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A Study of a Legume Weevil, Sitona scissifrons say, in South Dakota

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A STUDY OF A LEGUME WEEVIL, SITONA SCISSIFRONS SAY, IN SOUTH DAKOTA

BY

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A STUDY OF A LEGUME WEEVIL, *SITONA SCISSIFRONS* SAY, IN SOUTH DAKOTA

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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INTRODUCTION

No previous literature was found pertaining to the economic damage to crops by the weevil, Sitona scissifrons Say. Dr. Robert J. Walstrom of the Entomology-Zoology Department at South Dakota State College found heavy damage on roots of alfalfa in artificially infested cages which was believed to have been caused by this weevil. Field observations had revealed that many alfalfa as well as clover roots lacked nitrogen nodules. The S. scissifrons species alone or in combination with other root feeding insects was suspected of affecting the productivity and longevity of alfalfa plants in South Dakota.

Considerable leaf and bud feeding by adult forms of S. scissifrons had been noted on caged alfalfa plants in other South Dakota tests which might have reduced yields if heavy infestations had been present.

These indications of economic damage possibly caused by S. scissifrons to alfalfa under South Dakota conditions led the author to select the study of this insect as a thesis problem.

REVIEW OF LITERATURE

The genus Sitona is known for its root-feeding larvae on legumes in the United States and Europe as reported by Wildermuth (1910), Prescott and Reeher (1961). There are a number of species within the genus but all have quite similar habits.

This genus is characterized by Blatchley and Leng (1916) as having short, stout mandibles, the outer sides of which are convex, roughly punctured, and broadly notched at their tips. The beak is short, broad, flat, and emarginate at the tip. The antennal grooves are deep, short and curve abruptly downwards just behind the antennae. The antennae are seven jointed with the first and second segments short and thick with the third to seventh segments even shorter, subequal with a club elongate end. The eyes are small and rounded. The inner wings are present. The front coxae are contiguous and prominent while the hind coxae are widely separated, reaching the side margin. The claws are slender, divergent, and appendiculate.

Blatchley and Leng (1916) reported that Sitona scissifrons Say and S. indifferens (1831) were treated by Allard (1864) as varieties of the species, S. lineellus Bonsd. (1785). LeConte, as reported by Blatchley and Leng (1916), referred to this species from Kansas specimens which were later determined to be species called S. hispidula.

Although no specific literature is available on the species, Sitona scissifrons Say, the species is mentioned in a few other papers. The genus Sitona includes a large number of species, many of which are

known to be more or less injurious to leguminous crops. A study of other species within the genus Sitona gives a comparison to the weevil S. scissifrons Say in this study.

Prescott and Reeher (1961) reported that the pea leaf weevil, Sitona lineata (L.), had been especially destructive at times to peas, beans and clover in England as well as on the North American continent. The pea leaf weevil was found to be restricted in North America to the humid coastal area west of the Cascade Mountain Range in Oregon and Washington and to the western end of the Fraser River Valley in British Columbia. The ecological barriers, such as the timber covered mountain ranges, tended to confine the natural spread of the weevil thus limiting it to the leguminous crops of southwestern British Columbia, western Washington and Oregon. The larvae of S. lineata (L.) feed on the root nodules causing severe damage below the soil surface. The adults feed on the foliage also causing extensive damage.

Wildermuth (1910) reported that the flavescent clover curculio, usually called the clover curculio, Sitona flavescens Marsh, was very destructive to red and white clover. Sitona flavescens Marsh was commonly found in large numbers and had caused severe damage to these crops. This species was reported to be widespread in the United States and thought to be found in most regions where its host plants were grown. The larvae of S. flavescens were found to feed on the roots and the adults to feed on the foliage.

The clover root curculio, Sitona hispidula (Fabr.), has been found to attack red clover, sweetclover, alsike clover and alfalfa. This species was introduced into this continent from Europe. The first specimen was collected by LeConte at Long Branch, New Jersey, in 1876 about the roots of grass growing in sand dunes. By 1906, the species had spread as far west as Indiana. This species is widespread throughout the United States and may be found in most areas where its host plants are grown. Wildermuth (1910) reported that the clover root curculio, Sitona hispidula (Fabr.), overwintered in the adult form, hiding itself under rubbish and leaves close to the ground. He found that the adults came out of hibernation on the first warm days of spring and the females soon began oviposition. In a red clover field in the District of Columbia, he found nearly fully developed larvae on May 4. He accredited these to early egg laying in the later part of March. Bigger (1930) reported that as many as 43 clover root curculio larvae per square foot of soil were found in infested areas of Illinois. There is general agreement among investigators that the clover root curculio passes the winter in the egg, adult and larval stages and that the predominant condition is to pass the winter as young larvae as reported by Bigger (1930), Turner (1957), and Wildermuth (1910). Underhill, Turner and Henderson (1955) report that this weevil is one of the most common and injurious pests of alfalfa in Virginia.

The sweetclover weevil, Sitona cylindricollis Fabr., is probably best known in the midwestern states. Most of the American work deals with the damage and control of this weevil. Herron (1952) could not find a resistant variety of sweetclover. Wilson and Barber (1954) found the soil fertility to be a very important factor to insure vigorous plants which can better sustain the injury of the sweetclover weevil. Ellingboe, Kernkamp, and Haws (1957) found that the fungus, Beauvaria bassiana (Bals.) Vuill., infested and killed larvae of the sweetclover weevil and that the fungus was capable of infesting and killing the adult weevils in the field as well as in the laboratory. Connin, Gorz and Gardner (1958) state that there is general agreement among investigators that a new planting can withstand fairly large numbers of weevils if it can be grown beyond the seedling stage but that the exception to this generality occurs in areas such as the Red River Valley of North Dakota, Minnesota, and Canada. In this area they reported that many first year plants, 18 to 24 inches in height, were completely defoliated and killed by the feeding of adults that had migrated from adjacent second-year stands plowed down for green manure.

Farrar and Anderson (1953) reported that Sitona explicita Say was found to be a serious pest in 1950 for the first time on blue lupine, an important soil building crop in the southern counties of South Carolina. From a study made on this pest, larvae grew from 0.06 inch in length to mature larvae, 0.33 of an inch in length in February

and March. In April and May pupae were observed in earthen cells at depths of 2 to 4 inches below the soil surface. These workers were unsuccessful in their attempts to rear larvae and pupae collected in the field through to the adult stage. Repeated observations failed to locate the adults in the field until mid-July. From this time until late September adults were collected in quantities from wild cherry and wild plums. The complete life history of this species had not been fully determined at the time their work was published in 1953. Severely injured lupine plants typically lack nodules and root hairs.

PROCEDURE

The study of the species, Sitona scissifrons Say, required the development of a key to make positive identification of the species. A study of the other South Dakota species of the genus Sitona was undertaken. Previously identified specimens from reliable sources were included in this study.

Studies to determine the range of S. scissifrons were incorporated in the regular field work of the author acting in his capacity as State Survey Entomologist in South Dakota. Previous survey information was obtained from the IBM record files available in South Dakota for such studies. In addition, a new survey with a minimum of four stops per county was conducted throughout the state for the presence of this weevil.

A host plant survey in South Dakota included inspections of all types of economic crops as well as other likely plants. This phase of the work was concentrated in areas where S. scissifrons was found to be present.

Damage to the plants was studied in the field and in the laboratory. Field observations included observations of the weevils feeding on the foliage of the plants. Root damage by the weevil was checked in infested fields by digging and studying the root systems of the host plants. The laboratory studies included observations of foliage damage on infested alfalfa plants confined within screen cages.

The root damage was studied by washing the alfalfa roots obtained from cages which had been infested with S. scissifrons. Glass walled, soil-viewing chambers in which the alfalfa roots could be exposed to view were used in this study.

The life history study was conducted in both the field and the laboratory. Field studies were used as much as possible.

Mating adults were collected and placed in oviposition chambers for egg studies. The collected eggs were placed in and on the soil of potted alfalfa plants in an attempt to produce the larval and pupal stages. A Berlese type funnel system was used to separate overwintering adults from collections of surface soil and residue obtained from alfalfa fields.

TAXONOMY OF *SITONA* SPECIES IN SOUTH DAKOTA

The taxonomy of the *Sitona scissifrons* Say is still questionable to some degree. Wilfred S. Craig, Iowa State Entomologist, states there is some doubt as to the authenticity of *S. scissifrons* and *S. tibialis* (Say) in Iowa. Specimens from Lyon County, Iowa, were found to be *S. scissifrons*. Marlin S. Conrad, Entomologist, Plant Industry Division, State of Wisconsin, states that Wisconsin has recorded *S. tibialis* but has no record of *S. scissifrons*. However, he feels that *S. tibialis* may be *S. scissifrons*. No specimens were received from Wisconsin for study.

Blatchley and Leng, 1916, state that *S. lineellus* Bonsd. is a species of which *S. scissifrons* Say and *S. indifferens* Say are treated by Allard (1864) as varieties.

Vasco M. Tanner, Department of Zoology and Entomology, Brigham Young University, Provo, Utah, places *S. scissifrons* as a variety under the species *S. lineellus*.

In South Dakota *Sitona hispidula* (Fabr.), *S. cylindricollis* (Fabr.) and *S. scissifrons* Say are the only known *Sitona* species present. *Sitona flavescens* Marh. will be included in the key. Since it is found in both Iowa and Minnesota near the South Dakota border, it is possible that *S. flavescens* will be found in South Dakota soon.

The author, due to lack of specimens from states other than South Dakota, is considering *Sitona scissifrons* Say as a species.

The adult weevils of species of Sitona in South Dakota can be separated within the genus by size and color alone. Using portions of keys by other workers plus characteristics determined by personal observation the author developed the following key which was used to determine the species of the genus Sitona in this study.

KEY TO THE SOUTH DAKOTA SPECIES OF SITONA WEEVILS

1a. Setae of elytral intervals very distinct. Scales of upper surface dark gray over piceous black elytra. Under surface sparsely clothed with fine prostrate hairs. Length - 3.5-4.0 mm--hispidula (Fabr.).

1b. Setae of elytral intervals very minute or wanting--2.

2a. Scales brown to gold, setae nearly flat on elytra but well curved. Length - 4.5-5.5 mm--cylindricollis (Fabr.).

2b. Scales of upper surface brownish over piceous black elytra. Setae light in color. Length - 5.5-6.5 mm--flavescens Marh.

2c. Scales steel gray, elytra striped dark gray to black. Setae minute and at 45 degree angle. Length - 3-4.5 mm--scissifrons Say.

THE RANGE OF *Sitona scissifrons* Say

The distribution of *Sitona scissifrons* Say in the north central area of United States appears to be very spotty.

Postal Survey

A letter survey was conducted in several states in the north central and Rocky Mountain region around South Dakota. The following was reported:

North Dakota State University reported finding *S. scissifrons* in the adult form in Cass County in southeastern North Dakota in 1923 and again in 1947. These were the only records in North Dakota as of March 20, 1961.

The Division of Plant Industry of the Wisconsin Department of Agriculture indicated that the species was not present in the State as of March 30, 1961.

Iowa State University reported the species as being present in 12 Iowa counties as of March 22, 1961. All such counties are in the northern one-half of the state.

Montana State College on March 24, 1961, had no record of its presence in that state as of that date.

Colorado State University had no record of its presence in that state.

Wyoming State University had no record of its presence in Wyoming.

The author found this weevil on alfalfa in Dakota County, Nebraska, and the survey entomologist of Nebraska collected specimens from Cedar County in northeastern Nebraska for the first time in 1961.

The University of Minnesota has records of this weevil from central and southwestern Minnesota.

In 1954 the South Dakota State Survey Entomologist, William M. Hantsbarger, gave special attention to the distribution of Sitona scissifrons in South Dakota. At that time he found S. scissifrons in 33 counties, of which three counties were in the southwestern area of the state. The remaining 30 counties were all east of the Missouri River. In 1955, the species was recorded from three new counties. In 1956 and 1957 no new records were added to the list of infested counties. In 1958 two additional counties were found to have S. scissifrons present. Both of these counties were surrounded by counties in which infestation had been detected in earlier years. In 1959 no new counties were added to the list.

Field Survey

The study included a survey for the presence of Sitona scissifrons Say throughout the entire state during 1960. A minimum of four stops were made in each county during the conduct of this survey. Alfalfa was used as the host plant for this survey.

Fields surveyed were chosen by selecting four arbitrary points in each county on the state highway map. These locations were chosen

to give the best coverage of the county and still remain adjacent to the main roads. When the marked areas were reached by automobile, the first alfalfa field on either side beyond the mark was used for the survey.

The investigator started at one near corner, sweeping intermittently to the opposite corner. He then moved to the other corner farthest from the automobile and began sweeping intermittently to its opposing corner, forming an X pattern in the field.

After completing the X field sweeping pattern, the investigator walked toward the starting point taking consecutive insect net sweeps to get the count for the field as determined from 100 sweeps.

A standard 15 inch insect net made of white unbleached muslin was used throughout the survey.

In 1960, new records of S. scissifrons were established in four counties (Douglas, Edmunds, Sanborn and Sully) which extended the range for S. scissifrons to all of the area in South Dakota east of the Missouri River with the exception of Campbell, Walworth, Potter and McPherson counties (See Figure 1).

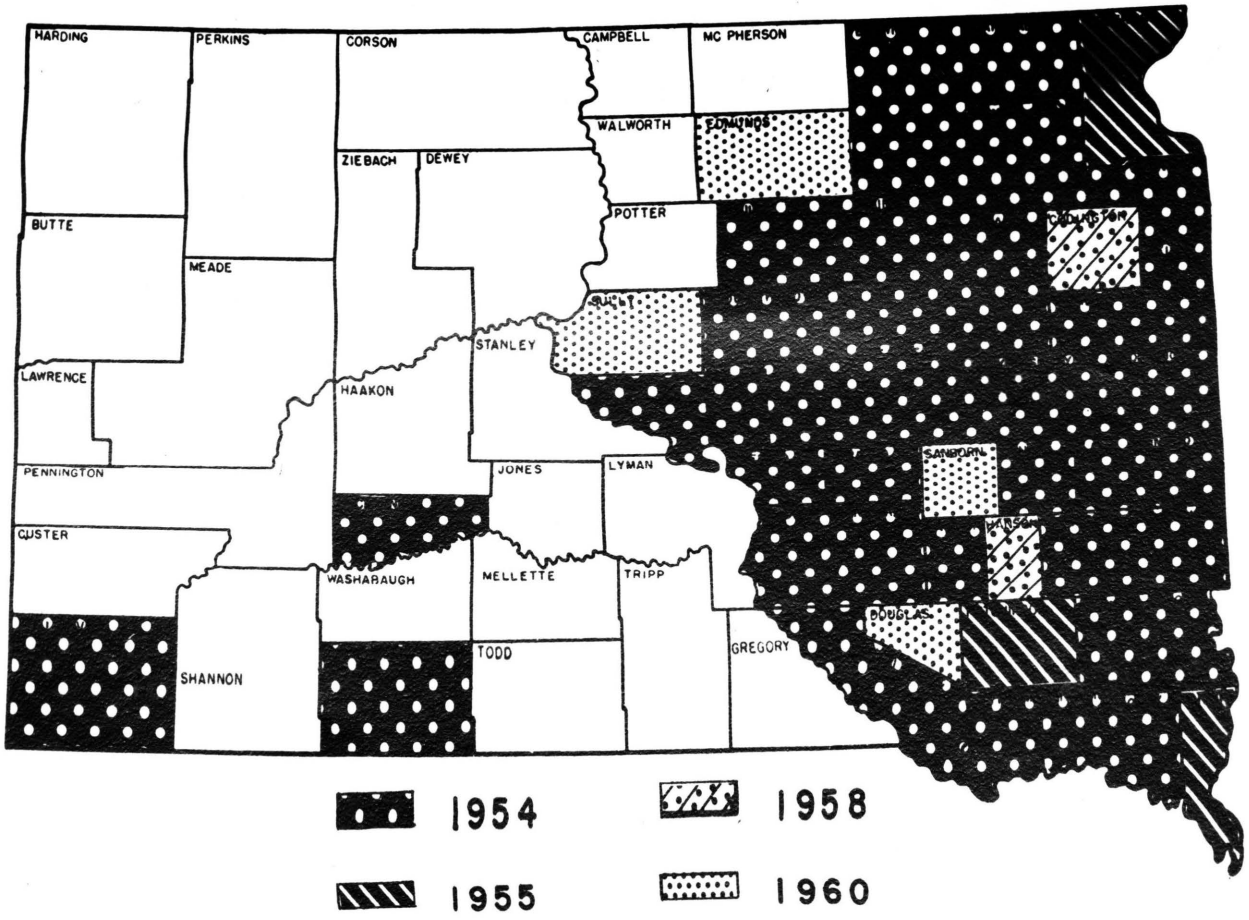

FIG. I. GEOGRAPHICAL DISTRIBUTION OF *Sitona scissifrons* Say IN SOUTH DAKOTA BY COUNTIES AND YEARS

HOST PLANTS

The host plants of the *Sitona scissifrons* Say were determined in the regular South Dakota State Economic Insect Survey by the author. As survey entomologist he surveyed all economic crops throughout the state and recorded the insect species and their habitats. All economic crops were surveyed throughout the state.

Plants of the family Leguminosae are the major food of *Sitona scissifrons* Say. Of these, alfalfa, *Medicago* sp.; sweetclover, *Melilotus* sp.; and red clover, *Trifolium pratense*, were the principle food plants. North Dakota reports indicated that, of three findings of this weevil in North Dakota, two were found on garden peas while the third was found on volunteer alfalfa in a farmyard.

The author found a number of adult forms of *S. scissifrons* in Canadian milk vetch, *Astragalus canadensis*, growing in wet areas near streams and on garden strawberry, *Fragaria* sp., in the east central and southeast areas of South Dakota. This weevil was not detected on any other economic cultivated crop in South Dakota. Few of the weeds were checked for this pest.

DAMAGE

The damage to host plants caused by Sitona scissifrons Say was determined by field observation and by studying the damage to alfalfa in artificially S. scissifrons infested control cages.

In field observations the author spent many hours watching the movement and feeding habits of the weevil. In the isolated cages, checks were made of the alfalfa plants and the damage caused to them by the weevil.

Damage by the adults of this species is characteristic for most species of Sitona. Adults chew subcircular notches in the spongy parenchyma areas of the margins of the leaves. However, seldom is a leaf vein chewed by the Sitona scissifrons Say. Foliage damage, though always evident when weevils were present, was never sufficiently severe to seriously damage the plants even when the weevils averaged 32 adults per 10 sweeps with the net. Commonly, damage caused by a complex of insects including this weevil was found. The weevils were also observed to feed on newly forming buds, flower stems, and at the base of young branch stems.

The larvae of all other Sitona weevils of South Dakota feed underground on the roots and root nodules. It seems logical to assume that S. scissifrons is no exception. However, field and laboratory studies failed to reveal the feeding location of the larval form. Evidence of the lack of nitrogen nodules was found on most plants studied from heavily infested fields. One alfalfa plant showing

severe root damage was found in an isolated cage which had been infested with S. scissifrons. The roots from one-half inch to four inches below the soil surface showed excessive surface feeding and tunneling. Nitrogen nodules were characteristically absent from the roots. This damage has not been duplicated in subsequent cage tests.

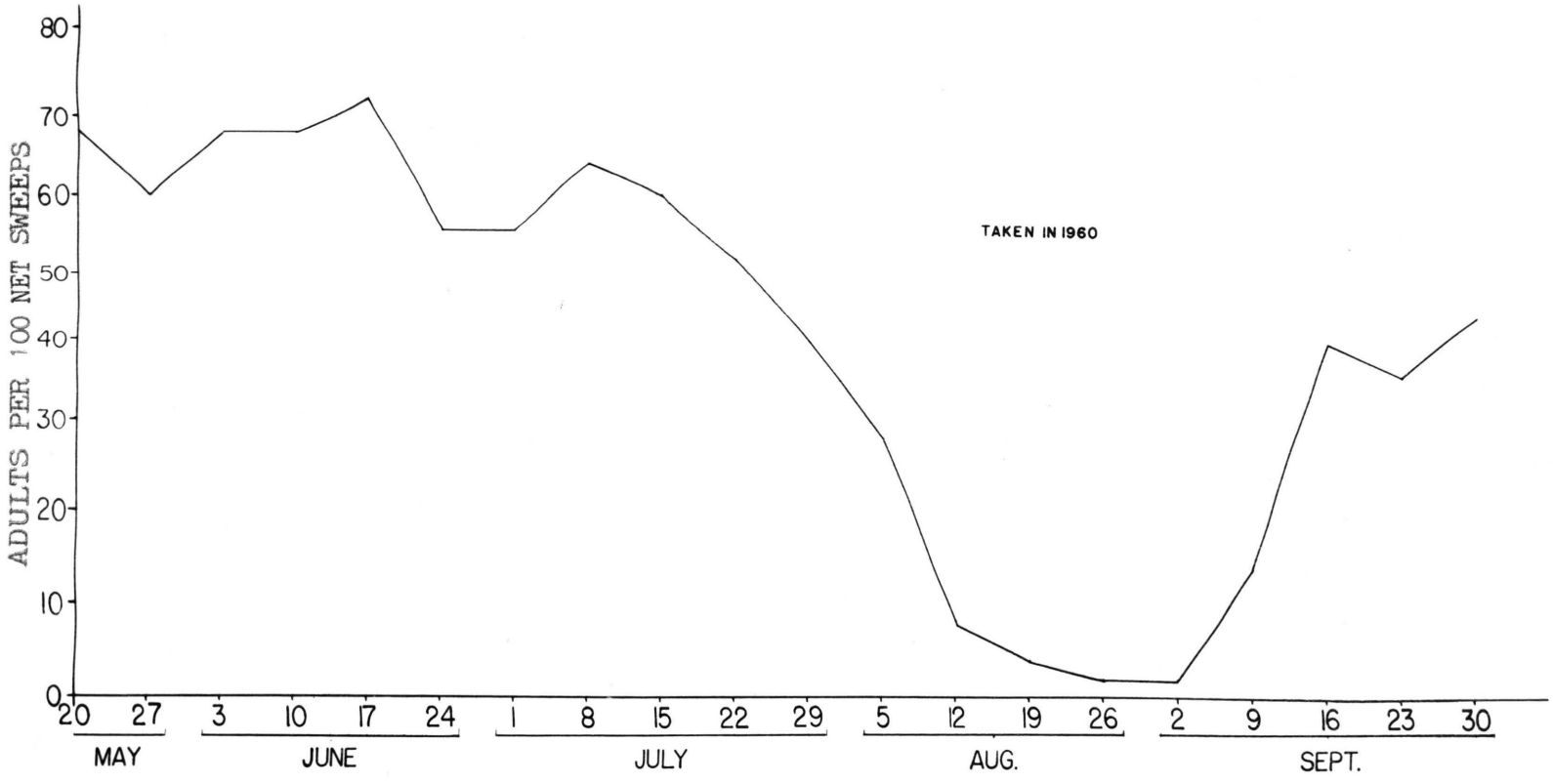

FIGURE 2. ADULT WEEVIL, *Sitona scissifrons* SAY, COUNTS FROM ONE FIELD IN BROOKINGS COUNTY

LIFE HISTORY STUDIES

One aspect of this study was to attempt to discover the life history of Sitona scissifrons Say under field conditions. In 1959, fields of alfalfa known to have high populations of S. scissifrons present the previous season were chosen in Lincoln, Union and Brookings counties. Weekly trips were made to the Lincoln County and Brookings County fields. Trips were started on May 18, 1959, and continued through the second week of October, except during the period of July 17 through August 2. On each of these trips two plants were dug from each field with as much soil as possible clinging to the roots, then boxed for further dissection and examination for the presence of larvae. Field observations were also made at the time the plants were collected. The soil clinging to the roots was broken up by hand and checked carefully for the presence of larvae. All unidentified larvae were then placed in potted alfalfa plants to determine if they could be reared to adults. No Sitona sp. larvae were found. On visits to each of the fields, alfalfa was swept with an insect net to collect adult beetles which were taken to Brookings for study. Of those collected, ten paired adults were placed in a screen cage enclosing potted alfalfa plants to get egg counts and to study weevil activity. This proved favorable for feeding and mating activity but was not satisfactory for egg counts. Although filter paper was placed on the surface of the soil in the pots, accumulated residue, moisture and trash on the paper

prevented egg counts. The Newton (1958) type oviposition chamber (See Figure 3) was then substituted for egg collection.

In early June, 50 adult unsexed weevils were placed in each of four soil-viewing alfalfa plant chambers (See Figure 4). The chambers were observed periodically for larvae of the insects in the soil. The adults remained active for several weeks but spent most of their time on the screen cloth of the cage. Adults apparently escaped from the cage although no opening could be found. It is believed that the sliding glass door opening might have allowed the insects to work their way out of the cages. Cover panels of the chambers were removed from time to time to observe underground insect activity on the alfalfa roots as exposed to the glass walls of the soil compartment. No activity was ever found, however, nodules on the roots were noticeably scarce. The potted alfalfa continued to grow well and put on 8 1/4 inches of growth over a four-week period. Moisture may have been a limiting factor as the growth chambers were not watered as often as was desired.

On August 3, two of the glass walled, soil-viewing chambers were opened to examine the soil and to dissect the alfalfa roots. No larvae, pupae or pupal cases were found. Once again root nodules were lacking.

In the second year, 1960, chambers were set up in screen cages in the field in Brookings County where more time could be spent with the cages. Two cages, 36 inches square and 24 inches high with an

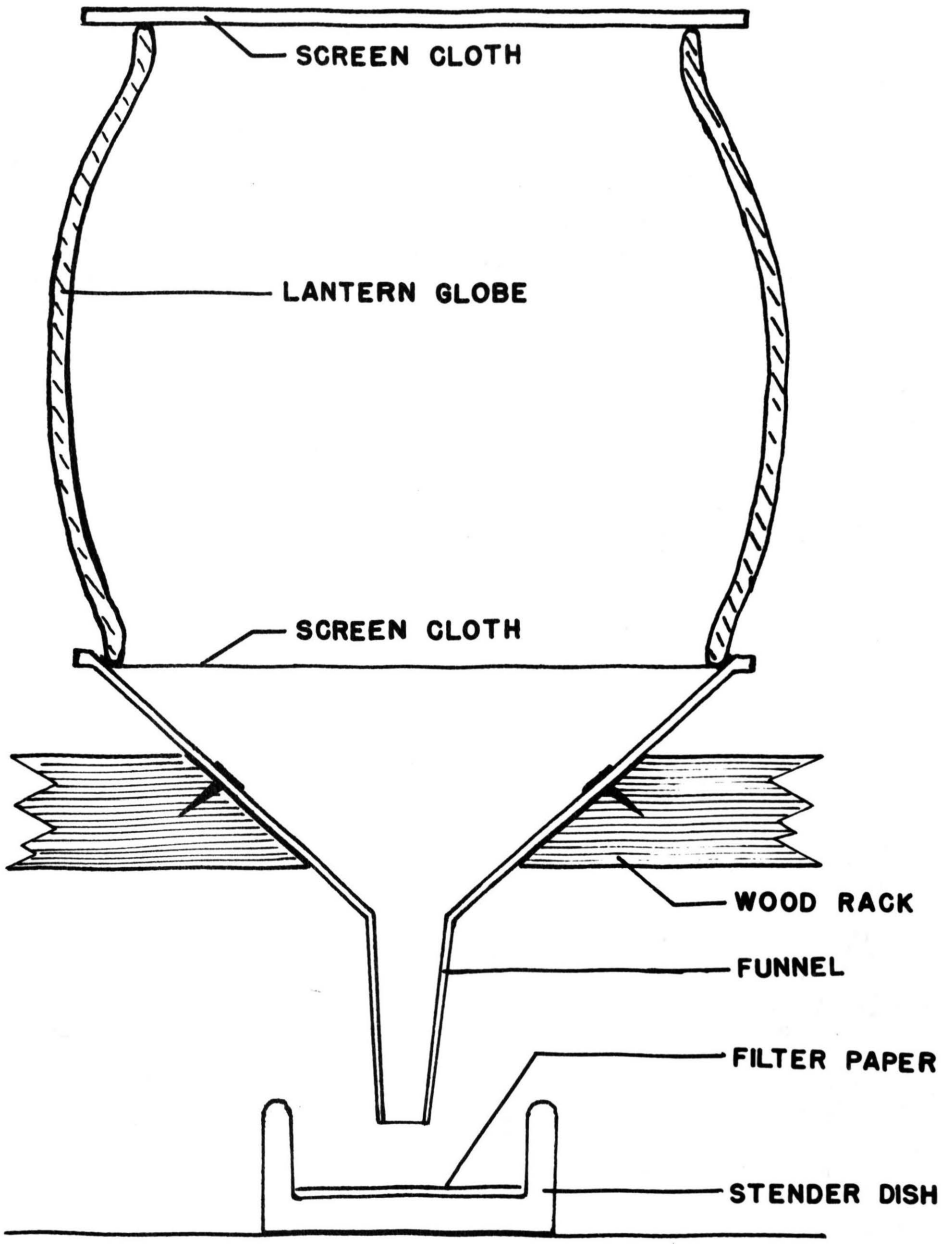

FIGURE 3. OVIPOSITION CHAMBER

FIGURE 4. GLASS WALLED, SOIL-VIEWING CHAMBERS FOR STUDYING LARVAL ACTIVITY ON THE ROOTS

additional 12 inches of screen below the soil level, were set up on 12 inches of screened soil and Green Thumb Potting Soil mixture. The soil was seeded with alfalfa provided by the Agronomy Department of South Dakota State College and was kept moist.

One hundred unsexed adult forms of S. scissifrons were placed in each of the two cages on June 6. At this time the alfalfa was about 4 inches in height. The alfalfa was then thinned to 16 vigorous plants per cage. The weevils were subsequently observed for activity, type of feeding and numbers present on each plant. On August 9, when counts per cage diminished to 20 adults, one cage was opened and the soil examined for larvae and larval damage. No actual root feeding was observed but no nitrogen nodules were found on any of the 16 plants. By August 12 the weevil population in the second cage decreased to 7 adults, thus the cage was opened, the soil was examined and roots were dissected. Again no larvae were found nor were there any nodules on the roots. It may be possible that too heavy a population was introduced and caused one or more density-dependent factors such as scarcity of food, oxygen, or excessive pH.

The overwintering stage of Sitona scissifrons Say was determined by collecting soil and debris samples from a known infested field. These samples were collected in December, 1960; February, 1961; and March, 1961; and placed into metal tubs for storage. The surface soil and the surface debris were kept in separate tubs which were stored out-of-doors in a cold, shaded location until used in the study.

Two three-unit batteries of Berlese type funnels were constructed with certain minor modification for use in sorting the soil and debris collections. These batteries were of the folding-break-down types which required the minimum space for storing and transporting (See Figure 5).

These batteries were set up in a room with temperature range of 70 to 75 degrees Fahrenheit. Soil about 1 1/2 inches deep was placed on the screened floor of the funnels. The light reflectors were lowered to one inch above the top edge of the funnels. The first samples were left in the funnels for a period of six days. It was noted that the live, active weevils could be collected in the catching jar at the bottom of the funnels within 24 to 48 hours. After the third week the running time for any one sample was cut to three days.

Snow and ice in the debris samples presented a problem at first. The collecting jars were found to fill with water due to the melting process within an hour and many times had to be emptied of water two or three times per sample. This problem was corrected by making screen enclosed collecting containers to replace the jars. Such collecting containers permitted the water to flow through and thus prevented the drowning of the weevils.

By this method a total of 18 adults were collected. Of these 18 adults, 13 were taken from the debris samples and five from the soil samples. This indicated that the adults overwinter in and under the debris material on the ground. It is possible that the five taken

FIGURE 5. BERLESE TYPE FUNNEL BATTERY

from the soil samples had worked their way below the soil surface in the frost cracks or down the crowns of old alfalfa plants. Sixteen of the adult weevils were collected alive and very active while two were found dead. The two dead weevils were drowned at the beginning of the experiment before modifications were made to release water from the snow filled trash samples.

In 1960 a second attempt was made to get egg counts and eggs which could be incubated. An oviposition chamber for this study was made similar to that developed by R. C. Newton (1958). A battery of four oviposition chambers was mounted on one board. One such unit is illustrated in Figure 3. A lantern globe with 32 x 32 mesh screen cloth fitted and glued to the bottom was placed over a plastic funnel tacked in place in a hole on the wooden rack. A stender dish with filter paper in the bottom was placed under the funnel. A removable metal-framed 32 x 32 mesh screen was put over the top of each unit to confine the weevils. Paired adult weevils were placed in each of the units and were fed daily with fresh alfalfa. Eggs were collected on the filter paper in the stender dishes and counts were made. Four female weevils were laying eggs when first placed in the chambers and they continued to lay for 41 days when the study was terminated. During this study 306 eggs were collected from the most productive female with 11 eggs found on the last day of the experiment. The lowest count was 67 eggs but not more than four eggs were produced by this specimen in any 24-hour period during the 41 days. The eggs were then

placed on and in the soil of potted alfalfa plants. Some eggs were placed on moist filter paper and a few were preserved.

It was noted that the milk-colored egg would turn black in six to eight hours after being laid. The eggs were smooth, nearly round and remained in this state for four to ten days after turning black (See Figure 6). After this time they became dehydrated and wrinkled on the surface. Closer study indicated that most of the eggs never started to develop into embryos but a few that had started died early. One egg hatched on moist filter paper. In an attempt to remove the larvae to soil media with a grafting tool such as used in transferring honey bee larvae it was injured and died.

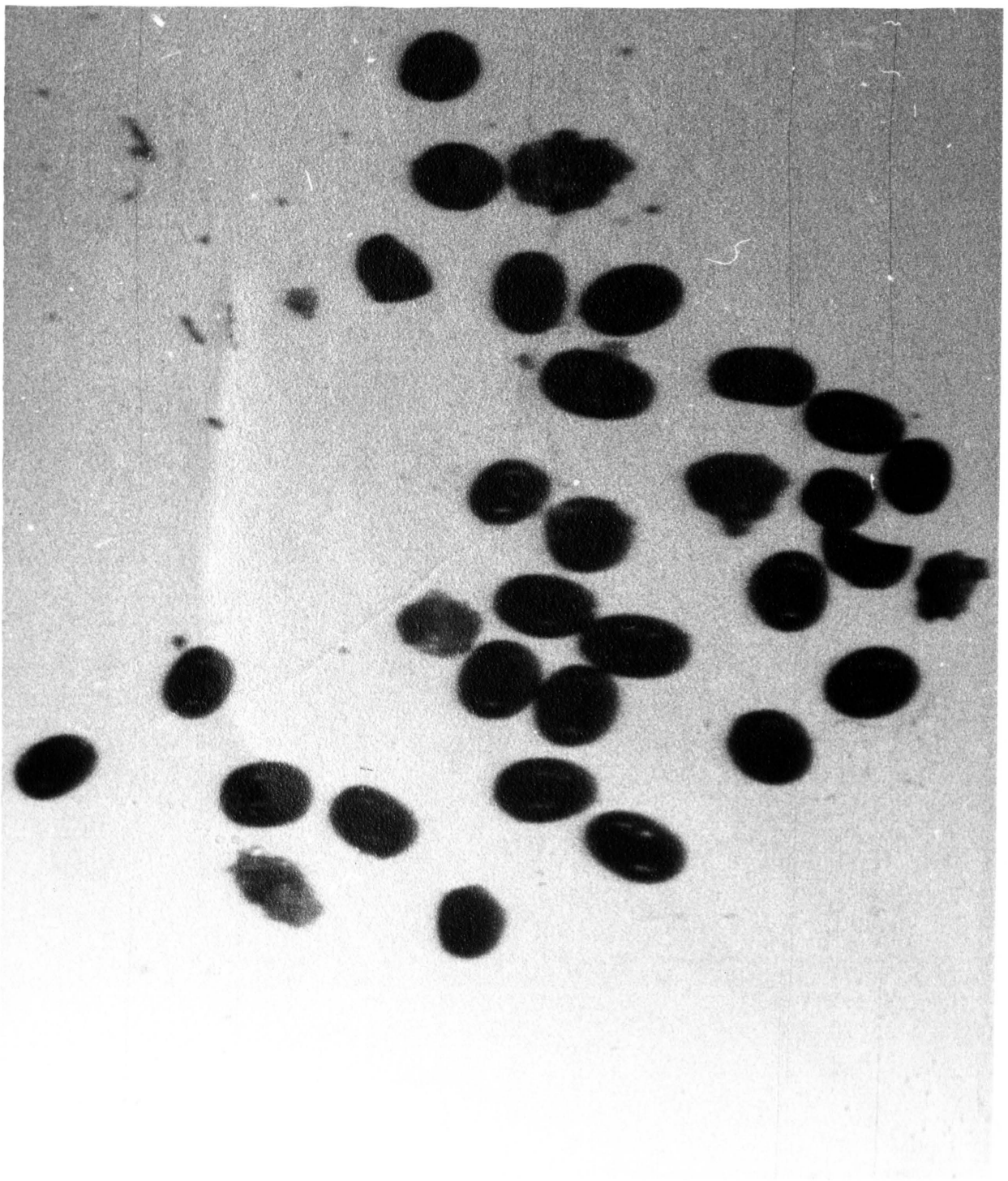

FIGURE 6. *Sitona scissifrons* Say EGGS ENLARGED ABOUT 120 TIMES

FIGURE 7. ALFALFA ROOTS BELIEVED TO BE DAMAGED BY

Sitona scissifrons Say

CONCLUSIONS

1. The adult forms of Sitona scissifrons Say feed on the foliage and can cause considerable damage due to defoliation.
2. Sitona scissifrons Say infested alfalfa plants lack nitrogen nodules on the roots.
3. This weevil will attack alfalfa, Medicago sp.; sweetclover, Melilotus sp.; red clover, Trifolium pratense; Canadian milk vetch, Astragalus canadensis; and garden strawberries, Fragaria sp., in South Dakota.
4. The range of Sitona scissifrons Say extends over most of eastern South Dakota. It has also been found in three counties in the southwestern area of the state. Reports from other midwestern states indicate that in the midwest South Dakota is on the western edge of this weevil's range. This weevil has been found only in a few northeastern Nebraska counties and in one southeastern North Dakota county. The range extends to the east through the southern half of Minnesota and northern half of Iowa.
5. The insect overwinters as an adult in the debris and upper part of the soil in host plant fields.
6. Eggs are laid at random during the spring and early summer. The females are very prolific and may lay more than 300 eggs within six weeks time.

7. The larvae could not be found in laboratory or field soil samples. The life history study should be continued to find the larval stage of the weevil.

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