Belg. J. Zool., 139 (1) : 22-39 January 2009

Immature stages of *Rabigus tenuis* (Fabricius, 1792) (Coleoptera, Staphylinidae, Staphylininae) with observations on its biology and taxonomic comments

Bernard Staniec & Ewa Pietrykowska-Tudruj

Department of Zoology, Maria-Curie Sklodowska University, Akademicka 19 Street, 20-033 Lublin, Poland

Corresponding author : Ewa Pietrykowska-Tudruj, e-mail:ewpiet@poczta.onet.pl

ABSTRACT. The paper describes and illustrates the morphology of all preimaginal stages of *Rabigus tenuis* (Fabricius, 1792), including a detailed account of chaetotaxy and porotaxy. This is the first description of the immature stages for the genus *Rabigus*. Morphological differences between the first (L_1) and next (L_2 and L_3) larval instars are to be found in the: chaetotaxy of head, profemur, protibia, tarsungulus, abdominal tergites, sternites and urogomphi; structure of antennae, maxillae and urogomphi; microstructure of abdominal tergites, proportions of the bodyparts, body colour and habitus. Diagnostic characters of egg, larva and pupa of this species are given. Some data on its distribution, environmental requirements and biology under laboratory conditions are also provided. All immature stages of *R. tenuis* were compared with those of related genera and the respective distinguishing characters are provided.

KEY WORDS : Staphylinidae, *Rabigus tenuis*, immature stages, morphology, chaetotaxy.

INTRODUCTION

Nineteen species of the genus *Rabigus* Mulsant & Rey, 1876 are currently known worldwide. Three occur in Europe, two of which are found in Poland: *R. pullus* (Nordmann, 1837) and *R. tenuis* (Fabricius, 1792). Until 1980 the taxon *Rabigus* was considered as a subgenus of the genus *Philonthus* Stephens, 1829 by most authors (Smetana, 1959; Lucht, 1987). In recent years, however, it is mostly considered as a genus of its own (Lohse & Lucht, 1989). The taxonomic history of the taxon clearly illustrates that it is closely related to *Philonthus*.

Nothing is known of the morphology and general biology of the preimaginal stages of the genus *Rabigus* (Paulian, 1941; Pototskaya, 1967; Kasule, 1970; Topp, 1978; Hinton, 1981; Staniec & Pietrykowska-Tudruj, 2007b). Some information on the ecology of *R. tenuis* is provided in Smetana (1958), Burakowski et al. (1980) and Szujecki (1980). The main goal of this study is to describe the immature stages (egg, all three larval instars and pupa) and to observe the biology of this species in captivity.

MATERIALS AND METHODS

All immature stages of *R. tenuis* (eggs, three larval instars and pupa) were obtained by rearing 37 adults (11 of them females). These adults were collected on April 27-29, 2006 in sunny places, free of vegetation, in Lublin, and on an exposed loess slope with xerothermic plants in Ciechanki Łańcuchowskie near Lublin, SE Poland.

The collected adults were divided in the laboratory into two groups. 1) In order to determine the life cycle, reproductive activity, fertility and mortality of this staphylinid, six pairs (female and male) were reared separately. 2) Specimens of the second group (25) were reared together. The immature stages obtained from these adults were used for the description of morphology.

All beetles were kept in plastic containers (10cm diameter x 7cm high), filled with soil. Two hundred eggs, coming from six pairs reared separately, were placed separately in plastic containers (7cm diameter x 4cm high) about 1/3 filled with moist soil. The insects were reared from egg to adult, at a temperature of 24±3°C. Different larval instars were fed with ant larvae. The immature stages obtained from the adults reared together were preserved in a 1:3 solution of glycerine and alcohol. For microscopic studies, the punctured larvae were rinsed in distilled water, cleared in chloralphenol and in lactic acid. Drawings were made from the preparations in lactic acid. Habitus illustrations of larvae, pupae and adults were based on photos of freshly-killed individuals.

The material examined comprises: a) 10 eggs, 11 L_1, 12 L_2, 11 L_3 and 16 pupae used for the study of morphology; all immature stages were reared from the eggs laid by the collected adults; b) 27 adults (including 12 females), 200 eggs, 141 L_1, 91 L_2, 52 L_3, 32 prepupae and 26 pupae, used for the study of life history.

Chetotaxy of *R. tenuis* is generally named based on the principles used for description of some species of the subfamily Staphylininae by Solodovnikov & Newton (2005) and summarized in Solodovnikov (2007).

Setae of thoracic segments I-III (chaetotaxy in L_1, L_2, and L_3 is the same) and abdominal segment IX (it is unclear which setae of L_2, L_3 are homologous with those of L_1) were not coded here.

RESULTS

1. Description of the developmental stages

Egg (Figs 1A-F)

Length: 0.90-1.04mm (mean 0.95mm), width: 0.58-0.66mm (mean 0.61mm). Macroscopic aspect (Fig. 1): milky white, oval; with about 35 unbranched, clearly visible, longitudinal ridges, about 12 of which reach posterior pole. Posterior pole with projection slightly widened on the end (Fig. 1A); egg 2.8-5.6 times as long as projection. Openings of aeropyles clearly visible, arranged between ridges in at least 10 rows from 6 to 8 aeropyles each (Figs 1; 1B). Microscopic aspect: aeropyles openings, chorion microstructure and anterior pole as in Figs 1B-F.

Date of the beginning of rearing adults: 26.IV.2006. The period of egg observation in the laboratory: 29.V-27.VI.2006.

Third instar larva (L_3)

Body length (from anterior margin of nasale to the end of pygopod): 6.10-7.10mm (mean 6.85mm); head width (between stemmata): 0.65-0.68mm (mean 0.66mm); head length (from anterior margin of nasale to neck): 0.83-0.90mm (mean 0.87mm); pronotum width in broadest place: 0.69-0.79mm (mean 0.72mm). Colour: head brown, mandibles dark brown, antennae, maxillae, labium yellowish, pronotum yellowish-brown, meso- and metanotum yellowish-grey, legs light yellowish-brown with brown tarsungulus, abdominal tergites grey-white, body and urogomphi dirty white, toracic sternite yellowish-brown, abdominal sternite yellowish-white. Macro and micro setae of head, thorax, some setae on abdominal segments simple (Fig. 4); most setae on abdominal segments and urogomphi rod-shaped and frayed apically (Figs 5-11). Body elongated, abdomen slightly widened to segment V and then gradually narrowed to the terminal segment of the body.

Head (Figs 13-15; 15B; 15D; 17-24; 26; 27): about 1.2 times as long as wide, side margins almost parallel; dorsal ecdysial lines bifurcate before half of head length (Fig. 13). Chaetotaxy of epicranial (E) part: with 32 setae (codes: 12-27), six pores (codes: a-c) and two glands (Gl); posterior (P) part with six micro setae (codes: 28-30) and two pores (code: d) (Fig. 13). Ventral side of head with about 14 setae, six pores and a pair of clearly visible tentorial pits (Figs 15; 15D). Apotome (Ap) (Figs 15; 21) in broad outline triangular, slightly extending beyond tentorial pits; with six setae, two pores and a pair of glandular pits (Gp). Each side of head with four stemmata (Figs 14; 14A) in a cluster, three stemmata almost of equal size, the fourth one clearly smaller than the others (Fig. 14A). Antenna (Figs 17; 18) 4-segmented, length ratio of segments I-IV 1.0:1.9:2.1:1.1. respectively; segment I 1.1 as wide at the base as long, with one pore ventro-apically; segment II 2.3 times as long as wide, with two pores (one dorsally, and one ventro-apically); segment III 2.5 times as long as wide in the widest place, with three macro setae (one ventro-laterally and two laterally), two sensory appendages (Sa) (one club-shaped and second tiny), two solenidia (So) and one pore ventrally; segment IV 2.5 times as long as wide at the widest place, about 2.1 times as long as sensory appendage, with three setae and four solenidia (So) apically. Nasale (Na) (Figs 13; 19) with 22 setae (14 macro and eight micro), two pores medially, two olfactory organs (Og) anteriorly and two glandular pits (Gp) posterio-laterally. Anterior margin of nasale (Fig. 19) with nine teeth divided into three distinct clusters (one middle and two lateral), each cluster with three teeth, paramedian teeth (Pmt) about 2.1 times as long as median tooth (Mt). Epipharynx (Fig. 20) with four bunches of straight, long hairs each, two olfactory organs (Og) at the anterior margin and 14 cuticular processes posteriorly. Mandible (Fig. 22) with uneven inner margin, two setae on outer margin and two pores dorsally. Maxilla (Figs 23; 24): length ratio of cardo (Cd) and stipes (St) 1:1.5; cardo 1.3 times as long as wide at the base, bearing one seta ventro-laterally; stipes 2.8 times as long as wide with seven setae (two on outer margin, two ventrally, three at the inner margin) and one pore. Mala (Ma) (Fig. 23) finger-shaped, with two long and two short setae apically; length ratio of mala and segment I of maxillary palp: 1:1.4.

Palpifer (Pf) (Fig. 23) with one pore and two micro seta ventrally. Maxillary palp (Pm) 4-segmented; length ratio of segments I-IV: 1.5:1.9:1.7:1.0 respectively; segment I 1.8 times as long as wide, with two pores; segment II 2.4 times as long as wide, with two setae and two pores; segment III 3.9 times as long as wide, with one digitiform sensory appendage basally on outer margin; segment IV 3.4 times as long as wide, with two pores and a few microsensory appendages on the apex (Fig. 24).

Hypopharynx: dorsal side of labium membranous and densely pubescent (Fig. 26). Labium (Fig. 27): ventral side of prementum (Pmnt) sclerotized, with four setae (two macro and micro) and two pores laterally. Ligula (Lg) conical, 2.5 times as long as wide at base; almost as wide as segment I of labial palp at the base; ligula almost as long as segment I of labial palp; apex with a few (clearly visible 2) microsensory appendages. Labial palps (Pl) 3-segmented; length ratio of segments I-III 2.1:1.4:1.0 respectively; segment I with one pore laterally; segment III with one pore laterally and one microsensory appendage apically.

Thorax (Figs 3; 28-30): pro-, meso-, and metanotum with mid-longitudinal ecdysial line. Pronotum (Fig. 28) with 46 (23 x 2) setae and eight pores; meso- (Fig. 28) and metanotum with similar chaetotaxy, each with 44 (22 x 2) setae (ten micro), eight pores and a pair of coeloconic sensilla (Cs) probably (Fig. 28D). Microstructure the anterior part pro- and mesonotum as in Figs 28A, C. Cervicosternum (Cr) (Fig. 29) triangular with ten setae (two micro). Prosternal area with two sternites (Sn), each with one seta; membranous surface between sternites and coxal cavities (Cc) with two pair setae, and between cervicosternum (Cr) and sternites (Sn) with six setae. Meso- and metasternal areas membranous, each with 12 micro setae: four between legs, six at the base of legs and two anteriorly (Fig. 29). The area between pro- and mesothorax with a pair of functional spiracles (Sp), one macro seta in front of each spiracle (Fig. 29). Foreleg (Fig. 30): femur (Fe) with 24 setae (15 spine-shaped of different length, nine micro, codes: 1-24) and two pores (codes: a, b); tibia (Tb) with 18 spine-shaped setae of different length (codes: 1-18) and one pore (code: a), tibial comb absent; tarsungulus (Tu) with three spine-shaped setae (codes: 1-3). Length ratio of profemur, protibia and protarsungulus 3.7:2.6:1 respectively.

Abdomen (Figs 3; 33; 34; 36; 37; 38; 40; 42): segments I-VIII each with tergite (Te) and sternite (St) divided into two parts by membranous area until segments VII, a pair of paratergites (Pt) and a pair of parasternites (Ps) laterally (Figs 33; 34; 36); on segment I paratergites and parasternites partly fused (Fig. 34). Segment I: tergite with 34 setae (20 macro and 14 micro, codes: 1-17) and eight pores (codes: a-d) (Fig. 33); sternite with 18 setae (four macro rod-shaped and frayed apically, 14 micro, codes: 1-9) and two pores (code: a) (Fig. 36); fused paratergites and parasternites each with seven setae (five macro rod-shaped and frayed apically, two micro). Segments II-VIII: tergites with about 40 setae (32-34 macro rod-shaped and frayed apically and 6-8 micro, codes: 1-20); sternites with 30-32 setae (22 macro rod-shaped and frayed apically, 8-10 micro, codes: 1-15); paratergites and parasternites each with four setae and six setae (1 micro) respectively. Tergites I-IX each with a pair of organs that are probably campaniform or coeloconic sensillae (Ca) antero-lateraly (Figs 33B, 34). Microstructure of tergites of segments I-VIII as in Figs 33A; C-F; tergite and sternite of segment IX with 18 setae (four micro) and 14 setae (four micro) respectively (Figs 37; 38; 40). Microstructure of tergite and sternite of segment IX as in Figs 37A; B; D; E. Segment IX with pair of two-segmented urogomphi (Figs 37; 38; 40; 42); segment I with 25 setae (codes: 4-28) and one pore (Fig. 42); segment II slightly curved with three setae, one long seta apically (codes: 1-3); length ratio of segments I and II of urogomphus and apical seta 3.5:1:2.0 respectively; segment I six times as long as wide, microstructure of urogomphi as in Figs 42A; B. Segment X (pygopod): dorsal side with about 26-30 setae (Fig. 37); ventral side with 30-35 setae (Fig. 38); microstructure as in Fig. 37F. Pygopod shorter than urogomphi (without seta apically) and only slightly longer than segments I of urogomphi, length ratio of pygopod and urogomphi (without seta apically) 1:1.2. Abdominal segments I-VIII, each with a pair of spiracles (Sp) located between tergite and paratergites at segment I and on lateral sides of tergites at segments II-VIII (Fig. 34).

Second instar larva (L_2)

Body length: 3.87-5.65mm (mean 4.93mm); head width (between stemmata): 0.52-0.56mm (mean 0.54mm); head length: 0.66-0.71mm (mean 0.69mm); pronotum width: 0.52-0.60mm (mean 0.56mm).

First instar larva (L_1)

Body length: 2.80-4.50mm (mean 3.45mm); head width (between stemmata): 0.46-0.48mm (mean 0.47mm); head length: 0.58-0.64mm (mean 0.60mm); pronotum width: 0.44-0.45mm (mean 0.45mm). Colour: head yellowish-brown, anterior part of head and mandibles light brown, tergites of pro-, meso-, and metanotum slightly darkened, antennae and legs light brownish, abdominal sclerites colourless, setae brown, body, urogomphi dirty white. Head about 1.3 times as long as wide; chaetotaxy of epicranial (E) part with 28 pairs of setae (codes: 12-14, 16-25, 27) and two pair of pores (codes: a, c) (Fig. 12). Structure of tentorial pit and microstucture of basal part of head as in Figs 15A & 15C respectively. Antenna (Fig. 16): length ratio of segments I-IV: 1:2.2:3.0:2.1 respectively; segment I 1.8 times as wide as long; segment II 1.5 times as long as wide; segment III 1.8 times as long as its maximal width, without one solenidium occurring in L_3 (Figs 16-18). Maxilla (Fig. 25): length ratio of cardo (Cd) and stipes (St) 1:1.9; cardo 1.1 times as wide as long; stipes 2.1 times as long as wide with five macro setae (Fig. 25). Length ratio mala (Ma) and segment I of maxillary palp 1:1.1 respectively; maxillary palp (Fig. 25): length ratio of segments I-IV 1.1:1.6:1.5:1 respectively; segment I 1.2 times as long as wide; segment II about 2.1 times as long as wide.

Foreleg (Fig. 31): femur (Fe) with 11 setae (code: 1, 2, 4, 6-8, 10, 11, 13, 15, 18) and two pores (a, b); tibia (Tb) with nine spine-shaped setae (code: 1-3, 6, 7, 12-15); tarsungulus (Tu) with two spine-shaped setae (code: 1, 2).

Abdomen (Figs 32; 35; 39; 41). Segment I: tergite with 32 (2 x 16) setae (code: 1-10, 12-17) (Fig. 32); sternite with 16 setae – 14 micro simple, two macro rod-shaped and frayed (code: 1, 2, 4-9) (Fig. 35). Segments II-VIII: tergite and sternite of each segment with 30 setae (code: 2, 3, 5, 6, 8, 9, 11, 13-20) and 26 setae (code: 1-5, 7, 8, 10-15) respectively; microstructure of tergites I-VIII as in Figs 32A-C. Segment IX (Fig. 39): tergite and sternite each with 12 setae; microstructure as in Fig. 37C. Segment X: microstructure and chaetotaxy as in Figs 37G; 39 respectively. Urogomphus (Ug): segment I with 18 setae (codes: 4-9, 11-13, 15, 17-20, 25-28); length ratio of segments I, II of urogomphus and apical seta 1.8:1:1.6 respectively; segment I 4.6 as long as wide (Fig. 41); microstructure of segment I and II as in Figs 41A, B.

Pupa (Figs 44-60)

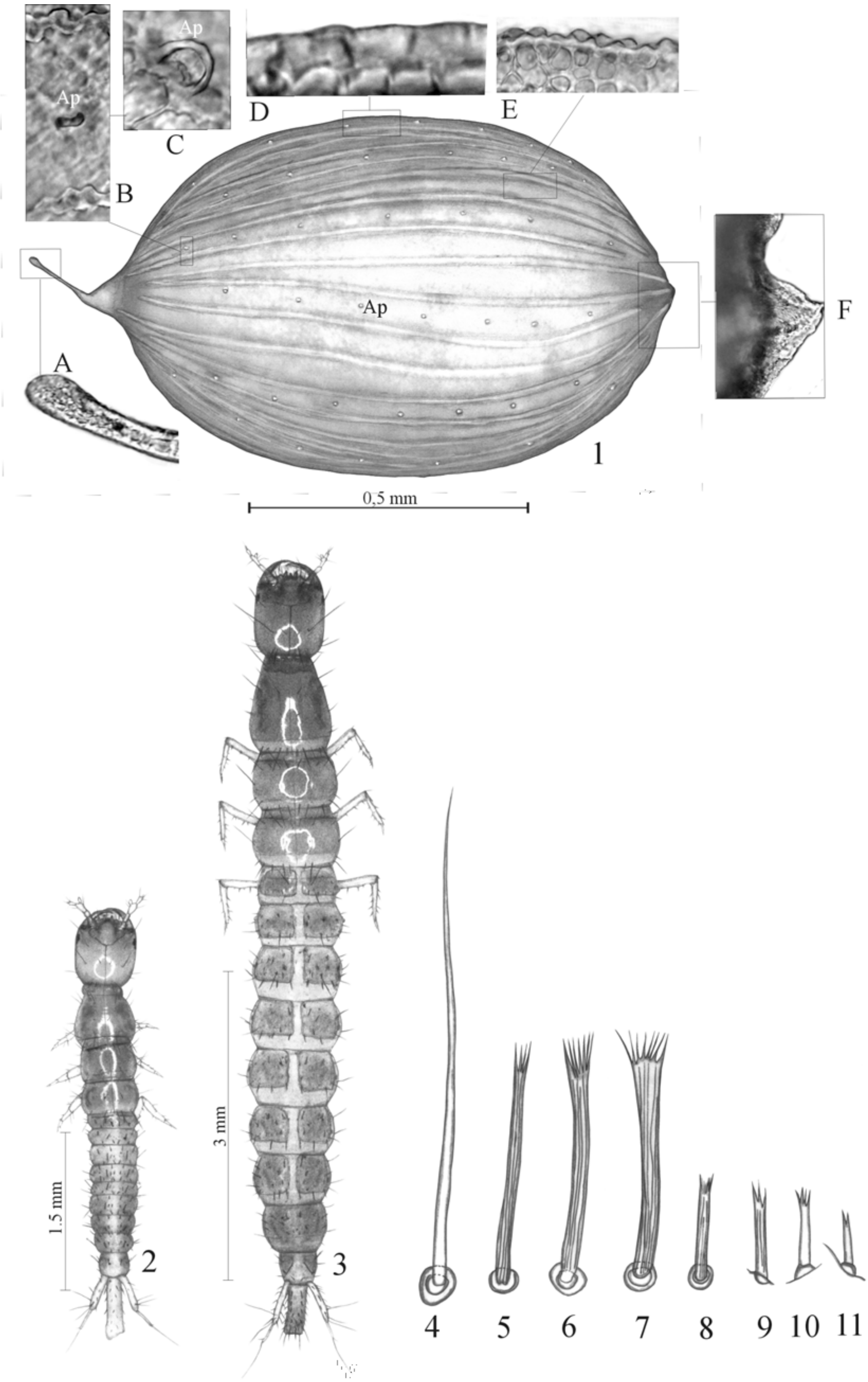
Before pupation, the mature larva constructs in the soil an oval cocoon about 5.0mm long (Fig. 43). Body length: 3.43-3.82mm (mean 3.59mm); maximal width (between hind knees): 1.51-1.72mm (mean 1.6mm); head width (between eyes): 0.73-0.82mm (mean 0.78mm); maximal width of pronotum: 0.90-1.00mm (mean 0.95mm). Colour: light yellow just after pupation, then orange with darker edges, projections on pronotum and abdomen light brown; shortly before metamorphosis pupa black except for orange pronotum. Head 1.3 times as long as wide; labrum relatively short and wide, 1.7 as wide at base as long. Antennae curved, lie on the knees of fore and middle legs, reaching almost two thirds of length of elytra (Figs 44; 45). Wings protruding beyond posterior margin of the first clearly visible abdominal sternite (Fig. 44). Pronotum 1.1 times as long as wide; anterior margin with 10-12 setiform projections (looking from ventral side 5/5, 5/6, 6/5, 6/6 projections on sides). Each fore and middle tibiae with three and seven clearly visible outlines of protuberances respectively. Hind tarsi slightly protruding posterior margin of segment IV (morphological segment VI) clearly visible abdominal segment (Fig. 44). Abdomen narrowed below segment IV (Fig. 46). Abdominal tergite I twice as long as tergite II. Segments III-VIII, each bearing a pair of setiform projections on sides (all six pairs). Setiform projections on segments III-VI short, spine-shaped, a least three times shorter than length of segments (Fig. 47); setiform projections on segments VII, VIII long, always longer than segment, with tiny processes occurring on the greater part of projections (Figs 48; 49). Microstructure of the abdominal tergite as in Figs 50-53. The first abdominal tergite with unidentified cuticular structure (Fig. 54). Abdominal tergites I-IV with tuberculate, functional spiracles (Fsp), the first pair bigger and situated more laterally than the rest, moderately protruding (Figs 45; 46; 55), tergites V-VIII with externally visible, but apparently atrophied spiracles (Asp) (Figs 45; 46; 56; 57). Terminal sternite: with well-marked sexual dimorphism (Figs 58; 59) in female with two well-developed ventral prolongations (Vp) terminal prolongation (Tp) mostly with numerous, sharp cuticular processes (Fig. 60).

2. Remarks on the ecology and biology of *Rabigus tenuis* under laboratory conditions and on its distribution

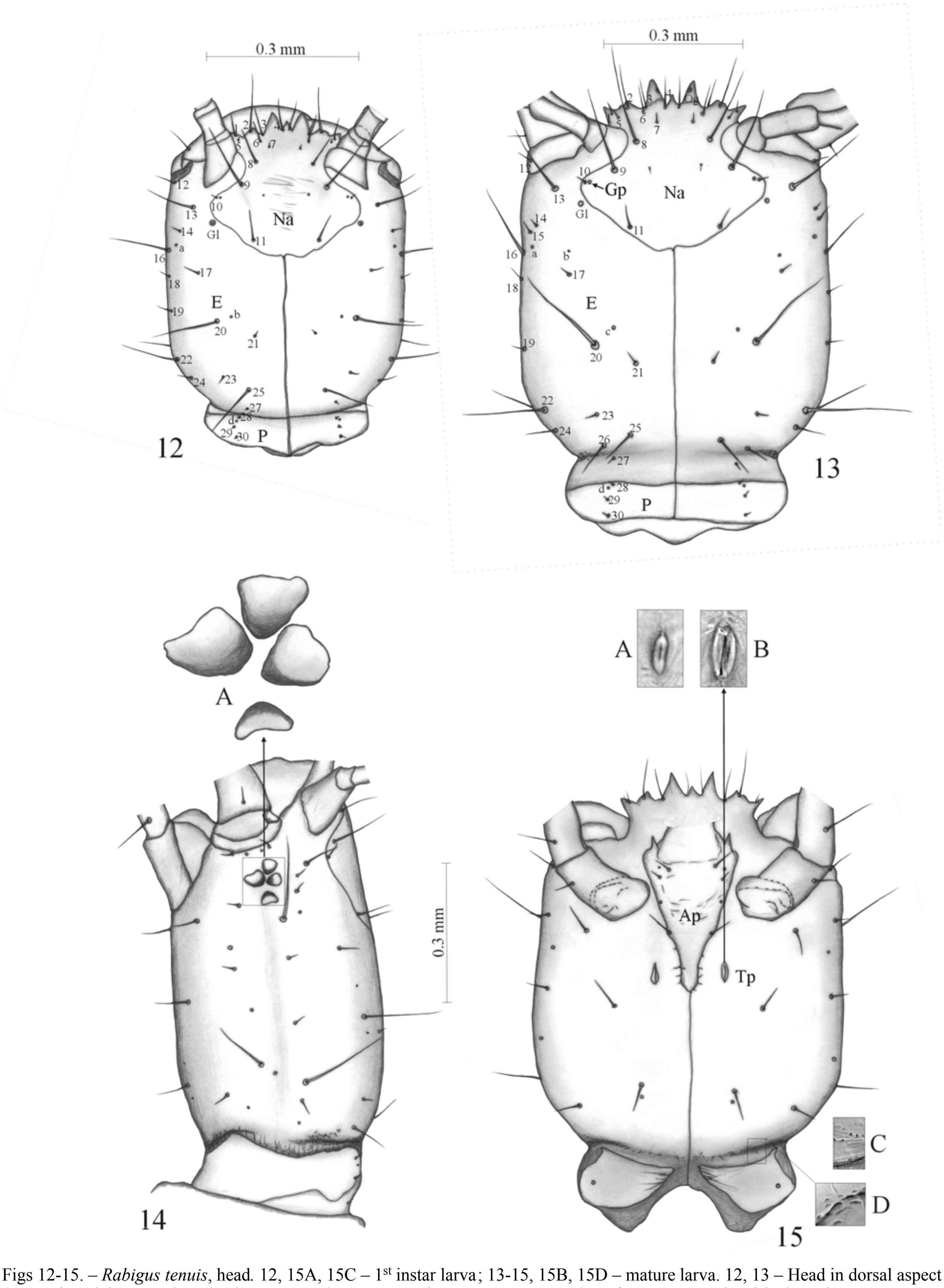
Rabigus tenuis (adult habitus and aedeagus as in Figs 61-63) is Palearctic species known from almost the entire European region, as well as from the central part of Russia (Siberian), Caucasus, Turkey, Iran, Uzbekistan, Mongolia, China and Japan. In Poland it is recorded from about twenty localities, distributed in the central and southern part of the country (Burakowski et al., 1980; Lucht, 1987; Staniec, 1991; Herman, 2001; Derunkov & Melke, 2001). It is defined as a eurytopic, psamophilous, ripicolous and phytodetriticolous species, inhabiting exposed, moist, sandy or clayey banks of rivers, streams, lakes, sunny clayey slopes and dirty roads. Under the climate of the south-eastern part of Poland *R. tenuis* distinctly prefers sunny, slightly moist places. It lives on clayey and loess soil sparsely covered by grasses or devoid of any vegetation. It also occurs very often in urban areas in exposed places, on pavement sides and in small rockeries (Burakowski et al., 1980; Koch,1989; the first author's observation).

During the rearing, conducted from the 26th of April 2006, oviposition was observed for 50 days; from April 29 to June 27 (Fig. 64; Table 1). The highest intensity of oviposition was observed in May (Fig. 64). Eggs were laid separately, distributed in the soil in a rearing container. During the reproductive period, a single female laid from one to four eggs per day, exceptionally five eggs. Six females kept in the laboratory (each kept with a male) laid a total of 605 eggs, whereas a single female laid 116, 83, 75, 128, 103, 100 eggs respectively; on average about 101 eggs per female. The embryonic development at a temperature of 24°C±3 lasted on average about six days (Table 2), the mortality rate being about 30%.

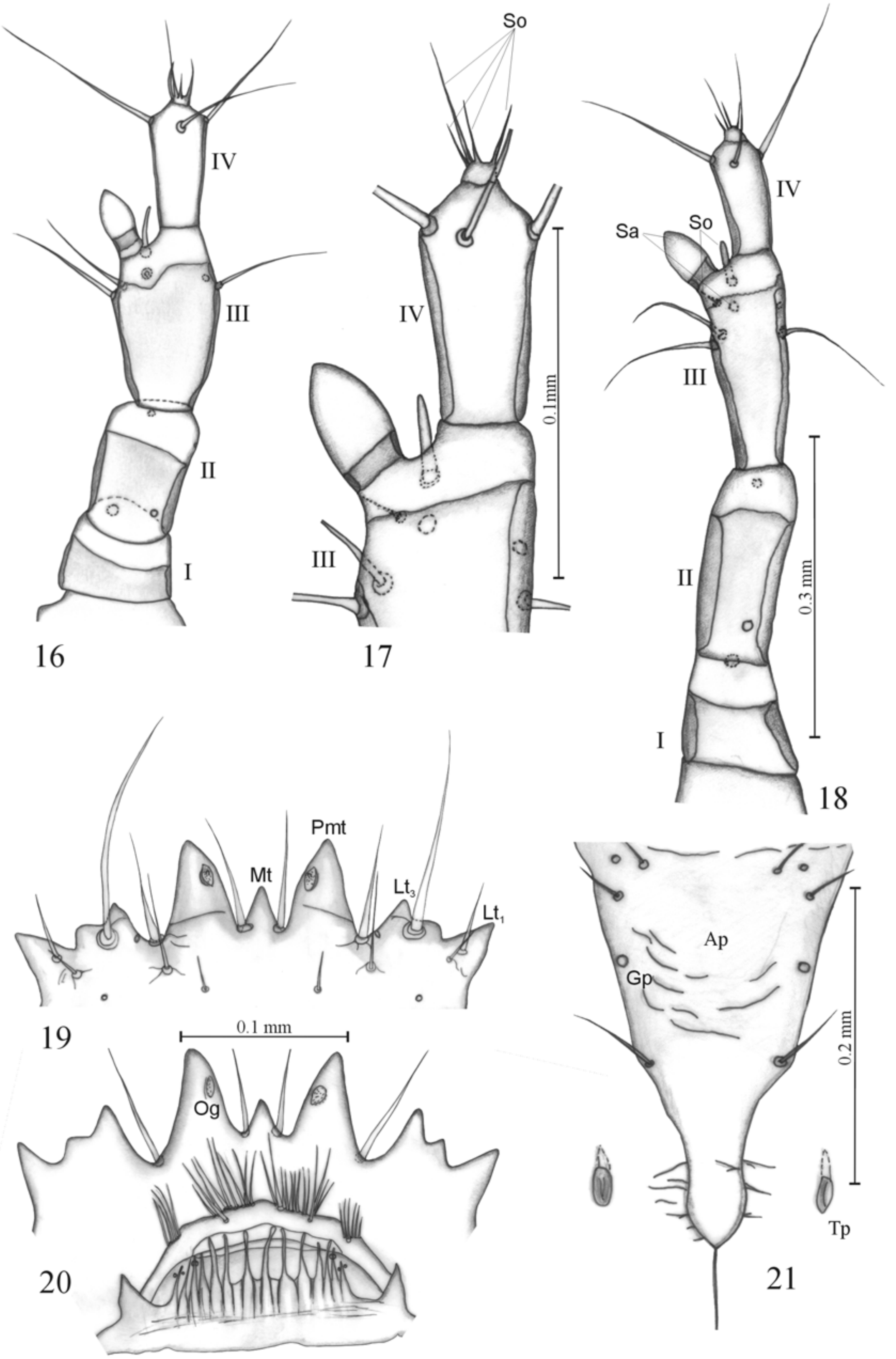
Under laboratory conditions the larvae appeared from the beginning of May until the last ten days of June (Table 1). Development of each larval instar lasted on average four to six days. The highest mortality rate among different larval instars was recorded in L_2 (Table 2). Usually shortly before pupation mature larvae (L_3) made cocoons with wet soil on the bottom of the containers, where pupation took place (Fig. 43). The prepupa and pupa are motionless stages, and lasted on average about four and seven days, respectively. Both stages showed the lowest mortality rates; for prepupa about 19%, for pupa 11.5% (Table 2). The prepupal and pupal stages were observed in the laboratory from the last ten days of May until almost the end of June. Adults of the new generation appeared from the end of May to the end of June. Under field conditions this period probably extended until the end of July, because the latest laid eggs of this species were recorded at the end of June. Out of two hundred specimens kept in the laboratory, only 23 (11.5%) completed their development from egg to adult. At a temperature of 24°C (±3), it lasted from 23 to 41 days, on average 26 days. Under laboratory conditions the last adults of the old generation lived until the ten-day period of July, with females generally living longer than males (Table 1).



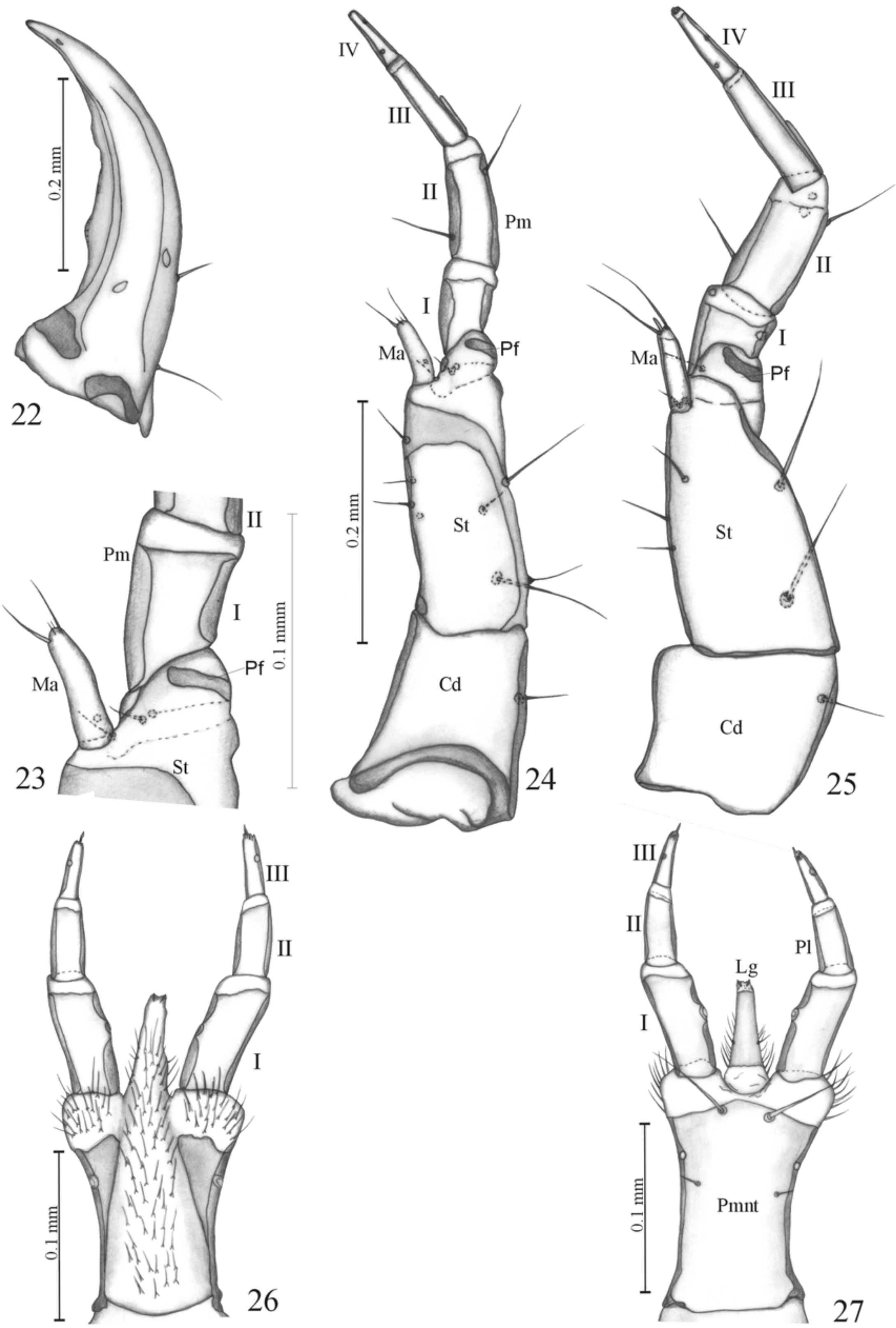
Figs 1-11. – *Rabigus tenuis.* 1, 1A-F – Egg; 2 – 1st larval instar; 3, 4-11 – mature larva. 1 – General view with aeropyles (Ap); 1A – distal end clubbed of posterior projection; 1B-E – microstructure with aeropyles (Ap); 1F – anterior pole; 2 – general view; 3 – general view; 4 – simple macro seta of pronotum; 5-10 – rod-shaped and frayed apically macro seta of abdominal tergite: I (5), IV (6), VI (7), X (8) and urogomphus (9-11).



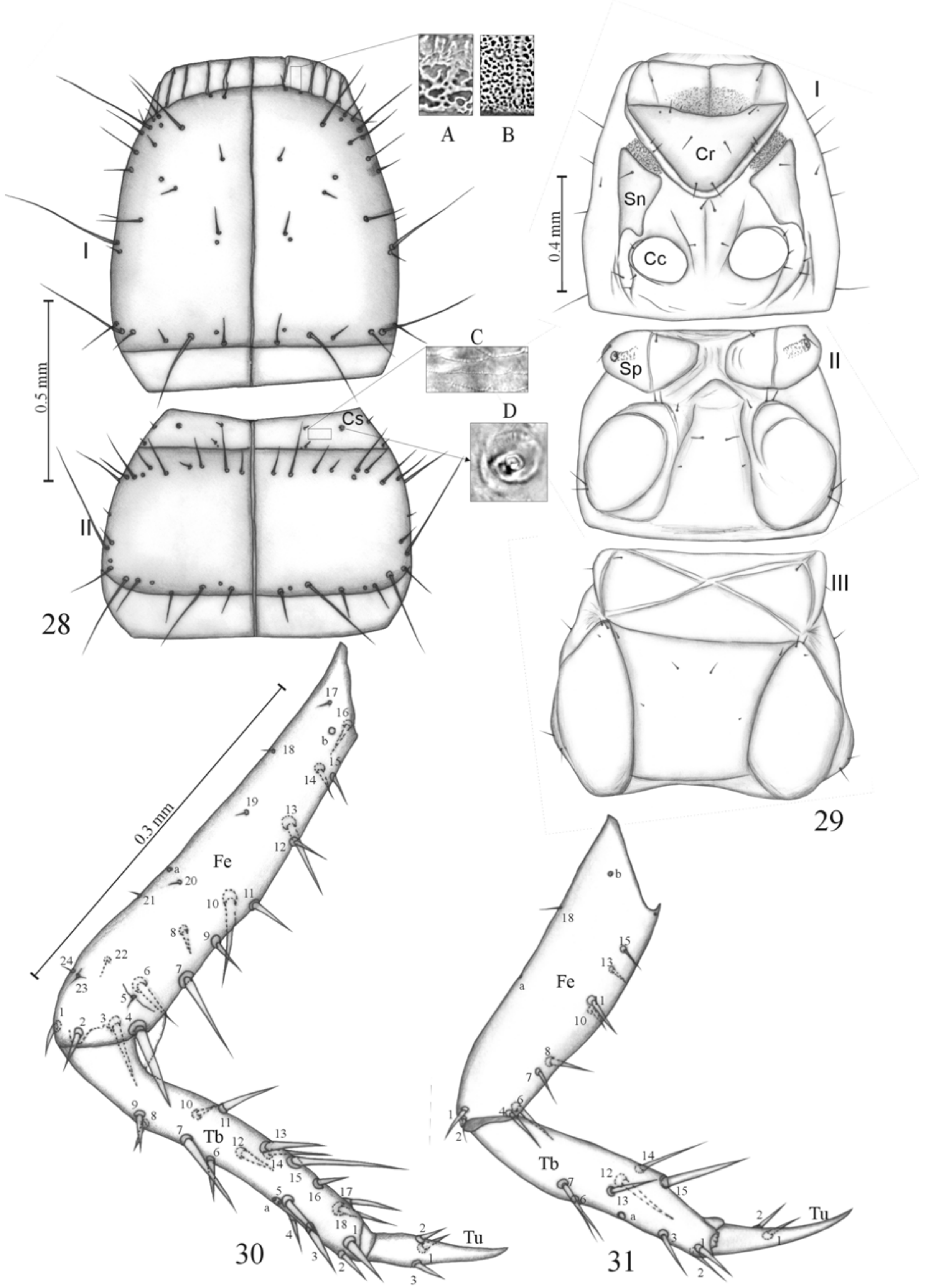
Figs 12-15. – *Rabigus tenuis*, head. 12, 15A, 15C – 1st instar larva; 13-15, 15B, 15D – mature larva. 12, 13 – Head in dorsal aspect (E – epicranial part, Gl – gland, Na – nasale, P – posterior part, 1, 2... – codes of setae); 14 – head in lateral aspect; 14A – stemmata; 15 – head in ventral aspect (Ap – apotome, Tp – tentorial pit); 15A, 15B - tentorial pit; 15C, 15D – microstructure of head.



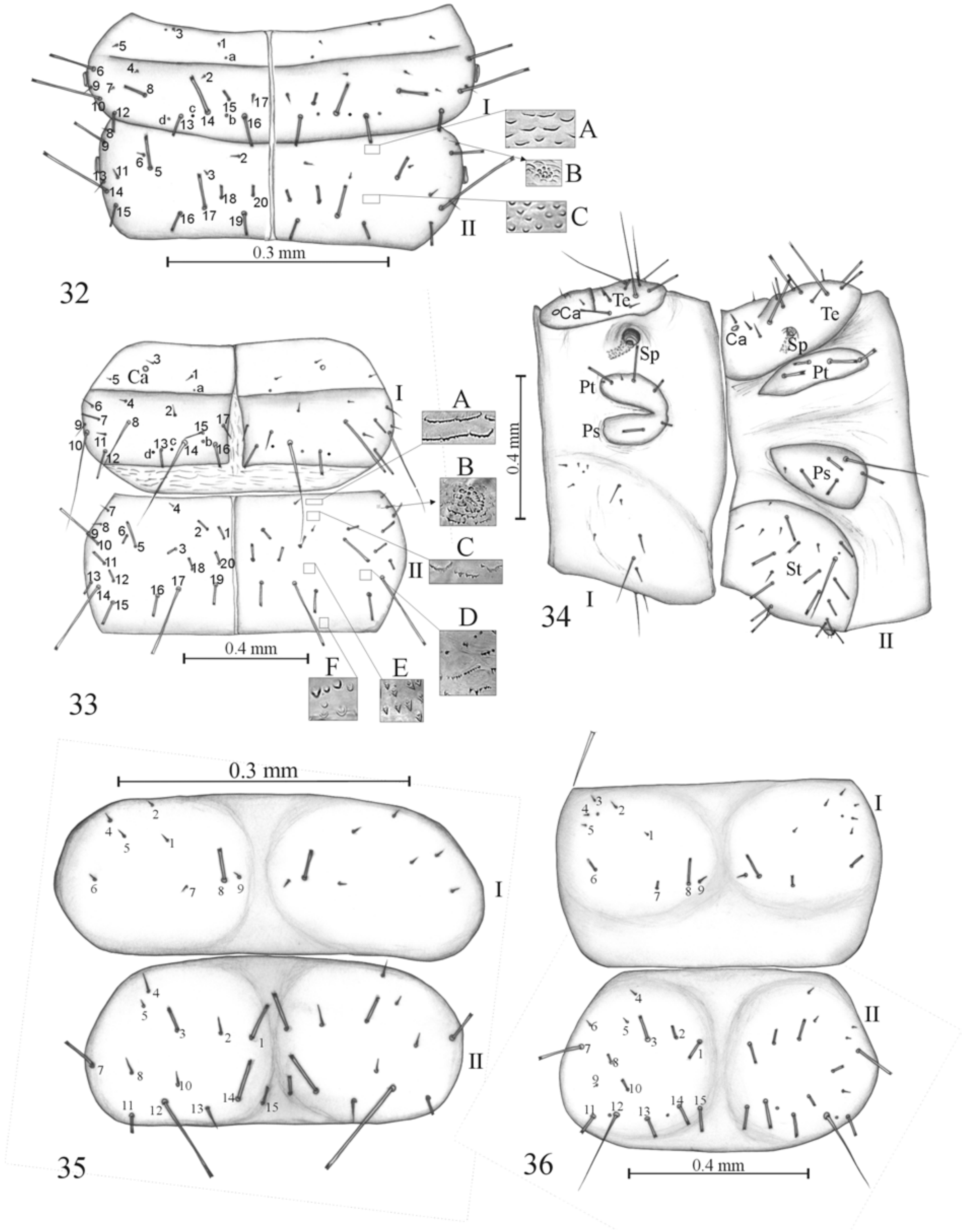
Figs 16-21. – *Rabigus tenuis*. 16 – 1st instar larva; 17-21 – mature larva. 16, 18 – Right antenna in dorsal aspect (I-IV – antennal segments); 17 – apical part of right antenna in dorsal aspect (Sa – sensory appendages, So – solenidia, III and IV – antennal segments); 19 – anterior part of nasale in dorsal aspect (Mt – median tooth, Pmt – paramedian tooth); 20 – epipharynx (Og – olfactory organ); 21 – apotome (Ap) and tentorial pits (Tp) (Gp - glandular pit).



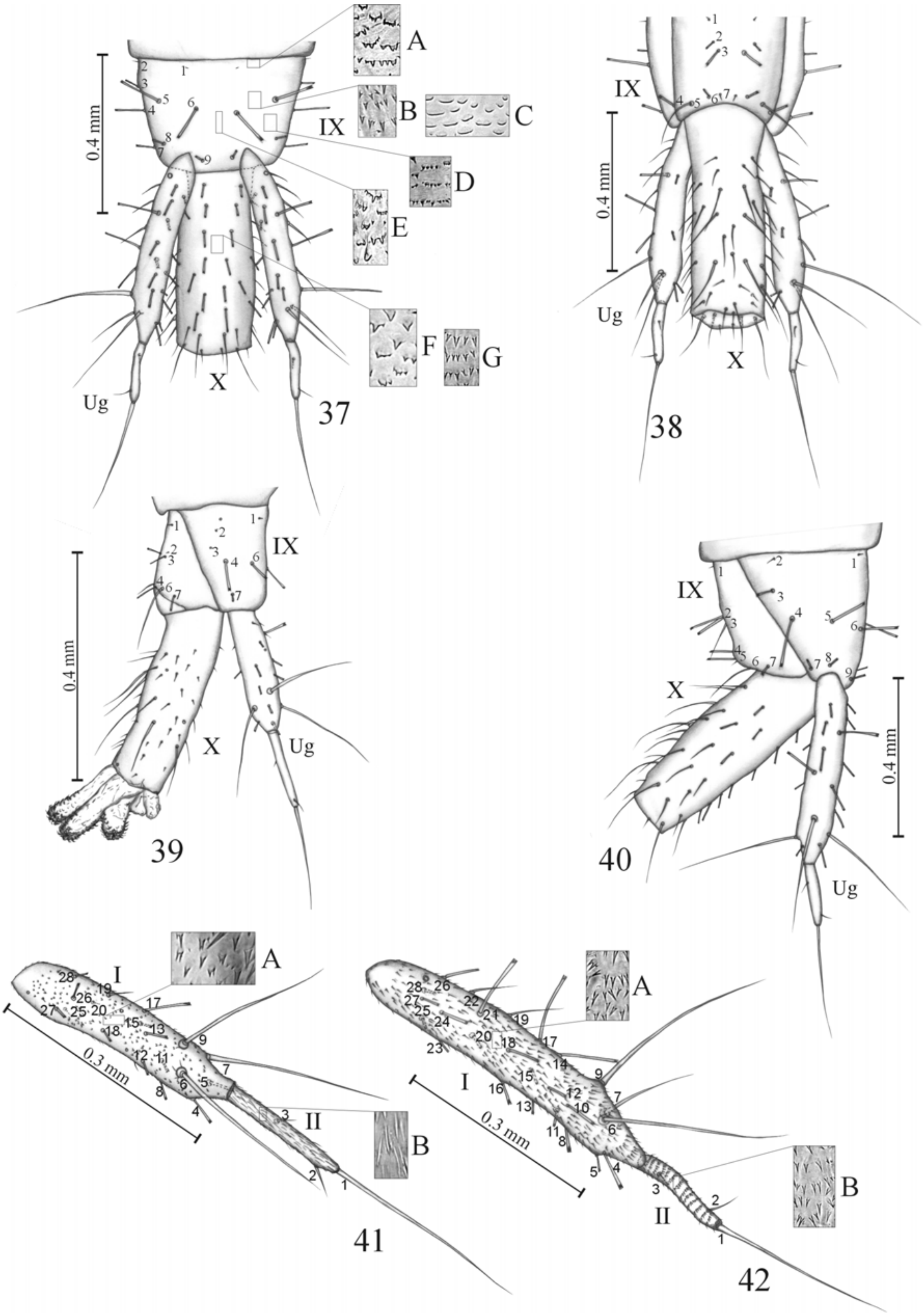
Figs 22-27. – *Rabigus tenuis*. 25 - 1st instar larva; 22-24, 26, 27 – mature larva. 22 – Right mandible in dorsal aspect; 23 - anterior part of stipes in dorsal aspect (Ma – mala, Pf – palpifer, Pm – maxillary palp, St – stipes); 24, 25 – right maxilla in dorsal aspect (Cd – cardo, Ma – mala, Pf – palpifer, Pm – maxillary palp, St – stipes); 26 - hypopharynx (I-III – segments of labial palp); 27 - labium in ventral aspect (Lg – ligula, Pl - labial palp, Pmnt – prementum, I-III – segments of labial palp).



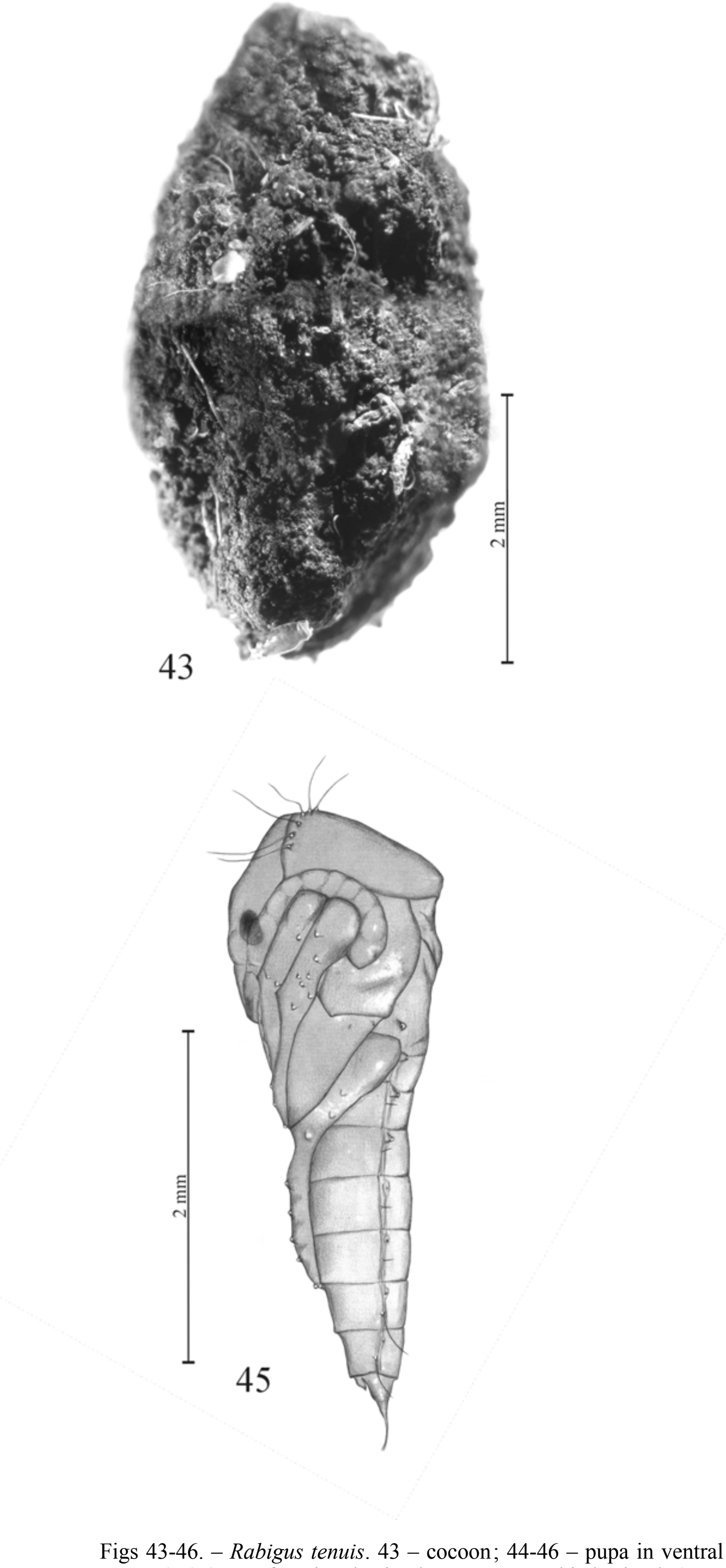
Figs 28-31. – *Rabigus tenuis*. 31 – 1st instar larva; 28-30 - mature larva. 28 - Prothorax (I) and mesothorax (II) in dorsal aspect (Cs – coeloconic sensillum); 29 – prothorax (I), mesothorax (II) and metathorax (III) in ventral aspect (Cr – cervicosternum, Sn – sternite, Cc – coxal cavity, Sp - spiracles); 30, 31 – fore leg in anterior aspect (a, b – codes of pores, Fe – femur, Tb – tibia, Tu – tarsungulus, 1, 2, … – codes of setae).



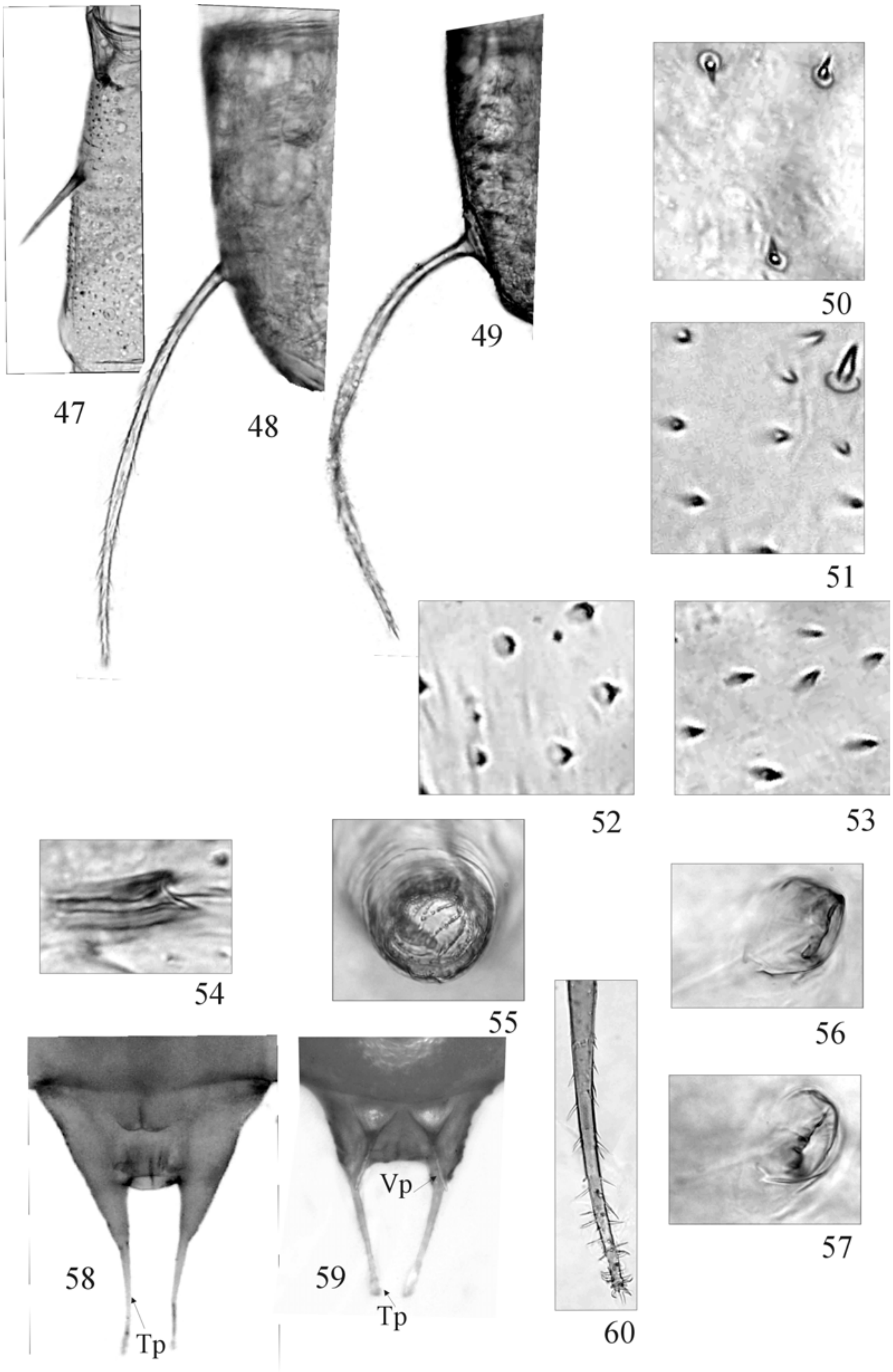
Figs 32-36. – *Rabigus tenuis*. 32, 32 A-C, 35 – 1st instar larva; 33, 33 A-F, 34, 36 – mature larva. 32, 33 – Abdominal tergites I and II (a, b … – codes of pores, Ca – coeloconic sensilla, 1, 2… – codes of setae); 32 A, C - microstructure of abdominal tergite II; 32 B – sensilla; 33 A, C, D-F - microstructure of abdominal tergite II; 33 C – sensilla; 34 – abdominal segments I and II in lateral aspect (Ca – coeloconic sensilla, Ps – parasternite, Pt – paratergite, Sp – spiracle, St – sternite, Te – tergite, 1, 2… – code of setae); 35, 36 – abdominal sternite I and II (1, 2… – codes of setae).



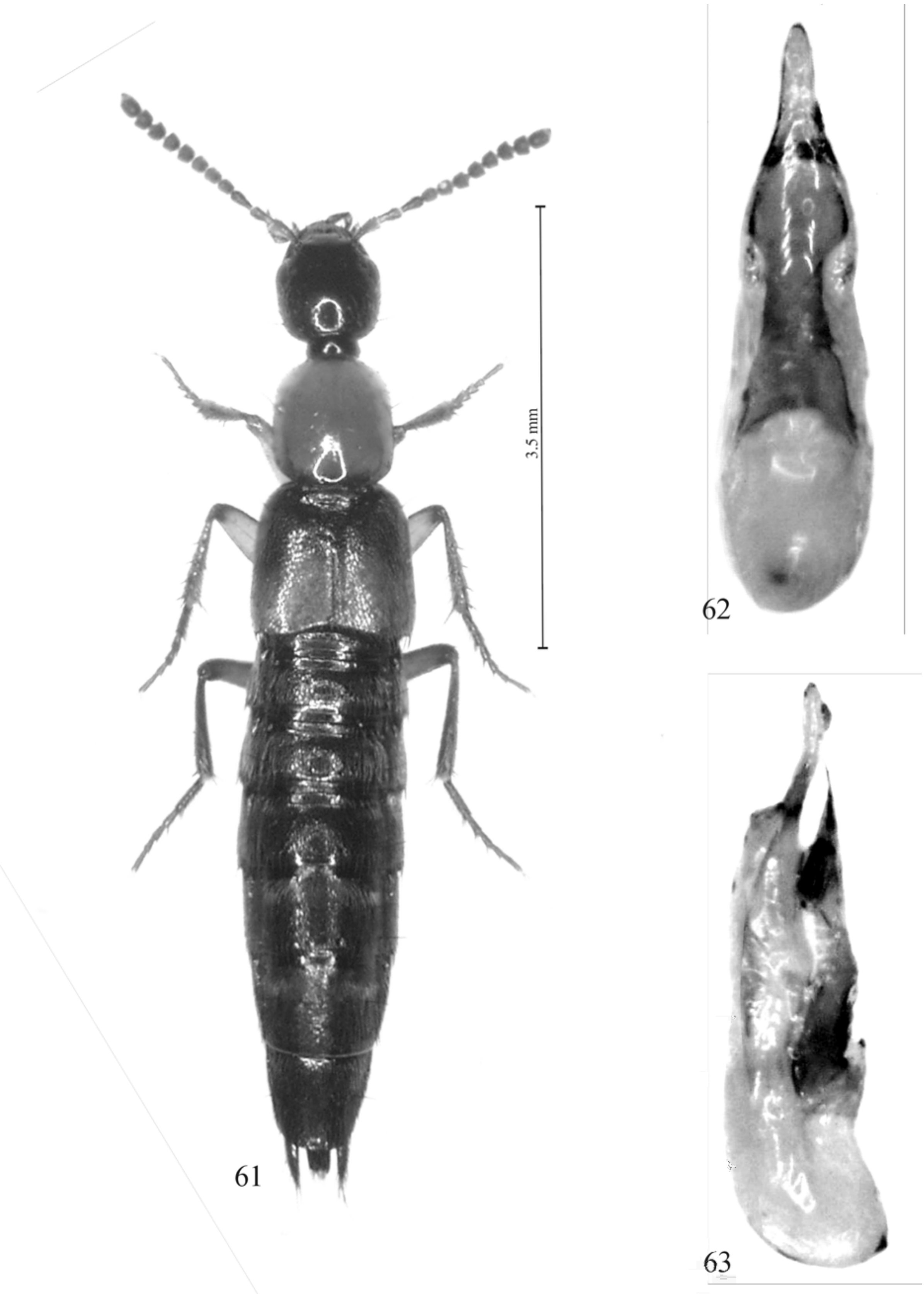
Figs 37-42. – *Rabigus tenuis*. 39, 37C, 37G, 41, 41A, 41B – 1st instar larva; 37, 37A, 37B, 37D-F, 38, 40, 42, 42A, 42B – mature larva. 37, 38 – Abdominal segment IX and X in dorsal aspect (37) and ventral aspect (38) (Ug – urogomphus); 37A-E – microstructure of abdominal segment IX; 37F-G – microstructure of abdominal segment X; 39, 40 – abdominal segment IX and X in lateral aspect (Ug – urogomphus, 1, 2… – codes of setae); 41, 42 – right urogomphus in dorsal aspect (I, II – segments of urogomphus, 1, 2… – codes of setae), 41A, 42A – microstructure of urogomphus of segment I; 41B, 42B – microstructure of urogomphus of segment II.



Figs 43-46. – *Rabigus tenuis*. 43 – cocoon; 44-46 – pupa in ventral aspect (44), lateral aspect (45), dorsal aspect (46) (Fsp – functional spiracles, Asp – atrophied spiracles).



Figs 47-60. – *Rabigus tenuis*, pupa. 47-49 – Lateral margin with setiform projection of abdominal segment III (47), VII (48) and VIII (49); 50–53 – microstructure of the abdomen: central part of abdominal tergite III (50), anterior part of tergite IV (51), tergite V (52), tergite VII (53); 54 – lateral cuticular structure of the first abdominal tergite; 55 – spiracles functional; 56, 57 – spiracles atrophied; 58, 59 – terminal sternite of male (58) and female (59) (Tp – terminal prolongation, Vp – ventral prolongation); 60 – terminal prolongation.



Figs 61-63. – *Rabigus tenuis*, adult. 61 – Habitus; 62, 63 – aedeagus in ventral aspect (62) and lateral aspect (63).

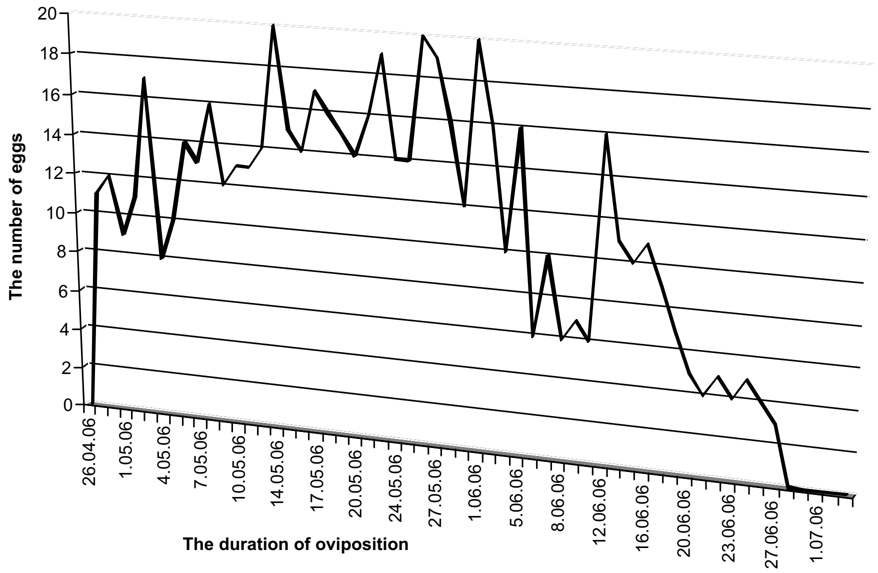


Fig. 64. – The intensity of oviposition of 6 females of *Rabigus tenuis* (at temperature of 24ºC±3).

TABLE 1

Occurrence in the rearing of the different developmental stages of *Rabigus tenuis* at the daily temperature of 24ºC (±3) ($L_{1\text{-}2}$ larval instars, ?=possibility occurrence, ^{NG}=new generation, ^{OG}=old generation).

Egg																		
L_1									?	?								
L_2									?	?								
L_3										?	?							
Prepupa										?	?	?						
Pupa										?	?	?						
^{NG}Adult										?	?	?	?					
^{OG}Adult	?	?																
Decade	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Month	**IV**			**V**			**VI**			**VII**			**VIII**			**IX**		

TABLE 2

Duration of immature stages of *Rabigus tenuis* at the daily temperature of 24ºC ±3) (N=number of specimens).

Duration (days)				
Stages	**Range of duration**	**Mean**	**Mortality (%)**	**N**
Egg	2-12	6	29.5	200
L_1	3-10	5.2	35.5	141
L_2	3-8	5.6	42.9	91
L_3	3-8	4.3	38.5	52
Prepupa	2-5	3.5	18.8	32
Pupa	5-9	6.7	11.5	26
Completed development	**23-41**	**26**	**88.5**	**23**

TABLE 3

The morphological differences between L_1 and L_3 of *Rabigus tenuis* (Fe=profemur, Tb=protibia, Tu=protarsungulus; Nrs=number of setae, Nrl=number of solenidium; (*1, 2,…*)=codes of lacking setae; Micr=microstructure; measurements in mm)

Character	L_1	L_3	Figure
	Head		
Width	0.46-0.48	0.65-0.68	-
Length	0.58-0.64	0.83-0.90	-
Colour	yellowish-brown	brown	-
Ratio length to width of head	1.3	1.2	12, 13
Nrs: dorsal side-epicranial part (E)	28 (*15, 26*)	32	12, 13
Length ratio of antennal segments: I:II:III:IV respectively	1:2.2:3:2.1	1.0:1.9:2.1:1.1	16, 18
Ratio width (y) to length (x) of antennal segment I	y/x 1.8 x	y/x 1.1x	16, 18
Ratio length to width of antennal segment II	1.5 x	2.3x	16, 18
Ratio length to width of antennal segment III	1.8 x	2.5x	16, 18
Nrl: antennal segment III	1	2	16, 18
Ratio length to width of cardo	1.1 x	1.3x	24, 25
Ratio length to width of stipes	2.1 x	2.8x	24, 25
Length ratio of cardo and stipes	1:1.9	1:1.5	24, 25
Length ratio of maxillary palp of segments: I:II:III:IV respectively	1.1:1.6:1.5:1	1.5:1.9:1.7:1	24, 25
Nrs: stipes	5	7	23, 24, 25
Length ratio of mala and segment I of maxillary palp	1:1.1	1:1.4	23, 24, 25
Ratio length to width of segment I of maxillary palp	1.2	1.8	24, 25
Ratio length to width of segment II of maxillary palp	2.1	2.4	24, 25
	Thorax		
Width of pronotum	0.44-0.45	0.69-0.79	-
Nrs: Fe, Tb, Tu respectively	11 (*3,5,9,12,14,16,17,19-24),* 9 (*4,5,8-11,16-18)*, 2 (*3*)	24, 18, 3	30, 31
	Abdomen		
Colour of terigite	colourless	grey-white	-
Colour of sternite	colourless	yellowish-white	-
Nrs: terigite I	32 *(11)*	34	32, 33
Nrs: tergites II-VIII	30 *(1, 4, 7, 10, 12)*	40	32, 33
Nrs: sternite I	16 *(3)*	18	35, 36
Nrs: sternites II-VIII	26 *(6, 9)*	30-32	35, 36
Nrs: tergite IX	12 *(5, 8, 9)*	18	37, 39, 40
Nrs: sternite IX	12 *(5)*	14	38, 39, 40
Nrs: urogomphus I	18 *(10, 14, 16, 21-24)*	25	41, 42
Length ratio of urogomphus segment I, II and apical seta	1.8:1:1.6	3.5:1:2.0	41, 42
Micr: abdominal tergites I-IX	-	-	32A,C, 33A,C-F, 37A-E,
Micr: abdominal tergite X	-	-	37F, 37G
Micr: urogomphus	-	-	41A, 41B, 42A, 42B

DISCUSSION

On the basis of their morphology, the eggs of 40 Central European species of Staphylininae Latreille, 1802, have been categorized into nine groups (Staniec & Pietrykowska-Tudruj (2007b). Following this classification, eggs of *R. tenius* were included into the *Philonthus atratus* group, which comprises such species as: *Philonthus atratus* (Gravenhorst, 1802), *P. corvinus* Erichson, 1839, *P. lepidus* (Gravenhorst, 1802), *P. micans* (Gravenhorst, 1802), *P. punctus* (Gravenhorst, 1802), and *P. rubripennis* Stephens, 1832. Morphological characters that distinguish the egg of *R. tenius* from the eggs of species mentioned above cover a) the number of nonbranched longitudinal ridges 35; b) aeropyles between longitudinal ridges in 10 rows each of 6-8 aeropyles; c) moderately widened end of posterior projection (this feature is shared with *P. atratus*, *P. corvinus* and *P. lepidus*); d) ratio of the length of egg to the length of its posterior projection 2.8-5.6:1.0; e) length: 0.90-1.04mm, similar to the size of the egg of *P. rubripennis* 0.98-1.10mm.

The morphological differences between L_1 and L_3 of *R. tenuis* are listed in Table 3.

Out of 63 genera representing the subtribe Philonthina Kirby, 1837 in the world, only the morphology of the larval stages of species belonging to a few genera are known so far (HERMAN, 2001). Morphological characters distinguishing the mature larva of *Rabigus* from the other described larvae of the subtribe Philonthina (POTOTSKAYA, 1967; KASULE, 1970; JAMES et al., 1971; TOPP, 1978; BOLLER, 1983; SCHMIDT, 1994; SCHMIDT, 1996; STANIEC, 2004; CHANI-POSSE, 2006) are as follows: 1) body length: 6.10-7.10mm, head width: 0.65-0.68mm; 2) head about 1.2 times as long as wide, almost parallel-sided; 3) each side of head with four stemmata in the cluster; 4) apotome slightly extending beyond tentorial pits; 5) length ratio of anntenal segments I-IV 1.0:1.9:2.1:1.1 respectively; 6) sensory appendage of anntenal segment III almost half as long as segment IV; 7) anterior margin of nasale with nine teeth, paramedian teeth about 2.1 times as long as median tooth; 8) epipharynx with four bunches of straight, long hairs each and 14 cuticular processes posteriorly (Fig. 20); 9) length ratio of segments I-IV of maxillary palp: 1.5:1.9:1.7:1.0 respectively; 10) length ratio of mala and segment I of maxillary palp: 1:1.4; 11) length ratio of segments I-III of labial palps 2.1:1.4:1.0 respectively; 12) ligula setose, 2.5 times as long as wide at base; almost as wide as segment I of labial palp at the base, almost as long as segment I of labial palp; 13) mandible (Fig. 22) with uneven inner margin, without serrations; 14) tibial comb absent; 15) tarsungulus with three setae; 16) segment IX with pair of two-segmented urogomphi; 17) length ratio of pygopod and urogomphi (excluding apical seta) 1:1.2; 18) length ratio of segments I and II of urogomphus and apical seta 3.5:1:2.0 respectively; 19) most setae on abdominal segments and urogomphi rod-shaped and frayed apically; 20) microstructure of urogomphi as in Figs 42A; B.

Comparison of the morphological characters of the larval genera of *Rabigus* and the other genera of the subtribe Philonthina reveals that the mature larva of *R. tenuis* shares the majority of generic characters with those of the genus *Philonthus* (KRANEBITTER & SCHATZ, 2002; PIETRYKOWSKA-TUDRUJ & STANIEC, 2006; STANIEC & PIETRYKOWSKA-TUDRUJ, 2007a; CHANI-POSSE, 2006). The only character that distinguishes the larva of *R. tenuis* from the known larvae of the genus *Philonthus* is the shape of the anterior margin of nasale: *R. tenuis* third lateral teeth (Lt_3) shorter than the first lateral teeth (Lt_1); *Philonthus aerosus* Kiesenwetter, 1851, *P. punctus* (Gravenhorst, 1802) and *P. rubripennis* (Stephens, 1832) third lateral teeth (Lt_3) longer than the first lateral teeth (Lt_1). However, we can assume that the shape of nasale and the length of tooth is a variable character within the genus. In order to confirm this hypothesis it is necessary to perform additional morphological studies of other species of *Philonthus* and *Rabigus*. Generally, as far as is known now, larval data do not support a separate generic status of *Rabigus*.

The morphology of the pupa for members of the genus *Rabigus* had never been studied up to now. The state of knowledge of Philonthina pupae is negligible, as is the case with the larvae. The pupae of species belonging to only nine genera have been described so far (SZUJECKI, 1965; JAMES et al., 1971; SCHMIDT, 1994; SCHMIDT, 1996; STANIEC, 2001; 2002; 2003; 2004; STANIEC & KITOWSKI, 2004; STANIEC & PIETRYKOWSKA, 2005; STANIEC & PIETRYKOWSKA-TUDRUJ, 2007a). Of these, the descriptions of pupae of three genera: *Belonuchus*, *Cafius* and *Remus*, are too superficial and inaccurate to be included in the comparative analysis on the generic level. Therefore, we compared these stages of *R. tenuis* with those of species of closely related genera: *Bisnius* Stephens, 1829, *Erichsonius* Fauvel, 1874, *Gabrius* Stephens, 1829, *Hesperus* Fauvel, 1874, *Neobisnius* Ganglbauer, 1895 and *Philonthus*. The pupa of *R. tenuis* can be separated from known pupae of Philonthina by the following features: a) cocoon; b) hind tarsi slightly protruding over posterior margin of segment IV (morphological segment VI) clearly visible abdominal segment; c) six pairs of setiform projections on abdomen (four short and two long); d) 10-12 number of setiform projections on pronotum; e) antennae reaching almost two thirds of length of elytra; e) the structure of the atrophied spiracles; f) body length 3.43-3.82mm; g) pronotum 1.1 times as long as wide.

One of the above-mentioned characters i.e. the length of hind tarsi protruding over posterior margin of VI morphological abdominal segment, was not observed in any hitherto described species. In view of the current state of knowledge of the pupae, we can consider it as a feature of *Rabigus* at the genus level. The presence of a cocoon is a common feature of *Rabigus* and *Gabrius*. However, we should notice its shape in two genera. The cocoon in *R. tenuis* is oval, while in *Gabrius splendidulus* (Gravenhorst, 1802) it is more roundish. However, in order to find whether the length of hind tarsi and the cocoon shape is a stable character within genera, the pupae of other species of *Rabigus*, *Gabrius* as well as other genera should be studied. Generally, the pupa of *Rabigus* is the most similar in morphology to the pupa of *Philonthus* (STANIEC & PIETRYKOWSKA-TUDRUJ, 2007a).

ACKNOWLEDGEMENTS

We wish to thank Alexey Solodovnikov for specific recommendations and the English language correction and two anonymous reviewers for reviewing the manuscript and providing very useful comments.

REFERENCES

BOLLER F (1983). Zur Larvalmorphologie der Gattung *Philonthus* Curtis (Coleoptera, Staphylinidae). Spixiana, 6:113-131.

Burakowski B, Mroczkowski M & Stefańska J (1980). Chrząszcze Coleoptera – Kusakowate Staphylinidae. część 2, Katalog Fauny Polski, XXIII, Warszawa, 7:1-272.

Chani-Posse MR (2006). Larval morphology and chaetotaxy of *Philonthus* Stephens (Coleoptera: Staphylinidae) based on descriptions of eight species from Argentina. Annales Zoologici, 56:7-28.

Derunkov AV & Melke A (2001). Staphylinidae bez Micropeplinae i Pselaphinae. In: Gutowski JM & Jaroszewicz (eds), Katalog Fauny Puszczy Białowieskiej, IBL, Warszawa: 133-147.

Herman LH (2001). Catalog of the Staphylinidae (Insecta: Coleoptera) 1758 to the end of the second Millennium. VI. Staphylininae group (Part 3). Bulletin of the American Museum of Natural History, 265:3021-3839.

Hinton HE (1981). Biology of insects eggs. Vol. 2. Pergamon Press, Oxford New York Toronto Sydney Paris Fankfurt.

James GJ, Moore J & Legner EF (1971). The larval and pupal stages of four species of *Cafius* (Coleoptera: Staphylinidae) with notes on their biology and ecology. Transactions on the San Diego Society of Natural History, 16:279-290.

Kasule FK (1970). The larvae of Paederinae and Staphylinidae (Coleoptera: Staphylinidae) with keys to the known British genera. Transactions of the Royal Entomological Society of London, 122:49-80.

Koch K (1989). Die Käfer Mitteleuropas, Ökologie. Goecke & Evers Verlag, Krefeld.

Kranebitter P & Schatz I (2002). The larval instars of *Philonthus aerosus* Kiesenwetter (subgenus Kenonthus Coiffait) from the central Alps (Tyrol, Austria) with a comparison of the known species of the genus (Coleoptera, Staphylinidae). Entomologische Blätter, 98:61-74.

Lohse GA & Lucht WH (1989). Die Käfer Mitteleuropas. 1. Supplementband mit Katalogteil. Goecke & Evers Verlag, Krefeld.

Lucht WH (1987). Die Käfer Mitteleuropas, Katalog. Goecke & Evers Verlag, Krefeld.

Paulian R (1941). Les premiers états des Staphylinoides (Coleoptera) étude de morphologie comparée. Mémoires du Muséum National d'Histoire Naturelle, 15:1-361.

Pietrykowska-Tudruj E & Staniec B (2006). Description of the egg and larva of *Philonthus punctus* (Gravenhorst, 1802) (Coleoptera, Staphylinidae, Staphylininae). Deutsche Entomologische Zeitschrift, 53:179-192.

Pototskaya VA (1967). Opredelitel' lichinok korotkonadkrylykh zhukov evropeiskoi chasti SSSR. Academiya Nauk SSSR, Izdatel'stvo Nauka, Moskva.

Schmidt DA (1994). Notes on the biology and a description of the egg, third instar larva and pupa of *Neobisnius sobrinus* (Coleoptera: Staphylinidae). Transaction of the Nebraska Academy of Science, 21:55-51.

Schmidt DA (1996). Description of the immature of *Erichsonius alumnus* Frank and *E. pusio* (Horn) (Coleoptera: Staphylinidae). The Coleopterists Bulletin, 50:202-215.

Smetana A (1958). Fauna ČSR. Svazek 12. Drabčíkovití-Staphylinidae. I. Staphylinidae. (Řád: Brouci-Coleoptera). Československé Akademie Věd, Praha.

Smetana A (1959). Bestimmungstabelle der mitteleuropäischen Arten der Gattung *Philonthus* Curt. Sensu lato. Entomologische Blatter für Biologie und Systematik der Käfer, 54:140-175.

Solodovnikov AY (2007). Larval chaetotaxy of Coleoptera (Insecta) as a tool for evolutionary research and systematics: less confusion, more clarity. Journal of Zoological Systematics and Evolutionary Research, 45:120-127.

Solodovnikov AY & Newton A (2005). Phylogenetic placement of Arrowinini trib.n. with the subfamily Staphylininae (Coleoptera; Staphylinidae), with revision of the relict South African genus *Arrowinus* and description of its larva. Systematic Entomology, 30:3-44.

Staniec B (1991). Rzadkie Staphylinidae (Coleoptera) ze wschodniej Polski. Wiadomości entomologiczne, 10:207-213.

Staniec B (2001). A description of the pupa of *Philonthus quisquiliarius* (Gyll.) and *P. nigrita* (Grav.) (Coleoptera: Staphylinidae). Polish Journal of Entomology, 70:39-49.

Staniec B (2002). A description of the pupae of *Philonthus albipes* (Gravenhorst, 1802) and *P. varians* (Paykull, 1789) (Coleoptera: Staphylinidae: Staphylininae). Genus, 13:337-343.

Staniec B (2003). Description of the pupa of *Philonthus corvinus* Erichson, 1839, *P. micans* (Gravenhorst, 1802), and *P. punctus* (Gravenhorst, 182) (Coleoptera: Staphylinidae). Genus, 14:15-26.

Staniec B (2004). The pupae of *Ontholestes murinus* (Linnaeus, 1758), *Philonthus rectangulus* Sharp, 1874 and a supplement to the pupal morphology of *Philonthus succicola* Thomson, 1860 (Coleoptera: Staphylinidae). Genus, 15:37-46.

Staniec B & Kitowski I (2004). A description of the pupae of *Philonthus umbriatilis* (Gravenhorst, 1802), *P. lepidus* (Gravenhorst, 1802) and *Bisnius* (=*Philonthus* sensu lato) *nitidulus* (Gravenhorst, 1802) (Coleoptera: Staphylinidae). Genus, 15:47-58.

Staniec B & Pietrykowska E (2005). The pupae of *Gyrohypnus fracticornis* (Müller, 1776) and *Philonthus tenuicornis* Mulsant & Rey, 1853 (Coleoptera: Staphylinidae). Genus, 16:331-339.

Staniec B & Pietrykowska-Tudruj E (2007a). Developmental stages of *Philonthus rubripennis* Stephens, 1832 (Coleoptera, Staphylinidae, Staphylininae) with comments of its biology. Deutsche Entomologische Zeitschrift, 54:95-113.

Staniec B & Pietrykowska-Tudruj E (2007b). Comparative morphology of the eggs of the sixteen Staphylininae species (Coleoptera; Staphylinidae). Deutsche Entomologische Zeitschrift, 54:235-252.

Szujecki A (1965). Obserwacje nad rozwojem i biologią *Philonthus fuscipennis* Mann. (Coleoptera, Staphylinidae). Fragmenta Faunistica, 12:165-175.

Szujecki A (1980). Klucze do oznaczania owadów Polski, Chrząszcze – Coleoptera, cz. 24c, Kusakowate- Staphylinidae, Kusaki- Staphylininae. Państwowe Wydawnictwo Naukowe, Warszawa.

Topp W (1978). Bestimmungstabelle für die Larven der Staphylinidae. In: Klausnitzer B (ed), Ordung Coleoptera (Larven). Bestimmungsbücher zur Bodenfauna Europas, Berlin: 10:304-334.

Received: September 5, 2007
Accepted: June 4, 2008