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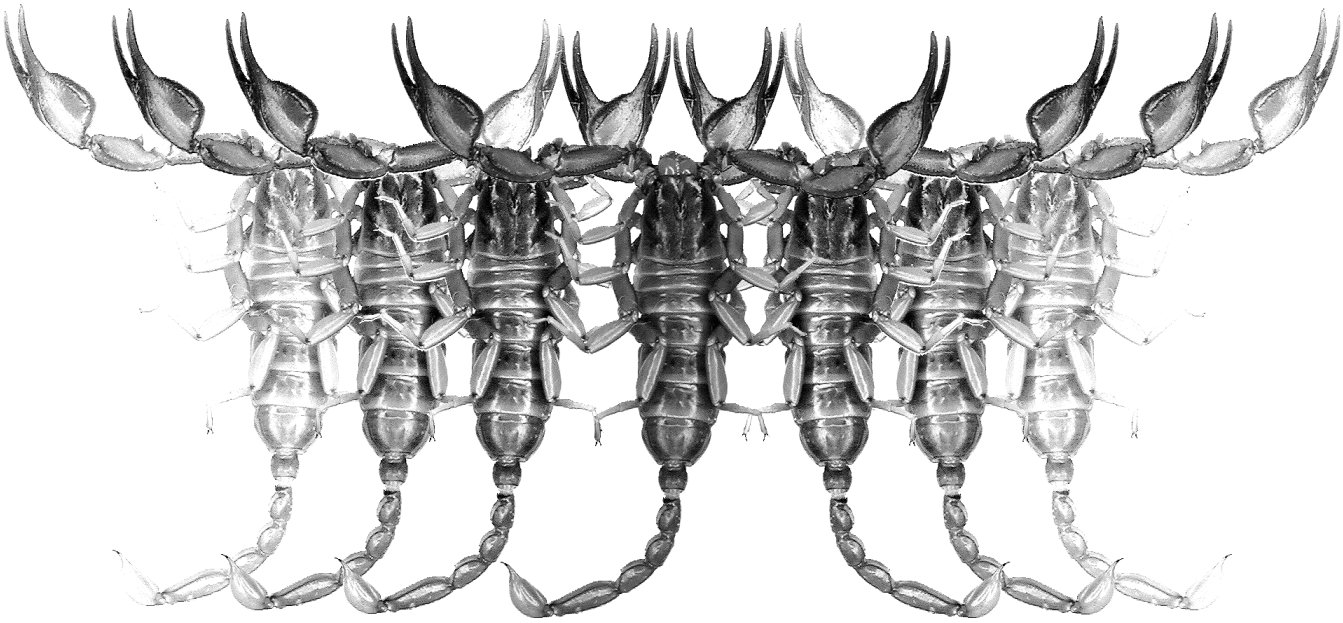

Review of the Genus *Neobuthus* Hirst, 1911 with Description of a New Species from Ethiopia (Scorpiones: Buthidae)

František Kovařík & Graeme Lowe

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Review of the genus *Neobuthus* Hirst, 1911 with description of a new species from Ethiopia (Scorpiones: Buthidae)

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Summary

We define key characters distinguishing between the genera *Neobuthus* Hirst, 1911 and *Butheolus* Simon, 1882. *Butheolus ferrugineus* Kraepelin, 1898 is transferred to the genus *Neobuthus* which includes only African species, in contrast to the genus *Butheolus* which now includes only species inhabiting the Arabian Peninsula. *Neobuthus awashensis* **sp. n.** from Ethiopia is described and compared with two closely related species, *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.** and *Neobuthus berberensis* Hirst, 1911. Recent collection of 78 specimens enabled direct comparisons of all three closely related species from their respective localities and discovery of characters hitherto not apparent from discolored specimens preserved for many years in alcohol. We photographically illustrate true coloration and pubescence for these three species, provide first information about their ecology, and present photographs of their habitats and localities. *Neobuthus berberensis* Hirst, 1911, is lightest colored with pubescence nearly absent, and is adapted to sandy desert conditions in the vicinity of Berbera City (Somaliland). Rocky deserts in Djibouti, Ethiopia (first report), Somaliland and Somalia host the widely distributed *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.**, which varies in color and bears sparse long setae (female) or spiniform setae (male). *Neobuthus awashensis* **sp. n.** is the darkest-colored of the three and possesses pubescence similar to *N. ferrugineus* **comb. n.**, from which it differs in having a longer and narrower pedipalp femur. We document strong sexual dimorphism in all three species, the lack of knowledge of which had caused the female holotype of *Neobuthus ferrugineus* (Kraepelin, 1898), **comb. n.** and the male holotype of *Neobuthus berberensis* Hirst, 1911 to be placed in different genera *Butheolus* Simon, 1882 and *Neobuthus* Hirst, 1911.

Introduction

The genus *Butheolus* has had a varied history. It was created by Simon (1882) to include two small species of scorpion: the type species *B. thalassinus* from Aden, Yemen, and *B. aristidis* from Nubia, Egypt. In a key, he diagnosed the former as having metasomal segments IV–V granulated, and the latter as having these segments dilated and punctuated. Additional species with dilated, punctuated metasoma IV–V were subsequently added: Pavesi (1885) described *Butheolus litoralis*, from Eritrea; Simon (1889) described *Butheolus conchini* from Turkmenistan; and Pocock (1897) added a number of new species from India. In 1898, Kraepelin added the first new species with a non-dilated, granulated metasoma, i.e. *Butheolus ferrugineus*, based on a single male specimen from French Somaliland (now Djibouti). Several similar scorpions with dilated, punctuated metasoma IV–V were also assigned to *Butheolus* (cf. Kraepelin, 1899, 1903). Kraepelin (1903) reassigned *B. ferrugineus* to the genus *Nanobuthus* Pocock, 1895, a genus created for a small scorpion, *N. andersoni*, from Sudan, and Birula (1905) transferred *B. litoralis* to *Microbuthus*. In 1910, Simon decided that the remaining species with dilated, punctuated metasoma IV–V should be placed in their own genus, *Orthochirus* Karsch, 1891. He also suspected that *Buthus anthracinus* Pocock, 1895, might be referable to *Butheolus*, but did not make a formal transfer. Although Simon noted that *B. ferrugineus* seemed very close to *Nanobuthus*, he kept it in *Butheolus*, which was then left with two species: i.e. the type species *B. thalassinus* and *B. ferrugineus*.

In 1911, Hirst created the genus *Neobuthus* for another small scorpion, *N. berberensis*, based on a single female specimen from Berbera, on the coast of Somaliland. He compared his new genus with *Butheolus* and *Nanobuthus*, and considered it most similar to *Nanobuthus* in the form, carination and granulation of the mesosoma, metasoma, telson and genital opercula. He noted that it was similar to *Butheolus* in carapace structure, but differed from it in lacking posteriorly dilated metasomal segments. This indicates that he was unaware that Simon (1910) had already separated *Orthochirus* from *Butheolus* in the previous year. The taxonomic status of *Neobuthus* was not addressed again until 1975, when Vachon indicated that both *Neobuthus*

and *Nanobuthus* should be downgraded to subgenera of *Butheolus*. The reason for this was not made clear, and in their buthid catalog, Fet & Lowe (2000) listed both as valid genera, pending further analysis. In 1980, Vachon described *Butheolus gallagheri* from a single male specimen collected in the Dhofar Province of Oman. In his taxonomic discussion, he followed Kraepelin's (1903) earlier decision, instead of Simon (1910), in placing *B. ferrugineus* under *Nanobuthus*. As no justification was given, Fet & Lowe (2000) still listed it under *Butheolus*, and also confirmed placement of *B. anthracinus* in the genus. Presently, *Butheolus* includes six species: type species *B. thalassinus*, *B. ferrugineus*, *B. anthracinus*, *B. gallagheri, B. villosus* Hendrixson, 2006 (from central Saudi Arabia), and *B. arabicus* Lourenço & Qi, 2006 (from western mountains of Saudi Arabia).

Recently, Lourenço (2001) proposed several characters to support the separation of the three genera, *Neobuthus*, *Nanobuthus* and *Butheolus*, and described a new species of *Neobuthus*. On the other hand, in a review of the scorpion fauna of countries in northeast Africa, the first author (Kovařík, 2003) examined the type specimens of *Butheolus ferrugineus* and *Neobuthus berberensis* and did not find sufficient evidence to keep them in separate species; therefore *Neobuthus* was placed in synonymy with *Butheolus*. However, the issue of synonymy and the validity of taxonomic characters remained controversial. Synonymy was not accepted and another new species was described in *Neobuthus* (Lourenço, 2005; Lourenço & Qi, 2006). The history of confusion surrounding these taxa is not unusual for small scorpions inhabiting geographically remote regions. They were rarely collected, and the limited availability of specimens of either sex has made it difficult to ascertain variation in taxonomic characters that were formulated to distinguish between species represented by just one or a few type specimens. Here, we re-evaluate the relationship between *Neobuthus* and *Butheolus* by examining variation in larger samples, including abundant new material obtained by the first author in an expedition to Ethiopia and Somaliland. We describe a new species of *Neobuthus*, and compare representatives of both sexes belonging to both genera. We conclude that the two genera are indeed distinct and we clarify their species composition based on a revised set of taxonomic characters.

Abbreviations

Specimen depositories: BMNH: Natural History Museum, London, United Kingdom; FKCP: collection of first author; GL: collection of second author; NMBS: Naturhistorisches Museum, Basel, Switzerland; WDS: collection of W. David Sissom; ZMUH: Zoologisches Institut und Zoologisches Museum, Universität Hamburg, Germany.

Systematics

Neobuthus Hirst, 1911
(Figs. 1–6, 9–74, 86, 89, 92, 95–96, 100–101)

Neobuthus Hirst, 1911: 462; Birula, 1917: 101; Borelli, 1919: 365; Werner, 1934: 270; Moriggi, 1941: 90; Vachon, 1960: 245; Bücherl, 1971: 326; Stahnke, 1972: 128; Lamoral & Reynders, 1975: 513; Fet & Lowe, 2000: 186; Lourenço, 2001: 176, 179; Soleglad & Fet, 2003: 88; Fet & Soleglad, 2005: 11; Fet, Soleglad & Lowe, 2005: 10, 12, 22; Lourenço, 2005: 26; Prendini & Wheeler, 2005: 481; Lourenço & Qi, 2006: 93; Dupré, 2007: 7, 13,16.

Butheolus (*Neobuthus*): Vachon, 1975: 1598; Francke, 1985: 6, 15; El-Hennawy, 1992: 97, 115.

Butheolus (in part): Kraepelin, 1899: 37; Vachon, 1952: 224; Vachon, 1980: 253; Sissom, 1990: 97, 101; Kovařík, 1998: 117; Fet & Lowe, 2000: 88; Lourenço, 2001: 176, 179; Kovařík, 2003: 137; Kovařík, 2004: 3; Lourenço, 2005: 26; Hendrixson, 2006: 56; Lourenço & Qi, 2006: 91; Kovařík, 2009: 31.

TYPE SPECIES: *Neobuthus berberensis* Hirst, 1911

DIAGNOSIS. Very small scorpions, total length 20 mm (males) – 30 mm (females); carapace strongly trapezoidal, in lateral view distinctly inclined downward from median eyes to anterior margin; surface of carapace granular, with only anterior median carinae developed; ventral aspect of cheliceral fixed finger with single enlarged denticle; tergites with three carinae, of which the lateral pair may be less conspicuous; sternites III–VI with finely micro-denticulate posterior margins, lacking larger non-contiguous denticles; pectines with fulcra, hirsute; metasomal segments I–III with 8–10 carinae; ventrosubmedian and ventrolateral carinae on segments II–III strongly developed with enlarged dentition; segment V with enlarged "lobate" dentition on ventrolateral carinae; telson rather bulbous, vesicle steeply inclined posteriorly, aculeus shorter than vesicle; strong sexual dimorphism in setation, metasomal dentition and granulation; all segments of metasoma and pedipalps sparsely hirsute, with long setae in females, short spiniform setae in males; pedipalps short with stout segments, movable finger of pedipalp with 5–6 rows of denticles; trichobothrial pattern type A, orthobothriotaxic or neobothriotaxic minorante; dorsal trichobothria of femur arranged in β-configuration; trichobothrium d_2 of pedipalp femur present on dorsal surface, but often smaller than other trichobothria or absent even in the

same population; d_2 of pedipalp patella either present but often smaller than other trichobothria, or absent even in the same population; d_3 of pedipalp patella internal to dorsomedian carina; tibial spurs present on legs III–IV.

Neobuthus berberensis Hirst, 1911
(Figs. 1–2, 9–17, 22–27, 39–40, 48, 72)

Neobuthus berberensis Hirst, 1911: 462; Borelli, 1919: 361, 365; Borelli, 1931: 219; Werner, 1934: 270; Caporiacco, 1937: 360; Moriggi, 1941: 90; Bücherl, 1971: 326; Lamoral & Reynders, 1975: 513; Fet & Lowe, 2000: 186; Lourenço, 2001: 178, 179; Lourenço, 2005: 27; Lourenço & Qi, 2006: 91.

Butheolus (*Neobuthus*) *berberensis* El-Hennawy, 1992: 97, 115.

Butheolus ferrugineus: Kovařík, 2003: 137 (in part); Kovařík, 2004: 4 (in part); Kovařík & Mazuch, 2011: 5.

TYPE LOCALITY AND TYPE DEPOSITORY. **Somaliland**, Berbera; BMNH.

TYPE MATERIAL EXAMINED. Somaliland, Berbera, 1♀ (holotype), BMNH No. 1906.3.25.125, leg. G.W. Bury.

ADDITIONAL MATERIAL EXAMINED. Somaliland, Berbera env., 10°22.8'N 45°02.2'E, 107 m a.s.l. (Figs. 9 and 13), 8.-10.VII.2011, 1♂1♂im.2♀1♀im.1juv. (topotypes), leg. F. Kovařík, FKCP.

DIAGNOSIS. Total length 20–21 mm (males) and 27–30 mm (females); carapace densely granulated with only anterior median carinae developed, area between these carinae yellow to orange; anterior margin of carapace straight or slightly convex; pectine teeth 14–16 in females, 18–20 in males; sternites III–VI without carinae; sternite VII more strongly granulated without carinae in males, with four incomplete carinae in females; pedipalps including trochanter yellow with a dark spot only on external surfaces of femur and patella, without dark setae; one dark macroseta may be preset on trochanter; femur and chela of pedipalp may bear only a few solitary long, thin setae (females) or long spiniform setae (males) on ventral and internal surfaces; metasomal segment V with less than 5 setae; legs I–III with bristle combs composed of long thin setae (females) or long spiniform setae (males); movable finger of pedipalp bearing 5–6 rows of denticles, with external and internal accessory denticles, and three distal denticles; pedipalp femur length to width ratio 2.35 in females and 2.5 in male.

Neobuthus ferrugineus (Kraepelin, 1898), **comb. n.**
(Figs. 3–4, 28–33, 41–43, 49–66, 72)

Butheolus ferrugineus Kraepelin, 1898: 43; Simon, 1910: 77; Vachon, 1949: 391, figs. 461, 465; Vachon, 1952: 319, figs. 461, 465; Bücherl, 1971: 326; Kovařík, 1998: 105; Fet & Lowe, 2000: 88; Lourenço, 2001: 177; Kovařík, 2003: 137 (in part); Kovařík, 2004: 4 (in part); Lourenço, 2005: 27; Lourenço & Qi, 2006: 92–93.

Nanobuthus ferrugineus Kraepelin, 1903: 564; Vachon, 1980: 255.

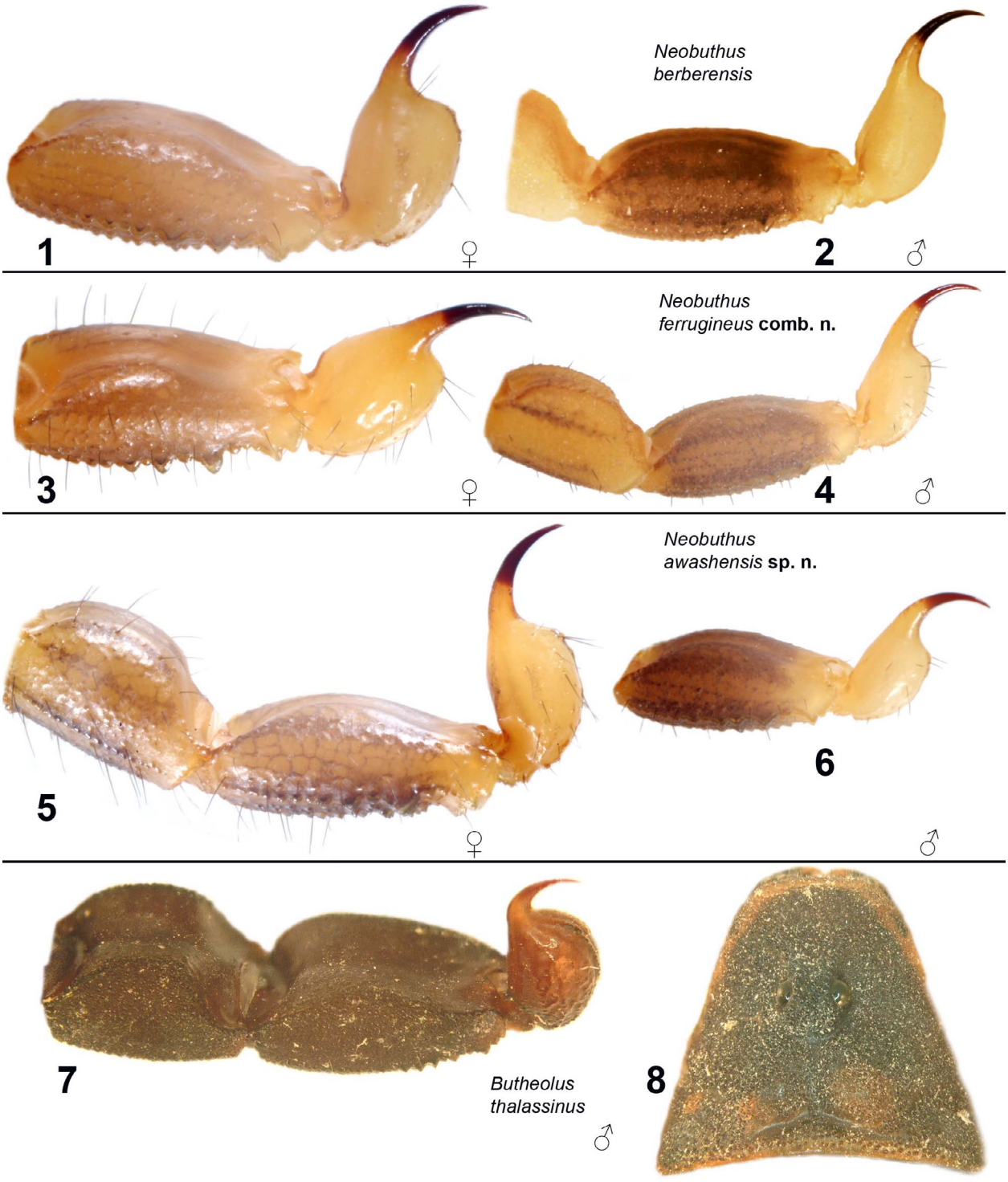
TYPE LOCALITY AND TYPE DEPOSITORY. **Djibouti**, Gulf of Aden, Tadjura Bay, ZMUH.

TYPE MATERIAL EXAMINED. DJibouti, Gulf of Aden, Tadjura Bay, 1♂ (holotype), ZMUH.

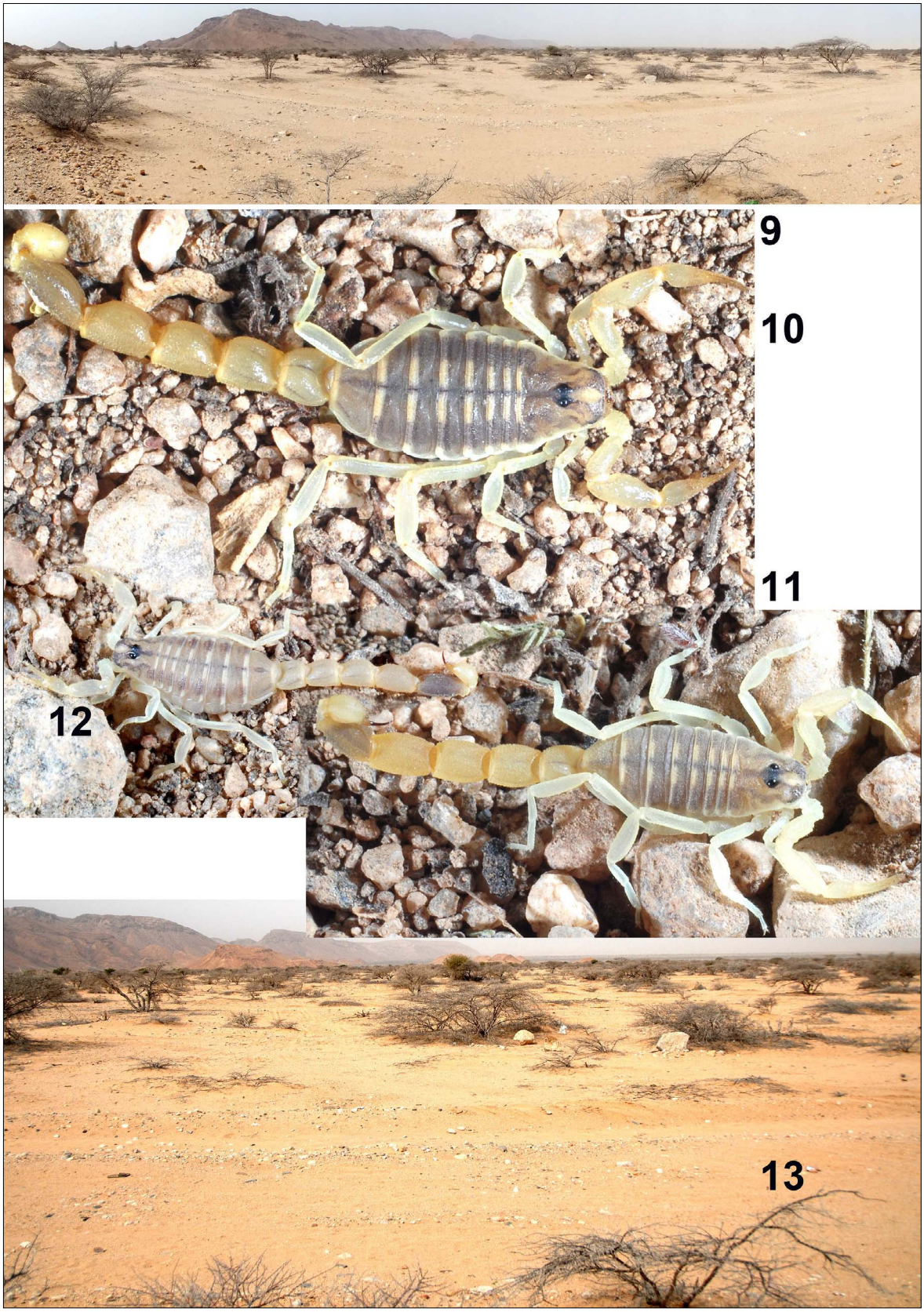
ADDITIONAL MATERIAL EXAMINED. **Ethiopia**, Dekhata valley, near Babile, Harar, 09°12'17.9"N 42°21'53.3"E, 975 m, 17.VII.2011, 1♂, leg. F. Kovařík. **Somaliland**, 15 km near Sheikh, Goolis Mountains, 09°58.9'N 45°10.3'E, 1247 m a.s.l. (Figs. 63–64), 10.VII.2011, 1♂ (Figs. 4, 32, 42, 50–51, 62), leg. F. Kovařík, FKCP; near Sheikh, 09°46.1'N 45°17.5'E, 1329 m a.s.l. (Fig. 66), 10.-11.VII.2011, 1♀ (Figs. 3, 29, 41, 52–53, 65), leg. F. Kovařík, FKCP; near Berbera, 10°15'30.5"N 45°06' 04.2"E, 376 m a.s.l. (Fig. 59) , 12.VII.2011, 1♂1♀1juv. (Figs. 28, 30–31, 33, 43, 49, 54–58) , leg. F. Kovařík, FKCP. **Somalia**, Chisimaio, VI. 1980, 1♀, leg. Dorsak, FKCP.

DIAGNOSIS. Total length 20–21 mm (males) and 27–30 mm (females); carapace densely granulated with only anterior median carinae developed, area between these carinae yellow to orange; anterior margin of carapace straight or slightly convex; pectine teeth 15–16 in females, 17–21 in males; sternites without carinae; pedipalps including trochanter, metasoma and telson with sparse dark, long setae in females and short spiniform setae in males; metasomal segment V with ca. 35–40 long setae in females or short spiniform setae in males; legs I–III with bristle combs composed of long thin setae (females) or long spiniform setae (males); movable finger of pedipalp with 5–6 rows of denticles, with external and internal accessory denticles, and three distal denticles; pedipalp femur length to width ratio 2.0–2.1 in females and 2.3 in males.

REDESCRIPTION. Adult males 20–21 mm long and adult females 27–30 mm long. For position and distribution of trichobothria of pedipalps see Fig. 47, they are identical with *N. awashensis* **sp. n.** Sexual dimorphism is noticeable. Males are substantially smaller with bristle combs composed of long spiniform setae, whereas females have bristle combs composed of long setae. All segments of metasoma and pedipalps are sparsely hirsute, with dark long setae in females (Fig. 41) and short spiniform setae in males (Fig. 43). Males also have longer pectines than females and are more granulated, with e.g. the chela of pedipalp granulate with carinae in males and smooth



Figures 1–8: Figures 1–7: Fifth (or fourth and fifth) metasomal segment and telson. Figures 1–2: *Neobuthus berberensis* Hirst, 1911, ♀ (1) and ♂ (2), Somaliland, Berbera env., 10°22.8'N 45°02.2'E, 107 m a.s.l., FKCP. **Figures 3–4:** *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.**, ♀ (**3**), Somaliland, near Sheikh, 09°46.1'N 45°17.5'E, 1329 m a.s.l., FKCP and ♂ (**4**), Somaliland, 15 km near Sheikh, Goolis mts., 09°58.9'N 45°10.3'E, 1247 m a.s.l., FKCP. **Figures 5–6:** *Neobuthus awashensis* **sp. n.**, ♀ allotype (**5**) and ♂ (**6**) holotype. **Figure 7:** *Butheolus thalassinus* Simon, 1882, ♂, Yemen, Ta'izz government, N of Al Makha by road, 13°23'37"N 43°16'22"E, 5 m a.s.l., FKCP. **Figure 8: Carapace**, *Butheolus thalassinus* Simon, 1882, ♂, same specimen locality as Figure 7.



Figures 9–13: *Neobuthus berberensis* Hirst, 1911.The locality Somaliland, Berbera env., 10°22.8'N 45°02.2'E, 107 m a.s.l. (9 and 13), ♀ (10), ♂ (11), and juvenile (12). The specimens were not photographed at the place of capture where the substrate is sand (photos 9 and 13); in photos 10–12 the substrate is rocky.

without granules in females. Other differences such as e.g. the carinae on metasoma are described below.

COLORATION. The mesosoma and carapace are dark (brown to black) with orange to yellow spots, but proportions of the colors are quite variable so that some specimens may be described as orange to yellow with brown to black spots. However, the space between the anterior median carinae on the carapace always bears an orange to yellow spot. The mesosoma bears a median black stripe and two orange stripes or only a stripe with orange spots surrounded by black. The base color of the metasoma, pedipalps and legs is yellow or orange with dark spots or reticulations. Carinae on the metasoma and rarely on the pedipalps are dark. Metasomal segment V is darker than others, with the contrast more profound in males. The chelicerae are yellow with reticulation only in anterior part, and with reddish denticles (Fig. 28).

CARAPACE (Figs. 28 and 31). The surface is densely granulated. Carinae are absent or inconspicuous, only anterior median carinae are well developed. The anterior margin of the carapace is straight, but in males may be slightly convex; it bears seven to eight macrosetae, which are long thin setae in females and short spiniform setae in males.

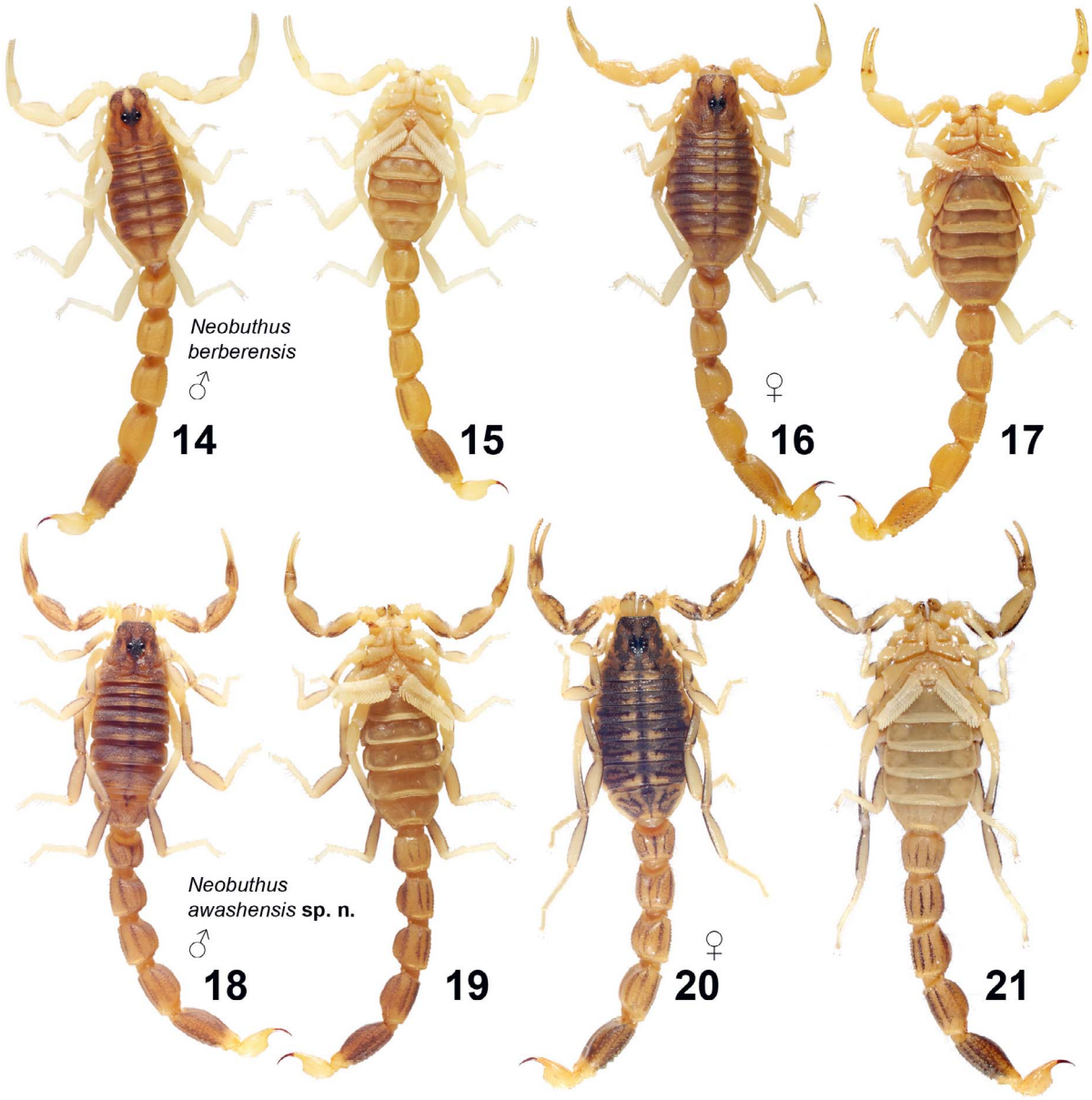
MESOSOMA. The mesosoma bears three carinae, of which the lateral pair are incomplete; in males even the median carina may be less conspicuous. The pectinal tooth count is 15–16 in females and 17–21 in males. The marginal tips of the pectines extend to the proximal half of sternite IV in females, and to the proximal half of sternite V in males. The pectines have three marginal lamellae and seven or eight middle lamellae. The lamellae bear numerous dark setae, three to six on each fulcrum; the setae are shorter in males. All sternites lack carinae; sternites may be weakly granulated, mainly in males. Sternite VII is more strongly granulated, with granulation apparent even in females.

METASOMA AND TELSON. Metasomal segments I–III bear ten or eight carinae; segment IV bears eight carinae that are complete in males, but in females only the ventrolateral carinae may be complete. Other carinae in females may be indicated only by several granules. Metasomal segment V of both sexes has only ventrolateral carinae, which in posterior halves bear several lobate granules usually more conspicuous in females. Granules on the ventral surface of segment V may form an irregular median carina in both sexes. Metasomal segments I–III are densely granulated, with granules of approximately equal size. Granules on segments IV–V are of unequal sizes and unevenly distributed, especially in females. The anal arch consists of two lobes in females, and three or four lobes in males. All segments are sparsely setose in females or spinose in males; on the fifth metasomal segment there are ca. 35–40 long setae in females or short spiniform setae in males. The telson is rather bulbous in females and rather elongate in males. The aculeus is slightly shorter than the vesicle in both sexes. The surface of the telson is bumpy, sparsely hirsute, without a subaculear tubercle, although the angular shape of the vesicle may appear like a protuberance (Fig. 3).

LEGS. The tarsomeres bear two rows of macrosetae on the ventral surface and numerous macrosetae on the other surfaces, which on legs I–III form bristle combs. The macrosetae are thin setae in the females and spiniform setae in the males. The femur and patella may bear four to six carinae, which however may be obsolete. The femur bears only solitary macrosetae.

PEDIPALPS. The femur is granulated and bears three to five carinae; the ventroexternal carina is incomplete or absent, the other carinae are granular. The patella is granular, with seven coarsely granular carinae in males and smooth, without carinae or obsolete carinae in females. The chela is granulate with five carinae, which may be weak and incomplete in males and smooth, without granules and carinae in females. All pedipalps segments including the trochanter are sparsely hirsute, with dark long setae in females (Fig. 41) and short spiniform setae in males (Fig. 43). The fixed and movable fingers bear five to six rows of denticles, with external and internal accessory denticles and three distal denticles (Fig. 49).

MEASUREMENTS IN MM. Male from Somaliland (15 km near Sheikh, Goolis Mountains, 09°58.9'N 45°10.3'E). Total length 20.2; carapace length 2.36, width 2.56; metasoma and telson length 12; first metasomal segment length 1.44, width 1.55; second metasomal segment length 1.65, width 1.45; third metasomal segment length 1.82, width 1.42; fourth metasomal segment length 2.15, width 1.40; fifth metasomal segment length 2.65, width 1.40; telson length 2.40; telson width 0.82; pedipalp femur length 1.45, width 0.62; pedipalp patella length 2.12, width 0.92; chela length 2.52; manus width 0.60; movable finger length 1.62.
Female from Somaliland (near Sheikh, 09°46.1'N 45°17.5'E). Total length 27; carapace length 3.32, width 3.80; metasoma and telson length 16.3; first metasomal segment length 1.95, width 2.20; second metasomal segment length 2.24, width 2.02; third metasomal segment length 2.36, width 2.00; fourth metasomal segment length 2.92, width 1.95; fifth metasomal segment length 3.62, width 1.87; telson length 3.32; telson width 1.37; pedipalp femur length 1.90, width 0.90; pedipalp patella length 2.60, width 1.28; chela length 3.50; manus width 0.88; movable finger length 2.35.



Figures 14–21: Figures 14–17: *Neobuthus berberensis* Hirst, 1911, Somaliland, Berbera env., 10°22.8'N 45°02.2'E, 107 m a.s.l., FKCP. **Figures 14–15:** Dorsal and ventral views, ♂ (20 mm). **Figures 16–17:** Dorsal and ventral views, ♀ (30 mm). **Figures 18–21:** *Neobuthus awashensis* **sp. n.**. **Figures 18–19:** Dorsal and ventral views, ♂ (20 mm) holotype. **Figures 20–21:** Dorsal and ventral views, ♀ (29 mm) allotype .

COMMENTS. *N. ferrugineus* **comb. n.** forms a color transition between two other species of the region, being relatively darker than *N. berberensis* and relatively lighter than *N. awashensis* **sp. n.** However, it must be kept in mind that the variation in color may be significant.

Neobuthus awashensis Kovařík et Lowe, **sp. n.**

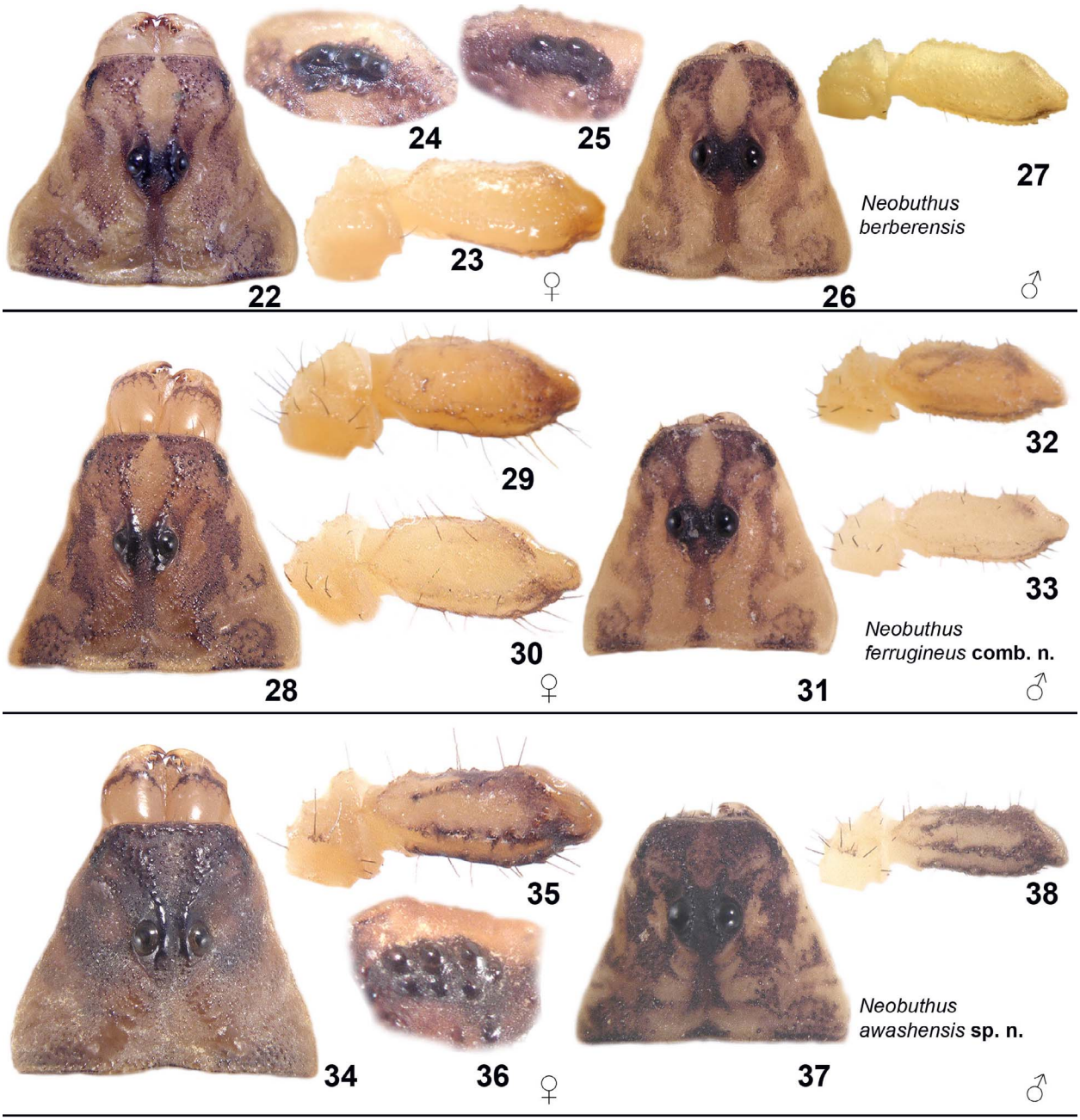
(Figs. 5–6, 18–21, 34–38, 44–47, 67–74, 86, 89, 92, 95–96, 100–101)

TYPE LOCALITY AND TYPE DEPOSITORY. **Ethiopia**, Awash, Metahara env., 08°54'N 39°54'E, 960-1050 m. a.s.l. (Fig. 71); the author´s collection (FKCP).

TYPE MATERIAL. Ethiopia, Awash, Metahara env., 08°54'N 39°54'E, 960-1050 m a.s.l. (Fig. 71), 1♀ (paratype), 2008, leg. V. Trailin, 2♀1♀im. (allotype and paratypes), XI.2010, leg. T. Mazuch and P. Novák, 32♂ (holotype and paratypes) 18♀ (paratypes) 11♀ims. 5♂ims. (paratypes), 19.-22.VII.2011, leg. F. Kovařík. Most types are in the collection of the first author (FKCP), two paratypes (♂♀) are in the collection of the second author (GL).

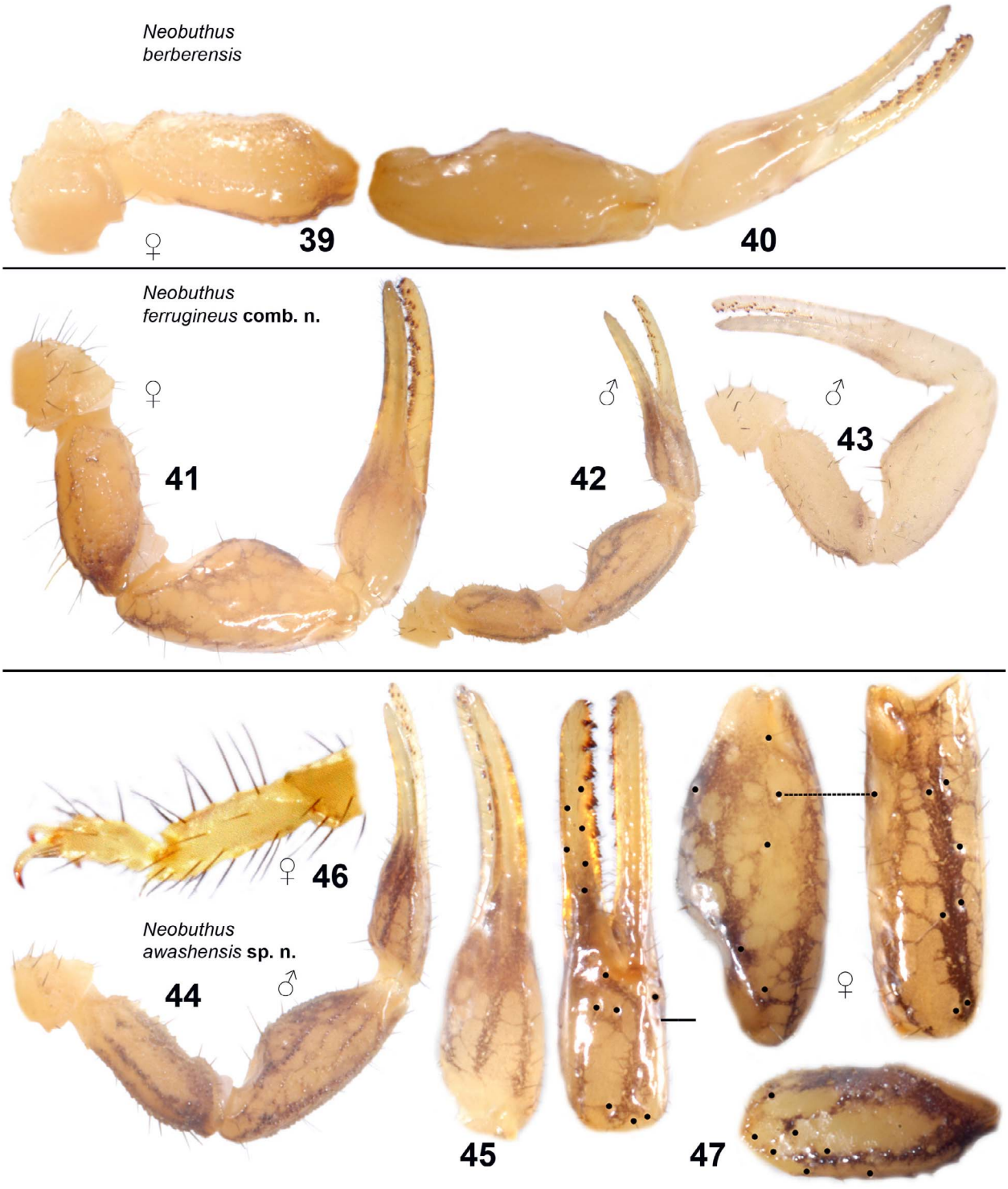
ETYMOLOGY. Named after the type locality.

DIAGNOSIS. Total length 20–21 mm (males) and 27–30 mm (females); carapace densely granulated with only

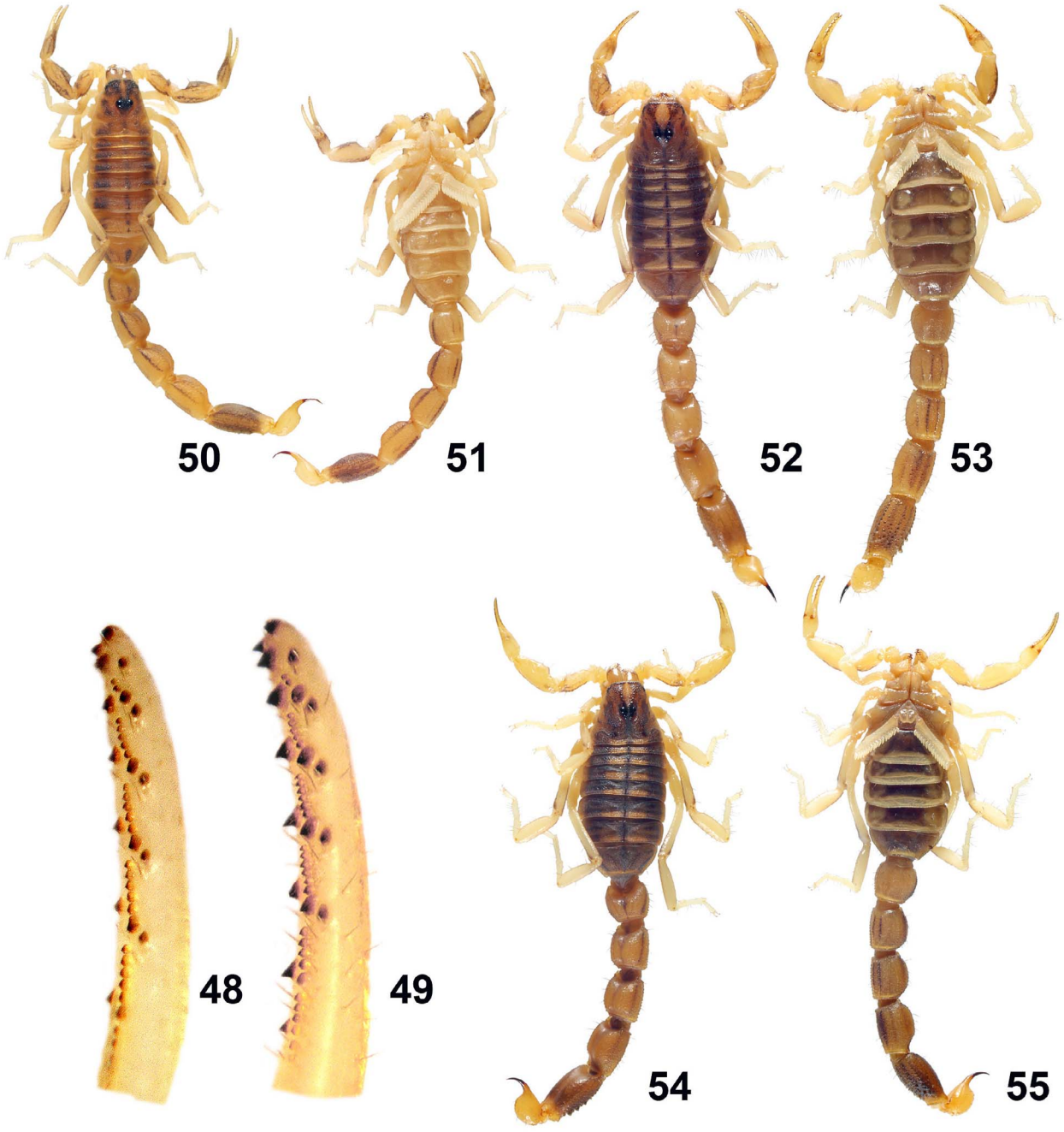


Figures 22–38: Figures 22–27: *Neobuthus berberensis* Hirst, 1911, Somaliland, Berbera env., 10°22.8'N 45°02.2'E, 107 m a.s.l. Carapace (**22**), trochanter and femur of pedipalp (**23**), and lateral eyes (24), ♀ (30 mm). Lateral eyes (25), carapace (**26**), and trochanter and femur of pedipalp (**27**), ♂ (20 mm). **Figures 28–33:** *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.**. Carapace (**28**) and trochanter and femur of pedipalp (30), ♀ (29 mm), Somaliland, near Berbera, 10°15'30.5"N 45°06'04.2"E, 376 m a.s.l., FKCP. Trochanter and femur of pedipalp (**29**), ♀ (28 mm), Somaliland, near Sheikh, 09°46.1'N 45°17.5'E, 1329 m a.s.l., FKCP. Carapace (**31**) and trochanter and femur of pedipalp (**33**), ♂ (21 mm), Somaliland, near Berbera, 10°15'30.5"N 45°06'04.2"E, 376 m a.s.l., FKCP. Trochanter and femur of pedipalp (**32**), ♂ (21 mm), Somaliland, 15 km near Sheikh, Goolis Mts., 09°58.9'N 45°10.3'E, 1247 m a.s.l. FKCP. **Figures 34–38:** *Neobuthus awashensis* **sp. n.**. Carapace (**34**), trochanter and femur of pedipalp (**35**), and lateral eyes (**36**), ♀ (30 mm) paratype. Carapace (**37**) and trochanter and femur of pedipalp (**38**), ♂ (21 mm) paratype.

anterior median carinae developed, area between these carinae fuscous; anterior margin of carapace straight or slightly convex; pectine teeth 15–18 in females, 17–21 in males; sternites III–VI smooth, sternite VII with 4 weakly granulated or obsolete carinae; pedipalps including trochanter, metasoma and telson with sparse dark, long thin setae in females and shorter spiniform setae in males; metasomal segment V with ca. 35–40



Figures 39–47: **Figures 39–40:** *Neobuthus berberensis* Hirst, 1911, Somaliland, Berbera env., 10°22.8'N 45°02.2'E, 107 m a.s.l. Trochanter and femur of pedipalp (**39**), and patela and chela of pedipalp (**40**), ♀ (30 mm). **Figures 41–43:** *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.**. Pedipalp (**41**), ♀ (28 mm), Somaliland, near Sheikh, 09°46.1'N 45°17.5'E, 1329 m a.s.l., FKCP. Pedipalp (**42**), ♂ (21 mm), Somaliland, 15 km near Sheikh, Goolis Mts., 09°58.9'N 45°10.3'E, 1247 m a.s.l. FKCP. Pedipalp (**43**), ♂ (21 mm), Somaliland, near Berbera, 10°15'30.5"N 45°06'04.2"E, 376 m a.s.l., FKCP. **Figures 44–47:** *Neobuthus awashensis* **sp. n.**. Pedipalp (**44**), ♂, (21 mm) paratype. Chela dorsal (**45**), tarsomeres of the second leg (**46**), and trichobothrial pattern (**47**), ♀ (30 mm) paratype.



Figures 48–55: Figures 48–49: Movable finger. Figure 48: *Neobuthus berberensis* Hirst, 1911, ♂ (20 mm), Somaliland, Berbera env., 10°22.8'N 45°02.2'E, 107 m a.s.l. , FKCP. **Figure 49:** *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.**, ♀ (29 mm), Somaliland, near Berbera, 10°15'30.5"N 45°06'04.2"E, 376 m a.s.l., FKCP. **Figures 50–55:** ***Neobuthus ferrugineus* (Kraepelin, 1898) comb. n.**. **Figures 50–51:** Dorsal and ventral views, ♂ (21 mm), Somaliland, 15 km near Sheikh, Goolis Mts., 09°58.9'N 45°10.3'E, 1247 m a.s.l. FKCP. **Figures 52–53:** Dorsal and ventral views, ♀ (29 mm), Somaliland, near Berbera, 10°15'30.5"N 45°06'04.2"E, 376 m a.s.l., FKCP. **Figures 54–55:** Dorsal and ventral views, ♀ (29 mm), Somaliland, near Berbera, 10°15'30.5"N 45°06'04.2"E, 376 m a.s.l., FKCP.

long setae in females, shorter spiniform setae in males; legs I–III with bristle combs; movable finger of pedipalp bears 5–6 rows of denticles, with external and internal accessory denticles and three distal denticles; pedipalp femur length to width ratio 2.4–2.6 in females, 2.5–2.7 in males.

DESCRIPTION. Adult males are 20–21 mm long and adult females are 27–30 mm long. The habitus is shown in Figs. 18–19 (male) and Figs. 20–21 (females). For position and distribution of trichobothria of pedipalps see Fig. 47. Trichobothrium d_2 of pedipalp femur present on dorsal surface but often smaller than other tricho-

bothria or absent. Trichobothrium d_2 of pedipalp patella either present but often smaller than other trichobothria, or absent. Sexual dimorphism is noticeable. Males are substantially smaller with bristle combs composed of long spiniform setae, whereas females have bristle combs composed of long thin setae. All segments of metasoma and pedipalps are sparsely hirsute, with dark long setae in females (Figs. 5, 35) and shorter spiniform setae in males (Figs. 38, 44). Males also have longer pectines than females and are more granulated, with e.g. the chela of pedipalp granulate with carinae in males, and smooth without granules in females. Males are matte, females and juveniles are glossy. Other differences such as metasomal carination are described below.

COLORATION. The mesosoma and carapace are dark (brown to black) with orange to yellow spots, but proportions of the colors are quite variable so that some specimens may be described as orange to yellow with brown to black spots. However, the space between the anterior median carinae on the carapace is always dark, and does not appear as an orange to yellow spot (Fig. 34). The mesosoma bears a median black stripe and two orange stripes or only a stripe with orange spots surrounded by black. The base color of the metasoma, pedipalps and legs is yellow or orange with dark spots or reticulations. Carinae on the metasoma and on the pedipalps are dark. The fifth metasomal segment is darker than others, with the contrast more profound in males. The chelicerae are yellow with reticulation only in anterior part, and with reddish denticles (Fig. 34).

CARAPACE (Figs. 34, 37, 74). The surface is densely granulated. Carinae are absent or inconspicuous, only anterior median carinae are well developed. The anterior margin of the carapace is straight, but in males may be slightly convex; it bears 8–11 macrosetae, which are long setae in females and shorter spiniform setae in males.

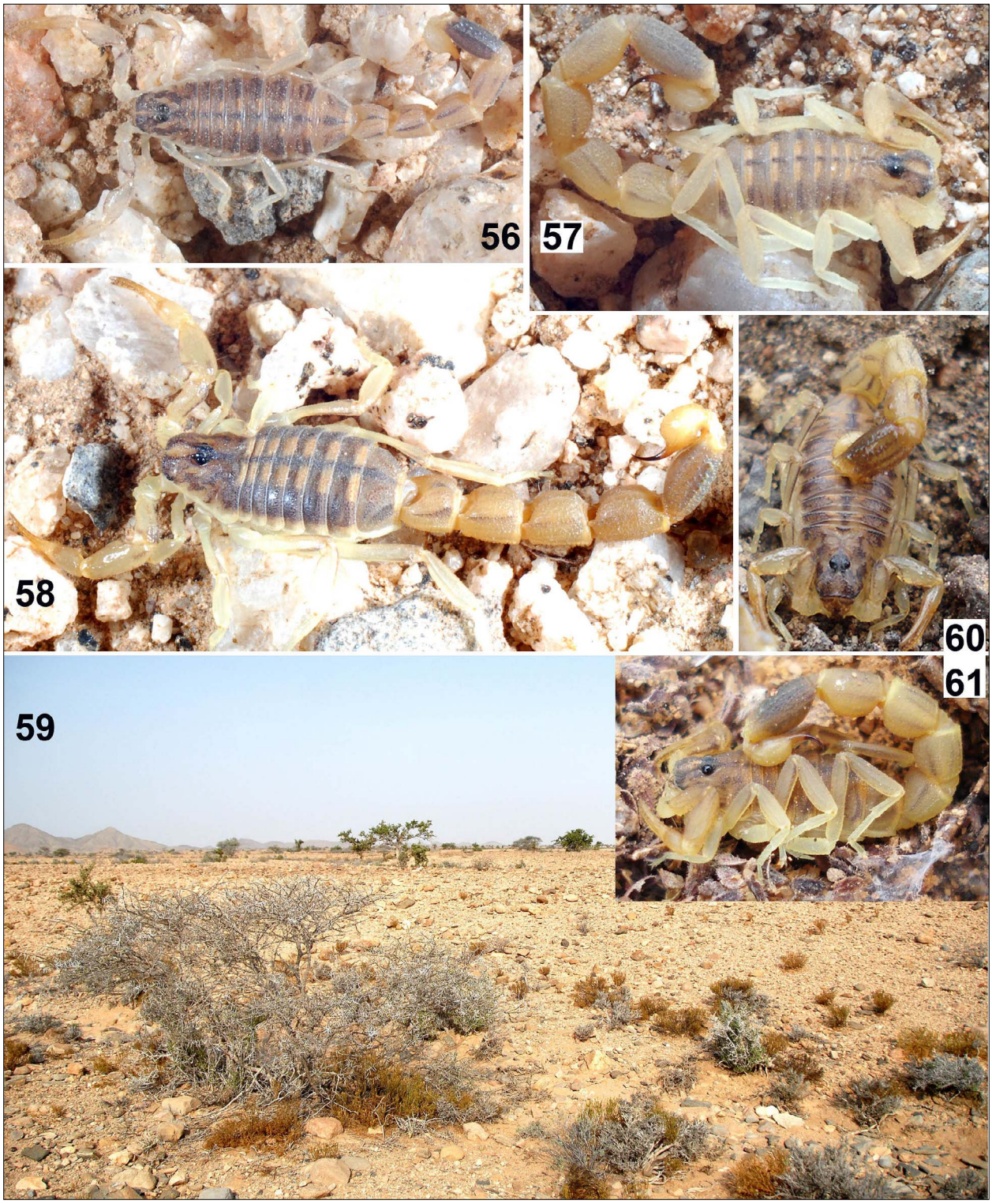
MESOSOMA. The mesosoma bears three carinae, of which the lateral pair are incomplete or absent; in males even the median carina may be less conspicuous. The pectinal tooth count is 15–18 (9x15, 23x16, 14x17, 2x18) in females and 17–21 (1x17, 6x18, 28x19, 27x20, 6x21) in males. The marginal tips of the pectines extend to the proximal half of sternite IV in females, and to the proximal half of sternite V in males. The pectines have three marginal lamellae and seven or eight middle lamellae. The lamellae bear numerous dark setae, three to six on each fulcrum; the setae are shorter in males. Sternites III–VI without carinae, but may be weakly granulated, mainly in males. Sternite VII is more strongly granulated, with granulation apparent even in females; there may be a weakly granulated pair of median carinae, and obsolete lateral carinae indicated by granules. Hemispermatophore with three short, spatulate or laminate basal lobes, and prominent pointed hook (Fig. 73).

METASOMA AND TELSON (Figs. 5–6, 95–96, 100–101). Metasomal segments I–III bear eight or ten carinae; segment IV bears eight carinae that are more complete in males, but in females only the ventrolateral carinae may be complete. Other carinae in females may be indicated only by several granules. Metasomal segment V of both sexes has only ventrolateral carinae, which in their posterior halves bear several lobate granules usually more conspicuous in females. Granules on the ventral surface of metasomal segment V may form an irregular median carina in both sexes. Metasomal segments I–III are densely granulated, with granules of approximately equal size. Granules on segments IV–V are of unequal sizes and unevenly distributed, especially in females. Granulation in females is sparse on all surfaces of segments I–III, and lateral and dorsal surfaces of segment IV (these surfaces more densely granulated in males). The anal arch consists of two lobes in females, three or four lobes in males. All segments are sparsely setose in females or spinose in males; on metasomal segment V there are ca. 35–40 long setae in females or shorter spiniform setae in males. The telson is rather elongate in both sexes. The aculeus is slightly shorter than the vesicle in both sexes. The surface of the telson is bumpy, sparsely hirsute and without a subaculear tubercle, although the angular shape of the vesicle may appear as a protuberance (Figs. 5, 100–101).

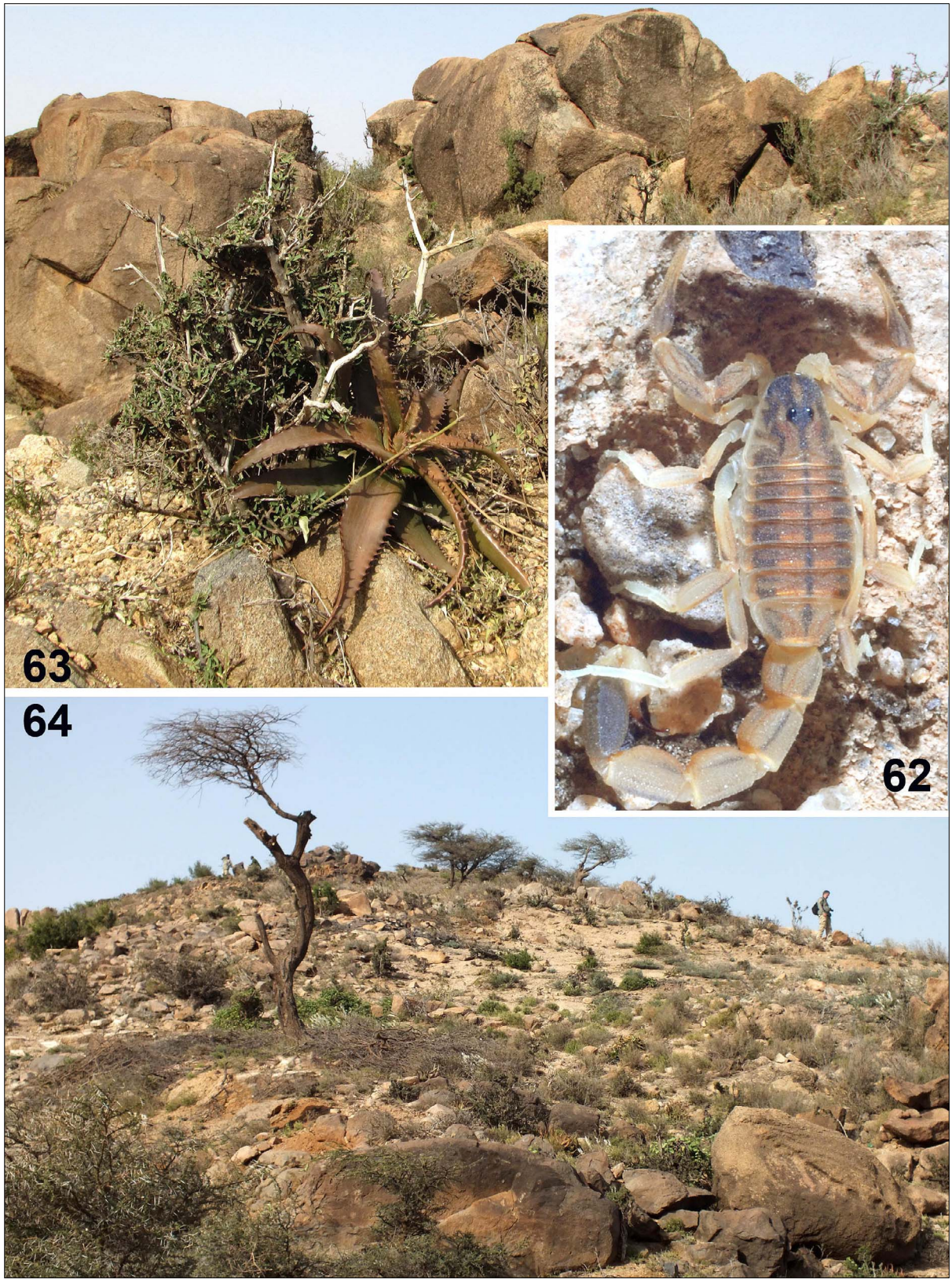
LEGS. The tarsomeres bear two rows of macrosetae on the ventral surface and numerous macrosetae on the other surfaces, which on legs I–III form bristle combs. The macrosetae are longer in females. The femur and patella may bear four to six carinae, which however may be obsolete. The femur bears only solitary macrosetae.

PEDIPALPS. The femur is granulated and bears three to five carinae; the ventroexternal carina is incomplete or absent, the other carinae are granular. The patella is granular, with seven coarsely granular carinae in males, and smooth, without carinae or obsolete carinae in females. The chela is granulate with five carinae, which may be weak and incomplete in males and smooth, without granules and carinae in females. All pedipalps including the trochanter are sparsely hirsute, with dark long setae in females (Fig. 35) and shorter spiniform setae in males (Fig. 38). The movable and fixed fingers bear five to six rows of denticles, with external and internal accessory denticles and three distal denticles (Fig. 49).

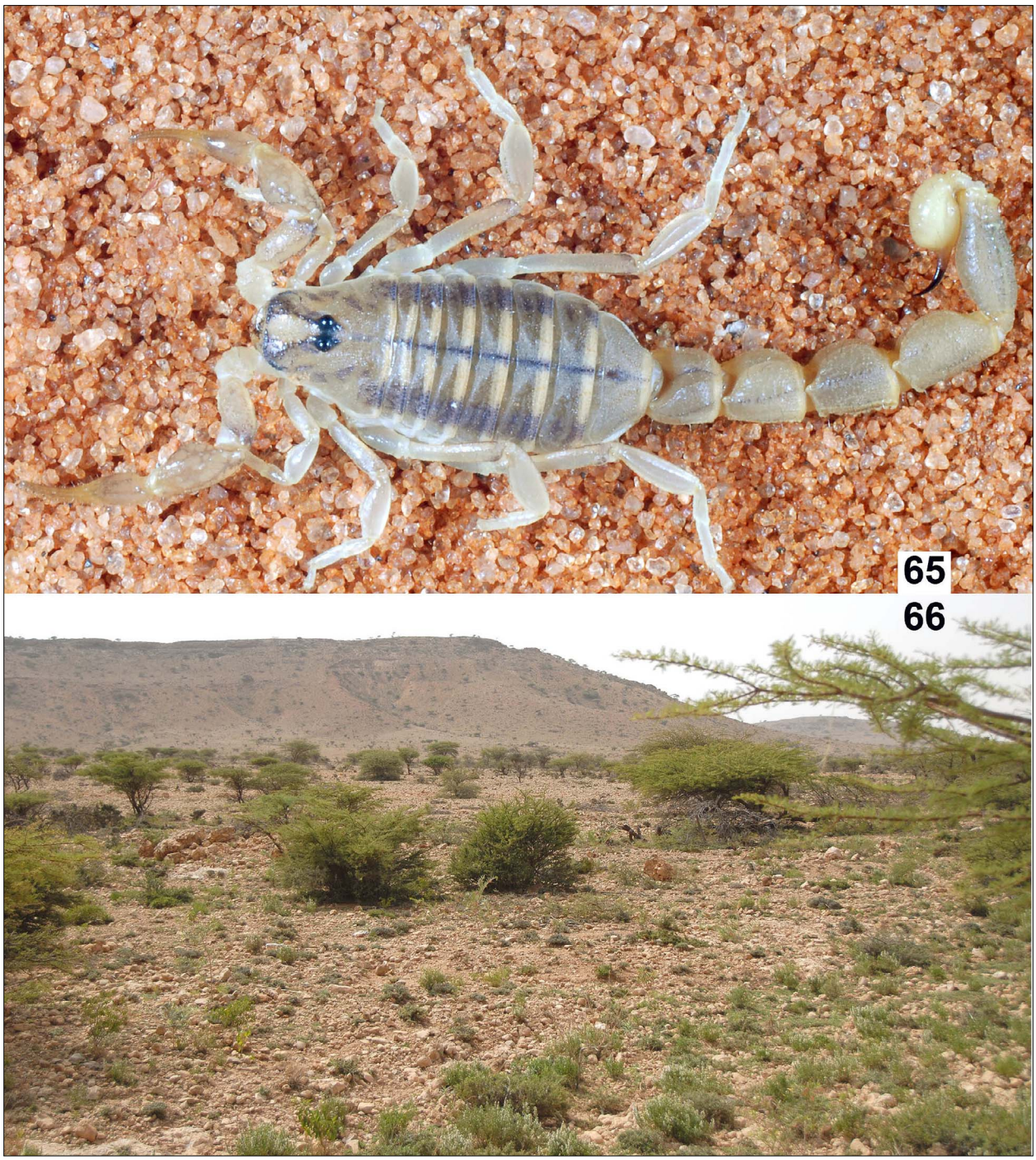
MEASUREMENTS IN MM. Male holotype. Total length 21; carapace length 2.28, width 2.65; metasoma and telson



Figures 56–61: *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.**. **Figure 56:** Juvenile at the locality in Fig. 59. **Figure 57:** Male at the locality in Fig. 59. **Figure 58:** Female at the locality in Fig. 59. **Figure 59:** Somaliland, near Berbera, 10°15'30.5"N 45°06'04.2"E, 376 m a.s.l. **Figure 60:** Female at the locality in Djibouti, near Goubetto, ca. 25 km S of Gulf of Tadjura, 10°23.5'N 42°55.5'E. **Figure 61:** Male at the same locality in Djibouti.



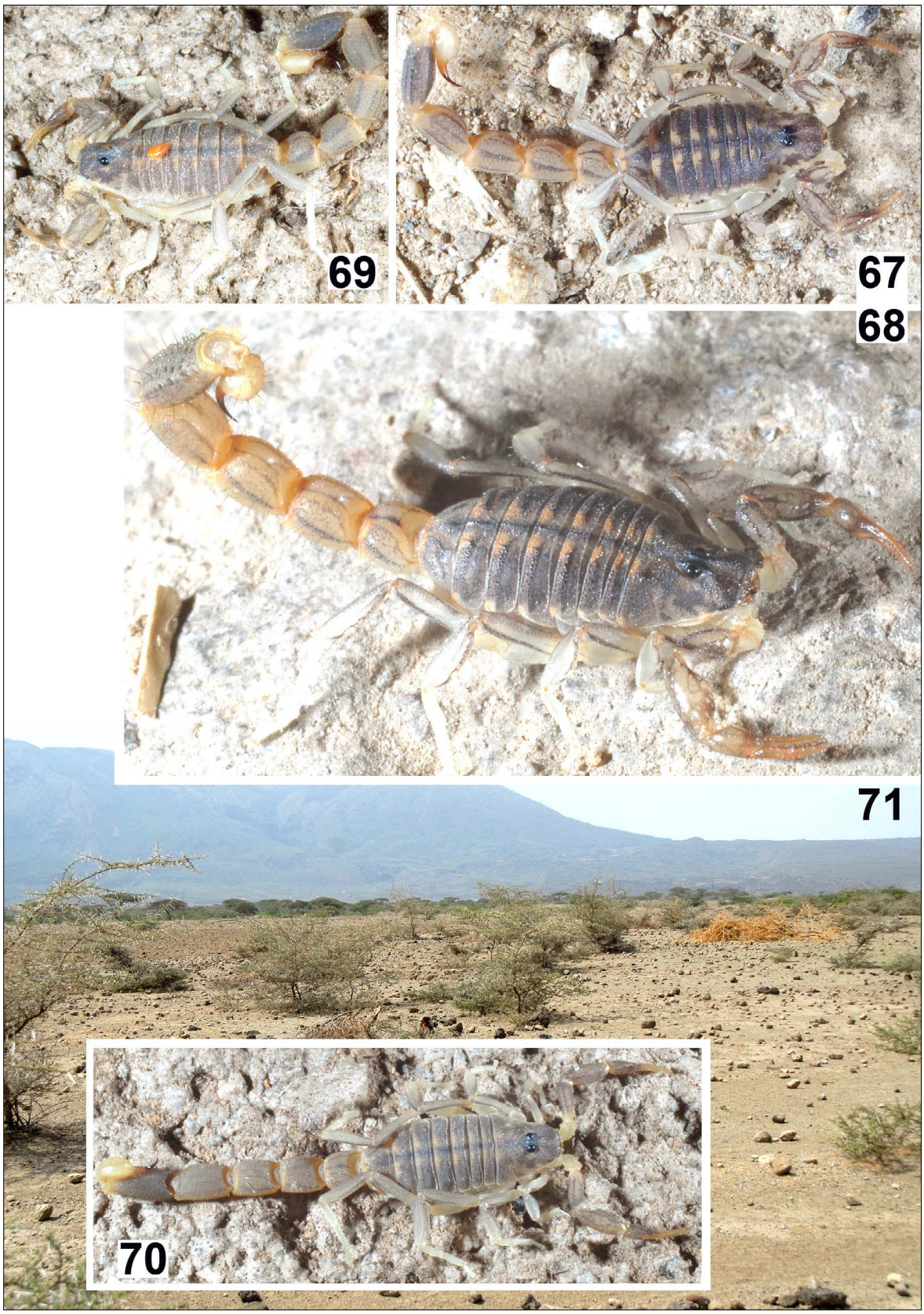
Figures 62–64: *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.**. **Figure 62:** Male at the locality in Figs. 63–64. **Figures 63–64:** Somaliland, 15 km near Sheikh, Goolis Mts., 09°58.9'N 45°10.3'E, 1247 m a.s.l.



Figures 65–66: *Neobuthus ferrugineus* (Kraepelin, 1898) **comb. n.**. **Figure 65:** Female from the locality in Fig. 66. The female was not photographed directly at the place of capture, the substrate is sand from another locality. **Figure 66:** Somaliland, near Sheikh, 09°46.1'N 45°17.5'E, 1329 m a.s.l..

length 12.4; first metasomal segment length 1.45, width 1.57; second metasomal segment length 1.72, width 1.45; third metasomal segment length 1.80, width 1.45; fourth metasomal segment length 2.12, width 1.40; fifth metasomal segment length 2.78, width 1.35; telson length 2.36; telson width 0.85; pedipalp femur length 1.57, width 0.62; pedipalp patella length 2.15, width 0.85; chela length 2.60; manus width 0.55; movable finger length 1.60.

Female allotype. Total length 29; carapace length 3.05, width 3.65; metasoma and telson length 16.6; first metasomal segment length 1.97, width 2.17; second



Figures 67–71: *Neobuthus awashensis* **sp. n. Figures 67–68:** Females paratypes at the type locality. **Figure 69–70.** Males paratypes at the type locality. **Figure 71:** Ethiopia, Awash, Metahara env., 08°54'N 39°54'E, 960-1050 m a.s.l. Type locality of *Neobuthus awashensis* **sp. n.** and *Buthus awashensis* Kovařík, 2011 together with *Compsobuthus abyssinicus* Birula, 1903 and *Parabuthus liosoma* (Ehrenberg, 1828).

metasomal segment length 2.28, width 1.95; third metasomal segment length 2.42, width 1.92; fourth metasomal segment length 2.95, width 1.85; fifth metasomal segment length 3.67, width 1.85; telson length 3.30; telson width 1.15; pedipalp femur length 2.00, width 0.83; pedipalp patella length 2.65, width 1.15; chela length 3.37; manus width 0.80; movable finger length 2.33.

AFFINITIES. The described features distinguish *Neobuthus awashensis* **sp. n.** from all other species of the genus. In contrast to *N. berberensis* the entire pedipalps are sparsely hirsute with dark setae (females, Fig. 35) or spiniform setae (males, Fig. 38) and there are one or more dark spots (Figs. 44, 47), whereas *N. berberensis* has the entire femur of pedipalp yellow without dark spots and with only several white setae (Figs. 39–40). The pubescence on trochanter and femur of pedipalps is the same in *N. ferrugineus* **comb. n.** and *N. awashensis* **sp. n.**, but the latter species is darker, which is best apparent from the coloration of the femur of pedipalp and the carapace; in *N. ferrugineus* **comb. n.** the space between the anterior median carinae on the carapace always has an orange to yellow spot (Fig. 28), which is absent in *N. awashensis* **sp. n.** (Fig. 34). Males of *N. ferrugineus* **comb. n.** have spiniform setae/macrosetae shorter than *N. awashensis* **sp. n.** (Fig. 33 vs. 38). *N. awashensis* **sp. n.** also differs from *N. ferrugineus* **comb. n.** morphometrically, in having a longer and narrower femur of pedipalp. The telson of females of *N. ferrugineus* **comb. n.** and *N. berberensis* have a more bulky vesicle compared to females of *N. awashensis* **sp. n.** (Figs. 1, 3 vs. Fig. 5).

Key to species of *Neobuthus*

1. Pedipalps including trochanter with sparse dark, long setae in females (Fig. 35) and shorter spiniform setae in males (Fig. 38) 2
– Pedipalps including trochanter without dark setae (Figs. 23, 27) on dorsal and external surfaces ..... ***N. berberensis*** Hirst, 1911 (Somaliland)

2. Carapace with yellow to orange coloration between anterior median carinae (Fig. 28). Femur of pedipalp length to width ratio 2.0–2.1 in females, 2.3 in males ..... ***N. ferrugineus*** (Kraepelin, 1898), **comb. n.** (Djibouti, Ethiopia, Somaliland, Somalia)
– Carapace fuscous without yellow to orange coloration between anterior median carinae (Fig. 34). Femur of pedipalp length to width ratio 2.4–2.6 in females, 2.5–2.7 in males ..... ***N. awashensis*** **sp. n.** (Ethiopia)

In this key, we have not included the species *Neobuthus cloudsleythompsoni* Lourenço, 2001, from Ethiopia, and *Neobuthus sudanensis* Lourenço, 2005 from Sudan, because we have not had the opportunity to examine the types, and the descriptions do not include enough information about characters that we consider here to be important either for differentiating between species within *Neobuthus,* or for unequivocally establishing membership in the genus according to our revised diagnosis. The first author previously declared *N. cloudsleythompsoni* as nomen dubium (Kovařík, 2003: 138) because he was not able to confirm its distinctiveness by direct examination. It was supposed to be differentiated by the presence of only 3 lobate denticles on the ventrolateral carinae of metasoma V, as opposed to 5 lobate denticles in *N. berberensis*. In the extensive *Neobuthus* samples studied here, there was considerable intrapopulational variation in the number of lobate denticles. The enumeration of these denticles may be subjective because they vary in size, with larger posterior denticles in the series alternating with smaller 'non-lobate' denticles, and they are sexually dimorphic, being smaller in males. The number of enlarged 'lobate' denticles can even vary within one individual, as illustrated by the female paratype in Fig. 96, whose metasoma V might be deemed to bear 2 enlarged denticles on its left ventrolateral carina, and 4 on its right. The number of lobes on the anal arch has also been utilized as a species level diagnostic character in buthid scorpions. However, the anal arch in the *Neobuthus* samples studied here may include 2 lobes (mainly in females, see Fig. 1, but rarely also in males, see Fig. 6) to 4 lobes (in males, see Fig. 2). In light of such variation, we do not find these lobe counts to be reliable for discriminating between *Neobuthus* species.

Both *N. awashensis* **sp. n.** and *N. cloudsleythompsoni* are from Ethiopia, so assuming that the latter is indeed a *Neobuthus*, we may ask whether they belong to the same species. We suggest that they differ morphometrically. For example, *N. cloudsleythompsoni* appears to have a more stout pedipalp femur, whose length to width ratio computed from nominal lengths and widths is 2.2 (♂) and 2.25 (♀) (cf. Lourenço, 2001, Table III). Actually, the imprecision of the reported measurements (given in mm rounded to one decimal place, for sclerites only a few mm in size) means that actual length to width ratios could lie within the ranges: 1.91–2.56 (♂) and 2.18–2.33 (♀). Nevertheless, these ranges are still significantly less than our measured femur length to width ratio for *N. awashensis* **sp. n.**, which varied in the ranges 2.5–2.7 (♂) and 2.4–2.6 (♀). We therefore suspect that these two Ethiopian forms are not conspecific.

BIOGEOGRAPHY AND ECOLOGY. *Neobuthus berberensis* appears to be endemic to sandy deserts in the vicinity of Berbera in northwestern Somaliland, in an area called Guban, whose southern edge lies in close proximity to

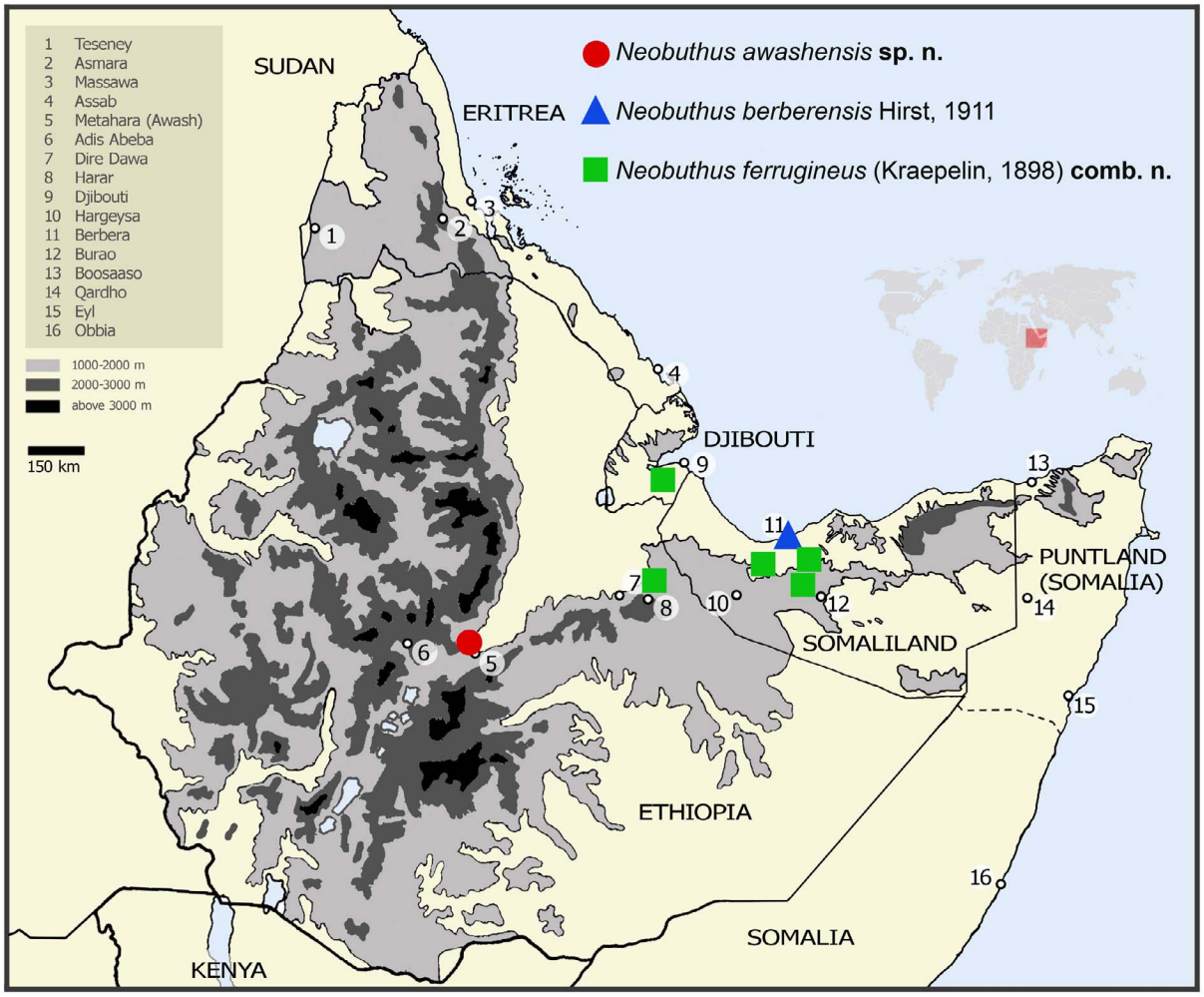


Figure 72: Distribution map of the three African closely related species of *Neobuthus* except Chisimaio (= Kismaayo), locality of *Neobuthus ferrugineus* (Kraepelin, 1898) in the southern part of Somalia.

the Goolis and Ogo Mountains Range. This low-lying area is extremely warm and dry, and hosts the scorpion *Parabuthus granimanus* Pocock, 1895 that reaches there from the coastal very warm northern areas in Djibouti and Eritrea, and also *Hottentotta polystictus* (Pocock, 1896) that has been able to adapt to a variety of biotopes in the region. *Neobuthus berberensis* was found in close proximity to Berbera City, exclusively in sandy desert (Figs. 9 and 13), and as soon as the landscape begins to change to rocky semi-desert this species disappears. In the local rocky semi-deserts (Figs. 59 and 63–64) it is replaced by *Neobuthus ferrugineus* **comb. n.**, which is darker-colored and exhibits a different behavior apparently in relation to the mechanics of motion in rocky terrain. *Neobuthus berberensis* exhibits a strong escape reflex by rapidly burying itself in the sand. In the rocky semi-deserts (Fig. 59) *N. ferrugineus* **comb. n.** occurs together with *Hottentotta polystictus* (Pocock, 1896), *Parabuthus granimanus* Pocock, 1895, *Buthus berberensis* Pocock, 1900, *Compsobuthus* sp. n. (*acutecarinatus* group), *Leiurus quinquestriatus* Ehrenberg, 1828 and *Hemiscorpius novaki* Kovařík & Mazuch, 2011. At farther removed localities in the Goolis Mountains. (Figs. 63–64) *N. ferrugineus* **comb. n.** reaches higher altitudes and occurs together with *Hottentotta polystictus* (Pocock, 1896), *Compsobuthus* sp. n. (*werneri* group), *Parabuthus heterurus* Pocock, 1897 and *Pandinus phillipsii* (Pocock, 1896).

N. awashensis **sp. n.** inhabits semi-desert in the proximity of the town of Metahara, Ethiopia. This area is characterized by volcanic bedrock with lava fields around the lake, and the terrain transitions to sandy semi-desert with scattered volcanic boulders further away from town. This environment appears to be optimal for the new species, which is sympatric with the more common *Buthus awashensis* Kovařík, 2011. Also

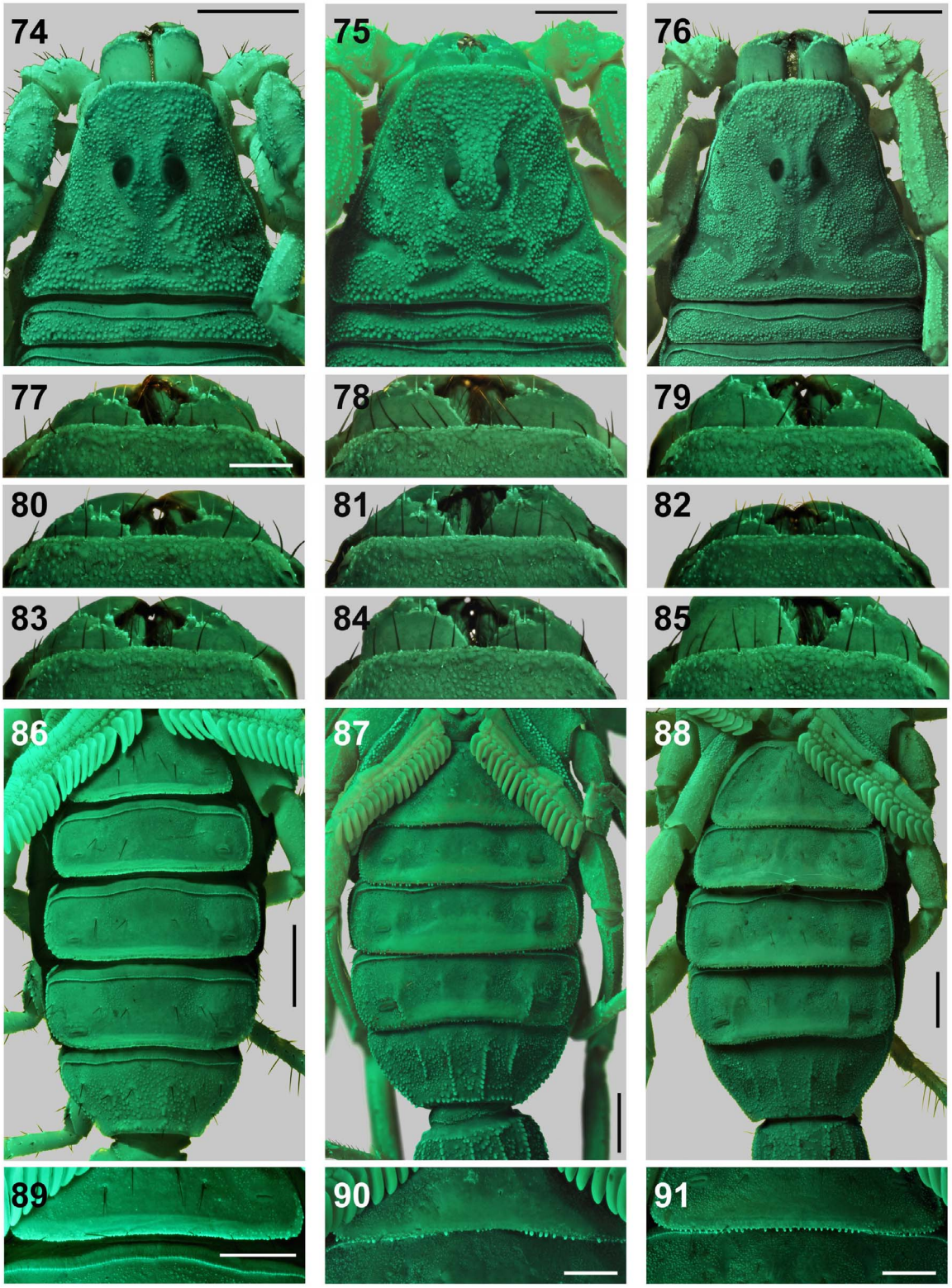
Figure 73: *Neobuthus awashensis* **sp. n.** Right hemispermatophore of paratype ♂, viewed from convex side. The structure has been compressed under a cover slip to reveal flat profiles of the basal lobes. Scale bar: 0.2 mm.

present, but in smaller numbers, are *Parabuthus liosoma* (Ehrenberg, 1828) and *Compsobuthus abyssinicus* Bir ula, 1903, of which the latter appears to be confined to more rocky areas.

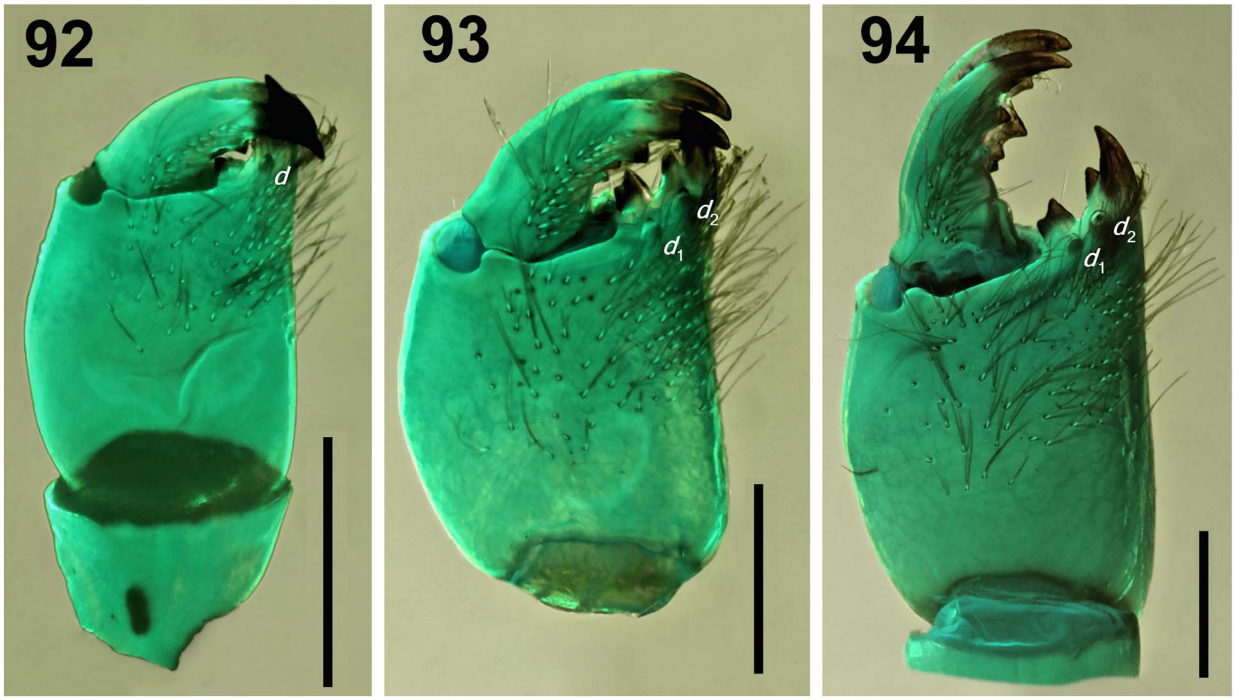
TAXONOMIC DISCUSSION. Lourenço (2001: 179) pre sented a table including seven characters to distinguish between *Butheolus*, *Nanobuthus* and *Neobuthus*. The latter two genera were synonymized with *Butheolus* by the first author (Kovařík, 2003: 137) on the basis of types studied and with attention paid to all seven characters that were subsequently used by Lourenço in reinstating the genera. Most of the characters cited by Lourenço pertain to intraspecific and/or intrageneric variation. One character that may be useful at the generic level is the number of lateral eyes. Lourenço (2001: 179) cited three identical lateral eyes for *Butheolus*, three plus one reduced for *Nanobuthus* and two plus one reduced for *Neobuthus*. During a recent expedition to Ethiopia and Somaliland the first author collected 78 specimens, and we are therefore able to state that this character is also variable, and that variation occurs even within a single population. Most frequent are three identical eyes (see Fig. 24 - female of topotype of *Neobuthus berberensis*), but one of them may be reduced, more often in males (see Fig. 25 - male of topotype of *Neobuthus berberensis*), and mainly in females there may be three identical eyes plus one reduced eye (see Fig. 36 - female paratype of *Neobuthus awashensis* **sp. n.**).

Lourenço did not accept synonymy of *Neobuthus* with *Butheolus*, and described *Neobuthus sudanensis* (Lourenço, 2005: 26–28). He admitted that some of his characters may be variable, but insisted on the validity of two of them (Lourenço and Qi, 2006: 93): (1) anterior margin of the carapace straight in *Neobuthus*, vs. slightly convex in *Butheolus*; and (2) ventrolateral carinae metasoma V with small number of lobate denticles, vs. numerous granules in *Butheolus*. The first character is here illustrated by photographs of male carapaces of *Butheolus thalassinus*, the type species of *Butheolus* (Figs. 8, 75), and *B. gallagheri* Vachon, 1980 (Figs. 76–85); and by both sexes of topotypes of *N. berberensis*, the type species of *Neobuthus* (Figs. 22, 26), and *N. awashensis* **sp. n.** (Fig. 37, 37, 74). These photographs show that any differences between the anterior margin profiles appear to be quite subtle and variable. If we compare a male *N. awashensis* (Fig. 74) to males of *B. thalassinus* (Fig. 75) and *B. gallagheri* (Fig. 76), we might perhaps discern a very slight convexity in the margins of the two *Butheolus* species, relative the straight margin in *Neobuthus*. However, inspection of a larger sample of 9 females of *B. gallagheri* (Figs. 77–85) shows that the margin can vary from straight (6/9, Figs. 77–82) to very slightly convex (3/9, Figs. 83–85). Similar variation occurs in anterior marginal profiles of *N. awashensis* **sp. n.**. In view of such intraspecific variation, we cannot regard this character as useful for differential generic diagnosis.

To support the second character, Lourenço (2005: 27, figs. 30–33), illustrated for comparison the metasomas of *Neobuthus* and *Butheolus* spp. However, the issue was confounded by strong sexual dimorphism that was not considered at the time, and by what we have now determined as a long standing generic misplacement of *Butheolus ferrugineus*. Thus, fig. 30 shows a **female** of *Neobuthus sudanensis*, whereas and figs. 31–33 show **males** of three *Butheolus* species, including *B. ferrugineus*. Although *Butheolus ferrugineus* Kraepelin, 1898 has long been the sole African representative of the



Figures 74–91: Prosomal and mesosomal characters in *Neobuthus* and *Butheolus*. **Figures 74–76:** Carapace and tergite I of ♂ *Neobuthus awashensis* **sp. n.** (**74**), ♂ *Butheolus thalassinus* (**75**), and ♂ *B. gallagheri* (**76**), showing granulation, carination, and margins. **Figures 77–85:** Carapace anterior margin of 9 ♀♀ *B. gallagheri*. **Figures 86–88:** Pectines and sternites of ♂ *Neobuthus awashensis* **sp. n.** (**86**), ♂ *Butheolus thalassinus* (**87**), and ♂ *B. gallagheri* (**88**). **Figures 89–91:** Higher magnification views of sternite III posterior margins of ♂ *Neobuthus awashensis* **sp. n.** (**89**), ♂ *Butheolus thalassinus* (**90**), and ♂ *B. gallagheri* (**91**), showing differences in denticle armature. Scale bars: 1 mm in **74–76**, **86–88**; 0.5 mm in **77–85** (bar in **77** applies to **77–85**), **89–91**. All photographs acquired by UV fluorescence imaging. Comparative material: *Butheolus gallagheri*, ♂, ♀, Oman, wadi above Khor Rhori Beach, E of Taqah, 17°3.22'N 54°25.33'E 18 Oct 1993, leg. G. Lowe, GL; *Butheolus thalassinus*, ♂ Yemen, Ta'izz, under rock on *Euphorbia-Aloe* hill 3800 ft, 10 Jan 1951, leg. H. Hoogstraal, WDS.



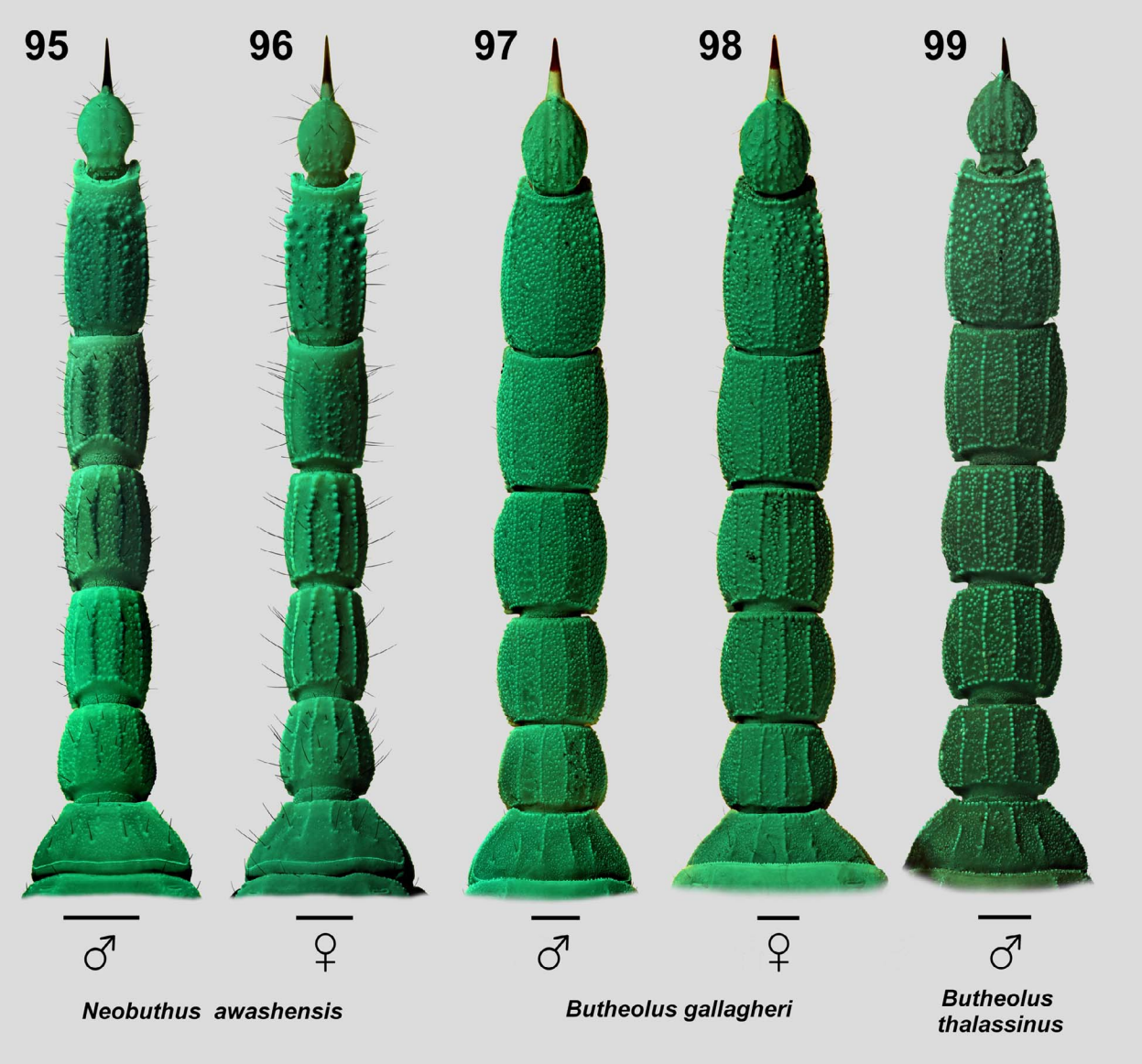
Figures 92–94: Ventral aspect of chelicerae of *Neobuthus* and *Butheolus*. **Figure 92:** *Neobuthus awashensis* **sp. n.**, paratype ♂, showing single denticle (*d*) on fixed finger. **Figures 93-94:** ♂ *Butheolus gallagheri* (**93**) and ♂ *Butheolus anthracinus* (**94**), showing two denticles, proximal (d_1) and distal (d_2), on fixed finger. We also examined the cheliceral fixed finger of *Butheolus thalassinus* and confirmed the presence of two ventral denticles (photo not shown). Scale bars: 0.5 mm. All photographs acquired by UV fluorescence imaging. Comparative material: *Butheolus gallagheri*, see data under caption for Figs. 74–91. *Butheolus anthracinus*, ♂, Oman, Nejd Desert, SW of Thumrait, 17°30.77N 54°2.28'E, 600 m a.s.l., 19 Oct 1993, leg. G. Lowe, NMBS.

genus *Butheolus*, its similarity to *Nanobuthus* was previously noted (Simon, 1910) and it was once transferred to that genus (Kraepelin, 1903; Vachon, 1980). The genus *Nanobuthus* appears to be closer to *Neobuthus*, than to *Butheolus*. Taking into account newly discovered sexual dimorphism (i.e. more lobate dentition in females), we now find that there are no significant differences in this character between *Butheolus ferrugineus* and *Neobuthus berberensis*. The other species that have been classified under *Butheolus* all originate from the Arabian Peninsula, and they do exhibit a different, more uniform pattern of granulate dentition along the ventrolateral carinae of metasoma V. We illustrate this sexual dimorphism and generic dichotomy by showing photos of metasomal segment V in both sexes of the three African species (Figs. 1–6, 95–96, 100–101), and of *Butheolus thalassinus* (males, Figs. 7, 99, 104) from Yemen (type species of *Butheolus*), and *B. gallagheri* from Oman (Fig. 97–98, 102–103).

The type species of *Neobuthus* Hirst, 1911 is *N. berberensis* Hirst, 1911, which was until now known only from the holotype female (30 mm long), whereas *Butheolus ferrugineus* was until now known only from the holotype male (21 mm long). These two species/genera were synonymized (Kovařík, 2003: 137). Our discovery of topotypes of both sexes of *Neobuthus berberensis* and of other specimens of both sexes of *Butheolus ferrugineus* Kraepelin, 1898 shows that they are in fact closely related species that clearly belong to the same genus. Moreover, the opportunity to examine a number of adults of both sexes has permitted us to redefine differences on the generic level between the three studied African species and the Arabian *Butheolus*. The apparent congruence of generic characters between *Neobuthus berberensis* and *Butheolus ferrugineus*, and the uncertain application of diagnostic characters proposed by Lourenço (2001: 179) has in the past led the first author to conclude that *Neobuthus* is a synonym of *Butheolus* (see Kovařík, 2003: 137). However, on the basis of our new observations, we now consider both genera to be valid, but we transfer *Butheolus ferrugineus* Kraepelin, 1898 to the genus *Neobuthus*. We surmise that the genus *Butheolus* does not occur in Africa and inhabits only the Arabian Peninsula. To differentiate between the two genera, we diagnose *Neobuthus* by the following combination of characters:

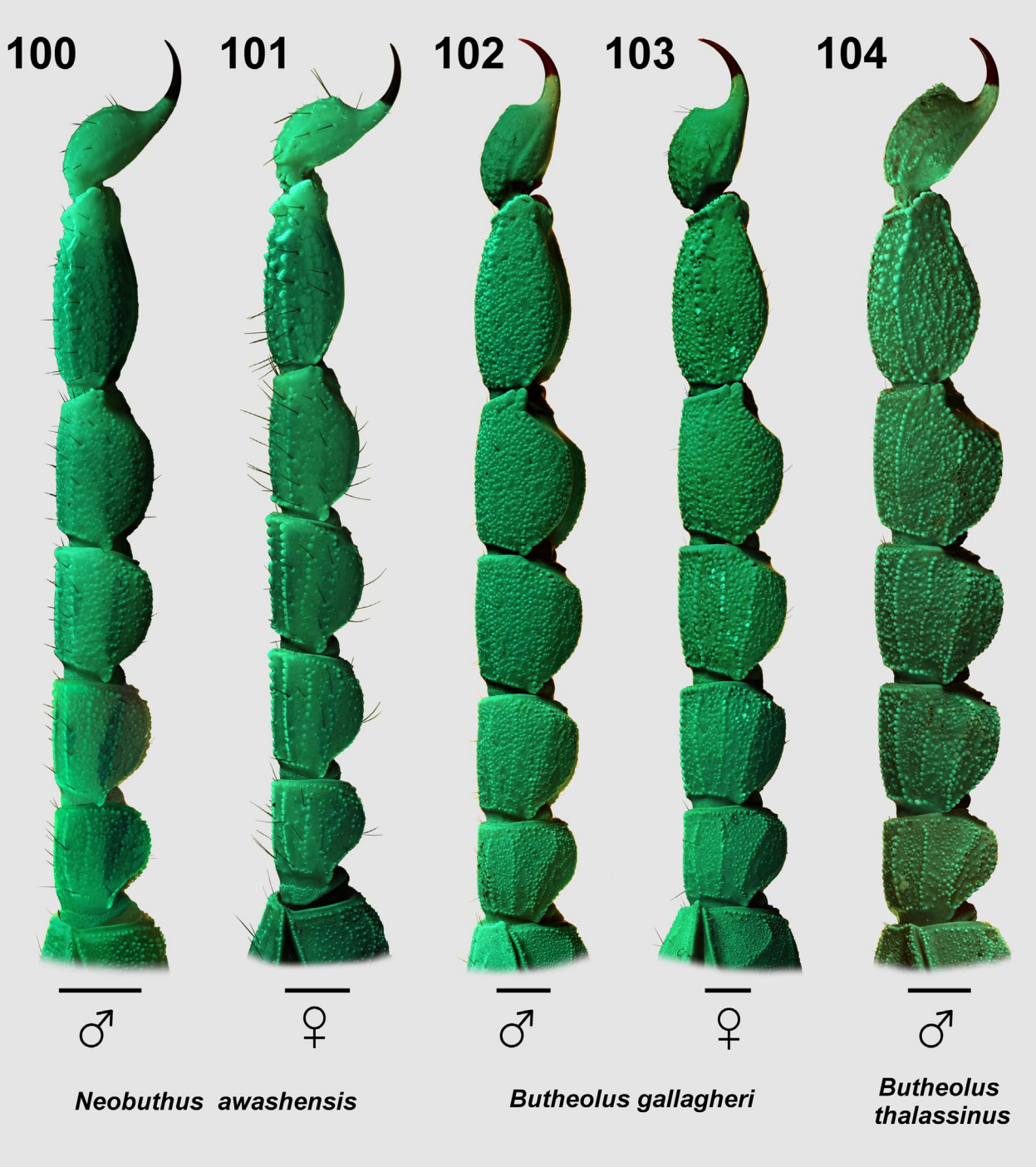
1. Very small size (vs. medium to small size of *Butheolus*), especially in males. All the 35 adult males examined were smaller (20–21 mm) than the 26 examined adult females (27–30 mm).

2. Ventral aspect of cheliceral fixed finger with single enlarged denticle (2 enlarged denticles in *Buth-*



Figures 95–99: Ventral aspect of metasoma and telson in *Neobuthus* and *Butheolus*. **Figures 95–96:** *Neobuthus awashensis* **sp. n.**, paratype ♂ (**95**) and ♀ (**96**). **Figures 97–98:** *Butheolus gallagheri*, ♂ (**97**) and ♀ (**98**). **Figure 99:** *Butheolus thalassinus*, ♂. Scale bars: 1 mm. All photographs acquired by UV fluorescence imaging. Comparative material: see data under caption for Figs. 74–91.

eolus). The number (n_D) of enlarged denticles on the ventral aspect of the cheliceral fixed finger is widely considered a key diagnostic character useful at the generic level for differentiating other distinctive lineages of buthids (e. g. n_D =1 for *Hemibuthus*, *Hemilychas*, *Isometroides*, *Lychas*, *Psammobuthus*, *Somalibuthus*; cf. Sissom, 1990; Kovařík, 2009). Hirst (1911) originally employed this character to diagnose *Neobuthus* and differentiate it from *Nanobuthus*, i.e. n_D = 1 in *Neobuthus*, vs. n_D = 0 in *Nanobuthus*. This character was not applied to differentiate *Neobuthus* from *Butheolus*, since Simon (1882) claimed that the type species, *Butheolus thalassinus*, also had n_D = 1. Pocock (1890: 121) challenged this, suggesting that *Butheolus* can have n_D = 2, but based his statement on *Butheolus melanurus*, which was later assigned to *Orthochirus*. Simon (1910) continued to claim that *B. thalassinus* only had one denticle, and that any second denticle was very small and difficult to see. Vachon (1960) also assumed n_D = 1 in *Butheolus*. This character was not considered recently presumably because of Simon's claim, and because n_D =1 is the condition in both *Butheolus ferrugineus* (= *Neobuthus ferrugineus* **comb. n.**) and *Neobuthus berberensis*. However, we find that n_D =2 in *Butheolus*



Figures 100–104: Lateral aspect of metasoma and telson in *Neobuthus* and *Butheolus*. **Figures 100–101:** *Neobuthus awashensis* **sp. n.**, paratype ♂ (**100**) and ♀ (**101**). **Figures 102–103:** *Butheolus gallagheri*, ♂ (**102**) and ♀ (**103**). **Figure 104:** *Butheolus thalassinus*, ♂. Scale bars: 1 mm. All photographs acquired by UV fluorescence imaging. Comparative material: see data under caption for Figs. 74–91.

thalassinus, *B. gallagheri* and *B. anthracinus*. We propose that this is the plesiomorphic condition in *Butheolus* (Figs. 93–94), and that *Neobuthus* has lost one denticle, a derived state (Fig. 92). The more distal position of the remaining denticle in *Neobuthus* suggests loss of the proximal denticle.

3. Metasomal segments relatively slender in both lateral and vertical dimensions, adult length to width

ratio of segment I > 0.85, of segment V > 1.80, surfaces moderately granular (relatively wider, taller, more stout, length to width ratio of segment I < 0.85, of segment V < 1.80, surfaces densely granular in *Butheolus*) (cf. Figs. 95–104 for comparison).

4. Pronounced sexual dimorphism in dentition of specific metasomal carinae (not seen in males and females of *Butheolus*). Compared to males, the females have enlarged dentition on ventrosubmedian and ventrolateral carinae of segments II–III, and enlarged "lobate" dentition on ventrolateral carinae on segment V. In *Butheolus*, females may have slightly larger series of denticles than males on ventrolateral carinae on segment V, but the denticles are not large and lobate (Figs. 97–99, 102–104).

5. Pronounced sexual dimorphism in setation (not seen in males and females of *Butheolus*). All segments of metasoma and pedipalps of *Neobuthus* are sparsely hirsute, with long setae in females (Figs. 3, 5, 41, 96, 101) and short spiniform setae in males (Figs. 4, 6, 43, 95, 100). This character is least apparent in the type species *Neobuthus berberensis*, whose pedipalps are nearly devoid of bristles (Figs. 39–40), but even in this species there are several long setae in females and short spiniform setae in males, which can be seen on the metasoma and the internal surface of the pedipalp chela. This character is much more obvious in the more hirsute *N. ferrugineus* **comb. n.** and *N. awashensis* **sp. n.** (Figs. 41–44, 95–96, 100–101).

6. Posterior margins of sternites III–VI finely microdenticulate (Figs. 86, 89), not armed with a fringe of larger, non-contiguous digitate denticles that are stronger in the male (in contrast to *Butheolus*, which does possess these denticles – cf. Figs. 87–88, 90–91). The fringe of larger denticles on the male sternites was strongly emphasized and illustrated by Vachon (1980) for *B. gallagheri*. We confirm that it is consistently expressed in *B. gallagheri*, *B. anthracinus* (Pocock, 1895), and *B. thalassinus*. The descriptions of *B. arabicus* Lourenço and Qi, 2006, and *B. villosus* Hendrixson, 2006, did not specify this character, and we have not examined the types of those species. We predict that it will be expressed in those species as well, and we propose that this is a derived character defining the genus *Butheolus*.

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