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ENTOMOLOGY RESEARCH DIVISION PROGRAMS RELATING TO FLORIDA INSECT PROBLEMS [1]

C. H. HOFFMANN [2]

It is a pleasure to be here today to discuss some of our Entomology Research Division programs that are related to insect problems of interest to members of the Florida Entomological Society.

According to the Florida Department of Agriculture, the Sunshine State produces a greater variety of crops than any other State. About 2,500,000 acres in farms and groves produce peanuts, pecans, cotton, tobacco, sugarcane, tung oil, grains, citrus, tropical fruits, and vegetables valued at $675,000,000 a year. Florida leads the world in citrus production. It is noted for fine vegetables. It ranks thirteenth among the beef-producing states of the Nation. Florida is also recognized as an outstanding resort state. And, although not publicized as much as the aforementioned achievements, it is noted for a large number of destructive insects which at times have seriously threatened the agricultural economy, the tourist trade, and land settlement.

You are aware that the Entomology Research Division cooperates closely with state agricultural experiment stations, state plant boards, state departments of agriculture, industry, and other agencies in the conduct of research studies. Although the results of these studies directly benefit the particular state in which the work is done, they also may be of considerable value to other states. Today I should like to talk about some fairly recent cooperative research relating to Florida insect problems. I will discuss some of the work done in the various branches and laboratories of the Division, including the Pioneering Research Laboratories, in order also to acquaint you with its present organization.

INSECT IDENTIFICATION AND PARASITE INTRODUCTION LABORATORIES

Identification work.—The Insect Identification and Parasite Introduction Laboratories have been engaged in research studies and much service work of direct interest to entomologists in Florida. During 1957 the Insect Identification staff received thirty lots of insects from the Florida Plant Board and submitted approximately 4,600 determinations. The Plant Board is using the returned, named material to build a reference collection of Florida insects. When such a collection is available, Florida entomologists should be able to identify most of their insects without sending them to Washington. In addition to the time saved, they will be able to familiarize themselves with the insects of Florida more easily, with consequent benefit to research in economic entomology.

One recent taxonomic study involving insects of economic importance to Florida is now complete. A revision of the fruit-piercing moths of the genus *Gonodonta* will shortly appear as a technical bulletin of the USDA.

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[1] Invitational paper presented on August 28, 1958, at the 41st Annual Meeting of the Florida Entomological Society, Tampa, Florida.

[2] Assistant Director, Entomology Research Division Agricultural Research Service, U. S. Department of Agriculture, Plant Industry Station, Beltsville, Md.

Several species occur in Florida and have been reported to injure citrus. Other species have caused serious losses of citrus fruit in Mexico and South America. The bulletin will summarize information on the habits, distribution, and economic importance of all species of the genus.

Another study under way concerns a fruit fly known as *Anastrepha fraterculus* (Wied.). In Mexico it is not important on citrus, but attacks rose apple, guava, peach, and almond, whereas in South America the species referred to as *fraterculus* sometimes causes 70 to 90 percent damage to citrus crops. This study is being made to determine whether more than one species is involved and to evaluate the extent to which the Mexican population of *fraterculus* constitutes a threat to the American citrus industry. Dr. R. H. Foote, who is conducting the research on *Anastrepha*, also assisted in establishing the Mediterranean fruit fly identification laboratory in Miami and directed the identification work during the peak of the eradication program in 1956.

Parasite introductions.—Personnel of these Laboratories stationed in France and India have shipped numerous parasites and predators to the United States. Some of these are received by the laboratory in Moorestown, N. J., where they are inspected for hyperparasites and then distributed for field release. To provide adequate stock for testing and release, many species are propagated at the Moorestown laboratory.

During 1956 the 26 shipments of biological-control agents to Florida included 14 species and 49,580 specimens, of which more than 33,500 were adult parasitic Hymenoptera, the remainder being eggs of different species of ladybird beetles and lacewing flies. Most of these parasites and predators were released against the yellow sugarcane aphid, the green peach aphid, or the Rhodes-grass scale.

Pesticide Chemicals Research Laboratories

New insecticides.—New insecticides less toxic to warm-blooded animals than any now in general use have recently been discovered by our chemists at Beltsville in their search for insecticidal chemicals that leave no harmful residue. The new compounds, esters of chysanthemumic acid, are only about one-eighth as toxic as pyrethrum and one-third as toxic as allethrin, previously considered our safest insecticides.

6-Chloropiperonyl chrysanthemumate, known as barthrin, has given good results in laboratory tests as a larvicide against the common malaria mosquito and salt-marsh mosquitoes. It is probably somewhat less effective than pyrethrum against the yellow-fever mosquito. It was found effective against the salt-marsh caterpillar, southern army worm, codling moth, boll weevil, body louse, and some species of cockroaches. Barthrin is now being produced on a pilot-plant scale in amounts sufficient for field testing against these insects, and it is also being evaluated against many other species. For some uses barthrin may have certain advantages over pyrethrum and allethrin—lower toxicity to warm-blooded animals, stability, broad range of killing power, and lower cost.

Attractants.—Attractants as well as insecticides are useful in the control and eradication of insect pests. In combination with toxicants they may lure insects to their death, or as baits in traps they may be used to

determine the location and extent of infestations. Both these uses played a large part in the success of the recent Mediterranean fruit fly eradication campaign in Florida.

A few weeks before the "Medfly" was found in Florida in the spring of 1956, entomologists of the Entomology Research Division in Hawaii discovered that angelica seed oil is an excellent attractant for the males. With the appearance of the fly in Florida, about 50,000 traps containing the oil were set out to determine the extent of the infestation, to guide the spraying program, and measure eradication progress. Since only about 600 pounds of angelica seed oil are produced in the world annually, the eradication program had consumed practically the entire supply by the latter part of 1956.

Chemists of the Division at Beltsville had been synthesizing organic compounds of many types for testing as attractants for several fruit fly species. Some of the esters of 6-methyl-3-cyclohexene-1-carboxylic acid were among the most effective attractants for the "Medfly" tried up to that time. Initial field tests indicated that the isopropyl ester was the most attractive, and arrangements were immediately made for the manufacture of several thousand pounds of it for use in the Florida eradication campaign. This material became available just in time to meet the emergency due to exhaustion of the angelica seed oil supply. Later the *sec*-butyl ester, now called siglure, was found to be about twice as attractive as the isopropyl ester, and production was shifted to the new compound. When used in proper dosage, siglure is as attractive to the "Medfly" as the best grades of angelica seed oil.

Field Crops Insects and Bee Culture Research Branch

Rhodes-grass scale.—Control of the Rhodes-grass scale through the release and establishment of a wasp parasite, *Anagyrus antoninae* Timberlake, is showing considerable promise. This scale has become widespread in southern and central Florida. It is often a serious pest of Rhodes, Para, Carib, St. Augustine, and other pasture grasses. Since it could not be economically controlled in pastures with insecticides, in July, 1954, 800 of the *Anagyrus* parasites were released near Clewiston. The initial release was made of free-living adults, and subsequent releases by placing stems of grasses infested with parasitized scales about infested pastures. In the area where the first releases were made it is now difficult to find Rhodes-grass scales. The parasite has spread over an area of several square miles. No release has failed to result in establishment of the parasites. The continued dissemination of this parasite should help solve the Rhodes-grass scale problem in southern Florida.

Sugarcane insects.—Recent studies in cooperation with the Florida Agricultural Experiment Station indicate that the difference in method of harvesting sugarcane in Florida and Louisiana may be responsible for differences in sugarcane borer populations. In southern Florida it is customary to burn the foliage in the field before it is cut. This burning produces high temperatures that result in destruction of the borer. By the use of a maximum thermometer, temperatures inside stalks were obtained in cane fields as they were burned. Inside stalk temperatures ranged from 125° to 190° F. Immersion of living fourth- and fifth-instar

larvae in water for 2 minutes at 125° and for 1 second at 190° resulted in 100 percent mortality.

Studies on biological control of the sugarcane borer, which were begun in 1915, consisted in the colonization of large numbers of the Cuban fly, *Lixophaga diatraeae,* in Louisiana. Liberations of this parasite in Florida were started in the thirties. The climate and cultural practices in southern Florida are much more favorable for parasite survival than those in Louisiana. The Cuban fly became well established in the State. However, even here the occasional frosty winter periods kill large numbers of this parasite, with consequent low parasitization the following season. At Fellsmere the average parasitism of the borer by the Cuban fly was 69 percent in 1957 but only 9 percent in 1956. Surveys made in the spring of 1958 revealed no living Cuban flies. The mortality was attributed to the severity of the past winter.

Biological-control studies are also being carried on with the yellow sugarcane aphid. In May of this year over 10,000 ladybugs, lacewings, and hymenopterous parasites received from Moorestown were released in cane fields to explore their possibilities in control of this aphid.

Work is also being done in cooperation with the Florida Agricultural Experiment Station to develop varieties resistant to sugarcane insects and to find better insecticides for control of the sugarcane borer and soil insects attacking sugarcane.

White-fringed beetle.—The white-fringed beetle was first found in the United States in a peanut field in Okaloosa County, Florida, in 1936. Much of the research on control methods for this pest has been done at the Division's Florala, Alabama, laboratory. These methods have been used with considerable success in Florida and other Southern States.

Hoja blanca.—After the discovery of hoja blanca on rice in Florida in 1957, our entomologists began making rather extensive collections of leafhoppers and other insects on rice. The only known vector of this disease is the leafhopper *Sogata orizicola,* a species found in Florida but not in abundance.

Corn earworm.—In cooperation with the Central Florida Experiment Station at Sanford a study was made in 1957 on the effect of different sweet corn plant types on earworm control by power spraying. No significant differences were found due to plant type under the unfavorable weather conditions prevailing. Work was also carried out at Belle Glade on the evaluation of sweet corn inbreds and hybrids for earworm susceptibility, and a promising Texas sweet corn hybrid was found to have both earworm and Helminthosporium resistance.

Fruit and Vegetable Insects Research Branch

Citrus scales and mites.—Work on insects and mites affecting citrus is carried on in Orlando, Florida, and Whittier, California, and supplements that of the Florida Experiment Station at Lake Alfred. In Florida the chief concern is the purple scale and several kinds of mites. There have been important contributions (1) in the development of spray schedules for the safe and effective use of parathion and malathion for scale control, (2) in the measurement of the early coloring and quality of citrus

sprayed with these materials as compared with that sprayed with oil, and (3) on the determination of residues in the fruit at harvest following their use in various schedules. These phosphorus insecticides, widely used for controlling mites on other crops, are ineffective against mites infesting citrus, and spray schedules in which they are included must be fortified with a miticide. There have been important contributions, too, in the evaluation of the new miticides and of combinations of them with materials used to control scale insects, so that it will not be necessary to make separate applications. This work has already led to the recommendation of dinitro insecticides, ovex, and Aramite for mite control, and other materials are showing promise. The systemic insecticides, demeton and schradan, have been found to be most effective against scale insects and mites when applied as full-coverage sprays.

In California there are under way basic studies of interest to Florida on factors that influence populations of the citrus red mite and on its development of resistance to miticides such as ovex and demeton. These studies have been made possible by the development of a technique for rearing this mite continuously under controlled conditions in the laboratory.

Biological control of citrus pests.—Biological-control studies have been largely exploratory to determine the beneficial species involved, the factors responsible for their effectiveness, and the feasibility of nonspray control programs. Limited releases of recently introduced beneficial coccinelids have been made, but establishment has not yet been found. There is particular interest in determining whether it is feasible for growers generally to adopt a nonspray program, and in developing recommendations for changing groves to such a program. Recently a Division entomologist with wide experience in biological control has gone to Lake Alfred to work with the entomologists of the Florida Experiment Station. Such a joint effort will undoubtedly accelerate the procurement of information on the basic factors involved in the biological control of citrus pests in Florida and of a practical way for growers to integrate natural and chemical control. Important beneficial species not already present will be introduced and colonized, and special attention will be given to the selection of pesticides that can be used to supplement the biological control with the least harmful effect on the beneficial forms.

Insect vectors of citrus diseases.—Research on the insect vectors of citrus diseases has been largely concerned with tristeza and has led to the incrimination of the spirea, cotton, and black citrus aphids as vectors. Experiments are under way to determine if insects are vectors of such diseases as xyloporosis, exorcortis, and blight.

Mediterranean and other fruit flies.—The recent "Medfly" eradication program in Florida focused attention on the research being conducted on fruit flies in Hawaii and Mexico. There is no doubt concerning the importance of the work on fruit flies at those field stations to the success of that program. That research provided valuable information on the status of important crops as hosts, and made possible the recommendation of ethylene dibromide fumigation to permit the normal movement of hosts maturing in infested areas. It also led to the recommendation of improved attractants for bait traps used to determine the area and intensity of infestation and effectiveness of the spray program. Moreover, the mala-

thion bait spray was found effective against the "Medfly" when dispersed from airplanes. An important early development during the eradication campaign was a plastic trap and a dry bait for use in such a trap. Technical advice was furnished on application schedules, insecticide formulations, proper type of spray coverage, and on trap placement and operation. When the protein attractant in the bait spray was in short supply, a suitable substitute was recommended. When the supply of the angelica seed oil attractant, depended on in the trapping program, was inadequate, research of chemists and entomologists in the Division led to the discovery and use of a synthetic substitute.

There is continuing in Hawaii work on all phases of fruit fly problems. The status of questionable and borderline hosts is being further evaluated, and improved and safer commodity treatments are being sought. A strong screening program for more attractive baits and for more desirable insecticides in the bait spray is being continued. The sterilization of males by irradiation is being considered as a possible means of eradicating incipient infestations of the "Medfly."

Pecan insects.—Work on pecans is carried on at Monticello in cooperation with the Florida Experiment Station, and also in Georgia and Louisiana. Important recent findings are that DDT and toxaphene are effective against the pecan weevil, an insect for which there was previously no satisfactory control; that many of the new insecticides, such as DDT, parathion, malathion, EPN, and Guthion, are much more effective against the pecan nut casebearer than the lead arsenate and nicotine sprays used previously; and that EPN and Guthion are fairly effective in preventing late-season damage by the hickory shuckworm, an insect for which there has been no effective control. Since neither EPN nor Guthion prevents early-season shuckworm damage and schedules may be too expensive for use against late-season damage, there is interest in exploring other methods of control. Therefore, studies on the flight habits of shuckworm moths and a screening program for attractants for possible use in bait sprays have recently been undertaken at Monticello.

Southern potato wireworm and cabbage looper.—The work on potato and cabbage insects at our Charleston, South Carolina, station is of special interest to Florida growers, particularly in the Hastings area where there has been so much difficulty in the control of the southern potato wireworm and the cabbage looper. The Charleston station cooperates with the Florida Potato Investigations Laboratory at Hastings.

The southern potato wireworm is now the major wireworm pest in vegetable-growing areas of the Southeastern States. Unlike the common Gulf Coast wireworm, this new pest has two generations a year. In experiments during 1956 with various chlorinated hydrocarbons, only DDT gave worth-while control. Consequently, in 1957, DDT at 20 pounds per acre was widely used in South Carolina. However, the results were variable. Studies during 1957 indicated that parathion at 2 pounds per acre would be more effective.

A screening program has been initiated at Charleston, in which the more promising new insecticides and nematocides are tested in the laboratory for toxicity to this wireworm. A large number of insecticides are also being tested in small-field plots for toxicity to the cabbage looper.

Tobacco insects.—In studies on tobacco in the Carolinas and Florida emphasis is given to methods of controlling insects without leaving insecticide residues on the leaf or in the soil. In North Carolina the biology and ecology of tobacco insects is being studied with emphasis on predators, parasites, and diseases. It has been indicated that *Polistes* wasps may be utilized to reduce the need for insecticides against hornworms. Encourging results have also been obtained by spraying the plants with cultures of the spore-forming bacterium *Bacillus thuringiensis.* Under some conditions control with this disease has compared favorably with that obtained with the most effective insecticides, but under other conditions not well understood the disease has not been so effective.

A search is also being made for suitable substitute insecticides to combat tobacco insects. Materials now recommended include parathion, endrin, DDT, and TDE, but although effective, they leave objectionable residues. As a substitute for parathion in the control of the green peach aphid in Florida, 3-percent Phosdrin dust has given good protection on shade-grown tobacco when applied once a week. There is evidence that excess dosages might injure the tender wrapper leaves. Thiodan has also given promising results against the aphid as well as against hornworms and other tobacco insects. Residues of Thiodan are less objectionable than those of the insecticides now in use. It appears to be effective against green June beetle larvae and earthworms in tobacco seed beds as well as against insects that feed on the foliage. The cabbage looper, a relatively new pest of tobacco, is controlled with endrin.

Investigations in cooperation with industry have shown that the usual accumulations of the recommended insecticides in soils will not lower the quality or yield of tobacco, except possibly where crop rotation is not practiced. Endrin, demeton, BHC, toxaphene, aldrin, dieldrin, and EPN can be applied to cotton foliage at the recommended dosages without danger that residues in the soil will affect the taste or flavor of subsequent crops of tobacco.

Insects Affecting Man and Animals Research Branch

Research on insects affecting man and animals has been of vital concern to the State of Florida for many years. In 1930 a Federal laboratory was established at Orlando which was concerned primarily with the biology and control of mosquitoes, especially the salt-marsh species. Early in 1942 the research program was expanded to include other pests of medical importance, including lice, ticks, fleas, flies, and chiggers. This expansion was necessary to fulfill the needs of our military services for repellents and insecticides to control medically important pests in overseas areas. However, most of these pests were problems in Florida, and research advances therefore were applicable over the State and also to other States.

Mosquitoes.—Early research on mosquitoes included taxonomy, biology, and eliminative control methods. The results were compiled in "Mosquitoes of the Southeastern States" a Department of Agriculture publication that has been of immense value to mosquito workers. Incidentally, Drs. King, Bradley, and Smith are working on an extensive revision of this publication.

The first and foremost accomplishment of the Orlando laboratory was, of course, the development of DDT for use in mosquito control. Research in 1942 showed that extremely small amounts of DDT would provide effective control of larvae and adults in their natural habitats. Airplane and ground equipment was developed for applying it over large areas. Thus, for the first time in history weapons were available for abating the mosquito nuisance in Florida and other problem areas.

Another significant contribution was the residual treatment of homes with DDT for the control of malaria. This discovery hastened the eradication of malaria in the United States, and its widespread application has brought about drastic reductions and elimination of the disease in some of the most malarious areas in the world. Lindane and BHC proved to be effective against DDT-resistant mosquitoes and were used extensively. However, recognizing that resistance to these materials was certain to develop, the search was continued and several promising organic phosphorus materials were found. One of these, malathion, has now been used in Florida for several years and is still giving good results, especially against adults. Diazinon and several other phosphorus compounds have also proved effective as larvicides and adulticides. In recent tests a new class of insecticides, the chrysanthemumic acid esters, has shown promise. Several of the phosphorus and chrysanthemumic compounds have shown exceptional promise for residual treatments of homes and are currently being tested under practical field conditions.

House flies.—During the war years the use of DDT in space and residual sprays, and as aerosols, was developed for fly control. This use was of great value in Florida and also in all areas where fly-borne diseases are a serious public health problem.

After several years flies became resistant to DDT, and it was necessary to find new insecticides for control. Chlordane, lindane, and several other chlorinated hydrocarbons were found to be effective, but flies became resistant to them within a year or two. Thus, by 1950 we had nothing to combat flies except pyrethrum. Special emphasis was placed on the development of baits containing organic phosphorus insecticides. This research led to a TEPP-molasses formulation which could be sprinkled on the floors of barns and other premises, and later to several granular baits which could be broadcast. These baits were very effective and convenient to use, and were soon being marketed all over the country.

Residual insecticides, such as malathion and Diazinon, are now widely used for fly control. Unfortunately, once again the specter of resistance has reared its ugly head and we apparently will soon need substitutes for the organic phosphorus compounds. However, we are confident that research will produce new insecticides which will enable us to combat the house fly problem in the future.

Fleas.—Research at Orlando showed that DDT was far more effective against fleas than either pyrethrum or rotenone. Other chlorinated hydrocarbon insecticides, including lindane, were also found useful, and methods of controlling fleas in yards, pens, and kennels were devised. When fleas became resistant to these insecticides, further experiments demonstrated the usefulness of organic phosphorus compounds, especially malathion and Diazinon.

Cockroaches.—In recent years the search for good cockroach killers has been intensified, primarily because a resistance problem exists with the German roach. Several colonies of this roach at Orlando are strongly resistant to chlordane and dieldrin. Our research has shown some resistance also to lindane, but the biggest surprise is a measurable amount of resistance to synergized pyrethrins. This discovery, made at Orlando, has special importance, since there was hope that if insects became resistant to modern insecticides we could return to plant derivatives.

In addition to laboratory and field tests with promising cockroach toxicants, our entomologists are studying roach repellents. Several compounds have shown excellent repellency in laboratory tests, and soon some of these will be field-tested in an area of substandard housing.

Repellents.—Today, largely because of the research done at the Orlando laboratory, we have several excellent repellents, including diethyltoluamide, ethyl hexanediol, dimethyl carbate, dimethyl phthalate, Indalone, and butyl ethyl propanediol. Through their use our men in the Armed Forces overseas are being protected against vectors of malaria, dengue, yellow fever, scrub typhus, and other arthropod-borne diseases. For the first time fishermen in areas where salt-marsh mosquitoes thrived could obtain protection for hours by a single application of repellent. Research at Orlando had selected compounds for repellency not only against mosquitoes, but also against ticks, fleas, chiggers, and various biting flies. Repellents have been developed for application to the bare skin, and also to clothing.

Screw-worm.—Although the Florida cattle industry is beset with many insect problems, the Entomology Research Division has conducted research on only a few of them. The greatest effort has been devoted to the screw-worm fly. Research has been centered on eradication through the release of males sterilized by exposure of the pupae to radiation from a cobalt-60 source. Field trials of the method were initiated about 1951 on Sanibel Island. Later the method was used to eradicate the screw-worm on the island of Curaçao. Following this successful demonstration, work was undertaken to obtain a low-cost larval medium and to improve rearing methods. These advancements were tested on a 2,000 square mile area in Florida last year as a dry run to the eradication attempt. Now, as you all know, the eradication effort has been under way about six months and the results look very promising. Recent reports by the Animal Disease Eradication Division indicate that no screw-worms have been found north of Orlando for several months, and infestations have been drastically reduced over the rest of the State. This reduction has been accomplished with releases of 10 to 14 million sterilized flies per week. Now the excellent Sebring facilities are in operation and about 50 millions of flies per week are being reared, sterilized, and released. Everyone concerned with this program is optimistic over the possibility of achieving eradication of the screw-worm, which has caused losses to southeastern cattle raisers as high as $20 million a year.

Pioneering Research Laboratories

I believe the members of this Society will also be much interested in knowing that the Agricultural Research Service has established at Belts-

ville two pioneering research laboratories in the Entomology Research Division, namely, an Insect Physiology Laboratory and an Insect Pathology Laboratory. The objective is to provide a steady stream of scientific knowledge and facts to meet the over-all objectives of ARS research programs. The laboratories are being equipped with modern instrumentation and staffed with only the most capable research scientists, who will make explorations into unknown fields. These scientists are freed of practically all administrative responsibilities and can pursue investigations without special regard to their applicability to economic problems. In other words, they will not be working on any crisis insect-control problems necessitating investigations toward definite economic goals. The establishment of these laboratories will not reduce the amount of basic entomological research investigations to be undertaken at our field laboratories.

Research in the Insect Physiology Laboratory is to include physiological and biochemical studies on insect growth, development, sensory perception, reproduction, and the utilization and fate of essential metabolites. Comparative studies with insects and mammals concerning the intoxication and detoxication systems involved in insecticide and synergist mode of action, and investigations on the biochemical and physiological bases of insect resistance to insecticides will also be conducted. The overall goal is to obtain information on the normal physiological and biochemical processes of insects, including the action of insecticidal compounds on these processes.

Research in the Insect Pathology Laboratory is to be on the fundamental nature of pathogenic microorganisms associated with insects. Fundamental studies will be made of entomogenous microorganisms and the environmental conditions under which they are capable of causing epizootics in insect populations. The insect pathologists will determine the type of pathogens involved, the conditions under which pathogenic organisms of various kinds are responsible for epizootics in insect populations, and methods of culture for possible practical application.

It is envisioned that the results of research obtained by these pioneering research laboratories will eventually be of great help to entomologists in Florida and throughout the Nation in meeting some of the complex insect problems facing our profession today.

Make plans now to attend the

42nd ANNUAL MEETING OF THE

FLORIDA ENTOMOLOGICAL SOCIETY

in Miami on September 10 and 11.

COMPARISON OF FIELD CORN VARIETIES FOR RESISTANCE TO CORN EARWORM AND STORED GRAIN INSECT INJURY IN THE EVERGLADES [1, 2]

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The literature on resistance of field corn varieties to attack by various insects has been extensively reviewed by Painter (1951, 1958). Dixie 18 has been described as the leading yellow hybrid of the southern United States and possessing resistance to both the corn earworm, *Heliothis zea* (Boddie), and the rice weevil, *Sitophilus oryza* (L.) (Douglas and Eckhardt, 1957). Although Dixie 18 has been recommended and used widely throughout most of Florida (Horner, 1954), Corneli 54 has been found to be agronomically superior in south Florida and is widely used (Green, 1956; Green, Forsee, Thames, and Boyd, 1957). Green *et al* reported that Corneli 54 has much more resistance to corn earworm attack than Dixie 18 or Big Joe and is about equal in resistance to Francisco Flint. Horner recognized that although Dixie 18 was adaptable to north Florida, it was not suitable for south Florida. He presented no data on resistance to attack by insects.

The authors conducted their studies on established varieties in an effort to find a variety suitable for cultivation in south Florida. Adaptability from the standpoint of insect attack was studied and the varieties were compared as to origin and yield of grain corn in bushels per acre (Table 1).

Two field experiments were conducted in 1957 to compare several varieties (Table 1) for adaptability to culture in the Everglades. This included a study of varietal resistance to corn earworm and stored grain insect attack. The only stored grain insect causing noticeable damage was the rice weevil.

Seed for the first experiment was planted on February 8 and that for the second on February 13, 1957, on Everglades peaty, muck soil that had been planted in corn every year for the preceding 15 years. Aldrin was applied for wireworm control at the rate of 5 pounds per acre before planting. Budworms were controlled by one application of DDT, 25% emulsion concentrate at 1 quart, and two applications of toxaphene, 40% wettable powder, at 2½ pounds per acre in 100 gallons of water. No insecticides were applied after the corn began to silk.

Each plot consisted of a single 50 foot row. The rows were spaced three feet apart and plants were spaced one foot apart in the row. Each variety was replicated six times in each planting. Nine varieties were compared in the first planting and ten were compared in the second. Six of these varieties were compared in both experiments.

The corn from both plantings was harvested, husked, and stored in mesh bags on July 24 in an open bin where it remained for approximately 6½ weeks before it was examined for corn earworm and stored grain

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[1] Florida Agricultural Experiment Station Journal Series, No. 784.

[2] The authors wish to thank Mr. C. E. Seiler and Mr. Robert Kent for assistance in evaluating the insect damage and Mr. Edward King, Jr., for preparing the graphs.

insect damage. Varieties from the earlier planting were examined on September 9; those from the second planting were examined on September 6.

TABLE 1. VARIETIES OF CORN USED IN STUDY OF INSECT INJURY. BELLE GLADE, 1957.

Variety Name	Breeding Origin *	Origin, Country	Grain Yield, Bu./ft. U.S. No. 2
Corneli 54	Hyb.	Cuba	83
Cueto 56	Hyb.	Cuba	81
Funk G-737A	Hyb.	USA (La.)	83
Funk G-740	Hyb.	USA (La.)	77
Rocamex H-503	Hyb.	Mexico	69
Dixie 18	Hyb.	USA (Fla.)	59
U. S. 625	Hyb.	USA (Md.)	90
U. S. 626	Hyb.	USA (Md.)	87
U.S. 645	Hyb.	USA (Md.)	99
DeKalb 1051	Hyb.	USA (Ill.)	58
Big Joe	Syn.	USA (Fla.)	70
Tiquisate	O.P.	Guatemala	66
Francisco Flint	O.P.	Cuba	59

* Hyb.—Double Cross Hybrid; Syn.—Multilined Synthetic; O.P.—Open-Pollinated Variety.

A sample of 25 ears was taken from each plot. Each ear was assigned two injury index numbers (0-5), one to indicate degree of earworm injury and the other to designate the extent of stored grain insect damage. The only stored grain insect that appeared to be damaging the corn was the rice weevil. An average index was computed for each plot and each insect species and multiplied by 100. The indexes were then analyzed statistically. The highest possible index, 500, would indicate the greatest amount of damage that would occur from either insect.

The index numbers for corn earworm damage were assigned according to the method of Walter (1948). Damage at the side of the ears from earworms penetrating through the husks was practically non-existent and was not included to obtain the indexes in this report. The system used to indicate the degree of rice weevil damage was arbitrarily established at the time of examination. Both indexing systems are shown in Table 2.

Although the percentage of infested or uninfested ears was obtained for each insect and variety, it is not presented, as this criterion has been found inferior to the indexing system for comparisons of varieties for earworm resistance (Harris, 1958). The two criteria were not compared for stored grain insect damage.

VARIETIES AND EARWORM DAMAGE. In the first planting the flinty Cuban varieties, Cueto 56 (a double-cross hybrid) and Francisco Flint (an open-pollinated selection), had significantly less earworm damage than Rocamex H-503, a white dent variety from Mexico, and Big Joe, a multilined synthetic variety released at the Everglades Experiment Station in

TABLE 2. INDEXES FOR SHOWING THE DEGREE OF INSECT DAMAGE TO FIELD CORN EARS.

Index	Corn Earworm Damage to Tip of Ear	Stored Grain Insect Damage
0	None	None
1	Tip of ear only	1-10 kernels
2	½" below ear tip	11-20 kernels
3	1¼" below ear tip	21-30 kernels
4	2½" below ear tip	31-40 kernels
5	More than 2½" below ear tip	40 or more kernels

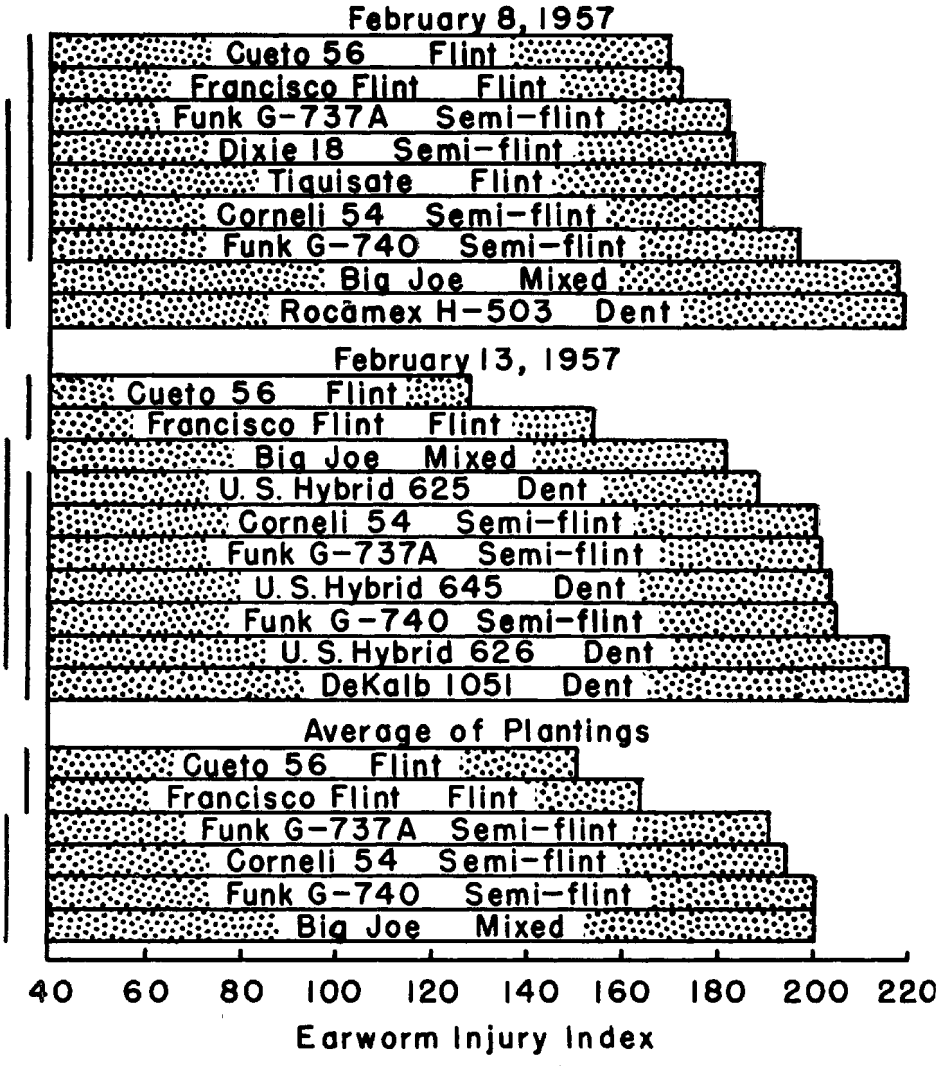

Fig. 1. Corn earworm damage among field corn varieties. Varieties joined by one of the vertical lines on the left side of the graph are not significantly different; those not joined are significantly different.

1943 (Figure 1). Big Joe can be expected to yield approximately equal numbers of flinty, semi-flinty, and dent ears.

In the second planting Francisco Flint and Cueto 56 had significantly less earworm damage than any other variety (Figure 2). Big Joe ranked next but was not significantly better than any other variety except DeKalb 1051, a dent corn from Illinois.

The data from the two plantings were grouped to compare the six varieties that were contained in both (Figure 3). Francisco Flint and Cueto 56 had significantly less earworm damage than the semi-flint Funk double-cross hybrids G-737A and G-740, Corneli 54 (the semi-flinty Cuban double-cross hybrid widely used in south Florida), and Big Joe, the Everglades Experiment Station synthetic variety that was widely used before the introduction of Corneli 54.

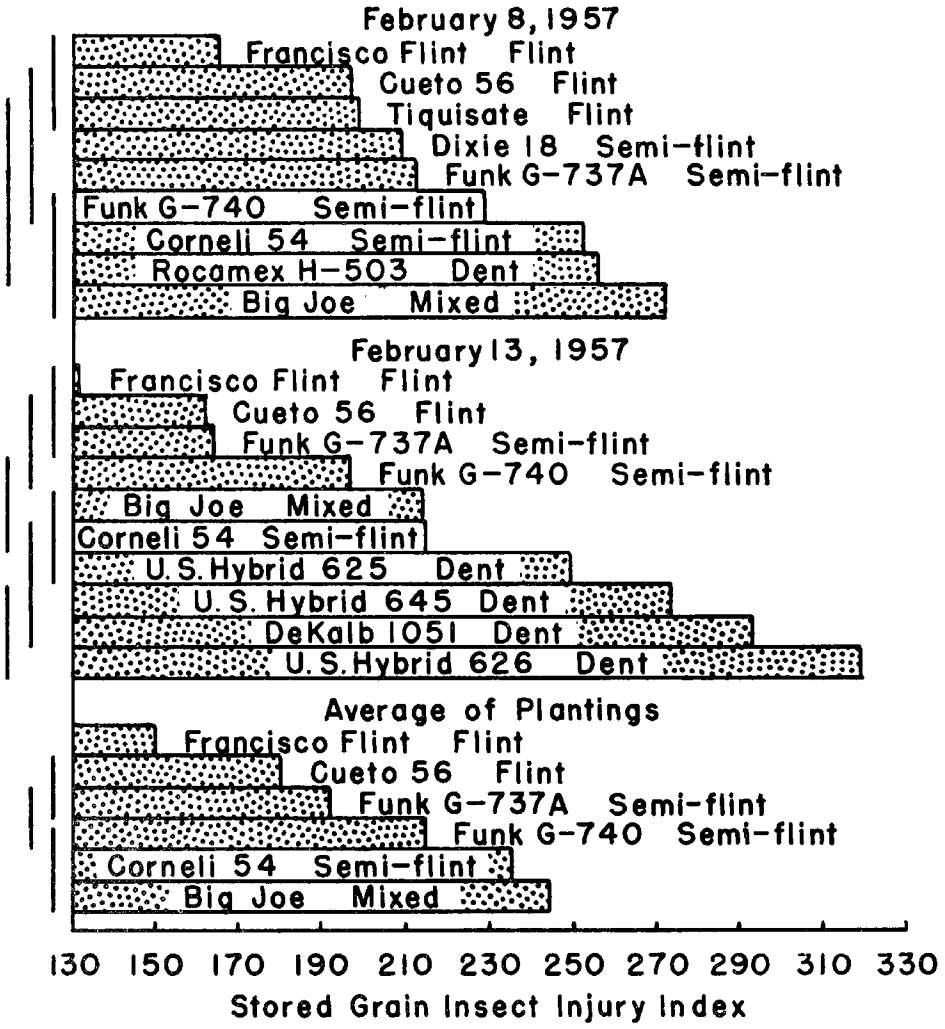

Fig. 2. Rice weevil damage among field corn varieties. Varieties joined by one of the vertical lines on the left side of the graph are not significantly different; those not joined are significantly different.

VARIETY AND RICE WEEVIL DAMAGE. Francisco Flint had significantly less rice weevil damage than all other varieties except Cueto 56, Tiquisate (an open-pollinated variety from Guatemala), and Dixie 18 (the double-cross hybrid grown widely in the southeast and north Florida) in the first planting (Figure 4). Cueto 56 had significantly less earworm damage than Corneli 54, Rocamex H-503, or Big Joe.

In the later planting Francisco Flint had a significantly more resistance to rice weevil damage than all other varieties except Cueto 56 and Funk G-737A (Figure 5). Cueto 56 and Funk G-737A were significantly better than all varieties other than Funk G-740, which was significantly better than four dent varieties: U. S. hybrids 625, 645, and 626, and DeKalb 1051.

Among the six varieties that were common to both plantings, Francisco Flint had a significantly lower degree of damage than the others. Cueto 56 ranked next and was significantly better than all other varieties except Funk G-737A. Funk G-737A had a significantly lower degree of damage than Corneli 54 or Big Joe.

CORN EARWORM AND RICE WEEVIL DAMAGE RELATED. In these tests there was a tendency for the varieties to be ranked similarly for corn earworm and rice weevil damage. In both plantings there was a highly significant correlation among the variety average indexes for earworm and rice weevil damage. There are probably at least two causes for this. Perhaps the same variety characteristics caused resistance or lack of resistance to both corn earworms and rice weevils, or earworm damage could make ears more readily accessible to the rice weevil as suggested by Douglas and Eckhardt (1957).

KERNEL HARDNESS AND INSECT DAMAGE. There seems to be a definite tendency for the degree of corn earworm or rice weevil damage to be lower among the flint corns and higher among the dent varieties, with the semi-flint corns occupying an intermediate position. This tendency seems to be greater for rice weevil damage than it is for corn earworm damage. Dicke and Jenkins (1945) reported that resistant corns which they worked with had hard, starchy kernels and that resistance was not always found in long-husked strains. The only variety in the present study that possessed a long-husked ear was Dixie 18.

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SUB-TROPICAL BRANCH, FLORIDA ENTOMOLOGICAL SOCIETY

Sixteen people attended the monthly meeting of the Sub-tropical Branch at the South Miami Community Hall on February 11, 1959.

Our speaker for the evening was Dr. Lowell D. Uhler, Professor of Biology, Department of Entomology, Cornell University. His topic, "The Life History of the Goldenrod Ball Gall, *Eurosta solidaginia* Fitch," proved to be very interesting and informative to the group.

CHARLES C. HILL
Secretary-Treasurer

A NEW GENUS OF MITES OCCURRING IN FLORIDA AND MEXICO (ACARINA: CALIGONELLIDAE)

DONALD DE LEON

Pensacola, North Carolina

The mite described here is an unusual raphignathoid in that it has exceptionally long body setae and its eggs are fastened to the ends of stalks.

Xenocaligonellidus, n. gen.

Caligonellids nearly circular in dorsal view; idiosoma without striae; many of the dorsal body setae nearly as long as or longer than width of body and with some of the dorsal body setae short and coarse; two pairs of eyes; anus ventral in female; tibial claw of palpus represented as a slender seta.

Type species: *Xenocaligonellidus ovaerialis*, n. sp.

Xenocaligonellidus ovaerialis, n. sp.
(Figures 1-6)

FEMALE: Body and legs red, dorsal body setae black; idiosoma somewhat depressed, nearly circular in dorsal view. Stylophore broad at base, fixed digit slender, sharply pointed. Peritremata extending from near bases of movable digits, Ω-shaped, short celled. Palpus 5-segmented, the tarsus longer than the tibia, with a basal sensillum and with setae as shown in figure 4. Idiosoma smooth above, striate below in parts, with ten pairs of whiplike setae most of them nearly as long as to much longer than width of body and five pairs of short (36-72 microns), coarse, distally spinose setae on dorsum; three pairs of genital setae and three pairs of anal setae, the caudalmost pair of anal setae very much longer (about 65 microns long) than the others; anus ventral. Legs relatively short and heavy, legs I-IV (from base of femur to end of claw) 123, 116. 109, and 126 microns long respectively, sensilla and setae as shown in figures 1-3. Length of idiosoma 217 microns, width 225 microns.

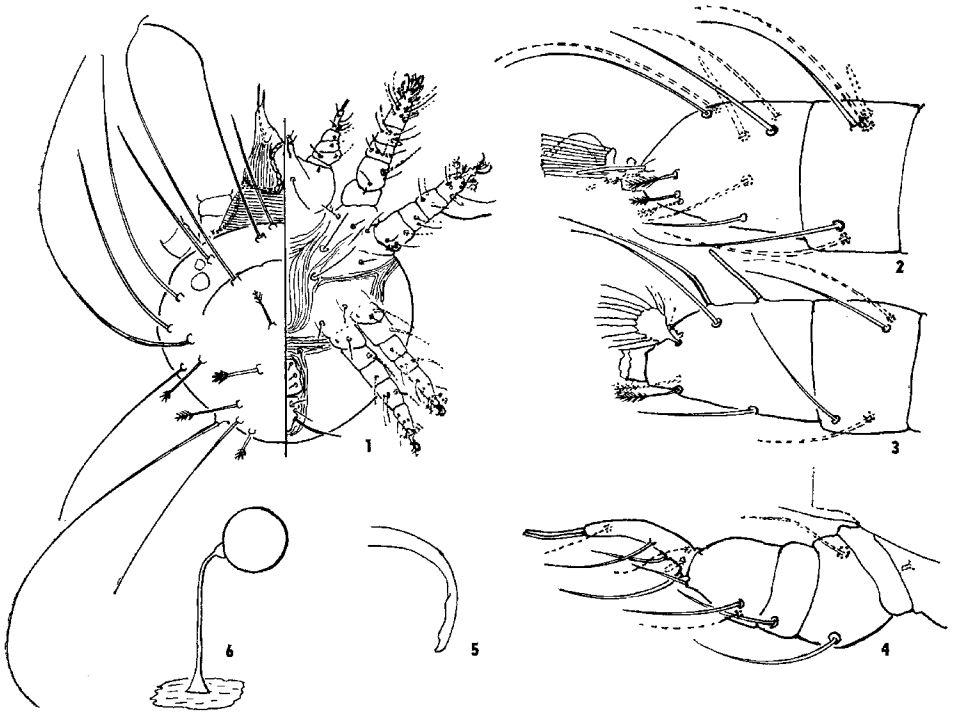
MALE: Resembles female, but dorsum with nine pairs of long whiplike setae, three pairs of rather short (45-55 microns), coarse, distally spinose setae and two pairs of short, weakly bracteate rather coarse setae, the anterior pair about twice as long as the posterior pair; three pairs of anal setae the caudalmost pair the longest; anal pore terminal; aedeagus of shape shown in figure 5. Tarsi I-IV each with a sensillum, the sensilla 18, 20, 9, and 10 microns long respectively, tapering slightly to tips. Length of idiosoma 157 microns, width 168 microns.

NYMPH: Resembles female, but dorsum with seven to eight pairs of long whiplike setae; caudalmost pair of anal setae about twice as long as female's.

LARVA: Resembles nymph, but dorsum with six pairs of long whiplike setae and four pairs of short, distally spinose setae; caudalmost pair of anal setae about as long as long dorsal setae.

EGG: Red, nearly round, about 25 microns in diameter; attached to the distal end of an erect stalk about 75 microns long.

Holotype: Female, Coral Gables, Florida, April 11, 1956, (D. De Leon) from *Quercus virginiana*. *Paratypes*: Two males, two females, two nymphs, 20 larvae, same data as for holotype and on same slide; two females, two larvae, December 27, 1955, other data as for holotype; one female, April 1, 1956, other data as for holotype; one male, one larva, Coral Gables, February 21, 1956, from *Persea borbonia*. Additional specimens were collected at Coral Gables, May 8, 1956, from *Celtis laevigata* and at San Blas, Nay., Mexico from avocado, *Inga laurina*, and several unidentified plants during April and May, 1957. Although the Mexican specimens are somewhat larger and the first two medial pairs of distally spinose setae are somewhat longer (61 and 65 microns against 45 and 55 microns respectively) than the Florida specimens, the differences do not appear to be specific.



Explanation of Figures

Xenocaligonellidus ovaerialis, n. sp.: Fig. 1, view of female (left half dorsal, right half ventral); Fig. 2, tibia and tarsus of leg I of female; Fig. 3, tibia and tarsus of Leg II of female; Fig. 4, palpus of female; Fig. 5, aedeagus; Fig. 6, egg.

These are slow moving mites which are generally found on twigs and often lay their eggs in clusters—21 eggs having been observed in one group. A colony was kept for a period of five weeks without any indication of predatory habits; at times the mites seemed to be probing the bark surface, but if they were feeding what they were feeding on could not be

determined. The distally spinose dorsal setae frequently bear what appear to be droplets of liquid on the distal ends.

Paratypes of the new species will be deposited in the University of Florida Collections, Gainesville; the type and remaining paratypes are in the author's collection.

The mite is placed in the Caligonellidae primarily because the peritremata enter the stylophore, extending caudad from the bases of the movable digits to the base of the stylophore; it lacks, however, the "thumb-claw" complex, an important character of the family. Thus it seems advisable to modify the diagnosis of the family (Summers and Schlinger, 1955) to read "with or without a claw on palptibia" and to erect two subfamilies distinguished as follows:

> Palptibia with short stout claw; palptarsus with stubby specialized distal setae; anal pore terminal or sub-dorsal; body elongate: Caligonellinae, genera:—*Caligonella* Berlese, *Neostigmus* Willmann, *Molothrognathus* Summers and Schlinger, and *Coptocheles* Summers and Schlinger.
>
> Palptibia lacking claw, claw replaced by seta; palptarsus with elongate specialized distal setae; anal pore ventral in female; body very broadly oval to nearly circular in dorsal view; many of the dorsal body setae long and whiplike: Xenocaligonellidinae, genus:—*Xenocaligonellidus*, n. gen.

The genus *Neophyllobius* Berlese previously considered to belong in the Caligonellidae has recently been placed by Southcott in a new family, Neophyllobiidae Southcott, 1957.

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CHRYSOPIDAE ASSOCIATED WITH CITRUS IN FLORIDA [1]

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Entomologist, Citrus Experiment Station, Lake Alfred, Florida

The following annotated list of green lacewings, Chrysopidae, represents the present known fauna of this family in Florida citrus groves. Because of their large size and common occurrence these predators have received some emphasis during an intensive survey of the predators and parasites of citrus insects and mites. As is usually the case with such lists, incompleteness is to be expected but it is believed that the common species have been recognized.

Literature references citing species of Chrysopidae from citrus in Florida are rare. Hubbard (1885) recorded a trash-bearing species as *Chrysopa oculata* that apparently was the *C. cubana* Hagen listed here. In addition Hubbard suspected the existence of several species, one of which he stated was described as *C. citri* by Ashmead, listed here as *C. rufilabris* Burm. Hubbard erroneously thought, however, that all of the species had similar habits. Miller (1929) recorded two lacewings feeding on aphids, *C. harrisii* Fitch and *C.* sp. (near *lateralis*). The former possibly was the *C. interrupta* Schneid. listed here, but the latter may have been any of the several trash-bearing species included in the present paper. All recent records of lacewings have been reported as *C. lateralis* Guer. or *Chrysopa* sp. and have been references to predatory habits.

In the annotated list of species given below the original description of each species is cited from Bickley and McLeod (1956), intra-state and seasonal distribution are discussed, food habits on citrus noted and the life cycle, when known, summarized. Larval and adult characters for field identification are given. Distribution on citrus is discussed for the common species, otherwise records are cited. For ease of reference the species are listed alphabetically. A key for field identification of the known species is also included.

Acknowledgments are due the survey staff of the University of Florida Citrus Experiment Station at Lake Alfred for valuable assistance in obtaining geographic and seasonal distribution records. This staff headed by Dr. R. M. Pratt includes H. Holtzberg, K. Townsend, W. Davis, T. B. Hallam and L. Sutton. Thanks are also due Dr. W. E. Bickley who identified the species.

KEY FOR FIELD IDENTIFICATION OF CHRYSOPIDAE ON CITRUS

Adults

Large species with at least one dark spot near end of front wing.

- Distinct markings on mesothorax, none on prothorax, fig. 8. Hind wings with two spots—*Allochrysa virginica* (Fitch).
- Distinct markings on prothorax. Hind wings with one spot.
  - Mesothorax without markings, antennae dark, fig. 16—*Nodita pavida* (Hagen).

[1] Florida Agricultural Experiment Station Journal Series, No. 769.

Mesothorax with distinct markings, antennae light.
With a dark bar on interocular area, fig. 12—*Nodita floridana* (Banks).
With two dark spots on interocular area, fig. 18—*Nodita callota* (Banks).

Small species without a dark spot on front wing.
With a pale yellow longitudinal stripe on abdomen.
Antennae and last segment of palpi dark, fig. 14—*Chrysopa plorabunda* Fitch.
Antennae and last segment of palpi light, fig. 9—*Chrysopa interrupta* Schneider.
Without a pale yellow longitudinal stripe on abdomen.
Antennae dark.
Interocular area behind antennae mainly pink, fig. 6—*Chrysopa* sp. (undetermined).
Interocular area behind antennae mainly green, fig. 4—*Chrysopa cubana* Hagen.
Antennae light.
First segment of antennae with one dark stripe, fig. 1—*Chrysopa bimaculata* McClendon.
First segment of antennae with two dark stripes, fig. 3—*Chrysopa bicarnea* Banks.

Larvae (3rd Instar)

Naked larvae, first thoracic scoli short and indistinct, aphis lions.
Head striped from mandibles to prothorax, fig. 10—*Chrysopa interrupta* Schneider.
Head not distinctly striped, fig. 13—*Chrysopa plorabunda* Fitch.

Trash-bearing larvae, first thoracic scoli elongate and distinct, trash bugs.
First thoracic scoli very long, extending forward beyond front margin of head.
Head markings extensive, head mainly dark, fig. 15—*Nodita floridana* (Banks).
Head markings restricted, head mainly light, fig. 17—*Nodita pavida* (Hagen).
First thoracic scoli long, extending forward to eye line.
Maxillary palpi dark at tips, fig. 5—*Chrysopa* sp. (undetermined).
Maxillary palpi light at tips, fig. 2—*Chrysopa bimaculata*. McClendon.
First thoracic scoli short, head markings transverse, fig. 7—*Chrysopa cubana* Hagen.

Allochrysa virginica (Fitch)
Figure 8.

Chrysopa virginica Fitch, 1856, First Rept. Ins. N. Y., p. 91.

The adult of this large, handsome species is easily separated from all other green lacewings found on citrus in Florida by the presence of

two dusky spots on each forewing and the unusual mesothoracic markings shown in figure 8. Larvae have not been obtained or identified as yet.

To date only one specimen has been taken from citrus and nothing is known of its life cycle or food habits.

FLORIDA DSITRIBUTION: Bartow, September, 1956, one specimen.

Chrysopa bicarnea Banks
Figure 3.

Chrysopa bicarnea Banks, 1920, Bull. Mus. Comp. Zool. 64: 338-339.

Only two specimens of this species have been taken from citrus. It is possible that they were accidental occurrences. Adults seem to be very closely related to *bimaculata*. This species has the sub-lateral prothoracic markings very pale and further removed from the margin of the prothorax and the two stripes on the basal segments of the antennae extend some distance onto the surface of the head (figure 3). Larvae are unknown and the food habits and life cycle have not been determined.

FLORIDA DISTRIBUTION: Both specimens of this species were collected from the West Coast citrus area, one from Rubonia, the other from Palmetto.

Chrysopa bimaculata McClendon
Figures 1 and 2.

Chrysopa bimaculata McClendon, 1901, Psyche 9: 215.

Adults of this species are readily distinguished from other green lacewings found on citrus by the presence of a pair of light to deep red, sublateral, prothoracic stripes and pale yellow antennae bearing a single narrow, lateral red stripe on the basal segment (figure 1). Adults have a quick darting flight when disturbed. The eggs are a green to yellow white in color when laid. Larvae are trash-bearers and are easily confused with those of *Chrysopa* sp. (undetermined), but may be separated by the distally pale labial palpi and less distinct or extensive caudal head blotches (figure 2). Larvae have an extremely erratic, jerky, walking gait and are found primarily on the leaves and fruit.

The life cycle of *bimaculata* has been studied in the laboratory at 80° F. utilizing two different hosts as food. On Florida red scale, *Chrysomphalus aonidum* (L.), four of six larvae completed development to the adult stage in a maximum of 37 days and a minimum of 31 days. None of the adults survived beyond the first day. On six-spotted mites, *Eotetranychus sexmaculatus* (Riley), five of five larvae completed development to the adult stage in a maximum of 35 days and a minimum of 30 days. Adults survived on honey and water from one to three days. At 70° F. only four out of 16 larvae developed to pupation on a diet of cloudy-winged whiteflies, *Dialeurodes citrifolii* (Morg.), in a maximum of 50 days and a minimum of 27 days with none surviving to emerge. Additional studies must be conducted before the preferred host can be determined.

FLORIDA DISTRIBUTION: This species seems to occur throughout the citrus belt. More than thirty specimens are in the collection; each major citrus growing area is represented.

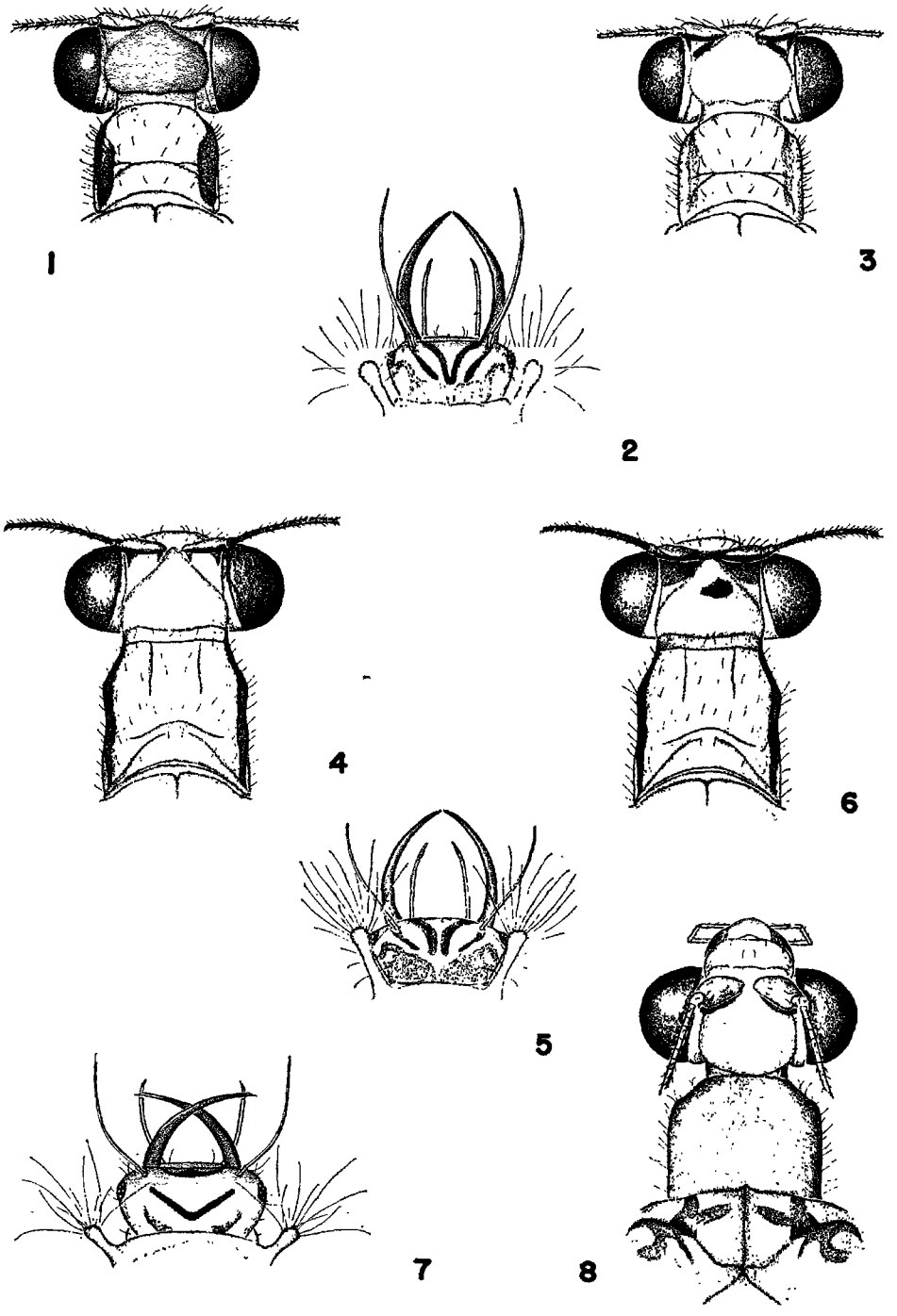

Plate I. Dorsal view of head and thorax of adult; fig. 1, *Chrysopa bimaculata* McClendon; fig. 3, *Chrysopa bicarnea* Banks; fig. 4, *Chrysopa cubana* Hagen; fig. 6, *Chrysopa* sp. (undetermined); fig. 8, *Allochrysa virginica* (Fitch). Dorsal view of head of third instar larva; fig. 2, *Chrysopa bimaculata* McClendon; fig. 5, *Chrysopa* sp. (undetermined); fig. 7, *Chrysopa cubana* Hagen.

Chrysopa cubana Hagen
Figures 4 and 7.

Chrysopa cubana Hagen, 1861, Smiths. Misc. Coll. 4: 215.

This species is the most common green lacewing found on citrus in the state. Adults are characterized by the presence of a pair of deep red to maroon, sub-lateral, prothoracic stripes, dark brown to black antennae that become lighter toward the distal end and one or two dark red sub-lateral stripes on the basal segment of the antennae (figure 4). Adults have a clumsy, fluttering flight when disturbed. The eggs are a light pearl grey when deposited. Larvae are trash-bearers and are distinctive, having all of the head markings extending transversely rather than longitudinally (figure 7). There are three dark transverse bars; one, somewhat curved, near the anterior margin of the head; a second, V-shaped, near the middle; the third, also V-shaped, with the basal part usually hidden by the prothorax. Larvae have a relatively smooth but erratic walking gait and are found primarily on leaves and fruit.

Laboratory life cycle and food-preference studies have been partially reported by Muma (1957). Although the species will feed and develop on several different food hosts, the most rapid development and more vigorous adults are produced on a restricted diet of Florida red scale and six-spotted mites. On these foods life cycles are completed in 32 and 30 days respectively resulting in large, active adults. Mites and armored scales were hosts used in the studies but soft-scales and mealybugs will have to be checked before the study can be considered complete, even for citrus groves.

FLORIDA DISTRIBUTION: This common green lacewing is distributed throughout the citrus growing areas of the state. Over 100 specimens are in the collection.

Chrysopa interrupta Schneider
Figures 9, 10, and 11.

Chrysopa interrupta Schneider, 1851, Mon. Chrysopae, p. 76.

In certain groves this species rivals *cubana* as the most common species. Adults are readily identified by red genae, red post-ocular spots, pale antennae and a median, white to yellow stripe that extends the entire length of the body (figure 9). Four specimens collected in the late fall and early winter have had pink blotches on the head and prothorax as shown in figure 11. Adults have a quick, darting flight when disturbed. The eggs are light, yellow-green in color. Larvae are naked aphis lions characterized by a pair of dark convergent head stripes (figure 10). They have a quick, flowing, undulate walking gait and to date have been found only on leaves and fruit.

Under laboratory conditions at 80° F. *interrupta* completes a life-cycle on Florida red scale in a maximum of 39 days and a minimum of 14 days. At 62° F. the maximum is 99 days and the minimum is 63 days. Larvae have been observed feeding in aphid and six-spotted mite colonies but the life cycle on these hosts has not been determined.

FLORIDA DISTRIBUTION: This common species is represented by more than 50 specimens in the collection. It is found throughout the citrus growing areas.

Chrysopa plorabunda Fitch
Figures 13 and 14.

Chrysopa plorabunda Fitch, 1856, First Rpt. Ins. N. Y., p. 88.

This species is easily confused with *interrupta* in the adult stage. It can be distinguished by the dusky antennae, pink spotted prothorax and light median stripe that does not extend anteriorly beyond the prothorax (figure 14). The eggs are yellow-green when laid. Larvae are naked aphis lions with the head distinctively marked with dusky spots and bars as shown in figure 13. They are more slender and move more rapidly than larvae of *interrupta*.

The life cycle has not been determined although larvae have been reared to the third instar on Florida red scale. Biological information available from literature indicates that the species feeds on mealybugs (DeBach and Fleschner, 1947), red spiders (DeBach and Fleschner, 1950), aphids (Davidson, 1914), and thrips (Essig, 1920). Putnam (1932) obtained an average life cycle of 31 days for the species when fed on oriental fruit moth eggs under insectary conditions.

FLORIDA DISTRIBUTION: Three specimens of this species are in the collection; one is from Lake Alfred, March 18, 1953, and two are from Weirsdale, December 20, 1956.

Chrysopa rufilabris Burmeister

Chrysopa rufilabris Burmeister, 1839, Handbuch der Entomologie 2: 979.

One female of the species was collected at a light in a citrus grove in 1953 and one larva was reared, but it is not known whether the species lives on citrus trees or on weed plants under the trees.

FLORIDA DISTRIBUTION: Lake Alfred, one specimen, March 18, 1953.

Chrysopa sp. (Undetermined)
Figures 5 and 6.

Adults of this lacewing are easily confused with those of *cubana*. This species may be identified by the pink color of the basal segments of the antennae which extends across the interocular area at the level of the antennae (figure 6). Adults have the same clumsy flight as *cubana*. Eggs of the species are light grey in color. Larvae are easily confused with those of *bimaculata*, but may be separated by the dark terminal segment of the labial palpi and darker, more extensive head blotches (figure 5). Larvae have the same jerky, erratic walking gait as *bimaculata* but most specimens have been found on limbs and trunks.

The life cycle of the species has been determined on Florida red scale. Development is completed in 25 to 28 days at laboratory temperatures. Nothing is known concerning food habits or preference of the species.

Adults of this species have been identified as *Chrysopa cubana* var. *sanchezi* Navas by Dr. William E. Bickley of the University of Maryland. Differences in head and thoracic color patterns and in behavior between larvae of this species and those of *C. cubana* Hagen have prompted its placement here in an undetermined status for the present. An attempt is presently being made to obtain a series of males of *cubana* and of this

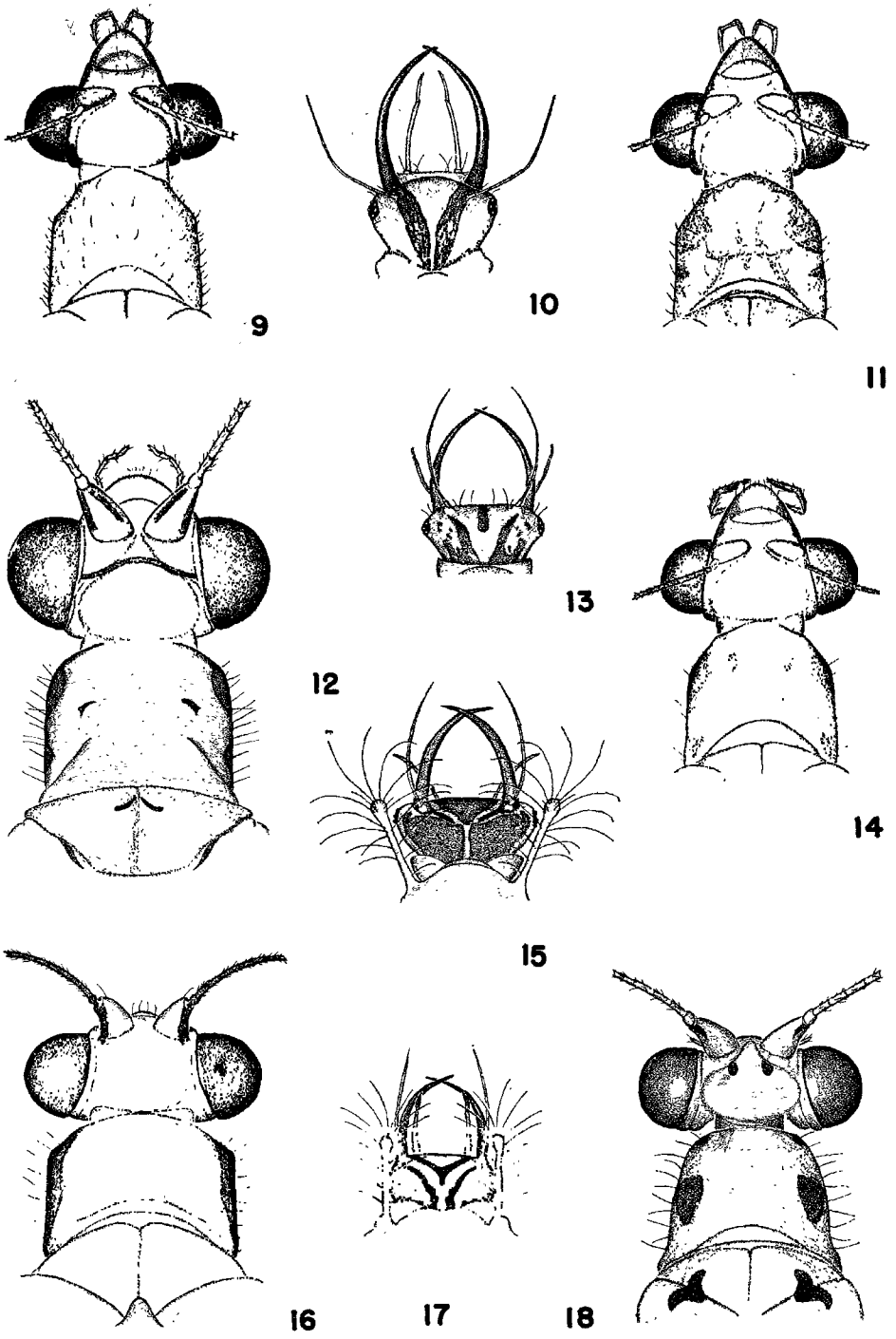

Plate II. Dorsal view of head and thorax of adult; fig. 9, *Chrysopa interrupta* Schneider, typical form: fig. 11, *Chrysopa interrupta* Schneider, variant; fig. 12, *Nodita floridana* (Banks); fig. 14, *Chrysopa plorabunda* Fitch; fig. 16, *Nodita pavida* (Hagen); fig. 18, *Nodita callota* (Banks). Dorsal view of head of third instar larva; fig. 10, *Chrysopa interrupta* Schneider; fig. 13, *Chrysopa plorabunda* Fitch; fig. 15, *Nodita floridana* (Banks); fig. 17, *Nodita pavida* (Hagen).

species for a systematic morphologic study of genitalia which may indicate its proper relationship with other species of the genus.

FLORIDA DISTRIBUTION: The species appears to be principally southern in distribution. Most of the 20 specimens in the collection are from southern citrus areas with the most northern being taken at St. Leo on November 31, 1956.

Nodita callota (Banks)
Figure 18.

Leucochrysa callota Banks, 1914, Proc. Acad. Nat. Sci. Phila. 66: 626.

Four adult specimens of this species have been taken from citrus trees. Adults are readily identified by the spotted-type of markings illustrated in figure 18. Larvae have not been collected or reared to determine the food habit or life cycle.

FLORIDA DISTRIBUTION: The four specimens in the collection are from central and southern citrus growing areas. Two are from Rubonia, January 16, 1956, one from Lake Placid, October 8, 1956, and one from Haines City, September 28, 1956.

Nodita floridana (Banks)
Figures 12 and 15.

Leucochrysa floridana Banks, 1897, Ent. News 8: 184.

In the adult stage this species is found more commonly on citrus than any other member of the genus. Larvae, however, have not been found on citrus trees to date. Adults are readily identified by the pale antennae, the basal segment of which is marked with two red to brown longitudinal stripes and a thin red to brown, transverse, interocular bar (figure 12). Adults have the same clumsy, fluttering flight as *C. cubana* Hagen but may be distinguished by their larger size. Larvae have head markings reminiscent of those of *C. bimaculata* and *Chrysopa* sp. (undetermined) but the pattern is much more extensive, causing the head to be almost entirely dusky (figure 15). Because of the long, forward-projecting, prothoracic scoli, the head of the larva is usually hidden beneath the trash packet.

The life cycle of the species has been investigated in the laboratory utilizing Florida red scale as larval food. A minimum of 56 days was required for complete development from egg to adult. It is felt that this probably is not a typical life cycle as nothing is known of the food habits of the species.

FLORIDA DISTRIBUTION: This species appears to be southern in distribution. All of the more than 20 specimens in the collection were taken from Polk County southward.

Nodita pavida (Hagen)
Figures 16 and 17.

Chrysopa pavida Hagen, 1861, Smiths. Misc. Coll. 4: 216.

This species, in the larval stage, is the most common member of the genus found on citrus. Adults, on the other hand, are comparatively rare and only two specimens have been collected under grove conditions. Adults are easily confused with *C. cubana* from which they may be distinguished

by their larger size, dark pterostigma of the wings and darker prothoracic and antennal markings (figure 16). Larvae are trash-bearers with a smooth running gait, "play possum" when disturbed, and are found on limbs and trunks. They are readily identified by the long, sub-parallel, prothoracic scoli which cause the packet to completely hide the head and the distinctive head markings shown in figure 17.

Because of the rarity of adults it has been impossible to obtain data on the life cycle of this species. Further, most efforts to rear larvae under laboratory conditions have failed owing, it is believed, to a lack of knowledge concerning food habits. On several occasions late instar larvae have pupated and produced adults, but from the only set of eggs obtained all but one larva died before pupation and it failed to emerge. Florida red scale was used as food in this case.

FLORIDA DISTRIBUTION: This seems to be a southern species. The ten or more specimens in the collection have been taken from the southern and central citrus areas.

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MITE CONTROL IN REDWORM BEDS [1]

WILLIAM B. TAPPAN [2]
North Florida Experiment Station, Quincy

Redworm production during 1956 was reduced considerably by heavy populations of mites in commercial beds. Some worm growers experienced losses of production ranging from 80 to 100 per cent. At this time the exact method by which these mites inflict damage is not fully understood. Hyche [3] suggested that some species are predaceous and may attack the worms, while others probably compete with the worms for available food. However, worm growers in the Quincy area consider mites harmful to the worms.

Previous tests conducted by Hyche (1956) showed that malathion, parathion, and Metacide effectively reduced mite populations seven days after treatment, whereas Aramite had little or no effect. Malathion at all concentrations and parathion and Metacide at high concentrations significantly reduced worm populations, but Aramite did not reduce the number of worms. These tests indicated that parathion could be used at low concentrations (360 p.p.m.) with no harmful effects to the worms.

In 1956 a test was conducted to study the effects of three acaricides and one insecticide on the control of mites in redworm beds; to make general observations of the effects of treatments on the worms; and to determine the species of mites present.

PROCEDURE

A wooden frame, 15 x 15 x 7 feet, housed all test beds. The frame was covered on the top and south side with two thicknesses of tobacco shade cloth, which gave protection from heavy rains and the hot sun. The other three sides remained open, but the west side was protected by an adjacent wooden building. Wooden cube-shaped boxes of one cubic foot capacity contained the test beds. The bottoms of the boxes were not water tight, thus providing adequate drainage.

The bed medium was made from compost consisting of horse manure and crushed corn and cobs. The compost was allowed to decompose for eight weeks, and was turned and mixed at intervals until the internal temperature had dropped below 60° F. Fifty-one boxes were filled with medium to a depth of 10 inches. One quart of mite-infested medium from a commercial bed was added and mixed thoroughly into the beds, but the number of mites added to each bed was not necessarily the same. Ten adult redworms were placed in each bed. Two thicknesses of burlap were placed over the surface to reduce loss of bed moisture. No provision was made to confine either the worms or mites to the beds. Worm food in the

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[2] The writer wishes to express sincere appreciation for the aid given by Drs. P. W. Oman and Edward W. Baker of the Insect Identification and Parasite Introduction Section, Entomology Research Branch, U. S. Department of Agriculture for identification of Collembola and mites and notes on the habits of the mites.

[3] Hyche, L. L. 1956. Control of mites infesting earthworm beds. Jour. Econ. Ent. 49(3): 409-410.

form of poultry laying mash was scattered over the surface of the medium at 7-day intervals. The worms were allowed to reproduce for twelve weeks before treatments were applied.

Four treatments at four levels of concentration and a check treated with only well water were replicated three times. Materials tested were parathion, tedion, Niagara 1240, and thiodan. All treatments were applied as sprays made from 25 per cent wettable powder, except parathion made from 15 per cent wettable powder. Well water was used in each spray formulation.

The bed medium was wet thoroughly through the burlap covering with well water one hour before treatment. The water caused the mites to congregate at the surface. The burlap was removed and the test materials were applied at the rate of one gallon per 16 square feet of bed surface. Two Belknap plunger-type atomizing hand sprayers were used to make all applications. Each sprayer was rinsed thoroughly in well water before each treatment.

A pre-application count was made four days before treatment. Succeeding counts were made at 2-, 7-, and 14-day intervals after treatment. The beds were watered before each count, except the 7-day count, when beds were moist from rainfall. The surface medium was mixed thoroughly to a depth of approximately two inches and a one-cubic-inch sample was removed for counting. Each sample was placed on white paper and dispersed with dissecting needles. At each count observations were made to determine whether any worms were dead in or near the surface two inches, and whether live worms were present below that level. Also, notes were taken on the activity of Collembola in the surface layer.

One commercial bed was sampled to determine the distribution of mites at various depth levels. The bed sampled was five inches deep, and was covered with galvanized iron over two thicknesses of burlap. The iron and burlap were removed and one-half of the bed was watered. The coverings were replaced and two hours elapsed before sampling. One-cubic-inch samples were taken from each inch of bed depth at three random locations in each half of the bed. Mite counts were made as stated previously.

Results

As shown in Table 1, all treatments gave a significant reduction of mites two days following application. Parathion showed excellent control throughout the test, while Niagara 1240, thiodan, and tedion were less effective. Dead worms were observed on beds treated with 400 p.p.m. thiodan as early as two days after application. Seven days following application, all concentrations of thiodan were killing the worms. Observations showed that dead worms were present only in the top two inches of the beds. Below that level there seemed to be no detrimental effect from the thiodan treatments. All other treatments apparently had no effect on the worms. It should be noted here that none of the treatments showed any effect on Collembola, *Lepidocyrtus* sp., which were present in great numbers.

Four species of mites were collected from the test beds. The most numerous were two species of *Macrocheles* spp., belonging to the family Macrochelidae. The other two species were *Fuscuropoda agitans* (Banks)

and *Fuscuropoda marginata* (Koch), family Uropodidae. *F. agitans* was identified as the mite damaging redworm beds by eating the worms' food. *F. marginata,* however, is a predator of *F. agitans,* which may account for the reduction of mite population in the check. The relationship of *Macrocheles* spp. to the bed complex is not understood. Some members of that genus have been reported to be predators of flies and perhaps other insects.

TABLE 1. NUMBERS OF LIVE MITES BEFORE TREATMENT AND PER CENT REMAINING AFTER TREATMENT IN THE SURFACE TWO INCHES OF REDWORM BEDS AT QUINCY, FLORIDA, 1956.

		Live Mites per Cubic Inch (Average of three replicates)			
Treatments	Concentration	Numbers Before Treatment	Per Cent Remaining After Treatment		
	(p.p.m.)	4 days	2 days	7 days	14 days
Parathion	50	56	0**	0**	0**
	100	59	2**	0**	0**
	200	26	0**	0**	0**
	400	67	2**	0**	0**
Niagara 1240	50	29	18**	89	57
	100	61	6**	12**	13*
	200	40	10**	12**	13*
	400	26	34**	37*	18*
Thiodan	50	55	28**	53	71
	100	66	55**	59	17*
	200	44	15**	14**	21*
	400	21	17**	18**	2**
Tedion	50	30	56*	118	87
	100	32	19**	93	91
	200	55	13**	40*	27*
	400	20	4**	58	60
Check	Untreated	54	104	105	92
L. S. D. at 5% level			43	55	62
at 1% level			57	74	83

* Reduction significant at 5% level.
** Reduction significant at 1% level.

Results of mite distribution counts from one commercial bed are shown in Table 2. Moisture was directly related to mite distribution. The mite population decreased as the depth of the bed increased, due to the increased moisture content at the lower depths. Wetting before counting caused

the mites to come to the surface. This technique was so successful that large numbers of mites left the bed and gathered in the dry burlap covering. However, 85 per cent of the mites found in the wet half of the bed were in the top two-inch layer. Counts in the portion of the bed receiving no water showed that 86 per cent of the mites found were in the surface two-inch layer.

TABLE 2. DISTRIBUTION OF LIVE MITES IN A COMMERCIAL BED AT VARIOUS DEPTH LEVELS. QUINCY, FLORIDA, 1958.

Treatment	Depth Level of Sample (Inches)	Live Mites per Cubic Inch (Ave. of three replicates)	Percentage of Mites at Each Level (Ave. of three replicates)
Watered 2 hours before sampling	0-1	17	64
	1-2	6	21
	2-3	2	10
	3-4	1	5
	4-5	0	0
Untreated	0-1	62	72
	1-2	11	14
	2-3	6	7
	3-4	4	5
	4-5	1	2

SUMMARY

A test was conducted to (1) study the effects of three acaricides and one insecticide on the control of mites in redworm beds; (2) make general observations of the effects of treatments on the worms present; and (3) determine the species of mites infesting the test beds. Also, counts were made to determine the distribution of mites infesting a commercial bed. Various concentrations of parathion, Niagara 1240, thiodan, and tedion were tested at the rate of one gallon per 16 square feet of bed surface.

All materials effectively reduced mite populations two days after application. Parathion alone remained effective at all concentrations 14 days following application. Niagara 1240, thiodan, and tedion were less effective. Thiodan was the only material which was toxic to the worms. None of the materials controlled Collembola that were present.

Four species of mites were collected from the test beds. Two species of the genus *Macrocheles* were the most numerous. *Fuscuropoda agitans* (Banks), which was present in lesser numbers, was identified as the mite causing damage by eating the worms' food.

Mites in a commercial bed were found in great numbers near the surface. Few to none were found at the bottom of the bed. When the bed was watered, the mites congregated in the surface two inches and dry burlap covering the bed.

BIOLOGICAL AND ECOLOGICAL OBSERVATIONS ON *MYDAS MACULIVENTRIS* WESTWOOD (DIPTERA: MYDAIDAE) AS A PREDATOR OF WHITE GRUBS [1]

WILLIAM G. GENUNG [2]

Very little is known concerning the life histories and habits of flies of the family Mydaidae. A perusal of the various indices and reviews shows that the literature is not extensive. Curran (1934) stated that probably larvae of all species live in rotten wood. Clausen (1940) reported that larvae of some species live in rotten wood and feed on coleopterous larvae in that environment. Howard (1903) mentioned several species as predators of insect larvae in wood and further mentioned that adults of several species are mimics of various wasps. Comstock (1949) reflected the general lack of knowledge on the habits of these flies by stating that "the larvae of some species at least live in decaying wood. . . . ". Essig (1942) stated succinctly that little is known concerning the biology of these flies. Several authors mention that some species live in rotten wood, but none appears to have reported members of this family as being of subterranean habits. C. W. Johnson has listed several Florida species (1913) and has contributed a partial revision (1926) of the North American species of the family. According to most authors the Mydaidae are largely tropical in their distribution.

The adult flies are known predators of various insects. It would appear from a search of the literature that any careful observations would be a contribution to our knowledge of the biology nd habits of these diptera. The present paper is an effort toward that end.

In October and November, 1953, larvae of Scarabaeidae were observed in considerable numbers under garden sod at Lake Worth, Florida. Associated with these grubs were large dipterous larvae that the writer tentatively identified at the time as probably maggots of the related family Asilidae, known predators (Sweetman, 1936) of Phyllophaga and related scarab genera. The maggots were obviously predatory upon the grubs.

The sod under which this fauna occurred was composed of crabgrass, *Digitaria sanguinalis* L.; broad-leaved carpet grass, *Axonopus furcatus* (Fugge); Bermuda grass, *Cynodon dactylon* (L.) Pers.; and St. Augustine grass, *Stenotaphrum secundatum* (Walt.) Kuntze. There were scattered plants of goose grass, *Elusine indica* Gaertn; smut grass, *Sporobolus poirettii* (Roem. and Schult.) Hitchc.; and on the higher spots Natal grass, *Rhynechelytrum roseum* (Nees.) Staff - Hubb. The area was partly shaded by some royal poinciana trees, *Delonix regia* (Boj.) Raf., and silk trees, *Albizzia julibrissin* (Willed.) Durazz.

Several of the predatory maggots were confined for observation in soil with the host insects. The host grubs were killed rather slowly over a period of two or three days, apparently by having their body fluids withdrawn by the maggots until the host was reduced to a shrivelled skin.

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Several of the maggots were taken to the Everglades Experiment Station on November 5, 1953, for rearing. They were placed in jars fitted with screen wire lids, partly filled with soil from the collection site, and periodically supplied with larvae of phytophagous scarabs. Since earthworms were quite plentiful in the moister and more fertile portion of the collection area, one larva was supplied only these worms for food after the second feeding. Soil moisture in the containers was maintained at a moderate level, avoiding both excessive aridity and saturation. The level maintained was approximately equivalent to that in the collection area at time of collection.

Since maggots of several stages were present, only those that appeared more mature, about one inch in length, were collected for rearing. However, pupation of three individuals did not occur until August 24 of the following year, and emergence of the imagoes about three weeks later on September 21, 1954. Another maggot had pupated by September 5 and emerged by September 30. One maggot failed to complete its development. Thus it would appear that the life cycle may require at least two years. The larva supplied with earthworms also completed its development, although in the latter instance the host was not killed by feeding of the maggots. The adult flies that emerged were recognized as belonging to the Mydaidae, not Asilidae as at first suspected. Specimens were sent to Dr. H. V. Weems of the Florida State Plant Board for determination. He identified the material as *Mydas maculiventris* Westwood, and subsequently had his determinations confirmed by W. W. Wirth of the U. S. National Museum. A few adult flies of this species have been observed annually during August, September and early October since the above determination was made, and were of frequent occurrence in the vicinity of the 1953 collection in the late summer of 1955.

Johnson (1926) gives *M. incisus* Macq., *M. pachygaster* Westw. and *M. parvulus* Westw. as synonyms of *M. maculiventris*. In the earlier paper (1913) he reported *M. maculeventris* from Florida under these synonyms. According to Johnson male dimorphism in the species has contributed to this confusion. While Johnson (1926) gave *M. incisus* as an absolute synonym in the text of his paper, he listed it as a variety of *M. maculiventris* in the key to species. All of Johnson's specimens were collected near St. Augustine between 1880 and 1888.

Adult females of *M. maculiventris* have been observed in August and September alighting on the sod surface and bending the abdomen downward and forward, probably to oviposit, although search did not reveal eggs.

In view of the fact that the larval habitat of Mydaidae is generally reported to be rotten wood, it is interesting to note that the larva of *Mydas maculiventris,* at least, is a soil inhabiting form predatory upon the larvae of phytophagous scarabs and have been observed on sandy soils with a relatively low organic content. This mydaid was observed in the Lake Worth area in numbers sufficient to indicate that, if the species were widely distributed in sod land areas, possibly the maggots would be of importance in helping to prevent development of serious white grub infestations. However, this mydaid probably is not generally common enough to be of much economic value.

The soil from which the maggots were collected was a very gently sloping, well drained to moderately drained Arzell or Davie fine sand. Only the lower end contained considerable organic content. This mydaid has not been observed on the organic soils, although larvae of *Cyclocephala borealis* Arrow, a probable host, constitute a conspicuous element of the soil fauna on much of these sod and pasture lands. The genus *Phyllophaga* must be extremely rare if it exists at all on the Everglades sawgrass peat and muck soils, except possibly where these lie adjacent to the mineral soils. Scarcity of suitable adult hosts in these areas may account for *Phyllophaga* scarcity. During a decade spent in the area the writer has not seen adult emergence of *Phyllophaga* on the organic soils. Species of *Phyllophaga* do occur commonly on certain adjacent sandy lands, and emergence of both *Phyllophaga* and *Cyclocephala* have been observed at the site of the 1953 collection of *M. maculiventris.*

Since scarab larvae other than *Phyllophaga* are quite plentiful and are occasionally economic pests on the organic soils of the Everglades, some soil factor may account for the apparent lack of these predatory Diptera in the Everglades.

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NOTES ON THE SYNTOMID MOTH *LYMIRE EDWARDSI* (GROTE) AND ITS CONTROL AS A PEST OF *FICUS* IN SOUTH FLORIDA [1]

WILLIAM G. GENUNG [2]

Larvae of the syntomid moth, *Lymire edwardsi* (Grote), occasionally are injurious to species of *Ficus* in south Florida. These are important ornamental and shade trees in this section. In exceptional cases some trees may be defoliated by the feeding of these caterpillars. During the summer of 1958 extensive damage by this insect was observed in Palm Beach County. Serious to complete defoliation was noted in West Palm Beach, Palm Beach, Lake Worth and at various points along the highways in Palm Beach County and adjacent counties. The 1958 infestation has been the most general and injurious that the writer has observed in ten years in the area. While *Ficus* on the coastal areas seemed to sustain the most injury, defoliation was observed also in the Everglades section.

In addition to damage to the trees, the species may be considered a household nuisance since the pre-pupae seem to prefer the walls of buildings for pupation, if available, to any other site. As many as 35 pupae, pre-pupae and abandoned cocoons and pupal cases have been counted per square foot on the sides of buildings. In such situations they detract from the appearance of the property.

NOTES ON THE STAGES

Egg: The eggs are pale, probably partially translucent and hemispherical in shape. Apparently fresh eggs required five days for incubation in July. All eggs observed were deposited singly on the underside of the foliage.

Larva: Newly hatched larvae are pale or cream colored with dark, well-spaced hairs. If touched, these young larvae can flip a considerable distance. Judging from the appearance of the chorion, newly emerged larvae feed on the egg shell. Subsequent instars develop more abundant and downier rufous hairs. The advanced larvae are whitish to cream colored. A darker group of hairs rises like a tuft from the thorax. Older larvae, if touched, may descend to the ground by suspension threads or may flip from the leaf. Larvae are heavy feeders and falling excrement under heavily infested trees sounds like a light sprinkle of rain. Holland [3] mentioned that Dyar observed and reported on the larval stages.

Pupa: Pupation occurs beneath a thin, silken cocoon flat against a tree, wall or other object. The cocoon is covered with the larval hairs. Pre-pupae may move to a pupation site a day or two prior to pupation.

Adult: The imago is an attractive bluish grey to purplish grey moth with the abdomen blue dorsally and white ventrally. The thorax is ornge-red

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[3] Holland, W. J. 1913. The moth book. Doubleday, Page and Co., New York.

ventrally. The cervix and humeral area are also orange-red. The antennae are blue and are plumose in form. The body is somewhat waspish in shape as is common with most Syntomidae. The adult moth depicted in Holland's plate XIII, fig. 11, appears to be discolored or faded. The moths are sluggish and can be captured by hand.

Type of Damage: Very young larvae eat partly through the leaf. Older larvae eat irregular areas completely through the leaf, but feed mostly from the margins. Under usual infestations a considerable amount of the foliage may show some chewing injury and control in some of these cases may be desirable depending on the location and use of the tree. When complete defoliation of valuable ornamentals and shade trees is threatened, control is most desirable. After defoliation has occurred, larvae have been observed chewing on buds and ends of twigs. Defoliated trees may be more susceptible to attacks of various wood borers. Ends of twigs have been observed to die after defoliation. Certainly the tree in such cases suffers a loss in vitality.

Parasites: Two species of the family Chalcididae have been observed attacking the pupae. Specimens reared for determination were identified by Dr. H. V. Weems of the Florida State Plant Board as *Brachymeria robusta* (Cresson) and *Brachymeria ovata* (Say). The former species was considerably more numerous than *B. ovata.* In addition to these wasps, a larvaevorid fly, tentatively identified by Weems as *Achaetoneura aletiae* (Riley), was reared from the pupae. The chalcids were quite selective regarding the host. Many pupae were examined by the wasps and rejected before they found suitable material. After a host was selected, the chalcids would settle on the pupa for several minutes before seeking additional material. Two or three chalcids working on the wall of a building were observed to examine over 200 pupae in a half-hour period. Those pupae rejected by the wasps may have been previously parasitized or perhaps were of too advanced age to be suitable. Total percent parasitization of pupae based on collected material ranged from zero in pupae collected on June 15 to 89.2 percent in pupae collected on July 15. The percent parasitization by the various species involved on the different dates is shown in Table 1. In some instances pupae produced neither parasites nor moths. This mortality is attributed in part to fungus disease and in part to the large number of larvae forced into early pupation through starvation.

Egg parasites were attacking 40 percent of the eggs by the middle of July near Lake Worth. These parasites were determined by Dr. C. F. W. Muesebeck to be *Telenomus* sp. (Family Scelionidae).

Predators: Three species of Pentatomidae were found to be predatory upon these larvae. A single nymph of *Euthrynchus floridanus* (L.) was observed feeding on the species. Adults of *Podisus maculiventris* (Say) and *P. mucronatus* Uhler were more abundant. A crossmating pair of the two latter species were observed feeding on the caterpillars. Identifications were made by the author.

The only bird actually observed feeding on *L. edwardsi* was the southern meadow lark, *Sturnella magna argutula* (Bangs). It was observed to approach a wall from a distance of 35 feet, and then flutter upward and

pull several pre-pupae from the building. Additional probable feedings by larks were observed under a heavily infested Ficus tree.

TABLE 1. PERCENTAGE PARASITIZATION OF PUPAE OF *Lymire edwardsi* (GROTE) AND EMERGENCE OF ADULT MOTHS, PALM BEACH COUNTY, 1958.

No. of pupae	Collection date	Percentage parasitized by	Percentage moths emerged	Percentage producing neither moths nor parasites
21	6/15/58	*B. robusta*— 0		
		B. ovata — 0		
		A. aletiae — 0		
		Total..... 0	100	0
67	7/1/58	*B. robusta*—56.7		
		B. ovata — 6.0		
		A. aletiae — 1.5		
		Total..... 64.2	19.4	16.4
58	7/15/58	*B. robusta*—87.8		
		B. ovata — 0.0		
		A. aletiae — 1.7		
		Total..... 89.5	1.7	8.8
16	8/1/58	*B. robusta*—12.5		
		B. ovata — 0.0		
		A. aletiae — 0.0		
		Total..... 12.5	00.0	87.5

CONTROL

Two of the cheaper and safer chlorinated insecticides were compared with an untreated check in a small test in order to have some positive information on control to answer inquiries of home owners. Toxaphene, 58 percent E. C., and DDT, 25 percent E. C., were applied to three individual Ficus limbs in each case. The number of larvae per limb exceeded one hundred. The insecticides were used at one pound technical toxaphene and one half pound technical DDT per 100 gallons. Enough spray was applied with a compressed air sprayer to wet thoroughly the foliage and twigs. Both toxaphene and DDT use resulted in 100 percent knockdown of the larvae, most of which were dead within 48 hours after application. The population in the checks remained unaffected.

In regard to the pre-pupae migrating to walls of buildings to pupate, observations in three instances showed that where the lawn was recently treated with DDT or other residual insecticide, few larvae were able to sur-

vive crossing the treated grass. Possibly an insecticide application to building walls before the pre-pupa could construct its cocoon would have some effect.

Discussion and Conclusions

The abnormally destructive appearance of the syntomid moth, *Lymire edwardsi* (Grote), in the Palm Beach County area has caused considerable concern among home owners. Recent tests and observations have indicated that toxaphene and DDT E.C. are highly effective in controlling this insect. The major difficulty to home owners is treating large trees, as equipment is usually not at hand to reach beyond a few feet overhead. The alternative control measure would be to use professional spray services.

Reasons for the exceptionally high populations of the caterpillars in the summer of 1958 appear to hinge primarily on some biotic imbalance that permitted the buildup of the exceptional populations. Perhaps the unusual and continuously cold winter of 1957-58 resulted in reduction of an effective parasite to very low levels, thus permitting the moths a temporarily unchecked reproduction. As of this writing (July 15) the host specific larvae will probably die in large numbers, in some instances from starvation. There is evidence that forced pupation resulted in failure of many pupae to develop into adult moths.

1957 NATIONAL ENTOMOLOGY WINNERS: Joe W. Simmons, California; Larry Ulmer, Jr., Delaware; David C. Johnson, Virginia; Paul Mayfield, Vice-President, Hercules Powder Company; Howard E. Breland, Mississippi; Jessie Malone, Jr., Montana; Jack Jewell, Kansas.

COLLEGE SCHOLARSHIPS OFFERED IN 1958 ENTOMOLOGY PROGRAM

To stimulate increased interest in entomology, Hercules Powder Company announces its participation in the 4-H Entomology Awards Program for the seventh consecutive year.

More than 200,000 boys and girls have become better acquainted with the entomological profession as a result of their taking part in this program. The enthusiastic support of all those associated with the advancement of entomological knowledge has been an important contribution to the success of this important youth activity.

The following awards are being offered during 1958:

COUNTY WINNERS: Gold-filled entomology medals.

STATE WINNERS: Trips to the '58 National 4-H Congress.

NATIONAL WINNERS: Six college scholarships of $400 each.

Agricultural Chemicals Division, Naval Stores Department

HERCULES POWDER COMPANY

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900 Market Street, Wilmington 99, Delaware

Producers of toxaphene and other basic chemicals for agriculture

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A Cyanamid Report:

What's new with Malathion?

New intervals for Malathion – Malathion continues to be the ideal material for late season insect control. Reduced intervals between last application and harvest were received on these crops in 1958:

Tomatoes – from 3 days to 1 day with malathion 57% Emulsifiable Liquid, malathion 25% Wettable Powder and malathion 4% to 5% dusts.

Pears – from 3 days to 1 day with malathion 57% Emulsifiable Liquid.

Cucumbers, Squash, Melons – from 3 days to 1 day with malathion 57% Emulsifiable Liquid, malathion 25% Wettable Powder and 4% to 5% dusts.

Brambleberry Family – from 7 days to 1 day with malathion 57% Emulsifiable Liquid, malathion 25% Wettable Powder and 4% to 5% dusts.

Extended interval: – The label for leaf lettuce has been extended from 10 days to 14 days. The label for head lettuce remains the same: 7 days.

New crop uses for Malathion – Label acceptance of malathion for insect control on figs and okra extends its already long crop use list to 95.

Okra – For the control of aphids. Use recommended rates of malathion Emulsifiable Liquid, Wettable Powder or dusts up to time pods start to form.

Figs – For control of dried fruit beetles and vinegar flies. Use Emulsifiable Liquid or dusts at recommended rates. Apply when necessary up to 3 days from harvest.

New animal claims – In addition to label acceptance for *direct application* on cattle, hogs, poultry, cats and dogs, malathion has received these labels for direct application on sheep, goats and swine:

For the control of lice, ticks and keds on sheep and goats. Apply 16 lbs. of malathion 25% Wettable Powder per 100 gallons of water. Spray animals thoroughly. Repeat application after 2 or 3 weeks if needed. Do not apply to milk goats. Do not treat animals under one month of age. When applying sprays, avoid contamination of feed, food containers and watering troughs.

For the control of lice on swine, use malathion 4% or 5% dust making a thorough application to the animals. In addition, pens should also be thoroughly dusted. Repeat application in 10 days, and thereafter as needed. Avoid contamination of feed, food containers and watering troughs.

Developer and producers of malathion and parathion.

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