Source: Japanese Journal of Applied Entomology and Zoology [Nihon Oyo Dobutsu Konchu Gakkai Shi, ISSN: 0021-4914] (1966) v.10 (2) p.89-91
Translated by Naoyuki Ochiai, Oregon State University; Edited by Mohan Ramaswamy, Kansas State University, 2003

Influence of the predation of Orius sp. (Hemiptera: Anthocoridae) on the aphid population in a soy-bean field; an example of interrelation between a polyphagous predator and its principal prey

OKU, Toshio & KOBAYASHI, Takashi
(Tohoku National Agricultural Experiment Station, Shimokuriyagawa, Morioka)

In general, minute pirate bugs are known as natural enemies of small insects and mites; while some species feed on specific prey (Anderson, 1962a, b), others are known to be polyphagous (Barber, 1936, and others). It goes without saying that in order to evaluate a predatory insect's role as a natural enemy, it is necessary to clearly identify the prey (Thompson, 1951); however, in the case of polyphagous predators it is essential to consider not only the preference as food of each prey species as emphasized by Anderson (1962b), but also the behavior and population density of each prey species. We have discovered that the predation of aphids by species of the genus *Orius*, which are found in large numbers in soybean fields in the Tohoku (Northeast) region, is influenced by the behavior and population density of 2 or 3 other prey species that appear concurrently with the aphids. The results of the study are reported here.

We would first like to express our appreciation to Yasushi[1] Maeda (technical officer of the Tohoku National Agricultural Experiment Station Insect Pest Research Center) for his assistance in research and invaluable advice, Hitoshi Hasegawa (head technical officer of the department of agriculture and forestry insect identification and classification research laboratory) for his assistance in insect identification, Dr. Shozo Ehara (College of Science, Hokkaido University), Isao Hiura (Osaka City Science Museum) and others who supported this research.

Methods

The study was conducted in 1963 and 1964 on an approximately 2-acre soybean plot within the Tohoku (Northeastern) National Agricultural Experiment Station located in Shimokuriyagawa, Morioka City. In 1963, the soybean variety mix included Tokachichosai[2], and in 1964 the only variety used was Tokachichosai. It was determined that there were no significant differences in the populations of the major arthropods due to variety differences. Fertilizer was managed in accordance with normal practices for the region.

In both years, the experimental plot was divided into 20 subplots. Every 10 ~ 20 days, 1 plant from each plot was sampled (a total of 20 plants per sampling date) by gently placing a 87 x 90cm polyethylene bag over the plant and tying it closed at crown, preventing the escape of arthropods from the plant, anesthetizing with ethyl acetate, then removing and counting each species. After observing the abundance of mites, the infestation rate was estimated by taking the average per-leaf infestation of three leaves taken from the lower, middle and high part of the plant and extrapolating to a per-plant basis. Soil-surface dwelling insects were sampled in 1964, at the same time as the on-plant sampling by vacuuming a 20 x 20cm area around the base of the plant, anesthetizing, and counting the numbers of each species.

[1] Translator footnote: I'm not sure about this first name.
[2] Translator footnote: This is a proper name and so it is difficult to tell how it is read; it could be "Tokachinagana"

In 1963, 20 plants were selected randomly, and the entire plant observed for approximately two hours in order to identify species preyed on by *Orius* sp., and the frequency of predation for each species.

Results and Discussion

1. Prey of *Orius* sp. in nature

The results of the field surveys of *Orius* sp. prey, conducted between late-June and mid-September of 1963, are given in Table 1. *Orius* sp. feed primarily on aphids (soybean aphid *Aphis glycines* MATSUMURA or potato aphid *Aulacorthum solani* KALTENBACH) or spider mites (mostly Kanzawa mite *Tetranychus kanzawai* KISHIDA), less frequently on thripids (mainly *Taeniothrips glycines* OKAMOTO and *Thrips hawaiiensis* MORGAN), and infrequently on other insects. Comparing the average per-plant infestation of each arthropod species on plants sampled in 1963, starting with those with low predation frequency, the densities of moth larvae (mainly the Japanese giant looper *Ascotis selenaria cretacea* BUTLER), the larvae of *Leucopis puncticornis* MEGIEN, and the hoverfly eggs were consistently less than 0.2, whereas the two aphid species, spider mites, and thripids – which were more heavily preyed on – were present in much higher numbers (Table 1) than the three former insects; in general, it appears that those species present in higher numbers are preyed upon with higher frequency. However, although the thripids had higher population densities than the aphids throughout the sampling period, they were preyed upon much less frequently, suggesting that aphids are more ready prey for *Orius* sp.; this may be because while the aphids are non-migratory and have a tendency to congregate – especially the soybean aphids, the thripids frequently move around and do not tend to form clusters.

2. Seasonal population dynamics of *Orius* sp.

The change in *Orius* sp. population for both years is given in the bottom graphs of Figures 1 and 2; in both years, adult insects arrived in the experimental plots in mid-July, and gradually increased in population until late-August, early-September, when they reached their peak. In this period, both adults and various-sized larvae were present, so it is difficult to determine the number of generations per year; however, because by late-July it was possible to find adult insects that appeared to have just emerged, it is believed that more than one generation is completed on soybeans. The growth of *Orius* sp. population was not significantly different between years up to the peak in late-August. However, the subsequent population decline was slightly faster in 1964. Based on the coincidence of the *Orius insidious* SAY population peak on corn with silking, Barber (1936) hypothesized that the population peak is a determined by the presence of silks which are optimal locations for egg-laying; in contrast, Dicke and Jarvis (1962) suggest that because the species feeds on corn pollen, the population peak is related to the maturation of the male flowers. In either case, it is believed that the population dynamics of *O. insiduosus* is intimately related to the developmental stage of the corn plants. The *Orius* sp. in this study also fed on plant material when bred in the laboratory, and layed their eggs in plant tissues in the same manner as similar species (Barber, 1936; Fulmek, 1930). According to figures 1 and 2, the population peak of *Orius* sp. coincided with seedpod appearance (end of flowering, [R3][3]), and the population declined from seedpod color maturation [R8][4] to the beginning of leaf fall. In 1964, the period between the end of flowering to seedpod color maturation was slightly shorter than in the previous year, and the fall population decline of *Orius* sp. was slightly faster. It appears that although the initial infestation and increase in population of this species in the experimental field did not differ significantly between years, the subsequent decline in population was related to the soybean maturation and that once the soybean plants had reached maturity, adult insects gradually migrated away from the experimental field. As mentioned earlier, because the population of *Orius* sp. began to decline even while mites, which are one

---

[3] Translator footnote: I believe that this refers to the developmental stage R3 as defined by Fehr and Caviness

[4] Translator footnote: see previous note

of the primary prey of *Orius* sp., continued to be present in high numbers, it is believed that the initiation of migration from the experiment field was not directly related to the prey population density.

3. Seasonal population dynamics of major prey species of *Orius*, sp.

The population dynamics of major prey species of *Orius* sp. for 1963 and 1964, are presented in figures 1 and 2. Although the beginning of the thripid population increase was slightly delayed in 1964 relative to the previous year, in general the pattern in both years was similar: the population reached a climax between late-July and mid-August, and subsequently declined; the population showed some recovery but gradually declined after the onset of senescence. The mite population began to increase rapidly approximately 1 month earlier in 1964 than in 1963, and achieved a much higher density at the population climax, exhibiting a clear difference in population dynamics. The population density of the potato aphid was somewhat lower in 1964 than in 1963; however, in both years the population showed some increase in the fall, which is consistent with previous literature (Hori, 1929; Koshimizu & Iitsuka, 1963). In contrast, the population dynamics of the soybean aphid was obviously different in the two years: while in 1963, the population density showed a striking decline in early-August and recovery in mid-August at the same time as an increase in mite population, in 1964, the population density increased steadily from late-July to early-August and remained at a high level until late-August. In general, winged soybean aphids migrate to soybean between late-June and mid-July, and from late-July onward infest the shoot apex and rapidly multiply (Hori, 1929; Sakai, 1949). In areas of Morioka city with high infestation, populations of soybean aphids from late-July to mid-August are remain consistently high (Koshimizu & Iitsuka, 1963). The 1964 population dynamics were consistent with typical seasonal population changes of the soybean aphids. The differences in population dynamics between 1963 and 1964 were obvious for mites and soybean aphid, which are heavily preyed upon by *Orius*, sp.

4. Influence of Orius sp. predation on seasonal population dynamics of aphids

Although clear differences in soybean aphid population dynamics could be seen in late-July to mid-August, there were no unusual environmental or man-made conditions which might have affected aphid populations. The population density of natural enemies of soybean aphids on the stems and leaves are given in table 2. The population of *Orius* sp. increased drastically from late-July to late-August, and it can be said that *Orius* sp. were the major predator during that period. In contrast, the populations of other natural enemies were either very low or increased after late-August and did not have a significant influence on changes in the soybean aphid population. Hori (1929) identified spiders as potential soil-surface dwelling predators of the soybean aphids. However, in the 1964 survey of soil-surface dwelling arthropods, the population of spiders was very low; there was only one observation of predation of soybean aphid, and mostly predation of four-winged insect adults, springtails, and hoverflies. It cannot be said that spiders are a major predator of soybean. Other potential soil-dwelling predators of soybean aphids were found in extremely low densities and it is not believed that they have an affect on the soybean aphid population. Subsequent studies have shown that the population of these soil-dwelling predators does not differ significantly from year to year, and it is believed that the population of these insects in 1963 was similar to that in 1964. Based on the above observations, it is hypothesized that although the population of soybean aphids is influenced by the population of its most important predator, *Orius* sp., the population of the predator itself does not differ substantially between years. Let us consider the interaction between soybean aphids, *Orius* sp., and the other major prey of *Orius* sp. – mites: In 1964, the mite population increased early in the season, and by the time the *Orius* sp. began multiplying, the population density of mites was much higher than that of aphids. It is believed that the Orius sp. preyed primarily on mites, and therefore had little affect on the population density of aphids.

In late-July of 1963, the population of soybean aphids was much higher than that of the potato aphids and mites. However, at this time, the population (a little over 22 aphids per plant) was believed to have been clustered near the shoot apices and had not yet dispersed to the lower leaves (Ito, 1953). In contrast, mites in early on in an infestation are found only on the lower leaves (Nishio & Imabayashi, 1959). In this case, the *Orius* sp. preyed mainly on the soybean aphids which were clustered on the shoot apex, causing a decline in soybean aphid population density towards mid-August; the mites, thus, escaped predation, allowing for the dramatic population increase. After the mites increased in population, it is believed that predation pressure on soybean aphids decreased as predation of mites increased, allowing the aphid population to recover (figure 1). (Of course, even if the mite population does not increase early in the season, if the initial soybean aphid population is extremely high, the effect of *Orius* sp. predation on soybean aphid may not be clearly recognizable). In addition, from late-July when *Orius* sp. became active, because the potato aphid population was lower than that of soybean aphids and mites and infestation is diffuse (Hori, 1929), there was little predation and populations in both years gradually increased towards fall. In conclusion, when evaluating *Orius* sp. as a natural predator of the soybean aphid, it is important to consider not only the population density of the predator, but also the relative abundance, location on plant, and degree of clustering of each prey species.

Summary

1. In 1963 and 1964, *Orius* sp. were observed in a soybean field in Morioka City preying on more than 7 arthropod species; most frequently on aphids, mites, and thripids.
2. *Orius* sp. adults arrived in the experimental plots in mid-July, reached peak population between late-August and early-September, and gradually declined after maturation of the soybeans.
3. The influence of *Orius* sp. predation on soybean aphid populations was reduced when mites were abundant. When mite populations increase early in the season, soybean aphids maintain high population densities. When mite populations increase late in the season, soybean aphid populations are suppressed through predation by *Orius* sp. until mite populations increase.
4. Because potato aphid population densities are lower than those of the soybean aphid and mites, and infestation is less clustered, predation by *Orius* sp. is less frequent and allows for a gradual population increase into the fall.

Table 1. Population and frequency of predation by *Orius* sp. of arthropod species on 20 soyban plants.

day	mo.	Soybean aphid	Potato aphid	thripids	Moth (larvae)	*L. puncticornis Meigen* (larvae)	Hoverfly (eggs)	Mites
26	July	5		1				
30		4			2	1		
1	Aug	7						
2		3	1	1				
5		11		1				1
8		2	6				1	4
9		3	4					4
16		3	6	2				6
30		3	2	3				8
5	Sept	4	2	1				7
10		1						5
17		3	5					13
	totals	49	26	9	2	1	1	48

Figure 1. Seasonal population dynamics (1963) of Orius sp. and major prey species
(notes) Tetranychidae spp.: mainly Kanzawa mites (egg counts are 1/10 of actual)
Aulacorthum solani: potato aphid
Aphis glycines: soybean aphid
Thripidae spp.: mainly *Taeniothrips glycines* OKAMOTO and *Thrips hawaiiensis* MORGAN)
Orius sp.: one species of flower insect
Left arrow: End of seed
Right arrow:

Figure 2. Seasonal population dynamics (1963) of Orius sp. and major prey species
(notes) same as for Figure 1

Table 2. Population density dynamics of natural enemies of aphids from late-July to late-August in experimental plots (average per plant)

	1963			1964		
	July 23	Aug 6	Aug 19	July 23	Aug 10	Aug28
Orius sp.	0.90	6.20	10.40	0.55	6.65	8.40
Nagamakibasashigame[5]	0.05	0.10	0.50	0.10	0.50	0.90
Hoverfly (larvae)	0.20	0.05	0	0.20	0	0.05
Sejiroaburakobai (larvae)[6]	0	0.20	0	0.05	0	0
Ladybugs	0.10	0.10	0.15	0	0.40	0
kusakagero (larvae)[7]	0	0.15	0.10	0.05	0.10	0.05
Aphidius sp.*	0.45	0.45	0.55	0.25	0.15	0.10
Parasitic wasp 1**	0	0.20	0.45	0	1.20	0.85
Microbial Parasite ***	0	0	0	0	0.05	0

* emerged from potato aphid *mummy*
** *Charips* sp. that emerged from soybean aphids mummy, but possibly a secondary parasite
*** number of soybean aphid carcasses resulting from fungal (bacterial) parasite

[5] Translator footnote: I couldn't find the common name or scientific name for this insect
[6] Translator footnote: see footnote 5: the name means white-backed oil small fly
[7] Translator footnote: see footnote 5.

References

ANDERSON, N. H. (1962a) Bionomics of six species of *Anthocoris* (Heteroptera: Anthocoridae) in England. Trans. Ent. Soc. Lond. 144: 67~95

ANDERSON, N. H. (1962b) Growth and fecundity of *Anthocoris* spp., reared on various prey (Heteroptera: Anthocoridae). Ent. Exp. Appl. 5: 40~52

BARBER, G. W. (1936) *Orius insidosus* (SAY), an important enemy of the corn worm. U.S. Dep. Agric. Tech. Bull. 504, 24pp.

DICKE, F. F. and JARVIS, J. L. (1962) the habits and seasonal abundance of *Orius insidiosus* (SAY) (Hemiptera: Anthocoridae) on corn. J. Kans. Ent. Soc. 35: 339~334.

FULMEK, L. (1930) Zur Kenntnis der Entwicklungsstadien von *Triphleps minuta* L. Z. wiss. Insektenbiol. 25:82~88

HORI, M[8]. (1929) Primary horticultural aphids in Hokkaido. *Hokunoshi-hokoku* [Report of the Hokkaido Agricultural Experimental Station][9]

ITOH, Y. (1953) Research on the multiplication and migration of the soybean aphid. reports 1 & 2. Applied Entomology. 8:141~148.

KOSHIMIZU, Y., IITSUKA, N. (1963) Research on viral diseases of soybeans. *Tohokunoshi-hokoku* [Report of the Tohoku Agricultural Research Center][10]. 27:1~103.

NISHIO, F.[11], IMABASYASHI, S. (1959) On the seasonal population dynamics of soybean mites. Presentation at the 1959 *Odokontaikai* [Applied Animal Science and Entomology Conference][12]

SAKAI, S. (1949) Research on the soybean aphid and similar Japanese chaff flower aphid (tentative name). *Konchu* [Insects][13] 17:54~56

THOMPSON, W. R. (1951) The specificity of host relations in predacious insects. Canada. Ent. 83: 262~269.

---

[8] Translator footnote: his first name is either Matsuji or Shoji

[9] Translator footnote: italicized name is the phonetic reading of the abbreviated journal name. in brackets is my best guess as to how that would be translated into English.

[10] Translator footnote: See footnote 9

[11] Translator footnote: I can't tell what the first name is, because readings of proper nouns are often different. My best guess if Fumiaki

[12] Translator footnote: See footnote 9

[13] Translator footnote: See footnote 9