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The importance of morphology of abdominal segment A8 for the determination of the males of the genus *Eupithecia* CURTIS 1825 (Lepidoptera, Geometridae)

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Abstract

The shape of sternum and tergum of abdominal segment A8 is an important practical feature to be used for the determination of species of the genus *Eupithecia* CURTIS 1825. The genus is divided into 8 characteristic groups according to the shape of apex caudalis of sternum A8. A detailed description of tergum A8 also helps significantly in the species identification. Morphological variability of sternum A8 and tergum A8 does not affect determination-results. Some changes and supplements to nomenclature of individual anatomical details of both parts of the 8th abdominal segment are proposed.

Key words: Lepidoptera, Geometridae, *Eupithecia*, Taxonomy, Male genitalia, 8th Abdominal segment, European species, Variability.

Zusammenfassung

Die Form des Sternum und Tergum des achten Abdominalsegmentes ist ein wichtiges praktisches Merkmal, welches für die Determination der Arten der Gattung *Eupithecia* CURTIS 1825 herangezogen werden kann. Die Gattung *Eupithecia* wird nach der Morphologie des Apex caudalis des Sternum A8 in acht Gruppen unterteilt. Die Beurteilung des Tergum A8 hilft auch signifikant bei der Artbestimmung. Die morphologische Variationsbreite des Sternum A8 und Tergum A8 hat keinen Einfluss auf die Art-Determination gehabt. Einige Vervollständigungen der Nomenklatur für Einzelheiten der beiden Teile des achten Abdominalsegmentes werden vorgeschlagen.

Introduction

The structure of the 8th abdominal sternum is an important criterion for the determination of the males of the genus *Eupithecia* CURTIS 1825. Morphological structures of sternum A8 are species–specific in shape. The characteristic shape of the 8th tergum can also be an useful supplement for determination (WHITE 1891, PETERSEN 1909, SCHÜTZE 1956, BOLTE 1990, DALL'ASTA 1994). In the case of *Eupithecia*, the variability of sternum A8 may be practically unknown (VOJNITS 1975, KRAMPL 1994).

Detailed further research is needed in the genus *Eupithecia* regarding variability caused by geographical origin, as it is described within other genera, e. g. *Glossotrophia* (HAUSMANN 1993, SIHVONEN 2007).

Dorsal tergum A8 and ventral sternum A8 are connected by a lateral membrane. Together, they form a ring enveloping the external genitalia (POVOLNÝ 1956, CHOI 1997).

The 8th tergum has been studied seldomly. WHITE (1891) was the first author to pay attention to its importance; however, his interest was focused only on its size. In subsequent publications, morphological descriptions are more or less inacurate, and, generally, inapplicable for practical determinations (CHOI 1997, VOJNITS 1974).

Nomenclatorically, the morphology of segment A8 is basically not uniform. WHITE (1891) describes segment A8 as "plates". This term was later specified by PETERSEN (1909) as "Ventralplatte" and "Dorsalplatte". Since then, these terms are used in the English versions as "ventral plate" and "dorsal plate" by some authors (MIKKOLA 1993). The law of priority is not applied in morphological nomenclature (BEIRNE 1942), that is why it was possible to use the terms sternum eight and tergum eight (SIHVONEN 2007) or sternum A8 and tergum A8 (MIRONOV 2003).

The nomenclature of the anatomical parts of segment A8 also lacks uniformity. First of all, the caudally directed processus lateralis is a good example. In the genus *Eupithecia*, these structures are species-specific in shape. In different genera (Sterrhini) of Lepidoptera, frequent names for these structures are: cerata, mensis, navicula, octavales (KLOTS 1970). The apex caudalis of some *Eupithecia* species consists only of a single rounded rod (MC DUNNOUGH 1949, MIRONOV 2003).

Most probably, the segment A8 plays a functional role in copulation (HAUSMANN 2001). The most likely hypothesis is the interaction of sternum A8 with the colliculum of females of *Eupithecia* during copulacion (MIKKOLA 1994).

Material and methods

Our collection contains 85 species of the genus *Eupithecia* (Tab. 1). The surrouding scales were removed with a fine brush after preparation in a hot solution of NaOH and intense washing in water (WHITE 1891, BOLTE 1990). The separated segments are stained in a solution of amidoblack and the preparation of sternum A8 and tergum A8 finally finished by its mounting in Euparal.

Preparations were photographed in the light microscope in constant magnification (obj. 3,2x, proj. 3,2 : 1, or, obj. 10x, proj. 3,2 : 1). Photographic magnification was the same. After conventional preparation, the electron-microscopical documentation was performed with the scanning electron microscope TESLA BS 300 (KUBÍN 2003).

As regards the nomenclatorial view, we used the most frequent terms (MIRONOV 2003). With some details we have proposed supplements corresponding with Latin terminology and grammar (Figs. 1, 2, 3) (DIAKONOFF 1954).

Localization of preparations

Preparations: *E. pantellata* has been deposited in collection of Senckenberg Naturhistorische Sammlungen of Dresden Museum für Tierkunde Germany; *E. pulchellata* and *E. pygmeata* has been deposited in collection of National Museum Prague CR. The rest of preparations is deposited in the private collection of the first author.

In the systematic part of the present study, the photographs of sternit A8 are positioned with processus caudalis upwards. On the contrary, tergit A8 is presented with its caudal part downwards. The reason for it is better orientation.

Tab. 1. List of used species

Species / Groups	Tergum Tab. 2 margo cranialis	Tergum Tab. 3 caudal margin	Sternum Tab. 4 apex caudalis	Figs.
E. abbreviata STEPHENS, 1831	2	1	2	58 - 60
E. abietaria (GOEZE, 1781)	2	3	5	179 - 181
*E. absinthiata (*CLERCK, 1759)	2	3	2	61 - 63
E. actaeata WALDERDORFF, 1869	1	3	5	182 - 184
E. alliaria STAUDINGER, 1870	1	2	5	185 - 187

	Tergum	Tergum	Sternum	
Species / Groups	Tab. 2 margo cranialis	Tab. 3 caudal margin	Tab. 4 apex caudalis	Figs.
E. breviculata (DONZEL, 1837)	1	2	1	28 - 30
E. cauchiata (DUPONCHEL, 1831)	1	2	3	98 - 100
E. centaureata (DENIS & SCHIFFERMÜLLER, 1775)	2	3	8	272 - 274
E. cocciferata MILLIÈRE, 1864	2	1	2	67 - 69
E. cretaceata (PACKARD, 1874)	3	1	3	101 - 103
E. denotata (HÜBNER, 1813)	1	1	3	104 - 106
E. denticulata (TREITSCHKE, 1828)	1	1	4	143 - 145
E. dissertata (PÜNGELER, 1905)	2	1	5	194 - 196
E. distinctaria HERRICH-SCHÄFFER, 1848	1	3	1	31 - 33
E. dodoneata GUENÉE, 1857	2	2	2	70 - 72
E. egenaria HERRICH-SCHÄFFER, 1848	1	3	5	191 - 193
E. ericeata (RAMBUR, 1833)	2	3	4	146 - 148
E. exiguata (HÜBNER, 1813)	1	1	2	73 - 75
E. expallidata DOUBLEDAY, 1856	1	1	3	107 - 109
E. extraversaria HERRICH-SCHÄFFER, 1852	2	3	8	275 - 277
E. extremata (FABRICIUS, 1787)	1	2	3	110 - 112
E. gelidata MÖSCHLER, 1860	1	2	1	34 - 36
E. gemellata HERRICH-SCHÄFFER, 1861	1	2	3	113 - 115
E. graphata (TREITSCHKE, 1828)	2	3	2	76 - 78
E. gueneata MILLIÈRE, 1862	1	1	2	79 - 81
E. haworthiata DOUBLEDAY, 1856	2	3	7	254 - 256
E. icterata (VILLERS, 1789)	2	2	8	278 - 280
E. immundata (LIENIG & ZELLER, 1846)	3	3	3	116 - 118
E. impurata (HÜBNER, 1813)	1	3	4	149 - 151
E. indigata (HÜBNER, 1813)	1	2	4	152 - 154
E. innotata (HUFNAGEL, 1767)	2	2	1	37 - 39
E. insigniata (HÜBNER, 1790)	2	3	3	119 - 121
E. intricata (ZETTERSTEDT, 1839)	2	2	1	40 - 42

	Tergum	Tergum	Sternum	
Species / Groups	Tab. 2 margo cranialis	Tab. 3 caudal margin	Tab. 4 apex caudalis	Figs.
E. lanceata (HÜBNER, 1825)	2	3	1	43 - 45
E. laquaearia HERRICH-SCHÄFFER, 1848	3	3	6	224 - 226
E. lariciata (FREYER, 1841)	2	3	3	125 - 127
E. linariata (DENIS & SCHIFFERMÜLLER, 1775)	3	3	6	227 - 229
E. millefoliata RÖSSLER, 1866	2	3	4	155 - 157
E. nanata (HÜBNER, 1813)	2	2	1	46 - 48
E. ochridata SCHÜTZE & PINKER, 1968	2	2	1	49 - 51
E. orana DIETZE, 1910	1	3	5	197 - 199
E. orphnata W. PETERSEN, 1910	1	1	4	158 - 160
E. oxycedrata (RAMBUR, 1833)	2	3	2	82 - 84
E. pantellata MILLIÈRE, 1875	3	3	4	161 - 163
E. pauxillaria BOISDUVAL, 1840	1	2	3	128 - 130
E. phoeniceata (RAMBUR, 1834)	3	3	4	164 - 166
E. pimpinellata (HÜBNER, 1813)	1	3	5	200 - 202
E. plumbeolata (HAWORTH, 1809)	3	2	6	230 - 232
E. pulchellata STEPHENS, 1831	3	3	6	233 - 235
E. pusillata (DENIS & SCHIFFERMÜLLER, 1775)	3	3	5	203 - 205
E. pygmaeata (HÜBNER, 1799)	2	1	7	257 - 259
E. pyreneata MABILLE, 1871	3	3	6	236 - 238
E. quercetica PROUT, 1938	3	3	5	206 - 208
E. reisserata PINKER, 1976	3	2	4	167 - 169
E. santolinata MABILLE, 1871	1	1	5	209 - 211
E. satyrata (HÜBNER, 1813)	1	2	2	85 - 87
E. scalptata CHRISTOPH, 1885	1	1	3	131 - 133
E. scopariata (RAMBUR, 1833)	1	2	5	212 - 214
E. selinata HERRICH-SCHÄFFER, 1861	1	2	2	88 - 90
E. semigraphata BRUAND, 1850	1	1	4	170 - 172
E. schiefereri BOHATSCH, 1893	1	3	6	239 - 241

	Tergum	Tergum	Sternum	
Species / Groups	Tab. 2 margo cranialis	Tab. 3 caudal margin	Tab. 4 apex caudalis	Figs.
E. simpliciata (HAWORTH, 1809)	1	2	2	92 - 94
E. sinuosaria (EVERSMANN, 1848)	2	1	6	242 - 244
E. spissilineata (METZNER, 1846)	1	2	2	95 - 97
E. subfuscata (HAWORTH, 1809)	1	1	6	245 - 247
E. subumbrata (DENIS & SCHIFFERMÜLLER, 1775)	1	2	4	173 - 175
E. succenturiata (LINNAEUS, 1758)	1	3	8	281 - 283
E. tantillaria BOISDUVAL, 1840	2	2	3	137 - 139
E. tenuiata (HÜBNER, 1813)	2	2	7	263 - 265
E. tripunctaria HERRICH-SCHÄFFER, 1852	1	2	5	215 - 217
E. trisignaria HERRICH-SCHÄFFER, 1848	2	1	6	248 - 250
E. ultimaria BOISDUVAL, 1840	2	1	7	266 - 268
E. undata (FREYER, 1840)	2	3	7	269 - 271
E. unedonata MABILLE, 1868	2	3	1	52 - 54
E. valerianata (HÜBNER, 1813)	3	2	3	140 - 142
E. venosata (FABRICIUS, 1787)	1	2	6	251 - 253
E. veratraria HERRICH-SCHÄFFER, 1850	3	2	4	176 - 178
E. virgaureata DOUBLEDAY, 1861	2	3	5	218 - 220
E. vulgata (HAWORTH, 1809)	1	2	1	55 - 57

Results

Sternum A8 has sharp contours in comparison with tergum A8 whose sides continue without evident borders into membrane. This is especially visible in their caudal margin. Only the margo cranialis is very sharp. Sclerotization of tergum A8 is more evident in the cranial part of the segment.

In many species, the shape of tergum A8 is very typical (*E.subfuscata* and others). In these cases, visual examination is quite sufficient for species determination. The shape of the margo cranialis is most important (Tab. 2). In some species it exceeds the breadth of the segment (45 % of species- Fig. 14), in some other species it ends at the shape of the segment (39 % of species- Fig. 15); and in the remaining species it does not project above the margin of the segment (16% of species- Fig. 16).

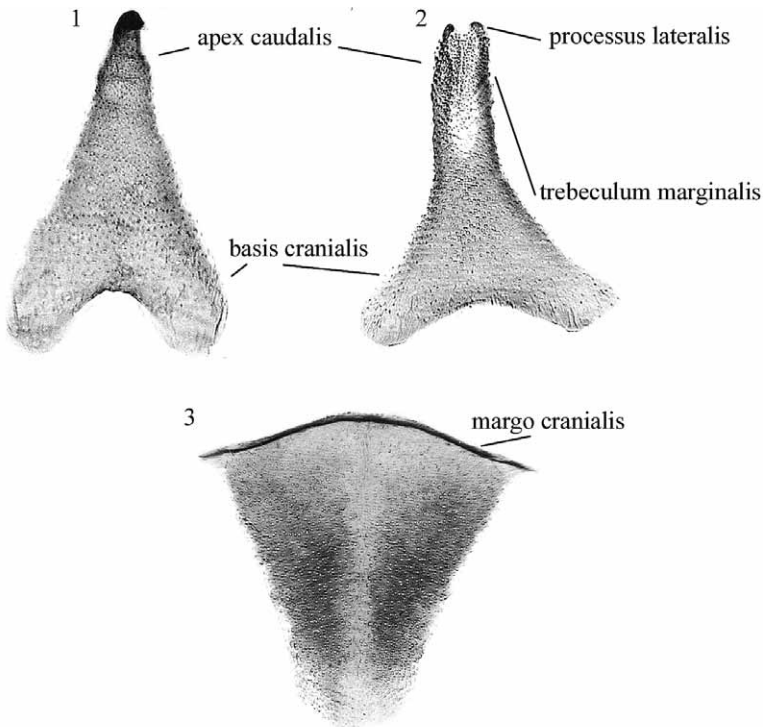
The next distinguishing sign is the caudal margin of tergum A8 (Tab. 3). In 19 % of the species the margin is divided into two distinct lobes (Fig. 17). In 39 % of species, these lobes are indicated only indistinctly (Fig. 18), and in 41 % of species the caudal margin of tergum A8 is undivided (Fig. 19).

The size of sternum A8 and tergum A8 varies noticeably in different species (Figs. 4, 5, 6). The majority of segments A8 are coverd with a large number of scales (Figs. 11, 12, 13). Both parts of segment A8 are connected laterally with a membrane enveloping the external genitalia (Fig. 7).

In some species, the caudal parts of the segments A8 are hooked medially and cranially. This may cause problems in primary considerations (Fig. 10). Within the preparatory work, these anatomical hook-like structures were mechanically elongated.

According to the shape of apex caudalis of sternum A8, all species of genus *Eupithecia* were subdivided into 8 characteristic groups (Figs. 20 – 27) (Tab. 4).

In the three species (*E. reisserata, E. simplicita, E. succcenturiata*), the variability of the shape of segment A8 was studied in a larger number of specimens (Figs. 284 – 311). The shape variance does not influence the reliability of determination (VOJNITS 1975, TRÄFF 1965, KRAMPL 1994).



Figs 1-3. Nomenclatorial proposal for the morphology of the 8th abdominal segment. 1-2. Sternum A 8. 3. Tergum A8

Figs 4-6. Comparison of the shape of sternum A8 in different species, using the same magnification. 4. *E. dodoneata*. 5. *E. virgaureata*. 6. *E. centaureata*

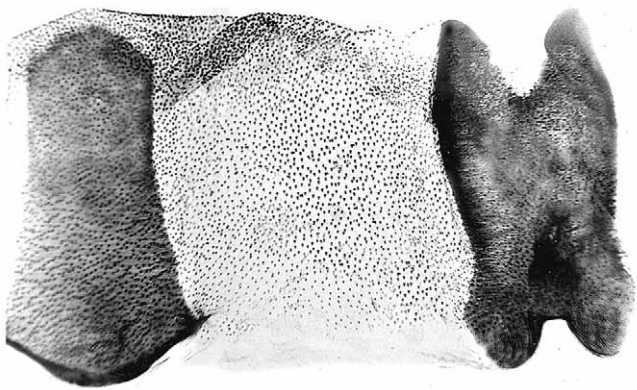


Fig. 7. Tergum A8 and sternum A8 connected by the lateral membrane in *E. succenturiata*

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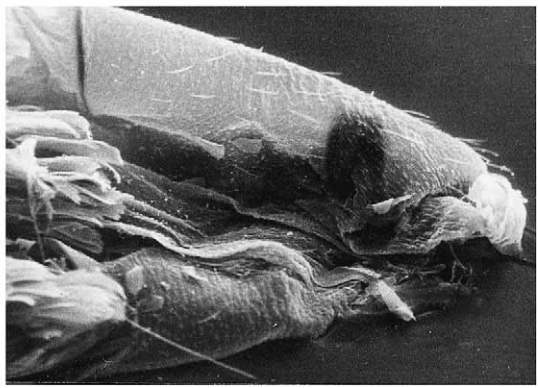

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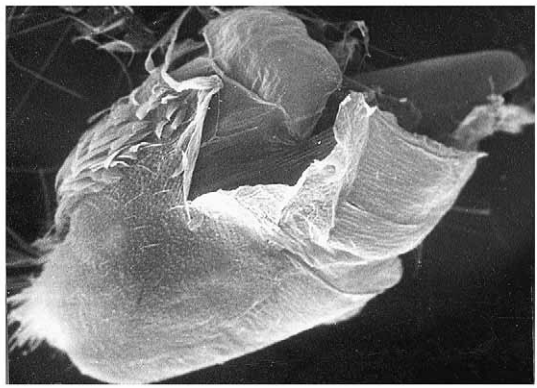

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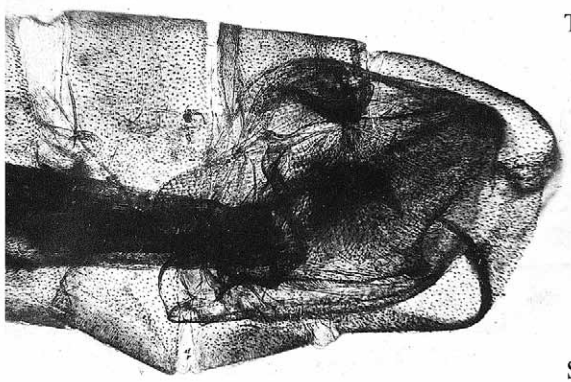

Figs 8-10. 8-9. *E. vulgata*.10. *E. pusillata.*

11

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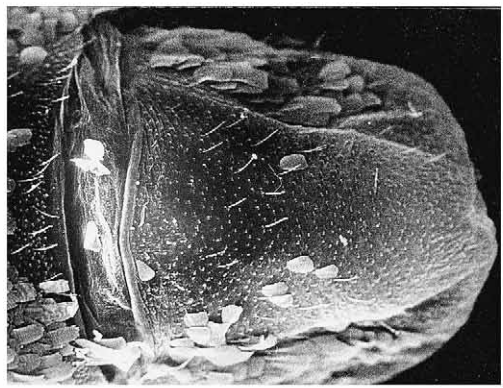

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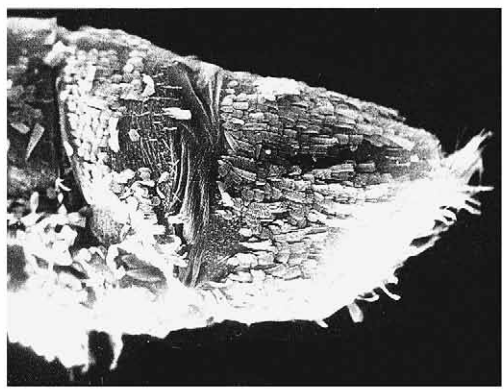


Figs. 11-13. 11. Sternum A8 *E. vulgata*. Scanning elektron microscope magn. 140x.
12. Tergum A8 *E. dodoneata*. Scanning elektron microscope magn. 220x.
13. Tergum A8 *E. vulgata*. Scanning elektron microscope magn. 97x.

Tab. 2. Determination on the basis of relation of margo cranialis to the breadth of the tergum A8

1. Margo cranialis exceeds the breadth of the segment (Fig. 14)

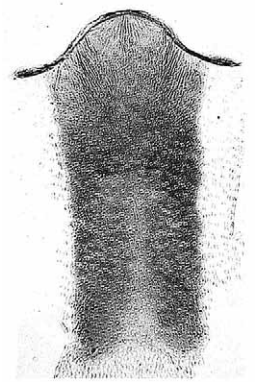


Fig. 14. *E. subfuscata*

E. actaeata
E. alliaria
E. breviculata
E. cauchiata
E. denotata
E. denticulata
E. distinctaria
E. egenaria
E. exiguata
E. expallidata
E. extremata
E. gelidata
E. gemellata
E. gueneata
E. impurata
E. indigata
E. inturbata
E. orana
E. orphnata
E. pauxillaria
E. pimpinellata
E. santolinata
E. satyrata
E. scalptata
E. scopariata
E. selinata
E. semigraphata
E. schiefereri
E. silenata
E. silenicolata
E. simpliciata
E. spissilineata
E. subfuscata
E. subumbrata
E. succenturiata
E. tripunctaria
E. venosata
E. vulgata

2. Margo cranialis does not exceed the breadth of the segment (Fig. 15)

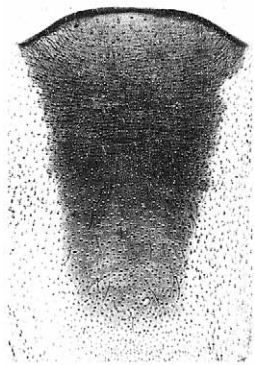


Fig. 15. *E. lanceata*

E. abbreviata
E. abietaria
E. absinthiata
E. analoga
E. assimilata
E. centaureata
E. cocciferata
E. dissertata
E. dodoneata
E. ericeata
E. extraversaria
E. graphata
E. haworthiata
E. icterata
E. innotata
E. insigniata
E. intricata
E. irriguata
E. lanceata
E. lariciata
E. millefoliata
E. nanata
E. ochridata
E. oxycedrata
E. pygmaeata
E. sinuosaria
E. tenuiata
E. trisignaria
E. ultimaria
E. undata
E. unedonata
E. virgaureata

3. Margo cranialis does not reach to the breadth of the segment (Fig. 16)

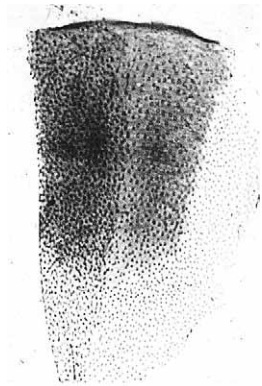


Fig. 16. *E. plumbeolata*

E. cretaceata	*E. phoeniceata*	*E. quercetica*
E. immundata	*E. plumbeolata*	*E. reisserata*
E. laquaearia	*E. pulchellata*	*E. tantillaria*
E. linariata	*E. pusillata*	*E. valerianata*
E. pantellata	*E. pyreneata*	*E. veratraria*

Tab. 3 Determination on the basis of morphology of the caudal margin of tergum A8

1. The caudal margin is separated in two expensive visible lobes (Fig. 17)

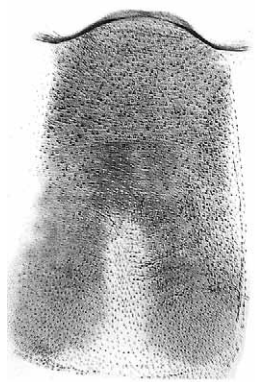


Fig. 17. *E. semigraphata*

E. abbreviata
E. analoga
E. cocciferata
E. cretaceata
E. denotata
E. denticulata
E. dissertata
E. exiguata
E. expallidata
E. gueneata
E. orphnata
E. pygmaeata
E. santolinata
E. scalptata
E. semigraphata
E. sinuosaria
E. subfuscata
E. trisignaria
E. ultimata

2. The caudal margin is only indistinctly separated in two visible lobes (Fig. 18)

Fig. 18. *E. alliaria*

E. alliaria
E. breviculata
E. cauchiata
E. dodoneata
E. extremata
E. gelidata
E. gemellata
E. icterata
E. indigata
E. innotata
E. intricata
E. inturbata
E. irriguata
E. nanata
E. ochridata
E. pauxillaria
E. plumbeolata
E. reisserata
E. satyrata
E. scopariata
E. selinata
E. simpliciata
E. spissilineata
E. subumbrata
E. tenuiata
E. tripunctaria
E. valerianata
E. venosata
E. veratraria
E. vulgata

The caudal margin is undivided (Fig. 19)

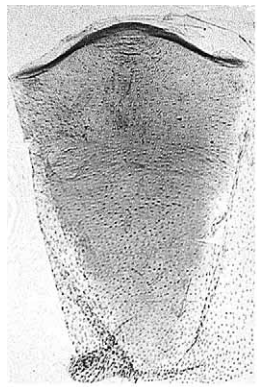


Fig. 19. *E. tantillaria*

E. abietaria
E. absinthiata
E. actaeata
E. assimilata
E. centaureata
E. distinctaria
E. egenaria
E. ericeata
E. extraversaria
E. graphata
E. haworthiata
E. immundata
E. impurata
E. insigniata
E. lanceata
E. laquaearia
E. lariciata
E. linariata
E. millefoliata
E. orana
E. oxycedrata
E. pantellata
E. phoeniceata
E. pimpinellata
E. pulchellata
E. pusillata
E. pyreneata
E. quercetica
E. schiefereri
E. silenata
E. silenicolata
E. succenturiata
E. tantillaria
E. undata
E. unedonata
E. virgaureata

Tab. 4. Division of the genus *Eupithecia* into eight groups on the basis of the morphological diversity of the apex caudalis of sternum A8

Group 1. Apex caudalis compact, not bifurcated (Fig. 20)

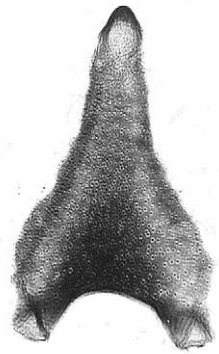


Fig. 20. *E. vulgata*

E. breviculata
E. distinctaria
E. gelidata
E. innotata
E. intricata
E. lanceata
E. nanata
E. ochridata
E. unedonata
E. vulgata

Group 2. Apex caudalis with shallow sulcus. Even in very small magnification apex appears frequently simple (Fig. 21)

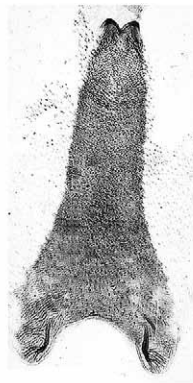


Fig. 21. *E. absinthiata*

E. abbreviata
E. absinthiata
E. assimilata
E. cocciferata
E. dodoneata
E. exiguata
E. graphata
E. gueneata
E. oxycedrata
E. satyrata
E. selinata
E. simpliciata
E. spissilineata

Group 3. Apex caudalis obviously more bifurcated, without beads on the tips of processus laterales (Fig. 22)

Fig. 22. *E. gemellata*

E. cauchiata
E. cretaceata
E. denotata
E. expallidata
E. extremata
E. gemellata
E. immundata
E. insigniata
E. irriguata
E. lariciata
E. pauxillaria
E. scalptata
E. silenata
E. tantillaria
E. valerianata

Group 4. Apex caudalis coresponds with group 3, but the tips of processus laterales are beadlike (Fig. 23)

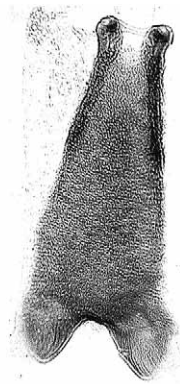


Fig. 23. *E. semigraphata*

E. denticulata
E. ericeata
E. impurata
E. indigata
E. millefoliata
E. orphnata
E. pantellata
E. phoeniceata
E. reisserata
E. semigraphata
E. subumbrata
E. veratraria

Group 5. Apex caudalis broadly bifurcated (Fig. 24)

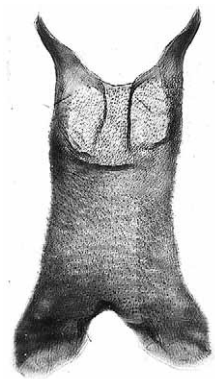


Fig. 24. *E. actaeata*

E. abietaria
E. actaeata
E. alliaria
E. analoga
E. dissertata
E. egenaria
E. orana
E. pimpinellata
E. pusillata

E. quercetica
E. santolinata
E. scopariata
E. tripunctaria
E. virgaureata

Group 6. Apex caudalis distinctive with long and narrow processus laterales. Sinus very deep, but does not reach to basis cranialis (Fig. 25)

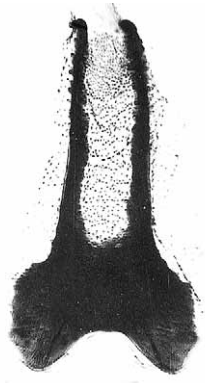


Fig. 25. *E. subfuscata*

E. inturbata
E. laquaearia
E. linariata
E. plumbeolata
E. pulchellata
E. pyreneata
E. schiefereri
E. sinuosaria
E. subfuscata
E. trisignaria
E. venosata

Group 7. Apex caudalis corresponds with group 6, but sinus reaches as far as basis cranialis (Fig. 26)

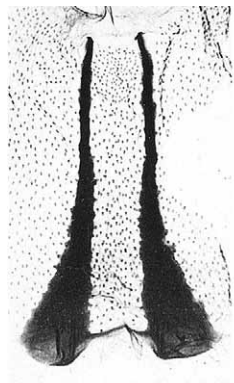


Fig. 26. *E. pygmaeata*

E. haworthiata *E. silenicolata* *E. ultimaria*
E. pygmaeata *E. tenuiata* *E. undata*

Group 8. Sternum A8 is markedly large in size and shape (Fig. 27)

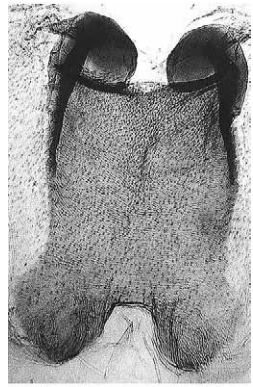
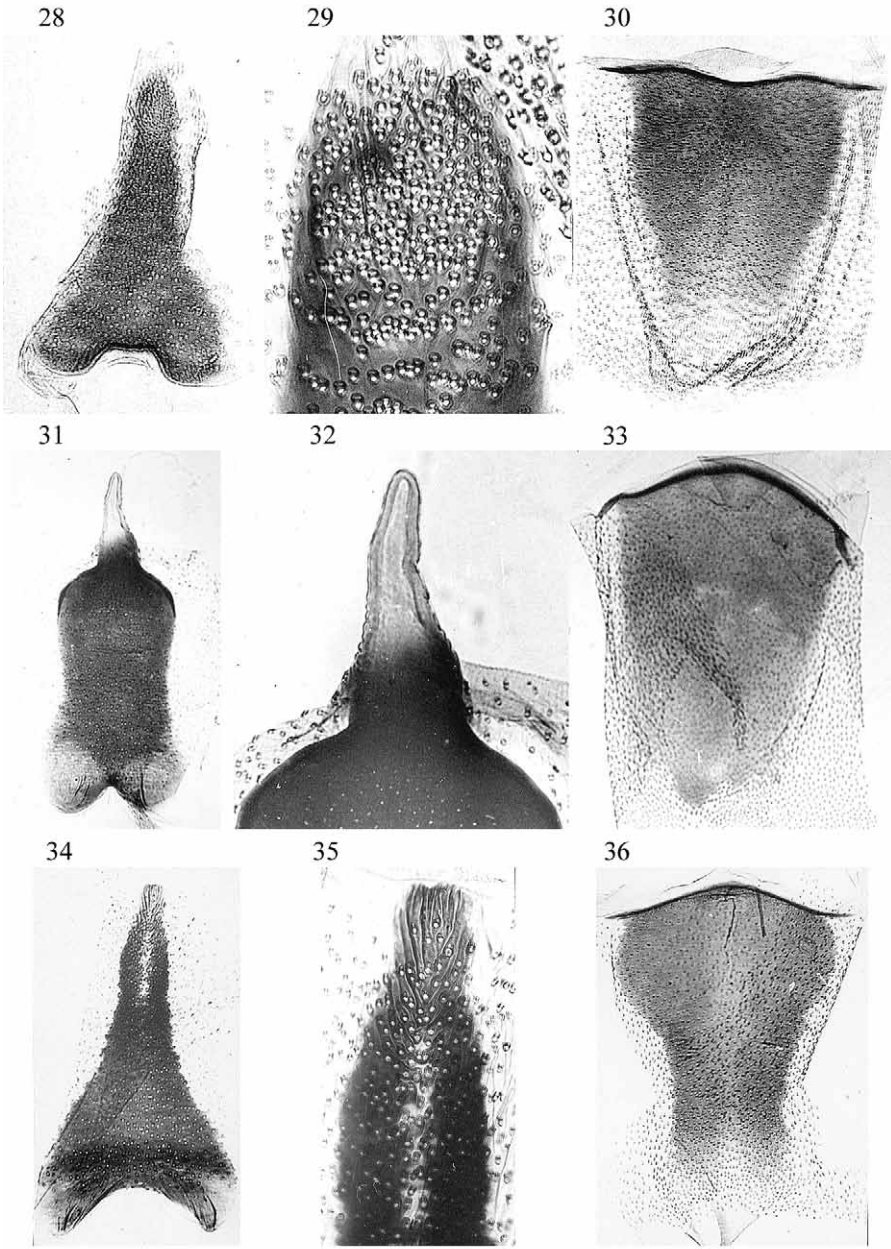
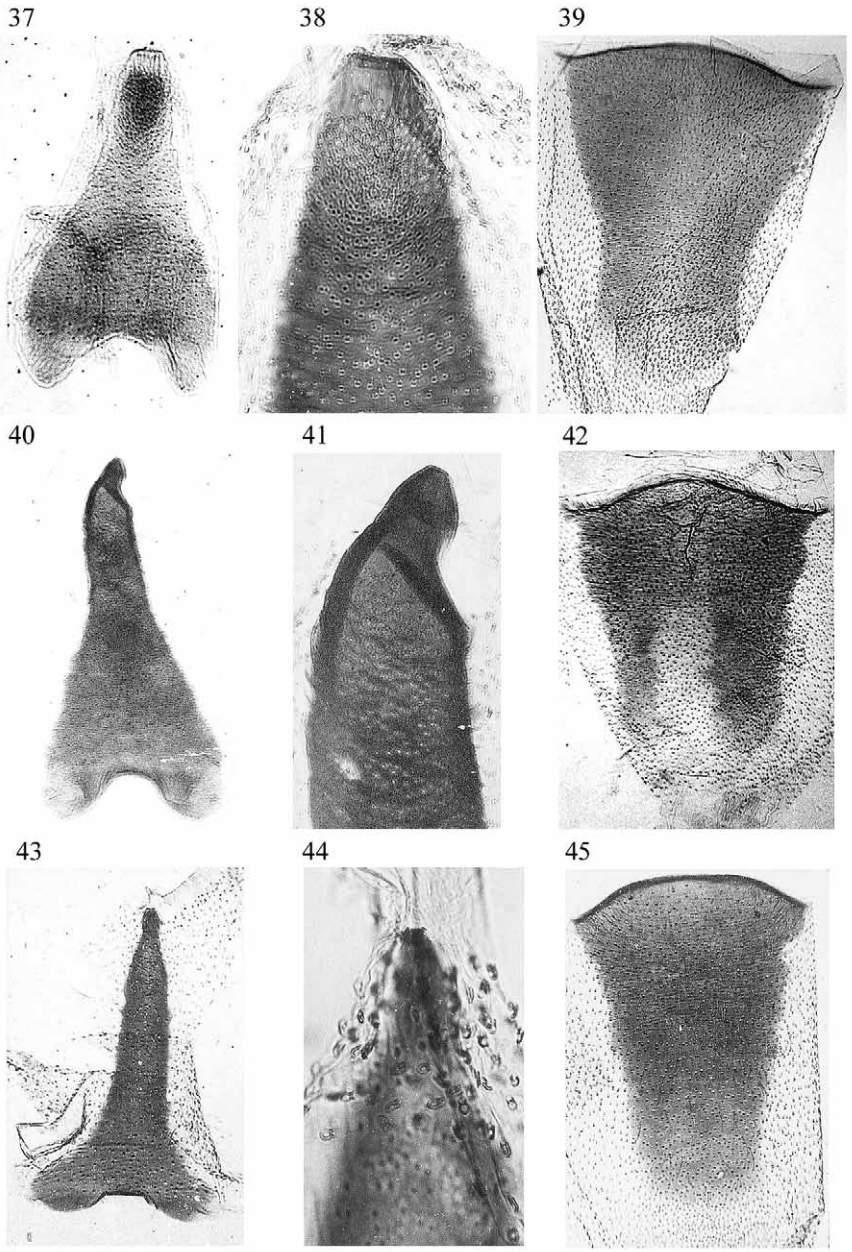


Fig. 27. *E. icterata*

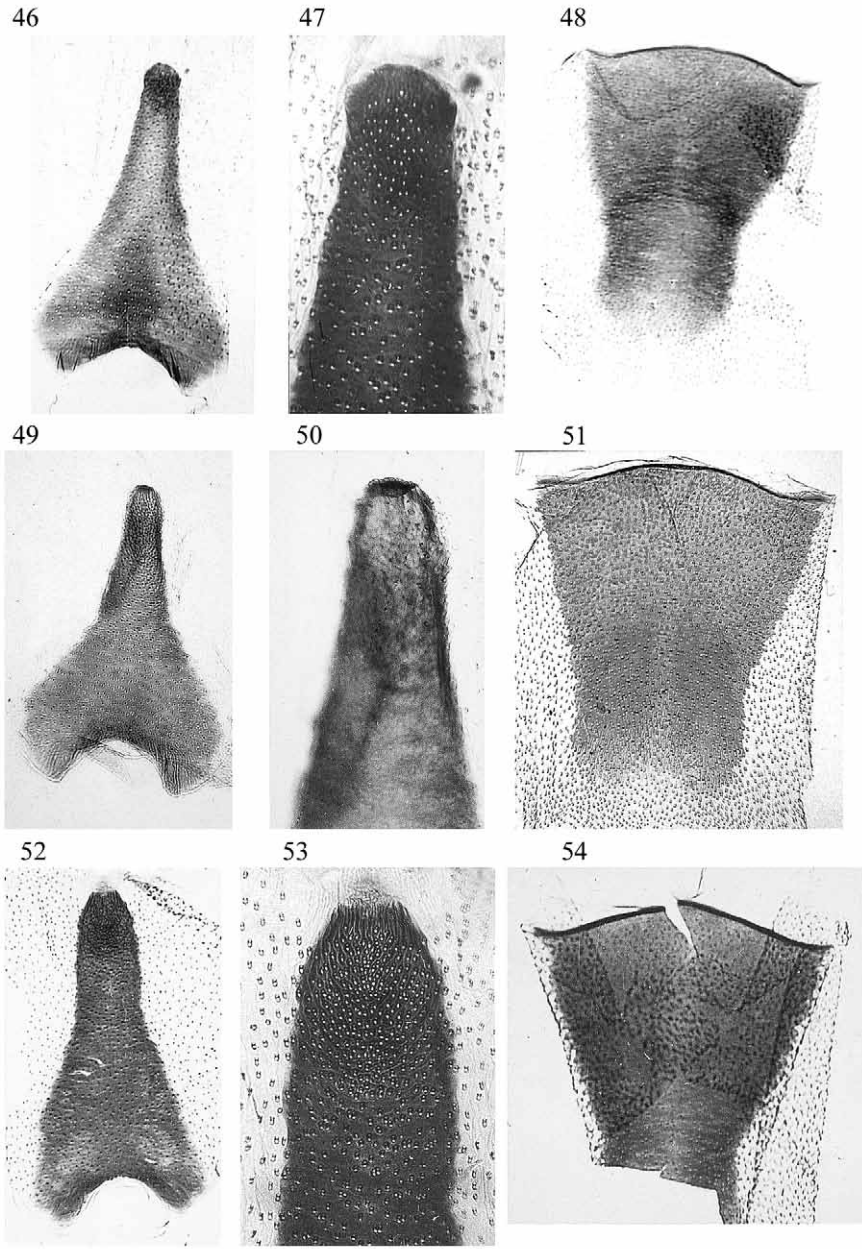
E. centaureata *E. icterata*
E. extraversaria *E. succenturiata*



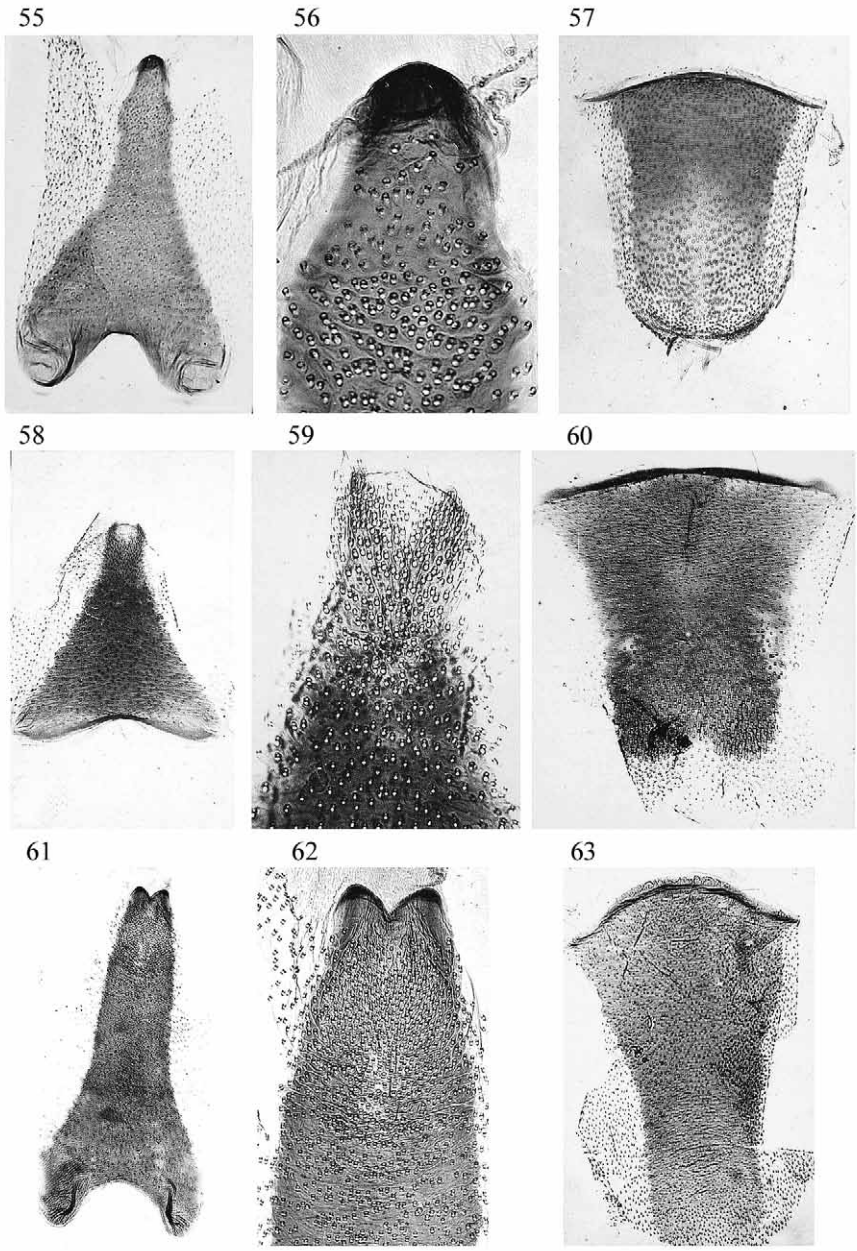
Figs. 28-36. **Group 1.** 28-30. *E. breviculata*. 31-33. *E. distinctaria*. 34-36. *E. gelidata*.



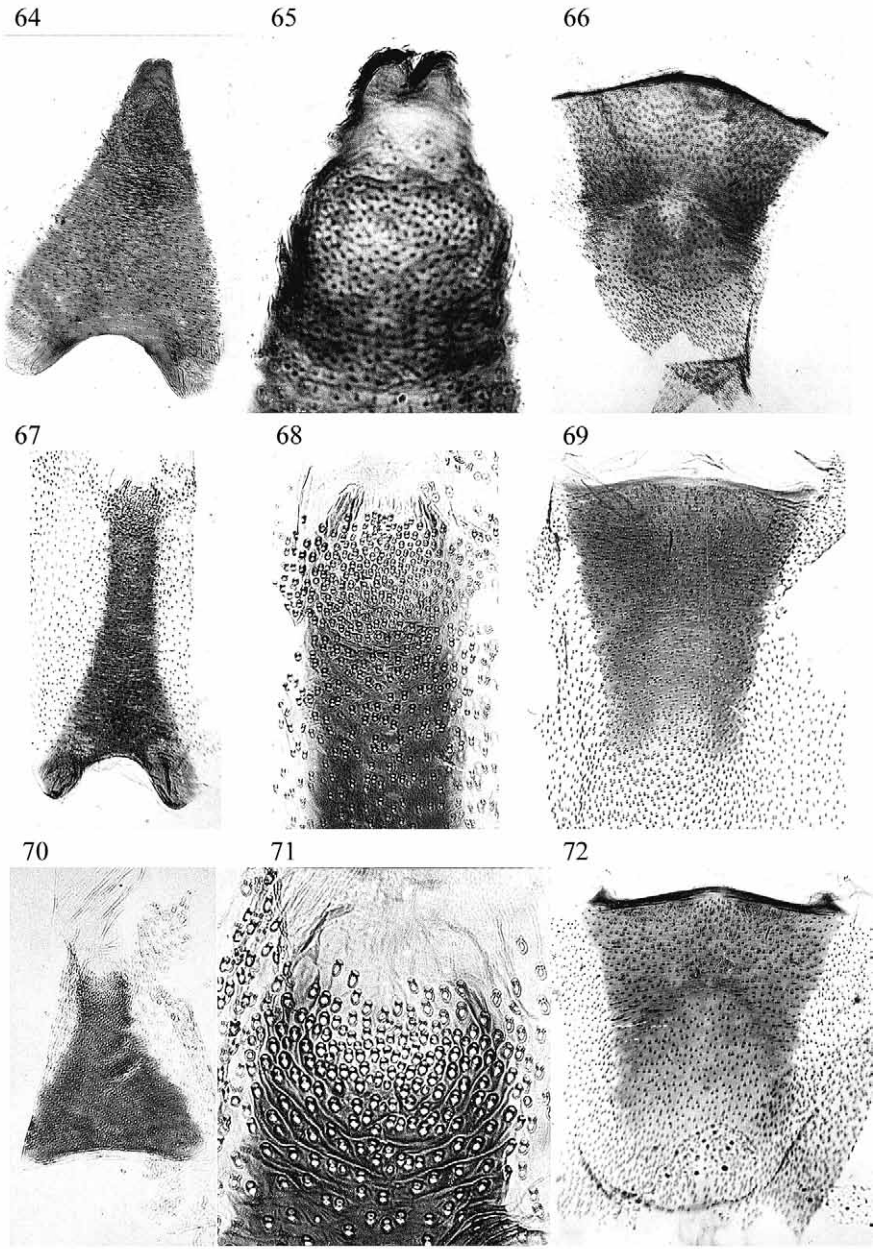
Figs. 37-45. **Group 1.** 37-39 *E. innotata*. 40-42 *E. intricata*. 43-45 *E. lanceata*.



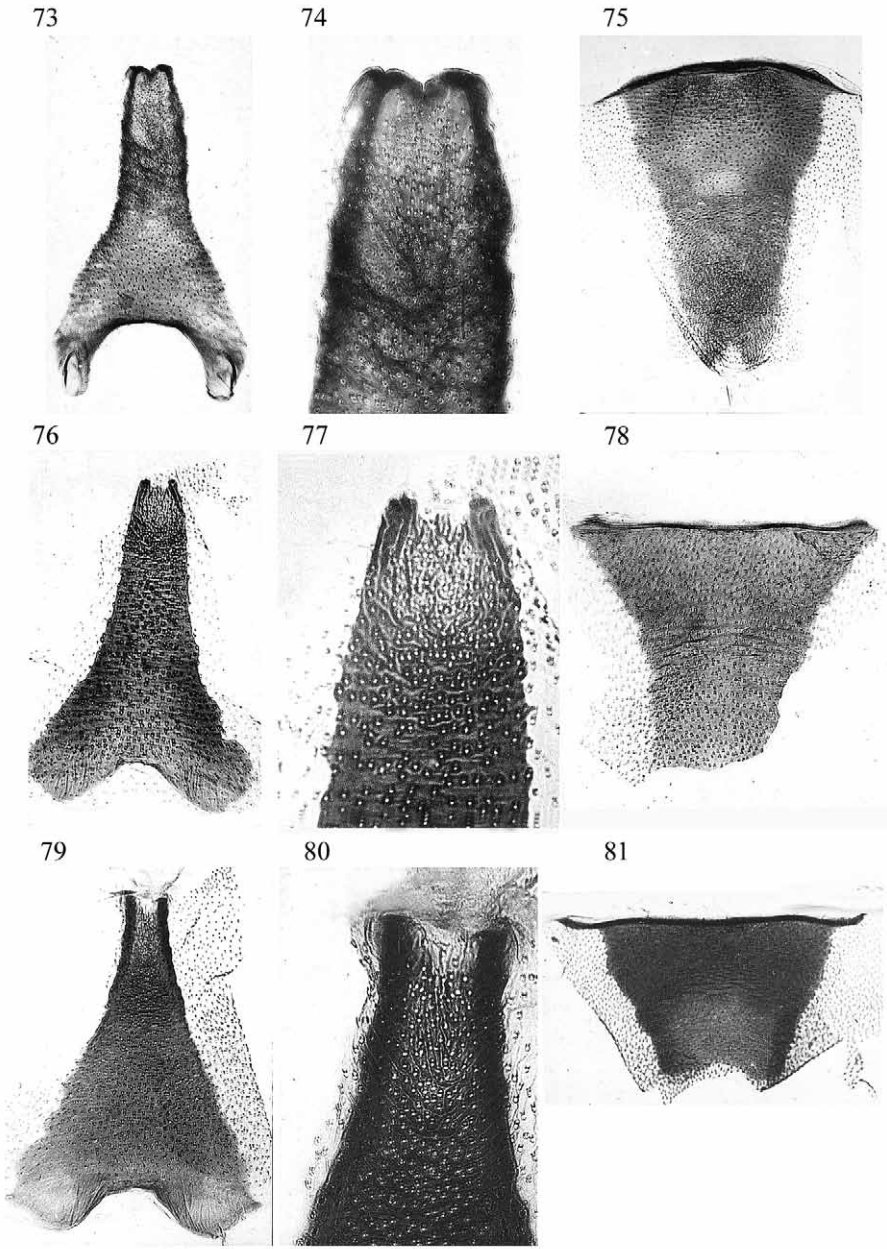
Figs. 46-54. **Group 1.** 46-48 *E. nanata*. 49-51 *E. ochridata*. 52-54 *E. unedonata*.



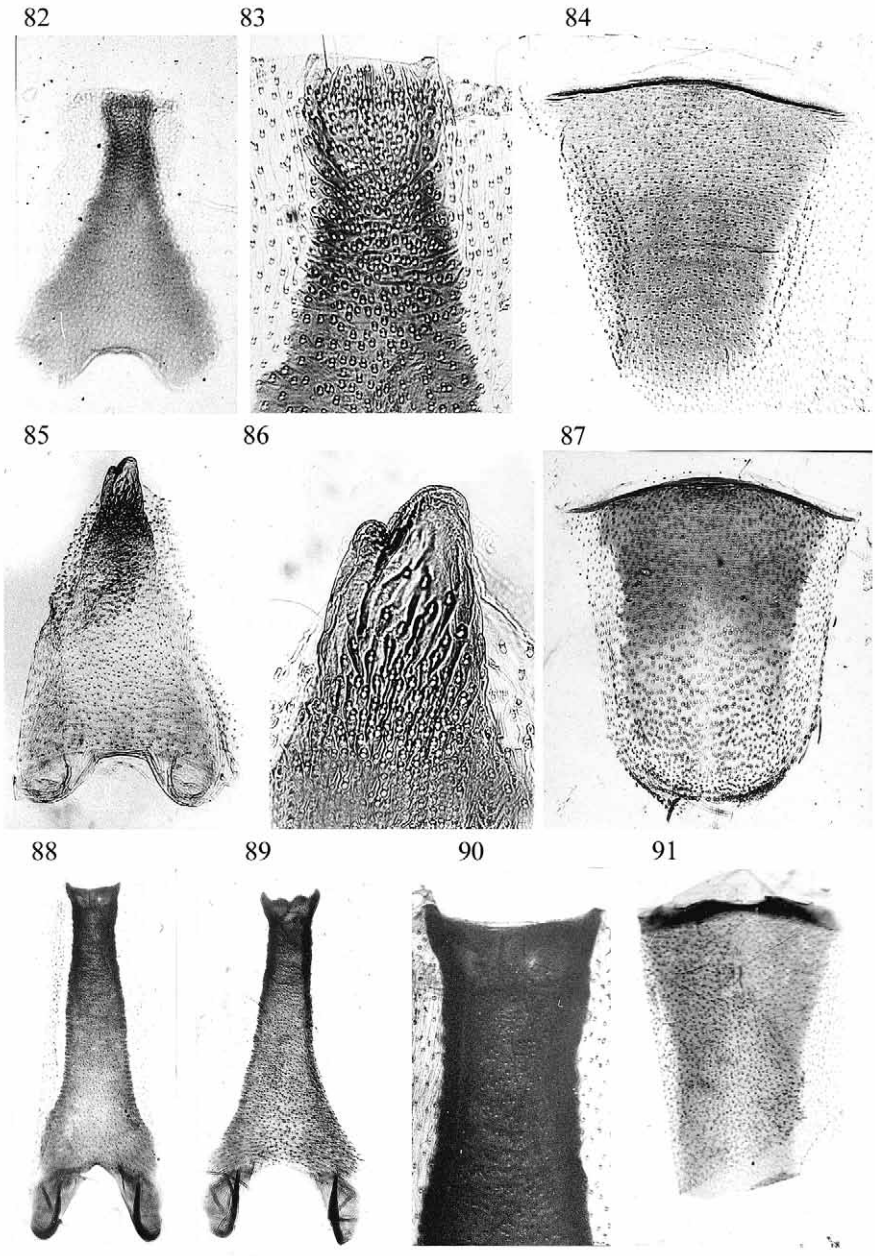
Figs. 55-63. **Group 1**. 55-57. *E. vulgata.*
Group 2. 58-60. *E. abbreviata*. 61-63. *E. absinthiata.*



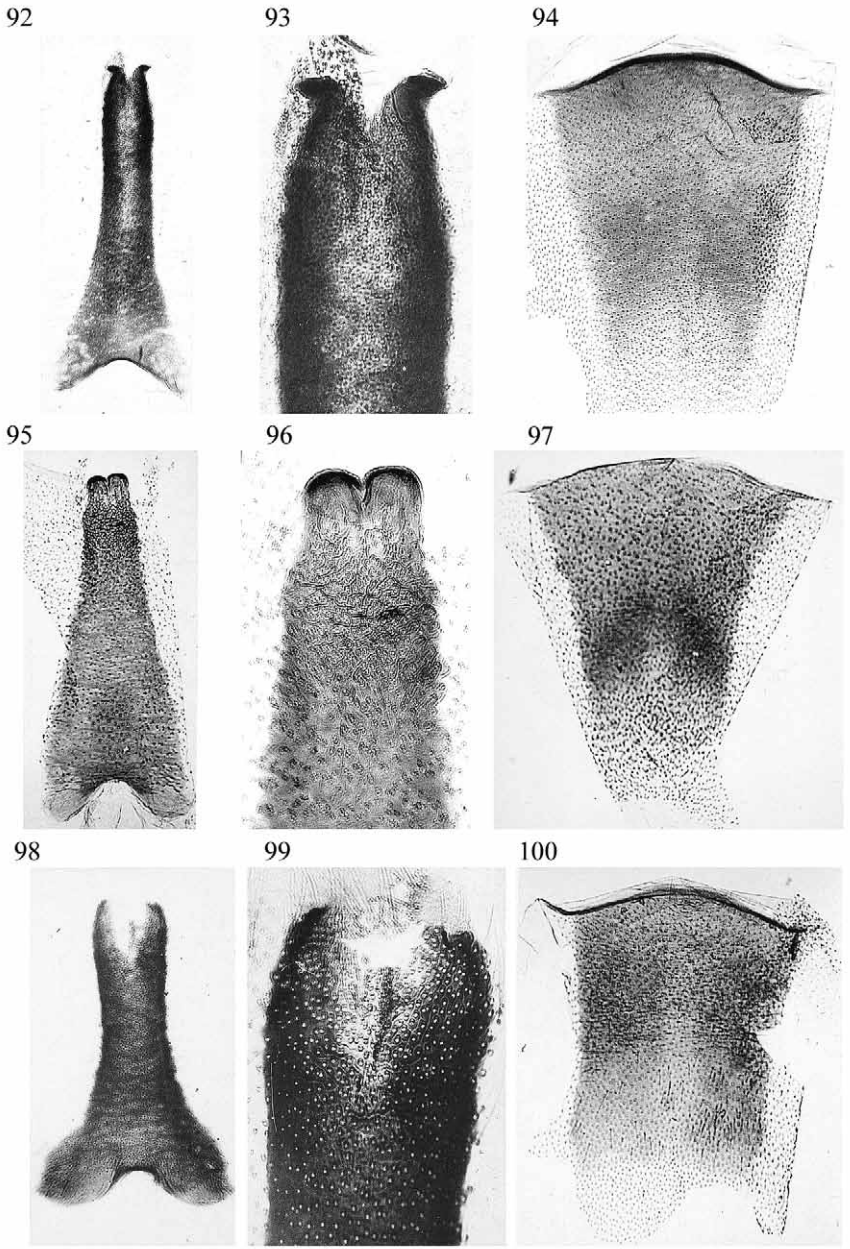
Figs. 64-72. **Group 2**. 64-66. *E. assimilata*. 67-69. *E. cocciferata*. 70-72. *E. dodoneata*.



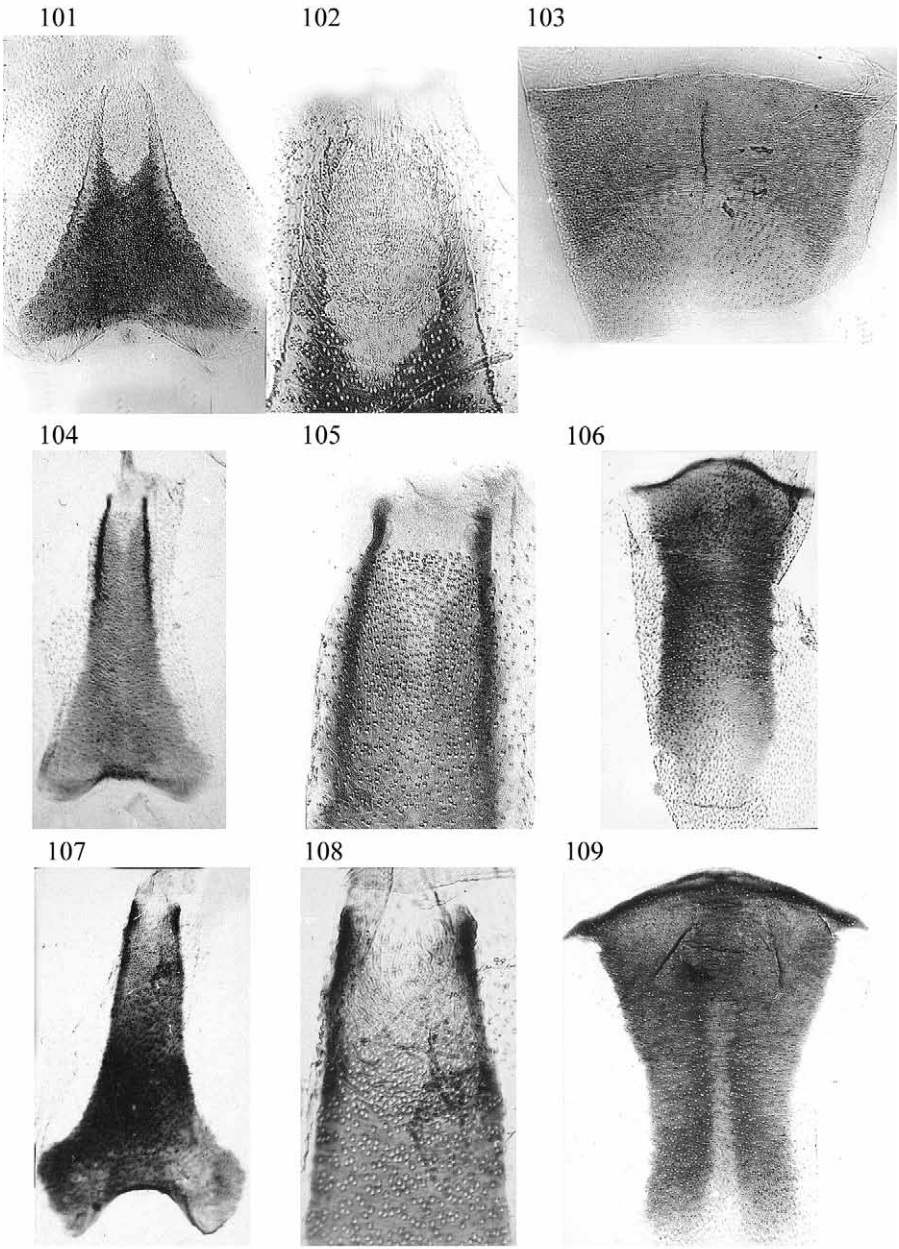
Figs. 73-81. **Group 2.** 73-75. *E. exiguata.* 76-78. *E. graphata.* 79-81. *E. gueneata.*



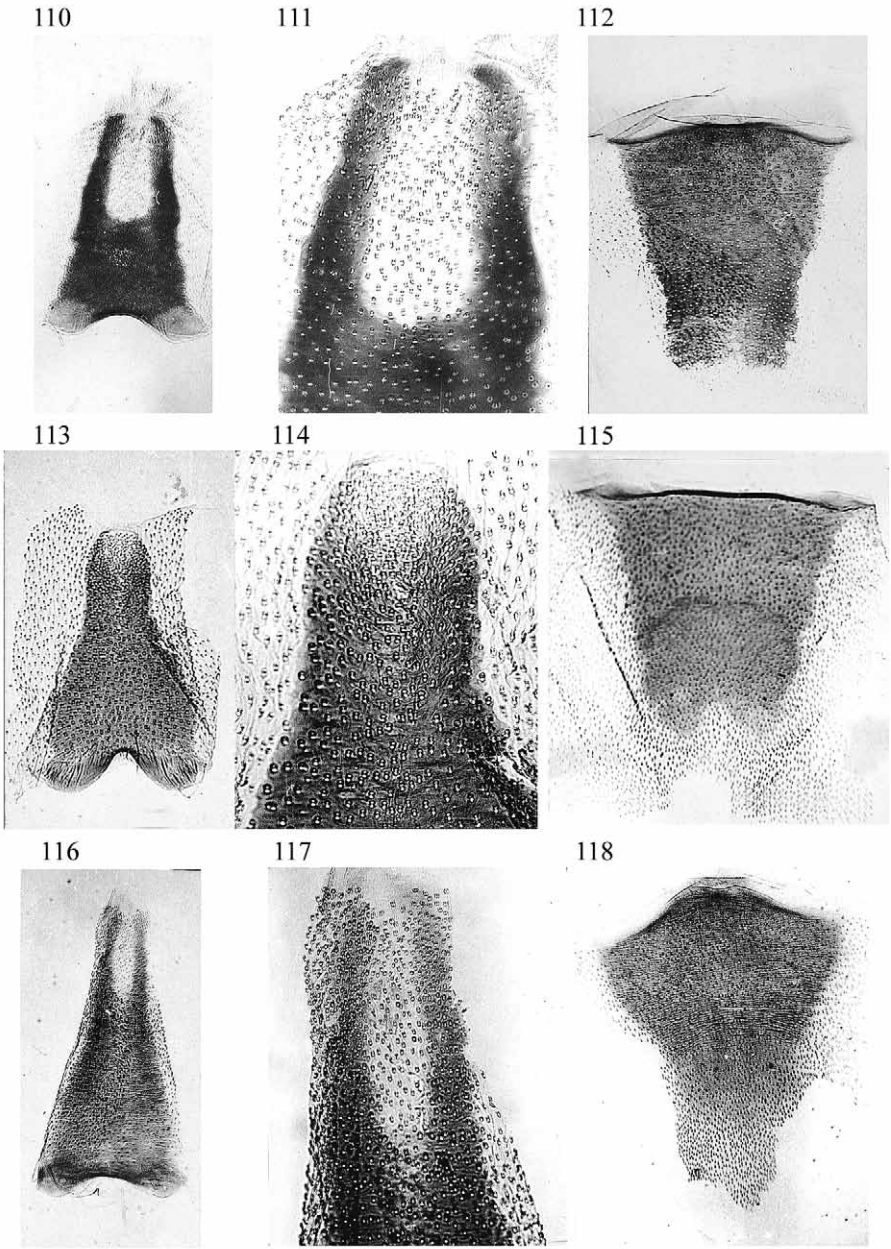
Figs. 82-91. **Group 2.** 82-84. *E. oxycedrata*. 85-87. *E. satyrata.* 88-91. *E. selinata.*



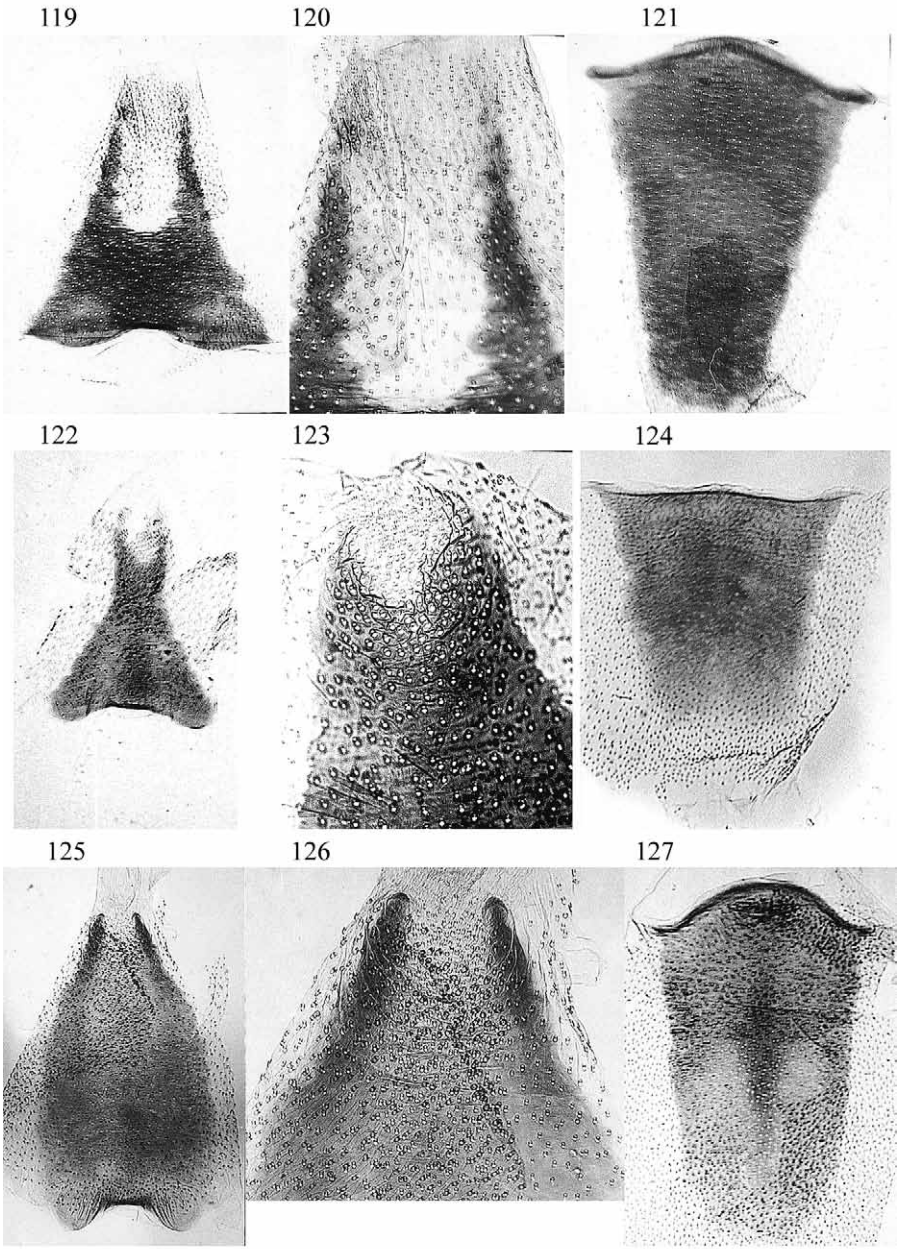
Figs. 92-100. **Group 2.** 92-94. *E. simpliciata*. 95-97. *E. spissilineata*.
Group 3. 98-100. *E. cauchiata*.



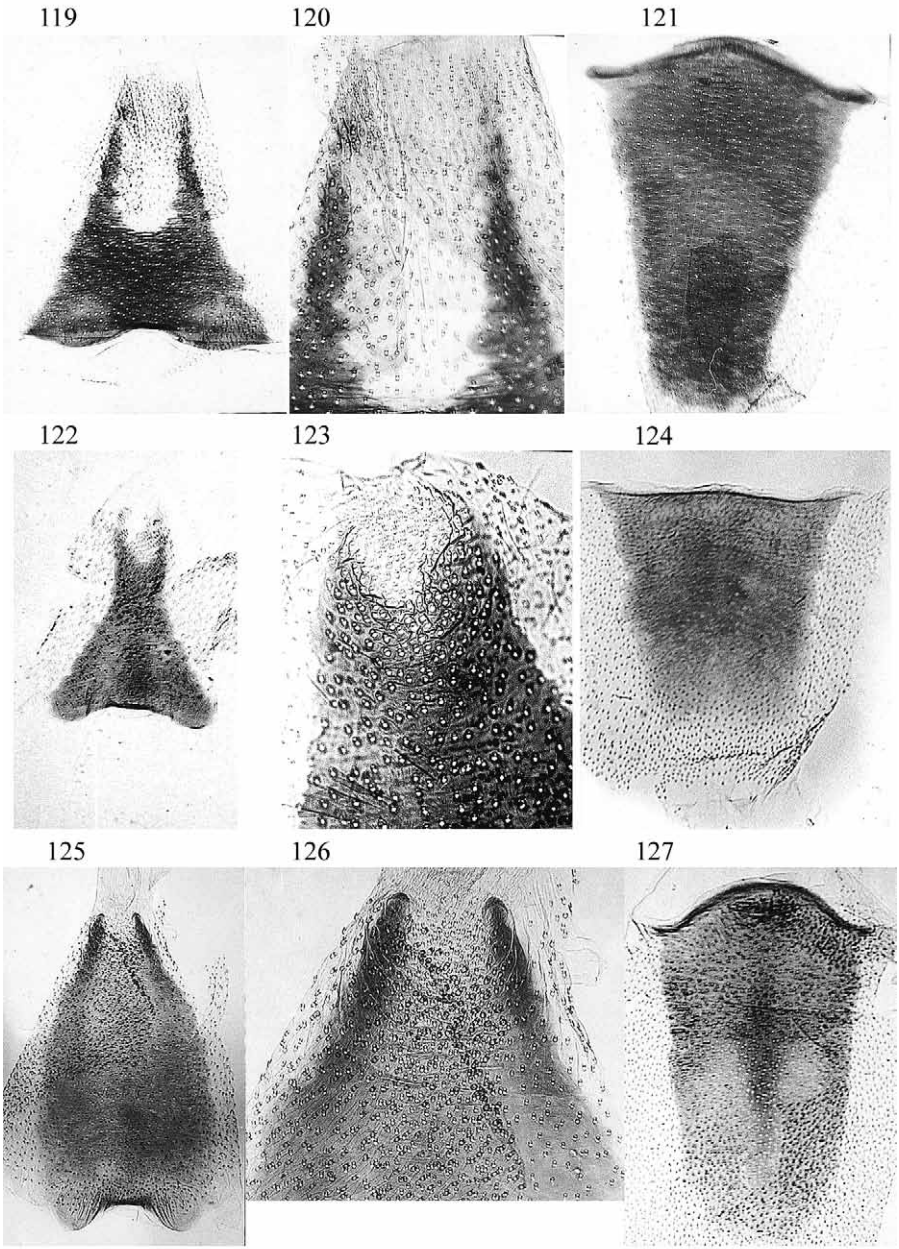
Figs. 101-109. **Group 3.** 101-103. *E. cretaceata.* 104-106. *E. denotata.* 107-109. *E. expallidata.*



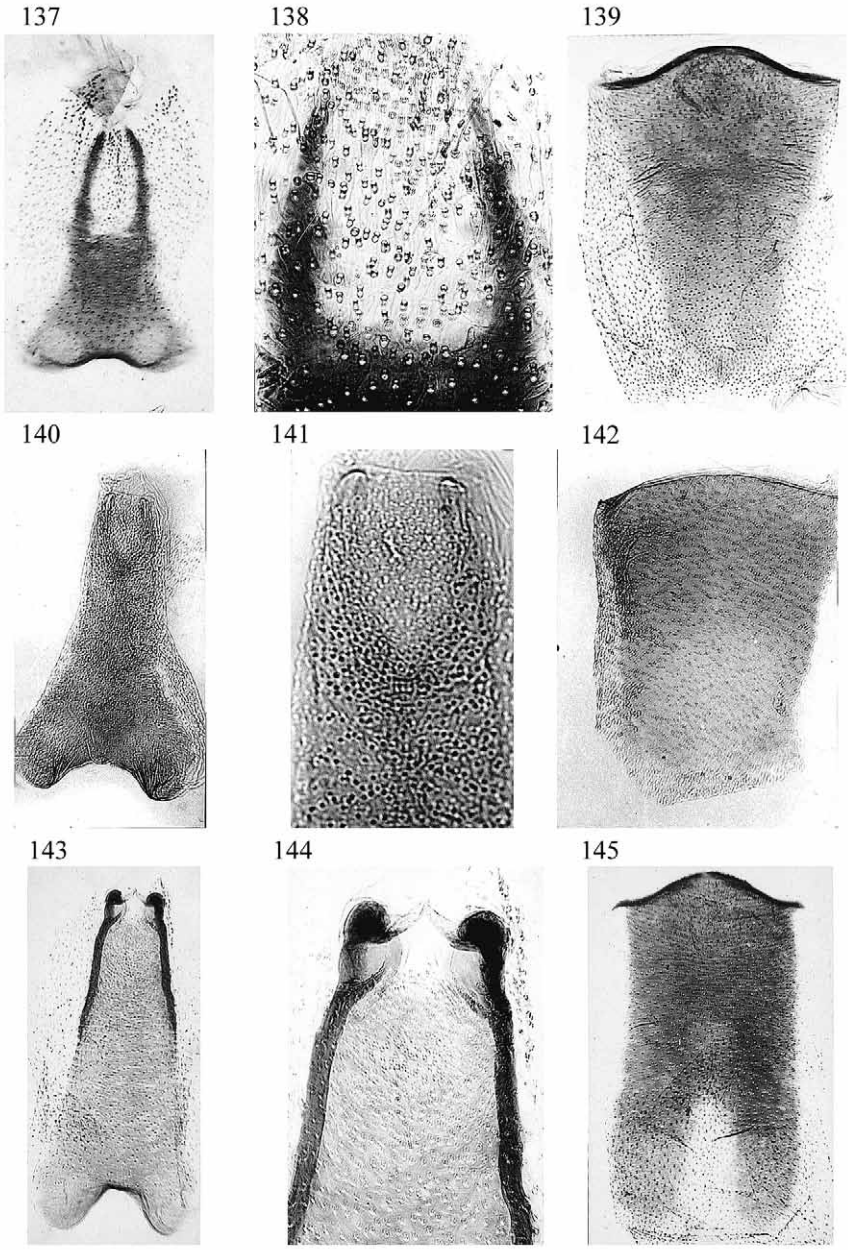
Figs. 110-118. **Group 3.** 110-112. *E. extremata.* 113-115. *E. gemellata.* 116-118. *E. immundata.*



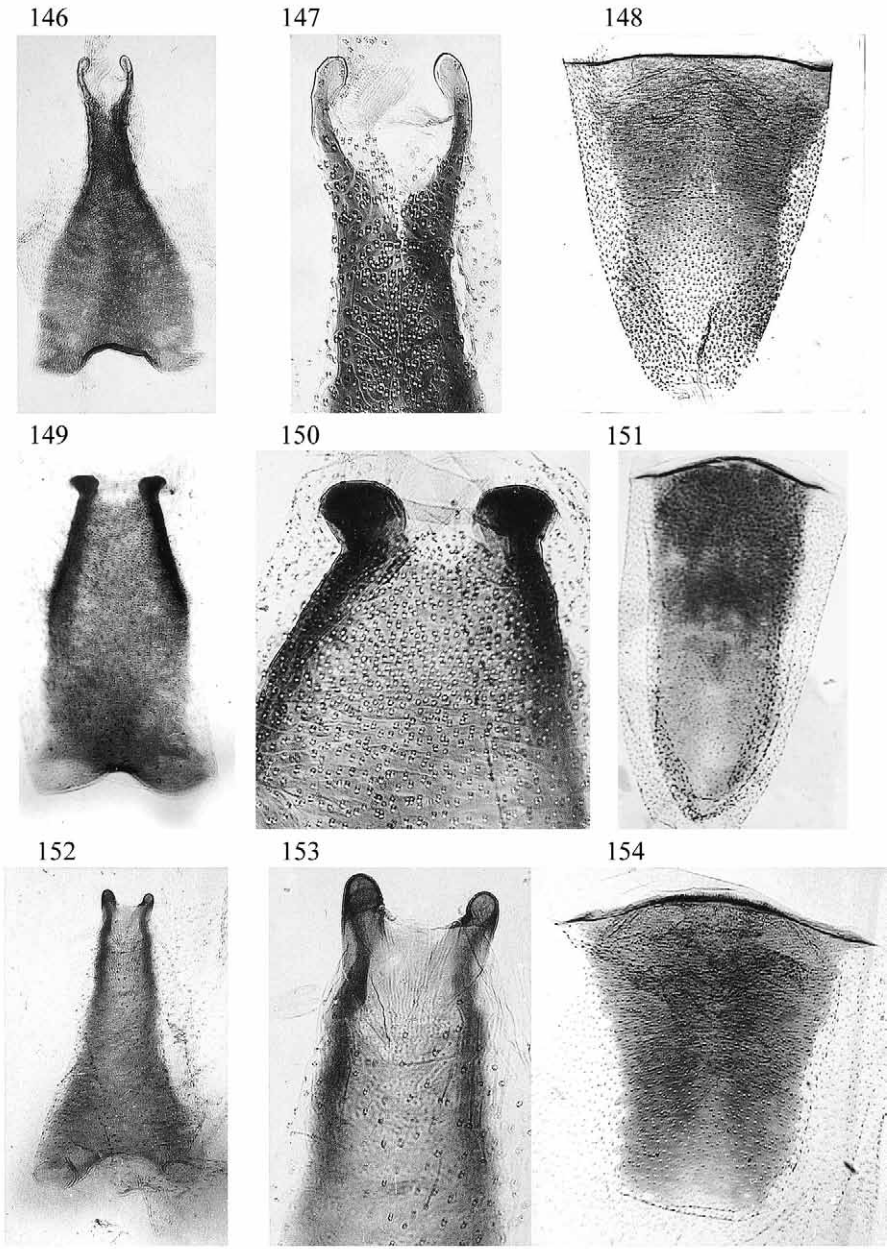
Figs. 119-127. **Group 3.** 119-121. *E. insigniata.* 122-124. *E. irriguata.* 125-127. E. *lariciata.*



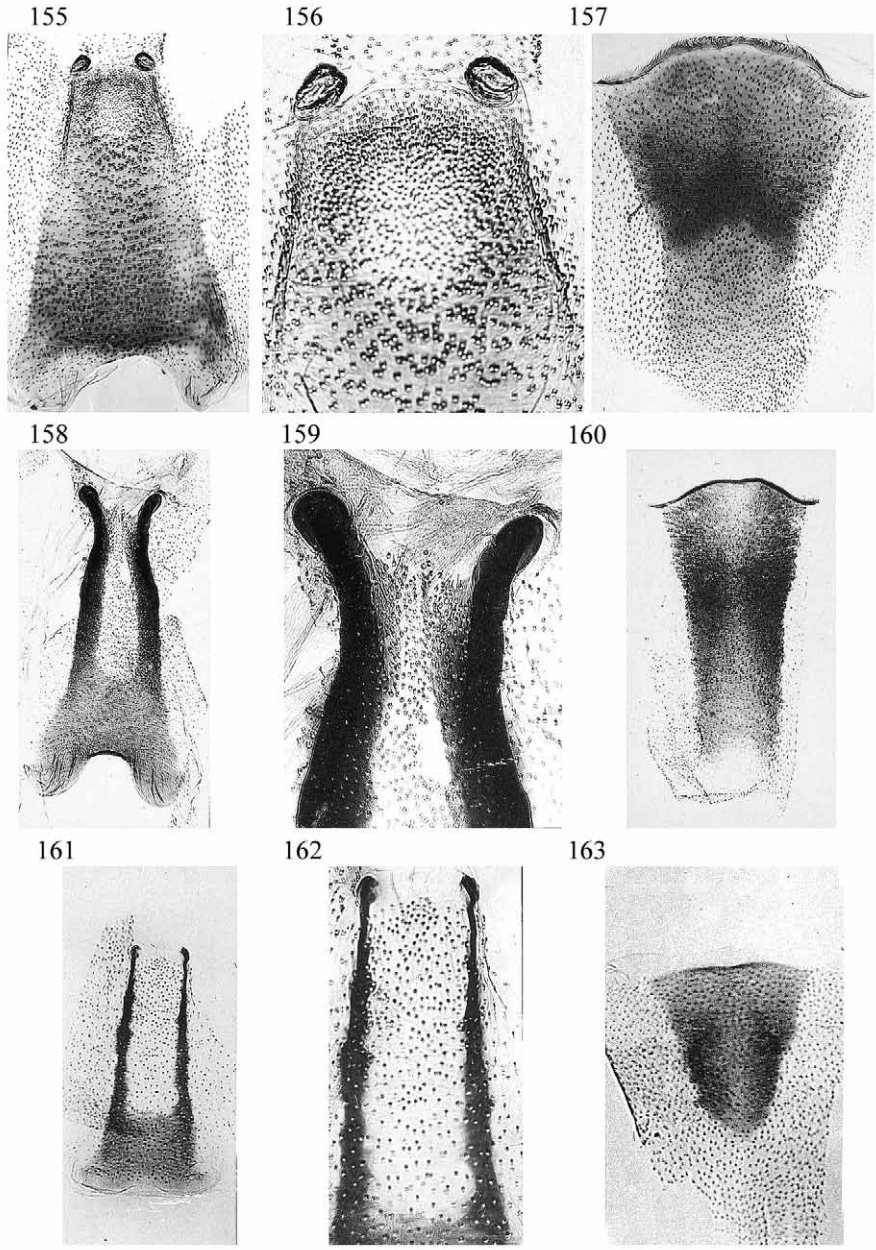
Figs. 119-127. **Group 3.** 119-121. *E. insigniata.* 122-124. *E. irriguata.* 125-127. E. *lariciata.*



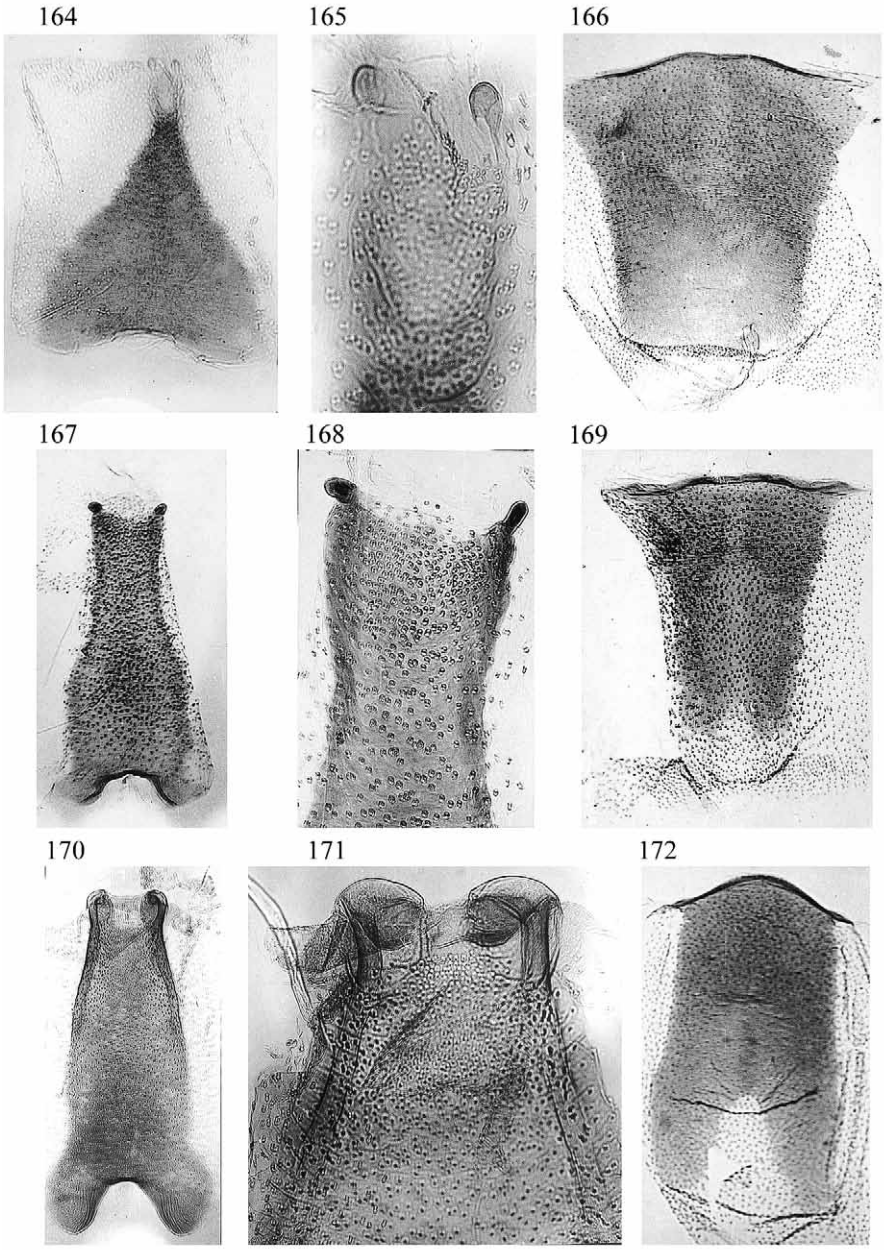
Figs. 137-145. **Group 3.** 137-139. *E. tantillaria*. 140-142. *E. valerianata.*
Group 4. 143-145. E. *denticulata.*



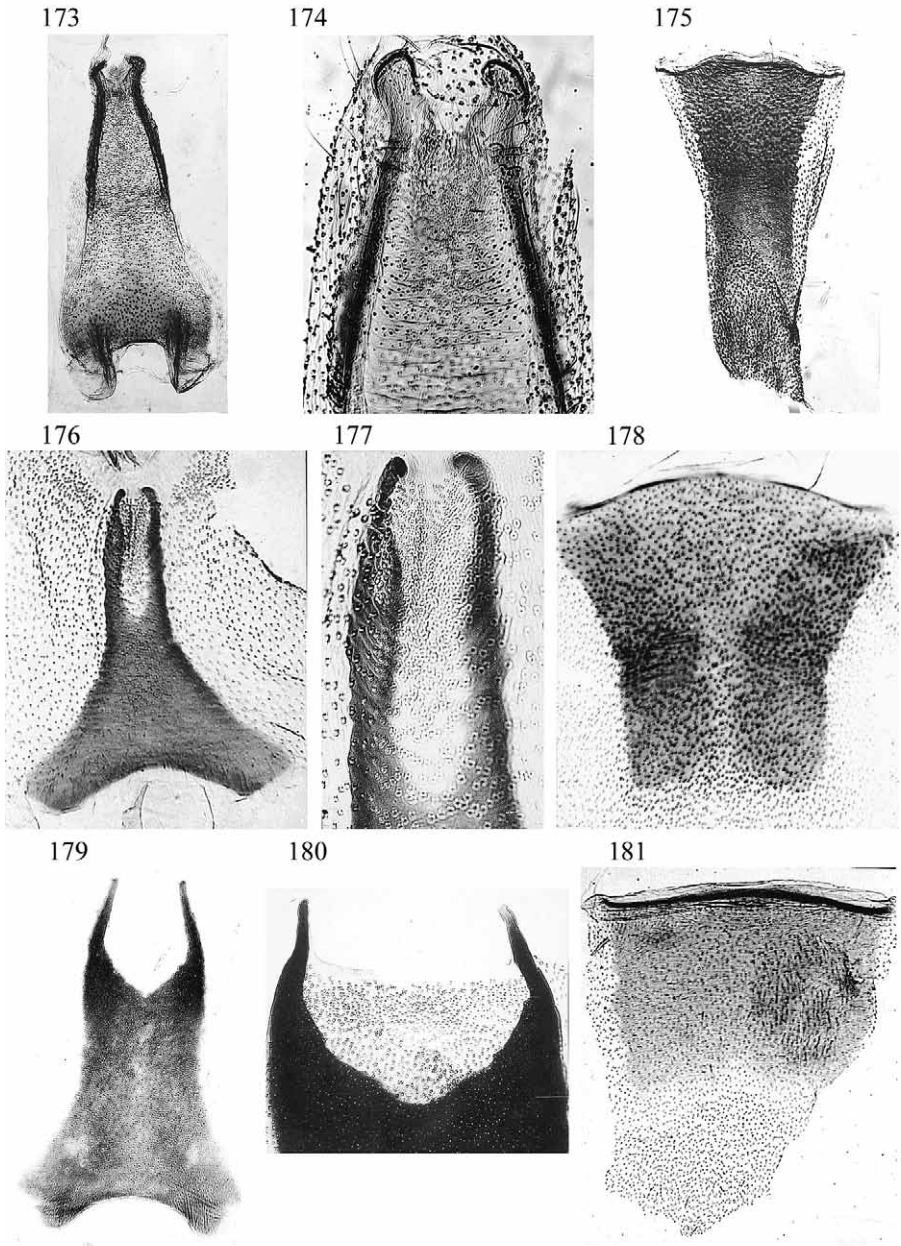
Figs. 146-154. **Group 4.** 146-148. *E. ericeata*. 149-151. *E. impurata*. 152-154. *E. indigata*.



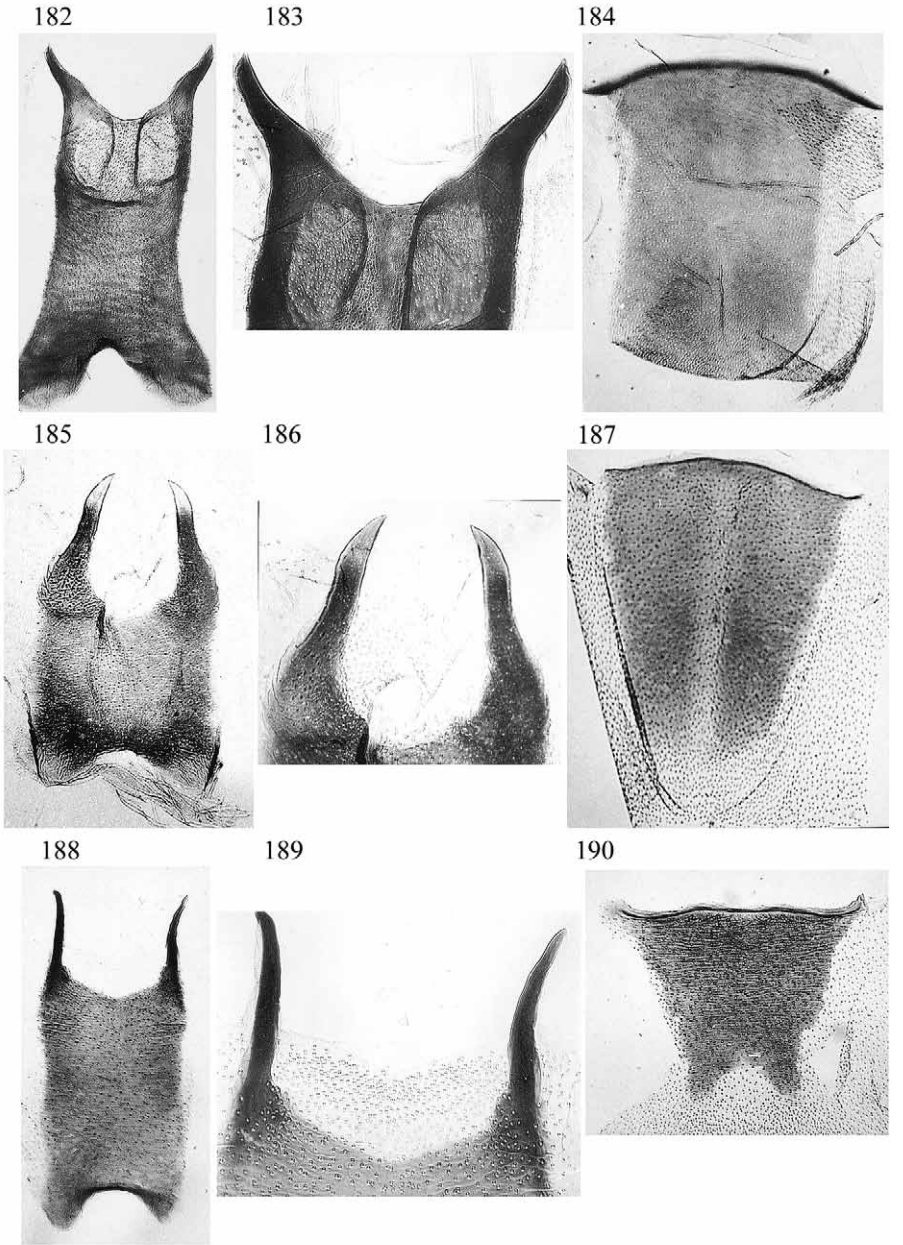
Figs. 155-163. **Group 4.** 155-157. *E. millefoliata.* 158-160. *E. orphnata.* 161-163. *E. pantellata.*



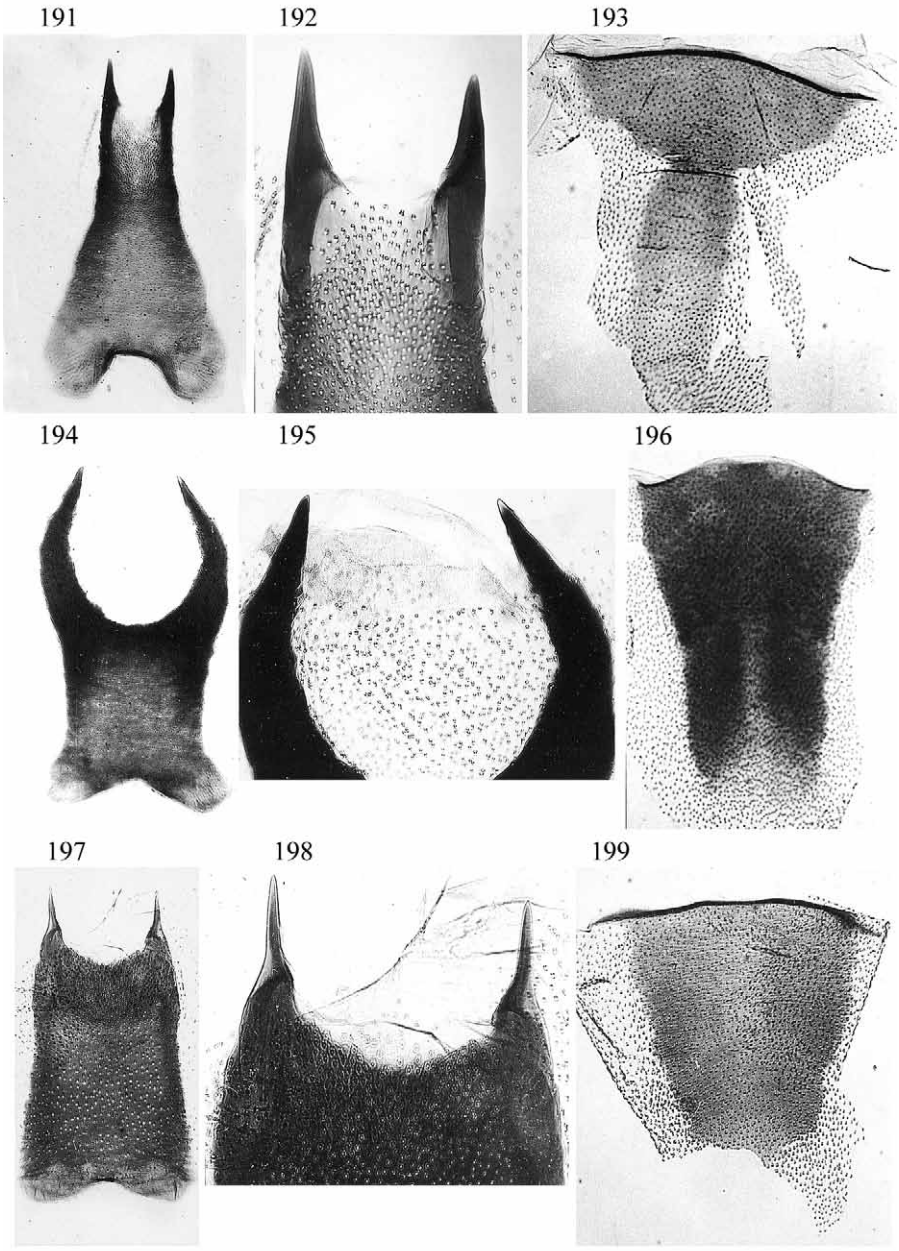
Figs. 164-172. **Group 4.** 164-166. *E. phoeniceata.* 167-169. *E. reisserata.* 170-172. *E. semigraphata.*



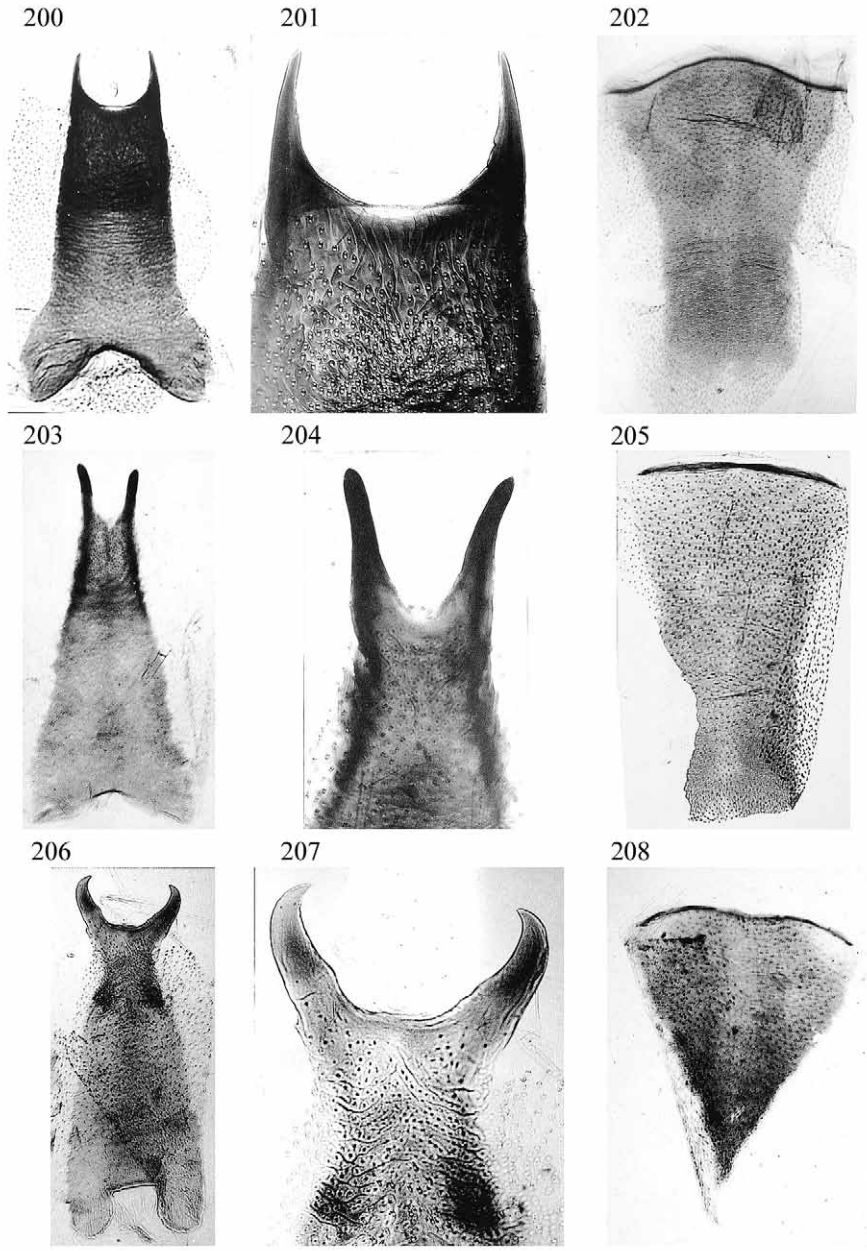
Figs. 173-181. **Group 4.** 173-175. *E. subumbrata.* 176-178. *E. veratraria.*
Group 5. 179-181. *E. abietaria.*



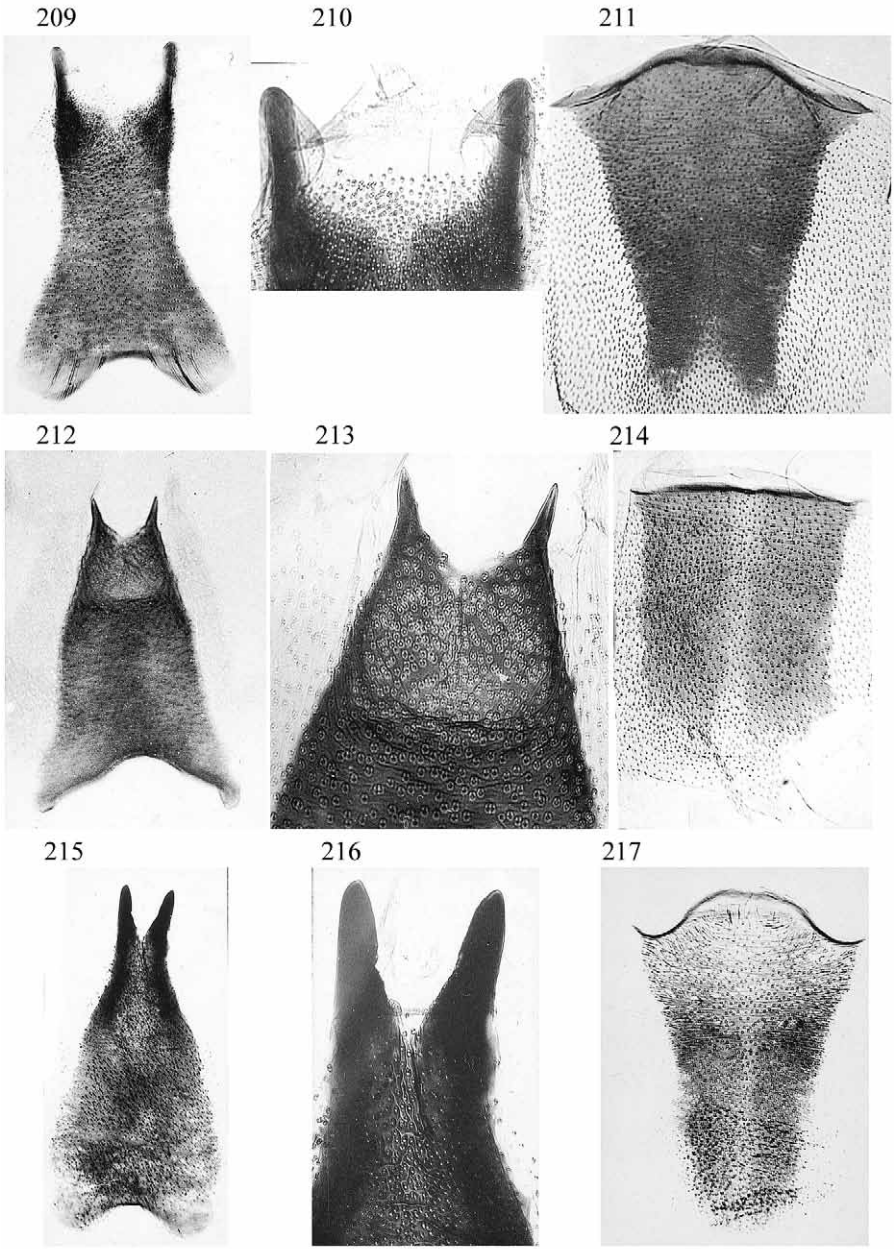
Figs. 182-190. **Group 5.** 182-184. *E. acteata*. 185-187. *E. alliaria*. 188-190. *E. analoga*.



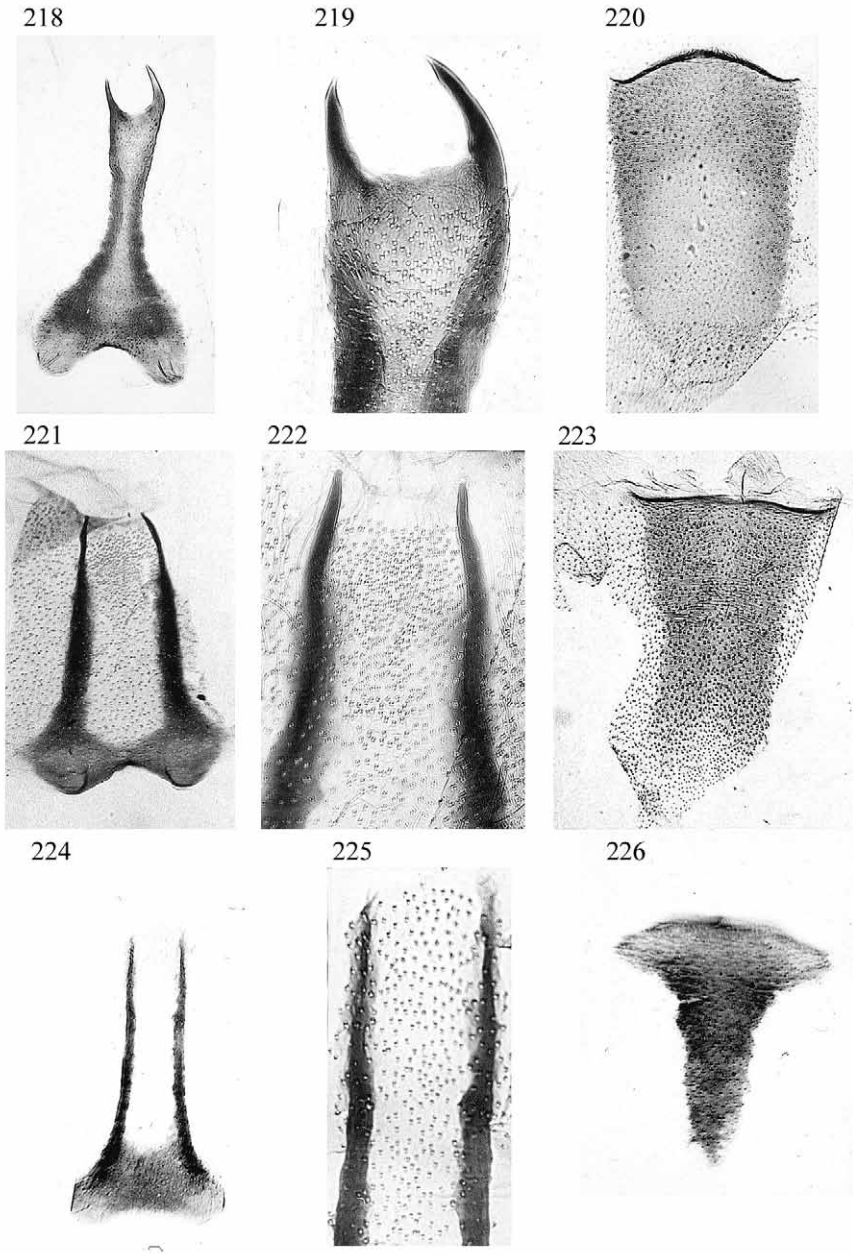
Figs. 191-199. **Group 5.** 191-193. *E. egenaria.* 194-196. *E. dessertata.* 197-199. *E. orana.*



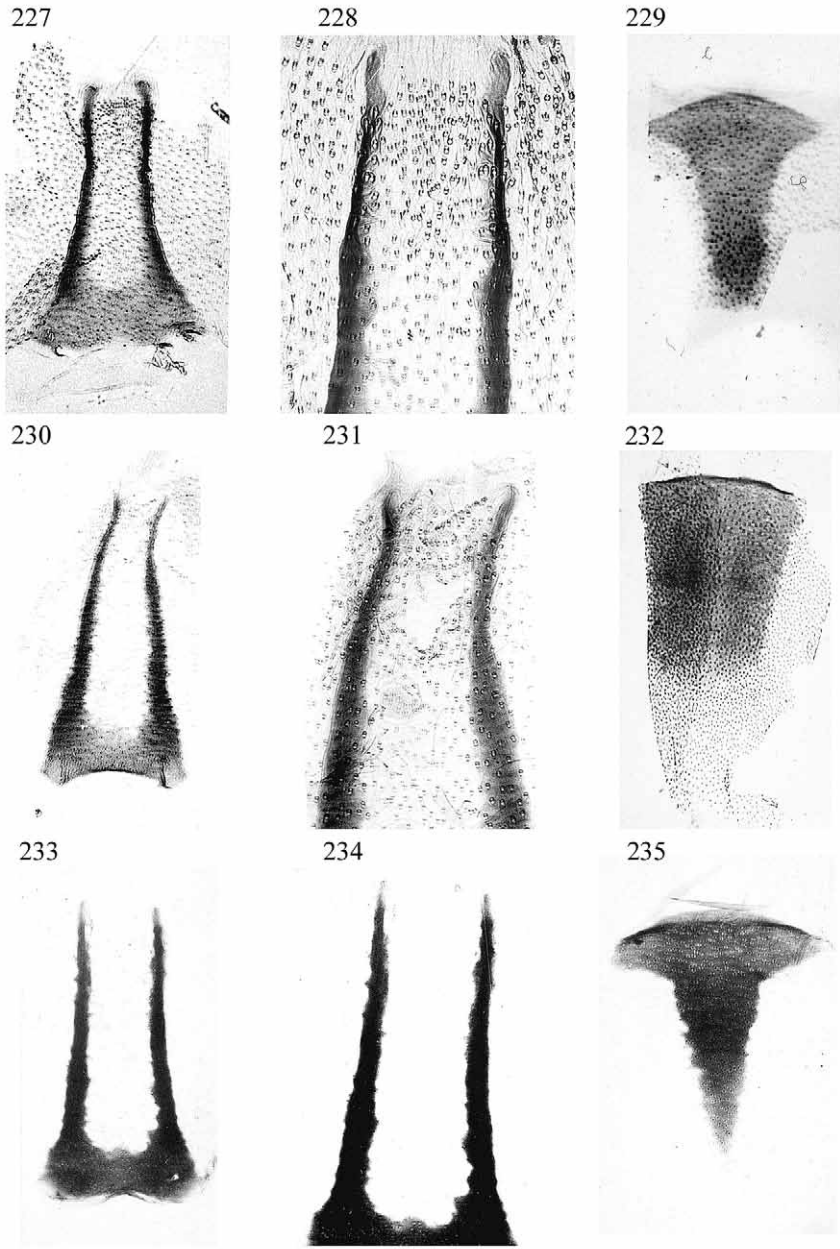
Figs. 200-208. **Group 5.** 200-202. *E. pimpinellata.* 203-205. E. *pusillata.* 206-208. *E. quercetica.*



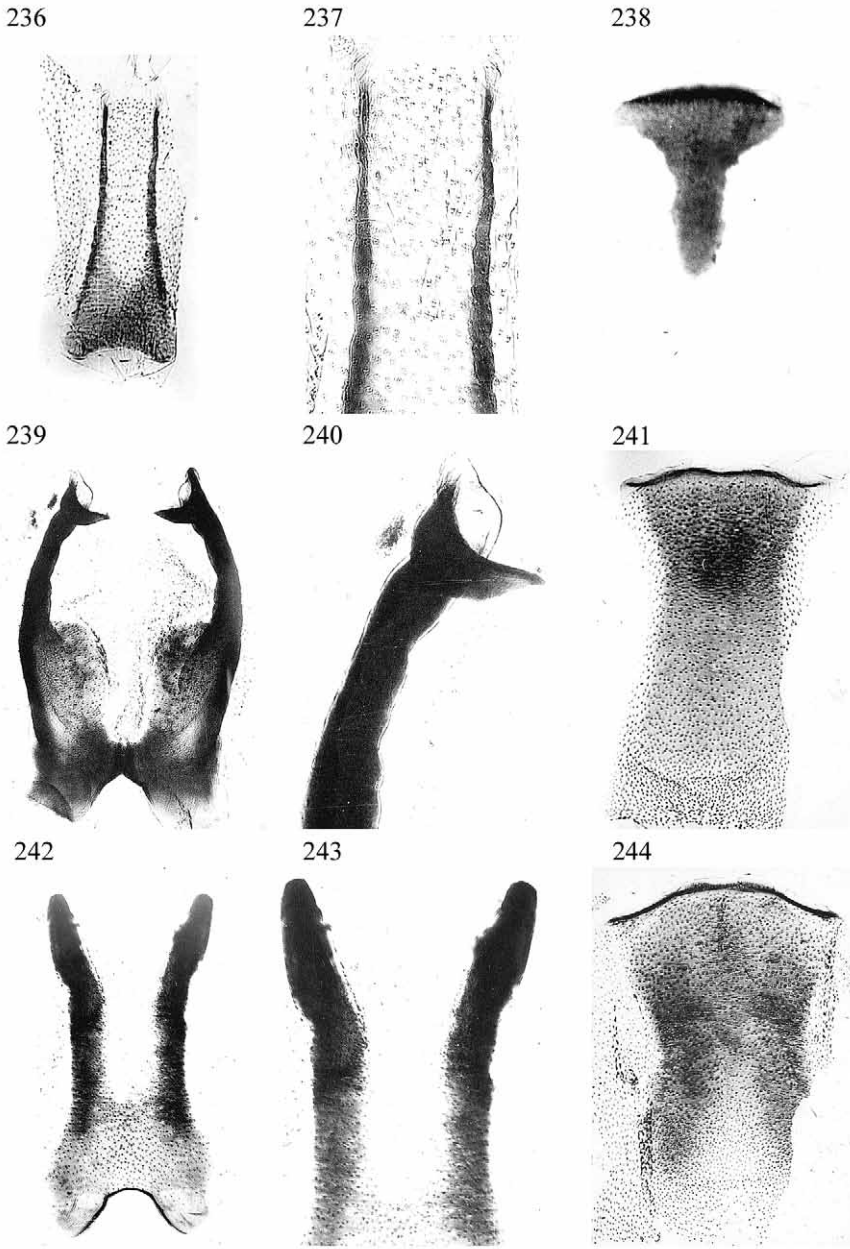
Figs. 209-217. **Group 5.** 209-211. *E. santolinata.* 212-214. *E. scopariata.* 215-217. *E. tripunctaria.*



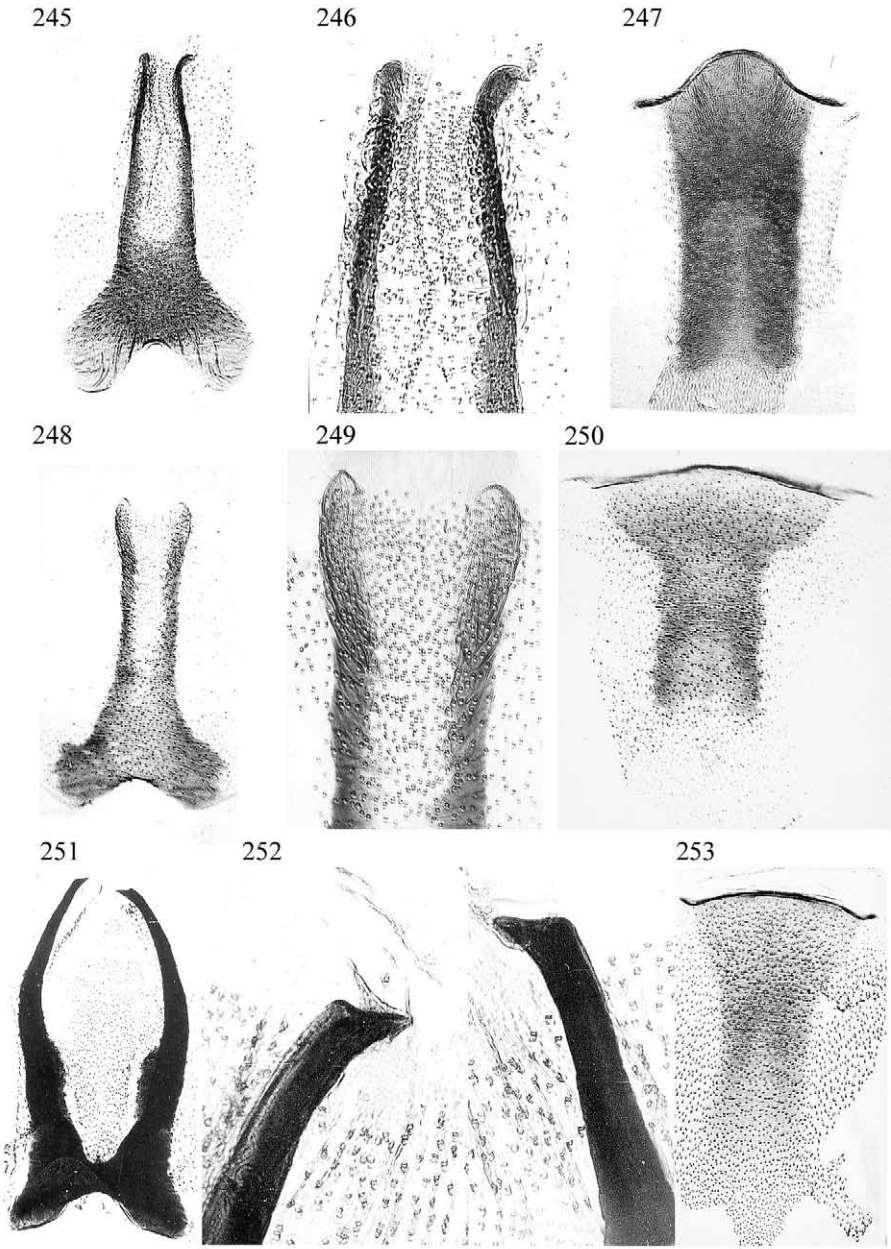
Figs. 218-226. **Group 5.** 218-220. *E. virgaureata.*
Group 6. 221-223. *E. inturbata.* 224-226. *E. laquearia.*



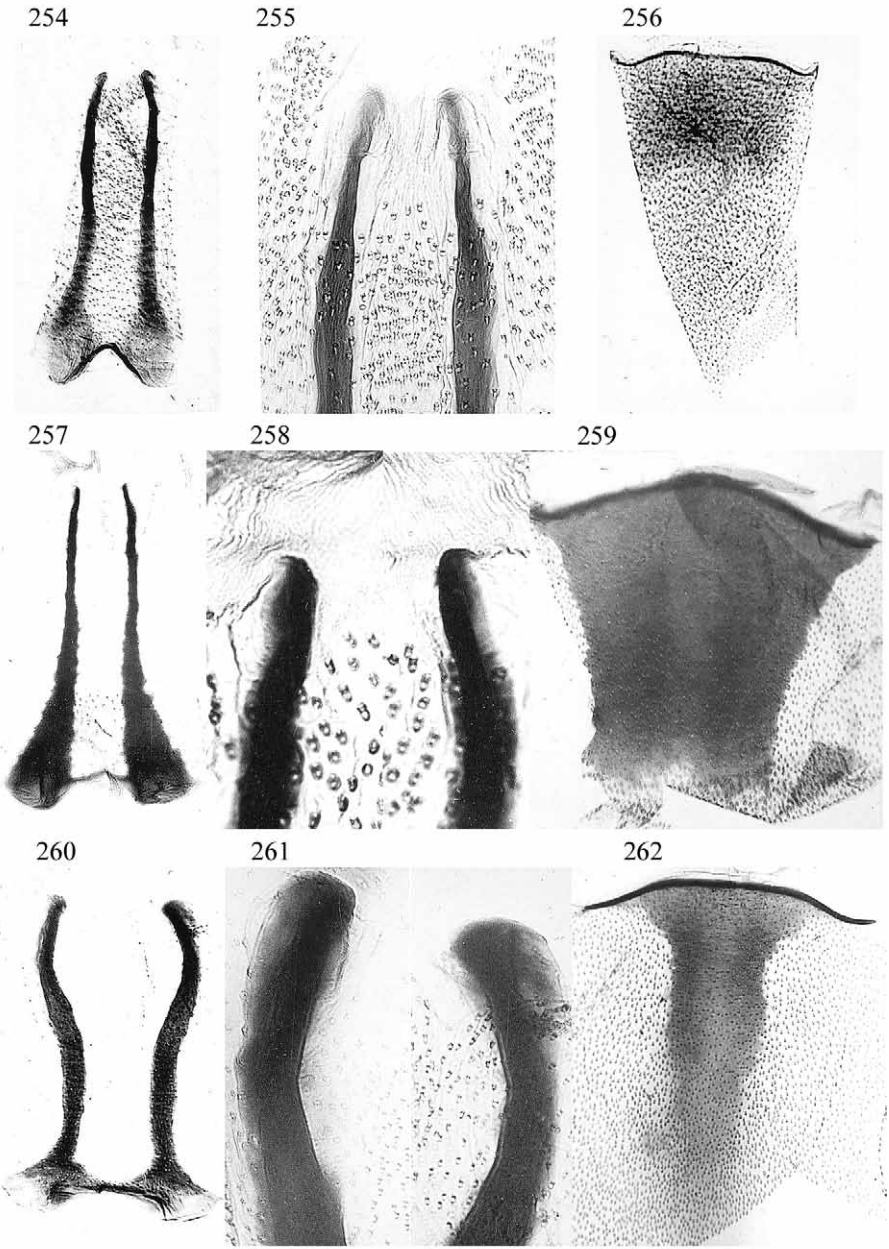
Figs. 227-235. **Group 6.** 227-229. *E. linariata*. 230-232. *E. plumbeolata*. 233-235. *E. pulchellata*.



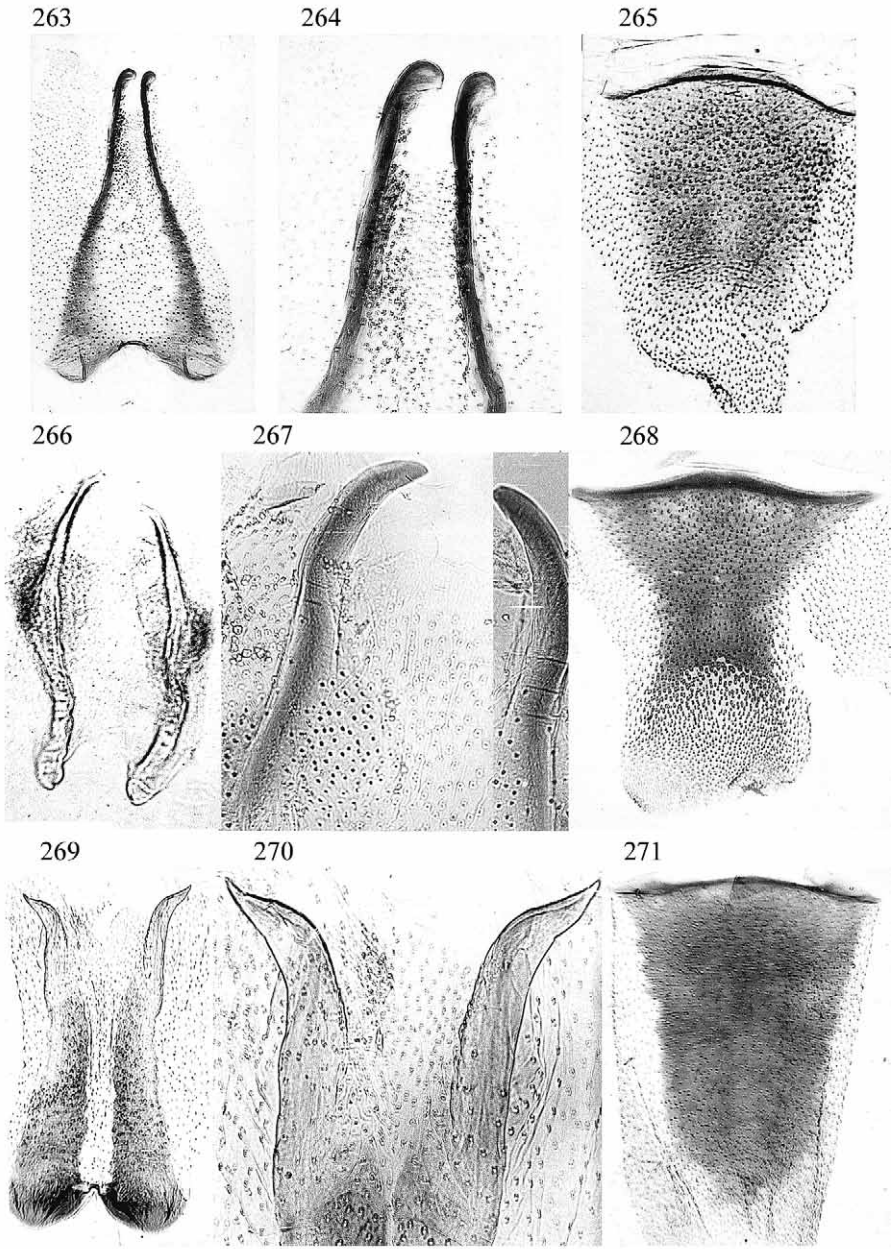
Figs. 236-244. **Group 6.** 236-238. *E. pyreneata*. 239-241. *E. schiefereri*. 242-244. *E. sinuosaria*.



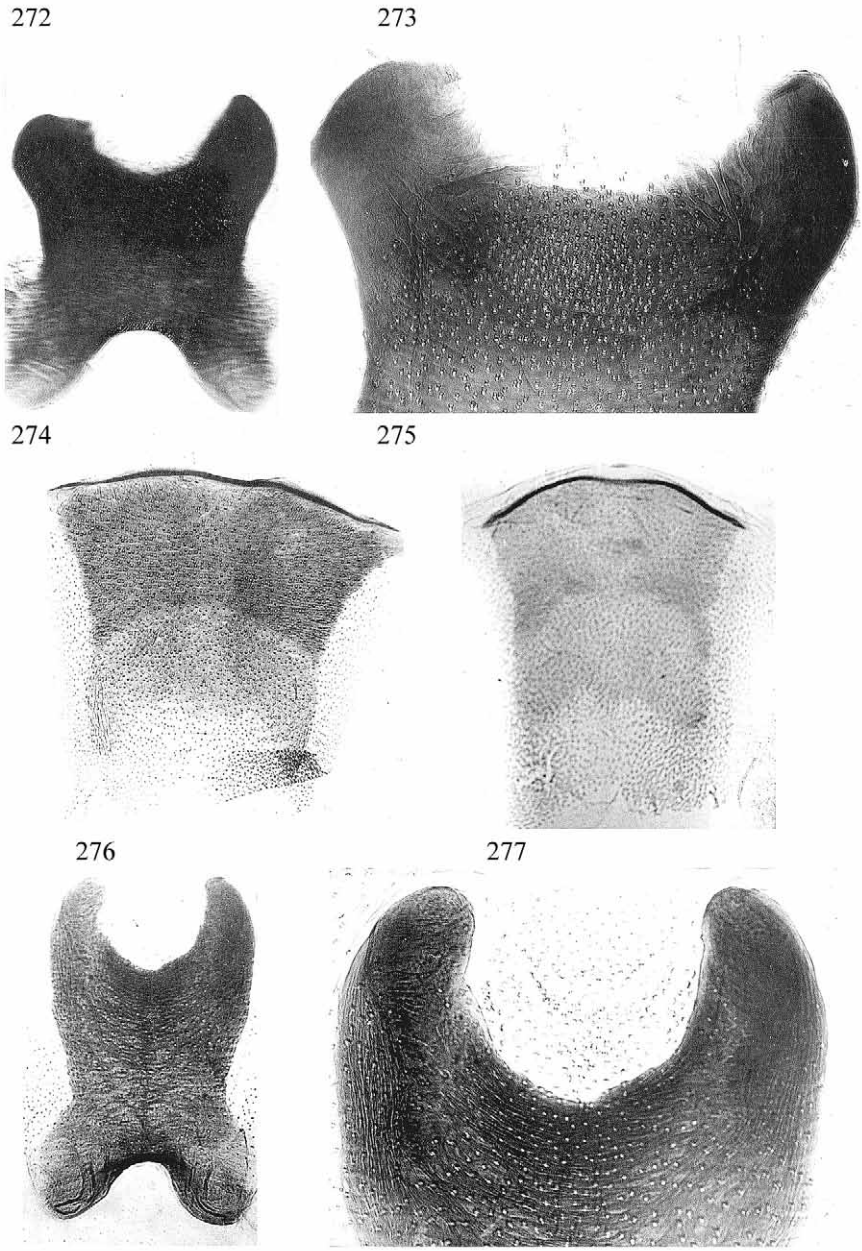
Figs. 245-253. **Group 6.** 245-247. *E. subfuscata*. 248-250. *E. trisignaria*. 251-253. *E. venosata*



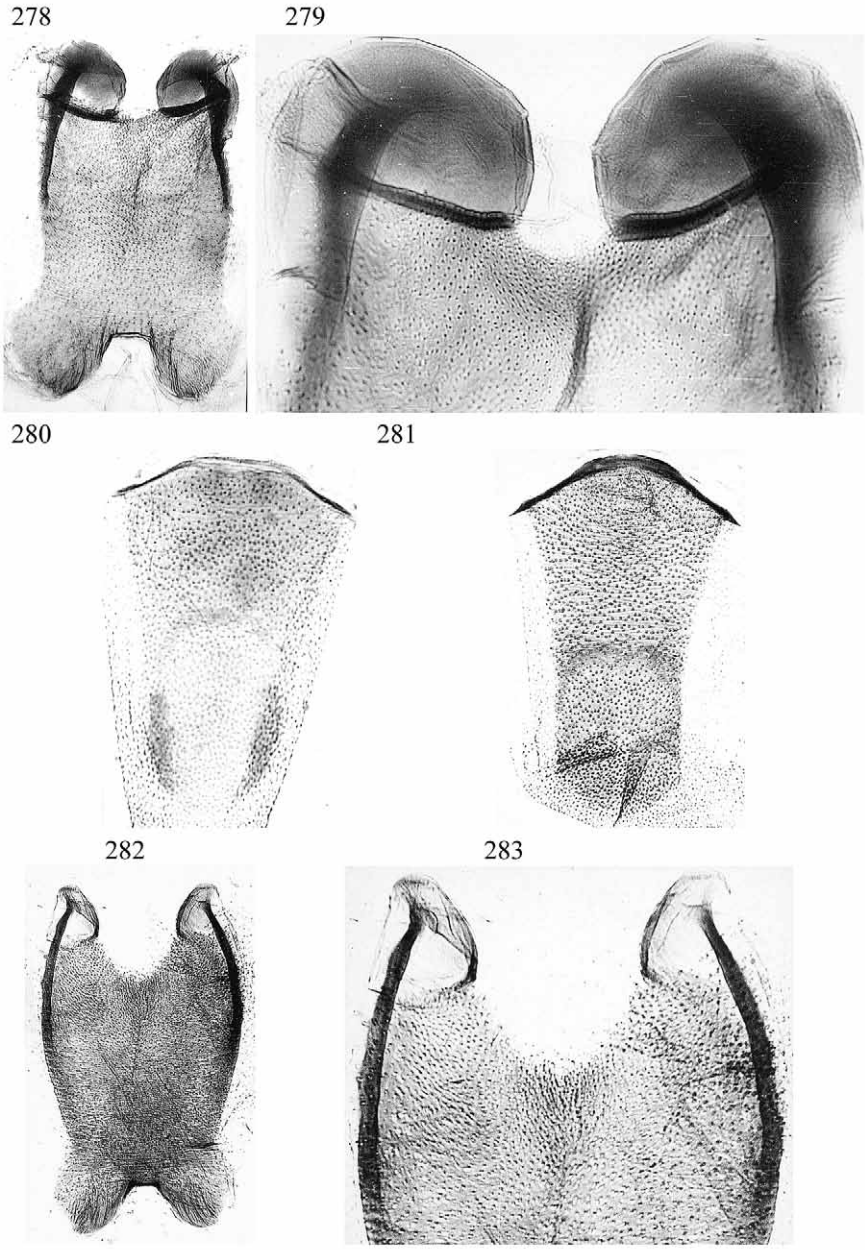
Figs. 254-262. **Group 7.** 254-256. *E. haworthiata.* 257-259. E. *pygmaeata.* 260-262. *E. silenicolata.*



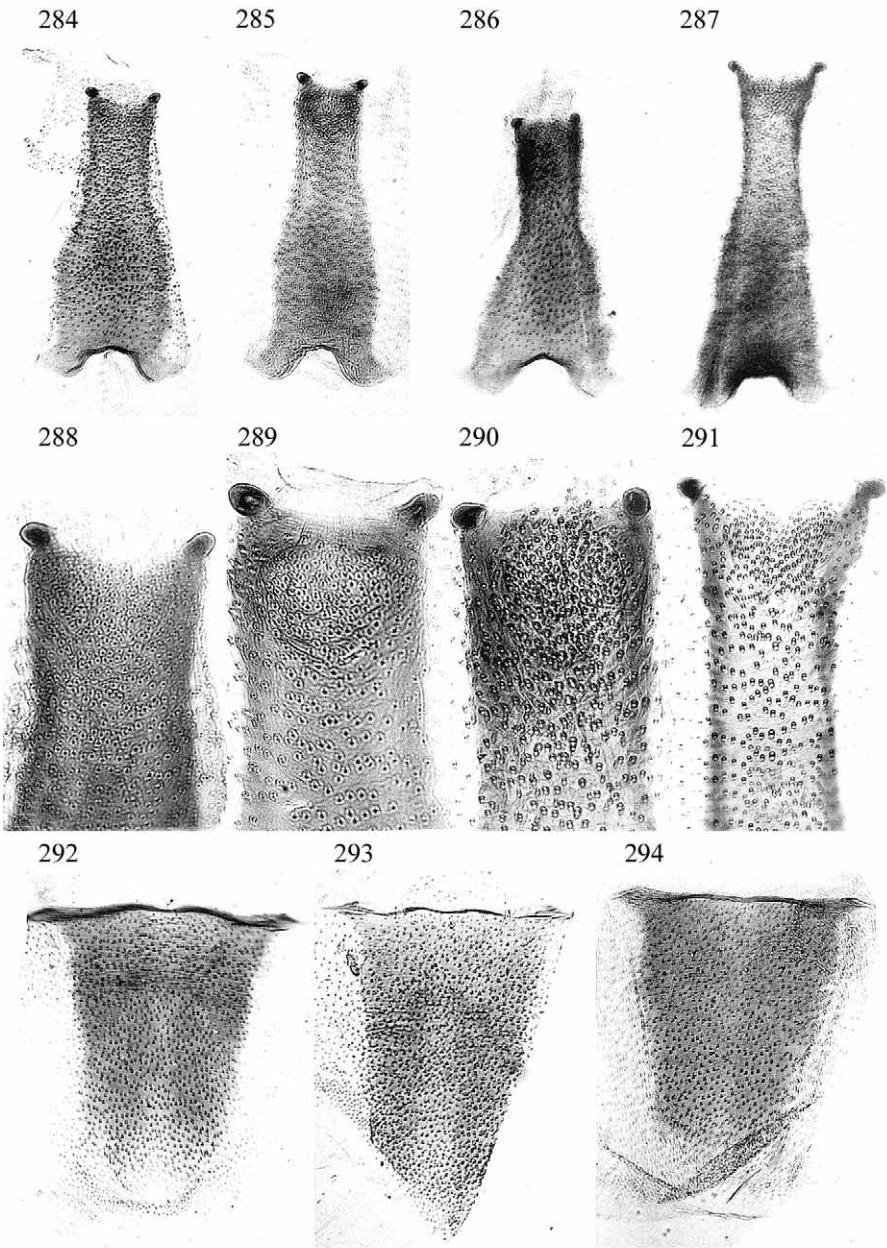
Figs. 263-271. **Group 7.** 263-265. *E. tenuiata.* 266-268. *E. ultimaria.* 269-271. *E. undata.*



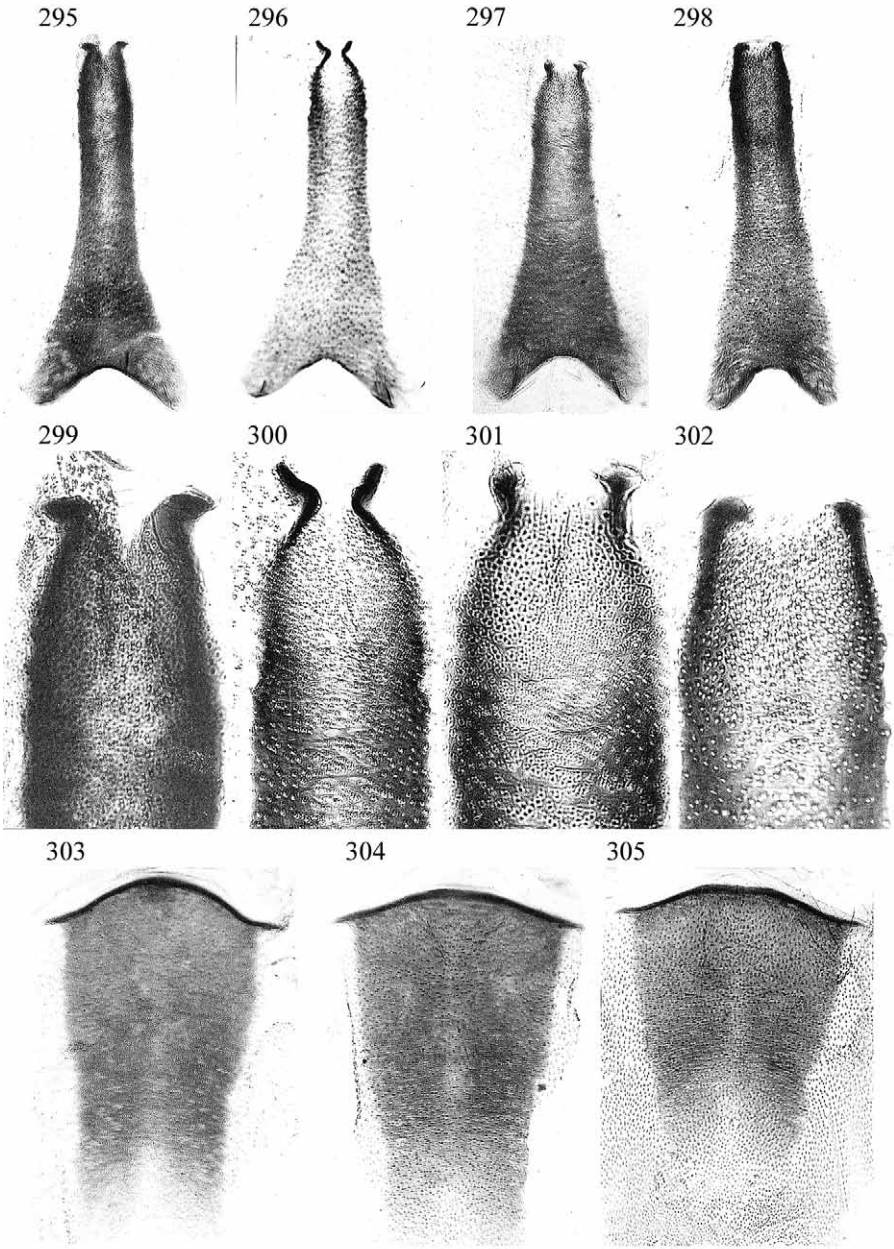
Figs. 272-277. **Group 8.** 272-274. *E. centaureata.* 275-277. *E. extraversaria.*



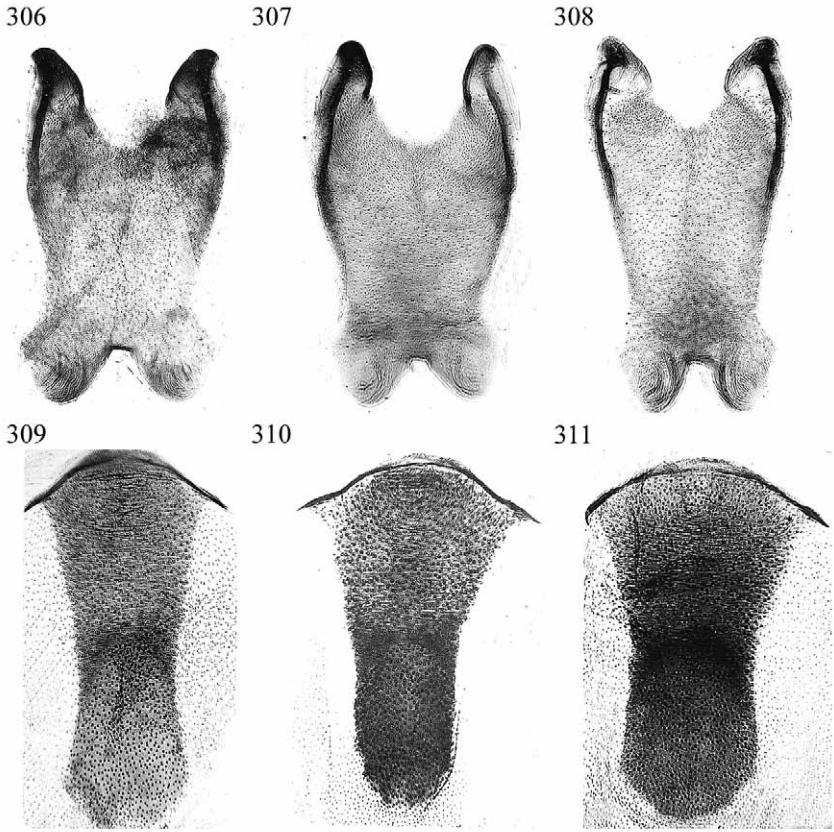
Figs. 278-283. **Group 8.** 278-280. *E. icterata*. 281-283. *E. succenturiata*.



Figs. 284-294. *E. reisserata.* 284-291. The morphological variability of sternum A8 and apex caudalis. 292-294. The morphological variability of tergum A8.



Figs. 295-305. *E. simpliciata.* 295-302. The morphological variability of sternum A8 and apex caudalis. 303-305. The morphological variability of tergum A8.



Figs. 306-311. *E. succenturiata.* 306-308. The morphological variability of sternum A8. 309-311. The morphological variability of tergum A8.

List of localities and collectors of used species

E. abbreviata, Bohemia, Družec, KUBÍN V. *E. abietaria*, Bohemia, Šumava - Nová Pec, KUBÍN V. *E. absinthiata*, Bohemia, Družec, KUBÍN V. *E. actaeata*, Bohemia, Červená n. Vltavou, NOVÁK I. *E. alliaria*, Slovakia, Slov. Kras - Vidová, LIŠKA J. *E. analoga*, Bohemia, Šumava - Jelení Vrchy, KUBÍN V. *E. assimilata*, Bohemia, Družec, KUBÍN V. *E. breviculata*, Greece, Parga, PROCHÁZKA J. *E. cauchiata*, France, , NOVÁK I. *E. centaureata*, Bohemia, Družec, KUBÍN V. *E. cocciferata*, France, Gourdon, SKYVA J. *E. cretaceata*, Italy, Alpes Maritimes, DVOŘÁK M. *E. denotata*, Bohemia, Družec, KUBÍN V. *E. denticulata*, Greece, Smolikas, SKYVA J. *E. dissertata*, Slovakia, Velká Fatra, LIŠKA J. *E. distinctaria*, Bohemia, Krkonoše - Černý důl, SKYVA J. *E. dodoneata*, Bohemia, Družec, KUBÍN V. *E. egenaria*, Bohemia, Písek, NOVÁK I. *E. ericeata*, Slovakia, Medovarce, SKYVA J. *E. exiguata*, Bohemia, Družec, KUBÍN V. *E. expallidata*,

Bohemia, Krkonoše - Lánov, SKYVA J. *E. extraversaria*, Bohemia, Družec, KUBÍN V. *E. extremata*, Greece, Pelopones, KUBÍN V. *E. gelidata*, Bohemia, Červené Blato, JAROŠ J. *E. gemellata*, Spain, Palomera, PROCHÁZKA J. *E. graphata*, Hungary, Csákberény, SKYVA J. *E. gueneata*, Hungary, Várpalota, VODRLIND B. *E. haworthiata*, Bohemia, Družec, KUBÍN V. *E. icterata*, Bohemia, Družec, KUBÍN V. *E. immundata*, Bohemia, Řevničov, PROCHÁZKA J. *E. impurata*, Slovenia, Julské Alpy - Vršič, SKYVA J. *E. indigata*, Bohemia, Družec, KUBÍN V. *E. innotata*, Bohemia, Družec, KUBÍN V. *E. insigniata*, Bohemia, Družec, KUBÍN V. *E. intricata*, Bohemia, Družec, KUBÍN V. *E. inturbata*, Bohemia, Teptín, ČÍLA P. *E. irriguata*, Greece, Pelopones, SKYVA J. *E. lanceata*, Bohemia, Družec, KUBÍN V. *E. laquaearia*, Spain, Ejulve, PROCHÁZKA J. *E. lariciata*, Bohemia, Družec, KUBÍN V. *E. linariata*, Bohemia, Družec, KUBÍN V. *E. millefoliata*, Bohemia, Družec, KUBÍN V. *E. nanata*, Bohemia, Červené Blato, JAROŠ J. *E. ochridata*, Bohemia, Praha, NOVÁK I. *E. orana*, Spain, Andalusia- Almeria, DVOŘÁK M. *E. orphnata*, Moravia, Podyjí - Šobes, MAREK J. *E. oxycedrata*, Greece, Pelopones, SKYVA J. *E. pantellata*, Spain, Aliaga, PROCHÁZKA J. *E. pauxillaria*, Italy, Ligurské Alpy, SKYVA J. *E. phoeniceata*, Greece, Pelopones, SKYVA J. *E. pimpinellata*, Bohemia, Družec, KUBÍN V. *E. plumbeolata*, Bohemia, Družec, KUBÍN V. *E. pulchellata*, Bohemia, Jizerské hory - Bukovec, NM Praha *E. pusillata*, Bohemia, Družec, KUBÍN V. *E. pygmaeata*, Moravia, Lednice, NM Praha *E. pyreneata*, Bohemia, Brná n. Labem, NOVÁK I. *E. quercetica*, Greece, Pelopones, SKYVA J. *E. reisserata*, Greece, Pelopones, SKYVA J. *E. santolinata*, Spain, , ŠUMPICH J. *E. satyrata*, Bohemia, Družec, KUBÍN V. *E. scalptata*, Greece, Diakofto, PROCHÁZKA J. *E. scopariata*, France, Cogolin, PETRŮ M. *E. selinata*, Bohemia, Krkonoše - Dvoračky, NOVÁK I. *E. semigraphata*, Croatia, Murter, KUBÍN V. *E. schiefereri*, Greece, Pelopones, SKYVA J. *E. silenata*, Bohemia, Lány, KUBÍN V. *E. silenicolata*, Greece, Leptokaria, SKYVA J. *E. simpliciata*, Bohemia, Družec, KUBÍN V. *E. sinuosaria*, Bohemia, Družec, KUBÍN V. *E. spissilineata*, Greece, Pelopones, SKYVA J. *E. subfuscata*, Bohemia, Družec, KUBÍN V. *E. subumbrata*, Bohemia, Šumava - Jelení Vrchy, KUBÍN V. *E. succenturiata*, Bohemia, Družec, KUBÍN V. *E. tantillaria*, Bohemia, Družec, KUBÍN V. *E. tenuiata*, Bohemia, Družec, KUBÍN V. *E. tripunctaria*, Bohemia, Družec, KUBÍN V. *E. trisignaria*, Bohemia, Družec, KUBÍN V. *E. ultimaria*, Italy, Portogruaro - Brussa, SKYVA J. *E. undata*, Italy, Ortler Gruppe - Passo di Stelvio, SKYVA J. *E. unedonata*, Spain, Andalusia - Almeria, DVOŘÁK M. *E. valerianata*, Slovakia, , NM Praha *E. venosata*, Bohemia, Šumava - Jelení Vrchy, KUBÍN V. *E. veratraria*, Bohemia, Novohradské Hory, JAROŠ J. *E. virgaureata*, Bohemia, Družec, KUBÍN V. *E. vulgata*, Bohemia, Družec, KUBÍN V.

Discussion

The 8th abdominal segment of males of the genus *Eupithecia* is substantially important for accurate determination of species. The membrane connecting sternum A8 and tergum A8 is slightly frilled laterally, which enables extending the ring of segment A8 during copulation (Figs. 8, 9). The strong membranous connection between sternum A8 and tergum A8 makes their separation often difficult.

After preparation, segments A8 have only two-dimensional proportion; therefore, they are distinguishable quite easy. In contrast to determination based on the shape and

numbers of cornuti in aedeagus, it is often more difficult in spite of the three-dimensional proportions. According to our results, we regard species determination based on the morphology of sternum A8 (or, possibly, tergum A8) as specific and in many cases quite satisfactory.

Preparation process may sometimes give rise to deformations, especially in the region of processus laterales. This circumstance does not influence the determination results. Deformations of this type differ from varibility (see *E. simpliciata*, Figs. 341 – 358).

Classification of species into Group 2 can be influenced by the microskopic equipment used. When using a minor magnification, species with shallow sulcus (Group 2) can be classified as Group 1 with compact apex caudalis, that is why we recommend a higher magnification (see *E. assimilata* Figs. 64, 65).

Species difficult to obtain were examined in very limited series, and in these cases we conmpared our results with the published ones by distinguished authors (WEIGT 1987, 1988, 1990, 1991, 1993, MIRONOV 2003).

One of the earliest descriptions of the 8th abdominal segment dates from the year 1891 (WHITE). The description of tergum A8 is, however, very inaccurate in this publication. Only a few contemporary authors, e.g. CHOI 1997, VOJNITS 1974, pay attention to the morphology of tergum A8. The reason may be the difficult preparation process of tergum A8, caused by its minimal mechanical resistence. In some species, its shape is distinctively typical (*E. subfuscata* and others); thus it may be quite satisfactory for the species determination.

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