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Phylogenetic placement of *Flacillula* Strand, 1932 with seven new species from Sri Lanka (Araneae: Salticidae)

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Abstract

The Oriental jumping spider genus *Flacillula* Strand, 1932 has remained taxonomically un-revised and has never been subjected to phylogenetic evaluation. Due to its ambiguous circumscription, several species not sister to its type species were subsequently placed in it, rendering the genus a "holdall." This study is designed to investigate the monophyly of the genus, its placement within the subtribe Simaethina Simon, 1903, and to review its composition. Using two target genes (*28S*, *COI*), we provide the first hypothesis on the internal phylogenetic structure of the genus and its placement within Simaethina. Additionally, we describe seven new species: *Flacillula dothalugala* sp. nov., *Flacillula ellaensis* sp. nov., *Flacillula henryi* sp. nov., *Flacillula hodgsoni* sp. nov., *Flacillula johnstoni* sp. nov., *Flacillula naipauli* sp. nov., and *Flacillula piyasenai* sp. nov. Further, the following new combinations are proposed: *Iona minuta* (Berland, 1929) comb. nov. and *Iona nitens* (Berry, Beatty & Prószyński, 1997) comb. nov. The newly described species might be endangered due to their small population size and restricted distribution in high-altitude cloud forest.

KEYWORDS
biogeography, evolution, invertebrates, Islands, South Asia

1 | INTRODUCTION

Jumping spiders (Salticidae Blackwall, 1841) are a highly diverse family of 658 described genera and over 6343 described species (World Spider Catalog, 2021). They are also the most species-rich lineage of spiders in Sri Lanka. Salticidae species are small- to large-sized, diurnal hunters (Foelix, 2011) that grab their prey using their chelicerae and front pair of legs (Bartos, 2013; Bear & Hasson, 1997; Edwards & Jackson, 1993; Forster, 1997; Harland & Jackson, 2004; Li & Jackson, 2003; Li et al., 2003). Their eye structure, complex vision-based courtship displays, mimicry, and predator ecology make them ideal model organisms for the study of visual physiology, behaviors and other evolutionary phenomena (Benjamin, 2004; Foelix, 2011; Jackson & Pollard, 1996; Kanesharatnam & Benjamin, 2016; Richman & Jackson, 1992).

Flacillula Strand, 1932 was erected as a replacement name for *Flacilla* Simon, 1901a (preoccupied in Gastropoda) for specimens collected in Sri Lanka. Simon (1903) placed *Flacillula* in his Salticidae group Flacilleae. Maddison (2015) provisionally placed *Flacillula* in the salticinae subtribe Simaethina, because of their robust bodies and genitalia typical of other Simaethines. *Flacillula* has never been subjected to phylogenetic evaluation.

Prior to this endeavor, *Flacillula* included six species: *Flacillula albofrenata* (Simon, 1905), *Flacillula incognita* (Zabka, 1985), *Flacillula lubrica* (Simon, 1901a), *Flacillula minuta* (Berland, 1929), *Flacillula nitens* (Berry et al., 1997), and *Flacillula purpurea* (Dyal, 1935). According to Simon (1901a), members of this genus are characterized by their robust first pair of legs, with one prolateral spine on the metatarsus and their other legs being spineless. Recently, *F. lubrica*

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was rediscovered in a forest fragment in the Southern Province of Sri Lanka. Additionally, seven new species were also discovered.

In this study, we investigate the monophyly of the genus *Flacillula* using two target genes, re-circumscribe *Flacillula* based on phylogenetic relationships, and infer its placement within the subtribe Simaethina Simon, 1903. In addition, the type species *F. lubrica* is re-described and seven new species are described.

2 | MATERIALS AND METHODS

2.1 | Taxon sampling

Fieldwork was conducted in all climatic regions of Sri Lanka (Koelmeyer, 1958). Spiders were collected by beating vegetation and general hand collection. The collected specimens were preserved in either 70% or 100% ethanol. A total of 24 specimens were examined and a total of 14 new sequences were generated for this study. Additionally, 57 sequences were obtained from GenBank (accession numbers are given in Table 1). The genera *Heliophanus* and *Frigga* were used to root the phylogenetic tree. Selection of all taxa relied on the recently published study on the molecular phylogeny of Salticidae (Maddison, 2015).

2.2 | Morphology

Specimen preserved in 70% alcohol were examined using a Leica S9E binocular stereomicroscope. Male palps (left) were dissected and immersed in methyl salicylate, slide mounted, observed, and illustrated with the aid of an Olympus BX51 compound microscope with an attached drawing tube. Highly sclerotized or darker areas of palps and epigynum were shaded with an HB pencil. The female epigastric region was dissected and digested in a pancreatin solution (Alvarez-Padilla & Hormiga, 2007) for about 3–7 days, slide-mounted, and illustrated as described above. Digital images of the specimens were taken using a Leica MC170 HD camera mounted on a Leica M205C stereomicroscope using the software package Leica Application Suite, LAS 4.6.2 (Leica Microsystems Limited). Acquired image stacks of different depths (20–50 images per stack) were assembled using Helicon Focus (version 6, Helicon Soft Ltd) to create a single image with the entire specimen in focus. All measurements are in millimeters. Body length was measured as carapace length plus abdomen length (excluding spinnerets). Types and other specimens of the new species described herein are currently in the National Institute of Fundamental Studies (NIFS) and will be deposited in the National Museum of Sri Lanka, Colombo.

2.3 | Abbreviations

ALE, anterior lateral eyes; AME, anterior median eyes; CO, copulatory opening; CA, cymbial apophysis; CF, Cymbial flange; Cy, cymbium; E, embolus; EP, epigynal pocket; FD, fertilization duct; PLE, posterior lateral eyes; PME, posterior median eyes; RTA, retrolateral tibial apophysis; S1, S2, spermathecae; T, tegulum; Ti, tibia.

2.4 | Other abbreviations

FR, forest reserve; NP, national park; SNR, strict nature reserve.

2.5 | Target genes and primers

A multilocus molecular approach was used for this study and the target loci were selected based on prior molecular phylogenetic studies of Salticidae (e.g. Bodner & Maddison, 2012; Hedin & Maddison, 2001). Partial fragments of the nuclear gene, *28S* ribosomal RNA (*28S*) and mitochondrial protein-coding gene, *cytochrome c* oxidase subunit I (*COI*) were amplified. *COI* gene region is more suitable to resolve more recent evolutionary events, whereas *28S* is more effective in resolving deeper nodes in phylogenetic trees (Edgecombe & Giribet, 2006). Details of each primer pair used, expected amplicon length (bp, number of base pairs), annealing temperature/time, primer sequences, and related references are given in Table 2.

2.6 | DNA extraction, PCR, and sequencing

Genomic DNA was extracted from ethanol-preserved leg tissue (balance of each specimen is vouchered in the NIFS arachnid collection) using the Qiagen DNeasy Tissue Kits (Qiagen). Extracted DNA was stored at −21°C until required for polymerase chain reaction (PCR). PCRs were carried out in total reaction mixes of 20 ml, including 2 ml of undiluted DNA template, 1.6 ml of each primer (10 pM/ml), 2 ml of "QSolution," and 10 ml of "Multiplex PCR Master Mix," containing hot start Taq DNA polymerase and buffers. The latter components come with the "Multiplex PCR" kit from Qiagen. Additionally, some PCRs were performed using Taq polymerase as follows: total reaction mix 20 µl, including 7.5 µl of water, 0.5 µl each of forward and reverse primers (10 pm/µl), 3.0 µl of buffers, 3.0 µl of $MgCl_2$, 1.0 µl of dNTP, 0.5 µl of Taq polymerase, and 4.0 µl undiluted DNA template. A negative control (minus the template) was included to test for contamination during all PCR runs. Targeted genes and primers used for amplification and their sources are given in Table 2. Amplicons were verified by size on a 1% agarose gel and purified using Gene Clean™ Turbo Kit (MP Biomedicals, LLC). All purified amplicons were Sanger sequenced (Sanger et al., 1977) in both directions by MACROGEN.

2.7 | Phylogenetic analysis

Sequences were edited, trimmed, and assembled using the Geneious 11.0 software package. New sequences generated by

TABLE 1 Details of exemplars used in this study including collection localities, GenBank accession numbers and NIFS voucher numbers. Accession numbers in bold denote sequences generated for this study. All species belong to the family Salticidae

Species	Voucher number	Geographic origin	*28S*	*COI*
Flacillula lubrica	NIFS_Sal_688	SL, SP, Hiyare	–	**MT654541**
Flacillula piyasenai	NIFS_Sal_473	SL, CP, Horton Plains	–	**MT654543**
Flacillula piyasenai	NIFS_Sal_1212	SL, CP, Horton Plains	–	**MT654544**
Flacillula johnstoni	NIFS_Sal_1082	SL, CP, Piduruthalagala	–	**MT654538**
Flacillula johnstoni	NIFS_Sal_1098	SL, CP, Piduruthalagala	**MT654533**	**MT654539**
Flacillula johnstoni	NIFS_Sal_1213	SL, CP, Horton Plains	**MT654532**	**MT654540**
Flacillula hodgsoni	NIFS_Sal_147	SL, CP, Thangapuwa	–	**MT654535**
Flacillula hodgsoni	NIFS_Sal_517	SL, NCP, Ritigala FR	**MT654531**	**MT654536**
Flacillula hodgsoni	NIFS_Sal_1188	SL, NCP, Ritigala FR	–	**MT654537**
Flacillula naipauli	NIFS_Sal_1006	SL, CP, Udaperadeniya	**MT654534**	**MT654542**
Iona minuta		French Polynesia	–	KX053225
Iona minuta		French Polynesia	–	KX053226
Iona minuta		French Polynesia	–	KX053227
Iona minuta		French Polynesia	–	KX053228
Iona minuta		French Polynesia	–	KX053229
Simaetha sp.		Australia	EU815477	EU815592
Ligurra latidens		Singapore	EF419026	EF419091
Ligurra latidens		Singapore	EF419059	KY017896
Ligurra latidens		Singapore	JX145749	JX145675
Mopsus sp.		New Caledonia	EU815518	EU815623
Heratemita alboplagiata		Philippines	AF327934	AF327991
Myrmarachne evidens		Gabon	JX145752	JX145678
Myrmarachne foenisex		Gabon	JX145753	JX145679
Myrmarachne japonica		China	JN817063	JN817283
Myrmarachne gedongensis		Malaysia	JX145750	JX145676
Peplometus sp.		Ghana	EU815515	EU815621
Ballus chalybeius		Germany	EF514398	EF514383
Afromarengo sp.		Gabon	JX145758	JX145682
Mantisatta longicauda		Philippines	AY297270	AY297399
Padilla mitohy		Madagascar	EF514377	EF514392
Gedea tibialis		Malaysia	KM033183	KM033223
Habrocestum albimanum		South Africa	EU815500	EU815611
Chinattus parvulus		USA	EU815464	EU815581
Hasarius adansoni		Pakistan	AY297281	AY297409
Bavia aericeps		Malaysia	EU815490	EU815603
Ghelna canadensis		USA	EF201651	KJ166721
Pelegrina aeneola		Canada	KY017331	KY017898
Sitticus ranieri		Canada	KY017336	KY017901
Sitticus palustris		Canada	DQ665778	DQ665760
Heliophanus cupreus		Poland	DQ665769	DQ665756
Frigga crocuta		Ecudor	AY297275	AY297402

Abbreviations: CP, Central Province; NCP, North Central Province; SL, Sri Lanka; SP, Southern province; UV, Uva Province.

TABLE 2 Gene targets, expected amplicon length, PCR conditions and primer data used in this study

Gene	Primers	Amplicon length (bp)	Annealing temperature/time	5′–Primer Sequence–3′	Reference
COI	C1-J-1718 (F)	400–500	47°C/50 s	GGA GGA TTT GGA AAT TGA TTA	Hedin and Maddison (2001)
	C1-N-2191 (R)			CCC GGT AAA ATT AAA ATA TAA ACT TC	Dallas et al. (2003)
	LCO-1628 (F)	500–600	48°C/50 s	ATA ATG TAA TTG TTA CTG CTC ATG C	Vandergast et al. (2007)
	C1-N-2191 (R)			CCC GGT AAA ATT AAA ATA TAA ACT TC	Vandergast et al. (2007)
28S	28S O(F)	700–800	55°C/45 s	GAA ACT GTC CAA AGG TAA ACG G	Hedin and Maddison (2001)
	28S C (R)			GGT TCG ATT AGT CTT TCG CC	Spagna and Gillipse (2008)

us together with sequences downloaded from GenBank (Table 1) were assembled, aligned, and edited manually using Mesquite 3.51 (Maddison and Maddison, 2018). This resulted in a total of 41 *COI* and 30 *28S* sequences. The protein-coding *COI* fragment was refined using protein sequence translations. Mesquite edited *28S* sequences (2766 bp) were subsequently treated with Gblocks 0.91b (Castresana, 2000; Talavera & Castresana, 2007) to cull positions of ambiguous homology as well as to reduce missing data at both ends. It should be noted that some of the sequences obtained from GenBank were significantly longer than the sequences generated by us leading to much longer final alignment lengths. Gblock parameters were defined as follows: a minimum number of sequences for a conserved position (50%), the maximum number of contiguous non-conserved positions (10), the minimum length of a block (5), and allowed gap positions (none). After Gblocks treatment, the final length of the *28S* alignment was 139 bp and the final *COI* alignment was 1228 bp. The final alignments of the two gene fragments were then concatenated using Mesquite, and the resulting alignment was 1367 bp in length. All three alignments are provided as Alignments S1–S3.

Model-based (maximum likelihood, ML) approach was used to infer the phylogenetic relationships of the targeted taxa. The best-fit model for likelihood analysis was searched by running the "find best DNA/protein model (ML)" option in MEGA X, and models with the lowest values of Bayesian Information Criteria and Akaike Information Criteria were selected. After selecting the model (GTR+G+I), the phylogenetic tree was obtained through the online server for RAxML (Boc et al., 2012; Stamatakis, 2006) performing 200 independent ML searches. The parameters used were as follows: substitution model (GTRGAMMAI), algorithm executed (Hill climbing -default), and the number of alternative runs on distinct starting trees (100).

A second set of analyses were performed using Bayesian methods as implemented in in MrBayes v 3.2.6, using default priors and unlinked model parameters (Ronquist & Huelsenbeck, 2003). The combined dataset (*COI*, *28S*) was partitioned to three partitions (first, second, and the third codon positions) using the Bayesian information criterion as implemented in PartitionFinder 2 on XSEDE (Lanfear et al., 2016) through the CIPRES Science Gateway v.3.3 (Miller et al., 2010). GTR+G+I was selected as the best-fit substitution model. The analysis was run for 4 million generations with two independent runs and four chains sampling every 1000 generations. The first 25% of sampled trees were discarded as burn-in. Convergence of the independent runs was assessed by examining split frequencies of clades across runs and effective sample sizes (ESS values) of the likelihood plots through time in Tracer v 1.7.1 (Rambaut et al., 2018). Branch support was estimated using 1,000 bootstrap pseudo-replicates for both analyses.

3 | RESULTS

3.1 | Phylogenetic analyses

The assembled matrix of the concatenated mitochondrial and nuclear markers included 57 sequences of 30 taxa; 15 of these sequences were newly generated for this study. The total length of the final matrix was 1367 bp. The best-fit model for the combined data matrix generated using MEGA was GTR+G+I and, accordingly, GTRGAMMAI was selected as the compatible model in RAxML.

The phylogenetic tree resulting from ML analysis of the combined data matrix is presented in Figure 1. The phylogenetic tree resulting from BI analysis is presented in Figure 2. All analyses recover a well-supported monophyletic *Flacillula*. It is sister to *Simaetha* in the ML analysis, inconclusive in the BI analysis because of the resulting polytomy. Within *Flacillula*, *Flacillula hodgsoni* is sister to *Flacillula naipauli* in the ML analysis. Those two species together are sister to *Flacillula johnstoni*. The relationship of *Flacillula piyasenai* and the type species *F. lubrica* to other congeners remain unresolved. *Flacillula johnstoni* is sister to all other *Flacillula* in the BI analysis. However, relationships within other *Flacillula* spp are inconclusive. *Iona minuta* (Berland, 1929) from French Polynesia, previously in *Flacillula*, forms a separate clade, not sister to the *Flacillula* of Sri Lanka in all analyses (Figures 1 and 2).

3.2 | Taxonomy

Family Salticidae Blackwall
Subfamily Salticinae Blackwall, 1841
Subtribe Simaethina Simon, 1903
Genus *Flacillula* Strand, 1932

Flacilla Simon, 1901a: 558 [junior homonym of *Flacilla* Koken, 1896: 92 (Gastropoda)].

Flacillula Strand, 1932 (replacement name for *Flacilla* Simon, 1901a).

Type species: *Flacilla lubrica* Simon, 1901a by original designation.

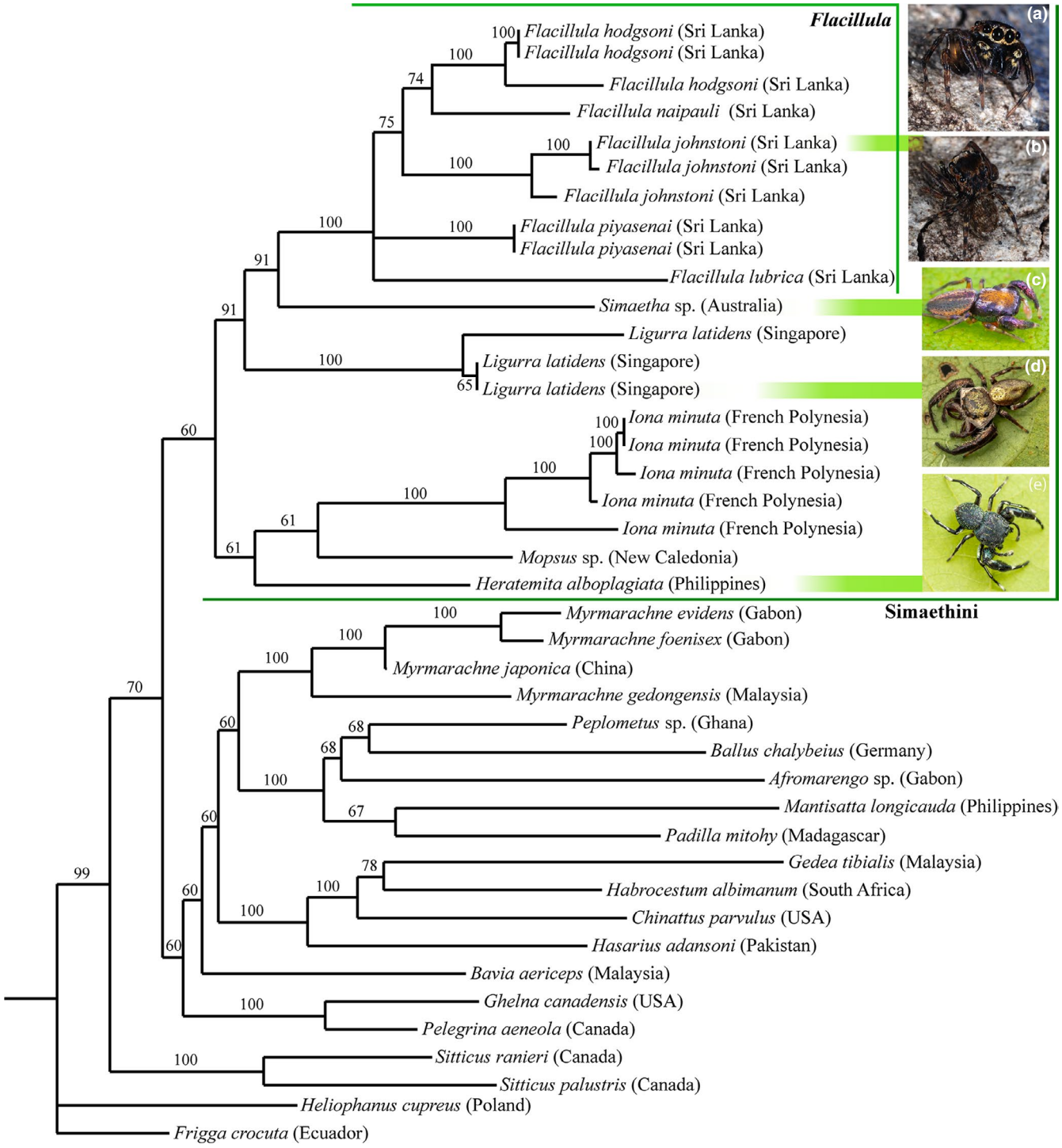

FIGURE 1 The single most likely tree obtained by ML analysis of the combined molecular data (*28S* and *COI*) in RAxML–VI–HPC. The numbers above the branches represent bootstrap values (only values 60 and above are given). Branches that are unsupported have been collapsed. In life images: (a), (b) *Flacillula johnstoni* sp. nov. from Sri Lanka; (c) *Ligurra latidens* from Singapore; (d) *Simaetha* sp. from Singapore; (e) *Heratemita* sp. Photo credits: Suresh P. Benjamin (a, b), Joseph K. H. Koh (c, d,e)

Diagnosis. Species of *Flacillula* can be separated from other Simaethina genera by the following characteristics: Small, round to oval body, prosoma with distinct species specific apodemes. Metatarsus I with apical spines which almost merge with hair, other legs spineless in both sexes. Male palpal tibia shorter or as long as the bulb, without modified leaf-like setae. retrolateral tibial apophysis (RTA) short, tapering, straight, not fully visible in ventral view. Subtegulum not visible in ventral view. Cymbium with retrotateral, proximal, species-specific modifications. Embolus (E) short, tapering, lateral/distal origin. Females with epigynal pockets (EP) covering the copulatory openings.

Description. Small spiders (body size 3.5–4.2). Prosoma long, flat, black smooth, shiny and with subparallel sides. Roughly rectangular in plan and about twice as long as broad. Resembling with narrow line of white hairs along the margin. Prosoma longer than abdomen, as broad as abdomen. Abdomen elongate and narrow, truncated at the front and tapering at the rear. There are some broken black and white lines dorsally with the sides pale and clothed with white hairs. Thoracic region marked by a small streak. Ocular field slightly raised. PME and PLE surrounded by black margins.

Chelicerale dark brown with oblique toothed margins, one retrolateral tooth, three pro-lateral teeth present. Labium longer than broad, maxillary lobes narrow and long, slightly divergent, sternum narrow at the base. Anterior eyes contiguous, in a recurved line. Eye formula, AME > ALE > PME > PLE. Legs are yellow in color, first pair strongly modified (robust) in both sexes, with elongated coxa, trochanter and patella. Femur, patella, tibia in Legs I are swollen. Legs I in male is longest and in female Legs IV is longest, II and III are same length in both sexes. Length of femur and patella in leg I equal to tibia and separated by a fine streak. Leg I: tibia in female with one submerged spine, the metatarsus and tarsus are short. The leg I: metatarsus I carries some strong spines ventrally in both sexes, no spines on other legs. Palp: tibia shorter that cymbium, tegulum simple, embolus moderately long and slender.

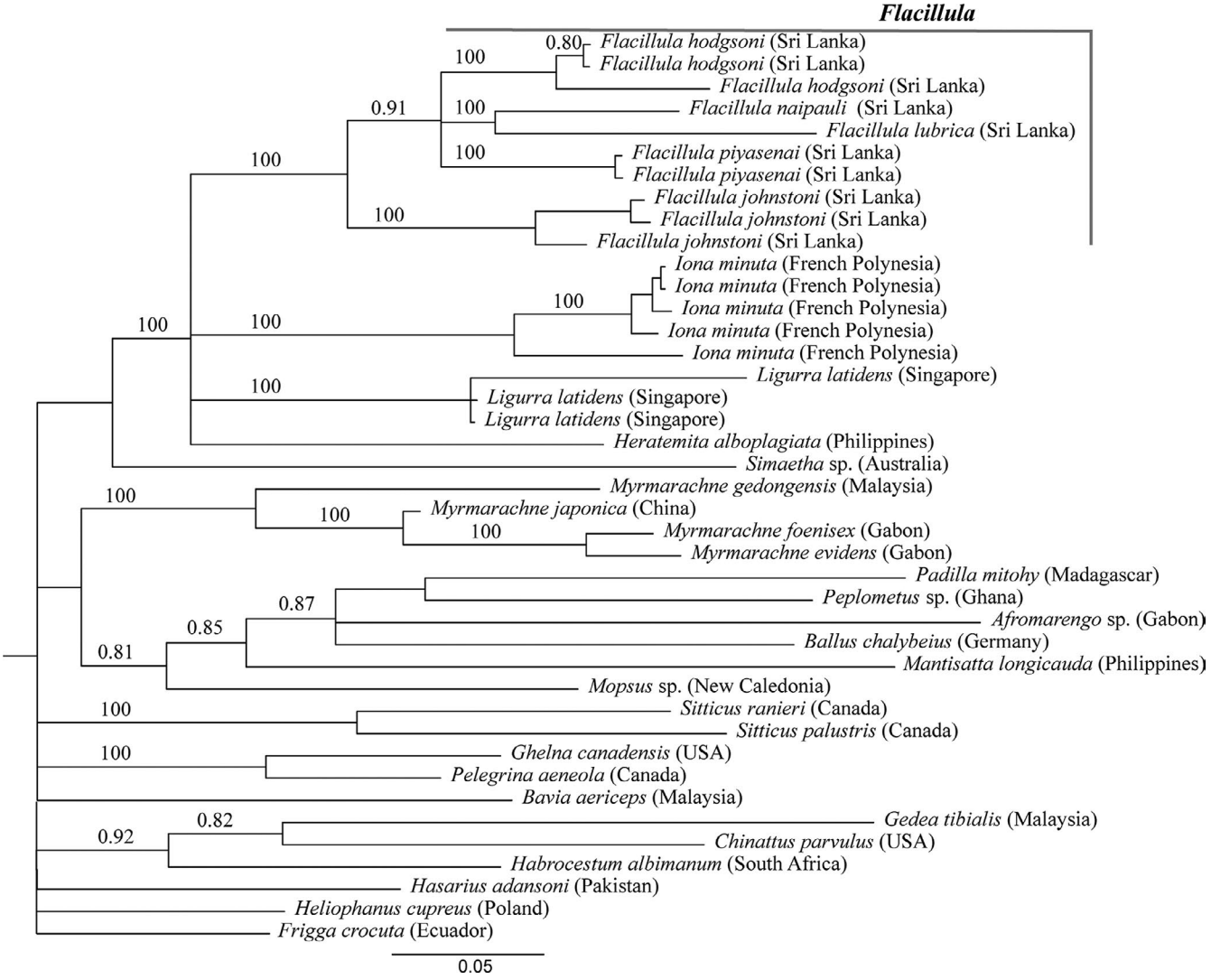

FIGURE 2 The phylogenetic tree obtained by analysis of the combined molecular data in MrBayes v 3.2.6, using default priors. The numbers above the branches represent posterior probabilities (only values 80 and above are given). Branches that are unsupported have been collapsed

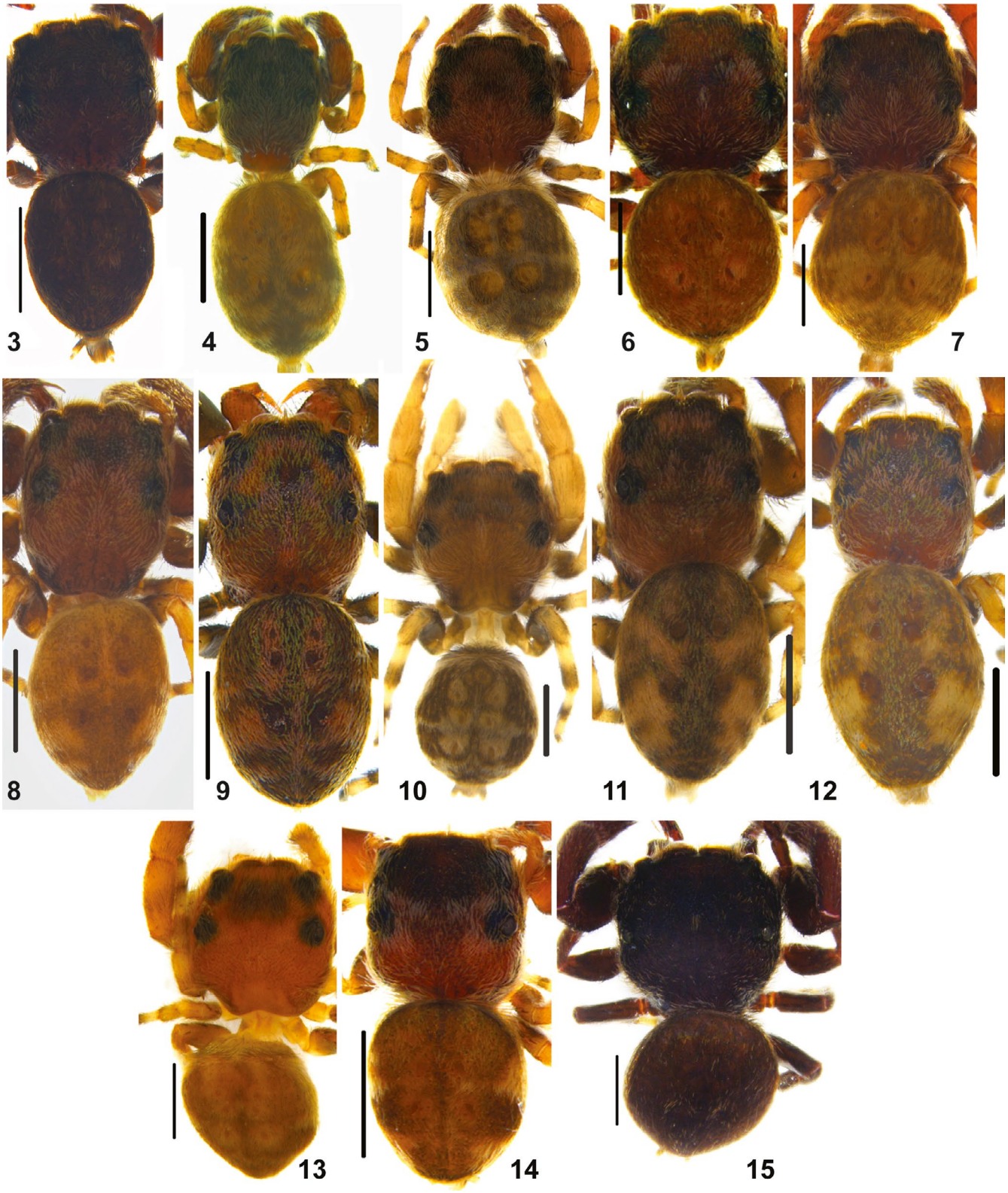

FIGURE 3–15 Habitus, dorsal view. 3, 4. *Flacillula dothalugala* sp. nov.; 5. *Flacillula ellaensis*, sp. nov.; 6, 7. *Flacillula henryi* sp. nov.; 8–10. *Flacillula piyasenai* sp. nov.; 9, 11, 12. *Flacillula johnstoni* sp. nov.; 13. *Flacillula lubrica*; 14. *Flacillula naipauli* sp. nov. 15. *Flacillula hodgsoni* sp. nov. 3, 6, 8, 9, 11, 13, 14. Male. 4, 5, 7, 9, 10, 12, 15. Female. Scale bars = 1 mm (3, 4, 6–9, 11–15); 2 mm (5, 10)

Composition. Eight species: *Flacillula dothalugala* sp. nov. *Flacillula ellaensis* sp. nov., *Flacillula henryi* sp. nov., *F. hodgsoni* sp. nov., *F. johnstoni* sp. nov., *F. lubrica* (Simon, 1901a), *F. naipauli* sp. nov. and *F. piyasenai* sp. nov.

Species misplaced. *Flacillula albofrenata* and *F. incognita* are most probably misplaced. *Flacillula albofrenata* is only known from its original description and more cannot be said without study of the type. *Flacillula incognita* Zabka, 1985 was described on the basis of a female (Zabka, 1985). We strongly suspect that this species is misplaced in *Flacillula*. Most probably this species is not even a Simaethini, as it lacks a central EP and two chambered spermathecae (S1 and S2) characteristic of all Simaethini. The enigmatic *F. purpurea* (Dyal, 1935) was described on the basis of a juvanile (Dyal, 1935). No illustrations are provided in the description. Depository of the syntype is unknown; currently no specimens from S. Dyal are found in the University of the Punjab. Thus, we declare this species name a *nomen dubium*. *Flacillula minuta* and *F. nitens* are transferred to *Iona*; see below.

Distribution. Currently known only from Sri Lanka. More species could be expected from South India.

Flacillula dothalugala sp. nov.

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(Figures 3, 4, 20, 21, 39, 40, 61, 62)

Type material: SRI LANKA: Central Province: male holotype (NIFS_Sal_1247) [17–18 October 2019, S.P. Benjamin et al.] Kandy District, Knuckles Mountain Range, Dothalugala nature trail (07°20′19″N, 80°51′3″E). Paratype: one female (NIFS_Sal_1253) same locality and collection data.

Additional material: SRI LANKA: Central Province: one juvenile (NIFS_Sal_1200) [17–18 October 2019, S.P. Benjamin et al.] same locality and collection data.

Habitat & distribution: Known only from the type locality. The spiders were collected by beating foliage up to a height of 2 m. This locality consists of submontane wet evergreen cloud forests and is part of the Dothalugala Man and Biosphere reserve.

Etymology: The specific epithet is taken from the type locality. Used as a noun in apposition.

Diagnosis: Similar to *F. johnstoni* sp. nov. Could be separated from other congeners by the RTA (longer), shape of the bulb (elongated oval) shape of the apical projection of the bulb (pointed; arrow in Figure 20) and the CA (prominent flange). Females could be separated by the shape of EP (as long as wide, shorter than that of *F. johnstoni* sp. nov.).

Description. Male (holotype): Total length 2.7; Color in Ethanol: shiny blackish Carapace: Prosoma length 1.3, width 1.3. Shiny blackish prosoma covered with pale white and yellowish-brown hairs. Anterior prosoma narrower than posterior region. Sternum rounded, blackish brown. Microscopic colurless setae scatter over AME and ALE. Ocular area, elevated, blackish brown. Lateral and posterior sides of prosoma almost vertical, posterior margin slightly truncated. Eye measurements: AME 0.38; ALE 0.22; PME 0.06; PLE 0.16; PME-PME 1.16; PLE-PLE 1.16; ALE-PME 0.18; ALE-PLE 0.5. Abdomen: Opisthosoma length 1.4, width 1.1. Egg shaped, narrower than prosoma, distinctive apodemes. Dorsum blackish brown, ventrum with longitudinal black-brown dash line from spinnerets to epigastric furrow. Legs: Leg formula I, II, IV, III: patella-tibia III shorter than IV. Leg I blackish brown, remaining legs yellowish brown. Metatarsus I, tibia I and metatarsus II with spines. Leg III and IV spineless. Leg measurements: I: 2.60 (0.28, 0.42, 0.73, 0.48, 0.69); II: 1.82 (0.18, 0.26, 0.52, 0.34, 0.52); III: 1.18 (0.12, 0.18,

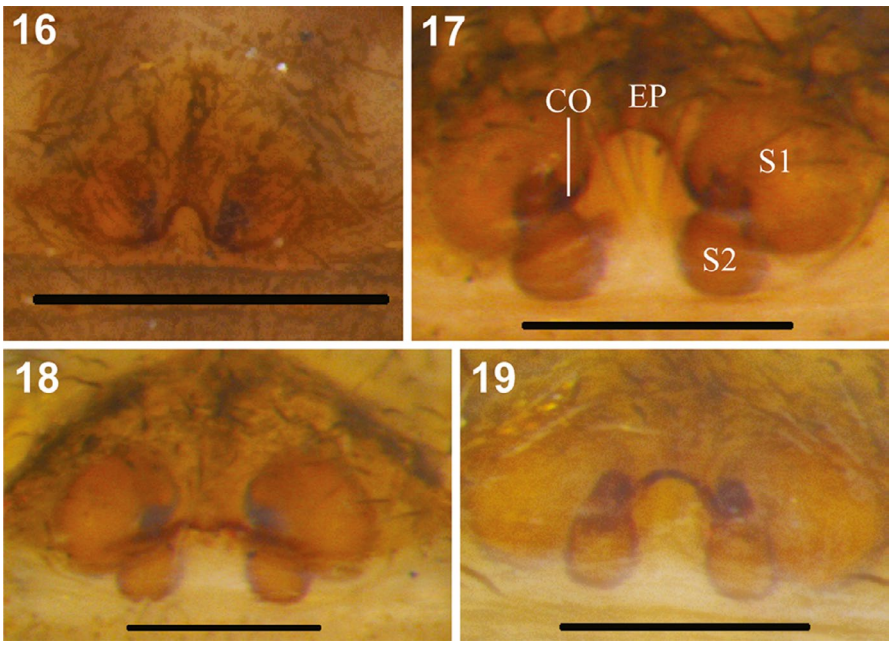

FIGURE 16–19 Epigynum, ventral view. 16. *Flacillula henryi* sp. nov.; 17. *Flacillula johnstoni* sp. nov.; 18. *Flacillula ellaensis*, sp. nov.; 19. *Flacillula hodgsoni* sp. nov.; Scale bars = 0.2 mm (17–19); 0.5 mm (16)

0.36, 0.22, 0.3); IV: 1.64 (0.18, 0.26, 0.46, 0.26, 0.48). Pedipalp: RTA relatively longer, narrow base, straight, tip blunt. Embolus broader at base, filiform. Tip moderately curved (Figures 20, 21, 61, 62).

Female (paratype): As in male except for the following. Total length 3.7; Color in Ethanol: as in male. Carapace: Prosoma length 1.3, width 1.1. Prosoma with more setae than male. PME and PLE surrounded by black margins. Rounded, blackish brown sternum. Eye measurements: AME 0.32; ALE 0.14; PME 0.05; PLE 0.13; PME-PME 0.95; PLE-PLE 0.9; ALE-PME 0.25; ALE-PLE 0.525. Abdomen: Opisthosoma length 1.8, width 1.4. Abdomen slightly broader and longer than prosoma and tapering posteriorly. Dorsum yellowish light brown with distinctive apodemes. Legs: Leg formula I, IV, III, II; patella-tibia II and III shorter than IV. Leg I light blackish brown and remaining legs are yellow. Leg measurements: I: 1.78 (0.16, 0.22, 0.46, 0.34, 0.6); II: 1.38 (0.16, 0.2, 0.36, 0.2, 0.16); III: 1.4 (0.16, 0.2, 0.36, 0.26, 0.42); IV: 1.7 (0.2, 0.24, 0.4, 0.3, 0.56). Epigynum: with a large, cone shaped EP, as long as wide (Figures 39, 40).

Flacillula ellaensis, sp. nov

urn:lsid:zoobank.org:act:5E21DC21-8BE1-4370-A470-2EBE09F35F70

(Figures 5, 18, 41, 42)

Type material: SRI LANKA: Uva Province: female holotype (NIFS_Sal_589) [18 May 2010, S.P. Benjamin, N.P. Athukorala] Badulla District, Mausagolla, Passara Ella road (B113), 18th mile post (06°54′32″N, 81°07′56″E).

Habitat & distribution: Known only from the type locality. The spiders were collected by beating foliage up to a height of 2 m from a remnant patch of submontane wet evergreen cloud forests.

Etymology: The specific epithet is taken from the type locality.

Diagnosis: Similar to *F. hodgsoni* sp. nov. and *F. henryi* sp. nov. Could be separated from them and other congeners by the narrower, cone shaped EP (Figure 41, 42).

Description. Female (holotype): Total length 4.2. Color in Ethanol: brown, Carapace: length 1.6, width 1.5; brown color, with pale whitish

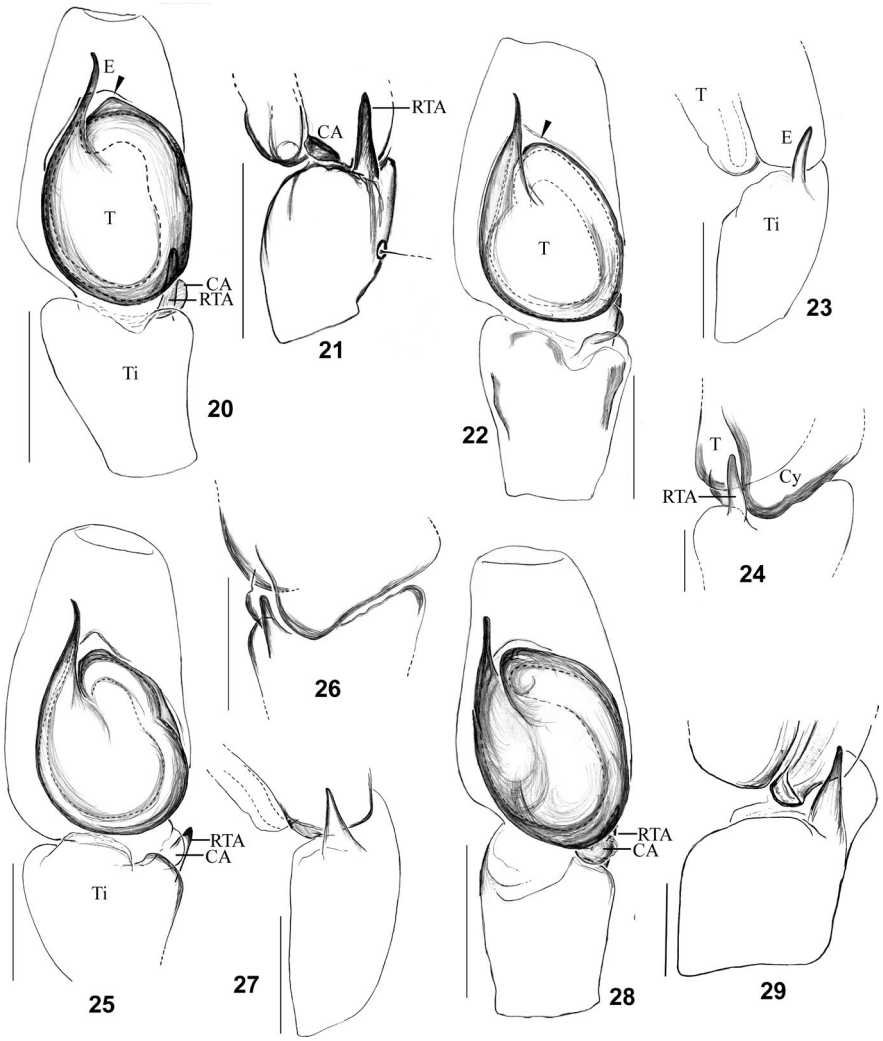

FIGURE 20–29 Male palp. 20, 21. Flacillula dothalugala sp. nov.; 22–24. *Flacillula henryi* sp. nov.; 25–27. *Flacillula hodgsoni* sp. nov.; 28, 29. *Flacillula johnstoni* sp. nov. 20, 22, 25, 28. Ventral view; 21, 23, 27, 29. Retrolateral view; 24, 26. Retrolateral/dorsal view. Scale bars = 0.1 mm (23, 28); 0.2 mm (20–22, 24–27, 29)

hairs. One retrolateral cheliceral tooth present. Labium reddish brown, black margin. Anterior prosoma narrower than posterior region. Sternum blackish brown. Microscopic colorless setae scattered over AME and ALE. Ocular area elevated, blackish brown, median ocular quadrangle much broader than long. Eye ratio AME > ALE > PLE > PME. Eye measurements: AME 0.4; ALE 0.24; PME 0.1; PLE 0.2; PME-PME 1.4; PLE-PLE 1.44; ALE-PME 0.2; ALE-PLE 0.56. Abdomen: slightly longer, broader than prosoma, tapering posteriorly. Dorsum whitish brown with distinctive apodemes. Ventral blackish and length 2.01, width 1.68. Leg formula I, II, IV, III; patella-tibia II and IV shorter than III. Leg I light brown and remaining legs yellow in color. Leg measurement: I: 2.94 (0.34,0.36,0.64,0.66,0.94); II: 2.30 (0.38,0.36,0.46,0.4,0.7); III: 1.96 (0.34,0.20,0.64,0.34,0.44); IV: 1.98 (0.32,0.4,0.3,0.26,0.7). Epigynum: Narrow, cone shaped EP as in Figure (41, 42).

Male: unknown.

Flacillula henryi sp. nov.

urn:lsid:zoobank.org:act:2E9EC367-9B80-4A8A-BF74-7530BB4429E5

(Figures 7, 8, 16, 22–24, 43, 44, 59, 60)

Type material: SRI LANKA: Sabaragamuwa Province: male holotype (NIFS_Sal_121) [23 February 2007, S.P. Benjamin, Z. Jaleel] Rathnapura District, Eastern Sinharaja, Morningside section (06°24′14.74″N, 80°36′33.27″E). Paratype: one female, one male (NIFS_Sal_120, NIFS_Sal_122) same locality and collection data.

Habitat & distribution: Known only from the type locality. The spiders were collected by beating foliage up to a height of 2 m from a remnant patch of submontane wet evergreen cloud forests.

Etymology: The specific epithet is in honor of George Morrison Reid Henry (1891–1983) who was a curator of systematic entomology at the Colombo museum. He is also the author of the classic,

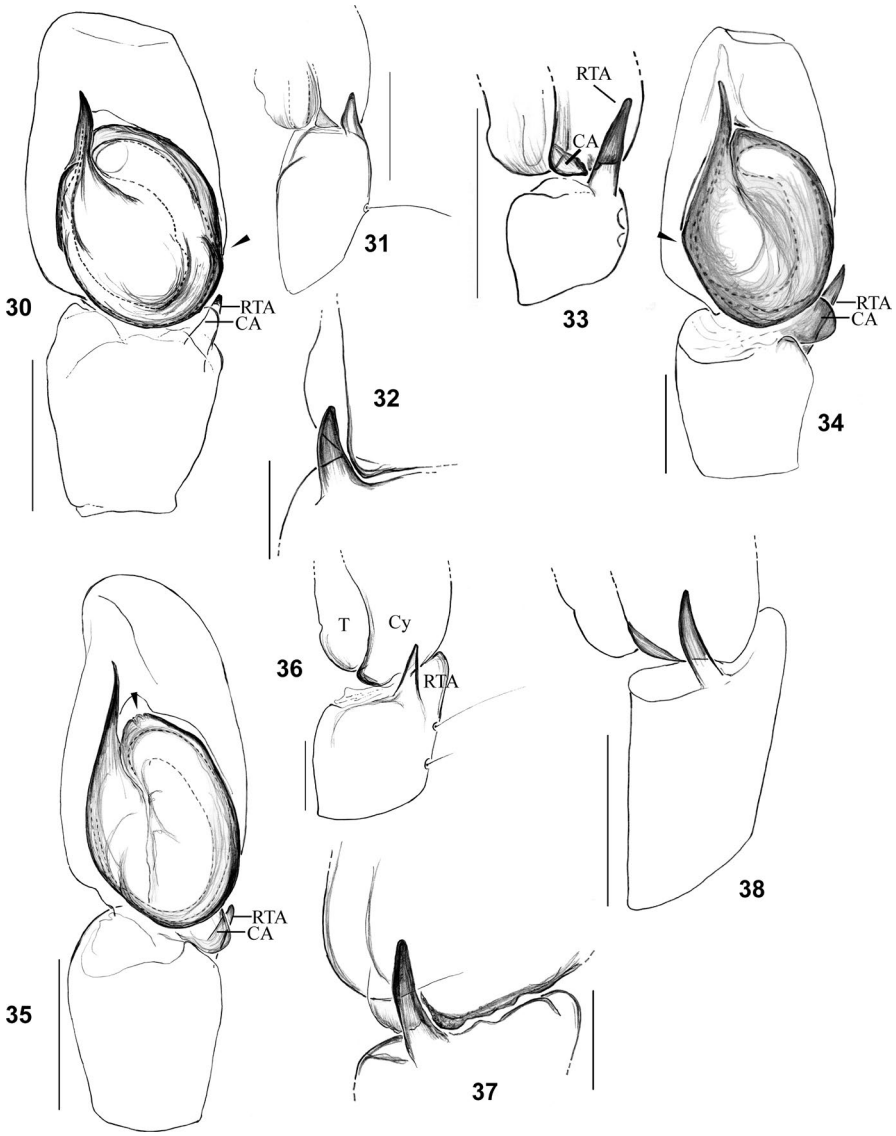

FIGURE 30–38 Male palp. 30–32. *Flacillula lubrica*; 33, 34. *Flacillula naipauli* sp. nov.; 35–38. *Flacillula piyasenai* sp. nov., 30, 34, 35. Ventral view; 31, 33, 36, 38. Retrolateral view; 32, 37. Retrolateral/dorsal view. Scale bars = 0.1 mm (32, 34, 36, 37); 0.2 mm (30, 31, 33, 35, 38)

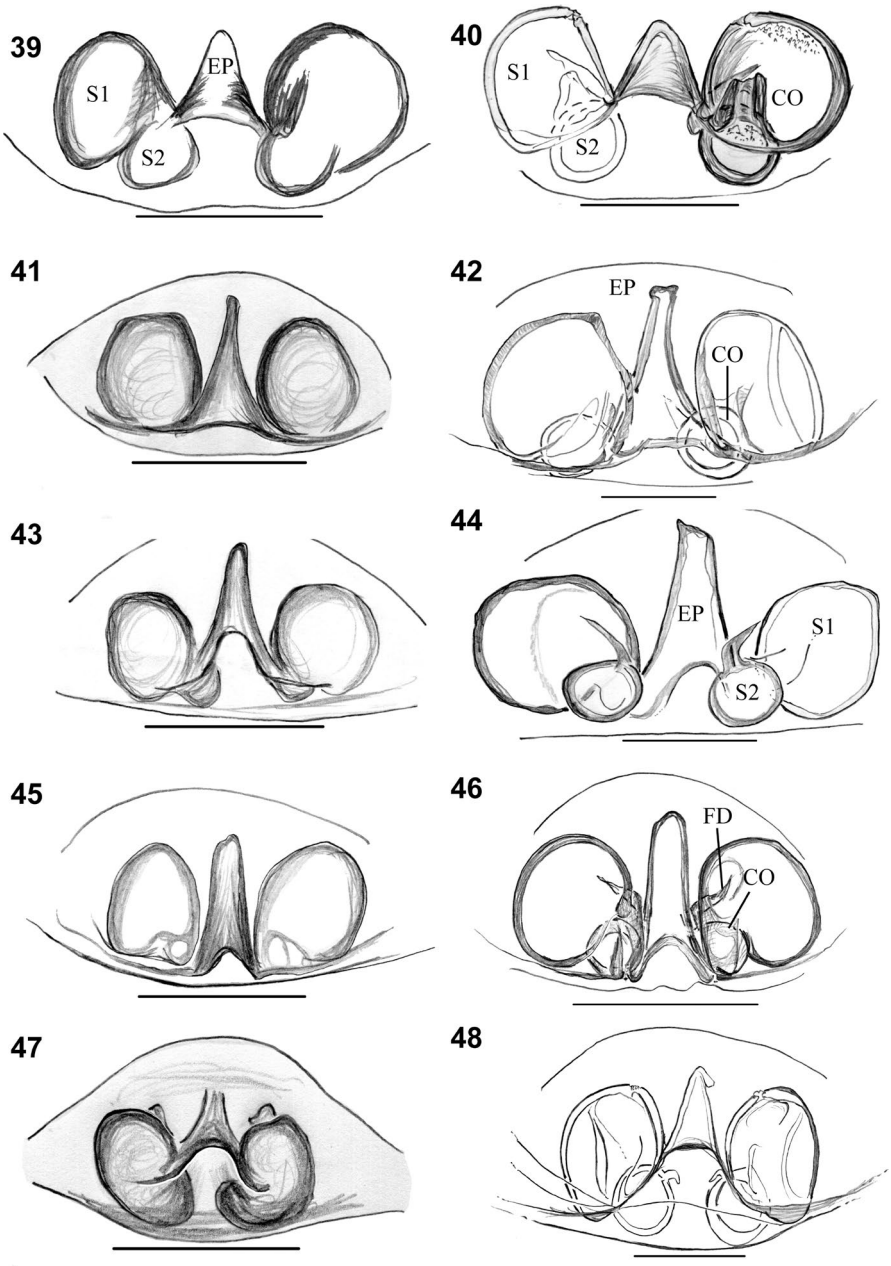

FIGURE 39–48 Female genitalia. 39, 40. *Flacillula dothalugala* sp. nov.; 41, 42. *Flacillula ellaensis* sp. nov.; 43, 44. *Flacillula henryi* sp. nov.; 45, 46. Flacillula hodgsoni sp. nov., 47, 48. *Flacillula johnstoni* sp. nov. 39, 41, 43, 45, 47. Epigynum ventral view; 40, 44, 46, 48. Vulva, ventral view, 42. Vulva, dorsal view. Scale bars = 0.2 mm

A Guide to the Birds of Ceylon (first published in 1955 by Oxford University Press, London).

Diagnosis: Similar to *F. dothalugala* and *F. hodgsoni* sp. nov. Could be separated from it and other congeners by the RTA (short, curved backwards), shape of the bulb (oval, smooth margins), shape of the apical projection of the bulb (rounded; arrow in Figure 22), shape of E (broader at the base, tapered tip, slightly bent) and CA (broad). Females could be separated by the shape of EP (prominent arch, large opening, cone-shaped).

Description. Male (holotype): Total length 3.8; Color in Ethanol: brownish yellow. Carapace: Prosoma length 1.65, width 1.68. Yellowish brown prosoma covered with pale white and yellowish brown hairs. Chelicerale pale brown in color. Anterior prosoma narrower than posterior region. Sternum blackish brown, edges bordered with brown colors. Microscopic colorless setae scatter over AME and ALE. Elevated ocular area blackish brown. Eye measurements: AME 0.42; ALE 0.33; PME 0.1; PLE 0.2; PME-PME 1.6; PLE-PLE 1.44; ALE-PME 0.8; ALE-PLE 0.2. Abdomen: Opisthosoma length 1.56, width 1.53. Egg shaped, narrower than prosoma, distinctive apodemes. Dorsum yellowish brown, ventrum pale yellow, spinnerets yellowish. Legs: First pair of legs more strongly modified in males than females, with elongated coxa, trochanter and patella. Leg formula I, II, IV, III: patella-tibia III shorter than IV. Legs I light brown, remaining legs yellow. Leg measurements: I: 4.72 (0.46, 0.5,

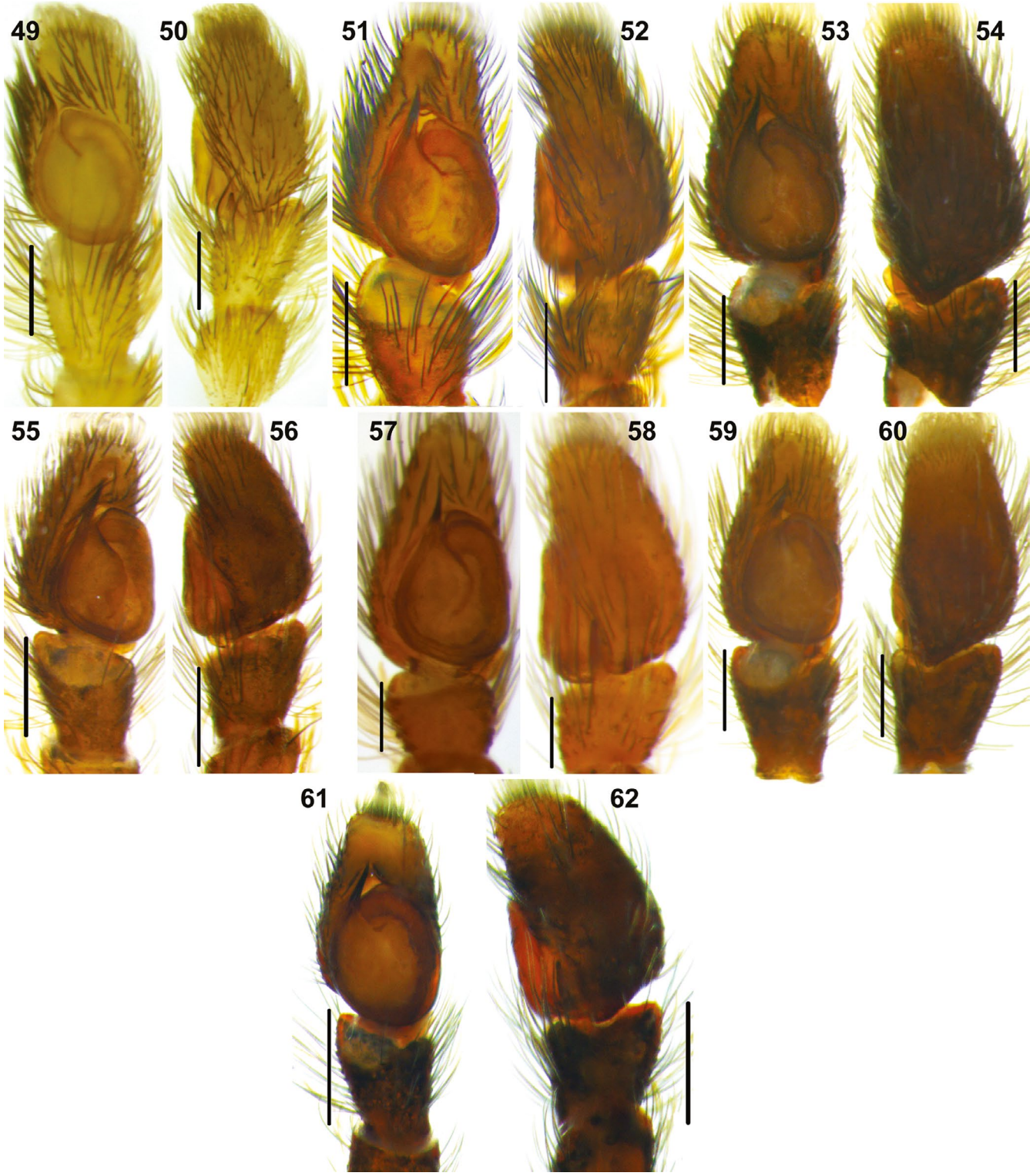

FIGURE 49–62 Male palps. 49, 50. *Flacillula lubrica* (Simon, 1901a); 51, 52. *Flacillula piyasenai* sp. nov.; 53–56. *Flacillula johnstoni* sp. nov.; 57, 58. *Flacillula naipauli* sp. nov.; 59, 60. *Flacillula henryi* sp. nov.; 61, 62. *Flacillula dothalugala* sp. nov. 49, 51, 53, 55, 57, 59, 61. Ventral view; 50, 52, 54, 56, 58, 60, 62. Retrolateral view. Scale bars = 0.1 mm (57, 58); 0.2 mm (49, 50, 57, 53–56, 61, 62)

1.1, 1.26, 1.4); II: 2.56 (0.38, 0.4, 0.58, 0.44, 0.76); III: 1.96 (0.34, 0.4, 0.54, 0.24, 0.44); IV: 2.22 (0.24, 0.42, 0.5, 0.46, 0.6). Pedipalp: RTA relatively shorter, tegulum oval, edges smooth, base broad, E curved as in (Figures 22–24, 59, 60).

Female (paratype): As in male except for the following. Total length 4.0. Carapace: prosoma length 1.65, width 1.65. More setae than in the male. Eye measurements: AME 0.33; ALE 0.24; PME 0.08; PLE 0.16; PME-PME 1.56; PLE-PLE 1.46; ALE-PME 0.6;

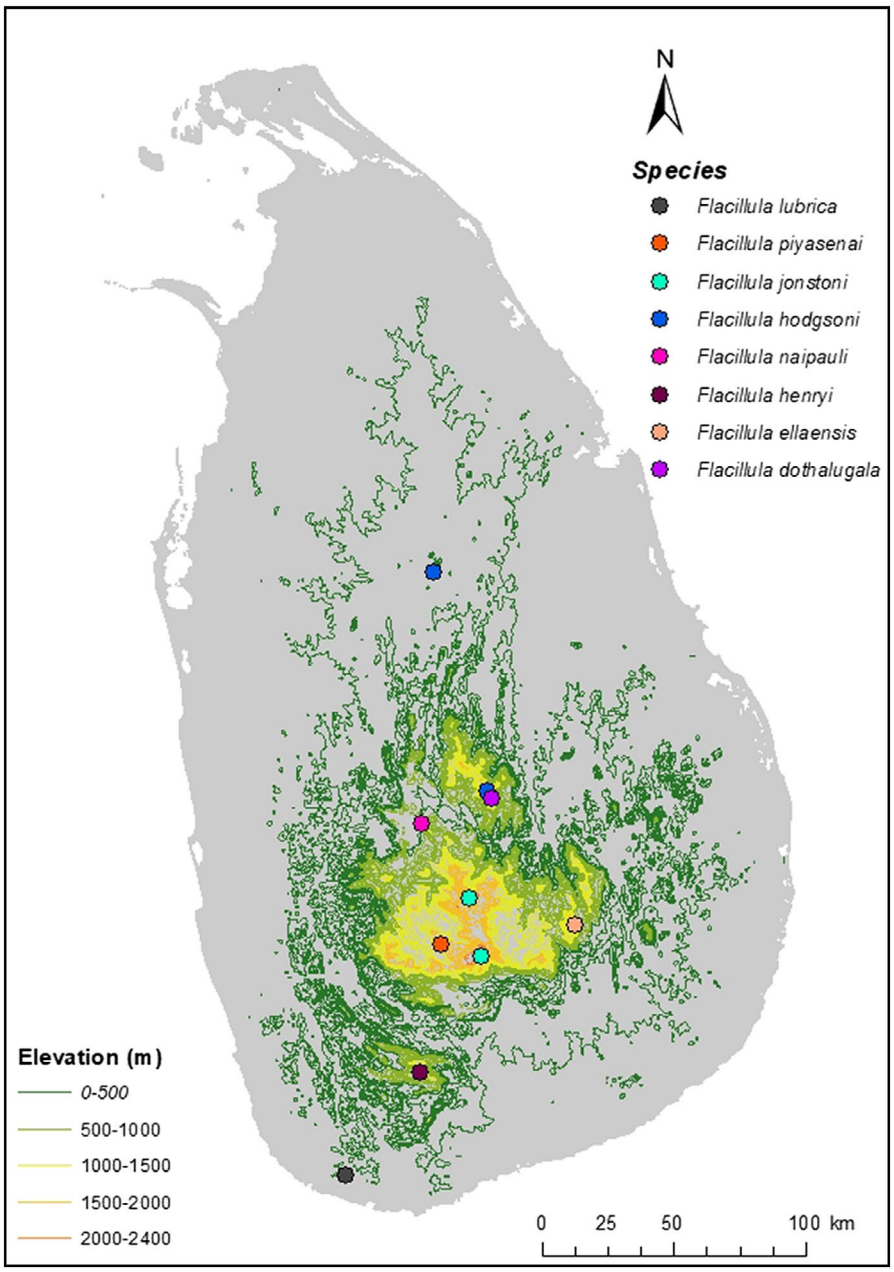

FIGURE 63 Distribution map of *Flacillula* spp

ALE-PLE 0.3. Abdomen: Opisthosoma length 2.01, width 1.71. Abdomen slightly broader and longer than prosoma and tapering posteriorly. Dorsum yellowish light brown. Legs: Leg formula I, IV, II, III; patella-tibia II and III shorter than IV. Leg I yellowish brown and remaining legs yellow. Metatarsus I, tibia I with spines and metatarsus II with spines. Leg III and IV spineless. Leg measurements: I: 3.78 (0.34, 0.36, 0.76, 0.96, 1.36); II: 2.10 (0.2, 0.26, 0.54, 0.46, 0.64); III: 1.64 (0.26, 0.2, 0.4, 0.36, 0.42); IV: 2.54 (0.34, 0.4, 0.46, 0.58, 0.76). Epigynum: EP with prominent arch, hood cone shaped and relatively shorter (Figures 43, 44).

Flacillula hodgsoni sp. nov.

urn:lsid:zoobank.org:act:6CA70E03-98B3-4107-A4DA-A7ACA2456F32

(Figures 15, 19, 25–27, 45, 46, 53, 54)

Type material: SRI LANKA: North Central Province: male holotype (NIFS_Sal_517) [28 June 2011, S.P. Benjamin, S. Batuwita] Anuradhapura District, Ritigala, Kodigala Sumt (08°06′33″N, 80°39′16″E).

Additional material: One juvenile (NIFS_Sal_1188) same locality and collection data as holotype. SRI LANKA: Central Province: one male, three females (NIFS_Sal_147-150) [02 April 2011, S.P. Benjamin] Kandy District, Thangappuwa, Knuckles range (07°21′42″N, 80°49′59″E).

Habitat & distribution: The spiders were collected by beating foliage up to a height of 2 m. Known only from the two localities of remnant patches of submontane wet evergreen cloud forests listed above.

Etymology: The specific epithet is in honor of Brian Houghton Hodgson (1800–1894) who was a pioneer naturalist and ethnologist working in India and Nepal.

Diagnosis: Similar to *F. ellaensis* sp. nov. and *F. henryi* sp. nov. Could be separated from them and other congeners by the RTA (short), shape of the bulb (oval, retrolateral invagination) and CA (indistinct flange). Females could be separated by the shape of EP (long, width equal along its length). Further, males of *F. hodgsoni* sp. nov can be separated from its congeners by the shiny blackish body (Figure 15).

Description. Male (holotype): Total length 3.8; Color in Ethanol: Blackish brown Carapace: Prosoma length 1.9, width 2.2. Prosoma shiny blackish. Chelicare dark brown. Rounded, blackish brown sternum, edges light brown. Lateral and posterior sides of prosoma almost vertical, posterior margin slightly truncated. Eye measurements: AME 0.5; ALE 0.28; PME 0.2; PLE 0.16; PME-PME 1.84; PLE-PLE 1.7; ALE-PME 0.86; ALE-PLE 0.54. Abdomen: Opisthosoma length 1.9, width 2.1. Rounded, smaller and narrower than prosoma. Ventrum with longitudinal black-brown dash line pattern from spinnerets to epigastric furrow. Legs: All legs blackish brown and II–IV tarsus, metatarsus with yellow bands. Metatarsus I, tarsus I with spines. Leg formula: I, IV, II, III. Patella-tibia III shorter than IV. Leg measurements: I: 4.84 (1.2, 1.34, 1.02, 0.78, 0.5); II: 2.54 (0.9, 0.42, 0.58, 0.4, 0.24); III: 1.94 (0.8, 0.22, 0.26, 0.4, 0.26); IV: 2.75 (1.18, 0.3, 0.5, 0.53, 0.24). Pedipalp: RTA short with relatively broader base, tapering tip. bulbus oval, with invagination at 3 o'clock position (Figures 25–27, 53, 54).

Female: Total length 4.15. As in male except for the following. Carapace: length 1.77, width 1.68. Eye measurements: AME 0.36; ALE 0.24; PME 0.02; PLE 0.16; PME-PME 1.42; PLE-PLE 1.4; ALE-PME 0.2; ALE-PLE 0.62. Abdomen: length 1.95, width 1.58. Leg measurements: I: 3.32 (0.82, 0.86, 0.74, 0.48, 0.42); II: 2.18 (0.64, 0.38, 0.4, 0.42, 0.34); III: 1.96 (0.5, 0.26, 0.4, 0.44, 0.36); IV: 2.36 (0.64, 0.44, 0.6, 0.36, 0.32). Epigynum: Epigyne with a cone shaped EP (Figures 45, 46).

Remarks: The specimens from Knuckles range are provisionally assigned to this species.

Flacillula johnstoni sp. nov.

urn:lsid:zoobank.org:act:66FC4246-ED14-4694-8A31-2E7949443574

(Figures 9, 11, 12, 17, 28, 28, 47, 48, 55, 56)

Type material: SRI LANKA: Central Province: male holotype (NIFS_Sal_1098) [14 February 2018, S. P. Benjamin et al.] Nuwara Eliya District, Piduruthalagala, between 3–4 km post (06°59′36″N, 80°46′15″E). Paratypes: two females (NIFS_Sal_1099, NIFS_Sal_1082), same locality and collection data as holotype.

Additional material: SRI LANKA: Central Province: one male, one juvenile (NIFS_Sal_1211, NIFS_Sal_1213) [01 March 2019, N.P. Athukorala et al.] Nuwara Eliya District, Horton Plains NP, Thotupola mountain trail (06°50′05″N, 80°48′56″E). Central province: one female (NIFS_Sal_464) [22 February 2007, S.P. Benjamin et al.] Nuwara Eliya District, Peak wilderness Sanctuary (06°75′42″N, 80°68′89″E), provisionally placed here.

Habitat & distribution: The spiders were collected by beating foliage up to a height of 2 m. Known only from the three localities of high-elevation montane cloud forests listed above.

Etymology: The specific epithet is in honor of Sir Alexander Johnston (1775–1849) a chief Justice of Ceylon and a founding member of the Royal Asiatic Society. During his service in Ceylon, he introduced a range of administrative reforms in Sri Lanka, introducing numerous liberal ideas and supporting the rights of locals.

Diagnosis: Males of *F. johnstoni* sp. nov. can be separated from congeners by its RTA (broad based, long, with blunt tip). E slender, short, straight and border at mid length. Females are separated by the kidney-shaped S1 and the short pointed EP.

Description. Male (holotype): Total length 3.1. Color in Ethanol: dark brown. Carapace: length 1.2, width 1.3; brown color, covered with pale white and yellowish brown hairs. Chelicerae pale brown in color. Labium reddish brown with black margin. Anterior prosoma narrower than posterior region. Elevated ocular area blackish brown, median ocular quadrangle much broader than long. Eye ratio AME > PLE > ALE > PME. Eye measurements: AME 0.34; ALE 0.2; PME 0.1; PLE 0.22; PME-PME 1.04; PLE-PLE 1.1; ALE-PME 0.52; ALE-PLE 0.2. Abdomen: dorsum yellowish brown with pattern consisting of median black are with lateral branches and with reddish brown markings. Ventral blackish brown near the yellowish spinnerets. length 1.8, width 1.3. Elongated, oval shaped and narrower than prosoma. Legs: First pair of legs more strongly modified in males than females, with elongated coxa, trochanter and patella. Leg formula I, II, IV, III: patella-tibia III shorter than IV. Legs I light brown, remaining legs yellow. Metatarsus I and tibia I with spines. Metatarsus II and tibia II with spine. Leg III and IV spineless. Leg measurements: I: 2.78 (0.82, 0.72, 0.6, 0.34, 0.3); II: 2.00 (0.7, 0.44, 0.34, 0.28, 0.24); III: 1.54 (0.3, 0.36, 0.28, 0.36, 0.24); IV: 1.78 (0.24, 0.4, 0.3, 0.44, 0.4). Pedipalp: RTA broader at base and slightly bent with blunt tip. Bulbus an irregular-round shape. E short, stout, broader at mid length (Figures 28, 29, 55, 56).

Female (paratype): As in male except for the following. Total length 3.2. Carapace: length 1.5, width 1.3. Eye measurements: AME 0.36; ALE 0.2; PME 0.08; PLE 0.2; PME-PME 1.16; PLE-PLE 1.24; ALE-PME 1.24; ALE-PLE 0.46. Abdomen: length 1.7, width 1.4. Leg measurements: I: 2.62 (0.7, 0.6, 0.64, 0.32, 0.36); II: 1.84 (0.44, 0.5, 0.4, 0.24, 0.26); III: 1.76 (0.46, 0.4, 0.24, 0.36, 0.3); IV: 1.98 (0.5, 0.54, 0.44, 0.2, 0.3). Epigynum: Epigynal and vulva with a long longitudinal epigynal ridge. Copulatory ducts short. Spermathecae kidney shaped (Figures 17, 47, 48).

Flacillula lubrica (Simon, 1901b)

(Figure 13, 30–32, 49, 50)

Flacilla lubrica,- Simon, 1901a: 558, f. 570–574.

Flacilla lubrica,- Simon, 1901b: 153.

Flacillula lubrica,- Strand, 1932: 137.

Flacillula lubrica,- Prószyński, 1984: 77.

Type material: SRI LANKA. Male holotype (MNHN 20642). Not examined.

Remarks: We were unable to examine the type due to the ongoing pandemic and our identification is based on our translation of Simon's (1902) description of the male syntype. Of all examined specimens the male from Galle (NIFS_Sal_688) best fits the published descriptions and illustrations for this species (Prószyński, 1984; Simon, 1901a). However, this assessment needs to be evaluated further when type become accessible.

Other material examined: SRI LANKA: Southern Province: one male (NIFS_Sal_688) (18 May 2010, S. P. Benjamin, S. Batuwita) Galle District, Kombala-Kottawa FR (06°03′53″N, 80°18′05″E).

Habitat & distribution: The spiders were collected by beating foliage up to a height of 2 m. Known only from Kombala-Kottawa FR a remnant patch of lowland wet evergreen forest.

Diagnosis: Males of *F. lubrica* can be separated from its congeners by the relatively short RTA, rounded bulb, the invagination at 4 o'clock position (arrow in Figure 30) and stout E.

Description. Male: Total length 4.1. Color in Ethanol: yellowish brown. Carapace: Prosoma length 1.8, width 1.7; yellowish brown prosoma covered with pale white hairs. Chelicera and labium yellowish in color. Anterior prosoma narrower than posterior region. Sternum yellowish brown and oval in shape. Eye measurements: AME 0.42; ALE 0.22; PME 0.14; PLE 0.06; PME-PME 1.38; PLE-PLE 1.34; ALE-PME 0.76; ALE-PLE 0.2. Abdomen: length 1.5, width 1.5. Egg shaped and narrower than prosoma. Ventrum whitish brown with several transverse black markings. Blackish brown near yellowish black spinnerets. Legs: First legs more strongly modified with elongated coxa, trochanter and patella. Leg I yellowish light brown and other legs are whitish brown. First leg is much heavier than the remaining legs. Metatarsus I, metatarsus II and tibia I with spines and Leg II-IV femur with spines. Leg formula I, II, III, IV: patella-tibia III longer than IV. Leg measurements: I: 3.5 (1.01, 1.02, 0.82, 0.44, 0.22); II: 1.78 (0.52, 0.36, 0.44, 0.22, 0.24); III: 1.52 (0.28, 0.3, 0.4, 0.24, 0.3); IV: 1.48 (0.46, 0.2, 0.38, 0.2, 0.24). Pedipalp: RTA short, broad base, slight hook, CF triangular. Bulb round, invagination at 4 o'clock position (arrow in Figure 30). Stout embolus, broader at mid length, slightly bent (Figures 30–32, 49, 50).

Female: Unknown.

Flacillula naipauli sp. nov.

urn:lsid:zoobank.org:act:E8E2331F-BC38-41DA-802E-9ED7E2EF9786

(Figures 14, 33, 34, 57, 58)

Type material: SRI LANKA: North Central Province: male holotype (NIFS_Sal_1006) [19 January 2017, N.P. Athukorala et al] Kandy District, Hantan mountain range, Uda Peradeniya (07°14′58″N, 80°36′43″E).

Habitat & distribution: The spiders were collected by beating foliage up to a height of 2 m. Known only from the type locality, which is a remnant patches of submontane wet evergreen cloud forests.

Etymology: The specific epithet is in honor of Sir Vidiadhar Surajprasad Naipaul (1932–2018), most commonly known as V.S. Naipaul. He was an Indian Trinidadian writer of works of fiction and nonfiction in English. He received a knighthood in Britain in 1990 and the Nobel Prize in Literature in 2001.

Diagnosis: Similar to *F. lubrica* and *F. piyasenai* sp. nov. Could be separated from these and other congeners by the RTA (longer, stout, blunt tip), shape of the bulb (projection at 9 o'clock position; arrow in Figure 34) shape of the distal projection of the bulb (pointed), Embolus (broader base, tapering towards tip) and the CA (prominent c-shaped flange).

Description. Male (holotype): Total length 2.3; Color in Ethanol: Light brown. Carapace: Prosoma length 1.1, width 1.1. Reddish brown prosoma covered with pale white hairs. Chelicare and labium yellowish brown in color. Anterior prosoma narrower than posterior region. Sternum yellowish brown and oval in shape, edges bordered, brown. Eye measurements: AME 0.3; ALE 0.12; PME 0.18; PLE 0.08; PME-PME 0.92; PLE-PLE 0.96; ALE-PME 0.52; ALE-PLE 0.24. Abdomen: opisthosoma length 1.2, width 1.02. Elongated, ova shaped and narrow than prosoma. Dorsum yellowish brown with several transverse black marking, black edges and red patches in the abdomen. Ventrum pale yellow, blackish brown near yellowish black spinnerets. Legs: First pair of legs more strongly modified with elongated coxa, trochanter and patella. Leg I yellowish dark brown and other legs are yellowish brown. Metatarsus I, metarsus II and tibia I with spines. Leg III and IV spineless. Leg measurements: I: 2.28 (0.7, 0.6, 0.48, 0.26, 0.24); II: 1.56 (0.5, 0.32, 0.28, 0.22, 0.24); III: 1.1 (0.3, 0.12, 0.16, 0.28, 0.24); IV: 1.54 (0.4, 0.28, 0.24, 0.34, 0.28). Pedipalp: RTA relatively longer, hook shaped, with slightly tilt towards dorsum. C-shaped CF, oval bulb. Embolus relatively longer, filiform (Figures 33, 34, 57, 58).

Female: Unknown.

Flacillula piyasenai sp. nov.

urn:lsid:zoobank.org:act:4350D381-4345-4B20-BC94-ABDB46A965F0

(Figures 8, 10, 35–38, 51, 52)

Type material: SRI LANKA: Central Province: male holotype (NIFS_Sal_473) [27 March 2012, S. P. Benjamin] Nuwara Eliya District, Horton Plains NP (06°68′05″N, 80°50′19″E).

Additional material: SRI LANKA: Central Province: one male (NIFS_Sal_119) [18–21 February 2007, S. P. Benjamin, Z. Jaleel) Nuwara Eliya District, Agarapatana-Bopathalawa Forest Reserve, bordering Torrington Estate, near Agarapatana (06°50′36″N, 80°40′40″E). One juvenile (NIFS_Sal_1212) [01 March 2019, N.P. Athukorala et al.] Horton Plains NP, Thotupola mountain trail (06°50′05″N, 80°48′56″E).

Habitat and distribution: The spiders were collected by beating foliage up to a height of 2 m. The two adjunct localities are high-elevation montane cloud forests.

Etymology: The specific epithet is in honor of the first author's father, Mr. Piyasena Bopearachchi.

Diagnosis: Similar to *F. lubrica* and *F. johnstoni* sp. nov. Could be separated from them and other congeners by the RTA (longer, tapered), CA (distinct flange as in Figure 33), shape of the bulb (oval,

distal modifications, prolateral ridges, flanges) and the E (elongated, tip filiform).

Description. Male (holotype): Total length 3.9. Color in Ethanol: brownish yellow. Carapace: Prosoma length 1.6, width 1.5; reddish brown prosoma covered with pale white hairs. Chelicera and labium yellowish brown. Anterior prosoma narrower than posterior region. Ocular region slightly raised. Sternum brownish black and oval in shape. Eye measurements: AME 0.36; ALE 0.2; PME 0.16; PLE 0.08; PME-PME 1.28; PLE-PLE 1.2; ALE-PME 0.58; ALE-PLE 0.2. Abdomen: length 1.9, width1.5. Oval, narrower than prosoma. Dorsum yellowish brown with several transverse black markings, black edges, distinctive apodemes. Venter pale yellow, blackish brown, yellowish black near spinnerets. Legs: First legs more strongly modified with elongated coxa, trochanter and patella. Leg I yellowish dark brown and other legs are yellowish brown. First leg is much heavier than the remaining legs. Metatarsus I, metatarsus II and tibia I with spines. Leg III and IV spineless. Leg formula I, IV, II, III: patella-tibia III shorter than IV. Leg measurements: I: 2.94 (1.04, 0.9, 0.1, 0.48, 0.42); II: 2.06 (0.64, 0.58, 0.24, 0.3, 0.24); III: 1.96 (0.64, 0.36, 0.16, 0.46, 0.34); IV: 2.14 (0.76, 0.38, 0.26, 0.38, 0.36). Pedipalp: RTA relatively long, slightly bent dorsally. Tegulum oval, with flanges at 12 o'clock position (arrow in Figure 35). Bulbus oval. Embolus filiform (Figure 35–38, 51, 52).

Female: Unknown.

Iona Peckham & Peckham, 1886

Type species: *Erasmia nigrovittata* Keyserling, 1882

Diagnosis (provisional): Cephalothorax is one third longer than wide and a little contracted toward the front. Quadrangle of eyes is wider than long, wider in front than behind. Third and fourth legs are equally long. First pair as stout than the others. Patella and tibia of the third leg longer than the patella and tibia of the fourth.

Description: See description of type species in Berry et al. (1997).

Composition: Four described species, *I. minuta* (Berland, 1929) comb. nov., *Iona nigrovittata* (Keyserling, 1882), *Iona nitens* (Berry et al., 1997) comb. nov. and *Iona opelli* (Berry et al., 1997) comb. nov.

Distribution: Known from Caroline Islands, Cook Islands, Niue Islands, Samoa Islands, French Polynesia: Tahiti Island, Moorea Island, Tonga Island (World Spider Catalog, 2021).

4 | DISCUSSION

We present a maximum likelihood phylogenetic tree supporting the monophyly of the jumping spiders in genus *Flacillula* for the first time. Our phylogenetic hypothesis confidently places *Flacillula* in the subtribe Simaethina within the subfamily Salticinae. The placement of *Flacillula* in Salticinae was previously suggested (Maddison, 2015), but never phylogenetically tested. Unfortunately, due to the lack of molecular grade tissue three species (*F. henryi* sp. nov., *F. ellaensis* sp. nov., *F. dothalugala* sp. nov.) were not included in this phylogenetic analysis; they should be included in future studies. However, some biogeographical patterns are worth mentioning. With eight known species and a further two new species (unpublished) known only from single female specimens, *Flacillula* seems to be highly diverse within Sri Lanka. Further, most of the species (six out of eight) occur in high-elevation (1000 m and above) forest. Furthermore, all species are very restricted in distribution (Figure 63).

4.1 | Monophyly and composition of Simaethina

Simaethina includes the following genera: *Flacillula* Strand, 1932, *Heratemita* Strand, 1932, *Iona* Peckham & Peckham, 1886, *Ligurra* Simon, 1903, *Mopsus* Karsch, 1878, *Phyaces* Simon, 1902, *Porius* Thorell, 1892, *Simaetha* Thorell, 1881, *Simaethula* Simon, 1902, *Stergusa* Simon, 1889, *Stertinius* Simon, 1890 and *Uroballus* Simon, 1902. *Simaethulina* Wesołowska, 2012 is excluded as its only species lacks the character listed below.

The following characters might turn out to be putative morphological synapomorphies for Simaethina; they need to be tested in a phylogenetic context in future studies: (a) retrolateral cymbial apophysis (CA), (b) oval tegulum, (c) short tapered embolus, (d) central EP, (e) two chambered spermathecae. Further, the first leg is furnished with a single pair of robust, short apical spines and the patella and tibia in equal in length in all Simaethini. Diagnosis of genera within Simaethini is more problematic. Both *Ligurra* and *Flaciulla* have a Ti shorter than Cy and a tapering RTA. In *Simaetha* Ti longer or equal to Cy, RTA is broad-based. In *Heratemita*, there are clearly visible (in lateral view) leaf-like setae on the Ti and Cy.

4.2 | Conservation

Sri Lanka's biodiversity is increasingly threatened by human activities, such as intrusion and disturbance remnant mountain forest, cultivation of European vegetable varieties, poaching and collection of forest products, climate change and severe weather, biological invasions and modification of forests for hydropower generation (Benjamin & Kanesharatnam, 2016). Less than 5% of Sri Lanka's original cloud forest remain. Both the Morningside section and the Sinharaja Forest Reserve proper are increasingly threatened by human activities. The Knuckles conservation area and Sinharaja Forest Reserve are designated biosphere reserves and world heritage sites. However, these designations have not bestowed much protection on them.

All new species described here are known from relatively few individuals and are restricted to mid and high-altitude cloud forest (900–1800 m) in the Central Province of Sri Lanka. Most known localities are within protected areas. Conservation status assessment using the IUCN criteria (IUCN, 2012) results in a status of vulnerable 'VU D2'. This assessment is based on an estimated <20 km^2 or and number of locations less 5.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

Alignment S1. Final alignment *CO1* dataset.

Alignment S2. Final alignment *28s* dataset.

Alignment S3. Final alignment, combined matrix (*CO1* + *28s*).

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