

# A new species of *Ditha* (Pseudoscorpiones, Chthoniidae, Tridenchthoniinae) from the Western Ghats of India, with an identification key for the genus

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## Abstract

A new species of the pseudoscorpion genus *Ditha* Chamberlin, 1929, is described from Kerala State, India. A detailed morphological description, diagnostic features, and illustrations of *Ditha* (*Paraditha*) *shivanparaensis* Jeong, Harms & Johnson, **sp. nov.** are provided. The current distribution of all the known *Ditha* species is mapped, and an identification key for the genus is provided.

## Key Words

Arachnida, Kerala, montane, morphology, taxonomy

## Introduction

Tropical montane cloud forests or ‘sholas’ of the Western Ghats of India encompass unique ecosystems characterized by their high elevations (>1000 m) and isolated nature. These sholas are considered as isolated ‘islands’ that are surrounded by the vast ocean of low-altitude forests or grasslands (Robin et al. 2015). The biota of these so-called ‘sky islands’ provide excellent templates for studying endemism and investigating the factors driving diversification and adaptation in such specialized environments. Pseudoscorpions (order Pseudoscorpiones de Geer, 1778) are one such group of arachnids found in these ecosystems. Globally, ca. 4000 nominal species are described in 25 fam-

ilies, with India hosting ca. 160 described species (WPC 2023). Due to their specific microhabitat preferences and poor dispersal abilities, most leaf-litter dwelling species, particularly those belonging to the family Chthoniidae Day, 1889, exhibit short-range distributions (Cosgrove et al. 2016; Johnson et al. 2022; Hlebec et al. 2023).

Tridenchthoniinae Balzan, 1892 is a chthoniid subfamily with 71 extant species in 15 genera and one extinct species (*Chelignathus kochii* Menge, 1854). Until recently, it was regarded as a distinct family within the Chthonioidea superfamily (Benavides et al. 2019). It differs from other chthoniid subfamilies in the presence of granulate carapace, spines on both coxa I and II, trichobothria *ib* and *isb* located basally or sub-basally on the chelal hand, and a galea with mul-

multiple ramifications in the juvenile stage (Morikawa 1960; Kennedy 1989). Tridenchthoniinae is divided into two tribes, Tridenchthoniini and Verrucadithini, and they can be distinguished by the shape of the marginal chelal teeth, being relatively acute and distinctly spaced in Verrucadithini, while they are closely contiguous in Tridenchthoniini (Chamberlin and Chamberlin 1945). Tridenchthoniini comprises nine genera; among these, the genus *Ditha* Chamberlin, 1929 is distributed from East Asia to Africa. It includes two subgenera, *Ditha* (*Ditha*) and *Ditha* (*Paraditha*) Beier, 1931, with seven species recorded in each subgenus. The subgenus *Paraditha* comprises seven species: *D. laosana* Beier, 1951, *D. pahangica* Beier, 1955, *D. sumatraensis* (Chamberlin, 1923) and *D. tonkinensis* (Beier, 1951) distributed in Southeast Asia; *D. latimana* (Beier, 1931) and *D. sinuata* (Tullgren, 1901) from Africa; and *D. marcusen-sis* (Morikawa, 1952) from East Asia (Fig. 1).

Hitherto, only two species of Tridenchthoniinae belonging to the genus *Compsaditha* Chamberlin, 1929 have been reported from India: *Compsaditha indica* Murthy, 1960, and *C. camponota* Sivaraman, 1980. Here, we present the first record of the genus *Ditha* (*Paraditha*) from India and describe a new species from the Southern Western Ghats (Kerala state) of India along with an identification key for the genus *Ditha*.

## Materials and methods

The specimens used for this study are lodged in the following institutions: Museum of Nature, Hamburg – Zoology (ZMH, formerly Zoological Museum Hamburg) and the Arachnology Division of Sacred Heart College, Thevara, India (ADSH). All specimens were initially preserved in 100% ethanol, with DNA extracted from the legs of one paratype female, while the other specimens are stored in 75% ethanol.

All specimens were examined using a Leica M125C stereomicroscope in 75% ethanol. Images were captured using a BK Plus Lab System (Dun, Inc.) equipped with a Canon EOS 7D Mark II camera fitted with a microscopic lens (5X, 10X magnification) using the software CAPTURE ONE PRO 9.3 64 Bit (v.9.3.0.85) and stacked using Zerene Stacker, and a Leica DMC4500 digital camera attached to a Leica M205A stereomicroscope, using the program, LEICA APPLICATION SUITE X (LASX), ver. 3.0.1. LASX was also used for taking the measurements. Mensuration and terminology largely follow Chamberlin (1931), with some minor modifications to the terminology of the trichobothria (Harvey 1992), chelicera (Judson 2007), and appendages (Harvey et al. 2012). Scanning electron micrographs were obtained with a Hitachi TM4000Plus scanning electron micrograph (SEM) system. Illustrations were created using ADOBE ILLUSTRATOR 2023 and edited with ADOBE PHOTOSHOP 2023. The distribution map was made using QGIS 3.22.10. Abbreviations used for chelal trichobothria: *b* – basal, *sb* – subbasal, *st* – subterminal, *t* – terminal, *ib* – internal basal, *isb* – internal subbasal, *eb* – external basal, *esb* – external subbasal, *it* – internal terminal, *ist* – internal

subterminal, *et* – external terminal, *est* – external subterminal, *xs* – duplex trichobothria; leg segments: *tr* – trochanter, *fe* – femur, *pa* – patella, *ti* – tibia, *mt* – metatarsus, *ta* – tarsus; cheliceral seta: *as* – accessory setae.

## Taxonomy

### Family Chthoniidae Daday, 1889

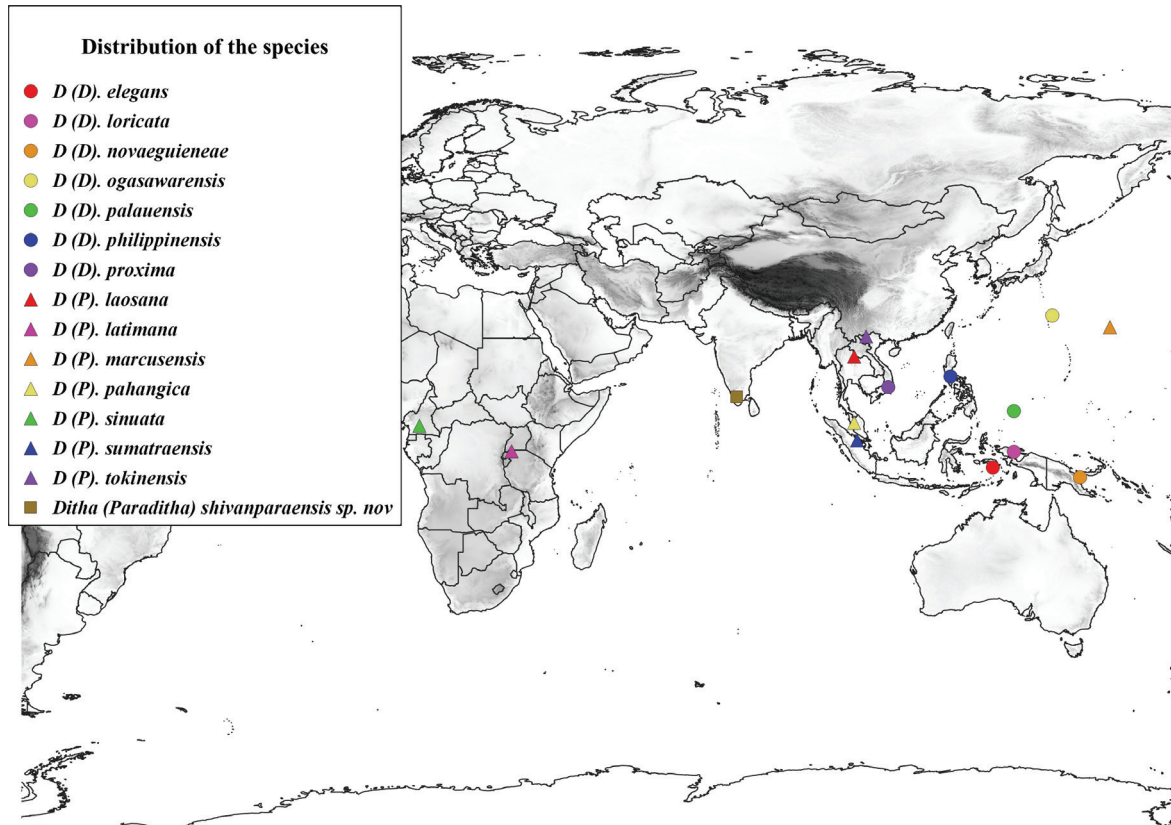
#### Subfamily Tridenchthoniinae (Balzan, 1892)

**Remarks.** Balzan (1892) proposed the family Tridenchthoniidae to include the species *Tridenchthonius parvulus* Balzan, 1887 from Paraguay which possessed triple galea in the chelicera. However, Hansen (1894) considered this species to be an unusual *Chthonius* and reduced the taxon to the subfamily Tridenchthoniinae. Since then, the taxonomic status of the group has undergone several changes. Chamberlin (1929) in his revised classification scheme for pseudoscorpions, proposed a new subfamily Dithinae Chamberlin, 1929 to include the new genus *Ditha* Chamberlin, 1929. Dithinae chthoniids closely resemble Tridenchthoniinae, except that they include non-galeate forms, but they differ from members of Chthoniinae proper in the characters such as the presence of coxal spines (of single simple type) on coxa I and II and the patella of leg IV being distinctly longer in relation to the femur. Chamberlin (1931) later raised this group to the family status. However, without providing proper justification, Beier (1932) reduced the family to the subfamily status and later to Dithiidae again. However, recognizing Balzan's species *T. parvulus* as a Dithiidae member, Chamberlin and Chamberlin (1945) proposed the family Dithiidae as a junior synonym of Tridenchthoniidae. Finally, in a recent study on pseudoscorpion transcriptomics (Benavides et al. 2019), the group was again reduced to a subfamily within Chthoniidae that now includes Tridenchthoniinae as a subfamily, alongside the Chthoniinae and Lechytiinae.

#### Genus *Ditha* Chamberlin, 1929

**Type species.** *Ditha elegans* Chamberlin, 1929.

**Diagnosis.** The genus *Ditha* can be diagnosed by the following combination of characters: tergites with biseriate setae; carapace with more than 50 setae; trichobothria *st* and *t* more than one areolar diameter apart, and triple galea in the juvenile stage. *Ditha* is divided into two subgenera, *Ditha* (*Ditha*) and *Ditha* (*Paraditha*). The subgenera *Paraditha* and *Ditha* can be differentiated based on the intercoxal tubercle and the number of accessory setae on the cheliceral palm (Beier, 1955). In *Ditha*, the intercoxal tubercle is strongly distinct and 10–12 accessory setae are present on the cheliceral palm, while the intercoxal tubercle is indistinct or even absent in *Paraditha* and only 1–2 accessory seta present on the cheliceral palm.



**Figure 1.** Distribution of the *Ditha* (*Ditha*) and *Ditha* (*Paraditha*) species.

***Ditha* (*Paraditha*) *shivanparaensis* sp. nov.**

<https://zoobank.org/879135E3-C951-4A67-9FF8-4233D198E34B>

Figs 1–4

**Type material.** *Holotype* (Fig. 2A, B). Female (ADSH PST0001. INDIA: Kerala: Shivanpara, Mathiketan Shola National Park, Kerala, Idukki, 9°58'05.1"N, 77°13'43.5"E, altitude 1072 m, litter sample (sifting and Berlese trap), J. Johnson leg.

**Paratypes** (Fig. 2C, D): 3 females (ADSH PST0003, ADSH PST0004, ZMH-A0013527) and one male (ADSH PST0002), same data as holotype.

**Etymology.** This species is named after the hill ‘Shivanpara’ in the Mathiketan Shola National Park, where all specimens were collected.

**Diagnosis.** Within the subgenus *Paraditha*, *Ditha shivanparaensis* sp. nov. closely resembles *D. tonkinensis* Beier, 1951 found in Vietnam in having an indistinct intercoxal tubercle between coxa III and IV, and presence of eight setae on the posterior margin of the carapace. However, the new species differs from *D. tonkinensis* and from all other species within the subgenus in having two accessory setae on the cheliceral palm. *Ditha shivanparaensis* sp. nov. also bears similarity to *Ditha* (*Ditha*) *proxima* (Beier, 1951) from Vietnam in terms of having two accessory setae on the cheliceral palm and 45–47 marginal teeth on the movable chelal finger. However, it differs from the latter in possessing 14 setae on the anterior margin of the carapace (as opposed to 10 setae in *D. proxima*) and by the positioning of *st*, i.e., halfway between *sb* and *t* (whereas *st* is much closer to *sb* in *D. proxima*).

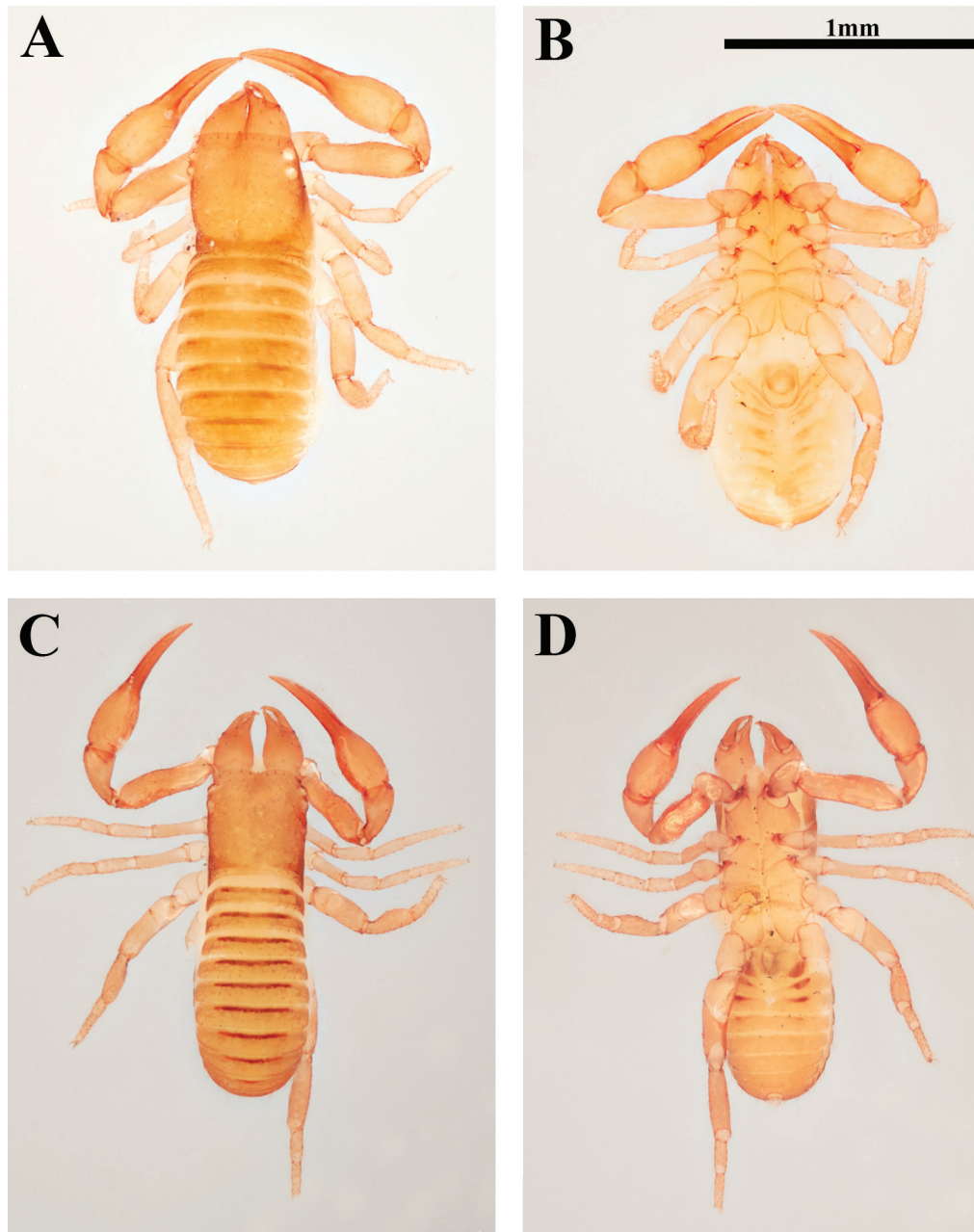
**Description.** *Female, adult* (holotype, Fig. 2A, B).

**Colour.** Uniformly orange-brownish, the legs lighter than the body.

**Chelicera** (Figs 3F, H, 4D, E). Cheliceral palm coarsely granulate and with seven setae (including two accessory setae), movable finger with one seta in medial position and seven marginal teeth, inner margin granulate; fixed finger with seven marginal teeth, the terminal one larger than the others (Fig. 3H); with two dorsal lyrifissures; rallum with ten blades (Figs 3F, 4E); serrula exterior with 16 blades of similar size.

**Pedipalp** (Figs 3G, 4B, C). Trochanter 1.44 times, femur 3.54 times, patella 1.83 times, chela (with pedicel) 3.79 times, hand 1.51 times longer than broad, movable finger 1.54 times longer than hand. Femur, patella, chela smooth. Fixed chelal finger with six trichobothria, movable finger with four trichobothria, *ib* and *isb* situated basally on the dorsum of the chelal hand; *sb*, *st*, and *t* located separately from *b*; *sb*, *st* and *t* all spaced more than one areolar distance; *st* slightly closer to *sb* than *t*; *eb*, *esb* and *ist* forming a group at basal to subbasal position; *esb* slightly closer to *ist* than *eb*; *est* and *it* positioned at the median on the fixed finger; *et* closely located with *xs*, almost less than one areolar distance (Figs 3G, 4B). Four lyrifissures on the dorsum of fixed chelal finger, one on the basal dorsum of chelal hand. Both fingers with small juxtadentate teeth; fixed finger with 55 triangular and retrose teeth; movable finger with 47 rounded teeth.

**Cephalothorax** (Figs 3A, D, E, 4F, G). Carapace 1.04 times longer than broad sub-rectangular; lateral margins almost parallel but slightly wide at the base; coarsely

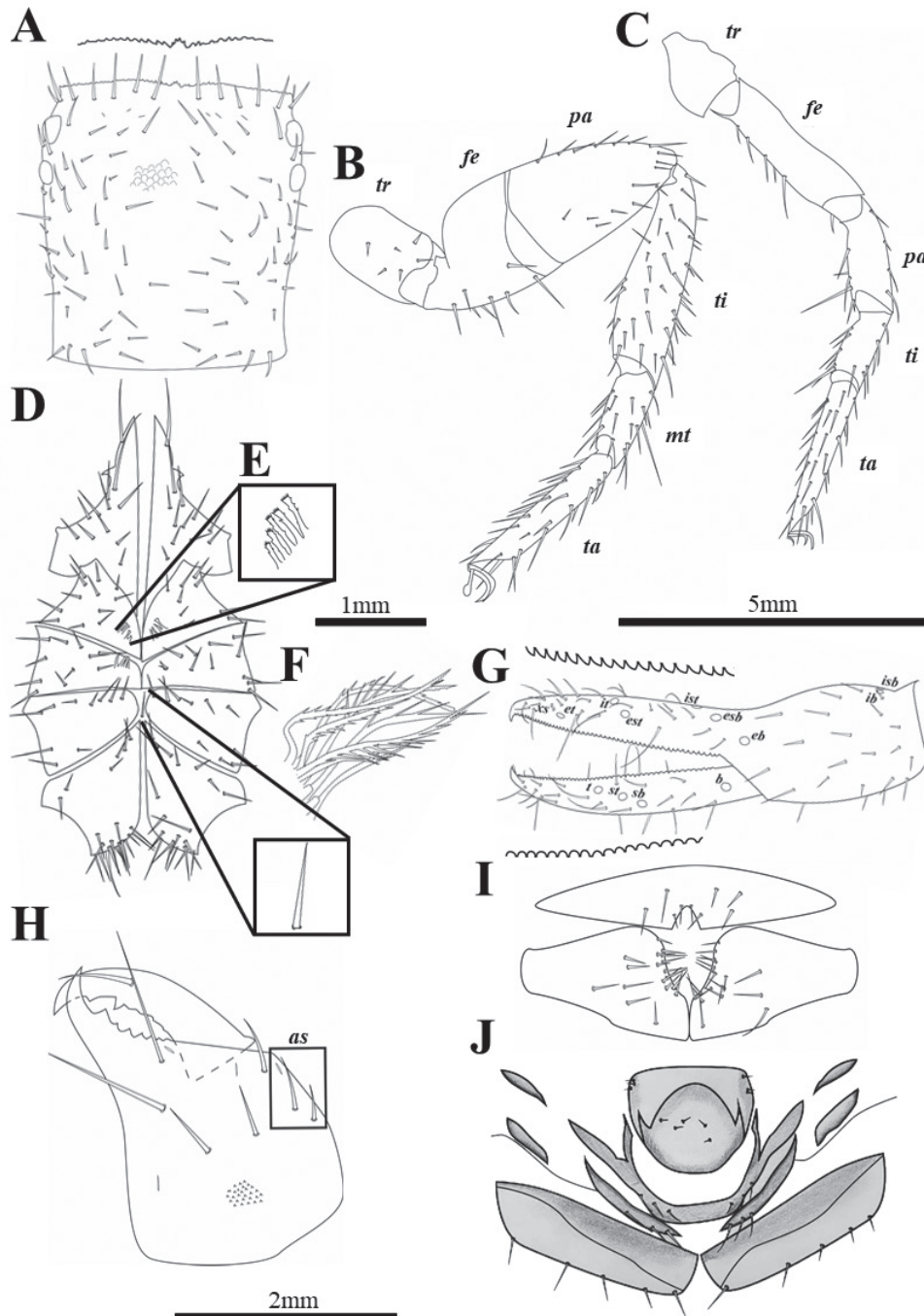


**Figure 2.** Habitus of *Ditha shivanparaensis* sp. nov. **A.** Female holotype, dorsal view; **B.** Female holotype, ventral view; **C.** Male paratype, dorsal view; **D.** Male paratype, ventral view. Scale bars: 1 mm.

granulate, without furrows; four corneate eyes; anterior margin serrated; epistome small and serrated; with 94 setae; 14 setae on the anterior margin, eight setae on posterior margin; setae short and acuminate; with ten lyrifissures, three each on the sides near the anterior margin, one between each eye, and one on each side situated near the posterior margin (Fig. 3A). Manducatory process with one long, acuminate setae, remainder of maxilla with ten setae; four lyrifissures on the maxilla. Coxal chaetotaxy: 10: 11: 11: 20 (Fig. 3D). Coxa I with ca. 5–6 spines, each spine serrated terminally, and ca. 2–3 spines from one base; coxa II with ca. 5–6 spines (Figs 3E, 4E, F); each spine serrated from the medial. Intercostal tubercle indistinctly present between coxa III and IV, seta weakly present (Fig. 4F).

**Abdomen.** Pleural membrane papillostriae, tergites undivided, but sternites III–IV partially divided; setae biseriate and acuminate. Tergal chaetotaxy, 14: 23: 23: 25: 26: 24: 24: 25: 21: 17: 13: 0. Sternal chaetotaxy, 15: 10: 8: 8: 8: 8: 9: 12: 4: 2. Sternite I with 4 setae in the genital opening area.

**Legs** (Fig. 3B, C). Leg I: trochanter 1.18 times, femur 3.87 times, patella 2.98 times, tibia 2.56 times, tarsus 5.93 times longer than broad, leg IV: trochanter 1.48 times, femur 2.75 times, tibia 3.44 times, metatarsus 2.57 times, tarsus 7.00 times longer than broad; leg IV: trochanter 1.67 times, femur 2.39 times, tibia 3.47 times, metatarsus 2.57 times, tarsus 5.49 times longer than broad. Tarsus of leg IV longer than the metatarsus; arolium undivided and shorter than the claws; pseudotactile seta located basally on leg I patella and medially on leg IV metatarsus.



**Figure 3.** Drawings of *Ditha shivanparaensis* sp. nov. (all paratypes unless mentioned otherwise) **A.** Carapace, dorsal view; **B.** Leg IV; **C.** leg I; **D.** Coxa; **E.** Coxal spines; **F.** Rallum; **G.** Left chela from the lateral; **H.** Cheliceral, dorsal view, two accessory setae in the box; **I.** Male genital area external view; **J.** Female genital area external view (holotype). Scale bars: 0.5 mm (**A–D, G**); 1 mm (**E–F**); 2 mm (**H–J**).

**Genitalia** (Fig. 3J). Typical shape of the genus *Ditha*. 15 setae in the genital opening area, including nine setae on the center of the opening and three setae each on either side of the opening; ten setae on the sternite III; six setae on the anterior part of sternite III; four setae on the posterior region, and two setae each on the part of sternite III.

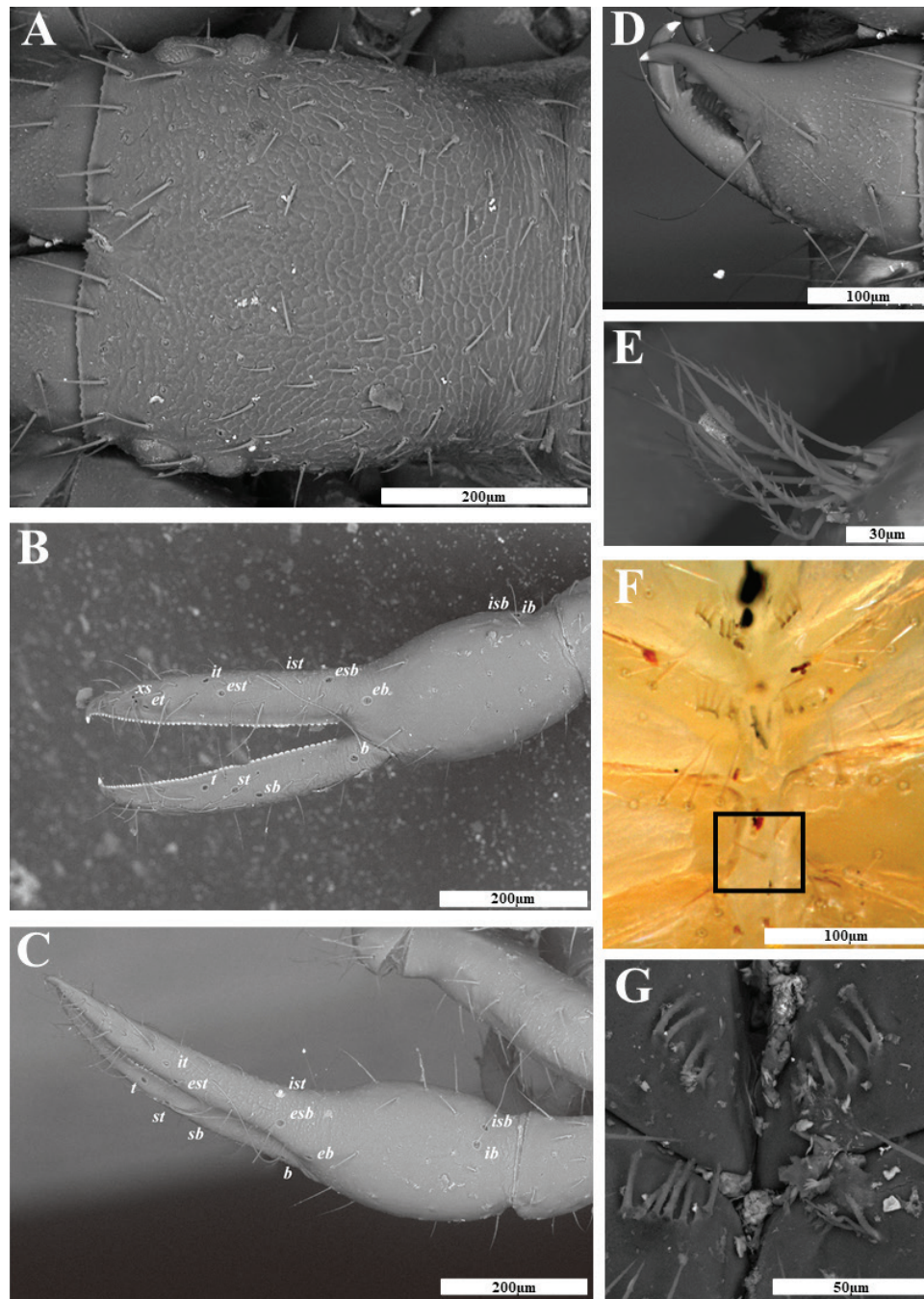
**Dimensions (in mm).** Body length 1.47; Pedipalp: trochanter 0.22/0.15, femur 0.48/0.13, patella 0.27/0.15, chela (with pedicel) 0.72/0.19, movable finger 0.45, hand 0.29/0.19; Chelicera: total 0.32/0.18, movable finger 0.17; Cephalothorax: Carapace 0.47/0.45, anterior eye

0.005, posterior eye 0.004; Leg I: trochanter 0.13/0.11, femur 0.27/0.07, patella 0.19/0.06, tibia 0.15/0.06, tarsus 0.27/0.05; Leg IV: trochanter 0.16/0.11, femur + patella 0.47/0.17, tibia 0.33/0.10, metatarsus 0.15/0.06, tarsus 0.28/0.04.

**Male, adult** (paratype, Fig. 2 C, D).

Same as the holotype, except slightly smaller (body length 1.291 mm).

**Pedipalp.** Trochanter 1.46 times, 3.54 times, patella 1.87 times, chela (with pedicel) 3.85 times, hand 1.47 times longer than broad, movable finger 1.56 times lon-



**Figure 4.** *Ditha shivanparaensis* sp. nov. **A.** Carapace, dorsal view; **B.** Left chela, lateral view; **C.** Left chela, dorsal view; **D.** Cheliceral, dorsal view; **E.** Rallum; **F.** Coxa (intercoxal tubercle in the circle); **G.** Coxal spine. Scale bars: 200 µm (**A–C**); 100 µm (**D, F**); 30 µm (**E**); 50 µm (**G**).

ger than hand; fixed finger with 50, movable finger with 48 teeth.

**Cephalothorax.** Carapace 1.06 times longer than broad; with 92 setae; 14 setae on the anterior margin, eight setae on the posterior margin; Coxal chaetotaxy: 10: 11: 11: 20. Coxa I with ca. 5–6 spines.

**Abdomen.** Tergal chaetotaxy, 10: 14: 15: 16: 19: 19: 19: 18: 16: 15: 13: 0. Sternal chaetotaxy, 10: 36: 6: 8: 10: 8: 13: 13: 11: 5: 2. Sternite II with nine total setae including six setae near the genital opening, sternite III with 38 total setae including 22 setae near the genital opening.

**Legs.** Leg I: trochanter 1.33 times, femur 3.65 times, patella 2.92 times, tibia 2.58 times, tarsus 5.80 times longer than broad; leg IV: trochanter 1.67 times, femur 2.39 times, tibia 3.47 times, metatarsus 2.57 times, tarsus 5.49 times longer than broad.

**Genitalia** (Fig. 31). Typical shape of the genus *Ditha*. 15 setae in the genital opening area, including nine on the center of the opening and three each on either side of the opening; ten setae on the sternite III; six setae on the anterior part of sternite III; four setae on the posterior region, and two setae each on the part of sternite III.

**Dimensions** (mm). Body length 1.29. Pedipalp: trochanter 0.19/0.13, femur 0.44/0.12, patella 0.24/0.13, chela (with pedicel) 0.64/0.17, movable finger 0.38, hand 0.24/0.17; Chelicera: total 0.30/0.16, movable finger 0.17; Cephalothorax: Carapace 0.42/0.39, anterior eye 0.005, posterior eye 0.004; Leg I: trochanter 0.12/0.09, femur 0.24/0.07, patella 0.16/0.06, tibia 0.39/0.09, tarsus 0.24/0.04; Leg IV: trochanter 0.18/0.11, femur + patella 0.40/0.17, tibia 0.31/0.09, metatarsus 0.14/0.05, tarsus 0.26/0.05.

**Variation of female paratypes (n=2). Pedipalp.** Trochanter 1.44–1.46 times, femur 3.46–3.68 times, patella 1.85–1.98 times, chela (with pedicel) 3.65–3.74 times, hand 1.48–1.52 times longer than broad, movable finger 1.43–1.44 times longer than hand. Movable finger with 48, fixed finger with 53–54 marginal teeth.

**Cephalothorax.** Carapace 1.04 times longer than broad. 96–100 setae.

**Abdomen.** Tergal chaetotaxy, 13–14: 21–23: 22–24: 24–25: 25–26: 23–25: 18: 15–16: 14–15: 0. Sternal chaetotaxy, 10: 10: 8: 7–8: 9–11: 8–10: 8–9: 10: 11–13: 4: 2.

**Legs.** Leg I: trochanter 1.20–1.34 times, femur 3.60–3.93 times, patella 2.61–2.64 times, tibia 2.47–2.77 times, tarsus 5.88–6.08 times longer than broad, leg IV: trochanter 1.59–1.66 times, femur 2.38–2.53 times, tibia 3.40–

3.55 times, metatarsus 2.17–2.29 times, tarsus 5.39–6.14 times longer than broad.

**Dimensions** (mm): Body length 1.33–1.41; Pedipalp: trochanter 0.21–0.22/0.15, femur 0.48–0.51/0.13–0.15, patella 0.28–0.30/0.15, chela 0.71–0.73/0.19–0.20, movable finger 0.41–0.43, hand 0.29–0.30/0.19–0.20; Chelicera: total 0.29–0.31/0.18–0.19, movable finger 0.18–0.19; Cephalothorax: carapace 0.46–0.47/0.45, anterior eye 0.005–0.006, posterior eye 0.004; Leg I: trochanter 0.12–0.13/0.10, femur 0.28/0.07–0.08, patella 0.17–0.19/0.07, tibia 0.14–0.16/0.06, tarsus 0.27/0.04–0.05; Leg IV: trochanter 0.21/0.13, femur + patella 0.43–0.44/0.17–0.18, tibia 0.35–0.37/0.10–0.11, metatarsus 0.14–0.15/0.06–0.07, tarsus 0.27–0.30/0.05.

**Distribution.** Currently known only from the type locality.

**Habitat.** The species was collected from moist leaf litter of montane ‘shola’ forests of the Mathiketan Shola National Park and is probably endemic to this mountain, although more field sampling is required to verify this.

**Erratum.** The sequences with GenBank accession numbers [OM792092.1](#), [OM832661.1](#) and [OM876917.1](#), previously attributed to the genus *Compsaditha* by Johnson et al. (2022), actually belong to the newly discovered species described herein as *Ditha shivanparaensis* sp. nov.

## Key to the species of *Ditha*

- 1 Intercoxal tubercle distinct; 10–12 accessory seta positioned on the cheliceral palm..... 2, subgenus *Ditha*
- Intercoxal tubercle indistinct or absent; 1–2 accessory seta positioned on the cheliceral palm..... 9, subgenus *Paraditha*
- 2 Cheliceral palm with less than six accessory setae..... 3
- Cheliceral palm with more than six accessory setae..... 4
- 3 Carapace with less than 100 setae ..... *D. proxima* (Beier, 1951) (Vietnam)
- Carapace with more than 100 setae..... *D. ogasawarensis* Sato, 1981 (Japan)
- 4 Carapace with less than 150 setae ..... 5
- Carapace with more than 150 setae..... 6
- 5 12 setae on the anterior margin of the carapace..... *D. novaeguineae* Beier, 1965 (Papua New Guinea)
- 14 setae on the anterior margin of the carapace..... *D. palauensis* Beier, 1957 (Palau)
- 6 Tergite I with 12 setae in male..... 7
- Tergite I with 21 setae in male..... *D. elegans* Chamberlin, 1929 (Indonesia)
- 7 14 setae on the anterior margin of the carapace..... *D. philippinensis* Chamberlin, 1929 (Philippines)
- 16 setae on the anterior margin of the carapace..... *D. loricata* Beier, 1965 (Indonesia)
- 8 Intercoxal tubercle absent ..... 10
- Intercoxal tubercle indistinct ..... 12
- 9 Intercoxal tubercle absent ..... 10
- Intercoxal tubercle indistinct ..... 12
- 10 Posterior margin of carapace with 8 setae ..... 11
- Posterior margin of carapace with 14 setae..... *D. marcusensis* (Morikawa, 1952) (Japan)
- 11 Carapace more than 70 setae..... *D. pahangica* Beier, 1955 (Malaysia)
- Carapace fewer than 70 setae..... *D. sumatraensis* (Chamberlin, 1923) (Indonesia)
- 12 Carapace with more than 100 setae..... *D. laosana* Beier, 1951 (Laos)
- Carapace with fewer than 100 setae ..... 13
- 13 Carapace with more than 70 setae..... 14
- Carapace with fewer than 70 setae ..... *D. sinuata* (Tullgren, 1901) (Cameroon)
- 14 Pedipalpal femur at least 4 times longer than broad ..... *D. latimana* (Beier, 1931) (Tanzania)
- Pedipalpal femur at least 4 times longer than broad ..... 15
- 15 Chelicera with 1 accessory setae ..... *D. tonkinensis* Beier, 1951 (Vietnam)
- Chelicera with 2 accessory setae ..... *D. shivanparaensis* sp. nov. (India)

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