THE LIFE HISTORY AND CONTROL OF THE BOXELDER BUG (*LEPTOCORIS TRIVITTATUS* (SAY) (COREIDAE), WITH SPECIAL REFERENCE TO KANSAS

by

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OBJECT OF INVESTIGATION

The present investigation was undertaken to determine the life history of the boxelder bug, Leptocoris trivittatus (Say), its food habits, the extent of damage caused by it in ordinary and extreme cases and what measures are effective in controlling it.

GENERAL REMARKS

The boxelder bug is one of the oldest and more commonly known insects throughout a greater part of the United States. Its habit of hibernating in houses, especially around windows and foundations (Fig. 10) makes it a disagreeable household pest during the fall, winter and spring.

The boxelder bug has been reported from some sections of the United States as a serious pest on apples, plums, peaches, grapes, strawberries and flowers. The insect does no appreciable damage however to such products in Kansas. A great many letters and inquiries are received by the department of Entomology asking for information on control measures for the insect. The relatively large number of letters received by the department of Entomology at Kansas State College gave an additional impetus for the study of the boxelder bug.

REVIEW OF LITERATURE

The boxelder bug has been the subject of considerable discussion in farm journals and papers of a semi-popular nature. Much of this writing is in the form of short articles discussing the general habits and probable measures of control. There are no published reports of a detailed study of the boxelder bug in the literature.

The original description was written by Thomas Say and published in the Journal of the Academy of Natural Science of Philadelphia in 1825 (Say, 1825) (LeConte, 1859). The specimens for this description were collected by him, while with Major Long's expedition to the Rocky Mountains in 1819-20, at "Engineer Cantonment" which was near the present site of Omaha, Nebraska, on the west side of the Missouri river (Popenoe and Marlatt, 1888).

Say originally placed the boxelder bug in the family Lygaeidae, it later being placed by Stal in the family Coreidae (Stal, 1870).

The first real outbreak of the insect was reported October 22, 1891, from Columbia County, Washington, by I.N. Newkirk (Riley and Howard, 1892). Newkirk reported the insect as doing much damage to fruit such as apples, plums, grapes and peaches. Riley and Howard recommended the use of a dilute kerosene-soap emulsion for the control of the insect.

Popenoe and Marlatt in the First Annaul Report of the Kansas Experiment Station (1888) report the insect as being very numerous and to have been observed feeding on many plants such as ash, maple, ampelopsis, geranium, cacti, lilies, coleus and ageratums as well as on many other plants. They included a plate of illustrations showing the eggs, nymphs and adult forms.

The insect was reported from North Dakota in 1894 as having occurred in outbreak proportions (Lintner, 1894). The wingless nymphs were described as occurring in patches varying from four or five feet to sixty feet in diameter and "forming a deep, writhing mass".

In 1898, Gillette states that he had tried kerosene emulsion, whale-oil soap, tobacco decoctions, zenoleum and pyrethrum all very strong, and with no effect except to make the bugs uncomfortable for a time. He states that whale-oil soap or kerosene emulsion may kill the nymphs.

Aldrich (1898) observed that the boxelder bug began mating about April 17 and that one week later eggs were found attached by the side to the boxelder trees and also attached to last-year strawberry leaves, at a distance of fifty yards from any boxelder trees.

The boxelder bug was quite widely distributed by 1898. Howard reported it as being known from Colorado, Arizona, California, Kansas, Missouri, Utah, and Mexico by 1880. In 1881 it was reported from Iowa. By 1887 there was no record of the insect east of the Mississippi river. In 1889 it was reported from Nebraska; 1891 from Washington State, Texas, Idaho, North and South Dakota, Minnesota, Wisconsin and Illinois; and in 1894 from Pennsylvania (Howard, 1898).

Milliken (1911) discussed the history and methods of prevention of this annoying insect. He suggests the bug may have come from Mexico and that it probably was present here before 1820, but was not reported due to lack of competent observers.

Some of the more recent observations made on the habits of the boxelder bug were made by Long in 1928. He observed that the insect showed a decided preference for the pistillate boxelder tree for feeding and place of oviposition. He reported that trees standing in the same yard with branches almost touching showed bugs only on the pistillate type of tree. He observed that the eggs were deposited on the fruit, usually in groups of three to eight, with only one group of eggs on each bunch of fruit. The eggs were glued flatwise to the side of the samara on the wing, in the curve just below the seed kernel and at the edge of the midrib of the fruit. Long suggests as a control of the boxelder bug the propagation of the boxelder tree from cuttings and thus grow only staminate trees.

Webster (1926) reported the boxelder bug as "sucking the juice out of all our apples" at Berrian and that they were thickest on Red June and Delicious apples in Benton County, Washington.

The bug has been reported as damaging tulip bulbs (Swenk, 1929).

McDaniel (1933) reports that the boxelder bug has increased steadily for the last three seasons in several sections of Michigan. She reports that some authorities contend that only eggs deposited in opening buds of the pistillate boxelder trees hatch and produce young. She states that when the bugs feed on fruit they cause it to become dimpled and deformed; that the young bugs feed through the summer and by early fall have completed their growth. McDaniel states that "the elimination of boxelders in the vicinity of houses would settle the local question of control measures for all time".

Deay (1928) in his taxonomic work on the Coreidae of Kansas found that the claspers of the genital capsule of the male are constant in the species and are of decided taxonomic value (Fig. 1).

Hutson (1932) of the Michigan State College reported an infestation of boxelder bugs on everbearing strawberries. The eggs, nymphs and adults being found on the plants. The nymphs and adults were feeding on the foliage and fruit with the result that the entire crop was lost and great apparent damage to the plants. Many plants were killed outright.

A review of the literature on the boxelder bug indicates that the insect has been and still remains a pest of considerable consequence and that further study and observation are needed.

DESCRIPTION

Original Description

Thomas Say, in the Journal of the Academy of Natural Science of Philadelphia, first described the boxelder bug as follows:

"*Lygeaus trivittatus*. Black, thorax trilinate, and hemelytra marginate with rufous. Inhabits Missouri. Body black; eyes and stemmata sanguineous; thorax mutic; two indented transverse lines near the head of which the anterior one is curved in the middle; three bright rufous lines, of which two are marginal; posterior edge obscurely rufous; hemelytra, cariaceous portion with a rufous exterior and posterior margin, membranaceous tip immaculate; trochanters rufous; tergum rufous with three lateral black punctures; venter, margin and middle rufous. Length, nine twentieths of an inch. Taken at Engineer Cantonment."

Egg

The egg of the boxelder bug is light straw color when first oviposited. It turns darker brown color within a few hours and gradually becomes darker red until it is dark reddish brown color before it hatches. The egg is oval in outline and averages 1.48 mm. in length and 0.86 mm. in diameter. Measurements of 50 eggs were taken with the following results:

Maximum length 1.66 mm.	Maximum width 1 mm.
Average length 1.48 mm.	Average diameter 0.86 mm.
Minimum length 1.3 mm.	Minimum diameter 0.766 mm.

The egg has a distinctly marked cap at one end which is nearly as large as the end of the egg. In this cap occurs a circular structure, the micropyle (Fig. 3).

Nymphal Stages

The nymph upon emergence from the egg is a bright red individual. The antenna, legs, head and thorax soon turn darker reddish color. The nymph is sparsely covered with short bristly hairs. The length of the nymph at hatching is approximately 1.6 mm. The abdomen becomes larger with nymphal feeding. For indications of instars and moulting, the nymphs were measured between the external margins of the compound eyes. This measurement is comparatively uniform in each instar.

The nymphs of the second and third instars are very similar in appearance to those of the first instar. The antenna, head, legs and thorax are slightly darker red than in the first instar.

The nymphs in the fourth instar have small slate colored wing pads which may be seen through the outer covering of the thorax. The posterior tip of the wing pads are not free in this instar (Fig. 6).

The wing pads are darker slate color and are free at the posterior tips in the fifth instar. The small pads cover approximately one-fourth of the abdomen. The legs and antenna during this instar become almost black.

The elongate, slate black wing pads project backward from the thorax over each side of the front one-third of the abdomen, in the sixth instar. The body of the nymph in this instar becomes darker red and is light slate color on a small portion of the dorsal side.

Adults

The adult boxelder bug has an elliptical body, with a pointed head which bears a projecting eye on each side. The color at moulting is bright red, which gradually changes to slate black on the dorsal side, except the compound eyes and ocelli, which remain red. The three stripes which give to the insect its specific name (one on the middle line of the thorax and one on each margin of the body from the head to the outer corner of the thickened base of the wings) and a V formed by the stripes that converge forward where the thick and thin parts of the wings unite, remain a reddish color. The red color is retained, on the ventral surface, on the coxae, the posterior margin of the metathorax, the median line of the abdomen to the last segment, and the outer margins of the abdomen to the last segment. The part of the body covered by the wings also remains red. The legs are slender and the four-segmented antennae are elbowed, with the distal segment of each slightly enlarged (Fig. 8).

SEX DIFFERENCES

The sexes of the boxelder bug may be distinguished by the genitalia and the size of the body. The genital capsule of the male, from the ventral aspect, reveals a pair of claspers. There is also a projection, from the ninth abdominal segment, on each side of the claspers (Fig. 9). This gives the abdomen of the male the appearance of having four distinct projections at the posterior end. These projections on the abdomen make the male easily distinguished from the female, which has no special structures of the genitalia visible from the ventral aspect, other than a tubular segmentation. The female boxelder bug is slightly larger than the male. The variation in size is shown in

Table I.

Table I. Variation in Size of 100 Adult Male and Female Boxelder Bugs.

	Body length in mm.		Width of thorax		Width across eyes	
	Male	Female	Male	Female	Male	Female
Maximum	12	14.5	4.5	5.0	2.3	2.33
Average	11.43	13.18	4.06	4.66	2.1	2.18
Minimum	10	12	3.5	4.0	2.0	2.0

SEX RATIO

There is a predominance of females in this species of insect. Five hundred fifty insects were collected on the east agricultural hall in November, 1932, and the sex determined. Three hundred fifty-two or 64 per cent were females. Four hundred fifty insects were collected and determined for sex in March, 1933, and of this number two hundred seventy-five or 61 per cent were females.

CLASSIFICATION

The boxelder bug is known as _Leptocoris trivittatus_ (Say), being originally described by Say as _Lygaeus trivittatus_ in 1825 (Say, 1825). Stal (1870) placed the insect in the genus <u>Leptocoris</u>. VanDuzee (1917) listed it under the tribe <u>Leptocorini</u>, family <u>Coreidae</u>, genus <u>Leptocoris</u>, species <u>trivittatus</u>. Blatchley (1926), listed it in the superfamily <u>Coreoidae</u>, tribe <u>Leptocorini</u>, family <u>Corizidae</u>, genus <u>Leptocoris</u>, species <u>trivittatus</u>. Brues and Melander (1932) listed the insect under the family <u>Alydidae</u>, genus <u>Leptocorisa</u>, species <u>trivittata</u>.

Specimens sent to the Bureau of Entomology, U.S.D.A., Washington, D. C., were identified by H. G. Barber of the taxonomy staff and classified in the same manner as Van-Duzee lists them.

The accepted common name for this insect is "boxelder bug". The insect is often spoken of as the "pop" bug, "populist" bug or the "democrat" bug. In the South it is often mistakenly called the "cotton stainer".

OVERWINTERING HABITS

The boxelder bug overwinters in the adult stage. The more noticeable hibernating places at Manhattan, Kansas, were found to be around the foundations and windows of buildings. The bugs commonly hibernate under leaves and other debris which has gathered under hedges, in road ditches and in other similar places. They were also observed hibernating in old buildings, in lumber and wood piles, in clay banks, under the bark and in hollows in trees.

The bugs began to seek places of shelter about October 1, 1932. By the middle of October, great numbers of the bugs were seen clustering on the south and west sides of the stone buildings on the campus. Many bugs were seen clustering and swarming along clay banks, on Wildcat and Cedar creeks near Manhattan, and going into hibernation in much the same places as do certain wasps (*Polistes* sp.). On warm days throughout the winter the bugs appeared in clusters outside their places of hibernation around buildings. A seldom used room, in a residence in Waldo, Kansas, was heated on November 28, 1932, and many boxelder bugs appeared. Some of the bugs were crushed on the rug and upholstered furniture, causing much discomfort and embarrassment to the lady of the house. The habit of crawling into the house throughout the fall, winter and spring makes the bug a very annoying pest.

At Manhattan in 1933 the insects began to leave their places of hibernation about the last week in March and by the middle of April practically all had left their hibernation quarters. The bugs feed approximately two weeks before copulation and oviposition takes place.

DISTRIBUTION

The boxelder bug has been reported in the United States from 27 states; namely, Washington, Oregon, California, Idaho, Utah, Arizona, New Mexico, Colorado, Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Michigan, Ohio, Indiana, Kentucky, North Carolina, Maryland and Pennsylvania. It has been reported from Mexico and three provinces of Canada; namely, Quebec, British Columbia and Saskatchewan.

The insect has not been reported from the states of Wyoming, Nevada, Arkansas and Louisiana west of the Mississippi river, but considering its reported distribution it is logical to assume that it is present in at least Wyoming and Nevada. The insect has not been reported south of North Carolina in the southeastern one-fourth of the United States. It has not been reported from the New England states. Since the boxelder bug, however, is found in Ottawa, Canada, Pennsylvania, Maryland and North Carolina, it probably is also present in New York State, West Virginia and Virginia.

The insect was not reported east of the Mississippi river before 1887, but since that time has spread north and eastward.

LIFE HISTORY STUDIES

The life history studies of the boxelder bug were begun during the last week of September, 1932. General observations were made as to the feeding habits, place and time of hibernation. Boxelder cuttings were planted, on October 10, in pots of moist sand, to provide host plants for rearings. These cuttings took root slowly and did not leaf out until about December 20. Strawberry plants were set in pots and these with the boxelder cuttings served as host plants for the bugs during the late winter and early spring. The rearings were carried on in the greenhouse until April 15 when similar experiments were carried on out of doors.

Approximately 150 adult insects were collected, in late October, and placed in an electric refrigerator for cooling and freezing so that they might be placed in the greenhouse in order to get early oviposition. The insects were left in the refrigerator for six weeks, because of what was then thought to be a lack of suitable host plants, and all died.

Bugs were collected on warm days during the winter and placed in screen cages, which were placed over growing boxelder and strawberry plants in the greenhouse. The warm temperatures of the greenhouse had little effect upon the bugs and no eggs were laid until March 23, which was only four weeks earlier than those found in natural conditions. A few eggs were laid early, but no nymphs were reared to the adult stage from these eggs.

The most successful rearings were conducted on leaves and stems confined in small fruit jars and jelly glasses. Newly hatched and freshly molted nymphs were placed in the jars, fed and observed daily. The leaves and stems of boxelder, pin oak, soft maple, pigweed and crabgrass were used for food. In order to determine the various instars and molts, the nymphs, other than newly hatched ones, were measured under the wide field binoculars and their head measurements recorded. The date of each molting was recorded and the nymph measured again if any question arose as to its particular instar.

Dyar's law was applied in checking the number of instars through which the boxelder bug passed. The rate of increase between two successive molts was determined and then by the application of the law the number of molts was computed. The rate of increase between the fifth and sixth molts was found to be 0.83. A comparison of the observed widths of the head capsule and the calculated width is given in Table II.

Table II. Observed and Calculated Head Widths of Boxelder Bug.

Instar	Number of insects	Observed minimum measurement in mm.	Observed maximum measurement in mm.	Observed average measurement in mm.	Calculated measurement constant 0.83
First	55	0.56	0.66	0.64	0.68 (0.82xc)
Second	58	0.7	0.83	0.78	0.82 (0.99xc)
Third	41	0.86	1	0.9	0.99 (1.2 xc)
Fourth	62	1.1	1.26	1.17	1.24 (1.5 xc)
Fifth	91	1.43	1.6	1.51	1.51 (1.82xc)
Sixth	71	1.7	1.93	1.83	1.82 (2.2xc)
Seventh	100	2	2.33	2.18	

A comparison of the figures of the observed series with those of the calculated series indicates that no instars were omitted.

Results

Egg Period. The period of incubation of the boxelder bug was found to vary from 11 days to 19 days, the average length being 13.75 days. The length and variation in the period of incubation is given in Table III.

Table III. Incubation Period of the Boxelder Bug.

Date of oviposition	Date of hatching	Length of incubation period in days	Place of incubation	Number of eggs
1933				
Mar. 25	Apr. 8	14	Greenhouse	19
Mar. 27	Apr. 9-10	13 and 14	Greenhouse	38
Mar. 30	Apr. 13	14	Greenhouse	9
Mar. 30	Apr. 13	14	Adv.Laboratory	21
Apr. 28	May 12	14	Adv.Laboratory	10
Apr. 28	May 9-10	11 and 12	Greenhouse	27
Apr. 28	May 17	19	East Insectary	Large number, not counted
Apr. 30	May 14	14	Adv.Laboratory	12
May 14	May 26	12	Adv.Laboratory	32
May 14	May 28	14	East Insectary	10

The peak of oviposition for the spring generation of the boxelder bug, in the vicinity of Manhattan, was from April 20 to May 10, 1933. The greatest mating activity was observed April 27. The females laid their eggs in the immediate vicinity of the mating grounds. The eggs were observed on stones, leaves, grasses, trees and shrubbery. The majority of the eggs laid early in the season were deposited in the crevices of the bark of trees, especially on the underside of the pieces of bark. The old maple trees, which had rough bark, were especially favorite places for oviposition (Fig. 9). Many eggs were found on the undersides of twigs and limbs of pin oak. The bugs began depositing a considerable number of eggs on the leaves of pin oak about May 10, and a few were deposited on the leaves of soft maple and strawberry.

The boxelder bugs came out of hibernation and fed approximately two weeks before mating and laying their eggs. The females laid an average of about ten eggs each, which were placed singly or in more or less irregular clusters (Fig. 9). The clusters usually numbered from three to ten eggs. No female, kept alone in a rearing cage, laid over 12 eggs. The period of oviposition in most cases was confined to one day, the eggs, usually, all being laid within a few hours. One female was observed to lay five eggs within a period of 40 minutes. Females kept in the rearing cages were all dead within a period of 11 days after having laid their eggs.

A summary of the data taken on egg production, place of oviposition and length of the life of the female after oviposition is given in Table IV.

Table IV. Observation on Egg Deposition and Time Factors of the Boxelder Bug.

Female No.	Date of oviposition	No. of eggs	Place of oviposition	Date female died	Length of life after oviposition
	1933				
2	Mar. 25	9	Side of cage	Apr. 2	8
3	Mar. 25	12	Side of cage	Mar. 30	5
5	Mar. 25	7	Side of pot	Mar. 27	2
9	Mar. 30	12	Side of cage & on strawberry leaf	Apr. 8	9
10	Mar. 30	10	Side and top of cage	Apr. 10	11
14	Apr. 2	9	Side of cage	Apr. 10	8
15	Apr. 2	10	Side of pot	Apr. 10	8
21	Apr. 28	8	Side of cage	May 7	9
22	Apr. 28	11	Side of cage	May 8	10
24	Apr. 29	9	Side of cage	May 7	8
25	Apr. 29	9	Side of cage	May 1	2
26	May 14	11	Side of cage	May 21	7
30	May 14	10	Side of cage	May 24	10

The eggs were fastened flatwise with a glue-like substance as they were laid. The proximal end of the egg, characterized by the cap and micropile, is raised slightly from the substratum.

Nymphal Period. The nymphal period varies from 50 to 78 days, with an average length of 59.5 days. The time in days between molts is given in Table V.

Table V. Number of Days Between Molts in the Boxelder Bug.

	1st molt	2nd molt	3rd molt	4th molt	5th molt	6th molt	Total days hatching to adult
Maximum:	8	9	14	11	17	19	78
Minimum:	3	5	7	10	12	13	50
Average	4.3	6.1	9.3	10.5	14.3	15	59.5
No. of insects averaged	32	19	9	6	6	10	

<u>Number of Generations</u>. The number of generations of the boxelder bug in Kansas is not definitely known. Last September and October the writer observed many nymphs ranging from the third instar to newly molted adults. The nymphs hatched this spring (1933) were practically all in the adult stage by July 20. This evidence indicates that there are two generations in Kansas.

McDaniel (1933) of Michigan reports that the nymph feeds throughout the summer, reaching maturity in early fall, thus inferring that there is but one generation. Long (1928) of New Mexico, in reporting his observations, infers that there are two generations of the insects.

NATURAL CHECKS

Climatic

The effect of low temperature on the boxelder bug was tested by placing 185 adult insects in a cigar box and placing the box on the window sill of the laboratory. Fifty-seven insects or 31 per cent were killed by a temperature of ten degrees above zero. The balance were all dead after two consecutive nights with the temperature reaching ten degrees below zero.

A box containing approximately 150 bugs was placed in an electric refrigerator, in the dairy department, October 18, 1932, and maintained at an approximate temperature of 40° F. for one week, and then at an approximate temperature of from 8° to 20° F. below freezing for another week and then left at approximately 40° F. for four weeks. The insects were all dead when removed from the refrigerator.

Considerable numbers of the boxelder bugs were found dead, during February and March, in places of hibernation such as the underside of loose bark of the soft maple trees and just below the soil line in the crack between the earth and the foundation of the east agricultural hall.

It is apparent that the boxelder bug cannot withstand continued extreme cold for any length of time without considerable protection. During the winter of 1932-33 a temperature of 18° F. below zero was reached at Manhattan. This temperature apparently caused considerable winter-killing among these insects. Newcomer (1926) stated that a mild winter (minimum temperature of 12° F. above zero) killed practically no boxelder bugs in the Yakima Valley.

High summer temperatures appear to affect only the behavior of the boxelder bug. During the part of the day when the temperature was high, great numbers of the insects were found clustered under the edges of bark and around the base of trees. This was especially true of the older nymphs and adults. Many others and especially the younger nymphs were found under leaves and in the grass and weeds. The bugs remain near the ground during the heat of the day.

The boxelder bug is easily drowned. When they become wet, they are almost helpless. This is especially true of the smaller nymphs. Many small nymphs and a few large nymphs and adults were found dead on the ground after a hard rain on June 25 and July 8, 1933. There was a high rate of mortality with the nymphs kept in moist rearing jars. If a few drops of moisture formed in the jar the insect usually drowned.

NATURAL ENEMIES

Parasites. The boxelder bug is exceptionally free from insect parasites. Four hundred fifty-two eggs were collected from trees and hatched under observation, with no emergence of insect parasites. No black eggs, which is generally the color of those parasitized, were found.

McCulloch (1916) found the adult boxelder bug to have immense numbers of parasitic flagellates in the intestinal tract. Mature bugs showed 100 per cent infestation. McCulloch states that apparently the parasitic flagellates do no harm to the insect. Many of the bugs with which Miss McCulloch worked came from Manhattan.

Predators. Observations were made of robins, blackbirds, thrashers and sparrows feeding where the boxelder bugs were very numerous and in no instance was a bird seen to catch or eat any of the bugs. The boxelder bug when crushed gives off a pungent odor. This odor is produced by glands common to hemipterous insects. No predators except the spiders were observed to feed on the boxelder bug.

Fungus. Many dead boxelder bugs, which were collected out of doors and taken from the rearing cages, were examined for fungus. No evidence of death having been caused by fungi was found.

HOST PLANTS AND FOOD HABITS

Contrary to general belief the boxelder bug feeds on a wide variety of plants. It was observed feeding on 23 known plants; namely, soft maple, ash, pin oak, boxelder, tree of heaven, mulberry, honey locust, buckeye, linden, spirea, ampelopsis, cactus, lilac, honeysuckle, iris, hollyhock, geranium, tulip, peony, asparagus, pigweed, crab grass, foxtail grass, as well as on several unidentified weeds, shrubs and grasses. The writer observed the insect feeding especially on grasses, weeds and the fruit of soft maple. The insect has been recorded many times as feeding on such fruits as the apple, plum, grape and peach.

The boxelder bug is slightly cannibalistic. It also feeds on injured or dead bugs. The bugs were observed feeding on a dead cicada and on a ground beetle.

The boxelder bug pierces the tissue of a plant or fruit and sucks the juice from it. They cause much injury and even kill such plants as the strawberry (Hutson, 1932). Their feeding on ripening fruit causes it to become unsalable. Excessive numbers of the insect feeding on the fruit left it dry and fibrous.

Approximately 60 adult bugs were placed on a single fruit bearing strawberry plant. In five days the plant began to show noticeable signs of weakening, the three berries on the plant were entirely ruined by the work of the bugs in four days. This plant was kept well watered. A similar plant was infested with approximately 50 adult bugs. This plant was not watered excessively and at the end of a ten-day period the plant was almost dead.

MEASURES OF CONTROL

Remedial

Many insecticides have been reported as being used to control the boxelder bug, none of which has proved entirely satisfactory. Twelve insecticides were tested, in this work. A list of the insecticides with the results obtained under greenhouse conditions is given in Table VI.

Table VI. Insecticides With Results Obtained Under Greenhouse Conditions.

Insecticide	Strength	Stage of insect	Number of insects	Number dead in 8 hours	Number dead in 24 hours	Temperature	Humidity	Per cent dead
Black leaf 40	1-800	Adult	20	0	1	91	30	5
Black leaf 40	1-400	Adult	20	1	1	91	30	5
Black leaf 40	1-200	Adult	15	1	2	75	51	13
Black leaf 40	1-100	Adult	15	3	3	75	51	20
Black leaf 40	1-25	Adult	20	5	7	77	44	35
Kerosene	Pure	Adult	65	45	55	82	44	84
Kerosene	Pure	Adult	22	16	20	73	45	90
Kerosene	Pure	Adult	27	20	20	71	56	74
Kerosene	Pure	Small nymph	5	5 dead in 1 hr.				100
Kerosene	Pure	Small nymph	7	5 dead in 1 hr.	7 dead in 1 hr.			100
Kerosene and Black leaf 40	1-50	Adult	74	56	60	79	54	81
Superla		Adult	52	10	12	68	58	12
Flit		Adult	22	13	14	70	60	63
Raleigh Insect Powder		Adult	26	9	11	70	60	40
Fish oil soap	1/4 to 2½ gal.	Adult	32	4	5	78	52	15
Fish oil soap	½ to 2 gal.	Nymph	28	12	14	73	56	50
Fish oil soap nitotrol	½ to 2 gal. and 1-100	Adults	30	18	18	80	45	60
Laundry soap	½ to 2 gal.	Nymph	20	4	7	72	54	35
Pryrethrum powder		Adult	14	2	2	87	34	14
Cyanogas			12	10 dead in 1 hr.		74	40	83
Nicotrol	1-100	Adult	25	7		76	75	28
Nicotrol	1-50	Adult	21	8		76	55	38

A list of the insecticides with the results obtained under conditions comparable to natural conditions is given in Table VII.

Kerosene applied undiluted proved to be the most effective commercial product used for controlling the boxelder bug. The spraying of the adults so that they were damp with the oil gave a good kill. It was not necessary to apply the kerosene so heavily to obtain good results against the nymphs. Kerosene should not be applied to growing plants or flowers. Its application on the bases of trees seemed to have no ill effects.

The application of hot water (165° to 180° F.) was undoubtedly the most effective method of killing the bugs. The application of the hot water by pouring with a long handled dipper directly on the insects gave excellent control. Water at a temperature of 180° F. had no apparent damaging effects upon the tree when applied to the bugs as they were clustered about the base. The hot water treatment should be used on the bugs that cluster about the bases of trees and around windows and foundations.

The application of water in large quantities by dashing it on the bugs gave fairly good control. From the results obtained by this mode of application, it appears to the writer that the application of quantities of water which is

Table VII. Insecticides With Results Obtained under Natural Conditions.

Insecticide	Strength	Stage of insect	Number of insects	Number dead in 12 hrs.	Temperature	Humidity	Per cent dead
Kerosene	Pure	Large nymph and adult	28	17	58	68	60
Kerosene	Pure	Small nymph	15	13	78	78	86
Nicotrol	1-100	Large nymph	12	3	100	52	33
Nicotrol	1-50	Large nymph	19	12	94	66	42
Nicotrol	1-25	Nymph and adult	21	12	92	65	57
Black leaf 40	1-100	Large nymph	18	3	92	88	17
Black leaf 40	1-50	Large nymph	18	5	82	85	28
Flit		Large nymph	10	2	101	81	20
Raleigh Insect Spray		Large nymph	10	3	86	66	30
Fish oil soap	½ to 2 gal.	Large nymph	23	8	86	66	35
Fish oil soap and Nicotrol	½ to 2 gal. 1-100	Large nymph	25	16	95	67	64
Water	140° F.	Large nymph	10	At end of 20 min. 2			20
Water	165° F.	Large nymph	10	At end of 20 min. 2			80
Water	180° F.	Large nymph	17	At end of 20 min. 17			100

under pressure would drown a great many of the insects and aid measurably in their control.

The combination of fish oil soap and nicotrol gave the best results for the insecticides that could be applied to growing plants such as the strawberry or iris. This insecticide gave the best results when sprayed on the insects until they were moist with the solution. The best dilution was 1 to 100 with soap at one-half pound to two gallons. Nicotine sulphate (Black leaf 40) when used at the commonly recommended dilutions was found to be ineffective against all stages of the boxelder bug.

Prevention

Much of the damage and annoyance from the boxelder bug can be eliminated by the exercise of a few preventive measures. The boxelder bug nymphs were found to be very local in their distribution. Most of the bugs which were hatched on the campus remained near the place of hatching until their place of shelter was removed, after which the bugs moved about 100 yards to new shelter. This was an accumulation of leaves, along the stone wall of the east campus boundary. Inasmuch as the nymphs live in such places as accumulations of old leaves, grass and other debris, it follows that the removal of such protective covering will remove the pest from the immediate vicinity. The writer recommends the removal of such cover and grass and weeds from the near vicinity of strawberry plants, iris, peony and other garden flowers near residences as a valuable preventive measure against this insect.

The elimination of the boxelder trees near houses as recommended by McDaniel of Michigan and the use of only staminate boxelder trees as recommended by Long of New Mexico would be of little or no value as a control measure for the boxelder bug in Kansas. In the investigations made this spring and summer no eggs of the boxelder bug were found on the boxelder tree, nor any clusters of the bugs on the pistillate boxelder trees on the campus or near Manhattan. The best mode of prevention would appear, to the writer, to be the removal of shelter from the region or building to be protected.

SUMMARY AND CONCLUSIONS

The boxelder bug is known chiefly as a household pest in Kansas. The insect requires from 50 to 78 days for its growth from egg to adult. The egg undergoes an incubation period of approximately two weeks. The nymphs molt six times and the total average time for the molts is two months.

The nymphs spend a greater part of their lives in weeds, grasses and under accumulations of old leaves. The insect was observed feeding on 23 known plants as well as on several unidentified ones, but chiefly on weeds and grasses.

The two best methods of control appear to be through prevention by removal of cover, and the application of hot water, kerosene or a nicotrol soap solution.

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EXPLANATION OF PLATES

PLATE I.

Fig. 1. Male genitalia.

Fig. 2. Female genitalia.

Fig. 3. Egg (X24).

Fig. 4. First instar nymph (X15).

Fig. 5. Second instar nymph (X5.5).

Fig. 6. Fourth instar nymph (X5.5).

Fig. 7. Sixth instar nymph (X5.5).

Fig. 8. Adult.

PLATE I.

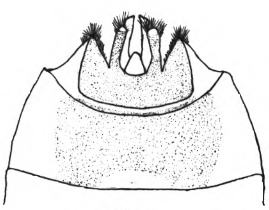
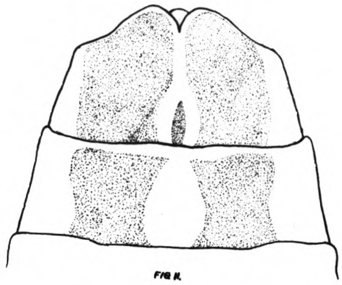


FIG. I.



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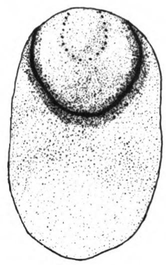
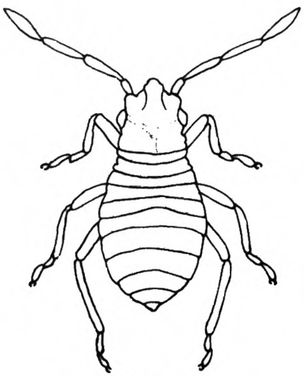


FIG III.



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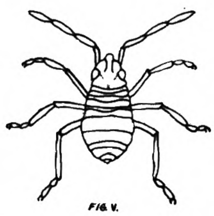

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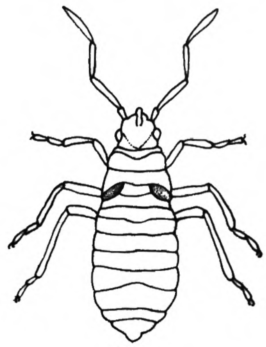

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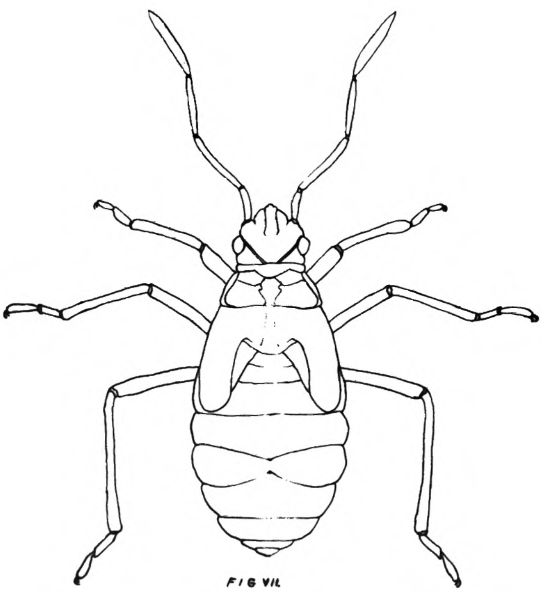

FIG VII.

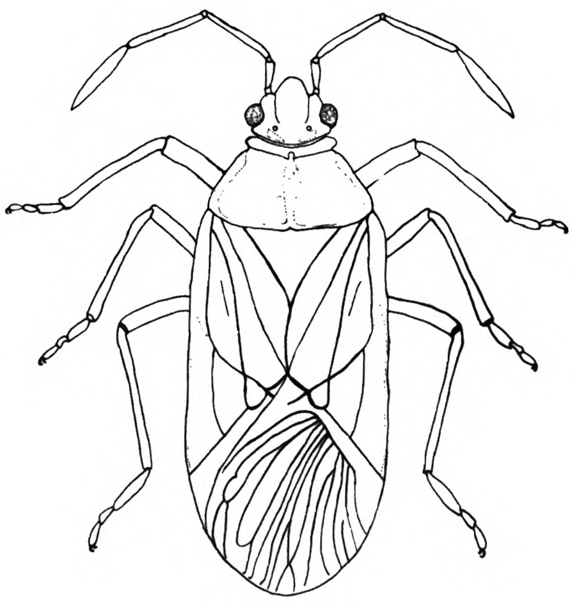

FIG. VIII.

Fig. 9. Egg mass on bark.

PLATE II.

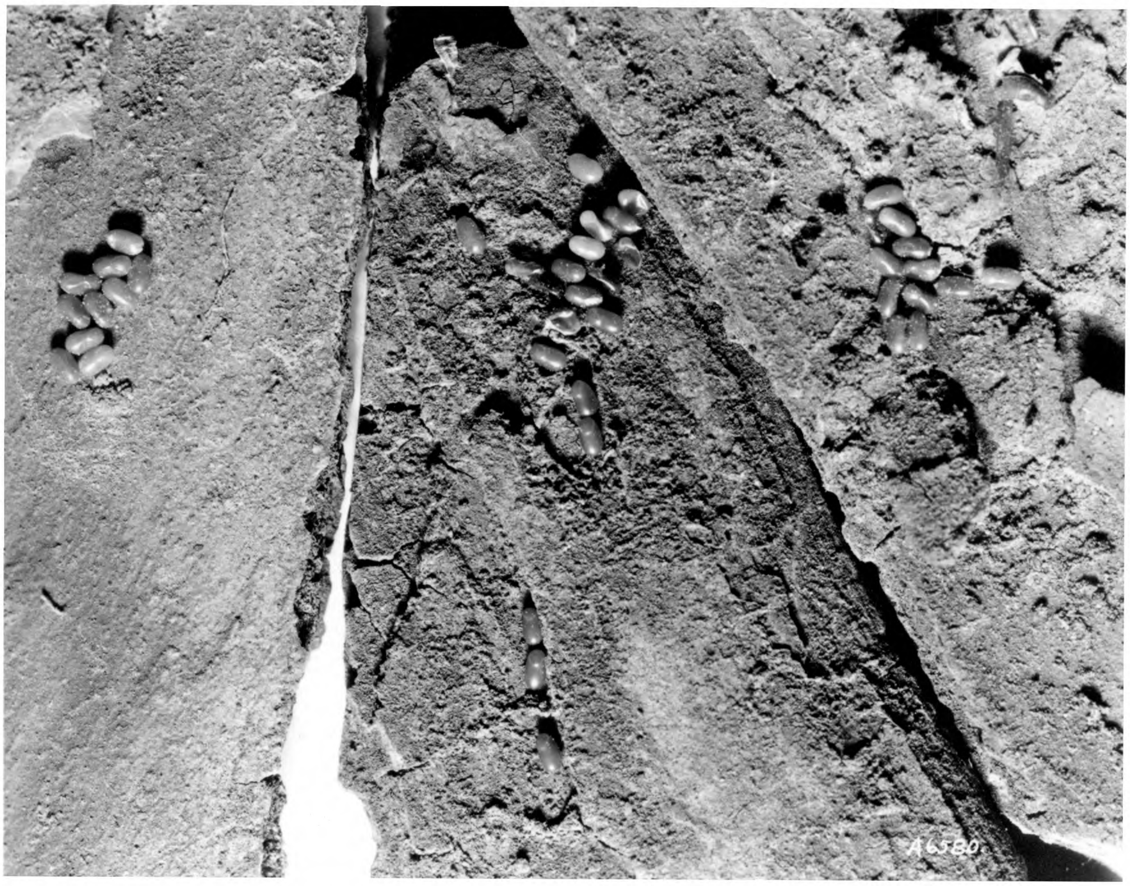

Figure 9.

PLATE III.

Fig. 10. Clusters of boxelder bugs.

PLATE III.

Figure 10.