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New species of *Cocalus* C.L. Koch, 1846 and *Habrocestum* Simon, 1876 (Araneae: Salticidae) from the South Western Ghats of India

Новые виды *Cocalus* C.L. Koch, 1846 и *Habrocestum* Simon, 1876 (Araneae: Salticidae) из Южно-Западных Гат Индии

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КЛЮЧЕВЫЕ СЛОВА: Aranei, описание, паук-скакунчик, новые виды, таксономия, Керала, Карнатака.

ABSTRACT. Two new species of jumping spiders, *Cocalus shendurneyensis* sp.n. (♂), and *Habrocestum mookambikaensis* sp.n. (♀), are described from the South Western Ghats of India. Detailed morphological descriptions, diagnostic features and illustrations of copulatory organs are given. The current distribution of the genus *Cocalus* C.L. Koch, 1846 and *Habrocestum* Simon, 1876 in India is also presented.

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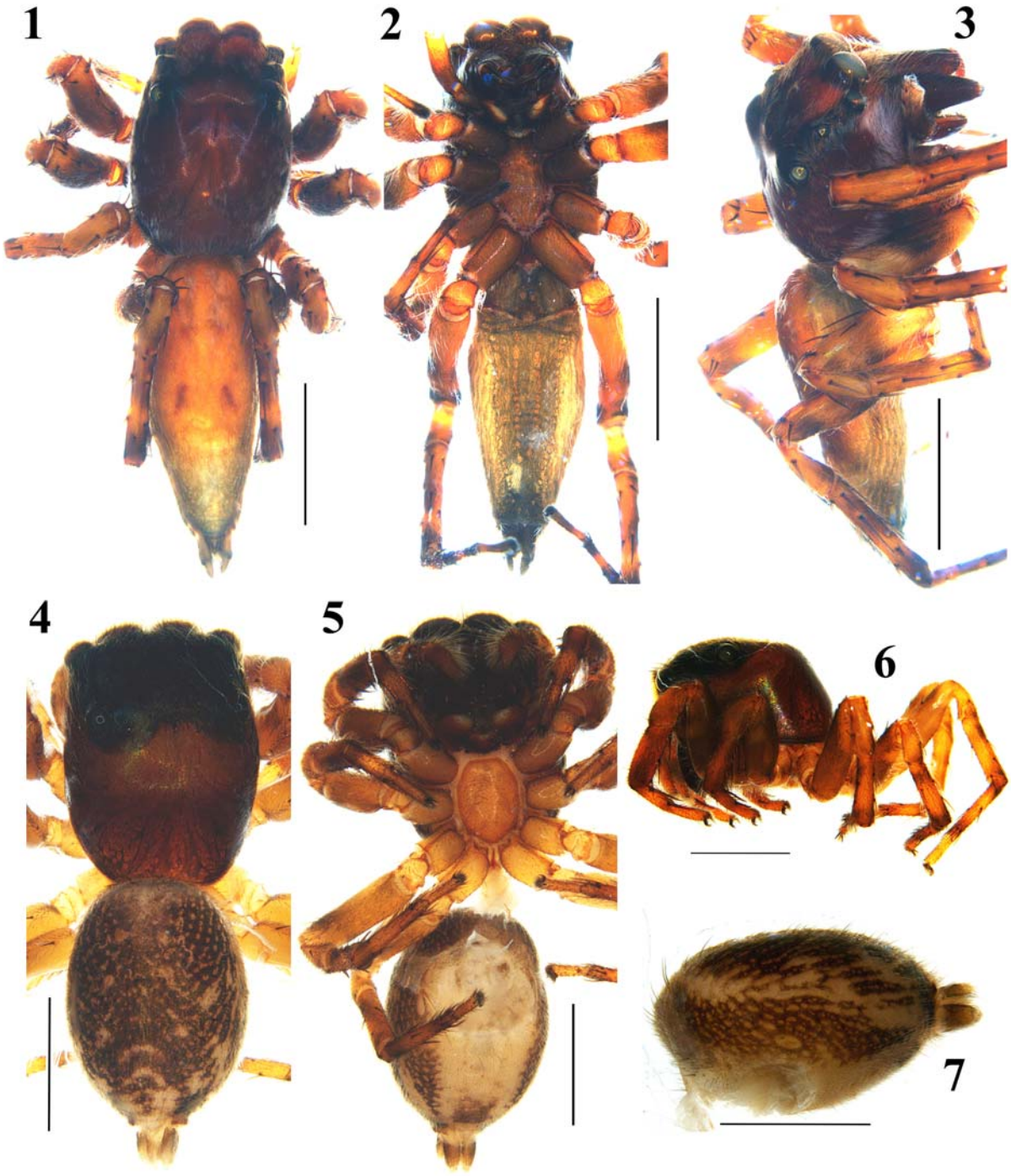
РЕЗЮМЕ. Два новых вмида пауков-скакунчиков, *Cocalus shendurneyensis* sp.n. (♂), и *Habrocestum mookambikaensis* sp.n. (♀), описаны из Южно-Западных Гат Индии. Приводятся подробные морфологические описания, диагностические признаки и иллюстрации. Показаны также современные находки видов из родов *Cocalus* C.L. Koch, 1846 и *Habrocestum* Simon, 1876 в Индии.

Introduction

The family Salticidae Blackwall, 1841 is the most diverse taxon of Araneae, consisting of 6428 species in 664 genera worldwide [WSC, 2022]. As of now, a total of 292 salticid species in 103 genera have been reported from India [Caleb, Sankaran, 2022]. Of these, over 123 species are still known only from a single sex [Caleb, 2019], indicating that the jumping spiders of India are not well documented, and their true diversity remains undetermined. Moreover, recent revisions have revealed that the status of many species is yet questionable, and some are to be considered synonyms of older names [Caleb *et al*., 2019, 2020, 2021, 2022; Sudhin *et al*., 2020]. Therefore, extensive surveys and studies focusing on the taxonomy and phylogeny of salticids are required to discover and understand the actual diversity of Indian salticids. While examining spiders collected during field surveys in the southern part of India, two unknown salticid specimens have been identified — one belonging to the spartaeine genus *Cocalus* C.L. Koch, 1846 and another to the hasariine genus *Habrocestum* Simon, 1876. *Cocalus* is a poorly known salticid group, distributed mainly in the Oriental and Australian Regions, and to date two species have been reported from India [Wanless, 1981; Caleb, Sankaran, 2022; WSC, 2022]. *Habrocestum* includes small, ground-dwelling spiders, distributed mainly in Africa and southern Eurasia. The genus currently has three representatives in India, all of which have been described from southern India [Sankaran *et al*., 2019; Asima *et al*., 2022]. The present paper deals with the description of two new species: viz., *Cocalus shendurneyensis* sp.n. (♂), and *Habrocestum mookambikaensis* sp.n. (♀), from the South Western Ghats of India.

Material and methods

The collected spiders were preserved in 70% ethanol. The morphological examination was carried out under a Leica M205A stereozoom binocular microscope and images were captured with a Leica DFC4500 camera and processed using extended focus montage LAS software (version 4.1.2). Distribution maps were prepared by using the online mapping software SimpleMappr [Shorthouse, 2010]. All mea-

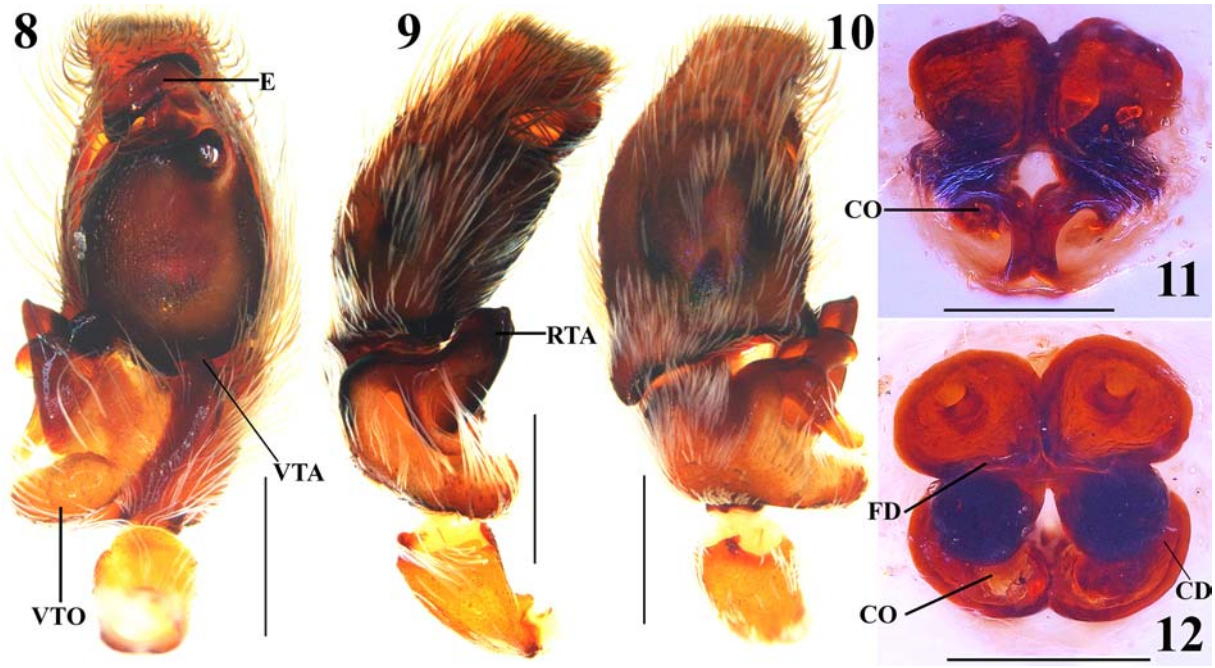


Figs 1–7. Somatic characters of *Cocalus shendurneyensis* sp.n., holotype ♂ (1–3), and *Habrocestum mookambikaensis* sp.n., holotype ♀ (4–7). 1, 4 — body, dorsal view; 2, 5 — ventral view; 3 — lateral view; 6 — carapace, lateral view; 7 — abdomen, lateral view. Scale bars: 2 mm (1–3), 1 mm (4–7).

Рис. 1–7. Соматические признаки *Cocalus shendurneyensis* sp.n., голотип ♂ (1–3), и *Habrocestum mookambikaensis* sp.n., голотип ♀ (4–7). 1, 4 — тело, вид сверху; 2, 5 — то же, вид снизу; 3 — то же, вид сбоку; 6 — головогрудь, вид сбоку; 7 — брюшко, вид сбоку. Масштаб: 2 мм (1–3), 1 мм (4–7).

surements are in millimeters (mm). Description of the length of palp and leg segments is as follows: total length [femur, patella, tibia, metatarsus (except palp), tarsus]. The terminology follows Reiskind [1969] and for leg spination follows Bossellaers & Jocque [2000]. The studied specimens are deposited in the National Zoological Collections of Zoological Survey of India (NZC-ZSI), Kolkata, India.

Abbreviations used in the text and figures are as follows: ALE — anterior lateral eye, AME — anterior median eye, C — cymbium, CD — copulatory duct, CO — copulatory



Figs 8–12. Copulatory organs of *Cocalus shendurneyensis* sp.n., holotype ♂ (8–10), and *Habrocestum mookambikaensis* sp.n., holotype ♀ (11–12). 8 — right male palp, ventral view, 9 — same, retrolateral view, 10 — same, dorsal view; 11 — epigyne, ventral view; 12 — vulva, dorsal view. Scale bars: 0.5 mm (8–10), 0.2 mm (11–12).

Рис. 8–12. Копулятивные ограны *Cocalus shendurneyensis* sp.n., голотип ♂ (8–10), и *Habrocestum mookambikaensis* sp.n., голотип ♀ (11–12). 8 — правая пальпа самца, вид снизу, 9 — то же, вид сбоку-сзади, 10 — то же, вид сверху; 11 — эпигина, вид снизу; 12 — вульва, вид сверху. Масштаб: 0,5 мм (8–10), 0,2 мм (11–12).

opening, do — dorsal, E — embolus, FD — fertilization duct, pl — prolateral, PLE — posterior lateral eye, PME — posterior median eye, plv — prolateral ventral, rl — retrolateral, RTA — retrolateral tibial apophysis, rlv — retrolateral ventral, v — ventral, VTA — ventral tibial apophysis, VTO — ventral tibial outgrowth.

Taxonomy

Cocalus C.L. Koch, 1846

TYPE SPECIES: *Cocalus concolor* C.L. Koch, 1846

Cocalus shendurneyensis **sp.n.**
Figs 1–3, 8–10, 13–14, Map.

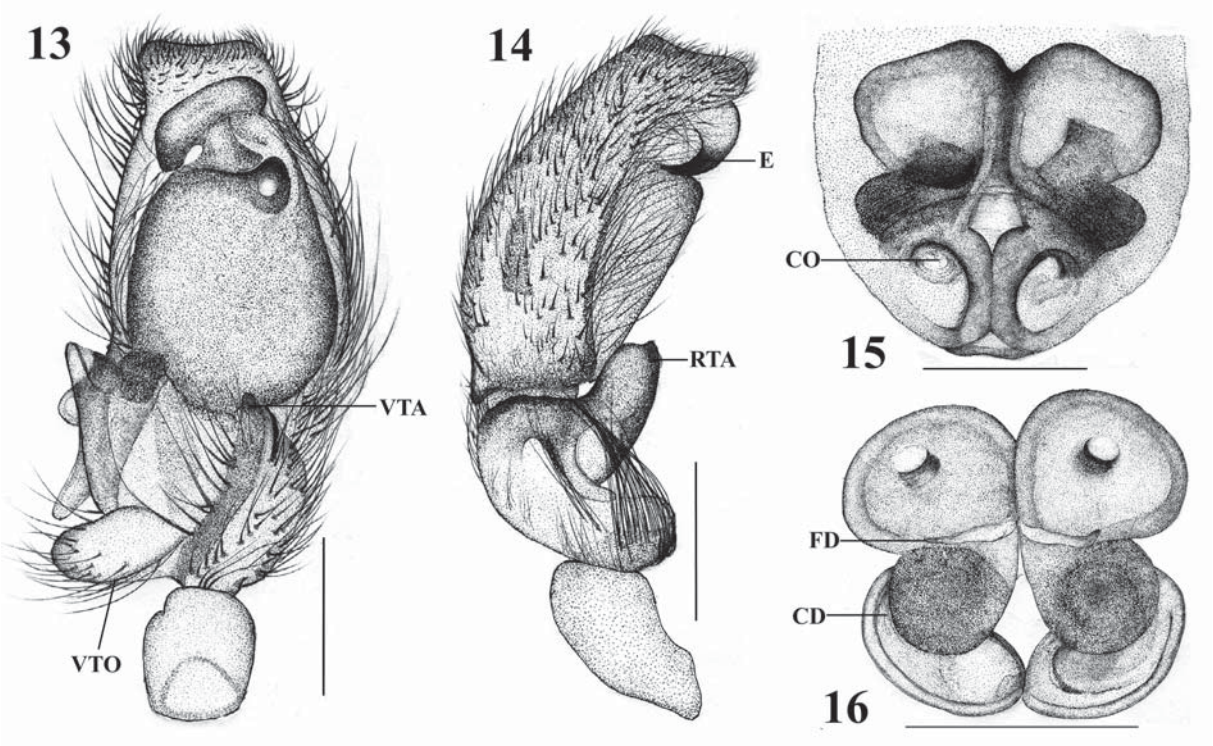
TYPE. Holotype ♂ (NZC-ZSI-7715/18), INDIA, Kerala, Kollam, Shendurney Wildlife Sanctuary (9°12′24″N, 77°11′94″E), 780 m a.s.l., 9.12.2021, P. Girish Kumar.

ETYMOLOGY. The specific epithet is an adjective derived from the name of the wildlife sanctuary from where the species was collected.

DIAGNOSIS. The male of *C. shendurneyensis* sp.n. can be easily distinguished from those of all other *Cocalus* species by the broader, longer RTA, and posteriorly oriented finger-like projection with its curved distal region directed retrolaterally (cf. Figs 9, 14 with figs 4C, 5C in Wanless [1981], fig. 4 in Davies & Żabka [1989], figs 13, 17 in Sudhin *et al*. [2019], and fig. 17 B in Cao *et al*. [2016]).

REMARKS. The genus *Cocalus* has two representatives in India: viz., *C. murinus* Simon, 1899 (♀) and *C. lacinia* Sudhin, Nafin, Sumesh et Sudhikumar, 2019 (♂♀). The record of *C. murinus* from India was based on the female specimen collected from Nagrakata Tea Estate, West Bengal [Roy *et al*., 2016]. However, illustrations of the female copulatory organs provided by Roy *et al*. [2016] do not match with that of the lectotype of *C. murinus*: copulatory opening very narrow and small (wider in *C. murinus*); epigyne nearly rectangular (almost pentagon in *C. murinus*) (cf. fig. 22D in Roy *et al*. [2016] with Fig. 3C in Wanless [1981]). Based on these observations, it is therefore safe to conclude that the Indian record of *C. murinus* by Roy *et al*. [2016] is mistaken, and that *C. murinus* is actually confined to Indonesia (Sumatra). In addition, the identity of the female specimen from West Bengal, India is uncertain and a re-examination is needed to validate its identity. It is therefore not likely that the male described below can be that of *C. murinus* recorded by Roy *et al*. [2016].

DESCRIPTION. MALE. (Figs 1–3, 8–10, 13–14). Measurements: body length 7.33. Carapace length 3.13, width 2.31. Abdomen length 4.14, width 1.56. Ocular area length 1.28, width 1.69. Eye diameters: AME 0.54, ALE 0.29, PME 0.21, PLE 0.20. Eye interdistances: ALE–AME 0.07, ALE–ALE 1.21, ALE–PME 0.29, PLE–PLE 1.33, PME–PME 1.31, PME–PLE 0.33. Measurements legs: leg I 7.38 [2.04, 0.97, 1.99, 1.50, 0.88], II 7.47 [2.02, 1.04, 1.91, 1.66, 0.84], III 6.65 [1.91, 0.87, 1.46, 1.57, 0.84], IV 8.25 [2.29, 0.96, 1.96, 2.09, 0.95]. Leg formula: 4213. Leg spination: femur I–II pl 2 rl 2 do 3, III–IV pl 3 rl 3 do 3; patella I–IV pl 1 rl 1; tibia I–II pl 3 rl 3 do 3 plv 3 rlv 3, III–IV pl 3 rl 3 do 2 plv 3 rlv 3; metatarsus I–II pl 3 rl 3 plv 1 rlv 1, III pl 3 rl 3 do 2 plv 2 rlv 2, IV pl 2 rl 2 do 2 plv 2 rlv 2; tarsus I–IV spineless. Carapace moderately high, longer than broad, red-



Figs 13–16. Copulatory organs of *Cocalus shendurneyensis* sp.n., holotype ♂ (13–14), and *Habrocestum mookambikaensis* sp.n., holotype ♀ (15–16). 13 — right male palp, ventral view, 14 — same, retrolateral view; 15 — epigyne, ventral view; 16 — vulva, dorsal view. Scale bars: 0.5 mm (13–14), 0.2 mm (15–16).

Рис. 13–16. Копулятивные орагны *Cocalus shendurneyensis* sp.n., голотип ♂ (13–14), и *Habrocestum mookambikaensis* sp.n., голотип ♀ (15–16). 13 — правая пальпа самца, вид снизу, 14 — то же, вид сбоку-сзади; 15 — эпигина, вид снизу; 16 — вульва, вид сверху. Масштаб: 0,5 мм (13–14), 0,2 мм (15–16).

dish brown, covered with white hairs; eye field densely covered with golden-brown hairs, eye bases black; fovea moderately long, black, longitudinal, lying behind PLEs at middle (Figs 1, 3). Clypeus low, vertical, covered with golden-brown hairs. Chelicerae reddish brown, frontal face with light brown hairs (Figs 2, 3), pro-and retromargins with three teeth, fangs medium-sized, light reddish brown. Endites yellowish brown, scopulate with dull white inner tips, margin of endites with narrow dark brown lines (Fig. 2). Labium brown, scopulate, with pale yellow tip (Fig. 2). Sternum nearly oval, yellowish brown, covered with short white hairs (Fig. 2). Abdomen light reddish-yellow, elongate, posteriorly narrowing, covered with short white hairs, anteromedially with a pair of light brown longitudinal stripes, and medially with a pair of light brown lateral markings (Fig. 1); lateral abdomen with light brown longitudinal lines extending the entire length of abdomen (Fig. 3); venter light yellowish brown, densely covered with short brown hairs, medially and laterally with a pair of yellowish dotted lines (Fig. 2). Spinnerets pale yellow, posterior pair light brown (Figs 1, 2). Legs pale yellow, with light brown markings on femora and tibiae. Palp densely covered by hairs; cymbium and tegulum reddish brown, other segments light reddish yellow; tibia base with a flap-like ventral outgrowth; VTA thumb like with sub-acute tip; RTA broad and elongated, finger-like protuberance posteriorly directed with its curved distal region directed at 4 o'clock position in ventral view; cymbium broad, moderately long, distally flat, with posterior triangular extension; tegulum ovoid, reddish brown with tegular furrow and retrolateral striae; embolus robust, hook-shaped, with the pointed tip curving inwards, towards the alveolar cavity (Figs 8–10, 13–14).

DISTRIBUTION. The type locality only (Map).

Habrocestum **Simon, 1876**

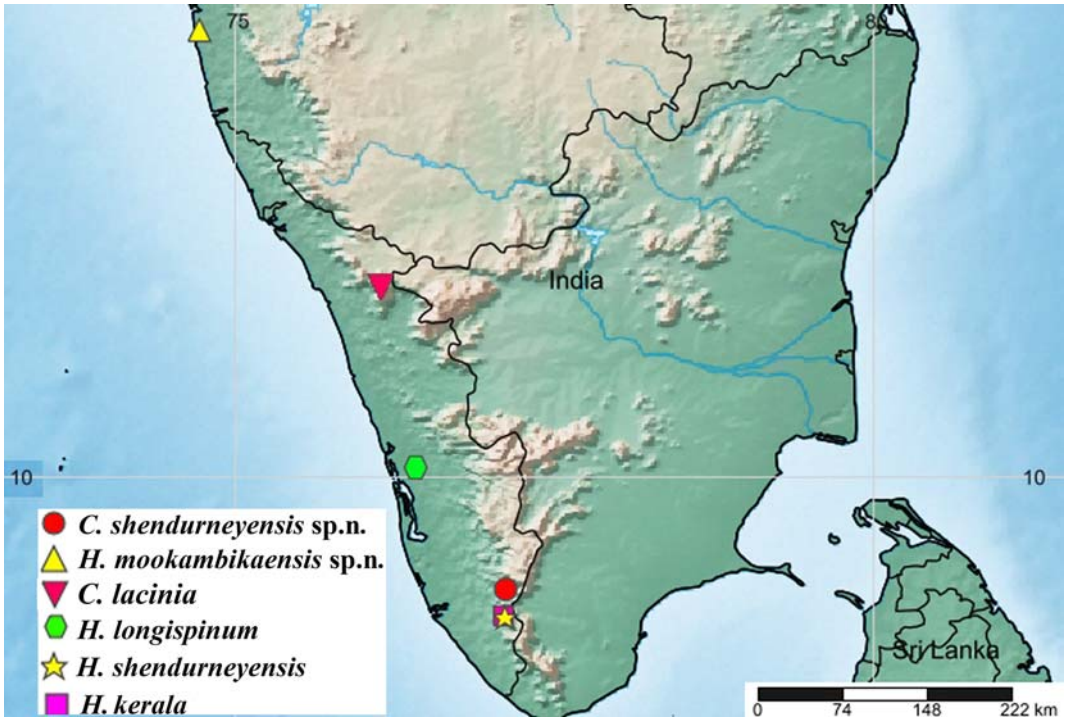
TYPE SPECIES: *Habrocestum pullatum* Simon, 1876

Habrocestum mookambikaensis **sp.n.**
Figs 4–7, 11–12, 15–16, Map.

TYPES. Holotype ♀ (NZC-ZSI-7678/18), INDIA, Karnataka, Udupi, Anejhari Butterfly Camp, Mookambika Wildlife Sanctuary (13°49′40″N, 74°48′06″E), 81 m a.s.l., 31.08.2021, V.D. Hegde. — PARATYPE: INDIA: 1♀ (NZC-ZSI-7679/18), from the same sanctuary (13°70′49.4″N, 75°05′50.8″E), Shimoga, 609 m a.s.l., 16.12.2021, S. Sen.

ETYMOLOGY. The specific epithet is an adjective derived from the name of the wildlife sanctuary from where the species was collected.

DIAGNOSIS. The female epigyne of *H. mookambikaensis* sp.n. is most similar to that of *H. namibicum* Wesołowska, 2006, from which it can be easily distinguished by the posteromedially placed copulatory openings, and short, broad copulatory ducts. The vulva is most similar to that of *H. laurae* Peckham et Peckham, 1903, from which it can be distinguished by the large globular spermathecae, medially placed, elongated fertilization ducts and the absence of pos-



Map. Collecting localities of the Indian *Cocalus* and *Habrocestum* species.
Карта. Точки находок индийских видов *Cocalus* и *Habrocestum*.

tero-medial epigynal pocket (cf. Figs 11–12, 15–16 with fig. 36 in Prószyński [1987] and figs. 34–37 in Wesołowska [2006]).

REMARKS. *H. kerala* Asima, Caleb, Babu et Prasad, 2022 was described from the males [Asima *et al*., 2022], and therefore there may be grounds for believing that the female described here could be conspecific to the male of *H. kerala*. However, female specimens collected recently by A. Asima (pers. comm., 30.07.2022) from the type locality of *H. kerala* are identical by their body colour pattern to the male described (see Asima *et al*. [2022: fig. 4]), and moreover, in their copulatory organs, they are most similar to those of *H. hantaneensis* Kanesharatnam et Benjamin, 2016 from Sri Lanka. Hence, the female holotype of *H. mookambikaensis* sp.n. is not conspecific to *H. kerala*, of which the female will be later described elsewhere.

DESCRIPTION. FEMALE (Holotype, NZC-ZSI-7678/18) (Figs 4–7, 11–12, 15–16). Measurements: body length 3.83. Carapace length 1.91, width 1.47. Abdomen length 1.92, width 1.36. Ocular area length 0.86, width 1.25. Eye diameters: AME 0.41, ALE 0.24, PME 0.08, PLE 0.20. Eye interdistances: AME–AME 0.02, ALE–AME 0.03, ALE–ALE 0.84, ALE–PME 0.29, PLE–PLE 0.98, PME–PME 1.14, PME–PLE 0.16. Measurements of palp and legs: palp 1.45 [0.52, 0.27, 0.20, 0.46], leg I 2.99 [0.95, 0.54, 0.71, 0.33, 0.46], II 2.68 [0.92, 0.45, 0.57, 0.39, 0.35], III 3.38 [1.24, 0.43, 0.75, 0.59, 0.37], IV 3.41 [1.08, 0.38, 0.73, 0.78, 0.44]. Leg formula: 4312. Leg spination: femur I–III pl 1 do 3, IV do 3; patella III pl 1 rl 1, IV rl 1; tibia I pl 1 plv 3 rlv 3, II pl 2 plv 3 rlv 3, III–IV pl 2 rl 2 plv 2 rlv 1; metatarsus I–II plv 2 rlv 2, III–IV pl 2 rl 2 do 1 plv 2 rlv 2; tarsus I–IV spineless. Carapace dark reddish brown, high with steep posterior slope; margin of carapace with black lines; eye field black, covered with short golden-brown hairs, intermixed with long black hairs, a row of long black hairs behind the anterior eyes; fovea short, black, longitudinal, lying behind PLEs at middle (Figs 4, 6). Clypeus low, vertical, yellowish brown, covered with light brown hairs. Chelicerae small, reddish brown, promargin with two teeth and retromargin with five teeth (Fig. 5). Endites yellowish brown, scopulate, with paler tips (Fig. 5). Labium yellowish brown, distally with black setae (Fig. 5). Sternum yellow covered with light brown hairs (Fig. 5). Abdomen oval, dorsum with several light grey patches and laterally with transverse dotted lines on brown background (Figs 4, 7); venter light grey, with a pair of median lines, posterior tip with light brown patch (Fig. 5). Spinnerets brown with paler tips. Legs light yellow, all femora ventrally with a row of trichobothria (Fig. 6). Epigyne longer than wide, heavily sclerotized, sparsely covered with long grey hairs; copulatory openings situated posteromedially and separated by thick septum; copulatory ducts short, broad, laterally diverging, entering the posterior region of spermathecae; spermathecae, large, bilobed, anterior lobe large and globular, posterior lobe small, nearly round, and highly sclerotized; fertilization ducts long, oriented laterally, positioned at the middle region of spermathecae (Figs 11–12, 15–16).

DISTRIBUTION. The type locality only (Map).

Discussion

In India, Salticidae is the most speciose family, with a total of 292 species in 103 genera having been reported/described to date [Caleb, Sankaran, 2022]. However, in some regions of India this diverse family has not received appropriate attention by taxonomists, especially in the Western Ghats (WG), one of the world

biological hotspots that is known to harbor a highly diverse, endemic flora and fauna. Some 90 salticid species in 52 genera have been reported from the WG [Sen, Sureshan, 2020; Maddison *et al*., 2020; Paul *et al*., 2020; Sudhin *et al*., 2021; Jose, Sudhikumar, 2022] representing 30% of the total Indian diversity of Salticidae. Of them, 42 species (46%) are endemics [Sen, Sureshan, 2020; Caleb, Sankaran, 2022]. Compared to few vertebrate [Vijaykumar *et al*., 2016] and invertebrate groups [Bharti *et al*., 2021; Johnson *et al*., 2022] whose diversity has been fairly studied, the salticid taxonomy and diversity in the WG is yet to be fully explored. Therefore, extensive surveys and studies are required to discover a real diversity of the salticids occurring in the WG.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical approval: No ethical issues were raised during our research.

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