THE BIOLOGY OF STERNECHUS PALUDATUS (CASEY)

(Coleoptera-Curculionidae)

by

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INTRODUCTION

Nothing heretofore has been published on the biology of Sternechus paludatus (Casey) as a careful examination in the United States Bureau of Entomology Library has confirmed.[1] Relatively little is known about the life history and habits of this weevil. The ease with which it leaves its wild host, the New Mexican black locust, Robinia neomexicana (Gray) to feed upon the bean plant, Phaseolus vulgaris L., and the increased numbers in which this weevil has been found on this domesticated host in the past four or five years are sufficient causes for much concern about its future economic importance.

The author became interested in the biology of Sternechus paludatus (Casey) when assigned work in June 1930 at the bean insect laboratory at Estancia, New Mexico, under the direction of Mr. J. R. Douglass, Associate Entomologist, Bureau of Entomology, United States Department of Agriculture. During the summers and falls of 1930 and 1931, as a field assistant, the author succeeded in working out all the life stages of

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1 A fact ascertained through correspondence with Ina L. Hawes, acting in charge of the United States Bureau of Entomology Library.

this insect, which had not been done in previous years, and the data obtained are given herein. The data pertaining to the egg laying records for 1929 and the hibernation, emergence and host data were recorded by Mr. Douglass.

DISTRIBUTION

From observation <u>Sternechus paludatus</u> (Casey) seems to be confined to the foothills of the Manzano Mountains which border the Estancia Valley on the west. The elevation at which it is found is about 6,800 to 7,300 feet. As far as is known, this weevil has not been found on its wild host plant either on the mountains or in the valley proper. Mr. Casey, in his original description of this species, lists it from Arizona (see page 18).

HOST PLANTS

The only natural wild host plant of <u>Sternechus paludatus</u> (Casey) known at present is the New Mexican black locust, <u>Robinia neomexicana</u> Gray, which seems to be the weevil's native food plant. The domesticated host upon which this weevil does extensive feeding is bean plant, <u>Phaseolus vulgaris</u> L. The commercial variety of bean grown in this region and fed upon by this weevil is the pinto bean plant. Three other hosts, one domesticated and two undomesticated, have been fed upon by this weevil under confinement. The domesticated one is the alfalfa plant, Medicago sativa L., a member of the same botanical family as the two hosts just discussed, and it seemed quite palatable to the weevils of Sternechus paludatus (Casey) when fed under confinement in rearing cages. The weevils emerging from hibernation material in cage No. 13 (see page 52) in the spring 1931, for want of something to eat, apparently, fed on Stellaria Jamesiana Torr.[2], a chickweed and a perennial which grew up from below the base of the hibernation material. Plate I illustrates the nature of feeding done on gamble oak, Quercus gambelii Nutt., by weevils of Sternechus paludatus (Casey). This stem is a sprout which grew up through the hibernation material in cage No. 7 (see page 52) during the spring of 1931 and was, thus, damaged before the newly emerged weevils were removed from the cage.

INJURY TO THE NEW MEXICAN BLACK LOCUST

Adult: The feeding of the weevils of Sternechus paludatus (Casey) on the New Mexican black locust, in case of heavy infestation, will cause complete defolia-

2 Determined by W. H. Horr of the University of Kansas.

tion of the compound leaves. This is caused by feeding upon the outer tissues of the compound leaf, midrib and petiole, death being caused by desiccation (see Plates II and III). Feeding on the bark of the twigs is also noticeable. Prolonged feeding causes the twigs to die, and, in the case of very severe infestation, branches and even the entire shrub may succumb. This is illustrated by Plate II.

The center of attack for feeding and egg deposition of this weevil is on the terminal growth. Most of the locusts examined and found infested by Sternechus paludatus (Casey) had the majority of the terminal shoots on its branches killed. This causes dieback and commonly a rosette growth takes place at the lower extremity of the dead wood (see Plates II and III). Damage done by feeding on the midribs and petioles of the compound leaves of the rosette growth is also illustrated in Plates II and III.

Egg Punctures: The type and appearance of the egg punctures caused by Sternechus paludatus (Casey) on the black locust are similar to those observed on bean plants. Egg punctures were found only in the terminal growth. Malformation of the locust stem is similar to that found in the bean plant (see page 7). It was also quite common to find egg deposition in the new stems resulting from rosette growths.

Larval Boring: The larvae bore or tunnel in the pith of the twigs in which the eggs are deposited. Boring or tunneling up or down the twig may cause hollowing out of the stem, leaving only a shell, for several inches. This damage alone may often cause the twig to die. Exit holes made in the twig by the larvae in order to drop to the soil to prepare for pupation were found. Excrement and frass have been noticed to bulge from the egg punctures.

INJURY TO THE BEAN PLANT

Adult: In the spring, as soon as the bean plant becomes of any size, as observed on trap crop No. 1, in the Tajique Canyon, the weevil of Sternechus paludatus (Casey) leave the black locusts in large numbers to feed upon this cultivated host, the pinto bean plant. In this case it was observed that the weevils first attack the plants at the margin of the field nearest the locust grove. This weevil eats long, deep lesions into the stems, stems of the plumule, leaf petioles, the primary pulvinus-- the elongated swelling connecting the leaf petiole to the stem, and the secondary pulvinus-- the elongated constriction connecting the leaf and the leaf petiole (see Plates IV, VII and VIIIB). The most serious damage is done to the plumule as illustrated especially in Plate VIII B. When the plumule is injured or killed by this weevil feeding, often, below this point, a swelling in the stem followed by a rosette growth not uncommonly takes place (see Plates IV and VII). The results are, as observed, a badly deformed plant. Plates IV - VI and VIII B indicate that severe damage is causing the death of several plants.

Egg Punctures: The female weevil of *Sternechus paludatus* (Casey) deposit her eggs within the stems, the leaf petioles, the stems of the plumules and occasionally in the primary pulvinus. Discoloration and swelling occurs at these egg punctures and the growth of the plant beyond these points is usually arrested. From one to a dozen eggs have been known to be deposited in a single plant. Not infrequently the weight of the foliage will cause the stem to break at the point of egg deposition.

Larval Boring: Immediately after the larva hatches, it commences to bore or tunnel through the hollow or pithy area of the stem and leaf petiole. A single larva may bore from one internode to another and even enter the leaf petiole. Boring causes discoloration, weakening of that section of the plant which is affected, and thus hindering growth and reproduction. Table I shows the total amount of feeding done by confined larvae upon the detached stems of young bean plants. The larvae were fed daily and the amount of boring was measured daily. Since these larvae, however, were fed upon stems from younger plants than ordinarily might be the food of the larvae in the field, the estimates given here for the amount of boring done probably represent the maximum amount of boring possible.

TABLE I----LARVAL BORING----1930

Experiment No.	Length of Larval Stage--in Days	No. of Inches of Boring
21-e	28	19 1/4
22-c	25	22
22-d	25	24 1/4
23-d	25	24 3/4
23-e	25	19 1/4

ECONOMIC STATUS

Owing to the general severe infestation of the Mexican bean beetle, Epilachna corrupta Muls., in the foothills on the west side of the Estancia Valley during the seasons of 1930 and 1931, no attempts were made to estimate the damage done by Sternechus paludatus (Casey) alone. Along with the Mexican bean beetle, Epilachna corrupta Muls., the corn earworm, Heliothis obsoleta Fab., the false wireworm, Eleodes spp., and the seedcorn maggot, Hylemyia cilicrura Rond., Sternechus paludatus (Casey) wherever found has taken its place as one of the major pests of beans in this region of New Mexico.

SYSTEMATIC HISTORY

Sternechus paludatus was described originally under the genus Plectromodes by Mr. T. L. Casey in 1895 (1). Mr. Leng, in his catalogue of Coleoptera (2), lists the genus Plectromodes as synonymous with Sternechus. The latter name, in this case, stands as the proper generic name.

COMMON NAME

Since it is only recently that Sternechus paludatus (Casey) has been discovered to be an insect of economic importance no common name has been adopted. Mr. Douglass suggests that the name "bean stalk weevil" would be very appropriate.

RELATED SPECIES

Sternechus paludatus (Casey) belongs in the subfamily Curculioninae of the family Curculionidae. The author realizing the potential importance of this weevil became interested in knowing about how many species in this subfamily are of economic importance. Surveys were made of "Bibliography of the More Important Contributions to American Economic Entomology", Parts I-V, by Samuel

Henshaw, and Parts VI-VIII by Nathan Banks; "Index to the Literature of American Economic Entomology", Vol. I by Nathan Banks, and Vol. II-IV by Mabel Colcord; and Metcalf and Flint, 1928, "Destructuve and Useful Insects", New York, McGraw-Hill Book Company, Inc. Two lists of related species, which I believe to be fairly complete, were made, and it will be seen that several of these are of great economic importance. No weevil has been included which has not received a common name. Besides the common name and the scientific name, the author has included the names of one or two of the main host plants.

The following list includes 30 common names officially approved for general use by the Committee of Nomenclature of the American Association of Economic Entomologists, etc.

Common Name	Scientific Name	Hosts
Clover root curculio	*Sitona flavescens* Marsh.	Clovers, alfalfa
Clover leaf weevil	*Hypera punctata* (Fab.)	Clovers, alfalfa
Lesser clover leaf weevil	*Phytonomus nigrirostris* (Fab.)	Clovers, alfalfa
Alfalfa weevil	*Phytonomus posticus* (Gyll.)	Alfalfa
White-pine weevil	*Pissodes strobi* (Peck.)	Pines, Spruces
Deodar weevil	*Pissodes deodarae* Hopk.	Cedar

Boll weevil	*Anthonomus grandis* Boh.	Cotton, okra
Thurberia weevil	*Anthonomus grandis thurberiae* Pierce	Wild and domesticated cotton
Strawberry weevil	*Anthonomus signatus* Say	Strawberry
Pepper weevil	*Anthonomus eugenii* Cano	Bell pepper
Cranberry weevil	*Anthonomus musculus* Say	Cranberry
Plum gouger	*Anthonomus scutellaris* Lec.	Plums, prunes
Apple flea weevil	*Orchestes pallicornis* Say	Apple, haw
Potato stalk borer	*Trichobaris trinotata* (Say)	Potato, egg plant
Plum curculio	*Conotrachelus nenuphar* (Hbst.)	Plum, apple
Quince curculio	*Conotrachelus crataegi* Walsh	Quince
Stsawberry crown borer	*Tyloderma fragariae* Riley	Strawberry
Apple curculio	*Tachpterellus quadrigibbus* (Say)	Apple, wild crab
Cabbage seed-stalk curculio	*Ceutorhynchus quadridens* (Panz.)	Cabbage
Cabbage curculio	*Ceutorhynchus rapae* Gyll.	Cabbage
Cowpea curculio	*Chalcodermus aeneus* Boh.	Cowpea, cotton
Grape curculio	*Craponius inaequalis* (Say)	Grape
Rhubarb curculio	*Lixus concavus* Say	Rhubarb, dock
Vegetable weevil	*Listronotus obliquus* Lec.	Turnip

Rice water weevil	Lissorhoptrus simplex (Say)	Rice
Grape cane gall maker	Ampeloglypter sesostris (Lec.)	Grape-canes
Clover head weevil	Tychius picirostris (Fab.)	Clover
Large chestnut weevil	Balaninus proboscideus (Fab.)	Chestnuts, acorns
Chestnut weevil	Balaninus rectus Say	Chestnuts, acorns
Pecan weevil	Balaninus caryae Horn	Pecans

The following list includes 65 common names not officially approved for general use by the Committee of Nemenclature of the American Association of Economic Entomologists, etc.

Common Name	Scientific Name	Hosts
Clover root curculio	Sitona flavescens Marsh.	Clovers, alfalfa
Clover root curculio	Sitona crinitus Gyll.	Clovers, alfalfa
Carrot weevil	Listronotus latiusculus (Boh.)	Carrots, parsley
Cranberry weevil	Anthonomus suturalis Lec.	Cranberry
Hawthorn blossom weevil	Anthonomus nebulosus Lec.	Hawthorn
Mottled poplar and willow borer	Cryptorhynchus lapathi (L.)	Poplars, willows
Pales weevil	Hylobius pales Boh.	Pines, spruces
Clover head weevil	Phytonomus meles (Fab.)	Clovers, alfalfa

Avocado weevil	*Heilipus lauri* Boh.	Avocado
Currant fruit weevil	*Pseudanthonomus validus* Dietz	Currants, gooseberries
Cambium curculio	*Conotrachelus anaglypticus* (Say)	Peach
Walnut weevil	*Conotrachelus juglandis* Lec.	Walnut
Amaranth curculio	*Conotrachelus seniculus* Lec.	Amaranth
Black walnut curculio	*Conotrachelus retentus* (Say)	Black walnut
Hickory nut curculio	*Conotrachelus affinis* Boh.	Hickory
Hickory shoot curculio	*Conotrachelus aratus* (Germ.)	Hickory
Common pecan weevil	*Conotrachelus naso* Lec.	Pecan
Pig nut leaf curculio	*Conotrachelus elegans* (Say)	Pig hickory
Smaller acorn curculio	*Conotrachelus posticatus* Boh.	Acorns, chestnuts
Dung bearing weevil larva	*Perigaster obscurus* (Lec.)	*Ludwigia alternifolia* L.
Apple stem piercer	*Magdalis barbicornis* (Latr.)	Apple, quince
Bronze apple tree weevil	*Magdalis aenescens* Lec.	Apple
Black fruit tree weevil	*Magdalis gracilis* Lec.	Almond, apple
Elm snout beetle	*Magdalis barbita* Say	Elm
Elm snout beetle	*Magdalis armicollis* Say	Elm
Hickory snout beetle	*Magdalis olyra* (Hbst.)	Hickory
Dendrobius weevil	*Acythopeus orchivora* Bladkb.	Orchid

Grape cane girdler	Ampeloglypter ater Lec.	Virginia creeper, grapes
Cattleya weevil	Cholus cattleyae Champ.	Orchids
European weevil	Ceutorhynchus marginatus (Payk.)	Taraxacum officinale Web.
Black diorymellus	Diorymellus laevimargo Champ.	Orchids
Cottonwood weevil	Dorytomus mucidus (Say)	Cottonwood
Willow leaf miner	Orchestes rufipes Lec.	Willow
Hazel nut weevil	Balaninus obtusus Blanch.	Hazel nut
Acorn weevil	Balaninus nasicus Say	Oak
Acorn weevil	Balaninus baculi Chitt.	Oak
Acorn weevil	Balaninus confusor Horn.	Oak
Grizzly acorn weevil	Balaninus q-griseae Chitt.	Acorns of griseous oaks
California acorn weevil	Balaninus uniformis Lec.	Acorns
Monterey pine weevil	Pissodes radiatae Hopk.	Pines
Terminal pine weevil	Pissodes terminalis Hopping.	Lodgepole pine
Barber's pine weevil	Pissodes barberi Hopk.	Sitka or tideland spruce
Burke's weevil	Pissodes burkei Hopk.	Alpine or balsam fir
California pine weevil	Pissodes californicus Hopk.	Yellow pine
Ribbed pine weevil	Pissodes costatus Mann.	Sitka and other spruces
Engleman spruce weevil	Pissodes engelmanni Hopk.	Engleman spruce

Douglas fir weevil	<u>Pissodes fasciatus</u> Lec.	Douglas fir
Lodgepole pine weevil	<u>Pissodes murrayanae</u> Hopk.	Lodgepole pine
Sitka spruce weevil	<u>Pissodes sitchensis</u> Hopk.	Sitka spruce
Webb's pine weevil	<u>Pissodes webbi</u> Hopk.	Lodgepole pine
Yosemite pine weevil	<u>Pissodes yosemite</u> Hopk.	Sugar, white, yellow pine
Balsam fir weevil	<u>Pissodes dubius</u> Rand.	Balsam fir
Two-spotted fir weevil	<u>Pissodes affinis</u> Rand.	White pine
Knotweed weevil	<u>Lixus parcus</u> Lec.	Knotweed
Wormwood weevil	<u>Lixus perforatus</u> Lec.	Wormweed
Smartweed weevil	<u>Lixus mucidus</u> Lec.	Smartweed
Radish weevil	<u>Cleonus sparsus</u> Lec.	Radish, turnip
Jipson weed borer	<u>Trichobaris mucorea (Lec.)</u>	Jimpson weed
Sunflower snout beetle	<u>Cylindrocopturus adspersus</u> (Lec.)	Sunflower
Cactus weevil	<u>Gerstaeckeria clathrata</u> (Lec.)	Opuntia cactus
Cactus weevil	<u>Gerstaeckeria basalis (Lec.)</u>	Opuntia cactus
Cactus weevil	<u>Gerstaeckeria porosa (Lec.)</u>	Opuntia cactus
Lupine seed weevil	<u>Tychius lineellus</u> Lec.	Lupines
Lupine seed weevil	<u>Tychius prolixus</u> Csy.	Lupines
Lupine seed weevil	<u>Tychius semisquamosus</u> Lec.	Lupines

DESCRIPTION OF THE INSECT

Egg: The egg (Plate) when first laid is pale yellow but within a day or two it becomes a darker yellow. The egg is about one millimeter in length and, roughly speaking, is oval in shape, with one end slightly broader than the other. No markings can be found on the chorion even under high magnification.

Larva: The larva (Plate) is a small, yellow, footless grub, and when full grown it is about eight millimeters long. There are three thoracic segments and apparently ten abdominal segments based on the assumption that the anal lobes represent the tenth. Thehhead is light brown with the mandibles and the anterior margin dark brown. The eye spots are of a darker brown than the mandibles and quite distinct. The row of yellowish-brown dots found on each side of the abdomen are spiracles. The antennae are small, segmented,and adjacent to the anterior extremity of the frontal suture. The clypeus and labrum of this larva are quite distinct.

Pupa: The pupa (Plate), as a whole, is a creamy yellow color, with brown mandibles and dark brown eyes. The antennae are larger and more distinct than they are in the larval stage. In the more mature pupae, the proximal tarsal segments are reddish-brown. The abdominal tip is truncate and armed with two spines, one on each side of the median line. The pupa is about the same length as the adult weevil, while it is noted that the larva is usually slightly longer than either the adult or pupa.

Adult: Mr. Casey's (1) original description of Sternechus paludatus (Casey) (Plate) under the genus Plectromodes, is given as follows:

"Plectromodes paludatus n. sp.-- Broadly oval, strongly convex, black and polished throughtout; pubescence consisting of sparse suberect white hairs, moderate in length, distinct and abundant on the pronotum, very sparse on the elytra but denser in a transverse region near basal third, much longer near the sides, in two spots near apical third and in two apical areas. Head distinctly less than one-half as wide as the prothorax, subglobular, broader at base, strongly and densely punctate, without interocular fovea, the eyes separated by a little less than their own width; beak thick, parallel, sub-cylindrical, nearly straight, three-fourths as long as the prothorax, feebly and gradually subdilated at apex, strongly, closely punctate, somewhat rugose at the sides, not at all carinate above; antennae rather thick, the basal joint of the funicle almost as long as the next three. Prothorax one-fourth wider than long, the sides subparallel and feebly arcuate to apical two-fifths, there minutely, angularly subtuberculate, thence strongly convergent and nearly straight to the apex, the latter arcuate and one-half as wide as the base, which is transverse and feebly lobed in the middle; disk strongly convex, strongly, deeply and very densely punctate, devoid of all trace of a modified median line. Scutellum small, rounded. Elytra exclusive of the posthumeral prominences, one-fifth longer than wide and fully two-fifths wider than the prothorax, strongly declivous behind in profile from just behind the middle; apex evenly rounded; humeri rounded and scarcely tumid; disk with feebly impressed series of coarse rounded punctures, the intervals polished, sparsely and scarcely visibly punctate. Abdomen strongly but rather sparsely punctate, feebly pubescent; legs strongly sculptured and sparsely, coarsely pubescent. Length 5.0-6.8 mm.; width 2.7-3.7 mm.

"Arizona.

"Widely distributed in American collections under the name _Chalcodermus spinifer_ Boh. It however does not agree in any way with the description of that species, and is not at all related to Chalcodermus. Four specimens."

Further differentiating characters of the adult are given under the notes on life history and habits (see page 49).

METHODS USED IN OBTAINING DEVELOPMENTAL RECORDS

The life history studies of _Sternechus paludatus_ (Casey) were conducted during the seasons of 1930 and 1931 in the screen insectary of the bean insect laboratory at Estancia, New Mexico, at an elevation of 6,140 feet. Adult weevils collected from the field and those emerging from hibernation cages in the spring were confined in large numbers in fine mesh wire cylindrical rearing cages (Plate VIII), 9 inches high and 6 inches in diameter, constructed to closely fit in the tops of 6-inch flower pots. The open end of each cage was covered with muslin which was sewed on, and each cage was fastened to a pot to prevent its being blown off.

Fresh food was given to the beetles as often as needed. The food used was the pinto bean plant, planted in beds, and transplanted by 3's or 4's (Plate VIII A) to a flower pot. The newly transplanted plants were not fed to the beetles until a day or two after transplanting. Both the potted and caged plants were kept fresh by daily watering.

As pairs were observed copulating they were transferred to individual cages where egg laying records were observed during the season. Daily observations were made and the numbers of eggs and egg cavities were recorded. In examining the plants for eggs, the stems were opened at each egg cavity to determine if the female had oviposited in it.

For obtaining developmental records, occasionally the cages and the pair of adults were removed from the potted plants within which eggs were laid, and these plants were given a number. The hatching of the egg was then observed by slitting up or down the stem with a sharp instrument as close to the egg as possible without causing injury.

The methods used in obtaining developmental records for the two seasons from here are quite different and will be treated separately.

During 1930, when the egg was about ready to hatch, a two or three inch section of the stem containing the egg was cut from the rest of the plant and it along with the rest of the eggs of the same experiment were placed in a shallow petri dish 3 1/2 inches in diameter, each dish having a number corresponding with the number on the incubating plant.

The newly hatched larvae were allowed to remain within the stem in which it hatched as long as the food was fresh and in edible condition. Then when new food was needed, a two or three inch section of a bean seedling stem was used. The larva was placed within the bean stem by slitting the side of the stem open with a sharp instrument, the slit being spread apart by means of the blunt ends of two tooth-picks and the larva then lifted into the hollow part of the stem by means of a dampened camel-hair brush.

The bottom of the petri dish was covered with a piece of filter paper, each day a few drops of distilled water being added, in order to keep the stems from drying out too readily. The larvae, like the eggs, were observed by slitting the stem of the plant. Molts were noted and each larva was given a fresh stem 2 or 3 inches in length when needed. During the fourth instar, when the larvae ceased feeding heavily, they (all of the same experiment) were transferred to a potted plant free from insects. The stems containing the larvae were laid on the soil and daily observations were made to determine when they left the stems and entered the soil for pupation. The plants to which the fourth instar larvae were transferred were watered daily until the adults ceased emerging; the newly emerged adults were transferred to new food.

During the season of 1931 bean stems containing hatching larvae were placed in separate test tubes which were 4 inches long and 1/2 inch in diameter. The tubes were plugged with cotton and set away horizontally in sets of ten on wooden tube racks, so constructed as to accommodate optimum atmospheric conditions around the tubes (see Plate IX). These tube racks measured 13 1/4 inches in length, 3 3/8 inches in width and 1 3/4 inches tall. The two side strips were made of 3/8 inch lumber. On top of the ends of the racks were added cleats 1/2 inch thick. These cleats cleared the tubes from the rack above. A similar cleat was inserted in the middle between the two sides next to the bottom to add strength. On the back of the rack a 1/4 inch strip of wood 1 3/8 inch wide was attached so as to allow the racks to be tilted to one side and thus prevent the tubes from sliding off the rack when handled.

During most of the season eleven racks of these tubes were in use and with this type of construction it was quite convenient to stack them in a minimum amount of space. The larvae were observed daily, and the cotton plugs used to close the ends of the tubes were moistened in distilled water at the time of observation, in order to maintain a moist atmosphere within.

During the fourth instar, when the larva ceased feeding heavily, it was transferred to a 5/8 inch shell vial which was 4 inches long. An inch of sifted soil was first placed in the bottom of the vial, then the stem containing the larva was set inside and a cotton plug was used to close the open end of the vial. These vials were supported and held upright in groups of ten by means of a wooden block. This block measured 1 1/8 inch thick, 2 inches tall and 15 1/2 inches long. Holes 11/16 inch in diameter were bored through the block at intervals of 1 3/8 inches. The bottom side of the block was then closed by the attachment of a thin strip of wood (see Plate IX). This type of rack not only served as a container for the vials but it also made possible a dark surrounding. Before the larva left the stem to enter the soil daily observations were made, and the cotton plug was at this time moistened. The larva upon entering the soil had darkness and the soil was kept moist by daily applications of water by means of an eye dropper.

When it was believed the prepupa should be transforming to a pupa the prepupa and soil was removed daily until this was observed. Upon pupating the pupa was transferred to a pupating rack (see Plate X). The sides consisted of thin window pane glass, set in grooves in wood and separated by about 3/4 inch of sifted soil. The ends and bottom of this rack were made of 7/8 inch lumber. The overall measurement of this type of rack was 1 7/8 inches wide, 7 inches long and 5 1/2 inches tall. The bottom of the rack was filled with about 1 1/2 inch of soil. At the spot where the author wished to place the pupa, the soil against the glass was moistened with water and a small cell amply large enough to hold the pupa was molded with the blunt end of a camel-hair brush. The pupa was placed inside this cell, which was then closed with wet soil. This rack held six pupae conveniently (3 next to each glass side) and when this number was in position, all were covered with about 1 1/2 inch of soil and life history numbers were written on labels on outside of the glass below the cells. The soil was kept damp by application of water twice weekly. Observations were made daily in order to record the date the pupae transferred to adults. A few days after the first pupa had transformed to an adult the top of the rack was closed with a wire screen to prevent the newly emerged adults from escaping. These pupal racks were kept in the cellar and covered with a box so placed as to allow air circulation and yet provide almost total darkness. The larval rack and pre-pupal blocks were kept on a suspended shelf in the screened insectary.

Field developmental records, during 1930 and 1931, were obtained by placing field cages over bean plants and introducing pairs of beetles for egg deposition. The field cages used were made of a wooden frame and measured 17 inches wide, 21 inches high, and 28 inches long. Four sides,-- both ends, the top, and one side were covered with fine mesh wire. The bottom was left uncovered so as to allow the cage to cover and enclose the bean plants. The corners of the cage were supported by square wooden posts, which extended about 4 inches beyond the bottom of the cage. Holes for the posts were dug with a garden trowel and the sides of the cage at the bottom were banked with dirt, thus making a tight enclosure at the surface of the earth. The unscreened side was covered with muslin in which two holes, 6 inches in diameter were cut, and to which sleeves of the same material were attached. The sleeves, which were closed by tying the free end with a string, were used to remove the snout beetles before transferring the cage to other plants and to place them within the cages after the cages had been moved to fresh plants. By using such a cage, only a few weevils escaped or were lost.

After the weevils had remained in the cage for a period of 24 hours, during which time eggs were deposited, the cage and weevils were removed to new plants for further egg deposition. Daily transfers with a series of three cages, each containing 2 or 3 pairs of weevils in 1930 and 3 or 4 pairs in 1931 were conducted from July 2 to July 15, and June 23 to July 18, respectively. The plants exposed to the weevils were marked with wooden stakes for identification. In making the 1931 field observations the number of plants exposed and the number of egg cavities made were recorded. The removal of the cage from the exposed plants made possible the development of the insect from egg to adult under natural field conditions.

LIFE HISTORY AND HABITS

EGG

Egg Deposition: Only the overwintering female weevils of Sternechus paludatus (Casey) have been found to oviposit. The female selects a location on the stem, petiole, stem of the plumule, or primary pulvinus, and with head down she excavates a cavity into the pith by means of her snout. She then reverses herself and feels about with her ovipositor until she finds the excavation, in which she deposits one egg (no more than one egg has been known to be deposited in a single egg cavity), forcing the egg up the hollow of the stem. Then with her ovipositor she rubs over the excavation and at the same time exuding a cementing fluid which covers the egg puncture. Upon drying, this fluid leaves a blackish appearance in the center of the longitudinal spot of damaged tissue caused by the female weevil rubbing the surface of the stem with her ovipositor (see Plate). This longitudinal spot measures about 2 to 2 1/2 millimeters in length and is about one-half as wide (see Plates IV, V, VII, and). A female may deposit as many as 12 eggs per day, the usual number being about four. Tables III, IV, and V inform us that she fails to deposit eggs only a few days during the entire egg laying period.

Table II gives a summary of the time required to deposit an egg. Of the six observations made the average time required for the excavating of the egg cavity, depositing the egg, and closing the egg cavity was 14.75 minutes.

Seasonal Egg Laying: Tables III, IV, and V give summaries of the oviposition of the female weevils of Sternechus paludatus (Casey) confined in wire cages which have already been described (see page 19 and Plate VIII C). Table III indicates that the period of oviposition of the five confined female weevils for 1929 lasted from June 7 to Aug. 25. Table IV shows that the oviposition period of the seven females of 1930 lasted from June 12 to Sept. 19. Table V. informs us that the oviposition period of the ten females of 1931 lasted from June 4 to Aug. 31. The average period of time during which a female of 1929 deposited eggs was 69.6 days, for 1930 75.8 days, and for

TABLE II----DEPOSITING OF EGGS BY STERNECHUS PALUDATUS (CASEY)----1931

Female of L. H. Exp.	Position of Head	Date of Egg Deposition	Time Started Boring	Time Excavating Egg Cavity*	Time Depositing Egg*	Time Closing Egg Cavity*	Total Time Required*
8	Down	Aug. 15	8:36 A. M.	5.50	1	8.50	15
10	Down	Aug. 15	8:54 A. M.	6	.75	7.25	14
11	Up	July 24	5:35 P. M.**	5	.50	3.50	9
9	Down	July 24	10:18 A. M.**	5.50	.50	6	12
8	Down	Aug. 17	9:26 A. M.**	9	1	11	20
8	Down	Aug. 22	8:34 A. M.**	9	.50	9	18.50
Average	----	--------	--------------	6.67	.71	7.54	14.75

* Time here is represented in minutes.

** Approximate time started.

TABLE III-----SUMMARY OF EGG LAYING BY STERNECHUS PALUDATUS (CASEY)-----1929

(Notes by J. R. Douglass.)

Female of L. H. Exp.	Date First Eggs Laid	Date Last Eggs Laid	No. Days Egg Laying Period*	Total No. Egg Cavities	Total No. Eggs Laid
1	June 7	Aug. 17	72	408	406
2	June 9	Aug. 14	67	268	265
3	June 12	Aug. 25	75	337	335
4	June 12	Aug. 18	68	311	308
5	June 15	Aug. 19	66	230	227
Total	--------	--------	348	1654	1641
Average	--------	--------	69.6	330.8	328.2
Range	June 7-Aug. 25		66-75	230-408	227-406

* A more detailed table would give the days eggs were not laid.

TABLE IV----SUMMARY OF EGG LAYING BY STERNECHUS PALUDATUS (CASEY)----1930

Female of L. H. Exp.	Date First Eggs Laid	Date Last Eggs Laid	No. Days Egg Laying Period*	Total No. E gg Cavities	Total No. Eggs Laid
1	June 12	Aug. 31	81	271	265
2	June 22	Aug. 25	65	191	191
3	June 27	Aug. 16	51	148	147
4	June 18	Sept. 19	94	300	293
5	June 19	Sept. 15	89	325	325
6	June 23	Sept. 6	76	352	347
7	June 23	Sept. 3	73	367	366
Total	-------	---------	529	1954	1934
Average	-------	---------	75.8	279.1	276.3
Range	June 12-Sept. 19		51-94	148-367	147-366

* A more detailed table would give the days eggs were not laid.

TABLE V----SUMMARY OF EGG LAYING OF STERNECHUS PALUDATUS (CASEY)----1931

Female of L. H. Exp.	Date First Eggs Laid	Date Last Eggs Laid	No. Days Egg Laying Period*	Total No. Egg Cavities	Total No. Eggs Laid
1	June 4	Aug. 29	86	282	282
2	June 18	Aug. 20	63	170	168
3	June 14	Aug. 29	76	128	126
4	June 4	Aug. 26	83	304	302
5	June 15	Aug. 22	68	256	254
6	June 14	Aug. 18	65	157	157
7	June 15	Aug. 9	55	204	204
8	June 14	Aug. 31	78	274	273
9	June 13	Aug. 14	62	215	214
10	June 13	Aug. 28	76	293	293
Total	--------	--------	712	2283	2273
Average	--------	--------	71.5	228.3	227.3
Range	June 4-Aug. 31		58-86	128-304	126-302

* A more detailed table would give the days eggs were not laid.

1931 71.5 days. These three tables show that the average number of eggs deposited in 1931 was smaller than for 1930 which was smaller than for 1929.

Figures 1, 2, and 3 show the variation in the total number of eggs deposited daily, during the seasons of 1929 to 1931 respectively, by these confined female weevils. Figures 4 and 5 illustrate the seasonal fluctuation in the amount of egg deposition during the seasons of 1930 and 1931 as drawn up from field and laboratory observations.

Relation between Temperature and Egg Deposition: The relationship between the temperature existing during the summer months and the number of eggs deposited is illustrated in Figures 1, 2 and 3. The high points of the temperature curve correspond for the most part with the high total number of eggs deposited. The highest mean temperature in Figure 2, for example, was 80° F. on June 28, a temperature which was only 1 degree higher than that of June 29, when 51 eggs, the largest number for any one day during the season, were deposited. Numerous other similar correlations are found in Figures 1, 2, and 3. Attention might be called at this time to the fact that precipitation has no bearing upon egg deposition (see Figures 1, 2 and 3). This would naturally lead one to think that humidity had little to do with egg deposition.

Incubation: In Table VI, the results of 12 experiments, during 1930, show that the minimum and maximum number of days required for incubation of the eggs of Sternechus paludatus (Casey) was 5 and 8 days respectively, and the average number of days was 6.1. Egg deposition in these experiments covered a period of 30 days, July 2 to Aug. 1. In Table VII, the results of 50 individual experiments during 1931, show that the minimum and maximum number of days required for incubation of the eggs of this insect was 4 and 7 respectively, and the average number of days was 5.32. Egg deposition in these experiments covered a period of 46 days, June 6 to July 22.

Percentage of Eggs Hatching: During the season of 1931, 780 eggs of Sternechus paludatus (Casey) were incubated during June, July, August and September. Of this total 167 or 21.28 percent. failed to hatch attributed to one cause or another. Of the eggs failing to hatch 64 or 38.32 per cent. failed to hatch due to thrips, species undetermined, puncturing the eggs and sucking out the contents. In many instances the eggs were even split open and emptied. Since there was no other animal life than the thrips present the author is inclined to believe that the thrips did the damage. Seven of the eggs or 4.19 per cent. failed to hatch due to the activities of nymphs of the insidious flower-bug, Orius insidiosus (Say), feeding on the egg in the same manner described for the thrips. The remaining 71 eggs or 57.49 per cent. failed to hatch either because of being lost, molded, shriveled and attributed to no certain cause.

The eggs of Orius insidiosus (Say) were found oviposited in the same section of the stem in which the egg of Sternechus paludatus (Casey) was incubating. Consequently it is easily seen, with the life cycle of this bug much shorter than that of Sternechus paludatus (Casey), how the nymphs of this species would be at hand to prey upon the host egg (3). Marshall (3) says, "The nymphs are very active and seem to be hunting continually". This the author found to be true and in one instance observed a nymph sucking the contents from a thrip nymph.

LARVA

Development: Summaries of the four larval instars of Sternechus paludatus (Casey) are given in Tables VI and VII. The number of days required for larval development during 1930 ranges from a minimum of 21 days to a maximum of 30 days, with 25.2 days as average. The third instar averaged the lowest in days, it being 4.7 days and the fourth the longest, averaging 9.6 days. During 1931 the number of days required for larval development ranged from a minimum of 16 to a maximum of 37 days, with 25.6 days as the average. The first instar averaged the lowest in days, it being 3.92 days and the fourth the longest averaging 12 days. Seasonal summaries of larval activity during 1930 and 1930 as correlated from field and laboratory observations are given in Figures 4 and 5.

Habits: A drawing of the larva is shown in Plate and its description is found on page 16. The pale yellow larvae immediately after hatching commence boring up or down the stems of the bean plants. After the larva commences to feed, the digestive track shows up dark through the larva skin. Before molting the larval body is of a darker yellow, while it is a pale yellow immediately after each successive molt. The author observed the molting of a larva from the first instar into the second. The brown head capsule split longitudinally down the middle of the dorsal side to the mandibles. The larva wiggled its way, head first, out of its old larval skin through this split head capsule. The head when it first emerged was dull white or pale yellow in color, the eye spots hardly visible though a 10X hand lens were black in color, and the mandibles were a nicotine brown color. During the 37 minutes of observing this molting process, the larva had only succeeded in wiggling out of the old skin three-fourths the length of its body. The split head capsule, attached to the old larval skin, was shoved along under the ventral half of the body. In the early and late stages of the first instar, the larvae measure about 1 1/2 to 3 millimeters, during the second instar from 3 to 5 millimeters, in the third instar from 5 to 6 millimeters, and the fourth instar from 6 to 9 millimeters in length. The first instar larva is about one-third as large in diameter as it is long, while the three other instars are only about one-fourth as large in diameter as in length.

During the season of 1930, when several larvae were being reared in separate stems in the same petri dish, what was believed to be cannibalism was observed. This happened when two larvae would be found in the same stem, one of these having left its original stem, and one or the other or both would be found with large body wounds which always resulted in death. In 1931, 23 cannibalistic tests of second and third instar larvae were made, placing two larvae in the same stem in the same slit or separate slits made by a sharp instrument. Within 4 or 5 days after each of these tests were started, the stems were split open and examined. Out of the 23 tests, 13 of them showed cannibalism, in 6 both larvae were dead or injured and in the other 7 tests only one larva was dead or injured.

One third instar larva was found dead in another experiment, and within the test tube a live nymph of Orius insidiosus (Say) was found. A second instar larva was found dead, and in this case a live nymph of a leafhopper was found.

PREPUPA

Several very careful field observations revealed the fact that prior to pupation, the larvae bore through the stem of the bean at any point from where the stem comes in contact with the soil up to as high as 6 or more inches above the surface of the soil (none have been found to bore through the stem below the surface of the soil). Dropping to the ground (this has not actually been observed), the larvae immediately enter the soil in preparation for pupation. During 1930 no observations were made to discover whether or not the larvae of Sternechus paludatus (Casey) spent any time (from a few hours to several days) in the soil prior to transforming to a pupa. By analogy it was presumed that a considerable period of time was spent in this larval or prepupal stage before molting into the pupal stage. With the new method used during the season of 1931 it was observed that the prepupal stage was of several days duration. Table VII shows that the minimum numbers of days spent as a prepupa was 5 and the maximum 10 days, the average being 7.66 days. The seasonal activity of the prepupa as observed from the field and laboratory studies is included with the pupal stage shown in Figures 4 and 5.

The prepupa upon entering the soil molds a cell large enough to enable it to lie curled up and later to molt to a pupa conveniently. Molting is similar to that of the larval stages. The prepupae were observed to wiggle violently when their cells were broken open, but if they were normal and were replaced in the soil they would again mold a cell in preparation to transforming to pupae.

PUPA

The head capsule of the prepupa of Sternechus paludatus (Casey), as in the larval stages, splits open and the prepupal skin is shed; they are pushed aside and the resulting pupa rests in the same cell until it molts to an adult. The pupa like the prepupa if disturbed will wiggle violently, even wiggling when exposed to light, indicating that they are, no doubt, negatively phototropic. Owing to the method used in rearing Sternechus paludatus (Casey) during the season of 1930 no data on the pupal stage is at hand. With the method used in 1931 (see page 23), accurate observations as to the exact length of the pupal stage was made possible. Table VII summarizes the pupal stage of the fifty weevils reared to adulthood in the insectary and cellar during the season of 1931. It reveals that the maximum length of time in days for the pupal stage was 18 days, the minimum 10 days, and the average 13.94 days. Seasonal activity of the pupal stage for the seasons of 1930 and 1931 drawn up from observations made in the field and insectary are shown in Figures 4 and 5. A drawing of the pupal stage is shown in Plate   and the description is found on page 16.

ADULT

Development: The pupa in transforming to an adult disposes of its cast skin in the same manner as that of the

TABEE VI-----RECORDS OF DEVELOPMENTAL RERIOD OF 33 STERNECHUS PALUDATUS (CASEY) WEEVILS----1930

Experiment Number	Date Eggs Deposited	Egg Stage*	Larval Instars* 1st.	2nd.	3rd.	4th.	Total Larval Stage*	Pupation Period*	Date Adult Emerged	Developmental Period*	Mean Temperature
	1930	Days	Days	Days	Days	Days	Days	Days	1930	Days	D.F.
1	July 2	7	7	5	4	8	24	31	Sept. 2	62	68.98
2	July 8	6	6	5	3	7	21	33	Sept. 4	58	68.67
3	July 9	6	6	5	3	10	24	36	Sept. 13	66	67.98
4	July 10	6	7	5	3	11	26	33	Sept. 13	65	67.86
5	July 15	5	6	4	5	11	26	32	Sept. 16	62	68.39
6.	July 20	8	5	3	5	11	24	37	Sept. 27	69	65.81
7	July 24	6	5	5	7	8	25	42	Oct. 5	73	65.01
8	July 26	6	5	5	6	8	24	41	Oct. 5	71	64.97
9	July 28	6	7	5	4	11	27	38	Oct. 7	71	64.59
10	July 31	5	7	5	4	9	25	37	Oct. 6	67	64.48
11	Aug. 1	5	8	5	5	8	26	40	Oct. 11	71	63.97
12	July 19	7	5	5	7	13	30	57	Oct. 21	94	62.97
Average	--------	6.1	6.2	4.8	4.7	9.6	25.2	38.1	--------	69.1	-----
Range	--------	5-8	5-8	3-5	3-7	8-13	21-30	31-57	--------	58-94	-----

* The length of these stages were determined by the first individual to hatch from egg, first individual to molt into the following larval instar, etc. These weevils were reared in the insectary.

TABLE VII----INDIVIDUAL RECORDS OF THE DEVELOPMENT OF 50 STERNECHUS PALUDATUS (CASEY) WEEVILS----1931*

Experiment Number	Date Eggs Deposited	Egg Stage	Larval Instars 1st.	2nd.	3rd.	4th.	Total Larval Stage	Pre-Pupal Stage**	Pupal Stage	Period Adult in Soil	Date Adult Emerged	Developmental Period	Mean Temperature
	1931	Days	Days	Days	Days	Days	Days	Days	Days	Days	1931	Days	D.F.
4-8	June 6	7	6	5	4	8	23	8	10	6	July 30	54	69.03
4-25	June 12	6	6	5	4	6	21	6	12	4	July 31	49	70.53
1-10	June 14	6	5	5	6	8	24	7	11	5	Aug. 6	53	70.06
4-32	June 15	6	3	3	6	9	21	5	12	4	Aug. 2	48	69.92
4-39	June 17	5	6	6	4	8	24	6	12	6	Aug. 9	53	70.33
1-19	June 17	5	4	4	6	17	31	6	12	7	Aug. 17	61	70.32
4-41	June 18	6	4	6	6	13	29	6	12	7	Aug. 17	60	70.31
9-31	June 18	6	4	6	6	11	27	6	12	9	Aug. 17	60	70.22
8-8	June 19	6	3	4	6	7	20	10	12	5	Aug. 11	53	70.50
7-6	June 19	6	4	3	4	17	28	6	11	6	Aug. 15	57	70.44
1-31	June 20	5	3	4	6	9	22	7	12	5	Aug. 10	51	70.63
10-16	June 20	6	3	6	5	8	22	6	12	6	Aug. 11	52	70.47
2-3	June 20	5	3	4	6	16	29	6	12	8	Aug. 19	60	70.32
3-3	June 20	5	3	5	6	15	29	6	12	7	Aug. 18	59	70.34

TABLE VII----INDIVIDUAL RECORDS OF THE DEVELOPMENT OF 50 STERNECHUS PALUDATUS (CASEY) WEEVILS---1931*
(Continued)

Experiment Number	Date Eggs Deposited.	Egg Stage	Larval Instars 1st.	2nd.	3rd.	4th.	Total Larval Stage	Pre-Pupal Stage**	Pupal Stage	Period Adult in Soil	Date Adult Emerged	Developmental Period	Mean Temperature
	1931	Days	Days	Days	Days	Days	Days	Days	Days	Days	1931	Days	D.F.
3-4	June 20	5	3	5	6	15	29	6	12	8	Aug. 19	60	70.32
3-6	June 21	5	3	5	3	9	20	7	12	5	Aug. 10	50	70.43
8-11	June 21	5	6	5	3	10	24	6	12	6	Aug. 13	53	70.41
4-51	June 21	5	4	5	5	11	25	6	12	12	Aug. 20	60	70.18
10-21	June 22	5	3	6	5	8	22	7	13	6	Aug. 14	53	70.41
6-10	June 22	5	3	5	4	12	24	6	11	10	Aug. 17	56	70.30
3-8	June 23	5	3	5	5	12	25	6	13	6	Aug. 17	55	70.31
5-6	June 27	6	5	4	4	6	19	6	13	6	Aug. 16	50	70.40
5-30	July 6	6	3	4	3	6	16	8	15	7	Aug. 27	52	70.44
1-35	June 21	5	3	4	5	20	32	8	16	6	Aug. 27	67	70.28
10-10	June 18	6	4	3	5	22	34	8	15	6	Aug. 26	69	70.23
5-7	June 27	6	6	4	4	12	26	9	16	7	Aug. 30	64	70.35
5-18	July 2	6	4	3	4	14	25	7	14	6	Aug. 31	60	70.44
10-42	July 5	6	5	5	5	12	27	10	14	7	Sept. 7	64	69.97

TABLE VII----INDIVIDUAL RECORDS OF THE DEVELOPMENT OF 50 STERNECHUS PALUDATUS (CASEY) WEEVILS----1931*
(Continued)

Experi-ment Number	Date Eggs Deposited	Egg Stage	Larval Instars 1st.	2nd.	3rd.	4th.	Total Larval Stage	Pre-Pupal Stage**	Pupal Stage	Period Adult in Soil	Date Adult Emerged	Develop-mental Period	Mean Temper-ature
	1931	Days	Days	Days	Days	Days	Days	Days	Days	Days	1931	Days	D.F.
8-15	July 6	6	5	3	3	10	21	7	18	6	Sept. 2	58	70.36
8-20	July 7	5	3	3	6	10	22	7	17	7	Sept. 3	58	70.36
5-47	July 10	4	3	4	4	8	19	7	18	6	Sept. 2	54	70.52
1-52	July 5	6	3	4	4	12	23	8	17	6	Sept. 3	60	70.26
1-48	July 2	6	4	4	4	23	35	10	15	5	Sept. 11	71	69.86
1-67	July 16	5	4	3	9	8	24	11	15	5	Sept. 14	60	69.39
2-22	July 11	4	4	4	4	12	24	10	13	7	Sept. 7	58	69.86
1-55	July 5	6	3	3	5	22	33	9	16	6	Sept. 13	70	69.86
3-23	July 16	5	3	4	8	7	22	10	16	7	Sept. 15	61	69.46
3-24	July 16	5	3	5	8	10	26	9	15	6	Sept. 15	61	69.46
4-74	July 12	4	3	4	3	20	30	10	14	6	Sept. 14	64	69.73
4-61	July 5	7	4	5	5	13	27	9	16	7	Sept. 9	66	70.00
5-36	July 8	5	3	5	4	11	23	10	14	6	Sept. 4	58	70.06
5-37	July 8	5	3	4	5	16	28	9	17	6	Sept. 11	65	69.94

TABLE VII----INDIVIDUAL RECORDS OF THE DEVELOPMENT OF 50 STERNECHUS PALUDATUS (CASEY) WEEVILS----1931*
(Concluded)

Experiment Number	Date Eggs Deposited	Egg Stage	Larval Instars 1st.	2nd.	3rd.	4th.	Total Larval Stage	Pre-Pupal Stage**	Pupal Stage	Period Adult in Soil	Date Adult Emerged	Developmental Period	Mean Temperature
	1931	Days	Days	Days	Days	Days	Days	Days	Days	Days	1931	Days	D.F.
1-80	July 22	4	6	5	7	9	27	9	16	7	Sept. 23	63	68.56
3-26	July 25	5	5	3	7	11	26	8	15	6	Sept. 23	60	68.22
4-85	July 22	4	4	6	8	11	29	9	15	7	S ept.24	64	68.41
5-40	July 9	5	3	4	4	26	37	8	16	6	Sept. 19	72	69.72
8-25	July 22	4	4	6	5	11	26	8	15	7	S ept.20	60	68.91
8-28	July 22	5	5	5	7	9	26	8	17	6	Sept. 22	62	68.64
10-45	J uly20	5	4	6	8	9	27	8	15	8	Sept. 21	63	69.06
5-54	July 22	5	5	5	6	11	27	8	15	11	Sept. 26	66	68.33
Average	--------	5.32	3.92	4.48	5.2	12.0	25.6	7.66	13.94	6.5	--------	59.14	------
Range	--------	4-7	3-6	3-6	3-9	6-26	16-37	5-10	10-18	4-12	--------	48-72	------

* This table treats insectary experiments and does not include two weevils which completed development on October 10 and 11, respectively.

** It is assumed that the time the larva spends in the soil prior to transforming to a pupa should be called the prepupal stage.

TABLE VIII----DEVELOPMENT OF STERNECHUS PALUDATUS (CASEY) IN THE FIELD----1936

Experiment Number	Date Eggs Deposited	Eggs Deposited No. of Eggs	Eggs Deposited On No. of Plants	No. Beetles to Emerge	Percentage to Emerge
1	June 23	27	15	4	14.81
2	June 24	30	15	2	6.67
3	June 25	38	14	3	7.89
4	June 26	44	12	7	15.91
5	June 27	55	19	10	18.18
6	June 28	48	15	6	12.50
7	June 29	47	12	7	14.90
8	June 30	49	11	7	14.29
9	July 1	57	14	9	15.79
10	July 2	51	12	6	11.76
11	July 3	44	16	10	22.73
12	July 4	48	14	8	16.67
13	July 5	52	13	6	11.54
14	July 6	47	14	6	12.77
15	July 7	41	12	11	26.83

TABLE VIII----DEVELOPMENT OF STERNECHUS PALUDATUS (CASEY) IN THE FIELD----1930 (Continued)

Experiment Number	Date Eggs Deposited	Eggs Deposited No. of Eggs	On No. of Plants	No. Beetles to Emerge	Percentage to Emerge
16	July 8	53	16	15	28.30
17	July 9	35	11	8	22.86
18	July 10	36	15	10	27.78
19	July 11	46	14	19	41.30
20	July 12	45	13	17	37.78
21	July 13	55	12	29	52.73
22	July 14	36	15	17	47.22
23	July 15	34	15	13	38.24
24	July 16	34	18	16	47.06
25	July 17	32	11	12	37.50
26	July 18	29	11	6	20.69
Average	-------	42.8	13.8	10.15	24.03
Range	-------	27-57	11-19	2-29	6.67-52.73

larva, and prepupa and pupa (see pages 34, 36 and 37). The newly transformed adult is at first light yellow in color but within a period of 24 hours it gradually darkens until it is a solid black color, the legs darkening first, then the head and elytra. Table VII informs us that the period of time spent in the soil as an adult, before coming to the soil surface,is several days. The maximum number of days spent by the 50 adults reared through during the season of 1931 was 12 days and the minimum 4 days, and the average was 6.5 days. The newly transformed adult during this period in the soil would remain in the same cell formed as occupied by the prepupa and pupa if they were under field conditions. The methods of rearing this insect in the insectary only allows the adult to remain in the pupal cell (see page 23). From a few to 24 hours before the adult emerges from the soil surface it begins to ascend slowly tunneling its way to the surface of the soil. In working its way through the soil the adult weevil of Sternechus paludatus (Casey) leaves a round tunnel filled with fine soil. The top of the tunnel is left open and measures about 3/16 inch in diameter. Frequently the adult would work up to the soil surface along side the glass plate of the pupal rack and its progress was easily watched.

When the newly emerged adult is transferred to a freshly potted and caged bean plant, it immediately becomes active and ascends the stem of the plant. After several hours, it begins to eat long, deep lesions into the plant. As is the case with other adults upon emergence from the soil, within a few days the pronotum and elytra changes from a black color to a dark brown color with a few light brown spots scattered over their surfaces. Some weeks later the pronotum and elytra turn a lighter brown, but the head, snout, and legs still remain black. On the pronotum are three gray lines of pubescence, one median line and two lateral lines (see Plate). The cephalic half of the elytra at this time are almost gray with this pubescence.

In the field experiments, during 1930, the first adults emerged from pupation on Sept. 4, while the first adults in the insectary experiments were found on Sept. 2. In both cases, the eggs were deposited by female weevils on the same day, July 2. The last adult in the field experiments emerged on Oct. 9, while the last one in the insectary emerged Oct. 21. The total number of adults observed to emerge in the field was 121 and that in the insectary was 33. In the field records the average number of days required for development of this insect-- from time of egg deposition to time the adult emerged from the soil-- was 70.79 days with a minimum of 56 and a maximum of 92 days. Table VI summarizes the development of <u>Sternechus paludatus</u> (Casey) in the insectary. Here it is found that the average is 69.1 days, with a minimum of 58 and a maximum of 94 days required for development. A summary of the activity of the new adults emerging from the soil in the field and insectary during 1930 is shown in Figure 4.

Table VII summarizes the development of Sternechus paludatus (Casey) in the insectary during the season of 1931. Here it is shown that the average time required for development of the fifty weevils reared through to adult is 59.14 days and the minimum and maximum as 48 and 72 days, respectively. A summary of the activity of the new adults emerging from the soil in the field and insectary during 1931 is shown in Figure 5. It shows especially that only one generation a year of this weevil occurs in this part of the state of New Mexico.

Table VIII summarizes the development of 267 weevils of Sternechus paludatus (Casey) in the field experiments during the season of 1931. The first eggs were deposited on June 23 and the last on July 18. The first adult to emerge was Aug. 18 and the last Oct. 5. An average of 3.1 eggs was deposited on each plant. The largest percentage of beetles to develop from one experiment was 52.73 and the minimum was 6.67 per cent., the average being 24.03 per cent. It is seen that the percentage of beetles developing in experiments 13 and 14 is much smaller than in experiments when the eggs were deposited a few days before or a few days afterwards. This can be explained partially in that each of these experiments were run on the lower end of two rows. When it rained heavily, or artificial irrigation was applied, the surface of the ridges of these rows were entirely submerged with water, thus, indicating that development of Sternechus paludatus (Casey) must be somewhat hindered by the soil that frequently becomes flooded and soggy.

Temperature and Development: Up to the present no effort has been made to visualize the correlation between temperature and development, if any, of *Sternechus paludatus* (Casey). It was illustrated in Figures 1, 2 and 3, that there is a correlation between the mean temperature and the total number of eggs deposited daily. The relation of temperature to the development of all the immature stages of *Sternechus paludatus* (Casey) produce hopeless looking graphs. This is also true for the development of each individual weevil from time of egg deposition until it emerges from the surface of the soil as an adult. Figures 6 and 7 show somewhat how there might be some correlation between temperature and development. The numbers on these figures represent the total number of individuals which developed in the designated number of days. Mean temperatures of each day of the weevil's development was obtained by readings of the maximum and minimum thermometers. These mean temperatures were added and the sum divided by the number of days required for development and the average temperature was thus acquired. Where more than one weevil completed its development in the same number of days, their average temperatures were averaged together. According to Figure 7 three weevils developed to adults in 82 days and the average of the average temperatures was 65.80° F. In reality Figure 8 shows no correlation between temperature and the number of days required for development. Since both Figures 6 and 8 illustrate the development of Sternechus paludatus (Casey) in the field for the seasons of 1930 and 1931 respectively, it is hard to understand why the curves are so greatly different. Soil temperatures, for the stages of this weevil spent in the soil, were not taken, but most assuredly such a striking variation in the results obtained would not be the case.

General Habits: No adults newly emerged from pupae during the seasons of 1930 and 1931 were observed copulating, and no eggs were found. No experiments were run to see whether or not old males, which had hibernated the previous winter, would mate with new females. If unmolested, after a few weeks of heavy feeding, the newly emerged adults acquire a short, thick tuft of reddish brown pubescent-like growth on each elytrum, at the summit of the declivity or the point at which the elytra make a sharp downward slope. This is well illustrated in Plate and . This growth gradually becomes long and ragged until it is rubbed off, and then new tufts seem to replace the old. This growth is also characteristic of the overwintering weevils.

When not feeding, the adults of Sternechus paludatus (Casey) will often be found clamping their legs around the wires of the cage. While resting this way, the snout beetle is difficult to dislodge without causing possible injury.

Special care must be taken not to mash the soft, newly-emerged beetles when removing them from the screen. In the early summer, before learning how to properly dislodge the over-wintering adults from the wire cage, a leg was pulled off of one of the weevils in the operation. The writer soon learned that by tapping the ends of the legs from the outside of the cage with a pencil or small stick that most of the beetles would readily loosen their grip and fall to the ground. Oftentimes, the weevils which were on the bean plants would behave similarly. But if the plant was disturbed very much, the weevils would generally drop to the ground and "play possum" , drawing up their legs and acting as if dead for several minutes.

In the fall, in the insectary, when the early morning temperatures were freezing or therabouts, most of the weevils would be found either on the ground or congregated on the screen cage where it comes in contact with the soil.

Hibernation and Emergence: It was not known with certainity until the fall of 1931 how and where the adults of Sternechus paludatus (Casey) overwintered. The author using a sifter, with sides made of wood and a 10-mesh wire screen tacked on the bottom, succeeded on Oct. 8 in finding quickly a few beetles in hibernation. Siftings were made from under four bushes and from two of these the writer succeeded in finding weevils. Under one of these bushes three live weevils and one dead weevil were found, the latter being covered with fungus. Only one weevil was found under the other bush. The top 2 or 3 inches of leaf trash at the base of the locust trunks from which the weevils were found consisted of locust and oak leaves and other dead plant material, such as sticks, weeds, and rotted wood. No adult weevils were found on the black locust bushes on Oct. 8, 1931, and in 1930 only a few weevils were found on the black locusts and in the bean fields after the first week of October. The last weevil to be found in a bean field in 1930 was in the foothills of the Manzano Mountains on Oct. 13, while the last weevil in the insectary emerged from the soil on Oct. 21. Only the adult stage of this weevil is known to overwinter.

Artificial hibernation experiments were conducted by Mr. J. R. Douglass during the winter of 1929-1930. Mr. Douglass (4) caged these snout beetles in regulation hibernation cages used for the overwintering of the Mexican bean beetle of which several thousand were also enclosed (see Plate XI). Mr. Douglass's description of these cages is as follows: "The hibernation cages used during these investigations were constructed out of 2 X 4 inch lumber, and measured 4 feet wide, 6 feet long and 3 1/2 to 4 feet high; they were covered with 14-mesh screen wire, and had removable tops. The tops were removed after the beetles had become dormant and were replaced before activity was manifested. In this manner conditions approximating, as nearly as possible, those prevailing under natural hibernation were obtained." The hibernation material used a mat combined of oak and pine leaves. Hibernation cage No. 7 was located at an elevation of 7,000 feet in the yellow-pine, Pinus ponderosa Laws. region, of the foothills of the Manzano Mountains. On Sept. 30, 200 weevils were placed in this cage. The first weevils emerged from hibernation on May 3, 1930. They were found on the cage screen and, as in the case of those found at different intervals later, they were removed in order to secure accurate emergence data. This applies also to cage No. 13. The last weevil emerged on June 5. The total number which survived was 37 or 18.5 per cent. of the total number placed in hibernation. Hibernation cage No. 13 was located at Estancia beside the insectary at an elevation of 6, 140 feet in the short-grass or semi-desert formation of the Estancia Valley. In this, at intervals between Sept. 7 to 25, a total of 326 weevils were encaged. The period of emergence from hibernation was from April 28 to June 2, 1930. A total of 27 or 8.28 per cent. of the snout beetles survived the winter. Precipitation seemed to have no bearing upon the emergence of this weevil from hibernation. A summary of the emergence of the overwintering weevils is given in Figure 4.

Mr. Douglass again conducted the hibernation experiments during the winter of 1930-1931. The same number of weevils as for 1929-1930 were placed in hibernation in cage No. 7 on Oct. 4, 1930. The first weevil emerged from hibernation on May 10, 1931 and the last one emerged on June 20. A total of 107 weevils emerged from hibernation, making a per cent. of 53.5 to survive the winter. A total number of 300 weevils were placed in hibernation cage No. 13 on Oct. 6 and 15, 1930. The first weevil to emerge from hibernation in this cage was on May 6, 1931, and the last on June 4. A total of 124 weevils or a percentage of 37.58 emerged from hibernation in this cage. Precipitation seemed to have no bearing upon the emergence from hibernation of Sternechus paludatus (Casey). Summaries of the emergence of the overwintering weevils is given in Figures 4 and 5.

Longevity: The longevity of Sternechus paludatus (Casey) seems to be something over a year. During the fall of 1928, Mr. Douglass placed newly emerged beetles in hibernation cages Nos. 7 and 13. Those emerging the following spring, 1929, and surviving the summer, were put in the cellar in flower pot cages (see page 55) for hibernation that fall and all were dead by January of 1930. Figure 4 gives a partial summary of the overwintering weevils, which emerged from the soil during the season of 1929, surviving the winter of 1929-1930. This same type of experimentation was started again in the fall of 1929 by Mr. Douglass. They were placed in hibernation the second fall, 1930, in the cellar in flower pot cages, and upon examination of the hibernation material on June 1, 1931, all the weevils were found to be dead. Figure 5 gives a partial summary of the overwintering weevils, which emerged from the soil during the season of 1930, surviving the winter of 1930-1931.

Three longevity experiments were started on July 24, 1931. The weevils used were those surviving the winter of 1930-1931. All three experiments were run in individual flower pot cages and the beetles were given new food when needed. In longevity experiment No. 1 only 4 of the 25 weevils placed in the cage on July 24, were dead by Oct. 13, and in experiment No. 2, 7 of the 25 weevils were dead on this date. In experiment No. 3, in which 32 weevils were confined, only 3 of the weevils were dead by Oct. 13, 1931. These weevils were hibernated in flower pot cages in the cellar on Oct. 16, 1931.

CONTROL

Natural Control: Probably three different species of fungi have been found attacking Sternechus paludatus (Casey). One of these fungi attacks the hibernating weevils, another the pupal and adult stages in the soil, and probably a third the larvae in the locust stems. They are:

(1) A fungous parasite Sporotrichum geobuliferum Speg., known to attack hibernating Mexican bean beetles,

Epilachna corrupta Muls. in the Estancia Valley, was observed during the winters of 1928-1929 and 1930-1931 to attack _Sternechus paludatus_(Casey) while in hibernation. These weevils were hibernated in flower pot cages (see page 19), in which a thick mat of gamble oak leaves, _Quercus gambelii_ Nutt., (without the bean plants), was used as a hibernating material being laid upon the earth used to fill these pots. These cages were placed in a dugout cellar, and no doubt the average higher humidity and more or less even temperature aided in propogating this fungous parasite.

(2) Many of the pupae and newly transformed adults in the pupal racks, kept in the dugout cellar, were found during the season of 1931 to be covered or to become covered with a matrix of a fungous mycelium. Fungous attack in each case was fatal to the insect. This fungus was determined as being a Fusaria sp.[4].

(3) During August 1931 upon examining the stems of the New Mexican black locust, _Robinia neomexicana_ Gray, infested by the larvae of _Sternechus paludatus_ (Casey), the author found several of the larvae dead. These larvae were examined under high magnification and most of them were found to be well enveloped with a fungous mycelium, as yet undetermined. Running about between the hyphae of this

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4 Determined by Dr. Vera K. Charles, Bureau of Plant Industry, Washington, D. C.

fungus were very small mites, Tarsonemus sp.,[5] visible only under high nagnification.

If is known definitely that at least two different insects attack Sternechus paludatus (Casey). The thrips as already mentioned (see page 32) are predatory upon the eggs as are the nymphs of Orius insidiosus (Say). These observations were made during the summer of 1931. On Sept. 13 and 17, 1930, single hymenopterous wasps were found within a petri dish containing larvae of Sternechus paludatus (Casey). All the larvae within this dish had died by Sept. 13. No actual proof is available that these wasps had originally been parasitic upon these larvae.

Artificial Control: No artificial control methods have been used at this bean insect laboratory in attempt to control Sternechus paludatus (Casey). Owing to the nature of this adult weevil's feeding, which covers relatively large areas on the bean plant, no doubt some arsenical poison would be effective.

SUMMARY

Sternechus paludatus (Casey), as far as it is known now, is confined to the states of New Mexico and Arizona. In the foothills of the Manzano Mountains on the west side of the Estancia Valley of New Mexico, this weevil has been

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5 Determined by Dr. H. E. Ewing, Bureau of Entomology, Washington, D. C. Dr. Ewing states, "No males located. Without a male no specific identification can be made."

observed to feed naturally only on the New Mexican black locust and on the cultivated bean plant. In the case of heavy infestation, both hosts suffer severe injury from the feeding of the adults and of the larvae. In recent years, this weevil has become important economically wherever found doing damage to the bean plant in the Estancia Valley.

This species of weevil was originally described under the generic name Plectromodes, which is synonymous to Sternechus. No common name has been adopted for it. Sternechus paludatus (Casey) has many close relatives which are important economically.

The methods used in obtaining developmental records in the insectary for the seasons of 1930 and 1931 were very much different. The methods used during 1931 were the more accurate and gave much more of the life history and habits of Sternechus paludatus (Casey)in detail than those of 1930.

The eggs of Sternechus paludatus (Casey) are deposit- singly in the stem, petiole, plumule, and primary pulvinus of the bean plant, and in the terminal growths of the New Mexican black locust. A single female may deposit from 125 to over 400 eggs during the egg laying season of June, July, August, and September. There seems to be a direct relation between temperature and the rate of egg deposition of this weevil. During the two seasons the egg stage ranged from 4 to 8 days in duration, averaging about 5.5 days. During the season of 1931, 78.72 per cent. of the eggs incubated hatched. Thrips and Orius insidiosus (Say) were found to be predatory upon a large per cent. of the eggs not hatching.

In the larval stage, Sternechus paludatus (Casey) passes through four larval instars, molting three times. The larva bores either up or down the stems of the hosts. The range of days for the larval stage during the two seasons was from 16 to 37 days with an average of a little over 25 days. A full grown larva will measure about 8 to 9 millimeters in length. From observations made the author is inclined to believe that the larvae of this weevil are cannibalistic.

With the rearing methods used during 1931 the author was able to work out the stages spent in the soil, the prepupa and pupal stages, and the period the adult spends in the soil prior to emerging from the surface. The prepupal stage averaged 7.66 days in duration with a range of 5 days as the minimum and 10 days as the maximum. The pupal stage averaged 13.94 days in duration with a range of 10 days as the minimum and 18 days as a maximum. The average period the adult spent in the soil prior to emergence was 6.5 days with a minimum of 4 days and a maximum of 12 days.

During the two seasons the total developmental period of Sternechus paludatus (Casey) averaged about 59.5 days, ranging from 48 to 94 days. There is only one generation a year. There appears to be no really definite relation between temperature and development-- according to the data at hand. Newly emerged weevils were not observed mating nor were the females known to oviposit during the current season. This weevil was found to hibernate in rubbish below the shrubs of the New Mexican black locust. Artificial hibernation experiments indicate that the weevils survive the winters better in the foothills than they do in the valley. This weevil can only survive one winter, dying off the second winter if hibernated.

Probably three different species of fungi attack Sternechus paludatus (Casey) in its various stages and there are two insect predators in the egg stage. No artificial control measures have been attempted.

REFERENCES CITED

(1) Casey, T. L., 1895.
Coleopterological Notices, VI. Annals New York Academy of Science. Vol. VIII, November, pp. 830-831.

(2) Leng, Charles W., 1920.
Catalogue of the Coleoptera of America, North of Mexico. p. 326. Mount Vernon, New York. John D. Sherman, Jr.

(3) Marshall, G. Edw., 1930.
Some Observations on Orius (Triphleps) insidiosus (Say). Jour. Kan. Ent. Soc., Vol. III, No. 2, pp. 29-32.

(4) Douglass, J. R., 1928.
Precipitation as a Factor in the Emergence of Epilachna corrupta from Hibernation. Jour. Econ. Ent. Vol. XIX, No. 1, pp. 203-213.

EXPLANATION TO FIGURES

FIGURE 1

The relation of temperature and precipitation to the deposition of eggs by five female weevils of *Sternechus paludatus* (Casey) during the season of 1929. Notes by Mr. J. R. Douglass.

------ mean temperature.

______ total number of eggs deposited.

FIGURE 1

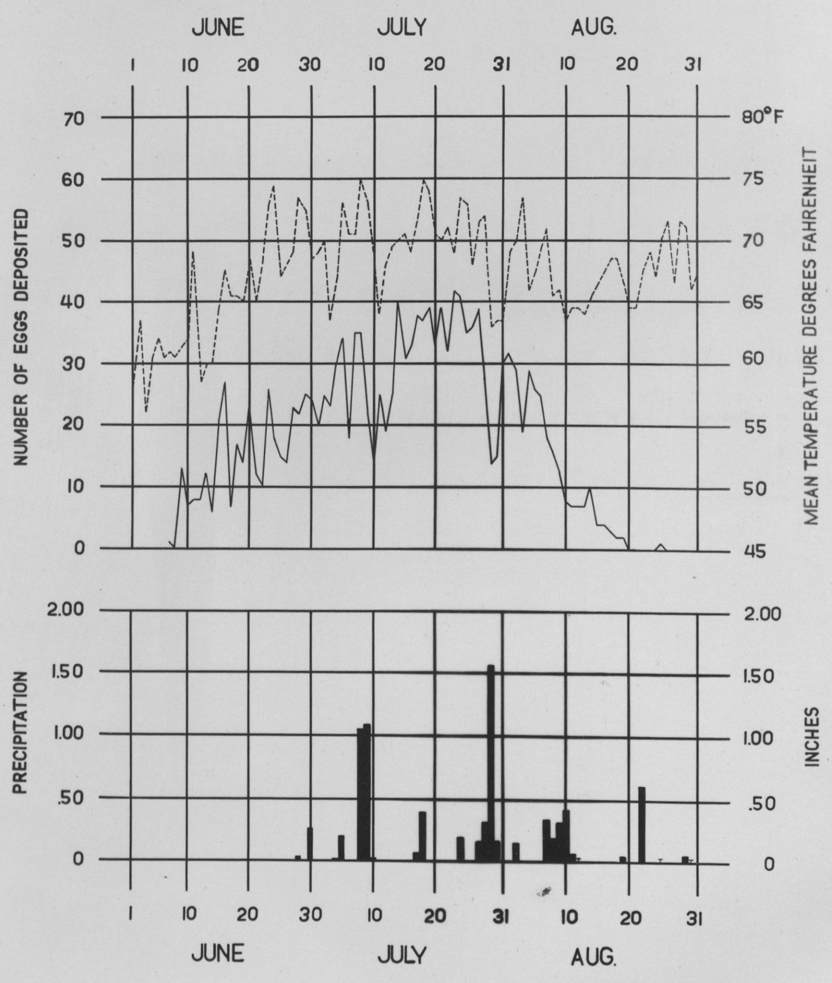

JUNE
JULY
AUG.
1
10
20
30
10
20
31
10
20
31
70
60
50
40
30
20
10
0
80°F
75
70
65
60
55
50
45
NUMBER OF EGGS DEPOSITED
MEAN TEMPERATURE DEGREES FAHRENHEIT
2.00
1.50
1.00
.50
0
PRECIPITATION
INCHES
JUNE
JULY
AUG.

FIGURE 2

The relation of temperature and precipitation to the deposition of eggs by seven female weevils of *Sternechus paludatus* (Casey) during the season of 1930.

------ mean temperature.

_____ total number of eggs deposited.

FIGURE 2

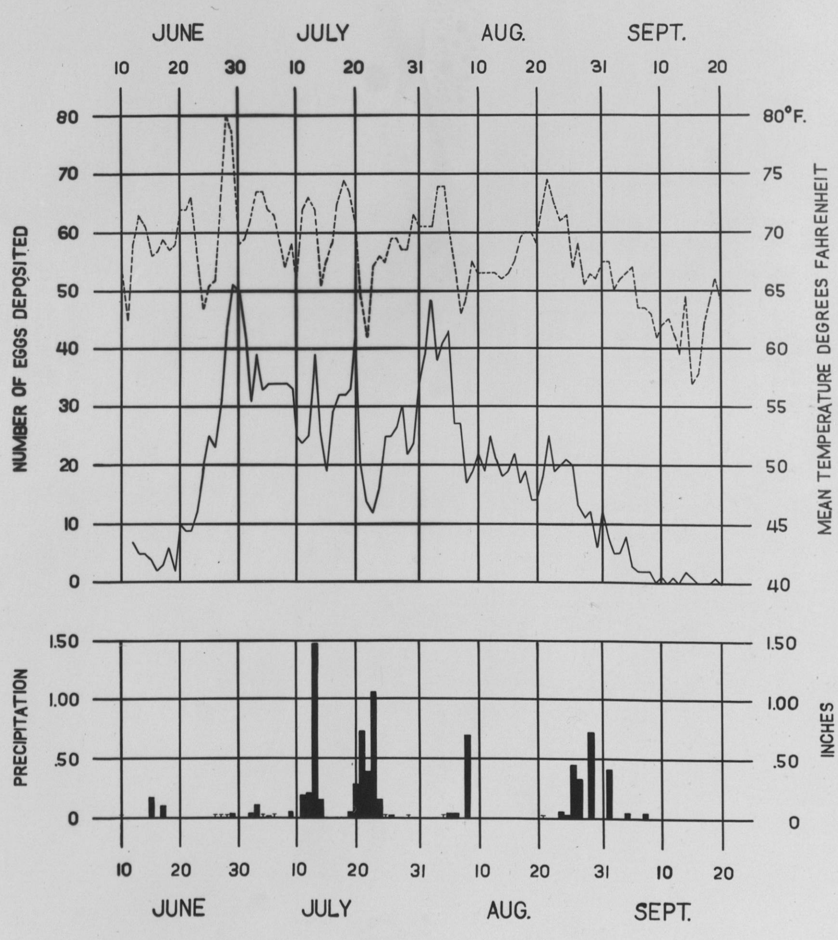

JUNE
JULY
AUG.
SEPT.
10
20
30
10
20
31
10
20
31
10
20
NUMBER OF EGGS DEPOSITED
0
10
20
30
40
50
60
70
80
80°F.
75
70
65
60
55
50
45
40
MEAN TEMPERATURE DEGREES FAHRENHEIT
PRECIPITATION
0
.50
1.00
1.50
INCHES

FIGURE 3

The relation of temperature and precipitation to the deposition of eggs by ten female weevils of Sternechus paludatus (Casey) during the season of 1931.

------ mean temperature.

______ total number of eggs deposited.

FIGURE 3

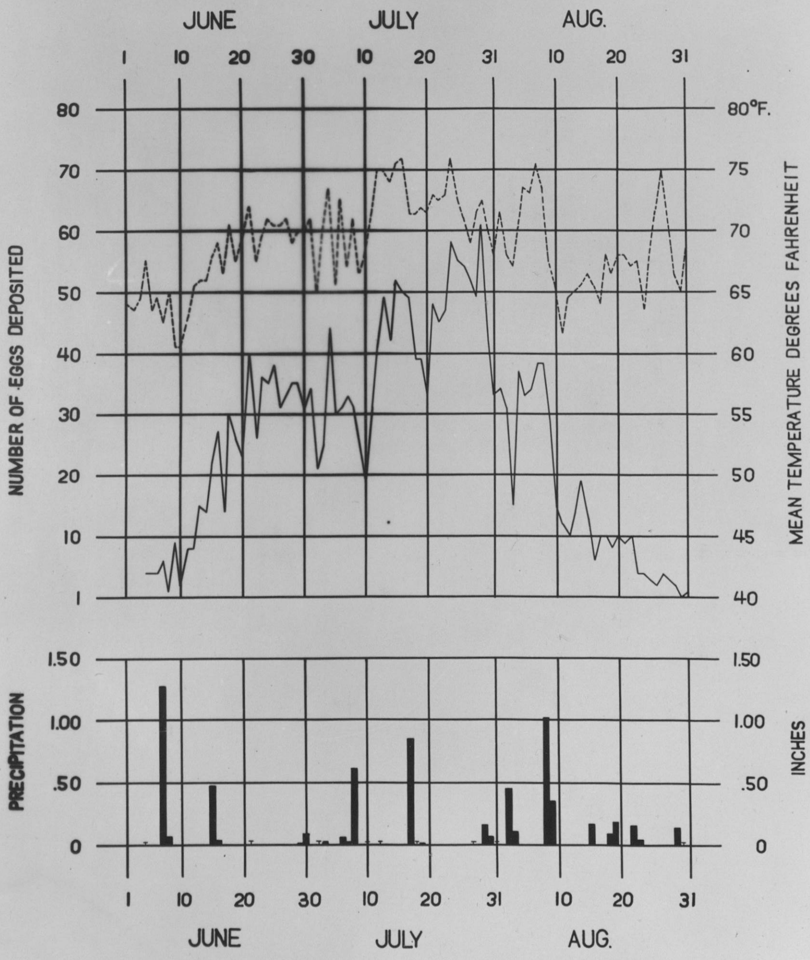
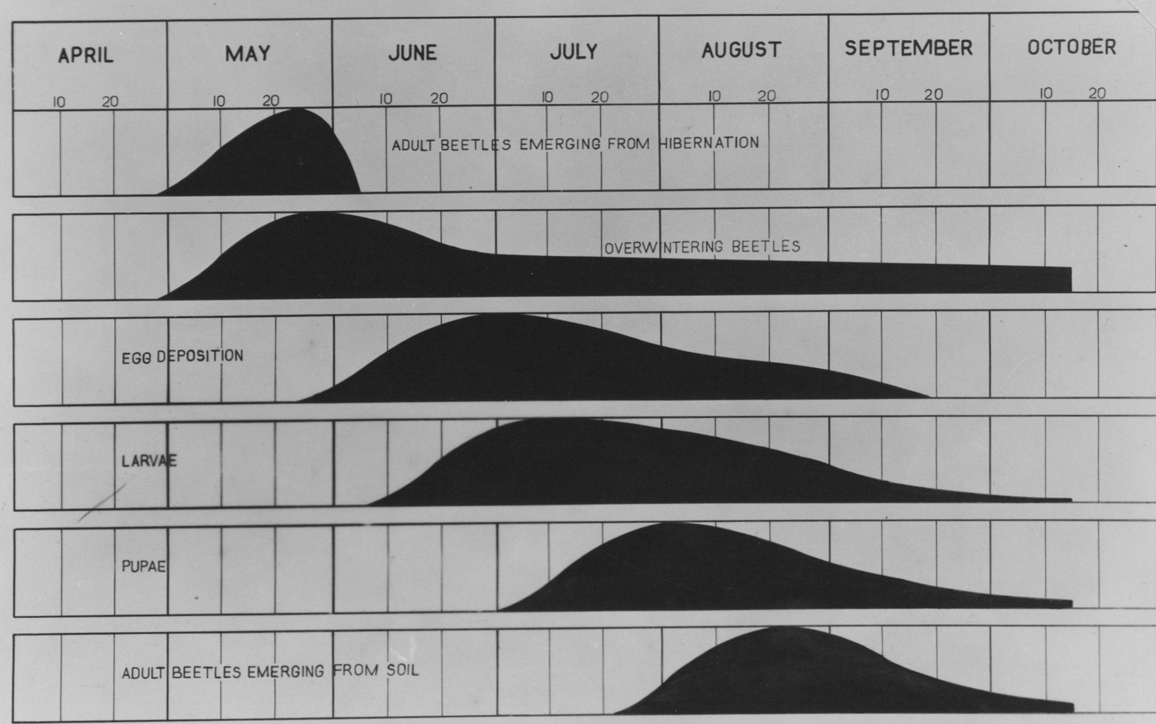

JUNE
JULY
AUG.
1
10
20
30
10
20
31
10
20
31
80
70
60
50
40
30
20
10
1
80°F.
75
70
65
60
55
50
45
40
NUMBER OF EGGS DEPOSITED
MEAN TEMPERATURE DEGREES FAHRENHEIT
1.50
1.00
.50
0
PRECIPITATION
INCHES
1
10
20
30
10
20
31
10
20
31
JUNE
JULY
AUG.

FIGURE 4

Various activities of Sternechus paludatus (Casey) during the season of 1930. The prepupal stage is included with the pupal stage.



APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
10 20
ADULT BEETLES EMERGING FROM HIBERNATION
OVERWINTERING BEETLES
EGG DEPOSITION
LARVAE
PUPAE
ADULT BEETLES EMERGING FROM SOIL

FIGURE 4

FIGURE 5

Various activities of Sternechus paludatus (Casey) during the season of 1931. The prepupal stage is included with the pupal stage.

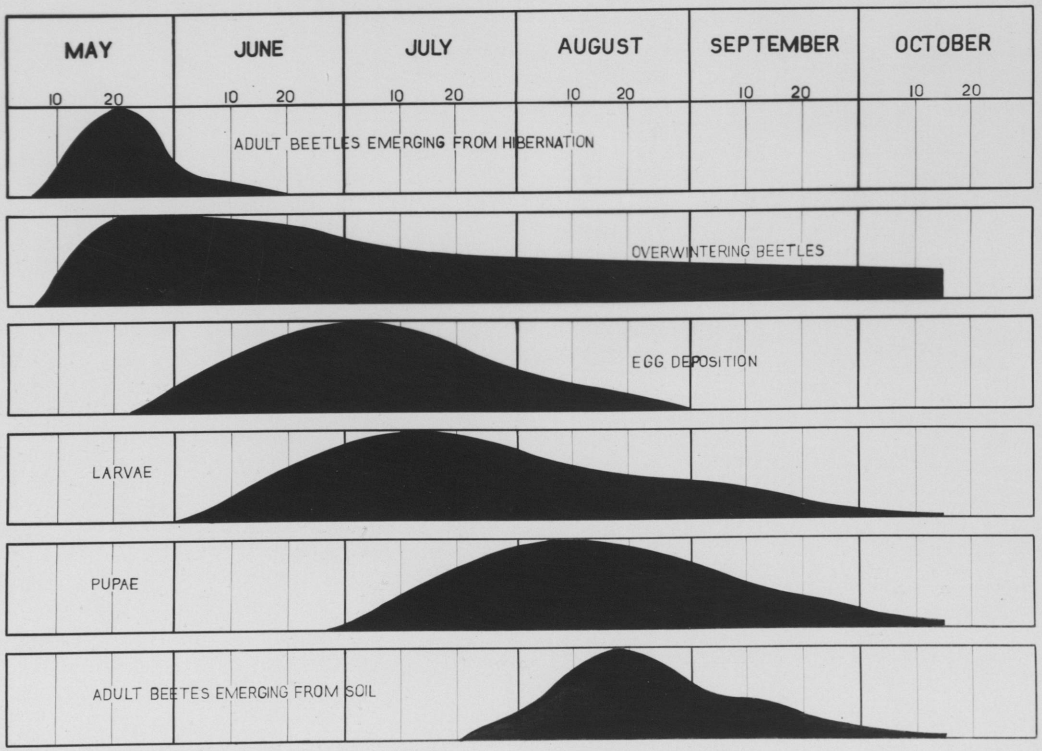

MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
10 20
ADULT BEETLES EMERGING FROM HIBERNATION
OVERWINTERING BEETLES
EGG DEPOSITION
LARVAE
PUPAE
ADULT BEETES EMERGING FROM SOIL

FIGURE 5

FIGURE 6

Curve showing the relationship between temperature and development of the 50 weevils of *Sternechus paludatus* (Casey) reared in the insectary during the season of 1931. Further explanation of the meaning of this Figure is given on page 48.

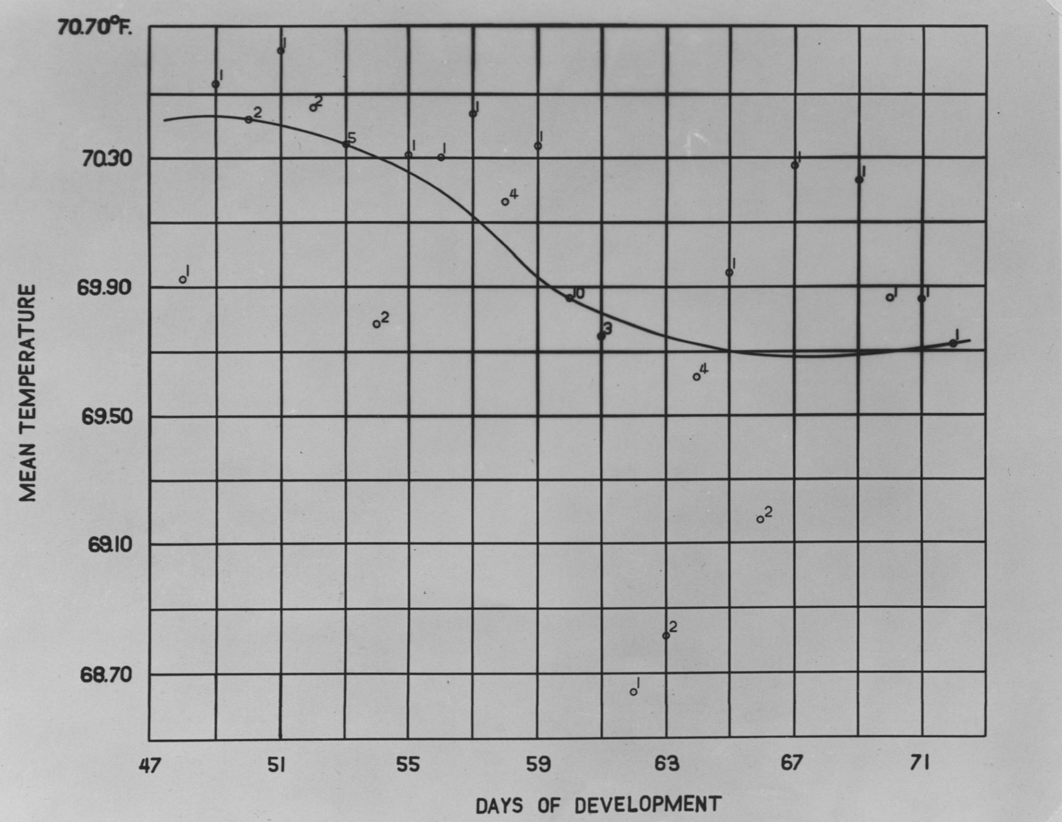

70.70°F.
70.30
69.90
69.50
69.10
68.70
MEAN TEMPERATURE
47
51
55
59
63
67
71
DAYS OF DEVELOPMENT

FIGURE 6

FIGURE 7

Curve showing the relationship between temperature and development of the 121 weevils of *Sternechus paludatus* (Casey) reared in the field during the season of 1930. Further explanation of the meaning of this Figure is given on page 48.

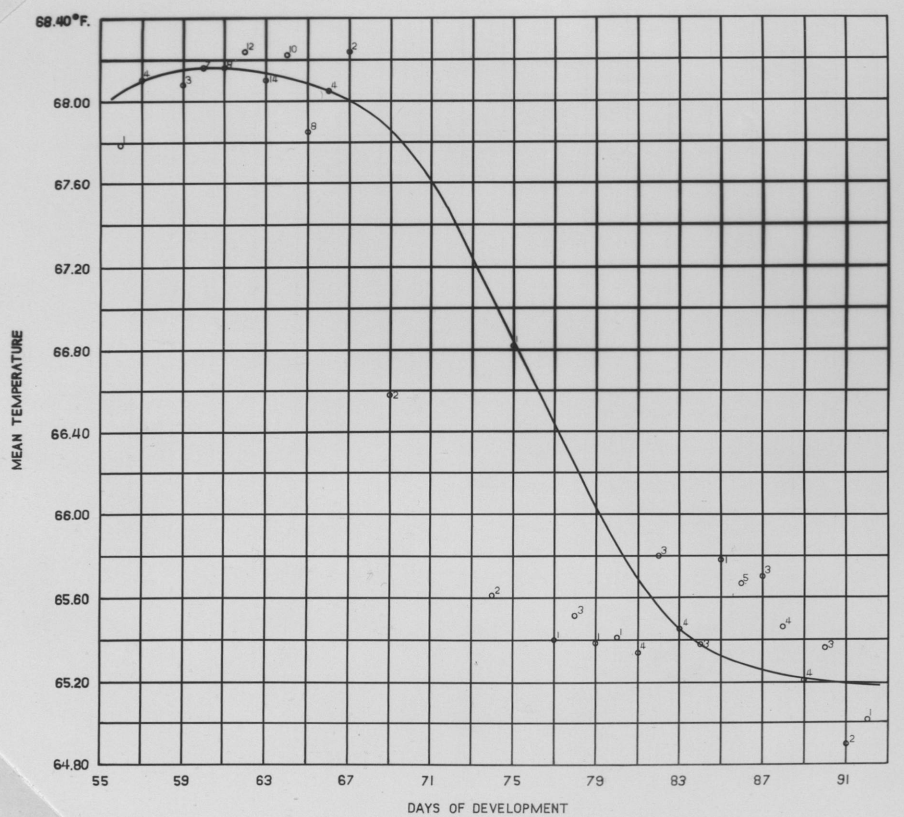

68.40°F.
68.00
67.60
67.20
66.80
66.40
66.00
65.60
65.20
64.80
MEAN TEMPERATURE
55
59
63
67
71
75
79
83
87
91
DAYS OF DEVELOPMENT

FIGURE 7

FIGURE 8

Curve showing the relationship between temperature and development of the 262 weevils of Sternechus paludatus (Casey) reared in the field during the season of 1931. Further explanation of the meaning of this Figure is given on page 48.

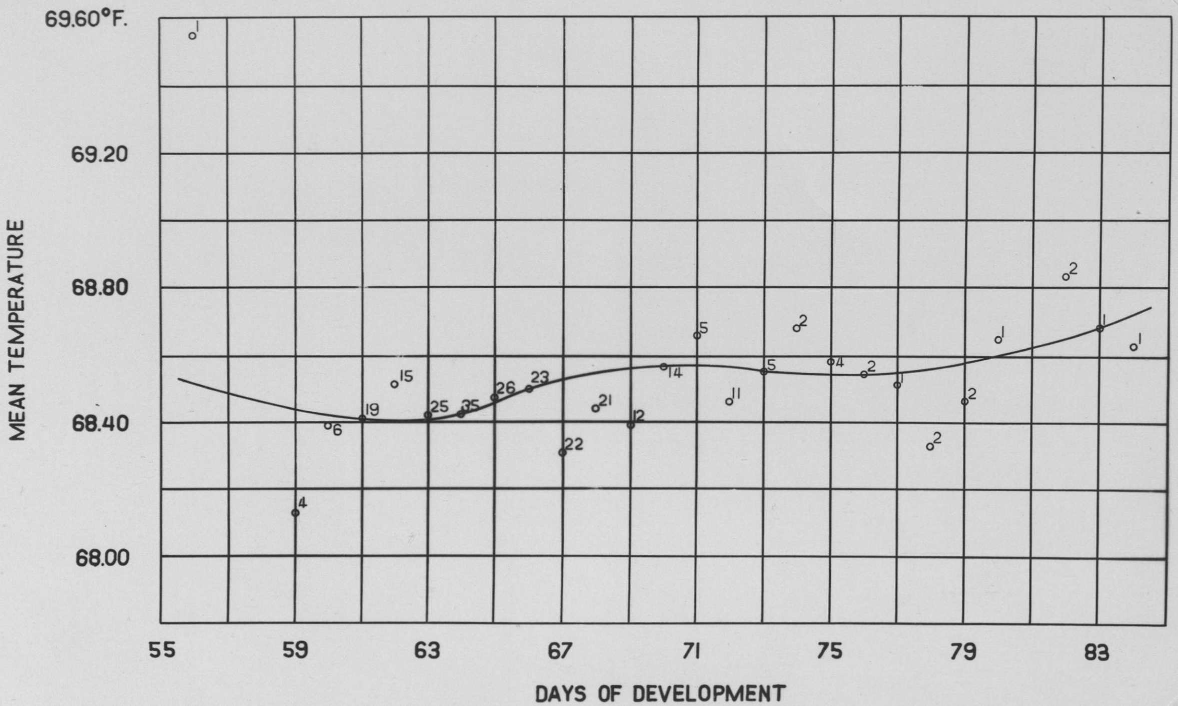

69.60°F.
69.20
68.80
68.40
68.00
MEAN TEMPERATURE
55
59
63
67
71
75
79
83
DAYS OF DEVELOPMENT

FIGURE 8

EXPLANATION TO PLATES

PLATE I

The bark of a gamble oak, *Quercus gambelii* Nutt., stem riddled by the feeding of the confined weevils of *Sternechus paludatus* (Casey)-- (see page 4).

PLATE I

PLATE II

A New Mexican black locust, _Robinia neomexicana_ Gray, shrub stunted and partially killed by the feeding and oviposition of _Sternechus paludatus_ (Casey). Note the defoliated midribs on the left.

PLATE II

PLATE III

A New Mexican black locust, _Robinia neomexicana_ Gray, shrub stunted and partially killed by the feeding and oviposition by _Sternechus paludatus_ (Casey). Note the rosette growth and defoliated midribs on it.

PLATE III

PLATE IV

Seedlings of beans badly damaged by feeding and oviposition by <u>Sternechus</u> <u>paludatus</u> (Casey). The oval shaped and dark spots are scars made during oviposition. The more elongated, narrow scars are caused by feeding.

PLATE IV

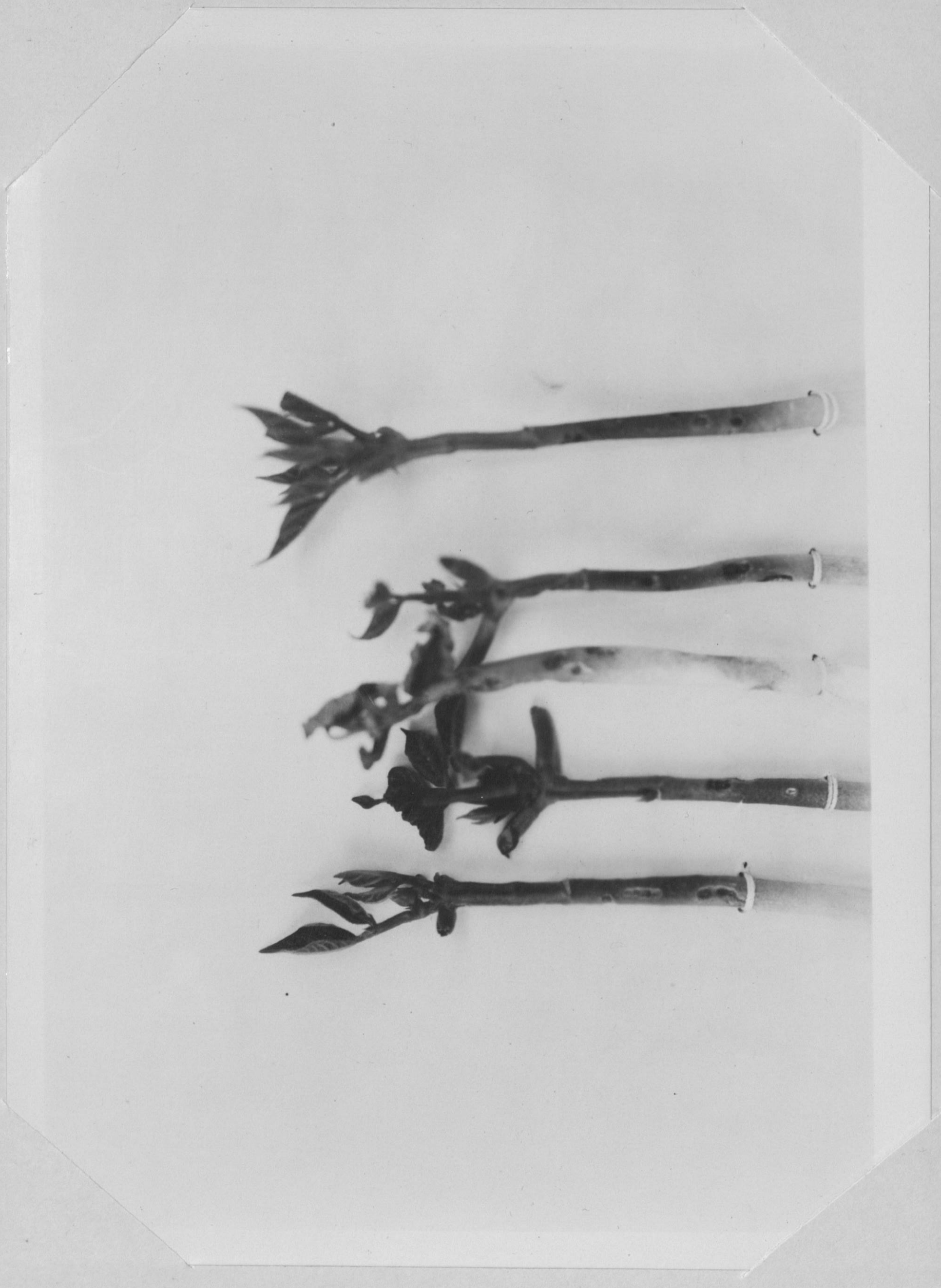


PLATE V

Seedlings of beans damaged as in Plate IV.

PLATE V

PLATE VI

Seedlings of beans damaged as in Plates IV and V. It will be noted in this Plate and Plates IV and V that the feeding of the weevils of *Sternechus paludatus* (Casey) has caused much defoliation.

PLATE VI

PLATE VII

Bean plants showing the rosette growth, caused by severe infestation of Sternechus paludatus (Casey), when in the seedling stage. The plant on the left, especially, shows a scar caused by egg deposition. The growth of the plant causes the scar to become much larger and result in the stem continuing to be weak. The more or less skeletionizing of the foliage is caused by the feeding of the adult Mexican bean beetles, Epilachna corrupta Muls.

PLATE VII

PLATE VIII

A. Normal transplanted pinto bean plants.

B. Plumules of bean plants damaged by the feeding of adult weevil of *Sternechus paludatus* (Casey).

C. Type of cage used for confining a pair of adult weevils of *Sternechus paludatus* (Casey) to obtain egg laying records of the female.

PLATE VIII

PLATE IX

The upper rack contains the test tubes used for rearing the larvae of *Sternechus paludatus* (Casey). The block lying on its side contains the shell vials which are used to keep the late fourth instar larvae and prepupae until molting to pupae.

PLATE IX

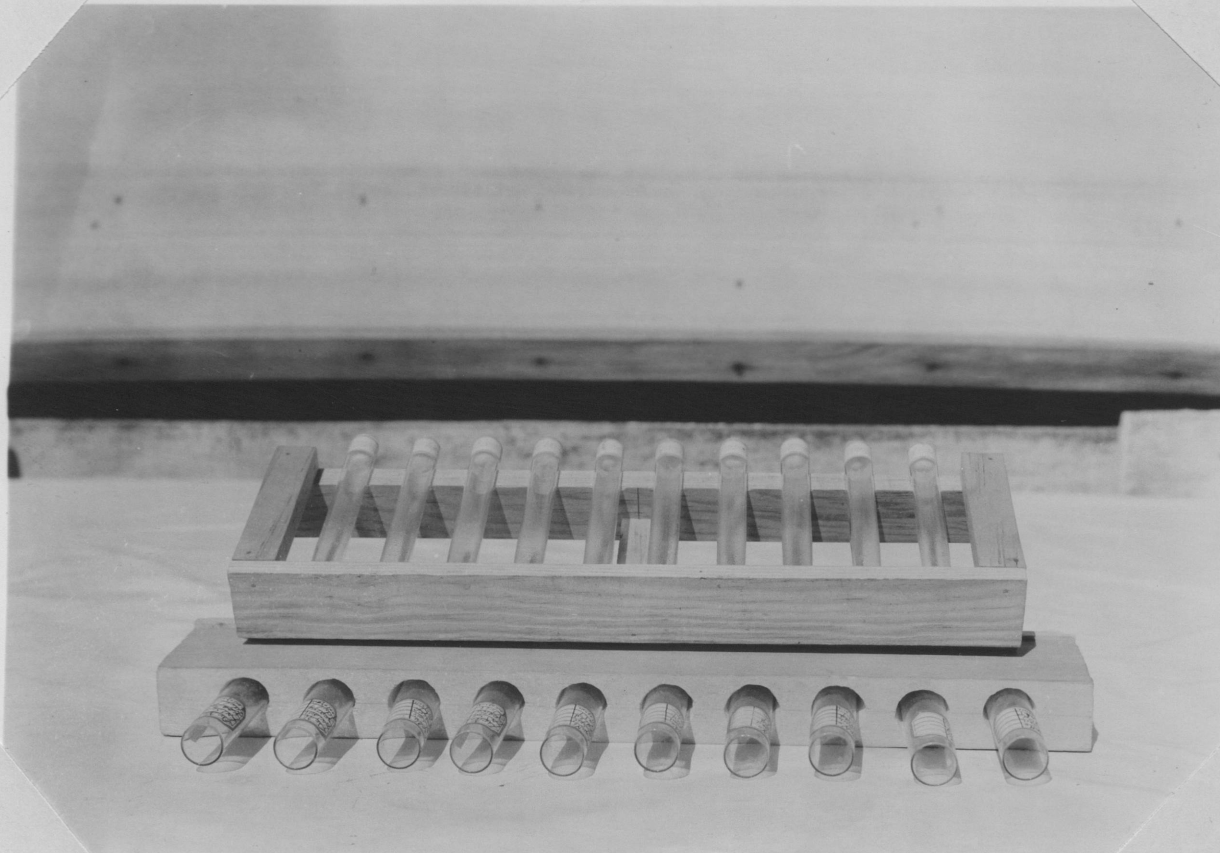


PLATE X

Pupal racks here shown held and accommodated the observation of the pupal stage of _Sternechus paludatus_ (Casey) and its transformation to an adult and its emergence from the soil. This type of rack held six pupae conveniently,-- three next to each glass plate. The rack on the right has a screen attached to the top of it to prevent escape of newly emerged adults. The weevil on the right end of this rack has made its exit through the soil surface by working its way up along side of the glass. The weevil on the left side of this rack has also made its exit from the soil surface while the one in the middle still remains in the pupal cell. The pupal cells of the rack on the left contain pupae.

PLATE X

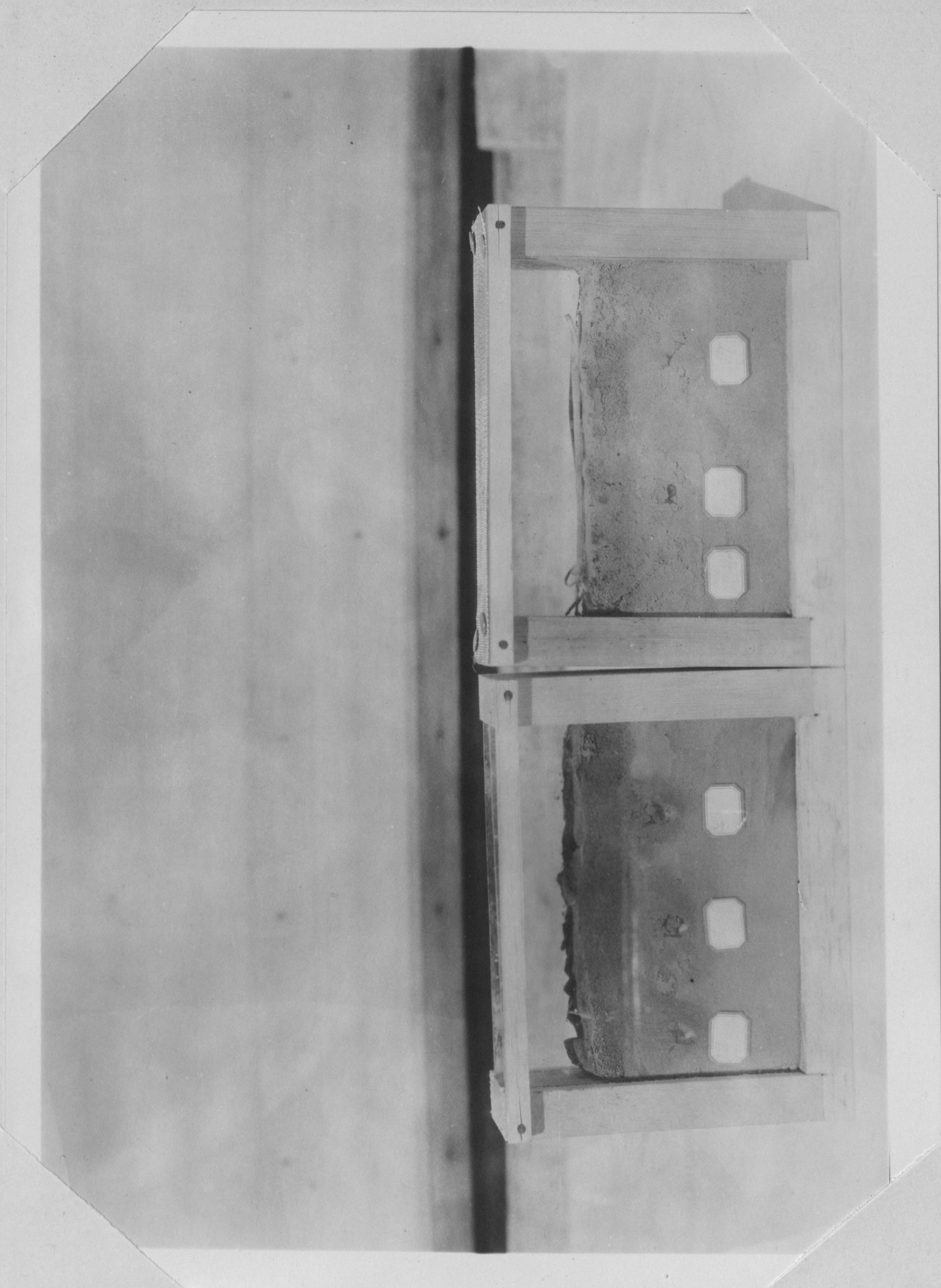


PLATE XI

Hibernation cage No. 7, one of the cages used to hibernate the weevils of *Sternechus paludatus* (Casey).

PLATE XI