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Biology of the Carrion Beetle *Silpha ramosa* Say[1,2]

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ABSTRACT

Adults of the carrion beetle *Silpha ramosa* Say first appear in mid-April. After mating, the white spherical eggs are laid about 4 cm deep in the soil. The 3 larval instars are found in the grass or burrowed into the soil. Decaying meat (mainly rodents) or dead-dying insects appear to be the only food of both immatures or adult beetles. Population studies conducted over a 3-year period suggest that there are 2 generations per year. However, adults from the 1st generation may continue to live and reproduce for up to 3 months. Populations of both adult and immature forms were relatively stable for the first 2 years of the study but declined drastically the 3rd year. A similar decline in rodent numbers in the area may account for the population reduction of *S. ramosa*.

Silpha ramosa Say occurs commonly in eastern Colorado. A partial life history was described by Gissler (1880) and additional information added by Goe (1919), who erroneously listed it as *S. inaequalis* Fab. (See Hatch 1927, p. 327). Goe's contribution on *S. ramosa* was further confused when the editor added a postscript to Goe's article referring to the illustrated early stages of *S. inaequalis* by Blatchley. Cooley (1917) presented an excellent report on the biology and description of *Silpha bituberosa* Lec., which appears to be fairly similar to *S. ramosa* except for the plant feeding habits of *S. bituberosa*. Here we consider the life cycle and report seasonal and annual changes in populations of *S. ramosa*.

Silpha ramosa was described by Say (1823). Arnett (1944) considered *S. aenescens* Csy and *S. ramosa* to be conspecific; however, Hatch (1946) has since shown *aenescens* to be a distinct species.

The present distribution[3] of *S. ramosa* includes the following states and provinces of the USA, Canada, and Mexico: Idaho, Oregon, Minnesota, Wisconsin, Michigan, Washington, New Mexico, Kansas, Colorado, Nebraska, Wyoming, Montana—USA; Alberta, Saskatchewan, Manitoba, Ontario—Canada; Sonora, Baja California—Mexico.

PROCEDURE

Study area. The primary study area was a grassy meadow near Platteville (Weld County), Colorado. A secondary area also used was a cottonwood grove located along the banks of the South Platte River.

Life history studies. The life history portion of the study was begun on April 24, 1974. Live adults were collected from the primary study area by placing dead mice (*Mus musculus*) under hardware cloth cages. Three days later the mice were checked and all silphids removed to the laboratory where they were placed in 1 pint jars containing about ½ pint of soil, topped with a clump of sod, and capped with a fiber screen lid. The soil was placed in the jars so that the arrangement of soil levels and soil particles were in the same order found in the field. A small amount of meat (hamburger or chicken liver) was added to each jar at the beginning of the study and periodically thereafter in some jars. Some jars were not provided with additional meat as part of a feeding experiment. Three or 4 adult beetles, including both males and females, were placed in each of the 12 jars. No immature beetles were used to start the colonies. We were able to observe mating, eggs, immatures, adults, and general behavior in these containers. For the 1st month of study moisture was provided only by adding water to the soil. Afterwards, cotton stoppered vials of water were kept in the jars so that beetles could have access to water at all times. In general, the colonies were maintained in darkness or semi-darkness between observations.

Population studies. Silpha ramosa was collected in the primary study area using 2 lines of 10 pitfall traps each and a 3rd line in the secondary study area. The pitfall traps, spaced 10 yards apart in 90 yard transects, consisted of 1 pint plastic freezer boxes buried with the tops level with the soil surface. A 2nd plastic box cut to ½ its original height was inserted inside the full size box but also level with the soil surface. The insert and its contents could then be removed at each sampling period without disturbing the trap location. Ethylene glycol was used in the traps as both a killing agent and a preservative. The traps were protected from cattle with small individual fences. The traps were serviced weekly from April 1972 until December 1974.

RESULTS AND DISCUSSION

General life history.—Analysis of collection data suggests that *S. ramosa* overwinters in the adult stage. The first adults emerge in mid-April and lay their eggs in the soil. The immature offspring appear about 2–3 weeks later. There are 3 larval instars and pupation occurs in the soil. The life cycle from egg to adult takes at least 30 days, probably depending on environmental temperature. Although Essig (1926) called *S. ramosa* the vegetable carrion beetle and reported that it fed on vegetation, Hatch (1927) indicated that the insects were necrobious. Our study supports the conclusion of Hatch in that we observed larvae and adults feeding on both decaying and fresh

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[3] Provided from the literature by T. S. Spilman, U.S. Department of Agriculture. Personal Communication.

meat, or dead-dying *S. ramosa*, but never on any type of vegetation. In addition, beetles not provided with some form of meat died or failed to develop.

Life stages.—*Eggs.*—The eggs are white and almost spherical when first laid (Fig. 1A). The chorion is thin, smooth, shiny, and translucent. As development progressed the eggs became more elongate and the brown tarsal claws and the tibial hairs of the larva could be seen through the egg shell just prior to hatching. The egg stage lasted approximately 5 days under our laboratory conditions. Although some eggs were observed on the soil surface, most were laid in the soil at various depths up to 4 cm. We did not collect eggs from the field, but a related species lays eggs under fairly similar circumstances in the field (Cooley 1917). Measurements of length and width of the eggs are presented in Table 1.

In the laboratory there was a very high rate of egg mortality. This probably does not reflect natural mortality because our handling of the eggs and the rearing environment was so unlike the natural habitat of the beetles. Many eggs were apparently laid away from the jar wall (and out of our view) because we always observed more larvae than eggs.

First instar.—Gissler (1880) indicated that the 1st instar was 6 mm long at hatching and Goe (1919) reported it was coal black with a yellowish-red head and black antennae. The measurements we obtained are shown in Table 1. The larvae were about 2 times as long as the egg and were rolled up inside the egg, much like a pill bug. Two hours after hatching the larva had turned grey and by 3 hours the entire body was black though the head was still white. Over the next several hours the head slowly turned orange in color. Measurements of head capsules and metathoracic tibiae showed very little variation. Approximately 75% of the larvae known to be 1st instars had head capsule widths of about 1.55 mm and hind tibia lengths of about 1.2 mm. The total length and width of the body was much more variable because the larvae extended and retracted the abdominal segments. New larvae were always first observed on the soil surface or in the dry grass. They were observed eating meat and drinking water but in general were less

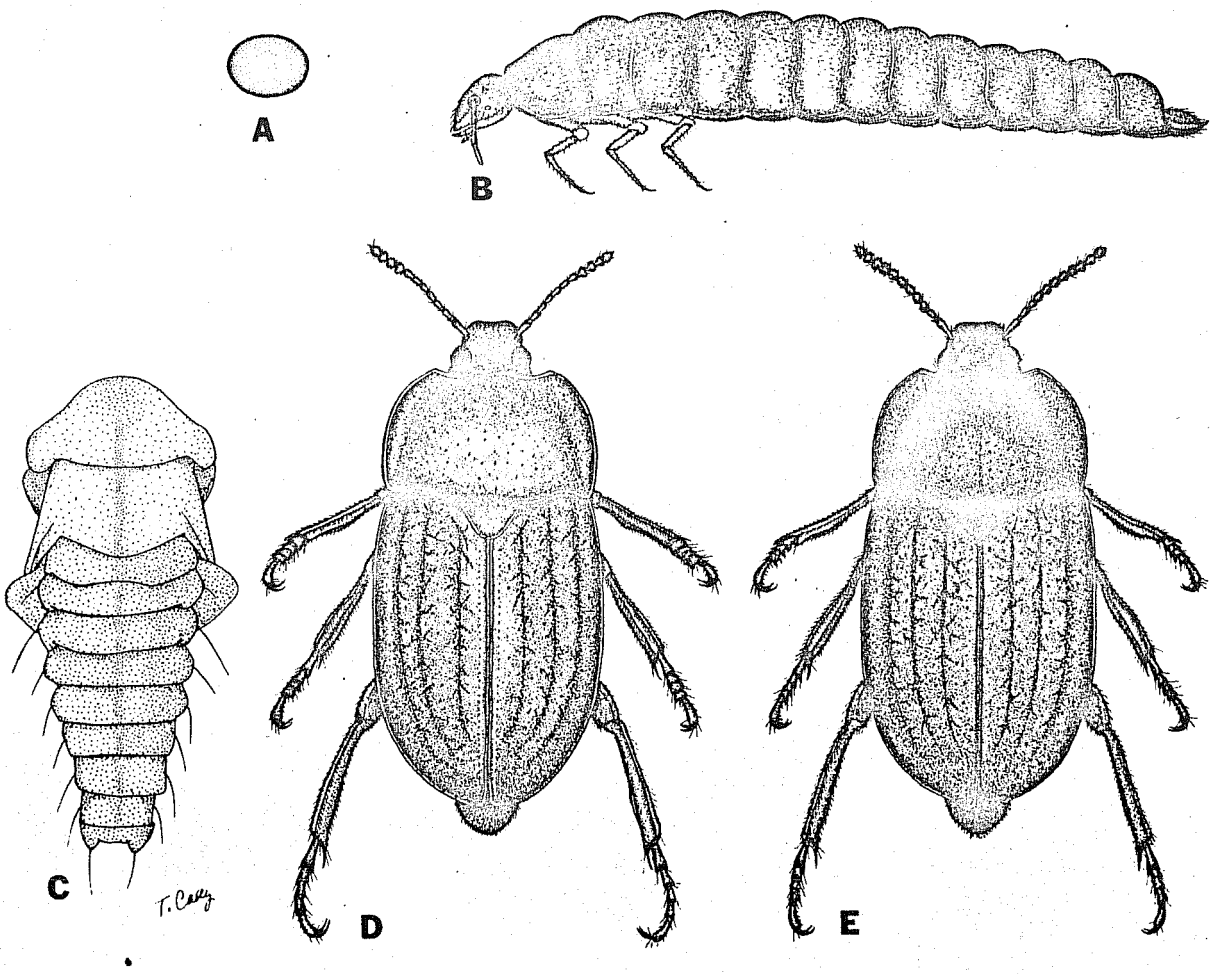

FIG. 1.—Life stages of *Silpha ramosa* Say. (A) egg, (B) third instar larva, (C) pupa, (D) male, (E) female. Drawn approximately 8 times normal size.

Table 1.—Duration and measurements of various stages of laboratory reared *Silpha ramosa*.[a]

Stage	Duration (days)	No. observed	Mean length (mm)	Mean width (mm)	Mean head capsule width (mm)	Length of metathoracic tibia (mm)
Egg	5	11	3.0 (2.8– 3.3)	2.4 (2.0–2.8)	—	—
1st instar[b]	4–5	15	7.1 (11.0–12.2)	3.7 (3.6–3.9)	1.5 (1.4–1.6)	1.2 (1.1–1.2)
2nd instar	5–6	24	12.6 (8.3–17.8)	5.3 (4.4–6.2)	2.1 (1.8–2.3)	1.8 (1.7–2.0)
3rd instar	8–10	44	17.6 (11.5–22.1)	5.9 (4.1–6.5)	2.6 (2.4–2.7)	2.2 (2.2–2.5)
Pupa[c]	8–9	1	—	—	—	—
Adult	2–3 months	63	14.4 (13.2–17.8)	7.2 (6.3–8.1)	2.5 (2.3–2.7)	3.8 (3.5–4.1)
Male		20	13.6 (11.9–15.1)	7.1 (6.2–8.1)	2.5 (2.4–2.8)	3.8 (3.5–4.0)
Female		20	14.1 (12.0–15.9)	7.3 (6.8–8.1)	2.5 (2.2–2.8)	3.8 (3.7–4.0)

[a] Range given in parenthesis.
[b] Newly hatched.
[c] Only one pupa was obtained and was not handled for fear of damaging it.

active than later instars. Mortality at this stage appeared to be very low under the conditions of our study although it was not possible to determine the exact number of deaths. There were some instances of suspected cannabalism which resulted in the death of at least 3 larvae.

Second instar.—Gissler (1880) reported that the freshly molted larva was pinkish and turned black within 12 minutes. We did not observe any freshly molted 2nd instars, but Gissler's comments do not seem precise in view of our observations on all other instars which were all white. Also, in our study the darkening process of the other stages required several hours instead of minutes. The measurements of this stage are presented in Table 1. There was much more variation in larval measurements in the 2nd than the 1st instar. The greatest growth occurs during the 2nd instar, with body lengths ranging 8.8–16.8 mm. This instar also seemed to be much more active than the 1st, but this may be a result of the larger larvae being more visible. The 2nd instars were normally first seen on the soil surface and fed and took water for longer periods of time. Mortality of this stage was very low under the conditions of this study.

Third instar.—The morphology of the mature larva has been described in detail by Gissler (1880) and Dorsey (1940). Just after molting to the 3rd instar the larva was a dirty white color. After almost an hour the larva had turned to a greyish-black and after 3 hours the coloration was the normal black (Fig. 1B). The 3rd instars observed frequently grew to more than 3 mm longer than the adult size and were very robust (being rounded as opposed to flattened as seen in the 1st and 2nd instars). Measurements of this instar are given in Table 1. Third instars were observed primarily on the soil surface and did not retreat to dry grass when disturbed. During the latter half of the 3rd stadium the larvae became inactive. They burrowed beneath the soil (frequently to the bottom of the jar which was approximately 5 cm) as reported by Gissler (1880). During this quiescent period all larvae made jerking motions for long periods of time. The head and abdomen would be drawn forward almost touching, and then back in the opposite direction. In all but one instance the larvae that underwent these jerking motions died. This jerking period lasted 3–4 days.

Pupa.—Although Goe (1919) reported rearing 3 *S. inaequalis* (=*ramosa*) to adulthood, he did not describe the pupa. In our study pupation occurred just beneath the soil surface with the head in a vertical position. The pupa was pearly white (Fig. 1C), very similar to the color of the eggs. The pupa remained this color until approximately 24 hours before adult emergence. At that time it turned tannish-brown in the head and thoracic regions but the abdominal region remained white. The pupal stage was quite inactive although circular movements of the tip of the abdomen were frequently observed.

Adult.—The adult has been described by Say (1823), Gissler (1880), Horn (1880), and Arnett (1944). Males can be distinguished from females by the slightly dilated pro- and meta-tarsi (Fig. 1D). In the female (Fig. 1E) the tarsi are slender, and the elytra more prolonged and slightly pointed than in the male (Horn 1880). In our studies the teneral adult was totally white except for a triangular tan patch that extended from the head over the center of the thoracic shield and ended near the top of the elytra. Within 24 hours the beetle was entirely black. The adult was by far the most active stage. When water but not meat was provided, some adults were observed feeding on other dead or dying beetles, but we did not actually observe one beetle killing another. There was, however, noticeable aggression. In jars with meat there was a direct correlation between the introduction of food and increased sexual behavior over a period of several days immediately following introduction. This might suggest that meat stimulates matings and may be required for production of eggs. Approximately 25 matings were observed. They were characterized by being slow and deliberate. The male seems to appease the female by thumping her thoracic shield with his antennae during copulation. The matings varied in duration from several minutes to almost half an hour. Matings were observed in both a horizontal and vertical orientation, depending on where the female was in the jar when approached by the males. The male was always on top of the female during copulation. Individual fe-

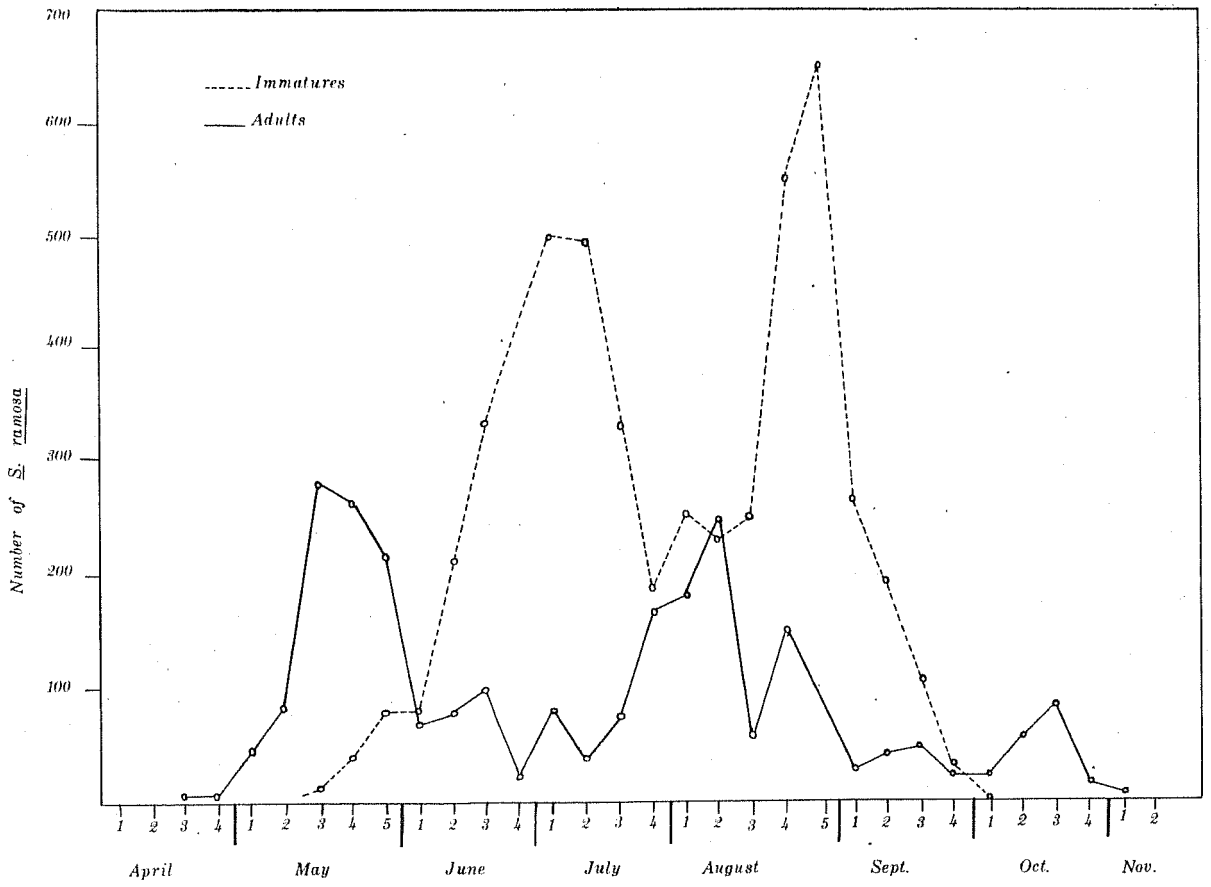

FIG. 2.—Total number of *Silpha ramosa* collected from 3 lines of pitfall traps of weekly collection periods for 1972, 1973, and 1974. Platteville (Weld County), Colorado.

males mated several times, but we did not determine if the partners were always the same. Under the conditions of our study individual adults with some form of meat lived and reproduced for at least 3 months.

Population studies.—Accumulated data from the pitfall trap collections of 1972, 73, and 74 (Fig. 2) show 2 major peaks of adult activity. The first, probably a result of the emergence of overwintering adults, occurs in mid-May. The second peak in late July-early August is probably due to the maturation of the 1st generation of the season. After about 6 weeks the peaks of adult activity are followed by 2 peaks of larval activity. The 1st of these, probably a result of reproduction of the overwintering adults, occurs in late June-early July. The 2nd peak of immature activity which occurs in late August-early September is probably the offspring of the new adults of the season. By late September the number of larvae had declined while the number of adults had increased somewhat. This is undoubtedly a result of maturation of the immature forms. After the 1st week of October only adults were collected until mid-November when all collections of this beetle ceased. Most of the immature forms collected were 3rd instars, which is correlated with the greater activity of this stage observed in the laboratory.

The total number of silphid adults collected in 1972 and 1973 was similar with slightly over 1000 specimens taken each year. There was a considerable reduction, however, in 1974 with only 530 adults being collected.

The reduction in the number of immature silphids was even greater, with well over 2000 beetles collected during 1972 and again in 1973, but under 400 in 1974. The great reduction in total numbers of both stages may be due in part to disturbance of the pitfall traps by cattle during 1974, but data from undisturbed traps indicate that populations of the beetles were, in fact, considerably lower in 1974 than in previous years. B. A. Wunder (personal communication) reported a 50% population reduction of the rodent species *Peromycus maniculatua* and *Mus musculus* in 1974 as compared to 1972 and 1973 levels. Since beetles were observed feeding on carcasses of *M. musculus*, at least that species, and perhaps both rodents, may be an important food source for *S. ramosa* and the decline in rodent numbers may be correlated with the reduction in populations of *S. ramosa*.

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