

A LIFE HISTORY STUDY OF THREE
SPECIES OF THE GENUS LEMA
(COLEOPTERA: CHRYSOMELIDAE)

by

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INTRODUCTION

The purpose of this study was to compare the biology and life histories of three species of the genus Lema (Coleoptera: Chrysomelidae). Two of the species, L. jacobina Linell and L. simulans Schaeffer, are of no known economic importance. The third species, L. trilineata (Olivier), was at one time a major pest of the potato, but it is no longer of economic importance as a result of modern control measures.

Greene (1961), collecting from the Donaldson Pastures northwest of Manhattan, Kansas, did not report L. simulans or L. jacobina. He did, however, note the occurrence of two species belonging to the genus Lema. Greene identified these as Lema sp. near coloradensis Linell and L. trilineata complex.

Except for L. trilineata, information concerning the habits and life histories of these species cannot be found in the literature. Bethune (1909), Beutenmuller (1890), Britton (1933), Criddle and Hanford (1933), Fitch (1864), Lintner (1885), Luggar (1899), Riley and Walsh (1868), Stuart (1937), Walsh (1866), and Wilcox (1954) have reported on the life history and habits of L. trilineata.

MATERIALS AND METHODS

Field observations and collections of adults were made in the Hunter's Island area southwest of Manhattan, Kansas. These adults were transferred to the insectary and mating

pairs were placed in cages constructed from quart jars and 9 cm. petri dishes. Vials of water containing cuttings of the host plant were placed in the cages for feeding purposes. Each day eggs were removed, placed on leaves in 9 cm. petri dishes, and then held in an incubation room at 25°C. to 27°C.

As first instar larvae emerged from the eggs, they were placed along with fresh food in 5 cm. plastic boxes for rearing. Moisture was supplied by wetting a small piece of filter paper cut to fit snugly into the box. Each day the cages were inspected for cast skins indicating the beginning of a new stadium. At various time intervals larvae were dissected and their head capsules measured (table 1). Dyar (1890) found that accurate measurements made of the head during a stadium could be used to determine if any instars had been missed during life history studies. Measurements of these capsules were made with a calibrated ocular mounted in a broadfield dissecting scope. As soon as the larvae entered the fourth stadium, soil was placed in the bottom of the plastic boxes to provide a more nearly natural environment for cocoon formation.

Slits were made in the cocoons to observe the larvae as they progressed through prepupal and pupal stages. The term prepupa as used in this study refers to the nonfeeding interim after the larvae spin cocoons and before they molt to the pupal stage. To determine whether the slit method had disturbed the development within the cocoons, an X-ray unit was employed to follow the prepupal and pupal stages (figs. 10-13). Radiographs

were taken for 150 seconds at 20 kilovolts and 5 milliamperes. No significant changes were noted in developmental periods between larvae checked with the X-ray unit and those checked with the slit method.

After emerging from their cocoons, adult L. trilineata and L. jacobina were placed in containers along with fresh leaves from their respective host plants. Mating pairs were removed to screen rearing cages in an outdoor insectary where more accurate egg-laying data could be taken. These methods were not used for reared adults of L. simulans because of the insufficient number of specimens that completed the transition from egg to adult.

In the larval descriptions the terms epimeron and episternum refer only to the sclerites found in the pleural region. Drawings of larvae were made with a Bausch and Lomb camera lucida while the subjects were submerged in 70% alcohol.

RESULTS AND DISCUSSION

Lema trilineata (Olivier)

Adult. Beutenmuller (1890) reported Datura stramonium and Physalis as host plants of L. trilineata and Wilcox (1954) observed the occurrence of L. trilineata on various Solanaceous plants throughout Ohio. In Manitoba Griddle and Hanford (1933) recorded a preference of L. trilineata for ground cherries, Physalis lanceolata, over other members of the nightshade family; other host plants listed included Physalis grandiflora,

P. edulis, and henbane, Hyocyanus niger. In the Hunter's Island area near Manhattan L. trilineata was found feeding on Physalis virginiana var. sonare (Torre) Waterfall. Adult beetles of this species chew numerous, irregular holes through the leaves (fig. 14). With the advent of cool, fall weather, adults caged in the insectary began to feed irregularly; within 14 days feeding ceased altogether.

Fitch (1864) noted the presence of adult L. trilineata under boards as early as 20 April and thus concluded that the insect passed the winter in the adult stage. Later writers such as Walsh (1866), Lugger (1899), and Bethune (1909) reported L. trilineata as overwintering in the pupal stage. Lema trilineata overwintered in the adult stage in the insectary at Kansas State University.

Walsh (1866) noted that there were two generations of L. trilineata each year; the first appearing in June and the second in August. Lugger (1899), Bethune (1909), and Britten (1933) all reported two generations per year. Fitch (1864), however, was convinced that there were more than two generations per year since he found individuals in all stages of development in June, July, and August. Two generations were noted at Hunter's Island, one occurring in June and the second in August.

Egg. In the insectary 55 egg clusters had a mean of 7.8 eggs and ranged from 2.0 to 21 eggs per cluster. Each of five L. trilineata females layed an average of eight eggs per

day over a period of 68 days. Daily egg-laying records varied from 0 to 48 eggs per female while the total number of eggs laid per female ranged from 290 to 558 eggs. Egg laying stopped when cool fall weather came.

Walsh (1866) noted that the eggs of L. trilineata are oblong-oval, golden yellow, and laid in groups of six or eight on the leaves. Lintner (1885) reported as many as 20 or more eggs per cluster. Bethune (1909) noted that the eggs are yellow and that they are laid on the underside of the leaf along the midrib. In the insectary the bright yellow eggs were deposited in two rows on the underside of leaves.

Fitch (1864) found the eggs of L. trilineata to be about 0.4 in. long (about 1.02mm.) and about 0.2 in. thick (about 0.51mm.). One hundred eggs of L. trilineata measured in the laboratory had a mean length of 1.14mm. with a range of 0.93mm. to 1.21mm. The mean width of 100 eggs was 0.55mm. with a range of 0.49mm. to 0.61mm. (table 2).

Fitch (1864) reported that eggs of L. trilineata in New York hatch in about two weeks. The incubation period for 100 eggs in the laboratory ranged from three to five days with a mean incubation period of four days (table 3).

Larva. Britton (1933) reported the yellow larvae of L. trilineata feeding side by side as they move from leaf margin to leaf base; Stuart (1937) confirmed this and added that larger veins are left intact. At Hunter's Island several instances of such larval feeding were noted. Often the larvae

on any one leaf represented two or three different instars.

Riley and Walsh (1868) reported that the larvae of L. trilineata display the trait of covering their backs with their own feces. The anal opening is located dorsally on the ninth abdominal segment (fig. 2, A0) and excrement is discharged from it onto the back until it piles up and covers the entire dorsal surface of the larvae. Bethune (1909) suggested that the excrement is a protective device against enemies. Another possible defensive phenomenon occurs when the larvae are disturbed tactually. When touched a spurt of brown material, similar to that found in the crop, comes from the mouth and sometimes engulfs the head. The liquid thus ejected may have an offensive odor or taste to attacking enemies.

Larvae of L. trilineata pass through four instars. One hundred larvae remained in the first stadium from one to two days with the mean being 1.2 days and the mode one day. In the second stadium 100 larvae spent a mean of 1.3 days and a mode of one day with a range of one to three days. The mean of 100 larvae in the third stadium was 1.7 days with a mode of two days and a range of one to three days. Sixty larvae remained from five to ten days in the fourth stadium with a mean of 7.6 days and a mode of seven days (table 4).

Britton (1933) reported that larvae of L. trilineata reach maturity in about two weeks and then enter the ground to pupate. Larvae reared in the laboratory matured (fourth

instar) in three to eight days. Between one and five days after the start of the fourth stadium the larvae entered the soil in the bottom of the cages and formed cocoons. After cocoons were constructed, the larvae began a nonfeeding prepupal stage. The prepupal period of 29 L. trilineata larvae varied from three to seven days with a mean of 4.4 days and a mode of four days (table 5).

Pupa. At the end of the prepupal period the last larval skin was shed and the pupa emerged. The pupal period of 69 L. trilineata specimens varied from two to seven days with a mean of 5.6 days and a mode of six days. The total time spent in the larval and pupal stages by 68 individuals ranged from 16 to 22 days. The mean time spent by these same 68 individuals was 17.7 days while the mode was 18 days. Adults were observed to remain in the cocoons, sometimes for several days, before emerging. Twenty adults remained from one to three days in the cocoon with a mean of 2.3 days and a mode of three days (table 5).

Larval Description. Fourth instar larva (fig. 2) 5mm. to 6mm. long and from 2.5mm. to 3.5mm. at greatest diameter; legged, subcylindrical with the posterior end curving gradually ventrad. Sides curved, narrowed anteriorly from first abdominal segment and posteriorly from fourth abdominal segment. Nine pairs dark brown spiracles (SP) present; one pair on mesothorax and one pair on each of first eight abdominal segments. Pseudopods (PS) present on all abdominal segments except ninth.

All setae with basal sclerites. Head width 0.33mm. to 0.36mm. in first instar, 0.45mm. to 0.51mm. in second instar, 0.68mm. to 0.83mm. in third instar, and 0.93mm. to 1.14mm. in fourth instar.

Fourth instar head capsule (fig. 1) dark brown and shiny. A distinct epicranial suture present; epicranial arms (FS) curving ventral to the stemmata (ST) and ending just posterior to the basal antennal segment. Frons (FR) complete with eight setae; one mesad each basal antennal segment and a row of three extending between each frontal suture (FS) and the clypeus (CP), the middle seta of each row displaced somewhat laterally.

Fronto-clypeal suture not well-defined. Clypeal area bearing a row of four setae. Clypeal-labral suture present. Labrum (LB) distinct, three times as long as wide with a deep mid-ventral incision. Ten setae present; six on ectal surface (three on either side of mid-ventral incision), and four on extreme ventral surface (two on either side of mid-ventral incision).

Twelve stemmata present, a mid-lateral group of eight (four on either side of head), and a ventral pair on each gena. Lenses raised and clear.

Mandibles (fig. 7) identical with six distal teeth, the sixth reduced to a knob. Teeth darker than rest of mandible. Outer surface of each mandible with two setae.

Prothoracic dorsum with a large dorsal sclerite bearing

20 setae; an anterior dorso-lateral row of 12 (six on either side of meson), a posterior dorso-lateral row of six (three on either side of meson), and one on the ventral tip of the sclerite on each side. Dorsal sclerite dark brown except for a lightly pigmented strip along meson. Dorsum also with a small sclerite bearing two setae immediately ventral to the dorsal sclerite on either side. Pleuron with epimeron (EPM) and episternum (EPS); each bearing two setae.

Mesothoracic and metathoracic segments variable. General setal pattern constant, but setal numbers varying from specimen to specimen and from mesothorax to metathorax on any one specimen. Mesothoracic dorsum bearing 32 to 36 setae: four to six in a dorso-lateral row on either side of meson; two setae on a small sclerite dorsal to each mesothoracic spiracle; a group of three or four posterior each mesothoracic spiracle, the most anterior two of which are borne by a single sclerite; a single seta ventral to this grouping on either side; five setae immediately ventral to each mesothoracic spiracle, four in a group near each spiracle and the fifth ventral to these. Metathoracic dorsum bearing approximately 26 setae: a dorso-lateral row of four or five on either side of meson; a group of three or four ventral to the dorsal lateral row on either side, the most anterior two of which are borne by a single sclerite; a single seta on either side of meson ventral to this grouping; two or three setae on either side of meson, dorsal and slightly anterior to the episternum. Mesothoracic and

metathoracic pleura with epimeron and episternum; each epimeron bearing two setae, each episternum bare.

Abdominal segments variable. Most consistent arrangement on first abdominal segment as follows: dorsum with an anterior dorso-lateral row of six setae (three on either side of meson), a posterior dorso-lateral row of eight setae (four on either side of meson), and a group of four setae ventral to each spiracle; tergum bearing three lateral setae on either side. Abdominal segments two through eight usually with dorsum bearing an anterior dorso-lateral row of four setae (two on either side of meson); a posterior dorso-lateral row of six setae (three on either side of meson); a horizontal row of three setae dorsal to each spiracle, the anterior two often paired and arising from a single sclerite, and sometimes with the posterior seta displaced dorsally so as to fall in line with the posterior dorso-lateral row; a group of four or five setae ventral to each spiracle. Tergum highly variable. Ninth abdominal segment usually bearing eight setae; three on either side of meson in a curving dorso-lateral row, and one at each lateral edge of the anal opening (AO). Tenth abdominal segment usually bearing eight setae; four on either side of meson in a curving dorso-lateral row.

Lema simulans Schaeffer

Adult. The host plant of L. simulans is the common roadside and woodland plant, Commelina erecta L. C. erecta,

according to Fernald (1950), is found in many eastern states and as far west as Kansas. It occurs in loamy or sandy soil as found in such areas as Hunter's Island. The most distinctive feature of the genus Commelina is the folded spathiform bracts in which the inflorescence is borne.

Unlike most Chrysomelidae which chew holes completely through the leaves, adults of L. simulans damage the host plant by chewing long, narrow furrows into the leaf surface (fig. 15). The entire leaf structure is eaten with the exception of the lower epidermis and the principle veins. Adults have also been observed feeding on the flowers, primarily the petals, in the early morning hours before the floral parts are withdrawn into the spathes.

Continuous generations from June to October were noted in the Hunter's Island region.

Egg. Eggs of L. simulans are yellow, glabrous, and smooth. They are usually laid singly, but sometimes may be laid in groups of from two to six. Eggs are deposited on the stem, leaves, and spathes of the host plant. The mean length of 100 eggs was 0.97mm. with a range of 0.83mm. to 1.13mm. One hundred eggs ranged in width from 0.39mm. to 0.50mm. with a mean of 0.45mm. (table 2). The incubation periods of 84 eggs ranged from two to six days with a mean of 4.5 days and a mode of five days (table 3).

Larva. Larval emergence was effected through a hole cut in the egg by the mandibles. Brues (1946) found that

Chrysomelid larvae usually feed on the underside of leaves, leaving only the upper epidermis intact. However, in the field no instances of L. simulans larvae feeding on leaves were noted. L. simulans larvae, upon hatching, entered the closed spathes of the host plant where they fed on the androeceium and gynoecium of the plant. In the laboratory a small number of larvae were fed leaves and successfully reared to adulthood.

The environment within the spathes was very moist and the larvae were sometimes submerged in liquid. The larvae often chewed their way through the seed coat and entered the seed to devour the endosperm. Within the spathes the exuviae were very difficult to find. This, plus the high mortality of first instar larvae, made rearing attempts particularly difficult.

Lema simulans larvae did not develop excrement mounds possibly due to the fluid content within the spathes. A dorsal anal opening (fig. 4, A0) on the ninth abdominal segment is present, however, and larvae reared experimentally on leaves did develop mounds of feces on their backs. The larvae pass a spurt of brown material from the mouth when stimulated tactually; the liquid thus ejected possibly has an offensive odor or taste to attacking enemies.

Larvae of L. simulans pass through four instars. Fifty-nine larvae spent between two and seven days in the first stadium with a mean of 3.3 days and a mode of three days. The mean for 43 larvae in the second stadium was 2.6 days with a mode of two days and a range of one to seven days. Thirty-three

larvae spent from two to seven days in the third stadium with a mean of 2.9 days and a mode of two days. The fourth stadium of 16 larvae varied from six to nine days with a mean of 7.6 days and a mode of seven days (table 4).

Between three and six days after the start of the fourth stadium the larvae entered the soil in the bottom of the cages and formed cocoons. After construction of the cocoons, the larvae began a non-feeding prepupal stage. The prepupal period of 32 L. simulans larvae ranged from one to four days with a mean of 3.1 days and a mode of three days (table 4).

Pupa. At the completion of the prepupal period the last larval skin was shed and the pupa emerged. The pupal period of 31 specimens varied from five to eight days with a mean of 5.9 days and a mode of six days. The total time spent in the larval and pupal stages by 18 L. simulans individuals ranged from 18 to 24 days with the mode being 20 days and mean 21.9 days. Adults were observed to remain within the cocoons for several days after metamorphosis. Seventeen adults remained from one to two days in their cocoons with a mean of 1.4 days and a mode of one day (table 5).

Larval Description. Fourth instar larva (fig. 4) 4mm. to 5mm. long and from 2.0mm. to 2.5mm. at greatest diameter; legged, subcylindrical with posterior end curving gradually ventrad. Sides curved, narrowed anteriorly from the third abdominal segment and posteriorly from the seventh abdominal segment. Nine pairs brown spiracles (SP) present; one pair on

mesothorax and a pair on each of first eight abdominal segments. Pseudopods (PS) present on all abdominal segments except ninth. Head capsule light yellow in first instar, becoming darker with each succeeding instar. Head width 0.30mm. to 0.40mm. in first instar, 0.44mm. to 0.53mm. in second instar, 0.55mm. to 0.74mm. in third instar, and 0.74mm. to 0.90mm. in fourth instar.

Fourth instar head capsule (fig. 3) golden yellow with a brownish tinge. A distinct epicranial suture present; epicranial arms (FS) curving ventral to the stemmata (ST) and ending just posterior to the basal antennal segment. Frons (FR) complete with eight setae; two ventral to the juncture of the frontal suture (FS) and the cranial suture (CS), a widespread pair ventral to these, and four in a row dorsal to the clypeus.

Clypeus (CP) six to seven times as long as wide with four well developed setae. Distinct fronto-clypeal and clypeal-labral sutures present. Labrum (LB) dark, three times as long as wide with a deep mid-ventral incision. Twelve setae present; six on ectal surface (three on either side of mid-ventral incision), and six on extreme ventral surface (three on either side of mid-ventral incision).

Twelve stemmata present; a mid-lateral group of eight (four on either side of head), and a ventral pair on each gena. Lenses raised and clear with black pigment bodies beneath.

Mandibles (fig. 8) identical with six distal teeth, the sixth vestigial. Teeth darker than rest of mandible. Outer surface of each mandible with one well developed seta.

Prothoracic dorsum with a large dorsal sclerite bearing 20 setae; a mid-dorsal pair (one on either side of meson), an anterior dorso-lateral row of ten (five on either side of meson), and a posterior dorso-lateral row of eight (four on either side of meson). Dorsum also bearing a pair ventral to the dorsal sclerite on either side. Dorsal sclerite same color as head capsule. Pleuron with epimeron (EPM) and episternum (EPS); each bearing a single seta.

Mesothoracic dorsum bearing 22 setae; 12 in a dorso-lateral row (six on either side of meson) with the most lateral two on either side displaced somewhat posteriorly, a pair ventral to the dorso-lateral row on either side, one pair ventral to each spiracle, and one immediately dorsal to the pleuron on either side. Pleuron with epimeron and episternum; epimeron bearing one seta; episternum bare. Metathorax identical to mesothorax except for lacking spiracles and the paired setae ventral to each spiracle.

Abdominal segments one through eight variable. General setal pattern constant, but setal numbers varying from specimen to specimen and from segment to segment on any one specimen. A typical arrangement as follows: dorsum bearing 18 setae; an anterior pair (one on either side of meson), a posterior dorso-lateral row of six (three on either side of meson), a group of

three dorsal and slightly posterior to each spiracle, and a pair ventral and slightly posterior to each spiracle. Tergum bearing one lateral seta on each side. Ninth abdominal segment bearing ten setae; four anterior to the anal opening (A0) (two on either side of meson), four posterior to the anal opening (two on either side of meson), and one at each lateral edge of the anal opening. Tenth abdominal segment bearing four setae; a pair at the base of the pseudopod on either side of the body.

Lema jacobina Linell

Adult. The host plant of L. jacobina is Commelina erecta. Adults display typical Chrysomelid feeding by chewing gapping, irregular holes through leaves (fig. 16). Continuous generations from June to October were noted in the Hunter's Island region.

Egg. In the insectary eight females layed an average of 4.3 eggs per day over a period of 60 days. Daily egg-laying records varied from 0 to 45 eggs per female while the total number of eggs laid per female ranged from 19 to 416 eggs. With the advent of cool, fall weather, oviposition stopped; adult feeding became irregular and dispensed altogether within ten days.

Eggs of L. jacobina are yellow, glabrous, and smooth. They are usually laid singly, but sometimes may be laid in groups of from two to six. Eggs are deposited on the stem,

leaves, and spathes of the host plant. The mean length of 100 eggs was 0.92mm. with a range of 0.81mm. to 1.11mm. One hundred eggs ranged in width from 0.40mm. to 0.56mm. with a mean of 0.49mm. (table 2). The incubation period for 304 eggs ranged from two to six days with a mean of 4.4 days and a mode of four days (table 3).

Larva. Larval emergence was effected through a hole cut in the egg by the mandibles. Larvae of L. jacobina display feeding habits similar to those of the adults; holes are chewed through the leaf surface usually beginning on the underside.

Larvae of L. jacobina characteristically carry mounds of their own excrement upon their dorsum. Excrement is discharged onto the back through a dorsally located anus as in L. trilineata and is moved forward by a series of peristaltic contractions of the body wall beginning with the last abdominal segment and proceeding anteriorly. During molting the mounds are sometimes shed along with the exuviae. When this occurs the new instar rebuilds the mound. At other times the mound of feces is not removed with the exuviae, but the cast skins are retained with the excrement on the back. Just as the excrement mounds of L. trilineata are a possible protective device, so too are the fecal discharges of L. jacobina. Another probable defensive phenomenon occurs when the larvae are disturbed tactually; a spurt of brown material similar to that found in the crop comes from the mouth. The liquid thus ejected may have an offensive odor or taste to attacking enemies.

Larvae of L. jacobina pass through four instars. One hundred and forty-two larvae ranged between one and four days in the first stadium with a mean of 1.6 days and a mode of two days. The mean for the second stadium was 1.5 days based on 114 specimens whereas the mode was one day and the range one to four days. Ninety-two larvae spent from one to seven days in the third stadium with a mode of one day and a mean of 1.9 days. The fourth stadium of 13 larvae varied from five to eight days with a mode of six days and a mean of 6.2 days (table 4). Between two and five days after the start of the 4th stadium the larvae entered the soil in the bottom of the cages and formed cocoons. After cocoons were constructed, the larvae began a non-feeding prepupal stage. Radiographs taken during this period show the larvae rotating within the cocoon. The prepupal period of 41 larvae varied from two to five days with a mean of 3.2 days and a mode of three days (table 5).

Pupa. At the end of the prepupal period the last larval skin was shed and the pupa emerged. The pupal period of 39 L. jacobina specimens ranged from five to eight days with a mode of six days and a mean of 6.3 days. The total time spent in the larval and pupal stages by 38 individuals varied from 14 to 23 days; the mode was 16 days while the mean was 16.7 days. Adults were observed to remain within the cocoon for several days after metamorphosis. Twenty-eight pre-emerged adults remained from one to four days in their cocoons with a mode of two days and a mean of 2.3 days (table 5).

Larval Description. Fourth instar larva (fig. 6) 4mm. to 5mm. long and from 2.5mm. to 3mm. at greatest diameter; legged, subcylindrical with the posterior end curving abruptly ventrad. Sides curved, narrowed anteriorly from the second abdominal segment and posteriorly from the sixth abdominal segment. Nine pairs dark brown spiracles (SP) present; one pair on mesothorax and a pair on each of first eight abdominal segments. Pseudopods (PS) present on all abdominal segments except ninth. All setae with basal sclerites. Head capsule black in first instar, becoming lighter with each succeeding instar. Head width 0.30mm. to 0.43mm. in first instar, 0.50mm. to 0.59mm. in second instar, 0.71mm. to 0.81mm. in third instar, and 0.90mm. to 1.06mm. in fourth instar.

Fourth instar head capsule (fig. 5) light brown and nodulose; most nodules slightly darker than surrounding area. A distinct epicranial suture present; epicranial arms (FS) curving ventral to the stemmata (ST) and ending just posterior to the basal antennal segment. Two lightly pigmented areas extend dorso-ventrally from the vertex to the frontal sutures (FS) on either side of the cranial suture (CS); a row of three setae arise within each area, running parallel to the cranial suture. Frons complete with eight setae; two ventral to the juncture of the frontal suture and the cranial suture, a wide-spread pair ventral to these, and four in a row dorsal to the clypeus.

Clypeus (CP) six to seven times as long as wide with four

well developed setae. Distinct fronto-clypeal and clypeal-labral sutures present. Labrum (LB) dark, three times as long as wide, with a deep mid-ventral incision. Eighteen setae present; six on ectal surface (three on either side of mid-ventral incision), and 12 on extreme ventral surface (six on either side of mid-ventral incision).

Twelve stemmata present; a mid-lateral group of eight (four on either side of head), and a ventral pair on each gena. Lenses raised and clear with black pigment bodies beneath.

Mandibles (fig. 9) identical with six distal teeth, the sixth reduced to a knob. Teeth darker than rest of mandible. Outer surface of each mandible with a well developed seta.

Prothoracic dorsum with a large dorsal sclerite bearing 20 setae arranged in two rows, an anterior row of 12 (six on either side of meson) and a posterior row of eight (four on either side of meson). Dorsum also bearing a pair ventral to the dorsal sclerite on either side. Dorsal sclerite same color as head capsule. Pleuron with epimeron (EPM) and episternum (EPS); each bearing single seta.

Mesothorax and metathorax similar except for mesothoracic spiracles. Dorsum bearing 22 setae; 12 in a dorso-lateral row (six on either side of meson), one pair ventral to the dorso-lateral row on either side of meson, one pair ventral to each mesothoracic spiracle, and one immediately dorsal to the pleuron

on either side. Pleuron with epimeron and episternum; epimeron bearing one seta; episternum bare.

Abdominal segments one through eight similar; each segment with 20 setae. Dorsum bearing one anterior pair (one on either side of meson), a posterior dorso-lateral row of six (three on either side of meson), one pair on either side ventral to the posterior row, one dorsal to each spiracle and slightly posterior to it in segments two through eight, and a pair immediately ventral to and slightly posterior each spiracle. Tergum bearing one lateral seta on either side. Ninth abdominal segment bearing six setae; two pair anterio-dorsal to the anal opening (AO) (one pair on either side of meson) and one pair posterior to the anal opening (one on either side of meson). Tenth abdominal segment bearing six dorsal setae. The three setae on either side of meson forming a triangle.

SUMMARY AND CONCLUSIONS

Biology and Life History

Host Plant. In the Hunter's Island area near Manhattan, Kansas, Lema trilineata (Olivier) was found feeding on Physalis virginiana var. sonare (Torre) Waterfall. Lema jacobina Linell and Lema simulans Schaeffer were observed feeding on Commelina erecta L., a common dayflower, in this same area.

Adults. Adult beetles of L. trilineata and L. jacobina exhibit similar feeding characteristics. Both species chew

gapping, irregular holes through the leaves of their respective host plants. Lema simulans, although having the same host as L. jacobina, chews long, narrow furrows into the leaf, leaving only the lower epidermis and principle veins intact. Adults of this latter species also have been noted feeding on flower petals in the early morning hours before the floral parts are withdrawn into the spathes.

In the Hunter's Island area L. simulans and L. jacobina have continuous generations whereas L. trilineata has two, one in June and one in August. With the onset of cool weather in the fall, adults of the three species in the insectary began to feed irregularly and stopped feeding within 10 to 14 days. Observations made under conditions in the insectary indicate that these species overwinter in the adult stage.

Eggs. In the insectary at Kansas State University, L. trilineata females laid an average of eight eggs per day as compared to an average of 4.3 eggs per day for L. jacobina females. Daily egg-laying records varied from 0 to 48 eggs per female for L. trilineata and from 0 to 45 eggs per female for L. jacobina. The total number of eggs laid per female ranged from 290 to 558 eggs for L. trilineata over a period of 68 days. A range of 19 to 416 eggs was recorded for L. jacobina females in a 60 day egg-laying period.

The eggs of the three species are oblong-oval and yellow in color. Lema trilineata places eggs in clusters of from 2 to 21 eggs on the leaves of the host plant. Lema simulans and

and L. jacobina usually lay eggs singly, but sometimes place them in groups of from two to six on the leaves, stem, and spathes of the host plant.

The eggs of trilineata were somewhat larger than those of L. simulans and L. jacobina. One hundred L. trilineata eggs averaged 1.14mm. in length and 0.55mm. in width as compared to a mean length of 0.97mm. and a mean width of 0.45mm. for 100 eggs of L. simulans. One hundred eggs of L. jacobina were very similar in size to those of L. simulans; the mean length was 0.92mm. and the mean width was 0.49mm. (table 2). No differences were observed between eggs of L. simulans and L. jacobina.

Eggs of L. trilineata hatched in a mean time of four days while those of L. simulans and L. jacobina had somewhat longer mean incubation periods of 4.5 days and 4.4 days respectively. The range of the incubation times was also greater for eggs of L. simulans and L. jacobina than for L. trilineata; the incubation range of the former two species varied from two to six days whereas that of L. trilineata varied from three to five days (table 3).

Larvae. Larvae of L. trilineata and L. jacobina display feeding habits similar to those of the adults. Lema simulans larvae, however, enter the closed spathes of C. erecta where they feed on the androecium and gynoecium of the plant; they often chew their way through the seed coat and enter the seed to devour the endosperm.

Larvae of the three species have a dorsal anal opening

on the ninth abdominal segment. Lema trilineata and L. jacobina larvae discharge excrement onto the back until it piles up and covers the entire dorsal surface. Larvae of L. simulans do not develop excrement mounds which may be the result of the fluid content within the spathes where they feed. It is possible that the mounds are a protective device. Another possible defensive phenomenon occurs when the larvae are disturbed tactually; a brown liquid, similar to that found in the crop, is ejected from the mouth and may have an offensive odor or taste to attacking enemies.

Larvae of the three species pass through four instars (table 4). The mean lengths of the first, second, and third stadia of L. trilineata were 1.2, 1.3, and 1.7 days respectively. These stadia were similar to the mean lengths of the same periods for L. jacobina which were 1.6, 1.5, and 1.9 days. These same stadia for L. simulans were found to be one to two days longer--3.3, 2.6, and 2.9 days. The fourth stadium of L. simulans was identical in mean duration to that of L. trilineata (7.6 days) while the fourth stadium of L. jacobina was approximately one day shorter (6.2 days).

Between one and six days after the start of the fourth stadium, larvae of each species entered the soil in the cages, formed cocoons, and began non-feeding prepupal periods. The duration for the prepupal stage in L. jacobina and L. simulans was 3.2 and 3.1 days respectively, but trilineata averaged approximately one day longer (4.4 days) (table 5).

Pupae. At the end of the prepupal period the last larval skin was shed and the pupa emerged. The means of the pupal periods for L. trilineata, L. simulans, and L. jacobina were 5.6 days, 5.9 days, and 6.3 days respectively. The mode of the pupal periods for each species was six days. The mean length of time spent by L. trilineata from time of hatching to adulthood was 17.7 days while L. jacobina and L. simulans averaged 16.7 and 21.9 days respectively. Adults were observed to remain in the cocoons, sometimes for several days, before emerging. Adults of L. trilineata and L. jacobina remained an average of 2.3 days in their cocoons as compared to adult specimens of L. simulans which had a mean pre-emergence time of 1.4 days (table 5).

Larval Descriptions

General Appearance. The fourth instar larvae of the three species, L. trilineata, L. simulans, and L. jacobina, are generally similar. They possess nine pairs of spiracles, pseudopods on all abdominal segments except the ninth, a dorsal anal opening on the ninth abdominal segment, a distinct frons bearing eight setae, twelve stemmata, six-toothed mandibles, and a large dorsal sclerite on the prothorax.

L. trilineata is generally larger than the other species, the length varying between 5mm. and 6mm. and the greatest width ranging from 2.5mm. to 3.5mm. The length of L. jacobina larvae varies between 4mm. and 5mm. while the greatest width

ranges from 2.5mm. to 3mm. The length of L. simulans larvae is approximately the same as that of the larvae of L. jacobina but the greatest width varies from 2.0mm. to 2.5mm.

Cephalic Features. The head capsules of 4th instar larvae differ in color and texture; L. trilineata has a dark brown and shiny capsule, L. simulans has a capsule of golden yellow with a brownish tinge, and L. jacobina has a nodulated, light brown capsule.

Fourth instar larvae of L. simulans and L. jacobina have a distinct fronto-clypeal suture, but this suture is not well-defined on L. trilineata. The labrum of each species differs in the number of setae borne on the ventral surface; L. trilineata possesses four, L. simulans has six, and L. jacobina bears twelve. The sixth mandibular tooth of L. trilineata and L. jacobina is reduced to a knob while the sixth mandibular tooth of L. simulans is vestigial.

Prothorax. The chaetotaxy on the large dorsal sclerite of the prothorax differs between species. L. trilineata has an anterior dorso-lateral row of 12 setae (six on either side of the meson), a posterior dorso-lateral row of six (three on either side of the meson), and one on the ventral tip of the sclerite on either side of the body. L. simulans has a mid-dorsal pair on either side of the meson, an anterior dorso-lateral row of ten (five on either side of the meson), and a posterior dorso-lateral row of eight (four on either side of the meson). L. jacobina has only the two dorso-lateral rows;

12 in the anterior row (six on either side of the meson) and eight in the posterior row (four on either side of the meson). Each episternum and epimeron of the prothorax of L. trilineata bears two setae as compared to L. simulans and L. jacobina whose prothoracic episterna and epimera bear single setae.

Mesothorax. The general setal pattern of the mesothoracic dorsum of L. trilineata is constant, but setal numbers vary from specimen to specimen. The mesothoracic dorsum of L. trilineata may have from 32 to 36 setae arranged as follows: four to six in a dorso-lateral row on either side of the meson; two on a small sclerite dorsal to each spiracle; a group of three or four posterior to each spiracle, the most anterior two of which are borne by a single sclerite; a single seta on either side of the meson ventral to this grouping; and five ventral to each spiracle, four in a group near each spiracle and the fifth immediately ventral to these. The mesothoracic dorsum of both L. jacobina and L. simulans bears 22 setae: L. jacobina has a dorso-lateral row of 12 (six on either side of the meson), one pair ventral to the dorso-lateral row on either side of the meson, one pair ventral to each spiracle, and one seta immediately dorsal to the pleuron on either side of the meson. The notal chaetotaxy of the mesothorax of L. simulans is identical to that of L. jacobina with the exception of having the most lateral two setae in the dorso-lateral row on either side of the meson displaced somewhat posteriorly. The mesothoracic episternum of L. trilineata is bare, but the epimeron bears

two setae. The mesothoracic pleura of L. simulans and L. jacobina are similar; epimera and episterna are present with each epimeron bearing one seta while each episternum is bare.

Metathorax. The number of setae on the metathoracic dorsum of L. trilineata is as variable as on the mesothorax. There are approximately 26 setae present in the following arrangement: a dorso-lateral row of four or five on either side of the meson, a group of three or four on either side of the meson ventral to the dorso-lateral row, a single seta on either side of the meson ventral to the latter grouping, and two or three setae on either side of the meson that are dorsal and slightly anterior to the episternum. Except for the mesothoracic spiracle, the metathorax and mesothorax of L. jacobina are similar. Beside the absence of spiracles, the metathorax of L. simulans differs from the mesothorax in lacking the paired setae that are ventral to each spiracle. The metathoracic epimera and episterna of the three species are identical to those of the mesothorax.

Abdomen. Abdominal segments one through eight of L. trilineata and L. simulans are variable. The general setal pattern is constant, but setal numbers vary from specimen to specimen and from segment to segment on any specimen. The first abdominal dorsum of L. trilineata is usually different from those of abdominal segments two through eight. The most consistent arrangement on the first abdominal dorsum is with an anterior dorso-lateral row of six setae (three on either

side of the meson), a posterior dorso-lateral row of eight setae (four on either side of the meson), and a group of four setae ventral to each spiracle. Abdominal segments two through eight usually have the dorsum bearing an anterior dorso-lateral row of four setae (two on either side of the meson); a posterior dorso-lateral row of six setae (three on either side of the meson); a group of three setae dorsal to each spiracle in a horizontal row (the anterior two often paired and arising from a single sclerite as well as occasionally with the posterior seta being displaced dorsally so as to fall in line with the posterior dorso-lateral row); and a group of four or five setae ventral to each spiracle. A typical abdominal dorsum of L. simulans has 18 setae: an anterior pair separated by the meson, a posterior dorso-lateral row of six (three on either side of the meson), a group of three dorsal and slightly posterior to each spiracle, and a pair ventral and slightly posterior to each spiracle. The dorsum of abdominal segments one through eight of L. jacobina are similar. Each bears 20 setae arranged in a posterior dorso-lateral row of six (three on either side of the meson), an anterior pair separated by the meson, one dorsal and slightly posterior to each spiracle in segments two through eight, and a pair immediately ventral to and slightly posterior to each spiracle. The ninth abdominal segment of L. trilineata usually bears eight setae; three on either side of the meson in a curving dorso-lateral row, and one at each lateral edge of the anal opening. L. simulans has

ten setae on the ninth abdominal segment: two on either side of the meson anterior to the anal opening, two on either side of the meson posterior to the anal opening, and one at each lateral edge of the anal opening. The ninth abdominal segment of L. jacobina bears six setae: a pair on either side of the meson anterio-dorsal to the anal opening and one on either side of the meson posterior to the anal opening.

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Table 1.--Dyar's Law calculations for the head capsule widths in millimeters for L. trilineata, L. simulans, and L. jacobina.

Instar	Dyar's Law Calculation	Observed Mean
<u>Lema trilineata</u>		
1	-- -- --	0.44
2	1.44 x 0.44 = 0.63	0.61
3	1.44 x 0.63 = 0.91	0.94
4	1.44 x 0.91 = 1.31	1.30
<u>Lema simulans</u>		
1	-- -- --	0.37
2	1.32 x 0.37 = 0.49	0.47
3	1.32 x 0.49 = 0.65	0.66
4	1.32 x 0.65 = 0.86	0.85
<u>Lema jacobina</u>		
1	-- -- --	0.39
2	1.36 x 0.39 = 0.53	0.54
3	1.36 x 0.53 = 0.72	0.76
4	1.36 x 0.72 = 0.98	0.97

Table 2.--Measurements of 100 eggs of L. trilineata, L. simulans, and L. jacobina.

	Length in millimeters		
	Maximum	Minimum	Mean
<u>L. trilineata</u>	1.21	0.93	1.14
<u>L. simulans</u>	1.13	0.83	0.97
<u>L. jacobina</u>	1.11	0.81	0.92
	Width in millimeters		
	Maximum	Minimum	Mean
<u>L. trilineata</u>	0.61	0.49	0.55
<u>L. simulans</u>	0.50	0.39	0.45
<u>L. jacobina</u>	0.56	0.40	0.49

Table 3.--Egg incubation periods for L. trilineata, L. simulans, and L. jacobina.

	Number Eggs	Days			
		Maximum	Minimum	Mode	Mean
<u>L. trilineata</u>	100	5	3	4	4.0
<u>L. simulans</u>	84	6	2	5	4.5
<u>L. jacobina</u>	304	6	2	4	4.4

Table 4.--Stadia-days for L. trilineata, L. simulans,
and L. jacobina.

	Number Individuals	Days			
		Maximum	Minimum	Mode	Mean
1st Stadium					
L. trilineata	100	2	1	1	1.2
L. simulans	59	7	2	3	3.3
L. jacobina	142	4	1	2	1.6
2nd Stadium					
L. trilineata	100	3	1	1	1.3
L. simulans	43	7	1	2	2.6
L. jacobina	114	4	1	1	1.5
3rd Stadium					
L. trilineata	100	3	1	2	1.7
L. simulans	33	7	2	2	2.9
L. jacobina	92	7	1	1	1.9
4th Stadium					
L. trilineata	60	10	5	7	7.6
L. simulans	16	9	6	7	7.6
L. jacobina	13	8	5	6	6.2

Table 5.--Duration of various life history stages of L. trilineata, L. simulans, and L. jacobina.

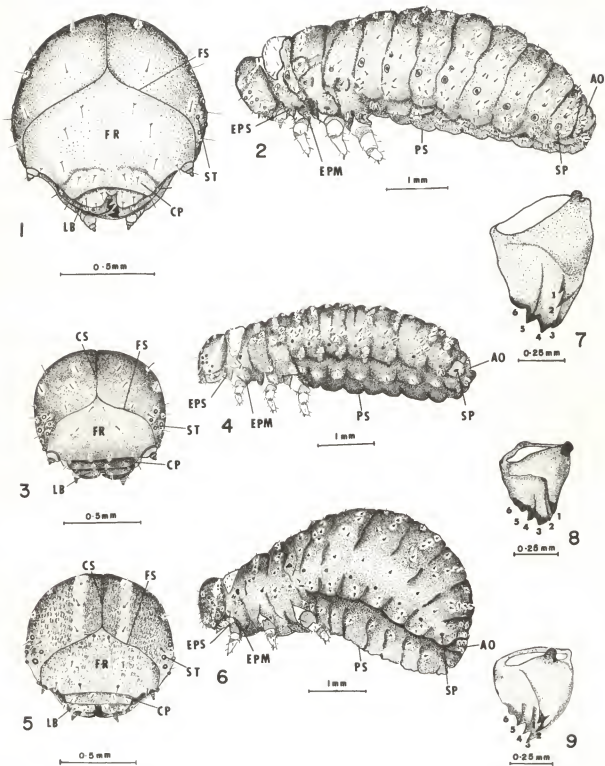
	Number Individuals	Days			
		Maximum	Minimum	Mode	Mean
Prepupa					
L. trilineata	29	7	3	4	4.4
L. simulans	32	4	1	3	3.1
L. jacobina	41	5	2	3	3.2
Pupa					
L. trilineata	69	7	2	6	5.6
L. simulans	31	6	5	6	5.9
L. jacobina	39	8	5	6	6.3
Larva and Pupa					
L. trilineata	68	22	16	18	17.7
L. simulans	18	24	18	20	21.9
L. jacobina	38	23	14	16	16.7
Pre-Emerged Adults					
L. trilineata	20	3	1	3	2.3
L. simulans	17	2	1	1	1.4
L. jacobina	28	4	1	2	2.3

EXPLANATION OF FIGURES 1 - 9

- Fig. 1. Lema trilineata (Olivier), frontal view of fourth instar head capsule.
- Fig. 2. Lema trilineata (Olivier), lateral view of fourth instar larva.
- Fig. 3. Lema simulans Schaeffer, frontal view of fourth instar head capsule.
- Fig. 4. Lema simulans Schaeffer, lateral view of fourth instar larva.
- Fig. 5. Lema jacobina Linell, frontal view of fourth instar head capsule.
- Fig. 6. Lema jacobina Linell, lateral view of fourth instar larva.
- Fig. 7. Lema trilineata (Olivier), ental view of right mandible of fourth instar larva.
- Fig. 8. Lema simulans Schaeffer, ental view of right mandible of fourth instar larva.
- Fig. 9. Lema jacobina Linell, ental view of right mandible of fourth instar larva.

ABBREVIATIONS USED IN FIGURES 1 - 9

AO - Anal opening	PS - Pseudopod
CP - Clypeus	SP - Spiracle
CS - Cranial suture	ST - Stemmata
EPM - Epimeron	
EPS - Episternum	
FR - Frons	
FS - Frontal suture	
LB - Labrum	



EXPLANATION OF FIGURES

- Fig. 10. Larva of Lema jacobina as it appears within the cocoon up to the time of hystolysis.
- Fig. 11. Larva of Lema jacobina as hystolysis occurs.
- Fig. 12. Pupa of Lema jacobina as last larval skin is shed.
- Fig. 13. Pupa of Lema jacobina.



Fig. 10



Fig. 11



Fig. 12



Fig. 13

EXPLANATION OF FIGURE

Fig. 14. Damage done to Physalis virginiana var. sonare (Torre) Waterfall by Lema trilineata adults.



Fig. 14

EXPLANATION OF FIGURES

- Fig. 15. Damage done to Commelina erecta F.
by Lema simulans adults.
- Fig. 16. Damage done to Commelina erecta F.
by Lema jacobina adults.

Fig. 16



Fig. 15



A LIFE HISTORY STUDY OF THREE
SPECIES OF THE GENUS LEMA
(COLEOPTERA: CHRYSOMELIDAE)

by

DAROL LEE KAUFMANN

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The life history and biology of Lema trilineata (Olivier) are covered very generally in the literature. Lema trilineata was at one time a major pest of the potato. Lema simulans Schaeffer and Lema jacobina Linell are of no known economic importance and their life histories and biologies are previously unmentioned.

Adults were collected in the Hunter's Island area south of Manhattan, Kansas. Mating pairs were caged and allowed to oviposit on cuttings of the host plants. As larvae emerged from the eggs they were placed in 5 cm. plastic boxes for rearing. Moisture was supplied by wetting small pieces of filter paper cut to fit snugly into the boxes. The boxes were inspected daily to record changes in instar either from exuviae or from head capsule measurements. Reared adults were caged in screen containers in an outdoor insectary where egg-laying and over-wintering data could be collected under more natural conditions.

At Hunter's Island trilineata was feeding on Physalis virginiana var. sonare (Torre) Waterfall. L. simulans and L. jacobina were feeding in this same area on Commelina erecta F., a common dayflower. Adults of L. jacobina and L. trilineata damage their host plants by chewing irregular holes through the leaves; L. simulans adults chew long narrow furrows into the leaf surface.

Both L. simulans and L. jacobina had continuous generations in the Hunter's Island area; L. trilineata had two generations,

one in June and one in August. Data collected under insectary conditions indicate that these species overwinter in the adult stage.

Larvae of L. trilineata and L. jacobina display feeding habits similar to those of the adults. L. simulans larvae, however, feed within the closed spathes of the host plant.

Larvae of L. jacobina and L. trilineata develop mounds of excrement on their backs; larvae of L. simulans do not, possibly as a result of the environment in which they live. A spurt of brown material similar to that found in the crop comes from the mouth when the larvae are disturbed tactually. The liquid thus ejected may have an offensive odor or taste to attacking enemies.

Larvae pass through four instars. The range of the first, second, and third stadia was between one and three days.

The fourth instar larvae of the three species are generally similar. They possess nine pairs of spiracles, pseudopods on all abdominal segments except the ninth, a dorsal anal opening on the ninth abdominal segment, a distinct frons bearing eight setae, twelve stemmata, six-toothed mandibles, and a large dorsal sclerite on the prothorax.

Between one and six days after the start of the fourth stadium, larvae of the three species entered the soil at the base of the host plant to form cocoons. After the cocoons were formed the larvae began a non-feeding prepupal period. At the end of the prepupal period the last larval skin was

shed and the pupa emerged. Adults remained in the cocoons, sometimes for several days, before emerging.