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THE DISTRIBUTION OF NATURAL ENEMIES OF THE CORN LEAF APHID (HOMOPTERA: APHIDIDAE) ON FIELD CORN[1]

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The corn leaf aphid (CLA), *Rhopalosiphum maidis* (Fitch), is found on field corn in the midwest United States each year. Except for infrequent and scattered outbreaks, CLA populations remain at low levels. Injury to corn occurs during tasseling (Snelling et al. 1941) and is caused by CLAs which are the progeny of colonizers that arrived 2–3 weeks earlier when the corn was in the whorl stage (Bryson 1934, Falter 1963). Yield reductions averaging up to 54% on heavily infested plants have been reported (Bigger 1958, Everly 1960, Randell 1967).

Various workers have shown that CLA biotype (Painter and Pathak 1962), corn variety (Gernert 1917, Everly 1971, Long et al. 1977) and planting date (McColloch 1921, Falter 1963) can influence CLA population levels. The impact of natural enemies on CLA populations has usually been assumed to be negligible.

This study was undertaken to learn which species of potential natural enemies, especially predators, were most abundant in corn fields in central Illinois and whether any of these was temporally and spatially synchronized with the CLA. All of the research was done in Champaign County, Illinois.

METHODS

Aphid and natural enemy populations on field corn were sampled during 1977 by nondestructive visual searches. Three groups, each consisting of 20 plants (four sets of five consecutive plants), were visually monitored between four and seven times during the whorl and tasseling stages. Each plant was marked and monitored at ca. 4-day intervals from whorl stage until CLA populations declined after tasseling. At each date, data were taken concerning selected predator and phytophagous insect species, abundance, location, and field corn maturity. Group 1 was located in Field 1, which tasseled 7 July. Groups 2 and 3 were both in Field 2: Group 2 tasseled 29 July, while Group 3 tasseled 16 August. For data analysis, the corn plant was divided into the upper plant (UP) and lower plant (LP). The UP consisted of either the tassel plus the upper two leaves or the whorl. The LP consisted of that portion of the corn plant from the ground to the whorl or to the second leaf from the top of the corn plant.

Parasitoids were reared from aphid mummies collected from corn in the vicinity of the three corn groups being monitored. A repesentative collection of parasitoids was identified by E. E. Grissell and Paul M. Marsh of the Systematic Entomology Laboratory, USDA, Agricultural Research Service, Beltsville, Maryland. The remainder of the specimens were identified by comparison and were deposited in the Illinois Natural History Survey insect collection.

Whorls cannot be sampled without destroying them, so another sampling procedure was initiated in 1977 to complement the data gathered by visual searches. Until tasseling occurred, whorls of five consecutive plants in the vicinity of each group of five marked plants were removed, placed in a plastic bag, and stored at 5°C. The whorl was disassembled into a 70% ethanol bath, shaken vigorously, and the leaves and tassel were then rinsed with 70%

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ethanol. All 70% ethanol was then filtered through ca. 100 mesh/inch organdy. The organdy was then inspected with a binocular microscope, and the number of CLAs and adult *Orius insidiosus* was recorded.

In the summer of 1978, plants in three fields of corn in the whorl stage of development were also censused. The whorl was removed and the insects associated with each leaf were noted as the leaf was removed from the whorl. Adult *O. insidiosus* (Say) (Hemiptera: Anthocoridae) and thrips were collected with an aspirator and preserved. *O. insidiosus* specimens were sexed and the thrips were identified to species. These data were gathered to determine whether thrips might serve as temporary prey for *O. insidiosus* prior to the arrival of the CLA.

RESULTS

The visual census of the three field corn groups from whorl through tasseling showed that CLA averaged 0 to 262 per plant depending on the corn groups and were located primarily on the UP (Table 1). Adult *O. insidiosus* averaged between 0.95 and 6.13 per UP during the whorl stage. Neuropteran larvae averaged 0 to 0.67 per plant and were located on the LP and larval coccinellids averaged between 0.05 and 1.10 per plant and were also found on the LP. *Frankliniella tenuicornis* Uzel (Thysanoptera: Thripidae) were always present in the whorl and in the leaf sheath. *Schizaphis graminum* (Rodani) (Homoptera: Aphididae), the greenbug, averaged from 0.4 to 14.3 per plant and was always located on the LP. Other insect species were found infrequently with average densities of at most a few per 20 plants and were also found on the LP.

CLA populations peaked within a week of tassel emergence: $\bar{X}$(SD) of 128(91), 38(79), and 236(479) respectively, for the three groups. CLA populations on the lower plant (LP) peaked at the same time as the UP population or a few days later and had peak values of 5.0(7.0), 1.4(2.4), and 25.9(97.7) for the three groups.

Populations of adult *O. insidiosus* on the UP peaked within 5 days of tassel emergence while populations on the LP peaked 3–11 days after tassel emergence. The relative distribution of this predator shifted from the UP prior to tasseling to the LP after tasseling. Correlations of CLA and adult *O. insidiosus* numbers on individual plants within a sampling date for the UP were significant once each at both 0.05 and 0.01 level and were not significant on 16 dates. Alternately, analysis of the distribution of the CLA, *O. insidiosus* and *F. tenuicornis* from the destructive sampling of whorls indicated that their distribution is random with respect to one another (χ^2, 2 × 2 contingency table, $P > 0.05$, n = 176, 57 plants in 1977 and 119 plants in 1978). *O. insidiosus* adults were observed feeding on CLAs on four occasions and once on thrips, probably *F. tenuicornis*.

Observations during the summers of 1977 and 1978 indicated that *F. tenuicornis* colonized plants prior to the whorl stage. Individuals remain under the leaf sheath or in the whorl until tasseling when populations decline and are found in the ear shucks.

Coccinellid and neuropteran distributions were almost exclusively limited to the LP for all life stages. The only exception to this was *Hippodamia convergens* Guerin-Meneville (*Coleoptera: Coccinellidae*) adults with 63.2% located on the UP. In contrast, 93.2% of the *Coleomegilla maculata* (DeGeer) (*Coleoptera: Coccinellidae*) adults were on the LP which is a significantly different distribution (χ^2 analysis of 2 × 2 contingency table, $P < 0.0005$) and in keeping with the results of Ewert and Chiang (1967).

The density of potential predators did not correlate well with aphid density except in one case: chrysopid egg density was significantly correlated with non-CLA populations on the LP ($P < 0.01$, $r = 0.60$, n = 18). Otherwise, neither eggs nor larvae of either coccinellids or neuropterans could be related to LP aphid density. On the premise that predator populations should lag behind prey populations, the analysis was repeated comparing predator density with the number of aphids found on the preceding sampling date, but in this case none of the correlation coefficients was significantly greater than zero.

Eight species of parasitoids emerged from the aphid mummies that were collected and returned to the laboratory (Table 2). Known primary parasitoids composed 18.7% of those

Table 1. Average population levels on three groups of plants monitored periodically, and in whorls of plants located near the groups, during the summer of 1977.

Group[a]	Date	Tassel Emergence	Sampling[b] Method and Number	Orius Adults UP	Orius Adults LP	CLA UP	CLA LP	Greenbug LP	Other Aphids LP	Neuropteran Eggs	Neuropteran Larvae	Coccinellid Eggs	Coccinellid Larvae
1	7-02	Before	W 23	1.04		54.80							
	7-10	After	E 21	0.95	0.62	89.14	3.50	3.52	0.40	0.24	0.00	0.90	0.48
	7-14	After	E 20	0.75	0.25	127.90	5.00	14.30	2.70	1.80	0.25	4.95	0.70
	7-18	After	E 20	0.75	1.65	48.80	0.05	8.15	1.10	1.45	0.00	3.70	1.10
	7-22	After	E 20	0.40	0.75	14.25	1.60	3.20	0.20	1.00	0.05	0.00	0.55
	7-26	After	E 20	0.00	0.75	1.80	1.35	2.50	0.50	0.60	0.10	0.00	0.15
2	7-12	Before	E 20	1.15	0.05	10.00	1.10	11.8	1.10	0.95	0.20	2.40	0.15
	7-16	Before	W 20	1.05		0.60							
	7-17	Before	E 20	1.95	0.10	0.00	0.00	11.25	2.60	0.90	0.00	3.45	0.20
	7-20	Before	E 20	1.10	0.25	0.20	0.00	4.00	0.90	0.55	0.25	0.95	0.05
	7-20	Before	W 14	2.14		4.30							
	7-24	Before	E 20	1.10	0.35	27.35	0.05	2.85	0.70	0.85	0.10	1.30	0.10
	7-25	Before	W 16	4.31		24.94							
	7-28	Before	E 20	2.85	3.35	37.75	0.05	2.15	0.25	0.55	0.00	0.60	0.10
	8-01	After	E 20	5.90	7.05	24.40	1.40	1.45	0.10	0.95	0.05	2.05	0.10
	8-06	After	E 20	2.95	2.70	0.00	0.65	0.50	0.05	0.85	0.00	8.65	0.25
3	8-8 & 10	Before	E 20	5.90	2.80	234.90	0.00	1.20	0.20	0.40	0.00	1.15	0.25
	8-13	Before	E 15	6.13	4.07	236.27	25.87	0.67	0.07	0.33	0.67	5.27	0.07
	8-19 & 20	After	E 20	4.60	4.35	187.45	13.95	0.90	3.00	0.00	0.00	6.35	0.25
	8-24	After	E 20	1.65	3.55	87.15	5.30	0.40	0.40	0.10	0.05	4.60	0.35

[a] 1 = field 1, tasseled 7-7; 2 = field 2, tasseled 7-29; 3 = field 2, delayed germination tasseled 8-16.
[b] E, entire plant was visually sampled (see Methods); W, only whorl was sampled (see Methods).

Table 2. Hymenopterous parasitoids reared from unidentified aphid mummies collected from corn at Urbana, Illinois, in 1977.

Parasitoid	Number of mummies	Percent of total	Trophic affinity[a]
Braconidae			
Aphidius sp.	17	18.7	I°
Eulophidae			
Tetrastichus minutus (Howard)	14	15.4	II°
Encrytidae			
Aphidencyrtus aphidivorus (Mary)	3	3.3	II°
Genus sp.	1	1.1	?
Pteromalidae			
Asaphes sp.	11	12.1	?
Pachneuron siphonophorae (Ashmead)	42	46.2	II°
P. altiscutum (Cook)	1	1.1	?
Megaspilidae			
Dendrocerus niger (Howard)	2	2.2	?

[a]I° = primary parasite of aphid, II° = secondary parasite of aphid.

emerging, while three species composing 64.9% of those emerging were secondary parasitoids. The trophic relationships of the remaining 16.5% are not known. Mummies on the monitored plants were located on the LP, often in clusters of greenbug. The number of mummies/plant were similar both between the different fields (2 miles apart) and on corn of differing age within the same field. While no data were gathered on percent parasitism, based on the low number of mummies found, it would appear that far less than 1% of the aphids were parasitized. Aphid flights were very low in 1977.

DISCUSSION

The results of these field observations indicate that potential CLA natural enemies other than *O. insidiosus* were generally restricted to the LP and thus could have little effect on CLA populations colonizing corn. The only exception to this was *H. convergens* adults, but any significant impact on CLA dynamics by this species was precluded by low numbers (maximum population = 0.2/plant). Ewert and Chiang (1967) and Havnvik and Frye (1969) noted associations between CLAs and both *H. convergens* and *H. tridecimpunctata,* but neither indicated that these species control CLAs.

Between-plant distribution of *O. insidiosus* is only slightly affected, if at all, by the between-plant distribution of CLA according to our analysis. This distribution of *O. insidiosus* adults is consistent with Isenhour's (1977) description of a floating adult *Orius* population. He argued that adults constantly sample the environment, moving from plant to plant within the corn and soybean fields under study. This behavior would tend to bring the predator into contact with newly arrived CLAs, when aphid populations are small and predation would have its greatest impact.

The pre-tasseling adult *O. insidiosus* density of ca. 1/plant found in this study and by others (Barber 1936, Dicke and Jarvis 1962) indicates that this predator is often present in corn fields in the eastern U.S. at levels which could impact CLA populations. While Dicke and Jarvis (1962) and Havnvik and Frye (1969) suggested that *O. insidiosus* may have controlled CLA populations in their studies, the actual impact remains uncertain because feeding studies have not been conducted.

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