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Contribution to the larval morphology of the third-instar larvae of *Laccophilus hyalinus* (DEG.) and *L. minutus* (L.) (*Coleoptera*: *Dytiscidae*)

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ABSTRACT. Larvae of *Laccophilus hyalinus* (DEG.) and *L. minutus* (L.) are redescribed, including several new diagnostic characters.

Key words: entomology, morphology, larvae, *Coleoptera*, *Dytiscidae*, *Laccophilus*.

INTRODUCTION

Laccophilus LEACH is represented by two species: *Laccophilus hyalinus* (DEG.) and *L. minutus* (L.) in Belarus. Their larvae are difficult to identify. The larvae of all instars of these species were described by BERTRAND (1928). He proposed the keys for identification which were based on the coloration, shape, and comparative size characteristics ("short - long", "narrow-wide") of head and body. The descriptions of larvae of *L. testaceus* AUBÉ (I, II, III instars) and *L. minutus* (L.) (II, III instars) were made by DE MARZO (1976). The only character that he used in the identification keys was the number of setae on the clypeal margin. The comparative characteristics of the size of head, body, and last abdominal segment and its chaetotaxy were used in the identification keys in GALEWSKI's (1978) work. Such characters as size of head and last abdominal segment, and the number of the setae of clypeal margin were used for identification of larvae in a recent work (KLAUSNITZER 1991). Therefore, many characters were used. However, all are in need of clarification. It is necessary to use a morphometric analysis for estimation of comparative size characteristics. At present, secondary chaetotaxy of legs is used successfully for identification of

species for larvae of the last instars. However, secondary setae on legs of mature larva were described by De Marzo (1976) only for *L. hyalinus* (Deg.) (as *L. testaceus* Aubé) and were not named. Therefore, it is important to study and compare secondary chaetotaxy of the legs of the larvae of *L. hyalinus* (Deg.) and *L. minutus* (L.).

MATERIAL AND METHODS

The third-instar larvae of *Laccophilus hyalinus* (Deg.) (15 spm.) and *L. minutus* (L.) (11 spm.) were studied. The larvae of *L. hyalinus* (Deg.) were collected in the Adrov River (near t. Baran, Orsha Dist., Vitebsk Prov., Belarus) on 6 July 1997. The larvae of *L. minutus* (L.) were collected in pond (near v. Bolshoe Selistche, Kamenets Dist., Brest Prov., Belarus) on 26 July 1995. Larvae were reared to obtain adult specimens to verify the identification. The larvae were fixed and preserved in 70% ethanol. Then they were disarticulated and mounted in constant (For's medium) and temporary (glycerin) preparations. The preserved material is deposited at the Laboratory of Entomology, Institute of Zoology, National Academy of Sciences of Belarus.

Morphometric analysis

Measurements were made with stereoscopic microscopes, MBS-10, MPSU-1, equipped with a micrometre eyepiece. The part to be measured was adjusted so that it was, as nearly as possible, parallel to the plane of the objectives. Length was measured along the longitudinal mid-line of the body part, and width was taken at the widest point.

The characters and terms used in the motphometric analysis are following (including those of Alarie et al. (1990b) and Alarie (1991)):

HL - total head length; HW- maximum head width; HL/HW - relative elongation of the head.

Antenna: AL - length of the antenna derived by adding the length of each segment including the longest last ones; AL/HW - relative length of the antenna. The lengths of all segments were compared with each other - A1L/A2L; A1L/A3L; A2L/A3L.

Mandible: MndL - maximum length of the mandible; MndL/HW - relative length of the mandible.

Maxilla: StpL - length of the maxillary stipes; StpL/HW - relative length of the maxillary stipes; PALmxL - length of the maxillary palpus derived by adding the length of each segment; PALmxL/HW - relative length of the maxillary palpus; StpL/PALmxL - ratio of the length of the stipes to the length of the maxillary palpus. The lengths of the segments (II, III, IV) were compared with each other - PALmx2L/PALmx3L; PALmx3L/PALmx4L.

Prementum: PrmW - maximum width of the prementum; PrmW/HW - relative width of the prementum; PALprmL - length of the labial palpus derived by adding the length of each segment; PALprmL/HW - relative length of the labial palpus; PALprmL/PALmxL - ratio of the length of the labial palpus to the length of the maxillary palpus.

Legs: the lengths of each segment and both claws were measured. The lengths of all segments, including the claws, were compared. The lengths of the legs (ProlegL, MesolegL, MetalegL) were derived by adding the length of each segment including the lowest claw. The relative lengths of the legs (ProlegL/HW, MesolegL/HW, MetalegL/HW) were calculated.

Body: BL - length of the body without head and urogomphus; the width and length of the segments of thorax (PronW(L), MesonW(L), MetanW(L)) and of 3 first segments of abdomen (Abs1W(L), Abs2W(L), Abs3W(L)) were measured. The length and width of each segment were compared. LLAS - length of the last abdominal segment, LLAS/HW - relative length of the last abdominal segment; WLAS - width of base of the last abdominal segment; LLAS/WLAS - relative elongation of the last abdominal segment; LS - length of the siphon - the dorsal prolongation of the last abdomina1 segment, LS/LLAS - ratio of the length of the siphon to the length of the last abdominal segment.

URL - length of the urogomphus; URL/LLAS - ratio of the length of the urogomphus to the length of the last abdominal segment; URL/HW - relative length of the urogomphus.

Chaetotaxic analysis

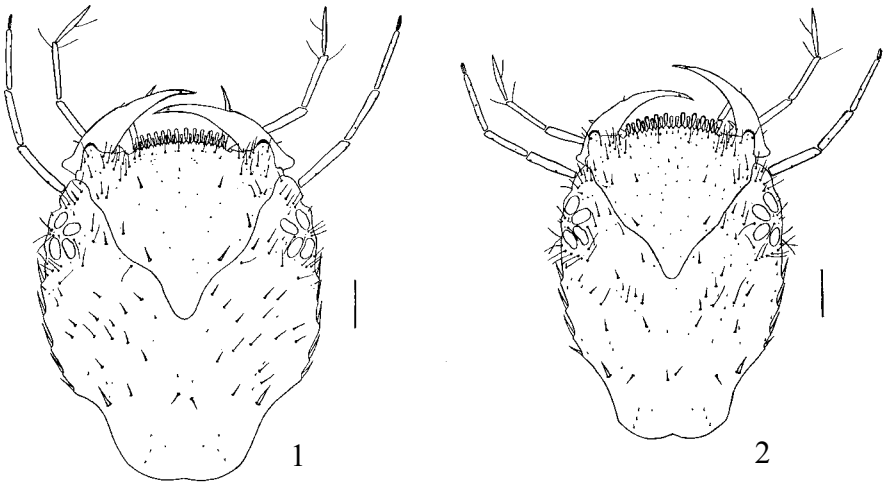
Study of chaetotaxy was carried out with microscope MBB-1A. The distinction between primary and secondary setae and pores of legs was made. The primary setae and pores of legs were coded according to the system proposed by Nilsson (1988) and Alarie et al. (1990a). The secondary setae were named in accordance with the system proposed by Wolfe and Roughley (1985, modified by Nilsson 1986, 1987a, 1987b). The series of secondary setae were divided into anterior (A), posterior (P), dorsal (D), ventral (V), proximal (Pr), and distal (Di) ones depending on their positions. V series of the setae of coxa and trochanter include AV, PV, and V setae. All counts of sensillar series include only the secondary setae.

REDESCRIPTION OF THE THIRD-INSTAR LARVA OF *LACCOPHILUS HYALINUS* (DEG.)

Colour. Dorsal surface of head creamy white to pale creamy yellow with pale yellowish brown darkenings on clypeal and lateral margins, in the center (near the forking of epicranial suture) of head and on lateral margins of neck; these darkenings include numerous small, brown, more or less evident spots; darkening on clypeal margin forms two parts in majority of specimens; two brown (or dark

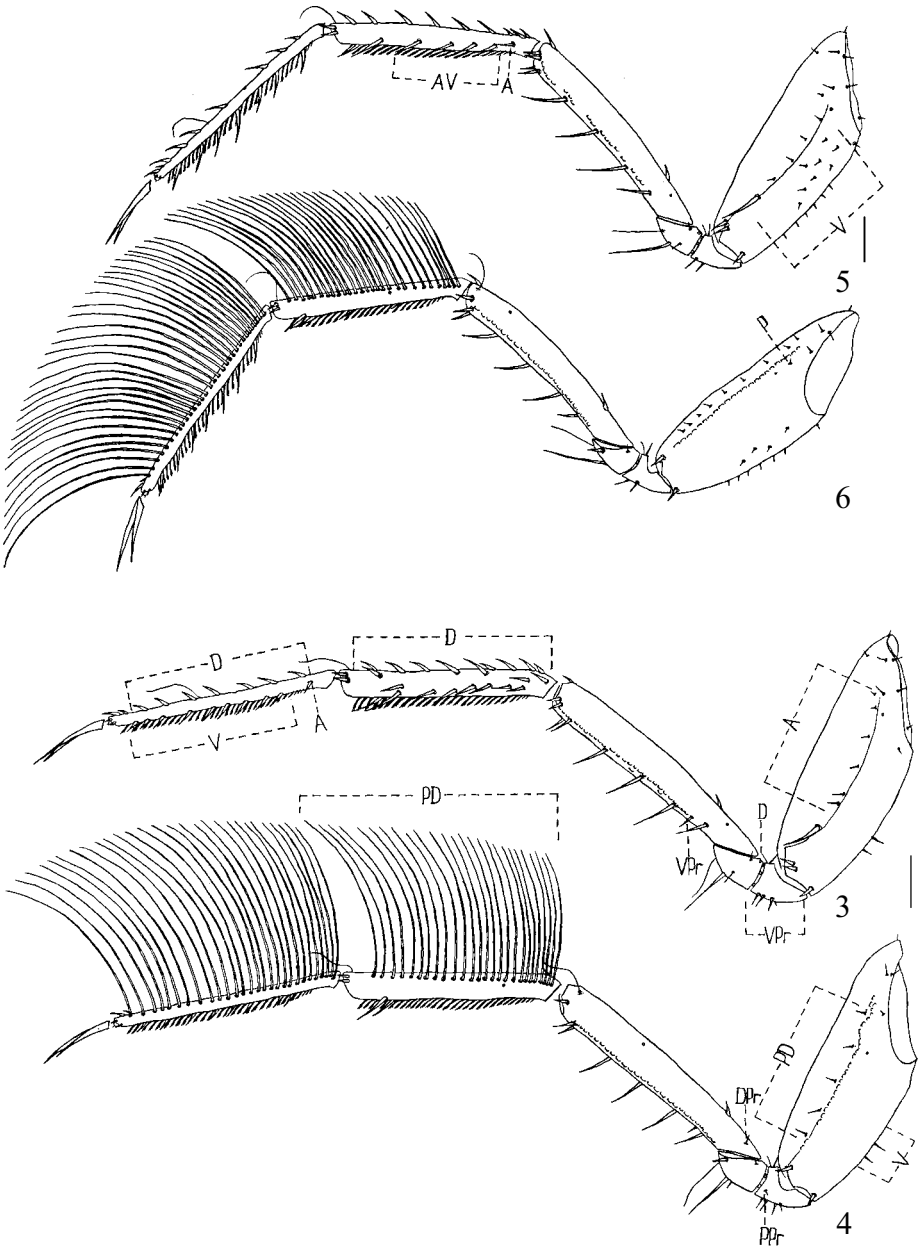
brown) large patches stand out against a background of darkening near the forking of epicranial suture; ventral surface of head white to pale creamy yellow without spots but with pale brown broken ring on the neck; head appendages pale creamy yellowish to pale creamy, mandibles bright brown apically, sclerites of body cream yellow to pale yellow with numerous small brown spots more or less contrasting, abdominal sclerites darker (reddish) than thoracic ones because of internal organs; parts of membranes bordering on sclerites dark brown; ventral surface of body pale creamy yellowish to white; legs white basally, pale yellow apically (tibia, tarsus); urogomphus pale creamy yelIow, darkened basally; points of insertion of setae darkened on all the surface of larva; living larva pale green, especially head and ventral surface of body.

Head (fig. 1). Cephalic capsule large and roundish with strongly pronounced neck; temporal angles evident; lateral margin of epicranium with 4-5 spiniform setae; clypeal margin broad, rounded with 2 ranges of lamelliform setae: anterior - 13-14 setae, posterior - 14-16 smaller ones arranged between setae of anterior range. HL = 1.3-1.4 mm ($\bar{x}$ = 1.38 mm); HW = 1.1-1.2 mm ($\bar{x}$ = 1.18 mm); HL/HW = 1.13-1.22 ($\bar{x}$ = 1.17).



1-2. Head dorsal: 1 - *Laccophilus hyalinus*, 2 - *L. minutus*.
Scale 0.2 mm

Legs (figs. 3, 4). All legs long and slender; position and form of primary setae and pores as described by NILSSON (1988) for genus *Laccophilus* except for setae: TR_3 (AV), FE_6 (PDDi) and pores: TR_a (ADDi), TR_B (D); setae T_{14} and T_{15} have PV position on prothoracic legs, FE_1 slightly displaced on posterior surface in some specimens; secondary setae (spiniform, spines, except for the natatory setae) present on every segment of legs; position and number of secondary setae as in Table 1.



3-6. Metathoracic legs: 3, 4 - *Laccophilus hyalinus*, 5, 6 - *L. minutus*.
Scale 0.2 mm

Coxa. Spines of V series small on pro- (present in 9 of the studied larvae) and mesocoxa (in 2 larvae) and coarse on metacoxa (in 4 larvae), these spines present on one leg of pair in most specimens; P spines present on proximal part of procoxa of 2 specimens.

Trochanter. All secondary setae present on proximal part of trochanter, PPr spines present on pro- (in 1 larva) and metatrochanter (in 3 larvae); in most studied larvae spines of V series slightly displaced on anterior and posterior surfaces in equal number.

Femur. Secondary setae: very small ADPr spine on profemur of 1 larva, VPr spines on meso- (in 2 larvae) and metafemur (in 2 larvae), DPr spine on metafemur of 1 larva.

Tibia. Setae of PD series are natatory setae; spines of D, A, and AV series mingled in most specimens. A spines of protibia proximal in position.

Tarsus. Setae of PD series are natatory setae; A spines present on meso- (in 2 larvae) and metatarsus (in 4 larvae), these spines are most likely derived from V series.

Body (figs. 7, 9). Larva broad; BL = 4.35-5.85 mm ($\bar{x}$ = 5.15 mm); broadest at pronotum, PronW = 1.78-1.93 mm ($\bar{x}$ = 1.83 mm); MesonW = 1.50-1.65 mm ($\bar{x}$ = 1.58 mm); width of metanotum equal to mesonotum, width of 3 first abdominal tergites equal, Abs1W = 1.4-1.55 mm ($\bar{x}$ = 1.48 mm); PronW/PronL = 1.95-2.15 ($\bar{x}$ = 2.06); MetanW/MetanL = 5.17-6.30 ($\bar{x}$ = 5.68); last abdominal segment broader, LLAS = 0.78-0.90 mm ($\bar{x}$ = 0.83 mm); LLAS/HW = 0.66-0.75 ($\bar{x}$ = 0.71); WLAS = 0.5-0.57 mm ($\bar{x}$ = 0.54 mm); LLAS/WLAS = 1.60-1.76 ($\bar{x}$ = 1.66); body with robust, distinct setae; urogomphus 2-segmented (second segment reduced) with subbasal suture, UL = 1.85-2.13 mm ($\bar{x}$ = 1.97 mm); UL/HW = 1.60-1.77 ($\bar{x}$ = 1.67); urogomphus with 45-49 setae of two kinds: short, robust and long, more slender.

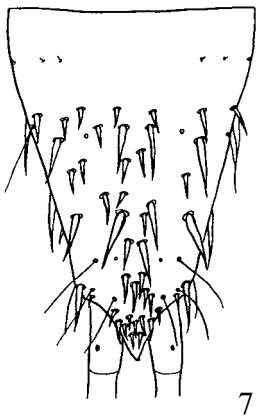
REDESCRIPTION OF THE THIRD INSTAR LARVA OF *LACCOPHILUS MINUTUS* (L.)

Colour. Like the third-instar larva of *L. hyalinus* (DEG.), but paler, less contrasting; small brown spots indistinct on the darkenings.

Head (fig. 2). Cephalic capsule narrow and elongate with strongly pronounced neck; temporal angles indistinct; lateral margin of epicranium with 3-4 spiniform setae; clypeal margin almost rectilinear with 1 range of 20-21 lamelliform setae; HL = 1.23-1.35 mm ($\bar{x}$ = 1.30 mm); HW = 0.95-1.05 mm ($\bar{x}$ = 0.99 mm); HL/HW = 1.17-1.40 ($\bar{x}$ = 1.31).

Legs (figs. 5, 6). All legs long and slender; position and form of primary setae and pores as in larva of *L. hyalinus* (DEG.) but setae T_{14} and T_{15} have V position on prothoracic legs, seta CO_7 has a more V position; secondary setae (spiniform, spines, except for the natatory setae) present on every segment of legs; position and number of secondary setae as in Table 1.

Coxa. Spines of V series numerous; P spines present on proximal part of pro- (in 7 larvae), meso- (in 3 larvae), and metacoxa (in 1 larvae).



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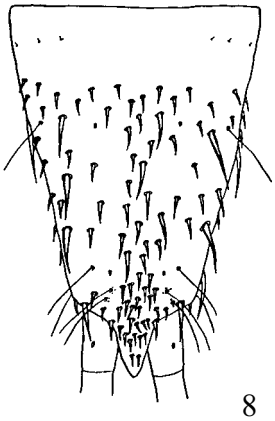

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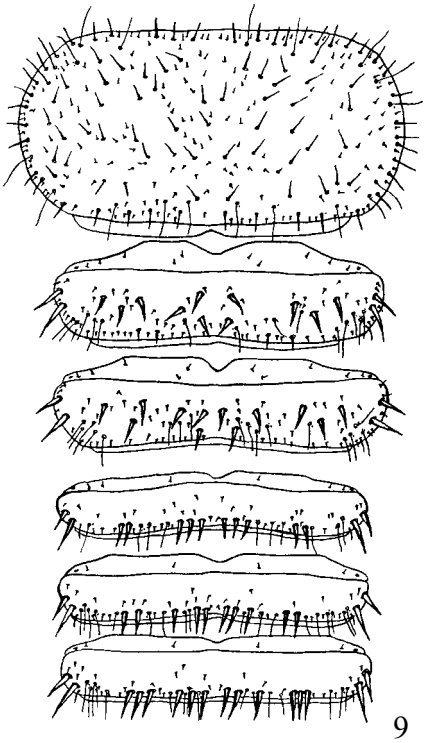

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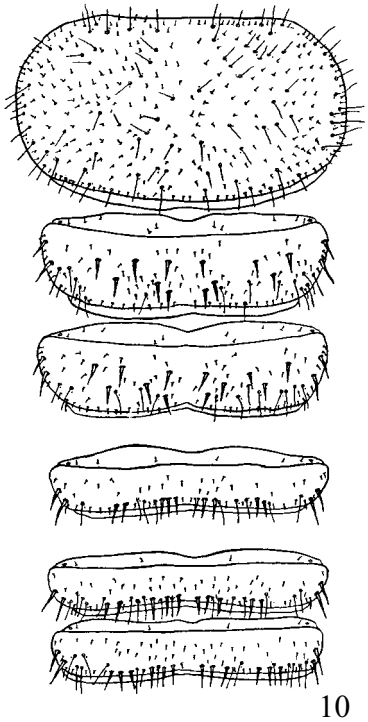

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7-10. Body: 7, 9 - *Laccophilus hyalinus*, 8, 10 - *L. minutus.* Scale 0.2 mm

Trochanter. All secondary setae present on proximal part of trochanter; APr (in 3 larvae) and PPr (in 1 larva) spines present on mesotrochanter; in most studied larvae spines of V series distinctly displaced on anterior surface.

Table 1. Number of secondary setae on the legs of the third-instar larvae of *Laccophilus hyalinus* and *L. minutus*

Species	Sensillar series																		
	ProCO				ProTR				ProFE			ProTI				ProTA			
	A	V	PD	P	D	VPr	APr	PPr	DPr	VPr	ADPr	D	PD	A	AV	D	PD	A	V
L.hyalinus	4-9	0-2	6-10	0-1	0-1	1-3	-	0-1	-	-	0-1	4-8	18-23	0-3	-	3-6	17-26	-	2-4
L. minutus	4-7	6-14	8-15	0-2	0-1	1-2	-	-	0-1	-	-	5-9	18-27	1-2	-	4-6	18-27	-	2-4
	MesoCO				MesoTR				MesoFE			MesoTI				MesoTA			
	A	V	PD	P	D	VPr	APr	PPr	DPr	VPr	ADPr	D	PD	A	AV	D	PD	A	V
L.hyalinus	4-9	0-1	5-10	-	0-1	1-4	-	-	-	0-1	-	6-10	21-27	0-5	0-4	3-8	22-33	0-1	5-8
L. minutus	5-9	8-20	5-14	0-2	0-1	1-2	0-1	0-1	0-1	0-1	-	5-10	21-31	0-3	0-4	4-7	23-31	0-1	3-7
	MetaCO				MetaTR				MetaFE			MetaTI				MetaTA			
	A	V	PD	P	D	VPr	APr	PPr	DPr	VPr	ADPr	D	PD	A	AV	D	PD	A	V
L.hyalinus	5-10	0-2	4-8	-	0-1	2-5	-	0-2	0-1	0-1	-	8-13	23-35	0-9	0-10	7-10	27-36	0-2	7-11
L. minutus	4-9	8-20	6-10	0-1	0-1	1-3	-	-	0-1	-	-	7-12	24-29	0-3	2-5	5-9	28-34	-	4-9

Femur. Secondary setae: DPr spine on pro- (in 1 larvae), meso- (in 2 1arvae), and metafemur (in 7 larvae), VPr spines on mesofemur (in 4 larvae).

Tibia. Setae of PD series are natatory setae; spines of A and AV series mingled in most specimens on meso- and metatibia; A spines of protibia proximal in position.

Tarsus. Setae of PD series are natatory setae; A spines present on mesotarsus in 2 larvae, these spines are most likely derived from V series.

Body (figs. 8, 10). Larva slender; BL = 4.15-6.05 mm ($\bar{x}$ = 4.99 mm); broadest at pronotum, PronW = 1.48-1.60 mm ($\bar{x}$ = 1.56 mm); MesonW = 1.25-1.38 mm ($\bar{x}$ = 1.35 mm); width of metanotum subequal to mesonotum, width of 3 first abdominal tergites subequal, Abs1W = 1.24-1.33 mm ($\bar{x}$ = 1.28 mm); PronW/PronL = 1.72-1.91 ($\bar{x}$ = 1.86); MetanW/MetanL = 4.08-5.09 ($\bar{x}$ = 4.66); last abdominal segment more elongate, LLAS = 0.83-0.90 mm ($\bar{x}$ = 0.87 mm); LLAS/HW = 0.81-0.95 ($\bar{x}$ = 0.89); WLAS = 0.45-0.48 mm ($\bar{x}$ = 0.46 mm); LLAS/WLAS = 1.90-2.00 ($\bar{x}$ = 1.94); body with more slender, numerous setae; urogomphus 2-segmented (second segment reduced) with subbasal suture, UL = 1.90-2.15 mm ($\bar{x}$ = 2.00 mm); UL/HW = 1.95-2.13 ($\bar{x}$ = 2.03); urogomphus with 41-49 setae of two kinds: short, robust and long, more slender.

Morphometric analysis has shown that head appendages and legs of *L. hyalinus* (DEG.) are longer in absolute length: e. g. AL_h = 0.76-0.83 mm ($\bar{x}$ = 0.80 mm); AL_m,= 0.69-0.75 mm ($\bar{x}$ = 0.71 mm); $ProlegL_h$ = 2.93-3.14 mm ($\bar{x}$ = 3.01 mm); $ProlegL_m$ = 2.72-2.89 mm ($\bar{x}$ = 2.77 mm) but shorter in comparison to HW: e. g. AL/HW_h = 0.66-0.70 ($\bar{x}$ = 0.68); AL/HW_m = 0.70-0.77 ($\bar{x}$ = 0.73); $ProlegL/HW_h$ = 2.46-2.68 ($\bar{x}$ = 2.57); $ProlegL/HW_m$ = 2.73-2.96 ($\bar{x}$ = 2.83) than

those of *L. minutus* (L.). However, it is difficult to use all the measurements of head appendages and legs. Interspecific variation was observed in absolute and relative size of most head appendages, their segments, and the segments of legs. Also interspecific variation was found in some measurements of urogomphus, head (in particular HL/HW), body, and its parts (in particular LLAS). Some parameters, for example HW, widths of thorax and abdominal tergites, WLAS, LLAS/WLAS, and others, as well as secondary chaetotaxy of the legs are found to be useful for identification. Diagnostic characters of the third-instar larvae of the studied species are listed in Table 2.

Table 2. Diagnostic characters of the third-instar larva of *L. hyalinus* (DEG.) and *L. minutus* (L.)

***L. hyalinus* (DEG.)**	***L. minutus* (L.)**
Clypeal margin broadly rounded with 2 ranges of lamelliform setae: anterior - 13-14 setae, posterior - 14-16 smaller ones.	Clypeal margin almost rectilinear with 1 range of 20-21 lamelliform setae.
Coxa of all legs without spines of V series or with only 1-2 spines.	Coxa of all legs with numerous spines of V series.
Head broad and roundish with evident temporal angles; HW = 1.1-1.2mm ($\bar{x}$ = 1.18 mm).	Head narrow and elongate with indistinct temporal angles; HW = 0.95-1.05 mm ($\bar{x}$ = 0.99 mm).
Tergites of body broader; PronW = 1.78-1.93 mm ($\bar{x}$ = 1.83 mm); MesonW = 1.50-1.65 mm ($\bar{x}$ = 1.58 mm); AbslW = 1.4-1.55 mm ($\bar{x}$ = 1.48 mm); PronW/PronL = 1.95-2.15 ($\bar{x}$ = 2.06).	Tergites of body narrow; PronW = 1.48-1.60 mm ($\bar{x}$ = 1.56 mm); MesonW = 1.25-1.38 mm ($\bar{x}$ = 1.35 mm); AbslW = 1.24-1.33 mm ($\bar{x}$ = 1.28 mm); PronW/PronL = 1.72-1.91($\bar{x}$ = 1.86).
Last abdominal segment shorter and broader; LAS/HW = 0.66-0.75 ($\bar{x}$ = 0.71); WLAS = 0.50-0.57 mm ($\bar{x}$ = 0.54 mm); LLAS/WLAS = 1.60-1.76 ($\bar{x}$= 1.66).	Last abdominal segment more elongate and slender, LAS/HW= 0.81-0.95 ($\bar{x}$ = 0.89); WLAS = 0.45-0.48 mm ($\bar{x}$ = 0.46 mm); LLAS/WLAS = 1.90-2.00 ($\bar{x}$ = 1.94).
Urogomphus shorter; UL/HW = 1.60-1.77 ($\bar{x}$ = 1.67).	Urogomphus longer; UL/HW = 1.95-2.13 ($\bar{x}$ = 2.03).
Setation of dorsal surface of segments of body sparser and robust.	Setation of dorsal surface of segments of body abundant and more delicate.
Coloration of larva brighter with more contrasting pattern.	Coloration of larva paler with indistinct pattern.

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