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On the mature larva of the western eyed click beetle *Alaus melanops* LeConte, 1863 with comparison to related species (Coleoptera: Elateridae)

Marcin Kadej, Adrian Smolis, and Dariusz Tarnawski*

Abstract

The last larval instar of *Alaus melanops* LeConte, 1863 (Coleoptera: Elateridae) is described. Morphological characters of the larva such as general morphology of antenna, frons, clypeus, mandible, maxillolabial complex, lacinia and galea, maxillary palp, labium, and abdominal terga are documented and discussed. Data on the natural history and distribution are provided.

Key Words: immature stage; morphology; saproxylic; North America

Resumen

Se describe el último estadio larval de *Alaus melanops* Leconte, 1863 (Coleoptera: Elateridae). Se documenta y discute las caracteristicas morfológicas generales de la larva, como la antena, frons, clípeo, mandíbula, complejos maxillolabial, lacinia y galea, palpo maxilar, labio, y terga abdominal. Se proveen datos sobre su historia y su distribución natural.

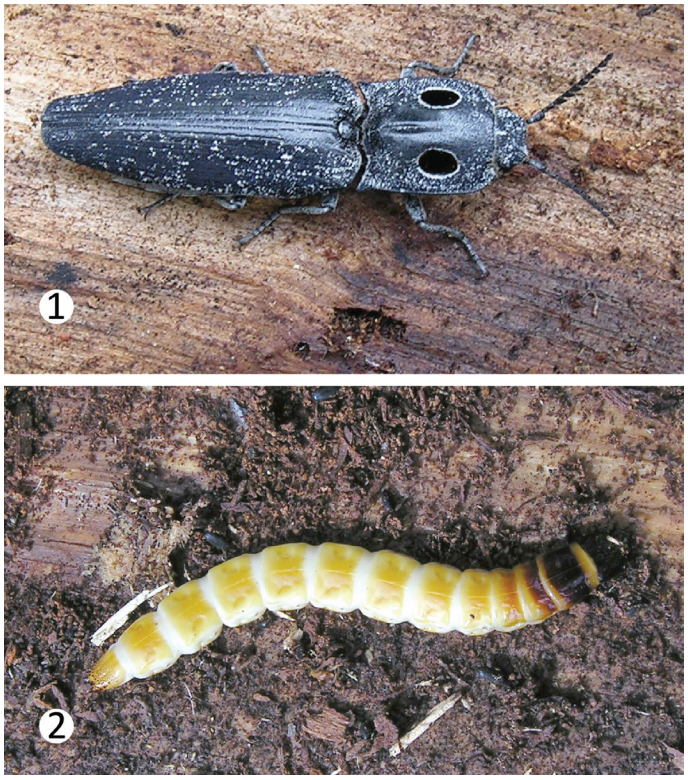
Palabras Clave: estadio inmaduro; morfología; saproxilic; América del Norte

Species of the elaterid genus *Alaus* Eschscholtz, 1829 (Coleoptera: Elateridae: Agrypninae: Hemirhipini) are among the largest click beetles in New World; they are characterized especially by 2 eye-like spots of variable size and shape on the pronotum (Fig. 1). At present, according to the analysis of Hemirhipini recently published by Casari (2008), the genus comprises 16 species distributed widely across the New World. Among the described taxa, 6 have been reported from the continental USA, and 3 of them—*A. lusciosus* (Hope, 1832), *A. melanops* LeConte, 1863, and *A. zunianus* Casey, 1893—have been recorded from the western part of the country (Evans & Hogue 2006; compare with map at http://bugguide.net).

Unlike larval morphology, the morphology of adults is relatively well studied and described (Casari 2003). Larvae of only 3 species have been described to date (blind click beetle *A. myops* (F., 1801), eastern eyed click beetle *A. oculatus* (L., 1758), and *A. nobilis* Sallé, 1855 (Böving & Craighead 1931; Peterson 1960; Becker 1991; Casari 2002).

Larvae of *Alaus* are among the largest predators living in various kinds of dead wood (Dajoz 2000). Despite being intensively studied, especially in the temperate and boreal zones (Siitonen 2001; Bobiec et al. 2005; Stokland et al. 2012), this unique habitat is still poorly known. Some of the gaps in the knowledge result from the scarcity of data on the morphology of immature stages of many saproxylic beetles, which form a significant proportion of all species living in decayed wood and play important roles in the ecosystem (Speight 1989).

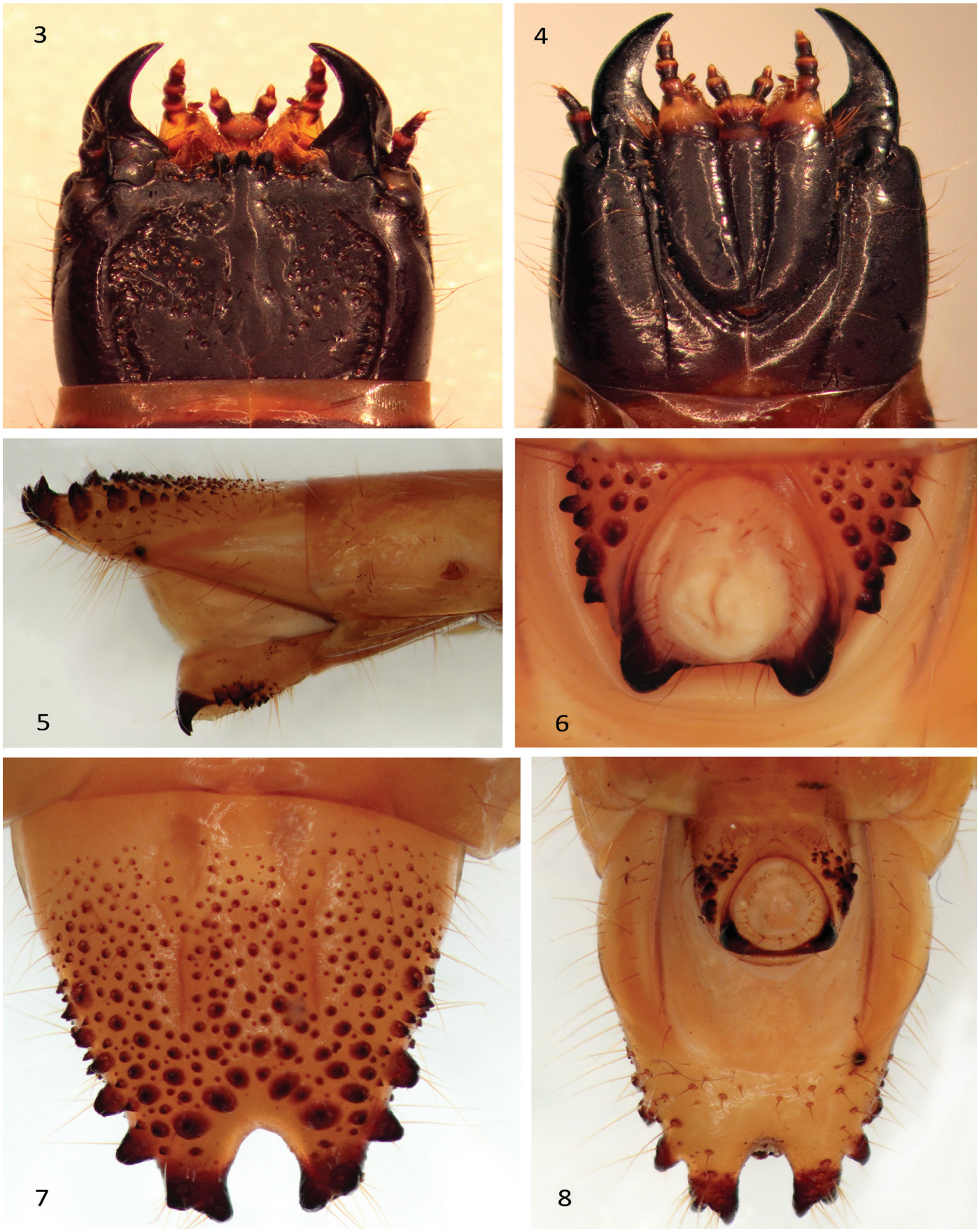
The larvae of the genus *Alaus* are characterized by large size, yellow coloration of body with black head (Fig. 2), distinctly flattened body, semicircular epicranial ridge punctate and setose internally, triangu-



Figs. 1 and 2. *Alaus melanops* LeConte, 1863. 1, Adult (habitus, dorsal); 2, larva (habitus, dorsal).

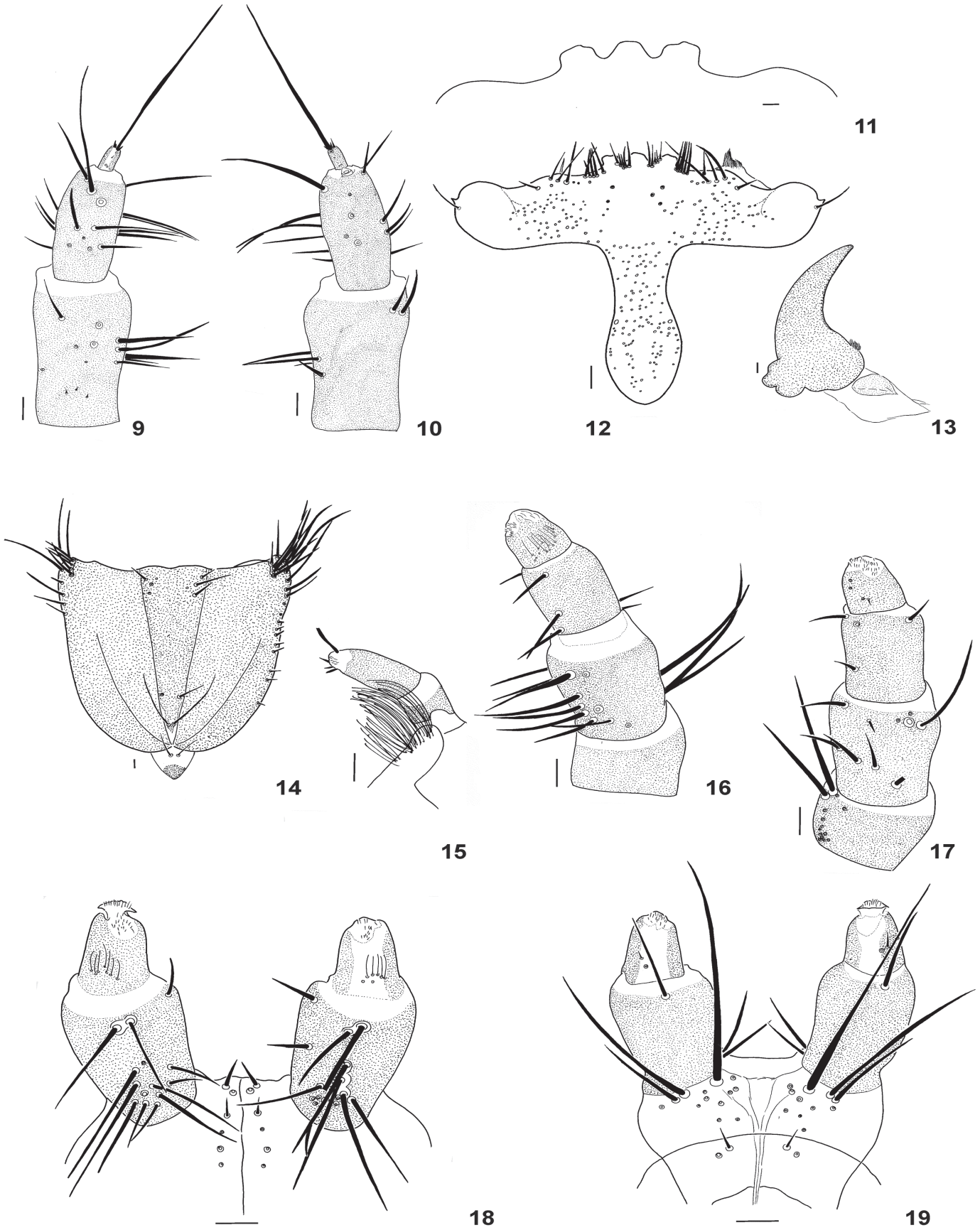
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Figs. 3–8. *Alaus melanops* LeConte, 1863, larva. 3, Head, dorsal; 4, head, ventral; 5, abdominal segments VIII–X, lateral; 6, anus on abdominal segment X; 7, abdominal segment IX, dorsal; 8, abdominal segments IX–X, ventral.

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Figs. 9–19. *Alaus melanops* LeConte, 1863, larva. 9, Antenna, dorsal; 10, antenna, ventral; 11, clypeus (= nasale), dorsal; 12, frons, dorsal; 13, mandible, dorsal; 14, hypopharyngeal complex, dorsal; 15, galea and lacinia, dorsal; 16, maxillary palp, dorsal; 17, maxillary palp, ventral; 18, labium, dorsal; 19, labium, ventral.

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lar submentum, mandibles without inner teeth, and 10th abdominal segment with strong teeth (Casari 2002). In this paper, we describe the morphology of the larva of *A. melanops* and provide taxonomically important characters.

Materials and Methods

The specimens of *Alaus melanops* LeConte, 1863 were obtained from USA (Oregon, *leg.* A. Smolis). The larvae were preserved in alcohol. Before examination, they were boiled for 3 to 10 min in 10% KOH, rinsed with distilled water, and placed in distilled water for about an hour to clean and soften the cuticle. All structures were placed in glycerin mounts. Larval structures were examined with a Nikon Eclipse E 600 phase contrast microscope with a drawing tube, and a Nikon SMZ–800 binocular microscope. Photographs were taken with a Canon 500D attached to a Nikon Eclipse 80i and a Nikon D5100 camera attached to a Nikon SMZ–800. Image stacks were processed using Combine ZM (Hadley 2010). Plates with figures of selected structures were prepared from larvae. The description and terminology used in this paper follow Casari (2002). Body length was measured along midline from head apex to apex of last abdominal tergum.

The following abbreviation was used in this study:

DIBEC—collection of the Department of Invertebrate Biology, Evolution and Conservation, Institute of Environmental Biology, Faculty of Biological Science, University of Wrocław, Przybyszewskiego 63/77, Wrocław, Poland.

Results

Subfamily Agrypninae Candèze, 1857

Tribe Hemirhipini Candèze, 1857

Genus *Alaus* Eschscholtz, 1829

Alaus melanops LeConte, 1863 (Figs. 1–19)

MATERIAL EXAMINED

United States of America: Oregon State, Deschutes County, east slope of Cascade Range, Deschutes National Forest, 11 km NW of Sisters Town, SE slope of Black Butte Mountain, ponderosa pine forest of the Ponderosa Pine Zone (Franklin & Dyrness 1988), 3 larvae *ex* decayed log, 2-VI-2009, *leg*. A. Smolis (DIBEC).

DESCRIPTION

Larva, last instar. Length: 45 mm, width of pronotum: 8 mm. Body dorsoventrally flattened. Yellow with black head and dark reddish-brown prothorax; meso-, metanotum, and legs reddish-brown; legs brown. Head (Figs. 2 and 4) prognathous, depressed; dorsal epicranial ridge irregular, semicircular, from frontal arms to near base, very coarsely and irregularly punctate and setose internally (setae not represented); ventral epicranial ridge almost straight, not reaching margins, with row of coarse setose punctures externally; each epicranial plate dorsally with one lateral inclined row of setae, starting in front of stemma and directed outside, and another ventrally parallel lateral margin. One subelliptical stemma dorsolaterally placed at base of each antenna. Coronal suture (Figs. 1 and 8) long; dorsally weak groove extending between frontal arms. Endocarina absent. Frontal suture lyre-shaped. Clypeus (= nasale) (Figs. 11 and 12) tridentate dorsally, teeth directed upward; 5 setae on each side of central tooth; integument ventrally rugose, clothed with short setae, and with transverse anterior carina. Anterior margin of clypeus (Fig. 11) distally fringed by ramified yellowish setae; 5 setae on each side of clypeus; 1 row with 5 setae (1 distinctly longer) near border of darker area, 1 short seta more laterally; each half with 11 setae (3 grouped below clypeus) and 1 on each side, near middle of narrower area.

Antennae (Figs. 9 and 10): basal segment dorsally bearing 12 setae (5 broken off, Fig. 9), ventrally bearing 4 setae (Fig. 10); 2nd segment dorsally bearing 10 setae (4 broken off, Fig. 9), ventrally bearing 8 setae (4 broken off, Fig. 10); apex of 2nd segment with tiny laterointernal cupuliform appendix; distal segment short and cylindrical, distally with 1 extremely long and 2 short setae and 2 dorsal sensorial pores near base.

Mandibles (Fig. 13) much elevated dorsally near acetabulum, deeply grooved laterally on median half; 2 dorsal setae present; penicillus short and brush-like.

Maxillolabial complex (Fig. 14): stipites elongate, membranous in narrow irregular distal area, bearing ventrally 11 setae near anterior half of lateral margin (7 forming a group) and dorsally 12 setae on anterior fourth; galea (Fig. 15) palpiform and 2-segmented; apex of distal segment conical and rounded, bearing 1 cupuliform membranous appendix with microsetae and 4 setae (1 distinctly wide and long). Lacinia lobe-like (Fig. 15), membranous at apex, fringed by ramified setae; maxillary palp 4-segmented (Figs. 3, 4, 16 and 17), basal segment ventrally bearing 2 or 3 setae and 10 or 11 sensorial pores (Fig. 17), 2nd



Figs. 20–21. Habitats of *Alaus melanops* LeConte, 1863 in Oregon, USA, forest of Ponderosa Pine Zone.

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segment dorsally with 11 setae (probably 3 of which are broken off, Fig. 16) and ventrally with 10 (probably 3 of which are broken off, Fig. 17), 3rd segment dorsally with 3 setae (Fig. 16) and ventrally 4 (but 1 probably broken off, Fig. 17), 4th segment dorsally with more than 10 thin and relatively short setae near base (Fig. 16) and ventrally with 4 short setae (probably 3 of which are broken off, Fig. 17).

Prementum transverse, hexagonal, membranous in anterior half, bearing 3 ventral setae on each side, arranged in transverse row at border of darker area (internal longest), 2 microsetae near base and 8 sensorial pores near middle (Fig. 19); dorsally with 4 pairs of sensorial pores and 2 pairs of short setae (Fig. 18). Postmentum (Fig. 14) elongate, narrowly triangular (narrowed in distal half with apex constricted, membranous distally, 4 setae on each side near anterior border of darker area (below prementum) and 4 setae (1 broken off) near apex.

Labial palp 2-segmented (Figs. 18 and 19); basal segment dorsally bearing 14 or 15 setae (Fig. 18), ventrally bearing only 2 or 3 setae (Fig. 19); distal segment bearing 7 thin dorsal setae near base, ventrally bearing only 2 short setae (1 broken off) near base (Fig. 19).

Length of pronotum equal to combined length of meso- and metanotum, bearing a transverse row of 19 or 20 long setae (parallel to anterior margin, interrupted at middle), and 2 long and 2 short setae on each side (parallel to posterior margin near lateral angle). Mesosternum with 1 lateroanterior pair of well-developed spiracles, each with 1 seta near internal borders.

Legs: coxa narrow, transverse, bearing moderately stout setae on distal third and long simple setae near margin; trochanter trapezoidal with stout and short setae on basal half and simple and long setae near posterior margin, and 1 short seta near anterior margin; femur elongate with stout and short setae near posterior margin and 2 simple setae at anterior margin; tibia elongate with stout and short setae near lateral and posterior margins, 5 simple setae near middle and 2 (1 longer) near anterior margin; tarsungulus bearing 2 basal setae.

Each side of abdominal segments I–VIII bearing a pair of laterodorsal anterior spiracles smaller than thoracic ones. Segment IX (Figs. 7 and 8) strongly notched in narrow almost parallel apical area; apex bearing 2 setose well-developed upward-directed tubercles on each side; dorsally with setose tubercles, irregularly arranged, decreasing in size towards base of segment; some marginal larger (Fig. 5). Segment X (Fig. 7) tubular, ventrally bearing 17 to 22 tubercles on each side (4 or 5 posterior larger) and 2 posterior distal hooks; anal orifice surrounded by long setae (Fig. 6).

Table 1. Comparison between larvae of some of North American *Alaus* species.

Characteristics	*A. melanops* LeConte, 1863	*A. myops* (F., 1801)	*A. oculatus* (L., 1758)
Number of setae on antennal appendix	1 long and 2 short setae	1 long and 2 short setae	Only 1 long seta
Apex of galea	rounded and tapered	blunt and widened	rounded and tapered
Number of setae on apex of galea	4	3	3
Length of basal setae on 1st segment of labial palp	long (longer than or equal to length of segment)	long (longer than or equal to length of segment)	short (distinctly shorter than length of segment)
Number of setae on cardo and cardines	1 and 2	2 and 4	3 and 6
Number of setae on each side of central clypeal tooth	5	3	4
Shape of the base of frons	slightly narrowed	rounded	rounded
Position of lateral setae of frons	near middle of lateral margin	near middle of anterior margin	near middle of lateral margin
Length of setae on segment IX	long (at least 3 or 4 times longer than tubercles)	long (at least 3 or 4 times longer than tubercles)	short (maximum twice as long as tubercles)
Shape of indentation between apices of segment IX	V-shaped	V-shaped	U-shaped
Tuberculation of dorsal side of segment IX	distinct	distinct	feeble
Number of tubercles on segment X	17–22	17	16

NATURAL HISTORY

Larvae develop inside dead and rotting wood of standing or fallen logs of different tree species, e.g., ponderosa pine (*Pinus ponderosa* Douglas ex C. Lawson) (Figs. 20 and 21), Jeffrey pine (*P. jeffreyi* Balf.), lodgepole pine (*P. contorta* Douglas ex Loudon), Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) (Pinales: Pinaceae), and several oak species (*Quercus*; Fagales: Fagaceae). They are predators and attack various insects (e.g., tenebrionid larvae) and other arthropods. Some authors suggest possibility of feeding on rotting wood. Adults, unlike the larvae, feed on nectar and can be observed out of the wood, especially from May to Jul. Adults are sometimes attracted to light (Lane 1971; Furniss & Carolin 1977; Evans & Hogue 2006).

DISTRIBUTION

In the original description of the species, LeConte (1863) mentioned *A. melanops* only from California and Oregon (USA). To date it has been recorded also from British Columbia (Canada), Colorado, Washington, Idaho, Utah, Arizona, Montana, and New Mexico (USA) (Evans & Hogue 2006; compare with map at http://bugguide.net).

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REMARKS

Among the known larvae of *Alaus* (Casari 2002), the mature larva of the western eyed click beetle *A. melanops* is most similar to the blind click beetle *A. myops* (compare with Table 1). It is worthy to note that a cladistic analysis based on the adult morphology placed *A. melanops* close to *A. zunianus* as sister taxa (Casari 2008). The observed morphological similarity between *A. melanops* and *A. myops* (at larval level) contradicts this result and suggests their close relationship. Besides, the current distribution of *A. melanops* (western North America: British Columbia, Washington, Utah, Oregon, Idaho, Montana, California, Colorado, Arizona, New Mexico; after http://bugguide.net) *versus A. myops* (eastern North America: Florida, South Carolina, North Carolina, Louisiana, Mississippi, Alabama, Georgia, Tennessee, West Virginia, Virginia, Ohio, New Jersey, Maryland, Massachusetts; after http://bugguide.net) could suggest allopatric speciation, probably caused by several glacial periods in the history of the North American continent. In this context, the phylogeography of North American *Alaus* species is still unclear, and genetic and ecological studies are required to shed light on it.

Acknowledgments

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