# EFFECT OF TIME OF DAY ON SURVEYS OF PREDACEOUS INSECTS IN FIELD CROPS [1]

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In recent years, numerous workers have studied the accuracy of various techniques for estimating insect and spider predator populations in field crops. The effect of many factors on these methods has been carefully appraised. Weather, type of plant growth, size of sample, personal factor, and other influences have been taken into consideration. However, very few investigators have stressed the effect of time of day on the counts or questioned the advisability of comparing results taken at different hours. In preliminary work conducted during 1959 and 1960 at Morrilton, Arkansas, surveys at 6 A.M. in insecticide treated cotton fields showed more *Lebia analis* Dej. present than in untreated fields at 1 P.M. It was questionable whether sampling done at different times of day could be logically compared. To investigate this, populations of various insect and spider predators were sampled at three different times of day near Little Rock, Arkansas, during the summer of 1961.

Specific information on the effect of temperature or time of day on sampling of any insect population is scarce, although it has been discussed in a general way in several papers, for example those of Wellington (1957), Andrewartha and Birch (1960), Morris (1960), Richards (1961), and Strickland (1961). Few papers resulting directly from field research have been published. DeLong (1932) pointed out that temperature could influence the number of certain insects taken in a sweep net and that, in areas of marked temperature variation, estimates of population based on sweep-net catches would change with the time of day samples were taken. In a study of the beet leafhopper, *Circulifer tenellus* (Baker), Romney (1945) found some catches with the sweep net 200% greater than others, depending on the time samples were taken. However, he observed little effect of temperature or time of day on samples taken with a metal cylinder. Wylie (1951), in studying the jarring method for plum curculio, *Conotrachelus nenuphar* (Herbst), population estimates, found the temperature too high during the summer in Arkansas for jarring to be effective during daylight hours. In sampling *Aphis fabae* Scop., Johnson (1952) found a double peak of aerial density, but this was only weakly correlated with weather factors. Hughes (1955) observed a striking difference among the net catches of a species of chloropid fly taken at different times of day.

## TECHNIQUE

A 30 acre soybean field near Little Rock, Arkansas, was chosen for the study. It was surrounded largely by trees and was somewhat isolated from other row crops; the nearest cotton and soybean fields were one-half mile away. A small plot of sweet corn was 200 yards from the soybean field and separated from it by a grove of trees.

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Two methods of estimating predator populations were used. The first consisted of complete plant examinations, as described by Lincoln (1955). In the second, the sweep method was used, in spite of the inadequacies pointed out by Gray and Treloar (1933) and others. The size of the sample taken and the ease with which the sweep method could be used, partly compensated for the drawbacks.

Twenty-five plants were examined at 7 A.M., 1 P.M., and 6 P.M. Monday and Friday of each week. The plants were located in groups of five, the same plants being examined each time. Because of the effect of handling on plant growth, these plants were changed every third week. Predators were removed during each examination. It was questionable whether the same plants should be examined at midday and in the evening after the removal of the insects in the morning. This was necessary because of simultaneous inspections for another project. The assumption that this removal made little difference, in the case of flying insects, seems justified, since the numbers of insects taken in plant examinations corresponded very well to the numbers taken in sweeps. There was no evidence that the removal lowered the later counts.

Sweep samples were taken at each location with a 15 inch net of the California type. A plastic vial attached to the bottom of the bag facilitated removal of specimens, as mentioned by Miner (1960). Early in the season, the whole plant was swept with the net. As the plant grew larger, only the upper portion was swept. Twenty-five sweeps were taken at each of four locations, immediately following the complete plant examinations, with each sweep made one step from the preceding.

Predators of lepidopterous larvae received special attention. Wherever feasible, counts were made of individual species. All identifications of specimens were verified in the laboratory, and in case of any question, determinations were checked by specialists. In all, 12 species or species complexes were numerous enough for consideration. Immediately prior to plant examination, temperature was recorded in centigrade, and weather conditions were noted. Plant height was measured each day populations were sampled.

## Results

Counts taken at the different times of day are summarized in Tables 1 and 2. As expected, results varied abruptly from species to species.

Counts of two of the three hemipterous predators gave significantly different results at the three times of day. Those of the third species did not (see Fig. 1). One of the first two, the insidious flower bug, *Orius insidiosus* (Say), often considered the most important predator of the eggs of the bollworm, *Heliothis zea* (Boddie), was most abundant in the morning, both in the plant examinations and in the sweep net (see Fig. 2). Not only were the differences statistically significant, but twice as many insidious flower bugs were taken in the plant examinations in the early morning as at other times. There were only a few exceptions to this; one of these occurred on July 7, when numbers of these insects were migrating into the field. A second exception took place on July 27 and 28, both days of complete cloud cover and rain. More big-eyed bugs, *Geocoris punctipes* (Say), were taken in the morning than at midday or evening by both methods. The difference was significant in the sweeps but not in the direct plant ex-

| | | 7:00 A.M | 1:00 P.M. | 6:00 P.M. | L.S.D. at 5% |
|---|---|---|---|---|---|
| Recurrent temperature range | | 21-26°C. | 33-36°C. | 25-30°C. | |
| PREDATOR | | | | | |
| Spotted lady beetle | (actual) | 2.87 | 2.26 | 1.74 | |
| *Coleomegilla maculata* (DeGeer) | (transformed)** | 1.9233 | 1.7185 | 1.4890 | 0.3269 |
| Ground beetle | (actual) | 4.61 | 1.78 | 5.39 | |
| *Lebia analis* Dej. | (transformed) | 2.1259 | 1.3336 | 2.2650 | 0.3768 |
| Nabids | (actual) | 1.74 | 1.69 | 2.04 | |
| *Nabis* spp. | (transformed) | 1.4145 | 1.3849 | 1.4150 | 0.2988 |
| Big-eyed bug | (actual) | 5.22 | 2.83 | 3.09 | |
| *Geocoris punctipes* (Say) | (transformed) | 2.2656 | 1.6622 | 1.7806 | 0.3244 |
| Insidious flower bug | (actual) | 1.08 | 0.61 | 0.7 | |
| *Orius insidiosus* (Say) | (transformed) | 1.1254 | 0.9842 | 1.0193 | 0.2384 |
| Polistes wasps | (actual) | 0.18 | 0.09 | 0.09 | ——* |
| *Polistes* spp. | | | | | |
| Other wasps | (actual) | 0.91 | 0.27 | 0.73 | —— |
| *Sphex* spp., etc. | | | | | |
| Green lacewing larvae | (actual) | 0.30 | 0.35 | 0.43 | —— |
| *Chrysopa* spp. | | | | | |
| Striped lynx | (actual) | 3.6 | 3.07 | 3.20 | |
| *Oxyopes salticus* Hentz | (transformed) | 2.1178 | 1.8416 | 1.8172 | 0.4007 |
| Orb weavers | (actual) | 0.93 | 0.47 | 0.6 | —— |
| *Aranea* spp. and *Neoscona* spp. | | | | | |
| Crab spiders | (actual) | 0.36 | 0.64 | 0.73 | —— |
| *Misumena* spp., *Misumenops* spp., and *Misumenoides* spp. | | | | | |
| Jumping spiders | (actual) | 0.46 | 0.46 | 0.62 | —— |
| *Phidippus* spp. | | | | | |

* No analysis made.

** Means based on square root transformation.

TABLE 2.—PREDATORS PER 100 PLANTS EXAMINED

| | | 7:00 A.M | 1:00 P.M. | 6:00 P.M. | L.S.D. at 5% |
|---|---|---|---|---|---|
| Recurrent temperature range | | 21-26°C. | 33-36°C. | 25-30°C. | |
| PREDATOR | | | | | |
| Spotted lady beetle | (actual) | 3.65 | 1.22 | 2.78 | ——* |
| *Coleomegilla maculata* (DeGeer) | (transformed)** | 2.0396 | 1.3109 | 2.1668 | 0.9136 |
| Ground beetle | (actual) | 3.30 | 0.34 | 1.74 | |
| *Lebia analis* Dej. | (transformed) | 2.3456 | 0.9642 | 1.9364 | 0.7718 |
| Nabids | | | | | |
| *Nabis* spp. | (actual) | 0.57 | 0.0 | 0.57 | —— |
| Big-eyed bug | (actual) | 1.91 | 1.22 | 0.86 | |
| *Geocoris punctipes* (Say) | (transformed) | 1.2950 | 1.1106 | 1.0145 | 0.3877 |
| Insidious flower bug | (actual) | 3.65 | 0.7 | 1.39 | |
| *Orius insidiosus* (Say) | (transformed) | 1.6878 | 0.9261 | 1.1106 | 0.4117 |
| Polistes wasps | (actual) | 0.0 | 0.0 | 0.0 | —— |
| *Polistes* spp. | | | | | |
| Other wasps | (actual) | 0.04 | 0.0 | 0.0 | —— |
| *Sphex* spp., etc. | | | | | |
| Green lacewing larvae | (actual) | 0.0 | 0.0 | 0.0 | —— |
| *Chrysopa* spp. | | | | | |
| Striped lynx | (actual) | 1.03 | 1.39 | 0.7 | —— |
| *Oxyopes salticus* Hentz | | | | | |
| Orb weavers | (actual) | 2.26 | 2.52 | 2.26 | —— |
| *Aranea* spp. and *Neoscona* spp. | (transformed) | 2.3100 | 2.3788 | 2.1050 | 1.8317 |
| Crab spiders | (actual) | 0.04 | 0.13 | 0.0 | —— |
| *Misumena* spp., *Misumenops* spp., and *Misumenoides* spp. | | | | | |
| Jumping spiders | (actual) | 0.086 | 0.04 | 0.0 | —— |
| *Phidippus* spp. | | | | | |

* No analysis made.

aminations. The fact that insufficient numbers were taken in the observations on the plants possibly explains this, since fewer than 25 of these insects were taken during the entire summer. The difference between midday and evening counts was not significant in either case. Too few nabids (*Nabis* spp.) were taken in the plant examinations to make comparisons. In the sweeps, however, numbers were ample, but, in spite of this, differences were not significant (see Fig. 1). No attempt was made to distinguish between the various species, although this might clarify the situation.

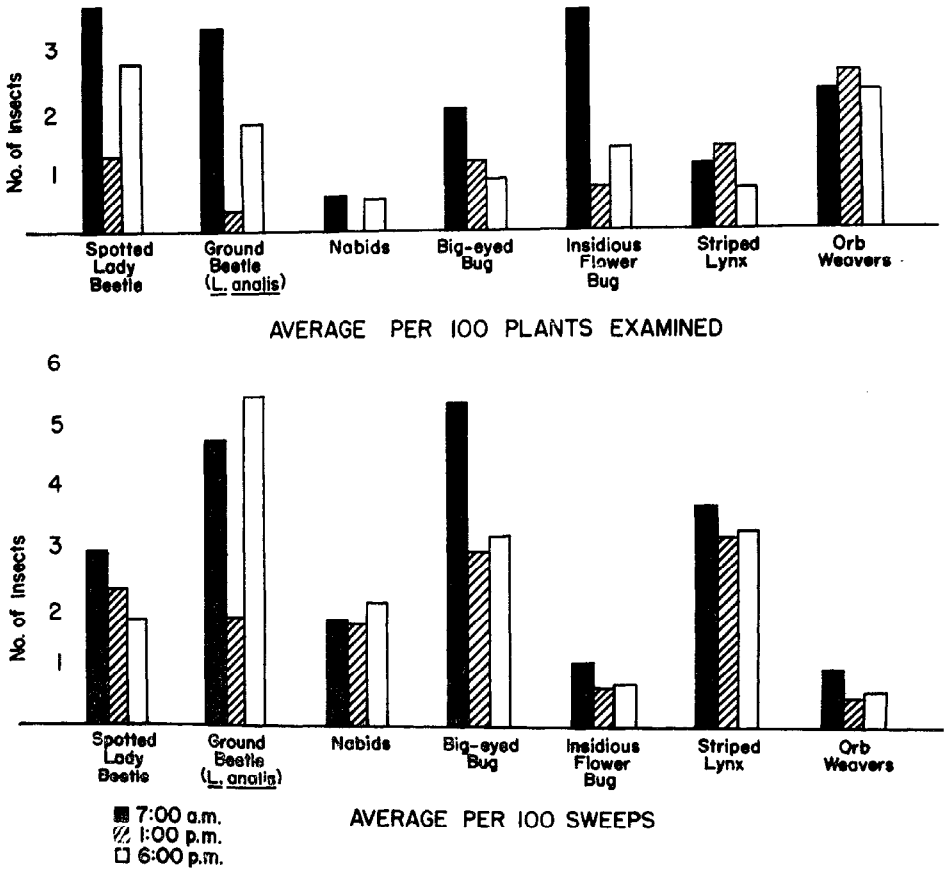


Figure 1. Average populations of predators sampled three times a day by the two methods at Little Rock, Ark., 1961.

Two families of Coleoptera were represented in the surveys. *Lebia analis* Dej. was the only ground beetle abundant enough for study. In this case, the counts at midday were distinctly lower than morning and evening counts, with fewer than half as many beetles taken at midday (see Fig. 3). Temperatures alone did not explain this. Some of the greatest differences in counts occurred on days, such as July 14, when temperatures differed only slightly all day. The two days when results were reversed (samples at midday were larger than those of the morning) occurred when morning temperature differences were normal. However, on those two days, it

rained, and there was complete cloud cover part of both days. In the sweeps, slightly more beetles were taken in the evening (6 P.M.) than in the morning (7 A.M.), but in the plant examinations a few more beetles were taken in the morning than in the evening. In neither case, were the differences significant. The spotted lady beetle, *Coleomegilla maculata* (DeGeer), was the only coccinellid abundant in the experimental field. Differences at various times of day were not significant, in either sweeps or plant examinations, but results were inconsistent. One day, counts made at midday were highest; on the following day, counts made in the evening were highest. No correlation with temperature, cloud cover, or humidity could be discovered. It was impossible to determine whether this held true for *Hippodamia convergens* Guer., *Coccinella novemnotata* Herbst, *Scymnus* spp., and the other coccinellids.

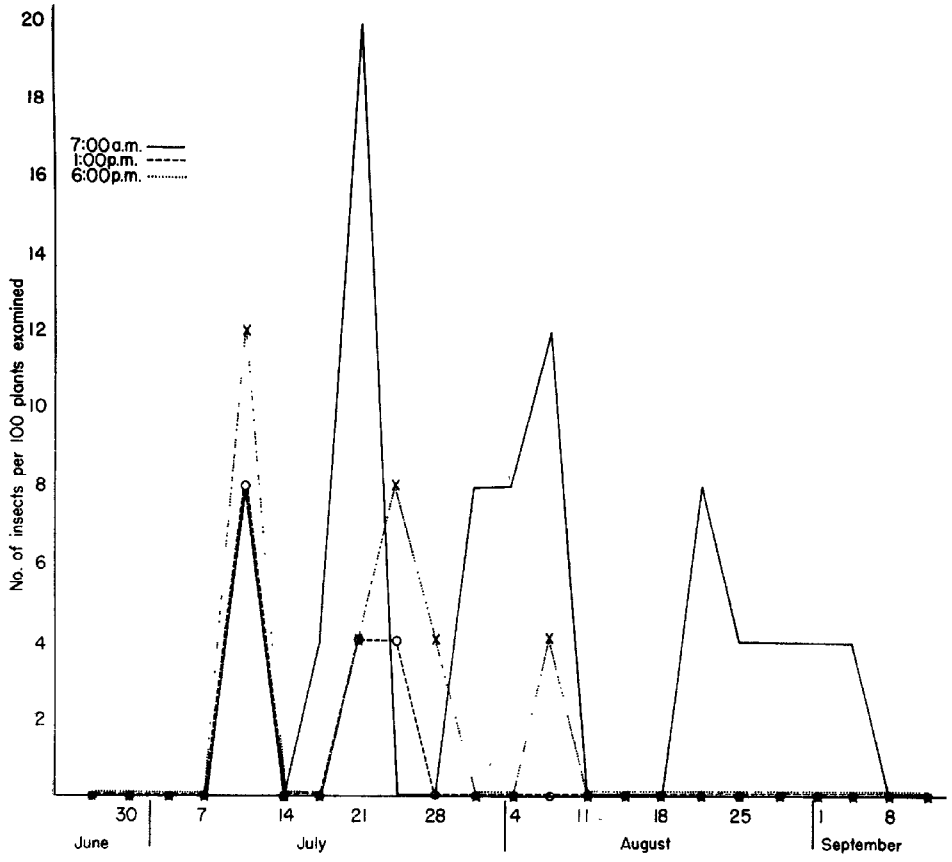


Figure 2. Bi-weekly populations of *Orius insidiosus* (Say) per 100 plants examined at three different times of day at Little Rock, Ark., 1961.

Differences in all of the spider counts were slight in both plant examinations and sweeps. This was equally true for wandering spiders and orb weavers and for matures and immatures and can be explained by the fact that counts were too low. There were indications that results might have been different, if samples had been larger or if nocturnal counts had been taken.

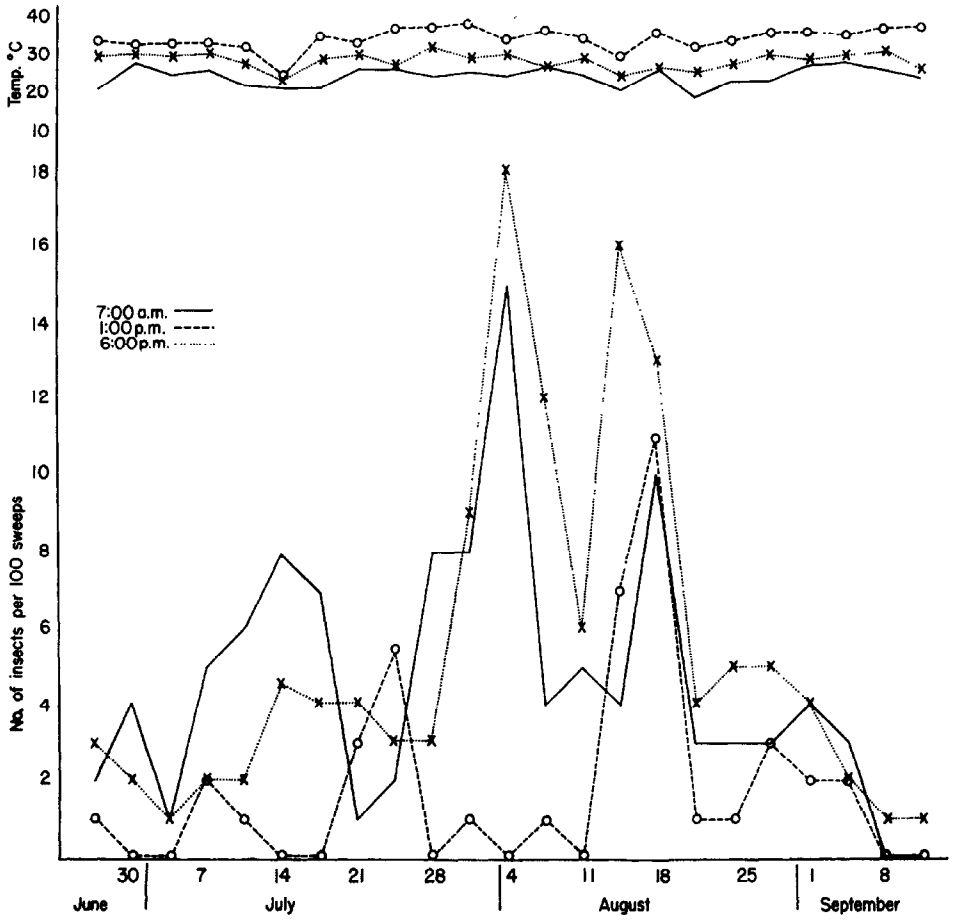


Figure 3. Bi-weekly populations of *Lebia analis* Dej. per 100 sweeps found at three different times of day and the temperature at the three times of sampling at Little Rock, Ark., 1961.

## Discussion

In most cases, fewer predators were taken during the hot hours of midday than at any other time. This was, however, especially evident in the case of certain species. More attention should be given to the hour when samples are taken, particularly in an open area such as a soybean or cotton field. In this experiment, in the case of the genus *Lebia*, time of day seemed to make more difference in size of samples than most other factors.

## Summary

Populations of 12 species or species complexes of predators were sampled at three different times of day in a soybean field near Little Rock, Arkansas. Two methods of sampling were used; the first consisted of complete examination of 25 plants, and the second, of 100 sweeps made with a 15 inch California type net. With very few exceptions, sweeps and plant examinations agreed closely. In many cases, counts taken in the morning and evening differed significantly from those taken at midday.

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