# INSECT HERBIVORES OF 12 MILKWEED (*ASCLEPIAS*) SPECIES

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**ABSTRACT:** To better understand the relationships between insect herbivores and their plant hosts, a study was undertaken involving the insect herbivores closely associated with milkweeds. More than 30,000 plants belonging to 12 milkweed species (*Asclepias amplexicaulis, Asclepias exaltata, A. hirtella, A. incarnata, A. lanuginosa, A. meadii, A. purpurascens, A. sullivantii, A. syriaca, A. tuberosa, A. verticillata*, and *A. viridiflora)* were studied, and approximately 750 specimens of 16 species of insect herbivores were observed feeding on these milkweeds. These 16 species were: a) 2 hemipterans (*Lygaeus kalmii, Oncopeltus fasciatus*), b) 4 coleopterans (*Tetraopes tetraophthalmus, T. femoratus, Labidomera clivicollis, Rhyssematus lineaticollis*), c) 3 lepidopterans (*Danaus plexippus, Cycnia tenera, Euchaetias egle*), d) 5 hompterans (*Aphis gossypii, A. nerii, A. rumicis, Myzus persicae, Macrosiphum rudbeckiae*) e) one dipteran (*Liriomyza asclepiadis*) and f) one thysanopteran (*Frankliniella tritici*). The food preferences of these herbivores for the different species of milkweeds, the part or parts of the plants that were preferentially used in feeding, and the insects' relative abundance throughout the growing season were determined. Differences between this study and others of a similar nature are discussed. Changes that may have occurred in the host-herbivore relationships with the destruction of the presettlement environment also is discussed.

*Key words*: milkweeds, insects, herbivores

## INTRODUCTION

There have been relatively few surveys on insects associated with milkweeds *(Asclepias spp).* Weiss and Dickerson (1921) listed 122 species of insects found on two species of milkweeds *A. syriaca* and *A. incarnata pulchra* in New Jersey together with ecological notes on the ecology of seven insect herbivores. Wilbur (1976) provided important additional ecological information on eight herbivorous species found on seven species of milkweeds (*A. exaltata, A. incarnata, A. purpurascens, A. syriaca, A. tuberosa, A. verticillata*, and *A. viridiflora*) in south-central Michigan. Both of the above studies provide qualitative estimates of herbivore abundance on each milkweed species, by using terms, such as, "very frequent," "frequent," "occasionally," and "rare." In another study, Dailey et al. (1978) collected 5959 beetles belonging to 25 families from a population of *A. syriaca* along a railroad right-of-way in Bowling Green, Ohio. They also included data on the relative seasonal abundance of 23 of the more abundant species collected. Price and Willson (1979) using quantitative data, reported on the relative abundance of 12 milkweed herbivores found on 6 species of milkweeds (*A. amplexicaulis, A. incarnata, A. sullivantii, A. syriaca, A. tuberosa*, and *A. verticillata)* in central Illinois. Ecological data on the herbivores was also included in the paper.

Between 1964 and 1967 extensive field studies were undertaken to understand better the relationships among 16 milkweed herbivores and 12 species of their *Asclepias* hosts. These studies were continued sporadically during the next quarter of a century. Data were collected on the herbivores' preferences for the different species of *Asclepias*, the parts of the plants they fed on, and their relative abundances throughout the growing season. Additional data were collected on the kind and extent of damage done to the host plants.

## STUDY AREAS AND METHODS

With the exception of *A. meadii,* all of the milkweed species studied occurred in the greater Chicago region. This area included southeastern Wisconsin, northeastern Illinois, and northwestern Indiana. Except for one specimen of that species from east-central Illinois, all of the 180 specimens of *A. meadii* studied were from western Missouri and eastern Kansas. In all there were 145 stations, involving 35,801 stems and 54,560 observations of these stems (Table 1). These *Asclepias* species were found in all types of habitats including: sand (*A. amplexicaulis*); virgin mesic prairie (*A. meadii*); dry prairie (*A. lanuginosa, A. tuberosa*, and *A. viridiflora*); wet prairie (*A. hirtella* and *A. sullivantii*); woods (*A.*

**Table 1.** Numbers of *Asclepias* stems observed, numbers of stations where *Asclepias* plants occurred, and number of stem observations for herbivorous insects.

| Asclepias Species | Number of Stems | Number of Stations Where Species Occurred | Number of Stems Observed |
|---|---|---|---|
| A. amplexicaulis | 318 | 4 | 952 |
| A. exaltata | 94 | 6 | 449 |
| A. hirtella | 216 | 8 | 639 |
| A. incarnata | 1117 | 17 | 2839 |
| A. lanuginosa | 600 | 2 | 1862 |
| A. meadii | 180 | 17 | 621 |
| A. purpurascens | 198 | 5 | 461 |
| A. sullivantii | 3276 | 12 | 4012 |
| A. syriaca | 5123 | 41 | 7679 |
| A. tuberosa | 2438 | 10 | 3258 |
| A. verticillata | 22092 | 18 | 31312 |
| A. viridiflora | 149 | 5 | 476 |
| Total | 35801 | 145 | 54560 |

*exaltata*); savanna (*A. purpurascens*); marshes (*A. incarnata*); old fields (*A. verticillata*); and waste places and cultivated fields (*A. syriaca*).

In this study the stem was used as the unit of reference rather than an individual plant because of the difficulty in distinguishing between individual plants in many milkweed species. Only in a few milkweed species, such as *A. meadii* and *A. tuberosa*, is it usually easy to make that distinction, because when ramets are produced they generally grow adjacent to one another from a single rootstock forming a clump. However, this is not the case with many of the other milkweeds studied. Species like *A. sullivantii, A. syriaca*, and *A. verticillata* have a tendency to produce extensive rhizomatous systems which produce spreading ramets that intermix with ramets from other clonal systems. This makes it impossible to determine one plant system from another. A mechanical hand counter was very useful in determining the number of stems in most of these clonal species.

However, it was frequently difficult to count the number of stems in *A. verticillata* colonies using such a device because they produce large colonies, covering extensive areas with hundreds of ramets free of any other plant growth. Since *A. verticillata* has narrow linear leaves, it was possible to view and examine the whole colony at once and to determine the presence of any herbivores on them. The approximate number of stems in colonies of this species was then determined by counting the number of stems in a square meter and extrapolating this figure to include the entire area of the colony. It is interesting to note that the number of stems/meter varied from one colony to another (Rommel 1967).

The studies were conducted from early June to early October during daylight hours. Most of the milkweed populations were carefully examined for herbivorous insects approximately every two or three weeks, and the herbivore species and their number on the different milkweed species were then recorded. Except for an occasional uncommon species, none of the other insects specimens was collected. Because specimens were not collected and removed from a station, it is possible that they could have been recorded again in a follow-up observation two or three weeks later. Because of this possibility, the term "observation" was used for recording the presence of a specimen found on a stem.

**Periods of Insect Abundance**

In the bar graphs showing the periods of insect abundance, the y-axis is labeled "Number of Insects" and the x-axis "Weeks." The "Number of Insects" is an estimated number of insects.

Since the number of milkweed plants observed for an insect species varied from week to week, the number of specimens observed each week could not be used as a true measure of the actual abundance for that insect over the time period used (first week in June to the fourth week in September). Because of this, it was necessary to calculate estimated numbers of insects observed during any given week within that period.

This was done by using the following formula: The estimated number of insects equals the number of insects observed on milkweeds during any given week **times** the total number of milkweeds observed throughout the period of observations **divided by** the number of milkweeds observed each week.

Most blank spaces for weeks in the figures indicate that insect observations were not carried out during those weeks and not because there was a lack of insects.

## RESULTS

### Bugs (Hemiptera)

**Small milkweed bug** (*Lygaeus kalmii* (Stahl)
This species belongs to the Lygaeidae or seed bugs. It is brightly marked with red and black, having a red X-shaped area on the hemelytra and a broad red band across the base of the pronotum. Both adults and nymphs feed on the juices of milkweeds during the early part of the growing season. During late fall and early spring they have the ability to survive on the matured seeds and dehisced pods of milkweeds.

This species was found on 10 of the 12 milkweed species studied. It has a preference for *A. incarnata* (14.0 specimens/1000 stems) and to a lesser extent *A. viridiflora* (10.5/1000) (Table 2). Sixty-three percent of the specimens observed on *A. tuberosa* were found on the pods, with another 20% on the leaves (Table 8).

Two generations a year were reported in the literature; the first generation appearing about the last week in June and the second in early August (Simanton and Andre 1936). However, this study indicates that there are three periods of abundance: 1) a relatively short one during the second week in July; 2) a long one during the second week in August and 3) a moderate one during the third week in September (Figure 1).

Usually only one or two specimens are found on a milkweed stem at any one time and cause very little damage to the host plant and its crop of seed.

**Large milkweed bug** (*Oncopeltus fasciatus* (Dallas)
This species also belongs to the Lygaeidae. Like *Lygaeus kalmii*, adults also are marked brightly red (older) or orange (younger) with three broad horizontal black bands. The nymphs are red with black antennae and legs. The adult bugs are easily sexed, with the male bearing a black band and the female two prominent black spots on the ventral side of the fourth abdominal segment (Lener 1966, Best 1977).

This species was found on 8 of the 12 milkweed species studied, having a preference for A. viridiflora (14.7 specimens/1000 stems), *A. syriaca* (13.4/1000), and *A. incarnata* (8.5/1000) (Table 2). Seventy-five percent of the specimens observed on *A. syriaca* and *A. incarnata* were found on the pods (Table 8).

Specimens of this species appeared during the first week in July with a rapidly increasing population reaching a peak during the fourth week in September (Figure 2). Toward the end of summer, this species usually occurs in clusters of 10 to 15 nymphs along with an adult or two. The number of nymphs is probably related to the number of eggs originally laid by a female on the surface of the pods.

Both the adults and nymphs are usually found on the pods (follicles) where they feed on the developing seeds within

**Table 2.** Number of *Lygaeus kalmii* and *Oncopeltus fasciatus* adults observed on *Asclepias* species.

| Asclepias Spp. | Lygaeus kalmii No.of Insects Observed on | Lygaeus kalmii No.of Insects per 1000 Stems | Oncopeltus fasciatus No.of Insects Observed on | Oncopeltus fasciatus No.of Insects per 1000 Stems |
|---|---|---|---|---|
| A. amplexicaulis | 1 | 1.1 | 2 | 2.1 |
| A. exaltata | 1 | 2.2 | 0 | --- |
| A. hirtella | 5 | 7.8 | 1 | 1.9 |
| A. incarnata | 40 | 14.1 | 26 | 9.2 |
| A. lanuginosa | 0 | --- | 0 | --- |
| A. meadii | 0 | --- | 0 | --- |
| A. purpurascens | 2 | 4.3 | 0 | --- |
| A. sullivantii | 5 | 1.3 | 9 | 2.3 |
| A. syriaca | 24 | 3.1 | 103 | 13.4 |
| A. tuberosa | 21 | 6.4 | 11 | 3.4 |
| A. verticillata | 38 | 1.2 | 11 | 0.4 |
| A. viridiflora | 5 | 10.5 | 7 | 14.7 |
| Total | 142 | | 170 | |

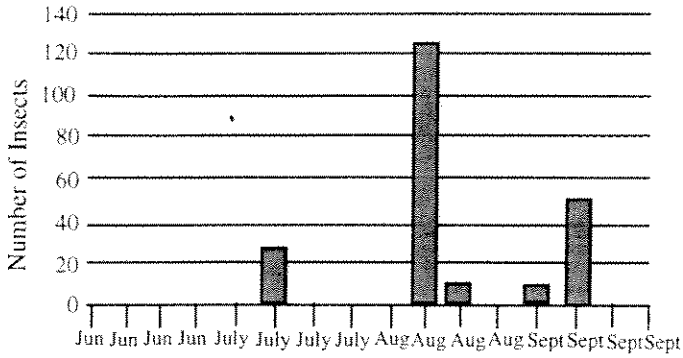


**Figure 1.** Weekly abundance of *Lygaeus kalmii* on *Asclepias tuberosa*, adjusted as in text.

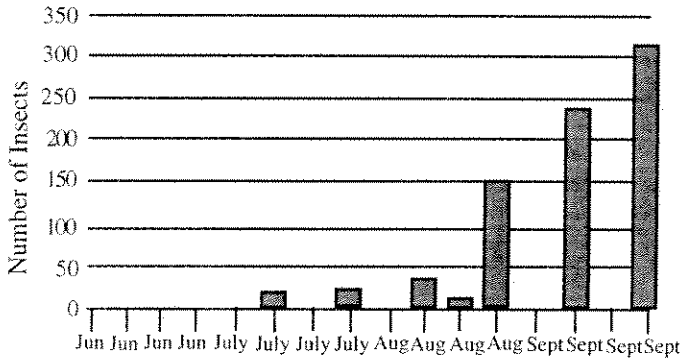


**Figure 2.** Weekly abundance of *Oncopeltus fasciatus* on *Asclepias incarnata* and *A. syriaca*, adjusted as in text.

the pods. Pods that are infested are peppered with hardened plugs of milky juice, sealing the holes produced by the insertion of the herbivores' beaks. Except for the seeds in a relatively few pods eaten by the clusters of nymphs on them, this herbivore causes little damage to the host stem and its crop of seed.

**Beetles (Coleoptera)**

**Common milkweed beetle** (*Tetropes tetrophthalmus* Forster) and **western milkweed beetle** (*T. femoratus* Leconte).

The adults of *T. tetraophthalmus* are red with four black spots on the pronotum and two pairs of black spots and one pair of vertical bars on outer edge of the elytra. The adults of the similar *T. femoratus* differ from the former species in having gray rings around the antennal segments and lack the vertical black marks on their elytra.

A third species of this genus, *T. quinquemaculatus* Haldeman, is also found in this region, but was not observed in this study. This species can be distinguished from *T. tetraophthalmus* by its lack of anterior elytral spots, its slightly annulated antennae, and the coarse elytral punctures. The nonelevated thoracic umbone will at once separate it from *T. femoratus*. (Chemsak 1963).

Adults of *T. tetraophthalmus* were found on 8 of the 12 milkweed species, showing a preference for A. purpurascens (19.5 specimens/1000 stems) and *A. syriaca* (19.4/1000) (Table 3). Price and Willson (1979) also observed adults of this species on *A. incarnata*. More than 80% of the specimens were found on the leaves (Table 8). Specimens were first observed during the second week in June and increased to a peak during the first week in July with the last specimens found during the third week in August (Figure 3).

*T. femoratus* was a much more rarely observed beetle in this study compared to *T. tetraophthalamus*. Thus, 18 observations of *T. femoratus* were made compared to 175 observations of *T. tetraophthalmus*. The adults of *T. femoratus* were found on 8 of the 12 milkweed species studied, showing a preference for a number of milkweed species, especially those that are rather uncommon. These include *A. lanuginosa* (1.1 specimens/1000 stems), *A. meadii* (1.6/1000), *A. hirtella* (1.9/1000), and *A. viridiflora* (2.1/1000) (Table 3). More than 94% of the specimens observed were found on the leaves (Table 8). This species is found much later than *T. tetrophthalmus*. The first specimens were observed during the third week in August and had a peak during the fourth week of August. Specimens last observed were found during the fourth week in September (Figure 4).

The adults of these three species feed first upon the smaller, younger more tender leaves at the upper extremity of the host plants. Feeding first at the tip of a blade, they eat holes a quarter- to three-quarters of an inch from the end of the leaf. Frequently, they may devour all the leaf tissue to the end of the blade, leaving a large U-shaped gouge at the extremity. The flower buds are fed upon as they begin to appear, and finally the emerged flowers themselves are devoured.

Since the grubs are root borers, the females lay their eggs at the base of milkweed stems. In one study, one-fourth of the larvae were found boring into the centers of *A. syriaca* roots (Williams 1941). Depending on their number and the species of milkweed host, they can do considerable damage to the stems. During the course of this study, many stems of *A. syriaca* and *A. meadii* were found dying back and even dead in the middle of the growing season. These were presumed to have been attacked by these boring grubs.

**Milkweed leaf-eating beetle** (*Labidomera clivicollis* (Chrevolat)

The adults of this species are robust in size and convex in

**Table 3.** Number of *Tetraopes tetraophthalmus* and *T. femoratus* adults found on *Asclepias* species.

| Asclepias Spp. | T. tetraophthalamus No.of Insects Observed on | T. tetraophthalamus No.of Insects per 1000 Stems | T. femoratus No.of Insects Observed on | T. femoratus No.of Insects per 1000 Stems |
|---|---|---|---|---|
| A. amplexicaulis | 1 | 1.1 | 0 | --- |
| A. exaltata | 1 | 2.2 | 0 | --- |
| A. hirtella | 1 | 1.6 | 1 | 1.9 |
| A. incarnata | 0 | --- | 2 | 0.8 |
| A. lanuginosa | 1 | 0.5 | 2 | 1.1 |
| A. meadii | 3 | 4.8 | 1 | 1.6 |
| A. purpurascens | 9 | 19.5 | 0 | --- |
| A. sullivantii | 6 | 1.5 | 1 | 0.3 |
| A. syriaca | 149 | 19.4 | 9 | 1.4 |
| A. tuberosa | 0 | --- | 1 | 0.3 |
| A. verticillata | 2 | 0.1 | 0 | --- |
| A. viridiflora | 2 | 4.2 | 1 | 2.1 |
| Total | 175 | | 18 | |

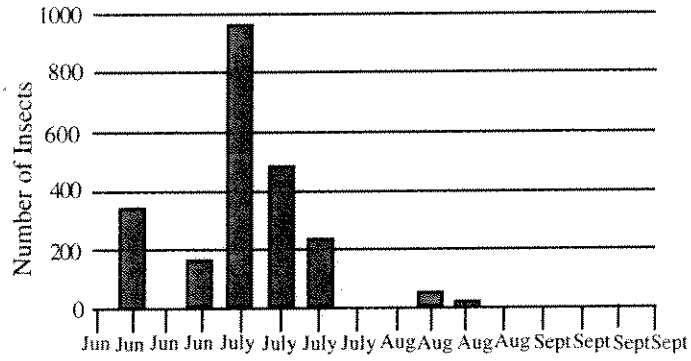


**Figure 3.** Weekly abundance of *Tetraopes tetraophthalmus* on *Asclepias purpurascens* and *A. syriaca*, adjusted as in text.

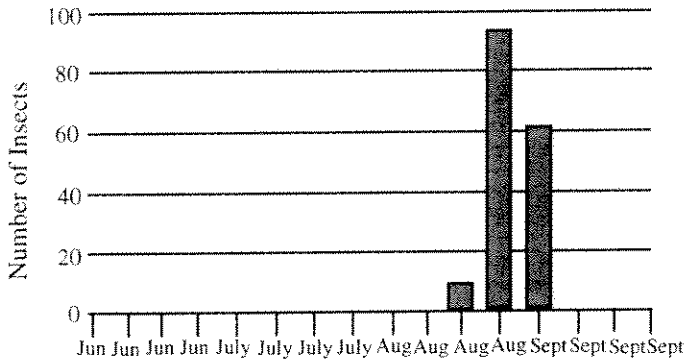


**Figure 4.** Weekly abundance of *Tetraopes femoratus* on *Asclepias syriaca*, adjusted as in text.

shape. Their head and pronotum are dark bluish black. The elytra are reddish yellow with black markings. The grubs are hump-backed, have a black head, and are slightly pinkish in color.

The adults were found on 5 of the 12 milkweed species studied, showing a preference for A hirtella (4.7 specimens/1000 stems) and *A. incarnata* (4.2/1000) (Table 4). This species was also reported to be very frequent on *A. exaltata* (Wilbur 1976). Seventy-eight percent of the specimens observed were on the leaves with most of the others found on the flowers (Table 8). This species is found throughout the summer from the second week in June to the fourth week in September (Figure 5).

Both adults and grubs can be found together feeding on the leaves. Unless they are especially numerous, they usually cause little damage to the plant.

**Common milkweed stem weevil** (*Rhyssematus lineaticollis* (Say)

The adults of this species are short, oval, and robust. They are black having a thorax with sides subparallel near the base and marked with strigae that are not oblique and nearly parallel with the medium line. The grubs are white with brown heads.

A second species, *R. annectans* (Casey), is of rare occurrence and was not observed during this study. It is primarily an eastern species near the end of its range in the Chicago area. It differs from *R. lineaticollis* in being slightly smaller, has a thorax with sides converging from base to apex, and is marked with more or less oblique strigae that converge toward the middle.

**Table 4.** Number of *Labidomera clivicollis* and *Rhyssematus lineaticollis* adults observed on *Asclepias* species.

| Asclepias Spp. | Labidomera clivicollis No.of Insects Observed on | Labidomera clivicollis No.of Insects per 1000 Stems | Rhyssematus lineaticollis No.of Insects Observed on | Rhyssematus lineaticollis No.of Insects per 1000 Stems |
|---|---|---|---|---|
| A. amplexicaulis | 0 | --- | 0 | --- |
| A. exaltata | 0 | --- | 2 | 4.5 |
| A. hirtella | 3 | 4.7 | 0 | --- |
| A. incarnata | 12 | 4.2 | 0 | --- |
| A. lanuginosa | 0 | --- | 0 | --- |
| A. meadii | 0 | --- | 2 | 3.2 |
| A. purpurascens | 0 | --- | 2 | 4.3 |
| A. sullivantii | 0 | --- | 0 | --- |
| A. syriaca | 10 | 1.3 | 8 | 1.0 |
| A. tuberosa | 2 | 0.6 | 1 | --- |
| A. verticillata | 34 | 1.1 | 0 | --- |
| A. viridiflora | 0 | | 0 | --- |
| Total | 60 | | 15 | |

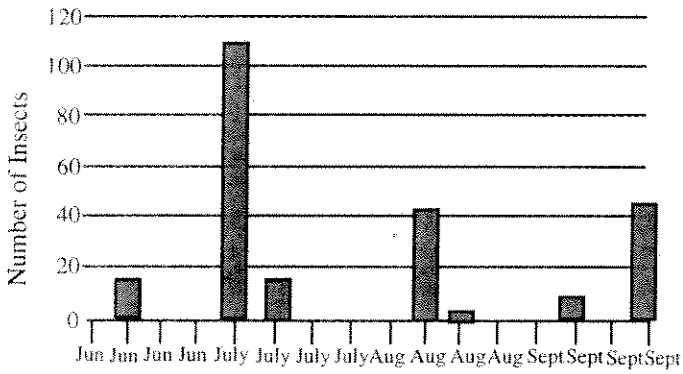


**Figure 5.** Weekly abundance of *Labidomera clivicollis* on *Asclepias verticillata*, adjusted as in text.

Adults of this species were found on 4 of the 12 milkweed species studied, showing a preference for *A. exaltata* (4.5 specimens/1000 stems) and *A. syriaca* (4.3/1000) (Table 4). In addition, Wilbur (1976) found adults on *A. incarnata, A. tuberosa, A. verticillata*, and *A. viridiflora*. In another study, adults were reported on *A. amplexicaulis* (Price and Willson 1979). Over 90% of the specimens observed were on the stems (Table 8). This species was observed from the end of June to the end of August. The peak is during the first week in June. (Dailey et al. 1978).

The adults are nocturnal and are more likely to be seen after sundown feeding and ovipositing on the stems. When exposed to light they drop to the ground and are difficult to find. The few that are found on the plant during daylight hours are usually observed hiding under the leaves or deep among the flowers of the umbel. During the day most hide in the duff and soil around the milkweed stem.

The grubs were found feeding in the pith of milkweed stems producing a black frass within the center of the stem. There can be up to 26 grubs in a stem. With large numbers, the entire stem can be hollowed out starting from almost the tip of the stem down to the beginning of the root. The grubs, however, do not feed on the roots.

The stems that are hosts to the grubs have vertical slits elongated along the stems produced by adults or ovipositing females. These vertical slits, which are between 1-3 mm long, are slightly opened with dried whitish gray exudate on their periphery sometimes extending down the stem. There can be up to six or seven of these slits on a stem.

Grubs do not pupate within the stems of the host but rather in the soil. They exit the stems presumably through the vertical openings or wounds. The winter is passed in the pupal stage. The adults emerge during the spring and early summer of the following year.

In order to verify the species identity of grubs found in the stems of A. syriaca, the following procedure was carried out. 1) The stems containing full-grown grubs were carefully cut during the third week of July and placed in a bottle of water to prevent wilting. 2) aluminum foil was then placed over the top of the bottle and

around the stems. This was to prevent the grubs from falling into the water and drowning. 3) The bottle in turn was placed in an empty aquarium tank to prevent the grubs from escaping if and when they left the interior of the stem. Within a few days most of the grubs had left the stems and fallen into the dry empty tank. They appeared to be very agitated and incessantly crawled around the bottom in an effort to get out. 4) They were then easily collected and placed in a jar with moist earth, into which they bored and pupated. Within four weeks adults were found in the soil and were identified as *Rhyssematus lineaticollis*. These studies were repeated for three consecutive years.

Unless grubs are present in large numbers in the thicker stemmed milkweed species, such as A. sy*riaca*, they cause very little damage to the plant. It appears that they feed mostly on the pith and do not injure the conducting tissues. However, with some of the thinner stemmed milkweeds, such as *A. meadii* and *A. quadrifolia*, grubs feeding in the stem can so weaken the stem as to cause it to collapse with its flower umbels and a large portion of the stem with leaves. Some of this damage may also be caused by the adults puncturing the stem either in feeding or in ovipositing. Approximately 3% of the single terminal umbels of *A. meadii* are toppled in this way.

**Butterflies and Moths (Lepidoptera)**

**Monarch butterfly** *(Danaus plexippus* (L.)
This species belongs to the Danaidae or monarch butterflies. Both the adult and larva are familiar to most people. The adults feed on nectar and cause no harm to the plant. They are minor pollinators of *A. incarnata* and *A. tuberosa* (Betz et al. 1994).

Larvae of this species were found on 8 of the 12 milkweed species studied, showing a preference for *A. syriaca* (4.0 specimens/1000 stems) and to a lesser extent for *A. tuberosa* (3.4)/1000 and *A. sullivantii* (3.5/1000) (Table 5). Larvae were also reported on *A. viridiflora* (Wilbur 1976) and on *A. amplexicaulis* (Price and Willson 1979). Over 84% of the larvae were observed on the leaves (Table 8). Few of these appear in June but most appear during the third week of August. The last specimens were seen during the second week in September (Figure 6).

The larvae of this species feed principally on leaves, but will also eat buds and flowers. Usually there is only one larva to be found on a stem; however, infrequently a number of larvae of the same or different instars can be found feeding on the same stem. Since the larvae have ravenous appetites they can cause considerable damage if they are numerous on a stem. Larvae are especially damaging to some of the smaller species of milkweed,

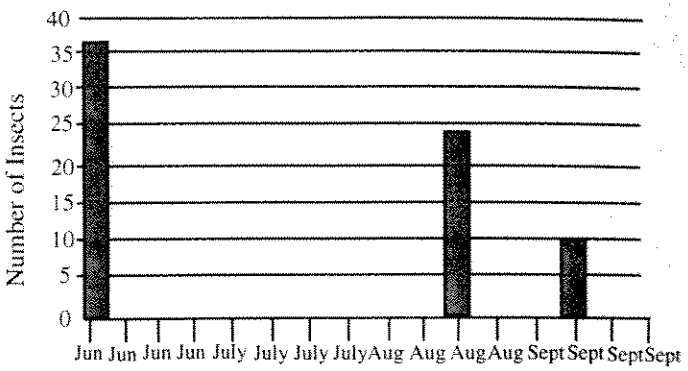


**Figure 6.** Weekly abundance of *Danaus plexippus* on *Asclepias sullivanti* and *A. syriaca*, adjusted as in text.

such as *A. meadii* and *A. quadrifolia*. There is a tendency for eggs to be laid on younger plants. Two or three first instars can wreak havoc in a flat of milkweed seedlings.

**Orange-margined milkweed moth** (*Cycnia tenera* Hubner)
This species is a member of the Arctiidae. Formerly, it was known as *Pygarctia eglenensis*. The adult, which is seldom collected, is a relatively small dull yellow grayish moth with black dorsal and lateral spots on its abdomen. The easily recognized larva is hairy with a deep reddish brown color and an orange head. It is easily detected as it feeds on the leaves of milkweed. They are very conspicuous in clones of *A. verticillata*.

Larvae of this species were observed on 8 of the 12 milkweed species studied, showing a preference for *A. purpurascens* (8.7 specimens/1000 stems) (Table 5). Larvae were also reported on *A. incarnata* (Price and Willson 1979). Forty-five percent of these specimens were observed on the leaves, and 27.5% on the flowers (Table 8). A few specimens were first seen during the second week in June, and the largest number observed during the second week of August. The last specimen was observed during the second week of September (Figure 7).

The larvae feed on the leaves of milkweeds. Since there is usually only a single individual to a plant, they cause very little damage.

**Harlequin caterpillar moth, milkweed tussock moth** (*Euchaetias egle* (Drury)
This species is also a member of the Arctiidae. Like *Cycnia tenera*, the adult is rarely collected. Its wings are of a dull grayish color and the body is light orange with black dots on its dorsal surface. Its larvae are conspicuously colored with tufts of black and orange hairs projecting from their bodies; their heads are black. Larvae of this species were found on 2 of the 12 milk-

**Table 5.** Number of *Danaus plexippus* and *Cyncia tenera* larvae observed on *Asclepias* species.

| Asclepias Spp. | Danaus plexippus No.of Insects Observed on | Danaus plexippus No.of Insects per 1000 Stems | Cycnia tenera No.of Insects Observed on | Cycnia tenera No.of Insects per 1000 Stems |
|---|---|---|---|---|
| A. amplexicaulis | 0 | --- | 0 | --- |
| A. exaltata | 0 | --- | 0 | --- |
| A. hirtella | 0 | --- | 0 | --- |
| A. incarnata | 5 | 1.8 | 0 | --- |
| A. lanuginosa | 2 | 1.1 | 2 | 1.1 |
| A. meadii | 1 | 1.6 | 2 | 3.2 |
| A. purpurascens | 1 | 2.2 | 4 | 8.7 |
| A. sullivantii | 14 | 3.5 | 1 | 0.3 |
| A. syriaca | 31 | 4.0 | 6 | 0.8 |
| A. tuberosa | 11 | 3.4 | 7 | 2.1 |
| A. verticillata | 3 | 0.1 | 34 | 1.1 |
| A. viridiflora | 0 | --- | 2 | 4.2 |
| Total | 68 | | 58 | |

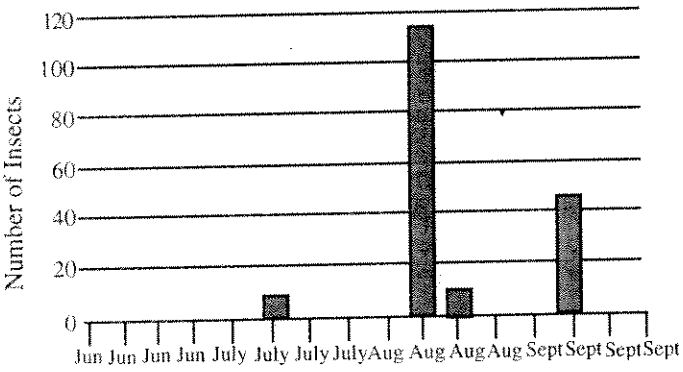


**Figure 7.** Weekly abundance of *Cycnia tenera* on *Asclepias purpurascens* and *A. viridiflora*, adjusted as in text.

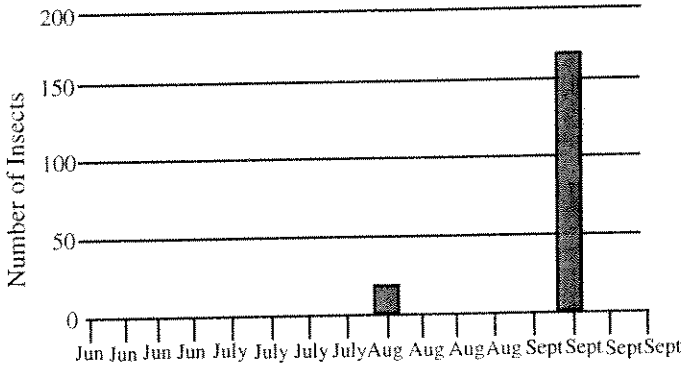


**Figure 8.** Weekly abundance of *Euchaetias egle* on *Asclepias syriaca*, adjusted as in text.

weed species studied, showing a preference for *A. exaltata* (51.2 specimens/1000 stems) and *A. syriaca*a (22.1 specimens/1000 stems) (Table 6). Larvae were also observed on *A. incarnata* (Price and Willson 1979). All of these larvae were found on the undersides of the leaves in tightly knit clusters of about a dozen or more individuals (Table 8). Few specimens were found during the first week of August; the peak population occurred during the second week of September (Figure 8).

The larvae feed on the leaves; whereas, the adults feed on flower nectar. There are two broods per season. Damage caused by the larvae depends on the number present. A few cause very little damage to a stem. However, large numbers can cause severe damage to the stem. A cluster of approximately 50 caterpillars on a mature milkweed stem will completely defoliate and skeletonize a stem down to the root.

It is interesting to note that occasionally isolated specimens of this species were observed on the leaves of dogbane (*Apocynum sibiricum*).

## Flies (Diptera)

**Milkweed leaf-miner fly** (*Liriomyza asclepiadis* Spencer)

The maggot of this tiny fly feeds on the mesphyll tissue of leaves leaving only the upper and lower epidermal tissues to form the characteristic transparent bloche mines (Spencer 1986).

Neither the maggot nor the adult fly was found. The oval-shaped blotched mines produced by these larvae were found on 3 of the 12 milkweed species—*A. purpurascens*, *A. sullivantii*, and *A. syriaca*. The maggots showed a preference for *A. syriaca* with mines being found on 14.7/

**Table 6.** Number of *Euchaetias egle* larvae observed on *Asclepias* species.

| Asclepias Spp. | Euchaetias egle No.of Insects Observed on | No.of Insects per 1000 Stems |
|---|---|---|
| A. amplexicaulis | 0 | ---- |
| A. exaltata | 23 | 51.2 |
| A. hirtella | 1 | 1.6 |
| A. incarnata | 0 | ---- |
| A. lanuginosa | 0 | ---- |
| A. meadii | 0 | ---- |
| A. purpurascens | 0 | ---- |
| A. sullivantii | 1 | 0.3 |
| A. syriaca | 162 | 21.1 |
| A. tuberosa | 0 | ---- |
| A. verticillata | 0 | ---- |
| A. viridiflora | -0 | ---- |
| Total | 187 | |

1000 stems. Mines were also observed on *A. amplexicaulis*, and *A. incarnata* (Price and Willson 1979).

The larvae of this species cause minimal damage to the leaves.

**Aphids (Homoptera)**

There are five species of aphids commonly associated with milkweeds. Colonies of them are found on the upper parts of the plant where they feeding on young stems and leaves by piercing them with their beaks and then sucking the sap. The removal of sap damages the plant cells, causing a characteristic curling and deformation of the leaves and stems. In severe infestations, the upper parts of the plant are killed. Aphids are especially preyed upon by the larvae and adults of ladybird beetles, lacewing larvae, and syrphid fly maggots. A characteristic ladybird beetle, closely associated with aphids on milkweeds, is *Brachacantha ursina* Fabricus.

It would have been time consuming to check each milkweed stem in order to observe the few isolated aphids that might be on it. For that reason, a colony of approximately 50 to 100 individuals, which could be easily seen, was taken to be the unit in this study (Dichtl 1967).

The peak of aphid infestation occurred during June. Only 4 of the 12 milkweed species studied were parasitized by aphid colonies. They were: *A. syriaca* (12.9% of the plants during June), *A. sullivantii* (6.6%) *A. viridiflora* (1.0%), and *A. hirtella* (0.5%).

**Yellow milkweed or oleander aphid** (*Aphis nerii* Boyer de Fonscolombe), formerly as (*A. asclepiadis* Fitch).

Colonies of this aphid were found on 4 of the 12 milkweed species studied and were easily seen because of their bright yellow color covering the upper leaves, stems, and pods. There is a preference for *A. incarnata* (10.6 colonies/1000 stems), *A. hirtella* (7.8/1000), *A. sullivantii* (7.5/1000) and *A. syriaca* (6.8/1000) (Table 7).

Large colonies of this aphid are sometimes found on *A. incarnata* and *A. hirtella*, covering the upper parts of the stem, causing extensive damage to the growing tip, leaves, and pods.

**Black aphid** (*Aphis rumicis* L.)
Colonies of this aphid were found on the upper parts of 2 of the 12 milkweed species studied. They were A. *sullivantii* (1.2 colonies/1000 stems) and *A. syriaca* (1.3/1000) (Table 7). This aphid may cause severe damage to the upper parts of stems, resulting in severe distortion of the leaves and stem.

**Green peach aphid** (*Myzus persciae* Sulzer).
Colonies of this aphid were found on the upper parts of 3 of the 12 milkweed species studied with most found on *A. syriaca* (3.5 colonies/1000 stems) (Table 7).

This species is usually found in a mutualistic relationship with certain species of ants. The aphid produces a sugary, energy-rich liquid called honeydew on which the ants feed. The ants in turn protect the aphids from predatory insects. This aphid is very common on many garden and crop plants and is involved in the transfer of plant viral diseases.

**Cotton** or **melon aphid** (*Aphis gossypii* Glover).
Colonies of this small green aphid with dark cornicles were found on the upper parts of 2 of the 12 milkweed species studied, with most found on *A. exaltata* (Table 7). This species is common on many garden and crop plants.

**Red aphid** (*Macrosiphum redbeckiae* Fitch).
Colonies of this relatively large red aphid were found on the upper parts of *A. syriaca* (0.5 colonies/1000). It is common on wild golden glow (*Rudbeckia laciniata*), a plant of shaded or partly shaded flood plains found along streams and rivers (Table 7).

**Thrips (Thysanoptera)**

Thrips are minute, slender-bodied insects (0.5–5.0 mm in

**Table 7.** Number of aphid colonies (50–150 individuals) observed on *Asclepias* species.

| Asclepias | *Aphis nerii* (yellow milkweed or oleander aphid) No.of Colonies Observed on | *Aphis nerii* (yellow milkweed or oleander aphid) No.of Colonies per 1000 Stems | *Aphis gossypii* (cotton or melon aphid) No.of Colonies Observed on | *Aphis gossypii* (cotton or melon aphid) No.of Colonies per 1000 Stems |
|---|---|---|---|---|
| A. exaltata | 1 | 2.2 | 1 | 7.0 |
| A. hirtella | 5 | 7,8 | 0 | --- |
| A. incarnata | 30 | 10.6 | 0 | --- |
| A. sullivantii | 30 | 7.5 | 0 | --- |
| A. syriaca | 52 | 6.8 | 1 | 0.9 |
| A. viridiflora | 0 | --- | 0 | --- |
| Total | 118 | | 2 | |

| | *Aphis rumicis* (black aphid) | | *Myzus persciae* (green peach aphid) | |
|---|---|---|---|---|
| A. exaltata | 0 | --- | 0 | --- |
| A. hirtella | 0 | --- | 0 | --- |
| A. sullivantii | 5 | 1.2 | 8 | 2.0 |
| A. syriaca | 13 | 1.7 | 45 | 5.9 |
| A. tuberosa | 1 | 0.3 | 0 | --- |
| A. viridiflora | 0 | --- | 1 | 2.1 |
| Total | 19 | | 54 | |

| | *Macrosiphum rudbeckiae* (red aphid) | |
|---|---|---|
| A. exaltata | 0 | --- |
| A. hirtella | 0 | --- |
| A. sullivantii | 0 | --- |
| A. syriaca | 4 | 0.5 |
| A. viridiflora | 0 | ---- |
| Total | 4 | |

**Table 8.** Parts of plant on which insects were observed.

| Insect Species | Leaves % on | Stems % on | Flowers % on | Pods % on | Roots % on |
|---|---|---|---|---|---|
| Cycnia tenera (larvae) | 45.0 | 5.0 | 27.5 | 15.0 | 0.0 |
| Danaus plexippus (larvae) | 84.5 | 10.3 | 3.4 | 3.4 | 0.0 |
| Euchaetias egle (larvae) | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Labidomera clivicollis (a/l) | 78.0 | 0.0 | 22.0 | 0.0 | 0.0 |
| Lygaeus kalmii (a/n) | 20.0 | 7.7 | 9.2 | 63.0 | 0.0 |
| Oncopeltus fasciatus (a/n) | 10.7 | 4.0 | 10.0 | 75.0 | 0.0 |
| Rhyssematus lineaticollis (a) | 4.5 | 90.1 | 4.5 | 0.0 | 0.0 |
| Rhyssematus lineaticollis (l) | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 |
| Tetraopes femoratus (a) | 94.2 | 0.0 | 0.0 | 5.9 | 0.0 |
| Tetraopes femoratus (l) | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| Tetraopes tetraophthalmus (a) | 80.2 | 4.6 | 20.9 | 0.0 | 0.0 |
| Tetraopes tetraophthalmus (l) | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |

*a= adult; l= larva; n= nymph

length) with four wings. These wings are long and narrow, with few or no veins, and fringed with long hairs. The nymphs are wingless. They have a piercing proboscis or beak with which they suck plants juices.

**Eastern flower thrip** (*Frankliniellia tritici* (Fitch). These tiny slender yellow and orange thrips, which can be seem with a hand-lens, were found among the flower umbels of *A. syriaca*. They were also seen on the flowers of *A. meadii*. Because of their small size and low numbers, they cause very little damage to mature milkweed plants. However, they can damage young milkweed seedings as shown by the curl and distortion of the leaves.

## DISCUSSION

### Less Abundant *Asclepias* Herbivores

There were other insects that were occasionally found on milkweeds. *Lygaeus bicrusis*, a relatively small hemipteran, was found once on *A. purpurascens* flowers and once on the flowers of *A. syriaca*. A forked-tailed bush katydid (*Scudderia furcata* Brenner) was found feeding on the flowers of *A. amplexicaulis*. A number of individuals of a small weevil species (*Gymnetron tetrum* (Fabricus) were found among the flowers of *A. syriaca*.

Occasionally, other insect herbivores associated with milkweeds are reported in the literature. They include (a) the mirid or plant-eating bugs *Ilnacora divisia* (Knight) and *Macrolophus brevicornis* (Fieber); (b) the chrysomelid leaf-eating beetles *Babia quadrigutta* (Olivier) and milkweed tortoise beetle *Chelymorpha cassidea* (Fabricus); and (c) the melloid blister beetle *Epicauta vittata* (Fabricus). Although 132 species of beetles (*Coleoptera*) have been collected on *A. syriaca* (Dailey et al. 1978), most of these species were not obligate milkweed herbivores. Some were predators feeding on milkweed herbivores, such as the milkweed ladybird beetle (*Brachyacantha ursina*). Others were general feeding herbivores, and still others were just perched on the milkweed.

### Warning Coloration of *Asclepias* Herbivores

Many milkweed herbivores are brightly colored in black and orange/yellow. It has been theorized that the reason for this coloration is that these colors are aposematic, that is, they convey a warning to predators, especially birds, that their potential prey is bad-tasting or even poisonous. This toxicity is due to the cardiac glycosides which have been obtained by insects from feeding on milkweeds. The tight orange and black clusters of the harlequin caterpillars (*Euchaetias egle*) observed hiding under milkweed leaves and the clusters of the large milkweed bug nymphs (*Oncopeltus fasciatus*) found on pods are probably an attempt to maximize the use of these aposematic colors.

It is interesting to note that the adult common milkweed stem weevil (*Rhyssematus lineaticollis*) is all black with no red or orange markings. It would seem that this is related to the fact that the weevil tends to be nocturnal and receives little or no benefit in having aposematic colors.

### Populations and Herbivore Preferences

It is probable that some herbivore preferences are based the on need to provide an adequate food supply for their developing young. For this reason, it is important that females oviposit on potential host plants that can support relatively large healthy populations of offspring. For the common milkweed weevil (*Rhyssematus lineaticollis*) this means ovipositing on the thicker stemmed milkweeds, such as *A. amplexicaulis, A. exaltata, A. purpurascens, A. sullivantii*, and *A. syriaca*. These produce relatively large amounts of pith on which the grubs feed. To oviposit on the thin-stemmed milkweeds with small amounts of pith, such *A. meadii* and *A. quadrifolia*, can at best result in a stunted grub or two.

This is probably also true for the milkweed long-horned boring beetles (*Tetraopes tetropthamus* and *T. femoratus*) for which is it necessary for the females to lay their eggs at the base of a large robust milkweed species having thick roots. It is interesting to note that the three specimens of *T. tetraopthalmus* adults observed on *A. meadii* were all small-sized, which no doubt was caused by the relatively small food supply of the root-stock on which the grubs had fed.

In many cases, it is difficult to draw conclusions on the reasons for the preferences shown by the milkweed herbivores for host plants. This is in part due to 1) the low populations of herbivores, 2) the fragmentation of the herbivore populations, and 3) the large variations in the populations of the species of milkweeds and their fragmentation.

In general, the mean populations of most species of herbivores observed in this study were low, i.e., approximately 2 to 7 specimens per 1000 stems. These numbers are somewhat lower than those reported by Price and Willson (1979). Also these mean populations for milkweed herbivores are much lower than many of the mean populations of herbivores reported for many other genera of plants. For example, the chrysomelid beetle *Trirhabda canadensis* (Kirby) produces large populations on tall goldenrod (*Solidago altissima*) in which almost every stem carries enough beetles to cause considerable damage to the leaves (personal observations).

Not only are the populations of these milkweed herbivores low, they are not uniform in their distribution. While there were some widely scattered specimens, there was a tendency for clusters of them to occur locally or in isolated pockets. This was especially true of insects, such as the aphids. A few isolated clones of *A. syriaca* would have a large proportion of the stems and upper leaves covered with green peach aphids (*Myzus persicae*); whereas, the majority of *A. syriaca* had few or none at all. The same was true of the milkweed aphid (*Aphis nerii*) on *A. incarnata* and *A. syriaca*. The clones of *A. syriaca* with stems infested with the larvae of the common milkweed weevil (*Rhyssematus lineaticollis*), and clones of *A. syriaca* with leaves which were hosts to the milkweed leaf miner fly (*Liriomyza asclepiadis*) were similarly localized.

In this study, over 35,000 stems of 12 species of Asclepias were observed for the presence of insect herbivores. The number of stems observed were not divided equally among these 12 species. Rather 92% of the stems observed belonged to four species: 1) common milkweed (*A. syriaca*), 2) whorled milkweed (*A. verticillata*), 3) prairie milkweed (*A. sullivantii*), and 4) butterfly weed (*A. tuberosa*). This disparity was not planned, but represents the populations available for study.

Present populations do not necessarily represent former relative abundance. Because of the widespread disturbance of natural habitats, a few species, such as A. syriaca, are probably more common today than they were in presettlement times. *A. syriaca* is especially abundant in waste places, old fields, agricultural fields, railroad rights-of-way, and even thickets. It is the common milkweed in the majority of studies on milkweeds. It would have been easily possible for *A. syriaca* to account for 95% of the plant stems observed. This would have modified the data in comparison to what they may have been in the past. During this study many large clones of *A. syriaca* were deliberately not observed because time was better spent searching for the rarer milkweed species with herbivore populations. All 18 of the herbivores of this study were observed on *A. syriaca*. None of the other 11 milkweed species came close to having this number of herbivores.

In presettlement times it is quite possible that *A. syriaca* may have been less abundant in climax or near-climax communities where disturbance was probably at a minimum. Other, now rarer species, such as, *A. exaltata, purpurascens, A. sullivantii,* and even the prairie-restricted *A. meadii*, were undoubtedly more abundant and provided more of the food source for many of the milkweed herbivores.

An interesting observation was made when 6 specimens each of 15 species of milkweeds (all 12 of the ones included in this paper, plus A. ovalifolia, *A. perennis, A. quadrifolia* and *A. variegata*) were grown from seeds and planted in the same plot next to one another. When a few specimens of common milkweed weevils (*Rhyssematus lineaticollis*) were observed in this milkweed colony of mixed species, they were feeding and ovipositing on *A. purpurascens* and not on *A. syriaca* (personal observation). This suggests that patterns of feeding and egg laying in the past may have been different from today for some herbivores.

**The Life History of Milkweed Weevils**

The discrepancies in the life histories of milkweed weevils (*Rhyssematus spp.*) need to be resolved. In this study, the larvae of *R. lineaticollis* were found feeding on the pith within milkweed stems, leaving the stem to pupate and metamorphose in the ground. This observation is in accord with the results of Wilbur (1976).

Notwithstanding this fact, most reports in the literature have the larvae of *Rhyssematus lineaticollis* feeding on developing seeds in the pods of *A. amplexicaulis* (Price and Willson 1979), *A. quadrifolia* (Chaplin and Walker 1982), *A. syriaca* (Weiss and Dickerson 1921), *A. incarnata* (Webster 1889–890), and several species of *Asclepias* (Blatchley 1916). In this regard, it should be noted that when 1672 pods belonging to 18 species of *Asclepias* spp. were opened and studied, none contained any weevil larvae (Betz and Lamp 1992).

One explanation is that the two species, *R. lineaticollis* and *R. annectens* have different life histories. This study indicates that *R. lineaticollis* has one generation a year. The grubs feed on pith within the milkweed stems of a number of *Asclepias* species. When fully developed they leave the stem, burrow into the ground, and pupate. The following June the adults leave the ground, mate, and begin another generation.

On the other hand, *R. annectens* has two generations a year and is associated only with *A. incarnata* and/or *A. incarnata pulchra*. The grubs of the first generation feed in the stem like the those of *R. lineaticollis*, but pupate within the stem rather than the ground. The adults of this first generation then oviposit in the developing folicles (pods) with the grubs feeding on the developing seeds. Afterwards the grubs leave the pods and pupate in the ground to form the adults for the following year (Weiss and Dickerson 1921).

A second explanation is that the species in question may have been misidentified. *R. lineaticollis* is recorded as breeding "in the seed pods of *Asclepias incarnata*, the larva feeding upon the seeds and transforming to the adult in late autumn" (Webster 1889–1890). However, Weiss and Dickerson (1921) noted that *Rhyssematus lineaticollis* of Webster "may possibly refer to *Rhyssematus annectans* Casey, a related species which we have found breeding in

the seed pods of *Asclepias pulchra (incarnata)*." In this same paper the species which they called *R. annectans* was observed only on *A. pulchra* and had two generations per year. The larvae of the first generation fed in the stems; the larvae of the second generation fed on the seeds in pods. During this second generation, "the larvae feed on the developing seeds usually in the center of the mass and when full grown pupate in cells composed of frass, etc., in the middle basal portion of the seed cluster." During the first part of October many pupae were found. By this time all the infested pods had split open on one side exposing the seeds; the seeds however do not disperse being webbed up and held together. During the first ten days of October the beetles leave the infested seeds and disappear" (Weiss and Dickerson 1921).

A third explanation may be that some of the reports in the scientific literature that *R. lineaticollis* feed in the pods are wrong and are not backed up by more intensive life-cycle studies. Perhaps it may have been an originally flawed observational study that has been passed on through the years in various journals.

A fourth, but unlikely, explanation is that there actually may be a population of *R. lineaticollis* whose larvae feed in the pods.

## CONCLUSIONS

A better understanding of the relationships among insect herbivores and their milkweed hosts can be achieved by including a larger number of the rarer species of *Asclepias* species than is usually the case.

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