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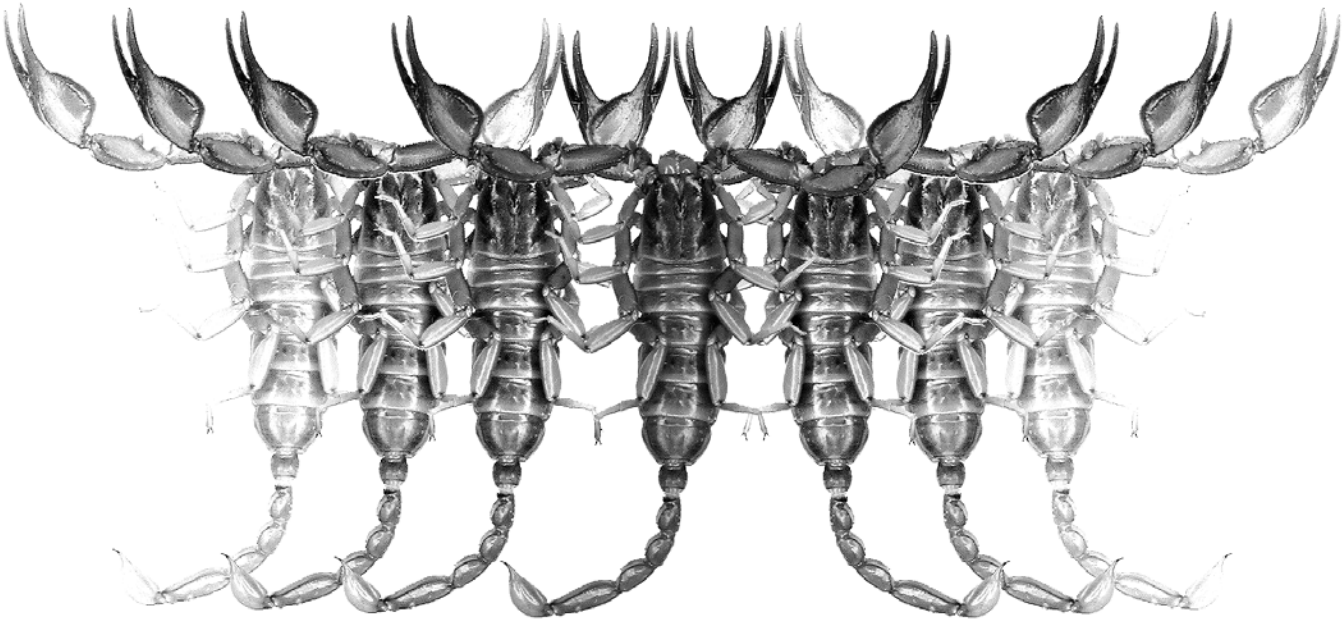

Serradigitus miscionei (Scorpiones: Vaejovidae), a New Species from Southern Arizona

Richard F. Ayrey

February 2011 – No. 111

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Summary

A new scorpion species, *Serradigitus miscionei*, is described, placed in the genus *Serradigitus* Stahnke, 1974. These are small reddish-brown scorpions found on vertical surfaces, in the San Pedro River system and other river systems in southern, Arizona.

Introduction

We found 16 small, reddish-brown adult female scorpions (Fig. 1) on vertical sand substrate along the San Pedro River and its tributaries, including Walnut Gulch (Fig. 2). These walls consist of older alluvial valley fill that is in the process of channel wall erosion (Harmon & Doe, 2001) forming Walnut Gulch, etc. We discovered all of the scorpions by means of ultraviolet lights, or we unearthed them hidden behind flakes of sand (Fig. 2). Both the floor of the wash itself, scanned with blacklights, and areas of previous bank erosion, where the sand had fallen away from the face of the wash and landed on the floor, were examined and not a single specimen was found. In one evening six of the scorpions were found while searching 40 square meters of vertical habitat, while no scorpions were found in 600 square meters of adjacent horizontal habitat. We collected one specimen on the floor of another wash in an area of intense human activity. An additional specimen was found on the vertical exterior of a residence. The owner reports frequent sightings of these scorpions on the exterior, vertical walls of the house. Seventeen of the eighteen specimens (94%), whose position was determined, were found on absolutely vertical surfaces. Six specimens kept in the laboratory almost exclusively use the available vertical surfaces. The author has found many scorpions climbing vertical surfaces, but no other species that appears to limit itself to vertical surfaces. The other Arizona members of the genus *Serradigitus* are usually lithophilic, but the author has found many of them on horizontal surfaces.

Recent taxonomic history of tribe Stahnkeini

The last *Serradigitus* species named, *S. yaqui*, was described 20 years ago by Sissom & Stockwell in 1991. In this excellent paper, details of the hemispermatophore were provided for the first time. Soleglad & Fet (2006) presented a detailed analysis of the diagnostic characters of this genus where many of the Williams' (1980) type and paratype specimens were examined. In this contribution, exact definitions of the basal pectinal teeth of the female, chelal serrated dentition, and the variable position of the internal trichobothria of the chela were provided. Soleglad & Fet (2006) named a new genus *Stahnkeus* and created a new tribe Stahnkeini. Graham & Soleglad (2007) described *Gertschius crassicorpus*, a new genus and species, from northern Sonora, Mexico. They also included *G. agilis* in this assemblage, previously assigned to *Serradigitus* by Sissom & Stockwell (1991). Later, Soleglad & Fet (2008) presented the systematics of two vaejovid subfamilies, Smeringurinae and Syntropinae, the latter divided into two tribes, Syntropini and Stahnkeini. Four genera were placed in Stahnkeini, *Gertschius*, *Serradigitus*, *Stahnkeus*, and *Wernerius*. Most recently, Francke & Ponce-Saavedra (2010) described a new genus and species, *Kuarapu purhepecha*, from Michoacán, Mexico. In this contribution the authors placed *Kuarapu* in tribe Stahnkeini. This species, lithophilic in nature, lacks modified basal pectinal teeth in the female, a major diagnostic character of tribe Stahnkeini. In addition, the chelal fingers are not noticeably serrated and the internal finger trichobothria placement does not match typical species in Stahnkeini, but does, however, exactly match the configuration seen in *Syntropis*, a lithophilic member of Syntropini (Soleglad, Lowe & Fet, 2007: fig. 4). For these reasons, in addition to the presence of a toothed mating plug barb and multiple pairs of ventral distal spinules on the leg tarsus, *Kuarapu* clearly belongs in tribe Syntropini (M. Soleglad, pers. comm, 2011).

Methods and Materials

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 &

Figure 1: *Serradigitus miscionei*, **sp. nov.**, on a vertical sand flake in Walnut Gulch.

Fet (2006), Graham & Soleglad (2007), Fet & Soleglad (2007), Soleglad, Lowe & Fet (2007), and Soleglad & Fet (2008).

Measurements are as described by Stahnke (1970), trichobothrial patterns and established homologies are as in Vachon (1974), and pedipalp finger dentition follows Soleglad & Sissom (2001).

Material

Besides type material listed below under new species description, and 18 specimens of the new species not included in the type series, the following additional specimens were examined:

Gertschius agilis (Sissom et Stockwell, 1991): 2 miles W of Peña Blanca Lake, Santa Cruz County, Arizona, USA, 1 March 2009 (R.F. Ayrey), specimen #212, author's collection; *Serradigitus gertschi gertschi* Williams, 1968: Chariot Canyon, ABDSP, California, USA, (33°1.8'N, 116°29.94'W) 3047 m. a. s. l. 30 August 1997 (M. Soleglad), 2 females (MES); *Serradigitus wupatkiensis* (Stahnke, 1974): Highway 89, 2 miles N of Wupatki National Monument, Coconino County, Arizona, USA, 12 September 2008 (R.F. Ayrey), specimen #216, author's collection. *Stahnkeus allredi* (Sissom et Stockwell, 1991): Picacho Peak, Pima County, Arizona, USA (32°38.717'N, 111°23.664'W), 557m a.s.l., 14 May 2010 (R.F. Ayrey) specimen #225, author's collection; *Vaejovis deboerae* Ayrey, 2009, holotype female, Santa Catalina Mountains, Pima County, Arizona, USA (32°23'13"N, 110°41'45"W), 2,142 m.a.s.l., 25 August 2008 (R.F. Ayrey), specimen #119 (CAS).

Systematics

Order Scorpiones C. L. Koch, 1850
Parvorder Iurida Soleglad et Fet, 2003
Superfamily Chactoidea Pocock, 1893
Family Vaejovidae Thorell, 1876
Subfamily Syntropinae Kraepelin, 1905
Tribe Stahnkeini Soleglad et Fet, 2006
Genus *Serradigitus* Stahnke, 1974

***Serradigitus miscionei* Ayrey, sp. nov.**
(Figs. 1, 3–16)

Diagnosis. Small reddish-brown scorpions (Fig. 1). The total length is 25 mm. The female pectinal tooth count is 13–14 (13.09) [44] and the number of modified pectinal

Figure 2: Habitat of *Serradigitus miscionei*, **sp. nov.**, Walnut Gulch, Cochise Co., Arizona, USA (top). Closeup of microhabitat (bottom).

Figure 3: *Serradigitus miscionei*, **sp. nov.,** female holotype, Walnut Gulch, Cochise Co., Arizona, USA. Ventral and dorsal surfaces.

teeth (diminished or completely lacking sensorial area) is 1.45 (20). The basal tooth, lacking a sensorial area, is subovoid and same length as the adjacent tooth. The trichobothrial pattern is orthobothriotaxic type C (Fig. 4). Trichobothria *ib* and *it* are positioned on the basal third of the fixed finger, *ib* located at the level of *ID* denticle 6, *it* located half way between *ID* denticles 5 and 6 (Figs. 4, 10). Inner accessory denticles (*IAD*) are lacking on the chelal fingers. The movable and fixed chelal fingers have 7 and 6 inner denticles (*ID*), respectively. The pedipalp chela fixed finger has 4 subrows of median (MD) denticles, 3 *OD* denticles and 6 *ID* denticles. Movable finger has 4 subrows of median (MD) denticles, 3 *OD* denticles and 7 *ID* denticles. The movable finger and fixed finger *OD* denticles are serrated and indistinguishable after *OD*-3, and the distal denticles are elongated and hook-like with a distal "whitish patch". Ventromedian (VM) carinae of metasomal segments I–IV are crenulate. Metasomal segments IV and V are the same color as I through III, with metasomal segment III about as long as wide and the ratio of metasomal segment V length/width is 1.69–1.72. A small subaculear tubercule is present on the telson.

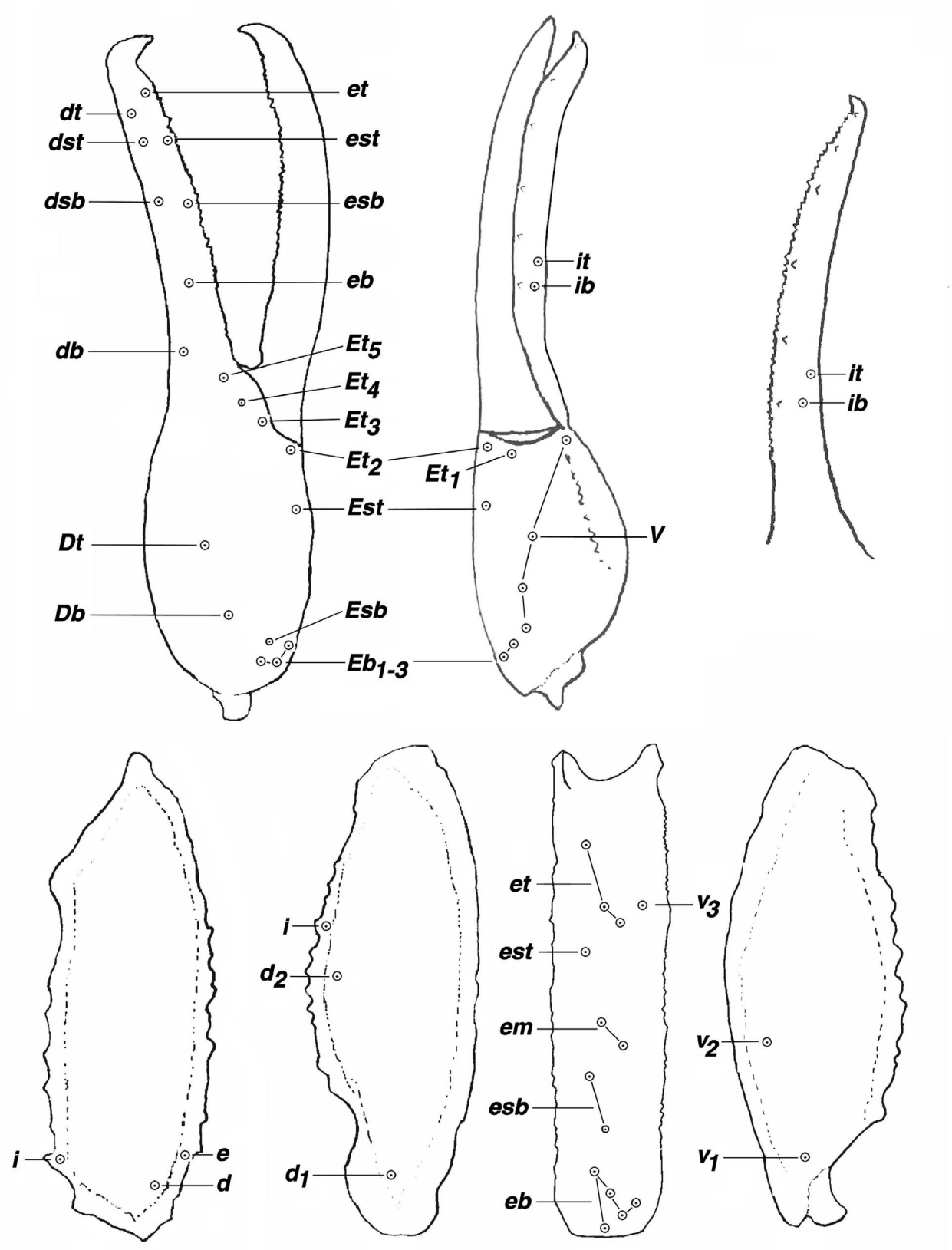


Figure 4: *Serradigitus miscionei*, **sp. nov.**, female holotype, Walnut Gulch, Cochise Co., Arizona, USA. Trichobothrial pattern.

Type material. USA: *Arizona:* Holotype female, Walnut Gulch, Cochise County (35°14'14.2"N, 112°06'44.4"W), 08 March 2009 (R. F. Ayrey) (CAS = California Academy of Sciences). Paratype female #2, Walnut Gulch, Cochise County (35°14'14.2"N, 112° 06'44.4"W), 08 March 2009 (R. F. Ayrey) (CAS). Paratype female #5, Walnut Gulch, Cochise County (35°14'142"N, 112°06'44.4"W), 25 April 2009 (R. F. Ayrey) (CAS). Paratype female, Cienega Creek, Pima County, 25 April 2009 (R. F. Ayrey) (CAS).

Etymology. This species was named in honor of Tom Miscione for originally discovering the scorpions.

Distribution. Known from the type locality Walnut Gulch, Cochise County, Arizona and the San Pedro and Santa Cruz River drainages of Southern Arizona, USA. See map in Figure 17.

Measurements (in mm). Male unknown. Holotype (female): total length 24.71; carapace length 3.06; carapace width at median eyes 2.89; mesosoma length 9.19; metasoma length 12.46; metasomal segment 1 length/width 1.26/1.96; segment II length/width 1.44/ 1.81; segment III length/width 1.74/1.79; segment IV length/width 2.32/1.76, segment V length/width 2.88/ 1.70; telson: length 2.82; telson vesicle length/ width/depth 1.67/1.11/0.80; aculeus length 1.15. Pedipalps: total length 10.13; femur length/width 2.49/0.86; patella length/width 2.93/0.98; chela length 4.71; chela palm length/width/depth 1.81/1.01/0.92; movable finger length 2.99; fixed finger length 2.48.

Paratype (female): total length 25.15; carapace length 3.17; carapace width at median eyes 2.59; mesosoma length 9.58; metasoma length 12.40; Metasoma: segment 1 length/width 1.22/1.92; segment II length/width 1.53/1.85; segment III length/width 1.71/1.74; segment IV length/width 2.23/1.71; segment V length/width 2.92/1.69. Telson: length 2.79; Telson Vesicle length/ width/depth 1.63/1.09/0.78; Aculeus length 1.16. Pedipalps: total length 10.55; femur/width 2.72/0.95; patella length/width 3.11/1.05; chela length 4.72; chela palm length/width/depth 1.90/1.05/0.96; movable finger length 3.09; fixed finger length 2.57.

Description. Based on holotype female, see Figure 3 for dorsal and ventral views. Table 1 contrasts *S. miscionei* with other *Serradigitus* species.

Color. The color is reddish-brown with dusky markings on carapace and tergites, fading to faint on metasoma, pedipalps and legs. Metasomal segments I–V are uniformly reddish-brown. The telson is orange-brown.

Carapace The carapace is finely granular and is longer than the fifth metasomal segment. The anterior margin of the carapace is slightly emarginated. Three lateral eyes on each side. Median furrow moderate and traverses entire length of carapace (see Figs. 5, 8).

Mesosoma. Tergites are finely granular. Tergite VII with two pairs of strong, crenulate carinae. Sternites III–VI smooth. Sternite VII with one pair of weak, granulose carinae. Stigmata are long and slit-like.

Pectines. Pectinal tooth counts for adult females are, 13/13(19), 14/13(2) and 14/14(1) with an average of 13.09(44). One or more of the most proximal pectinal teeth are modified (diminished or completely lacking sensorial area). Mean number of female modified pectinal teeth is 1.45(20) (see Figs. 7, 12). Fulcra 12/12. Middle lamellae 8/8.

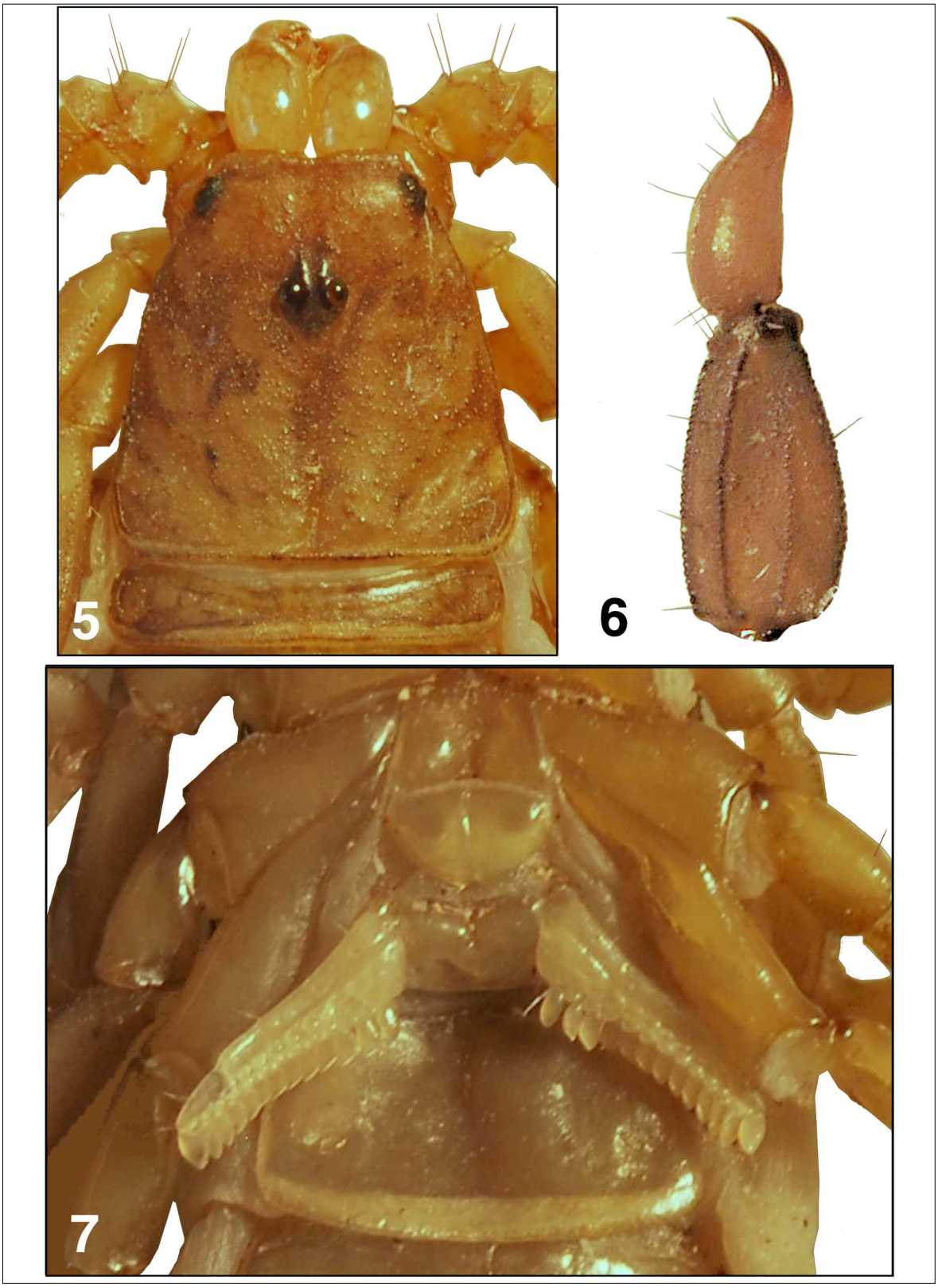
Chelicerae. Dorsal edge of movable finger with two subdistal (*sd*) denticles; ventral edge smooth with well developed serrula comprised of approximately 20 tines on distal half. Ventral edge of fixed finger smooth.

Metasoma. Segments I–III wider than long, IV 1.32 times longer than wide, V 1.73 times longer than wide. Segments I–IV: Dorsolateral carinae moderately strong, crenulate. Lateral supramedian carinae strong, crenulate. Lateral inframedian carinae moderate, crenulate; on posterior four fifths of I, on II present on posterior two-thirds, on III present on posterior one fourth, on IV absent. Ventrolateral carinae moderate, crenulate on posterior two thirds of I and posterior three quarters of II–IV. Ventral median carinae moderate, crenulate on posterior three quarters of I and on II–IV. Setal counts on segments I–IV: dorsolaterals, 0:1:1:2; lateral supramedians, 0:1:1:2; ventrolaterals, 2:2:3:3; ventral submedians, 3:3:3:3. Segment V dorsolateral carinae moderate, granulose; lateromedian carinae moderate on anterior four fifths; ventrolateral and ventromedian carinae moderate, crenulate. All intercarinal spaces on metasomal segments I–V moderately granular.

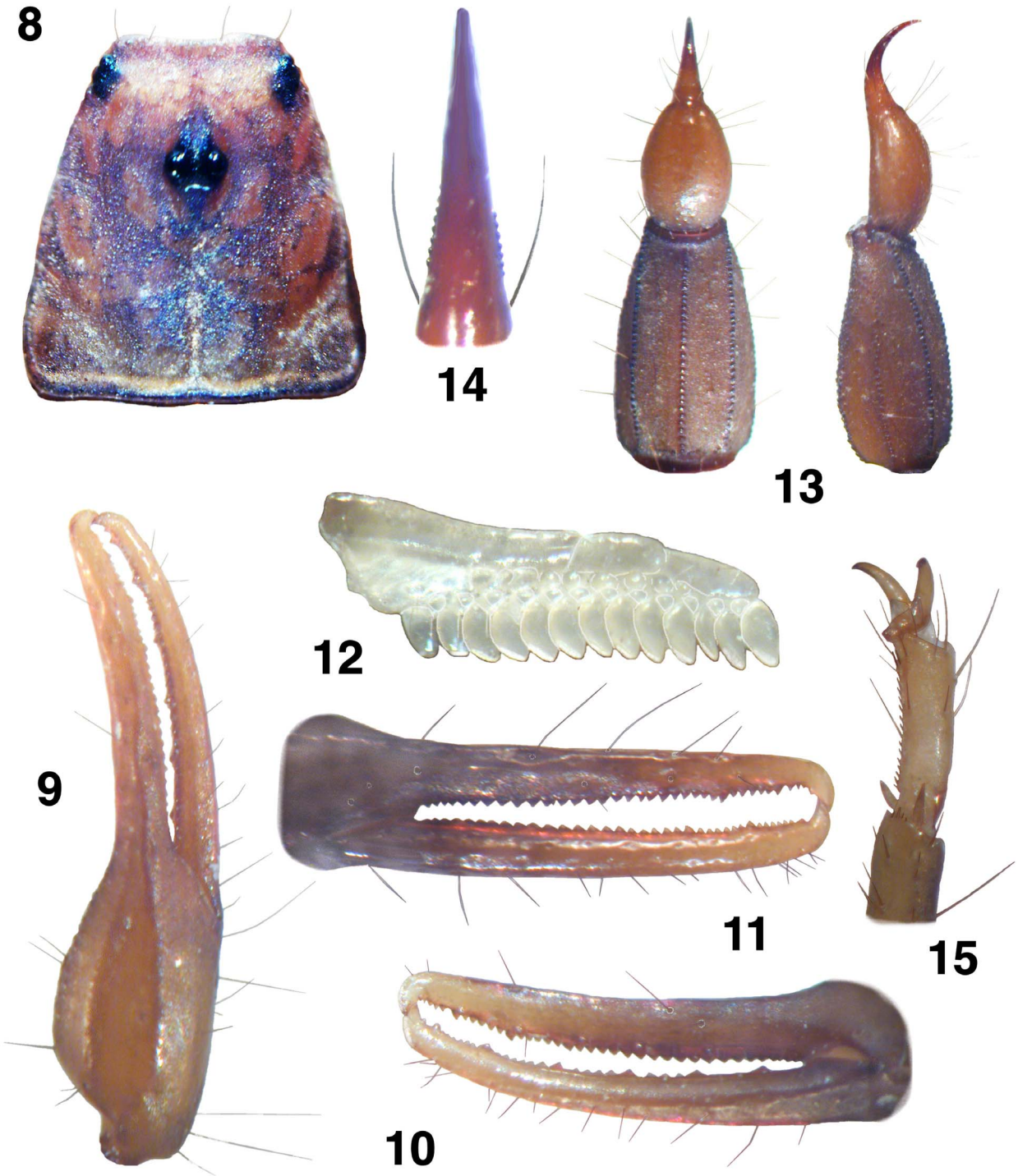
Telson (Fig. 6, Figs. 13, 14 paratype female). Ventral surface of vesicle very weakly granular; about 7 to 9 pairs of major setae. Subaculear tubercle very weak (see Figs. 6, 13). Laterobasal Aculear Serrations (LAS) present, holotype exhibiting 6-6 serrations (Fig. 14 shows these serrations on a paratype).

Pedipalps. Trichobothrial pattern orthobothriotaxic type C (Vachon, 1974), see Figure 4. Trichobothrium *ib* at level of *ID* denticle 6, trichobothrium *it* located half midpoint between *ID* denticles 5 and 6.

Chela (Fig. 9). Palm slightly inflated medially. Dorsal marginal carina moderate; dorsal secondary and external secondary carinae weak; ventroexternal carina weak; digital carina vestigial; ventromedian and ventrointernal carinae vestigial; dorsointernal carina weak, granulose. Fixed finger median (*MD*) denticles divided into 4 subrows; 3 *OD* denticles and 6 *ID* denticles. Movable finger median (*MD*) denticles di-



Figures 5–7: *Serradigitus miscionei*, **sp. nov.**, female holotype, Walnut Gulch, Cochise Co., Arizona, USA. **5.** Carapace and chelicerae, dorsal view. **6.** Metasomal segment V and telson, lateral view. **7.** Sternopectinal area.



Figures 8–15: *Serradigitus miscionei*, **sp. nov.**, female paratype, Walnut Gulch, Cochise Co., Arizona, USA. **8.** Carapace. **9.** Chela, lateral view. **10.** Chelal fingers, internoventral view, showing the position of trichobothria *ib–it* and six and seven inner denticles (*ID*) of the fixed and movable fingers, respectively. **11.** Chelal fingers, external view, showing the highly serrated outer (*OD*) and median (*MD*) denticles, diagnostic of the genus. **12.** Left pecten showing the lack of peg sensilla on the basal tooth and reduced developed of sensilla on second basal tooth. **13.** Metasomal segment V and telson, ventral and lateral views. **14**. Closeup of telson aculeus, ventral view, showing the development of the Laterobasal Aculear Serrations (LAS) with seven to eight serrations. **15.** Tarsus, left leg III, showing pedal spurs, ventral row of median spinules, and single pair of distal spinules.

Figure 16: *Serradigitus miscionei*, **sp. nov.,** with second instar juveniles.

vided into 4 subrows; 3 *OD* denticles and 7 ID denticles. Movable finger and fixed finger *OD* denticles are serrated and indistinguishable after *OD*-3. Distal denticles elongated and hook-like with distal 'whitish patch'. The chela length/width is 1.79.

Femur. Dorsointernal, dorsoexternal, and ventrointernal carinae moderate, crenulate; ventroexternal carina moderate, crenulate. Internal surface with 11 enlarged granules; other surfaces densely, minutely granular.

Patella. Dorsointernal and ventrointernal carinae moderate, crenulate; dorsoexternal and ventroexternal carinae weak, crenulate. Internal surface with up to fourteen enlarged tubercles forming an oblique longitudinal DPS carina; dorsal and ventral surfaces densely, minutely granular; external surface with numerous small granules along midline.

Legs (Fig. 15). Connective tissue between basitarsus and tarsus of right leg III with pedal spurs on both the external as well as internal surfaces. Right leg III tarsus with a single pair of distal spinules.

Variation. Variation was found in the number of modified pectinal teeth with counts of 2/2 (2), 2/1 (3), 1/1 (3) and ½ (2), with a mean of 1.45 (20), 7 of the 10 females examined had at least one pecten with more than one modified pectinal tooth.

Reproduction. All of the 22 specimens examined were found to be adult females. Three females were observed with second instar juveniles on their backs. The number of juveniles were 2 (Fig. 16) , 3, and 10; mean = 5 (3). A description of the male will be necessary when specimens become available.

Discussion

Serradigitus miscionei conforms with all diagnostic characters of its genus (note, male unknown, so hemispermatophore description not possible at this time). The basal pectinal tooth of the female lacks a sensorial area and therefore its shape is somewhat modified, less angled, more ovoid (Figs. 7, 12). It is not elongated, however, as seen in some of the larger species, though this is not unusual for the smaller species of *Serradigitus* (e.g., see Soleglad & Fet (2006: figs. 17–32)). The chelal fingers are noticeably serrated (Figs. 10, 11), terminating in an elongated distal denticle capped with a "whitish patch". Median to proximal outer denticles (*OD*) not distinguishable on the fingers. The number of MD + OD

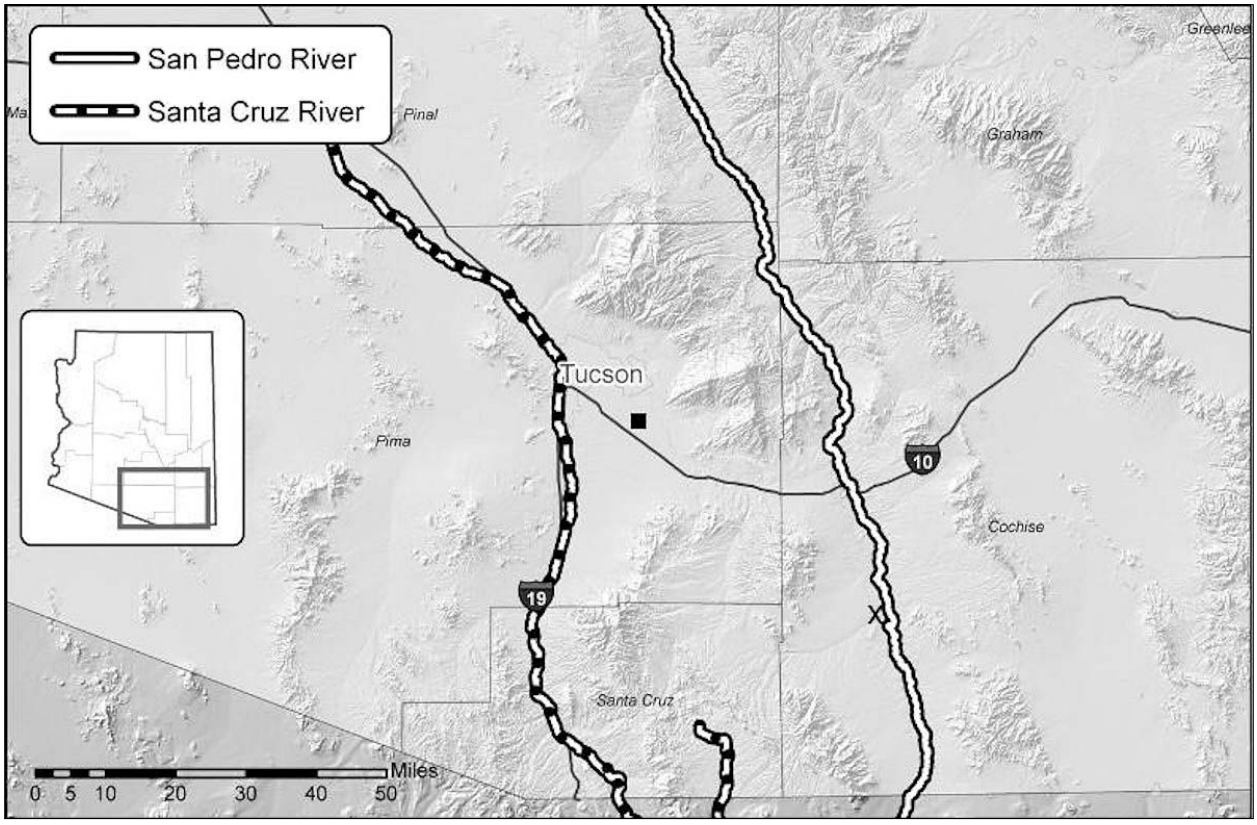


Figure 17: Distribution of *Serradigitus miscionei*, **sp. nov.**, showing the locations of the San Pedro and Santa Cruz Rivers. The (X) is the holotype location and (square) a paratype location.

denticles of the movable finger (based on a paratype female) is 36. Normalizing this number by the movable finger length / carapace length, gives us 37, certainly consistent for this genus which exhibits a considerably lower number of finger denticles (see Soleglad & Fet, 2006: tabs. 1, 2). The placement of the chelal *ib–it* trichobothria are located between the two most proximal outer denticles, somewhat basal, which is common for small species of this genus (on larger species these trichobothria can occur midfinger, between inner denticles *ID*-4 and *ID*-5). Note, the variability of *ib–it* positions is unique in Stahnkeini, and not fixed, as seen for example, in *Vaejovis deboerae* Ayrey, 2009, which has a basal position as in all "*mexicanus*" group species (Ayrey, 2009). The *ib*_position / fixed finger length ratio as described by Soleglad & Fet (2006: tab. 5) for this species is 0.258; normalized with the carapace length (an indicator of the scorpion's size), it is 0.086 (based on a paratype female). These numbers are consistent with *Serradigitus* species of the general size of *S. miscionei*.

Comparison of species

In Table 1, we compare *S. miscionei* with five other *Serradigitus* species that occur the closest geographically. We can separate *S. miscionei* from these species as follows: ***S. wupatkiensis***, found in northern Arizona, Utah, Nevada, and central California, is a larger and thinner species (34 mm vs. 25 mm; metasomal segments II–III longer than wide vs. wider than long), with larger pectinal tooth counts (16–17 vs. 13–14 in the female). The proximal pectinal tooth is elongated, extending beyond the adjacent tooth (not blunted and equal in length to the adjacent tooth). ***S. joshuaensis***, found in the Colorado Desert of southern California, is quite similar in size, morphometric proportions, and in pectinal tooth counts. It can be distinguished, however, by its noticeably smaller, more ovoid-shaped basal pectinal tooth which is smaller than the adjacent tooth, and the unusual reduction in inner denticles (*ID*) on both chelal fingers, only exhibiting four and five for the fixed and movable fingers, respectively (not six and seven as found on other species). ***S. g. gertschi***, found in extreme southwest California and coastal Baja California, Mexico, has a larger pectinal tooth count, averaging two more teeth. The basal pectinal teeth lacking a sensorial area usually number two and are elongated, longer than the adjacent tooth. The metasoma is also somewhat thinner. ***S. hearnei***, found in Baja California Sur, Mexico, though also a somewhat small *Serradigitus*

	Serradigitus					
	S. miscionei	***S. g. gertschi***	***S. hearnei***	***S. joshuaensis***	***S. wupatkiensis***	***S. yaqui***
Shape of basal pectinal tooth of female	Subovoid, same length as adjacent tooth	Elongated, longer than adjacent tooth	Elongated, longer than adjacent tooth	Ovoid, shorter than adjacent tooth	Elongated, longer than adjacent tooth	Elongated, same length as adjacent tooth
Modification of basal pectinal teeth of female	1–2 [1]	1–3 (2)	1	1–2 [1]	2	1–2 [1]
Pectinal tooth counts of female	13–14 (13)	14–16 (15)	15–16 (15)	12–15 (13)	16–17 (16.5)	13–15
Trichobothrium *it* placement	Between *ID*-5 & *ID*-6	Between *ID*-5 & *ID*-6	Adjacent to *ID*-5	Proximal to *ID*-4 [2]	Between *ID*-5 & *ID*-6	Between *ID*-5 & *ID*-6
Trichobothrium *ib* placement	Adjacent to *ID*-6	Adjacent to *ID*-6	Between *ID*-5 & *ID*-6	Proximal to *ID*-4 [2]	Between *ID*-5 & *ID*-6	Between *ID*-5 & *ID*-6
Number of chelal MF inner denticles (*ID*)	7	7	7	5	7	7
Metasoma segments II–IV (L/W)	II = 0.812 III = 0.978 IV = 1.311 V = 1.694	0.900 1.000 1.368 2.000	0.842 0.944 1.333 1.778	0.882 1.000 1.375 2.000	1.091 1.286 1.500 2.261	0.688 0.737 1.144 1.596
Ventromedian (VM) carinae of metasomal segment I–IV	I = crn II = crn III = crn IV = crn	crn crn crn-ser ser	obs- sm obs-sm sm crn	wk-crn wk-crn crn crn	wk wk crn crn	obs wk-grn wk-crn wk-crn
Adult size of female (in mm)	25	25	26	25	34	22

Table 1: Summary of important character comparisons between *Serradigitus miscionei* and related species (based on females). [1] indicates that most distal tooth in basal range only partially exhibits tooth modifications. [2] *S. joshuaensis* exhibits a reduced number of *ID* denticles, *ID*-4 is the most proximal denticle. crn = crenulated, obs = obsolete, sm = smooth, wk = weak, grn = granulated, ser = serrated. Data derived from specimens examined and Gertsch & Allred (1965), Williams (1968), Soleglad (1972), Williams (1980), Sissom & Stockwell (1991), and Soleglad & Fet (2006).

species, has a longer more modified basal pectinal tooth, its pectinal tooth counts for the female are roughly two greater in number (15–16 vs. 13–14), and the metasomal segments ventromedian (*VM*) carinae are less developed, smooth to obsolete on segments I–II, smooth on III, and irregularly crenulated on IV (not crenulate on all four segments). ***S. yaqui***, found on the central west coast of Sonora, Mexico, is probably one of the smallest *Serradigitus* species and therefore is similar in size, morphometric proportions, and in pectinal tooth counts. It can be distinguished, however, by its somewhat stocky metasoma, exhibiting length/width ratios for segments II–IV that are 18 %, 32.7 %, and 14.6 % smaller (implying a wider segment). The ventromedian (*VM*) carinae of metasomal segments I–IV are also less developed, obsolete on segment I, weakly granulated on II, and weakly crenualted on III–IV (not crenulate on all four segments). In *S. yaqui*, metasomal segment V is darker than the other segments (not the same color).

Geographic affinities

Serradigitus miscionei habitat is vertical sand substrate in the water courses of southern Arizona. *Serradigitus* species the closest geographically to *S. miscionei* are *S. joshuaensis, S. wupatkiensis, S. yaqui* and *S. hearnei*, are isolated approximately by 240 to 330 miles.

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