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FOOD OF CHIRONOMID LARVAE IN POLK COUNTY LAKES [1]

MAURICE W. PROVOST AND NINA BRANCH

The lakes of the Winter Haven area of Polk County, Florida, produce Chironomidae (= Tendipedidae), locally called "blind mosquitoes", in large numbers. *Glyptotendipes paripes* predominates, and *Tendipes decorus* is the most common of the lesser species. In the summer of 1956 a preliminary survey was made to determine whether nutrient effluents were the cause of eruptions of chironomid populations. Limnological and entomological assessments were made concurrently on thirteen lakes. Larval stomachs of *G. paripes* and *T. decorus* were studied for comparisons of food with the lake planktons. Larvae collected in January 1957 were then used for seasonal comparisons, although the plankton was not sampled at that time for lack of personnel.

The summer field work was done by two men: E. H. McConkey of the State Board of Health's Bureau of Entomology did the limnological work and Harry J. Hutton of the Polk County Arthropod Control Program did the larval sampling and lake bottom survey. Assistance in the ion measurements was rendered by the Bureau of Laboratories of the State Board of Health while the Bureau of Sanitary Engineering advised on B.O.D. and O_2 measurements. Plankton determinations and counts, in water samples and in stomachs, were made by the junior author. The winter larval collections were made, again, by Harry J. Hutton.

I. THE LAKES

Since it was desirable to learn the role of pollution in chironomid production, the study lakes were selected as follows: *Undisturbed*, Lakes Thomas (Auburndale) and "X" (Lake Wales); *"Industrial"*, with canning plants only significant nutrient source, Lakes Tracy (Haines City) and Conine (Winter Haven); *"Citrus"*, grove fertilizer runoff only significant nutrient source, Lakes Tennessee (Auburndale) and "Y" (Lake Wales); *"Septic-tank"*, with non-sewered homes only possible nutrient source, Lakes Deer (Winter Haven) and Lena (Auburndale); *"Sewage-plant"*, receiving effluents from sewage-treatment plants, Lakes Gibson (Lakeland) and Effie (Lake Wales); *"Chain-o-lakes"*, interconnected lakes with sewage-treatment plant, canning plants, septic tanks, and fertilizer run-off all as possible nutrient sources, Lakes Cannon, May, and Lulu (Winter Haven). Morphometric, limnological, and chironomid surveys were made on these 13 lakes in the summer of 1956.

The lakes varied from 3 to 635 acres in size and 4 to 22 feet in maximum depth. They were mostly quite turbid, with Secchi disc visibilities running from 6 inches to 4 feet in all but the two undisturbed lakes where they were 5 to 12 feet. Water temperatures (summer) ranged from 26.5° C to 32.0° with little change from surface to bottom. The pH readings ranged from 4.4 to 9.5, the two undisturbed lakes being quite acid (4.4-5.0) and the 11 disturbed lakes being circumneutral to basic. Alkalinity was low in the undisturbed lakes (6-9 p.p.m.) and medium (max. 197 p.p.m.) in the disturbed lakes. Dissolved oxygen one foot off the bottom ranged from zero

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to 14.1 p.p.m. and from 0 to 191% saturation, the supersaturations associated usually with algal blooms. The biological oxygen demand (B.O.D.) ranged as a means from 0.4 p.p.m. in the undisturbed lakes to 11.4 (7.6-19.0) p.p.m. in the lakes with sewage-treatment plants. Potassium ranged from 0.4 to 0.8 p.p.m. in the undisturbed lakes and from 1.4 to 4.9 p.p.m. in the disturbed lakes. Phosphates ran from 0 to 2.0 p.p.m. and ammonia from 0.05 to 0.57 p.p.m. Nitrates ranged from 0.22 to 8.86 p.p.m.

Temperatures in both disturbed and undisturbed lakes were only slightly higher than those recorded for an undisturbed lake and pond in the Welaka area by Pierce (1947). In all chemical characteristics, O_2, pH, alkalinity, and dissolved ions, the undisturbed lakes closely resembled Pierce's waters while the disturbed lakes were higher on virtually all counts. The high potassium levels of the disturbed lakes may be the result of commercial fertilizer washing in as well as increments from sewage plant effluent. Barrett (1957) showed that this ion is not used by plankton much beyond the naturally occurring levels (usually < 1 p.p.m.), therefore its artificial excess in disturbed lakes should give an indication of the artificial load of phosphates and nitrates introduced simultaneously but possibly consumed by plankton.

The artificial introduction of nutrient ions apparently resulted in a great increase in pH and in plankton, especially Myxophyceae (Brannon, 1945), and the plankton in turn increased the dissolved oxygen. The sum total of morphometrical and physical measurements is a fairly representative picture of central Florida lakes, all of which are essentially eutrophic. The differences in chemical measurements between the undisturbed and disturbed lakes reflect the eutrophication speed-up which is expected with increases in nutrient inflow (Hasler, 1947; Sawyer, 1947; Edmonton et al, 1956).

II. The Lake Plankton

Fifty-two limnological stations were established on the thirteen lakes, and all were visited two or three times between June and August. The average plankton counts per lake represent an arithmetic mean for all visits to all stations on any one lake. Plankton samples were collected one foot off the bottom, using a 3000 cc. Kemmerer sampler. A liter bottle was filled and centrifuged, the concentrate preserved with formalin and transported to Vero Beach for analysis at the E.R.C. laboratory. Identification was carried to genus in the more readily identifiable forms but for such groups identifiable only by rare specialists, as the blue-green algae (= Myxophyceae), most of the identification was to cells, filaments, spirals, or colonies only. Counting was by aliquot in a Sedgwick-Rafter cell under the compound microscope with calibrated optical micrometers.

The distribution and abundance of plankters is shown in a summary form in Figure 1. The poorness of the plankton in the undisturbed lakes is evident. There is a good correlation between plankton numbers and disturbance of the lakes by nutrient addition, this being especially noticeable in the critical blue-green algae.

Protozoa occurred in all lakes but the undisturbed Lake Thomas. They were especially abundant in Lake Lulu (7,220,048/L) where the dominant form was an actinopod, in Lake Effie (6,852,044/L) where euglenoids predominated, and in Lake "X" (1,357,024/L) where *Dinobryon* and other chrysomonads predominated. None of the protozoan forms identified belonged to the recognized "sewage protozoa".

ROTIFERS varied from 13/L in Lake Thomas to an enormous 76,564/L in Lake Lulu. Since any count above 1000 per liter is considered unusual and the highest recorded density from unpolluted waters is 5800 per liter (Pennak, 1953), it seems that the following lakes could be considered "polluted" by the rotifer criterion: May (mostly *Trichocerca* and *Brachionus*), "Y" (mostly *Brachionus, Keratella* and *Trichocerca*), Lena (mostly unidentified), and Lulu (mostly *Trichocerca*).

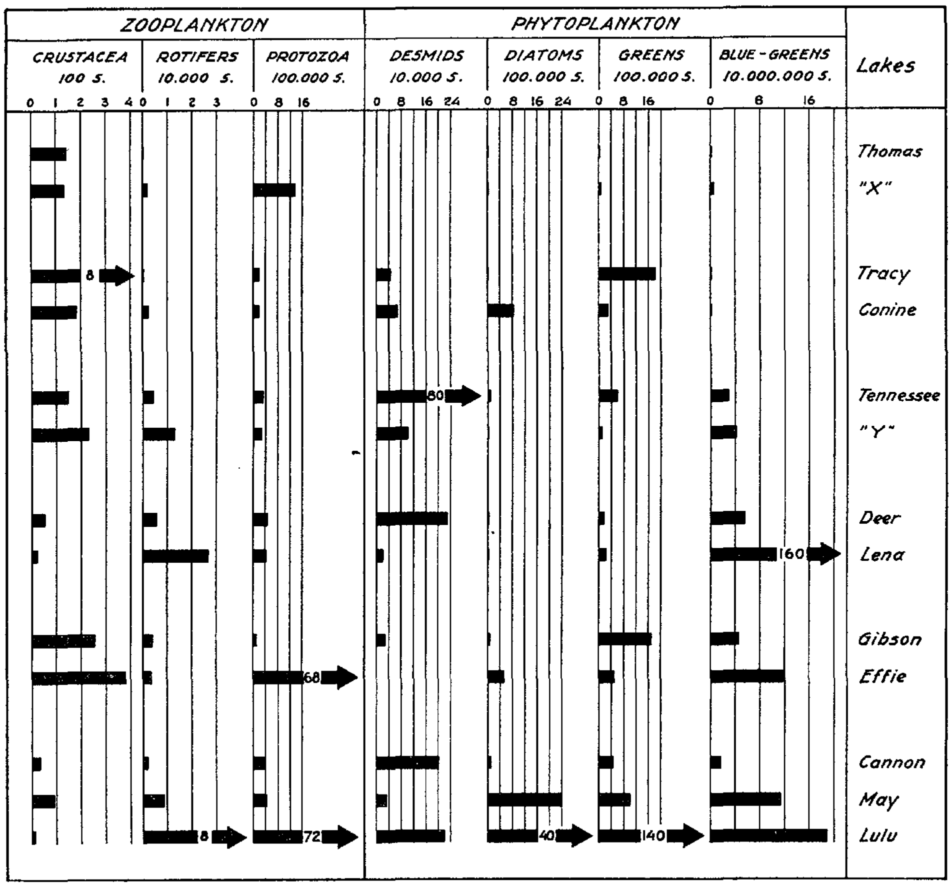

Fig. 1. Numerical occurrence of major plankton groups in Polk County lakes, summer 1956.

CRUSTACEA were scarce in all lakes. They were mostly Eucopepoda and Cladocera. The total absence of Ostracoda reflected the sparsity of vascular vegetation in these lakes.

MYXOPHYCEAE were scarce in undisturbed lakes and in "industrial" lakes. The "citrus" lakes averaged 24 and 40 million per liter while the lakes receiving effluents from either septic tanks or sewage-treatment plants averaged from 12 to 1616 million organisms per liter. The most widespread forms were round cells of various sizes (*Microcystis* type). These were especially numerous in Lakes Lulu and Effie, the two lakes on which municipal sewage-treatment plants were located. Blue-green filaments (single cells, narrow and very long) occurred in all but the undisturbed lakes; in Lake Lena, which bloomed chronically, they averaged 1,596,624,000 per liter.

CHLOROPHYCEAE, exclusive of Desmids, were found in relatively small numbers in all lakes, with *Scenedesmus* predominating. The latter averaged 13,844,000 per liter in Lake Lulu. Desmids were in very small numbers but in all lakes except the two undisturbed; the predominant form was *Staurastrum*.

BACILLARIOPHYCEAE were well under the blue-green algae in abundance. They reached above 72,000 per liter only in Lakes May and Lulu. Diatoms have a pronounced annual cycle of abundance frequently peaking in the cold season, so their position in these lakes cannot well be judged from summer sampling only.

As in their physical features, so in zooplankton the undisturbed lakes resembled those studied by Pierce (1947), but the disturbed lakes were enormously richer in rotifers, although the same genera predominated. The phytoplankton in the disturbed lakes generally exceeded densities found by Pierce, even those in the St. John's River when in algal bloom (average for summer—16,600,500 blue-green cells per liter). The green algal densities were far above Pierce's findings in the Welaka area, as were also desmids and diatoms. On the whole, the plankton densities during the summer of 1956 in the Polk County lakes more nearly resembled the classically high densities found during seasonal peaks in the Illinois River at the turn of the century (Kofoid, 1910) and in Lake Mendota (Birge and Juday, 1922) than those found in natural Florida waters by Pierce (1947).

III. THE CHIRONOMID FAUNA

Each of the 13 lakes was visited three times during the summer and systematically sampled with a 6-inch Ekman dredge. Sampling was along various transects intersecting at the center of the lake. Bottom characteristics and depth were recorded for each haul. All chironomid larvae were preserved and sent to the Vero Beach laboratory for identification and counting.

The chironomid fauna of these lakes was not very diverse. The two species whose food habits were studied were absent from the undisturbed lakes. *G. paripes*, the predominant pest species, was most abundant in the Winter Haven "Chain-o-lakes" and in the "citrus" lakes. *T. decorus* was abundant only in one of the "industrial" lakes (L. Tracy) and in one of the "sewage plant" lakes (L. Effie). The ecological influence of lake bottom type precluded any correlation directly with plankton density.

Of the 127 positive dredge hauls for *G. paripes*, 75% were on pure sand and 18% on peaty sand. The preference for sand and avoidance of muck definitely restricted this species in the deeper lakes to a littoral band of sand and peat. Small areas of sand in the deeper waters also produced this species although the surrounding muck bottoms were devoid of them. Although *T. decorus* was not absent from muck, of the 38 positive dredge hauls 92% had sand as a bottom ingredient, while peat prevailed considerably more than in the *G. paripes* sites. These apparent preferences for certain bottom types in both *G. paripes* and *T. decorus* may be related to actual preferences for tube building material. However versatile these larvae may be in utilizing materials, it has been shown that in choice experiments chironomid larvae exhibit very definite selectivity (Ohgaki, 1942). The preference of sand by *G. paripes* seems to limit the percentage of lake bottoms available to them as living substrates, in which case hydraulic dredging, commonly practiced in these lakes, may conceivably expand suitable bottom areas by mixing naturally accumulated muck deposits with sand or exposing the underlying sands.

IV. THE FOOD OF *G. paripes* AND *T. decorus*

From the summer collections, 259 *G. paripes* from nine lakes and 95 *T. decorus* from two lakes were dissected and stomach contents studied. For winter comparisons 25 *G. paripes* and 13 *T. decorus* were examined. Only large larvae were used. The contents of the forepart of the alimentary tract were much better preserved than those of the hindpart. The practice was then set of utilizing only the gut down to and including the fourth abdominal segment. The gut was dissected out of this portion of the larva and its contents, usually holding together well, were dispersed in a small amount of formaldehyde. In order to particulate the material as homogeneously as possible, the mixture was gently macerated in a mortar. From this point onwards the identification and counting of plankton—which constituted the entire contents—were carried out with the Sedgwick-Rafter cell technique given above for lake plankton studies. For convenience the larvae were pooled for each lake at each visit, the variable numbers in the pools always being correspondingly adjusted in the final "per ½ gut" datum.

Since plankters vary so much in size, the average green algal cell being about 100 times the average blue-green algal cell in volume and in turn but 1/100 the average crustacean nauplii, the commonly employed numerical representation of lake plankton (Fig. 1) gives a distorted picture of plankton as a food supply for other animals. From measurements with calibrated ocular micrometers, the volume, in cubic microns, was estimated for all the common plankters found. The lake plankton volumes were then computed (Table I) for comparisons with larval stomach contents and also computed volumetrically (Table II).

The average half-gut of *G. paripes* measured 741 million cubic microns and of *T. decorus*, 417 million cubic microns. The food totals for summer stomachs (Table II) represented stomach food densities of 10% and 1½% for the two species while the winter densities (Table III) were, respectively, ½% and 1½%. By comparison the lake plankton dilutions in the summer averaged .004% for the *G. paripes* lakes and .015% for the *T. decorus* lakes. Plankton in the larval stomachs was therefore 2500 times as concentrated in *G. paripes* stomachs as in the lake waters and in *T. decorus* 100 times. This gives a rough estimate of the efficiency of the filter-feeding mechanism in these chironomid larvae.

The larvae of *G. paripes* fed overwhelmingly (98.7%) on phytoplankton, with blue-green algae (60.7%) and green algae (31.3%) accounting for most of the dietary. The dominance between these two algal groups was evenly divided among the nine lakes. The blue-green algal food, volumetrically, was evenly divided between colonies and single cells. The green algal food occurred mainly as single cells, with *Scenedesmus* easily predominating. Desmids constituted 5.9% of the total food with a maximum in any one lake of 28.3%; the predominant form was *Staurastrum*. Diatoms, though numerous in the stomachs, nevertheless accounted for a mere 0.8% of the total food bulk. Protozoa represented the same percentage but they did reach as high as 15% in one lake. Rotifers were taken sparingly in larvae from several lakes and Crustacea only in one lake. The winter stomachs presented a very different picture, with Crustacea predominating as bulk (60.0%), green algae in second place (27.8%), and blue-green algae in a very minor role (2.4%).

TABLE 1. VOLUMETRIC ANALYSIS OF PLANKTON FROM 13 POLK COUNTY LAKES, SUMMER 1956, NINE OF WHICH PRODUCED *G. paripes* AND TWO, *T. decorus*. IN 10^6 μ^3 PER ml.

	1*	2	3	4	5	6	7	Total
G. paripes lakes								
Conine	1.0	1.2	.1	tr	3.8	.3	tr	6.6
Tennessee	4.6	2.1	11.2	tr	8.0	.4	.2	26.5
"Y"	11.1	.3	.3	tr	5.6	1.4	.6	19.4
Lena	98.0	2.2	.2	tr	3.7	3.0	tr	107.1
Deer	25.2	.5	.5	tr	5.7	.7	tr	32.6
Gibson	23.2	10.6	.1	tr	1.4	.6	.5	36.3
Cannon	4.1	1.8	.5	tr	4.9	.3	tr	11.6
May	5.8	4.2	tr	2.9	2.7	1.3	tr	17.1
Lulu	31.7	41.7	.7	1.4	8.3	7.6	tr	91.5
Average:	22.8	7.1	1.5	.5	4.9	1.7	.2	38.8
T. decorus lakes								
Tracy	tr	108.3	.4	tr	2.2	tr	4.2	115.2
Effie	33.2	1.5		tr	139.1	.5	3.2	177.5
Average:	16.6	54.9	.2	tr	70.7	.3	3.7	146.3
Non-producing lakes								
Thomas	tr	tr		tr		tr	.2	.3
"X"	.2	1.6		tr	13.5	.2	.2	15.6

* Column headings for major plankton groups: 1. Blue-green algae, 2. Green algae, 3. Desmids, 4. Diatoms, 5. Protozoa, 6. Rotifers, and 7. Crustacea.

The larvae of *T. decorus* in the summer fed also predominantly on phytoplankton (91.7%), but more on green algae (50.8%) than blue-green (26.2%). The blue-green algae were altogether single cells; the green algae were likewise single cells, with *Scenedesmus* predominating. Desmids figured more prominently (13.1%) than in *G. paripes* stomachs, with *Staurastum* similarly predominating. Zooplankton, all forms, were fed upon more than in *G. paripes*, Crustacea alone amounting to 5.0% of the food by bulk. The winter stomachs, as in *G. paripes*, contained far less blue-green algae, slightly more green algae and considerably more Crustacea.

TABLE II. VOLUMETRIC ANALYSIS OF STOMACH CONTENTS OF *G. paripes* AND *T. decorus* FROM THE LAKES OF THE WINTER HAVEN AREA, SUMMER 1956.

		G. paripes									*T. decorus*		Averages	
													G. paripes	*T. decorus*
Lake:		Con.	Tenn.	Y	Lena	Deer	Gibs.	Can.	May	Lulu	Tracy	Effie		
No. stomachs		10	50	40	4	17	11	50	60	17	25	70	259	95
Blue-green algae	$10^6\ \mu^3/\frac{1}{2}$ gut	1.1	26.3	137.6	5.5	1.3	99.3	55.3	6.6	10.2	tr	2.1	45.5	1.6
Green algae		12.5	15.0	.6	.9	5.2	8.8	12.7	35.9	125.0	1.5	4.1	23.5	3.1
Desmids		5.2	4.7	tr	1.6	3.4	1.3	6.5	8.4	.1	3.2		4.4	.8
Diatoms		.5	.4	tr	.1	.2	.1	.1	1.8	.1	.1	.3	.6	.1
Protozoa		.4	.2	1.0		1.8	tr	.8	.2	2.6	tr	.1	.6	.1
Rotifers			1.3	.3		.1		.1	.3		.1	tr	.2	.1
Crustacea					.5						.5	.3	.1	.3
Phytopl.		19.3	46.4	138.2	8.1	10.1	109.5	74.6	52.7	135.4	4.8	6.5	74.0	5.6
Zoopl.		.4	1.5	1.3	.5	1.9	tr	.9	.5	2.6	.6	.4	.9	.5
TOTAL		19.7	47.9	139.5	8.6	12.0	109.5	75.5	53.2	138.0	5.4	6.9	74.9	6.1
Blue-green algae	% of Food	5.6	54.9	98.7	64.0	10.8	90.7	73.3	12.4	7.4	tr	30.4	60.7	26.2
Green algae		63.5	31.3	.4	10.5	43.3	8.0	16.8	67.5	90.6	27.8	59.4	31.3	50.8
Desmids		26.4	9.9	tr	18.6	28.3	1.2	8.6	15.8	.1	59.3		5.9	13.1
Diatoms		2.5	.9	tr	1.1	1.7	.1	.1	3.4	.1	1.8	4.4	.8	1.6
Protozoa		2.0	.3	.7		15.0		1.1	.4	1.8	tr	1.4	.8	1.6
Rotifers			2.7	.2		.9		.1	.5		1.8	tr	.3	1.6
Crustacea					5.8						9.3	4.4	.2	5.0
Phytopl.		98.0	97.0	99.1	94.2	84.1	100.0	98.8	99.1	98.2	88.9	94.2	98.7	91.7
Zoopl.		2.0	3.0	.9	5.8	15.9	tr	1.2	.9	1.8	11.1	5.8	1.3	8.3

V. Discussion

The larvae of both *G. paripes* and *T. decorus* live in tubes on the lake bottoms which they build of bottom materials held by salivary secretion or silk. Within these tubes they spin nets which strain particulate matter out of the water made to flow through the tube by undulations of the larva's body (Leathers, 1922; Walshe, 1947, 1951; Ohgaki, 1942; Tsilova, 1955). The net and its contents are then consumed and a new net is spun.

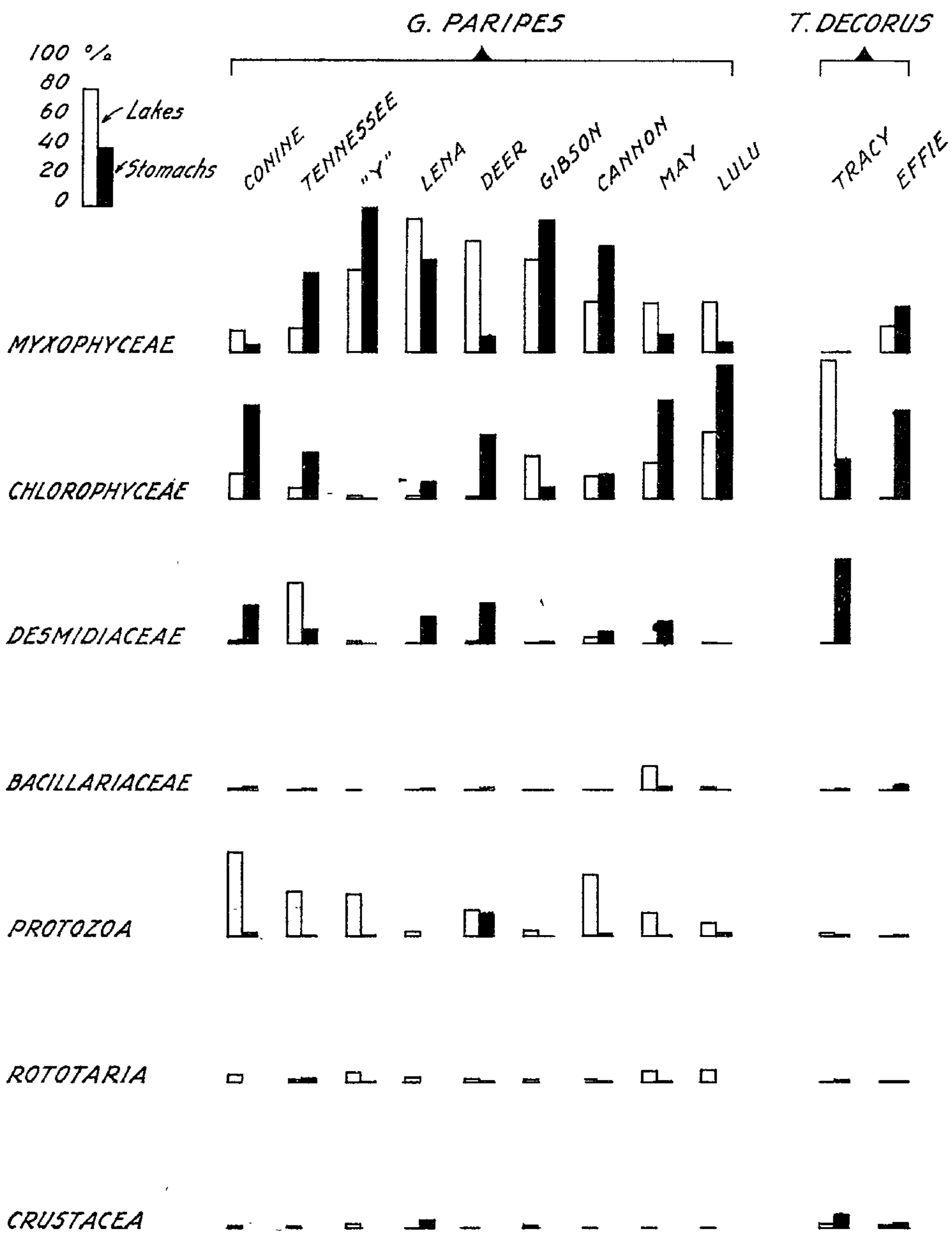

Fig. 2. Volumetric comparisons, on percentage basis, of major plankton groups, in stomachs of *G. paripes* and *T. decorus* with plankton in lakes from which collected.

Walshe (1951) found individual filterings to last from 1 to 5 minutes, with undulation frequencies ranging from 111 to 200 per minute. This activity goes on night and day. Such a feeding method can be inferred to be non-selective except for the exclusion of very fine particles which if smaller than the mesh of the net may pass through. In *T. plumosus*, Walshe (1947) found all particles greater than 17 μ in diameter and most over 12 μ retained. Tsilova (1955) reports only that particles leaving the tubes are incomparably smaller than those entering. These important details have yet to be determined for *G. paripes* and *T. decorus.*

Correlations between lake plankton and *G. paripes* larval stomachs for the summer of 1956 are given on a percentage basis, volumetrically, in Figure 2. The preponderance of blue-green algae in most *G. paripes* lakes and *G. paripes* stomachs is evident, but the picture is clouded by a few reversed ratios, as in Lakes Deer and Cannon. This may be due to the larvae filtering out mainly the larger blue-green cells and colonies. In both lakes small ($< 100\ \mu^3$) cells predominated in the lake plankton, constituting 99.2% of blue-green algal bulk in Lake Deer and 98.2% in Lake Cannon. The blue-green algal cell stomach content, contrariwise, was only 6.4% small cells in Lake Deer and 41.3% in Lake Cannon. The proportion of blue-green algal material existing in the lakes as free and small cells, which this analysis determined crudely only, may then determine the proportion of it actually retained in the larval nets, —assuming that the very small cells pass through the nets.

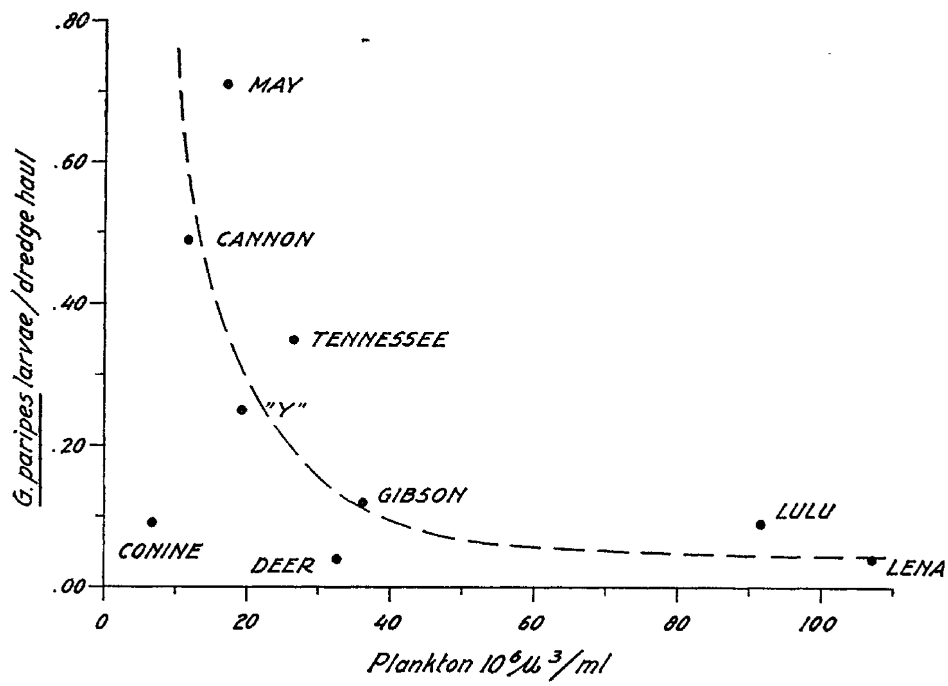

Fig. 3. Relationship between density of *G. paripes* larvae and lake plankton density for nine Polk County lakes, summer 1956.

In all lakes but two, one of *G. paripes* and one of *T. decorus*, the proportion of green algae in the stomachs was much larger than the proportion in lake plankton. This is almost certainly related to the large size of these cells compared, for instance, to most blue-green algal cells or diatoms. The same would apply to desmids which were similarly favored as food in all lakes but one. Diatoms, although reported by most of the literature on chironomid feeding (Thienemann, 1954) as the principal food, in this study showed poorly both in lakes and stomachs.

For virtually all lakes zooplankters constituted a greater percentage of bulk in the lake waters than in the larval stomachs. The most likely explanation is that their motility and large size together prevent their being drawn into the larval nets by the slight current set up by the larval undulations. The exceptions occurring with Crustacea and Rotatoria in *T. decorus* and with Crustacea in *G. paripes* from Lake Lena remain unexplained.

TABLE III. COMPARISON OF SUMMER AND WINTER FOOD HABITS OF *Glyptotendipes paripes* AND *Tendipes decorus.*

FOOD GROUPS		*G. paripes* summer 259	*G. paripes* winter 25	*T. decorus* summer 95	*T. decorus* winter 13
Myxophyceae	$10^6\ \mu^3/\frac{1}{2}$ gut	45.52	.10	1.57	.21
Chlorophyceae		23.53	1.16	3.13	4.27
Desmidiaceae		4.38	.23	.84	.67
Bacillariaceae		.57	.02	.07	.09
Protozoa		.57	.13	.04	.03
Rotatoria		.19	.03	.04	.03
Crustacea		.19	2.50	.25	1.00
Phytoplankton		74.00	1.51	5.61	5.24
Zooplankton		.95	2.66	.33	1.06
TOTAL		74.95	4.17	5.94	6.30
Myxophyceae	% of Food	60.7	2.4	26.4	3.3
Chlorophyceae		31.4	27.8	52.7	67.8
Desmidiaceae		5.9	5.5	14.1	10.6
Bacillariaceae		.8	.5	1.2	1.4
Protozoa		.8	3.1	.7	.5
Rotatoria		.2	.7	.7	.5
Crustacea		.2	60.0	4.2	15.9
Phytoplankton		98.8	36.2	94.4	83.1
Zooplankton		1.2	63.8	5.6	16.9
TOTAL		100.0	100.0	100.0	100.0

The difficulty in correlating plankton volume with chironomid larval numbers is that seasonal cycles in both are probably never synchronized, so that there can be no day-to-day correlation between them any more than there can be between plankton volume and its nutrients. The complexity of production, with all its lags and periodic reversals, can be understood only after several years of systematic sampling of nutrients, plankton, and larvae. In the short season here studied, there seemed to be an inverse relationship in the case of *G. paripes* (Fig. 3). This resembles the finding of Bradley (1932) in one of the few studies of mosquito (*Anopheles quadrimaculatus*) numbers as related to plankton abundance, where excessively high plankton densities in low mosquito production waters are attributed to other environmental factors than larval feeding. The two highest plankton lakes in Fig. 3 are Lena and Lulu, both frequently in algal bloom.

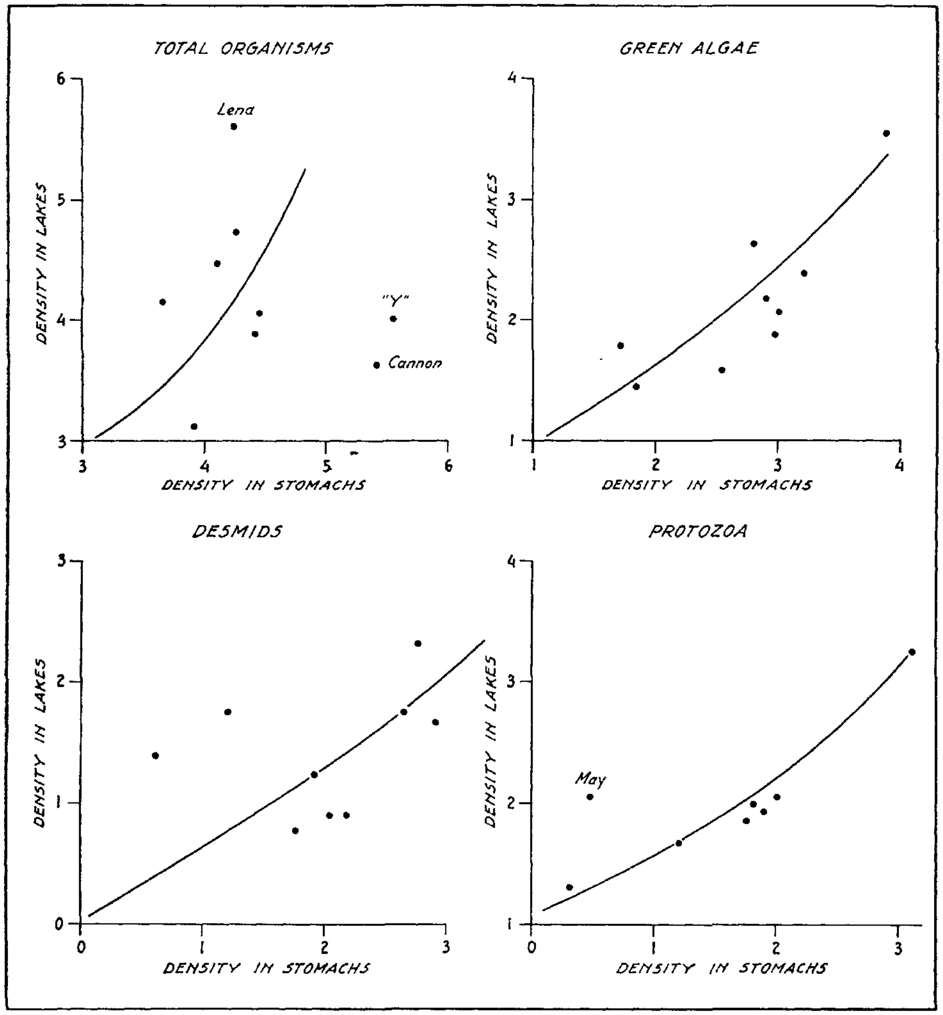

Fig. 4. Plankton density in stomachs of *G. paripes* as related to density in lakes: major plankton groups. Logarithms plotted for organisms per liter in lakes and organisms per half-gut in larvae.

If resort is made to plankton numbers rather than volumes, a relation between *G. paripes* larval feeding and plankton density does appear to exist (Fig. 4). The correlations are not very good with blue-green algae nor with diatoms, nor with total organisms which is so much affected by these small forms. But the correlations are good with green algae, desmids, and protozoa. They are even better with individual genera within these groups, e. g. *Scenedesmus*, *Staurastrum*, and actinopods (Fig. 5). It goes without saying that the possibility of food intake being related to amount of food, viz. plankton, present in the lakes is urgently in need of clarification. Should this be definitely proven, there would be at hand incontrovertible evidence that nutrients added to lakes increase the populations of *G. paripes* by way of the food-chain effect on rate of development and hence abundance.

Accelerated individual growth rates within a population of constantly propagating animals will directly affect production by shortening or telescoping the generations and thus pyramiding the total numbers. If the growth rate of *G. paripes* is proportional to the rate of food intake, a rea-

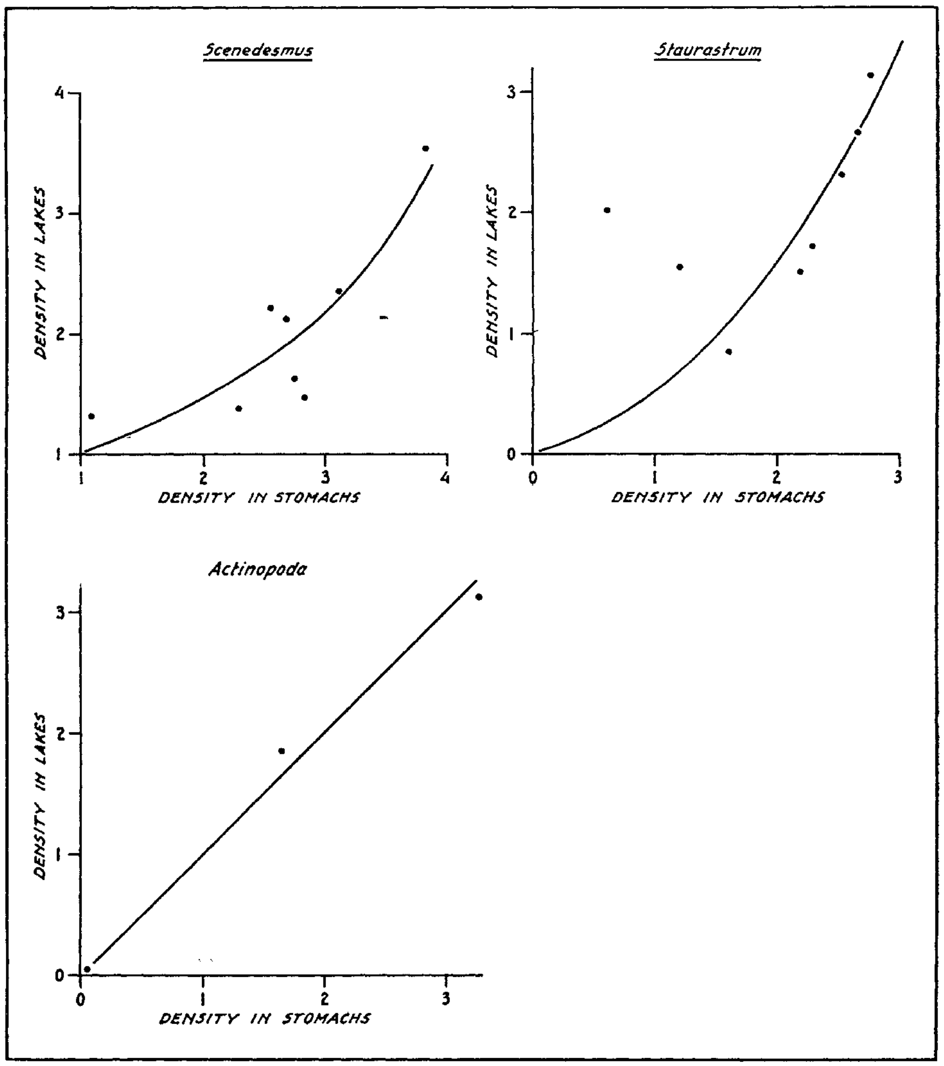

Fig. 5. Plankton density in stomachs of *G. paripes* as related to density in lakes: small plankton groups. Logarithms plotted for organisms per liter in lakes and organisms per half-gut in larvae.

sonable assumption, then its populations will be likewise proportional. The amount of feeding activity, i. e. frequency of spinning nets and eating them and rate of undulation, was measured in one species of *Glyptotendipes* by Burtt (1940) and two species of the same genus by Walshe (1950, 1951). Burtt found the activity correlated with temperature and light intensity, and Walshe found it negatively correlated with dissolved oxygen. But the significant finding of both workers is that the activity is completely independent of the amount of food trapped or load of the nets. It must follow then that light, temperature, and O_2 being equal the rate of food intake must be proportional to the food content of the water, i. e. plankton density. This conclusion from a knowledge of the feeding behavior is substantiated by the findings of the summer 1956 stomach analyses of *G. paripes* and the plankton in the Polk County lakes producing them.

VI. Summary

The summer's survey left no doubt about the dominant role of *Glyptotendipes paripes* in the "blind mosquito" problem. Its larvae occur on sand-peat bottoms and appear to be adversely affected by deposition of organic matter on lake bottoms, such as was demonstrated in Lakes Effie and Lulu. Since, however, an increase in plankton is likely to increase the production of this chironomid, it appears that enriching the lakes, whether through organic or inorganic nutrients, gears the lakes to *G. paripes* production at pest levels. Organic accumulations on the lake bottom may check this, but if dredging operations and other disturbing practices keep sandy bottoms exposed to larval invasion, the problem may become acute. This may be the explanation for the "blind mosquito" situation in the Polk County lakes, but it remains a hypothesis to be demonstrated.

Literature Cited

Barrett, Paul H. 1957. Potassium concentrations in fertilized trout lakes. Limnol. and Oceanogr. 2(3): 287-294.

Birge, E. A., and *Chancey Juday.* 1922. The inland lakes of Wisconsin. The plankton. Its quantity and chemical composition. Wis. Geol. and Nat. Hist. Surv. Bull. No. 64, Sci. Ser. No. 13. ix + 222 pp.

Bradley, G. H. 1932. Some factors associated with the breeding of *Anopheles quadrimaculatus.* J. Agric. Res. 44(5): 381-399.

Brannon, Melvin A. 1945. Factors affecting the growth and distribution of Myxophyceae in Florida. Quar. J. Fla. Acad. Sci. 8(4): 296-303.

Burtt, E. T. 1940. A filter-feeding mechanism in a larva of the Chironomidae (Diptera: Nematocera). Proc. Roy. Ent. Soc. Lond. 15: 113-121.

Edmonton, W. T., G. G. Anderson, and *D. R. Peterson.* 1956. Artificial eutrophication of Lake Washington. Limnol. and Oceanog. 1(1): 47-53.

Hasler, A. D. 1947. Eutrophication of lakes by domestic drainage. Ecology. 28: 383-395.

Kofoid, C. A. 1908. The plankton of the Illinois River, 1894-1899, with introductory notes upon the hydrography of the Illinois River and its basin. Bull. Ill. State Lab. Nat. Hist. 8: 2-360.

Leathers, A. L. 1922. Ecological study of aquatic midges and some related insects with special reference to feeding habits. Bull. U. S. Bur. Fish. 38: 1-61.

Ohgaki, Masahiro. 1942. (Nest building habit of Chironomus larvae.) (In Japanese). Zool. Mag. (Tokyo) 54(10): 375-386.

Pennak, Robert W. 1953. Fresh-water invertebrates of the United States. ix + 769 pp. New York: The Ronald Press Co.

Pierce, E. Lowe. 1947. An annual cycle of the plankton and chemistry of four aquatic habitats in northern Florida. Univ. Fla. Studies, Biol. Sci. Ser. 4(3), 67 pp.

Sawyer, Clair W. 1947. Fertilization of lakes by agricultural and urban drainage. J. New Engl. Water Works Assoc. 61: 109-127.

Thienemann, A. 1954. Chironomus. Die Binnengewässer, Bd. 20. xvi + 834 pp. Stuttgart.

Tsilova, A. N. 1955. (On the filtration method of feeding of flies [Diptera, Tendipedidae]). (In Russian). Doklady Academii Nauk, 105 (3): 596-598.

Walshe, B. M. 1947. Feeding mechanisms of *Chironomus* larvae. Nature, Lond. 160: 474.

Walshe, B. M. 1950. The function of haemoglobin in *Chironomus plumosus* under natural conditions. J. Exp. Biol. 27: 73-95.

Walshe, B. M. 1951. The feeding habits of certain chironomid larvae (subfamily Tendipedinae). Proc. Zool. Soc. Lond. 121: 63-79.

MOSQUITO PENETRATION TESTS WITH LOUVER SCREENING[1]

W. L. BIDLINGMAYER

Prior to World War II, the 16 x 16 mesh per square inch wire screening was widely used for excluding flies and mosquitoes from homes and buildings. It was not entirely satisfactory, as Herms and Gray (1944) had stated that many *Aedes* and some *Anopheles* mosquitoes would pass through it. Earle (1932) had approved the use of 16 x 16 mesh screening for use in malaria control in Puerto Rico. The U. S. Army (1945), however, specified 18 x 18 mesh screening.

During World War II, a wire screening with 18 vertical wires by 14 horizontal wires was produced to replace the 16 x 16 mesh as the new size could be manufactured more rapidly. Today, this mesh is a standard size and has replaced the 16 x 16 mesh screening. Tests comparing the 18 x 14 mesh with the 16 x 16 mesh were discussed by Bacon (1946) and reported in detail by Block (1946). Block found that *Anopheles quadrimaculatus* and *Culex quinquefasciatus* were unable to pass through either size mesh. When *Aedes aegypti* was used fourteen per cent of the normal sized mosquitoes escaped through screens of both sizes although the tolerances permitted the manufacturer would result in the 18 x 14 mesh screen being slightly less effective. From 30% to 50% of undersized *A. aegypti* escaped through these screens. No differences were noted whether the 18 x 14 mesh screen was mounted vertically or horizontally.

Louvered screening is produced with the purpose of excluding sunlight as well as insects. The louver screening used in the following tests was of copper, painted black, and had vertical wires spaced ½ inch apart and with 17 or 23 louvers to the inch. Each louver was from .048 to .050 inches wide and .006 to .007 inches thick. The 17 mesh screening had the louvers tilted at an angle of about 35° while the louvers of the 23 mesh were tilted about 25°. To determine the effectiveness of this type of screening, the 17 mesh louvered screening was compared with an 18 x 14 mesh copper screen and the 23 mesh louvered screening with a 22 x 22 mesh fiber-glass screen.

MATERIALS AND METHODS

The louvered screening was installed in a position to simulate the obstacles that would be encountered by a mosquito while it is trying to penetrate a louvered screen in a window. Confined mosquitoes had to pass upward between the downward sloping louvers in order to escape. The interior surface of the louvered screen covering the cage thus represented the exterior surface of the screen as it is usually installed. The 18 x 14 mesh screen was tested with the 18 mesh wire vertically and the 14 mesh wire horizontally.

Two methods were used to test these screens. In the first method, pint mason jars were used to hold the mosquitoes. A ⅜ inch hole was bored in the side of the jar and a circular piece of screening replaced the

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[1] Contribution No. 64 of the Florida State Board of Health, Entomological Research Center, Vero Beach.

jar lid and was held in place by the mason jar ring. As the screening was cut into circular pieces, the louvers were distorted along the edges where not supported on either side by a vertical wire. Therefore a paper disc with a 1½ inch by 1½ inch hole was placed between the screen and jar ring of all jars to expose only the central portion of the screen. A small cotton pad moistened with water was placed in each jar to maintain a suitable level of humidity.

A sheet metal cylinder, 19 inches in diameter and 10 inches high, had holes, each just large enough to insert a mason jar ring, cut into it midway about the circumference. In the center of the cylinder was either a 25-watt frosted light bulb or a 17-inch circular cage containing a rabbit, to serve as attractants.

Eight female mosquitoes were blown into the pint jars through the hole bored in the side which was then closed with masking tape. The jars were wrapped in several thicknesses of black cloth so only light that had passed through the screen could enter the jar. The jars were placed in a horizontal position around the outside of the cylinder by inserting the jar ring in the hole in the cylinder and placing a support under the bottom. Each jar then faced inward toward the attractant and with the jar ring fitted into the hole in the cylinder.

The second method to test the screens used large cages with dimensions 2 feet on each side. The cages were constructed entirely of wall board except for one side which was covered by the screen to be tested. All inside joints were sealed with masking tape to make a smooth interior. A ⅜ inch hole in the side of the cage was used for putting mosquitoes into the cage and a large door in the rear made it possible to insure complete removal of the mosquitoes at the end of a test. Each cage contained only a cotton pad moistened with water. The cages were arranged in pairs, face to face and about 12 inches apart. A rectangular rabbit cage, 10 inches wide, 20 inches long and 12 inches high was placed between the cages.

One hundred female mosquitoes were placed in each cage at the start of a test. At the completion of the test the front of the cage was covered with a sheet of clear celluloid, sealed with masking tape, and the mosquitoes knocked down with carbon dioxide. They were then collected with an aspirator, killed and counted.

The mosquitoes used in these tests were adult females of *Aedes aegypti* and *Aedes taeniorhynchus*. The *A. aegypti* were of normal size and were secured from a laboratory strain. The *A. taeniorhynchus* were collected in the field as immatures and allowed to emerge in a cage. The mosquitoes were at least 3 days old before use, although during those tests when light was used as an attractant, the addition of new adults into the stock cage made it possible that a small proportion of the adults could have been less. All adults were three days of age or older whenever a rabbit was used as the attractant.

The tests were made at a constant temperature of 25° C. and each test lasted from twenty to twenty-four hours. The percentage of mosquitoes which escaped was determined by the formula $\frac{X\text{-}A}{X\text{-}B}$ where X = the total number of mosquitoes placed in a cage, A = the total number recovered

TABLE 1. SCREENING EFFECTIVENESS FOR MOSQUITOES CONFINED IN PINT JARS.

Type of* Screen	No. of Tests Run	No. of Mosquitoes Tested	No. of Mosquitoes Escaped	Per cent Escaped *A. taenio-rhynchus*	Per cent Escaped *A. aegypti*
		Light as Attractant			
L 17	6**	44	0	0	
	4	30	2		6.7
C 18 x 14	6	47	0	0	
	4	26	0		0
L 23	6	46	0	0	
	4	30	0		0
FG 22 x 22	6	44	0	0	
	4	29	0		0
		Rabbit as Attractant			
L 17	12	94	2	2.1	
	12	96	42		43.8
C 18 x 14	12	93	0	0	
	12	95	0		0
L 23	12	95	2	2.1	
	12	95	3		3.2
FG 22 x 22	12	95	0	0	
	12	96	0		0

* L = Louvered; C = Copper; FG = Fiber glass.
** Upper number for *A. taeniorhynchus;* lower for *A. aegypti.*

TABLE 2. RESULTS OF CONFINING MOSQUITOES IN LARGE CAGES USING A RABBIT AS AN ATTRACTANT.

Type of Screen	No. of Tests Run	No. of Mosquitoes Tested	No. of Mosquitoes Escaped	Per cent Escaped *A. taenio-rhynchus*	Per cent Escaped *A. aegypti*
L 17	5	481	204	42.4	
	9	893	111		12.4
C 18 x 14	5	440	114	25.9	
	9	895	13		1.5
L 23	5	398	10	2.5	
	9	892	4		.4
FG 22 x 22	5	355	2	.6	
	9	899	1		.1

from the cage and B = the number of mosquitoes dead at the termination of the test.

Experimental Results

The results of the two tests with mosquitoes confined to pint jars and large cages are given in Tables 1 and 2, respectively. In Table 1 the results of using light and a rabbit as attractants are shown separately as it was noted that about six times as many *A. aegypti* would escape when the rabbit was used instead of the light. With the rabbit used as the attractant, 43.8% of the *A. aegypti* escaped through the 17 mesh louvered screening while none penetrated the 18 x 14 mesh copper screen. The differences between these screens are significant, with a P value of less than .01. There is no statistical significance to the differences found between the 23 mesh louvered screen and the 22 x 22 fiber-glass screen.

Table 2 presents the results from tests using the large cages. Again the loss of *A. aegypti* through the 17 mesh louvered screen was significantly different ($P = < .01$) from the escape through the 18 x 14 mesh copper screen. Large losses of *A. taeniorhynchus* through both coarser screens are apparent. These adults were noticeably smaller than those used in the jar tests, although both groups were collected in the field as mature larvae or pupae. The conditions in the breeding area did not appear to be unfavorable at the time of collection, so the cause of the smaller size is not known. However, adults of *A. taeniorhynchus* smaller than those used in these tests have been frequently observed to occur naturally so that the use of these mosquitoes is not considered prejudicial to the results. The intraspecific variation in size of mosquitoes is just as important in screening performance as size differences between species. The few escapes (Table 2) reported for the 22 x 22 fiber-glass screen are probably due to errors made when counting mosquitoes as occasionally more than 100 would be removed upon completion of a test.

Within the louver type of screening, the 17 mesh permitted far more mosquitoes to escape than the 23 mesh. It is also to be noted that the 23 mesh louvered screen was superior to the copper 18 x 14 mesh screen in retaining the smaller-sized *A. taeniorhynchus* ($P = .01$).

Aside from the retention and escape features of louver screening, it showed itself in this testing to be rather fragile in the sense that minor pressures distort and spread the louvers, resulting in larger openings at those points which could in practical use diminish or nullify their mosquito exclusion value. Such injuries to the louver screening were not present in the testing above reported.

Conclusion

These experiments demonstrate that the 17 mesh louver screening is not adequate for exclusion of the mosquitoes common in Florida. The 23 mesh louver screening may be satisfactory as long as it remains undamaged, i. e. never pushed against or crushed in any manner.

Literature Cited

Bacon, R. W. 1946. Effectiveness of insect wire screening. Mosq. News, 6(2): 85-88.

Block, S. S. 1946. Insect tests of wire screening effectiveness. Amer. J. Pub. Health, 36(11): 1279-1286.

Earle, W. C. 1932. Some observations of anti-mosquito screening and screening materials. Puerto Rico J. Pub. Health & Trop. Med. 8: 277.

Herms, W. B., and *H. F. Gray*. 1944. Mosquito Control. The Commonwealth Fund, New York, p. 281.

War Department Technical Manual TM 5-632. 1945. Insect and rodent control, p. 26.

One of our Florida entomologists, Lewis Maxwell, has just published a HANDBOOK OF FLORIDA INSECTS AND THEIR CONTROL. The handbook illustrates each species discussed with photographs taken by Mr. Maxwell. Copies can be purchased for $1.00 from the author or from the Great Outdoors Association, 4747 28th Street, St. Petersburg, Florida.

Dr. D. O. Wolfenbarger requests that all members of the Florida Entomological Society who expect to attend the International Congress of Entomology in Vienna in 1960 get together to make plans for the meeting. If you are interested in coordinating efforts with Dr. Wolfenbarger, he can be reached at The Subtropical Experiment Station, Route 2, Box 508, Homestead, Florida.

Some interest has been shown in the names of the Honorary Members of the Florida Entomological Society. The following list is current:

A. C. Brown
K. G. Bragdon
W. V. King
G. B. Merrill
W. W. Yothers.

STUDIES ON THE DEVELOPMENT OF RESISTANCE TO DDT AND MALATHION IN HOUSE FLIES

G. C. LABRECQUE, H. G. WILSON, M. C. BOWMAN, and J. B. GAHAN—
Entomology Research Division, Agr. Res. Serv., U. S. D. A.[1]

Resistance to DDT in house flies (*Musca domestica* L.) is now worldwide. Organophosphorus insecticides have been suitable replacements under most conditions, but resistance to many of these insecticides is also developing (Keiding 1956, Lindquist 1957, LaBrecque *et al.* 1957, 1958, and Kilpatrick *et al.* 1958).

Studies were initiated at the Orlando, Florida, laboratory in 1956 to determine the effect of selection with an organophosphorus insecticide and a chlorinated hydrocarbon when used individually, alternately, and in combination, on the rate of development of resistance.

Four experimental colonies of house flies were started from the regular (susceptible) colony by subjecting the adults of each generation to contact sprays in a wind tunnel by the technique of LaBrecque *et al.* (1957). Colony M was treated with malathion, colony D with DDT, colony DM with a combination of malathion and DDT, and colony DM-A with DDT or malathion alternately in successive generations. Selection was accomplished by exposing 100 to 200 4- to 5-day-old flies of undetermined sex to 0.25 ml. of an odorless kerosene solution of the insecticide. After treatment the flies were held for 24 hours and the mortality was recorded. The survivors were then released in a rearing cage where oviposition medium was available. Twenty-four hours later the eggs were collected and placed in larval medium for rearing of the subsequent generation.

The spray used in selecting the first 12 generations of each colony contained 1% of one or both insecticides, which killed about 90% of the flies. In later generations the concentration of either toxicant was raised only when all those colonies subjected to that toxicant could tolerate the increased concentration. The concentration of DDT was increased to 5% in the 13th generation, to 10% in the 17th, and to 20% in the 29th generation, in selecting the D, DM, and DM-A colonies. The concentration of malathion was increased to 2% in the 29th generation in the M, DM, and DM-A colonies.

As resistance developed its progress was followed by conducting wind-tunnel tests with DDT and malathion against 4- to 5-day-old female flies from the 11th, 15th, 20th, 25th, 30th, 31st, and 32nd generations. The concentration of insecticide was varied with the resistance encountered. After treatment the flies were transferred to screen holding cages and supplied with 10% sugar solution on absorbent cotton pads. Mortality was recorded after 24 hours. Duplicate tests with 20 female flies were run at each concentration of insecticide. An LC-50 was computed from the concentration-mortality data, and the degree of resistance determined from the ratio of this LC-50 to that of flies from the regular colony. The results of these tests are presented in table 1.

After 30 to 32 generations resistance to DDT was lower in the DM-A colony than in the D or DM colonies, but had nevertheless reached a high

[1] C. R. Crittenden and P. H. Adcock assisted in these studies.

TABLE 1.—LC-50's of DDT and Malathion in wind-tunnel tests against house flies of four experimental colonies and the regular colony, and degree of resistance as indicated by the ratio of the LC-50 of each experimental colony to that of the regular colony. (Average of 2 tests.)

	D Colony		M Colony		DM Colony		DM-A Colony		Regular
Generation	LC-50	Ratio	LC-50	Ratio	LC-50	Ratio	LC-50	Ratio	LC-50
					DDT				
11	>4.0	>16.0	—	—	>4.0	>16.0	>4.0	>16.0	0.25
15	27.0	64.4	4.0	9.6	10.3	24.6	15.8	37.7	.42
20	27.2	22.7	15.0	12.5	19.0	15.8	10.0	8.3	1.20
25	12.7	14.5	2.1	2.4	41.2	47.3	6.5	7.5	.87
30	35.0	53.8	>10.0	>15.4	>40.0	>61.5	24.0	36.9	.65
31, lot a	25.0	92.1	11.0	28.9	>40.0	>105.0	10.5	30.2	.38
lot b	17.5	47.3	4.5	12.2	28.0	75.6	7.1	19.2	.37
32	>40.0	>49.4	10.0	12.3	35.0	43.2	22.5	27.8	.81
					Malathion				
11	—	—	1.1	2.2	1.1	2.2	0.6	1.2	0.5
15	0.8	<1.0	1.7	1.1	.9	<1.0	.9	<1.0	1.5
20	1.3	<1.0	1.4	<1.0	1.5	<1.0	1.2	<1.0	1.9
25	.7	1.3	.4	<1.0	1.7	3.4	.8	1.7	.5
30	.7	1.1	1.3	2.2	3.6	6.0	1.8	3.0	.6
31, lot a	.5	1.3	1.4	3.5	2.4	6.0	.7	1.8	.4
lot b	1.5	3.8	1.4	3.5	1.5	3.8	.9	2.3	.4
32	1.8	2.6	1.8	2.6	1.6	2.3	1.2	1.7	.7

level, and even the M colony had developed 10- to 30-fold resistance to DDT. Resistance to malathion was much lower than to DDT, and was variable between generations, but the M and DM colonies consistently showed more than 2-fold resistance.

Since resistance to DDT was present in the M colony although the selection was made with malathion, tests were conducted to determine the extent of DDT detoxification to DDE. Adult flies were exposed to residues of 3.5 mg. of *p,p'*—DDT per square foot on glass surfaces for 5 hours. The flies were then analyzed for internal DDT and DDE. The analyses showed an average of 26.2 μg. of DDT and 89.5 μg. of DDE per 100 flies, indicating a high rate of detoxification of DDT to DDE in this strain of flies.

Literature Cited

Keiding, J. 1956. Resistance to organic phosphorus insecticides of the housefly. Science 123: 1173-74.

Kilpatrick, J. W., and *H. F. Schoof*. 1958. A field strain of malathion-resistant house flies. Jour. Econ. Ent. 51: 18-9.

LaBrecque, G. C., and *H. G. Wilson*. 1957. House fly resistance to organophosphorus compounds in Florida. Agr. Chem. 12: 46-7, 147, 149.

LaBrecque, G. C., H. G. Wilson, and *J. B. Gahan*. 1958. Resistance of house flies in Florida to organophosphorus insecticides. Jour. Econ. Ent. 51: 616-7.

Lindquist, A. W. 1957. Effectiveness of organophosphorus insecticides against houseflies and mosquitoes. Bul. World Health Organ. 16: 33-39.

SYNONYMY IN THE ANT GENUS MACROMISCHA ROGER

W. L. BROWN, JR.
Museum of Comparative Zoology, Harvard University

The heterogeneous assemblage called *Macromischa* Roger includes more than 80 named forms as it now stands. The genus is unsatisfactorily defined, merging into *Leptothorax* Mayr, and it probably represents a grand radiation of a *Leptothorax* stock in the Caribbean area, particularly in Cuba. It is also clear that much synonymy exists at species level in the group. Probably most of the synonymy involves forms that are geographical variants of single species. Another class of synonyms includes those described chiefly during the 1930's, when W. M. Wheeler, C. Aguayo and F. Santschi published a large number of forms within a brief period, resulting in some double description. I have been able to compare types of most of the forms discussed below in the Museum of Comparative Zoology (M. C. Z.). Only some of the most obvious and relatively uncomplicated synonymy is dealt with here.

Macromischa wheeleri Mann

Macromischa wheeleri Mann, 1920, Bull. Amer. Mus. Nat. Hist., 42: 422, fig. 6, worker, female. Type loc.: Mina Carlota, Trinidad Mts., Cuba. Syntypes in U. S. National Museum.

Macromischa wheeleri subsp. *petri* Aguayo, 1931, Psyche, 38: 181, worker. Type loc.: La Vigia, Maya Jigua, Las Villas Prov., Cuba. Syntypes in M. C. Z. NEW SYNONYMY.

Of five nest series taken in the Caibarien-Maya Jigua area of northeastern Las Villas, evidently seen by Aguayo at the time of his description, three contain workers both with and without the brief propodeal teeth supposedly diagnostic of *petri*, and all intergrades occur. Even in several topotypical collections of *wheeleri* (leg. W. S. Creighton, G. Salt, E. O. Wilson) the propodeal angles are often distinctly developed in certain workers in nests that also contain workers with perfectly rounded propodeum. The two populations therefore differ only in the breadth of the range of variation in propodeal armament.

Macromischa darlingtoni Wheeler

Macromischa darlingtoni Wheeler, 1937, Bull. Mus. Comp. Zool., 81: 450, worker. Type loc.: coast below Pico Turquino, Oriente, Cuba. Syntypes in M. C. Z.

Macromischa opalina Wheeler, 1937, Bull. Mus. Comp. Zool., 81: 451, worker. Type loc.: same as for *M. darlingtoni.* Holotype in M. C. Z. NEW SYNONYMY.

I consider that the unique holotype of *M. opalina* is merely a small, lightly sculptured worker of *M. darlingtoni.* The size difference is not so great as indicated by Wheeler, and his statements about the differences in clypeal shape and scape length are contradicted by the *opalina* type itself.

Macromischa dissimilis Aguayo

Macromischa dissimilis Aguayo, 1932, Bull. Brooklyn Ent. Soc., 27: 220, worker. Type loc.: Buenos Aires, Trinidad Mts., Cuba. Holotype in M. C. Z.

Macromischa chloana Wheeler, 1937, Bull. Mus. Comp. Zool., 81: 454, worker. Type loc.: Buenos Aires, Trinidad Mts., Cuba, 2500 to 3500 feet altitude. Syntypes in M. C. Z. NEW SYNONYMY.

Types compare well. The greenish infuscation of the head, nodes and gaster are seen to extend to the alitrunk in a series collected by E. O. Wilson at Naranjo, which is also in the Trinidad Mts.

Macromischa archeri (Wheeler) new status

Croesomyrmex aguayoi var. *archeri* Wheeler, 1931 (July), Bull. Mus. Comp. Zool., 72: 26, worker. Type loc.: San Vicente Valley, Viñales, Pinar del Rio Prov., Cuba. Syntypes in M. C. Z.

Macromischa (*Croesomyrmex*) *bierigi* Santschi, 1931 (September), Rev. Ent., Rio de Janeiro, 1: 273, fig. 7, worker. Type loc.: Viñales, Pinar del Rio Prov., Cuba. Types in Santschi Coll., Naturhistorisches Museum, Basel; not seen. NEW SYNONYMY.

Santschi's description and figure leave no doubt that his *bierigi* is the same as the var. *archeri* from the same general locality. E. O. Wilson has also collected several nest series of this form in the Vinales area and from Las Acostas, Pinar del Rio, somewhat farther west. The var. *archeri* is essentially like *M. aguayoi* Wheeler, but has the head smooth and shining above over the posterior half or third. In *aguayoi* the back of the head is subopaquely sculptured (opaquely sculptured in subsp. *natenzoni* Aguayo). *M. barroi* Aguayo is another member of this complex.

It is most convenient now to treat *archeri, aguayoi, natenzoni* and *barroi* arbitrarily as species. But it seems likely, when collections from the mountains of Pinar del Rio are more complete, that these four close allopatric forms will prove to be only local populations of a single variable species.

NEW RECORDS OF ORTHOPTERA AND DERMAPTERA FROM THE UNITED STATES

Ashley B. Gurney [1]

Three of the four species here recorded from Florida (two cockroaches and one earwig) are primarily West Indian, and the fourth, *Conocephalus cinereus* (Thunberg), a small widespread katydid, is more dominant there than in Central or South America. One of the cockroaches, *Hemiblabera tenebricosa* R. & H., was taken on Key Largo, Florida, more than 60 years ago, but a recent capture on Elliott Key is of interest in confirming its recent occurrence in Florida. Except for *C. cinereus,* which has been taken about 35 miles northwest of Lake Okeechobee, records of these four species in the United States are limited to Dade County or the Keys. The earwig, *Pyragropsis buscki* (Caudell), is represented by three specimens, all taken within about ten miles of Miami. This species is the first member of the family Pygidicranidae to be recorded from the United States.

Except as noted, all specimens recorded are in the U. S. National Museum.

I am grateful to the following scientists who have assisted materially by their generous cooperation in supplying specimens or collection data, or by making other specimens available for comparison: R. M. Baranowski, Subtropical Experiment Station, Homestead, Florida; H. H. Keifer, California Bureau of Entomology, Sacramento, California; J. A. G. Rehn, Academy of Natural Sciences of Philadelphia; Albert Schwartz, Albright College, Reading, Pennsylvania; H. F. Strohecker, University of Miami, Coral Gables, Florida; Howard V. Weems, Jr., Florida State Plant Board, Gainesville, Florida.

Eurycotis lixa Rehn (Orthoptera, Blattidae)

Figures 12-14

U. S. records: Key West, Fla., July 1952 (Schwartz and Porter), 1 female; Key West, Fla., Sept. 21, 1956 (W. W. Warner), 1 female.

Other records: "Taken at New York City on banana ship from Jamaica, Oct. 20, 1924 (F. M. Schott)", 1 male (holotype), 1 female (allotype) (Acad. Nat. Sci. Phila.). Original material described by Rehn (Trans. Amer. Ent. Soc. 56: 45-48, pl. 4, figs. 1-9, 1930).

This species was thought by Rehn (l. c.) to be native to Jamaica. Unfortunately, no confirming data are available. Concerning the Key West specimen taken in 1952, I am indebted to one of the collectors for comments about the circumstances of capture. Dr. Albert Schwartz (*in litt.*, Oct. 8, 1955) stated that the specimen was collected at night in the "downtown" section of Key West, probably along a low wall which separated a garden from a sidewalk. Regarding the 1956 specimen, Dr. Howard V. Weems has informed me (*in litt.*, April 25, 1958) that three additional specimens of *lixa* were taken by Mr. Warner.

The Key West specimens were identified by comparison with the types of *lixa* and a review of described species, especially the West Indian species treated in my 1942 key (Bull. Mus. Comp. Zool. 89: 34-37). *E. lixa* (fig.

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[1] Entomology Research Division, Agricultural Research Service, U. S. Department of Agriculture.

12) is approximately the same size as *E. floridana* (Walk.), which was shown in habitus sketch by Hebard (Mem. Amer. Ent. Soc. 2: pl. 6, fig. 11, 1917) and in photographs by Roth and Willis (Smithsonian Misc. Coll. vol. 122, no. 12: pls. 1, 3, 5, 1954).

E. floridana, the only other species of *Eurycotis* established in the United States, has very broad, subquadrate tegmina, quite unlike the lateral subtriangular tegmina of *lixa,* which in the Key West specimens vary as in figs. 13-14 and differ slightly from those of the allotype (Rehn, l. c., pl. 4, fig. 4). Most specimens of *floridana* are definitely brownish, whereas *lixa* is essentially black to the naked eye, though under magnification in a strong light a brownish tinge is noticeable, this being more conspicuous in the 1952 than in the 1956 specimen. The basal segment of the hind tarsus of *lixa* is more elongate than that of *floridana,* and the pulvillus occupies about one-fourth the ventral length of the segment, as contrasted with one-third to one-half the length in *floridana.*

Compared with *E. tibialis* Hebard of Hispaniola, *lixa* is blacker, averages larger, and the hind tibia is not broadened and pitted as in *tibialis* (see Gurney, l. c., fig. 4). The Brazilian *E. manni* Rehn is much like *lixa,* but differs noticeably in that the latero-posterior angles of abdominal terga 5-7 are only briefly produced as acute points. *E. manni* was described by Rehn (Trans. Amer. Ent. Soc. 42: 238-239, pl. 14, fig. 15, 1916), based on a single male. I have examined a male in the U. S. National Museum collected at Natal, Brazil, May 1925, by E. C. Green. Apparent relationship to *E. nigra* Princis may also be noted. Described from Caracas, Venezuela (Ann. Istit. Mus. Zool. Univ. Napoli 4: 4-6, fig. 2, 1952), *nigra* is smaller (body length of male 20 mm., pronotum 5.5), and the lateral tegmina have the apices reaching almost to the hind margin of the metanotum.

The two Key West females of *lixa* show some variation in the number and position of the spines borne by the hind tibia, and neither agrees exactly with the allotype as regards the spines on the outer lateral margin of the hind tibia (Rehn, l. c., pl. 4, fig. 8). Respective measurements in

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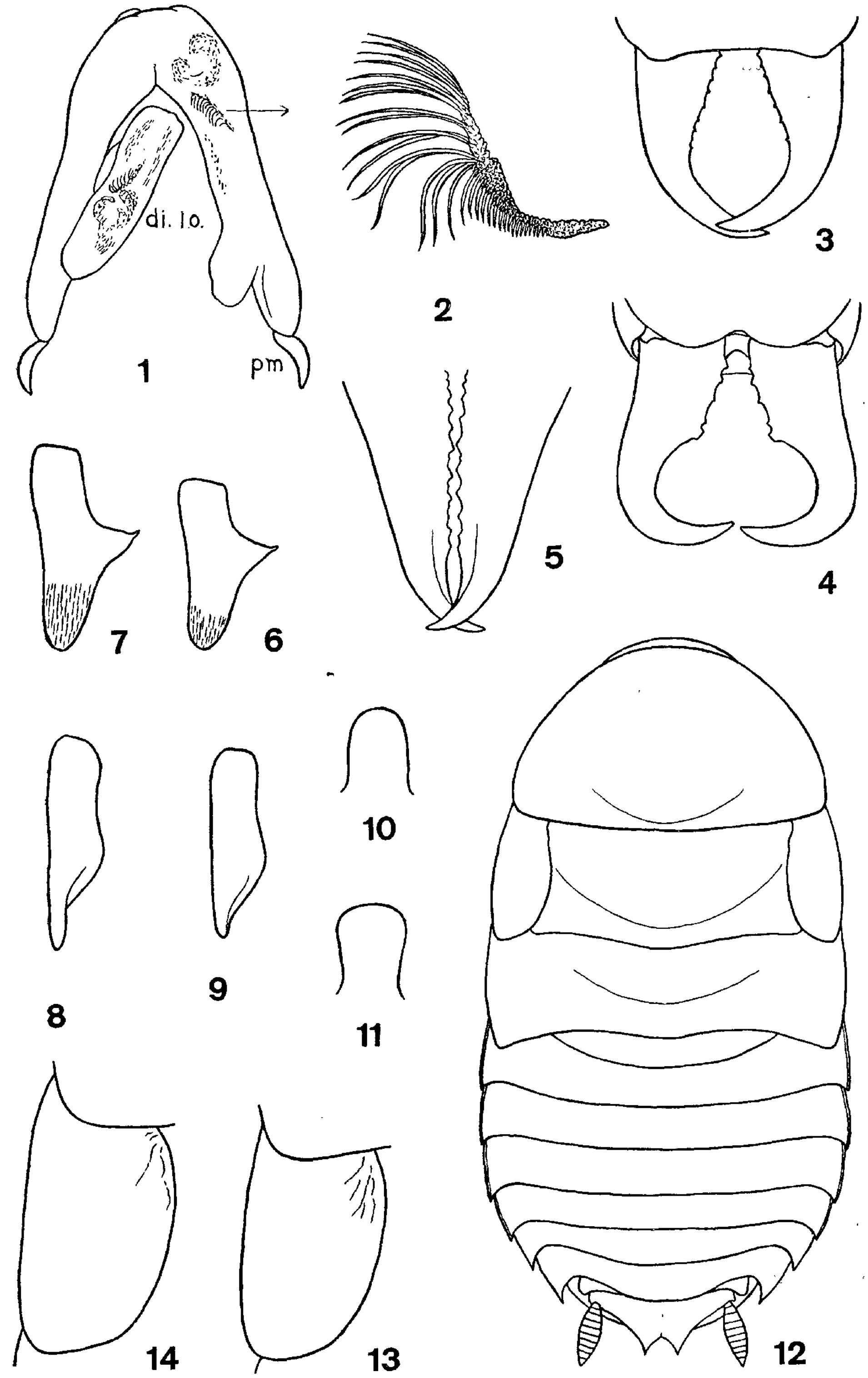
Explanation of Plate

1. *Pyragropsis buscki* (Caud.), male genital armature, non-KOH preparation in alcohol. Jamaica.
2. Same, partial details of distal lobe, KOH preparation on slide. Cuba, intercepted at N. Y.
3. Same, male forceps of elongate type, dorsal view. Holotype.
4. Same, male forceps of arcuate type, ventral view including apex of subgenital plate. Same specimen as fig. 1.
5. Same, female forceps, dorsal view, reconstructed from broken specimen. Palm Island, Fla.
6. *Conocephalus fasciatus fasciatus* (De G.), left cercus of male, dorsal view. Alachua Co., Fla.
7. *C. cinereus* (Thunb.), left cercus of male. Martin Co., Fla.
8. Same, left cercus of male, laterodorsal view. Same specimen as fig. 7.
9. *C. fasciatus,* left cercus of male, laterodorsal view. Same specimen as fig. 6.
10. Same, fastigium of female, dorsal view. Martin Co., Fla.
11. *C. cinereus,* fastigium of female, dorsal view. Martin Co., Fla.
12. *Eurycotis lixa* Rehn, dorsal view of female. Key West, Fla., July 1952.
13. Same, left tegmen, dorsolateral view. Key West, Fla., Sept. 21, 1956.
14. Same, left tegmen, dorsolateral view. Key West, Fla., July 1952.

(All drawings by the author)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millimeters of the 1952 and 1956 specimens are as follows: Body length, 34.0, 36.0; interocular width, 4.0, 3.7; length of pronotum, 10.5, 9.8; maximum width of pronotum, 14.6, 14.0; costal length of tegmen, 6.7, 5.7; maximum width of tegmen, 3.3, 3.2; length of hind tibia, 13.0, 11.7; length of hind tarsus, 8.7, 8.0.

Hemiblabera tenebricosa Rehn and Hebard (Orthoptera, Blattidae)

U. S. Records: Elliott Key, Fla. [about 20 miles south of Miami], about 1952 (Ray Porter), 2 females (Strohecker Collection); Key Largo, Fla., Jan. 1896 (E. A. Popenoe), 1 male, 1 female.

Other records: West Indies, including Nassau, Bahamas (Rehn and Hebard, Bull. Amer. Mus. Nat. Hist. 54: 271-274, pl. 19, figs. 9-11, 1927).

Brief comments on *tenebricosa*, including the Key Largo record, appeared in my 1953 paper (Gurney, Proc. U. S. Nat. Mus. 103: footnote, p. 46). This is a predominantly reddish-brown cockroach, ranging from 32 to 46 millimeters in body length, and with subquadrate tegmina covering less than half of the abdomen. In view of the recent Elliott Key records, it appears to be established in the Florida Keys, and perhaps on the adjacent mainland.

Conocephalus cinereus (Thunberg) (Orthoptera, Tettigoniidae)
Figures 7-8, 11

U. S. records: Sebring, Fla., Nov. 25, 1954 (H. V. Weems, Jr.), 1 male; Martin Co., Fla., Nov. 5, 1954 (H. V. Weems, Jr.), 8 males, 2 females; Dade Co., Fla., Oct. 22, 1954 (H. V. Weems, Jr.), 2 males, 4 females; Homestead, Fla., Dec. 2, 1946 (D. O. Wolfenbarger), 1 male. (Foregoing specimens Fla. Plant Board and USNM). 8 miles east of Homestead, Fla., Jan. 17, 1957 (R. M. Baranowski), 2 males (Baranowski and Strohecker collections).

Other records: This is a well known species of the Neotropical region, occurring from the Bahamas and northern Mexico to British Guiana and Peru. Tampico and Mazatlan are northern known limits in Mexico. It is a dominant species of the genus in the Bahamas, Greater Antilles, and northernmost Lesser Antilles (Rehn and Hebard, Trans. Amer. Ent. Soc. 41: 243-248, 1915); Hebard, Ibid. 58: 335, 1932). It was not listed by Piran in his catalogue of Argentine Tettigoniidae (Rev. Soc. Ent. Arg. 11: 119-168, 240-287, 1941 and 1942).

Conocephalus cinereus was originally described from Jamaica, and has been discussed fully by Rehn and Hebard (l. c.). It has been reported as injurious to tobacco seedlings at San Lorenzo, Puerto Rico, by Wolcott (Jour. Agric., Univ. P. R. 32: 54, 1950). Dr. R. M. Baranowski (*in litt.*, May 19, 1958) has reported that the specimens he collected were actively feeding on the banded cucumber beetle, *Diabrotica balteata* Lec. Among the few studies of food habits of the genus *Conocephalus* are those of the late F. B. Isely dealing with *C. fasciatus* (De G.) (Isely, Ann. Ent. Soc. Amer. 37: 62, 1944; Isely and Alexander, Science 109: 115-116, 1949), on the basis of which he concluded that *Conocephalus* is mainly carnivorous and seed-eating. It appears that careful observations are required to determine the exact food preferences of these small orthopterons.

C. cinereus is a small, slender katydid, or "meadow grasshopper," about 16 to 27 millimeters in length (including apices of folded tegmina). It is most likely to be confused with *C. fasciatus*, a species very widespread in the United States. The best feature enabling the separation of the two species is the cerci of adult males (figs. 6-9). The cercus of *cinereus* has on the dorsal surface a distinct flattened apical portion, but that of *fasciatus* is tapered near the apex. The cercus of *cinereus* usually is the same color as the apical portion of the abdomen, normally yellowish or light brown, while that of *fasciatus* usually is green, in contrast to the abdomen. In both sexes the lateral lobe of the pronotum is a helpful separating feature: In *cinereus* the humeral sinus is less evenly and broadly rounded, and the ventral margin is about right-angled, in contrast to the more evenly and broadly rounded humeral sinus and very broadly rounded ventral margin in *fasciatus* (see Rehn and Hebard, Trans. Amer. Ent. Soc. 41: pl. 17, fig. 2, pl. 22, fig. 12, 1915). When seen in dorsal view, the apical portion of the fastigium of *cinereus* usually shows lateral expansion, rather than approximately equal width as in *fasciatus* (figs. 10-11).

Other species of *Conocephalus* recorded from Florida are *aigialus* R. & H., *brevipennis* (Scudd.), *fasciatus fasciatus* (De G.), *gracillimus* (Morse), *nigropleuroides* (Fox), and *spartinae* (Fox). Material of *fasciatus* from Martin Co., Fla., with label data identical to that of *cinereus*, has been examined, suggesting that both species may occur together in some areas. The most distant Floridian localities occupied by *cinereus* are some 150 miles apart, and the earliest record is 1946, so the species appears to be well established. It is one of the very few katydids occurring in both the United States and South America. Isely (Ecol. Monogr. 2: 470, 1941) stated that *Neoconocephalus triops* (L.) is unique in such a distribution, and in a hasty check I had found no others until, now, *C. cinereus*.

Pyragropsis buscki (Caudell) (Dermaptera, Pygidicranidae)

Figures 1-5

U. S. records: Little River, Fla. [adjacent to Miami] intercepted in plant quarantine inspection of box of palm seed, at Redondo Beach, Los Angeles Co., Calif., March 9, 1947 (through H. H. Keifer), 1 male; Palm Island, Miami Beach, Fla., in house, July 24, 1951 (M. B. Byrne), 1 female; Key Biscayne, Fla., on *Cocos nucifera*, June 5, 1958 (C. F. Dowling, Jr.), 1 female (Fla. Plant Bd.).

Other records: Baracoa, Cuba, Oct. 14, 1901 (August Busck), 1 male (holotype), 1 nearly mature female; Cuba, intercepted in plant quarantine inspection at New York City, May 6, 1937, 1 male; Jamaica, in rotten palm, March 12, 1907 (J. R. Johnston), 3 males; Dominican Republic, intercepted in plant quarantine inspection at New York City, July 1934, 1 female.

This species originally was described in the genus *Pyragra* by Caudell (Jour. N. Y. Ent. Soc. 15: 166-167, 1907). It was listed in the genus *Propyragra* by Burr (Trans. Ent. Soc. London, p. 167, 1910; Gen. Insect. 122: 22, 1911). Rehn and Hebard (Bull. Amer. Mus. Nat. Hist. 37: 635-636, 1917) transferred it to the genus *Pyragropsis* and recorded a male from Santiago de Cuba, Cuba. Gowdey (Cat. insect. Jamaicensis, Dept. Agric. Jam. Ent. Bull. 4: 9, 1926) recorded it from Jamaica as *Pyragropsis buscki*. No records additional to those cited have come to my attention.

P. buscki varies in body length from 14 to 19 millimeters, and is fully winged. The abdomen is dark reddish-brown; the pronotum and tegmina light brown, the pronotum pale in the central area and along the lateral margins, each tegmen with small pale area near base; exposed portion of folded wings pale adjacent to tegmen; both tegmina and tip of folded wing bear numerous short stiff setae. Male forceps of two types (figs. 3-4), either evenly arcuate or more elongate; posterior margin of subgenital plate emarginate. Female forceps elongate with numerous denticulations (fig. 5); posterior margin of subgenital plate narrowly projecting mesally; terga 5-7 each with a very pronounced longitudinal ridge along lateral margin in male, ridge absent in female. This species differs from all other United States earwigs in the possession of a well developed padlike arolium between the tarsal claws, as illustrated for the Costa Rican *P. tristani* Borelli by Burr (Gen. Insect. 122: pl. 3, fig. 2a, 1911). The only other United States earwigs whose males have forceps at all resembling those of *buscki* are the species of *Euborellia* and *Anisolabis*, and of these *E. cincticollis* (Gerst.) is the only one here with fully developed wings, though rare winged examples of *E. annulipes* (Lucas) have been recorded abroad. The pronotum, tegmina and wings of *cincticollis* (which is frequently but not always winged) bear no such conspicuous setae as occur in *buscki*. A list of the United States species accompanied the initial report of *cincticollis* in this country (Gurney, Proc. Ent. Soc. Washington 52: 200-203, 1950).

P. buscki is the only species of Pygidicranidae in the United States. For information on the relationships of the family and genus, readers may consult the keys and references given by Hincks (Acta Zool. Lilloana 7: 623-652, 1949) in his comprehensive paper on Argentine earwigs. The male armature of *buscki* is distinctive, and differs from that of *P. brunnea* (Burr) of Argentina (Hincks, l. c., p. 627, fig. 1) by having curved parameres (fig. 1, *pm*) instead of relatively straight ones. Presumably the sclerotized structures of the distal lobes (*di. lo.*) (see fig. 2) also differ, but details of those structures in *brunnea* are not available to me. Hincks (pp. 66-69 *in* Taxonomist's glossary of genitalia in insects, S. L. Tuxen, Ed., 1956) has briefly discussed the anatomy of earwig genitalia.

OBSERVATIONS ON THE OCCURRENCE OF A MILKY DISEASE AMONG LARVAE OF THE NORTHERN MASKED CHAFER, *CYCLOCEPHALA BOREALIS* ARROW [1, 2]

EMMETT D. HARRIS, JR.
Everglades Experiment Station, University of Florida

The larvae of the northern masked chafer, *Cyclocephala borealis* Arrow, occur frequently among the roots of grasses in organic soils of the Everglades. They do not frequently cause noticeable damage to pastures but often distress the sod grower when he harvests his product. The sod pieces tend to fall apart as a result of root pruning and loosening of the soil when lifted from the soil surface. Under drought conditions root damage has resulted in the death of the grass.

On October 12, 1958, the author visited two pastures, one in pangolagrass, *Digitaria decumbens* Stent., at Clewiston and the other in St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, at Belle Glade that were heavily infested with northern masked chafer larvae that were causing brown areas. At each site there were approximately 8 to 10 grubs per square foot.

At the Belle Glade pasture five (17%) of thirty chafer larvae collected appeared to be diseased. Some of the sick larvae were flaccid and more opaquely white than healthy grubs, whereas others were darker and even more limp denoting a more advanced stage of the disease.

Diseased grubs were sent to Dr. S. R. Dutky, Beekeeping and Insect Pathology Section, U. S. D. A., Beltsville, Maryland. Dr. Dutky replied: "The specimens were examined and all were found to be milky diseased. The organism present in all specimens closely resembles the *Cyclocephala* strain of *Bacillus popilliae*."

Dutky (1940) described and named the organism, *Bacillus popilliae* Dutky, that is the causitive agent of type A milky disease of the Japanese beetle, *Popillia japonica* New. Dutky (1941) stated that *Cyclocephala borealis* Arrow larvae were susceptible to type A milky disease infection by injection and puncture inoculations and that a few instances of natural infection with type A milky disease had been found. White (1947) found northern masked chafer larvae in the field that were naturally infected with the milky disease. In most instances the causative agent was an organism similar to that causing type A milky disease. The milky disease was designated originally as atypical type A but later called type A (*Cyclocephala* strain). White reported an instance of northern masked chafer grub control with atypical type A milky disease at a site where the Japanese beetle grubs were infected with regular type A milky disease. He cited this as an indication that both organisms were present and working independently. A full description of the disease, the causative agent, and a review of the literature are given by Steinhaus (1949).

[1] Florida Agricultural Experiment Station Journal Series, No. 783.

[2] The author wishes to thank Mr. C. E. Seiler for help in making observations and Mr. Edward King, Jr. for preparing the graph.

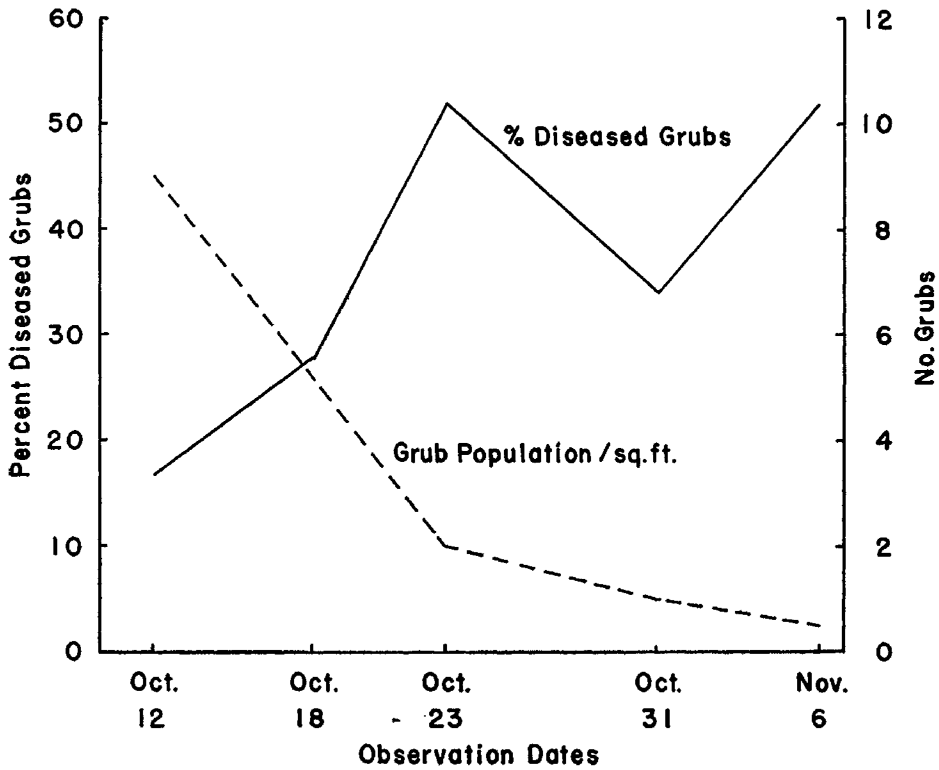

Fig. 1. Northern masked chafer grub population and incidence of milky-diseased individuals on several dates in a St. Augustine grass pasture.

The Belle Glade pasture was visited at 6 to 8 day intervals and examinations were made to obtain an estimate of the average number of grubs per square foot and the percentage of grubs that were diseased. Observations were hampered by difficulty in finding grubs that had decomposed after death. The area of soil examined gradually became larger as it became more difficult to find grubs because of the decreasing population. The number of grubs examined on each date was as follows: 12 October—30; 18 October—50; 23 October—52; 31 October—53; 6 November—21. The area of pasture soil examined on October 18 was not recorded so no estimate of the grub population per square foot is recorded for this date. In less than one month the number of grubs per square foot fell from 9 to 0.5 at the Belle Glade pasture (Figure 1). The percentage of diseased grubs increased from 17% on October 18 to 52% on October 23. It fell to 34% on October 31 but rose to 52% on November 6.

The pasture at Clewiston was not examined periodically, but Mr. W. G. Genung visited this location in late October and observed that there was a high incidence of diseased individuals and the grub population was greatly reduced.

It seems that the dry summer exaggerated the damage done by the grub and was unfavorable to the dissemination of the disease organism and inoculation of grubs. The wet soil caused by heavy rains during October and November probably accelerated dissemination and inoculation.

Literature Cited

Dutky, S. R. 1940. Two new spore forming bacteria causing milky disease of Japanese beetle larvae. Jour. Agr. Res. 61(1): 57-68.

Dutky, S. R. 1941. Susceptibility of certain scarabaeid larvae to infection by type A milky disease. Jour. Econ. Ent. 34(2): 215-216.

Steinhaus, Edward A. 1949. Principles of insect pathology. McGraw-Hill Book Company, Inc., New York. Pp. 258-276.

White, Ralph T. 1947. Milky disease infecting *Cyclocephala* larvae in the field. Jour. Econ. Ent. 40(6): 912-914.

RESULTS FROM THE USE OF ZINEB IN CITRUS GROVES DURING THE 1957 & 1958 GROWING SEASONS [1]

J. T. GRIFFITHS [2]

In 1956, Fisher (1957) found that zineb could be used to control citrus fruit russet. For many years sulfur had been the only known material which would satisfactorily kill rust mites, and thus prevent rust mite injury on fruit russeting. Fisher reported outstanding success with zineb. This stimulated considerable interest in the material, and a more detailed report was made by Johnson, et al. (1957) at the 1957 meetings of the Florida State Horticultural Society. They concluded that zineb killed rust mites and that it was very effective when applied during the post bloom, summer and fall spray periods. They reported good results with dosage as low as ½ pound per 100 gallons of spray material.

Work with zineb was started by the Eloise Groves Association in January 1957 in four 40-acre blocks of 12-year-old Valencia oranges. Four rows were set aside in the center of each block. Two of these in each block were sprayed with zineb by a Speed Sprayer driven at 2½ miles per hour and applying approximately 5 pounds of zineb per acre. The other two rows were sprayed with a Speed Sprayer driven at 1¼ miles per hour. In both blocks a double-headed machine was used. A similar application was repeated at the post bloom period. In the summer, the two rows where the Speed Sprayer had been driven at 2½ miles per hour were sprayed with a combination of oil-parathion and approximately 5 pounds of zineb per acre. The other two rows in each block were sprayed with a similar combination but at the rate of only 2½ pounds of zineb per acre. In both instances, a Model-36 Sprayer was used and the material was applied at 1 mile per hour with a single head. The remaining portion of all four blocks was sprayed with conventional wettable sulfur programs for rust mite control. In only one of the four zineb-sprayed blocks were additional sulfur sprays required for rust mite control. In this one block, one extra spray was sufficient. In the case of the standard wettable sulfur sprays, at least three additional sprays or dusts were required in each of the four blocks in order to maintain rust mite control throughout the fall. No differences were noted between rates of speed of application or between the amounts of zineb used in the summer application.

RESULTS OF SUMMER SCALICIDE IN 1957

During the summer scalicide period in 1957, zineb was applied in combination with oil or oil-parathion on more than 50% of the total acreage in Eloise Groves Association. In almost all cases zineb was used at 5 pounds per 500-gallon tank and applied at a rate of 10 pounds per acre on oranges, 15 pounds per acre on grapefruit and approximately 5 pounds per acre on trees which averaged about 10 to 12 years of age. In some blocks, this dosage was cut in half so the comparison could be made between the two rates of zineb.

[1] A report presented at the 41st annual meeting of the Florida Entomological Society, August, 1958.

[2] Production Manager, Eloise Groves Association, Winter Haven, Florida.

Zineb was found to be very effective in controlling rust mite infestations.

Table I shows the number of spray or dust applications which were required, following the summer scalicide spray, in order to maintain rust mite control throughout the late summer, fall, and early winter months. The only differences of any consequence will be noted between the presence or absence of zineb in the summer scalicide spray. Wherever zineb was used, regardless of the dosage, less applications were required.

TABLE I. NUMBER OF SPRAY OR DUST APPLICATIONS FOLLOWING SUMMER SCALICIDE SPRAY IN 1957

Scalicide	Lbs. Zineb per 500-Gal. Tank							
	Grapefruit				Oranges			
	0	2½	5	Avg.	0	2½	5	Avg.
Oil	1.6	0	0.5	1.1	1.4	0.6	0.4	0.8
Oil Parathion	1.7	—	0.2	1.0	2.4	0.8	0.8	1.3

Table II shows the actual number of days that elapsed between the time that the summer scalicide spray was applied and the time that an additional application was required for rust mite control. Some of the figures show a plus mark, which indicates that the period was longer than that listed. Thus, in many instances, no additional sprays or dusts were required until the post bloom application in 1958, but the tabulations were terminated during December, 1957. In this table, it becomes obvious that zineb was markedly superior to straight oil or oil-parathion, and that the 2½ pounds per tank were not quite as effective as the 5 pounds. However, the 2½ pounds were sufficiently satisfactory that there appears to be little justification for using the higher dosage. This is in line with results presented by Johnson (1957).

TABLE II. NUMBER OF DAYS BETWEEN SCALICIDE SPRAY AND RECOMMENDATION FOR ANOTHER APPLICATION

Scalicide	Lbs. Zineb per 500-Gal. Tank					
	Grapefruit			Oranges		
	0	2½	5	0	2½	5
Oil	51	81	104+	54	114	112+
Oil Parathion	23	—	114+	24	71	116+
Avg.	37	—	109+	39	83	114+

It should be noted here that, in a few places, russeting did occur following zineb application. This occurred where heavy infestations were not controlled with a zineb spray.

In a commercial operation, if rust mite control can be maintained from June or July for a period of approximately 90 days, it is possible to use sulfur dusts as an effective and economical method of rust mite control. Thus, it would be cheaper to apply an additional one or two dusts at this time than to use the increased amount of zineb during the summer scalicide spray in order to obtain somewhat longer control.

In three cases where the cost of the spray program was calculated in paired blocks, it was found that the zineb program resulted in savings of 15 cents, $4.60 and $1.90 per acre, when labor, equipment and materials were all included at standard cost figures. However, the cost picture does not tell the entire story, since the use of zineb resulted in less necessity for checking the grove for rust mites, and in a much more flexible work program.

Results From Post Bloom Sprays in 1958

Due to the disastrous freezes during the winter of 1957-58, no dormant sprays were made in Eloise Groves Association. Rust mites were at a generally low level throughout the winter, and post bloom sprays were applied during April, 1958. During this operation comparisons were made between sprays containing only sulfur; copper and sulfur; zineb and copper; and zineb alone. Some sprays contained zinc, manganese, or arsenic, but these materials were ignored so far as the results reported here are concerned. All sprays were concentrated and were applied with a Speed-Sprayer, using a double head and driven at 2½ miles per hour. Mature groves received zineb at approximately 5 pounds per acre. Groves in the 10 to 14-year-old category received only 3 pounds per acre. The results of these sprays are shown in Tables III and IV.

Table III shows the results where copper was included in the spray, and Table IV where no copper was present. The groves are divided into four categories depending on age and variety. The number of groves sprayed with each combination is shown; the average percentage number of fruit infested with rust mites is shown for the approximate dates of June 1st and July 1st. Some of the figures for July 1st are shown with a plus mark, which indicates that the populations would have been higher but, of necessity, were sprayed prior to the July 1st count. In the fourth column under each category is shown the percentage of groves in which rust mites were sufficiently high that treatment was required by approximately June 15th.

Zineb was materially superior to sulfur whether or not copper was included, but the inclusion of copper in the spray resulted in a reduced rust mite control with both materials. In spite of the reduction where copper was used with zineb, this was still a superior application to wettable sulfur alone. In no instance was it necessary to re-treat any of the groves sprayed with either zineb or zineb-copper prior to the summer scalicide.

Results of Summer Scalicide in 1958

As this report is being presented at the Annual Meeting of the Florida Entomological Society, it is impossible to finally evaluate the summer scali-

TABLE III. RUST MITE CONTROL AFTER POST BLOOM SPRAY IN 1958 WHEN COPPER SULFUR IS COMPARED WITH COPPER ZINEB

	SULFUR				ZINEB			
	No. Groves	% Rust Mites June 1	% Rust Mites July 1	% Groves Retreated By June 15	No. Groves	% Rust Mites June 1	% Rust Mites July 1	% Groves Retreated By June 15
Old Grapefruit	11	17	34+	36	7	0.5	37	0
Old Oranges	5	15	40+	50	7	0	5	0
Old Tangerines	—	—	—	—	—	—	—	—
Oranges (8-14 yrs.)	18	3	14	5	—	—	—	—
Avg.	—	12	29	30	—	7	19	0

TABLE IV. RUST MITE CONTROL AFTER POST BLOOM SPRAY IN 1958 WHEN SULFUR IS COMPARED WITH ZINEB

	SULFUR				ZINEB			
	No. Groves	% Rust Mites June 1	% Rust Mites July 1	% Groves Retreated By June 15	No. Groves	% Rust Mites June 1	% Rust Mites July 1	% Groves Retreated By June 15
Old Grapefruit	9	8	35+	33	10	0	8	0
Old Oranges	10	4	15+	10	25	0.4	4	0
Old Tangerines	5	16	25+	20	7	0	1	0
Oranges (8-14 yrs.)	2	0	0	0	9	0.5	3	0
Average	—	7	19	16	—	0	4	0

cide sprays. However, certain trends have become obvious and the results are worth noting here.

Zineb was applied in most instances in concentrated oil-parathion combinations with Speed Sprayers driven at 1 mile per hour. Model-40 Sprayers used a double head, and Model-36 Sprayers used a single head. On groves of approximately 10 to 14 years of age, about 3 pounds of zineb were applied per acre. On old oranges approximately 5 pounds were applied per acre, and on old grapefruit about 7 pounds were applied. At approximately 135 locations, rust mites were at a very low level when the summer scalicide was applied. As of the middle of August rust mites have not appeared in sufficient numbers to be cause for alarm in any of these blocks. In 32 locations, 20 grapefruit and 12 orange or tangerine, in which more than 40% of the fruit was infested at the time of the summer scalicide spray, failures were recorded in 75% of the grapefruit and approximately 20% of the orange and tangerine blocks. The criterion of failure was that 25% or more of the fruit was infested. In general, the infested fruit was found inside the tree, usually as clustered grapefruit. Leaves were generally completely uninfested, and outside fruit had a very low rate of infestation.

These results suggest that when high infestations are present at the time that the summer scalicide is applied, it may be well to increase the dosage of zineb. Whether or not this would result in fewer failures remains to be determined, but it is worth considering during the 1959 spray season.

Discussion

The results presented here, as well as those by many other commercial operators in Florida, all point up the fact that zineb gives excellent rust mite control. They show that zineb is effective both at post bloom time and during the summer scalicide period, that it may be applied at as little as 5 pounds per acre on old groves, and that coverage, at least during the post bloom period, is not as critical as may have previously been believed.

The data presented here indicate that none of the failures following the 1958 summer scalicide were groves in which straight zineb was applied at post bloom time. However, three failures followed a post bloom copper/zineb. All other failures followed the use of straight sulfur or copper-sulfur at post bloom. This is certainly suggestive that the use of zineb at post bloom time would result in better rust mite control, not only during the late spring but also following the summer scalicide period. If it can be successfully used when applied at 2½ miles per hour and relatively low dosage, the elimination of failures following the summer scalicide will justify any additional cost of material at post bloom time. Additional information is necessary to establish this as fact, but the suggestion that zineb be used at post bloom time is made for the 1959 season.

No results observed by the author give any indication of deleterious results from the use of zineb. This does not mean that such will not be the case in the future, as it may take several years for adverse results to become evident. Since zineb is a fungicide, it is to be expected that there may well be an increase of some insect or mite populations, perhaps even of insects or mites that have normally been considered to be of no economic importance in the past. It is possible that the elimination of sulfur from a spray program may also have deleterious effects, but no such results have yet become evident.

During both the 1957 and 1958 seasons, various combinations of zineb and wettable sulfur were tried. These varied from dosages of 1 pound of zineb with 50 pounds of wettable sulfur to 3 pounds of zineb with 25 pounds of wettable sulfur per 500-gallon tank, with approximately 1 tank of material being applied per acre of old grove. The replications of these dosages were too small to present here as averages. However, even the addition of 1 pound of zineb in a 500-gallon tank appears to have resulted in materially enhanced rust mite control. There have been no instances when these combinations as compared with wettable sulfur were not strikingly better than the wettable sulfur applications. Comparisons are too scanty for valid conclusions to be drawn, but they are very suggestive that such combinations should be further studied as they may represent a very satisfactory application for some periods of the year. If it becomes evident that sulfur is needed for the control of some insects, it may well be that zineb-sulfur combinations offer the correct answer. Certainly these combinations are well worth considering as a permanent part of a spray program during the coming years.

At the present time it is impossible to speak with authority on the type of over-all spray program that should be carried out in citrus groves in Florida today, but so far as the Eloise Groves Association is concerned, it is anticipated that zineb-sulfur sprays will be used for rust mite control during August, September and perhaps October, with sulfur dusts applied thereafter. Miticides for the control of purple mites or Texas citrus mites will be used only where infestations become relatively heavy during the fall months. Whether or not a routine dormant application will be made will have to be determined as the result of mite infestations and weather conditions during the late fall and early winter.

It is quite conceivable that citrus may well be placed on a program which involves no more than 3 spray applications, and in many instances, only two. It is quite possible that the elimination, or virtual elimination, of sulfur from the spray program will result in lowered purple mite infestations. If this be true, it may be possible to go through the winter in many groves without the necessity for purple mite control. This is perhaps wishful thinking, but it further emphasizes the fact that careful checking of groves during the fall and winter months will be essential in order to be certain that neither six-spotted mites, purple mites, nor Texas citrus mites are increasing.

Summary and Conclusions

Zineb was applied on groves belonging to Eloise Groves Association during the 1957 and 1958 seasons in such a manner that comparisons on methods of application and dosage could be made.

(1) Zineb was found to be very effective for rust mite control, but russeting did occur after the application of zineb in a few groves where rust mites were not satisfactorily controlled.

(2) Dosages in old orange groves as low as 5 pounds per acre were found to be quite effective.

(3) Excellent results were obtained with such dosages at post bloom

time when applied with a double-headed Speed Sprayer driven at 2½ miles per hour.

(4) Failures of zineb in the summer scalicide in 1958 appear to be the result of heavy rust mite populations at the time of spray. These infestations were related to the use of sulfur combinations at post bloom time. None was recorded where zineb had been used at post bloom.

(5) It is suggested that combinations of zineb and wettable sulfur may be practical for use at some times of the year on citrus.

Literature Cited

Fisher, Fran E. 1957. A summer application of Zineb for the control of citrus fruit russet. The Citrus Industry. 38(5): 5-6.

Johnson, R. D., John R. King, and *J. J. McBride, Jr.* 1957. Zineb controls citrus rust mite. Proc. of the Fla. St. Hort. Soc. 70: 38-48.

Book Reviews

COLLECTING, PRESERVING AND STUDYING INSECTS, by Harold Oldroyd. 327 pp., 135 figs. 15 pls., 1 map. MacMillan Co., New York. 1958. Price $5.00.

The title of this book clearly indicates its coverage. The first part, devoted to collecting, tells where to look for insects, catching and trapping them, keeping, breeding and rearing, and killing and temporarily preserving the catch. Part II gives instructions for preparing and mounting for permanent preservation, examining insects in a collection and photography. The last section concerns the study of insects, including the principles of zoological classification and nomenclature, what are insects and their allies, and how insects are identified. Further chapters discuss additional reading in entomology and the description of new species.

The book is written for the adult who becomes interested in insects or for students of entomology who are in the beginning stages of developing a knowledge of this science. It has been carefully planned to answer the needs of these two groups. Professionals may also find much of value in the book, particularly for use as a ready source of general information about insects.—L.B.

CHECKLIST AND BIBLIOGRAPHY ON THE OCCURRENCE OF INSECTS IN BIRDS NESTS, by Ellis A. Hicks. 681 pp. Iowa State College Press, Ames.

The author states that "This work represents an attempt to assort and consolidate information for the convenience of the user. As a result, the approach is two-fold: (1) entomological, and (2) ornithological. These two checklists are complimented by a third portion, a bibliography, which is as inclusive as I could make it over a period of about four years."

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