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REGULATORY ENTOMOLOGY AND BIOLOGICAL CONTROL: A TRIBUTE TO REECE SAILER

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Dr. Reece I. Sailer joined the faculty of the Entomology and Nematology Department, University of Florida, Institute of Food and Agricultural Sciences in early 1973, an opportune time to conduct biological control research (Fig. 1). He entered arguably the nations largest entomological community with a well-developed research and regulatory infrastructure. His research in insect biological control required taxonomists to provide authoritative identifications and an associated library, well-curated collections of specimens identified to species, and a secure building with limited access to contain exotic arthropods and arthropod pathogens. I committed my career to the creation of this kind of infrastructure for Florida and, with the help of a dedicated staff, obtained and managed many of the resources that supported Dr. Sailer. This work began 49 years ago, in July 1953, when I left the Entomology Department of the University of Florida and accepted a position as an Entomologist in the Entomology Bureau of the State Plant Board (SPB). I had been teaching biological control and apiculture, and was interested in insect taxonomy. Ed Ayers, the recently appointed Plant Commissioner, directed me to build an Entomology Bureau with an extensive insect collection and a regulatory capability second to no other state. Although the Bureau was not conducting biological control programs at that time, I was inspired by this opportunity to build for the future.

Fig. 1. Dr. Reece I. Sailer.

The Florida State Collection of Arthropods (FSCA) had less than 30,000 specimens prior to 1953, most of them poorly pinned and without labels. Today, it is one of the best collections in North America with more than eight million specimens well-pinned, labeled and identified to species. The professionally-curated collection also contains partially identified specimens, 344,000 in vials of alcohol and 340,000 mounted on slides. Of the specimens on slides, 100,000 are mites. There are 30,000 bulk samples in alcohol that contain millions of specimens collected across much of the world to be sorted, identified, labeled and added to the collection. Now the fifth largest arthropod collection in the U.S., it is curated by eight full-time taxonomists, one quarantine entomologist, six technicians, and five assistants. Dr. Howard Weems developed the supporting FSCA Research Associates program that has grown to more than 300 members. The taxonomic library is one of the most complete in North American, containing both American and European journals. These FSCA resources at the Florida Department of Agriculture and Consumer Services (DACS), Division of Plant Industry (DPI) are available to the staff, University of Florida faculty and students, and cooperators.

In 1870, Germany was the first country to pass a quarantine law, perhaps due in part to the threat posed by the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). This pest was first described by Thomas Say as an obscure chrysomelid found feeding on a wild solanaceous plant known as buffalo bur or sand bur that grows along the eastern slopes of the Rocky Mountains from Canada to Texas (Say 1824). For 30 years it continued to be of no economic importance until the pioneer settlers brought Irish potatoes into the area. The beetle quickly accepted the potato as a new source of food and became known as the Colorado potato beetle. It swept steadily eastward and arrived at the Atlantic Coast in 1874. This event did not go unnoticed in Germany but, with the help of man, the beetle found its way into Europe and eventually Germany in spite of the quarantine law.

The Florida Plant Act was passed on April 30, 1915 (Yonge 1915), soon after the U.S. enacted the Federal Plant Quarantine Act in 1912 and California became the first state to have regulatory authority, also in 1912. Regulations were required to control the spread of citrus canker that was found in Jefferson County on September 30, 1912. Some citrus was grown in the panhandle of Florida at that time, particularly Satsuma oranges. The Florida Department of Port and Railway Inspection of the SPB was created in June 1915 to inspect incoming ships and trains. The SPB was in charge of port inspections in Florida until 1958. It was administered by the Board of Control of the University of Florida and furnished office space on the fifth and sixth floors of the Seagle Building until moving to the Doyle Conner Building in 1967 (Fig. 2). The SPB became the DPI, one of the 11 divisions of DACS in 1960. The U.S. Department of Agriculture (USDA) also had their personnel at ports in Florida and, in 1958, accepted full responsibility for 100% inspection of all incoming cargo. Since 1960, the percentage of inspected cargo has steadily decreased to only 2-3% today. This decline was due to a large increase in the volume of cargo entering U.S. ports, including plants, other agricultural products, and passenger baggage.

Prior to the Florida Plant Act, there was no regulatory authority to control non-indigenous species in Florida, introduced or adventive, including biological control agents. Comprehensive records were not kept but it is estimated that about 35 species of parasites or predators were released in Florida from 1899 to 1964, based on information from the SPB, University of Florida, and USDA. The first was the vedalia beetle, *Rodolia cardinalis* (Mulsant), introduced into Florida from California in 1899 to control the cottony cushion scale, *Icerya purchasi* Maskell (Berger 1915). The vedalia beetle had been imported previously from Australia into California where it had become a very successful classical biological control agent. The SPB maintained a colony of the vedalia beetle until the mid 1930s and sold them to citrus growers and nurserymen at 10 beetles per dollar. Cottony cushion scale is no longer a pest in Florida probably because the vedalia beetle is still present and suppressing it to very low population levels. This classic example of biological control caught my attention as a student and I have been interested in the field ever since.

In addition to intentionally introducing insects for whatever purpose, some pests have arrived accidentally on agricultural products. The gypsy moth, *Lymantria dispar* (L.), was imported into the Northeast from Europe in about 1869 to improve silk production. Egg masses are routinely found in Florida on campers and travel trailers that arrive in the fall from infested areas. However, due to Florida's warm climate, this pest does not become established. The European corn borer, *Ostrinia nubilalis* (Hubner), was accidentally introduced in about 1908 on broomcorn from Italy or Hungary. By 1938, it had spread over practically all of New England. It reached the Florida Panhandle in 1975 when it was found in seven counties by DPI inspectors. The Japanese beetle, *Popillia japonica* Newman, was introduced into

Fig. 2. The Seagle Building (A) and Doyle Conner Building (B) in Gainesville, Florida successively housed the State Plant Board.

New Jersey on roots of nursery stock in about 1916 from Japan and spread south into Georgia in the late 1980s. It has been found in Florida as a hitchhiker but has not become established.

Among the more recent invasive pests is the sugarcane rootstalk weevil, *Diaprepes abbreviatus* (L.), first found in the Apopka area (Woodruff 1964). It is a native of the West Indies with many host plants, including ornamental nursery stock. Initially, only one specimen was discovered on a nursery plant, but an infestation was subsequently detected in a nearby citrus grove (Poucher 1968). The adults feed and lay eggs on the leaves of more than 200 hosts and larvae cause serious damage by feeding on roots. Larvae are difficult to control with insecticides after the first instar, even when chlordane, aldrin and dieldrin were available. A hymenopteran parasite, *Quadrastichus haitiensis* (Gahan) was released in the Apopka area but it was not effective because it could not overwinter. More recently, Dr. Jorge Peña reported that the egg parasites, *Q. haitiensis*, *Ceratogramma etiennei* Delvare and *Aprostocetus vaquitarum* (Wolcott), have been released and recovered in the southern part of the state (Peña 2002). The sugarcane root weevil has spread through 19 counties infesting more than 150,000 acres. The USDA's research showed that a kaolin-based particle film sprayed on the leaves reduced feeding damage by 68-84%. The film also prevents egg masses from sticking to the leaves, causing them to drop to the ground and either desiccate or be consumed by predators.

The Mediterranean fruit fly, *Ceratitis capitata* (Wied.), invaded Florida in 1929. As a requirement to ship fruit, growers had to keep the groves clean. Small boys were hired to collect fruit that dropped from trees and bury it three feet deep. At eight-years-old, I was paid 10 cents per hour to accomplish this task. The bottom limbs of citrus trees were not pruned in those days and it was difficult to crawl under them. As an adult, I have been involved in every medfly eradication program in Florida through 1990. The medfly has been trapped in Florida another 16 times. Extensive trapping followed single fly catches and aerial bait sprays were applied if additional flies were caught. The medfly was eradicated from Florida each time two or more flies were found. DNA studies of this fly have helped to determine pathways of introduction and prevent future infestations. Eradication is very expensive and the public is getting less tolerant of bait sprays. As an alternative, sterile male flies have been released in Hillsborough, Manatee, Sarasota, and Miami-Dade Counties since May 1998. Florida has been medfly free since October 1998 and, hopefully, sterile male releases will prevent infestations in the future.

The Caribbean fruit fly, *Anastrepha suspensa* (Loew), was discovered at Key West in 1935 and 175 flies were trapped during the next two years. During this period, only 20 flies were trapped in Dade, Broward, Palm Beach and Lee Counties. This species was not detected again in Florida until April 23, 1965 at Miami Springs, and it subsequently infested Surinam cherries in the same area. Federal personnel who worked in Puerto Rico thought that the caribfly was only a pest of ripe grapefruit, so it could not overwinter in Florida. Malathion (LV 95%) applied at the rate of 2 oz per acre and 5 oz (25% WP) plus 1 pint of SIB No. 7 bait per acre were tested on 200 acre blocks at Miami in 1965. Both sprays provided control sufficient for eradication of the Caribbean fruit fly. The Florida Legislature offered $1 million for an eradication program; however, it was deemed unnecessary based on information provided by the USDA, APHIS. Within a year, the caribfly spread to 30 counties and we have had to learn to live with it.

The citrus blackfly, *Aleurocanthus woglumi* Ashby, first detected and eradicated in 1935 at Key West, was found a second time on January 28, 1976 in Broward County. A survey indicated that Dade and Palm Beach Counties were also infested. DPI and APHIS attempted to eradicate the citrus blackfly using malathion at 12 oz per 100 gallons of water and later increased the rate to 20 oz per 100 gallons applied every 14-21 days. However, the treated areas became reinfested between applications, so the insecticide program was discontinued and two parasites were introduced from Mexico, *Encarsia perplexa* (Silvestri) and *Amitus hesperidum* (Silvestri). These natural enemies were controlling citrus blackfly in Mexico to a level below the economic threshold (Browning & Stimac 1994). At first, the Florida citrus growers did not believe that the parasites would control the blackfly and wanted it to be eradicated but Dr. Sailer monitored the parasite releases, observed the numbers of parasitized blackflies, and predicted that the wasps would provide excellent control in Florida as they had in Mexico. Blackfly infestations are occasionally encountered today and the growers are usually asked to not use insecticides on their citrus to give the parasites a chance to multiply. A similar situation occurred with classical biological control of Florida red scale, *Chrysomphalus aonidum* L., by the parasite, *Aphytis holoxanthus* De Bach.

The citrus leafminer (CLM), *Phyllocnistis citrella* Stainton, was first found in Florida in May 1993 and infested most of the commercial citrus plantings in the state within six months. The larva of this moth feeds on young leaves and forms serpentine mines. The citrus producers sponsored a classical biological control program in 1994 to import, rear and release the Asian parasite, *Ageniaspis citricola* Loginovskaya, even though the CLM was already serving as a host for as many 13 species of native parasitoids (Browning & Pena 1995). The CLM populations declined significantly in 1995, ostensibly due to *A. citricola* causing 60% control in 28 counties. Ants and ladybeetle larvae tear open mines and remove CLM larvae. Lacewing larvae, spiders and hemipteran predators simply pierce the mine and drain the body fluids from the larvae. A study of CLM in south Florida lime groves indicated that predators are the most important cause of mortality, killing about 50 percent of the population in most years (Amalin et al. 2001). It is quite likely that certain predators increase in abundance, especially those for which CLM represent a suitable food.

The brown citrus aphid (BCA), *Toxoptera citricida* (Kirkaldy), was discovered in south Florida in 1995 and quickly spread to nearly all commercial citrus growing areas. By 1997, major infestations of BCA were found throughout the state and the trees were covered with sooty mold. BCA is very efficient in the transmission of citrus tristeza virus (CTV). A parasite, *Lysiphlebia japonica*, was imported from Japan, mass reared and released at over 30 sites throughout the state but it apparently has failed to establish. Regardless, BCA populations have continued to decline as biological control improves due to a combination of generalist insect predators, primarily certain species of lady beetles and hover flies. Localized outbreaks may still occur, however, if biological control is disrupted by grove mismanagement (Michaud & Browning 1999). CTV transmission remains a problem, however, and it is doubtful that any natural enemies, whether native or exotic, will be able to reduce the incidence of CTV to the pre-BCA levels.

The Asian citrus psyllid, *Diaphorina citri* Kuwayama (ACP), was discovered in Florida by Dr. Susan Halbert and Ellen Tannehill, a DPI plant inspector, on June 2, 1998 during a routine survey of citrus for CTV. ACP is the primary vector of greening disease in Asia but, fortunately, this disease has not been detected in Florida, although trees are inspected continuously for its presence. Two parasites, *Tamarixia radiata* (Waterston) and *Diaphorencyrtus aligarhensis* (Shafee, Alan and Agaral), have been released at multiple sites in citrus growing areas of Florida (Hoy & Nguyan 2001). A wide range of generalist predators capable of developing on ACP has been identified, including lacewings, hover flies, ladybeetles and spiders. Most notable is the native ladybeetle, *Olla v-nigrum* (Mulsant), that has also been successfully introduced into Asia for biological control of *Heteropsylla cubana* Crawford, a psyllid of Caribbean origin (Michaud 2001).

Prior to 1965, no state agency regulated the movement of parasites and predators into and within the State of Florida. The USDA, APHIS issued a Plant Protection Permit (Form PPQ 526) for shipments of parasites or predators as a courtesy to expedite their entry into the U.S. or movement from state to state. Therefore, without clear authority but at the urging of the researchers in Florida who were interested in getting clearance for testing parasites and predators, I established the Arthropod Introduction Committee (Denmark & Porter 1973). Later, "Arthropod Pathogen" was added to the committee's title. The committee included representatives from the various organizations with an entomological interest: Florida Division of Health and Rehabilitative Services, DPI, Bureau of Entomology (now under DACS) and Division of Animal Industry; U. S. Public Health Services (USPHS), Veterinarian, Communicable Disease Center (Atlanta, Georgia); Florida Game and Fresh Water Fish Commission (FGFWFC), and the UF, Entomology and Nematology Department. When a request to import or release a natural enemy was received, I sent it to the committee members for their recommendations. Following committee approval, the request was forwarded to the DPI Director, Halwin Jones, for his concurrence. Although he was not particularly interested in the committee at that time, he agreed to sign the PPQ Form 526 and forward it to Beltsville, Maryland for final approval by USDA, APHIS. If approved, APHIS issued a shipping permit to the requesting individual and sent a copy to DPI. Voucher specimens of species being tested for safety and released into the environment were housed in the FSCA. If there was any question about the identity of a species released into the environment, it was available for further study. Due to an increased interest in conducting research on parasites and predators, as well as economic pests, Hal Jones decided to make the Arthropod and Arthropod Pathogen Introduction Committee official. He convened a meeting on September 22, 1965 in Orlando to formulate an addendum to the Florida Statutes making unauthorized movement of arthropods into and within the state a misdemeanor, and imposing a maximum penalty of one year imprisonment and a $5,000 fine (Denmark 1988).

In 1970, the Florida Legislature passed a bill giving the FGFWFC control over movement of all animal life into and within Florida. It was decided that DACS and FGFWFC would cooperate in the regulation of arthropods by means of FGFWFC representation on the Arthropod and Arthropod Pathogen Committee. Evidently it was the intent of the Florida Legislature for FGFWFC to only regulate the movement of vertebrates. The Florida Legislature consequently passed a bill in 1973 granting the DPI control over all plant pests. In 1990, the Florida Legislature passed a bill giving DPI control over pet shops selling spiders, tarantulas, scorpions, cockroaches, walkingsticks, beetles, moths and other exotic arthropods deemed a public nuisance if released into the environment. APHIS did not regulate these arthropods because they were not considered to be plant pests. A box containing specimens of the arthropods from pet shops was sent to Tallahassee for the legislators to view. It was immediately named the little box of horrors and the bill passed without any question. The DPI also monitors companies selling arthropods for other purposes, particularly biological control, to ensure that the species being sold is the one advertised. To my knowledge, Florida is the only state that identifies commercial species sent for verification every other year. Companies may not be aware that their cultures of small arthropods, such as mites, are contaminated. Actual samples assumed to contain a single species have been found to contain as many as three. This happens because almost no company employs a taxonomist who can identify or separate the species they are selling. Occasionally, for example, scavenger mites decimate the original colony. These problems can cause growers and homeowners to lose faith in biological control, particularly if no or minimal control is realized.

I visited the quarantine facility at Riverside, California in 1966 to formulate plans for a quarantine building in Florida. Plans were drawn and reviewed by colleagues who had experience in working in a containment building. The final plans were included in my budget for the next legislative session and sent to the DPI director for his approval. He thought the idea was good, but that the time was not right. The plans were included in my budget request for the next six years and I was told each year by the Commissioner of Agriculture, Doyle Conner, that my request was 3rd in priority but it never seemed to advance. The budget director in the governor's office was a strong supporter of biological control and, after being discretely informed of the request for a security building, added it into the budget that reached the governor. Such tactics were cause for termination of one's career with the state, if known by one's supervisor. Nevertheless, the first security building in Florida was dedicated in June 1973 at the DPI in Gainesville (Fig. 3). The primary purpose for the security building was to remove parasites and predators from host material, separate and remove any hyperparasites, and test the natural enemies against target pests before requesting permission to release them into the environment. Workspace was provided for USDA, ARS; University of Florida, Entomology and Nematology Department; and DPI scientists to conduct research in biological control. Space in this building was adequate for about 10 years. Plans for a second security building (Fig. 3) were submitted in 1983 and it was dedicated in 1989, after Senator Kirkland was persuaded to put the building request back into the Legislature's budget.

In 1973, Dr. Reece Sailer accepted the position of graduate research professor in the Entomology and Nematology Department at the University of Florida, Gainesville and was assigned space in one of the security laboratories to conduct his research. Dr. Sailer had previously served as a taxonomist responsible for the identification of true bugs and allied research for the USDA's Insect Identification and Beneficial Insect Introduction Branch of the Entomology Research Division. He was partially interested in the southern green stinkbug, *Nezara viridula* (L.), complex. He had numerous field assignments, including a study of the effects of DDT on forest fauna, and biological and ecological investigations on mosquitoes and other biting flies in Alaska. He became assistant chief of the Branch in 1960 and moved to Paris, France to serve as director of the European Parasite Laboratory. He returned to Beltsville, Maryland in 1966 and was appointed Branch Chief. Just before retiring from the USDA, he served as Chairman of the Insect Identification and Beneficial Insect Introduction Institute.

While at the University of Florida, he demonstrated that inoculative releases of the imported parasite, *Pediobius foveolatus* (Crawford), could provide effective control of the Mexican bean bee-

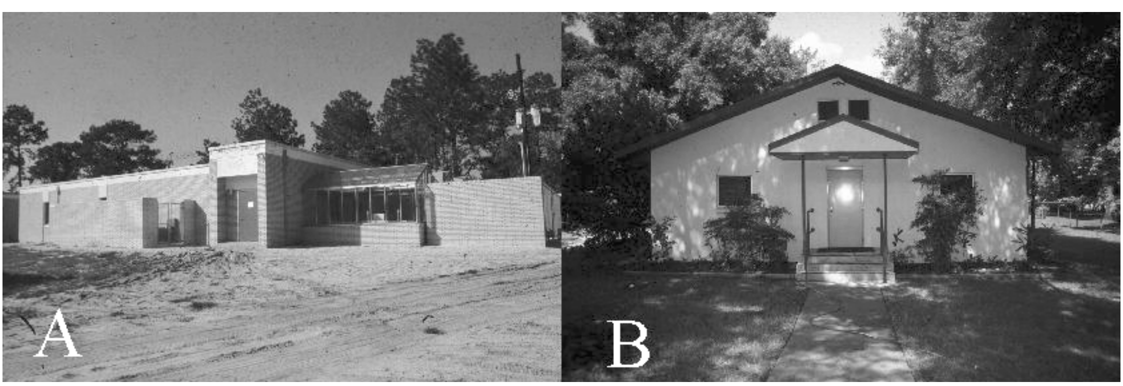

Fig. 3. First Security Building (A) and Second Security Building (B) at the Florida DACS Division of Plant Industry in Gainesville.

tle, *Epilachna varivestis* Mulsant. He was so pleased with this success that he promised to eat any beetles that were found in the parasite release areas. His student assistant, Limhuot Nong, searched for the beetles with great enthusiasm and determination, finding 12 at the organic gardens on campus. Being a man of his word, Dr. Sailer reported this find to the Florida Entomology Society at the next annual conference and ate them at the general session. One of his most significant achievements was importation of the parasite, *Encarsia lahorensis* (Howard), that provided excellent control of the citrus whitefly, *Dialeurodes citri* (Ashmead). He also was successful in establishing a South American mole cricket parasite, *Larra bicolor* Fab., in southern Florida. Although Florida still has tea scale, *Fiorinia theae* Green, Dr. Sailer introduced *Aphytis theae* (Cameron) to control it, including an infestation in my camellia garden. I sprayed an insecticide at least twice each year before the releases but *A. theae* completely controlled the tea scale after six months. He made the release more than 20 years ago and my camellias are still free of tea scale. Dr. Sailer's research will have a lasting effect on Florida's ecology and economy, and we are forever grateful for his contributions.

Acknowledgments

I thank the society for inviting me to present the seventh Pioneer Lecture. It has been a privilege to honor Dr. Reece I. Sailer. I also thank Dr. N. C. Leppla for nominating me to be a Florida Entomological Society Pioneer Lecturer, his help with writing my paper, and assistance in preparing the presentation. Drs. G. A. Evans, S. Halbert and J. P. Michaud graciously provided information and suggestions for the lecture. D. J. Sonke assisted with electronic editing.

Literature Cited

AMALIN, D. M., J. E. PEÑA, R. E. DUNCAN, H. W. BROWNING, AND R. MCSORLEY. 2001. Natural mortality factors acting on citrus leafminer, *Phyllocnistis citrella*, in lime orchards in south Florida. Biocontrol 47: 327-347.

BERGER, E. W. 1915. Cottony Cushion Scale. The Florida Grower. 12: 10-11.

BROWNING, H. W., AND J. L. STIMAC. 1994. Classical biological control of whiteflies on citrus, pp. 79-100. *In* D. Rosen, F. D. Bennet and J. L. Capinera (eds.), Pest Management in the Subtropics. Intercept, Andover.

BROWNING, H. W., AND J. E. PEÑA. 1995. Biological control of the citrus leafminer by native parasitoids and predators. Citrus Industry. 76: 46-48.

DENMARK, H. A., AND J. E. PORTER. 1973. Regulations of importation of arthropods into and of their movement within Florida. Florida Entomol. 56: 347-358.

DENMARK, H. A. 1988. Plant Industry (Review), Chapter 581, pp. 1-20. Florida Statutes.

HOY, M. A., AND R. NGUYEN. 2001. Classical biological control of Asian citrus psylla. Citrus Industry. 81: 48-50.

MICHAUD, J. P. 2001. Numerical response of *Olla v-nigrum* (Mulsant) (Coleoptera: Coccinellidae) to infestations of Asian citrus psyllid (Hemiptera: Psyllidae) in Florida. Florida Entomol. 84: 608-612.

MICHAUD, J. P., AND H. W. BROWNING. 1999. Seasonal abundance of the brown citrus aphid, *Toxoptera citricida* (Homoptera: Aphididae), and its natural enemies in Puerto Rico. Florida Entomol. 82: 434-447.

PEÑA, J. 2002. It's a bug-eat-bug world: research imports wasps from Caribbean to control destructive root weevils in Florida. UF/IFAS, News Release.

POUCHER, C. 1968. Sugarcane rootstalk borer weevil, pp. 132-140. Div. Plant Industry 28th Biennial Report.

SAY, T. 1824. American Entomol. 1: 1-18.

WOODRUFF, R. E. 1964. A Puerto Rican weevil new to the United States (Coleoptera: Curculionidae). Div. Plant Industry, Florida Dept. Agric. and Consumer Services, Circ. 35: 1-2.

YONGE, P. 1917. Florida Plant Act Report for the Year Ending April 30, 1916. Vol. 1.