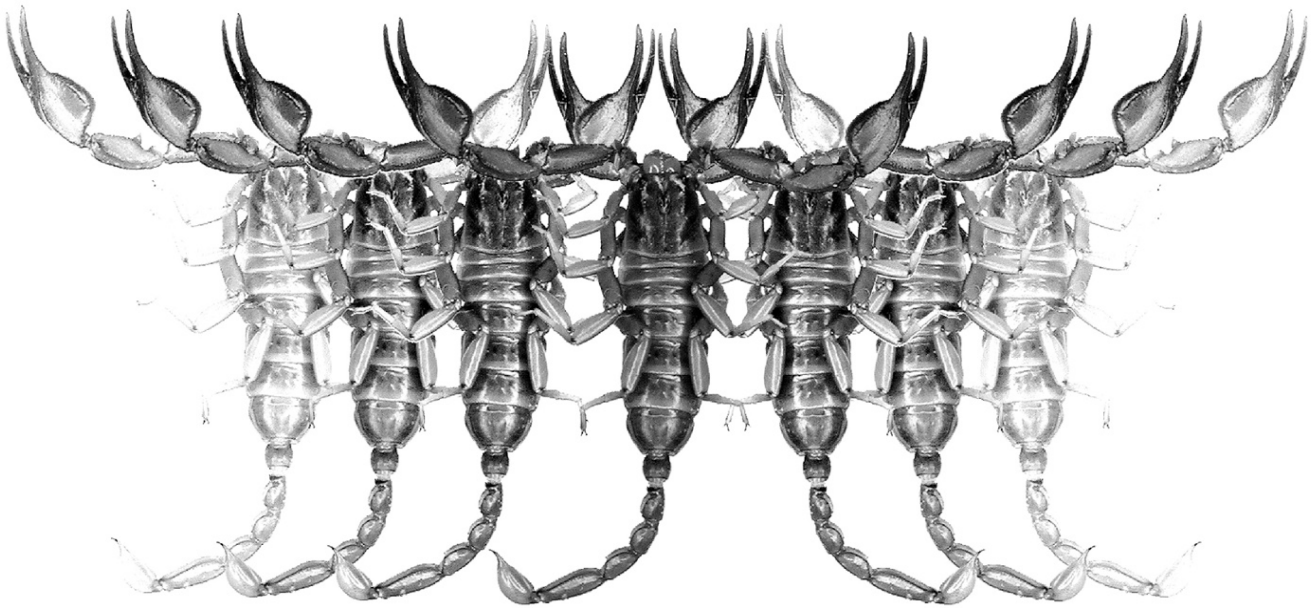


Euscorpius

Occasional Publications in Scorpiology



**Notes on *Compsobuthus*: redescription
of *C. arabicus* Levy et al., 1973 from Arabia, and
description of two new species from North Africa
(Scorpiones: Buthidae)**

František Kovařík, Graeme Lowe, Mark Stockmann & František Štáhlavský

February 2020 — No. 298

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Occasional Publications in Scorpiology

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Publication date: 6 February 2020

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Notes on *Compsobuthus*: redescription of *C. arabicus* Levy et al., 1973 from Arabia, and description of two new species from North Africa (Scorpiones: Buthidae)

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Summary

Two new species of *Compsobuthus* Vachon, 1949, are described: *C. turieli* sp. n. from Western Sahara and Morocco, and *C. ullrichi* sp. n. from Egypt. The species *C. arabicus* Levy et al., 1973 is redescribed based on analysis of the holotype plus extensive material from Oman and the United Arab Emirates. These species are compared to others from their respective regions: *C. kabateki* Kovařík, 2003, *C. levyi* Kovařík, 2012, and *C. polisi* Lowe, 2001, for which new illustrations and biometrics are provided based on types and topotypic material. The hemispermatophores of *C. arabicus*, *C. turieli* sp. n. and *C. ullrichi* sp. n. are illustrated and described. We also record the karyotypes of *C. acutecarinatus*, *C. arabicus*, *C. maindroni* and *C. ullrichi* sp. n. All examined specimens possess 2n=22 and chromosomes gradually decreasing in length.

Introduction

Kovařík & Ojanguren-Affilastro (2013) revised all 43 known species of *Compsobuthus* Vachon, 1949 and between 2013 and 2019 several additional species were described: *C. air* Lourenço & Rossi, 2018 (Niger), *C. armenicus* Lourenço et al., 2015 (Armenia), *C. eritreaensis* Kovařík et al., 2016 (Eritrea), and *C. maidensis* Kovařík, 2018 (Somaliland). Also described was *C. vannii* Rossi, 2017 from Djibouti, but this is a junior synonym of *C. abyssinicus* (Birula, 1903). *C. williamsi* Lourenço, 1999 was synonymized with *C. matthiesseni* (Birula, 1905) and *C. tassili* Lourenço, 2010 was confirmed as a valid species (Kovařík, 2018b). Together with the two species described herein, the genus *Compsobuthus* is now represented by 49 species ranging from Mauretania (western Africa) through Arabia to India (Asia).

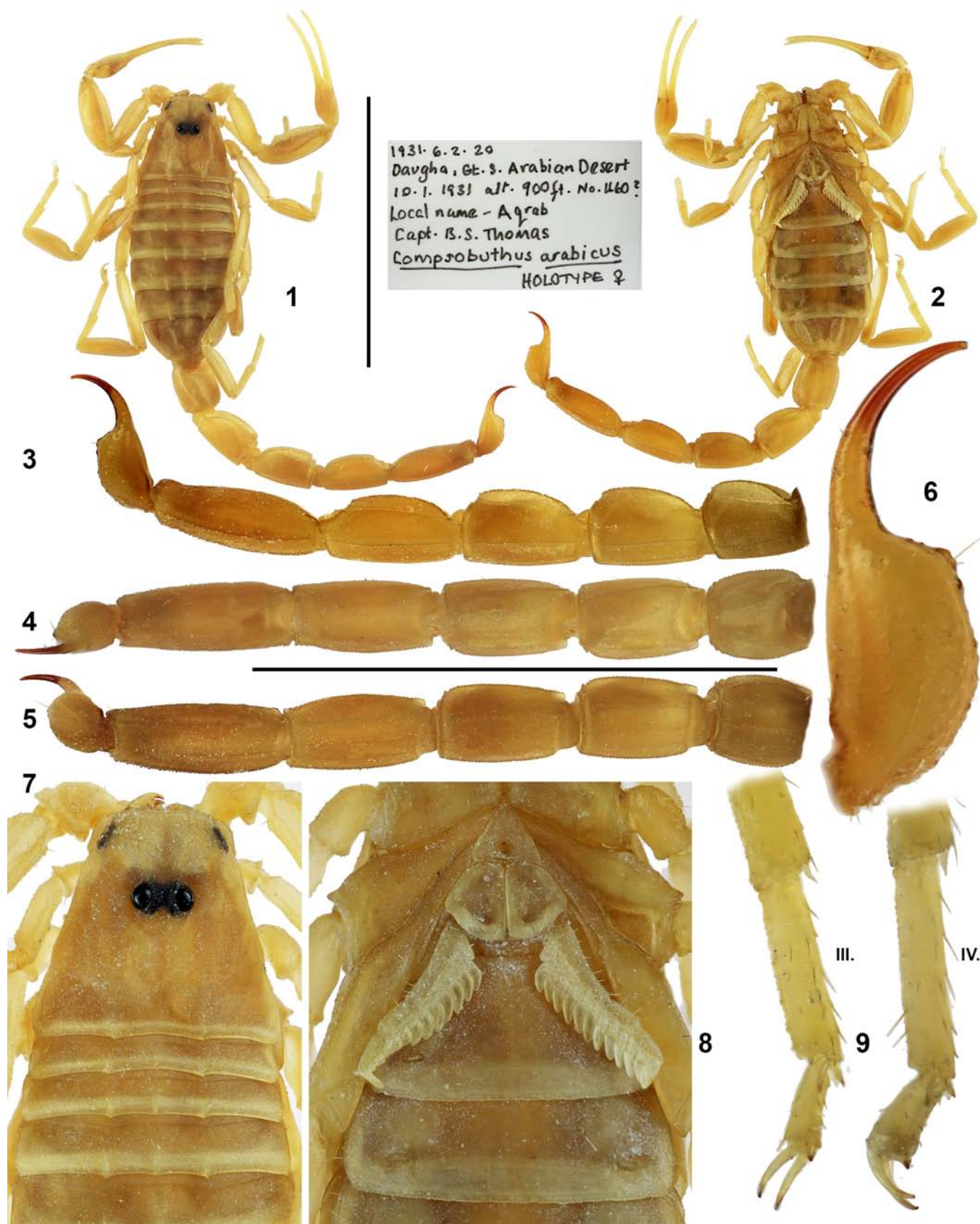
Methods, Materials & Abbreviations

Methods: Nomenclature and measurements generally follow Stahnke (1971), Sissom et al. (1990), Kovařík (2009), and Kovařík & Ojanguren-Affilastro (2013), except for trichobothriotaxy (Lowe & Kovařík, 2019; Vachon, 1974) and pedipalps (Lowe et al., 2014). Hemispermatophore terminology follows Kovařík et al. (2016b, 2018). Karyotype

analyses were based on chromosome preparations using the spreading technique, which is frequently applied in scorpion cytogenetics (e. g. Kovařík et al., 2009; Sadílek et al., 2015). The chromosomes were stained by 5% Giemsa solution in Sörensen phosphate buffer for 20 min. Five spermatocyte nuclei were measured using the software Image J 1.45r (<http://rsbweb.nih.gov/ij>) with the plugin Levan (Sakamoto & Zacaro, 2009). The relative lengths of the chromosomes were calculated for the diploid set.

Specimen depositories: BMNH (Natural History Museum, London, United Kingdom); FKCP (František Kovařík, private collection, Prague, Czech Republic); GLPC (Graeme Lowe, private collection, Auckland, New Zealand); MCZ, (Museum of Comparative Zoology, Massachusetts, USA); MNHN (Muséum National d'Histoire Naturelle, Paris, France); NHMB (Naturhistorisches Museum Basel, Switzerland); NMPC (National Museum of Natural History, Prague, Czech Republic); ONHM (Oman Natural History Museum, Muscat, Oman); TERC (Terrestrial Environmental Research Center, Abu Dhabi, United Arab Emirates); USNM (National Museum of Natural History, Washington, D.C., USA); ZSMC (Bavarian State Collection of Zoology, Munich, Germany). Note: FKCP collections will in future be merged with NMPC collections.

Morphometrics: D, depth; L, length; W, width.



Figures 1–9: *Compsobuthus arabicus* Levy, Amitai & Shulov, 1973, holotype female from Daugha, Saudi Arabia. **Figures 1–2.** Habitus in dorsal (1) and ventral (2) views. Scale bar: 10 mm. **Figures 3–5.** Metasoma and telson in lateral (3), dorsal (4) and ventral (5) views. Scale bar: 5 mm. **Figure 6.** Telson in lateral view. **Figure 7.** Carapace and tergites I–IV. **Figure 8.** Posterior coxosternal area, sternum, genital opercula, pectines and sternites III–IV. **Figure 9.** Right legs III–IV, tarsal segments, retrolateral aspect.

Systematics

Family Buthidae C. L. Koch, 1837

Compsobuthus Vachon, 1949

(Figures 1–224, Tables 1–4)

Compsobuthus Vachon, 1949: 93 (1952: 213); Fet & Lowe, 2000: 124 (complete reference list until 1998); Kovařík, 2003: 88 (in part); Kovařík, 2009: 31; Kovařík & Ojanguren-Affilastró, 2013: 145–158, figs. 777–941; Kovařík et al., 2016a: 1–21, figs. 1–77; Kovařík, 2018a: 1–11, figs. 1–39, tab. 1; Kovařík, 2018b: 4–6, figs. 1–9.

TYPE SPECIES. *Buthus acutecarinatus* Simon, 1882.

DIAGNOSIS. Small to medium-sized buthid scorpions, total length 20–55 mm. Carapace with distinct carinae, central lateral and posterior lateral carinae connected to form continuous linear series of granules, projecting beyond posterior margin as distinct spiniform processes. Carapace in lateral view with entire dorsal surface horizontal, 5 pairs of lateral eyes. Cheliceral fixed finger with two ventral denticles. Sternum type 1, sub-triangular. Pectines with fulcra, pectine teeth number 9–34. Hemispermaphore flagelliform, capsule in ‘3+1’-lobe configuration (*‘Buthus’* group; Kovařík et al., 2016a), with 3 sperm hemiduct lobes well separated from flagellum, basal lobe a well-developed acuminate hook. Tergites I–VI with three carinae projecting beyond posterior margins as distinct spiniform processes. Sternites III–VI with slit-like spiracles. Orthobothriotaxic type A. Pedipalp femur with dorsal trichobothria arranged in β -configuration. Pedipalp patella with trichobothrium d_3 internal to dorsomedian carina; chela with db basal to est , eb located on fixed finger; chela manus with Eb_{1-3} triad angled proximally (δ -configuration) or almost collinear (λ -configuration). Dentate margin of pedipalp chela movable finger with distinct granules divided into 8–14 linear rows, with 4 terminal granules and one basal terminal granule. Tibial spurs present on third and fourth pairs of legs.

REMARKS ON KARYOTYPES. We analyzed karyotypes of four *Compsobuthus* species (Table 4). All examined specimens of *C. acutecarinatus*, *C. arabicus*, *C. maindroni* and *C. ullrichi* sp. n. possess $2n=22$ (Figs. 210, 213, 216, 219, 222) and their chromosomes gradually decrease in length (Figs. 212, 215, 218, 221, 224, Table 4). This number of chromosomes was also previously found in *C. eritreaensis* Kovařík, Lowe, Plíšková & Šťáhlavský, 2016 (Kovařík et al., 2016a) and *C. matthiesseni* (Birula, 1905) (Šťáhlavský et al., 2014) (Table 4). This genus seems to have a conserved diploid number, similar to the genus *Androctonus*, which typically has $2n=24$ in all analyzed species (Sadílek et al. 2015). The chromosomes of all examined *Compsobuthus* species also exhibit typical buthid features such as holocentric organization and achiasmatic meiosis in males (e. g. Mattos et al., 2013). We observed only bivalents in one male of *C. acutecarinatus* from the locality W of Qairoon Hairitti

(Fig. 211) and in all males of *C. maindroni* (Fig. 220) during pachytene and postpachytene. However, we found also one quadrivalent in another two males of *C. acutecarinatus* from the localities Dhalkut beach and Wadi Ash Shuwaymiyyah (Fig. 214), in two males of *C. arabicus* from localities Jabal Bani Jabir and E of Wahiba (Fig. 217) and in the male holotype of *C. ullrichi* sp. n. (Fig. 223) during meiosis. Interestingly, the lengths of the chromosomes that form these multivalent associations are different among species (Figs. 215, 221, 224). This fact attests to the independent origin of these quadrivalents via reciprocal translocations that are very frequent chromosomal rearrangements within buthid scorpions (e. g. Šťáhlavský et al., 2014; Mattos et al., 2018).

Compsobuthus arabicus Levy, Amitai & Shulov, 1973

(Figures 1–63, 65–109, 216–218, Tables 1–2, 4)

Compsobuthus arabicus Levy, Amitai & Shulov, 1973: 122–124, figs. 17–20; Fet & Lowe, 2000: 125 (complete reference list until 1998); Tigar & Osborne, 1999: 174, 180, tab. 2; Lowe, 2001: 172; Fet et al., 2003: 3; Kovařík, 2003: 89 (?); Hendrixson, 2006: 62–64, figs. 10, 13; Lowe, 2009: 3; El-Hennawy, 2009: 121 (in part); Lowe, 2010: 36; Lourenço & Duhem, 2012: 124; Kovařík, 2012: 2; Kovařík & Ojanguren-Affilastró, 2013: 146–149 (in part); Alqahtani et al., 2019: 22, fig. 2d (?); Lowe et al., 2019: 24, fig. 108.

Compsobuthus acutecarinatus arabicus: Kovařík, 2001: 80.

Compsobuthus acutecarinatus: Kovařík, 2002: 7 (in part).

TYPE LOCALITY AND TYPE DEPOSITORY. Saudi Arabia, Daugha; BMNH.

TYPE MATERIAL. **Saudi Arabia**, Daugha [18.9833°N 51.1134°E], 10.I.1931, 900 ft a.s.l., 1♀ (holotype, 1931.6.2.20, examined), leg. B.S. Thomas, BMNH; Ramlat Mefel [19.9536°N 54.5516°E, 114 m a.s.l.] 1♀ (examined), Khor Mefel [19.9117°N 54.4814°E, 114 m a.s.l.] 1♀ (not examined), X.1945–II.1946, leg. W. Thesiger, BMNH. **Oman**: Wadi Mughshin [19.5476°N 54.8835°E, 114 m a.s.l.] 1♀ (not examined), X.1945–II.1946, leg. W. Thesiger, BMNH.

REMARKS. Locality coordinates of type material cited above (in square brackets) were obtained from maps published by the collectors (Thomas, 1931; Thesiger, 1946). Two paratype localities of Thesiger cited as ‘Ramlat Enfel’ and ‘Khor Enfel’ in the original description of Levy et al. (1973) were misspelt. In fact, Thesiger (1946) indicated on his map the localities Ramlat Mefel and Khor Mefel along the path of his travels. These two sites are near each other, positioned within the dunes of the Rub’ al-Khali in southeastern Saudi Arabia, close to the Oman border. Errors may have been due to misreading of labels, and were duplicated in subsequent listings (Fet & Lowe, 2000; El-Hennawy, 1992, 2009; Vachon, 1979; Alqahtani et al. 2019). The other paratype locality cited by Levy et al. (1973), ‘Wadi Mughhin’, is actually Wadi



Figures 10–17: *Compsobuthus arabicus*, holotype female, right pedipalp. **Figures 10–12.** Chela in dorsal (10), external (11) and ventrointernal (12) views. **Figures 13–15.** Patella in dorsal (13), external (14) and ventral (15) views. **Figure 16.** Trochanter and femur, dorsal view. **Figure 17.** Movable finger, dorsal view showing dentition. White circles: trichobothrial positions (Figures 10–14, 16).

Mughshin (Thesiger, 1946) (also spelt ‘Wadi Muqshin’), as suggested by Fet & Lowe (2000). Kovařík (2003) listed *C. arabicus* (1 ♂, immature) from 150 km SSW of Riyadh, central Saudi Arabia (see also Kovařík, 2002: 7). We have not re-examined this specimen to confirm its validity. Alqahtani et al. (2019) reported *C. arabicus* from southwestern Saudi Arabia, although we have not directly confirmed this record.

OTHER MATERIAL EXAMINED. Oman: Mintirib, 22°26'N 58°48'E, 268 m a.s.l., 13.II.1980, wadi, Oman Eastern Sands Project, 1♀, leg. W. Büttiker, NHMB 705.00; Wahiba Sands, 21°57'N 58°53'E, 22.XII.1985, 1♀, leg. M. D. Gallagher, NHMB; Shariq, 22°28'N 58°48'E, 295 m a.s.l., 9.II.1986, *Acacia* wood, Oman Eastern Sands Project, 1♀, leg. W. Büttiker, NHMB; Yalooni, 19°56'N 56°06'E, 2.XI.1993, 1♀, leg. Cjv, YAL 518, BMNH; Yalooni, 19°57'N 57°07'E, 154 m a.s.l., 18.XI.1993, inside portacabin, 1♂, leg. M. W. Lawrence, NHMB; Wahiba Sands, 22°10.68'N 58°51.16'E, 90 m a.s.l., 7.X.1993, 19:00 h, UV detection, base of shrub, nr base of linear dunes with vegetation, 2♂, leg. G. Lowe, M.D. Gallagher, N. Wood and S. Prakash, NHMB; Yalooni, Jiddat Al Harasis, 19°56'N 57°05'E, 154 m a.s.l., 14.III.1994, 22:00 h, on sand and stones, 1♀, leg. M.D. Gallagher, MDG 8561, GLPC; Yalooni, 19°56'N 57°05'E, 154 m a.s.l., 15.III.1994, 22:00–23:00 h, UV detection, still on plant remains, under *Acacia* bush on sand mound, clear sky,

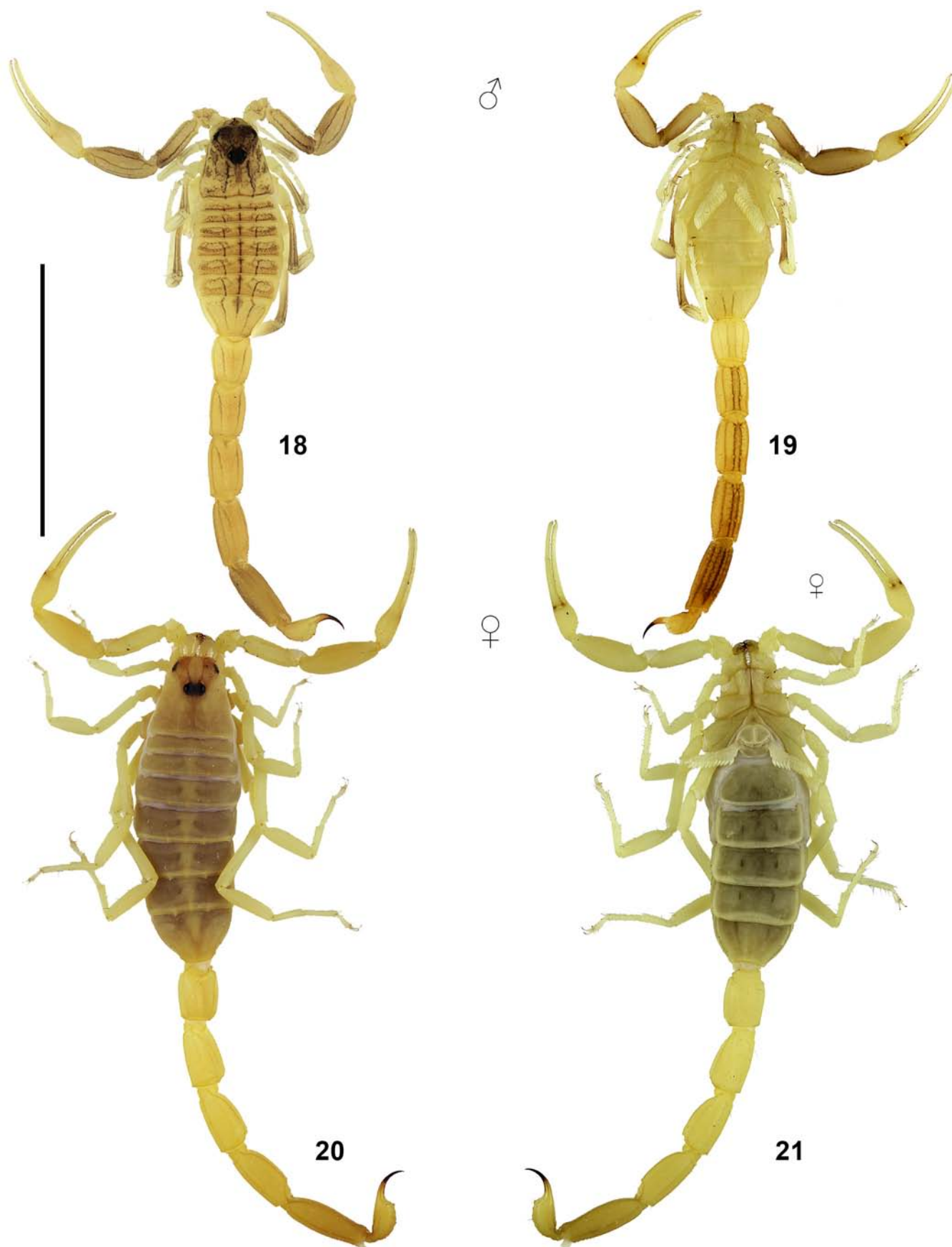
new moon, slight breeze, 1♀, leg. M. D. Gallagher, MDG 8564.5, NHMB; W of Ghabah, 21°23.89'N 57°09.56'E, 185 m a.s.l., 5.X.1994, UV detection on sand, sandy wadi with dunes and scrub adjacent to sabkha, windy, 2♂, leg. G. Lowe and M. D. Gallagher, MCZ; NW of Ghabah, 21°31.55'N 57°16.49'E, 180 m a.s.l., 5.X.1994, UV detection in small wadi, flat gravel plain, 1♂1♀, leg. G. Lowe and M. D. Gallagher, ONHM; Ramlat As Sahmah, 20°06.6'N 55°58.89'E, 155 m a.s.l., 7.X.1994, UV detection on sand, low dune slope, vegetated hummocks with *Calligonum*, 1♂, leg. G. Lowe and M. D. Gallagher, NHMB; S of Ghabah, 21°20.99'N 57°14.52'E, 180 m a.s.l., 8.X.1994, UV detection in sandy wadi with bushes, 1♂, leg. G. Lowe and M. D. Gallagher, GLPC; between Ghabah & Adam, 22°09.54'N 57°30.16'E, 250 m a.s.l., 16.IX.1995, 22:00–23:00 h, UV detection, sandy vegetated wadi in open gravel plain, trees and bushes, 1♂, leg. G. Lowe and J. Dundon, ONHM; nr Wadi Andam, road south of Sinaw, 21°19.35'N 58°15.55'E, 90 m a.s.l., 19.IX.1995, 23:00 h, UV detection on soft sand at base of shrubs, sandy soil mixed with firmer soil, gravel and small stones, patch of vegetation with shrubs and small trees, scorpions run quickly on sand when exposed to UV light, 1♀, leg. G. Lowe and M. D. Gallagher, NHMB; nr Wadi Andam, road south of Sinaw, 21°19.48'N 58°15.24'E, 90 m a.s.l., 19.IX.1995, 23:30 h, UV detection on soft sand at base of shrubs, sandy soil mixed with firmer soil, gravel and small

Dimensions		<i>C. arabicus</i> ♀ holotype	<i>C. arabicus</i> ♂ Dubai	<i>C. turieli</i> sp. n. ♂ holotype	<i>C. turieli</i> sp. n. ♀ paratype
Carapace	L / W	3.27 / 3.32	2.77 / 2.77	3.52 / 3.52	3.69 / 3.71
Mesosoma	L	6.70	5.74	7.65	9.03
Tergite VII	L / W	1.56 / 2.91	1.63 / 2.61	2.12 / 3.55	2.51 / 3.71
Metasoma + telson	L	15.45	14.16	18.18	17.96
Segment I	L / W / D	1.95 / 1.66 / 1.55	1.79 / 1.53 / 1.31	2.37 / 1.77 / 1.55	2.47 / 1.84 / 1.64
Segment II	L / W / D	2.27 / 1.49 / 1.38	2.15 / 1.37 / 1.34	2.73 / 1.54 / 1.49	2.71 / 1.56 / 1.53
Segment III	L / W / D	2.44 / 1.46 / 1.35	2.27 / 1.29 / 1.27	3.01 / 1.57 / 1.50	2.87 / 1.55 / 1.48
Segment IV	L / W / D	2.66 / 1.37 / 1.31	2.49 / 1.20 / 1.13	3.27 / 1.44 / 1.45	3.13 / 1.42 / 1.42
Segment V	L / W / D	3.28 / 1.32 / 1.17	3.00 / 1.13 / 1.02	3.62 / 1.35 / 1.26	3.58 / 1.43 / 1.31
Telson	L / W / D	2.85 / 0.98 / 0.93	2.46 / 0.82 / 0.86	3.16 / 1.11 / 1.09	3.21 / 1.11 / 1.10
Pedipalp	L	9.95	9.50	13.68	13.22
Femur	L / W	2.34 / 0.76	2.25 / 0.70	3.26 / 0.86	3.18 / 0.95
Patella	L / W	3.09 / 1.15	2.79 / 1.10	3.85 / 1.40	3.70 / 1.39
Chela	L	4.52	4.46	6.586	6.34
Manus	W / D	0.87 / 0.86	0.94 / 1.01	1.22 / 1.32	1.13 / 1.21
Movable finger	L	3.18	3.23	4.61	4.58
Total	L	25.42	22.67	29.33	30.68

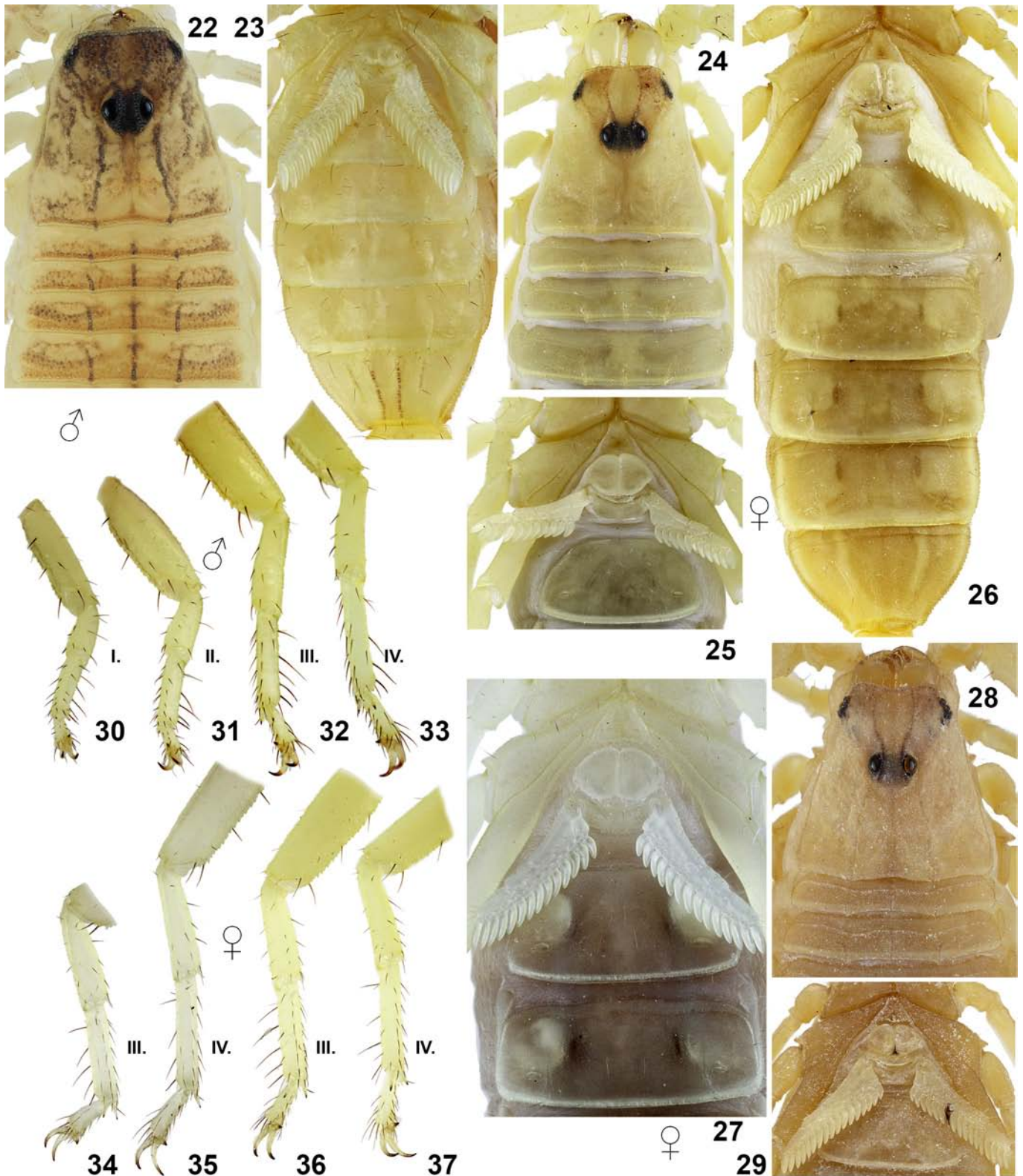
Table 1. Comparative measurements of adults of *Compsobuthus arabicus* and *C. turieli* sp. n. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

stones, patch of vegetation with shrubs and small trees, 1♂, leg. G. Lowe and M. D. Gallagher, NHMB; 10 km N Adam, 22°29.66'N 57°33'E, 300 m a.s.l., 23.X.1995, 22:45 h, in the open on sandy or gritty ground in a well vegetated small wadi, 1♀, leg. J. Dundon, GLPC; 55 km NW Ibri, 23°36.5'N 56°05.33'E, 290 m a.s.l., 22.XI.1995, 19:30-20:30 h, area of low sand dunes, scorpions found at entrance to burrows, 2♂, leg. J. Dundon 106, NMPC; 55 km NW Ibri, 23°35.5'N 56°04.33'E, 290 m a.s.l. 22.XI.1995, 20:30-21:30 h, area of low sand dunes, scorpions found at entrance to burrows, 1♂, leg. J. Dundon 107, NHMB; between Qarn Alan and Ghabah North, 21°22.03'N 57°05.47'E, 150 m a.s.l., 21.II.1996, UV detection on coarse grit on top of dusty alluvium, in shallow depression, *Acacia ehrenbergiana* with sand mounds at base, 1♂2♀1 juv., leg. M. D. Gallagher, MDG 8755, NHMB; 30 km S. of Adam, 22°05.9'N 57°31.12'E, 19.III.1996, 23:30-01:00 h, in sandy wadi, 2♀, leg. J. Dundon 118, NHMB; Ghneem (= Saiwan), 20°53.75'N 57°38.78'E, 17.IV.1997, 19:00-22:00 h, open sand between gravel ridges of small hills, 1♂, leg. M. D. Gallagher, I. D& M. Harrison and J. Peterson, MDG 8857, NHMB; Yalooni, 19°56'N 57°06'E, 1.VII.1997, Yalooni camp, 1♀, leg. S. Brend, YAL 617, NHMB; Ramlat Muqshin, 19°46.3'N 55°07.1'E, 100 m a.s.l., 29.XI.1997, on small dune sand, most under cover of scrub bushes, new moon, 4♀, leg. M. D. Gallagher and I. D. Harrison, MDG 8905, NHMB; Al Mushash, 19°39.5'N 54°00'E, 129 m a.s.l., 1.XII.1997, under rubbish on sand, 1♀, leg. M. D. Gallagher, MDG 8910, USNM; Wadi Qitbit, 19°07'N 54°31'E, 100 m a.s.l., 6.XII.1997, dry sandy desert with shrubs and small trees, strong new moon, no breeze, 1♀, leg. I. D. Harrison and M. D. Gallagher, MDG

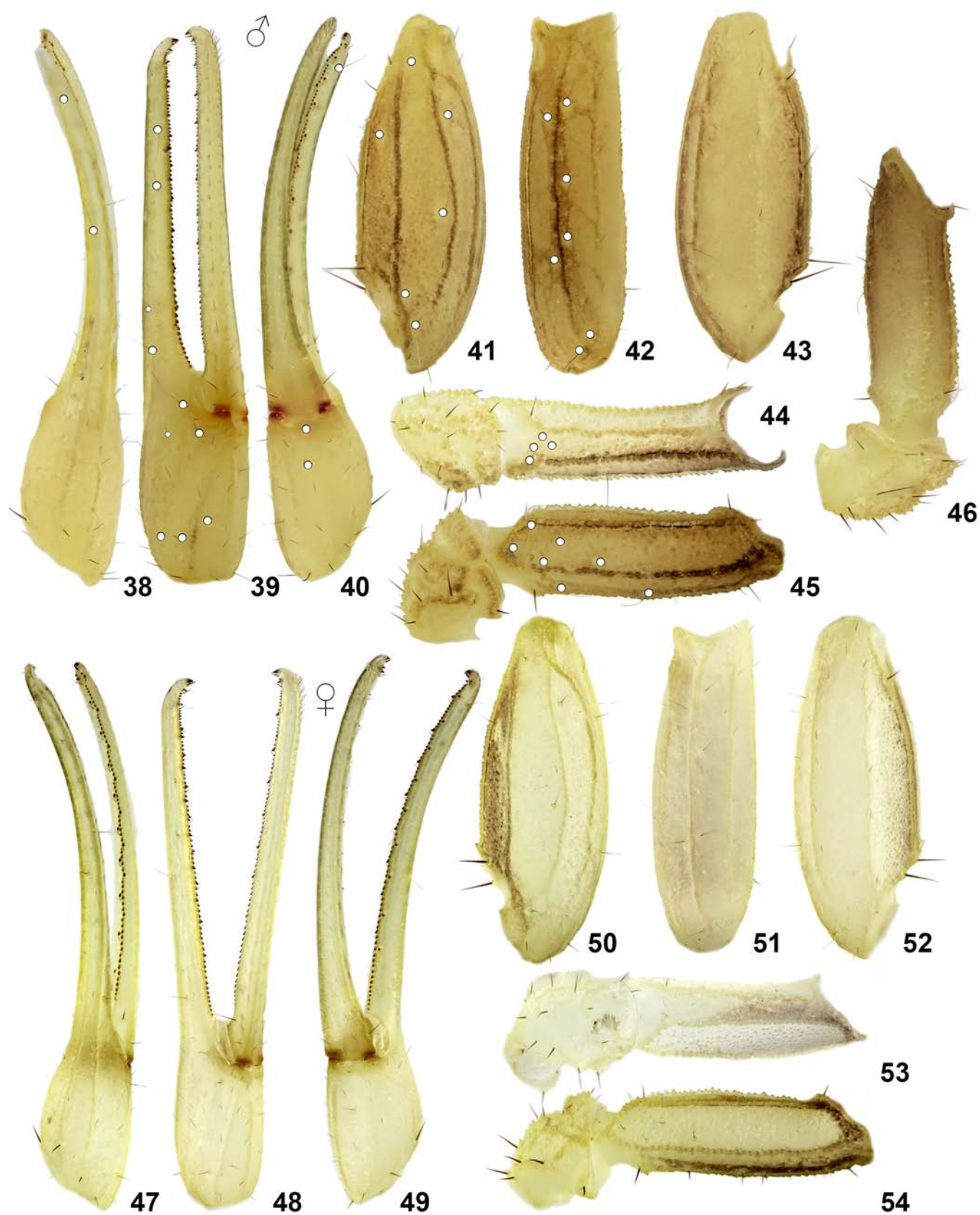
8923, ONHM; 15 km NNE of Fasad, 18°45.2'N 53°08.9'E, 290 m a.s.l., 29-30.I.1998, in high dunes and lower slopes, 1♂1♀, leg. M. D. Gallagher and J. N. Barnes, MDG 8940, GLPC; N. of Fasad, Empty Quarter, 18°40.3'N 53°04.4'E, 31.I.1998, under stone on level sand between dunes, 1♀, leg. J. N. Barnes, NHMB; E. of Ghabah Rest House, 21°22.8'N 57°15.2'E, 130 m a.s.l., 3.I.1999, 17:45 h, rocky plain with coarse grit, under rock, 1♀, leg. A. Winkler, ZSMC; Wadi Qit Bit, 19°08.11'N 54°31.08'E, 212 m a.s.l., 18.XII.2001, 16:30-17:45 h, day collection, under oil barrel, 2♀, leg. A. Winkler, ZSMC; Wadi Qit Bit, 19°09.33'N 54°30.47'E, 210 m a.s.l., 18.XII.2001, 20:00-21:00 h, UV detection, sandy dunes, near spring, on sand between shrubs, 1♂, leg. A. Winkler, ZSMC; W of Wahiba sands, 22.02990°N 58.18490°E, IX.2016, 1♂ (captive bred, 1801), 1♀, leg. M. Stockmann, FKCP; Al Wasil, 22.49143°N 58.71513°E (Fig. 107), XI.2017, dry dune area, sandy vegetated areas, UV detection at base of small shrubs, 1♂ (captive bred), 2♀, leg. M. Stockmann, FKCP; SW of Wahiba, 21°19.35'N 58°15.55'E, XI.2017, nr Wadi Andam, sandy area with small shrubs, 2♀, leg. M. Stockmann, FKCP; Dhofar Province, 236 km N Salalah, Wadi Qitbit, 19°9'20"N 54°30'27"E, 160 m a.s.l., 16-17.I.2018, 1♀, leg. P. Kabátek, FKCP; E of Aydam, 17.888736°N 53.066401°E (Fig. 108), X.2019, 1♂ (No. 1789), leg. M. Stockmann. **United Arab Emirates:** Bada Zaid, Abu Dhabi, 24°15'N 54°28'E, 20.V.1972, 1♀, leg. D. J. G. Williams, RS 6512, MNHN; Madinet Zayed, 23.68167°N 53.69861°E, 14.X.1993, 1♂1♀, leg. A. Saji, TERC; Al Khatim, 24.16849°N 54.98412°E, 17.XI.1993, 1♂, leg. A. Saji, TERC; env. Lahhab, Dubai, 24°59'00.7"N 55°39'36.2"E, 151 m a.s.l., 21.XI.2006, 1♂, leg. J. Batelka and H. Pinda, FKCP.



Figures 18–22: *Compsobuthus arabicus*, from Oman, habitus. **Figures 18–19.** Male from SW of Wahiba, 21°19.35'N 58°15.55'E, dorsal (18) and ventral (19) views. **Figures 20–21.** Female from Dhofar Province, Wadi Qitbit, 19°9'20"N 54°30'27"E. Scale bar: 10 mm.



Figures 22–37: **Figures 22–27:** *Compsobuthus arabicus*, prosoma and mesosoma. **Figures 22–23.** Male, SW of Wahiba, carapace and tergites I–IV (22), posterior coxosternal area and sternites (23). **Figures 24–25.** Female, Wadi Qitbit, carapace and tergites I–III (24), posterior coxosternal area and sternite III (25). **Figure 26.** Female, Oman, W of Wahiba sands (22.02990°N 58.18490°E), posterior coxosternal area and sternites. **Figure 27.** Female, SW of Wahiba (21°19.35'N 58°15.55'E, XI.2017), posterior coxosternal area and sternites III–IV. **Figures 28–29.** *C. polisi*, female paratype from Oman, Wadi Dirif, carapace and tergites I–II (28), posterior coxosternal area and sternite III (29). **Figures 30–37:** *C. arabicus*, legs, tibiae and tarsi, retrolateral aspects. **Figures 30–33.** Male, right legs I–IV. **Figures 34–35.** Female, SW of Wahiba, left legs III–IV. **Figures 36–37.** Female, Wadi Qitbit, left legs III–IV.



Figures 38–54: *Compsobuthus arabicus*, pedipalps. **Figures 38–45.** Male, SW of Wahiba, chela dorsal (38), external (39) and ventral (40), patella dorsal (41), external (42) and ventral (43), trochanter and femur internal (44), dorsal (45), and ventral (46) views. **Figures 47–54.** Female, SW of Wahiba, chela dorsal (47), external (48) and ventrointernal (49), patella dorsal (50), external (51) and ventral (52), trochanter and femur dorsointernal (53) and dorsal (54) views. White circles: trichobothrial positions (Figures 38–42, 44–45).



Figures 55–64: **Figures 55–63.** *Compsobuthus arabicus*. **Figures 55–57.** Male, SW of Wahiba, metasoma and telson lateral (55), ventral (56), and dorsal (57) views. **Figures 58–60.** Female, SW of Wahiba, metasoma and telson lateral (58), ventral (59), and dorsal (60) views. **Figures 61–63.** Female, Wadi Qitbit, metasoma and telson lateral (61), ventral (62), and dorsal (63) views. **Figure 64.** *C. polisi* Lowe, 2001, female paratype from Oman, Wadi Dirif, metasoma and telson lateral view. Scale bar: 10 mm.

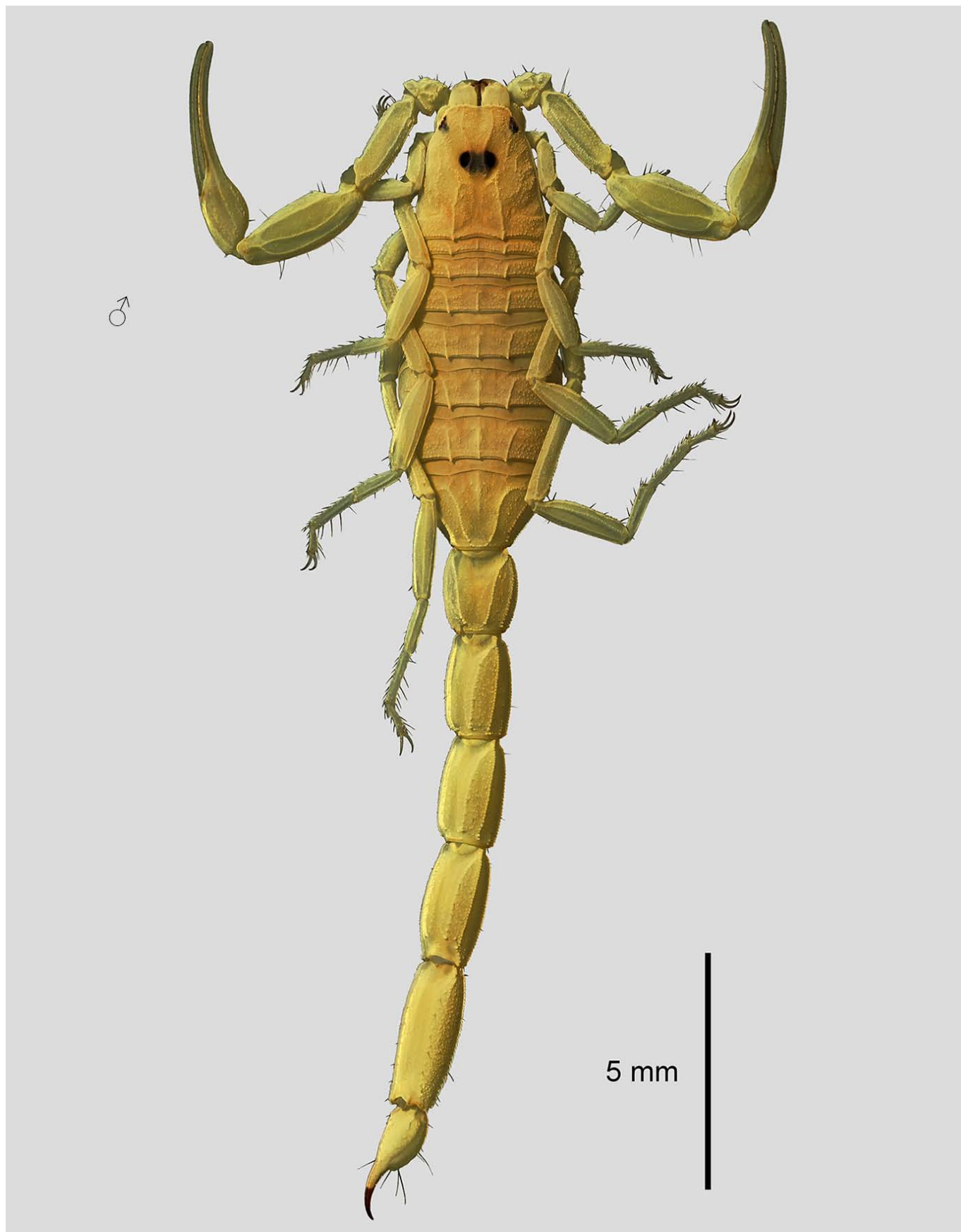


Figure 65. *Compsobuthus arabicus*. Male, Wahiba Sands (22°10.68'N 58°51.16'E, 7.X.1993), dorsal habitus. Color image with cuticular surface detail highlighted digitally by UV fluorescence. Scale bar: 5 mm.

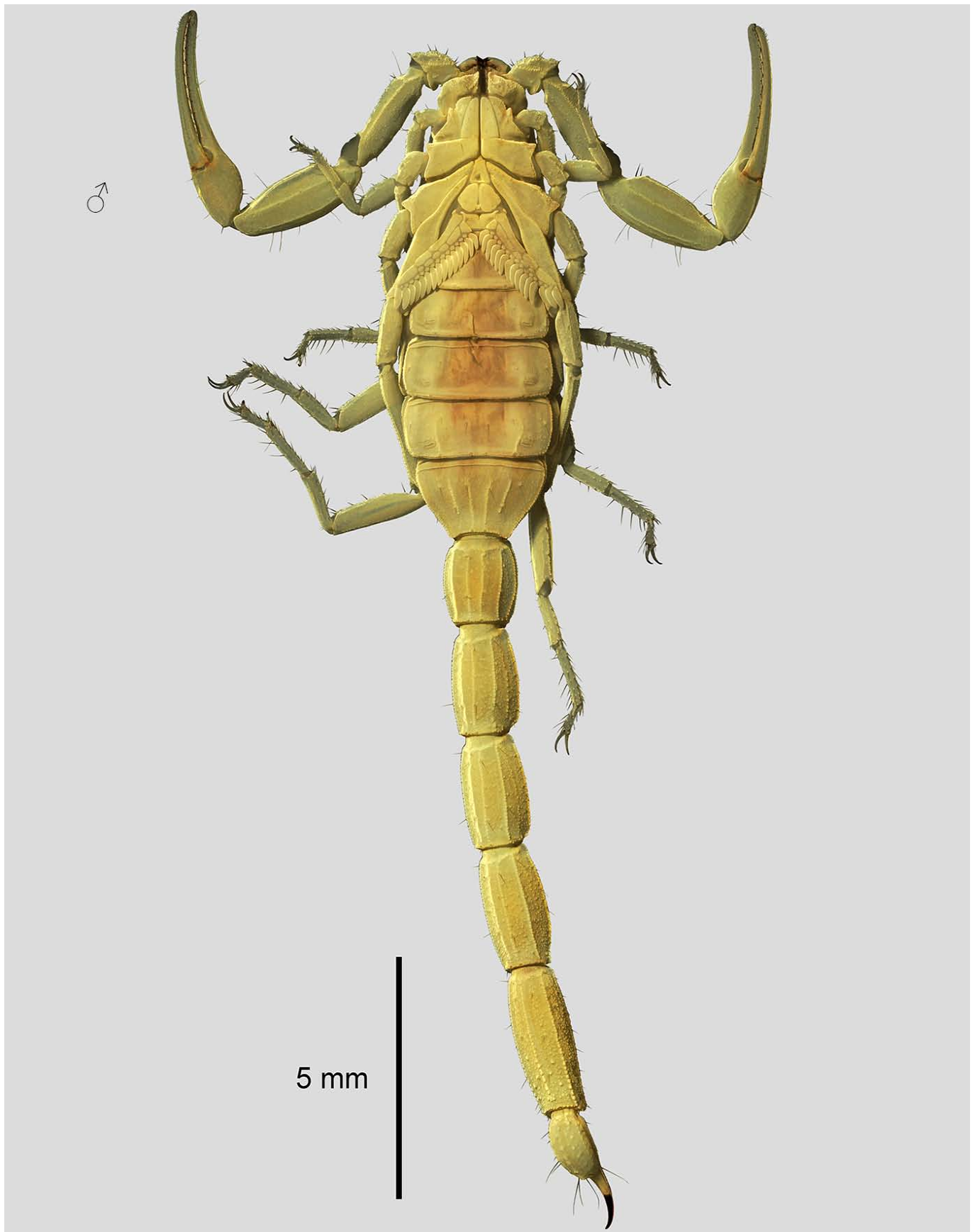


Figure 66. *Compsobuthus arabicus*. Male, Wahiba Sands (22°10.68'N 58°51.16'E, 7.X.1993), ventral habitus. Color image with cuticular surface detail highlighted digitally by UV fluorescence. Scale bar: 5 mm.

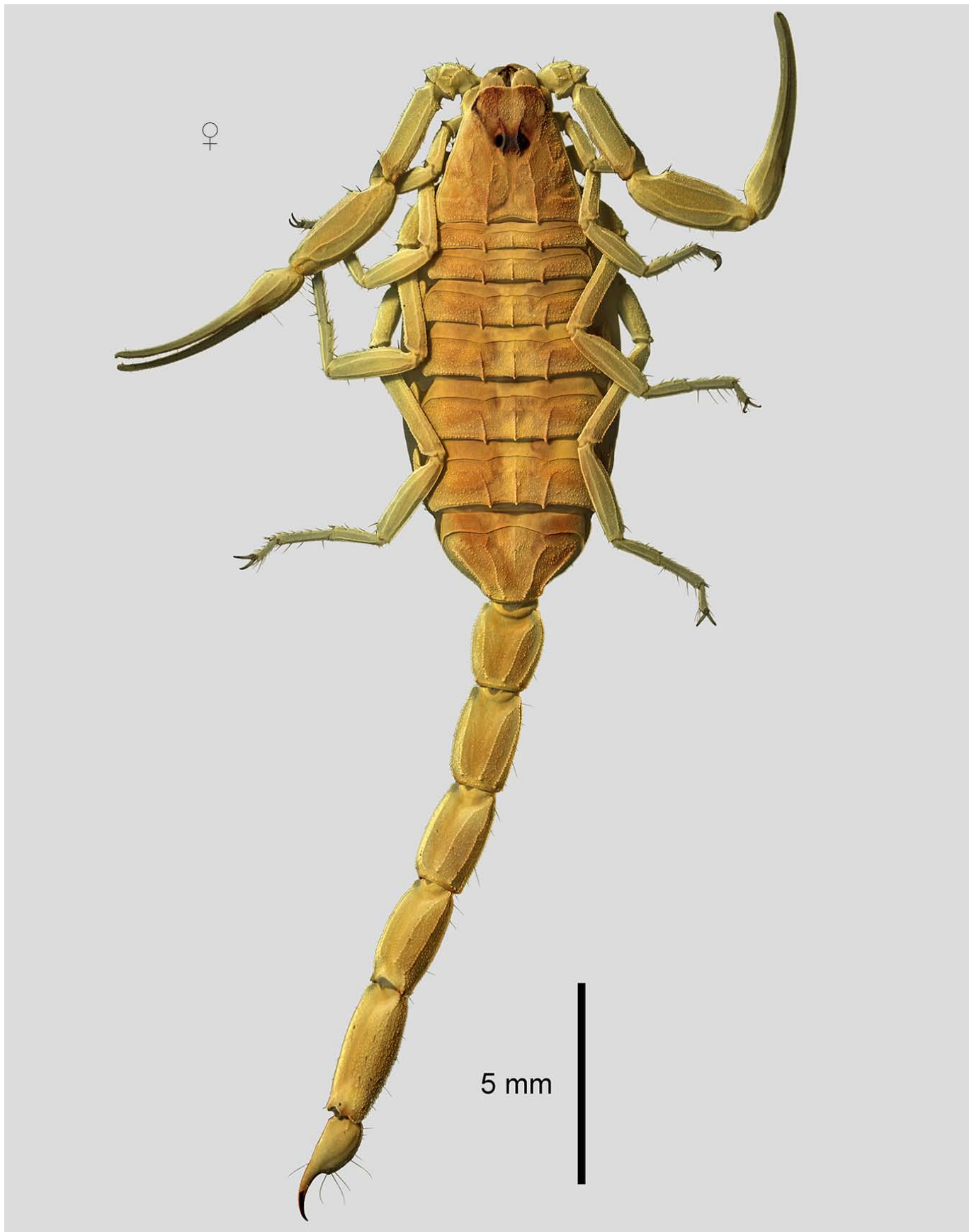


Figure 67. *Compsobuthus arabicus*. Female, 30 km S of Adam (22°05.9'N 57°31.12'E, 19.III.1996), dorsal habitus. Color image with cuticular surface detail highlighted digitally by UV fluorescence. Scale bar: 5 mm.

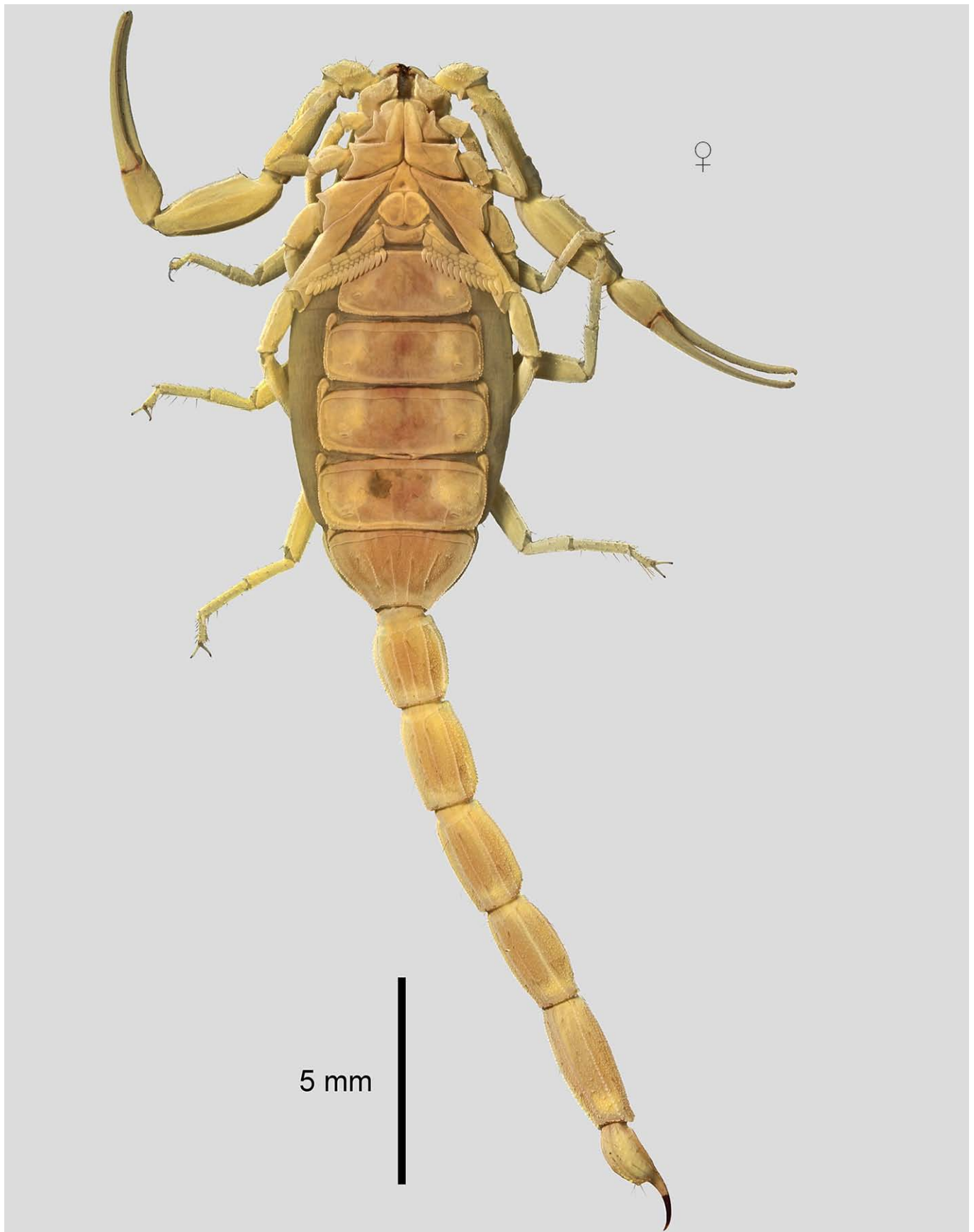


Figure 68. *Compsobuthus arabicus*. Female, 30 km S of Adam (22°05.9'N 57°31.12'E, 19.III.1996), ventral habitus. Color image with cuticular surface detail highlighted digitally by UV fluorescence. Scale bar: 5 mm.

segment(s)	ratio	♂ (N = 13)		♀ (N = 22)	
		mean ± SD	range	mean ± SD	range
Metasoma I	L/W	1.18 ± 0.03	1.14 – 1.23	1.18 ± 0.05	1.08 – 1.28
Metasoma II		1.58 ± 0.04	1.53 – 1.67	1.59 ± 0.06	1.52 – 1.69
Metasoma III		1.71 ± 0.04	1.63 – 1.76	1.73 ± 0.06	1.64 – 1.82
Metasoma IV		2.04 ± 0.04	1.97 – 2.11	2.05 ± 0.07	1.93 – 2.19
Metasoma V		2.59 ± 0.07	2.45 – 2.70	2.62 ± 0.12	2.37 – 2.80
Metasoma I	L/D	1.35 ± 0.06	1.27 – 1.43	1.35 ± 0.07	1.18 – 1.47
Metasoma II		1.69 ± 0.06	1.58 – 1.81	1.68 ± 0.08	1.53 – 1.81
Metasoma III		1.80 ± 0.06	1.68 – 1.92	1.79 ± 0.06	1.68 – 1.94
Metasoma IV		2.16 ± 0.07	1.98 – 2.29	2.16 ± 0.12	1.87 – 2.38
Metasoma V		2.91 ± 0.06	2.81 – 3.00	2.93 ± 0.13	2.57 – 3.20
Metasoma V	W/D	1.12 ± 0.03	1.08 – 1.15	1.12 ± 0.03	1.07 – 1.17
Pedipalp Femur	L/W	3.30 ± 0.14	3.05 – 3.57	3.29 ± 0.15	3.03 – 3.59
Pedipalp Patella		2.69 ± 0.09	2.57 – 2.82	2.77 ± 0.15	2.57 – 3.18
Pedipalp Chela		5.07 ± 0.23	4.70 – 5.47	6.06 ± 0.27	5.61 – 6.55
Pedipalp Movable Finger L/ Manus ventral L	L/L	2.26 ± 0.14	2.00 – 2.47	2.64 ± 0.11	2.38 – 2.81
Pedipalp Femur L/ Carapace L	L/L	0.83 ± 0.03	0.76 – 0.87	0.81 ± 0.03	0.76 – 0.86
Pedipalp Chela L/ Pedipalp Movable Finger L	L/L	1.41 ± 0.03	1.37 – 1.47	1.36 ± 0.03	1.28 – 1.41
Pectine L/ metasoma V W	L/W	1.65 ± 0.12	1.40 – 1.88	1.53 ± 0.09	1.38 – 1.69

Table 2. *Compsobuthus arabicus*, morphometric variation. Abbreviations: length (L), width (W), depth (D).

DIAGNOSIS. Total length 20–29 mm. Sexual dimorphism minor, pedipalp fingers straight in females, almost straight or weakly scalloped in males, male chela with broader manus, chela L/W ratio: ♂ 4.70–5.47, ♀ 5.61–6.55; metasomal segment proportions similar in both sexes. Base color uniform yellow. Carapace, tergites, pedipalps and legs densely, finely granular or shagreened. Anterior margin of carapace bearing 8–10 symmetrically distributed spinules. Pedipalp femur L/ Carapace L ratio: 0.76–0.87. Movable finger of pedipalp chela with 7–8 rows of granules, without external accessory denticles, with 9 internal accessory granules (*'acute carinatus'* group of Levy & Amitai, 1980). Manus of pedipalp chela shorter than fixed finger. Pedipalp chela L/movable finger L ratio: ♂ 1.37–1.47, ♀ 1.28–1.41. Metasoma I with 10 carinae, II–IV with 8 carinae. Median lateral carinae of segment II replaced by isolated granules that may coalesce into carinae posteriorly. All metasomal segments longer than wide; metasoma L/W ratios: III 1.63–1.82, IV 1.93–2.19, V 2.37–2.80. Metasoma V W/D ratio: 1.07–1.17. Ventral intercarinal surfaces of metasoma lacking macrosetae. Pectine teeth: ♂ 13–16, ♀ 9–15. Pectine L/ Metasoma V W ratio: ♂ 1.40–1.88, ♀ 1.38–1.69. Sternites and metasoma granulated. Sternite VI with 4 weak carinae, VII with 4 crenulate carinae. Telson elongate, aculeus shorter than vesicle. Subaculear tubercle moderate.

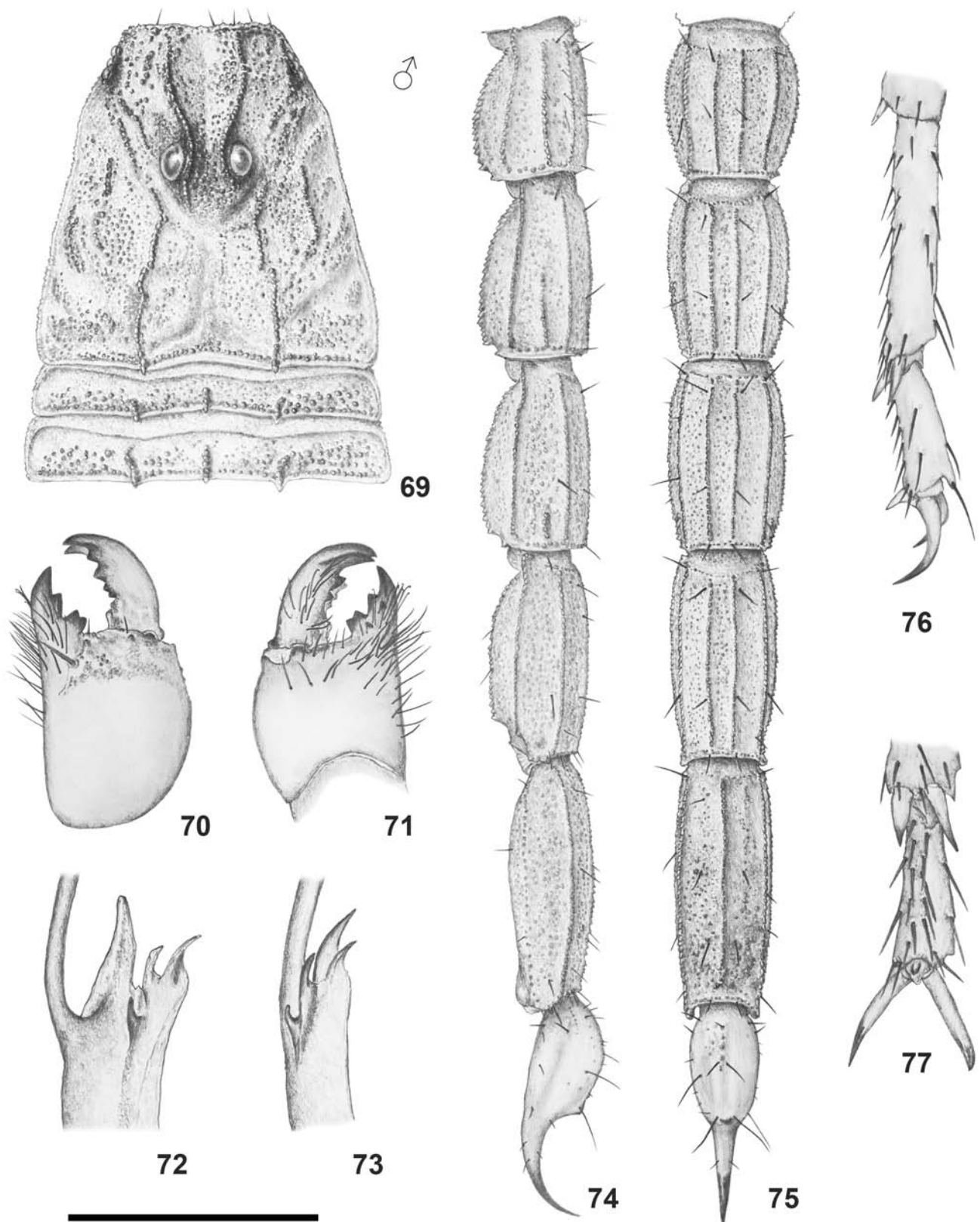
DESCRIPTION. Total length 21–29 mm in both sexes. The habitus is shown in Figs. 1–2, 18–21, 65–68, 103–104.

Trichobothriotaxy of pedipalps is shown in Figs. 10–14, 16, 39–42, 44–45, 78–82.

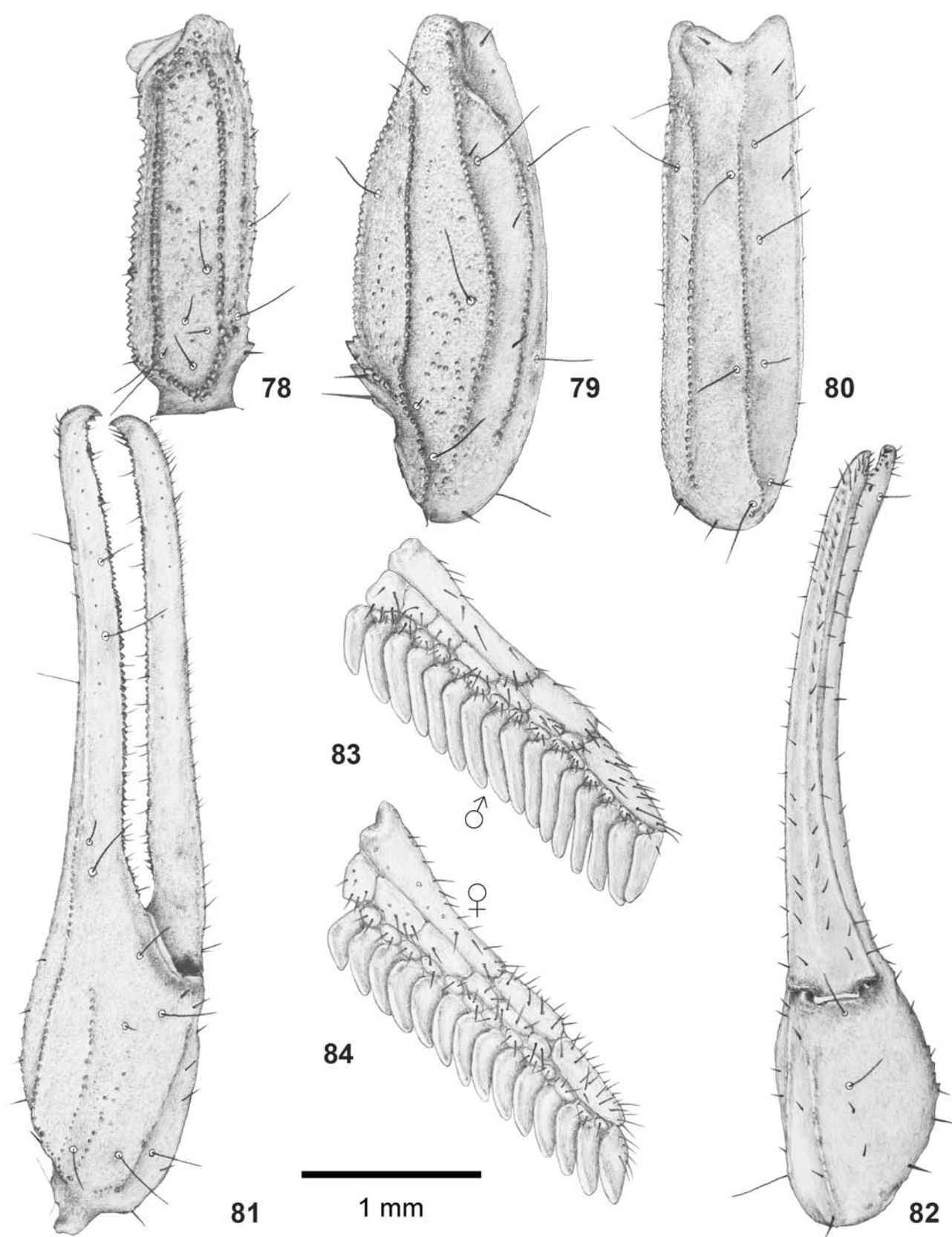
Sexual dimorphism. Sex differences are minor, females with straight pedipalp fingers (Figs. 11, 48), male fingers nearly straight, weakly undulate proximally with small gap (Figs. 39, 81). No sex differences in proportions of metasomal segments. Females with shorter pectines, smaller pectine teeth, larger genital opercula.

Coloration (Figs. 1–68). Base color is uniform yellow. Variable dark pigmentation may occur on the interocular triangle of carapace, pedipalp femur and patella, legs, and metasomal carinae. Metasoma V can have weak fuscosity that is barely visible.

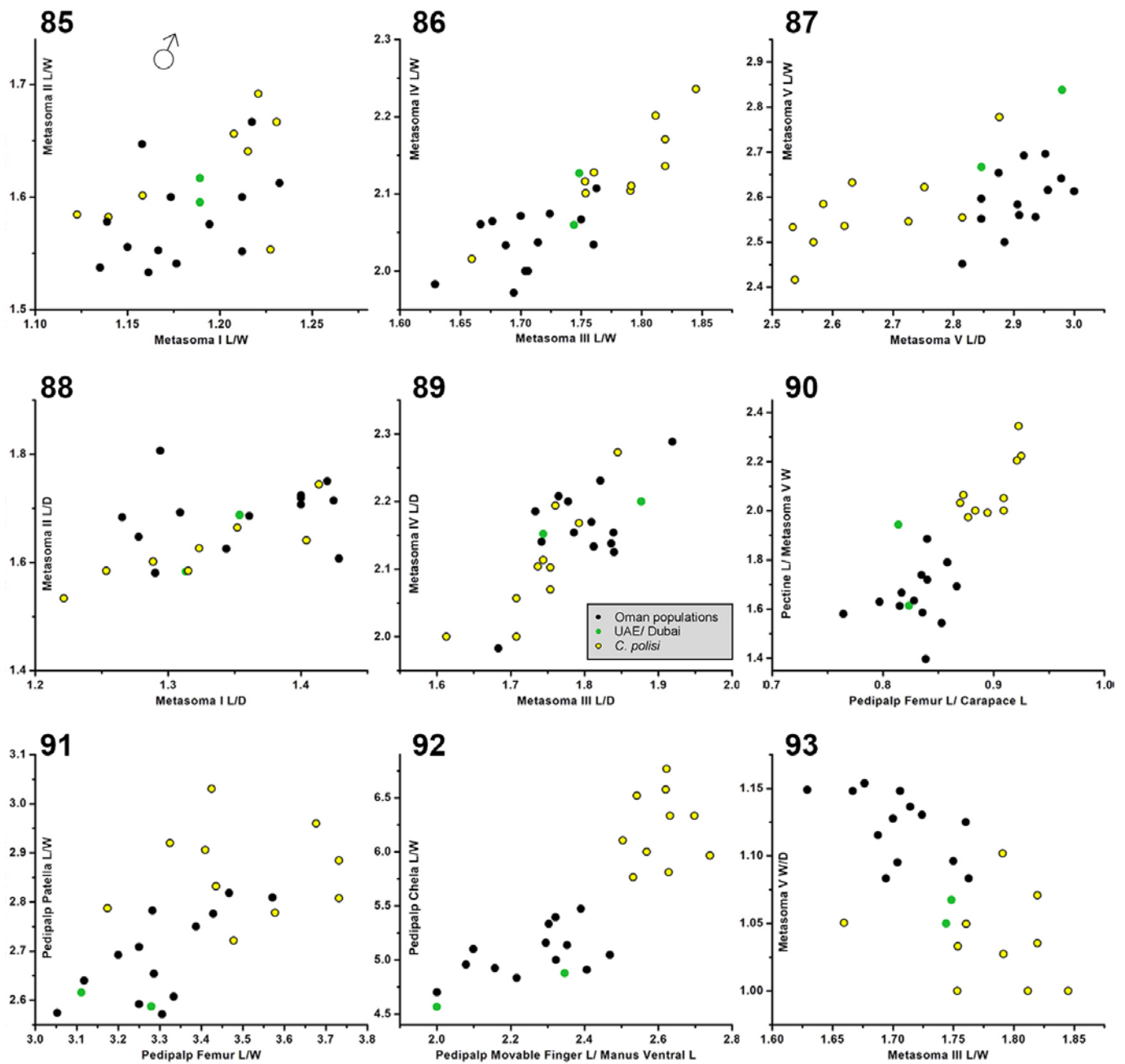
Carapace and mesosoma (Figs. 7–8, 22–27). The entire surface of the carapace is densely covered by granules of different sizes. The carinae are moderately to strongly developed and granular. The anterior margin of the carapace is weakly concave medially, and bears 8–10 symmetrically distributed spinules (macrosetae). The tergites are strongly granulated. Tergites I–VI are tricarinate, with strong, denticulate median and lateral carinae. Each carina terminates in a spiniform process that in the lateral carinae extends well past the posterior margin of the tergite. Tergite VII is pentacarinate, with lateral pairs of carinae strong, serratocrenulate, median pairs moderate, crenulate; median carina is weak and confined to the anterior half of the segment. Pectinal tooth counts: ♂ 13–16 (8×13, 9×14, 12×15, 4×16; N = 33 combs), ♀ 10–15



Figures 69–77: *Compsobuthus arabicus*. **Figure 69.** Carapace and tergites I–II. **Figures 70–71.** Right chelicera, dorsal (70) and ventral (71) views. **Figures 72–73.** Right hemispermatophore, capsule region, convex (72) and anterior (73) views. **Figures 74–75.** Metasoma and telson, lateral (74) and ventral (75) aspects. **Figures 76–77.** Right leg III, telotarsus and basitarsus, retrolateral view (76), and telotarsus, ventral view (77). Scale bar: 5 mm (69); 1 mm (70–71); 0.68 mm (72–73); 3 mm (74–75); 1.175 mm (76); 0.84 mm (77). Males from: 55 km NW of Ibra (23°36.5'N 56°05.33'E, 22.XI.1995) (69, 74–75); W of Ghabah (21°23.89'N 57°09.56'E, 5.X.1994) (70–71, 76–77); 15 km NNE of Fasad (18°45.2'N 53°08.9'E, 29–30.I.1998) (72–73).



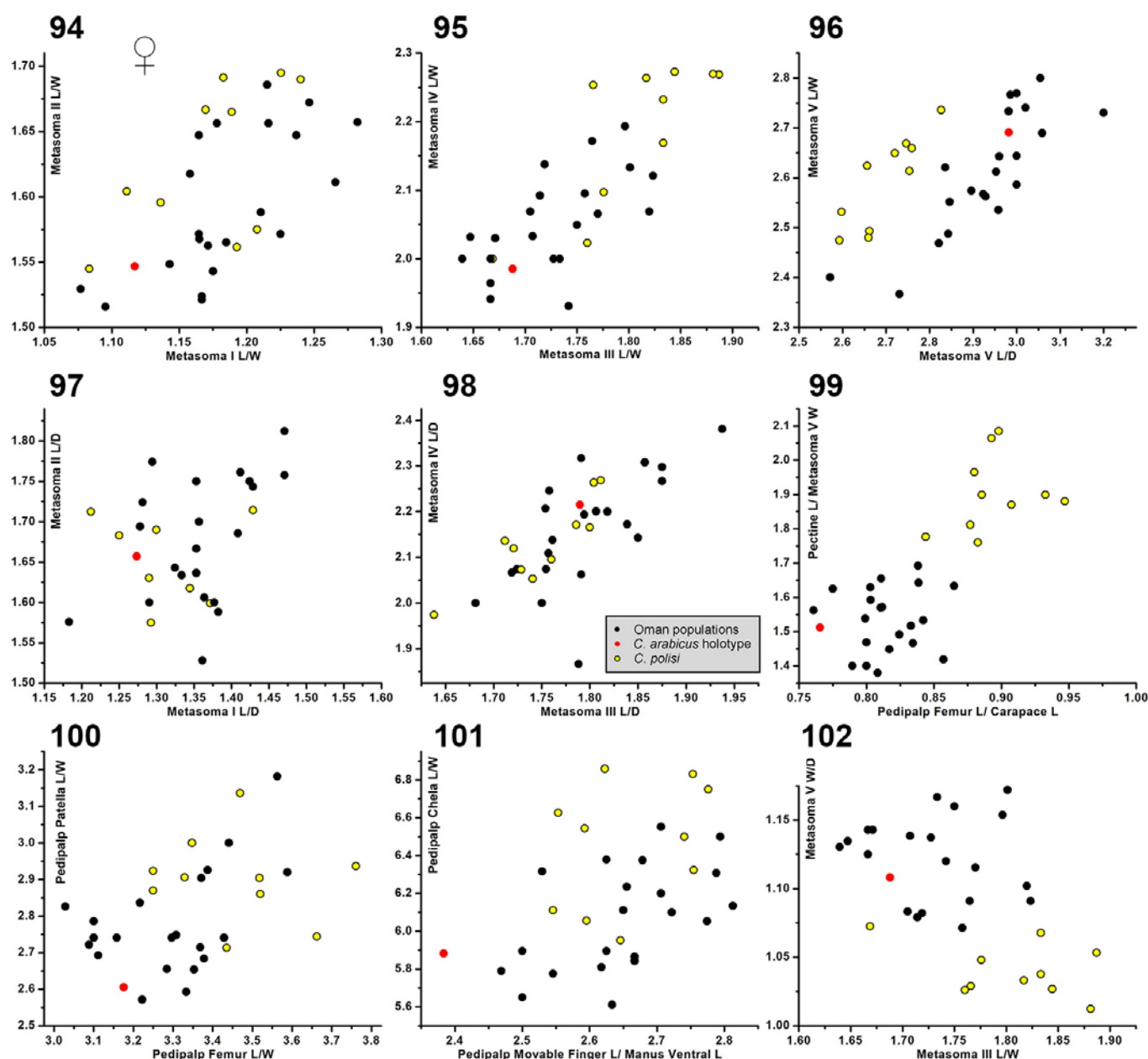
Figures 78–84: *Compsobuthus arabicus*. **Figures 78–82.** Right pedipalp, femur dorsal (78), patella dorsal (79), external (80); chela external (81), ventral (82). **Figures 83–84.** Left pectine, male (83), female (84). Scale bar: 1 mm. Male from 55 km NW of Ibra (23°36.5'N 56°05.33'E, 22.XI.1995) (78–83); female from 10 km N of Adam (22°29.66'N 57°33'E, 23.X.1995) (84).



Figures 85–93: Scatter plots showing variation in male morphometric ratios of *Compsobuthus arabicus*, and *C. polisi* Lowe, 2001. Metasoma I L/W vs. metasoma II L/W (85), metasoma III L/W vs. metasoma IV L/W (86), metasoma V L/D vs. metasoma V L/W (87), metasoma I L/D vs. metasoma II L/D (88), metasoma III L/D vs. metasoma IV L/D (89), pedipalp femur L/ carapace L vs. Pectine L/ Metasoma V W (90), pedipalp femur L/W vs. pedipalp patella L/W (91), pedipalp movable finger L/ manus ventral L vs. pedipalp chela L/W (92), and metasoma III L/W vs. metasoma V W/D (93). Black circles: *C. arabicus* samples from Oman; green circles: *C. arabicus* samples from United Arab Emirates; yellow circles: *C. polisi* samples (all from Oman).

(1×10, 2×11, 17×12, 17×13, 14×14, 1×15; N = 52 combs). The pectine marginal tips extend barely to the posterior margin of sternite III in females, and to half the length of sternite IV in males (not past the distal end of coxa IV). The pectines have 3 marginal lamellae and 6–8 middle lamellae. The lamellae bear numerous dark setae, and each fulcrum bears 2–3 dark setae. Sternites are finely granulated or shagreened, more strongly so on lateral areas of sternites III–VI which have smoother medial areas, and uniformly granulated on sternite VII. The

posterior areas of sternites lack a broad glabrous patch. Sternites VI–VII bear 4 crenulate carinae, weakly developed on VI and well developed on VII. Other sternites bear one pair of weak posterior carinae on the medial side of the spiracles. **Metasoma and telson** (Figs. 3–5, 55–63). Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with five carinae. Median lateral carinae of metasoma II are indicated by isolated granules that may coalesce into carinae posteriorly. All segments sparsely setose and densely



Figures 94–102: Scatter plots showing variation in female morphometric ratios of *Compsobuthus arabicus*, and *C. polisi*. Metasoma I L/W vs. metasoma II L/W (94), metasoma III L/W vs. metasoma IV L/W (95), metasoma V L/D vs. metasoma V L/W (96), metasoma I L/D vs. metasoma II L/D (97), metasoma III L/D vs. metasoma IV L/D (98), pedipalp femur L/ carapace L vs. Pectine L/ Metasoma V W (99), pedipalp femur L/W vs. pedipalp patella L/W (100), pedipalp movable finger L/ manus ventral L vs. pedipalp chela L/W (101), and metasoma III L/W vs. metasoma V W/D (102). Black circles: *C. arabicus* samples from Oman; red circle: *C. arabicus* holotype from Daugha, Saudi Arabia; yellow circles: *C. polisi* samples (all from Oman).

granulate. Accessory rows of granules may be present on dorsal surfaces of segments as well as on the ventral surface of segment V. The telson is elongate, with aculeus slightly shorter than vesicle, and a moderately developed subaculear tubercle.

Pedipalps (Figs. 10–17, 38–54). The pedipalps are finely granulated and sparsely hirsute. The femur bears 5 carinae, the patella 7 granular carinae, the chela 7 carinae. The movable and fixed fingers bear 7–9 rows of granules, without external accessory granules, with 9 internal accessory granules on both

fingers. Pedipalp chela L/W ratio: ♂ 4.70–5.47, ♀ 5.61–6.55. Manus of chela shorter than fixed finger. Pedipalp chela L/ movable finger L ratio: ♂ 1.37–1.47, ♀ 1.28–1.41.

Legs (Figs. 9, 30–37). Legs III–IV bear small tibial spurs. Retrolateral and prolateral pedal spurs are present on all legs. The tarsomeres bear two rows of macrosetae on the ventral surface and several macrosetae on the other surfaces. Sparse bristlecombs of 3–5 setae are developed on basitarsi of legs I–III. The femur bears 4 carinae, the patella 4–6 carinae. The femur and patella bear only solitary macrosetae and



Figures 103–104. *Compsobuthus arabicus*, in vivo habitus of females from Oman, W of Wahiba Sands (103), and SW of Wahiba (104).



Figures 105–106. *Compsobuthus arabicus*, female from Oman, W of Wahiba sands, 22.02990°N 58.18490°E with newborns (105) and juveniles after first ecdysis (106).



Figures 107–108. *Compsobuthus arabicus*, localities. **Figure 107.** Oman, W of Wahiba sands. **Figure 108.** Oman, E of Aydam.

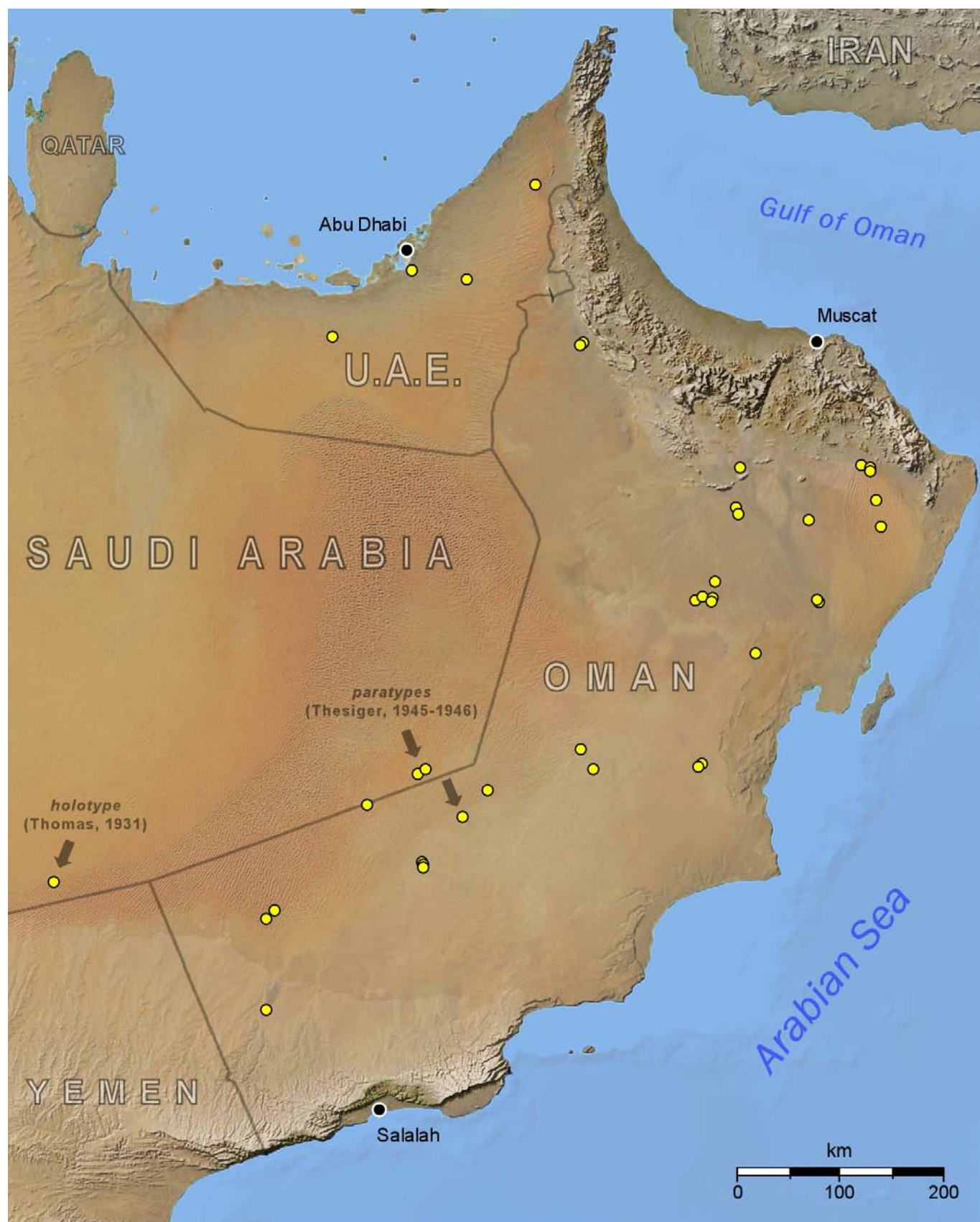


Figure 109. Map showing records of *Compsobuthus arabicus* Levy, Amitai & Shulov, 1973, in the southeastern Arabian Peninsula. The holotype and paratype localities are indicated by arrows. Plotted records were confirmed by examination of materials, with the exception of two of the three paratype localities of Thesiger.

are granulated on prolateral surfaces, weakly granulated or smooth on retrolateral surfaces. Tarsal ungues strongly elongated, curved.

Hemispermaphore (Figs. 72–73). Flagelliform, elongate and slender. Flagellum separated from external lobe. Capsule region with 4 lobes at base of flagellum. Posterior lobe longest, triangular, apically rounded, median lobe shortest, apically truncate, anterior lobe acuminate with long thin terminus. Basal lobe is strong with a broad base and sharp, falcate hook.

Measurements. Table 1 lists measurements for representative male and female specimens. Morphometric variation is summarized in Table 2 and is plotted in Figs 85–102. The plots indicate that two male samples taken from populations in the United Arab Emirates are not morphometrically separable from Oman populations (Figs. 85–93). They also indicate that the female holotype from Saudi Arabia is not morphometrically separable from Oman populations (Figs. 94–102). We therefore consider all of these populations to represent a single species exhibiting continuous variation across its geographic range (Fig. 109).

AFFINITIES. *C. arabicus* is one of the smaller members of the ‘*acutecarinatus*’ group (Levy & Amitai, 1980), and it has a correspondingly low pectinal tooth count (10–15 in females). Other *Compsobuthus* species from Oman in the ‘*acutecarinatus*’ group have higher numbers of pectine teeth. In females, *C. acutecarinatus* (Simon, 1882) has 20–27 teeth, *C. maindroni* (Kraepelin, 1901) has 19–21, *C. nematodactylus* Lowe, 2009 has 28–33 and *C. polisi* Lowe, 2001 has 16–20. In Oman, *C. polisi* is a small species (adults 22–35 mm) that is outwardly similar to *C. arabicus*. It can be differentiated by the presence of numerous short, macrosetae on ventral intercarinal surfaces of the metasoma. It differs morphometrically in having somewhat more elongated (higher L/W ratio) metasomal segments III and IV (Figs. 86, 95) and pedipalp femur and patella (Figs. 91, 100), although there is overlap in some of the ratios. Metasomal segments of *C. polisi* tend to be deeper than those of *C. arabicus*, as indicated by lower L/D ratios (Figs. 87, 89, 96) and W/D ratio (Figs. 93, 102) (see Fig. 64 vs. Figs. 55–63). In males, *C. polisi* is separable from *C. arabicus* by having pedipalp chelae more slender with longer fingers (Fig. 92). Geographically, *C. polisi* is distributed more along the coastal regions, whereas *C. arabicus* ranges further inland in major aeolian dunes (Wahiba/ Sharqiya Sands, Rub’ al-Khali). Two other similarly small species belonging to the ‘*acutecarinatus*’ group are *C. pallidus* Hendrixson, 2006, and *C. setosus* Hendrixson, 2006, from northern and central Saudi Arabia, respectively. The former can be differentiated by having 10–11 granule rows on the pedipalp fingers, and the latter by the presence of numerous ventral intercarinal setae on the metasoma and sternite VII (Hendrixson, 2006).

ECOLOGY (Figs. 107–109). *C. arabicus* is a psammophilic species found in the expansive aeolian dune systems of Ramlat al-Wahiba and Rub’ al-Khali. It is not an ultrapsammophile, as

it is also distributed over other interior regions of Oman where sand dunes intermingle with silty, gravelly or stony substrates, such as the plateau of Jiddat al Harasis (Fig. 109). Like other arenicolous desert scorpions, it excavates burrows near the bases of vegetation and emerges at night to take ambush positions near burrow entrances. Tigar & Osborne (1999) examined the relationship between the surface activity of a diverse assemblage of nocturnal arthropods and the lunar cycle in an area near Abu Dhabi. Analysis of data pooled from all surveyed taxa revealed significantly more pitfall trap captures on a new moon, than on a full moon. For *C. arabicus*, there were 2 records on new moon, and none on full moon. However, this sample is too small to test the hypothesis of moon avoidance for this one species. We have observed surface activity of *C. arabicus* on both moonlit and dark nights. Among 16 independent records of nocturnal surface activity, 12 nights (75%) were 5 days or less from a new moon. This is consistent with the hypothesis, but is not conclusive because there is likely to be an inherent sampling bias due to collectors preferring to search for scorpions by UV detection on darker nights. Other scorpions that were observed together with *C. arabicus* in sandy habitats include: *Androctonus crassicauda* (Olivier, 1807), *Apistobuthus pterygocercus* Finnegan, 1932, *Buthacus nigroaculeatus* Levy, Amitai & Shulov, 1973, *Picobuthus dundoni* Lowe, 2010, *P. wahibaensis* Lowe, 2010, *Vachoniolus gallagheri* Lowe, 2010 and *V. globimanus* Levy, Amitai & Shulov, 1973.

LIFE HISTORY (Figs. 105–106). The following data were obtained from captive rearing in a temperate climate. In a gravid female collected in IX–XI.2016, parturition was recorded in VII.2017, with litter sizes of 7 juveniles. Only two individuals were reared to maturity, at sixth (♂) and seventh (♀) instars. In two gravid females collected in XI.2017, parturition was recorded in VI.2018, with litter sizes of 7 and 10 juveniles. These were reared to maturity by VI–VIII.2018 and IX–XI.2018, at fifth (♂) and sixth (♀) instars.

Compsobuthus turieli sp. n.

(Figures 110–163, Table 1)

<http://zoobank.org/urn:lsid:zoobank.org:act:1BCCBD64-4FB0-45ED-B1E1-0C1A6DC01E50>

TYPE LOCALITY AND TYPE DEPOSITORY. Western Sahara, 70 km S of Ad-Dakhla, 23°04.13'N 016°05.08'W; FKCP.

TYPE MATERIAL EXAMINED. **Western Sahara:** 70 km S of Ad-Dakhla, 23°04.13'N 016°05.08'W, 7.II.2005, 1♂ (holotype) 1juv. (paratype), leg. R. et H. Fouqué & S. Bečvář. **Morocco:** At Akka, 29.390083°N 8.268220°W, IX.2013, dry, barely vegetated farmland nr Qued Akka, collected by day under rock left from road construction, 1♀ (paratype), leg. C. Turiel and M. Stockman, FKCP; N of Zag, 28.24872°N 09.33291°W (Fig. 156), X.2016, in sandy flats with large black rocks, loose cover of shrubs and solitary trees, collected by day under rocks and UV detection by night sitting on rock, 2♀ 1juv. (paratypes), leg. M. Stockmann, FKCP.

ETYMOLOGY. It is a pleasure to name this species after Carlos Turiel (Neuss, Germany).

DIAGNOSIS. Total length 29–31 mm. Sexual dimorphism minor, pedipalp fingers straight in females, almost straight in male holotype, male chela slightly more robust, chela L/W ratio: ♂ 5.39, ♀ 5.59; metasomal segment proportions similar in both sexes. Base color uniformly yellow to yellowish brown. Carapace and tergites densely, finely granular. Anterior margin of carapace bearing 8 symmetrically distributed spinules. Pedipalp femur L/ Carapace L ratio: 0.86–0.93. Movable finger of pedipalp chela with 9–11 rows of granules, without external accessory denticles, with 10 internal accessory granules (*'acute carinatus'* group; Levy & Amitai, 1980). Manus of pedipalp chela shorter than fixed finger. Pedipalp chela L/movable finger L ratio: 1.38–1.43. Metasoma I–II with 10 carinae, III with 8–10 carinae, IV with 8 carinae. All metasomal segments longer than wide; metasoma L/W ratios: III 1.85–1.92, IV 2.20–2.27, V 2.50–2.68. Metasoma V W/D ratio: 1.07–1.09. Ventral intercarinal surfaces of metasoma lacking macrosetae. Pectine teeth: ♂ 16, ♀ 13–14. Pectine L/ Metasoma V W ratio: ♂ 2.00, ♀ 1.46. Sternites and metasoma granulated, more strongly in females. Sternites VI–VII with 4 crenulate carinae. Telson rather elongate, aculeus shorter than vesicle. Subaculear tubercle absent.

DESCRIPTION. Total length 29–31 mm in both sexes. The habitus is shown in Figs. 110–113. Trichobothriotaxy of pedipalps is shown in Figs. 135–142.

Sexual dimorphism. Sex differences are minor, fingers of pedipalps straight in females and almost straight in the male holotype. No sex differences in proportions of metasomal segments. Female with considerably shorter pectines, smaller pectine teeth and larger genital opercula.

Coloration (Figs. 110–113, 157–159). The base color is uniformly yellow to yellowish brown. Weak fuscosity may be present on anterior interocular triangle.

Carapace and mesosoma (Figs. 123–126). The entire carapace is covered by granules of different sizes. The carinae are moderately to strongly developed and granular. The anterior margin of the carapace is weakly concave medially, and bears 8 symmetrically distributed spinules (macrosetae). The tergites are strongly granulated. Tergites I–VI are tricarinate, with strong, denticulate median and lateral carinae. Each carina terminates in a spiniform process that in the lateral carinae extends well past the posterior margin of the tergite. Tergite VII is pentacarinate, with lateral pairs of carinae strong, serratocrenulate, and median pairs moderate, crenulate; the median carina is weak and confined to the anterior half of the segment. Pectinal tooth counts: ♂ 16, ♀ 13–14 (3×13, 3×14). The pectine marginal tips extend barely to the posterior margin of sternite III in females, and to half the length of sternite IV in the male. The pectines have 3 marginal lamellae and 7–9 middle lamellae. The lamellae bear numerous dark setae, and each fulcrum bears 2–3 dark setae. All sternites are granulated. The posterior areas of sternites lack a broad glabrous patch. Sternites VI–VII bear 4 crenulate carinae, which are more strongly developed on VII. The other sternites bear one pair of carinae on the medial side of the spiracles.

Metasoma and telson (Figs. 114–122). Metasomal segments I–II with 10 carinae, III with 8–10 carinae, IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma III are indicated by isolated granules that may partially form carinae. All segments sparsely setose and densely granulate, more so in females. Accessory rows of granules are present on dorsal surfaces of segments as well as on the ventral surface of the fifth segment. The telson is rather elongate, with the aculeus a little shorter than the vesicle. A subaculear tubercle is absent.

Pedipalps (Figs. 135–155). The pedipalps are finely granulated and sparsely hirsute. The femur bears 5 carinae, the patella 7 granular carinae, the chela 5–7 carinae. The movable and fixed fingers bear 9–11 rows of granules, without external accessory granules, with 10 internal accessory granules on movable finger, 8–10 on fixed finger. Pedipalp chela L/W ratio: ♂ 5.39, ♀ 5.59. Manus of chela shorter than fixed finger. Pedipalp chela L/movable finger L ratio 1.38–1.43 in both sexes.

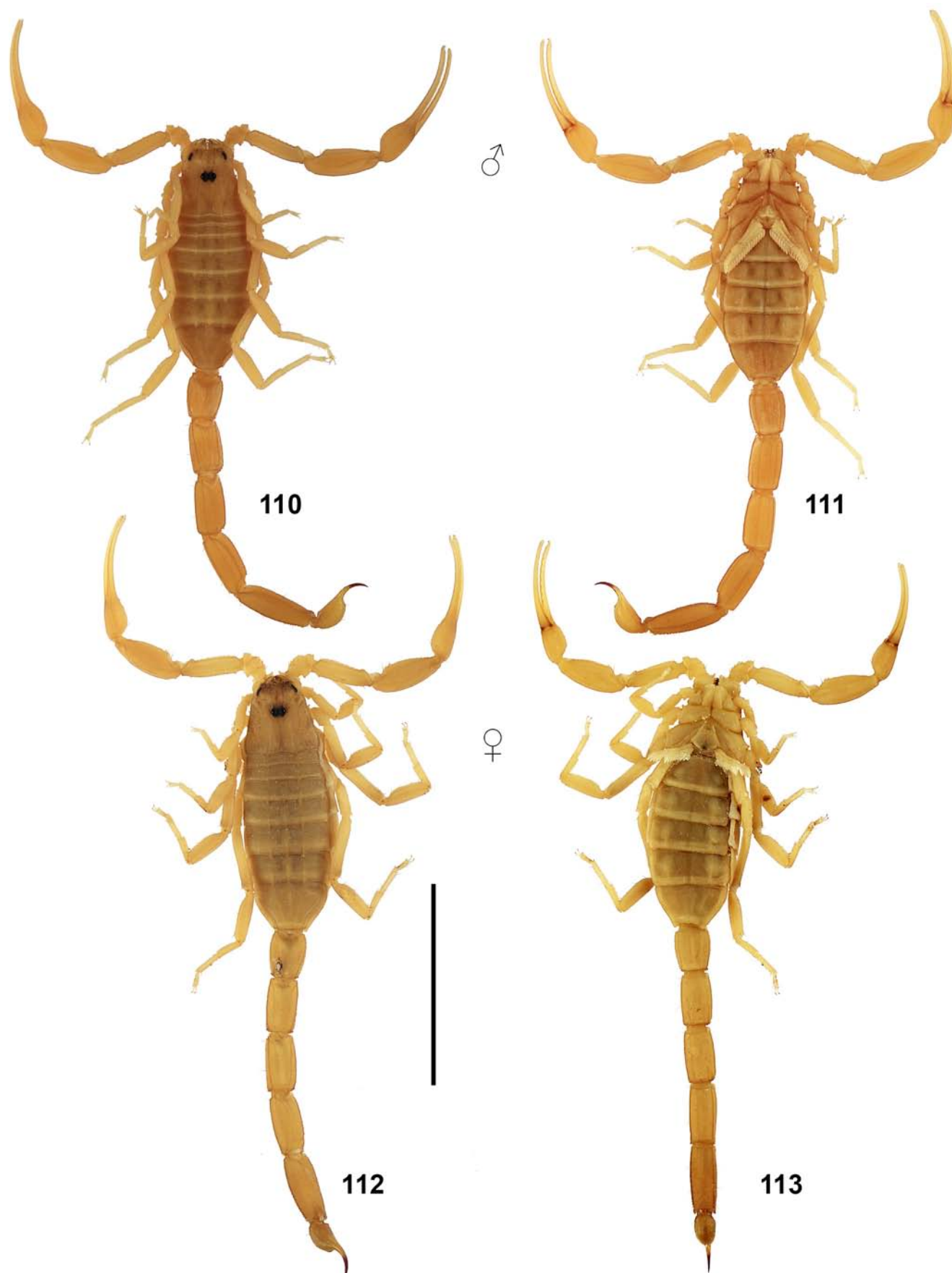
Legs (Figs. 127–134). Legs III–IV bear small to moderate tibial spurs. Retrolateral and prolateral pedal spurs are present on all legs. The tarsomeres bear two rows of macrosetae on the ventral surface and several macrosetae on the other surfaces. Bristlecombs are absent. The femur bears 4 carinae, the patella 4–6 carinae. The femur and patella bear only solitary macrosetae and are granulated on prolateral surfaces, smooth on retrolateral surfaces. Tarsal unguis moderately elongated, curved.

Hemispermaphore (Figs. 160–163). Flagelliform, elongate and slender, trunk ca. 7.7 times length of capsule region. Flagellum separated from external lobe, pars recta ca. 60% of trunk length, broad with anterior lamina, pars reflecta long, about the same length as trunk, thick, hyaline. Capsule region with 4 lobes at base of flagellum: posterior lobe longest, triangular, apically rounded, median lobe shortest, apically truncate, anterior lobe acuminate with long thin terminus. Basal lobe strong with broad base and sharp, falcate hook. Left and right hemispermaphores were similar.

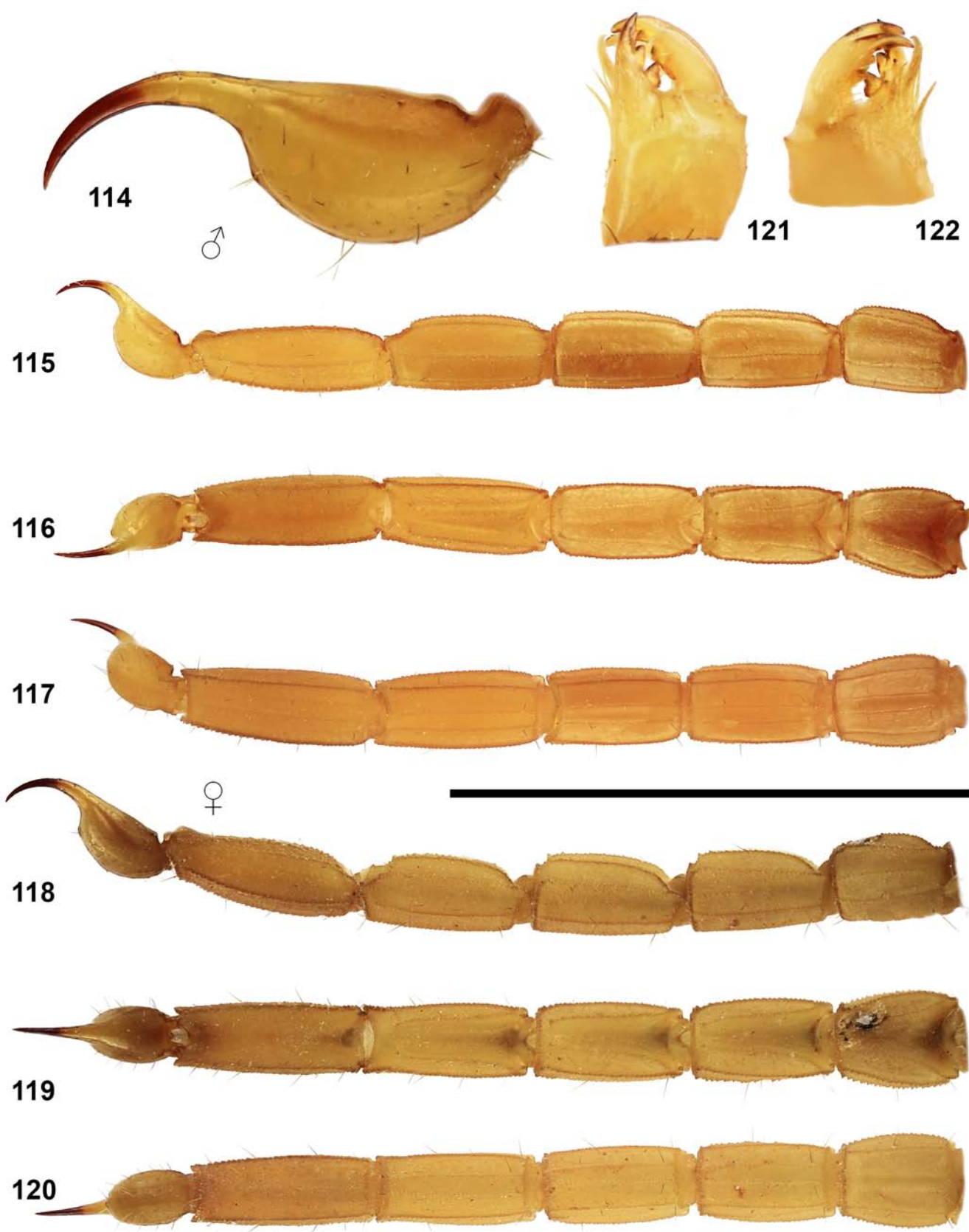
Measurements. See Table 1.

AFFINITIES. The described features distinguish *C. turieli* **sp. n.** from all other species of the genus. In the region, the only other known member of the *'acute carinatus'* group is *C. berlandi* Vachon, 1950, from Mauritania (type locality: Fort Gouraud, 400 km E of Villa-Cisneros) which is characterized by the presence of 7–8 rows of granules on the pedipalp movable finger, and total length 38 mm (Vachon, 1950). In contrast, *C. turieli* **sp. n.** has 9–11 rows of granules on the pedipalp movable finger, and total length < 31 mm.

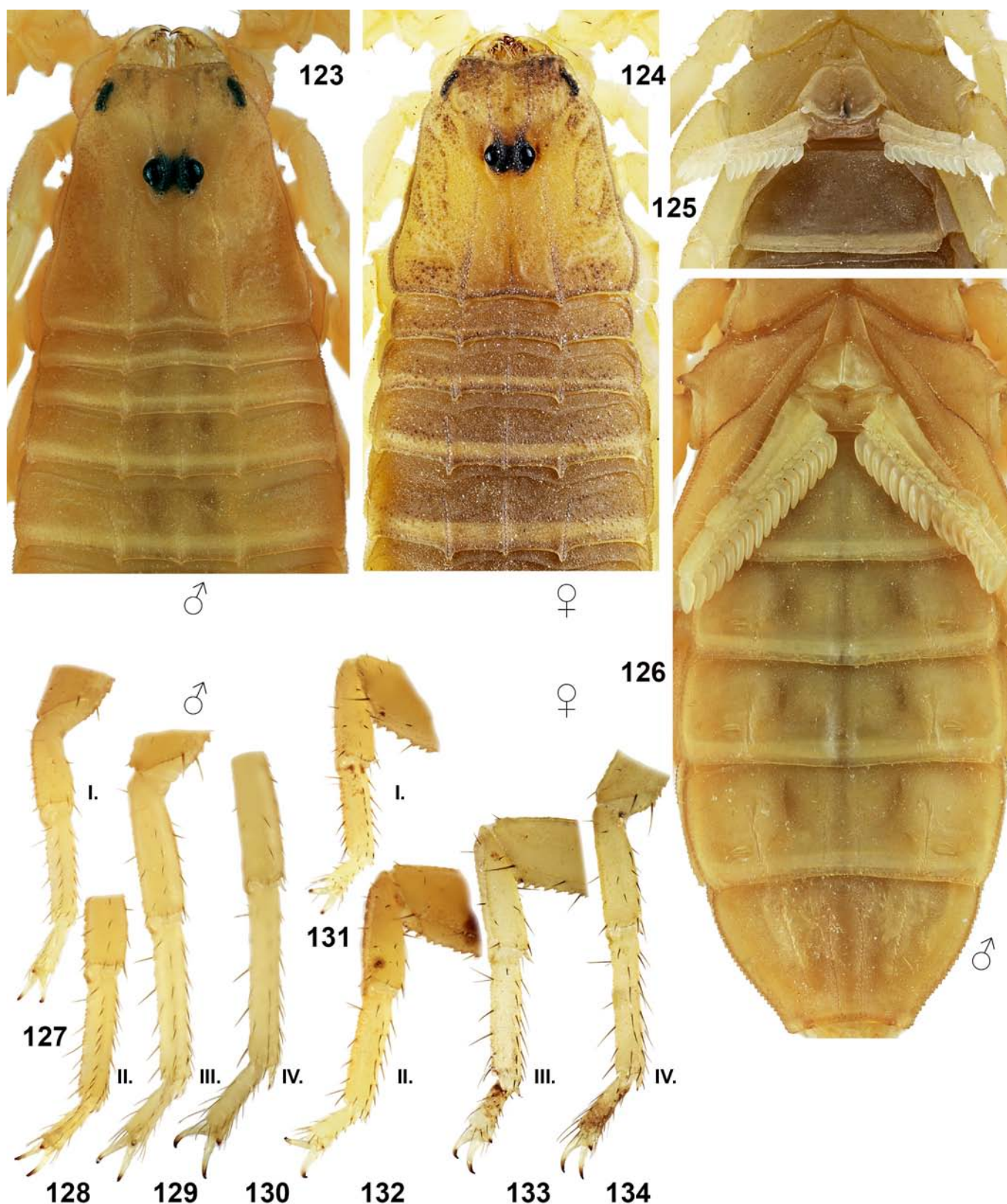
ECOLOGY. Specimens were found under rocks, or on rocks at night, in arid sandy terrain with rather sparse vegetation. Water was available only in an oasis or date plantations, or transiently (a few hours) after a heavy storm. Loamy soil was present but *C. turieli* **sp. n.** was only found in sandy areas. Other scorpions observed together with *C. turieli* **sp. n.** were: in sandy areas, *Androctonus amoreuxi* (Audouin, 1826), *Buthacus stockmanni* Kovařík, Lowe & Štáhlavský, 2016 and *Lissothus occidentalis* Vachon, 1950; in loamy areas, *Buthus mariefranceae* Lourenço, 2003.



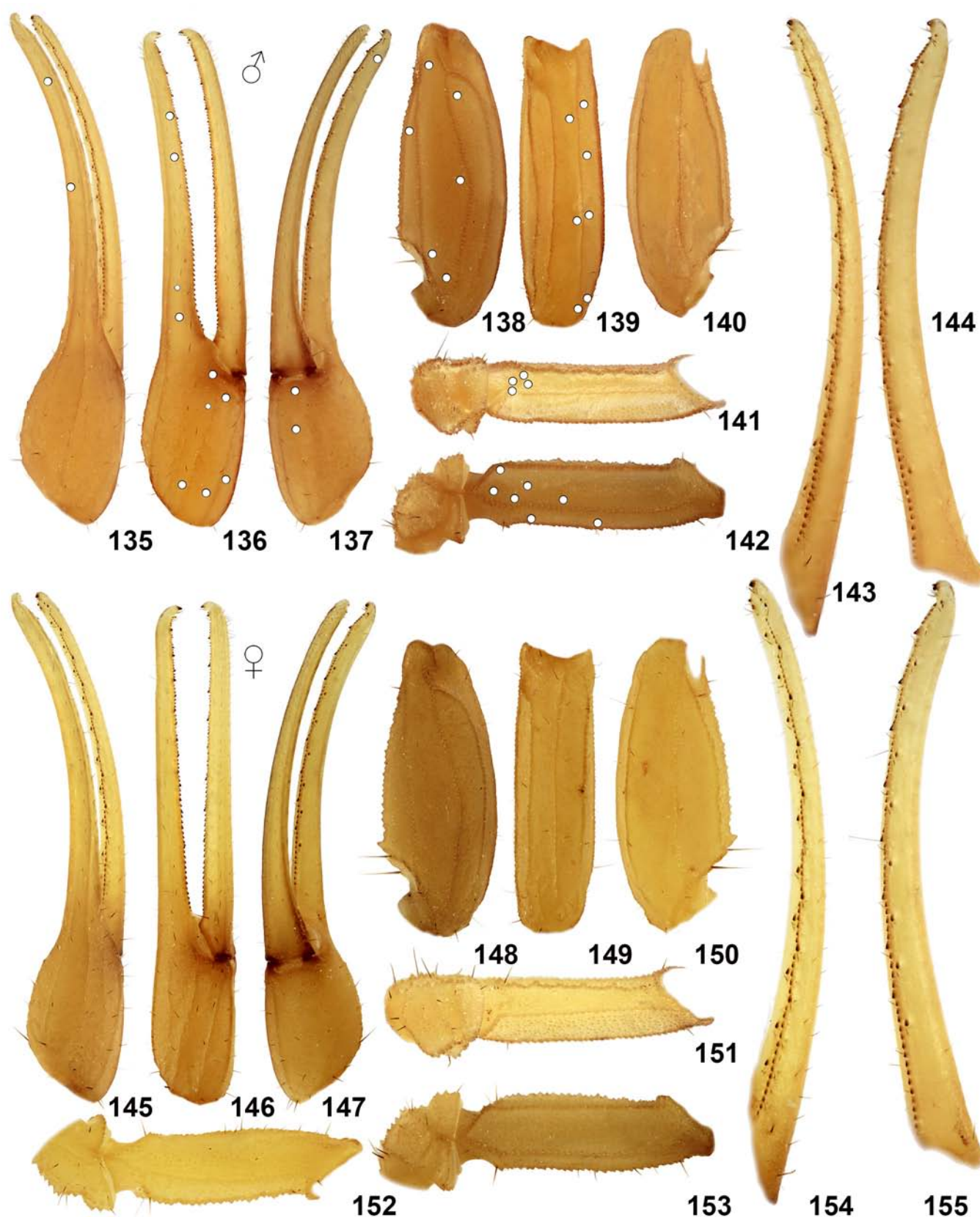
Figures 110–113. *Compsobuthus turieli* sp. n. **Figures 110–111.** Male holotype in dorsal (110) and ventral (111) views. **Figures 112–113.** Female paratype from Morocco, North of Zag in dorsal (112) and ventral (113) aspects. Scale bar: 10 mm.



Figures 114–122: *Compsobuthus turieli* sp. n. **Figures 114–117, 121–122.** Male holotype, telson lateral (114), metasoma and telson lateral (115), dorsal (116), and ventral (117) views. Right chelicera dorsal (121) and ventral (122). **Figures 118–120.** Female paratype from Morocco, North of Zag, metasoma and telson lateral (118), dorsal (119), and ventral (120) views. Scale bar: 10 mm (115–120).



Figures 123–134: *Compsobuthus turieli* sp. n. **Figures 123–126:** Mesosoma. **Figures 123, 126.** Male holotype, carapace and tergites I–IV (123) and posterior coxosternal area and sternites (126). **Figures 124–125.** Female paratype from Morocco, North of Zag, carapace and tergites I–IV (124) and posterior coxosternal area and sternite III (125). **Figures 127–134:** Left legs, retrolateral aspects. **Figures 127–130.** Male holotype. **Figures 131–134.** Female paratype from Morocco, North of Zag.



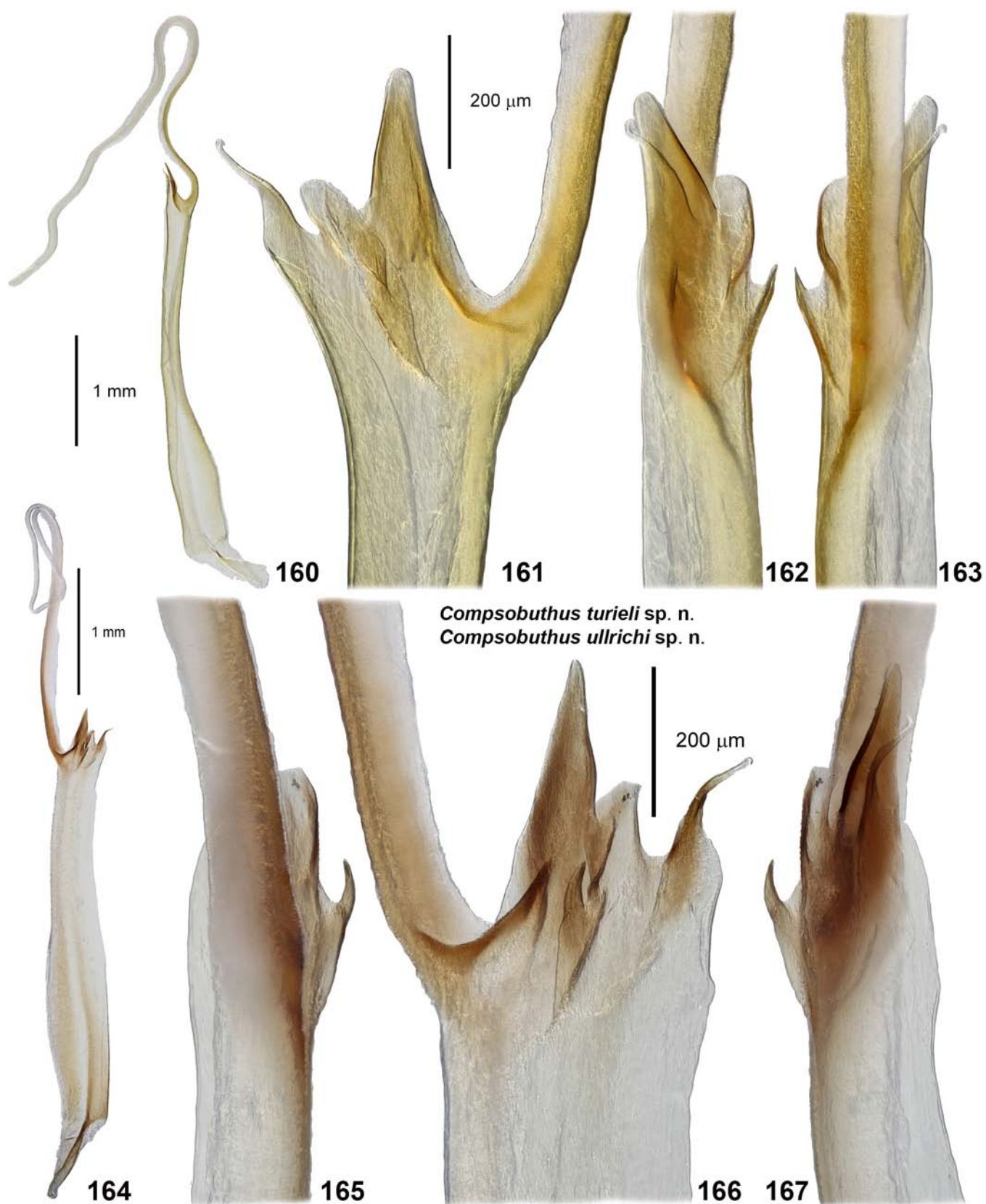
Figures 135–155: *Compsobuthus turieli* sp. n., pedipalps. **Figures 135–144.** Male holotype, chela dorsal (135), external (136) and ventrointernal (137), patella dorsal (138), external (139) and ventral (140), trochanter and femur internal (141), dorsal (142) views, and movable (143) and fixed (144) fingers dentition. **Figures 145–155.** Female paratype from Morocco, North of Zag, chela dorsal (145), external (146) and ventrointernal (147), patella dorsal (148), external (149) and ventral (150), trochanter and femur internal (151), ventral (152), and dorsal (153) views, and movable (154) and fixed (155) finger dentition. Trichobothrial pattern is indicated in Figures 135–139, 141–142 (white circles).



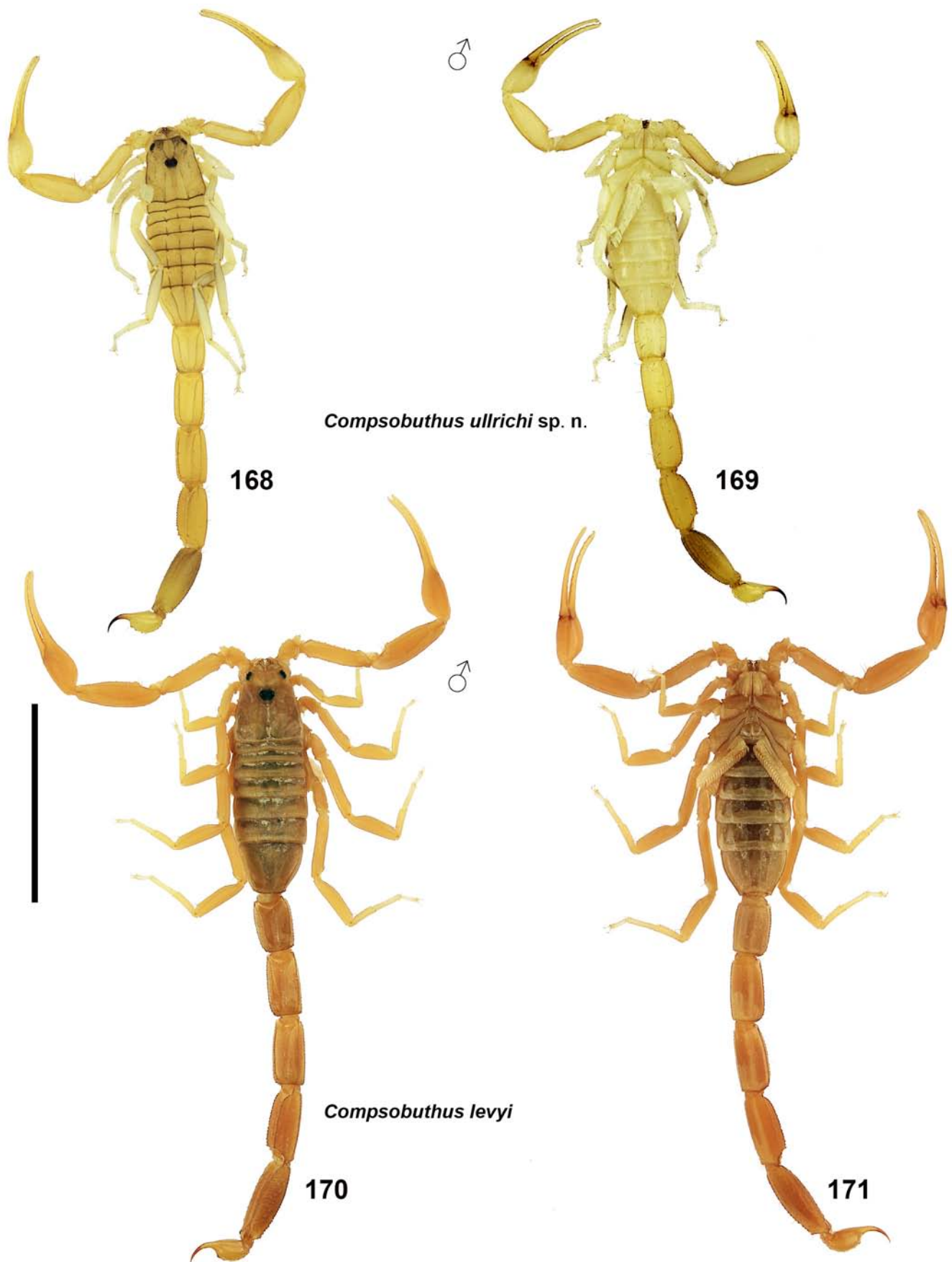
Figures 156–157. *Compsobuthus turieli* sp. n. **Figure 156.** Locality, Morocco, North of Zag. **Figure 157.** Female paratype from this locality with newborns.



Figures 158–159. *Compsobuthus turieli* sp. n., juvenile (158) and female (159) paratypes from Morocco, North of Zag in vivo habitus.



Figures 160–167: Hemispermatothores. **Figures 160–163.** *Compsobuthus turieli* sp. n., male holotype, whole hemispermatothore (160), capsule in convex compressed (161), anterior (162), and posterior (163) views. **Figures 164–167.** *C. ullrichi* sp. n., male holotype, whole hemispermatothore (164), capsule in posterior (165), convex compressed (166), and anterior (167) views. Scale bars: 1 mm (160, 164), 200 µm (161–163, 165–167).



Figures 168–171: Figures 168–169. *Compsobuthus ullrichi* sp. n., male holotype in dorsal (168) and ventral (169) views. Figures 170–171. *C. levyi*, male holotype in dorsal (170) and ventral (171) views. Scale bar: 10 mm.

Dimensions (MM)		<i>C. ullrichi</i> sp. n. ♂ holotype	<i>C. levyi</i> ♂ holotype	<i>C. kabateki</i> ♂ topotype
Carapace	L / W	3.32 / 3.11	3.75 / 3.45	2.93 / 2.77
Mesosoma	L	6.53	7.41	7.23
Tergite VII	L / W	2.03 / 2.93	2.49 / 3.32	1.99 / 2.67
Metasoma + telson	L	18.28	19.69	13.89
Segment I	L / W / D	2.38 / 1.73 / 1.69	2.65 / 1.75 / 1.70	1.84 / 1.71 / 1.51
Segment II	L / W / D	2.76 / 1.54 / 1.66	3.06 / 1.56 / 1.57	2.15 / 1.49 / 1.56
Segment III	L / W / D	2.93 / 1.51 / 1.67	3.26 / 1.47 / 1.52	2.18 / 1.43 / 1.53
Segment IV	L / W / D	3.26 / 1.45 / 1.56	3.56 / 1.44 / 1.47	2.40 / 1.42 / 1.52
Segment V	L / W / D	3.84 / 1.37 / 1.45	3.67 / 1.46 / 1.47	2.97 / 1.36 / 1.30
Telson	L / W / D	3.11 / 1.11 / 1.10	3.48 / 1.15 / 1.18	2.35 / 0.92 / 0.97
Pedipalp	L	13.39	13.90	9.57
Femur	L / W	3.167 / 0.90	3.36 / 0.87	2.29 / 0.74
Patella	L / W	3.88 / 1.27	4.07 / 1.25	2.82 / 1.03
Chela	L	6.35	6.47	4.47
Manus	W / D	1.34 / 1.26	1.35 / 1.35	1.04 / 1.09
Movable finger	L	4.32	4.32	3.01
Total	L	28.13	30.48	24.06

Table 3. Comparative measurements of adults of *Compsobuthus ullrichi* sp. n., *C. levyi* and *C. kabateki*. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

***Compsobuthus ullrichi* sp. n.**

(Figures 164–209, 222–224, Tables 3–4)

<http://zoobank.org/urn:lsid:zoobank.org:act:7EEF1EA-5294-4BAB-B92D-9F568946A2F4>

TYPE LOCALITY AND TYPE DEPOSITORY. Egypt, Daháb, 28°29'N 34°30'E; FKCP.

TYPE MATERIAL EXAMINED. **Egypt:** Daháb, 28°29'N 34°30'E, II.2019, 1♂ (holotype, 1597), leg. A. Ullrich, FKCP.

ETYMOLOGY. It is a pleasure to name this species after Alex Ullrich (Germany), collector of the male holotype.

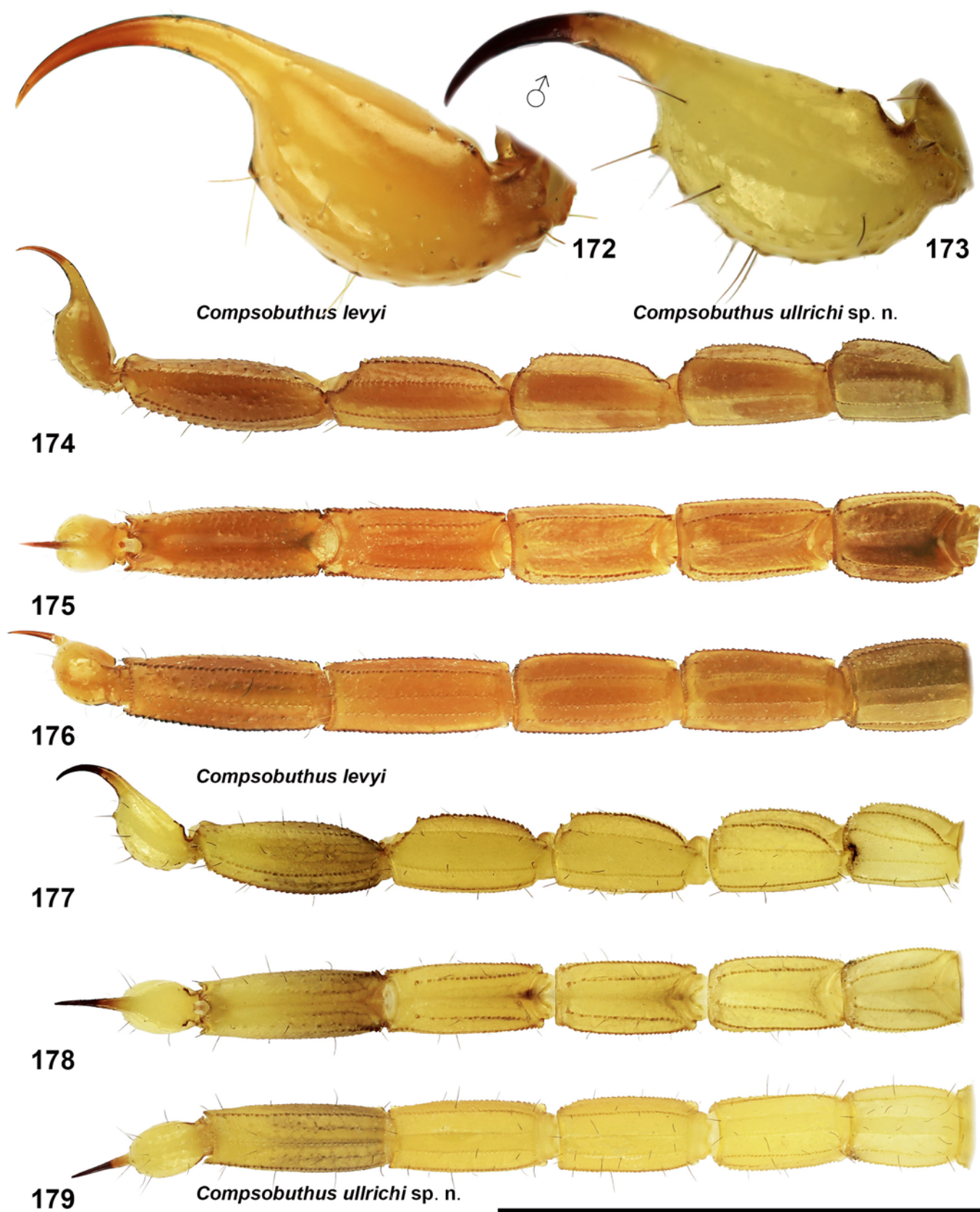
DIAGNOSIS (♂). Total length 28 mm. Male pedipalp fingers with dentate margins proximally undulate, chela L/W ratio: 4.75. Base color uniform yellow to yellowish brown with dark spot on fifth metasomal segment. Carapace and tergites finely granular with some larger granules. Anterior margin of carapace bearing 8 symmetrically distributed spinules. Pedipalp femur L/ Carapace L ratio: ♂ 0.95. Movable finger of pedipalp chela with 10–11 rows of granules, all rows with external and internal accessory denticles ('*wernerii*' group; Levy & Amitai, 1980). Manus of pedipalp chela shorter than fixed finger. Pedipalp chela L/movable finger L ratio: ♂ 1.47. Metasoma I–II with 10 carinae, III–IV with 8 carinae. All metasomal segments longer than wide; metasoma L/W ratios ♂: III 1.94, IV 2.25, V 2.80. Metasoma V W/D ratio ♂: 0.945. Ventral intercarinal surfaces of metasoma with macrosetae. Pectine teeth: ♂ 22–23. Pectine L/ Metasoma V W ratio:

♂ 2.31. Sternites smooth medially and finely granulated marginally; metasoma granulated. Sternites VI–VII with 4 crenulate carinae. Telson rather bulbous, aculeus shorter than vesicle. Subaculear tubercle weakly developed.

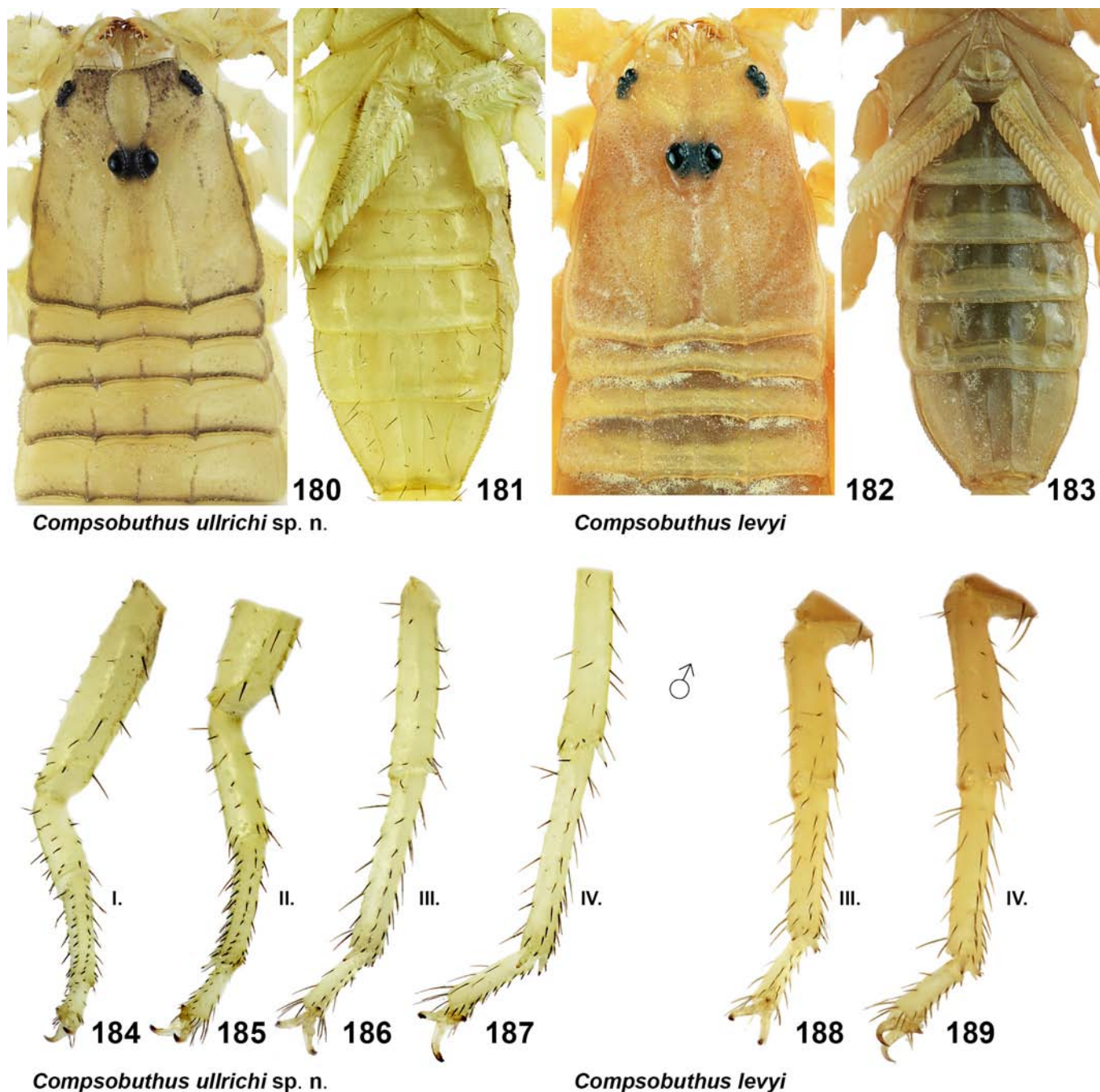
DESCRIPTION (♂ HOLOTYPE). Total length 28.13 mm. Female unknown. The habitus is shown in Figs. 168–169. Trichobothriotaxy of pedipalps is shown in Figs. 190–197. Male with pedipalp fingers proximally undulate.

Coloration (Figs. 168–169). The base color is uniform yellow to yellowish brown, with fuscosity on the anterior half of metasoma V.

Carapace and mesosoma (Figs. 180–181). The carapace is covered by granules of different sizes. The carinae are moderately to strongly developed and granular. The anterior margin of the carapace is weakly concave medially, and bears 8 symmetrically distributed spinules (macrosetae). The tergites are partially, coarsely granulated. Tergites I–VI are tricarinate, with strong, denticulate median and lateral carinae. Each carina terminates in a spiniform process that in the lateral carinae extends well past the posterior margin of the tergite. Tergite VII is pentacarinate, with lateral pairs of carinae strong, serratocrenulate, median pairs moderate, crenulate; median carina is weak and confined to the anterior half of the segment. Pectinal tooth count: ♂ 22–23. The pectine marginal tips extend to the posterior margin of sternite IV. The pectines have 3 marginal lamellae and 7–9 middle lamellae. The lamellae bear numerous dark setae, and each fulcrum bears 2–3 dark setae. Sternites are smooth medially and finely granulated marginally. The posterior areas of



Figures 172–179: Figures 172, 174–176. *Compsobuthus levyi*, male holotype, telson lateral (172), metasoma and telson lateral (174), dorsal (175), and ventral (176) views. Figures 173, 177–179. *C. ullrichi* sp. n., male holotype, telson lateral (173), metasoma and telson lateral (177), dorsal (178), and ventral (179) views. Scale bar: 10 mm (174–179).



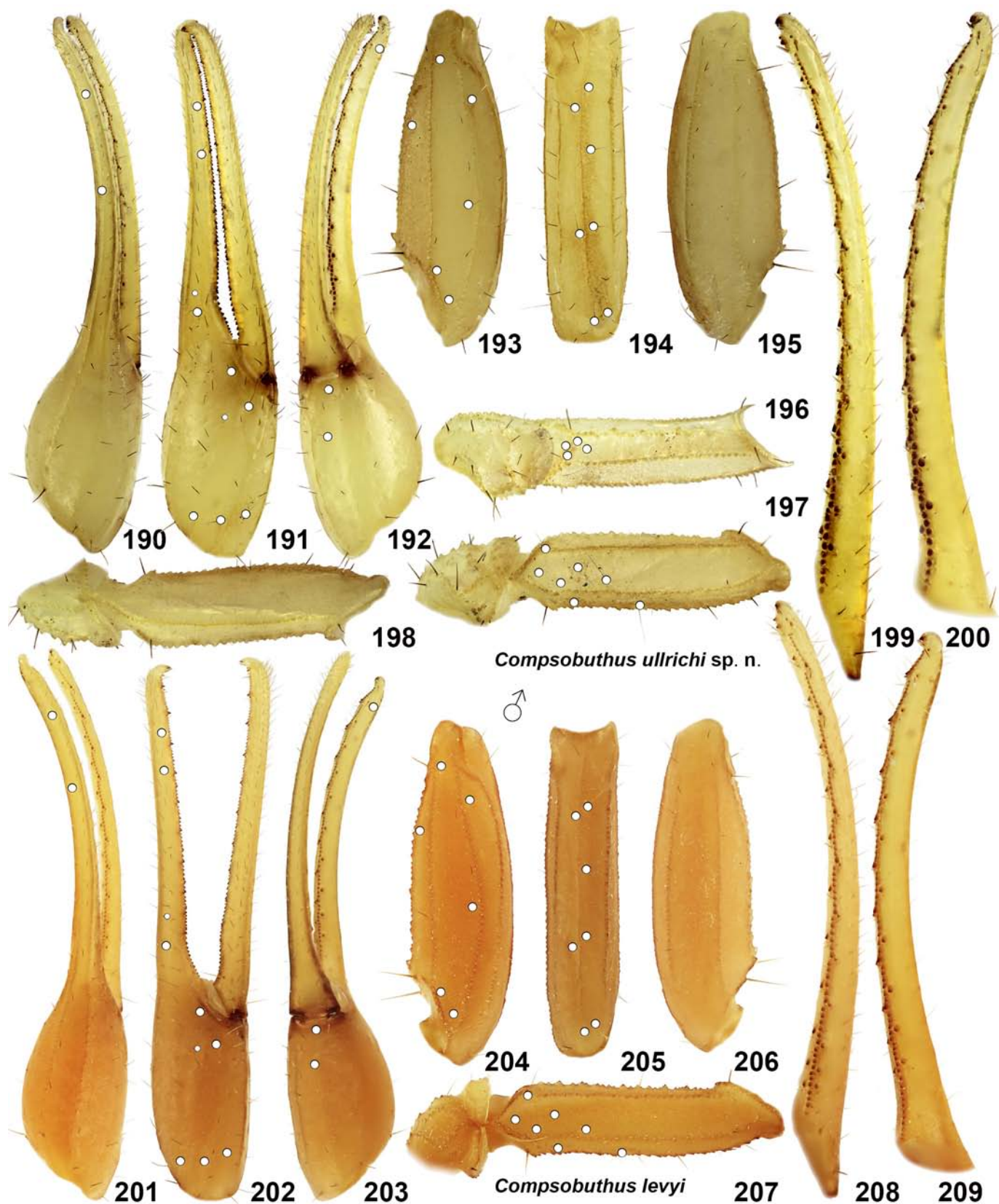
Figures 180–189: Figures 180–181, 184–187. *Compsobuthus ullrichi* sp. n., male holotype, carapace and tergites I–IV (180), posterior coxosternal area and sternites (181), and left legs I–IV, retrolateral aspects (184–187). Figures 182–183, 188–189. *C. levyi*, male holotype, carapace and tergites I–III (182), posterior coxosternal area and sternites (183), and left legs III–IV, retrolateral aspects (188–189).

sternites lack a broad glabrous patch. Sternites VI–VII bear 4 crenulate carinae which are more strongly granulated on VII. The other sternites bear one pair of carinae on the medial side of the spiracles.

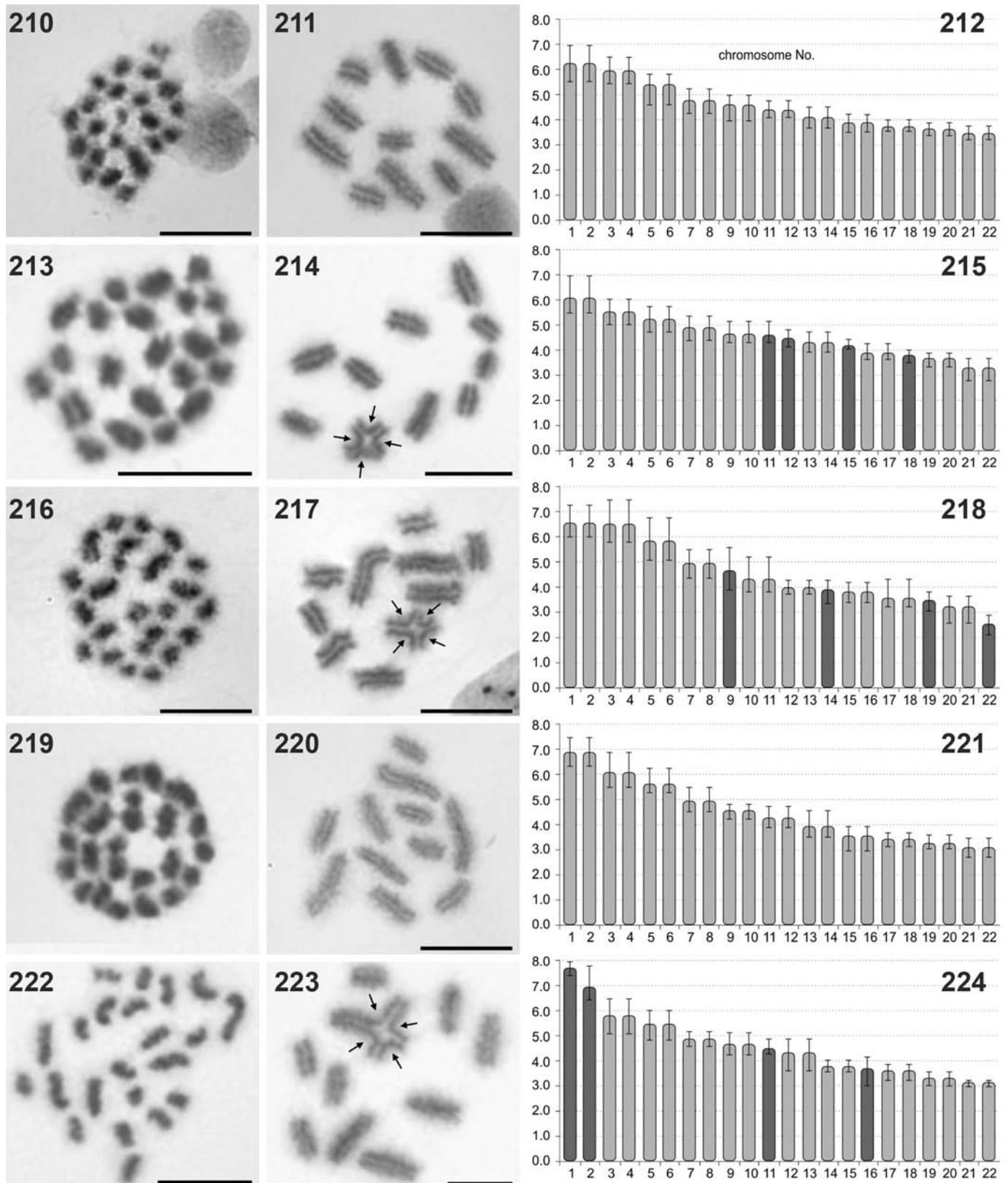
Metasoma and telson (Figs. 173, 177–179). Metasomal segments I–II with 10 carinae, III–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma III reduced and indicated only by several granules posteriorly. All segments sparsely setose and granulate. Accessory rows of granules are present on dorsal surfaces of segments as well

as on the ventral surface of segment V. The telson is rather bulbous, with the aculeus a little shorter than the vesicle. A subaculear tubercle is indicated.

Pedipalps (Figs. 190–200). The pedipalps are smooth, partly finely granulated and sparsely hirsute. The femur bears 5 carinae, the patella 7 granular carinae, the chela 5 rather smooth carinae. The movable and fixed fingers bear 10–11 rows of granules, all with external and internal accessory granules. Pedipalp chela L/W ratio: ♂ 4.75. Manus of chela shorter than fixed finger. Pedipalp chela L/movable finger L ratio: ♂ 1.47.



Figures 190–209: Pedipalps. **Figures 190–200.** *Compsobuthus ullrichi* sp. n., male holotype, chela dorsal (190), external (191) and ventrointernal (192), patella dorsal (193), external (194) and ventral (195), trochanter and femur dorsointernal (196), dorsal (197), and ventral (198) views, and movable (199) and fixed (200) fingers dentition. **Figures 201–209.** *C. levyi*, male holotype, chela dorsal (201), external (202) and ventrointernal (203), patella dorsal (204), external (205) and ventral (206), trochanter and femur dorsal (207) views, and movable (208) and fixed (209) finger dentition. Trichobothrial pattern is indicated in Figures 190–194, 196–197, 201–205, 207 (white circles).



Figures 210–224: Mitotic metaphases (210, 213, 216, 219, 222), male postpachytenes (211, 214, 217, 220, 223), and ideograms (212, 215, 218, 221, 224) (y axis: % of the diploid chromosome length, dark grey marks: chromosomes in multivalent association) of *Compsobuthus* species from Arabia and North Africa. **Figure 210.** Female of *C. acutecarinatus* ($2n=22$). **Figures 211–212.** Male of *C. acutecarinatus* ($2n=22$, 11II). **Figures 213–215.** Male of *C. acutecarinatus* ($2n=22$, 9II+CIV). **Figures 216–218.** Male of *C. arabicus* ($2n=22$, 9II+CIV). **Figures 219–221.** Male of *C. maindroni* ($2n=22$, 11II). **Figures 222–224.** Male of *C. ullrichi* sp. n. ($2n=22$, 9II+CIV). Arrows show chromosomes in multivalent association during postpachytene (214, 217, 223). Scale bar: 10 μ m.

Species	2n	Postpachytene configuration	% TCL	Country	Reference
<i>C. acutecarinatus</i>	22	11II	2x 6.23 – 2x 3.46	Oman	present study
<i>C. acutecarinatus</i>	22	9II+CIV	2x 6.08 – 2x 3.28	Oman	present study
<i>C. arabicus</i>	22	9II+CIV	2x 6.58 – 2.55	Oman	present study
<i>C. eritreensis</i>	22	11II	2x 6.70 – 2x 2.81	Eritrea	Kovářík et al., 2016a
<i>C. maindroni</i>	22	11II	2x 6.94 – 2x 3.12	Oman	present study
<i>C. matthiesseni</i>	22	11II	6.28 – 3.12	Turkey	Šťáhlavský et al., 2014
<i>C. matthiesseni</i>	22	7II+CVIII	6.68 – 3.15	Turkey	Šťáhlavský et al., 2014
<i>C. ullrichi</i> sp. n.	22	9II+CIV	7.66, 6.92, 2x 5.76 – 2x 3.10	Egypt	present study

Table 4. The diploid number, the postpachytene configuration, the percentage of the total chromosome length of the diploid set (% TCL) and the origin of *Compsobuthus* species cytogenetically investigated.

Specimens karyotyped: *C. acutecarinatus* (Simon, 1882): Oman, Dhalkut beach, 16.6989°N 53.2214°E, 1♂; E of Aydam, 17.8887°N 53.06640°E, 1♂; W of Qairoon Hairitti, 17.2564°N 54.0220°E, 2♂; Wadi Ash Shuwaymiyyah, 17.9293°N 55.5510°E, 1♂1♀. *C. arabicus* Levy, Amitai & Shulov, 1973: Oman, Al Wasil, 22.4914°N 58.7151°E, 2♂; Jabal Bani Jabir, 22.8132°N 59.0589°E, 1♂; E of Aydam, 17.8887°N 53.06640°E, 1♂; W of Wahiba, 22.0299°N 58.1849°E, 1♂. *C. maindroni* (Kraepelin, 1900): Oman, Khatm Ha'ir Asfar, 24.7750°N 55.9146°E, 2♂; Say Plateau, 23.1185°N 57.6311°E, 2♂. *C. ullrichi* sp. n., 1♂ holotype.

Legs (Figs. 184–187). Legs III–IV bear moderate tibial spurs. Retrolateral and prolateral pedal spurs are present on all legs. The tarsomeres bear two rows of macrosetae on the ventral surface and several macrosetae on the other surfaces. Bristlecombs are absent. The femur bears 4 carinae, the patella 4–6 six carinae. The femur and patella bear only solitary macrosetae and are granulated except for external lateral surfaces which are smooth. Tarsal unguis moderately elongated, curved.

Hemispermatothore (Figs. 164–167). Flagelliform, elongate and slender, trunk ca. 6 times length of capsule region. Flagellum separated from external lobe, pars recta ca. 50% of trunk length, broad with anterior lamina, pars reflecta ca. 75% of trunk length, narrow, hyaline. Capsule region with 4 lobes at base of flagellum: posterior lobe longest, triangular, median lobe shortest, apically truncate, anterior lobe acuminate with long thin terminus. Basal lobe strong with broad base and sharp, falcate hook. Left and right hemispermatothores were similar.

Measurements. See Table 3.

AFFINITIES. The described characters distinguish *C. ullrichi* sp. n. from all other known species of the genus. Among *Compsobuthus* species known from the region of Middle East and Egypt, *C. ullrichi* sp. n. is most similar to *C. levyi* Kovářik, 2012, from Jordan (type locality: near Qasr Burqu). The two species can be separated by several characters: males of *C. levyi* have longer and narrower pedipalp and metasomal segments (see Table 1 and Figs. 174–179). Pedipalp patella L/W ratio is 3.06 in male holotype *C. ullrichi*, 3.25–3.26 in males of *C. levyi*; metasoma I L/W ratio is 1.377 in male *C. ullrichi*, 1.51–1.54 in males of *C. levyi*; and metasoma IV L/W ratio is 2.24 in male *C. ullrichi*, 2.46–2.48 in males of *C. levyi*. In this region are found five other species of *Compsobuthus* belonging to the ‘*wernerii*’ group of Levy &

Amitai (1980). From these, *C. ullrichi* sp. n. can be clearly differentiated by metasomal segment I being narrower than that of other species: *C. carmelitis* Levy, Amitai & Shulov, 1973 from Israel, and probably also Jordan and Syria, has metasoma I of males wider than long, or as wide as long; *C. egyptiensis* Lourenco et al., 2009 from Egypt (type locality: NW of Siwa) has metasoma I L/W ratio 1.1–1.17 in males; and *C. kabateki* Kovářik, 2003 from Egypt (Luxor) has metasoma I L/W ratio 1.07 in males. In contrast, *C. ullrichi* sp. n. has metasoma I L/W ratio 1.37. *Compsobuthus longipalpis* Levy, Amitai & Shulov, 1973 from Egypt, Israel, Jordan, Saudi Arabia, and Syria, differs in having 14 rows of granules on the pedipalp movable finger and a total length of 40–50 mm (in *C. ullrichi* sp. n. there are 10–11 rows of granules on the pedipalp movable finger and total length is < 30 mm). *C. schmiedeknechti* Vachon, 1949 from Israel, Jordan, Lebanon, Syria, and Turkey differs in having 15–18 pectinal teeth in males; *C. kabateki* Kovářik, 2003 from Egypt (Luxor) differs in having 19 pectinal teeth in males (in *C. ullrichi* sp. n. there are 22–23 pectinal teeth in the male holotype).

Acknowledgements.

We thank the following curators for loans of material that contributed to this study: Jan Beccaloni and Dani Sherwood (Natural History Museum, London); Anitha Saji (Terrestrial Environmental Research Center, Abu Dhabi); and the late Jacqueline Heurtault (Muséum National d'Histoire Naturelle, Paris). Work in Oman by GL was sponsored by H. H. The Minister of National Heritage and Culture, Sultanate of Oman. Early fieldwork (1993–1995) and subsequent specimen collections (1995–2001) were supported by staff at the Ministry of National Heritage and Culture, coordinated by the late Michael D. Gallagher (curator, Oman Natural

History Museum). Study materials were contributed by: J. Neil Barnes, J. Batelka, Stanislav Bečvář, Jim Dundon, R. & H. Fouquè, Michael Gallagher, Ian Harrison and family, Petr Kabátek, Mark W. Lawrence, H. Pinda, J. Peterson, Anitha Saji, Carlos Turiel, Alex Ullrich and Alex & Birgit Winkler. Oliver Helker and Britta Stockmann assisted MS in collection of materials from Oman.

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