EUROPEAN JOURNAL OF ENTOMOLOGY
ISSN (online): 1802-8829
http://www.eje.cz
Eur. J. Entomol. **120**: 105–114, 2023
doi: 10.14411/eje.2023.013
ORIGINAL ARTICLE

Immature stages of the remarkable and rare West Palaearctic rove beetle *Emus hirtus* (Coleoptera: Staphylinidae: Staphylinini) in the phylogenetic context of the subtribe Staphylinina

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Key words. Egg, larva, pupa, ecology, behaviour, characters, phylogeny, *Platydracus*-group

Abstract. Based on reared material, all the immature stages of *Emus hirtus* (Linnaeus, 1758) are described. This is an especially interesting species of rove beetle because it looks very striking, hunts dung-inhabiting insects, has a patchy distribution and is a protected species in some countries. Descriptions are supplemented by a few field and laboratory-based observations on adult and larval behaviour and development. Since the phylogeny of the diverse subtribe Staphylinina is poorly known, all available information on the immature stages of the species in this subtribe was summarized and their phylogenetic utility evaluated. Data on *Emus* and other genera with known immature stages, even though highly fragmentary, reveal a phylogenetic signal in the larval and pupal morphology. They support the *Creophilus*- *Ocypus*- and *Platydracus*-groups as lineages hitherto only based on the morphology of adults and molecular data.

INTRODUCTION

In terms of the rove beetle fauna in the West Palaearctic, *Emus hirtus* (Linnaeus, 1758) is a striking, large and colourful coprophilous species (Fig. 1F, G). It has a patchy distribution from Europe to Middle Asia (Schillhammer, 2012) and the Altai mountains in Russia (Psarev, 2014). Usually adult *Emus hirtus* are found in open landscapes in cattle dung where they feed on *Aphodius* beetles and their larvae, *Sphaeridium* beetles and even maggots (Krawczynski et al., 2011; Biel et al., 2014; Waltrop & Emsdetten, 2016). Recently it was suggested that *Emus hirtus* should be protected in Europe because it is an endangered species (Biel et al., 2014). For example, since 2012 in Denmark *Emus hirtus* is only recorded at several scattered localities in Jutland and on a few small islands near the West Jutland coast (according to Denmark's national species portal www.naturbasen.dk). Despite being a striking beetle in Europe and even in the entire Palaearctic fauna, very little is known about its biology. For example, the only available description of its larva and pupa (Kemner, 1912) is more than a century old. Kemner's descriptions were based on larval material collected in the same habitat as adult *Emus hirtus* and reared to the pupal stage. Identification of the *Emus hirtus* larvae by Kemner (1912) was not confirmed either by rearing or a DNA test. In addition, his descriptions are outdated, albeit of a good quality even by modern standards.

Based on collecting several adults of *Emus hirtus* on the Danish island Samsø (Fig. 1A, C) and successfully rearing and documenting all the immature stages from egg to pupa, we provide their detailed description, along with notes on the species biology recorded in laboratory conditions. Apart from being valuable for the monitoring and conservation of this species, data on its biology and immature stages are important for understanding the sister group relationships of this striking species within the mega-diverse *Platydracus*-group (sensu Brunke & Smetana, 2019) of Staphylinina, which are poorly known. Therefore, a thorough comparison of all the life stages of *Emus hirtus* with those of other Staphylinina was also done in order to test hypothetical sister group of the genus *Emus* and the overall phylogenetic pattern for Staphylinina, earlier revealed by Brunke & Smetana (2019) based on the morphology of adults and molecular data.

MATERIAL AND METHODS

Rearing

Five adults (3♀, 2♂) of *Emus hirtus* were collected from pasture on May 19, 2022 (Denmark: Samsø: EJ: Følsdal Bakke, 55.9922N, 10.5515E) (Fig. 1A, C). They were brought to the laboratory alive for rearing, along with many adult *Aphodius* spp. and cow dung collected from the same pasture. *Aphodius* beetles were fed the dung and kept alive as food for *Emus hirtus*.

In the laboratory adult *Emus hirtus* were kept from May 19 to July 5, 2022 at room temperature in 3 separate plastic boxes

Fig. 1. *Emus hirtus* in nature and a laboratory. A – map showing the localities where it was collected in Denmark; B – larva collected by Mogens Frost Christensen at Rubjerg Knude in North-Western Jutland (photo by M.F. Christensen); C – locality where the authors collected adults on Samsø; D –adult hunting for *Aphodius fossor* in a pasture on Samsø (see also Video S1); E – adult with everted defence glands; F – adult in defensive position; G – adult feeding on *Aphodius fossor* in the laboratory; H – empty exoskeleton of *Aphodius fossor* remaining after it was eaten by an adult *Emus hirtus* in the laboratory; I – mating (with female eating an *Aphodius fossor*) in the laboratory.

(21.5 cm × 18 cm × 12 cm) with filter paper linings to the bottoms, which were changed every two days. Each box contained one female. Two males were placed with each female for some time during which they mated. Three *Aphodius* beetles were placed in each box every two days as food for the *Emus* adults. The hatched *Emus* larvae were fed with mealworms, which were purchased from pet shops. The containers were checked for eggs every day and each newly laid egg was placed individually in a small plastic box (11.5 cm × 8 cm × 4.5 cm) with wet filter paper, to maintain humidity. The three females laid 13 eggs, of which nine hatched, three did not hatch and one egg was destroyed by the *Emus hirtus* adult. From the nine eggs that hatched, three larvae were preserved in 70% alcohol at the first instar, two at the second instar and one at the third instar. Of the three larvae remaining, two died at the pre-pupal stage and one successfully pupated. Both dead pre-pupae and the pupa, whose development was terminated after two days, were preserved in 70% alcohol.

Photography and drawing

All the photographs of the specimens were taken using a 100 mm LAOWA macro lens attached to a Sony a7R III camera. For the habitus images of the larvae and pupa multiple images were stacked in Zerene Stacker. Adobe Illustrator CS4 was used to digitally ink details of the larval morphology based on the photographs and using a dissecting microscope LEICA M205 C.

Descriptions, terminology and abbreviations

To facilitate comparisons the descriptions followed the plan and terminology used by Pietrykowska-Tudruj & Staniec (2012) for larvae and Staniec (2004), Staniec & Pietrykowska (2005) and Staniec & Pietrykowska-Tudruj (2019) for pupae, as these authors provide the most recent, detailed and extensive descriptions of the immature stages of Staphylinidae. Mainly, the measurements and abbreviations for larvae and the pupa follow Pietrykowska-Tudruj & Staniec (2012): BL-Body length (larvae: from anterior margin of nasale to the end of pygopod, in dorsal view; pupa: from anterior margin of pronotum to the end of abdominal segment IX); HL-Head length (larvae: from anterior margin of nasale to neck; pupa: from the neck to the base of labrum); HWstem-Head width at level of stemmata; HWmax-Maximum width of head. The description of the egg is based on Hinton (1981) and Staniec & Pietrykowska-Tudruj (2007). The former author produced a key for Staphylininae eggs and in particular showed that the position and shape of the band composed of aeropyles can be used to distinguish different genera within the subtribe Staphylinina; the latter authors provide a clear description and illustrations of the chorion of an egg that varies within the Staphylininae.

RESULTS

Adult behaviour and feeding

In the pasture on Samsø in May 19 (Fig. 1C), most of the *Emus hirtus* adults were seen moving around on medium fresh patches of cow dung that were liquid inside, but with a crust perforated by other insects. Presumably they were hunting, as we observed and filmed one adult *Emus* trying to catch a large adult *Aphodius fossor* (Linnaeus, 1758) (Fig. 1D, Video S1). *Emus hirtus* bent its abdomen upwards when approached and sometimes exposed orange defensive glands (Fig. 1E, F), which, as far as we can judge, did not produce a smelly substance. All *Emus hirtus* adults were only recorded during sunny noons and never during cloudy afternoons even though a large area of the pasture and many cow pats were searched. Presumably, in cloudy conditions beetles hide under cow pats or elsewhere. Interestingly, Mogens Frost Christensen reports finding a live larva of *Emus hirtus* by a cow pat at Rubjerg Knude in North-Western Jutland on July 30, 2022 (Fig. 1A, B). The feeding of adult *Emus hirtus* was observed in the laboratory. First, it used its mandibles to cut off the head of *Aphodius fossor*, then consumed the tissue in its pronotum (Fig. 1G) and finally it cut the membrane between the thorax and abdomen and consumed the tissues in the abdomen. The entire process lasted for about 80 min, without interruption, until only the hard dung beetle exoskeleton remained (Fig. 1H).

Mating, oviposition, larval feeding and development

Before mating, *Emus hirtus* adults chased each other several times and mating lasted for about two minutes (Video S2). Once, mating occurred when a female was eating an *Aphodius* beetle (Fig. 1I). Oviposition was not observed, but some eggs (Fig. 2A–C) were laid in minute holes dug in the filter paper (Fig. 2F). In total, for three females, 1–3 eggs were found every 2–4 days from May 23 until June 11, after which no eggs were found. It took 3–5 days for an egg to hatch. During egg development, the dark coloured mandibles and overall body plan of the larvae could be observed through the egg chorion (Fig. 2D). Hatching was not observed, but the egg chorion left after hatching is depicted in Fig. 2E. A newly hatched larva had a milky white body (Fig. 2G), but then the colour of its head darkened to a chestnut colour and its thorax became brownish (Fig. 2H). Based on observations, the larvae were not interested in eating freshly killed mealworms. In contrast, when provided with a live mealworm *Emus* larvae tussled with it, killed and eventually consumed it (Fig. 2H). After 3–4 days the first instar larvae moulted to second instar and after the next 3–4 days the second instar moulted to the third instar. The duration of the third instar (based on one larva that pupated) before it entered the pre-pupal stage was 15 days (Fig. 2I). At the pre-pupal stage, a larva curled up (Fig. 2J) and after two days in that position it changed into a pupa (Fig. 2K). Duration of the pupal stage was not investigated as there was only one pupa, which after three days was preserved in alcohol for morphological examination.

Description of the egg (7 specimens, Fig. 2A–C)

Length 4.3–5.1 mm (mean 4.8 mm), width 2.9–3.2 mm (mean 3.1 mm). Shape oval, colour creamy-yellow. Chorion with several intermittent longitudinal ridges, which converge towards one pole and gradually disappear in a flat plate and at the other pole converge and form a small crescent projection. Aeropyles are arranged in a long undulating undivided band.

Description of the larva

As the character set for first and second larval instars is incomplete, a more detailed description of the third (final) instar is provided. For the first and second instar, only their difference from the third instar and from each other is described.

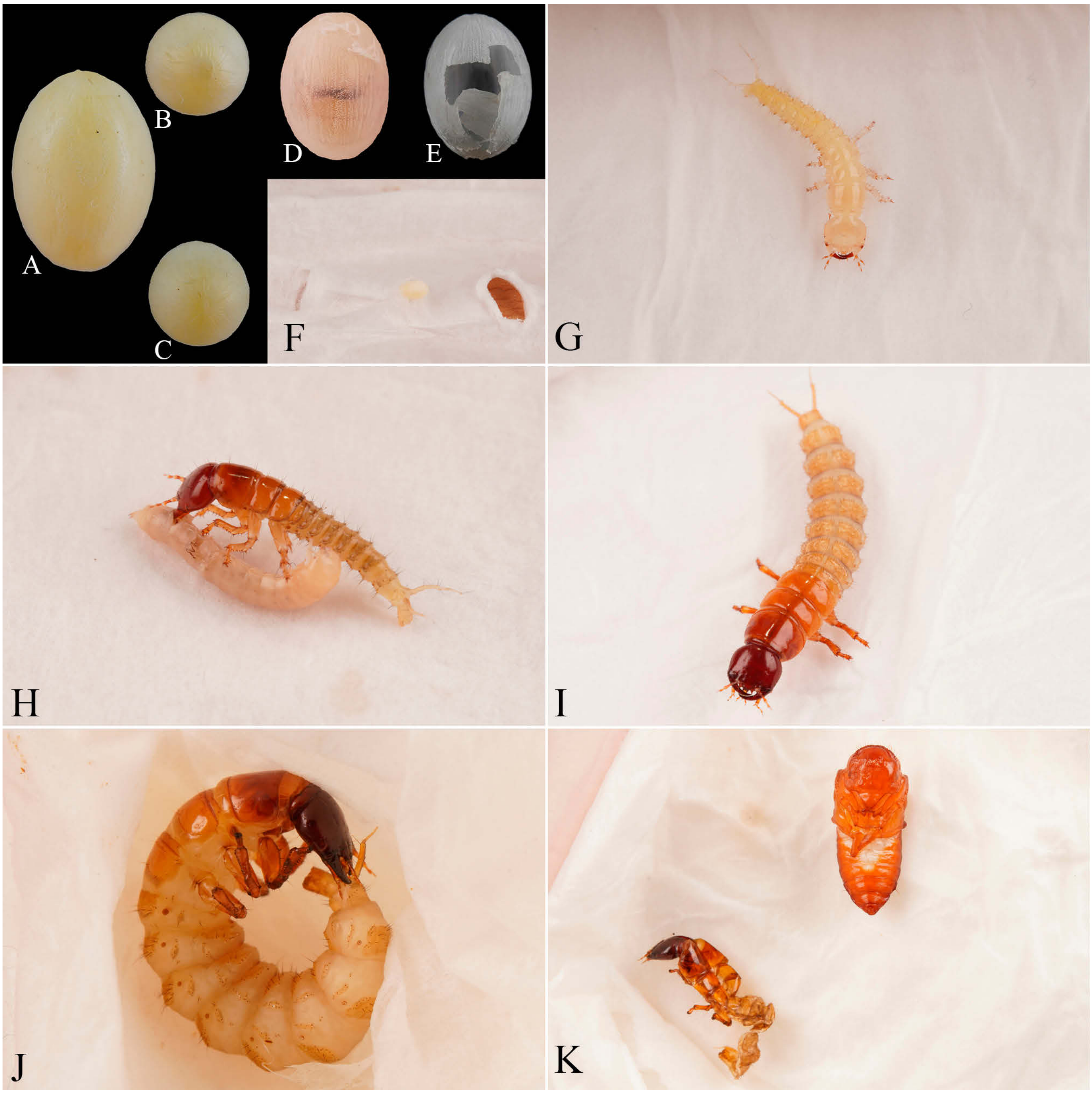

Fig. 2. Photographs of the different life stages of *Emus hirtus*. A – side view of egg; B, C – opposite poles of egg; D – egg with visible outline of a larva; E – egg after hatching; F – egg laid in the laboratory; G – freshly hatched first instar larva; H – first instar larva eating a mealworm; I – third instar larva; J – curled up pre-pupal larva; K – larval exuviae and pupa.

First instar larva (L1) (three specimens)

BL: 16.8–22.3 mm (mean 19.2 mm); HL: 2.4–2.8 mm (mean 2.6 mm); HWstem: 2.5–2.7 mm (mean 2.62); Hwmax: 2.6–2.8 mm (mean 2.72 mm). L1 (Figs 3A–C, 4A, C, E, 5A, D, G) can be distinguished from L2 and L3 as follows: it is much smaller size and paler; has fewer setae on its body sclerites than L2 and L3. Lateral margin of lateral teeth 1 (Lt1) on nasale with a small tubercle. Antennae and maxillary palps (Mp) relatively thicker than those of L2 and L3. Apotome (Ap) bell shaped and slenderer than in L2 and L3. Anterior leg length ratio of coxa : trochanter (Tr) : femur (Fe) : tibia (Tb) : tarsungulus (Tu) 2.6 : 1.9 : 2.1 : 1.4 : 0.8; anterior femur and tibia with fewer spine-like setae than in L2 and L3; tarsungulus with only two symmetrical ventral setae (as in L3 but different from L2 that also has a tiny latero-ventral seta). Abdominal segment I with two pairs of paratergites (Pt) and one pair of small parasternites (Ps) (in L2 and L3 segment I with one pair of paratergites and one pair of small parasternites). Length ratio of pygopod : urogomphi (Ug) segment I : urogomphi segment II 2.5 : 3.1 : 2.0; first segment of urogomphi longer than pygopod and curved inwards.

Second instar larva (L2) (two specimens)

BL: 19.4–24.5 mm (mean 21.95 mm); HL: 2.9–3.0 mm (mean 2.95 mm); Hwstem: 3.2 mm; Hwmax: 3.3 mm. L2

Fig. 3. Photographs of larvae and pupa of *Emus hirtus*. A–C – first instar larva: dorsal, lateral and ventral views; D–F – second instar larva: dorsal, lateral and ventral views; G–I – third instar larva: dorsal, lateral and ventral views; J–L – pupa: ventral, lateral and dorsal views. Scale = 2 mm (same scale bars for A–C, D–E, G–H and J–L).

(Figs 3D–F, 5E) is very similar to L3, but in addition to its smaller size, it also differs as follows: tarsungulus with three spine-like setae, two symmetrical ventral and one tiny latero-ventral setae. Length ratio of pygopod : urogomphi segment I : urogomphi segment II 3.0 : 3.4 : 1.5; first segment of urogomphi longer than pygopod, weakly curved inwards.

Third (last) instar larva (L3) (one specimen)

BL: 32.2 mm; HL: 3.5 mm; Hwstem: 3.5 mm; Hwmax: 3.6 mm. Colour: head dark chestnut brown; mandibles almost black; antennae, maxillae, labium, legs, mesonotum and metanotum yellowish brown; pronotum reddish brown; tergal and sternal sclerites of abdominal segments I–X and urogomphi yellowish; all setae brown. Head and thoracic segments with only simple setae, abdominal segments with simple and some frayed setae. Body elongated, abdominal segment I narrower than segment II, segments II–V of almost equal lengths, segments VI–X gradually narrowing apically. First segment of urogomphi straight from base to apex, shorter than pygopod.

Head (Figs 3G–I, 4B, 5B, C): almost as wide as long, margins moderately rounded, widest at about 2/3 along length of head; dorsal ecdysial line bifurcate before half length of head. Four stemmata almost of equal size, three of them form a row in front of the fourth. Anterior margin of nasale (Na) with 7 sharp teeth: one small middle tooth (Mt), a pair of bigger paramedian teeth (Pmt) and

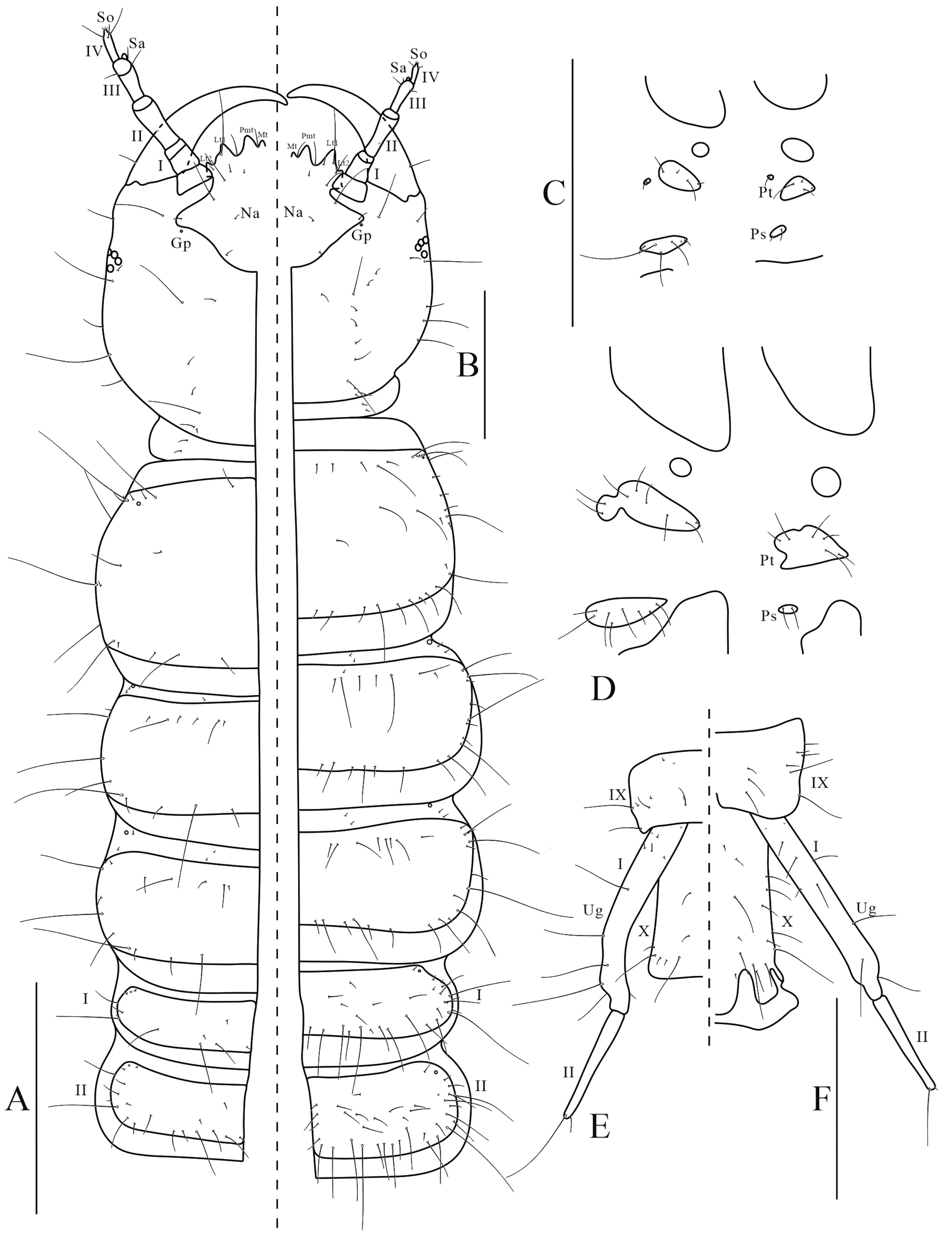

Fig. 4. Detailed morphological drawings of the first and third instar larvae of *Emus hirtus*. A – first instar head, thorax and abdominal segments I and II in dorsal view; B – third instar head, thorax and abdominal segments I and II in dorsal view; C – first instar abdominal segments I and II in lateral view; D – third instar abdominal segments I and II in lateral view; E – first instar abdominal segments IX and X and urogomphi in dorsal view; F – third instar abdominal segments IX and X and urogomphi in dorsal view. Scale = 2 mm (same scale bars for C and E, and D and F).

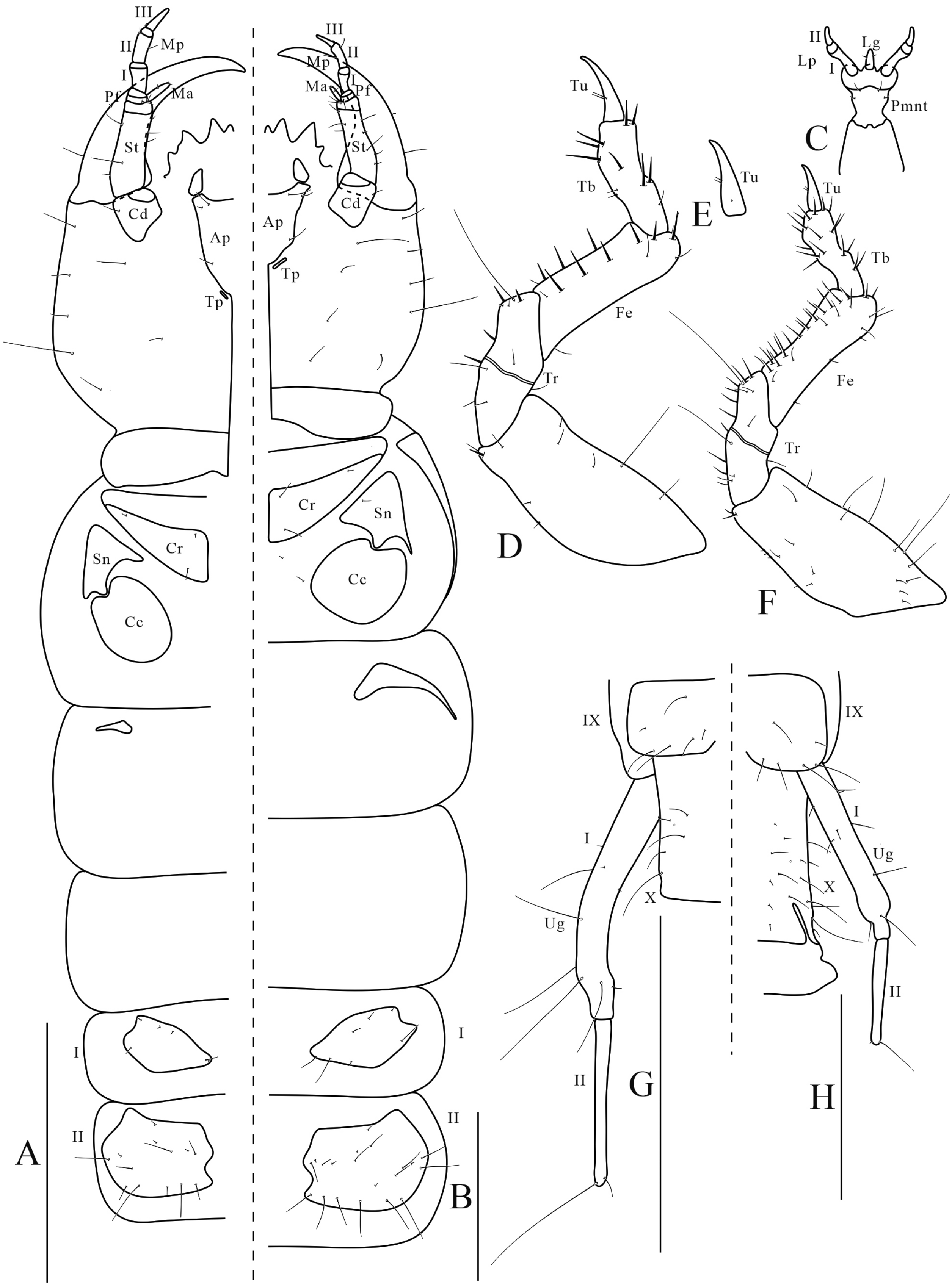

Fig. 5. Detailed morphological drawings of the first and third instar larvae of *Emus hirtus*. A – first instar head, thorax and abdominal segments I and II in ventral view; B – third instar head, thorax and abdominal segments I and II in ventral view; C – third instar hypopharynx, labium and ligula in ventral view; D – first instar anterior leg; E – second instar anterior tarsungulus; F – third instar anterior leg; G – first instar abdominal segments IX and X and urogomphi in ventral view; H – third instar abdominal segments IX and X and urogomphi in ventral view. Scale = 2 mm (same scale bars for D, E and G, and for C, F and H).

two pairs of lateral teeth (Lt1 and 2) of which Lt1 is almost the same size as the paramedian teeth. One pair of glandular pits (Gp) (also called epicranial glands) on either side of the nasale. Apotome bell shaped, with a broad stalk and posteriorly a pair of tentorial pits (Tp). Antenna four-segmented, length ratio of segments I–IV 1.9 : 3.4 : 2.3 : 1.3. Antennal segments I and II without setae; segments II–IV quite slender; segment III with three setae at apex, one big acorn-shaped sensory appendage (Sa) and possibly more very small sensory appendages that are barely visible under X160 magnification; segment IV with 3 setae and several solenidia (So). Mandible rather broad, moderately long, with two setae on outer margin. Maxilla: cardo almost as long as wide bearing one seta ventro-laterally; stipes 3.1 times as long as wide, without visible (under X160 magnification) hair-like cuticular processes. Mala (Ma) finger-shaped, slightly shorter than maxillary palp segment I, narrowed apically, with few sensory appendages apically. Palpifer (Pf) with one seta. Maxillary palps three-segmented, length ratio of segments I–III 1.7 : 1.7 : 1.1; segment I slightly wider apically; segment II almost cylindrical, with two setae; segment III fusiform, with one digitiform sensory appendage basally on outer margin. Hypopharynx mainly membranous and densely pubescent, sclerotized at sides. Prementum (Pmnt) consisting of anterior membranous sub-rectangular part with ligula (Lg) and a pair of labial palps, its posterior part narrower basally and sclerotized, with 4 setae. Labial palps (Lp) two-segmented, length ratio of segments I–II 1.0 : 2.2. Ligula (Lg) elongate, about half as long as first labial palpomere and with two setae ventrally.

Thorax (Figs 3G–I, 4B, 5B, F). Pronotum reddish brown and sub-trapezoid in shape, moderately convex; meso- and metanotum similar in shape and colour, yellowish brown and sub-rectangular; all thoracic tergites with mid-longitudinal ecdysial line, pronotum with distinct symmetrical irregularly darker brown area on both sides. Cervicosternum (Cr) triangular, completely divided by ecdysial longitudinal line. Anterior leg ratio of coxa : trochanter : femur : tibia : tarsungulus 4.0 : 2.7 : 3.1 : 2.0 : 0.9; trochanter with one quite long seta, femur slightly longer than tibia, with two rows of spines ventrally; tibia without tibial comb or bifid setae, slightly dilated before apex; tarsungulus with two symmetrical ventral spine-like setae.

Abdomen (Figs 3G–I, 4B, D, F, 5B, H) ten-segmented, segment I slightly narrower than segment II; segments II–V equally wide, from segment VI to X gradually becoming narrower; tergites clearly divided into two sclerotized parts; segments III–VIII with two pairs of paratergites (one pair large and the other small) and one pair of parasternites; segments I and II with one pair of paratergites and one pair of small parasternites; sternites I–VIII divided into two parts, sternites II–VIII nearly square. Urogomphi with two distinctly visible segments, length ratio of pygopod : urogomphi segment I : urogomphi segment II 4.2 : 3.8 : 2.1; pygopod and first segment of urogomphi sparsely setose, second segment of urogomphi slightly thinner than first, with one small and long seta apically.

Description of the pupa (one specimen, Figs 3J–L)

Body length (from anterior margin of pronotum to the end of abdominal segment IX): 16.9 mm; body width (at level of the joints between femora and tibia of hind legs): 7.0 mm. Head length (from the neck to the base of the labrum): 4.5 mm; width (between eyes): 4.0 mm; mandibles crossed; antennae reaching half way to the middle leg. Pronotum width (maximal): 4.6 mm, length: 4.4 mm, anterior margin with 27 setiform projections. Wings almost reaching posterior margin of first clearly visible abdominal sternite. Middle leg with several protuberances; hind leg reaching half of the length of the fourth visible abdominal sternite. Abdominal segments VII and VIII bearing a pair of setiform projections, without terminal prolongations. Abdominal tergites I–IV with tuberculate, functional spiracles, first one clearly bigger than others; tergites V–VIII with atrophied spiracles.

Diagnosis of the genus *Emus* based on the third (last) larval instar

Emus differs from all other genera in Staphylinina in combining the following characteristics: frayed setae on abdomen; nasale with seven sharp teeth; apotome wide without a distinct stalk between tentorial pits, with three pairs of moderately long setae; mandible with two setae; maxillary palps three-segmented, labial palps two-segmented; antenna with acorn-shaped sensory appendage; hypopharynx sclerotized laterally; cervicosternum triangular, divided into two sclerites along its midline; fore tibia without comb or bifid setae; middle of tarsungulus with two symmetrical ventral spine-like setae; urogomphi longer than pygopod, with scattered setae, second segment of urogomphi thinner than the first.

DISCUSSION

The examination of the reared larvae of *Emus hirtus* confirmed that Kemner (1912) correctly identified this species and that his description of the larva and pupa of this species is very accurate. The current study added more characters and illustrations of the larvae and pupa that clearly show differences between larval instars, and the first description of the egg. It was only possible to make a few biological observations, so there is a clear need for further studies on this striking species both in nature and the laboratory.

Morphological characters of the immature stages of *Emus hirtus* and other Staphylinina may provide information about the phylogeny of this large group of rove beetles. Comparison of the homological character states for this purpose, however, is difficult because current knowledge of the immature stages of Staphylinina is very limited and imprecise. Larval characters are available for 47 species from 12 genera of this subtribe (Table S1) and includes species for which morphological features are not assembled into cohesive descriptions, but mentioned in various forms in the phylogenetic data matrixes or identification keys. In addition, unpublished data on the larvae of the genera *Eucibdelus* Kraatz, 1859 and *Saniderus* Fauvel, 1895 provided by colleagues were used. Quality and degree of detail in the larval descriptions vary greatly, from very superficial fragmentary old descriptions such as Paulian (1941), Moore (1964) and Kasule (1970), which are mainly information on macromorphology and body proportions, to a few detailed recent descriptions, such as those of Staniec et al. (2009) and Pietrykowska-Tudruj & Staniec (2012), which also consider chaetotaxy. Some species are described many times and often it is not clear if subsequent descriptions are based on additional material, or simply reproduced, sometimes with some unexplained modifications. Most of the species have single larval descriptions based on one instar, mostly likely the second or third, and very often there is no indication of instar. All these constraints greatly reduce the number of characters of Staphylinina that can be compared. Nevertheless, based on the examination of *Emus hirtus* and assessment of the literature on the immature stages of Staphylinina, it is concluded that the recent division of Staphylinina into *Creophilus*-, *Ocypus*- and *Platydracus*-groups by Brunke & Smetana (2019) is supported by larval characters. In particular, the morphology of the larvae of *Emus* confirms the placement of this genus in the *Platydracus*-group of Brunke & Smetana (2019). This is noteworthy because Brunke & Smetana's (2019) phylogenetic analysis is based on adult morphology and molecular characters. Although currently it is impossible to suggest larval autapomorphies for each clade, it is possible to diagnose each respective group.

Larvae of the *Creophilus*-group (known for the genera *Creophilus*, *Hadropinus*, *Hadrotes* and *Thinopinus*) have nine or fewer teeth on the nasale; third segments of antenna with dilated and slightly transverse apex; three and two-segmented maxillary and labial palps, respectively; no bifid setae on anterior tibia of mature (second and third instars) larvae; mostly three spine-like setae or sometimes more on tarsungulus of mature (second and third instar) larvae; urogomphi with three or fewer segments (not a clearly described character, most likely with one-segmented urogomphi in *Thinopinus pictus* according to Böving & Craighead, 1931). Based on limited information and poor illustrations, it is likely that larvae of this group have heads notably wider than long, but this needs to be confirmed based on additional and more diverse material.

Larvae of the *Ocypus*-group (known for the genera *Dinothenarus, Ocypus*, *Tasgius* and unpublished data for *Eucibdelus*) have mostly nine teeth on the nasale; four and three-segmented maxillary and labial palps, respectively (except *Dinothenarus* and *Eucibdelus* with three and two segments); at least in mature (second and third instars) larvae anterior tibia mostly with bifid setae sometimes arranged in a comb, exceptionally without bifid setae; typically three spine-like setae on the tarsungulus of mature larvae (the number of setae varies from two to three depending on instar, based on Boháč, 1982); urogomphi with three or two segments. Bifid setae on fore tibia are also present in the first instar of *Tasgius* (*Rayacheila*) *melanarius* described by Boháč (1982); if the species and larval instar are correctly identified, then this species is unique among all known larvae of Staphylinina. Based on Boháč (1982), the anterior legs of *Dinothenarus, Ocypus* and *Tasgius* have tibia at least as long as the femur and without a marked subapical dilation. The utility of this character as diagnostic for the *Ocypus*-group should be reconsidered and tested based on more material.

Larvae of the *Platydracus*-group (known for the genera *Abemus*, *Emus*, *Ontholestes* and *Platydracus,* and unpublished data for *Saniderus*) have up to nine teeth on the nasale; three and two-segmented maxillary and labial palps, respectively; no bifid setae on the anterior tibia of mature (second and third instars) larvae; mostly two ventral spine-like setae on tarsungulus of mature (second and third instars) larvae; typically two-segmented urogomphi (or filament like urogomphi in *Abemus* and *Ontholestes*). According to Boháč (1982), larvae of all the species of *Platydracus* have burrowing type legs (tibiotarsus very short, at most half as long as femur and dilated before apex). This is not the case for the larvae of *Platydracus latebricola* described by Pietrykowska-Tudruj & Staniec (2012) and those of *Emus hirtus* described here. Still, presence of the burrowing legs should be considered as a potentially useful character for the *Platydracus* group until larvae of more species become known. This larval diagnosis for the *Platydracus* group casts doubts on whether the species described as *Platydracus jeanneli* in Paulian (1941) belongs to *Platydracus.*

Interestingly, Brunke & Smetana (2019) did not resolve the phylogenetic position of the genus *Staphylinus*, the type genus of Staphylinina, partly because they did not have molecular data for this genus and partly because the adult morphology of this genus is quite distinct and does not fit that of any of the proposed groups of genera. Currently larval descriptions are only available for three species of *Staphylinus* and that for *S. erythropterus* is inconsistent. Boháč (1982) states that this species has three larval instars, but Pietrykowska-Tudruj & Staniec (2012) reports only two. In addition, the descriptions and illustrations differ in terms of the presence of bifid setae on the anterior tibia and number of spine-like setae on the tarsungulus. The more detailed and better illustrated description of Pietrykowska-Tudruj & Staniec (2012) shows bifid setae on the anterior tibia of the second instar of *Staphylinus erythropterus.* Boháč (1982), who identified his material based only on Szujecki's (1966) description of the first instar larva of *Staphylinus dimidiaticornis*, assumed finding a third instar larva of this species in the field and the fore tibia of that larva lacked bifid setae. Based on the more convincing evidence that mature larvae of *Staphylinus* have bifid setae on the anterior tibia, this genus appears to be closer to the *Ocypus* group.

Because there is very little data on the eggs of Staphylinina (Table S1), their characteristics cannot be used to separate these three groups of genera. However, the key for identifying Staphylininae eggs of Hinton (1981) indicates that the position of aeropyles and band features are helpful in distinguishing between some genera of Staphylinina. Based on data on pupae of 19 species of nine genera of Staphylinina (Table S1) and Staniec & Pietrykowska-

Tudruj's (2019) comprehensive study, the terminal prolongations are helpful for separating pupae of different genera of Staphylinina. According to their study and the description of the pupa of *Emus hirtus* presented here*,* the *Platydracus* group lacks the terminal prolongations that are characteristic of the pupae of the *Creophilus*- and *Ocypus*-groups.

ACKNOWLEDGEMENTS. We are indebted to J. Pedersen, who suggested a good locality in Denmark for *Emus hirtus* and helped with the fieldwork. A.K. Hansen is greatly acknowledged for organizing a productive local field excursion to the locality on Samsø within the framework of an AV Jensens Foundation grant on the dung-inhabiting beetles of Denmark and also helped us with this study in other ways. Sincere thanks go to M.F. Christensen for reporting his finding of an *Emus hirtus* larva in NW Jutland and sharing his photographs with us. We are very thankful to C. Li who helped by rearing and collecting larvae of Staphylinina in China, and W.-X. Zhang and C.-L. Zhou who kindly checked the morphological characters of material not available to us. QZ acknowledges that his PhD study on the phylogeny and biogeography of Staphylinina was funded by the Chinese Scholarship Council.

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Received October 28, 2022; revised and accepted February 10, 2023
Published online March 31, 2023

Online supplementary files:
S1 (http://www.eje.cz/2023/013/S01.mp4). Video S1. *Emus hirtus* adult hunting for *Aphodius fossor* around a cow pat in a pasture on Samsø in Denmark.
S2 (http://www.eje.cz/2023/013/S02.mp4). Video S2. *Emus hirtus* mating in the laboratory.
S3 (http://www.eje.cz/2023/013/S03.xlsx). Table S1. The most important published information on the immature stages (eggs, larvae and pupae) of the rove beetle subtribe Staphylinina.