



The spiny theridiid genus *Meotipa* Simon, 1895 in India, with description of a strange new species with translucent abdomen and a phylogenetic analysis about the genus placement (Araneae, Theridiidae)

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Abstract

A characteristic new species *Meotipa sahyadri* n. sp. with tall and white translucent abdomen in females is described in detail based on morphology of both sexes, based on specimens collected from the Western Ghats of Maharashtra, Gujarat and Goa. The new species has epigynal projection which is known only in *Meotipa picturata* Simon, 1895, but differs in shape (trifid vs. quadrangular respectively). Males have longest straight embolus exceeding conductor length. Observations of its natural history are provided. *Meotipa picturata* is newly recorded from Goa, which extends its north-westward distribution from the previously known records from ‘Kodei Kanal’, India (type locality), Ratchasima Province, Thailand and East Kalimantan, Indonesia. A new combination *Meotipa andamanensis* (Tikader, 1977) n. comb. (= *Argyrodes andamanensis*) is proposed based on the comparison of description and illustrations provided in the original paper to that of the characters of the type species *M. picturata*. 242 morphological characters studied in the previous literature and one additional character ‘epigynal projection’ were scored for *Meotipa sahyadri* n. sp. and *Meotipa picturata*. These species were obtained monophyletic, placed within Theridiinae as sister to *Chryssio* cf. *nigriceps* using parsimony analysis and Bayesian inference.

Key words: Taxonomy, Comb-footed Spiders, Morphology, Phylogeny, Asian Tropics, Western Ghats

Introduction

Deeleman-Reinhold (2009) resurrected the theridiid genus *Meotipa* Simon, 1895 from the synonymy of the genus *Chryssio* O.P.-Cambridge, 1882 (previously synonymized by Levi & Levi (1962)). It can be recognized by ‘the tip of abdomen upward and backward over the spinnerets’ and the apex bearing flattened setae; and by a brush of flattened setae in the femur and tibia of legs I and IV (Deeleman-Reinhold 2009). The genus currently includes nine nominal species distributed in the Asian tropics except *Meotipa pulcherrima* (Mello-Leitão, 1917) which is pantropical. All *Meotipa* species are known by both sexes except *Meotipa pallida* Deeleman-Reinhold, 2009 and *M. picturata* which are known only by females (World Spider Catalog 2017).

Deeleman-Reinhold (2009) redescribed the type species *M. picturata* Simon, 1895 which was originally described from ‘Kodei Kanel’ (now Kodai Kanal), India and later also recorded from Thailand, Laos, Brunei and Indonesia. Other than *M. picturata*, *Meotipa argyrodidiformis* (Yaginuma, 1952) has been reported from India (Sen *et al.* 2015).

Prior to the resurrection of the genus *Meotipa* from *Chryssio*, the morphology-based phylogeny of Theridiidae placed *Chryssio* within Theridiinae as sister to two clades which included the genera *Tidarren*, *Nesticodes*, *Achaearanea* in one clade and *Theridula*, *Ameridion*, *Thymoites*, *Theridion*, *Helvibis* and *Coleosoma* in the other (Agnarsson 2004). The other studies on the phylogeny of Theridiidae placed *Meotipa* sp. within the sub-family Theridiinae, however its interrelationship with other Theridiinae genera have been inconsistent (Arnedo *et al.* 2007, Agnarsson *et al.* 2007, Eberhard *et al.* 2008, Liu *et al.* 2015).

In the present paper, we describe a new *Meotipa* species, provide information on its natural history and report *M. picturata* from the northern Western Ghats, India. A brief redescription with figures of *M. picturata* is provided for comparison with the new species. Another theridiid, *Argyrodes andamanensis* Tikader, 1977 is transferred to *Meotipa* based on the description and illustration in the original description (Tikader 1977). The phylogenetic position of the new *Meotipa* species and *M. picturata* within Theridiidae is analysed by adding its morphological character states to the dataset of Agnarsson (2004) with the inclusion of one additional character.

Methods

Taxonomy. Specimens were preserved in 70% alcohol, deposited at Bombay Natural History Society, Mumbai, India. Photographs were taken using a Leica DFC425 camera mounted on Leica M205A stereo microscope with Leica Application Suite 3.8 and assembled using Helicon Focus 5.1. All measurements are in millimetres (mm) with the range of variation provided in parentheses. Leg measurements are provided in the sequence of femur, patella, tibia, metatarsus, tarsus, separated by slash (/). Abdomen length was measured ventrally and height was measured from spinnerets to apex. Soft tissues of epigynum were digested following the protocol of Álvarez-Padilla & Hormiga (2008). For scanning electron microscopy (SEM), two females and one male were critical point dried, coated with gold-palladium (Au-Pd) and their ultrastructure was studied using a LEO1430VP scanning electron microscope. Illustrations were rendered on cotton paper by sketching over digital image. The map was produced with DIVA-GIS v. 7.5c.

Phylogenetic analyses. A previously published set of 242 morphological characters for Theridiidae phylogeny (Agnarsson 2004) were scored for *M. picturata* and *Meotipa sahyadri* n. sp. (Supplementary file). Four changes were made to the dataset of Agnarsson (2004): a. An additional state for Character 4 was defined—Copulatory pore position: (2) caudal, under epigynal projection (Fig. 44). b. An additional state for Character 6 was defined—Copulatory bursa, anterior margin: (2) medially obtuse (Figs. 22, 43). c. An additional state for Character 130 was defined—Interocular area: (2) not projecting beyond clypeus, but behind (Figs. 6, 40). d. An additional character (character 243) —‘epigynal projection’ was scored, which is (1) present in *M. picturata* and *Meotipa sahyadri* n. sp. (Figs. 22, 43); (0) absent in all other theridiids in the data matrix. Eight outgroups in Araneoidea, similar to (Agnarsson 2004) were used—*Argiope* (Araneidae), *Tetragnatha* (Tetragnathidae), *Linyphia* (Linyphiidae), *Pimoa* (Pimoidae), *Synotaxus waiwai* (Synotaxidae), *Synotaxus monoceros* (Synotaxidae), *Eidmanella* (Nesticidae) and *Nesticus* (Nesticidae).

Parsimony analyses were carried out in TNT (Goloboff *et al.* 2008). We performed 1,000 iterations of random addition searches (RAS) + tree bisection and reconnection (TBR), followed by 100 ratchet iterations. Different combinations of number of replicates and number of tree holding per replications were tested. Following this, Bremer support was calculated using *Bremer.run* script with setting suboptimal to 20 followed by stepwise increase from 1 to 20 to find upper limit of supports. Bootstrap values were calculated from 1000 replicates with 10 iterations of random addition of taxa holding 20 trees per iteration. Twelve uninformative characters were detected and inactivated for calculating consistency index (CI) and retention index (RI) using *stats.run* script from TNT package.

In addition to equal weights, analyses were also carried out under implied weights using concavity values from $k=1$ up to the first k value that gave the same tree length and topology as that of the most parsimonious tree from the equal weights, following the method used in Gavish-Regev *et al.* (2013). In the present dataset, k value of 17 gave the same tree length and topology.

Bayesian analysis for morphology was carried out using MrBayes 3.2.6 on XSEDE (Huelsenbeck and Ronquist 2001) on CIPRES cluster at the San Diego Supercomputing Center (Miller *et al.* 2010) using the Mk model (Lewis 2001). The Markov chain Monte Carlo search for each matrix ran twice with four chains for 10,000,000 generations sampling the Markov chain every 250 generations, and the sample points of the first 25% generations were discarded as burnin. Stationarity of chains was visualised using Tracer version 1.6 (Rambaut *et al.* 2014).

Abbreviations used. AC—aciniform gland spigots; AG—aggregate gland spigot; ALS—anterior lateral spinnerets; AME—anterior median eye; BNHS—Bombay Natural History Society; C—conductor; CD—copulatory duct; CO—copulatory opening; CS—cylindrical setae; CY—cylindrical gland spigot; E—embolus;

FL—flagelliform gland spigot; FS—flattened setae; mAP—minor ampullate gland spigot; MAP—major ampullate gland spigot; MNHN—Musée Nationale d'Histoire Naturelle, Paris; PES—pro-marginal escort seta; PI—piriform gland spigots; PLS—posterior lateral spinnerets; PME—posterior median eyes; PMS—posterior median spinnerets; SEM—scanning electron micrograph; SR—stridulatory ridges; ST—subtegulum; T—tegulum; TC—tarsal comb; TTA—theridiid tegular apophysis.

Results

Taxonomy

Meotipa Simon, 1895

removed from the synonymy of *Chryso* O. Pickard-Cambridge, 1882 by Deeleman-Reinhold, 2009: 407, contra Levi & Levi, 1962: 23.

Type species: *Meotipa picturata* Simon, 1895

Meotipa sahyadri new species

(Figs. 1–38)

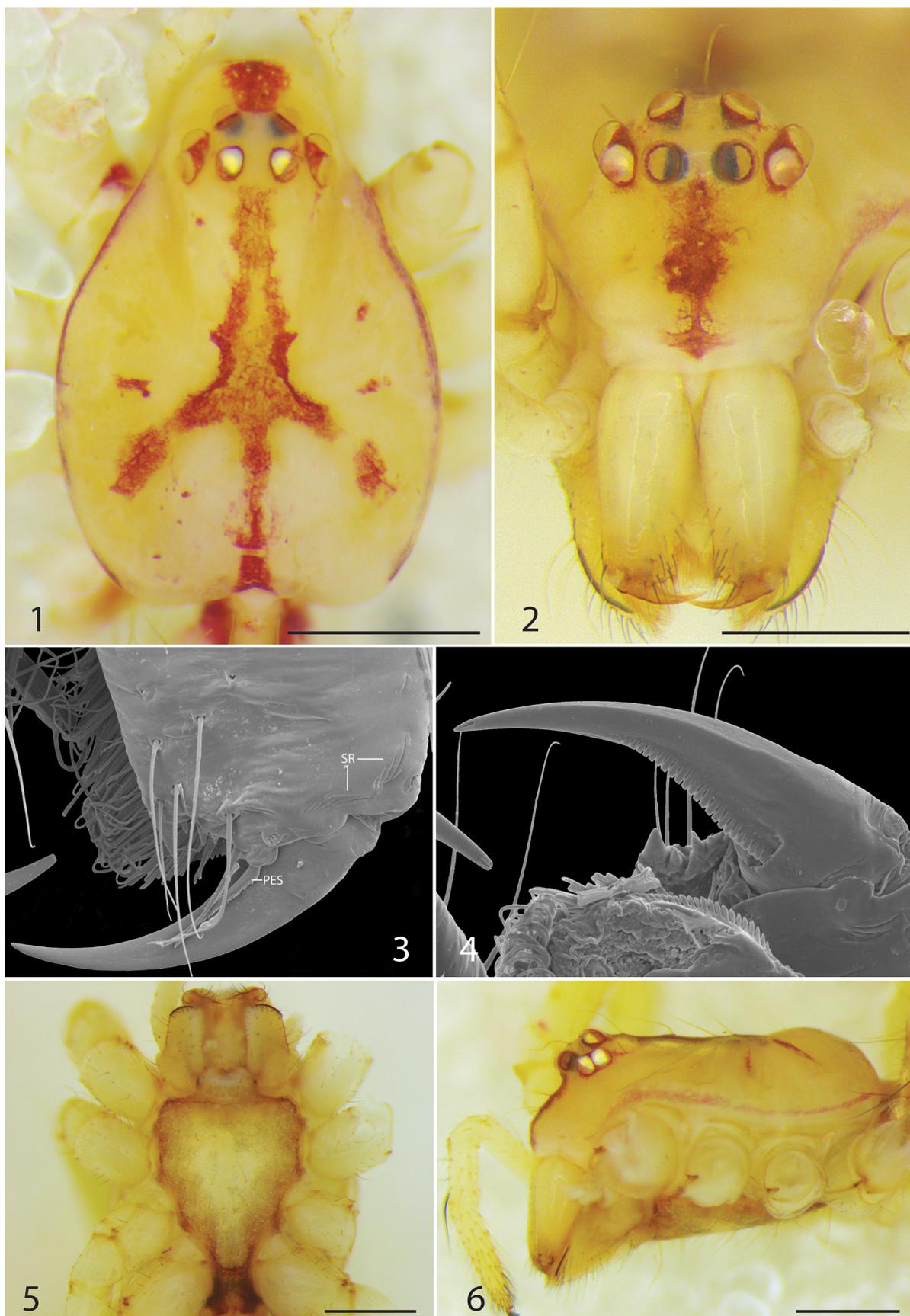
Diagnosis. The exceptionally tall and thin abdominal projection is characteristic for female *Meotipa sahyadri* n. sp. (Figs. 12, 13). This species is morphologically and geographically distributed close to *Meotipa picturata*; morphologically for presence of rod-shaped projection in epigynal atrium, but distinguishable by its trifold (Figs. 19, 22) (vs. flat, quadrangular (Figs. 43, 44)) shape, shorter and wider copulatory ducts (vs. narrow, long) and spermathecae being separated by less than their diameter. Copulatory duct 2.1 times longer than spermatheca width (Figs. 18, 23) (vs. 3.5 times longer (Figs. 42)). Width of epigynal projection at tip 0.5 times atrium radius (Fig. 22), (vs. equal to atrium radius (Fig. 43)). Males of *M. sahyadri* n. sp. have straight embolus (Figs. 29–31) (vs. coiled in *Meotipa bituberculata* Deeleman-Reinhold, 2009, *Meotipa impatiens* Deeleman-Reinhold, 2009) exceeding 1.7 times conductor length (vs. about 1.3 times in *Meotipa spiniventris* (O. Pickard-Cambridge, 1869), 1.1 times in *Meotipa vesiculosa* Simon, 1895, receding in *Meotipa argyrodiformis* (Yaginuma, 1952), *Meotipa pulcherrima* (Mello-Leitão, 1917) and *Meotipa thalerorum* Deeleman-Reinhold, 2009).

For differential diagnosis to female *Meotipa* species, refer Table 1.

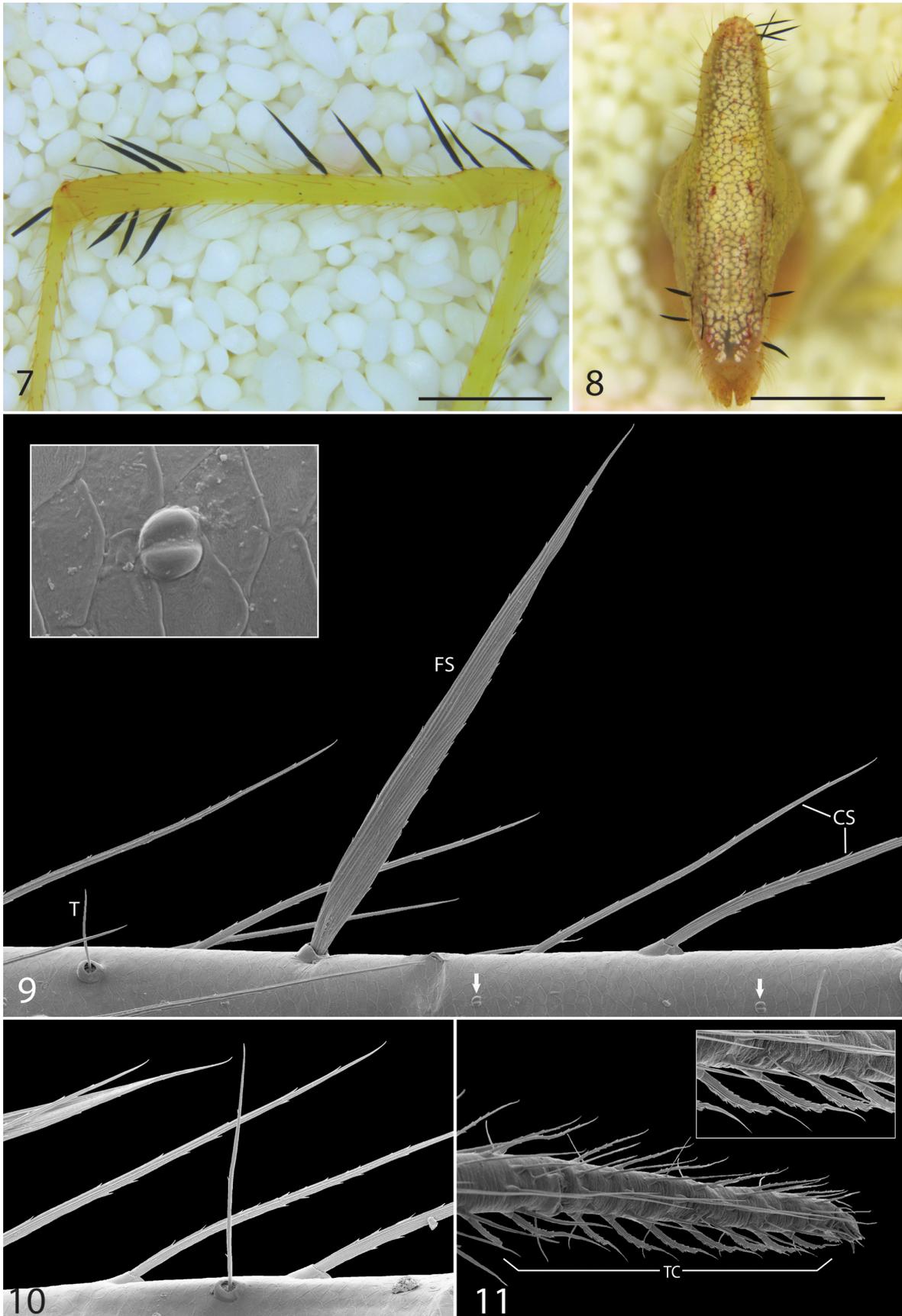
TABLE 1. Differential diagnoses in female sex of *Meotipa* species other than *M. picturata*.

Species vs. character	Median epigynal rod	Spermathecae distance	CD: spermathecae	FD: Spermathecae
<i>M. sahyadri</i> n. sp.	present	less than diameter	CD longer	Spermathecae longer
<i>M. vesiculosa</i>	absent	less than diameter	Spermathecae longer	Spermathecae longer
<i>M. thalerorum</i>	absent	less than diameter	Spermathecae longer	Spermathecae longer
<i>M. bituberculata</i>	absent	less than diameter	CD longer	FD longer
<i>M. impatiens</i>	absent	more than diameter	CD longer	FD longer
<i>M. pallida</i>	absent	more than diameter	CD longer	FD longer
<i>M. spiniventris</i>	absent	less than diameter	CD longer	Spermathecae longer
<i>M. argyrodiformis</i>	absent	less than diameter	Spermathecae longer	Spermathecae longer
<i>M. pulcherrima</i>	absent	more than diameter	Spermathecae longer	Spermathecae longer

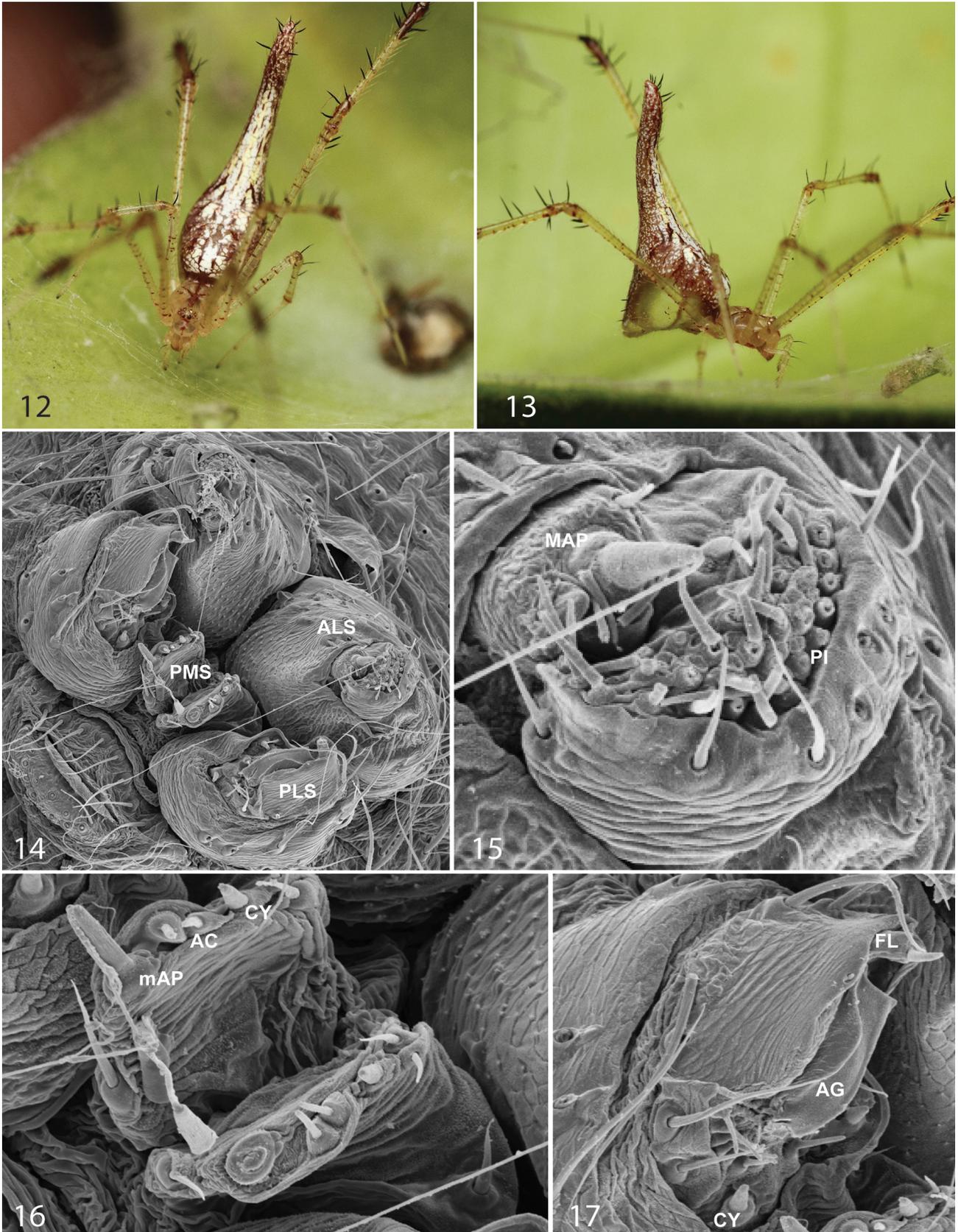
Etymology. The species is named after ‘Sahyadri’ (noun in apposition), a Sanskrit vernacular name for the northern Western Ghats which comprise all localities of the new species.



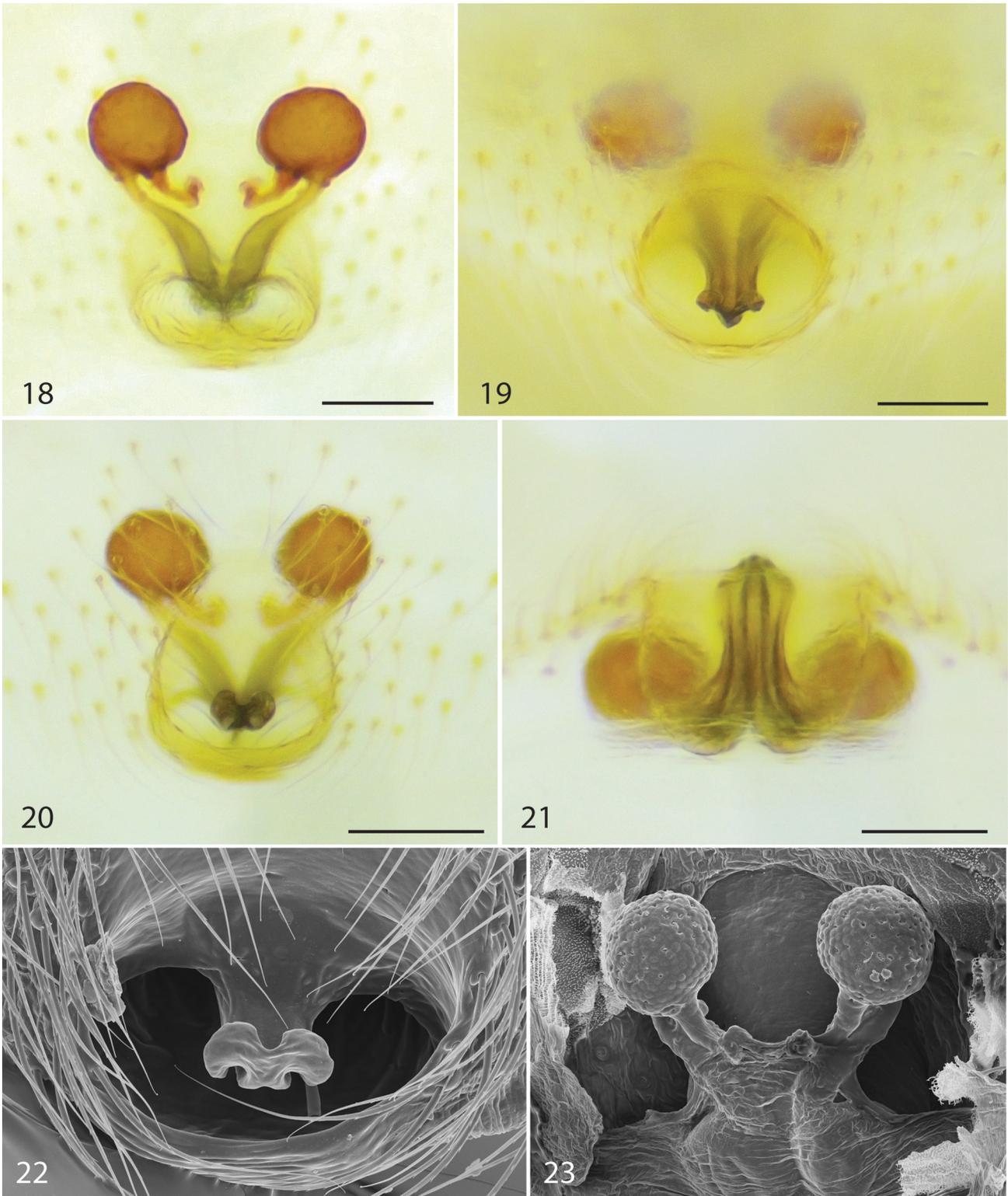
FIGURES 1–6. *Meotipa sahyadri* n. sp., female from India, holotype. **1** Carapace, dorsal view **2** Cephalothorax, frontal view **3** Chelicera base, dorsal view **4** Chelicera base, ventral view **5** Cephalothorax, ventral view **6** Cephalothorax, lateral view. Scale lines: 0.75 mm (Figs. 1–2); 0.5 mm (Figs. 5–6).



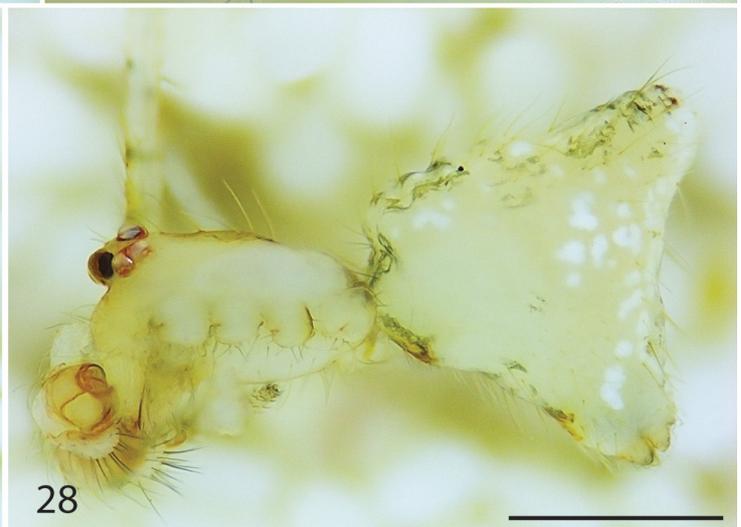
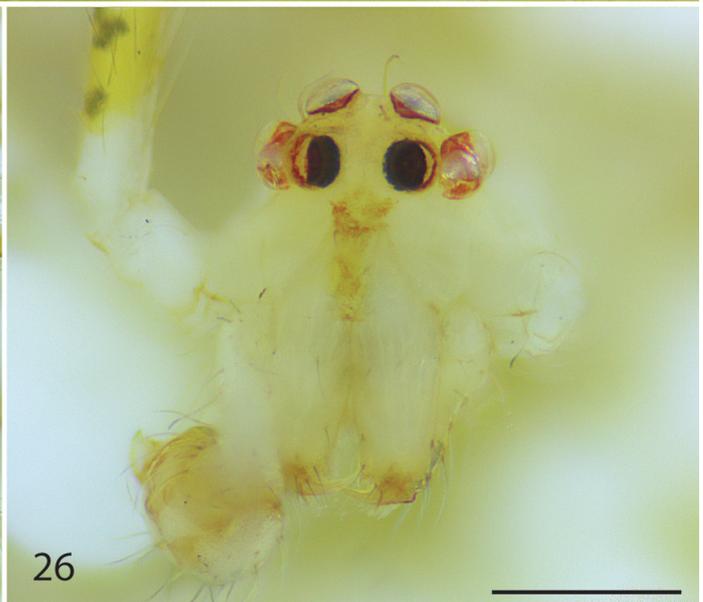
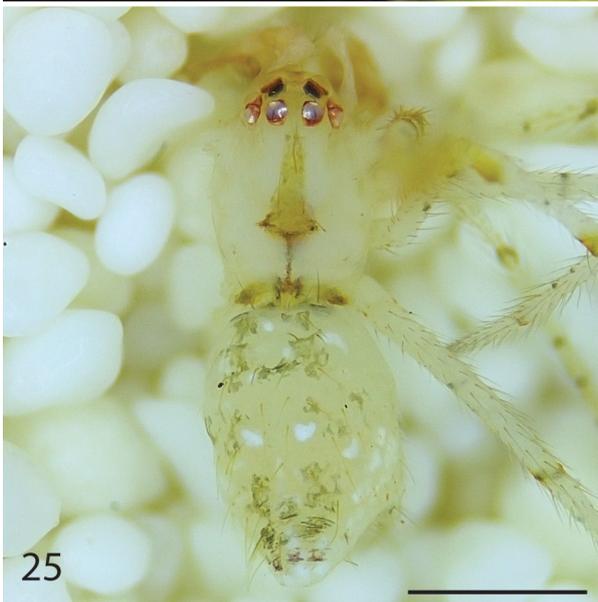
FIGURES 7–11. *Meotipa sahyadri* n. sp., female **7** Flattened setae on Leg IV **8** Flattened setae at abdomen base **9** Flattened, Cylindrical setae, Slit sensillum (inset and arrow) on leg IV **10** trichobothrium on leg IV **11** Tarsal comb on tarsus IV, close-up (inset). Scale lines: 0.75 mm (Fig. 7–8).



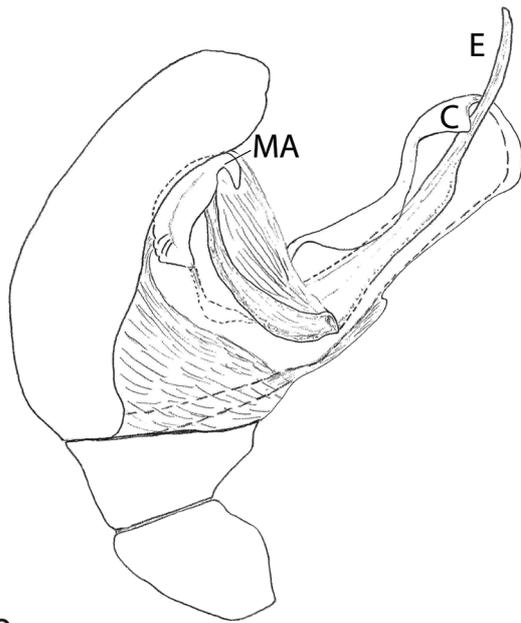
FIGURES 12–17. *Meotipa sahyadri* n. sp., female **12** Live female, anterior view **13** Live female, lateral view (note the translucent part of abdomen) **14** Spinnerets **15** Anterior lateral spinnerets **16** Posterior median spinnerets **17** Posterior lateral spinnerets.



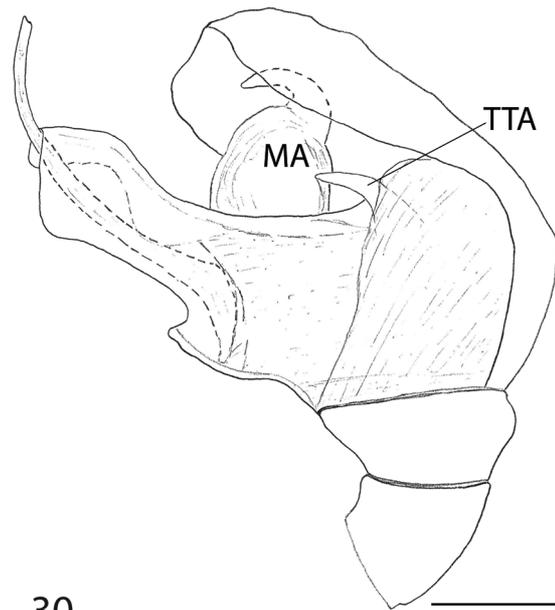
FIGURES 18–23. *Meotipa sahyadri* n. sp., epigynum 18 dorsal view 19 antero-ventral view tilted at 45 degrees 20 Ventral view 21 Posterior view 22 Epigynal projection 23 glands on spermathecal surface. Scale lines: 0.1 mm (Figs. 18–21).



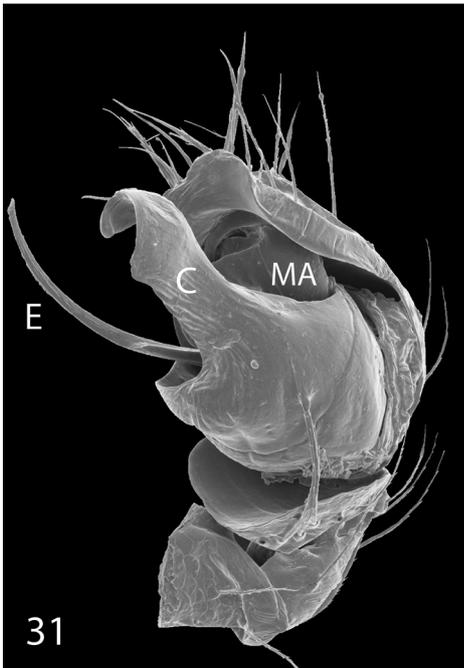
FIGURES 24–28. *Meotipa sahyadri* n. sp., male **24** live on female web **25** habitus, dorsal view **26** cephalothorax, anterior view **27** Habitus, ventral view **28** Habitus, lateral view. Scale lines: 0.5 mm (Figs. 25, 27–28); 0.2 mm (Fig. 26).



29



30



31



32



33

FIGURES 29–33. *Meotipa sahyadri* n. sp., male, left palp 29 ventral view 30 retro-lateral 31 pro-lateral view 32 Mesal view 33 Dorsal view. Scale lines: 0.1 mm (Figs. 29–30).

Type material. Holotype female, (BNHS Sp. 358), 12.i.2016, Botanical Garden, Yashwantrao Chavan Institute of Science, Satara (17.685 N, 74.011 E, 707 m), INDIA, coll. S. Kulkarni & V. Deshpande.

Additional material studied. 1 male, 1 female (BNHS), xi.2011, (type locality), coll. S. Kulkarni; 1 female (BNHS Sp. 71), (type locality), ix.2013, coll. S. Kulkarni and Y. Koli; 1 female (BNHS Sp. 98), (type locality), viii.2012, coll. S. Kulkarni; 3 females, (BNHS) x.2016, (type locality), coll. S. Yadav. 1 male, 1 female (BNHS Sp. 357), 16.xi.2014, Sanguem (15.229 N, 74.150 E, 58.9 m), Goa, INDIA, coll. D. Halali. 1 female, ix. 2014, near Bharuch (21.658 N, 72.956 E, 30.9 m), Bharuch District, Gujarat, INDIA, coll. P. Patel. 2 male, 9 females, (BNHS Sp. 359), 14.i.2015, near Boisar (19.800 N, 72.707 E, 13 m), Maharashtra, INDIA, coll. A. Vartak. 1 female, (BNHS), ix. 2013, Devihansol (16.744 N, 73.427 E, 140.5 m), Ratnagiri District, Maharashtra, INDIA, coll. S. Kulkarni.



FIGURES 34–38. *Meotipa sahyadri* n. sp., live female **34** with egg sac, underleaf **35** feeding on caterpillar **36** typical ‘*Meotipa*’ resting position **37** melanized form **38** unknown deposition in translucent part of abdomen.

Description. Female (holotype).

Measurements. Total length—5.4 mm, Carapace length—1.93 mm, width—1.5 mm, height—1.08 mm. Abdomen length—3.3 mm, height—5.1 mm, Leg I—5.38/0.55/3.56/4.42/0.69, Leg II—3.78/0.55/2.21/3.14/0.71, Leg III—2.8/0.51/1.8/2.3/0.7, Leg IV—4.98/0.67/3.07/4.56/0.85.

Medium-sized, grossly yellowish-white spider.

Cephalothorax: Carapace with dark brown inverted ‘Ψ’ (psi) mark, lateral margins brown (Fig. 1). Clypeus with mid-longitudinal brown stripe, narrowed at base, four times longer than AME diameter. AME dark except on lateral sides, all other eyes pearly white (Fig. 2). Chelicerae white, surface smooth, bearing one anterior, two pro-marginal, one retro-marginal tooth; whiskered PES at base and stridulatory ridges on dorso-lateral and ventro-lateral surface (Fig. 3). Fang surface dorsally smooth, ventrally serrated (Figs. 3, 4). Labium trapezoid, maxillae oval, both pale white; sternum sub-triangular, folded inwards at coxae (Fig. 5). In lateral view, cephalic region flat, thorax elevated distally (Fig. 6).

Legs: Legs slender, with brown, discrete rings on femora, tibia distally brown, metatarsus apically darker; black FS on patella to tibia (Fig. 7); these setae longitudinally striated, bearing spinules and sharp apically (Fig. 9). Cylindrical, forwardly pointed setae bearing spinules on all legs (Fig. 9). Tibia, metatarsus bearing row of slit sensilla (Fig. 9) and short trichobothria (Figs. 9, 10). Tarsal comb with elevated base, straight serrations, distinctly notched (Fig. 11) typical to that of Theridiinae (Agnarsson 2004).

Abdomen: tall, colour pale yellow, mottled with pearly white guanine spots, scattered brown, black pattern on dorsum (Fig. 12); laterally white, basal one-third white translucent in live specimens (Fig. 13) (turned opaque white in ethanol); back side of abdominal apex margined with dark brown lines; black FS on apex and base (Fig. 8).

Spinnerets: Spinnerets white with pair of brown dots and lines laterally. Arrangements of spigots on ALS, PMS, PLS similar to that of other Theridiinae (Fig. 14). About 40 piriform spigots on ALS (Fig. 15). One cylindrical spigot on PMS (Fig. 16) and two on PLS (Fig. 17), each with short base. Flagelliform spigot on PLS longer than its cylindrical spigot length. Two aciniform spigots on PMS. Shaft of minor ampullate spigot longer than cylindrical spigot on PMS.

Epigynum: small, CD longer than spermatheca diameter (Fig. 18). Epigynal projection emerging out medially from atrium (Fig. 19), perpendicularly (Fig. 20); its length slightly exceeding rim of atrium, lateral margins curved up to middle margin, converged apically (Fig. 21), its head trifold (Fig. 22). CO located underside of this projection.

Epigynal projection: Deeleman-Reinhold (2009) referred this term as ‘rod-shaped projection’ in *M. picturata*. In both, *M. sahyadri* n. sp. and *M. picturata*, it arises from the inward fold of upper margin of atrium (Figs. 22, 43) and CO located underside of it.

Variation (in females). Total length in 15 other females: 4.5 mm–5.6 mm, abdominal height: 4.7 mm–6.1 mm. The inverted ‘Ψ’ (psi) mark on carapace discrete in 9 females. Flattened setae on legs and abdomen detach easily in alcohol.

Description. Male. Measurements. Total length—1.25 mm, Carapace length—0.59 mm, width—0.39 mm, height—0.35 mm. Abdomen length—0.66 mm, height—0.83 mm, Leg I—1.28/0.18/0.9/1.17/0.48, Leg II—0.8/0.51/1.8/2.3/0.7, Leg III—0.77/0.20/0.52/0.66/0.32, Leg IV—0.85/0.16/0.45/0.87/0.39.

Small-sized, grossly yellowish-white at life, pattern similar to female (Fig. 24).

Cephalothorax: Carapace with complete mid-longitudinal brown stripe (Fig. 25), flat, covered with long setae. Clypeus with mid-longitudinal brown stripe, 2.2 times longer than AME diameter. Eye arrangement and colour similar to female. Chelicerae, labium, maxillae pale white (Fig. 26, 27). Labium trapezoid, maxillae oval, both pale white; sternum sub-triangular, 1.7 times longer than wide, uniform margin at coxae (Fig. 27).

Legs: Colour pattern similar to female, with cylindrical forwardly pointed setae, devoid of flattened setae.

Abdomen: pale white devoid of any translucence, with dark green spots on dorsum and venter, white guanine patches laterally. Abdominal shape triangular in lateral view, not elevated in comparison to female (Fig. 28).

Palp: Conductor mostly membranous, folded along length, broader and chitinous apically (Figs. 29, 30). Embolus exceeding conductor length (Figs. 29–31), broader at base, narrow apically (Fig. 32). Tegulum and sub-tegulum separated by thin margin (Fig. 33).

Distribution. Known from localities in the northern Western Ghats in India (see material examined, map Fig. 45).

Natural History. Females were observed with egg cases during post-monsoon months of September–October (Fig. 34). We observed more than one male on a female’s web. The rarity of males is known in *Meotipa*, where sex

ratio is biased towards females (Deeleman-Reinhold 2009). We collected 3 males and 18 females, however since our sampling was occasional, sex ratio in *M. sahyadri* n. sp. was not quantified.

The sampling sites included a botanical garden (type locality) and secondary forest (other localities) where we found that *M. sahyadri* n. sp. constructs web only on broad leaved plants viz. Fig *Ficus* sp., Teak *Tectona grandis* and Chapha *Plumeria* sp., at a height between 1–3 metres above the ground, but we did not locate them above 3 metres height. Each leaf had only one female web, although a branch with three leaves had a female on each. A caterpillar was observed captured in the web and being fed by female spider (Fig.35).

The resting position of adult and sub-adult female *M. sahyadri* n. sp. (Fig. 36) is similar to other *Meotipa* species during the day as described by Deeleman-Reinhold (2009); males are active diurnally. It remains motionless during the day, active during dark and has small web restricted to underside of leaf.

On a teak tree leaf located in busy industrialized region, a darker colour morph of *M. sahyadri* n. sp. was collected (Fig. 37). We could not locate any more specimens in that region or such darker forms in other localities. In spite of the darker body colour, the translucent part of abdomen and legs observed. Eggs were visible from the translucent part of abdomen.

There is no significant ontogenic colour variation based on our observations of first, second, third instars and adults of 28 live specimens from the type locality. We are not sure if the white translucence at part of abdomen is devoid of pigments and exploring that is beyond the scope of this paper. Some females had black deposition below the hypodermis of abdomen (Fig.38), possibly excretory product; however, we could not determine its nature.

***Meotipa picturata* Simon, 1895**

(Figs 39–44)

Meotipa picturata Simon, 1895: 133 (Df).

Meotipa picturata Levi & Levi, 1962: 47, f. 112–113 (f).

Meotipa picturata Deeleman-Reinhold, 2009: 410, f. 1–3 (f).

Diagnosis. as in Deeleman-Reinhold (2009).

Type material. (not examined) Female, MNHN AR 2009 Kodei Kanel, Tamil Nadu, India.

Material examined. 3 females (BNHS Sp. 355), Collem (15.339 N, 74.240 E), South Goa District, Goa, India, Dhiraj Halali.

Description. Female

Measurements. Total length—3.84 mm, Carapace length—1.65, width—1.1 mm, height—0.87 mm. Abdomen length—2.14 mm, height—3.39 mm, Leg I—5.2/0.71/3.27/5.15/0.89, Leg II—3.44/0.46/1.86/2.97/0.68, Leg III—2.1/0.38/1.2/1.77/0.67, Leg IV—4.76/0.75/3.09/3.03/1.37.

Carapace pale yellow. Eyes arrangement and coloration similar to *M. sahyadri* n. sp. (Fig.39). Black FS on patella to tibia, abdominal base and apex (Fig.40). Abdomen triangular, shorter than *M. sahyadri* n. sp., surface covered with brown and silver guanine spots (Figs. 39, 40); ventrally without any colour pattern (Fig. 41). Epigynum small, CD longer than spermatheca diameter (Fig.42). Epigynal projection quadrangular, emerging perpendicularly outwards from inner side of upper margin of atrium (Fig. 43). CO situated underside of epigynal projection (Fig.44).

Distribution. Known from India, Indonesia, Laos and Thailand (Fig. 45).

***Meotipa andamanensis* (Tikader, 1977) new combination**

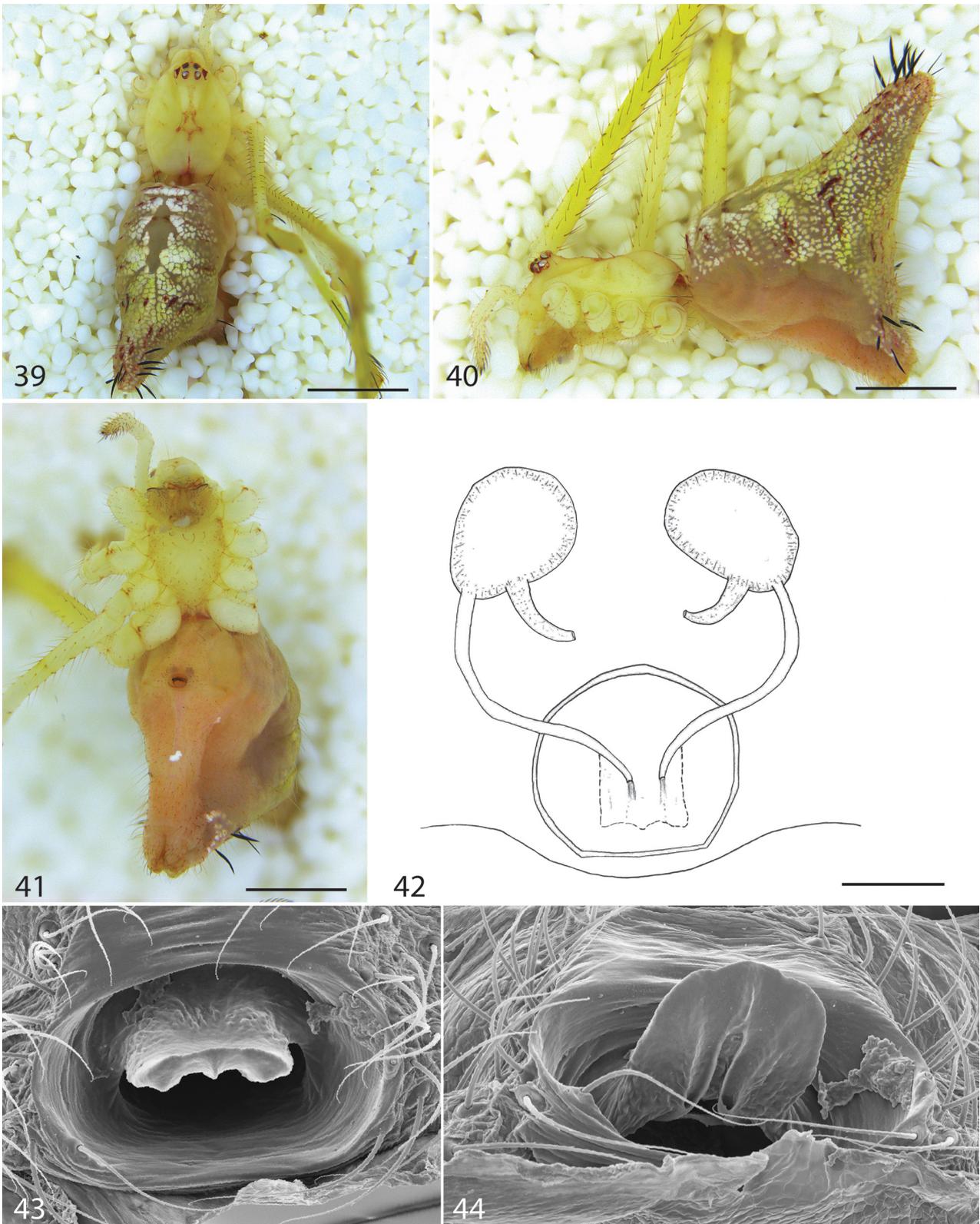
Argyrodes andamanensis Tikader, 1977: 170, f.7A–B (Df)

Holotype (not examined): Female, ZSI, Chiriatapu, South Andaman, India.

Original description and illustration of *Argyrodes andamanensis* mentioned black FS on legs and abdomen, shape of abdomen and colour pattern of white and brown patches (Tikader 1977). These characters as well as the illustrations provided by the author match closely with the type species *M. picturata* and thus leaves no doubt that *A. andamanensis* should be transferred to the genus *Meotipa* following the current diagnosis by Deeleman-

Reinhold (2009). Therefore we propose the new combination here as *Meotipa andamanensis* (Tikader, 1977) **n. comb.**

Distribution. Known from Chiriatapu, South Andaman, India.



FIGURES 39–44. *Meotipa picturata*, female. **39** habitus dorsal view **40** habitus, lateral view **41** habitus, ventral view **42** epigynum, dorsal view **43** epigynum, ventral view **44** copulatory openings at base of atrium. Scale lines: 1 mm (Figs. 39–41); 0.1 mm (Fig. 42).

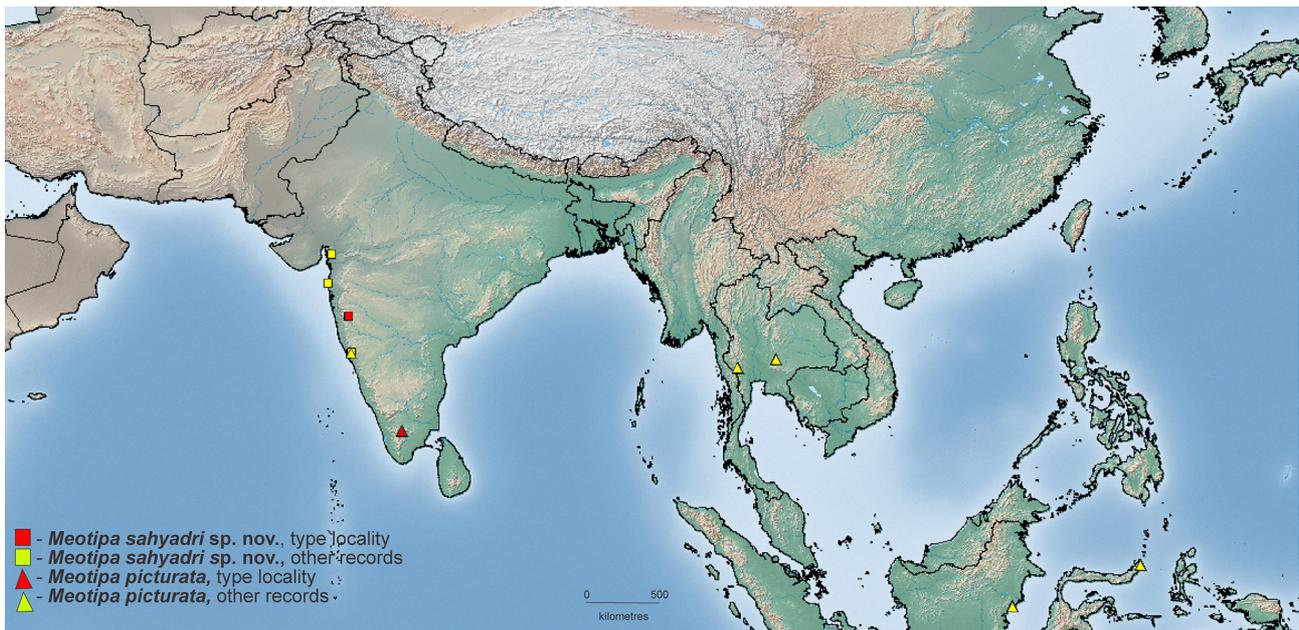


FIGURE 45. Distribution of specimen records of *Meotipa sahyadri* n. sp. and *Meotipa picturata*.

Phylogenetic analyses

A single most parsimonious tree was obtained under equal weights (Fig. 46) and for each implied weight ($k=1-17$). For equal weights, tree length 780, fit 71.65 (adjusted homoplasy), total fit 159.34, consistency index 0.366 and retention index 0.737 was obtained. With equal weights and implied weights ($k=1-17$), *Meotipa sahyadri* n. sp. and *M. picturata* were obtained monophyletic, placed within the sub-family Theridiinae and as sister to *Chrysso* cf. *nigriceps* with Bremer support eight and bootstrap 100. The sister group relationship of *Chrysso* with *Meotipa* is supported by following synapomorphies: broad cymbial hood (character 38), presence of subconductor (character 70), distinct apophysis on central region of median apophysis (character 76), separate patches of sclerotization on abdominal pedicel area (character 148) and weakly keeled stridulatory pick row (character 151). The monophyly of *Meotipa* is supported by following synapomorphies: copulatory pore under epigynal projection (character 4), longitudinal dark band on carapace (character 125), clypeus extending beyond interocular area (character 130), clypeus with a prominent projection (character 131), abdominal colour pattern in alcohol without folium, uniform (character 143), tibia I shorter than metatarsus I (character 187), curved serrations on tarsus IV comb (character 195) and presence of epigynal rod (character 243).

Bayesian inference also corroborates with the placement of *M. picturata* and *M. sahyadri* n. sp. within the sub-family Theridiinae and as sister to *Chrysso* cf. *nigriceps* with a 100% posterior probability (Fig. 47).

Discussion

The sister relationship of *Meotipa* with *Chrysso* obtained in the present study agrees with the morphological phylogeny proposed by Eberhard *et al.* (2008). However, the results with molecular data have been contrasting. Based on DNA sequences, an undetermined *Meotipa* species from Malaysia was placed as sister to *Theridion* species using Bayesian analyses (Agnarsson *et al.* 2007). Arnedo *et al.* (2007) obtained the *Meotipa* terminal within *Achaeranea* clade comprising the genera *Achaeranea*, *Arctathea*, *Takayus*, *Echinotheridion* and *Tidarren* with molecular data using parsimony and Bayesian analyses. Liu *et al.* (2015) placed the *Meotipa* terminal sister to *Takayus lyricus* and *Theridion palmgreni* based on nucleotide sequence and morphological data (Liu *et al.* 2015). The sister clade of the latter group also included *Achaeranea* sp., *Tidarren* sp. and *Chrysso octomaculata*. However, this position was inferred by representation of *Meotipa* by two genes, while many other taxa represented five genes plus morphological characters (Liu *et al.* 2015).

The phylogeny obtained in our study was limited by not having morphological characters for other *Meotipa* species that lack the epigynal projection and male *M. picturata* which can plausibly affect the topology as discussed above. From our study and previous studies, it is observed that *Meotipa* is placed within Theridiinae by morphological, molecular and total evidence analyses. However, morphology alone places *Meotipa* as sister to *Chryso* whereas molecular phylogeny and the total evidence analyses infer variable placements within Theridiinae.

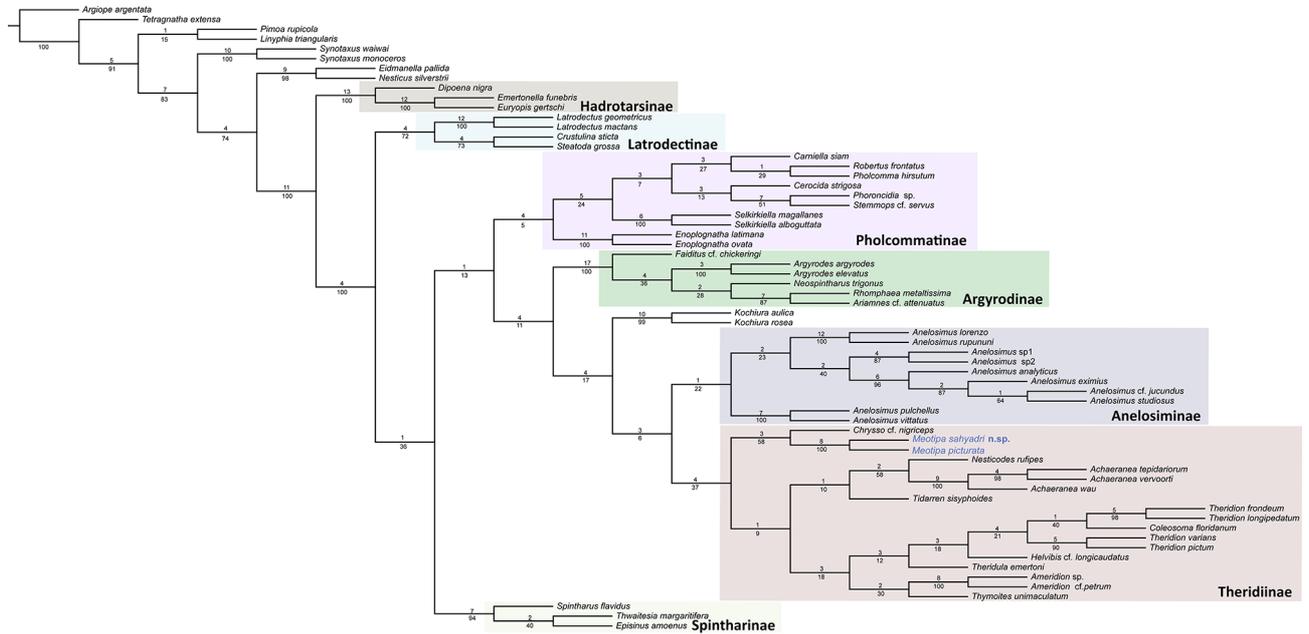


FIGURE 46. A single most parsimonious tree under equal weights of theridiid spiders based on morphological characters with numbers above branches indicating Bremer's support and below indicating bootstrap values.

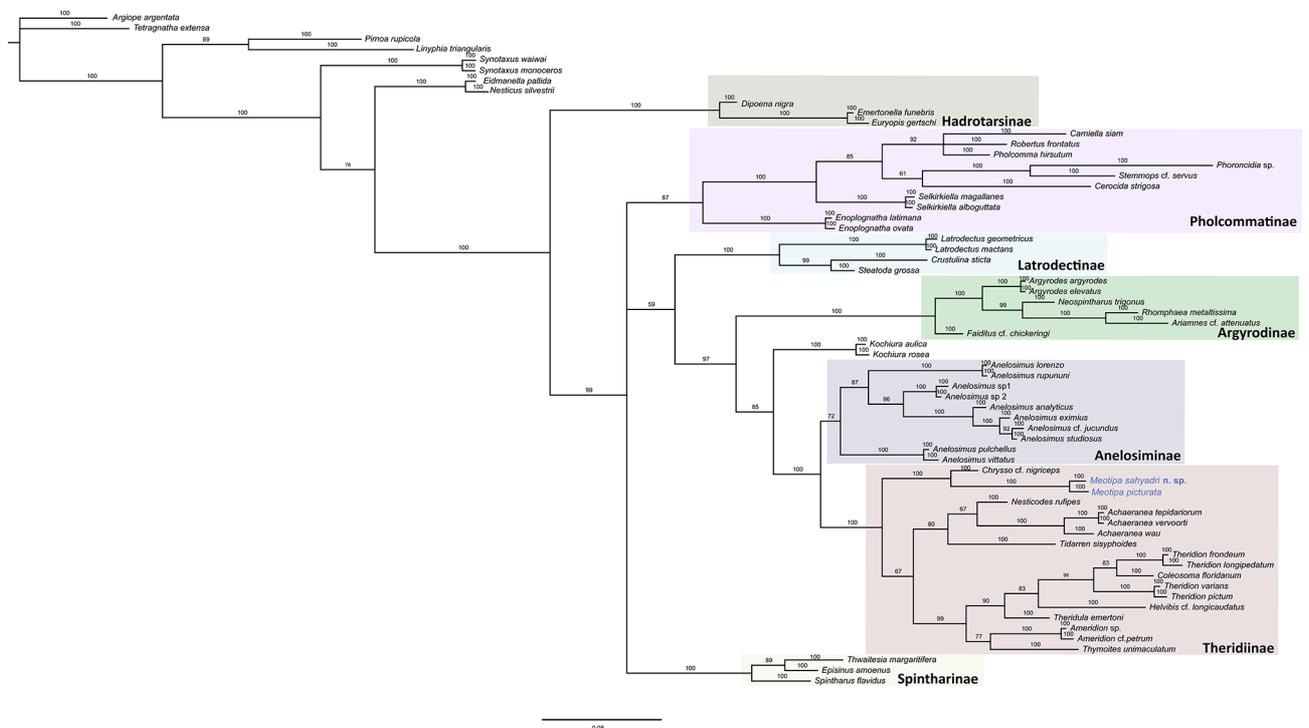


FIGURE 47. Bayesian tree of theridiid spiders based on morphological characters using Mk model based on the morphological characters with posterior probability values above the branches.

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SUPPLEMENTARY file. Character state matrix for *Meotipa picturata* and *Meotipa sahyadri* n. sp. with character descriptions following Agnarsson (2004) and additional character (Character 243).

Meotipa sahyadri n. sp.

00-20200-00001111220000000001-111----10020000000100000010?0001000000100000100-
1000000000000000011000000100110300000000001001000021001000100011--111110?00010?001?
11101011?1-1-00011100111000000111001?00001010000000111?10103106???0?01010?????1

Meotipa picturata

00-20200-0000??
10011030??0?00?0010?1000021??1000100011--1?1110?00010?001?11101???1-1-00011110?
11000000111001?00001010000000111?1?10310301??0?010???????1