https://doi.org/10.33307/entomon.v46i2.598
Entomon 46(2): 121-134 (2021)
Article No. ent. 46204

Revision of the Asian pseudoscorpion genus *Tullgrenius* Chamberlin, 1933 (Pseudoscorpiones: Atemnidae: Miratemninae), a tale of intraspecific variation

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ABSTRACT: The Asian pseudoscorpion genus *Tullgrenius* Chamberlin, 1933 is revised. A neotype is designated for *Tullgrenius indicus* Chamberlin, 1933, based on topotype material and a detailed description of its male is provided. Two new synonymies are proposed: *Tullgrenius vachoni* Murthy, 1962 **syn. nov.** and *Tullgrenius orientalis* Sivaraman, 1980 **syn. nov.** = *T. indicus*. Two distinct colour morphs of *T. indicus* are recognized: a brown and black morph. Supplementary descriptions and illustrations for *Tullgrenius afghanicus* Beier, 1959 and *Tullgrenius compactus* Beier, 1951 are detailed with current distribution of all the known *Tullgrenius* spp..

KEYWORDS: Morphology, neotype, synonymies, Western Ghats, India

INTRODUCTION

The family Atemnidae Kishida, 1929 represents a small family of pseudoscorpions currently having 21 extant and 1 extinct genera, the latter is from a Baltic amber (Beier 1955). Members of the family are bark- as well as litter-dwellers and are grouped into two subfamilies: Atemninae Kishida, 1929 with 15 genera and Miratemninae Beier, 1932 with six genera (Harvey 2013).

The genus *Tullgrenius* Chamberlin, 1933 of Miratemninae, which is restricted to the Oriental region (Harvey 2013), was established by Chamberlin (1933) as a monotypic taxon with the single species, *T. indicus*. Beier (1951) identified the specimen collected by Dawydoffi from Cambodia during the Indochina Expedition (1938–1939) as *T. compactus*. Later Beier (1959) identified *T. afghanicus* from the collections made by J. Klapperich during the Afghanistan Expedition (1952–1953). In 1962, Murthy described *T. vachoni* from Krusadai Island in the Gulf of Mannar Marine National Park and later, Sivaraman (1980) added *T. orientalis* from Tambaram, Tamil Nadu to the genus.

The unidentified pseudoscorpion specimens in the collections of Murthy and specimens of *T. indicus* collected by Sivaraman (1982), all the specimens are preserved at Loyola College, Chennai, Tamil Nadu were examined. Even though Sivaraman (1980) provided the type locality of his specimens, he never mentioned specific locations. Klausen (2005) collected *Tullgrenius* specimens from south India and identified them as *T. indicus* (Klausen,

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personal communication). Murthy (1983) collected specimens of *T. indicus* from Loyola College campus.

Murthy and Ananthakrishnan (1977) as well as Sivaraman (1980) identified *T. orientalis* based on the length of the pedipalpal segments and trichobothrial positions and ignored the genital features for identification. Chamberlin (1933) and Klausen (2005, 2009) provided good illustrations of male genitalia of *T. indicus*. The inconsistencies in the literature of Sivaraman (1980) and Murthy (1962) indicate that the species classification is not reliable.

The current investigation intends to explain the taxonomy of Indian *Tullgrenius* by comparing the male genital features rather than relying on the variable characters such as length of pedipal segments, rallum of chelicerae, position of trichobothria, which were considered for delineating the species in the past by Indian authors.

MATERIALS AND METHODS

Tullgrenius species were collected from a radius of 30 km, in and around the Nungambakkam City in Tamil Nadu. Perceiving the similarity of these specimens with *T. indicus*, collected *Tullgrenius* specimens from the Eastern Ghats and other regions of Tamil Nadu.

The type specimens of V.A. Murthy collections (VAM colls.) and Sivaraman which were deposited in the museum of Department of Zoology, Loyola College, Chennai are missing and were confirmed with personal observation and communication with S. Sivaraman and D. Sudarsanam. Thus, the revision of topotypes will end the ambiguity in the identity of the species. As the type specimens of *T. indicus*, *T. orientalis* and *T. vachoni* are lost, topotype materials were collected for redescription and the genitalia were examined in detail. All the accessible materials in the genus (113 ♂♂, 87 ♀♀) were examined and also the detailed study of the genitalia is prepared on the basis of the newly collected specimens from India. Moreover, two species, *T. vachoni* and *T. orientalis* are regarded as new synonymies of *T. indicus*. Additional illustrations and measurements are provided for *T. compactus* and *T. afghanicus*.

The specimens were preserved in 70 per cent ethanol and studied under a Leica M205C, a Zeiss Stemi SV 6 and a Nikon SMZ25 stereomicroscopes and a Nikon ECLIPSE Ni compound microscope. Drawings were made by the aid of a drawing tube. Photographs were taken in a JEOL Model JSM-6390 LV scanning electron microscope available at the Sophisticated Test & Instrumentation Centre (STIC) facility of Cochin University of Science and Technology (CUSAT), Cochin, Kerala, India. All measurements are in millimeters (mm). The specimens are lodged in the Division of Arachnology, Department of Zoology, Sacred Heart College, Thevara, Cochin, Kerala, India (ADSH) 110 ♂♂, 83 ♀♀, Loyola College, Chennai 2 ♂♂, Muséum d'Histoire Naturelle, Geneva (MHNG) 1♂, 1♀ and Naturhistorisches Museum Wien, Vienna (NHMW) 3♀♀. The holotypes are deposited in the MHNG and NHMW. For morphometric analysis, PCA was done using XLSTAT.

Morphological terminology and mensuration follow Chamberlin (1931), Harvey (1992), Judson (2007) and Harvey *et al*. (2012). The following trichobothrial abbreviations were used: *eb* = external basal; *esb* = external sub-basal; *ib* = internal basal; *isb* = internal sub-basal; *ist* = internal sub-terminal; *est* = external sub-terminal; *it* = internal terminal; *et* = external terminal; *t* = terminal; *st* = sub-terminal; *b* = basal; *sb* = sub-basal.

RESULTS AND DISCUSSION

Taxonomy

Family Atemnidae Kishida, 1929

Subfamily Miratemninae Beier, 1932

Genus *Tullgrenius* Chamberlin, 1933

(Figs. 1-7)

Tullgrenius Chamberlin, 1933: 263; Murthy and Ananthakrishnan, 1977: 133; Sivaraman, 1980: 359; Harvey, 1991: 481.

Type species *Tullgrenius indicus* Chamberlin, 1933, by original designation.

Redefinition and diagnosis

Rallum with four serrated blades. Chelicera with 5 setae, *bs*, *sbs* and *es* subequal in length and terminally or subterminally denticulate. Basal teeth of serrula exterior longer than the rest. Chaetotaxy of chela unique, Fixed chelal finger with 8 trichobothria: *est* almost basal in position and twice as far from *et* as from *esb*; *eb* and *esb* separated by one areolar diameter; *it*, *ist*, *isb* and *ib* clustered at base of finger; movable chelal finger with 4 trichobothria: *sb* and *st* situated diagonally opposite to *b*; *t* situated medially. Tergites with dentate setae; sternites with pointed setae. *est* almost basal in position and twice as far from *et* as from *esb*. *eb* and *esb* apart by one areolar diameter. *sb* and *st* diagonally opposite to *b*. *it*, *ist*, *isb* and *ib* are clustered at the base. Carapacal furrow indistinct. Carapace, tergites and pedipalps granulated. Eye spots distinct. Tarsus IV with a pseudotactile seta, one third of the segment length removed from its base.

Distribution: Asia, including Afghanistan, Cambodia, India, and Thailand (Fig. 7).

Tullgrenius indicus Chamberlin 1933 (Figs. 1–4)

Tullgrenius indicus Chamberlin 1931: 115, figs. 27b and 143, fig. 38n (illustrations of palp and chela); Chamberlin 1933: 264, fig. a (description and illustration of genitalia ♂); Roewer, 1937: 287; Murthy and Ananthakrishnan 1977: 133–134 (distribution of the species); Sivaraman & Murthy 1980: 163–167, fig. 1a–b (description and illustrations of pedipalp and chela ♀); Sivaraman, 1982: 187–194, fig. 3a–e (illustrations of chela of protonymph, deutonymph, tritonymph, male and female); Harvey, 1991: 481; Klausen 2005: 642, fig. 7 (illustration of male genitalia and distribution); Klausen, 2009: figs. 11, 15–16 (surface texture of carapace, illustrations of male and female genitalia).

Tullgrenius vachoni Murthy, 1962: 62–65, figs. a–b (description and illustrations of pedipalp and chela ♂); Beier 1974: 1010 (distribution of the species); Murthy & Ananthakrishnan, 1977: 134 (distribution of the species), **syn. nov.**

Tullgrenius orientalis Sivaraman, 1980: 359–362, fig. 7a–b (description and illustrations of pedipalp and chela ♀), **syn. nov.**

Material examined

Neotype (here designated)

INDIA: *Tamil Nadu*: 1 ♂ (ADSH PS0108), Kancheepuram, Guindy [13º00'41"N 80º13'45"E], 18 m a.s.l., 22 January 2019, M.V. Aneesh leg., under bark of *Azadirachta indica*, by hand.

Other materials

INDIA: *Andhra Pradesh*: 6 ♂♂, 2 ♀♀ (ADSH PS0110) Vijayawada [16º30'3"N 80º38'17"E], 20 m a.s.l., 10 October 2019; M.V. Aneesh leg., under bark of *Azadirachta indica*, by hand; ***Karnataka*:** 3♂♂, 3♀♀ (ADSH PS0111) Shivamoga [13º59'45"N 75º27'55"E], 690 m a.s.l., 31 Jan. 2020; M.V. Aneesh leg., under bark of *Tamarindus indica,* by hand; ***Kerala*:** 1♀ (Loyola College) Kollam, Kulathupuzha, 21 Feb. 1982, 3 ♂♂, 2 ♀♀ (ADSH PS0118) Theni [9º59'20"N 77º27'37"E], 300 m a.s.l., 31 July 2019, M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand;- ***Tamil Nadu*:** 9 ♂♂, 6 ♀♀ (ADSH PS0112) Coimbatore, Karunya nagar [10º56'12"N 76º44'22"E], 460 m a.s.l., 15 October 2019, M.V. Aneesh leg., under bark, 4♂♂, 2♀♀ (ADSH PS0113) Coimbatore, [11º7'4"N 77º1'47"E], 390 m a.s.l., 15 October 2019, M.V. Aneesh leg., under bark, 9 ♂♂, 5 ♀♀ (ADSH PS0114) Dindigul, [10º8'56"N 78º12'44"E], 300 m a.s.l., 31 July 2019, M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand, 16 ♂♂, 8 ♀♀ (ADSH PS0123) Kancheepuram, Tambaram [12º55'10"N 80º7'24"E], 40 m a.s.l., 10 December 2018, M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand, 16 ♂♂, 15 ♀♀ (ADSH PS0109) same data as for neotype; "22 January 2019", 1 ♂ (Loyola College) Kattupakkam, 26 March 1980, 1 ♂ (Loyola College) Madras, Tambaram, 27 July 1976, S. Sivaraman leg., under bark, 1 ♂ (MHNG)

Madras (now Chennai), Tambaram, 27 July 1976, S. Sivaraman leg., under bark, 1 ♀ (MHNG) Madras (now Chennai), Anamalai hills, Aliyar Dam, 550 m a.s.l., Besuchet C. and Lobl I. leg. 17 November 1932, 1 ♀ (NHMW 25185) Madras (now Chennai), Murthy leg., 5 ♂♂, 4 ♀♀ (ADSH PS0115) Madurai, [10º0’10"N 78º11’3"E], 140 m a.s.l., 30 July 2019 M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand, 2 ♂♂, 4 ♀♀ (ADSH PS0116; Madurai, 10º4’15"N 78º12’51"E, 230 m a.s.l., 30 July 2019 M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand, 3 ♂♂, 4 ♀♀ (ADSH PS0122) Rameswaram, Krusadai Island, [9º14’49"N 79º12’47"E] m a.s.l., 17 April 2019, M. V. Aneesh leg., under bark of tree, by hand, 6 ♂♂, 4 ♀♀ (ADSH PS0118) Tiruvallur, Avadi [13º8’8"N 80º6’10"E], 30 m a.s.l., 12 December 2018, M.V. Aneesh leg., under bark *Tamarindus indica*, by hand, 4 ♂♂, 6 ♀♀ (ADSH PS0119) Tirunelveli [8º54’9"N 77º20’7"E], 170 m a.s.l., 29 July 2019, M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand, 7 ♂♂, 3 ♀♀ (ADSH PS0120) Vinayaganallur, Kancheepuram [12º45’35"N 80º14’40"E], 10 m a.s.l., 12 August 2019, M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand, 2 ♂♂, 1 ♀ (ADSH PS0121) Viluppuram [11º42’4"N 78º56’22"E], 120 m a.s.l., 9 August 2019, M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand, 16 ♂♂, 13 ♀♀ (ADSH PS0117) Yercaud, Kanavaipudur [11º54’44"N 78º11’1"E], 490 m a.s.l., 29 March 2018, 02 April 2018 & 01 May 2018, M.V. Aneesh leg., under bark of *Tamarindus indica*, by hand.

Differential diagnosis

Tullgrenius indicus can be separated from *T. afghanicus* by the stouter nature of chela [chela (with pedicel) 2.47–2.75 (♀) x longer than broad] whereas in *T. afghanicus* it is less stout [2.85 (♀) x longer than broad]. The pedipalpal chela of *T. indicus* has 48–51 (♀) teeth on the fixed finger and 47–53 (♀) teeth on the movable finger, whereas *T. afghanicus* has 39 (♀) on the fixed and 44 (♀) on the movable finger. *T. indicus* can be separated from *T. afghanicus* by its stouter femur + patella of leg IV [femur + patella 2.06–2.15 x longer than deep] whereas in *T. afghanicus* it is slender [femur + patella 2.37 x longer than deep]. *T. indicus* can be separated by its longer pedipalpal chela [che1a (with pedicel) 1.807–1.904 (♀), chela (without pedicel) 1.700–1.792 (♀] than *T. compactus* [chela (with pedicel) 1.129 (♀), chela (without pedicel) 1.036 (♀)].

Redescription

Chelicera (Figs. 2C, 3A to F, 4A, D, E): all five setae of palm well developed; base of palm moderately granulated (Fig. 2C), with exterior and interior condylar lyrifissures and exterior and interior lyrifissures; *ib*, *isb* and *eb* short and terminally dentate. Lamina interior reduced, lamina exterior thin. Fixed finger with four marginal serrate teeth (Fig. 4A). Rallum with four serrate blades, increasing in length from proximal to distal (Figs. 3D to F). Serrula exterior with 20–21 (♂), 17–19 (♀) blades (Figs. 3A, B). Galea long with four terminals and two sub-terminal rami in males, five terminals and one subterminal in females (Figs. 3C, 4D, E).

Pedipalps (Fig. 2A, B, D): trochanter and femur granulated, except ventral surfaces; small setae terminally dentate on entire pedipalp, long setae acuminate. Patella heavily granulated retrolaterally, remainder finely granulated. Chelal hand heavily granulated retrolaterally, remainder finely granulated. Dorsal tubercle of trochanter well developed (Fig. 2D); trochanter 1.27–1.37 (♂), 1.18–1.56 (♀) x longer than broad. Femur 1.86–1.96 (♂), 1.68–1.90 (♀) x longer than broad. Patella 1.68–1.84 (♂), 1.67–1.78 (♀) x longer than broad. Chela with pedicel 2.63–2.80 (♂), 2.47–2.75 (♀) x longer than broad; fixed finger with 45–48 (♂), 48–51 (♀) teeth, movable finger with 51–56 (♂), 47–53 (♀) teeth. Fixed chelal finger with 8 trichobothria: *est* almost basal in position and twice as far from *et* as from *esb*; *eb* and *esb* separated by one areolar diameter; *it*, *ist*, *isb* and *ib* clustered at base of finger; movable chelal finger with 4 trichobothria: *sb* and *st* situated diagonally opposite to *b*; *t* situated medially (Figs. 2A, B).

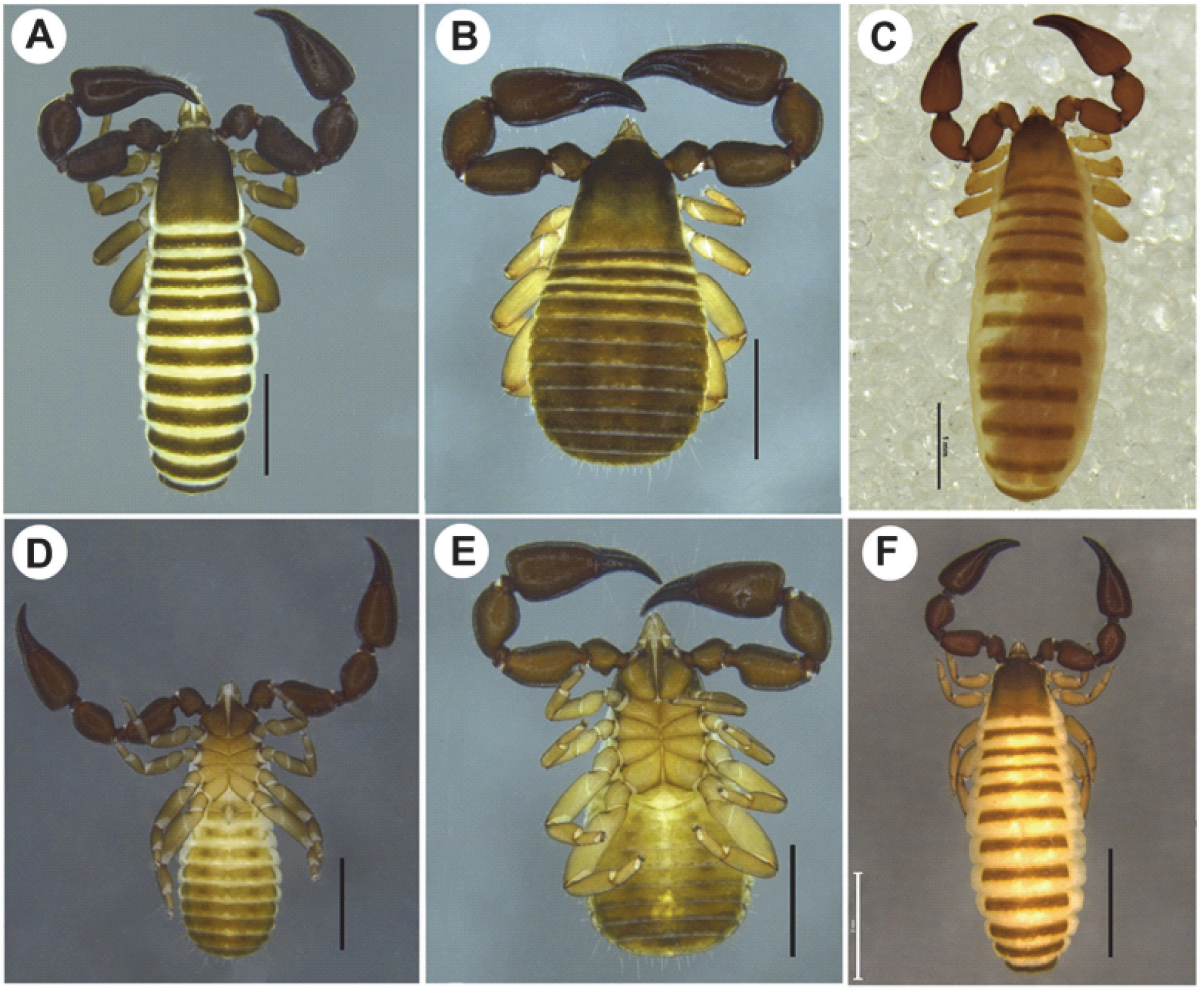

Fig. 1 *Tullgrenius indicus* - A. male Neotype, dorsal view; B. female dorsal view; C. female dorsal view (NHMW 25185); D. male Neotype, ventral view; E. female ventral view; F. female dorsal view (ADSH PS0112). Scale bars: A–D, 1mm.

Carapace (Fig. 3H to I): 0.94–1.18 (♂), 1.0–1.05 (♀) x longer than broad, granulated with two distinct eye spots, with two indistinct furrows (Fig. 3I), with ca. 42 (♂), 38 (♀) setae, including 4 at anterior margin and 9 near posterior margin. Vestitural setae terminally dentate (Fig. 3H).

Coxal region: maxillary lyrifissures situated medially. Coxal chaetotaxy: ♂, 7: 8: 4: 5: 9, ♀, 5: 7: 5: 6: 9.

Legs (Figs. 4B, C): light brown, granulated anterolaterally, with long, acuminate setae and small, terminally dentate setae, articulation between femur and patella oblique of Leg III and IV. Leg I (Fig. 4C): trochanter 0.97–0.98 (♂), 0.82–0.87 (♀), femur 0.89–0.97 (♂), 0.88–0.90 (♀), patella 1.67–1.80 (♂), 1.71–1.82 (♀), tibia 2.65–2.48 (♂), 2.55–2.63 (♀), tarsus 2.66–2.95 (♂), 2.71–2.81 (♀) x longer than broad. Leg IV (Fig. 4D): femoral lyrifissure present; trochanter 1.51–1.55 (♂), 1.53 (♀), femur+patella 2.12–2.20 (♂), 2.06–2.15 (♀), tibia 2.93–3.11 (♂), 3.02–3.16 (♀), tarsus 2.70–2.92 (♂), 2.62–2.95 (♀) x longer than broad; tactile seta situated one third of the tarsus from its base, TS=0.32.

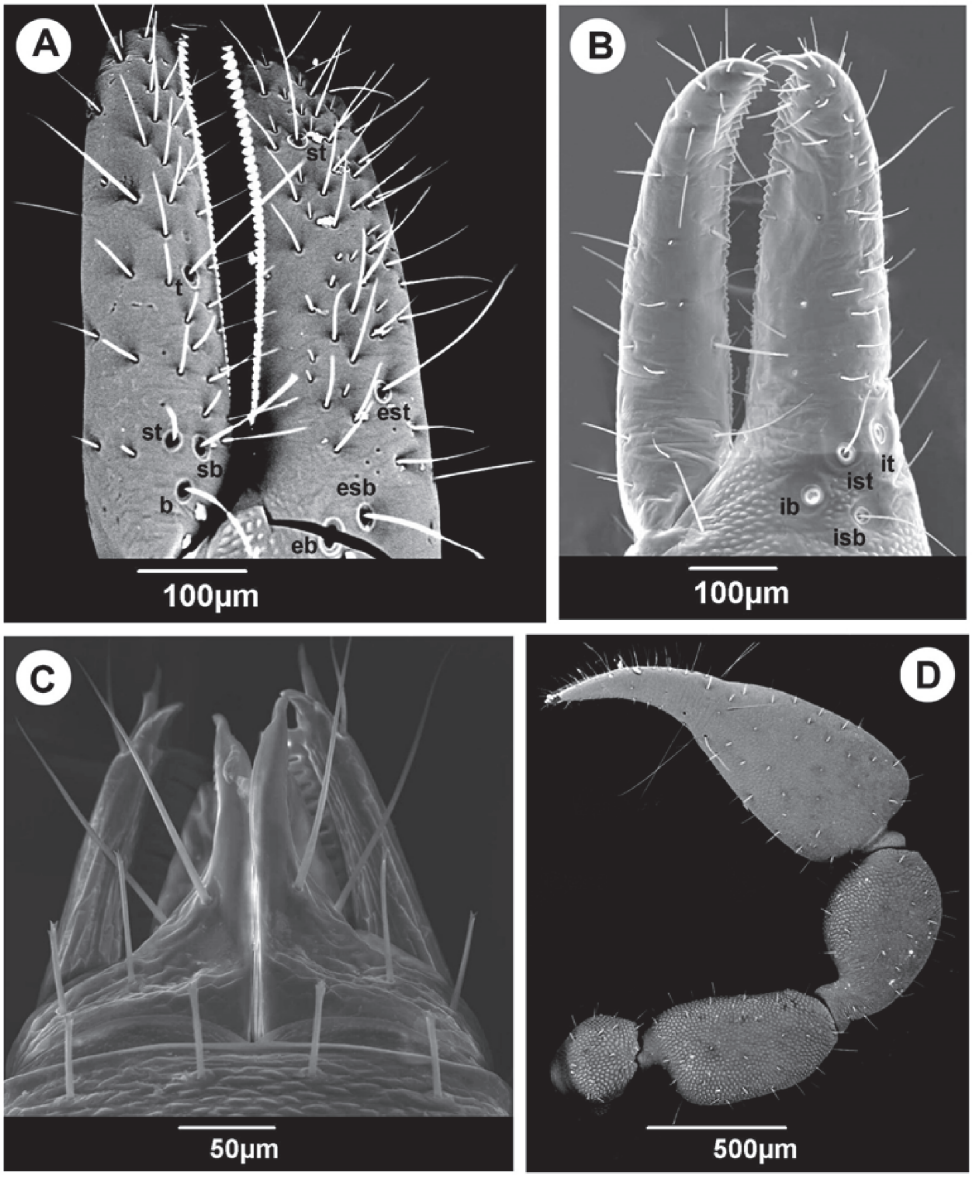

Fig. 2 *Tullgrenius indicus* male. A. Left chela; B. Right chela; C. Chelicerae; D. Right Pedipalp

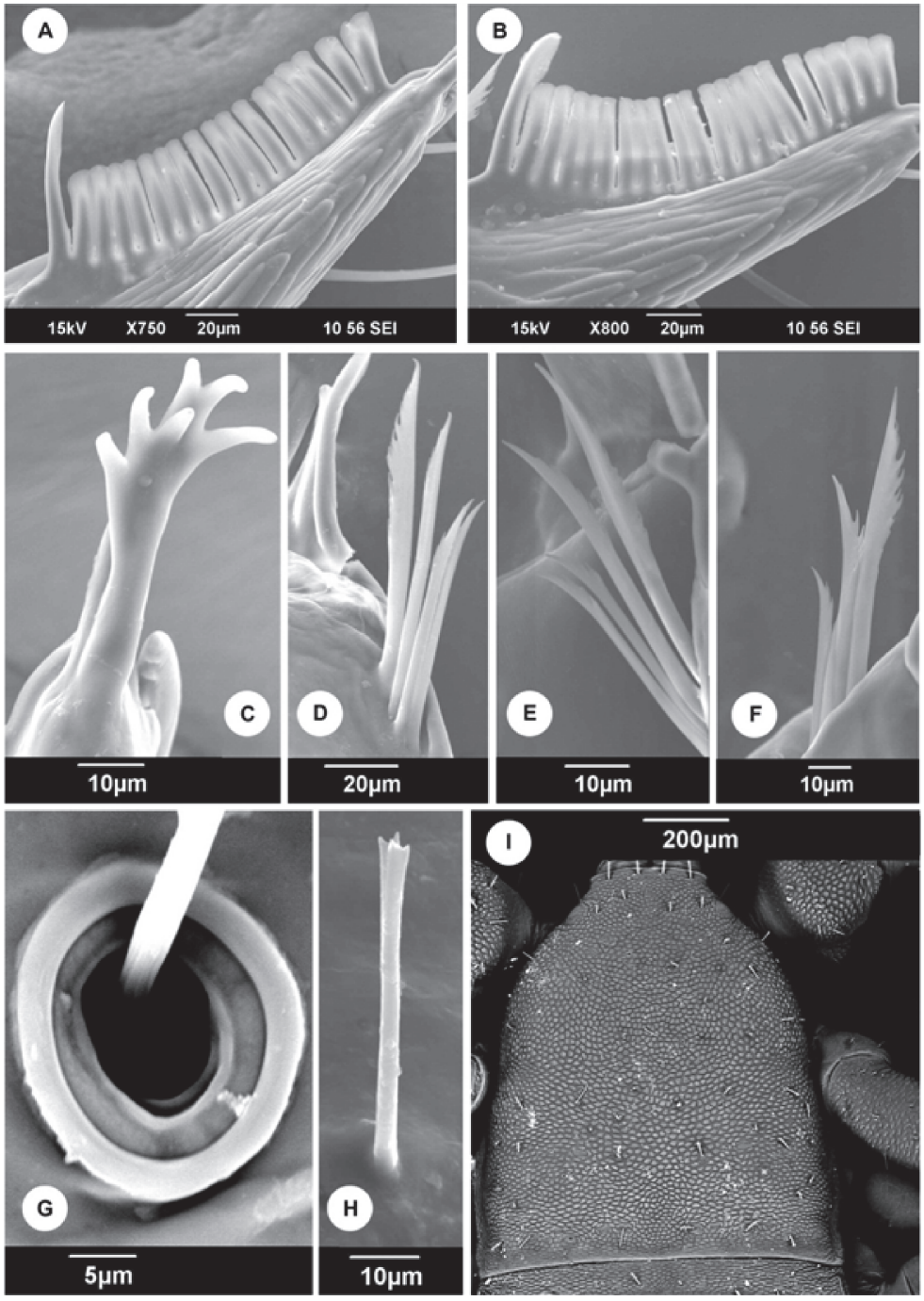

Fig. 3 *Tullgrenius indicus* female. A. Serrula exterior of female; B. Serrula exterior; C. Galea; D to F - Rallum of left chelicera; G. Arolium of *ist*; H. Terminally dentate setae on carapace; I. Carapace

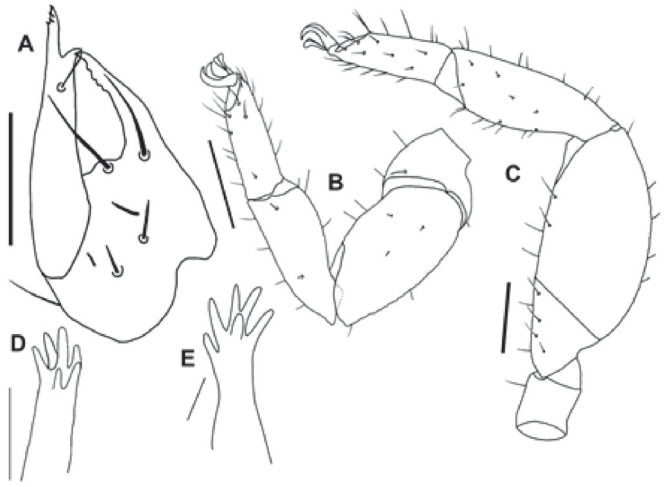

Fig. 4 *Tullgrenius indicus* male (A–E). A. Rallum; B. Left chelicera; C. Left leg I, lateral; D. Left leg IV, lateral; E. Left galea; F. Left galea of female. Scale bars: A–F, 0.2mm

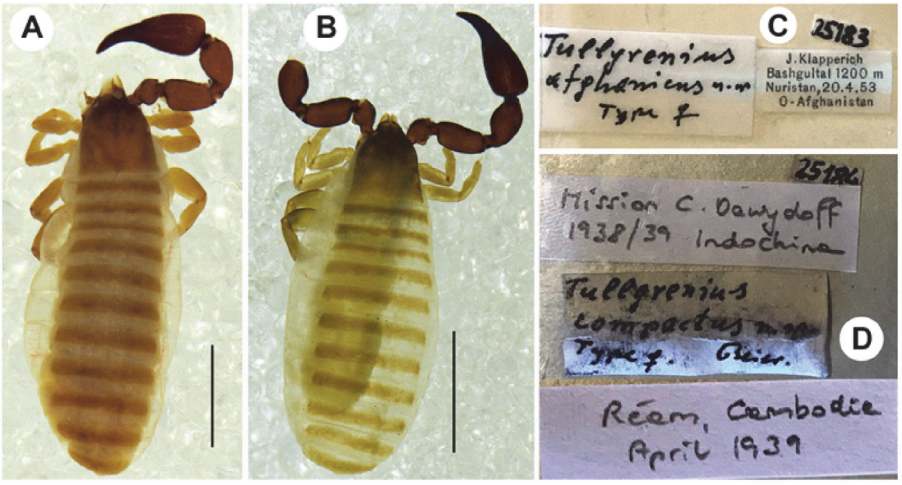

Fig. 5 A - *Tullgrenius compactus* female holotype; B - *Tullgrenius afghanicus* female holotype; C - Original label of *T. afghanicus;* D - Original label of *T. compactus*. Scale bars: A–B 1 mm

Opisthosoma (Figs. 1A to F): tergites granulated, with two thick brown patches, one on either side of tergites II and IV to X, which are said to be muscular insertions (Judson, pers. comm.) (Fig. 1A, B, E, F). Tergal chaetotaxy: ♂, 7–9: 8: 10: 10(2): 10(2): 8-–11(2): 8–10(2): 8–9(2): 8(2): 9–11 (including 4 tactile setae): 8-–11 (including 4 tactile setae): 2, ♀, 10: 10: 12: 10–12(2): 12(2): 12(2): 12–13(2): 12(2): 12(2): 13–15 (including 4 tactile setae): 12–13 (including 2 tactile setae): 2; small setae terminally dentate and tactile setae acute. Sternites IV to X with thick brown patches, one on either side (Figs. 1C, D). Sternal chaetotaxy: ♂, 7: 7: 8: 10: 9: 11: 10: 11: 11 (including 2 tactile setae): 10 (including 4

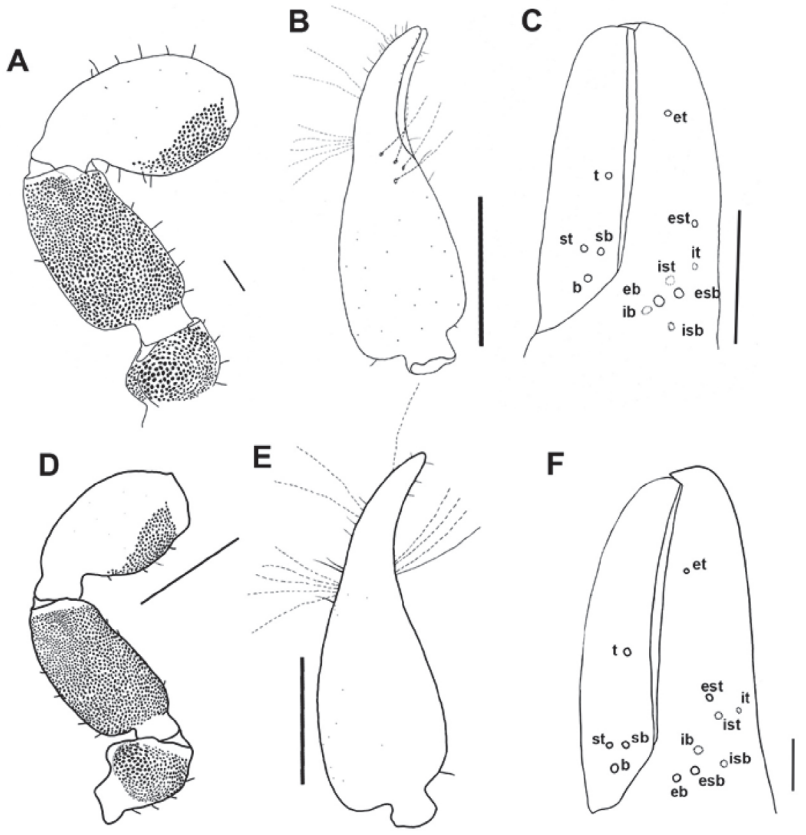

Fig. 6 *Tullgrenius compactus* (A–C). *Tullgrenius afghanicus* (D–F). A - Left pedipalp; B - Left chela; C - Left chela without hand; D - Left pedipalp; E - Left chela; F - Left chela without hand. Scale bars: A, F 0.1mm, C 0.2mm, B, D–E0.5mm

Table 1. Morphometric data revealing morphological variations among the three *Tullgrenius* species

Species	Patella	Femur	Chela with pedicel	Serrula exterior	Femur ratio	Patella ratio
T. indicus	0.958	0.936	2.47	17	1.68	1.7
T. indicus	0.972	0.956	2.75	19	1.96	1.78
T. indicus	0.921	0.907	2.6	18	1.72	1.78
T. compactus	0.596	0.566	2.6	17	1.9	1.8
T. afghanicus	0.772	0.796	2.85	17	2.2	1.9
T. indicus	0.962	0.946	2.68	19	1.76	1.7
T. indicus	0.942	0.921	2.55	19	1.82	1.76
T. indicus	0.953	0.938	2.67	19	1.8	1.78
T. indicus	0.946	0.923	2.65	17	1.7	1.74
T. indicus	0.956	0.929	2.7	19	1.76	1.67
T. indicus	0.966	0.949	2.5	19	1.76	1.7
T. indicus	0.91	0.902	2.7	17	1.74	1.74
T. indicus	0.917	0.904	2.65	19	1.62	1.7
T. indicus	0.938	0.919	2.54	19	1.6	1.7

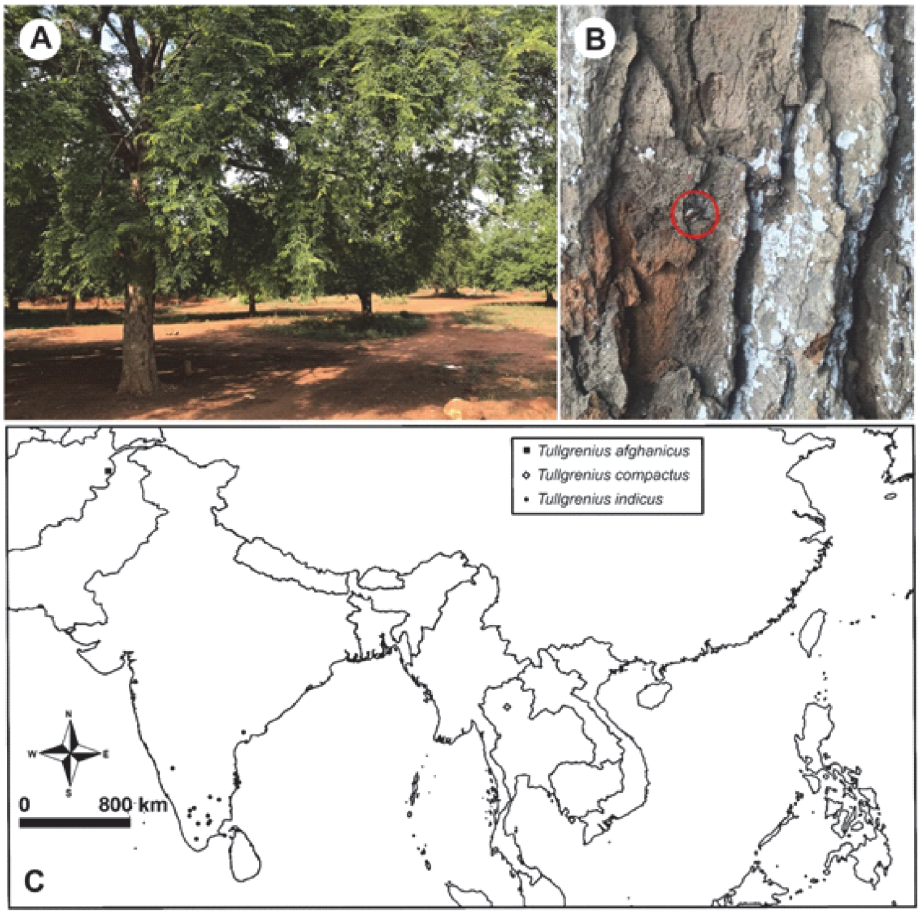

Fig. 7 A, B - Habitat of *Tullgrenius indicus*; C. Geographic distribution of known *Tullgrenius* spp.

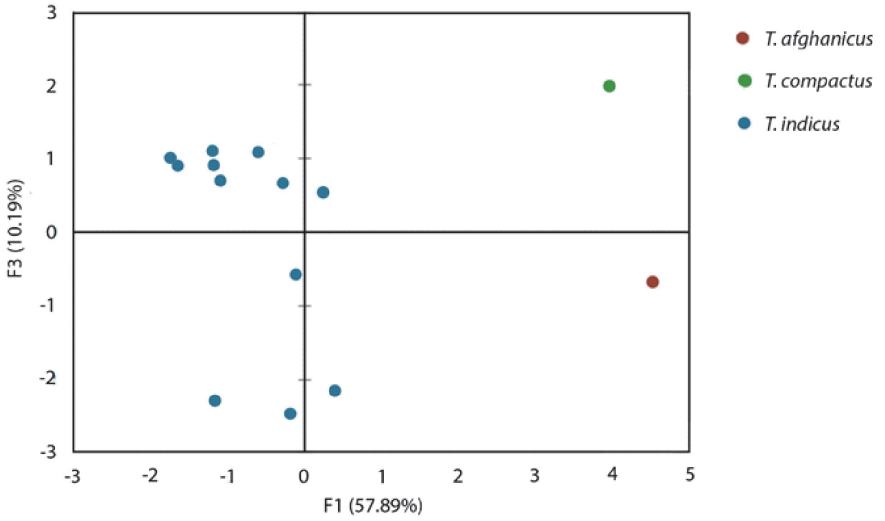

Fig. 8 Principal Component Analysis of morphological features obtained from the three known *Tullgrenius* species

tactile setae): 2, ♀, 6: 8: 10(2): 10(2): 12(2): 9–12(2): 11–13(2): 10–13(2): 13–14 (including 4 tactile setae): 13–14 (including 4 tactile setae): 2; all setae acute.

Measurements. *Males*: neotype followed by other males in parentheses: body length 3.5 (3.011–3.889). Carapace 0.988/1.030 (1.072–1.167/0.951–1.119). Pedipalps: trochanter 0.454/0.331 (0.408–0.598/ 0.380–0.439), femur 0.828/0.445 (0.802–0.921/ 0.437–0.511), patella 0.829/0.492 (0.789–0.928/ 0.446–0.532), chela (with pedicel) 1.599/0.576 (1.440–1.767/0.530–0.685), chela (without pedicel) 1.524/0.576 (1.359–1.662/0.530–0.685), hand (with pedicel) 0.855 (0.833–1.053), hand (without pedicel) 0.764 (0.751–0.939), movable finger 0.705 (0.625–0.816). Leg I: trochanter (0.182–0.210/0.187–0.213), femur 0.190/0.237 (0.256–0.278/0.262–0.311), patella 0.418/0.245 (0.474–0.502/0.263–0.30), tibia 0.419/0.156 (0.434–0.517/0.175–0.195), tarsus 0.345/0.106 (0.314–0.405/0.114–0.118). Leg IV: trochanter (0.313–0.358/0.201–0.236), femur+patella 0.818/0.379 (0.873–1.061/0.410–0.481), tibia 0.633/0.226 (0.682–0.832/0.232–0.264-), tarsus 0.424/0.145 (0.424–0.463/0.145–0.171).

Female: body length 3.05–4.38. Carapace 1.00–1.07/0.996–1.066. Pedipalps: trochanter 0.418–0.432/0.444–0.454, femur 0.907–0.936/0.531–0.552, patella 0.958–0.972/0.563–0.574, chela (with pedicel) 1.807–1.904/0.695–0.728, chela (without pedicel) 1.700–1.792/0.695-0.728, hand 0.922–1.102, movable finger. 0.797–0.896. Leg I: trochanter 0.150–-0.172/0.181–0.196, femur 0.212–0.218/0.240–0.249, patella 0.410–0.416/ 0.225–0.242, tibia 0.403–0.417/0.158, tarsus 0.318/ 0.113–0.117. Leg IV: trochanter 0.323–0.338/ 0.211–0.220, femur + patella 0.797–0.836/0.386–0.388, tibia 0.648–0.672/0.212–0.214, tarsus 0.388–0.396/0.134–0.148.

Remarks

Chamberlin (1933) doubted about a missing trichobothria, *t* on the movable finger of *T. indicus*. Later, Beier (1951) corrected this and suggested that the missing of trichobothria could not be considered as the characteristics of *Tullgrenius* species. Murthy (1962) described *T. vachoni* based on a single male holotype. Even though he mentioned one female allotype, he did not describe it. Without providing the details of males other than holotype, Murthy (1962) presented a range for pedipalpal measurements of *T. vachoni* in the description, which is confusing as the measurements of paratypes are not mentioned. He separated *T. vachoni* from *T. indicus*, based on the length of the patella and femur of pedipalp. In the present study, it was confirmed that the difference in the length of the patella and femur of pedipalp could not be considered as a significant feature to separate *Tullgrenius* species. Beier (1974) suggested that *T. vachoni* might be a junior synonym of *T. indicus* and is confirmed in the present study by examining the male genitalia of *T. vachoni*–medial diverticula reduced, two lateral lobes, ventral diverticulum with hood-like appearance (Klausen, 2005: Fig. 7). Sivaraman (1980) separated *T. orientalis* from *T. indicus* by comparing the length of the femur and patella of pedipalp and the nature of the flagellum. All the specimens collected in the present study had the femur longer than patella or of equal in length. From the morphological, morphometric and genital characters, it is confirmed that *T. orientalis* is a junior synonym of *T. indicus*. From the present study, it is clear that the chaetotaxy of the movable finger is complete (Fig. 2A) and the position of the trichobothria is considered to the generic level. The nature of the galea in both sexes are found stable (Figs. 2C, 4E, F). Serrula exterior of all the observed specimens showed variations (17–20) and is not considered significant to delineate species. Murthy (1962) and Sivaraman (1980) observed a second and a third flagella serrated. In the present study, it is confirmed as an intraspecific variation (Figs. 3D to F, 4A). The black coloured form (Figs. 1A to D) is considered as a colour morph of the brown form (Figs. 1E, F).

Note

The specimen of *T. orientalis* deposited in MHNG is designated as paratype, dated 27 July 1976, collected from Tambaram, Madras, is probably not a paratype.

***Tullgrenius compactus* Beier, 1951** (Figs. 5A, C, 6A, B)

Type material. Holotype. CAMBODIA: 1 ♀ (NHMW 25184), Riem [10º30'12"N 103º37'24"E], April 1939, C. Dawydoff leg., examined.

Differential diagnosis

T. compactus can be separated from other species of the genus by its longer pedipalpal chela [chela (with pedicel) 1.480 (♀), chela (without pedicel) 1.381 (♀)] than *T. afghanicus* [chela (with pedicel) 1.129 (♀), chela (without pedicel) 1.036 (♀)]. The pedipalpal chela of *T. compactus* has 44 (♀) teeth on the fixed finger and 47 (♀) teeth on the movable finger [whereas, it is 39 (♀) teeth on the fixed finger and 44 (♀) teeth on the movable finger of *T. afghanicus*].

Redescription

Chelicera: all five setae well developed; base of palm fairly granulated, *ib*, *isb*, *eb* short and terminally dentate. Lamina interior reduced, exterior thin. Fixed finger with four marginal serrations. Serrula exterior with 17 (♀) blades.

Pedipalps (Fig. 6A to C): reddish-brown; trochanter and femur granulated, except ventral; patella granulated retrolaterally, rest finely granulated. Chelal hand heavily granulated retrolaterally, remainder finely granulated. Dorsal tubercle of trochanter well developed (Fig. 6A); trochanter 1.47 x longer than broad. Femur 1.86 x longer than broad. Patella 1.79 x longer than broad. Chela with pedicel 2.61 x longer than broad; fixed finger with 44 teeth, movable finger with 47 teeth. *eb* and *esb* apart by one areolar diameter. *sb* diagonally opposite to *st*. *it*, *ist*, *isb* & *ib* are clustered at the base (Fig. 6C). Small setae terminally dentate, long setae acuminate.

Carapace: 0.93 x longer than broad, granulated, with two distinct eye spots, with two indistinct furrows, with ca. 38 setae, including 4 at anterior margin and 8 near to posterior margin. Vestitural setae terminally dentate.

Legs: brownish, granulated antero-laterally, with acuminate long setae and terminally dentate small setae, articulation between femur and patella oblique of Leg III and IV. Leg I: femur 0.760, patella 1.89, tibia 2.60, tarsus 2.80 x longer than broad. Leg IV: femur+patella 2.45, tibia 3.08, tarsus 2.69 x longer than broad; tactile seta situated one third of the tarsus from its base.

Measurements. *Female*: body length 3.737. Carapace 0.862/0.921. Pedipalps: trochanter 0.367/0.250, femur 0.566/0.303, patella 0.596/0.332, chela (with pedicel) 1.129/0.431, chela (without pedicel) 1.036/0.431, hand 0.560, movable finger 0.517. Leg I: femur 0.111/0.146, patella 0.321/0.169, tibia 0.305/0.117, tarsus 0.227/0.081. Leg IV: femur+patella 0.546/0.222, tibia 0.456/0.148, tarsus 0.267/0.099.

***Tullgrenius afghanicus* Beier, 1959** (Figs. 5B, D, 6C, D)

Type material. Holotype. AFGHANISTAN: Nuristan Province: 1 ♀ (NHMW 25183), Bashgultal, [34º56'56"N 70º57'34"E], 1200 m a.s.l., 20 April 1953, J. Klapperich leg., examined.

Differential diagnosis

T. afghanicus can be separated from other species of the genus by its shorter pedipalpal chela [chela (with pedicel) 1.129 (♀), chela (without pedicel) 1.036 (♀)] than *T. compactus* [chela (with pedicel) 1.480 (♀), chela (without pedicel) 1.381 (♀)]. The pedipalpal chela of *T. afghanicus* has 39 (♀) teeth on the fixed finger and 44 (♀) teeth on the movable finger [whereas, it is 44 (♀) teeth on the fixed finger and 47 (♀) teeth on the movable finger in *T. compactus*].

Redescription

Chelicera: all five setae well developed; base of palm fairly granulated, *ib*, *isb*, *eb* short and terminally dentate. Lamina interior reduced, exterior thin. Fixed finger with four marginal serrations. Serrula exterior with 17 blades.

Pedipalps (Figs. 6D to F): Reddish-brown; trochanter and femur granulated, except ventral;

patella granulated retrolaterally, rest finely granulated. Chelal hand heavily granulated retrolaterally, remainder finely granulated. Dorsal tubercle of trochanter well developed (Fig. 6D); trochanter 1.38 x longer than broad. Femur 2.04 x longer than broad. Patella 1.89 x longer than broad. Chela with pedicel 2.85 x longer than broad; fixed finger with 39 teeth, movable finger with 44 teeth. *eb* and *esb* apart by one areolar diameter. *sb* diagonally opposite to *st*. *it*, *ist*, *isb* & *ib* are clustered at the base (Fig. 6F). Small setae terminally dentate.

Carapace: 1.04 x longer than broad, granulated with two distinct eye spots, with two indistinct furrows, with ca. 31 setae, including 4 at anterior margin and 8 near to posterior margin. Vestitural setae terminally dentate.

Legs: brownish, granulated antero-laterally, with acuminate long setae and terminally dentate small setae, articulation between femur and patella oblique of Leg III and IV. Leg I: femur 0.949, patella 1.52, tibia 2.81, tarsus 2.70 x longer than broad. Leg IV: femur+patella 2.37, tibia 3.25, tarsus 2.82 x longer than broad; tactile seta situated one third of the tarsus from its base.

Measurements: *Female*: body length 4.690 Carapace 1.062/1.014. Pedipalps: trochanter 0.443/ 0.319, femur 0.772/0.378, patella 0.796/0.421, chela (with pedicel) 1.480/0.518, chela (without pedicel) 1.381/0.518, hand 0.739, movable finger 0.612. Leg I: femur 0.208/0.219, patella 0.321/0.202, tibia 0.397/ 0.141, tarsus 0.317/0.117. Leg IV: femur+patella 0.721/0.304, tibia 0.570/0.175, tarsus 0.399/0.141.

Note

Bashgultal -– now referred to as Bashgul Valley/ Landai Sin Valley situated near to Pakistan border.

T. compactus is known from its type locality and Thailand (Schawaller, 1994) while *T. afghanicus* is known only from its type locality. Both species are separated from each other by differences in the measurements of femur and patella of pedipalp and in the number of teeth on the movable and fixed fingers. From the present study, it is clear that collection from the type localities and further study on male genitalia is required to get more clarity on the characteristics for delineating species.

Key to species of the genus *Tullgrenius*

1. Chela with pedicel longer than 1.6mm and less than 2.8 times as long as wide..... *T. indicus*

   Chela with pedicel less than 1.6mm……2

2. Chela stouter and less than 1.2mm .....……..……*T. afghanicus*

   Chela with pedicel between 1.2mm and 1.6mm ……..……... *T. compactus*

Morphometric analysis

Morphometric data revealed morphological variations among the three *Tullgrenius* species and also concluded that the femur and patella length shows high level of correlation and cannot be considered for delineating species. The principal component analysis (Factors 1 and 3 jointly) explained 68.08% of the total variation among species, the first explaining 57.89 per cent and the second explaining 10.19% (Fig. 8). The variables most correlated to Factor 1 were Chela with pedicel, Femur ratio and Patella ratio (Table 1).

ACKNOWLEDGEMENTS

The authors sincerely thank Rev. Fr. Prasant Palackappillil CMI, Principal, Sacred Heart College, Thevara, Cochin, for his immense support and encouragement during the study. First author thanks Mag. Christoph Horweg, curator of NHMW for his hospitality and workspace and Dr. Peter Schwendinger for the facilities provided in the MHNG. Thanks to Dr. D. Sudarsanam for giving permission to access the specimens in Loyola College Museum, Chennai. Thanks to Dr. Mark Harvey (Western Australia Museum, Perth, Australia) for providing literature. Dr. Mark Judson (Muséum National d'Histoire Naturelle, Paris, France) is acknowledged for the literature, correcting the early draft and clarification on doubts regarding the genus. We express our gratitude to Prof. F.E. Klausen (University of Agder, Norway) and János Novák (Hungarian Natural History

Museum, Budapest,Hungary) for the comments on the genus. We thank the Director, STIC, CUSAT for providing the SEM facility. We thank the Chief Conservator of Forests, Karnataka, Kerala and Tamil Nadu Forest Division for permitting us to collect the specimens. We especially acknowledge the Science and Engineering Research Board (SERB)-DST, New Delhi for providing funding support under the Major Research Project No. CRG/2018/000286.

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(Received February 25, 2021; revised ms accepted April 04, 2021; printed June 30, 2021)