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Morphology of the larvae of three Central European *Strophosoma* Billberg, 1820 (Coleoptera, Curculionidae, Entiminae) species

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Abstract

The larvae of *Strophosoma* (*Strophosoma*) *capitatum* (DeGeer, 1775), *S.* (*Strophosoma*) *melanogrammum* (Forster, 1771) and *S.* (*Neliocarus*) *sus* Stephens, 1831, are illustrated and re-described or described for the first time. The first larval instar, and the mature or an older larval instar, are illustrated, and a general description of the *Strophosoma* larva is given. The biological data obtained from breeding and field-collecting are compared and discussed in relation to the known life-cycle data.

Introduction

The short-nosed weevil genus *Strophosoma* is represented in Southwest Europe (mainly Spain) and Northwest Africa (Morocco, Algeria) by more than 40 species (Pelletier 2013). Only a few species have a widespread distribution and are present in Southwestern Asia (two species) or Central Europe (five species), among them the parthenogenetic *Strophosoma melanogrammum* (Forster, 1771). Van Emden (1952) characterized the larvae of four species; in three, the description was based on L_1 larvae. Only in *S. faber* (Herbst, 1785) were higher stages also taken into account. This species was previously described by Urban (1913). Little additional information was added by Scherf (1964) on *Strophosoma* larvae. He included some brief information on the morphology of *S. melanogrammum*, but without any drawings. Only Willis (1964) characterized the mature larva of *S. melanogrammum* in any detail, but this source, a thesis of the Queen's University Belfast, is not readily available.

In this paper the L_1 larvae of *S. capitatum* (DeGeer, 1775) and *S. melanogrammum* and the mature larva of *S. melanogrammum* are re-described, the mature larva of *S. capitatum* is described for the first time, and the young and an old larval instar of *Strophosoma sus* Stephens, 1831 (syn. *S. laterale* (Paykull, 1792)) are also described for the first time. Priority is given to the chaetotaxy of the described larvae.

Materials and methods

The older larvae on which these descriptions are based on, were collected in the field or – in a few cases – bred

Table 1. Measurements of characteristic body parts of the *Strophosoma* species studied. HW – head width; HW* head width with prominent eyes included; HL - head length; BL – body length; BH – body height; L1 – first instar larvae, LM – larvae of last instars. All measurements in millimeters [mm].

	L1								LM							
	HW.*		HL.		BL.		BW.		HW.		HL.		BL.		BW.	
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
S. (*Strophosoma*) *capitatum*	0.19	0.20	0.16	0.17	1.00	1.10	0.23	0.28	0.80	0.90	0.70	0.75	5.2	6.0	1.5	1.8
S. (*Strophosoma*) *melanogrammum*	0.21	0.23	0.19	0.20	0.87	1.03	0.22	0.26	0.90	1.00	0.80	0.90	5.0	6.5	1.5	2.0
S. (*Neliocarus*) *sus*	0.23	0.24	0.22	0.23	0.95	1.11	0.28	0.31	0.57	0.65	0.75	0.80	3.50	5.0	1.1	1.8

in flower-pots. L_1 larvae were obtained from adults kept in the laboratory. Larvae of the polyphagous species *Strophosoma capitatum* and *S. melanogrammum* were dug out of soil under possible host plants or, in the case of the monophagous *S. sus*, under *Calluna vulgaris* (L.) Hull, and fixed in 80% ethanol. The specimens were examined under an optical stereomicroscope (Olympus SZ 60). Measurements were made by using calibrated oculars; first larval instars and older larvae of each species were measured using a calibrated microscopic eyepiece: The measurements (body length (BL), body height (BH), width and length of the head capsule (HW, HL)). Measurements of all the species described are summarized in Table 1.

Drawings were made using a drawing tube installed on a stereomicroscope and processed by computer programmes (Corel Photo-Paint X7, Corel Draw X7). Photos were made using an Olympus BX63 microscope and processed by Olympus *cellSens Dimension* software. Names and abbreviations of body parts follow the terminology proposed by Scherf (1964), setae according to Anderson (1947) and May (1994), and mouthparts and antennae by Marvaldi (1997, 1998a). All specimens are deposited in the collection of the Department of Zoology, Maria Curie-Skłodowska University, in Lublin.

Strophosoma (*Strophosoma*) *capitatum* (Fig. 41)

L_1 larvae: 45 ex., 28.04.2012. Adults collected in Brelingen, north of Hannover (Germany), border of an oak forest, 80 m, 16.04.2012.

Mature larvae: 8 ex., 12.03.2016, Niedersachsen, Deister Mountains, Bredenbeck-Steinkrug, southwest of Hannover (Germany), 165 m (Fig. 40): 6 ex. between roots of young *Fagus sylvatica* L. and 2 ex. between roots of young *Picea abies* (L.) Karst. trees.

Strophosoma (*Strophosoma*) *melanogrammum*

L_1 larvae: 80 ex., 10.06.2012. Adults collected in Brelingen from a row of old oak trees and from broom (*Cytisus scoparius* (L.) Link) in a disused sand pit nearby, 70 m, 15.04.2012.

Mature larvae (9 ex.): 1 ex., 04.10.2013, climate chamber of the Julius-Kühn-Institute in Braunschweig, breeding in flower-pots with *Prunus laurocerasus* L.; 4 ex., 17.04.2015, Sachsen-Anhalt, National Park Harz, Harz Mountains, Schierke, Hohnekamm, nutrient-poor grassland, 830 m; 1 ex., 30.03.2015, Sachsen-Anhalt, National Park Harz, Harz Mountains, Ilsenburg, Meineberg, pioneer forest with young birches (*Betula pendula* Roth), 340 m (Fig. 42); 2 ex., 06.07.2015, Niedersachsen, Brelingen, north of Hannover, disused sand pit, between roots of *Cytisus scoparius,* close to a row of old oak trees (*Quercus robur* L.), 70 m (Fig. 45); 1 ex., 30.12.2015, Niedersachsen, Hannover-Vahrenheide, Kugelfangtrift, nutrient-poor sandy grassland, 50 m, between roots of a mixed stand of *Geranium pusillum* L., *Erodium cicutarium* (L.) L'Hér. ex Aiton, grasses and a sedge species (*Agrostis capillaris* L., *Carex hirta* L., *Festuca rubra* L.), found together with pupae of *Phyllobius pyri* (Linnaeus) f. *vespertinus* (Fabricius).

Strophosoma (*Neliocarus*) *sus*

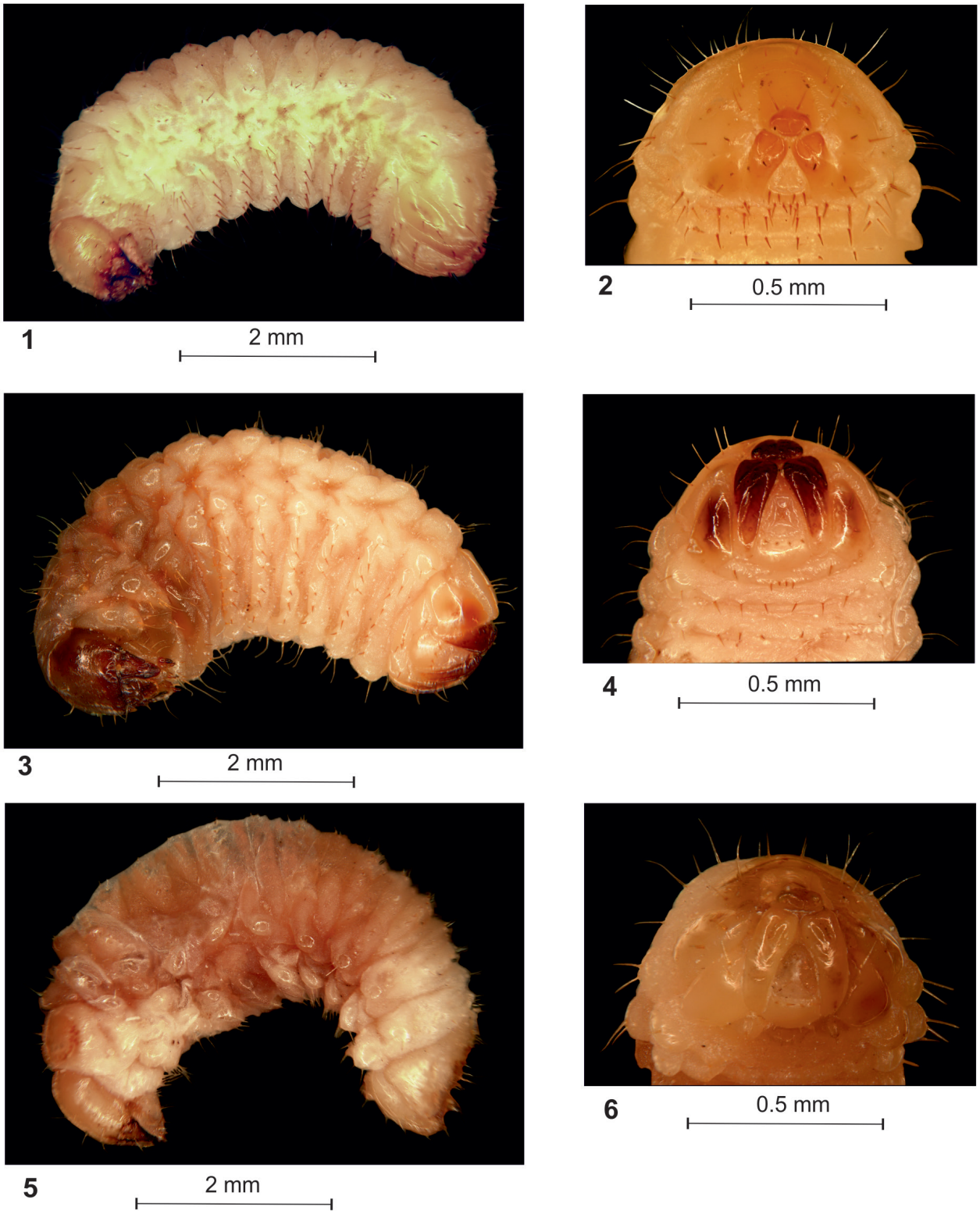
L_1 larvae: 6 exx., 23.05.2012. Adults collected in Berkhof, north of Hannover, heathland and light pine forest with *Calluna vulgaris*, 10.05.2012.

Old larvae (2 exx.): 1 ex., 25.07.2012, collected from under roots of *Calluna vulgaris* in Berkhof (Fig. 44); 1 ex. and 1 immature adult, 02.09.2012, from breeding in a flower-pot with *Calluna vulgaris* in Hannover, Curculio Institute (Fig. 43). In these cases it is not known, whether the larvae were in the last or the penultimate instar.

Results

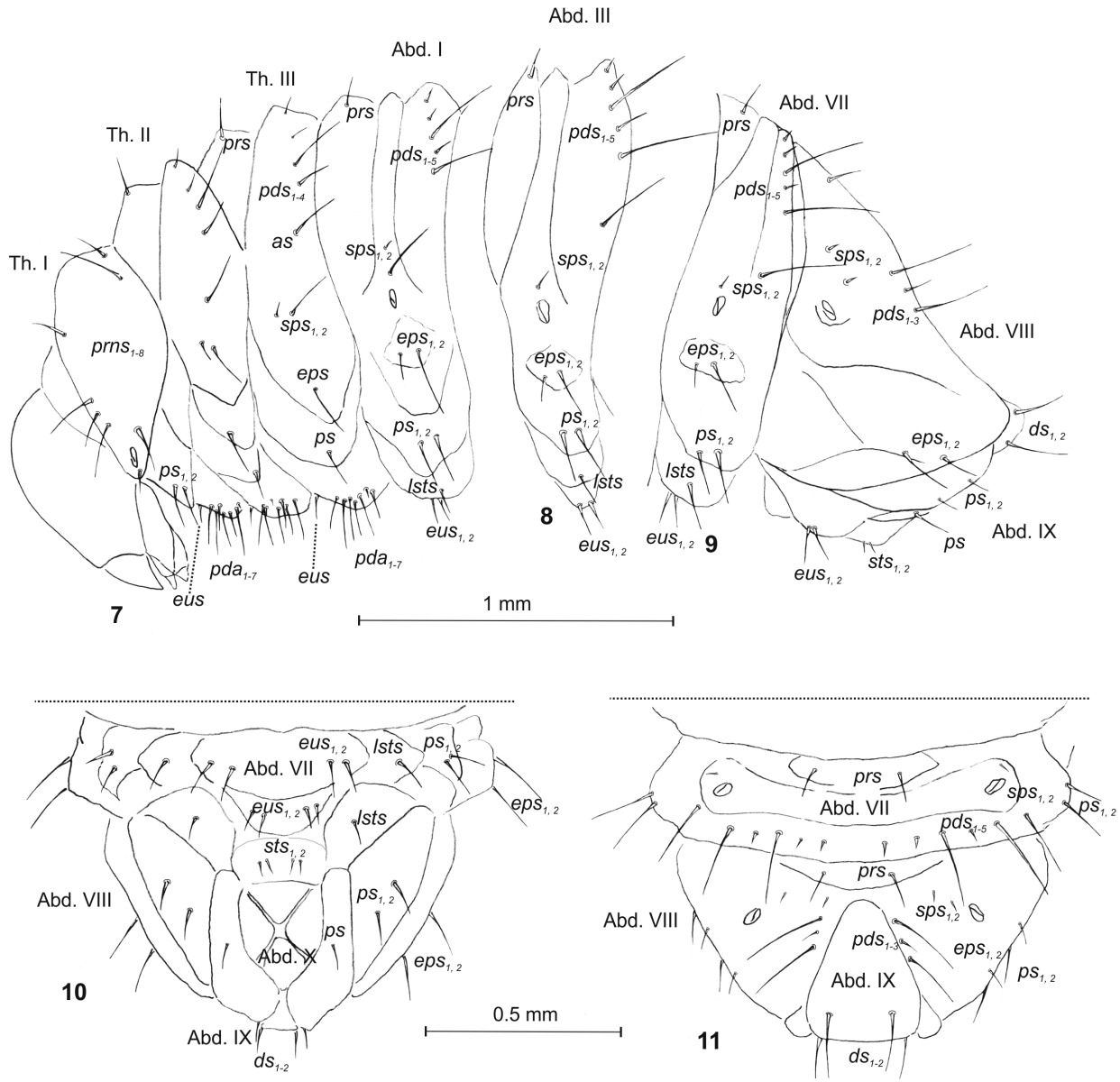
Description of larvae - general diagnosis

Body (Figs 1, 3, 5). Moderately slender, curved, rounded in cross section. Prothorax slightly smaller than mesothorax; metathorax as wide as mesothorax. Abdominal segments I–VII of almost equal length. Abdominal segment VIII wide, flattened posteriorly, with conical lateral lobes. Abdominal segment IX strongly reduced, consisting of four, well isolated lobes, distinctly smaller than previous segments. Abdominal segment X consists of four anal lobes of almost equal size. Anus located ventrally (Figs 2, 4, 6). Chaetotaxy well developed, setae capilliform, variable in length. Each side of prothorax with 8–11 *prns* (pronotal setae) of unequal length; 2 *ps* (pleural s.) and 1 *eus* (eusternal s.). Meso- and metathorax (Figs 7, 18, 29) on each side with 1 *prs* (prodorsal s.), 4 *pds*, variable in length (postdorsal s.), 1 long *as* (alar s.), 2 *ss* (spiracular s.), variable in length, 1 long *eps* (epipleural s.), 1 *ps* and



Figures 1–6. *Strophosoma capitatum*, **1, 2**; *S. melanogrammum* **3, 4**; *S. sus*, **5, 6; 1, 3, 5** - mature larva, lateral view; **2, 4, 6** - structure of last abdominal segments.

1 *eus*. Each pedal area of thoracic segments with 6–7 *pda* (pedal s.), variable in length. Abd. I-VII (Figs 7, 8, 18, 19, 29, 30) on each side with 1 medium-length *prs*, 5 *pds*, various in length and arranged along the posterior margin of each segment, 1 short and 1 long *ss*, 2 *eps* and 2 *ps*, 1 *lsts* (laterosternal s.) and 2 short *eus*. Abd. VIII (Figs 9–11, 20–22, 31–33) on each side with 1 medium-sized *prs*, 3–4 *pds,* different in length and arranged along the posterior margin, 2 very short *ss*, paired *eps* and *ps*, 1 *lsts* and 2 short *eus*. Abd. IX (Figs 9–11, 20–22, 31–33) on each



Figures 7–11. *Strophosoma capitatum*, mature larva, chaetotaxy. **7** - thoracic segments and first abdominal segment, **8** - third abdominal segment, **9** - the 7th – 10th abdominal segments, **10** - ventral view of abdominal segments 7th – 10th, **11** - dorsal view of abdominal segments 7th – 10th. Abbreviations Th. I-III – thoracic segments, Abd. I-X – abdominal segments. Setae: *as* – alar, *ps* – pleural, *eps* – epipleural, *ds* – dorsal, *lsts* – laterosternal, *eus* – eusternal, *pda* – pedal, *pds* – postdorsal, *prns* – pronotal, *prs* – prodorsal, *sps* – spiracular, *sts* - sternal.

side with 2 *ds* (dorsal s.), medium in length, located close to the posterior margin of the segment, 1 medium *ps* and 2 short *sts* (sternal s.). Each vertical anal lobe (Abd. X) with a pair of minute setae, sometimes absent.

Head (Figs 12, 23, 34). Light yellow to dark brown, almost oval or suboval, frontal suture distinct, Y-shaped, endocarina absent. Setae on head capilliform. $Des_{1, 2, 3, 5}$ (dorsal epicranial s.) usually equal in length; des_1 and des_2 located in the central part of epicranium, des_3 placed on frontal suture, des_5 located anterolaterally. $Fs_{3, 4}$ (frontal s.) almost equal in length, fs_3 located anteromedially, fs_4 anterolaterally, close to epistoma. Les_1 and les_2 (lateral s.) equal in length, slightly shorter than des_1. *Ves* (ventral s.) short, poorly developed. Postepicranial area with 4 very short *pes* (postepicranial s.). A pair of small stemmata (st) located anterolaterally on each side of head. Antenna (Figs 13, 24, 35) located at the end of frontal suture; antennal segment with sensorium, reniform, located medially; basal membranous article with 2-6 basiconic sensillae. Labrum (Figs 14, 25, 36) almost semicircular, anterior margin rounded or slightly sinuously emarginate; 3 pairs of *lrs* (labral s.) of different length, lrs_1 placed medially, lrs_2 anteromedially, lrs_3 anterolaterally; all

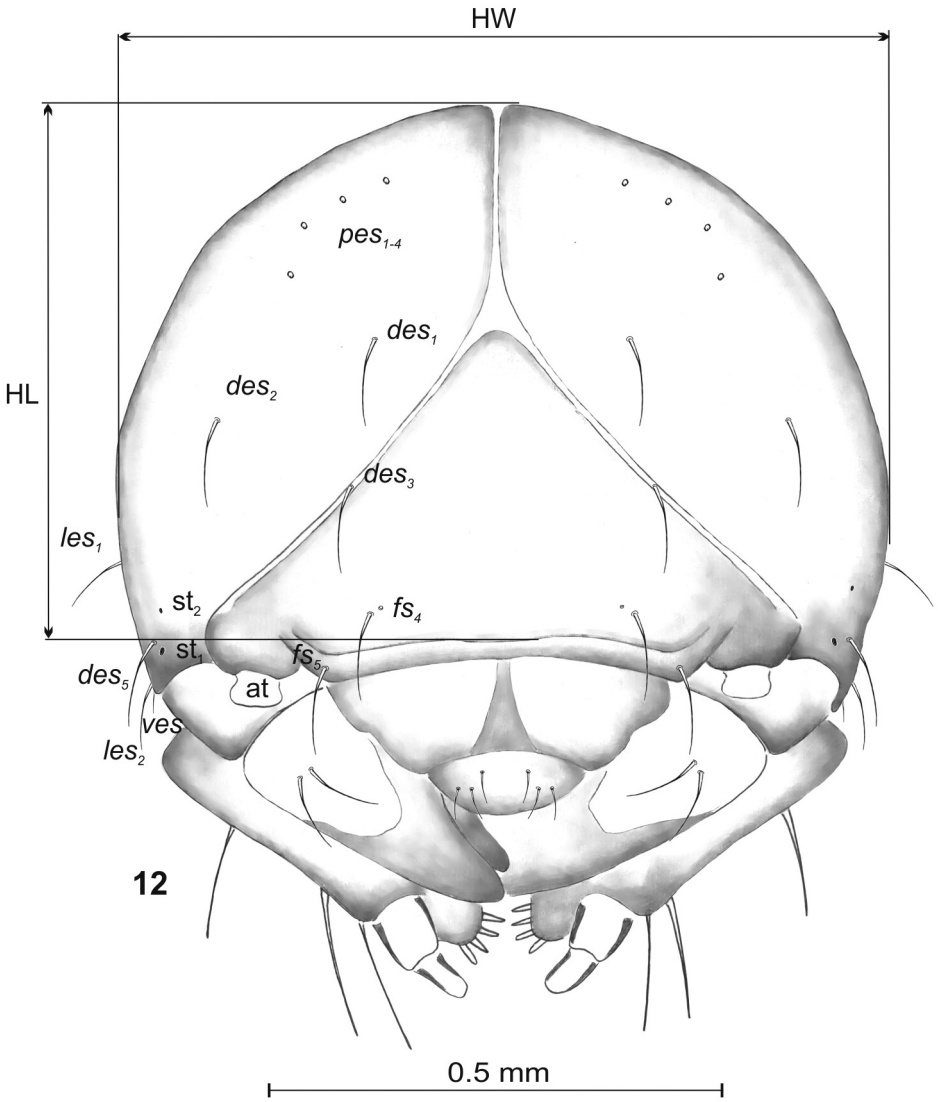
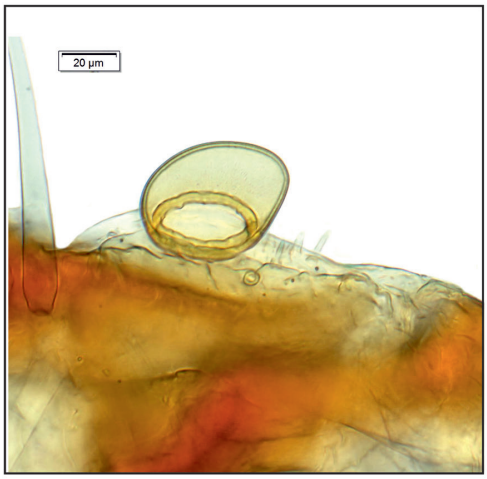


Figure 12. *Strophosoma capitatum*, mature larva, head. Abbreviations at – antenna, HL – head length, HW – head width, st – stemmata. Setae: *des* - dorsal epicranial, *fs* – frontal, *les* - lateral epicranial, *pes* – postepicranial, *ves* – ventral.

lrs without protuberances. Clypeus (Figs 14, 25, 36) of medium width, trapezium-shaped, lateral margins straight, anterior margin of clypeus straight or slightly concave; two pairs of *cls* (clypeal s.) reduced, vestigeal, located posteromedially; *clss* (clypeal sensorium) clearly visible, placed medially between *cls*. Epipharynx (Figs 14, 25, 36) with 3 pairs of rod-shaped or capilliform *als* (anterolateral s.) of almost equal length; 3 pairs of *ams* (anteromedial s.): ams_1 very short, ams_2 half the length of *als*, ams_3 shorter than ams_2; 2 pairs of finger-like *mes* (medial s.), variable in length: first pair placed anteriorly, second pair medially. Anterior margin of epipharynx smooth or serrate, due to the presence of thorn-like cuticular processes placed between labral rods. Labral rods rather elongated, converging posteriorly. Mandibles (Figs 15, 26, 37) slightly curved, narrow, with divided apex (teeth different in length). There is a protruding additional tooth on the cutting edge between the apex and the middle of the mandible; mds_{1-2} capilliform, almost equal in length. Maxilla (Figs 17, 28, 39) with 1 *stps* (stipal s.) and 2 *pfs* (palpiferal s.) of equal length; mala with 8 finger-like or capilliform *dms* (dorsal malar s.), equal in size, and 4 *vms* (ventral malar s.); *vms* shorter than *dms*; *mbs* (malar basiventral s.) medium in length or short. Maxillary palpi with two palpomeres, basal with short *mxps* (maxillary palp s.); distal palpomere apically with a group of sensillae, each palpomere with a pore. Praelabium (Figs 16, 27, 38) almost rounded or heart-shaped with 1 long *plbs* (prelabial s.), located medially. Ligula with 1-2 capilliform *ligs* (ligular s.), variable in length. Premental sclerite clearly visible, Q-shaped. Labial palpi two-segmented; apex of distal palpomere with some sensillae; each palpomere with a pore. Postlabium (Figs 17, 28, 39) with 3 capilliform *pslbs* (postlabial s.), the first pair located anteromedially, the remaining two pairs laterally; $pslbs_2$ always distinctly longer than others.



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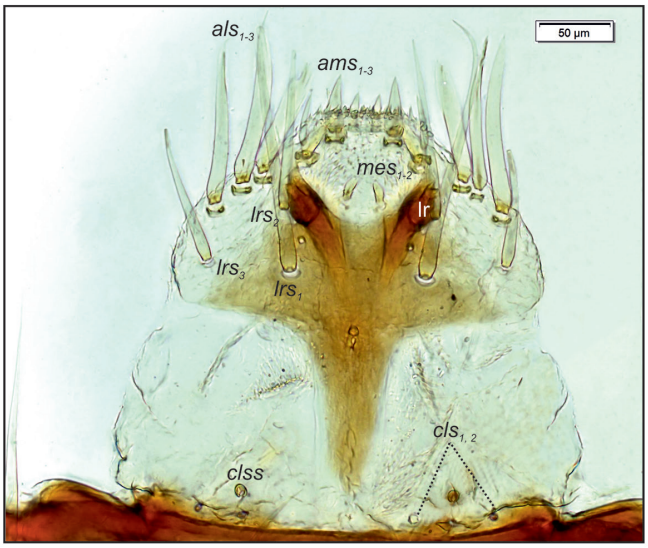

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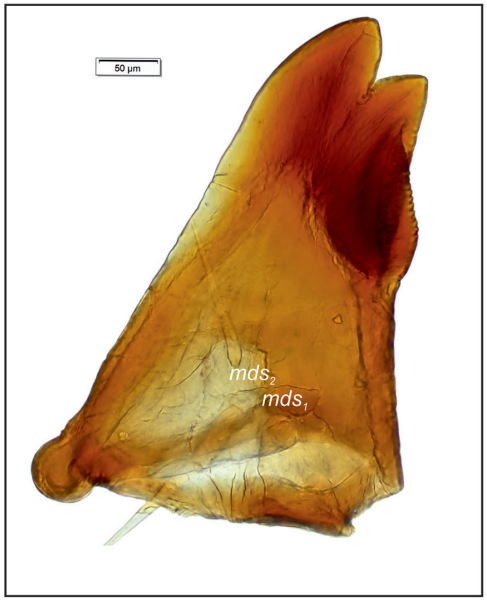

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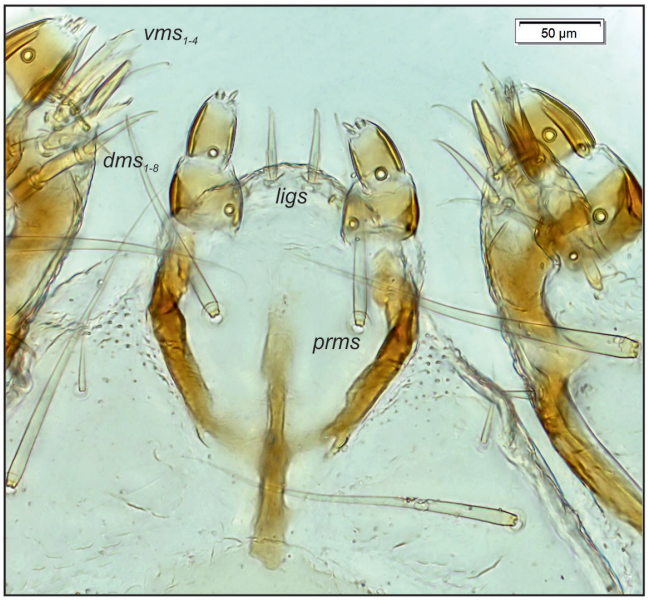

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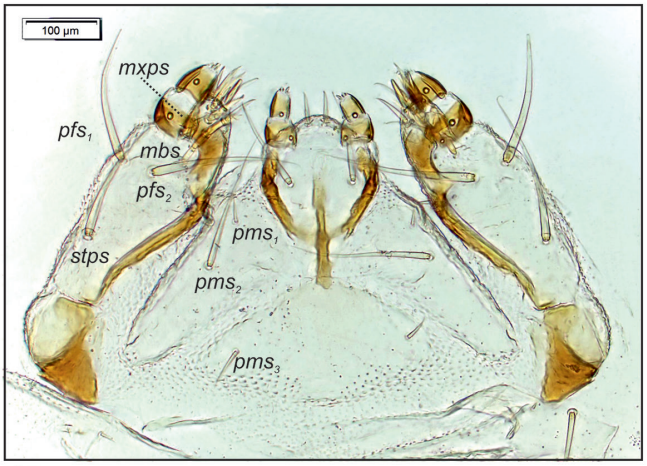

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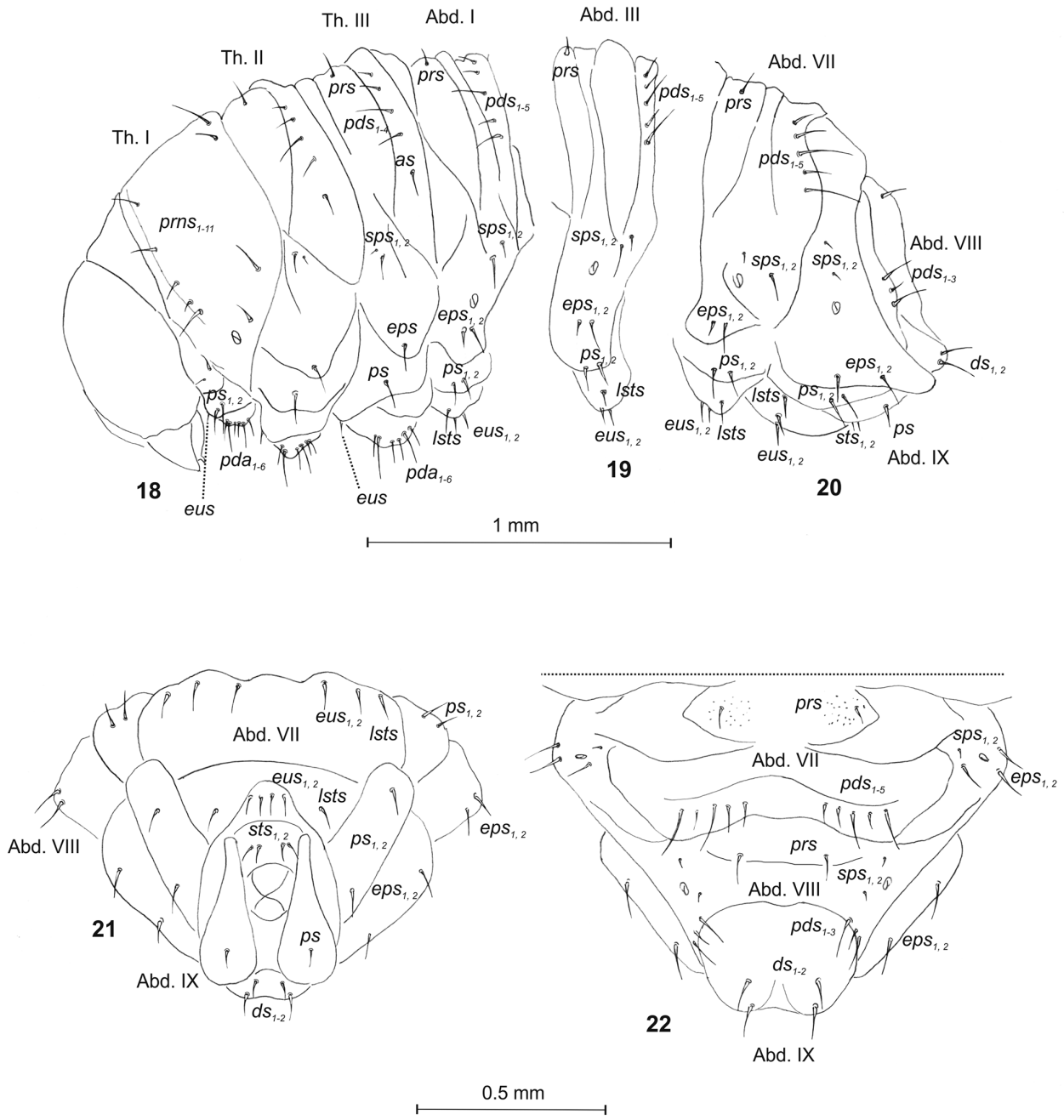
Figures 13–17. *Strophosoma capitatum* mature larva, body parts. **13** - left antenna, **14** - clypeus, labrum and epipharynx, **15** - left mandible, **16** – praelabium, **17** - maxillolabial complex, ventral aspect. Lr – labral rods. Setae: *als* – anterolateral, *ams* – anteromedial, *cls* – clypeal, *clss* – clypeal sensorium, *dms* - dorsal malar, *ligs* – ligular, *lrs* – labral, *mbs* – malar basiventral, *mds* – mandibular, *mes* – median, *mxps* – maxillary palps, *pfs* – palpiferal, *plbs* – prelabial, *pslbs* – postlabial, *stps* – stipal, *vms* - ventral malar.



Figures 18–22. *Strophosoma melanogrammum*, mature larva, chaetotaxy. **18** - thoracic segments and first abdominal segment, **19** - third abdominal segment, **20** - the 7th – 10th abdominal segments, **21** - ventral view of abdominal segments 7th – 10th, **22** - dorsal view of abdominal segments 7th – 10th. Abbreviations: Th. I-III – thoracic segments, Abd. I-X – abdominal segments. Setae: *as* – alar, *ps* – pleural, *eps* – epipleural, *ds* – dorsal, *lsts* – laterosternal, *eus* – eusternal, *pda* – pedal, *pds* – postdorsal, *prns* – pronotal, *prs* – prodorsal, *sps* - spiracular *sts* - sternal.

Diagnoses of the species

Strophosoma (*Strophosoma*) *capitatum*

Figs 1, 2, 7–17

Body. Rather elongate, white to yellowish, abdominal segment VIII dark yellow. Setae long to very short. Each side of prothorax (Fig. 7) with 8 *prns*, two setae placed close to spiracle. Meso- and metathorax (Fig. 7) each with 1 medium long *prs* and 4 *pds*: first and second short, third very long; fourth medium. Each pedal area with 7 *pda*, variable in length. Eps_1 on abdominal segments I-VII almost twice as long as eps_2 (Fig. 8), on next segments almost equal in length (Fig. 9). Abd. segments I-VII each with 5 *pds*: first, second and fourth very short, third and fifth very long. Abd. VIII with 3 *pds* and 1 very short *ss* (Figs 9–11).

Head. Yellow, oval (Fig. 12). Antennal basal membranous article with 3 basiconic sensillae and a pore

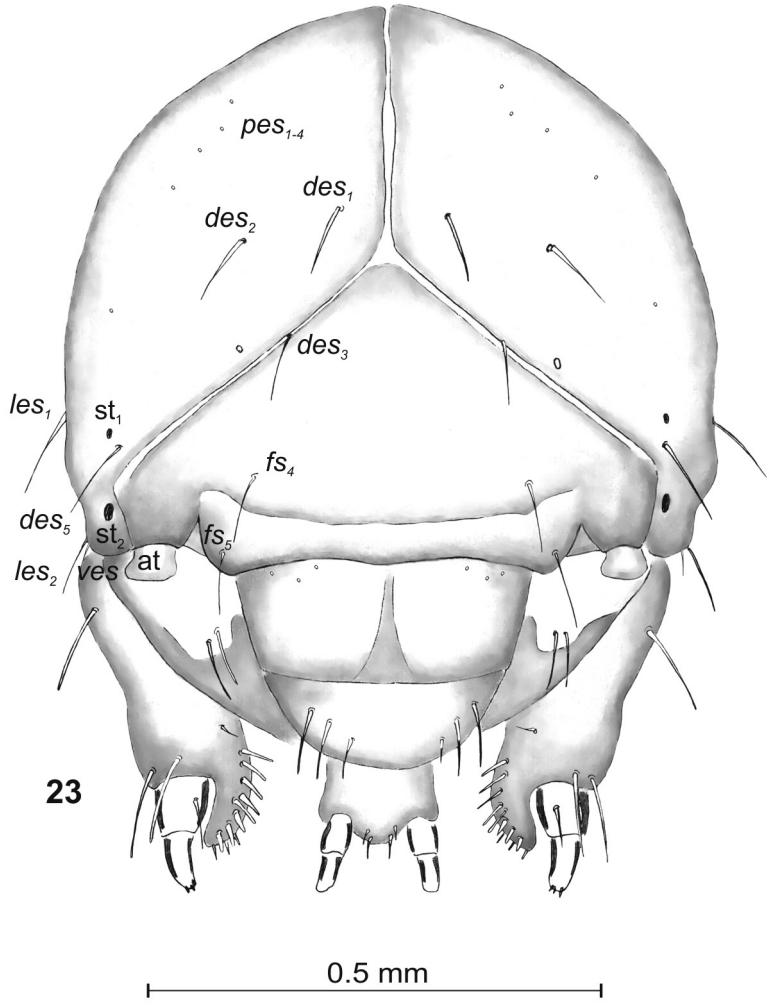


Figure 23. *Strophosoma melanogrammum*, mature larva, head. Abbreviations: at – antenna st – stemmata. Setae: *des* - dorsal epicranial, *fs* – frontal, *les* - lateral epicranial, *pes* – postepicranial, *ves* – ventral.

(Fig. 13). Labrum (Fig. 14) approximately 1.8 times as wide as long; anterior margin slightly sinuate, serrate due to some thorn-like cuticular processes located between *ams*; *als* capilliform. Surface of epipharynx between labral rods covered by very fine asperities. Labral rods of medium length. Clypeus (Fig. 14) 2.2 times as wide as long; anterior margin slightly convex. Mandible (Fig. 15) with a protruding cutting edge placed close to apex; *mbs* very long. Both maxillary palpomeres equal in length, but basal one wider than distal; maxilla with 8 *dms* and 4 *vms*, all capilliform (Figs 14, 16). Praelabium rounded, with a single pair of *ligs*; basal palpomere slightly longer and wider than distal; $pslb_2$ 6 times longer than remaining *pslb*.

Strophosoma (*Strophosoma*) *melanogrammum*

Figs 3, 4, 18–28, 45

Body. Rather stout, yellowish, abdominal segment VIII dark brown. Setae medium-length to very short. Each side of prothorax (Fig. 18) with 11 *prns*, two setae placed below spiracle. Meso- and metathorax (Fig. 18) each with one medium-sized *prs* and 4 *pds*: first very short, second short, third very long; fourth medium. Each pedal area with 6 *pda,* variable in length. Eps_1 on abdominal segments I-VII almost twice as long as eps_2 (Figs 19 20). Abd. segments I-VII each with 5 *pds*: first, second and fourth medium, third and fifth long. Abd. VIII with 3 *pds* and 2 very short $ss_{1, 2}$ (Figs 20–22).

Head. Dark brown, almost circular (Fig. 23). Antennal basal membranous article with 6 basiconic sensillae (Fig. 24). Labrum (Fig. 25) approximately 1.7 times as wide as long; anterior margin rounded, serrate due to some thorn-like cuticular processes located between *ams*; *als* rod-shaped. Surface of epipharynx between labral rods densely covered by conical asperities. Labral rods relatively short. Clypeus (Fig. 25) 2.5 times as wide as long; anterior margin almost straight. Mandible (Fig. 26) conical, cutting edge poorly developed; *mbs* rather short. Both maxillary palpomeres equal in length, but basal one distinctly wider than distal; maxilla with

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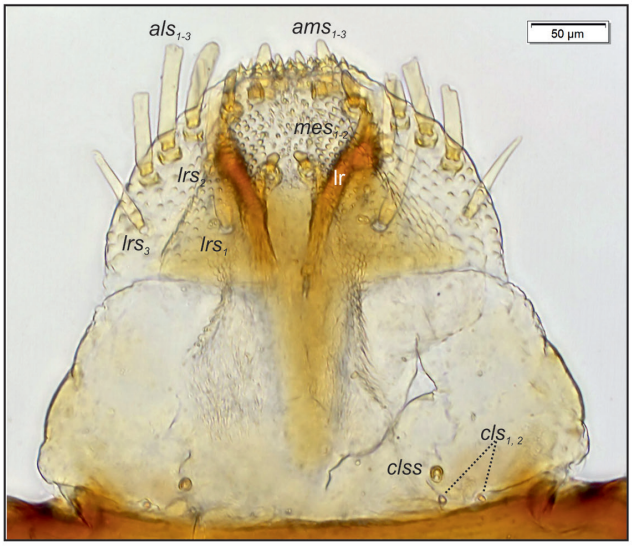

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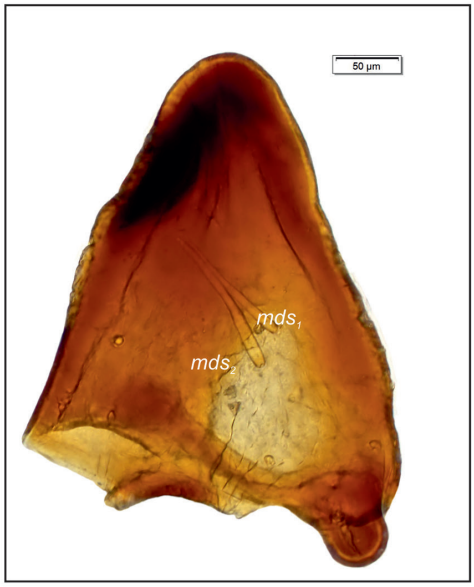

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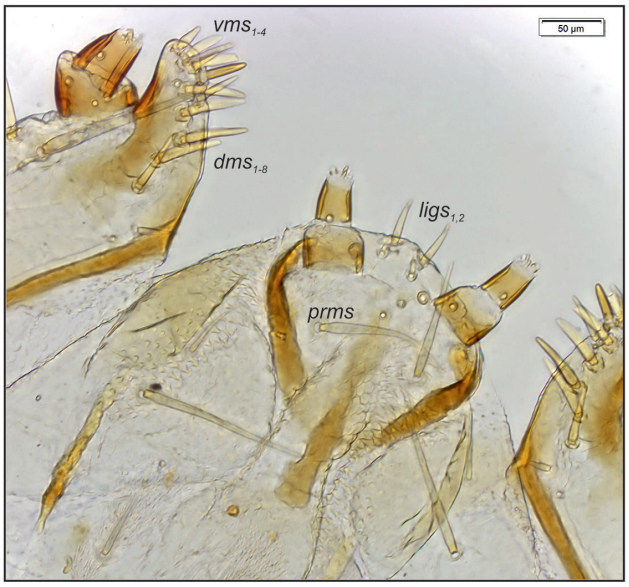

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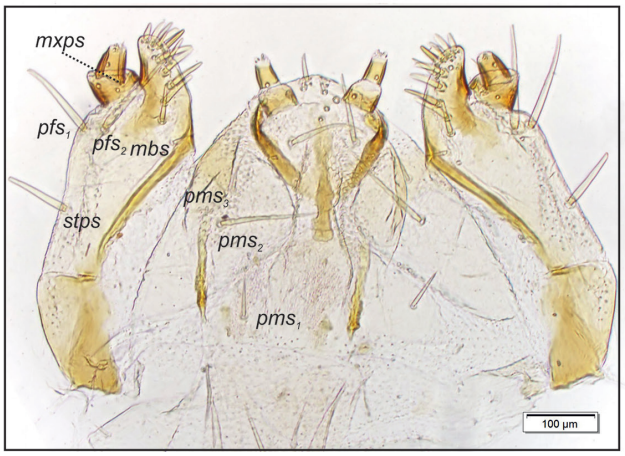

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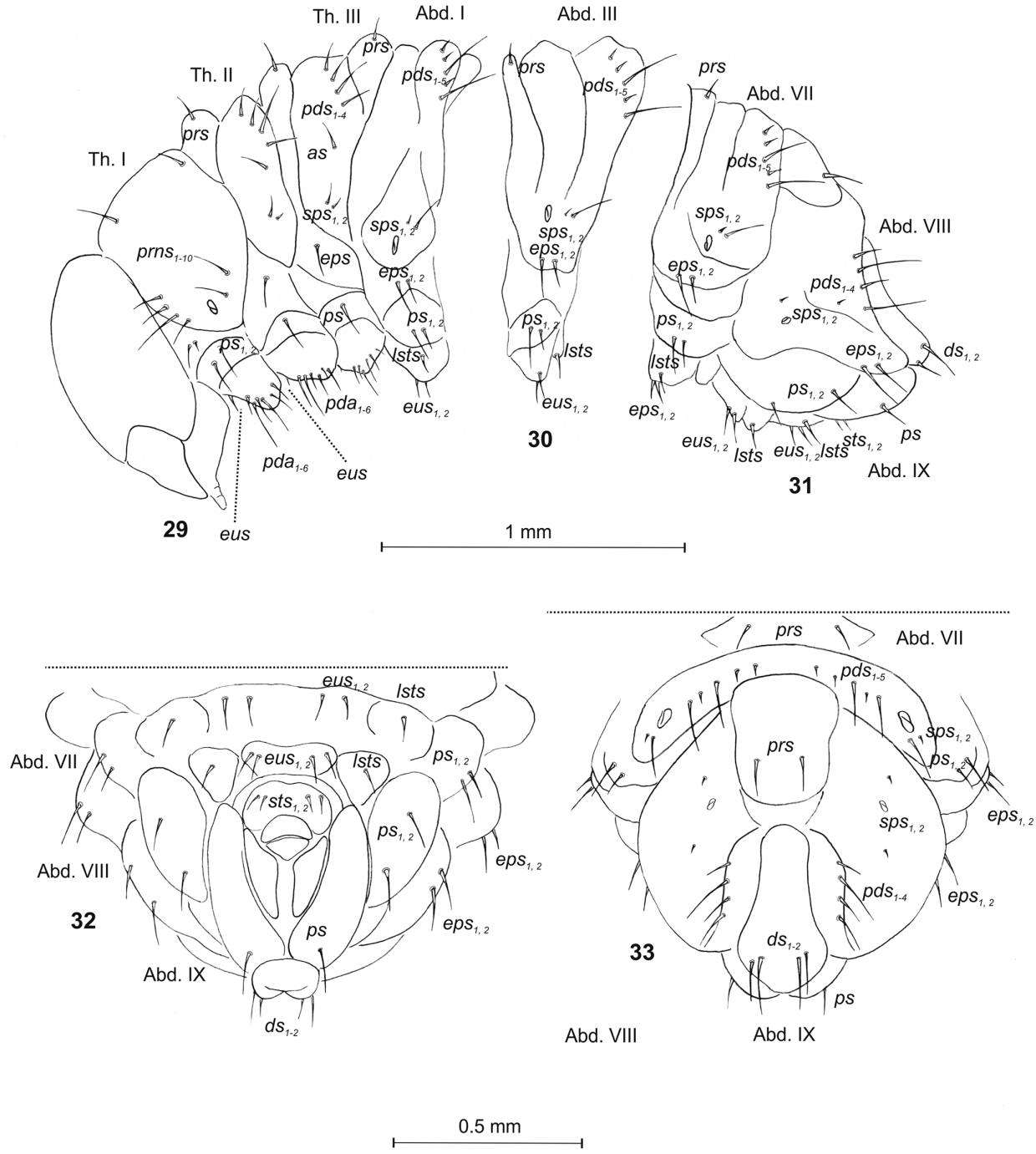
Figures 24–28. *Strophosoma melanogrammum*, mature larva, body parts. **24** - left antenna, **25** - clypeus, labrum and epipharynx, **26** - left mandible, **27** – praelabium, **28** - maxillolabial complex, ventral aspect. Lr – labral rods. Setae: *als* – anterolateral, *ams* – anteromedial, *cls* – clypeal, *clss* – clypeal sensorium, *dms* - dorsal malar, *ligs* – ligular, *lrs* – labral, *mbs* – malar basiventral, *mds* – mandibular, *mes* – median, *mxps* – maxillary palps, *pfs* – palpiferal, *plbs* – prelabial, *pslbs* – postlabial, *stps* – stipal, *vms* - ventral malar.



Figures 29–33. *Strophosoma sus*, larva of high instar, chaetotaxy. **29** - thoracic segments and first abdominal segment, **30** - third abdominal segment, **31** - the 7th – 10th abdominal segments, **32** - ventral view of abdominal segments 7th – 10th, **33** - dorsal view of abdominal segments 7th – 10th. Abbreviations: Th. I-III – thoracic segments, Abd. I-X – abdominal segments. Setae: *as* – alar, *ps* – pleural, *eps* – epipleural, *ds* – dorsal, *lsts* – laterosternal, *eus* – eusternal, *pda* – pedal, *pds* – postdorsal, *prns* – pronotal, *prs* – prodorsal, *sps* - spiracular *sts* - sternal.

6 *dms* and 4 *vms*, all finger-like (Figs 27, 28). Praelabium heart-shaped, with two pairs of *ligs*, variable in length; basal palpomere slightly shorter and wider than distal; $pslb_2$ 3 times longer than remaining *pslb*.

Strophosoma (*Neliocarus*) *sus*

Figs 5, 6, 29–39, 43

Body. Elongated, yellowish, abdominal segment VIII dark yellow. Setae medium long to very short. Each side of prothorax (Fig. 29) with 10 *prns*, two setae placed below spiracle. Meso- and metathorax (Fig. 29) each

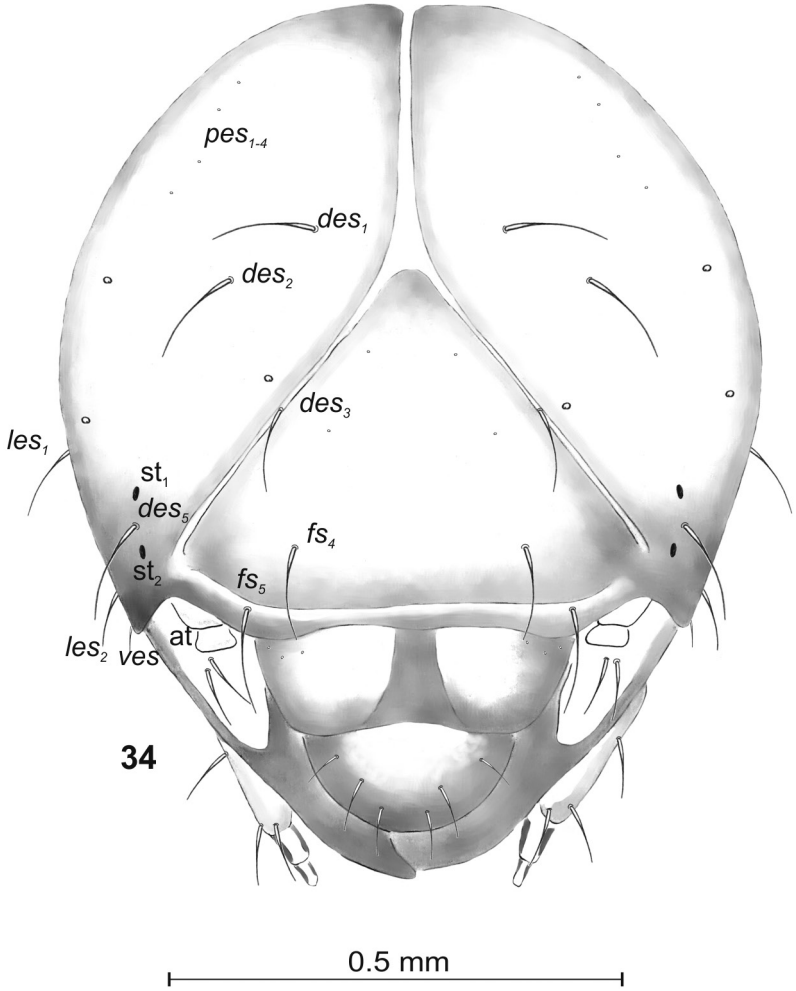


Figure 34. *Strophosoma sus*, larva of high instar, head. Abbreviations: at – antenna st – stemmata. Setae: *des* - dorsal epicranial, *fs* – frontal, *les* - lateral epicranial, *pes* – postepicranial, *ves* – ventral.

with one medium-length *prs* and 4 *pds*: first, second and fourth medium, third long. Each pedal area with 6 *pda*, variable in length. $Eps_{1, 2}$ on abdominal segments I-VII different in length (Figs 29–31). Abd. segments I-VII each with 5 *pds*: first, second and fourth short, third and fifth very long. Abd. VIII with 4 *pds* and 2 very short $ss_{1, 2}$ (Figs 31–33).

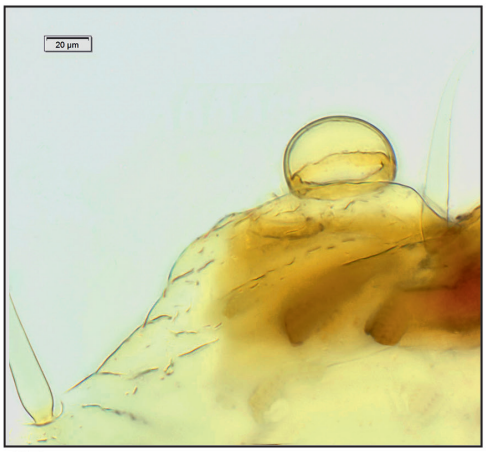
Head. Dark yellow to dark brown, slightly flattened bilaterally (Fig. 34). Antennal basal membranous article with two basiconic sensillae (Fig. 35). Labrum (Fig. 36) approximately twice as wide as long; anterior margin slightly sinuate; *als* rod-shaped. Surface of epipharynx (between labral rods) densely covered by conical asperities. Labral rods strongly elongate. Clypeus (Fig. 35) 2.6 times as wide as long; anterior margin straight. Mandible (Fig. 37) with protruding cutting edge placed in the middle; *mbs* very short. Both maxillary palpomeres equal in length, but basal one wider than distal; maxilla with 6 *dms* and 4 *vms*, all capilliform (Fig. 39). Praelabium rounded, with a pair of relatively long *ligs*; basal and distal palpomeres almost equal in size and shape; $pslb_2$ 3 times longer than remaining *pslb*.

Key to mature larvae of selected *Strophosoma* subgenera and species

The larva of *Strophosoma* (*Neliocarus*) *faber* distinguished according to Van Emden (1952) and Scherf (1964), the remaining species as in the present work. In *S. sus* based on the last or penultimate instar.

1 Abdominal segment VIII with 4 *pds*; anterior margin of epipharynx (between *ams*) almost smooth .... *Strophosoma* (*Neliocarus*)

– Abdominal segment VIII with 3 *pds*; anterior margin of epipharynx (between *ams*) distinctly serrate .... *Strophosoma* (*Strophosoma*)



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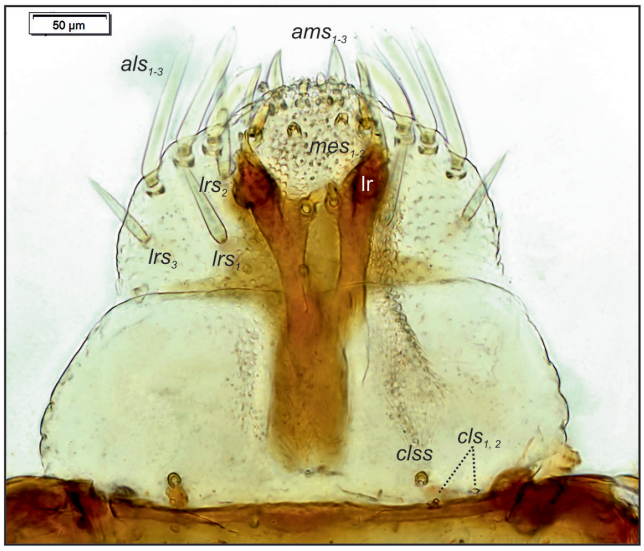

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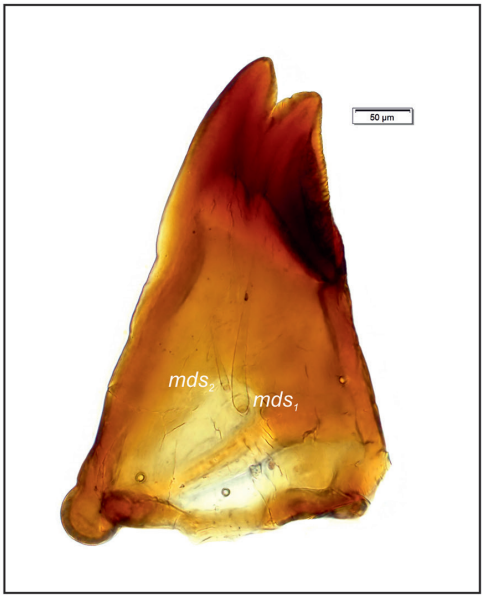

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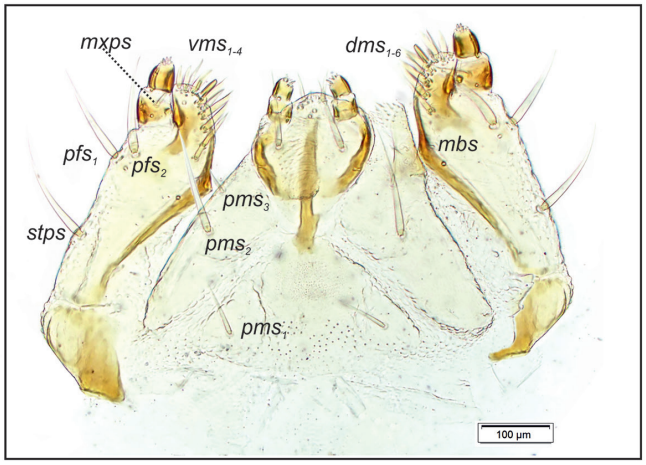

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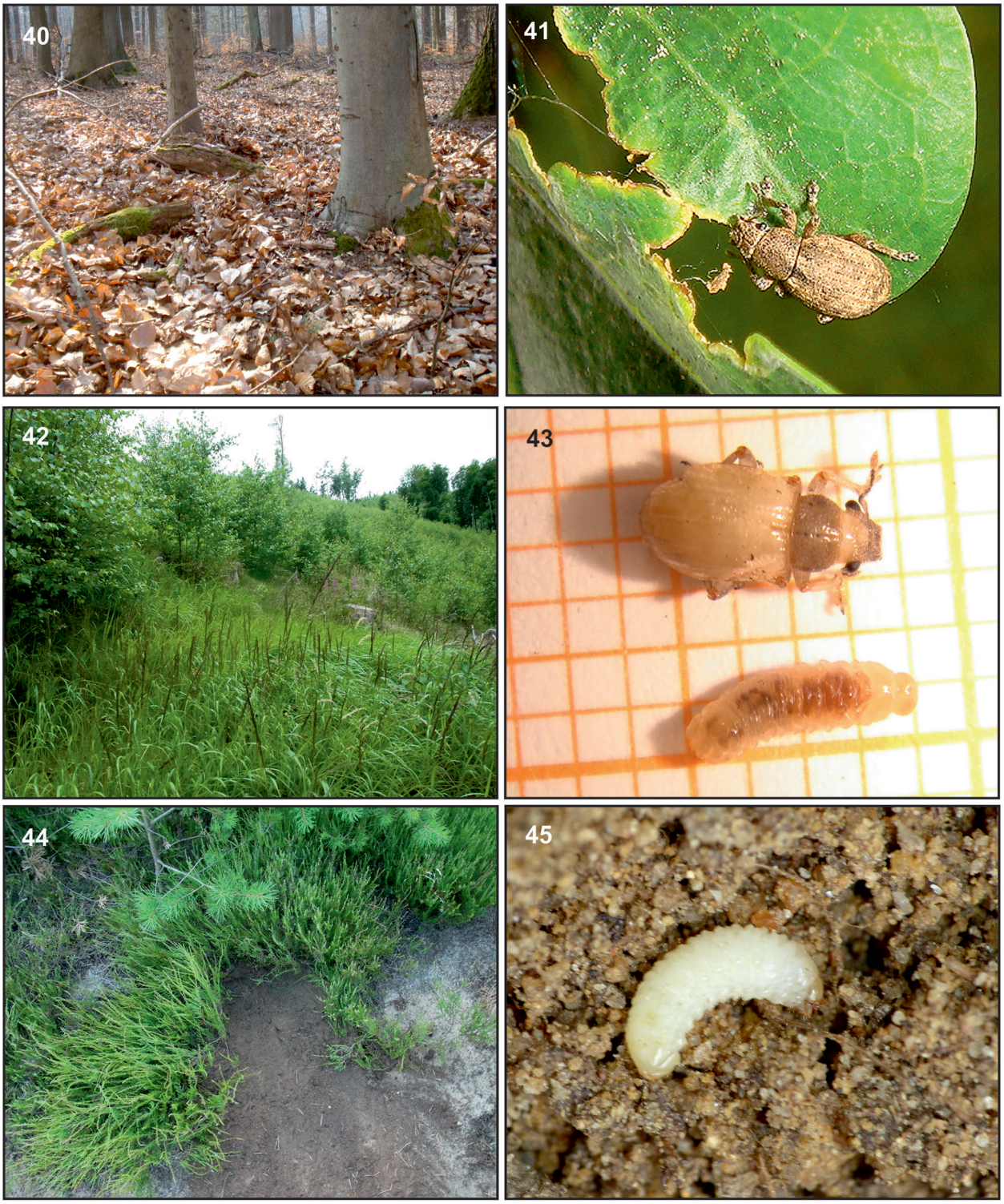
Figures 35–39. *Strophosoma sus*, larva of high instar, body parts. **35** - left antenna, **36** - clypeus, labrum and epipharynx, **37** - left mandible, **38** – praelabium, **39** - maxillolabial complex, ventral aspect. Lr – labral rods. Setae: *als* – anterolateral, *ams* – anteromedial, *cls* – clypeal, *clss* – clypeal sensorium, *dms* - dorsal malar, *ligs* – ligular, *lrs* – labral, *mbs* – malar basiventral, *mds* – mandibular, *mes* – median, *mxps* – maxillary palps, *pfs* – palpiferal, *plbs* – prelabial, *pslbs* – postlabial, *stps* – stipal, *vms* - ventral malar.



Figures 40–45. Sampling sites, host plants, larvae, teneral and mature adults. **40** – sampling site of *Strophosoma capitatum* in a beech forest in the Deister Mountains southwest of Hannover, **41** – adult *S. capitatum* feeding on *Salix caprea* in a pine forest on the outskirts of Celle (Niedersachsen), **42** – habitat of *S. melanogrammum* near Ilsenburg (Sachsen-Anhalt) in the National Park Harz, a broken down spruce plantation, now containing a pioneer forest with young birch trees, **43** – mature larva and fresh adult of *S. sus* from breeding, **44** - searching site for immature stages of *S. sus* between the roots of *Calluna vulgaris* in the southern part of the Lower Saxonian heathland near Berkhof, **45** – mature larvae of *S. melanogrammum* found between the roots of *Cytisus scoparius* near Brelingen in the north of Hannover.

Subgenus *Neliocarus*

1 Stemmata absent; head capsule slightly flattened bilaterally; labral rods elongate ..... *S. sus*
– Stemmata (two pairs) present; head capsule rounded; labral rods short .....*S. faber*

Subgenus *Strophosoma*

1 Pleural lobes of Abd. VII narrow, elongate; anterior margin of labrum slightly sinuate, *als* capilliform; praelabium with 1 pair of *ligs*; antennal basal membranous article with three basiconic sensillae and a pore; praelabium rounded ..... *S. capitatum*
– Pleural lobes of Abd. VII wide, triangular; anterior margin of labrum rounded, *als* finger-like; praelabium with 2 pairs of *ligs*; antennal basal membranous article with 6 basiconic sensillae; praelabium heart-shaped ..... *S. melanogrammum*

Conclusion

Remarks on the development of *Strophosoma* species

The data about the development of *Strophosoma melanogrammum* and *S. capitatum* (in part) have been mainly worked out and summarized by Grimm (1973) and Schauermann (1973). According to these sources both species develop in the Solling Mountains in the southern part of Niedersachsen (Germany) very similarly, and over a period of more than one year. After overwintering adults start to feed and to lay eggs from May to first half of July. Dieckmann (1980) found females with eggs still in the abdomen in August. The eggs are usually laid in clusters in any kind of sheltered situations, e.g. in cracks of cork, between dry leaves of litter, in soil (probably in crevices), between leaf or flower buds of the host plant, on the ground in needles of pine shoots (Breese 1948; Grimm 1973) and, in the laboratory, between rolled or pleated absorbent paper or between paper and the substrate. The eggs are held together by a viscid fluid. This agrees with observations in the laboratory, documented by Sprick and Stüben (2012), who found bulks of eggs deposited between the layers of absorbent paper close to its edges, where these were laid by the female's ovipositor, and by the observations of Wolcott (1933) on neotropical Entiminae genera of the (same) former subfamily Brachyderinae. He had fixed double paper strips in the field on the top of stakes beneath cultivated young *Citrus* plants, and found many eggs deposited between the paper strips or sheets.

Larvae then develop in soil and feed mainly on fine roots until the third or last (fourth) instar and overwinter. In the following year the larvae complete their development and pupate, mainly in August. Adults of the new generation emerge from September to November and single specimens also in spring of the succeeding year. Adults climb for maturation feeding in tree crowns in spring, late summer and early autumn. They also feed in the herb layer and in leaf litter. Urban (1913) gave a strikingly different time of pupation for *S. faber*: the second half of May, producing a newly emerged weevil in June.

According to Schauermann (1973) *S. melanogrammum* and *S. capitatum* have 4 larval instars. But there is no information about how these instars were differentiated. The method of Sprick and Gosik (2014) for the determination of larval instars failed in these species, as the eyes are strongly protruding over the edge of the head in the pupae.

The breeding of *Strophosoma melanogrammum* and *S. capitatum* in the climate chamber, which was very successful in the case of *Otiorhynchus* larvae (Gosik et al. 2016), did not result in any *S. capitatum* larvae (two attempts) and only one larva of *S. melanogrammum* (four attempts), although host plants, the size of flower-pots and the soil substrate were varied. Also an addition of eggs bred before in keeping boxes was not successful. For these reasons no pupae could be obtained by breeding. Field-collecting was conducted only rarely in August, the main month of pupation.

The larval development of any other *Strophosoma* species is apparently unknown. Breeding of *Strophosoma sus* in two flower-pots with *Calluna vulgaris* and *Erica arborea* L. revealed the following data (but only in the pot with *Calluna*): egg-laying started in May (first adults being already active in April) and a newly emerged, weak, adult and a larva were obtained in the beginning of September; four further larvae were seen in the flower-pots, but a further check 3 or 4 weeks later did not reveal any larva, pupa or adult weevil. The reasons for the failure of the continuation of this breeding attempt are not known. Three pupae of *Strophosoma* cf. *sus* were found in the field at the heathland site near Berkhof with *Calluna vulgaris* and young *Pinus sylvestris* trees, where *S. sus*, *S. capitatum* and, rarely, also *S. fulvicorne* (Walton, 1846) were present (Gosik and Sprick 2013). Two pupae were found on 9th July and one on 2nd September, indicating an earlier start of pupation than in *S. capitatum* or *S. melanogrammum* from the Solling Mountains. This is not surprising, as the heathland near Berkhof with a population of *S. sus* is a warm and dry lowland area that allows earlier development. From this, it would be of interest to determine whether the development of *S. capitatum* or *S. melanogrammum* is also possible within one year at such warm sites, or whether larval overwintering and diapause are obligatory in these species.

General remarks about the morphology of *Strophosoma* larvae

Some basic information regarding the morphology of the larva of *Strophosoma* (*Neliocarus*) *faber* (Herbst, 1785),

with drawings of head, mouthparts and apex of abdomen, can be found in the work of Urban (1913). However, the main sources of information about morphology (and egg-laying habits) of *Strophosoma* larvae are studies of Van Emden (1950, 1952), containing descriptions of the first larval instar of *S. melanogrammum*, *S. capitatum* and *S.* (*Neliocarus*) *nebulosum* Stephens, 1831 (syn. *S. retusum* Marsham, 1802), as well as of the mature *S. faber* larva. Van Emden (1952) also specified a number of characters of taxonomic importance for the entire genus *Strophosoma*, such as the presence of 3 or 4 *pds* on Abd. VIII, the conspicuously sclerotized apex of the abdomen, the shape of the premental sclerite, the proportions of setae on the pedal lobes, and the *pds* proportions on Abd. VIII.

The presence of four ventral malar setae in larvae of the genus *Strophosoma* confirms the observations of Marvaldi (1998a) that this character, as well as the shape of the antennal sensorium (Marvaldi 1997, 2003), can be considered an additional apomorphic character for larvae of the subfamily Entiminae, while other Curculionidae, e.g. Cyclominae in the sense of Marvaldi (1998b, 2003), possess the plesiomorphic number of five *vms*.

Further information on the morphology of preimaginal stages of the genus *Strophosoma* was provided by Willis (1964), who presented a very detailed, but unfortunately sparsely illustrated, description of the mature larva of *S. melanogrammum*. In addition to valuable information on the biology of reproduction and the morphology of larval stages of selected Entiminae species (genera *Otiorhynchus* Germar, 1822, *Barynotus* Germar, 1817, *Sciaphilus* Schönherr, 1823 and *Strophosoma*), Willis (1964) described a few general patterns valid for the morphology of weevils. Moreover, he observed changes in the proportions and relative lengths of setae when the larvae entered successive developmental stages. For this reason the key to the genus *Strophosoma* of Van Emden (1952), enabling identification of first-instar larvae to species level based on the proportions of setae, should be regarded – according to Willis (1964) – as at least inadequate for an identification of older larval instars. Changes in the proportions and shape of setae of weevil larvae when passing through successive developmental stages were also observed in later research on Entiminae (Gosik and Sprick 2012) and Hyperinae larvae (Skuhrovec 2004, 2006, 2007). Van Emden (1952) gave differences in the relative lengths of setae on pedal areas as the most important difference between *Strophosoma* sensu stricto and *Neliocarus*, but he did not mention the presence of four *pds* on the 8th abdominal segment in *Neliocarus* versus three *pds* in *Strophosoma*.

The differences in the number of setae and in the morphology of abdominal segments which are observed in the species treated in this paper (*S. capitatum*, *S. melanogrammum* and *S. sus*) as well as in the previously described larva of *S. faber* (Van Emden 1952; Scherf 1964) show that *Strophosoma* species can be easily recognized in both mature stages and in younger larvae. The differences between them (e g. number of setae and presence or absence of asperities on the epipharynx) seem to support the existing division into subgenera (*Strophosoma* and *Neliocarus*). However, due to a lack of information about the morphology of the larvae of the remaining subgenera (*Morphostrophus* Flach, 1907*, Pelletierius* Alonso-Zarazaga & Lyal, 1999 and *Subcaulostrophus* Flach, 1907 according to Pelletier (2013)), a definitive evaluation of these characters will only be possible after further research.

8th abdominal segment: adaptation to the environment versus phylogenetic relationship

Because of the morphology of the eighth abdominal segment, especially the sclerotization and the dark colour, larvae of the genus *Strophosoma* are among the most easily recognized weevil larvae. Only the larvae of the genera *Philopedon* Schönherr, 1826, and *Tanymecus* Germar, 1817, are similar to *Strophosoma* larvae with respect to the morphology of this segment (Van Emden 1950). This leads to the question: are these genera more closely related to each other than to other Entiminae genera? Here we can state the following: Smreczyński (1966) placed the genus *Strophosoma* in a separate tribe, Strophosomini, in a close relationship with the tribe Cneorhinini Lacordaire, 1863, with the genus *Philopedon*, whereas *Tanymecus* was placed in another subfamily (Tanymecinae). Dieckmann (1980) did not use tribes, but he also placed *Philopedon* next to *Strophosoma* (and between them only *Cneorhinus* Schönherr, 1823 with unknown larvae). *Tanymecus* was again placed in another subfamily. Today all these genera are members of the subfamily Entiminae, but they are placed in three different tribes: Brachyderini with *Strophosoma* (Pelletier 2013), Cneorhinini with *Philopedon* (Alonso-Zarazaga 2013) and Tanymecini with *Tanymecus* (Li Ren et al. 2013). A carefully reconstructed phylogeny, combining molecular, morphological and biological data, is still lacking.

Even if we do not know anything about the function of this conspicuous abdominal structure, the possibility that this is an adaptation to the environment has to be taken into account. It is found in a few genera of Entiminae only, larvae of which develop in soil. But there is no information as to whether these larvae exhibit behaviour or habits that are different from those larvae without a sclerotized 8th abdominal segment.

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References

Alonso-Zarazaga MA (2013) Cneorhinini. In: Löbl I, Smetana A. Catalogue of Palaearctic Coleoptera. Vol. 8. Curculionoidea II. Brill, Leiden, Boston 700 pp.

Anderson WH (1947) A terminology for the anatomical characters useful in the taxonomy of weevil larvae. Proceedings of the Entomological Society of Washington 49(5): 123–132.

Breese MH (1948) Notes on the ovideposition site and method of reproduction of the weevil Strophosomus melanogrammus (Forster) (Col.). Proceedings of the Royal Entomological Society of London (A) 23: 62–65. https://doi.org/10.1111/j.1365-3032.1948.tb00618.x

Dieckmann L (1980) Beiträge zur Insektenfauna der DDR: Coleoptera – Curculionidae (Brachycerinae, Otiorhynchinae, Brachyderinae). Beiträge zur Entomologie, Berlin 30(1): 145–310.

Emden FI Van (1950) Eggs, egg-laying habits and larvae of short-nosed weevils. Eighth International Congress of Entomology, Stockholm 1948: 365–372.

Emden FI Van (1952) On the taxonomy of Rhynchophora larvae: Adelognatha and Alophinae (Insecta: Coleoptera) - Proceedings of the Zoological Society of London 122(3): 651–795. https://doi.org/10.1111/j.1096-3642.1952.tb00248.x

Gosik R, Sprick P (2012) Larval morphology of Otiorhynchus ligustici, O. porcatus and O. salicicola (Coleoptera, Curculionidae, Otiorhynchini). Deutsche Entomologische Zeitschrift 59(2): 301–316.

Gosik R, Sprick P (2013) Morphology and identification of the pupae of several species of soil-dwelling broad-nosed weevils from Central Europe (Coleoptera, Curculionidae, Entiminae). Zootaxa 3731(4): 445–472. Incl. Erratum: Zootaxa 3745(2): 299–300.

Gosik R, Sprick P, Skuhrovec J, Deruś M, Hommes M (2016) Morphology and identification of the mature larvae of several species of the genus Otiorhynchus (Coleoptera, Curculionidae, Entiminae) from Central Europe with an update of the life history traits. Zootaxa 4108(1): 1–67. https://doi.org/10.11646/zootaxa.4108.1.1

Grimm R (1973) Zum Energieumsatz phytophager Insekten im Buchenwald. I. Untersuchungen an Populationen der Rüsselkäfer (Curculionidae). Rhynchaenus fagi L., Strophosomus (Schönherr) und Otiorrhynchus singularis L. Oecologia (Berl.) 11: 187–262. https://doi.org/10.1007/BF01882783

Li Ren, Sánchez-Ruiz M, Alonso-Zarazaga MA (2013) Tanymecini. In: Löbl I, Smetana A. Catalogue of Palaearctic Coleoptera. Vol. 8. Curculionoidea II. Brill, Leiden, Boston, 700 pp.

Marvaldi AE (1997) Higher level phylogeny of Curculionidae (Coleoptera: Curculionoidea) based mainly on larval characters, with special reference to broad-nosed weevils. Cladistics 13: 285–312. https://doi.org/10.1111/j.1096-0031.1997.tb00321.x

Marvaldi AE (1998a) Larvae of Entiminae (Coleoptera: Curculionidae): tribal diagnoses and phylogenetic key, with a proposal about natural groups within Entimini. Entomologica Scandinavica 29: 89–98. https://doi.org/10.1163/187631298X00212

Marvaldi AE (1998b) Larvae of South American Rhytirrhininae (Coleoptera: Curculionidae). The Coleopterists Bulletin 52(1): 71–89.

Marvaldi AE (2003) Key to larvae of the South American subfamilies of weevils (Coleoptera, Curculionoidea). Revista Chilena de Historia Natural 76: 603–612. https://doi.org/10.4067/S0716-078X2003000400005

May BM (1994) An introduction to the immature stages of Australian Curculionoidea. In: Zimmerman EC, Australian weevils. Volume II. Brentidae, Eurhynchidae, Apionidae. CSIRO, Melbourne, 364–391.

Pelletier J (2013) Brachyderini. In: Löbl I, Smetana A. Catalogue of Palaearctic Coleoptera. Vol. 8. Curculionoidea II. Brill, Leiden, Boston. 700 pp.

Schauermann J (1973) Zum Energieumsatz phytophager Insekten im Buchenwald. II. Die produktionsbiologische Stellung der Rüsselkäfer (Curculionidae) mit rhizophagen Larvenstadien. Oecologia (Berl.) 13: 313–350. https://doi.org/10.1007/BF01825524

Scherf H (1964) Die Entwicklungsstadien der mitteleuropäischen Curculioniden (Morphologie, Bionomie, Ökologie). Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 506: 1–335.

Skuhrovec J (2004) Descriptions of the larvae of the tribe Hyperini (Coleoptera: Curculionidae): I. Mature larvae of the nominotypical subgenus Hypera. Acta Societatis Zoologicae Bohemicae 68: 245–280.

Skuhrovec J (2006) Identification of instars of Hypera postica by using chaetotaxy. Journal of economic Entomology 99: 2216–2218. https://doi.org/10.1093/jee/99.6.2216

Skuhrovec J (2007) Descriptions of larvae of the tribe Hyperini (Coleoptera: Curculionidae): III. Mature larvae of the genus Donus Jekel, 1865. Zootaxa 1606: 1–28.

Smreczyński S (1966) Chrząszcze - Coleoptera, Ryjkowce – Curculionidae. Podrodziny Otiorhynchinae, Brachyderinae - Klucze do oznaczania owadów Polski XIX (98 b): 1–130.

Sprick P, Gosik R (2014) Biology and morphology of the mature larva of Mitoplinthus caliginosus caliginosus (Curculionidae, Molytinae). Snudebiller. Studies on taxonomy, biology and ecology of Curculionoidea 15, No. 229. Curculio-Institute, Mönchengladbach, 10 pp.

Sprick P, Stüben PE (2012) Rüsselkäfer in anthropogenen Lebensräumen - SNUDEBILLER*extra;* CD Rom, Mönchengladbach. With 1318 coloured photos and 60 maps, 170 pp.; available at: Julius-Kühn-Institut, Institut für Pflanzenschutz in Gartenbau und Forst, Messeweg 11/12, 38104 Braunschweig, Germany.

Urban C (1913) Beiträge zur Lebensgeschichte der Käfer. - Entomologische Blätter 9(3/4): 57–63.

Willis RJ (1964) The bionomics and larval morphology of the otiorhynchid pests of soft fruit crops - Thesis, The Queen's University of Belfast, Northern Ireland, 250 pp. and appendix of 60 pp.

Wolcott GN (1933) Otiorhynchids oviposit between paper. Journal of economic Entomology 26: 1172–1173.