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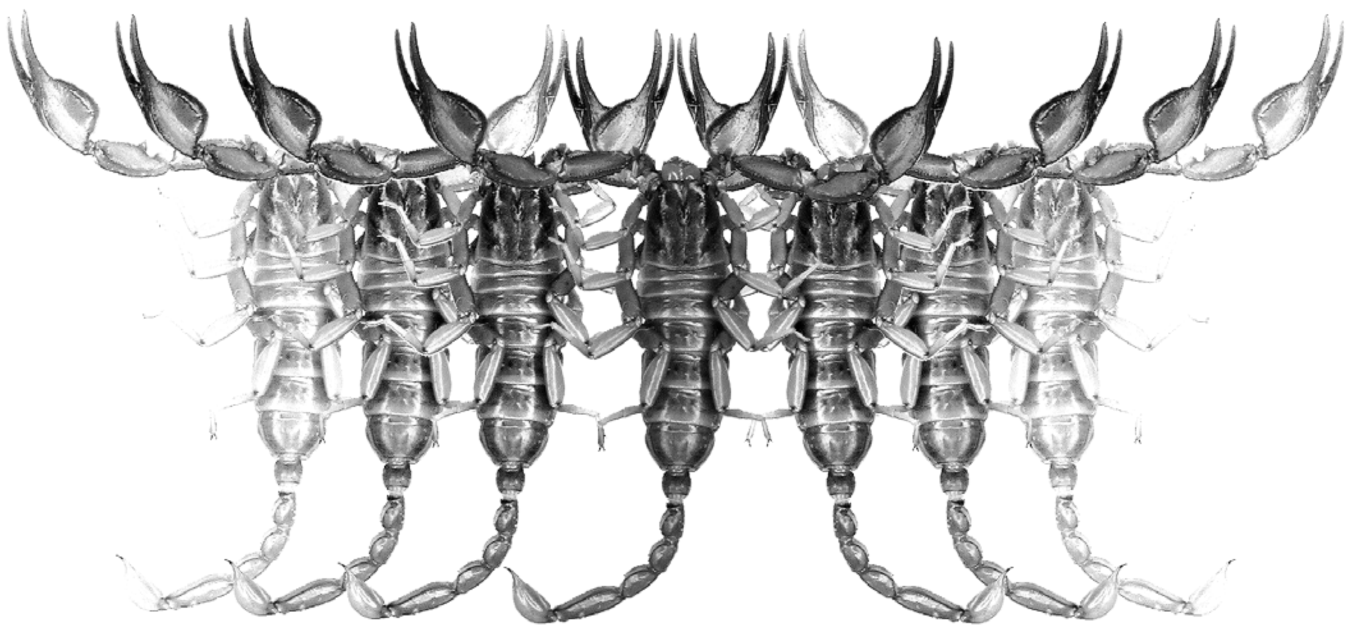

A New Lithophilic *Compsobuthus* Vachon, 1949 (Scorpiones: Buthidae) from Northern Oman

Graeme Lowe

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A new lithophilic *Compsobuthus* Vachon, 1949 (Scorpiones: Buthidae) from northern Oman

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Summary

A new species of *Compsobuthus* is described from the Al Hajar mountains of northern Oman. It is distinguished by a strongly dorsoventrally compressed body, reduced carination on the carapace and tergites, extreme elongation of legs and pedipalps, lack of external accessory denticles on the pedipalp fingers, chelal trichobothrium *est* placed closer to *dt* than *db*, heavy setation on the ventral metasoma, and 28–34 pectine teeth. It is an ultralithophilic scorpion, highly adapted to life in narrow rock fissures.

Introduction

The diverse physiography of southeast Arabia encompasses a great variety of habitats suitable for scorpion colonization and adaptive radiation. Vast dune systems, sweeping alluvial plains and towering mountain ranges provide abundant opportunities for the evolution of substrate specialists. Dominating the topography of northern Oman are the Al Hajar ranges, a rugged chain of mountains that stretches in a broad coastal arc from the spectacular fjords of the Musandam Peninsula in the northwest to a point near Ras Al Hadd, the southeastern tip of the Arabian Peninsula (Fig. 25). Orogeny of the Al Hajar ranges began in the late Cretaceous (~70 Mya) with obduction of the Semail ophiolite, a remnant of Tethyan oceanic lithosphere that was emplaced onto the Arabian continental margin. Subsequently, shallow-marine limestones were deposited during a long period of tectonic stability. In the mid-Tertiary (~30 Mya), the coastal deposits were uplifted by tectonic collision of Arabian and Iranian plates (Searle et al., 1983; Lippard, Shelton & Gass, 1986). Huge limestone blocks were thrust skyward, forming the majestic peaks of Jabal Akhdar. Substrates in the Al Hajar ranges incorporate a complex mixture of igneous, sedimentary and metamorphic rocks of varying antiquity. Assorted rocky substrates are exposed on open mountain slopes, or concealed in a labyrinth of convoluted *wadis* (Arabic term for valleys) carved out by millions of years of unrelenting erosion. Weathering processes lead to fracture and cleavage of foliated metamorphic rock, and layered separation of sedimentary strata, creating planar fissures. These two-dimensional realms are inhabited by creatures with extreme morphological modifications for life in narrow crevices. This paper describes one such denizen of this esoteric underworld, a new species of *Compsobuthus* collected from sheer rocky escarpments in the Al Hajar mountains.

Methods

Scorpions were collected by ultraviolet detection at night and preserved in the field by injection of a fixative (Williams, 1968). Locality data were recorded using portable GPS units. Specimens were examined under a dissecting microscope viewing reflected light under visible illumination, or fluorescence under ultraviolet LED illumination (Lowe, Kutcher & Edwards, 2003). Measurements were taken with an ocular reticle, using biometric definitions in Lamoral (1979) and Sissom, Polis & Watt (1990), except as follows: carapace anterior width taken between most medial pair of lateral eyes; telson and vesicle lengths taken from anterior limit of vesicle, pedipalp chela length as chord length from external proximal limit of manus to fixed finger tip; pedipalp manus width and depth measured with articular condyles level; pedipalp width including dorsal patellar spur (Soleglad & Fet, 2003). Carinal terminology follows Stahnke (1970), with amendments by Prendini (2001b). Hemispermatophore terminology follows Lamoral (1979). Figures 1–17 were rendered under visible light illumination and figures 18–23 are fluorescence images acquired under ultraviolet illumination (Prendini, 2003; Volschenk, 2005). Summary data is expressed as range and mean ± SD (standard deviation). Tests of significance and p values were computed using the Mann-Whitney U statistic.

Abbreviations

Specimen depositories: NMB, Naturhistorisches Museum Basel, Basel, Switzerland; GL, collection of the author; ONHM, Oman Natural History Museum, Muscat, Oman. Biometrics: L, length; W, width; D, depth.

Systematics

Compsobuthus nematodactylus sp. nov.
(Figs. 1–23, Table 1)

Type material

Holotype ♂, **Oman,** Musandam, mountain road SW of Khawr Najd, west slope, UV detection, rocky road cut, bare rock face, 26°05.12'N 56°19.44'E, 220 m a.s.l., 30 September 1994, leg. G. Lowe (NMB).

Paratypes. **Oman**, 1 ♀, Rte 13, Wadi Mistal to Al Awabi, UV detection, crevice in rocky road cut, rocky cliff, 23°19.18'N 57°35.64'E, ca. 400 m a.s.l., 26 September 1994, leg. G. Lowe & M. D. Gallagher (NMB); 1 ♀, Musandam, mountain road S of Khasab, ultraviolet detection, in crack under rock at base of rocky cliff, road cut, 26°01.81'N 56°12.69'E, 750 m a.s.l., 28 September 1994, G.Lowe, ONHM; 2 ♂, Musandam, mountain road S of Khasab, UV detection, rocky road cuts, 26°00.32'N 56°12.69'E, 980 m a.s.l., 28 September 1994, leg. G. Lowe (NMB, GL); 1 ♀, 1 immature ♂, Musandam, road from Khasab to Bukha, east of Hanah, UV detection, female in crevice in rocky road cut, damaged during extraction from rock, male on rock surface, rocky road cut, mountain pass, 26°13.98'N 56°12.56'E, 100 m a.s.l., 29 September 1994, leg. G. Lowe (NMB); 1 ♀, Musandam; mountain rd S of Khawr Najd, UV detection, rocky road cut, split rock face, ca. 5 m above road, 26°05.39'N 56°19.41'E, 275 m a.s.l., 30 September 1994, leg. G. Lowe (NMB); 1 ♂, same locality as holotype (ONHM).

Etymology. The specific epithet is derived by combining the Greek nouns, *nematos* (thread) and *daktylos* (finger), a reference to the long, tenuous pedipalp fingers.

Diagnosis. Medium-sized *Compsobuthus*, adults 31–43 mm; body strongly compressed dorsoventrally; color pale yellow with or without faint fuscous markings on carapace, tergites and legs; carapace nearly parallel-sided; carapace and tergites with weak or moderate carinae; carapace with central median carinae curved, partially fused or separated from posterior median carinae, anterior median and central lateral carinae weak or obsolete; pedipalps very slender, femur L/W 3.0–4.4, patella L/W 3.5–3.9, chela L/W 7.4–8.4; pedipalp femur and patella with smooth intercarinal surfaces, patella with dorsomedian and dorsoexternal carinae very weak, nearly obsolete; chela manus not swollen, smooth with all carinae obsolete, fingers very long and tenuous, movable finger L/manus ventral L 3.2–3.8; chela fingers with primary denticles on fixed and movable fingers divided into 11–12 subrows, lacking external accessory denticles, with full compliment of internal accessory denticles (i.e. a member of the 'acutecarinatus' group of *Compsobuthus* (Levy & Amitai, 1980)); trichobothria *db* and *dt* located in distal half of fixed finger; pedipalp fingers without scalloping on proximal margins; legs long, slender, laterigrade; tergites I–VI with several macrosetae on posterior margins; sternite VI smooth with carinae weak or obsolete; sternite VII smooth, tetracarinate, with weak median carinae and moderate, granulated lateral carinae; metasomal carinae moderately developed, smooth to granulate; median lateral carinae present on metasoma I, absent on metasoma II–IV; metasomal slender, elongate, metasoma IV L/W 2.3–2.7, metasoma V L/W 2.7–3.3; carinae and intercarinal surfaces of metasoma and sternite VII bearing numerous long, reddish macrosetae; telson moderately elongate (L/D 2.9–3.3), with very weak subaculear tubercle, bearing several long reddish macrosetae; pectine teeth: males, 31–33, females 28–34.

Comparisons. *C. nematodactylus* is clearly differentiated from other *Compsobuthus* by having (i) the central median carinae on the carapace curved and partially or weakly fused with the linear posterior median carinae, and (ii) very slender pedipalp chelae with extremely elongated pedipalp fingers greatly exceeding the length of the manus. The only other known member of the genus with similar pedipalp proportions is *C. longipalpis* Levy et. al. 1973, which differs in having dark pigment on metasoma V, less elongated pedipalp chelae (L/W 6.86), chela fingers with external accessory denticles present, 14 subrows of denticles on the fingers, and fixed finger trichobothrium *est* closer to *db* than *dt* (Hendrixson, 2006). Other *Compsobuthus* from the Arabian Peninsula without external accessory denticles but with internal accessory denticles on the pedipalp fingers (Kovařík, 2003) are differentiated as follows: *Compsobuthus acutecarinatus* (Simon, 1882): pedipalp chela with manus swollen, with smooth carinae, fingers much shorter, movable finger with 10 subrows of denticles, proximal margin of fingers weakly scalloped, sternite VI with 4 well developed carinae, carapace and tergites with strong carinae, telson vesicle bulbous, and fewer pectine teeth (males 23–29, females 20–27); *Compsobuthus polisi* Lowe, 2001: smaller species, fewer pectine teeth (males 18–20, females 16–20), metasoma finely granulated, median lateral carinae well developed on metasoma II, telson more slender with prominent subaculear tubercle; *Compsobuthus maindroni* (Kraepelin, 1900): smaller, narrower body, color darker, orange-brown with fuscous metasoma V, pedipalp chela with granulated carinae, movable finger denticles divided into 9 subrows, sternite VI with 4 carinae, metasoma with surfaces finely granulose, macrosetae sparse or absent, median lateral carinae well developed and complete on metasoma II–III, fewer pectine teeth (males 21–22, females 19–21); *Compsobuthus arabicus* (Levy, Amitai et Shulov, 1973): much smaller species, carapace with fuscous interocular markings, pedipalp chelae with distinct carinae, fewer pectine teeth (9–15), legs short and stout, sternite VI with distinct lateral carinae, sternite VII finely granular; metasoma densely, finely granular without numerous intercarinal macrosetae; *Compsobuthus vachoni* Sissom, 1994: smaller species, fewer pectine teeth (female 15), pedipalp movable finger with 9 subrows of primary denticles, trichobothrium *db* in basal half of fixed finger.

Description of holotype male

Coloration. Base colour pale translucent yellow; with faint fuscosity on lateral areas of carapace and tergites and anterior margin of carapace, darker pigmentation concentrated on posterior margins of carapace and tergites I–VI, and on dorsal retrolateral and ventral prolateral surfaces of femora and patellae of legs I–IV; median and lateral eyes with underlying melanic pigment; denticles of chelicerae and pedipalp fingers, articular condyles of pedipalp movable fingers, tarsal ungues and aculeus of telson castaneous; macrosetae on body and appendages a dark reddish color.

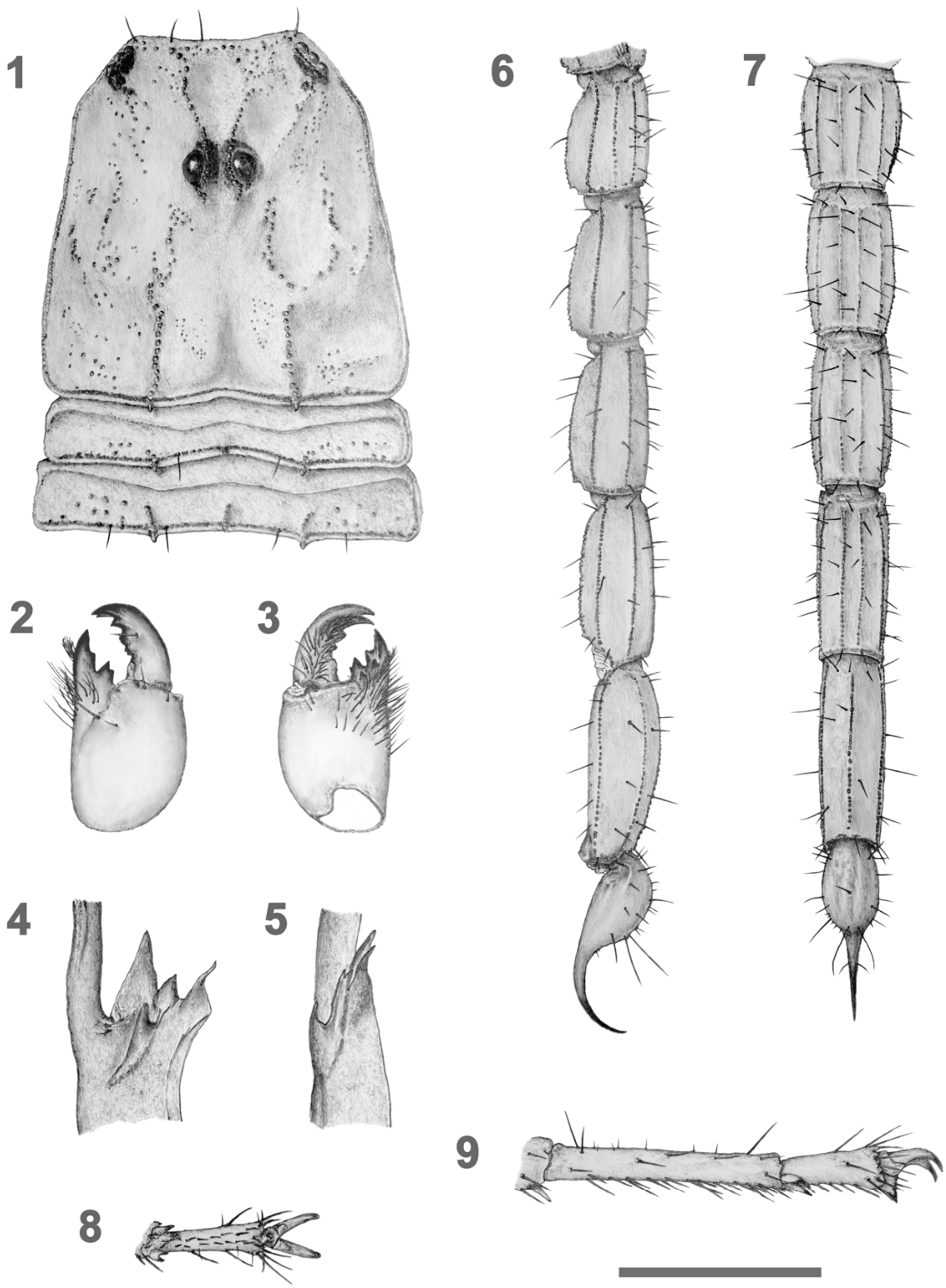
Carapace (Fig. 1). Weakly quadrate, nearly parallel sided, convergent on anterolateral margins; posterior width nearly equal to length; surface strongly compressed dorsoventrally, planar; median ocular tubercle depressed, level with surrounding surfaces; lateral eyes with 5 ocelli (3 large, 2 small); anterior margin concave, smooth; anterior median carinae granular, weak, confined to posterior part of interocular triangle; superciliary carinae distinct, granular; central median carinae weak, irregularly granulose, curved outward posteriorly; posterior median carinae strong, linear, with coarse regular granulation, terminating posteriorly in spiniform granules projecting beyond posterior margin of carapace; central median and central posterior carinae joined on the left, separated on the right; central lateral and lateral ocular carinae weak, less distinct, marked by irregular series of granules; other carinae indistinct; anterior margin bordered with series of weak, coarse granules; interocular triangle smooth medially, fine granulate laterally; medial and mediolateral surfaces smooth to finely shagreened, lateral flanks with scattered coarse and fine granulation; anterior margin of carapace with 3 pairs of macrosetae, carapace otherwise bare.

Chelicera (Figs. 2–3). Dorsal surface of manus smooth, glabrous, with pair of short pale microsetae on apical border, long reddish subapical macroseta on dorsointernal carina, and short pale microseta located anteromedially; dorsal surface of movable finger with 2 short pale microsetae; cheliceral dentition with characteristic buthid pattern (Sissom, 1990; Soleglad & Fet, 2003), ventral surface of fixed finger with two enlarged denticles.

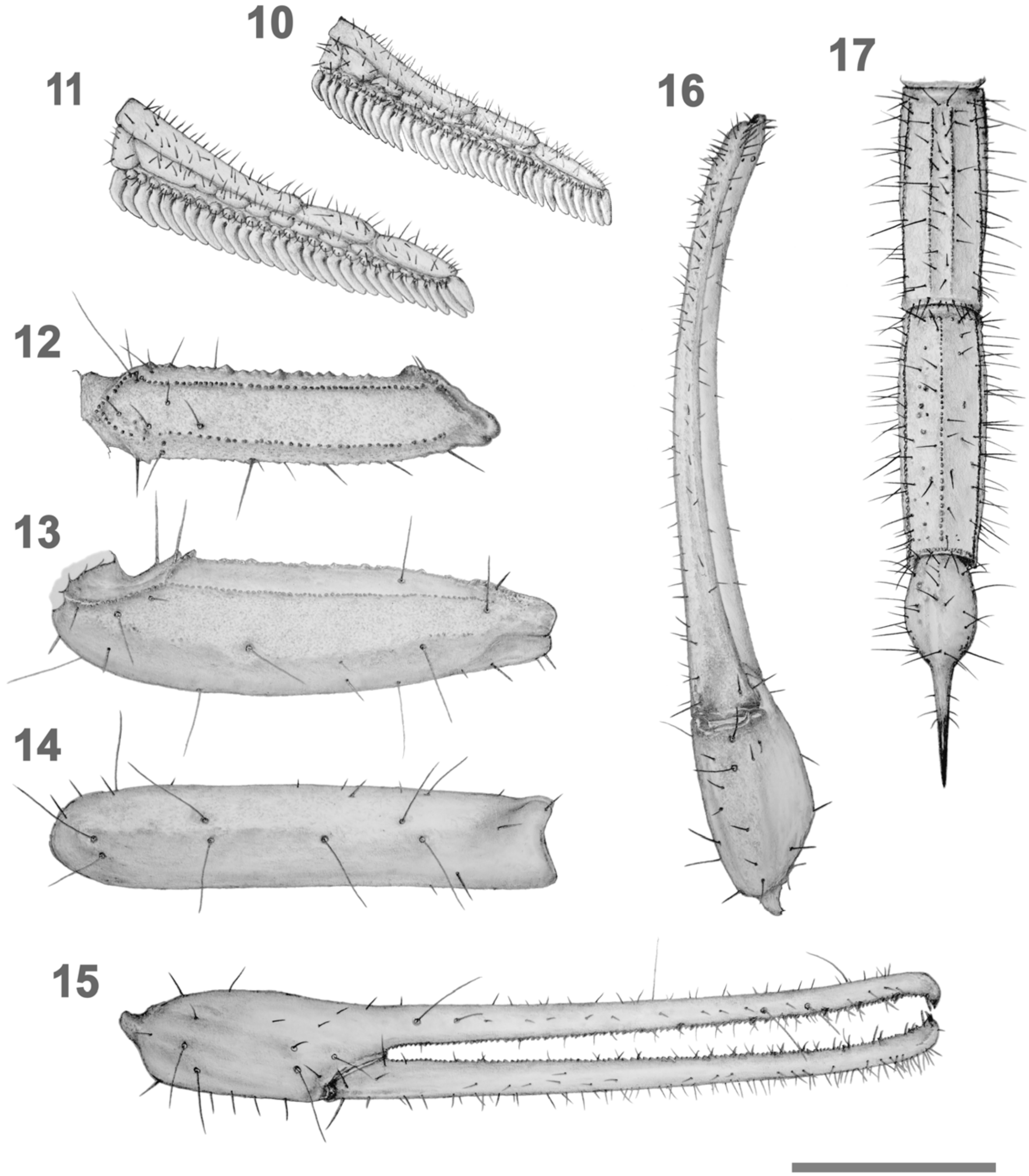
Coxosternal area (Figs. 19–21). Coxal surfaces smooth, anterior margins of coxae II–III and anterior and proximal posterior margins of coxa IV finely shagreened; setation sparse, fewer than 4 macrosetae per coxal segment; sternum triangular, smooth with shallow posterior depression; genital opercula smooth, with 2–4 lateral macrosetae; genital papillae present (in males).

Pectines (Figs. 10–11, 19–21). Basal piece rectangular, smooth, with deep anteromedian incision, distal tips of pectines extending to apical limit of trochanter IV; pectines with 3 marginal lamellae, 10–11 middle lamellae, and small intermediate lamella at distal end of basal marginal lamella, 32–32 teeth; all lamellae bearing numerous short reddish macrosetae, including 2–5 on fulcra; when anterior margins of left and right pectines are aligned with posterior margins of coxae IV, basal 2 pectine teeth overlap, with a gap between basal middle lamellae.

Mesosoma (Figs. 18–21). *Tergites*: pretergites smooth; tergite I with single pair of short granulose, lateral carinae, median carina obsolete, marked by single median granule; tergites II–VI with 3 granulose, moderately strong, longitudinal carinae; lateral carinae of all tergites terminating posteriorly in spiniform granules projecting beyond posterior margins of sclerite; median carinae of II–VI slightly projecting beyond posterior margins; lateral carinae of all tergites curved outwards anteriorly; tergite VII with two pairs of strong granular lateral carinae, and weak granular median carina; lateral flanks of tergites I–VI weakly sloped, finely shagreened with scattered coarse granulation; median intercarinal surfaces finely shagreened, without granules; tergite VII finely shagreened with scattered fine granulation on lateral flanks; tergites I–VI with 4 posterior marginal macrosetae, one medial pair on inner side of lateral carinae, one lateral pair (some setae lost, marked by insertion sockets); tergite VII lacking macrosetae. *Sternites*: all sternites smooth, sternite III without carinae, carinae on sternites IV–V obsolete; sternite VI with median carinae obsolete, lateral carinae smooth and nearly obsolete; sternite VII with median



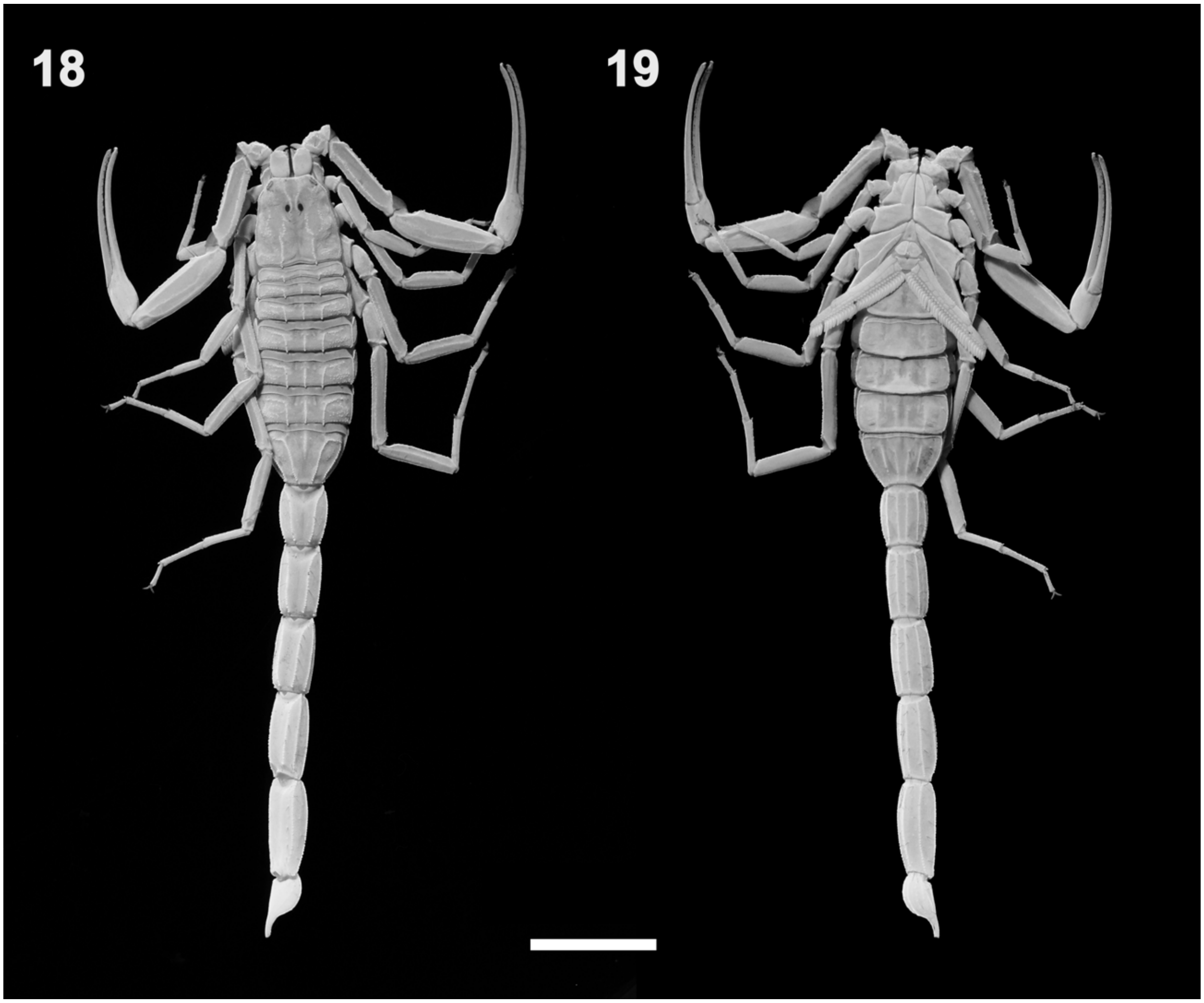
Figures 1–9: *Compsobuthus nematodactylus* **sp. nov. 1, 6–9**, holotype male, **2–5**, paratype adult males. **1.** Carapace and tergites I–II. **2–3.** Right chelicera, dorsal (2) and ventral (3) aspect. **4–5.** Right hemispermatophore, lobes at base of flagellum, dorsal (4) and ectal (5) aspects. **6.** Metasoma and telson, right lateral aspect. **7.** Metasoma and telson, ventral aspect. **8.** Right telotarsus III, ventral aspect. **9.** Right basitarsus and telotarsus III, retrolateral aspect. Scale bar: 1: 2 mm; 2–3, 8–9: 1.45 mm; 4–5: 0.725 mm; 6–7: 4.17 mm.



Figures 10–17: *Compsobuthus nematodactylus* **sp. nov. 11, 12–16**, holotype male, **10, 17**, paratype adult female (near Wadi Mistal). **10.** Left pectine of female, ventral aspect. **11.** Left pectine of male, ventral aspect. **12.** Right pedipalp femur, dorsal aspect. **13.** Right pedipalp patella, dorsal aspect. **14.** Right pedipalp patella, external aspect. **15.** Right pedipalp chela, external aspect. **16.** Right pedipalp chela, ventral aspect. **17.** Metasoma IV, V and telson of female, ventral aspect. Scale bar: 10, 11: 2.8 mm; 12–16: 2 mm; 17: 4.17 mm.

carinae weak, smooth, lateral carinae moderate, granular; all sternites with scattered, sparse short to long reddish macrosetae, 9 non-marginal setae on sternite VII.

Hemispermatophore lobes (paratype) (Figs. 4–5). Inner lobe broad, triangular; median lobe broad, triangular, 0.6 times length of inner lobe; outer lobe narrow, tapering apically, almost as long as inner lobe;



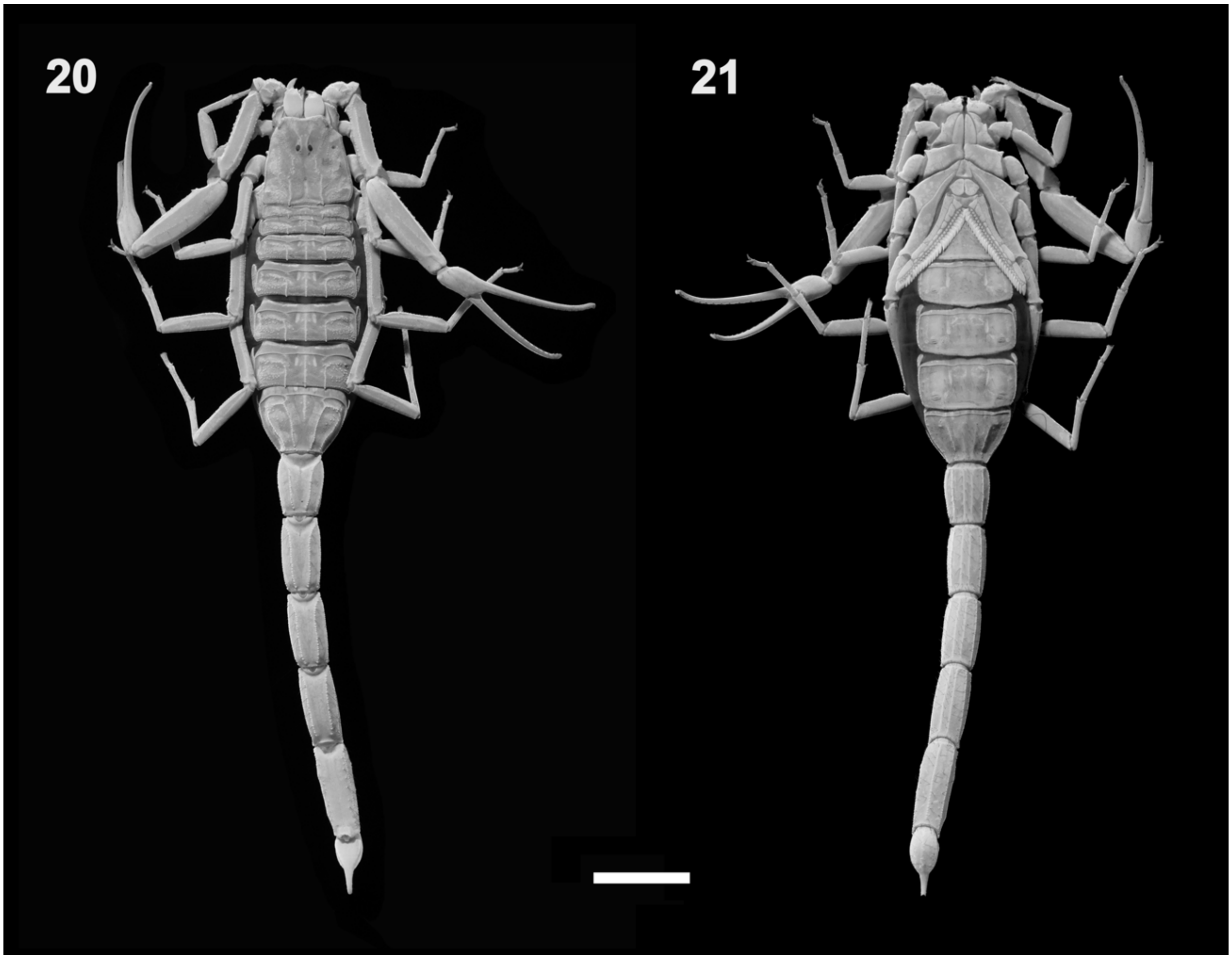
Figures 18–19: *Compsobuthus nematodactylus* **sp. nov.** holotype male, habitus. **18.** Dorsal aspect. **19.** Ventral aspect. Scale bar: 5 mm.

basal lobe with broad longitudinal base, and hook-like apex.

Metasoma (Figs. 6–7, 17, 18–21). Slender, elongate, exceeding length of prosoma and mesosoma, segments narrowing posteriorly; segment I with 10 carinae, segments II–IV with 8 carinae (median lateral carinae absent), segment V with 5 carinae; dorsosubmedian and dorsolateral carinae strong, crenulate-granulate on all segments; median lateral carinae moderate, crenulate-granulate on I, absent on other segments; ventrolateral carinae strong to moderate, crenulate-granulate all segments; ventromedian carinae weak on I–II, moderate, on III–IV, weakly crenulate; metasoma V with ventromedian carina strong, granular, ventrosubmedian carinae absent, intercarinal surfaces smooth on all segments; lateral anal lobes not dissected; ventral anal arc with fine granules. *Setation*: dorsosubmedian carinae on metasoma I–VI with irregular (1–5) macrosetae; dorsolateral carinae on metasoma I–VI with irregular macrosetae (1–3); dorsal surface of metasoma V with linear series of 3–4 macrosetae flanking dorsolateral carinae; lateral and ventral surfaces, and carinae of all segments with sparse, scattered macrosetae.

Telson (Figs. 6–7, 17, 18–21). Vesicle pyriform, dorsal and dorsolateral surfaces smooth, without setae; lateral and ventral surfaces with median and lateral longitudinal series of weak bumps corresponding to insertions of fine microsetae, and scattered macrosetae; subaculear tubercle weak, flanked by pair of long curved macrosetae; aculeus long, slender, strongly curved, as long as vesicle.

Pedipalp (Figs. 12–16, 22–23). *Femur* (Fig. 12): slender, 4.18 times longer than wide; dorsoexternal and



Figures 20–21: *Compsobuthus nematodactylus* **sp. nov.** paratype adult female (near Wadi Mistal), habitus. **20.** Dorsal aspect. **21.** Ventral aspect. Scale bar: 5 mm.

dorsointernal carinae moderate, finely granular; ventrointernal carina moderate, with larger granulation; other carinae obsolete; dorsal surface flat smooth, external surface convex with dispersed fine granules, ventral surface weakly concave proximally, smooth; internal surface convex with scattered enlarged granules; 9–10 macrosetae scattered on external surface, distal cluster not well defined. *Patella* (Figs. 13–14): slender, 3.52 times longer than wide; dorsointernal, dorsomedian, ventroexternal and ventrointernal carinae weak with very fine granules; dorsoexternal, external and ventromedian carinae weak, smooth; internal carina moderate, finely crenulate-granulate, with fewer larger granules; all intercarinal surfaces smooth; mostly bare, with two large proximal internal macrosetae and a few short macrosetae. *Chela* (Figs. 15–16): very slender, 7.45 times longer than wide, with long, tenuous fingers, movable finger 3.29 times manus ventral length; surface smooth with all carinae obsolete, proximal margins of fingers not scalloped; sparse short macrosetae scattered on external and ventral surfaces of manus and ventral aspect of movable finger; apex of movable finger with ventral and internal clusters of macrosetae, apex of fixed finger with dorsal and internal clusters of macrosetae; both fixed and movable fingers terminate in enlarged apical tooth capped by smooth patches of thickened cuticle; a pair of short, laminate, reddish setae present sub-distally under enlarged terminal teeth of fixed and movable fingers; movable finger with 4 subdistal denticles; 11–12 linear, non-imbricated primary denticle subrows on fixed and movable fingers (11 subrows correspond to proximal subrow fusions) (Figs. 22–23), separated by enlarged proximal denticles; all denticle subrows flanked by internal accessory denticles, external accessory denticles absent.

Trichobothrial pattern (Figs. 12–16). Orthobothriotaxic, type Aβ (Vachon, 1974, 1975); femur d_2, patella d_2, chela Eb_3, *Esb* and *esb* petite; *est* and *et* located on fixed finger between *db* and *dt*, with *est* approximately midway between *db* and *dt*, but closer to *dt* (Fig. 15).

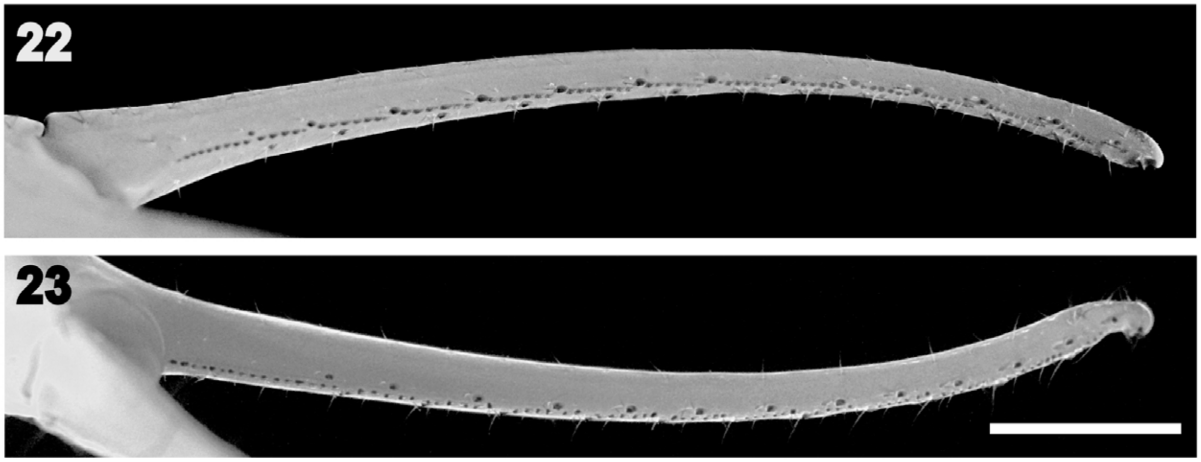
	Males	Females
Carapace posterior W/ L	0.94 – 0.99, 0.96 ± 0.02 (4)	0.99 – 1.01, 1.00 ± 0.01 (3)
Pedipalp movable finger L/manus ventral L	3.19 – 3.29, 3.22 ± 0.04 (4)	3.61 – 3.83, 3.73 ± 0.09 (4)
Telson vesicle D/ W	0.98 – 1.00, 0.99 ± 0.01 (4)	0.92 – 0.97, 0.94 ± 0.02 (4)
Pedipalp chela manus D/ carapace L	0.28 – 0.29, 0.28 ± 0.004 (4)	0.24 – 0.26, 0.25 ± 0.005 (4)
Pectine L/ carapace L	1.21 – 1.25, 1.22 ± 0.02 (4)	1.10 – 1.16, 1.13 ± 0.03 (4)
Pedipalp femur L/W	3.00 – 4.33, 4.05 ± 0.40 (9)	
Pedipalp patella L/W	3.45 – 3.91, 3.61 ± 0.14 (9)	
Pedipalp chela L/manus W	7.43 – 8.86, 7.97 ± 0.50 (9)	
Pedipalp femur L/ carapace L	1.02 – 1.11, 1.06 ± 0.03 (9)	
Pedipalp patella L/ carapace L	1.22 – 1.36, 1.29 ± 0.05 (9)	
Pedipalp chela L/ carapace L	1.92 – 2.17, 2.03 ± 0.07 (9)	
Pedipalp movable finger L/ carapace L	1.53 – 1.72, 1.60 ± 0.06 (9)	
Pedipalp chela manus W/ carapace L	0.24 – 0.28, 0.26 ± 0.02 (9)	
Leg III patella L/D	4.35 – 4.81, 4.58 ± 0.15 (9)	
Leg III patella L/ carapace L	0.86 – 0.92, 0.89 ± 0.02 (9)	
Metasoma I L/W	1.23 – 1.50, 1.32 ± 0.08 (9)	
Metasoma II L/W	1.67 – 2.01, 1.78 ± 0.10 (9)	
Metasoma III L/W	1.85 – 2.15, 1.97 ± 0.09 (9)	
Metasoma IV L/W	2.33 – 2.69, 2.47 ± 0.11 (9)	
Metasoma V L/W	2.71 – 3.25, 2.89 ± 0.16 (9)	
Vesicle L/ telson L	0.44 – 0.51, 0.47 ± 0.02 (8)	
Metasoma I L/ carapace L	0.66 – 0.73, 0.69 ± 0.03 (9)	
Metasoma II L/ carapace L	0.76 – 0.85, 0.80 ± 0.03 (9)	
Metasoma III L/ carapace L	0.79 – 0.89, 0.83 ± 0.03 (9)	
Metasoma IV L/ carapace L	0.91 – 1.01, 0.95 ± 0.03 (9)	
Metasoma V L/ carapace L	1.04 – 1.09, 1.06 ± 0.02 (9)	
Metasoma II W/ Metasoma I W	0.83 – 0.88, 0.86 ± 0.02 (9)	
Metasoma III W/ Metasoma I W	0.79 – 0.83, 0.81 ± 0.01 (9)	
Metasoma IV W/ Metasoma I W	0.72 – 0.77, 0.74 ± 0.01 (9)	
Metasoma V W/ Metasoma I W	0.68 – 0.74, 0.71 ± 0.02 (9)	

Table 1: Variation in selected morphometric ratios for adult *Compsobuthus nematodactylus* **sp. nov.** Indicated are ranges and mean ± SD, with sample sizes in parentheses. All samples are from adults. Values of variables significantly different between the two sexes ($p < 0.05$, Mann-Whitney test) are cited separately for males and females, and those not significantly different are pooled for both sexes.

Legs (Figs 8–9, 18–21). Very slender, laterigrade; leg III patella L/D 4.55; legs III–IV with tibial spurs; retrolateral pedal spurs simple, without setae; prolateral pedal spurs basally bifurcate, with 0–1 setae; telotarsi elongate, with two rows of short macrosetae on ventral surfaces (Fig. 8); basitarsi elongate, with two rows of stout macrosetae on ventral surface; bristle combs absent; ungues stout (Fig. 9).

Measurements of holotype male (mm). Total L 32.50; metasoma + telson L 20.00; carapace L 3.69, W 1.54 (anterior interocular), 3.48 (posterior), carapace preocular L 1.31; metasomal segments (L/D/W) I 2.46/1.63/2.00, II 2.92/1.59/1.75, III 3.08/1.58/1.67, IV 3.54/1.54/1.50, V 3.92/1.50/1.35; telson L 3.54; vesicle L 1.67, D 1.17, W 1.17; pedipalp chela L 7.52, manus ventral L 1.75, chela W 1.01, D 1.03, fixed finger L 5.21, movable finger L 5.75; pedipalp femur L 3.83, W 0.92, patella L 4.69, W 1.33; pectine L 4.46; leg III patella L 3.25, D 0.71.

Sexual dimorphism. Adult females differed as follows: larger size, adult female total L 40.00 – 43.00 (41.25 ± 1.26, $n = 4$), carapace L 4.67–4.87 (4.78 ± 0.08, $n = 4$), adult male total L 26.00 – 32.50 (30.70 ± 2.68, $n = 5$), carapace L 3.00 – 3.69 (3.53 ± 0.30, $n = 5$); denser setation on sternite VII and ventral surfaces of metasoma (Fig. 17); genital papillae absent; pectines shorter, distal tips not extending to distal limits of trochanter IV, smaller ratio of pectine L/carapace L ($p = 0.014$), pectine teeth shorter, such that when anterior margins of left and right pectines are aligned with posterior margins of coxae IV, basal pectine teeth do not overlap; lateral carinae obsolete on sternite VI, more weakly developed



Figures 22–23: *Compsobuthus nematodactylus* **sp. nov.** paratype adult male. **22.** Pedipalp chela, left movable finger dentition. **23.** Pedipalp chela, left fixed finger dentition. Scale bar: 1 mm.

on sternite VII; wider prosoma and mesosoma, larger ratio of carapace posterior W/ carapace L ($p = 0.025$), slightly longer pedipalp movable finger relative to manus ($p = 0.05$), telson vesicle depth smaller relative to width ($p = 0.014$), and less deep chela manus relative to carapace L ($p = 0.014$). Both dimorphic and non-dimorphic morphometric ratios are summarized in Table 1.

Measurements of paratype female (near Wadi Mistal) (mm). Total L 43.00; metasoma + telson L 26.00; carapace L 4.81, W 2.10 (anterior interocular), 4.83 (posterior), carapace preocular L 1.71; metasomal segments (L/D/W) I 3.33/2.08/2.46, II 3.83/2.00/2.05, III 4.08/2.00/1.99, IV 4.67/1.88/1.81, V 5.15/1.88/1.75; telson L 4.58; vesicle L 2.00, D 1.40, W 1.50; pedipalp chela L 9.80, manus ventral L 2.10, chela W 1.18, D 1.20, fixed finger L 7.08, movable finger L 7.91; pedipalp femur L 5.08, W 1.18, patella L 6.21, W 1.75; pectine L 5.29; leg III patella L 4.21, D 0.94.

Meristic variation. Pectinal tooth count was not sexually dimorphic in the small sample size available ($p = 0.49$): males 31–33 (mode 32; 1/10 combs with 31, 5/10 with 32, and 4/10 with 33 teeth), females 28–33 (mode 31; 1/8 combs with 28, 29, 32 and 33 teeth, 2/8 combs with 31 and 34 teeth). The number of denticle subrows on the pedipalp fingers was either 11 or 12, and the lower counts were associated with fusion, often of the proximal subrows. Among intact fixed fingers, there were 5/18 with 11, and 13/18 with 12 subrows; among intact movable fingers there were 8/17 with 11 subrows, and 9/17 with 12 subrows. Thus, the fixed fingers had the higher mean subrow count. Males had a significantly higher count of movable finger subrows than females ($p = 0.01$): among male intact movable fingers, there were 2/10 with 11, and 8/10 with 12 subrows; among intact female movable fingers, there were 6/7 with 11 and 1/7 with 12 subrows. The numbers of posterior marginal macrosetae on tergites I–VI was variable. In specimens of both sexes from the Musandam, the medial margins (inside the lateral carinae) normally had 2, and occasionally 3 macrosetae, and the left or right lateral margins (outside the lateral carinae) normally had 1, and occasionally 2 macrosetae, i.e. the setation formula (left lateral, medial, right lateral) was 0–1, 2–3, 0 –1. The female sample from near Wadi Mistal was distinctive in having higher numbers of marginal macrosetae, with setation formula for each tergite: I = 1,3,2, II = 3,3,2, III = 2,5,4, IV = 2,5,3, V = 3,7,3, VI = 1,6,2.

Variation with age. Study of a single available intermediate instar male (total L 26 mm, carapace L 3 mm) revealed significant ($p < 0.05$) morphometric differences from adult males: more slender pedipalp chelae (chela L/W 8.86), longer pedipalp fixed and movable fingers (fixed finger L/ manus ventral L 3.42, movable finger L/manus ventral L 3.72), more slender metasomal segments (segment L/W: I 1.5, II 2.0, III 2.15, IV 3.25), less bulbous telson vesicle (vesicle L/D 1.61). Intercarinal granulation was sparser and weaker on the carapace and tergites, and carinal granulation was weaker or finer on all sclerites. On the metasomal segments, ventromedian carinae were smooth, not crenulate.

Distribution. *C. nematodactylus* is probably endemic to Al Hajar Al Gharbi, the western section of northern Oman mountain ranges (Fig. 25). Although eight of the nine type specimens were collected from the Musandam Peninsula, the record from near Wadi Mistal indicates a wider and perhaps continuous distribution. It is likely to

Figure 24: Type locality of *Compsobuthus nematodactylus* **sp. nov.** Southward view of the western slope of the mountains and road SW of Khawr Najd, Musandam Peninsula, showing extensive layers of shelf carbonate with an abundance of rock fissures providing microhabitat for lithophilic scorpions. Date of photograph: 30 September 1994.

occupy the intervening mountains including parts within the borders of the United Arab Emirates. Although the lack of records from Al Hajar Ash Sharqi (eastern part of the ranges) might indicate that the species does not bridge the Sumail Gap (the large wadi separating eastern and western ranges), this might just be a reflection of insufficient sampling of this relatively small, secretive scorpion.

Ecology. All samples of the new species were collected at lower elevations (100–980 m a.s.l.) at night, by ultraviolet detection on vertical rock cliffs and road cuts. This species is apparently an obligate 'ultralithophile', a term describing scorpions that exclusively inhabit solid rock substrates, sheltering in fissures by day and emerging at night to forage on bare rock faces. The strongly flattened body, slender metasoma, long laterigrade legs armed with stout ungues, and elongated pedipalps with extremely tenuous fingers, are structural adaptations to an existence in narrow rock crevices (Polis, 1990; Prendini, 2001a). A similar morphology is observed in many members the lithophilic North American vaejovid genera *Serradigitus* and *Syntropis*, which also developed very slender pedipalp fingers with linear series of denticles, terminating in an enlarged tooth with smooth cap and apical clusters of sensory setae (Stahnke, 1974; Williams & Berke, 1986; Sissom & Stockwell, 1991; Soleglad & Fet, 2006; Soleglad, Lowe & Fet, 2007).

Discussion. The new species displays some significant differences from other known species of *Compsobuthus*. An original diagnostic character for the genus was the fusion of the central median and posterior median carinae of the carapace into a single continuous linear keel (Vachon, 1949, 1952). In the new species, these two carinae were frequently observed to be separated by gaps of one or more granule diameters. Although the posterior median carinae were linear with regular granulation, the central median carinae were curved and often exhibited irregular granulation. The carinae were fused in 10/18 cases, and separated in 8/18 cases. Fusion was not always left-right symmetric: carinae of 3/9 carapaces were bilaterally fused, 4/9 unilaterally fused (3 left, 1 right), and 2/9 bilaterally separated. In other respects, the new species conforms to the current definition of *Compsobuthus*, so it is placed within that genus. Sissom & Fet (1998) arrived at a similar tax-

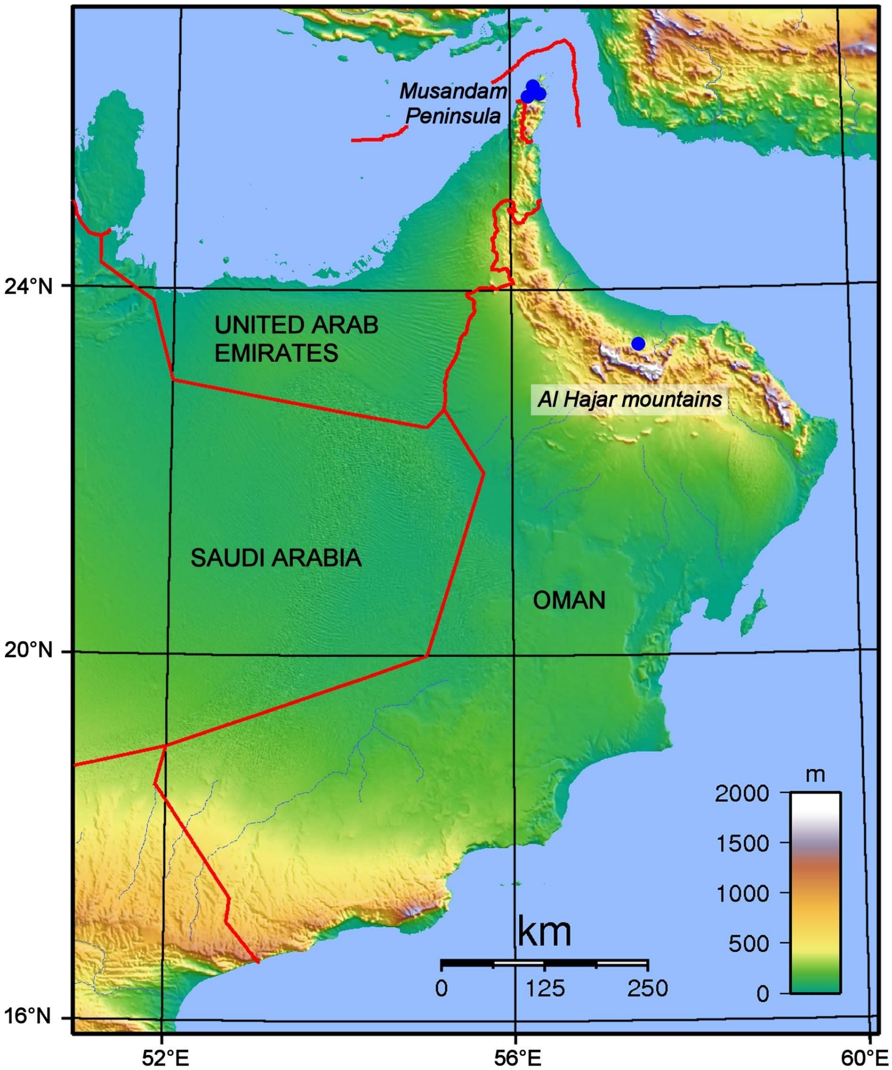


Figure 25: Topographic map of Oman in the southeastern Arabian Peninsula, with collection localities of *C. nematodactylus* plotted as blue circles (modified from a public domain topographic map available at http://en.wikipedia.org/wiki/File:Oman_Topography.png).

onomic decision for *C. matthiesseni*, which can also have these two carinae incompletely fused. *C. nematodactylus* is further distinguished by having the carinae on the carapace and tergites more weakly developed than many other *Compsobuthus*. These differences in carinal fusion and development can be interpreted as synapomorphic modifications linked to flattening and streamlining of the body. Robust, raised carinae are likely to serve a biomechanical function in arthropods, acting as reinforcing ribs for the rigid exoskeleton, while maintaining a relatively lightweight structure (Vincent & Wegst, 2004). In ultralithophilic scorpions, reduction of carinae has enabled them to squeeze tightly into very narrow fissures. It seems that any structural weakening of the integument incurred by carinal attenuation is amply compensated by protection gained from being able to retreat effortlessly into fortresses of solid rock.

The species closest to *C. nematodactylus*, both systematically and biogeographically, appear to be *C. acutecarinatus* from southern Oman (Dhofar) and Yemen, and *C. polisi* from the central coast of Oman and Masirah Island. All three species have lost the external accessory denticles of the pedipalp fixed fingers, presumably a derived condition of the 'acutecarinatus' group of *Compsobuthus* (Levy & Amitai, 1980). In addition, the sternites and ventrolateral and ventral aspects of the metasoma of these species bear numerous straight, reddish macrosetae on the carinae and intercarinal surfaces. This heavy setation is absent in most other known *Compsobuthus* (Kovařík, 2003; Kovařík & Ahmed, 2007), so it may be synapomorphy indicating shared ancestry within the 'acutecarinatus' group. The three species comprise an allopatric series of populations deployed along the south eastern coast of the Arabian Peninsula, extending from Aden to the Musandam Peninsula. In the northern mountains, competition between an 'acutecarinatus' ancestor and other scorpions species not present in the south (for example, *Compsobuthus maindroni*), may have been a factor leading to speciation of *C. nematodactylus* by specialization for ultralithophilic microhabitats.

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