

## A NEW SPECIES OF *PSEUDOCHACTAS* FROM AFGHANISTAN (SCORPIONES: PSEUDOCHACTIDAE)

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**Abstract:** A new species of the rare genus *Pseudochactas* Gromov, 1998 is described from south-central Afghanistan. The species, *P. mischi*, **sp. nov.**, is compared in detail to its northern sister species *P. ovchinnikovi* Gromov, 1998, known from Uzbekistan and Tajikistan. *P. mischi*, **sp. nov.** is a smaller, lighter colored species and has a considerably more robust metasoma, telson, and pedipalp chelae. Biogeographical observations on the genus *Pseudochactas* are provided.

**Key words:** Scorpiones, Pseudochactidae, *Pseudochactas mischi*, **sp. nov.**, Afghanistan.

**Una especie nueva de *Pseudochactas* de Afganistán (Scorpiones: Pseudochactidae)**

**Resumen:** Se describe una especie nueva del escaso género *Pseudochactas* Gromov, 1998 sobre material de Afganistán centro-meridional. La especie, *P. mischi*, **sp. nov.**, se compara en detalle con su especie hermana septentrional, *P. ovchinnikovi* Gromov, 1998, conocida de Uzbekistán y Tayikistán. *P. mischi*, **sp. nov.** es más pequeña y de color más pálido, y tiene el metasoma, el telson y las quelas pedipalpaes considerablemente más robustos. Se incluyen comentarios biogeográficos sobre el género *Pseudochactas*.

**Palabras clave:** Scorpiones, Pseudochactidae, *Pseudochactas mischi*, **sp. nov.**, Afganistán.

**Taxonomy / Taxonomía:** *Pseudochactas mischi* **sp. nov.**

### Introduction

From a phylogenetic perspective, the discovery of *Pseudochactas ovchinnikovi* Gromov, 1998 from Central Asia and a new family, Pseudochactidae, was undoubtedly one of the most important discoveries in scorpion systematics. It was readily apparent from its original description (Gromov, 1998) that this species exhibited several structural oddities that most likely were quite ancestral in Recent scorpions. Most noteworthy, the trichobothrial pattern was clearly new, not fitting into the three orthobothriotaxic patterns defined for Recent scorpions by Vachon (1974). This pattern (type D), which was first formally defined by Soleglad & Fet (2001: fig. 13) and modified by Prendini *et al.* (2006), proved to be basal in Recent scorpions; but see Prendini *et al.* (2006) for alternative hypotheses. The conclusion of Soleglad & Fet (2003b) was further supported when the trichobothrial pattern of the Cretaceous fossil scorpion *Archaeobuthus* was clarified (Baptista *et al.*, 2006: 8). Other unique characters, though plesiomorphic, also provided strong evidence for the basal position of *Pseudochactas*. The sternum, Type 1, was shown to be very plesiomorphic in structure exhibiting no horizontal compression, showing a strong resemblance to the sternum of the Carboniferous scorpion *Palaeopisthacanthus* (Soleglad & Fet, 2003a: 17–18). The ventral surface of metasomal segment V is armed with a pair of ventromedian carinae, unprecedented in Recent scorpions, though reported in the Carboniferous scorpion *Compsoscorprius* (Jeram, 1994; see Soleglad & Fet, 2003b: 9–10, for a detailed discussion).

Due to this fairly recent but isolated discovery of *Pseudochactas* in Central Asia, it is quite surprising that no

less than three more species in this family (Pseudochactidae) were discovered recently in Southeast Asia, almost 3000 miles from the type locality of *P. ovchinnikovi*! Lourenço (2007a, 2007b), described *Troglokhammouanus steineri* from Laos, and later, Lourenço & Pham (2010, 2012) described *Vietbocap canhi* and *V. thienduongsensis* from Vietnam. All three species were found in caves and considered troglomorphic or troglobitic. The *Vietbocap* species are truly troglobitic, exhibiting typical troglomorphy such as the loss of eyes and tibial spurs, reduction in granulation, elongation of segments, etc. With respect to significant taxonomic characters, however, these three species match *Pseudochactas* in all important characters such as trichobothrial patterns, sternum morphology, and cheliceral and chelal dentition, etc.

The discovery of *P. mischi*, **sp. nov.** in Afghanistan is not necessarily surprising, Prendini *et al.* (2006: 220) suggested that the range of *P. ovchinnikovi* may extend into Afghanistan. Of course, they were referring to the northern edge of Afghanistan, an area north of the immense Hindu Kush mountain range, which traverses the upper third of the country in a latitudinal direction. *P. mischi*, **sp. nov.**, however, is found considerably south of this range in south-central Afghanistan. The significant disjunction between these two species is discussed below.

The scorpiofauna of Afghanistan is quite insufficiently studied; the only existing faunistic review was published by Vachon (1958). The discovery of *Pseudochactas* in Afghanistan adds the third scorpion family for this country, Pseudochactidae (in addition to Buthidae and Euscorpidae).

## Material and Methods

### METHODS

#### Abbreviations

**List of depositories:** AG, Personal collection of A. Gromov, Almaty, Kazakhstan; GL, Personal collection of Graeme Lowe, Philadelphia, Pennsylvania, USA; FKCP, Personal collection of František Kovařík, Prague, Czech Republic; VF, Personal collection of Victor Fet, Huntington, West Virginia, USA.

#### Terminology and conventions

The systematics adhered to in this paper follows the classification as established in Fet & Soleglad (2005). Terminology describing pedipalp chelal finger dentition follows that described and illustrated in Soleglad & Sissom (2001), that of the sternum follows Soleglad & Fet (2003a), and the metasomal and pedipalp carination, and leg tarsus armature follows Soleglad & Fet (2003b). Trichobothrial nomenclature and hypothesized homologies are those described and illustrated in Soleglad & Fet (2001) and, in part, Prendini *et al.* (2006). Techniques using maximized morphometric ratios follow those described in Kovařík *et al.* (2010). Statistical data in this paper is presented as “minimum–maximum (mean) ( $\pm$ standard deviation) [number of samples]”.

### MATERIAL

*Pseudochactas ovchinnikovi* Gromov, 1998, Uzbekistan, Surkhandarya Province, Uzun District, E slope of Babatag Mt. Range, Okmachit [Akmechet], 2 ♂ paratypes (AG), 14 ♂, 8 ♀ (VF), 1 ♂ (GL); *Pseudochactas mischi* Soleglad, Kovařík et Fet, **sp. nov.**, 1 ♀ holotype (FKCP), Afghanistan, Uruzgan Province, Tarin Kowt District, village Bolakh, 1380 m (4300') asl, 32°32'N, 65°40'E (32.5364°N, 65.6667°E), November 2011, leg. Michael Misch.

### Systematics

Order **SCORPIONES** C. L. Koch, 1850

Suborder **Neoscorpiones** Thorell et Lindström, 1885

Infraorder **Orthosterni** Pocock, 1911

Parvorder **Pseudochactida** Soleglad et Fet, 2003

Superfamily **Pseudochactoidae** Gromov, 1998

Family **Pseudochactidae** Gromov, 1998

Genus *Pseudochactas* Gromov, 1998

*Pseudochactas mischi* Soleglad, Kovařík et Fet, **sp. nov.**

Fig. 1–19, Tables I–II

**HOLOTYPE:** ♀ (FKCP), AFGHANISTAN, Uruzgan Province, Tarin Kowt District, village Bolakh, 1380 m (4300') asl, 32°32'N, 65°40'E (32.5364°N, 65.6667°E), November 2011, leg. Michael Misch.

**DIAGNOSIS (BASED ON ADULT FEMALE HOLOTYPE):** Small species, 18 mm; clear yellow, essentially devoid of variegated patterns, chelal fingers reddish; pectinal teeth 9–10. Seven oblique median denticle (*MD*) groups on movable and fixed fingers of chelae; lateral and median eyes present; tibial spurs present on legs III–IV. Stocky in overall appearance, carapace wider than long, length to width ratio 0.94, metasomal segments I–III wider than long, segment V

length to width ratio 2.16; telson vesicle wide and granular, lateral rows of granules form distinct ridges at vesicle/aculeus juncture, length to width ratio 1.52; chelal fingers short, palm wide, movable and fixed finger lengths to palm width in ratios 1.54 and 1.11.

**DISTRIBUTION.** **Afghanistan** (south-central): Based on holotype female.

**ETYMOLOGY.** Named after Michael Misch who collected the holotype female and provided many of the photographs presented in this paper.

**FEMALE.** Description based on holotype female from Bolkh, Afghanistan. Measurements of the holotype are presented in Table I. See Figure 1 for a dorsal and ventral view of the female holotype.

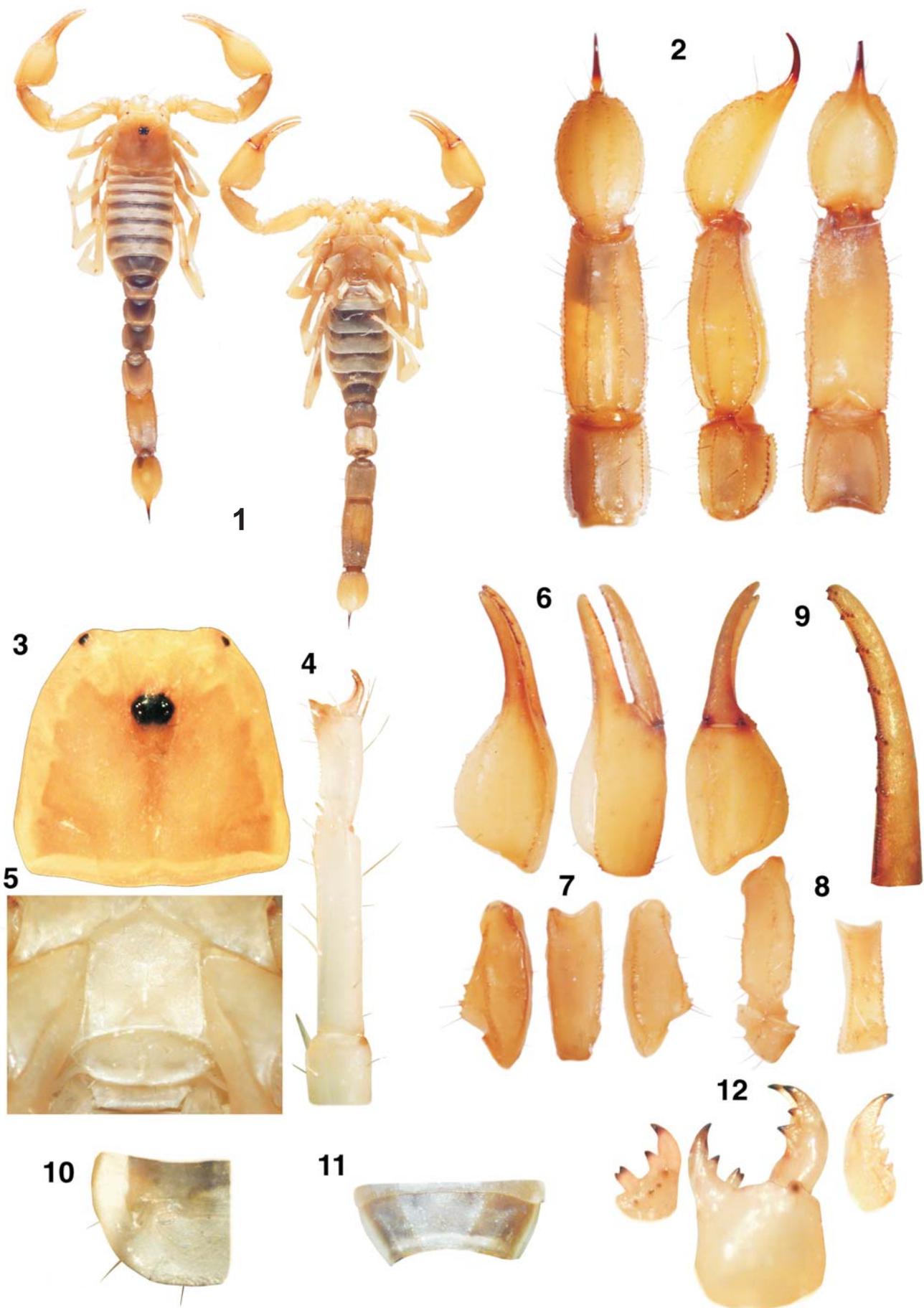
**Coloration.** The entire scorpion is pale yellowish-orange; dorsal surface, in particular the carapace, is devoid of patterns. The chelal fingers are darker in contrast to the palm, light reddish in color. Pectines, stigma, and the posterior edges of the sternites light yellow.

**Carapace** (Fig. 3). Somewhat square in appearance, slightly wider than long. Anterior edge essentially straight except for a wide shallow inset depression caused by the anterior edges of two subparallel sutures. The area between these lyre-shaped sutures, which taper posteriorly at the base of the median eyes, is essentially smooth with some traces of weak granulation anteriorly. The remainder of the carapace is rough in appearance lacking granulation. One lateral eye is present on each side. Median eyes are situated well beyond the midpoint with the following length and width ratios: 0.329 (anterior edge to median tubercle middle / carapace length) and 0.182 (width of median tubercle including eyes / width of carapace at that point).

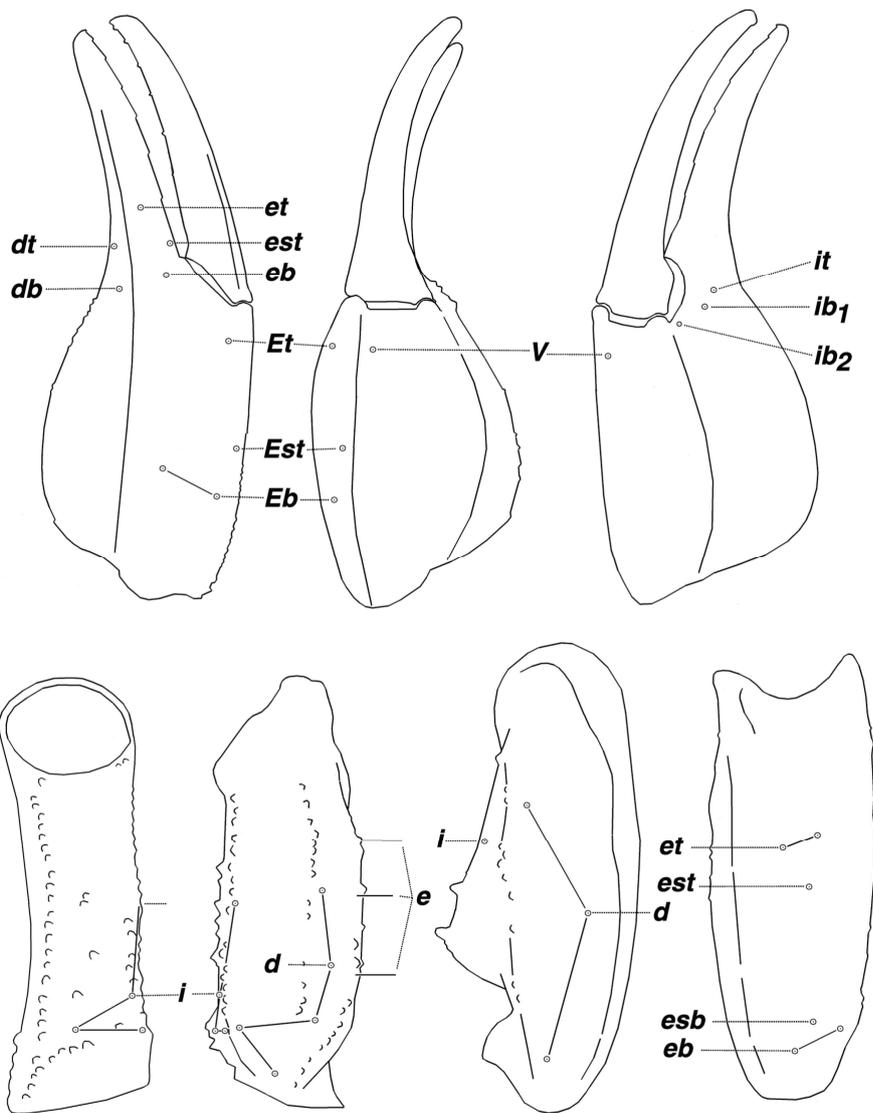
**Mesosoma** (Fig. 10–11). Tergites smooth, with two pairs of crenulated carinae on tergite VII. Sternites III–VII smooth, carinae absent on VII. Posterior edges with “whitish band”, extending 1/3 to 1/2 of segment, largest on segments V–VI. Stigmata small, subcircular in shape.

**Metasoma** (Fig. 2). Segments I–III are wider than long. Segments I–IV: dorsal and dorsolateral carinae crenulated; lateral carinae crenulated on I–II, one-half of III, and obsolete on IV; ventrolateral carinae crenulated on I–IV; ventromedian carinae smooth to obsolete on I, granulate to crenulated on II, and crenulated on III–IV. Segment V: dorsolateral carinae crenulated; lateral irregularly granulated on basal one-half; ventrolateral and ventromedian (paired) crenulated. Ventromedian carinae taper somewhat distally. Terminal spine on dorsal and dorsolateral carinae slightly elongated on segments I–IV; dorsolateral carinae terminus of IV rounded, terminating at condyle. Intercarinal areas essentially devoid of granulation. Anal arch with 20+ minute granules.

**Telson** (Fig. 2). Large somewhat globular vesicle with short curved aculeus; subaculear tubercle small, rounded and blunted with a pair of long setae. Vesicle surface traversed laterally with five pairs of granulated carinae: one pair originating basally from the vesicular tabs, two pairs found laterally, and two pairs situated ventrally, the first of terminating at the vesicle-aculeus juncture into conspicuous



**Fig. 1-12.** *Pseudochactas mischi*, **sp. nov.**, female holotype: **1.** dorsal and ventral views. **2.** Telson and metasomal segments IV-V, ventral, lateral and dorsal views. **3.** Carapace. **4.** Leg III (left) showing tibial spur. **5.** Sternum and genital operculum. **6.** Chela, dorsal, external and ventral views. **7.** Patella, dorsal, external and ventral views. **8.** Femur, dorsal and internal views. **9.** Chelal movable finger showing dentition. **10.** Stigma III (right). **11.** Tergite VII show two pairs of carinae. **12.** Chelicera.



**Fig. 13.** Trichobothrial pattern of *Pseudochactas mischi*, sp. nov., female holotype.

**Table I. Morphometrics (mm) of *Pseudochactas* species. *P. mischi*, sp. nov. (Bolakh, Afghanistan), *P. ovchinnikovi* (Babatag, Uzbekistan). D: depth; L: length; W: width**

	<i>P. mischi</i> sp. nov.		<i>P. ovchinnikovi</i>	
	♀ Holotype		♀	♀
Total L	18.03	27.32	29.97	
Carapace L	2.70	3.83	3.89	
Mesosoma L	4.64	7.88	10.04	
Metasoma L	7.56	11.18	11.35	
Segment I: L/W	0.97/1.51	1.40/1.94	1.40/1.94	
Segment II: L/W	1.13/1.40	1.67/1.62	1.73/1.67	
Segment III: L/W	1.19/1.35	1.84/1.62	1.84/1.62	
Segment IV: L/W	1.46/1.30	2.11/1.57	2.19/1.58	
Segment V: L/W	2.81/1.30	4.16/1.46	4.19/1.46	
Telson L	3.13	4.43	4.69	
Vesicle L	2.05	3.24	3.29	
W/D	1.35/1.11	1.89/1.62	1.84/1.58	
Aculeus L	1.08	1.19	1.40	
Pedipalp L	9.06	13.33	13.92	
Femur: L/W	2.32/0.76	3.45/1.08	3.62/1.19	
Patella: L/W	2.37/1.03	3.40/1.40	3.50/1.44	
Chela L	4.37	6.48	6.80	
Palm L	2.27	3.24	3.29	
W/D	1.51/1.57	2.05/2.32	2.05/2.27	
Fixed finger L	1.73	2.86	2.91	
Movable finger L	2.37	3.78	3.99	
Sternum: L/W	1.13/1.08	1.62/1.40	1.67/1.53	
Pectines Teeth	10-9	x-11	10-10	

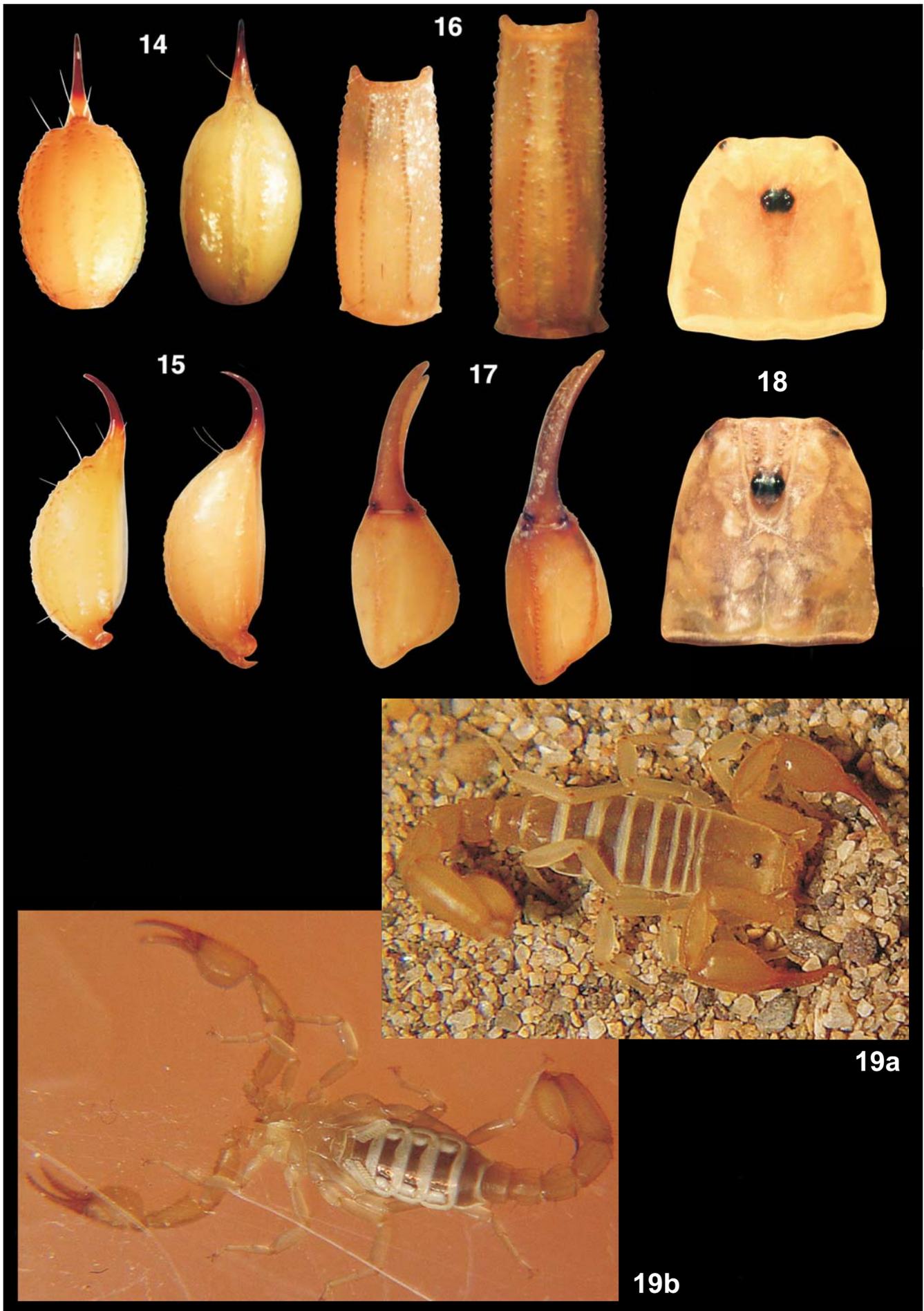
ridges, and the second pair terminating at the subaculear tubercle. Vesicular tabs equipped with two spines, small and medium in size.

**Pectines.** Well developed with three anterior lamellae, the basal considerably longer than sclerites 2 and 3. Distal anterior lamellae quite short, aligning with last two distal teeth. Middle lamellae well developed, nine (and eight) in number, aligned at the base of the first nine (and eight) teeth. Small fulcra present. Teeth number ten and nine. Sensorial areas present on all tooth edges. Basal piece elongated.

**Genital Operculum** (Fig. 5). Sclerites elongated laterally and connected for most of their length.

**Sternum** (Fig. 5). Type 1, large, quite flat in structure, slightly longer than wide, in ratio 1.046. Posterior depression wide and shallow.

**Chelicerae** (Fig. 12). Movable finger dorsal edge with only three denticles, distal denticle (*dd*), one subdistal (*sd*) denticle, and median (*m*) denticle, the basal (*b*) denticle is absent. Ventral edge with four well developed unpigmented rounded ventral accessory denticles (*va*) slanted slightly distally. Serrula is present on the distal third of the ventral edge. Distal denticles are not aligned, the ventral denticle



**Fig. 14-18.** Comparison of *Pseudochactas mischi*, **sp. nov.**, female holotype (left images), and *P. ovchinnikovi*, (right images), adult female. **14-15.** Telson, ventral and lateral views. **16.** Metasomal segment V, ventral view. **17.** Chela, ventral view. **18.** Carapace. **Fig. 19.** *Pseudochactas mischi*, **sp. nov.**, live female holotype, dorsal (**19a**) and ventral (**19b**) views. Photos courtesy of Michal Misch.

**Table II. Morphometric ratio comparisons (percentage of differences between means) of female *Pseudochactas ovchinnikovi* and *P. mischi*, sp. nov., based on respective dominant morphometrics.** This data illustrates the stockier (i.e., ratio values smaller) metasoma, telson, carapace, and chela found in *P. mischi*. Minimum, maximum, and mean values shown. \* both chela are considered in chelal morphometrics for *P. mischi*. A = adult, SA = subadult.

Morphometric Ratio		<i>P. ovchinnikovi</i> (n = 2)	<i>P. mischi</i> (n = 1, 2*)
Metasomal segment I (L/W)	A	0.72–0.72 (0.722)	(0.642) <i>P. mischi</i> < 12.3 %
Metasomal segment II (L/W)	A	1.03–1.04 (1.033)	(0.807) <i>P. mischi</i> < 28.0 %
Metasomal segment III (L/W)	A	1.14–1.14 (1.136)	(0.881) <i>P. mischi</i> < 28.9 %
Metasomal segment IV(L/W)	A	1.34–1.39 (1.365)	(1.123) <i>P. mischi</i> < 21.5 %
Metasomal segment V (L/W)	A	2.85–2.87 (2.860)	(2.162) <i>P. mischi</i> < 32.3 %
Vesicle length/Vesicle width	A	1.71–1.79 (1.751)	(1.519) <i>P. mischi</i> < 15.3 %
Carapace length/width	A	1.07–1.07 (1.069)	(0.939) <i>P. mischi</i> < 13.8 %
FF length / Metasomal segment V width	A	1.96–1.99 (1.976)	(1.331) <i>P. mischi</i> < 48.5 %
MF length/chela width	SA	1.90–2.24 (2.069)	<i>P. mischi</i> < 34.7 %
	A	1.84–1.95 (1.895)	1.50–1.57 (1.536) <i>P. mischi</i> < 23.3 %
FF length/chela width	SA	1.46–1.72 (1.591)	<i>P. mischi</i> < 43.4 %
	A	1.40–1.42 (1.407)	1.07–1.15 (1.109) <i>P. mischi</i> < 26.9 %

(*vd*) extends beyond its dorsal counterpart (*dd*). Fixed finger with four denticles, distal denticle (*dd*), subdistal denticle (*sd*), and the median (*m*) and basal (*b*) denticles forming an elongated bicuspid. Four flat slightly pigmented ventral accessory (*va*) denticles are found on the ventral edge. Thick growth of slender elongated setae present at the base of the outer edge of the fixed finger.

**Pedipalps** (Fig. 6–9, 13). Robust appendages, chelae palms enlarged with short fingers. Chelal fingers not scalloped or exhibiting finger lobes. Femur: Dorsointernal carina crenulated to serrated, ventrointernal and dorsoexternal carinae crenulated, and ventroexternal granulated. Dorsal surface with scattered granules basally, ventral smooth, internal with a line of six to seven serrated granules, and external surface with irregular line of granules. Patella: dorsointernal carina irregularly granulated, dorsoexternal irregularly smooth, and ventral carinae crenulated. Dorsal patellar spur carina (*DPS<sub>c</sub>*) and ventral patellar spur carina (*VPS<sub>c</sub>*) present but only represented by two granules. Dorsal and external surfaces smooth, ventral generally smooth except for rough basal aspect, internal surface protrudes conspicuously from the dorsointernal carina and is equipped with *DPS* and *VPS*, each represented by a small spine. Chela carinae: Chela complies with the “8-carinae configuration”, exhibiting six carinae. Digital (*DI*) carina strongly developed, granulated on basal one-sixth, smooth on remainder; dorsomarginal (*D4*) and dorsointernal (*D5*) rounded and granulated; ventroexternal carina (*V1*) strong and granulated on basal half; ventrointernal (*V3*) rounded, weakly granulated; internal (*I*) very weak with some granulation. Chelal finger dentition (Fig. 9): Median denticle (*MD*) row groups oblique and slightly imbricated, numbering 7/7 (left and right fingers) for both fixed and movable fingers; *MD* row terminates basally with an enlarged denticle. 6/6 internal (*ID*s) denticles on fixed finger and 7/7 *ID*s on movable finger; 6/6 outer (*OD*s) denticles on both fixed and movable fingers. No accessory denticles present. Trichobothrial patterns (Fig. 13): Type D, orthobothriotaxic.

**Legs** (Fig. 4). Both pedal spurs present, smooth, lacking spinelets; tibial spurs present on legs III–IV; unguicular spur (dactyl) well developed and pointed. Ventral aspect of tarsus with two rows of small spinules.

**Hemispermatothore.** Hemispermatothore is unknown for this species (the only known specimen is a female).

## Discussion

Diagnostic differences between the two species of *Pseudochactas* involve coloration, granulation, pectinal tooth counts, and morphometrics. We consider the significant morphometric differences presented below to be the most important characters that distinguish the two species. Also discussed is presence of cheliceral serrula since it often remains unreported in scorpions (see below).

**Coloration/granulation.** The contrast in coloration between *P. mischi*, sp. nov. and *P. ovchinnikovi* is quite striking: the entire dorsal surface of *P. mischi*, sp. nov. is essentially light yellow in color, no variegated patterns present, including the carapace. In contrast, the carapace, mesosoma, metasoma, telson, and pedipalps in *P. ovchinnikovi* are brown in color, and the carapace exhibits conspicuous darker variegated patterns (see Fig. 18). Both species do have contrasting chelal fingers, reddish in color. There are a few differences between the two species involving granulation: the dorsoexternal carina (*DEc*) of the patella is granulated in *P. ovchinnikovi* whereas it is smooth in *P. mischi*, sp. nov.; the lyre-shaped circumocular sutures on the carapace in *P. ovchinnikovi* contain two distinct linear rows of granules extending from the median eye tubercle to the anterior edge, whereas in *P. mischi*, sp. nov. these rows are irregular and rough to smooth distally. The telson vesicle in *P. mischi*, sp. nov. has conspicuous rows of granules traversing the ventral surface, two of which terminate at the vesicle-aculeus juncture into pointed ridges (see Fig. 14); the distinctness of these granule rows are less in *P. ovchinnikovi* and the ridges, if present, are quite reduced.

**Pectines.** We detected subtle pectinal tooth count differences between the two species; however, this is only based on the holotype female of *P. mischi*, sp. nov., which has 9–10 (9.500) ( $\pm 0.707$ ) [2] teeth. We examined 24 specimens of *P. ovchinnikovi*, eight females and 16 males. In these specimens we found 10–11 (10.533) ( $\pm 0.516$ ) [15] for females and 10–13 (11.692) ( $\pm 0.721$ ) [29] for males. Prendini *et al.* (2006: tab. 5), based on ten specimens (one male and nine females), reported 10–11 (10.667) ( $\pm 0.485$ ) [18] for females and 10–11 (10.500) ( $\pm 0.707$ ) [2] for males. Gromov (1998: 413) provided pectinal tooth data that was not always partitioned by gender, so we will not include it here, except to mention that in a series of juveniles he reports 9–13 pectinal teeth. We will assume here the lower range is a female and

the higher number is that of a male thus extending the ranges of the female by one tooth. The combined data based on our specimens and those of Prendini are 10–11 (10.606) ( $\pm 0.496$ ) [33] for females and 10–13 (11.581) ( $\pm 0.765$ ) [31] for males.

Prendini *et al.* (2006: 228) reported: "...Each pecten with two distinct marginal [= anterior] lamellae present in ♂ (Fig. 17), three in ♀ (Fig. 18) ...". This difference in the number of anterior lamellae between genders is quite unusual in scorpions. We checked our material and did not find a difference in anterior lamellae numbers, both genders having three, typical of Recent scorpions. After close inspection of the UV image of the male provided by Prendini *et al.* (2006: fig. 17) we can see subtle indications of the middle anterior lamella in the male where it meets with the third distal lamella.

**Morphometrics.** We analyzed *P. mischi*, **sp. nov.** morphometrics with two adult *P. ovchinnikovi* (see Tab. I) comparing all possible morphometric ratios (351 ratio comparisons). Based on dominant morphometrics across both species, we see that the metasoma segment width dominated in *P. mischi*, **sp. nov.** in all five segments, ranging from 22/4 (i.e., 22 ratios out of 26) to 26/0, as well as the chelal width, 21/5 (see Kovařík *et al.*, 2010, for a detailed description of this process). For *P. ovchinnikovi*, dominant morphometrics were fixed and movable finger lengths (26/0 and 25/1) and the telson vesicle length (24/2). This data alone suggests that the metasoma and telson are likely to be more stocky in *P. mischi*, **sp. nov.** and, with *P. ovchinnikovi*, the chela is likely to be more elongated based on the finger lengths. We tested these hypotheses by constructing ratios from these morphometrics that showed the greatest differences in their mean values and, which were also apparent when comparing the structures visually, thus constituting meaningful diagnostic characters. Table II shows these ratios involving the metasoma, telson, carapace, and the chela. Figures 14–18 illustrates these structures for both species where the morphometric differences are readily apparent by visual inspection. Incidentally, the largest ratio difference between these two species is the fixed finger length compared to the metasomal segment V width, exhibiting a 48.5 % mean value difference.

While conducting the morphometric analysis of this new species we considered the possibility that the holotype specimen may only be subadult, not an unreasonable consideration based on its small size. If this was the case, then the morphometric differences seen when compared to adult *P. ovchinnikovi* may be caused, in part, by the differences in ontogenetic development. Therefore we compared the chelal morphometrics of *P. mischi*, **sp. nov.** to that of two subadult female *P. ovchinnikovi* (see Table II). As was the case with adults, the movable and fixed finger lengths when compared to the palm width showed considerable differences, exhibiting 35 to 43 % differences in their means (both chelae of *P. mischi*, **sp. nov.** were used in these calculations). It is important to note that these differences exceeded the same comparisons when two adult *P. ovchinnikovi* were used, thus implying that the chela in *P. ovchinnikovi* becomes more robust in adult specimens. From this we can conclude that, if the *P. mischi*, **sp. nov.** holotype is indeed subadult, then its chelae would also become more robust at maturity, further exaggerating its differences with adult *P. ovchinni-*

*kovi* in these comparisons of the chelae. So in either case, adult or subadult, the morphometric differences are significant.

**Serrula.** Presence of serrula on the ventral edge of the movable finger of chelicerae is reported here for the new species *P. mischi*, **sp. nov.**, therefore, it is present in both known species of *Pseudochactas* Gromov. However, serrula was not originally reported for *P. ovchinnikovi* (Gromov, 1998). This important character was first mentioned and schematically illustrated in *P. ovchinnikovi* by Soleglad & Fet (2003b, fig. 49). Graham & Fet (2006) illustrated a broken serrula of *P. ovchinnikovi* with a SEM image (their fig. 1, magnification 200x), and explained how a serrula with broken teeth remains overlooked and unreported in many scorpion species without special attention and a high-resolution microscopy. Serrula was not reported by Prendini *et al.* (2006) in their otherwise comprehensive morphological analysis of *P. ovchinnikovi*. However, under a high magnification, their fig. 15 (right image) reveals presence of a "ridge of stubs", clearly a heavily broken serrula. Serrula also is present in two other pseudochactid genera, *Troglokhammouanus* and *Vietbocap* (Lourenço & Pham, 2012; Lourenço, pers. comm. to V.F., March 2012).

## Biogeography

With the discovery of the second species of *Pseudochactas*, the range of this genus expands considerably to the south. A clearly relict, undeniably basal scorpion family, Pseudochactidae remains endemic to Asia but exhibits spectacular range disjunctions. Lourenço (2007a) considered a possible connection between the distribution of pseudochactids of Central Asia and Indochina via the geological "old Asian core" (as opposed to Southeast Asian plate that has Gondwanan origin, and joined Asia in Triassic). This observation agrees with earlier suggestions of Soleglad & Fet (2003b) and Fet *et al.* (2004) on a Pangaeon (Permian to Triassic) origin of Pseudochactidae, which follow from its alleged basal position in scorpion phylogeny. Of course, it is not known when and how ancestral pseudochactids dispersed and how their range was fragmented. We must add, however, that all three genera of this family are essentially very uniform, save typical troglomorphisms of two cave-adapted *Vietbocap* species derived independently in several families of scorpions (cf. Fet *et al.*, 2011).

The two species of *Pseudochactas* are distinctly allopatric, separated by high mountains of Afghanistan (see map in Figure 21). *P. ovchinnikovi* (Gromov, 1998; Fet *et al.* 2004) is known from two nearby localities from Babatag Mts of Uzbekistan (Okmachit) and Tajik Depression in Tajikistan (Ganjina), both in low mountain ranges north of the Afghanistan border, in the watershed of Amu Darya River. Further south lies the majestic Hindu Kush, including its southwestern extension, the Koh-i-Baba (or Baba) mountain range, which rises to 2000–3000 m asl, and reaches in its highest peak almost 5000 m (Amin & Shilz, 1976). The locality of *P. mischi*, **sp. nov.** in southern Uruzgan Province (Tarin Kowt District) lies in the southern slopes of Koh-i-Baba, south of the Petawey Ghar range, in the mountainous watershed of Tarin River (a tributary of Hilmand River), ca. 100 km N of Kandahar. The locality, Sarab Kariz Wadi, lies about 1.5 km N of the Bolakh River, a tributary of Tarin.

In his classical treatise on Central Asian zoogeography, Kryzhanovsky (1965, fig. 24) provided one of the first schemes of zoogeographic division for Afghanistan, based on the data from several major insect groups. The scheme of Kryzhanovsky (1965, 1983) shows the mountainous Afghanistan-Turkestan Superprovince as the major barrier separating, in our case, two species of *Pseudochactas*. The range of the northern species *P. ovchinnikovi* is adjacent to the Turanian Desert Province, while the locality of the southern *P. mischi*, **sp. nov.** lies close to the Central Iranian Desert Province. Neronov & Arsenyeva (1980) presented a similar scheme based on their quantitative analysis of rodent fauna. They show a boundary between two high-rank zoogeographical units, the Saharo-Gobian Desert Region and the Central Asian Mountain Region; this boundary runs through Afghanistan, demarcating its Central Highlands from the west.

Another interesting zoogeographical scheme based on distribution of Orthoptera was published by Sergeev (2005), where a Turkmeno-Iranian Province with mixed (desert and mountainous) fauna stretches from the Caspian Sea to Indus and separates two major desert provinces, Turanian and Iranian. Within this scheme, genus *Pseudochactas* could be seen as an endemic of the Turkmeno-Iranian Province. In all these schemes, the disjunct range of *Pseudochactas* appears at the opposite fringes of the zoogeographically complex mountainous area that faces two major desert areas, northern and southern. This allopatry likely reflects a combination of geological and climatic events in the area since the Mesozoic. Fet *et al.* (2004) suggested that *Pseudochactas ovchinnikovi* could be a relict that survived extensive restructuring of ecosystems in the end of Cretaceous on the islands of Tethys. Since the end of Triassic, the uplift of Hindu Kush has divided the region into a North Afghan epicontinental sea and a Central Afghan sea, which were connected by Tethys channels until the Upper Cretaceous (Amin & Shilz, 1976). Further Oligocene to Miocene uplift as well as Cenozoic aridization and climatic fluctuations provided ample opportunities for ecological isolation of relict littoral taxa. Therefore, the distribution of both *Pseudochactas* species is consistent with them being remnants of widespread littoral fauna of the receded Tethys Ocean, captured in low mountains by Tertiary uplift; this hypothesis can be tested with molecular dating techniques. Many important floral elements of littoral origin are found in low mountains of Uzbekistan and Tajikistan (Kryzhanovsky, 1965; Kamelin, 1979).

## Ecology

The collector of the only known specimen of *P. mischi*, **sp. nov.**, Michael Misch, reports that it was found under a stone in semi-wet soil on the eastern bank of a dry river bed (wadi) named Sarab Kariz, running from north to south. The locality is depicted in Fig. 20. It was still quite warm there

in November 2011 (up to 30 °C at daytime, 14–15 °C at night). Humid conditions of this microhabitat are noteworthy since Fet *et al.* (2004) observed that *P. ovchinnikovi* in the Babatag Mts. also exhibited an (unusual for Central Asian scorpions) affinity to wet microhabitats (Fet *et al.*, 2004: figs. 6–8; Prendini *et al.*, 2006: figs. 4–7). It was found actively foraging at night on wet mud along a small temporary stream (bottom of Dukhone, or Dikhana, Canyon). Therefore, neither species of *Pseudochactas* appears to favor arid conditions, in contrast to the common Central Asian scorpions of family Buthidae. This ecological preference could be interpreted as ancestral, given the recent discovery of pseudochactids in the tropics of Southeast Asia, genera *Troglokhammouanus* and *Vietbocap*.

The new species has been collected at 1380 m above sea level, which is so far the highest altitude for any known species of Pseudochactidae. *P. ovchinnikovi* was collected in Uzbekistan between 722–1010 m asl (Prendini *et al.*, 2006) and in Tajikistan (Gandzhina) at 752 m asl (online map data, previously not reported). All three species of Southeast Asian pseudochactids are found in the lowland caves (entrances ca. 200 m asl) (Lourenço, 2007a; Lourenço & Pham, 2010, 2012).

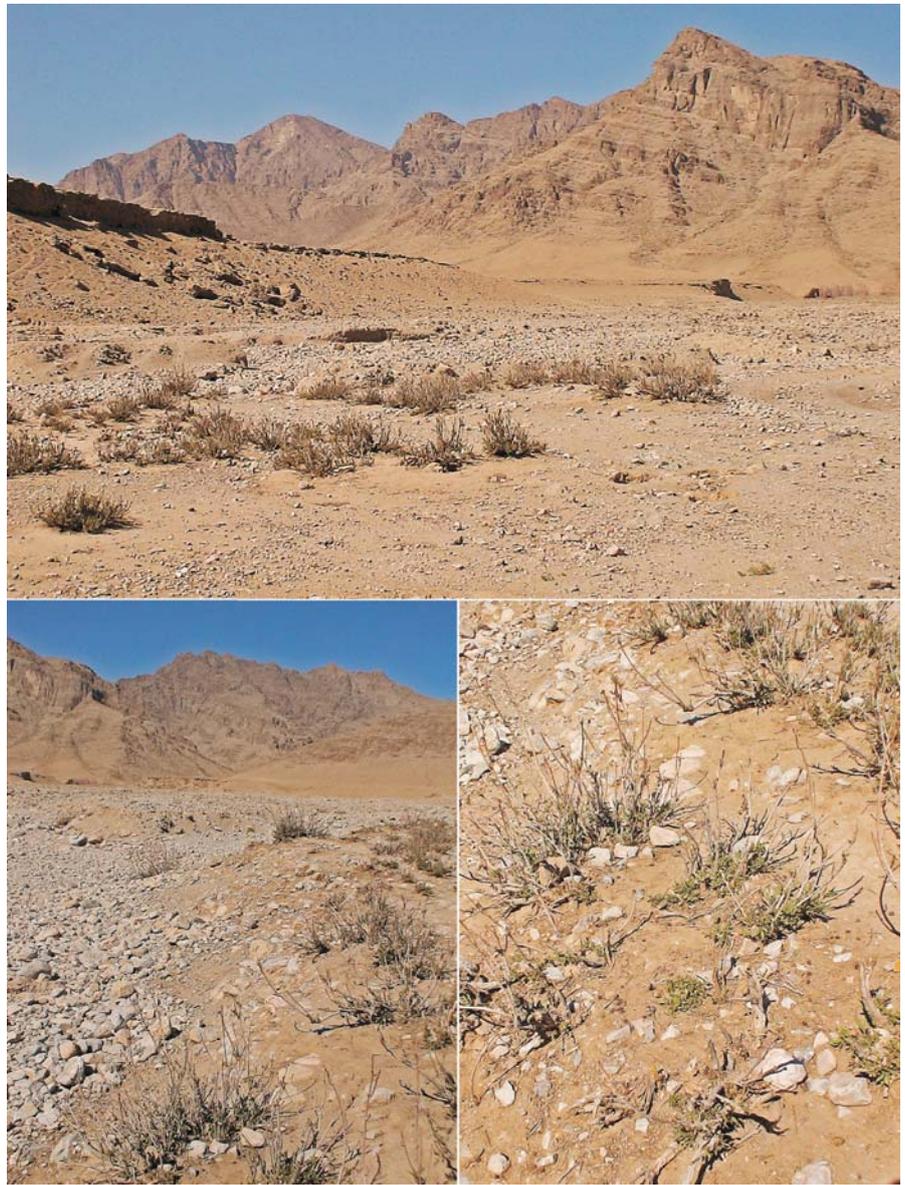
On February 8, 2012, M. Misch discovered, less than 50 meters away from the original location, the remains of a scorpion exuvium, likely belonging to the same species (judging from a non-granulated mesosoma and low pectinal tooth number). In addition to *P. mischi*, **sp. nov.**, in the direct vicinity of the Sarab Kariz wadi, Michael Misch collected also *Orthochirus afghanus* Kovařík, 2004, *Mesobuthus eupeus haarlovi* Vachon, 1958, *Hottentotta saulcyi* (Simon, 1880), and other scorpion species of the family Buthidae not identified at this time. The wadi area where the new species was collected, according to local villagers, was a largely untouched vegetated habitat until a decade ago. Then, after the fall of the Taliban, roads were constructed and the local population was able to collect firewood and livestock feed; this development might endanger the original habitat.

## Acknowledgments

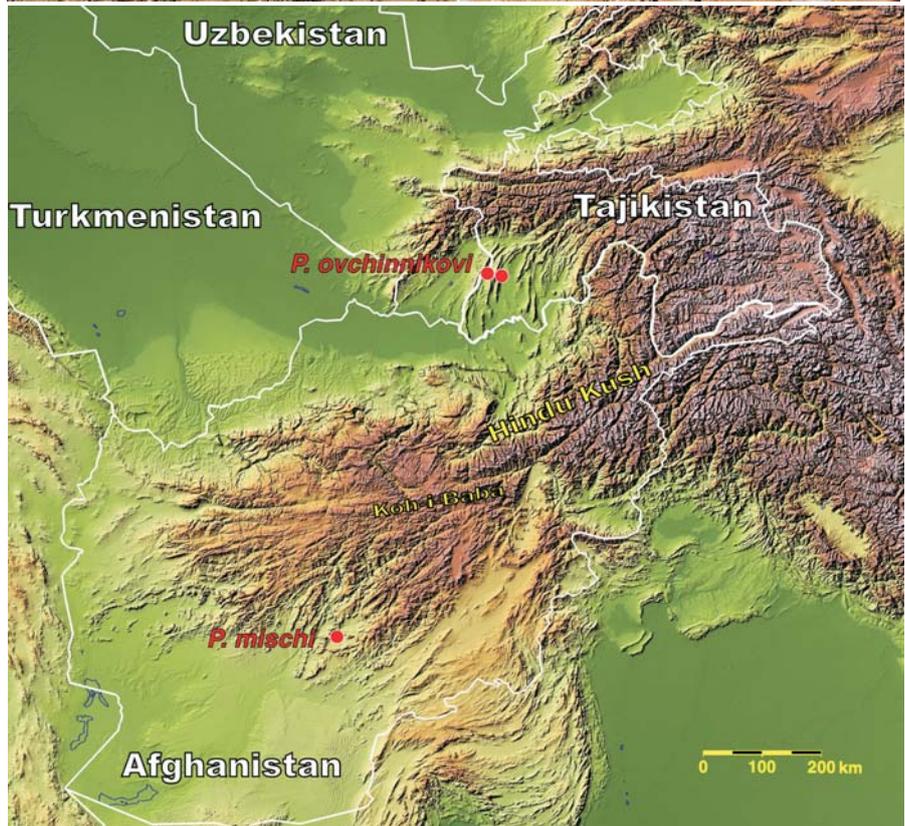
We thank first of all Michael Misch for the specimen, photographs, and information. Michael Misch, in turn, is grateful to his partner Miss Thao Ho for her help and support—including keeping, breeding and documenting over 2000 scorpions at their home, while Michael works in the field.

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**Fig. 20.** Bolakh, Tarin Kowt District, Uruzgan Province, Afghanistan, collection locality of *Pseudochactas mischi*, **sp. nov.**, female holotype. Photos courtesy of Michael Misch.



**Fig. 21.** Map of Central Asia showing distribution of genus *Pseudochactas*.



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