



A new species of *Leiobunum* from Arizona, U. S. A. highlights the limits of typological classification in harvestmen (Opiliones: Sclerosomatidae: Leiobuninae)

JEFFREY W. SHULTZ

Department of Entomology, University of Maryland, College Park, Maryland 20742, USA. E-mail: jshultz@umd.edu

Abstract

A new species of leiobunine harvestman from the Chiricahua Mountains of Arizona is described. The species lacks pro- and retrolateral submarginal rows of coxal denticles, a feature often considered diagnostic for the polyphyletic *Nelima*, and has greatly reduced ventral dentition on the palpal claw, as in the monotypic *Leuronychus*. In most other respects, the species is uniquely similar to members of a clade from central and western Mexico currently in the poly- and/or paraphyletic *Leiobunum*. These traits include a supracheliceral lamina with a wide transverse plate and a canaliculate ocularium, with an anterior surface that slopes dorsoposteriorly and a posterior surface that bulges rearward and is constricted at its base. There is thus a conflict between classification using traditional diagnostic characters and classification using unique similarity of non-traditional characters. The problem is exacerbated by the problematic status of each candidate genus. Here the species is placed in *Leiobunum* as *L. silum* **sp. nov.**, a decision that gives weight to probable phylogenetic affinity with species currently placed in that genus. *Leiobunum silum* provides an excellent example of the limits of traditional typological classification and the need for a broad-scale morphological and molecular revision of sclerosomatid harvestmen.

Key words: Taxonomy, North America, daddy longlegs

Introduction

While examining material from the personal collection of the late Marie L. Goodnight (provided by her son Charles Goodnight), I found specimens of an undescribed and unusual harvestman species collected from the Chiricahua Mountains of Arizona by the eminent arachnologist Willis Gertsch. The specimens bear several features characteristic of *Leiobunum* C.L. Koch, 1839, from Mexican Clade I of Hedin *et al.* (2012); specifically, a supracheliceral lamina with broad basal plates and a canaliculate ocularium with an anterior surface that slopes dorsoposteriorly and posterior surface that bulges posteriorly and is constricted basally (original observations). Two members of the clade, *L. townsendi* Weed, 1893, and the very similar *L. depressum* Davis, 1934, are known from the United States including Arizona (Cokendopher 1981), but the dark, hardened cuticle of the carapace and tuberculate *scutum parvum* of the new species are more similar to species from western and central Mexico (original observations).

Among the known Leiobuninae of North America, the new species *Leiobunum silum* is perhaps most similar to *L. nycticorpus* Goodnight & Goodnight, 1942. The body size and dorsal abdominal sculpture and armament are very similar. Males of the two species are dark brown to almost black (Fig. 1) (although *L. nycticorpus* has large splotches of white on the abdominal pleural region), but the females differ, with *L. nycticorpus* being essentially the same color as the male and *L. silum* having a distinctive black-and-white dorsal pattern (Fig. 4). *Leiobunum silum* also differs in having 1) a subterminal inflation of the male labrum (Fig. 12), 2) a high median supracheliceral arch on the anterior margin of carapace (Fig. 11); and, notably, 3) pedal coxae lacking all trace of pro- and retrolateral submarginal rows of denticles (Figs. 3, 6). The last of these features is generally considered the key characteristic of a different leiobunine genus, *Nelima* Roewer, 1910. However, in contrast to recent practice, I have chosen to include the new species in *Leiobunum* for reasons detailed below.

Nelima was erected by Roewer (1910) using the following diagnosis (translated from the original German):

“Body cuticle soft or leathery; abdomen without dorsal scutum, its segments marked by transverse furrows. Cephalothorax anterior and lateral to ocularium always smooth and unarmed. Ventral abdominal segments distinct; genital operculum and coxae mostly smooth, very rarely granulate. Coxae usually with fine setae, more or less scattered; coxae never with marginal rows of denticles or traces thereof.”

Two aspects of this diagnosis and its subsequent application are noteworthy. First, it aptly describes the juvenile stages of many sclerosomatid species, thereby opening the door to both the assignment of juveniles of diverse taxa to *Nelima* and to polyphyly resulting from homoplasious paedomorphosis (Hedin *et al.* 2012). Second, taxonomists have tended to focus on the last character to the exclusion of the others or else considered a reduction rather than total absence of coxal denticles as sufficient justification for assigning a species to *Nelima* (*e.g.*, *Nelima elegans* (Weed, 1889) tends to have short rows of marginal denticles on coxa I and II).

The genus has since expanded to become the second largest in Leiobuninae after *Leiobunum* and now contains over 40 species from Europe, East Asia and North America. Systematists have long suspected that the genus is artificial (*e.g.*, Martens 1969, 1978); its constituent species are heterogeneous in both somatic and genitalic structure and often resemble *Leiobunum* species from the same geographic region. The problematic status of *Nelima*, and also *Leiobunum*, was further demonstrated by a molecular phylogenetic analysis (Hedin *et al.* 2012), which showed that *Nelima* species have evolved multiple times from *Leiobunum* or *Leiobunum*-like ancestors located in the same or adjacent regions. In North America *Nelima elegans* and *N. paessleri* (Roewer, 1910) were found to be most closely related to *Leiobunum exilipes* (Wood, 1868) in which rows of coxal denticles are often reduced or absent (Davis 1934). In fact, *L. exilipes* is the senior synonym of *Nelima goodnighti* Schenkel, 1951 (Cokendolpher 1980). Thus, I have chosen not to include the new species in *Nelima*, because the reduction of coxal denticles is demonstrably homoplasious, none of the other diagnostic features described by Roewer (1910) are present, and no obvious close relative currently placed in *Nelima* appears to exist.

A case might be made for including the new species in *Leuronychus* Banks, 1900 (Leiobuninae), a genus of uncertain phylogenetic placement (Hedin *et al.* 2012; Burns *et al.* 2012). Banks separated the genus from *Leiobunum* due to 1) absence of ventral teeth on the palpal claw (*i.e.*, "palpal claw smooth"), a homoplasious feature (Cokendolpher 1984) traditionally considered typical of the Phalangiiidae, and 2) absence of "lateral rows of teeth on the coxae", as in *Nelima*. Female and some male *Leiobunum silum* also have reduced (but not eliminated) ventral denticles on the palpal claws and, as noted before, lack submarginal coxal denticles. However, Banks' generic diagnosis does not actually encompass its original and current sole member, *Leuronychus pacificus* (Banks, 1894), originally placed in *Leiobunum*. In contrast to Banks' (1900) generic diagnosis, *Leuronychus pacificus* varies in the expression of both the ventral teeth of the palpal claw (ranging from absent to obvious and concentrated toward the base) and submarginal coxal denticles, with the retrolateral row absent or weakly expressed and proteral row weakly to strongly expressed, especially on coxae I and II. From the standpoint of modern systematics, Banks had little justification to erect a new genus, which is apparently monotypic, with *Leuronychus fulviventris* (Pickard-Cambridge, 1905) being unrelated but of uncertain placement (Cokendolpher 1984), *Leuronychus parvulus* having been transferred to the phalangiid genus *Leptobunus* Banks, 1894, by Cokendolpher (1984) and *Leuronychus gertschi* (Schenkel, 1951) being a junior synonym of *Leiobunum exilipes* (Cokendolpher 1980).

Clearly, the traditional typological approach to classification in Sclerosomatidae provides limited guidance in placing *Leiobunum silum* in an appropriate leiobunine genus, although an attempt at a more natural classification is also made difficult by current ambiguity in sclerosomatid phylogeny. Here the species is placed in *Leiobunum* (rather than *Nelima*, *Leuronychus* or a new genus), a decision that attempts to give weight to unusual similarities (possible synapomorphies) shared with species that, for better or worse, are currently placed in *Leiobunum*. This problem highlights the need for a broad-scale morphological and molecular revision of sclerosomatid harvestmen.

Material and methods

All material was examined under 70–75% ethanol using a Leica MZ APO dissecting microscope (16X ocular, 0.63X objective, 8–80X zoom). Drawings were made with a drawing tube and then digitized and traced in Adobe Illustrator. Photographs were obtained with a PaxCam 3 digital camera mounted on the microscope. Images

obtained at different focal planes were combined using Helicon Focus software (HeliconSoft, Kharkov, Ukraine). Simple linear measurements were obtained using an ocular micrometer calibrated with a stage micrometer. Curved pedal tarsi were measured by tracing imported images within ImageJ (Rasband 1997–2016) with appropriate pixel-to-millimeter calibration.

Taxonomy

Family Sclerosomatidae

Subfamily Leiobuninae

Genus *Leiobunum* C. L. Koch, 1839

Type species. *Phalangium rotundum* Latreille, 1798

Leiobunum silum sp. nov.

Figs. 1–13

Type material. holotype ♂ (selected for relative completeness of legs), allotype ♀ (selected for relative completeness of legs), other paratypes 6 ♂, 2 ♀. U.S.A.: *Arizona*: Cochise County: Chiricahua Mountains, Coronado National Forest, "Rustler's Camp" [= Rustler Park Campground?], (31.9055° N, 109.279° W), elev. 8500' [2591 m], 9 Sept. 1950, W.J. Gertsch. Deposited in the American Museum of Natural History.

Etymology. *Silum* is the neuter form of the Latin word *silus*, meaning snub-nosed or pug-nosed. The name refers to the up-turned anterior margin of the carapace in both sexes (Fig. 11).

Diagnosis. Submarginal pro- and retrolateral rows of denticles entirely absent on pedal coxae (Figs. 2, 3, 5, 6), as in *Nelima*. Terminus of male labrum inflated to arrowhead shaped, armed with many minute denticles (Fig. 12). Median anterior margin of carapace reflected upward revealing an anterior transverse crescent-like plate, often bulging medially (Fig. 11). Significant sexual dimorphism in dorsal cuticle: Male carapace finely crenulate; *scutum parvum* and first two free tergites covered in low, rounded tubercles; dorsum primarily very dark brown to nearly black, median longitudinal mark subobsolete anteriorly, obsolete posteriorly (Fig. 1). Female dorsum granulate throughout, lacking crenulation and tubercles of male (some tubercles may occur on anterior scutal tergites); median longitudinal mark distinct on scutal tergite 1 but becoming increasingly indistinct posteriad, bordered laterad by light spots and splotches (Fig. 3). No similar combination of features is known from other *Leiobunum* species in the southwestern United States.

Description of male. *Measurements of male holotype (in mm).* Body length, 3.4, carapace length, 1.2., carapace width, 2.2. Palp: femur, 1.2; patella, 0.6; tibia, 2.1; tarsus, 1.4. Legs (femur, patella, tibia, basitarsus, telotarsus): I: 7.4, 1.4, 6.0, 8.2, 10.9; II: 11.4, 1.7, 10.1, 11.8, 21.3; III: 7.3, 1.4, 6.0, 9.0, 11.8; IV: 10.0, 1.6, 7.8, 12.3, 15.1.

Dorsum. Carapace finely granulate marginally, coarsely granulate medially, regions laterad and posteriad to ocularium finely crenulate; crenulations arranged in longitudinal crests and valleys at posterior margins of meso- and metapeltidia. Scutum and first two free tergites covered in low rounded tubercles. Last tergite and anal operculum finely granulate. Dorsal surface otherwise unarmed except for scattered erect setae. Ocularium smooth; weakly canaliculate anteriorly, becoming deeply canaliculate posteriorly; carinae unarmed except for scattered erect setae; anterior surface sloping steeply upward, posterior surface bulging posteriorly over post-ocularial carapace, base constricted posteriorly (Figs. 1, 3). Anteromedial margin of carapace without distinct doublure, forming vertical bulging crescent above supracheliceral lamina (Fig. 12). Supracheliceral lamina formed by two large, anteriorly projecting arched plates meeting at median sulcus; anteromedial margins with short, blunt, unarmed anterior projections. Ozophores prominent, surrounded with finely granulate cuticle, ozopores directed anterolaterally.

Venter (Fig. 2). Labrum (Figs. 2, 12) relatively long, projecting anteriorly between flexed chelicerae; shaft thick, swollen subterminally then tapering to blunt point, sometimes forming robust arrowhead; with scattered fine, dark denticles, density and size of denticles greatest on lateral surfaces of bulging region. Genital operculum finely

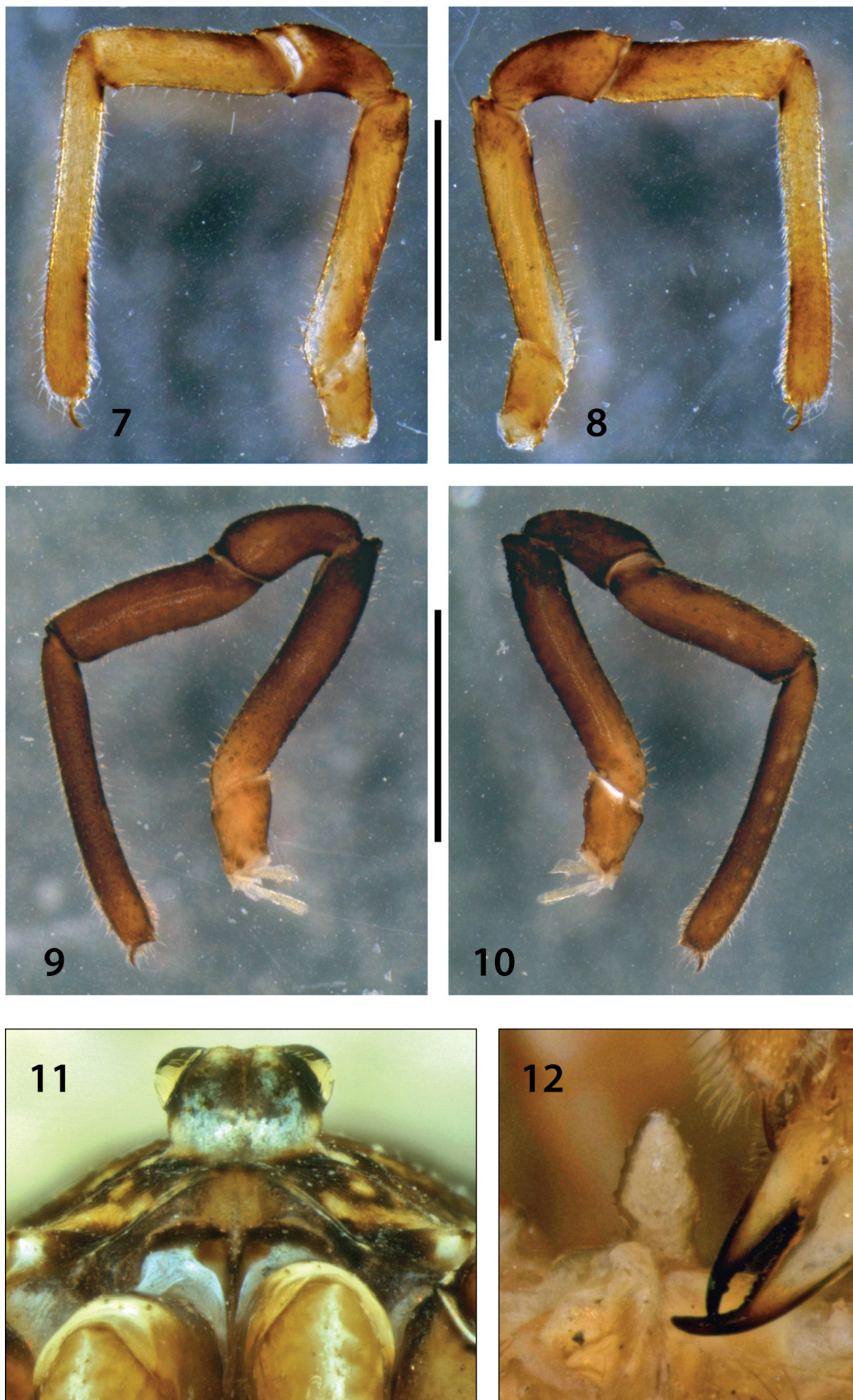
granulate, unarmed except for scattered erect setae. Sternites finely granulate, unarmed except for setae, most setae arranged in imperfect transverse row on each sternite.

Chelicera (Figs. 2, 3, 12): Basal article with short, prodorsal, longitudinal row of setae with row curving medially near distal margin; second article with prolateral (medial) row of setae increasing in density and length distally, several long setae on anterior surface at base of fixed finger.

Palps (Figs.1–3, 9–10): Trochanter simple, without apophyses, prolateral surface with marginal row of erect setae, retrolateral surface glabrous. Femur with broad dorsal and ventral fields of erect setae, densest on distodorsal surface; pro- and retrolateral surfaces largely glabrous; proximal retrolateral to ventral surfaces with field of denticles extending almost to midway of femur on retrolateral surface, femur otherwise unarmed. Patella and tibia unarmed except for scattered erect macrosetae, prolateral patellar apophysis absent; tibia with a few recumbent microsetae on retrodorsal surface. Tarsus as long as tibia + patella, coated with erect macrosetae (with ventral tuft near tip) and recumbent microsetae; long proventral row of ~26 sharp denticles, denticles spaced by a distance slightly greater than denticle thickness. Claw pectinate, with three or four small proximal teeth, or essentially smooth.



FIGURES 1–6. *Leiobunum silum* sp. nov. 1–3, Paratype male: 1, dorsal view, 2, ventral view, 3, lateral view. 4–6. Paratype female: 4, dorsal view, 5, ventral view, 6, lateral view. Scale bars = 1 mm.



FIGURES 7–12. *Leïobunum silum* sp. nov. 7–10, Palps: paratype female, left palp: 7, retrolateral view; 8, prolateral view; paratype male, right palp: 9, prolateral view, 10, retrolateral view. Scale bars = 1 mm. 11. Anterior view of a paratype female showing supracheliceral lamina and anterior margin of carapace. 12, Ventral view of labrum from male paratype.

Legs. Coxae (Figs. 2, 3) smooth, without a trace of pro- or retrolateral rows of marginal denticles, surface finely granulate, unarmed except for scattered erect macrosetae and a few scattered denticles along distal margin. Trochanters relatively smooth on lateral and medial surfaces, with a few denticles and setae on pro- and retrolateral surfaces. Femora without pseudoarticulations; patellae unremarkable; tibiae II with 3 pseudoarticulations, all others without pseudoarticulations; basitarsi with pseudoarticular formula 3-4,6-7,4,3-6; telotarsi and claws unremarkable.

Penis (Fig. 13). Ventrolateral sacs large, voluminous, extending longitudinally from glans-shaft articulation to about one-fourth to one-third length of shaft; sac openings wide, region around opening reinforced with collar-like sclerotization. Shaft broad posteriorly, tapering gradually to level of sac opening then narrowing abruptly at glans-shaft junction forming neck; glans slightly wider than neck. Dorsoproximal margin of basal hemocoelic opening to shaft posterior to ventral margin creating large ventroposterior opening. Shaft rather thick in lateral perspective and increasing in thickness posteriorly due to median longitudinal bulge that continues to posterior ventral margin. Stylus slightly less than half the length of glans.

Coloration (Figs. 1-3). Dorsum mainly dark toasted brown. Light brown mottling on carapace anterolateral to ocularium. Ocularium dark brown, each lens bordered by thin yellow line dorsally, line broadening posteriorly and ventrally, terminating anterolaterally at large patch of white at anterolateral base of ocularium. Medial margin of ozopore light brown. Dark median mark delimited laterally by lighter mottling, especially on scutal tergite 1, increasingly indistinct posteriorly. Pleural and intertergal membranes very dark brown with dense array of irregular white flecks, very obvious laterally, appearing dorsally as thin stripes separating meso- and metapeltidium, scutum, free tergites; membrane between last free tergite and anal operculum pure white. Anal operculum variable.

Venter (Fig. 2). Coxapophyses light yellow-brown. Genital operculum mottled with shades of brown, somewhat lighter medially, sometimes with short, fine anterior median stripe; anterior lip and anterior lateral margins yellow-brown. Sternites with mottled shades of brown anteriorly, yellowish posteriorly, with transition corresponding roughly to transverse row of setae.

Chelicera. Basal article mottled dark and light brown; second article nearly uniform toasted brown, but fixed and moveable fingers of chela abruptly yellow-brown with dark termini.

Palp. Coxa yellow; trochanter light brown; femur, patella, tibia and tarsus dark toasted brown, but tip of tarsus somewhat lighter.

Legs. Coxae dark toasted brown on distal (dorsal) surfaces but dark color increasingly restricted to exposed pro- and retrolateral surfaces proximad (ventrad) along coxa (marginal pro- and retrolateral surfaces light brown); middle and extreme proximal (ventral) surfaces a lighter brown but punctuated by dark-brown sigilla. Trochanters dark brown on ventral, prolateral and retrolateral surfaces, lighter but mottled with dark brown on dorsal surfaces. Base and terminus of femur light brown but remaining portion of femur, patella and tibia dark brown. Sometimes with slight evidence of alternating dark and light banding on femoral shaft. Basi- and metatarsi light brown.

Description of female. *Measurements of female allotype (in mm).* Body length, 6.4, carapace length, 2.0., carapace width, 2.5. Palp: femur 1.3, patella 0.6, tibia 0.9, tarsus 1.6. Legs (femur, patella, tibia, basitarsus, telotarsus): I: 6.2, 1.5, 4.9, 8.3, 9.1; II: 10.4, 1.8, 10.3, 10.5, 11.2; III: 6.1, 1.5, 4.7, 7.8, 9.3; IV: 6.0, 1.4, 5.0, 6.7, 8.7.

Dorsum. Carapace, scutum and free tergites finely granulate; carapace without crenulation of male; small, low rounded tubercles of male opisthosoma absent or limited to first three scutal tergites. Otherwise unarmed except for scattered setae. Supracheliceral lamina, anterior carapacial margin, ocularium and ozophore as in male (Fig. 11).

Venter (Fig. 5): Labrum not inflated or arrowhead shaped, terminus tapering but with scattered minute denticles, not as dense as in male. Venter finely granulate; sternites unarmed except for scattered short erect setae; genital operculum with wide, glabrous anterior lip delimited posteriorly by prominent submarginal sulcus, low transverse ridge delimited anteriorly by submarginal sulcus and posteriorly by weakly procurved sulcus, ridge with imperfect row of erect setae; otherwise operculum armed with scattered erect setae.

Chelicerae. Basal article with retrodorsal longitudinal row of a few setae, row bends medially near distal margin. Second segment with stiff, protrorse bristles on medial surface, increasing in density distally to form tuft near base of fixed finger, a few long setae near base of chelal fingers.

Palps (Fig. 7, 8). Unarmed except for setae. Femur with erect macrosetae on dorsal and ventral surfaces, pro- and retrolateral surfaces almost bare. Patella without distoprolateral apophysis. Patella, tibia and tarsus with erect macrosetae; tibia and tarsus with coat of distally recumbent microsetae. Tarsus longer than patella and tibia combined. Claw lacking well-developed teeth, but a few small denticles may represent vestigial teeth.

Legs. Shorter and more robust than in male, but otherwise similar, including same number of tibial pseudoarticulations, basitarsal pseudoarticulations 3,6,4,6

Coloration (Figs. 4–6). Dorsum. Propeltidium with dark-brown triangular region enclosing ocularium, with apex at mid-anterior margin and base formed by posterior margin; brown interrupted by bilateral light and dark sigillary spots and a pair of light spots at base of ocularium. Ocularium whitish at base and carinae, central furrow dark brown; lenses outlined in black. Supracheliceral lamina and region anterior to ozophore dark brown, with a bilateral pair of distinct white lines along lateral anterior border of the carapace. Lateral surfaces of carapace dominated by whitish color with thin, dark marginal line, dark line outlining margin of ozopore and two elongate, dark submarginal spots. Mesopeltidium offset from propeltidium by dark transverse sulcus. Meso- and metapeltidium with broad dark median band with reticulated mottling of buff spots; intertergal membranes dark brown with numerous white flecks; laterally with prominent whitish blotches and flecks.

Scutal tergites with dark longitudinal central figure continuing from carapace, distinct anteriorly but margins degrading posteriorly. Central figure of each scutal tergal region and first free tergite dark with numerous small buff flecks; lateral margin of central figure indicated by nearly pure black region on all tergites, contrasted by white region (tergite 1) or large buff or white spots, lateral margin of each terminating in large whitish spot, thus forming a longitudinal row of whitish spots. Each scutal and free tergite with medial pair of white spots, those of last scutal tergite within an irregular transverse whitish band. Intertergal regions of scutum with comparatively uniform dark cuticle and buff flecks, appearing as a continuation of flexible pleural cuticle. Last free tergite and anal operculum light mediad, darker laterad, but medial and lateral white spots still present on last free tergite.

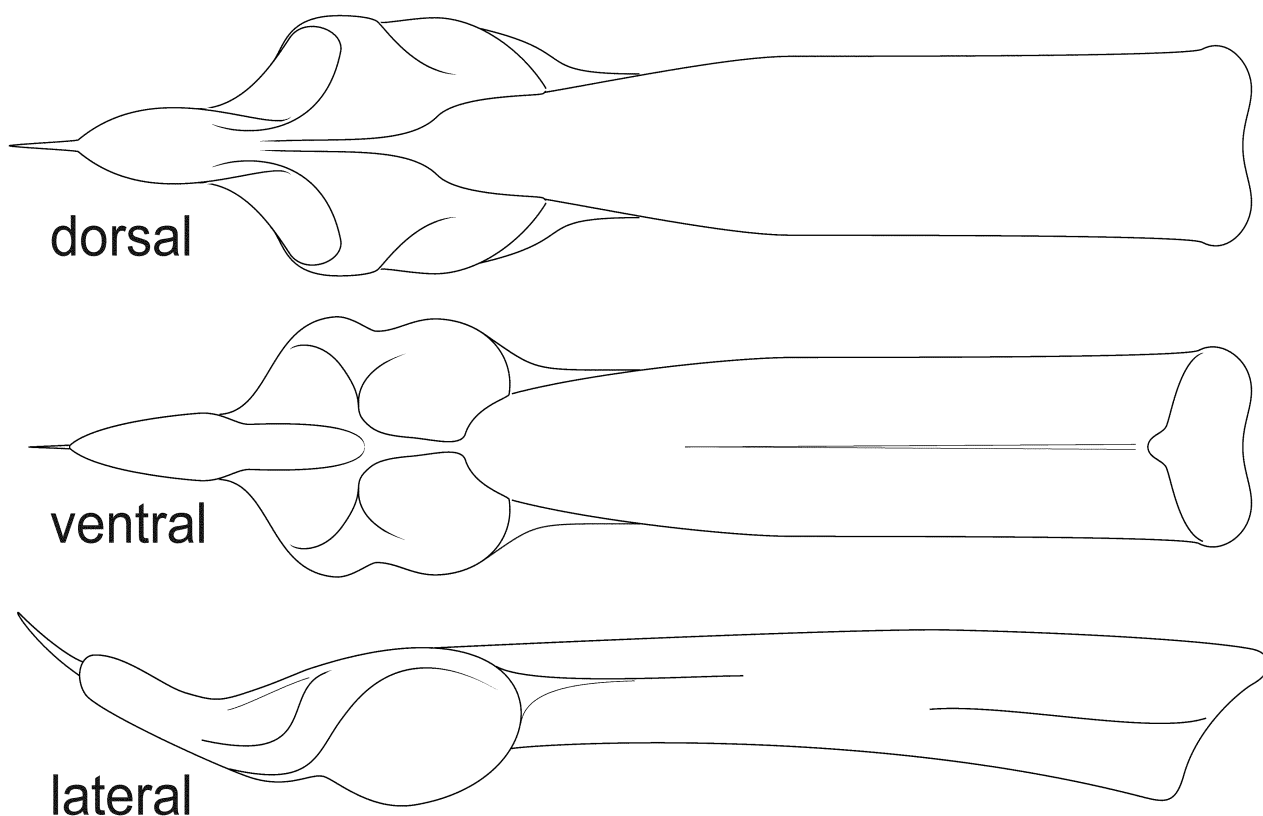


FIGURE 13. Penis from a paratype male of *Leiobunum silum* sp. nov. (body length = 3.65 mm, mid-line carapace length = 1.25 mm). Scale bar = 1 mm.

Venter (Fig. 5). Venter much lighter than dorsum, whitish with fine dark mottling in irregular transverse patterns, intersegmental sigilla dark brown; dark transverse bands contrasting with light sternites in lateral perspective. Genital operculum whitish with subtriangular midregion of fine dark mottling.

Chelicerae. Basal segment dark brown prolaterally, light brown retrolaterally with two regions separated by

white, setae occupying white region; second segment darker brown retrolaterally and lighter brown prolaterally divided centrally by whitish stripe, all fading to light yellow brown distally; chelal fingers light yellow-brown with dark tips.

Palps. Coxa, trochanter and prolateral to ventral surfaces of femur yellow-brown, femur brown on retrodorsal surface and distoprodorsal surface but these two regions divided dorsally by yellow-brown stripe extending from prolateral surface. Patella brown with yellow-brown distal margin. Tibia brown at proximal margin but brown area continuing distally on dorsal surface and gradually tapering distally, remainder yellow-brown. Tarsus yellow-brown but with darker patch on subterminal ventral surface.

Legs. Coxae dark brown distad, extending along exposed pro- and retrolateral surfaces narrowing ventrad (extreme pro- and retrolateral surfaces lighter brown), dark brown gradually replaced on exposed pro- and retrolateral surfaces by brown sigilla embedded in lighter cuticle, sigilla become increasing lighter ventrally; center of coxal surface with large, irregular whitish mark. Trochanters dark brown on prolateral, retrolateral and ventral surfaces, dorsal surface whitish bisected by dark longitudinal stripe, surface with clusters of fine, dark-brown sigilla and mottling. Femora dark brown at base followed by alternating series of broad light- and dark-brown bands terminating in light band. Patellae dark brown, mottled with light brown, especially at proximal and distal ends. Tibia brown with irregular narrow or broad dark-brown bands, with brown mottling distally. Basi- and telotarsi yellowish brown.

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