



The Legacy of Charles Marlatt and Efforts to Limit Plant Pest Invasions

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The problem of invasions by non-native plant pests has come to dominate the field of applied entomology. Most of the damaging insect pests of agriculture and forestry are non-native (Sailer 1978, Aukema et al. 2010) and this is a problem being faced around the world. This problem did not arise overnight; instead, there has been a steady accumulation of non-native insect species in nearly every region of the world over the last two centuries. Yamanaka et al. (2015) reported that there are presently more than 3,000 non-native insect species established in North America, and most are plant-feeding species.

Given the enormity of the problem, and the fact that there has been a stream of these species establishing in the U.S. for well more than a century, it is useful to closely examine the history of how entomologists came to identify the problem of plant pest invasions and took action to stem the flow of species. Here, we examine the history of importation to the U.S. of live plants, which is well known as a common pathway by which invading plant pests are inadvertently transported to non-native habitats worldwide (Kiritani and Yamamura 2003, Roques 2009, Liebhold et al. 2012). We focus on the history of plant imports, how this practice was eventually recognized as a risky practice, and attempts made to stem the flow of invading species via its regulation. Because long time lags often exist between when invading species establish and when their damage occurs, the regulatory actions from even a century

ago continue to profoundly affect damage currently caused by non-native plant pests (Epanchin-Niell and Liebhold 2015).

Early History

Prior to ca. 1870, there was virtually no public or scientific recognition that international movement of species could lead to problems. This naivety is captured by the popularity of acclimatization societies in the mid 1800s, the first of which was La Société Zoologique d'Acclimatation, founded in Paris in 1854 by Isidore Geoffroy Saint-Hilaire, son of the well-known French zoologist Étienne Geoffroy Saint-Hilaire (Osborne 1992). The work of La Société was based upon the concept that native fauna and flora were inherently deficient and that nature could be greatly improved

upon by the addition of more species. This movement became popular throughout the world and the American Acclimatization Society was founded in New York City in 1871, dedicated to introducing European flora and fauna into North America for both economic and aesthetic purposes (Todd 2002). Much of the effort made by the society focused on birds, and in the late 1870's, New York pharmacist Eugene Schieffelin led the society in a program to introduce every bird species mentioned in the works of Shakespeare; this included releases of European robins, tits, and starlings, the latter of which ultimately became ecologically damaging and a substantial nuisance (Linz et al. 2007).

Introduction and naturalization of exotic plants was a primary activity within the acclimatization movement. Many private individuals and horticultural societies, intrigued by the world's vast flora, set forth on searches for unusual plant species that might be imported, noting that many of these species thrived when planted in an exotic habitat (Pauly 2007). A major player in the endeavor to search for and import non-native plants was the U.S. Dept. of Agriculture (USDA). During much of the late 1800's, the USDA engaged in a diversity of efforts, combing the world searching for plant species of potential use in agriculture, test-planting them in the U.S., and distributing seeds to farmers (Griesbach 2013). This effort culminated in 1897 with the formation of the Office

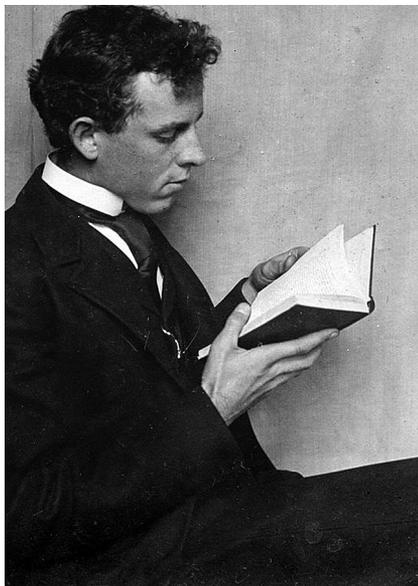


Fig. 1. David Fairchild, 1869-1954 (photo: Fairchild Tropical Botanic Garden).

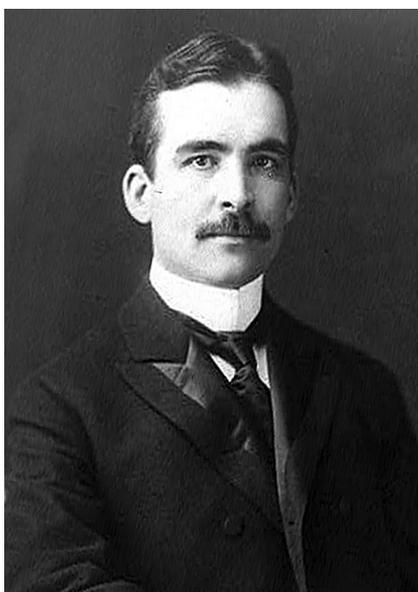
Fig. 2. Charles L. Marlatt, 1863-1954 (photo: Library of Congress Prints and Photographs Division).

of Seed and Plant Introduction within the Division of Plant Industries. Organizing this effort was USDA Secretary Edward Wilson, who strongly believed in the need for diversifying economic plants currently cultivated in the U.S. and to do so via global exploration for new species with potential domestic use.

Wilson's choice for the director of the new office was David Fairchild (Fig. 1), son of an abolitionist minister who later became president of Kansas State University. Fairchild had already achieved a reputation as a leading "plant explorer," having traveled the world collecting botanical specimens with financing from the philanthropist Barbour Lathrop. Through time, Fairchild's stature within the USDA increased, and he solidified his social status in Washington when he married Marian Bell, daughter of Alexander Graham Bell. As director of the USDA Office of Seed and Plant Introduction, he was very active, and during the course of his lifetime, he introduced some 200,000 species of plants to North America (Pauly 2007). Among these, Fairchild is credited with introducing hairy alfalfa from Peru, sweet peppers and seedless grapes from Italy, Feterita sorghum from Sudan, cotton from Egypt, and rice from China (Baker et al. 1963).

An Awakening to Danger

Just as the acclimatization movement started in Europe, so did the public realization that dangers lurked in movement of plants. In Europe, increasing awareness of the problem can be traced back to the devastation caused by the grape phylloxera, *Daktulosphaira vitifoliae* (Fitch). This pest of grapes was accidentally introduced to Europe in 1862 on infested vines imported from the U.S. to a vineyard in the Rhône valley of France for the purpose of hybridization with local varieties (Stevenson 1980, MacLeod et al. 2010). In reaction to the massive damage this pest caused to the viticulture industry in Europe, representatives from seven European countries met in Berne, Switzerland, in 1878, to develop what is considered the first international phytosanitary agreement. This took the form of the "International Convention on Measures to be taken against *Phylloxera vastatrix*" (*P. vastatrix* was the name used for *D. vitifoliae* in 1878). The convention specified



procedures for government certification of phylloxera-free status of plant material traded internationally and plant import inspection procedures. During this era, several European countries initiated their own measures to stem the flow of dangerous plant pests. For example, Great Britain implemented the Destructive Insects Act in 1877; this legislation provided for inspection and other measures to prevent the entry of plant pests (MacLeod et al. 2010).

Meanwhile, in the U.S., there was growing recognition of quarantine issues among entomologists and plant pathologists. In California, the fruit industry was being adversely affected by a series of devastating pests introduced and spread with nursery stock. Around 1870, the cottony cushion scale, *Icerya purchasi* Maskell, was introduced from Australia, as were the red scale, *Aonidiella aurantii* (Maskell), and the San Jose scale, *Quadraspidiotus perniciosus* (Comstock), accidentally introduced from China (Luck 2006). Alarmed by the appearances of an increasingly large number of damaging exotic pests, orchardists and horticulturalists voiced their concerns, and in 1881, the California Legislature passed the "Act to Promote and Protect the Horticultural Interests of the State." This legislation established a statewide system for inspection of imported plants as well as eradication of new infestations (Wiser 1974).

As these events unfolded, there was growing recognition among certain personnel of the USDA that regulatory action was needed to address the threat posed by insects and pathogens imported on

plants. In the late 1800s, the USDA Chief Entomologist was L.O. Howard (1897) and the Superintendent of the Vegetable Pathology and Physiology Division was plant pathologist Beverley T. Galloway; both recognized the problem and began to speak out. In 1889, Howard stated that 23 of the worst scale insects in the U.S. were of foreign origin and that such pests were hurting American farmers (Wiser 1974). In 1892, U.S. House of Representatives delegate Anthony Caminetti from California introduced a bill that would prohibit importation or transportation of plants (Weber 1930, Wiser 1974). The bill was referred to the House Agriculture Committee, but the Committee never took action and the bill died. In 1897, the Ohio State Horticultural Society drafted a bill, endorsed by Howard and Galloway, providing for inspection of foreign imports and interstate movement of nursery stock. This bill was introduced in Congress but ultimately failed.

Meanwhile, in the mid-1890s, the ravages to forests in New England caused by the newly discovered infestations of the gypsy moth, *Lymantria dispar* (L.), and the brown-tail moth, *Euproctis chrysorrhoea* (L.), were gaining wide attention. While the federal government refrained from funding the ongoing gypsy moth eradication program being carried out by the Commonwealth of Massachusetts, in 1897, Congress instructed the USDA to investigate the situation with these two insects and make recommendations regarding new federal legislation (Wiser 1974). Out of the 1897 USDA study, led by Howard and Galloway, emerged a recommendation for a federal inspection system targeting insects and fungal pests in interstate and foreign plant shipments.

Frustrated by Congress's inaction on the problem, Howard (1898) pointed out that most European countries had now enacted bans on imports of plants from the U.S. and stated, "Foreign nations are just beginning to do what we ourselves might long ago have done with advantage." The Bureau of Entomology also published a list of insect species potentially harmful to U.S. agriculture that were at risk of importation from Europe and Asia (USDA 1896).

In 1905, Congress finally passed legislation targeting injurious insects in the form of the Insect Pest Act, which placed prohibitions on the importation of damaging pest species. However, the act did

not place any prohibitions on plants or other objects likely to host such pests, nor did it specify any system for inspections, so the legislation had little impact (Weber 1935).

In the absence of a federal inspection system, in the early 1900s, the Bureau of Entomology established a system of voluntary inspection by which the U.S. Bureau of Customs would alert state inspectors of incoming shipments of plants. These inspections were inconsistent and deemed to not be very thorough; thus, this system was considered ineffective at excluding pests (Wiser 1974).

Enter Charles Marlatt

Charles Lester Marlatt (Fig. 2) was born in Atchison, KS, in 1863 and in 1884 graduated from Kansas State University, where he was a friend and classmate of David Fairchild. Marlatt went on to earn a master's degree in entomology at Kansas State. In 1889, C.V. Riley, Chief of the USDA Bureau of Entomology, hired him as an assistant entomologist. Marlatt and Fairchild both started their careers with the USDA in 1889, and Marlatt was the best man in Fairchild's wedding.

During his career, Marlatt conducted a variety of entomological research at the USDA. One of his impressive accomplishments was his compilation of county-level maps of every known periodical cicada (*Magicalcada* spp.) brood across the eastern U.S. (Marlatt 1907). Assembling such maps required sorting through a large number of collection records as well as considerable field work that Marlatt conducted himself. These maps were remarkably accurate; the geographical distribution of cicada broods that Marlatt described in 1907 are largely the same as described by current surveys, and the system he devised for numbering broods with Roman numerals remains in use today (Williams and Simon 1995). Marlatt's lifelong affinity for cicadas is evident in the carvings adorning the home he built on 16th St. in Washington, DC (Fig. 3). As was the case for most entomologists of his era, Marlatt also devoted considerable effort to taxonomic studies; among these, he published a single paper, Marlatt (1896), in which he described 90 new species of Tenthredinidae.

During the latter part of the 1800s, there was recognition within the USDA Bureau of Entomology of the value of implementing classical biological control



Fig. 3. Marlatt's home on 16th St. in Washington, DC. a) Exterior of the house. The Marlatt home now houses the Institute of World Politics (<http://www.iwp.edu>); b) Second-floor banister with carvings of periodical cicadas.

for mitigation of the damages caused by non-native insect pests. This work grew out of the successes made by Chief C.V. Riley against the cottony cushion scale and other pests. From 1901–1902, Marlatt and his wife embarked on their honeymoon to China and Japan where Marlatt, at his personal expense, took the opportunity to search out the native range of the San Jose scale and collect natural enemies of this species, which had become a serious agricultural pest in California (Marlatt 1953). During that trip, his wife contracted an unknown infectious disease that ultimately took her life. This experience no doubt shaped Marlatt's thinking and perhaps contributed to his strong concern about the dangers of accidentally importing species from overseas (Pauly 1996).

In 1911, Marlatt wrote a USDA bulletin (Marlatt 1911) warning of the grave danger posed by imports of nursery stock infested with the gypsy moth and brown-tail moth, and stated more broadly that the U.S. had become a "dumping ground" for contaminated nursery stock from Europe: "The fact that all the continental countries of Europe have enacted very strict inspection and quarantine laws relating to the entrance into their territories of nursery stock, or other living plant materials, operates very unfavorably for this country, where there is no bar to the entrance of any stock, however worthless, or insect-infested, or diseased. As a result, the United States receives, in addition to fairly good nursery stock brought in by



reliable importers, a great mass of refuse stock, imported under the worst conditions, massed in vast quantities in large packing cases, at best in poor condition and often diseased or insect-infested. The United States thus becomes a sort of dumping ground for material which could not find sale in Europe. Much of this worse-quality stock is that referred to elsewhere as being imported by department stores of our larger cities, and also by unscrupulous nurserymen who are careless of their own reputations and the interests of their customers" (Marlatt 1911).

Marlatt goes on to urge the U.S. Congress to enact plant quarantine legislation quickly: "The United States is the only great power without protection from the importation of insect-infested or diseased plant stock...A properly enforced quarantine inspection law in the past would have excluded many, if not most, of the foreign insect enemies which are now levying an enormous tax upon the products of the

farms, orchards, and forests of this country. Fully 50 per cent of the insect pests in this country are of foreign origin and new important foreign pests are becoming established practically every year. It is of the greatest importance, therefore, that an adequate inspection and quarantine law be passed at the earliest moment."

The Cherry Tree Debacle

By 1910, there was clearly conflict within the USDA. On one side were those promoting imports of more non-native plants, believing that doing so was key to the advancement of American agriculture and horticulture. On the other side were individuals who believed that current practices of free imports of plants put the country in grave danger by inadvertently introducing damaging pests that could further devastate American agriculture and forestry.

This dichotomy of beliefs was reflected in the conflict that had grown between David Fairchild and Charles Marlatt. These two individuals, originally close friends who had long shared many personal experiences, had become the spokespersons for two opposing camps within the USDA on the live plant import issue. This conflict came to a head in 1911 with the matter of Japanese cherry trees. Most Americans are familiar with the cherry trees planted along the Tidal Basin in Washington, DC, which tourists flock to see in bloom every spring, but few are aware of the drama that led to their existence.

During a visit to Japan in 1902, David Fairchild was enchanted by the beauty of flowering cherry trees, something largely unknown in the U.S. (Jefferson and Fusonie 1977). In 1906, he and his wife Marian ordered 60 cherries from the Yokahama Nursery Company and had them planted along a hillside on their property in Chevy Chase, MD, on the outskirts of Washington, DC. The trees flourished, and Fairchild embarked on a crusade to plant more cherries around the Washington area. During a tree-planting ceremony at a school, Fairchild met the writer Eliza Scidmore, who also resided in the Washington area, had traveled extensively in Japan, and was generally fond of Japanese culture. Scidmore shared Fairchild's admiration for Japanese cherries, and together they developed an idea to plant cherries along the Tidal Basin. In the early 1900s, under the direction of Engineer Colonel Spencer Cosby of the U.S.



Fig. 4. USDA staff inspecting cherry trees on the Washington Monument grounds, 7 Jan. 1910.

Army Corp of Engineers, much of what is now the National Mall was created by dredging mud flats along the Potomac River, and the area was in the process of being landscaped.

In 1909, Mrs. Scidmore sent a letter to the First Lady, Helen Herron Taft, outlining the plan and asking for her support. Mrs. Taft, who had lived in Japan and was also familiar with the beauty of the flowering cherry trees, sent a letter endorsing the plan to Colonel Cosby on 7 April 1909. The next day, Dr. Jokichi Takamine, a prominent chemist, was visiting from Japan; when informed of the situation, he offered to donate 2,000 trees from Japan on behalf of the citizens of Tokyo (U.S. National Park Service 2015).

On 6 January 1910, the 2,000 trees arrived in Washington from Japan. Prior to their arrival, Secretary of Agriculture James Wilson informed Colonel Cosby that upon arrival in Washington, the trees would be subjected to inspection by USDA officials "in order to ascertain whether they are free from insect pests new to this country or from other possible diseases." (Jefferson and Fusonie 1977). Upon arrival in Washington, the trees were moved to a USDA storehouse on the Washington Monument grounds to be examined by department scientists.

A team of scientists from the USDA Bureaus of Entomology and Plant Industry, led by Charles Marlatt, inspected the trees on the monument grounds (Fig. 4). On 19 January, Marlatt sent his report to Secretary Wilson, stating that the trees were heavily infested with many different

insect pests and diseases, noting serious infestations of crown gall disease (caused by *Agrobacterium tumefaciens*), white peach scale [*Pseudaulacaspis pentagona* (Targioni-Tozzetti)], the San Jose scale, and an unknown species of sesiid moth. Marlatt summarized, "I have no hesitation in saying that in a country where a proper inspection of disease material was legally in force with the object of protecting agriculture, the importation of these trees would not be permitted." He recommended that the trees should be burned immediately in order to exclude these damaging pest species. On 28 January, after receiving the consent of President Taft, Colonel Cosby ordered the trees burned, along with packing material shipped with the trees (Fig. 5) (Jefferson and Fusonie 1977).

Though most parties involved agreed that burning the trees was necessary, this was an awkward moment that created discomfort among many. By this time, the gift of the trees had received considerable attention in the press, both in the U.S. and in Japan. Some segments of the public reacted in shock and disbelief at the destruction of the trees; *The New York Times* published an editorial stating, "We have been importing ornamental plants from Japan for years, and by the shipload, and it is remarkable that this particular invoice should have contained any new infections." Prior to destroying the trees, there was a flurry of telegrams transmitted among various parties, including the mayor of Tokyo, the Japanese ambassador to the U.S., and the Secretary of State and

Fig. 5. Cherry trees being burned on the Washington Monument grounds.

Secretary of War (Jefferson and Fusonie 1977, Pauly 1996). Fortunately, the Japanese government did not express any negative reaction to what could have been interpreted as the U.S. snubbing their gift (Pauly 2007).

Following the destruction of the cherry trees, it was agreed that the city of Tokyo would send a new batch of trees. Professor S. I. Kuwana, director of the Imperial Quarantine Service, offered to select and fumigate the new trees prior to shipment to Washington. In February 1912, a new batch of 3,000 cherry trees, smaller than the previous trees and therefore considered less likely to be harboring insects and diseases, was shipped to Washington, DC. On 26 March, the trees arrived in Washington, were immediately subjected to inspection by USDA scientists, and were declared pest-free. The next day, a ceremony was held on the banks of the Tidal Basin, next to the statue of John Paul Jones; First Lady Taft planted the first tree, and Viscountess Chinda, wife to the Japanese Ambassador, planted the second tree.

Only a few of the original cherry trees still survive in Washington, but their descendants, propagated via graft, still adorn the Tidal Basin, representing the strong bond between the Japanese and American people (Pauly 1996). Since 1935, Washington has celebrated the event in an annual cherry blossom festival, and the trees have become a central attraction of the city, drawing many tourists every year.

Perhaps a less well-known aspect of the trees is their importance as a turning point in America's attitude toward plant imports and the growing recognition of the importance of phytosanitary laws. The drama of the cherry trees represented the culmination of a dispute within the USDA, and within the nation at large, regarding the importation of plants. One group of individuals felt that importing plants was harmless and yielded great benefits to society, but the other group recognized the danger associated with biological invasions of plant pests and advocated enactment of federal measures to limit plant imports. It also represented the culmination of a dispute between two men who had staked out their ground within the USDA on opposite sides of this dispute. These two old



friends, David Fairchild and Charles Marlatt, had become enemies, the leaders of opposing factions within the USDA. In the end, Marlatt would have his way and Congress would finally enact plant quarantine regulations. Fairchild would leave the USDA to pursue his dreams as a plant explorer, funded by wealthy philanthropists he had befriended.

Finally, Congress Acts

Between 1909 and 1912, Marlatt set to work drafting new congressional legislation that would give the USDA authority to impose quarantines on plant imports as well as limit interstate movement of plants. In 1909, the bill passed the House and was prepared to go before the Senate when the American Association of Nurserymen, upon learning about the bill, voiced their strong opposition, arguing that it would too strongly limit plant imports (White 1975). The nurserymen's actions effectively derailed the legislation. They argued for an alternative system that allowed free imports but relied upon inspections by officers in exporting countries to ensure pest-free status.

After much deliberation and modification, on 20 August 1912, Congress finally passed the Plant Quarantine Act (Weber 1930). The legislation provided for the establishment of the Federal Horticultural Board, composed of two representatives from the Bureau of Entomology, two from the Bureau of Plant Industry, and one from the Forest Service. The task of the Board would be to design and manage an import inspection system and make

recommendations to the Secretary of Agriculture on the designation of quarantines and eradication measures. Initially, the Act specified that inspection of imported goods should be conducted by state employees (with no federal funding) but coordinated by the Horticultural Board. This system was not uniformly carried out among states and responsibility for inspection was later made a federal responsibility (Weber 1930). The Act also provided for the USDA to impose domestic quarantines on interstate movement as well as carry out eradication of new pests.

Under this new legislation, the USDA Secretary would hold hearings prior to specifying any new domestic or international quarantines. It was then left up to the Horticultural Board to specify detailed regulations on how these quarantines would be carried out. During the first years of implementing the Plant Quarantine Act (1912-1919), plants could be imported depending upon whether the exporting country had a system for inspecting outgoing shipment for pests and diseases. If they had such a system, then commercial importation of plants was freely allowed, and when the plants arrived, the Horticultural Board notified state inspectors (at the destination of each plant shipment) so that they could inspect the shipment again. There was however, a type of "blacklist"—certain plants were prohibited or could only be imported with mandatory fumigation or post-entry quarantine. For exporting countries that did not have a system for inspection of exported material, only a few plants were

allowed to be imported for scientific and limited propagation purposes.

Marlatt was appointed as the first chair of the Horticultural Board in 1912 and played a major role in its implementation. However, it appears that he became concerned about whether the initial implementation of the Quarantine Act was adequately effective, in part because of the repeated detection by inspectors of potentially damaging pests in cargo. He also felt that some of the current practices, such as importation of woody plants with large root balls and soil, represented potential dangers. By 1917, he was advocating a total ban on plant imports in order to protect American agriculture and natural resources (Marlatt 1917). State entomologists, as well as entomology and plant pathology societies, were also voicing skepticism about the current regulations and advocated stricter measures (Weber 1930). Thus, in May 1918, Marlatt organized a conference to collect comments about the need for stricter regulation; in November 1918, the Department issued "Quarantine 37" (implemented in June 1919), which provided much stricter regulation of plant imports. While the Plant Quarantine Act had provided the USDA with enabling authority to implement Quarantine 37, the Act did not specify the more detailed quarantine regulations.

Under the new regulations of Quarantine 37, several more rigid limits were placed on plant imports. Soil could no longer accompany plants. Large shipments of all plants were forbidden. Fumigation was required of most shipments. All plant imports were required to pass through Washington, DC or San Francisco, where USDA employees would inspect them. It became the Department's intention that only small numbers of plants of a given species could be imported, with the idea that these plants could be used as breeding stock in the U.S. and all subsequent imports of that species would subsequently cease. Quarantine 37 would largely end the practice of importing plants for direct resale in the U.S. (i.e., "plants for planting"). With the end of commercial plant imports, there would no longer be a need for state inspectors—the limited numbers of plants imported could be entirely handled by USDA employees.

The implementation of Quarantine 37 evoked a vocal wave of protest from a large number of individuals and groups, most notably professional associations



Fig. 6. From *The Garden Magazine*, April 1919, volume 24, number 3. Caption reads, "Visitor to flower show in 1924, (greatly impressed by guide and special guard): "Well, Well, so that's an Azalea! - and they used to be quite popular Easter gifts! And it doesn't look in the least dangerous. Does it?"

such as the American Association of Nurserymen and the Society of American Florists. There had developed a profitable industry of importing and selling plants in the U.S., but these groups perceived that this practice would largely end with the implementation of Quarantine 37. One of the arguments made was that plants were not really that important as an invasion pathway: "The order is ineffective in that it cannot guarantee the immunity which it is supposed to produce since hemp rope, jute, and thousands of bales of peat moss litter and such like material are still likely to bring in insects in the future just as they have done in the past" (*The Garden Magazine*, April 1919, volume 24, number 3).

The nursery industry was quite vocal in expressing their displeasure for Quarantine 37 (e.g., Fig. 6). In response, Marlatt and his associates mounted something of their own publicity campaign, speaking at several large conferences and arguing that Quarantine 37 was both necessary (for protecting U.S. agriculture and forestry) and tolerable to the nursery industry. Their argument was that Quarantine 37 was needed, among other things, to protect the American nursery industry from the damages of non-native pests and that regulations would stimulate domestic plant propagation (Beattie 1922).

While the practice of importing plants for planting would largely end under Quarantine 37, the regulations did allow for free importation of a few types of plants. In particular, Quarantine 37 allowed unlimited importation of plants that could not be practically produced in the country. Bulbs became a matter of contention. Prior to Quarantine 37, large numbers were

imported, but these were largely halted and pressure was levied on the USDA to relax limits on their imports. This pressure came from segments of the nursery industry, but also from exporting countries such as the Netherlands, England, and France (Weber 1930). In 1923, the department relaxed regulations to allow unlimited importation of eight genera of bulbs, but in 1925, an embargo was placed on importation of *Narcissus* spp., citing the large numbers of insects that had been entering with these bulbs (Weber 1930). This ban was met with new outcries from the Nurserymen's Association, but surprisingly other segments of society criticized the ban as "protectionist" and designed solely to benefit bulb producers, mostly within the western U.S. (Wiser 1974).

As part of the 1922 appropriations, Congress designated that there should be a USDA Director of Regulatory Work, and Walter G. Campbell, Acting Chief of the Bureau of Chemistry, was appointed to the position in 1923. However, Campbell had little power (Wiser 1974), and Marlatt continued to direct the work of the Federal Horticultural Board until Congress replaced it with the Plant Quarantine and Control Administration as part of a department reorganization in 1928. As part of the reorganization, Marlatt was appointed Chief of the Plant Quarantine and Control Administration, a position he held simultaneously with serving as Chief of the Bureau of Entomology, having replaced L.O. Howard, who retired in 1927. In 1929, Marlatt stepped down as chief of the Plant Quarantine and Control Administration in order to devote his attention to the Bureau of Entomology. The position of Plant Quarantine Chief was given to Lee Strong (Henneberry 2008). Marlatt remained chief entomologist until retirement in 1933, when he reached mandatory retirement age and left the USDA after having served for 45 years (Rainwater and Parencia 1981). He died in 1954 at the age of 91. Before dying, he published in 1953 an autobiographical work, *An Entomologist's Quest: The Story of the San Jose Scale: The Diary of a Trip Around the World, 1901-1902*.

Plant Quarantine Enters the Modern Era

In 1932, the Plant Quarantine and Control Administration was replaced by the Bureau of Plant Quarantine. In 1934, the Bureau of Plant Quarantine was merged with the Bureau of Entomology to form the Bureau of Entomology and Plant Quarantine, and in 1942, the Bureau became part of the Agricultural Research Administration, which was renamed the Agricultural Research Service in 1953. Finally, in 1971, Congress moved all of the animal and plant regulatory activity into a new USDA agency, the Animal and Plant Health Service, which was renamed later that year to the Animal and Plant Health Inspection Service (APHIS), and this organization has continued to the present.

When Lee Strong replaced Marlatt in charge of Plant Quarantine, he brought a slightly different philosophy toward regulation (Pauly 2007). With the publication of a memo in 1938, "What's wrong with Quarantine No. 37?", Strong described this change in philosophy and set the stage for a series of changes to Quarantine 37 that would relax limitations on the size of shipments, mandatory fumigation, and post-entry quarantine procedures.

The relaxation of many of the limits that the USDA previously placed on plant imports was not only driven by changes in personnel within the Department, but also reflected changes within the country and more broadly in the world. These changes became most stark in the period following World War II with the movement toward liberalized trade. The turning point in this movement was the 1944 United Nations Monetary and Financial Conference (informally referred to as the "Bretton Woods Conference"), an international meeting of 730 economists and diplomats gathered to design a system for regulation of international monetary and financial order. The conference led to the General Agreement on Tariffs and Trade (GATT) in 1948. The seminal idea behind GATT was that liberalizing trade would reduce political tension and promote economic growth. GATT marched through eight rounds of negotiations between 1947 and 1995 as global efforts toward trade liberalization stepped through stages that first

emphasized free trade (removing tariffs), then fair trade (removing non-tariff and technical barriers), and finally safe trade (measures to protect human, animal or plant life or health). The Uruguay Round negotiations, which started in 1986 and concluded in 1994 (Fig. 7), were especially significant because they resulted in the creation of the Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement), which designated standards for regulatory measures implemented by member countries for the protection of plant, animal, and human life and health.

The Uruguay Round negotiations also expanded the scope of GATT by the formation of the World Trade Organization (WTO), which largely superseded GATT in 1994. Prior to this, agreements signed as part of GATT had no enforcement mechanism, nor was there an organization responsible for implementing the agreements. When GATT was initially conceived, delegates to the Bretton Woods conference envisioned formation of the "International Trade Organization" (ITO), an institution that would carry out and enforce the various agreements under GATT. But as a result of domestic opposition to such "institutional internationalism," the U.S. never ratified the agreement forming the ITO, and therefore, the ITO never came to exist. Thus, a key development in the evolution of free trade, as well as phytosanitary regulation, was the ratification of Uruguay Round agreements that resulted in the formation of the WTO, which fulfilled many of the original intentions of the failed ITO.

The SPS Agreement focused on international harmonization based on standards and specifically designated the International Plant Protection Conventions

(IPPC) as the organization providing this service to the phytosanitary community. The IPPC is a multilateral treaty overseen by the Food and Agriculture Organization (FAO) of the United Nations. Uruguay Round negotiations resulted in the establishment of a binding international dispute settlement mechanism administered by the WTO. The potential to challenge trading partners with binding results had profound effects on the regulatory community and quickly brought a critical eye to trade in plants and plant products.

A parallel trajectory in plant quarantine began in 1952 when the IPPC developed a system for phytosanitary certification. By placing some of the burden for preventing pest entry on the exporting country, the IPPC established the concept of pest exclusion as a regulatory responsibility shared by both importing and exporting countries. The evolution of the IPPC merged with the GATT when the SPS Agreement named the IPPC as the international standard-setting organization for phytosanitary measures.

While Marlatt's designs leaned toward protection in the balance between protection and trade, the SPS Agreement swung the pendulum the other direction, but with greater emphasis on scientifically defensible rationale for restrictions. Principles and procedures that followed from this fundamental shift in philosophy challenged many historical paradigms, as evidenced by a series of SPS-based disputes in the WTO.

The ultimate result of these international agreements was a more sophisticated view of the relationship between exclusion and all other measures and conditions that affect the risk of pest introduction from trade in plants. Although the concept of exclusion plays a key role in the plan, preventing pest entry is only part of the strategy, rather than the only tactic. Measures designed for exclusion must also be scientifically justified, and they must be the least restrictive for achieving the appropriate level of protection. Simply having protection as an objective does not provide carte blanche for all



Fig. 7. U.S. Trade Representative Mickey Kantor signs the final measure of the GATT Uruguay Round at Marrakesh. The signing of this treaty enacted the SPS agreement and formation of the WTO (photo: WTO).

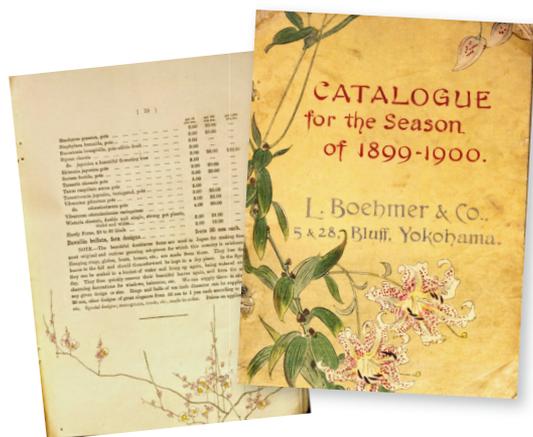


Fig. 8. L. Boehmer & Co., nurserymen & exporters of Japanese bulbs, seeds, plants, Yokohama, Japan, 1899-1900 Catalogue (photo: Smithsonian Libraries).

entomologists, including L.O. Howard, at least partially understood the potential damage that could be caused by non-native plant pests and recognized the need for national legislation to regulate plant imports. But their efforts were not effective at moving Congress into action and regulation of imports probably would

possible measures. Because false claims of risk to plant health can be used by nations in unfair protectionist strategies, the SPS Agreement requires countries to justify quarantines with scientific evidence of risk.

The disciplines created by the SPS Agreement are designed to ensure that barriers to trade that have the objective of providing protection are not overly restrictive or politically motivated. It creates a regulatory focus on *safe trade* as a singular objective, recognizing that neither the extremes of exaggerated protection nor completely open trade are desirable—a sort of Marlatt-Fairchild compromise.

Even though several of the strict limits that the original implementation of Quarantine 37 placed on plant imports have been removed, many other portions of the regulations persist to date. For example, current USDA regulations essentially ban the importation of certain plant species, such as those of agricultural importance. Furthermore, all plant imports are subjected to inspection at one of 17 stations operated at ports throughout the U.S. (Liebhold et al. 2012). Soil is not allowed to accompany plants entering the U.S., with the exception of plants imported from Canada.

With the relaxation of limits on plant imports, commercial imports of plants to the U.S. have steadily increased over the last 50 years. Currently, more than 4 billion plants are imported to the U.S. annually, though the vast majority of these plants are genera native to tropical or subtropical regions (Liebhold et al. 2012).

The Legacy of Charles Marlatt

The problem of biological invasions was generally not recognized for many centuries, and the U.S. was one of the last countries to impose laws that would limit both intentional and accidental imports of species (Crosby 1986, Coates 2007). Toward the end of the 19th century, many

have been further delayed had it not been for Charles Marlatt. Many people attribute Marlatt's commitment, if not obsession, as being the driving factor leading to the establishment of such regulations (Wiser 1974, Pauly 1996). His commitment to limiting pest invasions earned him considerable animosity, not only from members of Congress who grew tired of his pressure on them to pass quarantine legislation, but also from the nursery industry, who held him responsible for ruining what had been a lucrative plant import business (Cory et al. 1955, Wiser 1974).

We argue, however, that Marlatt's dedication to plant import regulation ultimately had a huge impact on the rate at which non-native insects invaded the U.S. and consequently yielded enormous benefits to American agriculture and forests. Prior to the enactment of the Plant Quarantine Act, there was an extensive industry importing plants to be planted in the U.S.. This industry is well documented by numerous catalogs of plants available for immediate shipment from

distant countries such as Japan (Fig. 8). The consequences of such shipments are well illustrated by the story of how the hemlock wooly adelgid, *Adelges tsugae* Annand, apparently entered and established in eastern North America (Havill and Montgomery 2008). In the early 1900s, many wealthy Americans were enamored by the beauty of Japanese gardens and attempted to replicate this beauty in their own gardens. In 1911, Major James and Sallie Dooley were landscaping their mansion, "Maymont," in Richmond, VA, and had several hemlock trees shipped from Japan to be planted in their garden. Unknown to them or their gardeners, these trees were apparently infested with the adelgid, but the population that established in their garden was not discovered until 1951. Since then, the insect has slowly spread in the eastern U.S., causing irrevocable loss of millions of hemlock trees throughout the U.S. (Morin and Liebhold 2015).

Unfortunately, importation of live plants represents the most common historical pathway by which plant-feeding insects have been transported into non-native regions worldwide (Kenis et al. 2007, Smith et al. 2007, Roques et al. 2009, Liebhold et al. 2012). Live plants can be considered an ideal medium for transporting insects because they provide a place for insects to eat and live during the trip. Many insect life stages, such as sap-feeding insects and the eggs of foliage-feeding insects, are small and difficult to see; consequently, plants have frequently transported species in these groups.

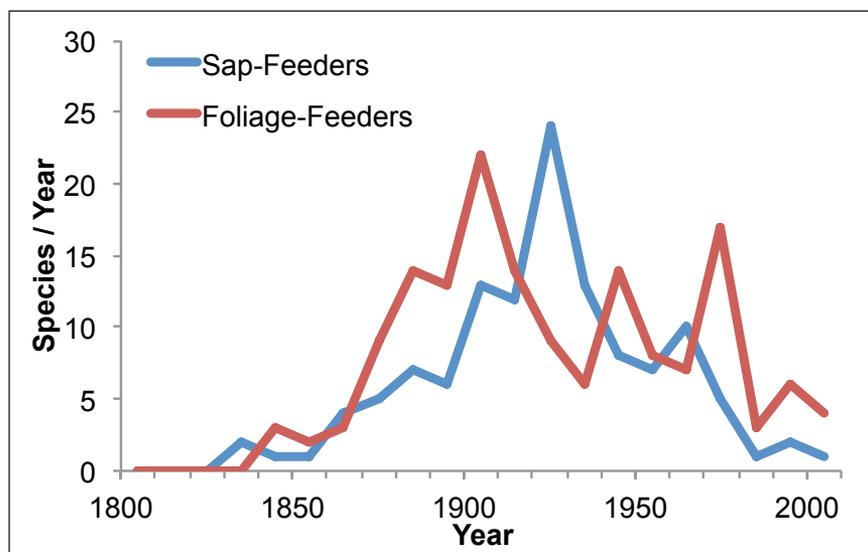


Fig. 9. Time series of frequency of initial discovery (proxy for establishment) of forest insects in the sap-feeding and foliage-feeding guilds. Redrawn from Aukema et al. (2010).

Historical records clearly show that the rates of establishment by foliage-feeding and sap-feeding insects in the U.S. have declined over the last six decades (Fig. 9) (Aukema et al. 2010). These records indicate that establishments increased from 1800 through 1910, and then decreased from 1920 to the present. While arrival and establishment of these species may have been affected by a variety of factors, we believe that most of these species were likely accidentally transported on live plants; the increase from 1800 to 1910 reflects historical increases in plant imports, but the decrease from 1920 onwards reflects the impact of the Plant Quarantine Act on excluding invasive plant-feeding insects. Even though portions of Quarantine 37 were relaxed in the post-World War II era, many portions of the regulations persist and effectively contribute to pest exclusion.

Thus, it is inescapable that the effort that Charles Marlatt put into shepherding Congress to pass plant quarantine regulations, and his effort to implement that legislation in effective government policies, has had tremendous benefit. Unfortunately, all of the plant pest species that established in the U.S. prior to the enactment of Quarantine 37 are still here and many of these, such as the hemlock woolly adelgid, are still expanding their ranges and causing immense impacts. Nevertheless, it is clear that had no action been taken in 1912 and 1918, we would be in a much worse situation today. Had Congress never enacted plant quarantine regulations, the curves shown in Fig. 9 would likely continue to increase, and this would have resulted in immense impacts on agriculture and forests. The benefits of Charles Marlatt's efforts are therefore very clear.

During much of his career, Marlatt's efforts to rein in plant pest invasions were met with considerable opposition from the nursery industry (e.g., Fig. 6) (Weber 1930, White 1975, Coates 2007). Following passage of the Plant Quarantine Act of 1912, Marlatt spent a great deal of time publicly countering arguments made by the nurserymen that plant quarantine regulations were unnecessary and harmful to the country (e.g., Marlatt 1917). It should be noted that over time, as the USDA relaxed many of the strict regulations in Quarantine 37, the nursery industry has also greatly softened their opposition to regulation (White 1975). Today, the nursery industry often works as a partner with

the USDA in implementing quarantine efforts. For example, the American Nursery & Landscape Association (ANLA) has been a key partner in the formation and implementation of the USDA National Clean Plant Network (NCPN), a partnership of centers that diagnose and eliminate plant pathogens in order to produce clean propagative plant material (Gergerich et al. 2015).

Despite the fact that the career of Charles Marlatt had tremendous positive impacts on the nation, he is rarely recognized as any sort of hero. In fact, in a recent historical analysis, Philip Pauly vilifies Marlatt and indirectly accuses him of engaging in a type of xenophobia, equating his promotion of quarantine regulations to the political movement opposing human immigration that also took place in the early 1900s (Pauly 1996, 2007). Pauly goes on to criticize the Plant Quarantine Act of 1912 as unnecessary and even argues that pre-emptive actions against non-native species are unwarranted and reflect a type of xenophobic discrimination, a theory that has been advanced by others (e.g., Davis 2011, Valéry et al. 2013, but see Simberloff and Vitale 2014). However, we agree with Simberloff (2003), who points out that Pauly's argument reflects a fundamental lack of understanding of biogeography and that discrimination against non-native insects differs profoundly from discrimination against non-native humans. The simple fact is that while not all non-native insect species become problems, a much larger fraction of non-native species cause problems than native species, and this is reason enough to take pre-emptive measures to minimize future invasions.

Though Marlatt's efforts to implement national programs to minimize invasions by non-native pests have clearly reduced the rate at which these species are accidentally imported with plants, the problem has not completely gone away. Economic factors and international trade agreements limit the ability of any government to impose regulations that might completely close this or most other invasion pathways. Efforts to prevent pest invasions often collide with efforts to promote free trade. Globalization has had clear benefits, and as a dominant trend, it is unlikely to retreat in the near future. The challenge ahead lies in identifying ways to minimize arrival of potentially damaging pests under the constraints of

a more mobile world.

Charles Marlatt may have been a person slightly ahead of his time in recognizing the need to limit plant pest invasions, but his actions yielded tremendous benefit to the U.S. historically and into the future. Within the U.S., his actions should probably receive greater attention within plant health fields, and his career should serve as a model for others to follow in the future.

It must also be noted that the U.S. has historically been slow to react to changing conditions with regard to trade and phytosanitary regulation. It was one of the last economically developed countries to implement national quarantine regulations governing plant imports in the early 1900s. Again, at mid-century, the U.S. failed to ratify the formation of the ITO and was thus slow in embracing the new era of institutional internationalism that ultimately came to dominate phytosanitary regulation. Given the never-ending trend of globalization, it may benefit the U.S. to perhaps be more proactive in the future by developing a regulatory framework that is more responsive, and even proactive, to future changes.

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