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STUDIES ON THE LARVAE OF DIGGER WASPS

(Hymenoptera, Sphecidae)

Part IV: Astatinae, Larrinae, and Pemphredoninae

BY

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STUDIES ON THE LARVAE OF DIGGER WASPS (HYMENOPTERA, SPHECIDAE) PART IV: ASTATINAE, LARRINAE, AND PEMPHREDONINAE [1]

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(Plates II to VIII)

This is the fourth of a series of five papers covering the comparative external morphology of the larvae of all available species of Sphecidae. None of the groups treated in this section is especially well known larva-wise, but enough information is available at least to characterize the subfamilies and some of the more common genera. Many of the drawings in this section were done by Enrico Sismondo.

Subfamily Astatinae

The published descriptions of the larvae of Astatinae, reviewed on a later page, are brief and in some cases rather puzzling. I have been able to collect 38 specimens of two North American species of *Astata*, and my interpretation of the characters of the subfamily is based entirely upon these specimens. In all of these specimens the salivary opening is paired as in other Sphecidae (except Sphecinae). Michener (1952, Jour. Kansas Ent. Soc., 25: 115) states that the salivary opening in the Astatinae is in the form of a transverse slit with a convex margin. His statement is, I believe, based on Maneval's description of *Astata boops*. Although *boops* is closely related to the North American species, there are many differences between the larvae of *boops*, as described by Maneval, and the larvae of *unicolor* and *occidentalis*

[1] Acknowledgement is made to the Grace H. Griswold Fund of the Department of Entomology of Cornell University for assuming the cost of engraving the plates. Many of the larvae described here were collected in the course of studies on the comparative ethology of digger wasps, a project supported by the National Science Foundation.

as described below. Apparently Maneval had only one specimen, and my feeling is that it may have been immature or poorly preserved. In any event I prefer to base my understanding of the larvae of this subfamily on my own studies until such time as other workers are able to shed light on some of the discrepancies.

Characters of the subfamily.—Body fusiform, the posterior end rather blunt, the anus terminal and inconspicuous; middle body segments, especially abdominal segment four, very prominent dorsally; integument apparently smooth, but under high magnification seen to bear minute, irregularly distributed spinules and setae on some parts; spiracles with the atrium lined with weak ridges, the opening into the subatrium simple, unarmed, the subatrium unusually short. Head much wider than high; parietal bands strong; epistomal suture strong; antennal papilla present. Labrum broad, the apex emarginate and with a series of conical sensilla; epipharynx with small spinules except medially; mandibles with a hyaline, strongly setose area laterally near the base, the apex of the mandibles with from two to four strong teeth in nearly the same plane; mandibles only about 1.5 times as long as their maximum width; maxillae with the lacinial area short, clothed with short, straight spinules; galeae slightly shorter and much more slender than the maxillary palpi; apex of labium with the spinnerets paired, slightly exceeding the labial palpi; maxillae and labium forming a closely associated unit, the maxillae directed mesad toward the labium.

Astata unicolor Say (Plate II, figs. 1-8)

Body.—Length 17 mm.; maximum width (abdominal segment 5) 6 mm. Fusiform, grub-like; anus terminal; pleural lobes present on all body segments except the last, rounded and not especially prominent; mid-abdominal segments, especially segment four, distinctly humped dorsally (fig. 1). Integument smooth and glistening, but under high magnification seen to be sparsely and irregularly clothed with minute spinules and a few very small setae (fig. 4). First pair of spiracles distinctly larger than the others; spiracular orifice unusually small, the peritreme poorly defined; walls of atrium lined with weak, concentric ridges which bear minute spinules; opening into the subatrium unarmed; subatrium very short, leading directly to the trachea (fig. 7).

Body of the diapausing larva similar, but each body segment bearing paired dorsal, transverse elevations; laterally these elevations are nearly continuous with the pleural lobes (fig. 2).

Head.—Width 1.6 mm.; height 1.2 mm. (fig. 5). Mostly pale, but with a dark spot at the anterior mandibular condyle; mandibles brown, the apical half darker; palpi and galeae light brown; labium with a brown band at the base of the prementum. Epicranial suture weak, but the branches of the Y evident, each terminating in a shallow depression in the middle of the front; parietal bands long (nearly .5 mm.); epistomal suture very strong; top and sides of the epicranium weakly roughened by small convexities. Antennal orbits large, subcircular, about 125 μ in diameter; antennal papilla about 50 μ long by 30 μ in maximum thickness (fig. 3). Head setae small and sparse except on the lower sides, where they are more numerous and as much as 50 μ in length. Anterior margin of clypeus weakly concave; clypeus with a transverse series of setae.

Mouthparts.—Labrum .53 mm. wide, its anterior margin with a broad, V-shaped emargination, its basal margin arcuately extended beneath the clypeus; apical half of disc with numerous (about 25) small setae; anterior margin beset with about 18 small, conical sensilla and a few short spinules (fig. 6). Epipharynx with an abundance of small spinules which are largely absent from the median area; sides of the median area with two or three strong sensory cones anteriorly on each side and five or six weak pores on each side basad of these. Mandibles stout and strong, about .6 mm. long and .4 mm. in maximum width; apex with four very strong teeth, all in about the same plane; base more weakly pigmented than the remainder of the mandible, especially in a lateral area which bears numerous (about 12) setae (fig. 5). Maxillae short, sides strongly setose, lacinial area with abundant short spinules; palpi stout, about 100 μ long and 65 μ wide at the base; galeae very slender, about 90 μ long and only 20 μ wide at the base (fig. 8). Labium broad and smooth apically, without papillae but with several setae; palpi about 70μ long and 50μ wide at the base, terminating in five small sensilla; spinnerets paired, only slightly exceeding the palpi.

Material.—Twenty-two specimens, eleven of them diapausing, taken from several nests at Ithaca, N.Y., August 1956-57 (H. E. Evans). Biological studies made in connection with these specimens are being published elsewhere (Jour. N.Y. Ent. Soc., in press).

Astata occidentalis Cresson (Plate VI, figs. 46-48)

Body.—Length 19 mm. Similar in every respect to *unicolor*. Fourth abdominal segment with a very large dorsal prominence, the preceding two segments somewhat less strongly produced.

Head.—Width 1.9 mm.; height 1.45 mm. Shape and features much as in *unicolor;* antennal orbits relatively somewhat smaller than in that species, only 90 μ in diameter; antennal papilla 40 μ long and 30 μ wide at the base. Top and sides of the head capsule strongly roughened; setae abundant on the lower sides, the longest ones about 50 μ in length.

Mouthparts.—Labrum .62 mm. wide, the apical margin with a broad, V-shaped emargination; surface with many (about 40) strong setae; anterior margin with a row of about 30 small, darkly pigmented conical sensilla (fig. 48). Epipharynx densely spinulose, the spinules directed antero-mesad, largely absent from the median area; sensory cones and pores as illustrated. Mandibles stout, about .7 mm. long and .48 mm. wide at the base; sides with a lightly pigmented area which bears 8 setae; apex of mandibles with two large teeth and with a very weak third tooth basad of these (fig. 46). Maxillae much as in *unicolor;* palpi 110 μ long; galeae more slender, 90 μ long. Labial palpi 80 μ long; spinnerets broad, slightly longer than the palpi, subtended by a pair of transverse, sclerotized bars (fig. 47).

Material.—Sixteen specimens taken from several nests at Versailles, Indiana, July 16-23, 1957 (H.E. Evans), in connection with biological studies being published elsewhere (Jour. N.Y. Ent. Soc., in press).

Astata minor Kohl

Grandi (1926, Boll. Lab. Zool. Portici, 19: 310-311) has described and figured the larva of this Palaearctic species. His larvae were immature, measuring about 8 mm. long. The body is fusiform, the posterior end somewhat conical. The head is wider than high and apparently very weakly setose; parietal bands are absent; the clypeus is slightly concave apically and the labrum very much so. The mandibles have only a minute tooth on the inner margin; the galeae and both pairs of palpi are very short, and the spinnerets are not visible.

Astata boops (Schrank)

The larva of this Palaearctic species has been described by Maneval (1939, Ann. Soc. Ent. France, 108: 70-72). The body is stout, fusiform, only 8 mm. long (and therefore probably not full-grown); the pleural lobes are rather narrow and elongate. The head is shaped much as in *unicolor* and the antennae of much the same form, but parietal bands are absent. The labrum is arcuately emarginate apically and bears a series of sensilla near the margin; the epipharynx is clothed with small spinules. The mandibles are rather slender and terminate in three teeth, the middle one rather small; there are apparently no setae laterally. The galeae and both pairs of palpi are very short (much as in

minor); the maxillae bear small papillae but no setae or spinules. The spinneret is a transverse slit which is arcuately produced.

Astata immigrans Williams

Williams (1946, Proc. Hawaiian Ent. Soc., 12: 645) presented a rough sketch of the larva of this species. There is general agreement in body form with *unicolor,* including the humping of the mid-abdominal segments. The shape of the head and form of the antennae are also about as in *unicolor.* The mandibles are shown as being tridentate apically, somewhat as described by Maneval for *boops.* The maxillae and labium are not shown in detail.

Subfamily Larrinae

I have studied relatively few larvae of this subfamily, and this section is therefore of a very preliminary nature. The published descriptions of Larrinae often leave something to be desired; few of them, for example, adequately describe the setae on the head and body, and few of them describe or illustrate the details of the maxillae and labium. I have seen larvae of three of the five Nearctic genera of Larrini (including Tachytini); the other two genera are known from published descriptions. In the Miscophini, I have seen larvae of only one genus, *Solierella,* and the larvae of only two other genera have been described; eight genera are listed for North America. The material available to me varies much in quality of preservation, and in almost every case I have had to work with very short series.

On the basis of available material, the Larrinae appear to be fairly uniform in structure. Clearly they belong to the same complex as the Trypoxyloninae and Crabroninae; indeed, it is impossible to point to any single character which will always separate the larvae of Larrinae from those of Crabroninae. The angulate lobe at the base of the inner margin of the maxilla serves to separate the Trypoxyloninae, which otherwise are very similar.

Characters of the subfamily.—Body subcylindrical, posterior end rather blunt; anus ventral, preapical, the anal segment forming a rounded terminal lobe; pleural lobes prominent, those on the thorax often strongly protuberant, conical, the prothorax

often with one or two pairs of additional lobes dorsad of the usual pair; integument usually smooth dorsally, often with small spinules on parts of the venter; body setae conspicuous to nearly absent; spiracles with the orifice large, the peritreme absent or poorly defined, the opening into the subatrium either simple or armed with a circlet of spines. Head as wide as or wider than high (except in *Palarus*); parietal bands present or absent; antennal papilla absent, the three sensory cones arising from the membrane of the orbit; head setae sparse or abundant, often fairly long. Labrum broad, bearing setae over much of the disc, the margin somewhat bristly, sometimes with a row of weak sensilla but never with large, barrel-shaped sensilla; epipharynx spinulose, but exhibiting much variation in the abundance and distribution of spinules; mandibles stout and heavy, approximately twice as long as their maximum width, base with a single large seta, inner margin with five teeth or with four teeth one of which is double (rarely with fewer teeth, and in *Palarus* apparently with only two); maxillae rather broad apically, the lacinial area usually projecting as a rounded or angulate lobe apically, the galeae always smaller than the palpi and sometimes extremely small; labium often spinulose above, the spinnerets paired, truncate or pointed, always much exceeding the labial palpi.

Table of Tribal and Generic Characters

A. Head higher than wide; epipharynx with pigmented sensory areas; mandibles with only two teeth .. PALARINI, *Palarus* [*variegatus*]

AA. Head as wide as, or wider than high; epipharynx with sensory areas unpigmented, often indistinct; mandibles with at least four teeth.

B. Lacinial area of maxilla with, at most, a few elongate papillae (fig. 45); setae unusually long, those on the prothorax, at least, very prominent; longest head setae much longer than the maximum diameter of the antennal orbit and often twice that length ..... MISCOPHINI [2]

C. Anterior lateral angles of epipharynx with an elongate group of large, blunt spinules which are quite unlike those on the remainder of the epipharynx (fig. 44) *Solierella* (*blaisdelli*, sp., [*peckhami, compedita, xambeui*])

[2] The larvae of only three genera of this tribe are known, and I have seen specimens of only *Solierella*. It is by no means certain that these characters will hold for all genera of this tribe.

CC. Epipharynx without specialized spinules on the anterior lateral angles; galea very small.

D. Inner margin of maxilla prolonged into a sharp point; head setae abundant, more or less evenly distributed. *Miscophus* [*bicolor*]

DD. Inner margin of maxilla not prolonged as above; head setae sparse, mostly on the top and sides. *Nitela* [*spinolae*]

BB. Lacinial area of maxilla densely clothed with strong spinules (figs. 12, 24, 38); body setae relatively inconspicuous, except on the thorax of certain genera; head setae short or fairly long, rarely twice as long as the diameter of the antennal orbit ..... LARRINI

C. Epipharynx with a dense covering of unusually strong spinules which converge upon a bare area in the center (fig. 41).

D. Parietal bands weak or absent; thoracic dorsum with numerous strong setae; head setae fairly long, the longest ones about equal to the diameter of the antennal orbit ..... *Motes* [*pompiliformis*]

DD. Parietal bands strong (fig. 39); body setae inconspicuous; head setae short, the longest ones not equal to the diameter of the antennal orbit. *Liris* (*haemorrhoidalis*)

CC. Epipharynx without unusually long spinules which converge on a bare median area (figs. 15, 23, 37).

D. Prothoracic dorsum with a transverse series of conspicuous setae (figs. 22, 30); head setae long, the longest ones considerably longer than the diameter of the antennal orbit (figs. 21, 33); galeae very small, scarcely rising above the surrounding papillae (figs. 24, 38).

E. Prothoracic lobes conical (fig. 22); apical two teeth of mandibles strong, juxtaposed one above the other (fig. 26); median area of epipharynx bare or with a few papillae or blunt spinules (fig. 23). *Tachysphex* (*terminatus*, [*costae, lativalvis, nitidus, pectinipes*])

EE. Prothorax with the upper pair of lobes slender, digitiform (fig. 30); penultimate tooth of mandibles small, in the same plane as the ultimate tooth (fig. 32); median area of epipharynx clothed with strong spinules (fig. 37). *Larropsis* (*distincta*)

DD. Prothoracic dorsum with only minute setae (fig. 10); head setae short, not usually longer than the diameter of the antennal orbit; galeae fairly strong (figs. 12, 19).

E. Pleural lobes of thorax very prominent, conical, the prothorax with three pairs of such lobes (fig. 10); parietal bands short, sometimes very weak (fig. 13).

Tachytes (*elongatus, mandibularis*)

EE. Pleural lobes of thorax moderately prominent, not strongly conical, the prothorax apparently with only one pair of lobes; parietal bands long and conspicuous.

Larra [*analis, luzonensis*]

Tribe Larrini

Tachytes elongatus Cresson (Plate III, figs. 9-17)

Body (diapausing larva).—Length 20 mm.; maximum width (abdominal segment 4) 7 mm. (fig. 9). Relatively stout, cylindrical, abruptly tapered at both ends; each segment with a prominent transverse elevation dorsally, not interrupted medially, extending laterally nearly to the pleural lobes; pleural lobes large, rounded, those on the anterior segments conically protruding, the prothorax with three pairs of such conical lobes (fig. 9, 10); anus distinctly ventral and preapical in position, the anal segment rounded. Integument mostly smooth dorsally, but the venter clothed rather densely with minute spinules; body setae not conspicuous, confined mostly to the thorax (fig. 14). Spiracles with the orifice large, the peritreme narrow, heavily pigmented; walls of the atrium lined with anastomosing ridges which bear short spines; opening into the subatrium armed with a strong circlet of spines; subatrium short and globular (fig. 17).

Head.—About as wide as high, measuring about 2.0 mm. each way (fig. 13). Mostly pale, the parietal bands dark, a dark spot at the anterior articulation of the mandibles; mandibles light brown, darker apically; clypeolabral suture brown; hypostomal thickenings, paired spots at the bottom of the occipital foramen, basal portion of maxilla, and line between mentum and prementum of labium dark; palpi, galeae, and spinnerets light brown. Front with a pair of shallow depressions in the middle, and with shallow longitudinal depressions laterad of these, running along the inner side of the antennal orbits; coronal suture weak; parietal bands strong but rather short, only about .28 mm. long, slightly curved; epistomal suture strong. Antennal orbits small, circular, about 70 μ in diameter, the three sensilla arranged in a triangle (fig. 11). Top and sides of head roughened by many small convexities; head setae sparse, fairly numerous on the lower sides, the longest about 70 μ in length. Clypeus bearing two irregular transverse rows of small setae.

Mouthparts.—Labrum nearly 1 mm. in width; anterior margin shallowly concave medially; disc with about 20 strong setae on the anterior half, these tending to form two irregular transverse rows; anterior margin strongly bristly laterally and with a series of very minute sensory pores (fig. 15). Epipharynx very strongly spinulose, especially latero-apically and medio-basally; sensory areas unpigmented, devoid of spinules, each with five pores. Mandibles 1.05 mm. long, .5 mm. in maximum width; base with a single lateral seta; apex with five teeth, four of them in the same plane, the ultimate and antepenultimate much more distinct than the other two, the fifth tooth blunt and situated ventrally beneath the antepenultimate tooth. Maxilla with a few setae laterally, extensively spinulose on the inner margin, the spinules long and rather flexible; apex papillose; palpi stout, about 130 μ long; galeae much more slender, about 60 μ long (fig. 12). Apex of labium broad, with abundant flexible spinules on the oral surface; palpi about 90 μ in length; spinnerets slender, blunt apically, about 140 μ in length (fig. 16).

Material.—Four larvae, all taken from cocoons, from sand dunes at Antioch, Calif., Sept. 15, 1940 (G. E. Bohart).

Tachytes mandibularis Patton (Plate IV, figs. 18-20)

Body.—The body of the mature, non-diapausing larva of this species has been figured by Strandtmann (1945, Ann. Ent. Soc. Amer., 38: 306). The single specimen available to me measures 17 mm. in length and agrees fairly well with Strandtmann's figure. The dorsum of each segment is divided into two annulets, with the anterior part of each posterior annulet forming a strong transverse welt; the pleural lobes of the thorax are very prominent and conical, much as figured for *elongatus*. Setae and spinules as described for *elongatus;* spiracles as in that species.

Head.—Width 1.9 mm.; height 1.75 mm. In general similar to *elongatus*. Parietal bands very short and virtually unpigmented, therefore scarcely visible. Antennal orbits ovoid, 70 μ in maximum diameter. Longest head setae about 60 μ in length. Clypeus with two transverse rows of fairly long setae.

Mouthparts.—Labrum .9 mm. wide, its anterior margin very weakly concave medially, bristly laterally; disc with about 35 strong setae (fig. 18). Epipharynx with dense, fairly long spinules except latero-basally; sensory areas not distinct. Mandibles 1 mm. long and .45 mm. in maximum width, as described for *elongatus*. Maxillae with numerous setae laterally, densely papillose apically, lacinial area prominent, clothed with dense spinules; palpi stout, about 100 μ long; galeae very small, only about 30 μ long (fig. 19). Labium more or less papillose apically, at the base of each palpus with a group of long, flexible spines; palpi about 100 μ long; spinnerets slender, the tips blunt, about 200 μ in length (fig. 20).

Material.—One specimen reared from an egg collected by the writer at Blackjack Creek, Pottawatomie Co., Kansas, July 3, 1953.

Tachysphex terminatus (Smith) (Plate IV, figs. 21-28)

Since the body of the single available non-diapausing larva is poorly preserved, the following description of the body is drawn from diapausing material. The remainder of the description, however, is drawn from this non-diapausing specimen; the other specimens agree in most details but show much wear of the mandibles and some changes in the spinnerets.

Body.—Length 9 mm.; maximum width 2.5 mm. In general similar to *Tachytes elongatus*, but the transverse dorsal elevations and the pleural lobes less prominent; the arrangement of the lobes on the thorax is the same as in Tachytes (fig. 22). Dorsum and pleural lobes of thorax, especially of the prothorax, with numerous large setae; remainder of body with scattered minute setae. Integument smooth dorsally, on parts of the venter clothed with minute spinules. Spiracles with the orifice large, the atrium lined with weak ridges; opening into subatrium simple, unarmed; subatrium long and broad, with a series of irregular transverse folds (fig. 27).

Head.—Subcircular in anterior view, measuring 1.1 mm. wide by 1.02 mm. high (fig. 21). Virtually unpigmented except for the anterior tentorial arms, hypostomal thickenings, mandibles, and palpi, which are light brown. Coronal suture short and weak; parietal bands absent. Antennal orbits nearly circular, about 60 μ in maximum diameter. Head with numerous very prominent setae, the longest ones measuring about 80 μ in length. Clypeus with numerous strong setae.

Mouthparts.—Labrum .44 mm. wide; anterior margin subtruncate; disc with about 12 large setae plus 4 more on the apical margin medially; margin with a series of minute sensilla, only very weakly bristly on the lateral angles (fig. 23). Epipharynx with strong bristles laterally and along the apical margin, those on the median area directed inward; remainder of epipharynx more or less bare except for a few weak sensory cones and a few spinules at the extreme base. Mandibles .52 mm. long and .26 mm. in maximum width; base with a single lateral seta; apex with five teeth, the apical two juxtaposed in such a way that the apex is strongly bifid in lateral view, one of the remaining teeth located beneath the other two (fig. 26). Maxillae papillose apically, laterally with strong setae; lacinial area somewhat protruding and with dense, erect spinules; palpi stout, about 70 μ in length; galeae small, only about 20 μ in length (fig. 24). Oral surface of labium papillose, some of the papillae grading into short spinules apically; palpi slender, about 80 μ in length; spinnerets slender, about twice the length of the palpi (fig. 25).

Material.—One specimen from Blackjack Creek, Pottawatomie Co., Kansas, Aug. 4, 1952 (H. E. Evans); two specimens from cocoons, Logan, Utah, Aug. 1953 (G. E. Bohart).

Tachysphex costae (Destefani)
Tachysphex lativalvis (Thomson)
Tachysphex nitidus (Spinola)
Tachysphex pectinipes (Linnaeus)

The larvae of these Palaearctic species have all been described and figured in considerable detail by Grandi (1928, Boll. Lab. Ent. Bologna, 1: 295-308; 1930, ibid., 3: 326-330; 1934, ibid., 7: 59-61). In every case the body form is very similar to that of *terminatus,* and as in that species there are prominent setae on the thoracic dorsum. The parietal bands are lacking in all four, and the antennal orbits are small and circular. There are minor specific differences in the characters of the labrum and epipharynx, but in general they do not depart notably from the condition in *terminatus*; the apical margin of the labrum varies from barely to quite strongly bristly; the median portion of the epipharynx is devoid of spinules in *nitidus* and *pectinipes,* but bears a few blunt spinules or papillae in the other two. The mandibles are without exception as described for *terminatus.* The maxillae are strongly papillose apically in all four species and the galeae are in every case very small; the lacinial area, at least so far as described, is spinulose and slightly protruding as in *terminatus.* The spinnerets are in every case approximately twice the length of the labial palpi.

Larropsis distincta (Smith) (Plate V, figs. 29-38)

Body.—Length 13 mm.; maximum width 4 mm. (fig. 29). Anus situated ventrally well before the tip of the abdomen and with distinctly raised lips. Abdominal segments with the posterior annulets elevated to form transverse welts which laterally are nearly continuous with the pleural lobes. Thoracic pleural lobes conically protuberant, the prothorax with three pairs of lobes, as in *Tachytes* and *Tachysphex,* the lobes unusually slender, the dorsal pair digitiform (figs. 29, 30). Prothoracic dorsum with a transverse band of prominent, dark setae; other body segments with a few weak setae dorsally. Integument in large part covered with small spinules which are removed from one another by approximately their own length (fig. 31); these spinules occur ventrally and extend more or less up the sides, but are

mostly absent dorsally. Spiracles with the atrium lined with fine ridges which tend to form elongate cells; subatrium elongate, narrowing gradually to the trachea; opening into subatrium small, simple (fig. 34).

Head.—Width 1.19 mm.; height 1.06 mm. (fig. 33). Coronal suture weak; parietal bands absent. Antennal orbits transversely elliptical, very small, measuring about 35 × 42 μ (fig. 35). Setae strong, the longest ones measuring about 65 μ. Clypeus with a single row of strong setae.

Mouthparts.—Labrum .54 mm. wide, the apical margin rounded, barely emarginate medially (fig. 37); disc with about 18 large setae, also with about 12 small sensilla toward the apical margin, which is strongly bristly. Epipharynx strongly spinulose except for a bare area on each side; several sensory pores are located in each bare area. Mandibles .65 mm. long, .32 mm. wide at the base; base with a single seta; inner margin with five teeth, the penultimate tooth weak and in the same plane as the apical tooth, the basal three teeth in a close group, one beneath the other two (fig. 32). Maxillae broad apically, strongly papillose, the lacinial area somewhat produced and strongly spinulose; palpi small, only about 60 μ long and nearly as wide; galeae minute, only about 20 μ long (fig. 38). Labium strongly spinulose on the oral surface; palpi about 50 μ long; spinnerets long, truncate apically, measuring about 110 μ from the base.

Material.—Two specimens from sandpit at Six-mile Creek, Ithaca, N.Y., Sept. 1957 (H. E. Evans).

Motes pompiliformis (Panzer)

Grandi (1928, Boll. Lab. Ent. Bologna, 1: 292-295) has described the larva of this Palaearctic species in considerable detail. The general form is similar to *Tachysphex*; as in that genus the thoracic segments bear strong setae dorsally and laterally, while the abdominal segments are weakly setose; the pleural lobes are apparently rounded on all segments, not conically produced, and the prothorax has but a single pair of lobes. The head shape is about as in *Tachysphex;* parietal bands are absent; the antennal orbits are small and circular; head setae are abundant but not especially long, the longest ones being about as long as the width of the antennal orbits. The labrum is large, convex apically; the disc bears numerous setae and the margin is bristly; the epipharynx has a dense covering of unusually long spinules which tend to converge toward a small, bare area in the middle. The mandibles have five sharp teeth, the apical two somewhat juxtaposed, much as in *Tachysphex*. The maxillae are papillose apically, the lacinial area with dense spinules, the galeae about

half the size of the palpi. The spinnerets are about twice the length of the labial palpi.

Liris haemorrhoidalis magnifica (Kohl) (Plate VI, figs. 39-41)

Williams (1928, Bull. Hawaiian Sug. Pl. Assoc., Ent. Ser., no. 19, pp. 49-53) presented notes on the biology of this wasp and a brief discussion of the larva. He states that the full-grown larva "measures 22 millimeters and as in related genera bears conspicuous lateral processes on the thorax". His sketch shows conical pleural lobes somewhat as in *Tachytes*. The slide which Williams made of the head capsule has been loaned to me and the following description is drawn from it.

Head.—Width 2.2 mm.; height 2.0 mm. (fig. 39). General features and pigmentation much as in *Tachytes;* parietal bands strong, about .5 mm. in length. Antennal orbits small, circular, 100 μ in diameter. Top and sides of head weakly roughened by small convexities; setae sparse and small, the longest ones about 80 μ in length. Epistomal suture strong; clypeus with a few rather strong setae.

Mouthparts.—Labrum about 1 mm. in width (fig. 41); apical margin convexly rounded, somewhat bristly, without noticeable sensilla; disc with numerous strong setae; epipharynx densely spinulose, the median apical spinules directed inward, and in fact all the spinules converging on a small median bare area, as shown in fig. 41 and very much as figured by Grandi for *Motes pompiliformis*. Mandibles 1 mm. long by .5 mm. in maximum width; outer margin sinuate about midway; apex with four teeth, the apical two in the same plane, the basal two more ventral in position; ventral surface of mandible excavated between the first and third teeth (fig. 40). Details of maxillae and labium, so far as visible in the preparation, not differing notably from *Tachytes;* galeae much smaller than the maxillary palpi; lacinial area spinulose, somewhat protruding; labial palpi about 100 μ long; spinnerets blunt, about 140 μ long.

Material.—A single balsam mount of a head capsule, made by F. X. Williams, specimen from No. Queensland, Australia, 1919.

Larra analis Fabricius (Plate VII, figs. 58, 59)

The larva of this North American species has been described by Cushman (1935, Proc. Ent. Soc. Wash., 37: 82-87). The body is said to be 20 mm. long, fusiform, slightly more swollen posteriorly; the anus is ventral and preapical, the lips of the anus somewhat protuberant, as in *Larropsis*. The pleural lobes are rounded, those on the thorax apparently not conically produced as in most

Larrinae; however, Cushman does state that " the thoracic pleura and the prosternum protrude beyond the general surface of the body ". No mention is made of setae on the body or head. The head is slightly broader than high; parietal bands are long and conspicuous; the antennal orbits are small and circular. The labrum is large, the margin convex, bristly; the epipharynx is wholly clothed with spinules. The maxillary palpi are somewhat longer than the galeae and the lacinial area is strongly spinulose and slightly protuberant; the spinnerets are about twice as long as the labial palpi.

Cushman's description is based on material collected by C. E. Smith in connection with his biological studies of this species (1935, ibid., pp. 65-82). I have been unable to find the specimens which Cushman worked with, but there are two cocoons collected by Smith in the U. S. National Museum. From one of these cocoons I was able to extract the remains of the larval head capsule, but this was in poor condition except for the mandibles. The mandibles have four teeth, but the third tooth is broad and emarginate so that it presents the appearance of two teeth (figs. 58, 59); the mandibles measure .9 mm. in length by .4 mm. in maximum width. The antennal orbits are circular, 100 μ in diameter, with the three sensilla in a triangle in the center. A very few setigerous punctures are present on the lower sides of the head; the longest setae measure about 50 μ.

Larra luzonensis Rohwer

Williams (1919, Bull. Hawaiian Sug. Pl. Assoc., Ent. Ser., no. 14, p. 134) states that the larva of this species has the pleural lobes well marked and " as usual in Larrids, tuberculate on the thorax. On the middle of the underside of the twelfth segment is a small, rather low tubercle." In the figure published later (1928, ibid., no. 19, p. 43) he shows prominent lobes on the thorax, but these are scarcely as pointed as in *Tachytes,* and there are no extra lobes on the prothorax.

Tribe Palarini

Palarus variegatus (Fabricius)

The larva of this species has recently been described and figured by Grandi (1954, Boll. Ist. Ent. Univ. Bologna, 20: 174-177). The body form is not dissimilar to that of *Tachytes*, but the thoracic pleural lobes are simple and rounded. The body is without conspicuous setae and those on the head are numerous but very small. The head is considerably higher than wide, parietal bands are absent, and the antennae are much as in the Larrini. The labrum bears numerous setae and the margin is bristly; the epipharynx is complex in structure and bears, among other things, a pair of pigmented sensory areas each bearing several small sensilla. The mandibles have a single lateral seta and terminate in only two distinct teeth. The maxillary palpi are large, the galeae very minute and scarcely visible above the papillae. The spinnerets are about twice the length of the labial palpi.

Tribe Miscophini

Solierella blaisdelli (Bridwell) (Plate VI, fig. 42)

Body.—Length about 4 mm.; grub-like, relatively short and stout (fig. 42). Each segment divided dorsally into two annulets, of which the posterior is the more prominent; anus distinctly preapical in position, the anal segment forming a rounded lobe; pleural lobes prominent, rounded, those on the thorax somewhat more produced than the others, the prothorax with two extra pairs of small lobes, as illustrated. Prothorax with numerous setae dorsally and laterally, the remaining body segments only very sparsely setose. Integument smooth, except slightly roughened by small spinules on parts of the venter. Spiracles small and unpigmented; walls of the atrium lined with weak ridges; opening into subatrium small, unarmed; subatrium long and slender.

Head.—Width .83 mm.; height .66 mm. General features about as described and figured for the following species, but the parietal bands not visible. Antennal orbits 40 μ in diameter. Setae sparse but large, the longest about 50 μ in length.

Mouthparts.—Labrum .32 mm. wide, its anterior margin broadly truncate; disc with 10 large setae and apical margin with a group of six setae medially; epipharynx spinulose apically and laterally, the antero-lateral angles with numerous rather stout, blunt spines. Mandibles badly worn, presumably similar to those of the following species. Maxillary palpi about 50 μ long; galeae slender, about 40 μ long; lacinial area somewhat produced, weakly spinulose. Labial palpi 40 μ long; spinnerets blunt, about 1.5 times the length of the labial palpi.

Material.—A single specimen taken from a cocoon, Putah Canyon, Calif., Dec. 18, 1939 (G. E. Bohart).

Solierella sp. (Plate VI, figs. 43-45)

Body.—Length about 4 mm.; maximum width about 1 mm. Each body segment with a very prominent transverse dorsal elevation which is interrupted medially; pleural lobes strong, conically protuberant, especially so toward the two ends of the body. Prothorax with a band of very strong, conspicuous setae on the dorsum and pleural lobes; other thoracic segments with somewhat fewer setae, the abdominal segments not noticeably setose. Integument and spiracles as described for *blaisdelli.*

Head.—Subcircular in anterior view; maximum width .73 mm.; height .63 mm. (fig. 43). Pale, the mandibles light brown, the anterior tentorial arms and hypostomal thickenings dark brown. Coronal suture very short; parietal bands present but very weak; antennal orbits small, about 35 μ in diameter. Setae few in number but unusually long, the longest ones about 70 μ in length; clypeus also with a few long setae.

Mouthparts.—Labrum .3 mm. wide, its anterior margin weakly concave medially; disc with about 10 very large setae, two of which are set in the margin medially; margin with a series of about 10 very small, nipple-like sensilla, somewhat spinulose laterally (fig. 44). Epipharynx with large, broad spinules basally and laterally; sensory areas each containing a few setiform sensilla; antero-lateral angles each with a transverse series of large, blunt spines. Mandibles .33 mm. long and .19 mm. wide at the base; base with a single lateral seta; apex with four large teeth, the apical two juxtaposed one above the other, also with a small fifth tooth located beneath the most basal tooth. Maxillae setose laterally, more or less papillose apically; lacinial area somewhat protuberant, with a few weak, blunt spinules; palpi stout, about 50 μ long; galeae also stout, about 30 μ long (fig. 45). Labial palpi about 40 μ long; spinnerets about twice that length, blunt apically.

Material.—Eight specimens, all diapausing, from Sacramento, Calif., March 1947 (G. E. Bohart).

Solierella peckhami (Ashmead)

Williams (1926, Proc. Hawaiian Ent. Soc., 6: 443) has presented sketches of the full-grown larva of this species (under the name *rohweri* Bridwell). The posterior end of the body is truncate; the pleural lobes are prominent, those on the thorax especially so, although not pointed; body setae are long and conspicuous, especially on the thoracic dorsum. I have been able to borrow a slide which Williams made of the head capsule, but unfortunately many of the details are not visible on this preparation. The form of the head is much as in the preceding species,

and the setae are also very long (maximum length 40 μ). The mandibles have five teeth, arranged as in the preceding species, but all very much sharper. The rest of the mouthparts cannot be seen clearly on the slide.

Solierella compedita (Piccioli)

The larva of this European species has been described by Soika (1934, Ann. Soc. Ent. France, 103: 342). The body shows the transverse dorsal elevations and strong pleural lobes described for *blaisdelli*; there appear to be additional lobes on the prothorax as in that species. Body setae are not mentioned or figured. The head is much as in figure 43, including the sparse but long setae. The labrum has several long setae; the epipharynx is more or less bare except for some short basal spinules, a few sensilla, and a transverse row of large, blunt spines on each side of the apical margin. The maxillary palpi and galeae are stout, the latter somewhat shorter than the former. The spinnerets are very slender, only a little longer than the labial palpi.

Solierella xambeui (André)

The larva of this Palaearctic species has been described by Micheli (1937, Atti Soc. Ital. Sci. Nat. Milano, 76: 287-290). Body setae are not mentioned or figured, but the head setae are sparse and rather long as in the preceding several species. The labrum is truncate apically and bears eight large setae plus some marginal, nipple-like sensilla. The epipharynx has a few basal spinules but is otherwise devoid of spines except for two large groups of long, blunt spines on the outer apical angles. The mandibles are hollowed out ventrally and are shown as having four teeth. The maxillary palpi are nearly twice as long as the galeae, the spinnerets about 1.5 times as long as the labial palpi.

Miscophus bicolor Jurine

Maneval (1939, Ann. Soc. Ent. France, 108: 72-74) has presented a description of the larva of this European species. The body is said to be 4 mm. long and to bear pale erect setae which are shorter and sparser ventrally. The head is broader than high and bears long setae distributed rather evenly over its entire surface. The antennal orbits are small and much as in *Solierella*. The labrum is truncate apically and bears numerous large setae

plus some short setae or setiform sensilla near the apical margin. The mandibles are five-toothed and as described for *Solierella*. The maxillae are wholly papillose apically, the lacinial area with a pointed apical projection; the galeae are very short, hardly longer than broad. The labium is finely papillose, the spinnerets long and pointed, about twice as long as the labial palpi.

Nitela spinolae Latreille

The larva of this species has recently been described very briefly by Valkeila (1955, Ann. Ent. Fennici, 21: 54-56). The pleural lobes are distinct; the prothorax has numerous rather conspicuous brown setae dorsally, the remaining body segments one row of such setae. The head is broader than high and has a row of large brown setae on the top and sides; the mandibles have five teeth, four on the "frontal edge" and one on the "inner edge". The maxillary palpi and galeae are both small, "nodule-like", the latter smaller than the former. The salivary opening is said to be transverse, but "in the rear two small openings of the salivary tubules are to be seen". Valkeila's description was drawn from an overwintering larva, and it may be that the spinnerets had undergone some deterioration.

Subfamily Pemphredoninae

The larvae of this subfamily which are before me are remarkably uniform in structure. They appear to be about as close to the Sphecinae as to any other group: the apical margin of the labrum usually has a thickened and often pigmented band, as in the Sphecini; the spinnerets are paired but often connected by a membrane, a condition approaching the broad, slit-like spinneret of the Sphecinae; antennal papillae are absent (except, according to Maneval, in *Ammoplanus*); and the mandibles are not dissimilar to those of the Sphecini.

The Pseninae, often regarded as a tribe of Pemphredoninae, have very different larvae, and will be treated in a subsequent section as a separate subfamily.

Characters of the subfamily.—Body elongate-fusiform, the dorsal profile often slightly serrate, the pleural lobes rounded, not especially strong; anus terminal, inconspicuous; integument smooth or with small spinules, with or without noticeable short

setae; spiracles with the peritreme distinct, rather large, the atrium globular, its walls not spined or otherwise modified, the opening into the subatrium simple, unarmed, the subatrium elongate, separated from the trachea by a constriction. Head wider than high; parietal bands absent; head setae very small, usually very sparse; antennal orbits relatively large, the three sensilla arising directly from the membrane of the orbit, which may be slightly elevated (but in *Ammoplanus* a distinct papilla is said to be present). Labrum very broad, usually strongly emarginate, the disc with only a few weak setae and a few small sensilla; apical margin not at all bristly, usually with a narrow marginal band which is sometimes pigmented; median line and basal marginal also sometimes pigmented; epipharynx mostly bare, with a few peg-like sensilla toward the median line and often with a few weak spinules laterally. Mandibles broad and short, considerably less than twice as long as broad, with a single seta laterally near the base, apically with four teeth in somewhat the same plane but tending to surround a slight ventral concavity; maxillae short and directed mesad, the lacinial area reduced and at most with a few weak, blunt spinules; maxillary palpi fairly strong, the galeae smaller and sometimes very weak or even (in *Ammoplanus*) apparently absent; apex of labium without papillae or spinules, the spinnerets relatively short, blunt or acute, often connected by a membrane.

Table of Generic Characters [3]

A. Antennal papilla present; body and head rather evenly clothed with small setae; labrum not emarginate; galeae absent (or perhaps very small and not readily visible) ..... *Ammoplanus* [*perrisi*]

AA. Antennal papilla absent, the sensilla arising directly from the membrane of the orbit; head and body setae very sparse; labrum emarginate apically; galeae well developed.

B. Integument spinulose at least antero-ventrally (figs. 51, 62); apical margin of labrum (at least usually) with a pigmented band (figs. 53, 64); setae on head and labrum fairly prominent; spiracular subatrium moderately broad (fig. 52).

[3] Includes five of the ten Nearctic genera, one of them known from published description only. The larvae of four of these genera are exceedingly similar, and the characters presented here may prove partly or wholly invalid when more species have been described.

C. Integument of body rather evenly spinulose anteriorly, including the thoracic dorsum; epipharynx not or very weakly spinulose (fig. 64).
Passaloecus (*mandibularis*, [*brevicornis, tenuis*])

CC. Integument spinulose only on parts of the sides and on the venter; epipharynx spinulose on the sides (fig. 53)
Pemphredon (*tenax, giffardi, concolor*, [*rugifer, lugubris* [4]])

BB. Integument apparently entirely without spinules; apical margin of labrum (at least usually) not pigmented (figs. 66, 68); setae on head and labrum very small; spiracular subatrium very slender (fig. 65).

C. Body generally larger and more fusiform, with a few inconspicuous setae; maxilla slightly roughened by small papillae or spinules (fig. 67); spinnerets usually acute apically.
Xylocelia (*franclemonti, virginiana*, [*minuta, tristis*])

CC. Body generally smaller and more cylindrical; maxilla smooth (fig. 69); spinnerets often blunt apically.
Stigmus (*inordinatus*, [*pendulus*])

Pemphredon (Cemonus) tenax Fox (Plate VII, figs. 49-55)

Body.—Length 8 mm.; maximum width (abdominal segment 3) 2 mm. (fig. 49). Fusiform-cylindrical; anterior portion of each posterior annulet raised to form a transverse elevation which is interrupted medially; pleural lobes present but small, rounded, those on the prothorax somewhat larger and lower than the others; anus terminal, the supra-anal lobe slightly more prominent than the subanal. Integument smooth and without conspicuous setae or spines; however, under high magnification some small spinules are apparent on some parts of the body, mostly antero-ventrally, as well as some minute setae (fig. 51). Spiracles as shown in figure 52, with the subatrium rather long and nearly as broad as the atrium, constricted for a distance before joining the trachea.

Head.—Wider than high; width .83 mm.; height .64 mm. (fig. 50). Pale and unpigmented except for certain parts which are dark brown; these are: anterior tentorial arms, entire margin of labrum plus a median longitudinal band, mandibles, margin and subapical ring on the maxilla, a circular ring surrounding the base of the prementum, and the palpi and galeae. Coronal suture and parietal bands not visible; epistomal suture barely defined, straight. Antennal orbits large, circular, 60 μ in diameter, the three sensilla forming a triangle in the center of the orbit. Head setae sparse and small, the longest ones only about 15 μ in length; clypeus with fairly numerous very small setae.

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[4] However, the larva of *lugubris*, as described by Grandi, differs in several characters from the other species and will by no means fit here. For further discussion, see under that species in text.

Mouthparts.—Labrum .3 mm. wide, .12 mm. in maximum height, thus about 2.5 times as broad as high (fig. 53). Entire margin of labrum, basal, lateral, and apical, with a pigmented band, the median line also with a pigmented band from base to apex; the outer marginal band appears somewhat striate because of small sensilla set within it; disc with 12 setae set back somewhat from the margin, also with a few small sensilla. Epipharynx apparently bare for the most part, but with a small group of conical sensilla on each side of the median line and a few weak spinules laterally. Mandibles .27 mm. long, .16 mm. wide at the base; base with a single seta laterally; apex with four large teeth, all in somewhat the same plane but tending to surround a slight ventral concavity, the apical two more or less one above the other (fig. 54, ventral view). Maxilla turned somewhat mesad apically, the lacinial area short, not noticeably spinulose; palpi stout, about 45 μ long; galeae much more slender, about 38 μ long. Labium smooth and rounded apically, without noticeable spines or papillae but with a few setae; palpi about 30 μ in length; spinnerets rather broad and blunt, connected by a membrane, exceeding the palpi only slightly (fig. 55).

Material.—Eight specimens taken from a nest in a rotten poplar log, Ithaca. N.Y., Aug.-Sept. 1956 (H. E. Evans).

Pemphredon (Cemonus) giffardi (Rohwer) (Plate VII, fig. 57)

Body.—About 9 mm. long, resembling that of *P. tenax* in all details. The spiracles are similar in structure and the integument is similarly smooth except for a few areas of minute spinules.

Head.—Width .95 mm.; height .76 mm. Antennal orbits circular, 70 μ in diameter. Setae sparse and short, as in *tenax,* the top of the head a little more roughened by small convexities than in that species.

Mouthparts.—Labrum .39 mm. wide, .15 mm. in median height, .17 mm. in maximum height, thus only about 2.3 times as broad as high (fig. 57); disc with a row of 12 setae toward the apical margin, but without sensilla except for a series of small ones set in the apical band near the median line. Mandibles as described for *tenax,* and the maxillae and labium very much as in that species; the lacinial area is very slightly roughened but not actually spinulose or papillose.

Material.—One specimen from Putah Canyon, Calif., from nest in stem of tree of heaven (G. E. Bohart).

Pemphredon (Cemonus) inornatus Say

Packard (1896, Jour. N.Y. Ent. Soc., 4: 159-160) presented a brief description of the larva of this species, but his description is not meaningful in the present context. He does state that in the "middle of the body the dorsal arches of the segments are

thickened suddenly so as to give a serrate outline to the back when seen in profile" and the "labrum is nearly three times as broad as long, slightly bilobate". Doubtless the larva of this species will be found to resemble closely that of the preceding two species.

Pemphredon (Cemonus) rugifer (Dahlbom)

Grandi (1929, Boll. Lab. Ent. Bologna, 2: 274-277) has described the larva of this European species(under the name *unicolor* Fabricius). The body form is exactly as in *tenax,* including the enlarged pleural lobe on the prothorax. Head setae are small, parietal bands are absent, and the antennal orbits are large and circular. The labrum is shaped much as in *tenax* and has a similar median pigmented band; however, Grandi makes no mention of the apical margin also being pigmented. The features of the labrum and epipharynx are very much as in *tenax,* the latter being mostly bare except for a few sensilla and a few lateral spinules. The maxillae and labium are exactly as described for *tenax,* and the spinnerets, as in that species, have a broad basal connection between them.

Micheli also described the larva of this species a year later than Grandi (1930, Mem. Soc. Ent. Italiana, 9: 61-64). His description agrees closely with that of Grandi but he does indicate a pigmented band along the apical margin of the labrum.

Pemphredon (Pemphredon) concolor Say (Plate VII, fig. 56)

This description is based on a single cast skin taken from a cocoon.

Body.—Integument mostly smooth, but in certain areas with fairly dense, minute spinules. Spiracles much as figured for *tenax* except that the subatrium is even more broadly swollen and just as wide as the atrium.

Head.—Antennal orbits circular, 60 μ in diameter, the three sensilla forming a triangle in the orbit. Lower sides of the head and also the clypeus with numerous very short setae, the longest ones about 25 μ in length.

Mouthparts.—Labrum .43 mm. wide, .16 mm. in maximum height; disc with a row of about 12 setae plus numerous additional punctures basad of these; margin with a row of minute sensory pores; median band and entire margin pigmented. Mandibles .3 mm. long, .22 mm. wide at the base, the apex with four teeth in about the same plane, the two middle teeth the strongest. Maxillary palpi slightly longer and thicker than the galeae;

lacinial area only slightly roughened. Spinnerets arising from a broad base, not exceeding the labial palpi (fig. 56).

Material.—Exuviae taken from a cocoon from which an adult had emerged; specimen from rotten log, Four Mile Run, Arlington, Va., May 1957 (J. G. Rozen) [U. S. Nat. Mus.].

Pemphredon (Pemphredon) lugubris (Fabricius)

The larva of this species, the type of the genus and subgenus, has been described by Grandi (1929, Boll. Lab. Ent. Bologna, 2: 271-274). I find Grandi's description puzzling; in certain features the larva agrees well with *concolor,* but in several important characters it is very different. The body is relatively short and thick, but otherwise not dissimilar to that of *concolor.* However, a distinct antennal papilla is present, the labrum bears several very large apical sensory cones and is without a pigmented border or median band, and the epipharynx is almost wholly covered with spinules. The mandibles and maxillae are shaped much as in *concolor* but the latter structures are papillose apically. The spinnerets are not described or figured.

The differences between *lugubris* and *concolor* are difficult to explain; certainly the adults of the two species appear to differ only in minor characters. The larva of *concolor* closely resembles that of several species of the subgenus *Cemonus.* Grandi's failure to provide descriptions and figures of the whole head capsule and of the spinnerets suggests that his material may have been deficient in certain respects. It is also, possible, of course, that his larvae were misidentified.

Passaloecus mandibularis (Cresson) (Plate VIII, figs. 60-64)

Body.—Length 7 mm.; maximum width 1.7 mm. (fig. 60). Fusiform and in general similar to *Pemphredon tenax;* pleural lobes rounded, fairly prominent; each abdominal segment except the last two with a pair of strong transverse swellings dorso-laterally; supra-anal lobe more prominent than subanal. Integument, at least anteriorly, clothed rather uniformly with small spinules which for the most part are separated by more than their own length, also with a few small, scattered setae (fig. 62). Spiracles similar to those of *Pemphredon tenax.*

Head.—Width .6 mm.; height .56 mm.; subcircular in anterior view; coronal suture fairly strong; parietal bands absent (fig. 61). Antennal orbits subcircular, 40 μ in diameter, the three sensilla forming a triangle in the center of the orbit. Setae sparse, fairly strong, the longest about 30 μ in length.

Mouthparts.—Labrum .24 mm. wide, .09 mm. high; apical margin somewhat emarginate; disc with about 12 strong setae, all near the anterior margin, plus several sensilla on or near the margin toward the median line; entire margin rather weakly pigmented, the median line with a prominent dark median band which, however, does not reach the base of the labrum (fig. 64). Epipharynx virtually bare except for twelve peg-like sensilla which are arranged in four groups of three each. Mandibles .2 mm. long, .13 mm. in maximum width; base with a single seta; apex with four teeth exactly as figured for *Pemphredon tenax* (fig. 54). Maxillae much as in *Pemphredon,* the lacinial area short and nearly smooth; palpi and galeae both about 35 μ long, the galeae slightly more slender. Labial palpi 30 μ long, the spinnerets broad, exceeding the palpi only slightly, connected by a membrane.

Material.—Three specimens from Ithaca, N.Y., July 1956 (H. E. Evans). Two specimens from Rochester, N.Y., Sept. 1953 (K. W. Cooper) [U.S. Nat. Mus.], determined as *Passaloecus* ? by K. V. Krombein, agree closely and may represent this same species.

Passaloecus brevicornis Morawitz

Grandi (1934, Boll. Lab. Ent. Bologna, 7: 42-46) presented a very detailed description of the larva of this Palaearctic species. The body form is much as in *mandibularis,* but the supra-anal lobe is rounded and only slightly more protuberant than the subanal. The thoracic segments are clothed with small spinules, as in *mandibularis*; there are a few small setae on all the body segments. Features of the head are very much the same as in *mandibularis.* The labrum is weakly emarginate apically and has a complete pigmented median band; the apical margin bears some conical sensilla but is not notably thickened or pigmented. The epipharynx is virtually bare except for four groups of peg-like sensilla as in *mandibularis.* The mandibles are 4-toothed and have a single seta at the base. The maxillae are about as described for *mandibularis,* but the galeae are shorter than the palpi. The spinnerets are broad and connected by a membrane.

Passaloecus tenuis Morawitz

According to Grandi (1934, ibid., pp. 47-48) the larva of this species is very similar to that of *brevicornis.* He figures the head, labrum, and mandibles, and they seem to differ scarcely at all from those of *brevicornis.*

Xylocelia franclemonti Krombein (Plate VIII, figs. 65, 66)

Body.—Length 7 mm.; maximum width 1.8 mm. Fusiform and in general much like that of *Pemphredon tenax;* each body segment except the first and last two with a pair of transverse dorsal elevations; pleural lobes rather weak, those on the prothorax situated rather low; anus terminal, the supra-anal and subanal lobes about equally prominent. Integument smooth and without noticeable spinules, but with a few small setae on the top and sides of the thorax. Spiracles about as in *Pemphredon tenax* except the subatrium relatively more slender (fig. 65).

Head.—Width .8 mm.; height .63 mm. Very much as described and figured for *Pemphredon tenax.* Antennal orbits large, circular, 60 μ in diameter, the three sensilla forming a triangle in the center of the orbit. Setae small and inconspicuous, the longest ones only 20 μ in length. There appear to be only about 30 setigerous punctures on the head capsule and about 16 more on the clypeus.

Mouthparts.—Labrum .32 mm. wide, .12 mm. in maximum height, with a weak apical emargination (fig. 66); disc with numerous punctures on the apical half, some of them bearing very short setae; median band complete, strongly pigmented; apex, sides, and base showing some evidence of a marginal band which, however, is not or scarcely pigmented. Epipharynx only weakly spinulose on the anterior lateral angles; sensory pegs prominent, six on each side in an oblique row. Mandibles .27 mm. long, .16 mm. wide at the base, exactly as described for *Pemphredon tenax.* Maxillae with several lateral setae; lacinial area short, somewhat roughened by small spinules; palpi stout, 40 μ in length; galeae slightly shorter and more slender. Labium with a few setae ventrally, the oral surface bare; palpi short and stout, 25 μ long; spinnerets prominent, acute apically, about 50 μ in length.

Material.—Three specimens from a sand bank, East Ithaca, N.Y., Aug. 11, 1956 (H. E. Evans).

Xylocelia virginiana Rohwer (Plate VIII, fig. 67)

Body.—Length 6 mm.; in every respect as described for *franclemonti.*

Head.—Width .82 mm.; height .65 mm. Antennal orbits 55 μ in diameter. Setae small and sparse, the longest ones about 20 μ in length.

Mouthparts.—Labrum .32 mm. wide, .13 mm. in maximum height; setae on the disc slightly larger than in *franclemonti;* sensory pegs of the epipharynx slightly farther removed from the apical margin than in that species. Mandibles virtually the same as figured for *Pemphredon tenax.* Maxillary palpi short and stout, about 30 μ long and nearly as wide; galeae much more slender but nearly as long. Labial palpi about 30 μ long; spinnerets tapering to an acute apex, about 50 μ long (fig. 67).

Material.—One specimen from Plummer's Island, Md., June 15, 1957 (K. V. Krombein).

Xylocelia spp.

Single, poorly preserved larvae of two other species of *Xylocelia,* with associated adults, are before me, but in both cases the species cannot be identified until a modern revision of this genus is available. These larvae are so similar to the two species described above that it seems unnecessary to describe them in detail. In both cases the labrum has a median pigmented band but the apical margin is unpigmented; in both cases the spinnerets taper to an acute apex and much exceed the labial palpi. The characters of the epipharynx, mandibles, and maxillae show no noteworthy differences from the preceding two species.

Material.—One specimen from Pottawatomie Co., Kansas, June 12, 1952 (H. E. Evans); one specimen from Logan, Utah, June 15, 1954 (G. E. Bohart).

Xylocelia minuta (Fabricius)

Grandi (1934, Boll. Lab. Ent. Bologna, 7: 50-52) has provided an excellent description of the larva of this European species. It appears to resemble the American species very closely. The labrum has a transverse pigmented band at the base and a longitudinal median pigmented band; the apical margin is unpigmented but has a few small sensilla near the median emargination. The apex of the maxilla is papillose, the palpi longer and thicker than the galeae. The major difference from the known American species seems to be in the spinnerets, which are much longer than the labial palpi, truncate apically, and connected by a membrane as in *Pemphredon.*

Xylocelia tristis (Van der Linden)

Maneval (1939, Ann. Soc. Ent. France, 109: 74-75) has described the larva of this species briefly. He reports that it resembles that of *minuta* very closely, differing chiefly in the more weakly dentate mandibles. Maneval's figure of the labium shows the spinnerets as being somewhat acute apically rather than truncate as in *minuta.*

Stigmus inordinatus Fox (Plate VIII, figs. 68, 69)

Body.—Length 4.5 mm.; maximum width about 1 mm. Form much as in *Pemphredon tenax,* but slightly more slender and cylindrical; supra-

anal lobe extending slightly beyond the subanal. Integument smooth, without spines or setae. Spiracles much as figured for *Xylocelia* (fig. 65), with the subatrium rather slender.

Head.—Width .5 mm.; height .43 mm. Virtually unpigmented; parietal bands absent; epistomal suture distinct. Antennal orbits circular, 40 μ in diameter, the three sensilla located on a somewhat dome-like elevation of the membrane of the orbit. A few setae are present below and to the sides of the orbits; these are very minute, the longest about 15 μ in length.

Mouthparts.—Labrum .22 mm. wide, .08 mm. in maximum height, thus over 2.5 times as broad as high; apical margin strongly emarginate; margin and median line unpigmented; disc with a few weak setae and sensory cones on the apical half (fig. 68). Epipharynx bare except for about four sensory cones on each side. Mandibles .18 mm. long, .11 mm. wide at the base, exactly as described for *Pemphredon tenax*. Maxillae smooth apically; palpi stout, about 25 μ long, the galeae somewhat smaller. Labium also smooth apically; palpi short and stout, only about 15 μ long; spinnerets truncate apically, slightly exceeding the palpi (fig. 69).

Material.—One specimen from elderberry stem, Logan Canyon, Utah, June 1944 (G. E. Bohart).

Stigmus fraternus Say

Packard (1896, Jour. N.Y. Ent. Soc., 4: 158-159) presented a few notes on the larva of this species. The labrum is said to be bilobate and with a distinct median line, presumably darkly colored. Other than this, there is nothing significant in his description.

Stigmus pendulus Panzer

Maneval (1939, Ann. Soc. Ent. France, 108: 76-78) has described the larva of this European species. The body is 4.6 mm. long and closely resembles that of *inordinatus*. The head is broader than high, the antennal orbits circular and with the three sensilla on a slight elevation. The labrum is broad, bilobed, and has a few setae and sensory cones near the anterior margin; the margin is not pigmented but there is a weak median band. The mandibles are exactly as in *inordinatus* and the maxillae similar but with the lacinial area acutely produced. The labial palpi are short, the spinnerets acutely pointed and about twice as long as the palpi.

Ammoplanus perrisi Giraud

Maneval (1939, ibid., pp. 80-81) has also described the diapausing larva of this species. The body is only 2.25 mm. long, with prominent pleural lobes and dorsal convexities, and is entirely clothed with small, pale setae. The head is subcircular in anterior view and more or less evenly clothed with short setae; antennal papillae are present and moderately long; parietal bands are absent. The labrum is not emarginate apically and is without setae or spines. The mandibles have three strong teeth and a weak fourth tooth basad of these. The maxillae have numerous short setae apically; the palpi are prominent, cylindrical; the lacinial area is reduced and without spinules. The labial palpi are unusually long and slender; the spinnerets are prominent, conical, and laterad of each spinneret is a long, sharply pointed process.

Michener (1953, Kansas Univ. Sci. Bull., 35: 990) remarks that the maxillary galeae are absent in *Ammoplanus*. It is true that Maneval omits them entirely from his sketch and description, but it should be remembered that the larva of *Ammoplanus* is very small, and Maneval may merely have been unable to see the galeae clearly in his preparation. It seems to me probable that, had Maneval been certain that the galeae were absent, he would have remarked on this fact. Galeae are present in all other known sphecid larvae.

Explanation of Figures

In drawings of the head, the anterior aspect is shown on the left side, the posterior aspect on the right side. In drawings of the labrum, the upper or anterior surface is shown on the left side, the under or posterior surface (epipharynx) on the right side.

PLATE II

Fig. 1.—*Astata unicolor* Say, body of non-diapausing individual.
Fig. 2.—Same, body of diapausing individual, from cocoon.
Fig. 3.—Same, antenna.
Fig. 4.—Same, portion of integument of prothorax under high magnification.
Fig. 5.—Same, head.
Fig. 6.—Same, labrum and epipharynx.
Fig. 7.—Same, spiracle.
Fig. 8.—Same, right maxilla and right half of labium.

PLATE III

Fig. 9.—*Tachytes elongatus* Cresson, body of diapausing larva.
Fig. 10.—Same, anterior part of body, ventral aspect.
Fig. 11.—Same, antenna.
Fig. 12.—Same, apex of maxilla.
Fig. 13.—Same, head.
Fig. 14.—Same, portion of integument of prothorax under high magnification.
Fig. 15.—Same, labrum and epipharynx.
Fig. 16.—Same, apex of labium, oral surface.
Fig. 17.—Same, spiracle.

PLATE IV

Fig. 18.—*Tachytes mandibularis* Patton, labrum and epipharynx.
Fig. 19.—Same, apex of maxilla.
Fig. 20.—Same, apex of labium, oral aspect.
Fig. 21.—*Tachysphex terminatus* (Smith), head.
Fig. 22.—Same, anterior portion of body.
Fig. 23.—Same, labrum and epipharynx.
Fig. 24.—Same, apex of maxilla.
Fig. 25.—Same, apex of labium, oral aspect.
Fig. 26.—Same, mandible, ventral (posterior) view.
Fig. 27.—Same, spiracle.
Fig. 28.—Same, portion of integument of dorsum of prothorax.

PLATE V

Fig. 29.—*Larropsis distincta* (Smith), body.
Fig. 30.—Same, anterior portion of body.
Fig. 31.—Same, portion of integument of prothorax under high magnification.
Fig. 32.—Same, mandible, dorsal (anterior) view.
Fig. 33.—Same, head.
Fig. 34.—Same, spiracle.
Fig. 35.—Same, antenna.
Fig. 36.—Same, apex of labium, oral surface.
Fig. 37.—Same, labrum and epipharynx.
Fig. 38.—Same, apex of maxilla.

PLATE VI

Fig. 39.—*Liris haemorrhoidalis magnifica* (Kohl), head.
Fig. 40.—Same, mandible, ventral (posterior) aspect.
Fig. 41.—Same, labrum and epipharynx.
Fig. 42.—*Solierella blaisdelli* (Bridwell), body.
Fig. 43.—*Solierella* sp., head.
Fig. 44.—Same, labrum and epipharynx.
Fig. 45.—Same, apex of maxilla.
Fig. 46.—*Astata occidentalis* Cresson, mandible.
Fig. 47.—Same, apex of labium, oral surface.
Fig. 48.—Same, labrum and epipharynx.

PLATE VII

Fig. 49.—*Pemphredon tenax* Fox, body.
Fig. 50.—Same, head.
Fig. 51.—Same, portion of integument of venter of thorax under high magnification.
Fig. 52.—Same, spiracle.
Fig. 53.—Same, labrum and epipharynx.
Fig. 54.—Same, mandible, ventral (posterior) aspect.
Fig. 55.—Same, apex of maxilla and labium.
Fig. 56.—*Pemphredon concolor* Say, anterior half of head.
Fig. 57.—*Pemphredon giffardi* (Rohwer), labrum.
Fig. 58.—*Larra analis* Fabricius, mandible, dorsal (anterior) aspect.
Fig. 59.—Same, mandible, mesal aspect.

PLATE VIII

Fig. 60.—*Passaloecus mandibularis* (Cresson), body.
Fig. 61.—Same, head.
Fig. 62.—Same, portion of integument of dorsum of thorax under high magnification.
Fig. 63.—Same, apex of maxilla and labium.
Fig. 64.—Same, labrum and epipharynx.
Fig. 65.—*Xylocelia franclemonti* Krombein, spiracle.
Fig. 66.—Same, labrum and epipharynx.
Fig. 67.—*Xylocelia virginiana* Rohwer, right maxilla and right half of labium.
Fig. 68.—*Stigmus inordinatus* Fox, labrum and epipharynx.
Fig. 69.—Same, apex of maxilla and labium.

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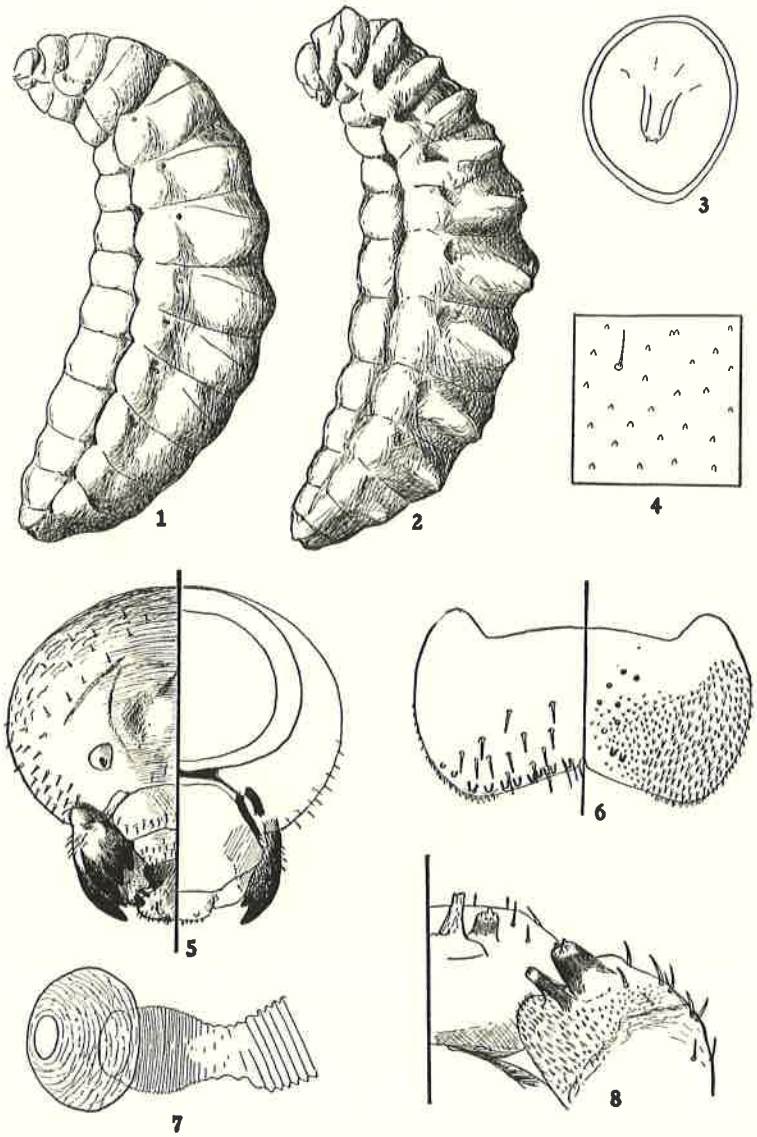
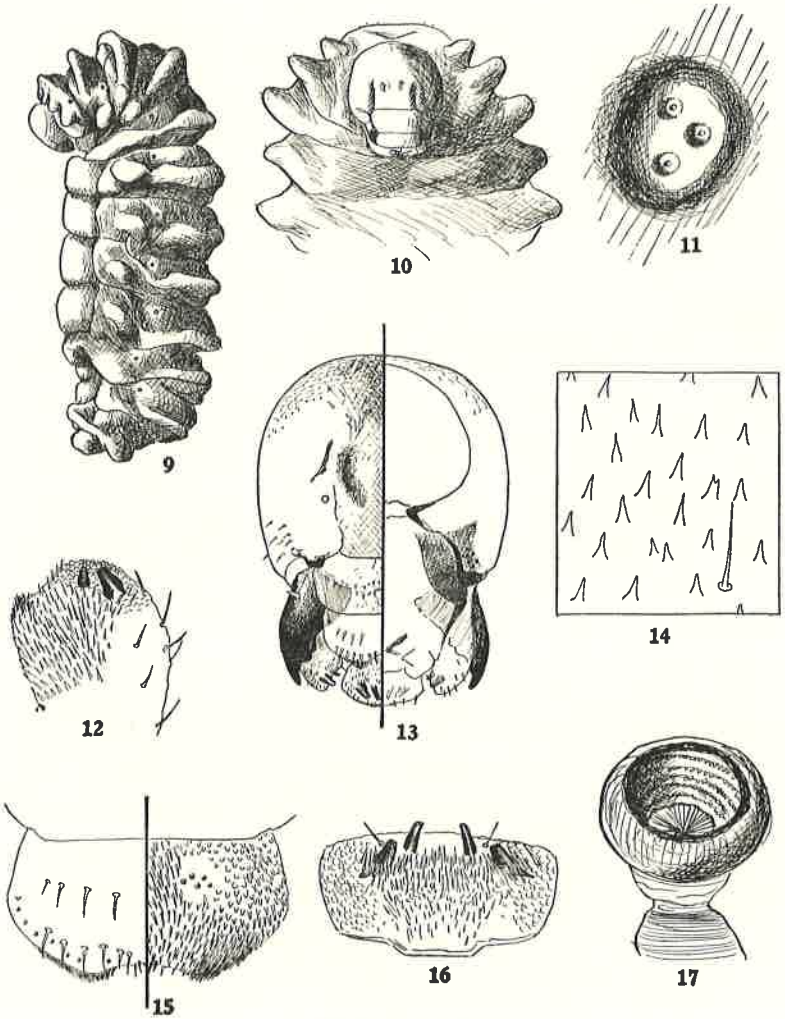


Astata unicolor Say

EVANS: LARVAE OF DIGGER WASPS



Tachytes elongatus Cresson

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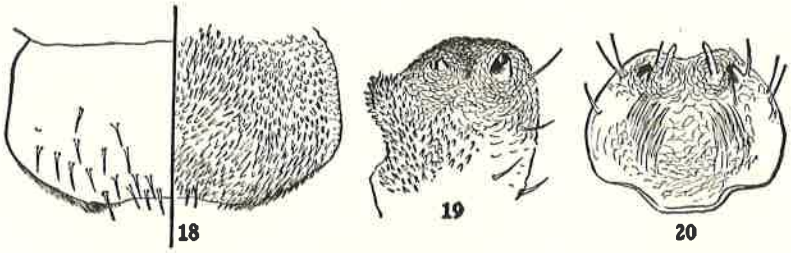
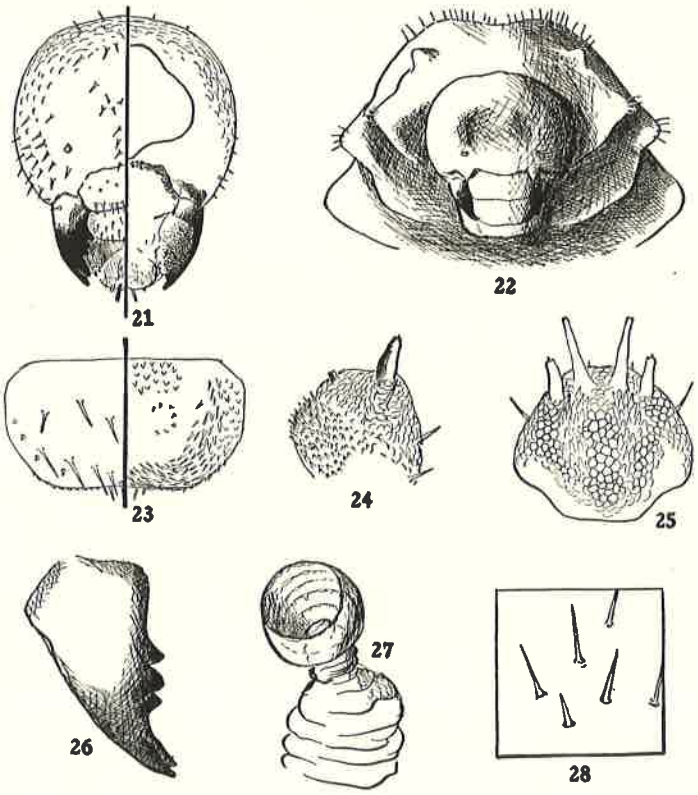


Tachytes mandibularis Patton



Tachysphex terminatus (Smith)

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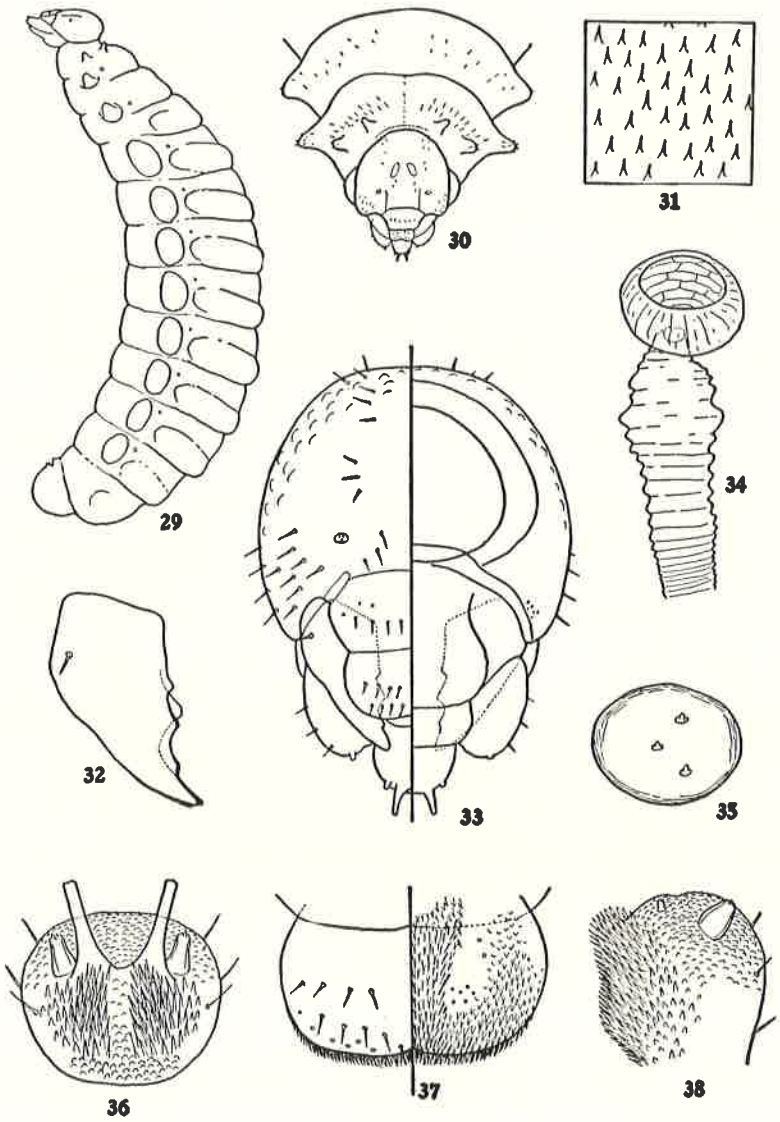

Larropsis distincta (Smith)

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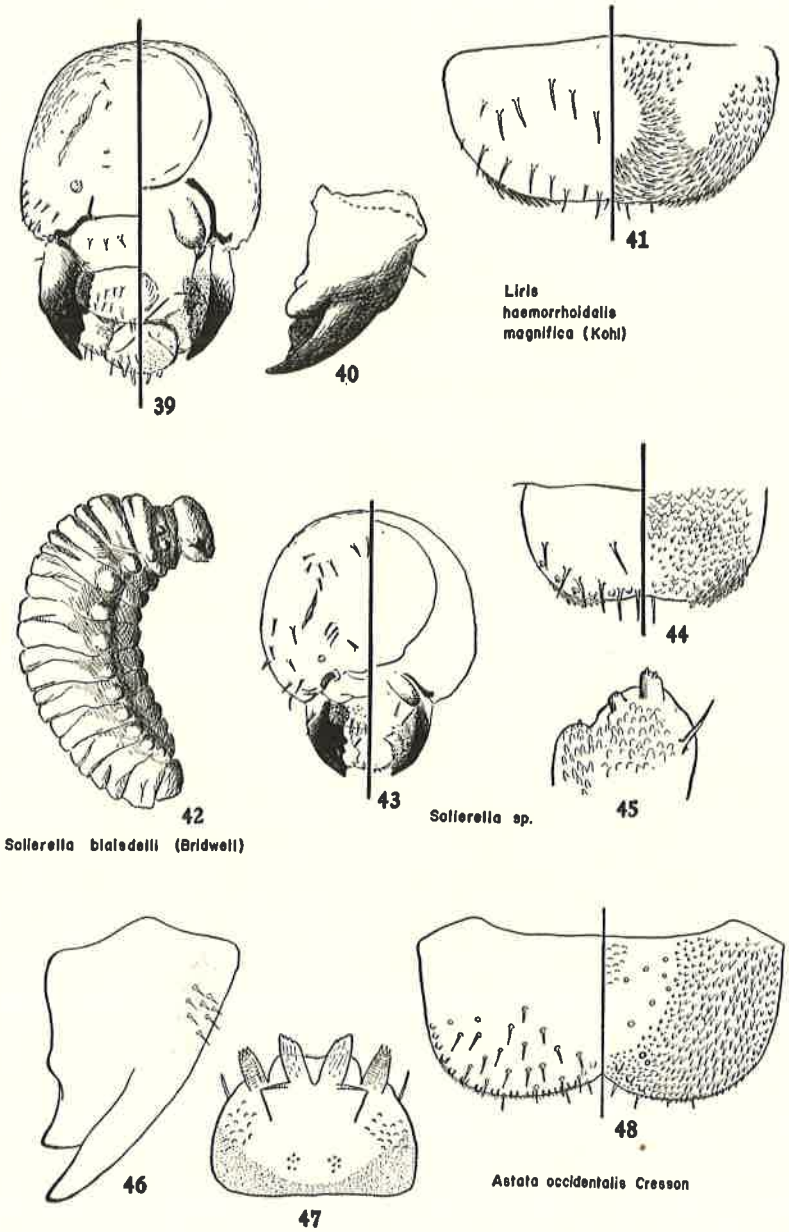

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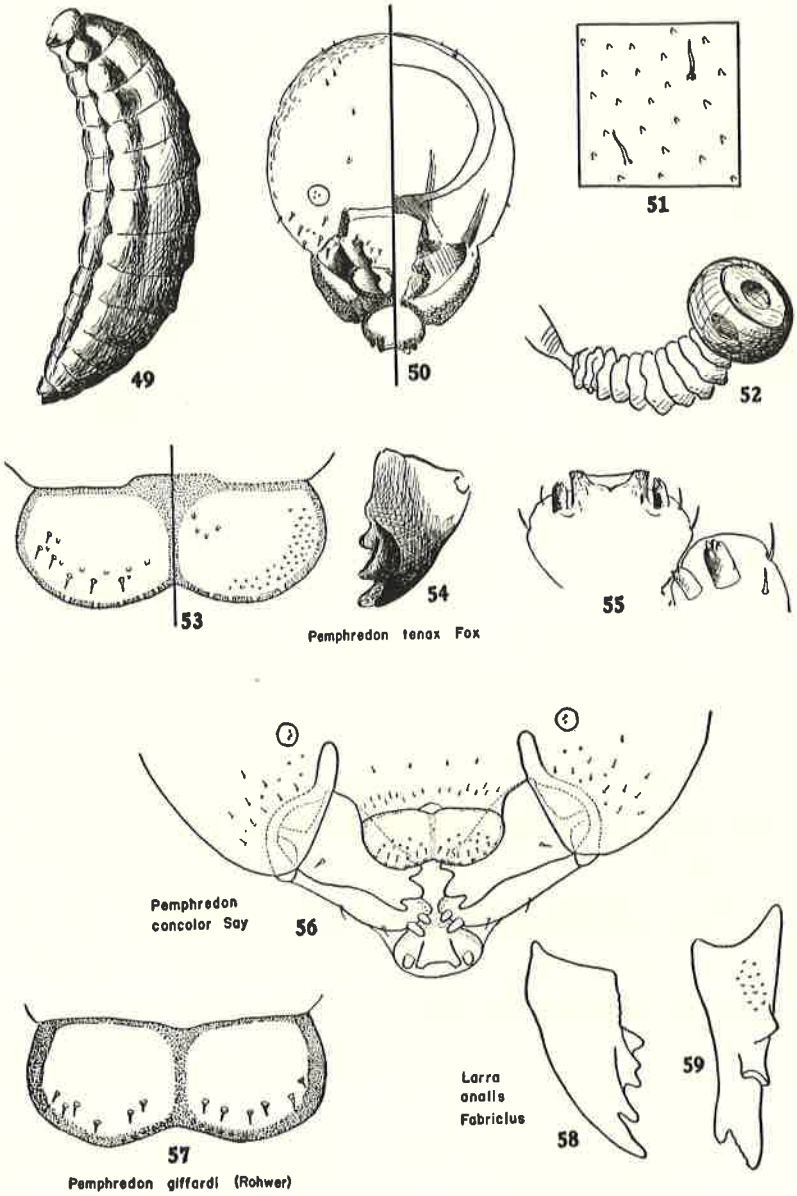

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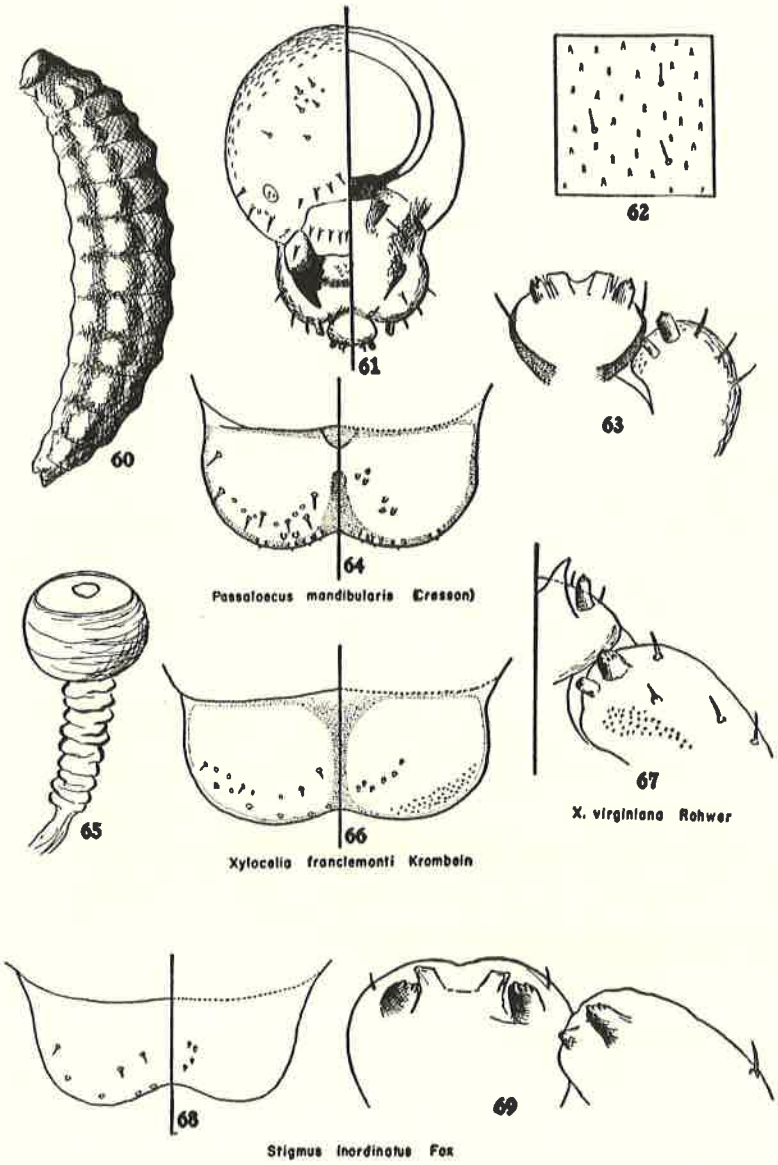

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