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Taxonomic revision of the monotypic genus *Psellonus* Simon, 1897 (Araneae, Philodromidae)

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Abstract

The monotypic genus *Psellonus* is revised, including the first description of the male of *Psellonus planus* Simon, 1897. One new synonymy is proposed: *Philodromus kendrabatai* Tikader, 1966 = *Psellonus planus* Simon, 1897 **syn. nov.**

Key words: India, morphology, running crab spiders, taxonomy, transfer, variation

Introduction

Philodromidae Thorell, commonly known as running crab spiders, is a relatively small spider family with 539 described species (Word Spider Catalog 2018). The family contains thirty genera, but many are poorly known. For example, the genera *Bacillocnemis* Mello-Leitão, *Eminella* Özdikmen, *Metacleocnemis* Mello-Leitão, *Philodromops* Mello-Leitão, *Procleocnemis* Mello-Leitão, *Psellonus* Simon are monotypic and each known from a single-sex only, further monotypic genera are *Pseudopsellonus* Balogh and *Vacchellia* Caporiacco, while *Gephyrellula* Strand, *Paracleocnemis* Schiapelli & Gerschman and *Tibitanus* Simon consist of two species, each being known from one sex.

Psellonus is such a poorly known genus that was erected by Simon in 1897 based on a male from Madurai, a city in the South Indian state of Tamil Nadu. Even 147 years after its erection the genus remains exclusively known from the original description, no species has been added and the female of the type species *Psellonus planus* remains undescribed. During our surveys on Indian spiders, we collected some specimens from Thirumangalam (located in the Madurai District of Tamil Nadu, 23 km from the type locality), Kayipuram, Irinjalakuda, Muriyadu, Pathiramanal Island, Perumbalam Island, Thevara and Wayanad (all belonging to the Kerala state of South India) that resembled the Pselloninae spiders. The details that accompanied the description and illustrations of *Psellonus* (Simon 1897: figs 9–10) focused exclusively on somatic morphology without paying attention to genitalic morphology. Close examination of our specimens led us to conclude that they are conspecific with *Psellonus planus*. The purpose of this paper is to revise the monotypic genus *Psellonus* by illustrating in detail the genitalic morphology of the genus and by describing the male for the first time. The somatic morphology is also illustrated to complement Simon's detailed description. Based on the overall somatic and genitalic similarity, we synonymize *Philodromus kendrabatai* Tikader, 1966 with *Psellonus planus*.

Material and methods

The specimens were preserved in 70% ethanol and studied under a Zeiss Stemi 2000-C stereomicroscope. The epigyne was cleared with 10% KOH solution. All measurements are in millimeters. The specimens are deposited in the reference collection of the Division of Arachnology, Department of Zoology, Sacred Heart College, Thevara, Cochin, Kerala, India (ADSH).

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Abbreviations used: AER—anterior eye row; CD—copulatory duct; E—embolus; FD—fertilization duct; MEQ—median eye quadrangle; PER—posterior eye row; PME—posterior median eyes; RTA—retrolateral tibial apophysis; S—subtegulum; SP—sperm duct; SPM—spermathecae; SPO—spermathecal organ; T—tegulum; TA—tegular apophysis; VTA—ventral tibial apophysis.

Taxonomy

Philodromidae Thorell, 1870

Psellonus Simon, 1897

Psellonus Simon, 1897: 14 (type species: *P. planus*, by monotypy).

Diagnosis. *Psellonus* can be distinguished from all other genera of Philodromidae by the flat, frontally truncated prosoma (Figs. 2A, 3A) in combination with a unique eye configuration (both eye rows occupying full width of cephalothorax, MEQ strongly trapezoid, more than 3 times wider than long, AER straight, PER slightly recurved, AER much narrower than PER, PME smaller than other eyes (Figs. 3A, C, 4A) and strongly elongated mouthparts (labium more than 3 times longer than wide, endites elongated, convergent blades (Figs. 2B, 3B). A similar eye configuration is found in *Pseudopsellonus* Balogh, but labium and endites are not elongated in this genus. Further diagnostic characters are seen in the chelicerae, which show strong bulges in both sexes (Figs. 2C, 3C). In the male, however, the chelicerae are strongly divergent and modified (Fig. 3C).

Psellonus planus Simon, 1897
(Figs. 1–4)

Psellonus planus Simon, 1897: 14, figs 9–10 (Holotype female from Madurai, Tamil Nadu, India, not traceable at MNHN [Muséum national d'histoire naturelle, Paris], personal communication through C. Rollard, not examined).

Philodromus kendrabatai Tikader, 1966: 38, fig. 3 (Holotype female from Peacock bay, N. D. A., Kharakvasla, Poona, Maharashtra, India, deposited in National Zoological Collections, Zoological Survey of India, Calcutta, No. 3134/18, examined). Tikader 1971: 72, figs 19A, B; Tikader 1980: 191, figs 261–262. Syn. nov.

Material examined. INDIA: *Kerala:* 11 males, 25 females, Alappuzha, Pathiramanal Island [9º37'08.27"N, 76º23'23.86"E], 0 m, 15 March 2014, 22 April 2014, 17 May 2014, 8 November 2014, January 2015, from foliage, by hand, leg., M.J. Jobi & Jimmy Paul;14 males, 27 females, 12 subadult males, 20 subadult females, Alappuzha, Perumbalam [9º50'54.13"N, 76º21'39.00"E], 10 m, 24 November 2015, 16 December 2015, 9 January 2016, 11 February 2016, 7 March 2016, from foliage, by hand, leg., M.J. Jobi & Jimmy Paul; 8 males, 16 females, 7 subadult males, 13 subadult females, Alappuzha, Kayipuram [9º37'41.22"N, 76º22'10.03"E], 12 m, 12 October 2015, 16 November 2015, 16 January 2016, 18 February 2016, 19 March 2016, from foliage, by hand, leg., M.J. Jobi & Jimmy Paul; 13 males, 18 females, 11 subadult males, 19 subadult females, Ernakulam, Thevara [9º56'33.40"N, 76º17'54.94"E], 7 m, 16 September 2015, 22 November 2015, 16 December 2016, 3 January 2016, 9 February 2016, from foliage, by hand, leg., M.J. Jobi; 1 male, 2 females, 4 subadult females, Thrissur, Irinjalakuda [10º20'40.80"N, 76º12'33.74"E], 15 m, 12 November 2015, from foliage, by hand, leg., K.S Nafin; 2 females, Thrissur, Muriyad [10º21'48.95"N, 76º15'44.62"E], 8 m, 7 December 2015, from foliage, by hand, leg., K.S Nafin; 2 females, Wayanad, Wayanad Wildlife Sanctuary [11º40'17.76"N, 76º22'07.16"E], 863 m, 7 January 2016, from foliage, by hand, leg., K.S Nafin & Sudhin. Tamil Nadu: 1 male, 2 females, 10 subadult males, 14 subadult females, Madurai, Thirumangalam [9º49'24.09"N, 77º59'17.13"E], 130 m, 22 December 2015, from foliage, by hand, leg., M.J. Jobi (all material ADSH).

Description. Male (from Thirumangalam):

Prosoma orange-yellow colored, hirsute, wider than long, forehead straight and truncated in the front, gradually expanded towards the back and largely truncated at the posterior, surface of the prosoma marked by fine stripes like rainbow, prosoma laterally clothed with fine bristles (Figs. 1A–D, 2A); eyes occupying the entire width of clypeus, anterior eye row almost a straight line, equally spaced, posterior eye row recurved, all eyes equal in size except for the very small PME (Fig. 2C); chelicerae strongly divergent, basal segment almost triangular with prominent dorsal hump, cheliceral furrow teethless (Fig. 2C); sternum straw colored, anteriorly broadly truncated (Fig. 2B); gnathocoxae strongly elongated, labium tongue like, twice as long as wide (Fig. 2B); leg formula 2314, spination variable and often asymmetric, but generally femora with 3–5 dorsal spines, tibiae I–II with 3–5 pairs of ventral spines and metatarsi I–II with two pairs of ventral spines. Opisthosoma straw colored, hirsute, longer than wide, narrow and parallel, wedge-shaped at the back, with tuft of hairs at the posterior end, two pairs of depression spots in the anterior half (Figs. 1A–D, 2A); venter smooth, a pair of depressions just before the spinnerets (Fig. 2B). *Palp* (Figs. 2D–F). Femur long, patella thick, tibia more than twice as long as wide, with numerous macrosetae and 2-3 trichobothria, RTA short, bifurcated; cymbium drop-like, covered with fine hairs, apical region with a bunch of tenent setae; tegulum oval with retrolaterally projecting apophysis; embolus with wide embolic base and narrow bent tip; sperm duct convoluted.

Measurements of palp and legs:

Leg segments	I	II	III	IV	Palp
Femur	1.51	1.70	1.60	1.43	0.53
Patella	0.55	0.63	0.52	0.35	0.28
Tibia	1.10	1.56	1.07	0.84	0.29
Metatarsus	0.88	1.31	0.90	0.56	----
Tarsus	0.53	0.58	0.55	0.39	0.46
Total	4.57	5.78	4.64	3.57	1.56

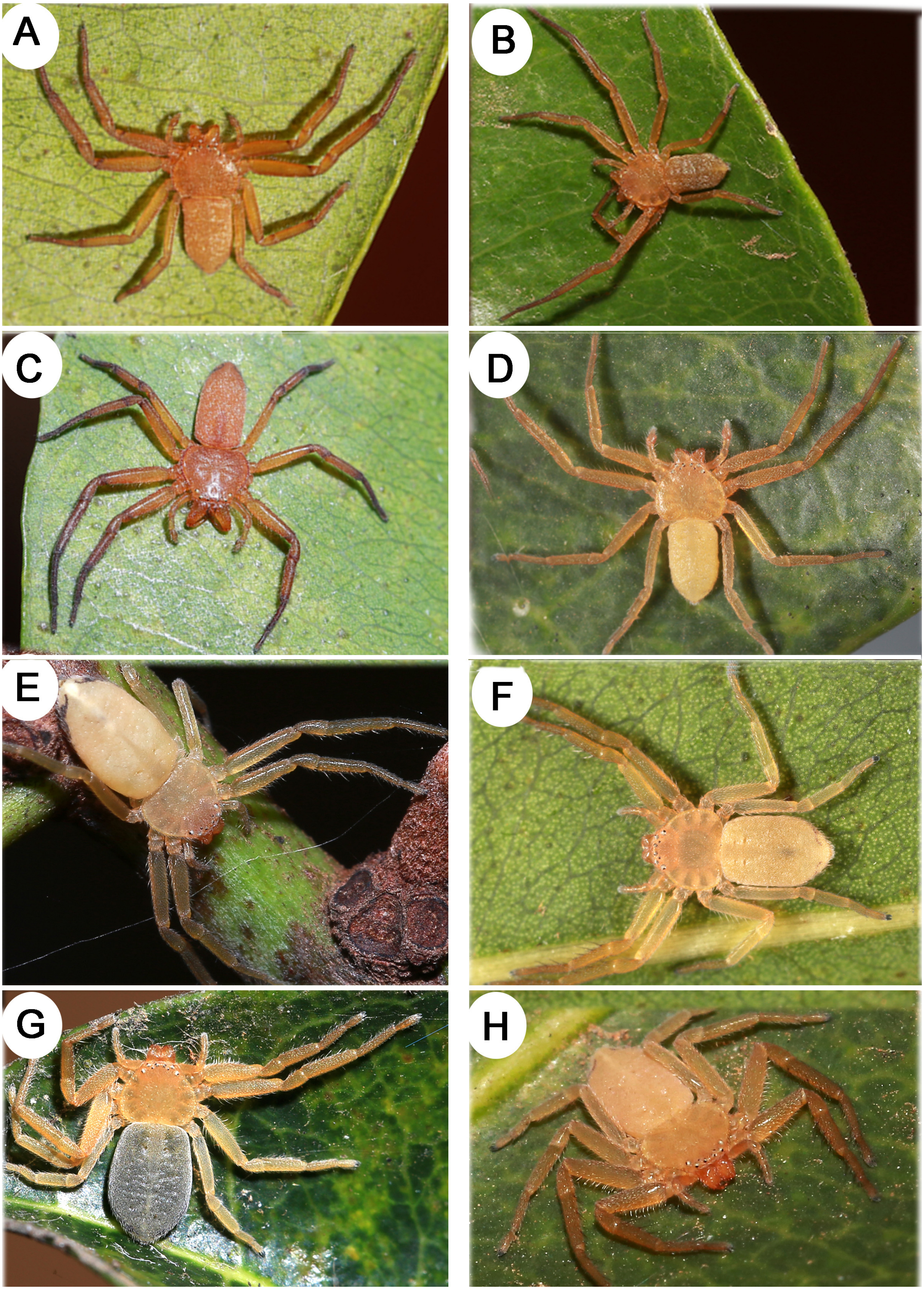
Female (from Thirumangalam): Prosoma straw colored, appearing transparent (Figs. 1E–H); eyes on white tubercles, except PME that are very small, largely separated from the lateral ones (Fig. 3A); venter smooth, sternum almost round (Fig. 3B); chelicerae conical shaped with very large, prominent dorsal hump, cheliceral promargin with one apical tooth (Fig. 3C); dorsum of tibiae, metatarsi and tarsi of the first three legs irregularly covered with short bristles, spination as in male, legs III and IV without spines, metatarsus of leg IV with conspicuous hair tuft; opisthosoma less hairy than in male, not smooth, with comma-shaped black patches posteriolaterally; median spinnerets covered with some black spots. *Epigyne* (Figs. 3D,E): epigynal groove with anteriorly elongated, sclerotized epigynal sutures, spermathecae globular, SPO on distinct stalks, FD elongated, CD very short, indistinct.

Measurements of legs:

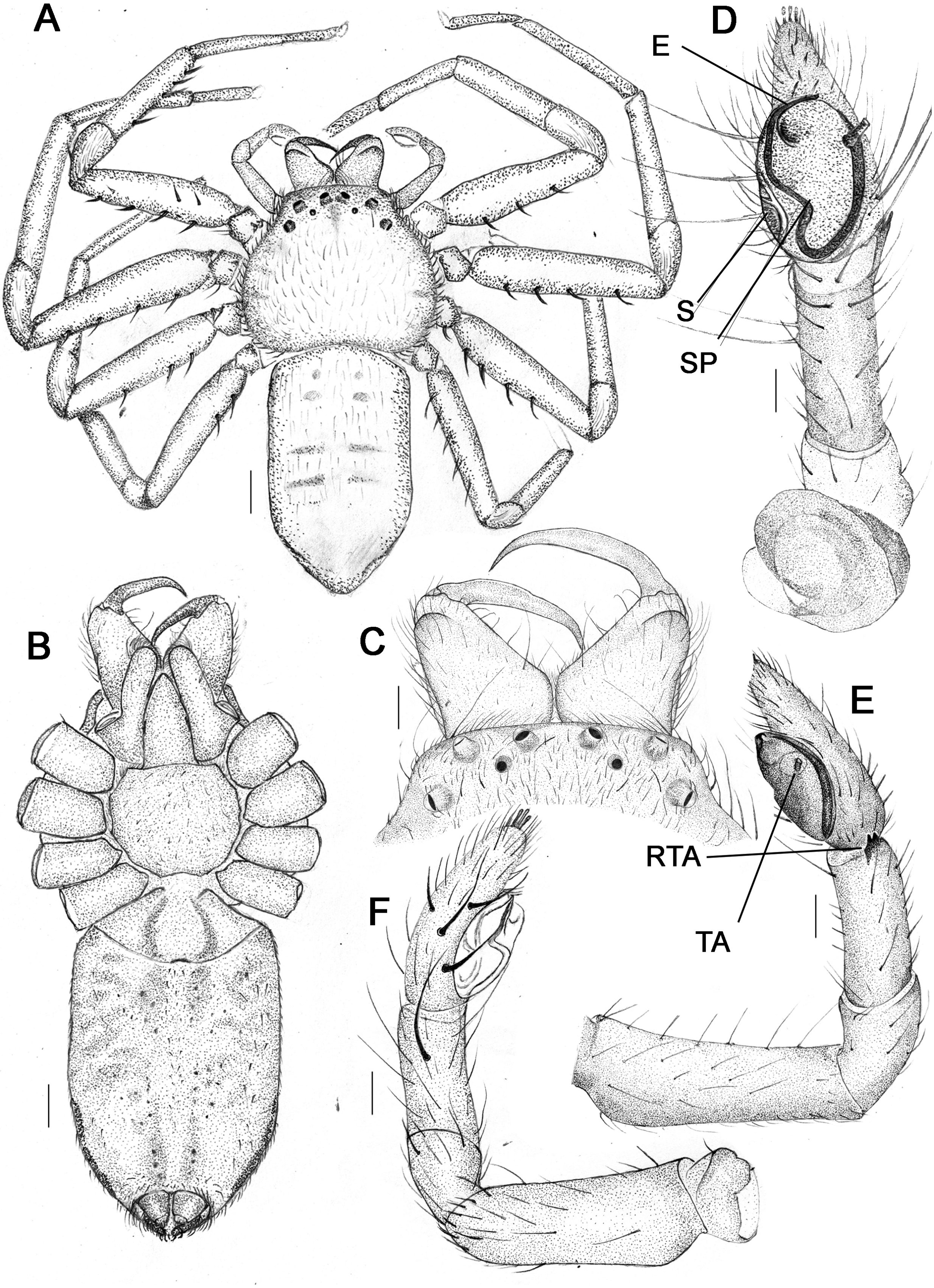
Leg segments	I	II	III	IV
Femur	1.13	1.34	1,27	1.24
Patella	0.46	0.66	0.45	0.36
Tibia	0.84	1.16	0.79	0.66
Metatarsus	0.69	0.94	0.70	0.39
Tarsus	0.36	0.56	0.39	0.30
Total	3.48	4.66	3.60	2.95

Natural History. Immature specimens of this species are very fast runners. Frequently we observed pre-ballooning tiptoe behavior (Figs. 4A–H) and realized wind carriage over long distances. Adult spiders may easily be caught when they rest in the foliage.

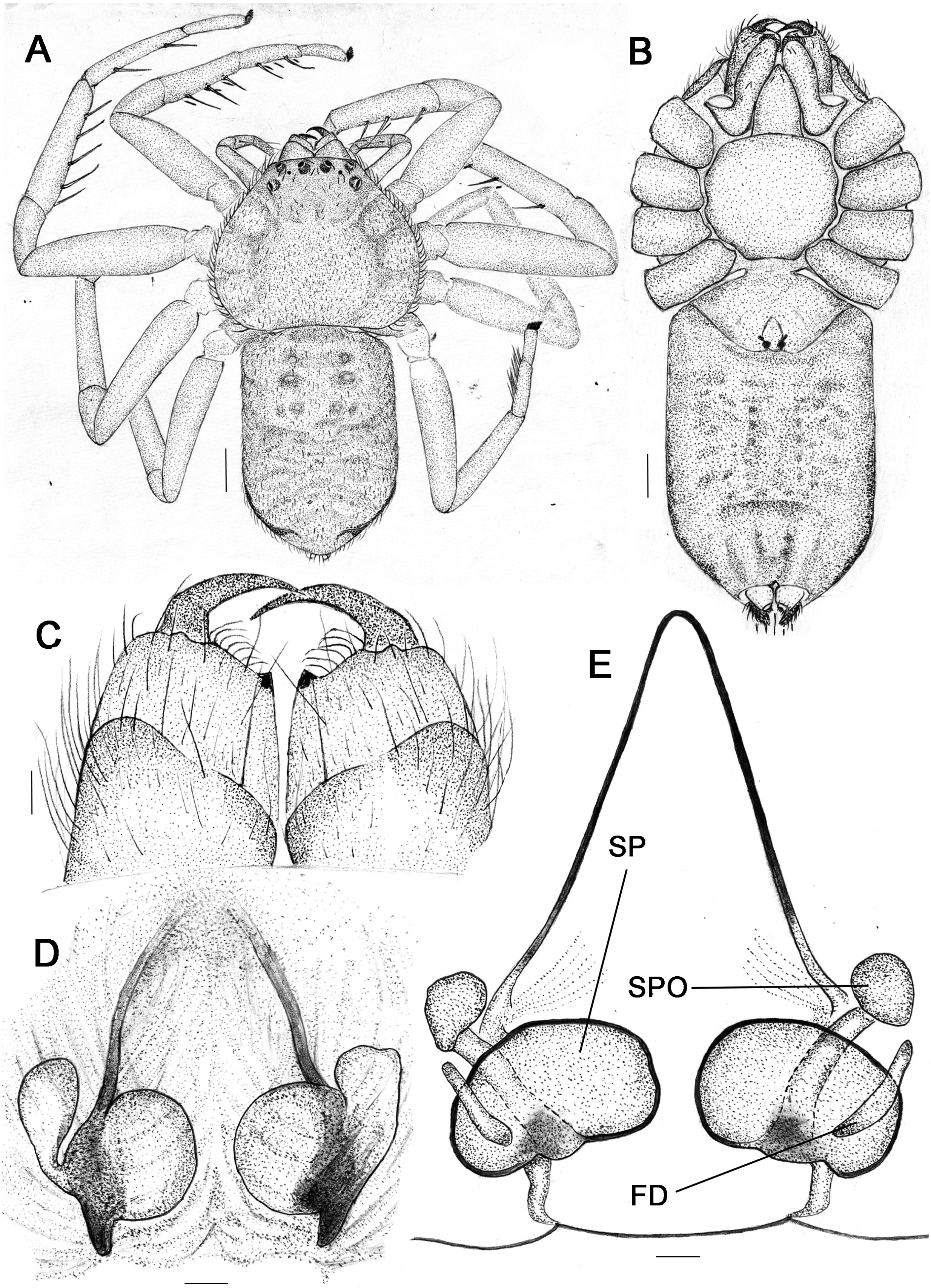
Distribution. Verified distribution records of *Psellonus planus* from South India: Tamil Nadu (Madurai, Thirumangalam) and Kerala (Kayipuram, Irinjalakuda, Muriyadu, Pathiramanal Island, Perumbalam Island, Thevara, Wayanad) are shown in a map (Fig. 5). Tikader (1966) recorded *Philodromus kendrabatai* from the Indian states Maharashtra and Karnataka, indicating that the species may be more widespread in India.



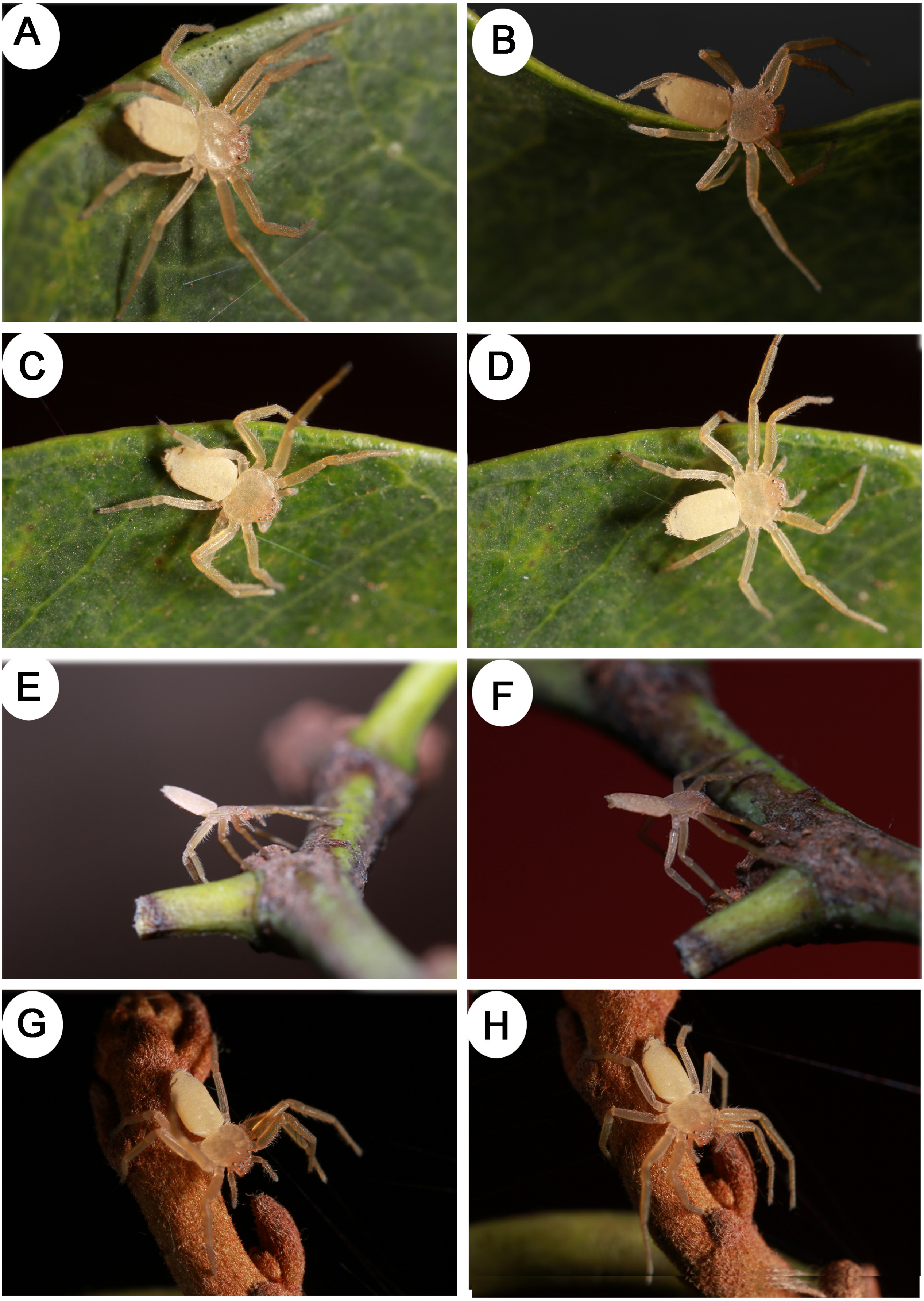
FIGURES 1A–H. Field photographs of *Psellonus planus*. A–D male; E–H female. Photo credit: Mr. Jimmy Paul.



FIGURES 2A–F. *Psellonus planus*. Male. A–B habitus (A dorsal, B ventral); C chelicerae, dorsal; D–F left pedipalp (D ventral, E retro-lateral, F pro-lateral). Scale bars: A 0.5 mm, B 0.3 mm, C 0.1 mm, D–F 0.2 mm. Abbreviations: E—embolus; RTA—retrolateral tibial apophysis; S—subtegulum; SP—sperm duct; T—tegulum; TA—tegular apophysis.



FIGURES 3A–E. *Psellonus planus*. Female. A–B habitus (A dorsal, B ventral); C chelicerae, dorsal; D epigyne, ventral; E vulva, dorsal. Scale bars: A 0.5 mm, A 0.5 mm, B 0.3 mm, C 0.2 mm, D 0.1 mm, E 0.05 mm. Abbreviations: FD—fertilization duct; SPM—spermathecae; SPO—spermathecal organ.



FIGURES 4A–H. Natural history of *Psellonus planus*. Photo credit: Mr. Jimmy Paul

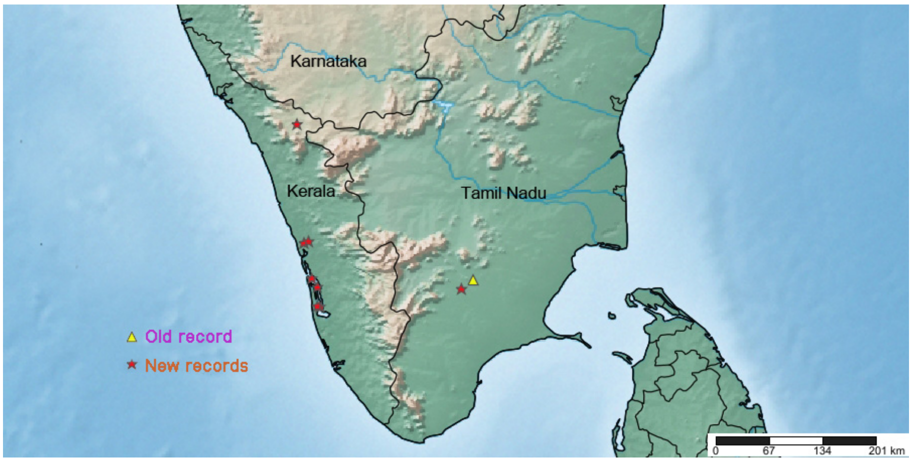


FIGURE 5. Collecting sites of *Psellonus planus* in Southern India.

Remarks. Simon (1897) described the monotypic genus *Psellonus* to accommodate the single species *P. planus* based on a single male sex from Madurai and placed the genus in the family Philodromidae. He recognized similarities with *Plator* Simon (Fam. Trochanteriidae Karsch) and *Selenops* Latreille (Fam. Selenopidae Simon), and due to the unique character configuration he erected the monogeneric subfamily Pselloninae. In the original description of *Psellonus*, Simon (1897) focused on somatic morphological characters. Our description of genitalic features in both sexes corroborates the inclusion of *Psellonus* in the family Philodromidae. Moreover, we record the presence of tenant setae with truncate tip at the palpal tarsus, a synapomorphy for Philodomidae recently proposed by Ramirez (2014).

Since the original description, no other species have been added to the genus. The original drawings and descriptive characters given for *Philodromus kendrabatai* Tikader, 1966 suggested that it may be conspecific with *Psellonus planus*. Examination of the type material confirmed this new synonymy. Among our material of *P. planus*, we observed remarkable variation in somatic (size, coloration, leg spination) and genitalic characters (most evident in the curvature of the sperm duct, but also in details of RTA, embolus, spermathecae and spermathecal organs). Since morphological variation did not show a geographical pattern, we consider the variation intraspecific. However, we cannot exclude the possibility that *Psellonus planus* could constitute a complex of cryptic species.

Psellonus shows remarkable similarity with the genus *Pedinopistha* Karsch, endemic to the Hawaiian Islands. The relationship has already been discussed by Simon (1899, 1900), but finally Simon (1900) considered *Pedinopistha* more closely related to Philodrominae than Pselloninae. Comprehensive phylogenetic studies are required to resolve the relationships of these genera and their placement within Philodromidae.

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Predatory efficacy of dominant spiders on insect pests in Kuttanad rice agro-ecosystem, Kerala, India

Efficacia predatoria dei ragni dominanti sugli insetti infestanti nell'ecosistema agricolo delle risaie in Kuttanad, Kerala, India

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Abstract

Spiders are important biological control agents in agro-ecosystems by suppressing the pest population to a safe level, which emphasizes the concept of integrated pest management in modern agriculture. Faced with the need to reduce pesticide use on crops and optimize natural biological control, the investigation was done to test the influence of spiders on pests. Spiders are considered as convenient model organisms for biological pest management and spiders in agro-ecosystems are used as tools to gain insight into the role of generalist predators in community and ecosystem function. As the part of the implementation of integrated pest management, experiments on feeding potential of the dominant spiders on major insect pests in Kuttanad rice agro-ecosystem revealed that most of the dominant spiders preyed on all insect pests vigorously.

Keywords: feeding potential; insect pest; integrated pest management; pesticides; pollution.

Riassunto

I ragni sono importanti agenti di controllo biologico negli ecosistemi agricoli tramite la repressione di popolazioni infestanti ad un livello di sicurezza, che enfatizza il concetto di gestione integrata delle infestazioni nella moderna agricoltura. Affrontata con il bisogno di ridurre l'uso di pesticidi sulle coltivazioni e di ottimizzare il controllo biologico naturale, la ricerca venne condotta per testare l'influenza dei ragni sui parassiti. I ragni sono considerati come organismi modello, utili per la gestione dei parassiti biologici, ed i ragni negli ecosistemi agricoli sono utilizzati come strumenti per ottenere comprensione nel ruolo di predatori generalisti in funzione di ecosistema e comunità. Come parte dell'attuazione di gestione integrata dei parassiti, esperimenti sulla potenziale alimentazione dei ragni dominanti sui maggiori insetti infestanti nell'ecosistema agricolo delle risaie in Kuttanad rivelava che la maggior parte dei ragni dominanti predava fortemente tutti i parassiti.

Parole chiave: potenziale alimentazione; insetti infestanti; gestione integrata dei parassiti; pesticidi; inquinamento.

Introduction

Spiders are carnivorous polyphagic predators and they form one of the most diversified organisms with 47,116 species found all over the world (World Spider Catalog, 2018). They are unique in their presence, as they inhabit even in water (*Argyroneta aquatica*). Spiders are common generalist predators that play a key role as predators in agro-ecosystems, woodlands, and other terrestrial ecosystems (Nyffeler & Benz, 1987). The factors like habitat fragmentation (Webb, 1990), use of pesticides and herbicides (Newton & Wyllie, 1992), increased use of drainage and fertilizers (Fuller, 1987), the loss and degradation of field boundary features (Barr *et al*., 1993), and changing patterns of cropping (Gibbons *et al*., 1993) has resulted in the decline of density and diversity of spiders in agricultural fields.

Insect pests have always been a constant source of threat to the welfare of the human beings since they compete with man for resources (Meena & Mital, 1997). Even though insecticides have been widely used to control rice pests for many decades, the continuous use of wide range of pesticides has caused many side effects, including loss of biodiversity, the problem of secondary pests, insecticide resistance, residual toxicity, the resurgence of insect pests and environmental pollution. The wide range of use of insecticides drastically disturbs the environment especially pose a great threat to the human health. Recently many efforts have been made to combine various non-chemical control methods with insecticides in systems of Integrated Pest Management (IPM). In this backdrop, spiders gain the attention to control the insects especially the rice pests as generalist predators. Spiders are an important animal group and good predators in the functioning of natural ecosystems since they make us free from a large number of pest insects (Samuel & Marcos, 2011). As spiders differ in their hunting strategies and habitat preferences and they show seasonal variation in their occurrence, the knowledge resulted from the spider diversity study in the different agricultural ecosystem is inevitable in IPM because these spiders attack a given pest (Marc *et al.*, 1999).

Spiders are of great importance in reducing and preventing outbreaks of insect pests in agriculture since they kill a large number of insects per unit time (Sunderland, 1999). Although spiders mainly prey on insects, little attention has been paid to the use of spiders as a bio control agent of insect pest suppression. Different spiders occurring in different seasons consume different insects, which balance the equilibrium of nature. The population densities and species abundance of spider communities in agricultural fields can be as high as in natural ecosystems (Greenstone & Sunderland, 1999). Despite the attention given to insect predators and parasites in different agro-ecosystems, relatively little is known about the feeding potential of spiders associated with rice agro-ecosystems. Spiders are obligate predators of insects with an immense potential to serve as biological control agents and capable of minimizing the insect populations in the crop field (Ferguson *et al.*1984; Whitmore *et al*. 2002).

Kuttanad is called one of the "Rice Bowls of Kerala", contributing nearly 20% of the total rice production of the state (Fig. 1). The region extends from 9° 17′ N to 9° 40′ N and 76° 19′ E to 76° 33′ E. This major rice-growing tract of Kerala state is facing the serious threat of environmental pollution due to the increased and indiscriminate use of pesticides. The pesticide consumption in Kuttanad during 2009-2010 was 485 tons. Spiders can be potential biocontrol agents because they are relatively long-lived and are resistant to starvation and desiccation. However, a number of entomologists have acknowledged the importance of spiders as one of the major predators regulating the pests of different crops (Gavarra & Raros, 1975). Unfortunately, there has been no information to date on their role as biopesticides in the paddy fields from India and studies on the predatory effect of the spider assemblages in the agriculture crops are meager, especially with regard to rice agro-ecosystem. Since Kuttanad is mainly an agricultural zone of Kerala, cultivation is done using the chemical fertilizers and pesticides, which significantly pollute the environment (Babukutty, 1997). These toxic chemicals being magnified through the biological systems pose a great threat to the natural enemies like spiders. In this paper, we focus to form a baseline data for the research on the role of spiders as biocontrol agents on various insect pests in Kuttanad rice agro-ecosystem. We also discuss the predatory potential of certain commonly encountered spiders and check whether these spiders have any preferences towards leaf and plant hoppers in the rice agro-ecosystem.

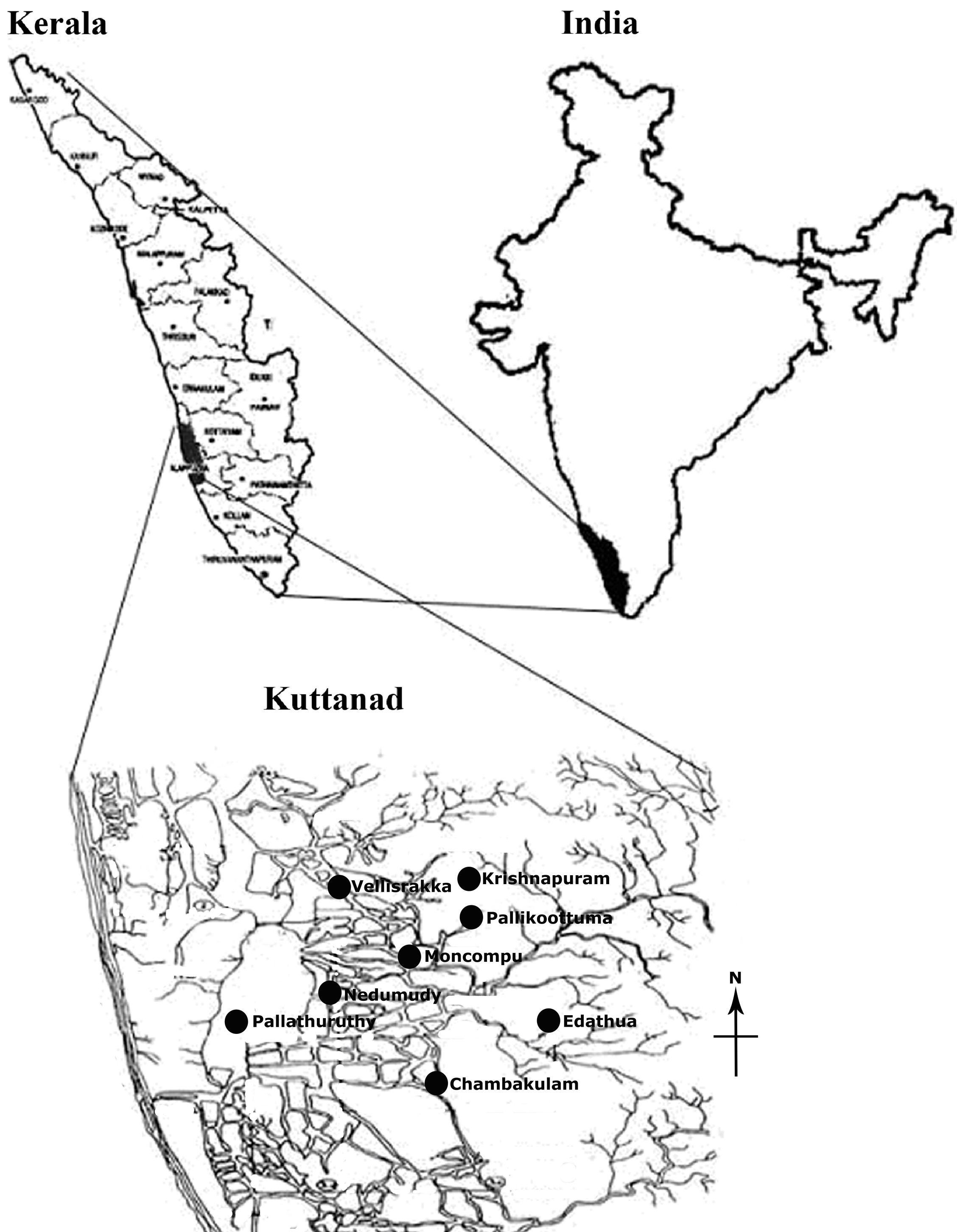

Fig. 1. Map of the study area.

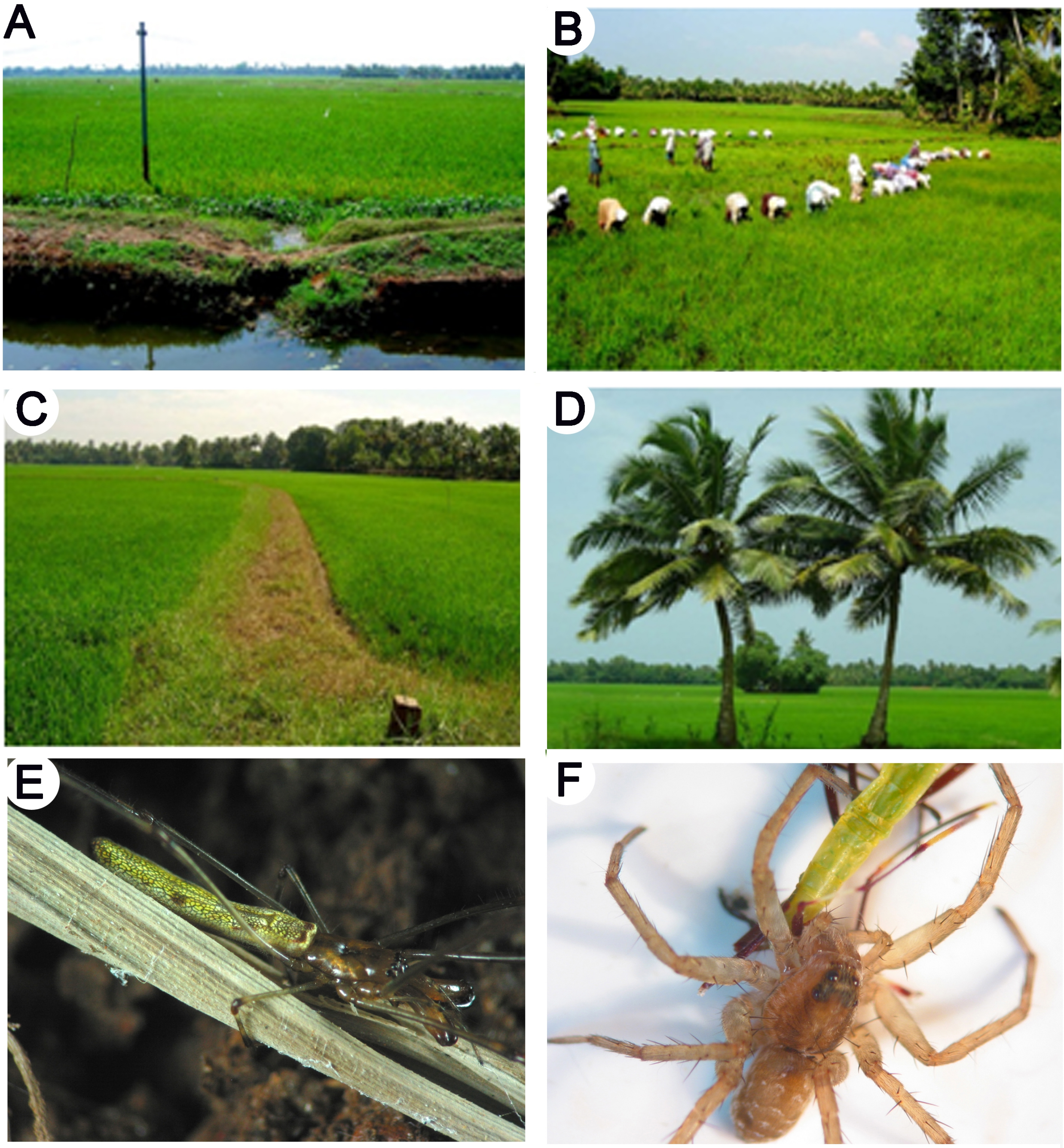

Fig. 2. **A-D**. Different views of the study area. **E**. *Tetragnatha mandibulata* on the rice plant. **F**. *Pardosa pseudoannulata* feeding on *Leptocorisa acuta.*

Materials and Methods

Kuttanad is a low-lying area of coastal Kerala formed by the confluence of four major river systems viz., Meenachil, Manimala, Pamba and Achancoil draining into the Vembanad Lake. It measures approximately 25 km east-west and 60 km north-south on the west coast of Kerala. In Kuttanad, rice is cultivated in 53,639 hectors, which is a warm, humid region with uniform temperature throughout the year ranging from 21°C to 36°C. Humidity, in general, is very high all throughout the year. The average annual rainfall received is around 300 cm of which about 83% are received during monsoon season.

The selected spiders and preys were collected from the Kuttanad rice agro-ecosystem (Fig. 2) and predatory potential of dominant spiders was evaluated in the laboratory by observing feeding capacity of spiders at various developmental stages in relation to the insect pests. The dominant spiders selected for the study were *Araneus ellipticus* (Tikader *et* Bal, 1981) (Araneidae), *Pardosa pseudoannulata* (Bösenberg *et* Strand, 1906) (Lycosidae) and *Tetragnatha mandibulata* Walckenaer, 1841 (Tetragnathidae). Five individuals of sub-adult males, sub-adult females, adult males and adult females were taken for the experiment. The insect pests selected were rice bug – *Leptocorisa acuta* (Thunberg, 1783) (Hemiptera: Coreidae), green leafhopper – *Nephotettix virescens* (Distant, 1908) (Hemiptera: Cicadellidae) and brown planthopper – *Nilaparvata lugens* (Stal, 1854) (Hemiptera: Delphacidae). Nymphs of the insects were used in the experiment. Spiders were placed individually in plastic Petri dishes, supplied with a certain number of food items and allowed to feed. The addition of the prey was made at such frequency that the prey density remained constant throughout the trial. Preys killed and consumed by the spiders were counted up to 24 hours at an interval of 6 hours. The coefficient of Variation (CV) was calculated to analyze the variation of feeding efficiency in different life stages of spiders.

Abbreviations used: AF = adult females, AM = adult males, BPH = brown planthopper, GLH = green leafhopper, IPM = integrated pest management, SAF = sub adult females, SAM = sub adult males.

Results

Araneidae: *Araneus ellipticus*

The feeding capacity of *A. ellipticus* on the nymphs of rice bug, *Leptocorisa acuta*, brown planthopper *Nilaparvata lugens* and green leafhopper *Nephotettix virescens* is provided (Table 1). *Araneus ellipticus* consumed an average of 2.01 individuals of rice bug with a maximum of 2.8 and a minimum of 1.5. Adult females consumed the maximum number and sub-adult males consumed the minimum. Each life stage of this spider showed much variation in the feeding capacity and the coefficient of variation (CV) was 38.51. The spider ingested an average of 4.4 individuals of BPH with a maximum of 6.2 and a minimum of 2.2. The various life stages showed much variation in the feeding capacity with a CV of 40.22. The spider absorbed an average of 4.12 individuals of GLH with a maximum of 5.2 and a minimum of 2.4 individuals. The different life stages of *A. ellipticus* exhibited more variations in their feeding capacity with a CV of 29.36 (Fig. 3).

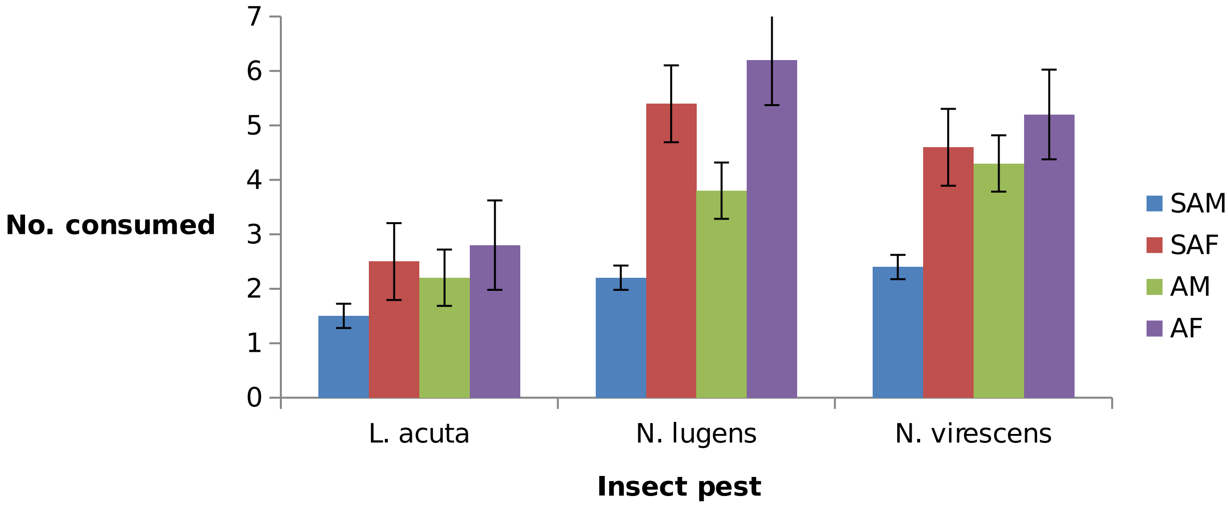

Fig. 3. Feeding potential of *A. ellipticus* on the nymphs of three insect pests.

3.2. Lycosidae: *Pardosa pseudoannulata*

The feeding potential of *P. pseudoannulata* on the nymphs of rice bug, brown planthopper and green leafhopper is experimented and provided (Table 2). *Pardosa pseudoannulata* preyed an average of 2.55 individuals of rice bug with a maximum of 3.6 and a minimum of 1.2**.** Each stage of this spider showed variation in the feeding capacity and the CV was 42.35. The spider consumed an average of 6.07 individuals of BPH with a maximum of 7.5 and a minimum of 5.2**.** The feeding capacity of *P. pseudoannulata* exhibited variations in the different life stages (CV 16.30). An average of 4.77 individuals of *N. virescens* with a maximum of 5.9 and a minimum of 4 were consumed by the spider (Fig. 4).

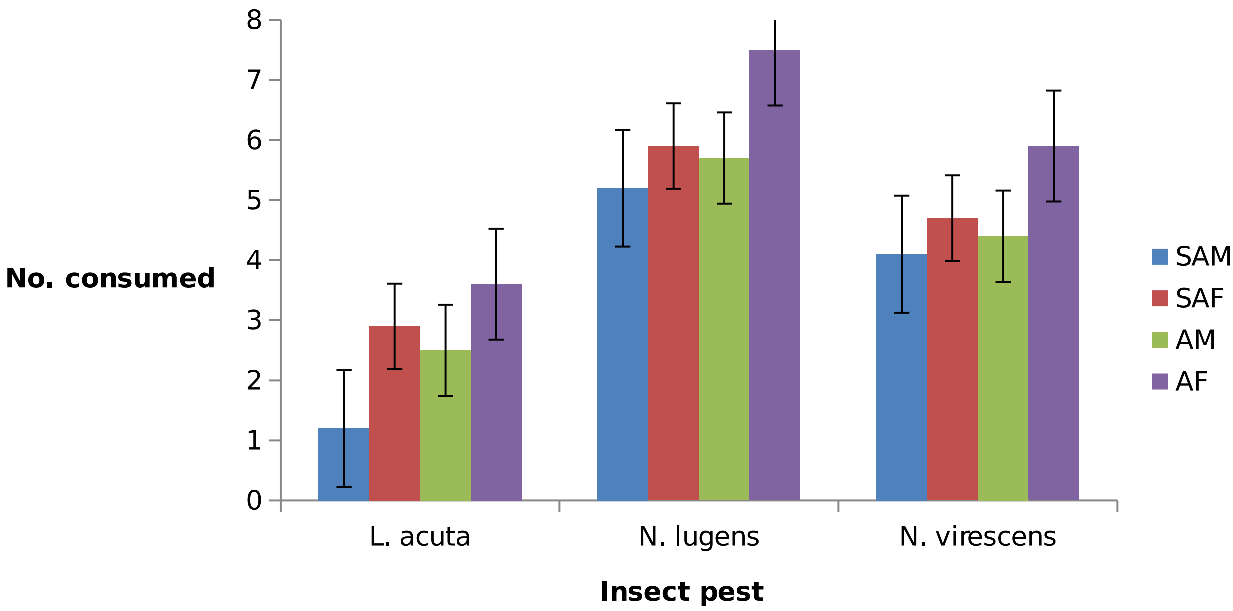

Fig. 4. Feeding potential of *P. pseudoannulata* on the nymphs of three insect pests.

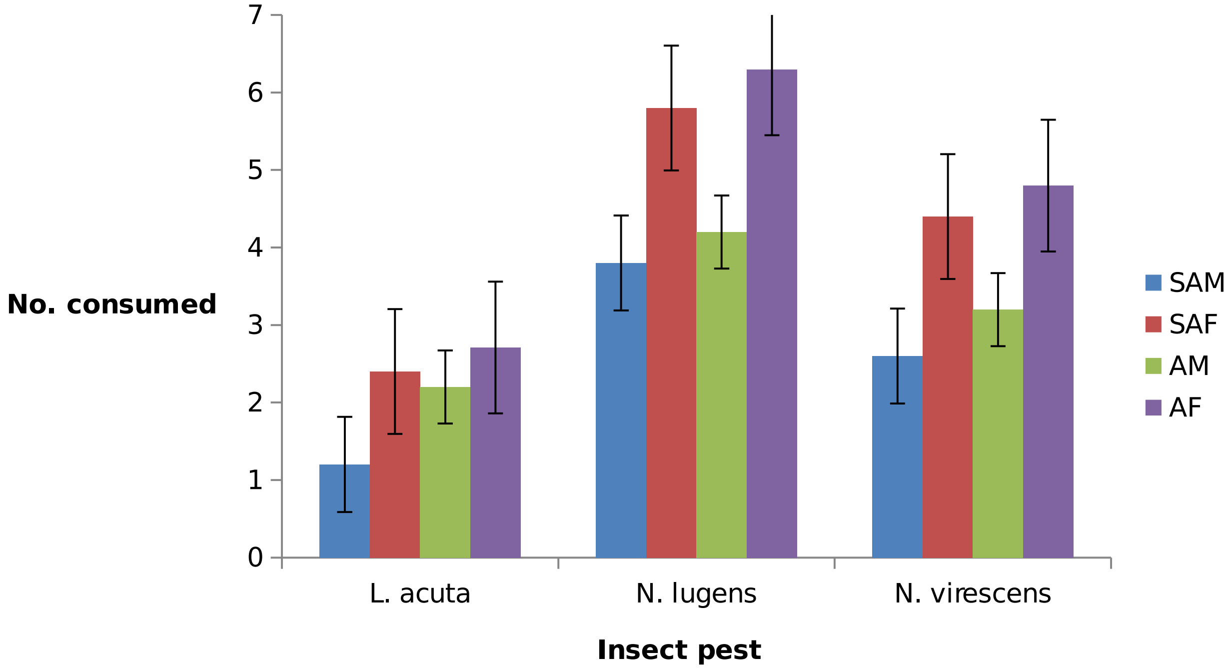

Fig. 5. Feeding potential of *T. mandibulata* on the nymphs of three insect pests.

3.3. **Tetragnathidae: *Tetragnatha mandibulata***

The predatory efficacy of *T. mandibulata* on the nymphs of rice bug, brown planthopper, and green leafhopper is provided (Table 3). *Tetragnatha mandibulata* ingested an average of 2.12 individuals of rice bug with a maximum of 2.7 and a minimum of 1.2. Adult females preyed the maximum number and sub-adult males with the minimum number of insects. Variations were observed in the feeding capacity in different life stages with the CV 30.66. The spider happened to prey an average of 5.02 individuals of *N. lugens* with a maximum of 6.3 and a minimum of 3.8 individuals. The different stages of the life cycle showed variations in their predatory efficacy with a CV of 24.10. The feeding rate of the spider is with an average of 3.75 individuals of *N. virescens* with a maximum of 4.8 and a minimum of 2.6 individuals. Adult females consumed the maximum number and the sub adult males did the minimum number of prey. The different life stages showed much variation in the feeding capacity and the CV was 27.20 (Fig. 5).

Discussion

Araneus ellipticus, *P. pseudoannulata* and *T. mandibulata* are the most common spiders in the Kuttanad rice fields and these appear in the rice field immediately after crop establishment. These are significant predators of small-bodied pests such as hopper nymphs, constituting an important component of the natural enemy complex that checks hoppers in irrigated rice. All these three spiders preyed actively on the nymphs of three insect pests.

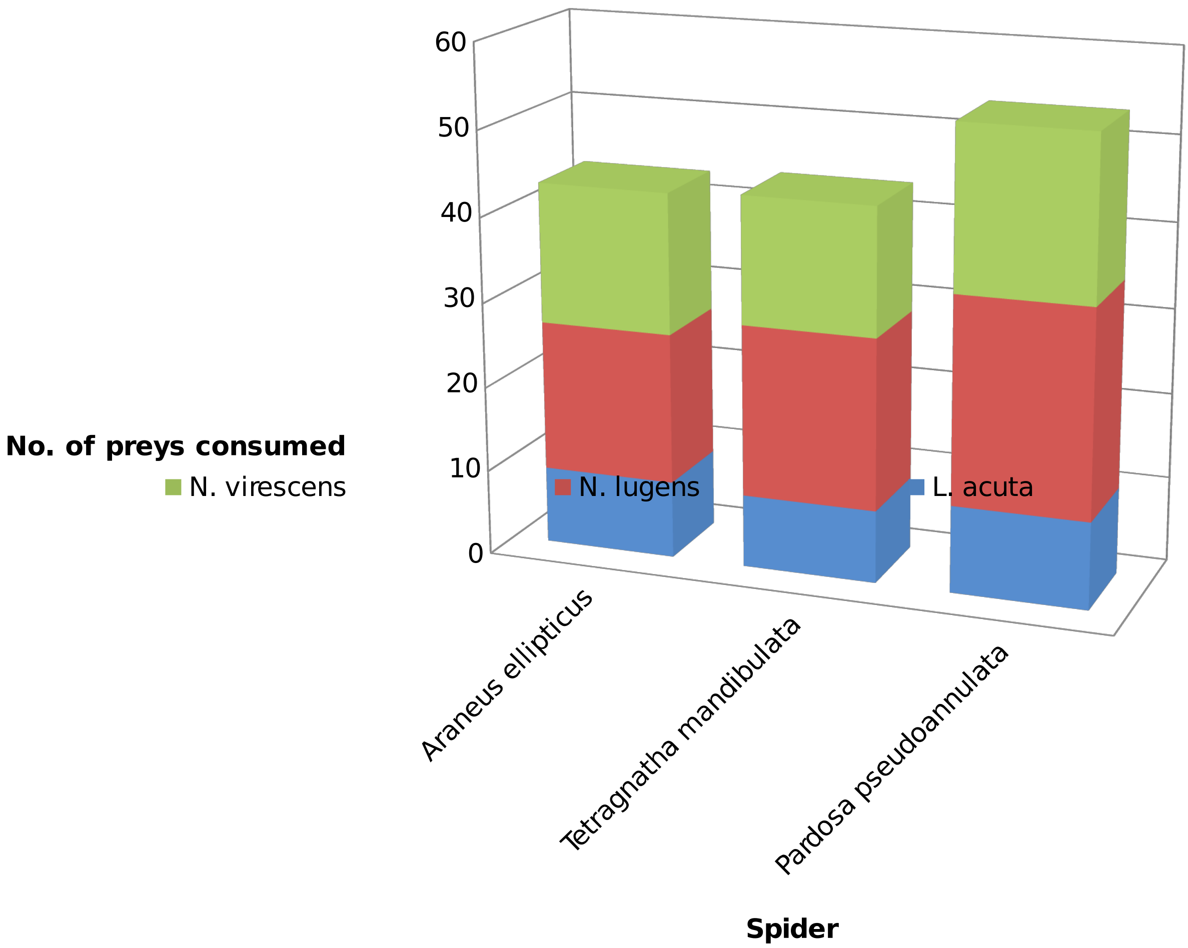

Fig. 6. Comparative predatory potential of three dominant spiders on major pests.

One of the most frequently analysed problems in a prey-predator relationship is the effect of prey and predator density during the course of predation. Predator recognition of patches of high prey density and the concentration of foraging activity in these areas can lead to stabilization, since predation pressure will be high where prey numbers are high and vice versa. In the field, spiders do inhabit areas where prey are abundant and will migrate from patches of decreasing prey density to patches of higher prey density (Harwood *et al.*, 2001). We noticed that these three common spiders actively feed on these three nymphs and exhibited an increase in prey capture when greater numbers of prey are available.

Spiders' preference to their prey is a matter of discussion. Bilsing (1920) stated that there is no evidence that any species of spider has a particular preference to the prey. Savory (1928) stated that spiders show no trace of discrimination for prey. However, Turnbull (1966) pointed out that the spiders will tolerate a wide range of species of prey and the preferred species will vary from time to time and from place to place depending on the particular time and place. It is common that when spiders have an excess of prey, they become more selective (Riechert & Harp, 1987). However, Bristowe (1941) has reported that spiders have preferences indicated by disagreeable odors and tastes, which cause them to reject any potential food items. In addition, each species of spider occupies a specific region of the agricultural habitat, from the ground to the top of the canopy. Different prey species can be found in different microhabitats as well. In our experiment, there is no evidence to prove that the tested spiders have a particular prey preference since all the selected spiders consumed the completely selected prey species dynamically. However, we propose that prey specialization by spiders could be an attribute found in ecosystems and some degree of specialization or monophagy by a predator on prey is necessary for the predator to reduce populations of that particular prey.

The rate of predation varied among the different species and sexes of the three spiders. Females of all spiders consumed a number of preys whereas their male counterparts consumed very less. The high rate of predation shown by the females is due to their high metabolic activity and size. In our case, the adult females are the potent predators and sub-adult males consumed very little since they are very small. It is discussed that the rate of predation always depends on the size of the animal and the females feed more because they need more protein for the egg formation as the quality and health of the female influences the fitness of their offspring.

The comparative feeding potential analysis of the three dominant spiders on the nymphs of three insect pests indicates that *P. pseudoannulata* was the most voracious predator on these three insect pests (Fig. 6). The diet of the wolf spider depends on the types of insects that are available but leaf hoppers and plant hoppers are the major preys. Spiders of the genus *Pardosa* feeds on nymphs and adults of the hopper and is considered as a major regulator of brown planthopper populations. A single wolf spider can eat up to 45 hoppers per day (Uetz *et al.*, 1999). The lycosid spider *P. pseudoannulata* is one of the major predators of rice planthoppers and other rice pests because of its mobility and high predation capacity (Riechert & Bishop, 1990). Hunting spiders might be better at controlling pests than web-weavers because most species of hunting spiders are capable of capturing a wide variety of prey types and sizes (Edwards, 1990). *A. ellipticus* and *T. mandibulata* prey very less on the nymphs of three insect pests compared to *P. pseudoannulata*. Since both of these species are web weavers and 'sit and wait' predators, they get rare chances to prey and have to wait for it rather than direct hunting spiders. Hunting spiders get more preying chances due to their hunting foraging strategy rather than the 'sit and wait' method. A desirable biological control agent is a predator that not only reduces pest densities, but also stabilizes them at low levels, while maintaining stable populations itself (Pedigo, 2001). In our study it is revealed that spiders can lower insect pest densities and stabilize populations by virtue of their microhabitat use, polyphagy and obligate predatory feeding strategies. They also play a significant role in the top-down effects, which means that plant damage by insect herbivores is lower during their presence rather than their absence in the rice field.

Natural rice fields with pure organic manure reasons quick raise in the populations of detritivores (such as collembolans and ephydrid flies) and plankton feeders (such as mosquito larvae and chironomid midge larvae), which are major alternative prey for ground spiders and these habitats carry an elevated abundance of spiders than traditionally farmed fields (Tahir and Butt, 2009). Since organic fields give spiders more safety from natural enemies and improve microhabitat, Organic farming can cause diversity to the soil structure and raise the richness of prey and in turn the abundance of spiders (Öberg, 2007).

In order to facilitate a stable agro-ecosystem, presence of permanent and uninterrupted natural habitat next to the Kuttanad crop field is essential. An undisturbed habitat is an excellent physical milieu for spiders with their sufficient food, refuge, prey availability and sites for web construction (Thomas and Marshall, 1999). A large percentage of perennial crops and heterogeneity of vegetation in the nearby areas of Kuttanad rice agro-ecosystem have been demonstrated to have a positive effect on spider abundance.

Conclusion and Recommendations

Spiders are effective predators of herbivorous insect pests and a diverse assemblage of spiders may have the greatest potential for keeping pest densities at low levels. In a healthy agro-ecosystem, spiders are the best classical natural enemy candidate for a classical biological control program. Natural enemy populations have the unique ability to be able to interact with their prey or host population and to regulate them at lower levels. Therefore, natural enemy conservation is the major step to eradicate the insect pests in the agro-ecosystems. Conservation of the natural enemy should be accomplished by minimizing the use of chemicals and the physical disturbances of the habitat. Natural practices of harvesting, ploughing and grazing instead of mechanical alterations to the land would increase spider diversity in agricultural land. Organic farming should be done avoiding the traditional practices like using insecticides, which threatens the natural enemies and declining the density and diversity of the spiders. Insecticides adversely affect the life cycle of natural enemies and the population density of these natural enemies in the paddy fields has been depressed by the imprudent use of it. The use of bio-pesticides rather than insecticides should be encouraged to preserve and retain the natural enemy population in the rice fields. Recent trends in agriculture towards reduced pesticide use and ecological sustainability have to lead to increased interest in spiders as potential biological control agents. Moreover, as spiders exhibit the ability to lower and stabilize pest populations, making them excellent biological pest management candidates. In order to conserve natural enemies in rice ecosystems of Kuttanad, it is required to adapt natural farming that improve the abundance of spiders or at least have a negligible toxic effect on them. In order to appreciate the ecological basis of biological control, it is desirable to have an idea of different pest groups and their major characteristic natural enemies. Since it is a baseline study focusing only on three preys and three predators, we recommend for a systematic study focusing on more predators and preys to get a more accurate result. It will help in the management of spiders and related pests in the study area so that we may gain a better understanding of the environmental factors that are important in determining the spider inhabitants. This knowledge can be used to influence agricultural habitats to enhance and maintain spider population in integrated pest management.

Pest	Spider life stage					
	SAM	SAF	AM	AF	Mean±SD	CV(%)
L. acuta	1.5±0.70	2.5±1.07	2.2±1.03	2.8±1.06	2.01±0.77	38.51
N. lugens	2.2±0.68	5.4±1.11	3.8±0.84	6.2±1.39	4.4±1.77	40.22
N. virescens	2.4±0.77	4.6±1.12	4.3±1.68	5.2±1.21	4.12±1.21	29.36

Table 1. Feeding potential of *Araneus ellipticus* on the nymphs of three insect pests

Pest	Spider life stage					
	SAM	SAF	AM	AF	Mean±SD	CV(%)
L. acuta	1.2±0.42	2.9±0.87	2.5±0.52	3.6±0.47	2.55±1.08	42.35
N. lugens	5.2 ±1.66	5.9±0.63	5.7±1.15	7.5±0.84	6.07±0.99	16.30
N. virescens	4.1±1.44	4.7±1.47	4.4±1.41	5.9±1.10	4.77±0.78	16.35

Table 2. Feeding potential of *Pardosa pseudoannulata* on the nymphs of 3 insect pests

Pest	Spider life stage					
	SAM	SAF	AM	AF	Mean±SD	CV(%)
L. acuta	1.2±0.52	2.4±0.88	2.2±075	2.71±1.21	2.12±0.65	30.66
N. lugens	3.8±1.32	5.8±1.21	4.2±1.65	6.3±1.87	5.02±1.21	24.10
N. virescens	2.6±0.88	4.4±1.22	3.2±1.33	4.8±1.42	3.75±1.02	27.20

Table 3. Feeding potential of *Tetragnatha mandibulata* on the nymphs of 3 insect pests

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Arthropoda Selecta 27(4): 330–334

A new species of the jumping spider genus *Icius* Simon, 1876 from India (Aranei: Salticidae: Chrysillini)

Новый вид из рода пауков-скакунчиков *Icius* Simon, 1876 из Индии (Aranei: Salticidae: Chrysillini)

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KEY WORDS: jumping spiders, South India, new species, taxonomy, distribution.
КЛЮЧЕВЫЕ СЛОВА: пауки-скакунчики, южная Индия, новый вид, таксономия, распространение.

ABSTRACT. A new species of the jumping spiders — *Icius vikrambatrai* sp.n. (♂♀) — is described from South India. A detailed morphological description, diagnosis and illustrations of the copulatory organs are provided. Distribution of all the Indian *Icius* species is mapped.

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РЕЗЮМЕ. Новый вид пауков-скакунчиков — *Icius vikrambatrai* sp.n. (♂♀) — описан из южной Индии. Даны детальное морфологическое описание, диагноз и рисунки копулятивных органов. Распространение всех индийских видов *Icius* прокартировано.

Introduction

A total of 35 valid species has been known worldwide in the genus *Icius* Simon, 1876 [WSC, 2018], of which seven have been recorded/described from south and south-east Asia: viz., one species is known from Afghanistan, three from China, one from Indonesia and two from India. *Icius alboterminus* (Caleb, 2014) and *I. kumariae* Caleb, 2017 were recently described from both sexes from India [Caleb, 2014, 2017]. *I. alboterminus* was originally described in the genus *Phintella* Strand, in Bösenberg et Strand, 1906 and then transferred to *Icius* [Caleb, 2017]. In present paper we aim to describe a new species *Icius vikrambatrai* sp.n. (♂♀) from southern India.

Materials and methods

Samples were hand-collected. The specimens were studied by means of a LEICA S8AP0 stereomicroscope. All measurements are in mm. Length of the palp and leg segments are given as follows: total (femur, patella, tibia, metatarsus (except palp), tarsus). Spine positions are as follows: prolateral, dorsal, retrolateral and ventral. B/W drawings were made by means of a drawing apparatus attached to the LEICA microscope. Digital images were taken by a Leica DFC2900 digital camera attached to the Leica M205 A stereomicroscope with the software package Leica Application Suite (LAS), version 4.5.0. The studied specimens have been deposited in the reference collection of the Division of Arachnology, Department of Zoology, Sacred Heart College, Thevara, Cochin, Kerala, India (ADSH). Abbreviations used in the text. ALE — anterior lateral eye, AME — anterior median eye, PLE — posterior lateral eye, PME — posterior median eye, I–IV — 1st to 4th legs.

Taxonomy

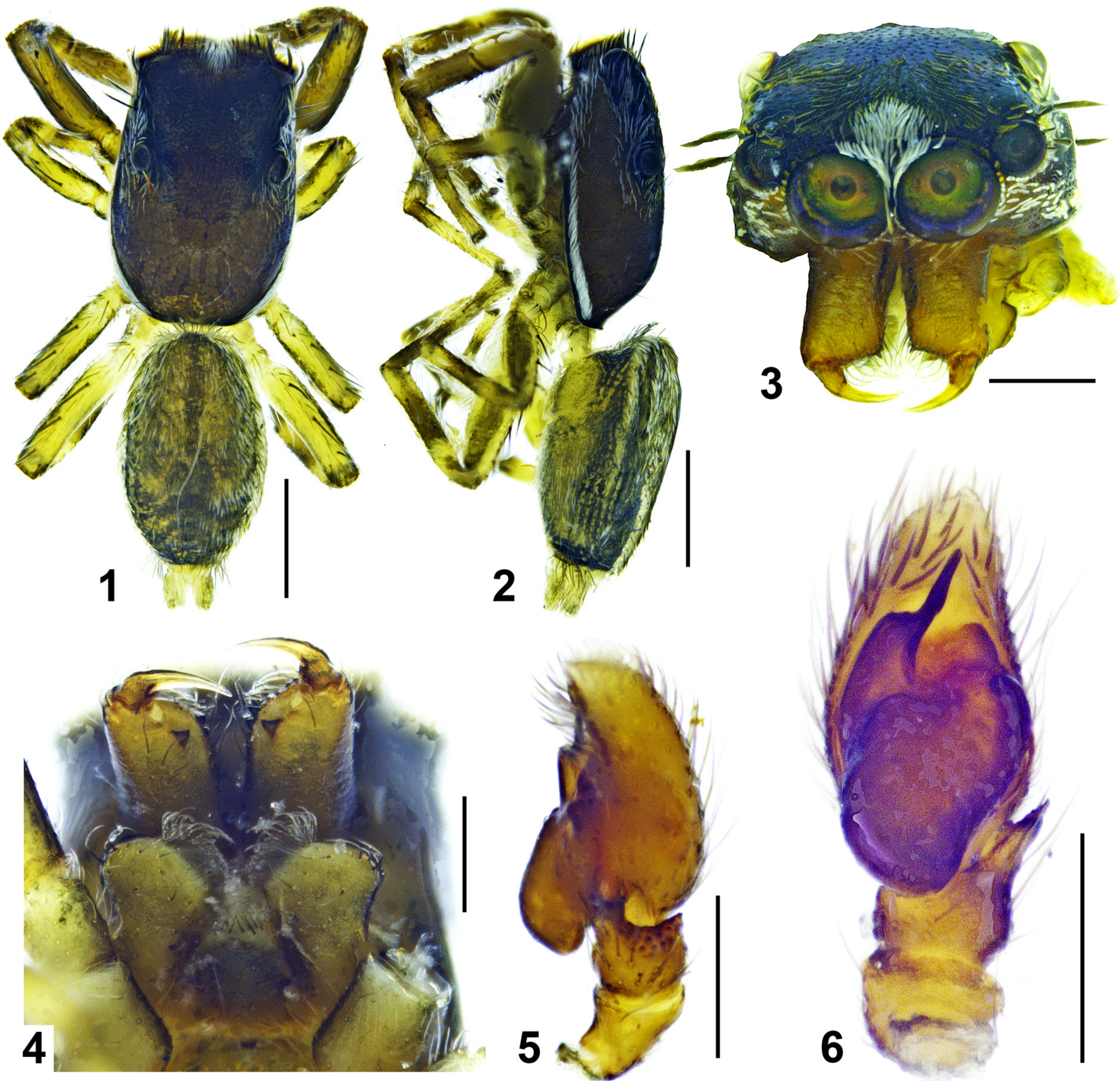
Icius Simon, 1876

Type species: *Icius hamatus* C.L. Koch, 1846.

Diagnosis. For diagnostic features and description of the genus see Alicata & Cantarella [1994].

Icius vikrambatrai **sp.n.**
Figs 1–17, Map.

TYPES: Holotype male (ADSH872381) from India, Kerala, Alappuzha, Pathiramanal Island (9°37'07.11''N, 76°23'04.95''E),



Figs 1–6. The holotype male of *Icius vikrambatrai* sp.n.: 1 — general appearance, dorsal view; 2 — ditto, lateral view; 3 — carapace, frontal view; 4 — chelicerae and endites, ventral view; 5 — left palp, retrolateral view; 6 — ditto, ventral view. Scale bars: 1, 2 (0.5 mm); 3–6 (0.2 mm).

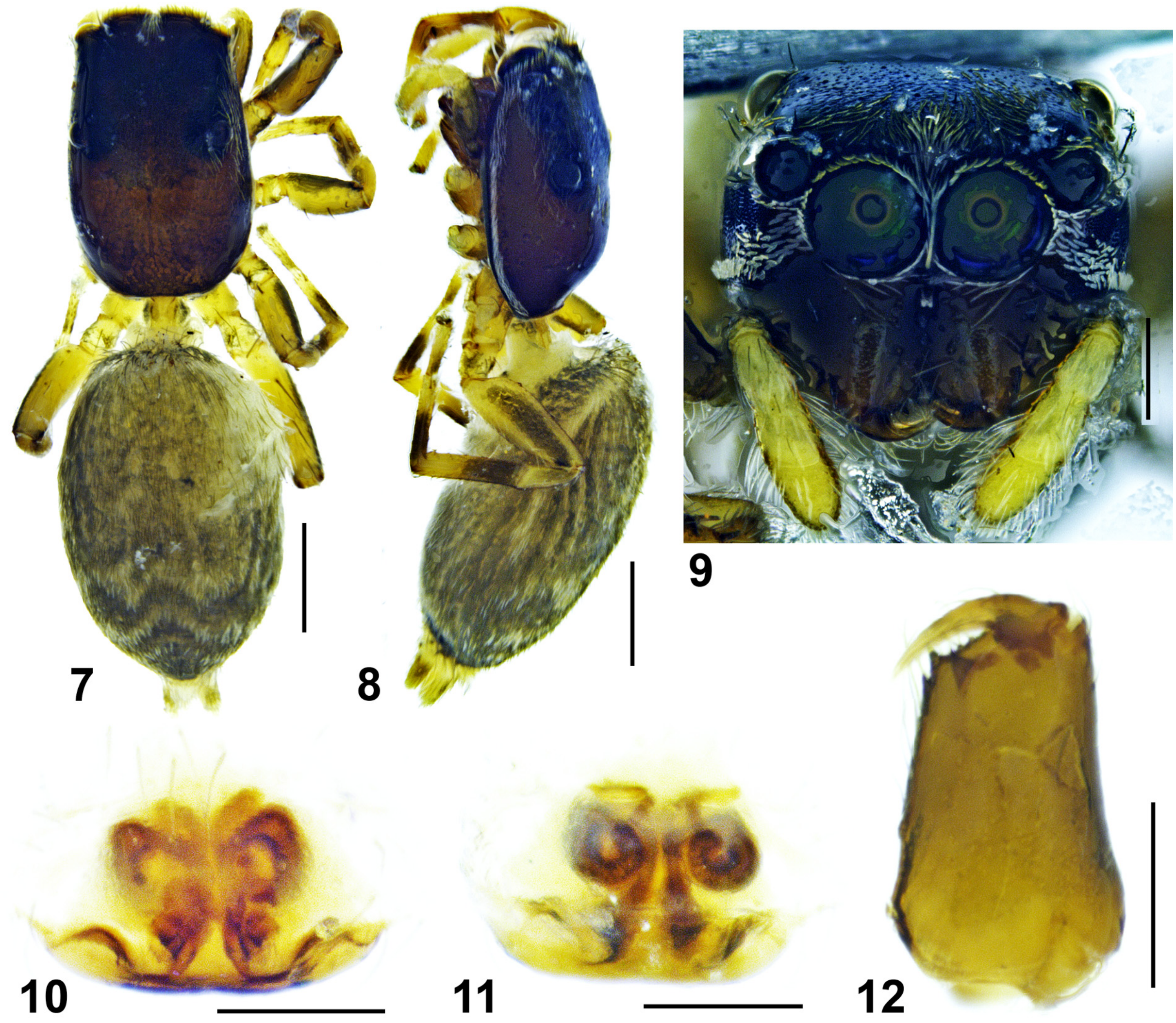
Рис. 1–6. Самец-голотип *Icius vikrambatrai* sp.n.: 1 — общий вид, дорзально; 2 — тоже, сбоку; 3 — головогрудь, спереди; 4 — хелицеры и максиллы, снизу; 5 — левая пальпа, сзади-сбоку; 6 — тоже снизу. Масштаб: 1, 2 (0,5 мм); 3–6 (0,2 мм).

0 m a.s.l., from foliage, 27.02.2015, M.J. Jobi & Jimmy Paul. Paratype: 1 ♀ (ADSH872382), together with the holotype.

ETYMOLOGY. The specific epithet is a tribute to the Indian Kargil war hero, Captain Vikram Batra, PVC, an officer of the Indian Army. He was posthumously awarded with the Param Vir Chakra (the India's highest and most prestigious award for valour) for his tremendous actions during the 1999 Kargil War in Kashmir, for which he was also known as 'Sher Shah' ('Lion King').

DIAGNOSIS. The new species is most similar to *I. kumariae*, but it can be easily distinguished from it by the following characters: the short, stout and flattened embolus having a uniform thickness (Figs 6, 13) (embolus long, apically narrowed and bent in *I. kumariae*; see figs 10 and 16 in Caleb [2017]); the tri-pronged retrolateral tibial apophysis with a broad base in the male (Figs 5, 13–15) (two retrolateral tibial apophysis in *I. kumariae*, see figs 10–12 and 16–17 in Caleb, [2017]); a pair of prominent sclerotized pockets situated at the posterior-lateral margin of the epigyne in the female (Figs 10, 16) (bow-shaped sclerotized epigynal margin, without a visible pocket, see figs 13–15 and 18–19 in Caleb [2017]).

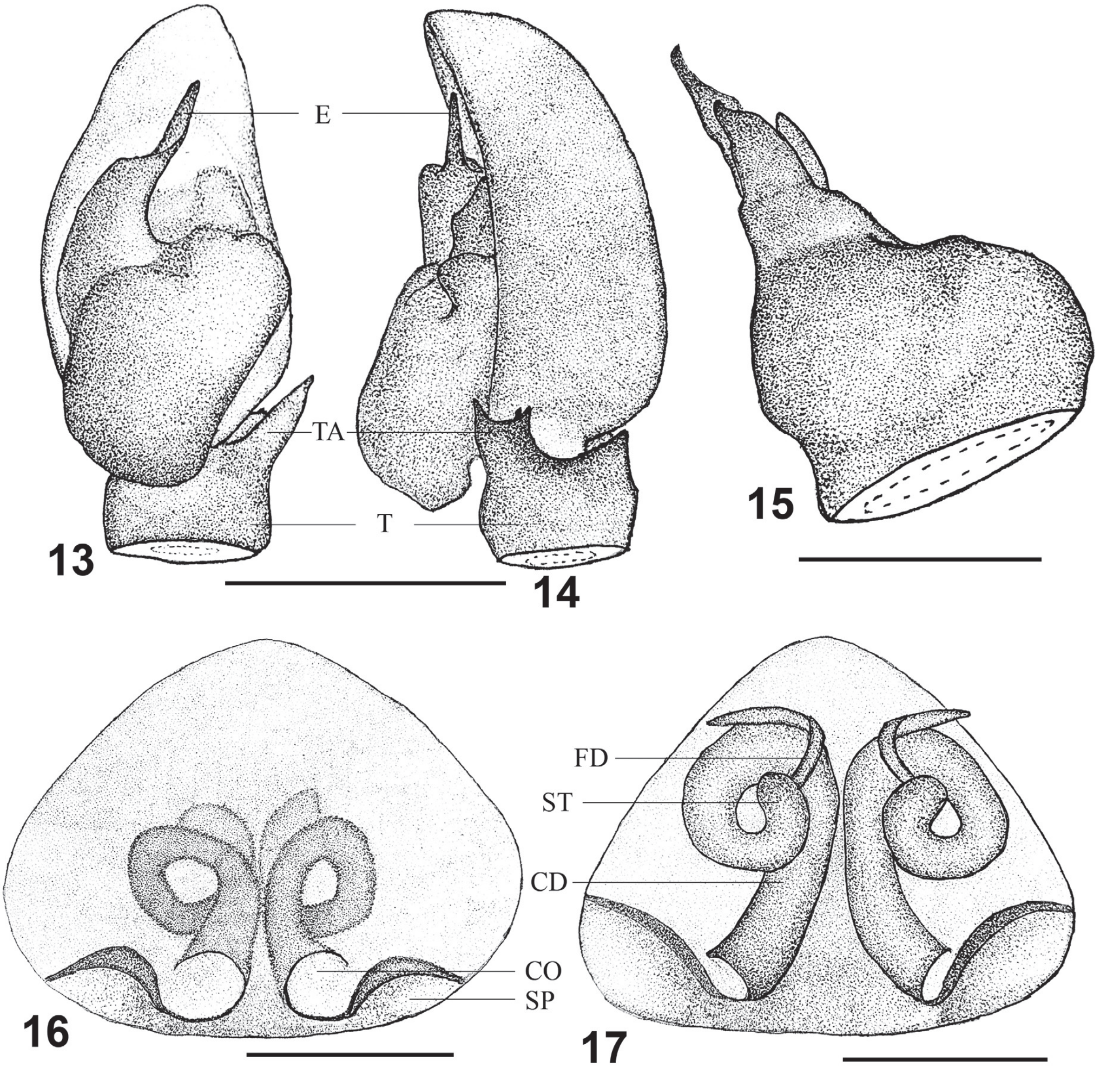
DESCRIPTION. Male (the holotype, Figs 1–6). Prosoma pear-shaped, brownish, with a thin white marginal stripes of uniform thickness; anterio-lateral sides of prosoma with whitish hairs. Cephalic region blackish, with scattered pale yellowish minute setae, eyes encircled by minute orange yellowish bristles, except for one-quarter part of AMEs that



Figs 7–12. The paratype female of *Icius vikrambatrai* sp.n.: 7 — general appearance, dorsal view; 8 — ditto, lateral view; 9 — carapace, frontal view; 10 — epigyne, ventral view; 11 — spermathecae, dorsal view; 12 — left chelicera, rear view. Scale bars: 7, 8 (0.5 mm); 9, 12 (0.2 mm); 10, 11 (0.1 mm).

Рис. 7–12. Самка-паратип *Icius vikrambatrai* sp.n.: 7 — общий вид, сверху; 8 — тоже, сбоку; 9 — головогрудь, спереди; 10 — эпигина, снизу; 11 — сперматека, сверху; 12 — левая хелицера, сзади. Масштаб: 7, 8 (0,5 мм); 9, 12 (0,2 мм); 10, 11 (0,1 мм).

is encircled by white setae; dorsally white coloured setae making a triangle-shaped figure located anterio-medially in between AMEs (Fig. 3); anterior row of eyes with eight apical-marginal and four (two pairs) leaf-like scales behind PMEs (Fig 1–3). Clypeus, chelicerae, endites, labium and sternum brownish. Clypeus with few whitish setae. Chelicerae with two promarginal and one retromarginal teeth (which can be also visible in *I. kumariae*, see fig. 9 in Caleb [2017]); fangs moderate in length, yellowish brown (Fig. 4). Legs pale yellow, with apical brownish region in each segments except for brownish legs I. Opisthosoma oval, dark brownish, with several whitish setae making irregular striae at its posterior region and chevron-shaped mark anteriorly; sides dark brown, with numerous white striae and patches of blackish hairs; venter light brown (Figs 1, 2). Spinnerets pale yellowish, encircled by black margin. Body length 2.16. Prosoma length 1.18, width (at the middle) 0.77, height (at the middle) 0.43. Opisthosoma length 0.98, width (at the middle) 0.63, height (at the middle) 0.53. Eye diameter: ALE 0.11, AME 0.24, PLE 0.14, PME 0.05. Eye interdistances: AME–AME 0.01, AME–ALE 0.009, ALE–ALE 0.46, ALE–PME 0.19, PLE–PLE 0.51, PME–PME 0.59, PME–PLE 0.12. Clypeus height at ALE 0.15, at AME 0.008. Chelicera length 0.29. Measurements of palp and legs. Palp 0.82 (0.32, 0.09, 0.10, 0.31), I 1.84 (0.56, 0.34, 0.42, 0.30, 0.22), II 1.44 (0.46, 0.24, 0.31, 0.25, 0.18), III 1.55 (0.48, 0.19, 0.36, 0.30, 0.22), IV 1.89 (0.63, 0.22, 0.43, 0.36, 0.25). Leg formula: 4132. Spination. Palp: 0100, 0000, 0000, 0000; legs: femora I 0400, II 0400, III 0400, IV 0300; patellae I–IV 0000; tibiae I 1002, II 0002, III 0001, IV 0002; metatarsi I 0004, II 1001, III 1010, IV 2021; tarsi I–IV 0000. Palp (Figs 5, 6, 13–15): palpal segments brownish, femur and tibia with darken blotches. Embolus stout, flattened and uniformed in thickness directed at one o'clock

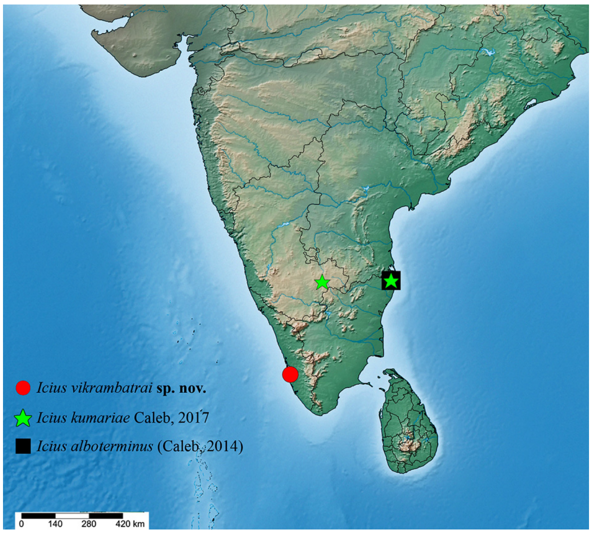


Figs 13–17. Copulatory organs of *Icius vikrambatrai* sp.n. (♂ holotype and ♀ paratype): 13 — left male palp, ventral view; 14 — ditto, retrolateral view; 15 — male retrolateral tibial apophysis, dorsal view; 16 — epigyne, ventral view; 17 — spermathecae, dorsal view. Scale bars: 13, 14 (0.2 mm); 15 (0.05 mm); 16, 17 (0.1 mm). Abbreviations: CD — copulatory duct; CO — copulatory opening; E — embolus; FD — fertilization duct; SP — sclerotized pocket; ST — spermatheca; TA — retrolateral tibial apophysis.

Рис. 13–17. Копулятивные органы *Icius vikrambatrai* sp.n. (голотип ♂ и паратип ♀): 13 — левая пальпа самца, снизу; 14 — тоже, сбоку-сзади; 15 — тибиальный отросток пальпы самца, сверху; 16 — эпигина, снизу; 17 — сперматека, сверху. Масштаб: 13, 14 (0,2 мм); 15 (0,05 мм); 16, 17 (0,1 мм). Сокращения: CD — копулятивный проток; CO — копулятивное отверстие; E — эмболюс; FD — осеменительный канал; SP — склеротизированый карман; ST — сперматека; TA — ректролатеральный отросток пальпы.

position (Figs 6, 13), straight spine-like appearance of the embolus is seen from the lateral view (Figs 5, 14). Retrolateral tibial apophysis tri-pronged, with a broad base; superior prong is bigger than two others (Figs 5, 14, 15). Bulb dark brownish, slightly projecting posteriorly, sperm duct is invisible externally because of the highly sclerotized bulb (Figs 5, 6).

Female (paratype, Figs 7–12, 16, 17): In all details as described for the male, except as follows: cephalic region without any leaf-like setae. Body length 2.74. Prosoma length 1.25, width (at the middle) 0.99, height (at the middle) 0.48. Opisthosoma length 1.49, width (at the middle) 0.89, height (at the middle) 0.84. Eye diameter: ALE 0.11, AME 0.24, PLE 0.12, PME 0.04. Eye interdistances: AME–AME 0.01, AME–ALE 0.007, ALE–ALE 0.46, ALE–PME 0.20, PLE–PLE 0.55, PME–PME 0.60, PME–PLE 0.13. Clypeus height at ALE 0.18, at AME 0.008. Chelicera length 0.27. Measurements of palp and legs. Palp 0.83 (0.35, 0.11, 0.12, 0.25), I 1.54 (0.50, 0.29, 0.34, 0.22, 0.19), II 1.34 (0.43, 0.21, 0.29, 0.22, 0.19), III 1.51 (0.46, 0.19, 0.32, 0.31,



Map. Collecting localities of *Icius* species in India.
Карта. Точки находок видов *Icius* в Индии.

0.23), IV 1.95 (0.66, 0.22, 0.46, 0.37, 0.24). Leg formula: 4132. Spination. Palp: spineless; legs: femora I 0300, II 0300, III 0300, IV 0300; patellae I–IV 0000; tibiae I–IV 0001; metatarsi I 0004, II 1001, III 0001, IV 1010; tarsi I–IV 0000. Epigyne (Figs 10, 11, 16, 17): epigynal plate simple, somewhat triangular, with more sclerotized posterior margin and a pair of prominent sclerotized pockets (=flaps) situated poserio-laterally. Copulatory ducts short, uniform in thickness except for being slightly broader near the copulatory openings, making a single loop apically (Figs 11, 17). Spermathecae small and simple, not reaching the height of the loop made by the copulatory ducts (Figs 11, 17) (in *I. kumariae*, the spermathecae reach the height of the loop made by copulatory ducts, see figs 13–15 and 18–19 in Caleb [2017]). Copulatory openings positioned posterior-medially, highly sclerotized, with their margin attaching to sclerotized pockets (Figs 11, 17). Fertilization ducts long (Figs 11, 17).

DISTRIBUTION. The type locality only: India: Kerala, Pathiramanal Island, Alappuzha (Map).

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First record of the spider genus *Wolongia* Zhu, Kim & Song, 1997 from India with the description of a new species (Araneae, Tetragnathidae)

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Zhu *et al.* (1997) erected the tetragnathid genus *Wolongia* to accommodate *Wolongia guoi* Zhu, Kim & Song, 1997 and *Wolongia wangi* Zhu, Kim & Song, 1997 collected from the Sichuan and Shaanxi Provinces in China. In 2009, Ping *et al.* described *Wolongia odontodes* from the Gaoligong Mountains and remained with a nominal representation after the erection of the genus. This situation was somewhat rectified by Jin-long Wan & Xian-jin Peng (2013) reporting seven new species from the Gaoligong Mountains (Yunnan Province, southwest China). The genus currently with ten nominal species; three are known only from females, while seven are from both sexes (World Spider Catalog 2017). During our survey in Pathiramanal Island we found an undescribed *Wolongia* species. This is one of the most diverse areas of the Kerala state of Southern India, situated in the Vembanad Lake, a Ramsar Convention (2013) site (wetland of international importance). In this paper, we describe this new species and provide the first report of *Wolongia* from India.

Descriptions were made based on specimens preserved in 75% ethanol. The specimens were examined as well as measured and the digital images were taken by Leica DFC2900 digital camera attached to Leica M205A stereomicroscope with the software package Leica Application Suite (LAS), version 4.5.0. Male palp and female genitalia were drawn after they were dissected from the spiders. Epigyna were removed carefully and treated in a 10% solution of potassium hydroxide (KOH) for several minutes. All measurements are given in millimetres. Legs were measured as follows: total length (length of femur, length of patella, length of tibia, length of metatarsus, length of tarsus). The specimens are deposited in a reference collection of the Division of Arachnology, Department of Zoology, Sacred Heart College, Thevara, Cochin, Kerala, India (ADSH).

Abbreviations used in the text: ALE—anterior lateral eye, AME—anterior median eye, PLE—posterior lateral eye, PME—posterior median eye, I–IV—1st to 4th leg.

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Taxonomy
Tetragnathidae Menge, 1866
Wolongia Zhu, Kim & Song, 1997

Diagnosis. The genus *Wolongia* is closely related to *Nanometa* Simon, 1908; but it can be differentiated from the latter by the following combination of characters: 1) absence of denticles between two cheliceral fang furrows in *Wolongia*, but present in *Nanometa* (Álvarez-Padilla & Hormiga 2011: fig. 88D); 2) some portion of the genital bulb concealed in cymbium in retrolateral view against the separated bulb from cymbium in *Nanometa* (Álvarez-Padilla & Hormiga 2011: fig. 90D); 3) copulatory duct tubular in *Wolongia* (Wan & Peng 2013: figs 6F, 10C, 12C, 14D, 18F, 22B, 26C, 28D, 32E, 34C; Present study: Fig, 3E) but as a modified sac in *Nanometa* (Álvarez-Padilla & Hormiga 2011: fig. 74B). *Wolongia* also similar to *Okileucauge* Tanikawa, 2001 in habitus and coloration, but differs from the latter by: 1) cymbium with an ectomedian and ectobasal process (Wan & Peng 2013: figs 5A–C, 9A–C, 17A–C, 21A–C, 25A–C, 31A–C, 33A–C; Present study: Fig, 3B,C) versus absent in *Okileucauge*; 2) embolic base exposed in *Wolongia* (Wan & Peng 2013: figs

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5A, 9A, 17A, 21A, 25A, 31A, 33A; Present study: Fig, 3B) which is hidden in conductor in *Okileucauge* (Zhu *et al*. 2003: fig. 155D); 3) female palpal tibia without long trichobothria while present in O*kileucauge* (Zhu *et al*. 2003: fig. 158C); 4) fertilization duct slightly curved (Wan & Peng 2013: figs 6F, 10C, 12C, 14D, 18F, 22B, 26C, 28D, 32E, 34C; Present study: Fig. 3E) against heavily coiled and sac-shaped FD in *Okileucauge*.

Type species, *Wolongia guoi* Zhu, Kim & Song, 1997, by original designation.

Composition. *Wolongia bicruris* Wan & Peng, 2013 (Gaoligong Mountains, Yunnan Province, China); *W. bimacroseta* Wan & Peng, 2013 (Gaoligong Mountains, China); *W. erromera* Wan & Peng, 2013 (Gaoligong Mountains, China); *W. foliacea* Wan & Peng, 2013 (Gaoligong Mountains, China); *W.guoi* Zhu, Kim & Song, 1997 (Sichuan and Shaanxi Provinces, China); *W. mutica* Wan & Peng, 2013 (Gaoligong Mountains, China); *W. odontodes* Zhao, Yin & Peng, 2009 (Gaoligong Mountains, China); *W. renaria* Wan & Peng, 2013 (Gaoligong Mountains, China); *W. tetramacroseta* Wan & Peng, 2013 (Gaoligong Mountains, China); and *W. wangi* Zhu, Kim & Song, 1997 (Sichuan and Shaanxi Provinces, China).

Wolongia papafrancisi new species (Figs. 1–3)

Types. Holotype male (ADSH9847A), INDIA: Kerala: Alappuzha, Pathiramanal Island, 9°37'07.11"N, 76°23'04.95"E, 4 m Elev., 24 November 2015, Jobi J Malamel & Jimmy Paul, leg., from foliage, by hand. Two female paratypes (ADSH9847B), same data as holotype except 5 October 2015.

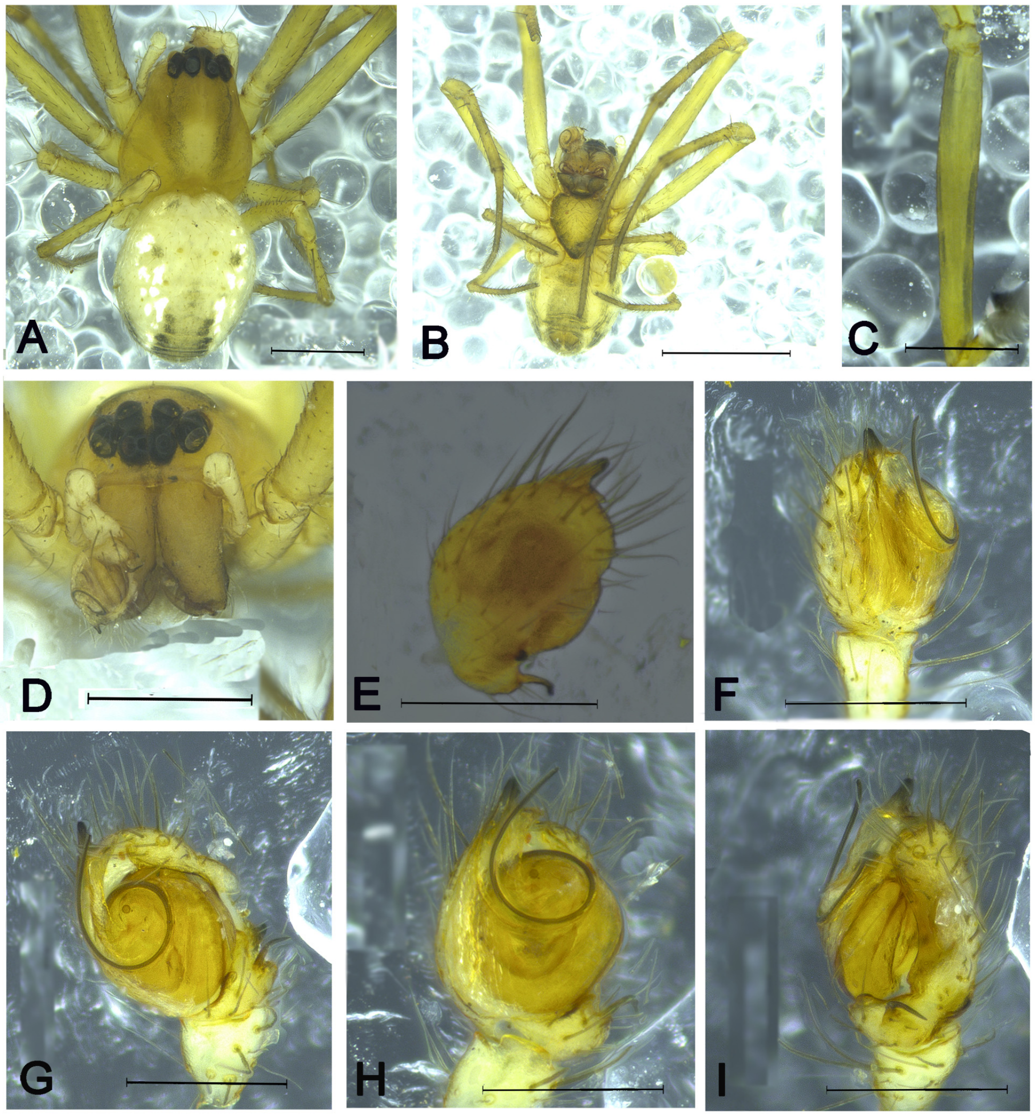

FIGURE 1. *Wolongia papafrancisi* **n. sp.** (ADSH9847A): A, male habitus, dorsal;B, same, ventral; C, same, frontal. D, same, male right femur I, ventral; E, right pedipalp, dorsal, F, left pedipalp, prolateral; G, same, ventro-retrolateral; H, same, ventral; I, same, retrolateral. Scale bars, A & C–D, 0.5 mm; B, 1 mm; E, I 0.2 mm.

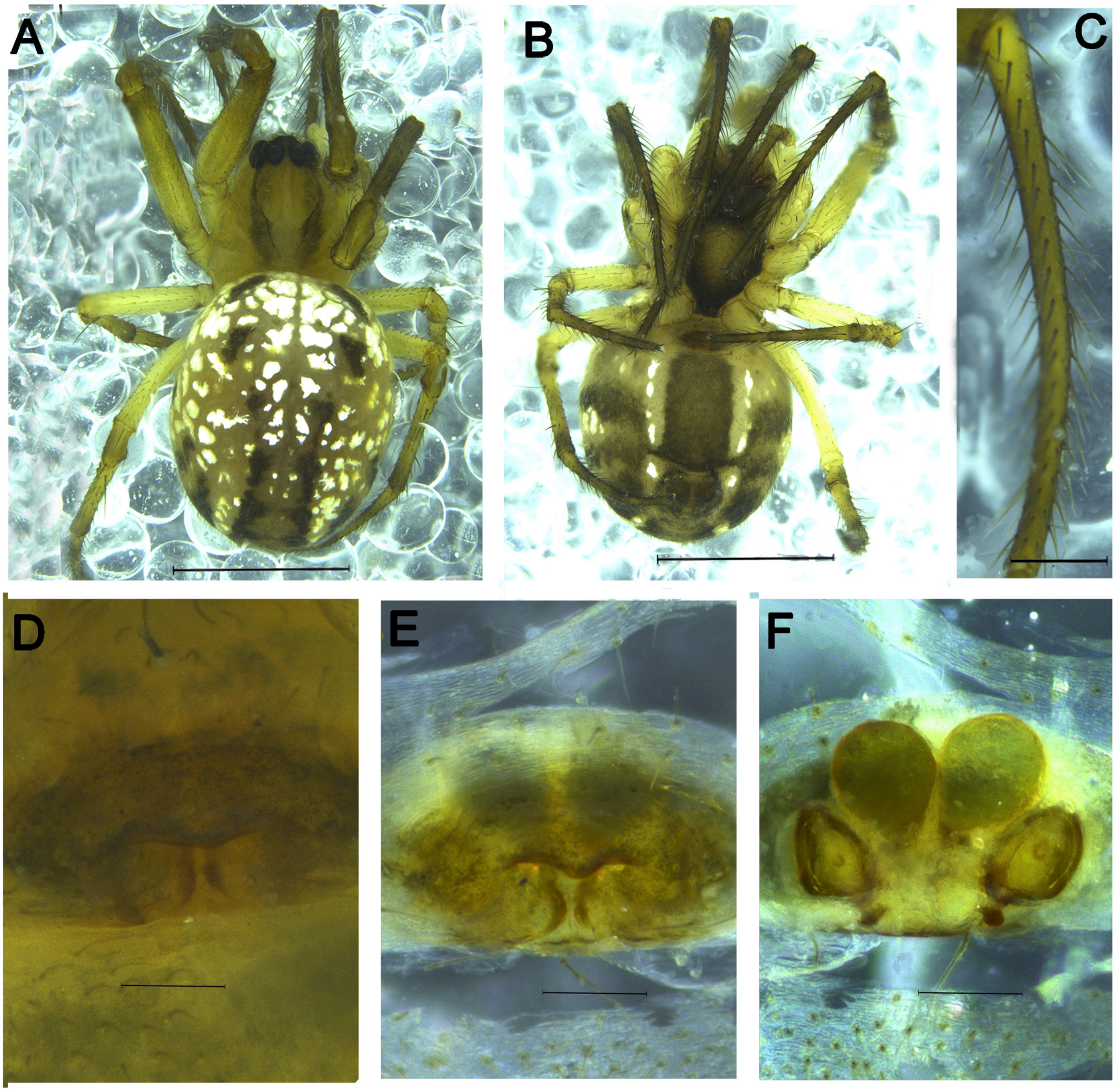

FIGURE 2. *Wolongia papafrancisi* **n. sp.** Female habitus (ADSH9847B): A, female habitus, dorsal; B, same, ventral; C, same, left metatarsus I, prolateral; D, epigynum before clearing, ventral; E, same, after clearing, ventral; F, same, vulvae, dorsal. Scale bars, A, 1 mm; B, 0.5 mm; C–F, 0.2 mm.

Etymology. This species is dedicated to Pope Francis, the present reigning Pope of the Catholic Church in honour of his great contributions as an environmental conservationist.

Diagnosis. Males of *W. papafrancisi* **n. sp.** are most similar to the males of *Wolongia bicruris* Wan & Peng, 2013, but can be separated from the latter by the following combination of features: narrow cymbial ectobasal process without bifurcation (*W. bicruris* with large cymbial ectobasal process with apical bifurcation), posteriorly oriented cymbial ectomedian process (*W. bicruris* with anteriorly oriented cymbial ectomedian process), small, mount-like paracymbium (paracymbium in *W. bicruris* long, with knob like apical part) conductor with apical bifurcation (conductor in *W. bicruris* with apical twist) and embolus not masked by conductor (*W. bicruris* with embolus being masked by conductor) (compare Figs 1E–I, 3A–C with Wan & Peng 2013: fig. 5A–C). Females of *W. papafrancisi* **n. sp.** can be easily distinguished from the females of all other described *Wolongia* species by the presence of a secondary spermathecae beside the true spermathecae (compare Figs 2F, 3E with Wan & Peng 2013: figs 6F, 10C, 12C, 14C, 18F, 22B, 26C, 28D, 32E, 34C).

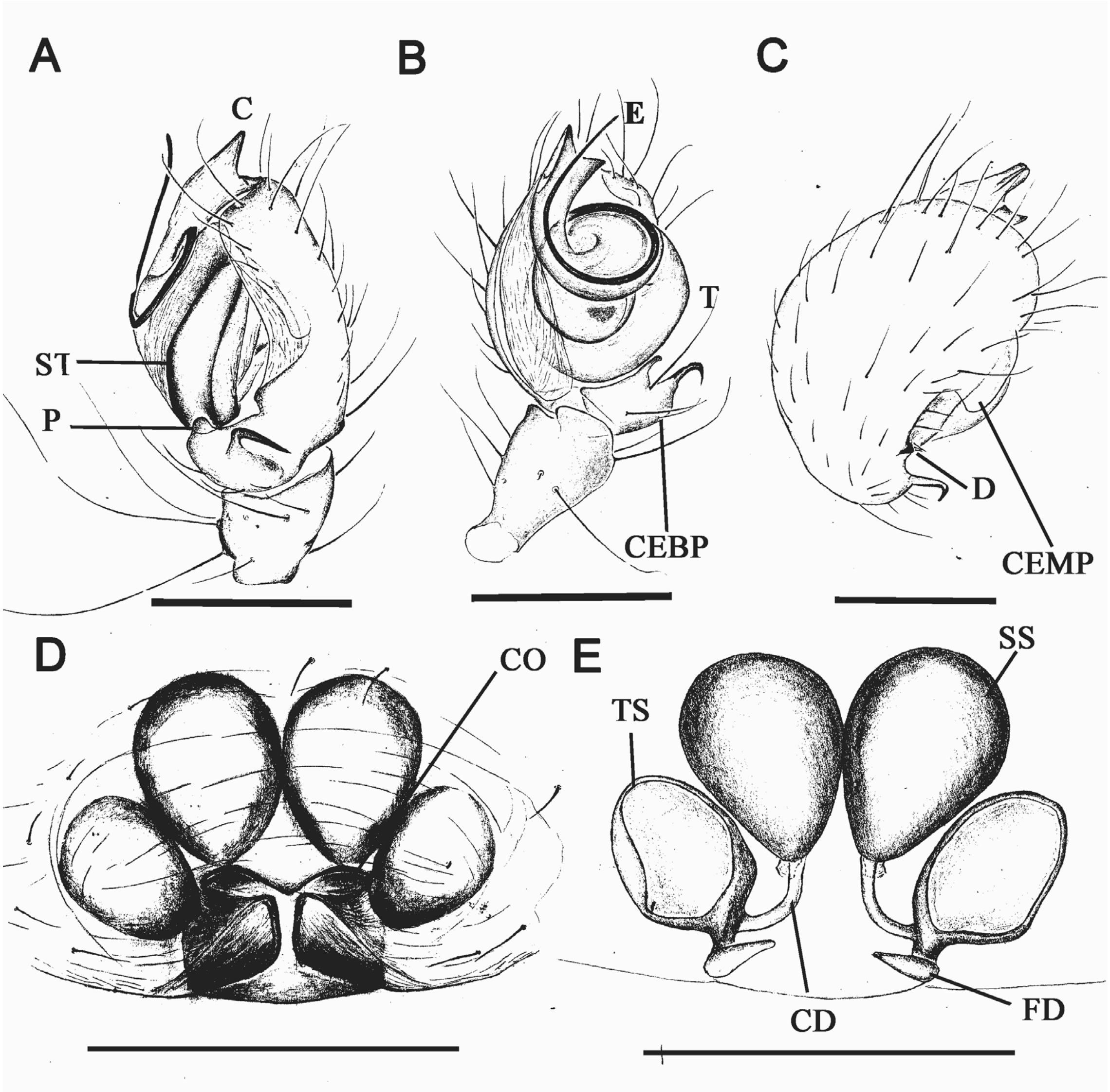

FIGURE 3. *Wolongia papafrancisi* **n. sp.** A–C Male left (A–B) and right (C) pedipalps: A, left palp, retrolateral; B, same, ventral; C, right palp, dorsal; D,epigynum, ventral; E, same, Vulvae, dorsal. Abbreviations: C, conductor; CD, copulatory duct; CEBP, cymbial ectobasal process; CEMP, cymbial ectomedian process; CO, copulatory opening; D, denticles; E, embolus; FD, fertilization duct; P, paracymbium; SS, secondary spermatheca; ST, subtegulum; T, tegulum; TS, true spermatheca. Scale bars, A–E, 0.2 mm.

Description. *Male* (holotype (ADSH9847A), Figs. 1A–D). Carapace, eye field, maxillae, labium, sternum, legs straw coloured. Carapace with paired longitudinal, black patches, one on each side of cephalic part. Eyes black. Chelicerae creamy; promargin with three teeth, retromargin without teeth. Maxillae, labium with black shades. Sternum with black border. Legs with black shades particularly on tibiae, metatarsi and tarsi, covered with short macrosetae more prominent on metatarsi and tarsi, but venter of femur I lacks rows of macrosetae (Fig. 1C). Opisthosoma oval, creamy with anterior part being overhanging on thoracic part; dorsum medially with two pairs of sigillae, medio-laterally with longitudinally arranged irregular silvery-white patches, postero-laterally with discontinuous longitudinal rows of black patches; venter with a median, broad, pale blackpatch. Body length 1.57. Prosoma length 0.74, width 0.71. Opisthosoma length 0.83, width 0.63. Eye diameters: ALE 0.07. AME 0.07. PLE 0.08. PME 0.08. Eye interdistances: AME–ALE 0.03.AME–AME 0.02. PME–PLE 0.03. PME–PME 0.04. Clypeus height at ALEs 0.07, at AMEs 0.02. Chelicerae length0.24. Measurements of pedipalp and legs. Pedipalp (right) 0.82 [0.29, 0.09, 0.16, 0.28], I 3.81 [1.13, 0.38, 0.84, 0.97, 0.49], II 3.43 [0.98, 0.34, 0.74, 0.93, 0.44], III 2.13 [0.52, 0.21, 0.37, 0.65, 0.38], IV 3.24 [0.95, 0.32, 0.81, 0.76, 0.40]. Leg formula: 1243.*Pedipalp* (Figs 1E–I, 3A–C). Cymbium baso-prolaterally provided with a small denticle (Figs 1E, 3C); cymbial ectobasal process narrow hook-like, with angular tip (Figs. 1E, I, 3A–C); cymbial ectomedian process roughly triangular, pointing posteriorly (Figs. 1E, 3C). Paracymbium reduced, mount like. Bulb circular in ventral view

(Figs. 1H, 3B); tegulum small, occupying medio-apical part of bulb (Figs. 1H, 3B); subtegulum prominent occupying half of the bulb (Figs. 1I, 3A). Conductor broad, elongated, originating apical to bulb, with basal twist, with apical bifurcation (Figs. 1G–H, 3A–B). Embolus long, filiform, arising apically to bulb, with a basal twist, distal half lying away from conductor, directed at one o'clock in ventral view (Figs. 1F–I, 3A–B).

Female (paratype ADSH9847B, Fig. 2A–C). Like male except the following: Opisthosoma with irregularly scattered silvery-white patches on dorsum and laterals; medio-lateral longitudinal rows of black patches complete; venter with a pair of longitudinal discontinuous stripes of silvery-white spots. Cheliceral promargin with three teeth, retromargin with two teeth; Body length 2.53. Prosoma length 1.03, width 0.75. Opisthosoma length 1.5, width 0.96. Eye diameters: ALE 0.09. AME 0.08. PLE 0.09. PME 0.08. Eye interdistances: AME–ALE 0.04. AME–AME 0.02. PME–PLE 0.02. PME–PME 0.03. Clypeus height at ALEs 0.09, at AMEs 0.03. Chelicerae length0.46; Measurements of palp and legs. Palp (right) 1.04 [0.33, 0.14, 0.20, 0.38], I 3.81 [1.13, 0.38, 0.84, 0.97, 0.49], II 3.43 [0.98, 0.34, 0.74, 0.93, 0.44], III 2.13 [0.52, 0.21, 0.37, 0.65, 0.38], IV 3.24 [0.95, 0.32, 0.81, 0.76, 0.40]. Leg formula: 1243. *Epigynum* (Figs. 2D–F, 3D–E). Simple, with a median triangular and lateral roughly rectangular plates (Figs. 2D–E, 3D). Copulatory openings narrow, medially placed, lying on each side of the median triangular plate (Fig. 3D). Vulvae consist of pear-shaped secondary spermathecae and roughly oval, shrunken true spermathecae, both are bridged through narrow, short copulatory ducts (Figs. 2F, 3E). Secondary spermathecae lying near to the copulatory openings, slightly larger than true spermathecae (Fig. 3E). Fertilization duct short, confronting each other, adjacent to true spermathecae (Fig. 3E).

Distribution. India, Kerala (Pathiramanal Island) (Fig. 4).

FIGURE 4. Collecting locality of *Wolongia papafrancisi* **n. sp.**

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