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Predators and Parasites of the Douglas-fir Beetle:

Description and Identification of the Immature Stages



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Predators and Parasites of the Douglas-fir Beetle:

Description and Identification of the Immature Stages

L. N. KLINE AND J. A. RUDINSKY

INTRODUCTION

The Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins (Coleoptera: Scolytidae), is the most destructive insect enemy of Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, throughout the range of this important tree species. During the epidemic of 1951-1954, for instance, it killed over three billion board feet of green timber in western Oregon and Washington alone.

The beetle is native to North America, and is preyed upon by a number of important predators and parasites. Some of these undoubtedly play a significant role in reducing the epidemic population of the beetle or in preventing its increase to destructive numbers.

Making a prognosis of the trend of the Douglas-fir beetle population in the field or forecasting the economic damage requires sampling not only Douglas-fir beetles, but also numbers and species of the immature stages of predators and parasites present under the bark. Past studies have been concerned more with the biology of the Douglas-fir beetle than with its natural enemies. The biology and identification, especially of the immature stages of the predators and parasites, are incomplete or in some instances virtually unknown.

This bulletin presents identifications, descriptions, and drawings of the immature stages of the main predators and parasites of the Douglas-fir beetle in the Intermountain and Pacific Northwest regions of the United States. Brief notes on the life histories of the predators and parasites, and a key separating the larvae are also included.

Emphasis is placed on the following species: *Enoclerus sphegeus*, *E. lecontei*, *Thanasimus undatulus*, and *Temnochila virescens*. The remaining species, *Medetera* spp., *Lonchaea* spp., *Coeloides brunneri*, and the pteromalids, are treated in a more general manner.

Three instars exist for the clerids, with five to six for the ostomatid.

LITERATURE REVIEW

A review of the literature shows that only limited studies have been made of the biology, habits, and identification of a few of the insect enemies of the Douglas-fir beetle.

In northern Idaho and Montana, Bedard (1, pp. 27-61) worked briefly on the biology, habits, and identification of *Enoclerus spehegeus* Fab. (Coleoptera: Cleridae); *E. lecontei* Wolc. (Coleoptera: Cleridae); *Thanasimus dubius* (Fab.) (Coleoptera: Cleridae), a mistaken identity for *T. undatulus* Say; *Temnochila virescens chlorodia* Mann. (Coleoptera: Ostomatidae); *Medetera aldrichii* Wh. (Diptera: Doli-chopodidae); *Lonchaea corticis* Tay. (Diptera: Lonchaeidae); *Coe-loides brunneri* Vier. (Hymenoptera: Braconidae); *Roptrocercus ec-coptogasteri* Ratz. (Hymenoptera: Pteromalidae); and *Cecidostiba dendroctoni* Ashm. (Hymenoptera: Pteromalidae). Bedard's descriptions and drawings of the larvae were only of the mature instars.

Böving, Craighead, and Champlain (4, 5, 6) published on the identification of the mature larval instars of *E. spehegeus*, *E. lecontei*, and *T. virescens*. Only a few drawings were made for *T. virescens*. These workers also included brief notes on the biology of some of the clerids preying on bark beetles in general. Habits of the adults and larvae and identification of four instars of *E. spehegeus* in relation to *Ips pini* (Say) and *Ips perrotti* Sw. on lodgepole pine slash in Alberta, Canada, have been reported by Reid (20). Person (17) worked on the life history, habits, importance as a natural control factor, and possibilities of increasing the effectiveness of *E. lecontei* in association with western pine beetle, *Dendroctonus brevicornis* Lec., in California. Some work has been done by Struble and Carpelan on the identification, biology, habits, and laboratory propagation of *E. spehegeus* and *T. virescens* in an attempt to rear these predators for liberation in the field as control agents of bark beetles (24, 25, 26).

A fairly complete study was made by DeLeon (8) on the biology, habits, and internal and external morphology of the larva of *Medetera aldrichii* Wh. in relation to mountain pine beetle, *D. monticolae* Hopk., in Montana and northeastern Washington. Also, several notes were made by Hopping (9) on the seasonal development of *M. aldrichii* as a predator of *D. pseudotsugae* in British Columbia.

Recently, Johnsey (10) studied the biology of *M. aldrichii* and *Lonchaea* sp. associated with the Douglas-fir beetle in western Oregon and Washington.

Ryan and Rudinsky (22) published on the biology, habits, and descriptions of the five larval instars, development of the immature stadia at various temperatures, and factors contributing to the effectiveness of *Coeloides brunneri* Vier., a parasite of the Douglas-fir beetle in western Oregon.

IDENTIFICATION OF THE INSECT ENEMIES OF DENDROCTONUS PSEUDOTSUGAE

As just noted, previous studies, with the exception of those by DeLeon (8, pp. 62-67), Reid (20), and Ryan (21), were concerned only with the identification of the mature larval stage. Past and present biological appraisals or population sampling of bark beetles have been based on immature stages found under the bark. Therefore, in this type of sampling, since all stages of the insect concerned may be encountered, all should be easily identified.

Discussed here are the methods and procedures used in rearing certain species in order to obtain specimens for study, and also the methods of measurement and drawing. To facilitate future identifications, a field key, descriptions, and illustrations of the immature stages of the most important species are included. The general biology, geographical distribution, and relative importance of each species are given, based on general observation.

Methods and Procedures of Study

Because of the scant taxonomical knowledge of the adults of the hymenopterous parasites and dipterous predators, it was possible in this study to identify the immature stages only to the family and generic levels. Available literature was used for the descriptions whenever possible, and other characters and material were included from personal observation.

The taxonomy of the adult coleopterous predators has been worked on more intensively but still presents a problem in associating adults with their immature forms. Therefore, each species was reared in order to obtain known specimens of each stage for study. These rearings were conducted in a manner similar to those reared by Struble (25).

Briefly, the method of rearing was as follows: Known identified adults of *Enoclerus sphegeus*, *E. lecontei*, *Thanasimus undatulus*, and *Temnochila virescens* were collected in the field on the bark and around Douglas-fir trees infested by *Dendroctonus pseudotsugae*. The

sex of the adults was determined whenever possible, using the sex characters described by Struble and Carpelan (26). The submental pit present only on the males of *T. virescens* was easy to observe with a 10x hand lens and was very dependable. However, the sex character suggested by the same workers for *E. sphaeus* was not easy to observe even under a microscope. It was found that the large size of the abdomen of certain clerids usually indicated the condition of a gravid female. This character, although not too dependable at times, was used for *E. sphaeus*, *E. lecontei*, and *T. undatulus*. No other secondary sex characteristic could be found. The adults of each species were originally placed in pint jars, and later in clear, plastic boxes, measuring 1 by 2.5 by 3.5 inches. A coarse piece of paper was glued to the bottom of the box to provide traction for the adults. Usually there was only one pair of each species per container, but occasionally more. This increased the probability of obtaining eggs in instances where sex determinations were not definite; however, there was the disadvantage of increasing mortality since the adults, as well as the larvae, are cannibalistic, especially under crowded conditions.

A spiral of blotting paper was made by rolling a triangular piece one to two inches wide at the base. One spiral was placed in each container. It served fairly well as an oviposition site when rolled to about one-quarter inch diameter, and most of the eggs were deposited between the overlapping layers. At times, especially with *T. virescens*, the eggs were laid around the edges of the paper bottom of the box, but these eggs were usually damaged by the activity of the adults. The spiral pieces of paper were examined at various intervals by unrolling the spiral. Portions of the spiral containing eggs were cut to minimize the amount of damage to the eggs. They were then placed in another small plastic box and left there during the incubation period.

Living adults of the Douglas-fir beetle were supplied in various numbers and at different intervals of time as food for the ovipositing predators.

As soon as eclosion took place, the larvae were removed by means of a camel's-hair brush and placed individually in a $\frac{3}{4}$ - by $\frac{3}{4}$ - by $\frac{3}{4}$ -inch clear plastic box. Only one larva could be placed in a container because all species are cannibalistic. A piece of blotting paper was placed over the larva to simulate bark, as it was found that the small larvae had difficulty in obtaining a purchase on their prey when this paper was absent. Each larva was fed enough Douglas-fir beetle larvae to insure survival. As in the case of the adults, no attempt was made to record the number of hosts consumed or to maintain

a constant feeding schedule. All rearings were made in the laboratory without attempting to control or measure temperature and humidity.

Measurements were taken at 15x, 30x, and 90x magnifications, depending on the size of the subject, with a dissecting microscope having a calibrated-micrometer eyepiece. Each micrometer unit at the three magnifications was equivalent to 0.096 mm, 0.034 mm, and 0.017 mm, respectively. All measurements were taken while the subject was immersed in alcohol.

Microscope slides were prepared for certain structures in order to make more detailed observations and drawings.

Drawings were made by using the same microscope, but with an eyepiece having a 10 by 10 grid. Tracing paper was placed over different scales of graph paper, and the image of the subject transferred from the microscope to the tracing paper by eye with the aid of the grid lines. All drawings were made from preserved specimens by L. N. Kline with the exception of the two of *Coeloides brunneri*, which were redrawn from Ryan (21).

Terminology in the descriptions follows Knull (11), Peterson (18, 19), and Torre-Bueno (27).

Known and Possible Predators and Parasites

Past studies concerning the Douglas-fir beetle have reported many species of insects that were supposedly predators or parasites. However, more recent studies have reduced the list of insects believed to cause appreciable mortality. The species which are known predators and parasites of the Douglas-fir beetle and those which are commensals or possibly predaceous or parasitic are listed in this section. The associated arthropods are believed to prey upon the secondary insects associated with the Douglas-fir beetle (Cerambycidae, Buprestidae, and Scolytidae), or they may be scavengers. Even some of the species which are listed as being known predators and parasites may cause only a very small percentage of mortality.

Known predators and parasites

CLASS INSECTA:

Coleoptera: Cleridae—*Enoclerus sphegus* Fab.

Enoclerus lecontei Wolc.

Thanasimus undatulus Say

Ostomatidae—*Temnochila virescens chlorodia* Mann.

Diptera: Dolichopodidae—*Medetera aldrichii* Wh.

Medetera sp. (near *nigrripes* Lev.)

Medetera sp. (near *oregonensis* Van Duzee)

Lonchaeidae—*Lonchaea* sp. (near *corticis* Taylor)

Lonchaea sp. (near *watsoni* Curran)

Hymenoptera : Braconidae—*Coeloides brunneri* Vièr.
 Pteromalidae—*Roptrocerus eccoptogasteri* Ratz.
Cecidostiba burkei Crawford
Cecidostiba dendroctoni Ashm.

Commensals or possible predators and parasites

CLASS INSECTA :

Coleoptera : Ostomatidae—*Tenebroides* sp.
 Histeridae—Undetermined species
 Staphylinidae—Undetermined species
 Othniidae—Undetermined species
 Tenebrionidae—*Corticeus* sp.
 Melandryidae—*Rushia* sp.
 Colydiidae—*Lasconotus* sp.
 Hemiptera : Anthocoridae—*Lycocoris* sp.
 Diptera : Scenopinidae—Undetermined species
 Stratiomyidae—Undetermined species
 Itonididae—Undetermined species
 Empididae—Undetermined species

CLASS ARACHNIDA : ORDER PSEUDOSCORPIONIDA

Field Key to the Insect Larvae of the Known Predators and Parasites

The following key is based on mature larvae and is designed for use with a 10x hand lens. No attempt has been made to separate the different instars, eggs, or pupae. Reference can be made to the descriptions of the species if separation of these stages is needed. Although color is generally undesirable as a primary separation character, it is often the most conspicuous feature of a larva and is therefore useful in field determinations. For this reason, color is used in separating the ostomatids from the clerids.

FIELD KEY

1. Larvae with legs 2
- Larvae without legs 5
2. Ventral mouthparts retracted; mesothoracic plates, except for first instar, superficially resembling one plate; all thoracic plates very visible; abdominal segments one to six with dorsal ampullae; apex of mandibles dentate; head, thoracic plates, basal plate and urogomphi very dark brown to black; abdomen white to blue gray at maturity. (Plate XII, Figure A; Plate XIII, Figures B, C, G, and H; Plate XIV, Figure A).....
Temnochila virescens
- Ventral mouthparts protracted; mesothoracic plates distinctly separated; all thoracic plates not very visible; abdominal segments without dorsal ampullae; apex of mandibles entire; head, thoracic plates, basal plate and urogomphi yellow ocher to dark brown; abdomen pink to lilac at maturity. (Plate III, Figures B, C, and E; Plate VI, Figures J and K; Plate VII, Figure B; Plate IX, Figures D, E, and F)..... 3

3. Epicranium with a dorsal tubercle on each side. (Plate I, Figure B; Plate II, Figures C and F) *Enoclerus spegeus*
- Epicranium without dorsal tubercle. (Plate VI, Figures B and L; Plate VIII, Figure F; Plate IX, Figure C) 4
4. Urogomphi somewhat swollen near apex. (Plate VI, Figure H)
 *Enoclerus lecontei*
- Urogomphi not swollen near apex. (Plate IX, Figure A)
 *Thanasimus undatulus*
5. Body slender and cylindrical; with ventral pseudopodia. (Plate XV, Figures B and C) 6
- Body crescent-shaped, fusiform, or cyphosomatic; without ventral pseudopodia. (Plate XVI, Figures A and D) 7
6. Body cylindrical, tapering slightly at each end; internal cylindrical, metacephalic and tentorial rods black; head subdivided; a small sclerotized plate on posterior region of head and anterior margin of prothorax; prothoracic spiracles small, circular; caudal pair larger, oval, with two large oval openings. (Plate XV, Figure B) *Medetera* sp.
- Body wedge-shaped or muscidiform, tapering gradually to a sharply pointed cephalic end; internal rods dark brown; fused at two locations, branching caudally; head not subdivided; no sclerotized plates on head or prothorax; prothoracic spiracles nine-lobed; caudal pair containing three slits situated at right angles to each other. (Plate XV, Figure C).....
 *Lonchaea* sp.
7. Body fusiform to cyphosomatic; spiracles located on prothorax and abdominal segments one to eight; lines between mouthparts and parts of head capsule heavily sclerotized, stripital sclerome between cardo and stripes; seven dorsal protrusile areas in the successive intersegmental areas, the most anterior between the metathoracic and first abdominal segment. (Plate XVI, Figures C and D)....(Braconidae) *Coeloides brunneri*
- Body wedge-shaped or muscidiform, tapering gradually to a sharply end; spiracles located on mesothorax, metathorax and abdominal segments one to seven; lines between mouthparts and parts of head capsule not or feebly sclerotized, cardo and stripes fused or nearly so, without a conspicuous stipital sclerome between them; without dorsal protrusile areas in the successive intersegmented areas. (Plate XVI, Figures A and B).....
 *Pteromalidae*

Description and Illustration of the Egg, Larva, and Pupa of the Known Predators and Parasites

Cleridae: *Enoclerus spegeus* Fabricius

The adult was originally described by Fabricius in 1787 (12, p. 385: 16, p. 84), with a more detailed description by Brown in 1957 (20). The mature larva was briefly described and illustrated by Böving (5, pp. 632-633) in 1920. Bedard (1, pp. 33-34) made very sketchy descriptions and illustrations of the egg and mature larva in 1933. In 1957, Reid (20) described the egg and four instars with some drawings.

This species is one of the more abundant and widely distributed clerids in the coniferous forests of western North America. It is an important enemy of many species of Scolytidae, principally *Dendroctonus* and *Ips*. Records indicate that the species is found as far south as Mexico and north into British Columbia, with its eastern boundary in Colorado and New Mexico (12, p. 150; 16, p. 84). Because of its abundance and apparent aggressiveness, this insect can be rated the most important coleopterous predator of *D. pseudotsugae*.

Briefly, the life cycle with special reference to the Douglas-fir beetle may be summarized as follows: There is only one generation per year, and the emergence of adults is closely synchronized with the emergence of the Douglas-fir beetle in April or May.

Mating takes place on and around material being invaded or already infested by the Douglas-fir beetle, and eggs are laid in clusters under scales of the outer bark. The first larval instars apparently enter the cambial region of the tree through the entrance and "ventilation" holes constructed by the bark beetles. The larvae develop under the bark, feeding on the eggs, larvae, pupae, and callow adults of its host. All three instars are present throughout the summer. A large percentage of the mature larvae (third instar) emerge in mid-summer and migrate on the outer bark to the base of the tree. Pupal cells are formed in the outer bark or in the duff around the root collar. The clerid overwinters as a prepupal larva. When this species was reared in the laboratory, it appeared not to require diapause.

Two generations of this species were reared for identification in the laboratory from adults collected in Idaho and Oregon.

Descriptions of immature stages. The egg, three larval instars, and pupa are described.

Egg: (Plate I, Figure A). Average length, 3.1 mm; range in length, 2.5 mm to 3.5 mm. Average width, 0.7 mm; range in width, 0.6 mm to 0.8 mm. Form subcylindrical, with a slightly curved longitudinal axis, tapering slightly at each end, broadest at the middle, a little wider at one end than at the other; margins slightly unequal; chorion smooth, shining, transparent, without ornamentation, becoming slightly rugose and dull as the embryo approaches maturity; color at first pale orange pink, with development gradually becoming bright salmon pink with translucent or opaque white portions at each end and lateral margins.

First instar: (Plate I, Figures B to E). Maximum length of larva, 7.30 mm; minimum length, 3.25 mm. Maximum width of body, 1.11 mm; maximum thickness of body, 1.11 mm. Average width of head capsule, 0.69 mm; range of width of head capsule, 0.64 mm

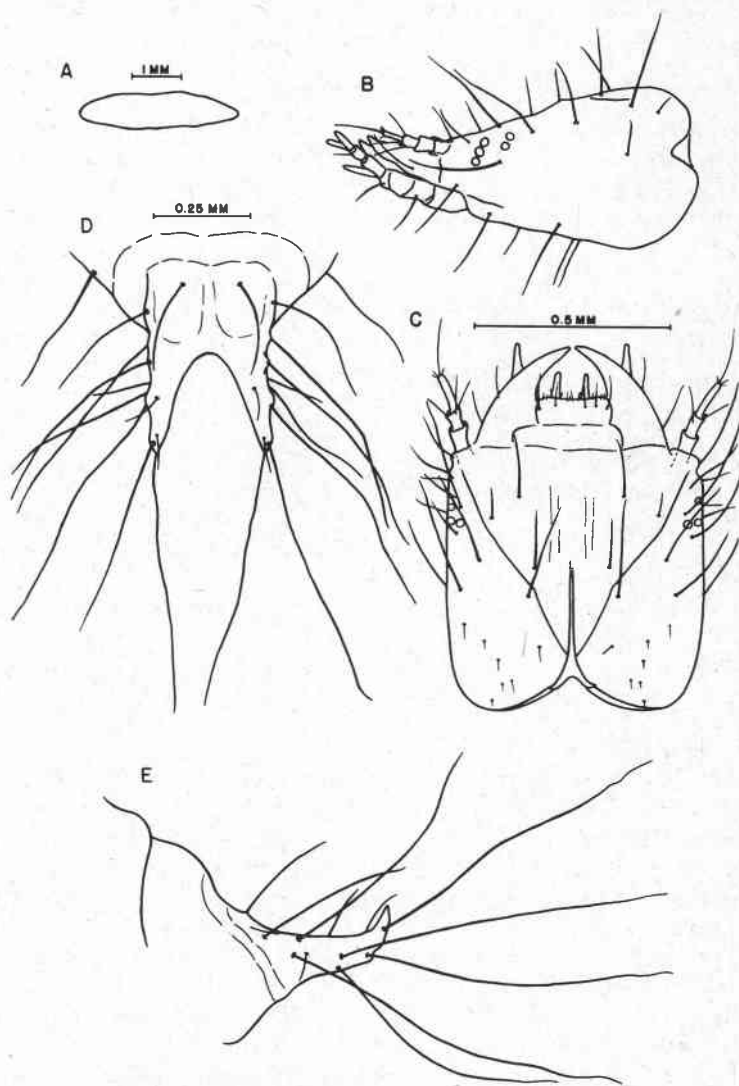


PLATE I

Enoclerus sphegeus Fab.: A, egg; B, first instar, lateral view of head; C, dorsal view of head; D, dorsal view of basal plate and urogomphi; E, lateral view of basal plate and urogomphi.

to 0.72 mm. Anterior width of prothoracic shield, about 0.72 mm. Width of basal plate of urogomphi, about 0.35 mm. Form orthosomatic; abdomen membranous, pale pink, with a few long, strong, scattered setae; ten abdominal segments with segments four to seven slightly wider; ninth abdominal segment crescentiform, dorsally with a basal plate and paired urogomphi; tenth segment located below the ninth, developed as a locomotive organ, with an ambulatory wart and anal opening; ambulatory wart surrounded anteriorly by four small papillae and posteriorly by one large, liplike lobe; papillae indistinct.

Head prognathous, exerted or slightly inserted; dorsal surface somewhat flattened, ventral surface somewhat convex, lateral margins parallel; as wide as long; with scattered setae, majority same length as mandible; heavily sclerotized, dark brown. Frons triangular, delimited by slightly curved frontal sutures which posteriorly form an acute angle; medially and internally with a well sclerotized, dark brown longitudinal endocarnia, one-half the length of head, branching posteriorly to form a "Y"; two parallel, slightly elevated ridges, one on each side of anterior portion of endocarina. Epicranium dorsally separated by frons into two epicranial halves, ventrally separated by an elongate, rectangular gula; slightly rugose; a very small tubercle located dorsally on each epicranial half near the middle-posterior portion of the frontal sutures. Ocelli located on epicranium behind ventrolateral part of antennal ring; arranged in an anterior row of three and a posterior row of two; rows parallel. Clypeus and labrum lightly sclerotized, yellow ocher, not distinct; anterior margin of labrum with a row of very small setae and posteriorly with a row of four to six longer setae. Antenna lightly sclerotized, yellow ocher; projecting from an antennal ring; extending beyond anterior margin of labrum; basal membrane large, whitish, transparent, and enclosing about one-half of basal segment; basal segment twice as long as second segment; second segment with a small appendix, three setae around distal margin; apical segment cylindrical, about three-fourths the length of basal segment, apex with one long seta surrounded by three very short setae. Mandible subtriangular, apex pointed, about three-fourths the length of frons, width at base slightly more than one-half length of mandible; retinaculum slightly closer to apex than to base of mandible; two short setae on the lateral mandibular face; with a longitudinal groove on the ventral surface. Ventral mouthparts protracted with distal half directed obliquely upwards; lightly sclerotized, yellow ocher.

Prothorax dorsally with a tergal shield or plate; heavily sclerotized, dark brown; anterior margin straight, curving ventrocephalad; rounded, posteriorly oblique side margins which end at the dorsal

notch; a longitudinal endocarnia starting from dorsal notch and continuing medially and anteriorly for three-fourths of the length of prothoracic plate, dark brown; long setae around outer margin with shorter setae internally. Ventrally, with a pair of subtriangular, presternal plates, one on each side of a narrow, lanceolate, sternal plate; all plates lightly sclerotized and very light yellow ocher or light brown.

Mesothorax dorsally with two, subtriangular plates; one small seta on each; ventrally with a very small, obtuse plate posterior to prothoracic lanceolate plate; a small, oblong plate posterior to obtuse plate.

Metathorax dorsally with two pentagonal plates; plates smaller and farther apart than mesothoracic plates; one small seta on each; ventrally with a small, oblong plate. Mesothoracic and metathoracic dorsal plates lightly sclerotized and light brown, less distinct on the living specimen than the prothoracic dorsal plate.

Thoracic legs five-segmented, no free claws.

Spiracles annular-biforous, located laterally on the mesothorax and abdominal segments one to eight; mesothoracic spiracle slightly larger than abdominal spiracles; metathoracic spiracle, rudimentary.

Basal plate of urogomphi lying at an angle on ninth abdominal segment; not well defined, fading into and surrounded by a lightly sclerotized, yellow ocher, crescent-shaped sclerite; length about one-half as long as frons, slightly wider than long; lightly sclerotized, dark brown ocher. Urogomphi subconical; directed slightly upwards, markedly divergent at apex, apex not recurved; outer margins unequal, inner margins equal; about as long as length of basal plate; heavily sclerotized, dark brown. A few scattered setae on basal plate, about as long as width of basal plate; setae on urogomphi more numerous and up to three times as long as urogomphi.

Second instar: (Plate II, Figures A to C). Maximum length of larva, about 17 mm; minimum length, about 14 mm. Maximum width of body, about 1.5 mm; maximum thickness of body, about 1.3 mm. Average width of head capsule, 0.99 mm; range of width of head capsule, 0.80 mm to 1.02 mm. Anterior width of prothoracic shield, about 1.04 mm. Width of basal plate of urogomphi, about 0.69 mm. Abdomen bright pink to light lilac color at maturity; dorsally the lilac color appearing as a mottled pattern with intervenient areas and ventral side being whitish lilac; setae more abundant. Head dark brown to black; dorsal epicranial tubercles becoming more prominent; apical segment of antenna about same length as second segment; anterior row of ocelli subparallel to slightly curved in relation to posterior row. Prothoracic shield darker brown. Basal plate of uro-

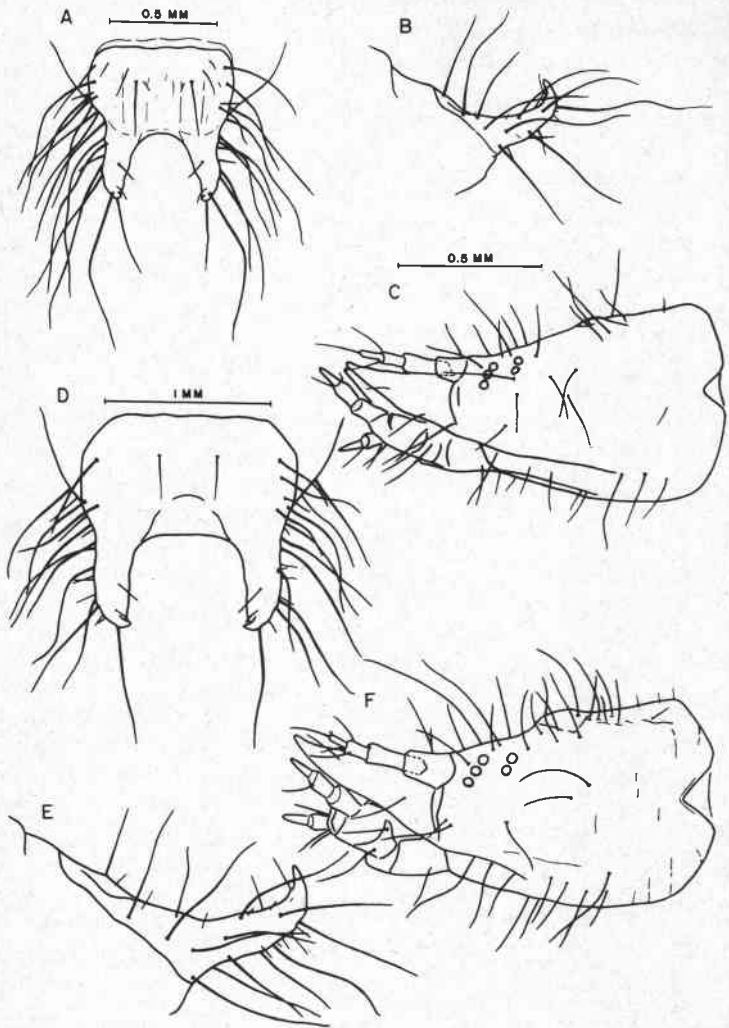


PLATE II

Enoclerus sphegeus Fab.: A, second instar, dorsal view of basal plate and urogomphi; B, second instar, lateral view of basal plate and urogomphi; C, second instar, lateral view of head; D, third instar, dorsal view of basal plate and urogomphi; E, third instar, lateral view of basal plate and urogomphi; F, third instar, lateral view of head.

gomphi well defined; anterior margin with a thin, subparallel, lightly sclerotized sclerite; length slightly less than one-half as long as frons, wider than long; heavily sclerotized, dark brown ocher. Urogomphi subconical; directed distinctly upwards, slightly divergent at apex, apex sharply recurved and turned slightly inwards; outer margins unequal, inner margins slightly unequal; about two-thirds to same length as basal plate; heavily sclerotized, dark brown. Setae more numerous on basal plate and urogomphi, scattered, about as long as width of basal plate; few small.

Third instar: (Plate II, Figures D to F; Plate III, Figures A to G; Plate IV, Figures A and B; Plate V, Figure D). Maximum length of larva, about 22 mm; minimum length, about 15 mm. Maximum width of body, about 3.0 mm; maximum thickness of body, about 2.7 mm. Average width of head capsule, 1.53 mm; range of width of head capsule, 1.40 mm to 1.72 mm. Anterior width of prothoracic shield, about 1.77 mm. Width of basal plate of urogomphi, about 1.19 mm. Abdomen dorsally light lilac to deep lilac color at pupation; ventrally more bluish gray; lilac color appearing as a mottled pattern with intervening areas very light blue; thorax more pinkish; setae very numerous and of varying lengths. Head dark brown to black. Frons with two circular, cushionlike elevations, one at base of each mandible; also with four parallel, slightly elevated ridges, two on each side of endocarina; posterior portion of frons rugose. Dorsal epicranial tubercles very large and prominent; epicranial halves very rugose; anterior and posterior rows of ocelli subparallel. Labrum and clypeus distinct. Antenna brown; basal segment about two to three times as long as second segment; apical segment about two-thirds the length of second segment. Metathoracic plates each bearing one long centrally located seta surrounded by four smaller setae. Basal plate of urogomphi about one-half the length of frons, twice as wide as long. Urogomphi not divergent at apex, apex turned more inwards; outer and inner margins more nearly equal; about the length of basal plate; heavily sclerotized, dark brown with apex and margins black; setae numerous, a few small, with remainder as long as urogomphi. The four small, anterior papillae of ambulatory wart very distinct.

Pupa: (Plate V, Figure B). Total length 8 mm to 10 mm; typically exarate; abdomen with nine visible segments dorsally and seven ventrally; head, thorax, and abdomen pink with white appendages, abdomen becoming lilac at maturity; a few, small, strong, scattered setae on head, legs, and abdomen; antennae bent downward along pleura; lateral spiracles on abdominal segments one to seven; apices of wings subequal, extending to middle of fourth abdominal segment;

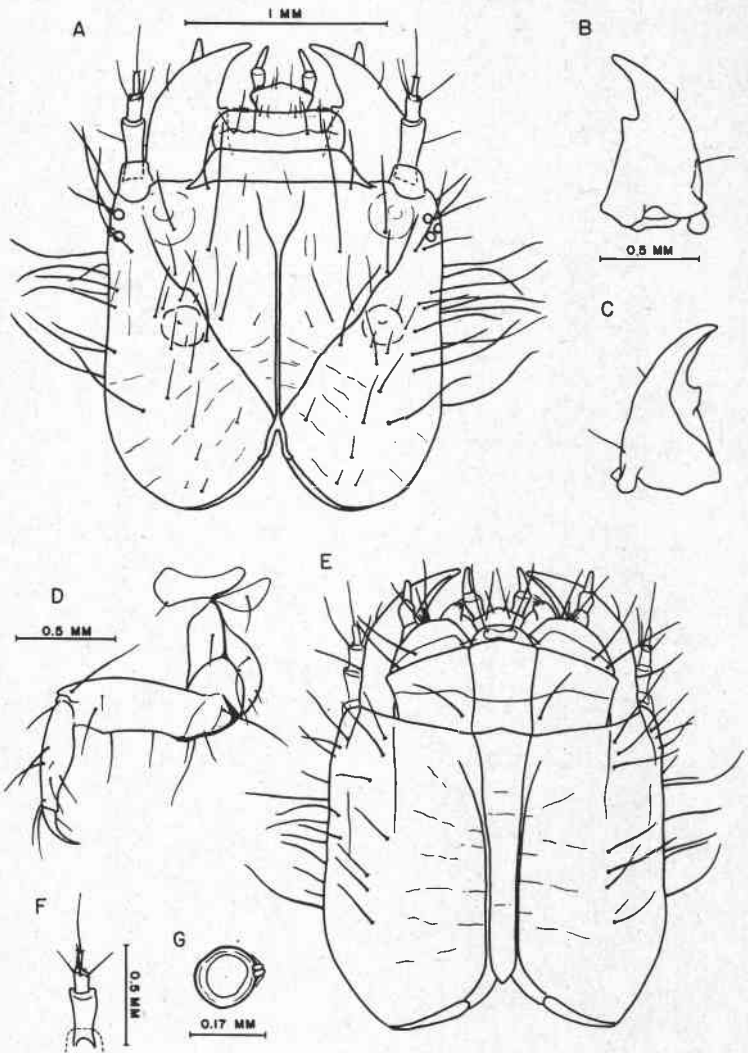


PLATE III

Enoclerus sphegeus Fab., third instar: A, dorsal view of head; B, dorsal view of mandible; C, ventral view of mandible; D, mesothoracic leg; E, ventral view of head; F, dorsal view of antenna; G, abdominal spiracle.

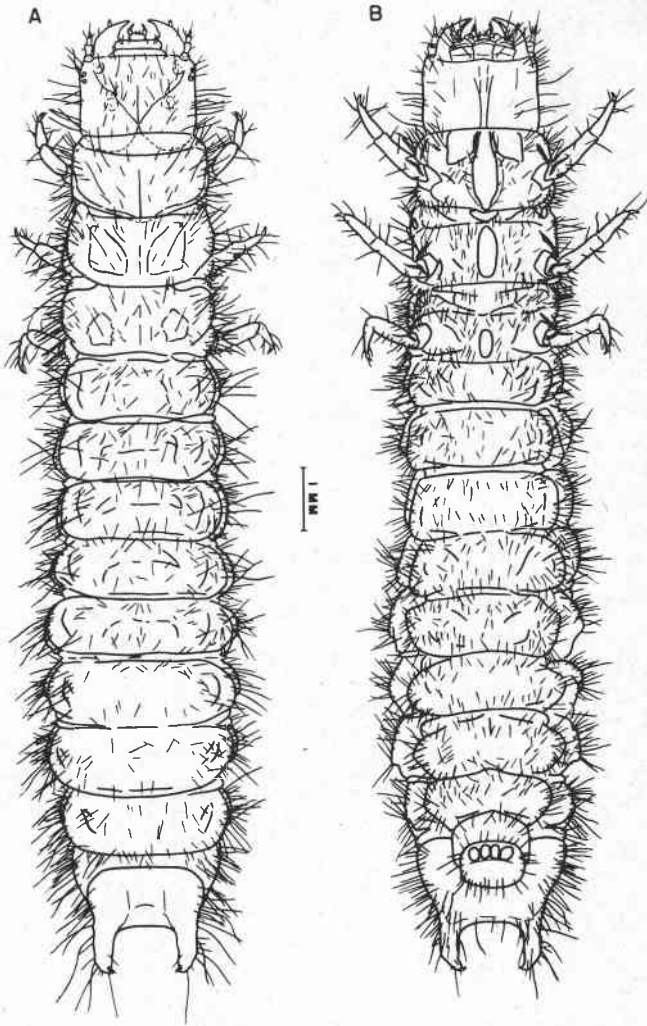


PLATE IV

Enoclerus sphegeus Fab., third instar: A, dorsal view of complete larva; B, ventral view of complete larva.

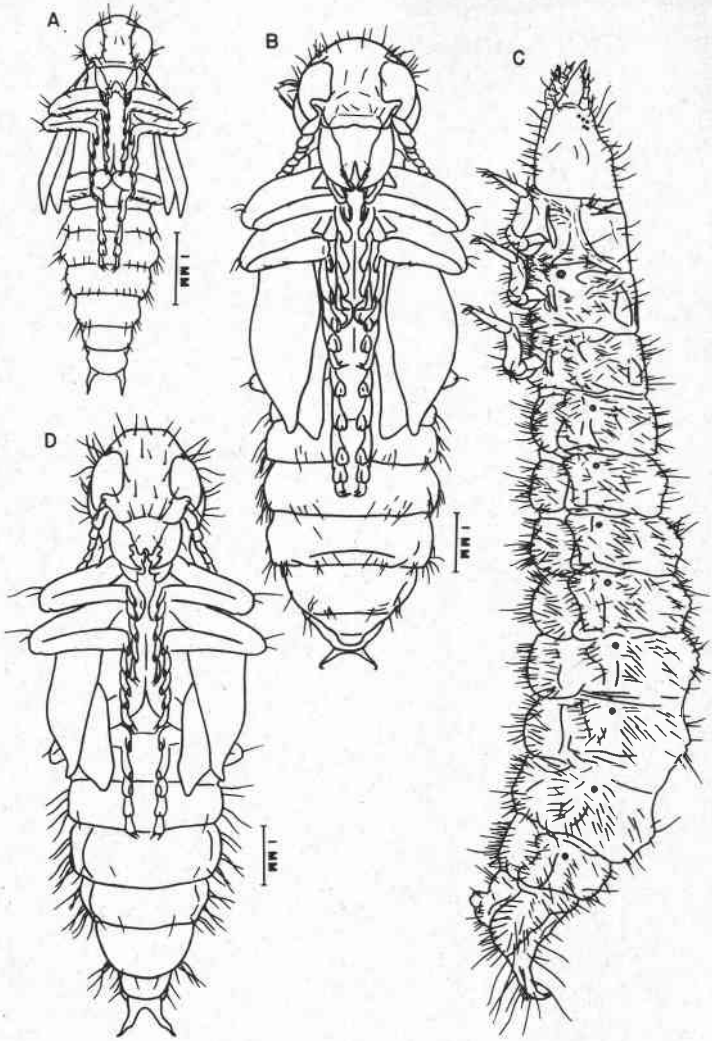


PLATE V

A, ventral view of pupa of *Enoclerus lecontei* Wolc.; B, ventral view of pupa of *Enoclerus sphegeus* Fab.; C, third instar, lateral view of complete larva of *Enoclerus sphegeus* Fab.; D, ventral view of pupa of *Thanasimus undatulus* Say.

apices of prothoracic tarsi extending to apex of thorax, those of mesothoracic tarsi to apex of second abdominal segment, those of metathoracic tarsi to apex of fifth abdominal segment; anal cerci present.

Cleridae: *Enoclerus lecontei* Wolcott

The adult was originally described by LeConte in 1861 as *Clerus nigriventris* from specimens collected near Fort Colville, Washington, and from the Bitterroot Valley, Montana (2, p. 33; 17). Schenkling in 1910 placed LeConte's *nigriventris* in the genus *Thanasimus* and called it *T. nigriventris*. The species was redescribed by Wolcott as *Clerus lecontei* in 1910.¹ Wolcott (4) stated, "The name *nigriventris* is preoccupied in *Clerus* by *C. nigriventris* Blanchard (an Argentina species described in 1842). Should the species be reassigned to the genus *Clerus*, the specific name of *lecontei* is suggested for it." In the same year, the genus *Clerus* was changed to *Enoclerus* (12). Böving (4) in 1928 called the clerid *Enoclerus lecontei* Wolc. The clerid was referred to as *Thanasimus lecontei* (Wolc.) by Person in 1940 (17), but he recently concluded that this was a mistaken identification.² Blackwelder in 1945 cited the species as *T. nigriventris* (Lec.) and gave *lecontei* Wolc. as a synonym.¹ Apparently, Blackwelder missed Blanchard's species *nigriventris* because there is no mention of it in his checklist. The species was called *Enoclerus lecontei* Wolc. by Wolcott in his catalog of 1947 (28, p. 79). Blackwelder (3, p. 14) in 1948 followed Wolcott. Apparently the correct name at present is *Enoclerus lecontei* Wolcott.

The mature larva was described and illustrated by Böving (4) in 1928 from material collected from *Ips* galleries near Coeur d'Alene, Idaho. The following is the first known description and illustration of all immature stages of this species. One generation was reared in the laboratory from adults collected in Oregon.

The known distribution of this species extends from British Columbia to Michigan and south to Guatemala (16, p. 84). It has been reported mainly as an enemy of bark beetles infesting *Pinus*. Bedard (1, p. 36) reports that it was associated with the Douglas-fir beetle, *Dendroctonus pseudotsugae*, in Montana. He states, "The scarcity of this insect in Douglas-fir prohibits it from being of any great value in the control of the Douglas-fir beetle." The clerid was not observed to be associated with the Douglas-fir beetle in southern

¹ Personal communication, P. J. Spangler, United States National Museum, Washington, D. C.

² Personal communication, H. L. Person, Foreign Forestry Services, Washington, D. C.

Idaho. As far as is known, there has been no earlier report of the presence of this species in association with *D. pseudotsugae* in western Oregon. Again, it is believed that *E. lecontei* is of no great importance in controlling the Douglas-fir beetle in this region. The clerid seems to be more abundant in association with the smaller bark beetles, such as *Scolytus unispinosus* Lec. and various species of the genus *Pseudohylesinus*. Its life cycle appears to be similar to *E. sphegeus* in Oregon.

Descriptions of immature stages. The egg, three larval instars, and pupa are described.

Egg: (Plate VI, Figure A). Average length, 1.3 mm; range in length, 1.2 mm to 1.6 mm. Average width, 0.4 mm; range in width 0.3 mm to 0.4 mm. Form subcylindrical, with a slightly curved longitudinal axis, tapering slightly at each end, broadest at the middle, a little wider at one end than at the other; margins equal; chorion smooth, shining, transparent, without ornamentation, becoming slightly rugose and dull as the embryo approaches maturity; color at first pale pink, with development gradually becoming brighter pink with translucent or opaque white portions at each end and lateral margins.

First instar: (Plate VI, Figures B to E). Maximum length of larva, 2.18 mm; minimum length, 1.34 mm. Maximum width of body, 0.37 mm; maximum thickness of body, 0.34 mm. Average width of head capsule, 0.27 mm; range of width of head capsule, 0.23 mm to 0.30 mm. Anterior width of prothoracic shield, about 0.29 mm. Width of basal plate of urogomphi, about 0.18 mm. Form orthosomatic; abdomen membranous, very pale pink, with long, strong, scattered setae; ten abdominal segments with segments four to six slightly wider; ninth abdominal segment somewhat crescentiform, dorsally with a basal plate and paired urogomphi; tenth segment located below the ninth, developed as a locomotive organ, with an ambulatory wart and anal opening; papillae of ambulatory wart indistinct.

Head prognathous, exerted or slightly inserted; dorsal surface flattened to slightly concave, ventral surface and lateral margins slightly convex; as wide as long; with scattered setae, majority same length as mandible; heavily sclerotized, light brown. Frons triangular, delimited by slightly curved frontal sutures which posteriorly form an acute angle; medially and internally with a well sclerotized, dark brown longitudinal endocarnia, two-thirds length of head, branching posteriorly to form a "Y." Epicranium dorsally separated by frons into two epicranial halves, ventrally separated by an elongate, rectangular gula; epicranial halves without tubercles. Ocelli located on

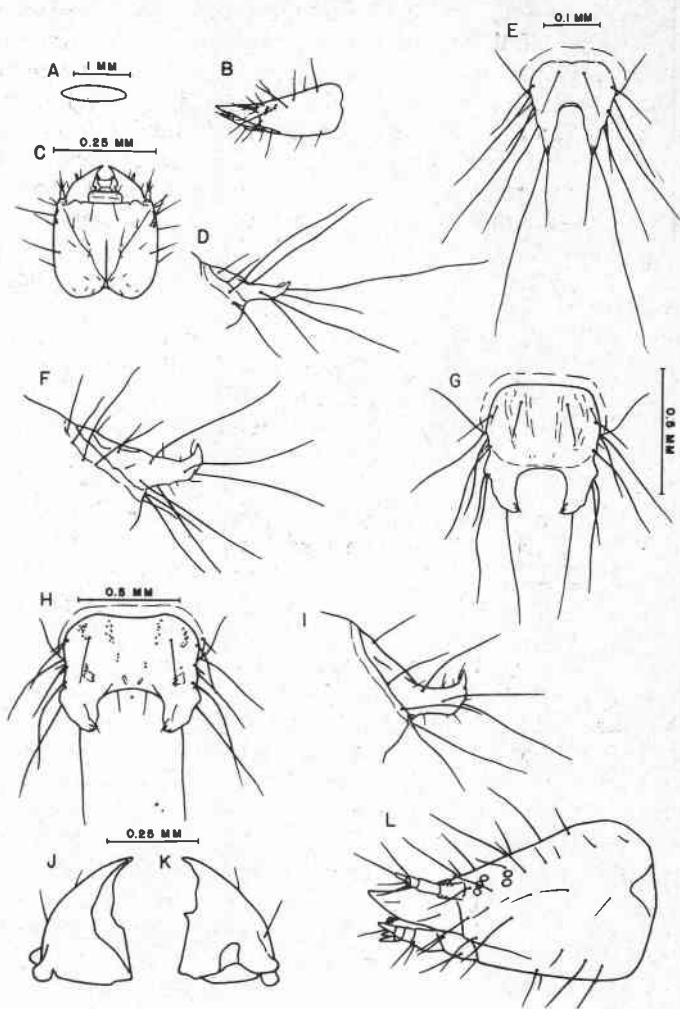


PLATE VI

Enoclerus lecontei Wolc.: A, egg; B, first instar, lateral view of head; C, first instar, dorsal view of head; D, first instar, lateral view of basal plate and urogomphi; E, first instar, dorsal view of basal plate and urogomphi; F, second instar, lateral view of basal plate and urogomphi; G, second instar, dorsal view of basal plate and urogomphi; H, third instar, dorsal view of basal plate and urogomphi; I, third instar, lateral view of basal plate and urogomphi; J, third instar, ventral view of mandible; K, third instar, dorsal view of mandible; L, third instar, lateral view of head.

epicranium behind ventrolateral part of antennal ring; arranged in an anterior row of three and a posterior row of two; rows parallel. Clypeus and labrum not distinct; anterior margin of labrum with a row of small setae. Antenna slightly sclerotized, light yellow ocher; projecting from an antennal ring; extending beyond anterior margin of labrum; basal membrane large, whitish, transparent, and enclosing about one-half of basal segment; basal segment about three to four times as long as second segment; second segment with a small appendix, three setae around distal margin; apical segment cylindrical, same length as second segment, apex with one long seta. Mandible subtriangular, apex pointed, about three-fourths the length of frons, as wide at base as long; retinaculum near middle of mandible; two short setae on the lateral mandibular face; with a longitudinal groove on the ventral surface. Ventral mouthparts protracted with distal half directed somewhat obliquely upwards; lightly sclerotized, yellow ocher.

Prothorax dorsally with a tergal shield or plate; heavily sclerotized, light brown; anterior margin straight, curving ventrocephalad; rounded, posteriorly oblique side margins which end at the dorsal notch; a longitudinal endocarnia starting from dorsal notch and continuing medially and anteriorly three-fourths length of prothoracic plate, dark brown; with scattered setae. Ventrally, with a pair of subtriangular, presternal plates, one on each side of a narrow, lanceolate, sternal plate; all plates lightly sclerotized and very light yellow ocher; not too distinct on living specimen.

Mesothorax dorsally with two subtriangular plates; one small seta on each; ventrally with a very small, obtuse plate posterior to prothoracic lanceolate plate; a small, oblong plate posterior to the obtuse plate; ventral plates not distinct on living specimen.

Metathorax dorsally with two subquadrangular plates; plates smaller and farther apart than mesothoracic plates; one small seta on each; ventrally with a small, nondistinct, oblong plate. Mesothoracic and metathoracic dorsal plates lightly sclerotized and light brown, less distinct on the living specimen than the prothoracic dorsal plate.

Thoracic legs five-segmented, no free claws.

Spiracles annular-biforous, located laterally on the mesothorax and abdominal segments one to eight; mesothoracic spiracle slightly larger than abdominal spiracles; metathoracic spiracle, rudimentary.

Basal plate of urogomphi lying at an angle on ninth abdominal segment; surrounded by a lightly sclerotized, yellow ocher, crescent-shaped sclerite; length slightly shorter than frons, wider than long; lightly sclerotized, light brown ocher. Urogomphi subconical; strongly

divergent at apex, apex not recurved; outer and inner margins unequal; slightly longer than length of basal plate; heavily sclerotized, light brown. A few scattered setae on basal plate, about as long as basal plate; setae on urogomphi more numerous and up to four times as long as urogomphi.

Second instar: (Plate VI, Figure F and G). Maximum length of larva, about 5 mm; minimum length, about 4 mm. Maximum width of body, about 0.80 mm; maximum thickness of body, about 0.77 mm. Average width of head capsule, 0.47 mm; range of width of head capsule, 0.37 mm to 0.52 mm. Anterior width of prothoracic shield, about 0.52 mm. Width of basal plate of urogomphi, about 0.40 mm. Abdomen bright pink; setae more abundant. Head and prothoracic shield dark brown. Basal plate of urogomphi well defined; surrounded by a narrow, lightly sclerotized sclerite; length about two-thirds as long as frons, slightly wider than long; somewhat sculptured with fine subparallel depressions running length of plate; heavily sclerotized, light brown ocher. Urogomphi subconical; swollen at base, not divergent at apex; apex not recurved but turned slightly inwards; outer margins unequal, inner margins equal; length about one-half as long as basal plate; heavily sclerotized, dark brown. Setae scattered, slightly longer than length of basal plate.

Third instar: (Plate VI, Figures H to L; Plate VII, Figures A to E). Maximum length of larva, about 11 mm; minimum length, about 8 mm. Maximum width of body, about 1.6 mm; maximum thickness of body, about 1.3 mm. Average width of head capsule, 0.80 mm; range of width of head capsule, 0.77 mm to 0.82 mm. Anterior width of prothoracic shield, about 0.91 mm. Width of basal plate of urogomphi, about 0.75 mm. Abdomen bright pink, becoming lilac color starting from the posterior end, very dark lilac at pupation; dorsally very dark mottled lilac pattern, ventrally more gray lilac; thorax more reddish brown; setae very numerous and about the same length. Head very dark brown to black. Frons with two circular, cushion-like elevations, one at base of each mandible; also with two parallel, slightly elevated ridges, one on each side of endocarnia. Anterior and posterior rows of ocelli subparallel. Labrum and clypeus distinct. Basal plate of urogomphi surrounded by a narrow, lightly sclerotized sclerite; slightly less than one-half the length of frons, twice as wide as long; somewhat sculptured with irregular shaped depressions scattered over plate; dark brown. Urogomphi subconical to subtriangular; swollen from base to near apex; apex turned sharply inwards; outer and inner margins unequal; length about two-thirds as long as basal plate; very dark brown to black. Setae scattered, a few very small with remainder about one-half to three-

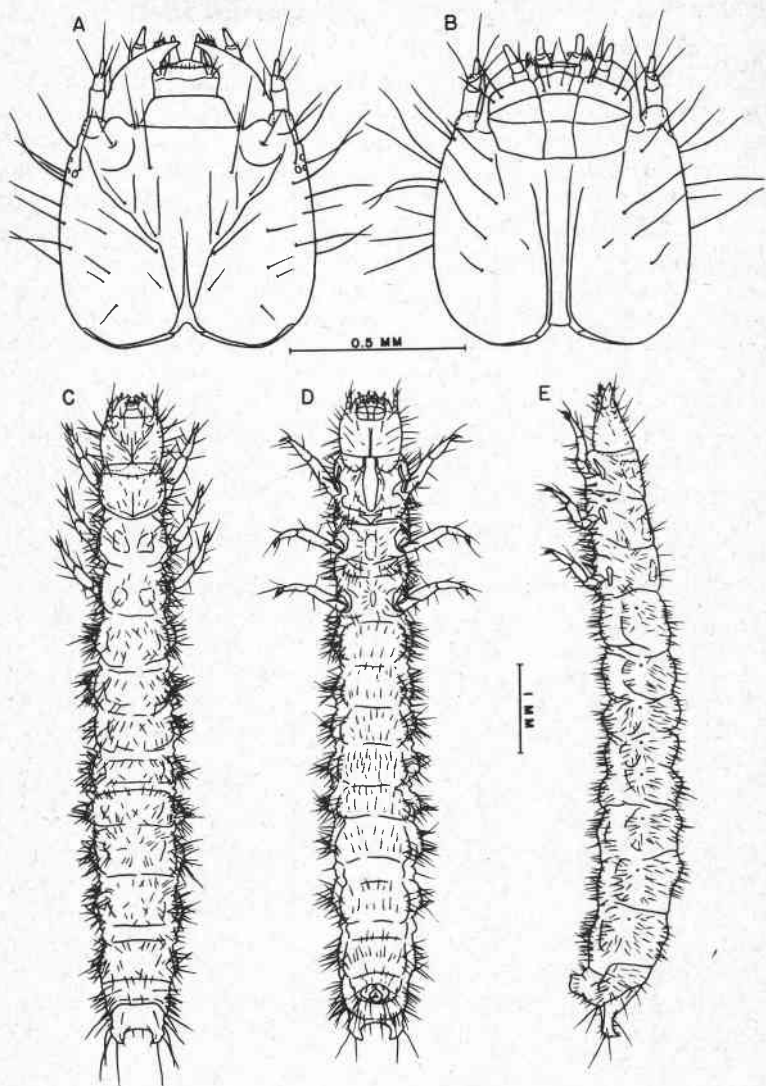


PLATE VII

Enoclerus lecontei Wolc., third instar: A, dorsal view of head; B, ventral view of head; C, dorsal view of complete larva; D, ventral view of complete larva; E, lateral view of complete larva.

fourths width of basal plate. Ambulatory wart surrounded anteriorly by four small papillae and posteriorly by one large lobe and anal opening; papillae and lobe very distinct.

Pupa: (Plate V, Figure A). Total length, about 6 mm; typically exarate; abdomen with nine visible segments dorsally and seven ventrally; head and thorax pink, abdomen dark pink with mottled lilac areas; appendages white to gray; a few small, strong, scattered setae on head, legs, and abdomen; antennae bent downward along pleura; apices of wings equal, extending to apex of fourth abdominal segment; apices of prothoracic tarsi extending to apex of thorax, those of mesothoracic tarsi to middle of third abdominal segment, those of metathoracic tarsi to apex of fifth abdominal segment; anal cerci present.

Cleridae: *Thanasimus undatulus* Say

The adult of this species was described by Say in 1835 (12, p. 149) as *Thanasimus undatulus*. Leng in 1920 (12, p. 149) listed the species as *T. undulatus* Say. In 1927 (13, p. 28) it was reported that *undulatus* was a typographical error for *undatulus*. This insect was mistakenly identified as *T. dubius* (Fab.) by Bedard (1, p. 28). The forms of the species appear different throughout its geographical distribution. Barr states, "I prefer for the present to call everything *T. undatulus*."³

It has been reported that the insect ranges from Alaska to New Mexico and eastward to New Hampshire (12, p. 149; 16, p. 82). The clerid occurs occasionally in association with the Douglas-fir beetle in Montana, Idaho, and Oregon; its preferred prey are smaller bark beetles such as various species of *Pseudohylesinus*, *Scolytus*, etc. The life cycle of this species appears to be similar to that of *E. sphegeus*, with the exception that the larvae do not migrate to the base of the tree. Two generations were reared in the laboratory from adults collected in Idaho.

The following is the first known description and illustration of all of the immature stages.

Descriptions of immature stages. The egg, three larval instars, and pupa are described.

Eggs: (Plate VIII, Figure E). Average length, 2.3 mm; range in length, 2.0 mm to 2.2 mm. Average width, 0.5 mm; range in width, 0.5 mm to 0.6 mm. Form subcylindrical, with a slightly curved longitudinal axis, tapering slightly at each end, broadest at the middle, one end slightly wider than the other, margins equal; chorion smooth,

³ Personal communication, W. F. Barr, University of Idaho, Moscow.

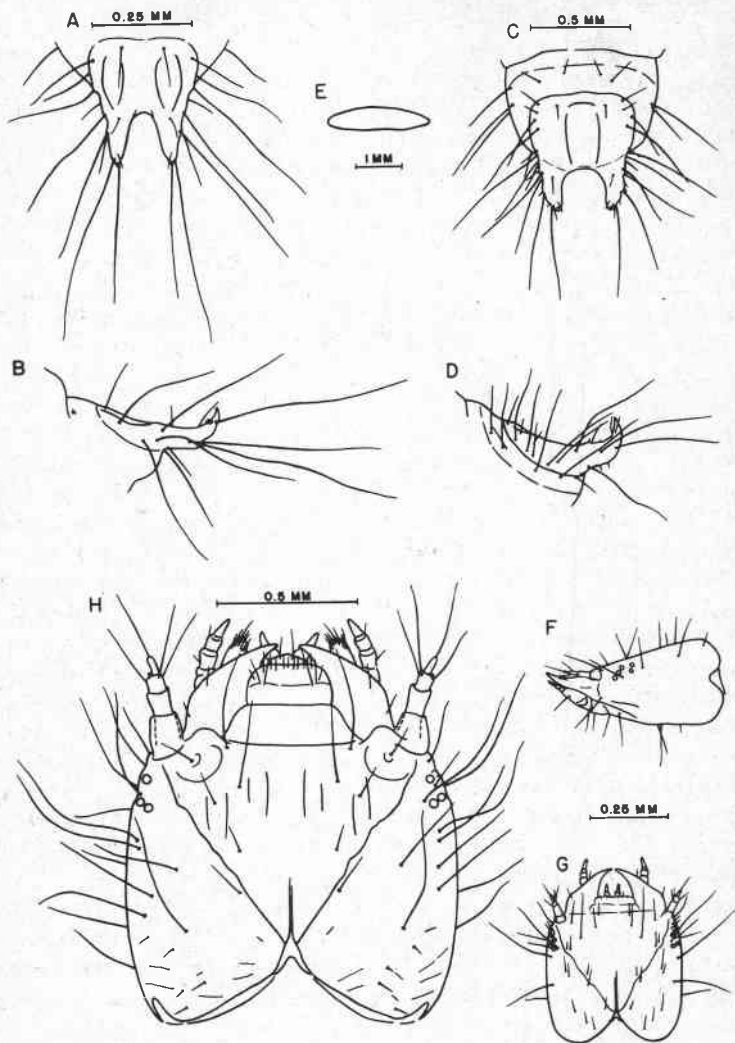


PLATE VIII

Thanasimus undatulus Say: A, first instar, dorsal view of basal plate and urogomphi; B, first instar, lateral view of basal plate and urogomphi; C, second instar, dorsal view of basal plate and urogomphi; D, second instar, lateral view of basal plate and urogomphi; E, egg; F, first instar, lateral view of head; G, first instar, dorsal view of head; H, third instar, dorsal view of head.

shining, transparent, without ornamentation; color opaque white throughout development.

First instar: (Plate VIII, Figure A, B, F, and G). Maximum length of larva, 3.77 mm; minimum length, 2.63 mm. Maximum width of body, 0.53 mm; maximum thickness of body, 0.50 mm. Average width of head capsule, 0.36 mm; range of width of head capsule, 0.35 mm to 0.38 mm. Anterior width of prothoracic shield, about 0.40 mm. Width of basal plate of urogomphi, about 0.27 mm. Form orthosomatic; abdomen membranous, very pale pink, with a few, long, strong, scattered setae; ten abdominal segments with segments four to seven slightly wider; ninth abdominal segment somewhat crescentiform, dorsally with a basal plate and paired urogomphi; tenth segment located below the ninth, developed as a locomotive organ, with an ambulatory wart and anal opening; ambulatory wart surrounded anteriorly by four small papillae and posteriorly by one large, liplike lobe; papillae indistinct.

Head prognathous, exerted or slightly inserted; dorsal surface flattened, ventral surface and lateral margins slightly convex; as wide as long; with scattered setae, majority same length as mandible; heavily sclerotized, dark brown. Frons triangular, delimited by slightly curved frontal sutures which posteriorly form an acute angle; medially and internally with a well sclerotized, dark brown, longitudinal endocornia, one-third length of head, branching posteriorly to form a "Y." Epicranium dorsally separated by frons into two epicranial halves, ventrally separated by an elongate, rectangular gula; epicranial halves without tubercles. Ocelli located on epicranium behind ventrolateral part of antennal ring; arranged in an anterior row of three and a posterior row of two; rows subparallel. Clypeus and labrum lightly sclerotized, yellow ocher, not distinct; anterior margin of labrum with a row of very small setae. Antenna lightly sclerotized, yellow ocher; projecting from an antennal ring; extending beyond anterior margin of labrum; basal membrane large, whitish, transparent, and enclosing about one-fourth of basal segment; basal segment about three times as long as second segment; second segment with a small appendix, three setae around distal margin; apical segment cylindrical, about twice the length of second segment, apex with one long seta. Mandible subtriangular, apex pointed, about three-fourths the length of frons, width at base about two-thirds length of mandible; retinaculum slightly closer to apex than to base of mandible; two short setae on the lateral mandibular face; with a longitudinal groove on the ventral surface. Ventral mouthparts protracted with distal half directed obliquely upwards; lightly sclerotized, yellow ocher.

Prothorax dorsally with a tergal shield or plate; heavily sclerotized, light brown, anterior margin straight, curving slightly ventro-caudad; rounded, posteriorly oblique side margins which end at the dorsal notch; a longitudinal endocarnia starting from dorsal notch and continuing medially and anteriorly three-fourths length of prothoracic plate, dark brown; with scattered setae. Ventrally, with a pair of triangular, presternal plates, one on each side of a narrow, lanceolate, sternal plate; all plates lightly sclerotized and very light yellow ocher.

Mesothorax dorsally with two subtriangular plates; three small seta on each; ventrally with a very small, obtuse plate posterior to prothoracic lanceolate plate; a small, oblong plate posterior to obtuse plate.

Metathorax dorsally with two subquadrangular plates; plates smaller and farther apart than mesothoracic plates; two small setae on each; ventrally with a small, nondistinct, oblong plate. Mesothoracic and metathoracic dorsal plates lightly sclerotized and light brown, less distinct on the living specimen than the prothoracic dorsal plate.

Thoracic legs five-segmented, no free claws.

Spiracles annular-biforous, located laterally on the mesothorax and abdominal segments one to eight; mesothoracic spiracle slightly larger than abdominal spiracles; metathoracic spiracle rudimentary.

Basal plate of urogomphi lying horizontally on ninth abdominal segment; anterior margin at times not well defined; two longitudinal grooves extending length of plate; length about two-thirds as long as frons, wider than long; lightly sclerotized, light brown ocher. Urogomphi subcylindrical; markedly divergent at apex, apex not recurved; outer margins slightly unequal, inner margins equal; about two-thirds length of basal plate; heavily sclerotized, dark yellow brown. A few scattered setae on basal plate, about as long as width of basal plate; setae on urogomphi more numerous and up to three times as long as urogomphi.

Second instar: (Plate VIII, Figures C and D). Maximum length of larva, about 13 mm; minimum length, about 8 mm. Maximum width of body, about 2.0 mm; maximum thickness of body, about 1.8 mm. Average width of head capsule, 0.63 mm; range of width of head capsule, 0.60 mm to 0.68 mm. Anterior width of prothoracic shield, about 0.69 mm. Width of basal plate of urogomphi, about 0.56 mm. Abdomen bright pink to light lilac at maturity; lilac color starting to appear at posterior end and progressing anteriorly; dorsally the lilac color appearing as a mottled pattern with intervenient areas and ventral side light blue; setae more abundant. Head and prothoracic shield dark brown. Basal plate of urogomphi lying at

an angle on ninth abdominal segment; well defined; surrounded by a lightly sclerotized, light brown sclerite; a large depression, centrally located and extending length of plate; length about as long as frons, wider than long; heavily sclerotized, dark brown ocher. Urogomphi subcylindrical; directed distinctly upwards, not divergent at apex, apex slightly recurved; outer margins unequal, inner margins equal; slightly more than one-half the length of basal plate; heavily sclerotized, dark brown. Setae more numerous on basal plate and urogomphi, scattered, about as long as width of basal plate; few small.

Third instar: (Plate VIII, Figure H; Plate IX, Figures A to F; Plate X, Figures A to C). Maximum length of larva, about 19 mm; minimum length, about 11 mm. Maximum width of body, about 2.8 mm; maximum thickness of body, about 2.7 mm. Average width of head capsule, 1.12 mm; range of width of head capsule, 1.09 mm to 1.19 mm. Anterior width of prothoracic shield, about 1.24 mm. Width of basal plate of urogomphi, about 0.99 mm. Abdomen dorsally lilac to deep lilac color at pupation; ventrally more bluish; lilac color appearing as a mottled pattern with intervenient areas light blue; thorax more whitish; setae very numerous and of varying lengths. Head dark reddish brown to black. Frons with two circular, cushionlike elevations, one at base of each mandible; also with four parallel, slightly elevated ridges, two on each side of endocarnia. Posterior portion of head slightly rugose. Labrum and clypeus distinct. Antenna brown; basal membrane enclosing about one-half to two-thirds of basal segment; apical segment about as long as second segment. Basal plate of urogomphi with several depressions extending length of plate; length three-fourths the width of plate, and slightly shorter than frons; dark reddish brown. Urogomphi subcylindrical; apex sharply recurved and turned inwards; outer and inner margins unequal; about one-half the length of basal plate; very dark brown to black; setae numerous, few small, with remainder slightly less than length of urogomphi. Four small anterior papillae of ambulatory wart very distinct.

Pupa: (Plate V, Figure D). Total length, about 10 mm; typically exarate; abdomen with nine visible segments dorsally and seven ventrally; head and thorax pinkish, appendages white, abdomen dark lilac; a few small, strong, scattered setae on head, legs, and abdomen; antennae bent downward along pleura; lateral spiracles on abdominal segments one to seven; apices of wings subequal, extending between the fourth and fifth abdominal segments; apices of prothoracic tarsi extending to apex of thorax, those of mesothoracic tarsi to apex of third abdominal segment, those of metathoracic tarsi to apex of fifth abdominal segment; anal cerci present.

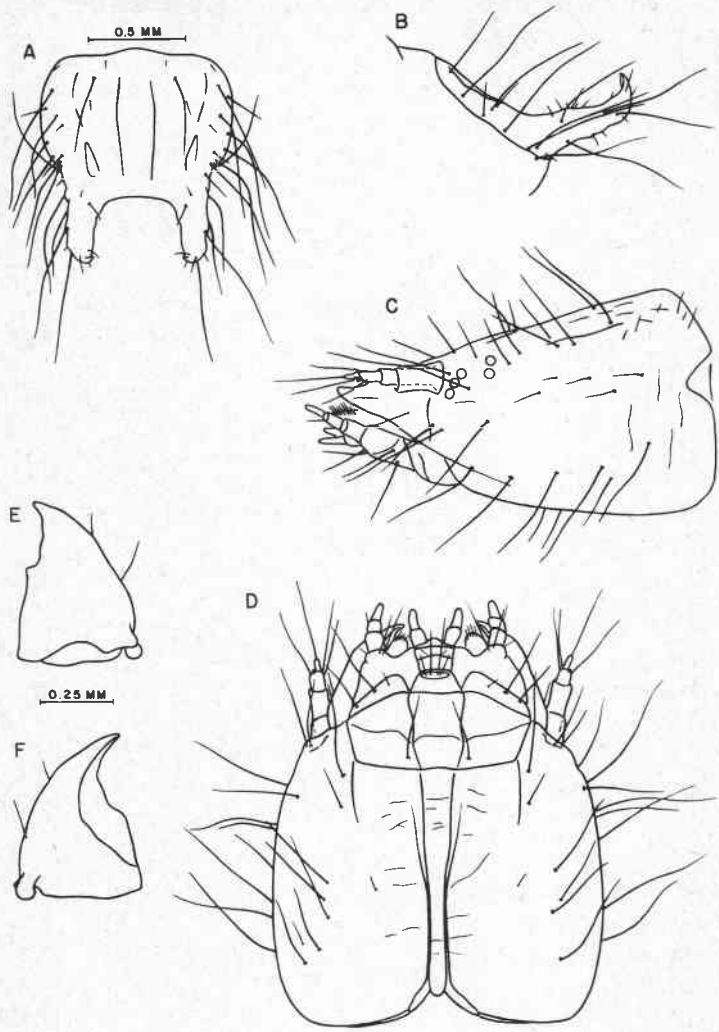


PLATE IX

Thanasimus undatulus Say, third instar: A, dorsal view of basal plate and urogomphi; B, lateral view of basal plate and urogomphi; C, lateral view of head; D, ventral view of head; E, dorsal view of mandible; F, ventral view of mandible.

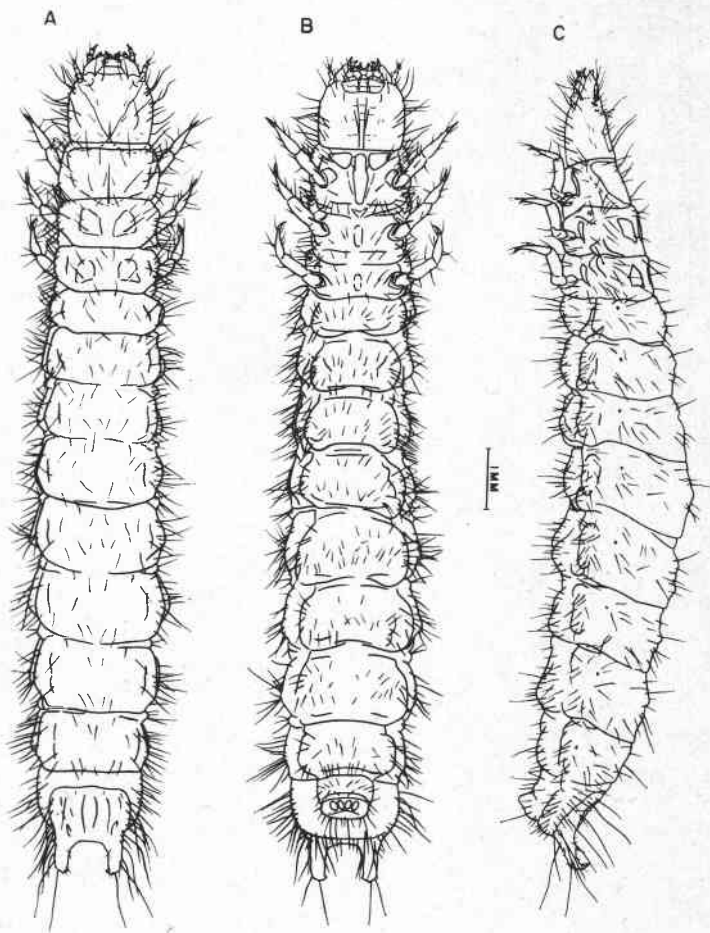


PLATE X

Thanasisimus undatulus Say, third instar: A, dorsal view of complete larva; B, ventral view of complete larva; C, lateral view of complete larva.

Ostomatidae: *Temnochila virescens chlorodia*
Mannerheim

Temnochila virescens was described by Fabricius in 1775 (12, p. 193). A subspecies, *T. virescens chlorodia*, was described in 1843 by Mannerheim (12, p. 193). The mature larva of *T. virescens* Fab. was illustrated by Böving and Craighead in 1930 (6, pp. 272-274). Bedard (1, pp. 38-39) and Struble (23, pp. 100-101) made some very general descriptions of the mature larva. Records indicate that *T. virescens* is found in the eastern states, while *T. virescens chlorodia* is found in the western states (12, p. 193).

This species is very abundant and widely distributed in coniferous forests of North America. It is an important enemy of many species of Scolytidae, principally *Dendroctonus* and *Ips*. Because of its abundance and apparent aggressiveness, this insect can be rated very close to *Enoclerus sphegus* in importance as a predator of *D. pseudotsugae* in the Intermountain Region. Its importance as a predator of *D. pseudotsugae* in the Pacific Northwest is less. Here the species is less abundant and seems to be somewhat aggregated in its distribution through the forest. It has been observed that the insect prefers more exposed, warmer sites of windthrown Douglas-fir in western Oregon. The life cycle of *T. virescens* follows closely that of the clerids with the exception that the larvae do not migrate.

The following is the first known description and illustration of the immature stages of this species. The insect was found to be more difficult to rear in the laboratory than the clerids. Apparently, the quantity of food, temperature, and humidity are very important in the development of the larvae. The number of times the larvae molted varied considerably, but the maximum number of instars observed was seven. There was a gradual increase in size of most structures, especially the head capsule, until the seventh molt. At that time the larva were about the size of the fifth instars, and this fact may indicate that the usual number of instars under field conditions is around five or six. There were no major morphological changes after the third instar. Therefore, the drawings of the sixth instar represent the third to sixth instars with the exception of change in size. No pupae were obtained. Two generations were reared in the laboratory from adults collected in Idaho and Oregon.

Descriptions of immature stages. The egg and six larval instars are described.

Egg: (Plate XI, Figure A). Average length, 2.3 mm; range in length, 2.2 mm to 2.5 mm. Average width, 0.4 mm; range in width, 0.4 mm to 0.5 mm. Form cylindrical, with a slightly curved longi-

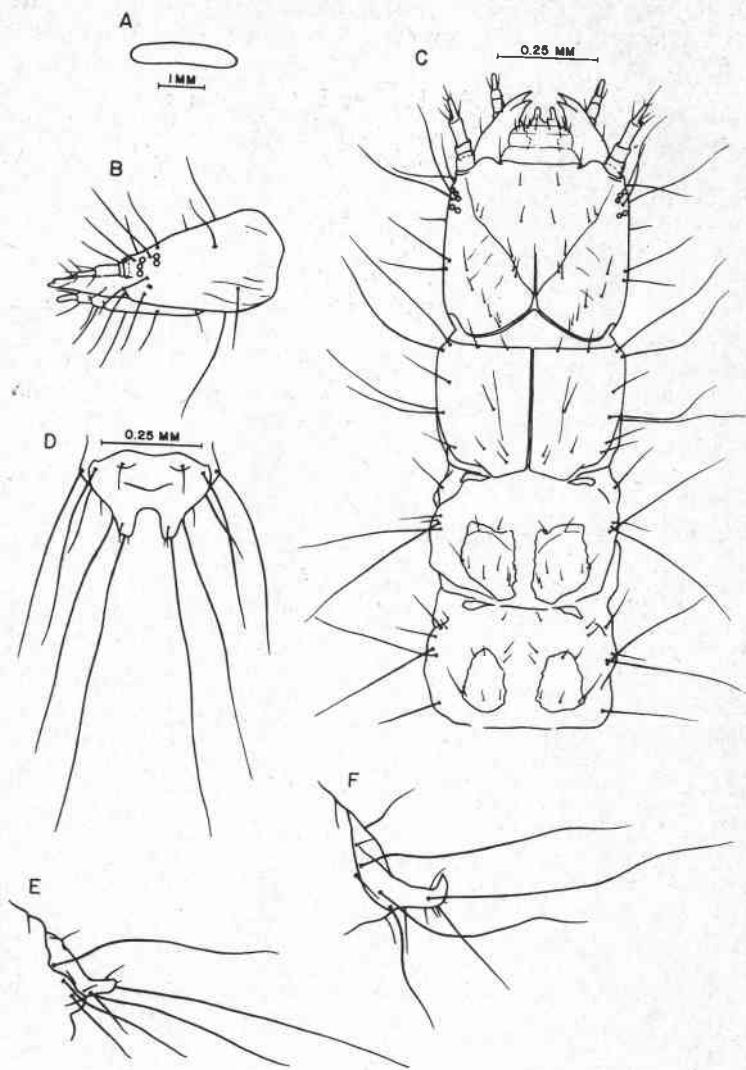


PLATE XI

Temnochila virescens chlorodia Mann.: A, egg; B, first instar, lateral view of head; C, first instar, dorsal view of head and thorax; D, first instar, dorsal view of basal plate and urogomphi; E, first instar, lateral view of basal plate and urogomphi; F, second instar, lateral view of basal plate and urogomphi.

tudinal axis, ends rounded; chorion smooth, dull, transparent, without ornamentation; color very pale, orange pink throughout development.

First instar: (Plate XI, Figures B to E). Maximum length of larva, 3.42 mm; minimum length, 2.45 mm. Maximum width of body, 0.50 mm; maximum thickness of body, 0.44 mm. Average width of head capsule, 0.42 mm; range of width of head capsule, 0.40 mm to 0.43 mm. Anterior width of prothoracic plates, about 0.46 mm. Width of basal plate of urogomphi, about 0.28 mm. Form orthosomatic; abdomen membranous, gray pink; setae strong and scattered, more abundant on ventral side than dorsal side, consisting of three lengths; all setae surrounded by a very small, black papilla, the longer setae raised on a small chalaza; ten abdominal segments with segments two to seven slightly wider; segments without dorsal ambulatory warts; ninth abdominal segment somewhat crescentiform, dorsally with a basal plate and paired urogomphi; tenth segment located below the ninth, developed as a locomotive organ, with an ambulatory wart and anal opening; ambulatory wart surrounded anteriorly by six small papillae and posteriorly by one large, liplike lobe; papillae indistinct.

Head prognathous, exserted or slightly inserted; dorsal surface with small, scattered grooves, ventral surface somewhat flattened, lateral margins parallel; about as wide as long; scattered setae small except for a few along the lateral margins of the epicranium which are about as long as the mandible; heavily sclerotized, dark reddish brown. Frons triangular, delimited by slightly curved frontal sutures which posteriorly form an acute angle; medially and internally with a well sclerotized, dark brown, longitudinal endocarnia, about one-third length of head, branching posteriorly to form a "Y." Epicranium dorsally separated by frons into two epicranial halves, ventrally separated by the retracted mouthparts and a short, broad gula surrounded by a pair of paragula; rugose; epicranial halves without tubercles. Ocelli located on epicranium behind ventrolateral part of antennal ring; arranged in an anterior row of three and a posterior row of two, rows subparallel; a single ocellus located ventrad of the two rows of ocelli. Clypeus and labrum lightly sclerotized, yellow ocher, not distinct; anterior margin of labrum with a row of very small setae. Antenna lightly sclerotized, yellow ocher; projecting from an antennal ring; extending beyond anterior margin of labrum; basal membrane large, whitish, transparent, and enclosing about one-fourth of basal segment; basal segment one-half the length of second segment; second segment with a small appendix, three setae around distal margin; apical segment cylindrical, about

three-fourths the length of second segment, apex with one long seta surrounded by two very short setae. Mandible subtriangular, apex dentate with distal ends pointed, about two-thirds the length of frons, width at base about two-thirds the length of mandible; retinaculum situated near the middle of mesal edge of mandible; a penicillus on the edge of a pseudomolar; mesal edge of mandible coarsely serrate; ventral surface somewhat grooved along the distal-mesal edge; two short setae on the lateral mandibular face. Ventral mouthparts retracted with distal half either horizontal or directed slightly downwards; lightly sclerotized, yellow ocher.

Prothorax dorsally with two tergal shields or plates, superficially resembling one plate; heavily sclerotized, anterior-mesal portion of plates light brown with the lateral margins and posterior portions dark brown to black; anterior margins straight, curving ventrocephalad; rounded, posteriorly oblique side margins which end at the dorsal notch; a shallow depression running the length of each plate; long setae around outer margins, with shorter setae internally; a pair of very small, black, subtriangular plates posterior to the large prothoracic plates. Ventrally, three pairs of subtriangular, presternal plates, one pair on each side of a narrow, lanceolate, sternal plate; all plates lightly sclerotized, light brown.

Mesothorax dorsally with two, distinctly separated subquad-rangular plates; heavily sclerotized, dark brown to black with anterior margin light brown; seven small setae on each plate; a pair of very small, black, subtriangular plates posterior to large, mesothoracic plates. Ventrally, spatulate plate posterior to the prothoracic lanceolate plate, lightly sclerotized, light brown; an oblong plate posterior to the spatulate plate, lightly sclerotized, yellow ocher, not too distinct on living specimen.

Metathorax dorsally with two subtriangular plates; plates smaller and farther apart than mesothoracic plates; four small setae on each; heavily sclerotized, dark brown to black. Ventrally with a small, obtuse plate; an oblong plate posterior to obtuse plate; lightly sclerotized, yellow ocher, not too distinct on living specimen.

Thoracic legs five-segmented, no free claws.

Spiracles annular-biforous, located laterally on the mesothorax and abdominal segments one to eight; mesothoracic spiracle slightly larger than abdominal spiracles; metathoracic spiracle, rudimentary.

Basal plate of urogomphi lying at an angle on ninth abdominal segment; well-defined; anterior margin sinuous; plate with two light brown tubercles, each with one seta; length about one-half as long as frons, twice as wide as long; heavily sclerotized, dark brown to black. Urogomphi subcylindrical; directed slightly upwards, slightly

divergent at apex; apex not recurved, circular in cross-sectional view; outer and inner margins equal; about one-half the length of basal plate; heavily sclerotized, brown. Scattered setae on basal plate, a few small with remainder slightly longer than abdominal setae; setae on urogomphi scattered, few small, with remainder up to eight times as long as urogomphi.

Second instar: (Plate XI, Figure F; Plate XII, Figures A and B). Maximum length of larva, about 5.40 mm; minimum length, about 3.69 mm. Maximum width of body, about 0.77 mm; maximum thickness of body, about 0.64 mm. Average width of head capsule, 0.72 mm; range of width of head capsule, 0.60 mm to 0.89 mm. Anterior width of prothoracic shields, about 0.80 mm. Width of basal plate of urogomphi, about 0.57 mm. Anterior margin of prothoracic plates straight, curving ventrocaudad. Mesothorax dorsally with two subquadrangular plates; plates not very close together, superficially resembling one plate; anterior margin of plates with a lightly sclerotized, yellow ocher sclerite; each plate with five small setae. Basal plate of urogomphi with the anterior-mesal portion of margin sinuous; lateral margins rounded, curving ventrocaudad; length about three-fourths as long as frons, width nearly twice the length; setae more numerous than on urogomphi; dark brown to black. Urogomphi subconical; not divergent at apex; apex turned sharply upwards and slightly inwards; outer margin unequal, inner margin equal; one-half the length of basal plate; with small setae, a few up to seven times as long as urogomphi; brown with apex black.

Third instar: Average length of larva, about 10 mm. Maximum width of body, about 2.01 mm; maximum thickness of body, about 1.68 mm. Average width of head capsule, 1.30 mm; range of width of head capsule, 1.22 mm to 1.37 mm. Anterior width of prothoracic shields, about 1.53 mm. Width of basal plate of urogomphi, about 1.10 mm. Head capsule ovate; posterior portion of endocarnia of head branching to form a small rectangle; posterior portion of epicranial halves nearly meeting each other. Basal segment of antenna about three-fourths the length of second segment; apical segment very short. Clypeus and labrum light brown, distinct. Abdomen becoming blue white. Dorsal ambulatory warts present on abdominal segments two to seven; papillae on second abdominal, ambulatory wart not too distinct or numerous; papillae on remaining ambulatory warts more distinct and numerous, arranged in two rows curving ventrocephalad; few papillae scattered on lateral margins. Ventral prothoracic plates light brown, distinct; ventral mesothoracic and metathoracic plates yellow ocher, more distinct. Papillae of ventral, tenth abdominal, ambulatory wart distinct. Basal plate of urogomphi

crescentiform, anterior and lateral margins rounded, curving ventro-caudal; mesal portion slightly concave, somewhat sculptured with a few, irregularly shaped depressions; length about two-thirds the width of plate and slightly shorter than frons. Urogomphi subconical; directed distinctly upwards and turned slightly inwards; apex sharply recurved and pointed; outer margins unequal, inner margins slightly equal; about one-third as long as basal plate; dark brown to black.

Fourth instar: Average length of larva, about 18 mm. Maximum width of body, about 2.35 mm; maximum thickness of body, about 2.35 mm. Average width of head capsule, 1.46 mm; range of width of head capsule, 1.24 mm to 1.64 mm. Anterior width of prothoracic shields, about 1.76 mm. Width of basal plate of urogomphi, about 1.29 mm. Setae on mesothoracic and metathoracic plates nearly lacking. Two small papillae appearing, one on each side of dorsal mesal line of first abdominal segment. Papillae on second abdominal, ambulatory wart more numerous and distinct.

Fifth instar: Average length of larva, about 17 mm. Maximum width of body, about 2.68 mm; maximum thickness of body, about 2.52 mm. Average width of head capsule, 1.63 mm; range of width of head capsule, 1.41 mm to 1.81 mm. Anterior width of prothoracic shields, about 1.95 mm. Width of basal plate of urogomphi, about 1.43 mm. Abdomen becoming light blue gray.

Sixth instar: (Plate XII, Figures C to E; Plate XIII, Figures A to H; Plate XIV, Figures A and B; Plate XV, Figure A). Average length of larva, about 16 mm. Maximum width of body, about 2.85 mm; maximum thickness of body, about 2.35 mm. Average width of head capsule, 1.87 mm; range of width of head capsule, 1.68 mm to 2.05 mm. Anterior width of prothoracic shields, about 2.27 mm. Width of basal plate of urogomphi, about 1.02 mm. Epicranial halves of head capsule slightly rugose. First abdominal spiracle slightly larger than remaining abdominal spiracles. Abdomen, blue gray.

Dolichopodidae: *Medetera* spp.

Specimens of adults from the Intermountain Region were identified by Dr. R. H. Foote, United States National Museum, as mostly *M. aldrichii* Wh., but some were identified as *M. sp.* (near *nigripes* Lev.) and *M. sp.* (near *oregonensis* Van Duzee).⁴ Specimens from the Northwest were identified by G. Steyskal, United States Department of Agriculture, as *M. aldrichii*. Since the classification of this

⁴ Personal communication, M. M. Furniss, United States Forest Service, Ogden, Utah.

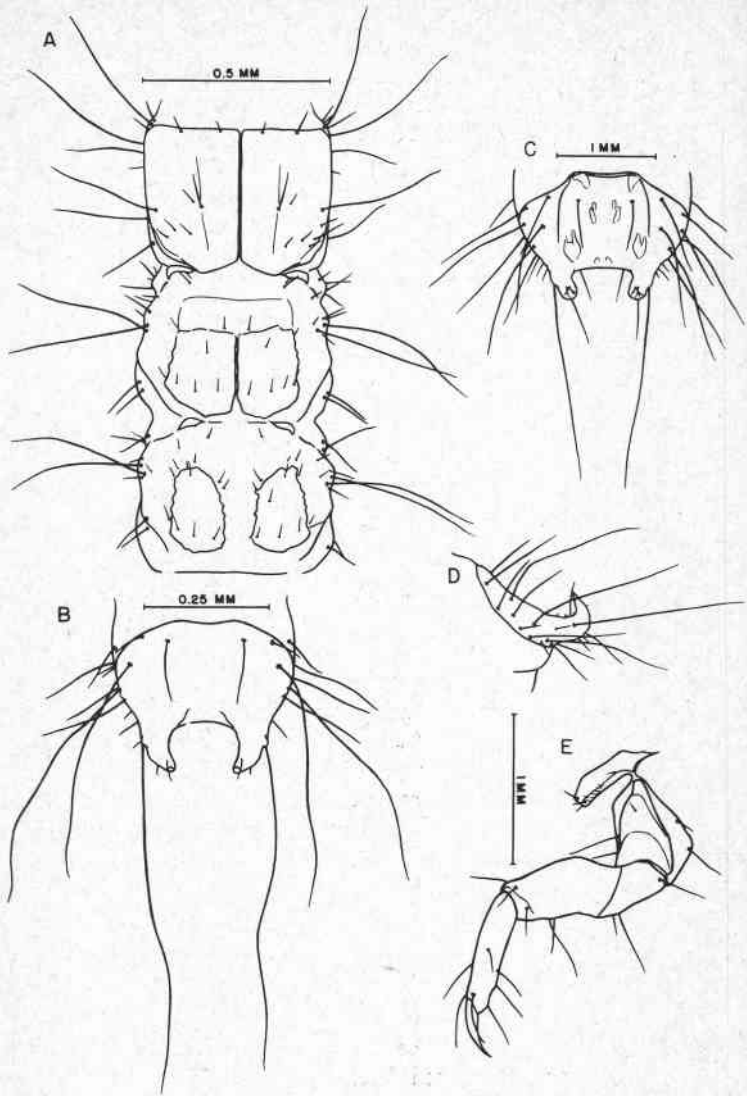


PLATE XII

Temnochila virescens chlorodia Mann.: A, second instar, dorsal view of thorax; B, second instar, dorsal view of basal plate and urogomphi; C, sixth instar, dorsal view of basal plate and urogomphi; D, sixth instar, lateral view of basal plate and urogomphi; E, sixth instar, mesothoracic leg.

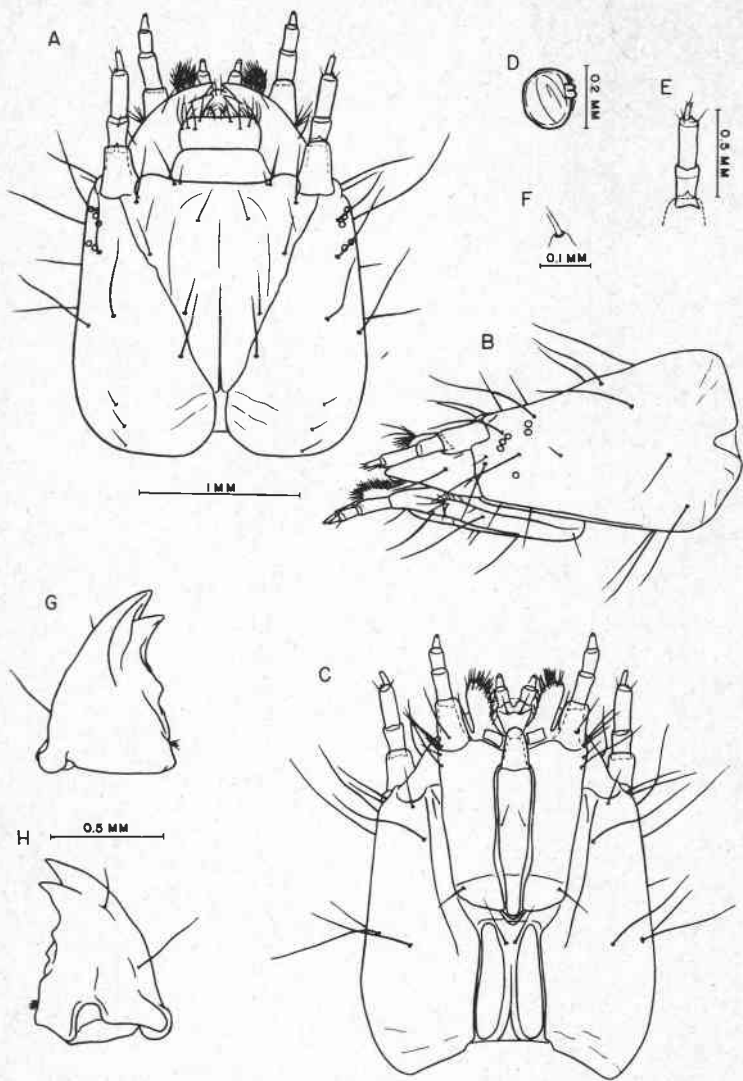


PLATE XIII

Temnochila virescens chlorodia Mann., sixth instar: A, dorsal view of head; B, lateral view of head; C, ventral view of head; D, abdominal spiracle; E, dorsal view of antenna; F, chalaza and base of abdominal seta; G, ventral view of mandible; H, dorsal view of mandible.

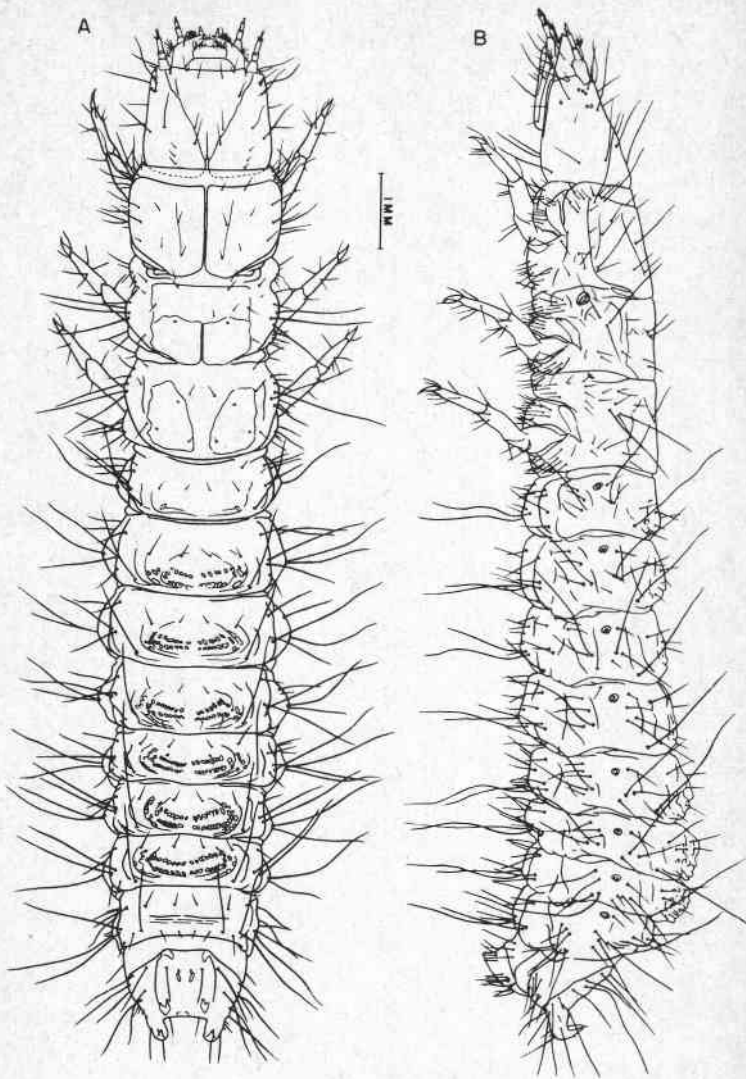


PLATE XIV

Temnochila virescens chlorodia Mann., sixth instar: A, dorsal view of complete larva; B, lateral view of complete larva.

group of flies is in a state of revision, no effort was made to identify the larvae down to the species level (10).

Species of this genus have been reported as being predaceous on many species of Scolytidae, mainly *Dendroctonus*, *Scolytus*, and *Ips*; and on Cerambycidae, Buprestidae, and Curculionidae. Records indicate that *M. aldrichii* is widely distributed throughout the coniferous forests of western United States and British Columbia (1, 7, 9).

Maggots of this insect are very abundant under the bark of trees infested by *D. pseudotsugae*. It is the most numerous of all of the predators, and ranks second in number only to the parasite *C. brunneri*. Despite its large numbers, this species is probably not so effective as *E. sphegeus* in the control of the Douglas-fir beetle population. DeLeon (8, p. 73) reported that the larvae of *M. aldrichii* find their prey fortuitously. Having no legs, the larvae are not very mobile and hence not very efficient in finding their hosts.

The observed life cycle of this insect is briefly as follows: Adults have been observed moving very rapidly over the bark of trees which the Douglas-fir beetle in the Intermountain Region is initially invading. The emergence of the fly in the Pacific Northwest appears to be considerably later than the initial attack by the bark beetle. Mating apparently takes place on the bark of infested material and the eggs are laid in small clusters under scales of the bark. Adults are present throughout the summer. There is only one generation per year with all three instars present throughout the summer (10). Pupation usually occurs under the bark in spring.

The following descriptions were taken from the literature on *M. aldrichii* Wh. by Bedard (1, pp. 40-42), DeLeon (8, pp. 62-67), and Hopping (9) with some additional observations. A drawing (Plate XV, Figure B) was made illustrating a complete, mature larva of *Medetera* sp.

Descriptions of immature stages. The egg, three larval instars, and pupa are described.

Egg: Average length, 0.86 mm; average width, 0.18 mm. Form subcylindrical, with a slightly curved longitudinal axis, convex dorsally, concave ventrally, pointed at one end; margins equal; chorion smooth and shining; color at first pearly white, becoming brownish orange with development.

First instar: Average length of larva, about 0.7 mm. Form slender, cylindrical; creamy white in color; metapneustic; number of body segments not determined; no sclerotized areas on the head or first thoracic segment.

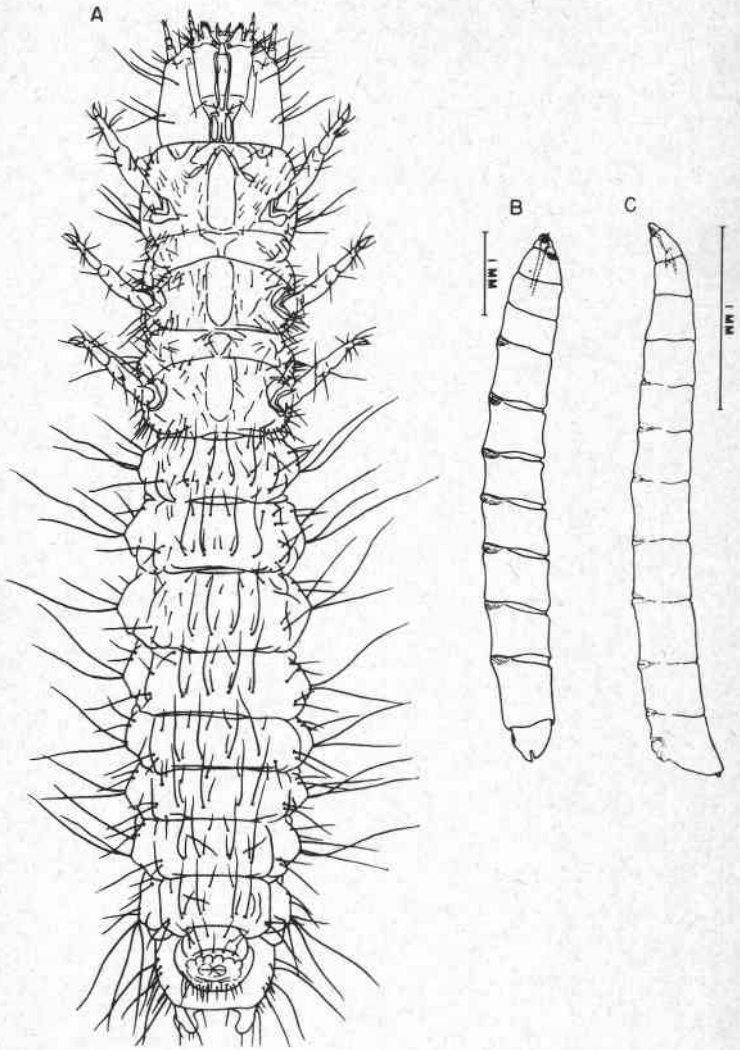


PLATE XV

A, sixth instar, ventral view of complete larva of *Temnochila virescens chlorodia* Mann.; B, mature larva, lateral view of complete larva of *Medetera* sp.; C, mature larva, lateral view of complete larva of *Lonchaea* sp.

Second instar: DeLeon (8, p. 62) states, "The second instar was not observed for this species. The larvae of *M. signaticornis* Loew, which were studied by the writer with greater care, went through three instars, and it is probable that there is the same number for *M. aldrichii*. The second instar of the former species resembles the first instar in lacking the sclerotized areas of the head and first thoracic segment." Johnsey observed a second instar for *Medetera* sp. associated with *Dendroctonus pseudotsugae* in Washington and Oregon. Again, the sclerotized areas of the head and first thoracic segment were not present (10).

Third instar: (Plate XV, Figure B). Average length, 8.5 mm. Form cylindrical with a slightly curved longitudinal axis, tapering slightly at each end with the tapering more pronounced cephalad; abdomen with a rather rigid cuticle, glabrous (although DeLeon mentions very minute sensillae on the body segments), grayish white; three thoracic and eight abdominal segments; abdominal segments five to ten are subdivided at the anterior margin, forming a narrow ring on all sides except the ventral; tenth segment is about 1.4 times as long as segment nine, and about 2.5 times as long as segment 11; each of the abdominal segments, except the eighth, with a ventral pseudopod; eighth abdominal segment with the anal opening and abdominal spiracle.

Head subdivided, exserted; caudal region of the dorsum of the posterior region of the head with a brownish, sclerotized, oval plate. Anterior region of head protruding forward in the form of two lateral lobes; lobes with the mandibles, mandibular plates, palpi, and other sensillae; a median spine extending anteriorly between the two lobes; internally and extending back into the mesothorax are two meta-cephalic and two tentorial black rods. Antennae apparently one-segmented, located on a pair of lateral lobes of the anterior head region.

Anterior margin of prothorax dorsally with a small crescent-shaped, sclerotized plate.

Amphipneustic type of respiratory system; two pair of spiracles; cephalic pair small, located below the median lateral, longitudinal line and behind the median transverse line of the prothorax; caudal pair located in the center of the four posterior protuberances of the eighth abdominal segment, larger than the cephalic pair, more strongly pigmented with brown, roughly oval in shape with two large oval openings into the stigmatic chamber; dorsal and lateral areas around the caudal pair of spiracles are slightly sclerotized with four branched spines located in this region close to the margin of the spiracles.

Eighth abdominal segment divided dorso-ventrally by a median groove and laterally by a transverse groove, thus forming four protuberances; two ventral protuberances project beyond the dorsal ones so that the former can be seen when viewed from above; also closer together and more sharply tapered than the dorsal pair of protuberances.

Anus opens as a longitudinal slit on the ventral surface of, and slightly anterior to, the eighth abdominal segment, in a more or less circular padlike swelling of the cuticula.

Pupa: Average length, about 4.5 mm; average width, about 2 mm; typically exarate; creamy white except for brownish sclerotized areas. Pair of sclerotized respiratory spines or horns directly behind the eyes with their bases extending parallel to the posterior margin of the eyes beneath the cuticula; pair of spiracles or vestigial spiracles on all but seventh and eighth abdominal segments. Single transverse row of spines located dorsally on all but eighth abdominal segment. Anterior to each row of dorsal abdominal spines an area of innumerable, minute, sharply pointed spines that diminish in number towards anterior margin of each segment; laterad, spines become smaller but are larger on the lateral swellings, forming distinct scabrous areas. Eighth abdominal segment with a series of five to seven pair of elongated spines; an inner, much shorter pair; all but inner and shortest pair hooked at end. Thorax with three pair of small spines; anterior spine in some instances doubled, so that on one side of pupa two spines may be present where there is normally one. Wings extend to apex of second abdominal segment, apices of prothoracic tarsi to apex of third abdominal segment, those of mesothoracic tarsi to apex of fourth abdominal segment, those of metathoracic tarsi to apex of fifth abdominal segment. Usually pupates in a white, silky-lined pupal cell.

Lonchaeidae: *Lonchaea* spp.

Adult specimens from the Intermountain Region were determined by Dr. C. W. Sabrosky of the United States National Museum and Dr. J. F. McAlpine of Ottawa, Canada. As in the case of *Medetera*, there was more than one species involved. The *Lonchaea* have been identified as *L. sp.* (near *corticis* Taylor) and *L. sp.* (near *watsoni* Curran),⁵ and those from the Northwest as belonging to the *L. watsoni* group (10).

Very little has been reported concerning this group of flies. Bedard (1, p. 49-49) included very brief descriptions and illustra-

⁵ Personal communication, M. M. Furniss.

tions of the egg, mature larva, and pupa of *L. corticis*. Species of this genus have been observed in association with *D. pseudotsugae* in Douglas-fir and *D. engelmanni* in Engelmann spruce in the Inter-mountain Region. It has been found under Douglas-fir bark in the Pacific Northwest. Bedard (1, p. 47) in 1933 stated, "The larvae of *L. corticis* unquestionably destroy much of the *D. pseudotsugae* broods, possibly even more than *Medetera*, as the larvae are more abundant in the infested trees than those of the latter species." From observations made in western Oregon, however, it appears that the larvae of this fly are more scavengers than predators. There are two generations per year and the adults of the first generation begin to emerge during the last week of June.

The following descriptions were taken from the literature by Bedard (1, p. 48-49) on *L. corticis*, with additional information from observation. A drawing (Plate XV, Figure C) of a complete larva is included.

Descriptions of immature stages. The egg, mature larva, and pupa are described.

Egg: Average length, 0.86 mm; range in length, 0.80 mm to 0.88 mm. Average width, 0.17 mm; range in width, 0.15 mm to 0.20 mm. Form subcylindrical, with a slightly curved longitudinal axis, tapering at one end, tapered end truncated; margins unequal; chorion smooth and shining; color pearly white.

Mature larva: (Plate XV, Figure C). Average length, about 9 mm. Form wedge-shaped or muscidiform, with a slightly curved longitudinal axis, tapering gradually to a sharply pointed cephalic end; creamy white and glabrous; three thoracic and eight abdominal segments; pseudopodia situated ventrally on second to eighth abdominal segments; setulae present about margins of anal area on eighth abdominal segment.

Head may be retractile; with small antennae and buccal appendages; mouthparts mainly internal, visible; anterior hooks black; posterior rods extending into the prothorax and mesothorax, dark brown, fused at two locations, branching caudally.

Head and prothorax without sclerotized plates.

Amphipneustic type of respiratory system; two pair of spiracles; cephalic pair small, nine-lobed, located laterad and caudal on the prothorax; caudal pair located on dorso-caudal end of bluntly pointed eighth abdominal segment, containing three slits situated at right angles to each other, heavily sclerotized on dorsal portion extending outward and upward to form a heavy, blunt, spine curving above each spiracle.

Pupa: Average length, about 5.0 mm; typically coarctate; puparium reddish brown, average length, about 5.2 mm; pupa creamy white, slightly shining; apices of wings extend to apex of third and last abdominal segment; apices of prothoracic tarsi to middle of same segment; apices of mesothoracic tarsi extend to apex of penultimate abdominal segment; those of metathoracic tarsi to middle of apical abdominal segment.

Braconidae: *Coeloides brunneri* Viereck

Identification of the immature stages of *Coeloides brunneri* Vier. was very briefly worked on by Bedard (1, p. 52). Recently, Ryan (21) published descriptions of the five larval instars.

This insect has been reported as being parasitic mainly on *Dendroctonus pseudotsugae* (1, p. 51; 22). Ryan and Rudinsky (22, p. 755) reported that a small percentage of parasitism occurs on *Melanophila drummondi*. It is the most abundant of all of the predators and parasites of *D. pseudotsugae*. In small trees and towards the top of larger trees, *C. brunneri* can be very effective in parasitizing a large percentage of the Douglas-fir brood.

Virtually nothing is known about the biology of this species in relation to the Douglas-fir beetle in southern Idaho, although adults have been observed on the bark of infested trees in early July. Ryan and Rudinsky (22, p. 755) reported that *C. brunneri* in Oregon "successfully parasitizes the Douglas-fir beetle only when the host is in the second, third, and fourth instars." There are three generations per year in western Oregon with varied incidence of diapause. The incidence of diapause increases as the season progresses, being only 5% in the first generation, 45% in the second one, and 95% in the third.

Records indicate that the parasite is widely distributed from British Columbia to California and eastward to Montana and Colorado (15, p. 160).

The following descriptions were taken from the literature on *C. brunneri* by Bedard (1, p. 52) and Ryan (21). Illustrations (Plate XVI, Figures C and D) were redrawn from Ryan.

Descriptions of immature stages. The egg, five larval instars, and pupa are described.

Egg: Average length, 1.3 mm; average width at widest point, 0.15 mm. Form cylindrical with a long tapering tail; widest portion approximately one-fifth of distance from broad, rounded anterior end; tail usually slightly curved and tapering to a small acute point;

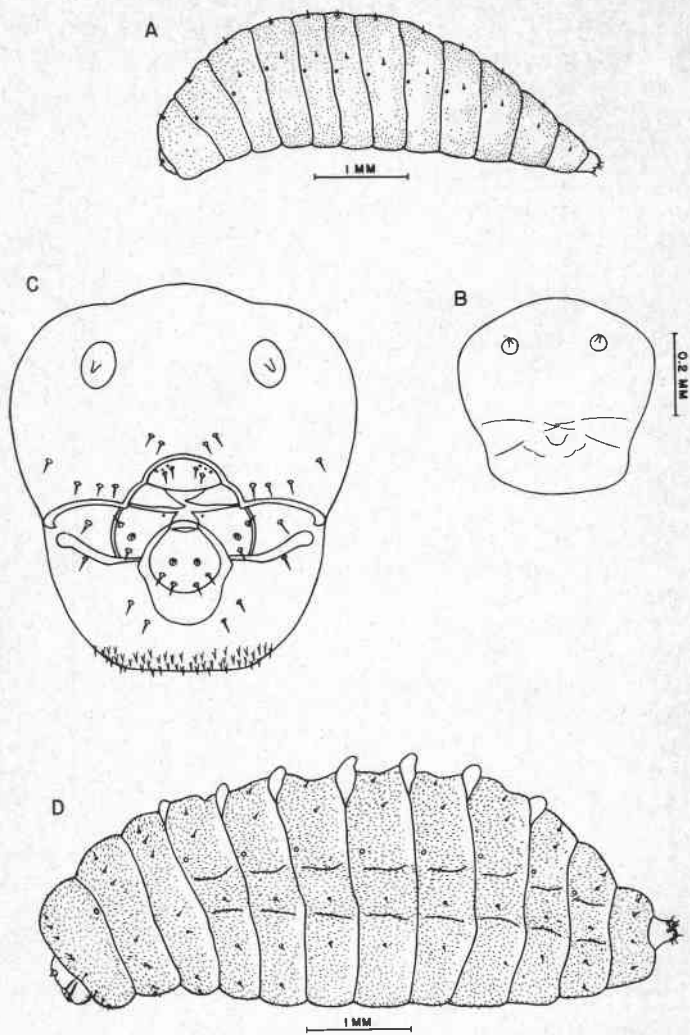


PLATE XVI

A, mature larva, lateral view of complete larva of Pteromalidae; B, mature larva, frontal view of head of Pteromalidae; C, fifth instar, frontal view of head of *Coeloides brunneri* Vier.; D, fifth instar, lateral view of complete larva of *C. brunneri* Vier.

chorion thin, elastic, translucent, without ornamentation; color white, ends becoming clear and transparent.

First instar: Average length, about 1.1 mm. Form cylindrical, tapering gradually towards caudal end; distinct head and 13 body segments; first 11 body segments with a prominent band of sensory setae around the middle in addition to several smaller scattered setae; twelfth and thirteenth body segments have only a few scattered setae; body membranous and white.

Head exerted; lateral margins in dorsal view nearly straight for approximately two-thirds the length of head, converging slightly anteriorly and merging with the broadly rounded cephalic margin; antennae conical in a cephalolateral position; labrum, maxillae, and labium grouped about mouth opening as a cup-shaped, prominent, cephaloventral projection from the head capsule proper.

Spiracles circular; one pair on prothorax and abdominal segments one to eight; all located slightly dorsad of midlateral line, that on thoracic segment just cephalad of caudal margin of that segment, while those on the abdominal segments lie just caudad of the cephalic margins of their respective segment.

Second, third, and fourth instars: Average length of second, third, and fourth instars, 1.4, 2.3, and 3.3 mm, respectively. Body fusiform; no prominent bands of setae present, although from four to eight individual setae aligned around center of each thoracic segment; abdominal segments with single setae present laterad of mid-dorsal and midventral lines and at the midlateral position. Head capsule spherical; outline of head in dorsal view curved with widest part in the center; mouth parts do not project.

Fifth instar: (Plate XVI, Figures C and D). Average length, about 6 mm. Body fusiform to cyphosomatic; seven dorsal protrusile areas in the successive intersegmental areas, the most anterior between the metathoracic and first abdominal segment; in living larvae the first eight abdominal segments have swellings in the midlateral areas; sensory setae slightly more numerous than preceding instars; numerous cuticular spines covering the first 12 body segments except along the intersegmental lines and on the dorsal protrusile areas, also not present on terminal body segment or on the head except ventral surface. Head in frontal view obovate, constricted slightly below the midline by the hypostoma, a slight depression on either side of the dorsal midline of the epicranium; bases of antennae surrounded by a broadly elliptic antennal foramina; six pair of setae dorsad of mouth armature; labiobase with three pair of setae dorsally and many cuticular spines ventrally; lines between

mouthparts and parts of head capsule heavily sclerotized, stipital sclerome between cardo and stipes.

Pupa: Average length, about 5.3 mm; typically exarate pupa; white in color, becoming darker with maturity; usually pupates in a white silken cocoon.

Pteromalidae: *Roptrocerus eccoptogasteri* Ratz., *Cecidostiba burkei* Craw., and *C. dendroctoni* Ash.

Adult specimens of this family which emerged from Douglas-fir slabs were determined by B. D. Burks, United States National Museum.⁶ The parasites were identified as *Roptrocerus eccoptogasteri* Ratzeburg, *Cecidostiba burkei* Crawford, and *C. dendroctoni* Ashmead.

R. eccoptogasteri has been reported as occurring in some of the Atlantic States and the Pacific Northwest. Its hosts are *Dendroctonus* and *Ips* (15, p. 549). *C. burkei* appears to parasitize species of *Dendroctonus* and occurs in the Pacific Northwest (15, p. 557). Records on *C. dendroctonus* state that this species is parasitic on *Dendroctonus*, *Ips*, and *Cylindrocopturus* and occurs in West Virginia and the Pacific Northwest (15, p. 557). These species are not very abundant in association with *D. pseudotsugae*. The biology and habits of this group are presumably similar to those of *C. brunneri*.

The following description is from characters by Michener (14, pp. 993-995), and Parker,⁷ and from observation. Drawings (Plate XVI, Figures A and B) were made from preserved specimens.

Mature larva: (Plate XVI, Figures A and B). Body form somewhat crescent-shaped to cyphosomatic, tapering sharply towards caudal end; distinct head and 13 body segments; abdominal segments one to four wider than remaining abdominal and thoracic segments; no dorsal protrusile areas in the successive intersegmental areas; a few sensory setae located dorsally on thoracic and abdominal segments; numerous cuticular spines scattered over the first 12 body segments; six setae around anus; body membranous and white. Head exerted, in frontal view broadly obovate, constricted slightly below the midline by the hypostoma; short, conical antennae with bases surrounded by a broadly elliptic antennal foramina; lines between mouthparts and parts of head capsule not (or feebly) sclerotized, cardo and stipes fused or nearly so, without a conspicuous stipital

⁶ Personal communication from M. M. Furniss.

⁷ Personal communication, D. E. Parker, United States Forest Service, Ogden, Utah.

sclerome between them. Spiracles circular; one pair on mesothorax, metathorax and abdominal segments one to seven; all except first abdominal spiracle located on midlateral line, that of first abdominal segment slightly dorsad of midlateral line; all spiracles near cephalic margin of their respective segment.

ACKNOWLEDGMENTS

This study is an outgrowth of a 1960 cooperative undertaking between Oregon State University and the Intermountain Forest and Range Experiment Station, United States Forest Service, Ogden, Utah, on the distribution of the parasites and predators of the Douglas-fir beetle infesting standing trees. Financial support for identification and description was provided by the Oregon Agricultural Experiment Station and National Science Foundation, grant No. G-14296. The work was done by research assistant L. N. Kline, under the direction of J. A. Rudinsky. Specimens from the Intermountain Region were collected from the Boise National Forest and Payette National Forest in Idaho, while L. N. Kline was employed by the United States Forest Service, and Pacific Northwest specimens were taken from the Marys Peak watershed near Corvallis, Oregon.

The authors acknowledge the assistance of D. E. Parker, United States Forest Service, Ogden, Utah, who originated the distribution project; M. M. Furniss, of the same agency, who helped in planning and in the field; and P. O. Ritcher, head of the Department of Entomology, Oregon State University, who checked many of the descriptions.

REFERENCES CITED

1. Bedard, W. D., *The Douglas-fir beetle, its seasonal history, biology, habits, and control*. USDA, Forest Service, Forest Insect Field Station, Coeur d'Alene, Idaho, 1933. (Processed.)
2. Blackwelder, Richard E., Fourth supplement to the *Leng Catalogue of Coleoptera of America, North of Mexico*. Mount Vernon, N. Y.: Freybourg, 1939.
3. Blackwelder, Richard E., and Ruth M. Blackwelder, Fifth supplement to the *Leng Catalogue of Coleoptera of America, North of Mexico*. Burlington, Vt.: Lane Press, 1948.
4. Böving, A. G., The larvae of *Enoclerus lecontei* Wolcott and *Callimerus arcufer* Chapin, of the beetle family Cleridae. Proc. of the Ent. Soc. of Wash., 30:94-100, 1928.
5. Böving, A. G., and A. B. Champlain, Larvae of North American beetles of the family Cleridae. Proc. U. S. Natl. Museum, 57:575-649, 1920.

6. Böving, A. G., and F. C. Craighead, An illustrated synopsis of the principal larval forms of the order Coleoptera. *Entomologica Americana*, 11:1-348, 1930.
7. DeLeon, Donald, The morphology of *Coeloides dendroctoni* Cushman (Hymenoptera: Braconidae), *Jour. of the N. Y. Ent. Soc.*, 42:297-317, 1934.
8. DeLeon, Donald, A study of *Medetera aldrichii* Wh. (Diptera: Dolichopodidae), a predator of the mountain pine beetle (*Dendroctonus monticolae* Hopk., Coleoptera: Scolytidae). *Entomologica Americana*, 15:59-91, 1935.
9. Hopping, George R., Notes on the seasonal development of *Medetera aldrichii* Wheeler (Diptera: Dolichopodidae) as a predator of the Douglas-fir bark beetle, *Dendroctonus pseudotsugae* Hopkins. *The Canadian Entomologist*, 79:150-153, 1947.
10. Johnsey, Richard L., The biologies of two dipterous predators of *Dendroctonus pseudotsugae* Hopkins (Coleoptera: Scolytidae) in western Oregon and Washington, Masters thesis, Oregon State University, Corvallis, 1964.
11. Knull, Josef N., The checkered beetles of Ohio (Coleoptera: Cleridea). *Ohio State Univ. Studies, Ohio Biological Surv. Bull.* 42, 1951.
12. Leng, Charles W., *Catalogue of the Coleoptera of America, North of Mexico*. Cambridge, Mass.: Cosmos Press, 1920.
13. Leng, Charles W., and Andrew J. Mutchler, supplement to *Catalogue of the Coleoptera of America, North of Mexico*. Cambridge, Mass.: Cosmos Press, 1927.
14. Michener, C. D., Comparative morphological and systematic studies of bee larvae with a key to the families of Hymenopterous larvae. *Univ. of Kansas Sci. Bull.*, 35:987-1102, 1953.
15. Muesebeck, C. F. W., Karl V. Krombein, and Henry K. Townes, *Hymenoptera of America North of Mexico*, USDA, Agriculture Monograph No. 2, 1951.
16. Papp, Charles S., The Cleridae of North America, Part I, The geographical distribution of Cleridae of North America, north of the Panama Canal. *Bull. Southern Calif. Acad. Sciences*, 59:76-88, 1960.
17. Person, Hubert L., The clerid *Thanasimus lecontei* (Wolc.) as a factor in the control of the western pine beetle. *Jour. of For.*, 38:390-396, 1940.
18. Peterson, Alvah, *Larvae of Insects: An Introduction to Nearctic Species, Part I, Lepidoptera and Plant Infesting Hymenoptera*. Ann Arbor, Mich.: Edwards Brothers, 1959.
19. Peterson, Alvah, *Larvae of Insects: An Introduction to Nearctic Species, Part II, Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera*. Ann Arbor, Mich.: Edwards Brothers, 1960.
20. Reid, R. W., The bark beetle complex associated with lodgepole pine slash in Alberta, Part III—Notes on the biologies of several predators with special reference to *Enoclerus sphegeus* Fab. (Coleoptera: Cleridae) and two species of mites. *The Canadian Entomologist*, 89:111-120, 1957.
21. Ryan, Roger B., Durations of the immature stadia of *Coeloides brunneri* (Hymenoptera: Braconidae) at various constant temperatures, with descriptions of the five larval instars. *Annals of the Ent. Soc. of Amer.*, 55:403-409, 1962.

22. Ryan, Roger B., and Julius A. Rudinsky, Biology and habits of the Douglas-fir beetle parasite, *Cocloides brunneri* Viereck (Hymenoptera: Braconidae), in western Oregon, *The Canadian Entomologist*, 94:748-763, 1962.
23. Struble, George R., The biology of certain Coleoptera associated with bark beetles in western yellow pine, *Univ. of Calif. Publications in Ent.* 5(6): 105-134, 1930.
24. Struble, George R., Biology of two native coleopterous predators of the mountain pine beetle in sugar pine, *The Pan-Pacific Entomologist*, 18:97-107, 1942.
25. Struble, George R., Laboratory propagation of two predators of the mountain pine beetle. *Jour. of Econ. Ent.*, 35:841-844, 1942.
26. Struble, George R., and L. H. Carpelan, External sex characters of two important native predators of the mountain pine beetle in sugar pine. *The Pan-Pacific Entomologist*, 17:153-156, 1941.
27. Torre-Bueno, J. R., De La, ed., *A Glossary of Entomology*. Brooklyn, N. Y.: Brooklyn Entomological Society, 1950.
28. Wolcott, Albert B., Catalogue of North American beetles of the family Cleridae. *Fieldiana: Zoology*, 32:61-105. 1947.