Bionomics of *Smicronyx fulvus* (Coleoptera: Curculionidae) on Cultivated Sunflower, *Helianthus annuus*¹

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ABSTRACT


*Smicronyx fulvus* LeConte adults were first observed on sunflower in the late vegetative and early budding stages and were present from June 30 to Sept. 3, 1976 and from June 27 to Aug. 9, 1977. Females oviposited between the hull and achene of developing sunflower seeds from mid-July to mid-Aug. Eclosion of larvae occurs in sunflower seed and the 5 larval instars feed on the kernel. Development, as observed in the laboratory, was 2–3 days for each larval instar excluding overwintering 5th instars. Fifth instars cut a circular opening in the hull, emerge, and drop into the soil to overwinter. Larvae emerged from seeds from mid-Aug. to mid-Sept. *Smicronyx fulvus* larvae were in soil from mid-Aug. to June of the following year when they pupated. The pupal period was 14 days in the laboratory. Soil texture did not significantly affect larval survival and thus is probably not a major factor in limiting the distribution of *S. fulvus*. Larvae were recovered from *Helianthus annuus* L., *H. maximiliani* Schrader, and *H. petiolaris* Nuttall. Natural enemies of *S. fulvus* in North Dakota include *Bracon mellitor* Say, *Neoliolus curculionis* (Fitch), *Trimeromicrus* sp., and *Cyclotelus rufidentis* (Loew).

The sunflower, *Helianthus annuus* L., native to North America, is second only to soybeans as a source of vegetable oil (Robertson 1975). Throughout the United States, sunflower is a minor oilseed crop (Putt 1978) but with continued improvements in varieties and production practices, sunflower acreage has steadily increased. Introduction of oil varieties from Russia in 1967 stimulated the 1st substantial production of oilseed sunflower in the United States (Cobia and Zimmer 1978). Sunflower production in North Dakota has increased from 44,000 ha in 1969 to 480,000 ha in 1977.

Insects associated with wild and commercial sunflowers have increased on commercial *H. annuus* since 1967 (Schulz and Lipp 1969, Lipp 1972). In 1974, *Smicronyx fulvus* LeConte was discovered infesting sunflower heads in North Dakota. In certain fields, larvae of *S. fulvus* were present in 50% of the sunflower heads and 80% of the seeds in each infested head contained larvae of *S. fulvus* (Cobia and Zimmer 1978). Populations of *S. fulvus* have attained economic levels in southeastern North Dakota since 1974. A decline in sunflower acreage in the United States, sunflower is a minor oilseed crop (Putt 1978) but limited to that by Satterthwait (1946), we initiated this study in the bionomics and life history of *S. fulvus* in North Dakota.

**Methods and Materials**

Research was conducted during 1976–77 near Leonard, ND, in a commercial sunflower field and at the main experiment station, North Dakota State Univ. (NDSU), Fargo. Both fields were seeded with sunflower hybrid 894. Commercial plantings of *H. annuus* adjacent to the Leonard field had high infestations of *S. fulvus* the previous 3 yr. In 1976, the nearest commercial sunflower field was 0.8 km S of the Leonard field and 0.1 km N in 1977. Field observations for adult activity were conducted twice per week on sunflower from the vegetative to the seed development stage. The terminology for the growth stages of sunflower development is that of Siddiqui et al. (1975).

Egg and larval development studies were initiated on sunflower when the outer quarter of inflorescence was complete (=4.2 substage of anthesis). Three sunflower heads were removed from each of 10 blocks, and 30 randomly selected seeds/sunflower head were dissected for the presence of eggs or larvae. Once adult activity had ceased in the Leonard field, 27 randomly selected sunflower heads were covered with microperforated plastic bags (Hercules Corp., Wilmington, DE) to capture emerging larvae. Contents of the bags were examined twice per week and the number of larvae recorded.

Number of larvae produced by females was determined by placing newly emerged males (10) and females (10) on each of 24 sunflower heads that had seed filling in the outer florets (=4.3–4.4 substage of anthesis). Each sunflower head was bagged prior to adult emergence. Bags prevented oviposition by natural populations of *S. fulvus*. After completion of larval emergence from seeds, bagged heads were returned to the laboratory and the number of larvae per bag was recorded. Head capsule width measurements were recorded for 97 larvae reared from eggs in the laboratory.

Vertical distribution of larvae in soil was determined by sampling soil from Oct. 1 to June 30 between 1976–77. Mature larvae from the Leonard field were placed in 1.8×5.3-cm plastic containers lined with moistened filter paper. Larvae were reared in an incubator at 27°C±2 °C and ca. 70% RH with 12-h photophase.

On Sept. 20, 1976, a study was initiated to determine the overwintering mortality of *S. fulvus* larvae and pupae in the fine, silty clay and the coarse, loamy soils of the NDSU and Leonard fields, respectively. Mature 5th-stage larvae of *S. fulvus* were collected as they emerged from sunflower heads in the Leonard field. Larvae were confined in cylindrical wire cages (7 cm × 39 cm high) constructed of 18×16-mesh window screen. Nylon screening secured by Ball® mason rings enclosed the

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0013-8746/79/0405-2405$00.75/0
ends of each cage. Twenty-five cages, each containing 10 larvae, were buried vertically in the Leonard field and in the NDSU field. Tops of the cages were 10 cm below the soil surface. In May, 1977, the upper 5–8 cm of soil within each cage was carefully removed to provide space for emerging adults. Each cage was marked and the number of adults that emerged from June to Aug. was recorded. In the laboratory, 10 last-stage larvae were placed in each of 25 plastic cups (9x14 cm) containing 450 g of dried, sterilized soil from the Leonard field and 25 cups containing soil from the NDSU plots. Distilled water (50 ml) was added to each container. After a cold treatment at 0° C for 2 wk, larvae and containers were placed in an incubator at 25°±2° C, 16-h photophase and ca. 70% RH. All containers were examined every 3 days for adult emergence over a 120-day period.

Surveys for additional hosts of *S. fulvus* were conducted in eastern North Dakota and western Minnesota during 1976–77. Adults of *S. fulvus* found on wild *Helianthus* spp. were confined to heads using microperforated plastic bags. Emergence of *S. fulvus* larvae from seeds indicated plants were suitable as hosts.

Sunflower seeds harvested from the Leonard field and infested with *S. fulvus* were placed into plastic containers and the contents observed for parasitoids that emerged from seeds.

### Results and Discussion

#### Adult

The stage of plant development has a marked effect on the appearance and duration of adult *S. fulvus* activity on cultivated *H. annuus*. The first *S. fulvus* adults appeared on volunteer *H. annuus* in the Leonard field margins during the last week in June of both 1976–77. Adults were first observed on cultivated sunflower in 1976 on July 10 and were present on sunflower for 53 days; in 1977, *S. fulvus* appeared on July 1 and remained on commercial sunflower for 40 days (Fig. 1). During this study, *S. fulvus* adults were present on sunflower at the 3.0–5.0 substage of seed development with the peak number at the 4.0 stage of anthesis.

Prior to the bud stage in sunflower development, *S. fulvus* fed on plant stem and leaf petioles. When buds appeared, *S. fulvus* adults formed pin-point feeding holes on the involucral bracts, and during subsequent anthesis, moved to the inflorescence and fed on pollen produced by disc flowers.

After a preoviposition period of ca. 2 wk, females oviposited on plants at anthesis substages 4.0–4.5. The pattern of oviposition followed the seed filling which proceeded from the periphery to the center of the head (Putt 1940). Adults either died or moved when sunflower developed to the seed development stage. Apparently, adults are no longer attracted to plants beyond the 5.0 substage because of depleted pollen and the hardened achene which prevents oviposition.

Adult *S. fulvus* did not readily fly and remained hidden among the corollas of disc flowers. Adults were not attracted to black light traps. Anderson (1962) gives a detailed description of *S. fulvus* adults.

#### Egg

Eggs of *S. fulvus* were white and averaged 0.28 x 70 mm (n=25). Eggs were embedded in the hull appressed
to the achene and were located in the distal or widest portion of the seed. Normally, an infested seed contained a single egg. Of the 500 infested achenes examined, 19% contained more than 1 egg, but the incidence of multiple larvae was 12%. The lower number of multiple larvae in comparison with the number of multiple eggs per infested seed indicates egg or larval mortality. The oviposition period lasted 20 days, and eclosion occurred in the seed.

**Larva**

After feeding on the seed, 5th instars cut a circular opening (Fig. 2) in the hull, drop out of the seed, and overwinter in the soil. A small but undetermined number of larvae overwintered in seed. Larval emergence from seeds began Aug. 20 in 1976 and Aug. 11 in 1977 (Fig. 3) and continued for ca. 30 days. As larvae dropped, they concentrated in a semi-circular pattern in the soil immediately beneath the drooping sunflower head. Minimal horizontal movement occurred because the semi-circular pattern was maintained from fall to spring. The vertical distribution of larvae in soil fluctuated at various times of the season perhaps in response to soil temperatures. On Jan. 16, 1976, larvae were collected at a depth of 28 cm and at this level, the soil temperature was 1° C. When the soil temperature at 25 cm rose to 6° C. on Apr. 4, 1976, larvae moved to 2.5 cm beneath the soil surface.

Ten confined *S. fulvus* females on sunflower heads (n=24) produced 198.7±41.2 larvae. Sunflower head diam ranged from 12.50 to 27.50 cm with no apparent correlation to the number of larvae produced. In the natural population, we found 6.6±0.3 adults/plant (n=60) on July 20 and 59.6±2.6 larvae/plant (n=60) on Sept. 2, 1976. A mean of 19.9±4.1 larvae was produced by a single female in the natural population and 18.1±0.8 larvae in the controlled study. The male:female sex ratio of *S. fulvus*, as determined in the Leonard field, was 53:47 (N=100) on July 20 and 48:52 (N=100) on Aug. 15, 1976. The closeness between observed and calculated means of the head capsule width, low probability of error, and coefficient of variation indicated 5 larval instars in *S. fulvus*. A detailed description of the 5th instar and pupa of *S. fulvus* is given by Oseto and Braness (1979). No significant difference in head capsule width occurred between larvae collected in the fall and the spring. Time of development from the 1st to the 5th stage was ca. 10 days in the field.

**Pupa**


**Soil Study**

Fourteen (5.6%) adult *S. fulvus* (N=250) emerged from fine textured soil at the NDSU field. No living larvae were recovered from overwintering cages on Nov. 2, 1977. Larval remains, apparently infected by a fungus, were recovered from both soil types.

In the laboratory, 35 and 38% of the adults emerged in fine and in coarse textured soils, respectively. The 1st adults emerged from both soil types 84 days after cold treatment (Fig. 4). After 330 days, an inspection of the soil revealed 51 larvae in the fine textured soil and 72 larvae in the coarse textured soil. A single pupa was recovered from coarse textured soil. The combined morality for larvae and pupae was approximately 42% in fine textured soil and 37% in coarse textured soil.

**Alternate Plant Hosts**

*S. fulvus* adults were observed feeding and mating on wild *Helianthus annuus* L., *H. maximiliani* Schrader, *H. petiolaris* Nuttal, and *H. tuberosus* L. in the Red River Valley of North Dakota and Minnesota. Larvae were recovered from *H. annuus*, *H. maximiliani*, and *H. petiolaris*, but not from *H. tuberosus*. Satterthwait (1946) reported that *S. fulvus* adults were not detected on plants other than on *Helianthus* spp. Schwitzgebel and Wilbur (1942) and Tuttle (1952) reported collecting *S. fulvus* adults in Kansas on ironweed, *Vernonia interior* Small, and on *Heliopsis helianthoids* L., respectively.

**Natural Enemies**

In our study, 2 braconid parasites, *Bracon mellitor* Say and *Neoliolus curculionis* (Fitch) (Hymenoptera: Braconidae) and a pteromalid, *Trimeromimus* sp. (Hymenoptera: Pteromalidae) emerged from sunflower achenes collected from the Leonard fields in 1976–77. Cockerell (1915) observed 2 adult chalcidoids, *Torymus* sp. and *Zaglyptonotus schwarzi* Cwfd. (Hymenoptera: Bethylidae) and a fungus, were recovered from both soil types.

![FIG. 2.—Sunflower seeds damaged by *S. fulvus* larvae. A = oviposition scar, B = emergence holes, C = achene damaged by larva.](https://academic.oup.com/aesa/article/72/4/524/83615)
FIG. 3.—Mean number of *S. fulvus* larvae emerging from 27 sunflower heads at Leonard, ND, 1976-77.

FIG. 4.—Adult emergence of *S. fulvus* in the laboratory from fine soil at Leonard, and coarse soil at Fargo (NDSU), ND.
Torymidae) associated with sunflower heads. Bigger (1930) confirmed parasitism of \textit{S. fulvus} larvae by \textit{T. albitarse} Huber. \textit{B. mellitor} was reported by Bigger (1931) to be a potentially important parasite of \textit{S. fulvus} and Bigger (1932) observed \textit{Eupelminus cyaniceps amicus} Girault (Hymenoptera: Eupelimidae) parasitizing \textit{S. fulvus}. Therevid larvae were reported by Cole (1923) as predaceous on soil inhabiting elaterid larvae. Larvae of \textit{Cyclotelus rufiventris} (Loew) (Diptera: Therevidae) fed on \textit{S. fulvus} larvae in the laboratory. No attempt was made to assess the importance of these natural enemies in the control of \textit{S. fulvus}.

Acknowledgment

We express appreciation to P. M. Marsh and E. E. Grissell, Systematic Entomology Laboratory, USDA-SEA, Beltsville, MD, for the identification of hymenopterous parasites and to M. E. Irwin, Univ. of Illinois at Urbana-Champaign, for the identification of the therevid.

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