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FLORIDA'S ROLE IN THE DEVELOPMENT OF TROPICAL HORTICULTURE — IN ENTOMOLOGY AND NEMATOLOGY

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Initiation of entomological and nematological work in Florida many years ago and its continued support helped place the State in responsible leadership of the profession. Seeking solutions for insect problems affecting horticultural crops has continued for over 50 years by men who were able, dedicated, and proud to serve science and to meet the needs of the people. Many rich heritages were left by early workers that are challenges to present day workers, even with the many sophisticated devices and methods of research available. What manner of choices, however, should present-day and future entomologists make in order to keep faith with our entomological pioneers? Are not many people looking to and depending on Florida for the solution of many entomological and nematological problems affecting horticultural crops?

Several organizations in Florida, some closely others remotely related, are concerned with entomology in its various branches. These include the Division of Plant Industry, Florida State Department of Agriculture; Institute of Food and Agricultural Sciences, University of Florida; Bureau of Entomology, Florida State Board of Health; Entomology Research Division and Plant Pest Control of the U. S. Department of Agriculture; and various members of industry. Many hobbyists, amateur and highly skilled insect collectors live and work in Florida. The Florida Entomological Society with its annual meeting tends to hold all in a professional organization.

Florida's Institute of Food and Agricultural Sciences, as part of the University of Florida, has 22 research units placed in various, strategic locations in the State. A budget of over \$12,000,000 supports more than 400 projects on current research problems affecting the immediate and future benefit to Florida and to the world. Teachers at the University teach all phases of agriculture and offer graduate students unexcelled opportunities for research in tropical horticultural disciplines.

Accomplishments of the Division of Plant Industry are set forth in the Biennial Report, July 1, 1966-June 30, 1968, and cover wide ranges of insect pests and nematological work, Jones, et al. (1968).

Cooperative work in which, for example, a large number of Florida scientists have worked in Costa Rica on the Mediterranean fruit fly, *Ceratitidis capitata* (Wiedmann), demonstrates how broad areas of work may be shared internationally. Although such efforts help foreign scientists, they help Florida men become experienced with foreign pests who are thus better able to combat these pests if they invade Florida.

Some Characteristics of Insect and Nematode Infestations in Florida.—Insects and nematodes affect horticultural crops in tropical as well as in other regions of the world. To state that insects and nematodes are "worse", meaning more numerous, in the tropics than elsewhere is not quite a true statement. It is true that insects have suitable flight and nematodes free moving conditions in tropical areas and are in evidence at all seasons; this may be suggestive of ever present attacks. Certain species, however, may be observed at certain seasonal periods, other species at other periods. Not all species

are active and abundant at all seasons.

Peninsular Florida projecting from the temperate zone into the tropical Caribbean seas occupies a unique horticultural position. It possesses many insects and has a very wide range of plant species.

Favorable climates in Florida are not found, however, for producing breadfruit, *Artocarpus communis*; coffee, *Coffea arabica*; cacao, *Cacao theobroma*; mangosteen, *Garcinia mangostana* and certain other strictly tropical species. Plants which grow do provide horticultural and entomological students many opportunities for study. These and other features provide many compensatory factors owing to the position of the State. Florida provides much for her professional workers and, in addition, the vast resources of the stable government of the United States may be called on for assistance. Entomological, nematological and other workers meet, speak a common language, discuss and compare methods and procedures relative to solution of the problems involved.

We entomologists and nematologists in Florida have a double duty. First, researching and serving the needs of our own people and second, helping to uphold the profession for those in our neighboring countries. The manner of helping our neighbors is of significance and needs consideration. A practising physician and I were discussing the training of his people, those of El Salvador. He indicated that he wanted their younger people to receive training and that it would be better to receive training in the home country rather than to go to the other countries. This practitioner pointed out that students who departed from their country were (1) tempted to remain in the land which provided their higher education and (2) those who returned often failed to adapt themselves to conditions of their homeland and to their fellow countrymen. Related to advanced education and to the remain-at-home concept is the comprehension that most problems connected with horticulture would be solved more expeditiously by working with the insect pests on hosts in the areas of their existence rather than in a foreign location. Insect and nematode problems of horticultural crops in Florida are sufficiently similar to those of neighboring lands that they are satisfactory for teaching purposes.

Relationship of Intercontinentally Distributed Insect Pests.—Relatedness of southern Flor-

ida's insect fauna with that in Cuba is illustrated by two examples. Subsequent to the determination of an insect species previously unknown to me I first refer to the list of Cuban insects affecting economic crops by Bruner, et al, (1945) before I refer to lists of insect species in the more northern of the United States. In a visit to Cuba in 1949 and a discussion with Doctor Bruner (then living and active) I was asked if the Colorado potato beetle, *Leptinotarsa decimlineata* (Say), and the Mexican bean beetle, *Epilachna varivestris* Mulsant, were present in the southern parts of Florida. I answered, "No". The Colorado potato beetle has been observed near Lake Okeechobee but not further south although potatoes are grown in all parts of the State. The Mexican bean beetle is in the northern counties of the State and although beans are produced over the entire State it is not distributed in the southern parts. Doctor Bruner reported that although both beetles had undoubtedly been brought into Cuba many times they had not become established therein. A relatedness of insects with those in Central America has been noted. "Essentially, the same insect pests encountered in Florida are found in Cost Rica; however, the problems have not been studied extensively", according to Kuitert (1958), after a year in Costa Rica.

A similarity with Brazilian insect pests was observed in an infestation of an ambrosia beetle, *Hypocryphalus mangiferae* (Stebbing), on mangoes, which is a minor problem in South Florida. Dying branches and trees in a large grove at the Instituto de Agricultura, Campinas, Brazil, were shown me by J. C. Rossetto who reported that *H. mangiferae* was responsible. The infestations in that grove were very severe and might be termed epidemic and endangering to all of the trees in the grove.

SOME ACCOMPLISHMENTS OF ENTOMOLOGISTS AND NEMATOLOGISTS

Pests and Diseases Affecting Man.—Mosquitoes were occasionally so numerous in Florida groves a decade and more ago that workers were not only inefficient but even refused to gather fruit. These insects have responded to control measures and to urban development in such manner that the numbers were greatly reduced. Mosquitoes as non-occupational pests around homes and in recreational areas are no longer

the dreaded annoyances of former years.

Entomology research work by the U. S. Department of Agriculture on insects affecting man and animals has continued in Florida for years, first at Orlando and now at Gainesville in a modern new laboratory. Work has also been continuing on mosquitoes, flies and other arthropods affecting man by the Florida State Board of Health. Malaria and yellow fever were prevalent in Florida several decades ago but are unknown today. This is largely attributed to the reduction of breeding areas through knowledge gained from research.

Biological Control.—An ideal toward which man may strive is to control harmful pests by means of other organisms through predation, parasitization or disease. Much has been done but much more might be accomplished if appropriation levels were increased many fold over those at present. Many injurious insects and mites affecting citrus production are held in check by natural controls. Were this not true Florida's citrus yields would be less remunerative. Other biotic and ecological factors must be considered and utilized wherever applicable, although they may be the unbalanced arm that achieves the most if the least glamorous results.

Florida red scale, *Chrysomphalus ficus* Ashmead, was of major importance for years but with the introduction of a parasite, *Aphytis holoxanthus* De Bach, Muma (1969) reported that the Florida red scale, ". . . is presently in extremely low population due to adequate control by parasites . . .".

Another armored scale, the purple scale *Lepidosaphes beckii* Newman, that was abundant and injurious in Florida citrus groves before 1960 has been adequately controlled, according to Muma (1969) by another aphytid parasite, *Aphytis lepidosaphes* Compere.

Sugarcane borer, *Diatraea saccharalis* (Fab.), parasite control work by the Entomology Research Division, ARS, U. S. Department of Agriculture has been proceeding for years to attain satisfactory results. Eggs are parasitized by *Trichogramma fasciatum* Perkins in late summer. Eggs and many young larvae are consumed by lady beetles and ants. A wasp *Agathis stigmatus* (Cresson) parasitizes borer larvae throughout the year.

A change in concept or understanding of an action or belief may be as important as the introduction of a positive or a new one. This

applies to insect and nematode control and may be exemplified by the following examples. Two fungi, *Sphaerostilbe aurantiicola* (Berk and Br.) Patch and *Nectria diploa* Berk and Curt, were believed by many early workers (decades ago) effective in reducing Florida red scale. They are now regarded as saprophytic in nature according to Muma (1969). Predaceous activities by a tree snail, *Drymaeus dormani* (Binney), years ago were often considered by some as effective in reducing scale, mealybug, whitefly, spider and rust mite, populations but are now believed of little value, Muma (1969).

Insects Affecting Forests and Forestry Products.—Much of Florida's acreage is devoted to forest or pasture usages. Tree and lumbering insects are some of Florida's important arthropod pests. Able researchers are striving to keep insects affecting lumber or the lumbering products in control. Termites, an everpresent scourge of wood or of wood products in the tropics, have been studied through the years. Part of the post-DDT insecticides have been highly effective in control of termites and have helped preserve wood and wood products for many years after treatment.

Leaf-cutting ants were described in letters to the author from southern Mexico as limiting Indian populations. Certain areas in the forests were described as infested with the ants which attack food plants with such voraciousness, suddenness and severity as to seriously restrict food and dietary materials.

Honey Bees are Given High Values in Tropical Agriculture.—Florida's honey crop in 1968 was 20,800,000 pounds and 16 percent more than in 1967; it exceeded that of any other state, Anonymous (1969). Their value as pollinators of many plants producing fruits and vegetables may exceed that of honey and wax production. Honey bees remain manageable (can be increased or decreased by man) as to population density and placement. Considerable work has been expended, however, to develop other bees for dispersing pollen.

Regulatory or honey bee disease control programs help to provide a balanced apicultural enterprise. One of the greatest needs of beekeeping is relief from the greater wax moth larvae, *Galleria melonella* (Linn.), which destroy many combs and even colonies of bees. Another need for relief is from toxic pesticide treatments which can severely reduce colony

strengths at the time most needed for pollination.

Regulatory or Restrictive Methods of Control.

—Early and continued efforts to prevent the entry of harmful insect pests and disease producing pathogens into the United States have been very successful. The Division of Plant Industry of the State Department of Agriculture and Quarantine Workers at the U. S. Department of Agriculture have been effective, ever-watchful agencies to detect a new pest or pathogenic organism in Florida. Regulatory measures are preventing entry of the citrus black fly, *Aleurocanthus woglumi* Ashby, into Florida since it is present on the neighboring islands of Cuba and New Providence Island. Three campaigns against the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), by the Division attest to successful campaigns against an unwanted pest.

A recently discovered infestation of the giant African snail, *Achatina fulica* Ferrusac, in Miami is providing the citizenry with a trying problem. Its original stock was evidently surreptitiously "slipped past" inspection officials. Discovery of the infestations in comparatively small areas, however, was admirable, affording more opportunity for circumvention of the pest.

Measures for Vegetable and Fruit Insect Control.—Experiment Station entomologists have developed control measures for whatever pest became harmfully abundant. These workers in various stations have made it practicable for growers to produce top-quality fruits and vegetables. Twenty-five years ago, before DDT, corn production was almost unknown in Florida owing to its insect pests. Now, however, sweet corn production is an important item of production. Two examples of problems remaining unsolved are (1) virus diseases transmitted by aphids and (2) the Caribbean fruit fly. Aphids are known to disseminate many viruses but the prevention of inoculation of healthy plants, even though effective aphicides have been applied has not been successful. Infestations of the Caribbean fruit fly have been destroying crops of peaches, guavas and other fruits.

Changes in Insecticides.—Work done by entomologists in Florida, on or with pesticides, has doubtless been fully the equal of that in other states. DDT was tried for the control of many insects and found useful on many plants, especially on annual plants such as tomatoes and many other vegetables. It was rejected for use

on many perennials, such as citrus since mites and scales often increased following its application. Certain insects soon developed resistance to it and increased in abundance following its use. A natural reaction, therefore, was to replace it with other materials when it failed to give desired control. In like fashion parathion, TEPP and other materials "paraded through" the entomologists "arsenal" against pests; others will follow.

Insecticidal materials have become ineffective for one or more reasons. Sometimes insect resistance has developed which made changes necessary. Sulfur, for example, was effective for many years for control of the avocado red mite, *Oligonychus yothersi* (McGregor), but is unsatisfactory today, especially in seasons when the mite infestations are usually abundant. The grove owner or caretaker then asks what he can use that is effective. DDT cannot be used on many plants, as is recognized by many; hence, some other material has been used.

Changes in pesticide usage have been necessary; other changes are expected to follow. Such changes should be made by those familiar with the situations. Changes due to untimely or legislative action are likely to be harmful, as reported by Smith (1969) who stated that ". . . substitute materials have been far worse than those [disruptive to beneficial insects] of DDT on natural enemies".

Recent research in nematode control exemplified by reports of Perry (1967) and Smart (1967) show a great advancement of nematological studies. Examination of a listing of courses of study in nematology at the University of Florida for undergraduate and graduate students attest to the present state of development of this study. A role of Florida's nematologists is the continuation and advancement of this science to meet the needs of our citizens and neighbors.

Outside Influences Affecting Entomologists in Florida.—Owing to the recent agitation to outlaw the use of DDT, and eventually other pesticides, increased hardships have been placed on the entomological profession. It is doubtless true that were the profession to receive enormous amounts of funds for the many biological and ecological control factors great reductions could be made, in time, in the quantities of pesticides needed. DDT and later pesticides were heralded as "wonder" materials and they were truly phe-

nomenal agents for protection of horticultural crops — and of man — from insect infestations or attacks. Housewives and others have long been favored, or spoiled, by top quality food products free of insect infestations and injuries and uncontaminated by insect parts and of fecal matter. Growers of horticultural food crops desire to market uninjured, uninfested and non-contaminated food products. Although some indiscriminate uses of the new pesticides have been made and some unfortunate results accrued through no fault of the pesticides, *per se*, an unbalanced understanding pervaded the people of our land. A present duty of entomologists is to assist in guidance to restore equilibrium in the use of pesticides. The role of an economic entomologist today continues to be that of providing recommendations for control of insect pests which will enable the grower to produce high quality crops free of insect infestations and damage.

Considerations for the Future.—Sometimes a grower applies more pesticide than is needed. Sometimes a harmful insect or nematode is not infesting some field but is severely abundant in others. One with training and experience in the fields may often designate which fields or areas need treatment and which do not. Ability is needed to tell when the abundances of insect or nematode pests are reaching an economic level of injury or when the food product would be so heavily contaminated with insect particles as to require condemnation under the pure food laws. This is a delicate balance on occasions. Owing to so many factors involved in crop production and to the great variability of abundances of insects a farm-by-farm recommendation is almost mandatory to make the needed control recommendations.

Entomologists and nematologists have been

employed in increasingly greater numbers by industry and the increase is likely to continue. Professional workers may be termed “practioners” or “prescription entomologists or nematologists” and function to solve many problems involved in individual groves or on farms. Such workers, whether industrial or professional, would require much training, guidance and leadership to observe and know field conditions and significant pests in order to make explicit recommendations. Scouts, assistants or others working with the professional service would also need training relative to insect pests.

What entomologists and nematologists can do owing to the unique position of Florida is to provide training for all types of personnel needed for such work. Library references, technical laboratories and equipment are available or are procurable at the Institute of Food and Agricultural Sciences, University of Florida. Training in entomology and nematology in Florida would contribute to the development of tropical horticulture.

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FLORIDA'S ROLE IN THE DEVELOPMENT OF TROPICAL HORTICULTURE — IN PLANT PATHOLOGY

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Development of a successful and progressive horticulture is dependent on application of

knowledge derived from several scientific disciplines. One of the more important of these is plant pathology. Unless adequate provisions are made to prevent or control diseases, no horticultural endeavor will flourish for more than a very short time. Florida's horticulture is a striking