b*, 1890*b*).

In July 1889, Hilgard toured prospective sites in southern California, finally spending the night at the home of Richard Gird of Chino (Anon. 1889*c*). A colorful, imposing figure, Gird (fig. 5-28) had made his fortune in the silver mines of Tombstone, where he bravely walked away from a gunfight with Wyatt Earp without losing face (Myers 1950; Graves 1968). He also managed to walk away from Tombstone with his wealth intact, purchasing the vast Chino Rancho, where he reintroduced cattle, pioneered sugarbeets, and set out to "do the most good and mold the destiny of those around me" (Gird 1881–1906). Gird offered Hilgard 40 acres of land on a long-term, rent-free lease to the University for use as a substation site (Gird 1890). He was later named patron of the substation and in the ensuing years remained its major benefactor.

Hilgard's abrupt announcement in 1890 that he had selected Pomona as the experiment station site caused an immediate uproar in Riverside, which had coveted the station (Anon. 1890*b*). Citrus grower T. H. B. Chamblin and business leader Frank Miller (the "Master of the Mission Inn") swept into action, forming a committee to halt the project. They managed to stop the Los Angeles State Fair Committee from donating the profits of that year's citrus fair to the new substation, but despite a trip to San Francisco they were unable to dissuade the Regents from approving Hilgard's choice (Anon. 1890*c*).

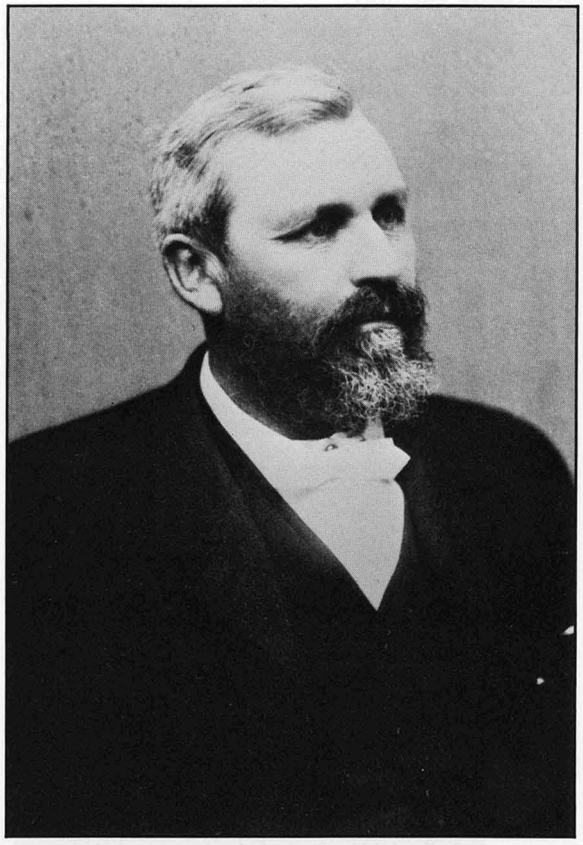


Fig. 5-28. Richard Gird, owner of the vast Rancho Chino, gave a plot of land near Pomona to the University of California to establish a cultural field station. A dynamic figure, he introduced the steam plow into the Pomona Valley, pioneered sugarbeet farming, and owned newspapers and banks, but he died bilked of most of his once vast estate. (Photo courtesy of Pomona Public Library.)

The Pomona station (fig. 5-29) was dedicated in the autumn of 1890, but Riverside citizens ignored the ceremony. The *Riverside Press and Horticulturist* responded petulantly to Pomona's victory:

> Our Pomona friends labor under a delusion. They fancy Riverside wanted an experiment station. On no! When Riverside wants a fancy public improvement of any kind she does not go skirmishing all over the country hunting up unused portions of fair funds. She just puts her hand in her pocket and furnishes the needful without a whimper (Anon. 1890*d*).

But Riverside had wanted the experiment station, and growers and civic leaders did not forget the

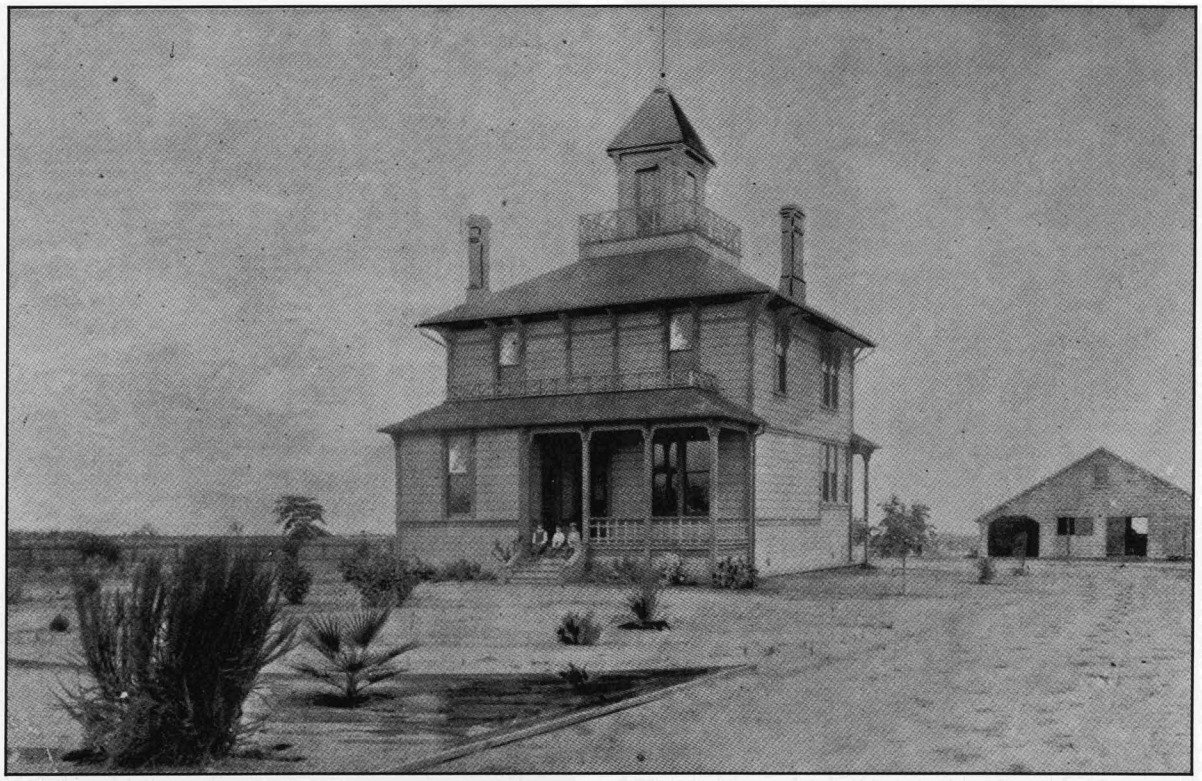


Fig. 5-29. The first experiment station in southern California was the Agricultural Experiment Station at Pomona. The citrus-growing town of Riverside was enraged at the University's choice of Pomona for the site. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

defeat. Among those who did not forget was John Henry Reed, a retired school superintendent and drygoods merchant from Mansfield, Ohio, who arrived in Riverside in the midst of the controversy (Baughman 1908; Cook 1976). Reed, 57 years old, had briefly attempted grain farming in Nebraska. Given 2 years to live by his doctor, he sold his farm and moved west, hoping to regain his health (Brown and Boyd 1922). Soon he was setting out an orange grove and reading every work he could find on scientific horticulture (Anon. 1918*a*).

The Pomona station got off to a bad start with a slothful supervisor whom Hilgard replaced in 1893 with James W. Mills (fig. 5-30), a layman of considerable ability who eventually was appointed superintendent (Shinn 1893, 1894; Hilgard 1904). Most of the research at the field station during its 15-year existence centered on major crops of the Chino region—sugarbeets, olives, grapes, and grain. Although the station orchard contained some 1,500 trees, most of them were deciduous fruits and nuts. Citrus remained confined to about 2 acres with examples of about 28 varieties (Mills 1902). In 1890, the USDA shipped nine date trees imported from the Middle East to Pomona, where they became the earliest such plantings in southern California (Van Deman 1890). The research emphasis of the station was on field trials of crop varieties.

In fiscal year 1894–1895, California growers shipped more than 1 million boxes of oranges and lemons. The number of boxes shipped doubled almost every year thereafter as new groves were planted and came into bearing (Lelong 1902). Citrus had finally become a multimillion dollar industry in California, and increasingly growers complained that the University was not addressing the problems of one of the state's major crops. In 1893, Mills was assigned to visit the leading orchards of Los Angeles, San Bernardino, and Riverside counties to collect data on the most successful cultural practices. This information proved mostly useful for dissemination to new growers. Pressed by the demands of orchardists in Riverside and other orange-growing districts for research of some sort, the substation launched a study on the effects of fertilizers on citrus in 1897 (Colby 1898).

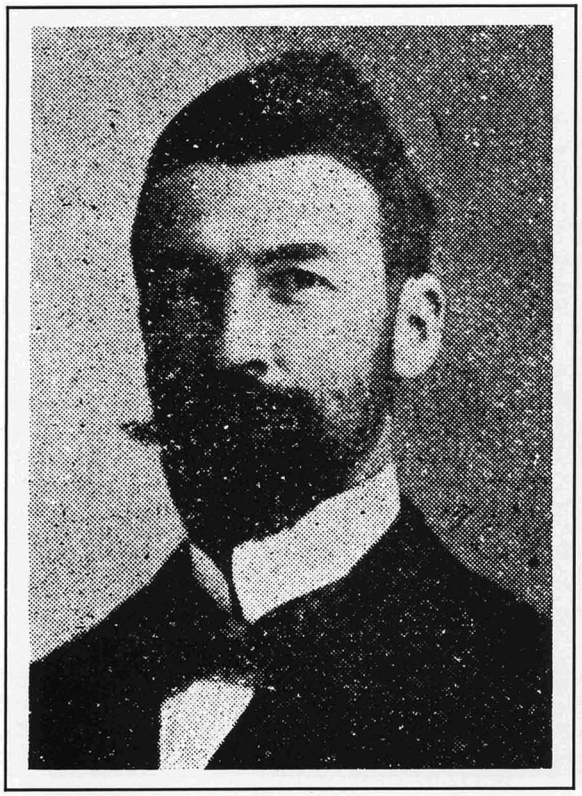


Fig. 5-30. James W. Mills, an early superintendent of the southern California Agricultural Experiment Station at Pomona, later was resident head of the Citrus Experiment Station at its first site at the foot of Mount Rubidoux in Riverside. Mills wrote the University's first general bulletin on citrus in 1902. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

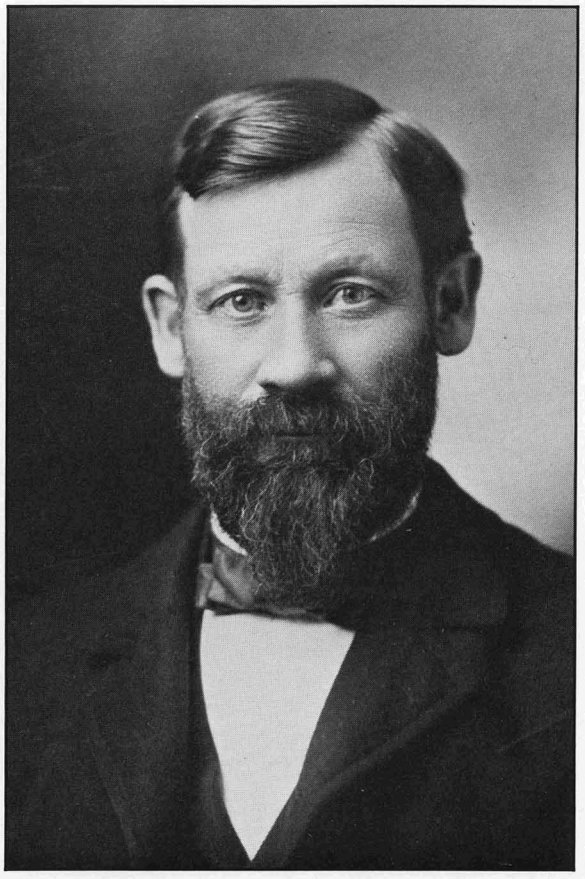


Fig. 5-31. Biologist Albert J. Cook of Pomona College was one of the first citrus researchers in southern California. He tirelessly assisted growers with pest problems in their orchards. (Photo courtesy of the Claremont Historic Resources Center.)

Relations between the University and growers began improving when Harvard-trained Albert J. Cook, a professor of biology and zoology, joined the staff of Pomona College in 1893 (Brackett 1944; Wright 1980). Cook had developed the first cheap, effective insecticide, the kerosene emulsion, in 1877; later he conducted pioneer work with arsenates to control codling moth (Howard 1930). Working closely with the Pomona substation, Cook won the respect of Hilgard in Berkeley. He became an articulate spokesman for the University's research, presenting frequent lectures with lantern slides to enable growers to recognize citrus pests, and bicycling great distances to help individual growers with problems. Cook deserves recognition as one of the first trained scientists working on citrus in southern California (fig. 5-31), and his studies of the control of insect pests were of inestimable value (Teague 1921). In 1911, he was appointed Secretary of Horticulture for California, and he played a major role in the passage of a national quarantine law in 1912. Among scientists who studied with Cook or whose careers he championed were E. O. Essig, H. S. Fawcett, Harry S. Smith, and R. S. Vaile.

The Farmers' Institutes

On March 10, 1891, the University Board of Regents, prompted by Hilgard, launched the Farmers' Institutes, which soon became hugely popular in southern California (Wickson 1903; Fiske 1979). E. J. Wickson (fig. 5-32), a lecturer in practical agriculture for the College of Agriculture, was placed in charge of the program, which by 1900 had sponsored about 80 institutes that reached 20,000 people every year (Stadtman 1970). In 1894, the Regents hired Albert Cook part-time to serve under Wickson as

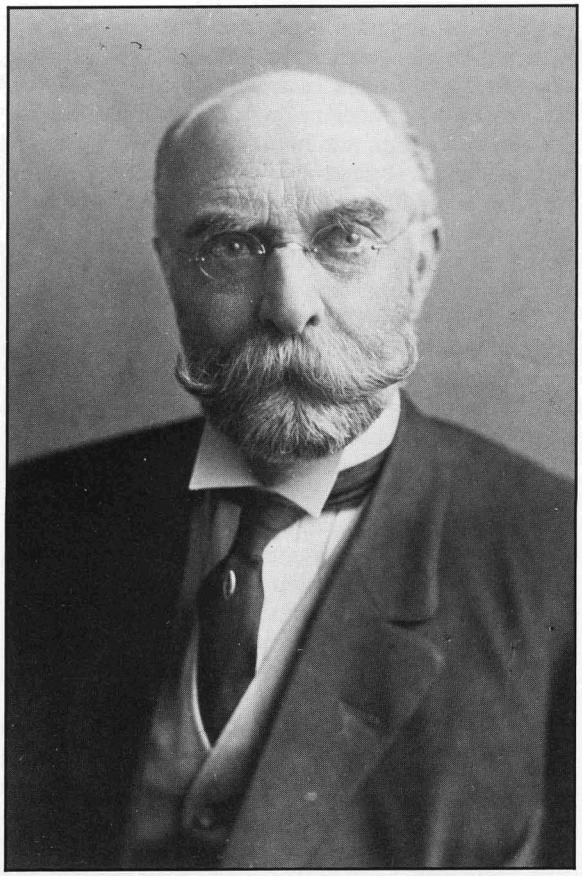


Fig. 5-32. E. J. Wickson, while a lecturer in practical agriculture at Berkeley, directed the University of California Farmers' Institutes, the most significant extension program of the 1890s. (Photo courtesy of the Ryerson Collection.)

conductor of the Farmers' Institutes in southern California, a position he held for many years (Wickson 1894).

The Farmers' Institutes brought agricultural scientists from the University via train and buggy to remote farming communities across the state (Fiske 1979). The institutes were important social and educational events throughout the citrus belt, drawing immense crowds and commanding popular approval of the University. At such institutes, sometimes lasting 3 days, scientists presented semitechnical papers on agricultural specialties and growers lectured from their own experience. In 1897, the Farmers' Institutes became part of the new Department of University Extension in Agriculture, the predecessor of today's Cooperative Extension.

The institutes encouraged formation of Farmers' Clubs in communities throughout the state. The first of these established in the citrus belt, the Eastside Horticultural Club, was organized in Riverside in 1894 by John Henry Reed, E. L. Koethen, and D. D. Pickett (Anon. 1894; Reed 1915). Reed was the leader in organizing the group, which was established to enable citrus growers to discuss their mutual interests (Reed 1904*a*). One of the club's most popular speakers was Cook, and Reed and Cook became active in forming other Farmers' Clubs in southern California. Such clubs were soon providing forums for exploring citrus problems that might be addressed more specifically at Farmers' Institutes.

The Farmers' Institutes were so successful that by the turn of the century they threatened to "wag the tail of the College of Agriculture dog" (Stadtman 1970). Hilgard complained in a report to the president of the University that demand for the institutes was so great that valuable faculty members were losing time from their classes and research. As a result, the Legislature in 1903 began providing appropriations for the support of Farmers' Institutes so that assistants could be hired to carry on lecture courses when professors were on institute duty (Jones 1901).

On April 16, 1895, Hilgard attended the first Farmers' Institutes held in Riverside, where he was besieged by growers arguing the need for citrus research. Although Hilgard recognized the need for specialized research, he believed many more basic issues in California agriculture demanded research attention. In a speech to the growers on "Science in the Orchard," Hilgard (1895) suggested that his listeners "constitute yourself an experiment station" by forming a club to conduct research. He assured them that the University would cooperate fully with such a project and "give you all the analyses that may be needed."

The Riverside Horticultural Club and Its Research

Hilgard's speech sparked the organization of the Riverside Horticultural Club, a group of sophisticated and scientifically enlightened Riverside growers who first met in the city courtroom on May 13, 1895 (Anon. 1895*a*, 1895*b*).[5] They agreed to eschew the social focus of many Farmers' Clubs and to concen-

[5]The earlier Eastside Horticultural Club was merged several years later into the Riverside Horticultural Club. John Henry Reed (1915) was a founder of both groups.

Fig. 5-33. "Smudging" or orchard heating for frost protection was first tested in Riverside in 1897 by the Riverside Horticultural Club. Southern Californians became inured to black skies on cold days up until the 1950s when improved orchard heating equipment ended most smudging. This photograph was taken in 1937. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

trate on conducting cooperative research (Reed 1895).

The club's most energetic organizer and dynamic spokesman was John Henry Reed, who because of a hearing impairment declined most offices, serving instead as chair of the club's experimental committee. His close friend E. L. Koethen was president of the organization throughout most of its existence. Other major figures associated with the club were James Boyd, G. W. Garcelon, E. W. Holmes, E. A. Zumbro, and later Ethan Allen Chase, then owner of the world's largest orange grove, measuring more than 1,000 acres (Clarke 1912).

Initial experiments focused on pruning and the effects of manure on young orchards (Anon. 1895*c*). Cook and James W. Mills of the Pomona Station lent advice on club projects; Reed sought out cooperative growers to establish trial plots and personally supervised many experiments. To scoffers who said that nothing significant would emerge from the experiments, Reed asserted that the club's research was the difference between "muscle and brains" (Anon. 1898*a*).

Within a few years, the club commanded the respect of scientists and citrus growers throughout the state. In 10 years, the club conducted pioneer research on irrigation, soil saturation and evaporation, citrus root structure, depth of cultivation, transplanting of trees, budding, mottle-leaf disease, and frost protection. Although the club published a set of proceedings, none of these records appears to have survived (Patterson 1971). Many club members, however, frequently published articles on experiments. Reed, the organization's most prolific writer, turned out more than 150 semitechnical and popular papers on citrus and other subjects between 1895 and 1915. In 1902, Mills incorporated many of the club's experiments into the first technical bulletin on citrus culture published by the University of California (Mills 1902).

The club's most dramatic experiments consisted of the first scientific tests on frost protection (Reed et al. 1902). In 1891, A. T. Copley of Riverside attempted to raise his orange grove's temperature during frosts by burning tar and wood. He finally settled on small wire baskets filled with coal (Anon. 1896). Copley claimed his experiments were successful, and the club subsequently tested his baskets and other methods, using dry heat, steam from a steam plant, and various smudging fuels. On the night of December 4, 1897, the club began a series of experiments in eight trial orchards (Holmes 1897). The club was a laughingstock in California for "trying to heat up the outdoors," but in 5 years it demonstrated the value of smudging (fig. 5-33) and established the first basic principles of frost protection (Brown and Boyd 1922). The *California Fruit Grower* praised "the Riverside people as showing themselves to be enterprising and public spirited " (Anon. 1897*a*).

In 1898, after an unsuccessful effort to get a U.S. Weather Bureau station located in southern California, the club organized what may have been the first fruit frost warning service in the United States (Anon. 1898*b*). Arrangements were made with the U.S. Weather Bureau as a cooperative experiment to send frost warnings by Western Union telegraph from its San Francisco office to Riverside. A messenger then routed the warnings to key growers in districts across the valley, who relayed the information through pyramids of growers subscribing to the system. Other citrus regions developed their own frost warning systems after Riverside's success (Turrell 1973). The most unusual of these warning systems was established in 1910 by the Pomona Valley Orchard Protective System (Turrell 1973). Six motorcycle riders were assigned to check out 140 thermometer stations and alert growers when frost was imminent. Such private frost warning systems were dissolved after 1917 when the U.S. Weather Bureau's Fruit Frost Warning Service was established with headquarters at Pomona.

The USDA Laboratories in Riverside

In 1892, the U.S. Department of Agriculture sent two young plant pathologists, Walter Tennyson Swingle and Herbert John Webber, to Eustis, Florida to establish a regional laboratory and to conduct the first broad scientific investigation of citrus diseases. Their studies were monitored by California growers through agricultural journals, and there was widespread interest in the bulletin describing their research published in 1896 (Swingle and Webber 1896). Soon afterward, Reed wrote to Beverly T. Galloway, chief of the USDA Bureau of Plant Industry, pressing the equally strong claim of California citrus growers for research on their problems (Chase 1916–1917). Reed, a persistent correspondent, is credited with hounding Galloway into sending a USDA investigator to Riverside (Shamel 1921). In January, 1904, USDA pomologist G. Harold Powell arrived in Riverside and began studying fruit decay, which was causing enormous losses to the citrus industry each year (fig. 5-34). Reed talked Ethan Allen Chase into setting up a laboratory for Powell on his ranch (Clarke 1912).

Powell returned to Riverside for five winters, bringing collaborators with him (Powell 1908). In the winter of 1903–1904, Powell completed a preliminary survey that indicated that postharvest citrus decay was especially troublesome in certain packinghouses. On April 7, 1905, at a Farmers' Institute in Riverside, Powell startled growers by providing dramatic proof that excessive decay was related to careless handling of citrus fruit (Powell 1905). Over the next 3 years, Powell developed improved methods for processing and shipping that saved growers three-quarters of a million dollars annually (Brown and Boyd 1922).

Powell's research occurred during the years when the Riverside Horticultural Club campaigned to establish a citrus experiment station in southern California. It was the first research investigation in which results of a study could be correlated clearly with financial savings that substantially outweighed research costs. The study supported growers' arguments for problem-oriented research. The presence of the USDA laboratory on Chase's ranch also influenced the selection of Riverside as the site for an experiment station in 1906.

One of Powell's collaborators was Archibald D. Shamel, who arrived in Riverside in March 1909 to assist in the project's lemon-handling studies (Shamel 1911). The fact that even better orchards contained many trees that produced inferior fruit had attracted John Henry Reed's attention, and for several years he had urged an investigation (Brown and Boyd 1922). Shamel, assigned to Riverside for only 3 months, became interested in the problem and presented Powell with a practical plan for its investigation. As a result, Shamel stayed on in Riverside permanently, and in 1910 he launched a long-term study of citrus bud variation and selection under the direction of the USDA Office of Pomology (Shamel 1911, 1946). The research of Powell and Shamel started a pattern of productive collaborative research between the USDA and the Citrus Experiment Station that has continued uninterrupted.

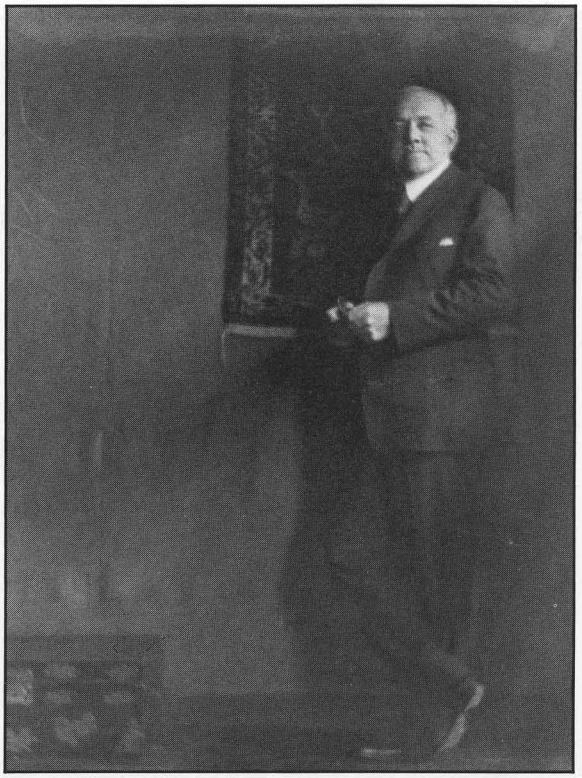


Fig. 5-34. G. Harold Powell arrived in Riverside in 1904 to investigate causes of citrus fruit decay. Powell later served as general manager of the California Fruit Growers Association. (Photo by Edward Weston, courtesy of the Lawrence Clark Powell Collection, Library of the University of California, Los Angeles.)

The Fight for a Citrus Experiment Station

Citrus growers of Riverside and their allies in other communities fought two difficult campaigns to secure a Citrus Experiment Station. The first battle, launched in 1900, lasted almost 6 years; much of it was waged almost single-handedly by John Henry

Reed, who kept the issue alive in the face of many setbacks (Anon. 1907*a*; Brown and Boyd 1922). The second campaign occurred in 1914 when the experiment station, then firmly established in Riverside, was threatened with removal to the San Fernando Valley. Reed, in his eighties and in perilous health, supported that battle, too, but the victory was won by a coalition from Riverside. Probably chief among the group's members was Ethan Allen Chase, with the backing of G. Harold Powell, who had left research to become general manager of the California Fruit Growers Exchange (Chase 1916–1917; Webber 1918).

The First Campaign

Although the State Agricultural Experiment Station in Berkeley was by no means inactive in citrus research toward the end of the century, growers in southern California felt that the station headquarters was too far away for effective, intensive research (Smith 1909). No trained scientists were assigned permanently to the Pomona station, and its efforts in citrus were confined mostly to gathering and disseminating data based on cooperative experiments conducted by the Riverside Horticultural Club and growers elsewhere. Grower sentiment was summed up by the *Riverside Daily Press*, which charged editorially that the Pomona substation had never "done anything whatever in the matter of experimental work in citrus" (Anon. 1904*a*).[6]

In 1899, Reed and Koethen developed a plan for a federally funded citrus experiment station to present to the horticultural club (Anon. 1899*a*). The idea for such a federal station appears to have been Reed's, but the campaign to secure it was formulated by both men.[7] Koethen followed up Reed's earlier contacts with Galloway of the U.S. Bureau of Plant Industry by sounding him out on the proposal. Galloway was receptive, but indicated growers would have to generate congressional support for the project. Reed acquired a letter of endorsement from Professor Cook of Pomona College, who promised to secure the cooperation of the University of California and the farmers' clubs. Reed and Koethen presented their summer's effort as a fait accompli that was approved by the club at its October meeting (Anon. 1899*a*).

In December 1899, learning by telegram that Walter Tennyson Swingle of the USDA would be stranded in Riverside for 3 hours on his way to the coast to examine citrus diseases, Reed and Koethen flushed him at the railroad depot, gave him a whirlwind tour of Riverside groves, and armed him with ammunition on grower problems to take back to Galloway (Anon. 1899*b*). Over the next 2 months Reed published drafts of a speech as the opening salvo in a campaign for a federally funded citrus experiment station. On January 4, 1900, Reed delivered a rousing speech to a large audience of citrus growers at the Pasadena Farmers' Club Institute, urging them to "demand" a federal station. His speech won overwhelming endorsement, touching off a long campaign (Anon. 1900*b*).

Over the next 5 years, Reed (fig. 5-35), entering his seventies, delivered speeches up and down the state and lobbied influential backers, ably supported by Koethen and Ethan Allen Chase (Reed 1900; Brown and Boyd 1922). The Riverside Horticultural Club circulated numerous petitions, obtaining endorsements from farmers' clubs, boards of trade, civic groups, and prominent individuals. On two occasions, the growers (with support from the USDA) almost succeeded in bringing appropriations bills for the federal station onto the floors of Congress (Anon. 1900*c*; Anon. 1901*c*).

In the winter of 1903–1904, Powell set up a laboratory to study citrus fruit decay on Chase's ranch. Perhaps USDA interest in the citrus station flagged once Powell was assigned to Riverside. Certainly, the grower movement lost steam for more than a year, and Reed carried it on virtually alone. In 1903, Reed shifted his strategy. Together with Koethen, he drafted a resolution that was endorsed

[6]The editorial was unduly harsh, since some citrus research was being carried on in Berkeley, particularly by C. W. Woodworth in entomology (Essig 1931). Reed and Koethen both admired the administrative virtuosity Hilgard had shown over the years in building the College of Agriculture and the State Agricultural Experiment Station. They understood his broad research priorities and recognized that limited funding was the major hindrance to concentrated citrus research. During the campaign for the experiment station, Reed (1901, 1904*b*) muted grower criticism of the University on several occasions by giving speeches praising its contributions to California agriculture. Later, Koethen (1929) described Hilgard as a "giant among men of the period."

[7]Reed was generous in crediting colleagues; therefore, his statement that he alone "commenced agitation" for the experiment station seems trustworthy (Reed 1914). Both James Boyd and E. W. Holmes, fellow members of the horticultural club, considered Reed to be the instigator of the fight for the experiment station, seconded by the efforts of Koethen and other club members (Brown and Boyd 1922; Holmes 1912).

Fig. 5-35. Riverside Tree Warden John Henry Reed (*standing*) chats with the noted naturalist John Muir (*seated in car*) on the streets of Riverside in June 1907. Reed's dream of a citrus experiment station in his city had culminated in the dedication of the Rubidoux Laboratory earlier that year. (Photo courtesy of Riverside Municipal Museum.)

by the annual state Fruit Growers' Convention in Los Angeles urging that either the "state or federal government" establish a citrus experiment station in southern California (Anon. 1903).

On December 20, 1904, Reed appeared before the Riverside Chamber of Commerce, traced the history of the movement, and pleaded for assistance in pushing a bill through the Legislature that would provide appropriations for an experiment station (Anon. 1904*b*). Cornelius Rumsey, a grower and civic leader, was appointed chair of a committee, which included Reed, to work with California State Assembly member Miguel Estudillo of Riverside in drafting the proposed bill (Patterson 1971).

Meanwhile, another movement had originated among the walnut growers and farming interests in the areas near the coast supporting a bill for the establishment of a plant pathology laboratory (Smith 1908). Two separate bills were finally combined into Estudillo's State Assembly Bill 552, which provided for a pathological laboratory and a branch experiment station in southern California (Anon. 1905).

On March 18, 1905, the Legislature empowered a board of three commissioners to represent the Regents of the University of California in selecting a site for the laboratory and experiment station (Statutes of California 1905). The commissioners appointed to carry out this task were Governor George C. Pardee; Benjamin Ide Wheeler, president of the University of California, and Professor E. J. Wickson, who, with Hilgard's retirement, was about to become director of the University's statewide Agricultural Experiment Station. The Legislature also appropriated $30,000 to implement the measure.

After inspecting sites in the citrus belt, the commissioners on May 21, 1906 decided on the organization of a single institution with two localized branches: a pathological laboratory at Whittier and a citrus experiment station at Riverside (State Board of Commissioners 1906). The site chosen for the experiment station comprised about 23 acres on the eastern slopes of Mount Rubidoux overlooking downtown Riverside. The Huntington Park Association, which owned most of the land, offered it to

the University virtually rent-free for 20 years (University Chronicle 1906). The site contained two cottages and a stable, and shortly after its acquisition several other small buildings were added to make up a headquarters complex (Boyce 1969).

On July 28, 1906, President Wheeler reportedly announced the Regents had decided upon two sites, and presented a detailed plan of research tasks that would be carried out at Whittier and Riverside (Anon. 1906*a*).[8] On August 21, 1906, the Regents appointed Dr. Ralph E. Smith (fig. 5–36), assistant professor of plant pathology at Berkeley, to serve as superintendent of the Southern California Pathological Laboratory and Experiment Station, thus placing him in charge of both the Whittier and Riverside research units (University of California Regents 1906). They also approved appointment of James W. Mills of the Pomona substation as an assistant in horticulture, making him responsible for cultural experiments at Riverside. Although the two leases for the Riverside site were still moving upward in University administrative channels, the Huntington Park Association apparently considered their approval a mere formality. Smith arrived in Riverside on August 27 and announced that work would begin the next day on a reservoir (Anon. 1906*b*). Mills had already taken possession of the station site, moving into a cottage on the grounds in June. In September, an assistant horticulturist, Thomas Francis Hunt, joined the station staff (Smith 1909).

On January 27, 1907, Riverside staged the largest Farmers' Institute ever held in California to mark the beginning of the Citrus Experiment Station (Wickson 1907). Governor Pardee, University President Wheeler, and Dean Wickson were among many honored guests and speakers at this special Citrus Fruit Growers' Institute, where John Henry Reed delivered the welcoming address (Anon. 1907*b*). Twenty cars filled with dignitaries were escorted on a tour of the new experiment station, which had been in operation since August with an irrigation system already laid out (Anon. 1907*c*). In a keynote speech, Wheeler observed that "we have now located in Riverside one branch of the University" (Anon. 1907*d*). A grower's resolution was passed commending Wheeler and the University for having established the station and singling out Reed for his "splendid work" in securing it (Anon. 1907*d*). Members of the Huntington Park Association were by then furious over the long delay of the Regents in signing the leases (Wickson 1906).[9]

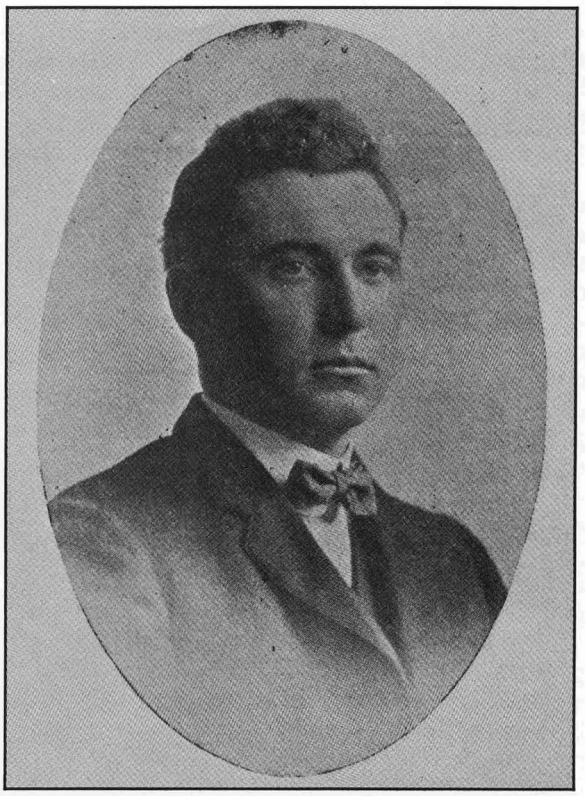


Fig. 5-36. Ralph E. Smith, a plant pathologist from Berkeley, served as superintendent of the Southern California Pathological Laboratory and Experiment Station. (Photo from *California Citrograph* 1(12):4.)

[8]Curiously, there appears to be no record in the minutes of the Regents approving the site selection or the research plan before the date of this announcement. The announcement appeared in the *Pacific Rural Press*, edited by Wickson. The technical plan set forth seems to be an actual text, rather than a news summary. It is unlikely Wickson would have published this story without the sanction of the Regents or President Wheeler. Other news stories announcing selection of the Whittier and Riverside sites appeared at about the same time in southern California newspapers.

[9]The Huntington Park Association was formed by Frank Miller of the Mission Inn, Henry E. Huntington, and other businessmen to develop Rubidoux Heights and create a park on Mount Rubidoux (Patterson 1971). The site had been offered to the University as a civic gesture, but the delay in the lease agreement, which included $4,000 compensation for structures on the site, held up the building of a road to the top of Mount Rubidoux. John Henry Reed, who had become city tree warden (1906–1911), directed the planting of 4,600 trees in the park (Anon. 1906*c*). His role as tree warden brought him national recognition among city planners (Brown and Boyd 1922).

It wasn't until February 14, 1907, however, that the Regents formally approved the leases for the Riverside site, and by then the Citrus Experiment Station had been in operation for almost 6 months (University of California Regents 1907).[10] The date of the signing of the leases, however, has since become the official date that the University recognizes for the founding of the Citrus Experiment Station (Pettit 1953; Stadtman 1968). At the same meeting, the Regents closed the southern California Agricultural Experiment Station at Pomona, ending its 15-year existence and reconveying the deed to Richard Gird's widow. The Paso Robles and Jackson substations in the north had been shut down earlier when it became clear in 1903 that Hatch Act funds would not cover all of the agricultural research planned by the University (Stadtman 1970). The Tulare station lingered until 1909 (Nye 1983).

The Rubidoux Laboratory

In 1905, the Legislature also approved the establishment of a University Farm; the following year a site was acquired near Davisville (Ferrier 1930). The University now concentrated on development of the Davis farm, which eventually became a University campus. Reed had urged Wickson in 1905 to appoint a professor from the College of Agriculture to direct the Riverside station (Reed 1905*a*).[11] Thus, it was a blow to citrus growers when they learned that budgetary restraints made it necessary to assign Smith to manage both the Riverside and Whittier units, leaving Mills to superintend the Riverside operation. Mills was respected and popular with growers, but his training was as a crop advisor and not as a scientific researcher.

Initially, the Rubidoux Laboratory (fig. 5-37), as it came to be known, was concerned with soil management, including fertilization and irrigation requirements (Smith 1908; Boyce 1969). Investigations were also conducted on rootstocks and on improving citrus varieties by bud selection. A collection of citrus species and varieties was also started on station grounds. Before 1912, the station was limited to two technically trained staff, visiting faculty researchers, and several staff assistants to carry out field operations.

The Whittier Laboratory (fig. 5-38) was built on a 1-acre site donated by the Whittier Board of Trade through local subscription (Smith 1908; Lampman 1984). As headquarters for investigations into plant pathology and entomology in southern California, its work centered largely on pests and diseases connected with walnuts, citrus, and vege-

Fig. 5-37. This cottage, one of several structures on the Rubidoux Laboratory site, served the experiment station until a main-office laboratory was built in 1912. The cottage was probably used by James W. Mills, resident superintendent, as both a home and headquarters of the laboratory. (Photo courtesy of the California Museum of Photography, University of California, Riverside.)

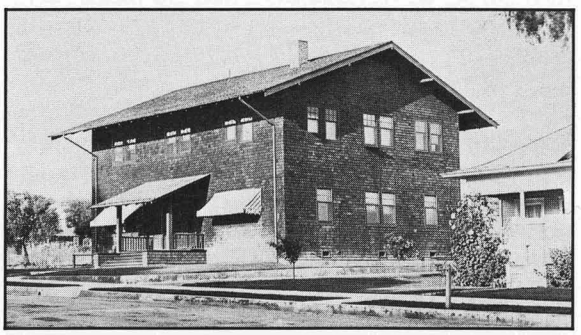


Fig. 5-38. The Whittier Laboratory was the headquarters of the University's southern California research on pest and disease problems associated with walnut, citrus, and vegetable growing. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

[10]Local historians and some staff members of the University of California, Riverside, have argued periodically for an official founding date of 1906 (Patterson 1982*a*). When Riverside County erected a historical marker on the UCR campus in 1967, observing the founding of the experiment station, it used the earlier date of 1906 on the bronze plaque at the recommendation of the Riverside County Historical Commission.

[11]Reed favored Arnold Stubenrauch, a horticulturist, who left the University for several years to join the USDA's research on citrus fruit decay in Riverside.

tables. Citrus research focused primarily on mottle-leaf or little-leaf disease, a major problem first noted in the Riverside area. Not until the 1930s was this abnormality found to be caused by zinc deficiency and correctable with sprays containing zinc. The scientific staff in the laboratory's first years included three plant pathologists, an entomologist, and a pomologist (Smith 1909).

University research did not end grower research. University experiments were usually long-term, aimed at establishing basic principles. Grower research sought short-term solutions to immediate problems. Despite fertilization studies at Riverside, two prominent citrus growers, C. C. Teague of the Limoneira Company of Santa Paula and C. C. Chapman of Fullerton, for example, carried out significant independent fertilizer experiments on oranges and lemons, respectively, during the early 1900s (Batchelor 1957; Teague 1944; Pflueger 1976).[12]

In 1908, Mills resigned as the superintendent of the Rubidoux Laboratory and was succeeded by J. H. Norton, a chemist formerly with the Arkansas Experiment Station (Kelley n.d.). Overall technical direction continued to come from Smith, assisted by E. B. Babcock, a professor of genetics at Berkeley (Coit 1962). Two years later, Norton was replaced by Hunt, the station's assistant horticulturist. The various shifts in staff, a seeming lack of research direction, and slender funding for the Rubidoux Laboratory from the Legislature over the next few years aroused mounting complaints from the citrus industry, which now grossed $20 million annually (Braunton 1907). As early as 1909, the *Riverside Daily Press* editorialized that the southern California orange growers had hoped to see a "great institution" emerge for the study of citrus culture once the station was founded (Anon. 1909). Instead, the newspaper lamented, more significant research was being generated privately in Riverside from orchard studies and from laboratory work carried out by the Arlington Heights Fruit Company.[13]

Powell was among those critical of the direction of research at Riverside. He had become an increasingly articulate voice for the orange growers. On April 5, 1909, Powell met privately in the Mission Inn with Arthur Foster, chairman of the University Board of Regents. Powell (1909*b*) told Foster about grower sentiment and suggested changes in the University's agricultural research structure. He noted that Foster had little conception of southern California's agricultural needs, but he found the Regent receptive.

In 1911, J. Elliott Coit, a horticulturist, assumed Smith's title as superintendent of the Whittier and Rubidoux Laboratories (Kelley n. d.). In that same year, the Legislature appropriated $25,000 for construction of a main-office laboratory at Riverside and purchase of the site from the Huntington Park Association. The building, equipped with a physiological laboratory, was completed in 1912, and its upper floor was assigned to the USDA investigators stationed in Riverside by the Bureau of Plant Industry (Hunt 1913). Coit's frequent presence at the station raised grower morale, but it did not diminish criticism of the scope of its research.

Meanwhile, Powell had resigned from the USDA in 1911 to become secretary and general manager of the Citrus Protective League, an influential citrus industry organization formed to handle public policy questions regarding railroad rates, tariff legislation, and other issues (Powell 1912).[14] In September of 1912, Powell also became general manager of the California Fruit Growers Exchange. From these two positions, he launched a citrus growers' movement that won increasing support in the Legislature and within the University for enlargement

[12]Teague, one of the founders of the lemon industry, was to serve from 1920 to 1950 as president of the California Fruit Growers Exchange (Ainsworth n.d.). Fertilizer experiments by the Limoneira Company, which he managed, were still being conducted as late as 1929, an unusually long duration for grower research (Jenson and Foote 1929). Blanchard (1983) has dealt with the history of the Limoneira Company. Chapman pioneered the orange industry in Orange County and became known as "The Father of the Valencia Orange Industry" (Pflueger 1976). He should not be confused, however, with Judge A. B. Chapman of San Gabriel, who appears to have imported the first trees of the Valencia variety from Rivers Brothers nursery of England in 1878 (Clark 1916; Wood 1916).

[13]Powell wondered whether the "Berkeley people" thought he had written the editorial. In a letter to his wife, he speculated that the author might be Reed (Powell 1909*a*). Lunching with Reed the next day, Powell (1909*b*) learned that E. P. Clarke, editor of the *Riverside Daily Press,* had written the editorial.

[14]The Citrus Protective League was formed on March 12, 1906 at a large assembly of citrus growers in Los Angeles (Anon. 1906*d*). Seven members of the 30-member general administrative committee, representing growers from all major citrus districts of southern California, were from Riverside. C. C. Chapman of Fullterton was elected president, and Harry B. Chase of Riverside became vice-president.

of the Citrus Experiment Station (Webber 1918). Chase (1916–1917) later credited Powell for his adroit behind-the-scenes lobbying that led to the creation of one of the world's great agricultural research institutions.

The Reorganization of Teaching and Research in Agriculture

In 1912, Wickson retired as dean of the College of Agriculture and director of the Statewide Agricultural Experiment Station. President Benjamin Ide Wheeler and the Regents immediately considered reorganizing the University's agricultural research and teaching activities (Webber 1918). In the summer of 1912, Thomas Forsythe Hunt was called from Pennsylvania State College to the University to direct the reorganization. Suggestions included formation of a graduate school of tropical agriculture in southern California (Hunt 1913).

In late 1912, Coit was transferred to Berkeley to establish a Division of Citriculture within the College of Agriculture (Coit 1916; Boyce 1969). Herbert John Webber, a professor of plant breeding at Cornell University, was appointed director of the Citrus Experiment Station and dean of the new Graduate School of Tropical Agriculture (fig. 5-39). His title became effective in January 1913. The Regents could scarcely have chosen a more able administrator or a more brilliant research scientist than Webber (Bliss and Buvens 1946). His pioneer research on citrus diseases and citrus breeding for the USDA early in his career was well known and admired by the citrus growers of southern California, including John Henry Reed and Ethan Allen Chase, who were to befriend Webber. He was forceful, enthusiastic, and possessed of broad vision; having grown up on a Nebraska farm, he understood the language and primary concerns of growers (Webber 1945).

On January 5, 1913, a record killing freeze in southern California caused immense losses to growers, and panic spread throughout the citrus industry (Milliken et al. 1919). The freeze lent urgency to the Regents' reorganization effort and provided new ammunition for Powell and the California Fruit Growers Exchange in lobbying politicians for increased citrus funding. At stake was a $175 million agricultural industry (Powell 1912).

The movement for expansion of citrus research by the University and the growers gained favor in Sacramento (Webber 1918). The result was passage of three acts in the 1913 session of the California Legislature providing $185,000 to fund an enlarged citrus experiment station to be located in one of the eight southern counties. Assembly member W. H. Ellis of Riverside, who drafted the original bill, was prevailed upon to withdraw it in favor of a "more inclusive bill" (Anon. 1914*a*). Later, he reported that fellow legislators had assured him there was no intent to move the Citrus Experiment Station away from Riverside and that the insertion of the names of other counties was simply a matter of legislative expedience (University of California Regents 1914). Governor Hiram W. Johnson approved the final bill for the purchase of land and water rights on June 9, 1913 (Statutes of California 1913).

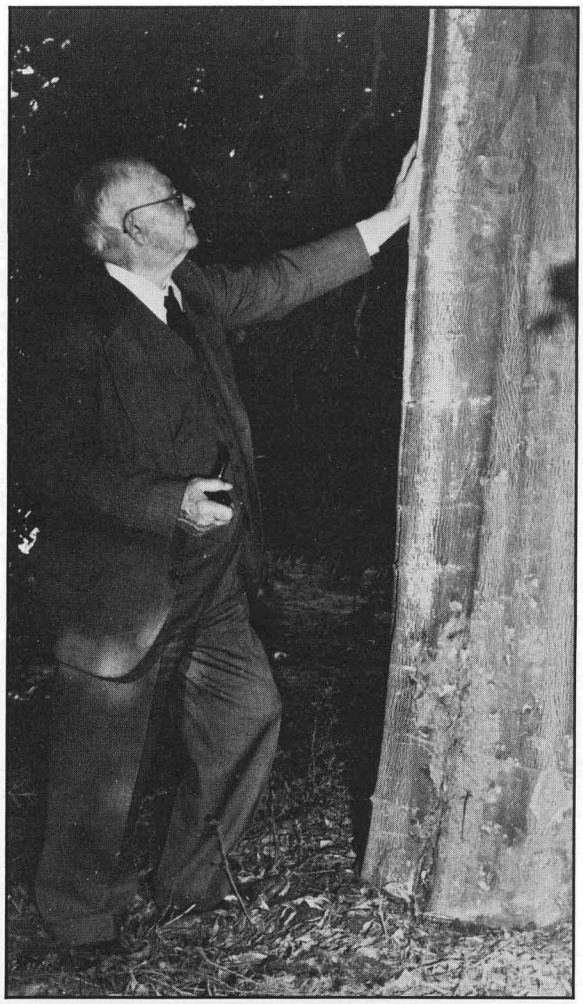


Fig. 5-39. Herbert John Webber, first director of the Citrus Experiment Station, is shown here in 1944 examining an 88-year-old sweet orange seedling in the Cram orchard in East Highland. The Cram grove, planted in 1869 in San Bernardino, was one of the pioneer orchards that inspired Riverside colonists to engage in citrus growing. The tree was chopped down in the 1960s by a developer. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

The Second Battle for a Riverside Site

In 1913, the Owens Valley aqueduct had been inching southward for 6 years toward its terminus in the San Fernando Valley north of Los Angeles. It had become one of the most massive construction projects in human history, employing 4,000 tunnelers and diggers who worked at times in temperatures of more than 110°F (Kahrl 1982).[15] In November 1914, the aqueduct gates opened officially to the cheers of 10,000 enthusiastic spectators as a roaring flood dashed down the cascade into the San Fernando Valley (Caldwell 1916). This monumental undertaking secured an additional and long-range water supply for Los Angeles and its environs, supposedly saving the city from a disastrous water shortage.

The controversial project, depicted as "the rape of the valley" by resistance leaders in Owens Valley, paved the way for extensive development of the San Fernando Valley (Kahrl 1982). On December 5, 1905, a syndicate of the most powerful development interests in the Los Angeles business community incorporated as the San Fernando Mission Land Company, issued a charter, and a year later bought up 16,000 acres of land in the valley at $35 an acre.[16] Other investors also bought their way into the syndicate, until by 1912 the holdings embraced the greater part of the valley.

These were the behind-the-scenes forces that the community of Riverside faced when the San Fernando Valley suddenly emerged as the front candidate for the new location of an expanded Citrus Experiment Station and Graduate School of Tropical Agriculture (Anon. 1914*b*).

Soon after arriving in Riverside in 1913, Herbert John Webber looked at potential sites for the expanded Citrus Experiment Station. He became convinced that the station should not be moved from Riverside, and he worked closely with the Riverside Chamber of Commerce, city officials, and growers to examine possible new locations. The site he eventually selected (fig. 5-40) and strongly recommended

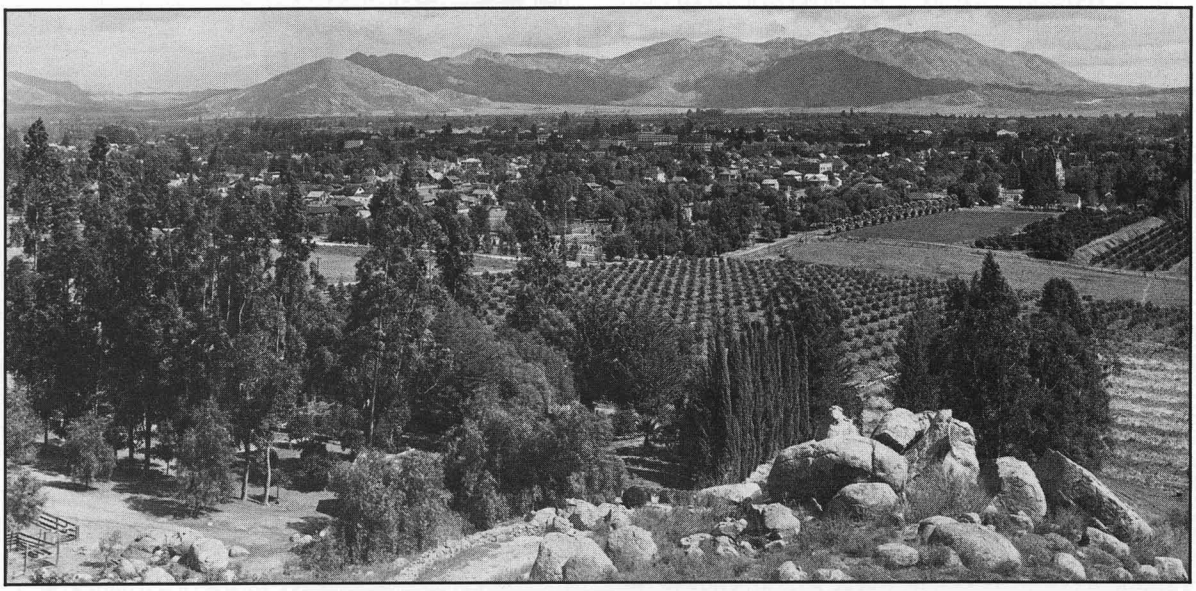


Fig. 5-40. This scenic view of Riverside from the slopes of Mount Rubidoux was photographed in 1911. The orchards in the foreground were part of the Rubidoux Laboratory. The site Herbert John Webber selected for the future Citrus Experiment Station was at the foot of the Box Springs Mountains, almost in a straight line from the top of the boulder-strewn hill in the foreground. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

[15]Chalfant (1933) wrote an embittered account of the history of the aqueduct from the viewpoint of resistance leaders in Owens Valley. Nadeau (1950) constructed a noble apologia for Los Angeles in his story of the aqueduct. Kahrl (1982) has written a scholarly, impartial examination of the conflicting personalities and forces involved.

[16]Among the better known of the original investors were Henry E. Huntington, founder of Pacific Electric Railway; E. H. Harriman, president of Union Pacific; and Harrison Gray Otis, publisher of the *Los Angeles Times*.

to the University comprised 475 acres of land, about 300 of which were tillable, located 2½ miles from the center of Riverside, adjacent to the Box Springs Mountains (Webber 1918).

Meanwhile, bitter competition over the site for the new institution arose among southern California communities scattered from Ventura to San Diego (Kelley n. d.; Boyce 1969). Initially, Webber was instructed by the University to inspect the various sites offered. Of 167 bids received by the University, only 60 were seriously studied by Webber and his staff, and these were narrowed down to about 10 sites of which the most attractive were at Riverside, Corona, Pomona, and San Fernando, not a notable citrus-producing district (Anon. 1914*c*). Webber remained unalterably disposed in favor of Riverside in the face of tremendous political pressures.

Pressing Riverside's claim was a Chamber of Commerce committee chaired by S. C. Evans (Anon. 1914*d*). Among the committee's many influential members and advisors were Chase, Frank Miller, L.V.W. Brown, and Reed, now in his eighties and in ill health (fig. 5-41).[17] Transfer of the station appeared unthinkable and would have disrupted the continuity of research being carried out under Webber's direction. Since Webber was backing Riverside, Riverside proponents were supremely confident of the outcome of the issue.

The Regents turned to a faculty committee made up of Hunt, Coit, and Webber for an opinion. Hunt and Coit voted for San Fernando, and Webber dissented (Anon. 1914*e*). Next, the Regents appointed and consulted a five-member grower advisory committee (Anon. 1914*f*). Four growers lived in the coastal area; only one, Ethan Allen Chase (fig. 5-42), represented the interior citrus belt. Chase voted for Riverside; the other growers voted for San Fernando (Anon. 1914*g*). Supposedly a strong factor against Riverside was the San Fernando Valley charge that it had become a "decadent" citrus region, heavily infested with mottle leaf.[18] Although USDA scientists in Riverside noted that mottle leaf existed in every citrus district, this slur hurt Riverside throughout the conflict (Anon. 1914*h*). Finally, a three-member Regents' committee, appointed to study the proposed sites, voted two to one in favor of San Fernando (Anon. 1914*g*).[19]

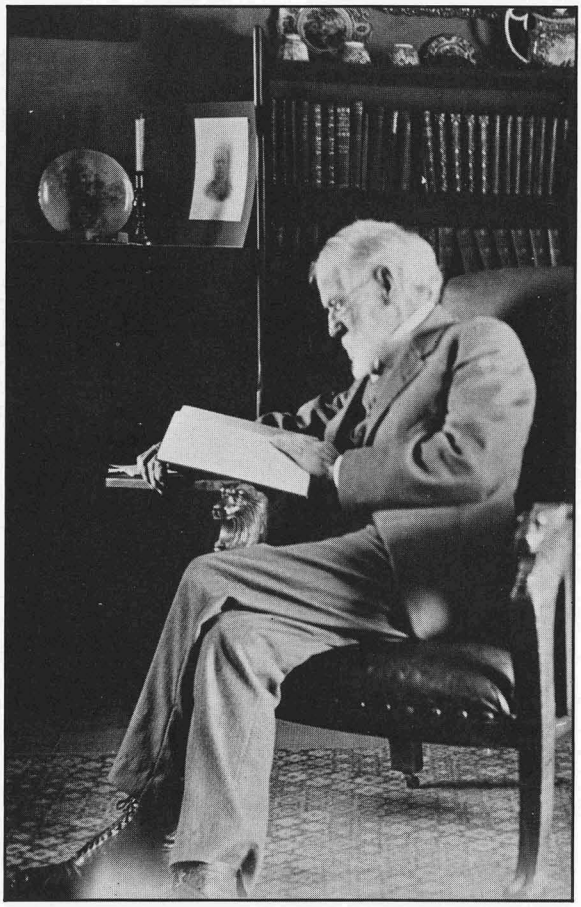


Fig. 5-41. One of the last photographs of John Henry Reed was taken in 1914 in his study. He lived to help dedicate the Citrus Experiment Station in 1918, and to be recognized as its co-founder with his friend, Ethan Allen Chase. (Photo courtesy of Mrs. Bessie Shewman.)

[17]Reed's primary role in the battle was a feebly worded protest to President Benjamin Ide Wheeler in a letter dated May 4, 1914. It lacked the style and forcefulness characteristic of his earlier writings (Reed 1914).

[18]Arguments offered in favor of the San Fernando site were that water would be cheaper, that the site contained the largest body of "high grade citrus lands yet undeveloped" and the most uniform body of soils except for the Corona site, and that the Regents "would be praised for their wisdom" 10 years hence (University of California Regents 1914). In regard to water, however, the federal government had not yet waived a proviso that Owens Valley aqueduct water could be used only for domestic purposes (Anon. 1914*e*).

[19]The Regents' committee consisted of Rudolph J. Taussig, A. Lowndes Scott, and James Mills. Taussig presented the majority report for San Fernando at the December 22 session of the Regents. Mills, a citrus grower, cast the minority vote for Riverside.

Fig. 5-42. Mr. and Mrs. Ethan Allen Chase posed for this photograph (ca. 1912) on the veranda of their Riverside home. Chase was the owner of the world's largest orange grove at the turn of the century. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

As the Regents continued deliberations, with the eventual vote rumored to be in favor of San Fernando, incredulity swept Riverside. The Riverside committee mobilized to counter the report of the grower advisory committee. On April 14, 1914, the Chamber of Commerce submitted a statement to the Regents, listing many reasons why the station should not be moved (Anon. 1914*h*). Other brief reports to the Regents followed in the next few months (Anon. 1914*i*, 1914*j*). In addition, the committee sought support from the citrus industry.

Meanwhile, outrage developed in the citrus belt communities, all of which had conspired for the station; none, however, wanted to see it moved to San Fernando. Hundreds of letters, telegrams, and phone calls of protest began inundating the Regents from growers, packinghouses, chambers of commerce, boards of trade, and civic groups in more than 30 cities (Anon. 1914*k*). The boards of supervisors of seven southern counties joined the protest. Encouraged by the sudden appearance of many allies, the Riverside Chamber of Commerce moved boldly, charging that a University experiment station and graduate school would be a "plum" for San Fernando land speculators to dangle before Los Angeles voters to secure annexation of the region (Anon. 1914*e*). In a clipsheet mailed to editors throughout the state, the chamber linked the bid for the experiment station to the Owens Valley aqueduct and land sales, concluding

> The gentlemen in Los Angeles who are planning what is known as Greater Los Angeles hope to have San Fernando and other cities annexed; also they have land to sell . . . (Anon. 1914*f*).

The Regents moved cautiously and deliberately in reaching a decision. While there were powerful business interests that stood to gain financially by pushing the San Fernando site, the location also seemed to possess advantages: location in a pleasant valley near the coast, nearness to a growing metropolis, and a climate more attractive than that of the interior valleys. None of these factors, however, was

directly related to citrus growing. Joint meetings were held by all three of the Regents' committees to reexamine the accumulated testimony. Webber appeared before the joint committee on July 6, 1914 and remained inflexible in his view that Riverside was the desirable location (University of California Special Committees 1914). Chase submitted a written defense of Riverside at the same meeting.

On December 23, 1914, when the Regents met in San Francisco to vote on the experiment station site, it was assumed that San Fernando would be selected. A delegation from Riverside led by S. C. Evans and L. V. W. Brown made a last-ditch plea for Riverside (Anon. 1914*l*). Evans and Brown delivered long, eloquent appeals before the Regents went into an executive session that was said, afterwards, to have been "hot." The Riverside delegation then "waited at the Fairmont Hotel for near two hours with rather gloomy faces and sinking hearts" (Boyce 1969).

To the delight of the delegation, the Regents emerged from executive session announcing a 14-to-4 vote in favor of Riverside (University of California Regents 1914). Regent James Mills had delivered a masterful minority report for Riverside; Regent Garrett McEnery had moved its adoption. A strong argument with the Regents appears to have been Webber's endorsement of Riverside. In recasting Webber's arguments, Mills praised him as "the greatest living authority on citrus culture" (University of California Regents 1914).[20]

News of the Regents' decision reached Riverside late the same day, causing jubilation among Christmas throngs in downtown Riverside (Anon. 1914*m*). The entire city turned into the streets, the steam whistle on the electrical plant blew for 15 minutes, and the Mission Inn bells were rung in celebration (Boyce 1969). Reed was quoted in the *Riverside Daily Press*:

> It is the most important day that has occurred in all the history of Riverside. It will mean that the fame of Riverside and the [graduate] school will become known the whole world over (Anon. 1914*m*).

The events leading to establishment of the Citrus Experiment Station at Riverside typified those happening elsewhere in the land grant movement that led to the founding of agricultural experiment stations in the United States. Yet it cannot be said to be an exemplary history. Elsewhere, it was often only the more informed farmers or groups with parochial interests that made use of the political process to achieve a goal made possible by the Hatch Act. In southern California's citrus belt, however, every citizen from the schoolteacher to the blacksmith understood that the region's welfare essentially depended on a single crop. The citrus growers had occasional minor conflicts, but in general they were united by (1) the monoculture they practiced; (2) ties developed early in fighting formidable railroad and marketing commission interests; (3) the resolution of issues related to water rights and the development of mutual water companies with grower shares; (4) the organization of grower cooperatives and grower interest groups able to deal effectively with such diverse matters as quarantines, tariffs, and labor; (5) mutual interaction at early citrus fairs and later in the Farmers' Clubs; and (6) long years of independent research and the sharing of discoveries. They attained their objective against many obstacles—including a lack of understanding in the north of the bonds that held the citrus belt together—primarily because they were perceived by the larger community to represent the economic and social interests of their region.

The Formative Years

Webber's Directorship

Before accepting the first directorship of the Citrus Experiment Station, Herbert John Webber had insisted on autonomy in matters of research (Bliss and Buvens 1946). He thus circumvented any possibility that the CES would become a field station largely dependent on the whims of administrators on the University campuses. Although citrus research was defined as a fundamental endeavor, Webber (1916*a*) conceived the overall mission of the station as conducting research on "problems connected with the prosecution of sub-tropical and tropical horticulture under irrigation." Equally important, Webber

[20]The *Riverside Daily Press* noted: "In the final vote the Regents from Los Angeles whose personal interests would be materially advanced by the selection of San Fernando voted without reservation for Riverside. It is eminently to their credit that they should listen to the voice of the industry against their personal interests when the committee reports could easily have been made to justify an adverse vote" (Anon. 1914*g*). Regent Guy Earl, brother of E. T. Earl, who had a heavy interest in the San Fernando land syndicate, refused to take part in the deliberations and honorably refrained from attending the meeting at which the vote was taken (Anon. 1914*g*).

(1918) asserted, would be extension work and teaching in the proposed graduate school of tropical agriculture.

Upon arrival in Riverside in 1913, Webber made his headquarters at the Rubidoux Laboratory, not in Whittier, and began integrating the research programs of both laboratories and planning an expanded research effort. He saw the institution as starting over from scratch, and recruited a talented core research and teaching team, many members of which he tapped from "distant parts of the nation" (Webber 1934). His goal was to assemble a "loyal group of men striving to succeed, in a loyal community lending freely its help and support" (Webber 1918).

Webber was no martinet—he viewed loyalty simply as intense enthusiasm on the part of his staff for the work of the station. Generous in disposition, unflagging in his own efforts, and egalitarian by nature, Webber sought criticism freely from his staff without holding grudges (Bliss and Buvens 1946). His flaw in the eyes of a few colleagues was that he sometimes leaned towards "popularized notions" (Kelly n. d.). The charge was valid, and would have amused Webber. As an agricultural research administrator, he recognized that the future growth of the CES lay in establishing many alliances outside the station. He was soon admired by growers for his unceasing public relations effort on behalf of the institution and for the support he frequently gave to growers' interests.

As early as 1916, Webber had assembled what became known as the "original staff" of the experiment station (fig. 5-43) (Boyce 1969). The research program was organized under six divisions, each with a head, as follows: W. P. Kelley, agricultural chemistry; H. S. Reed, plant physiology; J. T. Barrett, plant pathology; H. J. Quayle, entomology; L. D. Batchelor, plant breeding; and R. S. Vaile, orchard management. Associated with these departments as investigators were H. B. Frost, H. S. Fawcett, E. E. Thomas, C. O. Smith, and C. F. Burger. Agricultural Operations was headed by W. M. Mertz, and W. D. Drew ran Webber's office operation. In addition, the initial staff included a librarian, six laboratory and field assistants, four stenographers, and 14 supervisors, teamsters, and laborers in various capacities. The station's annual budget in 1916 was $66,000, a substantial investment for the period.

Webber was skillful in recruiting a staff. Most

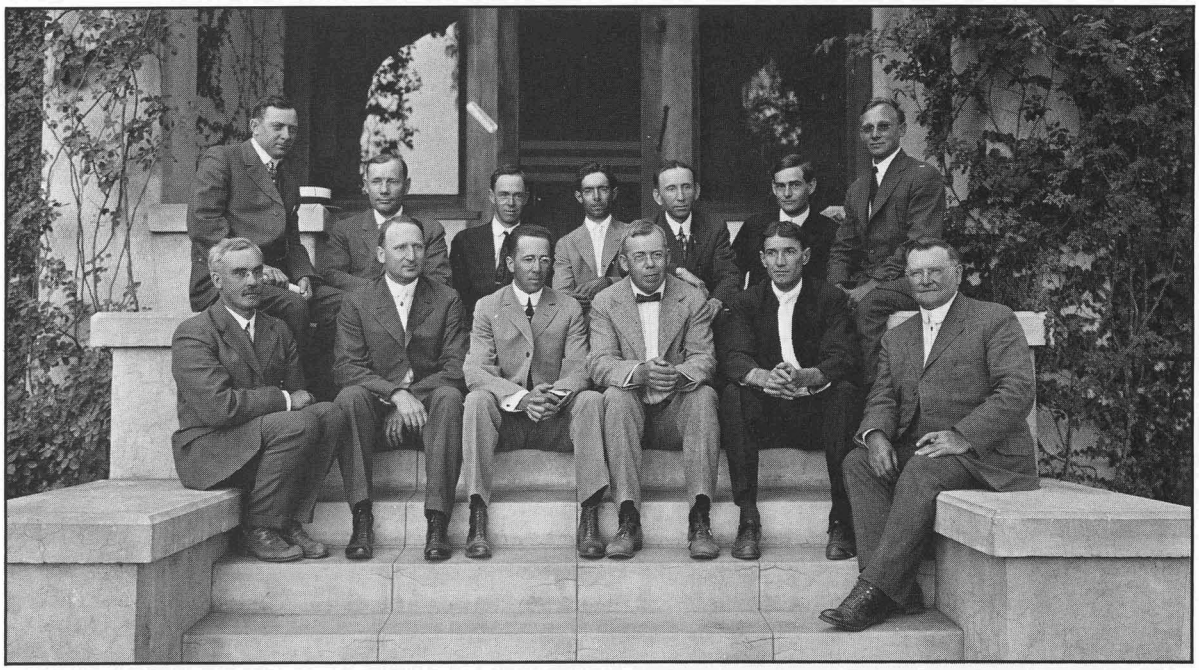


Fig. 5-43. The original staff of the Rubidoux Laboratory under Herbert John Webber. *Left to right, front row:* C. O. Smith, J. T. Barrett, L. D. Batchelor, H. S. Reed, W. P. Kelley, and H. J. Webber. *Back row:* H. J. Quayle, E. E. Thomas, W. M. Mertz, H. B. Frost, H. S. Fawcett, W. D. Drew, and R. S. Vaile. The researchers are shown seated on the steps of the main-office laboratory in 1916. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

of the scientists hired during his long tenure became leading figures in their disciplines and are now recognized as pioneers. The legendary example of his prescience in selecting scientists is Howard B. Frost, his protege in citrus genetics, who followed Webber from Cornell University to California in 1913 (Cameron, Lesley, and Soost 1970). A misanthrope with few intimate friends, Frost was a tireless researcher on the lonely frontier of citrus genetics (fig. 5-44). Three decades after his arrival he still labored on basic problems of genetic structure and hybridizing behavior in citrus that few colleagues believed would ever prove of practical value. The significance of his research became evident when a delegation of prominent Russian geneticists descended on the station in the 1940s eager to meet him. Frost's hybrid citrus varieties and nucellar budlines gave new vigor to the citrus industry, and today many orange and lemon varieties grown in California involve lines he developed.

In June 1917, Webber commenced directing installation of various experimental plots on the new station site below Box Springs Mountains. A 65-acre tract was planted to oranges in accordance with carefully devised plans for studies in cultivation and fertilization (Webber 1918). A 5-acre citrus variety collection was begun with the planting of some 500 types of citrus obtained from all over the world. This marked the nucleus of what would become the world's greatest collection of citrus tree varieties (Metcalf 1963).[21] The collection has been utilized by plant breeders producing thousands of hybrids, some of which have come into commercial use around the globe. Webber was also responsible for planting hundreds of other subtropical and tropical crops and plants on the Experiment Station grounds, plants that have served as a vast resource of living genetic material for study. Over the years, more than 70 varieties of avocado imported from Mexico, South and Central America, and the West Indies furnished material for an avocado-breeding program that has produced more than 45,000 hybrids through controlled pollination.

During Webber's administration, one significant new research unit was added to the station. In 1923, the State Legislature transferred the State Commission of Horticulture's biological control facility from its headquarters in Sacramento to Riverside (Riehl and DeBach 1982). This unit continued to function as a division of the Experiment Station under Harry S. Smith, who had served as its director since 1913 (Anon. 1973). Thus, Riverside became the first branch of the University of California with a unit in biological control research and pioneered many of the classical studies in this discipline.

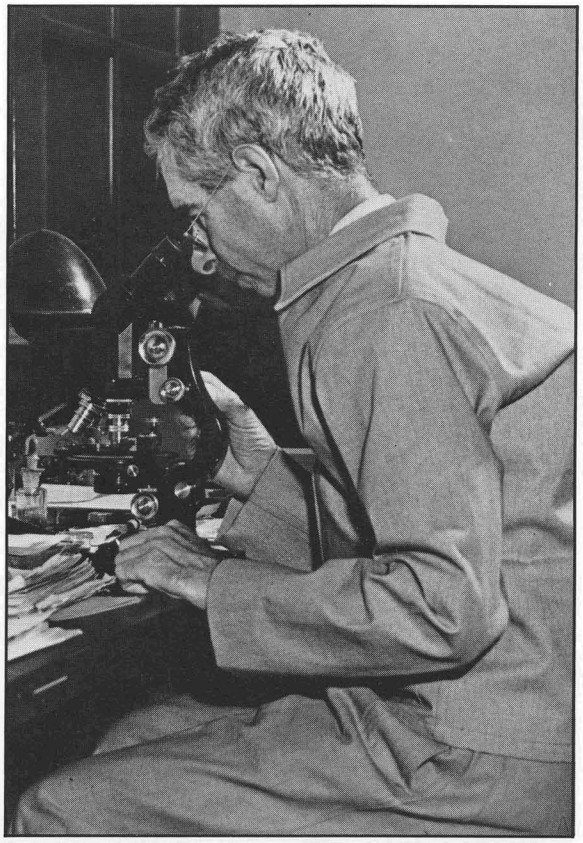


Fig. 5-44. Howard B. Frost, a brilliant researcher on the frontier of citrus genetics, developed hybrid citrus varieties and nucellar budlines that have revitalized the California citrus industry. (Photo courtesy of Alfred M. Boyce.)

In his early years as director, Webber guided the development of an extensive library as an indispensable research tool. His chief librarian for more than 40 years was Margaret Buvens, whose efforts established the present Bio-Agricultural Library at Riverside. She viewed herself as "cook and crew and captain bold" in forming a repository that by 1930 was receiving more than 500 serial publications annually (Buvens 1932). During her administration, a major collection of rare books on subtropical horticulture and citrus was developed. Among the li-

[21]In 1935, Webber visited Java, where he collected more than 50 exotic types of citrus, predominantly pomelos and shaddocks (Anon. n.d.). On subsequent trips around the world, he added frequently to the Experiment Station collection.

brary's many treasures is the *Hesperides* of Giovanni Battista Ferrarius, published in Rome in 1646, the earliest printed book on citrus.

Webber was an indefatigable ambassador outside the University, cementing the relationships between researchers and growers and continually assisting growers in many of their activities. He helped found the California Avocado Association in 1914 and served as president for its first 2 years (Webber 1916*b*). In 1918, as part of the war effort, he accepted the enormous task of organizing the Los Angeles County Farm Bureau, then the nation's largest (Anon. 1918*b*). He was also responsible for organizing the annual citrus institute of the National Orange Show in San Bernardino,[22] and he later established the Date Growers' Institute of Coachella Valley (Bliss and Buvens 1946). Soon after arriving in Riverside, Webber founded the Synapsis Club, a lecture and discussion group that served as a popular scientific forum for almost half a century until it disbanded in the 1960s (Kelly n. d.; Synapsis Club n. d.). This group made important contributions to the development of thought and theory in the early days of the Experiment Station.

The Original Buildings

In 1916, Webber supervised construction of the original laboratory, farm, and residence buildings on the Box Springs site. Lester H. Hibbard of Los Angeles, a graduate of the University of California School of Architecture, designed the Experiment Station buildings in association with a colleague, H. B. Cody (Webber 1916*a*).

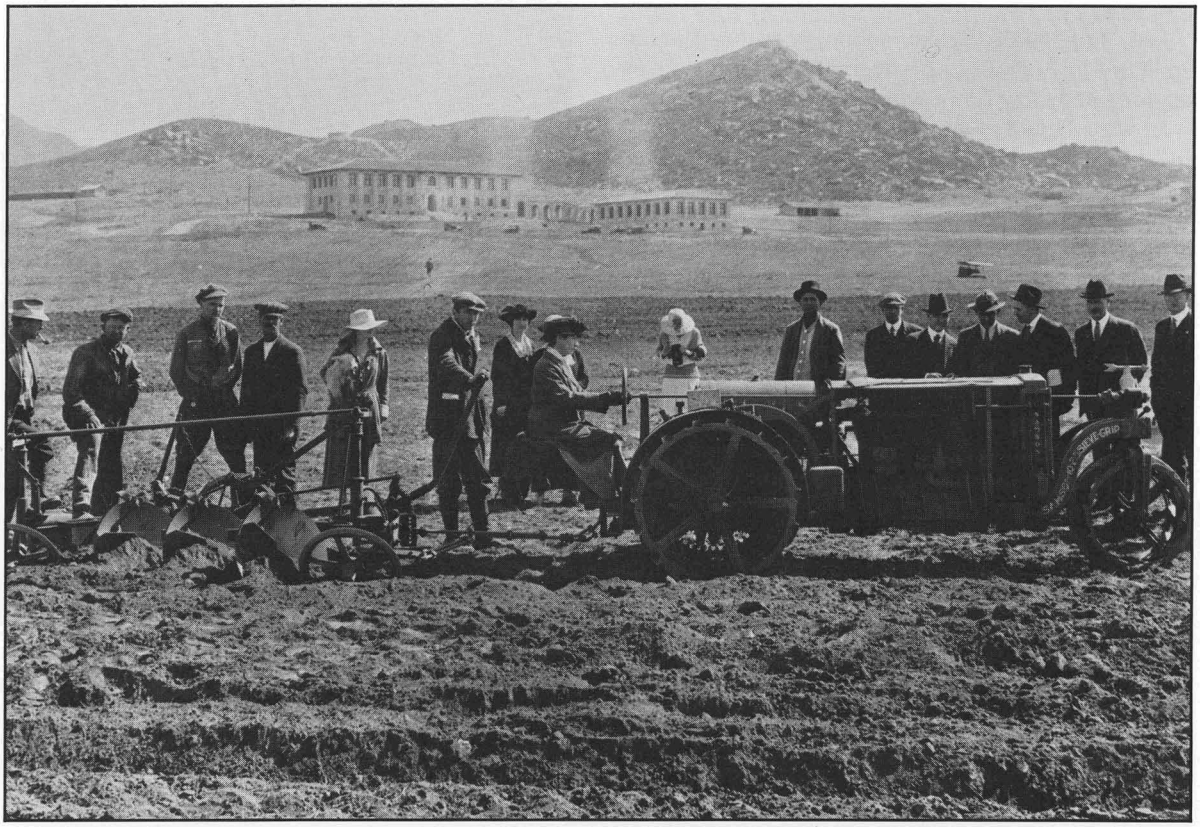


Fig. 5-45. A cultivation demonstration at the Citrus Experiment Station in 1917. The newly completed buildings of the main laboratory and the south wing of the experiment station are in the background. (Photo courtesy of Special Collections, Tomás Rivera Library, University of California, Riverside.)

[22]The National Orange Show of San Bernardino, still an annual event today, was not an outgrowth of the early citrus fairs in southern California. Instead, it was conceived in 1911 by Harry Perkins, a professional ice skater and entertainer, who won support for his idea from the San Bernardino Chamber of Commerce (Staff Correspondent 1919).

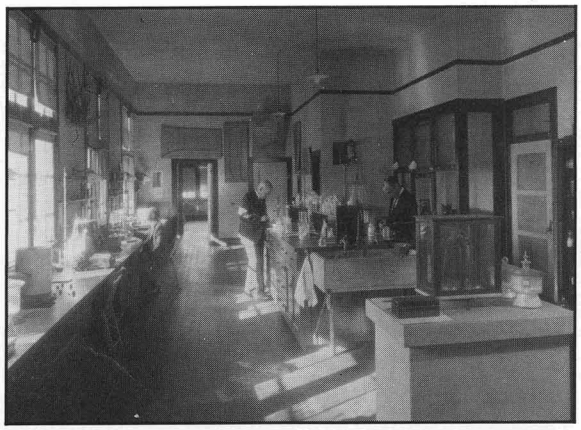


Fig. 5-46. Interior of the main laboratory building of the Citrus Experiment Station ca. 1920. (Photo courtesy of Alfred M. Boyce.)

The two-story main building and its south wing (figs. 5-45 and 5-46) were built at a cost of about $165,000 and situated at the base of a rocky peak now known as Picnic Hill. A north wing was deferred for future construction. In general, the architecture followed the Mission style then undergoing a revival in southern California. The broad, overhung tiled roofs, massive plastered walls, arched Spanish doorways, and picturesque open arcades running from building to building were intended to suggest the Spanish colonial heritage of California. The central building measured 154 by 57 feet. Each wing measured 100 feet by 57 feet, but only the south wing was finished when the structures were first occupied on May 21, 1917.[23]

The director's residence sat on a rocky knoll overlooking the surrounding countryside. Other buildings included a horse barn, a blacksmith shop, a farm office, and a carpenter shop arranged in a quadrangle around an enclosed court on what is now the west side of the Riverside campus.

With completion of the new quarters, the southern California Pathological Laboratory at Whittier ceased operation (Young 1916). The north wing for the main laboratory was finally constructed in 1931, but until then the Division of Agricultural Chemistry occupied laboratory space at the Rubidoux site. The buildings on the Rubidoux site today house the USDA Salinity Laboratory.

The Experiment Station and the new Graduate School of Tropical Agriculture (fig. 5-47) were dedicated on March 27, 1918 (Anon. 1918*c*, 1918*d*). Thomas Forsythe Hunt, dean of the College of Agriculture, presided at the dedication, and since the nation was at war President Benjamin Ide Wheeler delivered a "stirring patriotic speech." Webber gave a major address, observing that the future of the

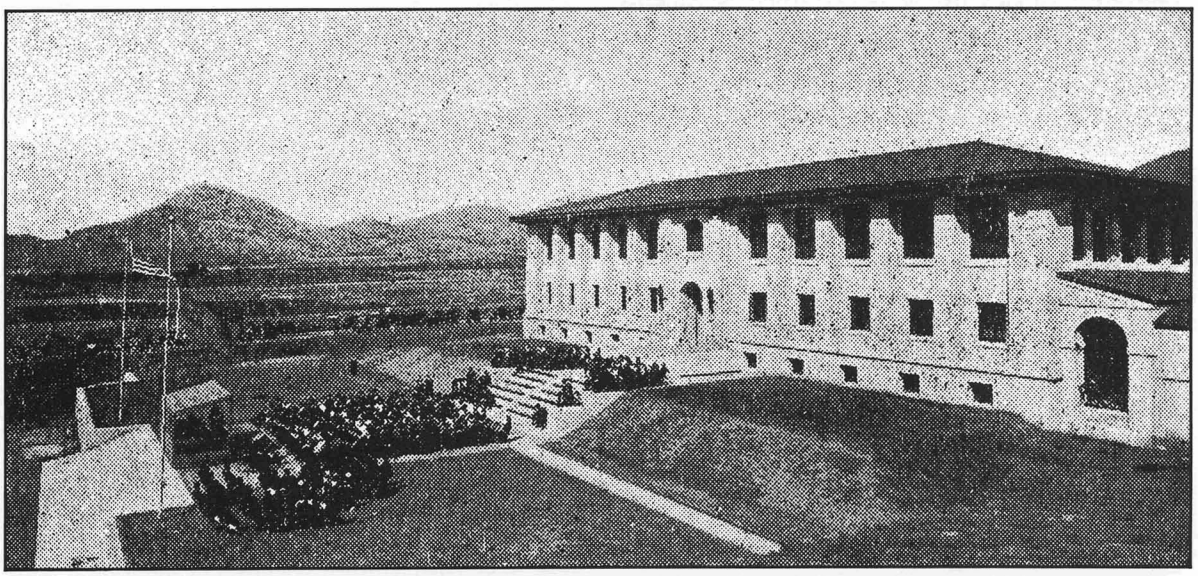


Fig. 5-47. Citrus growers and scientists gathered on March 27, 1918 for the dedication of the Citrus Experiment Station and the Graduate School of Tropical Agriculture.

[23]The main buildings and one wing of the Citrus Experiment Station were vacated in 1969 after structural engineering studies determined that they did not meet California earthquake standards.

institution would be bound unalterably to its accomplishments.

Among distinguished guests on the podium sat John Henry Reed, whom Webber introduced as one of the two men most responsible for the founding of the Citrus Experiment Station. The other, Ethan Allen Chase, was too ill to attend the ceremony. Chase had played a central role in the second fight for the station, but could not be considered a founder of the original institution. Perhaps Reed insisted on sharing credit with his old friend; if so, it would have been true to his character.

The Graduate School of Tropical Agriculture

In 1912, the Division of Citriculture was established in the College of Agriculture at Berkeley under J. Elliot Coit as part of Hunt's reorganization plan. The Division offered undergraduate and graduate programs in citriculture. In addition, courses in citriculture began to be included in the curriculum of the University Farm School at Davis (Anon. 1918*e*).

The Graduate School of Tropical Agriculture began operation at Riverside in 1917, with members of the research staff holding teaching appointments in the school. Webber and his fellow scientists had high hopes for the school, but their hopes were soon dashed in Berkeley. Only those students who had completed virtually all graduate course requirements at Berkeley were permitted to enroll at Riverside for dissertation research.

Unable to obtain more than a handful of students, the Graduate School of Tropical Agriculture soon languished. In 1924, the Riverside and Redlands chambers of commerce launched a drive to persuade the Regents to transfer advanced courses in citriculture and subtropical horticulture to Riverside (Anon. 1924). Meanwhile, the University of California at Los Angeles had been created in 1919 as the University merged with the Los Angeles Normal School, and the Los Angeles Chamber of Commerce made a strong move to locate subtropical horticultural studies there.

In 1932, a College of Agriculture was finally established on the Los Angeles campus, and the Division of Subtropical Horticulture was transferred there from Berkeley (Stadtman 1968). Gradually, various research units and staff from Berkeley, Davis, and Riverside were transferred to Los Angeles to support the new college. As a result, the Graduate School of Tropical Agriculture was discontinued in 1939 (Boyce 1969). In 1960, with the closing of the College of Agriculture at UCLA, many of its staff and research programs were transferred to Riverside.

Nevertheless, undergraduate instruction in subtropical horticulture was instituted at Riverside in 1924 in a successful series of 8-week summer sessions. These sessions were directed by R. W. Hodgson, then chairman of the Department of Subtropical Horticulture at Berkeley. The faculty included staff from the Berkeley and Davis campuses and from the Citrus Experiment Station. The summer sessions were dropped when the UCLA College of Agriculture opened for instruction in 1933 (Boyce 1969).

Research Achievements of the Webber Era

The directorship of Herbert John Webber lasted from 1913 until his retirement in 1929, except for intervals from 1919 to 1920 when he directed the statewide Agricultural Experiment Station in Berkeley and in 1921 when he entered private business with a seed company (Bliss and Buvens 1946). During his absence, J. T. Barrett served as acting director of the Citrus Experiment Station.

As early as 1918, the *California Citrograph* reported that the experiment station was saving growers thousands of dollars annually and that it would be impossible to "estimate the vast amount of good" that was flowing from its researchers (Anon. 1918*b*). Sometime in the 1920s, it became evident that Webber was building one of the world's outstanding agricultural research organizations. Scientists in subtropical horticulture and other visitors from all over

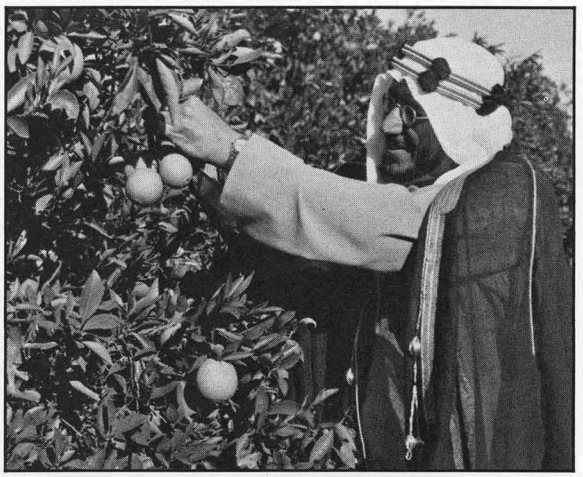


Fig. 5-48. Distinguished scientists in subtropical horticulture and other prominent visitors have made regular pilgrimages to the Citrus Research Center and Agricultural Experiment Station since its dedication in 1918. One illustrious guest was Ibn Saud, King of Saudi Arabia, a visitor in 1947. (Photo by John W. McCalley; courtesy of Alfred M. Boyce.)

the world arrived regularly in Riverside to confer with the research staff (fig. 5-48). At a June 1933 conference commemorating two decades of steady achievement by the CES, Webber reviewed its many impressive discoveries (Webber 1934). A few of the more important accomplishments of the Webber era follow.

Although excess quantities of alkali in irrigation waters had long been known to harm crops, it was generally believed that waters with low alkali content were safe. In an extensive survey of irrigation water used in walnut and citrus districts, Walter P. Kelley and co-workers determined that alkali would accumulate in soils until injurious concentrations were reached. This discovery led to methods for solving problems of alkali buildup in soils through drainage and other means. Eventually, techniques were developed for reclaiming thousands of acres of California land made unproductive by salt accumulation. In 1943, Kelley was elected to the National Academy of Sciences in recognition of his pioneering basic research on soils at Riverside (Chapman 1969).

Knowledge about citrus fertilization was in a chaotic state when the station opened. The discovery of the value of organic matter and nitrogen in citrus fertilization led to the recognition that their source was unimportant, and finally to the development of chemical fertilizers. Other research on fertilization, cultivation, and pruning profoundly influenced practices in citrus orchards. Much of the station's research on citrus fertilization also contributed to a general understanding of crop fertilization.

Investigations into an obscure cause of foliage discoloration in citrus resulted in the discovery of boron poisoning, methods for its control, and an understanding of the necessity of minute amounts of boron in citrus growth. Eventually, the dreaded mottle-leaf or little-leaf "disease" was found to be related to zinc deficiency. Similar studies established that manganese was essential to citrus growth. Such breakthroughs resulted in a new generation of soil researchers exploring every aspect of mineral nutrition in crop growing (Reuther and Jones 1982).

In breeding work, thousands of seedlings, most of them hybrids from promising parents, were grown and tested during the first two decades of the station's operation. Howard B. Frost was the first to accurately report the normal number of chromosomes for citrus, one of the first to discover polyploidy in citrus, and the first American to describe citrus tetraploids (Cameron and Soost 1982). From his research came tools valuable in guiding artificial hybridization for production of new citrus cultivars. This resulted in widespread propagation of nucellar lines, and eventually contributed to the improvement of citrus plantings throughout the world. Among Frost's own productions were high-quality hybrids such as the Kara, Kinnow, and Wilking mandarins, the Trovita orange, and Frost nucellar oranges and lemons.[24]

No type or group of diseases had caused more loss worldwide in citrus orchards by the 1920s than the gum diseases of gummosis. By working out the etiology of various types of this disease, and by demonstrating satisfactory methods of control, Howard S. Fawcett and his colleagues contributed significantly to citrus disease control (Fawcett 1941). Fawcett introduced the scraping treatment for citrus scaly bark (psorosis) in 1922, 11 years before he demonstrated the viral nature of the disease. During his last years, Fawcett played a major role in discovering the viral nature of quick decline of orange trees (Klotz and Carsner 1949). All of these diseases were highly destructive, and the tristeza virus that caused quick decline killed more than 3 million orange trees in California in a 25-year period, for a time threatening the citrus industry with extinction.

Methods of handling citrus trees injured by frost were developed in the aftermath of the great 1913 freeze as an outgrowth of early studies by Webber (1919, 1934). Citrus grove surveys and frost injury studies advanced the basic knowledge of frost problems and led much later to improved methods of frost protection. Grower Frank Chase, working in 1913 with researchers from the CES, perfected the first gravity water separator for frozen fruit. Wind injury studies in groves corroborated the value of windbreaks, already known to growers, and called attention to the importance of retaining optimum water conditions in groves where injury was likely to occur.

No institution during the Webber era contributed more to the fundamental knowledge of the life histories and control of southern California fruit and nut pests and parasites than did the CES following the 1918 establishment of the Division of Entomology. H. J. Quayle's research on citrus insects and mites and walnut insects brought worldwide recog-

[24]Frost's discoveries would have delighted John Henry Reed, one of the earliest growers to advocate research on citrus breeding and selection. He set forth his views in a paper published in 1905 in *Fruit World* (Reed 1905*b*). In that paper, "Scientific Breeding of Citrus Fruit," Reed alluded to the horticultural creations of Luther Burbank and showed familiarity with citrus genetics research by Herbert John Webber and Walter Tennyson Swingle.

nition to the station. He was one of the first to recognize the problem of insect resistance, correctly noting in 1918 that black scale and California red scale both developed resistance to fumigation with hydrocyanic acid (Riehl and DeBach 1982). Such control problems spurred research on petroleum and oil sprays, specifications for formulations, and development of such treatment procedures as the tank-mixture method for oil sprays, saving Orange County growers alone more than $125,000 annually by 1931–1932. Methods used to determine spray specifications were adapted in 1932 by California for the registration and labeling of such oils.

At Riverside, much-heralded and little-understood biological control finally became recognized as an effective, successful method of pest control. In 1927, Harry S. Smith sent a young collector, Harold Compere, off to Australia to determine whether the citrophilus mealybug (*Pseudococcus gahani*) and potential parasites of the pest existed there. The mealybug was then one of the most destructive and costly threats to citrus, and Smith had a hunch its origins lay in Australia. Within 3 weeks, Compere, who was on a 2-year assignment, cabled that he had found the mealybug in groves near Sydney. Three months later, he ended his assignment with the discovery of three promising parasites of the pest (Anon. 1928*b*). Two of these parasites (the chalcidoid parasites *Coccophagus gurneyi* and *Tetracnemus pretiosus*) had effected almost complete control by 1930. In 1934, Webber reported that these parasites were saving growers in Orange County up to $1 million in crop losses annually. Other important results from the Webber era included the control of yellow scale with an imported chalcid fly (*Comperiella*) from Japan (Webber 1934). It was in the 1920s that Smith and his co-workers began developing many of the principles of the bio-ecological approach that would firmly anchor their discipline and eventually lead to the concept of integrated pest management.

Finally, although its early major emphasis was on citrus, the Experiment Station under Webber studied and made research contributions to practically every crop grown in southern California (Webber 1934). New irrigation regimes were found to reduce heavy walnut crop losses to culls. Pioneer studies yielded new information on date palm diseases during the early years of the date industry in the nearby Coachella Valley. In the Webber era, the CES also became the world's leading research center in the study of the avocado, helping in the advance of California's infant avocado industry. When Webber retired in 1929, it was with the knowledge that he left behind the firm base of an enduring agricultural research institution.

Webber's monument, produced over a 16-year period after retirement, was a massive, two-volume reference work titled *THE CITRUS INDUSTRY*. The first volume was co-edited with his successor, Leon D. Batchelor, and published in 1946 by the University of California Press (Webber and Batchelor 1946). The second volume, under the senior editorship of Batchelor, appeared 2 years after Webber's death in 1946 (Batchelor and Webber 1948). This encyclopedic work, summing up all that was then known about citrus, became known throughout the world as the "Bible of the Citrus Growers."

Our purposes here have been to record the beginnings of citrus research in California, to chart the growers' movements that led to the founding of the Citrus Experiment Station, and to trace important events and research discoveries of those pioneer years. The full history of the Citrus Research Center and Agricultural Experiment Station, as it is known today, remains to be written. What follows is in the nature of a postscript and general summary.

Aftermath (1929–1987)

In 1929, after Webber's retirement, horticulturist Leon D. Batchelor became the second director of the Citrus Experiment Station (fig. 5-49). Under his direction, the land, capital facilities, and the operational budget of the CES expanded substantially (Batchelor 1957). The Experiment Station moved into many new areas of research, giving greater attention to all the major crops of southern California.

One of the first agriculturists to foresee the value of statistics and experimental plot design, Batchelor initiated many significant experiments in fertilizers, rootstocks, and other cultural areas. Studies of citrus genetics and breeding led to new commercial citrus varieties and improved quality through use of nucellar seedlings. Research in pre- and postharvest physiology resulted in improved handling and storage methods for citrus and avocados. Increased emphasis was given to breeding experiments with vegetables. Citrus Experiment Station scientists moved into many new areas of research and were among the pioneers in studies of herbicides to reduce weed losses, the effects of air pollution on crops, and the development of new compounds for controlling insect pests. Out of the latter studies emerged the first commercially successful synthetic organic acaricide, used as a weapon against spider mites in citrus and walnut.

Perhaps the most dramatic research of the Batchelor era was the successful fight against quick

Fig. 5-49. Leon D. Batchelor, a horticulturist, served as the second director of the Citrus Experiment Station. (Photo courtesy of George Hays.)

decline disease, which had wiped out much of the citrus industry in South America and South Africa. In 1946, CES investigators established that quick decline was caused by the tristeza virus and that the sour orange rootstock was responsible. The endangered California citrus industry was saved from possible extinction by the use of a new tristeza-resistant rootstock, the Troyer citrange.

In 1951, Batchelor retired, and Homer D. Chapman, a soil scientist, served as acting director for the remainder of the year. In January, 1952, Alfred M. Boyce, an entomologist on the staff since 1927, became director. This title was later changed to associate director, following the administrative pattern used on other University of California campuses engaged in Agricultural Experiment Station research. The change in title, however, did not alter the responsibilities of the office at Riverside.

Under Boyce, the CES embarked on an era of public and private support that culminated in its greatest period of growth (Anon. 1982*a*). This expansion reflected the enormous boom in southern California agricultural productivity after World War II, with more than 100 commercial crops grown and a continuous stream of new crops being added. New buildings were constructed to meet the needs of an expanding staff: the largest of these were Webber Hall (1954) and Batchelor Hall (1967). The old division organizational structure was replaced along departmental lines, and five new departments were added in areas requiring increased specialization. The new structure included the nation's first Department of Nematology. Other areas of major expansion included the Cooperative Extension headquarters at Riverside, established in 1954 to serve the southern counties of California, and the interdepartmental Committee on Air Pollution Research, formed in 1953. Riverside's early lead in the study of the crop-related effects of air pollution resulted in establishment of the statewide Air Pollution Research Center in 1961, now an autonomous unit of the University.

In 1954, a College of Letters and Science was established on the Riverside campus, although members of the CES staff did not then participate in instruction. Then in 1959 the Regents declared that Riverside would become a general campus and authorized the creation of a College of Agriculture. Boyce was appointed first dean of the new college, and scientists in the CES received joint teaching and research appointments. In 1961, the Regents changed the name of the Citrus Experiment Station to the Citrus Research Center and Agricultural Experiment Station, reflecting its increasingly broader scope of investigations.

Among major triumphs of the 1950s was the team research that halted the devastating march of the spotted alfalfa aphid in California. With the appearance of the organochlorine and organophosphorus compounds, Experiment Station entomologists conducted research on new pesticides such as DDT, malathion, parathion, and many others. They also played a leading national role in studies of insect resistance to pesticides and developed a methodology for measuring insecticide residues—techniques that came into wide use in obtaining federal and state approval for safe use of commercial pesticides. With losses from virus- and bud-perpetuated diseases increasing during the 1950s, a variety improvement program was inaugurated to provide disease-free, true-to-name budwood for nurseries (Reuther 1981; Calavan et al. 1982). Researchers developed techniques for detection of pathogens by indexing and these resulted in their elimination from desirable

clones. The Riverside program has reduced citrus tree losses and has been used as a model for similar projects in other countries. Continuing research in biological control resulted in more successes in California citrus than have been achieved with any experimental crop anywhere else (Riehl and DeBach 1982).

When Boyce retired in 1968, W. Mack Dugger, a botanist, was named dean of an enlarged College of Biological and Agricultural Sciences, and Boysie Day, a weed scientist, was appointed associate director of the CRC-AES (Anon. 1982*b*). Soon afterward, Day transferred to Berkeley, and Dugger assumed associate directorship of the Experiment Station. Lowell Lewis, a plant physiologist, was appointed associate dean for research with much of the administrative responsibility for the Experiment Station. Under Dugger, applied research was broadened and basic research was extended into new areas such as molecular biology, integrated pest management, plant genetics, climatology, and environmental protection. The Experiment Station's program was redesigned to meet the unique research needs of an increasingly urbanized southern California.

In 1974, the College of Natural and Agricultural Sciences was established at Riverside. Dugger, the major architect in bringing about new department consolidations, encouraged a high level of the natural sciences on the UCR campus. The college strengthened agricultural research in the Experiment Station by developing new interrelationships between CRC-AES scientists and researchers and investigators in other disciplines of the biological and physical sciences.

In the 1970s, the Experiment Station directed increasing attention to the problems of growing crops in arid and semiarid regions. New crops were developed for semiarid conditions, including jojoba, better-yielding varieties of sesame, and turfgrass with high tolerance for pollution and salinity. The station emerged as the primary research center in plant tissue culture, developing cloning techniques to propagate disease-free plants for many food, fiber, and ornamental species. Soil scientists started addressing problems of waste disposal and nitrate pollution. A new type of pathogenic RNA molecule (the viroid) was discovered as the cause of citrus exocortis disease. Entomologists began developing techniques for using insect sexual attractants (pheromones) for the control of pest outbreaks. New basic research showed the essential role of vitamin D in animal metabolism and indicated that further elaboration of crassulacean acid metabolism might lead to breakthroughs in drought-resistant plants. The CRC-AES also took a leading role in promulgating the concept of integrated pest management and participated in its worldwide development.

Increasingly, the CRC-AES became involved in international cooperation in many contexts, ranging from sending scientists to serve as consultants in foreign countries on specific research projects to helping other governments establish their own research centers or experiment stations. Citrus continued to be the largest single area of research investigation, however, and in 1967 the highly successful First International Citrus Congress was held in Riverside.

In 1981, Dugger resigned as dean to return to research and teaching duties. Under his successor Irwin Sherman, a parasitologist who assumed the dual post of dean of the college and associate director of the CRC-AES, researchers at Riverside continue to tackle new problems that will carry the Experiment Station into the twenty-first century. Serving as associate dean for research with a large responsibility for the CRC-AES is Seymour Van Gundy, a nematologist. New areas of research include increasing the yield and nutrient content of crops through recombinant DNA; controlling diseases and pests by tailoring chemicals and predators to act only on target organisms; making photosynthesis more efficient through genetic trapping devices; and restoring marginal soil to crop production through development of more toxin-tolerant plants and removal and detoxification of wastes.

The Citrus Research Center and Agricultural Experiment Station (fig. 5-50) has grown from a small, local research station employing a tiny staff to a major research center staffed by about 850 people, approximately 240 of whom are engaged in both research and teaching. Total University of California funding for research in 1986–1987 was about $28.3 million, with private contracts and grants increasing the funding by $10 million. Research is carried out on more than 150 agricultural commodities, with 20 percent of the projects still devoted to citrus.

Although southern California's historic citrus belt no longer exists, and the state's citrus orchards have dispersed into new, less-urbanized areas, the industry remains vigorous.[25] The Experiment Sta-

[25]Central California is the leading navel orange producer; less than half of California's citrus acreage today is located in the southern counties (Scheuring 1983). Total citrus acreage in California stands at about 300,000 acres and the industry constitutes a $1 billion business annually.

Fig. 5-50. The original headquarters and main laboratory building of the Citrus Research Center and Agricultural Experiment Station as it looks today. The building was vacated in the 1960s but eventually it may be restored to meet earthquake standards. A Riverside County landmark plaque on a boulder near the building commemorates the pioneer scientists who contributed to the Experiment Station's rich heritage. (Photo by Herbert Quick.)

tion that John Henry Reed and other citrus growers of the nineteenth century envisioned continues to play a crucial role in meeting the research needs of the citrus industry and can be expected to continue that task into the next century.

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