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A detailed updated description of the morphology of the larva of *Reesa vespulae* (Coleoptera: Dermestidae: Megatominae: Megatomini)

Marcin Kadej[1,], Joanna Guziak[1], and Dawid Marczak[2,3]*

Abstract

An updated description of the last larval instar (based on the exuvia) of *Reesa vespulae* (Milliron, 1939) (Coleoptera: Dermestidae) is presented. The paper is fully illustrated and includes some important additions to extend the poorly illustrated, short notes for this species available in the references. Summarized data about biology, economic importance, and distribution of *R. vespulae* are also provided.

Key Words: immature stage; seta; exuvia

Resumen

Se presenta una descripción actualizada del último instar larval (basado en la exuvia) de *Reesa vespulae* (Milliron, 1939) (Coleoptera: Dermestidae). El articulo está completamente ilustrado e incluye algunas adiciones importantes para ampliar las pobres ilustraciones y notas cortas de esta especie disponibles en la literatura.

Palabras Clave: estadio inmaduro; seta; exuvia

The monotypical genus *Reesa* Beal, 1967 is placed in the tribe Megatomini in the subfamily Megatominae. It is represented by 1 species *Reesa vespulae* (Milliron, 1939), widely distributed all over the world (Háva 2015). This species was described originally as *Perimegatoma vespulae* Milliron, 1939 from wasp nests from St. Paul, Minnesota (USA) (Bunalski & Przewoźny 2009). Beal (1967) transferred it to a new genus *Reesa*. According to the results of a phylogenetic analysis based on larval characters, *Reesa* is closely related to the *Trogoderma*-like Megatomini (such as *Cryptorhopalum* Guérin-Méneville, 1838, *Megatoma* Herbst, 1792, *Orphinus* Motschulsky, 1858, *Thaumaglossa* Redtenbacher, 1867, *Trogoderma* Dejean, 1821) that are characterized by progressive desclerotization of the posterior portions of some abdominal terga (Kiselyova & McHugh 2006). However, *Reesa* seems to be most similar to *Trogoderma* and *Megatoma*. The feature that distinguishes these 3 genera from *Cryptorhopalum*, *Megatoma*, *Orphinus*, and *Thaumaglossa* is that all hastisetae and hastisetal brushes are inserted on sclerotized areas of terga, never on membranes behind terga (hastisetae are concentrated on the lateral portions of the posterior abdominal terga, behind the row of stout spicisetae). In comparison, in such genera as *Cryptorhopalum*, *Orphinus*, and *Thaumaglossa*, brushes of the hastisetae are inserted on each side of a membrane behind the tergum (Beal 1991; Kiselyova & McHugh 2006).

Larval morphological characteristics that distinguish *Reesa* from related genera *Megatoma* and *Trogoderma* were given by Peacock (1993) and by Beal (1967; 1991), and are mainly expressed by the length of setae of the tarsungulus (pretarsus), the number and morphology of the middle 4 setae of the labro-epipharyngeal margin, and the morphology of the acrotergites.

The current paper provides a detailed morphological description of the mature larva of *R. vespulae*. The aim of this paper is to update the notes for this species available in the references (see Table 1). The following set of larval characters are described and illustrated: morphology of antenna, epipharynx, mandibles, maxilla, ligula with labial palp, hastisetae, spicisetae, legs, abdominal terga, and condition of antecostal suture.

Materials and Methods

For morphological examination, exuviae or larvae of the last instar were stored in ethanol. The material came from the collection of †Prof. Maciej Mroczkowski (Warszawa, Poland), Dr. Marek Bunalski (Poznań, Poland), and Dr. Dawid Marczak (Izabelin, Poland). Exuviae were boiled for 3 to 10 min in 10% KOH solution, rinsed with distilled water, and then placed in distilled water for approximately 1 h to clean and soften the material. All structures were mounted in glycerin on slides. The morphological structures were examined under a Nikon Eclipse E 600 phase contrast microscope with a drawing tube attached, and a Nikon SMZ-800 binocular microscope. Photos were taken with Canon 500D and Nikon Coolpix 4500 cameras under Nikon Eclipse 80i and Nikon SMZ-800 miscroscopes.

In addition to the description, plates with drawings of selected structures were prepared for the exuviae. The terminology used in this paper follows Kiselyova & McHugh (2006).

Figure abbreviations: ac–acrotergite; as–antecostal suture (ridge); br–transverse row of placoid sensilla on epipharynx; c–claw; cs–cam-

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Table 1. List of references to larval morphological characteristics of *Reesa vespulae* (Milliron, 1939).

Reference	Available data
Milliron 1939	Short description of larval morphology (p. 572)
Beal 1956	Short sentence in key (p. 561)
Beal 1967	Short sentence in key (p. 290), brief description of larval morphology (p. 310)
Zhantiev 1976	Short sentence in key (p. 94) [in Russian]
Weidner 1984	Illustration of larva (p. 88)
Sellenschlo 1987	Short description in key (p. 124), illustration of antenna (p. 123), papillae of epipharynx (p. 124)
Beal 1991	Short sentence in key (p. 439)
Peacock 1993	Short description in key (p. 37), illustration of pretarsus (p. 123), epipharynx (p. 126), antenna (p. 138), abdominal tergite I (p. 139)
Stejskal & Kučerová 1996	Picture of dorsal aspect of larva (p. 98), pretarsal claw (p. 99), abdominal hastisetae (p. 99)
Klausnitzer 2001	Short description in key (p. 33-34) [in German], illustration of antenna (p. 30), pretarsus (p. 30), epipharynx (p. 30), abdominal segment I (p. 30)
Kiselyova & McHugh 2006	Data matrix with larval characters (p. 498)
Hong et al. 2014	Illustration of larva (dorsal and ventral view, p. 307) and pupa in last larval exuvia (dorsal view, p. 307)

paniform sensillum; dst–distal epipharyengal sensilla; dmr– dorsomesal row of setae on lacinia; er–epipharyngeal rods; f–femur; gl–galea; l–lacinia; lp–labial palp(i); mp–mesal pair of labro-epipharyngeal setae; msr–mesal row of setae on lacinia; mxp–maxillary palp(i); p2–2nd pair of labro-epipharyngeal setae; pr–pretarsus; pls–placoid sensilla; prst–prostheca; s–sensorium (accessory sensory papillae); sbp–subproximal epipharyngeal sensilla; st–stipes; t–tibia; tr–trochanter.

Results

Subfamily Megatominae Leach, 1815

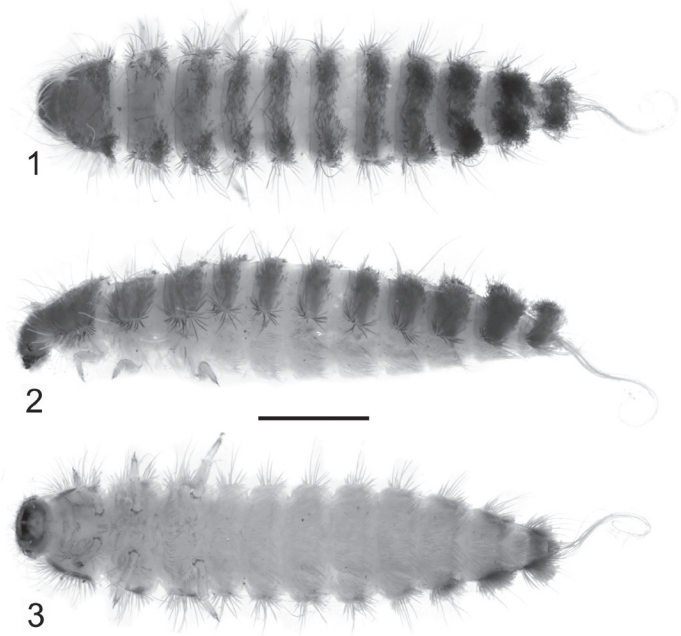
Tribe Megatomini Leach, 1815

Genus *Reesa* Beal, 1967

Reesa vespulae (Milliron, 1939) (Figs. 1–19)

MATERIAL EXAMINED

Six larvae: [handwritten and unreadable data on the label in the first 2 rows of the text] Erfurt 1969 / Inst. Zool. PAN Warszawa 47/71 / *Reesa vespulae* (Mill.) det. M. Mroczkowski 1971 [ex. coll. Prof. M. Mroczkowski]; 1 ex. of exuviae: Polonia, XV20 Poznań 28.IX.2006 leg. M. Bunalski / *Reesa vespulae* (Mill.) det. M. Bunalski; many exuviae: Kampinos National Park, Izabelin, Poland, 02.2016, leg. D. Marczak; all specimens deposited in the Department of Invertebrate Biology, Evolution and Conservation, Institute of Environmental Biology, Faculty of Biological Science, University of Wrocław, Przybyszewskiego 65, Wrocław, Poland.

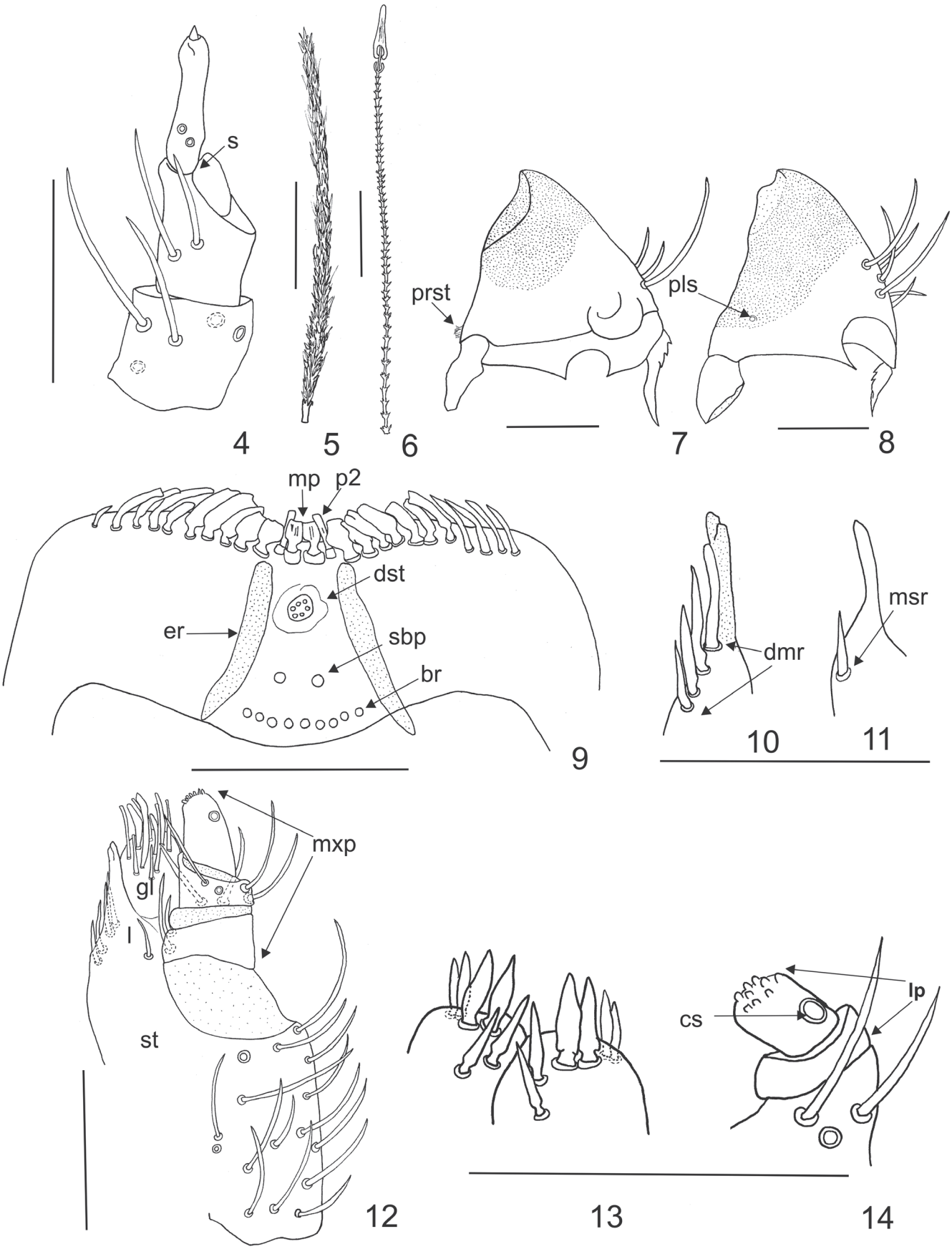


Figs. 1–3. Mature larva of *Reesa vespulae* (Milliron): **1,** dorsal view; **2,** lateral view; **3,** ventral view. Scale bar = 1.0 mm.

DESCRIPTION

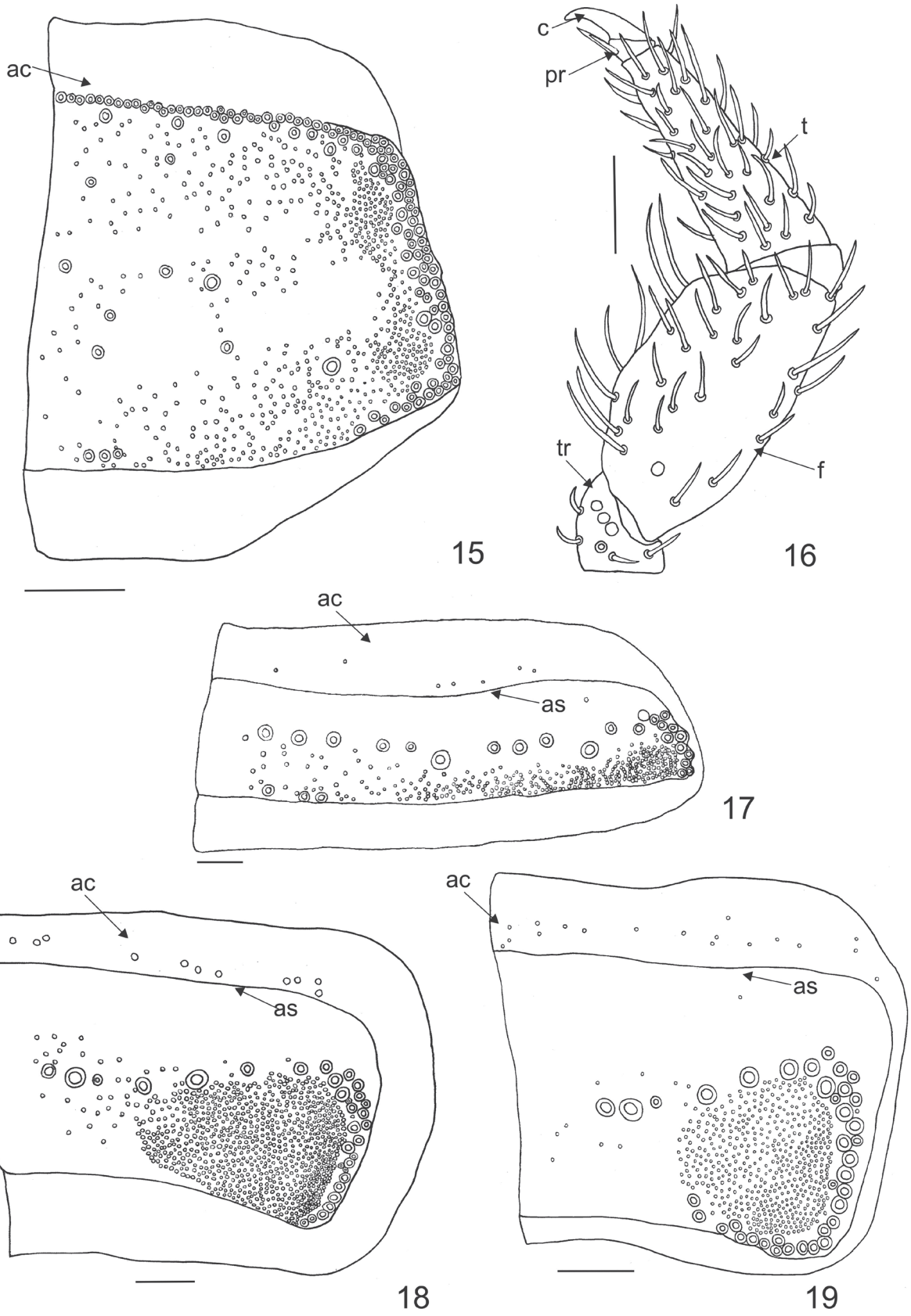
Larva, last instar. Length 5.0–6.5 mm. Body fusiform, and relatively long, rather flattened not hunchbacked (Fig. 2). Integument of head, nota, and terga yellowish brown; tergal plates sclerotized (Figs. 1 and 2), sterna hyaline (Fig. 3), femora and tibiae light yellowish (Figs. 1–3). Setae (spicisetae, Fig. 5, and hastisetae, Fig. 6) on tegra and sterna brown (Figs. 1–3). Head protracted and hypognathous (Figs. 2 and 3). Stemmata present on the head. Frons triangular, without frontal, median tubercule. Antennae orientated anterolaterally; composed of 3 antennomeres (Fig. 4). Terminal antennomere 4.0 times as long as wide, with 1 small sensory sensillum (appendage) on apex and 2 campaniform sensilla under half of length of antennomere. Ratio of length of terminal antennomere to length of penultimate and antepenultimate antennomeres combined nearly 0.6:1.0. Sensorium (or sensoria) arising from apex of antennomere 2, in apical position, excavated and slightly extending above apex. Two setae present on antennomere 2 under sensorium. Antennomere 1 with 2–6 long setae and 1–3 campaniform sensilla (cs) (Fig. 4), sensilla are sometimes lacking. Gula separate from postmentum; epicranial stem present. Median endocarina absent. Labro-epipharyngeal margin with 10 or 11 setae in the outer series. Mesal pair (mp) of labro-epipharyngeal setae spatulate (broad) whereas second pair (p2) stout (narrow). On ventral side of epipharynx basal transverse row (br) of placoid sensilla present. Epipharynx with 9 or 10 sensory cups in the proximal transverse series (br), epipharyngeal rods (er) present and diverging proximally. Two sensory cups in the subproximal epipharyngeal sensillum (sbp). Distal epipharyngeal sensilla (dst) arranged in 1 group (enclosed in distinct ring) of 6 (Fig. 9). Lateral setae on epipharynx absent (Fig. 9). Dorsal surface of labro-epipharynx with many setae. Mandible brown with dark brown (almost black) apices; apical teeth and ventral accessory process absent. Apical half of mandible heavily sclerotized and sharply delineated from the basal half (Figs. 7 and 8). Mandibular mola and pseudomola absent. Hyaline lobe at ventral base of mandible absent. Prostheca (prst) falciform (Fig. 7), brush of setae absent mesally near the mandibular base. Placoid sensilla (pls) present in approximately one-fourth to one-fifth of the basal dorso-lateral length of mandible (Fig. 8). Maxillary palp

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Figs. 4–14. Mature larva of *Reesa vespulae* (Milliron): **4,** antenna (dorso-fronto-lateral); **5,** spiciseta; **6,** hastiseta; **7,** right mandible (dorsal); **8,** mandible (latero-ventral); **9,** epipharynx (ventral); **10,** lacinia (dorsal); **11,** lacinia (ventral); **12,** maxilla (ventral); **13,** labium (ventral); **14,** labial palp (ventral). Scale bar = 0.1 mm.

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Figs. 15–19. Mature larva of *Reesa vespulae* (Milliron): **15,** pronotum (dorsal, right half; large circles represent points of insertion of large spicisetae, small circles represent points of insertion of hastisetae); **16,** right foreleg (dorsal); **17,** abdominal tergum I (dorsal, right half; large circles represent points of insertion of large spicisetae, small circles represent points of insertion of hastisetae); **18,** abdominal tergum VII (dorsal, right half); **19,** abdominal tergum VIII (dorsal, right half). Scale bar = 0.1 mm.

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composed of 3 palpomeres with terminal palpomere longest. Ratio of terminal palpomere length to the 2 proceeding palpomeres combined 1.0:1.0. First palpomere with 1 seta and 1 campaniform sensillum (sometimes absent), 2nd palpomere with 3 or 4 setae and 1 or 2 campaniform sensilla, and 3rd palpomere with 1 campaniform sensilla and group of 6–8 small sensilla situated in the apical area. Lacinia with 2 heavily sclerotized lacinial teeth, straight at apex. Sclerotization of lacinia separated from stipes. Four straight thick to slender setae present in a dorsomesal row on lacinia (dmr) (Fig. 10). Mesal row of setae on lacinia (msr) composed of 1 basally thickened seta (Fig. 11). Galea arising from stipes terminates close to the apex of lacinia. The apical area of galea covered densely with setae. Stipes with 15–20 long setae placed mainly near the anterolateral margin, 1 short seta present near the inner margin (under the 1st palpomere) (Fig. 12). Hypopharynx hyaline. Bridge sclerite (central part of the distal element of the hypopharyngeal sclerome) appearing jointed medially. Anterior arms of bridge sclerite and distal lateral sclerites of hypopharynx absent. Ligula with 12 lanceolate setae (Fig. 13). Labial palp with 2 palpomeres. First segment wider than 2nd segment; 3.5 times as wide as long, without setae on the disc. Terminal labial palpomere 1.5 times as long as wide, with group of 9 or 10 small sensilla in the apical area and 1 campaniform sensillum (cs) (Fig. 14).

Antecostal suture on notum I absent, but distinct and denticulate on nota II–III and abdominal terga I–IX. Acrotergites of notum I without setae, whereas acrotergites of nota II–III and abdominal terga I–VIII with setae (Figs. 17–19). Notum I with long, stout, large spicisetae along anterior (here directed anteriorly under the head), lateral and posterior margin (here directed latero-posteriorly and vertically upright). These setae on the posterior margin are situated near the latero-posterior angle, some additionally near the suture, and some also present on central area of disc of notum I (Fig. 15). Nota II and III and all abdominal terga with median row of large spicisetae, and along lateral margins of terga (Figs. 17–19). They are mainly directed latero-posteriorly and vertically (upright). Hastisetae of abdominal terga I–VIII forming dense lateral brushes, the longest and thickest on VI–VIII). Setal patterns of abdominal tergum I with numerous large spicisetae in median row; posterior margin bearing only few large spicisetae; hastisetae on median half of the tergite more numerous than spicisetae (Fig. 17). Abdominal tergum VII as illustrated (Fig. 18). Abdominal tergum VIII without pair of abdominal pits (oval apertures); setal patterns as illustrated (Fig. 19). Abdominal tergum IX reduced with numerous long setae. Legs covered with many setae as illustrated (Fig. 16). Claws dark brown. Ratio tibial to femoral length 0.8:1.0. Pretarsus with 2 narrow lanceolate setae inserted at base. Length of posterior pretarsal seta subequal to anterior pretarsal seta (Fig. 16).

Pupa unavailable, but is retained in last larval exuvia, which is interrupted from head to the last abdominal terga (Hong et al. 2014; compare with Fig. 2E, p. 307).

BIOLOGY

Despite the species' worldwide distribution, there is rather little knowledge about its biology and ecology. As the larvae can cause damage in museum collections and houses, the species has been classified as a pest of collections, households, and food stores. Thus, *R. vespulae* is also treated as a synanthropic species. The larvae were observed in entomological, bird-skin, dried fungus, or vascular plant collections. They feed on various materials such as dried insects, seeds of tomatoes, dried milk, flour, dried mushrooms, bread crumbs, and food residues. In the USA, the species has been found feeding on dead insects in wasps' nests (Beal 1967; Peacock 1993). It is likely that the species is parthenogenetic (Milliron 1939; Beal 1967). In synanthropic conditions, the larvae can be found throughout the year, but usually from Oct to May. The larvae can survive mild winters in non-heated stores (Bahr 1989; Stejskal & Kučerová 1996). The duration of the development can vary from a few months to 2–3 yr. The adults live from 1 to 2 wk. In Poland, *Reesa* often co-occurs with other synanthropic skin beetles like *Attagenus smirnovi* Zhantiev, 1973 (Bunalski & Przewoźny 2009).

ECONOMIC IMPORTANCE

Due to the fast infestation rate of the species in many European countries (Ólafsson 1979; Edwards 1982; Aldini 2003; Háva et al. 2003; O'Connor 2003; Telnov 2008; Bunalski & Przewoźny 2009), it is likely that the economic importance of *R. vespulae* is increasing. Larvae can cause serious damage not only in museum collections (Mäkisalo 1970; Bahr & Nussbaum 1974; Mehl 1975) but also to other products such as seeds of wheat, rye, tomatoes, dried milk, flour, dried mushrooms, bread crumbs, and dried plant materials (Luff 1982; Peacock 1993; Stejskal & Kučerová 1993, 1996).

DISTRIBUTION

Widely distributed in Europe. So far, *R. vespulae* has also been recorded from Algeria, Egypt, Morocco, Tunisia, Canada, Mexico, the USA, Chile, Afghanistan, China, Japan, Korea, Russia, Australia, and New Zealand (Bunalski & Przewoźny 2009; Hong et al. 2014; Háva 2015).

REMARKS

Kiselyova & McHugh (2006) described, compared, and discussed the larval morphology of *R. vespulae* and evaluated the phylogenetic position of *Reesa* within Megatominae. However, they found no apomorphic characters in the larvae, but nonetheless retained *Reesa* within Megatominae as sister to a clade containing such genera as *Trogoderma*, *Thaumaglossa*, *Megatoma*, and *Anthrenocerus* (see also Hong et al. 2014).

Peacock (1993) wrote that acrotergites are without setae. The results of our study contradict this observation. Acrotergites of abdominal segments possess some very short spicisetae (Figs. 17–19), only the acrotergite of the pronotum is free of setae (Fig. 15). Moreover, tergal color of studied specimens is lighter (yellowish brown to brown) than of those described by Peacock in the key (1993, p. 37: dark brown and strongly pigmented), but this discrepancy may be an expression of variability within the species.

Acknowledgments

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