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A PRELIMINARY REPORT ON PARATHION RESIDUES ON CITRUS[1]

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INTRODUCTION

The possibility that the new phosphatic insecticide, parathion (O,O-diethyl O-p-nitrophenyl thiophosphate) may be used as a spray material for the control of scale insects on citrus presents a unique problem as this material enters the peel or rind of the fruit. As this compound is toxic to warm-blooded animals it is very necessary to know how much may enter the peel of the fruits from trees which are sprayed with this material from a standpoint of time of application, concentration, and in combination with various spray materials.

EXPERIMENTAL

The following is an account of experimental studies made on parathion residues on foliage and in the peel of fruit from trees which have been sprayed with parathion at concentrations of 0.1 pound to 1.0 pound of active material per 100 gallons of water, at different time intervals starting March 15 and continuing through November 1, and in combination with various spray materials.

Determinations of the actual amounts of parathion present on the foliage following the spray application were made according to a modification of a method by Averill and Norris (1948). The procedure included the following technique: 100 discs 1 sq. centimeter in area were punched at random from leaves around the lower canopy of the tree with a punch to which a 125 ml.

[1] The author wishes to take this opportunity to thank W. L. Thompson and J. T. Griffiths of the Citrus Experiment Station for their help and cooperation.

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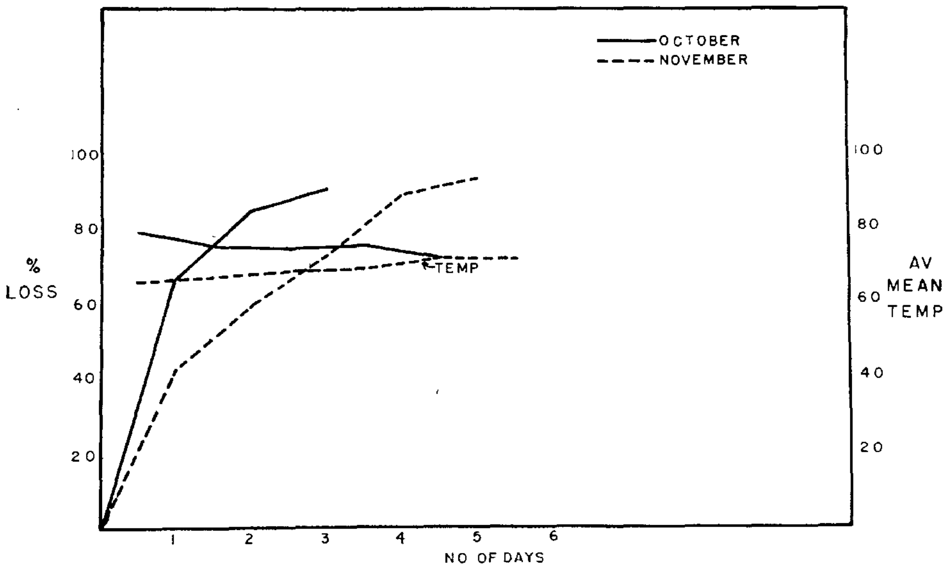
Erlenmeyer flask was attached allowing the discs to fall into the flask. These discs were extracted for one hour with 100 mls. of CP benzene which was added to the flask. The flasks were fitted with stoppers and shaken at five minute intervals. The benzene was decanted off through a funnel containing plugging cotton into a 200 ml. volumetric flask. A 50 ml. proportion of benzene was added to the discs in the flask and extraction continued for one-half hour longer with intermittent shaking. The discs and the benzene were transferred to the funnel. The sample flask was washed twice with 10 ml. portions of benzene which were poured over the discs in the funnel. The discs in the funnel were then washed with 2-10 ml. portions of benzene. The flask was made up to volume and 100 mls. of the benzene extract was concentrated to 10 mls. in accordance with the published procedure.

Determinations of the actual amounts of parathion present in the peel of the fruits were made according to the following technique: 4 pounds of oranges or 8 pounds of grapefruit were selected at random. Following thorough washing and rinsing the peel and albedo were removed and ground in a meat or food chopper. This sample of ground peel was then thoroughly mixed by halving, quartering, etc. A hundred gram sample of representative ground peel was placed in a Waring blendor with 200 grams of benzene, and ground until a puree was formed, usually within four minutes. This puree of peel and benzene was transferred to a 500 ml. Erlenmeyer flask. The blendor was then washed with 100 grams of benzene which was also transferred to the flask. The flasks fitted with stoppers were then placed on a tumbling machine for 1½ hours. Samples were filtered through plugging cotton and 100 grams of the extract was evaporated according to the published procedure. A modification of the procedure was necessary in order to remove peel oil. The sample after being reduced by the zinc and hydrochloric acid treatment was transferred to a 60 ml. separatory funnel. Twenty mls. of petroleum ether were added and the contents shaken for 1 minute. The bottom layer was withdrawn off through a funnel fitted with a No. 42 Wattman filter into a 50 ml. volumetric flask. If the sample was cloudy 5 to 10 mls. of 95 percent alcohol were added. This modification was suggested by Gunther. The published procedure was then followed from this point on.

FIGURE I

EFFECT OF TEMPERATURE ON RATE OF LOSS OF PARATHION FROM CITRUS FOLIAGE



RESULTS

Figure 1 presents data on rate of loss of parathion from foliage on the outside canopy of the tree during October and November. The average mean temperature was higher during the October interval than in November. No rain had fallen during either interval and both periods were relatively calm. It is evident that temperature is one of the most important factors affecting the rate of loss of parathion from the foliage. Around 90 percent of the parathion was lost within 72 hours during the October interval while a period of 96 hours was required during November to obtain the same loss. Although not shown in Fig. 1 the rate of loss of parathion was much slower from the leaves on the inside canopy of the tree.

The results as shown in Table 1 indicate that the date of the spray application has little effect upon the amount of parathion in the peel of the mature oranges when sprayed after a certain date. On March 15 the spray material was applied when the trees were in full bloom and no parathion was found when the fruit was mature. However, on April 1 traces of parathion were found and on this date the fruit was less than a quarter of an inch in diameter. From May 1 on there is no evidence that the date of spray application in any way affected the amount of parathion that was present in the peel of the mature fruit.

The results as shown in Table 2 indicate that the most important factor affecting the amount of parathion in the peel of oranges is the concentration of parathion in the spray solution. Although very little differences are noted between one-tenth of a pound and three-tenths of a pound, almost twice the amount is found in the peel when the concentration is increased to four-tenths of a pound. The amount of parathion in the peel of fruit is increased also when .5 pound of material is used in the spray solution.

The effect of various spray combinations on the parathion residue in the peel of grapefruit is shown in Table 3. These results indicate that spraying parathion in combination with various other spray materials has no effect upon the amount of parathion in the peel of grapefruit when the fruit is mature.

TABLE 1

THE EFFECT OF DATE OF SPRAY APPLICATION UPON PARATHION RESIDUES IN THE PEEL OF ORANGES.*

Date of Spray Application	Parson Brown		Pineapple	
	Date of Sampling	p.p.m. Parathion	Date of Sampling	p.p.m. Parathion
Mar. 15	Oct. 13	0.0	Nov. 26	0.0
April 1	Oct. 13	0.3	Nov. 26	.27
May 1	Oct. 13	2.0	Nov. 26	5.4
June 1	Oct. 13	1.0	Nov. 26	2.0
July 1	Oct. 13	0.7	Nov. 26	2.4
Aug. 1	Oct. 13	2.0	Nov. 26	3.2
Sept. 1	Oct. 13	2.0	Nov. 26	3.1

* 1 pound of technical parathion per 100 gallons.

TABLE 2

THE EFFECT OF CONCENTRATION UPON PARATHION RESIDUES IN THE PEEL OF PINEAPPLE ORANGES.*

Pounds Technical Parathion Per 100 Gallons	Date of Sampling	p.p.m. Parathion
0.1	Nov. 10	.7
0.2	Nov. 10	.8
0.3	Nov. 10	.9
0.4	Nov. 10	1.5
0.5	Nov. 10	1.7

* Sprays applied July 17.

TABLE 3

THE EFFECT OF VARIOUS SPRAY COMBINATIONS UPON THE PARATHION RESIDUES IN THE PEEL OF GAPEFRUIT.*

Pounds of Spray Materials per 100 Gallons	p.p.m. Parathion
Parathion—.5, W.S.[1]—10, Cop.[2]—3, ZN[3]—2	0.2
" " " + DN[4]—⅔	0.3
" " Cop.—3, Neotran[5]—2	0.3
" " " Neut. ZN—2, "	0.1
" " ZN SO_4—3, Lime—1 "	0.1
" " " " Borax—1 "	0.2

* Sprayed April 13 and analyzed October 19.
[1] Wettable sulfur.
[2] Neutral copper (34% metallic copper).
[3] Neutral Zn.

SUMMARY

It is evident that temperature is the most important factor which affects rate of loss of parathion from citrus foliage. The rate of loss from the inside canopy of the tree is lower than that from the outside of the canopy. Time or date of application of parathion had very little effect upon the amount of parathion in the peel of oranges with the exception of two spray dates: March 15 at the time when the trees were in full bloom and April 1 when the fruit was less than a quarter of an inch in diameter. No parathion was found in peel of the mature fruit from trees sprayed March 15 and only a trace in the peel when trees were sprayed April 1. The concentration of parathion in the spray solution controls or affects the amount of parathion which one finds present in the peel of mature oranges. The spraying of parathion in combination with various other spray materials has no effect upon the amount of parathion found in the peel of the fruit when mature.

REFERENCES

Averill, P. R., and Norris, M. V. 1948. Estimation of small amounts of O,O-diethyl O-p-nitrophenol thiophosphate. Anal. Chem. **20** (8):753-756.

Gunther, F. A. Personal correspondence.

THE POSSIBLE TRUER STATUS OF THE RED-HEADED SCALE-FUNGUS

A Preliminary Report

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For the past several years [1] extensive research into the biology and control of purple scale on citrus has been conducted. This is the most abundant of any of the scale insects preying upon citrus and doubtless does more damage than any one other citrus pest. During the course of this work the abundances of "friendly fungi" have always been noted numerically.

The fungus which is the most conspicuous and which outnumbers all others in abundance is the red-headed scale-fungus. It is this organism on purple scale which is referred to in this paper. In tabulating its abundance two methods have been used. The first states the fungus as a percentage of the total live and dead scale population. The second expresses it as the "fungus ratio". This term, as used here, refers to an inverse ratio, i.e., the number of live purple scale to each fungus-infected scale. Thus, a high fungus ratio would imply low fungus populations, while a low fungus ratio implies high fungus populations.

In 1933 it was noticed that the fungus ratio in randomly selected groves was rather uniform, except in such groves as had recent applications of Bordeaux, or other fungicidal sprays. As the period of time lapsed following the fungicidal spray the fungus ratio gradually assumed lower proportions. The most interesting feature of this study was the total lack of any fluctuations in unsprayed trees which might express a host-parasite relationship between purple scale and the red-headed scale-fungus. At the same time it was found that the fungus was attacking only a small percentage of the total dead scale.

In many groves in Florida growers rely upon this fungus for the control of purple scale. They use as an index of control the number of fungus-infected scale, omitting scalecidal sprays in many cases if the fungus is very abundant. This theory of control by fungous is time-honored and has been backed by the scientific publications of various research departments.

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[1] Manuscript received August, 1935.

In 1933 while conducting researches with a so-called non-residue-forming fungicide known as Coposil, it was found that there were at the end of the season marked differences in numbers of purple scale in blocks sprayed with varying fungicides and amounts of fungicides. In one test, for example, at the Ebert Grove at Leesburg equal amounts of metallic copper as Bordeaux and as Coposil in different plats were followed by differing numbers of scale. The Bordeaux resulted in 16 live scale per leaf; Coposil, 11; and an untreated check, 8. Since the residues left by Coposil spray was of a much lighter character than that of the Bordeaux application, it was considered that the differences in scale populations were due to a possible lower persistency of the Coposil which would allow a quicker re-infection of fungi.

In 1934 in order to check this theory an elaborate experiment was conducted in the Mills Grove at Clearwater, comparing Coposil and Bordeaux in regard to scale increases. The spray applications were similar except that in the two fungicidal treatments made in January and April one block received 3-4-50 Bordeaux and the other block Coposil at 2 pounds to the hundred gallons. Scale counts were made at six times during the year. The first four counts were made from 1933 foliage, while the last two were from 1934 (or current year) foliage. Although the fungus per leaf in both blocks followed parallel courses, the live scale per leaf in the Bordeaux plat was much higher than that in the Coposil block. These data pointed to the fact that the killing off of the fungus by the Bordeaux application is perhaps not the factor responsible for scale increases.

This experiment, coupled with other data previously taken, led the writer to become very suspicious of the benefits derived from the red-headed scale-fungus on purple scale. With this in mind, other data were taken to ascertain the true nature of this fungus.

The purpose of this paper is to present a series of data which seems to point to the conclusions that this organism is not an active pathogene; that, if any at all, it accounts for few killed scale; and that to rely upon it for control is to suffer great loss in physiological conditions of the trees. It is realized that these statements are rather contradictory to all established ideas, but the data collected are extensively and thoroughly taken and it would seem that they should alter the complexion of this theory.

The theory of fungus control of purple scale appears to have no scientific background. It seems to have been assumed because of the parallel infections of fungus with infestations of scale. Although mention has been made of this fungus during the course of many years, no attempt has been made to evaluate its results in control percentages. This fungus can be repeatedly found growing on the empty pupal cases of male purple scale. It has even been seen in a few cases to be growing on the scale covering live healthy purple scale.

The following statements are a resumé of the data collected during these studies and are in no cases assumptions.

1. There are more fungi on the upper surface of a citrus leaf than on the lower surface. Conversely, the abundance of scale insects is on the lower surface. These facts are apparently not inter-related. The fungus seems to be disseminated by a water-washed spore which allows it to become more abundant on the upper leaf surface than on the lower surface, while the scale prefer the greater security of the shade conditions offered on the lower leaf surface. This distribution is evidently not due to the killing off of the scale by the fungus. At no time during the life cycle of a leaf is the distribution reversed except as noted below. The mortality on the upper surface ordinarily averages a bit higher than that on the lower surface but does not account for the differences in scale populations on the respective surfaces, nor do these differences reach proportions which might be accountable by the distribution of the fungus.

Counts of 21,702 scale were made to find the relative abundance of live scale and fungus-infected scale on the respective surfaces, together with mortality. There was found to be a 75% total mortality on the lower leaf surface, with 5.46% of the total count infected with fungus. On the upper leaf surface there was a 84% total mortality with 19.9% infected with fungus. It will be seen that if the fungus had killed every scale which it had infected, it accounted for only 7.3% of the total dead on the lower leaf surface, and 23.6% on the upper surface. However, these data show that there was 14.4% more fungus-infected scale on the upper surface but only 9% more total mortality on this surface. In this case the fungus was not even accounting for its own abundance in mortality.

Exception.—In groves where whitefly is a major pest and the upper leaf surfaces are covered with "sooty-mold fungus" growing on the resultant honey-dew, purple scale will become more abundant on these surfaces because of the better shade conditions offered. The fungus will, however, remain in about the same proportions as shown above. Data were collected from a block of trees at the Mills Grove at Clearwater in August of 1934. This block of trees had received only one light dusting with 92-8 sulphur-lime dust for rust mite control and whitefly were very prevalent. Counts revealed 21.62 live scale and 7.46 fungus-infected scale per leaf on the upper surface, with 19.02 live scale and 1.8 fungus-infected scale on the lower surface. It will be noted that although the larger number of fungus-infected scale is on the upper leaf surface, the greater portion of the live scale is also on this surface. There were 35.04 live scale on the upper surface and 33.52 live scale on the lower surface of leaves on the inside of the trees, while on the outside leaves 8.2 live scale were found on the upper surface and 4.52 on the lower surface. The smaller difference on the two surfaces of inside foliage is probably due to two reasons: generally favorable shade conditions on both surfaces under ordinary conditions, and smaller quantities of sooty-mold fungus on the inside foliage.

2. There is averagely more fungus per leaf on the inside foliage than on the outside foliage and at the same time the greater scale populations are on the inside foliage. Counts of 12,573 scale showed an average of 4.94 live scale and 3.1 fungus-infected scale per leaf on outside foliage while there were 16.76 live scale and 7.11 fungus-infected scale per leaf of inside foliage. The total mortality was 71.2% on outside foliage and 73.1% on inside foliage. The fungus naturally found the inside foliage more ideal because of the cooler temperatures and more moist atmosphere conditions tending to longer periods of damp foliage. The scale enjoy the inside foliage because of the greater shade offered. Here again we find no correlation between percentages of total scale infected with fungus and total mortality. If the fungus had killed every scale which it had infected, it accounted for only 25.1% of the total dead on the outside foliage and 14.9% on the inside foliage.

3. It is a very common occurrence to find healthy scale living and reproducing under and in immediate contact with the mycelium of the fungus. It is realized that they may prove a built-up immunity by certain percentages of the scale insects. However, it is included here since counts of 1,652 fungus-infected scale revealed that 131, or 7.9%, harbored live scale directly underneath. Live crawlers, when found under a fungus-

infected scale, were not included in these counts since they had been there only for a short interval. No scale was counted unless it was in direct contact with the mycelium of the fungus. It would seem that the scale enjoy the shade conditions offered by the fungus-infected scale.

4. Fungus build-up in a grove parallels to a certain extent scale build-up, except during periods of very dry weather, i.e., more fungus will be found in a grove as the scale populations increase. During the rainy season the fungi show a very rapid increase, but this does not apparently affect the scale build-up. On the contrary, it would seem that there is more mortality during periods of dry weather than during the rainy season. Counts of blocks of trees under different spray programs made in June and in September showed higher fungus populations in September together with higher percentages of live scale at that time. The average percentage of live scale for the four plats on June 12 was 32.7% while on September 18 it was 41.9% or 9.2% greater. In the same plats the fungus increased from 0.09% (a negligible number) in June to 19.8% in September, an increase of 22,000%, and yet this increase had no influence on the percentage of total mortality. It is very common to find that during periods of dry weather the mortality will run much higher than during the rainy season.

5. This parallel build-up of scale and fungus may be shown by random counts from various groves under approximately similar spray schedules taken at any period during the year. Counts made from 11 groves during February of 1935 showed a variation of from 0.9 to 22.7 live scale per leaf with a somewhat parallel variation of from 0.2 to 5.5 fungus-infected scale per leaf. Beginning with the grove showing the least scale per leaf and going to the grove with the most scale per leaf, there was a gradual increase in fungus-infected scale at the same time.

6. In certain sections of the State, particularly along the East Coast, Australian pines are used for windbreaks. These pines provide a certain amount of shade for the rows of citrus trees immediately adjacent to them. This condition is excellent for development of purple scale and the parallel development of friendly fungus. Counts made in a grove at Vero Beach showed the following populations per 50 leaves. (Row One runs parallel with, and under, the pines, while rows Two to Five are pro-

gressively further away from this protection.) Row One: 138 live scale, 40 fungus-infected scale; Two, 24 scale, 16 fungus; Three, 28 scale, 12 fungus; Four, 20 scale, no fungus; and Five, 18 scale, no fungus. The most scale and fungus were found immediately under the windbreak.

7. Following scalecidal sprays a very rapid development of friendly fungus is often noted. This has been observed by several workers in Florida. At the Atwood Grove at Manavista during 1934 there were 1.3% of the total scale infected with fungus before spraying, while after a treatment with an oil emulsion there were 7.1% so infected; an increase of 546%.

8. Any spray residue whether fungicidal or non-fungicidal, unless distinctly scalecidal, will cause a build-up of purple scale in proportion to the amount and kind of residue. Residue is operative as a factor of shade. The increase of scale following an application of Bordeaux appears to be due to the building up of a residue which gives protection to the scale and increases the percentage of establishment, rather than to the killing off of the fungus. No correlation can be found between friendly fungus and scale populations, but a very distinct correlation can be found in every case between the amount and kind of spray residue and the scale build-up.

On April 24th three adjacent blocks of grapefruit in the Ostrander Grove at Auburndale were sprayed with increasing amounts of Coposil plus 1-100 oil emulsion. On August 20th, Plat A, receiving 2 pounds Coposil to the hundred gallons, showed 0.2 live scale per leaf; Plat B, receiving 3 pounds Coposil, showed 0.42 live scale; and Plat C, receiving 4 pounds Coposil, showed 0.7 live scale. Friendly fungus in all three blocks was almost negative. Data from other tests show similar results. Bordeaux with heavy residues of lime results in higher infestations of scale than does Coposil in which lime is not needed.

9. Aside from spray residues we find natural factors of shade which act in much the same manner such as: the natural shade of the inside of the tree, underside of the foliage, the calyx of the fruit, and aphis-curled leaves; sooty-mold fungus; empty whitefly pupal cases; residues from wooly-whitefly; white-fly fungus; spider webs; webbing of six-spotted mites; dead purple scale; dead red scale; living scale of all species; road dust; sand; windbreaks; and melanose lesions.

SUMMARY

From a very careful study of the biology of purple scale conducted over a period of four years, many facts are shown that point to a lack of effectiveness of the red-headed scale-fungus as a control for this scale. No host-parasite relationship could be found. The percentages of dead scale infected with fungus are always very small. Although greater numbers of the fungus are found on the upper leaf surface, the mortality on this surface does not reflect this condition. Greater numbers of fungus are found on the inside foliage of the tree, but there are always larger populations of live scale on this same foliage. As the populations of live scale build up, the fungus shows a parallel increase in numbers. Percentages of total scale infected with fungus increase rapidly after an application of a scalecide. Spray residues, whether fungicidal or non-fungicidal, or any natural residue, tend to a quicker build-up of scale populations without regard to fungus abundances. Greater mortalities are found during periods of dry weather when fungus is in small numbers, rather than during the rainy season when fungus is abundant.

CONCLUSIONS

The red-headed scale-fungus appears to be a negative factor in the control of purple scale. The factors which operate for its control under natural conditions apparently are lack of establishment of the young stages, adverse weather conditions operating through the tree and adverse physiological conditions of the host plant.

EDITOR'S NOTE:—The publication of the paper, "Progress Report on the Fungus Diseases of Scale Insects Attacking Citrus in Florida", by F. E. Fisher, W. L. Thompson, and J. T. Griffiths, Jr. (FLORIDA ENTOMOLOGIST: XXXI, No. 1. March 1949) has reminded several of the older members of the Florida Entomological Society that L. W. Ziegler presented a paper on this subject at a meeting of the Society several years ago. Some remembered that the paper had been submitted for publication in the FLORIDA ENTOMOLOGIST. A search of some old files of manuscripts that had been sent to the FLORIDA ENTOMOLOGIST, revealed the original typed copy of the paper by Mr. Ziegler which was presented at the meeting held during the summer of 1935. It is regrettable that the paper was not published then, as it foretold some facts which have since been substantiated by the work of Fisher, Thompson, and Griffiths. Inasmuch as the paper contains information on the biology of purple scale and other matter which is nowhere available, it is deemed proper that it be published now.

NOTES ON AQUATIC HEMIPTERA FROM LAFAYETTE AND MARSHALL COUNTIES, MISSISSIPPI

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Comparatively few species of aquatic Hemiptera have been recorded from Mississippi. Of the seventeen species included in the following annotated list, four are believed to represent new state records (indicated by *). Two of these, *Ranatra kirkaldyi* and *Notonecta raleighi,* might be considered rare, and the Mississippi records of each represent considerable extensions of their known ranges.

These records are based on material collected between July and November, 1947 in the vicinity of Oxford, Lafayette County and Spring Lake, Marshall County, Mississippi by Dr. George H. Bick. All specimens are in the Tulane University collections.

MESOVELIIDAE

Mesovelia mulsanti White.—one, Oxford (stock pond), 8-16-47 (TU 327).

HYDROMETRIDAE

Hydrometra martini Kirkaldy.—two, 1½ mi. e. Oxford, (flowing creek), 8-9-47 (TU 325); one, Oxford (stock pond), 8-16-47 (TU 327); two, Spring Lake, 10-5-47 (TU 339); one, Spring Lake, 11-9-47 (TU 347).

**Hydrometra myrae* Torre Bueno.—one, 1½ mi. e. Oxford (flowing creek), 8-9-47 (TU 325); one, Oxford (stock pond), 8-16-47 (TU 327); one, Spring Lake, 10-18-47 (TU 342).

Hydrometra australis Say.—two, 4 mi. n. Oxford (flowing creek), 7-20-47 (TU 317); one, Oxford (pond), 8-16-47 (TU 328); one, 2 mi. nw. Oxford (side pool by creek), 8-16-47 (TU 329).

GERRIDAE

Gerris canaliculatus Say.—two, Spring Lake, 10-18-47 (TU 342); one, 1½ mi. e. Oxford (flowing creek), 8-9-47 (TU 325); one, Spring Lake, 11-9-47 (TU 346).

Limnogonus hesione (Kirkaldy).—two, Oxford (stock pond), 8-16-47 (TU 327); four, Spring Lake, 9-28-47 (TU 331, 332).

GELASTOCORIDAE

Gelastocoris oculatus (Fabricius).—two, Oxford (edge of pond), 7-26-47 (TU 319); five, 1½ mi. e. Oxford (sand bank of flowing stream), 8-9-47 (TU 325).

NAUCORIDAE

Pelocoris femoratus (Palisot de Beauvois).—one, Spring Lake, 10-5-47 (TU 339).

NEPIDAE

Ranatra australis Hungerford.—two, Spring Lake, 10-5-47 (TU 339).

Ranatra buenoi Hungerford.—one, Spring Lake, 9-28-47 (TU 332).

**Ranatra kirkaldyi* Torre Bueno.— two, Spring Lake, 10-18-47 (TU 343).

**Ranatra fusca edentula* Montandon.—one, Oxford, Summer 1947 (TU 159); one, Spring Lake, 10-18-47 (TU 343); one, 2 mi. n. Oxford (stock pond), 11-28-47 (TU 350).

BELOSTOMATIDAE

Benacus griseus (Say).—one, 1½ mi. nw. Oxford (pond), 8-16-47 (TU 328).

Belostoma lutarium (Stal).—one, Oxford, Summer 1947 (TU 159); one, Spring Lake, 7-5-47 (TU 311); two, Oxford (stock pond), 8-16-47 (TU 327); one, Spring Lake, 10-5-47 (TU 339); one, Spring Lake, 11-9-47 (TU 347); one, 2 mi. n. Oxford (stock pond), 11-28-47 (TU 350).

NOTONECTIDAE

Notonecta indica Linneaus.—two, Oxford, Summer 1947 (TU 159).

Notonecta irrorata Uhler.—two, Oxford, Summer 1947 (TU 159); seven, Oxford (flowing creek), 7-18-47 (TU 314); one, 4 mi. n. Oxford (flowing creek), 7-20-47 (TU 317); twenty, 1½ mi. e. Oxford (flowing creek), 8-9-47 (TU 325); one, 2 mi. n. Oxford (stock pond), 11-28-47 (TU 350).

**Notonecta raleighi* Torre Bueno.—Hitherto unrecorded from the deep South, this species proved to be the most common *Notonecta* in the area. The records are: one, Oxford (stock pond), 8-16-47 (TU 327); Spring Lake: three, 9-28-47 (TU 332), ten, 10-5-47 (TU 335, 339), seven, 10-18-47 (TU 338, 341, 342), and nineteen, 11-9-47 (TU 345, 346, 347, 348, 349).

Of the twelve collections of *N. raleighi* most were in permanent (100%) bodies of shallow water (less than 18 inches) (73%), which were clear (90%), shaded (75%), static (100%), mud-bottomed (100%), and in which aquatic vegetation was present (100%). Collections were made from various points around the edge of Spring Lake (83%) and ponds (17%). Aquatic plants present in order of frequency were *Cabomba carolinensis*, *Utricularia* spp., *Myriophyllum* sp., *Ceratophyllum* sp., *Persicaria* sp. and *Polygonum* sp.

NINTH INTERNATIONAL CONGRESS OF ENTOMOLOGY

The IXth International Congress of Entomology will be held at August 17th-24th, 1951, in Amsterdam (Netherlands). Entomologists wishing to receive in due course programs and application forms are requested to communicate now with the Secretariate, c.o. Physiologisch Laboratorium, 136 Rapenburgerstraat, Amsterdam.

Further communications will follow in 1950.

NEPIDAE

Ranatra australis Hungerford.—two, Spring Lake, 10-5-47 (TU 339).

Ranatra buenoi Hungerford.—one, Spring Lake, 9-28-47 (TU 332).

**Ranatra kirkaldyi* Torre Bueno.— two, Spring Lake, 10-18-47 (TU 343).

**Ranatra fusca edentula* Montandon.—one, Oxford, Summer 1947 (TU 159); one, Spring Lake, 10-18-47 (TU 343); one, 2 mi. n. Oxford (stock pond), 11-28-47 (TU 350).

BELOSTOMATIDAE

Benacus griseus (Say).—one, 1½ mi. nw. Oxford (pond), 8-16-47 (TU 328).

Belostoma lutarium (Stal).—one, Oxford, Summer 1947 (TU 159); one, Spring Lake, 7-5-47 (TU 311); two, Oxford (stock pond), 8-16-47 (TU 327); one, Spring Lake, 10-5-47 (TU 339); one, Spring Lake, 11-9-47 (TU 347); one, 2 mi. n. Oxford (stock pond), 11-28-47 (TU 350).

NOTONECTIDAE

Notonecta indica Linneaus.—two, Oxford, Summer 1947 (TU 159).

Notonecta irrorata Uhler.—two, Oxford, Summer 1947 (TU 159); seven, Oxford (flowing creek), 7-18-47 (TU 314); one, 4 mi. n. Oxford (flowing creek), 7-20-47 (TU 317); twenty, 1½ mi. e. Oxford (flowing creek), 8-9-47 (TU 325); one, 2 mi. n. Oxford (stock pond), 11-28-47 (TU 350).

**Notonecta raleighi* Torre Bueno.—Hitherto unrecorded from the deep South, this species proved to be the most common *Notonecta* in the area. The records are: one, Oxford (stock pond), 8-16-47 (TU 327); Spring Lake: three, 9-28-47 (TU 332), ten, 10-5-47 (TU 335, 339), seven, 10-18-47 (TU 338, 341, 342), and nineteen, 11-9-47 (TU 345, 346, 347, 348, 349).

Of the twelve collections of *N. raleighi* most were in permanent (100%) bodies of shallow water (less than 18 inches) (73%), which were clear (90%), shaded (75%), static (100%), mud-bottomed (100%), and in which aquatic vegetation was present (100%). Collections were made from various points around the edge of Spring Lake (83%) and ponds (17%). Aquatic plants present in order of frequency were *Cabomba carolinensis*, *Utricularia* spp., *Myriophyllum* sp., *Ceratophyllum* sp., *Persicaria* sp. and *Polygonum* sp.

NINTH INTERNATIONAL CONGRESS OF ENTOMOLOGY

The IXth International Congress of Entomology will be held at August 17th-24th, 1951, in Amsterdam (Netherlands). Entomologists wishing to receive in due course programs and application forms are requested to communicate now with the Secretariate, c.o. Physiologisch Laboratorium, 136 Rapenburgerstraat, Amsterdam.

Further communications will follow in 1950.

A NEW SPECIES OF *RHEUMATOBATES* FROM FLORIDA (HEMIPTERA, GERRIDAE)

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The new species, *Rheumatobates crinitus,* described below represents the first published record for the genus from salt water. The species was first collected in Lake Worth, Palm Beach County, Florida, by the writer in June 1947 and belongs to the group with unmodified antennae and hind legs. All of the other members of this group are known from outside the United States. They are *R. clanis* Drake and Harris, described from Rio Grande, British Honduras in 1932, *R. minutus* Hungerford 1936 from Yucatan, Mexico (Merida, Niagra Cenote), and *R. vegatus* Drake and Harris 1942 from the Isle of Pines, Cuba. The description of *vegatus* is quite short so it appeared at first that *crinitus* was that species. However, Dr. Carl J. Drake carefully compared three of my specimens with the single male type of *vegatus* and pointed out the differences to the writer. There is sufficient material in the three series of *crinitus* to show that the Florida form is distinct.

In view of the constant differences in the proportions of the middle legs, slight differences in the number of hairs on the genital segment as well as the location of the black spines on the front legs of the male, I feel justified in according specific rank to the Florida form.

Rheumatobates crinitus sp. nov.
(Plate I)

DIAGNOSIS: This species may be distinguished from *R. vegatus* by the length and proportions of the middle legs.. In *vegatus* the middle leg is longer than in *crinitus,* ratio [1] (femur: tibia: tarsi) is 67.5: 57.5: 41.5 and that of *crinitus* is 60: 52: 37 in the holotypic male. In sixty-two other specimens measured from Lake Worth, Perrine and Big Pine Key, the intermediate femur varies in length from 57 to 64 units, with a mean of 59.7. The intermediate tibia varies 46 to 53 units, with a mean of 50.1, and the tarsal segments vary in length from 33 to 37 units with a mean of 34.3. The hind femur in both species is about the same (40 units). In other specimens of *crinitus* the range

[1] One unit = .0298 mm. for leg measurements; for the antennae, one unit = .0157 mm.

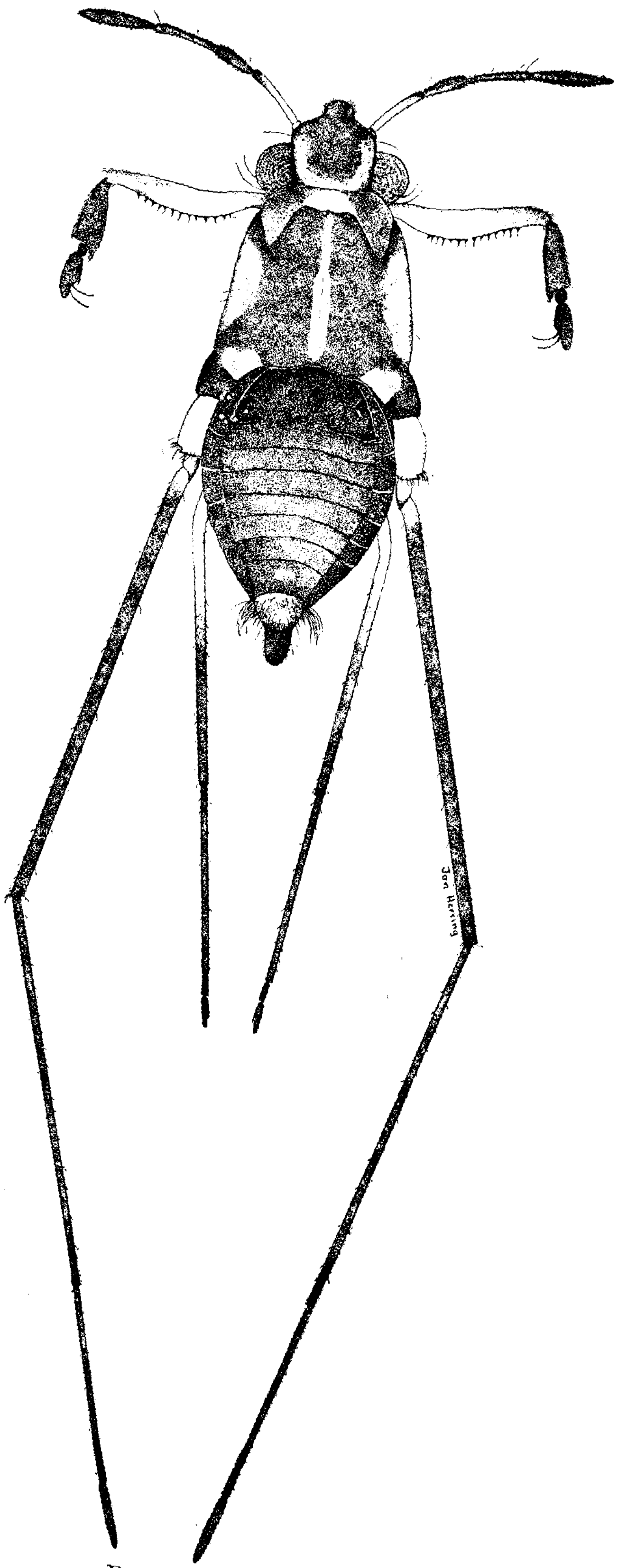

Plate I

Rheumatobates crinitus, n. sp.

Holotype male

is from 37 to 41 with a mean of 39.0. Further, there appears to be a few more hairs on the genital segment of the male of *crinitus*, and the spines on the anterior femur are perhaps faintly shorter and slightly farther apart than in *vegatus*.

The female of *crinitus* can be distinguished from *R. clanis* and *R. minutus* by having the fourth antennal the longest, and can also be distinguished from the latter by being much larger. The color pattern is also quite distinct.

DESCRIPTION OF APTEROUS FORM, MALE. *Length* 2.24 mm. *Head:* Nearly as broad between the eyes as long. A stout hair between the eye and base of antennae, two hairs directed forward from the posterior margin of each eye, and two shorter hairs on each side of lateral margin of head above anterior margin of eyes. Tylus fairly prominent. Beak smooth and hairless, *Antenna:* First joint nearly as long as the head; slender, without long hairs. Second short, about one-half as long as first; third slender, with two strong slender setae on the apical one-third, one slender spine on basal-half and a few fine, long hairs. Fourth, the longest, slender at base, swollen at apex. Antennal formula (I: II: III: IV): 20: 10: 15: 22. *Thorax:* Pronotum narrow at middle. Lateral lobes greatly prolonged, almost three times as long as the length of pronotum at middle. Mesonotum somewhat broader than long, about six times as long as pronotum, not defined from the pleura. Metanotum about two-thirds as long as mesonotum. *Anterior legs:* Ratio (Femur: tibia: tarsus): 22: 10: 10. Femur swollen at middle, posterior margin with a double row of black setae occupying the middle of femur, the basal and apical one-quarter being devoid of spines. The most dorsal row contains about 12 triangular pointed spines, varying from 10 to 13 in the other specimens. This row preceded at base by a slender long seta. The ventral row of 5 slender setae longer than the spines. Tibia with 2 long hairs on apical one-third. Tarsal claws long, slender, almost straight, slightly curved at apex. *Intermediate legs:* Coxa provided with long hairs at the apex. Femur and tibia provided on inner margin with short, curved hairs. Tibia approximately 5/6ths the length of femur. Basal joint of tarsus 2½ times as long as apical joint. Ratio (femur: tibia: tarsus): 60: 52: 37. *Hind legs:* Straight, reaching almost to the basal 2/5ths of intermediate tibia. Femur provided on inner margin with a row of very fine, pale hairs which taper in length from base to apex of femur; those on the base longer than the diameter of the segment. Tibia about 3/5ths the length of the femur. Tarsus ½ the length of the tibia. Basal joint of the tarsus shortest, 2/3rds the length of second joint. Ratio: 40: 23: 11. *Genital segments:* First genital segment expanded at base, constricted near the middle, then sides parallel to apex. A patch of long curved hairs on sides reaching to apex of first genital segment. These hairs arise on each side of the middle of the dorsal surface and on the lateral margins of the segment. The ventral surface is free of long hairs. *Genitalia*[2]*:* The dorsal and ventral shafts of crinitus exist as two separate pieces. The ventral shaft is long and slender and terminates in a finely coiled thread.

DESCRIPTION OF APTEROUS FORM, FEMALE: *Length* 2.95 mm. *Antenna:* Slightly longer than in the male, Ratio: 20: 10: 18: 23. *Anterior legs:* Ratio: 22: 11: 11. Femur much more slender than in the male. Posterior margin with a row of slender, long setae, those at the middle much longer than the diameter of the segment at the point where they arise. Two long setae dorsal to the first row. *Hind legs:* Ratio: 40: 25: 13. *Genital segment:* Elongate, as long as the mesothorax, broad at base then suddenly constricted before the middle and ending in a slender tubular structure. Dorsal surface clothed on either side with numerous prominent, black setae.

COLORATION: The following description, based primarily on the holotype and allotype, was made while these two specimens were in alcohol. Comparisons were made with dried specimens and there is very little difference. The dried specimens tend to be slightly more silvery, especially on the areas of the body that are clothed in fine pubescence, and the gradations from light brown to rich dark brown are not as distinct—their general coloration appearing slightly darker. Re-immersion in alcohol restores the color gradations.

COLORATION OF MALE: Abdomen, anterior tibia, tarsus, tylus and fourth antennal segment dark brown, almost black . The remainder of the head medium brown with a broad U-shaped stripe following the posterior and lateral margins of the head, light yellowish brown. This stripe ends just beyond the anterior margin of the eyes. The prothorax has a median rectangle of clear yellow, the remainder of prothorax medium brown, margined by a lighter stripe. On the mesothorax, there is a middorsal stripe of yellow extending from the prothorax and fading into pale brown on the posterior margin of the mesothorax. This stripe bordered by pale brown on each side. Remainder of dorsal surface of mesothorax dark fuscous brown. There are two irregular shaped patches of light yellow-brown on each pleura. The patches tend to merge into one large patch on each side in the other specimens. Basal segment of antenna yellow, tipped with light brown at apex. Remaining antennal segments dark brown, lighter at their bases. Anterior coxae and trochanter pale yellow. Base and apex of femur brown, that on the apex extending along anterior and posterior margin as a narrow stripe. Remainder of anterior femur yellow. Coxae of middle legs light yellow ringed with black at the apex. Trochanter light, darker toward apex. Femur pale brown at base, remainder of femur, tibia and tarsus dark brown. Posterior coxa, trochanter, and basal half of femur pale. Remainder of leg dark brown. Entire sternum, coxa and ventral side of head pale yellow. A ragged yellow stripe along the outside of the connexivum. Venter dusty brown. Eyes dark ruby red. Beak shining, light brown with apical segment dark brown, almost black.

COLORATION OF FEMALE: The coloration of female is almost identical with that of the male. The stripe on the mesothorax of the allotype is much narrower than that of the holotype. In some of the other specimens

[2] In Schroeder's work on the genitalia of the Genus *Rheumatobates* (1931), he reports that in the forms studied, the shafts are completely fused so that no joint is perceptible.

the stripe is approximately the same width. The yellow stripe on the outside margin of the connexivum in the female is over twice as wide as on the male. There is also an oval yellow to light brown spot on the dorsal surface of the genital segment. The entire ventral surface of the female is pale yellow except the caudal half of the genital segment and the lateral margins of the venter which are brown.

COMPARISON OF COLORATION WITH THAT OF R. VEGATUS. The coloration is quite similar to that of *vegatus*. The general color pattern is much lighter in the Florida form. The line on the mesothorax of the holotype is much more prominent and slightly wider than in *vegatus*. The spot on the pronotum is more yellowish and the legs beneath toward the base are pale, while in *vegatus* the legs are light brown. The front legs of *crinitus* are brownish yellow, much darker in *vegatus*.

Generally, the coloration of *crinitus* is somewhat variable. In the series taken from Big Pine Key, Florida, the yellow coloration is quite prominent. The stripe on the mesothorax is at least twice as wide as on the Lake Worth and Perrine, Florida series. This may be due to the ecological conditions of the habitat, since the Big Pine Key specimens were taken in the brilliant sunlight of the Gulf, while those from Perrine and Lake Worth were in more or less densely shaded mangrove swamps. I can determine no structural differences between this series and the other specimens.

MATERIAL EXAMINED: 365 specimens: 130 males, 235 females, all from Florida as follows: *Palm Beach County*, Singer Island in Lake Worth T42S, R43E, NE ¼ of S27, 115 males, 220 females (including holotype, allotype, paratypes) June 11, 1947. *Dade County*, 2.5 miles southeast of Perrine in Biscayne Bay, 8 males, 12 females (paratypes) April 8, 1948, E. D. McRae, Jr. and the author. *Monroe County*, southwest end of Big Pine Key in the Gulf of Mexico, approximately 35 miles northwest of Key West, 7 males, 3 females. November 27, 1947, E. D. McRae, Jr.

HOLOTYPE, ALLOTYPE, and PARATYPES in the museum of Zoology, University of Michigan; additional paratypes in the Carl J. Drake collection, Roland F. Hussey collection, and in the author's collection.

ECOLOGICAL NOTES

Rheumatobates crinitus was collected in salt water only. At one time there was a continuous series of lagoons along the entire east coast of Florida, but now most of them are connected by narrow passages through mangrove swamps and salt marshes, through which wander crooked tidal rivers. It was from such coastal marshes that *R. crinitus* was collected. The first locality, Lake Worth in Palm Beach County, is a straight lagoon about 22 miles long and approximately ½ mile wide, and is connected with the ocean on the east by Palm Beach Inlet, which separates Singer Island from Palm Beach proper. The island is bordered on the Lake Worth side by extensive growths of mangroves, where, in small tidal rivulets winding under the aerial roots, *R. crinitus* was taken in great numbers. They congregated in compact schools, moving only fast enough to keep their position and not be washed away by the tide. When disturbed, they scattered for a short time but soon returned to form colonies. The only other hemipteran taken in this area was *Rhagovelia plumbea* Uhler. Adults of this species were seen zigzagging in and out of the groups of *crinitus* and many nymphs were taken with the series of *crinitus*.

The second collection of *crinitus* was made on the gulf side of Big Pine Key in Monroe County. Here, they were found in the still water of a shallow mangrove swamp bordering Big Pine Channel. In this swamp the mangrove is much more sparse and the water receives full sunlight for most of the day. Adults and nymphs of *Rhagovelia plumbea* Uhler were taken with *crinitus*.

The third series was collected in a roadside canal in a mangrove swamp southeast of Perrine. This canal connects by means of a dense mangrove swamp with Biscayne Bay.

It appears that *Rheumatobates crinitus* is limited to the mangrove swamps of South Florida since fairly extensive collecting in the freshwater situations throughout the state and the salt marshes of North Florida have not revealed this species.

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NOTES ON THE VARIATION OF THE METROBATES OF FLORIDA (HEMIPTERA, GERRIDAE)

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JON L. HERRING, University of Florida, Gainesville

Inspection of numerous specimens of *Metrobates* collected by the junior author at various places in north-central Florida revealed to him an unexpected degree of variation in the brush-like hairs of the first antennal segment and in the extent of development of the curved hairs of the middle legs, both of which are secondary sexual characters limited to the males. This variation has led us to make a critical examination of the material at hand, with the result that we are able to recognize four distinct forms of *Metrobates* in this area. One of these has previously been described as *Metrobates anomalus* Hussey,[1] another is definitely a race of *anomalus,* while the remaining two, though differing from typical *Metrobates hesperius* Uhler, are unquestionably races of that wide-spread species.

In the course of this study we have noted several points that do not seem to have been mentioned before in connection with this genus. In the females of the species here discussed the second and third antennal segments have a relatively small number of flattened scale-like hairs at their apices below, corresponding to rudiments of the swollen combs on the same segments of the males; and the first antennal segment has one or two hairs of moderate length arising from its under side where the males of most of these *Metrobates* have a brush of long hairs of various lengths. The females, but not the males, have four or five long, widely spaced hairs on the under side of the fore femora; and the female fore tarsus is roughly one-fourth longer than in the males, both absolutely and in proportion to the tibial length.

On the ventral side of the middle leg in both sexes there is seen under high magnification a single row of extremely short oblique hairs, each one curving backward at its tip to meet the hair next behind it, forming a line scarcely more than 0.01 mm. in height along the apical half of the tibia, the entire length of the first tarsal segment, and at least the basal part of the second. This row of minute hooked hairs doubtless plays a role in the movements of the insect over the surface of the water. A similar band of hairs occurs on the *hind* legs of *Trepobates* (e.g., *T.*

[1] *Florida Entom.* 1948, 31 (4): 123.

subnitidus), and in other gerrid genera these extremely small hairs may be present or absent and may or may not be curved backward at the tips as described above.

Metrobates hesperius hesperius Uhler

It becomes necessary for us to use a trinomial designation for the typical form which is widely distributed in the northern states. In the males of this race the first antennal segment bears several types of hairs on its lower side: (1) a linear series of short oblique (almost prostrate) curved hairs beginning near the base of the segment and gradually becoming longer, more erect and straighter until, beyond the middle of the segment, they are not distinguishable among the hairs of the next type; (2) short bristly hairs, distinctly shorter than the thickness of the segment, beginning at about the basal third of the segment and continuing to its apex, most numerous on the apical third where they are densely and closely set; (3) long slender hairs, some of which are 2 to 2½ times as long as the segment is thick, forming a fairly thick brush on the middle third of the segment and occurring sparsely on the apical third. The second and third segments are shortly pilose beneath and the former has also one or two longer hairs.

The middle legs of the male are provided on their inner side with numerous, rather closely set, long curved hairs occurring on the entire length of the femur and the basal two-fifths of the tibia, set in a single linear series on the tibia but less regularly arranged on the femur where they form two or even three very irregular rows; among them are others about half as long. The hind femur bears a single row of shorter *hooked* hairs—not uniformly curved from the base, but bent obliquely just before their tips—on the basal two-fifths of its length below, and its upper side has about four long slender hairs near the base. The specimens here described were collected on the Huron River at Portage Lake, about 15 miles northwest of Ann Harbor, Michigan, in August, 1918 (R. F. Hussey).

Metrobates hesperius ocalensis, n. subsp.

This distinct race is represented by 56 specimens from the Rainbow River in Ocala National Forest, Marion County, Florida, collected August 4, 1946 (J. L. Herring). Representative males of this series have a distinctly thinner antennal brush than in typical *hesperius,* with the oblique hairs clearly visible to the end of the segment, the short bristly hairs much less numerous and occurring only on the apical half of the segment, and the long slender hairs fewer in number on the middle portion and absent from the apical third of the segment. There are curved hairs on the middle tibia as in typical *hesperius*, but those on the middle femur are very much shorter and less conspicuous than in that form. Here too they are of two lengths, with the shorter and more oblique ones about half as long as the longer erect ones, but even the longest ones are not more than half as long as the basal thickness of the femur or ⅔ as long as its thickness on the apical part, whereas in typical *hesperius* the curved hairs are very plainly longer than the femur is thick. The apical third of the femur here bears not more than four or five rather isolated hairs of this type. The hind femur is without hooked hairs beneath on the basal part and bears only two long setae above near the base.

Metrobates hesperius depilatus, n. subsp.

This form is known to us from some 530 specimens collected by the junior author at two localities in Hernando County, Florida, some 45 miles north and west of Tampa and a few miles inland from the Gulf of Mexico. Nearly 400 of these were taken on the Weekiwachee River July 18, 1948, and the others were obtained from Salt Creek, two miles east of Bayport, on five dates between January 29 and June 20, 1948. It is worth noting that despite its name Salt Creek is a fresh-water stream and, like the Weekiwachee, discharges into the Gulf by way of Mud River. The males of this series have the brush of the first antennal segment reduced to a single pair of long slender hairs spaced about as far from one another as they are long, and the segment has the usual short oblique hairs below. The legs of this form are as in *M. h. ocalensis*.

Metrobates anomalus anomalus Hussey

This form, which also must now be known by a trinomial designation, was described from a small series taken at Kissengen Springs in Polk County, Florida, July 11, 1948 (R. F. Hussey). Repeated visits to the type locality during the following twelve months failed to yield any additional material. *M. anomalus* is very near *M. hesperius* and might be considered a melanic variety of that species were it not for certain slight differences which seem to be significant, both in the type material and in specimens from other localities. The first antennal segment is somewhat shorter, averaging 1.19 times as long as the maximum width of the head in males and 1.01 in females, as compared with 1.35 and 1.09 respectively for the two sexes of *hesperius;* as compared with the length of the other three segments conjoined, the ratio is 97 : 100 in the males and 83 : 100 in the females, while in *hesperius* these ratios are respectively 104 : 100 and 93 : 100. The hind femur of *anomalus* is slightly shorter than that of *hesperius,* averaging 4.15 times as long as the head is wide (both sexes), while in *hesperius* this ratio is 4.40 for the males and slightly less for the females. It must be noted, however, that these ratios are averages, based on twelve specimens of *anomalus* and thirty-two specimens of the various subspecies of *hesperius.* Among these there are individuals of both species which approach one another so that intergrades are known to occur.

The male claspers of the two are quite similar, but in *anomalus* the dorsal prolongation is narrower, the posterior margin is not at all sinuate, and the thin expanded distal portion seems more strongly bent downward over the top of the genital segment. In the original description Hussey used the relative lengths of the two parts of the metanotum for separating the females of the two species, but critical examination of additional specimens of both species has shown that this is not a good character. Not only does some variation occur within each species, but in numerous individuals the boundary between the two sclerites is obliterated on the middle portion.

In the original description of *M. a. anomalus* no mention was made of the hairs on the legs of the male. Re-examination of the paratypes at hand shows that these hairs are very much reduced in number, the femur having at most four or five of the longer curved hairs on the apical fifth of its length, while the tibia may have from four to eighteen, all located on the basal fifth. The hind femur is without hooked hairs on its basal portion below.

Metrobates anomalus comatipes, n. subsp.

Numerous specimens taken by G. K. Reid, Jr., at Sweetwater Springs, Marion County, Florida, July 3, 1948, and by the junior author at Little Orange Creek in western Putnam County, May 22, 1947, are evidently referable to *M. anomalus* but differ sufficiently to constitute a distinct race. The antennal brush is somewhat thicker than in typical *anomalus,* while the pilosity of the middle and hind legs is like that of typical *hesperius* and thus is much heavier than in the *anomalus* originally described from Kissengen Springs.

Holotypes of the three new subspecies herein described will be deposited in the Museum of Zoology of the University of Michigan, those of *M. h. depilatus* and *M. a. comatipes* being respectively from the Weekiwachee River and from Sweetwater Springs, with the collecting data as given above. A female from the corresponding series in each case has been designated *allotype* and will be deposited with the male *holotypes,* but it should be stated that we are unable to differentiate the females of the various subspecies within each species treated herein. The males can be separated as follows:

1. First antennal segment shorter, averaging about 1/5 longer than the width of the head including the eyes, slightly shorter than the other three together; dorsal coloration largely black, the mesonotum and mesopleuron as seen from above not marked with gray, except through reflection from the pilosity. *(M. anomalus)* 2
   First antennal segment longer, averaging about 1/3 longer than the width of the head, slightly longer than the other three segments together; mesonotum and mesopleuron as seen from above marked with gray. *(M. hesperius)* 3

2 (1). Middle femur with only a few long curved hairs on the apical portion or with none, curved hairs on tibia only on the basal fifth of its length; hind femur below without hooked hairs basally. .... *M. anomalus anomalus* Hsy.
   Middle femur thickly provided with long curved hairs within for its entire length, curved hairs of tibia extending over the basal 2/5 to 1/2 its length; hind femur with shorter hooked hairs beneath on basal third or more .... *M. anomalus comatipes* n. subsp.

3 (1). First antennal segment with a brush of long hairs below on the middle portion, in addition to the more abundant but much shorter hairs covering most of the lower surface 4
   Brush of first antennal segment reduced to two long hairs about as far from one another as they are long, this segment also short-pilose below for almost its entire length; legs as in the subspecies immediately preceding. .... *M. hesperius depilatus* n. subsp.

4 (3). Middle femur on its inner side thickly clothed with long curved hairs for most or all of its length, in addition to more numerous shorter hairs which are about half as long as the ones just mentioned; hind femur with moderately long backwardly directed hooked hairs below on the basal third or more of its length. .... *M. hesperius hesperius* Uhl.
   Middle femur almost or wholly devoid of long curved hairs, those present not more than 2/3 as long as the femur is thick; hind femur without hooked hairs below .... *M. hesperius ocalensis* n. subsp.

CONTROL OF BUDWORMS AND HORNWORMS IN FLUE-CURED TOBACCO[1]

L. C. KUITERT and A. N. TISSOT[2]

Seven of the newer insecticides were tested on tobacco in a small plot experiment in the summer of 1948. DDT, Toxaphene, and Rhothane were much superior to all other materials in controlling budworms and hornworms. Parathion and Marlate gave good control of hornworms, but practically no control of budworms, and the plots receiving these treatments showed nearly as much plant injury as the check plots. Chlordane and Isotox were intermediate between the two groups but more nearly like the less effective materials. The wide variation in the degree of control obtained with the different insecticides clearly showed the need for further work. It was decided to repeat the experiment in 1949 and in this test larger plots were used and a larger number of materials were tested. The results of these tests are given in the pages that follow.

PLOT ARRANGEMENT.—The tobacco field used in the 1949 tests was approximately square and contained slightly less than one acre. The land sloped gently to the North and the field lay below a long and somewhat steeper slope. Early in March the land was prepared and the fertilizer applied but dry weather prevented planting until April 4. It began to rain just as the last plants were set and during the next 24 hours 7.14 inches of rain fell. Torrents of water rushed down the slope and through the tobacco field causing considerable damage. Many of the newly set plants were washed entirely out of the ground and others were completely buried. Recovery from the washing was surprisingly good but even with much replanting, many plants were missing and growth of the tobacco was uneven throughout the season. Scattered irregular areas of heavy rootknot infestation added a further complication. These various factors made it evident almost from the start that plot yields would be of little or no use in evaluating the effectiveness of the different insecticides.

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[1] Contribution from Entomology Department, Florida Agricultural Experiment Station, Gainesville, Florida.

[2] The writers are indebted to Mr. Fred Clark of the Agronomy Department, Florida Agricultural Experiment Station, who supervised the planting, cultivating, harvesting, and curing of the experimental tobacco and who gave other valuable assistance with the tests.

The experimental area was divided into 48 four-row plots arranged in three blocks of 16 plots each. Each of the plot rows contained 30 plants at planting time, but when the insecticide applications were made only two plots had their full complement of 120 plants. The poorest plot, which happened to be a check, contained only 71 plants. This plot arrangement provided for three replications of 15 treatments which included 11 dusts, three sprays and a poison bait. Each treatment appeared once in each block and the various treatments were located at random within the blocks. No buffer rows or alleys were left between plots or blocks as the 1948 tests showed that the slight drift of insecticides from plot to plot could be disregarded.

METHOD OF APPLICATION.—Dust materials were applied with rotary type (Root) hand dusters. Rather complete plant coverage was attained at the first application but when the plants got larger the dust was directed principally at the buds and upper leaves of the plants. An attempt was made to use equal amounts of the different dusts but in spite of all efforts there was considerable variation in the amounts actually applied.

Through an oversight the amounts of dust used at the first application were not determined. The amounts used at the second and third applications are shown in Table 1.

The sprays were applied with a continuous pumping (Champion) knapsack sprayer. In the first application the sprays were used at the rate of approximately 80 gallons per acre. In the second and third applications about 125 gallons per acre were used.

A pinch of the poison bait was applied with the fingers to the bud and upper leaves of each plant in the plot receiving this treatment. The amounts of bait used at the second and third applications are given in Table 1.

MATERIALS USED.—The materials tested, the formulations and concentrations used, and the sources of the materials were as follows: *Dusts*—(1) Toxaphene 10 percent, Alltox 100 made by California Spray-Chemical Corporation and purchased from a local insecticide store; (2) Toxaphene 5 percent, made by mixing equal parts of the above and Pyrax; (3) Rhothane 3 percent, prepared from 50 percent wettable powder, obtained from Rohm and Haas Company, and Pyrax; (4) Experimental Insecticide 497 1 percent, an experimental sample furnished by Julius Hyman and Company; (5) DDT 5 percent, Gesarol A-5 an agricultural dust prepared by Geigy Company, Inc.; (6) DDT 3 percent, Gesarol A-3 an agricultural dust from Geigy; (7) Parathion 1 percent, the dust for the first two applications prepared from 25 percent wettable powder, furnished by American Cyanamid Company, and Pyrax, and for the third application a 1 percent commercial dust purchased locally; (8) Isotox 1.5 percent gamma, Isotox 15 a commercial dust prepared by California Spray-Chemical Corporation; (9) Lead Arsenate 16 percent, prepared by mixing 1 part of commercial lead arsenate with 5 parts of Pyrax; (10) DDT 2.5 percent plus Parathion 0.5 percent, prepared by mixing equal parts by weight of materials 5 and 7 above; (11) DDT 2.5 percent plus Toxaphene 5 percent, prepared by mixing equal parts of materials 1 and 5 above; *Sprays*—(12) Tetraethyl Pyrophosphate, Vapotone 20 percent made by California Spray-Chemical Corporation, used at rate of one pint per 100 gallons of water; (13) Parathion, Vapophos 15 percent wettable powder made by California Spray-Chemical Corporation, used at 1 pound per 100 gallons of water; (14) Toxaphene, Alltox Wettable 400, a commercial 40 percent wettable powder, made by California Spray-Chemical Corporation, used at 2.5 pounds per 100 gallons of water; *Poison Bait*—(15) Chlordane bait, a commercially prepared bait containing 1.5 percent of chlordane in a citrus pulp base.

DATES OF APPLICATION.—The first application of insecticides was made May 18, 1949 between the hours of 5:30 and 7:30 A.M. Dusting conditions were good though there was a light variable breeze at times. The plants were wet with dew, the soil was dry, but the plants were not wilted at time of application. During the heat of the day the tobacco wilted badly.

On June 4, the second insecticide application was made from 5:00 to 7:50 A.M. Dusting conditions were excellent. There was practically no air movement and the dusts hung in the air about the plants with only a slight drift. The soil was dry and there was a light dew on the plants.

The third application was made June 16, from 5:00 to 7:30 A.M. Again dusting conditions were excellent. As before, the plants were wet with dew and the soil was fairly dry.

TEST INSECTS.—The principal insect pests on the tobacco were the tobacco budworm, *Heliothis virescens* (F.) and the tobacco hornworm, *Protoparce sexta* (Johan.). For several weeks the tobacco was surprisingly free of insects but by the middle of May some budworm damage began to appear and hornworm larvae were fairly common. The budworm infestation developed rapidly and by June first 25 percent of the plants in the check plots showed recent larval injury. Counts made in the middle of June showed that 50 percent of the plants in the check plots and in those treated with the less effective insecticides had been injured recently. Worm damage rapidly became more noticeable and by the end of June some plants were reduced to stems and bare midribs.

Winged aphids were noted frequently on the tobacco and at times they were so numerous that three or four individuals would be found on a single leaf. Specimens of the aphids were collected by means of a camel hair brush dipped in 70 percent alcohol. The green peach aphid, *Myzus persicae* (Sulzer), was taken every time a collection was made and on one occasion 20 individuals of this species were collected in less than an hour. They frequently were seen producing young but they rarely were successful in establishing themselves. During the entire season three or four small colonies were noted but these never contained more than a dozen individuals. This could not be attributed to the insecticides since there was a narrow border of untreated plants around the edges of the field in addition to the check plots. No satisfactory explanation could be given for the failure of the aphids to become established.

EVALUATION OF INSECTICIDES.—When insect damage began to appear in the field, it was already evident that the poor stand and uneven growth of the tobacco would make plot yield records of no value for comparing the effectiveness of the various insecticides. Careful counts of the larvae and observations on feeding damage seemed to be the most practical method available. In the count made May 16 preceding the first insecticide application, ten plants selected at random in every fourth row of the field were examined. The 120 plants thus examined had a total of 20 budworms and 42 hornworms. In the post-treatment count following the application, every fourth plant in each of the two inside rows of the plots was examined until a total of 10 plants per plot was checked. These early counts showed that the larvae were distributed very unevenly through the field and that examination of only a few plants per plot would not give a true picture of the infestation. In subsequent counts every plant in each plot was examined carefully and all larvae recorded. Sometimes the larvae could not be found even though there was evidence of recent feeding so the number of freshly injured plants also was recorded. It was felt that the counts made at the time of the first insecticide application had no significance because too few plants were examined so they are not recorded here. The number of larvae found before and following the second and third applications and the number of freshly injured plants noted at the pretreatment counts, are summarized in Table 1.

DISCUSSION.—The data given in the table clearly show that eight of the treatments gave excellent control of both budworms and hornworms. It is just as evident that the TEPP and Parathion sprays had very little if any effect on the larvae and that they failed entirely to protect the plants from injury. The remaining five treatments obviously gave some larval control and varying degrees of plant protection but the benefits were so small that it would be impractical to use them.

Although the table shows striking differences between the various materials, the figures alone do not give a complete picture. Attention is called to the small numbers of larvae found at the pretreatment counts in the plots receiving Experimental Material 497 (now known as Octalox), DDT, Toxaphene, and Rhothane. These attest to the excellent residual qualities of these insecticides and their value in preventing or delaying reinfestation. Likewise reference should be made to the plants with fresh injury. Plants were recorded as injured even though the damage was slight. In some cases the larvae that caused the injuries were newly hatched and it was quite certain that they would succumb to the insecticide within a few hours. A word of explanation also is needed relative to the hornworm counts at the June 16 application. In many cases the post-treatment counts are higher than the pre-treatment ones and this is especially noticeable in the plots receiving DDT 2.5 percent plus Parathion 0.5 percent and DDT 3 percent. At that time the hornworm moths were unusually active and they were laying eggs freely. Apparently the insecticides had little deterrent effect and they did not prevent the eggs from hatching. The majority of hornworm larvae, and to a lesser extent the budworms, were newly hatched ones which almost certainly were killed by the better insecticides before they could cause any material plant injury.

The Toxaphene spray appeared to be somewhat less effective than the Toxaphene dusts. This probably can be attributed to in adequate coverage with the spray. When the tobacco grew

TABLE 1.—EFFECTIVENESS OF INSECTICIDES IN CONTROL OF TOBACCO BUDWORMS AND HORNWORMS.

Materials	Total No. of Plants in 3 Plots	Application Made June 4						Application Made June 16					
		Amount Used—Pounds per Acre	No. of Plants with Fresh Injury	Number of Larvae Found				Amount Used—Pounds per Acre	No. of Plants with Fresh Injury	Number of Larvae Found			
				Budworms		Hornworms				Budworms		Hornworms	
				Pre-treat	Post-treat	Pre-treat	Post-treat			Pre-treat	Post-treat	Pre-treat	Post-treat
TEPP Spray 1 pt. 20% : 100 gals.	330		66	41	28	12	14		142	100	119	40	61
Toxaphene 10%	344	42	17	10	6	0	1	44	14	6	4	1	0
Toxaphene 5%	330	47	26	23	7	0	0	55	18	14	5	0	1
Rhothane 3%	319	45	28	19	1	2	0	36	13	8	4	0	4
Parathion Spray 1 lb. 15% : 100 gals.	318		66	47	27	5	3		168	107	90	62	66
DDT 2.5% plus Parathion 0.5%	323	40	23	9	7	5	4	19	13	6	4	1	23
DDT 2.5% plus Toxaphene 5%	318	37	20	11	6	0	0	22	17	13	6	0	3
Experimental Insec i cide 497 1%	277	35	7	6	1	3	0	39	3	2	2	1	4
DDT 5%	335	26	11	5	2	2	1	32	17	12	7	1	6
Check	287		72	45	42	4	6		143	102	136	49	83
Chlordane Bait	286	6	31	18	9	0	4	4	83	40	29	45	91
Lead Arsenate 16%	283	29	40	24	27	6	2	45	111	103	65	20	10
Parathion 1%	333	52	47	31	26	9	0	43	127	97	95	33	26
Toxaphene Spray 2.5 lbs. : 100 gals.	302		39	30	7	3	2		36	31	24	0	14
Isotox 1.5% gamma	293	24	20	8	6	5	2	29	89	57	66	19	75
DDT 3%	329	19	7	3	0	0	1	50	23	17	7	5	13

Pretreatment larval counts made June 3 and June 13-15; Post-treatment counts made June 7-8 and June 20-22.

large it was most difficult to get complete coverage with the type of sprayer used and some of the leaves likely did not get enough of the insecticide to protect them.

PHYTOTOXICITY.—Although some of the insecticide applications were considerably heavier than are recommended for tobacco, no evidence of insecticide injury was noted at any time during the 1949 tests. It is true that no yield records were taken and it cannot be said positively that none of the materials adversely affected production but there was nothing to indicate that such was the case.

CONCLUSIONS.—Of the 15 different insecticidal formulations used, Toxaphene, DDT, Experimental Insecticide 497, and Rhothane were outstanding in controlling tobacco budworms and hornworms. Lead Arsenate and Parathion dusts gave some control of the budworm and hornworm but were considerably inferior to the better materials. The Isotox and Chlordane bait treatments were effective during periods of light infestations but were definitely inferior to the better materials. When larval infestations were heavy, TEPP and Parathion sprays failed to give any appreciable control of budworms or hornworms, while the Toxaphene spray gave fair control in spite of rather poor coverage. The green peach aphid failed to become a serious pest in any plot during the season although the limiting factor could not be traced to the use of the insecticides. No phytotoxic reaction was noticed on any plant at any time.

RESEARCH NOTES

AN INTERESTING INSECT ASSOCIATION.—During the spring of 1948 Mr. T. E. Brooks of the Plant Pathology Department, Kansas State College, brought some parasitic wasps to me for examination. He stated that the wasps had emerged from packrat droppings which he had collected in Morris County, Kansas for purposes of culturing fungi. After collecting the droppings they were placed in petri dishes and stored at room temperature. Mr. Brooks reported that he had observed small wasps inside the petri dishes on numerous occasions.

The following observations were made from a study of several hundred packrat droppings furnished me by Mr. Brooks. Two species of coleoptera and two species of parasitic hymenoptera were obtained from the droppings. In numerous instances large it was most difficult to get complete coverage with the type of sprayer used and some of the leaves likely did not get enough of the insecticide to protect them.

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The following observations were made from a study of several hundred packrat droppings furnished me by Mr. Brooks. Two species of coleoptera and two species of parasitic hymenoptera were obtained from the droppings. In numerous instances larval, pupal, and adult stages of the beetles were present. Burrowing of the beetles back and forth through the droppings had reduced some of them to a thin hard shell containing a little powdery dust. Droppings which had small emergence holes in them never contained any form of the insects and were always found to be reduced to a hollow shell. In several instances some stage of both species of coleoptera were found in the same dropping. In one instance two individuals of a ptinid were found in the same pellet. Some of the droppings contained the pupal stage of a hymenopterous parasite.

Specimens of the beetles and parasitic wasps were forwarded to the National Museum for identification. The beetles were identified as *Oryzaephilus surinamensis* (L.) Cucujidae and *Ptinus hirtellus* Sturm syn. *brunneus* Duft. (Ptinidae) by W. S. Fisher. The hymenopterous parasites were determined as *Hemitrichus rufipes* Thomsen and *Muscidifuras* sp. by A. B. Gahan.

Doctor C. F. W. Muesebeck in Charge of the Division of Insect Identification, Bureau of Entomology and Plant Quarantine, in a letter to the writer, made the following comments: "According to our records *Hemitrichus rufipes* has never been reared before. We have been ignorant of its host. The ptinid is a common species which occurs under a variety of conditions, but Mr. Fisher knows of no record indicating the association you have observed."

The writer failed to determine whether the parasites were host specific. The correct relationship of the host-parasite also was not determined.—L. C. Kuitert, Entomology Department, Florida Agricultural Experiment Station, Gainesville.

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