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PAGES: 44-49

ORIGINAL PDF URL: <https://dergipark.org.tr/tr/download/article-file/2993349>

## On the Morphology of *Orthochirus stockwelli* (Lourenço & Vachon, 1995) with First Description of a Female (Scorpiones: Buthidae)

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Received: 06.03.2023

Accepted: 19.04.2023

Published online: 10.05.2023

Issue published: 30.06.2023

**Abstract:** *Orthochirus stockwelli* (Lourenço & Vachon, 1995) was originally described based on male holotype specimen from Bandar-Abbas (Hormozgan) under the genus *Paraorthochirus*. The morphology of this species is redescribed here based on the specimens collected from Bandar-Abbas on the basis of both sexes. The original description includes a female, but very little information was given on its morphology and does not include illustration belonging to the female. Therefore, the female is described for the first time in this study.

**Keywords:** Redescription, Iran, Hormozgan, scorpion.

### *Orthochirus stockwelli* (Lourenço & Vachon, 1995)'nin Morfolojisi Üzerine ve Dişinin İlk Deskripsiyonu (Scorpiones: Buthidae)

**Öz:** *Orthochirus stockwelli* (Lourenço & Vachon, 1995) ilk olarak Bandar-Abbas'tan (Hormozgan) *Paraorthochirus* cinsi altında erkek holotip örneğine dayanarak tanımlanmıştır. Bu türün morfolojisi, burada Bandar-Abbas'tan toplanan örneklerle ve her iki cinsiyete dayalı olarak yeniden tanımlanmıştır. Orijinal deskripsiyonda bir dişi yer almaktadır, ancak morfolojisi hakkında çok az bilgi verilmiştir ve dişiye ait illüstrasyon içermemektedir. Bu nedenle dişi ilk kez bu çalışmada tanımlanmıştır.

**Anahtar kelimeler:** Redeskripsyon, İran, Hormozgan, akrep.

#### 1. Introduction

*Orthochirus stockwelli* was described from Bandar-Abbas County, Hormozgan province of Iran under the genus *Paraorthochirus* by Lourenço and Vachon (1995). Navidpour et al. (2008a) synonymized the genus *Paraorthochirus* with the genus *Orthochirus* (Karsch 1892) and transferred this species to the genus *Orthochirus*.

Subsequently, this species was recorded from Khuzestan Province, Bushehr Province, and with further records from Hormozgan province (Navidpour et al. (2008a), Navidpour et al. (2008b), Navidpour et al. (2013).

The original publication by Lourenço and Vachon (1995) provided illustrations and description of the male holotype with very limited information regarding female allotype (only pectinal teeth number of 19-19 and metasoma being more hirsute were given) Navidpour et al. (2008a, 2008b) illustrated habitus of both male and female and Navidpour et al. (2013) illustrated metasoma from ventral aspect. However, a full and detailed illustration of this species has never been provided, particularly female morphology stayed unclear.

The aim of this study is to redescribe the *Orthochirus stockwelli* species based on both sexes and to provide full illustrations of this species. New materials collected from Hormozgan Province were used.

#### 2. Material and Methods

Specimens of *O. stockwelli* were collected from the Bandar-Abbas by the second author and preserved in

96% alcohol. Identification of specimens was done according to Lourenço and Vachon (1995) and Kovařík (2004). Illustrations were prepared with the method described in Yağmur (2021). The specimens were deposited in AZMM (Alaşehir Zoological Museum, Manisa Celal Bayar University, Alaşehir, Manisa, Turkey) and in the personal collection of the second author. Trichobothrial notation follows Vachon (1974, 1975) and morphological nomenclature follows Stahnke (1971) and Hjelle (1990).

#### 3. Results and Discussion

##### Family Buthidae C. L. Koch, 1837

*Orthochirus* Karsch, 1892

*Orthochirus stockwelli* (Lourenço & Vachon, 1995)

*Paraorthochirus stockwelli* Lourenço & Vachon, 1995: 299.

*Paraorthochirus stockwelli*: Lourenço & Vachon, 1997: 329; Kovařík, 1997: 50; Kovařík, 1998: 117; Fet & Lowe, 2000: 212; Kovařík & Fet, 2006: 9.

*Orthochirus stockwelli*: Navidpour et al., 2008a: 20; Navidpour et al., 2008b: 17; Navidpour et al., 2013: 17; Kovařík et al., 2020.

**Type Locality and Type Depository.** Iran, Hormozgan Province, Bandar-Abbas; MNHN.

**Material Examined.** Iran, 5 ♂♂, 23 ♀♀, Hormozgan Province, Bandar-Abbas County, 1 April 2000, leg. A. Akbari.

**Description.** Total length is 27.42 mm in the studied male and 31.23 mm in the studied female. Measurements of the carapace, mesosoma, segments of the metasoma, and segments of the pedipalps are given in Table 1.

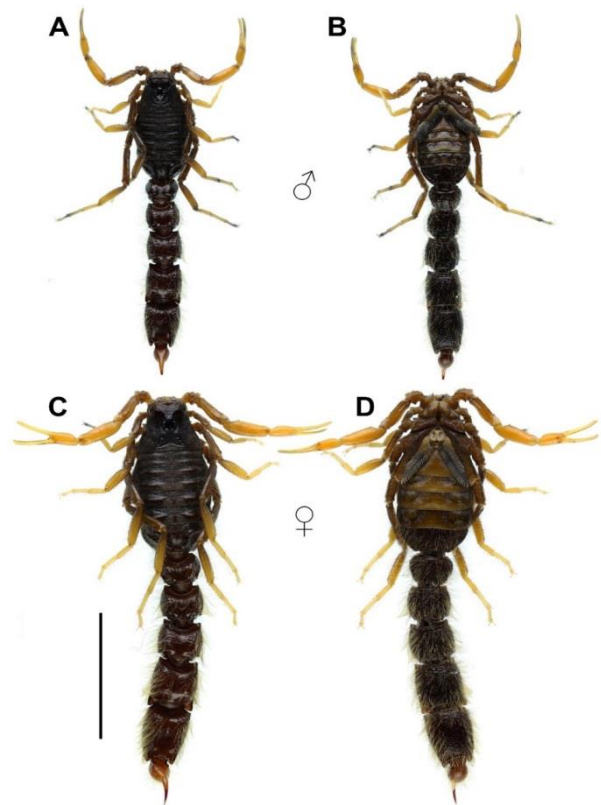
Table 1. Measurements of *Orthochirus stockwelli* a male and a female specimen. Abbreviations: length (L), posterior width (W), depth (D).

		<i>Orthochirus stockwelli</i>	<i>Orthochirus stockwelli</i>
Dimensions (mm)		♂	♀
Carapace	L/W	3.11/3.85	3.51/4.33
Mesosoma	L	06.99	9.45
Tergite VII	L/W	1.92/4.07	2.12/4.81
Metasoma + telson	L	17.32	18.27
Segment I	L/W/D	1.76/2.68/2.34	2.14/3.02/2.34
Segment II	L/W/D	2.27/2.76/2.35	2.24/3.04/2.30
Segment III	L/W/D	2.54/2.89/2.37	2.47/3.10/2.61
Segment IV	L/W/D	2.96/3.20/2.09	3.26/3.28/2.43
Segment V	L/W/D	4.19/3.06/2.27	4.06/3.21/2.05
Telson	L/W/D	3.60/1.34/1.13	4.10/1.43/1.19
Pedipalp	L	9.96	10.08
Femur	L/W	2.57/0.76	2.54/0.80
Patella	L/W	3.16/0.92	3.21/0.98
Chela	L	4.29	4.33
Manus	L/W/D	1.83/0.75/0.81	1.61/0.79/0.90
Movable finger	L	2.43	2.86
<b>Total</b>	<b>L</b>	<b>27.42</b>	<b>31.23</b>

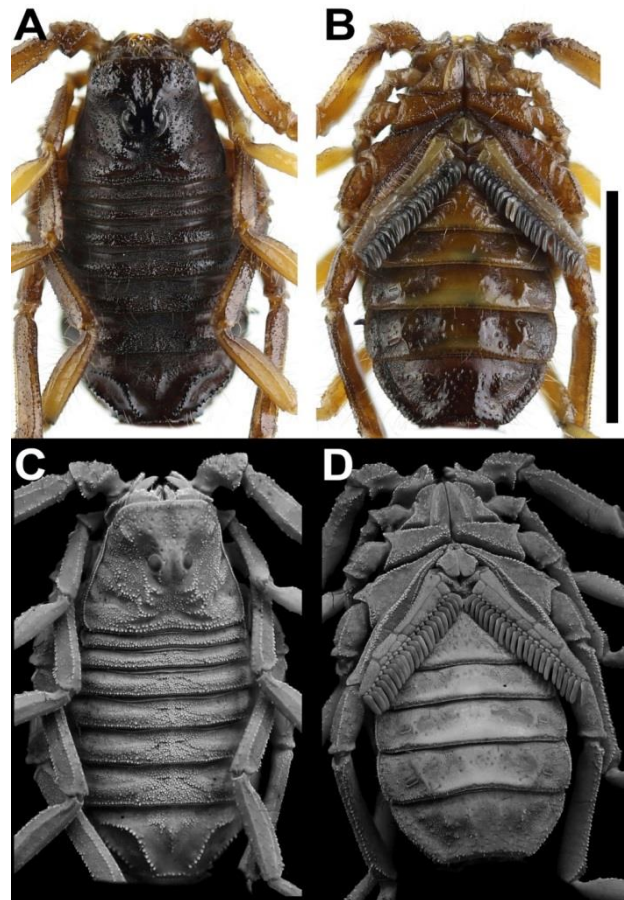
**Male.** Coloration (Figs. 1A-B). The carapace, mesosoma and metasoma dark reddish brown; the vesicle light reddish brown, aculeus dark reddish. Femur of pedipalp yellowish brown, patella of pedipalp and chela dark yellow. Femur of legs yellowish brown and tibia of legs very dark yellowish, other segments are yellow.

**Carapace and mesosoma** (Figs. 2A-D; 3A-D). Carapace is densely granulated but a triangular region between median eyes and anterior margin nearly smooth with fine granules medially and few swollen granules laterally, this region and anterior margin with scattered macrosetae, rest of the carapace without setae. Anterior margin of carapace is slightly convex. The region between median eyes and posterior furrows smooth. Centromedian and posteriomedian carinae and posterior margin with coarse granules. Median eyes large and located on the center of carapace on a distinct ocular tubercle, they are separated by a gap larger than an eye diameter. Three pairs of lateral eyes present. Ocelli equal in size.

Mesosomal segments I-VI densely granulated and bear a weak median carinae, the granules in the middle of tergite denser and larger, the posttergites bear larger granules than pretergites. Mesosomal segment VII bear five strong granular carinae; pretergite with dense granules medially. Posterior margins of tergites I-VII with some distinct macrosetae. Sternites III-VII smooth and lustrous medially and finely granular laterally; lateral surfaces of sternites IV-VI and, all surfaces of sternites III and VII covered with macrosetae.



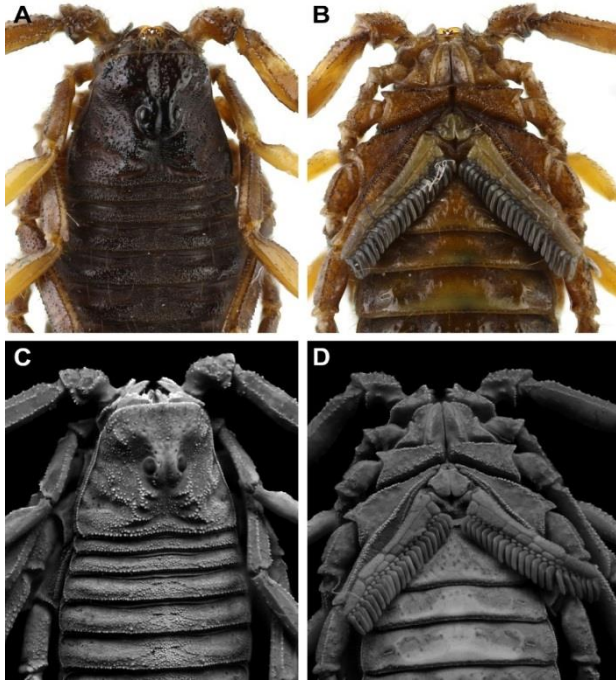
Figures. 1. *Orthochirus stockwelli*, general views of male and female. Figures A-B. Male. Figures C-D. Female. Figures A-C. Dorsal views. Figures B-D. Ventral views. Scale bar: 10 mm.



Figures. 2. *Orthochirus stockwelli*, carapace and mesosoma of male. Figures A, C. Dorsal views. Figures B, D. Ventral view. Figures A-B. Under white light. Figures C-D. Under UV light. Scale bar: 10 mm.



Lateral and posterior margins of sternites V-VII with scattered distinct macrosetae. Sternites V-VI with two smooth carinae, sternite VII with four carinae, median carinae smooth, lateral carinae finely granular. Coxa margins with dense rounded granules. Pectinal teeth number 20-22 and densely covered with macrosetae (Figs. 2A-D).



Figures 3. *Orthochirus stockwelli*, male. Figures A, C. Carapace and tergites I-V. Figures B, D. Coxal and sternopectinal region. Figures A-B. Under white light. Figures C-D. Under UV light.

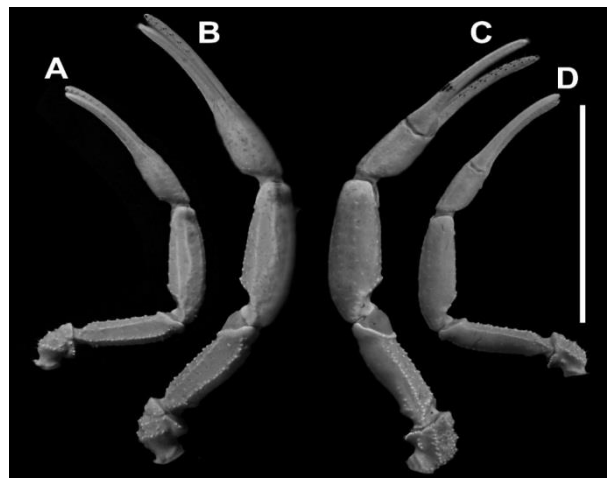
**Pedipalps** (Figs. 4A, D; 5A, D; 6A-E). The femur of pedipalp with five carinae, granules are rounded and spaced on the carinae, intercarinal area smooth with scattered setae. Trichobothrium  $d_2$  of pedipalp femur present on dorsal surface. The patella with seven smooth carinae, intercarinal area smooth with scattered setae. The chela is smooth, lustrous, without carinae. Manus is thinner than patella. Fingers are plump. The movable fingers and fixed fingers bear 7-8 rows of denticles with internal and without external denticles in the last three distal denticles. The chela with scattered and distinct hairs. Trichobothrial pattern is of Type A, orthobothriotaxic, dorsal trichobothria of femur are arranged in  $\beta$  configuration (Vachon, 1974, 1975). Trichobothrium  $dt$  is located between  $et$  and  $est$  but located closer to  $et$ . Trichobothrium  $db$  is located between  $esb$  and  $est$  in the middle (Figs. 6A-E).

Chelicerae with typical buthid dentition (Vachon, 1963), teeth pointed, ventral aspect of fixed finger with two denticles, dorsal surface of manus with subapical transverse band of small, rounded granules (Figs. 3A, C).

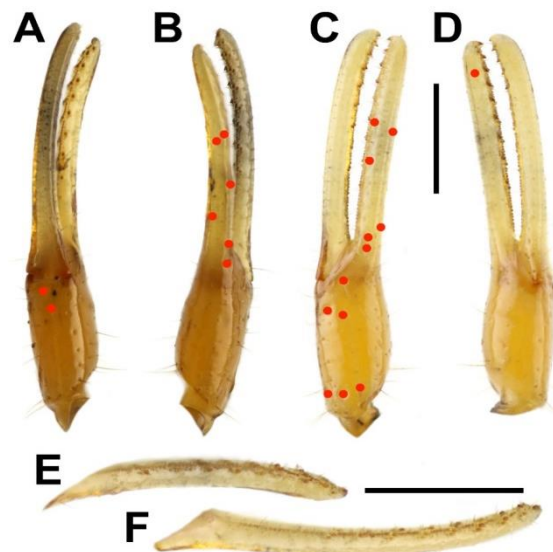
**Metasoma and telson** (Figs. 7A-F, Figs. 8A-D). Metasomal segment I with 10, segment II with 8, segment III with 6, segment IV-V with 2 granular carinae, granules on carinae rounded and spaced. Ventrolateral carinae on segment V gradually increase posteriorly. Intercarinal area rough with dense granules without punctae on segment I-III, smooth with dense punctae on segment IV-V. Width of segment I-V increase posteriorly.



Figures 4. *Orthochirus stockwelli*, pedipalp of male and female. Figures A, D. Male. Figures B, C. Female. Figures A, B. Dorsal views. Figures C, D. Ventral views. Trichobothrial pattern indicated by red circles. Scale bar: 10 mm.

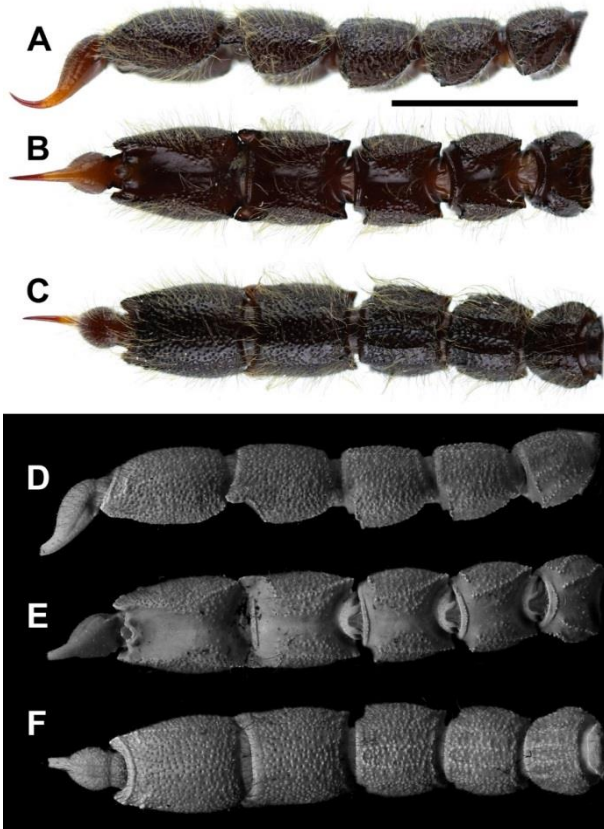


Figures 5. *Orthochirus stockwelli*, pedipalp of male and female, under UV light. Figures A, D. Male. Figures B, C. Female. Figures A, B. Dorsal views. Figures C, D. Ventral views. Scale bar: 10 mm.

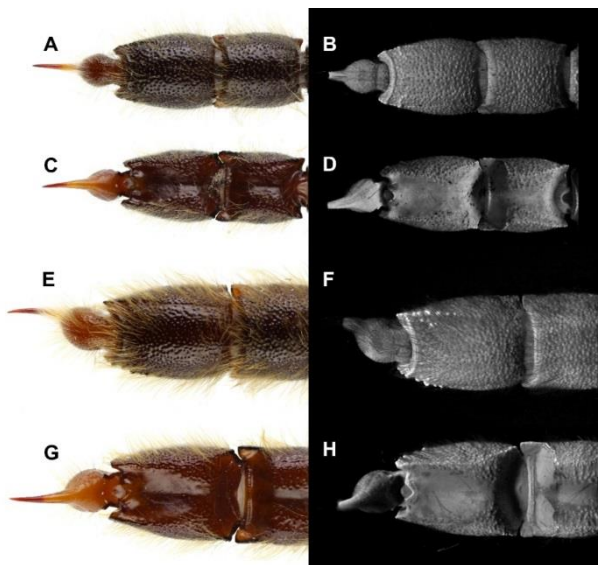


Figures 6. *Orthochirus stockwelli*, chela and chela fingers of male. Figure A. Chela ventral. Figure B. Chela dorsal. Figure C. Chela external. Figure D. Chela internal. Figures E. Movable finger dentition. Figures F. Fixed finger dentition. Trichobothrial pattern indicated by red circles. Scale bar: 1 mm.

Segment I-V densely hirsute with long and distinct hairs. Dorsal surface of segments I-V smooth mesially, granular and hirsute laterally. Dorsal surface of segment V with a few fine granules mesially. Telson is elongated, vesicle with small dense punctae and dense distinct setae, surface smooth. Aculeus slender as long as vesicle and not abruptly curved.

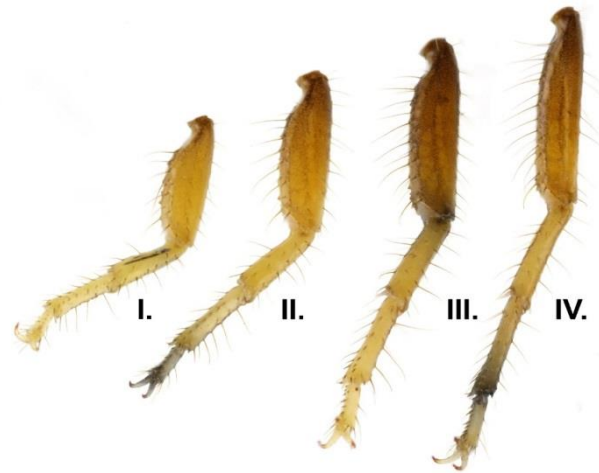


Figures 7. *Orthochirus stockwelli*, metasoma and telson of male. Figures A, D. Lateral. Figures B, E. Dorsal views. Figures C, F. Ventral views. Figures A-C. Under white light. Figures D-F. Under UV light. Scale bar: 10 mm.



Figures 8. *Orthochirus stockwelli*, metasoma segment V and telson of male and female. Figures A-D. Male. Figures E-H. Female. Figures A, B, E, F. Dorsal views. Figures C, D, G, H. Ventral views. Figures A, C, E, G. Under white light. Figures B, D, F, H. Under UV light.

*Legs* (Figs. 9). The femur and patella of the legs bear distinct macrosetae. Tarsomeres of legs I -III bear bristlecombs. The inner sides of all legs with two rows of spines.



Figures 9. *Orthochirus stockwelli*, right legs I-IV of male.

**Female.** Coloration (Figs. 1C-D). The carapace, mesosoma and metasoma reddish brown; the vesicle reddish brown, aculeus dark reddish. Femur of pedipalp yellowish brown, patella of pedipalp and chela dark yellow. Femur of legs yellowish brown and tibia of legs very dark yellowish, other segments are yellow.

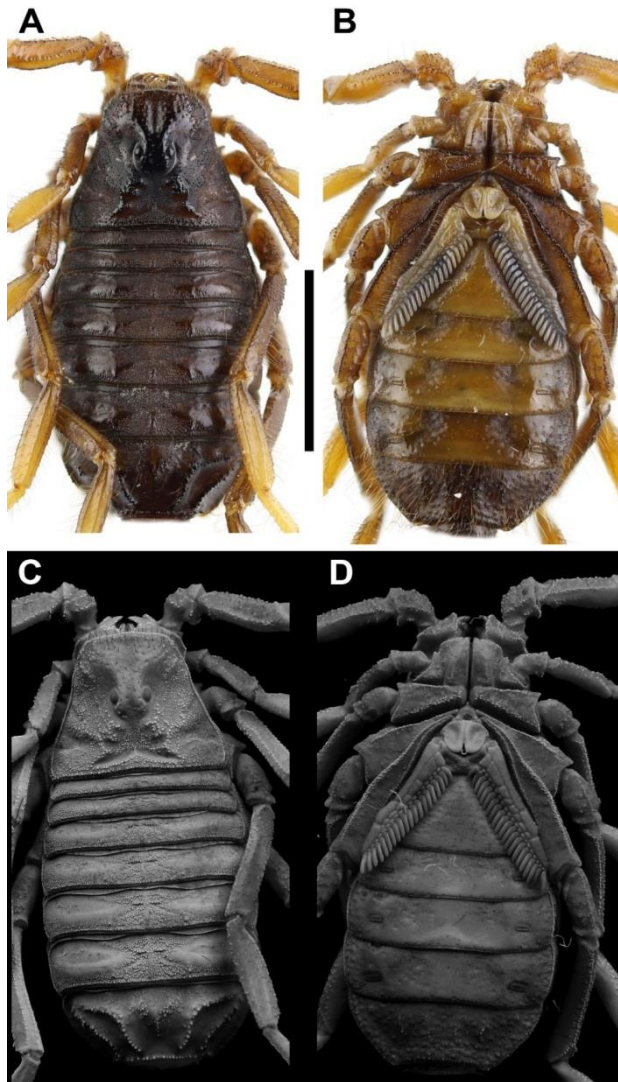
**Carapace and mesosoma** (Figs. 10A-D, 11A-D). The carapace is densely granulated, a triangular region between median eyes and anterior margin completely smooth, this region and anterior margin with dense macrosetae, rest of the carapace without setae. Anterior margin of carapace is slightly convex. The region between median eyes and posterior furrows smooth. Centromedian and posteriomedian carinae with coarse and posterior margin with moderate granules. Median eyes large and located in center of carapace on a distinct ocular tubercule, they are separated by a gap larger than an eye diameter. Three pairs of lateral eyes present. Ocelli equal in size.

Mesosomal segments I-VI densely granulated in median and lateral sides and bear a weak median carinae, the granules in the middle of tergite denser and larger, the posttergites granular but pretergites smooth on the two sides of mesial area. Mesosomal segment VII bear five strong granular carinae; pretergite with dense granules medially. Posterior margins of tergites I-VII with some distinct macrosetae. Sternites III-VI smooth and lustrous medially and finely granular laterally, sternites VII densely covered with fine granules. Lateral surfaces of sternites IV-VI and all surfaces of sternites III covered with macrosetae, and sternites VII covered densely by long macrosetae. Lateral margins of sternites V-VII with dense distinct macrosetae and posterior margins with scattered macrosetae. Sternites V-VI with two smooth carinae, sternite VII with four finely granular carinae. Coxa margins with dense rounded granules. Pectinal teeth number 16-21 and densely covered with macrosetae (Figs. 11A-D).

**Pedipalps** (Figs. 4B-C; 5B-C; 12A-E). The femur of pedipalp with five carinae, granules are rounded and spaced on the carinae, intercarinal area smooth with dense



macrosetae. Trichobothrium  $d_2$  of pedipalp femur present on dorsal surface. The patella with seven smooth carinae, intercarinal area smooth with dense macrosetae. The chela is smooth, lustrous, without carinae. Manus is thinner than patella. Fingers are thin. The movable fingers and fixed fingers bear 7-8 rows of denticles with internal and without external denticles in the last three distal denticles. The chela with many macrosetae. Trichobothrial pattern is of Type A, orthobothriotaxic, dorsal trichobothria of femur are arranged in  $\beta$  configuration (Vachon, 1974, 1975). Trichobothrium  $dt$  is located between  $et$  and  $est$  but closer to  $et$ . Trichobothrium  $db$  is located between  $esb$  and  $est$  but closer to  $esb$  (Figs. 12A-E).

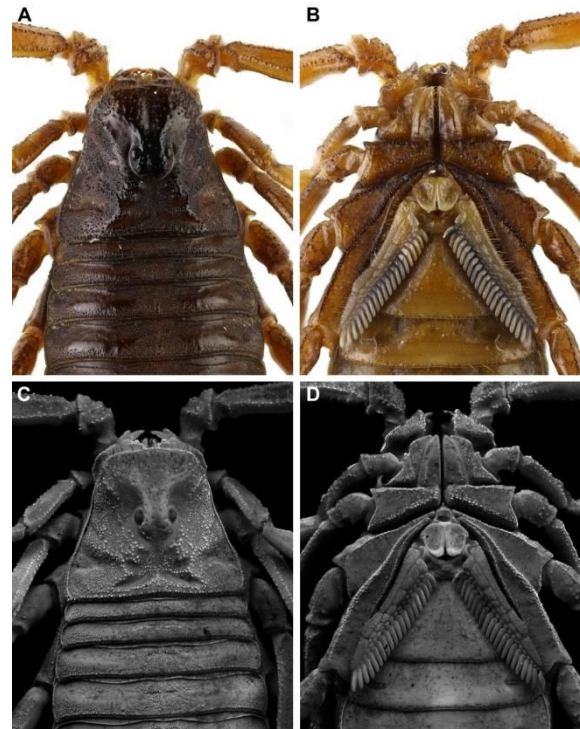


Figures 10. *Orthochirus stockwelli*, carapace and mesosoma of female. Figures A, C. Dorsal views. Figures B, D. Ventral views. Figures A-B. Under white light. Figures C-D. Under UV light. Scale bar: 10 mm.

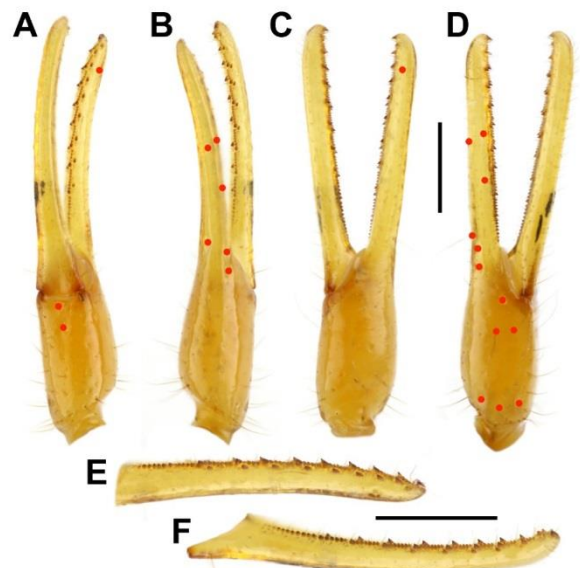
Chelicerae with typical buthid dentition (Vachon, 1963), teeth pointed, ventral aspect of fixed finger with two denticles, dorsal surface of manus with subapical transversal band of random granule (Figs. 11A-C).

*Metasoma and telson* (Figs. 13A-F, Figs. 8A-D). Metasomal segment I with 10, segment II with 8, segment III with 6, segment IV-V with 2 granular carinae, granules on carinae rounded and spaced. Ventrolateral carinae on segment V gradually increase posteriorly and bear

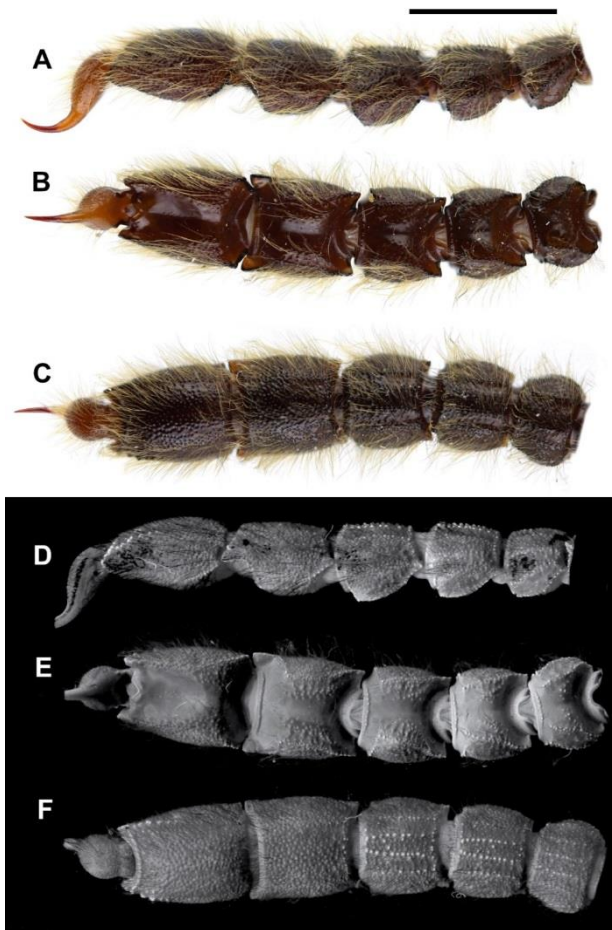
rounded granules. Intercarinal area rough with dense granules without punctae on segment I-III, smooth with dense punctae on segment IV-V. Width of segment I-V increase posteriorly. Segment I-V densely hirsute with very long and very distinct hairs. Dorsal surface of segments I-V smooth mesially, granular, and hirsute laterally. Dorsal surface of segment V with a few fine granules mesially. Telson is elongated, vesicle with dense small punctae and densely hirsute with long hairs, surface smooth. Aculeus slender as long as vesicle and slightly curved.



Figures 11. *Orthochirus stockwelli*, female. Figures A, C. Carapace and tergites I-V. Figures B, D. Coxal and sternopleural region. Figures A-B. Under white light. Figures C-D. Under UV light.



Figures 12. *Orthochirus stockwelli*, chela and chela fingers of female. Figure A. Chela ventral. Figure B. Chela dorsal. Figure C. Chela internal. Figure D. Chela external. Figures E. Movable finger dentition. Figures F. Fixed finger dentition. Trichobothrial pattern indicated by red circles. Scale bar: 1 mm.



Figures 13. *Orthochirus stockwelli*, metasoma and telson of female. Figures A, D. Lateral. Figures B, E. Dorsal views. Figures C, F. Ventral views. Figures A-C. Under white light. Figures D-F. Under UV light. Scale bar: 10 mm.

**Legs** (Figs. 14). The femur and patella of the legs bear distinct macrosetae. Tarsomeres of legs I -III bear bristlecombs. The inner sides of all legs with two rows of spines.



Figures 14. *Orthochirus stockwelli*, right legs I-IV of female.

**Sexual Dimorphism.** Males are darker than females. Size of female (31.23 mm) is bigger than male (27.42 mm). Pectinal teeth number 16-21 in males, 20-22 in females. Metasomal segment I stockier in male than female (length/width ratios 0.65 in male, 0.70 in female).

Metasomal segment V more elongate in male than female (length/width ratios 1.36 in male, 0.701.26 in female). Female has longer movable finger than male (movable finger length/ manus length ratios 1.32 in male, 1.77 in female).

**Ethics committee approval:** Ethics committee approval is not required for this study.

**Conflict of interest:** The authors declare that there is no conflict of interest.

**Author Contributions:** Conception – A.A., N.J.; Design – M.M., N.J.; Supervision – E.A.Y.; Fund – A.A.; Materials – A.A., N.J.; Analysis Interpretation – E.A.Y.; Literature Review – E.A.Y.; Writing – E.A.Y., M.M.; Critical Review – A.A., M.M.

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