Zootaxa 4942 (4): 451–500
https://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4942.4.1
http://zoobank.org/urn:lsid:zoobank.org:pub:B48F059D-7AC0-4132-9977-E2287308D82F

A comparative study of the immature stages of closely related species *Cassida pfefferi* Sekerka, 2006, *Cassida nobilis* Linnaeus, 1758 and *Cassida vittata* Villers, 1789 (Coleoptera: Chrysomelidae: Cassidinae: Cassidini)

JOLANTA ŚWIĘTOJAŃSKA[1,2] & EWA BELCZYK[1,3]
[1]*Department of Biodiversity and Evolutionary Taxonomy, University of Wrocław, Przybyszewskiego 65, 51-148 Wrocław, Poland.*
[2] *jolanta.swietojanska@uwr.edu.pl; https://orcid.org/0000-0002-6701-8809*
[3] *ewa.belczyk@uwr.edu.pl*

Abstract

Immature stages of *Cassida pfefferi* Sekerka, 2006 from Cyprus are described and illustrated for the first time and compared with immatures of closely related species *Cassida nobilis* Linnaeus, 1758 and *Cassida vittata* Villers, 1789. Detailed descriptions of mature larvae and pupae of *C. nobilis* and *C. vittata* are also given. Analysis of the morphological body structure of the preimaginal stages of the studied species reveals subtle characters distinguishing *C. pfefferi* from other species of *C. nobilis* groups and confirms its species status.

Key words: tortoise beetle, morphology, larva, pupa,immatures, Mediterranean Subregion

Introduction

The genus *Cassida* Linnaeus, 1758 with 459 described species is the most speciose genus of the subfamily Cassidinae (Borowiec & Świętojańska 2020). Members of this genus are distributed mainly in Madagascar, tropical Africa and Asia whereas in the Palaearctic region no more than 100 species occur. The genus *Cassida* includes many of closely related species pairs or groups which are difficult to identify. Such a group of closely related species is the *Cassida nobilis* complex which now comprises seven species: *C. nobilis* Linnaeus, 1758 (Figs 1, 2); *C. olympica* Sekerka, 2005; *C. ovalis* Spaeth, 1914; *C. parvula* Boheman, 1854; *C. persicana* Borowiec, 1999; *C. pfefferi* Sekerka, 2006 (Figs 5–10) and *C. vittata* Villers, 1789 (Figs 1–4). A key to imagines of the *C. nobilis* species complex was given by Sekerka (2006) along with the description of *C. pfefferi* and a discussion of the differences between this species and *C. nobilis*. Immature stages of *C. pfefferi* were unknown to that author, which made it impossible to compare them with the larvae of other species of this complex. The aim of our study was to indicate the differences between immatures of *C. pfefferi* and two other species of the *C. nobilis* complex. We compared *C. pfefferi* with *C. nobilis* and *C. vittata* because geographical ranges of these three species partly overlap. Immature *C. olympica*, *C. ovalis* and *C. persicana* species are still unknown (Świętojańska 2009), while for *C. parvula* mature larvae and pupae (Matys 1970) have been superficially described. For these reasons we did not examine and compare immatures characters of these species.

Below we present a detailed description of the immature stages of *Cassida pfefferi* for the first time and in detail last instar larvae and pupae of *C. nobilis* and *C. vittata*. Descriptions of mature larvae of *C. nobilis* and *C. vittata* have been published (Steinhausen 1950; Medvedev 1982; Brovdii 1983; Świętojańska 2009) but they were superficial and prevent good diagnostic comparisons. First instar larvae of these two species were described in detail by Świętojańska (2005). Thanks to detailed descriptions of immatures of all three species, we were able to perform a comparative analysis of diagnostic characters and confirm the distinctiveness of these taxa.

Accepted by C. Reid: 15 Feb. 2021; published: 16 Mar. 2021

Material and methods

Mature larvae, pupae and adults of *Cassida pfefferi* were collected in Pafos, Cyprus, 07.05.2012, by Lech Borowiec and Jolanta Świętojańska, on the food plant *Chenopodium murale* L. (Chenopodiaceae). Adults were reared in the laboratory, first instar larvae hatched on 22 June 2012 and the next generation of adult appeared on 06 July 2012. Adults of *Cassida nobilis* and *Cassida vittata* were collected by L. Borowiec and J. Świętojańska at rural sites in Wrocław (Lower Silesia, Poland) in June 2004 and then reared in the laboratory. All species were reared in petri dishes. Leaves of the same *Chenopodium album* L. were offered as a food plant for adults and larvae of all three species.

FIGURES 1–4. Adults. 1. *Cassida nobilis* Linnaeus, 1758, dorsal aspect; 2. *Cassida nobilis*, ventral aspect; 3. *Cassida vittata* Villers, 1789, dorsal aspect; 4. *Cassida vittata*, ventral aspect.

FIGURES 5–8. Adults of *Cassida pfefferi* Sekerka, 2006. 5. Dorsal aspect; 6. ventral aspect; 7. dorsal aspect of living specimen; 8. lab-grown adult devoid of pink elytral spots.

Field collected and laboratory reared larvae and pupae were preserved in 75–80% ethanol.

For examination the larvae were transferred from ethanol to a cold 10% NaOH solution, and left in it for 24 hours, then larvae were cleared in distilled water and finally mounted on slides with Swan's liquid (distilled water 20 g, gum arabic 15 g, chlorhydrate 60 g, glucose 3 g, glacial acetic acid 2 g) and glycerine. Heads of the larvae were separated from the rest of the body and mouthparts dissected.

Slides and measurements of larvae were made using a Nikon SMZ 1500 stereomicroscope. A Nikon ECLIPSE 80i light microscope with phase contrast was used for specimen examination and drawing figures.

The photos of mature larvae were made using a Nikon digital camera D 5100 and Nikon SMZ 1500 stereomicroscope and Helicon Focus software.

Larvae for SEM examination were transferred from 75% to 100% ethanol and dried using HMDS (Hexamethyldisilazane). After fixing on stubs with carbon tabs they were sputter-coated with silver. SEM photos for I instar larvae of *Cassida pfefferi* and *C. nobilis* were taken by Tesla BS 300 scanning microscope at Laboratory of Microscopic Techniques of the Faculty of Biological Sciences, University of Wrocław. No photos of first instar larva of *C. vittata* were taken due to a lack of material. SEM photos for fifth instar larvae of *Cassida pfefferi* were taken by HITACHI S-3400N scanning microscope at Department of Systematics and Zoogeography, Museum and Institute of Zoology, Polish Academy of Science.

Descriptions of immature stages and terminology of the chaetotaxy of head follows Borowiec & Świętojańska (2003), Świętojańska (2009) and Borowiec & Świętojańska (2014). For larvae, length was measured without head, from anterior border of pronotum to the base of supra-anal processes; width of body was measured across metanotum without lateral scoli. For pupae, length of body was measured from anterior border of pronotum to posterior border of abdominal segment VIII; width of body was measured across abdominal segment II, without lateral scoli; width of pronotum was measured at base; length of pronotum was measured along body axis. All measurements are in millimetres.

Studied material is deposited at Department of Biodiversity and Evolutionary Taxonomy, University of Wrocław, Poland.

Descriptions

Egg of *Cassida pfefferi*

(Figs 11–13, 18–21; Table 1)

Measurements (n=6). Length of egg: 1.10–1.20, width: 0.5–0.6 (Table 1).

TABLE 1. Measurements of *Cassida pfefferi* Sekerka, 2006 eggs (in millimetres).

Cassida pfefferi egg	length	width
1.	1.10	0.60
2.	1.20	0.50
3.	1.10	0.60
4.	1.15	0.50
5.	1.10	0.50
6.	1.15	0.55

Eggs are elongate-oval, yellowish-white. Eggs are deposited in oothecae which consist of translucent layers. Two to three eggs are usually deposited in one group (ootheca), but in the laboratory oothecae with a single egg were observed. Each egg is placed between two layers (Figs 11–13). Surface of the translucent layers is without any distinct sculpture (Figs 18–21). In nature on the top of ootheca a small piece of excreta is placed by female (Figs 11, 12), in laboratory some ootheca were without excreta (Fig. 13).

FIGURES 9–13. *Cassida pfefferi* Sekerka, 2006. 9, 10. Adults; 11–13. ootheca.

First instar larva of *Cassida pfefferi*

(Figs 22–70, 103–121, 140, 141)

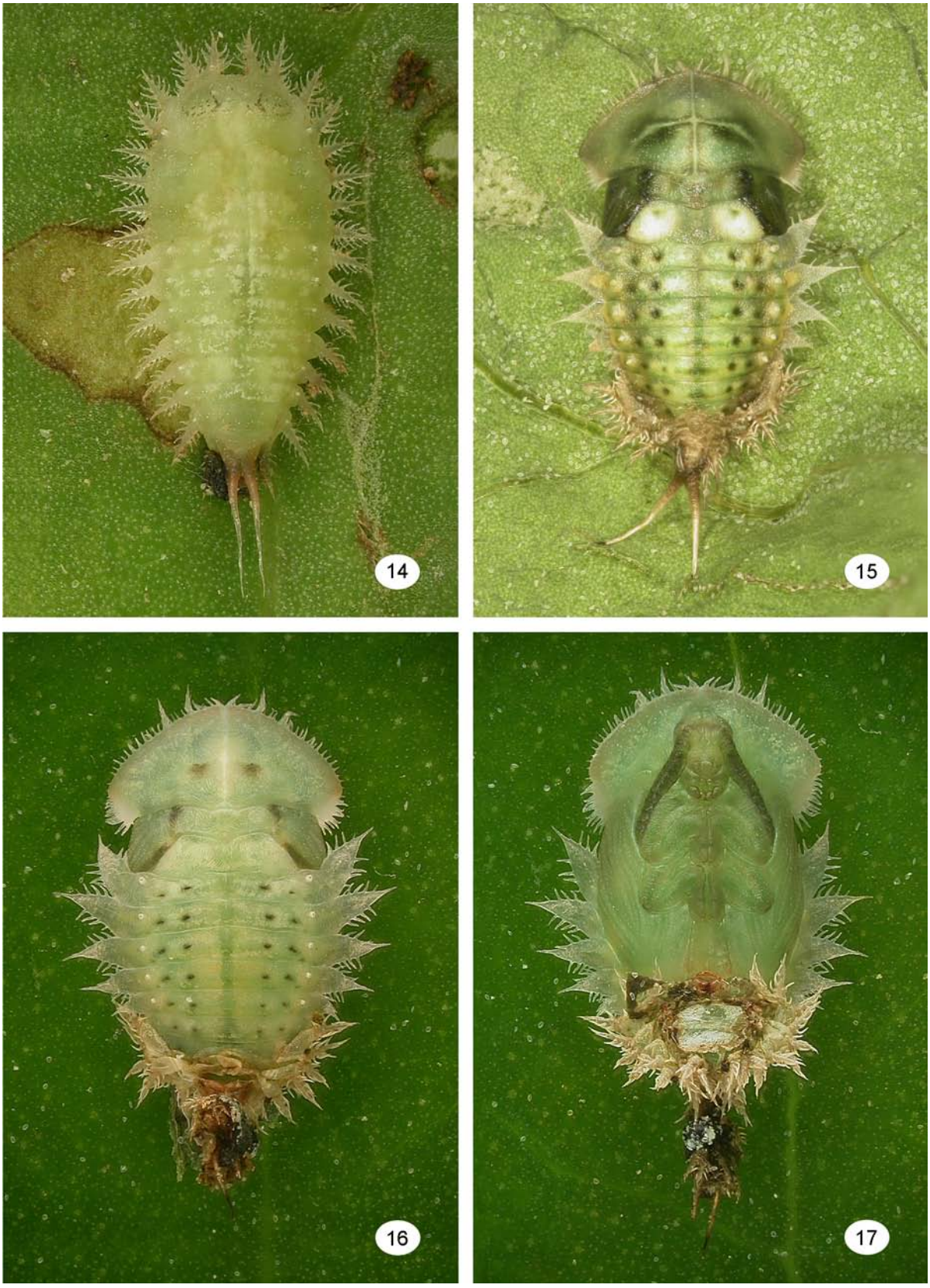
Measurements (n=12) are presented in Table 2.

Body dorso-ventrally flattened, oval, moderately narrowed posteriorly, widest across meso- and metathorax (Figs 22, 23, 103–105). Living specimens green with yellowish-brown supra-anal processes. Freshly emerged larvae, preserved in alcohol, white with yellow head and yellowish-brown supra-anal processes.

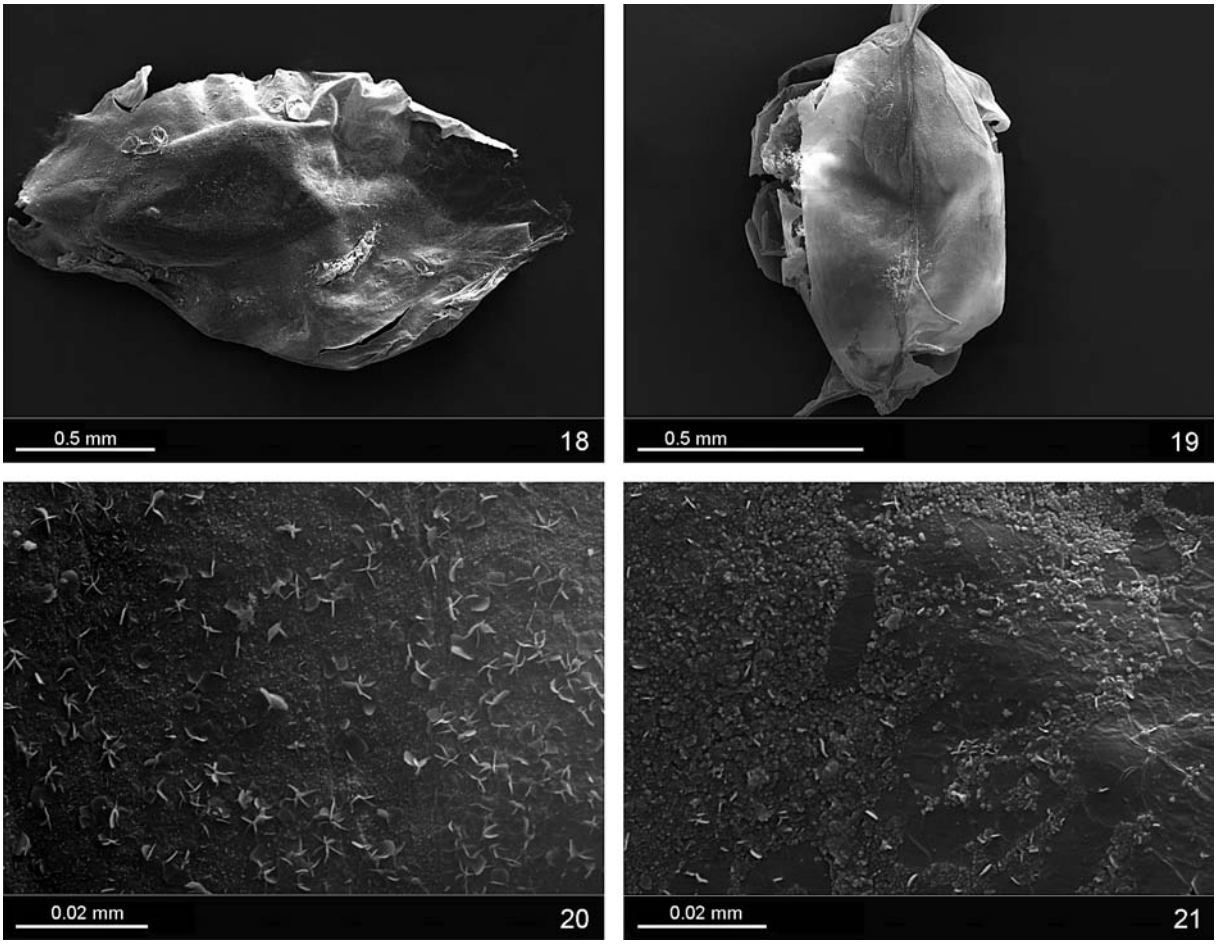
Body with 16 pairs of lateral scoli and a pair of supra-anal processes (Figs 22, 23, 103–105). Lateral scoli of 1st to 14th pairs gradually shortened posterad (Figs 22, 23, 50, 103–105), the length of each a half width of the segment they belong to. Scoli of 15th and 16th pairs the longest, 16th slightly longer than 15th. Each scolus of 1st–14th pairs apically armed with more or less elongate cauliflower-shaped sensillum, gradually shortened from 1st to 14th (Figs 45–47, 50–56, 103–105, 113–118). Scoli of pairs 15 and 16 apically armed with short blunt seta (Figs 57, 119, 120). Lateral scoli of first pair with one long and one short lateral branch, apically armed with elongate cauliflower-shaped sensillum (Figs 45, 47, 113), other scoli simple, without lateral branches but covered with a few cauliflower-shaped sensilla (Figs 54, 104, 105).

Supra-anal processes bent dorsally, in 1/2 basal length covered with numerous spines, apically flask-shaped without apical setae (Figs 58, 121).

Nine pairs of spiracles (one on thorax and 8 on abdomen), each distinctly elevated, visible from dorsal view (Figs 48–50). One minute seta is close to each pronotal spiracle and one very short seta and one small cauliflower-shape sensillum areclose to each abdominal spiracle (Fig. 49).



FIGURES 14–17. Living immature stages. 14. Mature larva of *Cassida pfefferi* Sekerka, 2006; 15. pupa of *Cassida vittata* Villers, 1789; 16. pupa of *Cassida pfefferi*, dorsal aspect; 17. pupa of *Cassida pfefferi*, ventral aspect.



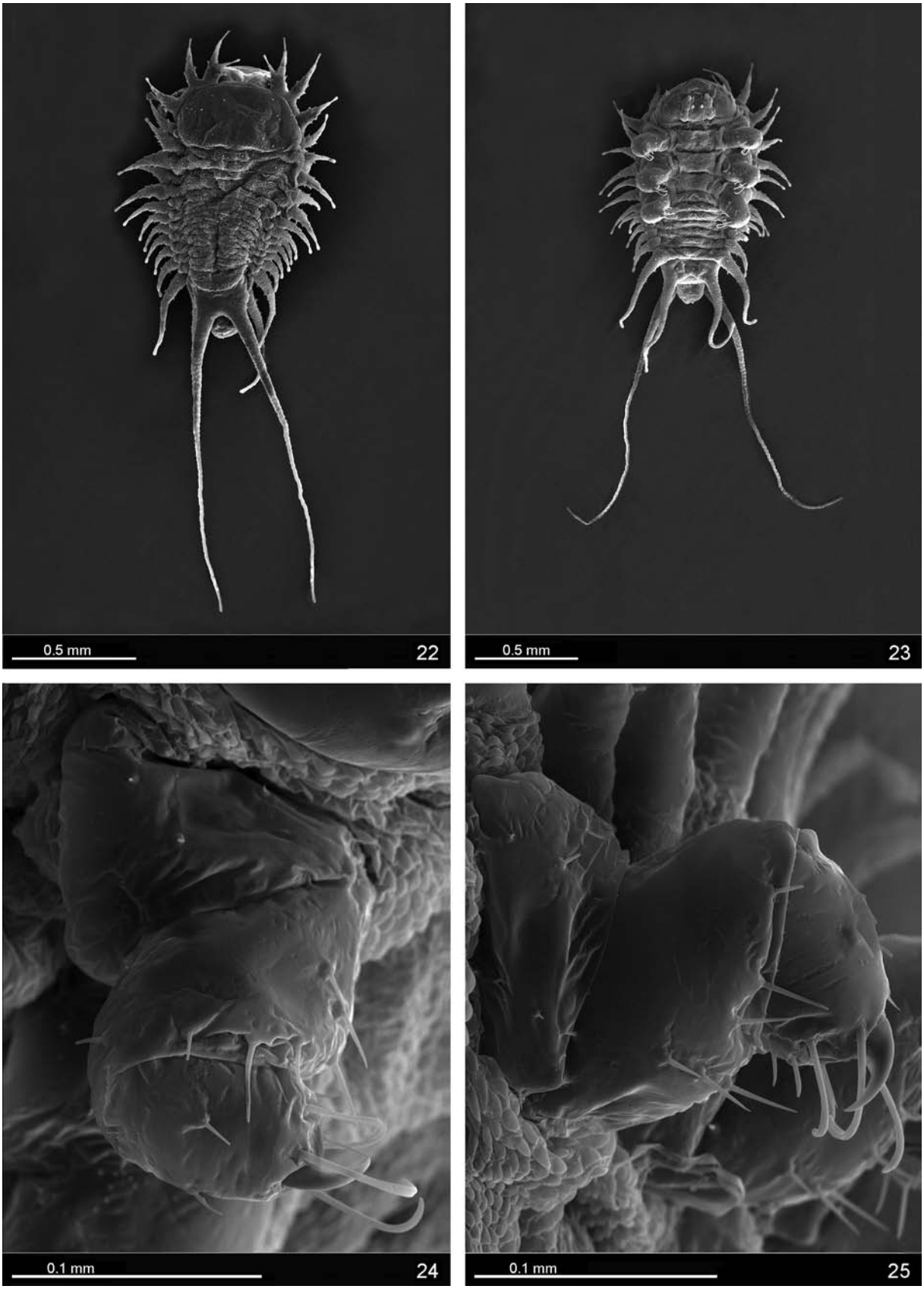
FIGURES 18–21. *Cassida pfefferi* Sekerka, 2006. 18. Ootheca with egg, dorsal view; 19. egg in ootheca, lateral view; 20, 21, surface of ootheca.

Dorsal and ventral surface of body distinctly granulate (Figs 26–44). Tergites and sternites covered with tiny cauliflower-shaped or blunt sensilla (Figs 26–31, 36–44) except for sternites of thorax and abdominal sternites I–III medially, which are covered with pointed setae (Figs 32–35, 38, 39, 105). Each tergite and sternite with minute setae at anterior border. Frons of head with mostly blunt setae (Fig. 106), temporal surface with pointed setae (Fig. 107). Setae of legs pointed except for blunt setae around pretarsus (Figs 24, 25, 34, 38, 140, 141).

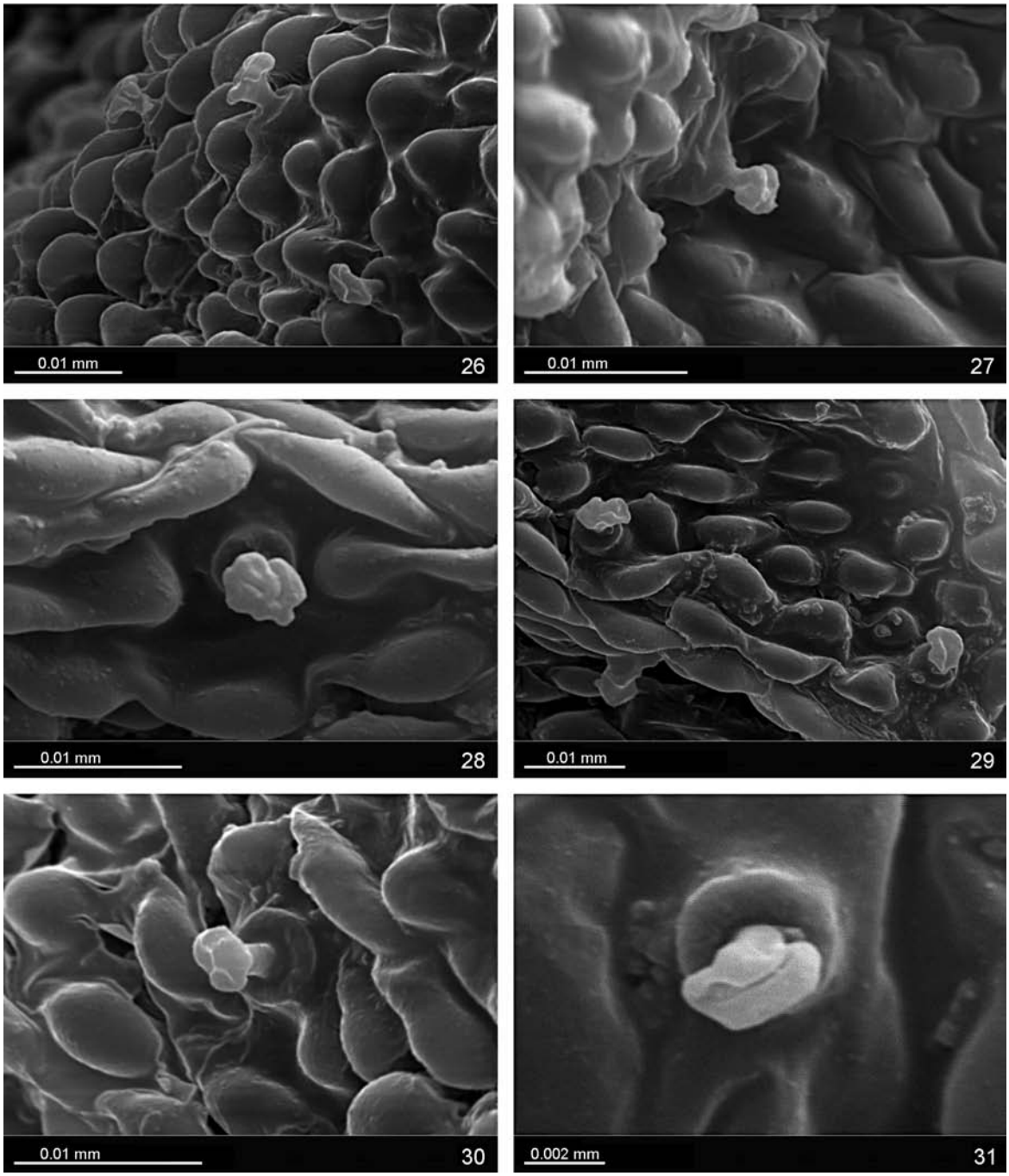
Each side of pronotum with 10 apically blunt short sensilla (Figs 45, 104). Meso- and metanotum each with two minute setae placed medially on anterior border, one short seta on each lateral side (setae on lateral side as long as short setae placed close to abdominal spiracles), a pair of blunt short sensilla placed antero-medially, arow of 10 blunt short sensilla running along width of tergite posteriorly and one blunt short sensilla on each antero-lateral side. Anterior border of abdominal tergites with pair of minute setae placed medially (Fig. 104). Moreover abdominal tergite I with two transverse rows of short blunt sensilla: one with 6 sensilla running anteriorly and the second with 4 sensilla running postero-medially; abdominal tergites II–VIII with two pairs of short blunt sensilla placed antero-laterally and transverse row of 4 setae running postero-medially.

Anterior border of pro-, meso- and metasternum with two pairs of minute setae (Figs 36, 37, 105). Two pairs of pointed setae in the middle of pro-, meso- and metasternum (Figs 36, 37, 105). Anterior margin of all abdominal sternites with pair of minute setae placed medially. Abdominal sternites I and II with 8 long, pointed setae in the middle of segment, abdominal sternite III with 6 long, pointed setae and two blunt apically setae in the middle of segment; moreover abdominal sternites I–III with two blunt short setae on each postero-lateral side and one blunt short seta on each antero-lateral side. Abdominal sternites IV–VI with 4 blunt short setae in the middle, two blunt short setae on each postero-lateral side and one blunt short seta on each antero-lateral side. Abdominal sternite VII with eight blunt short setae. Abdominal sternite VIII with six blunt short setae.

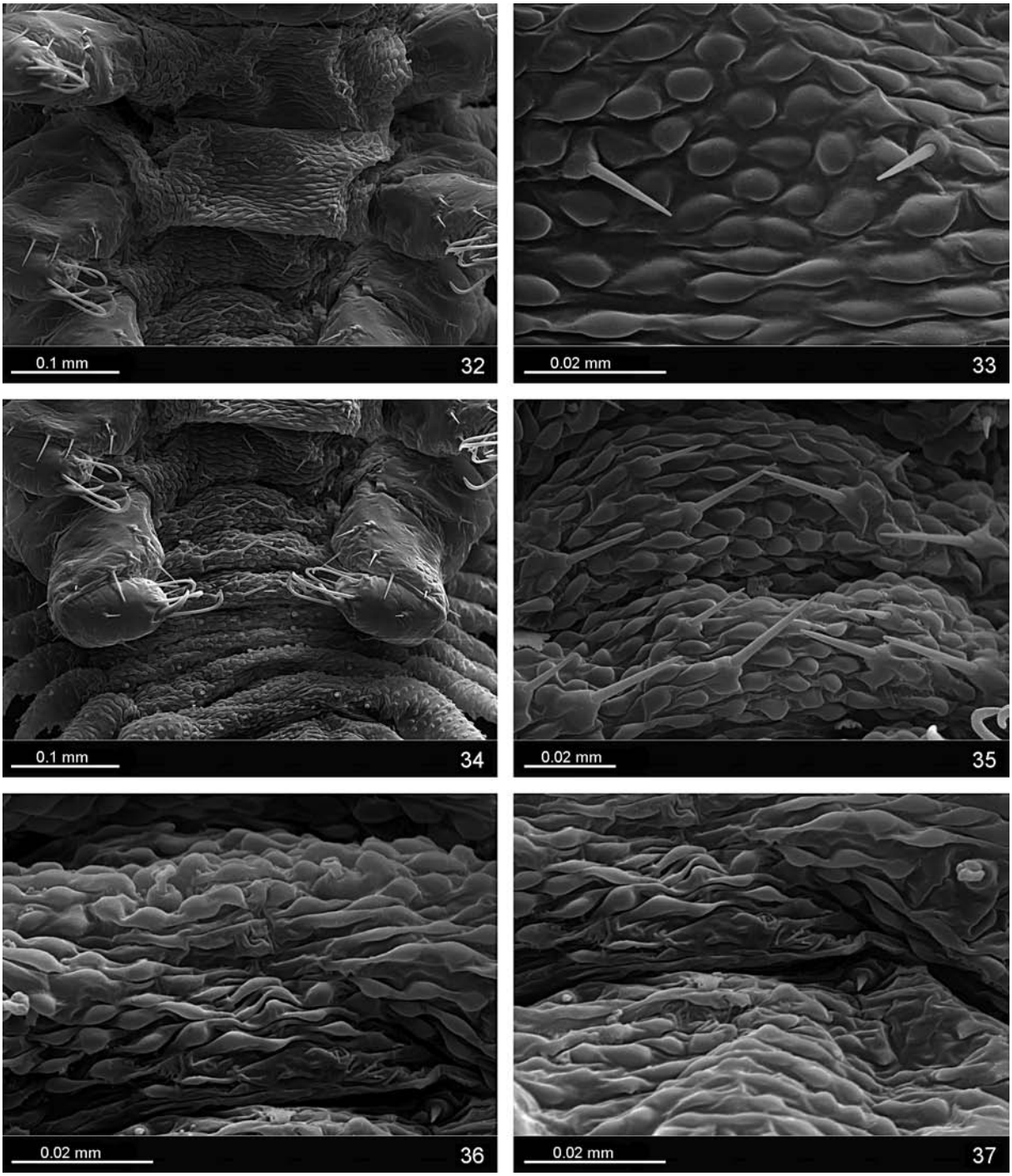
Anal turret distinct, two-segmented.



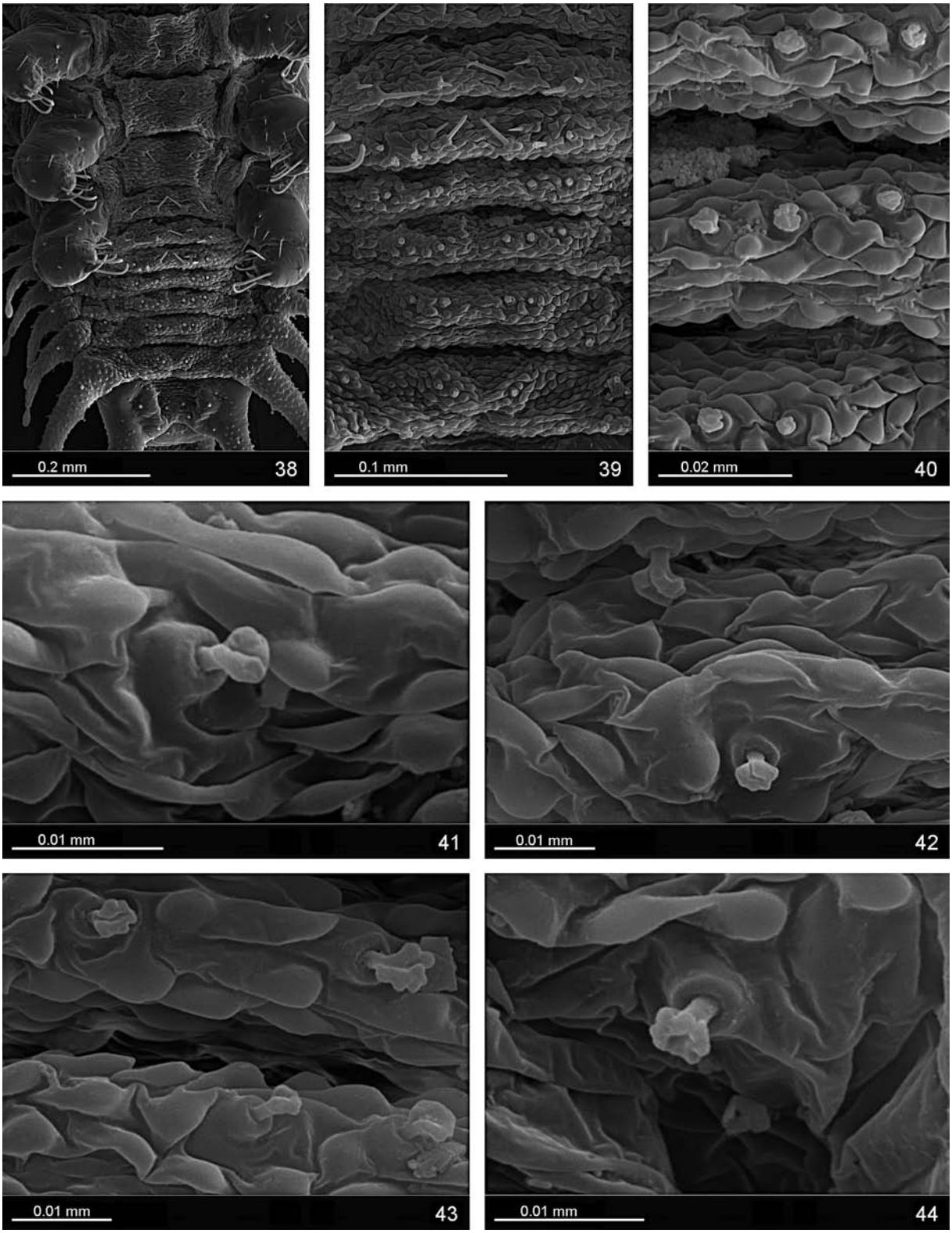
FIGURES 22–25. *Cassida pfefferi* Sekerka, 2006, first instar larva. 22. Dorsal aspect of larva body; 23. ventral aspect of larval body; 24, 25. leg.



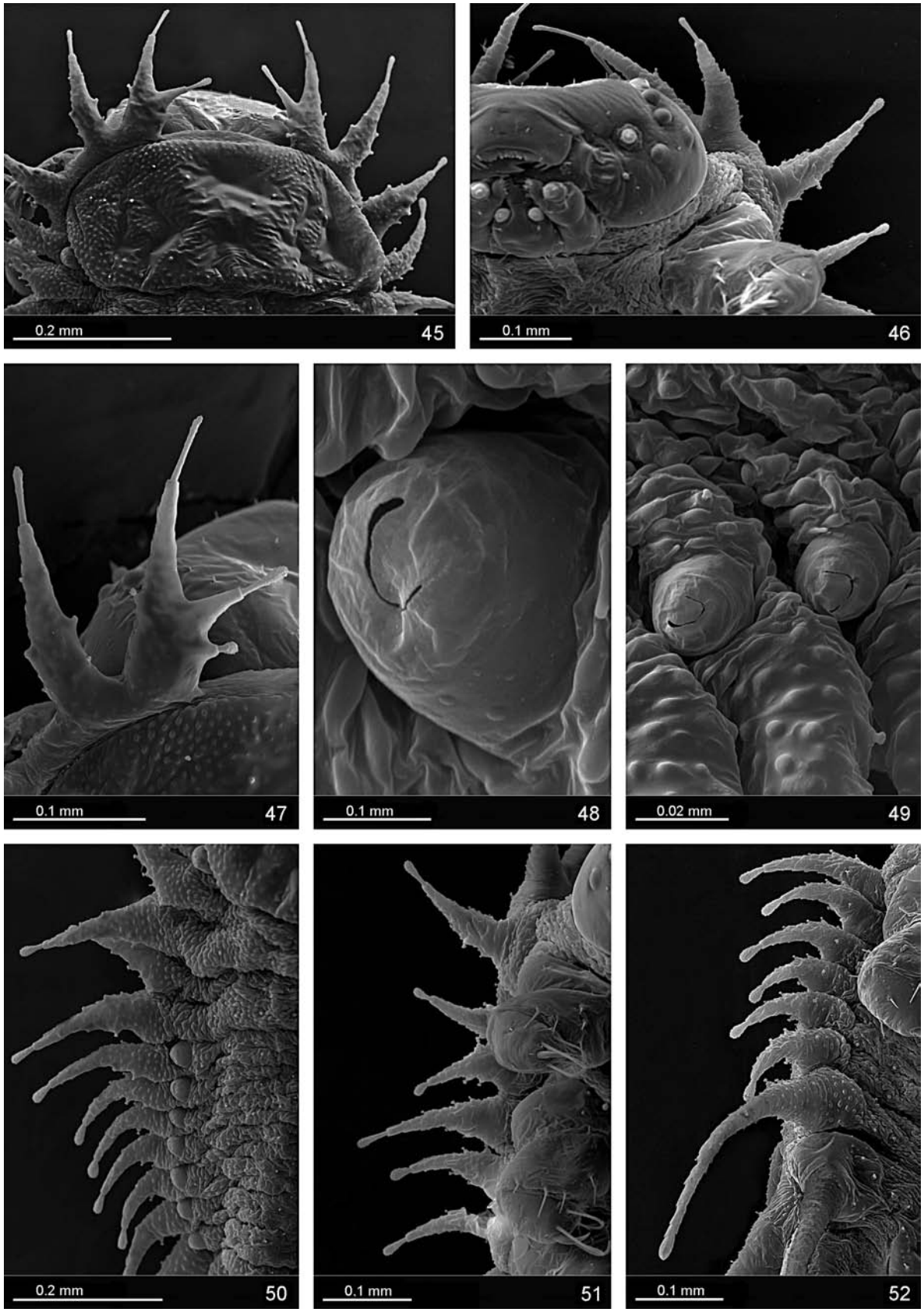
FIGURES 26–31. *Cassida pfefferi* Sekerka, 2006, first instar larva, cauliflower-shape sensilla of tergites.



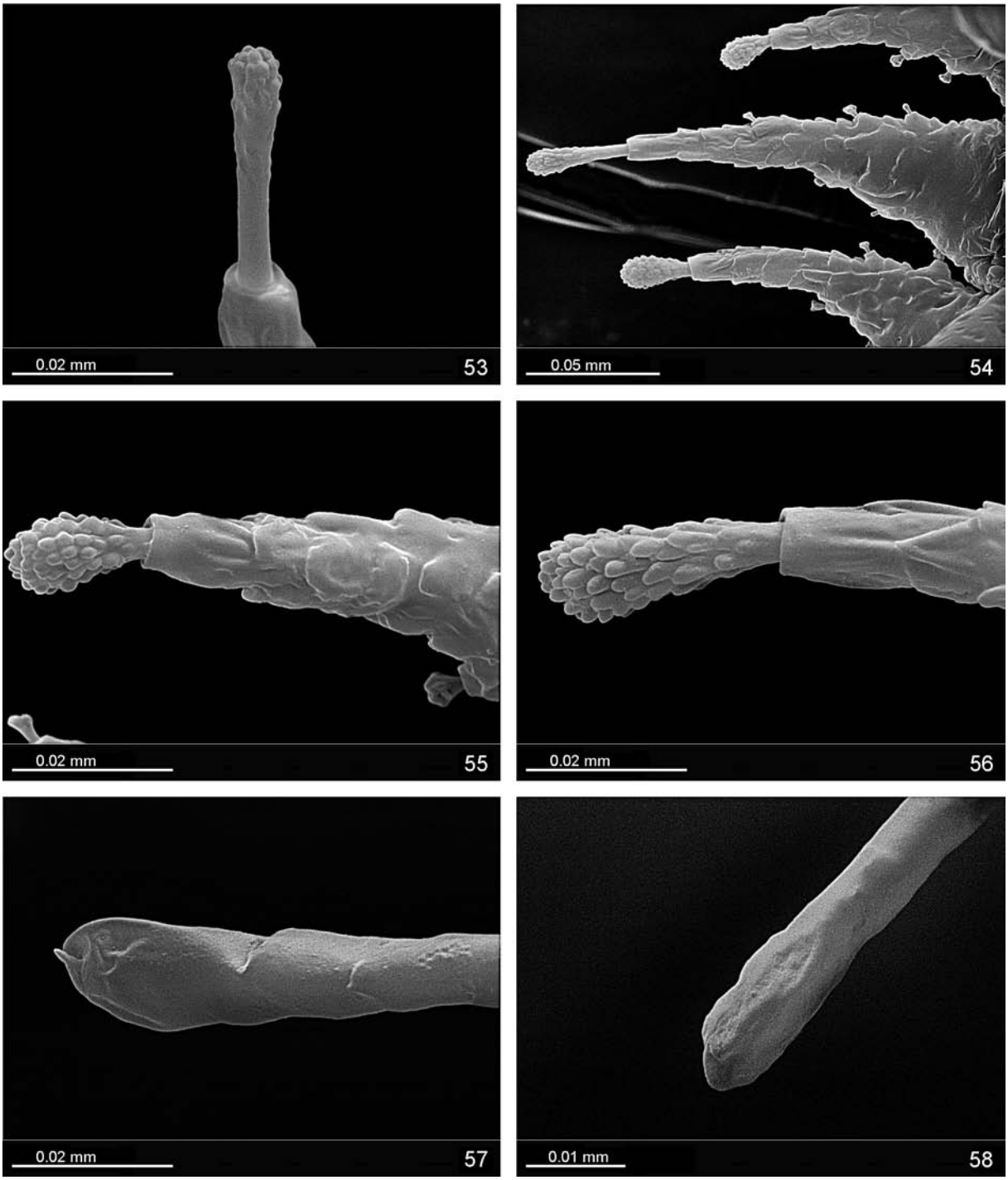
FIGURES 32–37. *Cassida pfefferi* Sekerka, 2006, first instar larva. 32. Pro-, meso- and metasternum and first abdominal sternites medially; 33. setae of mesosternum placed in anterior half of segment medially; 34. metasternum and abdominal sternites; 35. two first abdominal sternites medially; 36. sensillae of abdominal sternite VII; 37. seta of abdominal sternite VII, and minute setae of sternite VIII.



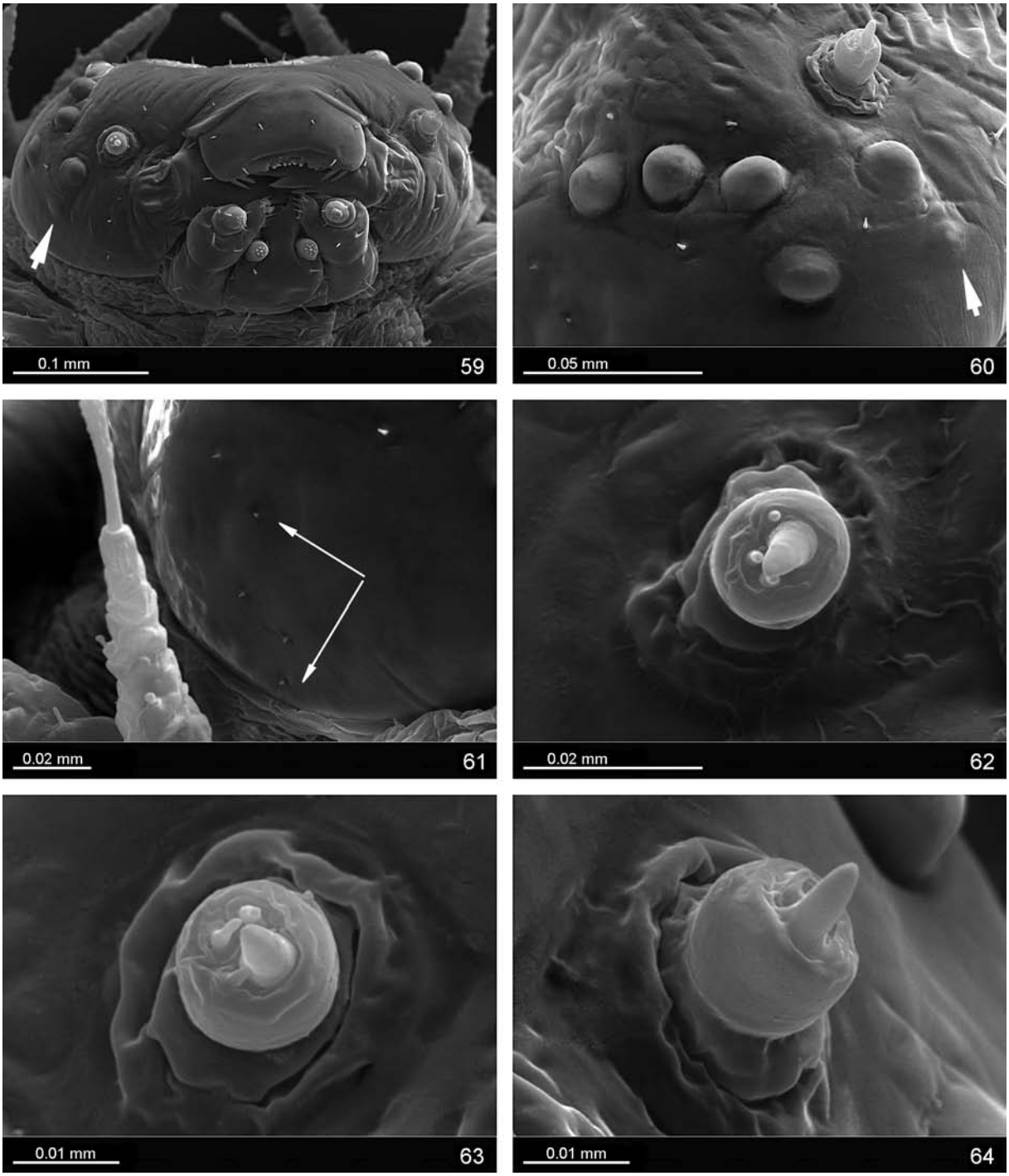
FIGURES 38–44. *Cassida pfefferi* Sekerka, 2006, first instar larva. 38. Body ventral aspect; 39. abdominal sternites II–VII; 40. abdominal sternites IV–VI; 41, 42, 43, 44. cauliflower-shape sensilla of abdominal sternites.



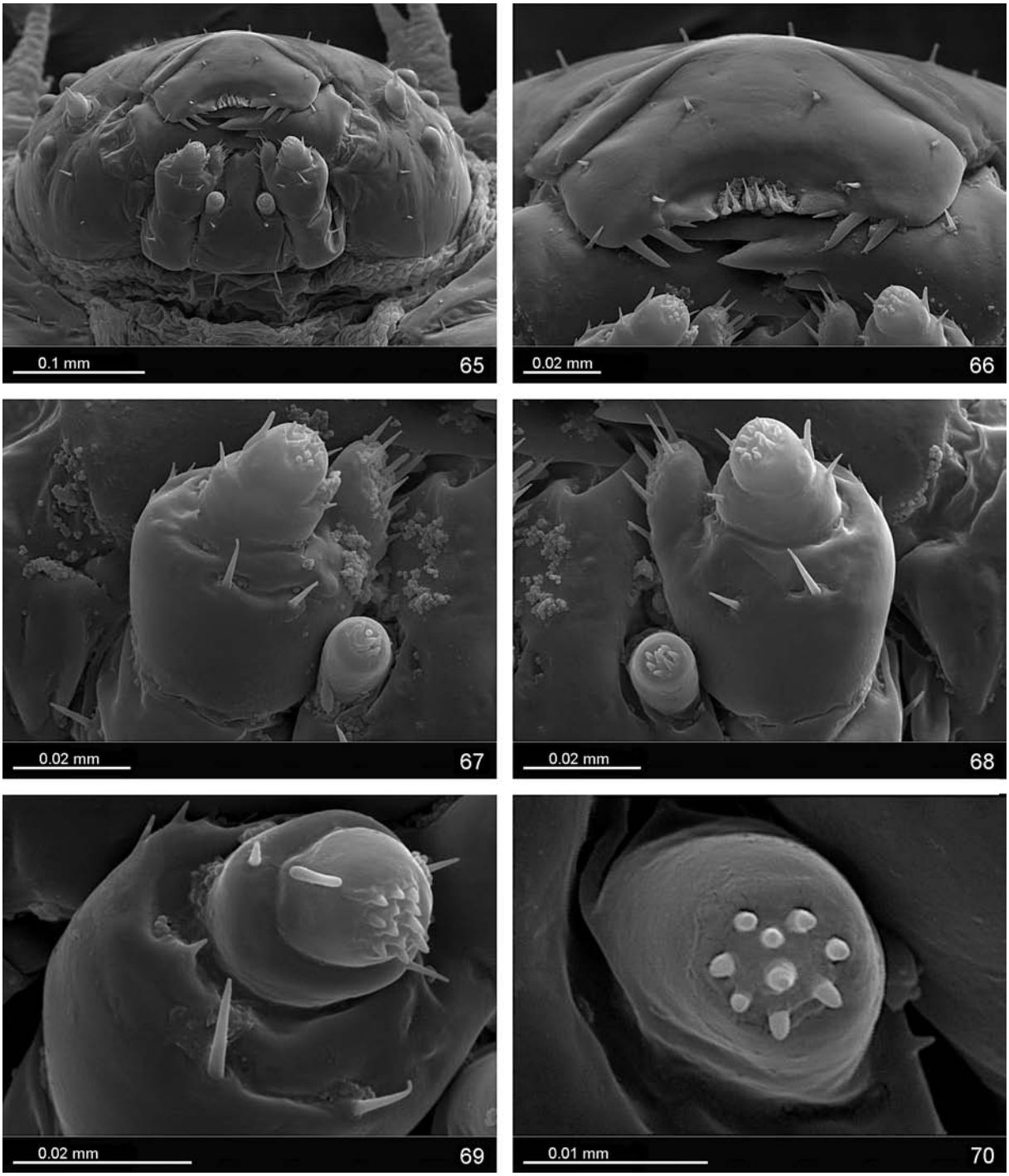
FIGURES 45–52. *Cassida pfefferi* Sekerka, 2006, first instar larva. 45. Pronotum; 46. head with view on 6 ocelli; 47. first two lateral scoli; 48. spiracle of second abdominal segment; 49. spiracles of third and fourth abdominal segments; 50. lateral scoli of thorax and abdomen, dorsal aspect; 51. lateral scoli of thorax and first scoli of abdomen, ventral aspect; 52. lateral scoli of abdominal segments I–VII, ventral aspect.



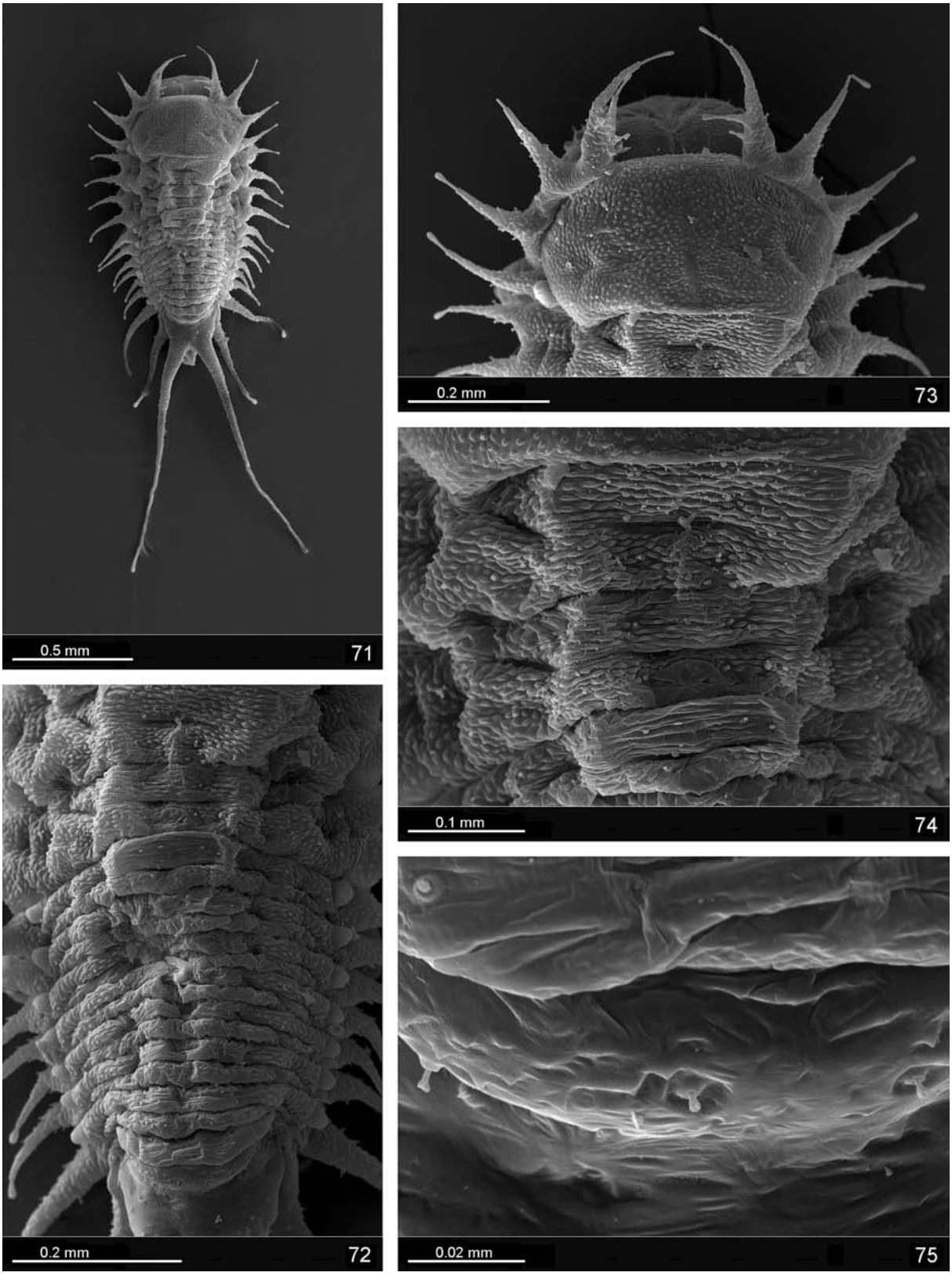
FIGURES 53–58. *Cassida pfefferi* Sekerka, 2006, first instar larva. 53. Sensillum at the top of scoli of second pair; 54. scoli of 5–7th pair; 55. sensillum at the top of scoli of 5th pair; 56. sensillum at the top of scoli of 9th pair; 57. sensillum at the top of 16th lateral scolus; 58. top of supra-anal process.



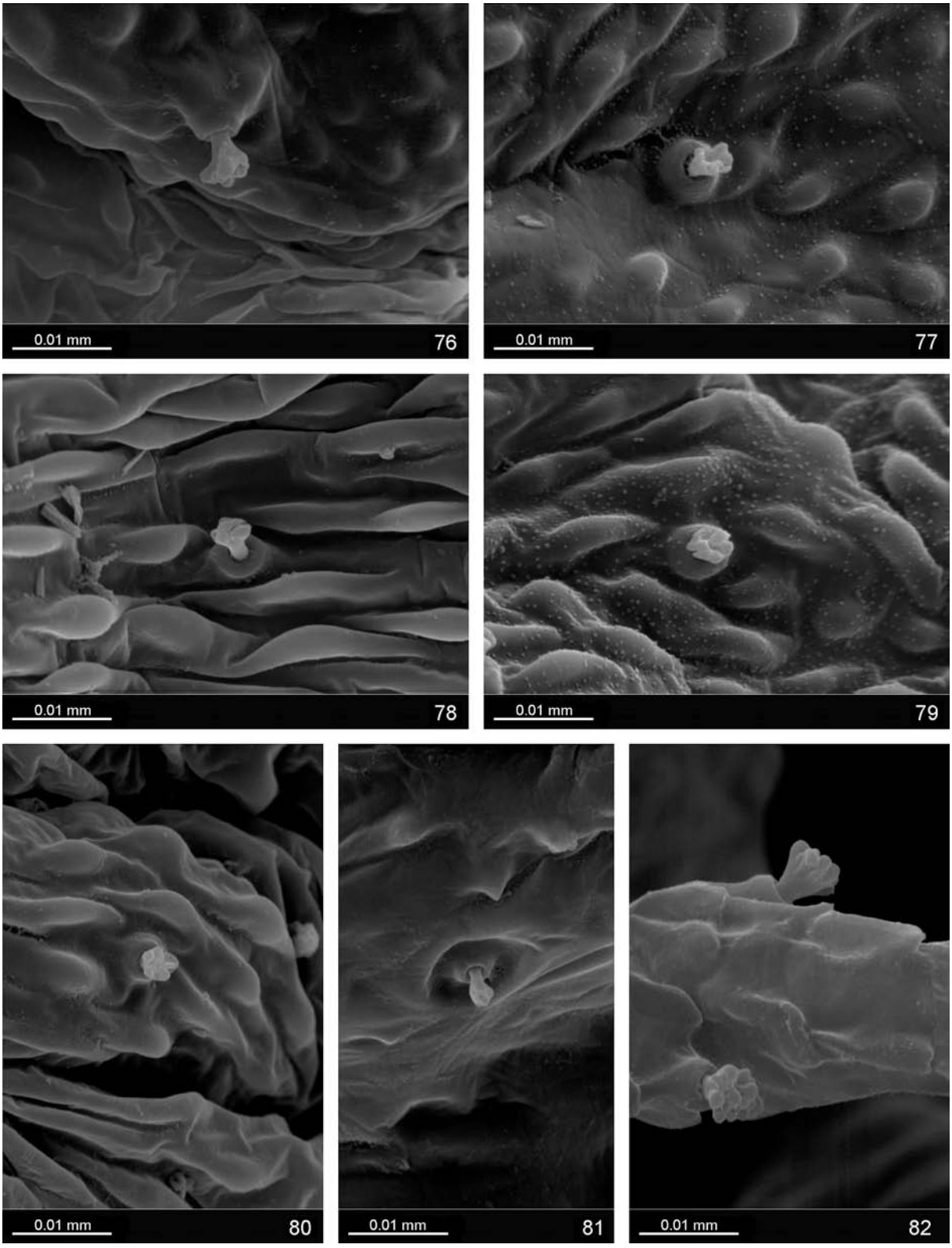
FIGURES 59–64. *Cassida pfefferi* Sekerka, 2006, first instar larva. 59. Head; 60. ocelli and antenna; 61. setae of vertex (V 1–4); 62– 64. antenna.



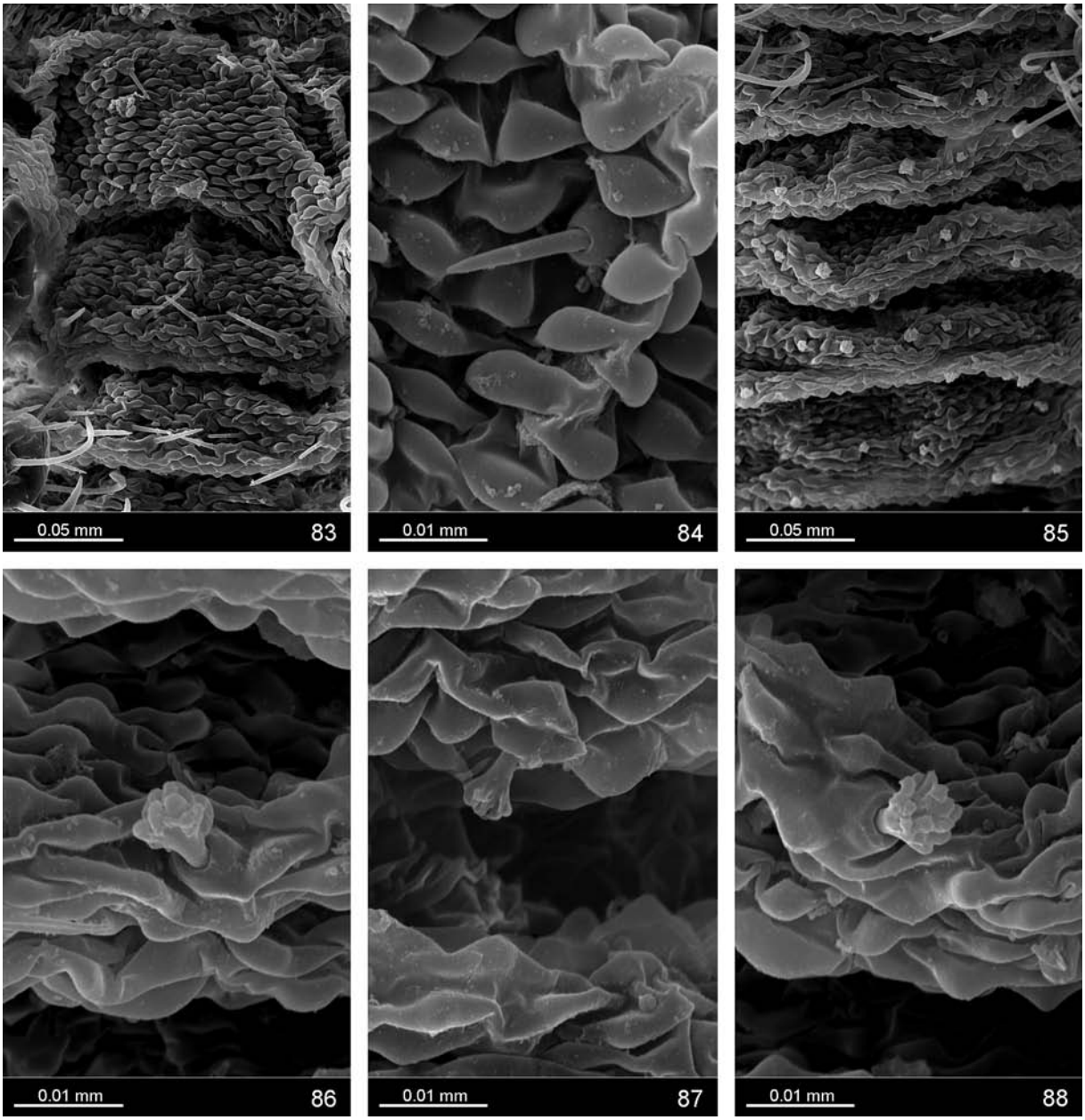
FIGURES 65–70. *Cassida pfefferi* Sekerka, 2006, first instar larva. 65. Mouth parts; 66. labrum; 67, 68. part of maxilla and labium; 69. maxillary palp; 70. labial palp.



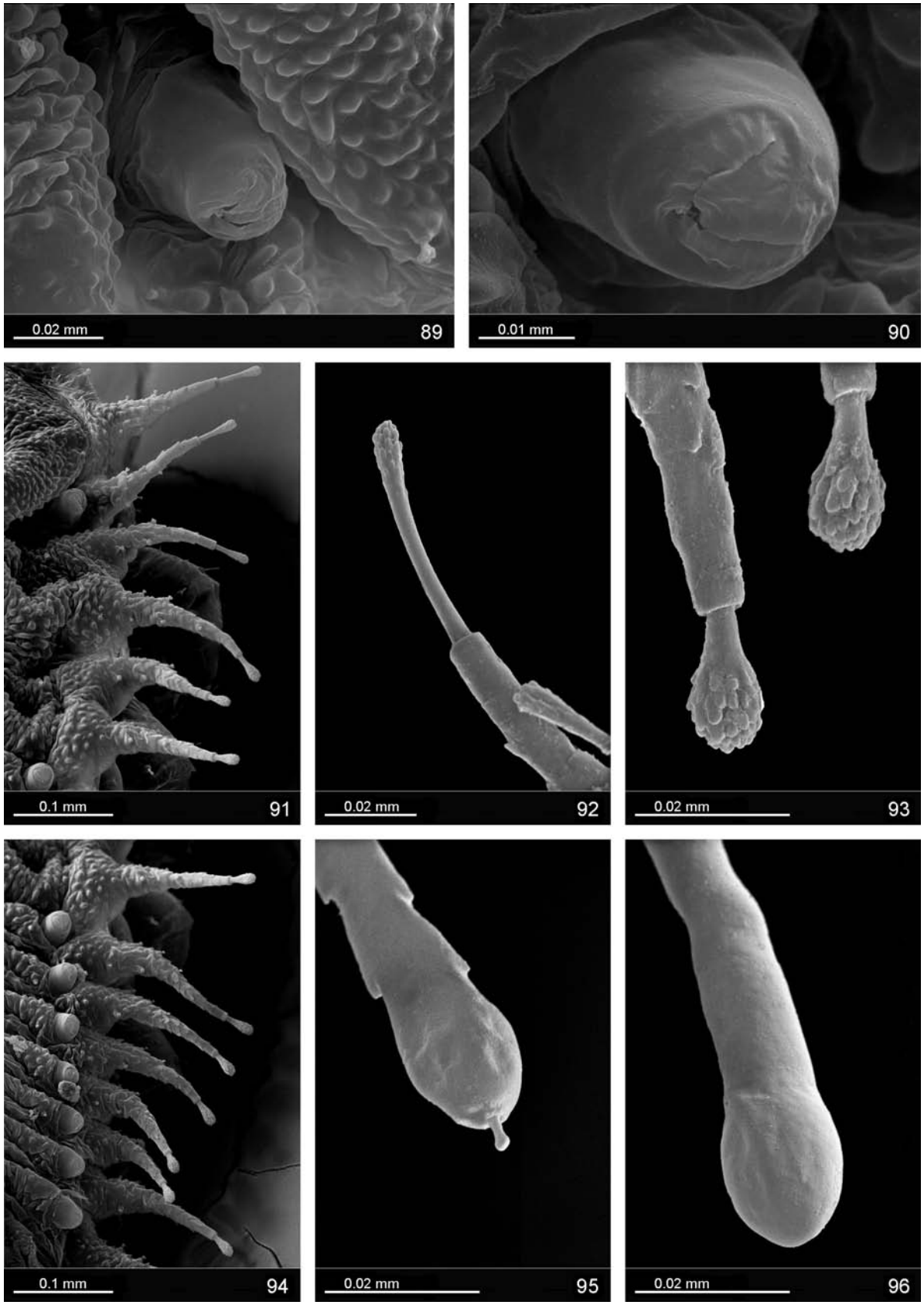
FIGURES 71–75. *Cassida nobilis* Linnaeus, 1758, first instar larva. 71. Dorsal aspect of larval body; 72. meso-, metanotum and abdominal tergites; 73. pronotum; 74. meso- and metanotum; 75. abdominal tergite VIII.



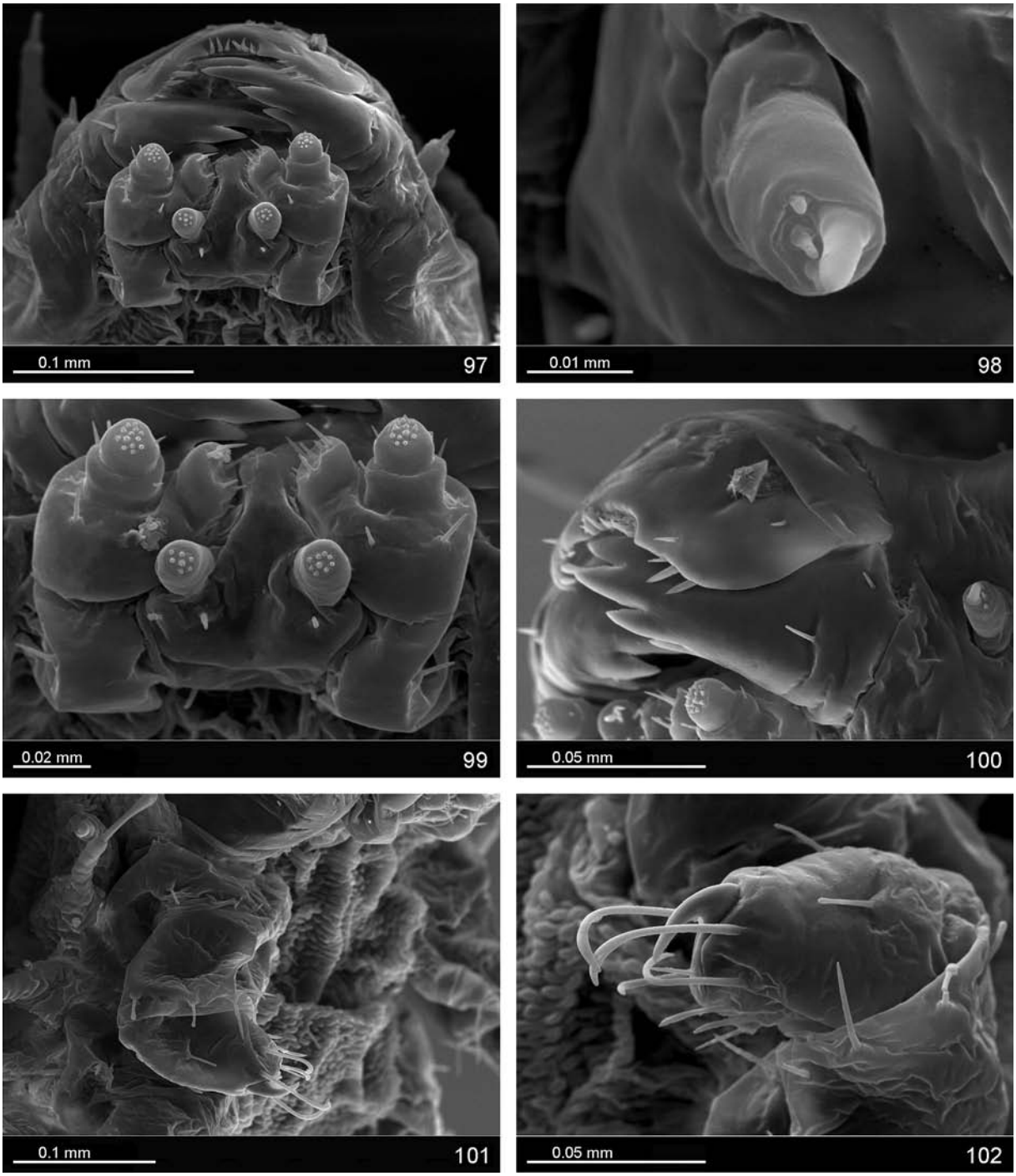
FIGURES 76–82. *Cassida nobilis* Linnaeus, 1758, first instar larva. 76, 77. Cauliflower-shape sensilla of pronotum; 78, 79. cauliflower-shape sensilla of metanotum; 80. cauliflower-shape sensilla of abdominal tergite II; 81. cauliflower-shape sensillum of abdominal tergite VIII; 82. cauliflower-shape sensilla of lateral scolus.



FIGURES 83–88. *Cassida nobilis* Linnaeus, 1758, first instar larva. 83. Metasternum and two first abdominal sternites medially; 84. pointed seta of mesosternum placed medially; 85. abdominal sternites III–VII; 86, 87. cauliflower-shaped sensilla of abdominal sternite IV; 88. cauliflower-shaped sensillum of abdominal sternite V.



FIGURES 89–96. *Cassida nobilis* Linnaeus, 1758, first instar larva. 89. Thoracic spiracle; 90. spiracle of first abdominal segment; 91. lateral scoli of tergites; 92. sensillum at the top of lateral scolus of first pair; 93. sensilla at the top of lateral scolus of 13th and 14th pair; 94. lateral scoli of abdominal sternites I–VII; 95. top of lateral scolus of 16th pair; 96. top of supra-anal process.



FIGURES 97–102. *Cassida nobilis* Linnaeus, 1758, first instar larva. 97. Mouth parts; 98. antenna; 99 maxillae and labium; 100. labrum and mandibula laterally; 101. leg; 102. top of leg.

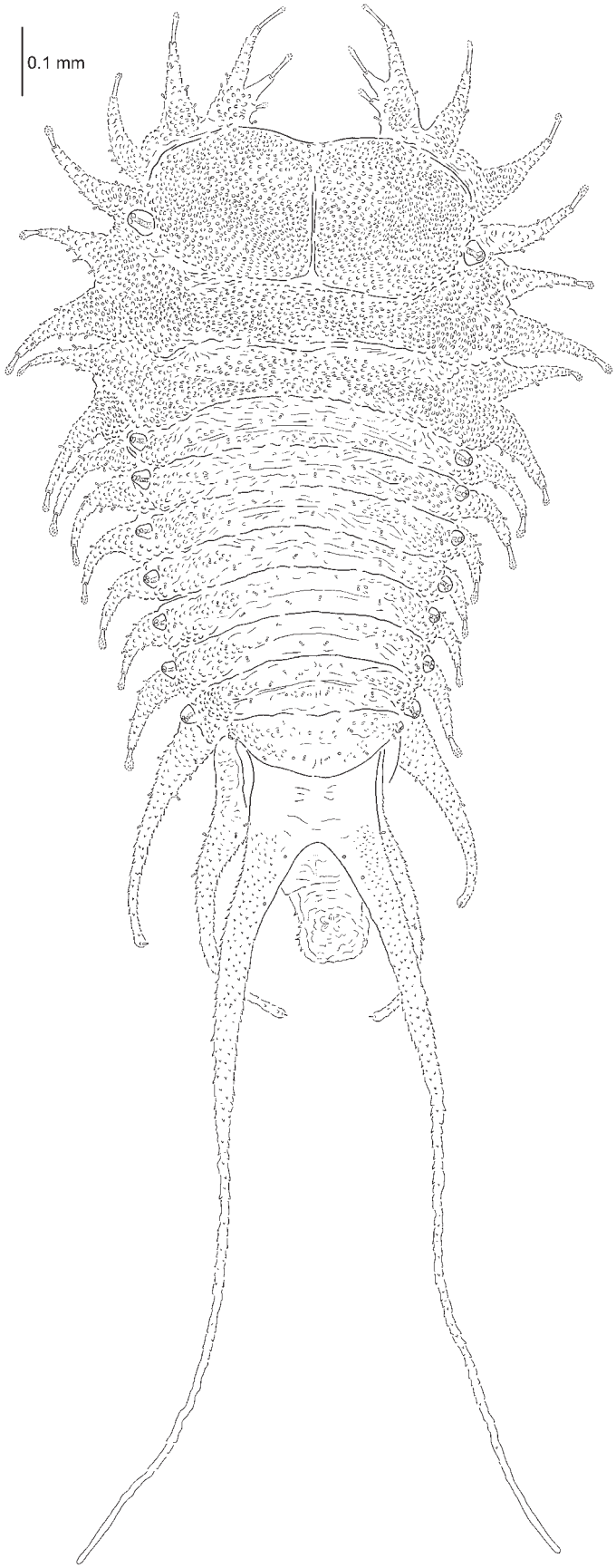


FIGURE 103. *Cassida pfefferi* Sekerka, 2006, first instar larva, dorsal aspect.

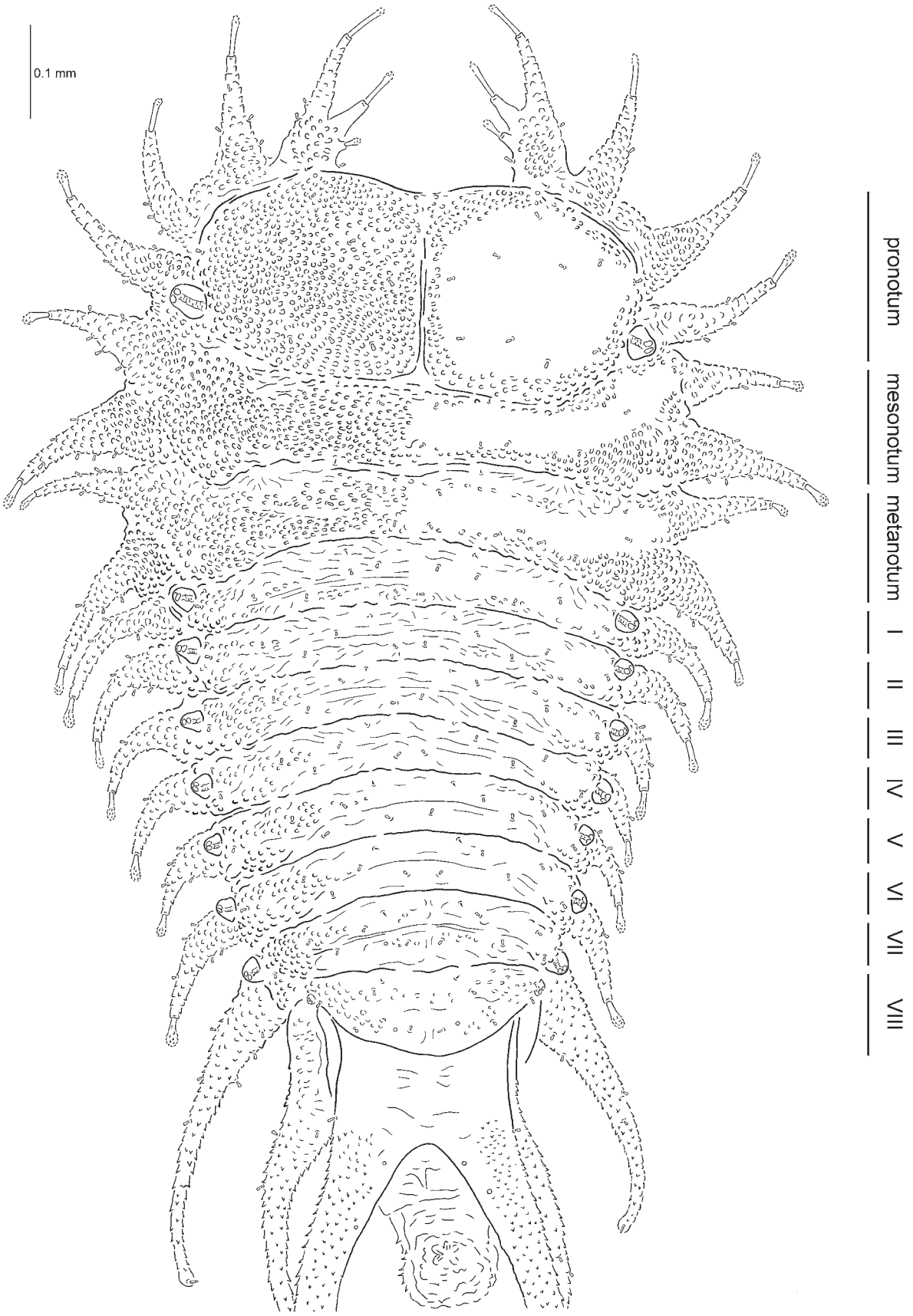


FIGURE 104. *Cassida pfefferi* Sekerka, 2006, first instar larva, chaetotaxy of tergites.

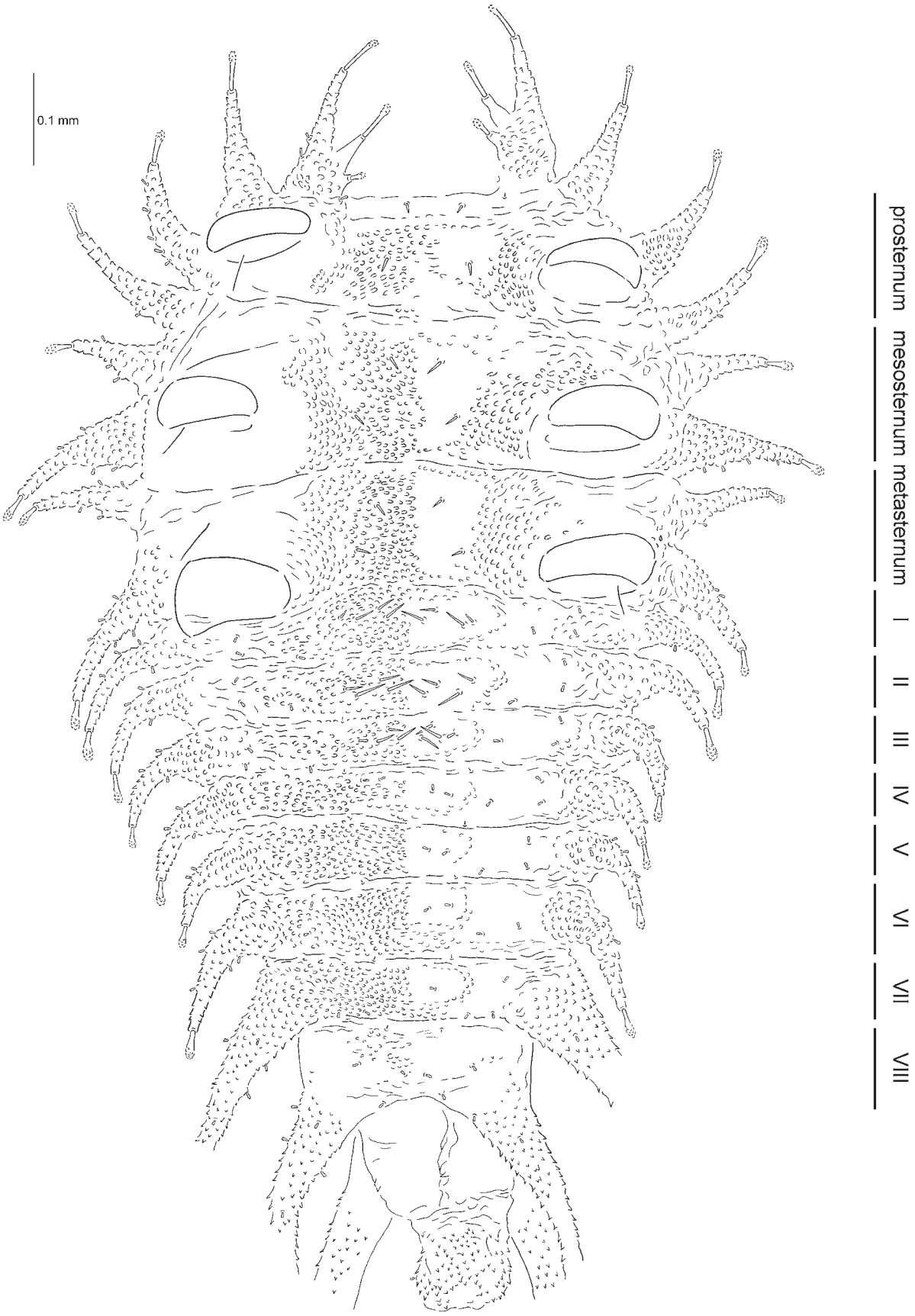
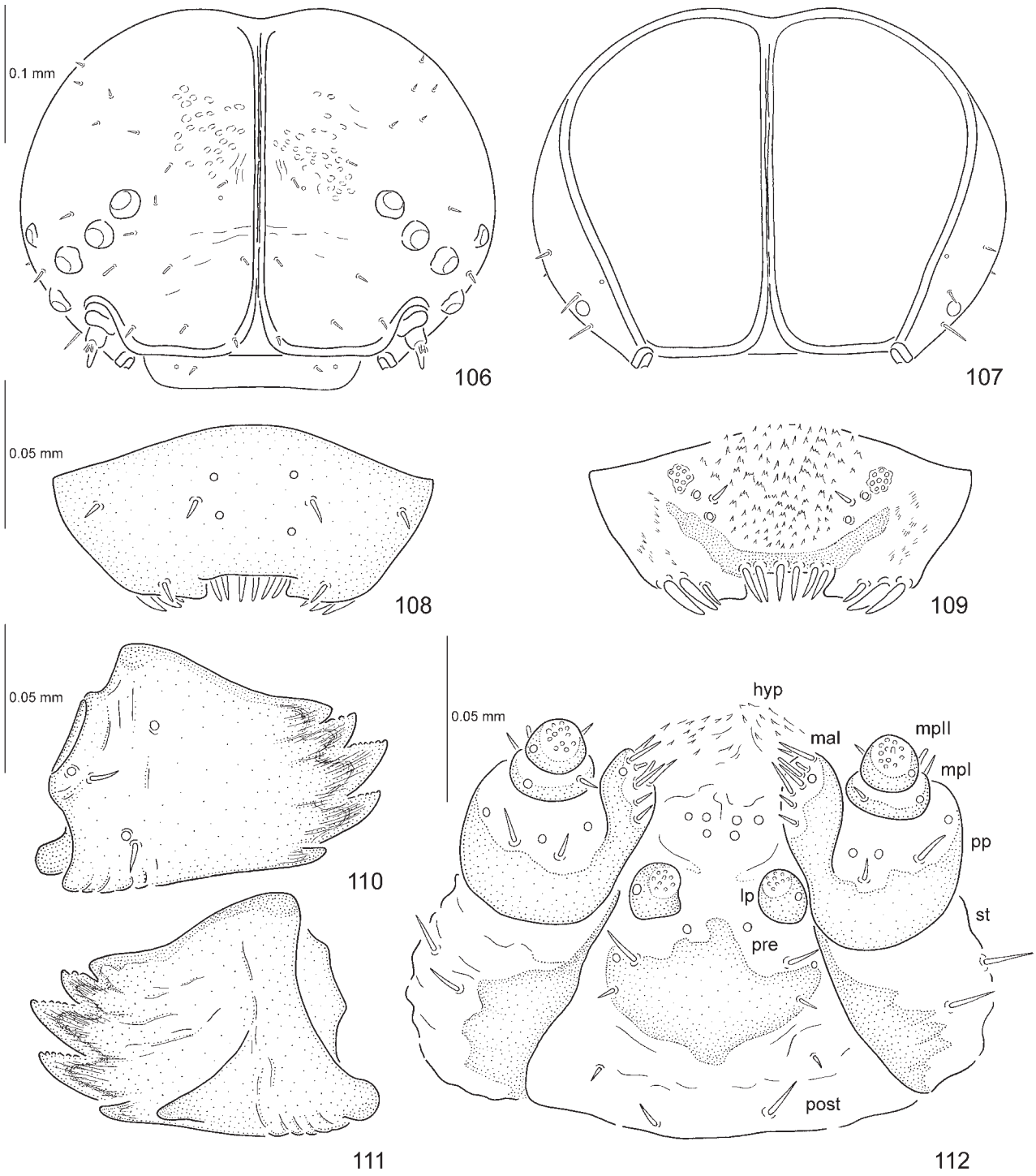
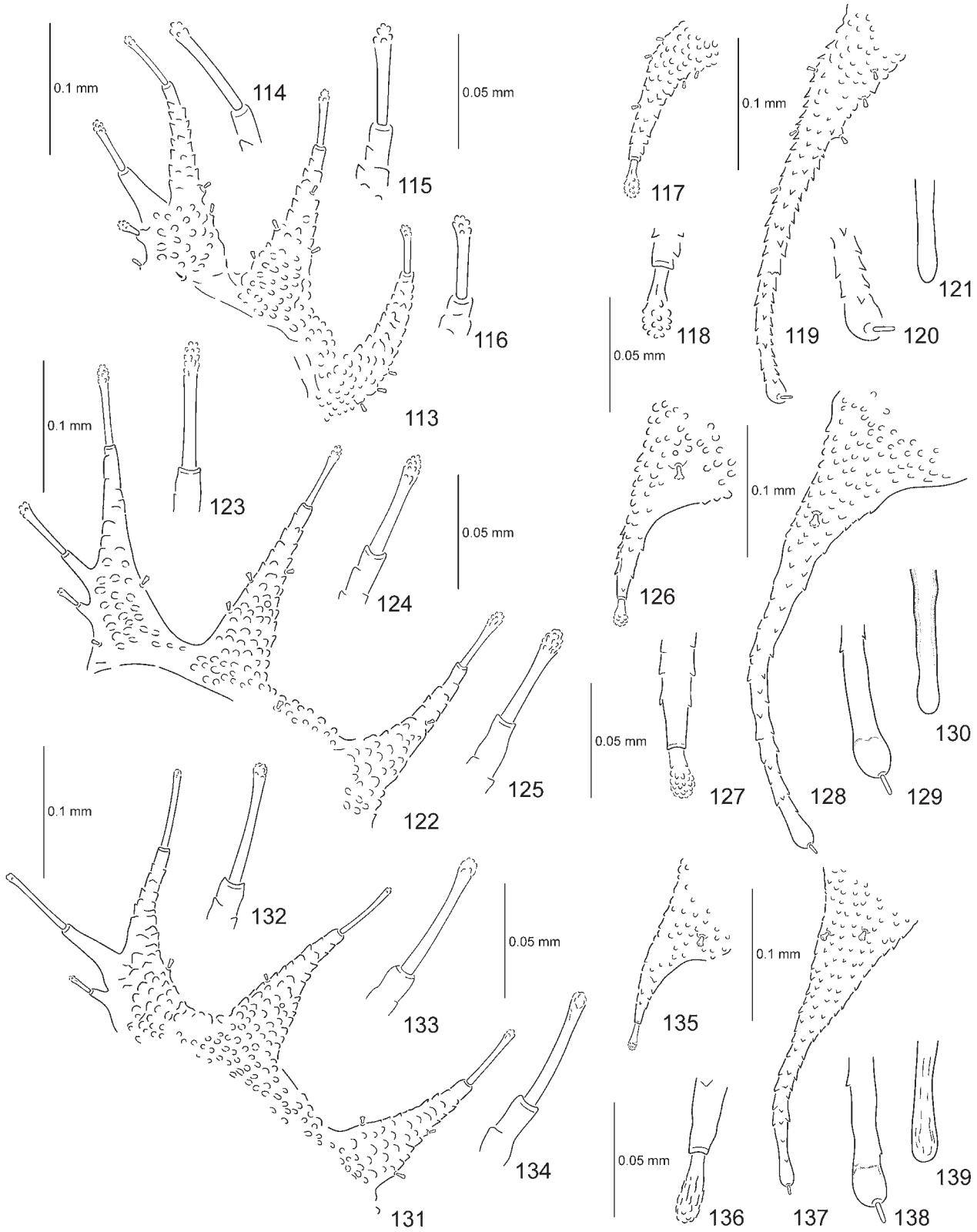


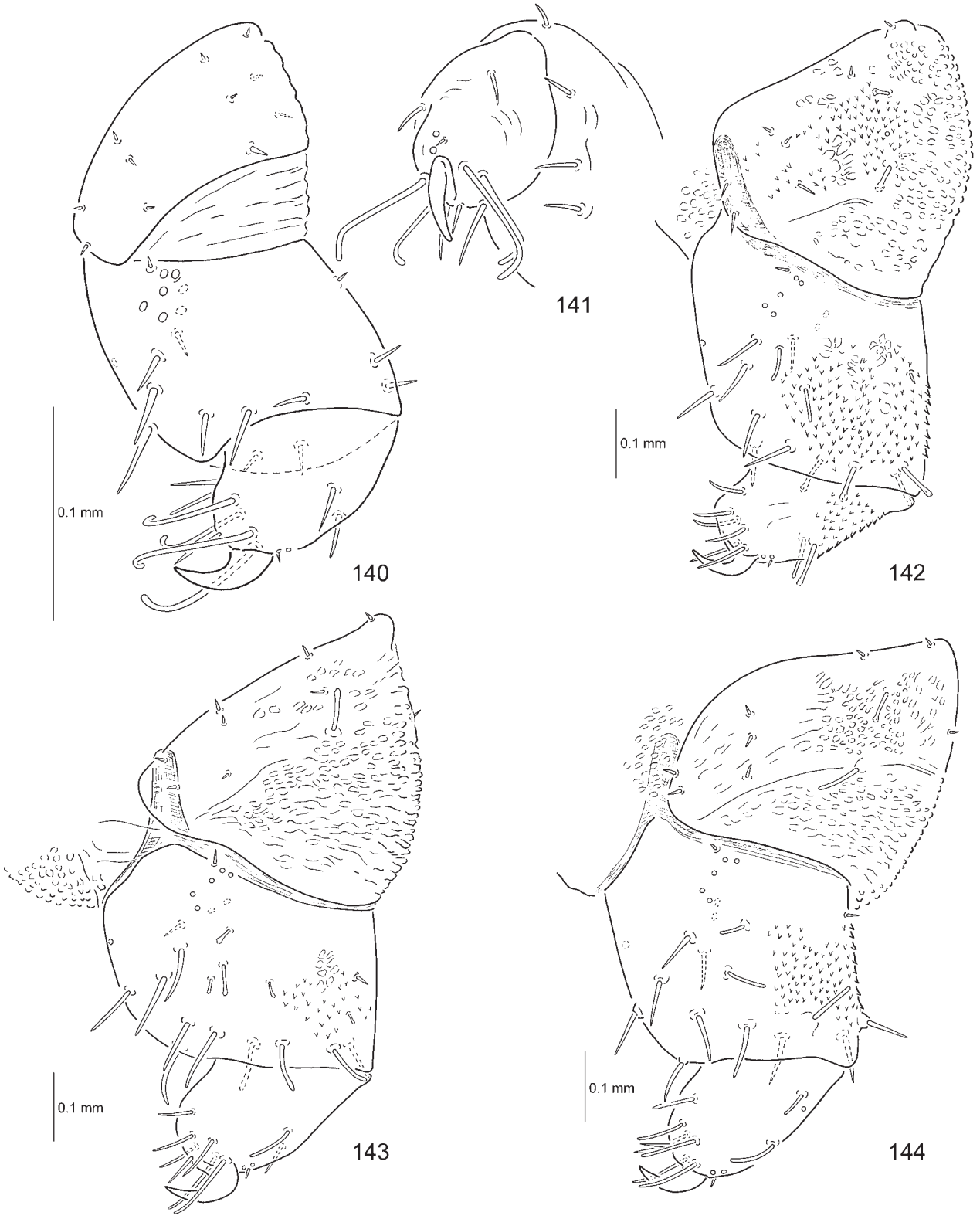
FIGURE 105. *Cassida pfefferi* Sekerka, 2006, first instar larva, chaetotaxy of sternites.



FIGURES 106–112. *Cassida pfefferi* Sekerka, 2006, first instar larva. 106. Frontal side of head; 107. temporal side of head; 108. dorsal side of labrum; 109. ventral side of labrum; 110, 111. mandibles; 112. maxillae and labium. Abbreviations: hyp—hypopharynx; lp—labial palp; mal—mala; mpI—first segment of maxillary palp; mpII—second segment of maxillary palp; post—postmentum; pp—palpifer; pre—prementum; st—stipes.



FIGURES 113–139. Lateral scoli, first instar larvae. 113–121. *Cassida pfefferi* Sekerka, 2006; 122–130. *Cassida vittata* Villers, 1789; 131–139. *Cassida nobilis* Linnaeus, 1758; 113, 122, 131. lateral scoli of first three pairs; 114, 123, 132. sensillum at the top of first lateral scolus; 115, 124, 133. sensillum at the top of second lateral scolus; 116, 125, 134. sensillum at the top of third lateral scolus; 117, 126, 135. lateral scolus of 14th pair; 118, 127, 136. sensillum at the top of 14th lateral scolus; 119, 128, 137. lateral scolus of 15th pair; 120, 129, 138. sensillum at the top of 15th lateral scolus; 121, 130, 139. top of supra-anal process.



FIGURES 140–144. Legs. 140, 141. *Cassida pfefferi* Sekerka, 2006, first instar larva; 142; *Cassida nobilis* Linnaeus, 1758, fifth instar larva; 143. *Cassida pfefferi*, fifth instar larva; 144. *Cassida vittata* Villers, 1789, fifth instar larva.

Head well sclerotized, hypognathous, retracted into pronotum. Median suture complete, connected with fronto-clypeal suture. Clypeus distinct, wider than long, with a pair of setae and a pair of campaniform sensilla (Fig. 106).

Six stemmata on each side of head: five distinct, the sixth clearly smaller than the others (Figs 59, 60, 106, 107).

Head on each side with four small (Fig. 61), vertical, pointed setae (V 1–4), and five frontal rows of setae: row Fa with 3 setae, Fb with 4 setae, Fc with 3 setae, Fd with single seta, Fe with 2 setae (Fig. 106). Temporal surface of head with 3 setae (Fig. 107).

Antennae two-segmented, set in membranous ring (Figs 62–64). Both segments stout: first is wider than long, second slightly longer than wide. First segment with three campaniform sensilla on lateral side, second with short seta on side and a group of four peg-like sensilla on the apex: one prominent (sensory appendix) and three small.

Labrum wider than long, anterior margin distinctly emarginate (Figs 59, 65, 66, 108, 109). Dorsal side of labrum with row of four long setae and two pairs of campaniform sensilla placed centrally. Anterior margin with 14 setae: 6 placed medially, three stout and long setae on each lateral side and one small on each side dorsally. A pair of small setae, four campaniform sensilla, and two groups of eight small sensilla in the mid part of ventral surface (epipharyngeal area). Numerous small spines in the central and lateral parts of ventral side of labrum.

Mandibles heavily sclerotized, palmate, with six triangular, apical teeth: five in row and sixth slightly retracted; and two setae and three campaniform sensilla at base dorsally (Figs 110, 111). Dorsal margin of second to fourth mandibular tooth finely crenulate.

Maxillae and labium connate (Figs 59, 65, 67–70, 112). Each stipes (st) with two long pointed setae. Mala (mal) not distinctly bordered from palpifer (pp). Six long pointed setae, one blunt seta, one peg like sensillum and one campaniform sensillum at the apex of broad and truncate mala. Palpifer with two long setae and two or three campaniform sensilla. Maxillary palp two-segmented: first segment (mpI) with two setae and one campaniform sensillum, second segment (mpII) with group of sensilla on apex, and with one campaniform sensillum, one pointed seta and digitiform sensillum below the apex. Labial palp (lp) one-segmented with group of sensilla on the apex and one campaniform sensillum below the apex. Hypopharynx (hyp) covered with numerous spines, with six campaniform sensilla at base. Prementum (pre) with two long and two short setae, and four campaniform sensilla. Postmentum (post) with two long and two short setae.

Legs stout, consisting of coxa, femur, tibiotarsus and pretarsus (Figs 24, 25, 34, 38, 140, 141). Internal side of coxa with setae arranged in three groups: first group with two short pointed setae (placed at border between coxa and body); second with three short pointed setae; third with three short pointed setae and one longer seta. Two short pointed setae on coxa externally. Femur with 11 long setae and one short seta placed dorsally close to the base. Group of five campaniform sensilla and one short pointed seta at base of femur internally, one campaniform sensillum ventrally, and two campaniform sensilla externally. Pretarsus heavily sclerotized, short and curved, single and simple, armed basally with pointed seta, surrounded by complex of six long setae, the longest four slightly curved apically. One short pointed seta and two campaniform sensilla dorsally at base of pretarsus. Two setae on the middle of tibiotarsus dorsally.

Fifth instar larva of *Cassida pfefferi*
(Figs 14, 143, 181, 182, 185)

Measurements (n=4) are presented in Table 2.

Body elongate-oval, slightly flattened dorso-ventrally, widest across metathorax, abdominal segments slightly narrowed posteriorly. Body of living larva green with two dark brown, irregular patches on pronotum and yellowish-brown supra-anal processes (Fig. 14). Larva preserved in alcohol mostly yellow with two light brown irregular patches on pronotum and light brown supra-anal processes (Figs 181, 182, 185).

Body with 16 pairs of lateral scoli and a pair of supra-anal processes (Fig. 181). Prothorax and mesothorax with three pairs of lateral scoli, metathorax with two pairs, abdominal segments I–VIII each with one pair. First two lateral scoli placed very close each other. All scoli short, more or less of the same length. Scoli covered with lateral branches (Fig. 222), each scolus armed with elongate blunt at the apex sensillum (Figs 223, 225), whereas each lateral branch armed with cauliflower-shape sensillum (Fig. 224). Sensilla at the tops of scoli gradually shortened posterad. Supra-anal processes short, bent dorsally, covered with asperities.

TABLE 2. Measurements of *Cassida pfefferi* Sekerka, 2006 first and fifth instar larvae (in millimetres).

Cassida pfefferi larva	body length	width of body across metathorax	length of supra-anal processes	width of head
first instar larva				
1.	1.70	0.53	1.20	0.33
2.	1.58	0.68	0.96	0.33
3.	1.08	0.50	0.80	0,33
4.	1.40	0.60	1.03	0.33
5.	1.20	0.56	1.10	0.36
6.	1.53	0.63	1.06	0.36
7.	0.85	0.55	0.97	0.35
8.	0.80	0.60	1.05	0.35
9.	0.75	0.52	1.00	0.34
10.	0.77	0.57	1.00	0.33
11.	0.80	0.52	1.05	0.35
12.	0.77	0.50	1.05	0.35
fifth instar larva				
1.	5.20	2.40		0.85
2.	5.30	2.30		0.85
3.	4.40	2.20		0.75
4.	4.30	2.30		0.70

Body distinctly granulate, distinct asperities on each abdominal tergite and sternite (Figs 202–219). Pronotum with cauliflower-shaped sensilla (Figs 202, 203, 222) distributed mostly along lateral and posterior margins of segment and in the middle along body axis. Meso-, metanotum and abdominal tergites with two minute setae (Fig. 206) at anterior border medially and two rows of cauliflower-shaped sensilla (Figs 204–207) which running across segment, posterior row with less numbers of sensilla than anterior. Number of cauliflower-shape sensilla on tergites decreases posteriorly. Size of cauliflower-shape sensilla also very slightly decreases posteriorly.

Two pairs of minute setae at anterior border of pro-, meso- and metasternum. Pro-, meso- and metasternum also with two groups of 3–5 setae placed antero-medially (very close to each other), a pair of setae postero-medially (Figs 208, 209) and 2–4 elongate cauliflower-shaped sensilla on each lateral side. Two minute setae at anterior border of each abdominal sternite. First three abdominal sternites with group (about 20) setae placed medially which are mostly pointed and some are blunt (Figs 210, 211, 214–217), and with tree cauliflower-shaped sensilla placed laterally (Fig. 218). Abdominal sternites IV–VIII with row of cauliflower-shaped sensilla which runs across sternite (Figs 212, 213, 219–221). Number of cauliflower-shaped sensilla on sternites decreases posteriorly.

Anal turret distinct and two-segmented.

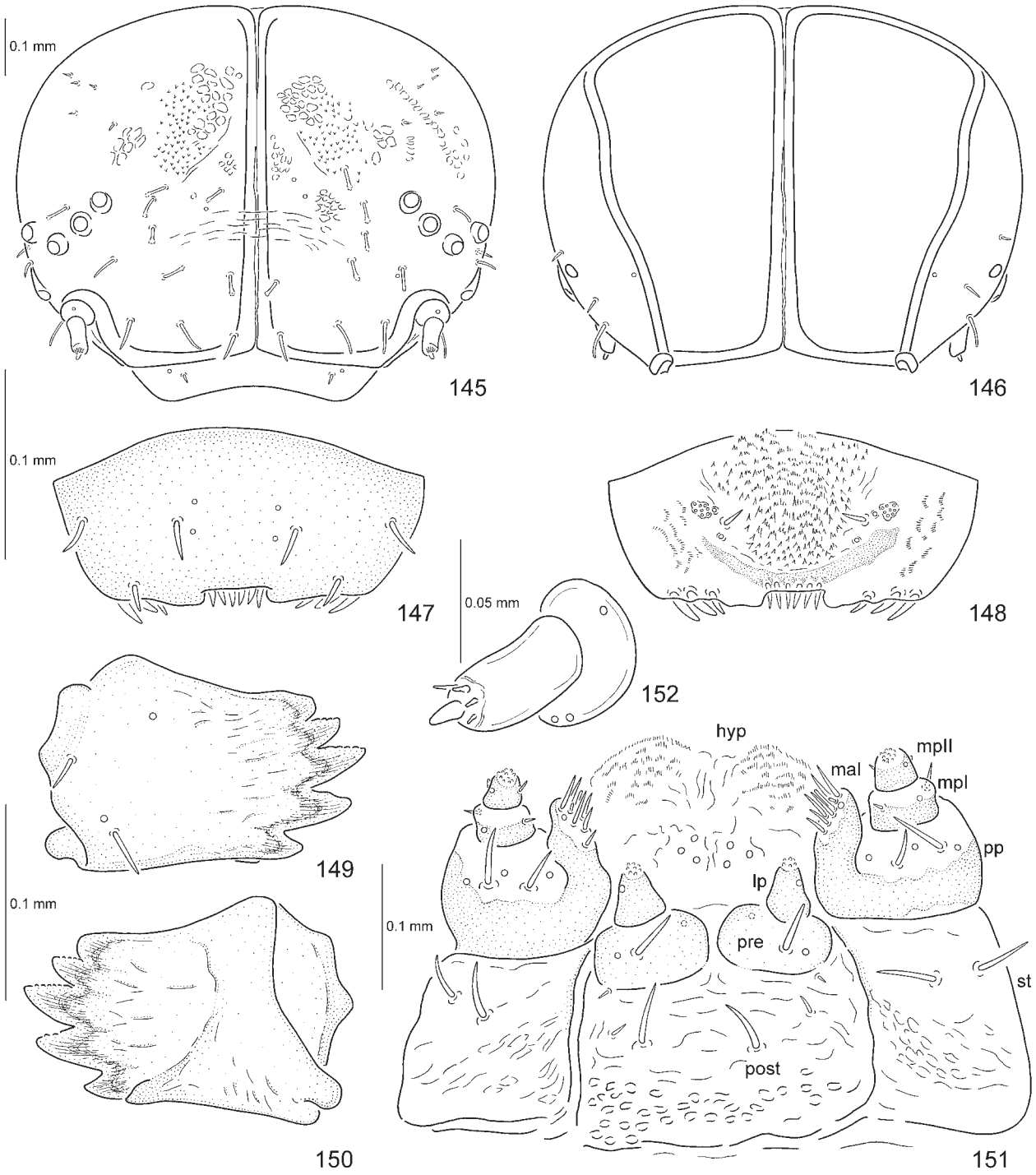
Nine pairs of spiracles (one pair on thorax and eight on abdomen). Spiracles visible from the dorsal side of body. Diameter of spiracles slightly decreasing posteriorly.

Head well sclerotized, hypognathous, retracted into pronotum. Median suture complete, connected with fronto-clypeal suture. Clypeus distinct, wider than long, with a pair of setae and pair of campaniform sensilla (Figs 145, 146).

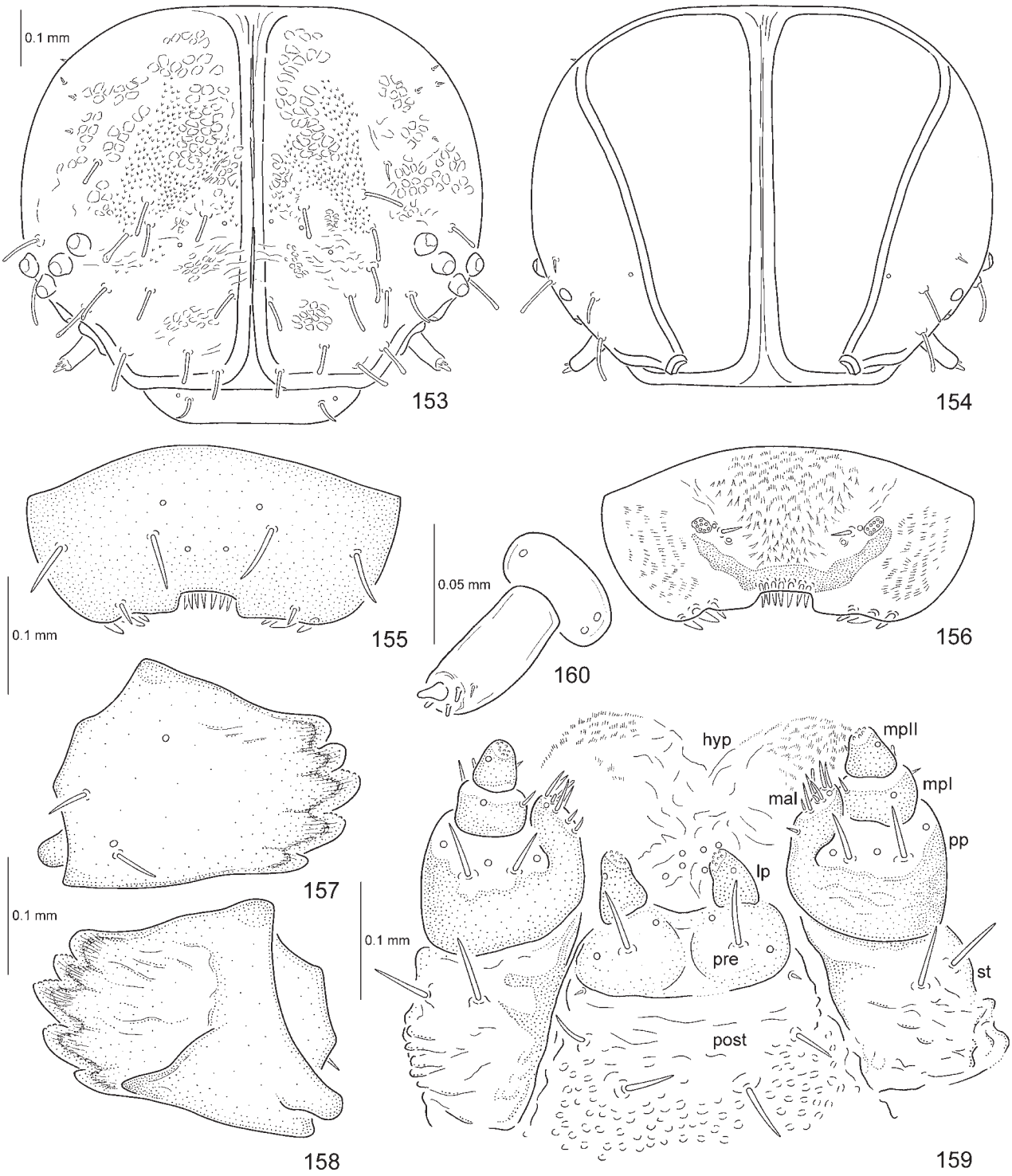
Six stemmata on each side of head.

Head on each side with four small, vertical, pointed setae (V 1–4), and five frontal rows of setae: row Fa with 3 setae, Fb with 4 setae, Fc with 3 setae, Fd with single seta, Fe with 2 setae (Fig. 145). Temporal surface of head with 3 setae (Fig. 146).

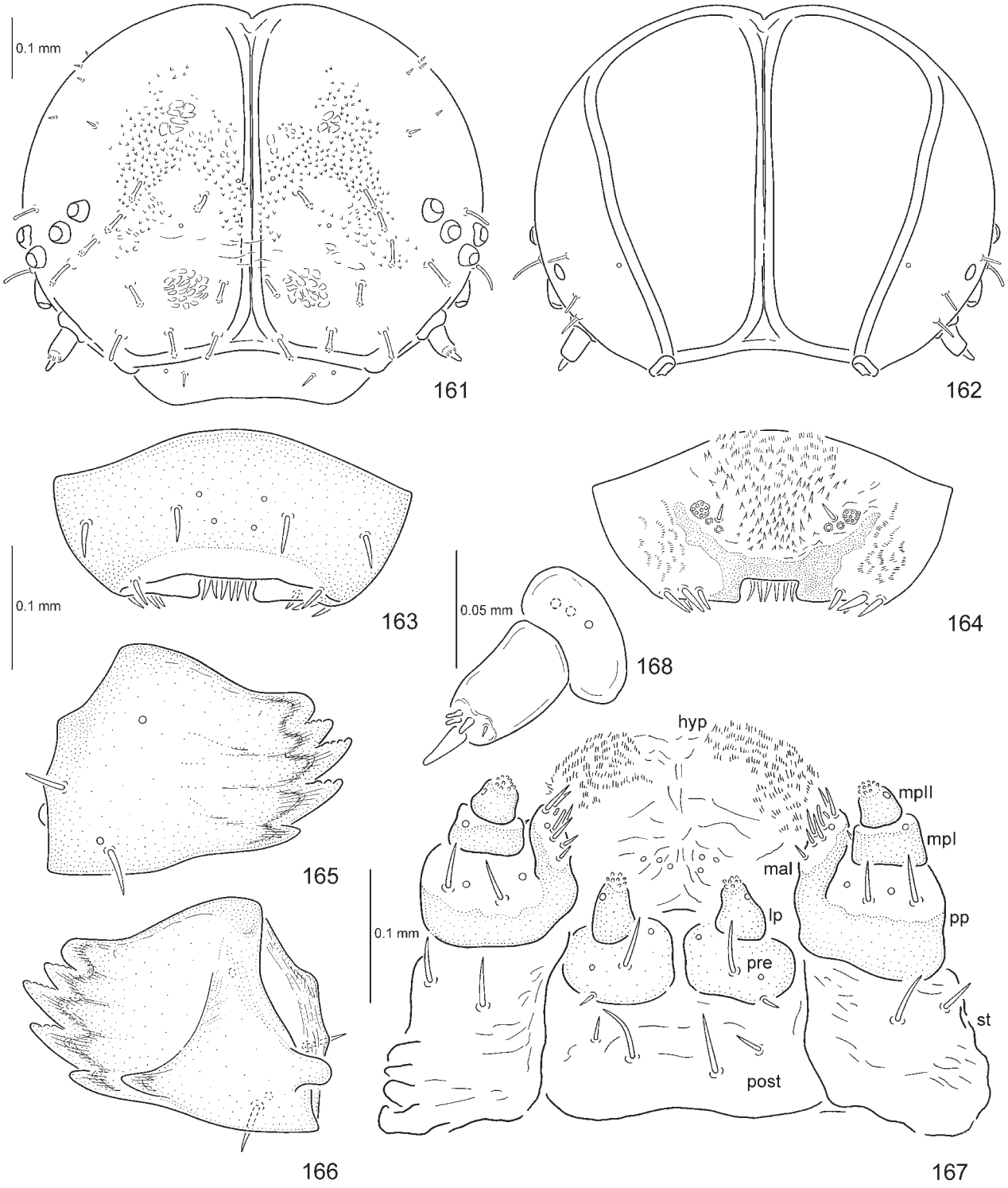
Antennae two-segmented, set in membranous ring (Fig. 152). First segment stout, slightly wider than long, second one approximately two times longer than wide. First segment with three campaniform sensilla, second with short seta and a group of four peg-like sensilla: one prominent (sensory appendix) and three small, on the apex.



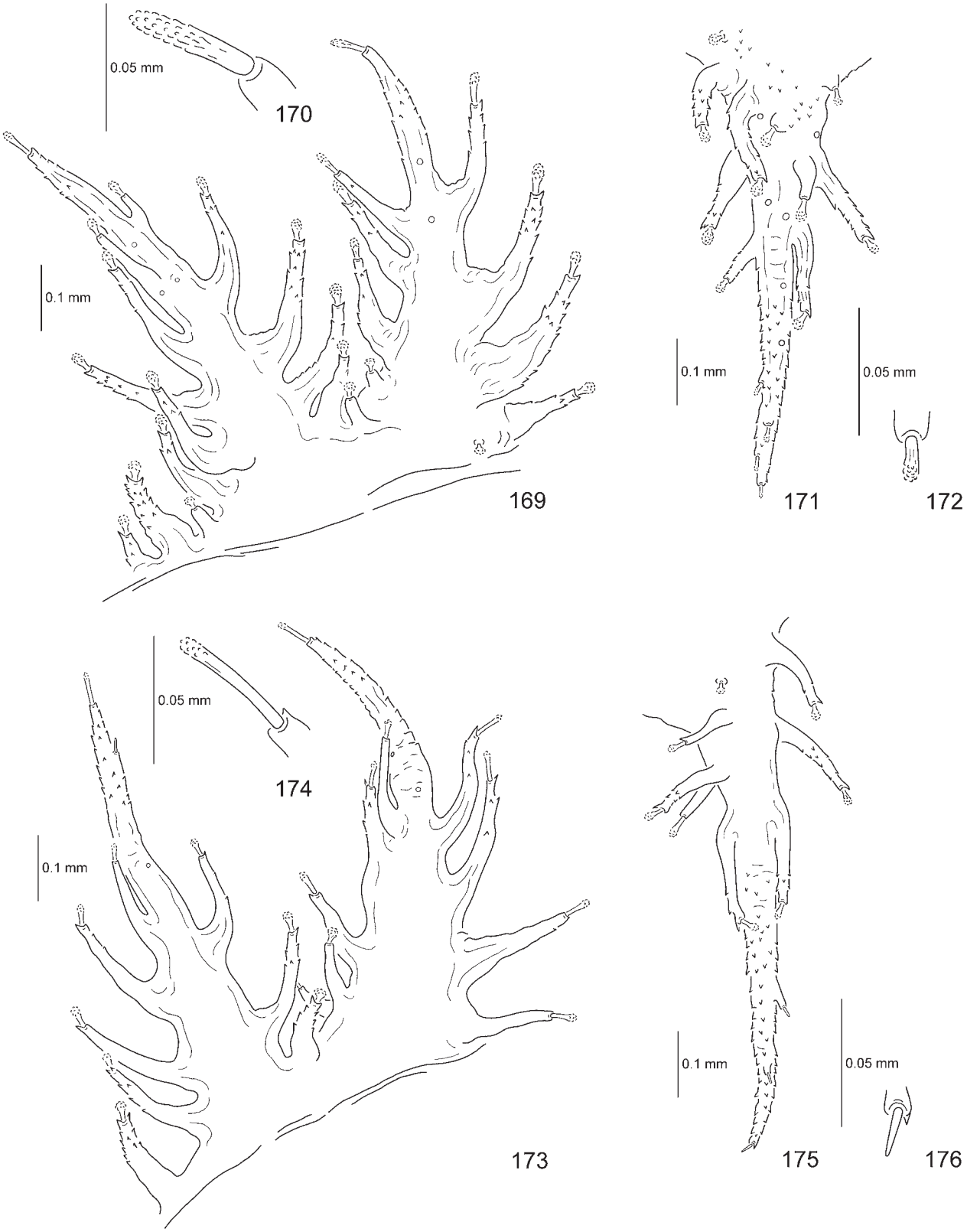
FIGURES 145–152. *Cassida pfefferi* Sekerka, 2006, fifth instar larva. 145. Frontal side of head; 146. temporal side of head; 147. dorsal side of labrum; 148. ventral side of labrum; 149, 150. mandibles; 151. maxillae and labium; 152. antenna. Abbreviations: hyp—hypopharynx; lp—labial palp; mal—mala; mpI—first segment of maxillary palp; mpII—second segment of maxillary palp; post—postmentum; pp—palpifer; pre—prementum; st—stipes.



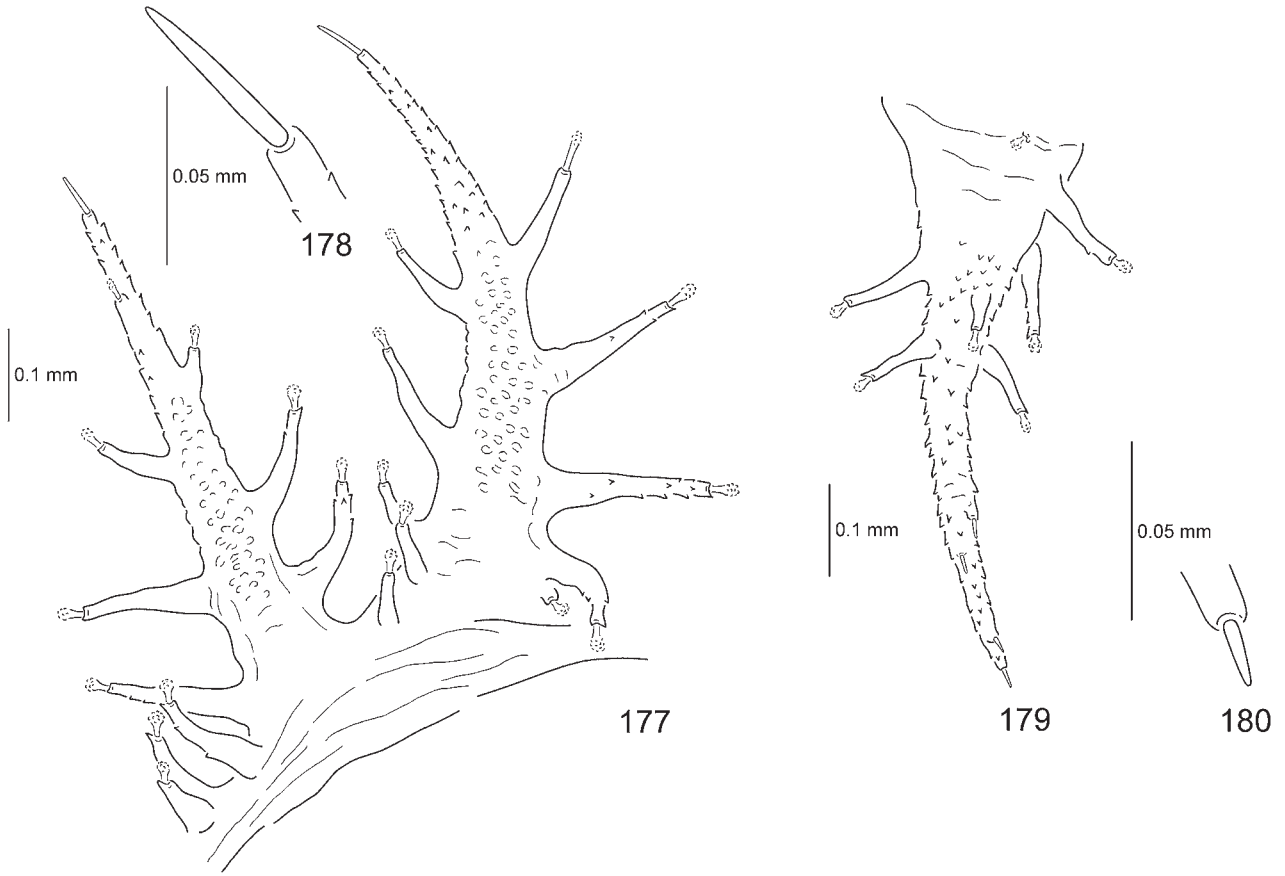
FIGURES 153–160. *Cassida vittata* Villers, 1789, fifth instar larva. 153. Frontal side of head; 154. temporal side of head; 155. dorsal side of labrum; 156. ventral side of labrum; 157, 158. mandibles; 159. maxillae and labium; 160. antenna. Abbreviations: hyp—hypopharynx; lp—labial palp; mal—mala; mpI—first segment of maxillary palp; mpII—second segment of maxillary palp; post—postmentum; pp—palpifer; pre—prementum; st—stipes.



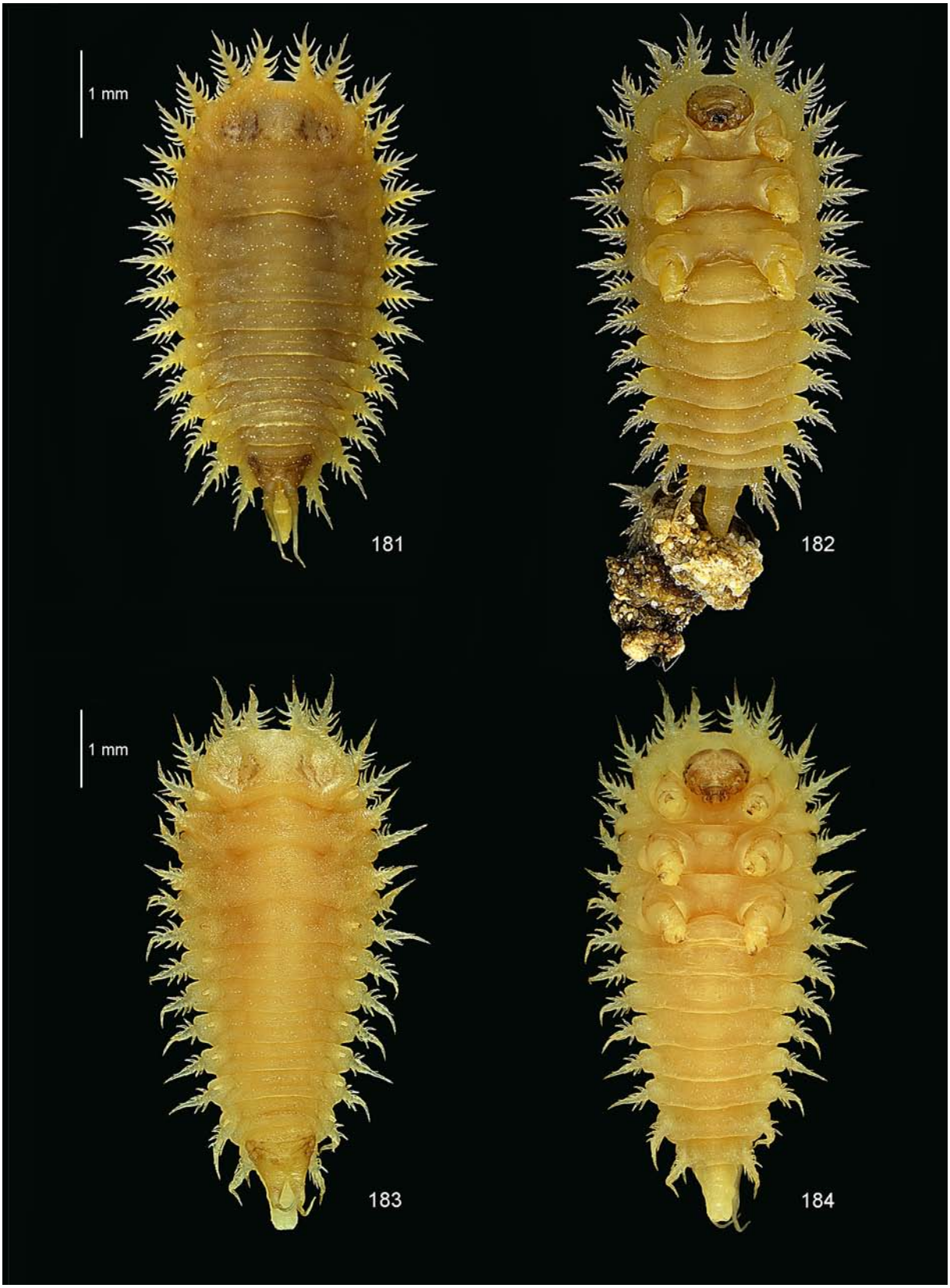
FIGURES 161–168. *Cassida nobilis* Linnaeus, 1758, fifth instar larva. 161. Frontal side of head; 162. temporal side of head; 163. dorsal side of labrum; 164. ventral side of labrum; 165, 166. mandibles; 167. maxillae and labium; 168. antenna. Abbreviations: hyp—hypopharynx; lp—labial palp; mal—mala; mpI—first segment of maxillary palp; mpII—second segment of maxillary palp; post—postmentum; pp—palpifer; pre—prementum; st—stipes.



FIGURES 169–176. Lateral scoli, fifth instar larvae. 169–172. *Cassida pfefferi* Sekerka, 2006; 173–176. *Cassida vittata* Villers, 1789; 169, 173. lateral scoli of first two pairs; 170, 174. sensillum at the top of scolus of first pair; 171, 175. scolus of 16th pair; 172, 176. sensillum at the top of scolus of 16th pair.



FIGURES 177–180. Lateral scoli, fifth instar larva, *Cassida nobilis* Linnaeus, 1758. 177. Lateral scoli of first two pairs; 178. sensillum at the top of scoli of first pair; 179. scolus of 16th pair; 180. sensillum at the top of scolus of 16th pair.



FIGURES 181–184. Fifth instar larva. 181. Dorsal aspect of *Cassida pfefferi* Sekerka, 2006; 182. ventral aspect of *Cassida pfefferi*; 183. dorsal aspect of *Cassida vittata* Villers, 1789; 184. ventral aspect of *Cassida vittata*.

FIGURES 185–189. Fifth instar larva. 185. Dorsal aspect of *Cassida pfefferi* Sekerka, 2006 with faecal shield; 186. dorsal aspect of *Cassida vittata* Villers, 1789 with faecal shield; 187. dorsal aspect of *Cassida nobilis* Linnaeus, 1758; 188. ventral aspect of *Cassida nobilis*; 189. dorsal aspect of *Cassida nobilis* with faecal shield.

Labrum wider than long, anterior margin distinctly emarginate (Figs 147, 148). Dorsal side of labrum with row of four long setae and two pairs of campaniform sensilla placed centrally. Anterior margin with 14 setae: 6 placed medially, three stout and long setae on each lateral side and one small on each lateral side dorsally. A pair of small setae, four campaniform sensilla, and two groups of eight small sensilla in the mid part of ventral surface (epipharyngeal area). Numerous small spines in the central and lateral parts of ventral side of labrum.

Mandibles heavily sclerotized, palmate, with six triangular, apical teeth: five in row and sixth slightly retracted; and two setae and two campaniform sensilla at base dorsally. Dorsal margin of second to fourth mandibular tooth finely crenulate (Figs 149, 150).

Maxillae and labium connate (Fig. 151). Each stipes (st) with two long pointed setae. Mala (mal) not distinctly bordered from palpifer (pp). Six long pointed setae, one blunt seta, one peg like sensillum and one campaniform sensillum at the apex of broad, truncate mala. Palpifer with two long setae and three campaniform sensilla. Maxillary palp two-segmented: first segment (mpI) with two setae and one campaniform sensillum, second segment (mpII) with group of sensilla on apex, and with one campaniform sensillum, one pointed seta and digitiform sensillum below the apex. Labial palp (lp) one-segmented with group of sensilla on the apex and one campaniform sensillum below the apex. Hypopharynx (hyp) covered with numerous spines, with six campaniform sensilla at base. Prementum (pre) with two long and two short setae, and four campaniform sensilla. Postmentum (post) with two long and two short setae.

Legs stout, consisting of coxa, femur, tibiotarsus and pretarsus (Fig. 143). Internal side of coxa with setae arranged in three groups: first group with two short pointed setae (placed at border between coxa and body); second with three short pointed setae; third with three short pointed setae and one blunt longer seta. Two short pointed setae on coxa externally. Femur with 13 long mostly pointed apically setae: 7 around distal margin, one on external side medially (close to two campaniform sensilla) and 5 on internal side medially. Moreover one to three short (about half of length of others) blunt setae on internal side medially, one short pointed seta placed dorsally close to the base, group of five campaniform sensilla and one short pointed seta at base of femur internally, one campaniform sensillum ventrally, and two campaniform sensilla externally. Pretarsus heavily sclerotized, short and curved, single and simple, armed basally with pointed seta and surrounded by complex of 6 long pointed setae. One short pointed seta and two campaniform sensilla dorsally at base of pretarsus. Two setae in the middle of tibiotarsus dorsally.

Larvae carry shields on a supra-anal processes constructed of the skins of previous instars and pieces of faeces (Figs 182, 185).

Pupa of *Cassida pfefferi*

(Figs 16, 17, 190–193)

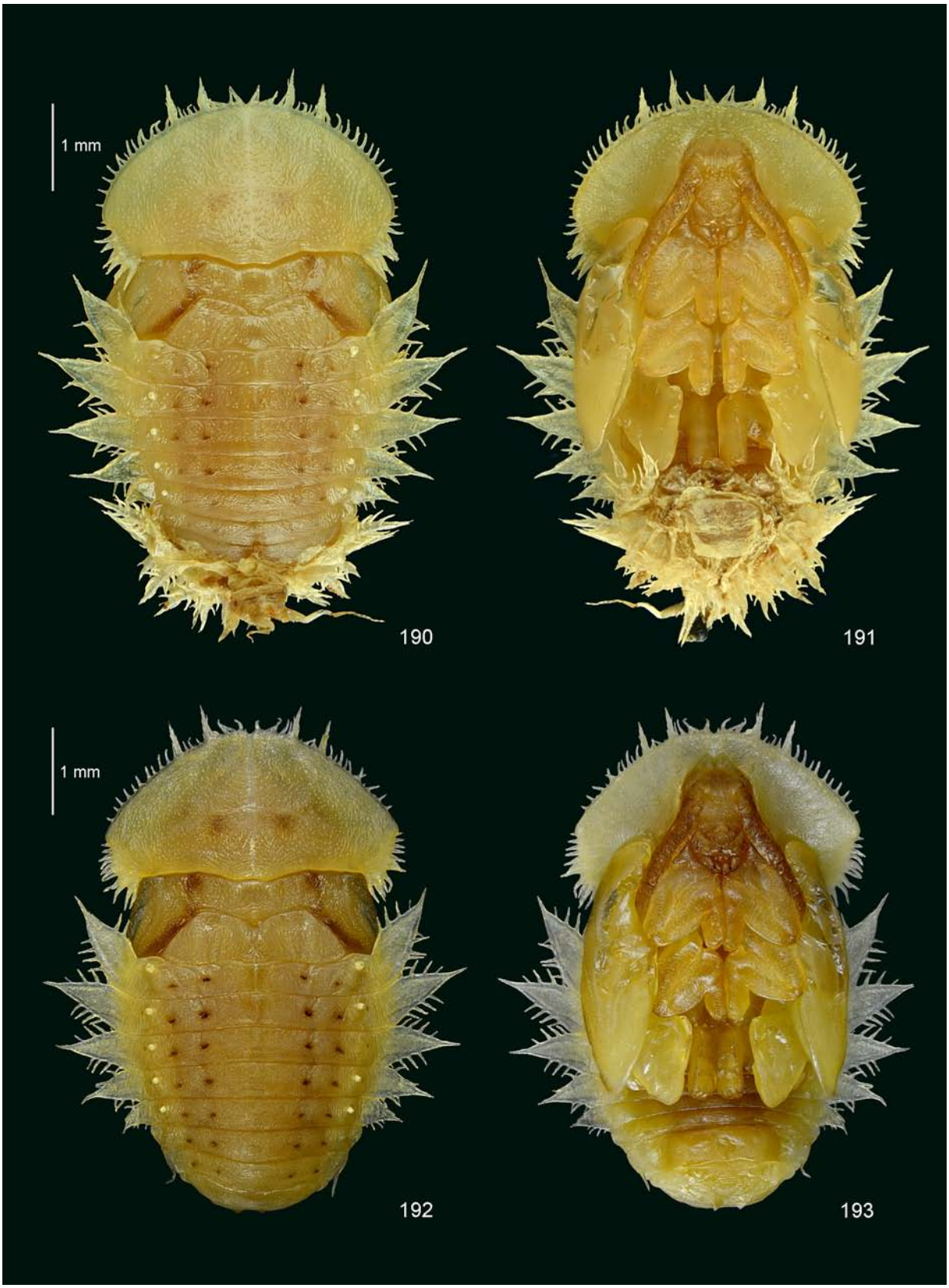
Measurements (n=7) are presented in Table 3.

TABLE 3. Measurements of *Cassida pfefferi* Sekerka, 2006 pupae (in millimetres).

Cassida pfefferi pupa	body length	width of body across II abdominal segment	length of pronotum	width of pronotum
1.	4.75	2.70	1.60	3.00
2.	5.10	3.00	1.60	3.10
3.	5.20	3.20	1.60	3.20
4.	5.10	3.00	1.70	3.10
5.	4.70	2.60	1.50	2.90
6.	5.20	3.00	1.70	3.20
7.	4.80	3.00	1.60	3.10

Body oval. Living specimens greenish-white with white cross in the middle of pronotum; two brown spots placed on pronotum medially—each spot placed on side of white cross; two brown spots on each elytral portion dorsally and four brown spots on each abdominal tergite. Spiracles white. Antennae brown. Head, mouthparts and

legs infuscate (Figs 16, 17). Pupae preserved in alcohol light yellow with brown spots, distributed as in living specimens (Figs 190–193).



FIGURES 190–193. *Cassida pfefferi* Sekerka, 2006, pupa. 190, 192. Dorsal aspect; 191, 193. ventral aspect; 190, 191. pupa with last larval skin.

Anterior margin of pronotum regularly rounded. Lateral margins of pronotum in front of basal angles shallowly emarginate. Pronotum with regularly distributed marginal processes. Six of these processes are distinctly stouter than remainder, four of them are also the longest and covered with few fine lateral processes (Figs 190–193). Each marginal process of pronotum armed with short blunt sensillum, but four the longest processes have distinctly longer sensilla than remainder.

Pro-, meso-and metanotum without lateral scoli. Margin of pronotum with mostly short projections distributed regularly along margin except for two projections on each anterior side which are distinctly stouter and longer (approximately three times) than remainder, moreover projections placed on posterior angles are two times longer and placed closer to each other than remainder.

Abdominal segments I–V with leaf-like lateral scoli which are gradually shortened posterad, these scoli are distinctly visible in dorsal as well as ventral view. Scoli of segments VI–VIII short, in form of simple processes. Segment IX with two short processes at posterior border.

Abdomen with 7 pairs of spiracles; spiracles of first pair the most elevated and with the greatest diameter; diameter and elevation of all spiracles slightly decrease posteriorly, 7th pair hardly visible.

Exuvium of last instar larva remains attached to last abdominal segments (VI–IX) of pupa (Figs 190, 191).

Biological notes

Living adults in natural environment on Cyprus are green with two pink spots on each elytron (Fig. 7). Adults reared from mature larvae and pupae collected on Cyprus were also green with pink spots on the elytra like adults from Cyprus. The second generation of beetles was reared in the laboratory. Due to the lack of host plant, the reared larvae were fed with plants of other species of the genus *Chenopodium album* L. The lab-grown adults of the second generation were devoid of pink elytral spots (Fig. 8).

Fifth instar larva of *Cassida vittata*

(Figs 144, 183, 184, 186)

Measurements (n=2) are presented in Table 4.

TABLE 4. Measurements of *Cassida vittata* Villers, 1789 fifth instar larvae (in millimetres).

Cassida vittata fifth instar larva	body length	width of body across metathorax	length of supra-anal processes	width of head
1.	6.40	2.20	2.00	0.90
2.	6.30	2.40	1.60	0.90

Body elongate-oval, slightly flattened dorso-ventrally, widest across metathorax, abdominal segments slightly narrowed posteriorly. Body of living larva green with two dark brown, irregular patches on pronotum and brown head, legs, spiracles and supra-anal processes. Larva preserved in alcohol mostly yellow with two brown, irregular patches on pronotum, and brown head, legs, spiracles and supra-anal processes (Figs 183, 184, 186).

Body with 16 pairs of lateral scoli and a pair of supra-anal processes (Fig. 183). Prothorax and mesothorax with three pairs of lateral scoli, metathorax with two pairs, abdominal segments I–VIII each with one pair. First two lateral scoli placed very close each other. All scoli short, more or less of the same length. Scoli covered with lateral branches, scoli of pairs 1–14 armed apically with elongate blunt at the apex sensillum, scoli of pair XV and XVI apically armed with blunt seta, whereas each lateral branch armed with cauliflower-shape sensillum. Sensilla at the tops of scoli gradually shortened posterad. Supra-anal processes short, bent dorsally, covered with asperities.

Body distinctly granulate, distinct asperities on each abdominal tergite and sternite. Pronotum with cauliflower-shaped sensilla distributed mostly along lateral and posterior margins and in the middle along body axis. Meso-, metanotum and abdominal tergites with two minute setae at anterior border medially and two rows of cauliflower-shaped sensilla which running across segment, posterior row with less numbers of sensilla than anterior. Number

of cauliflower-shape sensilla on tergites decreases posteriorly. Size of cauliflower-shape sensilla also very slightly decreases posteriorly.

Two pairs of minute setae at anterior border of pro-, meso- and metasternum. Pro-, meso- and metasternum also with two groups of 4–5 setae placed antero-medially (very close to each other), a pair of setae postero-medially and 2–4 cauliflower-shaped sensilla on each lateral side. Two minute setae at anterior border of each abdominal sternite. First three abdominal sternites with group (about 20) setae placed medially which are mostly pointed and some are blunt, and with three cauliflower-shaped sensilla laterally. Abdominal sternites IV–VIII with row of sensilla which runs across sternite. Sternites IV–V with blunt setae and elongate cauliflower-shape sensilla medially, and cauliflower-shape sensilla laterally. Abdominal sternites VI–VIII with cauliflower-shaped sensilla. Number of cauliflower-shaped sensilla on sternites decreases posteriorly.

Anal turret distinct, two-segmented.

Nine pairs of spiracles (one pair on thorax and eight on abdomen). Spiracles visible from the dorsal side of body. Diameter of spiracles slightly decreasing posterad.

Head well sclerotized, hypognathous, retracted into pronotum. Median suture complete, connected with frontoclypeal suture. Clypeus distinct, wider than long, with a pair of setae and pair of campaniform sensilla (Figs 153, 154).

Six stemmata on each side of head.

Head on each side with four small, vertical, pointed setae (V 1–4), and five frontal rows of setae: row Fa with 3 setae, Fb with 4 or 5 setae, Fc with 3 setae, Fd with single seta, Fe with 2 setae (Fig. 153). Temporal surface of head with 3 setae (Fig. 154).

Antennae two-segmented, set in membranous ring (Fig. 160). First segment stout, slightly wider than long, second one approximately two times longer than wide. First segment with three campaniform sensilla, second with short seta and a group of four peg-like sensilla: one prominent (sensory appendix) and three small, on the apex.

Labrum wider than long, anterior margin distinctly emarginate (Figs 155, 156). Dorsal side of labrum with row of four long setae and two pairs of campaniform sensilla placed centrally. Anterior margin with 14 setae: 6 placed medially, three stout and long setae on each lateral side and one small on each lateral side dorsally. A pair of small setae, four campaniform sensilla, and two groups of eight small sensilla in the mid part of ventral surface (epipharyngeal area). Numerous small spines in the central and lateral parts of ventral side of labrum.

Mandibles heavily sclerotized, palmate, with six triangular, apical teeth: five in row and sixth slightly retracted; and two setae and two campaniform sensilla at base dorsally (Figs 157, 158). Dorsal margin of second to fourth mandibular tooth finely crenulate.

Maxillae and labium connate (Fig. 159). Each stipes (st) with two long pointed setae. Mala (mal) not distinctly bordered from palpifer (pp). Six long pointed setae, one blunt seta, one peg like sensillum and one campaniform sensillum at the apex of broad, truncate mala. Palpifer with two long setae and three campaniform sensilla. Maxillary palp two-segmented: first segment (mpI) with two setae and one campaniform sensillum, second segment (mpII) with group of sensilla on apex, and with one campaniform sensillum, one pointed seta and digitiform sensillum below the apex. Labial palp (lp) one-segmented with group of sensilla on the apex and one campaniform sensillum below the apex. Hypopharynx (hyp) covered with numerous spines, with six campaniform sensilla at base. Prementum (pre) with two long and two short setae, and four campaniform sensilla. Postmentum (post) with four pointedsetae.

Legs stout, consisting of coxa, femur, tibiotarsus and pretarsus (Fig. 144). Internal side of coxa with setae arranged in three groups: first group with two short pointed setae (placed at border between coxa and body); second with three short pointed setae; third with two short pointed setae and two long apically blunt setae. Two short pointed setae on coxa externally. Femur with 13 long mostly pointed setae: 7 around distal margin, one on external side medially (close to two campaniform sensilla) and 5 on internal side medially. Moreover one short seta placed dorsally close to the base, group of five campaniform sensilla and one short pointed seta at base of femur internally, one campaniform sensillum ventrally, and two campaniform sensilla externally. Pretarsus heavily sclerotized, short and curved, single and simple, armed basally with pointed seta and surrounded by complex of 6 long pointed setae. One short pointed seta and two campaniform sensilla dorsally at base of pretarsus. Two setae in the middle of tibiotarsus dorsally.

Larvae carry shields on a supra-anal processes constructed of the skins of previous instars and pieces of faeces (Fig. 186).

Pupa of *Cassida vittata*
(Figs 15, 194–197)

Measurements (n=2) are presented in Table 5.

TABLE 5. Measurements of *Cassida vittata* Villers, 1789 pupae (in millimetres).

Cassida vittata pupa	body length	width of body across II abdominal segment	length of pronotum	width of pronotum
1.	5.60	2.70	1.50	3.20
2.	5.50	3.00	1.60	3.20

Body oval. Living specimens mostly green with white and dark green elements like in Fig. 15. Pronotum green with light green cross in the middle, and two dark brown spots—the horizontal arm of the cross goes through the spots; each elytral portion dark green; two white spots on metanotum; and four dark green spots on each abdominal tergite. Spiracles white. Head, antennae, mouth parts and legs dark green. Pupae preserved in alcohol yellow with a brown spots, instead dark green of living specimens, distributed like in Figs 194–197.

Anterior margin of pronotum regularly rounded. Lateral margins of pronotum in front of basal angles shallowly emarginate. Pronotum with regularly distributed marginal processes. Six of these processes are distinctly stouter than remainder, four of them are also the longest and covered with few fine lateral processes (Figs 194–197). Each marginal process of pronotum armed with short sensillum but four the longest processes have sensilla in form of pointed setae distinctly longer than blunt sensilla of remainder.

Pro-, meso-and metanotum without lateral scoli. Margin of pronotum with mostly short projections distributed regularly along margin except for two projections on each anterior side which are distinctly stouter and longer (approximately three times) than remainder, moreover projections placed on posterior angles are two times longer and placed closer to each other than remainder.

Abdominal segments I–V with leaf-like lateral scoli which are gradually shortened posterad, these scoli are distinctly visible in dorsal as well as ventral view. Scoli of segments VI–VIII short, in form of simple processes. Segment IX with two short processes at posterior border.

Abdomen with 7 pairs of spiracles; spiracles of first pair the most elevated and with the greatest diameter; diameter and elevation of all spiracles slightly decrease posteriorly, 7th pair hardly visible.

Exuvium of last instar larva remains attached to last abdominal segments (VI–IX) of pupa (Figs 194, 195).

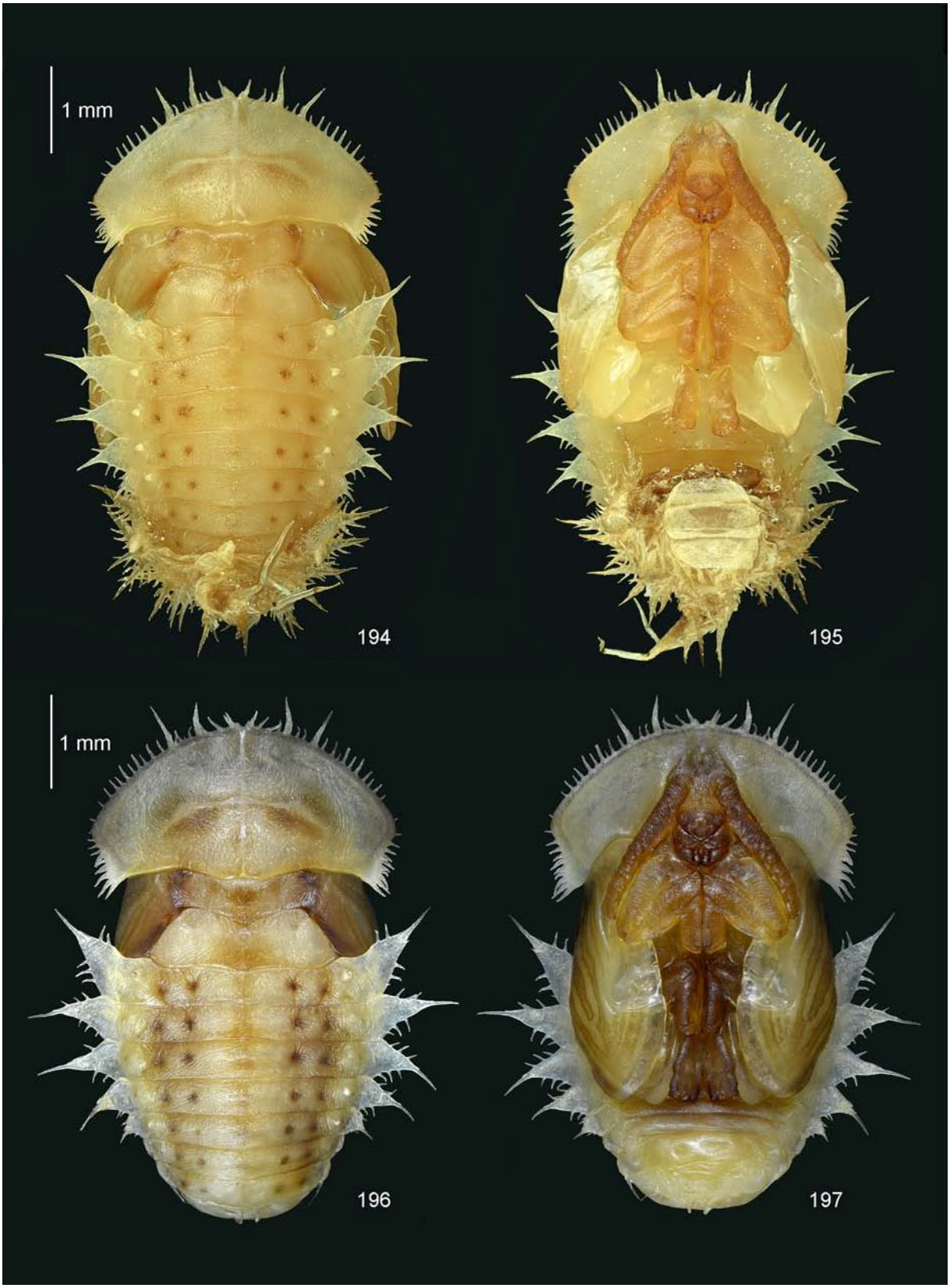
Fifth instar larva of *Cassida nobilis*
(Figs 187–189)

Measurements (n=2) are presented in Table 6.

TABLE 6. Measuremants of *Cassida nobilis* Linnaeus, 1758 fifth instar larvae.

Cassida nobilis fifth instar larva	body length	width of body across metathorax	length of supra-anal processes	width of head
1.	5.50	2.00	1.50	0.92
2.	6.00	2.30	1.50	0.80

Body elongate-oval, slightly flattened dorso-ventrally, widest across metathorax, abdominal segments slightly narrowed posteriorly. Body of living larva green with yellowish-brown supra-anal processes. Larva preserved in alcohol mostly yellow with light-brown supra-anal processes (Figs 187–189).



FIGURES 194–197. *Cassida vittata* Villers, 1789, pupa. 194, 196. Dorsal aspect; 195, 197. ventral aspect; 194, 195. pupa with last larval skin.

Body with 16 pairs of lateral scoli and a pair of supra-anal processes (Fig. 187). Prothorax and mesothorax with three pairs of lateral scoli, metathorax with two pairs, abdominal segments I–VIII with one pair. First two lateral scoli placed very close each other. All scoli short, more or less of the same length. Scoli covered with lateral branches, each scolus armed with elongate seta, whereas each lateral branch armed with cauliflower-shape sensillum. Setae at the topa of scoli gradually shortened posterad. Supra-anal processes short, bent dorsally, covered with asperities.

Body distinctly granulate, distinct asperities on each abdominal tergite and sternite. Pronotum with cauliflower-shaped sensilla distributed mostly along lateral and posterior margins of segment and in the middle along body axis. Meso-, metanotum and abdominal tergites with two minute setae at anterior border medially and two rows of cauliflower-shaped sensilla which running across segment, posterior row with less numbers of sensilla than anterior. Number of cauliflower-shape sensilla on tergites decreases posteriorly. Size of cauliflower-shape sensilla also very slightly decreases posteriorly.

Two pairs of minute setae at anterior border of pro-, meso- and metasternum. Pro-, meso- and metasternum also with two groups of 3–4 setae placed antero-medially (very close to each other), a pair of setae postero-medially and 2–4 cauliflower-shaped sensilla on each lateral side. Two minute setae at anterior border of each abdominal sternite. First three abdominal sternites with group (about 20) setae placed medially which are mostly pointed and some are blunt, and with three cauliflower-shaped sensilla laterally. Abdominal sternites IV–VIII with row of sensilla which runs across sternite. Sternites IV–V with elongate cauliflower-shape sensilla medially, and cauliflower-shape sensilla laterally. Abdominal sternites VI–VIII with cauliflower-shaped sensilla. Number of cauliflower-shaped sensilla on sternites decreases posteriorly.

Anal turret distinct, and two- segmented.

Nine pairs of spiracles (one pair on thorax and eight on abdomen). Spiracles visible from the dorsal side of body. Diameter of spiracles slightly decreasing posterad.

Head well sclerotized, hypognathous, retracted into pronotum. Median suture complete, connected with fronto-clypeal suture. Clypeus distinct, wider than long, with a pair of setae and pair of campaniform sensilla (Figs 161, 162).

Six stemmata on each side of head.

Head on each side with four small, vertical, pointed setae (V 1–4), and five frontal rows of setae: row Fa with 3 setae, Fb with 4 setae, Fc with 3 setae, Fd with single seta, Fe with 2 setae (Fig. 161). Temporal surface of head with 3 setae (Fig. 162).

Antennae two-segmented, set in membranous ring (Fig. 168). First segment stout, slightly wider than long, second one approximately two times longer than wide. First segment with three campaniform sensilla, second with short seta and a group of four peg-like sensilla: one prominent (sensory appendix) and three small on the apex.

Labrum wider than long, anterior margin distinctly emarginate (Figs 163, 164). Dorsal side of labrum with row of four long setae and two pairs of campaniform sensilla placed centrally. Anterior margin with 14 setae: 6 placed medially, three stout and long setae on each lateral side and one small on each lateral side dorsally. A pair of small setae, four campaniform sensilla, and two groups of eight small sensilla in the mid part of ventral surface (epipharyngeal area). Numerous small spines in the central and lateral parts of ventral side of labrum.

Mandibles heavily sclerotized, palmate, with six triangular, apical teeth: five in row and sixth slightly retracted; and two setae and two campaniform sensilla at base dorsally (Figs 165, 166). Dorsal margin of second to fourth mandibular tooth finely crenulate.

Maxillae and labium connate (Fig. 167). Each stipes (st) with two long pointed setae. Mala (mal) not distinctly bordered from palpifer (pp). Six long pointed setae, one blunt seta, one peg like sensillum and one campaniform sensillum at the apex of broad, truncate mala. Palpifer with two long setae and three campaniform sensilla. Maxillary palp two-segmented: first segment (mpI) with two setae and one campaniform sensillum, second segment (mpII) with group of sensilla on apex, and with one campaniform sensillum, one pointed seta and digitiform sensillum below the apex. Labial palp (lp) one-segmented with group of sensilla on the apex and one campaniform sensillum below the apex. Hypopharynx (hyp) covered with numerous spines, with six campaniform sensilla at base. Prementum (pre) with two long and two short setae, and four campaniform sensilla. Postmentum (post) with four setae.

Legs stout, consisting of coxa, femur, tibiotarsus and pretarsus(Fig. 142). Internal side of coxa with setae arranged in three groups: first group with two short pointed setae (placed at border between coxa and body); second with three short pointed setae; third with two short pointed setae, one cauliflower-like sensillum and one elongate

cauliflower-like sensillum. Two short pointed setae on coxa externally. Femur with 13 long mostly pointed setae: 7 around distal margin, one on external side medially (close to two campaniform sensilla) and 5 on internal side medially. Moreover one short seta placed dorsally close to the base, group of five campaniform sensilla and one short pointed seta at base of femur internally, one campaniform sensillum ventrally, and two campaniform sensilla externally. Pretarsus heavily sclerotized, short and curved, single and simple, armed basally with pointed seta and surrounded by complex of 6 long pointed setae. One short pointed seta and two campaniform sensilla dorsally at base of pretarsus. Two setae in the middle of tibiotarsus dorsally.

First instar larvae retain on their supra-anal processes pieces of excreta, while the next instars stop only exuviae without excreta, as a result of which the mature larva carries a shield made of 4 exuviae, but only the first exuvium is covered with excreta. (Fig. 189).

Pupa of *Cassida nobilis*
(Figs 198–201)

Measurements (n=4) are presented in Table 7.

TABLE 7. Measurements of *Cassida nobilis* Linnaeus, 1758 pupae.

Cassida nobilis pupa	body length	width of body across II abdominal segment	length of pronotum	width of pronotum
1.	4.50	2.30	1.40	2.60
2.	5.20	2.20	1.60	2.80
3.	4.90	2.00	1.50	2.60
4.	4.80	2.30	1.60	2.70

Body oval. Living specimens light green without any pattern. Pupae preserved in alcohol yellow (Figs 198–201).

Anterior margin of pronotum regularly rounded. Lateral margins of pronotum in front of basal angles straight. Pronotum with regularly distributed marginal processes. Six of these processes are distinctly stouter than remainder, four of them are also the longest and covered with few fine lateral processes (Figs 198–201). Each marginal process of pronotum armed with short sensillum but four the longest processes have sensilla in form of pointed setae distinctly longer than blunt sensilla of remainder.

Pro-, meso-and metanotum without lateral scoli. Margin of pronotum with mostly short projections distributed regularly along margin except for two projections on each anterior side which are distinctly stouter and longer (approximately three times) than remainder, moreover projections placed on posterior angles are two times longer.

Abdominal segments I–V with leaf-like lateral scoli which are gradually shortened posterad, these scoli are distinctly visible in dorsal as well as ventral view. Scoli of segments VI–VIII short, in form of simple processes. Segment IX with two short processes at posterior border.

Abdomen with 7 pairs of spiracles; spiracles of first pair the most elevated and with the greatest diameter; diameter and elevation of all spiracles slightly decrease posteriorly, 7th pair hardly visible.

Exuvium of last instar larva remains attached to abdominal segments VI–IX of pupa (Figs 198, 199).

Comparative diagnosis

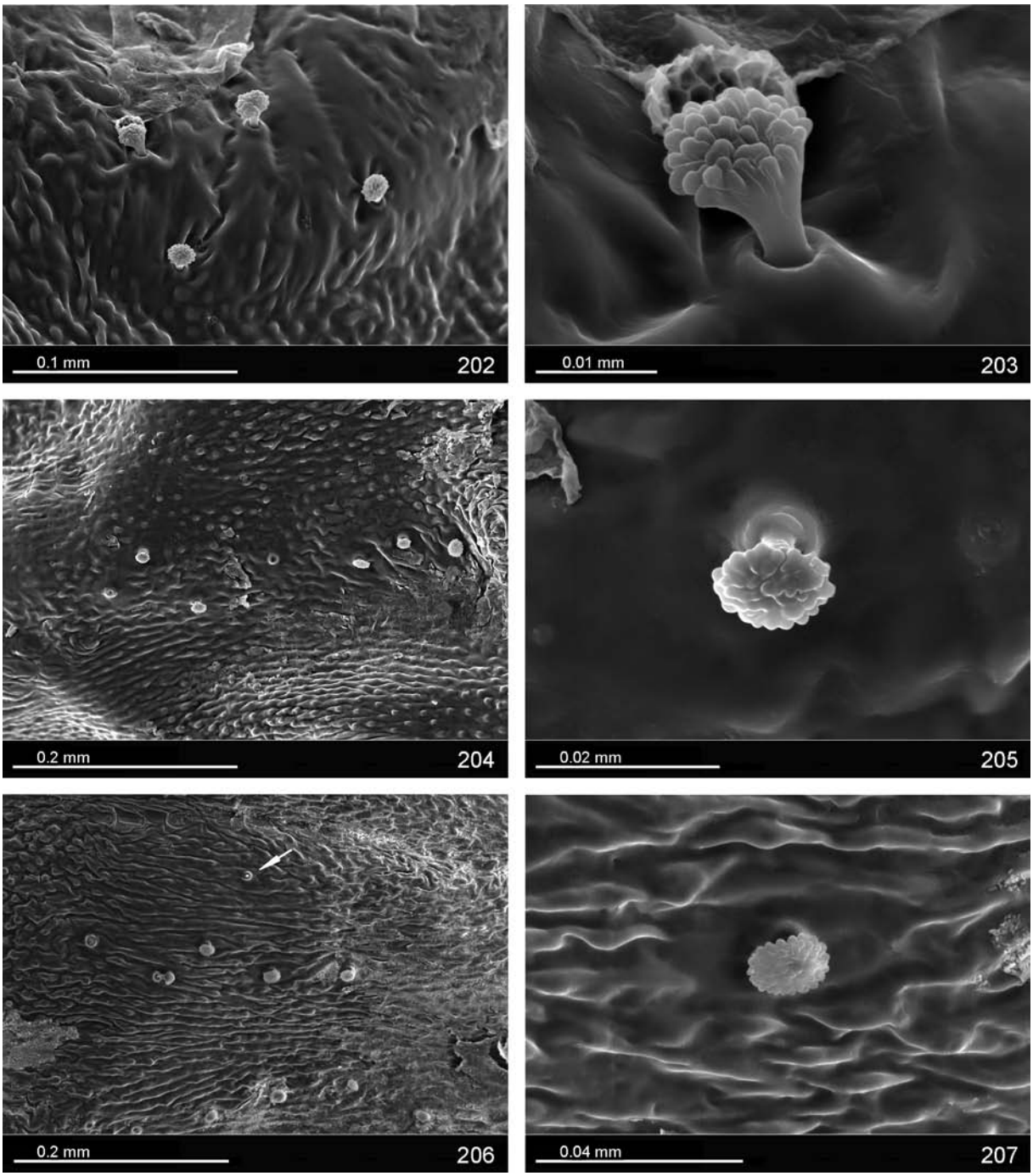
First instar larva

Larvae of all compared species are similar to each other and typical for *Cassida* species (Świętojańska 2009, Borowiec & Świętojańska 2014): dorso-ventrally flattened, oval, moderately narrowed posteriorly, widest across meso- and metathorax (Figs 22, 23, 71, 103).

FIGURES 198–201. *Cassida nobilis* Linnaeus, 1758, pupa. 198, 200. Dorsal aspect; 199, 201. ventral aspect; 198, 199. pupa with last larval skin.

Living specimens of *Cassida nobilis* first instar larvae are uniformly green whereas specimens of *Cassida vittata* are green with black head, legs, lateral scoli, supra-anal processes, spiracles, and two irregular pronotal

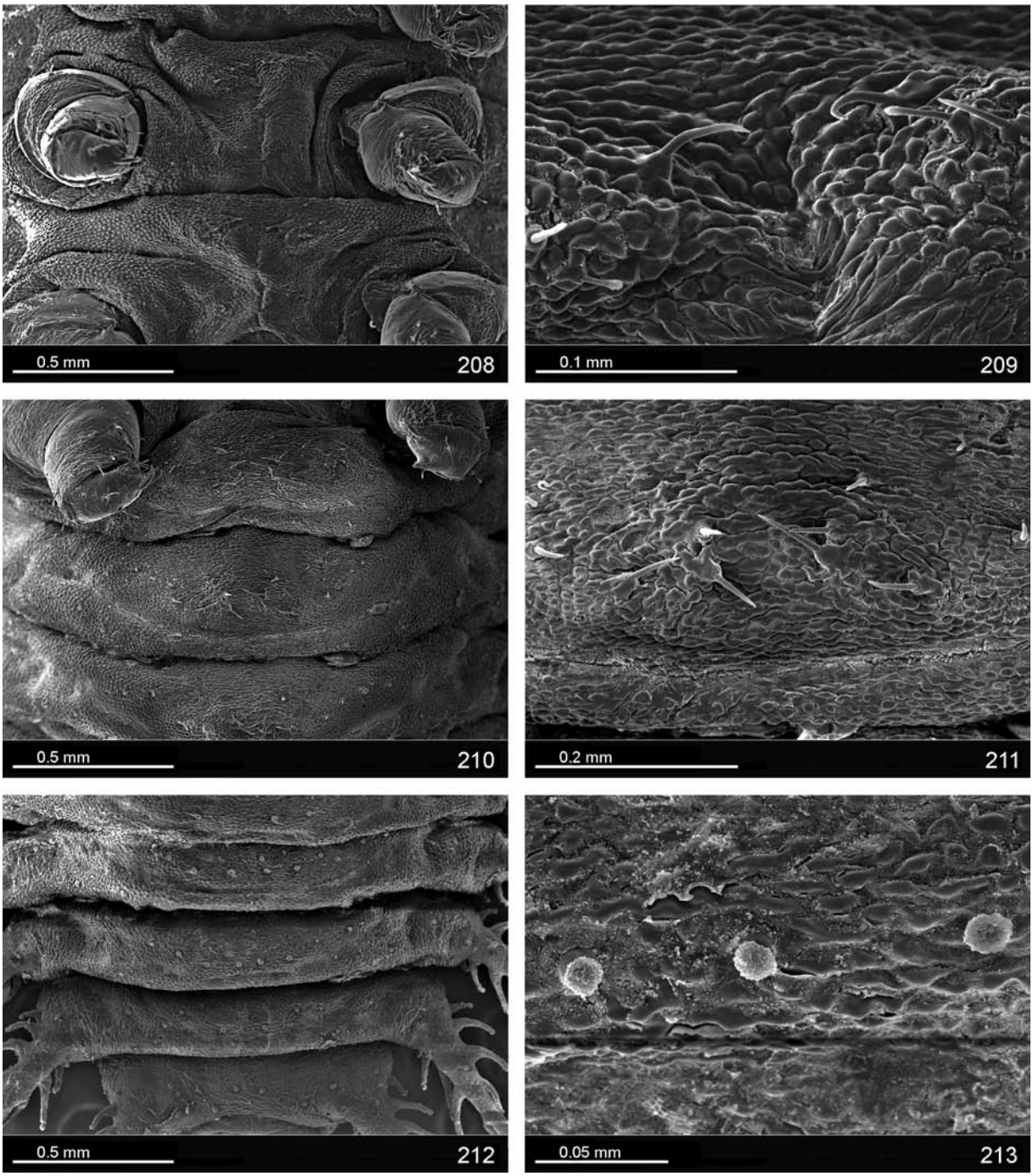
patches which cover practically whole surface of pronotum. Preserved in alcohol specimens of *Cassida nobilis* are uniformly yellowish-white, while in *C. vittata* dark parts of the body are retained, thus larva is yellowish-white with dark brown appendages (Świętojańska 2005). Living specimens of *C. pfefferi* are green with yellowish-brown head and supra-anal processes. Freshly emerged larvae preserved in alcohol are yellowish-white with yellow-brown head and supra-anal processes.



FIGURES 202–207. *Cassida pfefferi* Sekerka, 2006, mature larva. 202, 203. Cauliflower-shape sensilla of pronotum; 204, 205. cauliflower-shape sensilla of mesonotum, posterior row; 206, 207. cauliflower-shape sensilla of first abdominal tergite, white arrow on figure 206 point to minute seta.

Larvae of all species have 16 pairs of lateral scoli and a pair of supra-anal processes (Figs 22, 23, 71, 103–105). Lateral scoli of 1st to 14th pairs gradually diminish posterad (Figs 22, 23, 50, 91, 92, 103–105). Scoli of 15th and 16th pairs are longest, 16th slightly longer than of 15th. Each scolus of 1st–14th pairs is apically armed with a more or less elongate cauliflower-shaped sensillum (Figs 45–47, 50–56, 71, 73, 91–94, 103–105, 113–118). First pair of

lateral scoli have one long and one short lateral branch, apically armed with elongate cauliflower-shaped sensillum (Figs 45, 47, 73, 113). Other scoli are simple, without lateral branches but covered with a few cauliflower-shaped sensilla (Figs 54, 82, 91, 104, 105).

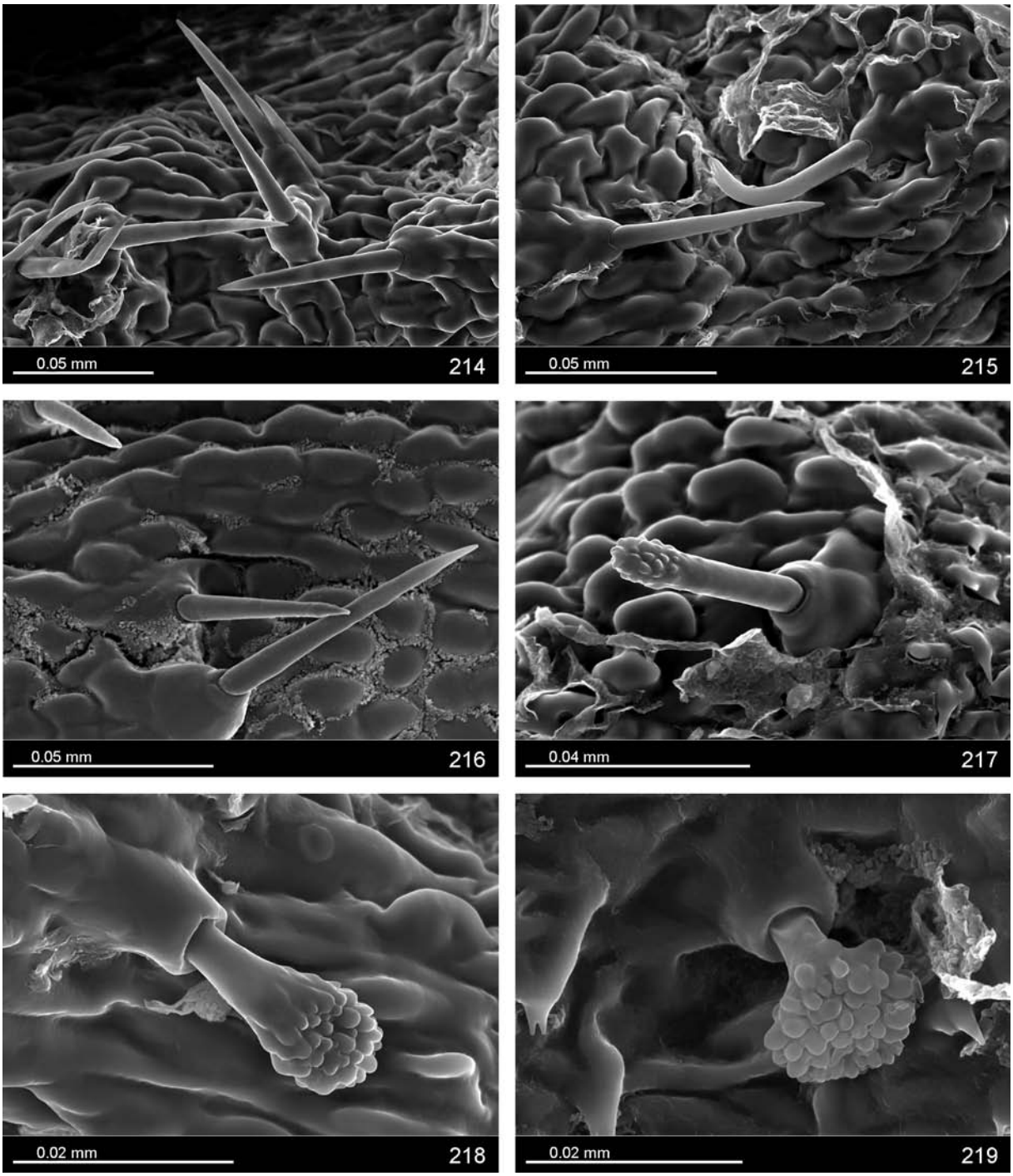


FIGURES 208–213. *Cassida pfefferi* Sekerka, 2006, mature larva. 208. Meso- and metasternum; 209. setae of mesosternum antero-medially; 210. first three abdominal sternites; 211. setae of second abdominal sternite medially; 212. abdominal sternites IV–VIII; 213. cauliflower-shape sensilla of abdominal sternite VI.

In general, scoli of *C. vittata* and *C. nobilis* seem to be slightly narrower than in *C. pfefferi* (Figs 113, 117, 122, 126, 131, 135). Sensilla at the apices of individual scoli from first to 14th pair are most elongate in *C. vittata*, while in *C. nobilis* they are the shortest (Figs 114–116, 118, 123–125, 127, 132–134, 136). Apices of scoli of 15th and 16th pairs are the same in all three species, with one apically blunt seta (Figs 57, 95, 119, 120, 128, 129, 137,138).

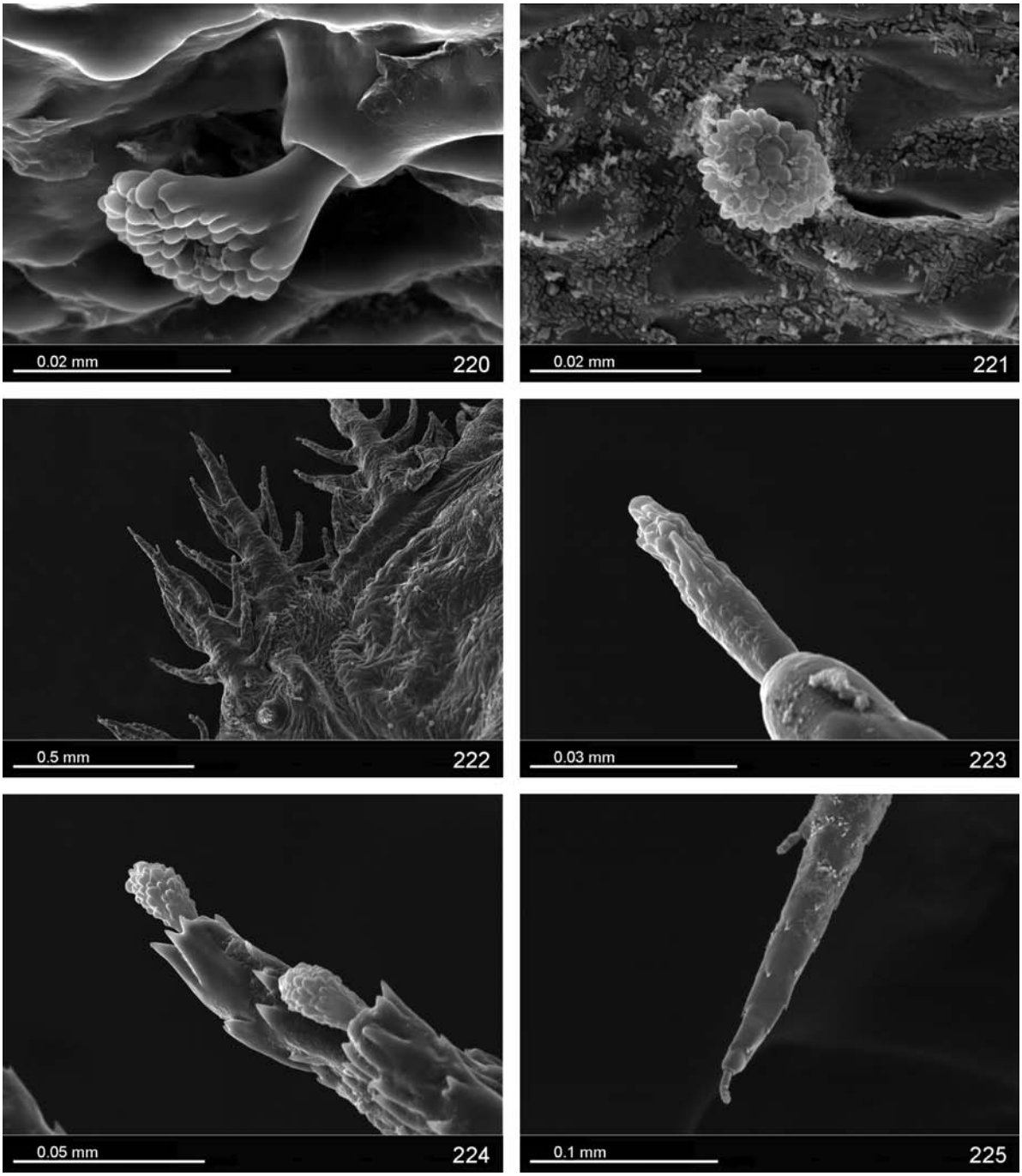
Supra-anal processes in relation to body length are shorter in *C. vittata* and *C. nobilis* than in *C. pfefferi* (Figs 22, 71, 103). In *C. vittata*, supra-anal processes are about half body length, in *C. nobilis* 0.46–1x body length where-

as in *C. pfefferi* they lare 0.6–1.36x body length. Distribution of dense spines on the supra-anal processes varies between species: in *C. vittata* and *C. pfefferi* they are present on the basal half of supra-anal processes whereas in *C. nobilis* fthey occur on to 2/3 of the process length. In all species there are no sensilla at the apices of supra-anal processes (Figs 58, 96, 121, 130, 139).



FIGURES 214–219. *Cassida pfefferi* Sekerka, 2006, mature larva. 214–217. Sensilla of second abdominal sternite medially; 218. cauliflower-shape sensillum of third abdominal sternite laterally; 219. cauliflower-shape sensillum of abdominal sternite IV.

In all species there are nine pairs of spiracles of the same build (Figs 48, 49, 89, 90; Świętojańska 2005). Each spiracle is distinctly elevated, visible from dorsal view (Figs 48–50, 72, 74, 91, 94). Close to each pronotal spiracle one minute seta is placed, close to each abdominal spiracle one very short seta and one small cauliflower-shape sensillum are placed (Fig. 49; Świętojańska 2005).



FIGURES 220–225. *Cassida pfefferi* Sekerka, 2006, mature larva. 220. Cauliflower-shape sensillum of abdominal sternite IV; 221. cauliflower-shape sensillum of abdominal sternite VI; 222. lateral scoli of pronotum; 223. sensilla at the top of lateral scolus of third pair; 224. lateral process of scoli of third pair; 225. sensilla at the top of lateral scolus of pair VI.

Dorsal and ventral body surface of all three species is distinctly granulate (Figs 26–44, 72–88; Świętojańska 2005). Tergites and sternites are covered with tiny cauliflower-shaped or blunt sensilla (Figs 26–31, 36–44, 75–81, 85–88) except for sternites of thorax and abdominal sternites I–III medially, which are covered with pointed setae (Figs 32–35, 38, 39,83, 84, 105); each tergite and sternite has minute setae at the anterior border; frons of head with mostly blunt setae (Fig. 106); temporal surface with pointed setae (Fig. 107); and setae of legs pointed except for blunt setae around pretarsus (Figs 24, 25, 34, 38, 101, 102, 140, 141,).

Cheatotaxy of body, head, mouth parts and legs are the same in all examined species (Świętojańska 2005). Antennae and mouth parts look the same in all species, without any unique characters which distinguish any of the compared species (Figs 59–70, 97–100, 106–112, Świętojańska 2005).

Mature larva

Bodies of all examined species are, like the first instar larvae, typical for *Cassida* species (Świętojańska 2009, Borowiec & Świętojańska 2014) They have 16 pairs of short, approximately equally long, lateral scoli and a pair of supra-anal processes (Figs 17, 181–189). In dorsal view, lateral scoli of *C. nobilis* seem narrower than those of *C. vittata* and *C. pfefferi*. Scoli of all three species are covered with lateral branches, each lateral branch apically armed with a cauliflower-shape sensillum (Figs 17, 181–189, 169–180). In the three species, apical sensilla of first two pairs of scoli are elongate whereas next sensilla are gradually shortened posterad, so that apical sensilla of pairs 15 and 16 of scoli are approximately a quarter the length of apical sensilla of first two pairs. Each lateral scolus of *C. pfefferi* is armed with an apically blunt sensillum (Figs 169–172). In *C. nobilis*, the first three pairs of lateral scoli are apically armed with pointed sensilla, apical sensilla of pairs 4–11 of scoli are blunt, of pairs 12–16 pointed (Figs 177–180). In *C. vittata* lateral scoli of pairs 1–14 are armed with apically blunt sensilla, apical sensilla of pairs 15 and 16 are pointed, or apical sensilla of pairs 1–4 blunt and of pairs 5–16 pointed (Figs 173–176). In summary, *C. nobilis* and *C. vittata* apical sensilla of scoli of 15 and 16 pairs are always pointed (Figs 175, 176, 179, 180), but blunt in *C. pfefferi* (Figs 175, 176), whereas apical sensilla of first two pairs of scoli are pointed in *C. nobilis* (Figs 177, 178) and blunt in *C. pfefferi* and *C. vittata* (Figs 169, 170, 173, 174).

In all three species, both size and number of cauliflower-shape sensilla on tergites decrease posteriorly. Sensilla of *C. pfefferi* and *C. nobilis* seem to be more similar each other—they are rather stout whereas such sensilla of *C. vittata* are a little more elongate in comparison with the previous one.

Larvae of *C. pfefferi* and *C. vittata* carry on their supra-anal processes a shield build of exuviae and pieces of excreta (Figs 185, 186). First instar larvae of *C. nobilis* retain on their supra-anal processes pieces of excreta, while the next instars retain only exuviae without excreta, as a result of which the mature larva carries a shield made of 4 exuviae, but only the first exuvium is covered with excreta (Fig. 189).

Pupa

Bodies of all examined species are oval, but pupae of *C. nobilis* are slightly narrower than of *C. pfefferi* and *C. vittata*.

Living specimens of *C. pfefferi* and *C. vittata* have similar colouration: light green with brown spots placed on pronotum medially, brown spots on each elytral theca dorsally and four brown spots on each abdominal tergite; spiracles white; head, antennae, mouthparts and tarsi brown (Figs 15–17). Pupae preserved in alcohol are yellow with brown spots distributed as living specimens (Figs 190–197). The difference between these two species is the intensity of brown spots on the body, darker in *C. vittata* and lighter in *Cassida pfefferi*. Living specimens of *C. nobilis* pupae are light green without any spots or patches and pupae preserved in alcohol are yellow (Figs 198–201).

The pronotal anterior margin is regularly rounded in all three species. Lateral margins of pronotum of *C. pfefferi* and *C. vittata* are shallowly emarginate whereas in *C. nobilis* they are straight. Marginal processes on lateral margins of pronotum are less numerous in *C. nobilis* than in *C. pfefferi* and *C. vittata*.

Spiracles of abdomen are most prominent in *C. vittata*, least in *C. nobilis*.

Conclusion

The high degree of similarity of the immature stages of the analyzed species confirms that these are closely related species. Both larvae and pupae show characters typical for immature stages of the genus *Cassida*. However, subtle differences indicate that they represent three distinct species. The general similarity of adult larvae and pupae may indicate a more closer relationship between *C. pfefferi* and *C. vittata* than between *C. pfefferi* and *C. nobilis*. This hypothesis requires confirmation by further research.

Acknowledgements

Jolanta Świętojańska would like to express her sincerely thanks to Lech Borowiec for his invaluable support during field work.

References

Borowiec, L. (1999) *A world catalogue of the Cassidinae (Coleoptera: Chrysomelidae)*. Biologica Silesiae, Wrocław, 476 pp.

Borowiec, L. & Świętojańska, J. (2003) The first instar larva of Cassida *nebulosa* L. (Coleoptera: Chrysomelidae: Cassidinae)—a model description. *Annales Zoologici, Warszawa*, 53, 189–200.

Borowiec, L. & Świętojańska, J. (2014) Cassidinae Gyllenhal, 1814. *In*: Kristensen, N.P.K. & Beutel, R.G. (Eds.), *Handbook of Zoology, Arthropoda: Insecta, R.A.B. Leschen, R.G. Beutel, Coleoptera, Beetles, Volume 3: Morphology and Systematics (Phytophaga)*, 2.7.2, pp. 198–217.

Borowiec, L. & Świętojańska, J. (2020) Cassidinae of the World—an interactive manual (Coleoptera: Chrysomelidae). Permanent electronic publication. Available from: http://culex.biol.uni.wroc.pl/cassidae/katalog%20internetowy/index.htm (accessed 6 October 2020)

Boheman, C.H. (1854) *Monographia Cassididarum. Tomus secundus.* Holmiae, 506 pp., 2 tabs.

Brovdii, V.M. (1983) Zhuki-listoidi, shchitonoski i shiponoski. *Fauna Ukraini*, Tom 19, vyp. 20, 1–188.

Linnaeus, C. (1758) *Systema Naturae, sive regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Editio Decima, reformata. I.* Impensis Direct. Laurentii Salvii, Holmiae, IV + 824 pp. https://doi.org/10.5962/bhl.title.542

Matys, E.G. (1970) Opisanie lichinok i kukolok nekotorykh maloizvestnykh vidov i imago odnogo novogo vida (Coleoptera, Cassidinae). *In*: *Entomologicheskie issledovaniya v Kirgizii*, Izdatel'stvo Ilim, Frunze, pp. 23–33.

Medvedev, L.N. (1982) *Listoyedy MNR. Opredelitel.* Nauka, Moskva, 303 pp.

Sekerka, L. (2005) *Cassida olympica*, a new species from Greece (Coleoptera: Chrysomelidae: Cassidinae). *Genus*, 16, 285–289.

Sekerka, L. (2006) A new species of *Cassida* Linné, 1758 from Cyprus (Coleoptera: Chrysomelidae: Cassidinae). *Genus*, 17, 253–262.

Spaeth, F. (1914) Über die paläarktischen Cassiden mit besonderer Berücksichtigung jener von Asien. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien*, 64, 128–147.

Steinhausen, W. (1950) *Vergleichende Morphologie, Biologie und Ökologie der Entwicklungsstadien der in Niedersachsen heimischen Schildkäfer (Cassidinae, Chrysomelidae, Coleoptera) und deren Bedeutung für die Landwirtschaft. Dissertation*, Technische Hochschule, Braunschweig, 69 pp.

Świętojańska, J. (2005) Comparative description of first instar larvae of *Cassida nobilis* Linnaeus, 1758 and *Cassida vittata* Villers, 1789 (Coleoptera: Chrysomelidae: Cassidinae). *Genus*, 16 (1), 49–68.

Świętojańska, J. (2009) *The immatures of tortoise beetles with bibliographic catalogue of all taxa (Coleoptera: Chrysomelidae: Cassidinae). Polish Taxonomical Monographs. Vol. XVI.* Biologica Silesiae, Wrocław, 157 pp.

Villiers, C. (1789) *Caroli Linnaei Entomologia, Faunae Suecicae descriptionibus aucta; DD. Scopoli, Geoffroy, De Geer, Fabricii, Schrank, etc. speciebus vel in Systemate non enumeratis, vel nuperrime detectis, vel speciebus Galliae Australis locupletata, generum specierum que rariorum iconibus ornata. I.* Sumptibus Piestre et Delamolliere, Lugduni, XVI + 766 pp., 3 pls.