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A NEW GENUS AND SPECIES OF SCORPION (SCORPIONES: VAEJOVIDAE) FROM MICHOACÁN, MEXICO

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Abstract: *Kuarapu purhepecha*, **gen. n., sp. n.**, from Municipio La Huacana, Michoacán, is described from eight adult specimens, four males and four females. It appears most closely related to *Serradigitus* Stahnke (tribe Stahnkeini Soleglad & Fet, 2006), sharing the serrated pedipalp finger dentition and the placement of trichobothria *ib-it* near the middle of the fixed finger. The characters that separate it from the four genera currently recognized in the tribe Stahnkeini are the presence of a retrobarbate mating plug in the spermatophore (smooth in other Stahnkeini), the presence of sensory pegs on the basal teeth of the pectines of females, and five distal spinules ventrally on telotarsus III (two on other Stahnkeini). Members of the tribe Syntropini Kraepelin, 1905 do not have serrated pedipalp finger dentition, and trichobothria *ib-it* are adjacent to the basal inner denticle.
Key words: Scorpiones, Vaejovidae, Syntropinae, Stahnkeini, rupicolous, Michoacán, Mexico.

Un nuevo género y especie de escorpión (Scorpiones: Vaejovidae) de Michoacán, Mexico
Resumen: Se describe *Kuarapu purhepecha,* **gen. n., sp. n.**, del Municipio La Huacana, Michoacán, a partir de ocho ejemplares adultos, cuatro machos y cuatro hembras. Está más cercanamente emparentado con *Serradigitus* Stahnke (tribu Stahnkeini Soleglad & Fet, 2006), compartiendo la dentición aserrada de los dedos de los pedipalpos y la posición de las tricobotrias *ib-it* en la región media del dedo fijo. Los caracteres que le hacen único dentro de dicha tribu son la presencia de un tapón postcopulatorio retrobarbado en el espermatóforo (liso en otros Stahnkeini), la presencia de papilas sensoriales en losdientes basales de los peines de las hembras y la presencia de cinco espínulas ventrodistales en el telotarso III (dos en otros Stahnkeini). Los géneros de la tribu Syntropini Kraepelin, 1905 tienen la dentición de los dedos granulosa (no aserrada) y las tricobotrias *ib-it* adyacentes al dentículo interno basal.
Palabras clave: Scorpiones, Vaejovidae, Syntropinae, Stahnkeini, rupícola, Michoacán, México.
Taxonomy / Taxonomía: *Kuarapu purhepecha,* **gen. n., sp. n.**

Taxonomy / Taxonomía: *Kuarapu purhepecha,* **gen. n. & sp. n.**

Introduction

We recently collected a new species of vaejovid scorpion in Municipio La Huacana, Michoacán. The specimens were collected at night using portable ultraviolet lamps, were found on rock faces along a road-cut, and were observed darting rapidly in and out of cracks. The adults are about 2-3 cm long, and examination in the field with a 20X magnifying lens revealed the granulation on the pedipalp chela fingers to be distinctly serrate, and fixed finger trichobothria *ib-it* located medially along the finger's length. These five characteristics -- size, rupicolous habits, darting behavior, finger serration and trichobothrial pattern -- led to a preliminary identification as a member of *Serradigitus* Stahnke, 1974. The 24 currently recognized species in that genus (Sissom, 2000) inhabit the greater North American Desert, ranging from Texas and Coahuila westward to California, Sonora and Baja California Sur. The distance from Cuatrocienegas, Coahuila, habitat of *Serradigitus calidus* (Soleglad, 1974) to La Huacana, Michoacán is approximately 900 km; and from Nacozari, Sonora, habitat of *Serradigitus agilis* Sissom and Stockwell, 1991, it is almost 1,400 km; from either direction the presence of the genus in Michoacán would have represented a significant geographical range extension for the genus. However, during the preparation of the description and the illustrations it became apparent that the new species did not belong to *Serradigitus* or any other described genus in the family. The objective of this contribution is to describe the new taxon.

The classification of the family Vaejovidae, the most diverse in North America, is problematical and controversial (e. g. Stahnke, 1974; Francke, 1977a; Sissom, 2000). A recent contribution by Soleglad and Fet (2008) recognized three subfamilies (diagnoses provided for only two of them) and four tribes, the monophyly of which has not been rigorously tested and several of which appear to be paraphyletic. Nonetheless, theirs is the most recently proposed classification of the family and we follow it for convenience even though the composition of several supraspecific taxa is questionable.

Materials and methods

Nomenclature and mensuration for the most part follow Stahnke (1970), with the following exceptions: metasomal carinal terminology after Francke (1977b), trichobothrial designations after Vachon (1974), chelal finger dentition terminology after Soleglad and Sissom (2001), and designations for the pedipalp femur and patella carinae after Acosta *et al*. (2008). Observations, drawings and photographs were made on a Nikon SMZ 800 microscope with a camera lucida and a Nikon Coolpix S-10 camera; photographs were

edited with Adobe Photoshop© ver. 7. Specimens are deposited at the Colección Nacional de Arácnidos (CNAN), Instituto de Biología, Universidad Nacional Autónoma de México (IBUNAM), and at the American Museum of Natural History (AMNH), New York. One specimen was preserved in 96% ethanol and refrigerated for future molecular analysis, stored at the Ambrose Monell Cryo Collection, at AMNH (MCC).

The hemispermatophore was dissected following Vachon (1952), and cleared with pancreatin (Álvarez-Padilla and Hormiga, 2007 (2008)).

Descriptions

Kuarapu, new genus

TYPE SPECIES. *Kuarapu purhepecha*, **new species**.

DIAGNOSIS. Orthobothriotaxic, Type "C"; chela trichobothria *ib-it* located medially along fixed finger length; female genital opercula with complete, median longitudinal membranous connection; basal pectinal tooth on females unmodified, with peg sensilla; aculeus with laterobasal serrations; pedipalp finger dentition clearly serrated, terminating in a sharp hook-like denticle bearing a distal white cap; telotarsus III ventrally with five distal, elongate spinules; hemimating plug of spermatophore with distal margin distinctly barbed (=retrobarbate). Cheliceral movable finger with five teeth (two subdistal) on dorsal margin; smooth ventrally, with prominent serrula. Telson lacks a spinoid subaculear tubercle.

Appears most similar to *Serradigitus* on account of the serrated pedipalp finger dentition and the distal denticle elongated and hook-like, fused female genital opercula, and position of trichobothria *ib-it* near the middle of the fixed finger; however, in *Serradigitus* the distal margin of the hemi-mating plug is smooth rather than barbed, telotarsus III ventrally has two distal spinules rather than five, and on females the basal pectinal teeth (one or two on each side) lack peg sensilla and are usually modified in shape. Differs from *Stahnkeus* Soleglad and Fet, 2006, in that it has a smooth distal margin on the hemi-mating plug, it has only one pair of ventral distal spinules on the telotarsi, and females have 1-4 basal pectinal teeth modified and without peg sensillae. Differs from *Gertschius* Graham and Soleglad, 2007 in that the pedipalp finger dentition is not serrated and the distal denticle is not enlarged and hook-like, and the distal margin of the hemi-mating plug is smooth [at least on *Gertschius agilis* (Sissom and Stockwell, 1991) *q. v.*]. Differs from *Wernerius* Soleglad and Fet, 2008 in that it has a conspicuous subaculear spinoid tooth, the pedipalp chela fingers are not serrated and the distal denticle is not elongated and hook-like, the distal margin of the hemi-mating plug is smooth, and trichobothria *ib-it* are located basally on the fixed finger. Finally, it differs from other vaejovids that have a retrobarbate mating plug in that those taxa have trichobothria *ib-it* more basal, and the pedipalp finger dentition is not serrated.

ETYMOLOGY. "Kuarapu" is used as a noun in apposition, and it means "scorpion" in the language of the Tarascan Indians that inhabit the state of Michoacan. It is masculine in gender.

Map 1. Distribution of *Kuarapu purhepecha,* **sp. nov.,** in Michoacan (circle), and its geographically nearest relatives: *Serradigitus agilis* in Sonora (triangle) and *Serradigitus calidus* in Coahuila (star).

Kuarapu purhepecha, new species

Fig. 1-27.

TAXONOMIC SUMMARY.

TYPE DATA. Holotype ♂ (CNAN T-0411) from MEXICO: Michoacán State, Municipio La Huacana, "El Vado", km 17 road from Zicuarán to Churumuco [N 18.8142° - W 101.91593°], 248 m, 30 July 2008, O. Francke, H. Montaño, J. Ponce, A. Quijano. Paratypes: 3♂♂, 3♀♀, [of these, 2♂♂ + 2♀♀ deposited at IBUNAM (CNAN T 0412); and 1♂ + 1♀ deposited at AMNH], same data as holotype; 1♀ [IBUNAM (CNAN T-0413)], same locality, 20 May 2007, O. Francke, J. Ballesteros, J. Ponce, A. Quijano, M. Villaseñor.

ETYMOLOGY. The specific name is a noun in apposition, and it is the term used by Tarascan Indians to refer to their own kind. *Kuarapu purhepecha* is indeed a Tarascan scorpion.

DISTRIBUTION. Only known from the type locality (map 1).

DIAGNOSIS. Adult males 19-21 mm long, adult females 25-27 mm. Pedipalp chela movable finger with seven inner denticles (ID) and four enlarged median denticles (MD), resulting in five denticle subrows; fixed finger with six inner denticles (ID) and four enlarged median denticles (MD) resulting in five denticle subrows. Pectinal tooth count 17-18 (mode=18) on males, 16-17 (mode=16) on females. Hemispermatophore mating plug with distal margin barbed, with 11 teeth. Metasomal segments I-IV with ventrolateral carinae strong, serrated; ventral submedian keels moderately strong, smooth to feebly serrate.

DESCRIPTION OF HOLOTYPE.

Color: light brown, with variegated fuscosity throughout, except opisthosoma ventrally (Figs. 1-4).

Carapace: Longer than wide (Fig. 5), shagreened to minutely, densely granulose; anterior margin straight, with six setae; median eyes on anterior 35%; three pairs of lateral ocelli, subequal in size with middle one slightly larger.

Sternum: Pentagonal, with three pairs of setae.

Tergites: Moderately granulose, granulation increasing in size and density along posterior margins; without median

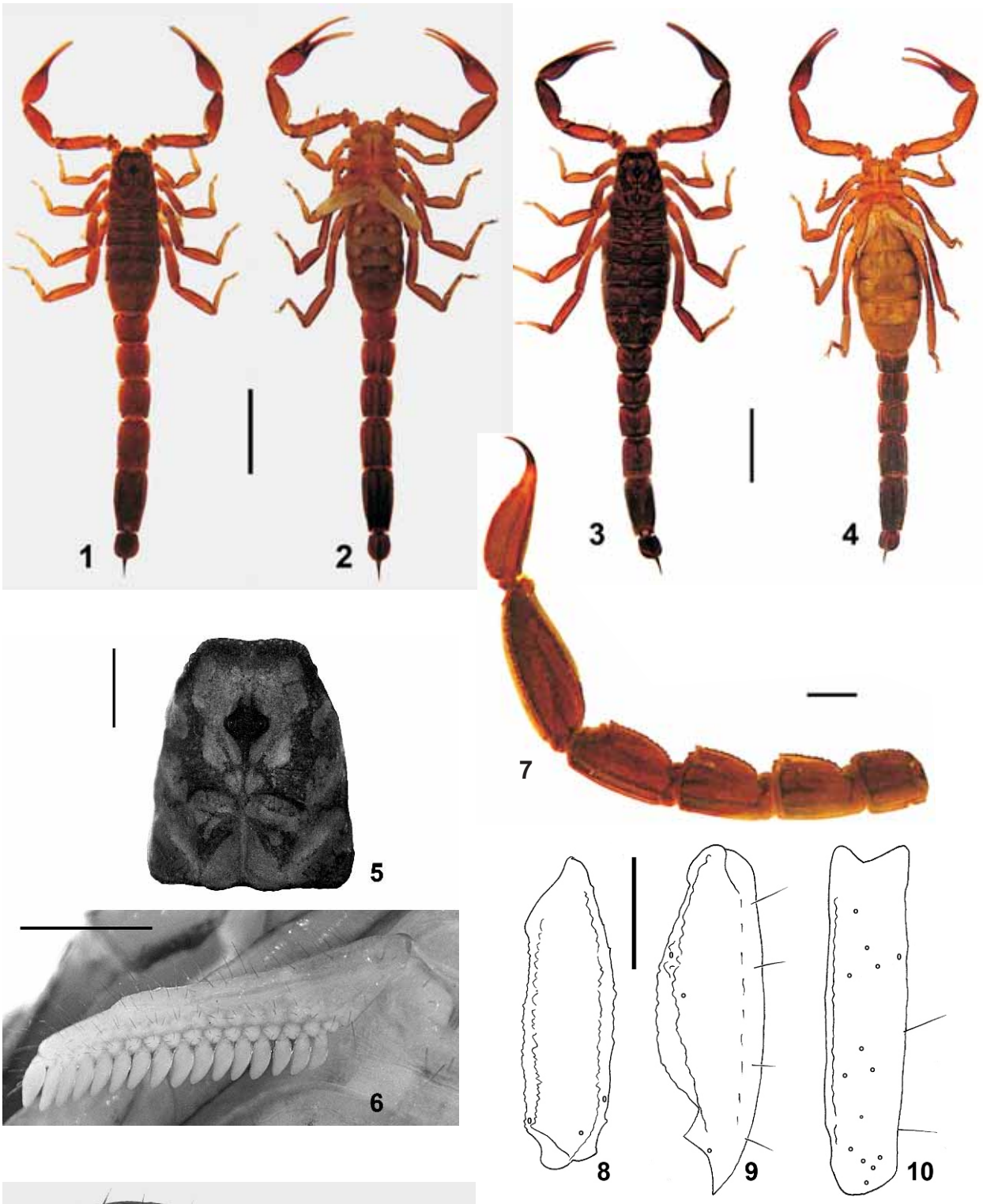

Fig. 1-12. *Kuarapu purhepecha,* **sp. nov. 1-2.** Habitus. Holotype male: **1**. Dorsal; **2**. Ventral. **3-4.** Habitus of paratype female: **3**. Dorsal: **4**. Ventral. **5-6.** Morphology: **5**. Carapace of holotype male, showing straight anterior margin and forward position of median ocelli; **6**. Right pectine of adult paratype female showing uniformity of basal tooth with other teeth. **7.** Lateral aspect of metasoma of holotype male. **8-10.** Morphology of holotype male showing primarily the trichobothrial patterns: **8**. Dorsal aspect of right pedipalp femur; **9**. Dorsal aspect of right pedipalp patella; **10**. Posterior aspect of right pedipalp patella. Scale: fig. 1-4 = 5 mm; fig. 6-10 = 1 mm.

longitudinal carinae. Tergite VII with four, moderately strong, serrated keels.
Genital opercula: Completely separated longitudinally; with three setae each; genital papillae present.
Pectines: 17-18 teeth; all teeth subequal in size; basal tooth with sensilla (Fig. 6).
Sternites: III-VI smooth, shiny; stigmata elongate; V with posteromedian whitish triangle. VII without submedian carinae; lateral carinae weak, serrated.
Metasoma: Dorsolateral carinae on I-IV strong, serrate to serrate-crenulate, distally terminating on an enlarged denticle (Fig. 7); setation 0:1:1:2. Lateral supramedian carinae on I-IV moderately strong, serrate; setation 0:1:1:2. Lateral inframedian carinae on I complete, moderate, serrate; on II present on distal one-half, weak to moderate, serrate; on III present on distal one-third, weak, serrate; on IV absent; setation 1:0:0-1:0. Ventrolateral keels on I-IV strong, serrate; setation 2:2:2:3. Ventral submedian keels on I-IV moderately strong, smooth to feebly serrate; setation 3:3:3:3. Segment V: Dorsolateral carinae moderately strong, serrate-granulose, with four setae each; lateromedian keels present on basal one-half, from moderately strong basally tapering backwards, feebly serrate, three setae on each side; ventrolateral keels strong, serrate, with five setae each; ventromedian keel strong, serrate, without setae on the keel and with five pairs submedially (including one pair on anal arc).
Telson: Vesicle smooth to vestigially granulose. Aculeus moderately curved, with 6-7 laterobasal serrations; with very small subaculear granule.
Chelicera: Manus infuscate, ventrally pilose. Fixed finger with four teeth, basal-most pair forming a bicusp. Serrula with 15-16 tines.
Pedipalp femur: Orthobothriotaxic, Type "C" (Fig. 8). Prodorsal keel moderately strong, serrate-granulose; retrodorsal keel weak to moderate, weakly granulose; proventral keel moderate, granulose; retroventral keel weak to moderate, feebly granulose; prolateral face coarsely granulose; dorsal, retrolateral and ventral faces smooth.
Pedipalp patella: Orthobothriotaxic, Type "C" (Figs. 9, 10). Prodorsal keel moderately strong, smooth to feebly granulose; median prolateral keel complete, moderately strong, granulose; retrodorsal keel weak to vestigial, smooth; proventral keel weak, granulose; retroventral keel weak, granulose.
Pedipalp chela: Orthobothriotaxic, Type "C" (Figs. 13-15); without keels (Figs. 11-12). Finger dentition clearly serrate in lateral view; denticle arrangement as in Figs. 16-17.
Legs: Telotarsus III ventrally with five distal, elongate spinules (Fig. 18).
Hemispermatophore: Length 3.6 mm. Lamellar hooks distal to capsule (Figs. 19-22); capsular region with one convoluted lobe or sac (Figs. 23-25). Hemi-mating plug (Fig. 26) not attached by chitin, but probably only by a thin membrane (which was digested by the pancreatin treatment); distal margin clearly barbed, with 11 teeth (Fig. 27).
Measurements. Table I.

Remarks

Variability. Sexual dimorphism: Females are larger than males (Table I), slightly darker, with slightly fewer pectinal teeth (see below) and more setose (see below). Basal-most pectinal tooth in both sexes same size as others, with peg sensilla. The genital opercula on males are completely separated longitudinally and open independently, whereas on females they have a complete median longitudinal membranous connection and they open as a unit; females lack genital papillae. Setation on females as follows (modal counts): dorsolaterals 1:2:3:3, rather than 0:1:1:2 as on males; ventrolaterals 2:3:3:4, rather than 2:2:2:3 as on males; ventrosubmedians 3:4:4:5, rather than 3:3:3:3 as on males. Segment V dorsolaterals with 7-8 setae, rather than 4 as on males; ventrolaterals with 10-13 setae, rather than five as on males.
Males: pectinal tooth counts varied as follows: one comb with 17 teeth, seven combs with 18 teeth. Setal count variation among paratype males as follows: dorsolateral II one specimen with 0-1, rather than 1-1; ventrolateral III one specimen with 2-3, rather than 2-2.
Females: pectinal tooth counts varied as follows: five combs with 16 teeth, three combs with 17 teeth. Setal count variation among females: one specimen with 3-4 setae on dorsolaterals IV; one specimen with 2-3 on ventrolaterals I.

Phylogenetic relationships. Using Hennigian argumentation we demonstrate the uniqueness of *Kuarapu* inside the family Vaejovidae, as follows: First, the position of trichobothria *ib-it* on the middle of the fixed finger is unique to among Vaejovidae to *Kuarapu, Stahnkeus* and *Serradigitus* (including subfamilies Smeringurinae and Vaejovidae, and the tribe Syntropini of the subfamily Syntropinae of Soleglad and Fet, 2008; and the genera *Gertschius* and *Wernerius* in the tribe Stahnkeini); Uroctoninae of Soleglad and Fet (2004) (*i. e. Uroctonus* Thorell, 1876 and *Anuroctonus* Pocock, 1893; long considered in Vaejovidae by most other authors), and numerous chactids (*i. e.* external group; such as *Chactas* Gervais, 1844, and *Teuthraustes* Simon, 1878). Therefore, we consider the basal position of trichobothria *ib-it* as plesiomorphic, and the mid-finger position as observed in *Kuarapu, Stahnkeus* and *Serradigitus* to be derived, *i. e.* a synapomorphy.

Second, the serrated condition of the pedipalp chela fingers with a hook-like termination likewise is also unique to *Kuarapu, Stahnkeus* and *Serradigitus*; and all other suprageneric taxa and out-groups mentioned above have rounded, blunt denticles. Therefore, we also consider serrated dentition as a synapomorphy between the new genus and *Stahnkeus* + *Serradigitus*.

Third, the possession of a retrobarbate mating plug in the spermatophore in *Kuarapu* is unknown among Stahnkeini, and previously has only been reported for the tribe Syntropini, and for the genus *Paravaejovis* Williams, 1980 [included in Smeringurinae by Soleglad and Fet (2008)]; other vaejovids (and chactids) either lack a sclerotized mating plug or if they do have a sclerotized mating plug then the distal end is not retrobarbate. Thus, the retrobarbate character state has apparently evolved more than once among vaejovids—Syntropini, *Paravaejovis,* and *Kuarapu*), and is here considered an autapomorphy for *Kuarapu* among Stahnkeini.

Fourth, the presence of five distal spinules ventrally on the telotarsus of leg III on *Kuarapu* is also unique within Stahnkeini, which possess only two spinules. Although the multi-spinuled (>2) condition is also known in some taxa of Vaejovinae and Syntropini (of Syntropinae) [some with up to nine spinules], this "homoplastic" character state has apparently evolved independently several times among vaejovids as well. However, the multi-spinuled condition in *Kuarapu* is considered an autapomorphy within Stahnkeini.

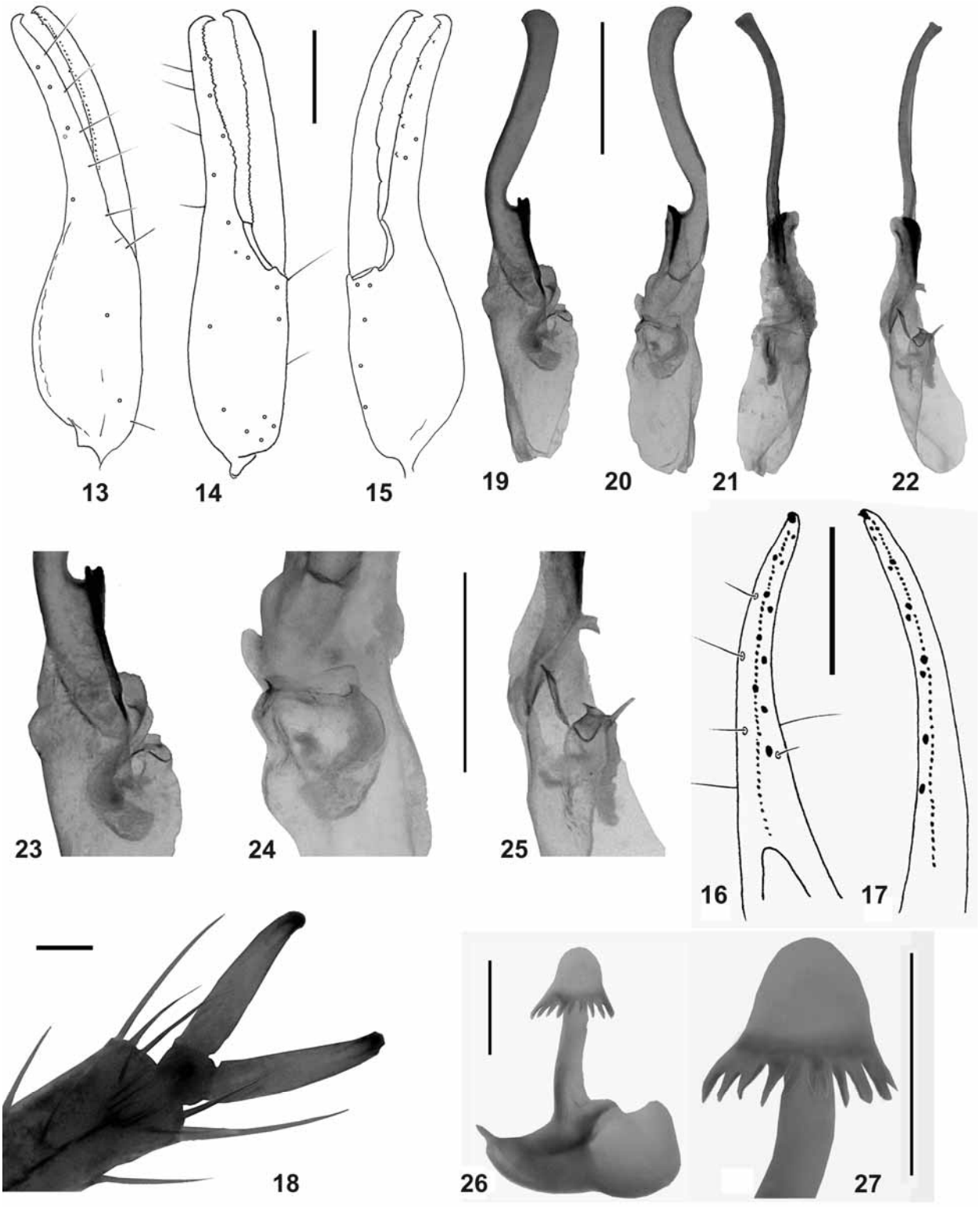

Fig. 11-27. *Kuarapu purhepecha,* **sp. nov.**: **11-12.** Right pedipalp chela of holotype male showing characteristic serrated finger dentition: **11**. Dorsal aspect; **12.** External aspect. **13-15.** Right pedipalp chela of holotype male showing trichobothrial pattern: **13**. Dorsoexternal aspect (stippled circle represents trichobothrium found on inner aspect of finger); **14**. External aspect; **15**. Ventrointernal aspect. **16-17.** Pedipalp finger dentition on holotype male: **16**. Right fixed finger; **17**. Right movable finger. **18.** Ventral aspect of right telotarsus III of holotype male of showing five distal spinules. **19-22.** Hemispermatophore dissected from a paratype male of **19**. Ectal aspect. **20**. Ental aspect. **21**. Ventral aspect; **22**. Dorsal aspect. **23-25.** Details of the capsular region in hemispermatophore from a paratype male: **23**. Dorsal aspect; **24**. Ental aspect; **25**. Ventral aspect. **26-27.** Hemi mating plug from the hemispermatophore from a paratype male: **26**. Complete view; **27**. Detail of barbed distal margin. Scale: figs. 11-17, 19-25 = 1 mm; figs. 18, 26-27 = 0.1 mm.

Table I. Measurements (in mm) of six specimens of *Kuarapu purhepecha*, new species
(L = length, W = width, D = depth) [figure in brackets indicates tip of the aculeus is broken off].

		Holotype male	Paratype male	Paratype male	Paratype female	Paratype female	Paratype female
Total	L	20.5	21.2	19.4	26.8	26.6	25.8
Carapace	L	3.2	3.2	3.0	4.2	4.0	3.9
	median W	2.5	2.5	2.5	3.0	2.9	2.9
Mesosoma	L	5.8	6.5	5.6	9.4	9.5	9.1
Metasoma	L	11.5	11.5	10.8	13.2	13.1	12.8
I	L	1.6	1.5	1.5	1.6	1.8	1.7
	W	1.9	1.7	1.7	2.4	2.3	2.3
II	L	1.8	1.8	1.7	2.1	2.0	2.0
	W	1.8	1.7	1.6	2.3	2.2	2.2
III	L	2.0	2.0	1.9	2.4	2.3	2.2
	W	1.7	1.6	1.6	2.2	2.1	2.1
IV	L	2.5	2.6	2.4	2.9	2.9	2.9
	W	1.6	1.6	1.5	2.2	2.1	2.1
V	L	3.6	3.6	3.3	4.2	4.1	4.0
	W	1.6	1.6	1.5	2.1	2.0	2.0
Telson	L	3.2	3.1	[2.9]	3.9	3.8	3.8
	W	1.2	1.2	1.1	1.6	1.5	1.5
	D	0.9	0.9	0.8	1.2	1.1	1.1
Pedipalp	L	10.8	10.8	10.1	13.8	13.1	13.1
Femur	L	2.8	2.8	2.7	3.7	3.4	3.4
	W	0.8	0.8	0.8	1.1	1.1	1.0
	D	0.5	0.5	0.5	0.7	0.7	0.7
Patella	L	3.2	3.1	3.0	4.1	4.0	4.0
	W	1.0	1.0	0.9	1.3	1.3	1.3
	D	0.7	0.7	0.7	1.0	1.0	1.0
Chela	L	4.8	4.9	4.4	6.0	5.7	5.7
	W	1.2	1.1	1.1	1.3	1.3	1.3
	D	1.0	1.1	1.0	1.2	1.1	1.1
Movable finger	L	2.9	3.0	2.6	3.8	3.7	3.6
Fixed finger	L	2.3	2.5	2.1	3.0	2.9	2.9
Pectinal teeth	Right/left	17-18	18-18	18-18	16-16	16-17	17-17

Therefore, two putative synapomorphies support the inclusion of the new genus within Stahnkeini: (1) serrated pedipalp finger dentition, and (2) position of trichobothria *ib-it* near the middle of the fixed finger. Two autapomorphies within Stahnkeini provide strong argumentation for the erection of *Kuarapu* as a new genus: (1) retrobarbate mating plug of the spermatophore, and (2) the number of distal spinules ventrally on telotarsus III.

Finally, it could be argued that *Kuarapu* actually belongs in Syntropini on account of (1) the retro-barbate mating plug of the spermatophore and (2) the multi-spinuled condition on telotarsus III; in this case however, the autapomorphies supporting the validity of *Kuarapu* as a new genus within that clade would be (1) the serrated dentition on the pedipalp fingers, and (2) the mid-finger position of trichobothria *ib-it*. Under either argumentation scheme there are at least two autapomorphies to support the creation of a new genus. Furthermore, for those readers that have reservations about monotypic genera, we consider that the discovery of additional species belonging to the genus *Kuarapu* is only a matter of time, as the scorpion faunas of large areas of western Mexico remain poorly explored.

Discussion

The description of the new genus is important because it points out some of the limitations of the classification of the family Vaejovidae recently proposed by Soleglad and Fet (2008), and the urgent need for a thorough cladistic analysis to test the monophyly of the groupings proposed by those authors. They divided the subfamily Syntropinae into two tribes: Stahnkeini, with four genera, and Syntropini with two subtribes with two genera each. *Kuarapu* clearly belongs to the subfamily Syntropinae Kraepelin, 1905, based on the following characters: (1) Spermatophore lamelliform, lamellar hook well developed with a conspicuous basal constriction and distally bifurcated; mating plug well developed and sclerotized, distal margin barbed. (2) Female genital opercula with complete, median longitudinal membranous connection. (3) Chelal trichobothrium *Dt* positioned distal of palm midpoint. (4) Trichobothria *ib-it* located submedially along fixed finger rather than basally. (5) Finger trichobothrium *dsb* distal to *esb*. (6) Finger trichobothrium *dst* distal to *est*. It shares with the tribe Stahnkeini Soleglad and Fet, 2006 (and which exclude it from the tribe Syntropini Kraepelin, 1905), the following characters: (1) Pedipalp finger dentition distinctly serrated, with five subrows of denticles on both the fixed and movable fingers. (2) Pedipalp chela fingers end in an enlarged, hook-like tooth with a distal white cap. (3) Patellar trichobothrium v_3 distal to et_3. *Kuarapu* shares with Syntropini (and which exclude it from Stahnkeini), the following characters: (1) Moderate serrula on the cheliceral movable finger, with less than 21 tines; (2) Distal margin of the mating plug of the male spermatophore barbed; (3) Basal pectinal tooth on females not modified and bearing peg sensilla; and (4) multi-spinuled telotarsus III.

The problem in fitting the new genus into the most recently proposed classification is that the character states used by Soleglad and Fet (2008) are not polarized, and thus under their scheme it is not possible to discern if *Kuarapu*

shares plesiomorphies (phylogenetically uninformative) or apomorphies with either tribe; or if we are dealing with extensive homoplasy, in which case one or more of the characters they use are phylogenetically less informative. The correct placement of *Kuarapu* within Syntropinae, as well as the validity of the genera proposed in Stahnkeini by Soleglad and Fet (2006, 2008) and Graham and Soleglad (2007) will be determined when the cladistic analyses by González *et al*. (2007) are completed.

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