T H E S I S

A STUDY OF THE LIFE HISTORY AND CONTROL OF *ELEODES HISPILABRIS* SAY ON THE DRY FARM LANDS OF EASTERN IDAHO

With Notes Concerning Other Species of the Tribe Eleodiini in Idaho.

Submitted by

Claude Wakeland

for the Degree of Master of Science

Colorado Agricultural College

Fort Collins, Colorado

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THIS THESIS HAS BEEN READ,

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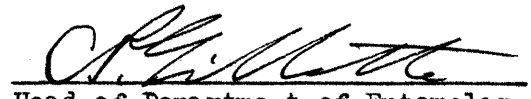

Head of Department of Entomology

Colorado Agricultural College

Fort Collins, Colorado

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THIS THESIS HAS BEEN APPROVED AND RECOMMENDED FOR

THE DEGREE OF MASTER OF SCIENCE

Chairman and Professor of Zoology

Professor of Horticulture

Professor of Veterinary Pathology

Committee on Advanced Degrees
Colorado Agricultural College
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By Claude Wakeland

Selection of the Problem for Experimental Work.

False wireworms, the larvae of several species of eleodes beetles, have become increasingly abundant in the dry farming sections of eastern Idaho during recent years. They are seriously injurious to wheat grown on non-irrigated land and not unusually cause a loss of from 10% to 40% of the crop and, in rare instances, more. The most severe and wide spread injury that has been reported in the state has been on a flat mesa known as Rexburg Bench. This mesa is underlaid with basalt over which is a rich, alluvial sandy loam soil of great depth in most places and with outcrops of basalt along the ravines. Rexburg Bench (Plate No. 1) is in Madison county adjacent to the town of Rexburg and comprises an approximate area of 50,000 acres. For three years the farmers of the infested area were insistent that the University carry on investigations to try to determine effective control measures. The matter was brot to the attention of the Experiment Station Entomologist but, owing to other work in progress, he was unable to undertake studies on eleodes beetles and it was mutually agreed between him and the writer, who was then Extension Entomologist for the University of Idaho, that the latter should conduct such inves-

tigational work as his time and opportunity permitted. Considerable work was thus done on the problem in 1920 and 1921. With the completion in 1921 of experimental projects under way and the appointment of the writer to the position of Station Entomologist investigations of eleodes beetles were undertaken as a major project.

Review of History, Literature, etc.

The first species of the tribe eleodiini were named and described by Thomas Say (28) in the year 1823.

Frank E. Blaisdell Sr. in his very extensive monographic revision of the Eleodiini (6) has the following to say concerning the tribe in general:

> Habits: Our species are terrestrial and cursorial, apparently strictly nocturnal or are about early in the morning or late in the day. On warm, cloudy days I have seen Eleodes grandicollis and Eleodes acuticauda walking about.
>
> The larger species, when disturbed, place their bodies nearly vertical, the head near the ground tail erect, and when touched or irritated will emit a dark, pungent, oleaginous, offensive secretion which, coming in contact with the skin of the hands, will stain brownish and remain for a long time and apparently fixed by an alkaline substance. (Horn.) The species of the present tribe rarely ascends plants; the smaller species (Blapylis) may be found on the stems or under bark of shrubs. When alarmed they run off with their bodies elevated. Probably it is this habit that suggested the name "circus bug" often applied to them in the

middle west. (Wickham) In California they are often spoken of as "stink" bugs, "beetle bugs" and "tumble bugs". The latter term is applied no doubt on account of their frequently tumbling over when excited; also "pinacate bugs". (V. Kellogg) They are a characteristic feature of the arid regions west of the Mississippi River.

Longevity: Some of the larger and more resisting species evidently live to be several years of age, especially in the warmer regions of California. (Horn) I have kept several Eleodes dentipes in captivity for over four years. Doctor Horn states that specimens have been kept pinned for two months without food or water. Eleodes clavicornis dies quickly in confinement and apparently lives but one season.

Food: All are vegetable feeders, apparently preferring dried vegetation and fungi, altho eating green plants.

Enemies: Quadripeds like skunks will feed on them, chickens devour them readily as well as ground owls; butcher birds empale them on thorns.

Economics: As far as I have been able to determine they are neither injurious nor beneficial, unless the larvae are in some way troublesome, but as they appear to prefer decaying vegetation to the living, I doubt that they can be considered objectionable.

Origin and Diffusion: It is impossible for me at this time to express an opinion on the origin and diffusion of the

species making up the tribe Eleodiini, but I believe the species to a great extent had their origin in Mexico, or in adjoining desert regions and that diffusion has been chiefly northward and westward. I know of no fossil remains of species referable to the tribe, and a few that were supposedly so were from very recent deposit and identical with species now existing. It remains for the study of Mexican fauna to aid us.

Distribution: Abundant both in species and individuals thruout the region west of the Mississippi river, from the northern boundary line of the United States southward into Lower California and Mexico to South America where they are replaced by Nycterinus. They also inhabit the islands adjacent to the western coast of the territory named above.

References to the economic importance of eleodes beetles have been few and, for the most part, of recent date. In 1883 C. V. Riley (35) mentions the report that adults of Eleodes quadricollis Lec. had destroyed 25 acres of grapes in California. Commenting on the report Riley says: "This communication, if correct, would indicate a change of habit hitherto unprecedented in the history of economic entomology and unless further proof be brot forth, we can hardly believe that the species referred to is the real author of the damage to grape vines."

One of the first references to eleodes beetles as of definite economic importance is that of Professor Lawrence Bruner (9) in 1891. He says: "A cabbage pest in the shape of a rather active, grayish-brown

coleopterous larva was noted for the first time during the past season here at Lincoln. (Nebraska) In some of our market gardens this larva did even more injury than was committed by the various cutworms that were quite plentiful and against which we are obliged to contend every spring. This larva not only attacked cabbage but showed a decided inclination to feed upon various other food products of the garden. It was also found to be a general feeder both upon the prairies and in the fields where it even attacked the weeds. By placing specimens of nearly fullgrown larvae into a breeding cage it was a surprise to me when I found that from them developed the common Eleodes tricostata Say. This insect appears to be greatly on the increase here in Nebraska and especially does it seem to be increasing over the settled portions."

In 1909 Professor Myron H. Swenk (43) wrote about Eleodes opaca Say, mentioning it as being "a new insect enemy of planted grain--- which destroys the seed in the ground before it can germinate." At the same time that Doctor Blaisdell was working on his monograph of the Eleodiini and finding from past records that they were "neither injurious nor beneficial" another investigator in a different state was learning that the larvae of one species at least "were doing a great deal of damage" to planted grains.

Apparently the first extensive economic study of eleodes beetles was undertaken by Mr. J. A. Hyslop. In the bulletin (25) written by him after the conclusion of his studies in the state of Washington he says "the results of three seasons' work in the Pacific Northwest demonstrate quite conclusively that the false wireworms are among the most destructive insects to recently planted wheat and corn in this region". In his bul-

letin he refers to an article published by C. V. Piper in the Northwest Horticulturist in 1895 in which he refers to eleodes larvae attacking garden crops. He also mentions that in 1898 Mr. Theodore Pergande received from McPherson, Kansas two tenebrionid larvae with the statement that they do serious damage to wheat in Salina county by attacking the grain when it becomes softened, destroying the germ. The species he found to be the most injurious and abundant in the Pacific Northwest were Eleodes pimeliöides Mann. and Eleodes letcheri Vandykei Blaisd. Other species mentioned in the same territory are Eleodes obscura Say var. sulcipennis Mann., Eleodes hispilabris Say var. laevis Blaisd., Eleodes extricata Say, Eleodes manni Blaisd., Eleodes humeralis Lec., Eleodes schwarzii Blaisd., and Eleodes nigrina Lec.

For control Hyslop recommends disking the land as early in the spring as it can be worked. This will conserve the moisture. Then plow as late as possible, even as late as the last of July or in early August. At this time the beetles (Eleodes letcheri Vandykei) are in the pupal stage. Plowing at this time turns out great numbers of pupae and they are eaten by birds, killed by the sun or crushed or suffocated in the broken pupal cells. He carried on experiments to determine whether larvae could be poisoned in the soil. Seed was treated with arsenate of lead, strychnine sulfate and coated with coal tar. Results were entirely negative.

Writing in 1912, Professor F. M.Webster mentioned (53) that Eleodes sulcipennis Mann. when confined to the laboratory readily fed on the larvae of the alfalfa weevil and that an allied species, Eleodes suturalis Say, had been observed by E. O. G. Kelly to devour chinch bug eggs.

In 1915 Professor E. O. Essig states (17) that adults of Eleodes omissa borealis Blaisd. attack apricot, orange and plum trees and may almost denude them of their foliage. They also injure watermelon vines.

Professor R. A. Cooley mentioned in 1916 (10) Eleodes extricata var. convexicollis Blaisd. as being very abundant in Montana and states that in several instances larvae had injured newly sprouted grain.

The life economy and economic importance of Eleodes tricostata Say is dealt with by Professor Jas.W. McColloch (31) in 1918. He says "In Kansas, tricostata appears to be confined almost entirely to the native pastures where the larvae feed on the roots of the various grasses occurring there. Practically all the adults and larvae collected in the field have been taken in such situations. A few larvae and adults have been found in wheat and corn fields but the data thus far collected indicate that this species is a pest of our native prairie grasses. In the laboratory, however, the adults and larvae feed readily on germinating wheat and corn and there seems to be no reason why this should not occur in nature. The adults also feed freely on young wheat plants growing in the cages." "Eleodes tricostata has not as yet become of sufficient economic importance to warrant any extensive experiments on control. The use of poisoned bran was tried, under laboratory conditions, on the adults with good success but the larvae lived for weeks on such a diet. With most of the injurious forms of Eleodes it has been found possible to control them by summer fallowing the ground. Rotation is also recommended in some cases since the beetles are wingless and move only on foot."

The following year Professor McColloch published another paper

(32) dealing with Eleodes opaca Say as an important enemy of wheat in the Great Plains area. He mentions that prior to 1918 opaca was not recognized as an insect of economic importance but suggests that much of the injury previously attributed to other causes was the result of the attack of this pest. He says, "The principal injury of Eleodes opaca is done by the larvae during the fall. At this time they attack the wheat seed immediately after planting and destroy it before germination. During dry years, when the grain may lie in the ground several weeks before sprouting, the injury becomes most severe. After the seed germinates the injury becomes less noticeable and often ceases altogether. In some cases, however, considerable damage may occur after the wheat is several inches high. This was especially true in 1911 when the larvae destroyed many fields by cutting the plants off just above the seed. Occasionally some damage occurs in the spring due to the larvae burrowing thru the stalks or even cutting them off. The original food of the larvae was apparently the roots and seeds of native grasses and weeds but within recent years, due to the breaking out of the native sod, wheat has apparently supplemented this food. ---During the present outbreak, serious damage has occurred in the spring to oats, barley, sorghums and corn.---Little is known concerning the amount of injury done by adults."

He deals with descriptions and biology of Eleodes opaca and closes his paper with recommendations for control. He says that adherence to a good rotation system would reduce the amount of injury and at the same time increase the yield. He says further "the practice of summer fallow, whereby the land lies idle for a year, being worked sufficiently

deep to keep down the plant growth, is practiced to a limited extent in western Kansas. Where this method is followed there has been little or no injury from false wire worms. Summer fallowing destroys the beetles and larvae and destroys many eggs. The beetles are also deprived of shelter during the day". He advocates the keeping down of weeds to deprive beetles of shelter and to deprive larvae and adults of food. He suggests the delaying of planting, especially during dry seasons, or in the spring on ground that has been sown and where the wheat has been destroyed by the worms, and states that in fields where plowing was done while the insects were in the pupal stage from 80% to 95% were destroyed. Concerning poisoning he says, "The use of poison bran mash as prepared for use against grasshoppers may prove beneficial in some cases in the control of Eleodes opaca. Under laboratory conditions the beetles ate it voraciously, and were attracted to it from a distance of two or three feet. The possibility of its use under certain conditions where the adults are congregated in large numbers around wheat shocks and stacks and piles of Russian thistles may prove practical. Experiments in poisoning the larvae have thus far given negative results.

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Review of the Observations of the Entomologist for the University of Idaho Extension Division in 1920 and 1921 and of Preliminary Experiments in Control in 1921.

Previous to 1920, no study had been made of the life economy and control of false wireworms in Idaho. During that year field observations by the writer, reports from farmers and from the County Agricultural Agent of Madison County led to the formation of tentative plans for conducting investigations of the feeding habits of adults and the determination to attempt control by poisoning. Literature records a few attempts to poison larvae all with negative results. McColloch (31) states that poison bran mash was tried under laboratory conditions against adults with success but that larvae lived on it for weeks. He suggests (32) that poison bran might prove beneficial in some cases where adults are congregated in large numbers but does not intimate that it was tried under field conditions.

Of necessity, observations by the Extension Entomologist were not as extensive as was to be desired and had to be made only in connection with other work in the field. In May 1920, numerous wheat fields were visited in which large areas had been killed by false wireworms and numerous live larvae were observed at a depth of from one to two inches below the surface of the soil. These areas, in some localities, had been attributed to "winter killing". For years, also, eleodes beetles locally known as "stink bugs" had been increasingly abundant until they had come to be considered as a nuisance but generally had not been associated with the false wireworms in the soil. Data collected from D. P. Murray, County Agricultural Agent for Madison County, and from

farmers were: Larvae numerous in the field in the early spring; pupae frequently plowed up in July; adults numerous in the spring, disappear in late June and early July but become abundant again in late July, August and September. Supplementing these data the writer found that in June adult females contained large numbers of eggs; that adults emerged in late July and early August; that during August adults did not copulate and numerous females dissected during the fall were found to contain no eggs.

These data indicated that there was a rather definite emergence date for adults. Observations showed that beetles fed greedily soon after emergence and continued to feed thruout the fall until cold weather drove them into hibernation quarters. Since they did not lay eggs until the following spring it appeared that, if they could be induced to eat poison and if the poison would kill them, they could be combatted before they had had opportunity to reproduce.

Work on Eleodes control was undertaken in August 1921 and was divided roughly into three parts: 1. Field observations. 2. Laboratory trials in poisoning adults. 3. Tests of poisoning beetles in the field. From observations of beetle activity and feeding habits in the field, the following facts, important when considered in relation to control measures, were learned:

1. Beetles feed freely on many vegetable substances, particularly on wheat kernels and wheat chaff on the ground.
2. Beetles feed less under bundles, piles of straw , etc., than when they are not protected.
3. Beetles feed actively only when the temperature is moderate.

On hot days they feed little. Following hot days they feed extensively from about two hours before sundown until dark. On warm nights they probably feed to some extent most of the night, but observations at 9 P. M. showed them to be much less numerous in the open than earlier in the evening. On warm mornings they begin feeding shortly after sunrise and continue until the heat drives them into protected places. (About 8 to 9 A. M. in August) On cooler days they begin feeding later in the morning and on cool, cloudy days, without rain, beetles feed thruout the day. During chilly, rainy days they remain in sheltered places and do not feed. On sultry, rainy days they feed actively when rain is not actually falling.

A series of laboratory cage experiments was conducted in which a total of thirteen different poison mash combinations, eleven of them arsenical, were fed to 1650 beetles. Repetitions of the most promising were made with results that indicated that potassium arsenate, Paris green, white arsenic and sodium arsenite were the most effective in the order named with an average killing efficiency of 99.5%, 95.9%, 92.9% and 71.6% respectively. Beetles in cages fed greedily on bran and on wheat chaff, either moist or dry and even when moistened with a saturated solution of salt water. Apparently they fed as freely on bran mash alone as when it was scented with amyl acetate or with lemon juice, but were more shy in feeding on mash containing commercial sodium arsenite than on that containing other arsenicals.

Poisoning beetles in laboratory was so successful that a Paris green bran mash was tried against them under field conditions. Because

of cost and availability, Paris green was selected for field tests in preference to potassium arsenate even tho the latter arsenical had given better results in laboratory trials. The writer spent many days and evenings wandering around over grain and stubble fields making observations of the habits of adults in traveling, feeding, etc. Among other characteristics he noticed that when beetles are crawling and their course of travel takes them to a furrow or a distinct depression, they alter their direction, much more often than not, and proceed along the bottom of the depression for a distance before climbing out again. They apparently follow the course of least resistance. This observation furnished the foundation for the idea of plowing a furrow and distributing poison mash along the bottom of it. Accordingly a furrow 390 yards long was plowed in a stubble field and a short, smooth log was attached to the plow in such a way that it dragged in the furrow just behind the share and made a smooth path for the beetles to follow. Poison bran mash was scattered lightly in the bottom of this furrow on the evening of August 18th, 1921. At 6 A. M. the following day very few beetles were observed, dead or alive, in the bottom of the furrow but at noon 610 dead ones were counted. On the succeeding day twice as many dead were counted and on the fourth day after the poison bait was distributed 4205 dead beetles were collected that were in sight in the furrow and on the dirt thrown out of it. Eleven days after the poison bran was scattered, the beetles were again picked up and counted and there were 3458 additional dead ones, making a total of 7653 dead that were killed with a single application of poison.

Examination under clods, Russian thistles, etc., near the fur-

row disclosed large numbers of dead beetles undoubtedly killed by the poison. Decreasing numbers were observed to a considerable distance on each side of the furrow and it was apparent that the number of dead beetles counted in the furrow and on the furrow slice was but a portion of those actually killed. An important fact was that mash that had laid in the furrow for nearly two weeks and had been soaked and mud-spattered by a rain was still effective in killing beetles. (In the spring of 1922 some of the same mash that had been exposed all winter was collected and fed to beetles in the laboratory and it killed them readily.) They also ate dry, hard chunks as freely, apparently as smaller moist flakes. It was interesting to note that beetles crawling on the furrow bottom when the mash was distributed usually stopped at once and began eating.

The first poison mash distributed was mixed at the rate of two pounds Paris green to 25 pounds bran but later mixtures were made with the arsenic content only half that amount and killing results were apparently as effective.

Results in the test furrow were so favorable that a field of approximately forty acres was chosen in which to make a more extensive test. A furrow was plowed entirely around it and cross furrows extending north and south were plowed at approximate intervals of 100 yards. Poison mash was mixed and placed in a spring wagon (Photograph 33) to the side of the box of which was attached a trough in such a way that the upper end projected into the wagon box and the lower end to a position a short distance above the furrow to be treated. One man drove the team and one slowly and uniformly fed the poison mash into the trough. Thru the trough, poison mash was distributed in the furrow and applicatinn

was thus made as fast as the team walked. By this method a total furrow length of 10, 560 feet was treated with 25 pounds of bran with results apparently comparable to those in the test furrow, tho no counts of dead beetles were made. The cost of material for treating the forty acres was 80¢ or but 2 cents per acre.

After threshing time beetles congregate by thousands around the straw stacks. (Photographs 8 and 9) They seek protection in the straw during the day time and feed in the morning and evening on the grain remaining in the chaff and especially on the broken kernels and waste grain left around the separator location. The chaff is literally a seething mass when they are feeding. A small amount of the poison bait (two double handsful) placed on the ground near a straw stack was sufficient to kill nearly all of the beetles congregated in the straw and among the sacks of grain that were piled nearby. Examination disclosed great numbers of dead many of which had crawled a foot or more into the straw and when the sacks of grain were removed there were thousands of dead beetles piled up among the sacks and on the ground. An extremely important fact was apparent, namely, that even where there was an abundance of grain and other food present the beetles ate the poison-mash readily.

Following the application of mash to the forty-acre field, it was distributed along weedy fence rows and on waste rocky land where beetles congregated and thousands of dead ones were observed under rocks and trash aside from large numbers that had undoubtedly crawled into ground squirrel holes and rock crevices before dying. Evidence that

large numbers died where they could not be seen was obtained by turning over large flat rocks under which dead beetles were very numerous.

Object and Plan of Work 1922.

Control of Eleodes beetles could not be worked out satisfactorily without being based upon biological studies. With the transfer of the writer from the University Extension Division to the Experiment Station it was decided to devote one season to the study of eleodes beetles and their control as a major project to be followed by such work as was necessary during succeeding years to complete the life history work on the most injurious species. Accordingly the project was drawn up by the Entomologist, approved by the project committee of the University and the writer moved to Rexburg where he lived from April 1st until October 1st 1922.

A List of Eleodes Beetles Known to Occur in Idaho.

Blaisdell (7) mentions six species as definitely occurring in Idaho. He further mentions one species from the Palouse country of Washington. Hyslop (25) mentions seven species as occurring in the Palouse country of Washington. Since the Palouse country as generally designated, extends into western Idaho and climate, types of soil, etc., are identical in the two states there is reason to believe that the same species of beetles occur in Idaho. During the present studies eleven species and thirteen varities of eleodes beetles have been collected in the state. It is therefor definitely known that fifteen species occur in the state and very probable that the number is seventeen. Doubtless the fauna of the state includes a number of species

that have not yet been collected.

1. Eleodes humeralis Lec. Hubbard and Schwarz (7), Palouse country,(Hyslop (25)).
2. Eleodes extricata Say. (7), Palouse country, (Hyslop (25)). var. cognata Hald. Rexburg (C. Wakeland), Aberdeen (Wakeland), Preston (Wakeland).
3. Eleodes sulcipennis Mann. Camas Creek (L. Bruner (7)), Palouse country, (Hyslop (25)), Rexburg (Wakeland), Parma (Wakeland), Payette (Whelan).
4. Eleodes pimelioides Mann. Camas Prairie (Riley (7)), Coeur d'Alene (Wickham (7)), Rexburg (Wakeland), var. brunnipes Casey, Palouse country (Hyslop (25)).
5. Eleodes nigrina Lec. (7), Palouse country (Hyslop (25)), Moscow (J. M. Aldrich), Boise (Wakeland), var. perlonga Blaisd. Rexburg (Wakeland).
6. Eleodes schwarzii Blaisd. Palouse country (7), Palouse country (Hyslop (25)).
7. Eleodes manni Blaisd. Palouse country (Hyslop (25)).
8. Eleodes hispilabris Say. Palouse country (Hyslop (25)), var. immunda Blaisd. and var. immunda small form, Madison county, Jefferson county, Fremont county, Clark county, Bonneville county, Franklin county, Bingham county, Bannock county, Oneida county, Power county, Ada county and Canyon county (Wakeland).

Footnote: Determinations of all specimens collected by Whelan and Wakeland were made by Dr. F. E. Blaisdell Sr.

9. Eleodes tenebrosa Horn. Rexburg (Wakeland).

10. Eleodes caudifera Lec. Bingham county (Wakeland).

11. Eleodes omissa pygmaea Blaisd. Madison county (Wakeland).

12. Embaphion contusum Lec. Madison county, Jerome county (Wakeland).

13. Embaphion elongatum Horn. Parma, Jerome, and Rexburg (Wakeland).

14. Eleodes verrucula Blaisd. Moscow (Aldrich), Camas Prairie (Wakeland).

15. Eleodes longipilosa Horn. Springfield (Wakeland).

16. Eleodes Blapylis sp. dub. Challis (Wakeland).

17. Eleodes vandykei Blaisd. (Northern Form). Felt (Wakeland).

On Rexburg Bench it is definitely known that 9 species of the tribe Eleodiini occur, 7 of them of the genus Eleodes (Photograph No. 4) and 2 of the genus Embaphion.

Eleodes hispilabris is the chief economic species of the dry farm lands of eastern Idaho and to date might be considered as the only species that has proven destructive enough on grain crops to warrant consideration of control methods. Eleodes extricata ranks second in importance but it was found to be more numerous than Eleodes hispilabris in only one wheat field on Rexburg Bench. In Teton county there has been caused some injury by Eleodes vandykei which is increasing there in numbers and distribution and some consideration has already been given by the farmers to the question of the need of control. The other species named in this thesis are observed so infrequently in the dry farming section of eastern Idaho that they are of interest economically only in the relation they bear to the injurious species, in their similarity of

habits and in the potentiality of their becoming injurious at some future time.

Since Eleodes hispilabris is of greatest economic importance, investigational work was restricted to it except where studies and observations of other species could be made conveniently in the course of work done on this species.

Field Observations of Adults.

Life cycle studies and observations of Eleodes hispilabris were continued in more detail in 1922 than during the former year. Adults were still in hibernation April 20, but were discovered under heavy rocks where they were observed to be in a torpid condition. The rocks were at the base of a cliff (Photograph No. 11) having a southwest exposure and they had been warmed by the afternoon sun. Adults under the rocks moved sluggishly when disturbed and were evidently just beginning to become active. Shortly after this live adults were observed crawling about under the edges of rocks in favored exposures and on April 27 the first live adults were observed emerging from ground squirrel burrows (Photograph No. 12) along a fence row on Rexburg Bench. After the latter date they increased in numbers very rapidly as the weather became warmer but were rarely found away from fence rows and rocky waste patches (Photograph No. 10) before May 15th. The temperature rapidly became greater after the middle of May and it was but a short time later that adults were increasingly numerous on cultivated ground and correspondingly less abundant along fence rows and on waste lands. As late as May 13th sluggish, mud-covered adults were observed issuing from

the mouths of ground squirrel burrows on north exposures and were evidently just emerging from hibernation. Dissection of these late emerging individuals showed there was nothing in the intestines, very little moisture was in the body and all the food content appeared to be small fat particles. In contrast with these, beetles which had been active for some time and had fed, generally had plump bodies and were full of moisture and the intestines were filled with material.

Field collected females were dissected daily after May 1st and the first gravid individual of Eleodes hispilabris was found May 12th; while the first pair in copulation was observed May 16th. On May 16th, dissections of females of Eleodes hispilabris and Eleodes extricata showed that 29.4% of the former and 50% of the latter were gravid, thus indicating earlier seasonal development for the latter species.

After the middle of May the numbers of adults gradually decreased. On June 12th adults were becoming hard to find and on June 22d after sundown, the most favorable time of day to find them, it required over an hour to collect 50 of them for the laboratory.

In some of the most heavily infested fields observations were made after June 20th to endeavor to learn the approximate date at which larvae entered the pupal stage under natural conditions. These observations were made by removing the earth with a shovel in successive layers and carefully examining each shovelful for the presence of pupae. The first pupa of Eleodes extricata observed was on June 28th. On July 1st three newly formed adults of Eleodes extricata were excavated. These were a dull olive color and had not yet changed to the shiny black which is characteristic after the beetles have emerged. On this date no newly formed

adults of Eleodes hispilabris were found which is another indication that the former species develops somewhat earlier in the season. The first larva of Eleodes hispilabris that was observed to be transforming to a pupa was on July 3d but pupae of this species were not numerous until July 10th. On July 8th an occasional newly emerged adult of Eleodes extricata was observed abroad in the fields but newly emerged adults of Eleodes hispilabris were not observed until July 15th. On this date adults of the former species were numerous but adults of the latter species were observed but rarely. It was not until the first of August that the ratio of the numbers of the two species was reversed and Eleodes hispilabris predominated. From all field observations it would appear that Eleodes extricata reaches maturity in from one to two weeks earlier than the latter species.

Newly emerged adults may be readily distinguished by their blacker color and more lustrous appearance and by the soft and pliable state of the elytrons. Old adults remaining in the field from the generation of the previous year usually are less shiny, varying from dull black to gray or brown and have elytrons that are very stiff and brittle.

A fact that the writer is at a loss to account for is that, with the exception of two small localities, adults did not emerge in nearly as great numbers in 1922 as during former years. On portions of Rexburg Bench one could walk across large wheat fields or along hundreds of rods of fence row without observing a single adult. In these same fields the year previous and during former years beetles were present in very great numbers. It would seem that all conditions of the winter of 1921-22 were favorable for a low death rate since the beetles went into hiber-

nation before the snow came, there was no frost in the ground and snowfall was heavy, offering good protection.

An interesting and important observation made on May 3d on the Swendson Ranch where the poison tests were conducted the fall previously was that on rocky waste patches where no poison had been distributed in 1921, adults were numerous while on patches of the same nature, where poison mash had been scattered, there were many old, dead beetles and live ones were rarely observed. Also, there were numerous live beetles along the fence row on the south side of the ranch where no poison had been scattered while along all fence rows that had been treated but very few live beetles could be found.

No attempt was made to compile a list of the food plants and substances of adults. They feed freely on most green grasses and weeds as well as on various weed seeds, grain and chaff. They were observed tenaciously gnawing on substances of little or no value such as dry wheat straw and bits of paper. A favorite food appeared to be green Russian thistle, (Salsola pestifer) when the plants were small. Eleodes hispilabris was never observed off from the ground but Eleodes extricata was frequently seen climbing on rabbit brush (Chrysothamnus sp.) and feeding on the tender growth in the tips.

Field Observations of Larvae.

Examinations of fields in April, 1922 soon after the snow had melted, proved that the abundance of larvae varied greatly in different localities. In some areas where they had been numerous during previous years they were in many instances very scarce. In only two small localities were they present on Rexburg Bench in as large numbers as during

former years. No probable explanation for this sudden decrease in larvae or adults has occurred to the writer. It is improbable that parasites or predaceous enemies were of any material importance as will be explained in a later paragraph.

Over-wintering larvae in the soil were, for the most part, from about one-third to one-half grown in late April. An occasional individual was excavated that might be either much smaller or much larger. Those observed in the early spring while there was much moisture in the ground were so near the surface as to be covered by but a very thin layer of soil. A fact that was apparent, with very few exceptions, was that the depth at which larvae lived in the soil was determined by the depth of the dry layer of soil on the surface. It was the general rule that they were found at the juncture of the dry top soil with the moist subsoil. As the season advanced and the moisture evaporated from the soil, larvae were found at an increasing depth excepting following rains when they would often be found nearly exposed on the surface.

Larval injury to grain is the most severe when the layer of soil in which the seed is planted and the sprouts produced is moist and when the soil is warm. An optimum condition is obtained during late April and early May and again in August and September on fall planted grain. That injury abates as the season advances is explained largely by the fact that larvae work deeper into the soil as the moisture recedes from the surface. When the moisture line is below the level of the grain seeds or sprouts injury is slight. The only exception observed was in spring planted grain where larvae were at a depth of $2\frac{1}{2}$ inches below the soil surface feeding on sprouting wheat kernels even tho the

soil was moist very nearly to the surface. This is a significant fact since in fields of fall planted grain where feed was available close to the surface of the soil, larvae were also very near the surface. From all observations made by the writer it is concluded that the following rule holds true: In grain fields false wireworms are always found at the juncture of the moist and the dry soils if grain seed is at or above the juncture; they may be found below the juncture when no food is available except at that depth.

On June 19th soil moisture had been exhausted to a considerable depth and larvae were found from 7 to 8 inches below the surface, and at the juncture of the plowed with the sub-soil. On July 1st a few larvae of Eleodes hispilabris were unearthed that were in the second six-inch layer of soil below the surface and three were observed that had made their way into the hard subsoil below the bottom of the old plow slice, or to a depth of approximately 12 inches below the soil surface.

Larvae were less numerous in the fields on Rexburg Bench in 1922 than during many former seasons, as has already been stated, yet it was the exceptional field in which at least one larva could not be found in each one-rod length of a drill row of wheat. Various counts were made in some of the moderately and heavily infested fields and a record of the numbers per rod and calculated number per acre is given in the following tabulation:

Date	Field	No. of larvae per rod of drill row	Calculated No. of larvae per acre.
Apr. 15	Ed. Swendsen	3	158,400
Apr. 20	Ed. Swendsen	12	633,600
Apr. 27	J. S. Webster	3	158,400
Apr. 27	Elmo Webster	6	316,800
May 4	R. L. Bybee	11	580,800
May 4	R. L. Bybee	7	369,600
May 4	R. L. Bybee	28	1,478,400
May 19	Henry Parkinson	30	1,584,000
May 19	Harvey Summers		2,587,200

Eleodes larvae are almost entirely subterranean in habit. On but seven occasions during the entire season were they observed on the surface of the ground and these made their way into the soil when they came to the first crack in the sufface. Examinations were made at night with a flashlight to learn whether larvae might not migrate over the surface of the ground at that time. They move swiftly and when exposed to light rapidly dig their way into the soil. This characteristic has caused the farmers to speak of them as"diving" when they have dug them out of the soil in the daytime.

A fact unaccounted for is that larvae are never found as abundantly on stubble field or fallow ground as on seeded ground. Since, when alternate cropping is practiced, seeded ground is either stubble land or fallow the following year one would expect to find larvae with comparative ease in stubble or fallow ground. It is not probable that larvae would or could migrate generally from stubble or fallow land to that which is in crop.

Dispersal of Larvae and Adults.

The adults are restless in habit and at times of the day when they are active they rapidly crawl long distances. There is no apparent

migration but their daily roving is sufficient to cause their spread from one field to another or from one community to another in a comparatively short time. Practically all of the dispersion takes place in the adult stage tho larvae doubtless are able to make their way considerable distances in the soil in search of food. They are frequently to be observed in open cracks which extend in all directions and which are closely interwoven in practically all dry land grain fields after the surface begins to dry in the spring. In these cracks they are enabled to make their way with speed and in comparative safety and there is little doubt that they move gradually from one part of the field to another in this way.

Types of Injury.

The amount of damage done by adults is not sufficient, in itself, to justify classifying Eleodes hispilabris as an injurious insect. Injury by adults consists almost solely of a small amount of feeding on the young wheat sprouts that have just come thru the ground and this feeding is confined to an area a rod wide or less along some of the fences (Photograph 13) and waste patches before beetles scatter over the fields in the springtime. Damage is noted for but a short time in the spring and injured plants rapidly recover after the dispersal of adults.

Injury by the larvae may be divided into three general types: 1. To the kernel; 2. To the sprout; 3. To the stem.

Shortly after planting, either spring or fall wheat may be injured by being eaten into by larva and having the embryo killed. This is the most common injury caused by the smaller sized larvae.

Frequently also kernels may be observed in which large cavities have been eaten, leaving nothing but a portion of the kernel and the surrounding seed coat or of which the seed coat alone remains. The entire end or side may be destroyed, irregular holes eaten into the kernel or a groove may be gnawed entirely around the seed. Doubtless many kernels are devoured completely.

The greatest amount of damage appears to be caused by larvae feeding on the tender sprout just as it is pushing out from the seed. This is a delicate morsel of food for larvae and a very slight injury to it results in the death of the plant. At this stage a single larva working its way along a drill row is capable of causing great damage.

Injury to the shoot or tender stem below the surface of the soil is common where plants have escaped the two types of injury already mentioned. Not infrequently strips of drill rows are noted in a wheat field where green shoots have made their way thru the ground but which later have wilted and died. Examination of these plants shows they have rarely been cut entirely off by the larvae but that they have been nibbled at and a portion of the stem below the ground has a scarified appearance as tho having been rasped by a dull file.

Natural Enemies.

Natural enemies of all species of Eleodes beetles under observation in Idaho appear to be of relatively small importance. Those observed are listed below:

Blackbirds.

Chickens and turkeys.

Coleoptera.

(a) Carabidae (ground beetles)

(1) Harpalus fraternus Lec. (1)

(2) Callisthenes luxatus Say. Var. (1)

(3) Calosoma semilaeve Lec. (1)

(b) Histeridae

(1) Hister ulkei Horn.

Diptera

(a) Sarcophagidae - Eleodiphaga caffreyi Walton (3)

Hymenoptera

(a) Braconidae - Perilitus eleodis Vier. (2)

Mites (species not yet determined.)

In 1921 blackbirds were observed in numbers in fields that were being plowed in July. They alighted in the furrow and on the freshly turned furrow slice just behind the plow and greedily devoured the cream-colored pupae exposed by the plow. Few birds were observed in 1922 and none were seen feeding on any stage of eleodes beetles. Farmers generally on Rexburg Bench regard blackbirds as being very helpful in destroying false wireworms and many of them remember having seen them follow the plow in this manner at some time in the past. There is no doubt that blackbirds may destroy many pupae and possibly larvae under conditions that make it possible for them to do so but their value, considered in relation to the entire problem is relatively small. At no time have they been observed or reported to feed on the beetles.

Footnote: (1) Determined by E. A. Schwarz
(2) Determined by A. B. Gahan
(3) Determined by J. M. Aldrich.

Chickens and turkeys feed greedily on Eleodes beetles but their range is so limited in area that they cannot be considered of any value economically.

Early in the spring of 1922 attention was attracted to small red mites which adhered in groups in the sutures on the ventral side of the body and in depressions around the juncture of legs and body of numerous adults. All thru the season these mite-infested beetles were observed but they appeared to be affected by the mites not at all and individuals collected and placed in rearing cages apparently thrived as well as uninfested ones. Mites, supposedly the same species, were found to attack Eleodes hispilabris, Eleodes sulcipennis, Eleodes nigrina and Eleodes extricata.

One of the common ground beetles, Harpalus fraternus, was observed in the field frequently under trash, in cracks in the soil and generally associated with several species of Eleodes beetles. It attacked eleodes larvae if caged with them and was suspected, in either adult or larval stage, of being predacious on false wireworms, but no field observations were made that would prove it to be an enemy of importance.

Another ground beetle , Callisthenes luxatus was observed frequently in the fields during the spring and summer. Adults ran nervously over the ground and were quick to seek protection under clods or in the soil cracks. They were so timid under field conditions as to prevent obtaining data on their natural feeding habits. On several occasions, when captured and placed in a jar with Eleodes larvae they killed and devoured them. On one occasion one adult killed 10 and de-

voured two of them completely in 2½ hours. They frequent soil cracks so generally and Eleodes larvae are observed so often in these cracks that there is little doubt that Callisthenes beetles are a valuable enemy under natural conditions. Their number, however, is comparatively so small that the number of larvae they devour is of little importance.

A large ground beetle , Calosoma semilaeve, was occasionally observed during the late summer and early fall. Its actions in the field are very similar to those of Callisthenes luxatus and it also devours Eleodes larvae in captivity. On two occasions an adult was observed following an adult of Eleodes hispilabris which was running away in an excited manner. The Calosoma beetle would rapidly overtake the Eleodes beetle and with its heavy mandibles sieze a rear leg of the latter when a struggle ensued in which the Eleodes beetle broke away and ran followed again by its attacker. This performance was repeated several times but on both occasions the Colosoma beetle became alarmed at being observed so closely and hastily made for cover. On observing farmer described a struggle in which a Calosoma beetle killed an Eleodes adult. When he observed it first it had hold of a rear leg of the Eleodes beetle but in the struggle that ensued it succeeded in obtaining a grasp between the head and the thorax and soon killed its prey. Like Callisthenes beetles, Calosoma beetles are of interest but are so few in numbers as to be of little importance economically.

A small black and red beetle, Hister ulkei, was frequently observed and was believed for some time to be a scavenger but upon one occasion it was observed feeding on a live Eleodes larva. It can be considered of no economic importance.

Thruout the season bodies of Eleodes hispilabris were observed containing hymenopterous larvae that were determined to be Perilitus eleodis. Following emergence in the fall dissection of 1800 beetles in August 1921 showed that 1.72% were parasitized. Dissection in May 1922 indicated that parasitized adults were most numerous about the middle of the month and that in a few instances parasitism was as high as 25%. Larvae of Perilitus eleodis measure less than an eighth of an inch in length when fully grown and are cream-white in color. They usually are so numerous in a parasitized individual as to completely fill the body cavity. On one occasion 89 larvae were removed from a dissected beetle and on another the same number emerged in a cage in the laboratory. Larvae emerge thru the anal opening of the host, usually singly, but two have been observed by the writer issuing at the same time. After they begin to emerge they may continue at long intervals for more than a day and when all emergence has ceased the body cavity of the host is almost entirely empty. Death of the host usually does not ensue until after the Perilitus larvae have emerged. After emergence the larvae spin light threads of silk thruout the soil and about themselves and pupate a small way under the surface of the soil. In laboratory, the pupal stage was found to be from 10 to 25 days depending on the temperature. The highest percentage of parasitism appears to occur before females of the host have deposited their eggs. Perilitus eleodis undoubtedly is the most important enemy of Eleodes hispilabris that occurs in Idaho yet it cannot be considered as having any great influence in reducing the numbers of its host to a point where

it obtains any degree of control.

Larvae of Perilitus eleodis were rarely observed in the bodies of Eleodes extricata and none were found in any of the other species of Eleodes beetles found on Rexburg Bench.

The most important enemy of Eleodes extricata is the Sarcophagid Eleodiphaga caffreyi. Thruout the early part of the season numerous beetles that had been killed by this insect were observed under rocks and clods and in the entrances to ground squirrel burrows. The maggots of this parasite occur singly in the body (two were rarely observed and it is likely that but one of these would have survived to emerge) and grow rapidly to such a size that one maggot almost completely fills the abdominal cavity of the host. When the maggot becomes fully grown the host dies and the maggot transforms to a pupa within the body cavity, always with the anterior end toward the head of the beetle. When the adult fly emerges the front cap of the pupal case is pushed off, the head of the host is severed from the thorax and the fly emerges thru the opening thus formed. On May 16, 1922, 167 specimens of Eleodes extricata were collected, the plan followed being to collect every beetle, dead or alive, that could be found in a certain period of time. Of these 68 dead beetles contained larvae or pupae of Eleodiphaga caffreyi and 24 live ones were also parasitized, making a total parasitism of 54.7%. This heavy parasitism occurred before the oviposition period of adults and doubtless is one of the factors that make Eleodes extricata of minor importance economically.

About the middle of September 1922 (the same observation was made in 1921) adults of Eleodes hispilabris were observed that had a small

larva adhering to the rear part of the elytrons. The caudal end of the larva was always stuck tightly to the elytron and its head extended backward and downward to a position even with the rear tip of the elytrons. Larvae moved very sluggishly but were often observed to stretch backward with the anterior end curved toward the anus of the beetle. It is presumed that they make their way into the body thru the anus tho this has not been verified by the writer. On September 18th a number of adults with these larvae adhering were captured and isolated in salve boxes with moist soil and food. On October 6th two of them were dead and dissection showed the body cavity to be nearly filled by a dipterous maggot. The maggots later died without transforming and no determination was possible.

Detailed Life Cycle Studies 1922, 1923 and 1924.

Eggs.

Studies of the life cycle of Eleodes hispilabris were begun in April, 1922. Over-wintering adults were collected in the field and caged in one quart fruit jars in the bottom of which was about one inch of soil. Studies conducted by McColloch (30) indicated that Eleodes tricostata would not oviposit freely unless the soil in the cages was dry. Accordingly, in the first cages experimented with the soil was kept dry and the beetles were supplied with water by moistening their food. After many attempts to secure eggs in this manner had failed the soil on one side of each cage was moistened and the same adults which had not oviposited in dry soil began almost at once to lay eggs. Eggs, however, were deposited in the dry soil. Adults were fed bran and wheat

kernels and were apparently readily "domesticated" to cage conditions. Copulation and oviposition were carried on freely and thousands of eggs were deposited in the cages over a period of 37 days.

The first eggs obtained were on June 16th. It is probable the beetles begin oviposition earlier under field conditions or that they might have done so in laboratory had the proper soil condition been created for them at the beginning. An observation that supports this supposition is that on May 22d field collected females were dissected that contained well developed eggs. In laboratory, a few eggs were deposited as late as the middle of August but under natural conditions indications are that practically all eggs were laid before July 1st.

With few exceptions, eggs laid in the laboratory on a given day all hatched within the same twenty-four-hour period. Those failing to hatch during that period usually failed to hatch altogether. Eggs were laid singly and shallowly in the soil at the juncture of the dry dirt with the moist soil. By digging with the front feet, the female excavated a shallow cavity into which she then extended the tip of her abdomen and deposited the egg.

When first laid eggs are creamy white, (Photograph 16) shiny and coated with a viscous substance (Photograph 17) that causes dirt particles to adhere freely to them rendering them extremely difficult to observe in the field. In the field they are laid in loose, moderately dry soil. In fallow ground they apparently are more numerous near the margins of the fields where adults are close to protection but in planted fields beetles appear to be distributed more or less uniformly.

The following technique was employed in deriving information

concerning the oviposition period: Eggs were removed from the breeding cages daily by means of a very small, moistened camel's-hair brush. At first they were placed in tin salve boxes and buried in the soil under out-of-doors conditions. They did not hatch satisfactorily so next they were placed in small glass vials, the vials then plugged with cotton and buried in the soil. By this method eggs either absorbed too much moisture from the soil or had moisture drawn from them by the surrounding soil. Very good results were finally obtained by placing the eggs in a small amount of slightly moist soil in the glass vials, corking the vials securely and placing them in the cellar. The original moisture was thus retained and a very large majority of all eggs so handled hatched. Eggs handled in the same manner but buried in the soil out of doors hatched in approximately the same length of time as those in the cellar.

The question of obtaining a successful hatch of Eleodes eggs under laboratory conditions appears to be one very largely of proper moisture conditions. When they were placed in the salve boxes or vials without being in the soil themselves they rapidly became dry and shriveled if the soil in which they were buried was dry or, if it was moist, the containers collected moisture in small droplets and eggs that became covered by this film would not hatch. If soil was placed in the vials it took up excess moisture or gave it off, depending on air conditions, and the eggs in it developed naturally.

Egg Incubation Record, Eleodes hispilabris.

947 Eggs.

Date Eggs Deposited 1922	No Eggs Observed	Eggs Hatched Date 1922	No.	Duration of Incubation Period, Days:
June 16	13	June 27	13	11
June 17	11	June 27	11	10
June 23	1	July 3	1	10
June 24	14	July 4	14	10
July 5	1	July 15	1	10
July 5	1	July 17	1	12
July 3	1	July 16	1	13
July 14	130	July 28	50	14
		July 29	80	15
July 17	81	July 31	1	14
		Aug. 1	30	15
		Aug. 2	50	16
July 19	50	Aug. 3	50	15
July 23	4	Aug. 10	4	18
July 25	3	Aug. 10	3	16
July 30	50	Aug. 14	50	15
Aug. 1	61	Aug. 16	61	15
Aug. 3	176	Aug. 18	176	15
Aug. 4	50	Aug. 19	50	15
Aug. 5	100	Aug. 20	100	15
Aug. 9	25	Aug. 24	25	15
Aug. 10	25	Aug. 25	25	15
Aug. 11	25	Aug. 26	25	15
Aug. 12	25	Aug. 27	25	15
Aug. 13	25	Aug. 28	25	15
Aug. 14	25	Aug. 29	25	15
Aug. 15	25	Aug. 30	25	15
Aug. 16	25	Aug. 31	25	15

Summary.

Maximum incubation period.....18 days
Minimum incubation period.....10 days
Average incubation period..14.91 days.

Dissections of seven gravid females and examinations of their ovarioles under binocular showed that, on an average, they contained 287 eggs each. There is no assurance that they had not already deposited some of their eggs but it is believed that this count represents close to the correct numbers of eggs contained since the examination was made very soon after the first gravid female was discovered.

No.	Date dissected	No. eggs per female.
1	May 22	240
2	May 22	257
3	May 22	304
4	May 22	307
5	May 22	367
6	May 25	251
7	May 25	284

Average.....287
Maximum.....367
Minimum.....240

The method of handling Eleodes extricata and Eleodes sulcipennis adults and eggs was identical with that used for Eleodes hispilabris.

Egg Incubation Record, Eleodes extricata.

170 eggs.

Date Eggs Deposited 1922	No. Eggs Observed	Eggs Hatched Date 1922	Eggs Hatched No.	Duration of Incubation Period, Days:
June 21	16	July 1	16	10
June 23	1	July 3	1	10
July 8	6	July 20	6	12
July 13	11	July 26	11	15
1923		1923		
June 17	56	June 27	56	10
June 18	32	June 29	32	11
June 25	40	July 5	40	10
June 27	8	July 10	8	13

Summary

Maximum Incubation Period....15 days
Minimum Incubation Period....10 days
Average Incubation Period.10.86 days.

A single specimen of Eleodes extricata was dissected on May 25th and she contained 120 eggs.

Egg Incubation Record, Eleodes sulcipennis

25 Eggs.

Date Eggs Deposited 1922	No. Eggs Observed	Eggs Hatched		Duration of Incubation Period, Days.
		Date 1922	No.	
Aug. 20	25	Sept. 9	25	20

Repeated attempts were made to procure eggs from Eleodes nigrina, all without success. Adults were given many conditions of soil, moisture and food and lived for months in cages in laboratory without depositing eggs.

Larvae.

Technique employed: Newly emerged larvae (Photograph No. 18) were placed singly in small shell vials containing a small amount of moderately moist soil and bran. Soil and bran were first passed thru a 30-mesh screen to eliminate coarse particles which might interfere with examinations for exuviae or that, in handling, might injure the larvae. Vials were tightly corked, arranged in series and numbered and were kept in a cellar which was slightly damp and thru which air circulated freely. Under these conditions larvae developed at about the same rate as those placed in test cages under out-door conditions. After the second (Photograph No. 19 and No. 21) or third instar (Photograph No. 20 and 22) larvae were too large for the shell vials and were then transferred to one-half ounce tin salve boxes. Salve boxes were filled about one-third full of moderately moist soil, a small amount of food placed in each and the lids kept tightly closed. At first considerable time was employed in preparing the soil to the proper degree of dampness and in placing the food in

each cage but after much experimenting it was determined that the simplest and also the best way of preparing the soil and placing food in the cages was to procure soil uniformly moist before screening and after it had been screened mix in it sufficient bran for the needs of all cages to be examined that day.

During the first instar, larvae were extremely delicate and mortality was high if the soil was too moist or too dry to even a slight degree. As they became older they were much less affected by the changes in soil moisture. During warm weather, food soon molded so, in order to keep the food in good condition and to maintain the proper soil moisture in the cages it was necessary to change food and soil each alternate day. During the late fall and early spring this period was safely extended and during the winter larvae were inactive and lived, stored in a cellar, without attention to change of food or soil excepting at long intervals.

When changes of soil were made each cage was examined each time to determine whether larvae had molted. The process that was finally evolved was to empty the contents of a cage into a watch glass, holding the cage in the right hand. The empty cage was then used as a scoop with which fresh soil and bran were scooped into it, the larva was then taken from the soil that had been emptied from the cage, returned to its cage, the lid replaced with the left hand and the cage returned to its position in the tray. The soil in the watch glass was then carefully examined and if a cast skin was detected the date of the molt and the number of the cage were recorded.

To expedite the work the salve boxes were numbered and arranged

in order in shallow trays all of which slid drawer-like into a compact cabinet (Photograph No. 14) made to contain them. The whole cabinet could be carried from cellar to laboratory with ease.

As larvae became older they were supplied with cracked wheat and finally whole wheat kernels, were placed in the cages. Whole bran was avoided as food because of the difficulty of readily distinguishing between the larger flakes and the cast skins of larvae.

Examinations for first molts were made by use of the binocular microscope but after the first instar, larvae were large enough that accurate observations could be made by use of a hand lens or with the unaided eye. It was found that the most rapid and accurate way of detecting cast skins was to hold the watch glass about six inches above a pan and by shaking it gradually the soil was poured out in a more or less steady stream. The exuvia being so much lighter than the soil could be readily detected on the surface of the pile of dirt as soon as it fell from the watch glass.

Duration of Larval Period, Eleodes hispilabris. 285 Larvae.

Cage No.	Date Larva Emerged 1922	Date of Pupation	Duration Larval Stage Days
8	6-13	8-7/23	420
12	6-13	8-8/23	421
32	6-27	8-9/23	408
104	7-28	8-17/23	385
105	7-28	8-19/23	387
107	7-28	8- 1/23	369
119	7-28	8-3/23	371
203	7-29	8-21/23	388
231	8- 1	8- 9/23	373
242	8- 1	8-19/23	383
243	8- 1	8-15/23	379
253	8- 1	8- 7/23	371
254	8- 1	8- 3/23	367
363	8-10	8-17/23	372
373	8-14	8- 7/23	358
374	8-14	8- 7/23	358
386	8-14	8-11/23	362
403	8-14	8-15/23	366
425	8-16	8- 3/23	352
446	8-16	8-15/23	364
451	8-16	8-13/23	362
506	8-18	8-11/23	358
508	8-18	8-17/23	364
517	8-18	8-17/23	364
523	8-18	8-21/23	368
531	8-18	9- 1/23	379
535	8-18	8-19/23	366
556	8-18	8-15/23	362
561	8-18	8-15/23	362
569	8-18	8-11/23	358
570	8-18	8-28/23	375
604	8-18	8- 9/23	356
610	8-18	8-19/23	366
614	8-18	8-15/23	362
617	8-18	8-15/23	362
625	8-18	8- 9/23	356
629	8-18	8-17/23	364
630	8-18	8-19/23	366
632	8-18	8-15/23	362
635	8-18	8-11/23	358
636	8-18	8-17/23	364
652	8-19	8- 3/23	349
666	8-19	8-11/23	357
673	8-19	9- 1/23	378
710	8-20	8-19/23	364
723	8-20	8-18/23	363
726	8-20	8-20/23	365
734	8-20	8-18/23	363
735	8-20	8-20/23	365
747	8-20	9-26/23	402
752	8-20	8-21/23	366
753	8-20	8-16/23	361
756	8-20	9- 4/23	380
771	8-20	8-29/23	374
779	8-20	8- 9/23	354
782	8-20	8-16/23	361
786	8-20	8-20/23	365
821	8-24	8-26/23	367
822	8-24	8-18/23	359
828	8-25	8-16/23	356
829	8-25	8- 7/23	347
842	8-25	8-31/23	371
844	8-25	8-27/23	367
358	8-26	9-22/23	392
863	8-26	9-22/23	392
864	8-26	8-18/23	357
880	8-27	8-20/23	358
886	8-27	8-16/23	354
898	8-27	8-21/23	359
915	8-28	8- 1/23	338
922	8-28	8-18/23	355
931	8-29	8- 7/23	343
934	8-29	8-20/23	356
937	8-29	8-18/23	354
941	8-29	8-11/23	347
943	8-29	8-16/23	352
953	8-30	8- 9/23	344
954	8-30	8-18/23	353
957	8-30	8-16/23	351
960	8-30	8-16/23	351
963	8-30	8-16/23	351
970	8-30	8-20/23	355
998	8-31	8-20/23	354
1000	8-31	8-16/23	350
5	6-13	8- 3/23	416
11	6-13	8 1/23	414
15	6-13	8-15/23	428
39	6-27	7-28/23	396

Cage No.	Date Larva Emerged 1922	Date of Pupation	Duration Larval Stage Days
674	8-19	8-15/23	361
687	8-19	9- 3/23	380
693	8-19	8-15/23	361
694	8-19	8-19/23	365
699	8-19	8-21/23	367
701	8-20	8-19/23	364
702	8-20	8-15/23	360
706	8-20	8-13/23	358
275	8- 2	8- 9/23	372
366	8- 3	9- 1/23	394
358	8-10	8-30/23	385
366	8-14	7-31/23	351
370	8-14	8-11/23	362
377	8-14	8-13/23	364
391	8-14	8-17/23	368
392	8-14	8- 9/23	360
409	8-14	8-19/23	370
410	8-14	8-17/23	368
426	8-16	8-15/23	364
427	8-16	8-19/23	368
428	8-16	8- 3/23	352
433	8-16	8-11/23	360
444	8-16	8- 7/23	356
447	8-16	8-17/23	366
449	8-16	8-11/23	360
453	8-16	8-19/23	368
456	8-16	8-15/23	364
458	8-16	8- 7/23	356
462	8-16	8-19/23	368
464	8-16	8- 7/23	356
470	8-16	8-11/23	360
472	8-16	8-13/23	362
507	8-18	8- 9/23	356
511	8-18	8-15/23	362
514	8-18	8-19/23	366
521	8-18	8- 3/23	350
524	8-18	8-15/23	362
525	8-18	8-19/23	366
537	8-18	8-21/23	368
539	8-18	8-11/23	358
541	8-18	8- 7/23	354
545	8-18	8-11/23	358
559	8-18	8-17/23	364
568	8-18	9- 3/23	381
571	8-18	8-21/23	368

Cage No.	Date Larva Emerged 1922	Date of Pupation	Duration Larval Stage Days
132	7-28	8-13/23	381
139	7-28	8-13/23	381
146	7-29	8-15/23	382
159	7-29	8-13/23	380
165	7-29	8-17/23	384
232	8- 1	8- 7/23	371
235	8- 1	8- 9/23	373
255	8- 1	8- 7/23	371
628	8-18	8-15/23	362
633	8-18	8- 7/23	354
639	8-18	8-19/23	366
644	8-18	8-15/23	362
645	8-18	8-26/23	375
647	8-18	8-21/23	368
648	8-18	8-11/23	358
654	8-19	8- 7/23	353
658	8-19	8-19/23	365
659	8-19	8-11/23	357
661	8-19	8- 9/23	355
662	8-19	8-29/23	375
665	8-19	8-17/23	363
669	8-19	8-19/23	365
670	8-19	8-11/23	357
675	8-19	8- 7/23	353
678	8-19	8-17/23	363
680	8-19	8-19/23	365
682	8-19	8-15/23	361
683	8-19	8- 9/23	355
686	8-19	8-17/23	363
688	8-19	5-20/24	640
689	8-19	8-11/23	357
695	8-19	8-17/23	363
698	8-19	8-15/23	361
700	8-19	8-17/23	363
707	8-20	8-17/23	362
708	8-20	8-21/23	366
718	8-20	8-29/23	374
719	8-20	8-16/23	361
733	8-20	8-16/23	361
736	8-20	9- 4/23	380
739	8-20	8-16/23	361
743	8-20	8-13/23	358
745	8-20	8- 7/23	352
746	8-20	8-18/23	363
754	8-20	9- 2/23	378

Cage No.	Date Larva Emerged 1922	Date of Pupation	Duration Larval Stage Days
575	8-18	8-19/23	366
577	8-18	8-15/23	362
590	8-18	8-19/23	366
592	8-18	8-15/23	362
602	8-18	8-21/23	368
603	8-18	8- 7/23	354
606	8-18	8-11/23	358
609	8-18	8-17/23	364
613	8-18	8-11/23	358
615	8-18	8-17/23	364
616	8-18	8-19/23	366
619	8-18	8-30/23	377
622	8-18	8-21/23	368
626	8-18	8-19/23	366
627	8-18	8-17/23	364
784	8-20	8-18/23	363
787	8-20	8-16/23	361
791	8-20	8-18/23	363
795	8-20	8-20/23	365
798	8-20	8-16/23	361
800	8-20	8-18/23	363
805	8-24	6-26/23	306
816	8-24	7-20/23	330
819	8-24	8-16/23	357
825	8-24	8-20/23	361
826	8-25	9- 4/23	375
837	8-25	8-18/23	358
841	8-25	8-21/23	361
846	8-25	8- 9/23	349
847	8-25	8-20/23	360
852	8-26	8-16/23	355
865	8-26	8-20/23	359
869	8-26	5-23/24	636
876	8-27	5-23/24	635
888	8-27	8-18/23	356
892	8-27	3-30/24	571
894	8-27	8- 7/23	345
895	8-27	8- 7/23	345
896	8-27	8- 7/23	345
897	8-27	8- 3/23	341
903	8-28	8- 9/23	346
904	8-28	8-23/23	340
906	8-28	8- 1/23	338
907	8-28	6-26/23	302
909	8-28	8- 3/23	340

Cage No.	Date Larva Emerged 1922	Date of Pupation	Duration Larval Stage Days
755	8-20	8-18/23	363
757	8-20	8-20/23	365
758	8-20	8-16/23	361
760	8-20	8- 9/23	354
762	8-20	5-23/24	642
763	8-20	5-20/24	639
764	8-20	8-31/23	376
765	8-20	8-18/23	363
767	8-20	5-23/24	642
768	8-20	8-26/23	371
773	8-20	8- 7/23	352
775	8-20	8-16/23	361
776	8-20	8-18/23	363
777	8-20	8-24/23	369
780	8-20	9-10/23	386
933	8-29	8-18/23	354
935	8-29	8-16/23	352
936	8-29	8- 7/23	343
939	8-29	8- 3/23	339
940	8-29	8- 7/23	343
942	8-29	8-20/23	356
944	8-29	8- 9/23	345
946	8-29	6-26/23	301
947	8-29	8-11/23	347
948	8-29	8-20/23	356
949	8-29	8-11/23	347
950	8-29	8-16/23	352
951	8-30	8-11/23	346
952	8-30	8- 3/23	338
955	8-30	8-20/23	355
958	8-30	8-18/23	353
959	8-30	8-20/23	355
961	8-30	8-18/23	353
962	8-30	8-20/23	355
964	8-30	8-21/23	356
965	8-30	8-18/23	353
967	8-30	8-27/23	362
972	8-30	8- 9/23	344
974	8-30	8-16/23	351
975	8-30	8-13/23	348
977	8-31	7- 9/23	343
979	8-31	8-20/23	354
980	8-31	8- 7/23	341
981	8-31	8- 7/23	341
982	8-31	8-18/23	352

Cage No.	Date Larva Emerged 1922	Date of Pupation	Duration Larval Stage Days
913	8-28	8-20/23	357
916	8-28	8-16/23	353
918	8-28	8- 3/23	340
920	8-28	8- 9/23	346
927	8-29	8-20/23	356
928	8-29	8-10/23	346
929	8-29	8- 1/23	337
930	8-29	8- 7/23	343
932	8-29	8-16/23	352
984	8-31	8-20/23	354
987	8-31	8- 7/23	341
989	8-31	8- 7/23	341
991	8-31	8-11/23	345
992	8-31	8-27/23	361
993	8-31	8-24/23	358
994	8-31	8-16/23	350
995	8-31	6- 5/24	644

Summary

Maximum Duration of Larval Period.....644 days.
Minimum Duration of Larval Period.....302 days.
Average Duration of Larval Period.....369.19days.

Record of Complete Molts, Larvae of Eleodes hispilabris. 92 Larvae.

Cage No.	Date Eggs Hatched	Number of Molts and Dates of Molting. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
8	1922 6-13	6-25	7- 3	7-11	7-21	7-29	8- 9	8-19	8-29	9- 6	9-23	1923 8- 7
12	1922 6-13	6-25	7- 1	7-11	7-19	7-28	8- 9	8-20	8-30	9-11	1923 7-25	8- 8
32	1922 6-27	7- 9	7-13	7-24	8- 3	8-13	8-22	8-30	9- 6	10-16	1923 6- 9	8- 9
104	1922 7-28	8- 8	8-18	8-24	9- 2	9-16	9-24	10- 5	10-19	1923 6-20	7- 7	8-17
105	1922 7-28	8- 8	8-18	8-24	9- 2	9-16	10- 8	11- 5	1923 5-28	6-13	7- 8	8-19
107	1922 7-28	8- 8	8-18	8-24	9- 2	9-26	10-17	11- 7	1923 5-30	6-20	8- 1	9-22
119	1922 7-28	8- 8	8-18	8-28	9- 6	9-24	10-11	11- 6	1923 5-24	6-26	7-10	8- 3
203	1922 7-29	8-10	8-20	8-29	9-14	10- 5	1923 5-21	6-23	7-17	7-26	8- 5	8-21
231	1922 8- 1	8-11	8-20	8-29	10- 1	10-14	1923 5-27	6-23	7- 5	7-15	7-27	8- 9
242	1922 8- 1	8-11	8-20	8-25	9-15	10- 3	11- 7	1923 5-27	6-20	7-10	7-25	8-19
243	1922 8- 1	8-11	8-21	8-28	9-16	10- 6	10-26	1923 5-27	6-26	7-12	7-23	8-15
253	1922 8- 1	8-11	8-20	8-27	9- 6	10- 4	10-27	1923 5-27	6-10	7- 5	7-20	8- 7
254	1922 8- 1	8-11	8-21	8-29	9-11	10- 2	10-20	1922 6-13	6-21	7- 6	7-20	8- 3
363	1922 8-10	8-20	8-30	9- 7	9-28	10- 3	10-13	10-23	1923 5-27	6-26	7-17	8-17
373	1922 8-14	8-24	9-17	10- 2	10-14	11-17	1923 5-30	6- 5	6-25	7-12	7-24	8- 7
374	1922 8-14	8-24	9-17	9-27	10-13	11-15	1923 5-25	6- 9	6-30	7-15	7-29	8- 7

Record of Complete Molts, Larvae of Eleodes hispilabris, 92 Larvae.

Cage No.	Date Eggs Hatched	Number of Molts and Dates of Molting.										
		1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
386	1922 8-14	8-24	9-17	10- 2	10-20	11-10	1923 5-27	6- 3	6-23	7- 2	7-25	8-11
403	1922 8-14	8-24	9- 7	9-27	10- 8	10-23	11- 6	1923 5-24	6-26	7- 9	7-28	8-15
425	1922 8-16	8-26	9- 9	9-20	10- 2	10-16	11-17	1923 4-25	5-24	6- 8	7- 1	8- 3
446	1922 8-16	8-26	9-13	9-24	10- 2	10-15	11- 7	1923 5- 4	5-20	6-19	7-12	8-15
451	1922 8-16	8-26	9-10	9-18	10- 1	10-14	11-30	1923 5-24	6-23	7-15	7-28	8-13
506	1922 8-18	8-28	9-12	9-23	10- 4	10-16	11- 7	1923 5-20	6- 9	6-26	7- 5	8-11
508	1922 8-18	8-28	9- 9	9-21	10- 4	10-17	11- 6	1923 5-26	6- 8	6-27	7- 7	8-17
517	1922 8-18	8-28	9- 7	9-21	10- 2	10-14	11- 8	1923 5-20	6- 8	6-25	7- 9	8-17
523	1922 8-18	8-28	9- 9	9-20	10- 2	10-17	1923 5-27	6- 6	6-15	7- 5	7-29	8-21
531	1922 8-18	8-28	9-12	9-17	10- 5	10-27	1923 5-27	6- 9	6-26	7-10	8- 2	9- 1
535	1922 8-18	8-28	9- 7	9-21	10- 5	10-27	1923 5-20	6-10	6-25	7-11	8- 5	8-19
556	1922 8-18	8-28	9- 8	9-23	10- 4	10-23	1923 5-20	6- 9	6-23	7- 5	7-28	8-15
561	1922 8-18	8-28	9-11	9-24	10- 4	10-17	1922 5-24	6-16	6-26	7-12	7-29	8-15
569	1922 8-18	8-28	9-11	9-21	10- 4	10-15	11-18	1923 5-24	6- 9	6-26	7-20	8-11
570	1922 8-18	8-28	9- 9	9-21	10- 4	10-20	11- 9	1923 5-24	6-26	7-15	8- 3	8-28
604	1922 8-18	8-28	9- 9	9-17	10-10	10-24	11- 2	1923 5-24	6- 5	6-26	7-15	8- 9

Cage No.	Date Eggs Hatched	Number of Molts and Dates of Molting. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
610	1922 8-18	8-27	9-10	9-23	10- 5	10-21	11- 2	1923 5-24	6-29	7-10	7-30	8-19
614	1922 8-18	8-28	9-12	9-28	10- 8	10-26	11- 2	1923 5-22	6-23	7- 5	7-28	8-15
617	1922 8-18	8-29	9- 9	9-24	10- 5	10-20	1923 5-24	6- 5	6-23	7- 8	7-29	8-15
625	1922 8-18	8-26	9- 8	9-24	10- 5	10-16	11-11	1923 5-27	6-29	7- 7	7-25	8- 9
629	1922 8-18	8-28	9-13	9-23	10- 5	10-17	1923 5-24	6-23	6-29	7- 5	7-23	8-17
630	1922 8-18	8-28	9- 9	9-17	10- 5	10-21	1923 5-24	6-23	6-28	7- 5	7-25	8-19
632	1922 8-18	8-29	9-12	9-17	10- 5	10-20	1923 5-24	6-23	6-28	7- 5	7-25	8-15
635	1922 8-18	8-28	9- 9	9-24	10- 5	10-23	11- 2	1923 5-24	6- 9	6-29	7-20	8-11
636	1922 8-18	8-28	9- 9	9-25	10- 6	10-20	11- 2	1923 5-24	6-23	7- 5	7-25	8-17
652	1922 8-19	8-29	9-12	9-18	9-30	10-14	11-12	1923 5-30	6-20	7- 5	7-25	8- 3
666	1922 8-19	8-29	9-11	9-23	10- 3	10-27	11-13	1923 5-21	6-23	7- 8	7-20	8-11
673	1922 8-19	8-29	9-12	9-23	10- 5	10-19	1923 5-24	6-26	7-15	8- 1	8-20	9- 1
674	1922 8-19	8-29	9- 9	9-23	10- 4	10-17	1923 5-24	6-10	7- 1	7-15	7-29	8-15
687	1922 8-19	8-29	9- 9	9-21	10-14	11-13	1923 5-27	6-20	7-15	7-29	8-17	9- 3
693	1922 8-19	8-28	9-13	10- 8	10-23	11-12	1923 5-24	6-26	7- 8	7-20	8- 1	8-15
694	1922 8-19	8-28	9- 6	10-11	11- 7	1923 5-30	6-14	6-29	7-10	7-22	8- 5	8-19
699	1922 8-19	8-28	9-11	9-18	9- 30	10-11	11-12	1923 6- 9	6-29	8-18	8- 3	8-21

Cage No.	Date Eggs Hatched	Number of Molts and Dates of Molting. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
701	1922 8-20	8-29	9-12	10--2	10-17	1923 5-24	6-15	6-25	7- 7	7-20	8- 1	8-19
702	1922 8-20	8-29	9-12	10--8	10-29	1923 5-27	6-13	6-24	7- 6	7-20	8- 3	8-15
706	1922 8-20	8-30	9-11	9-25	10- 8	10-27	1923 5-20	6- 7	6-28	7-15	8- 1	8-13
710	1922 8-20	8-30	9-12	9-18	10- 2	10-10	10-30	1923 5-27	6-23	7- 2	7-29	8-19
723	1922 8-20	8-30	9- 9	9-18	9-25	10-17	10-23	1923 5-24	6-26	7-19	8- 1	8-18
726	1922 8-20	8-29	9-12	10- 4	10-15	1923 5-24	6- 3	6-18	7- 5	7-25	8- 5	8-20
734	1922 8-20	8-30	9-10	9-18	9-26	10- 8	1923 5-24	6-26	7- 5	7-18	8- 3	8-18
735	1922 8-20	8-30	9-12	10- 4	10-13	11-13	1923 5-30	6-26	7- 7	7-27	8- 7	8-20
747	1922 8-20	8-29	9- 9	10- 5	10-20	1923 5-24	6-23	7- 5	7-23	8- 1	8-15	9-26
752	1922 8-20	8-30	9- 7	9-20	10- 2	10-14	11-13	1923 5-30	6-23	7-15	8- 2	8-21
753	1922 8-20	8-30	9- 7	9-18	10- 1	10-13	1923 5-24	6-23	7- 7	7-24	8- 1	8-16
756	1922 8-20	8-30	9- 7	9-18	10- 2	10-13	1923 5-24	6-23	7-10	7-29	8-16	9- 4
771	1922 8-20	8-30	9- 7	9-20	10- 2	10-13	11- 7	1923 6- 2	6-27	7-17	8- 7	8-29
779	1922 8-20	8-30	9- 7	9-23	10- 4	10-17	11-18	1923 5-30	6-19	7- 3	7-22	8- 9
782	1922 8-20	8-30	9- 7	9-17	10- 2	10-13	1923 5-24	6-29	7- 7	7-27	8- 2	8-16
786	1922 8-20	8-30	10- 4	10-13	11- 6	1923 5-30	6-10	6-23	7- 5	7-27	8- 8	8-20

Cage No.	Date Eggs Hatched	Number of Molts and Dates of Molting. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
821	1922 8-24	9- 1	9-11	9-20	10- 2	10-27	1923 5-27	6-10	7- 5	7-28	8-15	8-26
822	1922 8-24	9- 1	9-11	9-26	10- 8	10-23	1923 5-24	6-23	7- 2	7-20	8- 1	8-18
828	1922 8-25	9- 2	9-12	9-20	10- 1	10-14	1923 5-27	6-30	7- 4	7-23	8- 4	8-16
829	1922 8-25	9- 2	9-12	9-20	10- 2	10-13	1923 5-27	6-15	6-29	7-12	7-27	8- 7
842	1922 8-25	9- 2	9-12	9-23	10-19	11-13	1923 5-27	6-23	7- 9	7-23	8-14	8-31
844	1922 8-25	9- 2	9-12	9-20	9-30	11-10	1923 5-24	6-23	7-10	7-21	8-14	8-27
858	1922 8-26	9- 3	9-13	9-26	10- 7	10-27	1923 5-27	7- 5	7-25	8-14	9- 1	9-22
863	1922 8-26	9- 3	9-13	10- 2	10-11	10-28	1923 5-24	6-26	7-10	8- 1	8-27	9-22
864	1922 8-26	9- 3	9-13	10- 7	10-22	10-27	1923 5-27	6-25	7-10	7-25	8- 3	8-18
880	1922 8-27	9- 4	9-14	9-24	10- 1	10-13	10-30	1923 5-27	7- 5	7-28	9-10	8-20
886	1922 8-27	9- 4	9-14	9-24	10- 2	10- 9	10-26	1923 5-27	6-26	7-20	8- 4	8-16
898	1922 8-27	9- 4	9-14	9-22	10- 8	10-27	1923 5-24	6-26	7-12	7-30	8-11	8-21
915	1922 8-28	9- 5	9-15	9-22	10- 6	11- 1	1923 5-27	6-10	6-26	7- 5	7-18	8- 1
922	1922 8-28	9- 5	9-15	9-22	10- 1	10-27	1923 5-24	8-26	7- 5	7-17	8- 1	8-18
931	1922 8-29	9- 6	9-22	10- 4	10-13	11- 1	1923 5-30	6-20	7- 2	7-15	7-27	8- 7
934	1922 8-29	9- 6	9-22	9-30	10-13	11- 7	1923 5-27	6-15	6-30	7-14	7-29	8-20

Cage No.	Date Eggs Hatched	Number of Molts and Dates of Molting. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
937	1922 8-29	9- 6	9-17	9-25	10- 4	10-12	10-30	1923 5-24	6-26	7-15	8- 3	8-18
941	1922 8-29	9- 6	9-17	9-26	10-17	11- 7	1923 5-21	6-19	7- 1	7-13	7-29	8-11
943	1922 8-29	9- 6	9-17	10- 5	10-16	11- 2	1923 5-24	6-19	7- 3	7-20	7-31	8-16
953	1922 8-30	9- 7	9-29	10- 8	10-26	1923 5-27	6-26	7- 4	7-12	7-21	8- 1	8- 9
954	1922 8-30	9- 7	10- 2	10- 9	10-22	1923 5-21	6-19	7- 1	7-11	7-29	8- 9	8-18
957	1922 8-30	9- 7	9-30	10- 8	10-19	1923 5-24	6-27	7- 4	7-14	7-23	8- 4	8-16
960	1922 8-30	9- 7	10- 2	10-11	10-27	1923 5-24	6-26	7- 4	7-14	7-23	8- 4	8-16
963	1922 8-30	9- 7	10- 8	10-20	11-18	1923 5-24	6-19	7- 2	7-12	7-29	8- 9	8-16
970	1922 8-30	9- 7	9-26	10- 5	10-16	1923 5-24	6-19	6-30	7-10	7-24	8- 4	8-20
998	1922 8-31	9- 8	10- 5	10-17	11- 7	1923 5-21	6-19	7- 9	7-19	7-28	8- 8	8-20
1000	1922 8-31	9- 8	10-11	10-27	11-17	1923 5-21	6-19	7- 9	7-18	7-27	8- 9	8-16

Duration of Instars in Days
Larvae of Eleodes hispilabris, Blais.

92 Larvae.

Cage No.	No. of Instar.										
	1	2	3	4	5	6	7	8	9	10	11
8	12	8	8	10	8	11	10	10	8	17	318
12	12	6	10	8	9	12	11	10	12	317	14
32	12	4	11	10	10	9	8	7	40	236	61
104	11	10	6	9	14	8	11	14	244	17	41
105	11	10	6	9	14	22	28	204	16	25	42
107	11	10	6	9	24	21	21	204	21	42	52
119	11	10	10	9	18	17	26	199	33	14	24
203	12	10	9	16	21	228	33	24	9	10	16
231	10	9	9	33	13	225	27	12	10	12	13
242	10	9	5	21	18	35	201	24	20	15	25
243	10	10	7	19	20	20	213	30	16	11	23
253	10	9	7	10	28	23	212	14	25	15	18
254	10	10	8	13	21	18	236	8	15	14	14
363	10	10	8	21	5	10	10	216	30	21	31
373	10	24	15	12	34	194	6	20	17	12	14
374	10	24	10	16	33	191	15	21	15	14	9
386	10	24	15	18	21	198	7	20	9	23	17
403	10	14	20	11	15	14	199	33	13	19	18
425	10	14	11	12	14	32	159	29	15	23	33
446	10	18	11	8	13	23	178	16	30	23	34
451	10	15	8	13	13	47	175	30	22	13	16
506	10	15	11	11	12	22	194	20	17	9	37
508	10	12	12	13	13	20	201	13	19	10	41
517	10	10	14	11	12	25	193	19	17	14	39
523	10	12	11	12	15	222	10	9	20	24	23
531	10	15	5	18	22	212	13	17	14	23	30
535	10	10	14	14	22	205	21	15	16	25	14
556	10	11	15	11	19	209	20	14	12	23	18
561	10	14	13	10	13	219	23	10	16	17	17
569	10	14	10	13	11	34	187	16	17	24	22
570	10	12	12	13	16	20	196	33	19	19	25
604	10	12	8	23	14	9	203	12	21	19	25
610	9	14	13	12	16	12	203	36	11	20	20
614	10	15	16	10	18	7	201	32	12	23	18
617	11	11	15	11	15	216	12	18	15	21	17
625	8	13	16	11	11	26	197	33	8	18	15
629	10	16	10	12	12	219	30	6	6	18	25
630	10	12	8	18	16	215	30	5	7	20	25
632	11	14	5	18	15	216	30	5	7	20	21
635	10	12	15	11	18	10	203	16	20	21	22
636	10	12	16	11	14	13	203	30	12	20	23

Cage No.	No. of Instar.										
	1	2	3	4	5	6	7	8	9	10	11
652	10	14	6	12	14	29	199	21	15	20	9
666	10	13	12	10	24	17	189	33	15	12	22
673	10	14	11	12	14	217	33	19	17	19	12
674	10	11	14	11	13	219	17	21	14	14	17
687	10	11	12	23	30	195	24	25	14	19	17
693	9	16	25	15	20	193	33	12	12	12	14
694	9	9	35	27	204	15	15	11	12	14	14
699	9	14	7	12	11	32	209	20	19	16	18
701	9	14	20	15	219	22	10	12	13	12	18
702	9	14	26	21	210	17	11	12	14	14	12
706	10	12	14	13	19	205	18	21	17	17	12
710	10	13	6	14	8	20	209	27	9	27	21
723	10	10	9	7	22	6	213	33	23	13	17
726	9	14	22	11	221	10	15	17	20	11	15
734	10	11	8	8	12	228	33	9	13	16	15
735	10	13	22	9	31	198	27	11	20	11	13
747	9	11	26	15	216	30	12	18	9	14	42
752	10	8	13	12	12	30	198	24	22	18	19
753	10	8	11	13	12	223	30	14	17	8	15
756	10	8	11	14	11	223	30	17	19	18	19
771	10	8	13	12	11	25	207	25	20	21	22
779	10	8	16	11	13	32	193	20	14	19	18
782	10	8	10	15	11	223	36	8	20	6	14
786	10	35	9	24	205	11	13	12	22	12	12
821	8	10	9	12	25	212	14	25	23	18	11
822	8	10	15	12	15	213	30	9	18	12	17
828	8	10	8	11	13	225	34	4	19	12	12
829	8	10	8	12	11	226	19	14	13	15	11
842	8	10	11	26	25	195	27	16	14	22	17
844	8	10	8	10	41	195	30	17	11	24	13
858	8	10	13	11	20	212	39	20	20	18	21
863	8	10	19	9	17	208	33	14	22	26	26
864	8	10	24	15	5	212	29	15	15	9	15
880	8	10	10	7	12	17	209	39	23	13	10
886	8	10	10	8	7	17	213	30	24	15	12
898	8	10	8	16	19	209	33	16	18	12	10
915	8	10	7	14	26	207	14	16	9	13	14
922	8	10	7	9	26	209	33	9	12	15	17
931	8	16	12	9	19	210	21	12	13	12	11
934	8	16	8	13	25	201	19	15	14	15	22
937	8	11	8	9	8	18	206	33	19	19	15
941	8	11	9	21	21	195	29	12	12	16	13
943	8	11	18	11	17	203	26	14	17	11	16
953	8	22	9	18	213	30	8	8	9	11	8
954	8	25	7	13	211	29	12	10	18	11	9
957	8	23	8	11	217	34	7	10	9	12	12

Cage No.	No. of Instar.										
	1	2	3	4	5	6	7	8	9	10	11
960	8	25	9	16	209	33	8	10	9	12	12
963	8	31	12	29	187	26	13	10	17	11	7
970	8	19	9	11	220	26	11	10	14	11	16
998	8	27	12	21	195	29	20	10	9	11	12
1000	8	33	16	21	185	29	20	9	9	13	7

Summary of Instar Durations
Larvae of Eleodes hispilabris Blais.
92 Larvae.

No. of Instar	Duration in Days.		
	Maximum	Minimum	Average
1	12	8	9.45
2	35	4	13.28
3	35	5	11.77
4	33	7	13.71
5	221	5	44.80
6	228	6	104.25
7	236	6	79.20
8	216	4	25.04
9	244	6	19.54
10	317	6	20.99
11	61	7	19.33

Record of Molts Incomplete. Eleodes hispilabris
193 Larvae.

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
5	1922 6-13	6-24	7- 1	7-11	7-21	7-28	8- 7	8-19	8-30	1923 8- 3	---	---
11	1922 6-13	6-24	7- 2	7-13	7-19	7-29	8-10	8-19	8-30	9-26	1923 8- 1	---
15	1922 6-13	6-22	7- 1	7-11	7-21	7-29	8- 9	8-20	8-29	1923 8-15	---	---
39	1922 6-27	7- 9	7-13	7-19	7-29	8- 7	8-14	8-26	9- 6	1923 7-28	---	---
132	1922 7-28	8- 8	8-18	8-28	9-16	10- 9	1923 5-24	8-13	---	---	---	---
139	1922 7-28	8- 8	8-18	8-28	9-14	9-30	10-22	1923 8-13	---	---	---	---
146	1922 7-29	8-10	8-20	8-29	9- 6	9-21	10-10	1923 5-24	6-23	8-15	---	---
159	1922 7-29	8-10	8-19	8-30	9- 6	10- 1	10-24	1923 6-29	8-13	---	---	---
165	1922 7-29	10-14	1923 5-24	6-23	8-17	---	---	---	---	---	---	---
232	1922 8- 1	8-11	8-21	8-29	9-11	9-30	10-22	1923 6- 5	8- 7	---	---	---
235	1922 8- 1	8-11	8-20	8-30	9-14	9-26	10-11	1923 5-27	8- 9	---	---	---
255	1922 8- 1	8-11	8-21	8-30	9-15	10- 4	10-20	1923 5-27	7- 2	8- 7	---	---
275	1922 8- 2	8-12	8-21	8-29	9-15	10- 2	10-23	1923 6- 5	8- 9	---	---	---
336	1922 8- 3	8-13	8-24	9- 1	10- 2	10-19	1923 6- 9	9- 1	---	---	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
358	1922 8-10	8-20	8-30	9- 7	9-24	10- 3	10-14	10-23	1923 5-27	6-26	8-30	---
366	1922 8-14	8-24	9-17	10- 2	10-15	11-10	1923 5-27	6- 3	6-20	7- 2	7-31	---
370	1922 8-14	8-24	9- 7	10- 2	10-16	11-16	1923 6- 9	8-11	---	---	---	---
377	1922 8-14	8-24	9- 5	9-28	10-10	1923 5-27	8-13	---	---	---	---	---
391	1922 8-14	8-24	9- 5	9-17	10- 1	1923 5-24	6-23	8-17	---	---	---	---
392	1922 8-14	8-24	9- 5	10-13	1923 5-24	6-23	6-30	7-20	8- 9	---	---	---
409	1922 8-14	8-24	9- 5	9-17	10- 1	10-14	1923 5-24	8-19	---	---	---	---
2 410	1922 8-14	8-24	9- 6	9-17	10-14	11- 6	1923 5-24	6-23	8-17	---	---	---
426	1922 8-16	8-26	9-10	9-19	10- 2	10-16	11-17	1923 4-28	5-24	7- 2	8-15	---
427	1922 8-16	8-26	9- 7	9-19	10- 2	1923 5-27	6-26	8-19	---	---	---	---
428	1922 8-16	8-26	9-12	9-20	10- 2	10-14	11- 6	1923 5-27	8- 3	---	---	---
433	1922 8-16	8-26	9- 7	9-19	10- 1	11- 7	1923 6- 9	8-11	---	---	---	---
444	1922 8-16	8-26	9-10	9-19	10-13	11-12	1923 5-30	8- 7	---	---	---	---
447	1922 8-16	8-26	9-12	9-24	10- 4	10-17	11-15	1923 5- 8	6- 9	8-17	---	---
449	1922 8-16	8-26	9- 7	9-19	9-27	10-11	10-30	1923 5-30	6-10	7-12	8-11	---
453	1922 8-16	8-26	9- 9	9-19	10- 2	10-16	1923 5-24	6-23	8-19	---	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
456	1922 8-16	8-26	9-10	9-20	9-30	10-13	11- 1	1923 5-30	7- 5	8-15	---	---
458	1922 8-16	8-26	9-13	9-19	10- 2	1923 5-27	6-26	8- 7	---	---	---	---
462	1922 8-16	8-26	9-10	10- 2	10-16	1923 5-24	6-26	8-19	---	---	---	---
464	1922 8-18	8-26	9- 9	9-20	10- 1	10-13	1923 5-30	7- 5	8- 7	---	---	---
470	1922 8-16	8-26	9- 7	9-20	10- 4	10-17	1923 5- 4	6-19	8-11	---	---	---
472	1922 8-16	8-26	9-13	9-17	10- 5	10-16	1923 5-24	6-23	8-13	---	---	---
507	1922 8-18	8-28	9- 9	9-21	10- 1	10-14	11- 6	1923 8- 9	---	---	---	---
511	1922 8-18	8-28	9-20	9-23	10-17	11-13	1923 6- 9	8-15	---	---	---	---
514	1922 8-18	8-28	9- 9	9-20	10- 2	10-16	1923 5-24	6-23	8-19	---	---	---
521	1922 8-18	8-28	9 9	9-23	10-17	1923 5-24	6-23	7- 8	7-28	8- 3	---	---
524	1922 8-18	8-28	9- 9	9-19	10- 2	10-16	1923 6-26	8-15	---	---	---	---
525	1922 8-18	8-28	9-10	9-23	10- 4	10-17	10-18	1923 5-24	6-27	8-19	---	---
537	1922 8-18	8-28	9- 8	9-23	10- 4	10-17	1923 5-27	6-26	8-21	---	---	---
539	1922 8-18	8-28	9-10	10- 8	10-27	1923 5-27	7- 2	7-15	8-11	---	---	---
541	1922 8-18	8-28	9-10	9-23	10- 1	10-14	11-13	1923 6- 9	7- 2	7-23	8- 7	---
545	1922 8-18	8-28	8-28	9- 9	9-21	10- 5	10-16	1923 5-24	6-26	8-11	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
559	1922 8-18	8-28	9-12	10- 4	10-17	1923 5-30	6-12	6-22	7- 2	7-30	8-17	---
568	1922 8-18	8-28	9-12	10- 5	10-20	1923 6-23	9- 3	---	---	---	---	---
571	1922 8-18	8-28	9- 9	9-23	10- 4	11-20	1923 5-24	7- 2	8-21	---	---	---
575	1922 8-18	8-28	9- 7	9-23	10-10	10-27	1923 5-20	8-19	---	---	---	---
577	1922 8-18	8-28	9-13	10- 2	10-17	1923 5-24	7- 2	8-15	---	---	---	---
590	1922 8-18	8-28	9-12	9-21	10- 3	10-19	5-27	8-19	---	---	---	---
592	1922 8-18	8-28	9- 7	10- 1	10-16	1923 5-24	6-23	7- 6	7-29	8-15	---	---
602	1922 8-18	8-29	9-12	10- 4	10-20	1923 5-24	6-26	8-21	---	---	---	---
603	1922 8-18	8-27	9-10	10-17	1923 5-21	6-23	8- 7	---	---	---	---	---
606	1922 8-18	8-29	9- 7	9-22	10-14	11-18	1923 5-27	8-11	---	---	---	---
609	1922 8-18	8-28	9- 9	10- 7	1923 5-27	7- 5	8-17	---	---	---	---	---
613	1922 8-18	8-28	9- 9	9-24	10- 5	10-20	1923 5-24	6-29	8-11	---	---	---
615	1922 8-18	8-29	9-10	9-17	9-27	10- 7	10-27	1923 5-21	8-17	---	---	---
616	1922 8-18	8-29	9-10	9-17	10- 8	10-20	1923 5-24	6-23	8-19	---	---	---
619	1922 8-18	8-27	9-13	9-21	10- 5	10-16	11-18	1923 8-30	---	---	---	---
622	1922 8-18	8-29	9- 9	9-17	10- 7	10-27	1923 5-30	7- 5	8-21	---	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
626	1922 8-18	8-28	9-12	10-16	1923 5-24	6-23	8-19	----	---	---	---	---
627	1922 8-18	8-28	9-14	1923 8-17	---	---	---	---	---	---	---	---
628	1922 8-18	8-28	10- 5	10-20	1923 5-24	6-23	8-15	---	---	---	---	---
633	1922 8-18	8-28	9- 7	10- 4	10-17	1923 5-24	6-23	6-28	7- 4	7-20	8- 7	---
639	1922 8-18	8-28	9-12	9-24	10- 4	10-20	1923 5-24	8-19	---	---	---	---
644	1922 8-18	8-29	9-13	9-23	10-17	10-25	1923 6- 2	8-15	---	---	---	---
645	1922 8-18	8-28	9-11	9-21	10-17	1923 5-27	6-13	8-28	---	---	---	---
647	1922 8-18	8-29	9-12	10- 4	10-19	1923 5-30	6-23	7- 5	7-25	8-21	---	---
648	1922 8-18	8-27	9-12	9-24	10- 5	10-21	1923 8-11	---	---	---	---	---
654	1922 8-19	8-28	9-12	10- 5	10-17	1923 5-24	6-29	8- 7	---	---	---	---
658	1922 8-19	8-28	9- 9	10-17	10-27	11-12	1923 6-23	7-10	7-25	8-19	---	---
659	1922 8-19	8-28	9-10	9-18	10- 5	10-19	1923 5-24	6-23	8-11	---	---	---
661	1922 8-19	8-28	9- 8	10- 4	10-14	11- 7	1923 6- 2	8- 9	---	---	---	---
662	1922 8-19	8-29	9- 8	9-18	9-28	10-11	1923 5-21	6-23	8-15	---	---	---
665	1922 8-19	8-29	9-11	9-23	10- 3	10-17	1923 5-21	6-23	8-17	---	---	---
669	1922 8-19	8-29	9-10	9-18	10-14	11-13	1923 5-27	8-19	---	---	---	---
670	1922 8-19	8-29	9-11	9-18	10- 1	10-13	11-13	1923 6- 5	8-11	---	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
675	1922 8-19	8-28	9- 9	10- 5	10-17	1923 5-27	8- 7	---	---	---	---	---
678	1922 8-19	8-28	9- 7	9-20	10- 4	10- 4	1923 5-24	6-23	8-17	---	---	---
680	1922 8-19	8-29	9-10	9-21	10- 4	1923 5-24	6-26	8-19	---	---	---	---
682	1922 8-19	8-28	9-10	10- 4	1923 5-24	6-19	8-15	---	---	---	---	---
683	1922 8-19	8-29	9-12	9-28	10-11	11-11	1923 8- 9	---	---	---	---	---
686	1922 8-19	8-29	9-12	10- 5	10-16	11-11	1923 6- 2	8-17	---	---	---	---
688	1922 8-19	8-29	9- 8	9-18	10- 5	11-12	1923 5-24	6- 2	1924 5-20	---	---	---
689	1922 8-19	8-29	9- 7	9-23	10-15	11-12	1923 5-24	6-23	8-11	---	---	---
695	1922 8-19	8-29	9- 8	9-20	10-16	1923 5-24	6-26	8-17	---	---	---	---
698	1922 8-19	8-29	9- 6	10- 2	10- 7	10-27	1923 5-27	8-15	---	---	---	---
700	1922 8-19	8-29	9- 6	9-18	10- 2	10-10	10-21	11- 1	1923 6- 9	8-17	---	---
707	1922 8-20	8-30	9- 9	10-27	1923 5-27	8-17	---	---	---	---	---	---
708	1922 8-20	8-30	9-12	9-18	10- 2	10-14	11- 7	1923 5-30	7- 2	8-21	---	---
718	1922 8-20	8-29	9- 6	9-17	10- 2	10-11	10-28	1923 5-24	6-23	7-20	8-29	---
719	1922 8-20	8-30	9- 9	9-25	10-23	1923 7- 5	8-16	---	---	---	---	---
733	1922 8-20	8-29	9- 5	10- 8	10-28	1923 5-30	7- 5	7-20	8- 3	8-16	---	---
736	1922 8-20	8-30	9- 5	9-26	10- 8	10-27	1923 5-21	6-23	9- 4	---	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
739	1922 8-20	8-30	9- 9	9-18	9-26	10- 2	10-20	1923 5-24	8-16	---	---	---
743	1922 8-20	8-30	9- 9	9-26	10- 8	10-27	1923 6- 2	8-13	---	---	---	---
745	1922 8-20	8-30	9-12	9-18	10- 1	10-11	11- 2	1923 5-24	7- 2	8- 7	---	---
746	1922 8-20	8-29	9-10	9-20	10- 2	10-13	1923 8-18	---	---	---	---	---
754	1922 8-20	8-30	9- 9	10- 4	10-16	1923 5-24	6-26	9- 2	---	---	---	---
755	1922 8-20	8-30	9- 7	9-18	10- 4	11-16	1923 5-30	8-18	---	---	---	---
757	1922 8-20	8-30	9- 8	9-18	10- 1	11-13	1923 6- 9	8-20	---	---	---	---
758	1922 8-20	8-30	9- 9	9-18	10- 2	10-13	11-12	1923 6- 9	8-16	---	---	---
760	1922 8-20	8-30	9-12	9-22	10-13	11-13	1923 6- 2	8- 9	---	---	---	---
762	1922 8-20	8-30	9-10	10-13	1923 5-27	7- 5	1924 5-23	---	---	---	---	---
763	1922 8-20	8-30	9-11	9-18	10- 8	10-26	1923 5-27	6-29	1924 5-20	---	---	---
764	1922 8-20	8-30	9-12	9-19	9-30	10-16	1923 5-27	7-11	8-31	---	---	---
765	1922 8-20	8-30	9- 9	9-22	10- 5	10-13	11-12	1923 5-30	8-18	---	---	---
767	1922 8-20	8-30	9-12	10- 4	10-14	11-18	1924 5-23	---	---	---	---	---
768	1922 8-20	8-30	9- 8	9-16	10- 7	10-27	1923 8-26	---	---	---	---	---
773	1922 8-20	8-30	9- 9	9-25	10- 8	10-23	1923 6- 5	7- 5	8- 7	---	---	---
775	1922 8-20	8-30	9- 7	9-17	9-30	1923 5-24	6-23	7- 7	8- 1	8-16	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
776	1922 8-20	8-30	9- 7	9-20	10- 2	10-13	11-11	1923 6- 5	8-18	---	---	---
777	1922 8-20	8-30	9- 7	10-16	1923 5-24	7- 5	7-27	8- 5	8-24	---	---	---
780	1922 8-20	8-30	9- 7	10- 4	10-16	1923 5-24	6-29	7- 3	8-20	9-10	---	---
784	1922 8-20	8-30	9-20	10- 1	11- 5	1923 6- 5	8-18	---	---	---	---	---
787	1922 8-20	8-30	10-18	1923 5-24	6-26	8-18	---	---	---	---	---	---
791	1922 8-20	8-30	10-14	11-11	1923 5-30	6-21	7- 3	7-26	8- 7	8-18	---	---
795	1922 8-20	8-30	9-18	10- 1	10-13	1923 5-24	8-20	---	---	---	---	---
798	1922 8-20	8-30	10- 5	10-15	1923 5-24	6-26	8-16	---	---	---	---	---
800	1922 8-20	8-30	9-10	9-26	10- 7	1923 5-30	8-18	---	---	---	---	---
805	1922 8-24	9- 1	9-11	9-16	10- 8	10-23	1923 5-24	6-26	---	---	---	---
816	1922 8-24	9- 1	9-11	9-16	10- 8	10-27	1923 5-27	7- 5	7-20	---	---	---
819	1922 8-24	9- 1	9-11	9-16	10- 1	10- 8	10-22	1923 5-24	6-23	8-16	---	---
825	1922 8-24	9- 1	9-11	9-16	10- 2	10-26	1923 5-24	6-26	8-20	---	---	---
826	1922 8-25	9- 2	9-12	9-16	10- 2	10-10	11- 6	1923 6- 5	7-25	9- 4	---	---
837	1922 8-25	9- 2	9-12	10- 1	11-12	1923 5-30	8-18	---	---	---	---	---
841	1922 8-25	9- 2	9-12	9-20	10- 8	10-27	1923 5-24	6-26	8-21	---	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
846	1922 8-25	9- 2	9-12	9-18	10- 8	1923 5-23	5-30	7- 9	8- 9	---	---	---
847	1922 8-25	9- 2	9-12	9-23	9-30	10- 8	10-27	1923 5-27	8-20	---	---	---
852	1922 8-26	9- 3	9-13	9-24	10- 5	10-19	1923 5-27	8-16	---	---	---	---
865	1922 8-26	9- 3	9-13	9-16	10- 1	10-11	10-27	1923 5-24	6-26	8-20	---	---
869	1922 8-26	9- 3	9-13	10-27	11-11	1923 5-24	1924 5-23	---	---	---	---	---
876	1922 8-27	9- 4	9-14	10- 4	10-13	11- 3	1923 6-26	1924 5-23	---	---	---	---
888	1922 8-27	9- 4	9-14	9-20	10- 2	11- 7	1923 6- 2	6-29	8-18	---	---	---
892	1922 8-27	9- 4	9-14	9-17	10- 5	10-27	1923 5-21	6-19	1924 3-20	---	---	---
894	1922 8-27	9- 4	9-14	9-20	10- 1	10-27	1923 6- 2	7- 2	7-27	8- 7	---	---
895	1922 8-27	9- 4	9-14	9-17	10- 7	10-20	1923 5-24	6-26	8- 7	---	---	---
896	1922 8-27	9- 4	9-14	9-20	10- 2	10-13	1923 5-24	6-26	8- 7	---	---	---
897	1922 8-27	9- 4	9-14	9-21	10-13	10-23	1923 5-27	7- 2	8- 3	---	---	---
903	1922 8-28	9- 5	9-15	9-20	10- 2	10-30	1923 5-27	8- 9	---	---	---	---
904	1922 8-28	9- 5	9-15	9-20	9-30	10-12	10-27	1923 8- 3	---	---	---	---
906	1922 8-28	9- 5	9-15	9-20	9-30	10-27	1923 5-21	8- 1	---	---	---	---
907	1922 8-28	9- 5	9-15	9-20	9-30	10-12	10-26	1923 5-21	6-26	---	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
909	1922 8-28	9-30	10-30	1923 5-24	6-26	8- 3	---	---	---	---	---	---
913	1922 8-28	9- 5	9-15	10-26	1923 5-11	5-24	6-26	8-20	----	---	---	---
916	1922 8-28	9- 5	9-15	10-12	10-29	1923 5-24	8-16	---	---	---	---	---
918	1922 8-28	9- 5	9-15	10-12	10-27	1923 5-24	6-26	8- 3	---	---	---	---
920	1922 8-28	9- 5	9-15	10- 1	10-27	1923 6- 2	7- 2	8- 9	---	---	---	---
927	1922 8-29	9- 6	9-30	10-22	1923 6- 2	7- 2	7-20	8- 1	8-20	---	---	---
928	1922 8-29	9- 6	10-13	11- 1	1923 5-24	7- 9	8-10	---	---	---	---	---
929	1922 8-29	9- 6	9-22	10-30	1923 5-30	7- 2	8- 1	---	---	---	---	---
930	1922 8-29	9- 6	9-20	9-30	10-14	1923 5-21	6-19	8- 7	---	---	---	---
932	1922 8-29	9- 6	9-17	10- 5	10-15	11- 6	1923 5-21	7- 2	8-16	---	---	---
933	1922 8-29	9- 6	9-17	9-26	10-14	11- 2	1923 5-24	6-26	8-18	---	---	---
935	1922 8-29	9- 6	9-22	10- 4	10-14	11- 7	1923 5-24	7- 5	7-28	8-16	---	---
936	1922 8-29	9- 6	10- 2	10-11	10-26	1923 5-21	6-19	8- 7	---	---	---	---
939	1922 8-29	9- 6	9-17	10-30	1923 5-27	8- 3	---	---	---	---	---	---
940	1922 8-29	9- 6	9-17	9-26	10-30	1923 5-24	6-26	8- 7	---	---	---	---
942	1922 8-29	9- 6	10- 7	10-20	1923 5-21	6-19	8-20	---	---	---	---	---
944	1922 8-29	9- 6	9-17	10-14	10-30	1923 7- 5	8- 9	---	---	---	---	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
946	1922 8-29	9- 6	9-17	9-25	10- 2	10-15	11-17	1923 5-27	6-26	---	---	---
947	1922 8-29	9- 6	10- 2	10- 7	10-19	11-11	1923 5-24	6-26	8-11	---	---	---
948	1922 8-29	9- 6	9-17	9-25	10-14	11- 3	1923 5-24	6-26	8-20	---	---	---
949	1922 8-29	9- 6	10-13	10-30	1923 5-27	6-26	7-13	8- 1	8-11	---	---	---
950	1922 8-29	9- 6	9-20	10-2	10-11	11-18	1923 5-24	6-26	8-16	---	---	---
951	1922 8-30	9- 7	10-30	11-13	1923 5-24	6-26	8-11	---	---	---	---	---
952	1922 8-30	9- 7	9-26	10- 5	10-16	1923 5-21	6-26	7- 6	7-16	7-25	8- 3	---
955	1922 8-30	9- 7	10- 5	10-17	1923 5-24	6-19	8-20	---	---	---	---	---
958	1922 8-30	9- 7	10-20	1923 5-24	6-26	7-17	8- 3	8-18	---	---	---	---
959	1922 8-30	9- 7	10- 5	10-17	1923 5-21	8-20	---	---	---	---	---	---
961	1922 8-30	9- 7	9-23	10-14	10-14	11- 6	1923 5-27	7- 5	8-18	---	---	---
962	1922 8-30	9- 7	10-14	1923 5-27	6-26	7-17	8- 1	8- 9	8-20	---	---	---
964	1922 8-30	9- 7	10- 2	10- 8	10-22	1923 5-21	6-19	7- 9	8-21	---	---	---
965	1922 8-30	9- 7	10- 7	10-19	11-13	1923 5-24	6-26	8-18	---	---	---	---
967	1922 8-30	9- 7	9-26	10- 7	10-17	11-18	1923 5-24	6-19	8-27	---	---	---
972	1922 8-30	9- 7	10- 1	10- 5	10-19	11-18	1923 5-24	6- 3	6-19	7- 5	8- 9	---

Cage No.	Date Egg Hatched	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
974	1922 8-30	9- 7	9-23	10- 5	10-16	11-12	1923 5-27	6-26	8-16	---	---	---
975	1922 8-30	9- 8	10- 4	10-14	11- 6	1923 5-24	6-26	8-13	---	---	---	---
977	1922 8-31	9- 8	10- 7	10-17	11- 2	1923 5-21	6-19	7- 9	---	---	---	---
979	1922 8-31	9- 8	1923 5-24	6-26	7- 9	7-25	8- 8	8-20	---	---	---	---
980	1922 8-31	9- 8	10- 4	10-14	10-29	1923 5-21	8- 7	---	---	---	---	---
981	1922 8-31	9- 8	9-26	10-16	11- 2	1923 5-27	6-26	8- 7	---	---	---	---
982	1922 8-31	9- 8	9-26	10- 7	10-16	11- 7	1923 5-21	6-19	7- 9	8-18	---	---
984	1922 8-31	9- 8	9-30	10-20	1923 5-24	6-26	7- 9	7-22	8- 2	8-20	---	---
987	1922 8-31	9- 8	10-23	1923 5-27	6-26	7- 8	8-21	7-31	8- 7	---	---	---
989	1922 8-31	9- 8	10-14	11- 2	1923 5-21	6-19	8- 7	---	---	---	---	---
991	1922 8-31	9- 8	10-27	1923 5-21	6-19	7- 1	7-11	7-18	8- 1	8-11	---	---
992	1922 8-31	9- 8	10- 5	10-17	11- 7	1923 5-21	6-19	8-27	---	---	---	---
993	1922 8-31	9- 8	10- 5	10-16	10-30	1923 5-21	6-21	8-24	---	---	---	---
994	1922 8-31	9- 8	10-11	1923 5-21	6-19	7-17	8-16	---	---	---	---	---
995	1922 8-31	9- 8	10- 5	10-13	10-30	1923 5-21	1924 6- 5	---	---	---	---	---

Duration of Larval Period, Eleodes extricata Say.
Record of 15 Larvae.

Cage No.	Date Larva Emerged	Date of Pupation	Duration Larval Period Days
	1922		
44	7- 1	9-22/23	448
	1923	1924	
4A	6-27	6-14	353
5A	6-27	7- 3	372
10A	6-27	6-25	364
14A	6-27	7- 3	372
50A	6-29	6-20	357
53A	6-29	6-27	364
55A	6-29	6- 7	344
64A	6-29	6-27	364
74A	6-29	7- 7	374
80A	6-29	6- 7	344
85A	6-29	6-27	364
86A	6-29	6-30	367
107A	7- 5	6-27	358
127A	7- 5	7- 3	364

Maximum duration of larval period.....448 days.
Minimum duration of larval period.....344 days.
Average duration of larval period.....367.26days.

Record of Complete Molts, Larvae of Eleodes extricata
15 Larvae

Cage No.	Date Egg Hatched	Number of Molts and Date of Molting. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
44	1922 7- 1	7- 8	7-19	7-29	8- 3	8-13	8-21	8-31	9-15	9-24	1923 6-23	9-22
4A	1923 6-27	7-10	7-16	7-22	8- 4	8-14	9- 3	1924 3-24	4-20	5- 8	5-22	6-14
5A	1923 6-27	7- 7	7-16	7-26	8- 2	8-14	8-26	9-10	1924 3-24	4-22	5-12	7- 3
10A	1923 6-27	7- 8	7-16	7-22	8-12	8-30	11- 7	1924 4- 1	4-22	5-12	6- 1	6-25
14A	1923 6-27	7-12	7-16	8- 2	8-12	8-24	9- 1	11- 7	1924 4- 1	5-20	6-15	7- 3
50A	1923 6-29	7- 7	7-16	8-10	8-24	9-15	10-16	1924 3-17	4-11	5-12	6-10	6-20
53A	1923 6-29	7-12	7-16	7-24	8- 2	8-14	8-28	9- 9	1924 3-24	4-22	5-15	6-27
55A	1923 6-29	7-10	7-18	8- 2	8-14	8-26	9- 1	9-19	10-16	1924 5- 3	5-22	6- 7
64A	1923 6-29	7-12	7-18	7-22	8-10	8-14	8-28	10-16	1924 3-24	4-22	5-18	6-27
74A	1923 6-29	7-12	7-18	7-24	8- 2	8-10	8-16	9- 5	10-16	1924 3-24	5-12	7- 7
80A	1923 6-29	7-10	7-20	7-24	8- 2	8-12	8-22	8-28	11- 1	1924 3-24	4-22	6- 7
85A	1923 6-29	7-10	7-14	7-24	7-30	8-26	9- 9	1924 3-24	4-22	5-12	5-30	6-27
86A	1923 6-29	7-10	7-16	7-24	8-14	8-28	9-15	10-16	1924 4-22	5-12	5-30	6-30
107A	1923 7- 5	7-10	7-14	7-26	8-10	8-16	10-16	1924 4- 1	5- 1	5-13	5-30	6-27
127A	1923 7- 5	7-12	7-20	8-10	1924 3-24	4-11	4-22	5-12	5-25	6-10	6-25	7- 3

Duration of Instars in Days, Eleodes extricata Say.

Cage No.	Number of Instars.										
	1	2	3	4	5	6	7	8	9	10	11
44	7	11	10	5	10	8	10	15	9	272	91
4A	13	6	6	13	10	20	203	27	18	14	23
5A	10	9	10	7	12	12	15	196	29	20	52
10A	11	8	6	21	18	69	146	21	20	20	24
14A	15	4	17	10	12	8	67	146	49	26	18
50A	8	9	25	14	22	31	153	25	31	29	10
53A	13	4	8	9	12	14	12	197	29	23	43
55A	11	8	15	12	12	6	18	27	200	19	16
64A	13	6	4	19	4	14	49	160	29	26	40
74A	13	6	6	9	8	6	20	41	160	49	56
80A	11	10	4	9	10	10	6	65	144	29	46
85A	11	4	10	6	27	14	196	29	20	18	28
86A	11	6	8	21	14	18	31	189	20	18	31
107A	5	4	12	15	6	61	168	30	12	17	28
127A	7	8	21	227	18	11	20	13	16	15	8

Summary of Instar Durations, Larvae of Eleodes extricata.

No. of Instar	Duration in Days.		
	Maximum	Minimum	Average
1	15	5	10. 6
2	11	4	6.86
3	25	4	10.08
4	202	5	26.46
5	27	4	13,00
6	69	6	20.13
7	202	6	74.26
8	196	13	78.66
9	199	9	52.40
10	272	14	39.66
11	91	8	34.26

Record of Incomplete Molts- Larvae of Eleodes extricata.
18 Larvae.

Cage No.	Date Egg Hatched	Number of Molts and Date of Molting. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
12A	1923 6-27	7-18	8- 2	8-26	4- 1	1924 5-20	6-27	---	---	---	---	---
17A	1923 6-27	7-12	7-16	7-22	8-14	8-26	1924 4- 1	5- 1	5-20	5-23	---	---
33A	1923 6-29	7-12	7-18	1924 4-22	6-23	---	---	---	---	---	---	---
39A	1923 6-29	7-12	7-16	7-22	8- 2	8-12	1924 3-24	4-22	6-23	---	---	---
49A	1923 6-29	7-12	7-18	7-22	8- 2	8-24	1924 3-24	4-22	5-12	6-10	6-18	---
59A	1923 6-29	7- 7	7-16	8-10	8-30	10-16	1924 3-24	4-22	5-15	6-30	---	---
70A	1923 6-29	7-12	7-16	9- 1	10-16	1924 3-24	5-15	6-30	---	---	---	---
78A	1923 6-29	7- 5	7-16	8-20	1924 3-24	4-22	5-12	7- 7	---	---	---	---
79A	1923 6-29	7-10	7-18	7-24	9- 1	11- 1	1924 3-24	4-22	5-12	6-27	---	---
87A	1923 6-29	7-12	7-16	7-24	1924 6-30	---	---	---	---	---	---	---
96A	1923 7- 5	7-10	7-18	8-10	9- 3	1924 4-22	5-15	6-27	---	---	---	---
99A	1923 7- 5	7-12	8-20	9-15	1924 5-15	7- 3	---	---	---	---	---	---
103A	1923 7- 5	7-12	7-20	9- 1	11-23	1924 3-24	4-22	5-12	5-23	6-16	---	---
104A	1923 7- 5	7-12	7-18	8-10	8-22	1924 4-11	5-12	5-23	6- 8	6-20	6-30	---

Cage No.	Date Egg Hatched	Number of Molts and Dates of Molting										
		1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th
109A	1923 7- 5	7-12	7-20	8-20	9-15	1924 3-24	4-22	6-27	---	---	---	---
110A	1923 7- 5	7-10	7-18	8-22	11- 1	1924 3-17	4-11	5-12	5-20	6- 8	6-30	---
112A	1923 7- 5	7-10	7-20	9- 5	9-15	1924 3-17	4-22	5-12	5-21	6- 9	6-30	---

Seventeen eggs of Eleodes extricata were hatched in laboratory in 1922. Of the larvae emerging from these all died before reaching the pupal stage excepting No. 44 listed in one of the above tables. One hundred thirty six eggs of Eleodes extricata hatched in the laboratory in 1923. Of the larvae emerging from these, thirty three reached maturity and transformed to pupae as indicated in the above tables of complete and incomplete records of molts.

Record of Molts, Larvae of Eleodes sulcipennis.
6 Larvae.

Cage No.	Date Egg Hatched	Number of Molts and Dates of Molting									
		1st	2d	3d	4th	5th	6th	7th	8th	9th	10th
1007	1922 9- 9	9-19	10- 1	10-13	10-27	1923 5-24	6-26	7-17	7-28	1924 4-11	6- 5
1011	1922 9- 9	9-20	10- 1	10-10	10-23	1923 5-24	5-31	6-26	7-17	9- 6	1924 6-23
1014	1922 9- 9	9-20	10- 1	10-11	10-27	1923 5-22	6-26	7-13	7-25	8-11	---
1020	1922 9- 9	9-19	10- 2	10-11	10-27	1923 5-20	6-19	7- 9	8- 1	9- 8	1924 5-23
1021	1922 9- 9	9-20	10- 1	10-10	10-26	1923 5-15	6-19	7- 9	7-28	9- 5	1924 6-14
1025	1922 9- 9	9-20	10- 1	10-11	10-27	1923 5-30	6-24	7-17	7-26	8- 6	8-25

Of a number of females of Eleodes sulcipennis kept in laboratory but one laid any eggs. These all hatched on the same day and larvae emerging were placed in cages numbered consecutively from 1001 to 1025. But six of these reached maturity and pupated as recorded in the above table and a complete record of molts was not obtained from No. 1014.

Duration of Instars in Days, Eleodes sulcipennis.
6 Larvae.

Cage No.	No. of Instars.									
	1	2	3	4	5	6	7	8	9	10
1007	10	12	12	14	209	33	21	11	258	55
1011	11	11	9	13	213	7	26	21	51	291
1020	10	13	9	16	205	30	20	23	38	258
1021	11	11	9	16	201	35	20	19	39	283
1025	11	11	10	16	215	25	23	9	11	19

No. of Instar	Duration in Days.		
	Maximum	Minimum	Average
1	11	10	10. 2
2	13	11	11. 6
3	12	9	9. 8
4	16	13	15.00
5	215	201	208.60
6	35	7	26.00
7	26	20	22.00
8	23	9	16.60
9	258	11	79.40
10	291	19	181.20

Duration of Larval Period, Eleodes sulcipennis Blais.

Cage No.	Date Larva Emerged 1922	Date of Pupation	Duration Larval Stage Days.
1007	9- 9	6- 5/24	635
1011	9- 9	6-23/24	653
1020	9- 9	5-23/24	622
1021	9- 9	6-14/24	644
1025	9- 9	8-25/23	350

Maximum duration of larval period.....653 days
Minimum duration of larval period.....350 days
Average duration of larval period.....580.8days

Pupae.

When larvae had grown to maturity (Photographs 23, 24, 25, 26 and 27) in the cages they were often observed to become comparatively inactive and to assume somewhat different proportions. They seemed to shorten perceptibly and to become broader and more robust. At first it was thot this stage was more or less definite and a record was started of what was considered as a pre-pupal stage. As more observations were made however, it was learned that this stage was rather indefinite and often times a larva would reach maturity, cast its last skin and transform to the pupal stage without any perceptible change in proportions or without, apparently, going thru the inactive stage. For this reason no record of the prepupal stage was kept.

With the shedding of the last larval skin the naked pupa is found in the soil with appendages closely folded against the body. (Photographs 28, 29, 30.) As time progresses in the pupal stage, elytrons are gradually formed and the appendages relax and become free from the body. At first the pupa is creamy-white but gradually the joints of the legs first turn to a dull olive color and progressively the color becomes darker until the joints are black. The legs and antennae become black first followed by the color gradually changing over the entire body. When the new adult is formed and ready to emerge it is gray-black in general color and even after emergence the adults often have not turned to the deep black of complete maturity. Newly-emerged individuals are very soft and delicate, but soon harden after exposure to the air and sun.

Duration of Pupal Stage- Eleodes hispilabris.
136 Pupae.

No. of Cage	Date Pupated	Date Changed to Adult	Duration Pupal Stage Days
8	8- 7/23	8-30/23	23
12	8- 8/23	9- 1/23	24
32	8- 9/23	8-30/23	21
104	8-17/23	9-22/23	36
105	8-19/23	9-22/23	34
119	8- 3/23	8-28/23	25
203	8-21/23	9-26/23	36
231	8- 9/23	9- 3/23	25
243	8-15/23	9- 7/23	23
253	8- 7/23	9- 1/23	25
254	8- 3/23	9- 5/23	33
363	8-17/23	9-11/23	25
366	7-31/23	8-15/23	15
373	8- 7/23	8-30/23	23
374	8- 7/23	9- 5/23	29
386	8-11/23	8-30/23	19
392	8- 9/23	9- 3/23	25
402	8- 9/23	9-26/23	48
403	8-15/23	9-26/23	42
410	8-17/23	9-26/23	40
425	8- 3/23	9- 5/23	33
426	8-15/23	9-26/23	42
433	8-11/23	9- 9/23	29
446	8-15/23	9-22/23	38
447	8-17/23	9-26/23	40
449	8-11/23	9- 7/23	27
451	8-13/23	9-15/23	33
464	8-17/23	9-26/23	40
506	8-11/23	9-15/23	35
508	8-17/23	9-26/23	40
517	8-17/23	9- 7/23	21
521	8- 3/23	9- 5/23	33
523	8-21/23	9-26/23	36
524	8-15/23	9-22/23	38
531	9- 1/23	10-12/23	41
535	8-19/23	9-15/23	27
539	8-11/23	9- 9/23	29
541	8- 7/23	9- 5/23	29
545	8-11/23	10- 2/23	52
556	8-15/23	9- 5/23	51
559	8-17/23	9-22/23	36
568	9- 3/23	10- 8/23	35
569	8-11/23	9-11/23	31
570	8-28/23	10- 4/23	37
629	8-17/23	9-26/23	40
632	8-15/23	9-22/23	38
633	8- 7/23	9- 5/23	29
634	8-25/23	9-12/23	18
635	8-11/23	9-13/23	33
636	8-17/23	9-26/23	40
644	8-15/23	9-22/23	38
647	8-21/23	10- 1/23	41
652	8- 3/21	8-30/23	27
658	8-19/23	9-22/23	34
666	8-11/23	9-22/23	42
674	8-15/23	9-22/23	38
673	9- 1/23	10-12/23	41
687	9- 3/23	10- 1/23	28
688	5-20/24	6- 7/24	18
693	8-15/23	9-13/23	29
694	8-19/23	10- 1/23	43
699	8-21/23	10- 1/23	41
701	8-19/23	9-22/23	34
702	8-15/23	9-22/23	38
706	8-13/23	9- 7/23	25
710	8-19/23	9-26/23	38
718	8-29/23	10-12/23	44
723	8-18/23	9-22/23	35
726	8-20/23	9-22/23	33
733	8-16/23	9-26/23	41
734	8-18/23	9-26/23	39
735	8-20/23	9- 9/23	20
747	8-15/23	9-26/23	42
752	8-21/23	10- 4/23	44
753	8-16/23	9-26/23	41
756	9- 4/23	10- 4/23	30
763	5-20/24	6- 7/24	18
771	8-29/23	10-12/23	44
773	8- 7/23	8-20/23	13
775	8-16/23	9- 8/23	23
777	8-24/23	10- 8/23	45
779	8- 9/23	9-10/23	32
780	9-10/23	9-26/23	16
782	8-16/23	10- 1/23	46
786	8-20/23	9-26/23	37
791	8-18/23	10- 1/23	44
816	7-20/23	10- 4/23	76
821	8-26/23	10- 4/23	39

Cage No.	Date Pupated	Date Changed to Adult	Duration Pupal Stage Days
592	8-15/23	9-22/23	38
604	8- 9/23	9- 3/23	25
610	8-19/23	9-26/23	38
614	8-15/23	10- 4/23	50
617	8-15/23	9-26/23	42
625	8- 9/23	9-11/23	33
626	8-19/23	9- 9/23	21
869	5-23/24	6-14/24	22
880	8-20/23	9-22/23	33
886	8-16/23	10- 1/23	46
888	8-18/23	10- 1/23	44
892	3-20/24	6- 7/24	79
894	8- 7/23	9- 2/23	26
898	8-21/23	9- 4/23	14
915	8- 1/23	8-29/23	28
922	8-18/23	10- 1/23	44
928	8-10/23	8-31/23	21
931	8- 7/23	8-29/23	22
934	8-20/23	9- 3/23	14
935	8-16/23	9-22/23	37
937	8-18/23	9- 8/23	21
941	8-11/23	9- 4/23	24
943	8-16/23	9-14/23	29
949	8-11/23	9-14/23	34

Cage No.	Date Pupated	Date Changed to Adult	Duration Pupal Stage Days.
822	8-18/23	9-26/23	39
828	8-16/23	9-22/23	37
829	8- 7/23	9- 8/23	32
842	8-31/23	10-12/23	42
844	8-27/23	10- 4/23	38
858	9-22/23	10- 8/23	16
863	9-22/23	10-12/23	20
864	8-18/23	10- 1/23	44
952	8- 3/23	9- 2/23	30
953	8- 9/23	9- 6/23	28
954	8-18/23	9-14/23	27
957	8-16/23	9- 8/23	23
958	8-18/23	9-22/23	35
960	8-16/23	9-22/23	37
962	8-20/23	10- 8/23	49
963	8-16/23	9-10/23	25
970	8-20/23	9-22/23	33
979	8-20/23	9-22/23	33
984	8-20/23	9-22/23	33
987	8- 7/23	8-31/23	24
991	8-11/23	9- 6/23	26
992	8-27/23	10- 4/23	38
998	8-20/23	9-14/23	25
1000	8-16/23	9-22/23	37

Summary

Maximum duration of pupal stage.....79 days
Minimum duration of pupal stage.....13 days
Average duration of pupal stage.....33.59days

Duration of Pupal Stage - Eleodes extricata Say.

Cage No.	Date Pupated	Date Changed to Adult	Duration Pupal Stage Days	Cage No.	Date Pupated	Date Changed to Adult	Duration Pupal Stage Days
44	9-22/22	10/ 1/22	9	74A	7- 7/23	7-28/23	21
4A	6-14/23	6-30/23	16	78A	7- 7/23	7-14/23	7
5A	7- 3/23	7-14/23	11	79A	6-27/23	7- 7/23	10
10A	6-25/23	7- 7/23	13	80A	6-27/23	6-27/23	20
12A	6-27/23	7- 7/23	10	85A	6-27/23	7- 7/23	10
14A	7- 3/23	7-14/23	11	86A	6-30/23	7-12/23	12
17A	6-23/23	7- 7/23	14	87A	6-30/23	7-10/23	10
33A	6-23/23	7- 3/23	10	96A	6-27/23	7- 7/23	10
39A	6-23/23	7- 3/23	10	99A	7- 3/23	7-14/23	11
49A	6-18/23	7- 3/23	15	103A	6-16/23	7- 3/23	13
50A	6-20/23	7- 3/23	13	104A	6-30/23	7-14/23	14
53A	6-27/23	7-10/23	13	107A	6-27/23	7- 7/23	10
55A	6- 7/23	6-27/23	20	109A	6-27/23	7- 7/23	10
59A	6-30/23	7- 7/23	7	110A	6-30/23	7- 7/23	7
64A	6-27/23	7- 7/23	10	114A	6-30/23	7- 7/23	7
70A	6-30/23	7-10/23	10	127A	7- 3/23	7-14/23	11

Summary: Maximum Duration of Pupal Stage.....21 days.
Minimum Duration of Pupal Stage..... 7 days.
Average Duration of Pupal Stage.....11.40 days.

Duration of Pupal Stage - Eleodes sulcipennis Mann.

Cage No.	Date Pupated	Date Changed to Adult	Duration Pupal Stage Days.
1007	6- 5/24	6-14/24	9
1014	8-11/23	9- 2/23	22
1025	8-25/23	9- 4/23	10

Average Duration of Pupal Stage.....13.66 days.

Length of Life of *Eleodes hispilabris*
from Egg to Adult, Inc.
135 Individuals.

Stage	Number of Days		
	Maximum	Minimum	Average
Egg	18	10	14.91
Larva	644	302	369.19
Pupa	79	13	33.59
Possible Total	741	325	417.69

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Length of Life of *Eleodes extricata*
from Egg to Adult, Inc.
32 Individuals.

Stage	Number of Days		
	Maximum	Minimum	Average
Egg	15	10	10.86
Larva	448	344	367.26
Pupa	21	7	11.40
Possible Total	484	361	389.52

.....

Length of Life of *Eleodes sulcipennis*
from Egg to Adult, Inc.
3 Individuals.

Stage	Number of Days		
	Maximum	Minimum	Average
Egg	20	20	20
Larva	653	350	580.80
Pupa	22	9	13.66
Possible Total	695	379	614.46

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As previously mentioned, life history studies were begun in the upper Snake River valley and were continued there during one active season or from April until October 1922. Owing to other entomological problems that demanded attention in other parts of the state, headquarters for experimental work were moved in October 1922 from Rexburg to Parma which is located in the lower Boise valley in southwest Idaho. The journey was made by auto and Eleodes material was carefully packed and transported, stops being made so that routine examinations could be made and work done each alternate day. Material carried thru in fine condition with the loss of no more larvae than ordinarily might occur during a similar period of time. A small cellar was constructed at Parma and the larvae kept in it until the following spring.

It was found that temperature in the cellar was too cool in the summer to allow normal development it being much lower than the temperature of the surface strata of soil in which larvae ordinarily occur so the cabinet containing the cages was placed in the outdoor insectary. It is realized that the temperature conditions were not exactly what they are in the soil, but it is believed that average temperature conditions approximated the average conditions that commonly exist on Rexburg Bench; for there larvae may occur in soil that has a south exposure and which warms early in the spring, or they may occur in the proximity of heavy snow banks that last until the middle of July.

A surprising fact was learned by following the development of large numbers of larvae and this was that larvae of exactly the same age

vary greatly in size and in the length of life. This variance cannot be accounted for by the writer unless it be due to the amounts of food consumed by different individuals which in turn is influenced by what might be termed the "health" of individual larvae. This point is emphasized by comparing the larval record for individuals in cages 989 and 995. The eggs that produced these two larvae were laid on the same day, yet of the larvae one transformed to a pupa in 341 days while the other remained in the larval stage for 644 days or almost a year longer. Another fact was that, aside from the first instar and to a slight extent the second instar there was no apparent uniformity as to the duration of the instars.

By an oversight several cages containing field-collected larvae of Eleodes hispilabris were misplaced in the cellar in April 1923 and not examined again until October 20th of the same year. During this time the soil had not been changed nor food placed in the cages, but the soil had been moist and kept at cellar temperature. When examination was made in October it was found that there were several live larvae in each cage. These were much smaller than larvae of approximately the same age which had obtained food and in color they had changed from a shining yellow or orange to a dull olive. Larvae of the same appearance have been frequently observed in the field without explanation as to why they should vary from the average and a possible explanation is that where moisture is insufficient for the larvae to survive in the upper soil where the food occurs they are driven down to the moist soil where, lacking food, they exist in a semi-dormant stage.

Mortality in caged larvae was very high when life history was first begun because of a lack of knowledge concerning soil moisture but with experience it was relatively easy to carry the insects thru from eggs to adults with small loss. The securing of data on molts and lengths of instars was relatively very much more difficult. Larvae frequently devour their cast skins and records of larval transformation were often lost because of failure to find the cast skins. Owing to mortality and to failure to find cast skins of many of the larvae, complete records were obtained of but 92 of the 947 eggs with which the life history observations were begun. In the tabulations in this thesis records of all individuals that died before they pupated were omitted for conservation of space.

Conclusions Concerning the Life Cycle of Eleodes hispilabris. Based on Consideration of Field Observations and Laboratory Data.

Adult: Field observations indicate that the average adult (Photographs No. 5, 6, and 7) emerges about August 1st and lives until June 1st of the following year. Many of them emerge late in August and die soon after mating and laying eggs the following season. Others may live until late October of the year following emergence as has been proven by adults kept in cages. It is not probable that any appreciable number survive this long under field conditions but it is altogether possible that individuals that live until October might go into hibernation and survive a second winter. We know definitely therefore that the average life of the adults is about 10 months; that it is possible for them to reproduce after surviving only 8 months; and that a small percentage

live for from 14 to 16 months. The writer believes it probable that a very small percentage of adults survive a second winter but has no information as to whether they could lay eggs after that period.

Egg: The average incubation period was found to be 14.91 days. During warmer weather eggs hatched in as few as 10 days and incubation required as many as 18 days when the temperature was lower.

Larva: The average length of time that Eleodes hispilabris spends in the larval stage is 369.19 days tho an individual has been studied that existed in this form for only 302 days and another for more than double that time, or 644 days. It was determined that there are eleven instars which may last for almost any number of days from 4 to 317. In the case of larvae which existed many months over a year they remained week after week in an inactive condition. Soil was changed regularly and food was supplied them but they ate very little.

Pupa: The average length of the pupal stage was 33.59 days while some pupated in 13 days and others required as much as 79 days.

Duration of Complete Life Cycle- Eleodes hispilabris.

	Number of Days		
Stages	Maximum	Minimum	Average
Adult	488	242	304.00
Egg	18	10	14.91
Larva	644	302	369.19
Pupa	79	13	33.59
Possible Total	1229	567	721.69

From field observations and laboratory data it is indicated that the average life cycle of Eleodes hispilabris is approximately two years. The period of time required for a complete life cycle, however may vary from approximately one and one-half years to more than three and one-third years.

It was assumed, when control work was planned, that the life of the larvae was but a single season and subsequent life history studies have proven that this is true of the average or the majority. Control experiments were based on the proposition that work to be entirely successful must be conducted for two consecutive years. As a concrete illustration the control work undertaken in the fall of 1922, description of which is given in the latter part of this thesis, was directed against adults which had developed from eggs laid in the spring of 1921. At this time there were larvae in the soil which had been produced from eggs deposited in the spring of 1922 but which did not reach the adult stage until the fall of 1923. For this reason it would have been necessary to continue the poisoning campaign during the fall of 1923 to obtain complete control of Eleodes hispilabris on Rexburg Bench.

Poisoning Experiments in 1921 and 1922.

Experiments in 1921.

Numerous experiments were conducted in August, 1921 in an attempt to determine whether adults could be successfully killed by poisoning and, if so, what the most effective and economical poisons were. A machine shed on the Ed Swendsen ranch was used as a laboratory, and tests were made under conditions not entirely comparable to those in the field

since beetles had no choice of food. They were placed in large boxes that served as cages and in the bottoms of which was kept moist soil.

Results of Poisoning Experiments
on Eleodes hispilabris, 1921.

Cage No.	No. Beetles	Food	Date Fed	Number Dead -- Days 1	2	3	4	5	6	7	Tot.	% Dead
1	20	Bran, USSCO White arsenic Amyl acetate	Aug. 10	2	13	3	2				20	100
2	30	Bran, USSCO Sodium arsenite	Aug. 10	10	12	1	1				24	80
3	30	Bran and Paris Green	Aug. 10	15	11	4					30	100
4	30	Check	Aug. 10	0	1	0	1	0	1	0	3	10
5	30	Solution of sodium arsenite, water and molasses allowed to drip in cage	Aug. 10	4	7	4	0	0	1	0	16	53.33
6	40	Bran USSCO White arsenic Amyl acetate	Aug. 10	0	19	15	3	0			37	92.5
7	40	Bran, Paris Green and amyl acetate	Aug. 10	1	35	four missing						90
8	30	Bran, C. P. arsenic chloride oil rhodium	Aug. 10	0	12	16	Error cage closed					
9	40	Bran, c. p. potassium arsenate amyl acetate	Aug. 10	23	15	2					40	100
10	100	Solution of USSCO, sodium arsenite, water and amyl acetate. Dry bran in cage.	Aug. 10	6	10	24	18	8	5	15	86	86
11	50	Bran, c. p. copper chloride amyl acetate	Aug. 11	2	2	0	1	Poison ineffective.				
12	40	Bran, Paris green and amyl acetate	Aug. 11	33	6	0	0	1			40	100
13	30	Bran, Paris green and amyl acetate	Aug. 13	23	3	four escaped						

Cage No.	No. Beetles	Food	Date Fed	Number Dead -- Days 1	2	3	4	5	6	7	Tot.	% Dead
14	30	Bran & USSCO White arsenic	Aug. 14	1	9	11	4	1			26	86.6
15	30	Bran, c. p. arsenic chloride oil of rhodium	Aug. 14	2	5	8	10				25	83.3
16	50	Bran, c. p. potassium arsenate amyl acetate	Aug. 14	27	14	5	3				49	98
17	30	Bran and USSCO Sodium arsenite	Aug. 15	1	5	8	5				19	63.3
18	40	Bran, c. p. ferric acetate amyl acetate	Aug. 16	0	4	7	5	2			18	45
19	50	Bran, c. p. lead arsenite amyl acetate	Aug. 16	42	5						47	94
20	40	Bran, USSCO white arsenic amyl acetate	Aug. 17	27	6	4	three escaped					
21	40	Bran, Paris green and amyl acetate	Aug. 17	31	5	4					40	100
22	50	Bran, strychnine saccharine	Aug. 17	0	1	0	Poison ineffective					
23	30	Bran Nicotine sulfate amyl acetate	Aug. 18	14	10	5					29	90
24	50	Bran, c. p. potassium afsenate amyl acetate	Aug. 18	31	14	5					50	100
25	50	Bran, c. p. lead arsenite amyl acetate	Aug. 18	34	10	6					50	100
26	20	Bran 25 lbs. Paris green 2 lbs. amyl acetate $\frac{3}{4}$ oz.	Aug. 19	14	6						20	100
27	30	Bran 25 lbs. Paris green 1 lbs. amyl acetate $\frac{3}{4}$ oz.	Aug. 19	28							28	93.3
28	30	Bran, c. p. lead arsenite amyl acetate	Aug. 19	12	16	2					30	100
29	40	Bran, Paris green and amyl acetate	Aug. 19	33	7						40	100
30	50	Bran, c. p. copper arsenite amyl acetate	Aug. 19	8	23	5	1				37	74

Cage No.	No. Beetles	Food	Date Fed	Number Dead -- Days 1	2	3	4	5	6	7	Tot.	% Dead
31	30	Bran 25 lbs. Paris green 1 lb. amyl acetate 1 oz. Salt 1 lb.^{oo}	Aug. 20	21	6	three escaped						
32	40	Bran USSCO white arsenic amyl acetate	Aug. 20	12	twenty eight escaped							
33	50	Bran, c. p. lead acetate amyl acetate	Aug. 20	2	0	Poison ineffective						
34	30	Bran 25 lbs. USSCO white arsenic 2 lbs. amyl acetate 1oz.^{ooo}	Aug. 23	4	9	2	Thirteen escaped					
35	40	Bran 25 lbs. Paris green 1 lb. amyl acetate 1 oz.^{oo}	Aug. 23	3	20	2	4	Seven escaped				
36	40	Bran 25 lbs. Paris green 1 lb. amyl acetate 1 oz.^{oo}	Aug. 22	33	1	6					40	100
37	30	Bran, mixture sulfate, amyl acetate	Aug. 22	9	4	7	3	3			26	86.6
38	50	Bran, c. p. potassium arsenate amyl acetate	Aug. 22	43	4	3					50	100
39	50	Bran, c. p. lead arsenite amyl acetate	Aug. 22	18	12	7	3				40	80
40	30	Bran 25 lbs. Paris green 1 lb. amyl acetate 1 oz. salt 1 lb.^{oo}	Aug. 23	8	8	6	5				27	90
41	50	Bran, c. p. copper arsenite amyl acetate	Aug. 25	9	12	8	Discontinued					
42	30	Bran, Paris green	Aug. 15	0	17	8	4				29	96.6

^{o} Sample of poison bran mash used in field experiment No. 1
^{oo} Sample of poison bran mash used in field experiment No. 2
^{ooo} Sample of poison bran mash used in field experiment No. 5

Summary of Poison Results 1921.

Poison	No. of trials	Average % Killed
c. p. Potassium arsenite	4	99.5
Paris green	10	95.9
Lead arsenate, c. p.	4	93.5
USSCO white arsenic	4	92.9
Arsenic chloride, c. p.	1	83.3
USSCO Sodium arsenite	2	71.6

Considering comparative effectiveness of the various poison substances used, their relative cost and their distribution in the channels of trade where they might be freely purchased the poisoning tests indicated that Paris green is the most practicable poison to use against Eleodes beetles. It appeared that there was little difference in results obtained whether amyl acetate was used or not. Poisoning appeared to be so effective that it led to the field tests already mentioned and to more extensive tests during the following year.

Experiments in 1922.

Differing from the experiments of 1921 all poisoning tests were made under natural conditions and beetles were given their choice between poisoned and unpoisoned food. The attempted goal was to determine the specific poison, the optimum dosage, the most practicable poison to use under farm conditions and whether amyl acetate used as a scent added to the attractiveness of the poison bait. Cages were 12 inches wide and 16 inches long and extended into the ground 12 inches and above the surface 4 inches. (Photograph No. 15) The portion of the cages below ground was made of 1 X 12 boards and the upper portion was of tin nailed to the upper edges of the lumber cages. The tin was

smooth and served to prevent the beetles crawling out. In the center of each cage was laid a piece of board under which beetles sought protection at night or during the heat of the day. Moist, unpoisoned food was placed in one end of the cage and poisoned mash in the other so that beetles at all times had their choice of food. They were fed but once and after the mash became dry they were not given fresh, poisoned food.

Results of Poisoning Experiments on Eleodes hispilabris, 1922.

Cage No.	No. Beetles	Food	Date Fed	Number Dead -- days 1	2	3	4	5	6	7	Tot.	% Dead
1	20	Bran mash unpoisoned Check	June 22	0	0	1	2	3			6	30
2°	20	Bran 25 lbs. Deloro refined white arsenic 2 lbs	June 22	5	1	0	0	4			10	50
3°	20	Bran 25 lbs. Paris green 1 lb.	June 22	20							20	100
4	20	Check	June 22	0	1	0	1	1			3	15
5	20	Bran 25 lbs. Moistened, Paris green 1 lb	June 22	10	5	0	0	0			15	75
6	20	Bran 25 lbs. Paris green 1 lb. amyl acetate ¾ oz.	Sept 5	8	6	3	1	1			19	95
7	20	Bran 25 lbs. Paris green ½ lb. amyl acetate ¾ oz.	Sept 5	2	2	0	0	2			6	30
8	20	Bran 25 lbs. Paris green ¾ lb. amyl acetate ¾ oz.	Sept 5	8	5	4	0	0			17	85
9	20	Bran 25 lbs. Paris green 1½ lbs. amyl acetate ¾ oz.	Sept 5	11	5	2	0	1			19	95
10	20	Sawdust 25 lbs. Paris green 1 lb.	Sept 5	2	0	1	0	0			3	15
11	20	Sawdust 25 lbs. Paris green 1 lb. amyl acetate ¾ oz.	Sept 5 5	0	0	1	0	0			1	5

° Cages 2 and 3 no unpoisoned mash placed in them.

Cage No.	Beetles	Food	Date Fed	Number Dead -- days								% Dead
				1	2	3	4	5	6	7	Tot.	
12	20	Bran 25 lbs. Moistened USSCO white arsenic 1 lb. amyl acetate ¾ oz.	Sept 5	0	0	1	1	2			4	20
13	20	Bran 25 lbs USSCO white arsenic 2 lbs. amyl acetate ¾ oz.	Sept 5	0	0	1	0	0			1	5
14	20	Bran 25 lbs. Anaconda crude white arsenic 1 lb. amyl acetate ¾ oz.	Sept 5	0	0	1	1	0			2	10
15	20	Bran 25 lbs. Deloro refined white arsenic 1 lb. amyl acetate ¾ oz.	Sept 5	0	1	0	0	0			1	5
16	20	Bran 25 lbs. Deloro crude white arsenic 1 lb. amyl acetate ¾ oz	Sept 5	0	0	0	0	0			0	0
17	20	Bran 25 lb. Corona compound No. 610 amyl acetate ¾ oz.	Sept 5	1	0	1	1	1	Several sick		4	20
18	20	Bran 25 lbs. 7 lbs. "Guarantee" brand Grasshopper poison	Sept 5	0	0	0	1	0			1	5
19	20	Bran 25 lbs. 1 lb. c. p. potassium arsenate amyl acetate ¾ oz.	Sept 5	0	8	3	0	1			12	60
20	20	Bran 25 lbs. 1 lb. c. p. Sodium arsenate amyl acetate ¾ oz.	Sept 5	0	1	0	0	0			1	5
21	20	Bran 25 lbs. solution of 1 lb. Deloro refined white arsenic in water. amyl acetate ¾ oz.	Sept 5	0	1	1	0	0			2	10
22	20	Check	Sept 10	0	0	1	0	0	0	0	1	5
23	20	Bran 25 lbs. Paris green 1 lb.	Sept 10	14	2	0	1	0	0	0	17	85
24	20	Bran 25 lbs. Paris green 1 lb. amyl acetate ¾ oz.	Sept 10	15	0	1	2	0	0	1	19	95
25	20	Bran 25 lbs. Paris green ¾ lb. amyl acetate ¾ oz.	Sept 10	13	1	1	1	0	1	0	17	85
26	20	Bran 25 lbs. white arsenic 2 lbs. amyl acetate ¾ oz.	Sept 10	12	2	1	2	1	0	1	19	95

Cage No.	Beetles	Food	Date Fed	Number dead -- days								% Dead
				1	2	3	4	5	6	7	Tot.	
27	20	Bran 25 lbs. Anaconda crude white arsenic 2 lbs. amyl acetate ¾ oz	Sept 10	16	1	1	0	0	0	0	18	90
28	20	Bran 25 lbs. 2 lbs. Deloro crude white arsenic. amyl acetate ¾ oz.	Sept 10	2	0	3	1	0	1	0	7	35
29	20	Bran 25 lbs. 2 lbs. Deloro crude white arsenic. amyl acetate ¾ oz.	Sept 10	0	1	1	0	1	0	0	3	15
30	20	Bran 25 lbs. 2 lbs. c. p. Potassium arsenate, amyl acetate ¾ oz.	Sept 10	2	1	3	1	0	0	0	7	35
31	20	Bran 25 lbs. 2 lbs. c. p. sodium arsenate, amyl acetate ¾ oz	Sept 10	1	2	0	2	0	0	1	6	30
32	20	Bran 25 lbs. Paris green 1 lb. amyl acetate ¾ oz.	Sept 10	4	2	6	3	3	2	0	20	100
33	20	Check	Sept 10	1	1	2	0	0	0	0	4	20
34	20	Check	Sept 18	1	1	0	0	0			2	10
35	20	Bran 25 lbs. Paris green 1 lb.	Sept 18	14	0	1	0	1	0	0	16	80
36	20	Bran 25 lbs. Paris green 1 lb. amyl acetate ¾ oz.	Sept 18	19	0	0	0	0	0	0	19	95
37	20	Bran 25 lbs. Paris green 1 lb. amyl acetate	Sept 18	15	1	0	1	0	0	0	17	85
38	20	Bran 25 lbs. USSCO white arsenic 2 lbs. amyl acetate ¾ oz.	Sept 18	3	0	0	0	0	0	0	3	15
39	20	Bran 25 lbs. Anaconda crude white arsenic 2 lbs. amyl acetate ¾ oz	Sept 18	2	1	0	1	2	0	0	6	30
40	20	Bran 25 lbs. Deloro crude white arsenic 2 lbs. amyl acetate ¾ oz	Sept 18	2	1	0	0	0	0	0	3	15
41	20	Bran 25 lbs. Deloro refined white arsenic 2 lbs. amyl acetate ¾ oz.	Sept 18	0	1	1	1	2	0	0	5	25

Cage No.	Bee-Tles	Food	Date Fed	Number dead -- days								% Dead
				1	2	3	4	5	6	7	Tot.	
42	20	Bran 25 lbs. 2 lb. c. p. Potassium arsenate, amyl acetate ¾oz	Sept 18	12	0	2	six escaped. Incomplete					
43	20	Bran 25 lbs. 1 lb. c. p. potassium arsenate amyl acetate ¾ oz.	Sept 18	10	3	1	1	1	four escaped Incomplete			
44	20	Bran 25 lbs. Paris green 1 lb. amyl acetate ¾ oz.	Sept 18	11	1	2	0	0	four escaped Incomplete			
45	20	Check	Sept 18	1	0	0	0	1	0	0	2	10

Eleodes extricata. 1922.

Cage No.	Bee-tles	Food	Date Fed	Number dead -- days								% Dead
				1	2	3	4	5	6	7	Tot.	
1	20	Bran 25 lbs. Paris green 1 lb.	Sept 10	7	4	2	4	1	1	0	19	95
2	17	Bran 25 lbs. Paris green 1 lb. amyl acetate ¾ oz.	Sept 10	9	0	3	3	1	0	0	16	94
3	20	Bran 25 lbs. Paris green 1 lb.	Sept 10	17	0	0	0	3			20	100

Summary of Poison Results 1922.

Poison	No. Trials	Average Percent killed
Paris green 1 lb., amyl acetate ¾ oz. to 25 lbs. of Bran	4	96.25
Paris green ¾ lb., amyl acetate ¾ oz. to 25 lbs. of Bran	3	85.00
Sodium arsenite (c.p.) 1 lb., Bran 25 lbs.	1	60.00
Paris green 1 lb., Bran 25 lbs.	3	73.3
White arsenic 2 lbs., Bran 25 lbs.	9	36.5
Potassium arsenate (c.p.) 2 lbs. Bran 25 lbs.	1	35.00
Paris green ½ lb., Bran 25 lbs	1	30.00
Sodium arsenite (c.p.) Bran 25 lbs.	1	30.00
White arsenic 1 lb., Bran 25 lbs.	4	8.75

Poisoning experiments in 1922 bore out the conclusion of the year previous that Paris green is the most practicable poison that was tested against Eleodes beetles. Results were very much more conclusive

than in 1921 since feeding conditions approximated natural, out-of-door conditions more closely and beetles were not forced to eat food which they might have avoided had they had a choice. White arsenic, while in one instance it killed 95% of the beetles, was on the average so far below Paris green in killing effects that it appears to merit little consideration. Paris green, in a bait to which amyl acetate was added, gave better results when only ¾ pound poison was used than it did when 1 pound of the poison was used when there was no scent added, so it is to be concluded that amyl acetate has sufficient merit to justify its use.

An Experiment in Extensive, Organized Control of Eleodes Beetles, 1922.

Tests in 1921 established the fact that Eleodes beetles could be successfully and economically killed before they had an opportunity to lay eggs. Life history observations indicated that it would be necessary to carry on poisoning work for two successive seasons. Furthermore there was no question that work to be successful must be conducted over considerable area since adults migrate from one field to another so freely. Farmers in the immediate community where the poisoning experiments were conducted were desirous of carrying on a control campaign over a large area in 1922 and a tentative agreement was arrived at between them, the County Agricultural Agent and the Extension Entomologist for pursuing extensive control work as an experimental and extension project. The original district planned comprised about 12,000 acres. An agreement (see appendix) form was drawn up to be signed by all cooperating parties and

the farmers pledged themselves to conduct the work entirely under the supervision of entomologists of the University of Idaho.

When agreements were circulated for signing, other farmers of Rexburg Bench were found to be interested in the movement and they asked to be included in what might be termed the "volunteer pest control district". A meeting was then called in Rexburg early in January, 1921, which was attended by all cooperating parties and at which there were farmer representatives from every community on the Bench. The demand that the original control district be enlarged was so great that it was agreed at that meeting to include all of the Bench that would form itself into a compact district. It was the belief that a large district well organized could be covered as thoroly as a small one and, from the standpoint of eradication of beetles, it was desirable to have the district as large as could be supervised efficiently. A committee of sixteen was formed comprised of representative farmers from each community and officers were elected. Mr. Ed Swendsen, on whose ranch experimental work had been conducted the year previous, was chosen chairman and Mr. Wm. M. Webster, secretary-treasurer.

Copies of the agreement were supplied to each committeeman who volunteered to visit personally each farmer in his allotted territory and to give him an opportunity to become a cooperator. In a short time each farmer on the Bench had been called on and, without a single dissenter, all signed the agreement. The original pest district was thus increased by desire and action of the farmers from 12,000 to 50,000 acres.

The plan agreed on was that the Entomologist, while conducting research work on Eleodes beetles on Rexburg Bench, was to act in an advisory

capacity thruout the season, to furnish directions for carrying on control work and to supervise actual control work when it was undertaken in August. He was to have no part in the organization or in the securing or handling of funds. Organization was to be perfected by the County Agricultural Agent and members of the Committee and all funds collected and dispersed were handled by committeemen and by the treasurer.

After every man in the district had signed the agreement, most of them voluntarily, and the sentiment in favor of conducting the work was apparently unanimous, it was not to be expected that there would be great difficulty in carrying on the control campaign to conclusion, yet such eventually proved to be the case. Men who had asked for an opportunity to sign the agreement in the early spring and who acted as committeemen in their communities procrastinated in paying their share of the assessment or in securing funds from others in their districts until they came dangerously near causing the failure of the entire organization plan. Like many cooperative movements nearly all of the farmers who were to participate became inactive as soon as the organization was formed, each assuming that where "everyone" was in favor of the work there was no doubt it would be successful. According to the agreement, all assessments were to have been paid by June 1st, but they were so late in coming in that the final date for collection was postponed to June 15th, then to July 1st, and finally to July 15th.

In fairness it must be stated that the year was a trying one and that many of the farmers were pressed financially to a point where they had not a dollar of cash. Most of their ranches were mortgaged and with a dry

year upon them the fear of the loss of their property was uppermost in their minds. However, this does not excuse them for having signed the agreement since they were in as hard straits at the time it was circulated and no other conclusion is possible than that many of them had no intention of abiding by the agreement when they affixed their signatures to it. The banks were in sympathy with the work to the extent that they offered to loan money to farmers for control of Eleodes beetles where they often could not secure loans for other purposes.

A factor of great influence in increasing the difficulty of completing the organization plan and raising the funds was the resignation of Mr. D. P. Murray as County Agricultural Agent. He had worked for several years with the farmers of the Bench, knew them all personally and had their confidence. He had been first to call their attention to the losses occasioned by false wireworms and was very enthusiastic in working for the success of eradication. He was succeeded by Mr. John Morrison, who, under the conditions did all that he could to make the project a success but who worked under a handicap by not knowing the problem and the farmers more intimately and by not being personally enthused over making it a success. He persistently kept at work and the final control campaign was due in a large measure to his effort. Mr. Ed Swendsen, the chairman of the committee, gave freely of his time, often at considerable sacrifice to his own business, and to him more than to any other person is due the credit for the final accomplishment. In the writer's experience, he has never met another man who has given of his time and of himself so freely to a purely volunteer undertaking.

When it became apparent that added effort was needed to insure the success of the control district the entomologist spent a great deal of time with the County agricultural agent and with various members of the committee and with farmers in the district explaining the work, the need of cooperation, etc., and in so doing used time that he had originally planned to devote to research work. Many of the farmers were skeptical that the "bug came from the worm", that "stink bugs" laid eggs that hatched into false wireworms, etc, etc., and the only thing to be done was to explain the life economy to them, show them specimens and in general to educate them to the feasibility of control.

It became evident that there were entire localities in the volunteer control district that were procrastinating to the point where they threatened the failure of the entire district. A meeting of all committeemen was called in Rexburg on June 17th at which time it was decided to reduce the size of the district and to include in it only farms in a contiguous, compact area, assessment on which had been paid or was sure of being paid before time for control work. When this action was taken the size of the district was reduced from 50,000 acres to about 18,000. Money which should have been in the treasury by June 1st was much of it outstanding on July 15th. During this time Paris green had steadily advanced in price from 22¢ per pound to 34¢ per pound and as a result the district sustained a loss of $80.00 for poison alone. One of the largest cooperators had difficulty in procuring funds and finally agreed to use his credit for purchasing the bran for the entire district. Again delay followed and it was not until August 15th that all of the

materials were finally purchased and the date for control work to begin was August 21st.

In the face of uncertainty the committee chairman, the County agricultural agent and the entomologist worked persistently to have all preparations completed for the week of control. Material was purchased and a workman hired to construct a mixing machine. This machine was a square box type revolving on an axle running thru the center. (Photograph No. 35) In size it was 60" long and the depth and height were each 50". It was constructed to mix 200 pounds of bran at a single operation. Mixing was done by the contents falling from one corner to another while the mixer was revolving at a speed of about 36 revolutions per minute. A four-horse-power Fairbanks Morse "Z" engine, furnished the motive power and the desired revolving speed was obtained by a system of belts, and pulleys. The cost of material was $20.00 and of labor $30.00. The mixer was very rigidly constructed and painted and its life of service will be many years.

An attempt was made to maintain interest in the work and to keep all cooperators informed of the progress made, dates of meetings, etc., by sending a letter to each of them at times when the need was apparent. (See appendix.) Eleven days before control work was to be undertaken a meeting (Photographs No. 31 and 32) was called to stimulate enthusiasm and to explain phases of the work that might be doubtful to anyone. This meeting was well attended and farmers were very enthusiastic about the whole program. It was then agreed that, owing to the lateness of emergence of beetles, it was advisable to defer poisoning until the week

of August 21st instead of doing it during the week of August 14th as originally planned.

It was rather difficult to decide upon the time when poisoning should be conducted over so large an area since emergence varied so in the different localities. Beetles were not nearly so numerous,in most localities, as during former years and this fact led to uncertainty in establishing the date for control and also contributed in no small degree to the dilatory attitude of many of the farmers. Conditions doubtless were such as to justify abandonment of control work until future years had it not been that successful control can be obtained only by carrying on the work for two successive seasons. The only feasible thing to do, under the circumstances, was to continue the original plans, for it made no difference in the final outcome whether beetles were abundant or few as it was reasonably certain that they would be numerous again on succeeding years and to conduct control one season when there were relatively few beetles was an advantage in favor of the success of the campaign as a whole.

In the formation of plans it had been decided early that all poison bait for the entire district would be prepared at a central mixing plant and that each community or farmer would secure material on a certain day. The central mixing plant was thot advisable because it offered an opportunity for closer supervision of work, led to more simultaneous distribution of poison in the different districts and minimized the danger of poisoning animals or persons. On August 12th a letter (see appendix) of instructions was mailed to each farmer and was followed two days later

by another (appendix) detailing the days on which each man was to obtain his material from the mixer. Each cooperator was also supplied with a copy of the schedule of all other persons in the district in order to facilitate complete community cooperation in obtaining and distributing poison bait.

The first two days of the week selected for carrying on control work were very stormy and few farmers came to the mixing plant which fact was fortunate since the construction of the mixer was such that changes were necessary before it could operate under load. When the load of bran was placed in it, it was found that the belts would slip on the pulleys, also, the engine was not powerful enough to turn it. A Ford car was pressed into service to furnish power, (Photograph No. 33) and one belt was replaced with a drive chain. (Photograph No. 34) With the Ford car running in low gear the mixer revolved at a speed of 24 revolutions per minute and it worked satisfactorily during the rest of the time used.

The distributing device was changed somewhat from the one used in the tests in 1921. Instead of the trough being fastened rigidly to the side of the buggy or wagon it was fastened by means of a large strap hinge to the rear end by means of a bolt that acted as a pivot. With this arrangement the trough could swing sidewise or up and down so that irregularities of furrows or of driving within reasonable limits did not influence spread of poison in the furrows. The lower end of the trough was held off the ground by a narrow iron shoe curved backward in such a way that it did not efface the smooth path made by the dragging log. By this device more uniform application at greater speed was possible for

great care did not need to be exercised in driving at a certain distance from the furrow as had been necessary when the trough was fastened rigidly to the side of the wagon. With this improvement the team was driven so that one horse was on either side of the furrow and, with the shoe serving to guide the trough in the bottom of the furrow, the flexibility of the arrangement was such that the driver's only concern was to keep the furrow between his horses. Mr. J. W. Webster, whose farm comprises 5000 acres, devised a means of plowing the furrow, dragging the log and making poison application all at one operation, thus doubling the amount of work two men could do in a day. He constructed two of these large capacity outfits using in one of them a road grader and in another a two-way plow behind which was fastened a two-wheeled cart for hauling the poison mash. (Photographs No. 36 37, and 38.) Each was drawn by a four-horse team. With such an outfit it is possible to treat from 700 to 1000 acres per day.

The final working capacity of the mixer was two 80-pound sacks of bran which, when moistened made a weight of approximately 300 pounds of mash in each batch. The proportions of ingredients are given in the following table:

Coarse bran.....160 lbs.
Paris green.....6.4 lbs.
Amyl acetate.....4.8 oz.
Water to make a moist, crumbly mash.

The bran and the Paris green were first placed in the box and the mixer was revolved for a minute and a quarter to thoroly mix these two ingredients. The water and the amyl acetate were stirred together and then added to the dry ingredients and the entire mass mixed again for two and

a half minutes. Mash thus prepared was mixed very thoroly and uniformly. While it requited but four minutes for all of the mixing of each batch of mash, considerable time was required for filling, emptying, weighing, etc., and the average working capacity of the machine was about 10 minutes to the batch or 18,000 pounds of mash in a ten-hour day. With the machine working at this capcity, no difficulty was experienced in supplying poisoned mash to the farmers as rapidly as they came for it.

After the first two days farmers came for their material with a regularity that kept the mixer busy constantly until the fifth day when it was possible to mix a quantity in advance. Farmers in the worst infested areas used all of the mash for which they had paid while others in areas where there were few beetles used only a portion of their material and had a balance to their credit for 1923. A surprising fact was that very few of the men, when they came for their material, had read their letters of instruction or, if they had, had remembered much of their contents and it was necessary to instruct most of them in the use of the material before they drove away from the mixing plant.

The right-of-way of the Belt Line Branch of the Oregon Short Line Railroad extends thru nearly the entire area that was comprised in the pest control district. It is nearly all waste land with many rocks scattered along the cuts and grown up to weeds and brush. Beetles migrating from adjacent cultivated fields seek protection and hibernation quarters along the right-of-way and it was necessary to kill them there as well as on the farms. The cooperation of the railroad company was sought and readily obtained. It willingly paid its assessment for all

lands in the right-of-way and issued instructions to the section crew to carry out the distribution at the time and in the manner instructed. On the date set the crew loaded the poison bran on a motor car (photograph No. 39) and with the car going at a low rate of speed the writer broadcasted the poison along the entire length of the railroad property. It was broad casted first on one side and on the return trip the other side was treated. Application was heaviest in the weeds near the road bed, but handfuls of mash were thrown at intervals so they reached nearly the entire width of the right-of-way. Many thousands of dead beetles were in evidence after treatment had time to be effective and the application was proven to be very successful.

Results obtained were exactly in proportion to the degree of care exercised in following instructions. Beetles were killed effectively when poison was scattered where they could procure it, it mattered little whether it was placed in furrows or scattered broadcast. Experience has proven that it is easier to kill Eleodes beetles over a large area than it is to maintain an effective working organization for carrying on the work. It was impossible for entomologists to supervise distribution on each place and when desultory work was done indifferent results were obtained. Killing results over a large area were exactly comparable to those in tests, were it not for the fact that several individuals did the work instead of one. Two examples will suffice: One farmer, sincere in his efforts, with the use of one team and his boy to help, treated his ranch comprising 960 acres. Careful record kept by him showed that a fair day's work for two men and a team is to plow the furrows and scat-

ter the poisoned mash over 320 acres. He spread his mash uniformly and carefully, doing more than instructions called for and using his judgement which was good. He secured highly satisfactory results in killing beetles and his assertion at the close of the campaign was that he would carry on control on his own ranch from year to year whether his neighbors did or not. Another farmer, a renter, secured his allotted portion of mash and later returned some of it with the information that he had taken more than he needed. Examination of his land a few days later disclosed the fact that he had made only shallow creases or scratches in the soil, instead of furrows, had driven at times as far as 100 yards without scattering any poison whatever and then had dumped a pile of from a peck to a bushel in a single spot. He not only failed as a cooperator but ran the risk of poisoning live stock and of causing others to fear the use of poison bran mash.

In addition to the County Agricultural Agent and the Experiment Station Entomologist, D. P. Murray, District Leader of boys' and girls' clubs, and D. B. Whelan, Extension Entomologist gave their entire time during the week to aiding at the mixer and J. M. Raeder, Assistant Station Pathologist helped for a day and a half when the mixer was not working satisfactorily. These men volunteered their services to aid in making a success of the cooperative experiment and the original plan was that they were to devote their time to instruction and supervision and that farmers of the district were to take charge of the mixing. When the time arrived for mixing, all of the work devolved on these men who carried it rather than see the undertaking fail after so much had been done

to insure its success.

Control of Eleodes Beetles by Cultural Practices.

An effort was made thruout the seasons of 1921 and 1922 to gather data that would permit formation of conclusions concerning cultural practices that aid in the control of false wireworms. Out of all observations and interviews with farmers it was impossible to draw conclusions that would lead to the outlining of a definite cultural practice intended to control these insects. One would think that where thoro summer fallowing is followed there would be fewer false wire worms in the soil the following year. Such, however, is not the case as the worst infestations observed in 1922 were on land that had been fallow in 1921 and interviews with farmers elicited the information that this had been a common experience during the former years. Even on the best summer fallow obtainable there is always a certain amount of organic matter in the soil, small green weeds, germinating wheat kernels, weed seeds, chaff, etc., and to deprive larvae or beetles of food by maintaining a fallow would require more than a single season. This proposition is further supported by laboratory findings where larva were known to live for six months with no food to eat. It seems that the best cultural practice intended to give control of Eleodes beetles is the application of good farm practices which include summer fallowing, clean culture, weed eradication, gopher control, roadside cleanups, etc. Good farming on Rexburg Bench is the exception and is rendered difficult for even the best of farmers because of the large sized holdings of the individuals.

A Review of the Poisoning Campaign and Conclusions.

Reviewing the work for the season it appears that the entire plan of organization is one that might be adopted with success, with a few changes, in other communities. All assessments should be high enough to provide sufficient funds for hiring done all work at the mixing plant. It is not advisable to depend on volunteer work when the success of a community undertaking is at stake. The exceptional farmer is he who will have the time or make the time when his services are required, and action should be guided by the rule rather than by the exception. An error made by the writer in the conduct of the experimental organization was in undertaking too much work which should have been cared for entirely by cooperating farmers. Conditions appeared to justify his action but in a successful organization it is the part of wisdom to let the undertaking fail by default if responsibility is not shouldered by those on whom it should properly fall.

A large control undertaking, such as that on Eleodes beetles, appears to justify the enactment of a state law for the formation of pest control districts, provided that the law is drafted in such manner that selection of pest control problems is in the hands of conservative, qualified persons and cannot be used at the whim of a few who have a trivial insect problem. A striking fact, evident in the work of 1922, is that practically every farmer on Rexburg Bench would have signed a petition for the formation of a compulsory pest control district, levying an assessment for the work, when many of them failed completely as volunteer cooperators.

It appears likely that poisoning may be conducted as successfully without furrows as with them by the use of a greater amount of material. All observations indicate that beetles migrate generally from the fields and congregate along fence rows and along waste patches of land, in the fall and in the early spring. At these times of year persistent use of poison bran mash along fences, roadsides, cliffs, around "scab patches" and straw stacks will likely be as successful as treating whole fields and will be undertaken by farmers more generally than when control involves the extra time and labor of plowing furrows.

The year 1922 was a disastrous one for all farmers on dry lands in eastern Idaho and financial conditions the following year were such that no thot was given to continuing the control work which properly should have been repeated again during the fall of 1923. Conditions have steadily grown worse on Rexburg Bench until at the time of this writing many farmers have lost their ranches or are facing impending foreclosures and have no interest in anything save their own financial burdens. It has been impossible, for this reason, to continue the Eleodes control work over a two-year period to insure its entire success, but the field experience and observations and laboratory life cycle studies all indicate that the two-year pontrol project as originally planned is practicable.

Appendix.

Entomology Research Project.

FUND:- - - - - - State appropriation and Agricultural Experiment Station Funds.

PROJECT NO.:

TITLE:- - - - - Bionomics and Control of False Wireworms Injurious to Dry Land Grains.

DATE SUBMITTED: March 8, 1922.

DATE APPROVED BY DIRECTOR:

COOPERATING AGENCIES: Idaho Agricultural Experiment Station, University Extension Division and Farmers of Madison County.

LOCATION: - - - Rexburg Bench, Madison County, Idaho

ESTIMATED TIME: Two years.

PURPOSE: - - - - To determine definitely the following facts of importance which may have a bearing on practical, economical control of false wireworms:

1. Bionomics and life economy.
2. Amount and kinds of injury.
3. Parasitic and predacious enemies.
4. Advantageous cultural practices.
5. Effective methods of poisoning the adult beetles.
6. Demonstration of practical control by organization and cooperation over a definite, large area.

REASON FOR INVESTIGATION: Adults and larvae of various species of

eleodes annually are causing serious loss to grain growers in the dry land areas of the Pacific Northwest. Eleodes beetles are native to the western United States and are increasing rapidly in numbers and area of distribution under cultivated conditions. They are a decided nuisance to residents and a menace to wheat production. Numerous experiments have been conducted on control by poisoning larvae with results that have been negative. A small amount of investigational work done by the University Extension Entomologist in 1921 established facts that lead to the belief that the adults of certain species of false wireworms can be poisoned practically and economically before they can lay eggs.

METHODS: - - - - - Experiments on specific poisons, baits and combinations will be conducted in detail in laboratory and the most promising will be determined for use under field conditions.

Bionomics and economy will be studied in laboratory and extensive observations will be made in the field.

Studies of natural enemies will be made in laboratory and by field observations.

Farmers of a given area will be organized to conduct cooperative control campaign extending over a two-year period. They will pledge themselves to subscribe in

advance the money necessary to finance the poison campaign and will conduct all work strictly in accordance with instructions from Entomologists of the University.

PROBABLE COST: - $1640.00

Memoranda of Agreement

WHEREAS, the average uields of wheat on dry farms of the Rexburg Bench are reduced from eight to ten percent each year, as a direct result of the injury done by the eleodes beetles or false wireworms, and

WHEREAS, the work done by the Extension Division of the University of Idaho thru Claude Wakeland, Field Entomologist in cooperation with Swendsen Brothers in 1921 demonstrated conclusively that this loss can easily be eliminated with very little cost to each individual farmer if a systematic campaign is carried on over a period of two years for the eradication of the eleodes beetle, and

WHEREAS, The Extension Division of the University of Idaho has agreed to furnish expert help in conducting such a campaign, providing all the farmers in a given district will cooperate so as to cover all the land within said district in accordance with the plan as outlined by the representatives of the Extension Division of the University of Idaho in cooperation with the representative farmers of said district.

WE, the undersigned, hereby agree to cooperate with the Extension Division of the University of Idaho and the farmers of our respective districts, and to undertake a vigorous campaign in 1922-23, for the eradication of eleodes beetles. Each of us also agrees to pay 2½¢ per acre for each acre

of land owned for the purchasing of material to be used in the said campaign. Further, each of us agrees to pay his apportionment of this amount to the Treasurer of the Eleodes Beetle Committee on or before June 1st, 1922. We also agree to take up the work at the time and in the manner agreed upon by the representatives of the Extension Division of the University of Idaho and the representative farmers of the several separate districts.

The University of Idaho representatives agree to send a written plan of work to each farmer cooperating prior to the time when control shall be undertaken and to give the necessary instruction and direction, to hold demonstrations and give all aid possible to make the control campaign a success.

COOPERATING FARMERS	COOPERATIVE MEMBERS OF EXTENSION DIVISION
_____	_____ Extension Entomologist
_____	_____ County Agricultural Agent
_____	_____
_____	_____

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Rexburg

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County Agricultural Agent

June 5, 1922

Dear Sir:

The campaign for the control of the False wireworms has been under way since early spring, that is, Mr. Wakeland has been here on the job working diligently on details in connection with the control of this pest and his work has further assured us that there is no question about the control of this pest under the methods prescribed and demonstrated last summer.

The cost of control is so very small in comparison with the amount of good that will be accomplished that we hope every farmer in the territory will be enthusiastic about carrying on the work. Various estimates have been given on the damage done by False Wireworms, to the dry land crops, ranging from 5% to 25%. If the damage according to the lowest estimate should be correct then the amount of waste from one crop alone would be sufficient to pay for the carrying on of this work for several years, since the cost will be about 2½¢ per acre. Or, if the damage is as low as 1% the saving in one year will be more than as much again as the cost of this work. This is really one of the biggest pieces of work that has been attempted in the country and it offers the promise of the finest returns to the farmer considering the small cost to him,

of the control of this pest.

Hoping that you are enthusiastic about seeing this thing through and that you will encourage your committeeman when he comes to you by rendering what assistance you can in boosting for this piece of work, and hoping to lend you any assistance that I may in the accomplishment of this control measure, I beg to remain.

Very truly yours,

(Signed) John A. Morrison

County Agricultural Agent.

JAM:HS

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Rexburg

County Agricultural Agent

June 19, 1922

Dear Sir:

Last Saturday night the committee on eleodes beetles control work met at the Farm Bureau office and the boundaries for the control work were definitely fixed. The area of the district has been limited to the number of acres for which the treasurer of the committee has received the paid-up assessment of 2½¢ per acre. The district includes between 26,000 and 30,000 acres and finances have been raised so that we are sure of completing the project of control on this amount.

Many of the men of the district have expressed a desire to understand more fully the nature of the work and life history of the eleodes beetles, and it is deemed advisable by the members of the eleodes committee, to call a meeting, open to everyone interested in the work, at which all phases of life history of the beetle might be gone into, methods of procedure in this control work explained in detail, and any questions relative to the work, which may arise in the minds of those interested, can be completely discussed for the benefit of all those cooperating.

Your committee, which has been endeavoring to act in the best

interest of all, urges you to be present at a meeting to be held Saturday afternoon, June 24th, 1922 at Rexburg, at 5 P. M. in the court room at the county court house.

If you or your neighbors have any questions in relation to this work, be prepared to ask questions which will bring out proper discussion upon the points about which you are in doubt.

Very truly yours,

(Signed) Ed. Swendsen

Chairman of Eleodes Beetle Com.

(Signed) John A. Morrison

County Agricultural Agent.

JAM:HS

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July 22, 1922

TO MEMBERS OF ELEODES BEETLE CAMPAIGN:

Dear Sir:

The time is rapidly drawing near when we will conduct our work on the control of eleodes beetles or "stink bugs". You no doubt realize that this is a cooperative campaign entered into by us as individuals pledging ourselves to the success of the undertaking as a whole. The control district now comprises 30,000 acres. We have purchased 750 pounds of Paris Green, 6 gallons of amyl acetate, and arrangements have been made for the securing of 19,000 pounds of bran to cover the acreage in the district.

You can readily see from the figures mentioned that we have a "man sized" job on our hands and to put it over means that every one of us has to be an enthusiastic helper. We must have in mind definitely what to do and when to do it and for that reason your committee has deemed it advisable to have a demonstration of control measures and a meeting at which will be explained fully the plan of procedure to be followed by each cooperator. This meeting will be held at Webster's elevator on Rexburg Bench at 9:30 o'clock on THURSDAY MORNING AUGUST THIRD.

At the meeting Mr. Wakeland, Entomologist for the University of Idaho will explain in detail the plan to be followed and each man who is in the district will have a chance to advance ideas that will help toward the final success of the poisoning campaign. We each of us owe it to ourselves as well as to the organization as a whole to be on hand and push for the success of this meeting by which will be measured the success of the control campaign which is to follow during the WEEK OF AUGUST FOURTEENTH.

The meeting and demonstration requires a half day of our time and is worth it. May we depend upon you as a cooperator to be at Webster's elevator, THURSDAY, AUGUST THIRD AT NINE THIRTY A. M.

Very truly yours,

(Signed) Ed Swendsen

Chairman Eleodes Beetle Com.

(Signed) John A. Morrison

County Agricultural Agent.

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August 4, 1922

Dear Sir:

The following is a copy of the minutes with the developments of the meeting which took place at Webster's Elevator, August 3, 1922.

Eleodes beetle control meeting called for the above date at Webster's Elevator. 34 men present. Mr. Wakeland presented the plans of control for the consideration of those present.

Moved by Mr. Webster, seconded by Mr. C. P. Swendsen that we prepare to go ahead with the work as outlined by Mr. Wakeland and begin work about August 21, however the matter was left in the hands of a committee composed of Mr. Claude Wakeland, Mr. Ed Swendsen, and Mr. John A. Morrison, to fit the date to the developments of the conditions of the beetles so as to get the best results. This committee to confer with a representative from each one of the districts on the Bench in order to fix dates which are most satisfactory to all.

Mr. Ed. Swendsen gave plans for distributing of poison and displayed a trough thru which to distribute the poison as a demonstration for those who were present. Warned men to be careful about leaving poison in wagons or buggies when they drive in the yard as bad result would most likely follow.

It was decided that the various districts be given a particular day on which to receive poison from the mixing plant, and those who had a large tract and would necessarily require more than one day be permitted to come every day for what supply they would like and that the district be notified from the farm bureau office the dates on which they were to call for poison.

Mr. Webster gave a very good talk on the effectiveness of this poison in killing "stink bugs", or eleodes beetles, as demonstrated on Mr. Swendsen's place last year. This talk was very encouraging to the men present. He also spoke on growing of wheat. Gave some good instructions and urged that the farmers cooperate in controlling the weeds along fence rows. He suggested that it would be a blessing if all fence rows would be removed.

The question arose as to the source of funds for hiring a man to help with the mixer. Various suggestions were made. Mr. Webster volunteered to furnish a man and board him for the week to operate the mixing plant, providing the farmers who were present would take their mowing machines and cut down the weeds along their fence rows. This was put in form of a motion and unanimously accepted by those present.

You will be kept fully informed at least a week in advance of the final date set for conducting the work.

Very truly yours,

(Signed) John A. Morrison

County Agricultural Agent.

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County Agricultural Agent

August 12, 1922

TO THE FARMERS IN ELEODES CONTROL DISTRICT:

Dear Sir:

After interviewing all of the committeemen in the various communities and considering the matter with Mr. Swendsen, the chairman, and with Mr. Wakeland, it appears advisable to conduct the poisoning campaign for the control of eleodes beetles during the week of August 21 to 26. On Monday, August, 14, another and final letter will be mailed to you, and in it will be named the day when you and others in your district will come to the central mixing plant to obtain your share of the poison bran mash.

Enclosed are instructions for distributing the poison mash which Mr. Wakeland has prepared in accordance with his agreement with you last winter. Please read them over carefully. During the week preceding the control work it will be possible for you to plow all furfows and do all preliminary work so that poison may be distributed rapidly and while fresh. With attention to preliminary work but little time will be required for the actual poisoning.

A number of men have already shown their good will and mowed the weeds along their roadsides in acceptance of Mr. Webster's offer

made at the meeting last week. This is good work and if all will have their part done before August 21, it will help decidedly in our poisoning campaign as well as in limiting weed dispersal.

Very truly yours

(Signed) John A. Morrison

County Agricultural Agent

JAM:HS

DIRECTIONS FOR POISONING ELEODES BEETLES.

Compiled by Claude Wakeland
Entomologist Idaho Experiment Station.

CAUTION: The mash used to kill beetles contains Paris Green. It will kill any animal that eats it in sufficient quantities. Before mash is distributed in the field keep it carefully covered and away from where there is any possibility of stock obtaining it. When distributed as it should be in the field there is absolutely no danger to livestock, but poultry can obtain sufficient to kill them.

HOW TO SPREAD POISON MASH: Use a trough attached to back end of a buggy or wagon and sloping to the ground. Lower end of trough will be supported by a slender iron shoe so that end of trough will not drag on ground and stir up dust. Upper end of trough should extend over wagon box and into wagon so that mash can be fed into the trough easily. Upper end of trough should be flared out to form hopper into which bran may be easily fed. Trough should be fastened to buggy box with a strong strap hinge so that it will atuomatically raise and lower with changes of ground surface.

AMOUNT OF MASH TO USE: The tendency with everyone is to use more mash than necessary. Feed it lightly into trough being careful to break up lumps in the hands so that only small flakes slide down thru trough. Fifty pounds of wet mash is sufficient to treat three miles of furrow. Remember: Use mash sparingly and be careful to distribute it evenly. The beetles will actually eat only a portion of it even when a small amount is used. To use more would be only to waste it.

HOW TO PLOW THE FURROWS: Use narrow bottom plow if possible with rolling coulter to make a straight land side. Throw the furrow away from the fence, waste land, strawstack etc., so that a straight land side is next to fence etc. Have bottom of furrow as flat as possible and drag small, smooth log behind plow to make a smooth trail for beetles to travel in. They like a smooth path and best results will be obtained by making it for them and placing the poison in it.

HOW TO POISON SUMMER FALLOW LAND: Plow a furrow around entire outside of field and furrows one way across the field every three hundred yards apart. Drive the team so that one horse is on each side of the furrow and shoe on trough runs in bottom of furrow. Follow direction on "HOW TO SPREAD POISON MASH" and "AMOUNT OF POISON TO USE."

HOW TO POISON STUBBLE LAND: Where grain has been cut follow same directions as for SUMMER FALLOW LAND.

HOW TO POISON STANDING GRAIN LAND: The furrow method is much to be preferred since better results will be obtained. Loss from furrows every 300 yards apart will be negligible and they do not interfere with harvesting. Many will use furrow method in their standing grain,

but some will not care to. Where furrows are not used the poison mash should be distributed thru the trough by driving thru the field at distances of 300 yards apart. Back swaths will be cut around all grain fields however, and furrows should be plowed around each field and poison distributed.

HOW TO POISON WASTE LAND OR "SCRUB LAND PATCHES": If patches are small plow around outside and spread poison in furrows also drive thru center of patch and spread one streak of poison. If patches are large, follow same procedure but scatter streaks of poison about every 100 yards.

HOW TO POISON ROCKY CLIFFS: Scatter a streak of poison mash at top and at base of cliffs. If trough cannot be used, broadcast a narrow streak lightly by hand.

HOW TO POISON STRAW STACKS: Plow furrow around outside and treat it. Also broadcast a small amount of poison where beetles congregate thickest. If you have not threshed, save some of the poison bran and after you have threshed moisten and spread it.

FENCE ROWS : Application along fence rows must be very thorough. Use the furrow on the side toward the field and spread on ground thru trough on side toward fence. Concentrate efforts on fence rows and waste land where most of the beetles congregate and hibernate, but do not slight furrows or streaks in fields.

REMEMBER: This is cooperative work, but the success of the enterprise depends upon individual effort. Do your task thoroughly and conscienciously, not only for your own sake, but for the good of the entire district.

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August 14, 1922

Dear Sir:

The days allotted you for coming to the poison mixing station at J. W. Webster's elevator are August _____. The district has been divided, and allotments made so that each man having less than 800 acres to treat is allowed two days in which to obtain his poison mash. Those with more than 800 acres are granted a longer time. Please obtain as much of your poison as you can on the first of the days allotted to you and avoid congestion at the mixer. Come for your mash on the days that you should. Fresh mash will be ready for loading at the mixer at 7:30 each morning and may be obtained until 5:30 in the evening.

After the bran is wet it swells and the sacks in which it comes will not hold it. Bring extra sacks with you, at least one for every 200 pounds of bran you expect to haul away.

For each acre of ground on which you have paid assessment you will obtain one pound of mash from the mixer. On this basis communities or individuals can estimate the number of teams to send. Each community will need to make its own arrangements about sending teams if it plans on hauling cooperatively.

Mr. Wakeland, Entomologist for the State Experiment Station, Mr. Whelan, Entomologist for the University Extension Division, Mr.

Murray, and your county agent will give their entire time during the week of August 21 to 26 in helping with the work. Call on them for any suggestions or help needed.

The O. S. L. has paid for making a heavy application of poison bait on both sides of the right-of-way thru the entire district and you may rest assured it is doing its share.

Be careful not to scatter poison where poultry can obtain it. Beetles may effectively and safely be poisoned around buildings by placing bait under boards, old doors, or under the floor of buildings where poultry cannot gain access.

The following is a list of the names of men in the Eleodes control district and the dates they are to call for their poison bran mash.

AUGUST 21 and 22

William Freeman	Geo. Brindley	Geo. Weeks
Homer Peterson	Jr R. Smith	Chas. Cook
Otto Beck	Alex. Erkison	R. J. Comstock
Wm. Webster	Theo Simmons	D. A. Spaulding
James Woodmasse Estate	Peter R. Ricks	Willard Johnson
Josiah Hunsaucher	°Fred Smith	Herbert Freeman
Alma Johnson	Stanley Arnold	Carl Frandison

°Secure poison for Homer Woodard.

AUGUST 23 and 24

John Grover	Robert Leatham	Enoch Grover
Seth Grover	James Archibald	Searl Weeks
Albert Weeks	Lewis Byrne	Earl Smith
Orson Soule	Joseph Gerodone	John W. Jackson
Kenneth Bucklin	R. L. Bybee	Isaac Smith

AUGUST 21-22-23-24

Elmo Webster	N. M. Jensen	Swendsen Bros.

AUGUST 25 and 26

H. C. Blunck
John Clements
John L. Jones
L. G. Howells
Harvey Summers
W. W. Wasdon
Wm. Huskinson
Will Grover
Vern Grower
H. A. Munns
John Pearson
Martin L. Nave
George H. Huskinson
John Huskinson
Chas. Leatham
Geo. Gunnel
A. M. Carter
J. B. Hawkes
Henry Parkinson

AUGUST 23-24-25-26

James Byrne
Dan Shields
Will Rainey
Fred Smith Jr.
Fred Windsor
Kenneth Webster
Geo. Dille
J. S. Webster
Homer Reed

AUGUST 21 - 26

W. J. Webster

August 24

O. S. L. Railroad Company.

Yours truly

(Signed) John A. Morrison

County Agricultural Agent.

Eleodes Beetle Control Workers
August 21, 1922

Name	Amt. Paid	Acreage	Bal Due
Wm. Freeman	$ 6.00	240	$
Geo. Brindley	8.00	320	
Homer Peterson	10.00	400	
Otto Beck	4.00	160	
Alex Erkison		40	1.00
H. J. Comstock		320	
Wm. Webster	12.00	480	
Theo. Simmons	4.00	160	
Geo. Weeks	2.00	80	
J. R. Smith	4.50	180	
Chas Cook	6.00	240	

Name	Amt. Paid	Acreage	Bal. Due
D. A. Spaulding	$5.00	240	
Peter P. Ricks	4.00	160	
Willard Johnson	4.00	160	
Josiah Hunsacher	2.00	80	
Fred Smith (Homer Woodard)			4.00
Herbert Freeman	3.00	120	
Alma Johnson		80	2.00
Stanley Arnold		160	4.00
Carl Frandison		160	4.00
	August 23 and 24		
John Grover	6.00	240	
Will Grover	2.00	80	
Enoch Grover	2.50	160	
Seth Grover		80	2.00
Vern Grover	2.00	80	
Searl Weeks	2.00	80	
Albert Weeks	2.00	160	
Lewis Byrne		160	4.00
Earl Smith	6.00	240	
Kenneth Bucklin	2.00	80	
Joseph Gerodone		80	2.00
John W. Jackson	4.00	160	
Orson Soule	2.00	80	
W. L. Bybee		200	5.00
Isaac Smith	6.90	480	
Frank Kirkpatrick	.75	30	
	August 25 and 26		
H. C. Blunck	8.00	320	
Robert Leatham	8.00	320	
Chas. Leatham	12.00	480	
John Clements	5.25	210	
James Archibald	4.00	160	
Geo. Gunnel	8.00	320	
John L. Jones	4.00	160	
H. A. Munns	6.00	243	
A. M. Carter	4.00	160	
L. G. Howells	10.00	400	
John Pearson		500	12.50
J. B. Hawkes	2.50	100	
Harvey Summers	10.00	400	
Martin L. Nave	1.00	40	
W. M. Wasden	12.50	500	
Geo A. Huskinson	4.00	160	
Wm. Huskinson	3.75	150	

August 21-22-23-24

Name	Amount Paid	Acreage	Bal.Due
Elmo Webster	25.00	1000	
N. M. Jensen	16.00	960	
Swendsen Bros.	24.00	960	

August 23-24-25-26

James Byrne	20.00	800	
Fred Smith Jr.	18.00	700	
Geo. Dille	22.00	840	
Dan Shields	20.00	880	
Fred Winsor	21.00	880	
J. S. Webster	40.00	1600	
Will Rainey	27.50	1100	
Kenneth Webster	25.00	1000	
Homer Reed	20.00	800	

August 21-26

J. W. Webster	125.00	5000	

August 24

O. S. L. Railroad Co.	20.48	1000	

Plate No. 1. Map of Idaho showing the location of Rexburg where most of the studies described in this thesis were conducted.

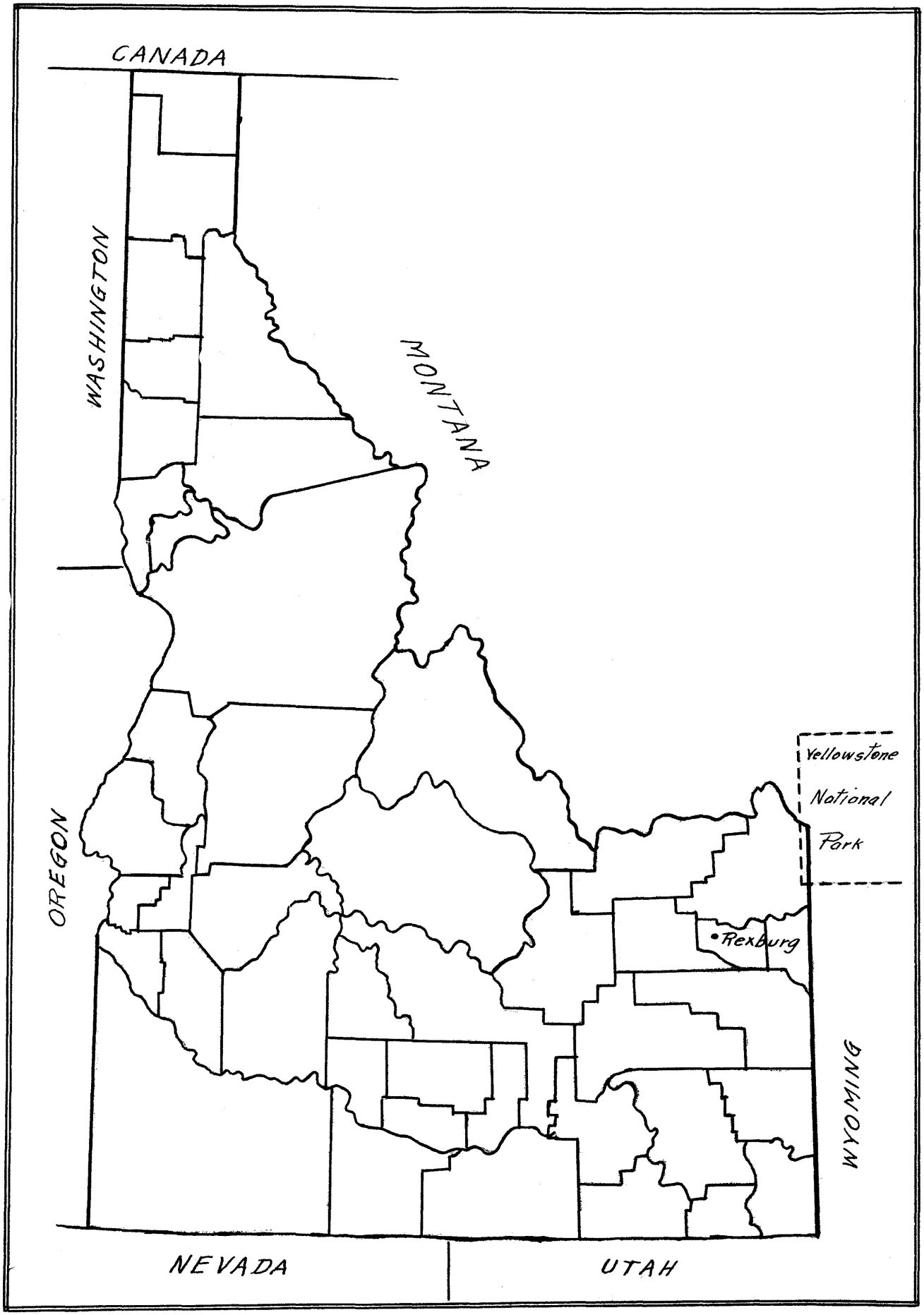
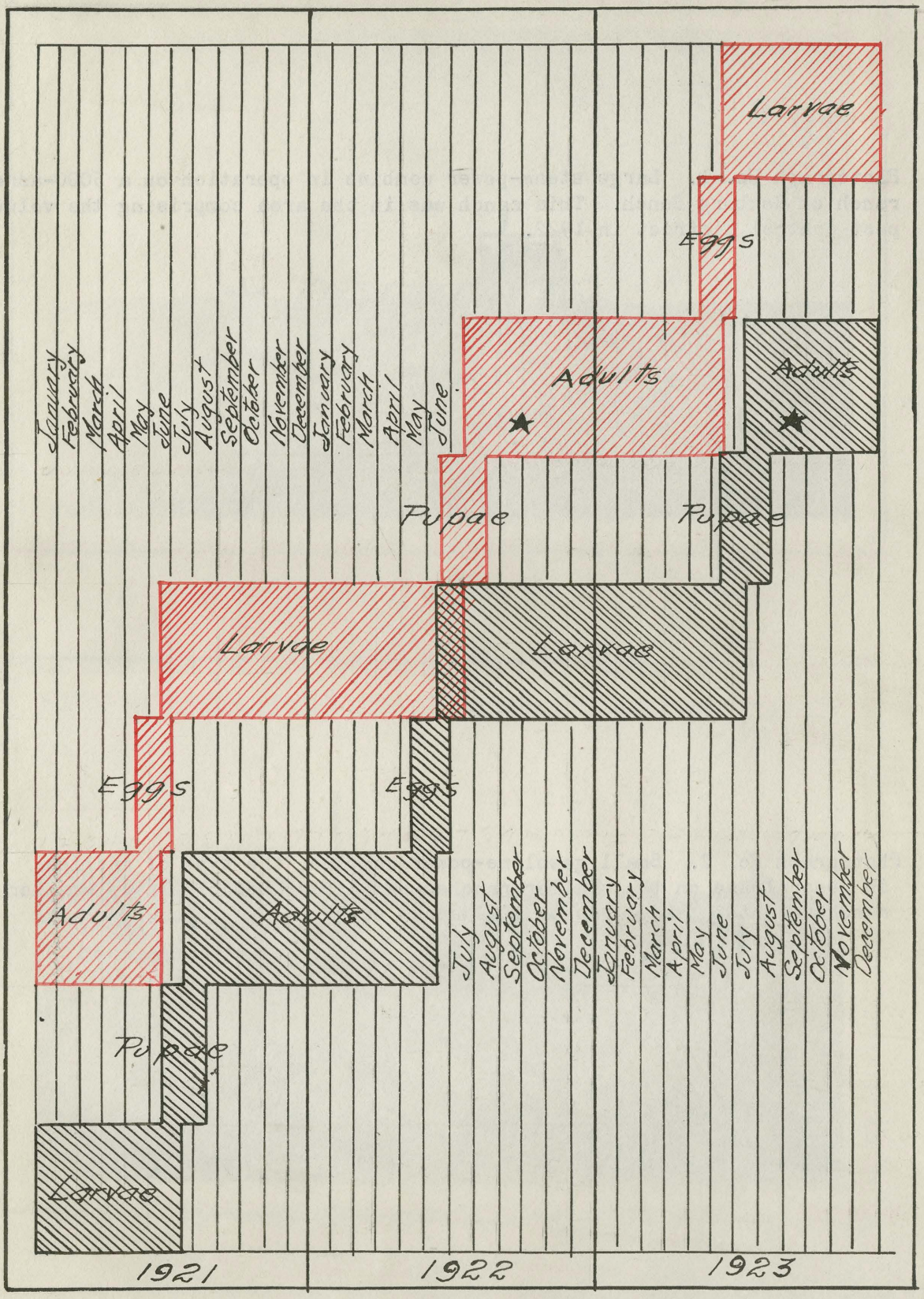

CANADA
WASHINGTON
MONTANA
OREGON
Yellowstone
National
Park
Rexburg
WYOMING
NEVADA
UTAH

Plate No. 2. Graphic chart depicting the life history and control of Elodes hispilabris. It will be noticed that there are two distinct generation lines in the field during any single season. For that reason, to obtain completely satisfactory control, it is necessary to conduct poisoning two years in succession over the same area. The proper time for the application of poison is indicated by a star.


Larvae
Eggs
Adults
Adults
Pupae
Pupae
Larvae
Larvae
Eggs
Eggs
Adults
Adults
Pupae
Larvae
January
February
March
April
May
June
July
August
September
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November
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January
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March
April
May
June
July
August
September
October
November
December
1921
1922
1923

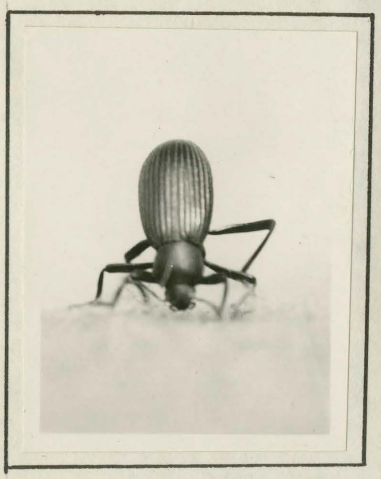
Photograph No. 1. Large steam-power combine in operation on a 5000-acre wheat ranch on Rexburg Bench. This ranch was in the area comprising the volunteer pest control district in 1922.

Photograph No. 2. Small gasoline-power combine, the type of machine in general use on the smaller ranches on Rexburg Bench. These smaller ranches contain 320 acres to 1000 acres each.

Photograph No. 3. A Threshing outfit in operation on Rexburg Bench. Straw stacks and piles of grain sacks as shown in this photograph afford abundant food and protection for Eleodes beetles in the fall and are a favorite place in which they congregate in countless numbers. The preliminary field poisoning experiments described in this thesis were conducted in the spot occupied in this photograph by the wagons and machinery.

Photograph No. 4. Six species of Eleodes beetles collected on Rexburg Bench. Reading from left to right they are in order: Eleodes sulcipennis Mann., Eleodes hispilabris var. immunda Blais., Eleodes nigrina Lec., Eleodes tenebrosa Horn., Eleodes extricata var. cognata Hald., and Eleodes pimelicides Mann.

Photographs No. 5, 6, and 7. *Eleodes hispilabris* adults in characteristic poses.



Photographs No. 8 and 9; Adults of Eleodes hispilabris congregated in and around loose chaff and straw at the base of a straw stack. The areas comprised in these photographs were nearly black with a seething countless number of adults before sunrise and at dusk, but when there was sufficient light to secure photographs most of them had already sought cover.

Photograph No. 10. A waste, rocky area grown up in weeds and grass and known locally as a scab patch. These patches are strewn with flat pieces of lava rock under which beetles seek protection in unfavorable weather and during the dormant season.

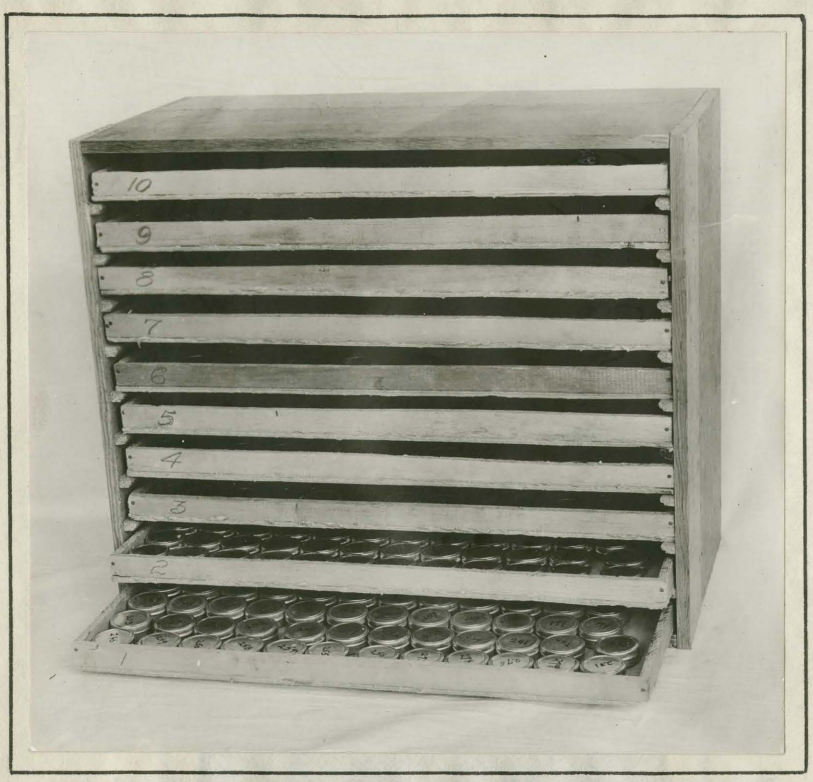
Photograph No. 11. A basalt ledge having a southwest exposure. Under flat rocks at the base of this ledge the first beetles coming out from hibernation in the spring of 1922 were observed.

Photograph No. 12. Beetles crowded together in the entrance of ground squirrel burrows. This photograph was taken along the fence row shown in Photograph No. 13. Beetles shown here were the first ones observed in cultivated areas during the spring of 1922. During the first day observed, adults huddled together in these holes all day long but after a day or so began to disperse along the brushy fence row.

Photograph No. 13. A brushy fence row where beetles were extremely numerous during the early spring of 1922. Scattered along the entire fence row were numerous ground squirrel burrow entrances. As the season advanced and grain fields became green the beetles worked out along the fence row and fed during favorable periods of weather but sought protection during the daytime in the weeds. They were observed freely feeding on the green grain in the early spring and an injured area is shown in the photograph. With the advent of warmer weather beetles generally migrated out away from the fence rows and scattered over the cultivated fields.

Photograph No. 14. Cabinet in which rearing cages were kept in chronological order during life history studies of Eleodes beetles. The tin salve boxes used as rearing cages are shown arranged in a partly open drawer.

Photograph No. 15. Out of door cages in which poisoning tests were conducted. The tin strips shown in the photograph were fastened on the upper edge of wooden cages of the same width and length but which extended into the ground one foot. Larvae were kept in the soil successfully without digging below the bottoms of the wooden cages and adults were unable to crawl out over the smooth tin tops. No covers were needed so that natural conditions were very closely approximated.


10
9
8
7
6
5
4
3
2
1

Photograph No. 16. Eggs of Eleodes sulcipennis. The soil particles that usually adhere to the eggs were removed with a camels hair brush before this photograph was taken. X 1.75

Photograph No. 17. Eggs of Eleodes hispilabris. Eggs taken from the soil where they were deposited and with the soil particles adhering. X 1.75.

Photograph No. 18. First instar larva of Eleodes hispilabris. X 1.75..

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Photograph No. 19. Second instar larva of Eleodes hispilabris. X 1.75.

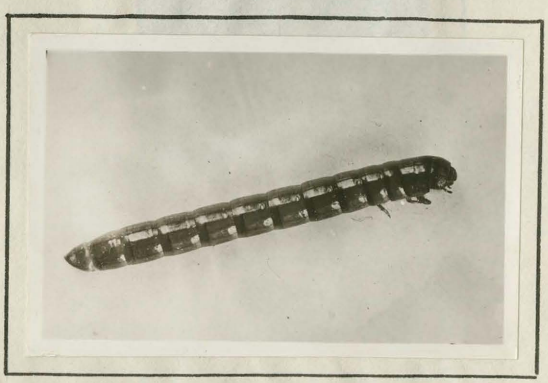
Photograph No. 20. Third instar larva of Eleodes hispilabris. X 1.75.

Photograph No. 20. A. Photograph of a larva of Eleodes hispilabris that has just molted and of the freshly cast skin. This larva was observed when the skin had just split over the head and thorax. Before the camera could be placed on the laboratory stand and the larva placed in position for photographing the process of shedding the skin had been entirely completed. X 1.75.

Photograph No. 21. Second instar of larva of *Eleodes extricata*. X 1.75.

Photograph No. 22. Third instar of larva of *Eleodes extricata*. X 1.75.

Photograph No. 23. Mature larva of *Eleodes hispilabris*. X 1.75.

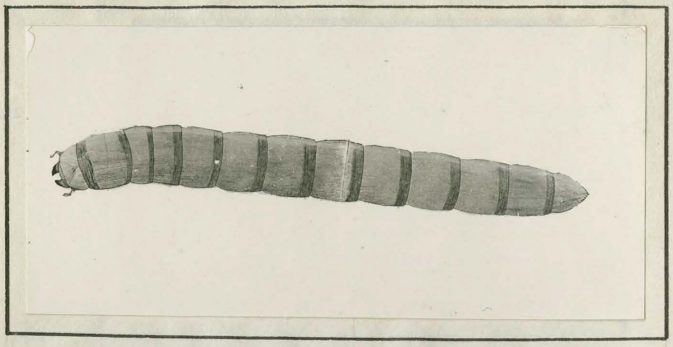


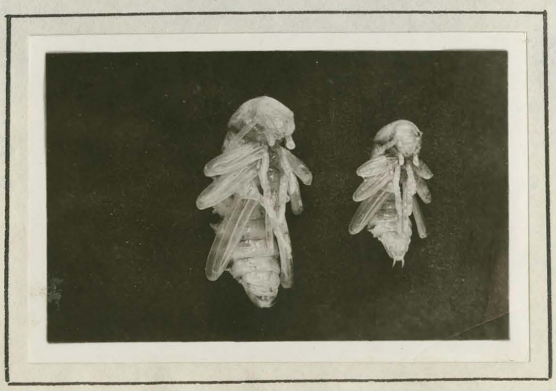
Photographs No. 24, 25, and 26. Dursal lateral and ventral views of larvae of Eleodes hispilabris. X 1.75.

Photograph No. 27. Photograph of a camera lucida drawing of larva of Eleodes hispilabris.

Photograph No. 28. Pupa of Eleodes hispilabris. X 1.75.

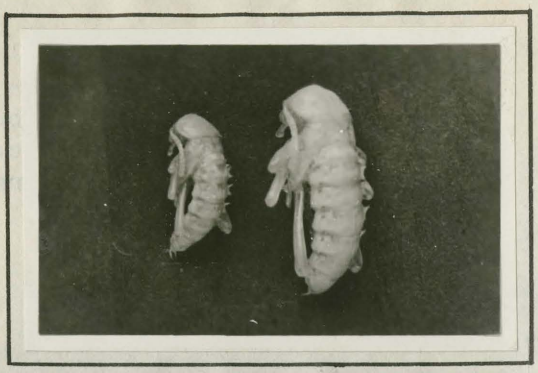
Photograph No. 29. Pupa of Eleodes hispilabris (large) and pupa of Eleodes extricata (small) Ventral views. X 1.75.





Photograph No. 30. Pupa of Eleodes hispilabris (large) and pupa of Eleodes extricata (small) Dorsal view. X 1.75.

Photograph No. 31. A meeting of cooperating farmers in the volunteer control district discussing plans for conducting the control campaign.

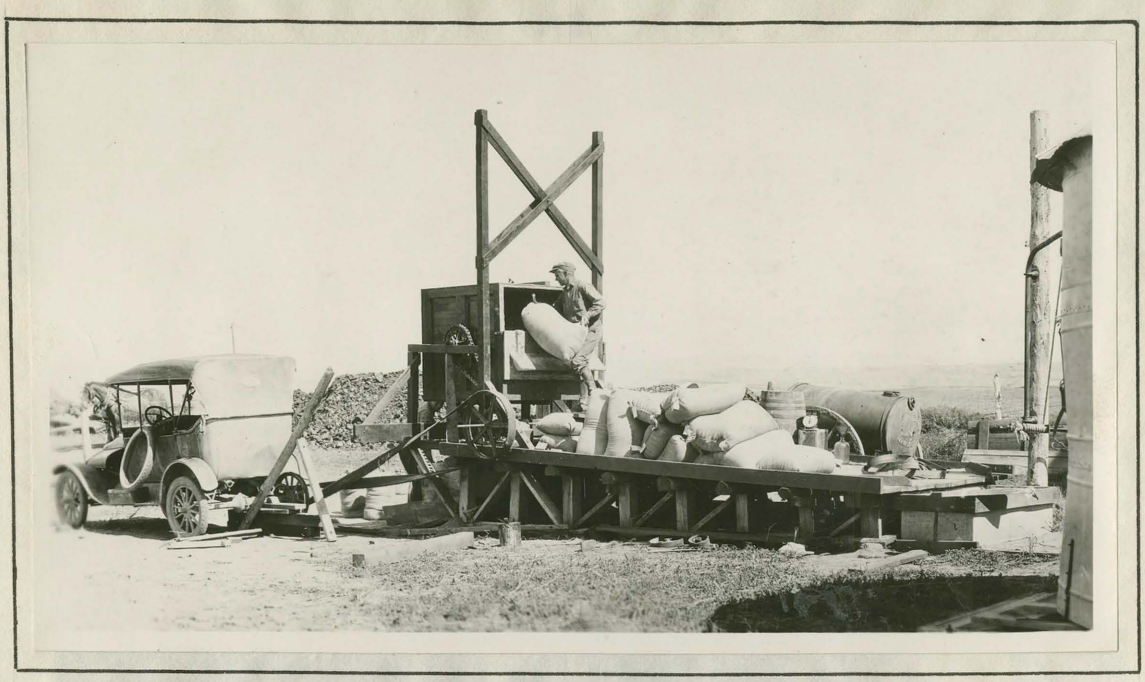



Fairbanks
Scales

Photograph No. 32. Farmers in attendance at a meeting for formulating final plans for carrying out control campaign against false wireworms.

Photograph No. 33. Device used in applying poisoned bran mash in plow furrows. This device was used in preliminary experiments in 1921, but in the work of 1922 it was found that a more satisfactory method and one that allowed greater dispatch in application was to attach the distributor trough to the rear end of the wagon arranged on a hinge and a pivot so that it could move sidewise or up and down to accommodate itself to irregularities in the furrow and the team was driven so that the furrow was underneath the wagon.

Photographs No. 34 and 34 A Two views of the poison bait mixer used in preparing the poison bran mash for the control campaign .



Photograph No. 35. The mixing machine used in preparing poison bran mash for control of Eleodes beetles.


Fairbanks
Scales

Photograph No. 36.and 37. Two views of an effieicnt distributing device used in the poisoning campaign. With this arrangement, the furrow was plowed, the log dragged to prepare a smooth path on the bottom of the furrow and the poisoned bait distributed at one operation.

36

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Photograph No. 38. An assembled device with which the furrow was plowed, the log dragged to make a smooth path in the bottom of the furrow and the poison bait scattered in the furrow at one oberation.

Photograph No. 39. The Oregon Short Line Railroad Company was an active cooperator in the control campaign conducted against Eleodes beetles on Rexurg I Bench in 1922. Employees of the railroad with poisoned bait loaded on a motor car ready for distribution along the right-of-way.