

RESEARCH PAPER

New species of bristletails of the genus *Lepismachilis* (Archaeognatha: Machilidae) from Serbia and Montenegro

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Abstract. The fauna of bristletails of the genus *Lepismachilis* Verhoeff, 1910 in Montenegro and Serbia includes only one species *L. (Berleselis) targionii* (Grassi, 1887) with 2 + 2 eversible vesicles on abdominal urocoxites II–VI. Three new species of this genus are described: *L. (Lepismachilis) prijepolja* sp. nov., *L. (Lepismachilis) limensa* sp. nov. from Serbia, and *L. (Lepismachilis) alexandrae* sp. nov. from Montenegro. All described new species belong to the species group of the subgenus *Lepismachilis* s. str. with 2 + 2 eversible vesicles on abdominal urocoxites II–V. *Lepismachilis prijepolja* sp. nov. differs from *L. γ-signata* Kratochvíl, 1945 and *L. notata* Stach, 1919 by the color, drawings and ratios of the compound eyes; ratios of sensory field on fore femur of male, number of divisions of ovipositor. *Lepismachilis limensa* sp. nov. differs from *L. hauseri* Bitsch, 1974 and *L. abchasica* Kaplin, 2017 by ratios of paired ocelli, sensory field on fore femur of male; ratios and chaetotaxy of maxillary and labial palps. *Lepismachilis alexandrae* sp. nov. differs from *L. abchasica* by the drawings of the compound eyes; ratios of paired ocelli, sensory field on fore femur of male; number of divisions of the parameres and gonapophyses. A list of the Machilidae occurring in Balkan Peninsula is also provided.

Key words. Archaeognatha, Machilidae, *Lepismachilis*, new species, taxonomy, Balkan Peninsula, Palaearctic Region

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Introduction

The fauna of bristletails of the family Machilidae in the Balkans is poorly studied and includes 36 species from 10 genera (Table 1). Of these, 35 species belong to the subfamily Machilinae and one species to the subfamily Petrobiinae. The genus *Trigoniophthalmus* Verhoeff, 1910 includes 11 species, *Lepismachilis* Verhoeff, 1910 – 8 species, *Silvestrichilis* Wygodzinsky, 1950 and *Charimachilis* Wygodzinsky, 1939 – 4 species each, *Trigoniomachilis* Stach, 1937 and *Stachilis* Janetschek, 1957 – 3 species each, *Machilis* Latreille, 1832, *Praetrigoniophthalmus* Janetschek, 1954, *Wygodzinskyilis* Janetschek, 1954 and *Petrobius* Leach, 1809 with 1 species from each genus. The largest number of species are known from Greece, Bulgaria and Croatia (17, 11 and 10 species, respectively) (SILVESTRI 1908, 1942; VERHOEFF 1910; STACH 1919, 1922, 1937, 1939, 1958; WYGODZINSKY 1941, 1958; KRATOCHVÍL

1945; JANETSCHKE 1954a,b; BITCH 1974; BACH DE ROCA et al. 2011; MENDES 2017).

The fauna of bristletails of the family Machilidae of Serbia and Montenegro is practically unstudied and includes only 4 species: *Lepismachilis (Berleselis) targionii* (Grassi, 1887), *Stachilis catamachilideus* (Stach, 1958), *Trigoniophthalmus alternatus* (Silvestri, 1904) and *T. remyi* Wygodzinsky, 1958 (STACH 1958, WYGODZINSKY 1958, MENDES 2017). Examination of bristletails collected in Serbia and Montenegro in August 2017 revealed three new species of the genus *Lepismachilis*, which are described in the present work.

The genus *Lepismachilis* includes two subgenera: *Lepismachilis* s. str. and *Berleselis* Verhoeff, 1910 with 2 + 2 coxal vesicles on male and female urites II–V (*Lepismachilis*) or II–VI (*Berleselis*). Now the numbers of the described species are 26 in *Lepismachilis* s. str.



Table 1. Bristletails of the family Machilidae of the Balkan Peninsula (after SILVESTRI 1908, 1942; VERHOEFF 1910; STACH 1919, 1922, 1937, 1939, 1958; WYGODZINSKY 1941, 1958; KRATOCHVÍL 1945; JANETSCHKEK 1954a,b; BITCH 1974; BACH DE ROCA et al. 2011; MENDES 2017).

Species	Distribution (country, region)
Subfamily Machilinae	
<i>Lepismachilis (Lepismachilis) notata</i> Stach, 1919	Albania, Austria, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Hungary
<i>Lepismachilis (Lepismachilis) y-signata</i> Kratochvíl, 1945	Austria, Croatia, Czech Republic, France, Germany, Hungary, Italy, Luxembourg, Poland, San Marino, Slovakia
<i>Lepismachilis (Lepismachilis) janetscheki</i> Stach, 1958	Bulgaria, Italy, Spain
<i>Lepismachilis (Lepismachilis) Janetschek</i> , 1959	Croatia
<i>Lepismachilis (Lepismachilis) hauseri</i> Bitch, 1974	Greece
<i>Lepismachilis (Lepismachilis) hoferi</i> Bitch, 1974	Greece, Spain
<i>Lepismachilis (Lepismachilis) handschini</i> Wygodzinsky, 1952	Greece (Cyclades Is.), Turkey
<i>Lepismachilis (Berlesilis) targionii</i> Wygodzinsky, 1941	Bulgaria, Croatia, France (including Corse), Greece (Dodecanese Is.), Italy (including Sardinia and Sicily), Malta, Montenegro, Romania, Serbia, Slovenia, Spain, North Africa
<i>Machilis (Machilis) albanica</i> (Stach, 1922)	Albania
<i>Praetrigoniophthalmus kuehnelti</i> Janetschek, 1954	Greece, Italy (incl. Sicily)
<i>Wygodzinskylis klinocellata</i> Janetschek, 1954	Croatia, Italy
<i>Trigoniophthalmus alternatus</i> (Silvestri, 1904)	Albania, Austria, Belgium, Croatia, France (including Corse), Germany, Great Britain, Italy, Luxembourg, Poland, Romania, Serbia (Sokobanya), Slovenia, Spain, Switzerland
<i>Trigoniophthalmus remyi</i> Stach, 1939	Austria, Bosnia and Herzegovina, Greece, Italy, Montenegro, Serbia, Slovenia, Spain (Balearic Is.)
<i>Trigoniophthalmus banaticus</i> (Verhoeff, 1910)	Bulgaria, Croatia, Hungary, Romania
<i>Trigoniophthalmus csikii</i> (Stach, 1922)	Albania
<i>Trigoniophthalmus equinus</i> Wygodzinsky, 1958	Macedonia
<i>Trigoniophthalmus graecanicus</i> Wygodzinsky, 1958	Greece
<i>Trigoniophthalmus hussoni</i> Wygodzinsky, 1958	Greece, Italy
<i>Trigoniophthalmus imitator</i> Wygodzinsky, 1958	Croatia
<i>Trigoniophthalmus mimus</i> Wygodzinsky, 1958	Greece
<i>Trigoniophthalmus wygodzinskyi</i> Stach, 1958	Bulgaria
<i>Trigoniomachilis remyiana</i> Wygodzinsky, 1958	Greece
<i>Trigoniomachilis thessalica</i> Wygodzinsky, 1958	Greece
<i>Trigoniomachilis urumovi</i> Stach, 1937	Bulgaria, Greece
<i>Stachilis (Stachilis) catamachilideus</i> (Stach, 1958)	Bulgaria, Montenegro, Serbia
<i>Stachilis (Stachilis) pectinata</i> Janetschek, 1957	Macedonia
<i>Stachilis (Admesomachilis) drenowskii</i> (Stach, 1958)	Bulgaria
<i>Silvestrichilis polyacantha</i> Janetschek, 1959	Greece
<i>Silvestrichilis uncinata</i> Janetschek, 1957	France, Greece
<i>Silvestrichilis heterotarsus</i> (Silvestri, 1942)	Bulgaria
<i>Silvestrichilis macedonica</i> Stach, 1958	Bulgaria
<i>Charimachilis armata</i> Stach, 1958	Bulgaria
<i>Charimachilis dentata</i> Wygodzinsky, 1941	Greece
<i>Charimachilis orientalis</i> (Silvestri, 1908)	Greece, Italy (including Sicily)
<i>Charimachilis relicta</i> Janetschek, 1954	Austria, Croatia, Greece, (including Crete), Italy (including Sicily)
Subfamily Petrobiinae	
<i>Petrobius adriaticus</i> (Verhoeff, 1910)	Croatia, Italy

and 3 species in *Berlesilis*. Among the species of the subgenus *Berlesilis*, *L. (B.) targionii* (Grassi, 1887) is widespread in southern Europe, ranging from Spain to Bulgaria and Romania and to North Africa; *L. (B.) affinis* Gaju-Ricart, Bach de Roca & Molero-Baltanas, 1993 was described from the Balearic Islands, and *L. (B.) rosannae* Kaplin, 2010 from Northern Italy (GAJU-RICART et al. 1993, KAPLIN 2010). Among the species of the subgenus *Lepismachilis* s. str., 21 species are distributed mainly in Southern Europe. Three species were described from Turkey, Iran and Abkhazia, one from each country re-

spectively (WYGODZINSKY 1952; BITSCH 1957, MENDES 1985, KAPLIN 2017). All species of the genus *Lepismachilis* inhabit forests in mountain landscapes. The fauna of bristletails of the genus *Lepismachilis* in Montenegro and Serbia is insufficiently studied, including only one species (*L. (B.) targionii*) (MENDES 2017).

Materials and methods

All specimens of bristletails were collected mainly in southern Serbia and on the southern coast of Montenegro under stones and were preserved in 70% ethanol. The holo-

types and some paratypes are mounted in Faure's solution on permanent microscope slides, the remaining paratypes are preserved in 70% ethanol. The specimens studied are deposited in the collection of the Zoological Institute, Russian Academy of Sciences, St. Petersburg (ZIN).

The following abbreviations are used:

- c distance between the border of the sensory field and the apex of the femur;
 d distance between the border of the sensory field and the basis of the femur;
 LF length of femur;
 LSF length of sensory field;
 WF width of femur;
 WSF width of sensory field.

Taxonomy

Lepismachilis prijepolja sp. nov.

(Figs 1, 2)

Type material. HOLOTYPE: ♂ (slide-mounted, ZIN), **SERBIA:** Zlatibor District, near Prijepolje, 43°32'38"N, 19°39'058"E, Lim valley, 560 m a.s.l., mixed forest, under stones, August 21, 2017, V. Kaplin leg. PARATYPES: 5 ♂♂ 5 ♀♀ (1 ♀ on slide), the same locality, V. Kaplin leg. (ZIN).

Description. Body length: male 10.5–12.3 mm, female 11.5–12.5 mm. Body width: male 2.3–2.6 mm, female 2.4–2.7 mm. General body color whitish, practically without hypodermal pigment. Antennal base, frons, clypeus, labium, mandibles, maxillae with violet-brown hypodermal pigment of weak or medium intensity. Color of scales on surface of body brown, dark brown, or blackish-brown. Antennae of male and female shorter than body. Distal chains of flagellum divided into 8–11 annuli in male and in female (Fig. 1D). Clypeus of male with long thin bristles. Cercus approximately 0.37–0.40 (male) or 0.34–0.36 (female) body length, including about 16–18 divisions. Apex of cercus with two well-developed lateral spines (Fig. 1C). All divisions of cerci, except for apical two, with 2–4 colorless supporting macrochaetae on inner side. Caudal filament without supporting macrochaetae on lateral side.

Compound eyes bicolored, brown with uneven whitish-grey stripes and spots (in alcohol) forming a pattern in the form of butterfly wings in the back of the eyes with two symmetrical longitudinal brown stripes and two transverse light stripes in the front of the eyes (Fig. 1A). Ratio of length to width of compound eye about 1.09–1.14; ratio of length of contact line to length of eyes 0.60–0.66 in both sexes. Paired ocelli sole-shaped, brownish-black with narrow white border, 3.4–4.0 (male) or 3.2–3.6 (female) times as wide as long. Distance between inner margins of paired ocelli 0.25–0.26 and between their outer margins 1.0 total width of compound eyes in both sexes.

Apical article of maxillary palp 0.74–0.76 (male) or 0.86–0.87 (female) times as long as preceding one. Their 5th article 1.2 (male) or 1.4 (female) times as long as 4th article. Dorsal surface of 7th, 6th and 5th articles of maxillary palp with 8–9, 8–9 and 2–3 (male) or 11–14, 10–13 and 3 (female) hyaline spines, respectively. Ventral surface of 2–7th articles of male maxillary palp as well as dorsal surface of 1–3rd articles of male labial palp with relatively numerous ciliary setae (Figs 1E, F).

Apical article of labial palp triangularly oval, 2.5–2.6 (male) or 2.6–2.7 (female) times as long as wide (Figs 1F; 2C). Mandibles with four distal teeth in both sexes (Figs 1B; 2A).

Fore femur and tibia of both sexes widened. Ratios of length to width of femur, tibia and tarsus as shown in Table 2. Ratio of length of 3rd tarsomere to total length of tarsus 0.32–0.33 in both sexes (Fig. 1G). Fore femur of male with opened, well-developed sensory field, including numerous small cluster-like sensilla and short, curved bristles connecting to the distal row of strong

Table 2. Ratios of length to width of main leg articles of *Lepismachilis prijepolja* sp. nov.

Leg articles		Sex	
		Male	Female
Femur	fore	2.04–2.06	1.79–1.81
	middle	2.54–2.59	2.22–2.27
	hind	2.60	2.46–2.51
Tibia	fore	2.35–2.37	2.25
	middle	2.20–2.25	1.80–1.96
	hind	3.68–3.78	2.91–2.93
Tarsus	fore	5.14–5.30	5.40–5.55
	middle	5.11–5.12	4.65–4.67
	hind	7.28–7.45	6.84–7.09

Table 3. Numbers of spines on legs of *Lepismachilis prijepolja* sp. nov.

Segments		Sex and pair of legs					
		Male			Female		
		fore	middle	hind	fore	middle	hind
Tarsomeres	1st	0	4	4–6	2–4	3–4	3–4
	2nd	0	12–14	12–16	4	10	10–12
	3rd	0	0	4–6	0	1–2	0
Tibia		0	4–6	6	2	1–3	2–3
Femur		0	0	8	0	0	2

Table 4. Ratios of lengths of some abdominal structures in *Lepismachilis prijepolja* sp. nov. Stylus length does not include apical spines.

Urites	Urostermite / urocoxite		Stylus / urocoxite		Apical spine / stylus	
	male	female	male	female	male	female
II	0.48	0.59	0.68	0.58	0.45	0.53
III–VI	0.60–0.64	0.70–0.72	0.56–0.62	0.48–0.52	0.50–0.56	0.58–0.62
VII	0.49	0.53	0.56	0.46	0.55	0.65
VIII	0.17	–	0.69	0.72	0.52	0.55
IX	–	–	0.88	0.54	0.40	0.38

Table 5. Distribution of sublateral macro- and mesochaetae on urotergites and urocoxites of *Lepismachilis prijepolja* sp. nov.

Urites	Urotergite		Urocoxite	
	male	female	male	female
I–III	0	0	0	0
IV	1 + 1	1–2 + 1–2	0	0
V	2 + 2	1–2 + 1–2	0	0
VI	2 + 2	2 + 2	0	0
VII	3 + 3	2–3 + 2–3	0	0
VIII	5 + 5	3–4 + 3–4	0	0
IX	5 + 5	4 + 4	0/5 + 4/0	0/5 + 3/0
X	2 + 2	3 + 3	–	–

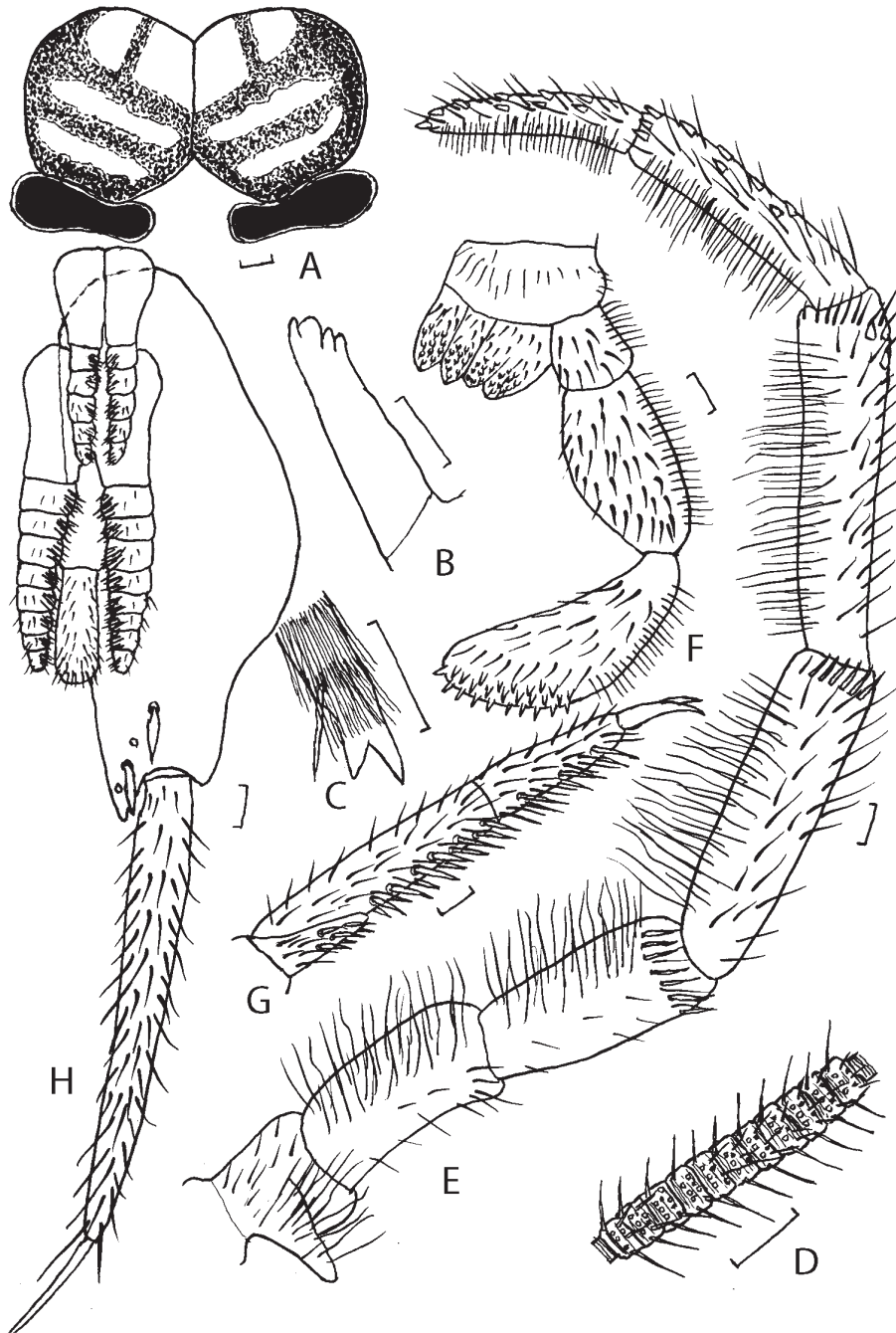


Fig. 1. *Lepismachilis prijepolja* sp. nov., male, holotype: A – eyes and ocelli, front view; B – apex of mandible; C – apex of cercus; D – distal chain of flagellum; E – maxillary palpus; F – labial palpus and labium (part); G – hind tarsus; H – parameres VIII, urocoxite IX, with parameres and penis. Scale bar: 0.1 mm.

setae (Fig. 2D). The metric relations found in the sensory field and femur are as follows: LSF/WSF: 2.3, LSF/LF: 0.68, WSF/WF: 0.60, d/LF: 0.14, d/LSF: 0.18, d/WSF: 0.42. Fore and middle trochanter and femur of female and especially males with long, thin bristles. Ventral surface of femora, tibiae and tarsi with spines (Fig. 1G). Number of spines as shown in Table 3. Middle and hind legs with coxal styli. Length of styli 0.7–0.8 mm in both sexes. Ratio of length of styli to width of coxae about 1.6 in male and female.

In both sexes, urites I, VI and VII with 1 + 1 eversible vesicles, urites II–V with 2 + 2 eversible vesicles. In the

male, the posterior angle of urosternites II, III–VI, VII and VIII are approximately 99°, 74–82°, 90° and 136°; but in the female, the posterior angles of urosternites II, III–VI and VII are about 96°, 74–77° and 97°, respectively. Ratios of lengths of stylus (without apical spine), urosternites and urocoxites II–IX as shown in Table 4. Thoracic tergites, urotergites I and II, urosternites and urocoxites I–VIII without macrochaetae in both sexes. Distribution of sublateral macrochaetae on other urotergites and urocoxites as shown in Table 5. Urocoxites IX with 3–5 + 3–5 inner sublateral macrochaetae in both sexes (Figs 1H, 2E).

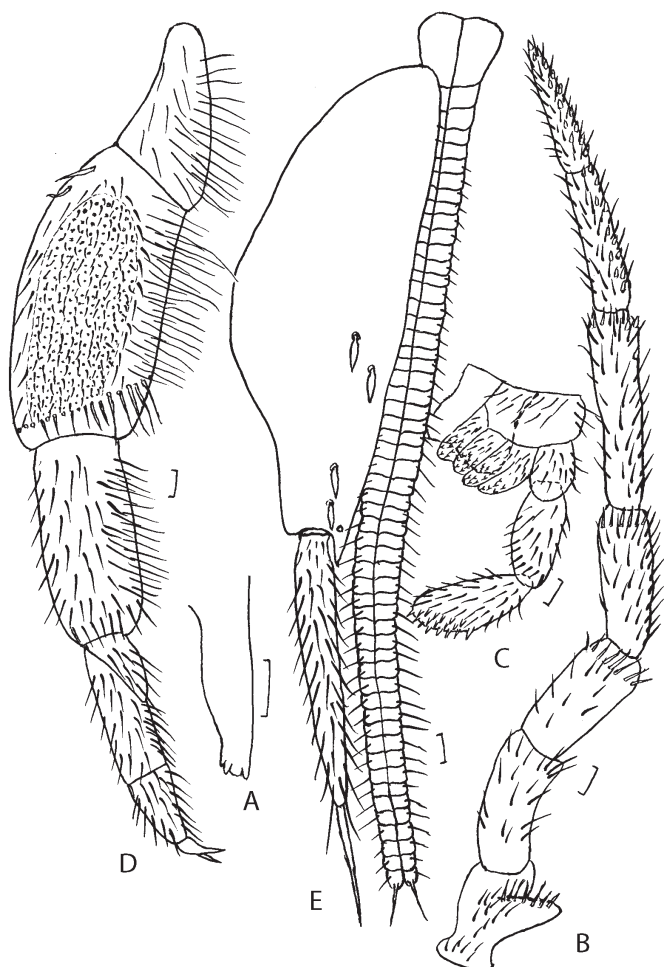


Fig. 2. *Lepismachilis prijeplja* sp. nov. (D – male, holotype; A–C, E – female, paratype): A – apex of mandible; B – maxillary palpus; C – labial palpus and labium (part); D – part of fore leg; E – urocoxite IX, with anterior gonapophyses. Scale bar: 0.1 mm.

Ovipositor slender, elongate (1.9–2.9 mm), reaching apex of styli IX (Fig. 2E). Anterior and posterior gonapophyses with approximately 54–58 divisions. Five basal divisions of anterior gonapophyses and about 35 basal divisions of posterior gonapophyses glabrous. Apical spines of gonapophyses as long as three or four apical divisions combined. Distal divisions of anterior and posterior gonapophyses with three or four setae (not counting sensory setae and apical spines).

Male genitalia with parameres on urites VIII and IX. Parameres VIII with 1 + 5, IX with 1 + 8 divisions. Ratio lengths of parameres VIII and parameres IX 1.5. Parameres IX slightly not reaching apex of penis. Penis and parameres IX significantly not attaining level of apex of urocoxites IX (Fig. 1H).

Differential diagnosis. *Lepismachilis prijeplja* sp. nov. belongs among the species of the subgenus *Lepismachilis* s. str. with 2 + 2 eversible vesicles on urocoxites II–V, and opened sensory field on the male fore femur. This group includes 6 described species (*L. notata* Stach, 1919, *L. y-signata* Kratochvíl, 1945, *L. kahmanni* Bitsch, 1964, *L. hauseri* Bitch, 1974, *L. gimnesiana* Mendes, 1981 and *L. civaldis* Kaplin, 2010), being closest to *L. y-signata* and *L. notata*. *Lepismachilis prijeplja* sp. nov. differs from *L. y-signata* and *L. notata* by the color, markings and ratios of the compound eyes, ratios of sensory field on fore femur of male and the number of divisions of the ovipositor (Stach 1919, Kratochvíl 1945). The main differences between these species are shown in Table 6.

Etymology. The new species takes its name from the type locality, Prijepolje in Serbia, though I adjust its orthography to *prijeplja*. Noun in apposition.

Distribution. Southern Serbia.

Table 6. Main morphological differences between *Lepismachilis prijeplja* sp. nov. and closest congeners.

Morphological characters	<i>L. prijeplja</i> sp. nov.	<i>L. notata</i> Stach, 1919	<i>L. y-signata</i> Kratochvíl, 1945
Color of compound eyes	Two-colored, brown with uneven whitish-grey stripes and spots (in alcohol) forming a pattern in the form of butterfly wings in the back of the eyes with two symmetrical longitudinal brown stripes and two transverse light stripes in the front of the eyes.	Like <i>L. prijeplja</i> sp. nov., but grey “butterfly wings” without symmetrical longitudinal brown stripes.	Mainly whitish-grey with brown color in the lateral and sublateral parts of the eyes and moving away from them to the line of contact of the eyes of the brown pattern in the form of a transverse letter Y.
Ratio of length to width of compound eye	1.1	1.0	0.8–0.9
Ratio of length to width of apical article of labial palp	2.5–2.7	1.6–1.8	2.1–2.4
Number of spines on 2nd tarsomere	10–16	3–4	no spines
Ratio of length to width of sensory field on fore femur of male	2.3	1.9	3.5
Ratios of lengths of sensory field and fore femur of male	0.68	0.73	0.71–0.74
Ratios of widths of sensory field and fore femur of male	0.60	0.74	0.55–0.60
Ratios of lengths of stylus (not including apical spines) and urocoxites VIII	0.7	0.5–0.6	0.7–0.8
Number divisions of ovipositor	55–58	45–54	38–53

***Lepismachilis limensa* sp. nov.**

(Figs 3, 4)

Type material. HOLOTYPE: ♂ (slide-mounted, ZIN): **SERBIA:** Zlatibor District, near Prijepolje, 43°32'38"N, 19°39'058"E, Lim valley, 560 m a.s.l., mixed forest, under stones, August 21, 2017, V. Kaplin leg.

Description. Male. Body length: 12.7 mm, width: 3.0 mm. General body color whitish, practically without hypodermal pigment. Antennal base, frons, mandibles, maxillae with violet-brown hypodermal pigment of weak intensity. Color of scales on surface of body brown. Antennae longer than body. Distal chains of flagellum divided into 10–13 annuli (Fig. 3A). Clypeus with long thin bristles. Cercus approximately 0.42 body length, including about 22–23 divisions. Apex of cercus with two well developed lateral spines (Fig. 3B). All divisions of cerci, except for apical one or two, with 2–5 colorless supporting macrochaetae

on inner side. Caudal filament without supporting macrochaetae on lateral side.

Compound eyes bicolored, brown with whitish-grey stripes and spots (in alcohol). Ratio of length to width of compound eye about 1.13; ratio of length of contact line to length of eyes 0.59. Paired ocelli sole-shaped, brownish-black with narrow white border, 3.3 times as wide as long. Distance between inner margins of ocelli 0.22 and between their outer margins 1.0 total width of compound eyes.

Apical article of maxillary palp 0.78 times as long as preceding one. Their 5th article 1.3 times as long as 4th article. Dorsal surface of 7th, 6th and 5th articles of maxillary palp with 13–16, 12–14 and 2–3 hyaline spines, respectively. Ventral surface of 2–5th articles of maxillary palp as well as dorsal surface of 2nd article of labial palp with relatively numerous ciliary setae (Figs 3C, D). Single

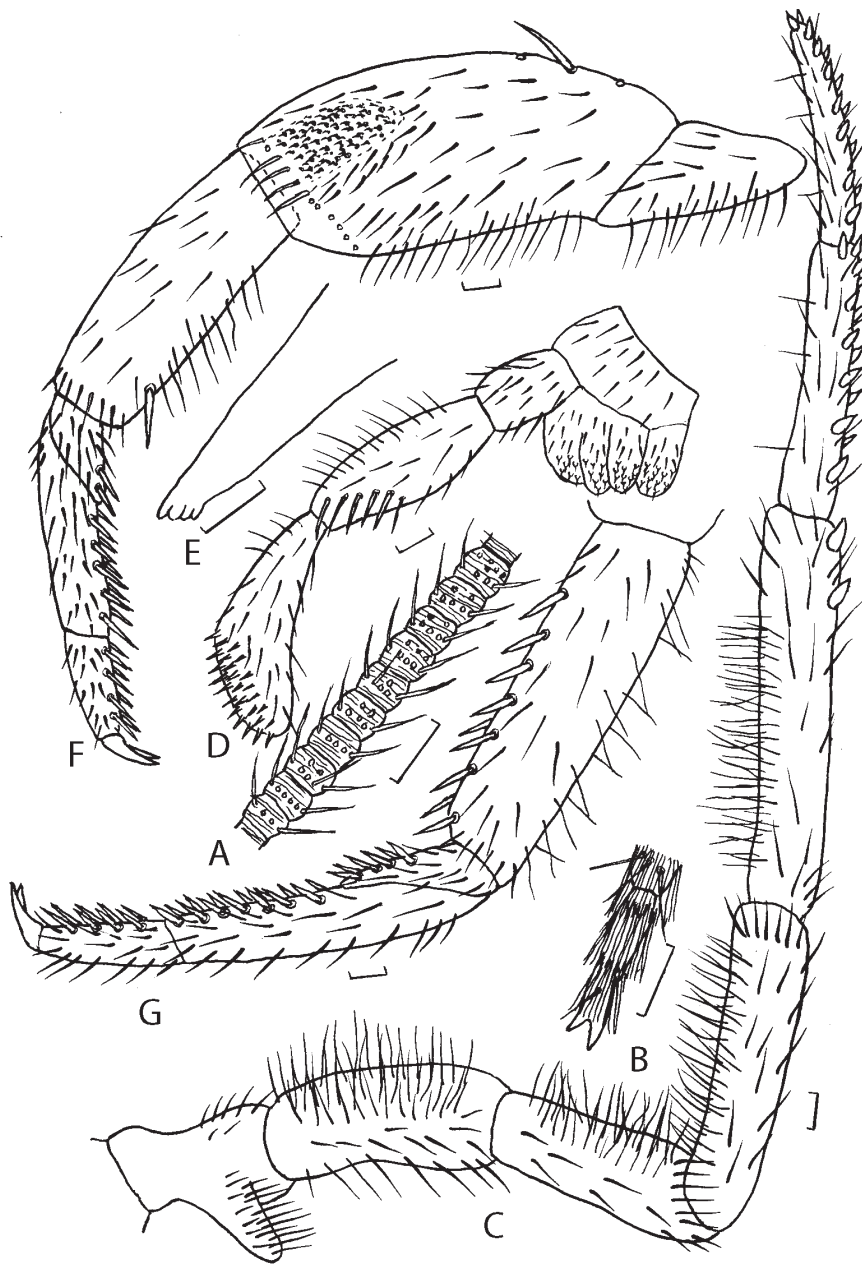


Fig. 3. *Lepismachilis limensa* sp. nov., male, holotype: A – distal chain of flagellum; B – apex of cercus; C – maxillary palpus; D – labial palpus and labium (part); E – apex of mandible; F – part of fore leg; G – tibia and tarsus of hind leg. Scale bar: 0.1 mm.

Table 7. Ratios of length to width of main leg articles of *Lepismachilis limensa* sp. nov. (male).

Leg articles	Pair of legs		
	fore	middle	hind
Tarsus	5.33–5.41	4.95–4.97	6.30–6.35
Tibia	2.67–2.69	2.48–2.50	3.90–4.00
Femur	2.22–2.25	2.68–2.70	2.90–2.94

Table 8. Numbers of spines on leg parts in *Lepismachilis limensa* sp. nov. (male).

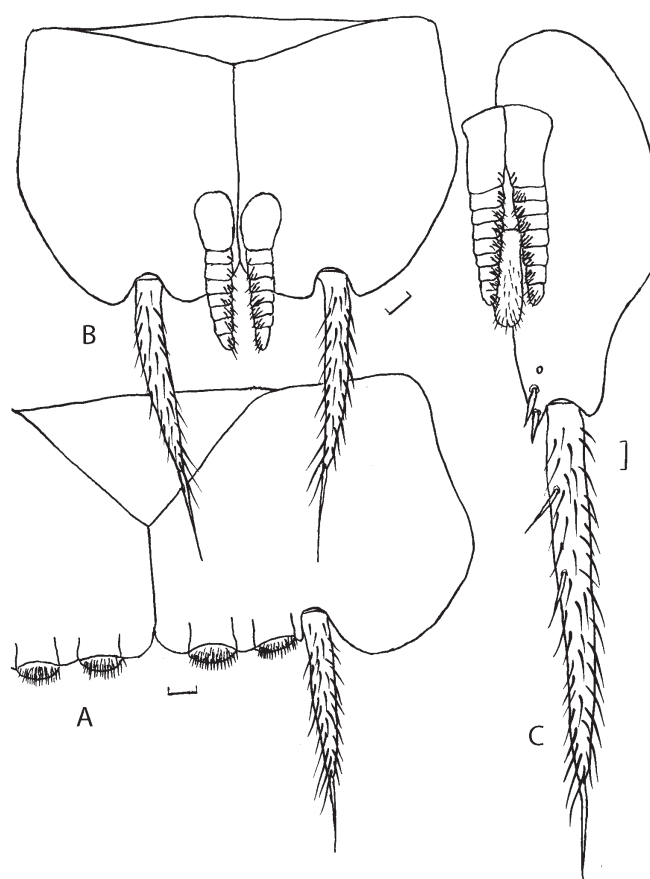
Leg articles	Pair of legs		
	fore	middle	hind
Tarsomeres	1st	2	5–6
	2nd	10–12	12
	3rd	8	8–10
Tibia	1–2	4	7–9
Femur	0	0	0

Table 9. Ratios of lengths of some abdominal structures in *Lepismachilis limensa* sp. nov. (male). Length of stylus does not include apical spines.

Urites	Urosternite / urocoxite	Stylus / urocoxite	Apical spine / stylus
II	0.48	0.62	0.45
III–VI	0.56–0.58	0.58–0.61	0.46–0.52
VII	0.52	0.52	0.56
VIII	0.17	0.72	0.51
IX	–	0.98	0.31

ciliary setae are also present on the ventral surface of the 6–7th articles of maxillary palps. Apical article of labial palp triangularly oval, slightly curved, 2.9–3.0 times as long as wide (Fig. 3D). Mandibles with four distal teeth (Fig. 3E).

Fore femur widened. Ratios of length to width of femur, tibia and tarsus as shown in Table 7. Ratio of length of 3rd tarsomere to total length of tarsus 0.30 (Fig. 3G). Fore femur of male with opened, well-developed sensory field, including numerous small cluster-like sensilla and short curved bristles, and contacting to the distal row of strong setae (Fig. 3F). The metric relations found in the sensory field and femur are as follows: LSF/WSF: 2.0–2.1, LSF/LF: 0.30, WSF/WF: 0.32, d/LF: 0.60, d/LSF: 2.04, d/WSF: 4.07. Fore and middle trochanter and femur with long, thin bristles. Ventral surface of tibiae and tarsi with spines (figure 3F, G). Number of spines as shown in Table 8. Middle

Fig. 4. *Lepismachilis limensa* sp. nov., male, holotype: A – urosternite and urocoxites (part V); B – urosternite, urocoxites and parameres VIII; C – urocoxite IX, with parameres and penis. Scale bar: 0.1 mm.

and hind legs with coxal styli. Length of styli 0.8–0.9 mm. Ratio of length of styli to width of coxae about 1.6.

Urites I, VI and VII with 1 + 1 eversible vesicles, urites II–V with 2 + 2 eversible vesicles (Fig. 4A). Posterior angle of urosternites II, III and VII, IV–VI approximately 89°, 86° and 83°, respectively. Ratios of lengths of stylus (without apical spine), urosternites and urocoxites II–IX as shown in Table 9. Thoracic tergites, urotergites I–V, urosternites, urocoxites I–VIII without macrochaetae. Urotergites VI, VII, VIII, IX and X each with 2 + 2, 3 + 3, 3 + 3, 4 + 4 and 2 + 2 sublateral macrochaetae respectively. Urocoxites IX with 2–3 + 2–3 inner sublateral spines (Fig. 4C).

Table 10. Main morphological differences between males of *Lepismachilis limensa* sp. nov. and closest congeners.

Morphological character	<i>L. limensa</i> sp. nov.	<i>L. hauseri</i> Bitsch, 1974	<i>L. abchasica</i> Kaplin, 2017
Ratio of length to width of compound eye	1.13	1.0	1.04–1.05
Ratio of length of contact line to length of eyes	0.6	0.5	0.55–0.65
Ratio of width to length of paired ocelli	3.3	5.8	2.9–3.1
Ratios of lengths of apical and preceding articles of maxillary palps	0.78	0.86	0.77–0.80
Ratio of length to width of apical article of labial palps	2.9–3.0	3.4	2.3–2.4
Sensory field on fore femur of male	opened	opened	closed
Ratios of lengths of sensory field and fore femur	2.0–2.1	2.8	2.1
Numerous ciliary setae on ventral surface of articles of maxillary palps	2–5th	2–7th	2–5th
Numerous ciliary setae on dorsal surface of articles of labial palps	2nd	2–3rd	no

Male genitalia with parameres on urites VIII and IX (Figs 4B, C). Parameres VIII with 1 + 7, IX with 1 + 7–8 divisions. Ratio lengths of parameres VIII and parameres IX 1.3. Parameres IX not reaching apex of penis. Penis and parameres IX significantly not attaining level of apex of urocoxites IX.

Female. Unknown.

Differential diagnosis. *Lepismachilis limensa* sp. nov. belongs to the species group of the subgenus *Lepismachilis* s. str. with 2 + 2 eversible vesicles on abdominal urocoxites II–V and opened sensory field on fore femur of male. By the structure of the sensory field *L. limensa* sp. nov. is most close to *L. hauseri* from Corfu (BITCH 1974). The main differences between these two species are shown in Table 10. Among the described species of the subgenus *Lepismachilis* s. str., 2–5th articles of the maxillary palps of the male with numerous long thin setae occur only in one additional species, *L. abchasica* Kaplin, 2017. However, the male of *L. abchasica* has labial palps without long thin setae and sensory field on fore femur closed (KAPLIN 2017).

Etymology. The new species is named after the type locality: Lim, Serbia. Adjective.

Distribution. Southern Serbia.

Lepismachilis alexandrae sp. nov.

(Figs 5, 6)

Type material. HOLOTYPE: ♂ (slide-mounted, ZIN): MONTENEGRO: Budva Municipality, near Petrovac, 42°12'20"N, 18°56'33"E, 15 m a.s.l., pine forest, under stones, August 08, 2017, V. Kaplin, A. Kaplina leg. PARATYPES: 3 ♂♂ 4 ♀♀ (one ♀ on slide), same locality, V. Kaplin, A. Kaplina leg.

Description. Body length: male 9.5–11.2 mm, female 10.0–12.2 mm. Body width: male 2.5–2.7 mm, female 2.6–3.2 mm. General body color whitish, practically without hypodermal pigment. Antennal base, frons, occiput, gena, mandibles, galea of maxillae with violet-brown hypodermal pigment of weak intensity. Color of scales on surface of body brown. Antennae of male and female slightly longer than body. Distal chains of flagellum divided into 9–13 annuli in both male and female. Clypeus of male with long thin bristles. Cercus approximately 0.38–0.44 (male) or 0.34–0.40 (female) of body length, including about 18–20 divisions. Apex of cercus with two well-developed lateral spines (Fig. 5B). All divisions of cerci, except for apical one or two, with 2–6 colorless supporting macrochaetae on inner side.

Compound eyes bicolored, greyish-brown with a brown pattern in the form of a transverse letter Y toward the line of contact of eyes, similar to the color of the eyes in *L. y-signata* (Fig. 5A). Ratio of length to width of compound eye about 1.06–1.12; ratio of length of contact line to length of eye 0.55–0.60 in both sexes. Paired ocelli sole-shaped, brownish-black with narrow white border, 3.9–4.2 times as wide as long. Distance between inner margins of ocelli 0.24–0.28 and between their outer margins 1.0 of total width of compound eyes in both sexes.

Apical article of maxillary palp 0.78–0.80 (male) or 0.89–0.90 (female) times as long as preceding one. Their 5th article 1.2–1.3 (male) or 1.3–1.4 (female) times as long as 4th article (Figs 5C, 6A). Dorsal surface of 7th, 6th

and 5th articles of maxillary palps with 16–18, 13–15 and 6–7 (male) or 12–13, 12 and 5–8 (female) hyaline spines, respectively. Ventral surface of 2–4th articles of male maxillary palp as well as dorsal surface of 2–3rd articles of male labial palp with relatively sparse and ciliary setae of medium length (Figs 5C, D). Such single setae are also present on the ventral surface of the 5–7th articles of male maxillary palps. Apical article of labial palp triangularly oval (male) or elongated oval (female), 2.3–2.4 (male) or 2.1–2.2 (female) times as long as wide (Figs 5D, 6B).

Table 11. Ratios of length to width of main leg articles of *Lepismachilis alexandrae* sp. nov.

Leg articles	Sex		
	Male	Female	
Femur	fore	2.15–2.19	2.10–2.11
	middle	2.30–2.33	2.34–2.36
	hind	2.67–2.74	2.41–2.49
Tibia	fore	2.30–2.32	2.09–2.21
	middle	2.17–2.22	2.00–2.06
	hind	3.26–3.45	3.20–3.30
Tarsus	fore	5.02–5.79	5.22–5.33
	middle	4.12–4.78	4.83–5.03
	hind	6.40–6.52	6.27–6.30

Table 12. Numbers of spines on leg parts in *Lepismachilis alexandrae* sp. nov.

Articles	Sex and pair of legs						
	Male			Female			
	fore	middle	hind	fore	middle	hind	
Tarsomeres	1st	3	3–5	7	2	3	4
	2nd	6	10	12	6–8	8–10	10–12
	3rd	1–2	1–2	2	0	1	1–5
Tibia	0	2–3	4	2	2	4–5	
Femur	0	0	0	0	0	1	

Table 13. Ratios of lengths of some abdominal structures in *Lepismachilis alexandrae* sp. nov. Length of stylus does not include apical spines.

Urites	Urosternite / urocoxite		Stylus / urocoxite		Apical spine / stylus	
	male	female	male	female	male	female
II–III	0.66–0.67	0.60–0.64	0.61–0.62	0.50–0.56	0.50–0.51	0.50–0.52
IV–VI	0.62–0.65	0.57–0.62	0.53–0.57	0.43–0.47	0.55–0.58	0.60–0.62
VII	0.56	0.54	0.52	0.51	0.60	0.62
VIII	0.17	–	0.54	0.75	0.48	0.56
IX	–	–	0.83	0.68	0.39	0.44

Table 14. Distribution of sublateral macro- and mesochaetae on urotergites and urocoxites of *Lepismachilis alexandrae* sp. nov.

Urites	Urotergite		Urocoxite	
	male	female	male	female
I–V	0	0	0	0
VI	0	1 + 1	0	0
VII	1 + 1	3 + 3	0	0
VIII	3 + 3	3 + 3	0	0
IX	3 + 3	3 + 3	0/5 + 5/0	0/5 + 6/0
X	3 + 3	2 + 2	–	–

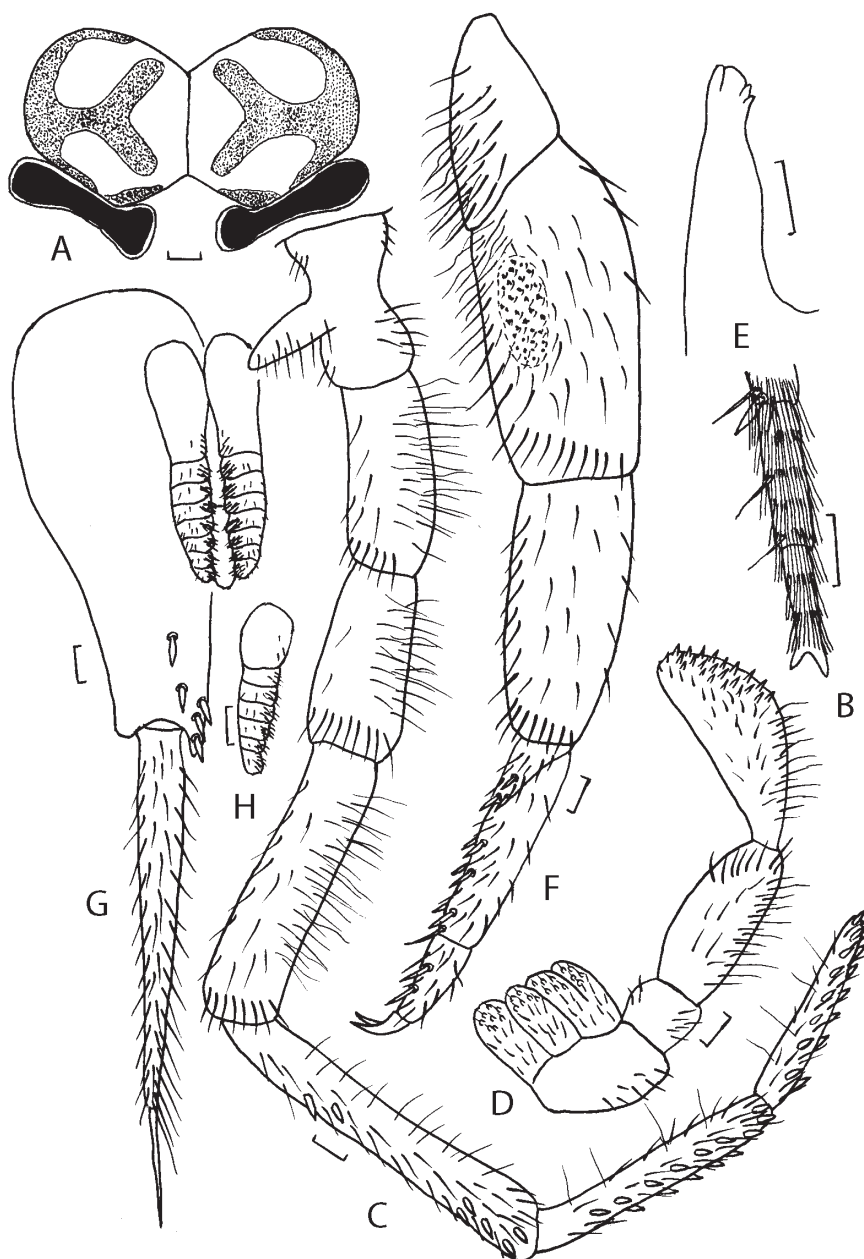


Fig. 5. *Lepismachilis alexandrae* sp. nov., male, holotype: A – eyes and ocelli, front view; B – apex of cercus; C – maxillary palpus; D – labial palpus and labium (part); E – apex of mandible; F – part of fore leg; G – urocoxite IX, with parameres and penis; H – paramere VIII. Scale bar: 0.1 mm.

Mandibles with four distal teeth in both sexes (Fig. 5E).

Fore femur in both sexes, fore and middle tibia of female widened. Ratios of length to width of femur, tibia and tarsus as shown in Table 11. Ratio of length of 3rd tarsomere to total length of tarsus 0.28–0.29 (male) or 0.34–0.34 (female). Fore femur of male with closed sensory field, including numerous small cluster-like sensilla and short curved bristles and not reaching the distal row of strong setae (Fig. 5F). The metric relations found in the sensory field and femur are as follows: LSF/WSF: 2.2–2.3, LSF/LF: 0.38, WSF/WF: 0.24, d/LSF: 0.22, c/LSF: 0.40–0.42, d/WSF: 1.2–1.3. The sensory field does not reach the ventral side of femur at 0.12–0.14, dorsal side 0.63–0.64 of the total width of femur. Sensory field is separated from the distal row of strong setae by six or seven rows of scales. Fore and middle trochanter and femur of male with rela-

tively long, thin bristles. Ventral surface of femora, tibiae and tarsi with spines (Figs 5F, 6C). Number of spines as shown in Table 12. Middle and hind legs with coxal styli. Length of styli 0.8–0.9 mm (male) or 0.6–0.7 mm (female). Ratio of length of styli to width of coxae about 1.6–1.7 (male) or 1.7–1.8 (female).

Urites I, VI and VII with 1 + 1 eversible vesicles, urites II–V with 2 + 2 eversible vesicles (Fig. 6D). In male, posterior angle of urosternites II–VI and VII approximately 93–94° and 87°; in female posterior angle of urosternites II–VI and VII about 83–86° and 82°, respectively. Ratios of lengths of stylus (without apical spine), urosternites and urocoxites II–IX as shown in Table 13. Thoracic tergites, urotergites I–VI (male) or I–V (female), urosternites, urocoxites I–VIII without macrochaetae in both sexes. Distribution of sublateral macrochaetae on other urotergites

Table 15. Main morphological differences between *Lepismachilis alexandrae* sp. nov. and *L. abchsica* Kaplin, 2017

Morphological characters	<i>L. alexandrae</i> sp. nov.	<i>L. abchsica</i> Kaplin, 2017
Body length (mm)	10–12	8–10
Color of compound eyes	Two-colored, greyish-brown	One-colored, dark
Ratio of length to width of compound eye	1.06–1.12	1.04–1.10
Ratio of length of contact line to length of eye	0.55–0.60	0.55–0.65
Ratio of distance between inner margins of paired ocelli to total width of compound eyes	0.24–0.28	0.28–0.32
Ratio of width to length of paired ocellus	3.9–4.2	2.9–3.1
Number of hyaline spines on dorsal surface of the 5th article of maxillary palp	5–8	2–4
Number of spines on 2nd tarsomere	6–12	2–6
Ratio of length to width of the sensory field on fore femur of male	2.3–2.4	2.1
Ratios of lengths of sensory field and fore femur of male	0.38	0.40
Number of inner sublateral macrochaetae on urocoxites IX	4–6	3–4
Number of divisions of male parameres IX	1 + 7	1 + 8
Number of divisions of male parameres VIII	1 + 6	1 + 4–5
Ratio of lengths of parameres IX and VIII	1.5	2.0
Number of divisions of ovipositor	58–60	70–72

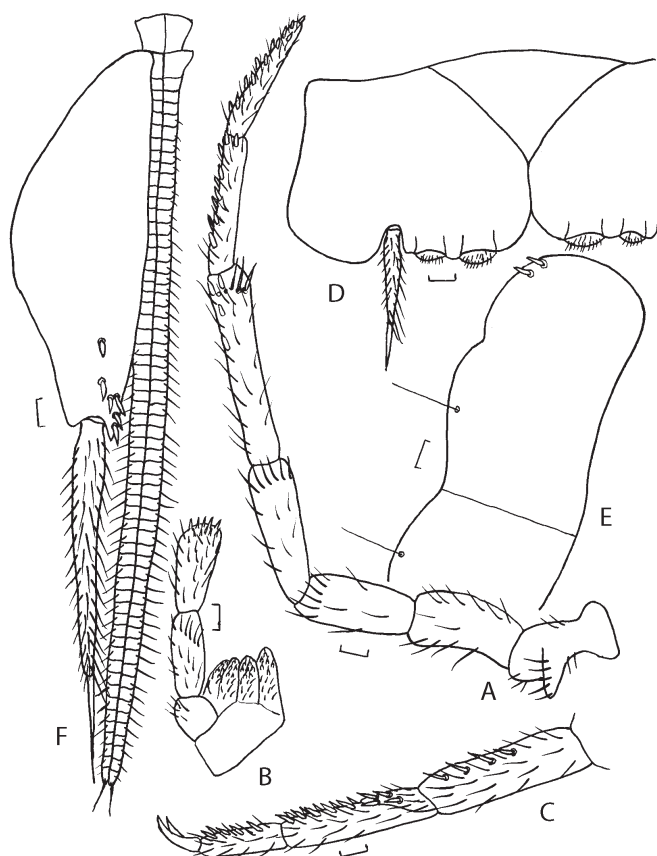


Fig. 6. *Lepismachilis alexandrae* sp. nov., female, paratype: A – maxillary palpus; B – labial palpus and labium (part); C – tibia and tarsus of hind leg; D – urosternite and urocoxites (part) V; E – urotergite X (part); F – urocoxite IX, with anterior gonapophyses. Scale bar: 0.1 mm.

and urocoxites as shown in Table 14. Urotergite X with 3 + 3 (male) or 2 + 2 (female) sublateral macrochaetae (Fig. 6E). Urocoxites IX with 5 + 5 (male) or 5–6 + 5–6 (female) inner sublateral spines (Figs 5G, 6F).

Ovipositor slender, elongate (3.0–3.4 mm), reaching apex of styli IX or slightly extend beyond them (Fig. 6F). Anterior and posterior gonapophyses with approximately 58–60 divisions. Four basal divisions of anterior

gonapophyses and about ten basal divisions of posterior gonapophyses glabrous. Apical spines of gonapophyses as long as three apical divisions combined. Distal divisions of anterior and posterior gonapophyses with four or five setae (not counting sensory setae and apical spines).

Male genitalia with parameres on urites VIII and IX. Parameres VIII with 1 + 6, IX with 1 + 7 divisions (Figs 5G, H). Ratio lengths of parameres IX and VIII 1.5. Parameres IX slightly not reaching apex of penis. Genital appendages of male IX not attaining level of apex of urocoxites IX.

Differential diagnosis. *Lepismachilis alexandrae* sp. nov. belongs to the species group of the subgenus *Lepismachilis* s. str. with 2 + 2 eversible vesicles on urocoxites II–V, closed sensory field on fore femur of male. The new species is closest to *L. abchsica* Kaplin, 2017 but differs by the colour pattern of the compound eyes, ocelli without white border, sensory field on the fore femur of male, male parameres and the number of divisions of the gonapophyses. The main differences between these species are shown in Table 15.

Etymology. The new species is named after my daughter Alexandra Kaplina, a student of Saint-Petersburg State Pediatric Medical University, for her help with collecting bristletails in Montenegro.

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