Russian Entomol. J. 31(2): 144–153

Larval description of *Lycoperdina smirnoviorum* Gusakov, 2017 (Coleoptera: Endomychidae: Lycoperdininae)

Описание личинки *Lycoperdina smirnoviorum* Gusakov, 2017 (Coleoptera: Endomychidae: Lycoperdininae)

A.A. Zaitsev
А.А. Зайцев

Moscow State Pedagogical University, Institute of Biology and Chemistry, Department of Zoology and Ecology, Kibaltchicha str. 6–3, 129164 Moscow, Russia. E-mail: ztema@mail.ru

Московский Педагогический Государственный Университет, институт биологии и химии, кафедра зоологии и экологии, ул. Кибальчича, 6–3, 129164 Москва, Россия.

KEY WORDS: Coleoptera, larva, Endomychidae, Lycoperdininae.

КЛЮЧЕВЫЕ СЛОВА: жесткокрылые, личинка, Endomychidae, Lycoperdininae.

ABSTRACT. The last-instar larva of *Lycoperdina smirnoviorum* Gusakov, 2017 is described. Some aspects of Lycoperdininae larval morphology are discussed.

РЕЗЮМЕ. Приводится описание личинки последнего возраста *Lycoperdina smirnoviorum* Gusakov, 2017. Обсуждаются некоторые особенности морфологии личинок Lycoperdininae.

Introduction

Lycoperdininae Redtenbacher, 1844 is the largest subfamily of Endomychidae Leach, 1815, consisting of 43 genera and over 700 species, mostly distributed in the Oriental region [Arriaga-Varela, Tomaszewska, 2016]. The knowledge of immature Lycoperdininae is rather poor with larvae described for 11 genera [Tomaszewska, 2005]. Genus *Lycoperdina* Latreille, 1807 includes 28 species [Shockley et al., 2009], of which five are known from Russia with single specimen *L. succincta* Linnaeus, 1767 from European part and West Siberia, and four species (*L. mandarinea* Gerstaecker, 1858; *L. dux* Gorham, 1873; *L. koltzei* Reitter, 1887; *L. smirnoviorum* Gusakov, 2017) from Far East region [Gusakov, 2017]. Larvae of this genus most commonly inhabit puffballs of *Lycoperdon* P. Micheli 1729 and frequently collected, but detailed descriptions are scarce (see Discussion).

Material and methods

Larvae of *L. smirnoviorum* were collected in Far East and identified by rearing in the laboratory to adults (Figs 1–5). The specimens were preserved in 70% ethanol or on slides with Faure's Berlese media and are deposited in Moscow Pedagogical State University, Moscow, Russia (MPGU).

Habitus photographs were taken with a Canon EOS 40D camera with a MP-E 65 mm macro lens. All photos were processed using Helicon Focus 7.0 software. Line drawings were made in CorelDRAW 12. The measurements were taken with an ocular-micrometer mounted on a MBS1 (Lomo) stereo microscope.

The following abbreviations were used:

body sclerites: CS — cervicosternum, EP — epipleurite, HY — hypopleurite, EM — epimeron, ES — episternum, FR — frontal sclerite, PR — pronotum, TE — tergite, LT — laterotergite, PS — prosternite, MS — mesosternite, MtS — metasternite, PA — parietal sclerite, Pga — paragular area;

head appendages and their parts: Dma — dorsal mandibular articulation, Vma — ventral mandibular articulation, Mm — mandibular membrane, Mxa — maxillary articulating area, Prxcdo — proxicardo, Dstcdo — disticardo, Stp — stipes, Ma — mala, Pf — palpifer, LA — labium, Mnt — mentum, Pmnt — prementum, Smnt — submentum, Lg — ligula;

endoskeletal structures of the head: Epr — epistomal ridge, Plstr — pleurostomal ridge, Hypstr — hypostomal ridge, Hypstrd — hypostomal rod, Hypbr — hypopharyngeal bracon; Hypsc — hypopharyngeal sclerome, R — hypopharyngeal rod, Tc — transverse curvation, Pstocr — postoccipital ridge, Ca — cardo attachment area, Prap — cardo promotor apodeme, Abdap — mandibular abductor apodeme, Addap — mandibular adductor apodeme, Tb — tentorial bridge, Pta — poste-

How to cite this article: Zaitsev A.A. 2022. Larval description of *Lycoperdina smirnoviorum* Gusakov, 2017 (Coleoptera: Endomychidae: Lycoperdininae) // Russian Entomol. J. Vol.31. No.2. P.144–153. doi: 10.15298/rusentj.31.2.09

Figs 1–5. *Lycoperdina smirnoviorum*, habitus: 1–3 — last-instar larva: 1 — dorsal view; 2 — ventral view; 3 — lateral view; 4 — male, dorsal view; 5 — female, dorsal view.

Рис. 1–5. *Lycoperdina smirnoviorum*, габитус: 1–3 — личинка последнего возраста: 1— сверху; 2 — снизу; 3 — сбоку; 4 — самец, сверху; 5 — самка, сверху.

rior tentorial arms, Ata — anterior tentorial arms, Atp — anterior tentorial pit;

other abbreviations: Asp — atrophied spiracle, Sp — spiracle, Sa — sensorial appendage, Ph — pharynx.

Chaetotaxy nomenclature was not provided because only larvae of last-instar were available, whose chaetome is characterized by numerous secondary setae of various size and topology. Still, when discussing labial palps structure, some setae and pores are coded, but only for convenience and not necessary homologous to that of other beetles larvae.

Results and discussion

Lycoperdina smirnoviorum Gusakov, 2017, last-instar larva Figs 1–3, 6–28.

MATERIAL EXAMINED. four last-instar larvae (one reared to adult): Russia, Primorsky krai, Land of the Leopard National park, ~2 km S from Listvennichny cordon, h~400m, 43°33'43"N 131°21'20"E, in fruiting body of *Lycoperdon*, 30.V.2019 (adult emerged 28.VI.2019), leg. A. Zaitsev, adult determined by K. Makarov (MPGU); five last-instar larvae (two reared to adults): Russia, Primorsky krai, Land of the Leopard National park, near Gusevsky cordon, 43°23´620´´N 131°32´200´´E, in fruiting body of *Lycoperdon*, 1.VI.2021 (adults emerged 24.VII.2021), leg. A. Zaitsev, adults determined by K. Makarov.

ADDITIONAL MATERIAL. *Aphorista vittata* Fabricius, 1787, two last-instar larvae: USA, Michigan, Portage, near Hampton Lake, 16.IV.1972, leg & det. D.K. Young; *Corynomalus* sp., four last-instar larvae, two adults: Peru, Junin province, Perene river, h=1100 m, 8 km NNE Puerto Ocopa, Cananeden vill., S 11°06´ W 73°50´, 23.III.2009, leg. A. Petrov, det. A. Zaitsev; *Endomychus coccineus* Linnaeus, 1758, 47 last-instar larvae (together with adults): Russia, Moscow region, Volokolamsk district, near Pagubino village, 55°57´480´´N 35°55´250´´E, on *Alnus* log, 8.V.2010, leg. & det. A. Zaitsev; *Mycetina marginalis* Gebler, 1830, 30 last-instar larvae (two reared to adult): Russia, Primorsky krai, Lazovsky dist., Lazo env., Proselochny cordon, 42°59´888´´N 134°06´935´´E under bark of *Quercus*, 18.VIII.2007, leg. A. Zaitsev & K. Makarov, adult determined by K. Makarov.

DESCRIPTION. Maximum body length (from anterior margin of clypeus to the apex of processes of abdominal segment IX) 8.1 mm; head length 0.9 mm; head width 1.2 mm; maximum width of thorax 1.9 mm; maximum width of abdomen 2.2 mm. Head distinctly narrower than prothorax; body elongate, cylindrical; widest across abdominal segment III, then tapering posterad. Each abdominal segment with medial paired tergal processes and well developed apically rounded laterotergites, all gradually increasing in length from I to IX segment; urogomphi absent (Figs 1–3). Head brown-grey dorsally and pale-grey ventrally; bottom half of the antennal ring as well as hypopharingeal rod darker. Antennomeres and labrum yellow-grey; mandibles darker, with brown apices; labium slightly pigmented. Thoracic tergites brown-grey, with lighter spots on areas of coxal muscles attachment (= sigillae). Laterotergites of meso- and metathorax greyish; pleurites barely pigmented except apodemes. Mesothoracic spiracle heavily pigmented, brown. Sternites very light colored, almost indistinguishable from surrounding cuticle.

Legs weakly pigmented. Coxae light colored at the base, apically becoming light-grey. Distal joints dorsally brown-grey, lighter than thoracic tergites, ventrally less pigmented.

Acute processes of abdominal tergites and laterotergites brown-grey, rest surface of tergites light-grey; spiracles well-pigmented, brown. Epipleurites faintly colored, greyish; on segments IV–VIII more pigmented. Hypopleurites and sternites very light colored, almost indistinguishable from surrounding cuticle. Abdominal segment X dorsally brown-grey, ventrally almost white.

Most surface of head and all sclerotized body areas are covered with long simple setae; membranous areas with numerous, usually shorter simple setae.

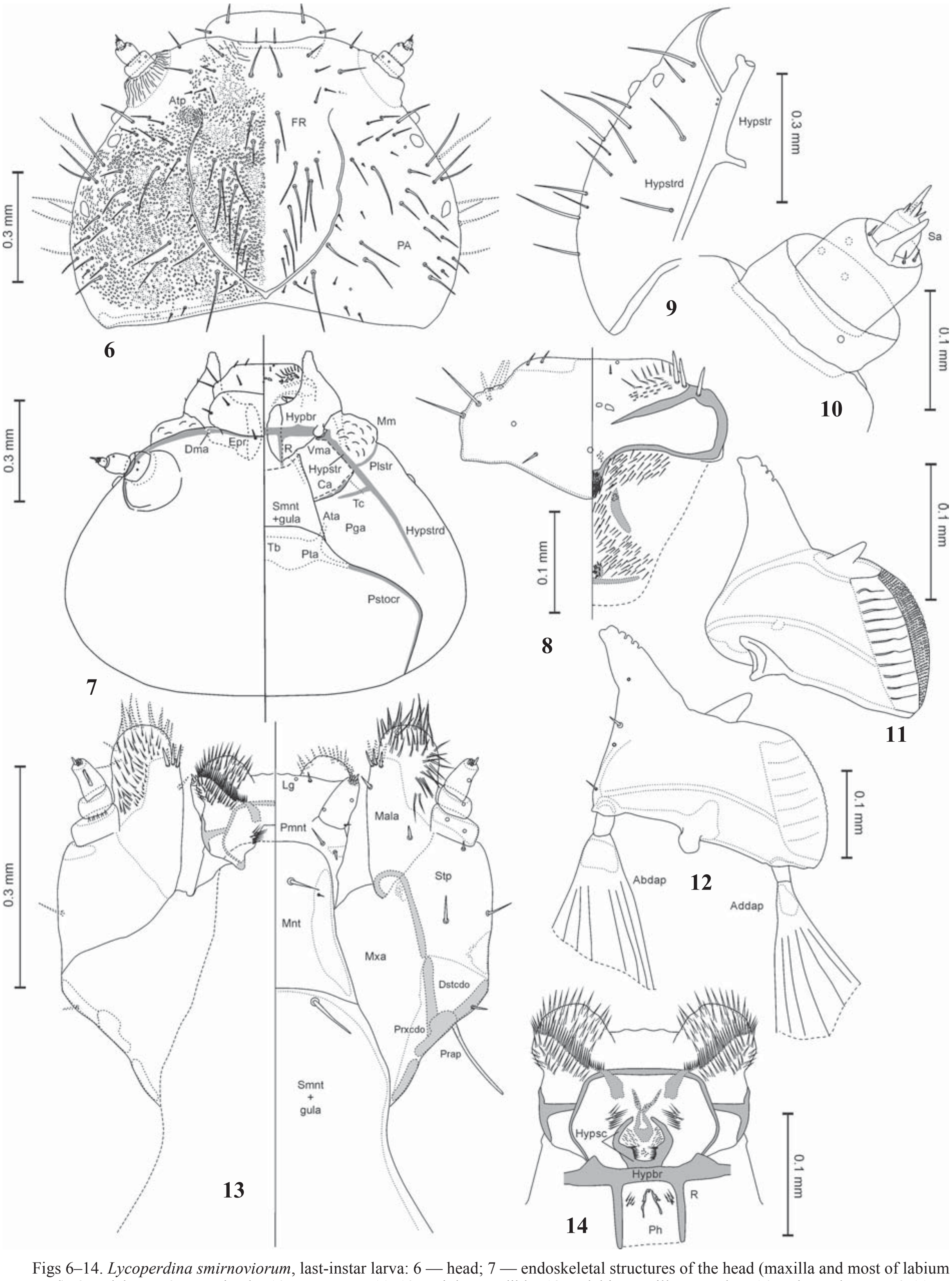
Head (Figs 6–14) prognathous, 0.75 as long as wide. Epicranial suture absent; frontal sutures U-shaped, reaching anterior tentorial pits, their bases contigous (Fig. 6). Frontoclypeal suture distinct, arcuate, epistomal ridge distinct. Stemmata four on each side (Fig. 3), three forming transverse row behind antennae's insertion, one located posteriorly.

Clypeus transverse, with rounded lateral margins, bearing two mesosetae on each side: one close to anterior margin, another on lateral edge (Figs 6–7). Clypeolabral suture distinct; labrum (Fig. 8) with truncate anterior margin, about 0.5 as long as basal wide; dorsally with five setae and single pore on each side: two microsetae on anterior margin, two macrosetae on lateral edge, one microseta near posterior margin and one pore located anteriorly to it. Moreover, unpaired pore present in central area. Frontal sclerite (Fig. 6) with numerous granules on all surface except anterior region before frontoclypeal suture and areas of muscles attachment; each side with ten macrosetae, eight mesosetae, two microsetae and single pore located at the level of anterior forth of frontal suture. Parietal sclerites dorsally (Fig. 6) covered with the same granulae except regions near antennal insertions and areas of muscles attachment; each sclerite with 12 macrosetae, 14 mesosetae, 11 microsetae and two pores (one near the distal stemma of transverse row, another near the posterior margin of the head). Ventral surface of parietal sclerites mostly smooth, each sclerite with 10 macrosetae, four mesosetae and two pores located near anterior part of hypostomal ridge (Fig. 9). Hypostomal ridge with transverse curvation below cardo; hypostomal rods diverging posteriorly, almost reaching posterior margin of the head capsule. Paragular area smooth, without setae. Tentorium with broad bridge; posterior arms basally connected with postoccipital ridge; each anterior arm reaching parietal sclerite, where distinct tentorial pit can be observed externally near the anterior end of frontal suture (Fig. 7).

Antenna (Fig. 10) short, with three antennomeres, 0.2 as long as head capsule length. Antennomere I 0.7 as long as wide, dorsally with two pores, ventrally with single pore. Antennomere II 1.2 as long as antennomere I and 1.2 as long as wide, dorsally with single subapical pore. Its apical part with elongated conical sensorial appendage, which is 1.3 as long as antennomere III; also three apical microsetae present ventrally. Antennomere III 0.4 as long as antennomere II and 1.1 as long as wide; its apical part with five smaller sensilla surrounding larger elongated one.

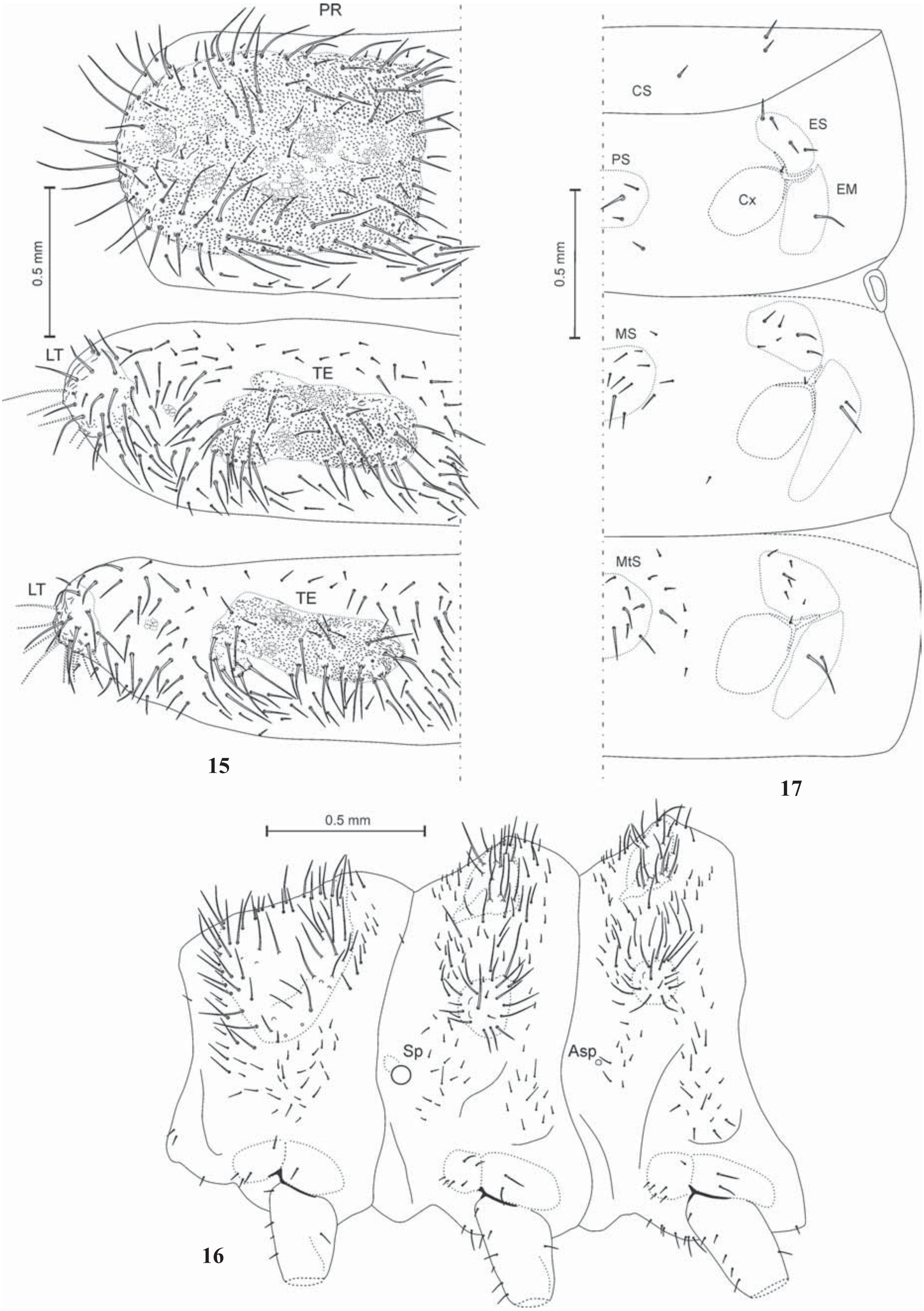
Epipharynx (Fig. 8). Anterior half on each side with numerous microtrichia of various length, absent in central area, where two sensilla located; one campaniform and one conical sensilla located near the anterior margin, and three mesosetae present laterally. Posterior half with numerous uniform microtrichia; mostly membranous except several areas with heavier sclerotized spines and tubercles.

Mandibles (Figs 11–12) almost symmetrical, very broad, each 0.9 as long as basal width, with large membranous area; when closed, their apices directed forward and almost parallel to each other (Fig. 7). Apex truncate, incisor area with 2–3 obtuse teeth; prostheca well developed, mostly membranous; mola tuberculate, with distinct lateral ridges (Fig. 11). Ventrally each mandible with two microsetae and two pores



Figs 6–14. *Lycoperdina smirnoviorum*, last-instar larva: 6 — head; 7 — endoskeletal structures of the head (maxilla and most of labium removed); 8 — labrum; 9 — parietale; 10 — antenna; 11–12— right mandible; 13 — labio-maxillar complex; 14 — hypopharynx. 6, 11 — dorsal view; 9, 10, 12 — ventral view; 7, 8, 13 — left — dorsal view, right — ventral view.

Рис. 6–14. *Lycoperdina smirnoviorum*, личинка последнего возраста: 6 — голова; 7 —эндоскелетные структуры головы (максилла и большая часть нижней губы удалены); 8 — верхняя губа; 9 — париетальный склерит; 10 — антенна; 11–12— правая мандибула; 13 — лабио-максиллярный комплекс; 14 — гипофаринкс. 6, 11 — сверху; 9, 10, 12 — снизу; 7, 8, 13 — слева — сверху, справа — снизу.



Figs 15–17. *Lycoperdina smirnoviorum*, last-instar larva, thorax: 15 — dorsal view; 16 — lateral view; 17 — ventral view.
Рис. 15–17. *Lycoperdina smirnoviorum*, личинка последнего возраста, грудной отдел: 15 — сверху; 16 — сбоку; 17 — снизу.

located along the outer margin. Due to such specific shape of mandible, its abductor muscle is larger than adductor, which reflects in the size of their apodemes (Fig. 12) and, possibly, in development of large membranous area. Such reversion in muscles size is rather rare in Coleoptera larvae, and has been described before for some Eucnemidae [Ford, Spilman, 1979].

Maxilla (Fig. 13) with somewhat triangular cardo, which is "divided" by the internal sclerotization into proxicardo with smooth surface, and disticardo bearing single mesoseta; maxillary articulating area membranous. Stipes ventrally smooth, with small sclerotized area on outer edge of basal part; with two mesosetae. Dorsal side of stipes mostly membranous. Mala broad with distal part slightly narrowed; its apex rounded. Ventral surface of mala with five mesosetae: one located on proximal part and other near the inner margin, distally to it there are three subapical mesosetae arranged in transverse row; apical area with numerous elongated spines. Dorsally mala with three subapical mesosetae arranged in transverse row; apical area covered in numerous distinctly shorter spines.

Maxillary palps three-jointed, palpifer with ventral microseta. Palpomere I 0.5 as long as wide, apex ventrally with two pores, dorsally with several small asperities. Palpomere II 0.8 as long as palpomere I and 0.7 as long as wide, ventrally with single apical pore. Palpomere III 1.7 as long as palpomere II and 1.7 as long as wide; ventrally with single pore, dorsally with medial digitiform sensillum. Apex of palpomere III with a group of six short conical sensilla.

Labium (Figs 13–14). Ligula with two lateral lobes, dorsally covered in numerous microtrichia; its anterior margin with ventral microseta and pore on each side. Prementum short, ventrally on each side with one micro- and one mesoseta shifted towards palpifer. Labial palps (Fig. 13) with single palpomere, which is 2.3 as long as wide; ventrally with basal microseta and pore on outer and inner margin accordingly, as well as single subapical pore; apex with a group of 7 short conical sensilla. Hypopharynx (Fig. 14) on each side with three oblique rows of microtrichia originated from antero-lateral edges of ligula lobes, and numerous microtrichia of various length located in medial part. Hypopharyngeal sclerotisation consists of well-defined sclerome, bracon and a pair of parallel rods.

Mentum (Fig. 13) distinct, trapezoidal, with paired lateral sclerites, each with single microseta; central area membranous, with single macroseta on each side. Submentum fused with gula in single large sclerite, bearing one anterior macroseta on each side.

Thorax (Figs 15–17). Cervicosternum membranous, with three mesosetae on each side (Fig. 17).

Thorax about 0.3 as long as total body length, widest across metathorax. Prothorax is 0.6 as long as wide, 1.2 as long as mesothorax and 1.4 as long as metathorax.

Prothorax with a pair of large pronotal sclerites, covered in numerous small tubercles except invaginated areas of muscles attachment; ecdysial line not distinct. Each pronotal plate with numerous simple setae of various length and eight pores (Fig. 15); membranous area surrounding pronotum with numerous microasperities and simple setae of various length.

Meso- and metathorax with each notal plate divided in two sclerites: larger dorsal (= tergite), covered in numerous small tubercles and bearing about 30 setae (mostly macro- and mesosetae) as well as two pores; smaller sclerite located laterally (= laterotergite) (Fig. 15), more convex, almost without tubercles and bearing about 20 setae as well as two pores. Membranous area with the same vestiture as on prothorax.

Mesothoracic spiracle annular, opening at the edge of membranous spiracular disk, which is lesser than spiracle; metathoracic spiracle rudimentary (Fig. 16).

Prothoracic episternum with four mesosetae; epimeron with single macroseta. Prosternite faintly sclerotized with two mesosetae and single macroseta on each side; a pair of mesosetae located posteriorly on membranous area (Fig. 17).

Meso- and metathoracic episternum differs from that on prothorax by additional two microsetae; epimeron with additional mesoseta. Meso- and metasternite as well as membranous area with additional meso- and microsetae.

Thoracic endoskeleton is of the same structure as was described for *L.* ?*dux* [Tomaszewska, Zaitsev, 2012].

Legs (Fig. 18) 5-jointed, short and stout, slightly increasing in size posteriorly; all three pairs similar in structure and

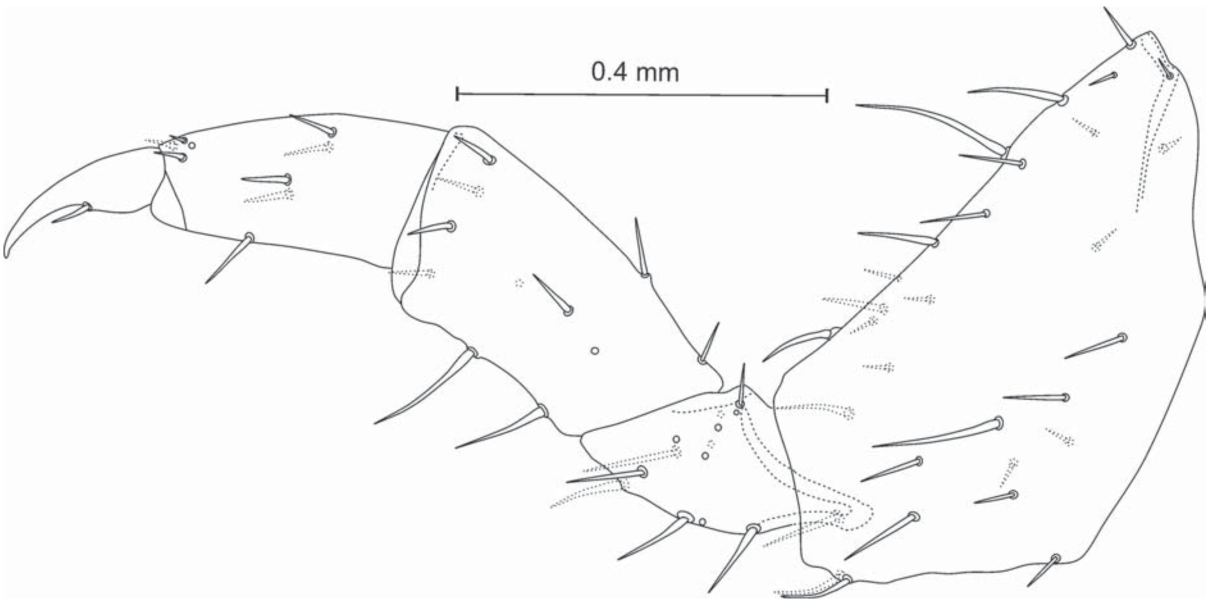
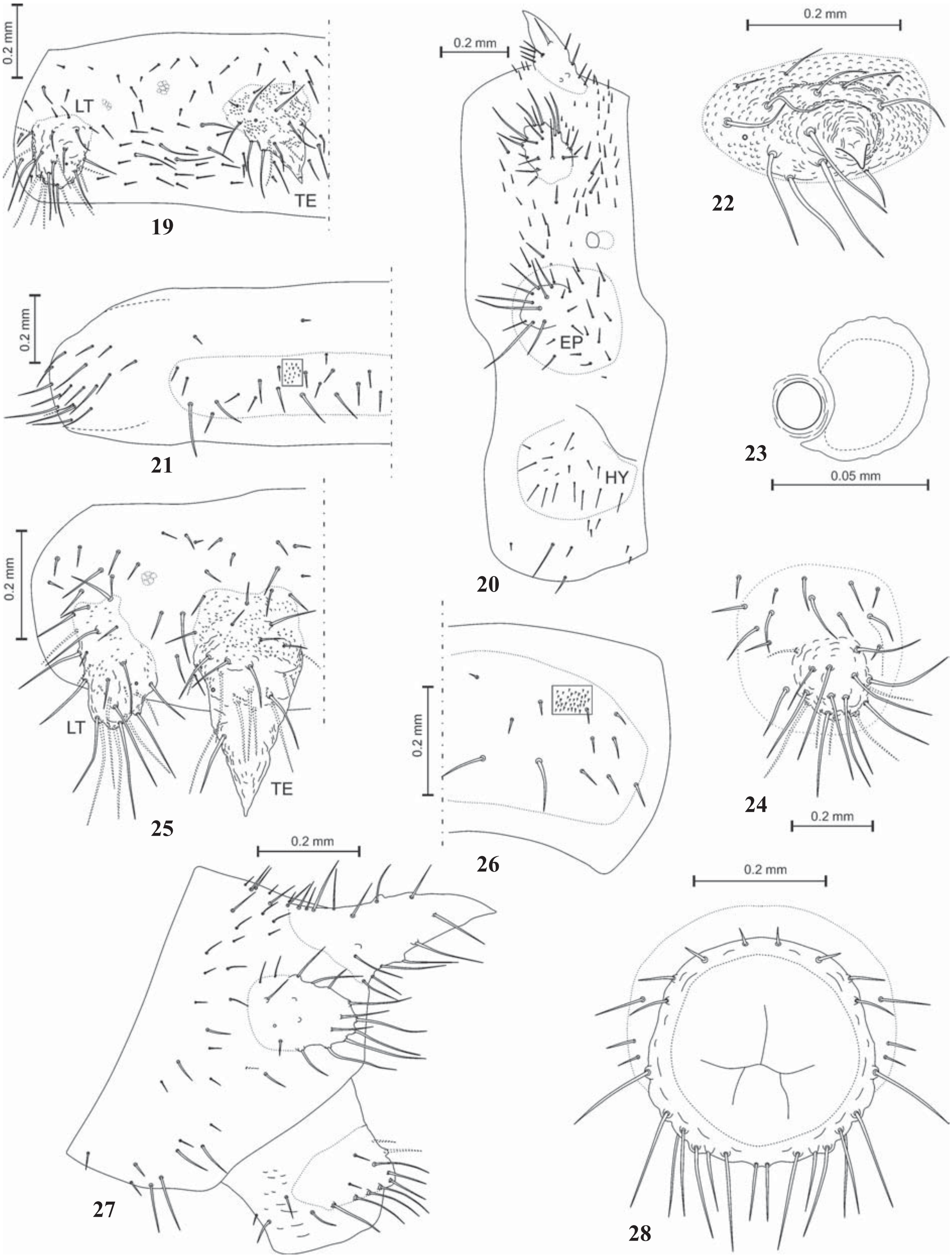


Fig. 18. *Lycoperdina smirnoviorum*, last-instar larva, middle leg, anterior.

Рис. 18. *Lycoperdina smirnoviorum*, личинка последнего возраста, нога второй пары, спереди.



Figs 19–28. *Lycoperdina smirnoviorum*, last-instar larva: 19–24 — abdominal segment IV; 25–28 — abdominal segments IX –X; 22 — tergite; 23 — spiracle; 24 — epipleurite; 19 — dorsal view; 20, 27 — lateral view; 21, 26, 28 — ventral view.

Рис. 19–28. *Lycoperdina smirnoviorum*, личинка последнего возраста: 19–24 — IV брюшной сегмент; 25–28 — IX–X брюшные сегменты; 22 — тергит; 23 — дыхальце; 24 — эпиплеврит; 28 — X брюшной сегмент; 19 — сверху; 20, 27 — сбоку; 21, 26, 28 — снизу; снизу.

chaetotaxy, covered in mostly meso- and macrosetae; length ratio of its joints to coxa is 0.5 : 0.7 : 0.6 : 0.3. Coxa with 30 setae: 5 dorsal, 3 ventral, 10 anterior and 12 posterior. Trochanter with six setae: two anterior, one posterior and three ventral; seven pores present: five anterior and two posterior. Femur with nine setae: two dorsal, two ventral, three anterior, two posterior, and two pores: one anterior, one posterior. Tibiotarsus with eight setae: four anterior, three posterior and one ventral; single apical anterior pore present. Pretarsus with single stout claw bearing single seta.

Abdomen (Figs 19–28). About 0.6 as long as total body length, widest across abdominal segment III, then narrowing posteriorly. Abdominal segments (AS) I–IX with both tergites and laterotergites developed; each tergite covered in small tubercules except apical part and forming acute process increasing in size on subsequent segments (Figs 1, 19, 25), on AS IX they sometimes called urogomphi (see Discussion). Laterotergites with less tubercles, rounded apically and becoming more convex on subsequent segments. Each tergite of AS I–VIII (Fig. 22) with 13–17 setae of various length and single pore; on AS IX (Fig. 25) with 22 setae and single pore. Each laterotergite on AS I–IX with 20–22 setae of various length and single pore (Figs 19, 25). Membranous area surrounding sclerites with numerous setae of various length.

Epipleurites (Figs 3, 20, 24) protruded, membranous on AS I–III, pigmented apically on AS IV–VIII, reduced on AS IX. Each epipleurite with about 20 mesosetae on flat part and 18 meso- and macrosetae on convex part (Fig. 24). All hypopleurites flat, membranous, largest on AS IV–V, decreasing in size on AS VI–VII, reduced on AS IX; with about 20 setae of various length on largest hypopleurite (Fig. 20).

Abdominal sternites I–IX faintly sclerotised, covered in microasperities which number increasing on subsequent segments; membranous areas with distinctly less number of microasperities. Sternite I on each side with one anterior microseta as well as one micro- and two mesosetae medially; sternites II–VIII (Fig. 21) on each side with total of 21 setae: two anterior microsetae as well as 14 micro-, four meso- and one macroseta medially; sternite IX (Fig. 26) on each side with ten microsetae and two mesosetae. Abdominal spiracles annular (Fig. 23), partially surrounded by membranous spiracular disk, which is distinctly larger than spiracle. Pygopod (abdominal segment X) about 0.8 as long as abdominal segment IX, membranous except well-sclerotized tergite, which bears one mesoseta and eight macrosetae on each side. Pleural and ventral areas with seven mesosetae on each side (Figs 27–28).

Comparative remarks

By now, the knowledge of *Lycoperdina* larvae is insufficient, with only five species mentioned in literature. Chapuis and Candèze [1853] were the first who gave the diagnosis and some illustrations of the larva of the genus, based on *L. succincta*; almost at the same time Dufour [1854] described the larva of *L. bovistae* Fabricius, 1792. Unfortunately, these studies are outdated. Böving and Craighead [1931] provided drawings of hypopharyngeal structures and mouthparts of *L. succincta* without any description given. Larva of North American *L. ferruginea* LeConte, 1824 appears to be the most studied within the genus, as more or less detailed descriptions have been executed by Peterson [1951], Pakaluk [1984], Tomaszewska [2005], and Böving and Craighead [1931] provided drawing of the head capsule. Hayashi and Nakamura [1953], Hayashi [1959] gave short descriptions of *L. dux* and *L. mandarinea,* but the latter turned out to be of *Pocadius* sp. (Nitidulidae) [Hayashi, 1978]. In the most recent publication, Sogoh and Yoshitomi [2017] used habitus photos of *L. dux* and *L. castaneipennis*, but unfortunately descriptions were lacking.

Thus, with most known larvae of the genus not adequately described, it is very hard to reveal the distinguishing features. Sogoh and Yoshitomi [2017] mentioned that larvae of *L. dux* and *L. castaneipennis* differ by the size of dorsal tergal processes on abdomen and setae on them. Moreover, when comparing larvae of *L. smirnoviorum* with other unreared species from Russian Far East in our collection, the differences in shape of antennomere II as well as of meso- and metathoracic tergites can be observed. So, detailed descriptions of reared larvae of other *Lycoperdina* species are needed to compile the appropriate key.

Morphological consideration

Nevertheless, during the study of *L. smirnoviorum* it becomes possible to clarify certain aspects of Lycoperdininae larval morphology. The first one is concerning "double" hypostomal rods which were mentioned by Lawrence et al. [1999] and Burakowski and Ślipiński [2000] as larval feature of *Lycoperdina* and later described and figured also for *Eumorphus* Weber, 1801 [Tomaszewska, 2005]. I was not able to locate "short hypostomal rod" in *L. smirnoviorum* larva and, most likely, that in fact it is apodeme of cardo promotor muscle [Das, 1937] seen through integument, which has exactly the same position as on figure in Tomaszewska' paper (Figs 7, 13).

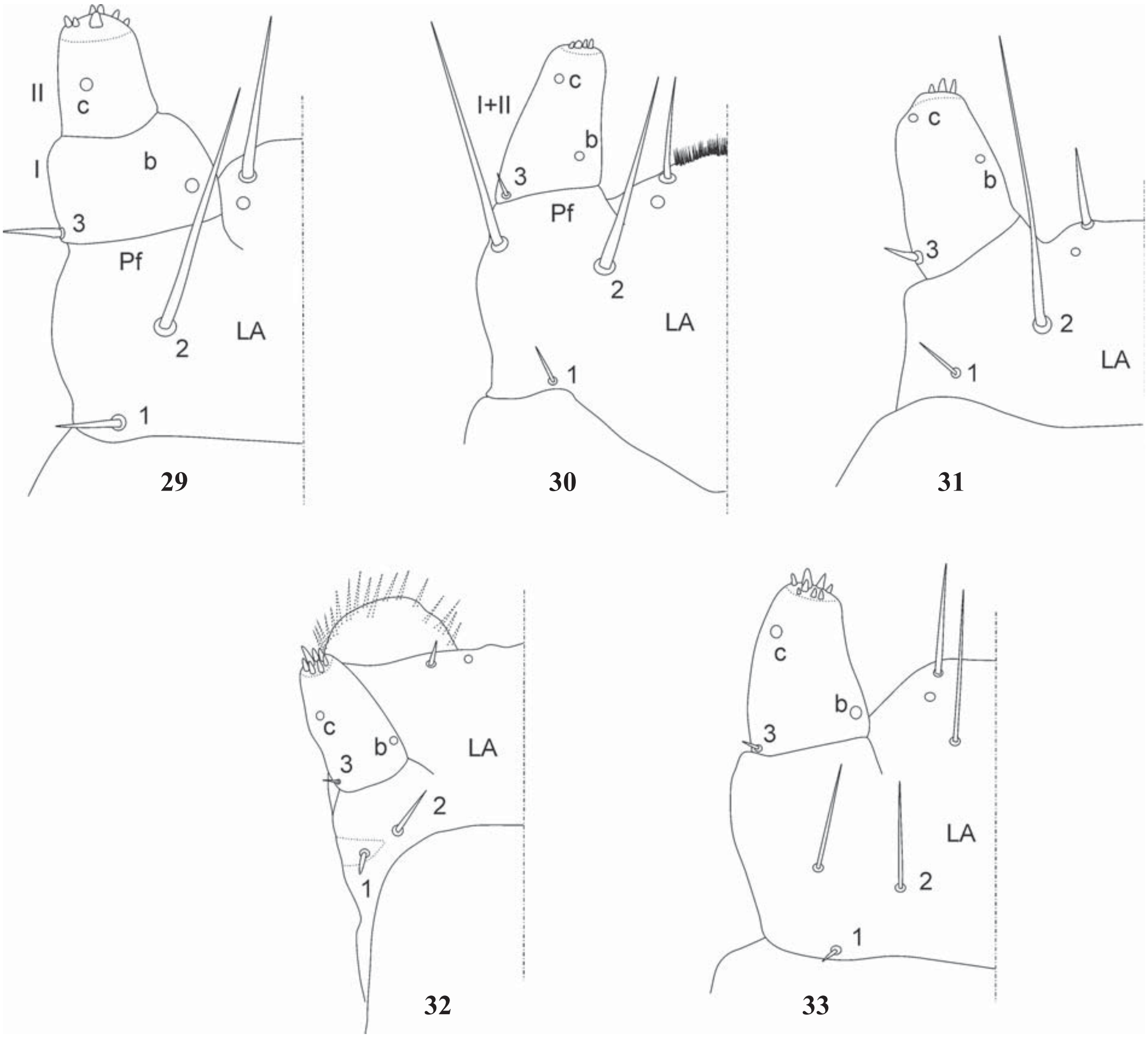
The second aspect is about the urogomphi, which presence in *Lycoperdina* have been mentioned by the majority of authors [Hayashi, Nakamura, 1953; Lawrence, 1991; Burakowski, Ślipiński, 2000; Tomaszewska, 2005]. At the same time, Pakaluk [1984] noted that urogomphi are absent and Peterson [1951] wrote: "ninth segment bearing two enlarged cone-shaped protuberances which may be urogomphi". Such uncertainty appeared because of common assumption that any paired tergal processes of IX abdominal segment are considered as urogomphi regardless of the origin. Term "urogomphus" was proposed by Böving [1929] for usually paired processus situated exclusively on the posterior end of IX abdominal tergite. But, as can be seen in *Lycoperdina*, such processes are present on each abdominal segment, varying only in size, and having the very same location and origin, which can be proved by the position of dorsal pore (Figs 19, 25). So, in this case it is just the common attribute of each abdominal segment and thus cannot be treated as true urogomphi. The same concerns some other larvae of Lycoperdininae, eg. *Eumorphus* and *Amphisternus* Germar, 1843, with laterotergites of IX segment usually described as urogomphi. It should be noted that in some Nitidulidae larvae, eg. *Pocadius* Erichson, 1843, dorsal tergal projections identical to those on preceding segments occur together with true urogomphi, and in this case named "pregomphi" [Böving, Craighead, 1931 Hayashi, 1978]. Thus, we have to agree with Pakaluk [1984] in that larvae of *Lycoperdina* lack true urogomphi; it also applies to the majority of Lycoperdininae (with exception of *Mycetina* Mulsant, 1846, which larvae do have true urogomphi, however they were not mentioned by previous authors [Zaitsev, in preparation]).

The last point relates to labial palps, which have been described as single- [Lawrence, 1991; Burakowski, Ślipiński, 2000] or two-jointed [Pakaluk, 1984; Tomaszewska, 2005]. Actual number of palpomeres can be established by the analysis of chaetotaxy (Figs 29–33). In various Endomychidae larvae studied (see Material and methods) prementum has conservative pair of ventral setae: one microseta located near the border with mentum (for convenience coded as LA_1), and other macroseta situated more or less anteriorly from it (LA_2). Truly two-jointed labial palps can be observed, for example, in *Endomychus coccineus* (Endomychinae), where distinct border between palpomeres exists (Fig. 29); palpomere I ventrally with basal microseta on outer edge (LA_3) and pore near inner edge (LA_b); palpomere II with single ventral pore (LA_c). In all Lycoperdininae larvae studied palpomere I fused with palpomere II, thus forming single-jointed palps; it can be proved by the position of LA_3 and LA_{b-c} (Figs 30–33). In paper of Tomaszewska [2005] "palpomere I" of *Aphorista* Gorham, 1843, *Amphisternus*, *Corynomalus* Chevrolat, 1836, *Lycoperdina* and *Mycetina* Mulsant, 1846 larvae is figured bearing LA_1, LA_2 or both of them, but actually it is no more than palpifer to which these setae may be shifted occasionally in case of prementum size reduction.

So, within Endomychidae, two-jointed labial palps are characteristic for Endomychinae (incl. Stenotarsinae), Leiestinae, Merophysiinae, Pleganophorinae and Xenomycetinae [Sasaji, 1978; Tomaszewska, Zaitsev, 2012; Burakowski, Ślipiński, 2000; Silvestri, 1912; Kemner, 1924; Johnson, 1986; Tomaszewska, 2004] and single-jointed labial palps are typical for Lycoperdininae as well as Epipocinae [McHugh, Pakaluk, 1997].

Because of the high morphological diversity of larval Lycoperdininae, no characters have been proposed so far that unite them [Burakowski, Ślipiński, 2000; Tomaszewska, 2005], so the presence of single-jointed labial palps in all studied representatives of this subfamily could become such feature. Moreover, as this character is also typical for Epipocinae, and high degree of similarity between larvae of these subfamilies have been observed earlier [Tomaszewska, 2005], it could serve as the reliable synapomorphy of this group.

Acknowledgements. The author is greatly indebted to Dr. K.V. Makarov (MPGU, Russia) for the permission of using the photo of *L. smirnoviorum* adult and valuable suggestions during the study, Dr. H. Yoshitomi (Ehime Univer-



Figs 29–33. Endomychidae larvae, prementum: 29 — *Endomychus coccineus*; 30 — *Corynomalus* sp.; 31 — *Mycetina marginalis*; 32 — *Lycoperdina smirnoviorum*; 33 — *Aphorista vittata*. Not to scale.

Рис. 29–33. Личинки Endomychidae, прементум: 29 — *Endomychus coccineus*; 30 — *Corynomalus* sp.; 31 — *Mycetina marginalis*; 32 — *Lycoperdina smirnoviorum*; 33 — *Aphorista vittata*. Без масштаба.

sity, Japan) for sending hard-to-find papers and A.V. Petrov (IFS RAS, Russia) for providing with *Corynomalus* larvae. Special thanks to the administration and staff of the Land of the Leopard National park (Russia, Primorsky Krai) for the opportunity to conduct the research.

References

Arriaga-Varela E., Tomaszewska W. 2016. *Hylaperdina squamosa*, a new species of Neotropical Lycoperdininae (Coleoptera, Endomychidae) from Brazil // Zootaxa. Vol. 4161. No.4. P. 567–572. Doi: 10.11646/zootaxa.4161.4.8.

Böving A.G. 1929. On the classification of beetles according to larval characters // Bulletin of the Brooklyn Entomological Society. Vol.24. No.2. P.55–97.

Böving A.G., Craighead F.C. 1931. An illustrated synopsis of the principal larval forms of the order Coleoptera // Entomologica Americana. Vol.11. P.1–351.

Burakowski B., Ślipiński A. 2000. The larvae of Leiestinae with notes on the phylogeny of Endomycidae (Coleoptera: Cucujoidea) // Annales Zoologici. Vol.50. P.559–573.

Chapuis M.F., Candèze M.E. 1853. Catalogue des larves des Coléoptères, connues jusqu'a ce jour: avec la description de plusieurs espèces nouvelles // Memoires de la Société royale des sciences de Liége. T.8. P.347–653. Doi: 10.5962/bhl.title.10014.

Das G.M. 1937. The Musculature of the Mouth-Parts of Insect Larvae // Journal of Cell Science. Vol.80. Is.317. P.39–77. Doi: 10.1242/jcs.s2-80.317.39.

Dufour L. 1854. Des métamorphoses de divers Coléoptères // Annales de la Société entomologique de France. Ser.3. T.2. P.647–664.

Ford E.J., Spilman T.J. 1979. Biology and immature stages of *Dirrhagofarsus lewisi*, a species new to the United States (Coleoptera, Eucnemidae) // The Coleopterists Bulletin. Vol.33. No.1. P.75–84.

Gusakov A.A. 2017. A new species of handsome fungus beetles, *Lycoperdina smirnoviorum* (Coleoptera: Endomychidae), from the South of the Russian Far East // Humanity space. International almanac. Vol.6. No.5. P.830–836.

Hayashi N. 1959. Illustrated insect larvae of Japan. (Ed. Kawada). Tokyo: Hokuryukan. 420 pp.

Hayashi N. 1978. A contribution to the knowledge of the larvae of Nitidulidae occurring in Japan (Coleoptera : Cucujoidea) // Insecta Matsumurana. New series. Vol.14. P.1–97.

Hayashi N., Nakamura M. 1953. Description on the larvae of three genera, Japanese Endomychidae (Coleoptera) // New Entomologists. Vol.3. P.26–34.

Johnson P. 1986. A description of the late-instar larva of *Xenomycetes laversi* Hatch (Coleoptera: Endomychidae) with notes on the species's host and distribution // Proceedings of the Entomological Society of Washington. Vol.88. P.666–672.

Kemner N. 1924. Über die Lebensweise und Entwicklung des ungeblich myrmecophilen oder termitophilen Genus *Trochoideus* (Col. Endomych.), nach Beobachtungen über *Trochoideus termitophilus* Roepke auf Java // Tijdshrift voor Entomologie. Vol.67. P.180–194.

Lawrence J.F. 1991. Order Coleoptera (general discussion, family key, 88 family treatments) // Stehr F.W. (ed.). Immature Insects. Vol.2. Dubuque, Iowa: Kendall/Hunt Publishing Co. P.144–658.

Lawrence J.F., Hastings A.M., Dallwitz M.J., PaineT. A., Zurcher E.J. 1999. Beetle Larvae of the World: Descriptions, Illustrations, Identification, and Information Retrieval for Families and Sub-families. CD-ROM, Version 1.1 for MS-Windows. CSIRO Publications: Melbourne.

McHugh J., Pakaluk J. 1997. Review of the larval stages of Epipocinae (Insecta: Coleoptera: Endomychidae) // Annales Zoologici. Vol.47. P.59–77.

Pakaluk J. 1984. Natural history and evolution of *Lycoperdina ferruginea* (Coleoptera, Endomychidae) with description of immature stages // Proceedings of the Entomological Society of Washington. Vol.86. P.312–325.

Peterson A. 1951. Larvae of insects. Part II. Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera. Edward Brothers, Inc., Columbus, OH. 416 pp.

Sasaji H. 1978. On the larva of a predaceous endomychid, *Saula japonica* Gorham (Coleoptera) // Kontyû. Vol.46. No.1. P.24–28.

Shockley F.W., Tomaszewska K.W., McHugh J.V. 2009. An annotated checklist of the handsome fungus beetles of the world (Coleoptera: Cucujoidea: Endomychidae) // Zootaxa. Vol.1999. P.1–113.

Silvestri F. 1912. Contribuzione alla conoscenza dei mirmecofili. II. Di alcuni Mirmecofili dell 'Italia meridionale e della Sicilia // Bollettino del Laboratorio di zoologia generale e agraria della R. Scuola superiore d'agricoltura in Portici. Vol.6. P.222–245.

Sogoh K., Yoshitomi H. 2017. Revision of the genus *Lycoperdina* (Coleoptera: Endomychidae) from Japan // Japanese Journal of Systematic Entomology. Vol.23. No.1. P.103–112.

Tomaszewska W. 2004. Larvae of *Xenomycetes* with description of mature larva of *X. morrisoni* Horn, 1880 (Coleoptera: Endomychidae) // Genus. Vol.15. No.2. P.163–171.

Tomaszewska W.K. 2005. Phylogeny and generic classification of the subfamily Lycoperdininae with a re-nalysis of the family Endomychidae (Coleoptera: Cucujoidea) // Annales Zoologici. Vol.55. P.1–172.

Tomaszewska W., Zaitsev A. 2012. Larva of *Ectomychus basalis* Gorham (Coleoptera, Endomychidae, Stenotarsinae) and its phylogenetic implication // Deutsche Entomologische Zeitschrift (neue Folge). Vol.59. No.1. P.81–90. Doi: 10.1002/mmnd.201200005.