

THE LARVAL AND PUPAL STAGES OF FOUR SPECIES OF *CAFIUS* (COLEOPTERA: STAPHYLINIDAE) WITH NOTES ON THEIR BIOLOGY AND ECOLOGY

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ABSTRACT.—Staphylinid beetles of the genus *Cafius* live in and under piles of decaying seaweed on beaches in southern California. Seven species (*seminitens*, *canescens*, *luteipennis*, *lithocharinus*, *decipiens*, *opacus*, *sulcicollis*) occur together in this habitat. Their food consists largely of fly (*Fucellia*) larvae and pupae, although some were seen to prey upon amphipods and barnacles and scavenge on dead fish, others were predaceous on their own larvae as well as those of other species of *Cafius*. In mating, end-to-end postures were observed, but more commonly males assumed a superior position. In the laboratory, eggs deposited in sand about one inch below the surface hatch in about 6 days, pupation occurring about 27 days later and adult eclosion on day 39. Early developmental stages are described and illustrated for *luteipennis*, *lithocharinus*, *canescens* and *seminitens*.

A unique group of arthropods live on decaying seaweed on the beaches of southern California. The habitat consists chiefly of surf grass, four species of brown algae, and ten species of red algae (Dawson, 1945, 1966). These plants are found together in clumps of all sizes, extending from the strand to the high tide level of the beach. From the moment that this vegetation appears on the shore, it is colonized by flies (*Fucellia* and *Leptocera*) and amphipods tolerant of repeated wetting and occasional submersion in sea water. Higher on the beach other accumulations of seaweed provide a habitat for additional species of flies as well as arachnids, mites, isopods and a variety of Coleoptera.

Three species of *Fucellia* are probably most common in these habitats, while of the coleopterans, the Staphylinidae are usually the most abundant (Moore, 1956). This paper is concerned with *Cafius*, one of the more conspicuous genera of Staphylinidae. The four commonly found species are *Cafius seminitens* Horn, *C. canescens* Mäklin, *C. luteipennis* Horn, and *C. lithocharinus* LeConte. Less common are *C. decipiens* LeConte, *C. opacus* LeConte, and *C. sulcicollis* LeConte. The slim elongated bodies of these species enable them to move easily within the clumps of seaweed and to burrow into the upper layer of mixed sand and seaweed.

METHODS

Observations and samples of this community were taken weekly from June 1966 through October 1967 on the beaches of San Clemente and Corona Del Mar in Orange County; and of La Jolla, Ocean Beach, Sunset Cliffs, and Coronado, all in San Diego County. All study sites were relatively undisturbed by beach cleaning machinery. Field and laboratory studies were conducted on feeding and mating behavior, the effects of physical factors and competition (James, 1968).

RESULTS AND DISCUSSION

Habitat Observations.—We noted that staphylinids always inhabited not only the seaweed but also the wet and slimy upper layer of sand beneath. If disturbed, they moved to the tips of the drier seaweed, then flew to other nearby clumps.

Laboratory experiments showed that all species were attracted to the smallest sand particles found in the beach habitat (James, 1968), and prefer a relative humidity of 95 percent. We also found that all species could survive without food for about a week, but that further starvation was detrimental. Survival of individuals on the surface of seawater

in a plastic container ranged from 45 to 72 hours.

We observed one individual of *Cafius lithocharinus* which had the longest survival in sea water, and found that it supported itself on its tibia on the water surface film for about 2½ hours. This individual, when placed in a plastic enclosed container partly filled with sea water, flew three times but finally resorted to merely floating on the surface as was characteristic of the other three species studied. When pushed beneath the water, all four species curled their abdomens up and back toward the thorax. The crook thus formed entrapped a bubble of air, which was carried beneath the surface. Upon release the beetle floated back to the surface and extended its abdomen, then groomed the head and antennae with the forelegs. Flotation ceased when the beetle dropped its abdomen below the water surface, curved the abdominal tip back towards the head, and ceased leg movement. The body then sank to the bottom and movement stopped.

Sea water thrown on beached seaweed caused beetles to come to the surface and fly away. A thorough soaking of the deposit drove out all beetles. Beetle flight was always away from the ocean, either up the beach or parallel to the surf, the ultimate goal being undisturbed piles of seaweed nearby.

Fresh piles of seaweed were colonized by large numbers of adult staphylinids within two weeks of deposition. Once 800 individuals of *Cafius lithocharinus* were captured, marked with white paint, and released on the beach near their capture. None of the marked individuals was ever recovered.

Predation.—*Cafius canescens* and *C. seminitens* were voracious predators of both larvae and pupae of *Fucellia*, while *C. lithocharinus* and *C. luteipennis* were only casual feeders on larvae under experimental conditions (James, 1968). The adults of the four common species are chiefly predatory, although some were seen to scavenge on dead grunion. Other known prey of *Cafius* includes amphipods and small barnacles; at times they also preyed on their own larvae and pupae as well as those of related species.

Feeding Behavior.—*Cafius seminitens* and *C. canescens* upon encountering a fly larva would grasp it with the mandibles, and break the larval intergment. Oozing body fluids attracted other staphylinids, which joined in the consumption of the prey. We observed *C. canescens* breaking the surface layers of seaweed with its mandibles to feed on fly larvae within. This action attracted additional staphylinids which then shared the kill. On one occasion seven beetles consumed a fly larva in nine minutes. *Cafius seminitens* and *C. canescens* were capable of excavating a hole in the puparium of a fly larva, and consuming the oozing fluids. Pupae were rarely shared.

Mating Behavior.—Although end-to-end mating postures were observed, usually the male assumed a superior position. The males use their mandibles to grip the females on the 2nd and 3rd abdominal segments below the elytra, in addition to using their legs to hold the female in position. In *C. canescens* the male extended the adaeagus while curling his abdomen around and downward to meet the female's upcurved abdomen. This position was retained for as long as 77 seconds.

Immature Stages.—In the laboratory, individually placed eggs of *Cafius canescens* were deposited about 1 inch below the sand surface. Gestation was about 6 days at room temperature. A newly hatched larva immediately excavated a burrow about 5 inches deep in a sand-filled test tube. Pieces of cockroaches which were dropped into the test tube were examined by the staphylinid larva on the surface and finally pulled into the sand burrow.

The larva oriented itself with its head toward the sand surface. The burrow was enlarged and extensions were made in succeeding larval stages. Pupation occurred about 27 days after egg laying at the 1/2 inch level in sand. Adult eclosion occurred on the 39th

day after the egg was laid.

Larvae of *C. canescens* were first collected from the beach at Coronado on 15 March 1967. Overwintering apparently occurs in either the egg, pupal or adult stage. After 1 April, *C. canescens* larvae were collected regularly in small numbers at all study sites. *Cafius luteipennis* larvae were placed in a cage on 25 March and pupated 31 days later. After 4 May, larvae of *C. luteipennis* were collected in small numbers from the Coronado site. On 8 July, larvae of *C. lithocharinus* were first collected at Coronado, and the pupae were formed 34 days after a second set of larvae was collected on 27 August.

The large larvae of *Cafius seminitens* were first observed at Corona Del Mar on 18 September. Pupation occurred 18 days later and adults emerged on the 28th day. Only *Cafius seminitens* larvae were seen to feed on seaweed fly larvae, devouring their prey in a similar manner as the adults.

The various species of *Cafius* apparently breed at different times of the year, as indicated by their appearance at different dates. *Cafius canescens* and *C. luteipennis* appear to breed in early spring, *C. lithocharinus* in early summer, and *C. seminitens* in late summer.

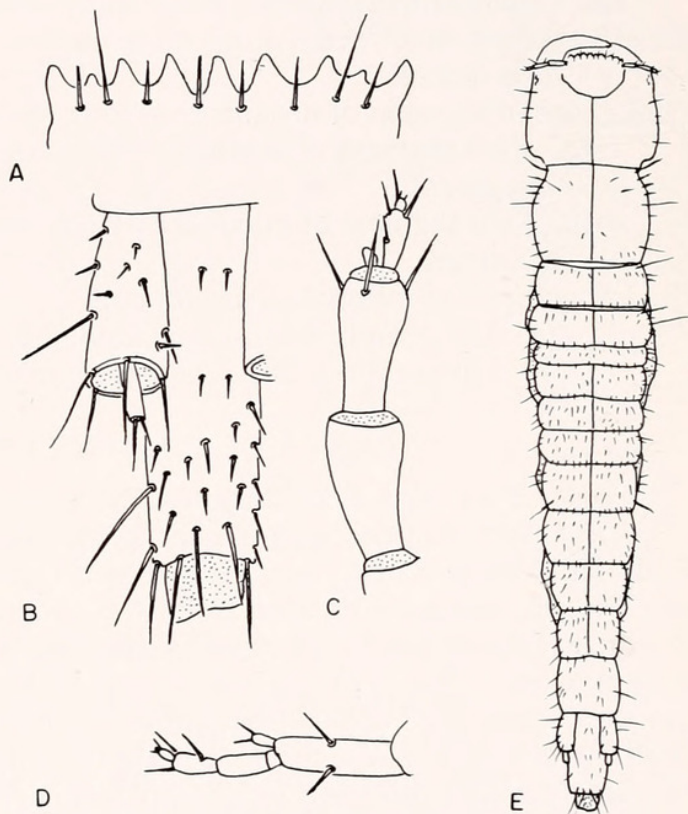


Figure 1. Larva of *Cafius canescens* Mäklin. a, anterior margin of clypeus; b, urogomphus and pseudopodia; c, antenna; d, maxilla; e, dorsal view of body.

DESCRIPTIONS OF EARLY STAGES LARVAE

The larva of the European *Cafius sericeus* Holme was described by Rey (1887) and that of *C. xantholoma* (Gravenhorst) by Rupertsberger (1880). Paulian (1941) redescribed both of these species, using the name *Remus sericeus* for the former. *Remus* generally is considered a subgenus of *Cafius*. Paulian gave no generic description for the larva of *Cafius*. But a combination of characters from his key makes a good diagnosis of this genus. It follows:

Cephalization accentuated; neck present; epicranial suture very long; gular sutures very long; ocelli four, arranged in a compact group near bases of antennae; nasal present; max-

illary palpus four-segmented; galea present, movable, with the aspect of a segment; lacina reduced at maximum to some local spines in the apical region of the stipes; prosternum strongly chitinized.

The combination of these diagnostic characters and the seashore habitat, permit easy recognition of *Cafius* larvae.

In his key Paulian used other characters which new material shows to be too variable for a generic definition. Thus the middle teeth of the nasal do not differ from the lateral teeth in all the Pacific Coast species. And although the urogomphus is two-segmented and longer than the pseudopod in two of our species, in the other two it is shorter than the pseudopod. In one of the latter the urogomphus is distinctly one-segmented and spherical.

KEY TO THE KNOWN LARVAE OF *CAFIUS*

- 1A. Urogomphus longer than pseudopod.
 - 2A. Second segment of urogomphus widest at base, tapered to apex.
 - 3A. Composite macrosetae much more numerous than simple macrosetae. *sericeus*
 - 3B. Simple macrosetae much more numerous than composite macrosetae *xantholoma*
 - 2B. Second segment of urogomphus long, slender, cylindrical.
 - 4A. First segment of maxillary palpus one-half as long as second segment. *luteipennis*
 - 4B. First segment of maxillary palpus about as long as second segment. *lithocharinus*
- 1B. Urogomphus shorter than pseudopod.
 - 5A. Urogomphus two-segmented, the segments subcylindrical *canescens*
 - 5A. Urogomphus one-segmented, spherical *seminitens*

LARVA OF *CAFIUS LUTEIPENNIS* HORN

Color.—Pale, with head dark testaceous.

Head subquadrate, widest near basal angles, slightly narrowed to apical angles. Neck about three-fourths as wide as head. Ocelli four, in a small cluster near apical angles. Clypeal margin with nine teeth, the two outer teeth on each side smallest, the next two on each side longer than wide, the central tooth little more than half as long as those next to it (Fig. 3A). Antennae four-segmented, the first segment short, the second and third about as wide as first and each about twice as long as wide, the third with a small ovoid seta at apex, the fourth about half as wide and half as long as third with a very small, round modified seta at apex (Fig. 3C). Maxilla (Fig. 3D) with the stipes almost as long as palpus; galea small elongate-ovoid; maxillary palpus four-segmented, the first segment about as long as wide, the second as wide as and twice as long as first, the third somewhat narrower and shorter than second, the fourth small, elongate-ovoid. Ligula about as long as first segment of labial palpus, pubescent basally. Labial palpus three-segmented, the first segment about twice as long as wide, the second a little narrower and shorter than first, the third much narrower and shorter than second. Gular sutures united in basal three-fifths, thence divergent to apex.

Thorax.—Pronotum a little wider than long, widest near basal angles, narrowed slightly to apical angles, with a few scattered setae at sides and on disc. Mesonotum and metanotum shorter and a little wider than pronotum, with sparse scattered setae.

Abdomen with parallel sides in basal half, thence slightly narrowed to apex, the

segments of about equal length throughout, sparsely setose. Pseudopod about twice as long as wide. Urogomphus two-segmented, longer than pseudopod, the segments very slender, the second segment much narrower and somewhat shorter than first.

Length.—7 mm.

Material examined.—Hotel Del Coronado Beach, Coronado, San Diego Co., California, April 1967, Gary James coll.

Notes.—This species can be distinguished by the combination of the very long slender two-segmented urogomphus and the very short first segment of the maxillary palpus.

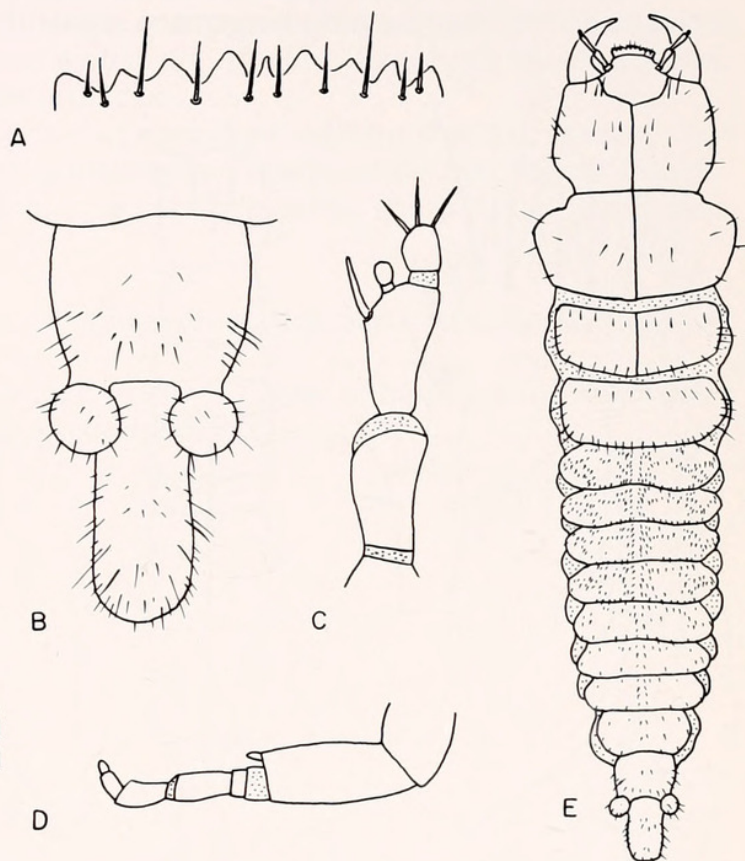


Figure 2. Larva of *Cafius seminitens* Horn. a, anterior margin of clypeus; b, urogomphus and pseudopodia; c, antenna; d, maxilla; e, dorsal view of body.

LARVA OF *CAFIUS LITHOCHARINUS* LE CONTE

Color.—Head and thorax dark ferruginous, abdomen pale ferruginous.

Head subquadrate, widest near basal angles, slightly narrowed from base to apex. Neck about four-fifths as wide as head. Ocelli small, dark, in a small cluster near apical angles. Frontal suture joining epicranial suture at an obtuse angle near anterior third of head. Clypeal margin with nine teeth, the central tooth and two outer teeth smallest (Fig. 4A). Antenna with first segment short, the second and third each about twice as long as wide, the third with an ovoid modified seta at apex, the fourth much narrower and shorter than third, with a small ovoid modified seta at apex (Fig. 4C). Maxilla (Fig. 4D) with stipes as long as palpus; galea very small, ovoid; maxillary palpus four-segmented, the first segment about twice as long as wide, the second a little narrower and shorter than the first, the third much narrower and somewhat shorter than second, the fourth small, ovoid. Ligula shorter than first segment of labial palpus, pubescent. Labial palpus three-segmented, the first segment almost twice as long as wide, the second narrower and shorter than first, the third small, ovoid. Gular sutures united in basal two-thirds, divergent anteriorly.

Thorax.—Pronotum about as wide as long, widest near basal angles, narrower ante-

riorly. Mesonotum and metanotum much shorter and slightly wider than pronotum.

Abdomen gently tapered from base to apex, the first segment short, the others progressively slightly longer, with scattered sparse setae throughout. Pseudopod nearly three times as long as wide. Urogomphus longer than pseudopod, two-segmented, the first segment almost as long as pseudopod, the second long and very slender (Fig. 4B).

Length.—8-11 mm.

Material examined.—Ten specimens: Hotel Del Coronado Beach, Coronado, San Diego Co., California, August 7, 1967, Gary James coll.

Notes.—This larva most closely resembles that of *C. luteipennis*, from which it may be distinguished by the relatively longer first segment of the maxillary palpus and by shorter clypeal teeth.

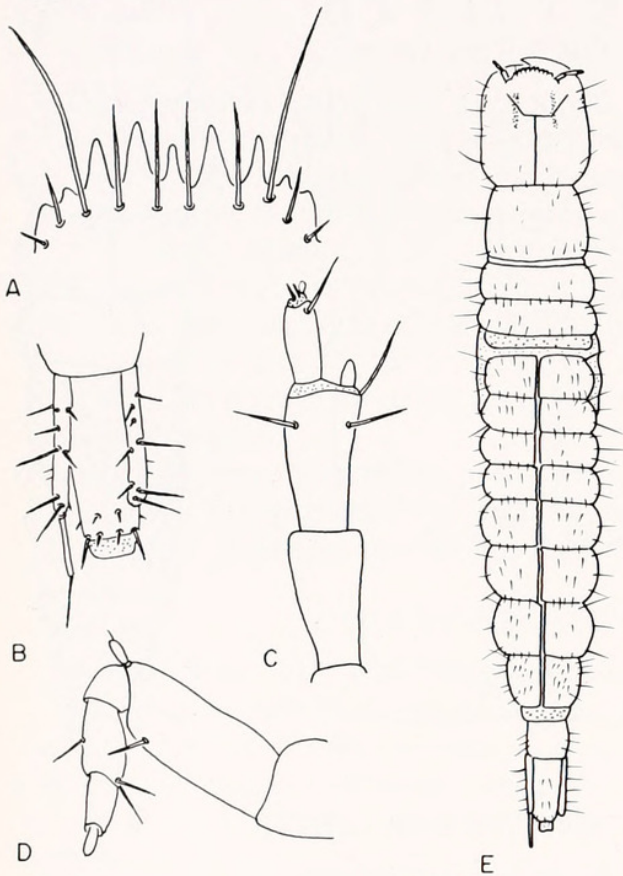


Figure 3. Larva of *Cafius luteipennis* Horn. a, anterior margin of clypeus; b, urogomphus and pseudopodia; c, antenna; d, maxilla; e, dorsal view of body.

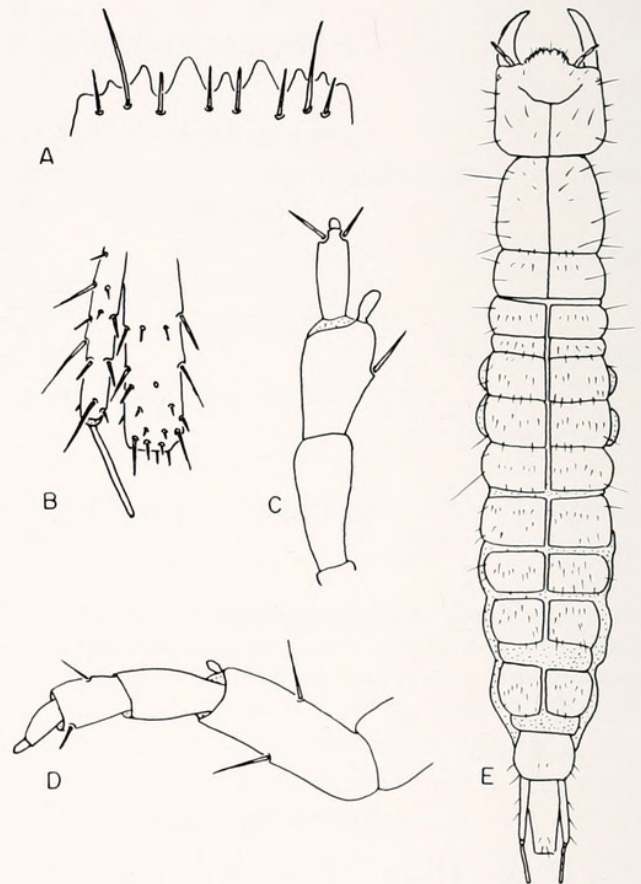


Figure 4. Larva of *Cafius lithocharinus* LeConte. a, anterior margin of clypeus; b, urogomphus and pseudopodia; c, antenna; d, maxilla; e, dorsal view of body.

LARVA OF *CAFIUS CANESCENS* MÄKLIN

Color.—Pale testaceous, with head ferruginous. Ocelli and base and apex of mandibles dark.

Head subquadrate, widest just before the rounded basal angles, gradually narrowed to near the ocelli. Neck about five-sevenths as wide as head. Ocelli four, in a close cluster near the anterior angles. Frontal suture joining epicranial suture at an obtuse angle at about the anterior third of the head. Clypeal margin with nine similar teeth, the penultimate outer tooth on each side somewhat shorter than the others (Fig. 1A). Antenna with first segment widest, about as long as wide, the second segment about twice as long as first, the third

about as long as second and with a small modified segment at apex, fourth segment much narrower and shorter than third (Fig. 1C). Maxilla (Fig. 1D) with stipes almost as long as palpus, about twice as long as wide. Galea small, ovoid; maxillary palpus with first two segments subequal, the third much shorter and narrower than second, the fourth minute. Ligula about as long as first segment of labial palpus, pubescent in basal half. Labial palpus three-segmented, the first segment about twice as long as wide, the second a little shorter and distinctly narrower than first, the third narrower than second, very little longer than wide. Gular sutures united in basal three-fifths, thence divergent to apex.

Thorax.—Pronotum subquadrate, a little wider than long, widest near middle, thence narrowed slightly to base and to apex. Mesonotum and metanotum much shorter than and about as wide as pronotum. Each segment with a row of setae at anterior, lateral and posterior margins and a very few scattered setae on disc.

Abdomen widest at base, slightly tapered to apex; first segment shortest, the segments increasing in length progressively to apex; a little more densely setose than thorax. Pseudopod about twice as long as wide. Urogomphus two-segmented, shorter than pseudopod, subcylindrical (Fig. 1B).

Length.—9 mm.

Material examined.—Five specimens, $\frac{1}{2}$ mile west of pier, San Clemente, Orange Co., California, 12 April 1967, Gary James coll.

Notes.—This larva differs from the other larvae of *Cafius* in having a two-segmented urogomphus that is much shorter than the pseudopod.

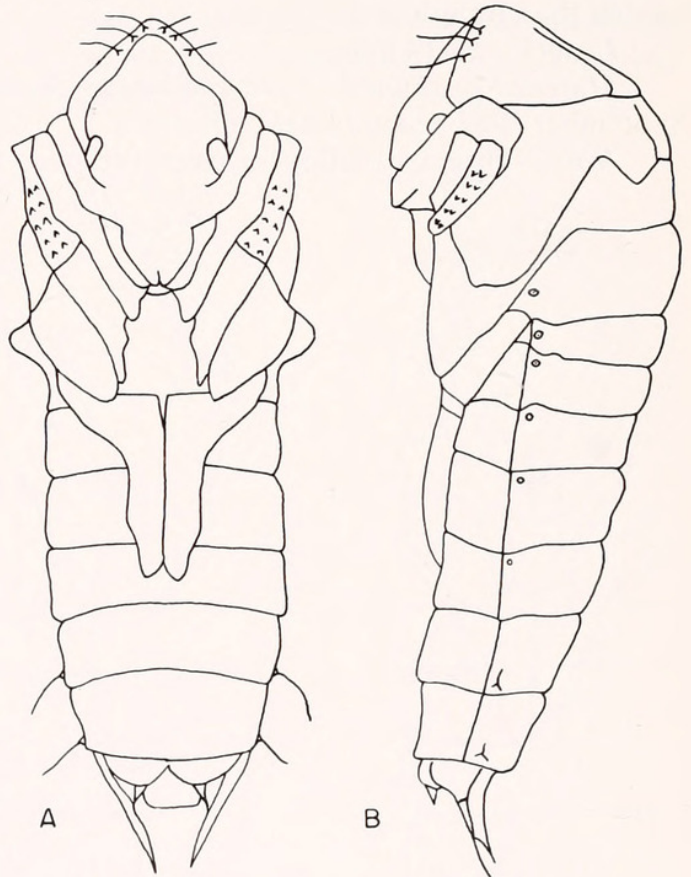


Figure 5. Pupa of *Cafius canescens* Mäklin. a, ventral view; b, lateral view.

LARVA OF *CAFIUS SEMINITENS* HORN

Color.—Pale testaceous, with head and pronotum ferruginous, the base and apex of mandibles darker. Head subquadrate, a little wider than long, widest near basal third,

thence slightly narrowed to apex. Neck about three-fourths as wide as head. Ocelli very pale, difficult to detect. Frontal sutures joining epicranial suture at an obtuse angle at about the apical third of head. Clypeal margin with nine teeth, the central tooth distinctly smaller than the others (Fig. 2A). Antenna four-segmented, the first segment short, the second and third as wide as and more than twice as long as first, the third with a rounded modified seta at apex, the fourth small ovoid (Fig. 2C). Maxilla with stipes as long as palpus, about twice as long as wide; galea small, oval; maxillary palpus (Fig. 2D) with a separate sclerotization forming a very short ring at base in the form of an extra segment which may represent the lacina; first segment of palpus about twice as long as wide, the second nearly as wide and as long as first, the third a little narrower and shorter than second, the fourth small, ovoid. Ligula about as long as first segment of labial palpus, pubescent at base. Labial palpus three-segmented, the first segment about twice as long as wide, the second narrower and a little shorter than first, the third much narrower and shorter than second. Gular sutures united in basal three-fifths, thence divergent to apex.

Thorax.—Pronotum transverse, the sides well rounded, widest at basal third, with a few scattered setae on disc and at sides. Mesonotum and metanotum narrower and shorter than pronotum, with a row of setae at base, sides and apex.

Abdomen slightly tapered from base to apex, the first few segments short, the apical segments progressively narrower and longer. First four segments irregularly, and densely set with short stout peg-like setae, the next five segments progressively more sparsely setose. Pseudopod about twice as long as wide. Urogomphus one-segmented, spherical, much shorter than pseudopod (Fig. 2B).

Length.—10-14 mm.

Material examined.—Five specimens, Corona Del Mar, Orange Co., California, 16 September 1967, Gary James collector.

Note.—This larva differs in several respects from other known larvae of *Cafius*, but par-

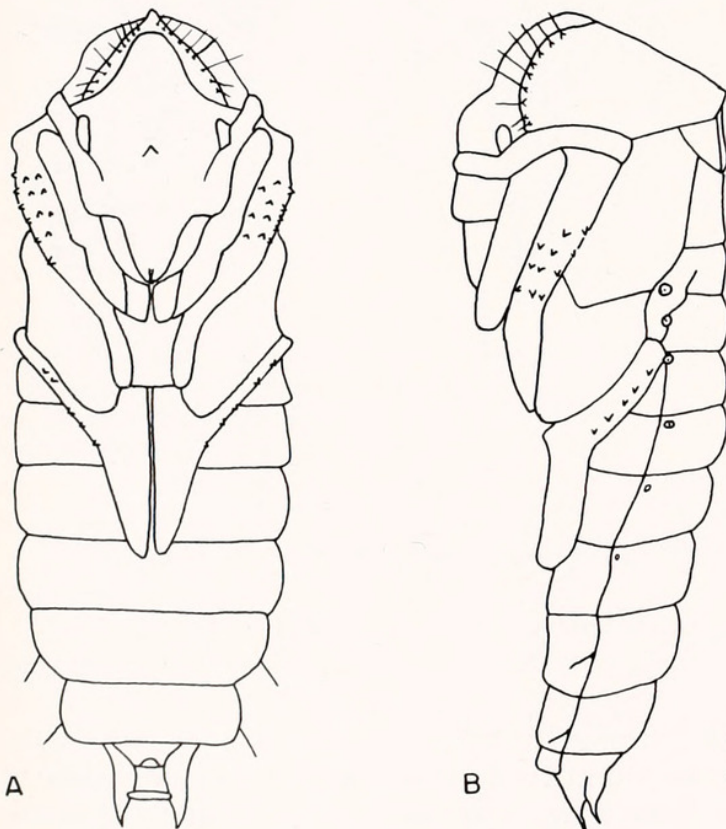


Figure 6. Pupa of *Cafius seminitens* Horn. a, ventral view; b, lateral view.

ticularly in the spherical one-segmented urogomphus, the "extra segment" at the base of the maxillary palpus, the very transverse pronotum and the densely setose first four abdominal segments.

On the basis of larval characters this species might be placed in a separate genus or even separate subfamily, but adult characters preclude such a course. Because of the great similarity of their imagoes, this species and *C. canescens* are usually placed by themselves in the subgenus *Bryonomus*.

PUPAE

The pupa of the European species *C. sericeus* Holme, was described and illustrated by Paulian (1941). In his key to the genera of the pupae of the Staphilinoidea he diagnosed *sericeus* as follows:

Pronotum with strong marginal setae, without discal setae; dorsum of abdomen flat, epipleurae prominent; with two long slender cerci which have whorls of fine setae apically.

The pupae of the Pacific Coast species show that some of these characters are specific rather than generic.

Hinton (1958, 1963a, 1963b) called attention to the fact that among the few pupae of Coleoptera studied the most apparent useful taxonomic characters are the number and arrangement of tubercles, macrosetae and pubescence. The pupae of *Cafius* which have been studied share the following characters:

Body without fine pubescence except dense fine pubescence at extreme tip of urogomphus. Tubercles arranged in a single row at anterior margin of pronotum, two to four rows on middle and posterior tibiae and one tubercle each at lateral margin of abdominal segments five and six. Macrosetae restricted to pronotal and abdominal tubercles.

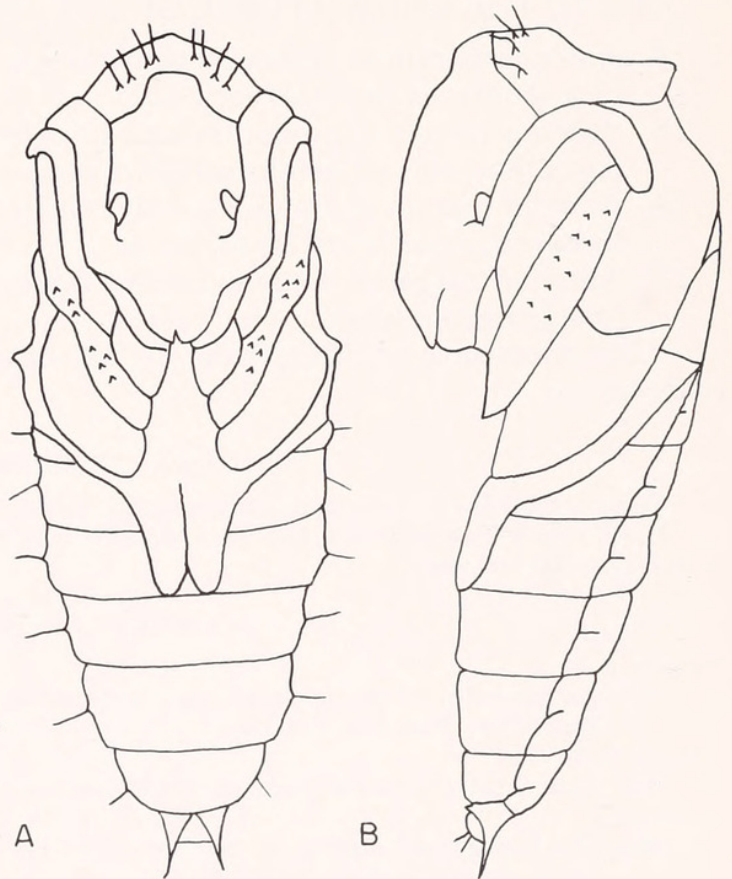


Figure 7. Pupa of *Cafius luteipennis* Horn. a, ventral view; b, lateral view.

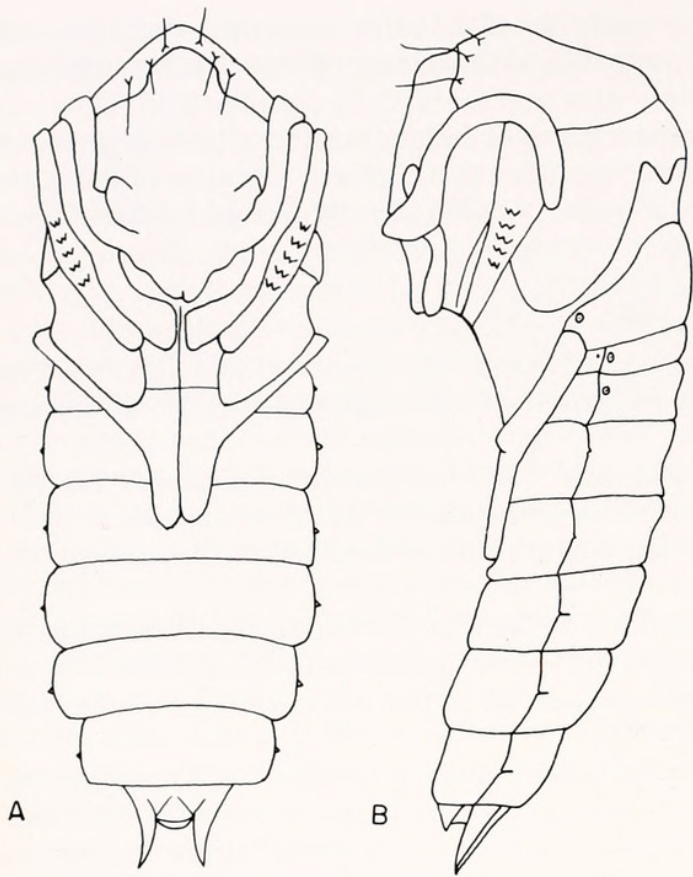


Figure 8. Pupa of *Cafius lithocharinus* Le-Conte. a, ventral view; b, lateral view.

KEY TO THE KNOWN PUPAE OF THE AMERICAN SPECIES OF *CAFIUS*

- 1A. Anterior margin of pronotum with a single row of nine setigerous tubercles each side *seminitens*
 - 1B. Anterior margin of pronotum with a single row of fewer than nine setigerous tubercles each side.
 - 2A. Anterior margin of pronotum with a single row of three setigerous tubercles each side *canescens, lithocharinus*
 - 2B. Anterior margin of pronotum with a single row of four setigerous tubercles each side *luteipennis*
- Characters have not been found for the separation of the pupae of *C. canescens* and *lithocharinus*.

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