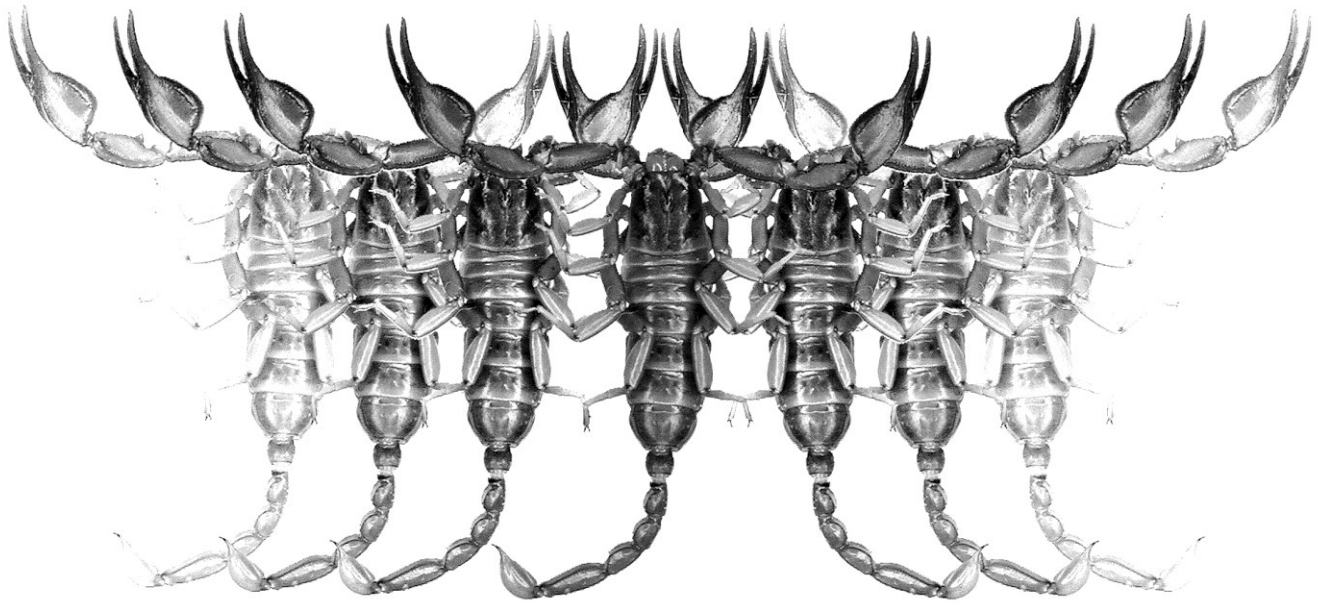


Euscorpius

Occasional Publications in Scorpiology



**A New Species of *Vaejovis* from Chaparral Habitat Near
Yarnell, Arizona (Scorpiones: Vaejovidae)**

Richard F. Ayrey

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Euscorpius

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A new species of *Vaejovis* from chaparral habitat near Yarnell, Arizona (Scorpiones: Vaejovidae)

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Summary

A new scorpion species, *Vaejovis grayae* **sp. nov.** is described and placed in the “*vorhiesi*” group of the genus *Vaejovis*. This small brown species is found near Yarnell, Arizona, USA. It appears most similar to *V. trinityae* Ayrey and *V. crumpi* Ayrey et Soleglad. It can be distinguished from the other members of the “*vorhiesi*” group by a unique combination of non-overlapping morphological characters and multilocus DNA data (Bryson et al., 2013). The pedipalp fixed finger has 6 *ID* denticles and the movable finger has 7, like most other northern Arizona “*vorhiesi*” group species. Another characteristic of this species is its unique Arizona chaparral habitat.

Introduction

Including the new species described in this paper from Yarnell, Arizona, there are now 17 “*vorhiesi*” group species in Arizona and New Mexico (USA) and Sonora (Mexico). Most of these scorpions live in Ponderosa pine forests or pine oak woodlands (Graham, 2007; Ayrey, 2009, 2012, 2013b; Ayrey & Soleglad, 2011, 2014; Ayrey & Webber, 2013). Unlike the other members of the group, *Vaejovis grayae* **sp. nov.** is found in Arizona chaparral habitat (see Figures 11 & 12), dominated by shrub live oak. Their presence in this very different habitat appears to be related to desertification with these scorpions being isolated in a habitat not usually associated with the “*vorhiesi*” group. This process would be expected to be accelerated by the current cycle of global warming.

This species is found syntopically with *Centruroides sculpturatus* and *Hoffmannius spinigerus*. These larger scorpion species are frequently found near the lower elevation range of other “*vorhiesi*” group species and predation from them is thought to be a factor limiting the lowest elevation for “*vorhiesi*” group species (Ayrey & Soleglad, 2014). This is another unique aspect of the biology of *Vaejovis grayae* **sp. nov.** that separates it from the other described species of the “*vorhiesi*” group.

Materials and Methods

Terminology and conventions

The systematics adhered to in this paper follows the classification as established in Fet & Soleglad (2005) and Soleglad & Fet (2008).

Measurements are as described in Stahnke (1970), trichobothrial patterns are as in Vachon (1974), pedipalp finger dentition follows Soleglad & Sissom (2001), hemispermaphore terminology follows Soleglad & Fet (2008), and sternum terminology as described in Soleglad & Fet (2003).

Abbreviations

CNAN, Colección Nacional de Arácnidos, Instituto de Biología, Universidad Nacional Autónoma de México, D.F., México; MES, personal collection of Michael E. Soleglad, Winchester, California, USA; RFA, personal collection of Richard F. Ayrey, Flagstaff, Arizona, USA; UANL, Universidad Autónoma de Nuevo León, San Nicolás de los Garza, Nuevo León, Mexico; and USNM, United States National Museum, Smithsonian Institution, Washington, DC, USA.

Material

Besides type material listed below under new species description, the following additional specimens were examined:

Vaejovis grayae **sp. nov.** USA: Arizona: Yavapai Co.: near Yarnell. 34.20849°N, 112.74905°W, 1459 m. 16 June 2012, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA).

Vaejovis bandido Graham, Ayrey et Bryson, 2012. Mexico: Sonora: Sierra de los Ajos Mountains, 12–13 October 2010, leg. R.W. Bryson, Jr., 3 ♂ (1 CNAN, 2 UANL), 3 ♀ (1 CNAN, 2 UANL).

Vaejovis brysoni Ayrey et Webber, 2013. USA: Arizona: Pima Co.: above Molino Basin on Catalina Highway near Seven Cataracts Vista, Santa Catalina



Figure 1: *Vaejovis grayae* sp. nov. in natural habitat. Paratype female (top) and paratype male (bottom).

Mountains. 16 March 2012, leg. R.W. Bryson, Jr., 1 ♂, 7 ♀ (RFA); 5 April 2012, leg. R.W. Bryson, Jr. & D. Hartman, 8 ♀ (RFA); same locality, 18 August 2012, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 8 ♀ (RFA).

Vaejovis cashi Graham, 2007. USA: Arizona: Cochise Co.: Cave Creek Canyon, Chiricahua Mountains, 2 August 2008, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 4 ♂, 4 ♀ (RFA); same locality, 23 August 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 4 ♀ (RFA).

Vaejovis crumpi Ayrey et Soleglad, 2011. USA: Arizona: Yavapai Co.: near Lynx Lake, Prescott, 14 August 2008, R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 5 ♀ from type locality (RFA); same locality, 14 September 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 4 ♂, 4 ♀ (RFA); same locality, 8 August 2010, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 5 ♀ (RFA).

Vaejovis deboerae Ayrey, 2009. USA: Arizona: Pima Co.: Rose Canyon Campground, Santa Catalina Mountains, 28 August 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 5 ♀ (RFA); same locality, 29 August 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 4 ♂, 4 ♀ (RFA).

Vaejovis electrum Hughes, 2011. USA: Arizona: Graham Co.: Upper Arcadia Campground, Mt. Graham. 17 July 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA); Mt Graham Hwy, Mt. Graham, 9415 feet asl, 18 July 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 4 ♀ (RFA).

Vaejovis feti Graham, 2007. USA: New Mexico: Meadow Creek, Black Mountains, 6 July 1978, leg. M. H. Muma 4 ♂, 3 ♀ (MES).

Vaejovis grahami Ayrey et Soleglad, 2014. USA: Arizona: Cochise Co.: Madera Canyon, Santa Rita Mountains, 11 June 2010, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 5 ♀ (RFA); Mount Hopkins, Santa Rita Mountains, 6 October 2009, leg. R. F. Ayrey, T. Miscione & R. Troup, 2 ♂, 6 ♀ (RFA).

Vaejovis halli Ayrey, 2012. USA: Arizona: Gila Co.: Mount Ord, 11 September 2010, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀, paratypes (RFA); same locality, 2 May 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 3 ♂, 5 ♀, paratypes (RFA).

Vaejovis jonesi Stahnke, 1940. USA: Arizona: Coconino County: near Wupatki National Monument, 1 April 2011, leg. R. F. Ayrey, 1 ♀ from type locality (RFA).

Vaejovis lapidicola Stahnke, 1940. USA: Arizona: Coconino County: Red Sandstone Quarry, Flagstaff, 1 June 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ from type locality (RFA).

Vaejovis paysonensis Soleglad, 1973. USA: Arizona: Coconino County: Control Road, 25 miles E of Payson. 5 July 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ from type locality (RFA); same locality,

6 July 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA).

Vaejovis tenuipalpus Sissom et al., 2012. USA: Arizona: Mojave Co.: Getz Peak, Hualapai Mountains, 9 August 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ (RFA).

Vaejovis trinityae Ayrey, 2013. USA: Arizona: Coconino Co.: along the Mogollon Rim, 31 August 2008, leg. R. F. Ayrey, 1 ♂, 4 ♀ (RFA); same locality, 31 May 2009, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 8 ♀ (RFA); same locality, 14 August 2010, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 8 ♀ (RFA); same locality, 16 September 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA); same locality, 17 October 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♀ (RFA); same locality, 18 May 2012, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 2 ♀ (RFA).

Vaejovis vorhiesi Stahnke, 1940. USA: Arizona: Cochise Co.: Miller Canyon, Huachuca Mountains, 24 May 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 1 ♂, 7 ♀ from type locality (RFA); Carr Canyon, Huachuca Mountains, 5 October 2008, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 6 ♀ (RFA); Garden Canyon, Huachuca Mountains, 26 August 2011, leg. R. F. Ayrey, 4 ♂, 6 ♀ (RFA); Lutz Canyon, Huachuca Mountains, 27 March 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♂, 2 ♀ (RFA); Ash Canyon, Huachuca Mountains, 24 May 2011, leg. R. F. Ayrey & M. M. DeBoer-Ayrey, 2 ♀ (RFA).

Vaejovis sp. cf. *vorhiesi* (“Whetstone” population in Bryson et al., 2013). USA: Arizona: Cochise Co.: French Joe Canyon, Whetstone Mountains, 14 October 2009, leg. R. Troup, 1 ♀ (RFA).

Systematics

Order **SCORPIONES** C. L. Koch, 1850
 Infraorder Orthosterni Pocock, 1911
 Parvorder Iurida Soleglad et Fet, 2003
 Superfamily Chactoidea Pocock, 1893
 Family Vaejovidae Thorell, 1876
 Subfamily Vaejovinae Thorell, 1876
 Genus *Vaejovis* Thorell, 1876

Vaejovis grayae Ayrey, sp. nov.

(Figs. 1–11; Tables 1 & 2)

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Diagnosis. Small (25.25 mm) scorpions. Color is medium brown, lighter on the legs, with underlying mottling on carapace, mesosoma and metasoma, telson orange (see Figure 1). Pedipalp movable finger has with 7 *ID* denticles and fixed finger has 6. Carapace of female is shorter than the fifth metasomal segment. Carapace of

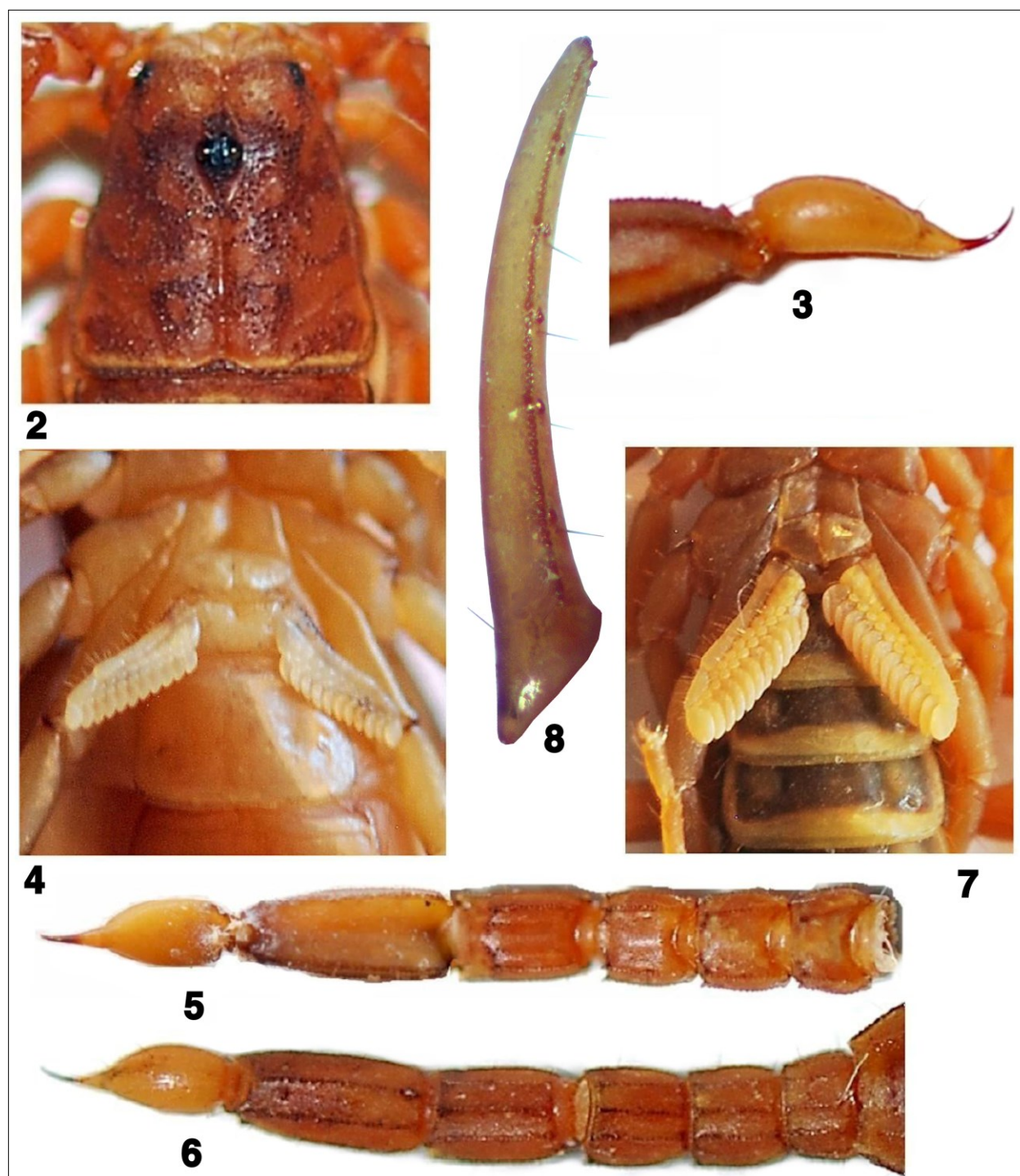


Figure 2–8: *Vaejovis grayae* sp. nov. paratype female 2. Carapace. 3. Telson. 4. Sternopectinal area. 5. Metasoma ventral view. 6. Metasoma dorsal view. Paratype male 7. Sternopectinal area. 8. Chelal movable finger dentition showing seven *ID* denticles.

male is elongated. Mean pectinal tooth count for females 11.125 [$n=16$], males 12.50 [$n=12$]. Small, spinoid subaculear tubercle. Ventral surface of tarsomere II with single median row of spinules terminating distally with one spinule pair.

Type material. Holotype female, Yarnell, Yavapai County, Arizona, USA, 16 June 2012 (R.F. AYREY) specimen #621, deposited in USNM. Paratype male, same locality, 16 June 2012 (R.F. AYREY) specimen #622, deposited in USNM. Paratype female, same lo-

	Female Holotype #621	Female Paratype #617	Female Paratype #623	Male Paratype #622	Male Paratype #616	Male Paratype #619
Total length	25.40	27.80	27.79	17.58	21.63	16.85
Carapace length	3.23	3.58	3.42	2.46	3.20	2.39
Mesosoma length	8.93	9.51	10.32	5.11	5.49	4.66
Metasoma length	9.93	11.30	10.74	7.79	10.13	7.60
Ca L/MetV L	0.93	0.94	0.95	1.21	0.92	0.93
Segment I length/width	1.22/1.83	1.38/1.91	1.14/1.91	0.91-1.30	1.29-1.79	1.02-1.46
Segment II length/width	1.43/1.56	1.79/1.80	1.69/1.82	1.21-1.37	1.54-1.74	1.13-1.32
Segment III length/width	1.51/1.46	1.81/1.74	1.81/1.76	1.29-1.23	1.65-1.78	1.20-1.29
Segment IV length/width	2.29/1.63	2.52/1.70	2.49/1.63	1.83-1.20	2.39-1.71	1.69-1.22
Segment V length/width	3.48/1.62	3.80/1.66	3.61/1.61	2.55-1.19	3.41-1.59	2.56-1.19
Telson length	3.31	3.41	3.31	2.22	3.02	2.20
Vesicle length/width	2.33/1.24	2.30/1.24	2.30/1.21	1.34/0.96	1.95/1.16	1.24/0.91
Aculeus length	0.98	1.11	1.01	0.88	1.07	0.96
Pedipalp length	10.57	12.16	11.98	7.83	10.25	7.46
Femur length/width	2.71/0.81	3.08/0.90	3.02/0.91	1.98/0.69	2.60/0.83	1.71/0.58
Patella length/width	2.92/0.90	3.57/1.03	3.50/1.04	2.17/0.74	2.99/0.97	2.21/0.75
Chela length	4.94	5.51	5.46	3.68	4.66	3.54
Palm length	1.89	2.30	2.19	1.69	2.19	1.34
Width/depth	1.09/1.12	1.31/1.10	1.26/1.07	0.91/0.72	1.38/1.02	0.79/0.59
Fixed finger length	2.53	2.45	2.41	1.82	2.12	1.73
Movable finger length	2.72	3.07	3.12	2.22	2.58	2.02
Pectinal Teeth	11-11	11-11	11-11	13-13	12-12	12/12

Table 1: Morphometrics (mm) of *Vaejovis grayae* sp. nov.

cality, 16 June 2012 (R.F. AYREY) specimen #623 (RFA). Paratype male, same locality, 16 June 2012 (R.F. AYREY) specimen #625 (RFA).

Etymology. This species is named in honor of Alice Gray who worked at the American Museum of Natural History in New York City and inspired the author to become a charter member of the American Arachnological Society.

Distribution. Known only from the type locality Yarnell, Yavapai County, Arizona, USA. See map in Figure 13.

Description. Based on holotype female, unless otherwise noted.

Color. Color is medium brown, lighter on the legs, telson orange. Faint underlying mottling on carapace and mesosoma.

Carapace (Fig. 2). Anterior margin of carapace moderately 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 0.32; carapace length/width at median eyes 1.33. Carapace of female is shorter than metasomal segment V.

Mesosoma. Tergites finely granular with vestigial median carina on Tergites I–VI. Tergite VII with weak median carina on anterior half and strong dorsal lateral and lateral supramedian granular carinae. Sternites III–VI finely granular and without carinae. Sternite VII with granular ventral lateral carinae on middle half. Pre-sternites smooth. Spiracles ovoid with median side rotated 35 degrees from posterior sternite margin. Sternites with variable number of microsetae.

Sternum (Figs. 4, 7). Sternum is type 2.

Genital Operculum (Figs. 4, 7). Sclerites separated on posterior one-fifth.

Pectines (Figs. 4, 7). Pectinal tooth count 11/11 for holotype female and 12/12 for paratype male. All pec-

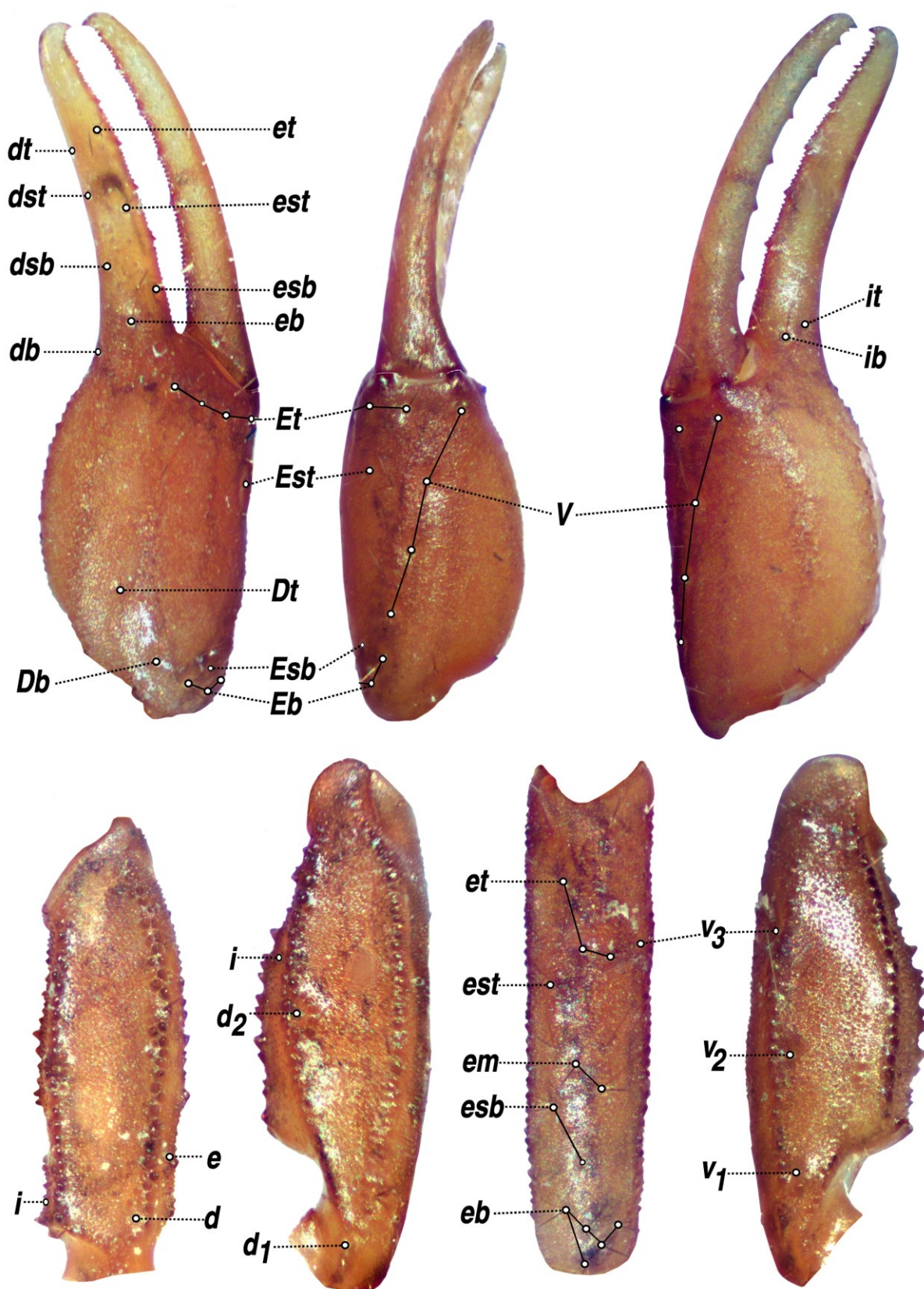


Figure 9: *Vaejovis grayae*, sp. nov., male paratype, Yarnell, Yavapai County, Arizona, USA. Trichobothrial pattern.



Figure 10: *Vaejovis grayae*, sp. nov., male paratype, Yarnell, Yavapai County, Arizona, USA. Right hemispermatophore (photographed submerged in alcohol). Complete structure, dorsal, interoventral, and ventral views. Note the bifurcated lamellar hook emanating entirely from the dorsal trough and the modest distal lamellar crest on dorsal and ventral (transparent reflection) views. The mating plug is partially visible in the interoventral and ventral views (indicated by an arrow pointing to its base).

tinal teeth have exterodistal angling with large sensorial area. Middle lamellae 7/7. Fulcra are present. Each fulcrum with 1–3 central setae.

Metasoma (Figs. 5, 6). Carapace of female is shorter than the fifth metasomal segment. Ratio of segment I length/width 0.67; of segment II length/width 0.90; of segment III length/width 1.03; of segment IV length/width 1.40; of segment V length/width 2.15. Segments I–IV: dorsolateral carinae strong and granular with distal denticle of I–IV enlarged and spinoid. Lateral supra-median carinae I–IV strong and granular with enlarged spinoid distal denticle. Lateral inframedian carinae moderately granular on segment I, posterior 4/5 of II and III, and weak on 2/5 of IV. Ventrolateral carinae I weak and granular; on II–III moderate, granular; on IV strong, 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. 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 (Figs. 5, 6). 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, spinoid subaculear tubercle present.

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

Pedipalps. Pedipalp ratios: chela length/width 4.53; femur length/width 3.35; patella length/width 3.24; fixed finger length/carapace length 0.78.

Chela (Fig. 8, 9). Carinae weak. 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 usually 7 *ID* denticles (Soleglad & Sissom, 2001). Trichobothria Type C, orthobothriotaxic (Fig. 13). Series *ib-it* located at fixed finger base, *Dt* positioned proximally of palm mid-point, and patellar *v₃* positioned distal of *et₃*.

Femur. Carinae moderate.

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



Figure 11: *Vaejovis grayae* sp. nov. paratype female with first instar juveniles.

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

Hemispermaphore (Fig. 10, paratype male). The right hemispermaphore is 2.55 mm in length, the lamina is 1.87 mm. in length, and the lamellar hook length is 0.52 mm. The hemispermaphore is lightly sclerotized with a lamella that is truncated distally. On the dorsal surface a modest distal crest is present on the inner distal aspect of the lamella, which is also visible from the ventral surface. The lamellar hook, which is highly sclerotized, is relatively short, emanating entirely from the dorsal trough, and is widely bifurcated. The shortness of the lamellar hook is also indicated by comparing its length to the lamellar length, a ratio value of 0.278. A mating plug, with a smooth barb edge, was located on the ventral surface on the internal area just below the ventral trough.

Variability. Pectinal tooth count 11/11 [n=5] and 12/12 [1] with a mean of 11.125 [n=16], standard deviation 0.34157 for females and 12/12[n=3] and 13/13[n=3] with a mean of 12.50 [n=12], standard deviation 0.52223 for males. Although variability in fixed finger *ID* denticle count is usually seen in the

“*vorhiesi*” group (Ayrey, 2012, 2013b; Ayrey & Webber, 2013), none was observed in the fixed fingers examined (12).

Reproduction. Several females were kept alive in captivity in order to observe them giving birth and to count the number of first instar juveniles (see Figure 11). Three females gave birth in the first week of August, 2012. The juvenile count was 24.67 (n=3). The 1st instar orientation on the mother’s back was non-random, as is seen with many other species of *Vaejovis* (Hjelle, 1974). They were facing anteriorly with the prosoma down and the metasoma raised over the prosoma of the juvenile immediately posterior to them, the same orientation as *V. halli* (Ayrey, 2012). Postpartum behavior is as described (Ayrey, 2013a).

Type Locality Description. The type specimens were found, using a blacklight at night near Yarnell, Yavapai County, Arizona (34.20849°N, 112.74905°W) at an elevation of 1459 m asl. The vegetation type is Arizona chaparral (see Fig. 12), dominated by shrub live oak. *Hoffmannius spinigerus* (Wood, 1863) and *Centruroides sculpturatus* Ewing, 1928 were found syntopically with *V. grayae*.



Figure 12: *Vaejovis grayae* sp. nov. habitat (top) and microhabitat (bottom).

Comparison of Species

Map in Fig. 13 shows the type localities of the 17 currently described species of *Vaejovis* from Arizona,

western New Mexico and northern Sonora, including new species *V. grayae*. Comparisons are made to all species. Estimated divergence times (in millions of years, Ma) of different lineages is from a recent time-

<i>V. grayae</i> Female Ratio Comparisons							
	<i>V. grayae</i> (3)	<i>V. trinityae</i> (3)	<i>V. bigelowi</i> (1)	<i>V. crumpi</i> (3)	<i>V. jonesi</i> (1)	<i>V. lapidicola</i> (1)	<i>V. paysonensis</i> (1)
Total length	25.40–27.80	23.55–25.34	27.84	25.53–27.56	44	28.5–28.7	26.95
Carapace length	3.23–3.58	3.20–3.39	3.61	3.18–3.40	5	4.1–4.3	3.56
Ca L/MetV L	0.93–0.95	1.03–1.12	0.97	0.92–0.94	0.91	-	1.00
Segment I length/width	0.60–0.72	0.60–0.81	0.93	0.76–0.84	0.92	0.86	0.90
Segment II length/width	0.92–0.99	0.84–0.97	1.07	0.86–1.00	-	1.08	1.00
Segment III length/width	1.03–1.04	0.93–1.15	1.21	1.05–1.14	-	1.17	1.14
Segment IV length/width	1.40–1.48	1.30–1.61	1.60	1.40–1.53	-	1.61	1.59
Segment V length/width	2.15–2.29	2.05–2.23	2.27	2.13–2.27	2.50	-	2.13
Telson Vesicle length/width	1.85–1.90	1.76–1.90	1.76	1.67–1.75	-	-	1.44
Femur length/width	3.32–3.42	3.11–3.39	3.48	2.56–2.84	-	3.31	3.21
Patella length/width	3.24–3.47	3.14–3.42	3.39	2.87–2.95	-	3.19	3.25
Chela length/width	4.21–4.53	3.88–4.13	4.21	3.82–4.11	-	4.73	4.07
Ff L/Ca L	0.68–0.78	0.72–0.83	0.83	0.72–0.79	0.66	-	0.74
Ff L/Ch L	0.44–0.51	0.50–0.56	0.52	0.48–0.51	-	-	0.50
Pectinal Teeth	11–12 11.13 (16)	10–14 11.72 (32)	10–10 10.00 (2)	10–11 10.80 (10)	13–13 13.00 (2)	11–13 12.00 (6)	11–12 11.50 (2)

Table 2: Morphometrics (mm) of female *V. grayae* versus other “*vorhiesi*” group species with seven inner denticles (*ID*) on the chelal movable finger. Comparisons for which there is no overlap with *V. grayae* **sp. nov.** are shown in **bold type**. *V. lapidicola* data from the original description and redescription (Stahnke, 1940 & Graham, 2006). Parenthetical number following species name is number of specimens utilized.

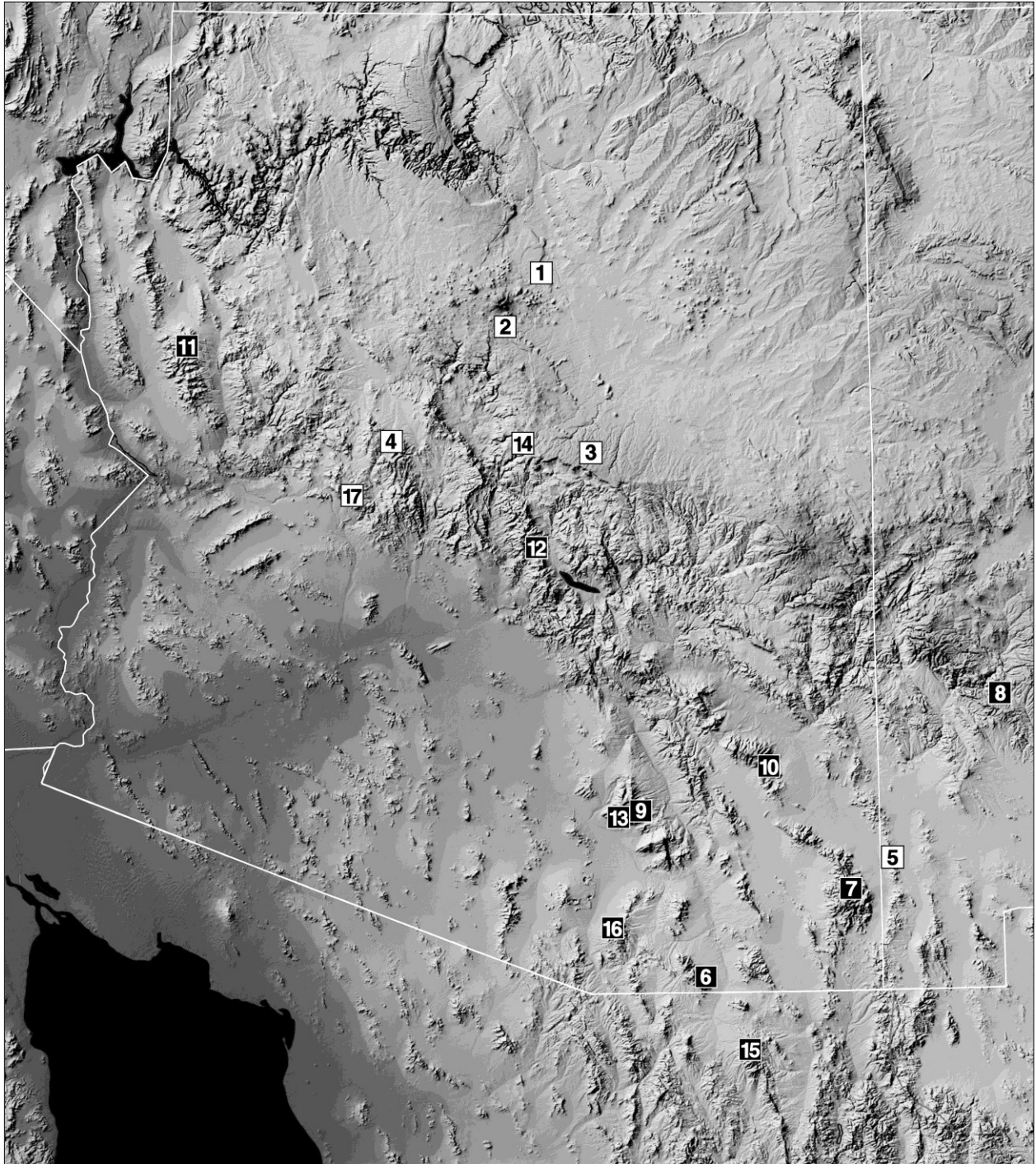


Figure 13: Map of Arizona, extreme western New Mexico and northern Sonora (Mexico) showing the type locality of all 17 *Vaejovis* “*vorhiesi*” group species, including new species *Vaejovis grayae*. Localities are divided into those species exhibiting seven inner denticles (*ID*) on the chelal movable finger (white rectangles with black lettering) and those with primarily six, or five *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 = *Vaejovis grayae* sp. nov. **Six *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*, and 16 = *V. grahami*.

calibrated phylogeny based on multilocus data (Bryson et al., 2013: fig. S2). This data is presented as 95% highest posterior density (HPD) intervals.

Vaejovis bandido, *V. brysoni*, *V. cashi*, *V. deboerae*, *V. electrum*, *V. feti*, *V. grahami*, *V. halli*, *V. tenuipalpus*, and *V. vorhiesi*: These species all exhibit 6

inner denticles (*ID*) on the chela movable finger, not 7 which is found on most of the northern Arizona “*vorhiesi*” group scorpions, including *Vaejovis grayae*.

***Vaejovis bigelowi*:** differs from *Vaejovis grayae* by having a lower pectinal tooth count and by six important morphometric ratios (see Table 2). This is the only species for which there is no DNA data available at this time. *V. grayae* is also widely allopatric with *V. bigelowi*.

***Vaejovis crumpi*:** differs from *Vaejovis grayae* by six important morphometric ratios which do not overlap (see Table 2). Bryson et al. (2013) estimated that lineages leading to *V. grayae* and *V. crumpi* diverged between 8.41 and 3.38 Ma.

***Vaejovis jonesi*:** Based on the original description by Stahnke (1939), *V. jonesi* is a much larger species, 58%. Four morphometric ratios can be calculated from the original description and all four of them do not overlap with *V. grayae* (see Table 2). Bryson et al. (2013) estimated that lineages leading to *V. grayae* and *V. jonesi* diverged between 23.9 and 12.58 Ma. *V. jonesi* is also widely allopatric with *V. grayae*.

***Vaejovis lapidicola*:** differs from *V. grayae* by five important morphometric ratios which do not overlap. The male of *V. lapidicola* differs by having a planate carapace (Graham, 2007; Ayrey & Soleglad 2011). Bryson et al. (2013) estimated that lineages leading to *V. grayae* and *V. lapidicola* diverged between 8.41 and 3.38 Ma. *V. lapidicola* is also widely allopatric with *V. grayae*.

***Vaejovis paysonensis*:** Compared to the remaining male and female from the original set used to describe the species (Soleglad, 1973), there is no overlap in nine important morphometric ratios (see Table 2). Bryson et al. (2013) estimated that lineages leading to *V. grayae* and *V. paysonensis* diverged between 23.9 and 12.58 Ma. *V. paysonensis* is also widely allopatric with *V. grayae*.

***Vaejovis trinityae*:** is a slightly smaller scorpion with a carapace longer than metasoma V. The female also differs from *Vaejovis grayae* by two important morphometric ratios (see Table 2). The males of *V. trinityae* differ by five non-overlapping morphometric ratios. Bryson et al. (2013) estimated that lineages leading to *V. grayae* and *V. trinityae* diverged between 8.41 and 3.38 Ma. *V. grayae* is also widely allopatric with *V. trinityae*.

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References

- AYREY, R. F. 2009. Sky island *Vaejovis*: A new species (Scorpiones: Vaejovidae). *Euscorpius*, 86: 1–12.
- AYREY, R. F. 2012. A new *Vaejovis* from the Mogollon Highlands of northern Arizona (Scorpiones: Vaejovidae). *Euscorpius*, 148: 1–13.
- AYREY, R. F. 2013a. Reproduction in the “*vorhiesi*” group of the genus *Vaejovis* (Scorpiones: Vaejovidae). Part I. Clutch size. *Euscorpius*, 166: 1–15.
- AYREY, R. F. 2013b. A new *Vaejovis* from the Mogollon Rim of northern Arizona (Scorpiones: Vaejovidae). *Euscorpius*, 176: 1–13.
- AYREY, R. F. & M. E. SOLEGLAD. 2011. A new species of *Vaejovis* from Prescott, Arizona (Scorpiones: Vaejovidae). *Euscorpius*, 114: 1–15.
- AYREY, R. F. & M. E. SOLEGLAD. 2014. New species of *Vaejovis* from the Santa Rita Mountains, Southern Arizona (Scorpiones: Vaejovidae). *Euscorpius*, 183: 1–13.
- AYREY, R. F. & M. M. WEBBER. 2013. A new *Vaejovis* C. L. Koch, 1836, the second known *vorhiesi* group species from the Santa Catalina Mountains of Arizona (Scorpiones: Vaejovidae). *ZooKeys*, 270: 21–35.
- BRYSON, R. W. JR., B. R. RIDDLE, M. R. GRAHAM, B. T. SMITH & L. PRENDINI. 2013. As old as the hills: montane scorpions in Southwestern North America reveal ancient associations between biotic diversification and landscape history. *PLoS ONE*, 8: 1–11.
- GRAHAM, M. R. 2006. Redescription and lectotype designation of *Vaejovis lapidicola* Stahnke (Scorpiones: Vaejovidae). *Euscorpius*, 46: 1–6.
- GRAHAM, M. R. 2007. Sky island *Vaejovis*: two new species and a redescription of *V. vorhiesi* Stahnke (Scorpiones: Vaejovidae). *Euscorpius*, 51: 1–14.
- GRAHAM, M. R., R. F. AYREY & R. W. BRYSON, JR. 2012. Multivariate methods support the distinction of a new highland *Vaejovis* (Scorpiones: Vaejovidae), from the Sierra de los Ajos, Mexico. *The Journal of Arachnology*, 40: 281–290.
- SOLEGLAD, M. E. 1973. Scorpions of the Mexicanus group of the genus *Vejovis*. *Wasmann Journal of Biology*, 31(2): 351–372.

- SOLEGLAD, M. E. & V. FET. 2003. The scorpion sternum: structure and phylogeny (Scorpiones: Orthosterni). *Euscorpius*, 5: 1–34.
- SOLEGLAD, M. E. & V. FET. 2008. Contributions to scorpion systematics. III. Subfamilies Smeringurinae and Syntropinae (Scorpiones: Vaejovidae). *Euscorpius* 71: 1–115.
- SOLEGLAD, M. E. & W. D. SISSOM. 2001. Phylogeny of the family Euscorpiidae Laurie, 1896: a major revision. Pp. 25–111 in Fet, V. & P.A. Selden (eds). *Scorpions 2001. In Memoriam Gary A. Polis*. Burnham Beeches, Bucks: British Arachnological Society.
- STAHNKE, H. L. 1939. *The Scorpions of Arizona* (Ph.D. Dissertation, unpublished). Iowa State College, 184pp.
- STAHNKE, H. L. 1940. The scorpions of Arizona. *Iowa State College Journal of Science*, 15(1): 101–103 (dissertation abstract).
- STAHNKE, H. L. 1970. Scorpion nomenclature and mensuration. *Entomological News*, 81: 297–316.
- VACHON, M. 1974. Etude des caractères utilisés pour classer les familles et les genres de Scorpions (Arachnides). 1. La trichobothriotaxie en Arachnologie. Sigles trichobothriaux et types de trichobothriotaxie chez les Scorpions. *Bulletin du Muséum National d'Histoire Naturelle*, Paris, (Ser. 3), 140 (Zool. 104): 857–958.