

## Description of the Taxonomic Terminology of Lepidoptera Larvae

MeiHua Piao<sup>1)</sup> and Chan Young Lee<sup>2)</sup>

### 나방류 유충의 분류학적 형질에 관한 연구

박미화<sup>1)</sup> · 이찬용<sup>2)</sup>

#### ABSTRACT

This paper gave detailed observation of the morphology of lepidoptera larvae, and viewed their character which is a key in the comparative study.

1. Head : ocelli, antenna, labrum, labium, mandible, maxilla, setae, frontal suture, adfrontal suture, and epicranial suture.
2. Thorax : thoracic shield, spiracle, setae and setal map.
3. Abdomen : anal shield, crochets of proleg, spiracle, setae and setal map.

**Key words :** morphology, larvae, Lepidoptera

#### 要 約

본 논문에서는 나방류 유충의 형태를 상세히 관찰하고 비교연구에 Key가 되는 형질에 관하여 조사하였다.

1. 頭部 : 單眼, 觸角, 上脣, 下脣, 上顎, 下顎, 刺毛, 前額縫線, 副前額縫線, 中縫線.
2. 胸部 : 前背板, 氣門, 刺毛와 刺毛配列.
3. 腹部 : 尾背板, 腹脚의 crochets, 氣門, 刺毛와 刺毛配列.

#### Introduction

This paper demonstrated terminology in a description and explained the figures of larva morphology and further discussed the meanings of the terms employed.

The setae of lepidopterous larvae are undoubtedly the most useful characters from the point of view of

- 
- 1) 강원대학교 대학원 : Dept. of Forestry, Graduate School, Kangwon National University, Chunchon 200-701, Korea
  - 2) 강원대학교 산림과학대학 산림자원보호학과 : Dept. of Forest Resources Protection, College of Forest Sciences, Kangwon National University, Chunchon 200-701, Korea

distinguishing species, genera, and even families that have been recognized in the larvae.

In the older literature, the descriptions of lepidoptera larvae are mostly very schematic. Muller(1886) was the first described pattern of setae in his work on Nymphalidae, but his description was simple. Later, Dyar(1896b), Fracker(1915), Heinrich(1916), Gerasimov(1935), Hinton(1946), and Mutuura(1956) proposed numerous systems.

The terminology about the system of the lepidoptera larvae was reviewed again according to Hinton's(1946) system to make a standard of the description above mentioned.

## Materials and Methods

The gross morphological features of entire larvae were examined on alcohol-preserved material. Then they were macerated in 10% KOH for several minutes and dissected under a stereoscopic microscope.

The head capsule with attached mouthparts was first removed from the body by a cut made with a fine forceps around the edges of the occipital foramen. The maxillae and labium as a unit were removed from the head capsule. Then the mandibles with attached tendons were removed from the head capsule. The head was sketched by this condition from dorsal and ventral sides. Mouthparts and skins were mounted on microscopic slides for detailed examinations.

## Morphology and Terminology

### 1. Head(Fig.1 A, C)

The head of lepidopterous larvae is defined, sclerotized, and frequently pigmented. The length

of the head is measured from the posterior edge of the cranium to the anterior margin of the epistoma, and the width of the head is measured at the widest place. The colour of the head capsule is brownish to yellowish brown and generally darker than body. Head with a large occipital foramen strengthened dorsally by a  $\lambda$ -shaped internal ridge. The anterior arms of the  $\lambda$ -shaped ridge extend anteriorly and are represented externally by the lateral adfrontal sutures. The stem, or epicranial suture(Es)(=median adfrontal suture) extends dorsally to the epicranial notch(=vertical notch or vertical triangle). The areas between the adfrontal suture and the front suture are the adfrontal area. Between the frontal suture is a triangular combined frons and clypeus or frontoclypeus. Anterior to the frontoclypeus(Fr+Cly) is the anteclypeus, which articulates with the labrum.

The head setae are defined into ten groups for the taxonomic purpose as follows:

Anterior(A) setae. There are usually three pairs of anterior setae on the area of between front and ocelli, and termed the anterior seta 1 to 3. The anterior seta 1(A1) located in front of ocelli II or III and the most ventral A seta; anterior seta 2(A2) located in front of ocelli II and directly above seta A1; seta 3(A3) highly variable, but usually above or behind and closest to seta A2 and ocelli I, sometimes closer to L1. One pair pore Aa usually above and closest to seta A2.

Ocellar(O) setae. There are generally three pairs of ocellar setae on the area of within and behind the ocellar semicircle, including ocelli I, II, III, IV, VI, which are termed ocellar seta 1 to 3. Ocellar seta 1(O1) usually close to ocelli II and III and within the ocellar semicircle, ocellar seta 2(O2) usually near the opening of the ocellar semicircle, ocellar seta 3(O3) usually behind ocelli VI. Ocellar pore Oa close to ocelli VI(often between VI and seta O3), ocellar pore Ob(often absent) close to ocelli IV(often between III and IV).

Subocellar(SO) setae. There are typically three pairs of subocellar setae on the ocellar area below, but including ocelli V. Subocellar setae 1(SO1) most ventral SO seta(closest to mandible), subocellar setae 2(SO2) variable, but between SO1 and subocellar setae 3(SO3). SO3 most posterior seta(toward the genal area). Pore SOa located within the subocellar area.

Frontal(F) seta. There are a pair of frontal setae on the frons area. Frontal seta 1(F1) only seta on the frons. Pore Fa only pore on the frons, mesad of F1.

Adfrontal(AF) setae. There are generally two pairs of adfrontal setae on the area of between adfrontal suture and frontal suture. Adfrontal seta 1(AF1) ventral seta, adfrontal seta 2(AF2) dorsal seta. Pore AFa usually between seta AF1 and AF2.

Clypeal(C) setae. There are usually two pairs of clypeal setae on the area of the clypeus. Clypeal seta 1(C1) medial seta, Clypeal seta 2(C2) lateral seta and nearly equal.

Lateral(L) seta. There are generally a pair of lateral setae on the above the ocelli and on the side of the head, Lateral seta 1(L1) above and somewhat behind ocellar I, often near A3. One pore La near and usually above seta L1.

Posteriorodorsal(P) setae. There are typically two pairs of posteriorodorsal setae on the upper face of the head between the lateral area and the upper adfrontal area. Posteriorodorsal seta 1(P1) ventral seta near adfrontal suture, Posteriorodorsal seta 2(P2) dorsal seta. Pore Pa ventral pore and closest to P1 or L1, pore Pb dorsal pore and usually closest to P2.

Vertical(V) setae. There are three pairs of vertical setae, on the vertical epicranium(vertex). Vertical seta 1(V1) ventral seta, vertical seta 2(V2) middle seta, vertical seta 3(V3) dorsal seta.

Pore Va between V2 and V3.

Genal(G) setae. There are one or two pairs of Genal setae on the area at the lower, rear portion of the head. Genal seta 1(G1) farthest from the ocelli, genal seta 2(G2) often absent, closest to the ocelli. Pore Ga closer to G1.

Antenna(Fig.1 B) are usually quite short, three segmented and usually arise from a U-shaped or  $\Delta$ -shaped membranous area adjacent to the base of the mandibles. The basic structure of antenna of all lepidopterous larvae is the same among them and has the distinguishable characteristics from the species of other orders. Those usually with three segment, second segment bear sensillum campaniformium(SC), second distally and third segment bear sensillum basiconicum and sensillum styloconicum.

The ocelli(Fig.1 C) are typically have six ocelli on each side of the head, arranged in a semicircle adjacent to the antennal sockets and numbered 1-6 bearing dorsally. Two common variations in the arrangement of the ocelli are as follows: ocelli I and II are sometimes close together and separated from the others; ocelli V is sometimes separated from the others, as in many macrolepidoptera, and may be difficult to see when it is very low. usually, all six ocelli are nearly equal in size.

The labium(Fig.2 A) consists of a prementum, mentum, and postmentum which divided into three parts. The prementum bears The median spinneret distally and the minute, usually two-segmented labial palpi laterally. The mentum general sclerotized, pigmentation. The postmentum is broadly membranous on the posterior part of the labium and has a pair of setae in general.

The maxilla(Fig.2 A) are situated alongside the labium well developed, usually consisting of cardo(CD), stipes(ST), and a three-segmented

palpus(Plp). Palpifer sclerotized, bearing one seta, the stipes mostly membranous, bears two pairs of setae, and cardo weakly delineated, mostly membranous, bear a hook-like sclerites basally.

The mandible(Fig.2 B, C) are opposable, toothed, short, stout, heavily sclerotized, and slightly convex dorsally or externally as opposed to the concave ventral or inner face. There are named as the mandibular seta 1 for the more posterior or dorsal seta, and the mandibular seta 2 for the rest. Mandible inner surface sometimes with internal tooth.

The labrum(Fig.2 E) may be deeply or acutely cleft on the meson of its distal margin. The labrum bears three pairs of median labral setae(M1 to M3), three pairs of lateral labral setae(L1 to L3), and one pair of labral puncture(P). They were reference to by number in description from the interior to exterior setae according to Heinrich'(1916)s nomenclature. In general, the labral punctures are located between the median seta 1 and 2 on each side.

The epipharynx(Fig.2 E) is the inner surface of the labrum and bears three pairs of epipharyngeal setae. Also, it has many small spines on the surface of the epipharynx. On the ventral side of the labrum with epipharyngeal rods(ER) the chitinized, epipharyngeal shield in the notch and three pairs of modified setae near the anterior lateral margin.

## 2. Thorax.

The three distinct thoracic segments are called respectively as pro-, meso-, and metathorax. one pair of spiracle is usually present on the prothorax or it may be located between T1 and T2. With one pair of straight or slightly curved segmented legs on each segment. Each leg usually consisting of a

coxa, trochanter, femur, tibia, tarsus, and claw. In familis with specialized habits(leaf miners), thoracic leg are rudimentary or lost. In the micropterigidae the coxa, trochanter, and femur are fused and the leg appears three-segmented. In some other families, the trochanter may be fused with the femur so the leg appears four-segmented.

## 3. Abdomen

The abdomen consists of ten segments, which can be divided into groups of roughly similar segments(A1 and A2), (A3-A6), (A7 and A8), (A9) and (A10). A1-8 bear spiracles(Fig.2 D) is circular or oval. The T1 and A8 spiracles are often larger than the others. A1 and A2 usually do not bear prolegs; A3-6 bear the ventral prolegs, usually with crochets; A9 never bears prolegs, and only in the later instars of the family Dalceridae does A7 bear crochets; A10 bears the caudal prolegs, usually with crochets, prolegs are paired ventral muscled outgrowths of the body wall. The proleg consists of two fundamental parts, a proximal base, distinguished by bearing the subventral(SV) setae, and a distal planta, which never bears setae and from which the crochets arise.

Crochets are small hooks arranged in rows or circle around the edge of the planta. Their development probably began from the enlargement of cuticular granules which gradually assumed the shape of hooks. The primitive arrangement would thus be large spines arranged in circular multiple rows(Fig.3 D, M). If all the crochets in a circle are the same length, they are uniordinal(Fig.3 A); two alternating lengths are termed biordinal(Fig.3 B); three alternating lengths are termed triordinal(Fig.3 C). If the crochets are interrupted mesally and are continuous laterally, the arrangement is a

lateropenellipse(Fig.3 H). If the crochets are interrupted laterally and are continuous mesally, it is a mesopenellipse(Fig.3 G). If a circle has a gap both laterally and mesally, the crochets are in two transverse bands(Fig.3 E). If a single transverse row of crochets is present, the arrangement is a single transverse band. Most leaf feeders have a mesoseries(Fig.3 I, J), which is a single longitudinal row of crochets on the mesal side of the planta, parallel to the meson. When the crochets are almost alike in structure and size throughout, they are termed a homoideous mesoseries(Fig.3 I). If the crochets in the center of a mesoseries are abruptly longer than those at either end, it is a heteroideous mesoseries(Fig.3 J). If two longitudinal parallel rows(Fig.3 K) occur, the outer is a lateroseries and the inner is a mesoseries. In addition to being broken by gaps, rows of crochets may be interrupted by structures such as a planta "sucker" in some geometrids and a spatulate fleshy lobe in most lycaenids and some riodinids(Fig.3 O)

#### 4. Setae.

Most setae are simple, but in some taxa, setae that are plumose, knobbed, spinelike, or spatulate are found, and some are poisonous or urticating. A seta arises from a small sclerotized ringlike papilla on the integument and internally connects with at least one hypodermal cell. A sclerotized area around the base of one or more setae is a pinaculum(Fig.5). If the "pinaculum" is distinctly elevated, cone-shaped, and bears a single seta, it is a chalaza(Fig.4 A, B). If the "chalaza" is a larger structure bearing setae or branching spines, it is a scolus(Fig.4 C, D). Setae may also be grouped on nonsclerotized fleshy lobes, or on rather flat, disclike verrucules with parallel setae(Fig.4 E) or

on more convex verrucae with divergent setae(Fig.4 F).

#### 5. Setal map.

A setal map(Fig.5) is a diagram showing the relative positions and size of setae and other structures on the left side of the thorax and abdomen. Each segment except A10(and sometimes A9) is drawn as a rectangle proportional to the shape of the segment and covering the area between the middorsal and midventral lines. A10 is drawn more similar to the A10 shape since it is so different from the other segments.

XD Group. The two XD setae are only found on the anterior margin of the T1 shield, XD2 is below XD1.

Dorsal(D) Group. Two D setae are usually present near the dorsal midline on all segments. On T1, both are on the shield and D1 is usually above D2. On T2 and T3, D1 is above D2, and they are usually close together. On A1-8, D1 is anterior to D2. On A9, D2 is above or posterior to D1.

Subdorsal(SD) group. Two SD setae are present on all segments except A9 where SD2 is absent, although SD2 is usually minute and sometimes absent on A1-8. On T1 they are usually on the T1 shield below D1, D2, XD1, and XD2. SD1 is usually below XD2 and anterior to SD2. Sometimes(in many Noctuidae) SD1 and SD2 are very close together and are located below the T1 shield. On T2 and T3, SD1 is below SD2, and D1, D2, SD2, and SD1 often form a nearly straight vertical line with D1 and D2 frequently on one pinaculum and SD1 and SD2 on another. On A1-8, SD2 is usually minute(sometimes absent) and anterior or anterodorsal to the spiracle; SD1 is usually above the spiracle. On A9, SD2 is absent

and SD1 is below D1.

**Lateral(L) Group.** Three L setae are usually present on all segments. On T1 they are anterior to the spiracle, usually on a single pinaculum. L1 is between L2 and L3, L2 is usually anterior to L1, and L3 is posterior and closest to the spiracle. In nearly all Copromorphoidea, Noctuoidea, and Pyraloidea, L3 is missing on T1. On T2 and T3, L1 is in the middle, L3 is caudodorsad of L1, and L2 is anteroventrad of L1, usually L1 and L2 share a pinaculum, and L3 is on its own. On A1-8, L1 and L2 are close together and below the spiracle in most Gelechioidea, Tortricoidea, and Pyraloidea, but they are far apart, with L1 often behind the spiracle, in most Tineoidea, Yponomeutoidea, Geometroidea, and Noctuoidea; L3 is caudoventral and farther from the spiracle than L1 and L2. On A9 the L Group is often unisetose or bisetose, L1 is always present. If all three are present on A9, they are usually arranged vertically with L1 in the middle and L3 below.

**Subventral(SV) Group.** The SV group is usually bisetose on T1 and unisetose on T2 and T3. They are above the coxa and are often on large pinacula. On A1-8, the SV group may be unstable in number, even on opposite sides of the same segment.

**Ventral(V) Group.** A single V seta is usually present on all segments. It is closer to the ventral meson than the SV group. On T1-3, it is on the underside of the coxa; on A3-6 it is on the inside of the proleg.

The 9th segment(A9). The setae of A9 are the most reduced in number, commonly reduced to D1 and D2, SD1, L1(sometimes L2 and L3), SV1(sometimes SV2) and V1. The relationships of D1, D2, and SD1 are frequently used on keys, with D1 usually located below D2, and sometimes located on the same pinaculum with SD1.

The Anal segment(A10). When the A10 segment is viewed as an anal shield and an anal proleg area there are fundamentally four setae on the anal shield(D1, D2, SD1, SD2) and nine on the anal proleg area(L1, L2, L3, SV1, SV2, SV3, SV4, V, and PP).

## References

- Dyar, H. G. 1896b. Note on the head setae of lepidopterous larvae. *Ann. Noy. Acad. Sci.* 8 : 194-232.
- Fracker, S. B. 1915. The classification of lepidopterous larvae. *Ill. Biol. Mono.* 2(1) : 1-169.
- Heinrich, C. 1916. On the taxonomic value of some larval characters in the lepidoptera. *Proc. Ent. Soc. Wash.* 18 : 154-64.
- Gerasimov, A. M. 1935. zur Frage der Homodymie der Borsten von schmetterling sraupen. *Zool, Anz.* 112 : 117-94.
- Hinton, H. E. 1946. On the homology and nomenclature of the setae of lepidopterous larvae, with some notes on the phylogeny of the lepidoptera. *Trans. Roy. Ent. Soc. Lond.* 97 : 1-37.
- Mutuura, A. 1956. On the homology of the body areas in the thorax and abdomen and a new system of the setae of Lepidopterous larvae. *Bull. Univ. Osaka. Pref. (Ser. B)* 6 : 93-122.
- Muller, W. 1886. Sudamerikanischer Nymphalidenraupen. ver such eines natuerlichen system der Nymphalliden. *Zool. Jahrb. Fur syst.* 1 : 417-678.
- Stehr, F. W. 1987. *Immature Insects(1)*. Kendall/Hunt Publishing company. Iowa. P. 288-304.

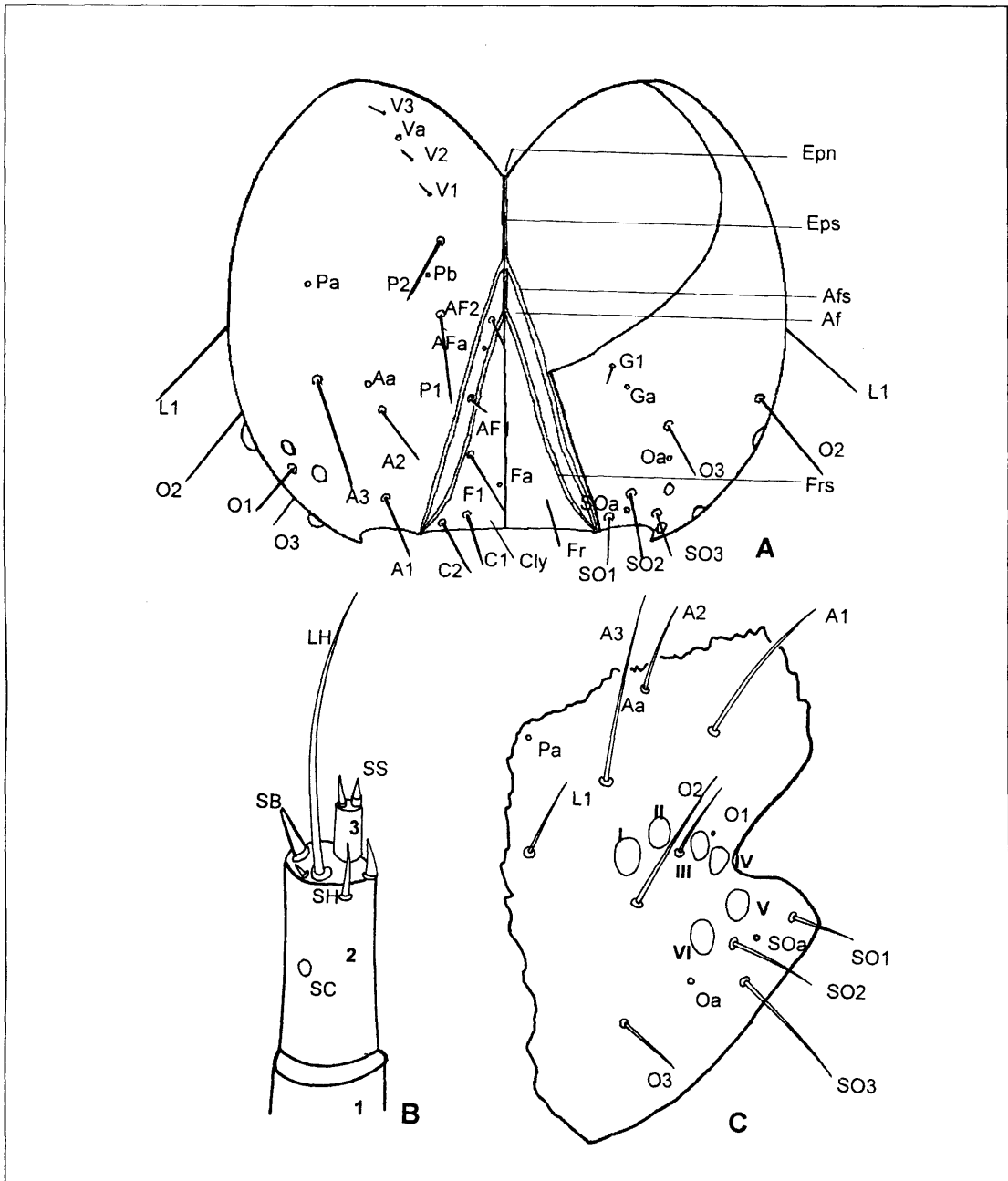


Fig. 1. Head and Antenna

A:Head(dorsal and ventral). B:Antenna C:Head(lateral).

A1 to A3:anterior seta. Af:adfrontal. Afs:adfrontal suture. AF1 to AF2:adfrontal seta.

C1 to C2 : clypeal seta. Cly:clypeus. Epn:epicranial notch. Eps:epicranial suture. F1, Fa:frontal seta and puncture. Fr:frons. Frs:frontal suture. G1, Ga:genal seta, and puncture. L1:lateral seta. LH:long hair. O1 to O3:ocellar seta. P1 to P2:posterior seta. SB:sensillum basiconicum. SC:sensillum companiformium. SH:short hair. SO1 to SO3:subocellar seta. SS:sensillum styloconicum. V1 to V1:vertical seta.

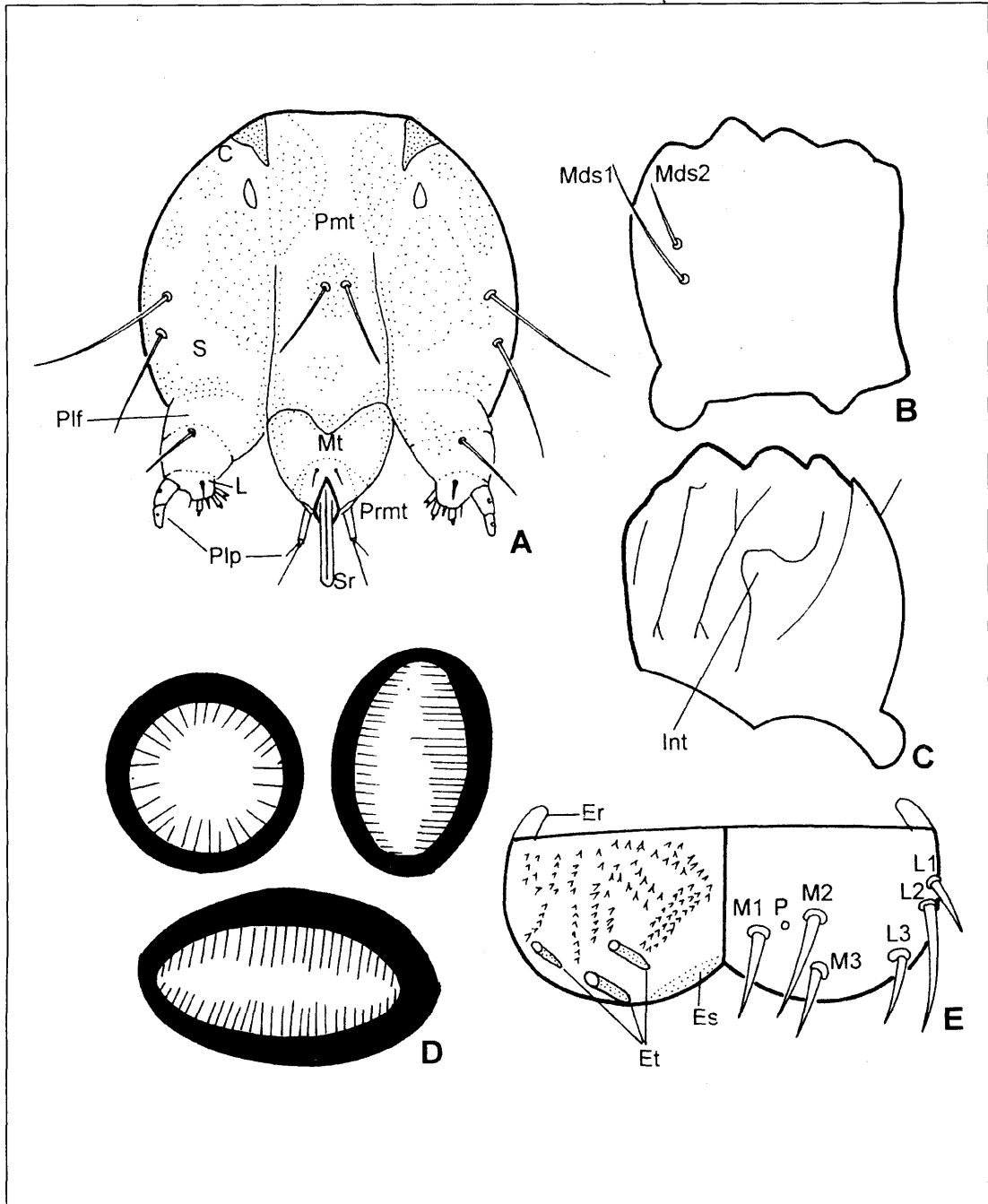


Fig. 2. Mouthpart and Spiracle

A: maxilla and labium. B, C: mandible (dorsal and ventral). D: spiracle. E: labrum and epipharynx. C: cardo. Er: epipharyngeal rod. Es: epipharyngeal shield. Et: epipharyngeal seta. Int: inner tooth. L1 to L3: labrum lateral seta. M1 to M3: labrum medial seta. Mds1 to Mds3: mandibular seta. Mt: mentum. Pif: palpifer. PIP: palpus. Pmt: postmentum, Prmt: prementum. S: stipes. Sr: spinneret.



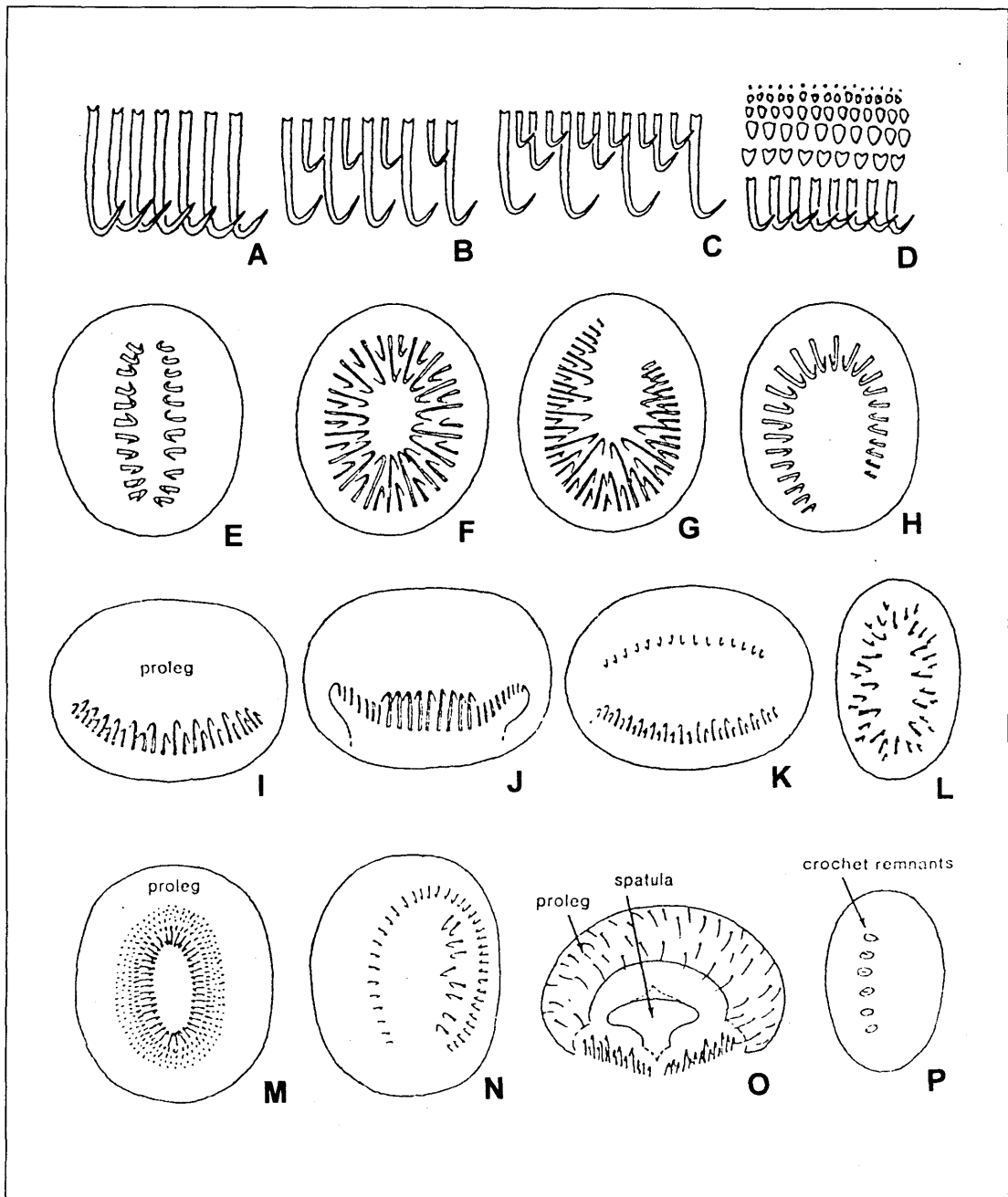


Fig. 3. Crochets of Proleg

A:uniordinal, uniserial. B:biordinal, uniserial. C:triordinal, uniserial. D:uniordinal, multiserial.  
 E:uniordinal, transverse bands. F:biordinal, circle. G:triordinal, mesal penellipse. H:uniordinal, lateral penellipse.  
 I:biordinal, homoideous meseries. J:heteroideous, meseries. K:uniordinal lateroseries, plus biordinal meseries.  
 L:multiserial, circle. M:multiserial, circle. N:lateral penellipse, plus scattered crochets.  
 O:triordinal interrupted meseries. P:uniordinal, single, transverse band.

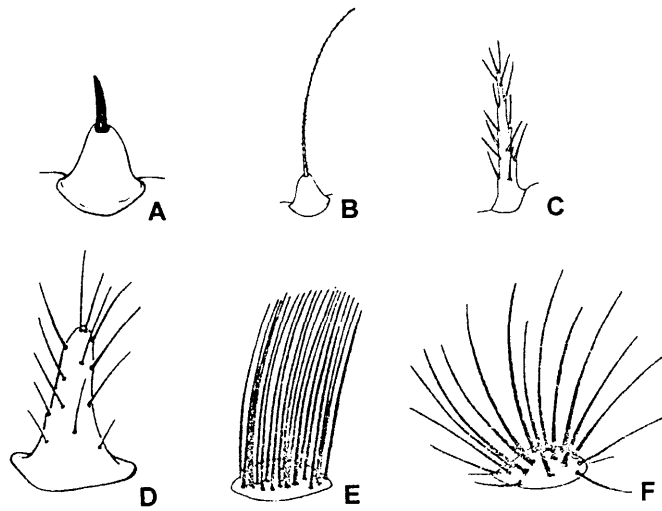


Fig. 4. Setae

A, B:chalaza. C, D:scolus. E:verricule. F:verrucae.

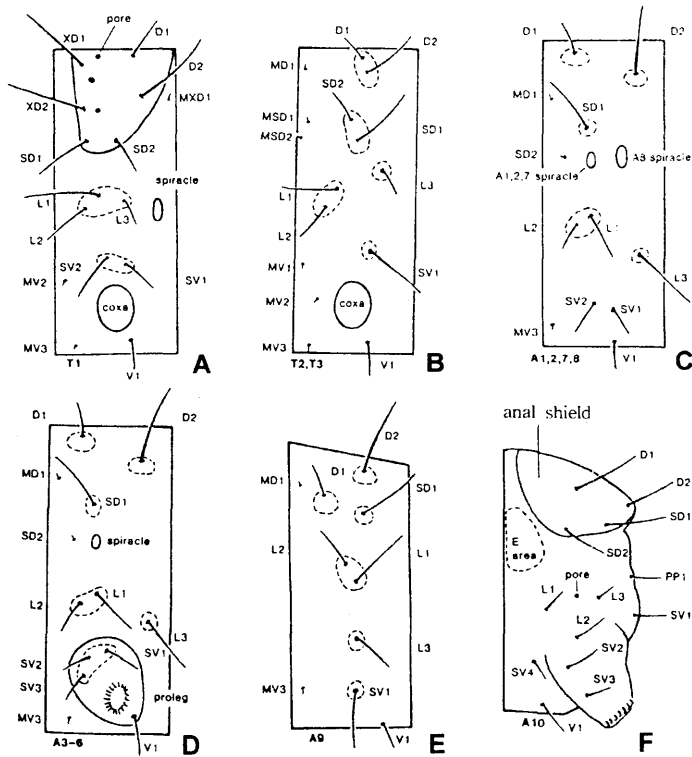


Fig. 5. Seta1 Map

A:T1. B:T2, T3. C:A1, A2, A7, A8. D:A2-6. E:A9. F:A10.