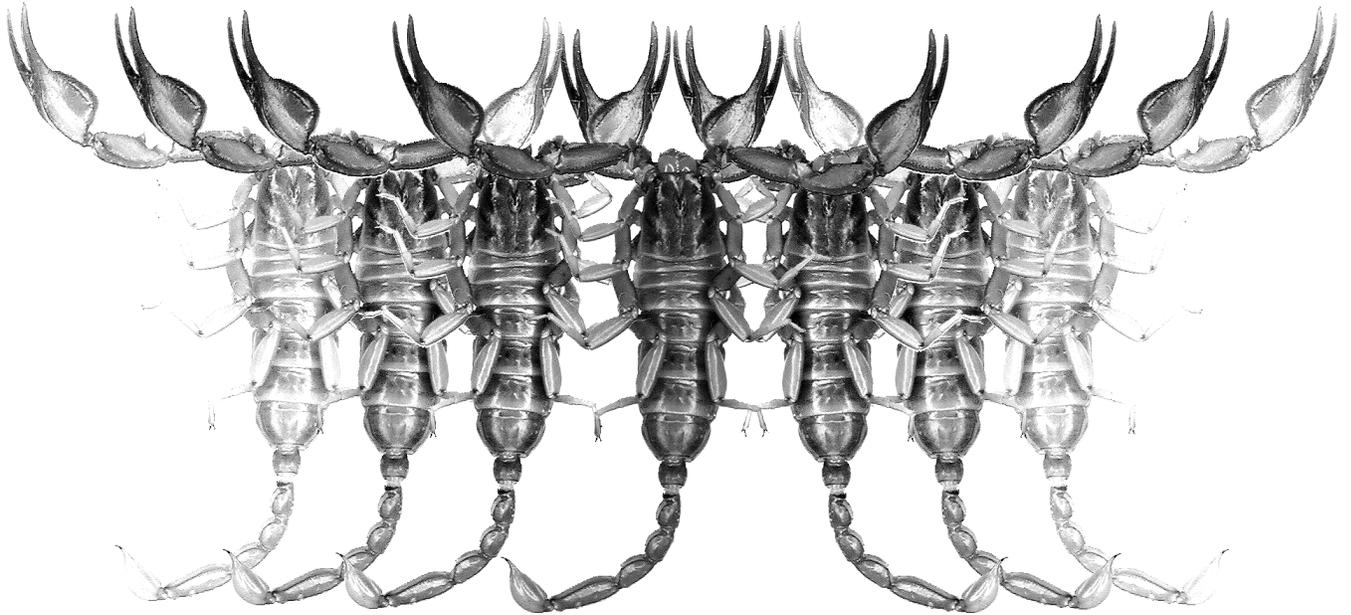


# *Euscorpilus*

Occasional Publications in Scorpiology



**A New Species of *Vaejovis* from  
Prescott, Arizona (Scorpiones: Vaejoidea)**

**Richard F. Ayrey & Michael E. Sologlad**

**May 2011 — No. 114**

# *Euscorpius*

## Occasional Publications in Scorpiology

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*Euscorpius* is located on Website '<http://www.science.marshall.edu/fet/euscorpius/>' at Marshall University, Huntington, WV 25755-2510, USA.

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## A new species of *Vaejovis* from Prescott, Arizona (Scorpiones: Vaejovidae)

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### Summary

A new scorpion species, *Vaejovis crumpi*, **sp. nov.**, is described from Prescott, Yavapai Co., Arizona. This species is related to *V. paysonensis* Soleglad, 1973, and the “sky island” species of southern Arizona. *V. crumpi* is compared to the seven *Vaejovis* species currently reported for Arizona, in particular to *V. paysonensis*.

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### Introduction

Seven species of *Vaejovis*, including the new species described in this paper, occur in Arizona. Three of these were named by Herbert Stahnke in 1940, *V. lapidicola* and *V. jonesi* from northern Arizona, and *V. vorhiesi* from southeastern Arizona. The published descriptions (Stahnke, 1940a) were quite brief, in contrast to the unpublished PhD dissertation (Stahnke, 1940b) where the descriptions were reasonably complete. *V. lapidicola* and *V. vorhiesi* were redescribed by Graham (2006, 2007), while *V. jonesi* still remains to be redescribed and its exact identity is unknown. Soleglad (1973) described species *V. paysonensis* in the same paper where the “mexicanus” group of *Vaejovis* was defined (see below). Graham (2007) described two new species, *V. cashi* from southeastern Arizona, and *V. feti* from central New Mexico. In this same paper, Graham designated a lectotype for *V. vorhiesi*, which he redescribed. Finally, Ayrey (2009) named *V. deboerae* from Tucson, Arizona. This species and *V. vorhiesi* and *V. cashi* (as well as *V. feti* from New Mexico) are nicknamed “sky island” species (a term originally applied to them by Graham, 2007) since they occupy unique disjoint mountain top areas, areas hypothesized to be isolated habitats.

In this paper *Vaejovis crumpi*, **sp. nov.**, (Fig. 1) is described. It is only known from its type locality, Prescott, Yavapai Co., Arizona. It is closely related to *V. paysonensis* and the “sky island” species from southeastern Arizona. It also appears to be related, in part, to the unique species *V. lapidicola*, especially based on the hemispermaphore (see discussion below). *V. crumpi* is compared to the other six *Vaejovis* species found in Arizona. In particular, *V. crumpi* is compared in detail to

*V. paysonensis*, a species found within 80 miles in Payson, Arizona. Detailed morphometric analysis between these two related species is presented.

### The “mexicanus” group in Vaejovinae: a short history

In 1973, Soleglad defined the informal taxonomic *Vaejovis* “mexicanus” group. The impetus for this definition was based on two observations: 1) in then recent papers by Williams (1972) and Hjelle (1972), these authors portrayed *Vaejovis* with a completely fused genital operculi in the female, as contrasted with *Uroctonus* and *Paruroctonus*, whose operculi exhibited separation on the posterior one-fifth. The scope of *Vaejovis* as defined by Williams (1972) and Hjelle (1972) only included members, placed at that time, in the informal “wupatkiensis” group (= tribe Stahnkeini, in part), “eusthenura” group (= genus *Hoffmannius*), and “punctipalpi” group (= genus *Kochius*), all members of subfamily Syntropinae (Soleglad & Fet, 2008); 2) many *Vaejovis* species were ignored in their definition, species found primarily in mainland Mexico (e.g., *V. mexicanus*, the type species of the genus!). For these species, the genital operculi are separated on the posterior one-fifth to one-third. The characters specified by Soleglad (1973), in his definition of the “mexicanus” group, are characters today that are found in most taxa of the subfamily Vaejovinae and therefore are not diagnostic for a genus.

Sissom & Francke (1985) defined the *Vaejovis* “nitidulus” group. For the next 20 years, additional species were added to this group (Sissom, 1991; Capes, 2001; Sissom & González Santillán, 2004; Soleglad & Fet, 2005). In 2005, this group was reduced in species



**Figure 1:** *Vaejovis crumpi*, sp. nov.. Male paratype in its natural habitat, Prescott, Yavapai Co., Arizona.

number by Soleglad & Fet when they described new genus *Franckeus* (comprised of six species) and renamed the group as the “*nigrescens*” group. These authors also presented a detailed review of the diagnostic characters of the “*nigrescens*” group established primarily by Sissom & Francke (1985), pointing out that many were not necessarily synapomorphic, and the value of these characters was diluted as new species were added to the group. Most recently, Soleglad & Fet (2008) presented a partial revision of the family Vaejovidae, focusing on the subfamilies Syntropinae and Smeringurinae (new), and establishing several new genera that incorporated many species formerly placed in *Vaejovis*. Since subfamily Vaejovinae was not addressed by Soleglad & Fet (2008), all remaining *Vaejovis* species were categorized as either belonging to the “*mexicanus*” or “*nigrescens*” groups.

Currently, the subfamily Vaejovinae is composed of the genus *Franckeus*, two distant and closely related genera *Pseudouroctonus* and *Uroctonites*, and two informal taxonomic groupings of the genus *Vaejovis*, the *Vaejovis* “*mexicanus*” and “*nigrescens*” groups. *Pseudouroctonus* and *Uroctonites* are well defined taxonomic clades and are quite distinct from the other species in Vaejovinae. For the remaining vaejovine species, except

for the small genus *Franckeus*, which is defined by a single but irrefutable synapomorphy (i.e., unique neobothriotaxy), the “above-species” level differentiation in genus *Vaejovis* is not clear if one were to use solely the “*mexicanus*” and “*nigrescens*” groups as a basis for species partitioning. The suggestion by Santibáñez-López & Francke (2010) that the “*mexicanus*” group is a much smaller assemblage is clearly true. Further studies will show the true scope of this group, which must be formed around *Vaejovis*’s type species, *V. mexicanus* C.L. Koch, 1836 (redescribed by Fet & Soleglad, 2007). Whatever this final assemblage becomes, it will be the true *Vaejovis*. The remaining species will be placed in one or more new genera.

## Materials and Methods

### *Terminology and conventions*

The systematics adhered to in this paper is current and therefore follows the classification as established in Fet & Soleglad (2005) and as modified by Soleglad & Fet (2006), Graham & Soleglad (2007), Fet & Soleglad (2007), Soleglad et al. (2007), and Soleglad & Fet (2008).



**Figure 2:** *Vaejovis crumpi*, sp. nov.. Male holotype, dorsal (top) and ventral (bottom) views.

Measurements are as described in Sissom (1990), trichobothrial terminology and stated homologies are as in Vachon (1974), and pedipalp finger dentition follows Soleglad & Sissom (2001). Hemispermaphore terminology follows Soleglad & Fet (2008). Techniques using maximized morphometric ratios follow those described in Kovařík et al. (2010).

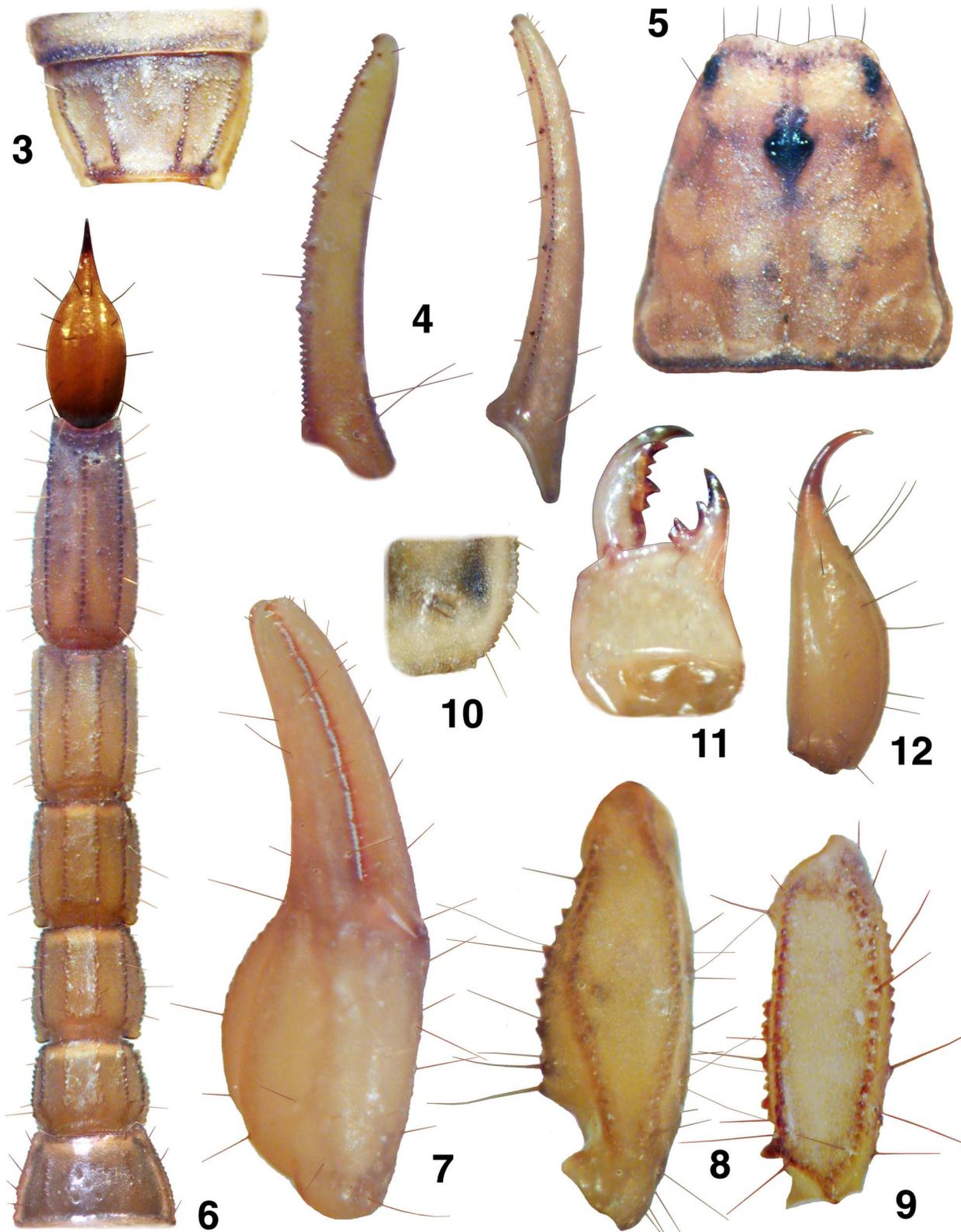
### **Map generation**

The map was generated from Earth Explorer 6.1, with positional data compiled through Google Maps.

### **Material**

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

*Vaejovis jonesi* Stahnke, 1940: 1 female, northeast of Flagstaff, Coconino Co., Arizona; 1 female (RFA), 13.5–16 mi N Sedona, Coconino Co., Arizona (MES). *Vaejovis lapidicola* Stahnke, 1940: 2 males, 8 females, Flagstaff, Coconino Co., Arizona (RFA); 1 male, Coconino Co., Arizona (MES); *Vaejovis* sp. cf. *lapidicola*: 2 males and 7 females, Hualapai Mountains, Mojave Co., Arizona (RFA). *Vaejovis paysonensis* Soleglad, 1973: 1 male and 1 female, 25 NE Payson, Gila Co., Arizona (MES); 1 male, 2 females, Mogollon Rim, Coconino Co., Arizona (RFA). *Vaejovis vorhiesi* Stahnke, 1940: 4 males, 13 females, topotypes, Miller Canyon, Huachuca Mountains, Cochise Co., Arizona (RFA). *Vaejovis cashi* Graham, 2007: 4 males, 8 females, Chiricahua Mountains, Cochise Co., Arizona (RFA). *Vaejovis deboerae* Ayrey, 2009: 6 males, 21 females, topotypes, Santa Catalina Mountains, Pima Co., Arizona (RFA).



**Figures 3–12:** *Vaejovis crumpi*, sp. nov. 3, 5–10 & 12. Male holotype. 4 & 11. Female paratype. 3. Tergite VII. 4. Chelal fingers, fixed and movable, showing dentition. 5. Carapace. 6. Telson, metasoma, and sternite VII. 7. Chela, external view. 8. Pedipalp patella, dorsal view. 9. Pedipalp femur, dorsal view. 10. Left stigma IV. 11. Chelicera, dorsal view. 12. Telson, lateral view.

	<i>V. crumpi</i>						<i>V. paysonensis</i>	
	Male holotype	Male paratype	Male paratype	Female paratype	Female paratype	Female paratype	Male topotype	Female topotype
Total length	21.16	21.01	21.49	25.53	27.56	27.56	18.16	26.95
Carapace length	2.75	2.52	2.48	3.40	3.29	3.18	2.38	3.56
Mesosoma length	5.72	6.15	6.60	7.35	10.69	8.96	6.00	9.05
Metasoma length	9.83	9.63	9.71	11.33	10.42	-	7.48	11.10
Segment I length/width	1.30/1.57	1.32/1.49	1.35/1.51	1.55/1.84	1.40/1.84	1.40/1.73	1.05/1.25	1.60/1.78
Segment II length/width	1.57/1.57	1.40/1.40	1.51/1.51	1.73/1.73	1.51/1.75	-/-	1.20/1.30	1.73/1.73
Segment III length/width	1.62/1.57	1.67/1.40	1.67/1.46	1.90/1.67	1.73/1.64	1.73/1.62	1.25/1.20	1.84/1.62
Segment IV length/width	2.21/1.46	2.11/1.34	2.16/1.35	2.48/1.62	2.27/1.62	2.21/1.51	1.60/1.15	2.48/1.56
Segment V length/width	3.13/1.40	3.13/1.34	3.02/1.46	3.67/1.62	3.51/1.65	3.45/1.57	2.38/1.15	3.45/1.62
Telson length	2.86	2.64	2.70	3.45	3.16	3.13	2.30	3.24
Vesicle length	1.89	1.73	1.70	2.27	2.05	2.05	1.40	2.10
width/depth	1.08/0.91	1.08/0.76	0.97/0.86	1.30/1.03	1.23/0.99	1.20/0.87	0.97/0.65	1.30/0.97
Aculeus length	0.97	0.91	1.00	1.18	1.11	1.08	0.90	1.14
Pedipalp length	9.17	8.79	9.18	11.33	10.75	10.68	7.75	11.59
Femur length/width	2.32/0.86	2.21/0.80	2.43/0.76	2.75/0.97	2.64/1.03	2.64/0.97	1.95/0.60	2.95/0.92
Patella length/width	2.59/0.97	2.48/0.86	2.65/0.92	3.24/1.13	3.14/1.08	3.13/1.06	2.25/0.70	3.35/1.03
Chela length	4.26	4.10	4.10	5.34	4.97	4.91	3.55	5.29
Palm length	2.05	1.94	2.05	2.32	2.37	2.27	1.65	2.45
width/depth	1.30/1.40	1.19/1.30	1.20/1.30	1.30/1.40	1.30/1.41	1.20/1.30	0.85/0.95	1.30/1.40
Fixed finger length	2.11	1.94	1.94	2.70	2.37	2.40	1.78	2.65
Movable finger length	2.59	2.37	2.37	3.30	2.91	2.97	2.15	3.15
Pectines teeth	12-12	12-12	12-12	10-10	11-11	11-11	12-12	11-12

**Table 1:** Morphometrics (mm) of *Vaejovis crumpi*, **sp. nov.**, Prescott, Yavapai Co., Arizona, USA, and *Vaejovis paysonensis*, Payson, Gila Co., Arizona, USA.

## Systematics

Order SCORPIONES C. L. Koch, 1850

Suborder Neoscorpiones Thorell et Lindström, 1885

Infraorder Orthosterni Pocock, 1911

Parvorder Iurida Soleglad et Fet, 2003

Superfamily Chactoidea Pocock, 1893

Family Vaejovidae Thorell, 1876

Subfamily Vaejovinae Thorell, 1876

### *Vaejovis crumpi* Ayrey et Soleglad, **sp. nov.**

Figures 1–20; Table 1

**Diagnosis:** Small scorpion, 21–28 mm, color medium brown, lighter on the legs and telson with underlying mottling on carapace and mesosoma. Chelal palm large and bulbous on the male, chela length/width = 3.380 and chela length/depth = 3.117. Pedipalp movable finger with 7 *ID* denticles. Ventral surface of tarsomere II with single median row of spinules terminating distally with one spinule pair. Hemispermaphore with short bifurcated lamellar hook, distal crest on lamina terminus, and sclerotized mating plug with smooth barb. Carapace is

shorter than the fifth metasomal segment. Pectinal tooth counts 11–13 (12) for the male, and 10–11 (11) for the female.

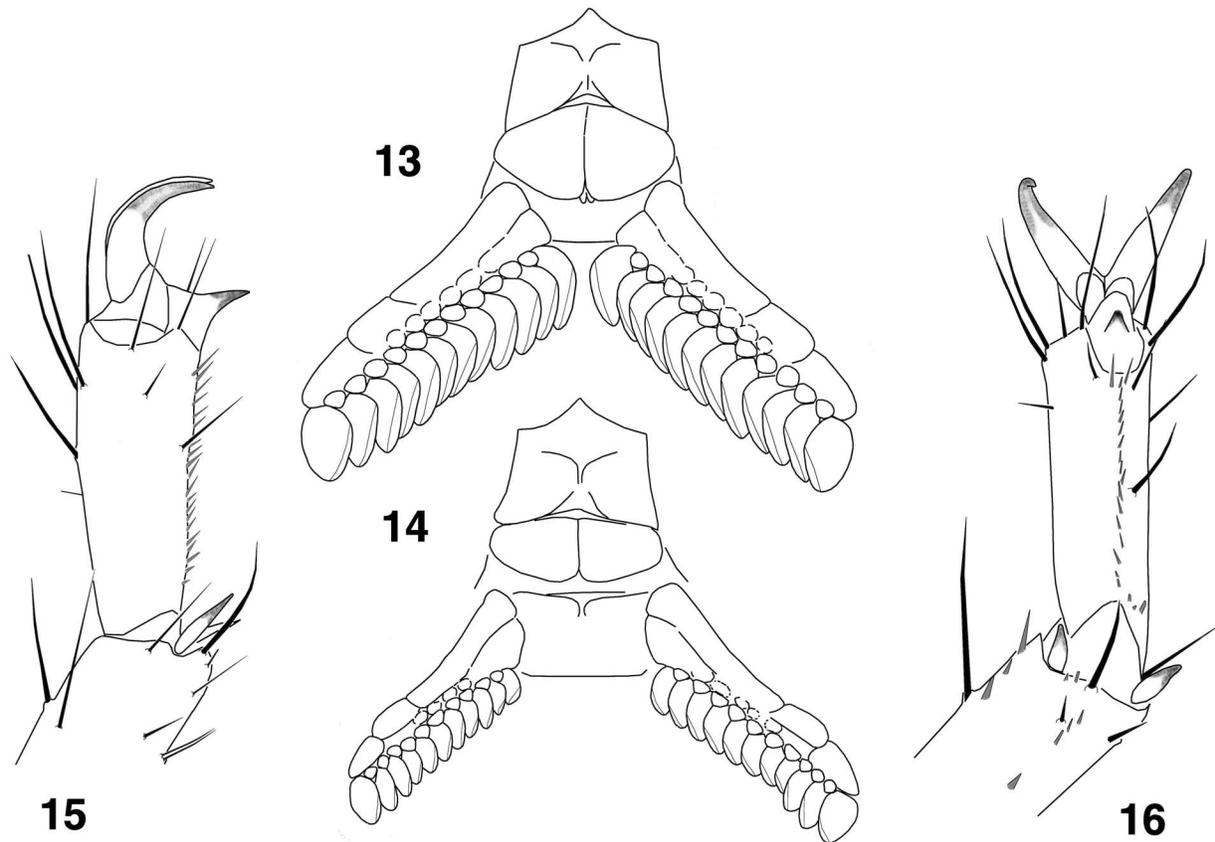
**Distribution:** Known only from the type locality, Prescott, Yavapai County, Arizona, USA. See map in Fig. 22.

**Etymology:** This species was named in honor of Darrell Crump for originally discovering the scorpions.

**Type:** Holotype male, Prescott, Yavapai County, Arizona, USA, 14 September 2009 (R. F. Ayrey), specimen #251, deposited in California Academy of Sciences (CAS).

**MALE.** Description based on holotype male except where noted. See Fig. 2 for dorsal and ventral views of a male paratype and Table 1 for measurements of holotype male and male and female paratypes.

**COLORATION.** Color is medium brown, lighter on the legs, telson orange. Underlying mottling on the carapace and mesosoma.



**Figures 13–16:** *Vaejovis crumpi*, sp. nov. 13. Male holotype. 14. Female paratype. 15–16. Male paratype. 13. Sternopectinal area. 14. Sternopectinal area. 15. Right leg II tarsus, lateral view. 16. Right leg III tarsus, ventral view.

**CARAPACE (Fig. 5).** Anterior margin of carapace moderately emarginated. Carapace moderately 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 0.326; carapace length/width at median eyes 1.394.

**MESOSOMA (Figs. 3, 6, 10, 19 paratype male and female).** Tergites moderately granular with vestigial median carina on Tergites I–VI. Tergite VII with strong median carina on distal 2/3 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 third. Pre-sternites smooth. Sternite V posterior medial edge slightly swollen and whitish in color (Fig. 19), more so than other sternites. Spiracles ovoid with median side rotated 35 degrees from posterior sternite margin. Sternites with variable number of microsetae.

**STERNUM (Fig. 13, 14, paratype female).** Sternum conforms to type II, lateral lobes and apex subtly defined. Sclerite is wider than long.

**GENITAL OPERCULUM (Fig. 13, 14, paratype female).** Sclerites separated on most of length, genital papillae visible between sclerites at posterior edge. See comparison to female below.

**PECTINES (Fig. 13, 14, paratype female).** All pectinal teeth, 12 in number, have exterodistal angling with large sensorial area. Middle lamellae 7/7. Fulcra are present. Each fulcrum with 1–3 central setae.

**METASOMA (Fig. 6).** 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 segment I, posterior 3/4 of II, posterior 1/2 of III, and obsolete on IV. Ventrolateral carinae strong, granular. Ventral submedian carinae moderate, granular. Dorsal and lateral intercarinal spaces very finely granular. Segment I–IV ventral submedian setae 3/3. Segment V: Dorsolateral carinae strong, distally crenulate, basally granular. Lateromedian carinae strong, granular on basal 3/5, obsolete on distal 2/5. Vento-

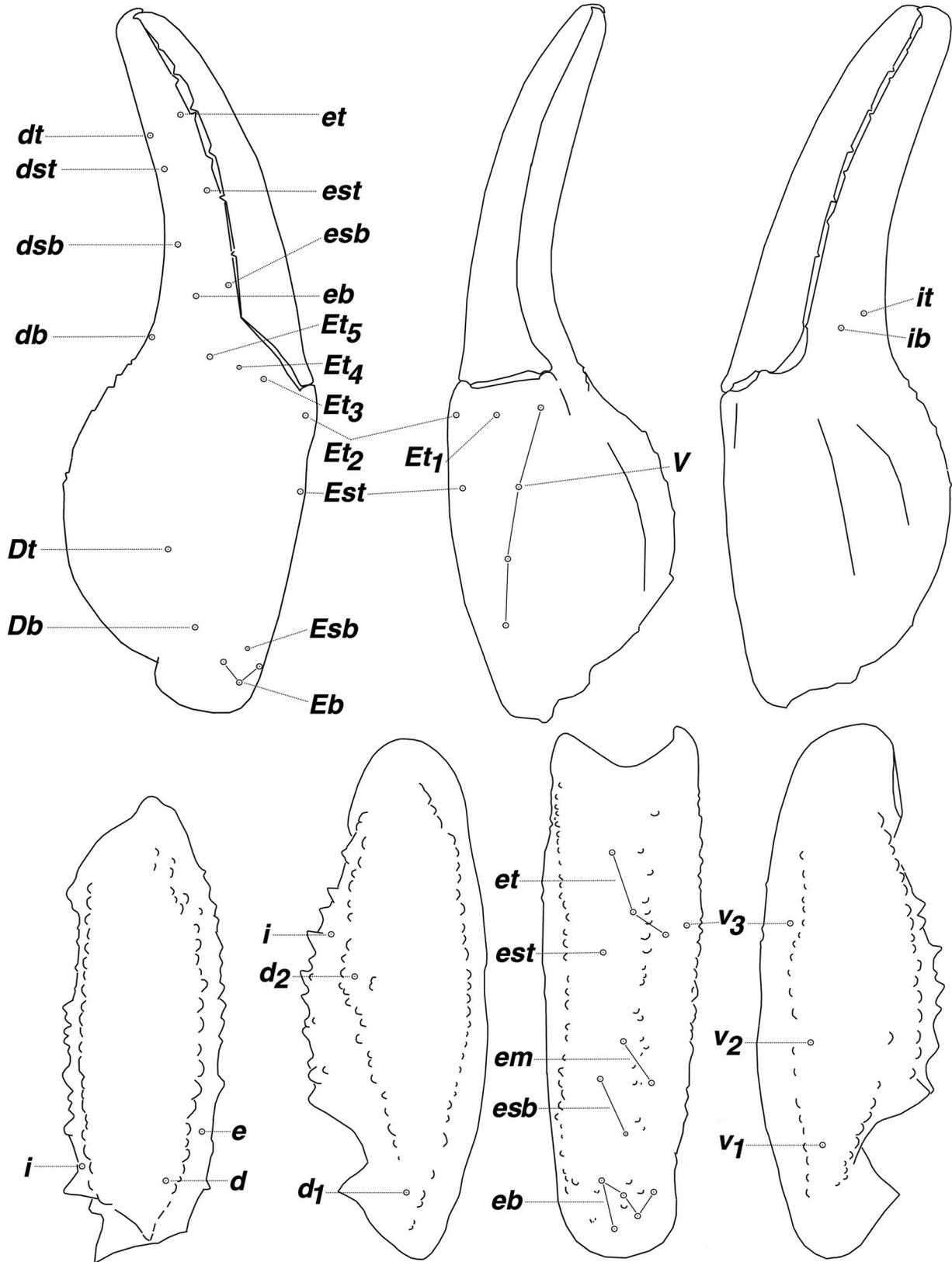


Figure 17: *Vaejovis crumpi*, sp. nov., male holotype. Trichobothrial pattern.



**Figure 18:** *Vaejovis crumpi*, sp. nov., male paratype. Right hemispermatophore. **Top.** Dorsal, closeup of lamellar hook, internoventral, and ventral views. Note bifurcated lamellar hook emanating from the dorsal trough in dorsal view and distal lamellar crest on dorsal and ventral (transparent reflection) views. **Bottom.** Mating plug, dorsal and lateral view. Note the slightly sclerotized smooth barb in the dorsal view.

lateral carinae strong, granular. Ventromedian carina moderate, granular. Intercarinal spaces finely granular. Segment V ventrolateral setae 4/4.

**TELSON (Figs. 6, 12).** Smooth with four pairs of large setae on the ventral surface, three large setae along both lateral edges of the vesicle and numerous smaller setae. Subaculear tubercle present but small. LAS present with 6-6 serrations.

**CHELICERAE (Fig. 11, paratype female).** Dorsal edge of movable cheliceral finger with 2 subdistal (*sd*) denticles. Ventral edge is smooth, with well developed serrula on distal half.

**PEDIPALP (Figs. 7-9, 17, 4, female paratype).** **Femur.** Dorsointernal carina serrated, dorsoexternal and ventrointernal crenulated, ventroexternal rounded. **Patella.** Dorsointernal carina serrated, ventrointernal cren-



**Figure 19:** *Vaejovis crumpi*, sp. nov., male and female paratypes. Sternite V showing the subtle medial white expansion of the posterior edge on the male.

ulated, dorsoexternal and ventroexternal carinae granulated. Dorsal patellar (*DPS*) and ventral patellar (*VPS*) spurs formed with a pointed granule, *DPS<sub>c</sub>* carina well developed with 9 serrated granules. **Chela.** Digital (*D1*) carina weak, irregularly granulate, subdigital (*D2*) represented with a single rounded granule, dorso-secondary (*D3*) rounded with slight median granules, dorsomarginal (*D4*) round and smooth, dorsointernal (*D5*) rounded and irregularly granulated, ventroexternal (*V1*) and ventromedian (*V2*) carinae rounded and smooth, ventrointernal (*V3*) rounded, and external (*E*) carina weak to obsolete. Inner base of fixed finger with small raised area covered with 5 to 6 granules. Chelal finger median denticle (*MD*) rows in straight line. Fixed finger median denticles (*MD*) divided into 6 groups by 5 outer (*OD*) denticles, and 6 *ID* denticles are found on the inner edge. Movable finger with 6 *MD* groups, 6 *OD* denticles and 7 *ID* denticles. Trichobothrial pattern type C orthobothriotaxic (see Figure 17). Chelal *ib* and *it* trichobothria located at fixed finger's base, considerably proximal of sixth *ID* denticle; *Dt* on chela is proximal of palm midpoint; *dt* and *dst* are proximal to *et* and distal of *est*; patellar *v<sub>3</sub>* is located on external surface and positioned distally of *et<sub>3</sub>*.

**LEGS (Figs, 15, 16, paratype male).** Ventral surface of tarsomere II with single median row of spinules terminating distally with one spinule pair.

**HEMISPERMATOPHORE (Fig. 18, paratype male).** The hemispermatophore is lightly sclerotized with a somewhat centrally wide lamella that tapers distally. On the dorsal surface a 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 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 0.288. Also,

comparing the trough difference (i.e., the vertical distance between the ventral and dorsal troughs) to the lamellar hook length, a ratio of 0.774, indicates the hooks relative shortness. Due to the wide internommedian area of the lamella, a narrow non-conspicuous basal constriction is present. A weak, subtle truncal flexure is visible on the external aspect of the trunk/lamella juncture. A quite small slightly sclerotized mating plug was located on the ventral surface, on the internal area just below the ventral trough. Its stock is somewhat thick and the barb's ventral edge is smooth.

**Variability, male and female (Figs. 13, 14, paratype female, 19).** Pectinal teeth are longer and more angled in the male than in the female, the basal tooth is located closer to the pectinal base. Pectinal tooth counts are 11–13 (12.09) ( $\pm 0.47$ ) [32] for the male and 10–11 (10.80) ( $\pm 0.42$ ) [10] for the female. The genital operculum is larger and longer in the male, the sclerites disconnected for most of their length, genital papillae protruding proximally. The genital operculum in the female is separated only on the proximal one-fifth. Posterior edge of sternite V expanded medially on the male (Fig. 19). The metasomal segments are slightly thinner in the male, mean value differences of length to width ratios ranging from 0.8 % to 8.1 % (based on three males and females).

**Dominant morphometrics, female/male (Tab. 1).** Comparing 351 possible ratios from 27 separate morphometrics between the female and male (three specimens each), the following morphometrics dominated for each gender: holotype male: chelal palm depth 26/0 and chelal palm width 25/1; paratype female: carapace length 26/0, chelal movable finger length 25/1, and chelal fixed finger length 24/2. These data imply that the male has a wider and deeper chelal palm whereas the female has a relatively longer carapace and longer chelal fingers. Maximizing on these data (i.e., using the most dominant morphometric per gender), six



**Figure 20:** *Vaejovis crumpi*, sp. nov. Female with first instar juveniles.

morphometric ratios show 20 % or greater MVD between these two genders, the carapace length / chelal depth = 24.1 %, the largest.

**Type locality description.** All of the type specimens were found on tributary washes of Lynx Creek, Prescott, Yavapai County, Arizona (N 34.5361°, W 112.3925°), at an elevation of 1688 m asl. The holotype male was found under a rock near the floor of a wash (see Fig. 1). Most of the specimens were found in leaf litter with a blacklight at night. The vegetation type is mesic Ponderosa Pine and mixed evergreen oak woodland (see Fig. 20). No other scorpions were found syntopically with *V. crumpi*, during 8 field trips to the area. Figure 20 shows a female with first instar juveniles. Figure 21 shows the locality of the holotype specimen.

**Type material. Holotype:** male, Prescott, Yavapai County, Arizona, USA, 14 September 2009 (R. F. Ayrey) specimen #251, deposited in CAS. **Paratypes** (5 specimens): Prescott, Yavapai County, Arizona, USA, 14 September 2009 (R. F. Ayrey), 2 males, 3 females (RFA).

### Comparison to Related Species

The map in Fig. 22 shows the locality of the seven currently known *Vaejovis* species found in Arizona (type localities are indicated). We compare new species *V.*

*crumpi* with all six species, five of these briefly, but concentrating specifically on species *V. paysonensis*, its closest relative.

***Vaejovis vorhiesi*, *V. cashi*, and *V. deboerae*:** These species, occurring in the southeast corner of Arizona, roughly 180 miles from *V. crumpi*'s locality, along with *V. feti* found in New Mexico, are referred to as the “sky island” species (Graham, 2007; Ayrey, 2009). They are very closely related, exhibiting minor morphological differences, and all occupy their own unique mountain tops. However, they all exhibit only six inner denticles (*ID*) on the chelal movable finger, not seven which is commonly found in the vaejovids, including *V. crumpi*.

***Vaejovis lapidicola*:** This species, one of Stahnke's “inscrutable species”, was recently redescribed by Graham (2006) where a lectotype was declared and described. *V. lapidicola* has a very unique carapace, referred to as “planate (= flat)” by Graham (2007: 3). Its uniqueness, however, in our opinion, is its shape: the lateral sides from the proximal edge to the median eyes are subparallel, the carapace tapering abruptly from this point to the anterior edge (see Graham, 2007: figs. 1, 12). In contrast, the carapace in *V. crumpi* (Fig. 5) tapers evenly from its proximal edge to the anterior edge. To quantify this difference in the two carapaces, we have constructed three morphometric ratios for two male type specimens: decrease in width from posterior edge to

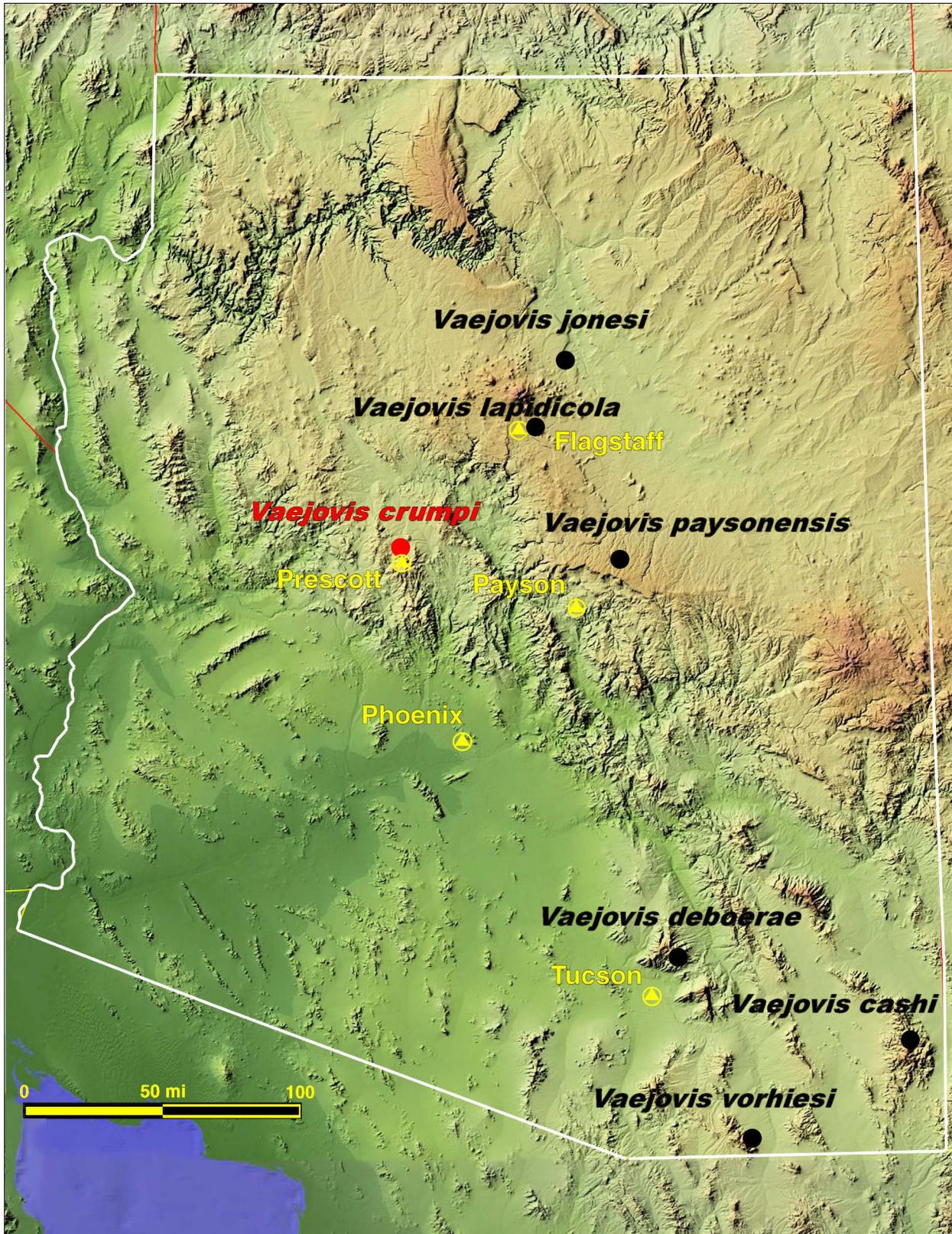


**Figure 21:** *Vaejovis crumpi*, sp. nov. Habitat, Prescott, Yavapai Co., Arizona, USA.

median eyes, 16.4 and 24.6 %, decrease in width from median eyes to the anterior edge, 39.3 and 29.8 %, and overall decrease in width from posterior edge to anterior edge, 49.3 and 47.1 %, for *V. lapidicola* and *V. crumpi*, respectively. From this data it is clear that in *V. lapidicola*, carapace tapers much less proximally than in *V. crumpi* (50 % difference) but increases in narrowing anteriorly (32 % difference) where the percentage of tapering is larger. The last ratio shows that the overall carapace tapering between the two species is essentially the same (only a 4.7 % difference), further emphasizing the abruptness of the anterior tapering of *V. lapidicola*. The carapace in *V. lapidicola* is longer than metasomal segment V (1.033) and pectinal teeth number is 14 in males, and 13 in females. In *V. crumpi*, the carapace is shorter than segment V (0.835, n = 3) and pectinal teeth number 12 in males, and 11 in females. Of particular interest is the close similarity of the hemispermatophore of these two species. Soleglad & Fet (2007: figs. 71–73) illustrated the hemispermatophore of three *Vaejovis* species, including *V. lapidicola* (fig. 71). Comparing the two hemispermatophores (see our Fig. 18) we see that both species exhibit a short bifurcated lamellar hook and

a distal crest on the lamina terminus. Two morphometric ratios, lamellar hook length/lamina length and trough difference/lamellar hook length, are almost identical between the two species, showing only 1.4 and 0.1 % difference.

***Vaejovis jonesi*:** This species is not well known, and has yet to be redescribed; though the type specimen exists and resides at the California Academy of Sciences (pers. comm. Vincent Lee, March 2011), the depository for the original Stahnke ASU collection. Therefore our comparison is based primarily on Stahnke's (1940: 84–86) original description in his unpublished PhD thesis, based on a adult female, as supplemented with presumably *V. jonesi* specimens available to us. *V. jonesi* is a larger species, roughly 50 % larger than *V. crumpi*. Stahnke provides measurements of the carapace (47 % larger), metasomal segments I (48.4% larger) and V (49.9 % larger), the telson (44.9 % larger), and the chelal movable finger length (45.5 % larger). These size differences are further endorsed by the pectinal tooth counts, *V. jonesi* female with 13 teeth and *V. crumpi* with 11 (a 18 % difference). Stahnke reports *V. jonesi* with two pairs of carinae on the seventh sternite whereas



**Figure 22:** Map of Arizona showing the type locality of the seven *Vaejovis* species currently recorded for this state, including new species *Vaejovis crumpi* (red icon, other species black icons).

Morphometric Ratio		<i>V. crumpi</i>	<i>V. paysonensis</i>
Carapace length/metasomal segment V length	♂ + ♀	0.81–0.88 (0.835)	(1.000) <i>V. paysonensis</i> > 19.8 %
		0.92–0.94 (0.928)	(1.032) <i>V. paysonensis</i> > 11.1 %
Carapace length/femur width	♂ + ♀	3.15–3.26 (3.204)	(3.967) <i>V. paysonensis</i> > 23.8 %
		3.19–3.51 (3.326)	(3.870) <i>V. paysonensis</i> > 16.3 %
Carapace length/patella width	♂ + ♀	2.70–2.93 (2.820)	(3.400) <i>V. paysonensis</i> > 20.6 %
		3.00–3.05 (3.018)	(3.456) <i>V. paysonensis</i> > 14.5 %
Patella length/patella width	♂ + ♀	2.67–2.88 (2.811)	(3.214) <i>V. paysonensis</i> > 14.3 %
		2.87–2.95 (2.909)	(3.252) <i>V. paysonensis</i> > 11.8 %
Femur length/femur width	♂ + ♀	2.70–3.20 (2.886)	(3.250) <i>V. paysonensis</i> > 12.6 %
		2.56–2.84 (2.707)	(3.207) <i>V. paysonensis</i> > 18.5 %
Carapace length/chela width	♂ + ♀	2.07–2.12 (2.100)	(2.800) <i>V. paysonensis</i> > 33.3 %
		-	-
Carapace length/chela depth	♂ + ♀	1.91–1.96 (1.937)	(2.505) <i>V. paysonensis</i> > 29.3 %
		-	-
Chela length/chela width	♂ + ♀	3.28–3.45 (3.380)	(4.176) <i>V. paysonensis</i> > 23.6 %
		-	-
Chela length/chela depth	♂ + ♀	3.04–3.15 (3.117)	(3.737) <i>V. paysonensis</i> > 19.9 %
		-	-
Movable finger length/chela width	♂ + ♀	1.97–1.99 (1.986)	(2.529) <i>V. paysonensis</i> > 27.3 %
		-	-
Movable finger length/chela depth	♂ + ♀	1.82–1.85 (1.832)	(2.263) <i>V. paysonensis</i> > 23.5 %
		-	-
Fixed finger length/chela width	♂ + ♀	1.62–1.63 (1.623)	(2.094) <i>V. paysonensis</i> > 29.0 %
		-	-
Fixed finger length/chela depth	♂ + ♀	1.49–1.51 (1.497)	(1.874) <i>V. paysonensis</i> > 25.1 %
		-	-

**Table 2:** Morphometric ratio comparisons (percentage of differences between means) of *Vaejovis crumpi*, **sp. nov.**, and *V. paysonensis* based on respective dominant morphometrics (see Tables 1 and 3). Minimum, maximum, and mean values shown.

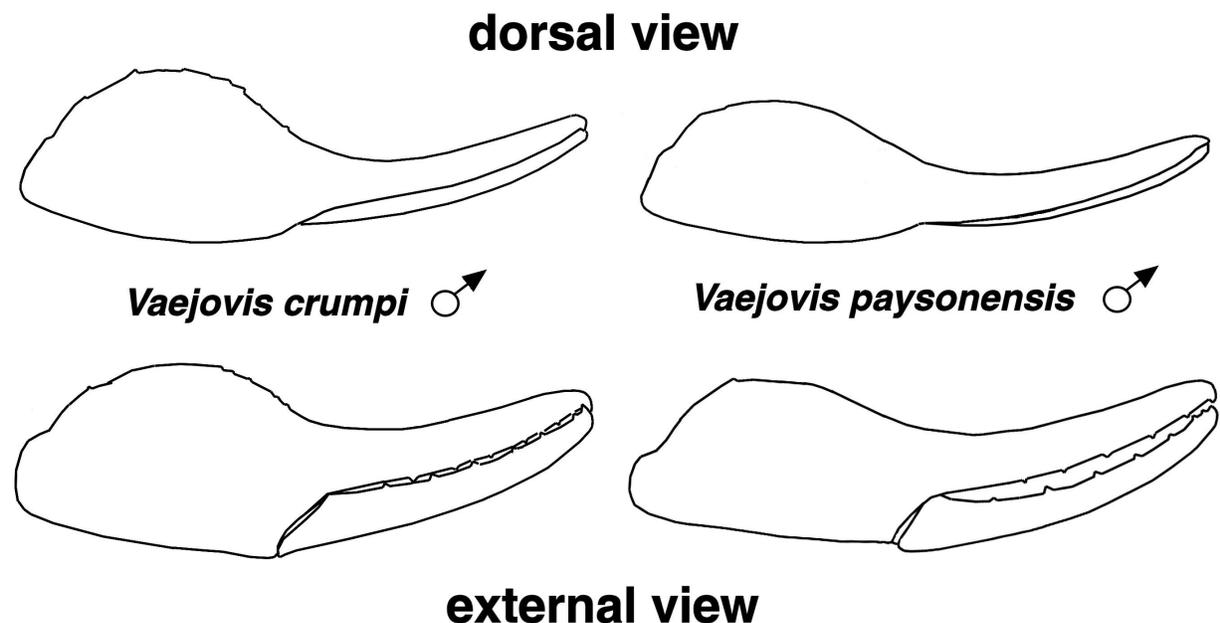
only the lateral carinal pair is present in *V. crumpi* (Fig. 6). Finally, McWest (2001: fig. 241) reports that *V. jonesi* has two distal pairs of ventral spinules on the leg tarsus, while *V. crumpi* has a single pair (Fig. 16).

***Vaejovis paysonensis*:** We consider *V. paysonensis* the closest relative of *V. crumpi*. They agree in all major structural characteristics; i.e., chelal finger dentition, carapace shape and coloration, overall carination, pectinal tooth statistics, etc. However, by simple observation, it is clear that *V. crumpi*'s chela palm in the male is noticeably globular, much more so than that exhibited in *V. paysonensis*. Consequently, we measured three male and female *V. crumpi* and a single male and female of *V. paysonensis* (the remaining specimens from the original set used to describe this species, Soleglad (1973)). From these eight morphometric sets, all possible morphometric ratio combinations were tested between *Vaejovis crumpi*, **sp. nov.**, and *V. paysonensis*. 26 possible ratio combinations per morphometric value are possible. Table 1 shows the actual morphometric values of all eight specimens and Table 3 presents the key morphometric values that dominated in the ratio comparisons. We see a trend in this data: the chela, patella, and femur of *V. crumpi* are relatively wider than

in *V. paysonensis*, where the widths dominated on an average of 21.88 tests out of 26. In *V. paysonensis*, 20.38 tests out of 26 dominated for these segments lengths (or fingers in the case of the chela). When these dominant value pairs are compared across the two species, we obtain ratio differences that are significant for the males in six ratios and for the females in two ratios (see Table 2). These ratio mean value differences ranged 12.6–27.3 % for the males and 11.8–18.5 % for the females. Another important dominant morphometric is the carapace length in *V. paysonensis* which dominated 25 and 23 tests for the male and female, respectively. In contrast, metasomal segment V length dominated in *V. crumpi*, 19 and 24 tests for the male and female, respectively. Combining the carapace length with metasomal segment V and the pedipalp patella and femur widths, we obtain, again, significant ratio differences between the two species, 19.8–23.8 % for the males and 11.1–16.3 % for the females. In all, thirteen morphometric ratios exhibited mean value differences of 12.6–33.3 % for the male, and five ratios with differences of 11.1–18.5 % for the female. We hypothesize here that the male differences are more exaggerated due to the noticeable sexual dimorphism in the male *V. crumpi*

	Male	Female
<b><i>Vaejovis crumpi</i>:</b>		
Chela width	26/0	14/12
Chela depth	25/1	15/11
Metasoma segment V length	19/6	24/2
Femur width	23/3	26/1
Patella width	21/5	25/1
<b><i>Vaejovis paysonensis</i>:</b>		
Carapace length	25/1	23/3
Femur length	17/8	25/1
Patella length	22/4	18/7
Fixed finger length	24/2	21/5
Movable finger length	23/3	13/12

**Table 3:** Dominant morphometrics for *Vaejovis crumpi*, sp. nov., and *V. paysonensis*. Based on 26 possible morphometric ratio comparisons.



**Figure 23:** Diagrammatic views of the chela comparing the morphometric proportions of male *Vaejovis crumpi*, sp. nov., and *V. paysonensis*. Dorsal view (top) showing differences in the chelal width vs. length and external view (bottom) showing differences in the chelal depth vs. length. See Table 2 for statistical data. Illustrations based on male holotype of *V. crumpi* and male topotype of *V. paysonensis*.

whose chelae are noticeably inflated. This is quite apparent in Fig. 23 where the male chela of *V. crumpi* is compared to that of *V. paysonensis*.

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