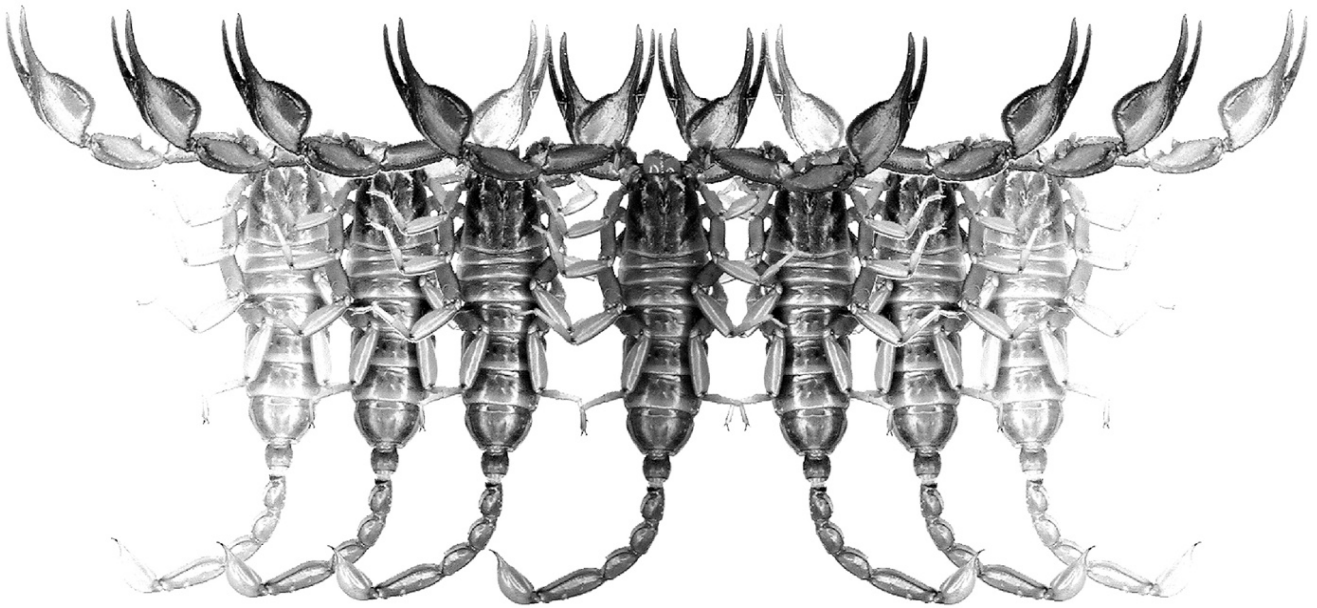


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**A new species of *Vaejovis* from Mingus
Mountain, northern Arizona
(Scorpiones: Vaejoidea)**

Richard F. Ayrey

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A new species of *Vaejovis* from Mingus Mountain, northern Arizona (Scorpiones: Vaejovidae)

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<http://zoobank.org/urn:lsid:zoobank.org:pub:B01260F2-C164-4DF5-A70D-8BE46189179A>

Summary

A new scorpion species, *Vaejovis elii* sp. n., is described. This small, dark brown species is found on Mingus Mountain, Yavapai County, northern Arizona, USA. It is geographically closest to *V. crumpi* Ayrey & Soleglad. We compare it to that species and two other species found in northern Arizona. The pedipalp fixed finger has 6 ID denticles and the movable finger has 7, like in most, but not all, of the other northern Arizona *Vaejovis*. Carapace of female is longer than metasomal segment V.

Introduction

Including the new species described in this paper from Mingus Mountain, Arizona, there are now 22 “*vorhiesi*” group scorpions in Arizona, western New Mexico (USA) and northern Sonora (Mexico). Most of these scorpions live in Ponderosa Pine forests or pine oak woodlands (Ayrey, 2009, 2018; Ayrey & Soleglad, 2011; Ayrey & Myers, 2019), as does *Vaejovis elii* sp. n.

The type locality of *V. elii* sp. n. is at the top of Mingus Mountain, along the canyon of the Verde River, which separates it from *V. lapidicola* and *V. jonesi*. It is also separated from *V. crumpi* by the Prescott Valley and the Bradshaw Mountains. See map (Fig. 21) for locations.

This species was one of the subjects of an ABC Nightline news segment on scorpions, which was aired on 28 September 2016. It can be viewed on Youtube.com via the following link: <https://www.youtube.com/watch?v=H-B0YhGt9u4>

Methods, Material & Abbreviations

Measurements are as described in Stahnke (1971), trichobothrial patterns are as in Vachon (1974), and pedipalp finger dentition follows Soleglad & Sissom (2001).

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

Systematics

Family Vaejovidae Thorell, 1876

Subfamily Vaejovinae Thorell, 1876

Vaejovis elii sp. n.

(Figures 1–13, Tables 1–2)

<http://zoobank.org/urn:lsid:zoobank.org:act:4CACA78A-2A84-42FE-8132-05B04F2D11A9>

TYPE LOCALITY AND TYPE DEPOSITORY. USA, Arizona, Yavapai County, Mingus Mt., 34.70111°N 112.13939°W, 2,291 m a. s. l.; USNM.

TYPE MATERIAL. USA, Arizona, Yavapai County, Mingus Mt., 34.70111°N 112.13939°W, 2,291 m a. s. l., leg. R. F. Ayrey, 31 May 2019 1♀ (holotype, #RA2888), USNM, 1♂3♀ (paratypes, #RA2901, 2887, 2889, 2890), RFA, 31 August 2016, 3♂ (paratypes, #RA2442, 2885, 2886), RFA, 30 June 2012, 3♀ (paratypes, #RA756, 761), RFA.

The type specimens were found with a black light at night. The vegetation type is Ponderosa Pine Forest (Figs. 18–19). No other scorpion species were found syntopically.

ETYMOLOGY. The species epithet is a patronym in honor of Eli Ayrey who found the holotype specimen and many of the other types.

DIAGNOSIS. Small (holotype length 24.58 mm) scorpions. Color is dark brown, lighter on the legs, with underlying mottling on carapace and mesosoma (Fig. 1). Pedipalp movable finger with 7 ID denticles and fixed finger with 6, similar to most northern Arizona members of the “*vorhiesi*” group. Carapace of female is longer than the fifth metasomal



Figures 1–2. *Vaejovis elii* sp. n., live female (1) and male (2) paratypes.

Dimensions (mm)		<i>V. elii</i> sp. n.	<i>V. elii</i> sp. n.	<i>V. elii</i> sp. n.	<i>V. elii</i> sp. n.
		♀ holotype	♀ paratype	♀ paratype	♂ paratype
Carapace	L / W	3.26 / 2.90	3.47 / 3.14	3.61 / 3.55	2.96 / 2.88
Mesosoma	L	8.44	8.75	6.25	5.19
Tergite VII	L / W	2.24 / 3.11	2.04 / 3.16	2.11 / 3.20	1.47 / 2.34
Metasoma + telson	L	12.88	13.45	14.83	12.10
Segment I	L / W / D	1.47 / 1.75 / 1.36	1.38 / 1.78 / 1.37	1.54 / 1.87 / 1.48	1.41 / 1.61 / 1.26
Segment II	L / W / D	1.53 / 1.61 / 1.23	1.57 / 1.73 / 1.33	1.77 / 1.82 / 1.42	1.49 / 1.47 / 1.25
Segment III	L / W / D	1.70 / 1.60 / 1.26	1.68 / 1.64 / 1.36	1.90 / 1.76 / 1.47	1.55 / 1.42 / 1.14
Segment IV	L / W / D	2.33 / 1.52 / 1.33	2.38 / 1.57 / 1.39	2.67 / 1.70 / 1.32	1.95 / 1.35 / 1.28
Segment V	L / W / D	3.08 / 1.32 / 1.20	3.45 / 1.40 / 1.23	3.49 / 1.46 / 1.33	2.93 / 1.27 / 1.06
Telson	L / W / D	2.77 / 1.09 / 0.82	2.94 / 1.27 / 0.93	3.46 / 1.40 / 0.98	2.77 / 0.95 / 0.71
Pedipalp	L	10.27	11.23	11.52	9.09
Femur	L / W	2.80 / 0.79	2.97 / 0.84	3.06 / 0.86	2.22 / 0.83
Patella	L / W	3.06 / 0.98	3.25 / 1.07	3.26 / 1.08	2.71 / 0.92
Chela	L	4.41	5.01	5.20	4.16
Manus	L / W / D	1.75 / 1.29 / 1.09	2.29 / 1.33 / 1.30	2.36 / 1.38 / 1.38	1.92 / 1.30 / 1.19
Fixed Finger	L	1.99	2.37	2.51	1.97
Movable finger	L	2.66	2.72	3.02	2.24
Total	L	24.58	25.67	24.69	20.25

Table 1: Morphometrics (mm) of *Vaejovis elii* sp. n.

segment. Pectinal tooth count for females 11.50 [n=8] and 13.00 [n=2] for males. Small poorly developed subaculear tubercle.

DESCRIPTION. Based on holotype female, unless otherwise noted.

Color. Color is dark brown, lighter on the legs. Faint underlying mottling on carapace and mesosoma.

Carapace. (Figs. 4, 6) Anterior margin of carapace moderately emarginated, posterior margin slightly emarginated. Carapace finely granular. Three lateral eyes on each side. Median furrow moderate and traverses entire length of carapace. Ratio of median eyes location from anterior edge/carapace length 0.33; carapace length/width at median eyes 1.44. Carapace of female is longer than metasomal segment V.

Mesosoma. Tergites finely granular with vestigial median carina on tergites I–VI. Tergite VII with vestigial carina on anterior third and strong dorsal lateral and lateral suprmedian granular carinae on posterior half. Sternites III–VI finely granular and without carinae. Sternite VII with granular ventral lateral carinae on proximal 1/2, very weak to absent on posterior 1/5. Presternites smooth. Spiracles ovoid with median side rotated 35 degrees from posterior sternite margin. Sternites with variable number of microsetae.

Sternum (Figs. 5, 7). Sternum is Type 2.

Genital Operculum (Fig. 5). Sclerites separated on posterior one-fifth.

Pectines (Figs. 5, 7). Pectinal tooth counts 11/11 [2], 11/12 [1], 12/12 [n=6] and 13/12 [1] with a mean of 11.80 [n=20], SD 0.52 for females and 13/13 [1], 13/14 [2], and 14/13 [n=1],

with a mean of 13.38 [n=8], standard deviation 0.52 for males. All pectinal teeth have exterodistal angling with large sensorial area. Middle lamellae 7/6. Fulcra are present. Each fulcra with 1–4 central setae.

Metasoma (Fig. 11). Ratios of segments I–V length/width see Table 2. Segments I–IV: dorsolateral carinae strong and granular with distal denticle of I–IV enlarged and spinoid. Lateral suprmedian carinae I–IV strong and granular with enlarged spinoid distal denticle. Lateral infrmedian carinae moderately granular on segment I, weakly granular on II, III, and IV. Ventrolateral carinae I weak and granular; on II–III and IV moderate, granular. Ventral submedian carinae weak on segment I, weak to moderate on II, moderate, granular on III and IV. Dorsal and lateral intercarinal spaces very finely granular. Segment I–IV ventral submedian setae 3/3:4/4:4/4:4/4. Segment V: Dorsolateral carinae moderate, distally crenulate, basally granular. Lateromedian carinae weak and granular on basal 3/5, obsolete on distal 2/5. Ventrolateral and ventromedian carinae strong. Intercarinal spaces finely granular. Segment V ventrolateral setae 4/4.

Telson (Fig. 12). Smooth with 4 pairs of large setae on the ventral surface, 3 large setae along both lateral edges of the vesicle and numerous smaller setae. Small, poorly developed subaculear tubercle present. Subaculear setae present at basal portion of subaculear tubercle. Small number of lateral aculear serrations (LAS) present; average of 5.25 (holotype and paratypes).

Chelicerae (Fig. 13). Dorsal edge of movable cheliceral finger with two subdistal (*sd*) denticles. Ventral edge is smooth, with well-developed serrula on distal half. Fixed cheliceral finger



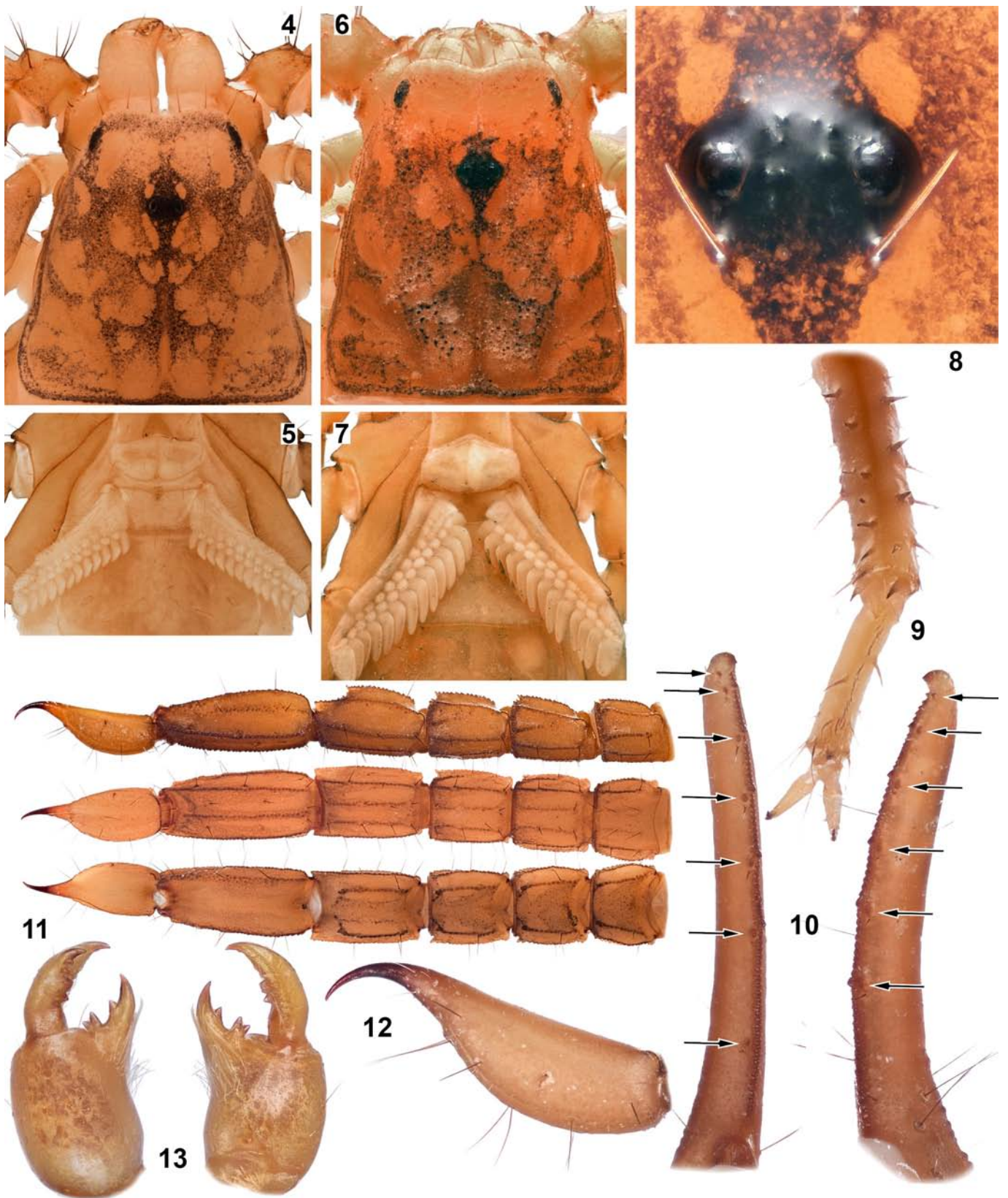
Figure 3: *Vaejovis elii* sp. n., paratype female, dorsal and ventral views.

with four denticles: basal, median, subdistal and distal. Basal and median denticles forked. Typical for genus.

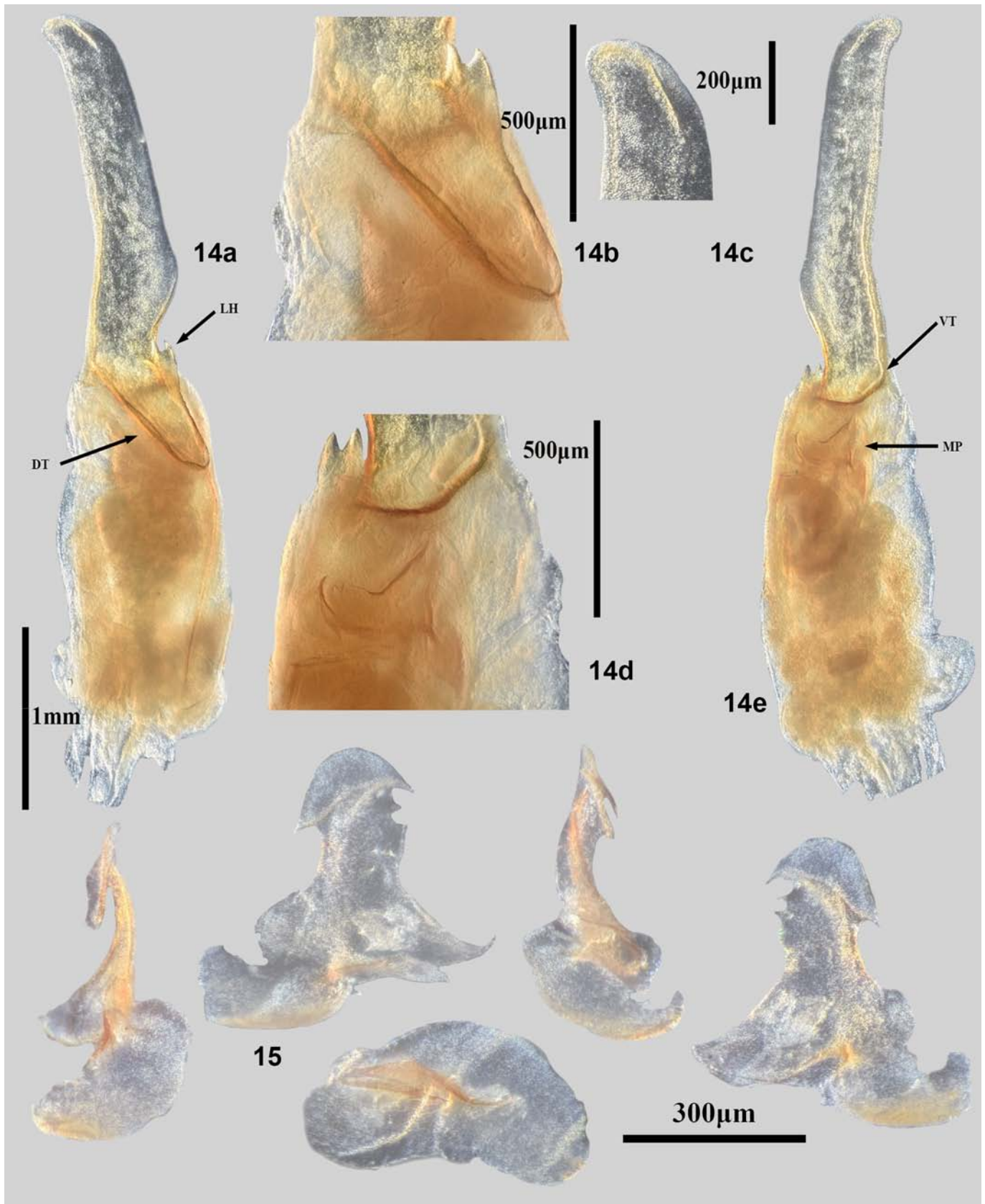
Pedipalps (Fig. 20). Trichobothrial pattern type C (Vachon, 1974). Trichobothria *ib* and *it* at base of fixed finger. Pedipalp ratios: chela length/width 3.42; femur length/width 3.54; patella length/width 3.12; fixed finger length/carapace length 0.61.

Chela. Carinae moderate. Fixed finger median (MD) denticles aligned and divided into 6 subrows by 5 outer (OD) denticles and 6 inner (ID) denticles. Movable finger with 6 subrows, 5 OD denticles and 7 ID denticles (Soleglad & Sissom, 2001).

Femur. Carinae moderate.



Figures 4–13: *Vaejovis elii* sp. n. **Figures 4–5, 8–13:** Female paratype. **Figures 6–7:** Male paratype. **Figures 4, 6.** Carapace. **Figures 5, 7.** Pectines area. **Figure 8.** Median eyes. **Figure 9.** Right leg III. **Figure 10.** Fixed and moveable pedipalp chela fingers showing interior denticles by arrows. **Figure 11.** Metasoma in dorsal, ventral, and lateral views. **Figure 12.** Telson in lateral view. **Figure 13.** Chelicera in dorsal and ventral views.



Figures 14–15: *Vaejovis elii* sp. n., paratype male. **Figure 14.** Left hemispermatophore, dorsal view with sheath still attached (14a, 14b), ventral view showing embedded mating plug (14c, 14e), distal tip of lamella, showing distal crest (14d). Note: abbreviations are as follows: LH (lamellar hook), DT (dorsal trough), VT (ventral trough), MP (embedded mating plug). Scale bars: 1 mm (14a, 14e), 500 µm (14c, 14e), 200 µm (14d). **Figure 15.** Left mating.



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Figures 16–17. *Vaejovis elii* sp. n., female with newborns (16) and with juveniles after the first ecdysis (17).



Figures 18–19. *Vaejovis elii* sp. n., habitat (18) and microhabitat (19) on Mingus Mountain, Yavapai County, Arizona.

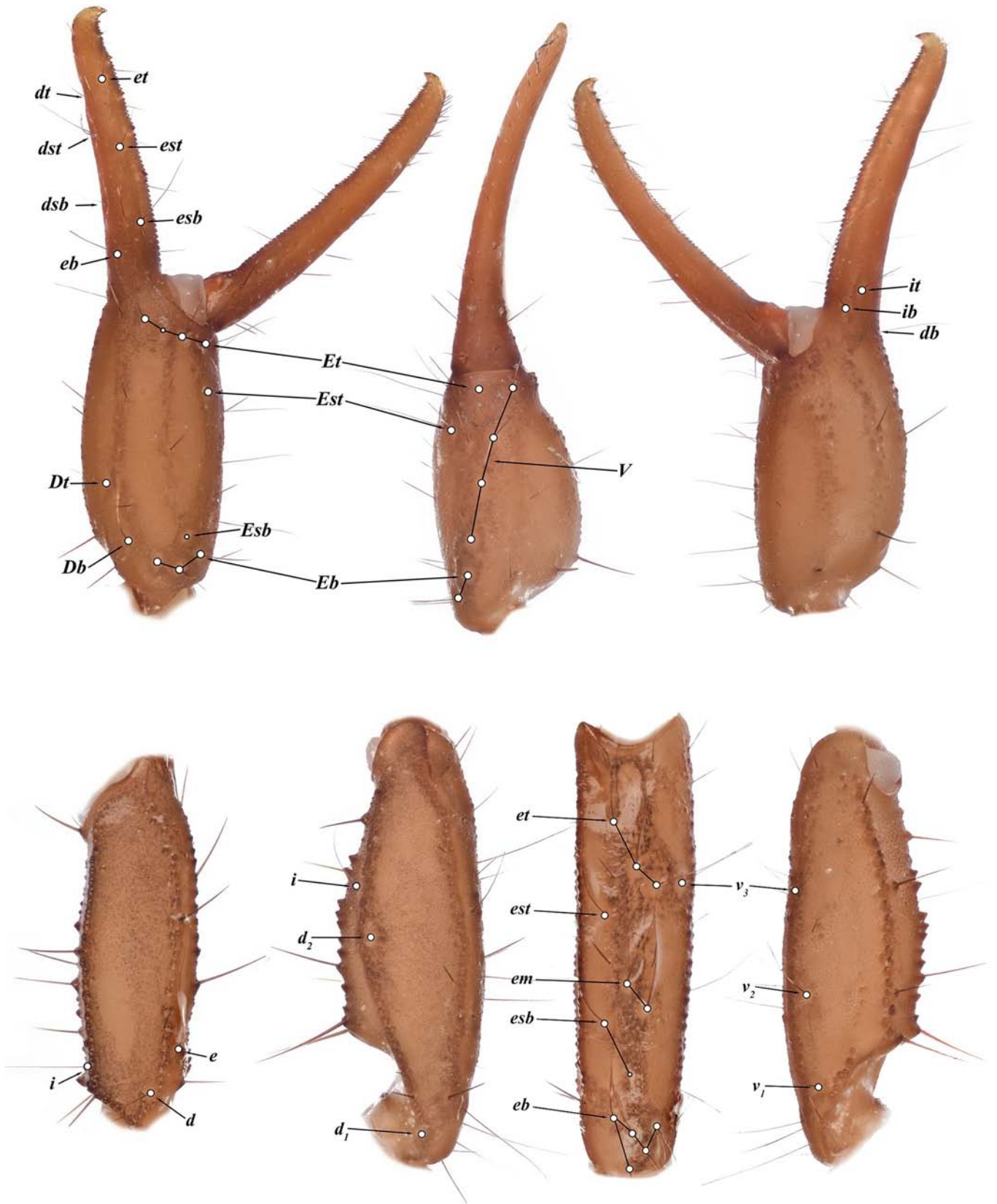


Figure 20. *Vaejovis elii* sp. n., female paratype, trichobothrial pattern.

Ratios of adult males	<i>V. elii</i> sp. n. (n = 3)	<i>V. crumpi</i> (n = 3)	<i>V. grayae</i> (n = 3)	<i>V. lapidicola</i> (n = 1)	<i>V. trinityae</i> (n = 3)
Carapace (L)	3.26–3.61 (3.45)	3.18–3.40	3.23–3.58	4.00	3.20–3.39
Carapace (L)/Metasomal V (L)	1.01–1.06 (1.03)	0.92–0.94	0.93–0.95	–	1.03–1.12
Metasomal segment I (L/W)	0.78–0.84 (0.81)	0.76–0.84	0.60–0.72	0.86	0.60–0.81
Metasomal segment II (L/W)	0.91–0.97 (0.94)	0.86–1.00	0.92–0.99	1.08	0.84–0.97
Metasomal segment III (L/W)	1.02–1.08 (1.05)	1.05–1.14	1.03–1.04	1.17	0.93–1.15
Metasomal segment IV (L/D)	1.52–1.57 (1.54)	1.40–1.53	1.40–1.48	1.61	1.30–1.61
Metasomal segment V (L/W)	2.33–2.46 (2.39)	2.13–2.27	2.15–2.29	–	2.05–2.23
Vesicle (L/W)	1.56–1.68 (1.63)	1.67–1.75	1.85–1.90	–	1.76–1.90
Femur (L/W)	3.54–3.56 (3.55)	2.56–2.84	3.32–3.42	3.31	3.11–3.39
Patella (L/W)	3.10–3.36 (3.06)	2.87–2.95	3.24–3.47	3.19	3.14–3.42
Chela (L/W)	3.42–3.77 (3.65)	3.82–4.11	4.21–4.53	4.72	3.88–4.13
Fixed Finger (L)/Carapace (L)	0.61–0.70 (0.66)	0.72–0.79	0.68–0.78	0.77	0.72–0.83
Fixed Finger (L)/Chela (L)	0.45–0.48 (0.47)	0.48–0.51	0.44–0.51	0.49	0.50–0.56
Pectinal Teeth	12–13 (12.17)[6]	10–11 (10.80)[10]	11–12 (11.13)[16]	13–13 (13)[2]	10–14 (11.72)[32]
Total (L)	24.5–25.7 (25)	25.5–27.6	25.4–27.8	–	23.5–25.4

Table 2: Comparison of morphometrics of *Vaejovis elii* sp. n., *V. crumpi*, *V. grayae*, *V. lapidicola*, and *V. trinityae* (see Additional Material Examined)

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

Legs. (Fig. 9). Ventral surface of tarsomere II with single median row of spinules terminating distally with one spinule pair.

Hemispermatothore (Figs. 14–15). All descriptions based on left hemispermatothore. Wide hemispermatothore trunk. Lamellar hook sclerotized, strongly bifurcated at distal tip. Deep trough. Trough difference accounts for 85% of entire lamellar hook length. Weak distal crest is present on the inner distal aspect of the lamella, which is also barely visible from the ventral surface. *Measurements* (mm): trough difference, 0.60; lamellar hook length, 0.71; lamina length, 2.30; trunk width, 0.81; lamina width, 0.47; ratio of lamellar hook length to lamina length, 0.21; ratio of trough difference to lamellar hook length, 0.85.

Variability. Variability of male and female pectine counts found in most species of the “*vorhiesi*” group was also noted in *V. elii*. See the pectine section.

REPRODUCTION. Several females were kept alive in captivity in order to observe them giving birth and to count the number of first instar juveniles (Fig. 16). Nine females gave birth. The juvenile counts were: 16, 18, 19, 20, 24, 24, 30, 31, and 31; mean = 23.67 (n=8), SD = 5.8524. Birth and postpartum behavior are as described in Ayrey (2013a).

AFFINITIES. With the description of *Vaejovis elii* presented herein, 22 species are currently placed in the “*vorhiesi*” group of *Vaejovis* (see map, Fig. 21). Comparisons are made to *Vaejovis crumpi*, *Vaejovis grayae* and *Vaejovis trinityae*, the three species that are found nearest to Mingus Mountain, the locality of *Vaejovis elii* sp. n. It differs from all species compared by a combination of three important morphometric ratios: metasoma

V L/W, femur L/W and chela L/W as well as the following.

V. crumpi differs from *V. elii* sp. n. by six, *V. grayae* by seven, and *V. trinityae* by seven important morphometric characters (see Tab. 2).

DISTRIBUTION. Known only from the type locality, Mingus Mountain, Yavapai County, Arizona, USA.

Additional Material Examined

In addition to type material listed below under new species description, the following specimens were examined (see Tab. 2).

Vaejovis crumpi Ayrey et Soleglad, 2011

USA, Arizona, Yavapai Co., by Lynx Lake, Prescott, 14 August 2008, 3♂5♀ (topotypes), 14 September 2009, 4♂4♀ (topotypes), 8 August 2010, 3♂5♀ (topotypes), leg. R. F. Ayrey & M. M. DeBoer-Ayrey (all in RFA).

Vaejovis grayae Ayrey, 2014

USA, Arizona, Yavapai Co., Yarnell, 16 June 2012, 1♂1♀ (USNM), 16 June 2012, 2♂2♀, leg. R. F. Ayrey & M. M. DeBoer-Ayrey (RFA).

Vaejovis lapidicola Stahnke, 1940

USA, Arizona, Coconino County, Red Sandstone Quarry, Flagstaff, 1 June 2011, 1♂7♀ (topotypes), leg. R. F. Ayrey & M. M. DeBoer-Ayrey (RFA).

Vaejovis trinityae Ayrey, 2013

USA, Arizona, Coconino County, along the Mogollon Rim, 31 August 2008, leg. R. F. Ayrey, 1♂4♀, 31 May 2009, 8♀, 14 August 2010, 8♀, 16 September 2011, 2♂6♀, 17 October 2011, 1♀, 18 May 2012, 2♂2♀, leg. R. F. Ayrey & M. M. DeBoer-Ayrey (all in RFA).

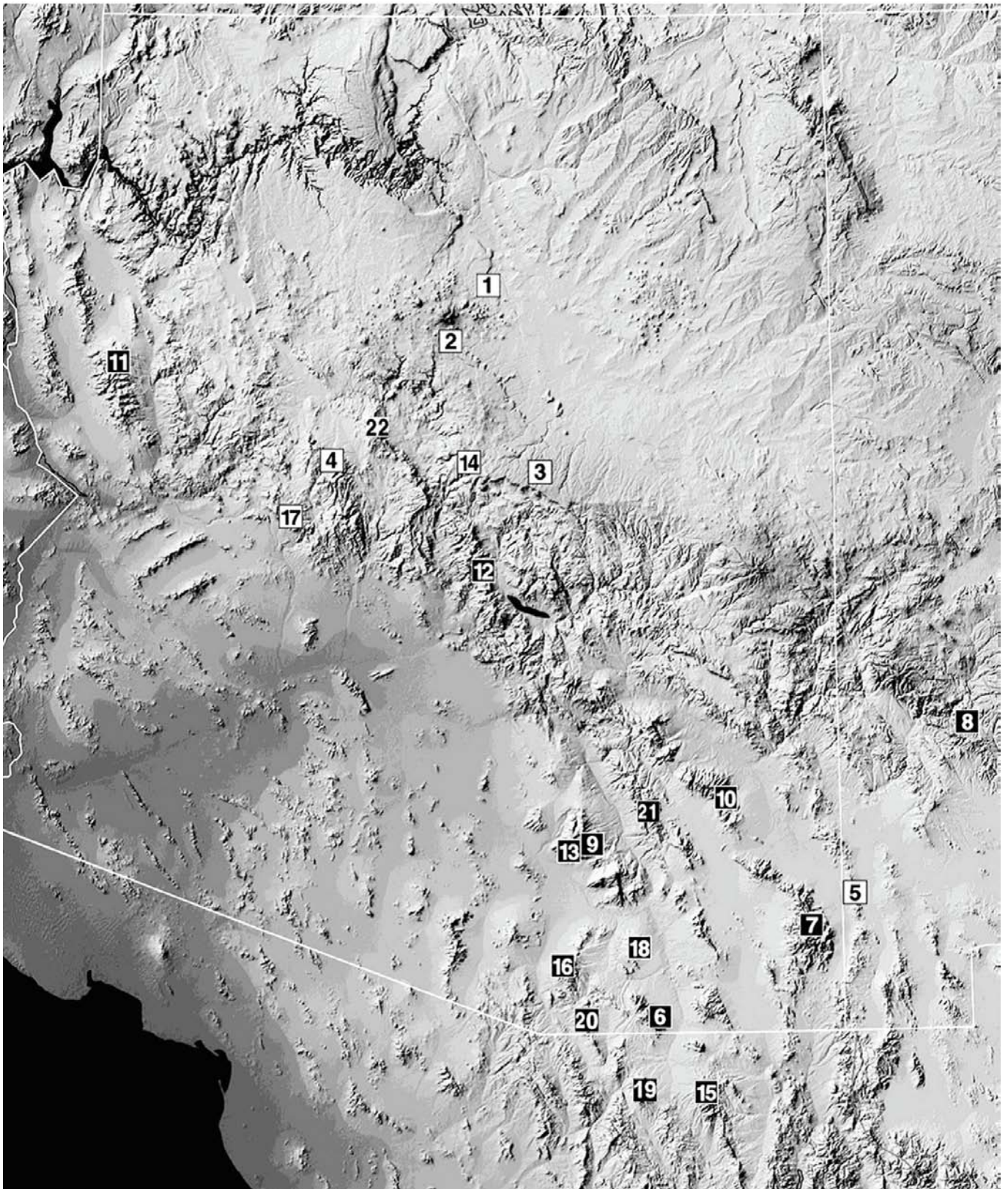


Figure 21. Map of Arizona, extreme western New Mexico (USA) and northern Sonora (Mexico), showing the type locality of all 22 species of the *Vaejovis* “*vorhiesi*” group, including *Vaejovis elii* sp. n. Localities are divided into those of species exhibiting 7 inner denticles (*ID*) on the chelal movable finger (white rectangles with black lettering) and those with primarily 6 or 5 *ID* denticles (black rectangles with white lettering). **Seven *IDs*:** 1 = *V. jonesi*, 2 = *V. lapidicola*, 3 = *V. paysonensis*, 4 = *V. crumpi*, 5 = *V. bigelowi*, 14 = *V. trinityae*, 17 = *V. grayae*, 22 = *V. elii* sp. n. **Six or five *IDs*:** 6 = *V. vorhiesi*, 7 = *V. cashi*, 8 = *V. feti*, 9 = *V. deboerae*, 10 = *V. electrum*, 11 = *V. tenuipalpus*, 12 = *V. halli*, 13 = *V. brysoni*, 15 = *V. bandido*, 16 = *V. grahami*, 18 = *V. troupi*, 19 = *V. islaserrano*, 20 = *V. patagonia*, 21 = *V. stetsoni*.

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I would like to thank my wife Melinda DeBoer-Ayrey for participating in three field trips to Mingus Mountain and Brandon Myers for his assistance with the hemispermaphore and mating plug. I would also like to thank the producers of ABC Nightline for coming to Mingus Mountain, with myself, to film the discovery of *Vaejovis elii* sp. n. for national television. The video from the ABC Nightline television program can be found via the link in this paper. I also thank two anonymous reviewers for their help and comments.

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