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PRELIMINARY REPORT ON WIREWORM INVESTIGATIONS IN THE EVERGLADES [1]

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The problem of wireworm control has engaged the attention of economic entomologists in all sections of the United States and, unfortunately, no one has yet been able to suggest an entirely satisfactory control program. Thomas (1930) has reviewed the extensive world literature on wireworm control, listing approximately 385 papers. Since 1930 there has been a steady increase of papers on the same subject. Almost every conceivable means of control has been tried, some fairly satisfactory, but none entirely so. It seems that each section of the country has different species and different climatic conditions to combat which make that section's problem different from all other sections. For example, the most prevalent species we have in the Everglades, *Melanotus communis*, (Gyll.) is capable of surviving for long periods of time without moisture on the muck soil. This is all the more remarkable because the Everglades for periods during the year is very wet. In addition flooding experiments conducted during July and August, in other investigations, have proven ineffective against this species.

As indicated above *Melanotus communis*, Gyll. is the most abundant destructive elaterid larva we have in the Everglades. Collections to date have revealed five other species present. These are *Heteroderes laurentii* Guer., a species causing considerable damage in other sections, *Glyphonyx recticillis* (Say.), *Aeolus dorsalis* Say., *Dolopius* sp. and *Conoderus* sp. All determinations were made by W. S. Fisher of the National Museum. The last two named species are rare and are probably not of economic importance anywhere. *Melanotus communis* is the only species being studied at this time and subsequent statements refer to this species.

[1] Paper read before the meeting of Fla. Ent. Soc. Dec., 1939.

In most sections of the country the wireworm larvae attack a number of unrelated crops. This is true in the Everglades. Growers of sugarcane have stated that in heavily infested fields they have to replant three or four times to get a stand. No method has yet been developed for estimating the damage to the stubble crop. Last year one celery grower lost approximately 20 percent of his celery plants where the wireworm population was 21,780 larvae per acre. The same grower had a planting of peppers completely destroyed. The acreage of potatoes planted is increasing each year, but no estimate of wireworm damage has yet been obtained. Other species in other sections of the country are responsible for severe damage to the potato crop. Corn is largely grown for windbreaks in the bean fields, but if figures from other sections apply at all to our section, the wireworms also cause much damage to corn. Thus, in the Everglades, we have four major crops, sugarcane, celery, peppers and potatoes that are severely injured by wireworms.

Life history studies of *Melanotus communis* were begun in April, 1939. It now appears that this insect is capable of completing its life cycle in one year's time in South Florida, but, like many other insects in our southern climate, all stages are likely to be found at any time during the year. Two adults were collected January 13, 1939 and others during the spring months. It seems possible that these early emerging adults were produced from eggs laid in the late summer, 18 months previously. Three adult females collected in May laid a total of 123 eggs in the insectary. The adults were placed in tin boxes with moist blotting paper in the top and bottom with a piece of corn stalk cut to fit between the lid and the bottom. The adults were fed corn pollen. Evidently the females were fertilized before they were placed in the boxes because copulation was not observed and 69 percent of the eggs hatched. Many of the eggs not hatching were killed by mold. One of the difficulties of working with this species is that satisfactory external characters for distinguishing males from females have not yet been found. That the average of 41 eggs for each female is below the usual number laid in the field is indicated by the fact that four females not laying in the insectary and dissected after death contained an average of 123 fully developed, probably infertile eggs.

A total of 85 eggs hatched in the insectary between May 26 and June 19 with a maximum incubation period of 17 days, a minimum of 12 days and an average of 13.66 days. These lar-

vae were placed in tin boxes with germinated corn between moist blotting paper. They were kept in the insectary until July 15 when 28 larvae were placed in four 8 inch pots filled with sifted and sterilized muck. Corn was planted in the pots for food. The pots were examined October 18, revealing 14 larvae 24 mm. in length. Eight of the 28 larvae had molted three times before July 15.

The experience of other investigators indicates that chemicals strong enough to kill the wireworm larvae are too expensive for general field use. Nevertheless preliminary investigations with calcium cyanide, carbon bisulphide and chloropicrin were made with the hope that one of these chemicals might prove useful for control of wireworms in seed beds. A seed bed four feet wide was divided into six 10-foot plots with three foot alleyways between plots. In each plot a screen cage 1.5 inches in diameter and six inches long, containing 25 wireworms was buried at three and six inch levels. The materials were applied in holes three inches deep and six inches apart, 3 cc. of the material to each hole and the holes immediately filled with dirt. After the application of the materials was completed the bed was covered with heavy tarpaulins which remained in place for 48 hours.

TABLE 1.—RESULTS OF SEED BED TREATMENT WITH VARIOUS SOIL FUMIGANTS APPLIED NOVEMBER 23, 1938, SOIL TEMP. 27° C. NEAR BELLE GLADE, FLORIDA.

Treatment No.	Material used and rate per acre	Number larvae alive 48 hours after		Percent Killed
		Cage 3″ deep	Cage 6″ deep	
1	Chloropicrin 300 lbs. dissolved in 96% alcohol	7	11	36
2	Chloropicrin 600 lbs. dissolved in 96% alcohol	0	0	100
3	Check untreated	22*	24*	
4	Carbon bisulphide 1383 lbs. per A.	0	0	100
5	Cyanogas 300 lbs. broadcast	24	23*	2
6	96% Alcohol	25	25	0

*Treatment 3: 3 larvae missing from Cage 3 inches deep and 1 from Cage 6 inches deep. Treatment 5: 2 larvae missing.

The larvae were placed in tin boxes with soil from their respective plots for six days. None of the larvae counted as dead revived and only one of those found alive died during this time.

Although the chloropicrin at 600 pounds per acre gave complete control the cost is almost prohibitive. The method of appli-

cation was clumsy and slow. The experiment was repeated emulsifying the materials with soap, diluting with water and applying them with a sprinkling can. In spite of the fact that at 300 pounds per acre chloropicrin gave 100 percent control the method was a failure. This is due to the fact that application with a sprinkling can is entirely unsatisfactory and at one dollar a pound for chloropicrin the cost of this method for materials and labor would be approximately $460 an acre.

Baits of many kinds have been used in attempts to control wireworms attacking many crops. Yet a survey of the literature failed to show that some chemicals recently used for insect control had been used in this connection. With this in mind 600 wireworm larvae were released in a screened insectary 12x15 ft. without a floor. An experiment was designed to determine the preferred food among the following: wheat, corn, graham flour, beans, potatoes, oats, wheat bran, cottonseed meal and corn meal. Five rows, three feet apart, were laid out across the insectary and each row divided into nine 12 inch sections. Each material was placed in each row in a random distribution and covered with three inches of soil on January 12, 1939. On January 23 the soil from each plot in each row 6x6x12 inches was sifted and the number of wireworms recorded. This data was subjected to an analysis of variance, demonstrating that the wireworms preferred these materials in the following order: oats, wheat, corn, potatoes, corn meal, string beans, cottonseed meal, graham flour and wheat bran. There was no significant difference between the first three foods.

Since corn and wheat were the most easily obtained of the three they were used in subsequent experiments conducted in the greenhouse to determine the effectiveness of the following chemicals: Tartar emetic, Thallium sulphate, potassium fluoride, and zinc phosphide. None of the arsenicals were tried because Woodworth (1938) working with *Limonius canus* Lec. in Washington has shown that this species is not affected by arsenicals. Various strengths of the chemicals were dissolved in a constant volume of water and rosin residue emulsion used as a sticker. Corn and wheat were treated with these preparations, dried and planted in jars containing five wireworms. Each treatment was replicated five times and examinations were made two weeks after the experiments were started. The examination showed that the wireworms had fed on the grain but were not affected by the chemicals. In some cases the chemicals were

made up to a saturated solution before the grain was treated. Likewise corn stored with paradichlorobenzene and naphthelene was ineffective. The latter is contradictory to results obtained by other investigators, Miles (1937), Headlie (1929) and Hawkins (1936). The only explanation I can offer is that the paradichlorobenzene and naphthalene absorbed by the grain was not sufficient to act either as a repellant or as an insecticide.

TABLE 2.—WIREWORM POPULATION IN COVER CROP PLOTS APRIL 26, 1939. TEN SAMPLES OF 1 SQ. FT. 6 INCHES DEEP TO THE PLOT AND OCTOBER 7, 1939, AFTER COVER PLOWED UNDER.

Block and Treatment*	Calculated No. Wireworms per acre 4/26/39	Calculated No. Wireworms per acre 10/7/39	Increase or Decrease
I—1	2,396	1,089	—1,307
I—2	1,742	871	— 871
I—3	871	653	— 218
I—4	2,396	2,396	0
I—5	2,831	218	—2,613
II—1	1,525	218	—1,307
II—2	871	218	— 653
II—3	1,742	0	—1,742
II—4	871	4,138	+3,267
II—5	1,960	1,742	— 218
III—1	436	871	+ 435
III—2	436	0	— 436
III—3	871	436	— 435
III—4	0	10,237	+10,237
III—5	436	2,396	+1,960
IV—1	218	436	+ 218
IV—2	218	436	+ 218
IV—3	436	871	+ 435
IV—4	0	1,307	+1,307
IV—5	218	436	+ 218
V—1	436	436	0
V—2	0	436	+ 436
V—3	871	1,089	+ 218
V—4	218	4,574	+4,356
V—5	218	2,831	+2,613

*Treatment No. 1 Fallow, No. 2 Iron Cowpeas, No. 3 Speckled Velvet Beans, No. 4 Grass and Weeds, No. 5 O-too-tan Soybeans.

Mr. R. N. Lobdell, formerly of the Everglades Experiment Station, has advanced the theory that adult *M. communis* females would not lay eggs on land planted to velvet beans. An experiment was designed to test this theory using the following treatments: velvet beans, weeds and grasses, fallow, cowpeas, and soybeans. These are the usual plants used for summer cover excepting fallow cultivation. The field plots were laid out in a Latin square, each plot 40x50 feet. A crop of spring

beans was plowed under in early April, the plots laid out and 10 samples of one foot square and six inches deep taken in each plot to determine the wireworm population.

TABLE 3.—INCREASE IN WIREWORM POPULATION AFTER SUMMER COVER CROP AND FALLOW TREATMENT. CONDENSED FROM TABLE 2.

Treatment	*Wireworms*
Grass and Weeds	+19,221
Soybeans	+ 1,960
Cowpeas	— 1,252
Velvet Beans	— 1,742
Fallow	— 1,961

On October 12 the plots were planted with four rows each of celery, string beans, Lima beans, corn and potatoes to determine the effect of the wireworms on these crops. Usually the noticeable damage to celery is inflicted on the newly transplanted seedlings. No damage to any of the crops has yet been observed. This may be due in part to the fact that the wireworms present in my plots are about 12 mm. long while the wireworms observed in celery fields last year were 24 to 36 mm. long. Another factor is that of population. In the most heavily infested of my plots there are only about ten thousand wireworms to the acre while in the celery field losing 20 percent of stand there were about 22 thousand wireworms to the acre.

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