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Revision of the Genus *Nebo* (Simon, 1878) in Saudi Arabia with a Description of a New Species from the Jazan Province (Scorpiones: Diplocentridae)

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Abstract: The genus *Nebo* Simon, 1878 in Saudi Arabia is revised based on morphometric and morphological characters for adult specimens. The presence of *Nebo hierichonticus* (Simon, 1872) has been justified for the first time from Saudi Arabia and compared with materials collected from Jordan. More specimens of *Nebo yemenensis* Francke, 1980 including adult males and females were collected and recorded in this study. *Nebo jazanensis* sp. n. is described and fully illustrated based on adult males and females collected from Jazan Province and compared with other species of the genus *Nebo* known from the Arabian Peninsula and Jordan. Notes on its habitats are provided.

Key words: Scorpions, *Nebo jazanensis*, Jazan province, Arabian Peninsula.

Introduction

The genus *Nebo* has been established by Simon in 1878 by transferring *Hemiscorpio hierichonticus* (Simon, 1872) to the new genus. His description was based on two specimens collected from Jericho, the Jordan Valley. This genus includes nine species all of which occurring in the Arabian Peninsula and the Middle East; *Nebo poggesii* Sissom, 1994, *Nebo flavipes* Simon, 1882, *Nebo grandis* Francke, 1980 and *Nebo yemenensis* Francke, 1980 in Yemen, *Nebo omanensis* Francke, 1980, *Nebo franckei* Vachon, 1980 and *Nebo whitei* Vachon, 1980 in Oman, *Nebo henjamicus* Francke, 1980 in the island of Henjam, Arabian Gulf, and *Nebo hierichonticus* Simon, 1872 in Jordan, Palestine and Sinai (Francke, 1980).

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Over the decades, the taxonomy of this genus remained unclear and problematic (Birula, 1910,1917; Vachon, 1965, 1980). Francke (1980) made the most comprehensive revision of the genus providing specific morphometric ratios as a reliable and consistent method to resolve the problem of morphological homogeneity of this genus exhibited across its wide geographical ranges. These ratios were used to recognize *Nebo hierichonticus* and *Nebo flavipes* as valid species, and to describe four more new species of *Nebo* from southern Arabian Peninsula.

Vachon (1980) described two more species of *Nebo* from Oman; *Nebo whitei* Vachon, 1980 and *Nebo franckei* Vachon, 1980, from immature specimens, depending on morphological characteristics and variations on trichobothrial arrangements on external surface of pedipalp patella.

Kinzelbach (1985) and Vachon & Kinzelbach (1987) argued that all *Nebo* species should be regarded as subspecies of *N. hierichonticus* Simon, 1872 without providing proper justification. Hendrixon (2006) depicted a map showing the distribution of *Nebo* sp. in the Arabian Peninsula, however, he was cautious not to assign it to a specific level. Similarly, Francke (1980) did not assign *Nebo* in Saudi Arabia to a specific taxon. The following authors Al-Asmari *et al.* (2007, 2009, 2013), Alqahtani *et al.* (2019) and Alqahtani and Badry (2021) considered all *Nebo* specimens collected from various regions in Saudi Arabia as *Nebo hierichonticus* without providing morphological diagnosis or morphometric measurements. Alqahtani (2022) recorded

Nebo yemenensis from southern Saudi Arabia for the first time.

Meanwhile, morphometric ratios provided by Francke (1980) were adopted by Sissom (1994) as valid and reliable characters to distinguish species of this genus, since other morphological characters previously used to separate species within other diplocentrine genera (e.g., trichobothrial patterns, pectinal tooth counts, tarsomere II spine-formulas and carination) were proved to be with limited significance in distinguishing *Nebo* species. Sissom (1994) also provided important amendments and expanded on the morphometric ratios stated by Francke (1980) as a result of the examination of new specimens and added on the morphology of male hemispermatophore as a distinguishing character that supports Francke (1980) described species diagnosed solely on morphometric ratios, Hemispermatophore character was more recently found to be variable by Hendrixon (2006) when he examined more specimens from Saudi Arabia.

Other recent studies reported on the scorpions of Saudi Arabia (Alqahtani *et al.,* 2019; Aloufi *et al*., 2022; Alqahtani & Badry, 2021).

In this study, we adopted morphometric ratios to prove the validity of the presence of both *Nebo hierichonticus* and *Nebo yemenensis* in Saudi Arabia. Also, we described a new species *Nebo jazanensis* sp. n. based on specimens collected from Jazan province.

Materials and Methods

Twenty males and nineteen females were collected from five localities in Saudi Arabia (Table 1). One male and one female collected from two localities in Jordan were used in the comparative study.

Illustrations and measurements were made with the aid of stereoscopic microscope with a camera and an ocular micrometer (efix). Measurements follow Sissom (1990) and are given in mm. Carinal terminology is after Francke (1977). Trichobothrial notations follow Vachon (1974, 1975) and morphological terminology mostly follows Vachon (1952), Stahnke (1970) and Hjelle (1990). Specimens were collected by ultraviolet detection at night and preserved in 80% alcohol. Many collected subadult and juvenile specimens were excluded from this study because morphometric characteristics work only for adults (Francke,1980), sexual maturity was assumed by a combination of characteristics; in males by the presence of fully developed paraxial organs and the presence of prominent scallops on the pedipalp chela fingers, in females on the basis of size and on examining reproductive system in certain cases. Holotype male and other paratypes of the new species, and all other examined material in this study will be deposited in the Department of Biology, the University of Jordan, Amman, Jordan (JUST).

Seven morphometric ratios were established by Francke (1980): **1**= carapace length / metasomal segment II length; **2**= pedipalp

Table 1. Localities from which scorpions were collected.

Locality	Governorate / Country	No. of specimens ♂	No. of specimens ♀	N	E
Al Bahah	Al Bahah / Saudi Arabia	0	2	20° 01’ 20.12”	41° 28’ 18.11”
Al Boqa’a	Jazan / Saudi Arabia	15	15	17° 20’ 29.04”	43° 09’ 43.90”
Al Fegrah	Al Madinah / Saudi Arabia	1	0	24° 21’ 44.34”	38° 57’ 44.75”
Wadi Al Muataf	Jazan / Saudi Arabia	2	2	17° 19’ 19.50”	43° 08’ 40.50”
Wadi Awed	Jazan / Saudi Arabia	1	0	17° 20’ 53.81”	43° 10’ 16.68”
Alqan	Tabuk / Saudi Arabia	1	0	29° 05’ 33.20”	35° 22’ 50.20”
Al Mujeb	Amman / Jordan	1	0	31° 24’ 36.60”	35° 53’ 55.30”
Kufranjeh Dam	Ajloun / Jordan	0	1	32° 16’ 10.70”	35° 39’ 01.40”

femur length / width; **3**= metasomal segment V length / pedipalp chela movable finger length; **4**= metasomal segment V length / carapace length; **5**= metasomal segment V length / metasomal segment II width; **6**= pedipalp chela length / depth; **7**= pedipalp femur length / pedipalp chela depth.

Specimens were measured, then the seven ratios were calculated. Table (2) shows the codes, sex, species, and localities of studied specimens.

Table 2. Codes, sex, species, and localities of studied specimens.

Code	Sex	Species	Locality	Date	Code.	Sex	Species	Locality	Date
1 H	♂	*N. hierichonticus*	Al Boqa'a	4. 5.2022	22 h	♀	*N. hierichonticus*	Al Bahah	5.2005
2 H	♂	*N. hierichonticus*	Al Wadi Muataf	5.5.2022	23 h	♀	*N. hierichonticus*	Al Bahah	5.2005
3 H	♂	*N. hierichonticus*	Al Boqa'a	9.7.2022	24 Y	♂	*N. yemenensis*	Wadi Al Muataf	5.5.2022
4 H	♂	*N. hierichonticus*	Al Boqa'a	9.7.2022	25 Y	♂	*N. yemenensis*	Al Boqa'a	19.7.2022
5 H	♂	*N. hierichonticus*	Al Boqa'a	9.7.2022	26 y	♀	*N. yemenensis*	Al Boqa'a	4.5.2022
6 H	♂	*N. hierichonticus*	Al Boqa'a	9.7.2022	27 y	♀	*N. yemenensis*	Al Boqa'a	4.5.2022
7 H	♂	*N. hierichonticus*	Al Boqa'a	9.7.2022	28 y	♀	*N. yemenensis*	Wadi Al Muataf	5.52022
8 H	♂	*N. hierichonticus*	Al Boqa'a	9.7.2022	29 y	♀	*N. yemenensis*	Wadi Al Muataf	5.5.2022
9 H	♂	*N. hierichonticus*	Al Boqa'a	20.7.2022	30 y	♀	*N. yemenensis*	Al Boqa'a	9.7.2022
10 H	♂	*N. hierichonticus*	Al Boqa'a	20.7.2022	31 y	♀	*N. yemenensis*	Al Boqa'a	9.7.2022
11 H	♂	*N. hierichonticus*	Al Fegrah	28 .8.2022	32 J	♂	*N. jazanensis*	Al Boqa'a	9.7.2022
12 H	♂	*N. hierichonticus*	Alqan	26.6.2012	33 J	♂	*N. jazanensis*	Al Boqa'a	20.7.2022
13 H	♂	*N. hierichonticus*	Wadi Al-Mujeb\ Jordan	8.5.2020	34 J	♂	*N. jazanensis*	Al Boqa'a	20.7.2022
14 h	♀	*N. hierichonticus*	Al Boqa'a	4.5.2022	35 J	♂	*N. jazanensis*	Al Boqa'a	20.7.2022
15 h	♀	*N. hierichonticus*	Al Boqa'a	9.7.2022	36 J	♂	*N. jazanensis*	Al Boqa'a	28.8.2022
16 h	♀	*N. hierichonticus*	Al Boqa'a	9.7.2022	37 j	♀	*N. jazanensis*	Al Boqa'a	9.7.2022
17 h	♀	*N. hierichonticus*	Al Boqa'a	20.7.2022	38 j	♀	*N. jazanensis*	Al Boqa'a	9.7.2022
18 h	♀	*N. hierichonticus*	Al Boqa'a	20.7.2022	39 j	♀	*N. jazanensis*	Al Boqa'a	9.7.2022
19 h	♀	*N. hierichonticus*	Al Boqa'a	20.7.2022	40 j	♀	*N. jazanensis*	Al Boqa'a	20.7.2022
20 h	♀	*N. hierichonticus*	Al Boqa'a	20.7.2022	41 j	♀	*N. jazanensis*	Al Boqa'a	20.7.2022
21 h	♀	*N.hierichonticus*	Kufranjeh Dam\ Jordan	3.5.2020					

Results

Systematics

Family **Diplocentridae** Karsch, 1880
Genus ***Nebo*** Simon, 1878
Nebo hierichonticus (Simon, 1872)
Figs. 1,4, Tab. 2-7, 12

Type locality and type depository: Jericho in the Jordan Valley, and was placed in the genus *Hemiscorpio* Peters, 1861 Family Scorpionidae (Genus *Hemiscorpius*. Now in Family Hemiscorpiidae). Simon (1878) established the genus *Nebo* for this species. Holotype is at Muséum national d'Histoire naturelle, Paris, France (MNHN).

Material examined: **Saudi Arabia**, Jazan Province, Al Boqa'a, Al-Dayer Governorate , 937 m a. s. l., 1 ♂, 1♀, 04May 2022, *leg*. A. Aloufi; Jazan Province, Wadi Al Muataf, Al-Dayer Governorate, 785 m a. s. l., 1 ♂, 05 May 2022, *leg*. A. Aloufi; Jazan Province,

Al Boqa'a, Al-Dayer Governorate, 937 m a. s. l., 6 ♂♂, 2♀♀, 09 July 2022, *leg*. A. Aloufi; Al Boqa'a, Jazan Province, Al-Dayer Governorate, 937 m a. s. l., 2 ♂♂, 4♀♀, 20 July 2022, *leg*. A. Aloufi; Al Madinah Al Monawwarah Province, Al Fegrah, 1549 m a. s. l., 1♂, 28 August 2022, *leg*. A. Aloufi; Tabuk Province, Alqan, 1209 m a. s. l., 1♂, 26 June 2012, *leg*. A. Aloufi; Al Bahah Province, 2170 m a. s. l., 2 ♀♀, May 2005, *leg*. M. El-Hawagry. **Jordan**, Amman Governorate, Al-Mujeb, 661 m a. s. l., 1♂, 8 May 2020, *leg*. B. Abu Afifeh; Ajloun Governorate, Kufranjeh Dam, 83 m a. s. l., 1♀, 3 May 2020, *leg*. B. Abu Afifeh.

Diagnosis of examined material: Adult males 90.85-123.45 mm long (Table 4), females 91.50 – 140.60 mm long (Table 6). Pectinal tooth count 16–19 in males, 13–16 in females. Carapace length to metasomal segment II length ratio (#1) 1.31-1.43 in males, 1.44-1.61 in females; pedipalp femur length to width ratio (#2) 2.70-3.33 in males, 2.65-2.82 in females; metasomal segment V length to pedipalp chela movable finger length ratio (#3) 0.90-1.16 in males, 0.95-1.06 in females; metasomal segment V length to carapace length ratio (#4) 1.12-1.24 in males, 1.04-1.12 in females; metasomal segment V length to metasomal segment II width ratio (#5) 2.57-3.16 in males, 2.57-2.96 in females; pedipalp chela length to depth ratio (#6) 2.66-2.94 in males, 2.40-2.67 in females; pedipalp femur length to pedipalp chela depth ratio (#7) 1.30-1.66 in males, 1.16-1.29 in females.

Remarks: The material examined in this study from Saudi Arabia, compared with male and female from Jordan, has morphometric ratios given in Tables (5 and 7), found to be compatible with the ratios established by (Francke, 1980) (Table 3), with exceptions of small deviations in ratios #1, #2, and #4; for females; so the morphometric ratios given by (Francke, 1980, Table 3, p. 40) for females *Nebo hierichonticus* has been modified and expanded as follows: ratio #1 ≤ 1.61 instead of < 1.60; ratio #2 ≥ 2.65 instead of >2.65; and ratio # 4 ≥ 1.04 instead of >1.10. Adult males of *Nebo hierichonticus* have the unique feature of the presence of undulations and a noticeable gap between pedipalp chela fingers when they are totally closed. (Fig. 4C), this character did not exist

Table 3: Morphometric characterization of adult *Nebo* species, based on ratios established by Francke (1980), and Sissom (1994), Characters represent morphometric ratios as follows: **1**= carapace length to metasomal segment II length; **2**= pedipalp femur length to width; **3**= metasomal segment V length to pedipalp chela movable finger length; **4**= metasomal segment V length to carapace length; **5**= metasomal segment V length to metasomal segment II width; **6**= pedipalp chela length to depth; **7**= pedipalp femur length to pedipalp chela depth.

Species	**Sex**	**Morphometric Ratios**						
		#1	#2	#3	#4	#5	#6	#7
Nebo hierichonticus	♂	< 1.45	>2.65	> 0.90	> 1.10	> 2.55	> 2.65	> 1.25
	♀	≤ 1.61	≥2.65	> 0.90	≥ 1.04	>2.55	>2.30	> 1.15
Nebo flavipes	♀	1.73 -1.79	2.20- 2.39	0.77– 0.89	0.83- 0.92	1.87- 2.22	2.10- 2.18	0.96- 1.00
Nebo henjamicus	♂	< 1.20	>3.00	> 1.20	> 1.25	> 3.10	< 2.60	> 1.25
Nebo grandis	♂	1.42	3.00	0.92	1.14	2.81	2.59	1.34
	♀	< 1.60	≥ 2.40	0.84- 1.00	0.96- 1.10	> 2.60	< 2.30	< 1.15
Nebo poggesii	♂	1.27	3.56	1.04	1.26	3.22	2.91	1.61
	♀	1.51- 1.56	2.54- 2.72	0.88- 1.04	1.04- 1.10	2.67- 3.11	2.42- 2.52	1.19- 1.25
Nebo omanensis	♂	1.25- 1.70	2.75- 3.00	1.10- 1.20	1.10- 1.20	2.60- 3.10	2.35- 2.50	1.20- 1.30
	♀	1.25- 1.70	2.30- 2.60	1.00- 1.10	0.95- 1.10	2.50- 3.00	2.20- 2.30	1.05- 1.15
Nebo yemenensis	♂	1.50- 1.60	2.30- 2.60	0.90- 1.00	1.00- 1.10	2.30- 2.55	2.45- 2.55	1.20- 1.30
	♀	1.54- 1.70	2.30- 2.66	0.90- 1.07	0.90- 1.03	2.27- 2.56	2.27- 2.55	1.14- 1.23
Nebo jazanensis sp. n.	♂	1.66- 1.78	2.38- 2.65	0.85- 0.99	0.86- 0.96	2.08- 2.38	2.64- 2.87	1.28- 1.33
	♀	1.71- 1.75	2.30- 2.50	0.88- 0.98	0.91- 0.95	2.16- 2.33	2.45- 2.71	1.10- 1.28

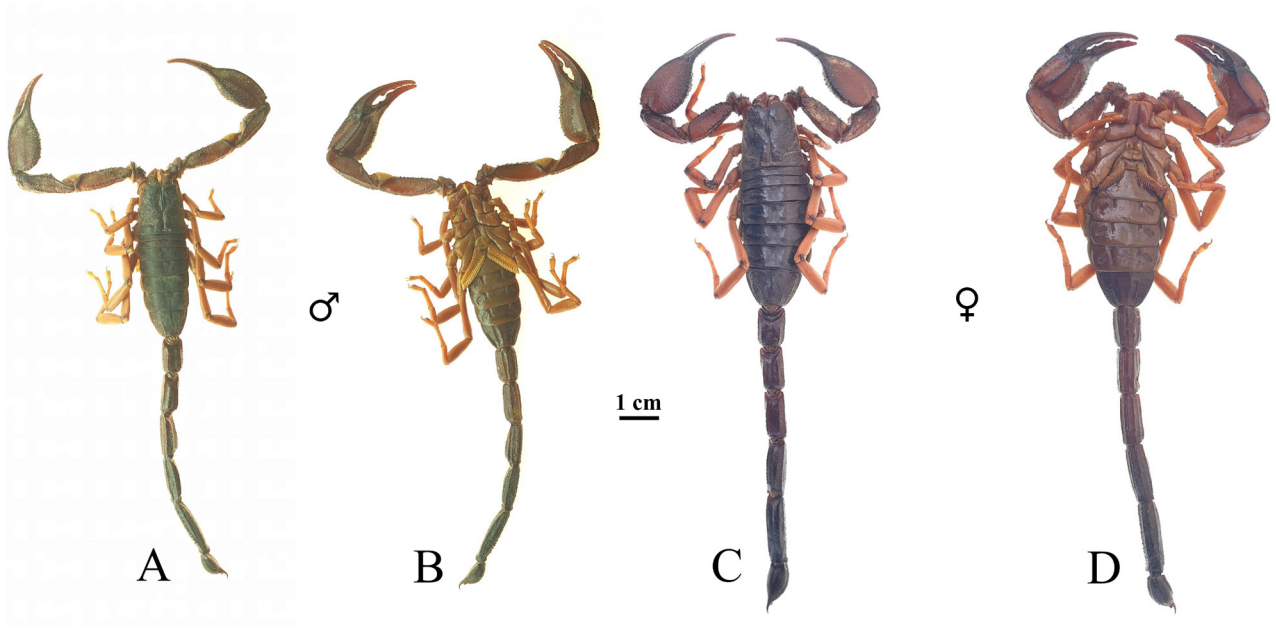

Figure 1. Male and female *Nebo hierichonticus* from Al Boqa'a, Jazan Province, Saudi Arabia. Scale bar: 1 cm.

in males of *Nebo yemenensis* (Fig. 4B), nor in *Nebo jazanensis* sp. n. (Fig. 4A).

Distribution: Palestine, Jordan, Egypt, and Saudi Arabia.

Nebo yemenensis Francke, 1980

Figs. 2, 4, Tab. 2-3, 8-9, 12

Type locality and type depository: Holotype adult female, from Yemen Arab Republic, 15 miles NW Sana, under stones at top of El Kaber Pass between Hugga and Haz (ca. 9200 ft.), 2 February 1938 (E. B. Britton; British Museum Expedition to SW Arabia); British Museum of Natural History (BMNH).

Material examined: **Saudi Arabia**, Jazan Province, Al Boqa'a, Al-Dayer Governorate, 937 m a. s. l., 2♀♀, 04 May 2022, *leg*. A. Aloufi; Jazan Province, Wadi Al Muataf, Al-Dayer Governorate, 785 m a. s. l., 2 ♀♀, 05 May 2022, *leg*. A. Aloufi; Jazan Province, Al Boqa'a, Al-Dayer Governorate, 937 m a. s. l., 1 ♂, 2♀♀, 09 July 2022, *leg*. A. Aloufi; Jazan Province, Al Boqa'a, Al-Dayer Governorate, 937 m a. s. l., 1 ♂, 19 July 2022, *leg*. A. Aloufi.

Diagnosis of examined material: Adult males 92.05 -94.50 mm long, females 87.10 – 105.45 mm long (Table 8). Pectinal tooth counts 16–19 in males, 14–15 in females. Carapace length to metasomal segment II length ratio (#1) 1.56-1.58 in males, 1.60-1.70 in females; pedipalp femur length to width ratio (#2) 2.51-2.57 in males, 2.36-2.63 in females; metasomal segment V length to pedipalp chela movable finger length ratio (#3) 0.91-0.94 in males, 0.90-0.95 in females; metasomal segment V length to carapace length ratio (#4) 1.00 in males, 0.93-1.00 in females; metasomal segment V length to metasomal segment II width ratio (#5) 2.39-2.43 in males, 2.27-2.50 in females; pedipalp chela length to depth ratio (#6) 2.54-2.55 in males, 2.32-2.55 in females; pedipalp femur length to pedipalp chela depth ratio (#7) 1.24-1.26 in males, 1.14-1.23 in females.

Remarks. *Nebo yemenensis* has been recorded in Saudi Arabia from Jazan by Alqahtani (2022). The newly examined material has morphometric ratios given in Table (9) which is compatible with those calculated by Francke (1980) and later expanded by Sissom (1990) (Table 3).

Distribution: Yemen, and Saudi Arabia.

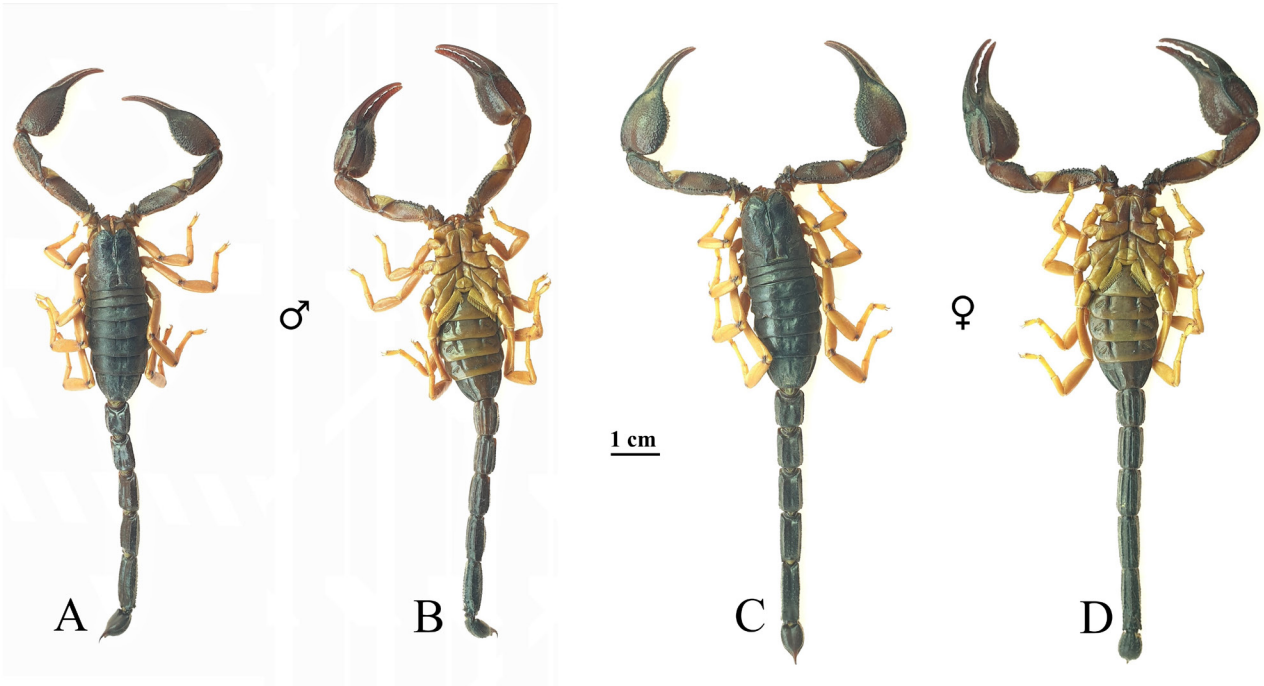

Figure 2. Male and female *Nebo yemenensis* from Al Boqa'a, Jazan Province, Saudi Arabia. Scale bar: 1 cm.

Nebo jazanensis sp. n.
Figs. 3-6, Tab. 2-3, 10-12

Type locality and type depository: **Saudi Arabia**, Al Boqa'a, Al-Dayer Governorate, Jazan Province, 937 m a. s. l., 17° 20' 29.04"N, 43° 09' 43.90"E, Department of Biology, the University of Jordan, Amman, Jordan (JUST).

Type material examined: **Saudi Arabia**, Al Boqa'a, Al-Dayer Governorate, Jazan Province, 937 m a. s. l., 1♂, 2♀♀, 09 July 2022, *leg*. A. Aloufi; Al Boqa'a, Al-Dayer Governorate, Jazan Province, 937 m a. s. l., 3 ♂♂, 3♀♀, 19 July 2022, *leg*. A. Aloufi; Wadi Awed, Al-Dayer Governorate, Jazan Province, 839 m a. s. l., 1♂, 23 May 2022, *leg*. A. Aloufi.

Etymology: The specific name refers to Jazan; the province from which the new species was collected.

Diagnosis: Adult males 77.20-98.20 mm long, females 85.20–104.55 mm long (Table 10). Pectinal tooth count 16–19 in males, 12–15 in females. Carapace length to metasomal segment II length ratio (#1) 1.66-1.78 in males, 1.71-1.75 in females; pedipalp femur length to width ratio (#2) 2.38-2.65 in males, 2.30-2.50 in females; metasomal segment V length to pedipalp chela movable finger length ratio (#3) 0.85-0.99 in males, 0.88-0.98 in females; metasomal segment V length to carapace length ratio (#4) 0.86-0.96 in males, 0.91-0.95 in females; metasomal segment V length to metasomal segment II width ratio (#5) 2.08-2.38 in males, 2.16-2.33 in females; pedipalp chela length to depth ratio (#6) 2.64-2.87 in males, 2.45-2.71 in females; pedipalp femur length to pedipalp chela depth ratio (#7) 1.28-1.33 in males, 1.10-1.28 in females.

Comparison: Adult *Nebo jazanensis* sp. n. can be separated from adult *N. hierichonticus* by ratios #1, #2, #4, and #5; from adult *N. yemenensis* by ratios #1, #4, and #6 in males, (and for females only #1); from adult *N. omanensis* Francke, 1980 by ratios #2, #3, #4, #5 and #6 in males, and by ratios #1,#2,#3,#5 and #6 in females; from adult females *N. flavipes* Simon, 1882 by ratios #6 and #7; from adult females *N. poggesii* Sissom, 1994 by ratios #1,#2, #4 and #5; and from adult females *N. grandis* Francke, 1980 by ratios#1, #4, #5, and #6. (Tables 3 and 12).

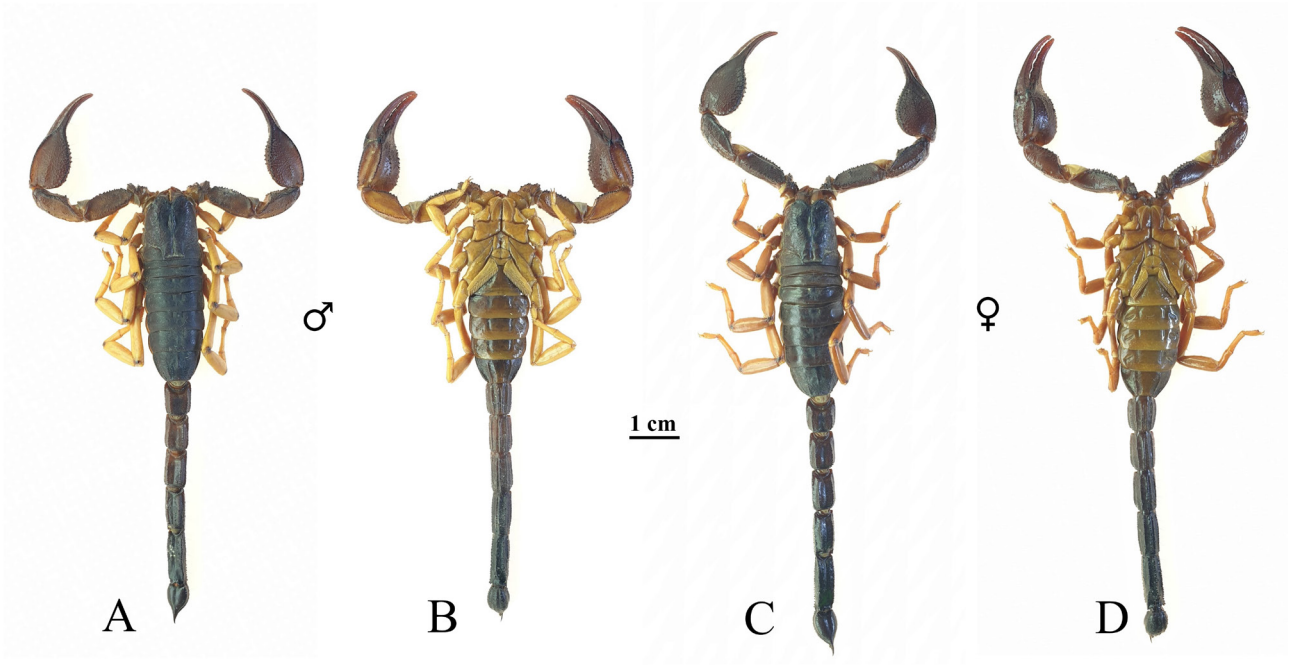

Figure 3. Male holotype and female paratype *Nebo jazanensis* sp. n**.** from Al Boqa'a, Jazan Province, Saudi Arabia. Scale bar: 1 cm.

Description: Based on male holotype (unless otherwise specified). Measurements are in Table (10).

Coloration: Carapace is reddish brown. Mesosoma: Tergites dark reddish brown. Sternites olive-brown. Coxae, coxapophyses, sternum, genital operculum, and pectines yellowish-olive. Pedipalp: femur, patella, and chela manus light reddish-brown dorsally, and olive-brown ventrally, carinae of femur, patella, and chela manus dark reddish-brown, chela fingers and granules dark reddish-brown. Internal surface of chela manus reddish-brown; light reddish brown to olive-brown around the joint with patella. Finger denticles and movable finger condyles black. Metasoma: metasomal segments I-II reddish brown; III reddish brown anteriorly and dark brown to black posteriorly, IV-V dark brown to black. Granules on dorsolateral, ventrolateral, and ventral submedian carinae light reddish brown. Telson dark reddish brown to black. Walking legs: yellowish olive, spines and condyles red or reddish-brown. Chelicerae: chelicera manus reddish-brown with dark-brown reticulations, fingers reddish-brown, teeth dark reddish-brown.

Chelicerae: dorsal surface of manus smooth, convex; prolateral and ventral surfaces densely setose; cheliceral fingers with normal diplocentrid dentition (Vachon, 1963); fixed finger dorsal and ventral surfaces densely setose, dorsal margin bears 4 teeth: distal, subdistal, median, and basal; ventral margin without teeth; movable finger dorsal surface smooth; ventral surface densely setose; dorsal margin bears 4 teeth: external distal, subdistal, median, and basal; ventral margin with internal distal teeth. The movable finger always ends in two distal teeth, one external and one internal, between which is inserted the distal tooth of the fixed finger.

Prosoma: Carapace anterior margin strongly bilobed; anteriomedian longitudinal carapacial furrow suturiform. Carapace acarinate, only posterior lateral carina visible, carapacial surface granular with small to medium granules; posterior lateral surfaces shagreened with fine granules. Posterior lateral furrows distinct; a deep transverse posterior median furrow passing along posterior margin and joining median furrow in the middle which extends towards the median eyes. Anterior margin with a

few medium setae and distinct depression. Median ocular tubercle distinct and situated anterior to the middle. A pair of median eyes separated from each other by more than their diameter; and three pairs of lateral eyes arranged in a slight curve; anterior eyes slightly larger and closer to each other than to smaller posterior eyes. A few moderate setae on surface of carapace; two setae situated behind median eyes.

Mesosoma: Tergites I-VI acarinate, matt covered with fine granules completely in males; glossy and smooth, at most slightly shagreened laterally in females. Tergite VII with four distinct carinae in posterior half of segment, densely shagreened in males, usually only slightly shagreened, mainly near carinae, in females, posterior margin of tergites with microsetae and a long seta on seventh tergite at posterior third of each lateral carina. Sternites smooth and shining, only sternite VII slightly shagreened laterally in males with four smooth carinae which are sometimes only slightly indicated; sternites with setae. Genital operculum subtriangular in males, subovoid in females, wider than long and distinctly shorter than the subpentagonal sternum in both sexes. Pectines of male relatively long; reaching well beyond coxa-trochanter articulation of leg IV; not reaching this articulation in the female.

Metasoma: (Figure. 6). Segments I-III with 10, segment IV with 8, and segment V with 7 carinae. Dorsolateral and lateral supramedian carinae moderate, crenulate on I-III, serrate on IV. Lateral inframedian carinae on segments I-III moderate, granular; on I with complete carinae; on II-III present on posterior three-fourth; on IV represented by a faint line of small granules; on V present on anterior two-thirds of segment. Ventral submedian and ventrolateral carinae moderate, smooth on I-III; moderate, crenulate on IV. Intercarinal surfaces on segments I-V sparsely to moderately granular. Segment V: dorsolateral carinae moderate, irregularly serrate; lateromedian carinae present on anterior two-thirds of segment, strong, irregularly serrate; ventromedian and ventrolateral carinae very strong, serrate. Dorsal and lateral intercarinal surfaces moderately, coarsely granular; ventral intercarinal surfaces with large, spiniod denticles distally. All segments with moderate red setae.

Telson: (Figure. 6). Vesicle flat and smooth dorsally, globular and granulated ventrally and laterally; ventral aspect with numerous small, spinoid granules, vesicle with many red macrosetae even on the base of aculeus. Aculeus strongly curved and very short; vesicle 5 times longer than aculeus. Subaculear tubercle present, strong, subconical; surface of the subaculear tubercle with tiny granules and many red setae.

Pedipalp: Femur: dorsointernal, ventrointernal, and dorsoexternal carinae strong, granulose; ventroexternal carina weak, granular. Dorsal, ventral, and inner surfaces densely granulate (Figure 5A). Patella: dorsointernal, ventrointernal, external, and ventroexternal carinae strong, granulose; dorsoexternal carinae moderate, with rather fused granules; dorsomedian carina weak to moderate. Dorsal surface densely granulated with fine to moderate rounded granules, internal surface with fine to moderate, rather pointed granules, ventral surface rather smooth except several granules mainly around indistinct and irregular ventromedian carina (Figures 5B-D). Chela with dorsal marginal carina strong, granulose; dorsointernal carina strong, serrate; digital carina strong, smooth; external secondary carina weak, granular; ventroexternal carina weak, coarsely crenulate basally, smooth to granular distally; ventromedian carina weak, smooth; ventrointernal carina strong, smooth; inner accessory carina with six to eight medium-sized granules. Dorsal surface with moderate reticulation; external face reticulate or densely, coarsely granular; inner surface densely, coarsely granular (Figures 5E-H).

Chela fingers are relatively long. Fixed and movable fingers with 7 strong accessory denticles. Trichobothriotaxy of type C; orthobothriotaxic (Vachon, 1974); femur of pedipalp with 3 (1 internal, 1 dorsal, 1 external, and 0 ventral) trichobothria; patella of pedipalp with 19 (1 internal, 2 dorsal, 13 external, and 3 ventral) trichobothria; chela of pedipalp with 26 trichobothria; of them 16 on the hand (0 internal, 2 dorsal, 10 external, and 4 ventral) trichobothria; and 10 on the fixed finger (2 internal, 4 dorsal, 4 external, and 0 ventral) trichobothria (Figure. 5).

Legs: tibial spurs lacking; tarsi with prolateral pedal spurs only; basitarsus of all legs with 4-6 spines near spur ventrally on outer side and another spine more proximally, tarsi of right legs I to IV with 7/9 - 8/9 - 8/9 - 9/9 internal and external spines arranged in two rows extending to narrow latero-apical lobes near claws; tarsi with a small dorsal finger-like process apically between claws.

Sexual dimorphism: Males differed from females as follows: (**a**) tergites I-VI matt, completely covered by fine granules in males, but glossy and smooth, at most slightly shagreened laterally in females, tergite VII densely shagreened in males, usually only slightly shagreened, mainly near carinae, in females. Sternite VII slightly shagreened laterally in males and almost smooth in females; (**b**) genital operculum subtriangular in males, subovoid in females; (**c**) dentate margin length of pecten to pecten length is longer in males than in females; 0.92-0.94 in males (n=5), and 0.77-0.79 in females (n=5); (**d**) pectinal tooth count 16-19 in males (of 10 combs from n=5 males: 1 comb with 16 teeth, 2 with 17, 6 with 18, 1 with 19); the average pectinal tooth count per pecten in males is 17.7, 12-15 in females (of 9 combs from n=5 females, 1 is damaged: 1 comb with 12 teeth, 4 with 14, 4 with 15); the average pectinal tooth count per pecten in females is 14.2.

Distribution: Jazan Province, Saudi Arabia.

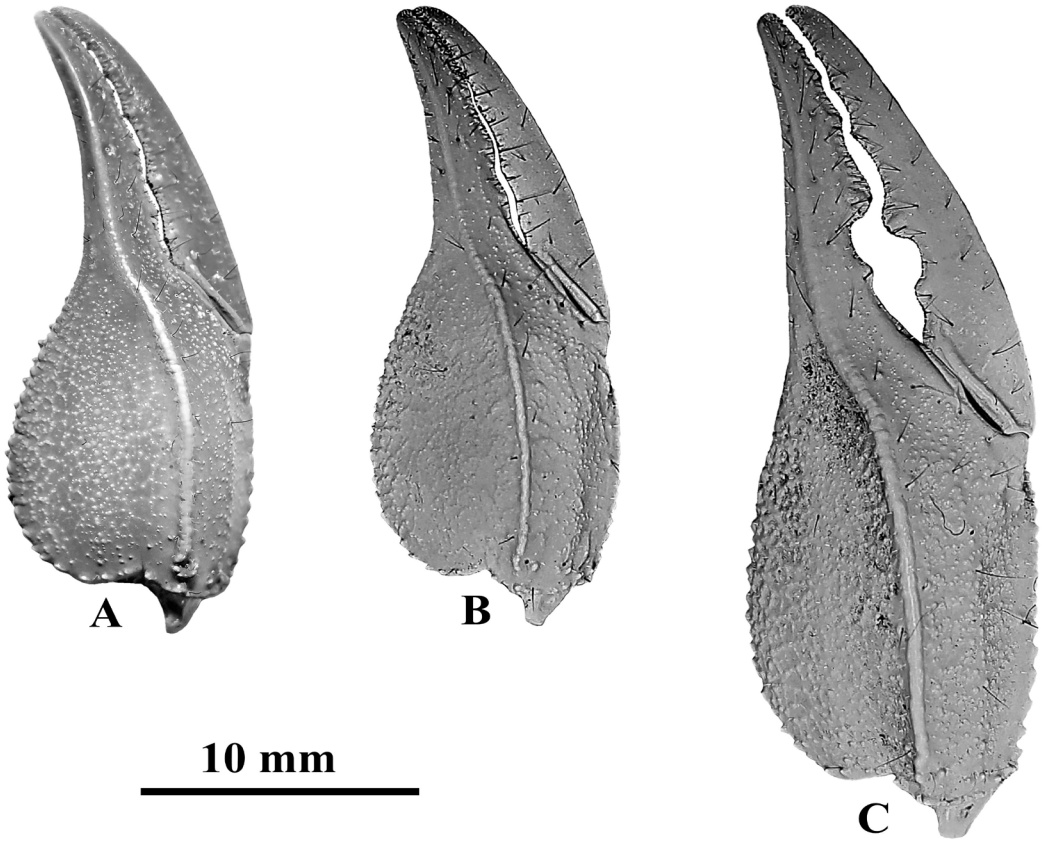

Figure 4. Dextral pedipalp chelae of males. **A**. *Nebo jazanensis* sp. n., **B**. *Nebo yemenensis*. **C**. *Nebo hierichonticus*. Scale bar: 10 mm.

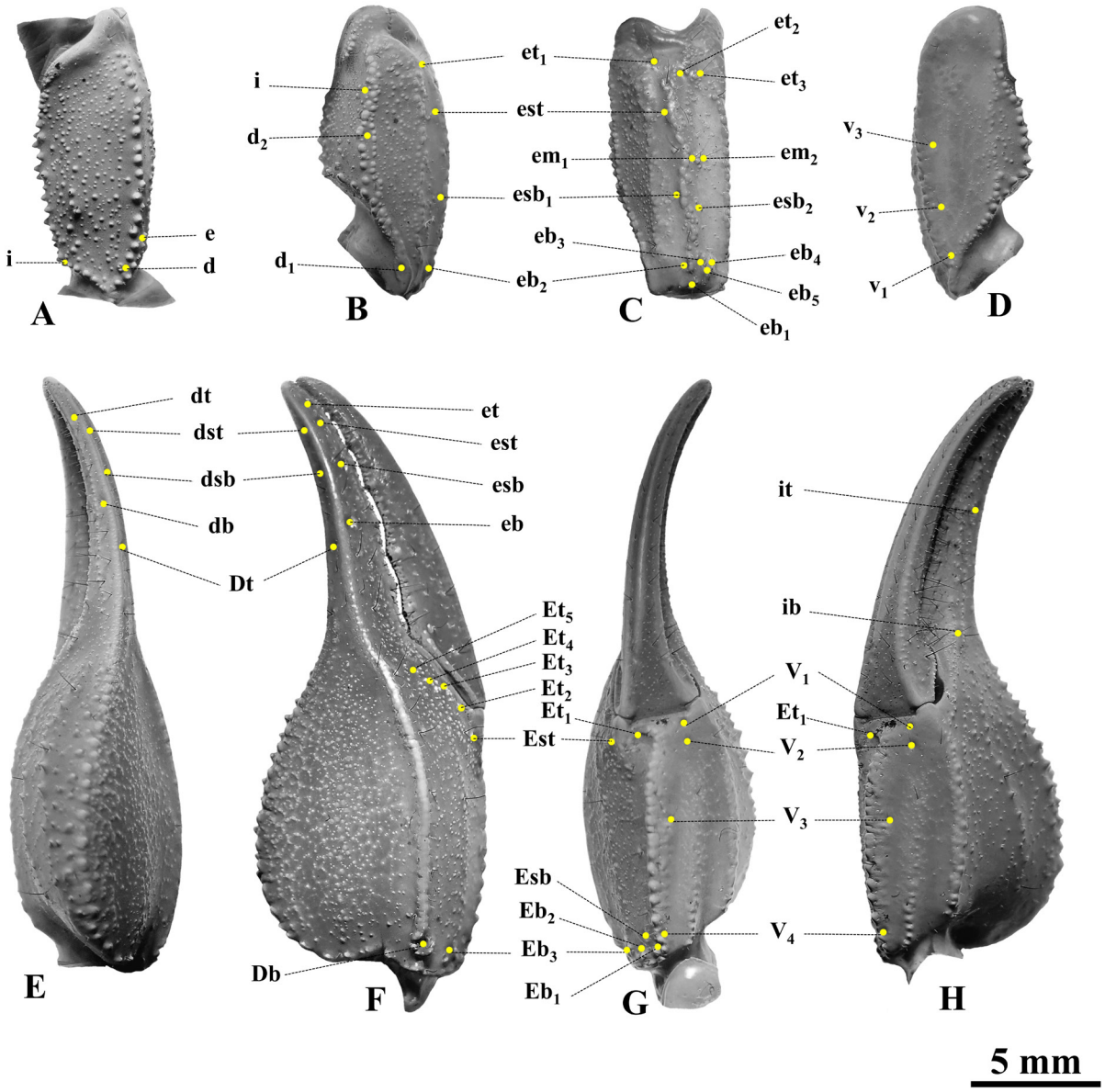

Figure 5. Dextral pedipalp of *Nebo jazanensis* **sp. n.**, male holotype. **A**. Femur, dorsal aspect. **B**. Patella, dorsal aspect. **C**. Patella, external aspect, **D**. Patella, ventral aspect. **E**. Chela, dorsal aspect. **F**. Chela, external aspect. **G**. Chela, ventral aspect. **H**. Chela, ventrointernal aspect. Abbreviations for trichobothria: On the femur, patella and fingers, the trichobothria are denoted by small letters as **d**: dorsal, **v**: ventral, **e**: external, **i**: internal. On the hand, they are denoted by capital letters: **D**, **V**, and **E**. The dorsal ones on fixed finger can be dorsal basal **db**; dorsal suprabasal **dsb**; dorsal subterminal **dst**; dorsal terminal **dt**, but on the hand, dorsal basal **Db**; dorsal terminal **Dt**. The external ones can be basal **b**, suprabasal **sb**, median **m**, subterminal **st**, terminal **t**. Thus, a trichobothrium on external surface of fixed finger or patella symbolized by **eb**: external basal; **esb**: external suprabasal; **em**: external median;**est**: external subterminal; **et**: external terminal. Whereas on external surface of the hand symbolized by **Eb**: external basal; **Esb**: external suprabasal; **Est**: external subterminal; **Et**: external terminal. Scale bar: 5 mm.

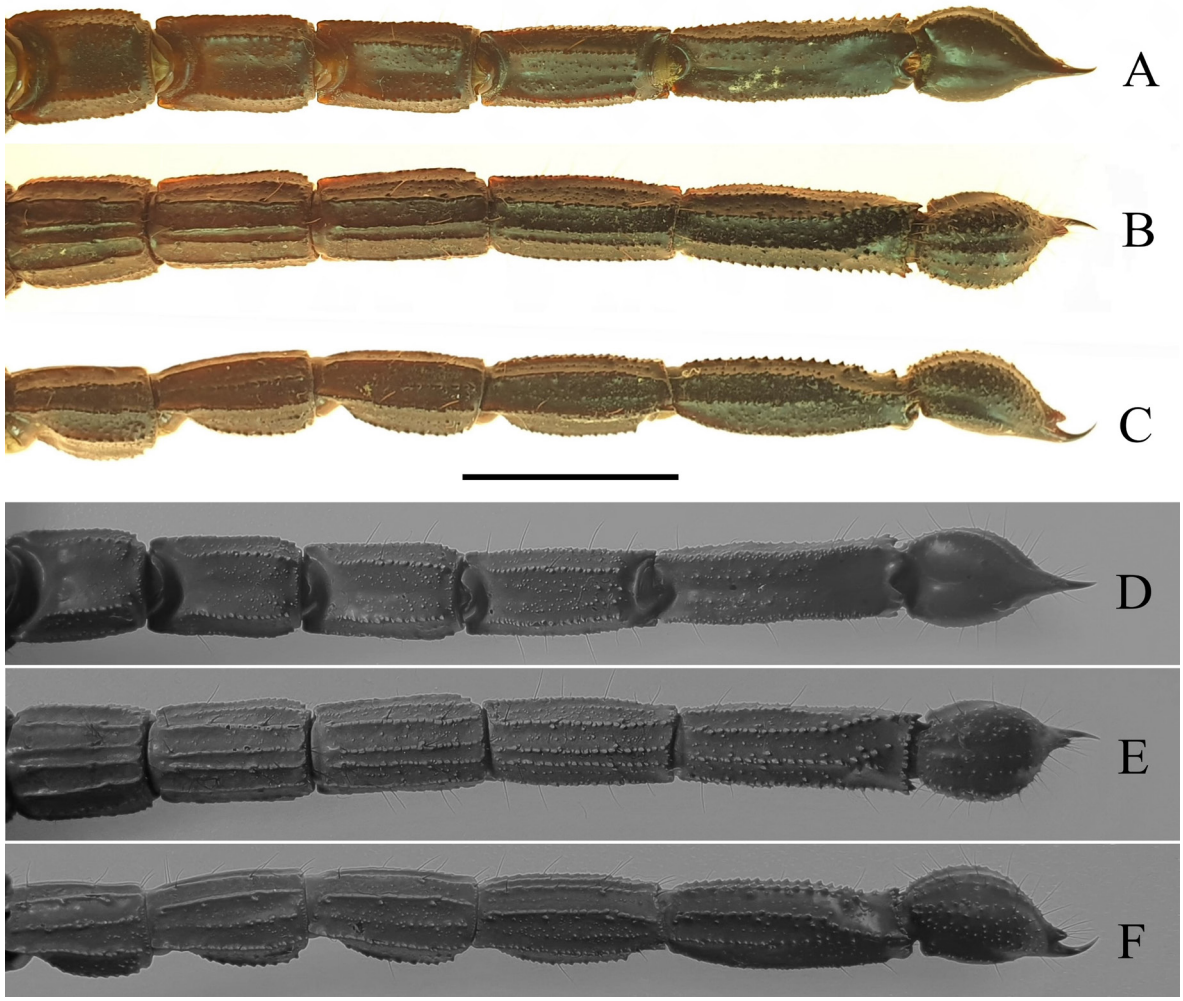

Figure 6. *Nebo jazanensis* **sp**. **n**., male holotype, metasoma and telson in dorsal (**A**, **D**), ventral (**B**, **E**) and lateral (**C**, **F**) aspects. **A-C**. Under white light. **D-F**. Under UV light. Scale bar: 10 mm.

Table 4: Measurements for adult males of *Nebo hierichonticus*. Measurements and morphometrics are in mm.

	1 H	2 H	3 H	4 H	5 H	6 H	7 H	8 H	9 H	10 H	11 H	12 H	13 H
Total length	117.35	11.45	117.6	123.45	118.35	113.4	105.7	108.1	112.7	117.5	110.4	94.60	90.85
Carapace Length	13.80	13.32	14.15	14.45	14.40	14.10	12.65	13.15	13.56	14.17	12.85	10.96	10.15
Metasoma II Length	10.20	9.84	10.15	11.00	10.60	10.35	9.55	10.10	9.72	10.68	9.48	7.62	7.10
Metasoma II Width	5.64	5.28	5.55	5.55	5.75	5.40	5.45	5.30	5.28	5.64	5.16	4.44	4.43
Metasoma V Length	16.81	16.33	15.90	17.55	17.30	16.85	14.90	15.85	15.85	16.81	15.97	12.36	11.50
Pedipalp Femur length	15.00	14.65	15.55	17.30	16.80	15.45	13.90	14.55	14.89	15.97	13.69	10.68	10.20
Pedipalp Femur width	4.80	4.68	5.25	5.20	5.35	5.10	4.95	4.70	4.68	5.16	4.56	3.96	3.80
Pedipalp Chela length	29.70	29.00	29.25	30.45	30.50	29.05	26.25	29.40	29.29	31.93	26.29	22.17	22.35
Pedipalp Chela depth	10.20	9.85	10.80	10.40	10.75	10.55	9.72	10.30	10.20	11.16	9.90	8.20	7.80
Movable finger Length	18.60	16.80	16.80	17.05	17.75	16.85	14.70	15.60	15.60	17.41	13.81	12.00	12.10

Table 5: Morphometrical ratios for adult males of *Nebo hierichonticus.*

	Ratios \ Specimen code	1 H	2 H	3 H	4 H	5 H	6 H	7 H	8 H	9 H	10 H	11 H	12 H	13 H
1	Carapace length / Metasoma II length	1.35	1.35	1.39	1.31	1.36	1.36	1.32	1.30	1.40	1.33	1.36	1.44	1.43
2	Pedipalp Femur length / Width	3.13	3.13	2.96	3.33	3.14	3.03	2.81	3.10	3.19	3.09	3.00	2.70	2.68
3	Metasoma V length / Movable finger length	0.90	0.97	0.95	1.03	0.97	1.00	1.01	1.02	1.02	0.97	1.16	1.03	0.95
4	Metasoma V length / Carapace length	1.22	1.23	1.12	1.21	1.20	1.20	1.18	1.21	1.17	1.19	1.24	1.13	1.13
5	Metasoma V length / Metasoma II Width	2.98	3.09	2.86	3.16	3.01	3.12	2.73	2.99	3.00	2.98	3.09	2.78	2.78
6	Pedipalp Chela length / Chela depth	2.91	2.94	2.71	2.93	2.84	2.75	2.70	2.85	2.87	2.86	2.66	2.70	2.70
7	Femur length / chela depth	1.47	1.49	1.44	1.66	1.56	1.46	1.43	1.41	1.46	1.43	1.38	1.30	1.31

Table 6: Measurements for adult females of *Nebo hierichonticus*. Measurements and morphometrics are in mm.

	14 h	15 h	16 h	17 h	18 h	19 h	20 h	21 h	22 h	23 h
Total length	114.85	116.95	122.50	129.20	125.40	109.10	112.80	91.50	140.60	115.30
Carapace Length	15.00	14.60	16.05	16.21	15.61	14.17	15.36	10.20	16.81	15.01
Metasoma II Length	9.48	9.05	10.35	10.80	10.44	9.00	9.84	7.08	11.40	9.60
Metasoma II Width	5.80	5.25	5.90	6.00	6.12	5.64	5.64	4.44	6.48	5.76
Metasoma V Length	15.60	15.15	16.95	17.77	16.81	15.01	16.57	11.40	18.61	16.00
Pedipalp Femur length	13.55	12.90	14.55	15.49	14.89	12.73	14.05	9.85	15.73	13.81
Pedipalp Femur width	5.04	4.85	5.45	5.52	5.28	4.80	5.16	3.66	5.88	5.20
Pedipalp Chela length	27.50	26.70	30.10	31.93	30.75	27.49	29.65	22.45	33.61	31.21
Pedipalp Chela depth	10.50	10.92	12.55	12.00	11.52	10.80	11.64	8.40	12.85	11.76
Movable finger Length	14.65	15.30	17.90	17.89	17.05	14.41	16.21	12.00	19.45	16.56

Table 7: Morphometrical ratios for adult females of *Nebo hierichonticus*.

	Ratios \ Specimen code	14 h	15 h	16 h	17 h	18 h	19 h	20 h	21 h	22 h	23 h
1	Carapace length / Metasoma II length	1.58	1.61	1.55	1.50	1.50	1.57	1.56	1.44	1.47	1.56
2	Pedipalp Femur length / Width	2.69	2.66	2.67	2.81	2.82	2.65	2.72	2.69	2.68	2.66
3	Metasoma V length / Movable finger length	1.06	0.99	0.95	0.99	0.99	1.04	1.02	0.95	0.96	0.97
4	Metasoma V length / Carapace length	1.04	1.04	1.06	1.10	1.08	1.06	1.08	1.12	1.11	1.07
5	Metasoma V length / Metasoma II Width	2.69	2.74	2.87	2.96	2.75	2.66	2.94	2.57	2.87	2.78
6	Pedipalp Chela length / Chela depth	2.62	2.45	2.40	2.66	2.67	2.55	2.55	2.67	2.62	2.65
7	Femur length /chela depth	1.29	1.28	1.16	1.29	1.29	1.18	1.21	1.17	1.22	1.17

Table 8: Measurements for adult males and females of *Nebo yemenensis*. Measurements and morphometrics are in mm.

	24 Y	25 Y	26 y	27 y	28 y	29 y	30 y	31 y
Total length	92.05	94.50	101.65	87.10	96.05	93.55	105.45	101.50
Carapace Length	11.90	12.14	13.80	12.00	13.09	12.61	14.15	13.80
Metasoma II Length	7.55	7.80	8.40	7.75	7.92	7.56	8.82	8.55
Metasoma II Width	4.90	5.10	5.52	4.90	5.16	5.04	5.64	5.50
Metasoma V Length	11.95	12.20	13.81	11.12	12.24	11.88	13.95	13.60
Pedipalp Femur length	10.80	11.28	12.24	10.20	11.40	11.04	12.48	12.30
Pedipalp Femur width	4.20	4.50	4.80	4.32	4.56	4.32	4.90	4.85
Pedipalp Chela length	22.10	22.80	24.80	21.85	23.53	22.25	25.93	25.55
Pedipalp Chela depth	8.70	8.95	10.68	8.64	9.24	9.00	10.80	10.80
Movable finger Length	13.05	12.97	14.65	12.35	13.60	12.48	14.89	14.60

Table 9: Morphometrical ratios for adult males and females of *Nebo yemenensis*.

	Ratios \ Specimen code	24 Y	25 Y	26 y	27 y	28 y	29 y	30 y	31 y
1	Carapace length / Metasoma II length	1.58	1.56	1.64	1.70	1.65	1.67	1.60	1.61
2	Pedipalp Femur length / Width	2.57	2.51	2.55	2.36	2.50	2.56	2.60	2.63
3	Metasoma V length / Movable finger length	0.91	0.94	0.94	0.90	0.90	0.95	0.94	0.93
4	Metasoma V length /Carapace length	1.00	1.00	1.00	0.93	0.94	0.94	0.99	0.99
5	Metasoma V length / Metasoma II Width	2.43	2.39	2.50	2.27	2.37	2.36	2.47	2.47
6	Pedipalp Chela length / Chela depth	2.54	2.55	2.32	2.53	2.55	2.47	2.40	2.37
7	Femur length /chela depth	1.24	1.26	1.15	1.18	1.23	1.23	1.16	1.14

Table 10: Measurements for adult males and females of *Nebo jazanensis* sp. n. Measurements and morphometrics are in mm.

	32 J	33 J	34 J	35 J	36 J	37 j	38 j	39 j	40 j	41 j
Total length	89.10	78.40	77.30	77.20	98.20	94.45	86.25	104.55	100.10	85.20
Carapace Length	12.35	10.44	10.68	9.60	12.97	12.80	12.00	13.33	13.35	11.04
Metasoma II Length	7.40	5.88	6.24	5.76	7.80	7.45	6.95	7.80	7.80	6.30
Metasoma II Width	4.80	4.32	4.32	4.08	5.28	5.40	4.95	5.40	5.40	4.44
Metasoma V Length	11.40	9.00	9.84	8.76	12.48	11.65	11.40	12.36	12.60	10.08
Pedipalp Femur length	11.15	9.00	9.48	8.64	11.76	10.95	10.45	11.52	11.05	9.24
Pedipalp Femur width	4.40	3.78	3.84	3.48	4.44	4.45	4.20	4.60	4.56	4.02
Pedipalp Chela length	23.00	19.69	20.29	18.61	23.41	22.95	22.20	24.37	24.97	20.19
Pedipalp Chela depth	8.70	6.96	7.56	6.48	8.88	9.35	8.40	9.00	10.08	7.68
Movable finger Length	13.10	10.56	10.92	9.60	12.61	13.20	12.85	13.05	13.45	10.32

Table 11: Morphometrical ratios for adult males and females of *Nebo jazanensis* sp. n.

	Ratios \ Specimen code	32 J	33 J	34 J	35 J	36 J	37 j	38 j	39 j	40 j	41 j
1	Carapace length / Metasoma II length	1.67	1.78	1.71	1.67	1.66	1.72	1.73	1.71	1.71	1.75
2	Pedipalp Femur length / Width	2.53	2.38	2.56	2.48	2.65	2.46	2.49	2.50	2.42	2.30
3	Metasoma V length / Movable finger length	0.87	0.85	0.90	0.91	0.99	0.88	0.89	0.95	0.94	0.98
4	Metasoma V length / Carapace length	0.92	0.86	0.92	0.91	0.96	0.91	0.95	0.93	0.94	0.91
5	Metasoma V length / Metasoma II Width	2.38	2.08	2.28	2.15	2.36	2.16	2.30	2.29	2.33	2.27
6	Pedipalp Chela length / Chela depth	2.64	2.83	2.68	2.87	2.64	2.45	2.64	2.71	2.48	2.63
7	Femur length /chela depth	1.28	1.29	1.30	1.33	1.32	1.17	1.24	1.28	1.10	1.20

Table 12: Identification aid matrix for three *Nebo* species (adult males and females). The numbers in the matrix refer to the ratios given in Table 3.

Males / Females	*Nebo hierichonticus*	*Nebo yemenensis*	*Nebo jazanensis* sp. n.
Nebo hierichonticus		2, 4, 5, 6	1, 2, 4, 5
Nebo yemenensis	2, 4, 5		1, 4, 6
Nebo jazanensis sp. n.	1, 2, 4, 5	1	

Ecology

The collection site is located in the village of Al Boqa'a (1061 m asl), located in the southwestern heights of the Sarawat Mountains, Al-Dayer Governorate, to the east of Jazan region. The terrain consists of rocky slopes below that embrace deep valleys (Figure 7). It is intensively used as a farmland growing millet, coffee, and quince. Other wild flora includes *Ficus vasta*, *Tamarindus indica*, *Acacia asak*, and *Ficus cordata* ssp. *salicifolia*, in addition to *Cissus rotundifolius* covers the valley with many aromatic plants such as *Ocimum tenuiflorum* and *Artemisia judaica.* Other scorpions that were found in the same area include *Compsobuthus manzonii, Hottentotta scaber, N. yemenensis* and *N. hierichonticus* and *Parabuthus liosoma*.

Discussion

The present study described a new species to the genus *Nebo*, increasing the number of species for this genus to 10. Morphometric ratios of the new species show that it is clearly different from both syntropic species, *N. yemenensis* and *N. hierichonticus* (Table 12). Within the same study area, Al Boqa'a, Al-Dayer Governorate, three species of *Nebo* occur. Similar observation of presence of sympatric species of the genus *Nebo* was documented by Francke (1980), whereas *N. flavipes*, *N. grandis* and *N. yemenensis* were reported in close proximity from each others in Yemen. The distance between *N. grandis* and *N. yemenensis* is about 110 km, and that between *N. flavipes* and *N. yemenensis* is about 66 km. In Oman, the distance between *N. franckei* and *N. whitei* is about 112 km (Vachon, 1980).

It seems that *N. hierichonticus* distribution range extends from Jordan, Sinai, and Palestine (Francke, 1980, Amr and Al-Oran, 1994, Qumsiyeh *et al.,* 2014) further south into Saudi Arabia in around Tabuk in the north to Al Madinah Al Monawwarah provinces and, further south to Al Bahah reaching Jazan close to Yemen borders these records reduce the geographical discontinuity between the previously known northern distribution of the genus from Egypt and Jordan and the densely speciated southern distribution in Yemen and Oman. Francke (1980) stated that specimens collected from north of Jiddah and Qunfidan (= Qunfidah) are morphometrically closer to *N. hierichonticus* on some ratios, while closer to *N. yemenensis* in others. It seems that Yemen is the source of speciation for the four species of this genus in southwestern Arabia.

Similar sympatric species that occur within confined geographic areas were reported in Wadi Araba. Both *Buthacus arava* Cain, Gefen & Prendini, 2021 and *Buthacus yotvatensis* Levy, Amitai & Shulov, 1973 were collected from the same locality in Wadi Khanzeerah, Karak Governorate, Jordan (Cain *et al.,* 2021).

Our study included a large collection of adult *Nebo* specimens from Saudi Arabia and comparative materials from Jordan confirms the significance of morphometric ratios as a valid tool to distinguish species

Figure 7. Al Boqa'a, Jazan Province, the locality from which Nebo jazanensis sp. n. was collected.

of this enigmatic genus as suggested by Francke (1980). The recent molecular work of Alqahtani *et al.* (2023) predicted the presence of interspecific and intraspecific variations among or within *Nebo hierichonticus* and *Nebo yemenensis* that may indicate the presence of other distinct species. This finding supports our newly described species.

Finding three sympatric species within the same area requires further scrutiny by means of molecular tools to reveal their identity and phylogenetic relationship.

Acknowledgments

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