Citriculture: Past, Present, and Future

HERMAN J. REITZ[1]

We in Florida are honored to receive this delegation from the Peoples Republic of China. In recent years, several such delegations have visited Florida, and similar U.S. groups have visited China. We have profited by these contacts and believe that such contacts are mutually beneficial, not only through sharing factual information but also by increasing the general level of understanding of our peoples.

It is my purpose to describe the development of citriculture from the American viewpoint. Our citrus history spans less than 500 years. China's written citrus history is more than 8 times that long, as the first known written reference to oranges was in a book entitled "Tribute to Yu," an Emperor who ruled before 2100 B.C. Of course, China's unwritten history and experience with citrus predates the written record by thousands of years.

No one seriously questions that Southeastern Asia is the native home of citrus and its relatives. China and the countries of the Malayan Archipelago presumably enjoyed citrus for many millenia before the rest of the world learned about its pleasures and benefits. Only in the last 2000 years has the rest of the world gradually adopted the various kinds of citrus, and only in the last 50 years has citrus become a large volume staple commodity for mass distribution and consumption in a world market.

The spread of citrus to the Western world is a relatively recent development, assisted in many cases by the war campaigns of a series of empire-building conquerors. Alexander the Great (around 330 B.C.) took botanists on his invasions into the Mideast, and they noted the presence of citrons in the invaded lands. The Greeks presumably brought the citron to the Mediterranean coastal area. The Romans may have known about the sour orange, the sweet orange, and the lemon, but those fruits were neither mentioned extensively in their literature nor were they very widely established. If established at all, they may have been frozen out or perhaps abandoned after the invasion of the Barbarians about 568 A.D. The Arabs in the tenth century greatly expanded the distribution of citrus incidental to their conquests of the Near East and North Africa, and in Spain where they had introduced sour oranges and lemons by 1150 A.D. The warships and merchant fleets of Genoa and Venice in the Eastern Mediterranean brought modest amounts of citrus to Europe from the overland trade routes to the Far East. The returning Christian Crusaders helped in popularizing citrus in Europe, establishing the fruits as great delicacies, highly prized by the rich and powerful. Citrus in the 14th to the 16th centuries was grown as a status symbol in temperate zone countries of northern Europe in mica-covered "orangeries," the forerunner of modern glasshouses. However, at the time the trees were highly prized as ornamental plants, and the fruits were mostly used as seasonings rather than as main food items.

Sweet oranges were not widely established in Europe until about 1400. Very important importations of superior Chinese sweet orange varieties

[1]University of Florida, IFAS, Agricultural Reserach and Education Center, Lake Alfred, FL (Retired).

were made by the Portuguese after their discovery of sailing routes to the Far East around the south of Africa in 1498.

Citrus was introduced into the Americas by Spanish and Portuguese explorers bent on colonizing the newly discovered lands. Columbus brought sour orange and lemon seeds to Hispaniola in 1493, and other Spanish explorers spread citrus wherever they went. Among the many places where citrus became feral was the Florida Everglades, from which commercial citrus growers commonly obtained seeds for rootstocks in their nurseries. And in this manner, citrus over a 2500 year period has spread to every corner of the world where its growth can be supported.

We are extremely fortunate to be the beneficiaries of China's prodigy, the orange, which provides the human race with one of its favorite flavors and essential vitamins.

Before the Industrial Revolution, citrus, like other fruits, was limited by lack of technological advancement. In addition to unalleviated production problems of pest control and fertilizer deficiencies, there were limitations on shipping times and distances, and limited demand for the expensive products. But as the proverb states, "a rising tide lifts all boats." Citrus growers did little to create the Industrial Revolution, but they profited immediately from its giant strides in transportation. At first steamboats and then steam powered railways opened markets previously inaccessible. Railroads reached north Florida only in 1893, but California had begun to ship trainloads of oranges across the United States in 1877.

A production technology revolution began about the same time. Chemists began to understand how plants work and what they require from soils. The vision of a more productive agriculture through systematic research began to receive popular support. In the U.S., government-sponsored agricultural research was begun about 1862 when Congress established the United States Department of Agriculture, and the Land Grant Colleges. Citrus research by the USDA began in Florida soon after. The early programs included hybridization of citrus with trifoliate orange in 1893, but many of the first progeny were killed by the great freezes of 1894-95. The Department has continued research in citrus in both California and Florida for about 100 years.

Research in the States was greatly stimulated by federal legislation called the Hatch Act, enacted in 1887, which promoted the establishment of Agricultural Experiment Stations in every State. California established a Citrus Experiment Station in 1907, and Florida established one in 1917. Other major citrus-producing countries undertook citrus research programs.

Thus, the stage was set for a substantial increase in citrus production. Engine-powered equipment replaced animal power and sailing ships. Chemists and engineers devised new procedures, processes, and products to facilitate production and transportation. The agricultural research agencies systematically identified remedies for many biological problems.

The development of canning and concentrating technology for citrus fruits was the most important step in the liberation of the citrus industry from the restraints imposed by its perishable commodity status. Processed products have added tremendous volume to the demand for citrus, particularly orange juice, in the last 50 years. Without processed products, the size of the citrus industries of Florida and Brazil in particular would be much smaller, and the number of people enjoying and benefiting from citrus would be substantially smaller.

Reported world citrus production since 1947 has increased fourfold, to 44 million metric tons annually. Some of the reported increase is likely due to improved statistical reporting accuracy, but in any event the increase has been very substantial. The increased production reflects the profitability of citrus, the increasing affluence of many peoples, the need of some countries for exportable products and foreign currency exchange, and the ready availability of technological developments in the citrus research institutions and industrial laboratories.

Those who have participated in citrus research have good reason to be proud of their efforts, but they have no justification for complacency. However great are the accomplishments in overcoming mineral deficiencies, offsetting the losses to fungi, identifying the nature of virus and virus-like diseases, originating fruit processing technology, and exploiting the characteristics of petrochemical derivatives, many more opportunities exist.

Variety improvement is a challenging field for research workers and their sponsoring agencies. The major source of citrus varieties throughout the world is the selection of natural mutants done by growers. Citrus trees produce "limb sports" or mutations rather readily, and observant growers have propagated the more desirable ones. Over a period of centuries, this has resulted in numerous locally important varieties as well as some of world-wide significance. Hodgson describes eight named sweet orange varieties originating in Florida alone. Two of these plus the ubiquitous Valencia are the major Florida sweet orange varieties. The Valencia orange, the world's most widely planted variety, is doubtless of that origin. It has been recognized since its 1865 introduction into England from the Azores. Two varieties dominate the California orange industry: the Valencia and the Washington navel (and its several similar selections), known since about 1810.

So far no major citrus variety has resulted from systematic research programs. Probably the most widely-planted research-produced variety is the Orlando tangelo, a hybrid of Duncan grapefruit and Dancy tangerine. The cross was made in 1911 by W. T. Swingle and was released by U.S.D.A. in 1931. In 1982 it occupied 12,677 acres in Florida, about 1.5% of the total Florida citrus acreage. It is losing popularity in Florida now and is of little importance elsewhere. Other hybrids involving mardarin varieties are replacing it. Of greater importance is the use of Troyer and Carrizo citranges as rootstocks.

It should be noted that hybridization programs have been in existence for less than 100 years, while selection by growers has been going on for many centuries.

Nonetheless, a steady stream of new varieties has been offered by research agencies for many other annual and perennial crops.

Agency-sponsored organized citrus hybridization programs are handicapped by some characteristics of the Citrus genus. These primarily are nucellar embryony and juvenility. Nucellar embryony dilutes the citrus breeder's efforts and increases the cost of the program. The problem is particularly acute with the sweet orange and is somewhat less so in efforts restricted to those few kinds producing seeds containing only one zygotic embryo such as Clementine, Temple, and the shaddocks.

Juvenility makes a citrus variety improvement program a very long-range enterprise, requiring an expectional degree of commitment from the investigator as well as his sponsoring organization and administration. Most of this work has been done in the U.S., but no major sweet orange or grapefruit variety has resulted so far.

Some very long range hope lies in the field of genetic engineering, but first some very difficult techniques must be mastered. Molecular biologists must be able to identify desirable genes and isolate the appropriate DNA fragments containing them, and develop appropriate techniques to transfer them into the cells of citrus plants. Plant physiologists must develop tissue culture techniques that enable the growth of a whole plant from a single protoplast. There may still remain the long-time course required to prove the success of the work and the value of the progeny. Much effort is being made in this field today, but the successes so far are in the fields of bacteria and herbaceous plants. Ultimately the techniques may allow introduction into citrus varieties of disease tolerance, cold hardiness, fruit quality, and even overall productivity, but this is only a long-range research goal at present.

We must eventually look to variety improvement in both scion and rootstock for minimizing tree losses due to the numerous tree decline diseases. None of the major tree decline diseases can be as satisfactorily treated as they can be avoided by planting tolerant plant material. This is true whether the causal agent is known or unknown. Grower observations, organized hybridization and testing programs, and futuristic genetic engineering research may all play a part.

Retention of our germ plasm base is required for ultimate maximum exploitation of our biological potential in citrus variety improvement. Losses of part of that genetic base are probably occurring now. In our budwood registration programs, and in our increasingly narrow number of planted varieties, we may inadvertently be losing some valuable germ plasm. But such developments are occurring worldwide not only with citrus plant material but possibly with important members of the pest-predator-parasite complex capable of giving such a high degree of biological control. We probably still lack in Florida significant desirable members of that ultimate complex, and there is concern that some effective but unknown species in that complex will vanish from the earth. The human race squanders vast resources and energies on far less important enterprises than germ plasm retention. Perhaps our efforts here will raise this subject to a higher level of our collective consciousness. We also need to be investigating alternate methods for preserving citrus germ plasm to supplement the reliance on the continuous existence of semi-wild specimen plants or the continuous maintenance of arboretums as germ plasm repositories.

The world citrus industry has been in a very rapid stage of development since 1945. Production and processing technology have changed substantially. Some countries which had undeveloped potential for low-cost citrus production have increased production rapidly. Each region has been forced to find a nitch in the world citrus market where it can survive. Some artificial trade barriers still exist. and may persist for many decades to protect special interests. However, the world citrus industry now has the characteristics of a worldwide market. Since citrus is so generally popular with all people, and since the worldwide per capita consumption is so low, there would appear to be a large untapped market. But, the development of that market must await the development of a greater affluence for the average man in the world's growing population.