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THE BIOLOGY OF THE LESSER CLOVER LEAF WEEVIL *Hypera Nigrirostris* (Fab.) (Coleoptera: Curculionidae) IN OHIO

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OHIO AGRICULTURAL EXPERIMENT STATION

WOOSTER, OHIO

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The Biology of the Lesser Clover Leaf Weevil *Hypera Nigrirostris* (Fab.) (Coleoptera: Curculionidae) in Ohio

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INTRODUCTION

The lesser clover leaf weevil, *Hypera nigrirostris* (Fab.), is distributed throughout Europe, northern Africa, and western Asia Minor (Markkula and Tinnila, 1956), and has spread over the northern United States and southern Canada since its introduction in 1865 on the East Coast, and 1875 on the West Coast (Webster, 1909).

The lesser clover leaf weevil is a snout beetle of the family Curculionidae, subfamily Curculioninae, and tribe Hyperini. Fabricius described the weevil as *Curculio nigrirostris* in 1775, and since that time seventeen different generic, specific, and varietal names have been used (Titus, 1911). Germar, in 1817, proposed the genus *Hypera,* in which he placed nigrirostris. However, European workers refer to the lesser clover leaf weevil under *Phytonomus* Schonher (Markkula and Tinnila, 1955 and 1956). A more complete synonymy can be found in Titus (1911).

The habits of this weevil have caused it to be overlooked by many investigators, since the damage is inconspicuous. Often thought to be of little economic importance, this small curculionid is reported to have caused significant reductions in yield, especially of clover seed (MacNay, 1952).

The lesser clover leaf weevil is the smallest of five species of the same genus which attack forage. *Hypera postica* (Gyllenhal) and *H. brunneipennis* (Boh.) feed on alfalfa, *Medicago sativa; H. meles* (Fab.) and *H. nigrirostris* (Fab.) feed on red clover, *Trifolium pratense;* and *H. punctata* (Fab.) feeds on both plant species.

LIFE HISTORY

Equipment and Procedure

The rearing containers used in this study were assembled utilizing a water filled 125 ml Erlenmeyer flask as the base. A shoot of clover was placed with the excised stem in the water and with a cotton plug

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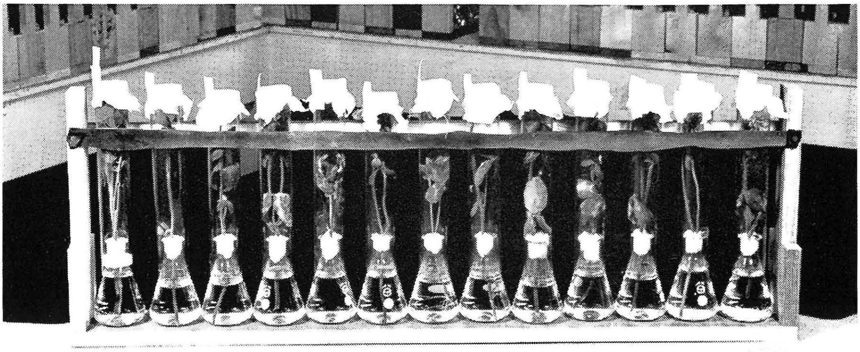

Fig. 1.—Cages used in the life history studies.

in the neck of the flask to prevent movement of beetles from the foliage down into the water. A glass cylinder was placed over the clover shoot and rested on the neck of the flask. The upper end of the cylinder was closed with cheesecloth and the cages were placed in a specially designed rack (Figure 1).

Every day a pair of weevils was placed in a container and all eggs were counted and recorded. When the eggs hatched, the larvae were counted as they were transferred to separate containers. The newly spun cocoons were removed to individual containers with a fresh shoot of clover. Upon emergence of the new adult, the sex was determined and it was placed on fresh clover.

Observations were made daily during 1961 to determine larval movement, color, feeding, and the duration of the stadia. These cages were kept in a rearing room held at approximately 80° F and 50 percent relative humidity.

Hibernation

Overwintering adults are reported by Detwiler (1923) to hibernate in ditches, fence rows, and wood lots. He also stated that the weevils hibernate among clover plants where debris has had an opportunity to collect. However, Markkula and Tinnila (1956) found weevils overwintering mainly in the red clover field. At Wooster, Ohio, adult weevils were observed to overwinter successfully in screened potted clover plants and in a small screened plot of clover. Eggs and resulting larvae were observed in these cages the next spring.

Thorough searching in clover fields, wood lots, fence rows, and leaf-filled ditches revealed that the majority of the weevils overwinter in clover fields, but some may also be found in adjacent ditches.

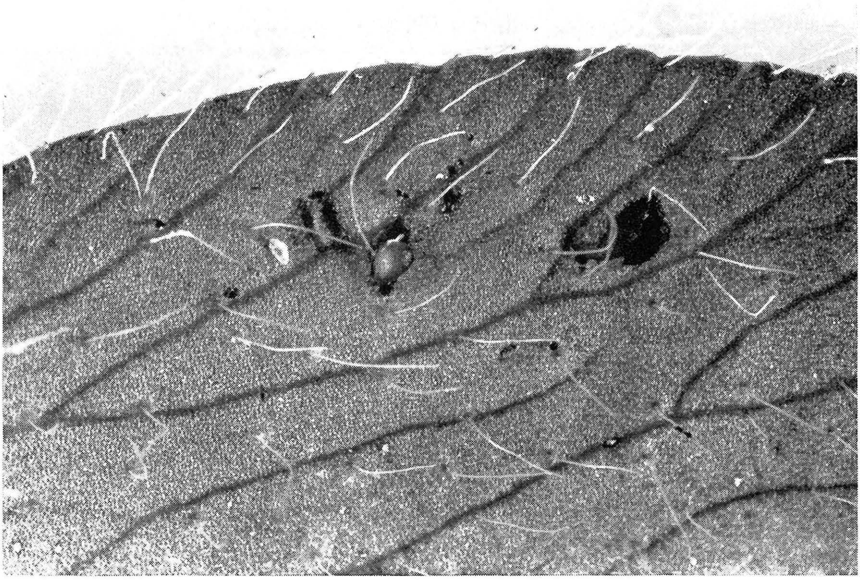

Fig. 2.—Lower surface of red clover leaflet showing oviposition punctures and one protruding egg (13X).

Occasionally, adults have been observed to fly in the spring and fall. Each year the first flight activity was observed at the end of March. However, no mass movements have been observed, and most of the weevils apparently crawl to new clover fields. Sticky board traps containing horizontal and vertical surfaces up to three feet above the ground did not yield more than an occasional lesser clover leaf weevil adult. These traps were established in a clover field during April and May.

Oviposition

Egg Location:

The lesser clover leaf weevil female lays eggs on or in the leaves, petioles, stipules, and stems of red clover. Figure 2 shows the lower surface of a red clover leaflet in which oviposition marks are present. In making an oviposition slit, the female first cuts into the epidermis with her mandibles. She then inserts her snout through the slit and eats a cavity in the parenchyma. During oviposition, some eggs may be forced between the epidermis and parenchyma on the upper or lower surface of the leaflet, irrespective of the point of oviposition. Eggs

TABLE 1.—Location of eggs of H. nigrirostris **on red clover plants under insectary conditions.**

Location	Number Observed	Percentage
Entire Leaf	666	55
Top of leaflet	208	17
Bottom of leaflet	279	23
Petiole	179	15
Stem	133	11
Stipule	403	34

may be pushed completely through the leaflet and protrude through the opposite side. When ovipositing in stems and petioles, the female deposits the eggs in the pith. These oviposition slits are often difficult to distinguish, even with magnification. Webster (1911), Parks (1920), Everly (1953), Johnson and Nettles (1953), and Goleman *et al.* (1954) also found eggs to be laid interepidermally in leaflets, in leafsheaths about growing stems, or in the bud of the axil of the leaf.

Houghton (1908) found eggs individually or in pairs, and Everly (1953) reported eggs were deposited individually during April. In Ohio, from one to seven eggs were found per oviposition site.

Table 1 presents the location of eggs on red clover plants examined during insectary rearings in 1960. Fifty-five percent of the eggs were deposited in the leaves (leaflets and petioles). Markkula and Tinnila (1956) reported that 99.49 percent of 4,000 eggs collected both from insectary rearings and in the field, were found in the leaflets. In this investigation only 40 percent of the 1,202 eggs observed were deposited in the leaflets proper. This may be due to the variety of red clover used or to the behavior of the weevil population under study.

Duration of Oviposition Period:

Oviposition, in 1960, was first observed when the daily mean temperature reached 50° F. This was approximately two weeks after the activity of adults was first observed. Once oviposition started, the critical mean temperature for egg-laying dropped to approximately 43° F per day. Markkula and Tinnila (1956) observed the daily mean temperature to be 15° C (59° F) on May 20, 1954, the first day of oviposition in Finland.

Everly (1953) stated that the oviposition period was during the month of April in Indiana, and Houghton (1908) reported that it

TABLE 2.—Egg production of H. nigrirostris **on red clover in the insectary during spring and summer of 1960.**

Female	Egg-Laying Period (days)	Days Eggs were Laid	Total Eggs	Eggs Per Day
A	10	6	35	5.8
B	2	2	4	2.0
C	44	16	55	3.4
D	45	25	149	6.0
E	30	6	24	4.0
F	59	26	179	6.9
G	13	13	127	9.8
H	46	8	30	3.8
J	21	11	65	5.9
K	42	20	86	4.3
L	57	44	332	7.5
M	0	0	0	0
N	52	34	166	4.9
P	43	16	101	6.3
Q	33	9	32	3.6
R	0	0	0	0
S	4	4	22	5.5
T	2	2	5	2.5
U	0	0	0	0
W	1	1	1	1.0
Averages*	29.6	14.3	83.1	4.9

*Non-ovipositing females disregarded.

occurred during May in Delaware. Hudson and Wood (1924) found the maximum period to extend for 16 days, from May 7 to May 23.

Markkula and Tinnila (1956) reported the egg-laying period in the insectary was from 35 to 54 days, averaging 47 days. In the present study, duration of the oviposition period in the insectary ranged from zero to 59, with a mean of 29.6 days (Table 2). Three females did not deposit any eggs in the insectary rearings. Although in 1960 and 1961, oviposition began the second week of April, in 1962 it began the last week of March. Oviposition ended on July 11, 1960, in the insectary but continued until approximately September 1, 1960 and 1961 in the field. This five-month oviposition period had its peak in the middle of April. Detwiler (1923) has reported newly laid eggs found as late as October 7. Oviposition occurred during both day and night in Ohio.

Egg

External Characteristics:

The eggs are pearly white when first laid (Figure 3), but have a light-green appearance when in contact with the plant. On the third

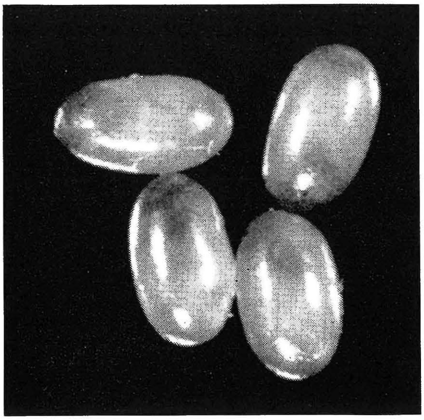

Fig. 3.—Lesser clover leaf weevil eggs (18X).

or fourth day, the eggs begin to turn gray, gradually becoming darker until one or two days before hatching, at which time the eggs are black. One-half to one day before hatching, the larva becomes visible through the egg wall, which has become transparent.

Detwiler (1923) and Markkula and Tinnila (1956), reported similar findings, but they stated that the blackening of the egg was due to the sclerotization of the head capsule of the larvae. This seems doubtful since the larvae is visible shortly before hatching, at which time the shell does not appear black, but rather semi-transparent.

Houghton (1908), Titus (1911), Detwiler (1923), and Markkula and Tinnila (1956) reported the eggs were regularly ellipsoidal and ranged from 0.5 to 0.75 in length and from 0.2 to 0.4 mm in width. Hudson and Wood (1924) stated that the egg shell became finely sculptured on the fourth day; the sculpturing being so fine that it could not be seen with a 10X hand lens.

In the present study, the average width of 50 eggs was 0.35 mm (range 0.28 – 0.41 mm) and the average length was 0.60 mm (range 0.49 – 0.69 mm). When three or four eggs were pushed into a feeding cavity, the eggs became misshapen and were not within these limits. No adverse effect on hatching was observed from these abnormally-shaped eggs. Extremely fine sculpturing, as noted by Hudson and Wood (1925), was observed on some eggs, but is not evident in the photograph (Figure 3).

Incubation Period:

The incubation period for the eggs varied from 7 to 22 days depending upon temperature. The mean incubation period for 222 eggs observed in the insectary during spring and summer was 13.2 days

TABLE 3.—Average number of days in various developmental stages of *H. nigrirostris* **on red clover.**

Stage	1960*	1961†
Egg	13.2	7.20
1st larval instar		3.50
2nd larval instar		2.75
3rd larval instar		2.50
4th larval instar		4.75
Total larval	22.0	13.50
Pre-pupal		1.50
Pupal	10.8	4.25
Post-pupal		1.25
Total pupal		7.00
Total	48.1‡	27.70

*Unheated Insectary.
†Rearing room at 80° F and 50 percent R. H.
‡Includes data from individuals which succumbed before completion of development.

(Table 3). In the spring the incubation period was longer than in the summer.

Under constant 80° F and 50 percent relative humidity conditions, the incubation period averaged 7.2 days. Houghton (1908) reported the incubation period of the species was 8 days at 60-70° F. The longest egg incubation period reported by Hudson and Wood (1925) was 26 days and the shortest was 5 days. Markkula and Tinnila (1956) recorded incubation periods of 8 days at approximately 14° C and 30 days at approximately 11.5° C.

Larva

External Characteristics:

The newly hatched, legless, grub-like larva has a white body with a black head and cervical shield. The head capsule and cervical shield become dark gray and the body becomes dull white at the end of the first instar. The second instar larval body is a light gray and the head and cervical shield are a charcoal color. During the third instar the body becomes dark gray, while the head capsule and cervical shield are light gray. The fourth instar larval body (Figure 4) is a light yellowish tan to yellowish gray, and it gradually becomes dull yellow, yellowish tan, or light gray-green with a dorsal longitudinal line. The cervical shield and head become tan or very light brown. The cervical shield may be nearly indistinguishable in some larvae, especially when near pupation.

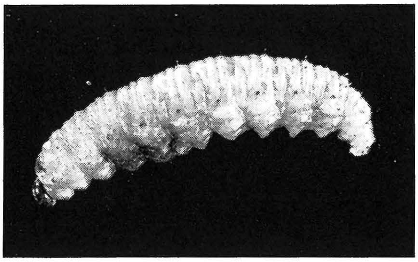

Fig. 4.—Lesser clover leaf weevil fourth instar larva (7.5X).

Detwiler (1923) gave the following figures for head widths of the respective instars: I – 0.20 mm; II – 0.28 mm; III – 0.38mm; and IV – 0.50 mm. In the present study, the head capsule measurements were as follows: I – 0.22 mm (range 0.21 – 0.25 mm); II – 0.29 mm (0.28 – 0.31 mm); III – 0.39 mm (0.36 – 0.44 mm); and IV – 0.53 mm (0.46 – 0.61 mm). These are in close agreement with Detwiler's averages.

Anderson (1948) has presented a key to the mature larvae of the most of the common *Hypera*.

Duration of the Larval Period:

The first larvae in Wayne County were observed on April 25 in 1960 and 1961, and on May 9 in 1962. Markkula and Tinnila (1956) reported first larvae on May 31, 1954, and on June 26, 1955 in Finland.

Webster (1911), Everly (1953) and Markkula and Tinnila (1956) reported the larval period to vary from 14 to 25 days. Detwiler (1923) showed considerable uniformity in the stadia, with the following averages reported: I – 5 days, II – 3 days, III – 3 days, and IV – 8 days.

In a rearing room held at 80° F, the larval period lasted an average of 13.5 days (Table 3). Although the relative humidity of the room was held at 50 percent, the humidity inside the rearing containers was considerably higher.

Behavior:

From hatching to pupation, the lesser clover leaf weevil larvae follow definite patterns of movement on the plant. Immediately upon hatching, the small larva moves to a stipule, young folded leaf, or a flower on which to feed. This movement may consist of crawling into the closest bud or stipule, but most often the larva moves directly to the terminal bud. After the larva has eaten all of the bud, it moves down the stem to the next bud and continues this procedure until it matures or until there are no remaining buds. If the larva feeds on an axillary bud on its way up the stem, it eats all young tissue and moves upward to the next axillary or terminal bud. When a lateral stem is present, the larva may move out on it. The movement here is the same as it was on the main stem.

When an immature larva has eaten all of the buds on any particular stem, it will crawl until it finds another stem and will usually start feeding on the terminal bud. Occasionally, a larva will tunnel into the stem after eating all of the bud tissue in a stipule.

Any disturbance may cause a larva to drop to the ground or move to a new feeding location. When disturbed, the larva crawls backward rapidly until it touches another part of the plant, or crawls off the edge of the plant and falls to the ground. In either case, the larva again searches for a feeding site, which may be the same as the previous one.

At maturity, the larvae seek suitable places for spinning cocoons and pupation. They may crawl or drop to the ground and move into a hole or crack in the soil surface, a folded leaf, or any other type of shelter. Many larvae feeding in flower heads spin their cocoons in the same location. Cocoons also can be found in folded leaves and within stipules on the plant.

Pupa

Pre-pupal Stage:

The pre-pupal period generally has been considered part of the larval period because the larva does not pupate immediately after spinning a cocoon. Since feeding has stopped and the cocoon has been spun, the larva is thought to be in preparation for pupation. Markkula and Tinnila (1956) observed this period to be from 1 to 3 days; Detwiler (1923) noted it to be 2 to 3 days: Hudson and Wood (1924) reported it to be a maximum of 6 days and a minimum of 2 days, with an average of 3.39 days for 115 specimens. Under the controlled enviroment of the rearing room, an average of 1.5 days was required for the pre-pupal period (Table 3).

Pupal Stage:

Markkula and Tinnila (1956) reported that at first the pupa is a light dirty-yellow color, whereas, as the pupa aged, the general coloration changed to a reddish-brown. In our observations, the pupa was initially yellow to yellow-green, gradually changing to a dark tan, and eventually developing a brown head and thorax and a yellow abdomen.

The delicately-formed, lacy cocoons were described by Detwiler (1923) as ellipsoidal and often symmetrical, averaging 4.5 millimeters in length and 2.5 millimeters in width. Titus (1911) noted that the cocoons consisted of very fine, white treads intermixed with coarser threads, and that they were more nearly globular than the cocoons of

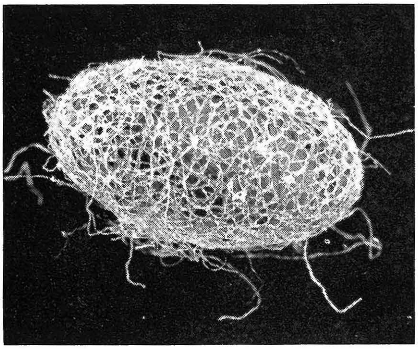

Fig. 5.—Lesser clover leaf weevil cocoon (9X).

H. postica. The meshes were rather irregular and open, not arranged in a fine, close and even manner. In this study, the ellipsoidal cocoons averaged 4.08 mm (range of 3.64 – 4.42 mm) in length and 2.56 mm (2.39 – 2.76 mm) in width (Figure 5).

Herrick and Detwiler (1919) reported that from the time the cocoon was spun until emergence of the adult, 13 to 16 days had elapsed. Detwiler (1923) reported 5 to 8 days for the pupal period. Hudson and Wood (1925) stated that with 123 specimens the pupal period averaged 5.22 days.

Under insectary conditions, an average of 10.8 days was necessary from the spinning of the cocoon until emergence of the young adult (Table 3). Daily observations of insects under controlled temperature and humidity indicated the average pre-pupal period was 1.50 days, the average pupal period was 4.25 days, and the average post-pupal period was 1.25 days. The total pupal period averaged 7.0 days in controlled conditions, while the period under natural outdoor conditions averaged 10.8 days. These observations are in agreement with those of Detwiler (1923) who stated that development was more rapid due to higher temperatures. Yet, the shorter period may also be due to a higher humidity and not temperature alone.

When disturbed by touch, the pupa moves its abdomen in a circle, causing it to roll around in the cocoon. Since the cocoon is usually fastened to a part of the plant, it does not become dislodged.

Post-pupal Stage:

Detwiler (1923) noted that the new beetle remained in the cocoon for 2 to 3 days and at first "is light in color but very soon turns fawn-colored." In the rearing room, an average of 1.25 days was required for the post-pupal period. During this time, the new adult changes in color from a very light tan to copper. The exoskeleton hardens and the weevil may eat part or most of its cocoon.

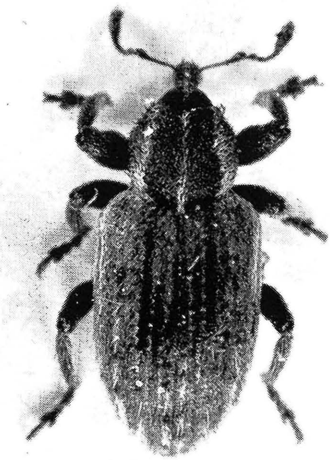

Fig. 6.—Lesser clover leaf weevil adult male (12X).

Adult

External Characteristics:

Webster (1909), Detwiler (1923), Everly (1953), and Markkula and Tinnila (1956), reported that the new adult was brown, but within a week turned to deep green or blue-green. Detwiler (1923) reported that the adult had three dorsal stripes and the head, beak, and legs were black.

In the rearing room, the new adult was a very light tan when first formed but was copper color by the time of escape from the cocoon. Two days after emergence the adult became dark brown and faint traces of light green lines on the elytra were observed. On the fourth and fifth days, these green lines gradually widened until on the seventh day the new adult appeared brownish-green. Usually, by eight days after emergence, the new adult is a bright, almost fluorescent, green. The adult male is illustrated in Figure 6. The female can be distinguished only by examination of ventral terminal abdominal segments. In the fall, the adults are a deep green, whereas, adults that emerge from hibernation are a dark blue-green. The green color results from small V-shaped scales on the head, thorax, and elytra.

According to Detwiler (1923), and Hudson and Wood (1925), the adult is 3.7 mm long, its width being just under half its length. Markkula and Tinnila (1956) reported the average of 33 specimens

TABLE 4.—Measurements of adult *H. nigrirostris*.

Structure Measured	Range (mm)	Average (mm)
Width of Head	0.54 — 0 68	0.61
Width of Thorax	0.96 — 1.25	1.13
Width of Elytra	1.43 — 1.90	1.74
Body Length	3.23 – 4 42	3.92

to be 3.6 mm in length and 1.7 mm in width. Table 4 gives the measurements taken from 50 randomly selected adults from field collections and insectary rearings.

Sexual Activity:

A few of the first new adults may mate soon after emergence from their cocoons, although mating and oviposition are not prominent at this time (Figure 7). The adults emerging later appear to seek a hibernation site. Soon after resumption of activity in the spring, mating occurs, and one female may mate several times with different males. Oviposition follows and continues until the death of the individual.

Total Development Period

Webster (1911) reported that adults emerged some 32 days after oviposition, whereas, Detwiler (1923) reported that they appeared after 25 to 52 days. Markkula and Tinnila (1956) stated that the total developmental period ranged from 32 to 68 days when reared at natural temperatures.

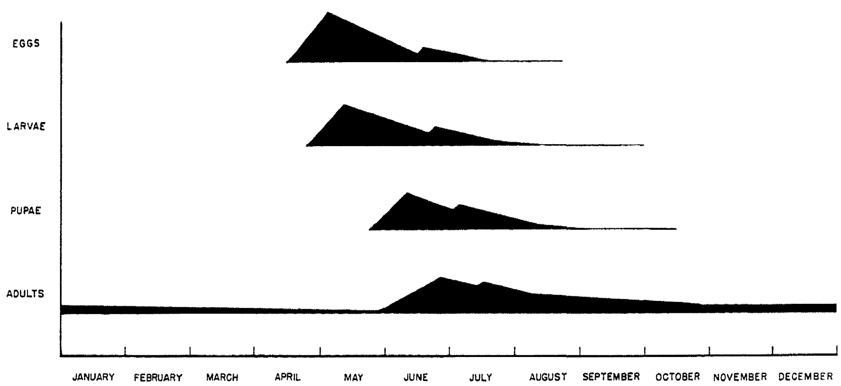

Fig. 7.—Seasonal abundance of the life stages of the lesser clover leaf weevil as observed at Wooster, Ohio, during 1960 and 1962.

TABLE 5.—Developmental time for H. nigrirostris **in the insectary during 1960, as influenced by time of oviposition.**

Month in Which Eggs were Laid	Number of Observations	Days Required to Complete Development
April	109	52.74
May	26	42.36
June	31	36.39

The average developmental period in the insectary in the present study was 48.1 days with a range of 30-60 days. Under controlled temperature of 80° F, 27.8 days were necessary (Table 3).

With eggs laid during April, 1960, 52.7 days were needed for complete development, whereas, the developmental period for May eggs was 42.4 days and for June eggs was 36.4 days. Thus, a decrease was observed in the length of the total developmental period as the temperature increased.

Second Generation

According to experiments by Detwiler (1923), a partial second generation existed in New York. Goleman *et al.* (1954) working in Iowa, agreed that there must be a partial second generation, but the other authors report only one generation.

During rearing experiments in 1960, eighteen newly emerged adult weevils were caged as sexual pairs. No eggs or any indication of a second generation were observed at that time and the weevils did not survive the winter. In mid-June of 1962, eggs were produced by newly emerged, field collected adults being used in the preference observations described later. These adults had not overwintered and could be readily separated from such forms on the basis of color. It is concluded, that although most adults overwinter, a partial second generation does occur in Ohio. Figure 7 diagramatically illustrates seasonal abundance of the various stages of the lesser clover leaf weevil in Ohio.

HOST PLANTS

The lesser clover leaf weevil is a pest of the plants belonging to the Leguminosae (Papilionaceae) family. The principal food plants are *Trifolium pratense, T. repens, T. incarnatum, T. medium, T. hybridum,* and *Medicago sativa*, but it shows a preference for red (*T. pratense*) clover (Titus, 1911; Detwiler, 1923; Markkula and Tinnila, 1956). Rice *et al.* (1945) reported that in May of 1945, a small planting of lima beans and an adjacent area in soybeans of Sussex County, Delaware,

TABLE 6.—Laboratory studies on host plants for H. nigrirostris.

	Acceptability†		Preference‡	
	Larva	Adult	Feeding	Oviposition
Red Clover **(Trifolium pratense)**	3.0	2.7	3	3
Ladino White Clover **(T. repens)**	1.2	2.7	2	2
Alsike Clover **(T. hybridum)**	—	—	2	2
Dixie Crimson Clover **(T. incarnatum)**	1.7	1.3	2	2
Trefoil **(Lotus corniculatus)**	0.0	0.3	1	3
Mt. Barker Subclover **(T. subterraneum)**	—	—	1	1
Rose Clover **(T. hirtum)**	1.5	0.3	1	1
Large Hop Clover **(T. procumbens)**	0.2	0.7	1	1
Vernal Alfalfa **(Medicago sativa)**	0.2	0.7	1	1
Persian Clover **(T. resupinatum)**	0.7	1.0	1	1
Yellow Sweet Clover **(Melilotus officinalis)**	0.0	1.0	1	1
White Sweet Clover **(M. alba)**	1.0	1.3	1	0
Penngift Crown Vetch **(Oronilla varia)**	—	—	1	0
Palestine Strawberry Clover **(T. fragiferum)**	2.8	1.0	—	—

Key:
0 – No feeding, or oviposition
1 – No feeding, or oviposition
2 – Moderate feeding, or oviposition
3 – Severe feeding, or oviposition
†One plant species only offered.
‡Two to four plant species offered simultaneously.

were completely destroyed by the lesser clover leaf weevil. Markkula and Tinnila (1956) demonstrated that red clover (*T. pratense*) was the important host for this weevil in Finland.

Acceptability Observations

In an effort to determine the food plant most favorable to the development and feeding by the lesser clover leaf weevil, eleven species of plants were tested during the spring of 1961. Six first-instar larvae and three adults were placed individually on sprouts that were taken from each plant species. The larvae were allowed to mature, pupate, and emerge as adults if they were able to survive. The adults were allowed to feed throughout the period of time that the larvae were maturing. Feeding injury was classified by a numerical rating system (Table 6).

The weevil feeds on the *Trifolium* spp. more than other forage legumes such as alfalfa, the sweet clovers, and trefoil. Of the seven clovers tested, Penscott red clover was most acceptable.

The plant species must be acceptable as food by both the adults and larvae for it to be a suitable host. In the case of red clover, the adults feed on the plant and larvae mature on it. Palestine strawberry clover does not appear to be very desirable to the adults, thus some question exists as to whether oviposition would occur in this host. Undoubtedly the larvae would mature if oviposition occurred on this species. Ladino clover is acceptable to the adults, but only 2 of the 6 larvae tested were able to mature on it. Dixie crimson clover is not readily accepted by the adult weevil, however, female weevils will occasionally oviposit in it.

Clover species with such morphological characteristics as large stipules and flower head appear to be more acceptable to the weevil. This preference may be related to an abundance of food and protection within the stipules. Red clover flower heads, with the large stipules at the base, offer protection and a very plentiful food supply.

Suitability for weevil development may be evaluated on the basis of the presence of these morphological characters for three plant species which did not produce suitable shoots in time for the tests. Alsike clover has stipules similar in size to red clover and a similar pattern of lateral stems and axillary buds. Even though the flower head is not partially surrounded on the bottom by a stipule, the acceptabililty of Alsike clover would appear high, although not as high as for red clover. Mr. Barker subclover has stipules similar to alsike and probably would rank very close to it in acceptibility. Since Penngift crown vetch has infinitesimal stipules and provides little shelter, the acceptability of the weevil for this species would be expected to be nearly zero.

It is possible that later instar larvae would be able to mature on these test species. During rearings in 1960 of field collected larvae for parasites, late third and early fourth instar larvae were observed to feed and grow to maturity on ladino clover.

Obviously, more than morphological characters are pertinent in a test of tolerance. One would expect rose clover to be more acceptable than the tests indicate, since large stipules do occur.

Preference Tests

During the spring of 1962, 13 species of plants were used in preference tests. One young leaf from each of two, three, or four plants of different species was placed in a small cage with field collected adults. The amount of feeding and oviposition was recorded (Table 6). It should be noted that not all combinations were tested, although the ratings given are averages of several trials for each species.

Red clover was found to be the most preferred host species by the lesser clover leaf weevil. Ladino, Alsike, and crimson clovers were

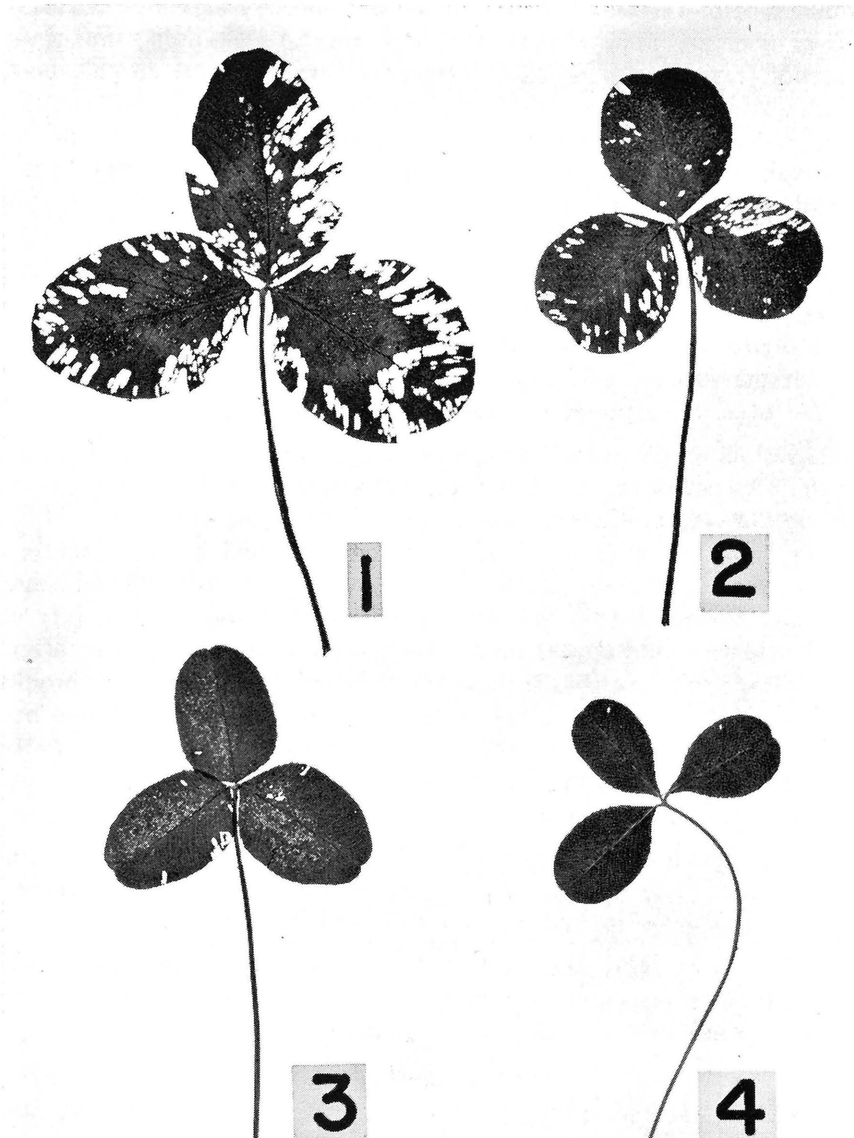

Fig. 8.—Typical feeding of lesser clover leaf weevil adults from preference tests. 1, red clover; 2, ladino clover; 3, Alsike clover; and 4, strawberry clover. White stippling is due to mite feeding.

also preferred and in some replicates were equal to or slightly more preferred than red clover. Figure 8 represents typical feeding in the preference tests. No feeding or oviposition was observed for Penngift crown vetch. Feeding occurred on all other species, but oviposition was more common on the red, ladino, alsike, and crimson clovers, and trefoil.

DESTRUCTIVENESS

Damage by the lesser clover leaf weevil varies according to locality and with the stage of the insect which is doing the damage. After hatching, the larvae migrate to the axils between two stipules, to the flower head, or to the stem. The feeding has a stunting effect on the clover, and in many cases the clover shoot is completely destroyed (Detwiler, 1923; Markkula and Tinnila, 1956). The adults feed on nearly all above-ground parts of the plant showing a preference for the leaves. Small rectangular holes result from the feeding of adults on the leaves. Severe infestations cause complete defoliation of the clover plants and greatly reduced seed yield (Houghton, 1908; Rice *et al.*, 1945; MacNay, 1952; Markkula and Tinnila, 1956). Everly, (1953) reports that for each 1 percent increase in larval numbers in the stems and axillary buds, seed yields decrease 2.61 pounds per acre, and for each additional adult per 100 stems, seed yields decrease 2.73 pounds per acre.

In Ohio the female weevil has been observed to eat small holes under the epidermis of the plant to be used for the deposition of eggs. When the larvae hatch, they move to nearby stipules and feed on the new buds. If buds emerge from the stipules after larvae have discontinued feeding, the leaves have irregular holes (Figure 9). The larvae may also girdle stems and tunnel within immature shoots and flowers. Leaf feeding by newly emerged adults results in either irregular blotches (Figure 10) or long narrow slits between the veins (Figure 11). A single individual may alternate between both types of feeding. The adults also eat large holes in the petioles and stems. The stems may wilt or break off at the point of damage.

Table 7 is a compilation of damage counts made during 1958, 1959, 1960, 1961. The 1959 counts represent flower heads gathered during sweeping. The damage percentage for stems is usually higher than for buds since all of the buds per stem are not usually attacked. Damage is most severe when the stems are small at the time of attack. Many times the young shoots are killed by the larvae. If buds survive, they may outgrow some of the damage, but the stems are usually dwarfed.

Fig. 9.—Damage resulting from lesser clover leaf weevil larval feeding. Note holes in leaves of left stem, and dead lateral buds of right stem.

Fig. 10.—Young lesser clover leaf weevil adult blotch-type feeding injury (actual size).

TABLE 7.—Field observations of H. nigrirostris **damage.**

County	Percent of Buds Damaged	Percent of Stems Damaged	Crop	Date of Observation
Wayne	—	41	First	May 23, 1958
Wayne	—	33	First	May 26, 1958
Wayne	—	39	First	June 3, 1958
Lorain	—	18	First	May 27, 1958
Lorain	—	21	First	May 29, 1958
Wayne	28	—	First	June 4, 1958
Wayne	63	—	Second	August 5, 1959
Ashland	35	—	Second	August 10, 1959
Huron	42	—	Second	August 10, 1959
Wayne	10	51	Second	July 12, 1960
Wayne	13	45	First	June 20, 1961
Wayne	7	37	Second	August 14, 1961
Mahoning	25	65	Second	August 15, 1961
Columbiana	35	87	Second	August 15, 1961
Huron	16	60	Second	August 18, 1961

Attempts to demonstrate green forage yield losses have been unsuccessful, partially because of inadequate control measures.

Fig. 11.—Young lesser clover leaf adult slit-type feeding injury. Note the damaged lateral buds (actual size).

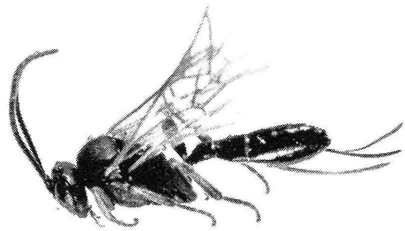

Fig. 12.—Bathylectes exiguus (Grav.) adult female (10.8X).

NATURAL ENEMIES

The lesser clover leaf weevil has several natural enemies. Peairs and Davidson (1956), Detwiler (1923), and Rockwood (1920) report larval parasites. Elliott (1952), Rockwood (1951), and Webster (1909) report larval or pupal attack by fungi.

During the spring of 1960, 75 lesser clover leaf weevil eggs were field collected in Wayne County, Ohio, and maintained in the insectary. No parasites were observed to emerge from these egggs. None of the field collected eggs showed evidence of attack by predators.

Several hundred weevil larvae were collected throughout Ohio during the fall of 1960 and summer of 1961 and three parasitic species were observed. Specimens were identified by the staff of the United States National Museum.

Bathyplectes exiguus (Grav.) (*Ichneumonidae*) feeds internally on the weevil larvae. After the weevil larva finishes spinning its cocoon, the parasite emerges from the body of the weevil and pupates within the weevil cocoon (Figures 12 and 13).

Bracon mellitor Say (Braconidae) is an external feeder on the weevil larvae, which appear to be paralyzed while being consumed. After draining the internal contents of the weevil larvae, the braconid larvae may pupate near the feeding site or elsewhere (Figures 14 and 15). *Bracon tenuiceps* (Muesebeck) (*Braconidae*) is also an external feeder (Figure 16) and pupates in a manner similar to *B. mellitor*. The cocoons of the two braconids are very similar.

One predaceous stink bug (*Podisus maculiventris* Say) was observed feeding on weevil larvae in the insectary rearings.

Some larvae and pupae are apparently killed by an unidentified fungus. The symptoms caused by this fungus strongly resemble those caused by *Empusa* (*Entomophthora*) *sphaerosperma* Fres. attacking the clover leaf weevil (*H. punctata*).

Fig. 13.—Cocoon of *Bathyplectes exiguus* **(Grav.) in stipule. Note remains of lesser clover leaf weevil cocoon and emergence hole for adult parasite (9X).**

Fig. 14.—*Bracon mellitor* **Say, adult female (7.2X).**

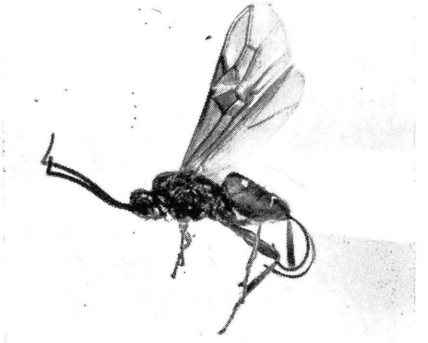

Fig. 15.—Cocoon of *Bracon mellitor* **Say in clover head (12X).**

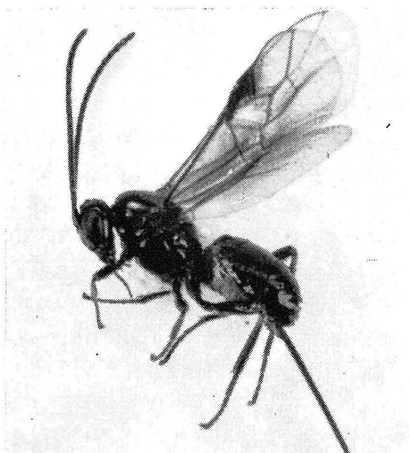

Fig 16.—*Bracon tenuiceps* **Mues., adult female (13.2X).**

It is estimated that 30 to 40 percent of the lesser clover leaf weevil larvae are killed by hymenopterous parasites in Ohio. Approximately five percent are killed by fungi.

SUMMARY

Since its introbuction into the United States between 1865 and 1875, the lesser clover leaf weevil (*Hypera nigrirostris*) (Fab.) has become a pest of clover over the entire country. Control measures have not been satisfactory and no thorough study of its biology in the United States has been undertaken in recent years.

A biological study of this weevil was carried out from 1959 to 1962 at the Ohio Agricultural Experiment Station, Wooster, Ohio, in the field and in the insectary. Hibernating adults were found in clover fields and in debris-filled ditches next to the fields. No weevils were found in wood lots. The weevils fly and crawl to hibernating quarters in the summer and fall; and in the spring, fly and crawl to clover plants. Activity begins with warm weather in late March.

During 1960 in the insectary, 17 percent of the eggs laid were in the top of the leaflets, 23 percent in the bottom of the leaflets, 15 percent in the petioles, 34 percent in the stipules, and 11 percent in the stems. The average oviposition period in the insectary was 29.6 days with a maximum of 59 days. In the field (because of a partial second generation) oviposition occurred from April to September. A mean temperature of 50° F per day was necessary to initiate oviposition. Maximum production per female was 406 eggs.

The newly hatched larva is white with a black head and cervical shield. Four instars occur in Ohio and the larva becomes darker with each instar. The mean head capsule widths were: I – 0.22mm; II – 0.29 mm; III – 0.39 mm; and IV – 0.53 mm. At 80° F the average larval instar periods were: I – 3.5 days; II – 2.8 days; III – 2.5 days; and IV – 4.8 days. The larval period averaged 22.0 days in the insectary. The larvae feed mainly on new buds and flowers, but also tunnel in stems and feed on leaves.

The mean pupal period was 10.8 days in the insectary. At 80° F the pre-pupal was 1.5 days, the pupal period was 4.3 days, and the post-pupal period was 1.3 days. The lacy, ellipsoidal cocoons averaged 4.08 mm in length and 2.56 mm in width.

The new adult is light tan, but within a week is almost a flourescent green. They are deep green in the fall and blue-green after hibernation. Adults averaged 0.61 mm in width of head, 1.13 mm in width of thorax, 1.74 mm in width of elytra, and 2.92 mm in total length.

In the insectary, 48.1 days were needed for total development, but at 80° F only 27.8 days were needed. A partial second generation occurs in Ohio.

Red clover was found to be the most acceptable food plant for the lesser clover leaf weevil. In addition, the larvae showed preference for most clovers having large stipules and flower heads.

Damage results from both adult and larval feeding. The larvae damaged or killed the buds, whereas, adults fed mainly on the leaves.

Bathyplectes exiguus (Gravenhorst), *Bracon mellitor* Say, and *Bracon tenuiceps* (Muesebeck) are larval parasites. One stink bug, *Podisus maculiventris* Say, was observed feeding on the larvae. Larvae and pupae were killed by a fungus, possibly *Empusa* (*Entomophthora*) *sphaerosperma* Fres.

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