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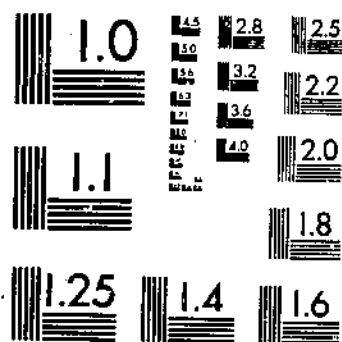
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ORRUS INSIDIOSUS (SAY), AN IMPORTANT NATURAL ENEMY OF THE CORN EAR WORM

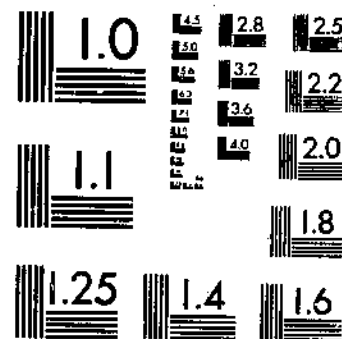
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UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

ORIOUS INSIDIOSUS (SAY), AN IMPORTANT NATURAL ENEMY OF THE CORN EAR WORM

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INTRODUCTION

In the course of a study at Richmond and Charlottesville, Va., from 1924 to 1927, on field oviposition by the corn ear worm (*Heliothis obsoleta* Fab.) and the fate of the eggs deposited on corn, it was found that the most important natural destroyer of ear worm eggs, especially those deposited on corn silks, was the small anthrenid bug, *Orius insidiosus* (Say), formerly known as *Triphleps insidiosus*. The writer has previously observed its abundance on corn and its important relationship to the European corn borer in Massachusetts (2),¹ and the literature showed that it was widely distributed, not only on corn but on many other plants, where it fed on numerous small insects many of which were injurious to crops. All of this information was fragmentary, and it appeared that little

¹ Italic numbers in parentheses refer to Literature Cited, p. 22.

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was known about the biology or economic importance of this useful predator. During the years 1928 and 1929, in the vicinity of Richmond, Va., the writer learned much more about this species, especially as found on the corn plant and as related to the corn ear worm, and the information gained in this study is summarized in the present bulletin.

ECONOMIC IMPORTANCE

Orius insidiosus apparently occurs over most of the United States and in southern Canada. Records in literature show its occurrence in 31 States as well as in 2 Canadian Provinces. It occupies among the Hemiptera a position similar to that occupied by *Trichogramma minutum* Riley among the parasitic Hymenoptera, for frequently these two small species, taken together, form the most important natural control of an injurious insect, especially among those attacking the corn plant, the one destroying the eggs alone, and the other feeding on both eggs and newly hatched larvae.

M. P. Jones, in an unpublished manuscript, reports that (*Triphleps*) *Orius insidiosus* was found feeding on probably 4 percent of the pupae of the Mexican bean beetle (*Epilachna corrupta* Muls.) late in June 1924.

The insects attacked by *O. insidiosus*, according to the writer's observation in various localities, were among the most important enemies of the corn plant in these several areas and included not only the corn ear worm but the European corn borer (*Pyrausta nubilalis* Hbn.), in Massachusetts in 1923 and 1924, the fall army worm (*Laphygma frugiperda* S. and A.), in Georgia in 1930, and the larger corn stalk borer (*Diatraea crambidoides* Grote), in Virginia in 1928 and 1929.

REVIEW OF LITERATURE

Notes from published writings show that *O. insidiosus* not only occurs widely over the country but is found on a wide variety of vegetation, including trees, shrubs, field crops, vegetables, and many wild plants. On many of these it is found principally on the blossoms, but it also searches for food over the entire plant. When corn is available it lays its eggs principally in the strands of fresh silk, where also the young nymphs begin feeding.

ORIUS INSIDIOSUS IN RELATION TO THE CORN EAR WORM

Forbes records *O. insidiosus* as an enemy of corn ear worm eggs and (13) notes its abundance on corn. Garman and Jewett (16) reared *O. insidiosus* from the egg, and figured the eggs for the first time; they reckoned its life cycle from egg to adult as 15 days, 3.25 hours. They state (16, p. 587): "It appears to feed to some extent on plant juices, but is fond of the juices of various insects, such as species of 'thrips,' and is very useful because of its destruction of the eggs of the corn worm." Mally (29, p. 39) noted that this insect was beneficial in destroying bollworm eggs. Quaintance and Brues (36, p. 107), in an elaborate report on the bollworm say:

The nymphs and adults of *Triphleps insidiosus* Say * * * have been repeatedly observed feeding on bollworm eggs and on very small larvae. This little heteropterous is especially abundant in fresh corn silk, and is often seen frequenting cotton plants also. Although in a number of instances noticed in

the laboratory they seem loath to attack living larvae, they are sometimes to be seen in the field with newly hatched larvae impaled on their slender beaks. Their principal value lies, however, in the large number of eggs which they destroy. A special count was made at Sulphur Springs, Tex., on August 16, 1904, to determine the probable proportion of eggs destroyed by this agency. The eggs on 10 different silking ears were examined, and, on an average, 55 percent of the eggs were found to be shriveled. It is probable that most of these shriveled eggs had been punctured and their contents sucked out by the Triphleps, which were numerous on the silks at that time. This is no doubt an exceptional case but it serves to show of what great value the Triphleps may be under favorable conditions.

Webster (43) noted as early as 1885 that *O. insidiosus* may frequently be found in all stages literally swarming among the corn silks with no other visible food supply. Winburn and Painter (50) state, regarding the corn ear worm: "Among the predators, *Orius insidiosus* is probably the most beneficial."

ORIUS INSIDIOSUS IN RELATION TO OTHER INSECTS AND TO MITES

Besides the eggs and young larvae of Lepidoptera, the insects recorded as prey of *Orius insidiosus* include thrips, aphids, white flies, leaf hoppers, the young of lace bugs, the chinch bug, midges, red spiders, and mites. One writer (38) records it as even attacking man. Another (26) thought that it transmitted corn-ear rot (*Diplodia* sp., *Fusarium* sp.). Still another (39) referred to the feeding and egg-laying injury to chrysanthemums attributed to *O. insidiosus*. A list of insects preyed upon by *O. insidiosus* and references to records of such attack in literature follow:

Thysanoptera (14, p. 434; 42):

- Thrips tabaci* Lind. (4, 5).
- Euthrips nicotianae* Hinds (= *Frankliniella fusca* Hinds) (18).
- Euthrips pyri* Daniel (= *Taeniothrips inconsequens* Uzel) (15).
- (*Euthrips*) *Scirtothrips citri* Moul. (19).
- Frankliniella tritici* Fitch (19).
- Prosopothrips cognatus* Hood (22).
- Heliothrips fasciatus* Perg. (40).

Homoptera:

- (*Macrosiphum*) *Illinoia pisi* Kalt. (6; 11, p. 151).
- Phylloxera vitifoliae* Fitch (12, p. 86; 14; 23).
- Myzus brassicae* Gillette (21).
- Phorodon humuli* Schrank (33).
- (*Chaitophorus*) *Periphyllus negundinis* Thos. (49).
- (*Acyrodes*) *Trialeurodes vaporariorum* Westw. (16).
- Empoasca mali* Le Baron (= *Empoasca fabae* Harr.) (1; 47; 48, p. 400).

Hemiptera:

- Corythucha citrata* Say (31, 41).
- Gargaphia solani* Heid. (9).
- Blissus leucopterus* Say (10; 12, p. 86; 14; 23; 38; 44; 45; 46).

Lepidoptera:

- Lophygma frugiperda* S. & A. (24).
- Rhodophora florida* Guen. (7).
- Pyrausta nubilalis* Hbn. (2).
- (*Plutellinae*) *Gnorimoschema operculella* Zell. (17).

Diptera: *Dasyneura leguminicola* Lintu. (11, p. 123).

Acarina (37): *Tetranychus telarius* L. (*bimaculatus* Harvey) (8, 25, 26, 27).

In Virginia the writer has found it preying upon several aphids, including *Tritogenaphis* sp.² feeding on wild lettuce (*Lactuca cna-densis*) and *Illinoia pisi* Kalt.² feeding on crimson clover.

² Determined by P. W. Mason, Bureau of Entomology and Plant Quarantine.

SEASONAL HISTORY

BEFORE CORN BECOMES AVAILABLE

Orius insidiosus evidently passes the winter as an adult in protected places. Blackman and Stage (3, p. 201) recovered it from dead hickory on the ground. Hyslop (20) states that it is known to hibernate in the rubbish in cornfields. McGregor and McDonough (27) say, "These bugs pass the winter in the adult stage and usually become active some time in April, although they have been seen as early as the middle of March." Garman and Jewett (16) say, "It hibernates as an adult among rubbish at the bases of plants." Marshall (30) states that the insects hibernate as adults in "any place where the drainage is good and where a fairly good covering of leaves and rubbish can be found."

In New England, Parshley (34) obtained records of adults throughout the season, from June 22 to October 3. In Virginia the writer has seen adults from March to November; but of the large populations that occur in corn during July, August, and September apparently few survive to enter hibernation, and previous to the appearance of corn in the field they are rarely met with. The earliest observed individuals are on flowers, such as dandelions, whither they are likely attracted by thrips and other small, soft-bodied insects that occur there. They may then be swept from almost any plant association, being at this time of the year—March to May or June—rather pressed for food, and they seem to breed sparingly, if at all, on these plants, very few or no nymphs being observed or swept up in the collecting net. Its general occurrence has been suggested in the literature reviewed, and Parshley (35) notes that it is "very commonly met with in sweeping, as it lives in large numbers in the flowers of various plants * * *". Osborn and Drake (32, p. 68) say, "It is a grass- and herb-inhabiting insect, especially common in open grassy areas." Perhaps neither of these authors had ever examined corn plants during the growing season and had thus missed seeing *O. insidiosus* in its most favored habitat.

ON THE CORN PLANT

While *Orius insidiosus* continues to occur generally on miscellaneous vegetation throughout the season, as soon as the first corn is about a foot high the adults begin to congregate on these plants, feeding at first upon thrips, aphids, and other small insects that then infest the plants. From this time onward through the season they occur principally on corn plants, breeding sometimes in large numbers. On the small corn plants they are found running about on the leaves and stalks, or hiding between the leaf sheath and the stalk. As soon as the young tassels begin to develop in the bud the adults seek these tender parts, where they feed on small insects, probably on the young tassel buds as well, and perhaps lay a few eggs. When the silks appear beyond the husks of the developing ears, however, the adults seek these parts, both to feed upon and to lay their eggs in the tender, fresh strands of silk which will provide food for the young nymphs. When nymphs, which are able to develop entirely upon the silks as food, are about half grown they make excursions from the silks to all parts of the plant to seek

animal food, especially small thrips, that occur between leaf sheaths and stalk, as well as other small insects, and they are to be seen with their captured prey impaled on their strong beaks stretched straight out before them. Since corn plants develop irregularly, and the fields are seeded over a period of 2 or 3 months in central Virginia, a succession of plants is to be found throughout the season in stages of growth most attractive to *O. insidiosus*. It therefore breeds continuously throughout the period from May to September, or later, when the disappearance of fresh corn silks makes further breeding impossible.

Series of field counts made during 1928 and 1929 in Richmond, Va., to determine the population of *O. insidiosus* on corn plants in all stages of growth represented in the field through the seasons showed similar seasonal trends of population—greater in 1929, however, than in 1928. Populations fluctuated greatly from time to time,

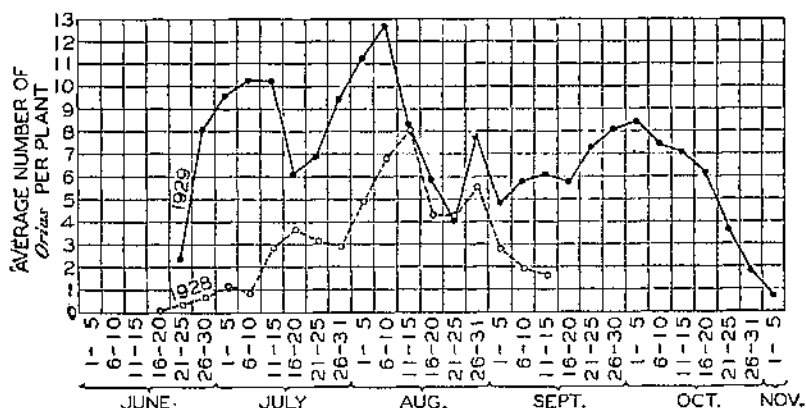


FIGURE 1.—Average populations of *Orius insidiosus* on selected corn plants in all stages of growth in the field throughout the seasons of 1928 and 1929 at Richmond, Va.

building up gradually during fair, warm weather and decreasing rapidly during periods of storms that wash off and drown large numbers of these small insects. Thus on August 10, 1928, an average of 6.55 *O. insidiosus* (1.99 adults and 4.56 nymphs) per corn plant were recorded, plants of all stages of growth being represented. On August 11 and 12 a terrific storm occurred, accompanied by heavy rains and wind sufficient to blow over the corn plants. Counts on August 17 and 18 similar to those made on August 10 showed 3.51 of these insects per corn plant (2.26 adults and 1.25 nymphs), or its population had been reduced nearly one-half by the storm, most of the individuals that had perished being nymphs. The following year, at about the same time, after a storm of even greater fury had lashed the cornfields, large numbers of dead insects were found on the corn plants, particularly between the leaves and stalk, where they had doubtless been trapped and drowned. These storms so greatly decimated the populations of the insect that in neither year did it regain its former abundance.

In figure 1 is given the average population of *O. insidiosus* (adults and nymphs) occurring per plant (for 2,890 plants of all stages represented in the field) during each 5-day period in 1928 and 1929.

In each case the insect began to appear on corn plants the third or fourth week in June and reached maximum populations the first or second week in August. In each year the record shows several periods during which populations grew rapidly and were then checked or decimated, only to begin a new period of rapid increase. They were much more abundant throughout 1929, and this may be attributed in part to the presence, through the season, of varieties of corn more favorable for its breeding than were planted in 1928. On the appearance of cold weather and the ripening of plants, large numbers of the adults of *O. insidiosus* die in the field and are to be seen strewn on the leaves and on the ground.

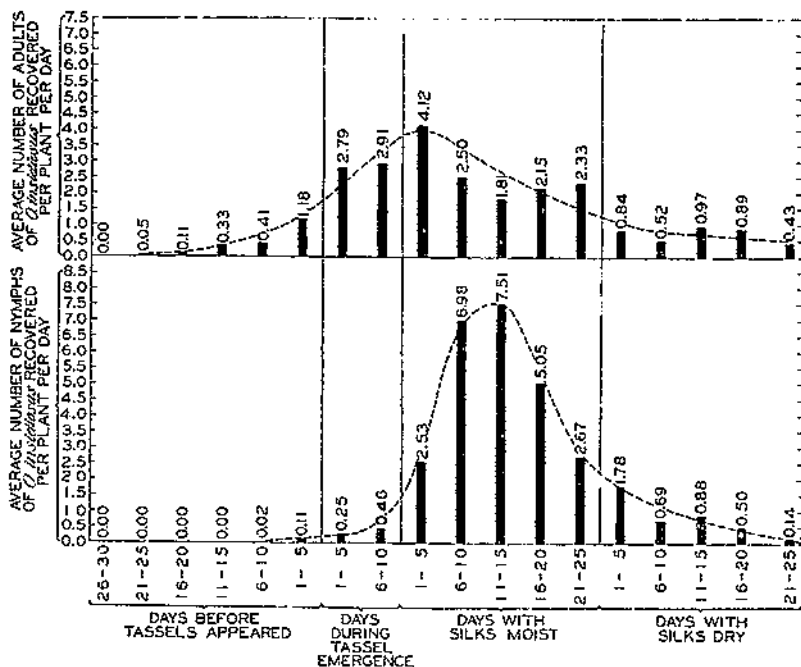


FIGURE 2.—Occurrence of adults and nymphs of *Oryza insidiosus* on corn plants during the periods when plants were in the several stages of growth, Richmond, Va., 1928.

ABUNDANCE ON CORN PLANTS IN THEIR SEVERAL STAGES OF GROWTH

During 1928 the populations of *Oryza insidiosus* on individual corn plants during the entire growing season were studied by weekly examinations. Varieties of both yellow dent and white dent corn were used as well as Country Gentleman sweet corn. In general, the growth of these plants could be divided into the following periods: 30 days before tassels appeared; 10 days during which tassels were exposed but before silks appeared; 25 days during which silks were exposed and moist in some parts, and during which the kernels were fertilized and passed through the milk and dough stages; and 25 days during which the exposed silks were dry, no longer affording nourishment to the insect and unsuitable for egg laying, and during which the kernels were hardening and ripening.

It was found that adults occurred in varying abundance on the corn plants during a period of about 12 weeks. First appearing on the small plants about 3 weeks before tasseling, they gradually increased in abundance, reaching a peak (during the first week that silks were exposed and fresh. After this there was, in general, a gradual decrease, but the bugs occurred in small numbers even on the ripe plants. The nymphs were rarely found on plants before tasseling and were few in number during the period of tassel emergence. They appeared in numbers soon after the silks were exposed, reaching a peak of abundance during the second week of this period, and from that time onward decreased regularly on the plants (fig. 2). The smoothed curve of occurrence of nymphs, more abrupt and occupying a shorter period of time, follows the curve of adult occurrence and shows that feeding conditions favorable to nymphs occurred principally during the period of fresh silks.

The average daily occurrence of adults and nymphs on corn plants during the specified stages of growth as shown by these field examinations covering 2,440 plants in 2 years is shown in table 1. Populations varied in different fields and in time, as is indicated by these data. Plants in one plot examined in 1928 showed greater populations of both adults and nymphs than plants in another plot. The population of *O. insidiosus* during 1929—4.08 adults and 3.38 nymphs per plant throughout the season—was considerably greater than during the preceding year.

TABLE 1.—Daily occurrence of adults and nymphs of *Orivus insidiosus* on four stages of growth of corn plants at Richmond, Va., during the seasons of 1928 and 1929

Year and plot no.	Stage of growth of plants	Plants examined	O. insidiosus four 1 on plants per day		Average O. insidiosus per plant per day	
			Adults	Nymphs	Adults	Nymphs
1928, plot 1.	Before tassels appeared.....	Number 244	Number 104	Number 6	Number 0.43	Number 0.025
	Period of tassel emergence.....	116	387	43	3.34	.28
	Plants with silks moist.....	161	465	834	2.89	5.18
	Plants with silks dry.....	139	111	158	.80	1.14
	Total.....	660	1,067	1,081	1.92	1.50
1928, plot 2.	Before tassels appeared.....	120	185	20	1.51	.17
	Period of tassel emergence.....	140	647	135	4.62	.96
	Plants with silks moist.....	200	482	1,250	2.41	6.25
	Plants with silks dry.....	200	176	253	.88	1.20
	Total.....	660	1,490	1,658	2.26	2.51
1929.	Before tassels appeared.....	180	803	13	3.35	.07
	Period of tassel emergence.....	270	1,818	293	6.61	.80
	Plants with silks moist.....	350	1,762	1,553	5.31	4.74
	Plants with silks dry.....	340	351	1,975	1.03	5.81
	Total.....	1,120	4,501	3,784	4.08	3.38
Total.	Before tassels appeared.....	514	592	39	1.61	.07
	Period of tassel emergence.....	526	2,882	401	5.48	.76
	Plants with silks moist.....	691	2,709	3,647	3.92	5.28
	Plants with silks dry.....	675	638	2,386	.94	3.51
	Total.....	2,440	7,121	6,473	2.92	2.65

The greatest number of adults on any one plant was 24 and the greatest number of nymphs 37. Plants not yet in tassel showed adult populations of from 0 to 12; plants during tassel emergence, from 0 to 24; plants with moist silks, from 0 to 20; plants with dry silks, from 0 to 8. From 0 to 3 nymphs were recovered from plants not yet in tassel, from 0 to 9 on plants during tassel emergence, from 0 to 37 on plants with moist silks, and from 0 to 19 on plants with dry silks. A brief summary of the distribution of the populations of *O. insidiosus* on 1,780 corn plants is given in table 2.

TABLE 2.—Distribution of population of adults and nymphs of *Orius insidiosus* on corn plants at Richmond, Va., during seasons of 1928 and 1929

Stage of insect	Stage of growth of plants	Plants examined	Plants upon which the indicated number of individuals were found									
			None	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	
Adult		No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	
	(Not yet in tassel)	306	45	227	24	4						
	Period of tassel emergence	410	11	201	144	47	5	2				
	With silks moist	530	6	310	115	32	6					
	With silks dry	540	255	277	8							
	Total	1,780	378	1,015	291	83	11	2				
Nymph			Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	
	Percentage of whole		21.23	57.02	16.35	4.67	0.62	0.11				
		No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	
	(Not yet in tassel)	306	274	26								
	Period of tassel emergence	410	231	172	7							
	With silks moist	530	20	297	131	38	14	10	9	1	1	
Nymph	With silks dry	540	126	302	84	23	5					
	Total	1,780	660	797	222	61	19	10	9	1	1	
			Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	
	Percentage of whole		37.08	44.78	12.47	3.43	1.07	0.56	0.51	0.05	0.05	

OCCURRENCE ON THE SEVERAL PARTS OF THE CORN PLANT

Since, as has been shown, *O. insidiosus* is particularly attracted to plants during the period of tassel emergence and while with fresh or moist silks, it might be supposed that on plants in such condition these parts would show the largest numbers of individuals. This is not necessarily so, for both adults and nymphs are very active and run over all parts of the plants, according as weather conditions permit and wherever small insects or insect eggs that serve as food attract them. The adults, besides running rapidly, are quick to fly and are not easily captured. Even during the period when silks are fresh and eggs are being deposited, they search over all parts of the plants for the animal food evidently necessary for egg production. The larger nymphs also seek animal food and may be found on all parts of the plants. Both stages, especially the nymphs, probably migrate in considerable numbers from the larger plants when the leaves of different plants come into contact. In fair weather they are frequently found on the upper surface of leaves, but during cloudy or stormy weather they hide between leaves and stems. They are rarely found on the under surface of leaves. Both

stages are abundant on the stems, in the silks, and either running over or hiding beneath the leaves that compose the husk of the ear. Adults are abundant on young tassels, but nymphs are not so frequently found on these parts, perhaps because the tassels usually have dried before the nymphs become abundant on the plants. In table 3 the occurrence of adults and nymphs on the several parts of the corn plant during different stages of growth of such plants is summarized, the data being derived from observations on the same insects referred to in table 2.

TABLE 3.—Average daily occurrence of adults and nymphs of *Orius insidiosus* on various parts of corn plants in four different stages of growth, Richmond, Va., 1928 and 1929

Stage of growth of plants	Plants	Part of plant	Adults		Nymphs	
			Number	Percent	Number	Percent
Not yet in tassel.....	309	Upper surface of leaves.....	521	50.12	15	48.40
		Lower surface of leaves.....	129	10.37	3	9.09
		Stalks.....	138	17.51	14	42.42
		Tassels.....				
		Husks.....				
		Silks.....				
		Total.....	788	100.00	33	100.00
Period of tassel emergence..	410	Average individuals per plant per day.....	2.53		0.11	
		Upper surface of leaves.....	1,083	43.41	130	35.33
		Lower surface of leaves.....	62	2.48	6	1.63
		Stalks.....	453	18.10	174	47.28
		Tassels.....	757	30.34	48	13.04
		Husks.....	140	5.61	10	2.72
		Silks.....				
With silks moist.....	530	Total.....	2,495	100.00	363	100.00
		Average individuals per plant per day.....	4.69		0.69	
		Upper surface of leaves.....	768	31.22	513	18.24
		Lower surface of leaves.....	19	.86	38	1.36
		Stalks.....	243	10.83	577	20.61
		Tassels.....	69	3.08	25	.89
		Husks.....	525	23.39	693	24.64
With silks dry.....	540	Silks.....	620	27.63	967	34.37
		Total.....	2,244	100.00	2,813	100.00
		Average individuals per plant per day.....	4.23		5.31	
		Upper surface of leaves.....	134	25.43	364	18.34
		Lower surface of leaves.....	4	.76	12	.54
		Stalks.....	48	8.73	220	9.88
		Tassels.....	10	1.80	6	.40
Total.....	1,780	Husks.....	205	38.90	826	37.07
		Silks.....	128	24.20	707	35.77
		Total.....	527	100.00	2,228	100.00
		Average individuals per plant per day.....	0.98		4.12	
		Upper surface of leaves.....	2,500	41.39	1,023	18.70
		Lower surface of leaves.....	214	3.54	69	1.09
		Stalks.....	880	14.54	985	18.10
		Tassels.....	836	13.81	92	1.51
		Husks.....	870	14.37	1,520	23.09
		Silks.....	748	12.35	1,704	32.42
		Total.....	6,054	100.00	5,442	100.00
		Average individuals per plant per day.....	3.40		3.06	

RELATIVE ATTRACTIVENESS OF DIFFERENT VARIETIES OF CORN

In different corn varieties the quantity of silk exposed on the ears varies with the number of kernels to the ear. For example, silks are very profuse on ears of Country Gentleman sweet corn, which bear a large number of small, closely packed kernels; while in Hickory King, the kernels of which are very large and comparatively few in number, silks are relatively sparse. *Orius insidiosus* makes three principal uses of corn silks—for food for both adults and nymphs, especially for the latter; for egg laying; and for shelter against inclement weather, as they hide among the strands of silk at the tip of the ear, or, if the ear is open or the husk loosely wrapped about it, beneath the protecting husk. Corn varieties characterized by abundant silk and several ears per plant are more favorable to, and harbor greater numbers of, *O. insidiosus* than varieties having sparse silk. At whatever season examinations were made, Country Gentleman sweet corn showed larger populations of both adults and nymphs than any other varieties observed, although these included white and yellow dent as well as other sweet-corn varieties. Often the populations of this insect on Country Gentleman sweet corn were several times as great as on other corn varieties in the same stage of growth, and the silks were fairly swarming with nymphs. In these cases the greater attractiveness of Country Gentleman corn to adults had resulted in greater breeding and egg laying in the silks of these plants. Fields of this variety acted as reservoirs from which *O. insidiosus*, having built up large populations, migrated, when the plants were no longer attractive, to field corn in the vicinity, where breeding had proceeded on a much reduced scale, owing to lesser attractiveness of the plants to the adults.

Successive plantings of this variety of corn through the season of 1929 on a Virginia farm where these studies were made, probably had much to do with the finding of much larger populations of the insect generally in the vicinity in 1929 than in 1928, when no such successive plantings occurred, for *O. insidiosus* bred freely and continuously throughout the season in its silks.

RELATIONSHIP OF THE SEASONAL HISTORY AND ABUNDANCE OF *ORIUS INSIDIOSUS* ON CORN PLANTS TO THE CORN EAR WORM

The occurrence of *Orius insidiosus* on corn plants is more or less closely coincidental with the occurrence of ear worm eggs, not only as to the period of the year, but as to stages of growth of plants and as to parts of the corn plant. Although *O. insidiosus* feeds extensively upon these eggs and its presence might seem a consequence of the presence of this food supply on the plants, this is the case only in part. *O. insidiosus* occurs as well upon plants bearing no ear worm eggs and during periods of the year when ear worm eggs are few in number or entirely absent. It does not seem to be primarily the ear worm eggs, or any other specific animal food, that mostly attracts *O. insidiosus* to corn. It is attracted, rather, because the plant provides a desirable place for egg laying where plant food for the younger nymphs is abundantly available.

Animal food of some sort is usually present on corn in abundance, often far in excess of the possible needs of *O. insidiosus*, and both the adults and larger nymphs accept whatever food is available, such as eggs of the ear worm or of the fall army worm, the young caterpillars of these and other species of Lepidoptera, aphids, thrips, leaf hopper nymphs including certain fulgoroidea, and other small, soft-bodied insects. Ear worm eggs, therefore, are probably accepted because they provide a supply of desirable, although not necessarily the most eagerly sought for, food; in fact, in the writer's experience, the young of thrips seem to be preferred to other animal food. In view of its general acceptance of any small insect, the importance of *O. insidiosus* in the control of the corn ear worm through destruction of the eggs depends on the abundance on the corn plant of various other insects that it might take as food. Its effect on the ear worm is greater when no thrips, aphids, or other host insects are present, and less when such alternative food is plentiful and more easily found than ear worm eggs.

In central Virginia there are two principal generations of the corn ear worm annually. Eggs of the first generation, deposited by moths emerging from hibernation, are laid in June and July, and eggs of the second are deposited during August and September. Between these two periods of oviposition there is usually a period of 1 or 2 weeks, late in July and early in August, when eggs are scarce or absent. Yet it was during these periods of scarcity of eggs, between generations, when *O. insidiosus* was found to be most plentiful in 1928 and 1929 (fig. 1). While, therefore, populations of *O. insidiosus* do not fluctuate with occurrence of corn ear worm eggs, the one being independent of the other, their seasonal distribution is similar.

Also, for independent reasons, *O. insidiosus* is attracted to plants in certain stages of growth in the same way that the corn ear worm is attracted. Thus both are more attracted to corn while it bears moist silks than at any other time, and the second most attractive period for both species is while the plants are in tassel before the silks appear.

Again, individuals of *O. insidiosus* and eggs of the corn ear worm are recovered from the different parts of corn plants in somewhat similar numbers. This is shown in the brief summary given in table 4.

TABLE 4.—Comparison of the distribution of *Orius insidiosus* and of corn ear worm eggs on the various parts of the corn plant

Plant part	Proportion of the whole population of corn ear worm eggs recovered	Proportion of the whole population of <i>O. insidiosus</i> recovered	Plant part	Proportion of the whole population of corn ear worm eggs recovered	Proportion of the whole population of <i>O. insidiosus</i> recovered
	Percent	Percent		Percent	Percent
Upper surface of leaves...	17.2	30.7	Husks.....	3.9	20.9
Lower surface of leaves...	4.6	2.4	Silks.....	44.9	21.9
Stalks.....	7.8	10.2			
Tassels.....	21.6	7.9	Total.....	100.0	100.0

The data on the corn ear worm included in this table are based on records of 33,519 eggs recovered from corn plantings throughout the seasons of 1924 to 1927, inclusive. Those on *O. insidiosus* represent an adaptation of the records of 11,496 individuals of those shown in table 3 recovered from corn plants throughout the seasons of 1928 and 1929. Most of the specimens of *O. insidiosus* recovered from husks of corn consisted of individuals normally inhabiting the silks, but hiding temporarily under the modified leaves of the husks. When the husk and silk populations of *O. insidiosus* are combined (42.8 percent of the whole recovery), the similarity to the percentage of ear worm eggs recovered from silks (44.9 percent) is apparent.

FOOD HABITS OF ADULTS

The variable nature of the food of the adult *Orius insidiosus* has already been indicated in the review of literature. Animal food is needed for a long life and much reproductive activity. In cages, adults were fed on eggs and newly hatched larvae of *Heliothis obsoleta*, on eggs and newly hatched larvae of *Laphygma frugiperda*, and on larvae of *Diatraea crambidoides* (eggs of this species are not accepted as readily as ear worm eggs), as well as on the eggs of several undetermined Lepidoptera. They were also fed on aphids and thrips of several species, and they fed readily on partly grown larvae of the corn ear worm which had been maimed.

When attacking an active insect, such as an aphid or small caterpillar, *O. insidiosus* extends its beak forward in line with the body and approaches stealthily, gently easing the tip of the beak through the exoskeleton of the prey which soon succumbs without noticeable struggle. After a few moments the predator may walk away with the prey impaled upon its extended beak. It has seemed probable to the writer that an anaesthetizing fluid might be injected into the wound coincidentally with the puncturing by the beak. Aphids and small caterpillars respond to the prick of a fine needle by promptly moving away from the disturbance, but when attacked by *O. insidiosus* they show no recognition of an injury or of danger. Once impaled upon the beak, the prey is sucked of its juices until the body is dry, or until the predator is satisfied with the feast, when the corpse is dropped.

Eggs, such as those of the corn ear worm, are devoured in the same way, the shell collapsing as the contents are drained. Eggs in all stages and conditions are taken, from those newly laid to those about to hatch, and even occasionally when the hatching larva has partly escaped from the egg. Eggs parasitized by *Trichogramma minutum* are also drained. Eggs of other Lepidoptera, having a more rigid shell, collapse in various ways, but some retain the original shape and appear transparent. The number of eggs of the corn ear worm consumed by observed individuals of *O. insidiosus* is given in table 5. Females devoured from 0 to 5 eggs (average, 1.75) daily, males from 0 to 3 eggs (average, 1.08), while paired individuals devoured an average of 2.65 eggs daily.

TABLE 5.—Feeding of nymphs and adults of *Orius insidiosus* on corn ear worm eggs at Richmond, Va., during 1929

Stage or sex	Observations ¹	Instances in which the indicated number of eggs were devoured per day						Total eggs consumed	Average eggs devoured per individual per day
		None	1	2	3	4	5		
Larger nymphs.....	Number 93	Number 12	Number 30	Number 60	Number 1	Number	Number	Number 133	Number 1.43
Female adults.....	659	115	197	159	133	28	22	1,161	1.76
Male adults.....	263	58	133	66	0			283	1.08
Paired male and female adults.....	779	5	74	178	458	61	3	2,003	2.65

¹ Number of insects times number of days observed.

Eggs are devoured in greatest numbers during the first 5 days of adult life, but even senile individuals, no longer laying eggs, continue to feed on corn ear worm eggs, the last record of such feeding being on the one hundred and fourteenth day of life of an individual *O. insidiosus*.

Orius insidiosus is cannibalistic, both as a nymph and as an adult. Adults feed upon nymphs, and females frequently feed upon males. The larger nymphs also devour smaller nymphs.

LENGTH OF LIFE OF ADULTS

Adults of summer broods of *Orius insidiosus* live for remarkably long periods in cages when supplied with food daily. Without such food the life span is brief. The average length of life of adults of both sexes, when supplied various foods, is shown graphically in figure 3. The individuals that lived longest were those supplied with eggs of the corn ear worm, while those not supplied with some sort of animal food lived for only brief periods. The longest lived female of *O. insidiosus* lived for 118 days, becoming adult on July 2 and dying on October 28; while her mate lived for 83 days, becoming adult on June 29 and dying on September 20. This pair of insects consumed a total of 267 corn ear worm eggs, and the female laid 169 eggs. The fact that adults of *O. insidiosus* are essentially predacious is thus borne out by these studies.

PROPORTION OF SEXES

The proportion of sexes of adults of *Orius insidiosus* was found to vary with the season. Early in the summer, before breeding on corn had begun, females were found to be a little more than twice as abundant as males. While breeding on corn, the sexes were, in general, comparatively equal in numbers; whereas in the fall, when breeding had ceased, males were found to be twice as numerous as females.

OVIPOSITION

THE EGG

The egg of *Orius insidiosus* is subcylindrical, 0.47 mm long by 0.17 mm broad, tapering to a distinct white cap 0.10 mm in diameter. It is extraordinarily large in comparison with the size of the adult. The integument is smooth and translucent. As the embryo develops, its red color becomes distinct, even through the silk strand which contains the egg, if the silk is not too coarse or too dark. The egg is firmly imbedded in the silk, the cap always being exposed and extending from the surface about 0.05 mm. Eggs hatch in from 3 to 4 days, depending on the temperature.

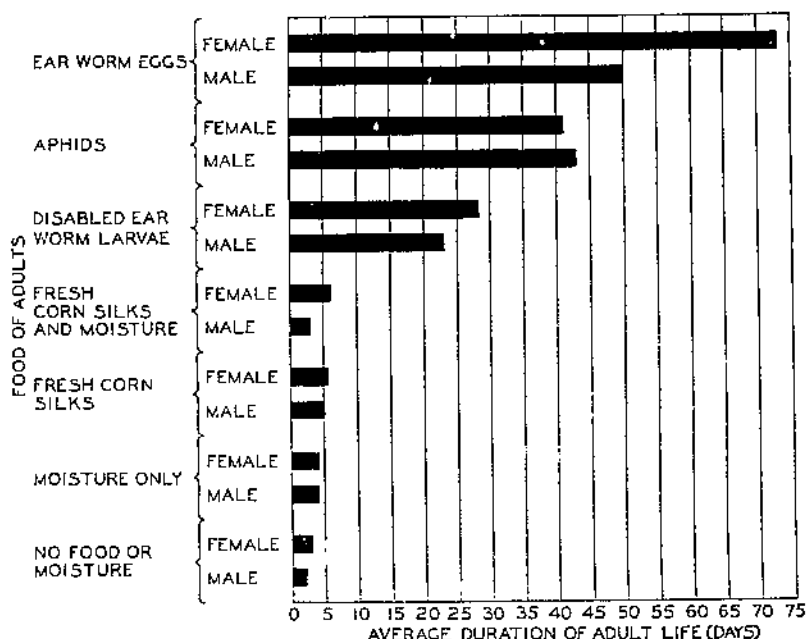


FIGURE 3.—Average duration of adult life of *Orius insidiosus* in relation to the nature of the food supplied.

PLACES CHOSEN FOR EGG LAYING

Although *Orius insidiosus* prefers the moist, fresh silks of corn for egg laying, other locations are occasionally chosen. In cages, eggs were laid in tender corn tassel and bits of tender husk, and in green clover leaves and petals; and once, when a mass of several hundred eggs of an undetermined lepidopteron was offered as food, the eggs of *O. insidiosus* were placed in the egg mass. In corn silk the eggs are inserted at right angles, obliquely, or even parallel to the strand; in each case the cap of the egg extrudes slightly. In fine silk the length of the egg is often equal to the diameter of the silk and causes a swelling of the silk strand, in which case the eggs can just be seen by the unaided eye. In coarser silks the length of the egg may equal only half the diameter of the strand of silk, and the

egg, causing no perceptible swelling of the strand, cannot be seen with the unaided eye. Usually eggs, being laid only a few at a time, are well scattered in several strands of silk; at other times all or most of the eggs deposited on 1 day by a female may be laid in a single strand of silk and closely bunched together. Eggs were commonly found in a silk below a drained ear worm egg, the adult probably having deposited an egg while in the act of feeding. One female seemed particularly disposed to do this and laid many, and sometimes all, of her total daily complement during several consecutive days in the corn silk just under the *Heliothis obsoleta* eggs that she had drained. Marshall (30) states:

In alfalfa the eggs are generally inserted in the main stem at a node. Oviposition seldom occurs in the tough lower part of the stem, but often the tender growing distal portion is selected. Occasionally eggs are found in the leaf petioles.

RELATION OF FOOD OF ADULTS TO THEIR EGG-LAYING CAPACITY

It has been shown (fig. 3) that the longevity of the adult of *Orius insidiosus* is most influenced by the nature of the food it obtains. This factor also controls the number of eggs a female will deposit, or, indeed, whether she will lay any at all. The largest number of eggs were deposited in cages by adults given eggs of the corn ear worm as food. The average number deposited by such adults was 114. Adults given only plant lice as food laid, on an average, 38.8 eggs. The species of aphid given as food throughout the experiments was *Tritogenaphis* sp. feeding upon wild lettuce (*Lactuca canadensis*). This species was used because it was the only aphid available in abundance during the experimental period. Adults of *O. insidiosus* that received no animal food at any time laid no eggs at all, though specimens collected from the field laid a few eggs when provided only fresh silk as food; but these individuals had doubtless fed as predators before their capture. Data showing the relationship of different foods to the egg laying of adults are given in table 6.

In order that *O. insidiosus* may lay many eggs, animal food not only must be plentiful but it must also be available over a period of several months, because of the small egg-bearing capacity and the long oviposition period of the females.

Eggs usually are laid each day in small numbers over a period of weeks or months, probably as they continue to develop in the abdomen, but rarely they are laid at intervals in larger numbers. During the life period of females given corn ear worm eggs as food, the average daily deposition of eggs was 1.56. On 56.75 per cent of the days of life no eggs were deposited. Most frequently only a single egg was laid, depositions of from 1 to 8 eggs per day occurring in decreasing frequency, and larger numbers of eggs per day were rare, the greatest number recorded being 14. During the first 5-day period of adult life almost no eggs were deposited, but from the sixth to the fifteenth day of life egg production was at its height, gradually decreasing thereafter. The average daily oviposition by *Orius insidiosus* females and their rate of devouring corn ear worm eggs during various periods of adult life are compared in table 7.

TABLE 6.—Length of life, food consumed, and oviposition of *Orius insidiosus* when given various foods

Kind of food	Source of adults	Females														Males		
		Indi-vid-u-als in test	Aver-age pre-ovipo-sition period	Aver-age ovipo-sition period	Aver-age eggs laid	Maxi-mum eggs from one female	Fe-males that laid no eggs	Longest ovipo-sition period	Aver-age post-ovipo-sition period	Aver-age days on which eggs were laid	Maxi-mum days on which eggs were laid	Aver-age dura-tions of life	Maxi-mum lon-gevity	Aver-age eggs or aphids con-sumed during life	Indi-vid-u-als in test	Aver-age dura-tion of life	Maxi-mum lon-gevity	
		Number	Days	Days	Number	Number	Number	Days	Days	Number	Number	Days	Days	Number	Number	Days	Days	
Ear worm eggs.....	Reared.....	13	5.4	51.3	114.0	173	0	77	16.2	31.6	49	72.9	118	164.7	14	40.9	94	
Plant lice.....	do.....	14	11.2	26.3	38.8	76	2	65	7.2	14.6	28	46.9	76	114.0	12	43.0	74	
Small disabled ear worm larvae.....	do.....	12	8.7	13.6	35.9	90	5	37	3.9	10.3	20	28.3	54	-----	12	22.8	40	
Fresh corn silks.....	do.....	16	-----	-----	.0	-----	16	-----	-----	-----	-----	5.9	13	-----	22	5.2	13	
Fresh corn silks and moisture.....	do.....	23	-----	-----	.0	-----	23	-----	-----	-----	-----	6.2	16	-----	8	3.3	8	
Moisture only.....	do.....	11	-----	-----	.0	-----	11	-----	-----	-----	-----	4.4	7	-----	8	4.1	7	
No food or moisture.....	do.....	21	-----	-----	.0	-----	21	-----	-----	-----	-----	2.9	6	-----	15	2.1	3	
Ear worm eggs.....	Collected from corn plants.....	7	-----	18.8	26.1	51	0	31	8.2	9.3	18	32.3	44	83.0	-----	-----	-----	
Fresh corn silks.....	do.....	23	-----	3.1	1.1	9	16	8	4.1	1.0	3	5.7	13	-----	6	5.3	10	

TABLE 7.—Comparison of consumption of corn ear worm eggs by *Orius insidiosus* with oviposition by this species

Period of life (days)	Females	Average daily consumption of ear worm eggs	Average eggs laid daily by <i>O. insidiosus</i>	Period of life (days)	Females	Average daily consumption of ear worm eggs	Average eggs laid daily by <i>O. insidiosus</i>
	Number	Number	Number		Number	Number	Number
1-5.....	13	3.10	0.02	66-75.....	5	1.43	0.22
6-15.....	13	3.03	3.66	76-85.....	4	.95	.14
16-25.....	13	2.79	2.77	86-95.....	2	.53	.06
26-35.....	13	2.58	2.35	96-105.....	2	.65	.00
36-45.....	11	2.38	1.55	106-115.....	1	.45	.00
46-55.....	10	2.22	.88	116.....	1	.00	.00
56-65.....	8	1.96	.45				

Under the most favorable conditions, when animal food—corn ear worm eggs—was constantly before them, the average number of eggs deposited by *O. insidiosus* was only 114 (table 6). The greatest number of eggs deposited by one female under such conditions was 173 by an individual living for 91 days; the least was 33 eggs by an individual living 71 days. The egg-laying capacity decreases as the available animal food becomes less desirable; the average for individuals fed upon aphids was 38.8 (table 6) and the greatest deposition of eggs by one female was 76. Without animal food, females of *O. insidiosus* laid no eggs in the breeding cages.

RELATION OF SIZE OF EGGS TO THE EGG-LAYING HABITS

The egg of *Orius insidiosus* is so extraordinarily large in comparison with the size of the adult that 10 to 12 eggs would probably completely fill the abdomen of a female of average size. In order to lay many eggs, therefore, so as to insure progeny in numbers likely to continue the race, a long life is necessary. Table 8 shows that oviposition continues for several months, and that the females lay eggs, a few at a time or a few every day, over much of this period.

TABLE 8.—Records of oviposition by 13 females of *Orius insidiosus* during various periods of life at Richmond, Va., during 1929

Period of life	Females	Days on which no eggs were laid	Days on which the indicated number of eggs were deposited by any one female														Total eggs deposited
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
1 to 5 days.....	13	64	1														1
6 to 15 days.....	13	31	11	13	8	18	11	14	11	6	1	1	1	3	1		476
16 to 25 days.....	13	35	23	18	16	10	7	7	4	0	1	4	3	1	0	1	360
26 to 35 days.....	13	46	17	10	17	11	9	5	2	3	0	1	0	1	2		392
36 to 45 days.....	11	61	21	15	8	5	5	3	1	2	1	0	2				195
46 to 55 days.....	10	63	22	0	2	3	2	0	1	2							91
56 to 65 days.....	8	67	7	5	4	0	2										39
66 to 75 days.....	5	55	0	3	1	1											13
76 to 85 days.....	4	40	2	0	0	1											6
86 to 95 days.....	2	33	0	1													2
96 to 105 days.....	2	20															
106 to 120 days.....	1	23															
Entire life period.....		533	104	89	56	49	36	29	19	13	3	6	6	5	3	1	1,485
Percentage of the whole.....		56.75	10.97	8.44	5.91	5.17	3.79	3.06	2.00	1.37	0.32	0.63	0.63	0.53	0.32	0.11	

† Individuals still living at end of a period.

* Based on a total of 948 days of life for the 13 predators.

INCOMPLETED OVIPOSITION

Females of *Orius insidiosus* often die with the abdomen packed with fully developed eggs; in fact, this was characteristic of those given corn ear worm eggs as food, and it was found that 69.23 per cent of individuals so fed still bore eggs at the time of death. The number of fully developed eggs found at death in females in cages (where seemingly optimum environmental conditions were provided by an abundance of fresh, desirable food available at all times and protection from enemies and unfavorable weather) ranged from 4 to 11 per individual, with an average of 8.9. As an example of this peculiar phenomenon, a female which lived for 115 days and whose last oviposition occurred on the sixty-first day of life was found to contain eggs at the time of her death, 54 days thereafter. This female fed regularly during the entire period.

THE NYMPHS

Upon hatching, the nymphs begin to feed upon the fresh corn silks, or occasionally upon other tender plant parts. They are able to subsist entirely on such food, but during the older instars they prefer animal food, especially young thrips. Individuals that become adults without having animal food are smaller and less vigorous than those which obtain such food.

Five nymphal instars have been recognized, although Garman and Jewett (16) found but 4, and the total period elapsing from egg to adult ranges approximately from 11 to 18 days, the average being about 15, as was also found to be the case by Garman and Jewett. Marshall (30) describes 5 nymphal stages with a total duration of 17 days, or, from egg deposition to adult, an elapsed period of 21 days, 17 hours. During the earlier instars the nymphs usually remain hidden away among the silks at the tip of the ear, but from the third or fourth instar onwards the desire for animal food prompts them to disperse over the plants. They are often found hiding between the leaves and the stalks, which is the usual location of thrips infestations on larger corn plants. During the fourth or fifth instar, the nymphs devour ear worm eggs, taking usually 1 or 2 daily, the average daily consumption being 1.43 (table 5), when confined in breeding cages.

NUMBER OF GENERATIONS ON CORN

Considering the duration of the egg stage, the length of life of the nymphs, and the preoviposition period of the adults, the shortest possible period from egg to egg, under the most favorable conditions, was about 24 days. During the growing season of corn in Virginia, from the time that adults are first attracted to it in June until the corn plants have all ripened in October, not more than 4 generations of *Orius insidiosus* appear possible on this plant; and since the adults deposit eggs over protracted periods, 2 or 3 generations annually on corn in central Virginia are probably more usual.

THE IMPORTANCE OF ORIUS INSIDIOSUS IN THE NATURAL CONTROL OF THE CORN EAR WORM

While *Orius insidiosus* has been found to be the most important insect enemy of the corn ear worm in central Virginia, its importance in the natural control of this injurious pest varies from year to year and during different seasons of any one year, depending on the yearly and seasonal abundance of both and on the available supply of other suitable animal food on the corn plant. Because of gradual emergence from hibernation, ear worm moths occur over much, or all, of the period from June to October, except during very unusual years, and eggs are laid continuously, although not in uniform numbers, these depending on moth populations and the stages of growth in which the corn plants are found at any time. Usually, the ear worm eggs are sparsely distributed, only a few to a plant. These facts favor the destruction of larger numbers of them by *O. insidiosus* than would be possible if ear worm eggs were deposited during shorter periods and in greater numbers.

During studies of ear worm oviposition from 1924 to 1927, eggs deposited on selected representative plants in the field during different years in different localities in Virginia throughout the corn-growing season were marked and their fate determined by daily examinations. Of the several thousand eggs so studied, the destruction of 38.47 percent was attributed to feeding by *Orius insidiosus*. On an average, the percentages of ear worm eggs destroyed by *O. insidiosus* increased from the first of June and reached an extreme during the first 10 days of August, when, as has been shown, *O. insidiosus* were usually very abundant whereas ear worm eggs were relatively scarce. From then on to the first of October, the importance of *O. insidiosus*, on an average, remained fairly uniform, sometimes more than 40 percent of the ear worm eggs being destroyed by it throughout this period.

In table 9 the percentage of eggs destroyed by *Orius insidiosus* is given for each 10-day period from May 20 to October 10 in corn-fields under observation in different localities during the 4 years 1924 to 1927. In each year the seasonal history and abundance of the ear worm were different, and in each year populations of *O. insidiosus* probably varied. Consequently, quite different percentages of ear worm eggs were destroyed by this predator during the several 10-day periods, or for any year, or either locality. The greatest percentage of ear worm eggs destroyed during any 10-day period was 76.92, during the period August 1-10, at Charlottesville, Va., in 1924.

The percentage of eggs of the ear worm laid throughout any year that were destroyed by *Orius insidiosus* ranged from 14.12 to 53.89. This predator apparently occurred in smaller numbers in 1926, was extremely plentiful in 1925, and of intermediate abundance in other years. During 1925 the corn ear worm was present in unusually large numbers, especially at Richmond, whereas the population during 1926 was somewhat below the average. It seems, therefore, that large ear worm populations are favorable to the development and increase of *Orius insidiosus*, since under such conditions animal food is plentiful and easily found. Abundant animal food is also available for the nymphs, thus insuring a large survival and, perhaps,

TABLE 9.—Percentages of eggs of the corn ear worm destroyed by *Orius insidiosus* on corn plants in the field during 1924 to 1927 in Virginia

Locality	Year	May	June				July			August			September			October	Average for year
		20-31	1-10	11-20	21-30	1-10	11-20	21-31	1-10	11-20	21-31	1-10	11-20	21-30	1-10		
Richmond	1925	0.00	0.00	0.00	0.00	18.18	43.10	59.02	51.72	61.68	53.17	47.83	43.48	(1)	-----	49.89	
	1926	0.00	0.00	0.00	0.00	4.26	4.89	12.33	7.69	8.11	21.00	41.07	-----	-----	-----	14.12	
	1927	20.27	0.67	33.61	35.47	30.34	52.17	36.36	47.06	50.00	33.23	60.00	53.84	-----	-----	33.79	
	1924	-----	-----	-----	0.00	3.03	12.60	27.27	76.92	30.43	63.00	52.94	-----	-----	-----	36.71	
Charlottesville ²	1925	-----	-----	-----	0.00	0.00	66.07	0.00	50.00	51.61	63.03	62.50	-----	-----	-----	47.73	
	1926	-----	-----	-----	0.00	50.00	-----	-----	0.00	47.83	55.45	60.27	53.10	36.49	-----	53.89	
	1927	-----	-----	0.00	22.22	0.00	20.00	25.00	44.44	60.00	10.71	44.19	43.41	42.58	45.65	41.58	
	1924	-----	0.00	13.33	33.33	33.33	22.73	34.09	55.55	-----	50.00	33.33	67.24	37.25	42.11	38.49	
Average	-----	0.00	12.12	3.41	26.34	19.59	24.43	37.09	49.71	43.48	40.03	44.38	45.91	40.14	42.11	38.47	

¹ Blank spaces indicate periods when no ear worm eggs were recovered on the several plots.² Two series of corn plots at Charlottesville, were used during 1924 and 1925.

less cannibalistic feeding. In addition to these differences in populations, 1925 was marked by droughts, especially at Richmond, during which long periods of hot, dry, sunny weather occurred, which is a most favorable factor for rapid development and long life, and consequently high reproduction, by *Orius insidiosus*. On the other hand, 1926 was characterized by numerous storms and heavy rains. Not only were the populations of nymphs decimated by these adverse weather conditions, but the duration of life of adults was probably much shorter, and consequently considerably less egg laying occurred.

A summary of the destruction of ear worm eggs deposited on various parts of the corn plant by *O. insidiosus* is given in table 10. A larger percentage of those deposited on silks was destroyed by *O. insidiosus* than of those on any other parts. Many of the eggs deposited on stalks, tassels, and husks, and but relatively few on the leaves were destroyed. The largest proportion of ear worm eggs destroyed by *O. insidiosus* on any plant part in any year was 82.72 percent of those deposited on silks at Richmond during 1925. On each plant part the percentage of eggs destroyed depended upon the populations of *O. insidiosus*, the seasonal occurrence and the varying populations of ear worm moths, and the development of the corn plants.

TABLE 10.—Percentages of eggs of the corn ear worm destroyed by *Orius insidiosus* on various parts of the corn plant in Virginia

Locality	Year	Upper surface of leaves	Lower surface of leaves	Stalks	Tassels	Husks	Silks	Average for the year
Richmond	1925	23.55	25.00	60.65	51.00	61.02	82.72	49.89
	1926	3.95	5.45	12.77	27.27	26.63	26.32	14.12
	1927	11.28	22.58	45.28	60.00	48.48	55.87	33.79
	1924	8.51	(1)	-----	-----	-----	60.00	36.71
Charlottesville ¹	1925	25.64	-----	50.00	-----	-----	71.43	47.73
	1926	30.95	30.00	74.23	15.00	50.00	60.28	53.89
	1927	18.00	-----	44.05	38.98	40.00	45.78	41.58
	1924	20.51	-----	11.76	-----	25.00	24.59	21.31
Average	-----	16.45	9.09	30.30	40.00	53.33	52.00	38.49
Average	-----	16.24	17.75	46.80	43.43	48.42	51.10	38.47

¹ Two series of corn plots were under observation in 1924 and 1925 at Charlottesville.² Blank spaces indicate that no eggs of the corn ear worm were found.

From the data presented on the length of life and rate of feeding of adults of *Orius insidiosus*, it would seem possible that, except during seasons of very large corn ear worm populations, a single pair of *O. insidiosus* and their progeny, if they remained on a single corn plant, might keep the plant nearly or quite free from ear worm infestation. This they would accomplish by feeding upon and destroying the eggs and young larvae, especially by devouring the former, as they were deposited day by day, since *O. insidiosus* most often inhabits those parts of the plant where eggs are most likely to be placed. From the writer's observation, however, it is not usually the case that they remain on one corn plant, and this is probably due to the difficulty in finding the eggs. The corn plant is large, eggs may be placed anywhere on it, and *O. insidiosus* is small. No evidence has been obtained that *O. insidiosus* can locate ear worm eggs by any other means than by minutely exploring the plant, or that it can by means of any sense recognize an egg except when it is directly upon it. Since ear worm eggs may be deposited on a plant on any day, or, indeed, on every day from the time when it consists of a few leaves until the silks are dry and the grain partly matured, the discovery of all or even many of the eggs means constant minute exploration by *O. insidiosus* day after day. Even though these predators are very active, it is remarkable that so large a percentage of ear worm eggs is commonly found and devoured.

The availability of other food—aphids, thrips, eggs, and young larvae of other species of Lepidoptera, and other small insects—affects the efficiency of *Orius insidiosus* as a destroyer of ear worm eggs. These other insects occur in varying numbers on different corn plants in the same field, during different seasons of any one year, and during different years. If plentiful and more easily found, as thrips often are when they occur by hundreds in masses between leaves and stalks, or when large colonies of aphids occur on tassels or other parts of the plant, there will naturally be little urge for *O. insidiosus* to seek out the more scattered ear worm eggs which, although providing a greater feast, require more labor to discover. Conversely, when alternate animal food is scarce or wholly wanting, the search over the plant will become very intense, and larger percentages of ear worm eggs will be destroyed.

SUMMARY

This bulletin reports studies of the importance of *Orius insidiosus* (Say) as a natural enemy of the corn ear worm (*Heliothis obsoleta* Fab.), based upon work done principally at Richmond, Va., during 1928 and 1929.

The insect occurs throughout most of the United States and southern Canada. It is abundant in many sections and is beneficial because it attacks many injurious insects.

Its occurrence is general on many plants, but its particular habitat is corn, where eggs are deposited, for the most part, in the fresh, moist silks.

Adults are most plentiful on corn plants which have young tassels or are in silk, whereas nymphs occur principally during the silking period. Abundance of silk appears to attract great numbers of adults, affording favorable breeding areas—a place for egg laying,

a shelter from inclement weather, and food for both adults and nymphs, especially the latter.

Animal food is needed for a long life and much reproductive activity. Adults, in cages, lived for many days; and females deposited eggs over long periods, a few eggs at a time, provided animal food was plentiful. Individuals receiving no animal food lived for brief periods and deposited no eggs. Adults were fed on corn ear worm eggs, newly hatched larvae, and partly grown larvae that had been maimed.

The egg is very large in proportion to the size of the adult, from 10 to 12 eggs representing the capacity at one time of an average sized female. Females frequently die with their abdomens packed with fully developed eggs.

The nymphs emerge 3 or 4 days after deposition of the eggs, feed at first upon the moist silks, but prefer animal food during later instars. The nymphal stage occupies about 15 days.

Four generations annually seem possible in central Virginia, though 2 or 3 are probably more common. The shortest possible complete life cycle occupies about 24 days.

In central Virginia *O. insidiosus* was the most important insect enemy of the corn ear worm, having been found over a period of years to have destroyed an average of 38.47 percent of the ear worm eggs deposited on corn plants.

The percentage of corn ear worm eggs destroyed by *O. insidiosus* varies during different years and during the different seasons of the year, as well as according to the location of the eggs on the plants and the available supply of other suitable animal food.

LITERATURE CITED

- (1) ACKERMAN, A. J.
1919. TWO LEAFHOPPERS INJURIOUS TO APPLE NURSERY STOCK. U. S. Dept. Agr. Bull. 805, 35 pp., illus.
- (2) BARBER, G. W.
1920. SOME FACTORS RESPONSIBLE FOR THE DECREASE OF THE EUROPEAN CORN BORER IN NEW ENGLAND DURING 1922 AND 1924. Ecology 7: 143-162, illus.
- (3) BLACKMAN, W. M., and STAGE, H. H.
1924. ON THE SUCCESSION OF INSECTS LIVING IN THE BARK AND WOOD OF DYING, DEAD, AND DECAYING HICKORY. N. Y. State Col. Forestry, Syracuse Univ., Tech. Pub. 17: 3-35, illus.
- (4) CHITTENDEN, F. H.
1913. INSECTS INJURIOUS TO THE ONION CROP. U. S. Dept. Agr. Yearbook 1912: 319-334, illus.
- (5) ———
1919. CONTROL OF THE ONION THRIPS. U. S. Dept. Agr. Farmers' Bull. 1007, 16 pp., illus.
- (6) DAVIS, J. J.
1915. THE PEA APHIS WITH RELATION TO FORAGE CROPS. U. S. Dept. Agr. Bull. 276, 67 pp., illus.
- (7) DICKERSON, E. L., and WEISS, H. B.
1920. THE INSECTS OF THE EVENING PRIMROSES IN NEW JERSEY. Jour. N. Y. Ent. Soc. 28: 32-74, illus.
- (8) EWING, H. E.
1914. THE COMMON RED SPIDER OR SPIDER MITE. Oreg. Agr. Expt. Sta. Bull. 121, 95 pp., illus.
- (9) FINK, D. E.
1915. THE EGGPLANT LACE-BUG. U. S. Dept. Agr. Bull. 239, 7 pp., illus.
- (10) FLINT, W. P.
1918. INSECT ENEMIES OF THE CHINCH-BUG. Jour. Econ. Ent. 11: 415-419.

- (11) FOLSOM, J. W.
1909. THE INSECT PESTS OF CLOVER AND ALFALEA. Ill. Agr. Expt. Sta. Bull. 134, pp. 113-196, illus.
- (12) FORBES, S. A.
1910. THE ECONOMIC ENTOMOLOGY OF THE SUGAR BEET. Ill. State Ent. Rept. 21, pp. [51]-169, illus.
- (13) ———
1905. A MONOGRAPH OF INSECT INJURIES TO INDIAN CORN, PART II. Ill. State Ent. Rept. 23, 273 pp., illus.
- (14) ——— and HART, C. A.
1900. THE ECONOMIC ENTOMOLOGY OF THE SUGAR BEET. Ill. Agr. Expt. Sta. Bull. 69, pp. 397-532, illus.
- (15) FOSTER, S. W., and JONES, P. R.
1915. THE LIFE HISTORY AND HABITS OF THE PEAR THRIPS IN CALIFORNIA. U. S. Dept. Agr. Bull. 173, 52 pp., illus.
- (16) GARMAN, H., and JEWETT, H. H.
1914. THE LIFE-HISTORY AND HABITS OF THE CORN-EAR WORM (CHLORIDEA OBSOLETA). Ky. Agr. Expt. Sta. Bull. 187, pp. 511-591, illus.
- (17) GRAF, J. E.
1917. THE POTATO TUBER MOTH. U. S. Dept. Agr. Bull. 427, 56 pp., illus.
- (18) HOOKER, W. A.
1907. THE TOBACCO THRIPS, A NEW AND DESTRUCTIVE ENEMY OF SHADE-GROWN TOBACCO. U. S. Dept. Agr., Bur. Ent. Bull. (n. s.) 65, 24 pp., illus.
- (19) HORTON, J. R.
1918. THE CITRUS THRIPS. U. S. Dept. Agr. Bull. 616, 42 pp., illus.
- (20) HYSLOP, J. A.
1916. TRIPHEPS INSIDIOSUS AS THE PROBABLE TRANSMITTER OF CORN-EAR ROT (DIPLODIA SP., FUSARIUM SP.). Jour. Econ. Ent. 9: 435-438.
- (21) JONES, T. H.
1918. MISCELLANEOUS TRUCK-CROP INSECTS IN LOUISIANA. I.—INSECTS INJURIOUS TO THE GLOBE ARTICHOKE IN LOUISIANA. U. S. Dept. Agr. Bull. 703: 1-5, illus.
- (22) KELLY, E. O. G.
1915. A NEW WHEAT THRIPS. Jour. Agr. Research 4: 219-224, illus.
- (23) LUGGER, O.
1900. HEMIPTERA OR BUGS DESTRUCTIVE IN MINNESOTA. Minn. State Ent. Ann. Rept. 6, 259 pp., illus.
- (24) LUGENBILL, P.
1928. THE FALL ARMY WORM. U. S. Dept. Agr. Tech. Bull. 34, 92 pp., illus.
- (25) MCGREGOR, E. A.
1912. THE RED SPIDER ON COTTON (TETRANYCHUS BIMACULATUS HARVEY). U. S. Dept. Agr., Bur. Ent. (irc. 150, 13 pp., illus. (Superseded by Bur. Ent. (irc. 172, 22 pp., illus., 1913.)
- (26) ———
1914. RED SPIDER CONTROL. Jour. Econ. Ent. 7: 324-336.
- (27) ——— and McDONOUGH, F. L.
1917. THE RED SPIDER ON COTTON. U. S. Dept. Agr. Bull. 416, 72 pp., illus.
- (28) MALLOCH, J. R.
1916. TRIPHEPS INSIDIOSUS SAY SUCKING BLOOD (HEM., HET.). Ent. News 27: 200.
- (29) MALLY, F. W.
1902. REPORT ON THE HOLL WORM. 45 pp. Austin, Tex.
- (30) MARSHALL, G. E.
1930. SOME OBSERVATIONS ON ORIUS (TRIPHEPS) INSIDIOSUS (SAY). Jour. Knos. Ent. Soc. 3: 29-32.
- (31) MORRILL, A. W.
1903. NOTES ON THE IMMATURE STAGES OF SOME TINGITIDS OF THE GENUS CORYTHUCA. Psyche 10: [127]-134, illus.
- (32) OSBORN, H., and DRAKE, C. J.
1922. AN ECOLOGICAL STUDY OF THE HEMIPTERA OF THE CRANBERRY LAKE REGION, NEW YORK. N. Y. State Col. Forestry, Syracuse Univ., Tech. Pub. 16: 5-86, illus.
- (33) PARKER, W. B.
1913. THE HOP APHIS IN THE PACIFIC REGION. U. S. Dept. Agr., Bur. Ent. Bull. (n. s.) 111, 43 pp., illus.

- (34) PARSHLEY, H. M.
1917. FAUNA OF NEW ENGLAND 14; LIST OF THE HEMIPTERA-HETEROPTERA.
Boston Soc. Nat. Hist. Occas. Papers 7, 125 pp.
- (35) ———
1923. HEMIPTERA OF CONNECTICUT. Conn. Geol. and Nat. Hist. Survey
Bull. 34, 807 pp., illus.
- (36) QUAINANCE, A. L., and BRUES, C. T.
1905. THE COTTON BOLLWORM (*HELIOTHIS OBSOLETA* FABRICIUS). U. S.
Dept. Agr., Bur. Ent. Bull. (n. s.) 50, 155 pp., illus.
- (37) QUAYLE, H. J.
1912. RED SPIDERS AND MITES OF CITRUS TREES. Calif. Agr. Expt. Sta.
Bull. 234, pp. [483]-530, illus.
- (38) RILEY, C. V.
1881. THE CHINCH BUG. Amer. Agr. 40: 515, illus.
- (39) ———
1888. GENERAL NOTES; THE INSIDIOUS FLOWER BUG. Insect Life 1: 122.
- (40) RUSSELL, H. M.
1912. THE BEAN THRIPS. (*HELIOTHIRIS FASCIATUS* PERGAENDE.) U. S. Dept.
Agr., Bur. Ent. Bull. (n. s.) 118, 49 pp., illus.
- (41) WADE, O.
1917. THE SYCAMORE LACE BUG (*CORYTHUCA CILIATA*, SAY). Okla. Agr.
Expt. Sta. Bull. 116, 16 pp., illus.
- (42) WATSON, J. R.
1918. THYSANOPTERA OF FLORIDA. Fla. Buggist 1: 53-55, 67-77.
- (43) WEBSTER, F. M.
1885. INSECTS AFFECTING THE CORN CROP. Ind. Agr. Rept. 1885, 36 pp.,
illus.
- (44) ———
1907. THE CHINCH BUG. U. S. Dept. Agr., Bur. Ent. Bull. (n. s.) 60, 95
pp., illus.
- (45) ———
1900. THE CHINCH BUG (*BLISSUS LEUCOPTERUS*, SAY). U. S. Dept. Agr.,
Bur. Ent. Circ. 113, 27 pp., illus.
- (46) ———
1915. THE CHINCH BUG. U. S. Dept. Agr. Farmers' Bull. 657, 28 pp.,
illus.
- (47) WEBSTER, R. L.
1910. THE APPLE LEAF-HOPPER *EMPOASCA MALI* LE B. Iowa Agr. Expt. Sta.
Bull. 111, 12 pp., illus.
- (48) ———
1915. POTATO INSECTS. Iowa Agr. Expt. Sta. Bull. 155, pp. 350-420,
illus.
- (49) ———
1917. THE BOX ELDER APHID (*CHAETOPHORUS NEGUNDINIS*). Iowa Agr.
Expt. Sta. Bull. 173, pp. [95]-121, illus.
- (50) WINBURN, T. F., and PAINTER, R. H.
1932. INSECT ENEMIES OF THE CORN EAR WORM (*HELIOTHIS OBSOLETA* FABR.).
Jour. Kans. Ent. Soc. 5: 1-28.

END