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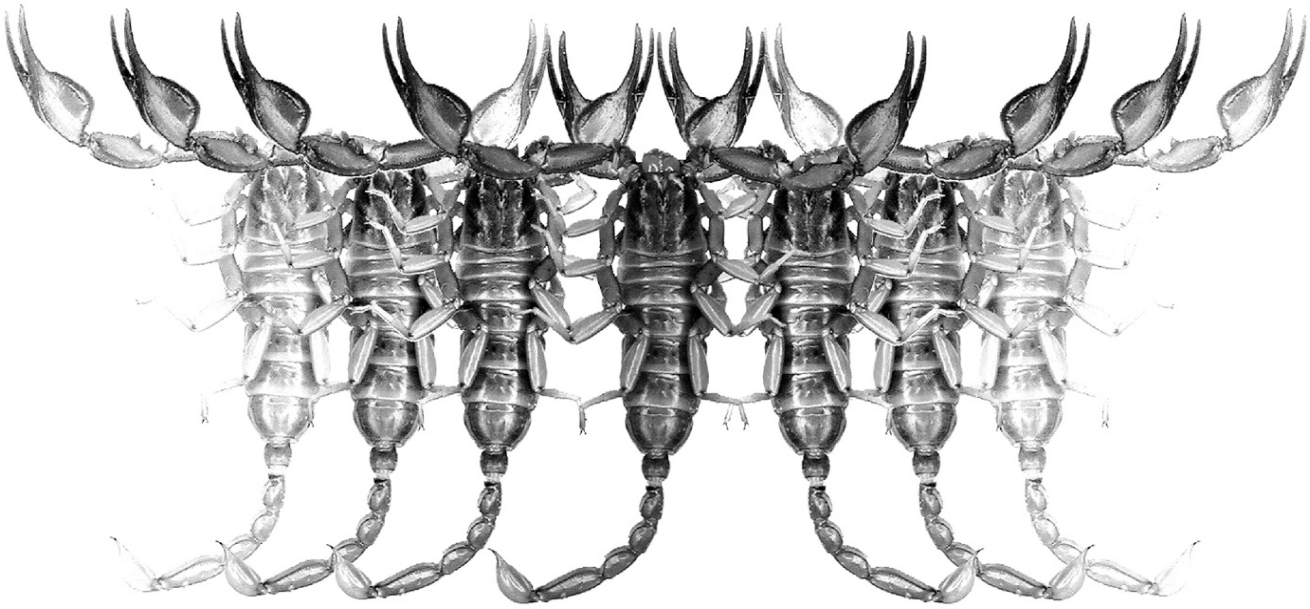

Description of the male of *Wernerius mumai* (Sissom, 1993) from western Arizona, with data on reproduction (Scorpiones: Vaejovidae)

Richard F. Ayrey & Brandon T. Myers

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Euscorpius — Occasional Publications in Scorpiology. 2020, No. 317

Description of the male of *Wernerius mumai* (Sissom, 1993) from western Arizona, with data on reproduction (Scorpiones: Vaejovidae)

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http://zoobank.org/urn:lsid:zoobank.org:pub:CBB9D2AA-980B-4F22-9BA2-C0BAF01F7F1

Summary

A male of *Wernerius mumai* (Sissom, 1993) is described for the first time, collected at the type locality (Gold Road, Black Mountains, Mohave County, Arizona). Originally placed in the genus *Vaejovis,* this species later was transferred by Soleglad & Fet (2008) to the genus *Wernerius*. It is one of the smallest vaejovid species known. The pedipalp fixed finger usually has 6 ID denticles and the movable finger has 7. The most unique characteristic of this species is the long, pointed, subaculear tubercle.

Introduction

Wernerius mumai (Sissom, 1993), originally placed in the genus *Vaejovis,* was described from the Gold Road, Black Mountains, Mohave County, Arizona, USA. The holotype female specimen and four juvenile paratypes were collected by Mont A. Cazier and Oscar F. Francke in 1969. Sissom (1993) noted that "the species is probably very uncommon and/or exhibits infrequent surface activity during the year." Not only is this species uncommon, but the entire genus consists of only three species of which males are known for only two.

Originally placed in the genus *Vaejovis,* this species later was transferred by Soleglad & Fet (2008) to the genus *Wernerius*. This is a small vaejovid genus with only three species: *W. mumai, W. spicatus* (Haradon, 1984) and a recently described *W. inyoensis* Webber et al., 2012. When Sissom (1993) described *W. mumai*, adult males were unknown to him, and therefore no description of the male was produced. Having had success collecting adult male specimens at the type locality in 2016−2020, we present that description now, including characteristics of the hemispermatophore and mating plug of the male. Techniques for studying these structures became available only recently, and we are beginning to describe these structures for species for which this information is lacking (Myers & Ayrey, 2020).

One reason the male of *W. mumai* was never published before now is probably that it is one of the smallest vaejovid species yet described. Another factor attributing to the scarcity of *W. mumai* in collections is that it is generally found on the surface in the very early spring (late February through March), and early fall (late August through October). We attribute this to the fossorial nature of the species and the extremely high summer temperatures in its habitat.

Noted in the description of *W. inyoensis*, the authors made an observation that *W. inyoensis* appears most morphologically similar to *W. spicatus*, with which we agree. The adults of *W. mumai* are much larger in size, though we understand size can vary. The largest morphological differences observed between *W. mumai* and the other two species are in the pedipalps. The femur and patella are much broader in *W. mumai* than in *W. inyoensis* and *W. spicatus*, in both males and females. Other contrast can be seen in the morphometric ratios of metasomal segments I−II, with the respective ratios of length to width being as follows: *W. mumai*: 0.75, 0.81; *W. inyoensis*: 0.81, 0.91; *W. spicatus*: 0.86, 0.95. As a male of *W. mumai* was not available for study during the description of *W. inyoensis*, an accurate comparison of the male specimens could not be made. With the differences in hemispermatophore morphology, as well as the variation noted above, we can now safely affirm the status of *W. inyoensis*, as well as the genus *Wernerius* currently containing three distinct species.

Methods, Materials & Abbrevations

The systematics adhered to in this paper follows the classification as established in Fet & Soleglad (2005) and modified by Soleglad & Fet (2006, 2008). Measurements are as described in Stahnke (1971), trichobothrial patterns are as in Vachon (1974), and pedipalp finger dentition follows Soleglad & Sissom (2001).

Specimen Depositories: RFA (personal collection of Richard F. Ayrey, Flagstaff, Arizona, USA); USNM (United States National Museum, Smithsonian Institution, Washington, DC, USA).

Figures 1–**2**. *Wernerius mumai* adult (1) and subadult (2) topotype males in vivo habitus.

Systematics

Family Vaejovidae Thorell, 1876
Subfamily Syntropinae Kraepelin, 1905
Tribe Stahnkeini Soleglad & Fet, 2006
Wernerius Soleglad & Fet, 2008
Wernerius mumai (Sissom, 1993)
(Figures 1−21, Tables 1−2)
http://zoobank.org/urn:lsid:zoobank.org:act:6DC0F0B2-2926-4BB9-84E9-AC062D2D83DF

Vaejovis mumai Sissom, 1993: 64–65, 68, figs. 1−7; Sissom, 2000: 551.
Wernerius mumai: Soleglad & Fet, 2008: 88; Webber et al., 2012: 2.

Material examined (topotypes). USA: *Arizona*, Mohave County, Gold Road, 35.04119ºN 114.37191 Wº, 986 m a. s. l. (Figs. 18–19), 20 March 2018, 2♂, RA2907 (USNM), RA2650 (RFA), leg. R. F. Ayrey, 11 March 2012, 1♀, RA573, 1♂, RA574 (RFA), 16 March 2012, 2♂, RA575, RA576 (RFA), 24 March 2020, 1♀, RA593 (RFA), leg. R. F. Ayrey & M. DeBoer-Ayrey, 04 April 2016, 1♂, RA2332 (RFA), 1 ♀, RA2331 (RFA), leg. R. F. Ayrey, 12 April 2020, 1♂, RA2924 (RFA), 13 April 2020, 1♀, RA2923 (RFA), 14 April 2020, 1♂, RA2928 (RFA), 19 April 2020, 1♀, RA2927 (RFA), leg. R. F. Ayrey & M. DeBoer-Ayrey.

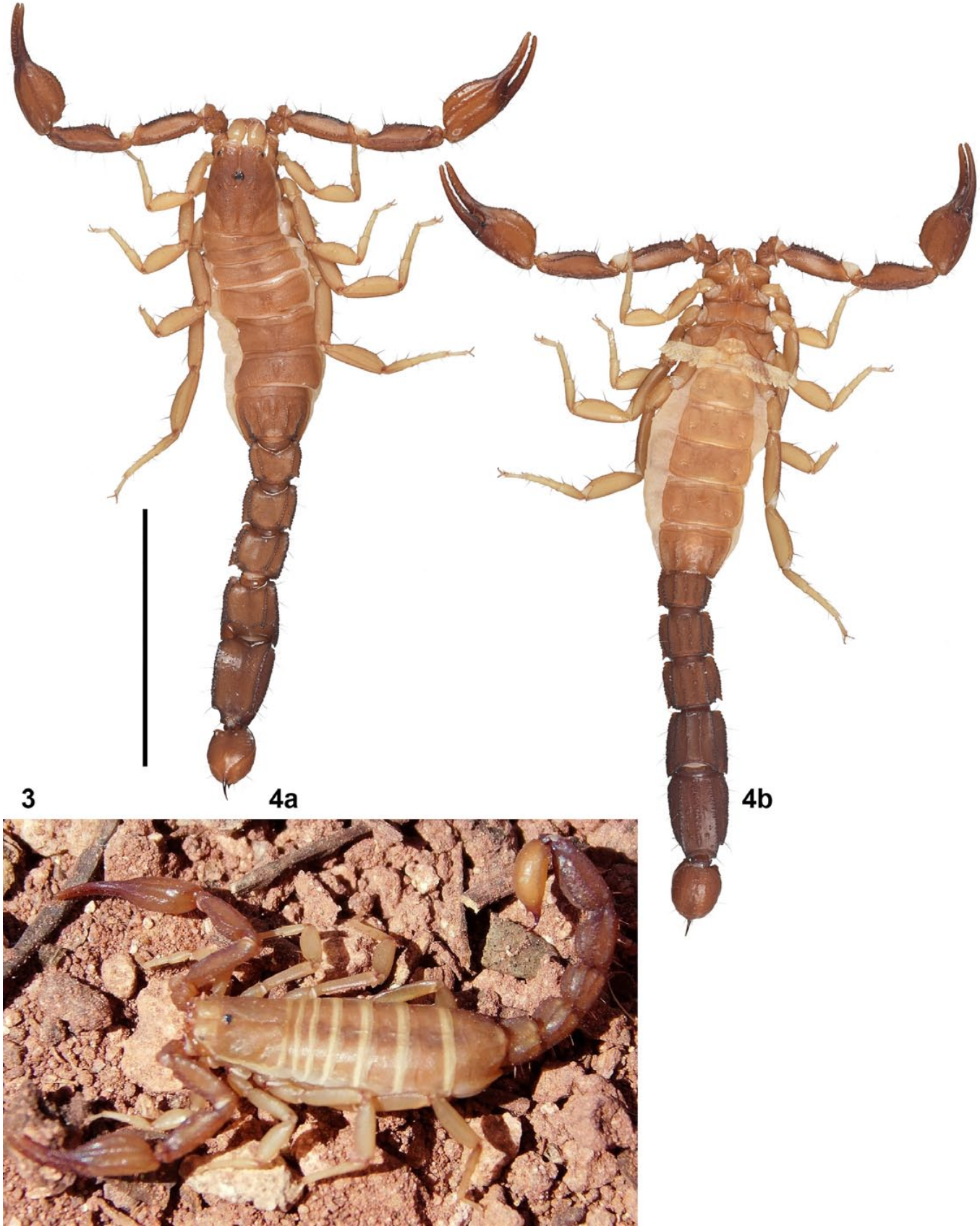
Diagnosis. Small (27.74 mm) scorpions. Color is reddish brown, lighter on the legs. (see Fig. 1). Pedipalp movable finger with 7 ID denticles and fixed finger with 6. Carapace of male is longer than the fifth metasomal segment. Pectinal tooth count for males 12.31 [n=16]; for females 11.40 [n=10]. Prominent subaculear tubercle.

Description. Based on a topotype male (specimen RA2907), unless otherwise noted; see Fig. 4 for dorsal and ventral views.
Coloration (Figs. 1–2). Color is reddish brown, lighter on the legs.
Carapace (Fig. 5). Anterior margin of carapace moderately emarginated, posterior margin slightly emarginated. Carapace finely granular, with larger granules dispersed throughout. Three lateral eyes on each side. Six macrosetae situated along the anterior edge of carapace. One pair of macrosetae positioned behind lateral eyes on each side. One pair of macrosetae positioned directly behind median eyes, located on either side of median furrow. Median furrow moderate and traverses entire length of carapace. Ratio of median eyes location from anterior edge/carapace length 0.36; carapace length/width at median eyes 1.39. Carapace of male is longer than metasomal segment V.
Mesosoma. Tergites finely granular with vestigial median carina on tergites I−VI. Tergite VII with weak median carina and strong dorsal lateral and lateral supramedian granular carinae. Sternites III−VI finely granular and without carinae.

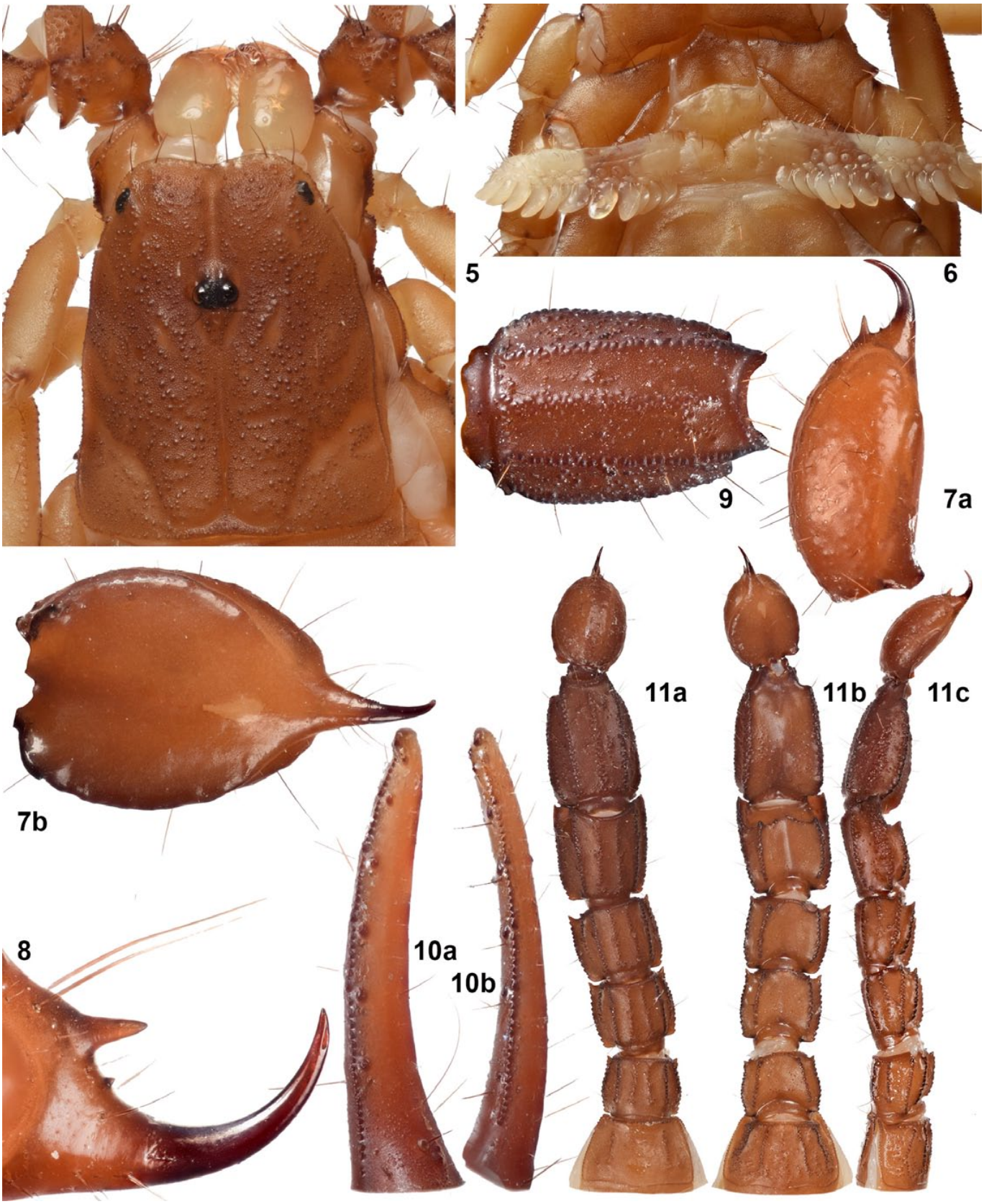
Dimensions (mm)		*Wernerius mumai* ♂
Carapace	L / W	3.59 / 2.99
Mesosoma	L	9.02
Tergite VII	L / W	3.01 / 1.87
Metasoma + telson	L	15.13
Segment I	L / W / D	1.67 / 2.10 / 1.63
Segment II	L / W / D	1.79 / 2.21 / 1.70
Segment III	L / W / D	1.98 / 2.26 / 1.76
Segment IV	L / W / D	2.41 / 2.20 / 1.95
Segment V	L / W / D	3.44 / 2.18 / 1.72
Telson	L / W / D	3.84 / 1.88 / 1.49
Pedipalp	L	11.53
Femur	L / W	2.97 / 1.00
Patella	L / W	3.37 / 1.19
Chela	L	5.19
Manus	L / W / D	2.48 / 1.57 / 1.76
Fixed Finger	L	2.10
Movable finger	L	2.71
Total	**L**	**27.74**
Pectinal teeth number	Le / Ri	13 / 12

Table 1. Comparative measurements of adult male of *Wernerius mumai*. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D), left (Le), and right (Ri).

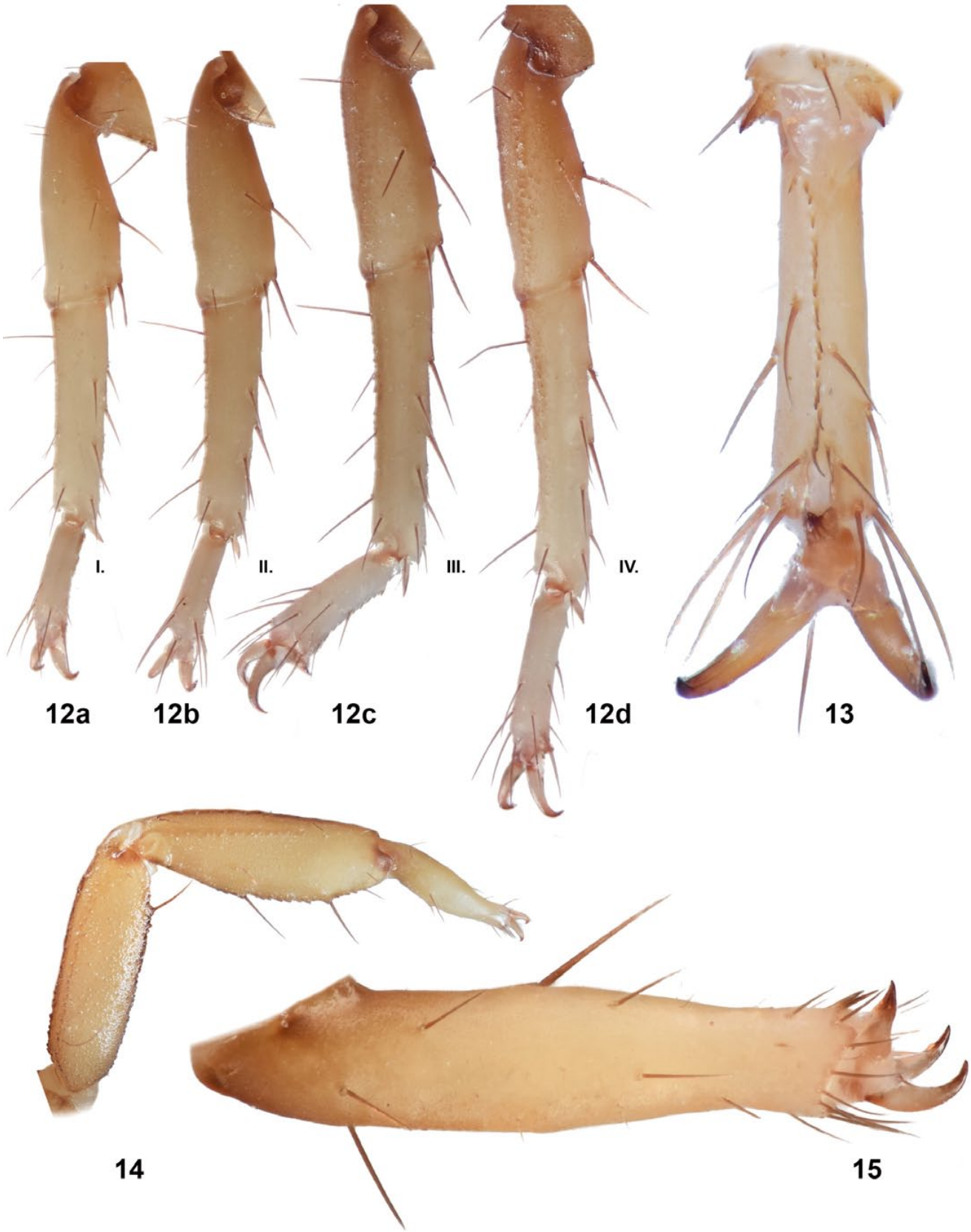
Sternite VII with granular ventral lateral carinae on posterior half. Presternites smooth. Spiracles ovoid with median side rotated 35 degrees from posterior sternite margin. Sternites with variable number of microsetae.
Sternum (Fig. 6). Sternum is type 2.
Genital Operculum (Fig. 6). Sclerites separated on posterior one-fifth.
Pectines (Fig. 6). Pectinal tooth counts 12/12 [n=5], 13/12 [n=1] and 13/13[n=2], with a mean of 12.31 [n=16], SD = 0.464 for males; 11/11 [n=3] and 12/12[n=2], with a mean of 11.40 [n=10], SD = 0.516 for females. All male pectinal teeth have exterodistal angling with large sensorial area. All female pectines have at least 1 and sometimes 2 of the most proximal teeth smaller and lacking sensorial area, mean of 1.10 [n=10]. Middle lamellae 8/8. Fulcra are present. Each fulcra with 1−3 central setae.
Chelicerae. Dorsal edge of movable cheliceral finger with two subdistal (sd) denticles. Ventral edge is smooth, with well-developed serrula on distal half.
Pedipalps (Figs. 10, 21). Trichobothrial pattern type C (Vachon, 1974). Trichobothria *ib/it* at base of fixed finger. Pedipalp ratios: chela length/width 3.31; femur length/width 2.97; patella length/width 2.83; fixed finger length/carapace length 0.58.
Chela. External carinae weak; D1 and D3 carinae weak. D4 and D5 carinae weak, granular, with individual granule



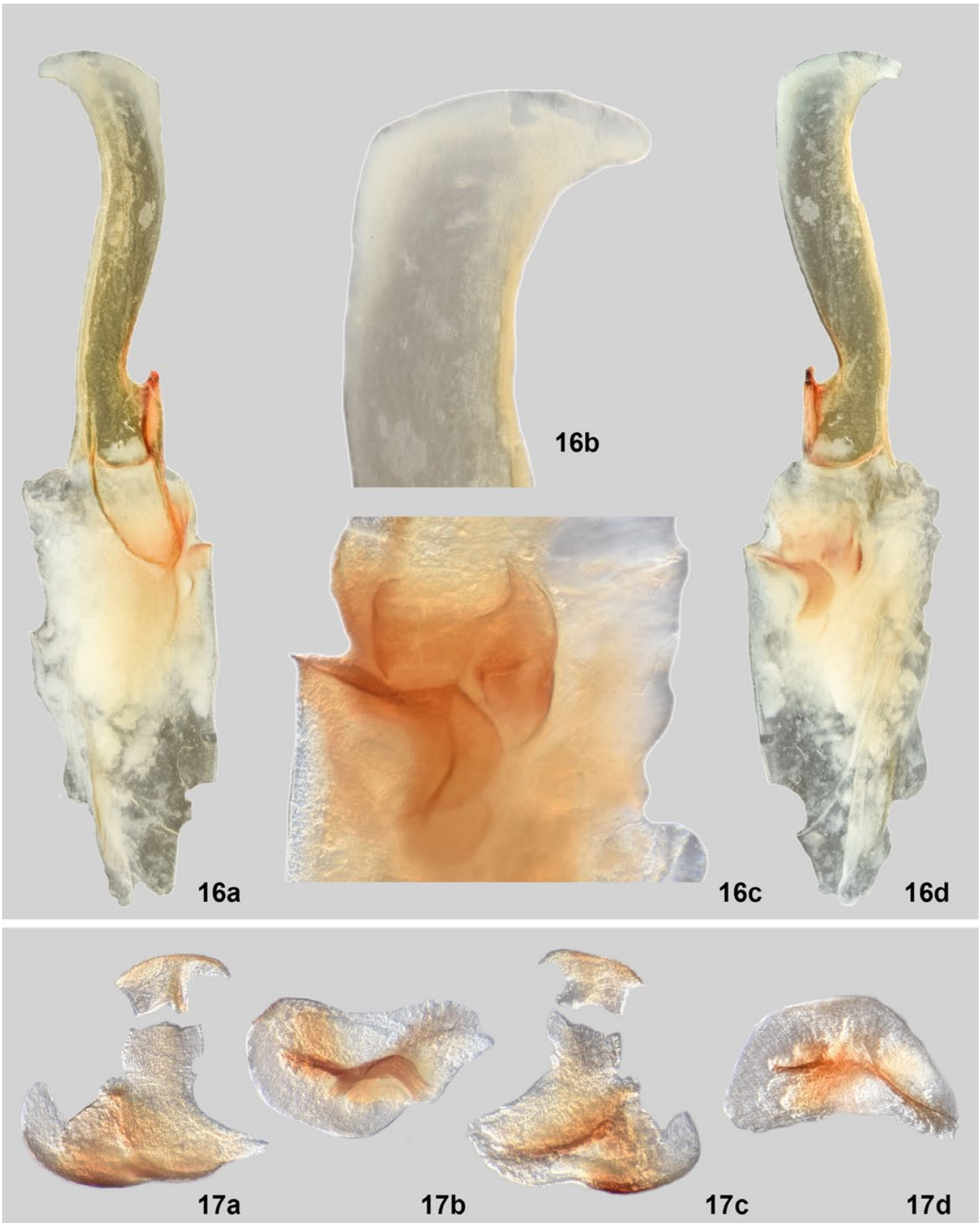
Figures 3–**4**: *Wernerius mumai*. **Figure 3**. Topotype female in vivo habitus. **Figure 4**. Topotype male in dorsal (4a) and ventral 4(b) views. Scale bar, 10 mm.



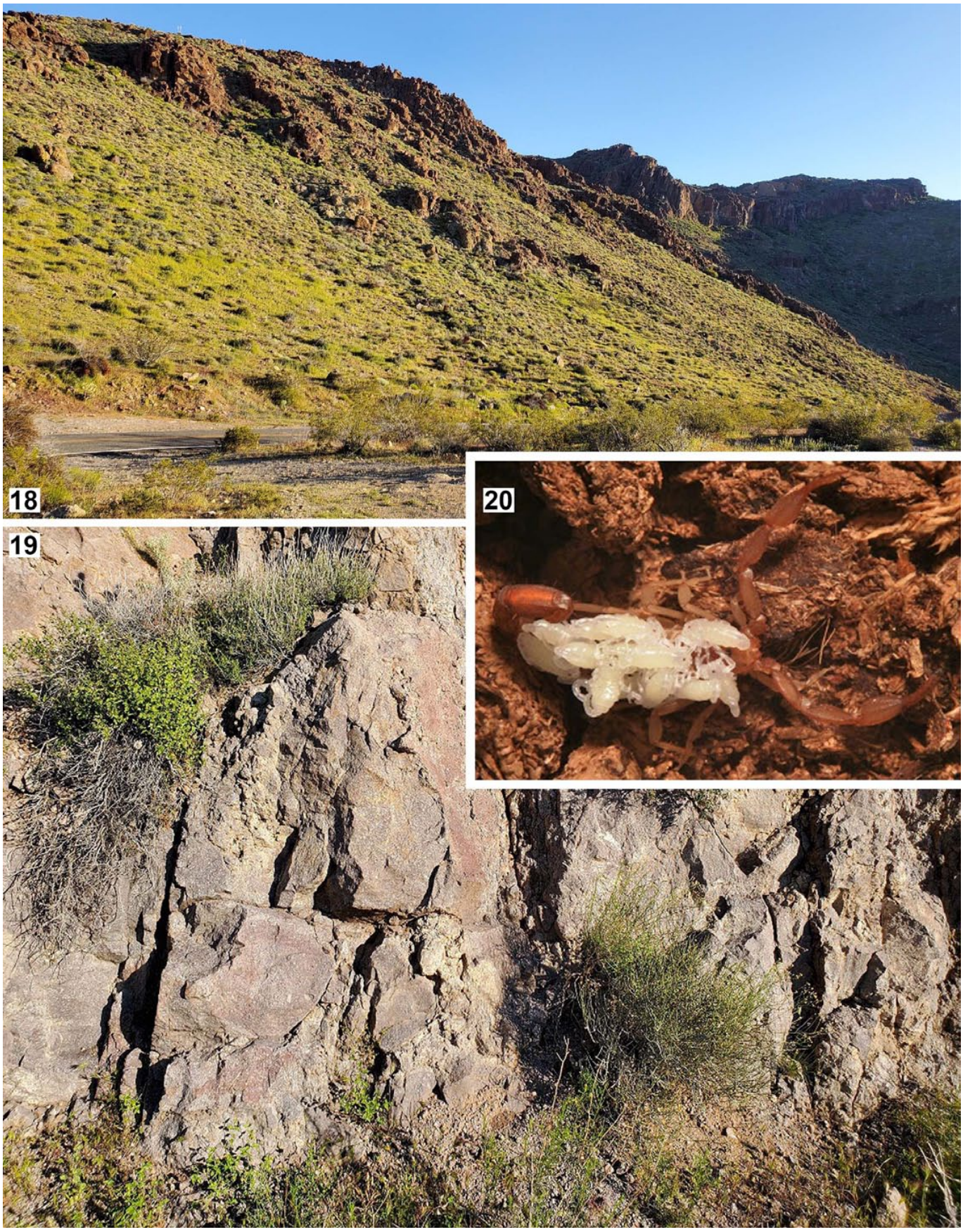
Figures 5–**11**: *Wernerius mumai*, topotype male. **Figure 5**. Carapace. **Figure 6**. Pectines. **Figure 7**. Telson in lateral (7a) and dorsal (7b) views. **Figure 8**. Telson, lateral view, close-up of aculeus and subaculear tubercle. **Figure 9**. Metasoma V, ventral view. **Figure 10**. Chela fixed (10a) and movable (10b) fingers dentition. **Figure 11**. Metasoma and telson in ventral (11a), dorsal (11b), and lateral (11c) views.



Figures 12–**15**: *Wernerius mumai*, topotype male, legs. **Figure 12**. Right legs I–IV, prolateral view. **Figure 13**. Right telotarsus III, ventral view. **Figure 14**. Left leg III, showing femur, patella, tibia, and lack of basitarsus and full telotarsus. **Figure 15**. Left leg III, close-up of leg anomaly showing the apotele growing directly from tibia.



Figures 16–**17**: *Wernerius mumai*, topotype male. **Figure 16**. Hemispermatophore, dorsal (16a) and ventral (16d) views, close-up of distal tip (16b), and close-up of embedded mating plug (16c). **Figure 17**. Mating plug in dorsal (17a), internal (17b), ventral (17c), and external (17d) views.



Figures 18–**20**: *Wernerius mumai*. **Figure 18**. Habitat, Gold Road, Arizona. **Figure 19**. Microhabitat. **Figure 20**. Topotype female with newborns.

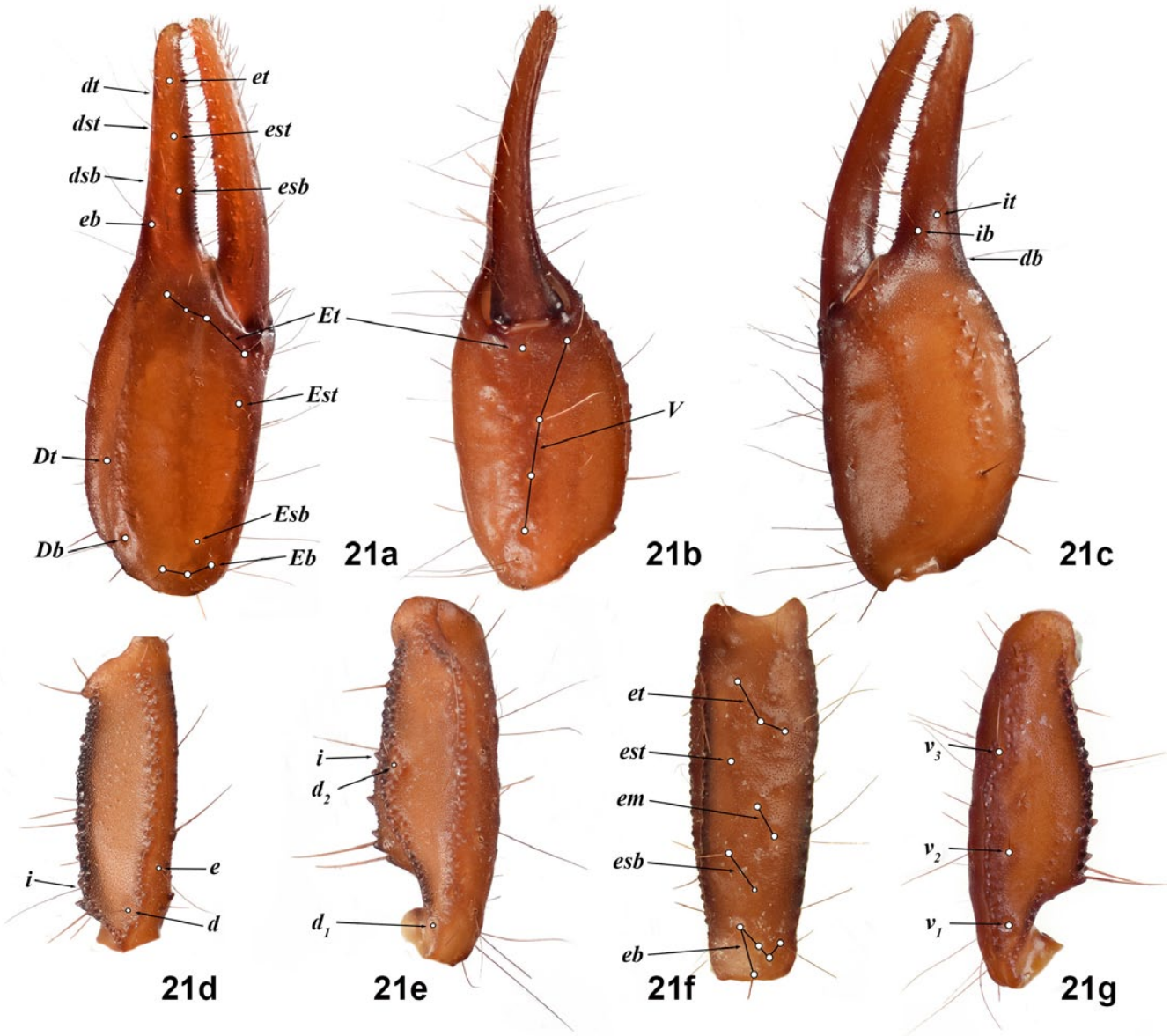


Figure 21. *Wernerius mumai* topotype male, trichobothrial pattern. Chela external (21a), ventral (21b), and internal (21c) views. Femur dorsal (21d) view. Patella dorsal (21e), external (21f), and ventral (21g) views.

size increasing distally. Internal and ventral carinae weak to obsolete. Fixed finger median (MD) denticles aligned and divided into 6 subrows by 5 outer (OD) denticles and 6 ID denticles. Movable finger with 6 subrows, 5 OD denticles and 7 ID denticles (Soleglad & Sissom, 2001).

Femur. Carinae moderate.

Patella. Carinae strong, internal surface with very large granules on the *DPSc* carina.

Legs (Figs. 12–15). Ventral surface of tarsomere I with single median row of spinules terminating distally with one spinule pair. An anomaly was discovered on left leg III (Figs. 14 & 15). It appears that the basitarsus and telotarsus never completely developed. These segments are completely missing with the apotele growing directly from the tibia. The tibia appears to be mostly complete, however the patterns of macrosetae are not consistent with the tibia on other legs. Numerous macrosetae are situated at the distal edge of the tibia. While references of limb regeneration in scorpions appear to be rare, Maruzzo & Bortolin (2013), did provide a similar observation, noting that only the apotele appears to regenerate.

Metasoma (Fig. 11). Carapace of male is longer than the fifth metasomal segment. Ratio of segment I length/width 0.80; of segment II length/width 0.81; of segment III length/width 0.88; of segment IV length/width 1.10; of segment V length/width 1.58. Segments I–IV: dorsolateral carinae strong and granular with distal denticle of I–IV enlarged and spinoid. Lateral supramedian carinae I–IV strong and granular with enlarged spinoid distal denticle. Lateral inframedian carinae moderately granular on posterior 4/5 of segments I–II, posterior ½ of III, and weak to obsolete on IV; individual granules increasing in size distally on segments II–III. Ventrolateral carinae moderately granular on I–III; IV strong, granular. Ventral submedian carinae weak to moderate on I–IV. Dorsal and lateral intercarinal spaces very finely granular.

Ratios of adult males	*Wernerius mumai* ♂ (n = 1)	*Wernerius inyoensis* ♂ (n = 1)	*Wernerius spicatus* ♂ (n = 1)
Carapace (L)	3.59	2.38	2.20
Carapace (L) / Metasoma V (L)	1.04	1.04	1.07
Metasomal segment I (L/W)	0.75	0.81	0.86
Metasomal segment II (L/W)	0.81	0.91	0.95
Metasomal segment III (L/W)	0.88	0.89	0.96
Metasomal segment IV (L/W)	1.10	1.14	no data
Metasomal segment V (L/W)	1.58	1.58	1.46
Pedipalp femur (L/W)	2.97	3.54	3.55
Pedipalp patella (L/W)	2.83	3.69	3.58
Pedipalp chela (L/W)	3.31	3.84	3.35
Fixed finger (L) / Carapace (L)	0.58	0.75	0.73
Fixed finger (L) / Chela (L)	0.40	0.50	0.56
Pectinal teeth number	13/12	11/11	12/12

Table 2. Morphometric ratios for males of all three species of *Wernerius*. Data for *W. inyoensis* after Webber et al. (2012), and for *W. spicatus*, after Sissom (1993). Abbreviations: length (L), and width (W).

Segment I–IV ventral submedian setae 3:3:3:3. Segment V: Dorsolateral carinae moderate, distally crenulate, basally granular. Lateromedian carinae weak and granular on proximal 3/5, obsolete on distal 2/5. Ventrolateral and ventromedian carinae strong. Intercarinal spaces finely granular. Segment V ventrolateral setae 4/4.

Telson (Figs. 7–8). Rough with 4 pairs of large setae on the ventral surface, 3 large setae along both lateral edges of the vesicle and numerous smaller setae. Prominent, spinoid subaculear tubercle present. Small, triangular granule positioned between subaculear tubercle and base of aculeus. Lateral aculear serrations present, numbering 4 on either side of aculeus.

Hemispermatophore (Fig. 16). All descriptions based on right hemispermatophore. Fairly narrow hemispermatophore as shown by trunk and lamina width. Strong basal constriction where lamina widens distally and ends in a wide projection at distal edge. This projection is not seen in the descriptions of either *Wernerius inyoensis* Webber et al., 2012, or *W. spicatus* (Haradon, 1974), the only two other known species in the genus. Webber et al. (2012), in their description of *W. inyoensis* discussed the tapering of the lamina of both *W. inyoensis* and *W. spicatus*, showing the ratios of lamina width at distal end of lamina/width at lamina midpoint as 0.900 & 0.652, respectively. In *W. mumai*, this ratio is 1.871. Lamellar hook sclerotized, weakly bifurcated at distal tip. Shallow dorsal trough.

Measurements (mm): trough difference, 0.46; lamellar hook length, 0.87; lamina length, 2.39; trunk width, 0.60; lamina width, 0.33; ratio of lamellar hook length to lamina length, 0.36; ratio of trough difference to lamellar hook length, 0.53.

Mating Plug (Fig. 17). Sclerotized mating plug with wide base. Stem of average width. Smooth barb, with one tine significantly longer than the other. During dissection, the barbed tip was severed from the stem. In the close-up image of the embedded mating plug, it can be seen that the barbed tip was actually disjointed before the mating plug was removed.

Sexual dimorphism is evident, primarily in the body shape, pedipalp ratios, and pectines. The pedipalp fixed finger usually has 6 ID denticles and the movable finger has 7. The mesosoma of the females are wider than those of the males. The pedipalp femur, patella and chela of the male is broader, while female's pedipalps are more slender. The mean pectinal tooth count for males is 12.31 [n=16], SD = 0.464, for females 11.40 [n=10], SD = 0.516. Also, the pectines of the male are both longer and wider, while females have 1 to 2 of the most proximal teeth smaller and lacking sensorial area, making it easy to distinguish the two sexes.

Ecology. The topotype specimen was found using a blacklight at night at Gold Road, Mohave County, Arizona (35.04119ºN 114.37191 Wº) at an elevation of 986 m a. s. l. The vegetation type is low desert scrub (see Figs. 18–19). This species lives under rocks and on canyon walls (see Fig. 19). *Paravaejovis spinigerus* (Wood, 1863), *Stahnkeus subtilimanus* (Soleglad, 1972), and *Serradigitus wupatkiensis* (Stahnke, 1940) were found syntopically with *Wernerius mumai* during 12 field trips to Gold Road.

Wernerius mumai exhibit bimodal periods of activity. They are found active on the surface most often in March and April and again in September and October. The authors have not observed surface activity with this species in any other months of the year. This information represents a total of 25 field trips to the topotype locality as well as a second locality discovered by Graeme Lowe while collecting with Wendell Icenogle, along Old Kingman Highway (Black Mountains, SW of Union Pass, 29 August 1992). This bimodal pattern appears to be related to the extreme summer temperature highs found in both localities. According to NOAA (National Oceanic and Atmospheric Administration, USA), the average high air temperatures, per month, at the type locality are: January, 67°F; February, 73°F; March, 83°F; April, 89°F; May, 98°F; June, 108°F; July, 112°F; August, 110°F; September, 103°F,

October, 90°F; November, 78°F; and December, 65°F. This species appears to be surface active when daytime highs are in the 80's. This would be from March until early in May and again from late August through October.

Reproduction. Two adult females were kept alive to determine 1st instar behavior. Both gave birth with the average number of 1st instars being 12.00 [n=2]. The 1st instar orientation on the mother's back was generally non-random, as is seen with many species of *Vaejovis* (Ayrey, 2012, 2013a, 2013b). Most were facing anteriorly with the prosoma down and the metasoma raised over the prosoma of the juvenile immediately posterior. The photo above, taken 24 hours after birth, shows 8 juveniles displaying the standard orientation for the tribe Stahnkeini, while what appears to be the last 5 instars oriented randomly. This type of orientation has been observed, by the authors, in some other genera of Vaejovidae.

Distribution. Known only from the Black Mountains, Mohave County, Arizona.

Acknowledgments

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