SHEPARD, WILLIAM DOUGLAS

A MORPHOLOGICAL STUDY OF LARVAL FORMS OF NORTH AMERICAN SPECIES OF STENELMIS (COLEOPTERA:ELMIDAE)

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A MORPHOLOGICAL STUDY OF LARVAL FORMS OF NORTH AMERICAN SPECIES OF STENELMIS (COLEOPTERA:ELMIDAE)

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WILLIAM DOUGLAS SHEPARD

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A MORPHOLOGICAL STUDY OF LARVAL FORMS OF NORTH AMERICAN SPECIES OF STENELMIS (COLEOPTERA:ELMIDAE)

APPROVED BY

Harley P. Brown

Gail H. Schnell

James M. Robertson

Cluff E. Hopla

Frank J. Sonleitner

DISSERTATION COMMITTEE

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A MORPHOLOGICAL STUDY OF LARVAL FORMS OF NORTH AMERICAN SPECIES OF STENELMIS (COLEOPTERA:ELMIDAE)

INTRODUCTION

Stenelmis in North America

The genus Stenelmis was erected in 1835 by Leon Dufour for the European species Elmis canaliculata. Shortly thereafter, the North American species Elmis crenata Say was reassigned to Stenelmis. Between 1852 and 1938, 12 more species of Stenelmis were described from this continent. In 1938, M. W. Sanderson published a monograph on North American species of Stenelmis in which 18 new species were described and four previously recognized species were relegated to synonymy. Sanderson's monograph has remained the largest single work on North American species of Stenelmis. Since 1938, only two new species have been described although approximately six recognized but undescribed species are known to exist. Table 1 summarizes additions and deletions to the list of North American species.

In North America, very little has been done with larvae except in connection with characterizing the family Elmidae (Böving and Craighead 1930, Peterson 1951) or characterizing genera within the family (West 1929, Sanderson 1938 and 1954, Green 1972, Brown 1972). Larval descriptions exist for two species of Stenelmis--S. bicarinata (Matheson 1914) and S. crenata (Böving and Craighead 1930, LeSage and Harper 1976a and 1977)--although they are generally too brief to help distinguish the species. In addition to these studies, the larval respiratory system of S. sulcatus (=S. quadrimaculatus) was described in detail by Susskind (1936) and the life cycle has been worked out for

S. sexlineata (White 1978), S. crenata (LeSage and Harper 1978, Seagle 1978) and S. exigua (Farmer 1978). Table 2 gives the chronology of these developments.

Worldwide, much of the work involving larval Stenelmis and other elmids has been done by H. Bertrand (1939, 1967, 1969 and 1972). In England S. canaliculata has been studied by Holland (1972) and Claridge and Staddon (1960). This same species was studied in Italy by Saraceni (1969).

Other Elmid Larval Research

The larvae of several other genera of elmids have been investigated morphologically. They include: Elmis (Berthelemy and Riols 1965), Limnius (Berthelemy 1967, Berthelemy et Stragiotti 1965), Riolus (Marvillet 1960, Berthelemy et Stragiotti 1965), Macronychus (Perez 1863), Esolus and Oulimnius (Berthelemy et Ductor 1965), Normandia and Grouvellinus (Bertrand 1967) and Zaitzevia (Pennak 1953). In addition, larvae of many genera have been treated morphologically and illustrated in a number of works dealing with elmids from a restricted area (Bertrand 1939, 1969, 1972, 1973 and 1974; Holland 1972; Brown 1972). The structure and function of the anterior digestive tract in elmid larvae has been studied by Delachambre (1964). Finally, Hinton (1939) and Green (1972) used larval morphology as part of the basis for revising the higher classification in the superfamily Dryopoidea.

Table 1. Taxonomic actions involving North American species of *Stenelmis*.

Date	Author	Taxa described	Changes
1824	Say	*Elmis crenata*	
1835	DuFour	*Stenelmis*	
1852	LeConte	*S. sinuata*, *S. bicarinata*	*E. crenata* reassigned to *Stenelmis*
1859	Motschulsky	*S. humerosa*, *S. markelii*, *S. sordida*, *S. elongata*	
1869	Zimmerman	*S. linearis*, *S. vittipennis*	
1870	Horn	*S. quadrimaculata*	*S. linearis* = *S. humerosa*
1901	Fall	*S. nubifera*	
1910	Blatchley	*S. sulcata*	
1925	Blatchley	*S. fuscata*	
1933	Musgrave		*S. sulcata* preoccupied, renamed *S. blatchleyi*
1938	Sanderson	*S. concinna*, *S. tarsalis*, *S. knobeli* *S. exilis*, *S. mera*, *S. douglasensis* *S. mirabilis*, *S. sexlineata*, *S. antennalis* *S. exigua*, *S. beameri*, *S. lateralis* *S. musgravei*, *S. decorata*, *S. convexula*	*S. sordida* = *S. crenata* *S. blatchleyi* = *S. quadrimaculata* *S. elongata* = *S. canaliculata* (not in N. America)
1940	Musgrave		*S. tarsalis* preoccupied, renamed *S. sandersoni*
1949	Chandler	*S. calida*	
1958	Sanderson		*S. nubifera* reassigned to *Ordobrevia*
1978	White and Brown	*S. gammoni*	

Table 2. Works involving larvae of North American species of *Stenelmis*.

Date	Author	Contents
1914	Matheson	Describes *S. bicarinata* larva and pupa
1929	West	Describes larval morphology of *Stenelmis*
1930	Böving and Craighead	Illustrates larval structures of *S. crenata*
1936	Susskind	Describes larval respiratory system for *S. quadrimaculata*
1938	Sanderson	Describes larval morphology of *Stenelmis*
1951	Peterson	Illustrates *Stenelmis* larva
1972	Green	Describes larval morphology of *Stenelmis*
1976	LeSage and Harper	Describes *S. crenata* larva and gives habits and habitats
1977	LeSage and Harper	Describes *S. crenata* larva
1978	White	Describes life cycle of *S. sexlineata*
1978	Seagle	Describes life cycle of *S. crenata*
1978	Farmer	Describes life cycle of *S. exigua*

Need for Research

Beetles of the genus Stenelmis are very common members of benthic stream communities. Within North America 28 described species are now known as are several undescribed species. The described species occur in a variety of aquatic situations from northern Mexico north through Canada and from the Atlantic coast west to Nevada and Oregon (Brown 1972 and pers. comm.). In many streams they are one of the dominant benthic organisms (e.g., Morse et al. 1980). Stenelmis is encountered by investigators studying aquatic biology, ecology and entomology. Professionals engaged in impact assessments and related studies also frequently collect Stenelmis. Different species of Stenelmis have varying susceptibilities to a number of common pollutants (Roback 1974, Sinclair 1964); thus, it may be of practical importance to be able to discriminate between or identify species of Stenelmis. Hilsenhoff (1977) has demonstrated that members of this group are potentially valuable as indicators of water quality. Resh et al. (1975) have indicated how specific identifications enhance the accuracy and efficacy of the application of the indicator organism concept. Presently, investigators have associated larvae with adults for only 4 of 28 species of Stenelmis. Therefore there existed a need for a morphological and systematic study such as done here. This work should be of benefit to studies of stream ecology, pollution biology and impact assessment as well as to the fields of insect morphology and taxonomy.

Life Cycle

Eggs

Oviposition has only been studied twice--in S. sexlineata by White (1978) and in S. exigua by Farmer (1978). Periods of oviposition are mid-May to mid-August in S. sexlineata and March to April plus mid-July to August in S. exigua. Stenelmis sexlineata oviposits in crevices on rocks. The eggs are 0.55-0.62 mm long, whitish yellow in color and have no readily discernable surface structure (White 1978). Approximately seven days are required for development prior to eclosion.

Larvae

There are eight larval instars (Farmer 1978, LeSage and Harper 1978). Although White (1978) reported seven for laboratory-reared and field-collected S. sexlineata, my reanalysis (unpubl.) of his field data indicates eight instars. Presence of seven instars in laboratory-reared specimens may reflect optimum or abnormally high growth rates.

Larvae or parts of larvae have been illustrated and described by a number of workers, but generally in a brief manner. LeSage and Harper (1976a) are the only workers who have described the various instars. A translation of their descriptions of S. crenata is included below:

> First Instar--Length of prothorax 0.14-0.16 mm. The diagnostic character occurs on the ninth abdominal segment: the extremities of the posterior projections are bilobed; the larger external lobes bear a very large apical bristle, whereas the smaller internal lobes bear a shorter branched seta. A pair of lateral bristles near the apex of the ninth abdominal segment. Three pair of lateral branched setae. Finally, two other pair of branched setae dorsal to the apex. Surface of the tergites entirely covered by serrated asperities. One or two very

small piligerous tubercles on the first abdominal tergite.

Second Instar--Length of prothorax 0.18-0.20 mm. Posterior projections of the ninth abdominal segment simple; dorsal surface of this segment ornamented with 15-18 very asymmetrical piligerous tubercles, one arm of which is rounded and the other pointed; there is also a dorso-lateral row of 12-14 spines which correspond, actually, to very modified piligerous tubercles. Two to three pointed piligerous tubercles are found on each postero-lateral angle of the tergites; elsewhere on the tergites, small branched setae foretell the future piligerous tubercles.

Third Instar--Length of prothorax 0.22-0.26 mm. The lateral spines of the ninth abdominal segment, 20-24 in number, are distributed in two to three more-or-less distinct rows; the dorsum is ornamented with 25-28 pointed tubercles. Some large polygonal cells appearing at the base of the segments. On the tergites there are 12-16 asymmetrical, pointed, piligerous tubercles.

Fourth Instar--Length of prothorax 0.28-0.32 mm. Lateral spines of the ninth abdominal segment are less coarse with the result that they are confused with the dorsal, pointed, piligerous tubercles, which number 50-60. Serrated asperities less distinct, but present on all the surface of the tergites, except at the base where the polygonal cells now form a narrow band. Pointed, asymmetrical piligerous tubercles, 24-32 in number, on the first abdominal tergite.

Fifth Instar--Length of the prothorax 0.34-0.40 mm. About 100 pointed, piligerous tubercles on the first abdominal segment. The serrated asperities are found on the second third of the tergites. Polygonal cells more numerous and better defined than in the preceding instar. About 48-56 piligerous tubercles on the first abdominal tergite; the tubercles are less asymmetrical and less pointed.

Sixth Instar--Length of the prothorax 0.42-0.50 mm. Serrated asperities no longer visible on the tergites; in their place appear numerous small cuticular protuberances. Between 100-130 piligerous tubercles on the first abdominal tergite.

Seventh Instar--Length of the prothorax 0.52-0.64 mm. The 180-200 piligerous tubercles of the first abdominal tergite have nearly acquired their definitive form.

Eighth Instar--Length of the prothorax 0.66-0.92 mm. About 400 asymmetrical but not pointed, piligerous tubercles distributed on all the surface of the tergites. Abdominal spiracles conical and open.

Single characters that are useful in distinguishing the instars are length of the ninth abdominal segment, number of piligerous tubercles (Lesage and Harper 1976a) and head capsule width (White 1978, Farmer 1978).

The duration of the larval stage is quite variable. In the laboratory, S. sexlineata has completed the larval stage in 6 months (White 1978). Field studies indicate, however, that larval maturation generally requires 2 years (Farmer 1978, White 1978) and even a third year in northern areas (LeSage and Harper 1976a). This is undoubtedly temperature-related. In most streams, due to offset periods of oviposition and individual growth rates, larvae of most instars can be found at any time of the year.

White (1978) is the only one who has published notes on behavior of the various larval instars. He noted that after eclosion, the young larvae leave the rocks and seek out sand and/or fine gravel. Only after the fifth instar is reached do the larvae return to the rocks.

The larval diet has been studied by Green (1972), Farmer (1978) and Seagle (1978). Detritus is the main food type. Diatoms and other algae are also utilized.

Last-instar larvae must leave the water for pupation. Matheson (1914) indicated that this is an active process on the part of the larvae. Recent workers suggest that the larvae migrate to the stream margin and then wait to be exposed by a drop in water level. This idea is supported by similar behavior in laboratory-reared larvae (White 1978). This transition from an aquatic existence to a terrestrial one is

facilitated by acquisition of open spiracles in the last-instar larvae. Once free from the water, the larvae form pupal chambers in damp soil around and under rocks, debris, moss, etc. (LeSage and Harper 1976a).

Pupae

Pupae have been described for S. bicarinata (Matheson 1914), S. canaliculata (Bertrand 1939) and S. crenata (LeSage and Harper 1976b). Since the description of S. crenata is most detailed, a translation of it is offered here:

> Length, from the cerci at the ends of the anterior pronotal corners, 4.72 mm; width, at the base of the elytra 1.24 mm. Color white, except the eyes which are brown.
>
> Head with about 100 setae; most of the setae dispersed on the vertex and around the eyes, in addition 19 setae on the anterior part of the labrum and one lateral mandibular seta.
>
> Pronotum bearing four brownish hooks recurved like fishhooks at the end and ornamented with spinules that are more numerous near the base; anterior pronotal hooks measuring 0.36 mm, directed diagonally toward the front; posterior pronotal hooks measuring 0.40 mm, directed nearly at a right angle to the axis of the body. About 300 pronotal setae, longer near the anterior and lateral margins: six anterior marginal setae (3-M-3) between the anterior pronotal corners, 35 lateral marginal setae (18-M-17) and others dispersed on the pronotal disc.
>
> Elytra visible dorsally back to the middle of the second abdominal segment. The tibio-femoral joint bearing 14-18 setae, unequal in number on each side. Anterior joints with 34 setae (16-M-18); middle joints with 29 setae (15-M-14); posterior joints with 33 setae (18-M-15).
>
> Abdominal segments having 12-21 setae generally asymmetrically disposed. Abdominal segments I-VIII with, on each side, one tergal seta on the postero-lateral angles and 10-19 tergal setae along the posterior margins of the tergites. These setae are divided as follows excluding the latero-tergal setae: first abdominal segment with 19 setae (10-M-9), second abdominal segment with 12 setae (6-M-6), abdominal segments III-V with 10 setae (5-M-5), sixth abdominal segment with 13 setae (7-M-6), seventh abdominal segment with eight setae (4-M-4). In addition, two pleural setae on each side on abdominal

segments III-VIII.

Ninth abdominal segment bearing two brownish cerci, hooked at the end, ornamented with spinules along their length and measuring 0.40-0.42 mm. Sixteen setae on each cercus: nine dorsal setae on the basal half, three lateral median setae and four ventral setae near the middle. Two setae (1-M-1) on the median lobe between the cerci and one seta on each side between the base of the cerci and the parameres.

Antennae directed obliquely backward and placed against each other on the head. Femora placed at right angles to the axis of the body; tibiae folded against the femora; tarsi oriented backward following the axis of the body. The bases of the posterior femora and the apices of the posterior tibiae covered by the ends of the elytra.

Variations--Length 3.7-4.7 mm; width 0.9-1.1 mm. Head with 90-120 setae of which 10-22 occur on the labrum. Anterior pronotal horns 0.36-0.44 mm. Pronotum with 250-325 setae: 5-9 anterior marginal setae between the anterior pronotal horns and 13-19 lateral marginal setae on each side of the pronotum. Twenty to 36 setae on the mesonotum; 25-51 setae on the metanotum. Eleven to 21 setae on the knee of the legs, ordinarily 15-16. Ten to 20 tergal setae on the abdominal segments but generally 6 pair per segment. Two or three pleural setae, more often two. Cerci, 0.40-0.64 mm. Seven to nine dorsal setae on the cerci.

Pupae have been observed in the field or laboratory by Matheson (1914), LeSage and Harper (1976a and 1976b), White (1978) and Farmer (1978). The following is a summarization of their findings. Pupae can be located from June to September, with most occurring from mid-July to mid-August. The pupal stadium is 8-12 days. The pronotal horns and the multitude of setae around the pupa serve to keep it supported above the soil of the pupal chamber. Pupae are most often found lying on the dorsum although they are occasionally on the venter or side. Upon disturbance they rotate the abdomen vigorously in a circular fashion.

Adults

Descriptions of adults are plentiful (see Table 1). For the most comprehensive treatment, see Sanderson (1938).

Generally, adults are present all year around in the field. Individuals kept in containers in the laboratory have remained alive for up to 394 days (Cole 1957). Other elmids have survived even longer periods (Brown 1973) but these extremes are probably not naturally realized. Generally there is recruitment of newly emerged adults from summer through fall. However, different species apparently have different periods of maximum recruitment. Young adults are easily distinguished by the lack of an epifauna or incrustations on their dorsal side. The new adults have a short period of dispersal (by flight) prior to entering the water. During dispersal flights they are often attracted to lights in abundance. Only these young adults are able to live any appreciable time away from water (White 1978). The sexual ratio is relatively even in August but becomes heavily skewed in favor of the females during and after winter until new adults appear (Farmer 1978).

Respiration of submerged adults is by means of a plastron. The plastron and associated behavior is discussed by Sanderson (1938).

During their aquatic life, the adults usually cling to submerged objects (rocks, wood, debris, plants, etc.) since they are incapable of swimming. Usually the adults are found on the lower surface of objects. They can, however, release their grip on a substrate, hold their legs against the body and float to the surface. At the surface, the adults are carried about by currents. This behavior is terminated by the beetle extending all the legs and floating until an object is snagged by one of the tarsal claws (personal observations).

Adults rely on detritus and various green algae as food although other items are also used (Seagle 1978, Sanderson 1938, Farmer 1978).

Farmer noted that feeding ceases at water temperatures below 5° C.

As mentioned previously, Stenelmis, among other elmids, has varying tolerances to pollutants. Although this aspect of their biology is not being presently investigated, some information can be gained by simply noting the occurrence of adults and water chemistry during the collection. This has been done to some extent by Roback (1974) for 18 species of Stenelmis.

METHODS AND MATERIALS

Larval specimens of Stenelmis were obtained through loans from a number of individuals (see Acknowledgments). Larvae were used only from sites at which a single species of Stenelmis was known to occur. Several last-instar larvae were separated from each collection for interspecific comparison. The last instar was distinguished by the presence of conical spiracular tubercles (Susskind 1936, LeSage and Harper 1976a). Use of the same instar is necessitated as there is a gradual change and increase in much of the surface ornamentation with increase in age of an individual larva (LeSage and Harper 1976b).

In preparation for mounting on microscope slides, the larvae were soaked in 10% KOH for a time sufficient to clear the internal structures. After clearing, the larvae were soaked in tap water to leach the KOH. Specimens were mounted on slides in Hoyer's medium, often after dissection prior to applying the cover slip.

I made drawings of larval morphology with the aid of an ocular grid and tracing paper overlying gridded paper. Each drawing was an "average" of the structure seen in all the specimens for each species. Comparison of these drawings formed the basis for selection of characters for differentiating the various species.

I used 44 characters to define each species: of these 32 were measurements and counts while 12 were values assigned to each species depending on the most common character state represented.

The characters were selected on the basis of two criteria: (1) they were observed to vary appreciably, and (2) they were from parts of the body involved in far different tasks. It was thus hoped that few

important characters would be missed and that redundancy would be minimized.

The lengths and widths of various sclerites are often susceptible to distortion depending on the means of preservation and/or mounting (Britt 1953). Particular care was thus given to choosing sclerites with well-defined borders or landmarks and to those in a position less likely to result in mismeasurements. Therefore, rather than than measure segment widths and lengths, widths and lengths of sternites of those segments were measured. Likewise, pronotal length was judged to be better than total length when comparing length to counts of tubercles and spines. The appendix gives descriptions and illustrations of how the measurements were taken and how certain characters varied.

The first 32 characters (Table 3) were analyzed numerically to determine relationships among species and among characters. For all species, each character was the mean of all measurements of that character that could be obtained from the specimens available. Some species were represented by more specimens than others and some specimens had areas that were rendered opaque due to material within the intestine. Therefore, the means are derived from varying numbers of individuals and/or observations. This original data was standardized prior to submitting it to the analysis program.

The numerical analysis methods involve numerical taxonomic computer programs (NT-SYS) described in Sokal and Sneath (1973). The numerical methods terminology is also defined in Sokal and Sneath (1973). Their programs include an analysis of relationships among species as well as among characters. Extracted from the NT-SYS programs and used in

this study are subprograms yielding the following: (1) phenograms of taxonomic distance between the species (range from 0 to 1, low values indicate similarity) and correlation between the characters (range from -1 to 1, higher absolute values indicate higher correlation); (2) a 3-dimensional model of the distribution of the species in the space described by the characters (from principal components analysis); and, (3) a Wagner network which indicates the relatedness of the species studied. Agreement of the phenograms with the original matrices was evaluated by calculation of the cophenetic correlation coefficient. Values approaching unity indicate high correlation.

GENERAL MORPHOLOGY

Setation and Surface Ornamentation

The external morphology of Stenelmis larvae includes two classes of structures, those general structures shared with most coleopteran larvae and the more specialized structures that occur less commonly. The first group of structures contains the various typical sclerites and appendages. These have been well illustrated and/or described (e.g. Böving and Craighead 1931, Brown 1972, Peterson 1951) and there is a consensus regarding terminology. The second group of characters, which have not been so consistently treated, includes such features as the various types of setae, spines and ornamentations. Several names often exist for the same structure, thus leading to confusion when descriptions by different authors are compared. The terminology used in this paper is defined and synonyms are given.

Setae

Simple--Long, narrow, hair-like structure that is flexible (Fig. 1)
= soie of LeSage and Harper (1976a, etc.) and of Berthélemy (1967, etc.).

Piligerous--Simple seta with small hair-like projections along its length (Fig.2)
=phanere ramifie of LeSage and Harper (1976a, etc.)
=plumose seta of Hinton (1939).

Plumose--Simple seta with longer projections which are usually in definite tracts (Fig. 3).

Spines

Simple--Long or short, wide, nonflexible hair-like projection (Fig. 4)
= grosse soie of LeSage and Harper (1976a, etc.).

Plumose--Flattened, simple spine with numerous regular projections along the edges (Fig. 5)
= poil of Berthélemy (1967, etc.)
= branched seta of Green (1972).

Tufted--Simple spine with the apex divided yielding several to many acicular projections (Fig. 6)
= phanere ramifié of Berthélemy (1967, etc.)
= branched seta of Green (1972)
= poiles laciniés of Berthélemy and Stragiotti (1965)
= poile aplati of Berthélemy and Stragiotti (1965)
= poile palmé of Berthélemy and Stragiotti (1965).

Branched--Tufted spine that is secondarily furcate (Fig. 7).

Cuticular projections

Mammillae--Small, low, rounded protrusions of the cuticle (Fig. 8)
= mammelons of Berthélemy and Stragiotti (1965).

Piligerous tubercles--Larger, raised cuticular projections that are usually bifurcate with a seta or spine in the bifurcation (Fig. 9)
= tubercules piligeres of LeSage and Harper (1976a, etc.) and of Marvillet (1960)
= projecting scales of Pennak (1953).

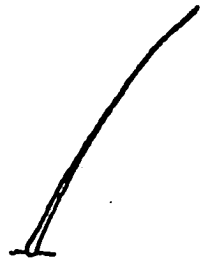
Cuticular depressions

Sensory pits--Small, round depressions scattered about the cuticle (Fig. 10)
= pores sensorial arrondis of Berthélemy (1967, etc.).

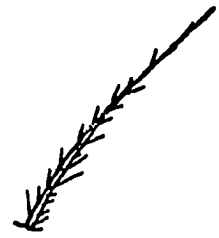
Scaling--Polygonal markings produced by intersecting grooves on the anterior portions of the sclerites (Fig. 11)
= reticulation of Hinton (1939)
= polygonal cellules of LeSage and Harper (1967a, etc.).

Figures 1-11. Setation and surface ornamentation.

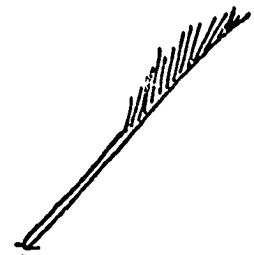
Setae (1-3)



1. Simple



2. Piligerous



3. Plumose

Spines (4-7)

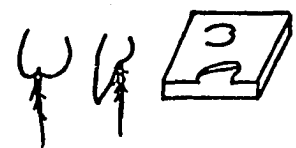
4. Simple

5. Plumose

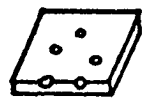
6. Tufted

7. Branched

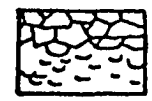
8. Mammillae



9. Piligerous Tubercle



10. Sensory Pits



11. Scaling

External Anatomy of the Larva of Stenelmis

The larvae are elongate with a slightly rounded head and the last abdominal segment tapered to two sharp apices separated by a truncated margin (Figs. 16 and 17). Cross-sections of the body vary from elliptical at the head to subpentagonal at the prothorax to almost circular at the middle of the ninth abdominal segment. The length is extremely variable and often depends on the circumstances of preservation. In general, mature larvae vary from 4.0 to 9.0 mm, depending on the species involved.

The color of the larvae varies from pale cream to a dark, blackish brown. Generally the body is relatively light in color and has areas of darker pigmentation. The latter areas usually include the dorsum of the head, the ventral portion of the head exclusive of the mouthparts, the coxal margins, the posterior end of the last abdominal segment and various carinae on the body and legs. Often there is a fine, light-colored line along each side of the body, parallel to the long axis of the body and just dorsal to the spiracles, from the second to the sixth abdominal segment. A similar line is located mid-dorsally and runs from the prothorax to the last abdominal segment.

The general body surface is covered with variously-shaped setae, spines, tubercles, pits and other markings (Figs. 1-11). The setae, spines and certain other markings are always distinct. However, the piligerous tubercles may be obscure and, in such cases, their position is evidenced by a V-shaped indentation in which is located a seta.

The prognathus, heavily-sclerotized head is generally wedge-shaped, being thicker at the base and tapering to the apex (Figs. 18 and 19).

In cross section, the head capsule is slightly convex dorsally and broadly rounded laterally. The base of the head is slightly wider than the apex. The epicranial suture is Y-shaped with the stem barely perceptible.

The frons is subtriangular with the base pointed and the apex extending from antennal base to antennal base. The fronto-clypeal suture is either indistinct or absent. The frons shows some light scaling at the base with the remainder covered with piligerous tubercles. Along the midline, the piligerous tubercles are symmetrical. However, along the lateral margins the tubercles are asymmetrical. Those in the basal third have the mesial side larger, whereas those in the anterior two-thirds and along the sides of the frons have the lateral or exterior portion progressively larger until the mesial area or portion disappears. These arms then are slightly inclined toward the longitudinal midline. Across its width, the frons bears setae (usually tufted) which originate in V-shaped openings. The clypeus is translucent and devoid of ornamentation. On either side of the clypeus are frontal horns or teeth. They are short, conical and slightly convergent. Often they bear irregular depressions and a few setae. At approximately three-fourths on either side of the midline are tentorial pits. Just anterior and lateral to each of these is a long, simple seta the base of which is often surrounded by several small mammillae. Lateral to the stem of the epicranial suture the vertex is lightly scaled, forming a generally ellipsoidal area of scaling with the previously mentioned scales on the frons basally. Dorsally the posterior one-fourth of the head capsule is unornamented except for this scaling

and a series of four short, simple spines on each side. These spines are presumably tactile as this portion of the head is commonly withdrawn into the prothorax in living larvae. Piligerous tubercles cover the dorsal surface from one-fourth to the antennal bases and onto the genae. Three long, simple setae surrounded by small mammillae are located dorsally in the anterior half of each gena in a generally triangular pattern (one mid-laterally just anterior to one-half, one near the epicranial suture at one-half, one at about three-fourths and between the others). In some species there is a short, tufted seta just anterior to these three. The piligerous tubercles along the outside of the epicranial suture have the medial arm enlarged whereas the others are either symmetrical or have the lateral arm enlarged.

From a dorsal view, the lateral margin of the head has an indentation just posterior to one-half. The posterior part of this indentation is reinforced with stout piligerous tubercles and forms a point of articulation with the prothorax when the head is withdrawn. All large cephalic ornamentation and setation is located anterior to a line connecting the two indentations.

Piligerous tubercles are often absent in two areas on the dorsal half of the head. The first is in the triangular area delimited by the three large dorsal setae. The second is on the lateral margin in the anterior half. The latter is associated with the eyespots and is unpigmented. The former, while situated dorsal to the eyespots, is usually as darkly pigmented as the rest of the head.

Ventrally, the head is usually devoid of piligerous tubercles (Fig. 19). However, there are generally two long, simple setae on each

side close to one-half. The hypostomal margins are distinct and extend from the antennal bases almost to the posterior of the head capsule. Along their posterior third are located four to six short, simple spines that are tactile like the two dorsal series. The angle of the hypostomal margin is almost 90° anteriorly but gradually becomes obscure in its posterior third, in the region of the tactile spines, where the gena is flat. On each side, between the hypostomal margin and the gular suture, near the anterior two tactile spines, is located a large tentorial pit.

The gula occupies the medial half of the posterior half of the head. Posteriorly it forms part of the posterior margin of the head capsule. Anteriorly it descends under the mouthparts and provides points of articulation for them. It is generally flat except for two roughly semicircular, depressed areas in its anterior corners. Two ellipsoidal tentorial pits are located near its posterior border.

The ocelli are fused into eyespots that are located laterally in the anterior half of the head capsule. The only external evidence of their position is an area devoid of piligerous tubercles.

The antennae are three-segmented and approximately one-third the length of the head. The first segment is subquadrate and has two circular sensoria along the distal border, several simple setae along the disto-lateral border and light scaling dorsally and occasionally ventrally. The second is cylindrical, about four times as long as wide and devoid of ornamentation. Its apex is truncate and supports the third segment and a stout spine which is slightly longer than the third segment. The third segment is similar in shape to the second but about one-fourth as long. Distally it bears a simple seta.

The transverse labrum is free and symmetrical (Fig. 26). In the middle of the anterior margin is a short arcuate projection. Several long, simple setae are usually present, five of which follow a regular pattern on each side of the labrum (two are located on the anterior margin near the base of the arcuate projection, one is in the middle of the labrum behind and slightly lateral to the first two, two are along the lateral margin dividing it into three subequal lengths). Scattered over the general labral surface may be a few additional long, simple setae and many short, tufted setae.

The epipharynx (Fig. 27) has on its anterior corners a series of three to six short, stout, simple spines that are slanted medially. Along the middle of the anterior margin and extending slightly posteriorly is a subtriangular patch of minute punctures with two short, simple setae near its posterior apex. On either side of the midline are two patches of short, simple bifurcate setae (branched setae with only two distal arms) that point medially and posteriorly. These two patches cover most of the general surface.

The mandibles are free-moving and symmetrical with the tips tridentate (Figs. 24 and 25). There is a median, internal depression. On the medial margin is located an oral brush and an elongate setose prostheca. A condyle projects from the ectal (toward the outside) surface of the postero-lateral corner and articulates with an acetabulum at the anterior end of the hypostomal margin. Entally (toward the inside), an acetabulum in the same area articulates with a condyle on the antero-lateral area of the frons. Muscles attach to the extreme lateral and medial corners of the posterior border of the

mandible. Entally, near the lateral margin at one-half, are one or two small, simple setae.

The maxilla is elongate, movable, unequally bisected and supports two lobes and a palp (Fig. 21). The cardo is distinct and articulates with the stipes.

Lying almost perpendicular to the main axis of the body, the cardo is a triangular sclerite at the base of the stipes. A small, simple seta is located near the middle of the anterior border. The median half of the anterior margin is grooved to allow movement of the stipes. The medial one-fourth is depressed and located under the labium when the mouthparts are retracted.

The stipes is generally rectangular and about twice as long as wide. A singular circular sensorium is located at three-fourths and slightly off-center toward the median edge. A single, long, simple seta is present just below the palpal origin. A few small, simple setae are variously located just below and paralleling the distal border. A transverse palpifer is present distally at the outer margin.

The one-segmented, elongate lacina (Fig. 22) is fused to the stipes along half its length. Where it is fused to the stipes, the free portion is depressed below the surface of the stipes and serves as a point of articulation for the labium. The distal half, which projects beyond the stipes, has a deep groove along the median border and in which are located several long, stout spines. A distal fringe of short, simple setae may be present.

The one-segmented galea (Fig. 22) is slightly more than twice as long as wide, fused to the stipes and gently curved medially. Six to

eight long, stout spines are located at the distal end. A single circular sensorium is found on the ectal surface.

The maxillary palp is four-segmented with the first transverse, the second subquadrate and the third and fourth elongate. The second and third segments bear one and two circular sensoria, respectively. The fourth segment bears several short, elongate and blunt spines on its flattened distal end.

The elongately rectangular labium is composed essentially of a single sclerite as any remaining suture lines are very faint and often discontinuous (Fig. 23). The general surface is smooth except for an area of scaling in the middle half of the proximal third. Short, simple setae are often found among the scales, especially along the edges of this scaly area. A long, simple seta is located laterally on each side, at three-fourths. Between these setae and more medially situated are two circular sensoria. At each disto-lateral corner is located a long, blunt spine, borne on a short, elongate spinifer. Anterior to these spines are located the very short palpifers. Between the palpifers and slightly distal are located four to six short, simple setae arranged in an anteriorly-projecting arc.

The labial palpi are short and two-segmented. The first segment is as long as wide, possesses a single circular sensorium on the medial side and has setae along the disto-lateral border. The cylindrical second segment is slightly to twice longer than broad. A single circular sensorium occurs along the lateral edge. The terminal end is flattened and bears several short, elongate and blunt spines.

The cervical sclerite (Fig. 20) is triangular with the apex directed

posteriorly and the base straight to slightly sinuate. Ornamentation is limited to an occasional few mammillae. It is covered completely by the cervical membrane and prothorax when the head is in a normal position.

The thorax is represented by a well-developed prothorax, mesothorax and metathorax separated by flexible membranes. The prothorax is almost twice as long as either the meso- or the metathorax but about as wide as each of these. The meso- and metathorax are very similar in many respects and quite different from the prothorax. Only the mesothorax bears a spiracle. Ornamentation consists of the usual structures. Each segment is represented by a dorsal tergite, a ventral sternite and, on each side, a pleurite and a well-developed leg.

The pronotal tergum (Fig. 28) is approximately 1.5 times as wide as long with the midline clearly marked by a line. The base is usually wider than the apex. Each side generally has nine long, simple setae arranged in a definite pattern. Three form an equilateral triangle in the posterior half of the tergum with the apex pointed anteriorly. Three form another triangle in the anterior half with the apex pointed antero-laterally. The remaining three are located along the tergo-pleural suture at about one-fourth, two-thirds and three-fourths. All nine setae are surrounded basally by rings of small mammillae of varying numbers. Other setae may be located on the tergum, though they generally are not surrounded by mammillae. The general surface is covered with piligerous tubercles that are arranged with their arms pointed in different directions depending on their location. Many of the tubercles are symmetrical, but some have one arm larger than the other.

In the middle of the posterior half of each side are several roughly circular areas that are devoid of tubercles. These areas often are faintly rugose. Anterior and posterior borders are bluntly serrate due to projecting arms of piligerous tubercles occurring along the borders.

The mesonotal tergum is twice as wide as long and roughly rectangular. The anterior border is generally indistinguishable from the intersegmental membrane. Piligerous tubercles line the posterior border, forming a bluntly serrate to dentate margin. The acrotergum is covered with irregular polygonal scales. Initially the scaling is quite faint but it grades to distinct posteriorly. Usually there follows a narrow area ornamented by an abundance of small mammillae. Gradually the mammillae are replaced by posteriorly directed piligerous tubercles. These tubercles are symmetrical near the midline but toward the sides become asymmetrical with the lateral arm accentuated. Two rugose patches are located in the middle of each half of the mesonotum at one-half and three-fourths. Four long setae surrounded basally by mammillae also occur on each side of this tergum. They describe a rough rectangle. The mesonotal spiracle is located along the tergo-pleural suture at one-half. It is conical and inclined slightly posteriorly.

The metanotum is very similar to the mesonotum in most respects except for the lack of spiracles.

The proepisternum and proepimeron form most of the procoxal margins (Fig. 29). They meet only at the extreme lateral edge of the coxal cavity. Their common border is very short with the pleural suture obscured by stout tubercles except on the interior of the coxal cavity.

The anterior border of the proepisternum and the posterior border of the proepimeron are bluntly serrate to dentate. The borders along the coxal cavities are heavily reinforced and dip entally for articulation of the coxae. All other borders are smooth. The two proepisterna meet medially along the midline. The proepimera medially border the prosternum. Setation is usually limited to a long seta, whcih may be surrounded by a ring of mammillae, postero-laterally located on each of the proepimera and a somewhat shorter seta along each posterior coxal margin. Ornamentation is represented by an abundance of piligerous tubercles and mammillae. On the proepisterna the tubercles are directed anteriorly or antero-laterally whereas on the proepimera they are directed laterally. Most of the tubercles are symmetrical. A circular sensorium occurs on each pleurite near the medial border.

The elongate mesepisterna and mesepimera are approximately twice as long as wide (Fig. 30). Only the posterior borders of the mesepimera are dentate, all others being simple. The mesepisterna are scaled and possess a single long, stout tactile seta anteriorly. The mesepimera bear a small number of piligerous tubercles and no scaling or setation. The medial one-fourth or so of the mesepimera are covered by the mesosternum.

The metapleurites are very similar to the mesopleurites, but are longer and possess more piligerous tubercles and mammillae (Fig. 31). Setation is the same. The metepimera are overlapped by the metasternum.

The prosternum (Fig. 36) is pentagonal and pointed at the anterior apex. The two antero-lateral sides are strengthened and border the coxal cavities. Ornamentation consists of mammillae, scaling and

anteriorly directed, symmetrical, piligerous tubercles. Sometimes faint scaling is present on the surface, especially near the posterior margin.

The mesosternum (Fig. 37) is roughly rectangular and twice as wide as long. The anterior half bears no tubercles or setae but is scaled. A short tactile spine occurs near the sterno-pleural suture at one-fourth. The anterior border is broad, reinforced and bears several short tactile spines medially. The posterior border is prolonged into a medial mesosternal spine and forms the anterior margins of the mesocoxal cavities. The presence of numerous piligerous tubercles along most of the border gives it a thickened appearance. The arms of these tubercles often overlap the otherwise smooth border and produce a serrate to spiny appearance.

The metasternum (Fig. 38) is similar in shape to the mesosternum but slightly larger. Additionally, it bears a median, longitudinal carina in the anterior one-third to one-half. This carina divides an anterior depression forming two areas in which the mesothoracic femora can freely move during locomotion. The carina is flat-topped and generally smooth, some piligerous tubercles being occasionally located on it. Anteriorly it joins with a transverse basal ridge and posteriorly it abruptly terminates in a short line of piligerous tubercles. Within the two depressions, ornamentation is limited to light scaling and there is no setation. The remainder of the metasternal surface is covered with piligerous tubercles and mammillae. Two circular sensoria are located posteriorly near the border. Setation is comprised of two pair of setae near the sterno-pleural suture at

one-fourth and three-fourths and another pair near the midline at three-fourths. The posterior border is smooth to serrate and bears a metasternal spine that is sometimes reinforced by ridges and contorted piligerous tubercles.

The bilabiate thoracic spiracle is located at the middle of the mesothorax near the tergo-pleural suture. The spiracle is located atop a bluntly conical elevation that is slightly inclined posteriorly.

The coxal cavities are each approximately one-third as wide as the thorax and oblong in shape. Each procoxal cavity is ringed by two prothoracic pleurites and the prosternum. It is obliquely oriented with the lateral end more anterior. The meso- and metacoxal cavities are transverse and located intersegmentally between the meso- and the metasternum and the metasternum and the first abdominal sternite, respectively.

The legs are all of normal appearance (Figs. 39-44). Each is composed of a coxa, trochanter, femur, tibia and tarsungulus. The coxae are transverse with the medial one-third subconical for attachment of the trochanter. The remainder is generally flat or grooved for reception of the femur in repose. There are several short, tactile spines and light scaling on the surface most often facing the substrate, i.e., the posterior surfaces of the procoxae and the anterior surfaces of the meso- and metacoxae. Apically, several small flanges surround the origin of the trochanter. The trochanter lies in the plane of the femur and is about as long. It is completely bisected by an irregular line but no articulation is evident. Setation is represented by scattered short and long, simple setae and plumose spines. The basal half of the

trochanter is subcylindrical whereas the apical half is saddle-shaped. The femur is cylindrical and two to three times as long as wide. There is no movable articulation basally with the trochanter. Apically, articulation with the tibia is facilitated by an infolded membrane and a notch on the dorsal margin. Setation is represented by three types. Along the dorsal surface is a row of several long, simple setae. Along the ventral surface and the antero-apical margin, long, stout, plumose and simple spines are arranged in two rows. Short, simple setae are located variously over the remainder of the surfaces. The ventral surface, mainly between the two rows of spines, is granulate to muricate. The apical margin is muricate with the anterior portion more strongly so. The tibia is similar in size and shape to the femur. Distally there is a shallow U-shaped indentation which allows the tarsungulus a greater freedom of movement. On the ventral edge there are usually six to eight long, simple spines in a row. In the middle of the anterior surface and arranged longitudinally are three to six long, plumose spines. The dorsal margin bears several long, simple setae. Several other simple setae, long or short, may occur generally on the surface of the tibia. Ornamentation is limited to a small patch of scaling just distal to the basal protuberance. The movable tarsungulus is one-third to one-half as long as the tibia, tapered to a blunt point and curved apically (Figs. 39-44, 62 and 63). Its surface is smooth and a single, long, simple seta occurs on the inside of the curved portion.

The abdomen is cylindrical, well sclerotized and composed of nine segments, all visible dorsally and ventrally (Figs. 16 and 17). Segments 1-6 are similar in most respects, being composed of a tergum,

sternum and, on each side, a pleurite. Segments 7 and 8 differ in the reduction and absence, respectively, of the pleurites. Segment 9, being terminal, is shaped quite differently. Located ventrally and apically is an operculum which covers the three groups of gills and the anus. The abdominal surfaces bear a variety of both setation types and ornamentations. Segments 1-8 bear spiracles on conical spiracular tubercles.

The first segment is very similar to the other segments but it has unique characteristics due to the proximity of the metathoracic legs. The anterior border of the tergum is obscure and hidden by retraction into the metathorax. The acrotergite is a zone of distinct scaling. Following this is a zone of small mammillae among which may occur small faint piligerous tubercles. The remainder of the surface is ornamented with distinct piligerous tubercles and mammillae. Setation consists of four long, simple setae surrounded basally by rings of mammillae. Two such setae occur in the middle of the tergum at one-third and two-thirds, another closer to the lateral margin and at one-half and the last at two-thirds just at the tergo-pleural suture. Small, simple setae are scattered about the remainder of the surface. The posterior border is generally serrulate, becoming serrate laterally. The setae from the piligerous tubercles along the lateral aspect of the posterior border are much longer than elsewhere. The spiracular tubercle is located laterally at one-half and is slightly inclined posteriorly. The pleurites are elongately rectangular with the same zones of ornamentation (Fig. 32). A single long, simple seta occurs along the tergo-pleural suture at one-half. The basal margin of each pleurite is indistinct and covered whereas the posterior margin is serrulate. The sternite is

rectangular, depressed in the basal half and bisected by a carina forming two broad, subrectangular areas for reception of the metathoracic legs in repose (Fig. 45). Basally is a broad flat area of distinct scaling upon which the metathorax articulates. Two short tactile spines are near the middle of this area. Distally, to about two-thirds, are the two depressed areas. They are faintly scaled whereas the carina separating them often bears piligerous tubercles. The rest of the sternal surface is ornamented with piligerous tubercles. Short, simple setae may occur variously over the surface. Two long, simple setae occur at about three-fourths and just on either side of the middle. At one-half and near the sterno-pleural sutures are located two subcircular, alutaceous patches. The posterior border is serrulate to serrate.

Abdominal segments 2-6 are very much like the first. On the tergum there are only three long, simple setae, the medial pair of the first segment being replaced by a single one. Additionally, along the tergo-pleural suture at three-fourths on each side there are two setae that appear to arise from the pore. The pleurites are similar to that of the first segment except in a few respects. There is no medial carina nor lateral depressed areas (Fig. 46). The two tactile spines of the first segment are replaced by two patches of four to five spines located at one-fifth and near the sterno-pleural suture. Finally, the zone of faint scaling is shorter, only extending to one-half.

The seventh segment differs from the previous ones only in the shape of the pleurites and the sternite. The pleurites taper posteriorly to a point and have far fewer piligerous tubercles (Fig. 35). Correspondingly, the posterior portion of the sternite is expanded (Fig. 47).

In the eighth abdominal segment, the pleurites are lacking as are any trace of tergo-pleural sutures, although the limits of the tergal area can be ascertained by the presence of their laterally-placed double setae (Fig. 48). Thus, in the absence of sutures, the eighth segment appears to be represented by a single, continuous, sclerotized ring.

The ninth abdominal segment is subconical in shape and two to three times as long as the other segments (Figs. 16, 17 and 49). Its apex is prolonged into two short spines which are separated by a broad truncation. Dorsally and ventrally there are three pair of long, simple setae located laterally at one-fifth, one-third, one-half and two-thirds. As with other segments, there is basally a zone of scaling followed by a short zone of mammillae and then piligerous tubercles. These tubercles become more acutely pointed and asymmetrical proceeding apically. They also become more asymmetrical proceeding from the midline toward the sides. The posterior third of the venter is occupied by an operculum which covers the gill chamber.

The operculum is pentagonal to subtriangular in shape with the apex pointed (Fig. 51). The base and approximately one-half of each side is depressed and covered by portions of the ninth abdominal segment. These areas are heavily scaled. Two auricular projections extend out from the ental surface at two-thirds. In the same area but more anterior are two short clefts in the margin. Two rugose patches occur on either side of the midline at one-fifth. Two long, simple setae are located near the borders at two-thirds and extend out over the auricular projections. The general surface has numerous long, piligerous setae,

some of which originate from piligerous tubercles. These setae are more concentrated along the border in the apical third. Small mammillae are scattered about the surface. Entally the most prominent feature is a pair of hooks that are about one-half as long as the operculum and are capable of a wide range of movements. The hooks are armed with patches of long setae on the medial and lateral edges and on the ental surface. Many of the setae are unilaterally plumose apically. Also on the ental surface of the operculum are two patches of long setae at one-half and near the lateral border plus an area with small papillae located medially between the hooks and near the apex. Short, simple setae occur along the border entally from the auricular projections to the apex.

SYSTEMATIC TREATMENT

Within North America there are 28 valid species in the genus Stenelmis. Several undescribed species are also known, some of which will be described soon. They vary from very rare (S. knobeli) to very common (S. crenata). Distributions of these species are listed in Brown (1972) and in White and Brown (1978) for S. gammoni. Below is a list of the known species.

S. antennalis
S. beameri *
S. bicarinata *
S. calida
S. concinna
S. convexula
S. crenata *
S. decorata
S. douglasensis
S. exigua *
S. exilis
S. fuscata
S. gammoni *
S. grossa *
S. humerosa
S. hungerfordi
S. knobeli
S. lateralis
S. markeli
S. mera *
S. mirabilis
S. musgravei
S. parva *
S. quadrimaculata
S. sandersoni *
S. sexlineata *
S. sinuata
S. vittipennis *
undescribed species ***

* species for which larvae were available

Key to the Known North American Larvae of Stenelmis

1 In warm springs and streams in Nevada ---------- S. calida

Elsewhere ---------- 2

2 [illegible] of mesosternum no more than 0.25 mm; length of metasternum less than 0.33 mm; length of ninth abdominal segment less than 0.90 mm ---------- 3

Not as above (larger) ---------- 4

3 Piligerous tubercles on dorsum of head and pronotum faint (Fig. 55); ninth abdominal segment less than twice as long as wide; posterior third of hypostomal margin not distinct ---------- S. gammoni

Piligerous tubercles on dorsum of head and pronotum very distinct; ninth abdominal segment more than twice as long as wide; posterior third of hypostomal margin distinct ---------- S. parva

4 Tarsungulus slender (Fig. 63) ---------- 5

Tarsungulus normal in shape (Fig. 62) ---------- 7

5 Length of mesosternum at least 0.38 mm; length of metasternum at least 0.46 mm ---------- S. sandersoni

Mesosternum less than 0.36 mm long; metasternum less than 0.44 mm long ---------- 6

6 Metasternal spine reinforced (Fig. 59); coxal margins on meso- and metasternum lateral to sternal spine curved (Fig. 60); mammillae on eighth abdominal sternum restricted to the sides; mesosternum greater than 0.336 mm long; ninth abdominal segment greater than 1.25 mm long ---------- S. new species C

Metasternal spine not reinforced; coxal margins on the meso- and metasternum lateral to sternal spine straight (Fig. 61); mammillae generally distributed on the eighth abdominal sternum; mesosternum less than 0.336 mm long; ninth abdominal segment less than 1.25 mm long ---------- S. new species B

7 Sternal spine reinforced (Fig. 59) ---------- 8

Sternal spine not reinforced (normal) ---------- 10

8 Prosternum with 15-21 piligerous tubercles present; length of metasternum greater than 0.396 mm; first abdominal sternite more than 0.33 mm long; posterior borders of abdominal sternites spiny ---------- S. grossa

Prosternum with 7-14 piligerous tubercles present; length of metasternum less than 0.396 mm; first abdominal sternite less than 0.33 mm long; posterior borders of abdominal sternites not spiny ---------- 9

9 Greatest width of seventh abdominal sternite just anterior to the posterior border ---------- S. crenata

Greatest width of seventh abdominal sternite at the posterior border ---------- S. sexlineata

10 First abdominal pleurite with 13 or fewer piligerous tubercles; second abdominal pleurite with 17-18 piligerous tubercles; unornamented area preceding the meso- and metasternal spines (Fig. 58) ---------- S. new species A

Not with the above combination of characters ---------- 11

11 Posterior border of the abdominal sternites faint (Fig. 65) ---------- S. mera

Posterior border of the abdominal sternites normal (Fig. 64) ---------- 12

12 Mesosternal piligerous tubercles faint (Fig. 55) --- S. bicarinata

Mesosternal piligerous tubercles normal (Fig. 52) ---------- 13

13 Piligerous tubercles faint on the center of the frons and the abdominal sternites; numerous mammillae on the abdominal sternites ---------- S. exigua

Piligerous tubercles not faint; few mammillae on the abdominal sternites ---------- 14

14 Piligerous tubercles in the center of the frons elongate; maximum width of seventh abdominal sternum just anterior to the posterior border; length of ninth abdominal segment more than 1.064 mm ---------- S. beameri

Piligerous tubercles in the center of the frons not elongate; maximum width of seventh abdominal sternum at the posterior border; length of ninth abdominal segment less than 1.064 mm ---------- S. vittipennis

Descriptions of Species

Mature Larva of Stenelmis beameri Sanderson 1938

Stenelmis beameri Sanderson, 1938, p. 671.

DIAGNOSTIC DESCRIPTION: Frons 0.312-0.384 mm long ($\bar{x}$=0.345); 0.288-0.384 mm wide ($\bar{x}$=0.348); central piligerous tubercles separated by more than their own length and with both arms elongate and rounded apically. Labrum 0.192-0.228 mm long ($\bar{x}$=0.210). Labium 0.276-0.312 mm long ($\bar{x}$=0.287); 0.144-0.168 mm wide ($\bar{x}$=0.159). Posterior third of hypostomal margin distinct. Gula 0.228-0.288 mm wide ($\bar{x}$=0.257). Cervical sclerite 0.036-0.060 mm long ($\bar{x}$=0.052); 0.144-0.180 mm wide ($\bar{x}$=0.158). Pronotum 0.668-0.817 mm long ($\bar{x}$=0.747). Prosternum 0.156-0.276 mm long ($\bar{x}$=0.221); 0.192-0.264 mm wide ($\bar{x}$=0.233); 3-21 piligerous tubercles present ($\bar{x}$=13.938). Proleg with 9-16 spines on the tibia ($\bar{x}$=12.467). Mesosternum 0.288-0.360 mm long ($\bar{x}$=0.323); 0.504-0.636 mm wide ($\bar{x}$=0.573); piligerous tubercles normal in shape; spine normal; coxal margins lateral to spine curved. Metasternum 0.324-0.444 mm long ($\bar{x}$=0.390); 0.528-0.696 mm wide ($\bar{x}$=0.625); piligerous tubercles normal in shape; spine normal; coxal margins lateral to spine curved. Metepisterna each with 2-10 piligerous tubercles ($\bar{x}$=5.912). Tarsungulus normal in shape. Abdominal pleurites bearing piligerous tubercles in the following ranges: AI--14-25 ($\bar{x}$=17.500); AII--17-33 ($\bar{x}$=24.088); AVI--13-26 ($\bar{x}$=18.944); AVII--4-9 ($\bar{x}$=6.412). Abdominal sternites with normally shaped piligerous tubercles, few mammillae and normal posterior borders. AI sternite 0.288-0.360 mm long ($\bar{x}$=0.324); 0.468-0.600 mm wide ($\bar{x}$=0.532). AII sternite 0.288-0.360 mm long ($\bar{x}$=0.323); 0.468-0.588 mm wide ($\bar{x}$=0.534).

AIV sternite 0.300-0.372 mm long ($\bar{x}$=0.342); 0.444-0.576 mm wide ($\bar{x}$=0.517). AVII sternite 0.288-0.360 mm long ($\bar{x}$=0.331); 0.528-0.648 mm wide ($\bar{x}$=0.591); maximum width just anterior to posterior border. AIX segment 1.064-1.188 mm long ($\bar{x}$=1.130); 0.569-0.718 mm wide ($\bar{x}$=0.663). Total length 6.5-8.25 mm ($\bar{x}$=7.328).

REMARKS: The anterior border of the cervical sclerite is doubly sinuate in most of the larvae. Labral teeth vary from three to five per side. The eighth abdominal segment ventrally has many more mammillae than occur on the preceding abdominal sternites. The ninth abdominal segment has a gentle, angular sinuation along the lateral margins opposite the last half of the operculum. In a few specimens this sinuation is very angular. This species is one of the largest when comparing total lengths. This is the darkest of all the species, its base color often darker than the darker areas of other species. The head capsule is very dark except on the gula and on two lateral triangular patches extending from the base of the antennae back to the base of the head. The mandibles are very dark and the posterior third of the ninth abdominal segment is slightly darker than the rest.

This species occupies an intermediate position relative to the variation shown amongst the species examined. It is closely related to S. bicarinata.

HABITS AND HABITATS: In rocky or gravelly stream beds.

LARVAL REFERENCES: None

TYPE LOCALITY: Arkansas, Berryville

GEOGRAPHIC RANGE:

Southwest	Middle States	Southeast
Oklahoma	Missouri	Arkansas
Texas		

MATERIAL EXAMINED:

7 specimens	10 specimens
Arkansas: Washington Co.	Arkansas: Washington Co.
½ mi. S of Johnson	5 mi. W of Fayetteville
29/X/1975	22/X/1973
J. McCraw, leg.	P. Kittle, leg.

Mature Larva of Stenelmis bicarinata LeConte 1852

Stenelmis bicarinata LeConte, 1852, p. 44.

DIAGNOSTIC DESCRIPTION: Frons 0.288-0.360 mm long ($\bar{x}$=0.334); 0.336-0.372 mm wide ($\bar{x}$=0.358); central piligerous tubercles rounded; faint in outline and widely spaced. Labrum 0.204-0.228 mm wide ($\bar{x}$=0.216). Labium 0.288-0.300 mm long ($\bar{x}$=0.296); 0.168-0.180 mm wide ($\bar{x}$=0.175). Posterior third of hypostomal margin distinct. Gula 0.240-0.252 mm wide ($\bar{x}$=0.250). Cervical sclerite 0.048-0.060 mm long ($\bar{x}$=0.051); 0.156-0.168 mm wide ($\bar{x}$=0.159). Pronotum 0.718-0.743 mm long ($\bar{x}$=0.739). Prosternum 0.190-0.228 mm long ($\bar{x}$=0.213); 0.216-0.252 mm wide ($\bar{x}$=0.231); 7-14 piligerous tubercles present ($\bar{x}$=10.857). Proleg with 7-13 spines on tibia ($\bar{x}$=10.286). Mesosternum 0.312-0.336 mm long ($\bar{x}$=0.321); 0.564-0.600 mm wide ($\bar{x}$=0.578); piligerous tubercles faint in outline; spine normal in shape and preceded by an unornamented area; coxal margins lateral to spine curved. Metasternum 0.384-0.420 mm long ($\bar{x}$=0.401); 0.612-0.648 mm side ($\bar{x}$=0.627); piligerous tubercles faint in outline; spine normal in shape and preceded by an unornamented area; coxal margins lateral to spine curved. Metepisterna each with 9-13 piligerous tubercles present

($\bar{x}$=10.286). Tarsungulus normal in shape. Abdominal pleurites bearing piligerous tubercles in the following ranges: AI--14-21 ($\bar{x}$=17.857); AII--17-25 ($\bar{x}$=22.214); AVI--17-21 ($\bar{x}$=19.071); AVII--5-10 ($\bar{x}$=7.500). Abdominal sternites with faintly outlined piligerous tubercles, numerous mammillae and normal posterior borders. AI sternite 0.324-0.348 mm long ($\bar{x}$=0.333); 0.492-0.528 mm wide ($\bar{x}$=0.521). AII sternite 0.324-0.348 mm long ($\bar{x}$=0.336); 0.516-0.540 mm wide ($\bar{x}$=0.525). AIV sternite 0.348-0.360 mm long ($\bar{x}$=0.353); 0.504-0.528 mm wide ($\bar{x}$=0.513). AVII sternite 0.324-0.336 mm long ($\bar{x}$=0.327); 0.552-0.588 mm wide ($\bar{x}$=0.573); maximum width at posterior border. AIX segment 1.089-1.163 mm long ($\bar{x}$=1.135); 0.644-0.718 mm wide ($\bar{x}$=0.661). Total length 6.75-7.75 mm ($\bar{x}$=7.20).

REMARKS: The anterior border of the cervical sclerite is bisinuate in most of the larvae. The piligerous tubercles on many of the sclerites may be so faint in outline as to leave only a V-shaped depression where the seta arises. This is an intermediate sized larva both in regard to total length and measurements of individual sclerites. The color of this species is darker than most other species. It is uniformly colored except for darker mandibles and longitudinal areas along the hypostomal margins.

HABITS AND HABITATS: In rocky or gravelly stream beds.

LARVAL REFERENCES: Matheson, 1914

TYPE LOCALITY: Ohio

GEOGRAPHIC RANGE:

Southwest	Middle States	Middle Atlantic
New Mexico	Kansas	New York
Oklahoma	Ohio	New Jersey
Texas		Pennsylvania

MATERIAL EXAMINED:

7 specimens
New Mexico
Malaga
24/III/1972
H. P. Brown, leg.

Mature Larva of Stenelmis crenata (Say 1824)

Elmis crenata Say, 1824, p. 275.
Stenelmis sordida Motschulsky, 1859, p. 51.

DIAGNOSTIC DESCRIPTION: Frons 0.264-0.360 mm long ($\bar{x}$=0.330); 0.312-0.348 mm wide ($\bar{x}$=0.329); central piligerous tubercles elongate and separated by less than their own length. Labrum 0.192-0.204 mm long ($\bar{x}$=0.202). Labium 0.264-0.288 mm long ($\bar{x}$=0.274); 0.144-0.168 mm wide ($\bar{x}$=0.153). Posterior third of hypostomal margin distinct. Gula 0.228-0.264 mm wide ($\bar{x}$=0.240). Cervical sclerite 0.036-0.060 mm long ($\bar{x}$=0.053); 0.156-0.168 mm wide ($\bar{x}$=0.161). Pronotum 0.644-0.693 mm long ($\bar{x}$=0.664). Prosternum 0.204-0.228 mm long ($\bar{x}$=0.213); 0.216-0.240 mm wide ($\bar{x}$=0.223); 7-14 piligerous tubercles present ($\bar{x}$=10.714). Proleg with 8-11 spines on tibia ($\bar{x}$=9.214). Mesosternum 0.288-0.324 mm long ($\bar{x}$=0.300); 0.480-0.528 mm wide ($\bar{x}$=0.501); piligerous tubercles normal in shape; spine reinforced; coxal margins lateral to spine curved. Metasternum 0.348-0.384 mm long ($\bar{x}$=0.363); 0.528-0.588 mm wide ($\bar{x}$=0.545); piligerous tubercles normal in shape; spine reinforced; coxal margins lateral to spines curved. Metepisterna each with 6-9 piligerous tubercles ($\bar{x}$=7.214). Tarsungulus normal. Abdominal pleurites with piligerous tubercles in the following ranges: AI--15-26 ($\bar{x}$=19.214); AII--20-28 ($\bar{x}$=24.657); AVI--13-22 ($\bar{x}$=19.214);AVII--5-8 ($\bar{x}$=6.571). Abdominal sternites with normally

shaped piligerous tubercles, numerous mammillae and faint posterior borders. AI sternite 0.288-0.312 mm long ($\bar{x}$=0.303); 0.480-0.528 mm wide ($\bar{x}$=0.495). AII sternite 0.300-0.312 mm long ($\bar{x}$=0.305); 0.468-0.516 mm wide ($\bar{x}$=0.490). AIV sternite 0.312-0.336 mm long ($\bar{x}$=0.324); 0.468-0.504 mm wide ($\bar{x}$=0.480). AVII sternite 0.300-0.324 mm long ($\bar{x}$=0.307); 0.528-0.564 mm wide ($\bar{x}$=0.550); maximum width just anterior to posterior border. AIX segment 0.965-1.064 mm long ($\bar{x}$=1.025); 0.619-0.693 mm wide ($\bar{x}$=0.639). Total length 6.25-7.5 mm ($\bar{x}$=7.179).

REMARKS: The cervical sclerite generally has a straight anterior border. Some specimens have the AVII sternite with a portion along the posterior border devoid of mammillae. This species has intermediate sized larvae and is darker in color than most. The head capsule is generally very dark except for lateral patches. Other darker areas include edges of sternites and carinae associated with the coxal cavities, the pronotum and the posterior one-third to one-half of the ninth abdominal segment.

HABITS AND HABITATS: Little is known about the life style of this species although it perhaps is the best known of all the species. It occurs in a variety of substrates from sand to rock. Riffles and pools are inhabitated but the former are preferred. Larvae will descend to an appreciable depth in coarse sediments.

LARVAL REFERENCES: LeSage and Harper, 1976a
LeSage and Harper, 1977a
Seagle, 1978

TYPE LOCALITY: Pennsylvania (Say's type which was lost)
Tennessee, Guthrie (Sanderson's neoholotype)

GEOGRAPHIC RANGE:

Laurentian	Middle States	Maritime	New England
Wisconsin	Kansas	Newfoundland	Maine
Minnesota	Illinois	Middle Atlantic	Massachussetts
Ontario	Indiana	New York	Connecticutt
Quebec	Southwest	Pennsylvania	Southeast
	Oklahoma	Maryland	Mississippi
	Texas	D. of Col.	Alabama
		Virginia	Tennessee

MATERIAL EXAMINED:

7 specimens
Alabama: Cullman Co.
Creek near Trimble
14 VIII/1976
H. P. Brown, leg.

Mature Larva of Stenelmis exigua Sanderson 1938

Stenelmis exigua Sanderson, 1938, p. 669.

DIAGNOSTIC DESCRIPTION: Frons 0.276-0.324 mm long ($\bar{x}$=0.307); 0.312-0.336 mm wide ($\bar{x}$=0.322); central piligerous tubercles separated by more than their own length and faintly outlined. Labrum 0.192-0.204 mm long ($\bar{x}$=0.198). Labium 0.252-0.276 mm long ($\bar{x}$=0.264); 0.144-0.156 mm wide ($\bar{x}$=0.154). Posterior third of hypostomal margin distinct. Gula 0.216-0.252 mm wide ($\bar{x}$=0.234). Cervical sclerite 0.036-0.060 mm long ($\bar{x}$=0.042); 0.108-0.156 mm wide ($\bar{x}$=0.132). Pronotum 0.644-0.718 mm long ($\bar{x}$=0.689). Prosternum 0.204-0.228 mm long ($\bar{x}$=0.220); 0.216-0.240 mm wide ($\bar{x}$=0.228); 11-17 piligerous tubercles present ($\bar{x}$=14.000). Proleg with 10-13 spines on tibia ($\bar{x}$=11.667). Mesosternum 0.288-0.300 mm long ($\bar{x}$=0.298); 0.504-0.552 mm wide ($\bar{x}$=0.534); piligerous tubercles normal in shape; spine normal; coxal margins lateral to spine curved. Metasternum 0.348-0.372 mm long ($\bar{x}$=0.360); 0.564-0.600 mm wide ($\bar{x}$=0.582); piligerous

tubercles normal in shape; spine normal; coxal margins lateral to spine curved. Metepisterna each with 4-7 piligerous tubercles ($\bar{x}$=5.500). Tarsungulus normal in shape. Abdominal pleurites with piligerous tubercles in the following ranges: AI--12-22 ($\bar{x}$=19.583); AII--18-25 ($\bar{x}$=22.167); AVI--14-20 ($\bar{x}$=17.667); AVII--5-8 ($\bar{x}$=6.500). Abdominal sternites with faintly outlined piligerous tubercles, numerous mammillae and normal posterior borders. AI sternite 0.264-0.300 mm long ($\bar{x}$=0.290); 0.444-0.504 mm wide ($\bar{x}$=0.478). AII sternite 0.276-0.300 mm long ($\bar{x}$=0.298); 0.456-0.504 mm wide ($\bar{x}$=0.478). AIV sternite 0.288-0.324 mm long ($\bar{x}$=0.312); 0.444-0.480 mm wide ($\bar{x}$=0.466). AVII sternite 0.276-0.300 mm long ($\bar{x}$=0.296); 0.504-0.600 mm long ($\bar{x}$=0.542); maximum width at posterior border. AIX segment 0.965-1.015 mm long ($\bar{x}$=1.007); 0.569-0.618 mm wide ($\bar{x}$=0.586). Total length 6.5-7.25 mm ($\bar{x}$=6.875).

REMARKS: The cervical sclerite has a straight anterior border. Piligerous tubercles are faintly outlined on many parts of the body. This species is one of the smallest of the intermediate-sized group of larvae. It is relatively pale in color, but darker pigmentation occurs on the head capsule, except for lateral spots, on the mandibles, around the coxal cavities and on the posterior third of the ninth abdominal segment including the operculum.

HABITS AND HABITATS: Larvae are detritivores primarily but also utilize attached algae. They have been kept in the laboratory using sycamore bark as a food. Feeding ceases with water temperatures below 5° C.

LARVAL REFERENCES: Farmer, 1978

TYPE LOCALITY: Arkansas, Polk

GEOGRAPHIC RANGE:

Southwest	Middle States	Southeast
Oklahoma	Missouri	Arkansas
	Kentucky	

MATERIAL EXAMINED:

6 specimens
Oklahoma: McCurtain Co.
Glover River
12/VII/1973
H. P. Brown, leg.

Mature Larva of Stenelmis gammoni White and Brown 1978

Stenelmis gammoni White and Brown, 1978, p. 189.

DIAGNOSTIC DESCRIPTION: Frons 0.300-0.312 mm long ($\bar{x}$=0.306); 0.300 mm wide ($\bar{x}$=0.300); central piligerous tubercles very faintly outlined and widely separated. Labrum 0.180 mm wide ($\bar{x}$=0.180). Labium 0.252-0.264 mm long ($\bar{x}$=0.258); 0.120-0.132 mm wide ($\bar{x}$=0.126). Posterior third of hypostomal margin distinct. Gula 0.204 mm wide ($\bar{x}$=0.204). Cervical sclerite 0.048 mm long ($\bar{x}$=0.048); 0.120 mm wide ($\bar{x}$=0.120). Pronotum 0.594-0.668 mm long ($\bar{x}$=0.631). Prosternum 0.144 mm long ($\bar{x}$=0.144); 0.168-0.180 mm wide ($\bar{x}$=0.174); 4 piligerous tubercles present ($\bar{x}$=4.000). Proleg with 9-11 spines on tibia ($\bar{x}$=9.750). Mesosternum 0.240 mm long ($\bar{x}$=0.240); 0.444 mm wide ($\bar{x}$=0.444); piligerous tubercles faintly outlined; spine normal in shape and preceded by a short unornamented area; coxal margins lateral to spine curved. Metasternum 0.288-0.300 mm long ($\bar{x}$=0.294); 0.480-0.540 mm wide ($\bar{x}$=0.510); piligerous tubercles faintly outlined; spine normal in shape and preceded by a short unornamented area; coxal margins lateral to spine surved. Metepisterna each with 2-3 piligerous tubercles ($\bar{x}$=2.250). Tarsungulus normal in shape. Abdominal

pleurites with piligerous tubercles in the following ranges: AI--6-10 ($\bar{x}$=7.750); AII--7-11 ($\bar{x}$=9.000); AVI--7-9 ($\bar{x}$=8.500); AVII--3-4 ($\bar{x}$=3.250). Abdominal sternites with faintly outlined piligerous tubercles, few mammillae and indistinct posterior borders. AI sternite 0.216 mm long ($\bar{x}$=0.216); 0.408-0.420 mm wide ($\bar{x}$=0.414). AII sternite 0.204-0.216 mm long ($\bar{x}$=0.210); 0.420 mm wide ($\bar{x}$=0.420). AIV sternite 0.216-0.228 mm long ($\bar{x}$=0.222); 0.408 mm wide ($\bar{x}$=0.408). AVII sternite 0.204 mm long ($\bar{x}$=0.204); 0.408-0.468 mm wide ($\bar{x}$=0.438); maximum width at posterior border. AIX segment 0.767 mm long ($\bar{x}$=0.767); 0.520 mm wide ($\bar{x}$=0.520). Total length 4.75-4.8 mm ($\bar{x}$=4.776).

REMARKS: The two characteristics that distinguish this species most are its small size and the faint piligerous tubercles. As noted for the adult, this is one of the smallest Stenelmis known. On most sclerites, the position of the piligerous tubercles is evidenced only by a V-shaped depression in which a seta inserts. The cervical sclerite has a slight swelling on the middle of the anterior border. Unmounted larvae have darker pigmentation in the following areas: head capsule except for lateral triangular areas from the antennal base to the rear of the lateral margin of the capsule, coxal margins and the end of the ninth abdominal segment.

This species is most closely related to S. parva, the two forming a small cluster of their own far removed from the other species (Fig. 13-15).

HABITS AND HABITATS: Unknown

LARVAL REFERENCES: None

LARVAL REFERENCES: None

TYPE LOCALITY: North Carolina: Ashe Co., 3.7 km se of Jefferson, New River

GEOGRAPHIC RANGE:

Southeast
North Carolina

MATERIAL EXAMINED:

2 specimens
North Carolina: Ashe Co.
New River
12/V.1972
E. F. Benfield, leg.

Mature Larva of Stenelmis grossa Sanderson 1938

Stenelmis grossa Sanderson, 1938, p. 686.

DIAGNOSTIC DESCRIPTION: Frons 0.336-0.420 mm long ($\bar{x}$=0.372); 0.324-0.360 mm wide ($\bar{x}$=0.346); central piligerous tubercles normal in shape and separated by less than their own length. Labrum 0.204-0.228 mm wide ($\bar{x}$=0.220). Labium 0.288-0.312 mm long ($\bar{x}$=0.305); 0.144-0.168 mm wide ($\bar{x}$=0.159). Posterior third of hypostomal margin distinct. Gula 0.252-0.276 mm wide ($\bar{x}$=0.266). Cervical sclerite 0.060-0.072 mm long ($\bar{x}$=0.066); 0.180-0.192 mm wide ($\bar{x}$=0.183). Pronotum 0.792-0.842 mm long ($\bar{x}$=0.813). Prosternum 0.240-0.252 mm long ($\bar{x}$=0.246); 0.240-0.264 mm wide ($\bar{x}$=0.250); 15-21 piligerous tubercles present ($\bar{x}$=18.167). Proleg with 10-12 spines on tibia ($\bar{x}$=11.300). Mesosternum 0.324-0.348 mm long ($\bar{x}$=0.340); 0.564-0.612 mm wide ($\bar{x}$=0.584); piligerous tubercles normal in shape; spine reinforced; coxal margins lateral to spine curved. Metasternum 0.396-0.420 mm long ($\bar{x}$=0.414); 0.612-0.660 mm wide ($\bar{x}$=0.642); piligerous tubercles normal in shape; spine reinforced; coxal margins lateral to spine curved. Metepisterna each with 4-11 piligerous

tubercles ($\bar{x}$=8.167). Tarsungulus normal in shape. Abdominal pleurites with piligerous tubercles in the following ranges: AI--16-28 ($\bar{x}$=23.000); AII--24-35 ($\bar{x}$=29.083); AVI--16-25 ($\bar{x}$=20.000); AVII--5-9 ($\bar{x}$=6.917). Abdominal sternites with normal piligerous tubercles, few mammillae and spiny borders. AI sternite 0.336-0.348 mm long ($\bar{x}$=0.338); 0.564-0.576 mm wide ($\bar{x}$=0.572). AII sternite 0.324-0.336 mm long ($\bar{x}$=0.334); 0.552-0.588 mm wide ($\bar{x}$=0.570). AIV sternite 0.336-0.360 mm long ($\bar{x}$=0.348); 0.528-0.564 mm wide ($\bar{x}$=0.550). AVII sternite 0.312-0.336 mm long ($\bar{x}$=0.322); 0.576-0.612 mm wide ($\bar{x}$=0.605); maximum width at posterior border. AIX segment 1.089-1.188 mm long ($\bar{x}$=1.139); 0.569-0.644 mm wide ($\bar{x}$=0.598). Total length 6.5-8.75 mm ($\bar{x}$=7.550).

REMARKS: This species is one of the largest of the species studied. It also has the greatest range in total length. The piligerous tubercles are larger, denser and more pigmented than in most species. The cervical sclerite has a bisinuate anterior border. The apex of the ninth abdominal segment, between the spines, is generally transversely truncate rather than rounded. Darker pigmentation of the head is similar to that mentioned for other species but it also includes a broad, elongate spot in the basal half of the labium.

HABITS AND HABITATS: Larvae occur chiefly on waterlogged wood in sandy-bottomed streams.

LARVAL REFERENCES: None

TYPE LOCALITY: Mississippi, Ireland

GEOGRAPHIC RANGE:

Southwest	Southeast
Oklahoma	Arkansas
Texas	Louisiana
	Mississippi

MATERIAL EXAMINED:

7 specimens
Texas: San Jacinto Co.
Cold Spring
26/III/1965
H. P. Brown, leg.

Mature Larva of Stenelmis mera Sanderson 1938

Stenelmis mera Sanderson, 1938, p. 682.

DIAGNOSTIC DESCRIPTION: Frons 0.276-0.360 mm long ($\bar{x}$=0.309); 0.288-0.372 mm wide ($\bar{x}$=0.372); central piligerous tubercles rounded to elongate and separated by less than their own length. Labrum 0.168-0.228 mm wide ($\bar{x}$=0.183). Labium 0.216-0.288 mm long ($\bar{x}$=0.240); 0.132-0.168 mm wide ($\bar{x}$=0.137). Posterior third of hypostomal margin distinct. Gula 0.228-0.264 mm wide ($\bar{x}$=0.255). Cervical sclerite 0.048-0.060 mm long ($\bar{x}$=0.051); 0.132-0.180 mm wide ($\bar{x}$=0.147). Pronotum 0.594-0.743 mm long ($\bar{x}$=0.663). Prosternum 0.204-0.240 mm long ($\bar{x}$=0.212); 0.192-0.240 mm wide ($\bar{x}$=0.211); 11-18 piligerous tubercles present ($\bar{x}$=14.889). Proleg with 6-13 spines on tibia ($\bar{x}$=10.600). Mesosternum 0.264-0.324 mm long ($\bar{x}$=0.288); 0.492-0.600 mm wide ($\bar{x}$=0.515); piligerous tubercles normal in shape; spine normal; coxal margins lateral to spine curved. Metasternum 0.336-0.420 mm long ($\bar{x}$=0.364); 0.528-0.648 mm wide ($\bar{x}$=0.565); piligerous tubercles normal; coxal margins lateral to spine curved. Metepisterna each with 5-10 piligerous tubercles ($\bar{x}$=7.450). Tarsungulus normal in shape.

Abdominal pleurites with piligerous tubercles in the following ranges: AI--16-25 ($\bar{x}$=20.000); AII--18-31 ($\bar{x}$=24.000); AVI--14-22 ($\bar{x}$=18.150); AVII--4-8 ($\bar{x}$=5.650). Abdominal sternites with normal piligerous tubercles, numerous mammillae and faint posterior borders. AI sternite 0.264-0.348 mm long ($\bar{x}$=0.293); 0.444-0.540 mm wide ($\bar{x}$=0.473). AII sternite 0.252-0.336 mm long ($\bar{x}$=0.284); 0.444-0.540 mm wide ($\bar{x}$=0.477). AIV sternite 0.276-0.348 mm long ($\bar{x}$=0.302); 0.432-0.528 mm wide ($\bar{x}$=0.467). AVII sternite 0.240-0.312 mm long ($\bar{x}$=0.268); 0.492-0.600 mm wide ($\bar{x}$=0.520); maximum width at posterior border. AIX segment 0.817-1.213 mm long ($\bar{x}$=0.976); 0.495-0.644 mm wide ($\bar{x}$=0.525). Total length 4.3-6.5 mm ($\bar{x}$=4.944).

REMARKS: This is one of the smallest larvae. In size and ornamentation it is similar to S. parva, from which it can be distinguished most readily by the greater number of prosternal piligerous tubercles (approx. 2X as many). Darker pigmentation of the head involves a dorsal circular spot occupying approximately three-fourths of the dorsal surface, the ventral portions of the genae (which are a little darker than the other areas) and the gula. The labium may have a small dark circular spot basally. The last third to half of the ninth abdominal segment is also darkly pigmented, especially on the dorsal and lateral margins and around the operculum. The ninth segment is more triangular in cross section, often having definite dorsal and ventro-lateral carinae.

HABITS AND HABITATS: Among rocks and gravel of stream substrates.

LARVAL REFERENCES: None

TYPE LOCALITY: Tennessee, Guthrie

GEOGRAPHIC RANGE:

Laurentian	Middle Atlantic	Southeast
Quebec	New York	Arkansas
New England	Pennsylvania	Tennessee
Massachusetts	West Virginia	North Carolina
	Virginia	

MATERIAL EXAMINED:

10 specimens
Virginia: Warren Co.
Front Royal
22/IV/1978
South Fork of the Shenandoah River
H. H. Seagle, leg.

Mature Larva of Stenelmis parva Sanderson 1938

Stenelmis parva Sanderson, 1938, p. 688.

DIAGNOSTIC DESCRIPTION: Frons 0.264-0.300 mm long ($\bar{x}$=0.274); 0.264-0.288 mm wide ($\bar{x}$=0.281); central piligerous tubercles rounded and separated by less than their own length. Labrum 0.168-0.180 mm wide ($\bar{x}$=0.175). Labium 0.216-0.252 mm long ($\bar{x}$=0.236); 0.120-0.132 mm wide ($\bar{x}$=0.129). Posterior third of hypostomal margin distinct. Gula 0.192-0.216 mm wide ($\bar{x}$=0.205). Cervical sclerite 0.048 mm long ($\bar{x}$=0.048); 0.108-0.132 mm wide ($\bar{x}$=0.123). Pronotum 0.594-0.619 mm long ($\bar{x}$=0.598). Prosternum 0.132-0.156 mm long ($\bar{x}$=0.144); 0.180-0.204 mm wide ($\bar{x}$=0.199); 6-8 piligerous tubercles present ($\bar{x}$=6.429). Proleg with 7-12 spines on tibia ($\bar{x}$=9.714). Mesosternum 0.228-0.240 mm long ($\bar{x}$=0.237); 0.456-0.498 mm wide ($\bar{x}$=0.471); piligerous tubercles normal in shape; spine normal and preceded by a short unornamented area; coxal margins lateral to spine straight. Metasternum 0.276-0.288 mm long ($\bar{x}$=0.281); 0.492-0.516 mm wide ($\bar{x}$=0.506); piligerous tubercles normal in shape; spine normal and preceded

by a short unornamented area; coxal margins lateral to spine straight. Metepisterna each with 3-5 piligerous tubercles ($\bar{x}$=4.143). Tarsungulus normal in shape. Abdominal pleurites with piligerous tubercles in the following ranges: AI--7-12 ($\bar{x}$=8.788); AII--9-15 ($\bar{x}$=12.500); AVI--8-11 ($\bar{x}$=10.071); AVII--2-5 ($\bar{x}$=3.357). Abdominal sternites with normal piligerous tubercles, few mammillae and faint to normal posterior borders. AI sternite 0.216-0.228 mm long ($\bar{x}$=0.218); 0.384-0.408 mm wide ($\bar{x}$=0.399). AII sternite 0.204-0.228 mm long ($\bar{x}$=0.214); 0.408-0.420 mm wide ($\bar{x}$=0.415). AIV sternite 0.216-0.240 mm long ($\bar{x}$=0.225); 0.384-0.420 mm wide ($\bar{x}$=0.398). AVII sternite 0.204-0.228 mm long ($\bar{x}$=0.211); 0.408-0.432 mm wide ($\bar{x}$=0.420); maximum width at posterior border. AIX segment 0.767-0.842 mm long ($\bar{x}$=0.813); 0.396-0.470 mm wide ($\bar{x}$=0.421). Total length 4.5-5.75 mm ($\bar{x}$=5.208).

REMARKS: Of the three shortest species, S. parva can be distinguished from S. mera as mentioned in the remarks under S. mera and from S. gammoni by the presence of distinct, rounded piligerous tubercles rather than faint ones. The anterior border of the cervical sclerite is straight. The legs have a more robust appearance than in most species. The prosternum is obviously more transverse compared to all other species. Darker areas of pigmentation are on the head capsule, the mandibles, coxal cavity margins and most of the ninth abdomnial segment. However, the darker areas are not as dark relative to most of the body as in other species.

Stenelmis parva is closely related to S. gammoni and distantly to S. mera (Fig. 14).

HABITS AND HABITATS: On submerged wood.

LARVAL REFERENCES: None

TYPE LOCALITY: Oklahoma, Latimer Co.

GEOGRAPHIC RANGE:

Southwest
Oklahoma
Texas

MATERIAL EXAMINED:

7 specimens
Oklahoma: Mccurtain Co.
Hochatown
7/VII/1962
H. P. Brown, leg.

Mature Larva of Stenelmis sandersoni Musgrave 1940

Stenelmis tarsalis Sanderson, 1938, p. 675.
Stenelmis sandersoni Musgrave, 1940, p. 48.

DIAGNOSTIC DESCRIPTION: Frons 0.372-0.408 mm long ($\bar{x}$=0.392); 0.384-0.396 mm wide ($\bar{x}$=0.388); central piligerous tubercles generally separated by more than their own length, rounded and faintly outlined. Labrum 0.168-0.180 mm wide ($\bar{x}$=0.174). Labium 0.300-0.324 mm long ($\bar{x}$=0.312); 0.216 mm wide ($\bar{x}$=0.216). Posterior third of hypostomal margin distinct. Gula 0.288-0.300 mm wide ($\bar{x}$=0.291). Cervical sclerite 0.048 mm long ($\bar{x}$=0.048); 0.180 mm wide ($\bar{x}$=0.180). Pronotum 0.842-0.866 mm long ($\bar{x}$=0.850). Prosternum 0.264-0.288 mm long ($\bar{x}$=0.276); 0.240-0.252 mm wide ($\bar{x}$=0.244); 12-15 piligerous tubercles present ($\bar{x}$=13.333). Proleg with 10-14 spines on tibia ($\bar{x}$=12.500). Mesosternum 0.384-0.408 mm long ($\bar{x}$=0.396); 0.624-0.648 mm wide ($\bar{x}$=0.636); piligerous tubercles normal; spine faintly reinforced; coxal margins lateral to spine curved. Metasternum 0.468-0.480 mm long ($\bar{x}$=0.472); 0.684-0.708 mm wide ($\bar{x}$=0.692);

piligerous tubercles normal; spine faintly reinforced; coxal margins lateral to spine curved. Metepisterna each with 6-10 piligerous tubercles ($\bar{x}$=7.667). Tarsungulus slender. Abdominal pleurites with piligerous tubercles in the following ranges: AI--15-25 ($\bar{x}$=18.333); AII--16-21 ($\bar{x}$=18.833); AVI--13-15 ($\bar{x}$=14.333); AVII--3-6 ($\bar{x}$=4.500). Abdominal sternites with normal piligerous tubercles, numerous mammillae and normal posterior borders. AI sternite 0.336-0.348 mm long ($\bar{x}$=0.340); 0.576 mm wide ($\bar{x}$=0.576). AII sternite 0.336 mm long ($\bar{x}$=0.336); 0.576-0.588 mm wide ($\bar{x}$=0.580). AIV sternite 0.348-0.362 mm long ($\bar{x}$=0.353); 0.564-0.588 mm wide ($\bar{x}$=0.572). AVII sternite 0.288-0.312 mm long ($\bar{x}$=0.300); 0.648-0.672 mm wide ($\bar{x}$=0.656); maximum width at posterior border. AIX segment 1.040-1.114 mm long ($\bar{x}$=1.081); 0.668-0.718 mm wide ($\bar{x}$=0.685). Total length 5.94-6.04 mm ($\bar{x}$=6.007).

REMARKS: Although not the largest species in total length, this species most often had the largest measurements of various sclerites. However, total lengths were taken from dissected specimens so they may include an unintentional, conservative bias. With the large size and heavy ornamentation, S. sandersoni presents a rather robust appearance, such as in S. grossa or S. new species C. There is much variation in the shape of the anterior border of the cervical sclerite. Areas of darker pigmentation include the head capsule excluding triangular lateral patches, the legs, carinae and lateral edges of thoracic sternae and the first abdominal sternum, the coxal cavity margins and much of the ninth abdominal segment.

Stenelmis sandersoni, while being one of the larger species, differs enough from the rest of the larvae to occupy its own cluster (Figs. 13 and 14).

HABITS AND HABITATS: Found on rocks or gravel in riffles.

LARVAL REFERENCES: None

TYPE LOCALITY: Virginia, Winchester

GEOGRAPHIC RANGE:

Laurentian	Southwest	Southeast
Ontario	Oklahoma	Arkansas
Middle States	Middle Atlantic	Tennessee
Indiana	West Virginia	North Carolina
	Virginia	

MATERIAL EXAMINED:

3 specimens
North Carolina: Ashe Co.
New River
1/VI/1972
E. F. Benfield, leg.

Mature Larva of Stenelmis sexlineata Sanderson 1938

Stenelmis sexlineata Sanderson, 1938, p. 663.

DIAGNOSTIC DESCRIPTION: Frons 0.288-0.384 mm long ($\bar{x}$=0.342); 0.336-0.372 mm wide ($\bar{x}$=0.360); central piligerous tubercles elongate and separated by less than their own width. Labrum 0.204-0.216 mm wide ($\bar{x}$=0.213). Labium 0.288-0.312 mm long ($\bar{x}$=0.300); 0.156-0.168 mm wide ($\bar{x}$=0.162). Posterior third of hypostomal margin distinct. Gula 0.240-0.264 mm wide ($\bar{x}$=0.261). Cervical sclerite 0.060 mm long ($\bar{x}$=0.060); 0.168-0.192 mm wide ($\bar{x}$=0.177). Pronotum 0.594-0.842 mm long ($\bar{x}$=0.724). Prosternum 0.204-0.252 mm long ($\bar{x}$=0.228); 0.192-0.252 mm wide ($\bar{x}$=0.231); 7-12 piligerous tubercles present ($\bar{x}$=9.500). Proleg with 11-13 spines on tibia ($\bar{x}$=12.125). Mesosternum 0.276-0.336 mm long ($\bar{x}$=0.309); 0.564-0.600 mm wide ($\bar{x}$=0.576); piligerous tubercles normal; spine reinforced; coxal margins lateral to spine curved. Metasternum 0.348-0.396 mm long

($\bar{x}$=0.372); 0.600-0.684 mm wide ($\bar{x}$=0.633); piligerous tubercles normal; spine reinforced; coxal margins lateral to spine curved. Metepisterna each with 4-9 piligerous tubercles ($\bar{x}$=6.000). Tarsungulus normal in shape. Abdominal pleurites with piligerous tubercles in the following ranges: AI--16-27 ($\bar{x}$=22.625); AII--24-35 ($\bar{x}$=29.000); AVI--15-26 ($\bar{x}$=21.250); AVII--4-8 ($\bar{x}$=6.500). Abdominal sternites with normal piligerous tubercles, few mammillae and normal posterior borders. AI sternite 0.276-0.312 mm long ($\bar{x}$=0.297); 0.492-0.564 mm wide ($\bar{x}$=0.531). AII sternite 0.252-0.312 mm long ($\bar{x}$=0.291); 0.480-0.576 mm wide ($\bar{x}$=0.525). AIV sternite 0.264-0.324 mm long ($\bar{x}$=0.303); 0.468-0.552 mm wide ($\bar{x}$=0.513). AVII sternite 0.252-0.312 mm long ($\bar{x}$=0.288); 0.540-0.648 mm wide ($\bar{x}$=0.591); maximum width at posterior border. AIX segment 1.040-1.089 mm long ($\bar{x}$=1.064); 0.644-0.743 mm wide ($\bar{x}$=0.687). Total length 5.5-7.0 mm ($\bar{x}$=6.250).

REMARKS: The anterior margin of the cervical sclerite is bisinuate to broadly U-shaped. The legs are relatively robust. Its total length puts this species in the group of intermediate-sized larvae. Areas of darker pigmentation include the head capsule except for lateral patches, the mandibles and carinae on the meso-, meta, and first abdominal sternum.

HABITS AND HABITATS: Early instars magrate to sand where they bury themselves down to the last segments. Later instars migrate to rocks where they prefer the downstream face and crevices. Larvae move to objects near the water's edge prior to pupation.

LARVAL REFERENCES: White, 1978

TYPE LOCALITY: Kansas, Lawrence

GEOGRAPHIC RANGE:

Middle States	Southwest
Kansas	Oklahoma
Indiana	Texas
Ohio	Southeast
Kentucky	Tennessee

MATERIAL EXAMINED:

4 specimens
Kentucky: Spencer Co.
Brashears Creek
19/VIII/1970
V. Resh, leg.

Mature Larva of Stenelmis vittipennis Zimmerman 1869

Stenelmis vittipennis Zimmerman, 1869, p. 259.

DIAGNOSTIC DESCRIPTION: Frons 0.312-0.348 mm long ($\bar{x}$=0.330); 0.324-0.360 mm wide ($\bar{x}$=0.342); central piligerous tubercles rounded and separated by more than their own length. Labrum 0.204-0.228 mm wide ($\bar{x}$=0.216). Labium 0.252-0.276 mm long ($\bar{x}$=0.264); 0.156 mm wide ($\bar{x}$=0.156). Posterior third of hypostomal margin distinct. Gula 0.240 mm wide ($\bar{x}$=0.240). Cervical sclerite 0.048-0.060 mm long ($\bar{x}$=0.054); 0.144-0.168 mm wide ($\bar{x}$=0.156). Pronotum 0.718 mm long ($\bar{x}$=0.718). Prosternum 0.204-0.216 mm long ($\bar{x}$=0.210); 0.228-0.252 mm wide ($\bar{x}$=0.240); 10-14 piligerous tubercles present ($\bar{x}$=12.000). Proleg with 10-12 spines on tibia ($\bar{x}$=10.750). Mesosternum 0.300-0.336 mm long ($\bar{x}$=0.318); 0.528-0.588 mm wide ($\bar{x}$=0.558); piligerous tubercles normal; spine normal; coxal margins lateral to spine curved. Metasternum 0.360-0.396 mm long ($\bar{x}$=0.378); 0.564-0.624 mm wide ($\bar{x}$=0.594); piligerous tubercles normal; spine normal; coxal margins lateral to spine curved. Metepisterna each with 6-11 piligerous tubercles ($\bar{x}$=8.750). Tarsungulus normal in shape. Abdominal

pleurites with piligerous tubercles in the following ranges: AI--17-26 ($\bar{x}$=21.000); AII--20-31 ($\bar{x}$=25.500); AVI--14-22 ($\bar{x}$=18.750); AVII--4-8 ($\bar{x}$=6.000). Abdominal sternites with normal piligerous tubercles; few mammillae and normal posterior borders. AI sternite 0.300-0.312 mm long ($\bar{x}$=0.306); 0.492-0.516 mm wide ($\bar{x}$=0.504). AII sternite 0.288-0.300 mm long ($\bar{x}$=0.294); 0.504-0.528 mm wide ($\bar{x}$=0.516). AIV sternite 0.312-0.324 mm long ($\bar{x}$=0.318); 0.480-0.516 mm wide ($\bar{x}$=0.498). AVII sternite 0.300-0.312 mm long ($\bar{x}$=0.306); 0.528-0.576 mm wide ($\bar{x}$=0.552); maximum width at posterior border. AIX segment 1.040-1.064 mm long ($\bar{x}$=1.052); 0.594-0.619 mm wide ($\bar{x}$=0.606). Total length 5.5-7.25 mm ($\bar{x}$=6.375).

REMARKS: This species is intermediate in all measurements and counts. It is generally pale in color with dark pigmentation on the tip of the ninth abdominal segment including the operculum, carinae, margins of coxal cavities, head capsule except lateral areas and on the mandibles. The legs are relatively robust. The shape of the prosternum varies from regularly pentagonal to having the two lateral edges almost parallel.

HABITS AND HABITATS: Unknown

LARVAL REFERENCES: None

TYPE LOCALITY: South Carolina

GEOGRAPHIC RANGE:

Prairie	Middle States	Middle Atlantic
North Dakota	Kansas	New Jersey
Laurentian	Illinois	West Virginia
Montana	Indiana	Southeast
Wisconsin	Southwest	South Carolina
Quebec	Oklahoma	
	Texas	

MATERIAL EXAMINED:

2 specimens
Kansas: Ellis Co.
Smoky Hill R.--bridge on Highway 183
16/VI/1976
T. Oldham, leg.

Mature Larva of Stenelmis new species A

DIAGNOSTIC DESCRIPTION: Frons 0.300-0.348 mm long ($\bar{x}$=0.324); 0.336 mm wide ($\bar{x}$=0.336); central piligerous tubercles rounded and separated by less than their own length. Labrum 0.192-0.204 mm wide ($\bar{x}$=0.198). Labium 0.276-0.288 mm long ($\bar{x}$=0.282); 0.144 mm wide ($\bar{x}$=0.144). Posterior third of hypostomal margin distinct. Gula 0.240-0.252 mm wide ($\bar{x}$=0.246). Cervical sclerite 0.048-0.060 mm long ($\bar{x}$=0.054); 0.144-0.156 mm wide ($\bar{x}$=0.150). Pronotum 0.693 mm long ($\bar{x}$=0.693). Prosternum 0.204 mm long ($\bar{x}$=0.204); 0.216-0.228 mm wide ($\bar{x}$=0.222); 11-12 piligerous tubercles present ($\bar{x}$=11.500). Proleg with 10-11 spines on tibia ($\bar{x}$=10.750). Mesosternum 0.288-0.312 mm long ($\bar{x}$=0.300); 0.516-0.540 mm wide ($\bar{x}$=0.528); piligerous tubercles normal in shape; spine preceded by a short unornamented area; coxal margins lateral to spine curved. Metasternum 0.360-0.372 mm long ($\bar{x}$=0.366); 0.552-0.576 mm wide ($\bar{x}$=0.564); piligerous tubercles normal; spine preceded by a short unornamented area; coxal margins lateral to spine curved. Metepisterna each with 4-6 piligerous tubercles ($\bar{x}$=5.000). Tarsungulus normal in shape. Abdominal pleurites with piligerous tubercles in the following ranges: AI--10-13 ($\bar{x}$=11.250); AII--17-18 ($\bar{x}$=17.750); AVI--13-15 ($\bar{x}$=14.000); AVII--5-6 ($\bar{x}$=5.250). Abdominal sternites with normal piligerous tubercles, numerous mammillae and normal posterior borders. AI sternite 0.288 mm long ($\bar{x}$=0.288);

0.504 mm wide ($\bar{x}$=0.504). AII sternite 0.288-0.300 mm long ($\bar{x}$=0.294); 0.492-0.504 mm wide ($\bar{x}$=0.498). AIV sternite 0.312 mm long ($\bar{x}$=0.312); 0.480 mm wide ($\bar{x}$=0.480). AVII sternite 0.300 mm long ($\bar{x}$=0.300); 0.540-0.552 mm wide ($\bar{x}$=0.546); maximum width at posterior border. AIX segment 1.040-1.089 mm long ($\bar{x}$=1.064); 0.594 mm wide ($\bar{x}$=0.594). Total length 7.0-7.2 mm ($\bar{x}$=7.100).

REMARKS: This species is one of the smallest of the intermediate-sized larvae. Areas of darker pigmentation include the head except for lateral patches, the mandibles, coxal cavity margins and the ninth abdominal segment. The legs are relatively robust. Dr. H. P. Brown will describe this species from adults.

HABITS AND HABITATS: Unknown

LARVAL REFERENCES: None

GEOGRAPHIC RANGE:

Southeast
Louisiana

MATERIAL EXAMINED:

2 specimens
Louisiana: Livingston Parish
Albany
27/VI/1973
Little Natalbany River
B. Stark, leg.

Mature Larva of *Stenelmis* new species B

DIAGNOSTIC DESCRIPTION: Frons 0.348-0.372 mm long ($\bar{x}$=0.356); 0.360-0.372 mm wide ($\bar{x}$=0.369); central piligerous tubercles separated by more than their own length and normal to rounded in shape. Labrum 0.216 mm wide ($\bar{x}$=0.216). Labium 0.288-0.312 mm long ($\bar{x}$=0.300); 0.156-0.180 mm

wide ($\bar{x}$=0.165). Posterior third of hypostomal margin distinct. Gula 0.276 mm wide ($\bar{x}$=0.276). Cervical sclerite 0.048-0.060 mm long ($\bar{x}$=0.057); 0.168-0.180 mm wide ($\bar{x}$=0.176). Pronotum 0.767-0.817 mm long ($\bar{x}$=0.777). Prosternum 0.228-0.240 mm long ($\bar{x}$=0.234); 0.240-0.252 mm wide ($\bar{x}$=0.249); 14-22 piligerous tubercles present ($\bar{x}$=18.000). Proleg with 10-13 spines on tibia ($\bar{x}$=12.000). Mesosternum 0.324-0.336 mm long ($\bar{x}$=0.329); 0.552-0.576 mm wide ($\bar{x}$=0.570); piligerous tubercles normal; spine normal; coxal margins lateral to spine straight. Metasternum 0.384-0.408 mm long ($\bar{x}$=0.394); 0.600-0.636 mm wide ($\bar{x}$=0.627); piligerous tubercles normal; spine normal; coxal margins lateral to spine straight. Metepisterna each with 7-11 piligerous tubercles present ($\bar{x}$=8.300). Tarsungulus slender. Abdominal pleurites with piligerous tubercles present in the following ranges: AI--13-24 ($\bar{x}$=20.200); AII--22-33 ($\bar{x}$=28.100); AVI--19-27 ($\bar{x}$=23.900); AVII--5-9 ($\bar{x}$=6.900). Abdominal sternites with normal piligerous tubercles, numerous mammillae and spiny borders. AI sternite 0.324-0.336 mm long ($\bar{x}$=0.331); 0.540-0.576 mm wide ($\bar{x}$=0.555). AII sternite 0.312-0.336 mm long ($\bar{x}$=0.326); 0.528-0.552 mm wide ($\bar{x}$=0.546). AIV sternite 0.324-0.360 mm long ($\bar{x}$=0.343); 0.516-0.552 mm wide ($\bar{x}$=0.537). AVII sternite 0.300-0.336 mm long ($\bar{x}$=0.318); 0.576-0.624 mm wide ($\bar{x}$=0.603); maximum width just anterior to posterior border. AIX segment 1.188-1.238 mm long ($\bar{x}$=1.207); 0.619-0.693 mm wide ($\bar{x}$=0.656). Total length 6.8-8.25 mm ($\bar{x}$=7.72).

REMARKS: This species is one of the larger forms and exhibits a wide range in total length. Areas of darker pigmentation include the dorsum of the head capsule, the hypostomal margin areas, mandibles and the last third of the ninth abdominal segment excluding the operculum. The

piligerous tubercles on this species tend to be smaller than those of other species. Stenelmis new species C is very closely related to this species. Dr. H. P. Brown will describe this species from adults.

HABITS AND HABITATS: Found on submerged wood in streams with mud bottoms.

LARVAL REFERENCES: None

GEOGRAPHIC RANGE:

Southwest
Oklahoma
Texas

MATERIAL EXAMINED:

5 specimens
Texas
E of Wilmeth
29/V/1969
H. P. Brown, leg.

Mature Larva of Stenelmis new species C

DIAGNOSTIC DESCRIPTION: Frons 0.300-0.372 mm long ($\bar{x}$=0.344); 0.372-0.384 mm wide ($\bar{x}$=0.380); central piligerous tubercles separated by more than their own length and faintly outlined. Labrum 0.216-0.240 mm wide ($\bar{x}$=0.228). Labium 0.300-0.312 mm long ($\bar{x}$=0.306); 0.168-0.180 mm wide ($\bar{x}$=0.176). Posterior third of hypostomal margin distinct. Gula 0.276-0.288 mm wide ($\bar{x}$=0.280). Cervical sclerite 0.060 mm long ($\bar{x}$=0.060); 0.180 mm wide ($\bar{x}$=0.180). Pronotum 0.792-0.842 mm long ($\bar{x}$=0.825). Prosternum 0.228-0.240 mm long ($\bar{x}$=0.236); 0.240-0.264 mm wide ($\bar{x}$=0.252); 14-23 piligerous tubercles present ($\bar{x}$=17.333). Proleg with 13 spines on tibia ($\bar{x}$=13.000). Mesosternum 0.336-0.348 mm long ($\bar{x}$=0.340); 0.564-0.600 mm wide ($\bar{x}$=0.584); piligerous tubercles normal; spine reinforced; coxal

margins lateral to spine curved. Metasternum 0.396-0.420 mm long ($\bar{x}$=0.412); 0.636-0.660 mm wide ($\bar{x}$=0.648); piligerous tubercles normal; spine reinforced; coxal margins lateral to spine curved. Metepisterna each with 6-10 piligerous tubercles ($\bar{x}$=8.800). Tarsungulus slender. Abdominal pleurites with piligerous tubercles present in the following ranges: AI--20-32 ($\bar{x}$=24.333); AII--22-35 ($\bar{x}$=28.000); AVI--19-31 ($\bar{x}$=23.000); AVII--4-8 ($\bar{x}$=6.167). Abdominal sternites with normal piligerous tubercles, few mammillae and spiny borders. AI sternite 0.348 mm long ($\bar{x}$=0.348); 0.540-0.588 mm wide ($\bar{x}$=0.568). AII sternite 0.336-0.348 mm long ($\bar{x}$=0.340); 0.528-0.588 mm wide ($\bar{x}$=0.564). AIV sternite 0.360 mm long ($\bar{x}$=0.360); 0.516-0.564 mm wide ($\bar{x}$=0.544). AVII sternite 0.324-0.372 mm long ($\bar{x}$=0.344); 0.552-0.636 mm wide ($\bar{x}$=0.596); maximum width just anterior to posterior border. AIX segment 1.287-1.312 mm long ($\bar{x}$=1.295); 0.619-0.718 mm wide ($\bar{x}$=0.660). Total length 6.75-7.5 mm ($\bar{x}$=7.125).

REMARKS: This species is one of the largest of the larvae. Darker pigmented areas include the dorsum of the head capsule, the hypostomal margin areas, the mandibles, margins and carinae associated with the coxae and legs and the posterior third of the ninth abdominal segment. The anterior border of the cervical sclerite is straight. The meso- and metasternal spines are more heavily reinforced than in other species. This species is very closely related to the previous one. Dr. H. P. Brown will describe this species from adults.

HABITS AND HABITATS: Found in rocks and gravel.

LARVAL REFERENCES: None

GEOGRAPHIC RANGE:

Mountain
Oregon
Idaho
Utah
Montana

MATERIAL EXAMINED:

3 specimens
Utah: Box Elder Co.
Deep Creek Station 4-C
3/I/1971
D. W. Shaw, leg.

DISCUSSION

Characters

For the numerical analysis, the characters used and their abbreviations are given in Table 3. The means, standard deviations and sample sizes of those characters are given in Table 4. The remaining characters are given in the species descriptions.

A phenogram of the correlation of the characters is given in Fig. 12. Four main groups of characters are seen. They are: (1) most of the measurements and the tibial spine counts (FRSW to SPT1); (2) most of the piligerous tubercle counts and labral width (LBRW to TMTP); (3) the tubercle count on the prosternum (TPRS); and (4) the length of the cervical sclerite (CSL). It was expected that the measurements and the counts might separate from one another. The separation of the tubercle count on the prosternum and the length of the cervical sclerite, however, are puzzling. Perhaps they represent areas with a special function. Clusterings of characters that indicate redundancy are all abdominal lengths, all abdominal sternal widths and all tubercle counts on the abdominal pleurites. It was expected that the mouthpart measurements might cluster together but, as noted, they are somewhat scattered.

While taking measurements and counts, I found that the two generally increased together. Under oil immersion it was seen that each tubercle and seta arose from only one epidermal cell, although not every cell produced a tubercle or seta. Thus it follows that increasing length of a sclerite gives rise to a greater area and potentially more cells to cover the area and therefore potentially more tubercles. An analysis

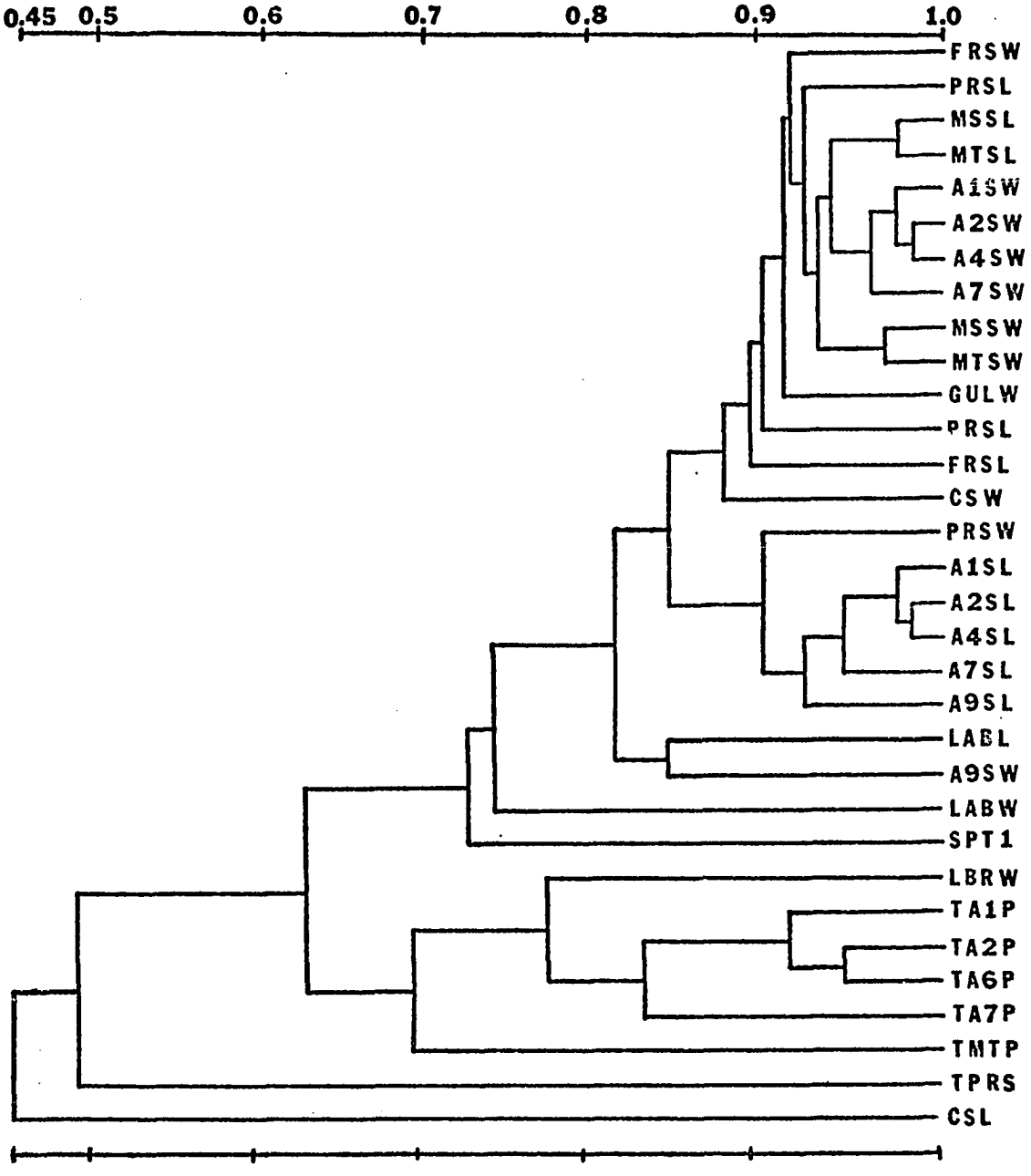
Table 3. Characters used to evaluate the species numerically.

Abbreviation	Definition
FRSL	Length of frons
FRSW	Width of frons
LBRW	Width of labrum
LABL	Length of labium
LABW	Width of labium
GULW	Width of gula
CSL	Length of cervical sclerite
CSW	Width of cervical sclerite
PRNL	Length of pronotum
PRSL	Length of prosternum
PRSW	Width of prosternum
MSSL	Length of mesosternum
MSSW	Width of mesosternum
MTSL	Length of metasternum
MTSW	Width of metasternum
SPT1	Number of spines on the tibia of the proleg
TMTP	Number of tubercles on the metepisterna
A1SL	Length of first abdominal sternite
A1SW	Width of first abdominal sternite
A2SL	Length of second abdominal sternite
A2SW	Width of second abdominal sternite
A4SL	Length of fourth abdominal sternite
A4SW	Width of fourth abdominal sternite
A7SL	Length of seventh abdominal sternite
A7SW	Width of seventh abdominal sternite
A9SL	Length of ninth abdominal segment
A9SW	Width of ninth abdominal segment
TA1P	Number of tubercles on the first abdominal pleurite
TA2P	Number of tubercles on the second abdominal pleurite
TA6P	Number of tubercles on the sixth abdominal pleurite
TA7P	Number of tubercles on the seventh abdominal pleurite
TPRS	Number of tubercles on the prosternum

Table 4. Means and standard deviations for characters used in the numerical analysis (N=14).

Character	Mean value	Standard deviation
FRSL	0.33	0.0297
FRSW	0.341	0.0302
LBRW	0.202	0.0179
LABL	0.280	0.0248
LABW	0.157	0.0229
GULW	0.250	0.0253
CSL	0.0531	0.00614
CSW	0.157	0.0211
PRNL	0.722	0.0751
PRSL	0.215	0.0352
PRSW	0.228	0.0217
MSSL	0.310	0.0402
MSSW	0.547	0.0510
MTSL	0.376	0.0477
MTSW	0.597	0.0544
SPT1	11.30	1.22
TMTP	6.80	2.12
A1SL	0.302	0.0412
A1SW	0.509	0.0547
A2SL	0.510	0.0416
A2SW	0.510	0.0508
A4SL	0.315	0.0436
A4SW	0.496	0.0506
A7SL	0.294	0.0415
A7SW	0.556	0.0639
A9SL	1.05	0.139
A9SW	0.608	0.0757
TA1P	1.81	5.15
TA2P	22.5	6.130
TA6P	17.60	4.447
TA7P	5.82	1.30
TPRS	11.8	5.19

Figure 12. Correlation phenogram of the 32 characters used in the numerical analysis. The cophenetic correlation is 0.851. Clustering was carried out using the unweighted pair-group method using arathmetic averages.


0.45
0.5
0.6
0.7
0.8
0.9
1.0
FRSW
PRSL
MSSL
MTSL
A1SW
A2SW
A4SW
A7SW
MSSW
MTSW
GULW
PRSL
FRSL
CSW
PRSW
A1SL
A2SL
A4SL
A7SL
A9SL
LABL
A9SW
LABW
SPT1
LBRW
TA1P
TA2P
TA6P
TA7P
TMTP
TPRS
CSL

of the pronotal length and counts of tubercles and tibial spines was preformed across all species (Table 5). All counts were significantly correlated with pronotal length except the count of tubercles on the seventh abdominal pleurite. The lack of correlation here may be involved with the greatly reduced tubercle-bearing area. The number of spines on the protibia did not correlate highly with tubercle counts although both correlated significantly with pronotal length. Thus both counts should be used in future studies. A similar comparison was done for the single species S. beameri (Table 6). Although the trends were the same, there was little correlation with the metepisternal tubercle count. Thus there is more variation within the species than among the species.

The principal components analysis used three components to explain 89% of the variation among the species. The contribution of each character to each component is shown by the loadings in Table 7. The characters contributing most to Component I are most of the sclerite measurements and most of the counts of piligerous tubercles. Component II is composed mainly of the labral width, labial width and abdominal pleurite tubercle counts. Component III is composed of the cervical sclerite length and the prosternal tubercle counts. As is often the case, the first component relates to the general size of the species. The other components might relate to feeding methods or food choices.

Phenetic Relationships of the Species

The larvae separate into three main groups of rather unequal size. This is shown in the distance phenogram (Fig. 13 and the model from principal components analysis (Fig. 14).

Table 5. Correlation of means of counts and pronotal lengths for all species. Pearson correlation coefficient / Probability (N=14).

	PRNL	SPT1	TMPT	TA1P	TA2P	TA6P	TA7P
SPT1	0.77 ***						
	0.0012						
TMTP	0.63*	0.52					
	0.0139	0.0547					
TA1P	0.65*	0.57*	0.73***				
	0.0116	0.0332	0.0026				
TA2P	0.57*	0.49	0.71***	0.94***			
	0.0301	0.0730	0.0039	0.0001			
TA6P	0.57*	0.56*	0.74***	0.90***	0.96***		
	0.0321	0.0355	0.0024	0.0001	0.0001		
TA7P	0.43	0.49	0.73***	0.78***	0.85***	0.88***	
	0.1170	0.0690	0.0028	0.0008	0.0001	0.0001	
TPRS	0.71***	0.55*	0.65*	0.76***	0.77***	0.77***	0.64*
	0.0044	0.0405	0.0106	0.0014	0.0012	0.0012	0.0119

*, $P < .05$; **, $P < .01$; ***, $P < .005$.

Table 6. Correlation of means of counts and pronotal lengths for Stenelmis beameri. Pearson correlation coefficient / Probability / Number of observations.

	PRNL	SPT1	TMTP	TA1P	TA2P	TA6P	TA7P
SPT1	0.47 0.0801 15						
TMPT	0.73*** 0.0010 17	0.16 0.5719 15					
TA1P	0.36 0.1614 17	0.15 0.5855 15	0.34 0.1843 17				
TA2P	0.54* 0.0262 17	0.09 0.7406 15	0.38 0.1326 17	0.88*** 0.0001 17			
TA6P	0.49* 0.0460 17	0.31 0.2678 15	0.29 0.2549 17	0.67*** 0.0033 17	0.77*** 0.0003 17		
TA7P	0.09 0.7229 17	-0.07 0.7975 15	0.24 0.3436 17	0.63** 0.0072 17	0.61* 0.0101 17	0.70*** 0.0019 17	
TPRS	0.86*** 0.0001 16	0.68** 0.0076 14	0.62* 0.0107 16	0.53* 0.0361 16	0.54* 0.0295 16	0.48 0.0610 16	0.07 0.8107 16

*, $P < .05$; **, $P < .01$; ***, $P < .005$.

Table 7. Character loadings on the first three components from principal components analysis.

Character	Components I	II	III
FRSL	0.874	-0.321	0.193
FRSW	0.937	-0.219	0.131
LBRW	0.654	0.625	0.217
LABL	0.866	-0.211	0.341
LABW	0.760	-0.529	-0.134
GULW	0.936	-0.161	0.007
CSL	0.539	0.418	0.617
CSW	0.929	0.013	0.278
PRNL	0.924	-0.247	0.112
PRSL	0.925	-0.157	-0.139
PRSW	0.943	0.129	-0.078
MSSL	0.934	-0.311	-0.092
MSSW	0.938	-0.232	-0.013
MTSL	0.940	-0.277	-0.124
MTSW	0.940	-0.251	0.055
SPT1	0.779	-0.178	-0.030
TMTP	0.782	0.247	-0.269
A1SL	0.981	0.067	-0.107
A1SW	0.985	-0.064	0.107
A2SL	0.964	0.060	-0.191
A2SW	0.983	-0.100	0.078
A4SL	0.959	0.074	-0.213
A4SW	0.985	-0.130	0.060
A7SL	0.911	0.249	-0.158
A7SW	0.972	-0.151	0.012
A9SL	0.934	0.213	-0.029
A9SW	0.864	-0.088	0.148
TA1P	0.826	0.364	-0.051
TA2P	0.784	0.548	0.060
TA6P	0.796	0.536	-0.007
TA7P	0.717	0.568	-0.132
TPRS	0.581	0.178	-0.534

The distance phenogram (Fig. 13) separates S. parva and S. gammoni far from the other species and close to each other. Stenelmis sandersoni forms the next apparent group. It is closer, however, to the remaining species than to the first group. The remaining species form a group that contains two distinct subgroupings. The two subgroups are rather compact with S. sexlineata in an intermediate position. The cophenetic correlation is 0.885, indicating a good agreement between this phenogram and the matrix from which it was generated.

The 3-dimensional model from principal components analysis shows groupings similar to the distance phenogram. Component I was a general size factor and split the species into two groups. Stenelmis parva and S. gammoni are the smallest species and are at this extreme of component I. The remaining species are intermediate to large and are spread evenly across that half of this component. Component II is very effecient in separating S. sandersoni from the other larger species. Relative to this component, the S. beameri-S. sexlineata subgroup is very consistent whereas the S. crenata-S. mera subgroup contains more variation. Component III (height in Fig. 14) distinguishes S. mera and S. exigua from the other species in the S. crenata-S. mera subgroup and S. sexlineata from the other species in the S. beameri-S. sexlineata subgroup.

Addition of the remaining species (when discovery of their larvae permits) will perhaps have the greatest effect upon the last two groups. The subdivisions of the third group may then prove to be more apparent than real. Stenelmis sandersoni may also then prove to be not so different from the third group.

Figure 13. Distance phenogram of the larvae of 14 species of Stenelmis based on an unweighted pair-group method of cluster analysis using arithmetic averages for the 32 characters. The cophenetic correlation is 0.885.

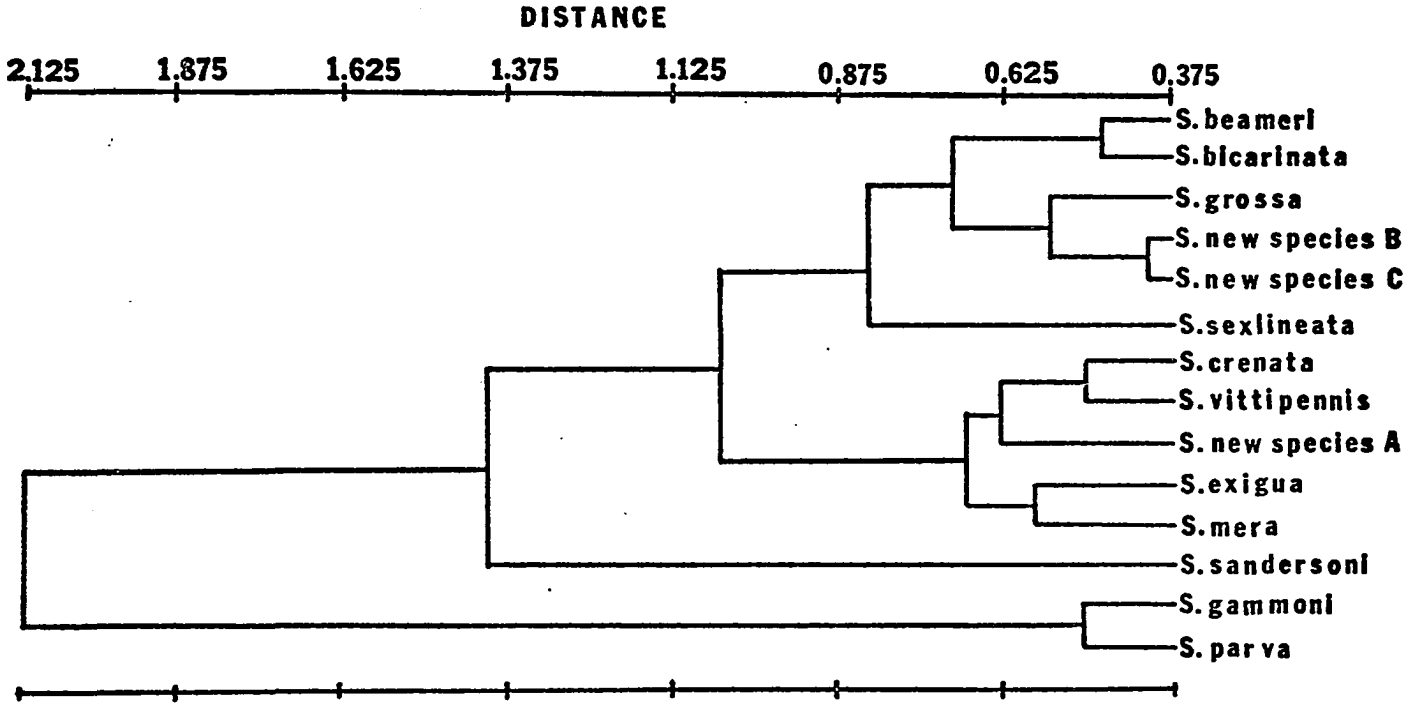
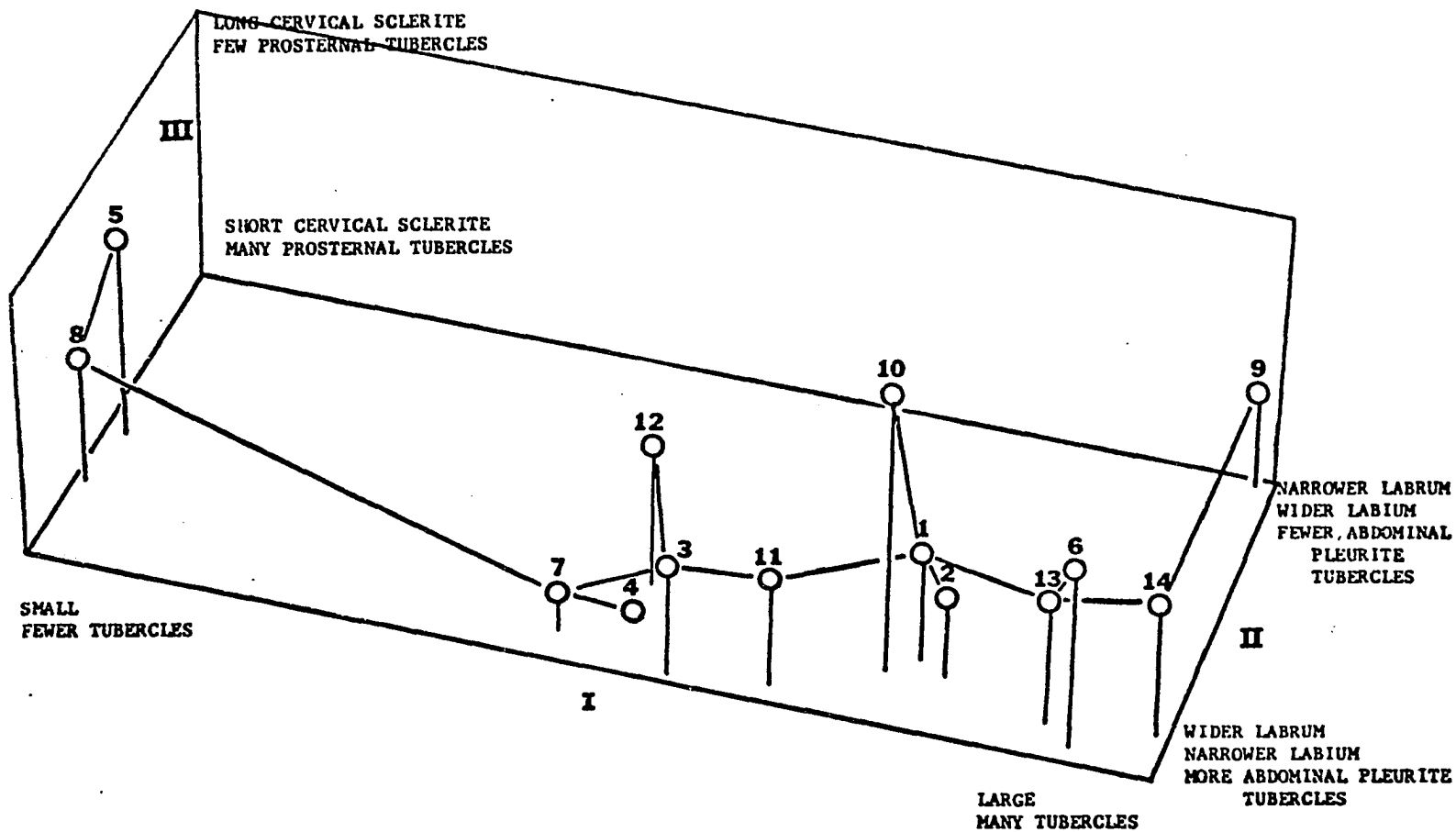

DISTANCE
2.125
1.875
1.625
1.375
1.125
0.875
0.625
0.375
S. beameri
S. bicarinata
S. grossa
S. new species B
S. new species C
S. sexlineata
S. crenata
S. vittipennis
S. new species A
S. exigua
S. mera
S. sandersoni
S. gammoni
S. parva

Figure 14. Three-dimensional projection of the species onto the first three principal components based on a matrix of correlations among characters. Components I and II are indicated and III is the height. A minimum spanning tree is given for the species. The species are: 1-beameri, 2-bicarinata, 3-crenata, 4-exigua, 5-gammoni, 6-grossa, 7-mera, 8-parva, 9-sandersoni, 10-sexlineata, 11-vittipennis, 12-new species A, 13-new species B, 14-new species C.


LONG CERVICAL SCLERITE
FEW PROSTERNAL TUBERCLES
III
SHORT CERVICAL SCLERITE
MANY PROSTERNAL TUBERCLES
5
8
10
9
12
NARROWER LABRUM
WIDER LABIUM
FEWER, ABDOMINAL
PLEURITE
TUBERCLES
7
3
11
1
6
4
2
13
14
SMALL
FEWER TUBERCLES
II
I
WIDER LABRUM
NARROWER LABIUM
MORE ABDOMINAL PLEURITE
TUBERCLES
LARGE
MANY TUBERCLES

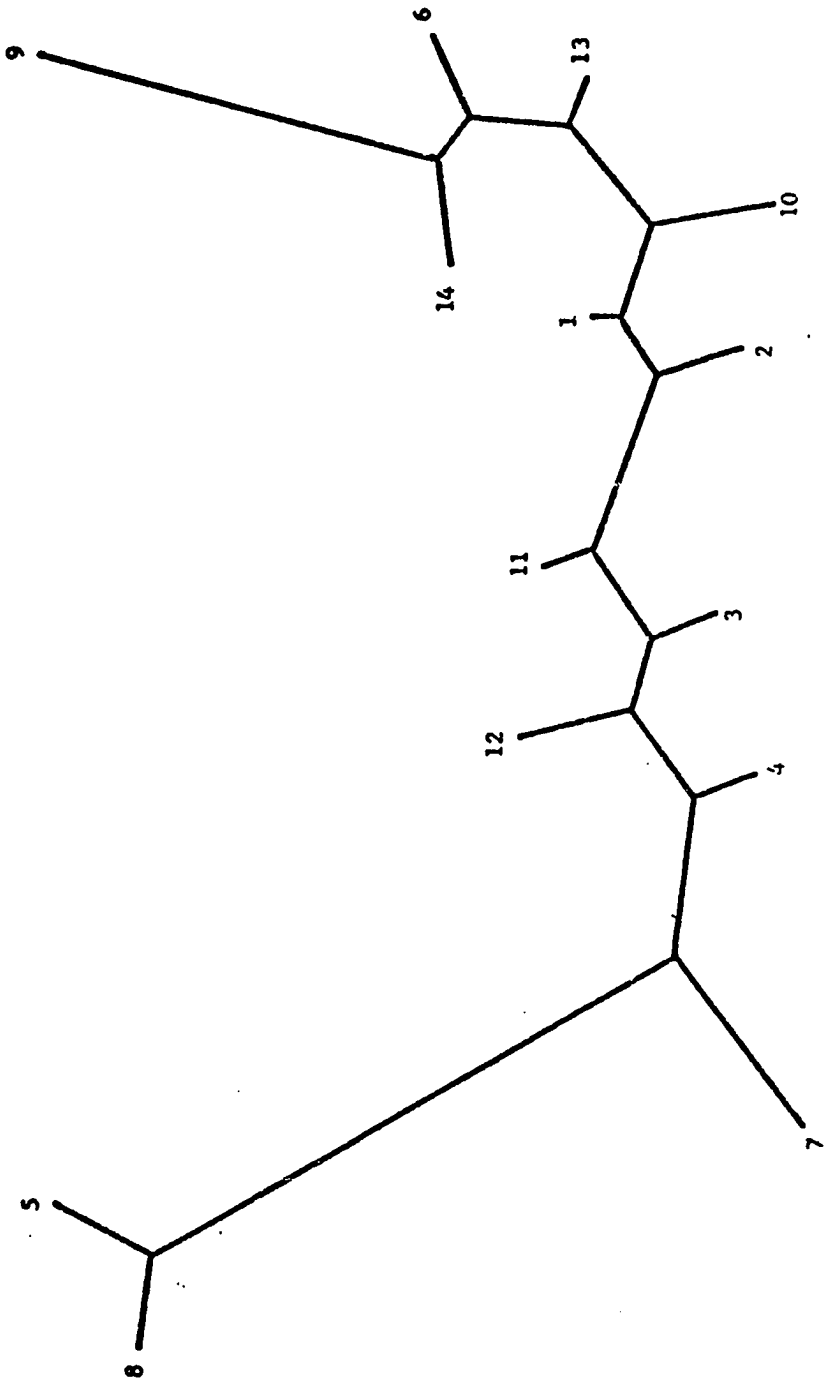
Phylogenetic Relationships of the Species

The relationships and groupings of the larvae are quite different from that indicated by Sanderson (1938) for the adults. This is probably a result of the lack of newer data plus Sanderson employed divisive rather than agglomerative clustering. Merging of data from the larvae with data from adults will undoubtedly lead to a more sound analysis of the genus. This will require some time, however, as not all larvae are known and there are still a number of undescribed species as far as the adults are concerned.

Since only approximately half of the known species are included in this study, speculation on their phylogeny is very tenative, but certain aspects of it can reasonably be discussed. Stenelmis parva and S. gammoni are so similar and yet so distinct from the rest that they probably represent a lineage of their own. The other species are so closely clustered (even S. sandersoni) as to make separation of lineages presently difficult. Figure 15, a Wagner network, indicates the relationships of the larvae as presently known. As with the phenetic analysis, three main clusters are evident.

Because of intergrading adult characters, investigators have suggested that S. exigua is synonymous with S. beameri and S. mera is synonymous with S. bicarinata (H. P. Brown pers. comm.). My analysis does not support this hypothesis. Quite to the contrary, S. bicarinata is closely related to S. beameri and S. exigua is closely related to S. mera. The association of S. grossa with S. vittipennis on the basis of aedeagal structure is also unsupported but the close association of S. vittipennis with S. crenata is supported. The principal components analysis also

Figure 15. Wagner network illustrating the relatedness of the larvae of 14 species of Stenelmis. Stem length indicates distance to a common ancestor. The species are: 1-beameri, 2-bicarinata, 3-crenata, 4-exigua, 5-gammoni, 6-grossa, 7-mera, 8-parva, 9-sandersoni, 10-sexlineata, 11-vittipennis, 12-new species A, 13-new species B, 14-new species C.


9
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8

indicates that S. new species B and S. new species C are very closely related and associated with S. grossa.

It appears that the area in which speciation has been most intense is the Ozark Mountain region east to the southern end of the Appalachian Mountain region. This may be a result of the partial isolation of river systems in this area by a rise in sea level during the Tertiary period (see maps in Thornbury 1965 and Eardly 1965).

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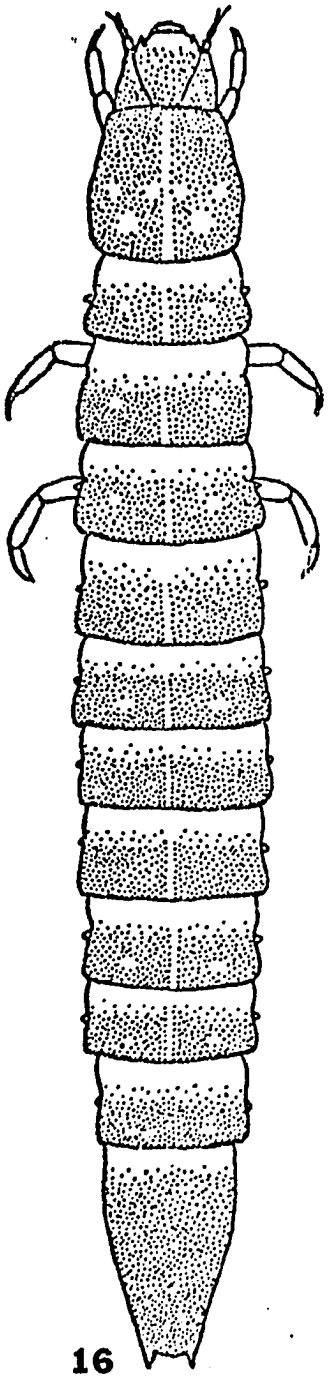
Figures 16-17. Stenelmis beameri--mature larva: 16, Dorsal; 17, Ventral. Line = 0.45 mm.



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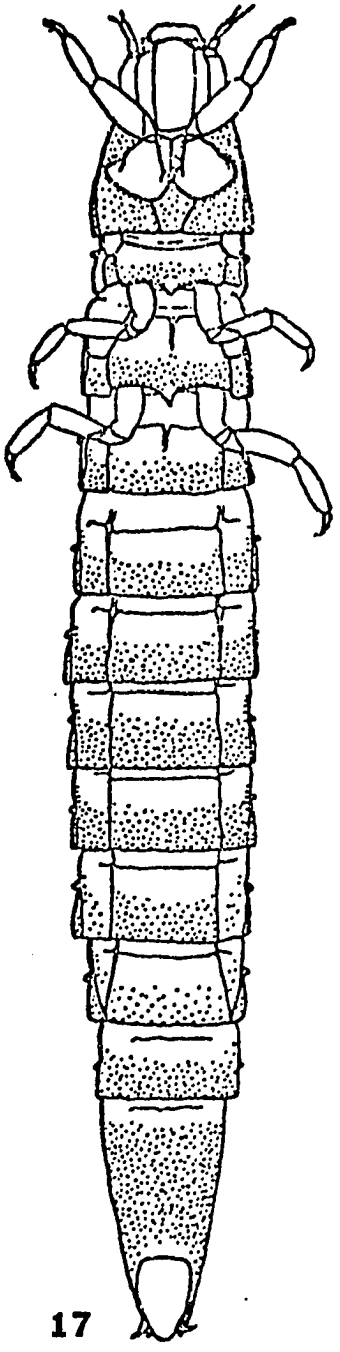

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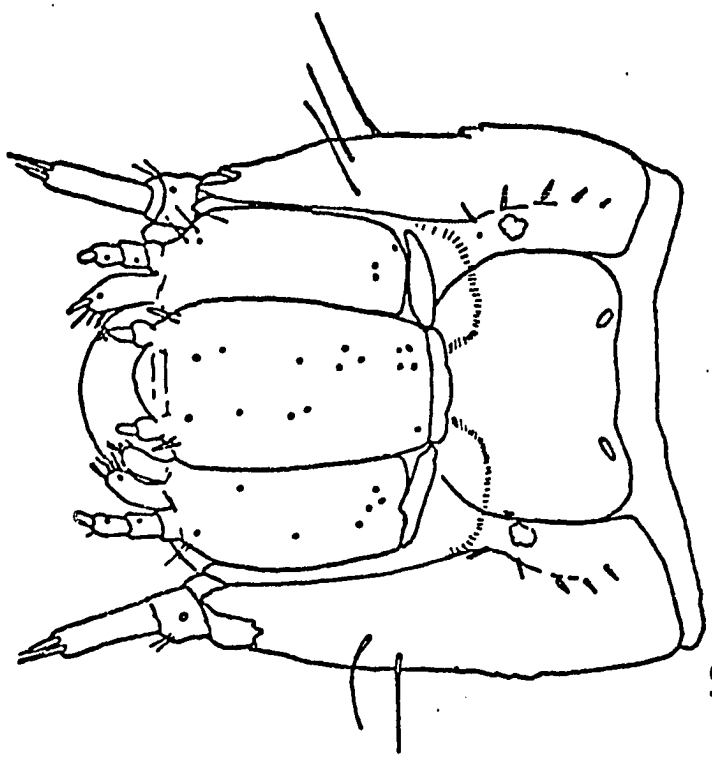
Figures 18-20. Stenelmis beameri--mature larva: 18, Head, dorsal; 19, Head, ventral; 20, Cervical sclerite. Line = 0.048 mm.



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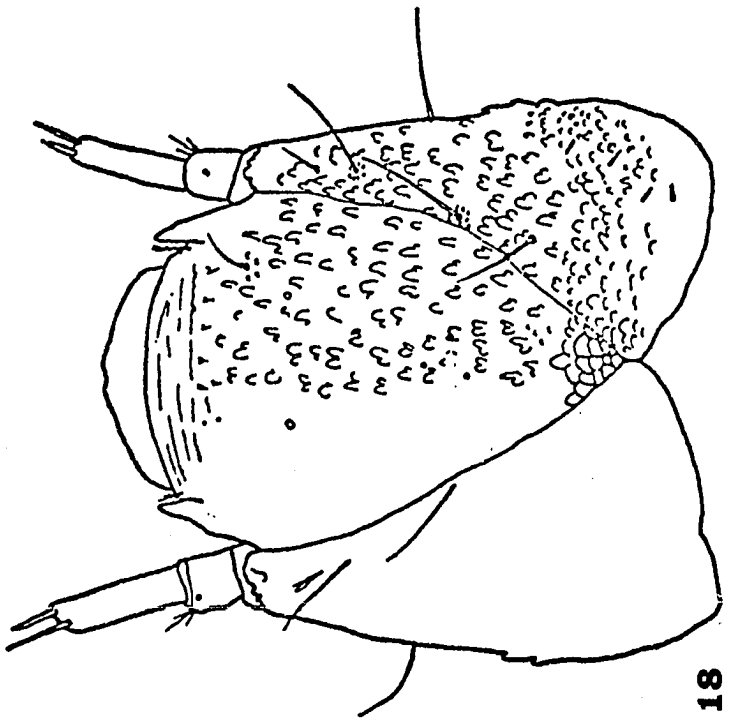

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Figures 21-27. Stenelmis beameri--mature larva: 21, R maxilla; 22, Maxillary galea and lacina; 23, Labium; 24, R mandible, ectal view; 25, R mandible, ental view; 26, Labrum; 27, Epipharynx. Line = 0.048 mm for 21 and 23-27. Line = 0.021 mm for 22.

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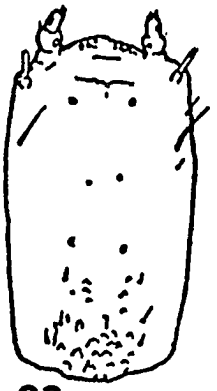

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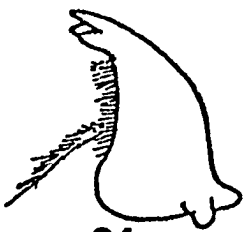

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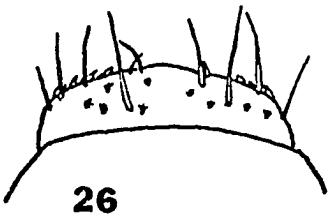

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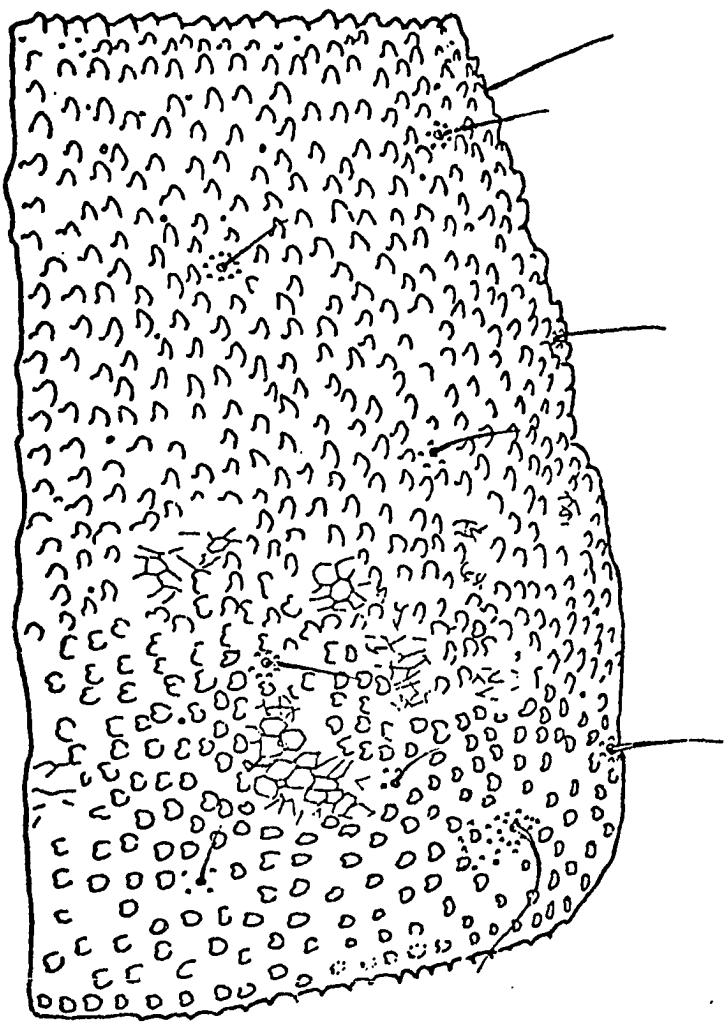
Figure 28. Stenelmis beameri--mature larva: Pronotum, R side. Line = 0.048 mm.



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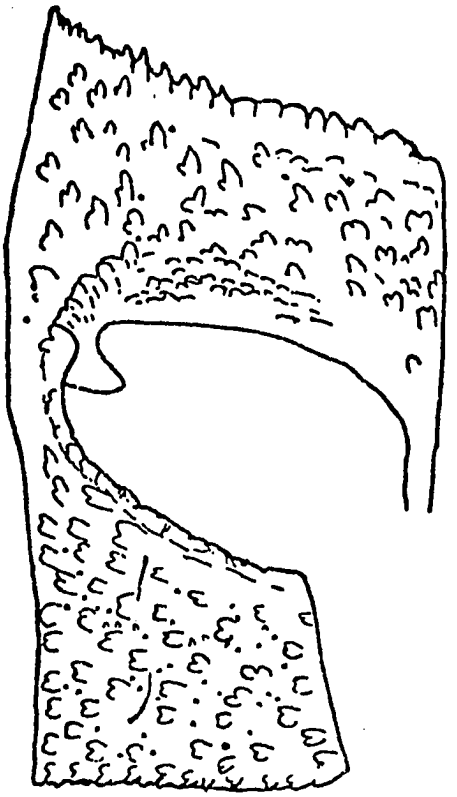
Figures 29-35. Stenelmis beameri--mature larva: 29, Proepisternum and proepimeron; 30, Mesepisternum and mesepimeron; 31, Metepisternum and metepimeron; 32, First abdominal pleurite; 33, Second abdominal pleurite; 34, Sixth abdominal pleurite; 35, Seventh abdominal pleurite. Line = 0.048 mm.



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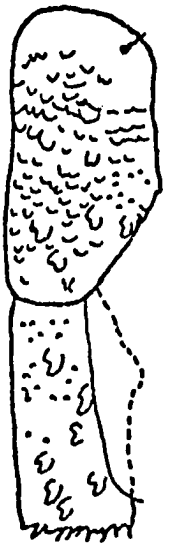

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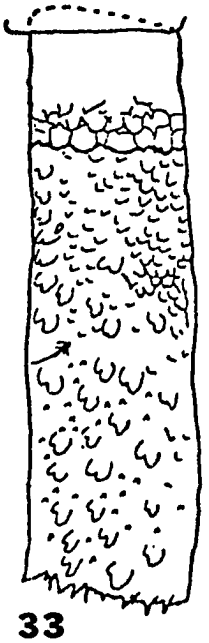

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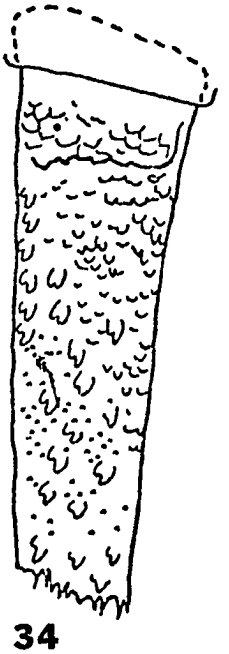

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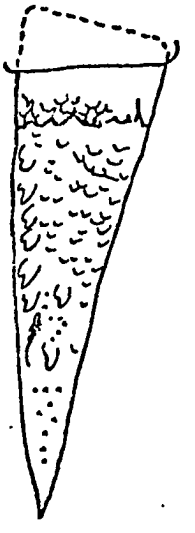

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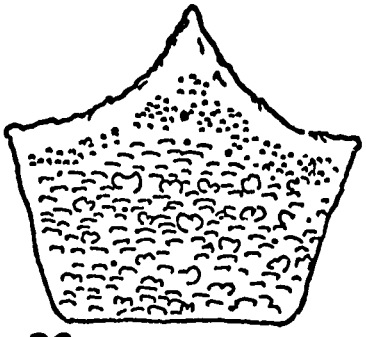
Figures 36-38. Stenelmis beameri--mature larva: 36, Prosternum; 37, Mesosternum; 38, Metasternum. Line = 0.048 mm.



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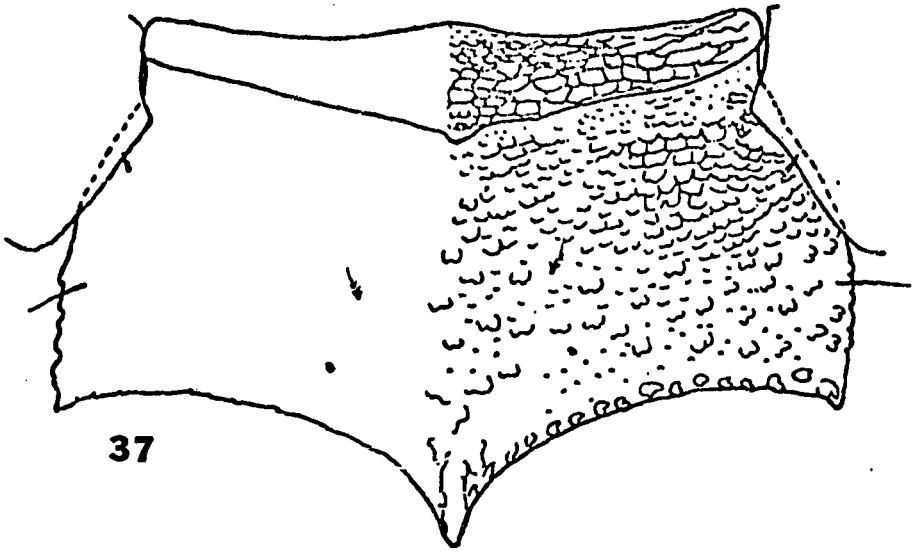

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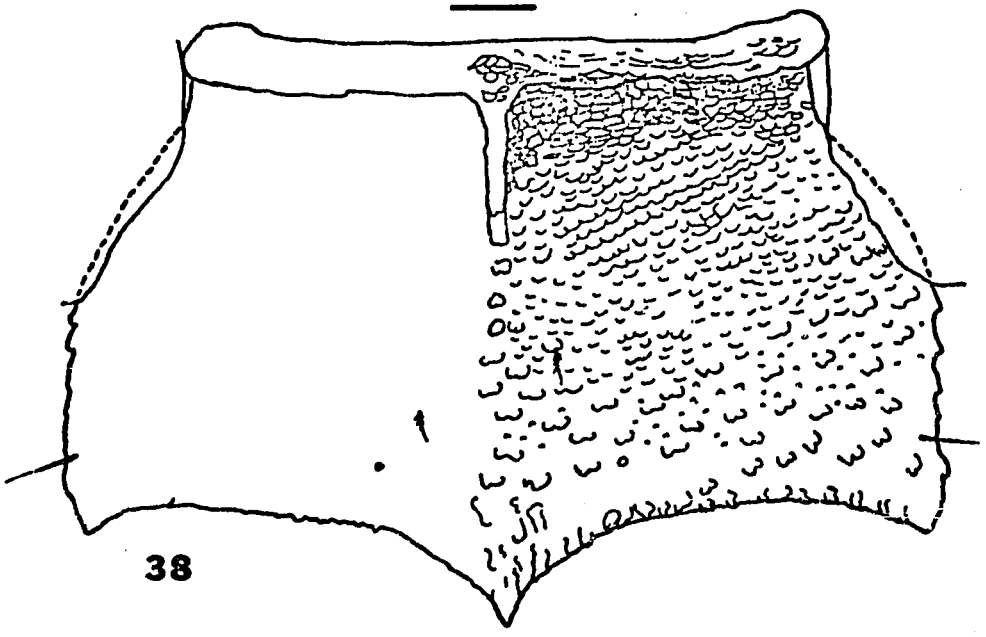

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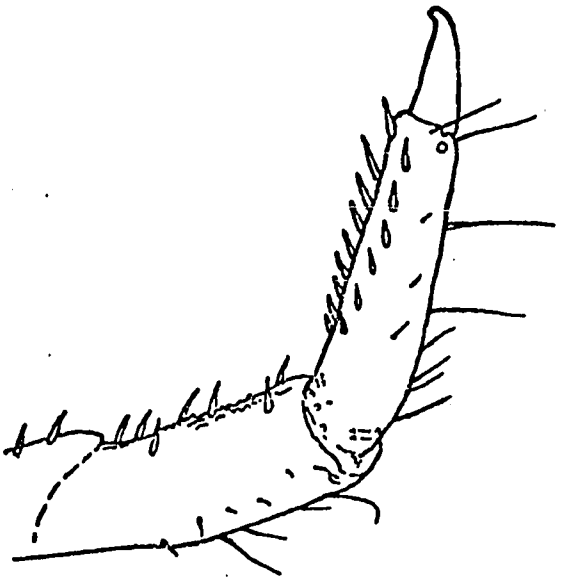
Figures 39-40. Stenelmis beameri--mature larva: 39, R prothoracic leg, anterior view; 40, R prothoracic leg, posterior view. Line = 0.048 mm.



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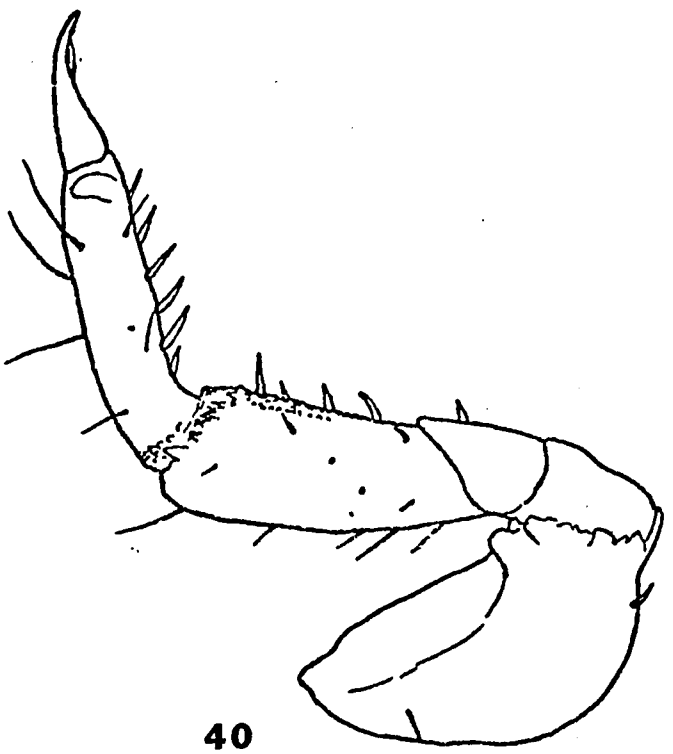

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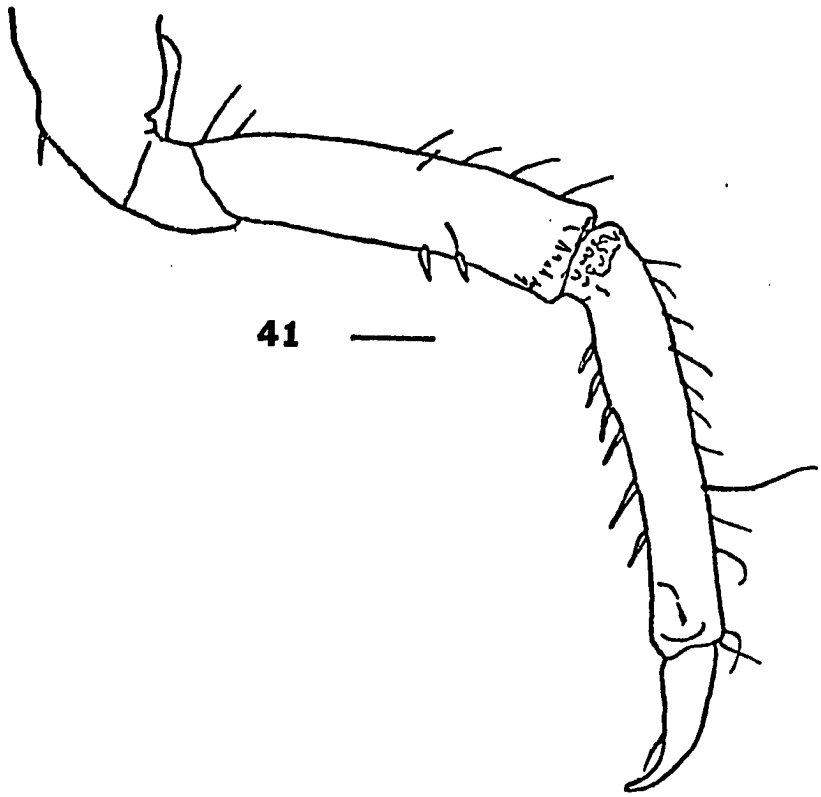
Figures 41-42. Stenelmis beameri--mature larva: 41, R mesothoracic leg, anterior view; 42, R mesothoracic leg, posterior view. Line = 0.048 mm.



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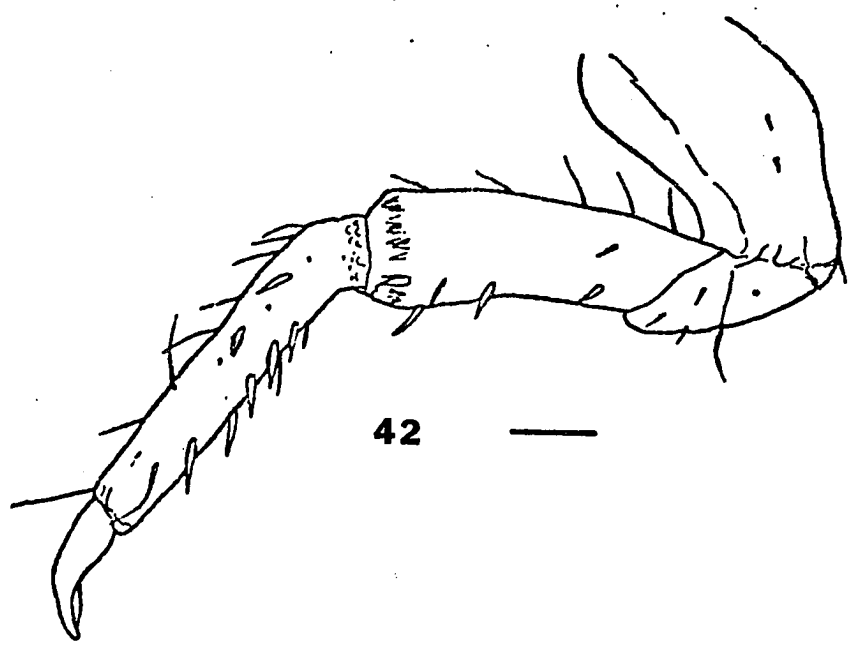

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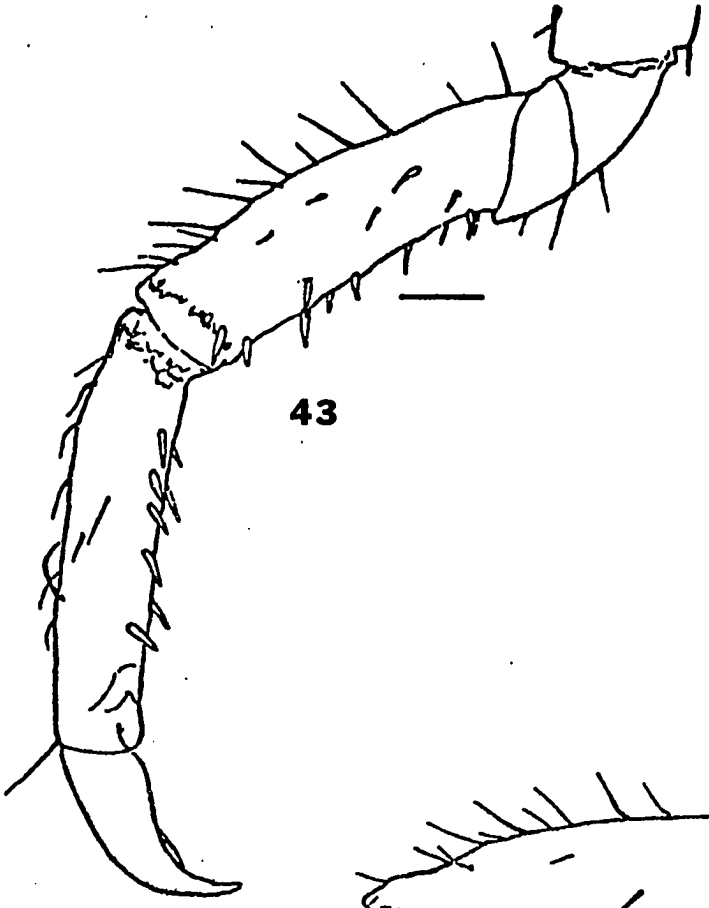
Figures 43-44. Stenelmis beameri--mature larva: 43, R metathoracic leg, anterior view; 44, L metathoracic leg, posterior view. Line = 0.048 mm.



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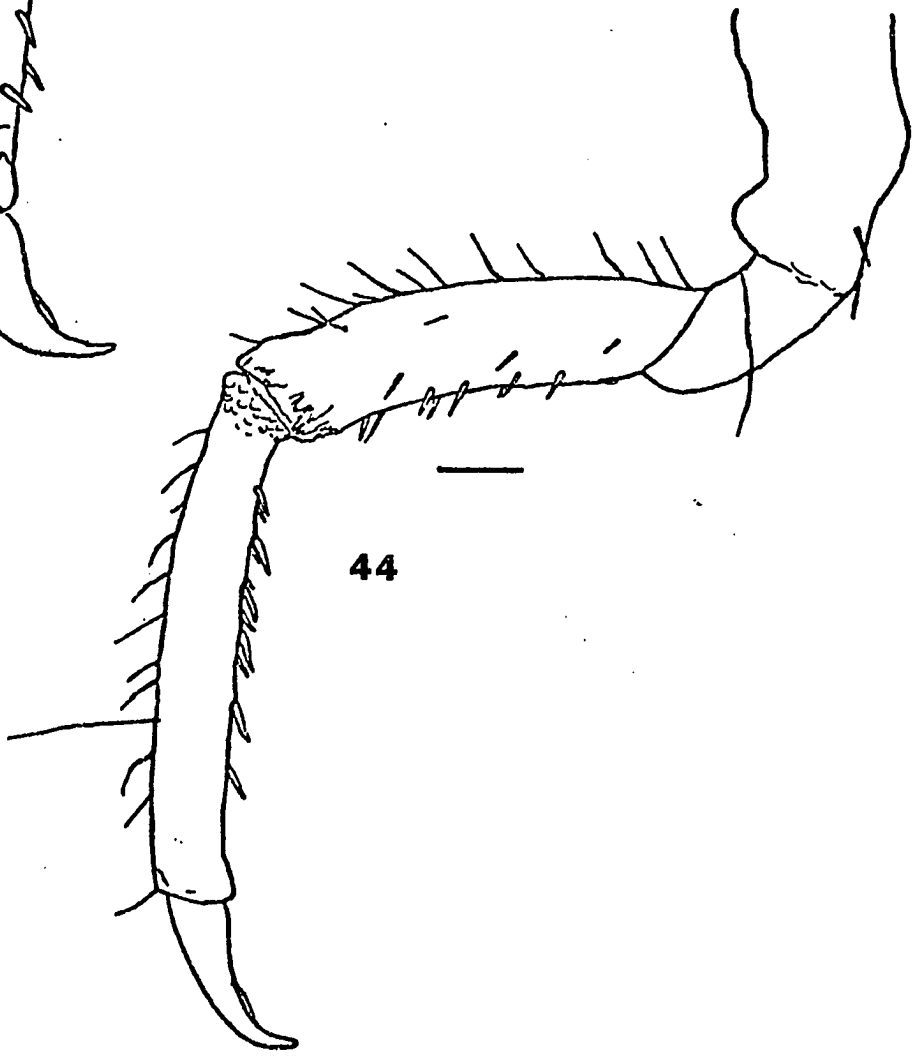

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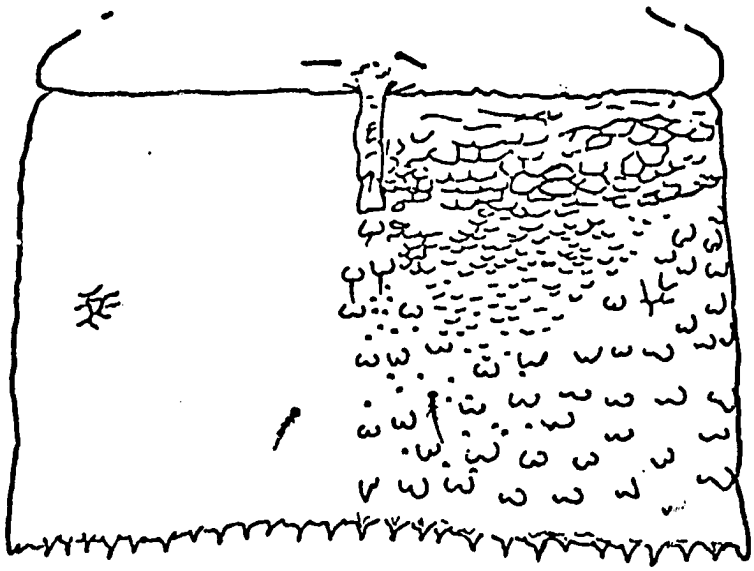
Figures 45-46. Stenelmis beameri--mature larva: 45, First abdominal sternum; 46, Second abdominal sternum. Line 0.048 mm.



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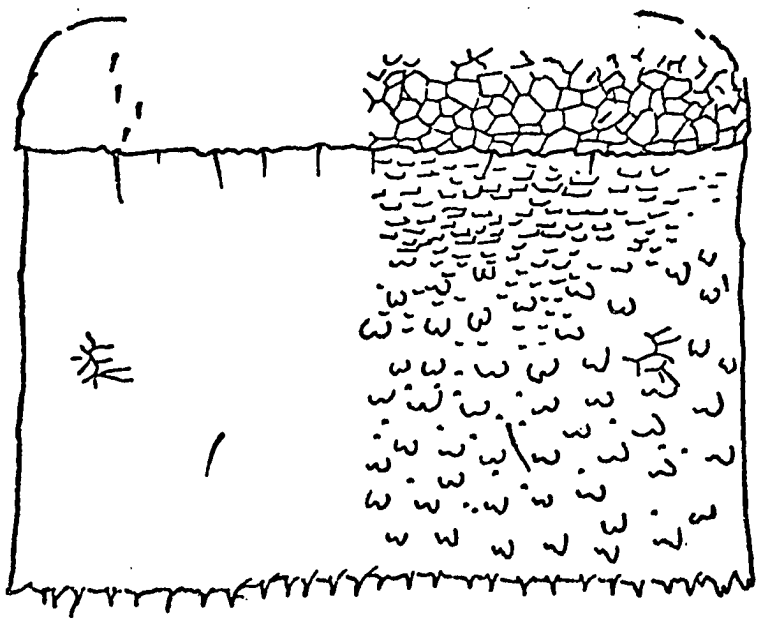

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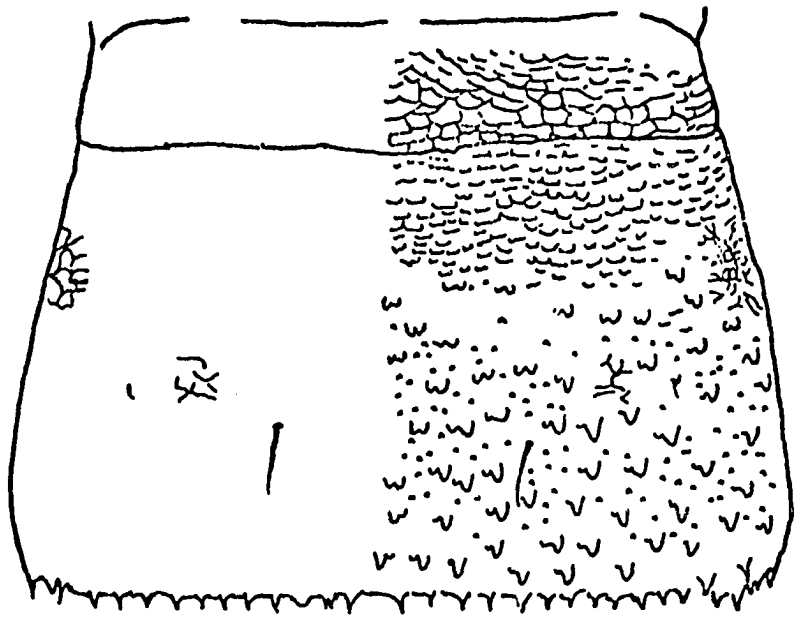
Figures 47-48. Stenelmis beameri--mature larva: 47, Seventh abdominal sternum; 48, Eighth abdominal segment, ventral view. Line = 0.048 mm.



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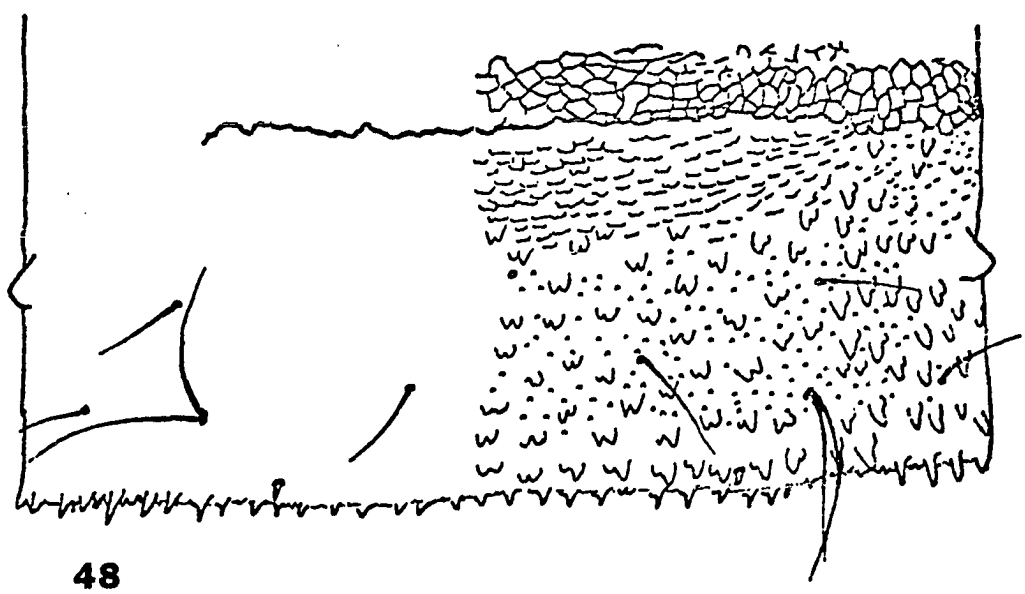

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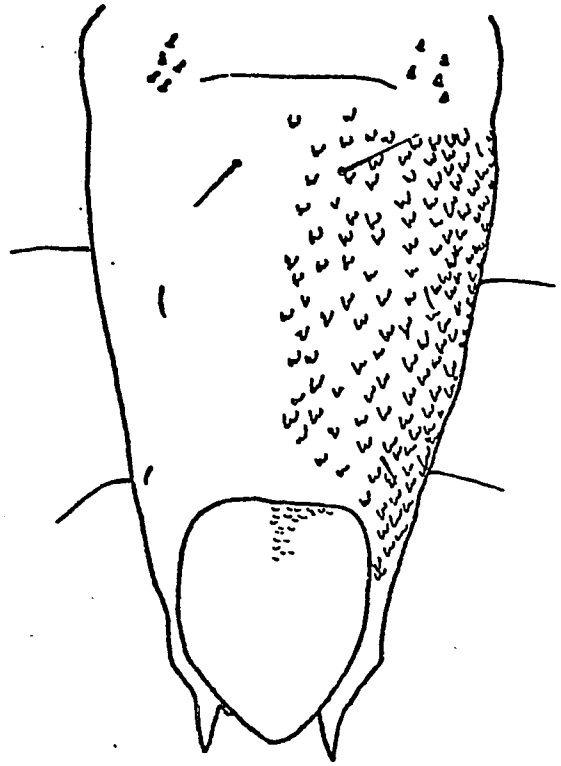
Figures 49-50. Stenelmis beameri--mature larva: 49, Ninth abdominal segment, ventral view; 50, Operculum, ental view. Line = 0.096 mm for 49. Line = 0.048 mm for 50.



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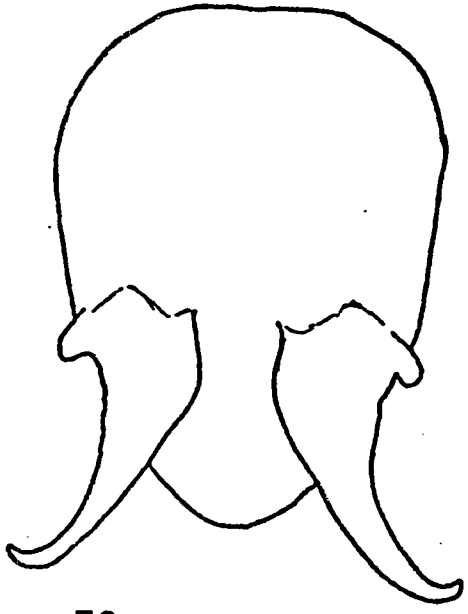

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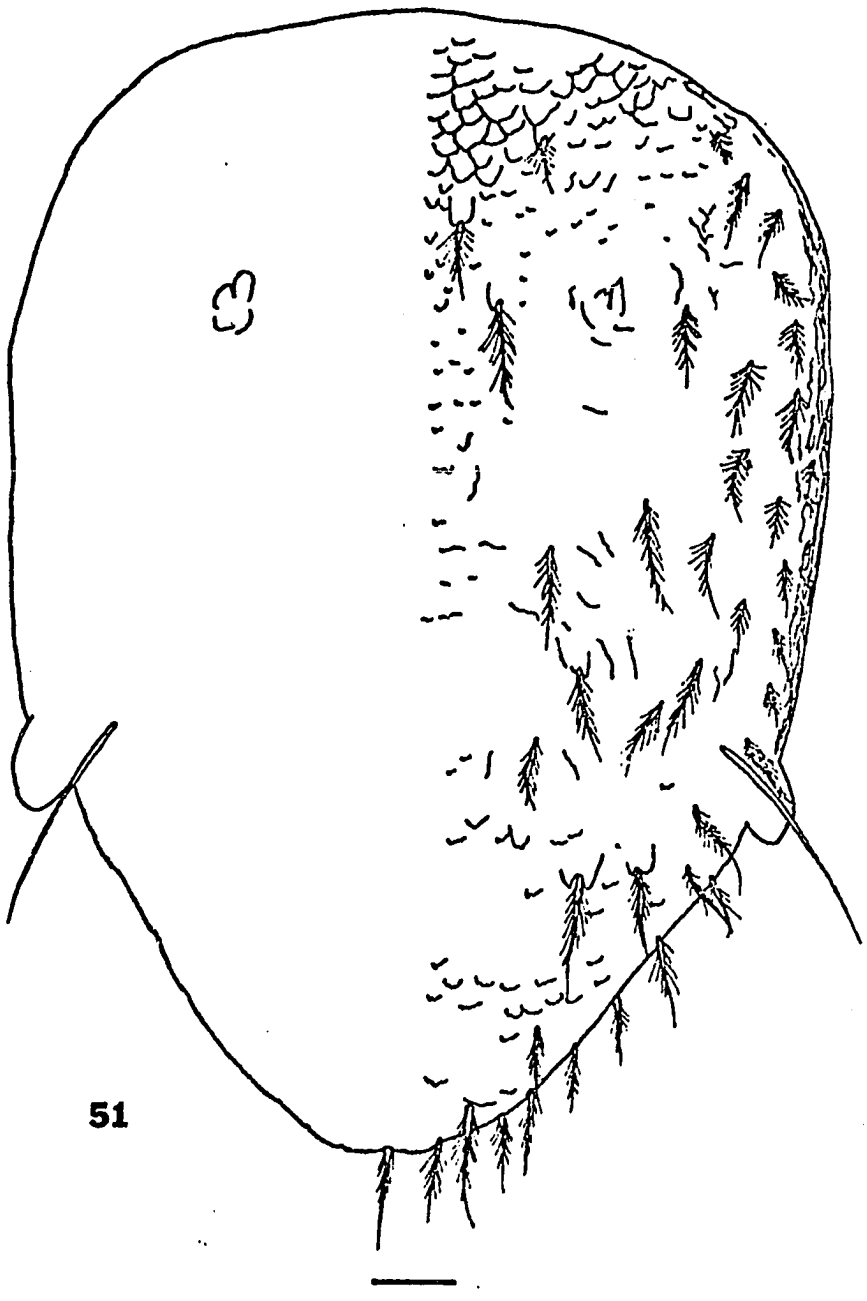
Figure 51. Stenelmis beameri--mature larva: Operculum, ectal view. Line = 0.021 mm.



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APPENDIX

Stenelmis beameri was used as an example of the genus and variations from it are given here. Also included are methods of determining the lengths and widths of various sclerites. The characters and character states are as follows.

A. Piligerous tubercles

1. Normal, Fig. 52
2. Rounded, Fig. 53
3. Elongate, Fig. 54
4. Faint, Fig. 55
5. Asymmetrical, Fig. 56

B. Meso- and metasternal spines

1. Normal, Fig. 57
2. Preceded by an unornamented area, Fig. 58
3. Reinforced, Fig. 59

C. Meso- and metacoxal margins lateral to spines

1. Curved, Fig. 60
2. Straight, Fig. 61

D. Tarsungulus

1. Normal, Fig. 62
2. Slender, Fig. 63

E. Posterior border of abdominal sternites and pleurites

1. Normal, Fig. 64
2. Faint, Fig. 65

3. Spiny, Fig. 6f

F. Measurements of sclerites - mesothorax through seventh abdominal segment

1. Length--greatest distance, parallel to the long axis of the body, from an imaginary line through the intersections of the lateral margins and the distinct transverse groove bisecting the scaled area, posterior to the tip of the spine or the posterior border of that sclerite, Figs. 67,68 .

2. Width--greatest distance, perpendicular to the length, from lateral edge to lateral edge of an undistorted segment, Figs. 67, 68

G. Measurements of ninth abdominal segment

1. Length--distance along the longitudinal axis from the distinct transverse groove bisecting the scaled area, posterior to an imaginary line between the apices of this segment, Fig. 69

2. Width--greatest distance, perpendicular to the length, from lateral edge to lateral edge of an undistorted segment Fig. 69

H. Measurements of labium

1. Length--greatest distance along the longitudinal axis from base to apex, Fig. 70

2. Width--greatest distance, perpendicular to the length, from lateral edge to lateral edge, Fig. 70

I. Measurements of cervical sclerite

1. Length--greatest distance, along the long axis of the body, from an imaginary line connecting the lateral arms to the posterior

most projection, Fig. 71

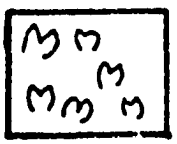
J. Measurements of the frons

1. Length--greatest distance along the long axis from an imaginary line connecting the anterior extremities of the arms of the frontal suture to the posterior most portion of this sclerite, Fig. 72
2. Width--distance between the extremities of the anterior arms of the frontal suture, Fig. 72

K. Measurements of the prosternum

1. Length--greatest distance, along the long axis of the body, from anterior to posterior, Fig. 73
2. Width--greatest distance, perpendicular to the length, from lateral edge to lateral edge, Fig. 73

Figures 52-63. Stenelmis spp.--mature larvae: 52, Normal piligerous tubercles; 53, Rounded piligerous tubercles; 54, Elongate piligerous tubercles; 55, Faint piligerous tubercles; 56, Asymmetrical piligerous tubercles; 57, Normal sternal spine; 58, Sternal spine preceded by an unornamented area; 59, Reinforced sternal spine; 60, Coxal margins curved lateral to sternal spine; 61, Coxal margins straight lateral to sternal spine; 62, Normal tarsungulus; 63, Slender tarsungulus.



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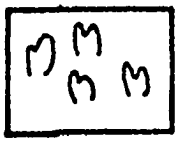

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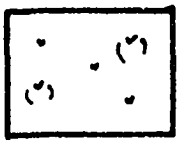

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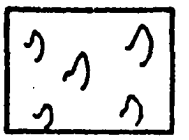

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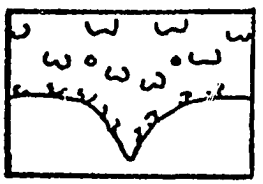

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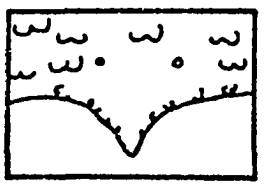

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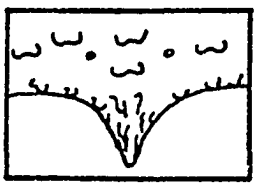

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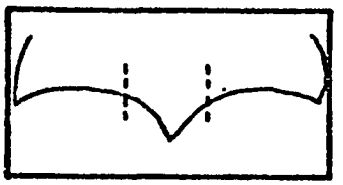

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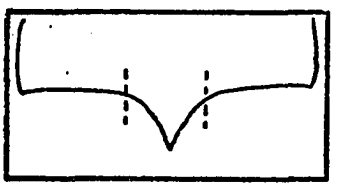

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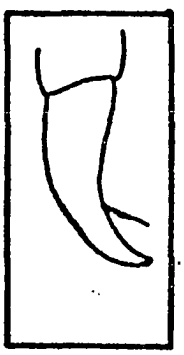

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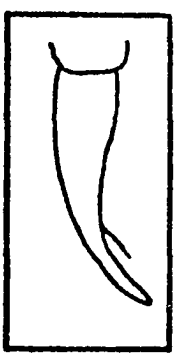

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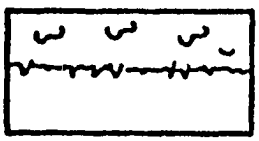
Figures 64-69. Stenelmis spp.--mature larvae: 64, Normal posterior sclerite border; 65, Faint posterior sclerite border; 66, Spiny posterior sclerite border; 67, Length (L) and width (W) of the meso- and metasternum; 68, Length (L) and width (W) of the abdominal sternae; 69, Length (L) and width (W) of the ninth abdominal segment.



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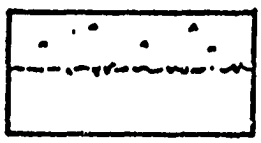

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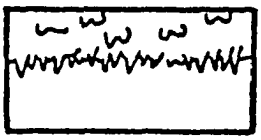

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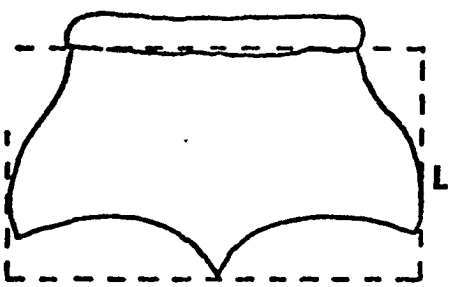

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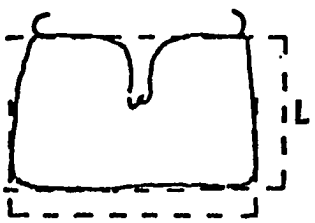

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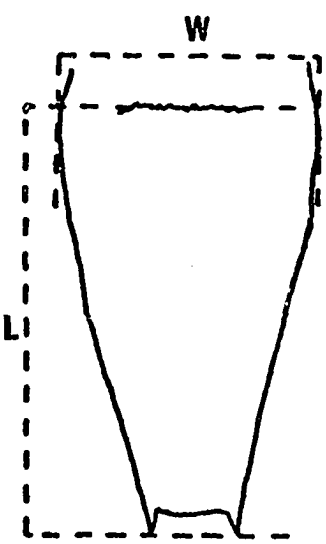

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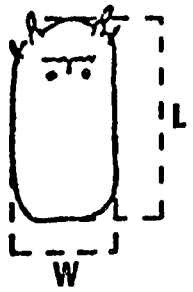
Figures 70-73. Stenelmis spp.--mature larvae: 70, Length (L) and width (W) of the labium; 71, Length (L) and width (W) of the cervical sclerite; 72, Length (L) and width (W) of the frons; 73, Length (L) and width (W) of the prosternum.



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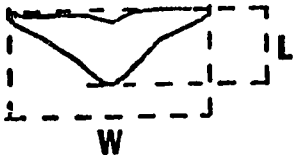

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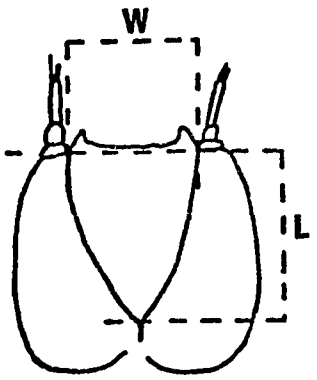

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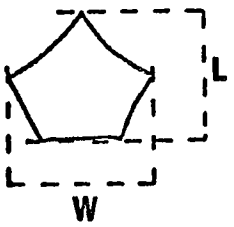

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