

TAXONOMY AND MOLECULAR PHYLOGENY OF LONG JAWED SPIDERS (ARANEAE: TETRAGNATHIDAE) IN KERALA

Thesis submitted in partial fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY IN ZOOLOGY

Under the Faculty of Science

University of Calicut



by

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June, 2026

DECLARATION

I, ANJU K. BABY, declare that the work presented in the thesis titled, **‘TAXONOMY AND MOLECULAR PHYLOGENY OF LONG JAWED SPIDERS (ARANEAE: TETRAGNATHIDAE) IN KERALA’** submitted to the University of Calicut in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Zoology is a bonafide record of the research work carried out by me under the supervision of **Dr. USHA BHAGIRATHAN**, Assistant Professor, Department of Zoology, Sree Kerala Varma College, Thrissur and **Dr. SUDHIKUMAR A.V.**, Professor, Department of Zoology, Christ College (Autonomous), Irinjalakuda, affiliated to the University of Calicut. No part of the thesis has formed the basis for the award of any degree, diploma or other similar titles of any university. The contents of the thesis have undergone a plagiarism check using iThenticate software at C.H.M.K. Library, University of Calicut, and the similarity index was found to be within the permissible limit. I also declare that this thesis is free from AI-generated content.

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This is to certify that the thesis entitled “**TAXONOMY AND MOLECULAR PHYLOGENY OF LONG JAWED SPIDERS (ARANEAE: TETRAGNATHIDAE) IN KERALA**”, submitted to the University of Calicut in partial fulfilment of the requirements for the award of the Degree of **Doctor of Philosophy in Zoology**, is a bonafide and original record of the research work carried out by **Ms. Anju K. Baby**, under my supervision in the Centre for Animal Taxonomy and Ecology, Department of Zoology, Christ College (Autonomous), Irinjalakuda, affiliated to the University of Calicut. No part of the thesis has formed the basis for the award of any degree, diploma, or other similar title of any university. It is further certified that the corrections/ suggestions recommended by the adjudicators have been incorporated into the thesis and that the contents of the thesis and the soft copy are one and the same.

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“If you do not know the names of things, the knowledge of them is lost, and with it the understanding of their relationships and place within the order of nature.”

-Carl Linnaeus

സംഗ്രഹം

നീണ്ട താടിയെല്ലുള്ള ചിലന്തികൾ എന്നറിയപ്പെടുന്ന ടെട്രാഗ്നാമിഡേ കുടുംബം ലോകത്തിലെ ഉഷ്ണമേഖലാ, ഉപ ഉഷ്ണമേഖലാ പ്രദേശങ്ങളിൽ കൂടുതലായും കാണപ്പെടുന്നു. കേരളത്തിലെ ടെട്രാഗ്നാമിഡുകളുടെ വർഗ്ഗീകരണത്തെയും തന്മാത്രാ പരിണാമത്തെയും കുറിച്ച് വ്യവസ്ഥാപിതമായി അന്വേഷിക്കുന്ന ആദ്യ പഠനമാണിത്, കൂടാതെ സ്പീഷീസ് അതിരുകൾ വേർതിരിക്കുക, അവ തമ്മിലുള്ള പരസ്പരബന്ധം മനസ്സിലാക്കുക എന്നിവയും ലക്ഷ്യം വെക്കുന്നു. ഈ പഠനത്തിൽ, എട്ട് ജനസുകളിലായി 27 ടെട്രാഗ്നാമിഡുകളെ കേരളത്തിൽ നിന്ന് രേഖപ്പെടുത്തിയിരിക്കുന്നു, ഇത് ഇന്ത്യയിലെ ടെട്രാഗ്നാമിഡ് ജന്തുജാലങ്ങളുടെ 48% ആയി കണക്കാക്കപ്പെടുന്നു. പഠനത്തിനിടെ വിവരിച്ച ആറ് കുടുംബങ്ങളുള്ള പുതിയ ഇനം *ഡോളികോഗ്നാത്ത സ്പീഷീസ്* ആയ, *ഡോളികോഗ്നാത ചിമ്മിനിയൻസിസ്*, ഇന്ത്യയിൽ നിന്നുള്ള ഈ ജനസ്സിലെ മൂന്നാമത്തെ ഇനത്തെ പ്രതിനിധീകരിക്കുന്നു. *ടെട്രാഗ്നാത കൊച്ചിനെൻസിസ്*, *ടെട്രാഗ്നാത വിരിഡോറഫ*, *ടൈലോറിഡ ഫ്ലാവ*, *അറ്റലിഡിയ സ്പീഷീസ്* എന്നിവ ഇന്ത്യയിൽ മാത്രം കാണപ്പെടുന്നവയാണ്. ഇന്ത്യയിൽനിന്ന് ആദ്യമായി *ടെട്രാഗ്നാത ലോട്ട*, *ടെട്രാഗ്നാത സ്ക്വാമെറ്റാ*, *ടെട്രാഗ്നാത സെറ*, *ടെട്രാഗ്നാത ജാക്കലേറ്റർ*, വെള്ളി നിറത്തിലുള്ള ചിലന്തി, *ലൂക്കേജ് റൂബ്രോമാകലേറ്റ* എന്നിവയെ രേഖപ്പെടുത്തി. *ലൂക്കേജ് ഫാസ്റ്റിഗേറ്റ*, *ടൈലോറിഡ ഫ്ലാവ* എന്നീ ഇനങ്ങളിലെ ആൺ ജീവികളെ ഇന്ത്യയിൽ ആദ്യമായി രേഖപ്പെടുത്തി, ഇവയിൽ രണ്ടാമത്തെ ചിലന്തിയെ ശരീര രൂപഘടനയെയും ജനനേന്ദ്രിയ സ്വഭാവങ്ങളെയും കുറിച്ചുള്ള സമഗ്രമായ വിശദീകരണത്തോടെ ആദ്യമായാണ് വിവരിക്കുന്നത്. കൂടാതെ, *ടെട്രാഗ്നാത ചോബർലിനി*

എന്ന സ്പീഷീസിനെ ടെട്രാഗ്നാഥ ജവാന എന്ന സ്പീഷീസുമായും ടെട്രാഗ്നാഥ ആൻഡമാനൻസിസ് എന്ന സ്പീഷീസിനെ ടെട്രാഗ്നാഥ ഹാസെൽറ്റി എന്ന സ്പീഷീസുമായും സംയോജിപ്പിച്ചു. ടെട്രാഗ്നാഥിഡുകളിൽ പലതിന്റെയും വർഗ്ഗീകരണ വിവരണങ്ങൾ അപര്യാപ്തമായതിനാൽ, ടെട്രാഗ്നാഥ കൊച്ചിനെൻസിസ്, ടെട്രാഗ്നാഥ ജെനിക്കലേറ്റ, ടെട്രാഗ്നാഥ സെറ എന്നിവയുടെ പുനർവിവരണം നൽകി, കൂടാതെ ആദ്യത്തെ സ്പീഷീസിനെ ഒരു നൂറ്റാണ്ടിനു ശേഷമാണ് പുനർവിവരണം ചെയ്തിരിക്കുന്നത്. ഈ പഠനത്തിനിടെ സൃഷ്ടിച്ച ബാർകോഡ് ഡാറ്റ പരമ്പരാഗത രൂപാന്തര സ്വഭാവങ്ങളുമായി തൃപ്തികരമായി യോജിക്കുന്നു. COI, 18S എന്നിവയുടെ സംയോജിത ന്യൂക്ലിയോടൈഡ് ശ്രേണികൾ, നെയ്ബർ ജോയിനിംഗ്, മാക്സിമം പാർസിമണി, മാക്സിമം ലൈക്ക്ലിഹൂഡ്, ബയേഷ്യൻ ഇൻഫെറൻസ് എന്നിവ ഉപയോഗിച്ച് ടെട്രാഗ്നാഥിഡുകൾ തമ്മിലുള്ള പരിണാമ ബന്ധം വ്യക്തമാക്കി. ടെട്രാഗ്നാഥിനെ, ലൂക്കേജിനെ, മെറ്റെറനെ, നാനോമെറ്റിനെ എന്നിങ്ങനെ നാല് ഉപകുടുംബങ്ങളിലായി ടെട്രാഗ്നാഥിഡേ കുടുംബത്തിന്റെ മോണോഫെലി വ്യക്തമായി.

സൂചക പദങ്ങൾ: വട്ടവല ചിലന്തികൾ, പശ്ചിമഘട്ടം, പുതിയ ജീവിവർഗ്ഗങ്ങൾ, പര്യായപദം, പരിണാമ ഘടന.

ABSTRACT

The family Tetragnathidae, commonly known as long jawed spiders, is distributed in the tropical and subtropical areas of the world. The present study is the first to systematically investigate the taxonomy and molecular phylogeny of tetragnathids in Kerala with the purpose of delimiting species boundaries and understanding interrelationships between them. The study documented a total of 27 tetragnathids under eight genera from the state of Kerala, which constitutes 48% of the Indian tetragnathid fauna. A new six-eyed *Dolichognatha* species, *D. chimminiensis* sp. nov., described during the study represents the third of the genus from India. *Tetragnatha cochinensis*, *T. viridorufa*, *Tylorida flava*, and *Atelidea* sp. were recorded as endemic to India. This is the first to record *T. lauta*, *T. squamata*, *T. serra*, *T. jaculator* and a silvery spider, *Leucauge rubromaculata* from India. Males of *L. fastigata* and *Tylorida flava* were recorded for the first time in India and this is the first to describe the latter species with an exhaustive account of its body morphology and genitalic characters. Furthermore, *T. chamberlini* was proposed as the junior synonym of *T. javana* and *T. andamanensis* was synonymized with *T. hasselti*. Since the taxonomic accounts of many of the tetragnathids were inadequate, *T. cochinensis*, *T. geniculata*, and *T. serra* were rigorously redescribed and the former species was revised after a century. The barcode data generated during the current study were satisfactorily concordant with the traditional morphological characters. The concatenated nucleotide sequences of CO1 and 18S fairly resolved the evolutionary relationship between tetragnathids by employing Neighbour Joining (NJ), Maximum Parsimony (MP), Maximum Likelihood (ML), and Bayesian Inference (BI) approaches. The monophyly of the family Tetragnathidae was evident with the clustering of four subfamilies, such as Tetragnathinae, Leucauginae, Metainae, and Nanometinae.

Keywords: Orb web spiders, Western Ghats, New species, Synonym, Evolutionary pattern

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

Arthropoda, the largest phylum in the animal kingdom, encompasses millions of invertebrates. They are remarkable for their pivotal role, primarily in pollination, yet they have been noted for transmitting different diseases. Unlike any other arthropods, members of the order Araneae, the seventh largest order in the animal kingdom serve an indispensable function in controlling the pest populations, including the insect vectors (Diaz, 2004). By balancing insect populations in various ecosystems like agricultural, grassland, forest, and many other biomes, in fact spiders aid the functioning of the ecosystem and the overall ecological balance (Nyffeler & Benz, 1987). Therefore, the economic value of spiders in the biological control of insects is always undebatable, and they are also found to be potential bioindicators in assessing the health of the ecosystem (Song et al., 1999). About 300 million years ago, in the carboniferous period the order Araneae originated on the earth (Selden & Penny, 2010). Among the two suborders of Araneae, Mesothelae Pocock, 1892 has the typical body segmentation, and constitutes merely one representative family, Liphistiidae Thorell, 1869. The suborder Opisthothelae Pocock, 1892 encompasses two descendants, Mygalomorphae Pocock, 1892 and Araneomorphae C. L. Koch, 1850, the former comprises mainly tarantulas, and the latter lineage covers true spiders which account for 90% of the existing spider species (Coddington, 2005). Araneomorph lineage has a unique web-spinning architecture with sticky silks and appears to be exceptional in their functions like prey capturing, ballooning, locomotion, and reproduction (Song et al., 1999). Among Araneomorphs, the lineage Orbiculariae is recognized as one of the largest entelegyne groups, which includes superfamilies Aranoidea Latreille, 1806 and

Deinopoidea C. L. Koch, 1851; both build similar webs however, the former spins viscid silks, whereas members of Deinopoidea yield much arid silks, which are produced by a special silk spinning plate called cribellum (Coddington, 2005; Dimitrov et al., 2017).

1.1. Orb weaving spiders – the unique architects of webs

The most exquisite yet intricate behaviour of spider fauna is web building. Web building is a complex behaviour with great taxonomic importance, and it could play a significant role in the classification of taxa at a higher level (Agnarsson et al., 2013). It is thought to have evolved in the early Jurassic period and the orb-web achieved significant modifications in the late Jurassic period (Vollrath & Selden, 2007; Hormiga & Griswold, 2014; Dimitrov et al., 2017). Orb-weavers have been considered as the model organisms to understand the pattern of response to environmental changes (Hesselberg, 2015; Hesselberg & Simonsen, 2019). Even though they are notable for their proficiency in web building, they partially rely on eyesight, and the unique structural frameworks of the orb web make the availability of prey profound. The bridge line is the base of the orb web on which additional silken threads are added and form the frame of the web. Radial threads are formed in successive stages, the first of which is referred to as the primary radial thread and the number of radial lines varies in different groups. Not all radial threads are connected to the centre of the web, and additional strengthening spirals attach to lateral sides. Web symmetry of spiderlings might not be identical to those of mothers, but either symmetrical or asymmetrical and are indeed inherited (Bristowe, 1958). Orb weavers exhibit a somewhat homogenous foraging strategy and web pattern throughout their life stages, and they can make webs soon after hatching

from the eggs. Despite that, the larger spiders spin relatively larger webs, and these architectural advancements have been attained at the evolutionary level (Sensenig et al., 2011). The body size does not show any relation with the number of spirals, radii and angles of the webs (Nasir et al., 2018). Size and position of the orb web depend on certain factors like habitat type, prey availability, and some environmental factors, and tetragnathids, which are closely associated with aquatic habitats produce large amounts of silk to withstand harsh conditions especially in riverbanks. Factors like water flow, exposure, substrate availability etc., could affect the web architecture of tetragnathids (Cardona-Rivera & Cotoras, 2021). Overall, with the presence of well-structured bidimensional geometric snare typically assembled by set of radii and sticky spirals makes Tetragnathidae unique among Orbiculariae (Dimitrov et al., 2017).

1.2. Family Tetragnathidae Menge, 1866

More than 135 million years ago, the family Tetragnathidae emerged on the earth with the record of fossil species, *Macryphantes cowdenei* Selden, 1990 (Selden, 1990; Alvarez-Padilla et al., 2009). At first, the family was designated as a distinct group (Menge, 1866). Thereafter, the taxonomic positions of this family were frequently changed by different taxonomists (Simon, 1894; 1895; Kaston, 1948; Levi, 1986; Roewer, 1942; Locket et al., 1974). The family Tetragnathidae was recognized as a subfamily of Argiopidae and designated two subfamilies, Tetragnathinae and Nephilinae, and metines were also circumscribed in the subfamily Tetragnathinae (Simon, 1894, 1895). The monophyletic origin of the family was revealed at first through the morphology-based phylogenetic analysis (Coddington, 1900). Afterward, the family was separated from Araneidae as an independent family and also designated the subfamily Metainae (Levi, 1986).

The family Tetragnathidae or long-jawed spiders, is one of 17 members of the superfamily Araneoidea, which includes orb web weavers, cobweb weavers, sheet web weavers and irregular three-dimensional web builders (Dimitrov et al., 2017). Tetragnathids are mostly distributed in the tropical and subtropical areas of the world, and few of them have cosmopolitan distribution and some genera have limited distribution (Alvarez-Padilla et al., 2020). Currently, the family constitutes 988 species belonging to 45 genera distributed across the world (World Spider Catalog, 2025). They are cribellates, and the body size ranges from small to large (2–40 mm) with unattractive body colour, mostly dull brown or grey. They mostly construct horizontal webs with few radii and open hubs and rarely build large vertical orb webs, and their distribution is also highly varied, occupying damp areas, near the ponds, streams, caves, shady areas of forest, under stones, hollow plant stems, close to the ground and leaf litter (Song et al., 1999; Kim & Lee, 2013). They have two rows of eyes parallel or slightly recurved, and the laterals are mostly adjoining and rarely being apart. The carapace is nearly rectangular and extended (Kim & Lee, 2013). The presence of long chelicerae often furnished with numerous teeth and robust apophysis is found to be unique in the family (Eberhard & Huber, 1998). Males have simple pedipalp usually the embolus coiled with conductor. Furthermore, there are few aciniform spigots on the posterior median spinnerets (Yoshida, 1999). By the presence of morphological characters like femoral trichobothria, aggregate silk glands, and paracymbium as well as the loss of the cribellum, the family exhibits morphological similarity with other members of Araneoidea (Griswold et al., 1998).

Generally, spiders possess two kinds of genital morphology: entelegynes and haplogynes. Most spiders are entelegynes, in which females have both copulatory

ducts and fertilization ducts connected to spermathecae, whereas haplogynes possess simple female genital morphology, in which a single duct that connects spermatheca to the genital cavity (Coddington & Levi, 1991). Members of the subfamily Tetragnathinae are regarded as the typical haplogynes, and the distinct genital morphology has evolved independently. Nevertheless, the majority of tetragnathids have complex entelegyne genital morphology (Dimitrov et al., 2007; Alvarez-Padilla & Hormiga, 2011; Cabra-García et al., 2014).

Currently, the family has four subfamilies, such as Tetragnathinae, Menge, 1866, Leucauginae Caporiacco, 1955, Metainae Simon, 1894, and Nanometinae Forster and Forster, 1999, but many genera are still not being grouped into subfamilies (Alvarez-Padilla et al., 2009; Alvarez-Padilla & Hormiga, 2011; Alvarez-Padilla et al., 2020).

1.2.1. Subfamily Tetragnathinae Menge, 1866

The subfamily Tetragnathinae includes nine extant genera *Tetragnatha* Latreille, 1804, *Cyrtognatha* Keyserling, 1881, *Glenognatha* Simon, 1887, *Pachygnatha* Sundevall, 1823, *Mollemeta* Alvarez-Padilla, 2007, *Hispanognatha* Bryant, 1945, *Antillognatha* Bryant, 1945, *Dyschiriognatha*, Simon, 1893, and *Doryonychus* Simon, 1900, and many more remain to be classified (Hormiga et al., 1995; Alvarez-Padilla et al., 2009; Dimitrov & Hormiga, 2009, 2011; Alvarez-Padilla & Hormiga, 2011). The synapomorphies that define the monophyly of the subfamily Tetragnathinae include males with long chelicerae, which are responsible for the interlocking during the mating process, haplogyne genitalia, and extremely prolonged sperm duct and cymbium (Alvarez-Padilla, 2007). In India, the subfamily

has been represented by two genera, *Tetragnatha* and *Glenognatha* (Caleb & Sankaran, 2025).

The genus *Tetragnatha* Latreille, 1804, the type genus of the family Tetragnathidae, currently comprises 321 species, including eight subspecies, and is known from India by 23 species (World Spider Catalog, 2025). The genus known as the largest cosmopolitan group in the family Tetragnathidae is distributed in all continents and can be found in islands and in arctic, temperate, and tropical climates (Levi, 1981). Members of the genus have distinct body morphology with extremely long chelicerae and elongated abdomens and are mostly unattractive, often pale brown or pale yellowish-brown to pale green. They are nocturnal in habit, whereas during the daytime, they usually rest under the foliage, stretching their legs (Okuma, 1968; Okuma et al., 1993; Biswas & Raychaudhuri, 1996).

The genus *Glenognatha* currently comprises 36 nominal species distributed in the new world regions, Afrotropic, Indo-Malaya, Oceania, and Palearctic regions (Cabra-García & Brescovit, 2016; Sankaran et al., 2020; World Spider Catalog, 2025). Many species are abundant in humid forests, paddy fields, and other varieties of crops where there are specialist predators of planthopper nymphs (Dupo & Barrion, 2009; Cabra-García & Brescovit, 2016). Web aggregations can be commonly found in their habitats with interconnected radial threads and several central hubs (Cabra-García & Brescovit, 2016).

1.2.2. Subfamily Leucauginae Caporiacco, 1955

The genera *Leucauge* White, 1841, *Azilia* Keyserling, 1881, *Atelidea* Simon, 1895, *Orsinome* Thorell, 1890, *Tylorida* Simon, 1894, *Metleucauge* Levi, 1980, *Okileucauge* Tanikawa, 2001, *Metabus* O. Pickard-Cambridge, 1899, *Mecynometa*

Simon, 1894, *Mesida* Kulczynski, 1911 and the newly erected *Harlanethis* Álvarez-Padilla, Kallal & Hormiga, 2020 fall under the subfamily Leucauginae (Hormiga et al., 1995; Álvarez-Padilla & Benjamin, 2011; Álvarez-Padilla et al., 2020; Ballesteros & Hormiga, 2021). The monophyly of the subfamily is generally explained on the basis of four synapomorphies, such as ventrally enlarged but weakly sclerotized spermathecal walls, long sperm duct with a switchback and ectally placed tegulum (Álvarez-Padilla, 2007). Currently four genera have been recorded from India, *Leucauge*, *Tylorida*, *Mesida*, *Orsinome* and *Atelida* (Caleb & Sankaran, 2025).

Leucauge White, 1841, is the second-largest species-rich genus in the family Tetragnathidae with 175 species and seven subspecies and is widely distributed around the world, except in Antarctica and Europe (Ballesteros & Hormiga, 2021; World Spider Catalog, 2025). The genus has been considered the most diverse in the tropical and subtropical regions, while some species occur in the temperate regions of Asia, Australasia, and the Americas. They typically build large orb webs near the freshwater bodies, and some species can be found in pristine primary forests (Álvarez-Padilla & Hormiga, 2011; Ballesteros & Hormiga, 2018). The genus *Tylorida* Simon, 1894, is extensively dispersed in Asian countries, West Africa and certain East and Central African regions (World Spider Catalog, 2025). The genera *Mesida*, *Orsinome* and *Atelidea* are the least speciose groups among the subfamily and the former genus has a significant cheliceral morphology, where males possess a prominent median spur on the chelicerae (Barrion & Litsinger, 1995).

1.2.3. Subfamily Metainae Simon, 1894

The subfamily Metainae includes *Dolichognatha* O. Pickard-Cambridge, 1869, *Meta* C. L. Koch, 1835, *Metellina* Chamberlin & Ivie, 1941, and *Diphya* Nicolet, 1849, (Alvarez-Padilla et al., 2009) and the most recently introduced genus *Zhinu* Kallal & Hormiga, 2018 (Kallal & Hormiga, 2018). The genus *Dolichognatha* can be seen worldwide, but mostly around tropical and subtropical areas of the world (Levi, 1981). Members of the genus are either eight-eyed or six-eyed (PMEs absent) (Wang et al., 2020). Among tetragnathids, the strong reduction of posterior median eyes has only been recorded in the genus *Dolichognatha*. This phenomenon is exhibited by certain cave-dwelling spiders, and can also be found in the genus *Meta*, which is the only group in the family Tetragnathidae which inhabits caves, and possesses eight eyes, however, the process of evolution behind the phenomenon remains unknown (Dimitrov et al., 2010). The genus *Diphya* is dispersed in the Americas, South and East Africa, and Russia and nearly half of the species inhabits Asian countries (World Spider Catalog, 2025). The genus *Metellina* is the least speciose group within the subfamily. Unlike in *Metellina*, the genus *Chrysometa* has many significant morphological traits, like distinct cymbial apophysis and much sclerotized fertilization ducts (Levi, 1986). The newly described genus *Zhinu* is morphologically similar to *Dolichognatha*, but notable differences were noted in the structure of pedipalps and found to inhabit the high-altitude areas (Kallal & Hormiga, 2018).

1.2.4. Subfamily Nanometinae Forster and Forster, 1999

The subfamily Nanometinae is the most recently introduced group in the family Tetragnathidae disclosed by Forster and Forster in 1999, and its sub familial position

has been formally recognized by Alvarez-Padilla and Hormiga in 2011. This Australian endemic group has only two genera, *Nanometa* Simon, 1908, and *Pinkfloydia* Dimitrov and Hormiga, 2011 (Dimitrov & Hormiga, 2011; Hormiga, 2017; Alvarez-Padilla et al., 2020). The subfamily has several morphological synapomorphies, like the male palp with twisted embolus and the conductor originating near the tegulum, female chelicerae with a few minute denticles positioned between the two rows of teeth, the copulatory duct looking like a sac rather than a tract, and a cuticular stridulatory organ present on the book-lungs of the male. Even though the exclusive function of the stridulatory organ still remains unknown, it persists as a unique character among tetragnathids (Alvarez-Padilla et al., 2009).

1.3. Molecular phylogeny of the family Tetragnathidae

Prior to the era of molecular phylogenetics, in the late 19th century, understanding of spider phylogenetics completely relied on morphological or behavioural characteristics, and it seems to be ambiguous in explaining evolutionary relationships due to constrained characters and poor taxon sampling (Coddington & Levi, 1991). In this context, the homoplasy, character convergence and smaller data size could bias the phylogenetic pattern eventually confounding phylogenetic reconstruction, and this is profound in the family Tetragnathidae (Eberhard, 1982; Alvarez-Padilla & Hormiga, 2011). Moreover, in the context of millions of species which exist on the planet, species delineation based on morphology has several limitations, especially dealing with morphologically cryptic species, phenotypic plasticity and the identification of juveniles where taxonomic keys are only available for adults (Hebert et al., 2003a). Nevertheless, the morphological, behavioural, and

ecological characters remain imperative when convergence and homology traits are in an uncertain circumstance (Agnarsson et al., 2013).

In the 20th century, phylogenetics went through substantial progress in support of molecular approaches that actually expanded the field of systematics. In spite of the advancements in the spider phylogenetics, understanding of molecular data was limited to a few markers like Cytochrome C Oxidase 1 (CO1), histone H3, 18s, 16s, NADH1, etc. and it was actually less progressive when comparing to advancements in the phylogenetics of other arthropods (Agnarsson et al., 2013). The well-known molecular tool, DNA barcoding, utilizes short standard segment of DNA called ‘DNA barcode’, which serves as the benchmark approach in species delineation and helps in rapid identification of animals (Hebert et al., 2003a). These barcodes are unique among species so that unknown species can easily be identified based on the reference barcode available in the genetic databases and repositories. Among barcode data, the most represented group is the Arthropoda, with 16 million barcodes of 3,76,000 nominal species (Emerson, 2025). The reliability of the barcoding is greatly influenced by the significant ‘barcode gap’ which is measured based on the distinction between increased intraspecific variability and minimum interspecific variability (Blagoev et al., 2009). Being a single copy in the nuclear genome and having a slow divergence rate perhaps aroused the debate on the efficacy of nuclear gene markers (Zhang & Hewitt, 2003). It is thought to have mitochondrial markers, which are more efficient than the nuclear gene markers due to their maternal inheritance pattern, and the lack of introns and tandem repeats (Saccone et al., 1999; Hebert et al., 2003a). Initially, much attention was garnered by mitochondrial ribosomal genes such as 12S and 16S, yet insertion and deletion mutations are high that affect the multiple sequence alignment (Doyle & Gaut, 2000;

Hebert et al., 2003a). The mitochondrial protein-coding gene markers possess sufficient point mutations than in 12s and 16s, which serve as the basis for rapid genetic divergence (Herbert et al., 2003a). Among mitochondrial protein coding gene markers, CO1 is highly effective in species delineations of taxonomically complex groups and dealing with congeneric groups with comparable genetic divergence (Hebert et al., 2003a, b) and the universal primers of CO1 appear to be highly competent in molecular analysis at large scale (Folmer et al., 1994). Apparently, the CO1 divergence is substantial to discriminate congeneric species and it clearly reflects its feasibility and robustness (Hebert et al., 2003b).

Molecular phylogeny of tetragnathids has attained less attention, as most studies have been focused on morphological and behavioural characteristics (Alvarez-Padilla et al., 2009). Many morphological and behavioural synapomorphies, like separated piriform bases, presence of ecto-basal and ecto-median process in cymbium, nearly roundish tegulum with long palpal tibia, horizontally oriented web with open hubs and several additional characters, have received greater attention in the phylogenetic analysis (Alvarez-Padilla & Hormiga, 2011). In the last decade, there has been an attempt to resolve deep phylogenetic relationships of the family Tetragnathidae by multi-loci analysis of nuclear ribosomal genes r18S and r28S, nuclear protein coding gene histone H3 (rarely Histone H4), and mitochondrial ribosomal genes r16S and r12S and protein coding Cytochrome C Oxidase subunit 1 (CO1) and integrated with morphological and behavioural traits (Alvarez-Padilla et al., 2009; Dimitrov & Hormiga, 2011; Ballesteros & Hormiga, 2021), and these molecular markers are also prevalent among approximately all spiders (Agnarsson et al., 2013). Over the last many years, there have been many disputes related to different taxonomic identification methods, inferring that the barcoding using

nuclear and mitochondrial markers integrating with morphological or behavioural characters undermines the impediments in the progress of arachnological research and biodiversity assessment (Rubinoff, 2006; Blagoev et al., 2009).

1.4. Background of the study

In past decades, the taxonomy of the family Tetragnathidae found in India is still in its infancy. The family has not been explicitly documented, yet the subfamily Tetragnathinae was being well studied (Gravely, 1921a). The diversity of the genus *Tetragnatha* was documented in West Bengal (Basu & Raychaudhuri, 2016). Additionally, the genus *Tylorida* was also being reviewed from Kerala (Sankaran et al., 2017). Despite these studies, most tetragnathids were described and recorded from India as a part of the general spider surveys (Thorell, 1891, 1892; Pocock, 1900, 1901; Tikader 1970, 1977, 1982, 1987; Gajbe, 2004; Sen et al., 2015). The genus *Wolongia* was recorded from India for the first time, which was collected from Pathiramanal Island of Kerala state (Malamael et al., 2018). *L. granulata* was also documented from the same locality and the study proposed three new synonymies (Malamel & Sebastian, 2018). In recent years, the genus *Atelidea* was also recorded from Kerala with the description of a new species (Sankaran et al., 2017). Notably, these studies have been based on traditional taxonomic methods and the molecular approaches have never been exploited. This study aims to provide a comprehensive account of the taxonomy and phylogeny of Tetragnathidae in Kerala by combining morphological and molecular approaches. Amidst the challenging threats to biodiversity due to climatic changes, habitat destruction and several anthropogenic activities, the exclusive studies on tetragnathids have great importance in biodiversity conservation as they serve as excellent predators of pest populations and potential bioindicators of ecosystem health.

The following are the objectives of the study:

1. Collection and description of tetragnathid spiders found in Kerala.
2. Barcoding of tetragnathid spiders of Kerala using molecular markers.
3. Study the interrelationship between members of Tetragnathidae in Kerala and comparison with other Tetragnathidae across the world.

CHAPTER 2

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. Tetragnathidae: A brief taxonomic history

The family Tetragnathidae was first established by Menge (1866) as a separate family. Simon (1894) considered the family Tetragnathidae as a subfamily of Argiopidae and divided it into seven different groups. The genus *Nephila* Leach, 1815, had also been included in the family Tetragnathidae along with the genera *Tetragnatha* Latreille, 1804, and *Leucauge* White, 1841. Petrunkevitch (1911) divided tetragnathids into two subfamilies, such as Tetragnathinae Menge, 1866, and Metinae Simon, 1894. Later, the taxonomic position of Tetragnathidae changed many times and was recurrently misplaced in the family Araneidae Clerck, 1757 (Alvarez-Padilla et al., 2009). The genera *Tetragnatha* Latreille, 1804, *Pachygnatha* Sundevall, 1823, and *Glenognatha* Simon, 1887, were grouped into the family Tetragnathidae by Kaston (1948) under the two subfamilies Tetragnathinae and Glenognathinae, but the genus *Meta* C. L. Koch, 1835, was also included in the later subfamily. Later, Metines were included in the family Tetragnathidae by Locket et al. (1974). Levi (1986) separated this family from Araneidae and also included the subfamily Metinae, which includes *Dolichognatha* O. Pickard-Cambridge, 1869, *Chrysometa* Simon, 1894 and *Homalometa* Simon, 1898. The family Tetragnathidae was separated from the family Araneidae by the presence of a tarsal organ in the cymbium, a flat epigynum, long chelicerae, and the unique palpal morphology. Coddington (1990) considered Nephilinae Simon, 1894 as a subfamily and designated the three genera *Tetragnatha*, *Pachygnatha* and *Glenognatha* as a monophyletic group on the basis of the morphology of the paracymbium, conductor, tegulum, and the embolus. Hormiga et al. (1995) carried

out the phylogenetic analysis of the family Tetragnathidae based on the morphological and behavioural characters, particularly the morphology of spinneret silk gland spigots, and they detected the monophyletic origin of Nephilinae, which belongs to the family Tetragnathidae. Additionally, they proposed that the Metines can be regarded as a distinct family or subfamily. Alvarez-Padilla (2007) who first explicitly studied the phylogenetic relationships of the family Tetragnathidae on the basis of molecular data combined with morphological and behavioural characters and revealed the monophyletic origin of this family and also found Nephilids as the basal lineage of the family Araneidae. Additionally, the study grouped tetragnathids into three subfamilies, such as Tetragnathinae Menge, 1866, Leucauginae Caporiacco, 1955 and Metainae Simon, 1894. At a later time, the subfamilial configuration was changed into four: Tetragnathinae, Leucauginae, Metainae and Nanometa clade by Alvarez-Padilla et al. (2009).

2.2. Taxonomy of the family Tetragnathidae across the world

Initially, the taxonomy of the family Tetragnathidae based on the morphology was always inconsistent. Since most tetragnathids have haplogyne genitalia, without distinct fertilization and copulatory ducts, the identification of tetragnathid fauna, particularly the members of the type genus, *Tetragnatha*, seemed to be uncertain. Moreover, most descriptions were purely based on the body colour, shape of the carapace, eye pattern, shape and size of abdomen etc. (Walckenaer, 1841; Thorell, 1890; Tullgren, 1902; Bryant, 1940; Hingston, 1927). Many taxonomists debated the reliability of the cheliceral morphology as the identification character of *Tetragnatha* species (Chickering, 1957a, b; Levi, 1981). Levi (1981) observed that the size and shape of chelicerae, the number of cheliceral teeth, and the presence of cheliceral fang cusps differ within the species, and it seemed to be ambiguous in the

identification of juveniles. In contrast to this, they can be distinguished by palp morphology and the structure of the seminal receptacle.

In contrast to the above, Okuma (1987, 1988a, b, c) described and illustrated many tetragnathids based on the cheliceral morphology and comprehensively studied the family Tetragnathidae across the world, especially from Asian countries. For instance, the Australian *Tetragnatha* species were explicitly revised and introduced new terminologies for cheliceral teeth accompanied by the description of 31 species including 11 new species and five new synonymies (1987). Additionally, five *Tetragnatha* species were recorded along with illustrations of chelicerae, which were collected from the tropical and temperate countries, and proposed eight new synonymies (1983). Okuma (1988a, b) reviewed the genus *Tetragnatha* from Asia for the first time and provided a taxonomic key based on the cheliceral dentitions. Similarly, Gillespie (1992a, b, 1994) followed the taxonomical approaches which were adopted by Okuma; however, the leg spinations were also taken into account in the classification. In accordance with this, *Tetragnatha* species found in the Hawaiian archipelago were grouped into different clades, such as the spiny leg clade, which has prominent leg spines, and a clade with a pointed abdomen known as the *T. acuta* clade, but these were not validated by genetic analysis (Gillespie, 1992a, b).

Song & Zhu (1994) erected the orb-weaving genus *Dianleucauge*, which is exclusive to China to date. Barrion & Litsinger (1995), who studied rice land spiders of Philippines and described many tetragnathids, and included the genera *Meta* C.L. Koch, 1836, *Tylorida* Simon, 1894, *Mesida* Kulczyński, 1911, and *Leucauge* White, 1841, under an independent family, Metidae. Apart from this, on the basis of the position of spinnerets and the size of the abdomen, the genus *Tetragnatha* had been

divided into two subgenera, *Eucta* and *Tetragnatha* by Biswas & Raychaudhuri (1996). Chen (1997) recorded two tetragnathid spiders *L. termisticta* Song & Zhu, 1992 and *T. caudicula* (Karsch, 1879), for the first time from Taiwan. Song et al. (1999) synonymised *L. szechuensis* Schenkel, 1936, to *L. blanda* (L. Koch, 1878) and proposed *Tetragnatha aduncata* Wang, 1991, as a junior synonym of *T. hasselti* Thorell, 1890. *L. argentina* (Hasselt, 1882), *L. tessellata* (Thorell, 1887) and *M. gemmea* Hasselt, 1882, were new to Taiwan and recorded by Tso & Tanikawa (2000). Brescovit & Cunha (2001) described a new *Dolichognatha* species from Brazil and recorded a female of *D. maturaca* Lise, 1993, for the first time, which is an endemic species to the country. Zhu et al. (2002) revised Chinese *Tylorida* species and synonymised *T. sphenoida* (Wang, 1991) with *T. ventralis* (Thorell, 1877) and transferred *L. cylindrata* (Wang, 1991) to the genus *Tylorida*. Gillespie (2002) described five new *Tetragnatha* species which belong to the spiny leg clade from Hawaii. Gillespie also illustrated cheliceral morphology of *Tetragnatha* species along with detailed descriptions, which were collected from Marquesas Island (2003a) and Society Islands (2003b). Additionally, four new species belonging to web-building groups were also described from the Hawaiian archipelago (2003c). In addition, Dondale et al. (2003) broadly studied the spider fauna of Canada, described 25 long-jawed spiders, and provided a taxonomic key to the species. Tanikawa (2005) recognised *T. magniventer* Bosenberg & Strand, 1906, as the synonymy of *T. striata* (Thorell, 1877).

Levi (2005) examined *Alcimophenes* species which were deposited in the Museum of Comparative Zoology, Cambridge, and proposed four new synonymies and a new combination. Levi (2008) gave an account of the genera *Alcimosphenus* Simon, 1895, *Leucauge* White, 1841, *Mecynometa* Simon, 1894 and *Opas* O. Pickard-

Cambridge, 1896. The study proposed three new synonymies for *M. globosa* O. Pickard-Cambridge, 1889 and a new synonymy for *L. funebris* Mello-Leitao, 1930. Also synonymised *L. venustella* Strand, 1916 and *L. mandibulata* F.O. Pickard-Cambridge, 1903 to *L. mariana* (Taczanowski, 1881). Additionally, the natural history of each genus is briefly noted. The genus *Agriognatha* O.P.-Cambridge, 1896 has unique female genital morphology among the family Tetragnathidae in the presence of extremely reduced spermathecae and specialized distal compartment within the median membranous chamber and the unique female genital morphology of the genus serves as the evidence for its monophyly (Dimitrov et al., 2007). Smith (2008) added notes on the tetragnathid genus *Dolichognatha* O. Pickard-Cambridge, 1869, and synonymised the genus *Homalopollys* Simon, 1895, with *Dolichognatha*, which was previously included in the family Araneidae. The type material status of the genus *Sternospina* Schmidt & Krause, 1993, was assessed by Dimitrov et al. (2008) and they considered the genus as the junior synonym of the genus *Tylorida* and designated *S. concretipalpis* Schmidt & Krause, 1993 as a junior synonym of *T. striata* (Thorell, 1877). They also designated the genus *Prionolaema* Simon, 1894, as a junior synonym of the genus *Tetragnatha* Latreille, 1894, and proposed two new combinations. Yoshida (2009) reviewed the genus *Leucauge* from Taiwan and proposed four new synonymies. Tanikawa (2009) studied spiders of Japan and described 46 tetragnathids and provided a key to species.

The female genitalia of the orb-weaving genus *Glenognatha* Simon, 1887, has similarity with the genus *Dyschiriognatha* Simon, 1893, and *Pachygnatha* Sundevall, 1823. They are secondarily haplogynes, having a slit-like genital opening internally with a pair of spermathecae, a copulatory duct, and a membranous chamber that opens to the uterus externus (Cabra-Garcia et al., 2014). A new species

of the monophyletic genus *Chrysometa* Simon, 1895, *C. pena* Simó, Álvarez & Laborda, 2016, was described and illustrated by Simo et al. (2016) from the north and east of Uruguay. Zhu & Zhang (2011) elaborately studied the spider fauna of Henan, China, recorded tetragnathids from various habitats and provided a taxonomic key to the species. This species inhabits the base of tree trunks and near the watery areas of riparian forests. Castanheira et al. (2019) added taxonomic notes on the genus *Tetragnatha*, found in the Neotropical region and provided a significant account of its cheliceral dentitions, proposed 20 new synonymies and recognised two species as nomina dubia. Of most importance, Nentwig et al. (2019) proposed seven new synonymies of *Leucauge grata* (Guérin, 1838) which were classified as subspecies of the same. Castanheira & Baptista (2020) added taxonomic notes on the genus *Tetragnatha* and described three new species from the Neotropical regions and also from China and Japan. Furthermore, *Tetragnatha exilima* (Mello-Leitão, 1943), *T. filigastera* Mello-Leitão, 1943, and *T. lactescens* (Mello-Leitão, 1947) were recognised as nomina dubia. They also redescribed two *Tetragnatha* species from the Neotropical regions and proposed three new synonymies (2021a). Three tetragnathids, *T. guatemalensis* O. Pickard-Cambridge, 1889, *T. laboriosa* Hentz, 1850 and *T. jaculator* Tullgren, 1910, were redescribed from South America and new synonymies of these species were proposed (2021b). Castanheira et al. (2022) described five new species of *Tetragnatha* from South America and proposed two new synonymies and four nomina dubia. Ceccolini & Cianferoni (2022) designated the genus *Sancus* Tullgren, 1910 as a junior homonym of the genus *Leucognatha* Wunderlich, 1992, thus considering it as a valid name. Seven new species of long jawed spider genus *Meta* were described by Wang et al. (2022) from Southwest China. Ott et al. (2023) described a new species of the genus *Diphyia* Nicolet, 1849,

based on both sexes, along with the first description of male *D. bicolor* Vellard, 1926. They proposed two new synonymies of *D. bicolor*, *Oarces ornatus* Mello-Leitão, 1935, and *Azilia eximia* (Mello-Leitão, 1940). Lin et al. (2023) synonymised *Leucauge talagangiba* Barrion, Barrion-Dupo & Heong, 2013 to *L. tanikawai* Zhu, Song & Zhang, 2003 and proposed *Tetragnatha bandapula* Barrion-Dupo, Barrion & Heong, 2013 as the junior synonymy of *T. squamata* Karsch, 1879. Two new species, *Glenognatha dubiosa* and *Leucauge rubromaculata* were described from Sri Lanka by Benjamin (2024). Eskov & Marusik (2024) formulated a different subfamily configuration for the family Tetragnathidae where they added Diphyainae as a subfamily along with Tetragnathinae, Leucauginae, Metainae, and Nanometinae. However, the classification was exclusively based on the trichobothrial morphology without the support of molecular evidence. Fomichev & Omelko (2025) described a new six-eyed species of the genus *Dolichognatha* from Southeast Asia. The genus *Azilia* has been revised by Brescovit et al. (2025) based on the specimens collected from the Americas and they added taxonomic notes of its type species, and proposed four new synonymies of *Azilia histrio* Simon, 1895 along with the record of eight new species.

2.3. Phylogeny of the family Tetragnathidae around the world

The phylogenetic studies of the family Tetragnathidae began in the late 20th century. In the meantime, Levi (1980) provided the morphological evidence for the evolutionary relationships among the genera *Mecynogea*, *Pachygnatha*, *Glenognatha*, and *Azilia* and placed tetragnathids under the family Araneidae. The monophyly of the family was first revealed by Coddington (1990) and included the three subfamilies Tetragnathinae, Metinae and Nephilinae. This subfamilial classification was followed by Hormiga et al. (1995), and the phylogenetic analysis

by combining the morphological and behavioural data sets suggested the monophyletic origin of the family, and they proposed that tetragnathids are sister to Araneidae. Furthermore, the evolutionary distinctiveness of the family within the superfamily Araneoidea was explained by Griswold et al. (1998) on account of web-building behaviour and several morphological characters, particularly the cheliceral and spinneret morphology. At a later time, Kuntner (2005, 2006) unveiled that the Nephilines are not sister to Tetragnathidae.

The genus *Sancus* Tullgren, 1910, had been included in the family Tetragnathidae. Kuntner & Alvarez-Padilla (2006) reviewed the genus, and phylogeny was tested by analysing 60 morphological and behavioural characters and they designated *Leucognatha* Wunderlich, 1992, as the junior synonym. Alvarez-Padilla (2007) erected two new genera, *Allende* and *Mollemeta*, and suggested that tetragnathids are sister to the reduced piriform clade (RPC). Alvarez-Padilla et al. (2009) who first comprehensively studied the phylogenetic relationships of tetragnathids based on molecular data integrating with both morphological and behavioural traits. They generated molecular data from both nuclear genes (18S, 28S, histone H3) and mitochondrial genes (12S, 16S, and cytochrome c oxidase subunit 1). Tetragnathids were grouped into four subfamilies, such as Tetragnathinae, Leucauginae, Metainae and the Nanometa clade. This study could not reveal the position of the family within the Araeoidea, but it is evident that Nephilids are not sister lineages; rather, it closely related to Araneidae. Dimitrov & Hormiga (2009) recognised *Agriognatha* O.P.-Cambridge, 1896, as a junior synonym of the genus *Cyrtognatha* Keyserling, 1881, and the cladistic analysis based on morphological and behavioural characters revealed its monophyly. Dimitrov et al. (2010) recognised the genus *Atimiosa*, Simon 1895, as a junior synonym of *Dolichognatha* O. P. -Cambridge, 1869, and

proposed two new combinations. Cladistic analysis revealed the phylogenetic position of *Dolichognatha* in which *Metellina* Chamberlin & Ivie, 1941, is its sister group, and *Dolichognatha*, *Meta*, and *Metellina* form a monophyletic group. Alvarez-Padilla & Benjamin (2011) conducted a phylogenetic analysis of the genus *Atelidea* Simon, 1895, and revealed its monophyly, and they designated *A. globosa* Yamaguchi, 1957, as a nomen dubium in the absence of the type material. Dimitrov & Hormiga (2011) erected a new genus, *Pinkfloydia* and investigated its phylogenetic relationships among tetragnathids using molecular data generated from six molecular markers (12S, 16S, 18S, 28S, cytochrome c oxidase subunit 1, and histone 3) in addition to both morphological and behavioural data. The genus is positioned within the *Nanometa* clade. *Pinkfloydia harveii*, a new species collected from the Stirling Range National Park, Western Australia, was also described and illustrated. According to Cabra-Garcia & Brescovit (2016), the genus *Glenognatha* Simon, 1887, is a monophyletic group. The genus *Pachygnatha* is sister to *Glenognatha*. The phylogenetic analysis was based exclusively on the morphological data sets, and the monophyly was proved by seven synapomorphies. They also transferred *Dyschiriognatha dentata* to the genus *Glenognatha*. The subfamily Metainae was phylogenetically revised by Kallal & Hormiga (2018) based on the molecular data and analysed by maximum likelihood and Bayesian inferences. They synonymised the genus *Menosira* Chikuni, 1955, with *Metellina* Chamberlin & Ivie, 1941, and described a new genus, *Zhinu* from Taiwan. Salgueiro & Alvarez-Padilla (2018) analysed the phylogeny of the genus *Chrysometa* using a CO1 fragment and the cladogram resulted in evidence for monophyly of the genus. Alvarez-Padilla et al. (2020) who explicitly studied the taxonomy and phylogeny of the subfamily Nanometinae for the first time, which were collected from Australia.

Among the four newly described genera, the subfamilial position of the genera such as *Taraire*, *Tawhai*, and *Lamarra* were not resolved, yet the genus *Harlanethis* was positioned within the subfamily Leucauginae. Ballesteros & Hormiga (2021) used the marker histone H4 for the first time in the spider phylogenetics along with five other commonly used DNA markers. The deep evaluation of the interrelationships of the subfamily Leucauginae depicted the circumscription of the genera *Alcimosphenus* Simon, 1895, *Opas* Pickard-Cambridge, 1896, *Opadometa* Archer, 1951, and *Mecynometa* Simon, 1894, under the genus *Leucauge*. In addition, Nasir et al. (2023) explored the phylogeny of 17 Malaysian tetragnathids using CO1 and 18S gene sequences. The phylogenetic trees were almost similar for both gene sequences, but the intraspecific variations were not explicitly fixed due to the small sample size.

2.4. Studies on the family Tetragnathidae in India

The family Tetragnathidae was first recorded from India by Walckenaer (1841) with a representative species, *Tetragnatha bengalensis*. Thorell (1891) described three novel species, *Leucauge nicobarica*, *L. tristicta*, and *T. delumbis* from the Nicobar Island. Three species including a new species, *T. irridescens* were described by Stoliczka (1869) from West Bengal. Pocock (1900, 1901) classified tetragnathids under the family Argiopidae and described many species including five novel species, *T. coelestis*, *T. paradisea*, *Opadometa armata*, *Argyropeira beata*, from the northeast regions and *O. marmorea* from Ponmudi in Thiruvananthapuram. Simon (1906) described three species including a new species, *L. rubrotrivittata*. Gravely (1921a), who had provided significant contributions on the subfamily Tetragnathinae, which were distributed in India. The four genera, such as *Tetragnatha*, *Eucta*, *Orsinome* and *Leucauge* were grouped under this subfamily.

The descriptions were purely based on the cheliceral dentitions rather than any other somatic or genitalic characteristics. Meanwhile, he also recorded three *Tetragnatha* species from Barkuda Island of Odisha (1921b). Hingston (1927) described *T. foliferens* from Nicobar Island.

The Indian spider fauna had been elaborately studied by Tikader for many decades and marked a significant milestone on the biodiversity and taxonomy of Indian spiders including spider fauna of the Andaman and Nicobar Islands. Tikader (1966) redescribed *Leucauge celebesiana* (Walckenaer, 1841) and *L. tessellata* (Thorell, 1887), which were collected from the Khasi and Jaintia Hills of Assam. Tikader (1970) also redescribed and illustrated four *Leucauge* species, which were found in Sikkim. Additionally, Tikader (1982) examined the Indian orb-weaver spiders and included the tetragnathid genus *Leucauge* under the family Araneidae and provided a key to the *Leucauge* species and described nine species, including a new species, *L. dorsotuberculata*. Furthermore, a handbook of Indian spiders was written by Tikader (1987) including the life history and morphology of spider fauna and the classification of all other arachnids. Additionally, the taxonomic key to the tetragnathid genera was also provided.

Gajbe (2004) misclassified tetragnathids under two genera, *Eucta* and *Tetragnatha*, and misidentified *T. javana* (Thorell, 1890) as *T. chamberlini*. Sunil Jose et al. (2004) redescribed *T. viridorufa* Gravely, 1921, from Kerala. Furthermore, Sunil Jose (2014) redescribed a female *Dolichognatha longiceps* (Thorell, 1895), a six-eyed tetragnathid species, collected from Idamalayar, southern part of the Western Ghats region. Kulkarni (2014) described a new species, *Tylorida sataraensis*, based on females, from the northern Western Ghats of India. Kulkarni & Lewis (2015) recorded its male from the same locality. Bodkhe & Manthen (2015) described a

new six-eyed species, *D. lonarensis* from Lonar Crater Sanctuary, Buldhana, Maharashtra, based on females and provided an account of its natural history. Basu & Raychaudhuri (2016) recorded *Tetragnatha chauliodus* (Thorell, 1890), *T. bogotensis* Keyserling, 1865 and *T. josephi* Okuma, 1988, for the first time from India and provided a taxonomic key to the *Tetragnatha* species found in the rice lands of West Bengal. Sen et al. (2015) in their monograph of the spiders from the reserve forests of Dooars, documented the distribution of seven tetragnathids and provided an identification key to the species. Kulkarni & Yadav (2015) synonymised *Tylorida stellimicans* (Simon, 1886) to *T. striata* (Thorell, 1877). Anis & Premila (2016) analysed species composition of tetragnathids found in rice fields of Kerala and recorded a total of 11 species. Sankaran et al. (2017) who explicitly reviewed the genus *Tylorida* for the first time from India and described a new species, *T. flava*, and they transferred *Orsinome marmorea* to *Tylorida* and *T. culta* to *Mesida*. Furthermore, they designated *T. sataransis* Kulkarni, 2014 and *T. cylindrata* (Wang, 1991) as new synonymies of *T. marmorea* (Pocock, 1901). Moreover, the genus *Atelidea* was recorded for the first time from this country with the description of a new species, *A. nona*. Three new synonymies of the species *L. granulata* (Walckenaer, 1841) were proposed by Malamel & Sebastian (2018). Malamel et al. (2018) recorded the genus *Wolongia* Zhu, Kim & Song, 1997 from India for the first time and introduced a new species, *W. papafrancisi* from Pathiramanal Island in Alappuzha district. Caleb et al. (2018) synonymised *Orsinome listeri* Graveli, 1921, and *Labulla nebula* Tikader, 1970, with *O. vethi* (Hasselt, 1882). A new species of the genus *Glenognatha* Simon, 1887, *G. paullula*, was described by Sankaran et al. (2020), inhabiting the leaf litter collected from Akambadam in Malappuram district of Kerala. Additionally, they synonymised *Pachygnatha silentvalliensis* Biswas &

Roy, 2004, with *Tylorida marmorea* (Pocock, 1901) and transferred *Dyschiriognatha ganeshi* Bodkhe, Manthen & Tanikawa, 2014 to *Glenognatha*. Anju et al. (2024b) added taxonomic notes on the genus *Tetragnatha* and redescribed three species including *T. serra* Doleschall, 1857, and *T. lauta* Yaginuma, 1959, which were recorded for the first time this country and they proposed *T. chamberlini* as the junior synonym of *T. javana*.

In India spiders were identified by DNA barcodes by Tyagi et al. (2019) and the family Tetragnathidae was represented by the single genus *Leucauge*. However, the molecular phylogeny of the family has not been explored to date. Inadequacy of comprehensive studies on the taxonomy of the family Tetragnathidae limits the knowledge of the majority of the genera and further highlights the revision of the same. Of most importance, the evolutionary relationship of Indian tetragnathid fauna is far from the primary understanding and it underscores the necessity of inferring the evolutionary relationship of the family.

CHAPTER 3

METHODOLOGY

3. METHODOLOGY

Methodology is the integral part of any scientific research, which provides a framework for the data collection, analysis and interpretation. The robust and systematic methods enhance the reliability and reproducibility of scientific research, thereby upholding the integrity of research. The major methods employed for the current research are described in this chapter.

3.1. Study area

Kerala, the state located in the southwestern region of the Indian subcontinent, is occupied between the Arabian Sea and the Western Ghats. The state is situated in the tropical region of the Indian Peninsula. Among the designated 39 sites of the Western Ghats declared by UNESCO; 19 sites are located in Kerala (Kerala State Council for Science, Technology and Environment, 2011). Moreover, the state is remarkable for its wetlands, coastal ecosystem and particularly tropical forest which occupies approximately 28% of the total geographical area (Forest Survey of India, 2021). The major forest types include dry deciduous forest, moist deciduous forest, semievergreen forest, shola forest and evergreen forest (Champion & Seth, 1968). The protected area includes five national parks, 17 wildlife sanctuaries, two biosphere reserves and one community reserve. The average rainfall is high and varies from 360 cm and during the southwest monsoon season, which is the major rainy season, the state receives approximately 70% of its annual rainfall. The average temperature ranges between 28°C and 34°C and usually lowers to 3°C-5°C during the monsoon season, and it fluctuates at different elevations. The relative humidity is nearly 70% and higher in coastal regions (Kerala State Council for Science, Technology and Environment, 2011). Due to the favourable microclimatic

conditions and topography, this land has remarkable biodiversity rich in flora and fauna. By exploring the biodiversity of this state, we actually foster the understanding of its current status and ultimately facilitates various conservation strategies in the future.

3.2. Taxonomic assessment

3.2.1. Sampling

A rigorous sampling was done for a period of two years and five months from August, 2021 to January, 2024. Sampling was done in the early morning period (7.00 am to 9.00 am) and late evening period (5.00 pm to 6.30 pm) in the following localities of 14 districts of Kerala state (Figs. 3.1, 3.2, 3.3, 3.4; Table 3.1). Samples were collected from various habitats including grasslands, tropical evergreen forests, semi-evergreen forests, deciduous forests, rivers, streams, marshy areas, paddy fields, mangroves, sacred groves, plantations, etc. The collection localities were mapped using the open-source geographic information system (GIS) software QGIS 3.40.11. and also using online tool, SimpleMappr (Shorthouse, 2010). Coordinates of the sampling sites were recorded using GPS or extracted from the Google Earth Pro version 7.3.6.10201.

Sl. No.	District	Localities	Coordinates	Date of collection
1	Kasaragod	Kumbala	12°35'48"N, 74°56'47"E	27 September 2022
		Ranipuram	12°24'39"N, 75°21'22"E	28 September 2022
		Uppala	12°40'28"N, 74°54'15"E	29 September 2022
2	Kannur	Madayipara	12°01'53"N, 75°15'18"E	18 October 2021
		Madayikavu	12°02'04"N, 75°15'28"E	18 October 2021

		Dharmadam	11°46'25"N, 75°28'22"E	13 March 2022
		Valapattanam	11°55'44"N, 75°21'19"E	13 March 2022
		Meloor	11°48'18"N, 75°28'01"E	14 March 2022
		Andalur Kavu	11°47'42"N, 75°28'38"E,	15 March 2022
		Ezhome	12°02'25"N, 75°17'51"E	15 March 2022
		Pazhayangadi	12°01'09"N 75°15'33"E	15 March 2022
		Kunjimangalam	12°04'17"N, 75°13'42"E	15 March 2022
		Koduvally	11°21'38"N, 75°54'47"E	16 March 2022
		Alakapuri waterfalls	12°08'33"N, 75°37'42"E	22 November 2023
		Sasippara	12°08'42"N, 75°37'21"E	24 November 2023
3	Wayanad	Valery	11°45'52"N, 75°55'56"E	28 October 2021 29 November 2021
		Vythiri	11°36'36"N 75°59'11"E	11 December 2021
		Makkiyad	11°45'06"N, 75°53'53"E	26 December 2021
		Vemom	11°49'23"N, 76°01'30"E	26 December 2021
		Tharuvana	11°44'06"N, 75°58'52"E	26 December 2021
		Thirunelly	11°54'38"N, 75°59'30"E	12 January 2022
		Pozhuthana reserved forest	11°35'11"N, 76°00'56"E	4 April 2022 15 January 2025
		Chirappullu Hill	11°42'37"N, 75°54'12"E	18 April 2022 25 May 2022
		Arattuthara	11°48'40"N, 76°03'17"E	19 April 2022
		Thrissilery	11°50'36"N, 76°01'42"E	02 December 2022 04 December 2022 14 January 2025

		Koilery	11°47'02"N, 76°02'33"E	02 December 2022 13 November 2023
		Periya reserved forest	11°46'39"N, 75°50'53"E	04 December 2022 07 December 2022 12 November 2023
		Padinjarathara	11°40'48"N, 75°58'44"E	15 April 2023
		Tholpetty	11°57'04"N 76°03'43"E	09 June 2023
4	Kozhikode	Peruvannamuzhi	11°35'51"N, 75°49'27"E	21 April 2022
		Thusharagiri	11°28'24"N, 76°03'13"E	18 November 2023 29 November 2023
5	Malappuram	Kakkadampoyil waterfalls	11°20'45"N, 76°06'51"E	15 October 2021
		Nellikuthu	11°16'37"N, 76°13'33"E	11 October 2021
		Chembankolli	11°21'10"N, 76°13'34"E	12 October 2021
		Vazhikadavu	11°23'13"N, 76°20'43"E	15 October 2021
		Kakkad	11°02'12"N 75°56'24"E	16 October 2021
6	Palakkad	Attappadi	11°04'05"N, 76°34'01"E	03 February 2023
		Thavalam	11°05'46"N, 76°35'33"E	03 February 2023
		Mukkali	11°03'25"N, 76°31'58"E	04 February 2023
		Kakkuppadi	11°03'55"N, 76°32'58"E	04 February 2023
7	Thrissur	Athirappilly waterfalls	10°17'11"N 76°34'16"E	11 August 2021
		Thommana	10°20'32"N, 76°15'09"E	13 May 2022
		Sree Kerala Varma College Campus	10°31'47"N, 76°11'43"E	14 July 2022 18 July 2022
		Pullu	10°27'17"N, 76°09'14"E	27 November 2022 21 January 2025

		Muriyad	10°21'46"N, 76°15'46"E	02 March 2023 24 February 2023 11 October 2023
		Ayyappankavu	10°31'40"N, 76°16'58"E	02 March 2023
		Thekkinkadu	10°31'29"N, 76°12'52"E	03 March 2023
		Manakkodi	10°29'06"N 76°10'18"E	26 November 2023 06 December 2024
		Chimmini Wildlife Sanctuary	10°25'51"N 76°29'27"E	14 December 2023
8	Ernakulam	Kothamangalam	10°03'32"N, 76°38'07"E,	10 December 2021
		Mangalavanam Bird Sanctuary	9°59'18"N, 76°16'19"E	15 October 2023
9	Idukki	Chinnar Wildlife Sanctuary	10°18'34"N, 77°11'13"E	10 January 2024
		Mankulam	10°07'03"N, 76°55'30"E	08 December 2023
		Viripara	10°08'41"N, 76°95'74"E	08 December 2023 15 December 2023 01 February 2024
		Anakkulam	10°09'33"N 76°54'49"E	09 December 2023
		Marayoor	10°17'20"N, 77°10'06"E	09 January 2024
		Karimutty waterfalls	10°21'69"N, 77°18'36"E	09 January 2024
		Kanthalloor	10°12'15"N, 77°12'19"E1	11 January 2024
10	Kottayam	Teekoy	9°42'11"N, 76°48'45"E	30 July 2022
		Kalathukadavu	9°43'14"N 76°46'37"E	30 July 2022
		Kattikkayam waterfalls	9°46'35"N, 76°48'25"E	14 December 2022
		Illikkal Kallu	9°45'06"N, 76°49'20"E	15 December 2022
		Marmala waterfalls	9°47'06"N 76°43'52"E	15 December 2022
		Ilaveezhapoonchira	9°47'34"N 76°47'26"E	16 December 2022

		Aruvickal waterfalls	9°23'43"N, 76°45'37"E	14 May 2023
		Moonnillavu	9°44'55"N, 76°47'02"E	15 May 2023
		Muttom	9°33'09"N 76°30'38"E	15 May 2023
		Erumely	9°28'37"N, 76°50'41"E	16 May 2023
		Erattupetta	9°41'04"N 76°46'28"E	07 August 2022
11	Alappuzha	Pathiramanal Island	9°37'07"N 76°23'04"E	26 September 2021
12	Pathanamthitta	Gavi	9°26'09"N, 77°09'55"E	11 November 2021
13	Kollam	Shenduruny Wildlife Sanctuary	8°51'27"N, 77°12'58"E	16 September 2022
		Kattalappara	8°55'12"N, 77°05'46"E	16 September 2022
		Thenmala	8°57'47"N, 77°03'53"E	17 September 2022
		Palaruvi waterfalls	8°56'40"N, 77°09'48"E	18 September 2022
		Aaryankavu	8°58'41"N, 77°08'54"E	19 September 2022
		Punalur	9°01'07"N, 76°55'35"E	20 September 2022
14	Thiruvananthapuram	Kombaippara	8°32'02"N, 77°09'02"E	28 December 2022
		Charupara	8°32'02"N, 77°09'00"E	29 December 2022
		Kombai	8°32'02"N, 77°09'00"E	30 December 2022
		Puravimala	8°32'03"N, 77°08'52"E	31 December 2022

TABLE 3.1. Collection localities in 14 districts of Kerala state including coordinates and date of collection.

3.2.2. Collection methods

1. Visual searching and hand picking

This method involves rigorous sampling of spiders from various habitat types and includes ground hand collection which explicitly searches for samples in vegetation

mostly under foliage, shrubs, and grasses which grow up to knee level, whereas the aerial hand collection targets spiders inhabiting vegetation from knee to arm level (Coddington et al., 1996) (Fig. 3.5). Samples were carefully transferred to labelled vials containing ethyl alcohol for further examination.

2. Sweep netting

Sweep netting is an efficient method for quickly collecting a wide range of arthropods including spiders, which inhabit lower vegetation like shrubs and grasses up to knee level. Contrarily, the sweeping is ineffective for spider sampling in certain habitat types like woody vegetation and ground cover in damp areas. Moreover, the sampling could be influenced by particular climatic conditions like heavy wind and rainfall (Churchill & Arthur, 1999; Spafford & Lortie, 2013). This method involves systematic sweeping of vegetation back and forth using a sweep net of mesh size 1.5 mm and net depth of 45 cm with an aluminium ring frame consisting of a 30 cm diameter in support of a long metal hand of 80 cm. The collected samples were immediately transferred to vials containing ethyl alcohol from the net by hand or tweezers (Fig. 3.6F).

3. Beating

The beating method was adopted for sampling spiders occupying small trees, shrubs and other higher vegetation. This method includes meticulous beating of vegetation using a strong stick with a provided white cloth beneath. This method could be utilised for the effective sampling from the forest understory (Fig. 3.6E). The collected samples were transferred to plastic vials containing ethyl alcohol by using tweezers or by hand.

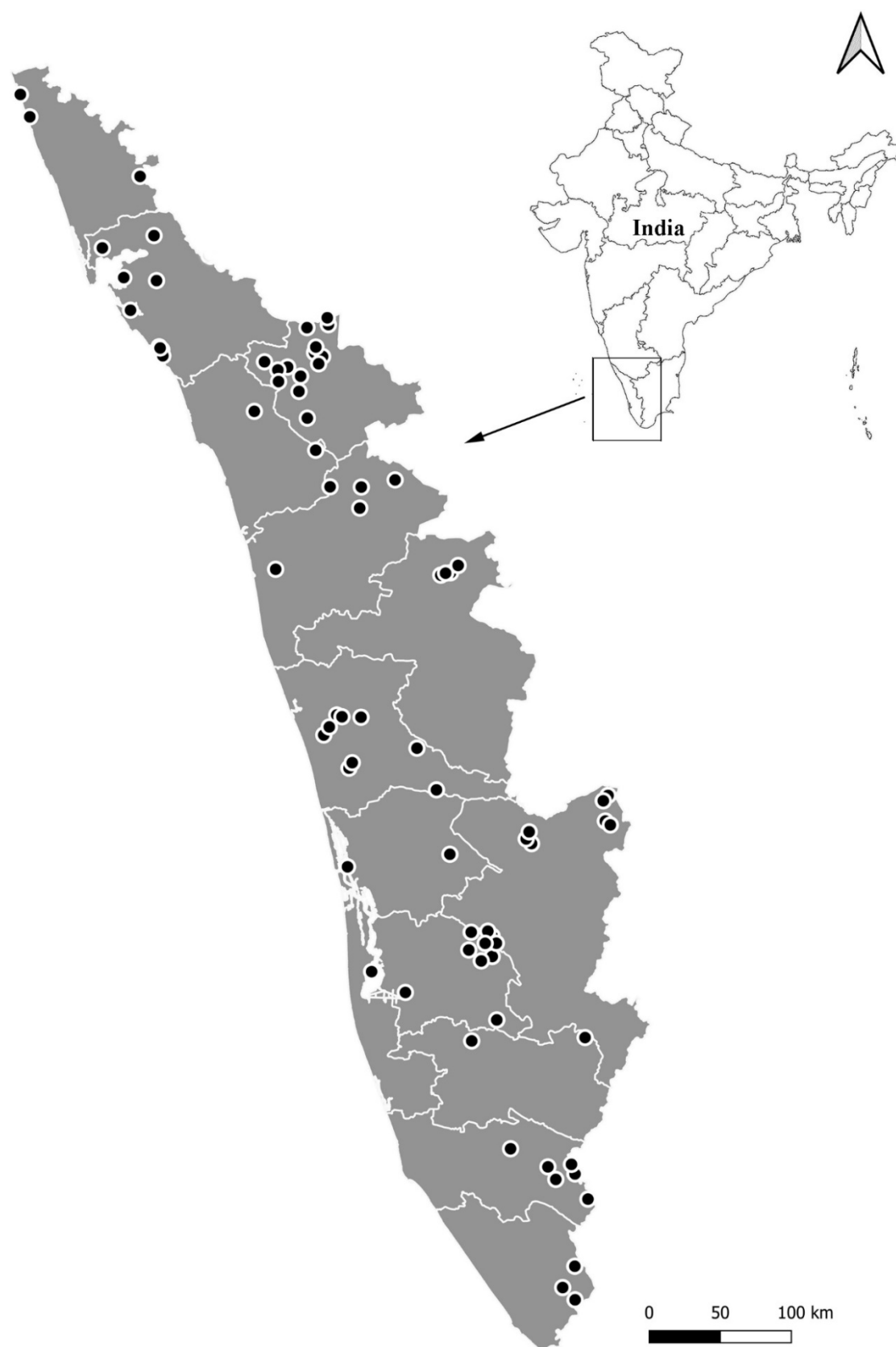


FIGURE 3.1. Collection localities of tetragnathids in Kerala.



FIGURE 3.2. Collection localities: A, Mankulam, Idukki, B, Anakkulam, Idukki C, moonnilavu, Kottayam, D, Pullu Kole Wetland, Thrissur, E, Kunjimangalam, Kannur, F, Padinjarathara, Wayanad, G, Kattikkayam waterfalls, Kottayam, H, Periya reserved forest, Wayanad.



FIGURE 3.3. Collection localities: A, Thenmala, Kollam, B, Makkiyad, Wayanad, C, Ranipuram Reserved Forest, Kasaragod, D, Thirunelly, Wayanad, E, Madathala, Idukki, F, Kanthalloor, Idukki.



FIGURE 3.4. Collection localities: A, Thrissilery, Wayanad, B, Karimutty, Idukki, C, Pazhayangadi, Kannur, D, Valapattanam, Kannur, E, Tholpetty, Wayanad, F, Chinnar Wildlife Sanctuary, Idukki, G, Mankulam, Idukki, H, Teekoy, Kottayam.

3.2.3. Digital documentation

The morphology of the specimens was carefully examined with a Leica M205C stereomicroscope. Photographs were taken by a Leica DMC4500 digital camera provided with Leica M205C stereomicroscope and with the support of the software package Leica Application Suite (LAS), version 4.3.0 LAS montage facility. The dorsal, ventral and lateral habitus images of the specimens were taken for further examinations along with the cheliceral and genitalic images. Drawings were made by graphite pencils and detailed drawings of dorsal and ventral views of chelicerae, genitalic characters including pedipalp and internal genitalia of females were provided. All photographs were modified in Adobe Photoshop 2020 (Adobe Inc., 2020). Morphometric characters were recorded by dorsally placing the specimen and the body length can be accounted by measuring it from the upper border of the cephalothorax to the posterior end of the body (Castanheira et al., 2022). Pedipalp and leg measurements were as follows: total length [femur, patella, tibia, metatarsus (except pedipalp) and tarsus]. All measurements are in millimetres (mm).

3.2.4. Preservation and storage

Adult specimens were preserved in 70% or absolute ethyl alcohol for further examination and storage. For molecular analysis, merely 3-5 specimens were preserved in absolute ethyl alcohol and stored at -20°C and the rest of the samples were preserved in 70% ethanol for morphological examinations. All specimens were stored in plastic vials with due labels and properly kept in closed racks. Specimens were deposited in the reference collection at the Centre for Animal Taxonomy and Ecology (CATE), Department of Zoology, Christ College (Autonomous), Irinjalakuda, Kerala, India and the National Zoological Collections at the Zoological

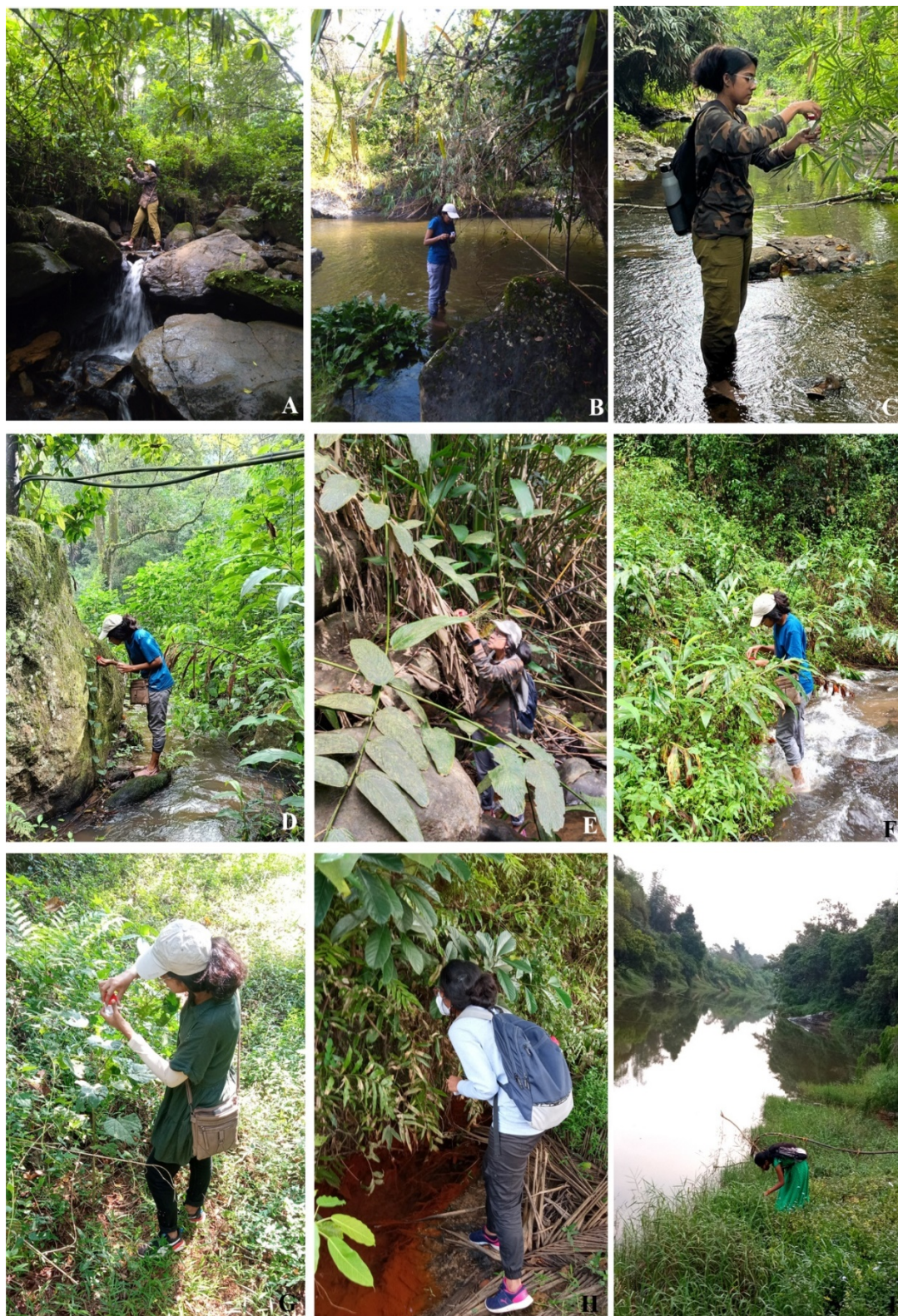


FIGURE 3.5. Collection of tetragnathids from various habitats by hand picking method.



FIGURE 3.6. Collection of tetragnathids from various habitats by different methods. A–D, hand collection, E, beating, F, sweeping.

Survey of India, Western Ghat Regional Centre (WGRC), Kozhikode, Kerala.

3.2.5. Identification

Morphological identification was done by using a Leica M205C stereomicroscope attached to a Leica DMC4500 digital camera. Members of the genus *Tetragnatha* could be primarily identified based on cheliceral dentitions. The position of teeth, presence of cheliceral apophysis and the fang cusps were noted to confirm the species. The conspecific male and female were matched based on the cheliceral morphology and collection locality (Castanheira et al., 2019). Female genitalia were cleared in warm 10% potassium hydroxide (KOH) solution. The identification was also supported by taxonomic keys (Barrion & Litsinger, 1995; Okuma, 1988a, b), available literature (Gravely, 1921a; Tikader, 1982; Gillespie, 1991; Zhu et al., 2003; Castanheira et al., 2019) and most of the literature was mined from the website World Spider Catalog (2025).

3.2.6. Abbreviations used in the text and figures

Abbreviations follow Okuma (1987), Castanheira et al. (2019), Wang et al. (2020) and Castanheira & Baptista (2020).

ALE: anterior lateral eye; AME: anterior median eye; C: conductor; CD: copulatory duct; CDBP: cymbial dorso-basal process; CEBP: cymbium ecto-basal process; CS: central membranous sac; dmtT: disto-median triangular process; E: embolus; EB: embolic base; FD: fertilization duct; GF: genital fold; K: knob on the ectal side of paracymbium; L: translucent lobe on the mesal side of the paracymbium; N: notch at the apex of the paracymbium; P: paracymbium; PLE: posterior lateral eye; PME: posterior median eye; Sp: spermatheca; ST: subtegulum; T: tegulum; Y: cymbium

Structures of chelicerae

- a: male dorsal apophysis, used to lock the fangs of females during copulation.
- AXl: auxiliary guide tooth of the lower row, present in some species.
- AXu: auxiliary guide tooth of the upper row, above Gu, present in some species.
- BC: basal cusp on the cheliceral fang of females.
- CB: cheliceral bulging.
- Gl: guide tooth of the lower (or ventral) row.
- Gu: guide tooth of the upper (or dorsal) row.
- IC: inner cusp of fang.
- L2–n: teeth on the lower row numbered from the distal end after Gl.
- MC: median cusp on the female's cheliceral fang.
- OC: outer cusp of fang.
- Prt1–n: small teeth on the upper row of chelicerae.
- Ret1–n: small teeth on the lower row of chelicerae.
- rsu: remaining proximal teeth on the upper row of males after T.
- S: swelling at the base of the apophysis on the upper side of paturon.
- sl: first major tooth after Gu in the upper row of males (absent in some species).
- t: a tooth or prominence found in males of some species.
- T: elongated tooth in the upper row of some males.
- U2–n: teeth on the upper row numbered from the distal end after Gu.

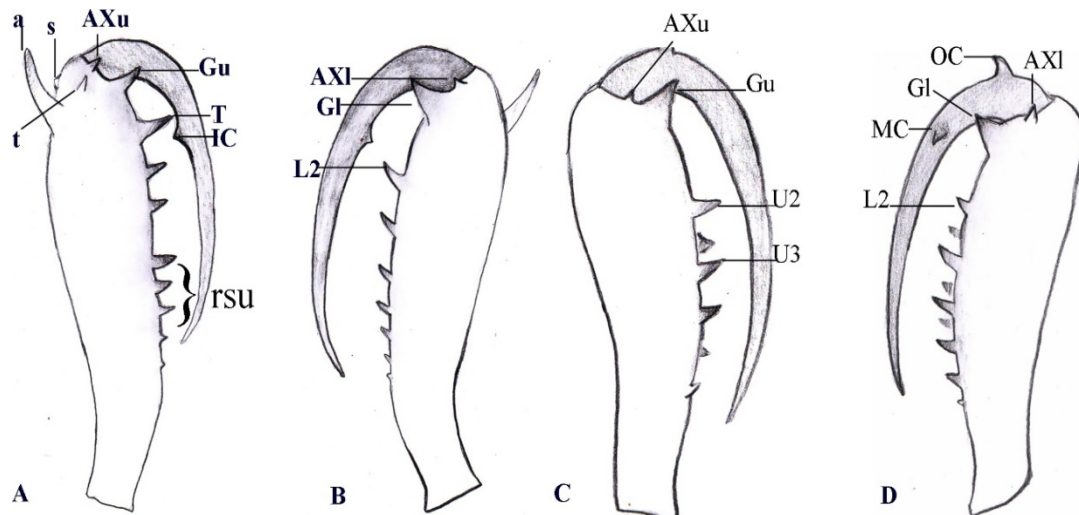


FIGURE 3.7. Structure of chelicerae (A–D). A, B, left male chelicerae, A, same, upper view, B, same, ventral view. C, D, left female chelicerae, C, same, dorsal view, D, same, ventral view.

3.3. Molecular techniques

DNA barcoding is a widely recognized molecular tool and serves as the most reliable and accurate approach in the field of molecular taxonomy. For DNA barcoding, a mitochondrial genetic marker, Cytochrome C Oxidase subunit 1 (CO1), and a nuclear ribosomal marker, 18S rRNA were used in this study. The former genetic marker could effectively address the species delimitation, as it has rapid genetic divergence, whereas the latter genetic marker is prevalently used to assess the deep phylogenetic relationships. Additionally, these barcodes were further utilized for inferring the phylogenetic relationships. For the present study, the barcodes were generated by the biotechnology lab, Barcode Biosciences Pvt. Ltd (BBS), Bangalore, Karnataka. The voucher specimens were deposited in the reference collection at the Centre for Animal Taxonomy and Ecology (CATE), Department of Zoology, Christ College (Autonomous), Irinjalakuda, Kerala, India. The two-dimensional DNA barcodes were generated by the online tool Bio-Rad DNA Barcode Generator (<http://biorad-ads.com/DNABarcodeWeb/>) (Bio–Rad

Laboratories, n.d.). The major molecular techniques such as DNA isolation, amplification and sequencing are described in this section.

3.3.1. DNA isolation

The genomic DNA was extracted from the samples, which were properly stored in absolute ethyl alcohol at -20°C. The high-quality DNA was isolated from the legs of the sample using the QIAGEN DNeasy UltraClean Microbial Kit (Cat. No. 69504 /ID: 12224-50), and two to four legs were used for this process. The liquid nitrogen (3–5ml) was used to crush the materials which were then subjected to Proteinase K digestion. This step was followed by quality checking on 1.0% agarose gel and a band of high molecular weight DNA was observed.

3.3.2. PCR amplification

PCR conditions of Cytochrome Oxidase Subunit 1 (CO1) gene

A total reaction volume of 25 µL contains 2 µL of DNA template (10-100 ng/µL), 2.5 µL of 10X PCR buffer, 0.5 µL of dNTP mix, 0.5 µL of taq DNA polymerase, 0.5 µL of forward primer, 0.5 µL of reverse primer, 1.5 µL of MgCl₂ and an adequate volume of nuclease-free water.

The reaction commenced with the temperature of 95°C kept for 1 min to secure complete denaturation of DNA strands. Furthermore, the denaturation extended for 1 min at 95°C. This was followed by annealing at 40°C for 1 min and subsequently extension at 72°C for 1 min 5 sec for 40 cycles. The final extension was performed at 72°C for 3 min. Approximately 600 bp PCR amplicon band which is a distinct one, was obtained after the gel electrophoresis. Additionally, the contaminants and impurities were removed from the PCR amplicon using the QIAGEN QIAquick

PCR Purification Kit (Cat. No./ID: 28104). The details of primer pairs for the amplification of CO1 and 18S genes are provided below (Table 3.2).

Gene	Primer	Sequences	References
CO1	LCO1490	5'-GGTCAACAAATCATAAAGATATTGG-3'	Folmer et al., 1994
	HCO2198	5'-TAAACTTCAGGGTGACCAAAAAATCA-3'	Folmer et al., 1994
	Chelicerate R2	5'-GGATGGCCAAAAAATCAAAATAAATG-3'	Hebert et al., 2003
18S	18S a0.7	5'-ATTAAAGTTGTTGCGGTTA-3'	Whiting, 2002
	9r	5'-GATCCTTCCGCAGGTTACCTAC-3'	Whiting et al., 1997

TABLE 3.2. Details of primers used for amplifying CO1 and 18S genes.

PCR conditions of 18S rRNA gene

The reaction mixture consists of 2.5 µL DNA template, 5 µL of dH₂O, 2.5 µL forward primer, 2.5 µL reverse primer, 0.5 µL dNTP mix, 2 µL 10X PCR buffer, 0.5 µL taq DNA polymerase, 1.5 µL of MgCl₂ and this was made up to 25 µL total reaction volume by adding nuclease-free water.

The reaction was set at 94°C for 2 min followed by 94°C for 20 seconds, 60°C for 35 seconds, 65°C for 30 seconds, for 13 cycles. Thereafter, 21 cycles were set at 94°C for 15 seconds, 48°C for 35 seconds, 65°C for 30 seconds and the final extension at 72°C for 3 minutes (Nasir, 2016). A nearly 700-800 bp long amplicon was observed after resolving in 2% agarose gel. The PCR amplicon was purified by the QIAGEN QIAquick PCR Purification Kit (Cat. No. /ID: 28104).

Sl. No.	Voucher	CO1		18S rRNA	
		Forward primer	Reverse primer	Forward primer	Reverse primer
1	CDZ_DoCh1	LCO1490	Chelicerate-R2	18Sa	9r
2	CDZ_LeDe1	LCO1490	HCO2198	18Sa	9r
3	CDZ_LeFa1	LCO1490	Chelicerate-R2	18Sa	9r
4	CDZ_LuRu1	LCO1490	Chelicerate-R2	18Sa	9r
5	CDZ_LuTs1	LCO1490	Chelicerate-R2	18Sa	9r
6	CDZ_OrVe1	LCO1490	HCO2198	18Sa	9r
7	CDZ_TyVn1	LCO1490	HCO2198	18Sa	9r
8	CDZ_TySt1	LCO1490	HCO2198	18Sa	9r
9	CDZ_TyFl1	LCO1490	Chelicerate-R2	18Sa	9r
10	CDZ_TyMa1	LCO1490	Chelicerate-R2	18Sa	9r
11	CDZ_MeCu1	LCO1490	Chelicerate-R2	18Sa	9r
12	CDZ_GlDe1	LCO1490	Chelicerate-R2	18Sa	9r
13	CDZ_TeCe1	LCO1490	Chelicerate-R2	18Sa	9r
14	CDZ_TeCo1	LCO1490	Chelicerate-R2	18Sa	9r
15	CDZ_TeGe1	LCO1490	HCO2198	18Sa	9r
16	CDZ_TeHs1	LCO1490	Chelicerate-R2	18Sa	9r
17	CDZ_TeJa1	LCO1490	HCO2198	18Sa	9r
18	CDZ_TeKe1	LCO1490	Chelicerate-R2	18Sa	9r
19	CDZ_TeLt1	LCO1490	Chelicerate-R2	18Sa	19
20	CDZ_TeMn1	LCO1490	HCO2198	18Sa	9r
21	CDZ_TeSq1	LCO1490	Chelicerate-R2	18Sa	9r
22	CDZ_TeVi1	LCO1490	Chelicerate-R2	18Sa	9r
23	CDZ_TeJr1	LCO1490	Chelicerate-R2	18Sa	9r
24	CDZ_TeSe1	LCO1490	Chelicerate-R2	18Sa	9r
25	CDZ_TeNi1	LCO1490	Chelicerate-R2	18Sa	9r

TABLE 3.3. Details of forward and reverse primers used for amplifying CO1 and 18S genes.

3.3.3. DNA sequencing

The Sanger dideoxy chain termination method was employed for the DNA sequencing. This was carried out with defined primers using the BDT v3.1 cycle

sequencing kit applied Biosystems™ MiniAmp™ Plus Thermal Cycler and analysed on ABI 3730xl Genetic Analyzer. To get a high-quality full-length barcode, the chromatogram was checked and trimmed using the software program BioEdit v7.2.5. The quality of the sequence alignment was further assessed by the BLAST tool and the sequences were deposited in GenBank using the submission tool BankIt.

3.4. Molecular phylogenetic analysis

For inferring the interrelationship between members of the family Tetragnathidae, a total of 44 taxa has been selected, including two outgroups as terminals. The details of the samples acquired from the public sequence databases like GenBank and BOLD for the current analysis are given in Table 3.4. The phylogenetic reconstruction was done by concatenated nucleotide sequence data of two molecular markers such as a mitochondrial marker, Cytochrome Oxidase subunit 1 (CO1), and a nuclear marker, 18S rRNA. Two species, *Mimetus hesperus* Chamberlin, 1923 (Family: Mimetidae Simon, 1881) and *Epeirotypus chavarria* Coddington, 1986 (Family: Theridiosomatidae Simon, 1881) were selected as outgroups. The phylogenetic reconstruction has been done by four various methods such as Maximum Likelihood (ML), Bayesian Inference (BI), Neighbour Joining (NJ), and Maximum Parsimony (MP).

1. Maximum Likelihood (ML)

The method of phylogenetic analysis using the maximum likelihood criterion is based on the principle of assessing tree topology or testing the phylogenetic hypothesis that maximises the probability of observing the sequence data under a substitution model and that will concurrently change according to the parameters of

the selected model. The resulting phylogeny is supported by statistically rigorous estimates and thereby optimises the likelihood scores (Huelsenbeck & Crandall, 1997; Cunningham et al., 1998). Here the ML analysis was employed by IQ-TREE v3.0.1 software which selects the optimal substitution model by means of ModelFinder based on the Bayesian Information Criterion (BIC).

2. Bayesian Inference (BI)

The phylogenetic analysis by Bayesian Inference actually integrates a prior probability with observed sequence data to a posterior probability distribution. The Markov Chain Monte Carlo (MCMC) method is used to directly estimate the highest posterior probabilities under optimum parameterization (Yang & Rannala, 1997). Apart from generating a single best-fitting tree using the Maximum Likelihood criterion, Bayesian Inference uses posterior probabilities as a direct measure of clade credibility. The sophisticated software package BEAST v1.7.4 was used to generate phylogeny by means of Bayesian Inference under a specified substitution model (Nascimento & Yang, 2017).

3. Neighbour Joining (NJ)

Neighbour Joining is a method for reconstructing phylogenetic trees based on genetic distance data. This method functions based on the principle of minimum evolution and minimizing the total branch length at each step of clustering. This method is best to cluster the Operational Taxonomic units (OTUs) joined by a single interior node, which produces an unrooted bifurcated phylogenetic tree, clearly reflecting the genetic distances (Saitou & Nei, 1987). In the present study, the software MEGA12 was employed to generate a preliminary phylogenetic tree under the Neighbour Joining method with 1000 replicates, and for inferring the phylogeny,

the pairwise genetic distance of aligned sequences was calculated using the same software.

4. Maximum Parsimony (MP)

Maximum Parsimony is a character-based approach which implements the position-specific analysis of nucleotide data. For inferring the phylogeny, the Maximum Parsimony method estimates the smallest number of evolutionary changes that yields the most parsimonious tree. The non-parametric bootstrap sampling provides the measure of nodal support values which reveal the reliability of inferred clades with a specified number of replicates (Yang, 1996; Takahashi & Nei, 2000). Here, we used the software MEGA12 for reconstructing the phylogenetic tree under the Maximum Parsimony criterion with the given 10000 bootstrap replicates. This process does not require any specified substitution models thereby avoiding sophisticated parameter estimations.

3.4.1. Computer programmes and databases

BioEdit version 7.2.5

BioEdit is a biological sequence alignment editor employing nucleotide and protein sequence editing and yielding high-quality sequences. It confers options for sequence annotation, merging, manipulation etc. (Hall, 2004). The software interface enables the manual editing of ambiguous codes, checking of background noises, trimming of poor-quality ends and finally, consensus sequences can be generated for the downstream process (Hall, 1999).

Sl. No	Species	Status	Accession number		Reference
			CO1	18S rRNA	
1	<i>Epeirotypus chavarria</i>	Acquired from GENBANK	HM030431	HM030410	Lopardo et al., 2011
2	<i>Mimetes hesperus</i>	Acquired from GENBANK	KP271827	KP271688	Dimitrov et al., 2017
3	<i>Dolichognatha sp.</i>	Acquired from GENBANK	EU003285	EU003346	Alvarez-Padilla et al., 2009
4	<i>Dolichognatha longiceps</i>	Acquired from GENBANK	GU129632	MF668719	Dimitrov & Hormiga, 2011/Kallal & Hormiga, 2018
5	<i>Leucauge argyra</i>	Acquired from GENBANK	MG738495	MZ604145	Ballesteros & Hormiga, 2018/ Ballesteros & Hormiga, 2021
6	<i>Leucauge venusta</i>	Acquired from GENBANK	MG738574	MZ604190	Ballesteros & Hormiga, 2018/ Ballesteros & Hormiga, 2021
7	<i>Leucauge venusta</i>	Acquired from GENBANK	MG738561	MZ604189	Ballesteros & Hormiga, 2018/Ballesteros & Hormiga, 2021
8	<i>Leucauge argyrobapta</i>	Acquired from GENBANK	MG738539	MZ604148	Ballesteros & Hormiga, 2018/ Ballesteros & Hormiga, 2021
9	<i>Leucauge argyrobapta</i>	Acquired from GENBANK	MG738547	MZ604151	Ballesteros & Hormiga, 2018/ Ballesteros & Hormiga, 2021
10	<i>Leucauge decorata</i>	Acquired from GENBANK	KU836874	KU836905	Unpublished
11	<i>Leucauge tessellata</i>	Acquired from GENBANK	KU836877	KU836908	Unpublished
12	<i>Orsinome sp.</i>	Acquired from GENBANK	EU003305	EU003362	Alvarez-Padilla et al., 2009
13	<i>Tylorida ventralis</i>	Acquired from GENBANK	KM486470	KM486207	Dimitrov et al., 2017
14	<i>Tylorida striata</i>	Acquired from GENBANK	EU003309	EU003365	Alvarez-Padilla et al., 2009

15	<i>Tetragnatha hasselti</i>	Acquired from GENBANK	KU836891	KU836924	Unpublished
16	<i>Tetragnatha keyserlingi</i>	Acquired from GENBANK	KU836893	KU836926	Unpublished
17	<i>Tetragnatha lauta</i>	Acquired from GENBANK	KU836892	KU836925	Unpublished
18	<i>Tetragnatha pinicola</i>	Acquired from GENBANK	KU836895	KU836928	Unpublished
19	<i>Tetragnatha pinicola</i>	Acquired from GENBANK	KU836896	KU836929	Unpublished
20	<i>Tetragnatha jaculator</i>	Acquired from BOLD	EMFLO5358-22	-	Unpublished
21	<i>Metellina segmentata</i>	Acquired from GENBANK	FJ607572	FJ607498	Blackledge et al., 2009
22	<i>Meta menardi</i>	Acquired from GENBANK	EU003295	EU003353	Alvarez-Padilla et al., 2009
23	<i>Meta ovalis</i>	Acquired from GENBANK	FJ607571	FJ607497	Blackledge et al., 2009
24	<i>Pinkfloydia rixi</i>	Acquired from GENBANK	MF281417	KM486190	Hormiga, 2017/ Dimitrov et al., 2017
25	<i>Nanometa forsteri</i>	Acquired from GENBANK	KM486458	KM486175	Dimitrov et al., 2017
26	<i>Nanometa forsteri</i>	Acquired from GENBANK	KM486459	KM486176	Dimitrov et al., 2017
27	<i>Nanometa sarasini</i>	Acquired from GENBANK	EU003299	EU003357	Alvarez-Padilla et al., 2009
28	<i>Pachygnatha degeeri</i>	Acquired from GENBANK	EU003306	EU003363	Alvarez-Padilla et al., 2009
29	<i>Mesida yini</i>	Acquired from GENBANK	KU836880	KU836912	Unpublished
30	<i>Mesida yini</i>	Acquired from GENBANK	KU836881	KU836913	Unpublished
31	<i>Tylorida tianlin</i>	Acquired from GENBANK	KU836886	KU836918	Unpublished
32	<i>Metellina marianae</i>	Acquired from GENBANK	EU003298	EU003356	Alvarez-Padilla et al., 2009

TABLE 3.4. List of tetragnathid spiders retrieved from the GENBANK or BOLD databases along with its accession numbers and references.

ExPASy translate tool

ExPASy (Expert Protein Analysis System) is an online bioinformatics tool operated by the Swiss Institute of Bioinformatics. This programme is integrated with other databases and several analysis tools, which actually function for similarity searches, analysis of protein structure and several other tasks related to protein structure and functions. This computational tool is utilized for determining the best open reading frame of nucleotide sequences minimising the errors in protein-coding regions (Gasteiger et al., 2003).

GENBANK

GENBANK is a public database of nucleotide and protein sequences maintained by National Centre for Biotechnology Information (NCBI). The users can directly submit the sequences to the portal through a web-based submission tool, BankIt or Sequin. Additionally, the data retrieval system, Entrez enables the accessibility of nucleotide and protein sequence data for various comparative and phylogenetic analyses (Benson et al., 1999).

BLAST

BLAST (Basic Local Alignment Search Tool) is a heuristic search tool mostly used to assess the sequence similarity and to confirm sequence identity with different databases. This tool provides an overall idea of the quality of the sequence alignments and potential biological relationship by exploring the E-value (expected value), bit score, percentage identity etc. (Madden, 2013). The BLAST output gives authenticity on the sequence identification and validation for the phylogenetic analysis.

ClustalX version 1.8.1

ClustalX is a bioinformatics computer programme for inferring the multiple sequence alignment of nucleotide or amino acid sequences. The program has optimized graphical user interface (GUI) and graphical modules for deriving multiple sequence alignments (Thompson et al., 2003). The optimal alignment is provided with coloured conserved sequences and it is most flexible for manual realignment of misaligned sequences by adjusting the gap penalties (Thompson et al., 1997).

MEGA version 12

MEGA (Molecular Evolutionary Genetics Analysis) is widely used for evolutionary analysis providing a platform for Maximum Parsimony analysis (MP), Maximum Likelihood analysis (ML), Neighbour Joining (NJ) and several other distance-based methods. It offers amino acid or nucleotide substitution models and a framework for generating phylogenetic trees using high bootstrap methods as well as the assessment of sequence divergence and evolutionary time scale. Furthermore, the pairwise sequence divergences can be calculated under specified models (Kumar et al., 2024). The phylogenetic reconstruction by Neighbour Joining (NJ) and Maximum Parsimony (MP) analysis was done by MEGA12.

jModelTest version 2.1.10

This programme is a tool for statistical selection of models of nucleotide substitutions. The best-fitting nucleotide substitution model is determined by jModelTest (Posada, 2008). The likelihood scores were calculated under the heuristic options, Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC). The resulting model with the lowest BIC score was treated as the

best-fitting model and subsequently performed maximum likelihood and Bayesian phylogenetic analysis.

DnaSP version 6

DnaSP (DNA sequence polymorphism) is a software package for the exhaustive analysis of DNA polymorphism data utilized by an efficient graphical user interface (Rozas et al., 2017). The software program is compatible with multiple file formats including NEXUS (Maddison et al., 1997). Furthermore, the sequence data can be exported in various nucleotide data file formats such as NEXUS, PHYLIP, NBRF etc. for further downstream phylogenetic analysis (Librado & Julio, 2009). For the present study, the aligned sequence file was converted to NEXUS (.NEX) format using this software for further analysis.

BEAST version 1.7.4

The BEAST (Bayesian Evolutionary Analysis by Sampling Trees) package includes the core programme BEAST which performs the Markov Chain Monte Carlo (MCMC) algorithm for Bayesian inference analysis. The BEAST package also includes Bayesian Evolutionary Analysis Utility (BEAUti) as the graphical user interface and allows the generation of XML input files. Furthermore, the TreeAnnotator version 1.7.4 generates a maximum clade credibility tree and the LogCombiner version 1.7.4 assists to check the convergence and avoid false optima (Drummond et al., 2012).

Tracer version 1.7.2

The open-source software tool, Tracer assists the visualization and analysis of Markov Chain Monte Carlo (MCMC) trace files generated by BEAST software and other Bayesian Inference analysis software. It provides summary statistics of

posterior distribution, considering the appropriate parameters and most importantly, an effective sample size (ESS) value of more than 200 ensures the reliability of posterior estimates (Rambaut, 2018).

IQ-TREE version 3.0.1

IQ-TREE is open-source software for phylogenetic analysis using a Maximum Likelihood approach. This programme automatically determines the best nucleotide substitution model using MixtureFinder algorithm based on the Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC) and corrected Akaike Information Criterion (AICc). The robust branch support was statistically estimated by means of bootstrap resampling/Ultrafast Bootstrap Approximation(UFBoot)/Shimodaira-Hasegawa-like aLRT (SH-aLRT) (Lam-Tung et al., 2015; Wong et al., 2025). The resulting output file (.iqtree file) was visualised and annotated using FigTree v1.4.4 software tool.

FigTree version 1.4.4

FigTree is a graphical tool primarily utilized for visualisation and annotation of phylogenetic trees generated by Maximum Likelihood and Bayesian inference analysis. It is a Java-based programme that provides platforms for the tree annotation and manipulation. This programme supports the reliable interpretation of phylogenetic trees with bootstrap and posterior probability values, scale bars, labelling etc. (Rambaut, 2018; Bianchini & Baracaldo, 2024).

CHAPTER 4

RESULTS

4. RESULTS

Members of the family Tetragnathidae are morphologically remarkable for their elongated chelicerae usually armoured with numerous teeth, which actually gives them the name long jawed spiders, and the majority of them have slender abdomens with long legs and their lateral eyes are usually separated. Their body size varies from small to large and they mostly build small horizontal orb webs with few radii and an open hub. In males, the embolus and conductor of the pedipalp usually coiled with each other whereas females have a weakly sclerotized epigynum mostly with an oblique slit internally with a pair of small spermathecae (Dondale & Redner, 2003).

In this chapter, the morphology of the family Tetragnathidae was explicitly described along with illustrations and taxonomic keys and followed by barcode data of collected tetragnathids and the phylogenetic account of the family with the support of molecular evidence.

4.1. Taxonomic description of collected tetragnathids

Key to genera of the family Tetragnathidae

- 1a. Abdomen elongated and mostly cylindrical, chelicerae extremely large and elongated with prominent apophysis, prolonged maxillae with long genital fold..... *Tetragnatha*
- 1b. Abdomen oval to roundish, chelicerae small to medium size with small apophysis, small maxillae with short genital fold..... **2**
- 2a. Short embolus and conductor, haplogyne genitalia..... *Glenognatha*

- 2b. Long embolus and conductor, entelegyne genitalia3
- 3a. Cephalic region extended and nearly rectangular, PMEs smaller than PLEs, leg without any trichobothria, spermathecae chambered..... *Dolichognatha*
- 3b. Cephalic region not extended, PMEs larger than PLEs, leg with long trichobothria, spermathecae lobe-like.....4
- 4a. Lateral eyes prominent, carapace with black contour, tegulum smaller *Atelidea*
- 4b. Lateral eyes small, carapace without contour, tegulum larger 5
- 5a. Chelicerae with distinct median-spur on the dorso-lateral side..... *Mesida*
- 5b. Chelicerae without any spur.....6
- 6a. Dorsum of abdomen with shiny silver guanine spots, copulatory ducts less coiled or without any coils and embolus weakly sclerotized..... *Leucauge*
- 6b. Dorsum of abdomen mostly with yellow guanine spots; copulatory ducts highly coiled with sclerotized embolus.....7
- 7a. Embolus and conductor extremely long, disto-median triangular process absent, CEBP positioned far from the base of cymbium, chelicerae much bulkier..... *Orsinome*
- 7b. Short embolus and conductor, disto-median triangular process present, CEBP positioned on the base of the cymbium, chelicerae longer rather than bulky..... *Tylorida*

4.3.1. Genus *Dolichognatha* O. Pickard-Cambridge, 1869

Diagnosis. Members of the genus *Dolichognatha* can be differentiated from all other tetragnathids by the following characteristics: carapace with dark contour, cephalic region extended and nearly rectangular, AMEs prominent, PMEs smaller than PLEs or PMEs completely absent, chelicerae moderate-sized with prominent teeth, abdomen with a few humps and dorsum with black random patches, embolus short, conductor bulky and short, cymbium large and cymbial ecto-basal process extremely large with broad basis, atrium oval, spermathecae chambered with short copulatory ducts and fertilization ducts, and copulatory ducts without any coils.

Type species. *Dolichognatha nietneri* O. Pickard-Cambridge, 1869.

***Dolichognatha chimminiensis* sp. nov.**

Type material. **Holotype** ♂ (ZSI/WGRC/I. R.-INV. 27150) and **paratypes** male and female (ZSI/WGRC/I. R.-INV. 27151) from **INDIA: Kerala:** Thrissur, Chimmini Wildlife Sanctuary, 10°26'52"N 76°27'38"E, 133 m a.s.l., 30 January 2024, leg. Anju K. Baby.

Etymology. The specific epithet refers to Chimmini Wildlife Sanctuary, from where the species was collected. The name is considered a noun in apposition.

Diagnosis. The new species resembles *D. longiceps* (Thorell, 1895) (Dimitrov et al., 2010: 15, figs. 4A–F, 5A–D, 6A–D, 7), *D. junlitjri* (Barrion-Dupo & Barrion, 2014) (Barrion-Dupo & Barrion, 2014: figs. 1A–N) and *D. bannaensis* Wang, Zhang & Peng, 2020 (Wang et al., 2020: figs. 2A–E, 3A–I) in having six eyes (PME absent), embolus with a protruding apex, extremely broad cymbial ectobasal process, and nearly oval atrium. Males of the new species can be separated by having an extended cymbial ectobasal process with a projection at the slope (whereas short and

uneven edge in *D. longiceps*, three apical protrusions in *D. junlitjri*, and extended but without any projections in *D. bannaensis*), the extremely elongated paracymbium (vs. small in *D. longiceps*, indistinct in *D. junlitjri*, and oval in *D. bannaensis*), and the distal end of the conductor broad and transparent (vs. narrowing end in *D. longiceps*, slender in *D. junlitjri*, and truncated in *D. bannaensis*). Females can be differentiated by copulatory openings near to posterior margin of the epigynum (vs. laterally placed in *D. longiceps* and *D. bannaensis* and completely enfolding spermathecae in *D. junlitjri*) with long fertilization ducts initially close to each other (vs. short and laterally placed in *D. longiceps*, located nearby but extremely short in *D. junlitjri* and *D. bannaensis*) (Anju et al., 2024a).

Description. Male (Fig. 4.1.1, Fig. 4.1.3A–C). Carapace pale yellow with black contour; dark patches arise near PLEs and pass to fovea. PMEs absent and anterior eyes are on tubercles. Clypeus brownish yellow. Fovea distinct. Labium and endites brownish. Sternum yellowish with dark spots and sparse hairs. Chelicerae yellowish brown. Upper row with three teeth: Prt1 triangular and closer to fang basis; Prt2 thumb-shaped; Prt3 larger than Prt2. Lower row with four teeth: Ret1 long, Ret2 extremely smaller, Ret3 and Ret4 sharing the same basis and oriented in opposite directions. Legs yellowish with random dark patches. Abdomen oval; dorsum greyish with numerous guanine spots and brownish markings. Pedipalp with long tibia; cymbial ecto-basal process distally curved towards dorsal side with a small flap-like projection at the slope. Cymbial tarsal organ large and roundish; paracymbium elongated with undulating apex. Conductor large with blunt apex; embolus filiform and upright; metaine embolic apophysis broad distally and directed upward, with a distinct process at midway (Anju et al., 2024a).

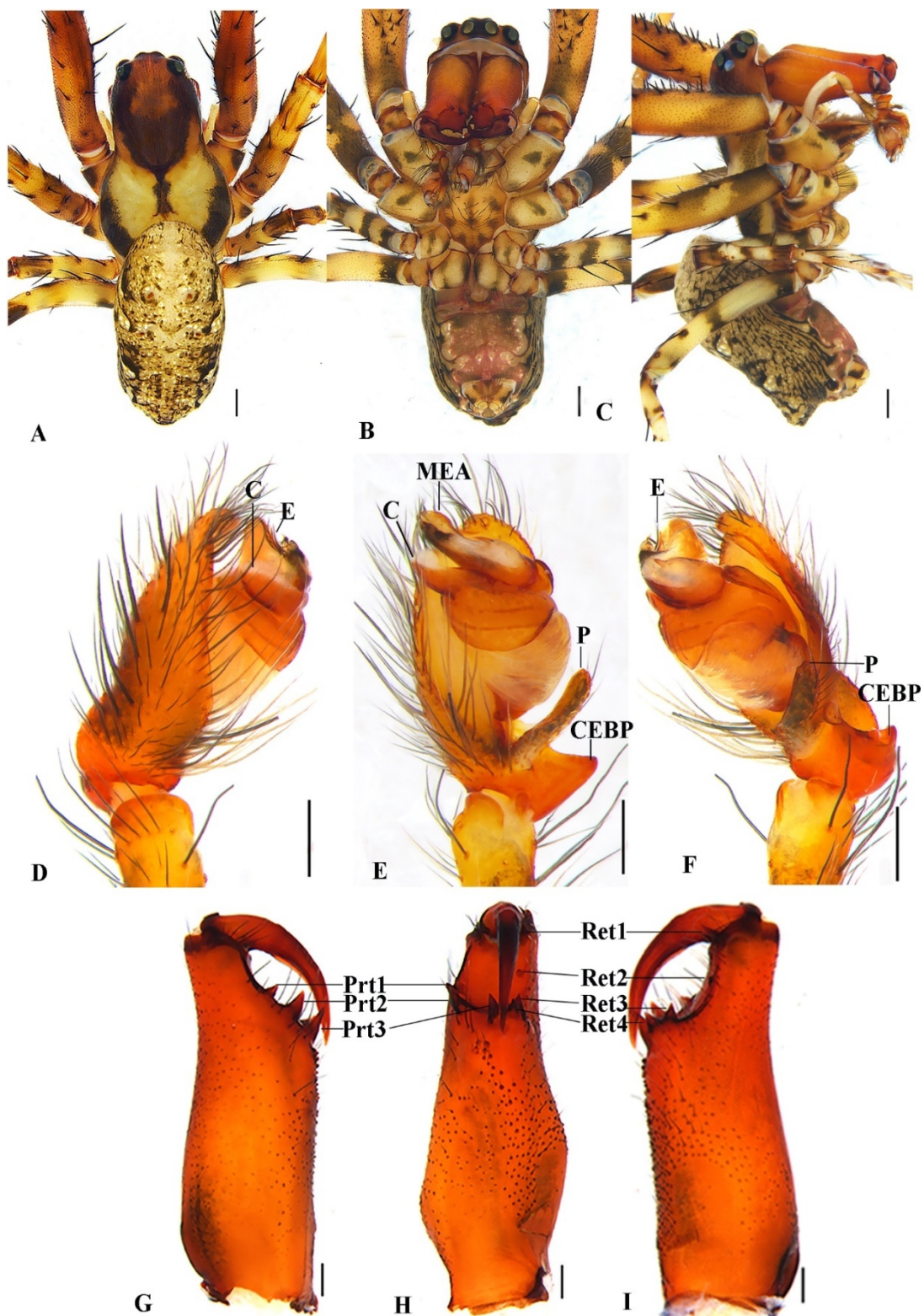


FIGURE 4.1.1. *Dolichognatha chimminiensis* sp. nov., holotype male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F, G–I: 0.2 mm.

Measurements. Total length: 7.41. Carapace 3.61 long, 2.33 wide. Abdomen: 3.80 long, 2.24 wide. Eye diameters: AME 0.28, ALE 0.25, PLE 0.26. Clypeus height 0.08. Chelicerae 2.51 long, 1.20 wide. Palp and leg measurements: pedipalp 1.21 [0.16, 0.36, 0.16, 0.53], leg I 15.94 [4.34, 1.48, 4.92, 3.12, 2.08], II 15.60 [4.51, 1.39, 4.14, 4.19, 1.37], III 6.87 [1.70, 0.73, 1.70, 1.91, 0.83], IV 9.82 [3.13, 0.88, 2.41, 2.66, 0.74]. Leg formula: 1243 (Anju et al., 2024).

Female (Fig. 4.1.2, Fig. 4.1.3D, E). Carapace, eyes, clypeus, fovea, labium, maxillae, sternum, and legs as in male. Chelicerae short. Upper row with three teeth about equal in size. Lower row with four teeth: Ret1 large and subsequent teeth smaller. Abdomen overhanging the carapace; dorsum with random guanine spots and numerous brownish patches. Atrium nearly oval; spermathecae chambered; copulatory openings lie close to each other and passing through the lateral sides of spermathecae; fertilization duct transparent and initially close to the copulatory openings (Anju et al., 2024a).

Measurements. Total length: 10.15. Carapace 4.56 long, 2.58 wide. Abdomen: 5.59 long, 3.67 wide. Eye diameters: AME 0.28, ALE 0.27, PLE 0.27. Clypeus height 0.10. Chelicerae 2.25 long, 0.99 wide. Palp and leg measurements: palp 3.15 [1.15, 0.66, 0.38, 0.96], leg I 17.01 [4.79, 1.72, 5.19, 3.75, 1.56], II 13.16 [3.52, 1.33, 3.72, 3.21, 1.38], III 7.23 [2.06, 0.81, 1.60, 1.89, 0.87], IV 11.71 [3.70, 1.03, 2.71, 3.14, 1.13]. Leg formula: 1243 (Anju et al., 2024a).

Distribution (Fig. 4.1.4). India.

4.1.2. Genus *Glenognatha* Simon, 1887

Diagnosis. The genus *Glenognatha* differs from all other tetragnathids in having large and broad carapace, extremely swollen chelicerae, small globose abdomen,

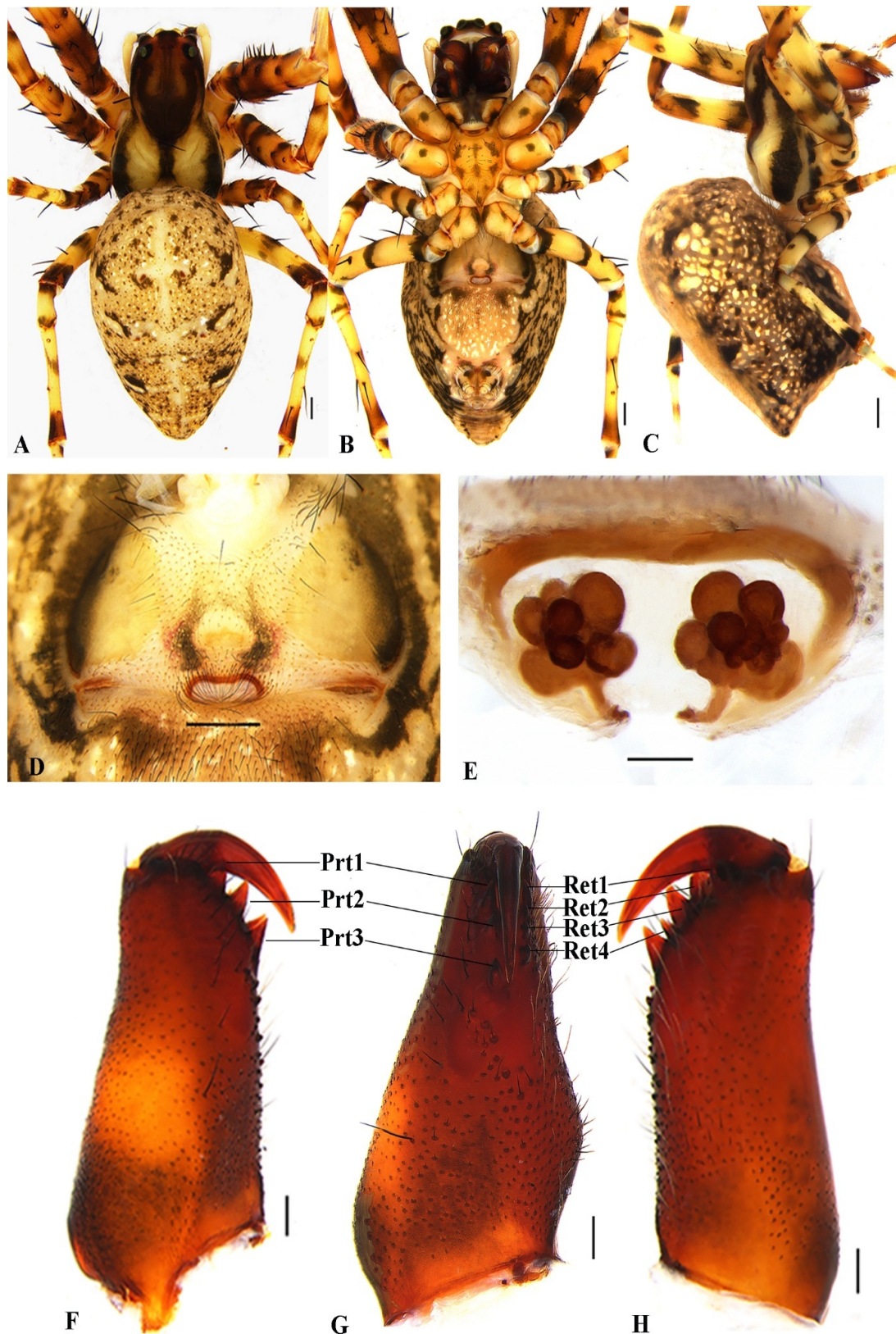


FIGURE 4.1.2. *Dolichognatha chimminiensis* **sp. nov.**, paratype female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–D: 0.5 mm. E: 0.1 mm, F–H: 0.2 mm.

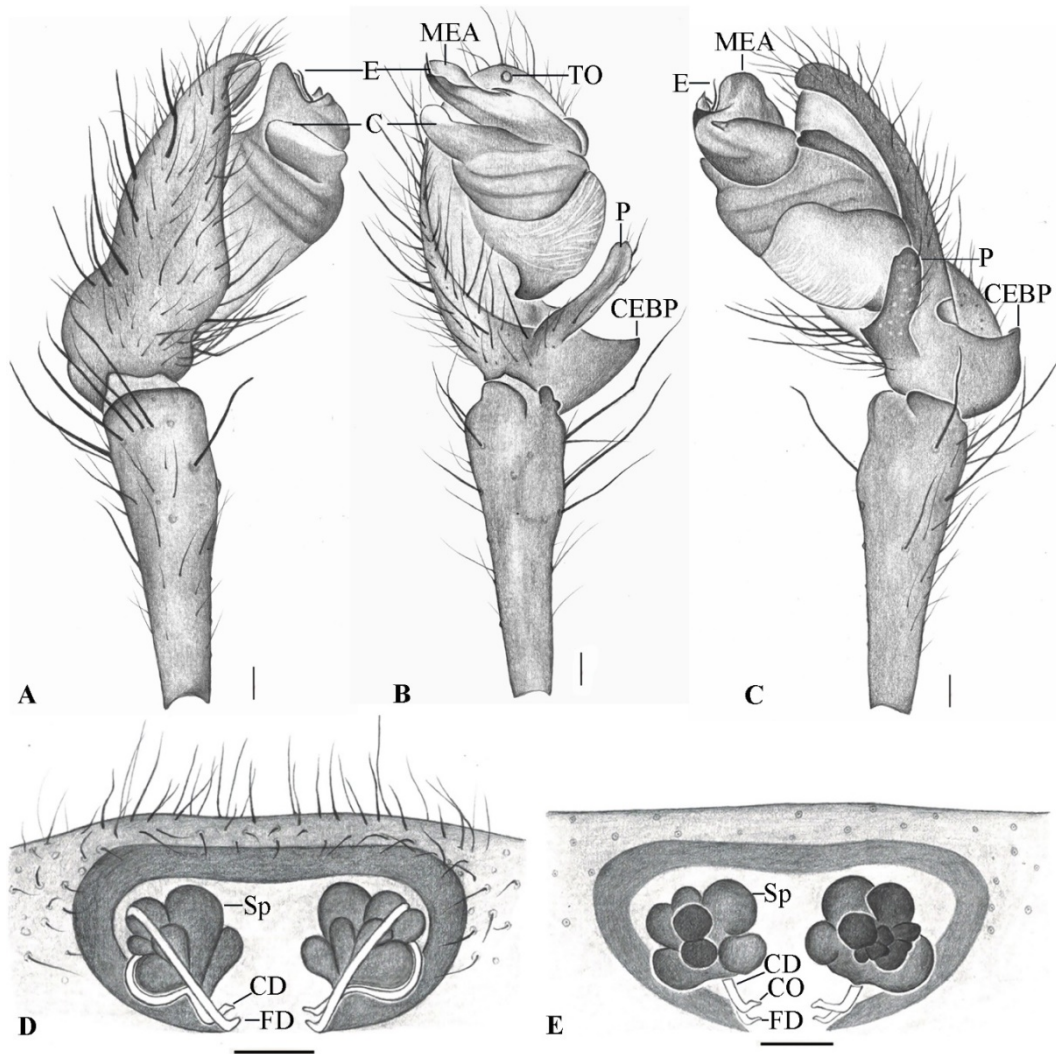


FIGURE 4.1.3. *Dolichognatha chimminiensis* **sp. nov.**, holotype male (A–C) and paratype female (D, E). A–C, Left male palp, prolateral view. B, ventral view. C, retrolateral view. D, E, epigynum, vulva. D, ventral view. E, dorsal view. Scale bars: A–C, 0.2 mm. D–E, 0.1 mm.



FIGURE 4.1.4. Distribution of the genus *Dolichognatha* in India.

short tibia and globose tegulum, cymbium extremely slender with small tarsal organ and without any dorsal process, paracymbium distally projected opposite of the tegulum, embolus and conductor very short, and tracheal spiracle positioned on the posterior of the abdominal venter prior to the spinnerets. Females have simple haplogyne genitalia, in which fertilization ducts are absent but with small spermathecae and a large uterus externus. Epigynal plate absent instead simple epigynal slit present.

Type species. *Glenognatha emertoni* Simon, 1887.

***Glenognatha dentata* (Zhu & Wen, 1978)**

Dyschiriognatha dentata Zhu & Wen, 1978: 16, figs. 1–9 (♂♀); Zhu et al., 2003: 204, figs. 111A–K, 112A–G, plate VIIA–D (♂♀, synonymy of *D. hawigtenera*); Cabra-García et al., 2014: 1029, figs. 1E, 2C, F, 5D, 7C (♀).

Glenognatha dentata Cabra-García & Brescovit, 2016: 53, figs. 38A–H, 39A–F, 40A–H, 41A–G, 42A–H, 43A–J, 44A–F (transferred from *Dyschiriognatha*).

Material examined. INDIA: Kerala: Wayanad district, Thrissilery, Paddy field 11°50'42"N, 76°01'29"E, 773 m a.s.l., 4 December 2022, leg. Anju K. Baby & Manu K. Baby, 6♂ 7♀. Western Ghats, Wayanad district, Periya Reserved Forest 11°46'39"N, 75°50'53"E, 802 m a.s.l., 7 December 2022, leg. Anju K. Baby & Manu K. Baby, 1♀. Thrissur district, Muriyad Kol wetlands, Muriyad 10°21'45"N, 76°15'46"E, 33 m, 2 March 2023, leg. Anju K. Baby & Greeshma T. S., 7♂ 10♀. Thrissur, Manakkodi 10°29'08"N 76°10'18"E 14 m, 06 December 2024, leg. Anju K. Baby & Greeshma T. S., 3♂ 4♀. Thrissur district, Pullu Kol wetlands 10°27'17"N, 76°09'14"E, 26 m, 25 January 2025, leg. Anju K. Baby & Jyothi U. M., 4♂, 4♀.

Diagnosis. Males of the species can be easily distinguished from all other *Glenognatha* species in having tooth-like projections on the distal end of the conductor. Females can be differentiated in having two pairs of black spots on the abdominal dorsum with small, oval and sclerotized spermathecae.

Redescription. Male (Fig. 4.1.5). Carapace yellow-brownish; cephalic region raised, with dusky patches on lateral edges. PME's closely placed than AME's, lateral eyes contiguous. Clypeus pale yellow. Fovea dark and indistinct. Labium subquadrate and pale brownish. Maxillae elongated, yellow-brownish, and apically with distinct scopulae. Sternum brown, with pale brown contour, and with numerous depressions bearing setae and strong intercoxal extensions at mid-length. Chelicerae brown. Upper row with three teeth: Prt1 and Prt2 small; Prt3 large and pointed. Lower row with three teeth: Ret1 close to fang basis and a large gap between Ret2 and Ret1; Ret2 long and curved; Ret3 longer and closer to Ret2. Cheliceral fang fairly bent at the middle, with strong cusp. Legs pale yellow. Abdomen oval; dorsum pale yellow with yellow guanine spots and two pairs of black spots on the lateral edges; venter pale yellowish, with a transverse brown band midway near the epiandrous fusules and a pair of black spots on either side. Tracheal spiracle prominent and located above the spinnerets. Pedipalp with short tibia; globular tegulum; cymbium with numerous setae, proximal half enlarged, medially constricted and gradually enlarging towards the apex; embolus dark, completely enclosed with conductor; conductor folded at mid-length, distally broad, and tooth-like projections on the apex of the conductor; paracymbium proximally slender, gradually enlarging midway and apically broad with long setae.

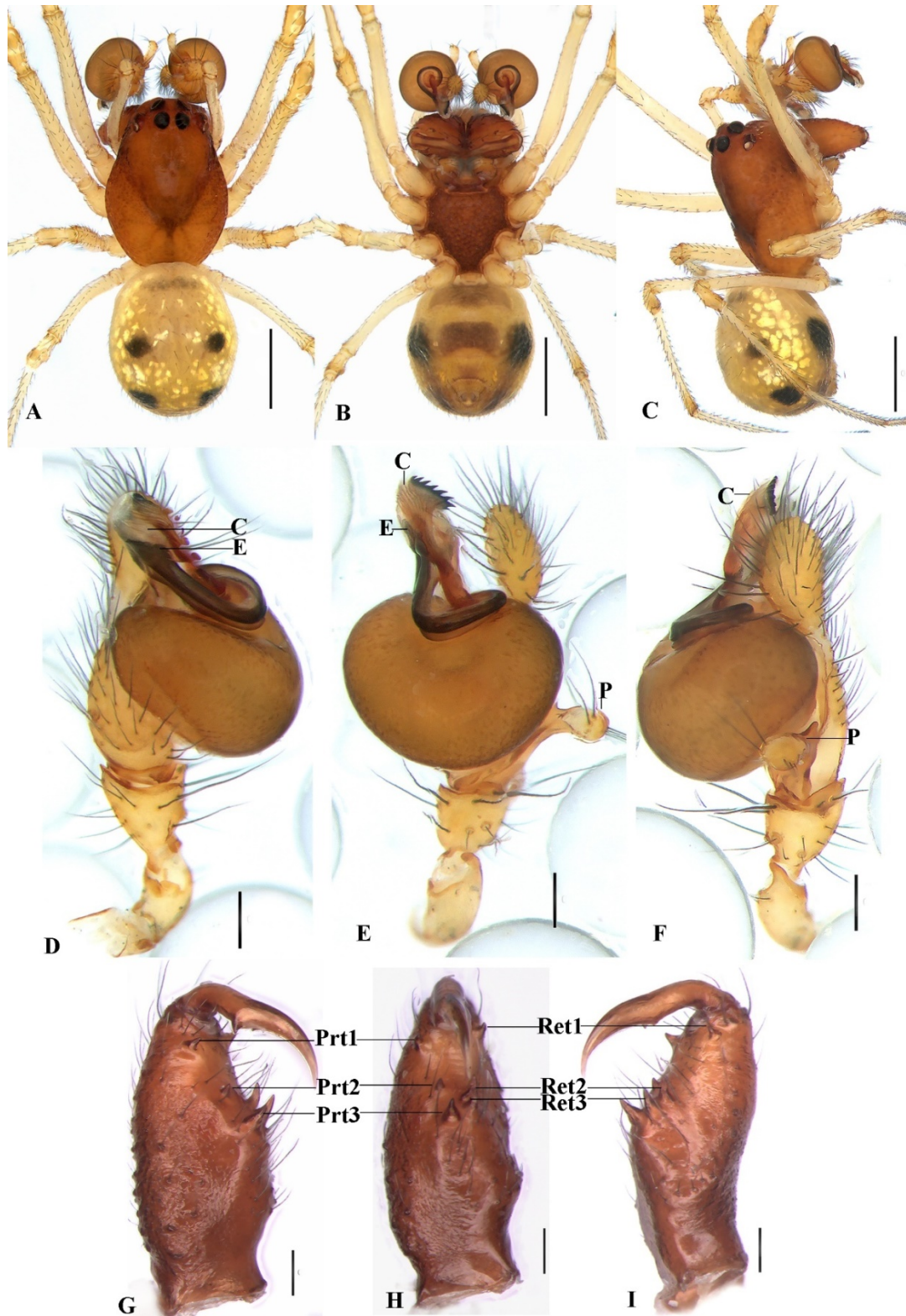


FIGURE 4.1.5. *Glenognatha dentata* (Zhu & Wen, 1978), male (A-I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D-F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G-I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A-C: 0.5 mm. D-F, G-I: 0.2 mm.

Measurements. Total length: 2.42. Carapace 0.98 long, 0.62 wide. Abdomen: 1.42 long, 0.59 wide. Ocular area length 0.22, width 0.23. Eye diameters: AME 0.10, ALE 0.06, PME 0.09, PLE 0.06. Clypeus height 0.05. Chelicerae 0.79 long, 0.34 wide. Palp and leg measurements: pedipalp 1.19 (0.37, 0.13, 0.14, 0.55), Leg 1 6.58 (1.78, 0.33, 1.89, 1.70, 0.88), II 5.97 [1.69, 0.33, 1.74, 1.44, 0.77], III 3.29 [1.11, 0.23, 0.70, 0.81, 0.44], IV 4.29 [1.45, 0.22, 1.14, 0.99, 0.49]. Leg formula: 1243.

Female (Fig. 4.1.6). Carapace, eyes, clypeus, fovea, labium, maxillae, and sternum, as in male. Chelicerae stout and brown. Upper row with three teeth: all teeth almost equidistant, Prt1 directed upward, Prt2 triangular and larger than Prt1, followed by Prt3; retromarginally with four teeth, Ret1 close to fang basis, Ret2 about the same size as Ret3. Ret1, Ret2 and Ret3 are almost equally spaced, with Ret4 larger than Ret3 and set apart by a moderate distance from Ret3. Cheliceral fang slender, brown, protruding, and without any prominence. Legs pale yellow. Abdomen oval; dorsum pale yellow, centrally with reddish patch and a pair of large black spots, laterally with yellow guanine spots; venter brownish yellow, laterally with two black spots. Tracheal spiracle well sclerotized, slit-like gonopore surrounded by numerous setae.

Measurements. Total length: 2.52. Carapace 1.29 long, 0.59 wide. Abdomen: 1.23 long, 0.61 wide. Eye diameters: AME 0.09, ALE 0.07, PME 0.08, PLE 0.06. Clypeus height 0.04. Chelicerae 0.58 long, 0.30 wide. Palp and leg measurements: pedipalp 0.89 (0.26, 0.11, 0.10, 0.42) Leg 1 4.74 (1.44, 0.52, 1.22, 1.01, 0.55), II 4.71 (1.43, 0.51, 1.13, 1.03, 0.61), III 3.35 (1.04, 0.40, 0.85, 0.58, 0.48), IV 4.64 (1.43, 0.29, 1.36, 1.10, 0.46). Leg formula 1243.

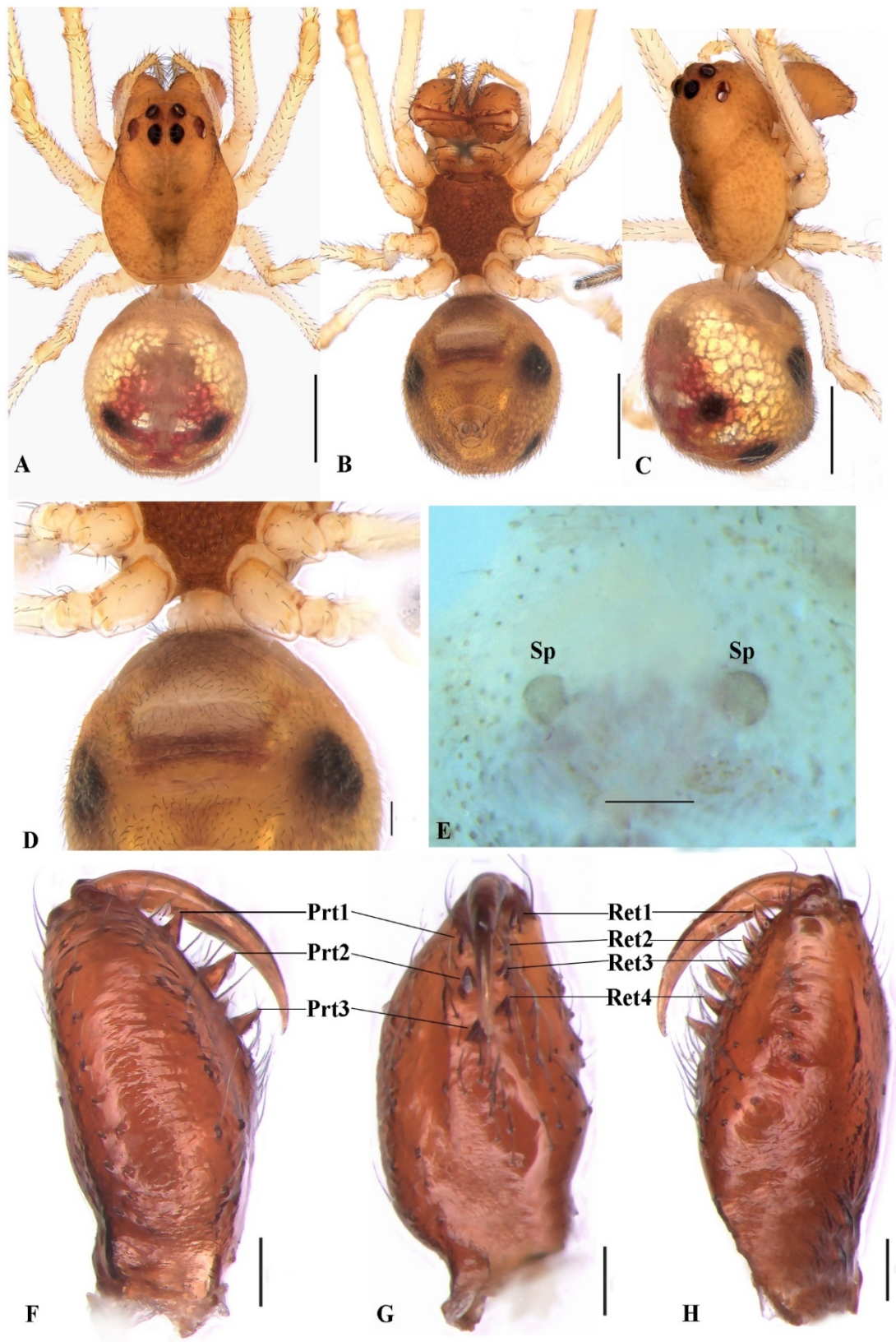


FIGURE 4.1.6. *Glenognatha dentata* (Zhu & Wen, 1978), female (A–C). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–C: 0.5 mm. D–H: 0.1 mm.

Distribution. China, India, Bangladesh, Myanmar, Vietnam, Philippines (World Spider Catalog, 2025).

4.1.3. Genus *Leucauge* White, 1841

Diagnosis. Members of the genus *Leucauge* can be easily distinguished by the presence of shiny silvery abdomen overhanging the carapace, proximally with two rows of trichobothria on the femur IV, epigynal plate smaller, copulatory ducts with a few coils, fertilization ducts twisted and fairly coiled with the copulatory ducts, embolus weakly sclerotized with wide basis and sperm ducts strongly convoluted.

Type species. *Leucauge argyrobapta* White, 1841

Key to *Leucauge* species

- 1a. Tibia IV with dense brush of hairs, abdomen overhanging the carapace2
- 1b. Tibia IV without dense brush of hairs, abdomen slightly overhanging the carapace3
- 2a. Abdominal dorsum with orange markings, tegulum small with extremely long tibia, and chelicerae with numerous macrosetae *L. fastigata*
- 2b. Abdominal dorsum with yellow markings, tegulum large with short tibia, and chelicerae with a few spines *L. tessellata*
- 3a. CEBP absent, lower row of chelicerae with three teeth and upper row with five teeth..... *L. rubromaculata*
- 3b. CEBP present, lower row of chelicerae with three teeth and upper row with four teeth..... 4

- 4a. Abdomen posteriorly extended beyond spinnerets, atrium small and spermathecae slender and elongated..... ***L. decorata***
- 4b. Abdomen posteriorly not extending beyond spinnerets, atrium large and spermathecae balloon-like ***L. celebesiana***

***Leucauge decorata* (Blackwall, 1864)**

Tetragnatha decorata Blackwall, 1864: 44 (♂).

Nephila angustata Stoliczka, 1869: 241, plate 20, fig. 7 (♀).

Tetragnatha decorata O. Pickard-Cambridge, 1869: 389, plate 13, figs. 61–68 (♂♀).

Argyropeira celebesiana Workman, 1896: 52, plate 52 (♀ misidentified).

Tetragnatha decorata O. Pickard-Cambridge, 1869: 389, plate 13, figs. 61–68 (♂♀).

Leucauge decorata Dippenaar-Schoeman et al., 2023: 17, plate 17: 1–7, plate 18: 8–9 (♂♀).

(For complete list of references, see World Spider Catalog, 2025).

Materials examined. INDIA: Kerala: Alappuzha district, Pathiramanal Island 9°37'07"N 76°23'04"E, 18 m, 26 September 2021, leg. Anju K. Baby, 1♀. Nilgiri Biosphere Reserve, Malappuram district, Nilambur north, Chembankolli 11°21'10"N, 76°13'34"E, 58 m, 12 October 2021, leg. Anju K. Baby, 2♂ 3♀. Ernakulam district, Kothamangalam 10°03'33"N, 76°38'04"E, 39 m, 10 November 2021, leg. Shilpa K. R., 1♀. Kannur district, Andalur Kavu 11°47'42"N 75°28'38"E, 35 m, 15 March 2021, leg. Anju K. Baby, 2♀. Kannur district, Koduvally

11°21'38"N 75°54'47"E, 80 m, 16 March 2022, leg. Anju K. Baby & Shilpa K. R., 2♂. Kottayam district, Teekoy 9°42'11"N, 76°48'45"E, 96 m, 1 August 2022, leg. Anju K. Baby & Adeena Shaji, 2♀. Thrissur district, Ayyappan Kavu 10°31'40"N, 76°16'58"E, 52 m, 03 March 2023, leg. Anju K. Baby & Greeshma T. S., 1♀. Ernakulam district, Mangalavanam Bird Sanctuary 9°59'18"N 76°16'19"E, 28 m, 15 October 2023, leg. Amulya Baji, 1♀. Kannur district, Kanjirakolly, Alakapuri waterfalls 12°08'33"N 75°37'42"E 356 m, 22 November 2023, leg. Anju K. Baby & Nikhil K. J., 1♀. Kannur district, Sasippara 12°08'42"N 75°37'21"E, 612 m, 24 November 2023, leg. Anju K. Baby, 1♀. Idukki district, Viripara 10°08'41"N, 76°95'74"E, 100 m, 01 February 2024, leg. Anju K. Baby & Greeshma T. S., 2♂. Wayanad district, Thrissilery, paddy field 11°50'36"N, 76°01'42"E, 795 m, 14 January 2025, leg. Anju K. Baby & Nikhil K. J., 2♂.

Diagnosis. Males of *L. decorata* closely resembles *L. celebesiana* (Walckenaer, 1841) in having similar body morphology but it differs from the latter by the following characteristics: tibia extremely elongated, tegulum smaller, embolus and conductor distally elongated, cymbial ecto-basal process long and slender. Females with a pair of black spots on the antero-dorsum of the abdomen (which lack in *L. celebesiana*), abdomen posteriorly constricted and extended, copulatory ducts strongly curved anteriorly, spermathecae constricted (much inflated in *L. celebesiana*).

Redescription. Male (Fig. 4.1.7). Carapace elongated, anteriorly raised, and yellow. Anterior eyes are strongly recurved, AMEs are elevated, and all eyes with black border. Clypeus yellow. Fovea distinct and deep. Labium subquadrate and yellow.

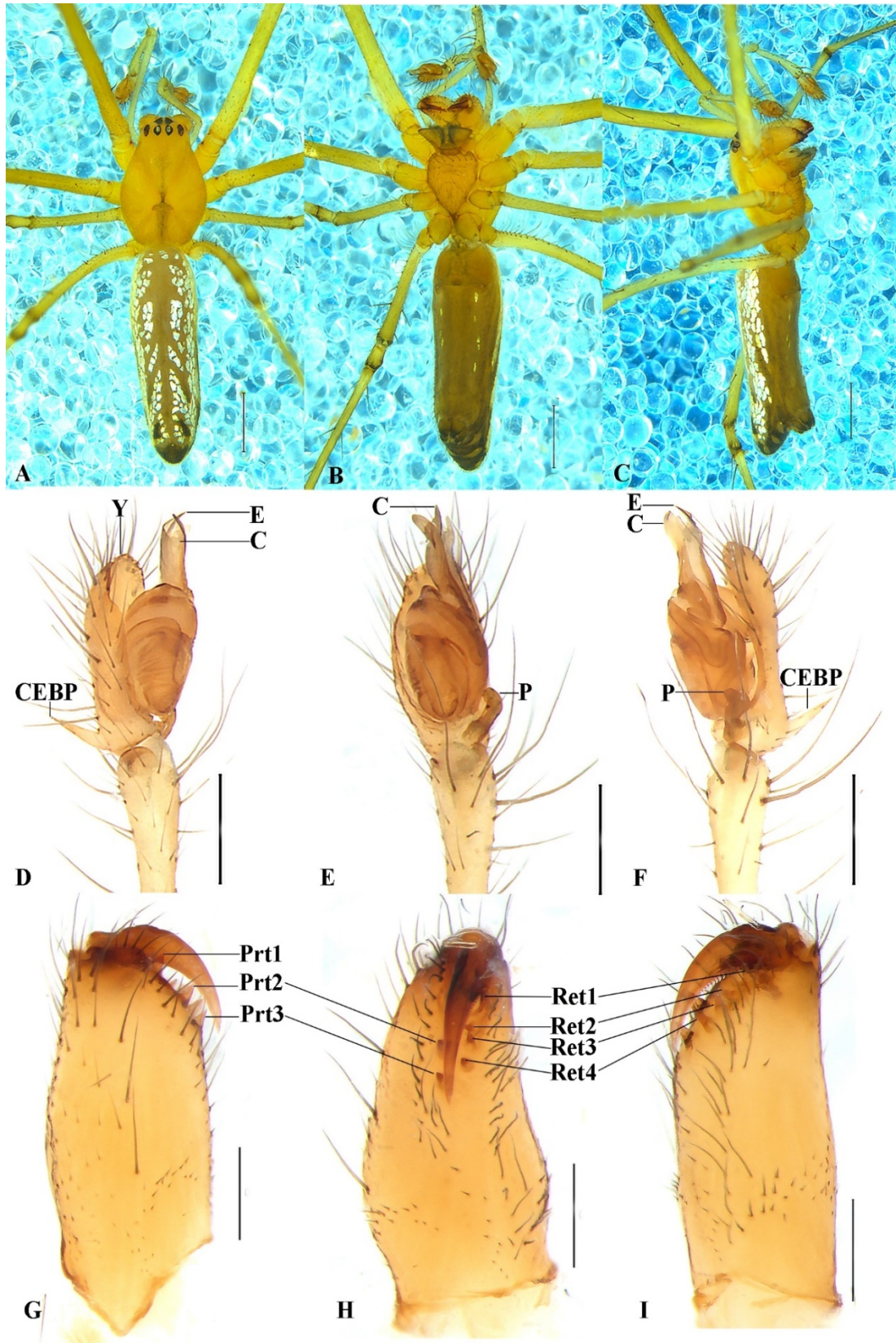


FIGURE 4.1.7. *Leucauge decorata* Blackwall, 1864, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F, G–I: 0.2 mm.

Maxillae long, anteriorly broad with short base, and proximally with distinct scopulae. Sternum heart shaped with sparse hairs. Chelicerae short and yellowish. Upper row of chelicerae with three teeth: Prt1 triangular and much closer to fang basis; Prt2 larger than Prt1 and a significant gap between Prt1 and Prt2; Prt3 small and pointed. Lower row with four teeth: Ret1 smaller with wide base and closer to fang basis; Ret2 slightly displaced from the row; Ret3 upward directed; Ret4 larger than Ret3. Cheliceral fang short, serrated, and yellow. Legs yellow, femur IV with two rows of parallel trichobothria. Abdomen cylindrical, pale yellow; dorsum with silver guanine spots and six pairs of transverse lines, posteriorly dark, and a pair of black spots on the postero-lateral side; venter pale yellow, without any markings, and laterally with random guanine spots. Spinnerets posteriorly placed. Pedipalp with extremely long tibia; cymbium broad with numerous setae; cymbial ecto-basal process thin, long, straight, projected upward, with very sharp apex; paracymbium slender, moderate-sized, and touching the tegulum; sperm duct with numerous folds; conductor broad with blunt tip and facing towards the prolateral side; embolus thin, distally enclosed with conductor and protruding, apex oriented towards the ventral side.

Measurements. Total length: 2.56. Carapace 1.05 long, 0.62 wide. Abdomen: 0.72 long, 0.63 wide. Ocular area length 0.22, width 0.23. Eye diameters: AME 0.09, ALE 0.07, PME 0.08, PLE 0.06. Clypeus height 0.03. Chelicerae 0.50 long, 0.24 wide. Palp and leg measurements: pedipalp 2.75 (1.21, 0.28, 0.68, 0.58), leg I 22.30 [5.98, 0.99, 6.56, 7.11, 1.66], II 15.16 [4.51, 1.01, 4.11, 4.38, 1.15], III 6.82 [2.43, 0.42, 1.41, 1.87, 0.69], IV 11.97 [4.11, 0.56, 3.03, 3.50, 0.77]. Leg formula: 1423. Leg formula: 1423.

Female (Fig. 4.1.8). Carapace, eyes, fovea, clypeus, labium, maxillae, sternum, and legs as in males. Chelicerae stout and brownish yellow. Upper row of chelicerae with three teeth: Prt1 closer to the fang basis; Prt2 smaller than Prt1; Prt3 set apart by a small distance from Prt1; all teeth are directed upward. Lower row with four teeth: Ret1 closer to the fang basis, distal half curved towards the upper side; Ret2 parallel to Ret1; Ret3 very sharp; Ret4 smaller than Ret3. Cheliceral fang short, serrated, and brownish. Abdomen elongated, slightly overhanging the carapace; dorsum silvery with random yellow patches, anteriorly with a pair of large black spots, with a longitudinal patch, and four pairs of transverse stripes arising from the longitudinal patch, posteriorly bent, constricted, and prolonged, laterally with greyish patches; venter dark greyish, centrally with silvery spots. Epigynal plate semicircular, dark, with elongated atrium; median septum basally wide, medially constricted; copulatory duct with a few folds; fertilization duct indistinct; spermathecae elongated and transparent.

Measurements. Total length: 1.77. Carapace 2.39 long, 2.01 wide. Abdomen: 7.56 long, 2.87 wide. Ocular area length 0.23, width 0.22. Eye diameters: AME 0.12, ALE 0.06, PME 0.15, PLE 0.07. Clypeus height 0.04. Chelicerae 1.10 long, 0.45 wide. Palp and leg measurements: pedipalp 2.64 [1.17, 0.53, 0.26, 0.68], leg I 17.92 [5.43, 0.92, 4.64, 5.42, 1.51], II 13.55 [4.10, 1.12, 3.41, 3.72, 1.20], III 6.90 [2.14, 0.56, 1.57, 1.85, 0.78], IV 13.57 [4.46, 0.79, 3.24, 4.00, 1.08]. Leg formula: 1423.

Distribution. Tanzania, Botswana, Mozambique, South Africa, Comoros, Pakistan, India, Nepal, Bangladesh, China, Japan, Thailand, Philippines, Indonesia, Papua New Guinea, Australia (World Spider Catalog, 2025).

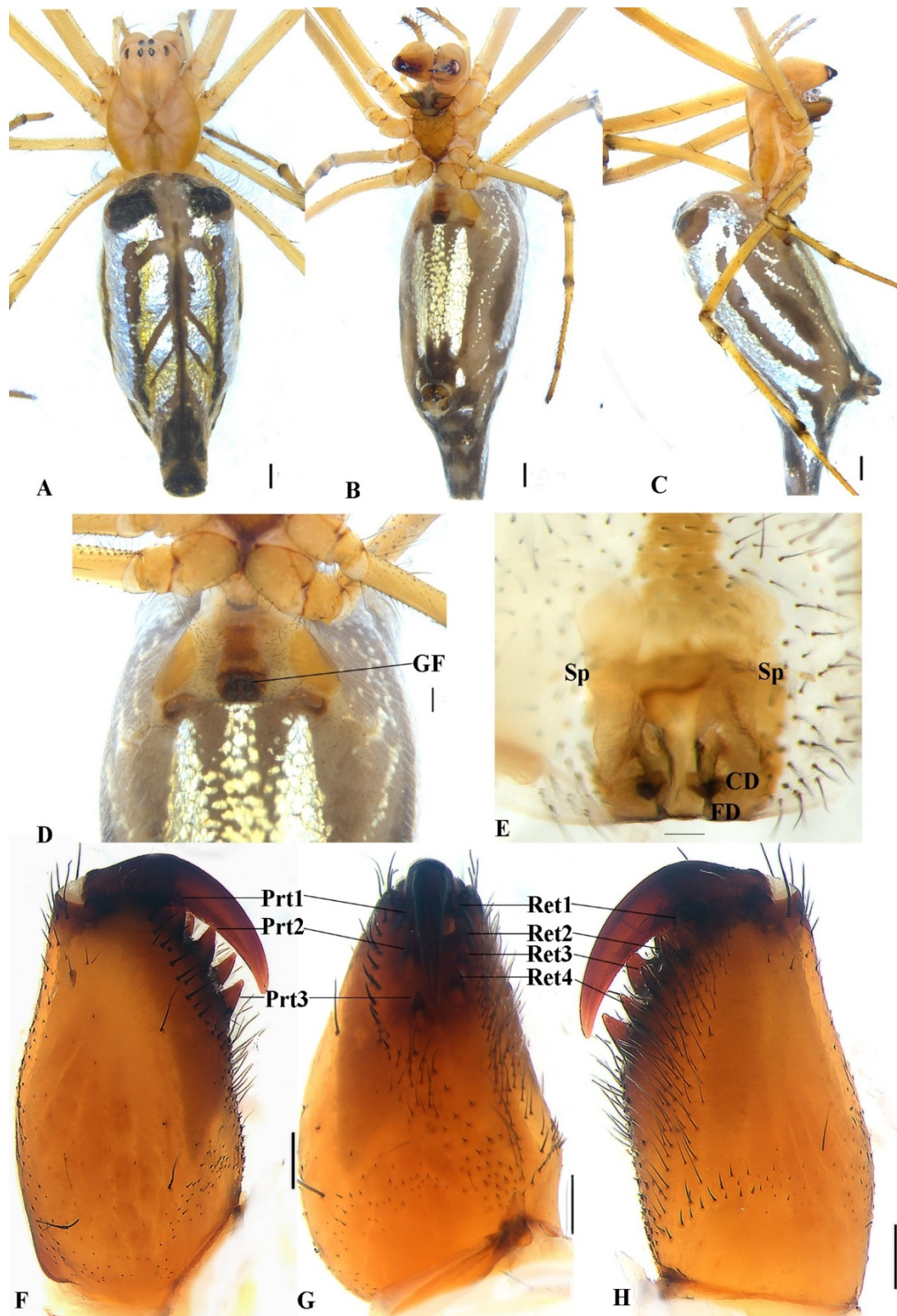


FIGURE 4.1.8. *Leucauge decorata* Blackwall, 1864, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–D: 0.5 mm. E: 0.05 mm, F–H: 0.2 mm.

***Leucauge celebesiana* (Walckenaer, 1841)**

Tetragnatha celebesiana Walckenaer, 1841: 222 (♀).

Leucauge celebesiana Gravely, 1921b: 454, figs. 8b–c.

Leucauge retracta Song, 1988: 127, figs. 6A–C (♂♀, synonymy of *L. veterascens*)

Argyropeira nigrotrivittata Thorell, 1890: 198 (♂).

Leucauge tuberculata Wang, 1991: 156, fig. 16 (♂ misidentified).

Leucauge celebesiana Song & Zhu, 1992: 112, figs. 3C–D (synonymy of *L. retracta*).

Leucauge magnifica Song, Zhu & Chen, 1999: 216, figs. 121M–N, 130P–Q (♀, figs. 122I–J, = *L. subblanda*).

Leucauge tuberculata Song, Zhu & Chen, 1999: 216, figs. 123F (♂ misidentified).

Leucauge subblanda Kim et al., 1999: 48, figs. 5, 30, 52 (misidentified per Yoo et al., 2015: 39).

Leucauge magnifica Zhu, Song & Zhang, 2003: 231, figs. 125A–F (♀, figs. 126A–D, *L. subblanda*).

Leucauge celebesiana Yoshida, 2009: 12, figs. 1–4 (♂♀, synonymy of *L. magnifica*); Zhang, 2018: 47, figs. 6–1. A–H, plate 11 (♂♀).

Material examined. Idukki district, Viripara 10°08'41"N, 76°95'74"E, 100 m, 01 February 2024, leg. Anju K. Baby & Greeshma T. S., 1 ♀.

Diagnosis. Females of *L. celebesiana* resemble *L. decorata* (Blackwall, 1864) but can be differ from the latter in having a posteriorly blunt abdomen (vs. an abdomen posteriorly extended and elevated in *L. decorata*), atrium larger and rectangular, spermathecae much larger and copulatory duct anteriorly with a twist.

Redescription. Female (Fig. 4.1.9). Carapace flat, yellowish, and laterally greenish; cephalic groove indistinct. Fovea deep and light brownish. All eyes with black

border, anterior eyes are strongly recurved, AMEs closer than PMEs. Labium dark brownish. Maxillae long and laterally with long hairs. Sternum dark brownish with a posterior extension. Chelicerae short, stout, and yellow. Upper row of chelicerae with three teeth: all teeth are upward directed and blunt; Prt1 extremely wide, curved, and closer to the fang basis; Prt2 shares the same basis as Prt1; and Prt3 smaller than Prt2. Lower row with four teeth: Ret1 larger with wide basis; Ret2 much closer to Ret1 and sharing the same basis; Ret3 similar shape as Ret2; Ret4 straight with blunt apex. Cheliceral fang short, serrated, and brownish. Legs greenish with random yellow patches, and the proximal half of femur IV with two rows of trichobothria. Abdomen moderate-sized; dorsum greyish, centrally with a longitudinal greyish stripe and two parallel longitudinal black stripes thickened near the posterior end; three pairs of transverse black stripes and four pairs of sigilla with numerous silvery guanine spots and random yellow guanine spots; venter elevated, dark greyish with two parallel greyish bands with shiny guanine spots; laterally with numerous guanine spots with random black patches. Spinnerets posteriorly placed with a cluster of yellow guanine spots on either side of the anterior spinnerets. Epigynal fold semicircular, atrium rectangular; internally spermathecae elongated and transparent; copulatory duct without any folds; fertilization duct narrowed and oriented inward.

Measurements. Total length: 9.19. Carapace 2.55 long, 2.46 wide. Abdomen: 6.64 long, 3.75 wide. Ocular area length 0.46, width 0.36. Eye diameters: AME 0.14, ALE 0.06, PME 0.14, PLE 0.07. Clypeus height 0.06. Chelicerae 1.39 long, 1.01 wide. Palp and leg measurements: pedipalp 3.11 [1.18, 0.65, 0.31, 0.97], leg I 18.11 [5.77, 1.35, 4.85, 4.44, 1.70], II 15.05 [4.18, 1.15, 3.71, 4.55, 1.46], III 7.75 [2.22, 0.73, 1.55, 2.23, 1.02], IV 11.76 [3.83, 1.00, 2.93, 3.11, 0.89]. Leg formula: 1243.

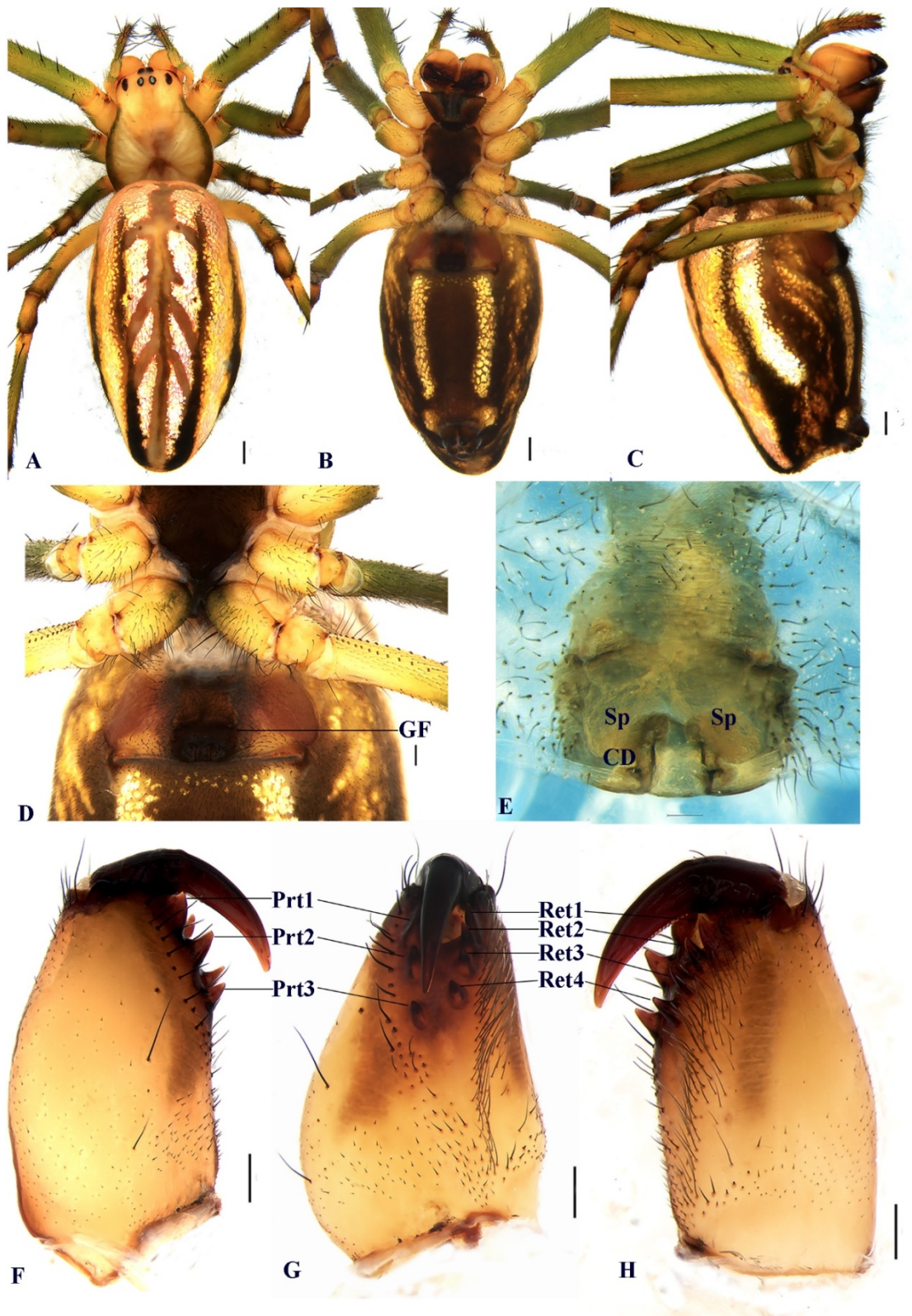


FIGURE 4.1.9. *Leucauge celebesiana* (Walckenaer, 1841), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–D: 0.5 mm. E: 0.1 mm, F–H: 0.2 mm.

Distribution. Russia (Far East), Korea, India to China, Vietnam, Laos, Japan, Indonesia (Sulawesi), New Guinea (World Spider Catalog, 2025).

***Leucauge dorsotuberculata* Tikader, 1982**

Leucauge dorsotuberculata Tikader, 1982: 74, figs. 147–150 (♀).

Type material (Fig. 4.10). **Holotype** ♀ (4934-35/18) from **INDIA: Maharashtra:** Satara district, Pachgani, 17°55'23"N, 73°47'50"E, 1280 m a.s.l., 24 August 1977, leg. B. K. Tikader, repository **National Zoological Collections of Zoological Survey of India (NZC-ZSI)**, Kolkata, India, examined.

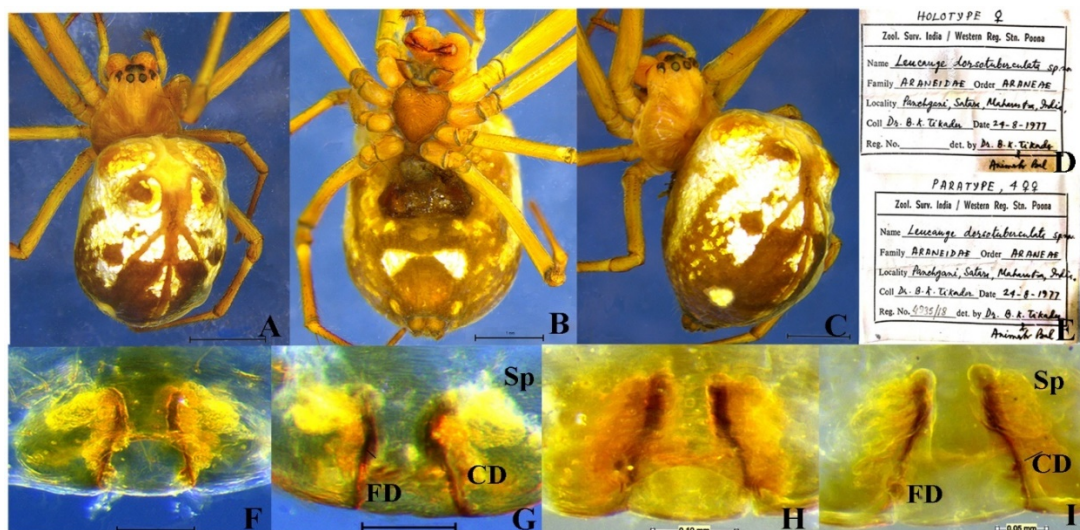


FIGURE 4.1.10. *Leucauge dorsotuberculata* Tikader, 1982, holotype female (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. D, E, labels. Epigynum (F–I), F, same, ventral view, G, same, dorsal view, H, same, ventral view (paratype), I, same, dorsal view (paratype). Scale bars: A–C: 1 mm. F–H: 0.1 mm. I: 0.05 mm.

Remarks (Fig. 4.1.10). Measurements (paratype). Total length: 4.18. Carapace 1.47 long, 1.14 wide. Abdomen: 2.71 long, 1.92 wide. Eye diameters: AME 0.11, ALE 0.09, PME 0.10, PLE 0.07. Clypeus height 0.03. Chelicerae 0.61 long, 0.35 wide. Palp and leg measurements: palp 1.31 [0.36, 0.14, 0.28, 0.53], leg I 7.51 [2.17, 0.53, 2.03, 1.94, 0.84], II 5.82 [1.93, 0.44, 1.40, 1.59, 0.46], III 3.30 [1.15, 0.34, 0.67, 0.71, 0.43], IV 5.04 [1.50, 0.33, 1.23, 1.42, 0.56]. Leg formula: 1243.

Epigyne. Epigynal plate flat and nearly semicircular. Internal genitalia with a pair of median-sized spermathecae which are laterally oriented, copulatory ducts long with a few coils and copulatory openings indistinct. Fertilization duct narrows and without any coiling and positioned close to copulatory duct (Anju et al., 2025).

***Leucauge rubromaculata* Benjamin, 2024**

Leucauge rubromaculata Benjamin, 2024: 3, figs. 1A–F, 2A–F, 3A–B, 4A–F, 5A–D (♂♀).

Material examined. Western Ghats, Wayanad district, Periya Reserved Forest (11°46'39"N, 75°50'53"E, 802 m a.s.l.), 7 December 2022, leg. Anju K. Baby, 6♂, 7♀ (CATE1151749, CATE1151750). Idukki district, Kanthalloor 10°12'15"N, 77°12'19"E, 718 m, 10 January 2024, leg. Anju K. Baby & Greeshma T. S., 1♀.

Diagnosis. *L. rubromaculata* is most similar to *L. fastigata* (Simon, 1877) and *L. granulata* (Walckenaer, 1841). Males of *L. rubromaculata* can be distinguished from males of *L. fastigata* by the following characteristics: carapace longer than the abdomen, posteriorly slanted abdomen, abdominal venter with a bean-shaped cluster of shiny silver guanine spots, conductor and embolus protruding, and sperm duct less convoluted (Anju et al., 2021b, figs. A–F). Males of this species separated from *L. granulata* in having a pair of trichobothria on the femur IV (while single row in *L. granulata*), and embolus distally pointed (Malamel & Sebastian, 2018, figs. 3A–G, 4A–D). Females of *L. rubromaculata* have similarities with *L. fastigata* but differ from the latter by two pairs of elevations on the abdomen, abdomen moderately overlapping the carapace (while strongly overlaps in *L. fastigata*), epigynal plate with a semicircular atrium, copulatory ducts with numerous folds, and a highly sclerotized fertilization duct (Anju et al., 2021b, figs. A–E). Females are separated

from *L. granulata* by having two pairs of abdominal elevation (with three pairs in *L. granulata*), copulatory ducts oriented in different direction and fertilization duct indistinct (Malamel & Sebastian, 2018, figs. 3H–M, 4E–H).

Redescription. Male (Fig. 4.1.11). When in alcohol, carapace elevated, yellowish with green markings on lateral edges, and with sparse greenish hairs. Eye field darker, all eyes with black border, AMEs slightly raised, distance between AME and ALE almost same that of distance between PME and PLE. Fovea deep and distinctly marked. Clypeus greenish yellow. Labium greenish with few hairs distally. Maxillae long with narrow base. Sternum yellowish-green with dark contour, with sparse hairs. Chelicerae short, yellowish with three teeth on the upper row and five teeth on the lower row; cheliceral fang short, light brownish and strongly geniculate. Legs yellowish green, proximal half of femur IV pale yellow and prolaterally with two parallel rows of trichobothria extending more than half of its length. Abdomen shorter than carapace, greenish, distally slanted; dorsum with a longitudinal greyish band, anteriorly broad, and four pairs transverse greyish lines arising from the longitudinal band, laterally with silver guanine spots, postero-laterally with a cluster of silver guanine spots partially lined by yellow thin markings (red orange when live); venter elevated, yellowish-green, centrally with bean-shaped cluster of shiny silver guanine spots lined by greyish thick border, anteriorly marked by thin yellowish line (red orange when in live). Spinnerets yellowish green, posteriorly placed and three pairs of hairs anterior to spinnerets. Palpal tibia short with long spines; tegulum expanded; cymbium with numerous macrosetae; embolus apically projected; conductor with a thick tip; paracymbium hook-shaped, apically swollen, brownish, with cluster of setae at the base (Anju et al., 2025).

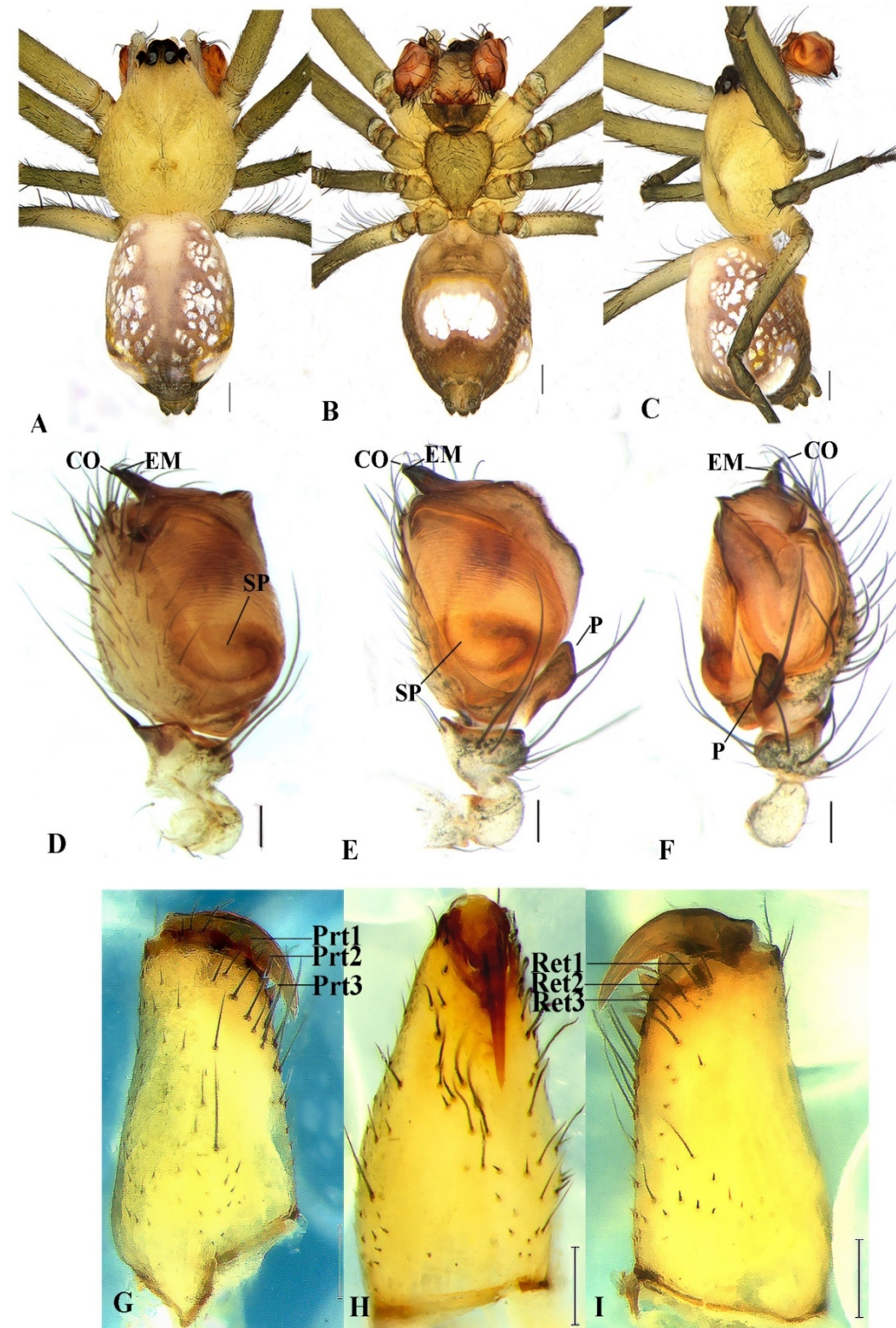


FIGURE 4.1.11. *Leucauge rubromaculata* Benjamin, 2024, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F, G–I: 0.2 mm.

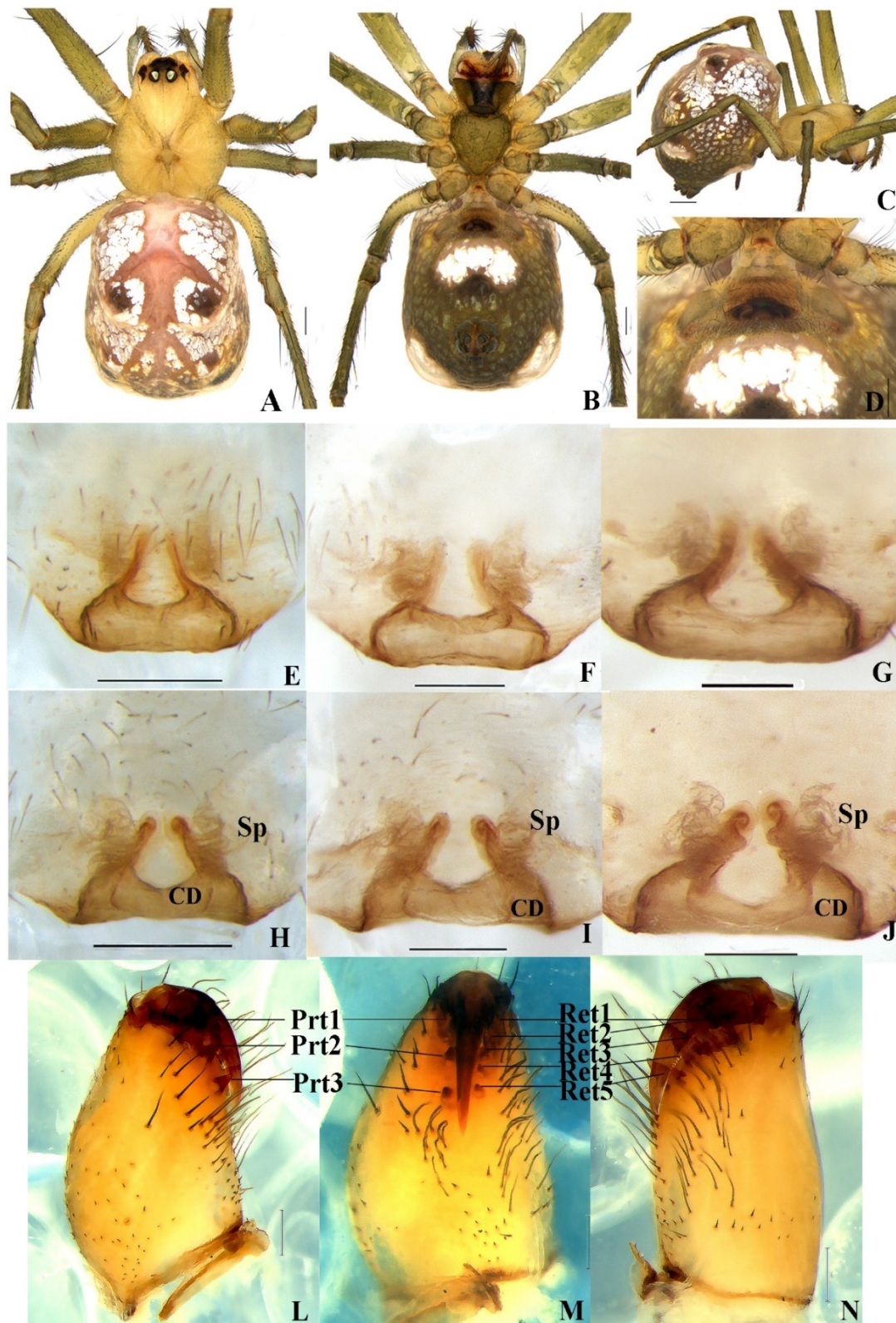


FIGURE 4.1.12. *Leucauge rubromaculata* Benjamin, 2024, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–D: 0.5 mm. E–J: 0.1 mm, L–N: 0.2 mm.

Measurements. Total length: 2.34. Carapace 1.22 long, 1.03 wide. Abdomen: 1.12 long, 0.78 wide. Ocular area length 0.22, width 0.23. Eye diameters: AME 0.09, ALE 0.07, PME 0.08, PLE 0.06. Clypeus height 0.03. Chelicerae 0.50 long, 0.24 wide. Palp and leg measurements: pedipalp 3.92 [0.16, 0.36, 0.16, 0.53], leg I 7.99 [2.27, 0.42, 2.10, 2.14, 1.06], II 6.16 [1.73, 0.41, 1.50, 1.71, 0.81], III 3.04 [0.91, 0.27, 0.63, 0.79, 0.44], IV 5.12 [1.61, 0.28, 1.18, 1.42, 0.63]. Leg formula: 1423.

Female (Fig. 4.1.12). Carapace, eyes, fovea, clypeus, labium, maxillae, sternum, and legs as in male. Chelicerae larger than in males, yellowish with three teeth on the upper row and five teeth on the lower row; cheliceral fang brownish and strongly geniculate. Abdomen nearly roundish, anteriorly raised, overlapping the carapace; dorsum with silver guanine spots, a wide longitudinal band moves antero-posteriorly and four pairs transverse greyish lines arising from the longitudinal band, single pair of shoulder humps with two black spots, a pair of grey spots at the mid-length, laterally with sparse yellow markings (red orange when live), postero-laterally with cluster of silver guanine spots as in males, single pair of black spots near the anterior lining of the cluster of silver guanine spots, posteriorly greenish and lateral sides much darker; venter greenish with random yellowish markings on either side of epigynum (red orange when in live), centrally elevated with bean-shaped cluster of silver guanine spots as in males. Spinnerets as in figures and numerous hairs just above the anterior spinnerets. Epigynal plate elevated, nearly semi-circular atrium, anteriorly with sclerotized arch; copulatory ducts with numerous folds and fertilization duct strongly sclerotized (Anju et al., 2025).

Measurements. Total length 4.35. Carapace 1.45 long, 1.21 wide. Ocular area length 0.24, width 0.26. Eye diameters: AME 0.14, ALE 0.08, PME 0.09, PLE 0.04.

Clypeus height 0.03. Chelicerae 0.66 long, 0.40 wide. Palp and leg measurements: pedipalp 3.92 [1.69, 0.56, 0.42, 1.25], leg I 8.57 [2.48, 0.46, 2.27, 2.33, 1.03], II 6.82 [2.02, 0.37, 1.62, 1.94, 0.87], III 3.48 [1.14, 0.25, 0.65, 0.88, 0.56], IV 5.67 [1.87, 0.32, 1.23, 1.48, 0.71]. Leg formula: 1423.

Intraspecific variations (Figs. 4.12 E–J). Female (n=7) epigyne vary in the size, orientation, and coiling of the copulatory ducts and shape and size of spermathecae, indicating potential intraspecific variation; female body morphology does not show any significant variations, though genitalic structures show slight differences such as copulatory ducts less coiled and compactly arranged in some individuals, with significant variations in the size of spermathecae as in figures (Fig. 4.12 E–J); however, male genitalia do not differ significantly (Anju et al., 2025).

Distribution (Fig. 4.1.13). Sri Lanka, India (new record).



FIGURE 4.1.13. Collection localities of *Leucauge rubromaculata* in Kerala State.

Leucauge fastigata (Simon, 1877)

Meta fastigata Simon, 1877: 79, plate 3, fig. 10 (♀).

Callinethis elegans Thorell, 1895b: 156 (♂).

Opadometa fastigiata Archer, 1951: 9 (transferred from *Leucauge*).

Leucauge fastigata Barrion & Litsinger, 1995: 540, figs. 335a–f (♀, synonymy of *L. fastuosa*).

Opadometa fastigata Sen et al., 2015: 100, figs. 580–584, plate 20 (♀).

Leucauge fastigata Anju, Bhagirathan & Sudhikumar, 2021: 162, figs. 1A–F, 2A–E (♂♀).

Material examined. Kannur district, Andaloor Kavu 11°47'42"N, 75°28'38"E, 35 m, 15 March 2022, leg. Anju K. Baby, 1♀. Malappuram district, Nilambur, Nellikkuthu 11°16'37"N, 76°13'33"E, 11 October 2021, leg. Anju K. Baby, 4♂ 5♀. Kollam district, Shendurney Wildlife Sanctuary 8°51'27"N, 77°12'58"E, 325 m, 16 September 2022, leg. Anju K. Baby & Manu K. Baby, 6♀. Idukki district, Mankulam 10°07'03"N, 76°55'30"E, 700 m, 08 December 2023, leg. Anju K. Baby, 3♂ 4♀. Idukki district, Anakulam 10°09'25"N, 76°54'51"E, 358 m, 10 December 2023, leg. Anju K. Baby & Greeshma T. S., 3♀. Idukki district, Chinnar Wildlife Sanctuary, Alampetty 10°18'34"N, 77°11'13"E, 765 m, 09 January 2024, leg. Anju K. Baby & Natarajan, 1♂ 2♀. Thrissur district, Christ College Campus 10°21'15"N 76°12'48"E, 40 m, 1 September 2023, leg. Anju K. Baby, 2♀. Wayanad district, Pozhuthana reserved forest 11°35'11"N, 76°00'56"E, 762 m, 15 January 2025, leg. Anju K. Baby & Sibi John, 1♀.

Diagnosis: They are characterized by two rows of recurved eyes, lateral eyes closely placed and median ocular quadrangle longer than wide, and two rows of trichobothria on femur IV. Males can be differentiated by broad cymbium, long cymbial ecto-basal process, short paracymbium, and chelicerae with numerous macrosetae. Females are much larger than males, which are very minute. Female has dense black hairs on tibia IV, which lack in males and epigynal plate semicircular (Anju et al., 2021b).

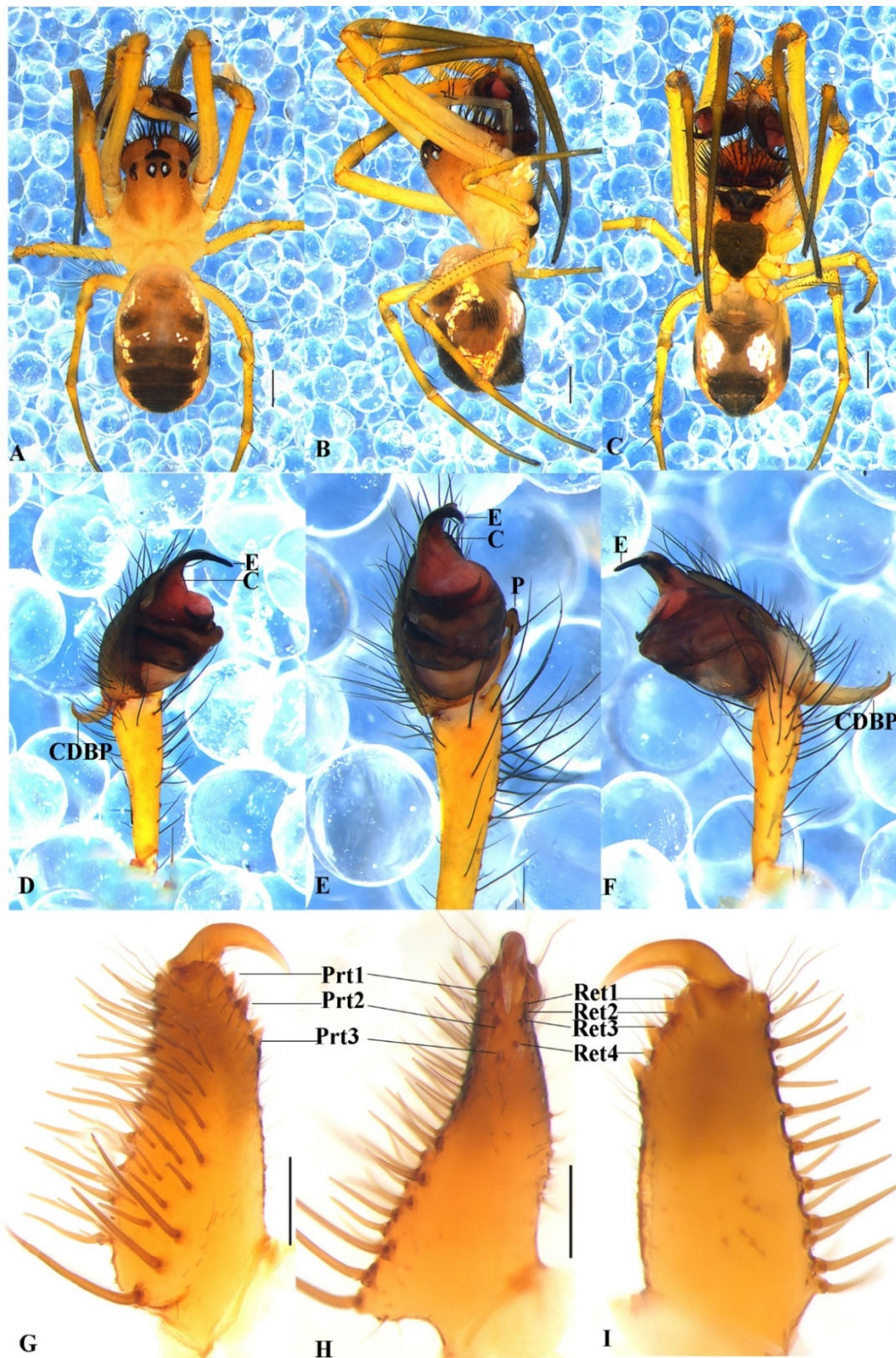


FIGURE 4.1.14. *Leucauge fastigata* (Simon, 1877), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F, G–I: 0.2 mm.

Redescription. Male (Fig. 4.1.14). Carapace high, yellowish-brown anteriorly and pale yellow posteriorly. Both rows of eyes are recurved, surrounded by black contour, median ocular quadrangle longer than wide, lateral eyes closely placed. Clypeus pale yellow in colour. Labium broad and yellowish brown. Maxillae long, dark brown with distinct scopulae. Sternum yellowish-black and heart shaped. Chelicerae stout, yellowish brown with numerous black spines is present. Upper row with three teeth and lower row with four teeth. Legs are slender, yellow and distally brown; ventrally, two rows of trichobothria are present on femur IV. Abdomen oval, with pale brown markings on the antero-dorsal side followed by a pair of brown patches; horizontally with brown patches and silvery guanine spots present along the sides of brown patches with pale brown markings on the lateral side; abdominal venter pale black with a pair of silvery guanine spots located on the middle. Palp with broad cymbium; CDBP long, slender and distally projected upward; paracymbium broad at the base, overlapping the tegulum and somewhat bulbous distally; conductor broad at the base, gradually narrowed and curved; embolus overlapping the conductor (Anju et al., 2021b).

Measurements. Total length 2.50. Carapace 1.21 long and 0.88 wide. Abdomen length 1.29, width 0.85, height 0.42. Clypeus 0.06. Ocular area length 0.28, width 0.25. Eye diameters: AME 0.12, ALE 0.10, PME 0.10, PLE 0.07. Chelicerae 0.79 long, 0.33 wide. Palp and leg measurements: pedipalp 2.36 (1.18, 0.13, 0.45, 0.60), leg I 4.61 (1.38, 0.31, 1.23, 1.13, 0.56), II 3.93 (1.22, 0.29, 0.99, 0.92, 0.51), III 1.78 (0.53, 0.19, 0.33, 0.43, 0.30), IV 2.88 (1.00, 0.26, 0.59, 0.68, 0.35). Leg formula 1243 (Anju et al., 2021b).

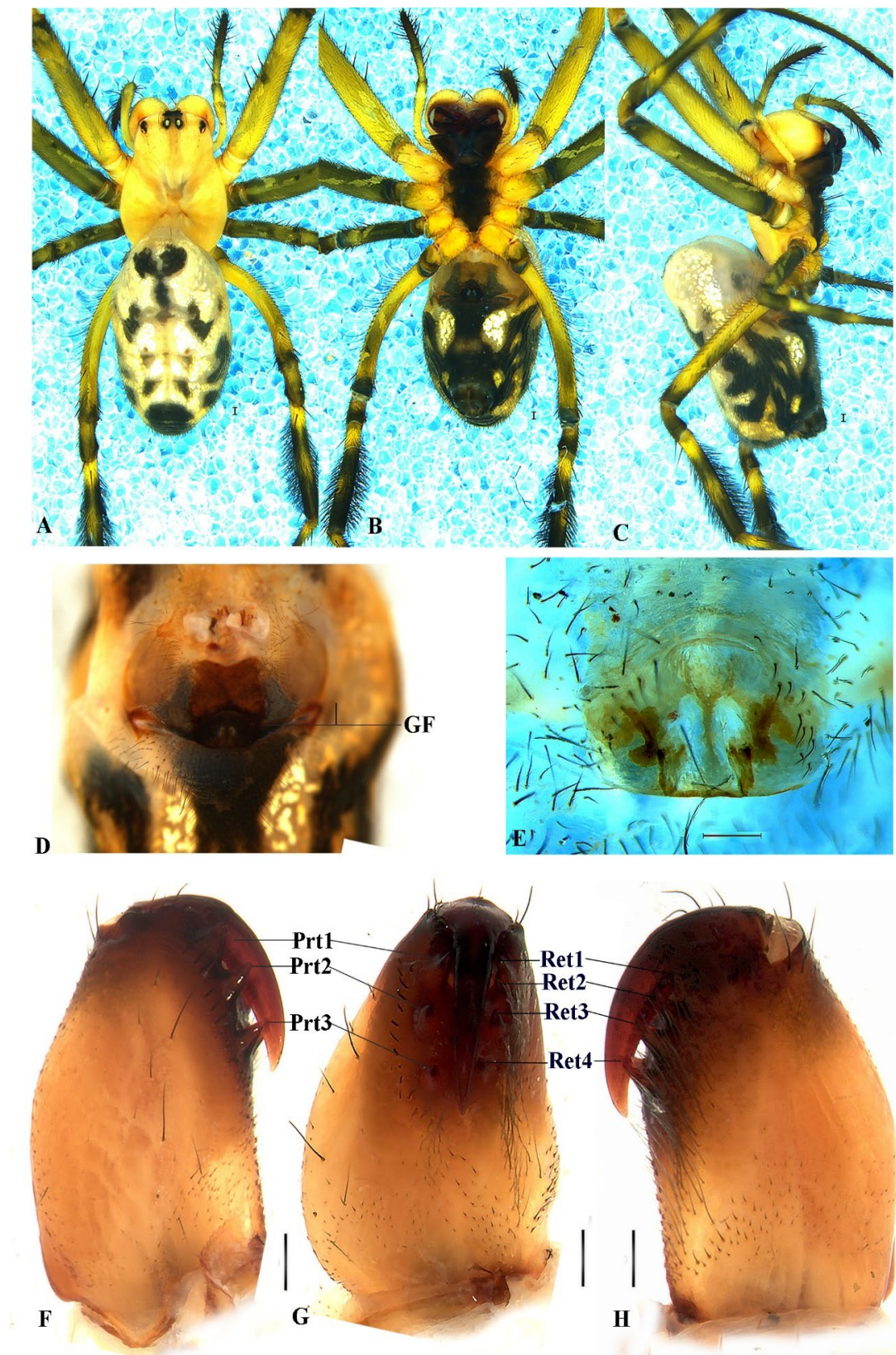


FIGURE 4.1.15. *Leucauge fastigata* (Simon, 1877), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–D: 0.5 mm. E: 0.1 mm, F–H: 0.2 mm.

Female (Fig. 4.1.15). Carapace flat, yellow, anteriorly narrowed and medially broad. Both rows of eyes are recurved, surrounded by black contour, median ocular quadrangle longer than wide, lateral eyes closely placed. Clypeus yellow. Labium broad and yellowish brown. Maxillae long, dark brown with distinct scopulae. Sternum black, heart shaped. Chelicerae stout, yellow at the base and brownish yellow distally. Chelicerae with three promarginal teeth and four retromarginal teeth. Legs are robust, olive green with yellow markings. They have two rows of trichobothria on femur IV and dense black hairs on tibia IV. Abdomen narrowed anteriorly and blunt shoulder humps strongly overhanging the cephalothorax. The dorsum of the abdomen with prominent black markings and guanine spots; venter dark with two pairs of bright guanine spots on the middle. Epigynal plate flat, dark and semicircular; copulatory ducts sclerotized, strongly folded medially with large inflated balloon like spermathecae (Anju et al., 2021b).

Measurements. Total length 9.33. Carapace 3.50 long and 2.55 wide. Abdomen 5.83 long, 3.66 wide. Clypeus height 0.18. Ocular area length 0.50, width 0.40. Eye diameters: AME 0.18, ALE 0.18, PME 0.17, PLE 0.13. Chelicerae 1.90 long, 1.01 wide. Palp and leg measurements: pedipalp. 3.07 (1.10, 0.29, 0.62, 1.06). Leg I 17.23 (5.12, 1.10, 4.55, 4.98, 1.48), II 16.88 (4.80, 1.08, 4.53, 5.04, 1.43), III 7.25 (2.45, 0.60, 1.46, 1.89, 0.85), IV 12.58 (4.32, 0.76, 2.83, 3.50, 1.17). Leg formula 1243 (Anju et al., 2021b).

Distribution (Fig. 4.1.16). India, Indonesia, Philippines (World Spider Catalog, 2025).



FIGURE 4.1.16. Distribution of *Leucauge fastigata* in Kerala state.

***Leucauge tessellata* (Thorell, 1887)**

Callinethis tessellata Thorell, 1887: 135 (♀).

Argyropeira tessellata Pocock, 1900: 216.

Leucauge tessellata Gravely, 1921b: 455 (♂); Zhu et al., 2003: 244, figs. 134A–F, 135A–G, plates VIIIA–D (♂♀, synonymy of *L. lygisma* and *L. termisticta*); Yoshida, 2009: 15, figs. 14–18 (♂♀, synonymy of *L. nitella* and *L. subtessellata*); Sen et al., 2015: 102, figs. 590–594, plate 21 (♀); Zhang, 2018: 48, figs. 6–2.A–C, plate 11 (♀).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. INDIA: Kerala: Wayanad district, Tharuvana 11°44'06"N, 75°58'52"E, 779 m, 26 November 2021, leg. Anju K. Baby & Manu K. Baby, 2♀. Wayanad district, Valery 11°45'52"N, 75°55'56"E, 773 m, 29 November 2021, leg. Anu K. Baby, 6♂ 7♀. Shendurney Wildlife Sanctuary, 8°51'26"N, 77°13'00"E, 335 m, Anju K. Baby & Subramanyan, 2♀. Kollam district, Punalur 9°01'07"N 76°55'35"E, 51 m, 20 September 2022, leg. Anju K. Baby, 1♂ 3♀. Thrissur district,

Thekkinkadu 10°31'29"N, 76°12'52"E, 52 m, 02 March 2023, leg. Greeshma T. S. & Anju K. Baby, 1♂ 2♀. Idukki district, Viripara 10°08'41"N, 76°95'74"E, 100 m, 08 December 2023, leg. Anju K. Baby & Greeshma T. S., 4♂ 12♀. Idukki district, Chinnar wildlife Sanctuary, Madathala 10°17'44"N, 77°13'05"E, 900 m, 09 January 2024, leg. Anju K. Baby & Greeshma T. S., 2♀.

Diagnosis. Males of *L. tessellata* resemble *L. fastigata* but can be differentiated from the latter by having slender abdomen, chelicerae less spinous (chelicerae with strong spines in *L. tessellata*), paracymbium short, tip of the embolus not enclosed with conductor and short tibia. Females are also similar to *L. fastigata* but can be distinguished from the latter by having cephalothorax without any markings, abdomen without strong humps, copulatory ducts with two folds with enlarged spermathecae.

Redescription. Male (Fig. 4.1.17). Carapace flat, yellow, postero-laterally with brownish spots, a shallow longitudinal line arising between the anterior median eyes and extending to the fovea. AMEs slightly raised, and all eyes with black border. Fovea with inverted U-marking. Clypeus yellow. Labium subquadrate and yellow. Maxillae long, dark with distinct scopulae. Sternum heart-shaped, posteriorly protruding with numerous hairs. Chelicerae slender, yellow, and brownish towards the cheliceral fang. Upper row of chelicerae with four teeth: Prt1 larger; Prt2 and Prt3 about the similar size; Prt4 smaller and curved. Lower row with three teeth: Ret1 closer to fang basis, Ret2 triangular; all teeth are almost equally spaced. Cheliceral fang short, curved, brown, and serrated. Legs yellow to green; femur IV with two rows of parallel trichobothria. Abdomen cylindrical; dorsum greyish with silver guanine spots, anteriorly with a pair of pale black spots, yellow patches in

lateral edges, and a pair of black spots on the posterior end; venter brownish, anteriorly with an orange patch near the pedicel, antero-laterally with reddish patches, centrally with a longitudinal patch and light-green spots on either side of the longitudinal patch, irregular black stripes on lateral edges, tracheal spiracle prominent, located above the spinnerets, and glossy yellow spots on either side of the tracheal spiracle. Pedipalp with median-sized tibia; tegulum enlarged, brownish, and slightly slanted towards the ventral side; subtegulum prominent and brownish; cymbium broad with numerous macrosetae; sperm duct proximally widening and gradually narrowing with strong folds; CDBP long and distally curved; paracymbium anteriorly broad with a curved tip; embolus dark, distally narrowing and wavy, distally not enclosed with conductor; conductor thick, dark, and distal end flap-like facing towards the dorsal side.

Measurements. Total length: 4.27. Carapace 2.13 long, 2.14 wide. Abdomen: 2.65 long, 1.43 wide. Ocular area length 0.30, width 0.13. Eye diameters: AME 0.13, ALE 0.04, PME 0.11, PLE 0.05. Clypeus height 0.08. Chelicerae 1.32 long, 0.69 wide. Palp and leg measurements: pedipalp 3.23 [1.45, 0.26, 0.43, 1.09], I 30.07 [8.09, 1.07, 10.64, 8.44, 1.78], II 23.10 [6.51, 0.88, 6.26, 7.72, 1.73], III 6.60 [2.79, 0.61, 1.75, 0.78, 0.67], IV 12.79 [3.88, 0.97, 4.70, 2.55, 0.69]. Leg formula: 1243.

Female (Fig. 4.1.18). Carapace flat, yellow; cephalic region much darker with black postero-lateral edges. Eyes, fovea, clypeus, labium, maxillae, sternum, and legs as in males. Chelicerae short, stout, and dark brownish. Upper row of chelicerae with three teeth: *Prt1* closer to the fang basis; *Prt2* about the same size as *Prt1*; all teeth are equidistant and directed upward. Lower row with four teeth: *Ret1* bulky; *Ret2* parallel to *Ret1*; *Ret3* slightly displaced from *Ret2*; *Ret4* distally curved. Cheliceral fang short and brownish. Abdomen elongated, slightly overhanging the carapace,

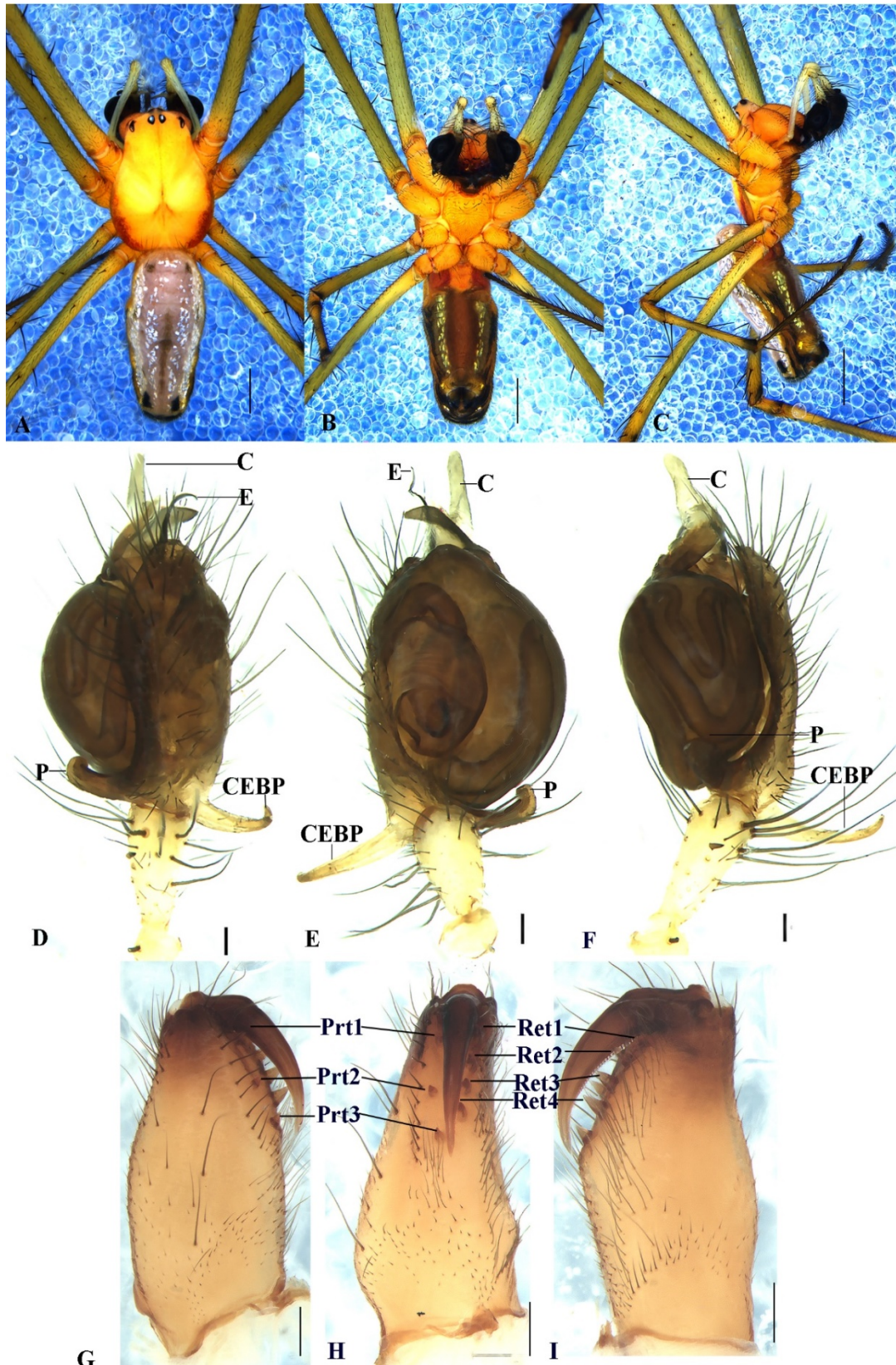


FIGURE 4.1.17. *Leucauge tessellata* (Thorell, 1887), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F, G–I: 0.2 mm.

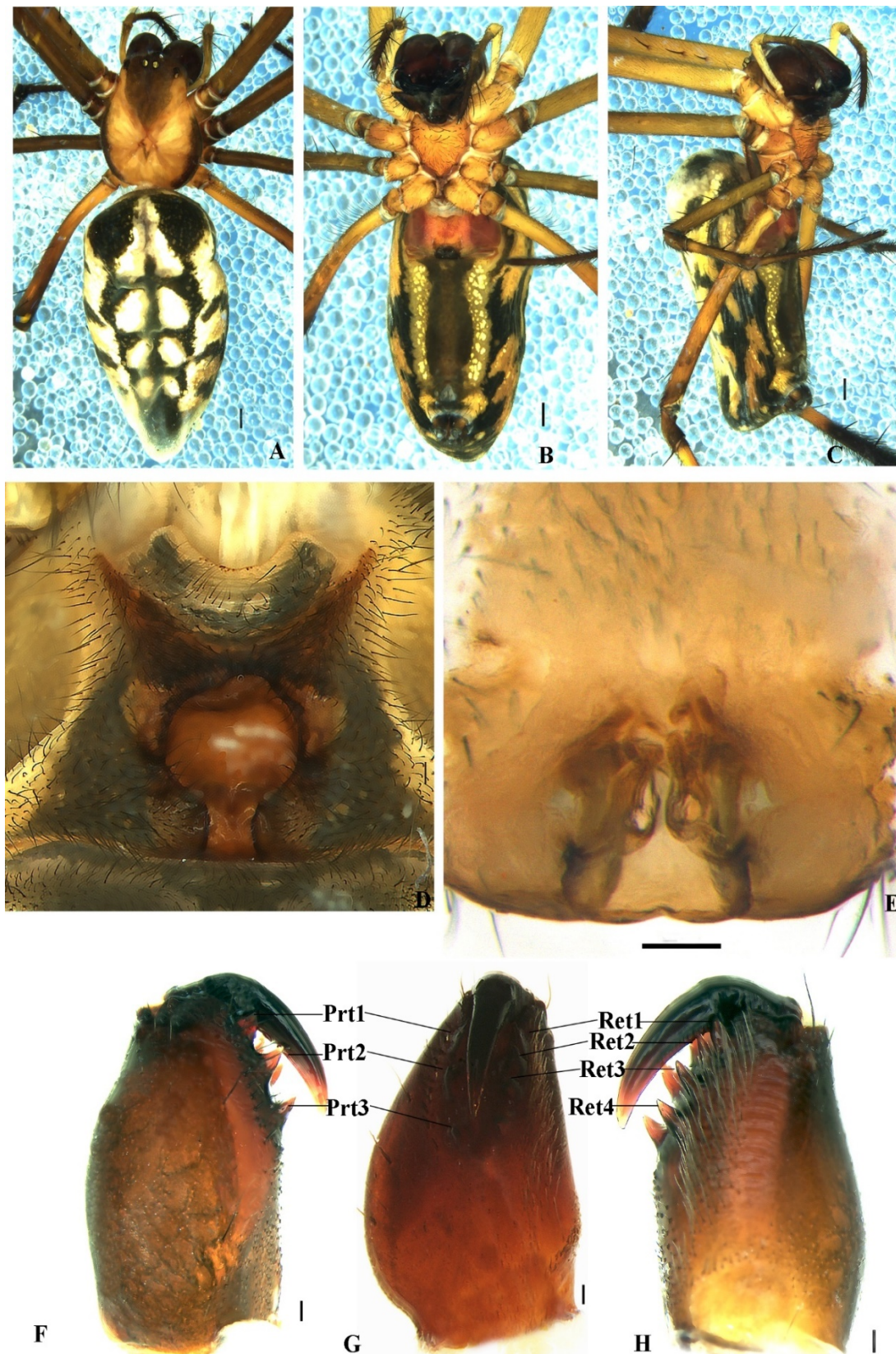


FIGURE 4.1.18. *Leucauge tessellata* (Thorell, 1887), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–C: 0.5 mm. D, E, F–H: 0.1 mm.

anteriorly broad, gradually narrowing towards the posterior side; dorsum pale yellowish, anteriorly with two black spots, a long longitudinal black stripe moves antero-posteriorly, three pairs of transverse stripes arising from longitudinal stripes, and all stripes are connected laterally, laterally with irregular black stripes and a large black spot on the posterior edge; venter with a long black patch and yellow guanine spots on either side with irregular black patches, anteriorly with an orange patch near the pedicel, and antero-laterally with reddish patches as in males; tracheal spiracle prominent, located above the spinnerets. Epigynal plate dark, elongated atrium and internal genitalia composed of copulatory ducts with numerous folds; fertilization duct indistinct.

Measurements. Total length: 10.81. Carapace 3.27 long, 2.65 wide. Abdomen: 7.54 long, 3.81 wide. Ocular area length 0.29, width 0.30. Eye diameters: AME 0.14, ALE 0.08, PME 0.17, PLE 0.11. Clypeus height 0.08. Chelicerae 1.36 long, 0.59 wide. Palp and leg measurements: pedipalp 3.59 [1.22, 0.32, 0.72, 1.33], I 23.7 [5.57, 1.36, 5.88, 6.54, 1.70], II 17.42 [5.30, 1.18, 4.55, 4.97, 1.42], III 8.78 [3.14, 0.74, 1.90, 2.58, 0.42], IV 15.44 [5.46, 0.99, 4.01, 3.91, 1.07]. Leg formula: 1243.

Distribution. India, China, Thailand, Vietnam, Laos, Taiwan, Indonesia (World Spider Catalog, 2025).

4.1.4. Genus *Mesida* Kulczynski, 1911

Diagnosis. This genus can be easily distinguished from all other tetragnathids in having green and silvery body colour, distinct median spur on the dorso-lateral side of the male chelicerae, embolus filiform, conductor bulky, fertilization ducts and copulatory ducts are parallel and small spermathecae.

Type species. *Mesida humilis* Kulczynski, 1911.

***Mesida culta* (O. Pickard-Cambridge, 1869)**

Tetragnatha culta O. Pickard-Cambridge, 1869b: 390, plate 13, figs. 69–75 (♂♀).

Leucauge sexpustulata Simon, 1906c: 307 (♀).

Leucauge culta Gravely, 1921b: 453, figs. 8a.

Anopas cultus Archer, 1951a: 8 (transferred from *Leucauge*).

Leucauge culta Tikader, 1982a: 87, figs. 172–174 (♀).

Mesida culta Sankaran et al., 2017b: 315 (transferred from *Tylorida*).

Material examined. Idukki district, Viripara 10°05'01"N 76°57'27"E1, 115 m, 15 December 2023, leg. Anju K. Baby & Greeshma T. S., 2♂ 7♀. Idukki district, Anakulam 10°09'25"N, 76°54'51"E, 358 m, 10 December 2023, leg Anju K. Baby & Greeshma T. S., 2♀. Wayanad district, Pozhuthana reserved forest 11°35'11"N, 76°00'56"E, 762 m, 15 January 2025, leg. Anju K. Baby & Sibi John, 2♀.

Diagnosis. Males of *M. culta* are most similar to that of *M. martinika* but differ in the following characteristics: sperm duct less convoluted (highly convoluted sperm duct in *M. martinika*), CDBP long with a curved apex, and paracymbium with a small notch (Barrion & Litsinger, 1995, figs. 330a–h). Females are most similar to *M. gemmea* but can differ from the latter in having semicircular epigynal plate, internal genitalia with two pairs of spermathecae oriented downward, and short copulatory ducts (Zhu et al., 2003, figs. 144A–H).

Redescription. Male (Fig. 4.1.19). Carapace elevated, pale yellowish with olive-green contour, and the cephalic groove distinct. Anterior eyes are strongly recurved, all eyes with black border, AMEs elevated with dark border sharing with PMEs. Clypeus pale yellow. Fovea deep. Labium subquadrate and brownish. Maxillae elongated, anteriorly broad, and fairly constricted at the base. Sternum olive-green

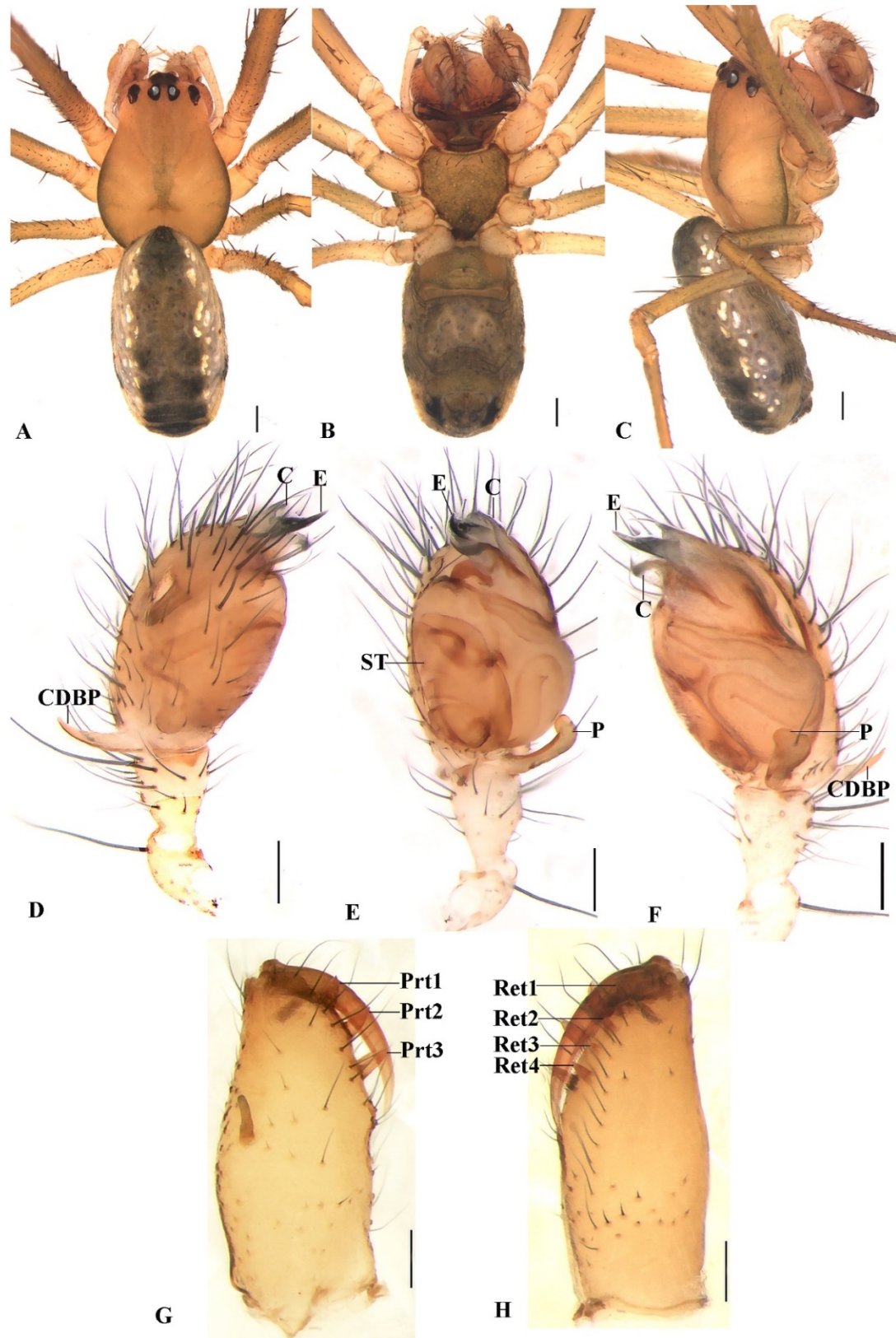


FIGURE 4.1.19. *Mesida culta* (O. Pickard-Cambridge, 1869), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, ventral view. Scale bars: A–C: 0.2 mm. D–H: 0.1 mm.

with dark contour and a few spines. Chelicerae short, thin, yellow, with strong spines and distinct median-spur on the dorso-lateral side. Upper row of chelicerae with three teeth: all teeth are equidistant; Prt1 thumb-like; Prt2 similar in shape to Prt1; Prt3 longer and linear. Lower row of chelicerae with four teeth: Ret1 stout with wide basis and closer to fang basis; Ret2 long; Ret3 very small with blunt apex; Ret4 larger than Ret3 and straight. Cheliceral fang slender and short. Legs greenish-yellow. Abdomen oval; dorsum greyish, medially long longitudinal black patch with four pairs of black spots near the posterior end laterally with numerous silver guanine spots; venter dark greyish with numerous wrinkles, and a pair of black spots on either side of spinnerets. Pedipalp with short tibia; subtegulum brownish; cymbium broad with numerous spines; cymbial dorso-basal process extended, stout, and distal end curved upward with blunt apex; paracymbium long, and apex curved, enlarged, and touching the tegulum with a small notch; sperm duct less convoluted; conductor bulky and transparent embolus dark, protruding and distally with a twist; embolic base strongly curved.

Measurements. Male. Total length: 2.50. Carapace 1.14 long, 0.80 wide. Abdomen: 1.36 long, 0.51 wide. Ocular area length 0.32, width 0.29. Eye diameters: AME 0.07, ALE 0.02, PME 0.07, PLE 0.02. Clypeus height 0.04. Chelicerae 0.59 long, 0.25 wide. Palp and leg measurements: pedipalp 1.60 [1.01, 0.09, 0.11, 0.39], leg I 6.44 [1.97, 0.30, 1.65, 1.83, 0.69], II 4.97 [1.42, 0.37, 1.17, 1.17, 1.41, 0.60], III 2.39 [0.73, 0.17, 0.61, 0.62, 0.26], IV 3.54 [1.18, 0.24, 0.78, 0.93, 0.41]. Leg formula: 1243.

Female (Fig. 4.1.20). Carapace, eyes, fovea, clypeus, labium, maxillae, sternum, and legs as in males. Chelicerae short, stouter than in males, and brownish yellow.

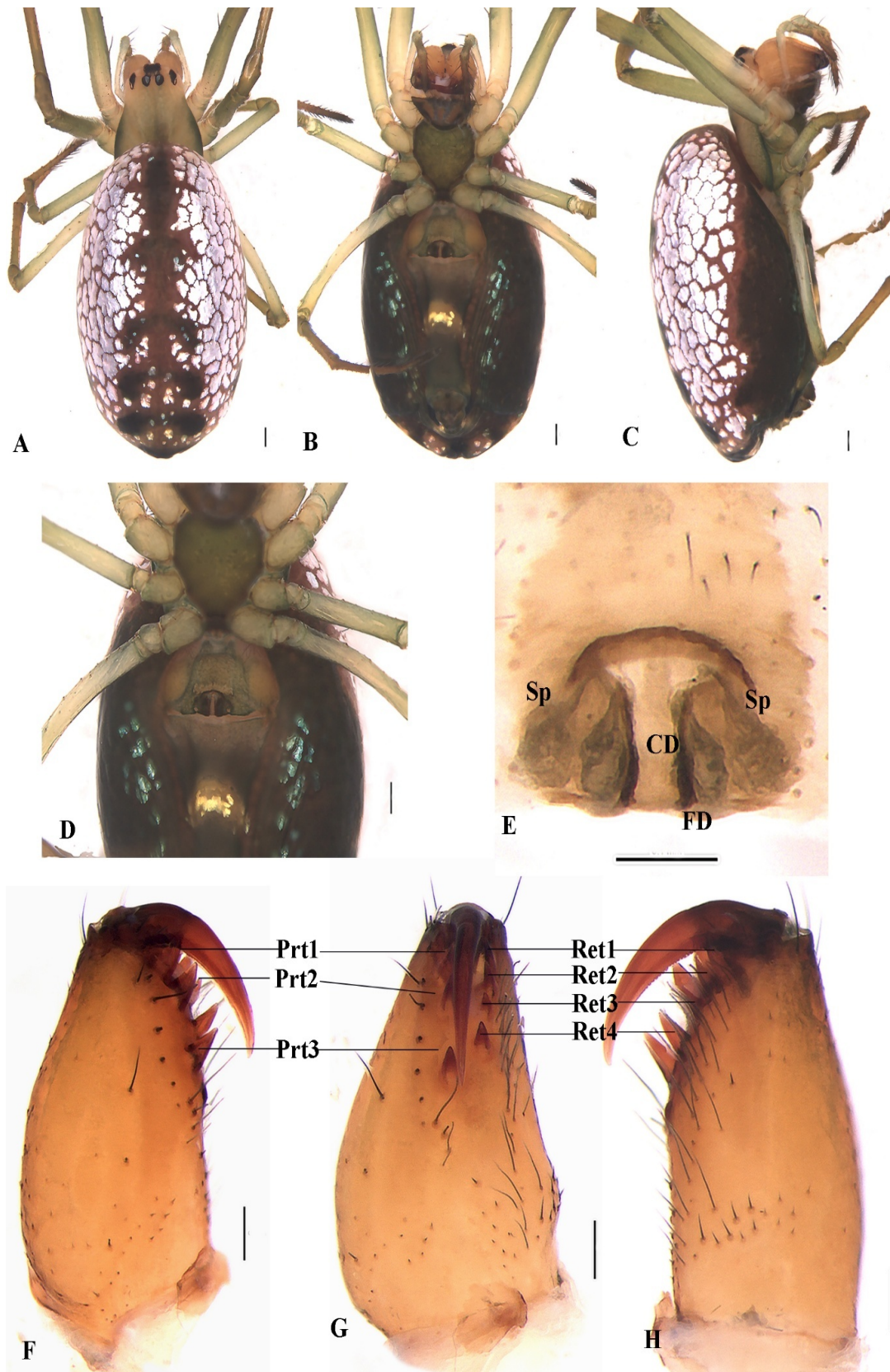


FIGURE 4.1.20. *Mesida culta* (O. Pickard-Cambridge, 1869), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–C: 0.2 mm. D–H: 0.1 mm.

Upper row of chelicerae with three teeth: Prt1 wider, closer to fang basis; Prt2 blunt, smaller, and similar shape to Prt1; Prt3 upward projected, and a significant gap between Prt2 and Prt3. Lower row with four teeth: Prt1 and Prt2 close to each other, curved and similar in shape; Prt3 smaller, pointed, and slightly curved; Prt4 longer than Prt3, bulky and upward projected. Cheliceral fang short, serrated, and brownish. Abdomen oval; dorsum brownish, with numerous silver guanine spots; a long brownish stripe moves antero-posteriorly with three pairs of black spots and a large black spot on the posterior end; venter elevated with numerous wrinkles, dark brownish, centrally with a few guanine spots. Spinnerets posteriorly placed. Epigynal plate semicircular; internally two pairs of small spermathecae oriented downward; fertilization duct narrow and tubular; copulatory ducts tubular and short, copulatory openings indistinct; median septum long and arterially wide.

Measurements. Female. Total length: 8.16. Carapace 1.16 long, 1.09 wide. Abdomen: 3.01 long, 2.27 wide. Ocular area length 0.34, width 0.33. Eye diameters: AME 0.07, ALE 0.02, PME 0.07, PLE 0.02. Clypeus height 0.04. Chelicerae 0.81 long, 0.39 wide. Palp and leg measurements: pedipalp 2.87 [0.40, 1.10, 1.01, 0.36], leg I 7.37 [2.14, 0.48, 1.86, 2.07, 0.82], II 5.62 [1.69, 0.48, 1.33, 1.55, 0.57], III 2.90 [0.96, 0.22, 0.58, 0.79, 0.35], IV 4.61 [1.60, 0.28, 0.93 1.25, 0.55]. Leg formula: 1243.

Distribution. India, Sri Lanka (World Spider Catalog, 2025).

4.1.5. Genus *Orsinome* Thorell, 1890

Diagnosis. The genus *Orsinome* can be distinguished from all other tetragnathids by the presence of stout chelicerae, shiny guanine spots on the dorsum of the abdomen, extremely elongated embolus and conductor, embolus with broad basis distally

curved, originating near the subtegulum, tegulum small, copulatory ducts highly coiled and sclerotized, sperm duct less convoluted, spermathecae larger, cymbium broad, elongated and extending beyond the tegulum, cymbium basal-dorsal process positioned middle of the cymbium, and paracymbium long.

Type species. *Orsinome vethi* van Hasselt, 1882.

***Orsinome vethi* (van Hasselt, 1882)**

Pachygnatha vethii, van Hasselt, 1882: 32 (♂).

Orsinome vethi, Thorell, 1890: 209 (♀).

Labulla nepula Hormiga & Scharff, 2005: 393 (misplaced in this genus).

Orsinome vethi Caleb, Ghosh & Kumar, 2018: 343, figs. 1–32 (♂♀, synonymised with *Orsinome listeri* and *Labulla nepula*).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. **INDIA: Kerala:** Nilgiri Biosphere Reserve, Malappuram district, Nilambur north, Kozhippara waterfalls 11°21'13"N, 76°06'28"E, 572 m, 15 October 2021, leg. Anju K. Baby & Aswathy P. G., 2♀. Malappuram district, Kakkad 11°02'12"N 75°56'24"E, 37 m, 16 October 2021, leg. Anju K. Baby, Adarsh P. K., 3♀. Kottayam district, Erattupetta 9°41'04"N 76°46'28"E, 68 m, 07 August 2022, leg. Anju K. Baby, 1♀. Wayanad Wildlife Sanctuary, Periya Reserved Forest 11°46'37"N, 75°50'48"E, 816 m, 07 December 2022, leg. Anju K. Baby & Manu K. Baby, 5♂ 7♀. Kottayam district, Marmala waterfalls 9°47'06"N 76°43'52"E, 214 m, 15 December 2022, leg. Anju K. Baby, 2♀. Neyyar Wild life Sanctuary, Charupara 8°32'02"N, 77°09'00"E, 120 m, 29 December 2022, Anju K. Baby & Rajesh, 3♀. Kannur district, Kanjirakolly, Alakapuri waterfalls 12°08'33"N 75°37'42"E 356 m, 22

November 2023, leg. Anju K. Baby & Nikhil K. J., 1♂ 2♀. Thrissur district, Chimmini Wildlife Sanctuary 10°25'52"N 76°29'27"E, 147 m, 14 December 2023, leg. Anju K. Baby & Greeshma T. S., 2♂ 2♀.

Diagnosis. Males of *O. vethi* are similar to *O. megaloverpa* Hormiga & Kallal, 2018 but can be separated from the latter by the following characteristics: paracymbium short, cymbium broad and extended to the apex of the embolus (vs. extremely short cymbium), CBDP positioned at the mid-dorsal side of the cymbium. Females can be separated from those of *O. megaloverpa* by extremely elongated spermathecae, copulatory duct much more compressed, and fertilization ducts with a twist (Kallal & Hormiga, 2018, figs. 8A–G, 9A–E, 10A–I).

Redescription. Male (Fig. 4.1.21). Carapace elongated, anteriorly constricted, medially broad, and gradually narrowing towards the posterior rim; cephalic region slightly elevated and dark brownish; a pair of pale-yellow longitudinal patches on either side of the fovea. Anterior eyes are raised, all eyes with black border, and the ocular quadrangle longer than wide. Fovea deep, dark, and with inverted U-marking. Clypeus dark brownish. Labium subquadrate and dark. Maxillae long with numerous scopulae. Sternum black, with strong intercoxal extensions. Chelicerae short and brownish. Upper row of chelicerae with three teeth: Prt1 triangular; Prt2 extremely small and a large gap between Prt1 and Prt2; Prt3 large and displaced from the row, followed by a small knob. Lower row with two teeth: Ret1 and Ret2 extremely small, followed by a small knob. Legs I and II are brownish yellow, and Legs III and IV are light yellowish. Abdomen elongated; dorsally greyish, numerous silver guanine spots with irregular black patches on mid-dorsal side and silver guanine spots clumped on lateral sides; venter black, two parallel longitudinal greyish

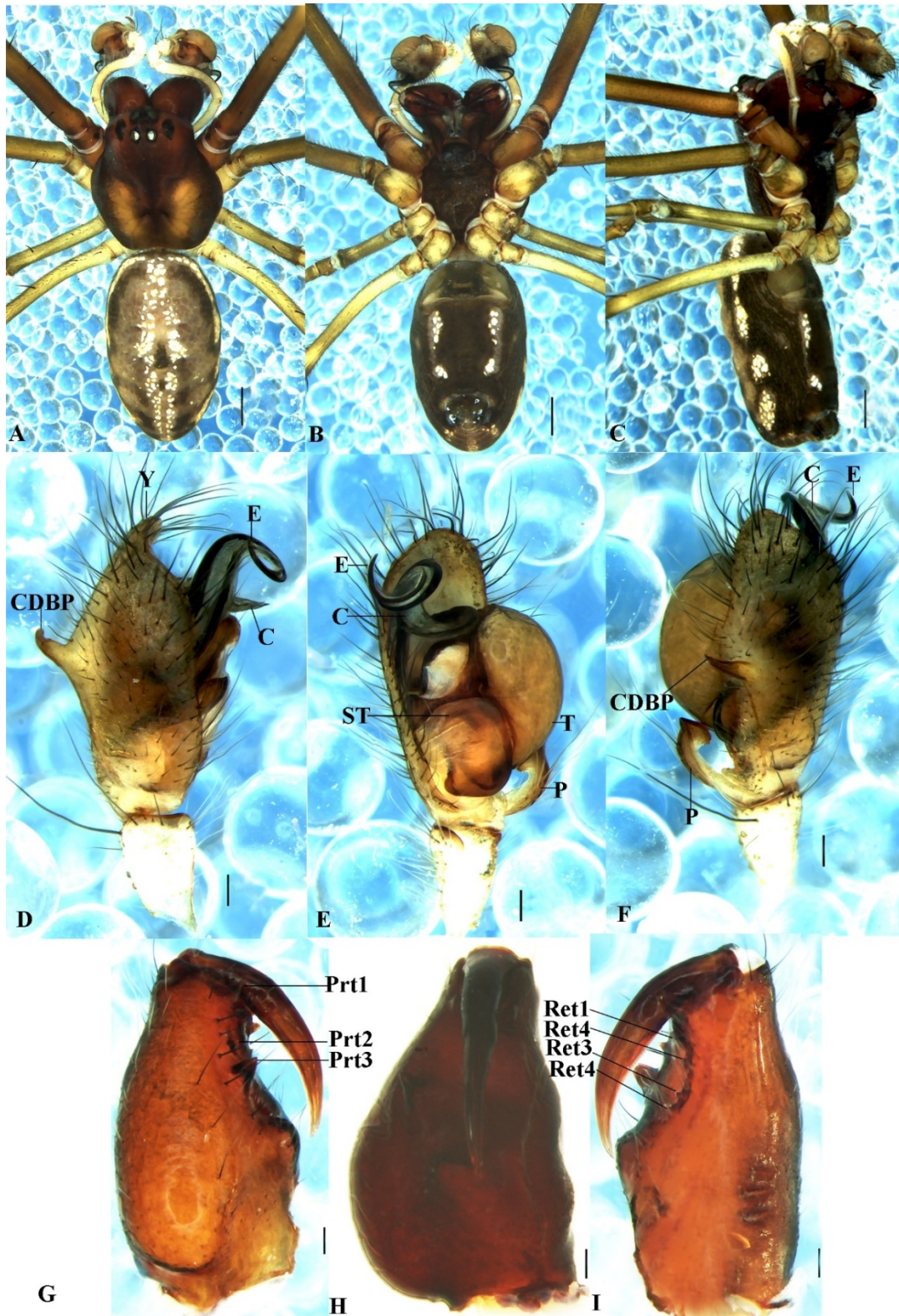


FIGURE 4.1.21. *Orsinome vethi* (van Hasselt, 1882), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F: 0.1 mm. G–I: 0.2 mm.

with silver guanine spots arising near epiandrous fusules. Spinnerets posteriorly placed. Pedipalp with short tibia; tegulum longer than wide; subtegulum light brownish and rectangular; broad cymbium with numerous spines; CBDP distinct, pointed, slightly curved at the mid-length, oriented towards the retrolateral side; pracymbium moderate-sized, tubular, curved inward, and broad at the apex, with long setae near the apex; embolus thin at the base, with two twists in the distal half with a protruding apex; embolic base positioned above the tegulum; conductor enclosed with the embolus halfway, initially broad and gradually narrowing.

Measurements. Total length: 5.87. Carapace 2.25 long, 2.21 wide. Abdomen: 3.62 long, 1.70 wide. Ocular area length 0.47, width 0.43. Eye diameters: AME 0.15, ALE 0.08, PME 0.14, PLE 0.13. Clypeus height 0.08. Chelicerae 1.64 long, 0.85 wide. Palp and leg measurements: pedipalp 2.78 [1.15, 0.40, 0.35, 0.88], leg I 24.14 [6.48, 1.27, 6.77, 8.13, 1.49], II 15.56 [4.56, 1.01, 4.29, 4.61, 1.09], III 6.82 [2.13, 0.61, 1.48, 1.95, 0.65], IV 12.38 [3.95, 0.70, 3.00, 3.83, 0.90]. Leg formula: 1243.

Female (4.1.22). Carapace anteriorly constricted, medially broad, gradually narrowing towards the posterior rim; yellowish brown with black patches on the lateral sides. Eyes, fovea, clypeus labium, maxillae, and sternum, as in the male. Chelicerae short and yellowish brown. Upper row with three teeth: Prt1 stout and closer to fang basis; Prt2 longer, pointed, slightly bent at the mid-length and upward projected; Prt3 triangular and very sharp. Lower row with four teeth: all teeth are pointed and upward directed; Ret1 stout with wide base, and close to fang basis; Ret2 thorn-like and closer to Ret1; Ret3 shorter than Ret2; Ret4 smaller. Cheliceral fang short, brownish, and serrated. Legs brownish with yellow patches. Abdomen elongated; dorsum greyish, with two pairs of small black spots, a thin greyish

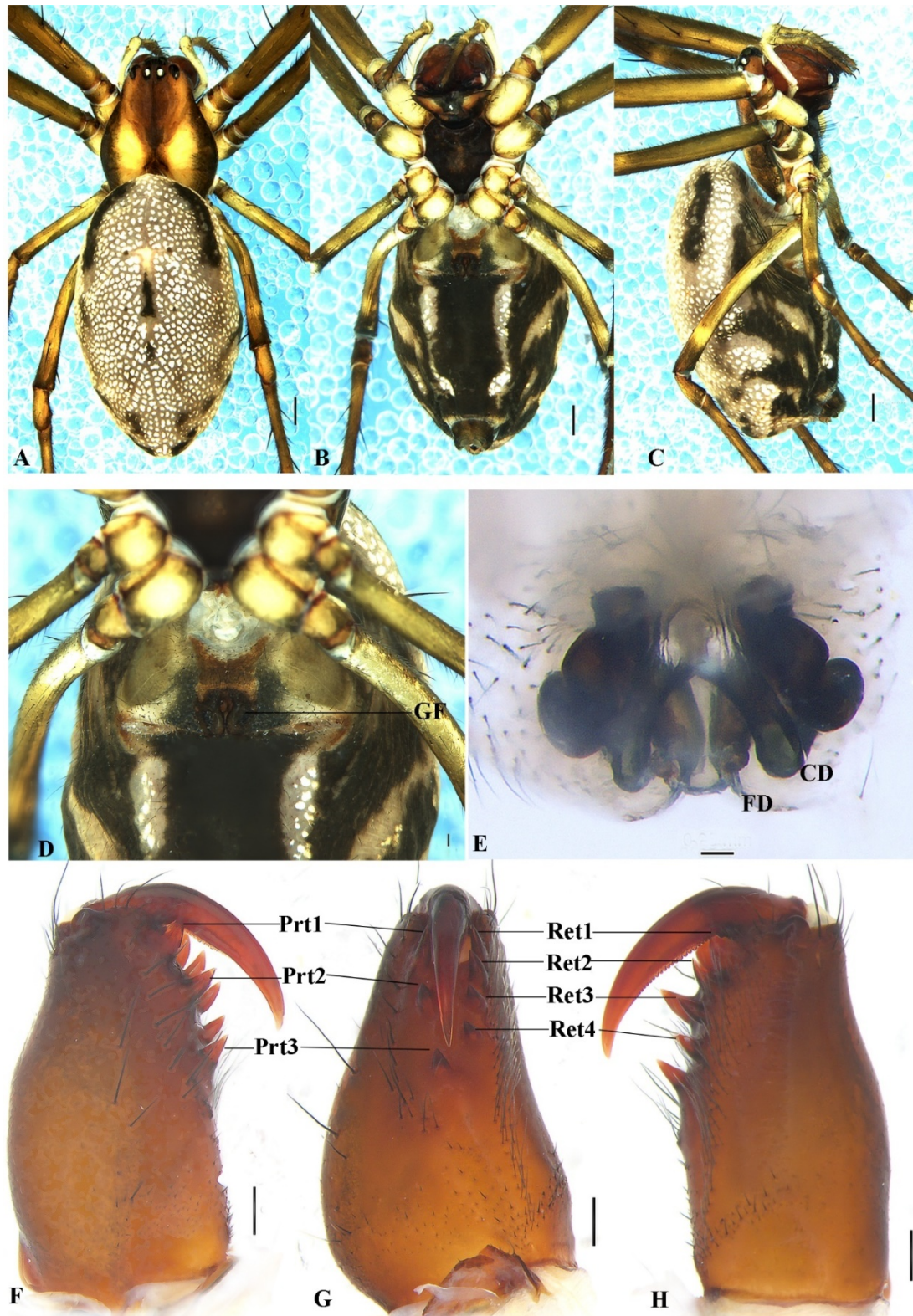


FIGURE 4.1.22. *Orsinome vethi* (van Hasselt, 1882), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–C: 0.5 mm. D: 0.1 mm. E: 0.05 mm. F–H: 0.2 mm.

longitudinal line, and five transverse lines arising from the longitudinal line; numerous silver guanine spots with random black patches; venter black, with two parallel longitudinal greyish patches with silver guanine spots arising near the epigynal fold; laterally, with random greyish patches. Spinnerets posteriorly placed. Epigynal plate round. Internal genitalia composed of well-sclerotized copulatory ducts with numerous folds. The copulatory duct opens to a common chamber in the centre of the epigynal plate; spermathecal bulb large, globular, and almost transparent; fertilisation duct thin.

Measurements. Total length: 6.88. Carapace 3.00 long, 2.22 wide. Abdomen: 3.88 long, 2.38 wide. Ocular area length 0.33, width 0.45. Eye diameters: AME 0.15, ALE 0.05, PME 0.13, PLE 0.09. Clypeus height 0.04. Chelicerae 1.42 long, 0.81 wide. Palp and leg measurements: pedipalp 2.43 [0.38, 0.77, 0.24, 1.04], leg I 23.76 [6.95, 1.59, 6.84, 6.76, 1.62], II 16.95 [4.98, 1.17, 4.29, 5.32, 1.19], III 7.45 [2.33, 0.76, 1.55, 1.96, 0.85], IV 13.49 [4.47, 0.99, 3.36, 4.18, 0.49]. Leg formula: 1243.

Distribution. India, China, Laos, Vietnam, Indonesia, Malaysia (World Spider Catalog, 2025).

4.1.6. Genus *Tetragnatha* Latreille, 1804

Diagnosis. The genus *Tetragnatha* can be distinguished from all other tetragnathids in having slender and elongated abdomen, flattened carapace, prolonged maxillae, long legs, and lateral eyes being apart. They have extremely elongated chelicerae with numerous teeth and clasping apophysis. Females have haplogyne genitalia which do not possess distinct fertilization and copulatory ducts but a single duct connected to the spermathecae, epigynal slit posterior to book lung slits with elongated epigynal fold and single or two pairs of small spermathecae.

Type species. *Tetragnatha extensa* Linnaeus, 1758.

Key to *Tetragnatha* species (Males)

- 1a. Abdomen short (less than 3.5 mm length)..... **2**
- 1b. Abdomen long (more than 3.5 mm length)..... **4**
- 2a. Abdomen green in colour, chelicerae with long apophysis, cheliceral fang with distinct outer cusp and inner cusp ***T. squamata***
- 2b. Abdomen not in green colour, chelicerae with short apophysis, cheliceral fang without any cusps **3**
- 3a. ALEs and PLEs touching, chelicerae without 't' and 'sl', 'a' with blunt apex and positioned near to fang basis, palp with stout embolus, paracymbium with distinct notch ***T. lauta***
- 3b. ALEs and PLEs separated, chelicerae with prominent 't' and 'sl', 'a' bifurcated and positioned far from fang basis, palp with filiform embolus, paracymbium without any notch..... ***T. jaculator***
- 4a. Spinnerets positioned on the $\frac{3}{4}$ the length of the abdomen ***T. javana***
- 4b. Spinnerets positioned towards the tip **5**
- 5a. Abdomen overhanging the spinnerets **6**
- 5b. Spinnerets positioned on the tip **7**
- 6a. Upper row of chelicerae with extremely large Gu and remaining teeth are smaller, conductor without any bifurcation ***T. hasselti***
- 6b. Upper row of chelicerae with extremely large Gu and U2, conductor fairly bifurcated ***T. viridorufa***
- 7a. Chelicerae moderate-sized **8**
- 7b. Chelicerae extremely long **9**

- 8a. Abdomen moderate-sized, chelicerae with 't' moderate sized and protruding,
Gu triangular, Gl extremely larger with wide basis, conductor pleated-like
..... *T. ceylonica*
- 8b. Abdomen long, chelicerae with 't' small with blunt apex, Gu smaller and blunt,
Gl smaller, conductor without any pleats *T. cochinesis*
- 9a. AXu present **10**
- 9b. AXu absent **11**
- 10a. Gu and U2 about similar size, L2 extremely larger and bulky, 't' absent, 'S'
present on the lateral side *T. geniculata*
- 10b. U2 larger than Gu, L2 smaller, 't' present, 'S' absent *T. nitens*
- 11a. Tegulum not slanted *T. serra*
- 11b. Tegulum slanted **12**
- 12a. Gu larger and U2 smaller, 'a' located on the mid-dorsal side of the chelicerae,
conductor distally with a bulge *T. mandibulata*
- 12b. Gu and U2 extremely elongated, 'a' laterally placed, conductor with curved
apex *T. keyserlingi*

Key to *Tetragnatha* species (Females)

- 1a. Abdomen elongated with long chelicerae..... **2**
- 1b. Abdomen oval with short chelicerae..... *T. squamata*
- 2a. Spinnerets positioned on the mid-ventral of the abdomen, a protuberance on
the mid-dorsal side of the chelicerae *T. javana*
- 2b. Spinnerets posteriorly positioned, chelicerae without any protuberance on the
dorsal side **3**

- 3a. AXu and AXI absent, cheliceral fang without any cusps 4
- 3b. AXu present, AXI extremely long, cheliceral fang with prominent basal cusp and small inner cusp *T. mandibulata*
- 4a. Chelicerae dark brownish, Gu longer than U2, Gl smaller than L2, internal genitalia with two rows of spermathecae *T. ceylonica*
- 4b. Chelicerae yellowish, Gu shorter than U2, Gl larger than L2, internally with a single pair of spermathecae 5
- 5a. Abdomen anteriorly constricted, medially enlarged and gradually narrowing towards the end 6
- 5b. Abdomen cylindrical or slightly enlarged anteriorly 7
- 6a. Abdomen glossy and centrally with yellowish-orange patches, paturon slender, Gu stout with wide basis, Gl closer to fang basis, and fang serrated and not geniculate *T. jaculator*
- 6b. Abdomen with darker colour hue, without any yellowish-orange patches, paturon stout, Gu smaller, Gl not much closer to fang basis, and fang strongly geniculate and without any serrations..... *T. lauta*
- 7a. Gu, U2 and U3 are equidistant, Gu larger than U2, L2 triangular..... *T. nitens*
- 7b. Gu and U2 are set apart by large distance, Gu smaller than U2, distal half of L2 curved upward 8
- 8a. Cheliceral fang with median and basal cusp, spermathecae curved at the middle, central membranous sac subquadrate with stout stalk *T. geniculata*

- 8b. Cheliceral fang without median and basal cusp, spermathecae without any curves at the middle, central membranous sac not subquadrate in shape 9
- 9a. Cheliceral fang with a large median cusp *T. cochinensis*
- 9b. Cheliceral fang without any median cusp 10
- 10a. Abdomen dark brownish, genital fold long, central membranous sac not arch-like 11
- 10b. Abdomen greenish, genital fold short, central membranous sac arch-like 12
- 11a. AXI smaller and located on the fang basis, spermathecae oval, central membranous sac nearly roundish..... *T. keyserlingi*
- 11b. AXI much larger and located on lateral side, spermathecae anteriorly constricted, central membranous sac oval..... *T. serra*
- 12a. Gu stout and blunt, G1 and L2 extremely larger, L2 thumb-shaped, L2 and L3 closely situated..... *T. hasselti*
- 12b. Gu linear, G1 and L2 are smaller and about similar size of remaining teeth, L2 triangular, G1–L4 equidistant *T. viridorufa*

***Tetragnatha ceylonica* O. Pickard-Cambridge, 1869**

Meta gracilis Stoliczka, 1869: 244, plate 19, figure 2 (♀, preoccupied in *Tetragnatha* by Lucas, 1838).

Tetragnatha ceylonica O. Pickard-Cambridge, 1869: 394, plate 13, figs. 83–88 (♂♀).

Tetragnatha latifrons Thorell, 1877: 434 (♂♀).

Tetragnatha ceylonica Dippenaar-Schoeman et al., 2020: 34, 9 (♂♀). Dippenaar-Schoeman et al., 2023: 37, figs. 1–6 (♂♀).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. **INDIA: Kerala:** Kannur district, Meloor 11°48'18"N, 75°28'01"E, 36 m, 14 March, 2021, leg. Anju K. Baby, 2♂ 3♀. Kottayam district, Kalathukadavu 9°43'14"N 76°46'37"E, 63 m, 30 July 2022, leg. Anju K. Baby & Adeena Shaji, 2♀. Kollam district, Kattalappara 8°55'12"N 77°05'46"E, 173 m, 16 September 2022, leg. Anju K. Baby & Manu K. Baby, 2♀. Palakkad district, Mukkali 11°03'25"N, 76°31'58"E, 603 m, 04 February 2023, leg. Anju K. Baby & Manu K. Baby, 5♂ 7♀. Wayanad district, Padinjarathara, paddy field 11°40'48"N, 75°58'44"E, 760 m, 15 April 2023, leg. Anju K. Baby, 4♂ 7♀. Kozhikode district, Thusharagiri 11°28'24"N, 76°03'13"E, 449 m, 18 November 2023, 29 November 2023, leg. Anju K. Baby & Nikhil K. J., 2♂ 1♀. Kannur district, Kanjirakolli, Alakapuri waterfalls 12°08'43"N, 75°37'42"E, 388 m, 22 November 2023, leg. Anju K. Baby & Nikhil K. J., 2♂ 5♀. Idukki district, Marayoor, Karimutty waterfalls 10°17'20"N, 77°10'06"E, 930 m, 9 January 2024, leg. Anju K. Baby & Greeshma T. S. 1♂ 2♀. Thrissur district, Chimmuni Wildlife Sanctuary 10°25'52"N 76°29'27"E, 147 m, 14 December 2023, leg. Anju K. Baby & Greeshma T. S., 1♂ 2♀. Wayanad district, Thrissilery, paddy field 11°50'36"N, 76°01'42"E, 795 m, 14 January 2025, leg. Anju K. Baby & Nikhil K. J., 1♀. Wayanad district, Pozhuthana reserved forest 11°35'11"N, 76°00'56"E, 762 m, 15 January 2025, leg. Anju K. Baby & Sibi John, 1♀.

Diagnosis. *T. ceylonica* is most similar to *T. lauta* Yaginuma, 1959, in somewhat similar cheliceral morphology, but can be distinguished from the latter by the presence of bifurcated apophysis on the chelicerae (blunt in *T. lauta*), large ‘t’,

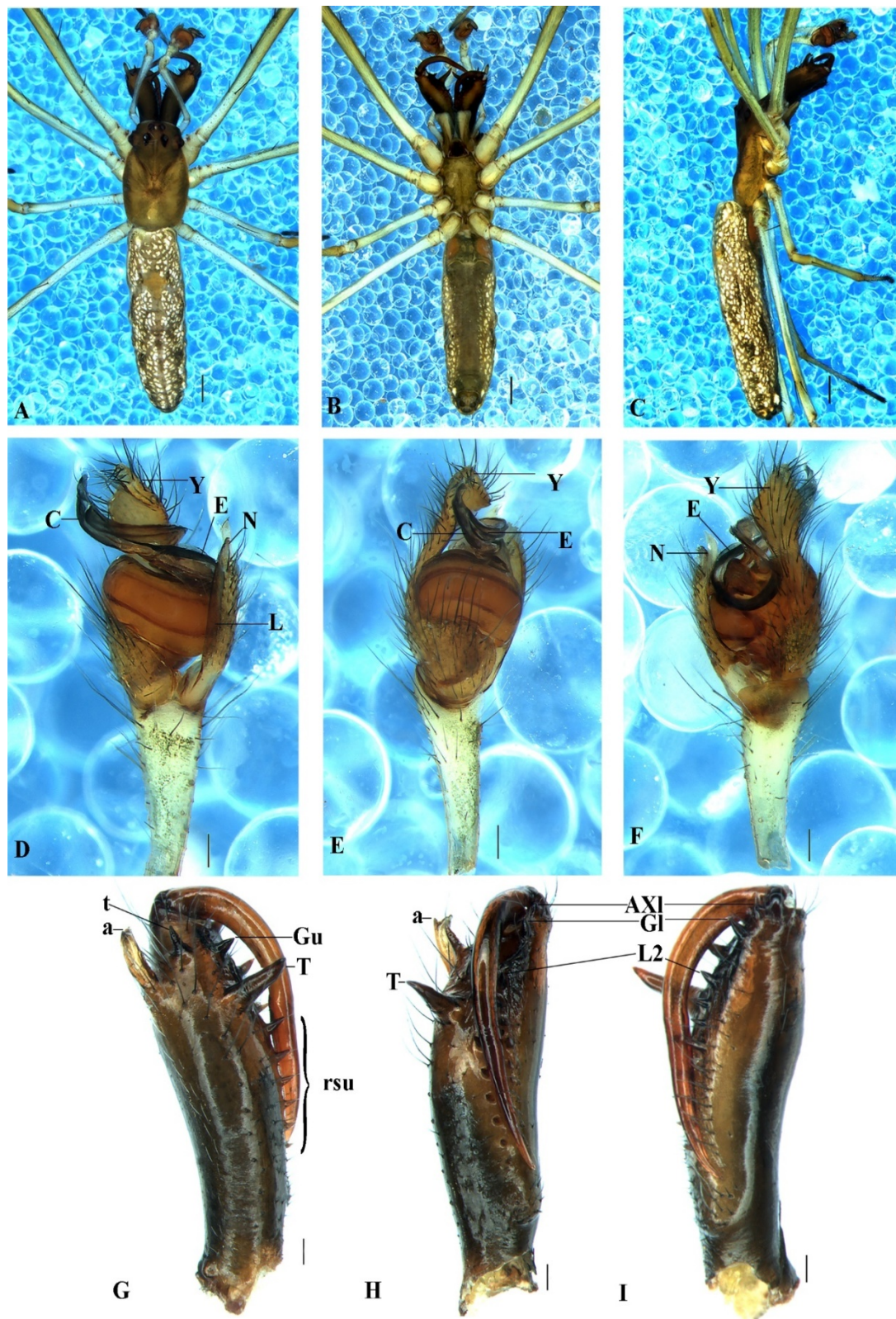


FIGURE 4.1.23. *Tetragnatha ceylonica* O. Pickard-Cambridge, 1869, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.1 mm.

slanted tegulum, and pleated-like conductor. Females are separated from the latter by the presence of cheliceral fang with serrated margin, Gu and U2 are closely positioned (a moderate gap between Gu and U2 in *T. lauta*), internal genitalia with two rows of spermathecae (single pair in *T. lauta*).

Redescription. Male (Fig 4.1.23). Carapace flat, elongated, anteriorly constricted, olive-green to pale yellowish; cephalic region much darker; cephalic groove distinct and dark; two parallel stripes arising between posterior median eyes and reaching to fovea. Anterior eyes are linear, AMEs eyes are much closer than PMEs, PLEs are located on the knobs, and all eyes with black border. Fovea distinct, deep, and dark. Labium subquadrate and dark. Maxillae elongated, pale yellowish and bent at the mid-length. Sternum with numerous hairs and strong intercoxal extensions. Paturon dark brownish, dorsally bent, and almost 5x longer than wide. ‘a’ stout, almost the same width throughout the length, oriented towards the lateral side with a bifurcation; ‘t’ with a wide basis and blunt tip, separated from the fang basis, distally narrowing, and oriented in the same direction as ‘a’. AXu absent. Upper row of chelicerae with eight teeth: Gu triangular, stout with pointed tip; ‘T’ extremely large, projected upward, slightly displaced from the row with wide basis and curved tip; ‘rsu’ almost equally spaced, decreasing in size. AXI small, closer to the fang basis with a blunt tip. Lower row with seven teeth: G1 moderate size, directed upward, and pointed; L2 triangular, very sharp, and a large gap between G1 and L2; L3 outwardly directed and opposite to L2; L4 smaller but similar in shape to L3; L5 extremely large, followed by two teeth decreasing in size. Cheliceral fang longer, pale brownish without any cusps. Abdomen cylindrical; dorsum dark greyish with random dark greyish spots and numerous silvery guanine spots; venter dark greyish

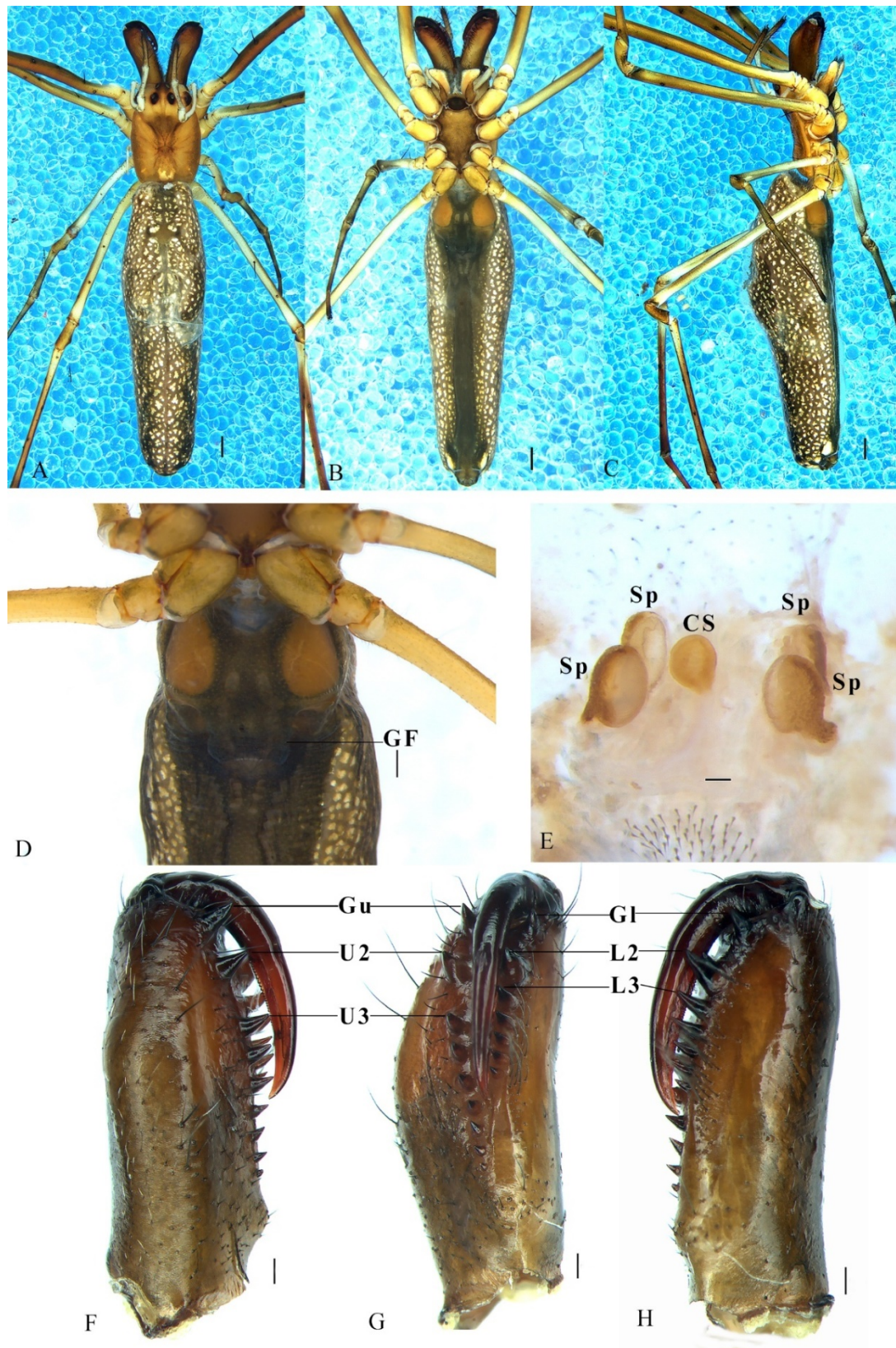


FIGURE 4.1.24. *Tetragnatha ceylonica* O. Pickard-Cambridge, 1869, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: A–C: 0.5 mm. D: 0.2 mm. E: 0.05 mm. F–H: 0.1 mm.

and laterally with numerous guanine spots. Spinnerets posteriorly placed, and a pair of silver spots on either side of the anterior spinnerets. Pedipalp with long tibia; tegulum gently slanted; moderate-sized cymbium with several spines; paracymbium elongated, occupying $\frac{3}{4}$ length of the tegulum, strongly bifurcated, translucent lobe elongated, extending towards the apex, with an extended knob at the ectal side; conductor basally bulky, twisted at mid-length, distally broad, wavy, and bifurcated; embolus dark, distally narrowing.

Measurements. Total length: 8.16. Carapace 2.46 long, 1.49 wide. Abdomen: 5.70 long, 1.04 wide. Ocular area length 0.46, width 0.51. Eye diameters: AME 0.15, ALE 0.06, PME 0.14, PLE 0.09. Clypeus height 0.12. Chelicerae 1.89 long, 0.60 wide. Palp and leg measurements: pedipalp 3.57 [1.45, 0.40, 0.71, 1.01], leg I 27.32 [7.46, 0.97, 8.05, 9.09, 1.75], II 15.33 [4.93, 0.85, 3.79, 4.79, 0.97], III 5.72 [2.21, 0.65, 1.14, 1.24, 0.48], IV 14.57 [5.07, 0.58, 3.49, 4.59, 0.84]. Leg formula: 1243.

Female (Fig. 4.1.24). Carapace, eyes, fovea, labium, maxillae and sternum as in males. Paturon short and dorsally enlarged. AXu absent. Upper row of chelicerae with nine teeth: Gu closer to fang basis, with broad base and very sharp apex; U2 triangular and protruding; U3 smaller than U2, bent at the middle and a significant gap between U2 & U3; U4–U6 equidistant; U7 upward directed; U8 very sharp; U9 with blunt apex. AXI absent. Lower row with seven teeth: G1 short and upward directed; L2 extremely larger, stout with wide basis and curved apex; L3 & L4 similar in shape but L3 much thinner; L5 & L6 parallel; L7 small and very sharp; L5–L7 almost equidistant. Cheliceral fang short, serrated, and brownish. Abdomen anteriorly constricted, then gradually enlarging and posteriorly narrowing; dorsum greyish, with numerous guanine spots, and a longitudinal stripe moves antero-

posteriorly, and a small hub at the mid-length; venter dark greyish and laterally with numerous silver guanine spots. Spinnerets posteriorly placed, and a pair of silver spots on either side of the anterior spinnerets. Epigynal fold wider than long. Internal genitalia composed of two pairs of spermathecae; anterior pair of spermathecae small, widely separated, and closer to posterior pair, posterior pair oval with highly sclerotized lateral edges; and the central membranous nearly roundish.

Measurements. Total length: 4.16. Carapace 2.57 long, 1.59 wide. Abdomen: 7.69 long, 2.26 wide. Ocular area length 0.46, width 0.49. Eye diameters: AME 0.15, ALE 0.08, PME 0.14, PLE 0.14. Clypeus height 0.10. Chelicerae 1.88 long, 0.56 wide. Palp and leg measurements: pedipalp 2.19 [0.84, 0.34, 0.63, 0.38], leg I 24.08 [7.17, 1.10, 7.03, 7.62, 1.16], II 13.84 [4.60, 0.90, 3.81, 3.73, 0.80], III 5.39 [1.37, 0.55, 1.29, 1.51, 0.67], IV 11.50 [3.99, 0.74, 3.31, 2.96, 0.50]. Leg formula: 1243.

Distribution. New Guinea, Philippines, Mozambique, India, South Africa, Thailand, Japan, Seychelles (World Spider Catalog, 2025).

***Tetragnatha cochinensis* Gravely, 1921**

Tetragnatha cochinensis Gravely, 1921: 442, figs. 4a–b (♂♀); Anju, Bhagirathan & Sudhikumar, 2021: 86, figs. 1A–H, 2A–F (♂♀).

Type material (Fig. 4.1.27). **Syntypes** ♂♀ (register number not specified) from **INDIA: Kerala:** Parambikulam, 10°26'55"N 76°49'19"E, 617 m a.s.l., collection details are not mentioned, repository **National Zoological Collections of Zoological Survey of India (NZC-ZSI)**, Kolkata, India, examined.

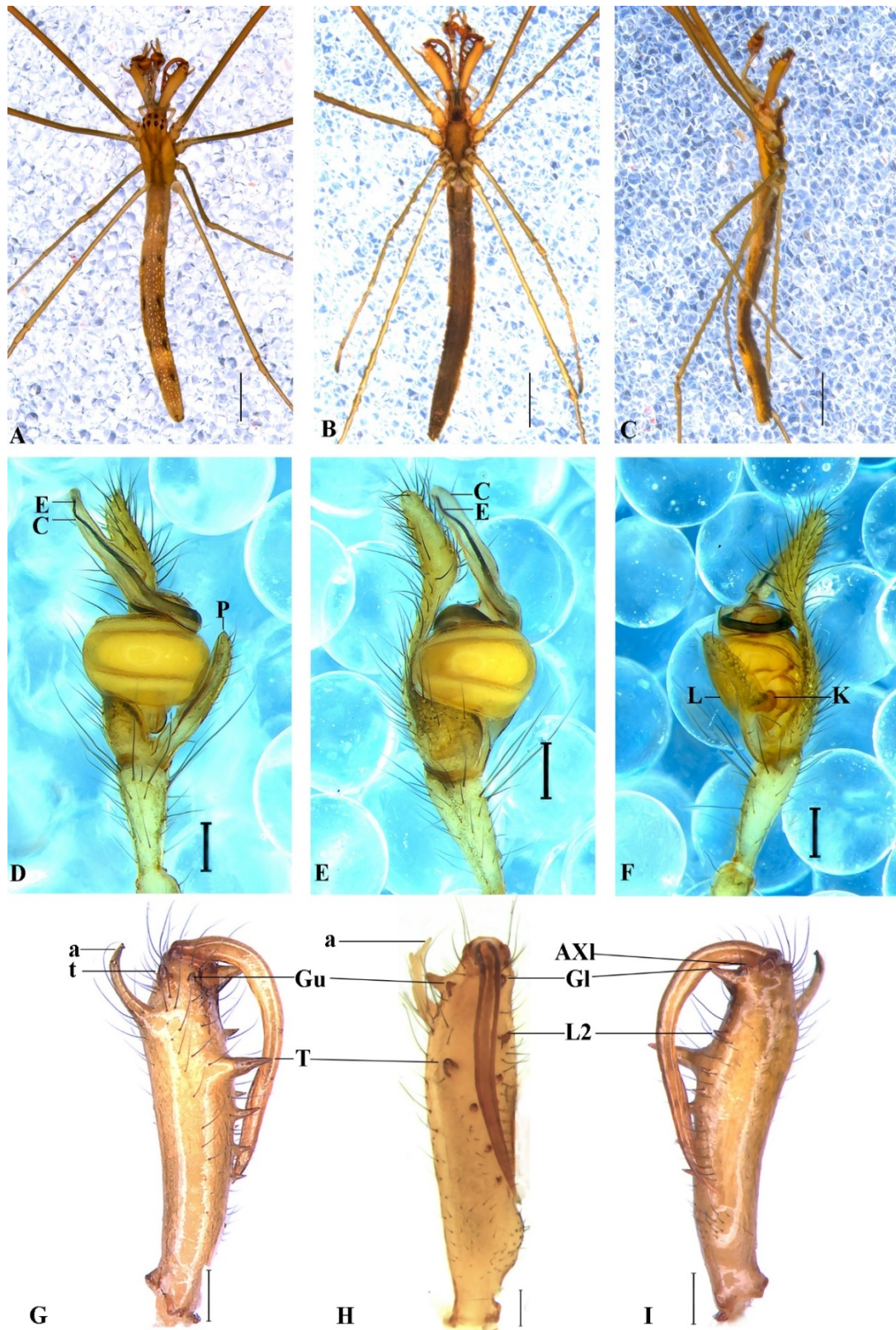


FIGURE 4.1.25. *Tetragnatha cochinensis* Gravely, 1921, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F: 0.1 mm. G–I: 0.2 mm.

Material examined. Thrissur district, Athirappilly waterfalls 10°17'11"N 76°34'16"E, 178 m, leg. Anju K. Baby & A. V. Sudhikumar, 11 August 2021, 3♂ 4♀. Wayanad district, Makkiyad 11°45'06"N, 75°53'53"E, 778 m, 26 December 2021, leg. Anju K. Baby & Manu K. Baby, 3♂ 4♀. Wayanad district, Pozhuthana reserved forest 11°35'11"N, 76°00'56"E, 762 m, 4 April 2022, leg. Anju K. Baby & Jomit P. J., 4♂ 9♀. Kasaragod district, Uppala 12°40'28"N, 74°54'15"E, 31 m, 29 September 2022, leg. Anju K. Baby & Vishnu Das E. H., 1♀.

Diagnosis. Males of *T. cochinensis* resemble to *T. geniculata* Karsch, 1892 in having similar cheliceral dentitions but can be differed from the latter in having chelicerae with long, slender and curved apophysis, 'S' absent, Gu smaller and conductor without any bifurcations. Females also similar to those of *T. geniculata* but can be distinguished by small chelicerae, AXu absent, Gu small (extremely larger in *T. geniculata*), fang without any outer cusp, genital fold long, spermathecae oval with bean-shaped central membranous sac (Anju et al., 2021a).

Redescription. Male (Fig. 4.1.25). Carapace yellow, elongated, much narrower anteriorly and with two darker thin parallel lines from the cephalic furrow, passing through the fovea, reaching the posterior region. Anterior lateral eyes are smaller and are near to posterior laterals. Clypeus pale yellow in colour. Labium elongated. Sternum light yellow with darker contour. Chelicerae light yellow in colour. 'a' very slender distally with truncate apex, directed upward and outward. 't' larger than Gu and directed upward. Gu small and a large gap between Gu and 'T'. 'T' with larger base, elongated and pointed. AXu absent. 'rsu' with four teeth evenly spaced and arranged in descending series. AXl and Gl are present on the fang base. AXl small and both sharing same basis. Gl large and slightly projected upward. L2 much

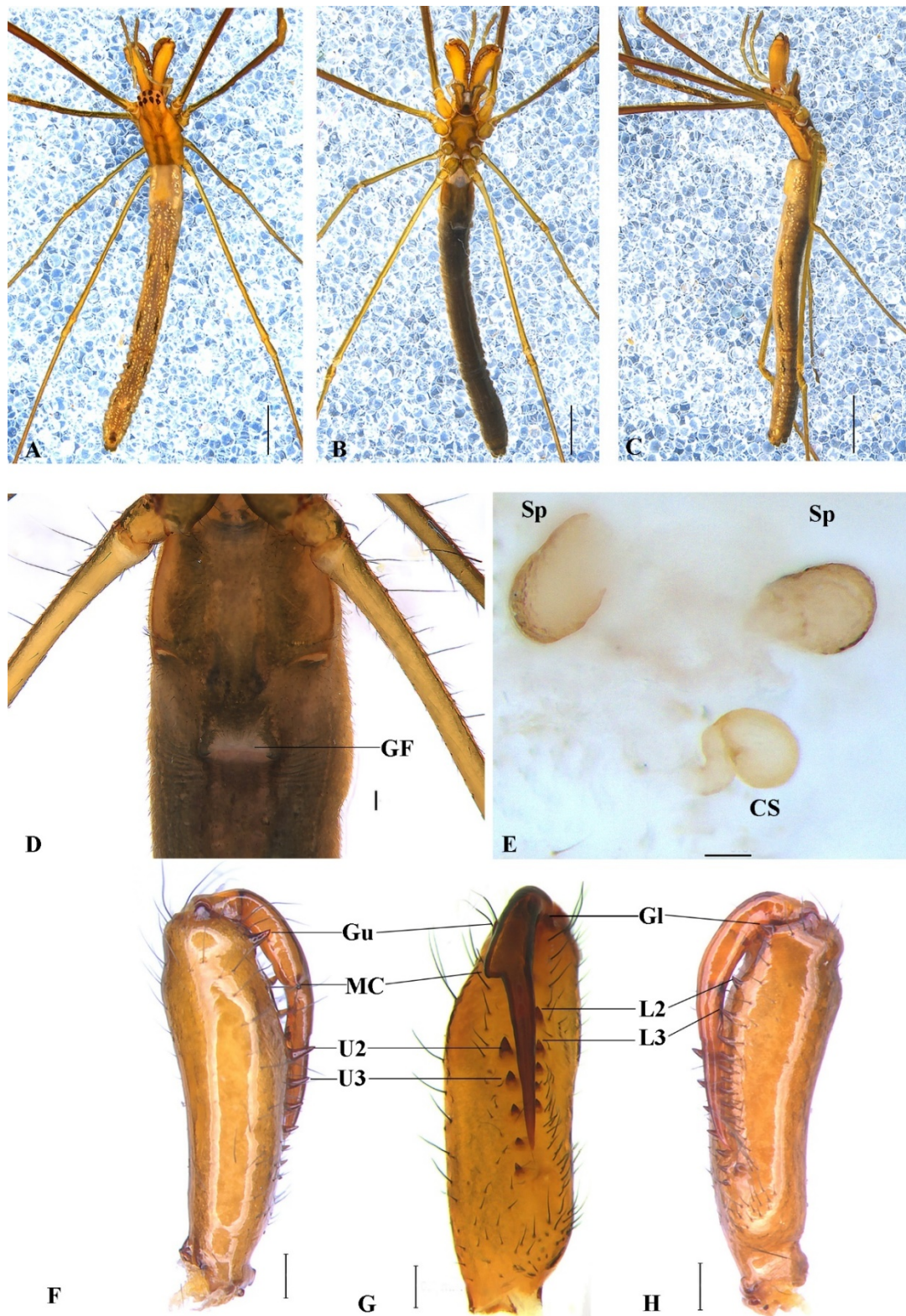


FIGURE 4.1.26. *Tetragnatha cochinensis* Gravelly, 1921, female (A–I). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. D–E: 0.05 mm. F–H: 0.2 mm.

smaller than G1 followed by four teeth. Fang without any projections. Abdomen slender, cylindrical and yellow coloured with guanine spots; black spots present in the dorsum of the abdomen and also with a black spot on the postero-dorsal region of the abdomen; venter much darker than in female. Pedipalp with elongated cymbium; paracymbium short, thick and a knob present at the ectal side; conductor almost transparent, tapering towards the apex and not twisted at the distal halves with embolus; embolus thickened proximally and relatively narrows at the distal end and originating at the middle portion of the bulb, with a long curve at the initial portion (Anju et al., 2021a).

Measurements. Total length 4.40. Carapace length 1.24 and width 0.58. Abdomen length 3.16 and width 0.38. Ocular area length 0.51, width 0.59. Eye diameters: AME 0.14, ALE 0.11, PME 0.13, PLE 0.16. Clypeus 0.09. Chelicerae 1.08 long, 0.30 wide. Palp and leg measurements: pedipalp 1.59 (0.64, 0.22, 0.22, 0.51), Leg I 14.22 (3.89, 0.41, 4.58, 4.30, 1.04), II 7.80 (2.51, 0.38, 2.10, 2.22, 0.59), III 3.57 (1.27, 0.22, 0.77, 1.10, 0.21), IV 8.23 (2.92, 0.27, 2.32, 2.16, 0.56). Leg formula 1423 (Anju et al., 2021a).

Female (Fig. 4.1.26). Carapace, eyes and sternum same as in male. Labium elongated and dark brown in colour. Chelicerae yellow and comparatively shorter than in males. Upper row of chelicerae with eight teeth: AXu absent; Gu directed upward and not much closer to the fang; U2 slightly larger than Gu, pointed and well separated; U2 opposite the fifth ventral; remaining teeth decreasing in size. Lower row with eleven teeth. G1 near to the fang base and AXl absent; L2 pointed upward and remaining nine teeth are decreasing in size; L2 and L3 larger than G1; comparatively a large round prominence found in the lower side of the retromargin. Cheliceral fang with a median cusp. Abdominal dorsum with guanine spots along

with dark spots. A noticeable black spot present on the postero-dorsal region of abdomen; venter dark without any markings. Legs slender and pale yellow in colour. Genital fold long, laterally compressed, with thick and straight tip, internally a pair of oval spermathecae, with a bean shaped central membranous sac which positioned below the plane of spermathecae (Anju et al., 2021a).

Measurements. Total length 6.45. Carapace 1.24 long and 0.75 wide. Abdomen 5.21 long and 0.46 wide. Clypeus 0.08. Ocular area length 0.59, width 0.64 Eye diameters: AME 0.17, ALE 0.09, PME 0.15, PLE 0.18. Palp and leg measurements: pedipalp 3.58 (1.52, 0.49, 0.41, 1.16), Leg I length 16.68 (5.08, 0.49, 5.48, 4.78, 0.85), leg II 9.42 (2.97, 0.39, 2.85, 2.68, 0.53), leg III 4.44 (1.60, 0.26, 0.94, 1.18, 0.46), leg IV 10.23 (3.33, 0.37, 3.08, 2.88, 0.57). Leg formula 1423 (Anju et al., 2021a).

Distribution. India.

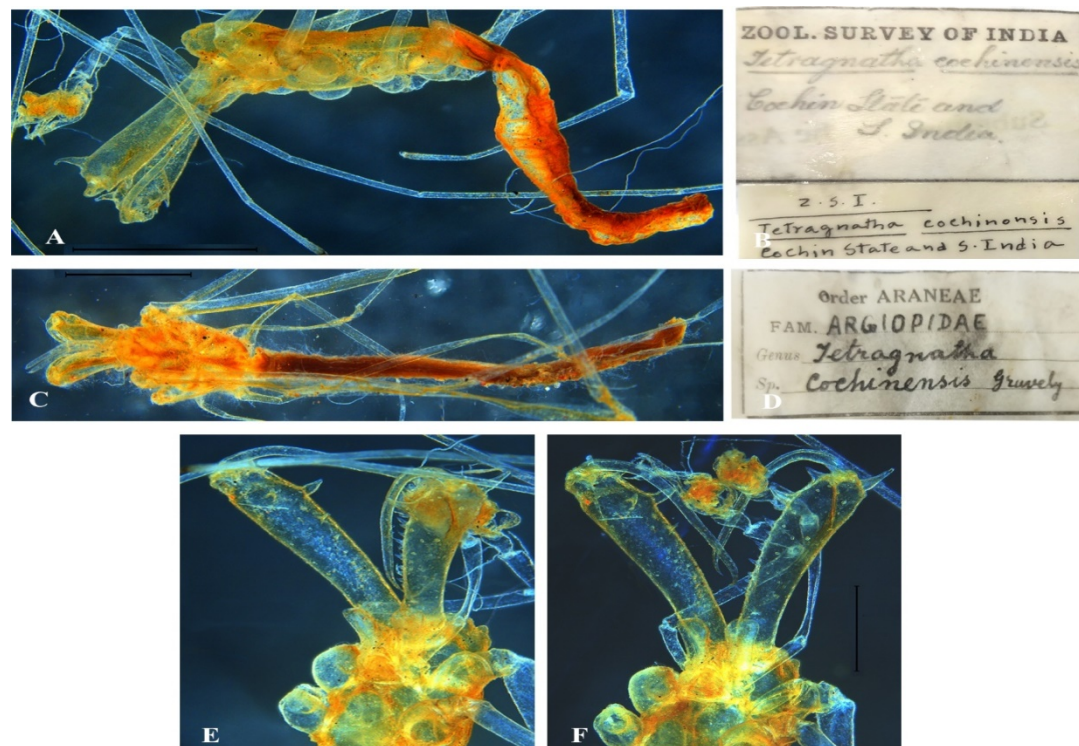


FIGURE 4.1.27. *Tetragnatha cochinensis* Gravely, 1921, syntypes, male (A, E, F). A, male habitus, lateral view, B, D, labels, C, female, dorsal view. D, E, labels. Scale bars: A–C: 1 mm. F–H: 0.1 mm. I: 0.05 mm.

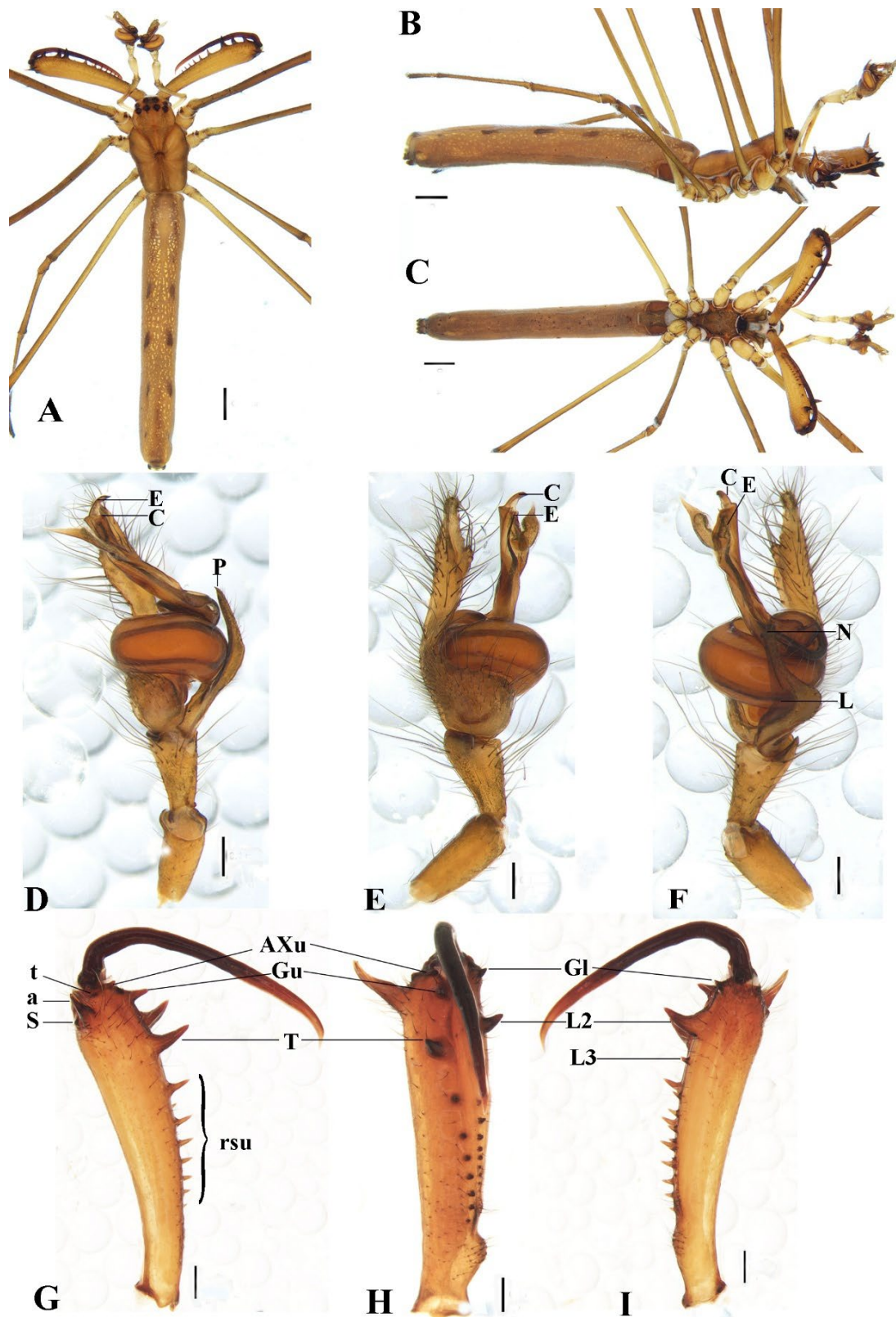


FIGURE 4.1.28. *Tetragnatha geniculata* Karsch, 1892, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–H: 0.2 mm.

***Tetragnatha geniculata* Karsch, 1892**

Tetragnatha geniculata Karsch, 1892: 286 (♀); Gravely (1921): 426, 441, fig. 3b (♀); Okuma (1988): 198, figs. 13A–L (♂♀); Zhu, Song & Zhang (2003): 138, figs. 67A–G, 68A–G (♂♀); Anju et al., 2024: 989, figs. 1A–K, 2A–I, 3A–G (♂ ♀).

Material examined: **INDIA: Kerala:** Nilgiri Biosphere Reserve, Malappuram district, Nilambur north, Nellikkuthu, 11°22'53"N 76°21'30"E, 84 m, 11 October 2021, leg. Anju K. Baby, 3♂ 5♀. Same collection data as for preceding (ZSI/WGRC/I. R.INV.23643) 1♂, 1♀. Wayanad district, Vythiri, 11°36'36"N 75°59'11"E, 1082 m, 11 December 2021, leg. Anju K. Baby & Manu K. Baby, 2♂ 6♀. Kottayam district, Kattikkayam water falls, 9°46'35"N 76°48'25"E, 581 m, 14 December 2022, leg. Anju K. Baby & Roshna V. Shaju, 4♂ 5♀, 2 juveniles. Agasthyamalai Biosphere Reserve, Thiruvananthapuram district, Neyyar Wildlife Sanctuary, 8°32'02"N 77°09'00"E, 98 m, 29 December 2022, leg. Anju K. Baby & Rajesh, 3♂, 6♀. Idukki district, Kanthalloor 10°12'15"N, 77°12'19"E, 718 m, 11 January 2024, leg. Anju K. Baby & Greeshma T. S., 5♂ 6♀.

Diagnosis: Males of *T. geniculata* Karsch, 1892 differ from all other *Tetragnatha* by the extremely bifurcated conductor with a conspicuous flap. Females are most similar to those of *T. chauliodus* (Thorell, 1890). Both species have elongated and slender bodies with dorsal black spots, Gu long, closer to fang basis and a large crest in between Gu and U2, AXI absent, GI closer to fang basis, cheliceral fang with strong median cusp, and similar shaped genital fold (Castanheira & Baptista, 2020: figs. 10D–I). Nevertheless, *T. geniculata* can be separated from *T. chauliodus* by the following characters: chelicerae with AXu present, Gu stronger with wide basis,

cheliceral fang with strong outer cusp and basal cusp absent, and genital fold slightly shorter (Castanheira & Baptista, 2020: figs. 10A–H).

Redescription. Male (Fig. 4.1.28, Fig. 4.1.30A, B, F). Carapace yellowish brown, flat, elongated with dark contour, olive green spots arising from ocular region, darker near fovea and extend towards posterior rim; cephalic groove distinct and dark. AMEs raised, closely placed than PMEs, AME and ALE with large gap, PME and PLE with moderate gap, anterior row strongly recurved, ocular quadrangle wider than long. Fovea distinct, circular, deep, and dark. Labium dark and subquadrate. Sternum olive green, slightly elevated with sparse setae and strong intercoxal extensions. Chelicerae with paturon elongated, gently curved dorsally, almost 6× longer than wide, enlarged anteriorly and gradually narrowing towards posterior region, and yellowish brown, darkening towards upper side. ‘a’ with bifurcated tip, laterally with small conspicuous swelling ‘S’; ‘t’ vestigial, knoblike, about same size as ‘S’, located close to fang basis and centrally placed. Upper row with nine teeth: AXu with blunt tip, close to fang basis; Gu protruding with wide basis, directed downward, ‘T’ stout, clearly bent towards upside, pointed, and elongated, distance between ‘T’ and Gu is almost similar to distance between ‘T’ and U3; ‘rsu’ with seven pointed teeth decreasing in size and almost equally spaced. AXI absent. Lower row with eleven teeth: G1 short with wide basis near to fang basis, distal half gently bent upside; L2 very strong with stout basis, separated from G1 by a large distance; L3 thorn-like, distance between L2 and G1 almost equal to distance between L2 and L3; L4 slightly shorter than L5 and L5–L11 decreasing in size with similar gap distance. Cheliceral fang slender, slightly constricted at middle, and dark brown with yellowish brown apex curved inward. Legs yellowish brown. Abdomen

cylindrical, elongated with round tip; dorsum brownish yellow with guanine spots and five pairs of black stripes on sides, venter with wrinkles and a pair of pale-yellow markings beyond the spinnerets. Pedipalps with short tibia; cymbium long with broad basis; tegulum wider than long, spherical, medially yellowish-brown with two parallel transverse dark stripes; conductor distal half with single twist, bifurcated apex with a conspicuous large flap. Embolus dark, proximally stout, distally tapering, originating from the middle of tegulum near paracymbium, initially directed upside then downward up to midway of length and completely enfolded with conductor. Paracymbium long, slanted inward, reaching above the tegulum, initially constricted, medially enlarged with narrowed distal end, apex with distinct divided notch, blunt knob at the ectal side which is broad and dark, translucent lobe wide and long extending towards apex and occupying about half of the paracymbium width.

Measurements: Total length 11.37. Carapace length 2.94, width 1.51. Abdomen length 8.43, width 0.74. Ocular area length 0.61, width 0.93. Eye diameters: AME 0.15, ALE 0.10, PME 0.14, PLE 0.18. Clypeus height 0.11. Length of chelicerae 3.23, width 0.56. Pedipalp and leg measurements: pedipalp 3.92 [1.69, 0.56, 0.42, 1.25], leg I 37.50 [10.64, 0.93, 10.96, 12.79, 2.18], II 19.80 [5.64, 0.76, 5.69, 6.39, 1.32], III 9.27 [3.43, 0.48, 1.93, 2.66, 0.77], IV 21.48 [7.23, 0.65, 5.73, 6.75, 1.12]. Leg formula: 1423.

Female (Fig. 4.1.29, 4.1.30C, D). Carapace, eyes, fovea, labium, sternum and legs as in male. Chelicerae with paturon slender, dorsally curved inward, 7× longer than wide, and yellow. AXu small, close to fang basis, share same basis with Gu, directed outward with blunt apex. Upper row with eight teeth: Gu extremely bulky, with stout basis, protruding; U2 smaller than U3, triangular, distance between Gu and U2 is

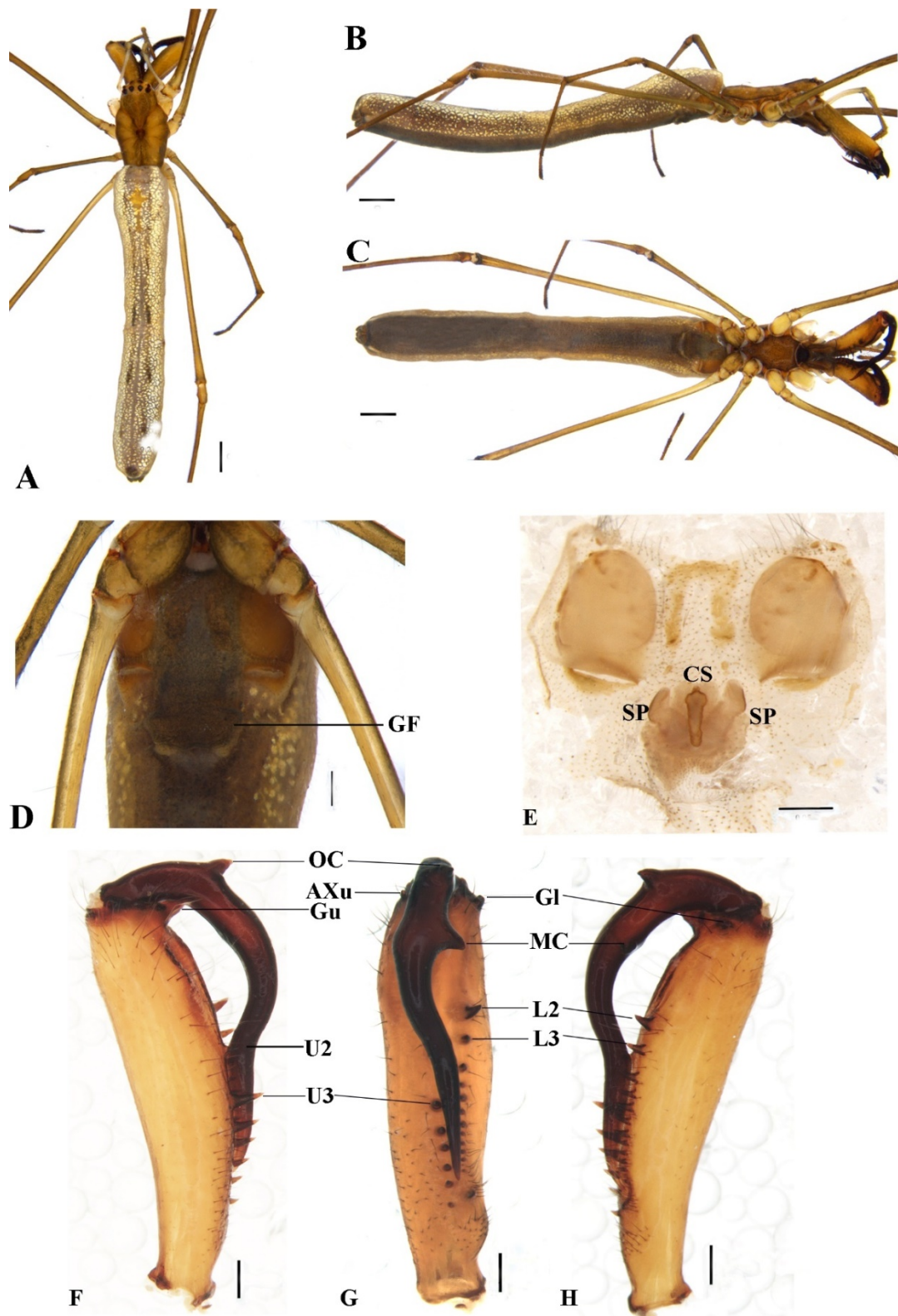


FIGURE 4.1.29. *Tetragnatha geniculata* Karsch, 1892, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. D–E: 0.05 mm. F–H: 0.2 mm.

almost 3× larger than distance between U3 and U2; U3–U8 pointed and decreasing in size. AXI absent. Lower row with fourteen pointed teeth: G1 small, close to fang basis, directed outward; L2 with about the same size of L3 and L4, L5–L14 decreasing in size. Cheliceral fang with stout basis, proximally bent, uniformly tapering to apex, curved medially below the median cusp, distal half inserted between two rows of teeth, bearing strong median and outer cusps, with protruding tips. Abdomen as in male but bulkier. Genital fold slightly elevated, 2× longer than wide, anteriorly constricted, wide at the midway with gently curved apex; Internal genitalia composed of pair of oval spermathecae, highly sclerotized, connected to central membranous sac, nearly subquadrate with long, tubular and stout stalk.

Measurements: Total length 11.75. Carapace length 3.07, width 1.58. Abdomen length 8.68, width 0.85. Ocular area length 0.61, width 0.93. Eye diameters: AME 0.19, ALE 0.11, PME 0.17, PLE 0.20. Clypeus height 0.12. Length of chelicerae 3.69, width 0.53. Pedipalp and leg measurements: pedipalp 3.92 [1.69, 0.56, 0.42, 1.25], leg I 39.87 [11.82, 1.06, 11.71, 12.95, 2.33], II 22.53 [7.41, 0.94, 5.98, 6.83, 1.37], III 10.77 [4.11, 0.54, 2.26, 2.95, 0.91], IV 23.74 [8.49, 0.76, 6.34, 6.86, 1.29]. Leg formula: 1423.

Distribution. Myanmar, Vietnam, China, Sri Lanka, Thailand, India (World Spider Catalog, 2025).

***Tetragnatha hasselti* Thorell, 1890**

Tetragnatha hasseltii Thorell, 1890: 217 (♀); Merian, 1911: 185, figs. C–J (♂♀);

Okuma, 1988a: 190, figs. 6A–K (♂♀).

Tetragnatha aduncata Wang, 1991: 159, figs. 25–30 (♂♀).

Tetragnatha hasselti Okuma et al., 1993: 42, figs. 38A–G (♂♀); Song et al., 1999: 221, figs. 126C, J, 127K–L (♂♀); Zhu et al., 2003: 142, figs. 70A–G, 71A–G (♂♀).

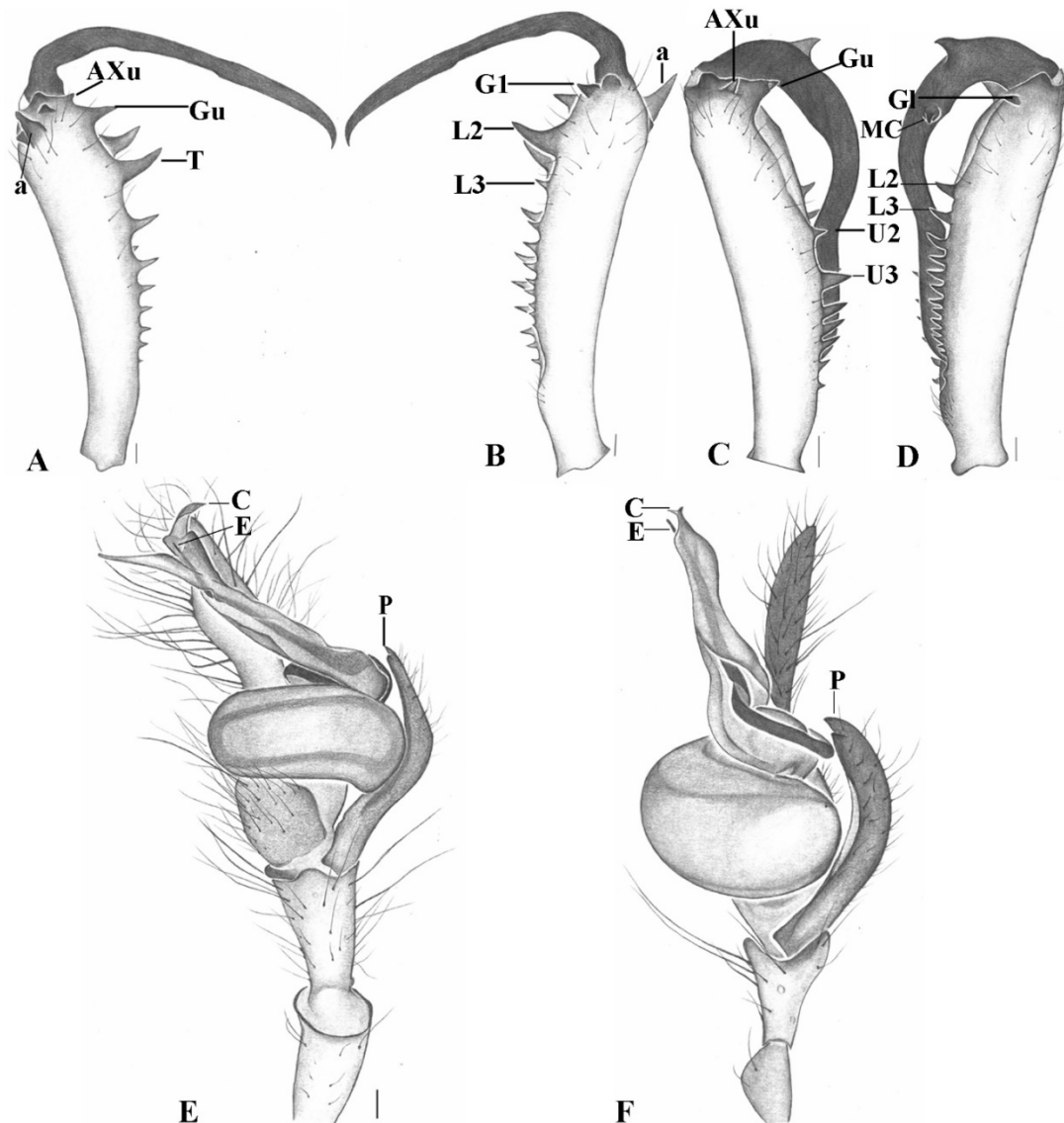


FIGURE 4.1.30. *Tetragnatha geniculata* Karsch, 1892, male (A, B, E). Left chelicerae (A, B), A, dorsal view, B, ventral view. Left palp, E, ventral view. Female (C, D). Left chelicerae, C, dorsal view, D, ventral view. *Tetragnatha lautata* Yaginuma, 1959, male (F), left palp, F, ventral view. Scale bars: A–F: 0.2 mm.

Tetragnatha zhuzhenrongi Barrion, Barrion-Dupo & Heong, in Barrion et al., 2013: 33, figs. 37A–F (♀).

Tetragnatha hasselti Sen et al., 2015: 99, figs. 574–579, plate. 20 (♂); Basu & Raychaudhuri, 2016: 223, figs. 26–30, 58–61 (♀); Lin et al., 2023: 517 (synonymy of *Tetragnatha zhuzhenrongi*).

Tetragnatha andamanensis Tikader, 1977: 175, figs. 10A–E (♂♀); Biswas & Raychaudhuri, 1996: 50, figs. 9–16 (♂♀), New synonymy.

Type materials. *Tetragnatha hasselti*. **Holotype** (Fig. 3.1.33) female from **INDONESIA: Celebes:** Gorontalo 0° 32' 32" N, 123° 3' 41" E, collection date not specified, leg. Van Hasselt, repository **Swedish Museum of Natural History (SMNH)**, Stockholm, Sweden, register number: 656a, examined. *T. andamanensis*. **Paratype** (Fig. 3.1.34) female from **INDIA: South Andaman:** Chiriatapu 23°09'2"N, 79°58'35"E, 436 m a.s.l., 25 August 1971, leg. B. K. Tikader, repository **National Zoological Collections of Zoological Survey of India (NZC-ZSI)**, Kolkata, India (no register number specified), examined.

Material examined. Kozhikode district, Peruvannamuzhi dam 11°35'51"N, 75°49'27"E, 100 m, 21 April 2022, leg. Anju K. Baby & Manu K. Baby, 2♀. Wayanad Wildlife Sanctuary, Tholpetty 11°57'04"N 76°03'43"E, 883 m, 9 June 2023, leg. Anju K. Baby & Manu K. Baby, 1♀.

Diagnosis. Males of *T. hasselti* somewhat similar to that of *T. viridorufa* Gravely, 1921 but can be differentiated from the latter by the following characteristics: conductor distally curved but without any bifurcations (vs. conductor with strong bifurcation in *T. viridorufa*), U2 extremely smaller, L2 larger almost similar size of Gu. Females also show similarities to *T. viridorufa* Gravely, 1921 but can be distinguished from the latter in having moderate-sized chelicerae (vs. extremely elongated chelicerae in *T. viridorufa*), Gu stout and blunt, a large gap between Gu and U2 than U2 and U3, G1 and L2 large and internal genitalia with two rows of spermathecae (while single pair of spermathecae in *T. viridorufa*).

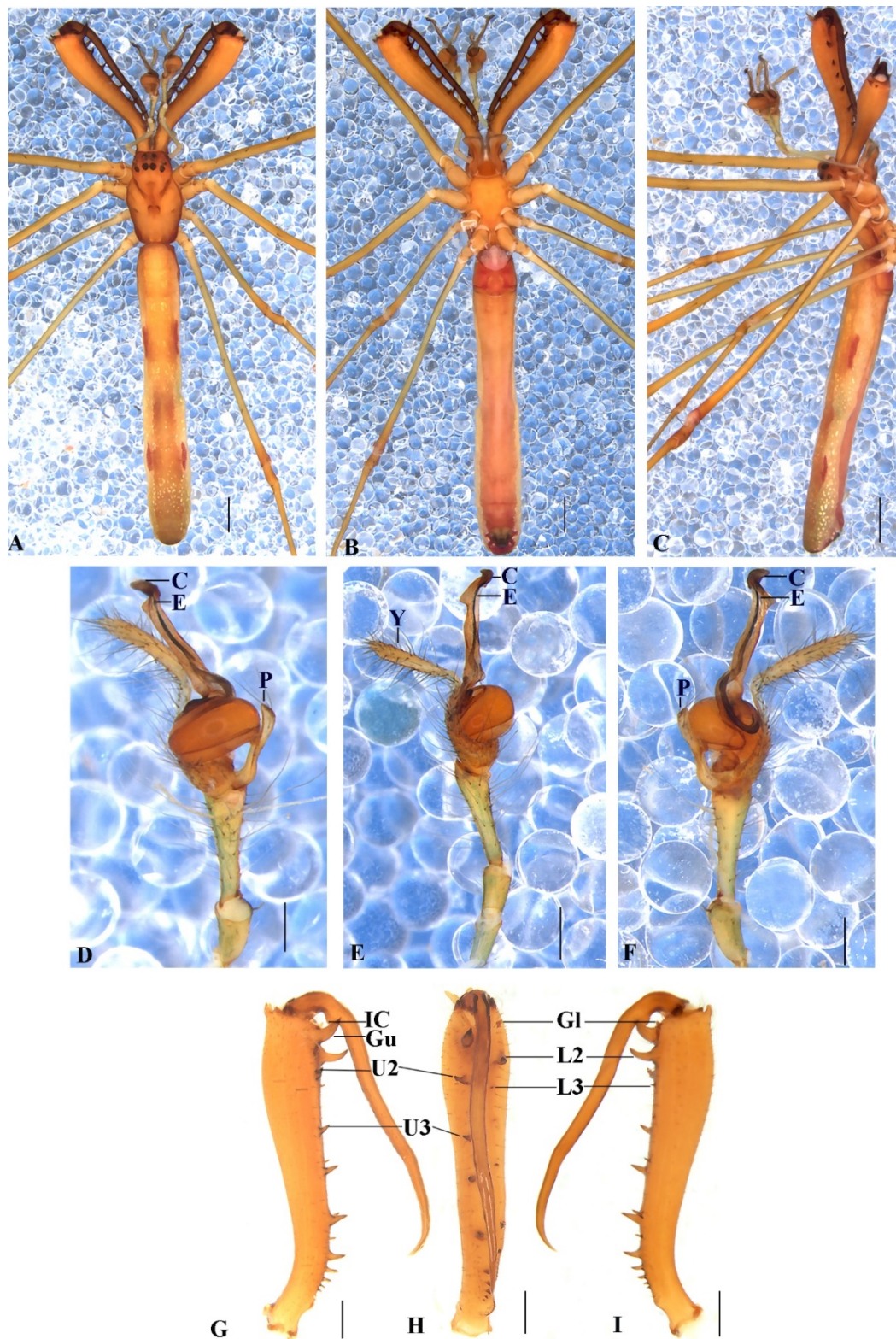


FIGURE 4.1.31. *Tetragnatha hasselti* Thorell, 1890, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.2 mm.

Redescription. Male (Fig. 4.1.31). Carapace extremely elongated, pale yellowish with greenish contour; cephalic region distinct with nearly roundish green markings. Two rows of eyes are recurved, PMEs closer than AMEs. Fovea oval and deep. Labium subquadrate. Maxillae elongated, anteriorly broad, with distinct scopulae. Sternum greenish with a brownish contour and strong intercoxal extensions. Chelicerae slender and extremely elongated. Upper row of chelicerae with ten teeth; Gu extremely large and curved with pointed apex; U2 smaller than U3, blunt and directed upward; U3 linear, U4 triangular; the distance between U3, U4, and U5 almost equal; U6–U10 decreasing in size. Lower row six teeth; G1 very small close to fang basis; L2 larger and almost similar size and shape of Gu; L3 minute and straight; L4 directed upward and a large gap between L3 and L4; L5 moderate sized; L6 closer to L5. Cheliceral fang long with a distinct inner cusp. Abdomen elongated, greenish, laterally with red markings; venter elevated. Pedipalp with long tibia and slanted tegulum; paracymbium curved and extends to the middle region of tegulum; cymbium slender; conductor long and the apex strongly curved; embolus filiform and curved at the apex.

Measurements. Total length: 6.41. Carapace 1.98 long, 1.38 wide. Abdomen: 4.43 long, 0.47 wide. Ocular area length 0.28, width 0.27. Eye diameters: AME 0.09, ALE 0.02, PME 0.07, PLE 0.05. Clypeus height 0.07. Chelicerae 1.85 long, 0.44 wide. Palp and leg measurements: pedipalp 3.34 [1.11, 0.52, 0.41, 1.30], leg I 36.81 [12.17, 2.10, 9.27, 10.16, 3.11], II 21.24 [7.41, 0.83, 4.77, 6.12, 2.11], III 7.87 [1.99, 0.65, 1.87, 2.48, 0.88], IV 17.85 [7.12, 0.50, 5.10, 4.11, 1.02]. Leg formula: 1243.

Female (Fig. 4.1.32). Carapace, eyes, fovea, labium, maxillae, and sternum as in males. Chelicerae elongated, paturon almost 3x longer than wide, dorsally with numerous pale brown roundish markings. AXu absent. Upper row of chelicerae with

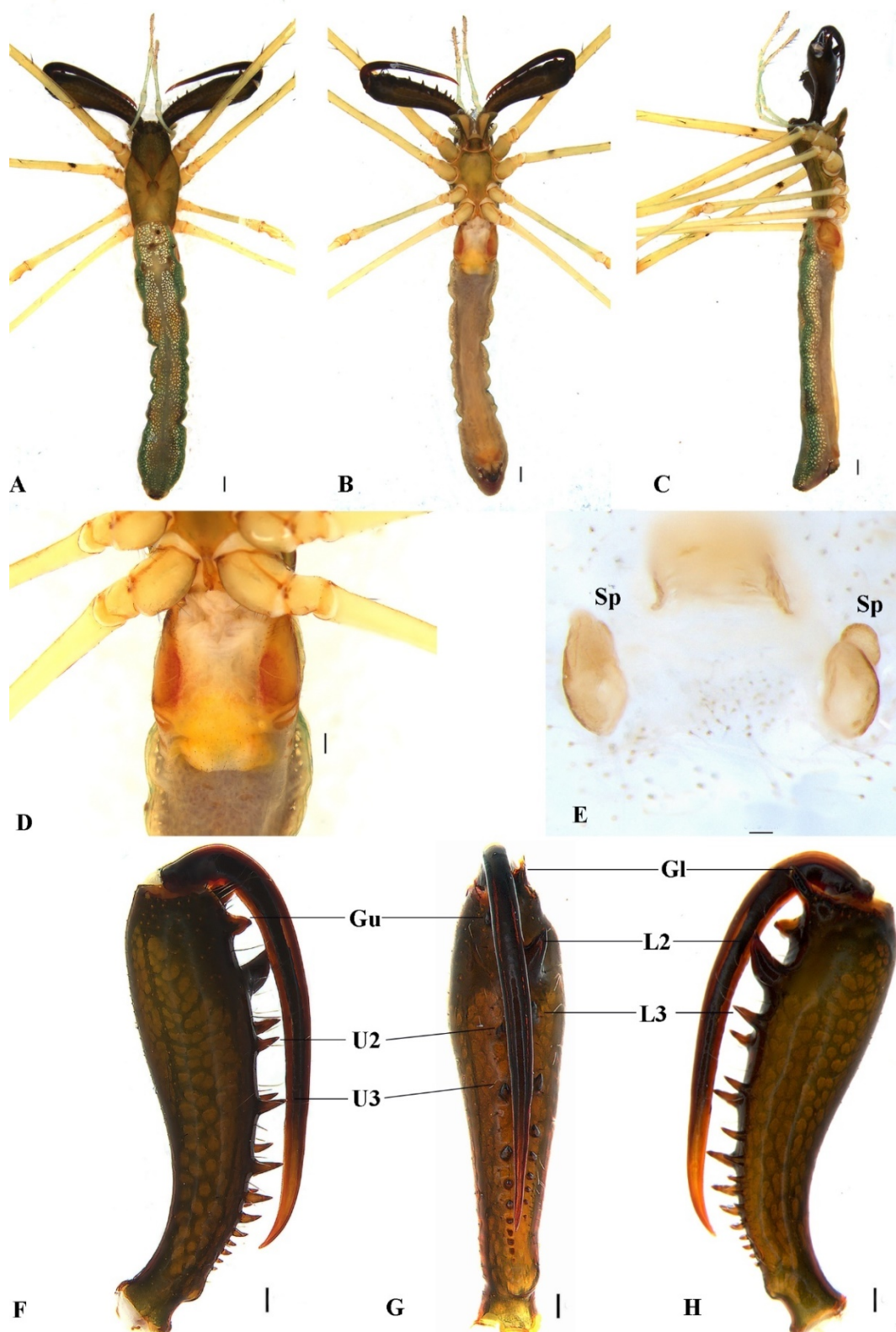


FIGURE 4.1.32. *Tetragnatha hasselti* Thorell, 1890, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. D–E: 0.02 mm. F–H: 0.05 mm.

ten teeth: Gu stout, outward directed with blunt apex; U2 bent at the middle towards the upper side with protruding apex; U3 longer than U2; U4 slanted; U5 linear; U5–U10 decreasing in size. AXI absent. Lower row with ten teeth: G1 extremely large with wide basis, closer to fang basis with blunt apex; L2 stouter than G1 and strongly slanted towards the upper side; L3 smaller; L4 linear with pointed apex; L5 slanted; L6–L10 decreasing in size and equidistant. Cheliceral fang brownish and without any cusps. Abdomen elongated: dorsum greenish with silver and yellow guanine spots, and posteriorly with a pale dark spot; venter elevated, greyish without any markings. Epigynal fold short and wider than long. Internally, two pairs of spermathecae; anterior pair of spermathecae oval, small, and widely separated; posterior pair oval, two times larger than the anterior pairs and parallel to the anterior pairs; and the connecting stalk are indistinct.



FIGURE 4.1.33. *Tetragnatha hasselti* Thorell, 1890, holotype, female (A–F). A, female habitus, dorsal view, D, ventral view. Chelicerae (B, C), B, dorsal view, C, ventral view. E, epigynum, ventral view. F, labels. Scale bars: A–D: 0.5 mm. B, C, E: 0.2 mm.



FIGURE 4.1.34. *Tetragnatha andamanensis* Tikader, 1977, paratype, female (A–D). A, female habitus, dorsal view, C, ventral view. Chelicerae, B, ventral view. D, label. Scale bars: A, C: 2 mm. B: 0.2 mm.

Measurements. Total length: 6.53. Carapace 2.02 long, 1.43 wide. Abdomen: 4.51 long, 0.59 wide. Ocular area length 0.29, width 0.28. Eye diameters: AME 0.09, ALE 0.03, PME 0.08, PLE 0.07. Clypeus height 0.07. Chelicerae 1.79 long, 0.54 wide. Palp and leg measurements: pedipalp 3.39 [1.23, 0.44, 0.64, 1.08], leg I 36.41 [11.21, 1.45, 10.29, 11.20, 2.26], II 19.42 [6.31, 0.55, 5.60, 5.59, 1.37], III 8.41 [2.77, 0.61, 1.78, 2.48, 0.77], IV 18.32 [6.44, 0.60, 4.78, 5.21, 1.29]. Leg formula: 1243.

Justification for synonymy. Tikader (1977) originally described *T. andamanensis* on the basis of a female specimen collected from Chiriatapu, located in South Andaman, India and a male specimen collected from Delanipur in Andaman Island. In the absence of a holotype, we examined the paratype of *T. andamanensis* and observed that the cheliceral and body morphology of this species exactly matches with the holotype *T. hasselti* (which was deposited in the Swedish Museum of Natural History), where both have Gu slightly set apart from the cheliceral basis and

the remaining teeth decrease in size, the lower row with slightly curved G1 and fangs without any cusps. Therefore, *T. andamanensis* could be designated as the junior synonym of *T. hasselti*.

Distribution (Fig. 3.1.35). Indonesia, China, India (World Spider Catalog, 2025).

***Tetragnatha jaculator* Tullgren, 1910**

Tetragnatha jaculator Tullgren, 1910: 150, plate 3, figs. 73 (♂♀).

Tetragnatha argyroides Mello-Leitão, 1945b: 243, figs. 20–21 (♂).

Tetragnatha jaculator Castanheira & Baptista, 2021b: 3047, figs. 56–81 (♂♀, synonymy of *T. argyroides*, *T. lewisi* and *T. riveti*; *T. riveti* revalidated by Dupérré, 2023: 216); Dippenaar-Schoeman et al., 2023: 40, figs. 1–8 (♂♀).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. Wayanad district, Thrissilery, Paddyfield 11°50'36"N, 76°01'42"E, 795 m, 01 December 2023, leg. Anju K. Baby, 4♂ 7♀.

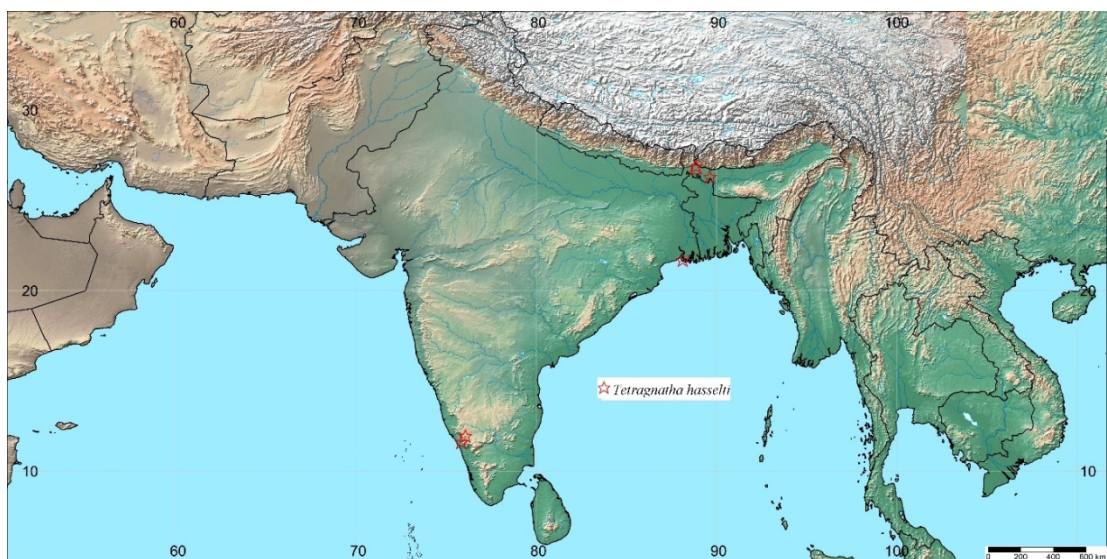


FIGURE 4.1.35. Distribution of *Tetragnatha hasselti* in India.

Diagnosis. *T. jaculator* resembles to *T. lauta* Yaginuma, 1959 but can be distinguished from the latter in having chelicerae with bifurcated ‘a’, small ‘t’ and protruding ‘sl’, strongly slanted tegulum and filiform embolus. Females of the species can be separated from the latter in having moderate-sized chelicerae, large Gu, oval spermathecae with small central membranous sac (in *T. lauta*, spermathecae extremely elongated and central membranous sac absent).

Redescription. Male (Fig. 4.1.36). Carapace pale yellow and olive-green spots arising near the ALEs and reaching to fovea. Anterior eyes smaller than posterior eyes, AMEs are on the tubercle, PMEs centrally placed, AME and ALE with large gap, PME and PLE with moderate gap; cephalic groove distinct and dark. Clypeus pale yellow. Fovea deep with inverted U-marking. Labium pale yellow and long. Sternum yellowish with olive green patches. AXu absent. ‘t’ small knob like set apart from the row; sl protruding, linear with wide basis, and sharing same basis with ‘T’. Upper row of chelicerae with seven teeth: Gu smaller, blunt, and closer to fang basis; ‘T’ extremely elongated and strong; ‘rsu’ four in number and decreasing in size. AXI present. Lower row with seven teeth: G1 large, straight and pointed; L2 directed outward; L3 upright; L4 blunt and larger than L3; L5 & L6 similar in shape; L7 smaller. Cheliceral fang long, brownish, and distally curved. Abdomen cylindrical, short, yellow with numerous guanine spots; venter without any markings. Pedipalp with short tibia; tegulum fairly slanted, embolus filiform and enfolded with the conductor without apex, and protruding. cymbium short and spinous with long paracymbium.

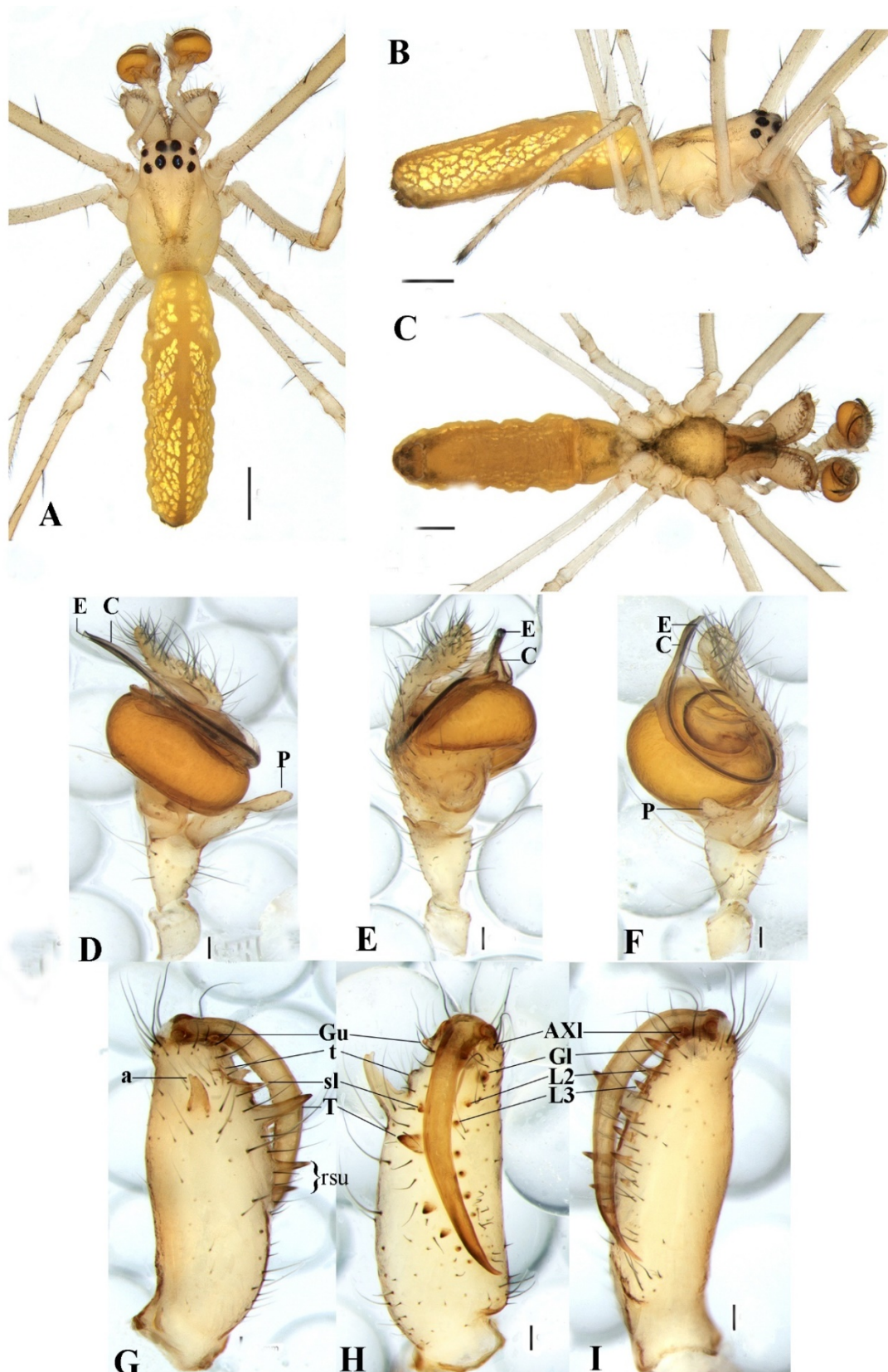


FIGURE 4.1.36. *Tetragnatha jaculator* Tullgren, 1910, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.1 mm.

Measurements. Total length 4.82. Carapace 1.77 long 0.98 wide. Abdomen 2.95 long 0.76 wide. Ocular area length 0.27, width 0.22. Eye diameters: AME 0.09, ALE 0.05, PME 0.15, PLE 0.10. Clypeus height 0.07. Left chelicera 0.72 long 0.39 wide. Pedipalp and leg measurements: pedipalp 1.09 [0.32, 0.10, 0.16, 0.51], leg I 13.57 [3.67, 0.69, 4.01, 4.11, 1.09], II 8.59 [2.56, 0.57, 2.23, 2.37, 0.86], III 4.35 [1.22, 0.39, 0.94, 1.14, 0.66], IV 8.54 [2.88, 0.37, 2.29, 2.32, 0.68]. Leg formula: 1243.

Female (Fig. 4.1.37). Carapace yellowish orange, elongated, with dark contour, pale brownish spots arising from the ocular area and extends towards the fovea. Eyes, clypeus, fovea, labium and legs as in males. Sternum brownish yellow with dark contour, single row of hairs on the anterior region. Paturon yellow, long, almost 3x longer than wide, dorsally flattened and anteriorly constricted, then almost same width throughout length. AXu absent. Upper row of chelicerae with eight teeth: all teeth are pointed, Gu with strong basis, very sharp and distal half slightly bent towards upper side; U2 straight, longer than Gu, protruding and a considerable gap between Gu and U2; U3 about similar shape to U2, U4 smaller than U3 and slightly bent at the midway; U5 thinner, U3–U5 parallel, U6 linear, directed outward with acute tip; U7 strongly directed upward, U8 very small with stout basis and distally pointed. AX1 absent. Lower row with eight teeth; G1 with stout basis, thumb-shaped, pointed, opposite to Gu; L2 long, directed upward and a moderate gap between G1 and L2; L3 straight, triangular and opposite to U2; L4 & L5 about similar shape and linear, L5 shorter than L4; L6 with stout basis, slightly curved distal half and gradually narrowing towards the apex; L7 not much sharp, L8 very small and pointed. Cheliceral fang brownish, without cusps, serrated, and curved inwards distally. Abdomen short, stout, anteriorly constricted, medially enlarged and consistently narrowing towards the posterior region; dorsally with a yellowish

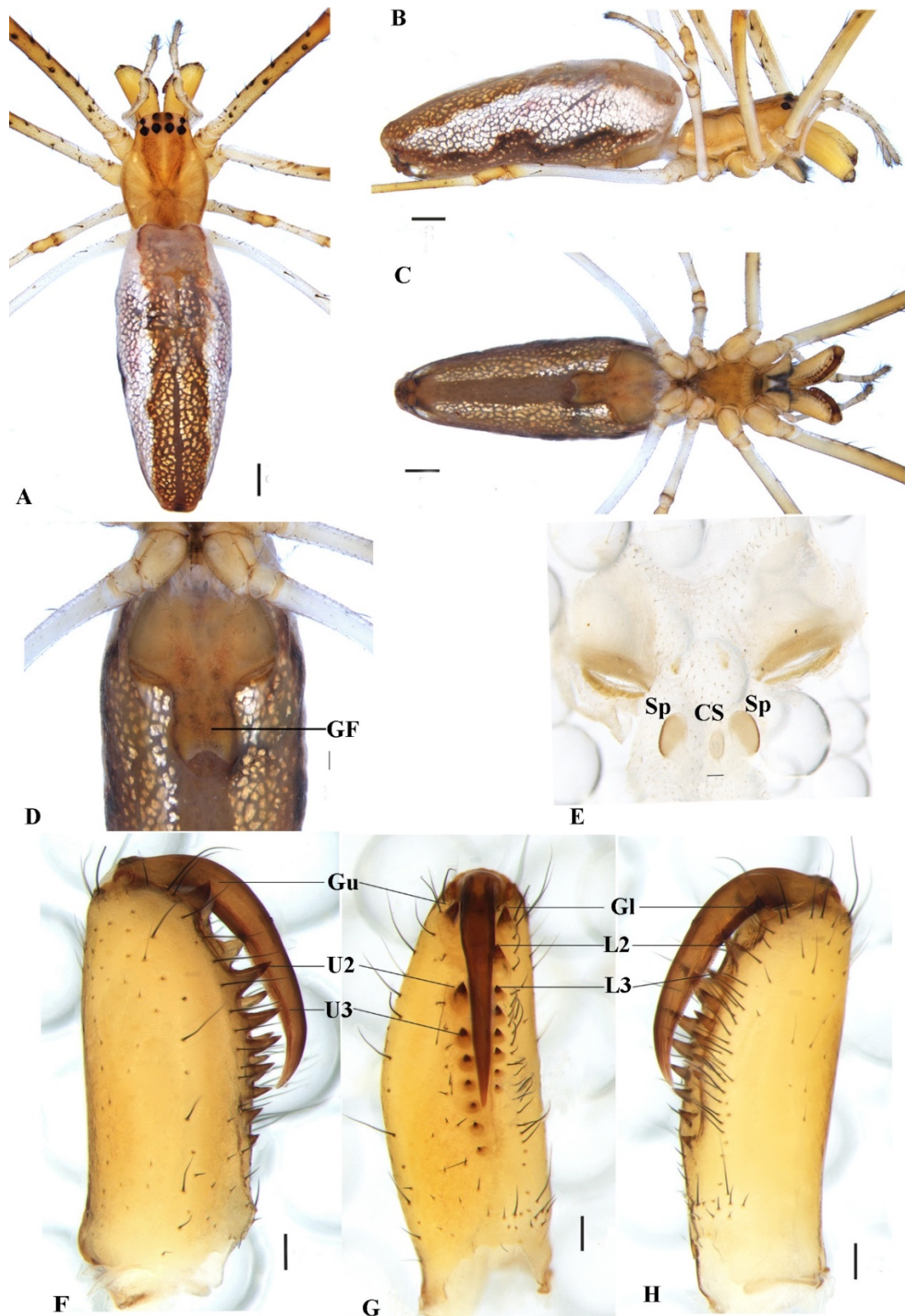


FIGURE 4.1.37. *Tetragnatha jaculator* Tullgren, 1910, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.1 mm.

orange broad patch extending along the entire length of the abdomen, laterally with silvery spots, with dark brownish asymmetrical contour; venter greyish with similar lateral silvery spots, medially with a longitudinal greyish band extending from epigynal fold to anterior spinnerets, posteriorly with a pair of pale black slanted patches beyond the anterior spinnerets. Epigynal fold short, wider than long, slightly enlarged distal half with blunt edge. Internal genitalia composed of a pair of spermathecae, oval-shaped, slanted inward with dark brownish lateral edges; central membranous sac small, oval-shaped, transparent with short stalk.

Measurements: Total length 6.16. Carapace 1.71 long, 1.17 wide. Abdomen: 4.45 long, 1.79 wide. Ocular area length 0.29, width 0.24. Eye diameters: AME 0.11, ALE 0.06, PME 0.15, PLE 0.11. Clypeus height 0.06. Chelicerae 1.19 long, 0.42 wide. Epigynal fold 0.56 long, 0.62 wide. Pedipalp and leg measurements: pedipalp 2.25 [0.79, 0.21, 0.48, 0.77], leg I 13.17 [3.87, 0.61, 3.86, 3.71, 1.12], II 8.88 [2.65, 0.55, 2.37, 2.40, 0.91], III 4.25 [1.33, 0.42, 0.91, 1.05, 0.54], IV 8.69 [2.92, 0.48, 2.20, 2.36, 0.73]. Leg formula: 1243.

Distribution. South America, Africa, Caribbean, China, New Guinea, India, Indonesia (World Spider Catalog, 2025).

***Tetragnatha javana* (Thorell, 1890)**

Eucta javana Thorell, 1890: 236 (♂); Thorell, 1895: 146 (♀).

Arundognatha vermiventr Brignoli, 1983: 221 (transferred female from *Tetragnatha*).

Tetragnatha javana Dimitrov & Hormiga, 2009: 104, figs. 67A–G, 68A–I, 69A–D (♂); Yin et al., 2012: 456, figs. 207a–g (♂♀), Sen et al., 2015: 99, figs. 563–567,

plate 20 (♀); Basu & Raychaudhuri, 2016: 218, figs, 1–5, 36–39 (♀); Anju et al., 2024b: 995, figs. 9A–D (♀, synonymy of *T. chamberlini*).

(For complete list of references, see World Spider Catalog, 2025).

Type material. Allotype (Fig. 4.1.38) ♀ (no register number specified) from **MYANMAR: Tharrawaddy**, north of Rangoon, leg. Eugene W. Oates, repository the **Natural History Museum (NHM)**, London (no register number), examined. *T. chamberlini*. **Holotype** (Fig. 4.1.39) female from **INDIA: Madhya Pradesh: Jabalpur**, Pachpedi, 23°09'2"N, 79°58'35"E, 436 m a.s.l., 7 July 1997, leg. P. Gajbe, repository **National Zoological Collections of Zoological Survey of India (NZC-ZSI)**, Kolkata, India (no register number specified), examined.

Material examined. Thrissur district, Pullu Kol Wetlands 10°27'26"N, 76°09'05"E, 14 m, 27 November 2021, leg. Anju K. Baby & Vishnu Das E. H., 9♂ 7♀. Wayanad district, Vemom, paddy field 11°49'23"N, 76°01'30"E, 784 m, 26 December 2021, leg. Anju K. Baby & Manu K. Baby, 6♀. Wayanad district, Arattuthara, paddy field 11°48'40"N, 76°03'17"E, 794 m, 19 April 2022, leg. Anju K. Baby, 4♂ 6♀. Thrissur, Thommana, paddy field 10°20'32"N, 76°15'09"E, 23 m, 13 May 2022, leg. Anju K. Baby & Shilpa K. R., 5♂ 7♀. Wayanad district, Koilery, paddyfield 11°42'43"N, 76°09'53"E, 813 m, leg. Anju K. Baby & Manu K. Baby, 13 November 2023, 4♀. Thrissur district, Manakkodi Kol Wetlands 10°29'06"N 76°10'18"E, 15 m, 26 November 2023, leg. Anju K. Baby & Greeshma T. S., 2♂ 3♀. Neyyar Wildlife Sanctuary, Kombaippara 8°32'02"N, 77°09'02"E, 110 m, 28 December 2022, leg. Anju K. Baby & Rajesh, 4♂ 8♀. Idukki district, Maryoor, Karimutty Waterfalls 10°17'20"N, 77°10'06"E, 930 m, 9 January 2024, leg. Anju K. Baby & Greeshma T.



FIGURE 4.1.38. *Tetragnatha javana* (Thorell, 1890). Allotype, female (A–D). A, female habitus, lateral view, B, chelicerae, ventral view, C, habitus, ventral view, D, epigynum, ventral view. Scale bars: A, C: 0.5 mm. B, D: 0.2 mm.

S., 1♀. Wayanad district, Thrissilery, paddy field 11°50'36"N, 76°01'42"E, 795 m, 14 January 2025, leg. Anju K. Baby & Nikhil K. J., 3♂, 4♀.

Diagnosis. *T. javana* can be easily separated from all other tetragnathids by the presence of spinnerets on the mid-ventral of the abdomen. Males are characterized by small AXu and AXI, presence of Gu on the cheliceral bulging (CB) with slanted and nearly rectangular tegulum. Females have an unusual protuberance on the dorsal side of the chelicerae which is absent in males and a significant gap between Gu and U2.



FIGURE 4.1.39. *Tetragnatha chamberlini* Gajbe, 2004, Holotype, female (A–E). A, cephalothorax, dorsal view, B, abdomen, dorsal view, C, same, lateral view, D, chelicerae, ventral view, E, label. Scale bars: A: 1 mm. B, C: 2 mm. D: 0.5 mm.

Redescription. Male (Fig. 4.1.40). Carapace elongated, anteriorly constricted, yellowish, with pale brown spots arising near the posterior eyes, passing through the fovea, and reaching the posterior rim; cephalic groove distinct. AMEs are linearly positioned, PMEs are strongly recurved, lateral eyes are not contiguous, and ocular quadrangle longer than wide. Fovea nearly roundish and deep. Labium subquadrate and pale brownish. Maxillae elongated with distinct scopulae. Sternum yellow with brown patches and strong intercoxal extensions. Chelicerae with paturon, yellowish brown, dorsally somewhat flattened. ‘a’ stout, oriented towards the dorsal side, and strongly bifurcated. AXu small, closer to a fang basis and positioned on a cheliceral bulge. Upper row with seven teeth: Gu small, with a pointed tip and located on the same cheliceral bulge; ‘T’ linear, stout, upward projected with a blunt apex and

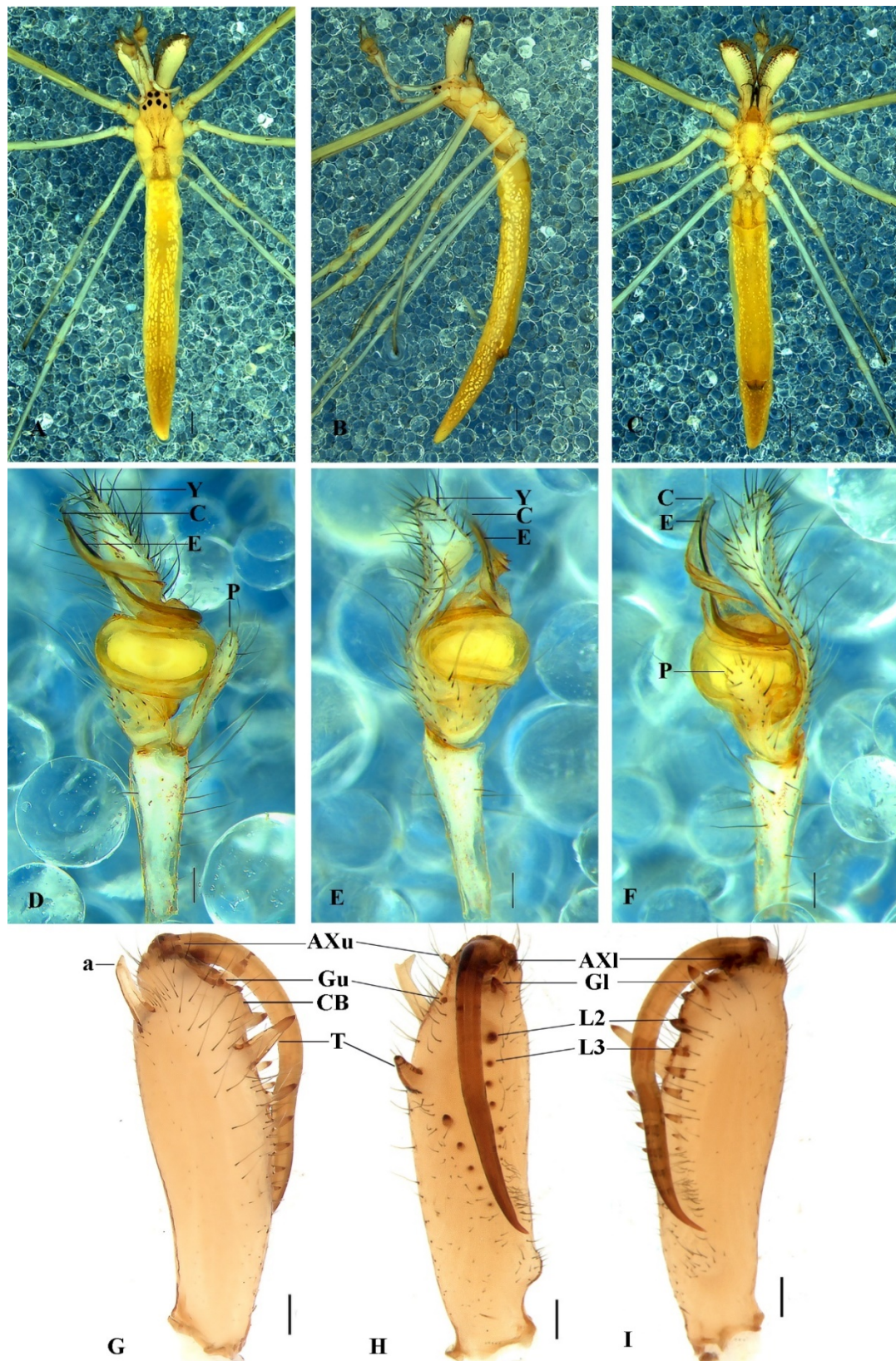


FIGURE 4.1.40. *Tetragnatha javana* (Thorell, 1890), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F: 0.1 mm. G–I: 0.2 mm.

displaced from the row; 'rsu' seven in number, almost equidistant and decreasing in size. AXI small and positioned closer to a fang basis. Lower row with seven teeth: G1 large, with wide basis and protruding apex; L2 small and curved at the middle; L3 straight with pointed tip and opposite to 'T'; L4–L7 decreasing size. Cheliceral fang pale brownish, and the distal half strongly geniculate with curved apex. Abdomen elongated, thin; dorsum yellow with numerous golden guanine spots; venter yellow with a few golden guanine spots; laterally yellow with golden guanine spots. Pedipalp with long tibia; tegulum slightly slanted and nearly rectangular; conductor almost transparent, completely enclosed with embolus with many folds and curved apex; embolus filiform, darkens towards the apex without any twists and pointed apex; cymbium long with numerous spines, with broad base; paracymbium straight, touching the tegulum with a thin translucent lobe, long spines, and a moderate-sized knob at the ectal side.

Measurements. Total length: 12.80. Carapace 2.432 long, 1.49 wide. Abdomen: 10.48 long, 1.14 wide. Ocular area length 0.39, width 0.37. Eye diameters: AME 0.11, ALE 0.08, PME 0.08, PLE 0.09. Clypeus height 0.11. Chelicerae 1.62 long, 0.59 wide. Palp and leg measurements: pedipalp 2.79 [0.95, 0.30, 0.68, 0.86], leg I 25.55 [7.39, 0.83, 7.63, 8.29, 1.41], II 13.49 [4.27, 0.58, 3.70, 4.00, 0.94], III 5.66 [1.90, 0.46, 1.27, 1.45, 0.58], IV 14.17 [55.01, 0.67, 3.82, 3.87, 0.80]. Leg formula: 1423.

Female (Fig. 4.1.41). Carapace, eyes, fovea, labium, maxillae, sternum and legs as in males. Paturon moderate-sized, slender, yellowish with numerous spines, and a protuberance on the dorsal side. AXu absent. Upper row of chelicerae with six teeth: Gu small, straight, and closer to the fang basis; U2 stout and a large distance from

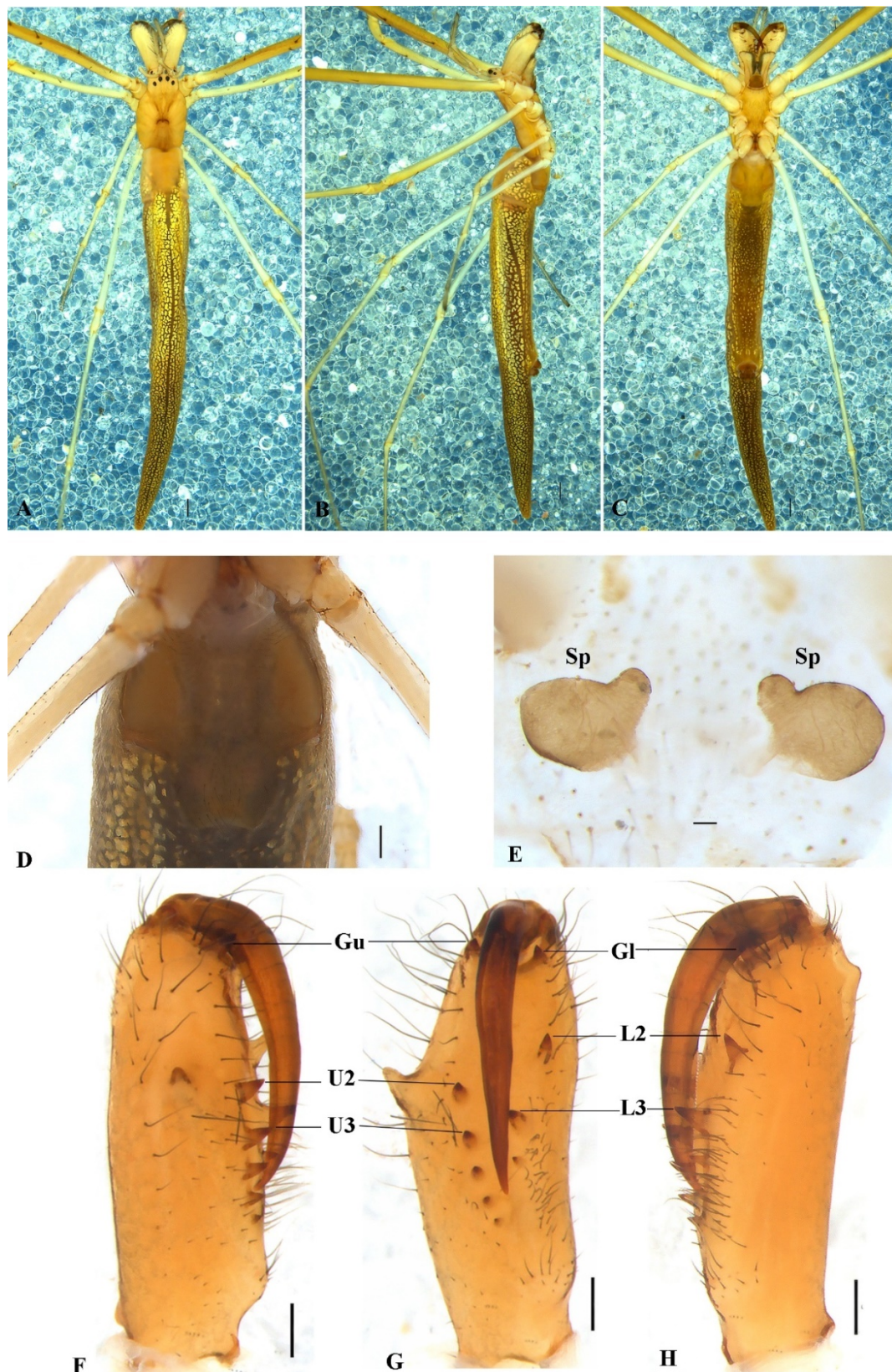


FIGURE 4.1.41. *Tetragnatha javana* (Thorell, 1890), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.2 mm.

Gu; U3 sharp and longer than U2; U4 directed upward; U5 triangular; U6 very small. AXI absent. Lower row with four teeth: G1 small, much closer to the fang basis, with sharp apex; L2 slightly displaced from the row and oriented towards the upper side; L3 larger, with blunt apex, L4 small and triangular. Cheliceral fang short and brownish. Abdomen extremely elongated, tapering towards the posterior end; dorsum pale brownish with numerous golden guanine spots; venter brownish with golden guanine spots. Spinnerets positioned mid-ventrally. Epigynal fold short, medially enlarged and slightly narrowing towards the posterior region; internally, a pair of spermathecae oriented inside, dorsally compressed, anteriorly with a bulging, brownish with a few wrinkles, and without central membranous stalk.

Measurements. Total length: 12.80. Carapace 2.43 long, 1.49 wide. Abdomen: 10.48 long, 1.14 wide. Ocular area length 0.39, width 0.37. Eye diameters: AME 0.11, ALE 0.08, PME 0.08, PLE 0.09. Clypeus height 0.11. Chelicerae 1.62 long, 0.59 wide. Palp and leg measurements: pedipalp 2.79 [0.95, 0.30, 0.68, 0.86], leg I 25.55 [7.39, 0.83, 7.63, 8.29, 1.41], II 13.49 [4.27, 0.58, 3.70, 4.00, 0.94], III 5.66 [1.90, 0.46, 1.27, 1.45, 0.58], IV 14.17 [55.01, 0.67, 3.82, 3.87, 0.80]. Leg formula: 1423.

Justification for synonymy. *T. chamberlini* was originally described by Gajbe (2004) based on a female specimen collected from India (Pachpedi, Jabalpur, Madhya Pradesh). The species was described purely based on body morphology, though the cheliceral dentitions and structure of chelicerae had received least consideration. Gajbe also noted the similarity of the species to *T. javana* but distinguished it from the latter on the basis of markings on the thoracic region and abdominal patterns. On examination of the holotype of *T. chamberlini*, which was deposited at the repository of the National Zoological Collection of the Zoological Survey of India (NZC-ZSI), the similarity of body morphology (especially the

presence of spinnerets on the mid of the abdomen) and cheliceral patterns of the species to that of *T. javana* was clearly revealed. Therefore, *T. chamberlini* is regarded as the junior synonym of *T. javana* (Anju et al., 2024b).

Distribution. Africa, Asia (World Spider Catalog, 2025).

***Tetragnatha keyserlingi* Simon, 1890**

Tetragnatha mandibulata Keyserling, 1865: 848, plate 21, 6–9 (♂♀, misidentified);

L. Koch, 1872: 194, plate 17, 2–3 (♂♀, misidentified).

Tetragnatha keyserlingi Simon, 1890: 134 (♂♀).

Tetragnatha kochi Thorell, 1895: 140 (♂♀).

Tetragnatha keyserlingi Castanheira et al., 2019: 477, figs. 8A–J, 9A–I, 10A–F, 20C, 21H–I, L–M, O (♂♀, synonymy of *T. ethodon*, *T. kochi* and *T. maxillosa*);
Dippenaar-Schoeman et al., 2023: 41, figs. 1–7 (♂♀).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. INDIA: Kerala: Thrissur district, Pullu Kol Wetlands 10°27'16"N, 76°09'22"E, 15 m, 27 November 2021, leg. Anju K. Baby, 6♂ 5♀. Wayanad district, Vemom, paddy field 11°49'25"N, 76°01'29"E, 786 m, 26 December 2021, leg. Anju K. Baby, 5♂ 7♀. Wayanad district, Thirunelly 11°54'38"N 75°59'30"E, 858 m, 12 January 2022, leg. Anju K. Baby, 2♂ 3♀. Thrissur district, Thommana, paddy field 10°20'22"N, 76°15'01"E, 17 m, 13 May 2022, leg. Anju K. Baby, 11♂ 9♀. Kollam district, Thenmala 8°57'47"N, 77°03'53"E, 201 m, 17 October 2022, leg. Anju K. Baby, 5♂ 7♀. Wayanad district, Tharuvana, paddy field 11°44'05"N 75°58'58"E, 784 m, 27 December 2022, leg. Anju K. Baby & Manu K. Baby, 7♂ 6♀. Neyyar Wildlife Sanctuary, Thiruvananthapuram district, Puravimala 8°32'03"N 77°08'52"E, 110 m, 31

December, 2022, leg. Anju K. Baby & Rajesh, 4♂ 7♀. Palakkad, Attappadi 11°04'05"N, 76°34'01"E, 682 m, 03 February 2023, leg. Anju K. Baby & Manu K. Baby, 4♂ 6♀. Wayanad district, Padinjarathara, paddy field 11°41'15"N 75°57'49"E 746 m, 9 February 2023, leg. Anju K. Baby & Manu K. Baby, 5♂ 8♀. Kottayam district, Erumely 9°28'37"N 76°50'41"E, 89m, 16 May 2023, leg. Anju K. Baby & Adeena Shaji, 3♀. Kottayam district, Muttom 9°33'09"N 76°30'38"E, 37 m, 15 May 2023, leg. Anju K. Baby, 1♀. Thrissur district, Muriyad, paddy field 10°21'46"N, 76°15'46"E, 32 m, 11 October 2023, leg. Anju K. Baby & Manu K. Baby. Wayanad district, Periya 11°50'14"N 75°51'06"E, 756 m, 12 November 2023, leg. Anju K. Baby & Manu K. Baby, 9♂ 12♀. Thrissur district, Manakkodi Kol Wetlands 10°29'06"N 76°10'18"E 15 m, 26 November 2023, leg. Anju K. Baby & Greeshma T. S., 2♂ 3♀. Idukki district, Kanthalloor, Theerthamala 10°14'41"N 77°11'15"E, 1029 m, 10 January 2024, leg. Anju K. Baby & Nagarajan, 3♂ 7♀. Idukki district, Chinnar wildlife Sanctuary, Alampetty 10°18'45"N 77°11'07"E, 782 m, 09 January 2024, leg. Anju K. Baby & Greeshma T. S., 6♂ 11♀. Idukki district, Viripara 10°08'41"N, 76°95'74"E, 100 m, 01 February 2024, leg. Anju K. Baby & Greeshma T. S., 1♂ 2♀. Wayanad district, Thrissilery, paddy field 11°50'36"N, 76°01'42"E, 795 m, 14 January 2025, leg. Anju K. Baby & Nikhil K. J., 4♂, 5♀.

Diagnosis. Males of *T. keyserlingi* are most similar to *T. serra* Doleschall, 1857 in having elongated and slender chelicerae, a moderate gap between Gu and U2, and small AXI. It shows dissimilarities in the presence of the following characteristics: AXu present, Gu straight, Gu U2 and U3 are equidistant, tegulum slightly slanted, paracymbium extending beyond the tegulum and conductor distally without any bifurcations. Females also show similarities to *T. serra* in having brownish and

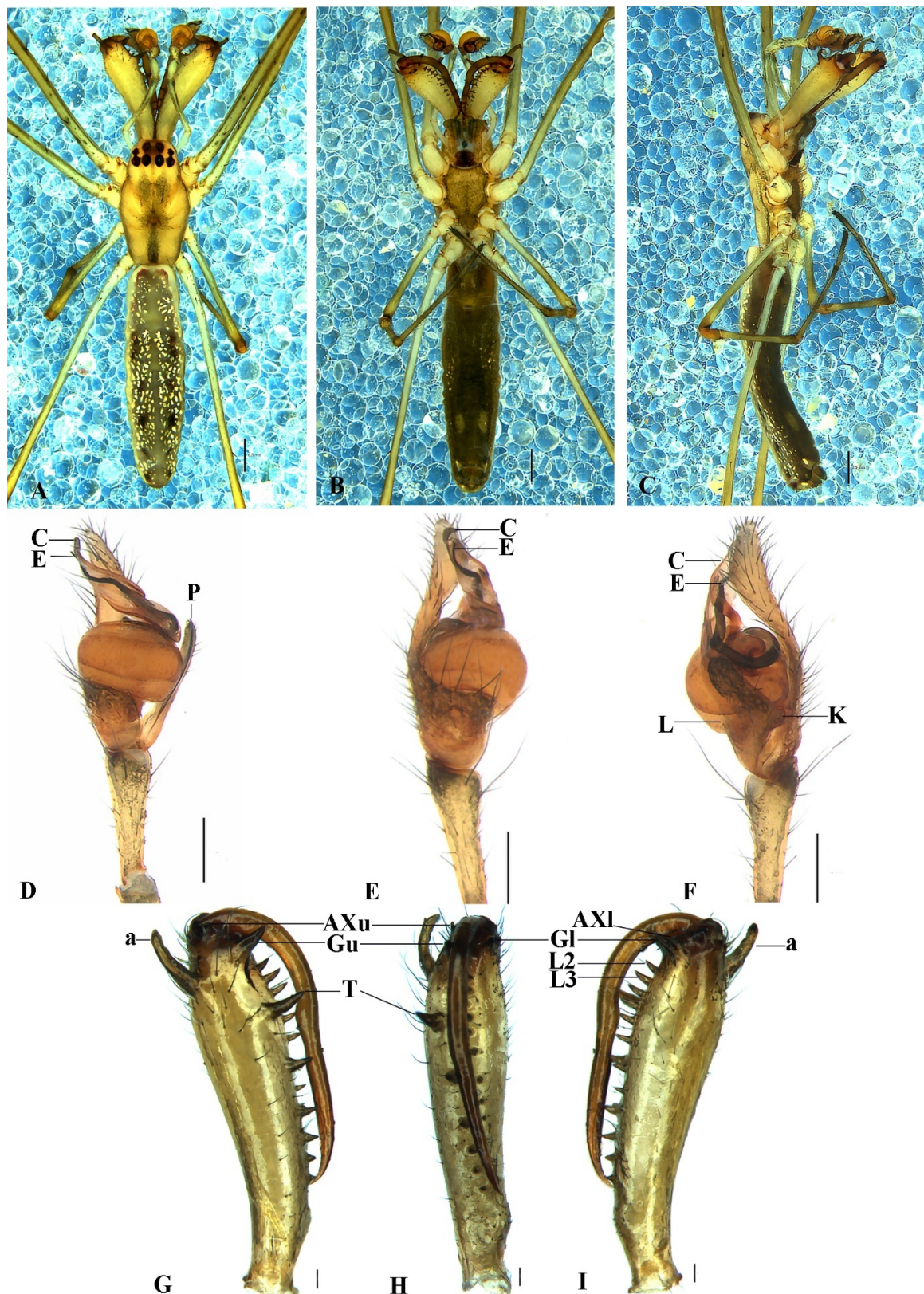


FIGURE 4.1.42. *Tetragnatha keyserlingi* Simon, 1890, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–F: 0.2 mm. G–I: 0.1 mm.

moderate-sized abdomen, Gu and U2 with a wide distance, and long genital fold. It differs in having moderate-sized chelicerae (elongated in *T. serra*), cheliceral fang without any cusps, AXI small and positioned on the basis of GI, and oval spermathecae.

Redescription. Male (Fig. 4.1.42). Carapace elongated, anteriorly constricted, yellowish, olive-green spots arising near the posterior of lateral eyes pass through the fovea and reach the posterior rim. Anterior eyes are strongly recurved, AMEs share the same border, and the ocular quadrangle longer than wide. Clypeus pale yellow. Fovea inverted, U-shaped and deep. Labium subquadrate and brown. Maxillae long with a thin base and anteriorly broad. Sternum flat, greenish yellow, with sparse hairs. Chelicerae with paturon elongated, almost 3x longer than wide, 'a' slanted, oriented towards the dorsal side with bifurcated apex, 't' small, blunt, positioned above 'a'. AXu absent. Upper row of chelicerae with seven teeth: Gu extremely large, closer to the fang basis with a wide basis; 'T' slightly bent at the middle, and a considerable gap between Gu and 'T'; U3 curved with a blunt apex, and U4–U7 decreasing in size. AXI close to GI and shares the same basis. Lower row of chelicerae with ten teeth: GI long, slender with blunt apex; L2 smaller; L2–L6 parallel and equidistant; L7 linear and protruding; L8 long and pointed; L9 very sharp; L10 small, pointed and opposite to U4. Cheliceral fang brownish, without any cusps, and slightly bent at the middle. Abdomen elongated; dorsum greyish, with numerous golden guanine spots and six pairs of black spots; venter dark greenish, with few golden guanine spots and a pair greyish spot on the $\frac{3}{4}$ the length of abdomen. Pedipalp with moderate-sized tibia; tegulum slanted towards the ventral side with two parallel brown stripes; cymbium with broad base and numerous spines, and steadily narrowing; paracymbium long with thin base, touching the

tegulum with a small notch; translucent lobe thin, almost transparent without any curves; and a small knob at the ectal side; conductor bulky, broad at the base, twisted at the middle with distal end curved towards the mesal side; embolus dark, originating at the middle of the bulb, twisted at the mid-length, distally bent towards the dorsal side, gradually narrowing, and apex not enclosed with the conductor.

Measurements. Total length: 4.32. Carapace 1.56 long, 0.86 wide. Abdomen: 2.76 long, 0.60 wide. Ocular area length 0.65, width 0.60. Eye diameters: AME 0.10, ALE 0.04, PME 0.09, PLE 0.05. Clypeus height 0.07. Chelicerae 0.94 long, 0.31 wide. Palp and leg measurements: pedipalp 3.70 [1.72, 0.31, 0.51, 1.16], leg I 12.86 [4.49, 0.44, 3.07, 3.95, 0.91], II 7.55 [2.48, 0.48, 2.57, 1.56, 0.46], III 6.65 [2.44, 0.39, 1.41, 1.74, 0.67], IV 12.18 [4.26, 0.36, 3.12, 3.61, 0.85]. Leg formula: 1423.

Female (Fig. 4.1.43). Carapace, eyes, clypeus, fovea, maxillae, sternum, and legs as in males. Chelicerae with paturon elongated, dorsally flattened, yellowish brown, and much darker towards the fang. AXu absent. Upper row with eight teeth: Gu thumb-shaped, bulky with wide basis; U2 smaller than Gu, upward directed, set apart by a large distance from Gu; U3 smaller and similar shape to U2; U4 upward projected, curved at the mid-length and pointed; U5 small with a thin base and enlarged at the mid-length; U6 thin, straight, and upward directed; U7 with blunt apex, U8 vestigial. AXI small with blunt apex and slightly displaced from the row. Lower row with eleven teeth: G1 not much closer to fang basis, apex slightly curved and pointed; L2 triangular upward directed and a significant gap between Gu and L2; L3 longer than L2 and curved at the middle; L4 triangular; L5 longer than L4 and distal end curved towards the upper side; L2–L5 almost equidistant; L6–L11 decreasing in size. Cheliceral fang geniculate, yellowish brown, and without any

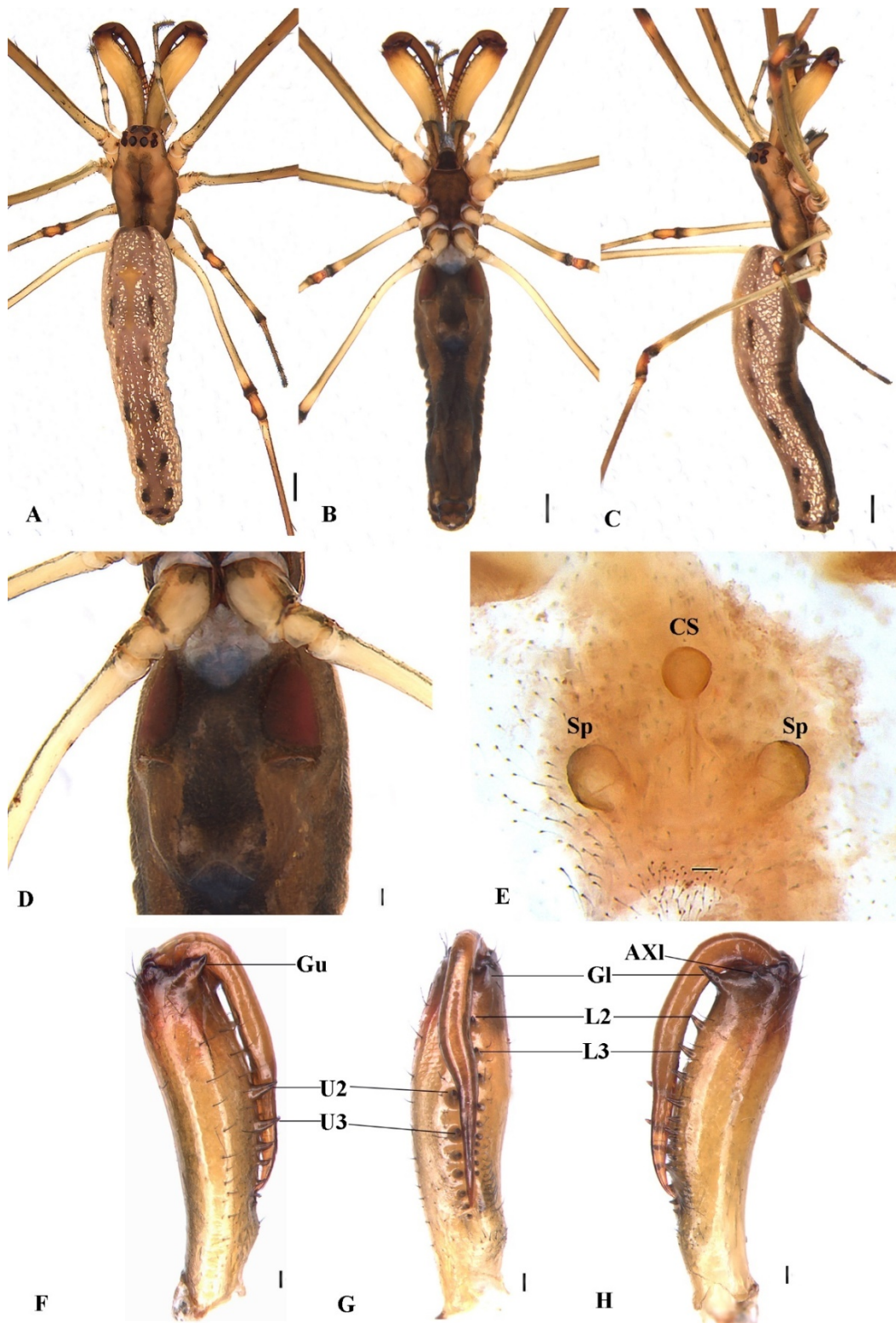


FIGURE 4.1.43. *Tetragnatha keyserlingi* Simon, 1890, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.2 mm.

cusps. Abdomen elongated; dorsum greyish with shiny guanine spots and five pairs of shiny black spots; venter black with brown patches, with several wrinkles. Epigynal fold longer than wide, anteriorly constricted, and steadily enlarging with a strongly curved apex. Internal genitalia composed of a pair of spermathecae which are anteriorly enlarged and constricted at the base, moderately sclerotized, and oriented towards the lateral sides; the central membranous sac nearly roundish, positioned far from the spermathecae, with extremely long stalk.

Measurements. Total length: 8.35. Carapace 2.97 long, 2. wide. Abdomen: 3.62 long, 1.70 wide. Ocular area length 0.47, width 0.43. Eye diameters: AME 0.15, ALE 0.08, PME 0.14, PLE 0.13. Clypeus height 0.08. Chelicerae 1.64 long, 0.85 wide. Palp and leg measurements: pedipalp 2.78 [1.15, 0.40, 0.35, 0.88], leg I 24.14 [6.48, 1.27, 6.77, 8.13, 1.49], II 15.56 [4.56, 1.01, 4.29, 4.61, 1.09], III 6.82 [2.13, 0.61, 1.48, 1.95, 0.65], IV 12.38 [3.95, 0.70, 3.00, 3.83, 0.90]. Leg formula: 1243.

Distribution. Polynesia, Central America, New Hebrides, Caribbean, Philippines, Brazil, India, Korea, Africa (World Spider Catalog, 2025).

***Tetragnatha lauta* Yaginuma, 1959**

Tetragnatha lauta Yaginuma, 1959: 11, figs. 1–7 (♂♀); Paik & Namkung, 1979: 53, figs. 37.1–2 (♂♀); Yaginuma, 1986: 131, figs. 70.6 (♂); Okuma, 1988a: 200, figs. 14A–K (♂♀); Chikuni, 1989: 93, fig. 11 (♂); Kim et al., 1999: 66, figs. 17, 41, 64, 75–76 (♂♀); Song et al., 1999: 221, figs. 126D, M, 127R–U (♂♀); Anju et al., 2024b: 991, figs. 4A–K, 5A–H, 6A–G (♂♀); Nojima, 2024: 38, figs. 7 (♂).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. INDIA: *Kerala*: Kasaragod district, Ranipuram Reserved Forest 12°24'39"N, 75°21'22"E, 671 m a.s.l., 28 September 2022, leg. Anju K. Baby,

Vishnu das E. H., Sibi K. K., 3♂ 4♀. Wayanad district, Periya Reserved Forest 11°46'39"N, 75°50'53"E, 802 m a.s.l., 5 December 2022, leg. Anju K. Baby, 5♂ 6♀. Idukki district, Mankulam 10°07'02"N 76°55'38"E, 699 m, 09 December 2023, leg. Anju K. Baby & Abhijith V., 1♀.

Diagnosis: Males of *T. lauta* are most similar to *T. jaculator* Tullgren, 1910 in having similar short chelicerae, with small-sized 'a', AXu absent, Gu short, a moderate gap between 'T' and U3, cheliceral fang strongly geniculate without cusps, and Gl and L2 close to fang basis, besides pedipalps with distal portion of embolus being projected, and apex not enclosed by conductor (Castanheira & Baptista, 2021a, figs. 59–65). However, *T. lauta* differs by having chelicerae more curved, with pointed 'a', 'sl' absent, Gu far from fang basis, and AXI absent, bulb not slanted and paracymbium much more elongated.

On females, body morphology is similar: carapace anteriorly narrowed and medially broad; abdomen short, medially enlarged and gradually narrowing towards the posterior region; chelicerae without AXu and AXI, U2 longer than Gu, and a moderate gap between Gu and U2 (Figs. 2A–G, 3F–G; Castanheira & Baptista 2021, figs. 68–73). However, *T. lauta* can be distinguished by having stout chelicerae, much dark near the fang basis, with small Gu, U2 bulky, and long Gl and not much close to fang basis.

Redescription. Male (Fig. 4.1.44). Carapace elongated, yellowish brown, with lateral sides with golden yellow spots and olive-green spots arise from ocular region extends towards the fovea; cephalic region slightly elevated; cephalic groove distinct and dark. AMEs raised, share thick dark border, AME and ALE with large gap, PME and PLE with moderate gap. Clypeus light brown. Fovea deep without strikes.

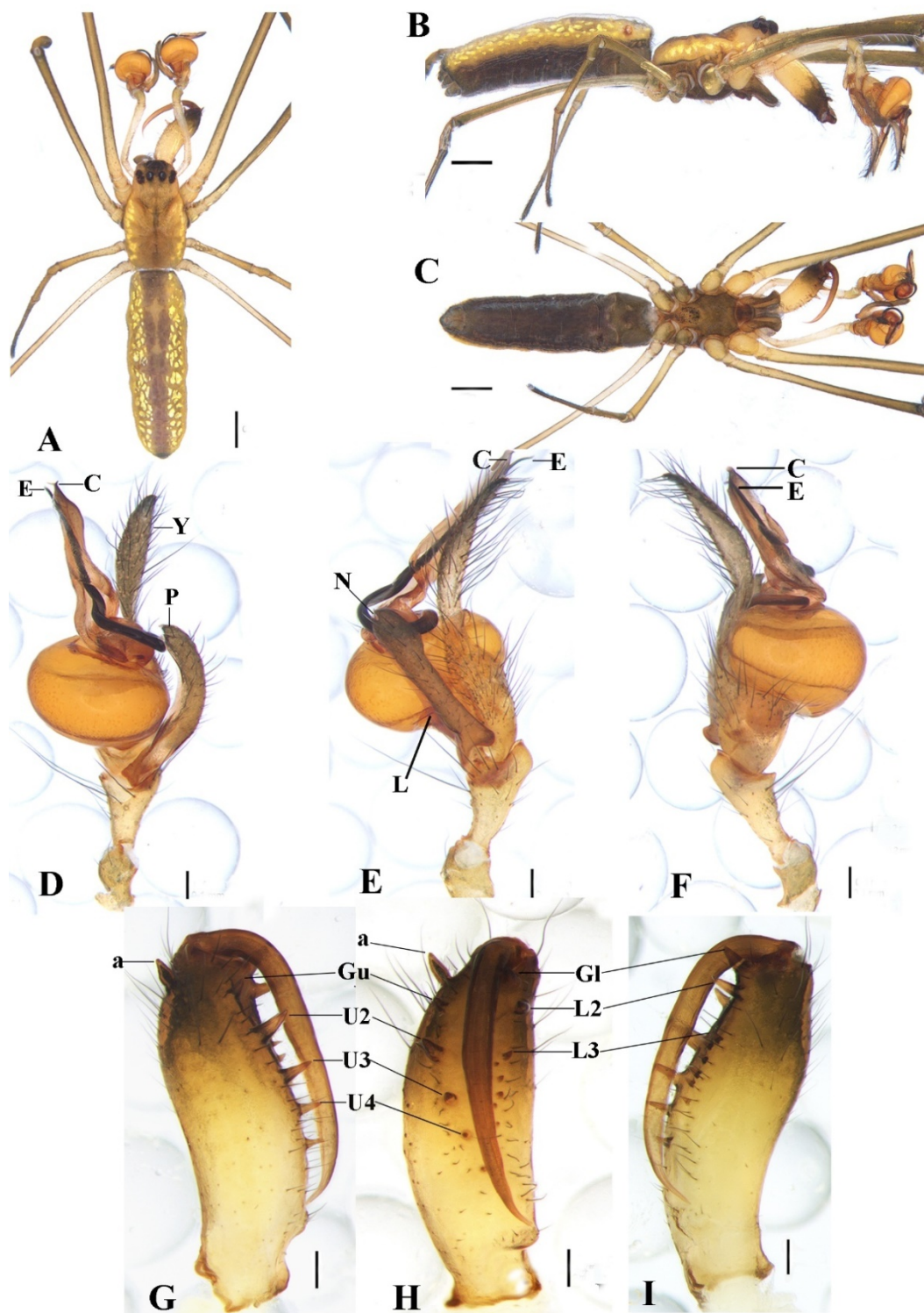


FIGURE 4.1.44. *Tetragnatha lauta* Yaginuma, 1959, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.1 mm.

Labium subquadrate and brown. Sternum olive green with dark contour, with strong intercoxal extensions and bifid posterior extension. Chelicerae with paturon curved outwards, elongated, almost 4x longer than wide, much darker towards fang basis; 'a' reduced to small and slanted. AXu absent. Upper row with five teeth: Gu distally projected and set apart by large distance from fang basis; 'T' protruding, strong with wide basis; 'rsu' with three pointed teeth reducing in size. AXI absent. Lower row with eight teeth: G1 strong, bulky with wide basis, and sharing same basis with L2 much closer to fang basis, both pointing distally. L2 slightly slanted, relatively slender, adjacent to G1 and largely displaced from the row; L3–L8 reduced in size, almost like denticles, and apart from L2 by a large gap. Cheliceral fang long, strongly geniculate, about $\frac{3}{4}$ of paturon length, without cusps, and with a curved tapering tip. Legs yellowish brown, proximal half of femur IV pale yellow. Abdomen cylindrical, slender, median-sized; dorsum yellow with guanine spots and a long grey longitudinal patch; venter dark without any markings. Pedipalps with short tibia; tegulum spherical; cymbium long, proximal half wide, distal half gradually narrowing and bent towards the ventral side; conductor strong, basally wavy with bifurcated apex and a single twist at distal half; embolus filiform with a strong twist at mid-length, originating at the middle of the bulb near the cymbium, proximal half not enclosed by conductor, distal half enfolding with transparent conductor in some way, apex not enclosed with conductor and clearly bent towards mesal side; paracymbium slender, very elongated, strongly curved inward, with divided notch, translucent lobe thin and occupying about $\frac{1}{3}$ of the paracymbium width, and knob rounded and basally projected (Anju et al., 2024).

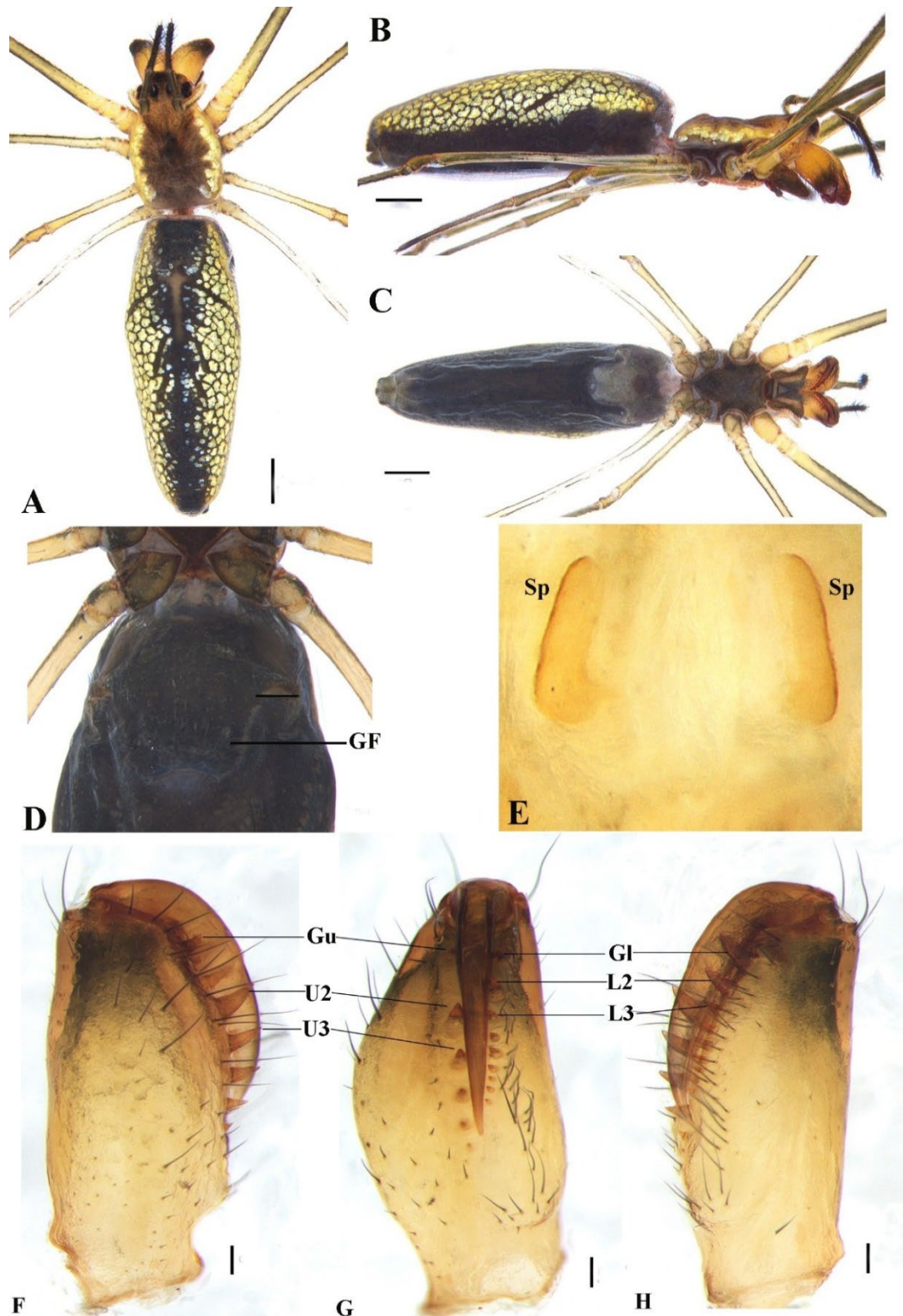


FIGURE 4.1.45. *Tetragnatha lauta* Yaginuma, 1959, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.1 mm.

Measurements: Total length 3.59. Carapace length 1.26, width 0.75. Abdomen length 2.36, width 0.73. Ocular area length 0.28, width 0.30. Eye diameters: AME 0.12, ALE 0.05, PME 0.09, PLE 0.06. Clypeus height 0.05. Length of chelicera 1.20, width 0.32. pedipalp 2.30 [0.91, 0.23, 0.27, 0.89], leg I 11.50 [3.71, 0.34, 3.80, 3.22, 0.43], II 6.28 [1.95, 0.30, 1.81, 1.64, 0.58], III 2.99 [0.98, 0.15, 0.67, 0.80, 0.39], IV 6.63 [2.07, 0.28, 1.74, 1.88, 0.66]. Leg formula: 1423.

Female (Figs. 4.1.45, 4.1.46C, D). Carapace yellowish brown, medially much darker, lateral sides with golden yellow spots; cephalic groove indistinct. Clypeus, fovea, labium, sternum and legs as in male. Chelicerae with paturon almost 3x longer than wide, medially broad and constricted at the base, yellow and much darker towards fang basis. AXu absent. Upper row with six teeth: Gu slender, pointed, with about the same size of U5, opposite to G1 and set apart by a small gap from fang basis; U2 strong, longer than Gu, distal half bent towards upper side and a significant gap between Gu and U2; U3–U6 pointed, reducing in size and almost equally spaced. AXl absent. Lower row with nine teeth: G1 distally curved, large and stout, equally spaced from U2 and fang basis; L2 slender, relatively small and parallel to G1; L3–L9 reducing in size and almost equidistant. Cheliceral fang strongly geniculate, slightly enlarged midway, tapering, without cusps and positioned between both rows of teeth. Abdomen as in male but larger and with stronger colour hue. Genital fold short, almost as longer as wide, slightly elevated, with straight tip. Internal genitalia composed of two spermathecae inverted comma-like, elongated, $\frac{3}{4}$ of length slanted inward, widely separated without central membranous sac and base of spermathecae strongly curved.

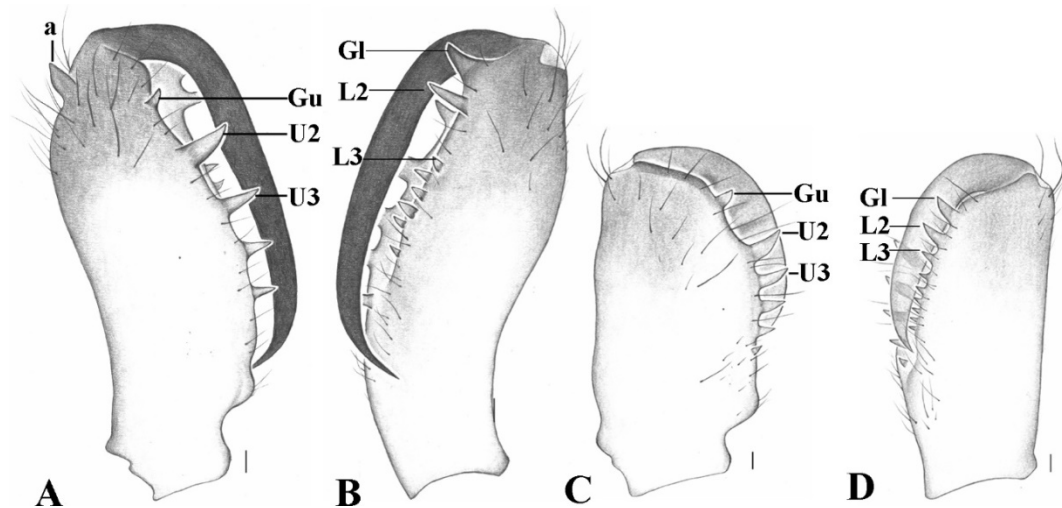


FIGURE 4.1.46. *Tetragnatha lauta* Yaginuma, 1959, male (A, B). A, left chelicerae, dorsal view, B, same, ventral view. female (C, D), C, left chelicerae, dorsal view, D, same, ventral view. Scale bars: A–D: 0.1 mm.

Measurements: Total length 4.82. Carapace length 1.49, width 0.88. Abdomen length 3.35, width 1.13. Ocular area length 0.27, width 0.28. Eye diameters: AME 0.92, ALE 0.04, PME 0.09, PLE 0.06. Clypeus height 0.06. Length of chelicera 0.92, width 0.34. Epigynal fold length 0.44, width 0.53. Pedipalp and leg measurements: pedipalp 1.65 [0.46, 0.11, 0.30, 0.55], leg I 15.85 [4.58, 0.52, 4.48, 5.13, 1.14], II 7.11 [2.25, 0.45, 1.66, 2.05, 0.70], III 3.27 [1.00, 0.16, 0.73, 0.87, 0.51], IV 7.20 [2.51, 0.34, 1.71, 1.97, 0.67]. Leg formula: 1423.

Distribution (Fig. 4.1.47). Laos, India, Korea, China, Japan, Taiwan (World Spider Catalog, 2025).

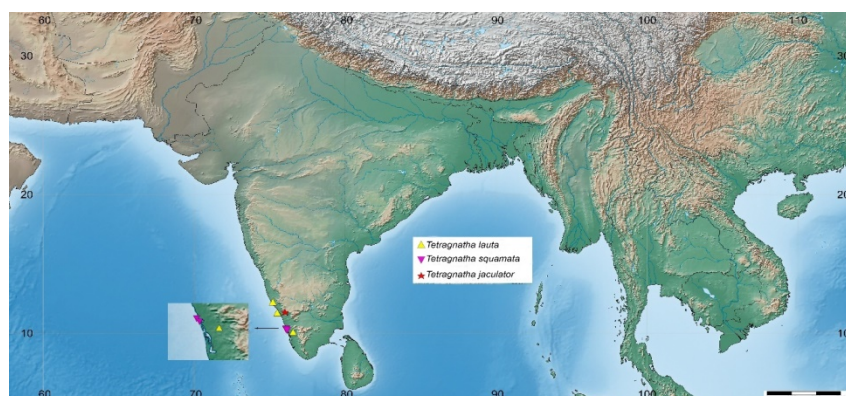


FIGURE 4.1.47. Distribution of *Tetragnatha lauta*, *T. squamata*, and *T. jaculator* in Kerala state.

***Tetragnatha mandibulata* Walckenaer, 1841**

Tetragnatha mandibulata Walckenaer, 1841: 211 (♂♀).

Tetragnatha minax Blackwall, 1877: 20, plate 2, fig. 14 (♂♀).

Tetragnatha mandibulata Tanikawa, 2007: 108, figs. 404–405, 870–873 (♂); Tanikawa, 2009: 419, figs. 112–115 (♂); Yin et al., 2012: 458, figs. 208a–k, 3–13a (♂♀); Castanheira et al., 2019: 482, figs. 11A–K, 12A–I, 13A–H, 20D, 21R–X (♂♀, synonymy of *Tetragnatha infusata* (removed from synonymy with *T. boydi*), *Tetragnatha confraterna*, *T. necatoria* and *T. petrunkevitchi*).

(For complete list of references, see World Spider Catalog 2025).

Material examined. INDIA: Kerala: Kannur district, Madayikavu 12°02'04"N, 75°15'28"E, 61 m, 18 October 2021, leg. Anju K. Baby & Aswathy P. G., 4♂ 8♀. Nilgiri Biosphere Reserve, Malappuram district, Chembankolly 11°21'22"N, 76°13'36"E, 62 m, 13 October 2021, leg. Anju K. Baby & Suryanarayanan T. B., 7♂ 4♀. Wayanad district, Valery, paddy field 11°45'43"N 75°56'07"E, 751 m, 28 October 2021, leg. Anju K. Baby & Manu K. Baby, 3♂ 1♀. Thrissur district, Pullu Kol wetlands 10°27'17"N, 76°09'14"E, 26 m, 27 November 2021, leg. Anju K. Baby, 9♂, 12♀. Kannur district, Dharmadam 11°46'25"N, 75°28'22"E, 26 m, 13 March 2022, leg. Anju K. Baby & Vishnu Das E. H., 4♂ 9♀. Kannur district, Pazhayangady 12°01'09"N 75°15'33"E, 28 m, 15 March 2022, leg. Anju K. Baby, 2♂ 1♀. Kannur district, Kunjimangalam 12°04'17"N 75°13'42"E, 29 m, 15 March 2022, leg. Anju K. Baby & Vishnu Das E. H., 2♂ 2♀. Thrissur, Thommana, paddy field 10°20'31"N, 76°15'03"E, 17 m, 13 May 2022, leg. Anju K. Baby, 3♂ 7♀. Kottayam, Kalathookadavu 9°43'16"N, 76°46'40"E, 51 m, 02 August 2022, leg. Anju K. Baby & Adeena Shaji, 2♀. Kollam district, Thenmala 8°57'47"N, 77°03'53"E, 201 m, 17

August 2022, leg. Anju K. Baby & Manu K. Baby, 3♂ 2♀. Thrissur district, Sree Kerala Varma College Campus 10°31'47"N, 76°11'43"E, 32 m, 15 July 2022, 18 July 2022, leg. Anju K. Baby & Sari K. V., 2♀. Kasaragod district, Kumbla 12°35'48"N 74°56'47"E, 49 m, leg. Anju K. Baby & Shilpa K. R., 27 September 2022, 1♀. Neyyar Wildlife Sanctuary, Thiruvananthapuram district, Kombai 8°32'02"N 77°09'00"E, 117 m, 30 December, 2022, leg. Anju K. Baby & Rajesh, 4♂ 7♀. Palakkad, Kakkuppadi 11°03'55"N, 76°32'58"E, 561 m, 04 February, 2023, Anju K. Baby, 2♂ 5♀. Kannur district, Sasipara 12°08'42"N 75°37'21"E, 24 November 2023, leg. Anju K. Baby & Nikhil K. J. 1♂. Thrissur district, Manakkodi Kol Wetlands 10°29'06"N 76°10'18"E 15 m, 26 November 2023, leg. Anju K. Baby & Greeshma T. S., 2♂ 3♀. Thrissur district, Chimminey Wildlife Sanctuary 10°25'52"N 76°29'27"E, 147 m, 14 December 2023, leg. Anju K. Baby & Greeshma T. S., 2♂ 3♀. Idukki district, Marayoor, Karimutty waterfalls 10°17'20"N, 77°10'06"E, 930 m, 9 January 2024, leg. Anju K. Baby & Greeshma T. S., 1♂ 4♀. Wayanad district, Thrissilery, Paddy field 11°50'42"N, 76°01'29"E, 773 m a.s.l., 14 January 2025, leg. Anju K. Baby & Nikhil K. J., 3♀.

Diagnosis. Males of *T. mandibulata* resemble *T. nitens* (Audouin, 1826) in having pointed 'a', AXI and GI closely placed, distally twisted embolus, and conductor. It shows dissimilarities from *T. nitens* in the following characters: AXu and 't' absent; Gu much larger and closer to U2. Females of *T. mandibulata* are similar to *T. serra* in having extremely elongated AXI positioned on the lateral side of chelicerae and small basal cusp on the fang. It can be separated from the latter by having Gu and U2 closely placed, AXI, GI and L2 are equidistant, cheliceral fang with small inner cusp and central membranous sac larger than spermathecae.

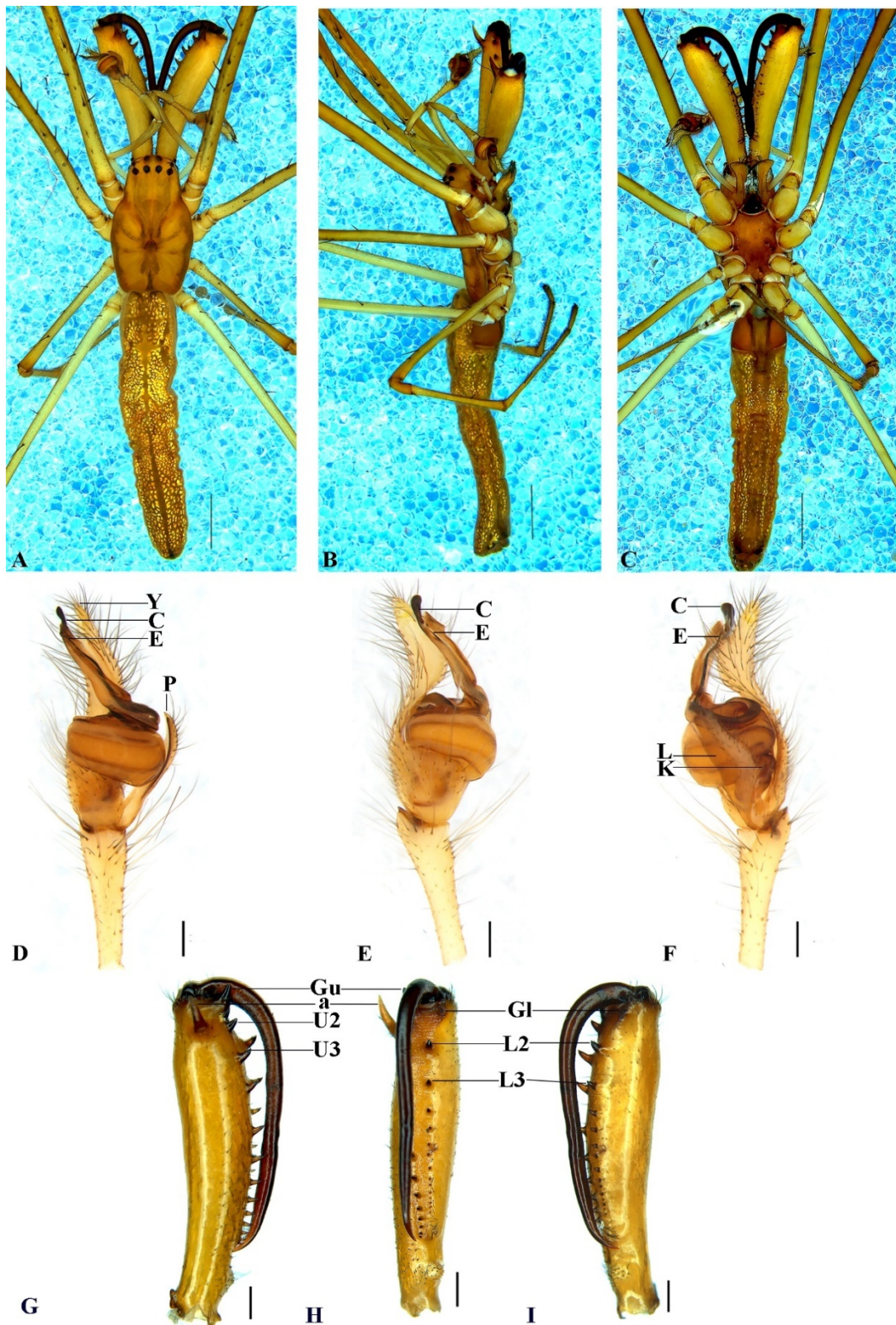


FIGURE 4.1.48. *Tetragnatha mandibulata* Walckenaer, 1841, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.2 mm.

Redescription. Male (Fig. 4.1.48). Carapace elongated, anteriorly constricted, yellowish with brownish yellow patches on lateral edges, with many wrinkles; cephalic region slightly raised, olive green spots arise near the posterior lateral eyes and reach to the fovea. Anterior eyes are strongly recurved, anterior lateral eyes are on the knob, and lateral eyes contiguous. Fovea distinct, deep, and inverted U-shaped. Labium subquadrate and brownish. Maxillae long and thinner, with a broad apex and distinct scopulae. Sternum brownish-yellow with numerous hairs and strong intercoxal extensions. Paturon extremely elongated, slender, almost 5x longer than wide, and yellowish. 'a' long, positioned mid-dorsally and oriented towards the lateral side with a protruding apex. AXu absent. Upper row of chelicerae with thirteen teeth: Gu large, with a wide basis, upward-directed, and blunt apex; U2 short, closer to Gu; U3 longer than U2, distally curved upward; U4 thinner, slightly curved at the middle; U2–U4 equally spaced; U5 longer, similar shape to U4, very sharp, set apart by large distance from U4; U6 thinner, longer and pointed; U7 similar to U6; U8 triangular followed by three teeth decreasing in size; U7–U12 directed outward; U13 very small, closer to U12 and directed downward. AXI absent. Lower row with sixteen teeth: G1 smaller, not much closer to fang basis; AXI closer to G1; L2 short, bulky; L3 smaller, similar shape to L2 and pointed; L4–L6 similar in shape, equally spaced; L7 slightly displaced from the row; L8 larger than L7 and bulky; L9–L17 decreasing in size. Cheliceral fang extremely long, distally curved inward, brownish, and without any cusps. Abdomen cylindrical, elongated; dorsum yellow with numerous golden guanine spots; a greyish band moves antero-posteriorly; venter yellow with numerous guanine spots and without any markings. Pedipalp with long tibia, cymbium elongated, with a broad base, medially

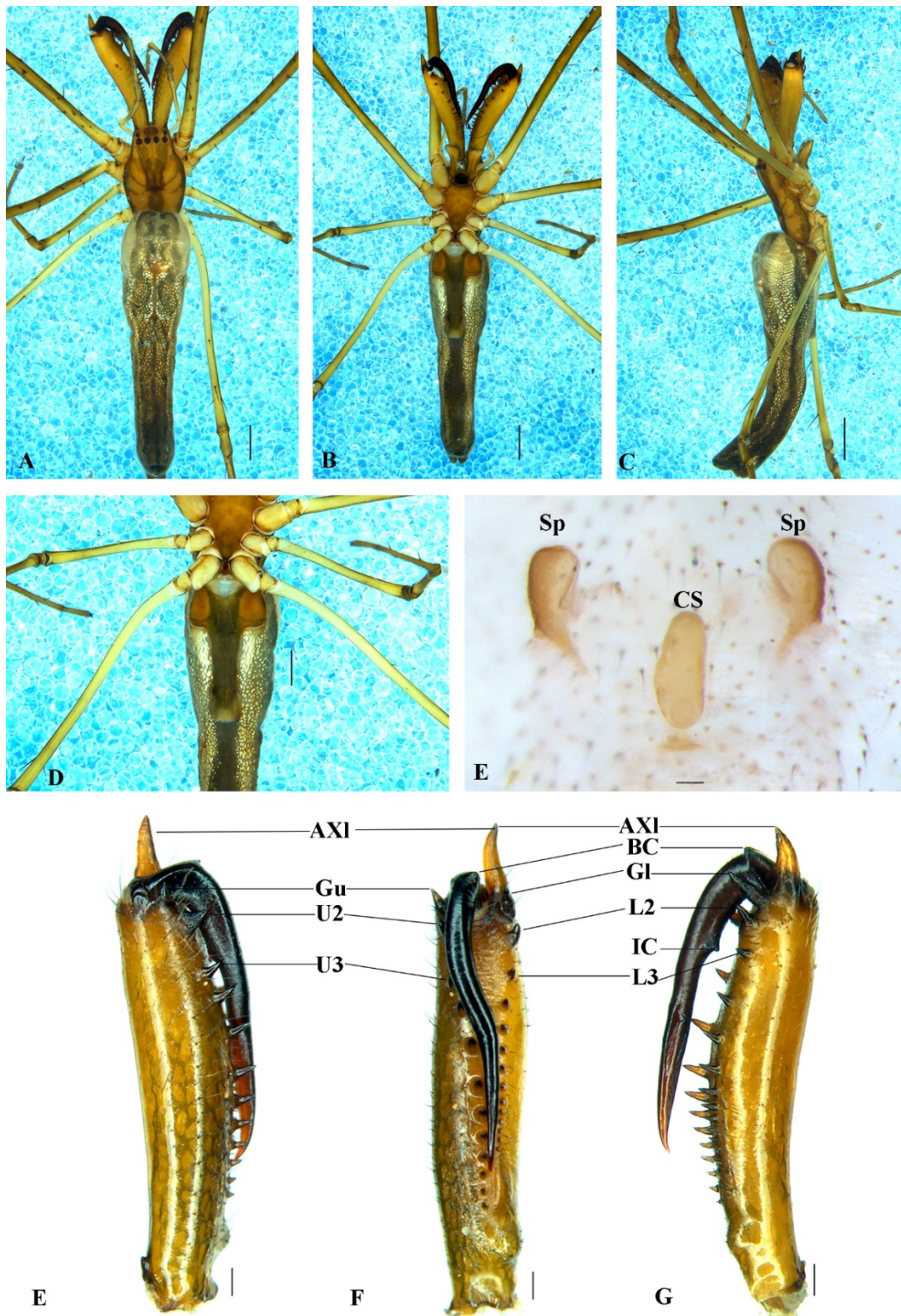


FIGURE 4.1.49. *Tetragnatha mandibulata* Walckenaer, 1841, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.2 mm.

constricted and gradually narrowing, and with numerous spines; tegulum slightly slanted towards the ventral side; embolus with broad base, twisted at the mid-length, distally narrowing with protruding apex; conductor enclosed with embolus twisted at mid-length with knob-like apex; paracymbium long, touching the tegulum, distal end curved inward, with distinct notch; translucent lobe thin, transparent, and a small knob at the ectal side.

Measurements. Total length: 4.99. Carapace 1.42 long, 0.69 wide. Abdomen: 3.57 long, 0.55 wide. Ocular area length 1.00, width 0.83. Eye diameters: AME 0.32, ALE 0.17, PME 0.024, PLE 0.18. Clypeus height 0.13. Chelicerae 1.91 long, 0.37 wide. Palp and leg measurements: pedipalp 2.78 [1.15, 0.40, 0.35, 0.88], leg I 14.97 [4.18, 0.49, 4.53, 4.85, 0.92], II 8.85 [2.74, 0.41, 2.53, 0.59, 0.58], III 3.66 [1.31, 0.29, 0.77, 0.97, 0.32], IV 8.84 [3.00, 0.33, 2.38, 2.63, 0.50]. Leg formula: 1243.

Female (Fig. 4.1.49). Carapace, eyes, fovea, labium, maxillae, sternum and legs as in males. Paturon yellowish brown, proximal half with random circular markings. Upper row of chelicerae with twelve teeth: Gu vertical and close to fang basis; U2 with wide basis, curved at the middle and very sharp; U3 smaller, directed upward, slightly displaced from the row, and a significant gap between U2 and U3; U4 longer and similar shape to U3; U5 straight, pointed; U6–U10 equidistant; U11 & U12 linear, outward directed. AXI bulky, distal half slightly bent inward. Lower row with fourteen teeth: G1 straight, strong, sharing same basis with AXI; L2 smaller than G1; G1 and L2 oriented in opposite direction; L3 smaller, outward directed and pointed; L4 linear, upward directed, and a large gap between L3 and L4; L5 bent at the middle towards the upper side; L6 opposite to L5; L7–L14 decreasing in size. Cheliceral fang with distinct basal cusp and inner cusp, dark brown. Abdomen

anteriorly enlarged and gradually narrowing; dorsum dark greyish, with golden guanine spots; a dark greyish band moves antero-posteriorly; venter dark greyish, numerous shiny golden spots on lateral edges; and epigynal fold positioned at the centre. Internal genitalia composed of two spermathecae, which are anteriorly enlarged with a thin base; central membranous sac elongated, with a short stalk.

Measurements. Total length: 5.21. Carapace 1.38 long, 0.98 wide. Abdomen: 3.82 long, 0.69 wide. Ocular area length 0.67, width 0.71. Eye diameters: AME 0.21, ALE 0.15, PME 0.19, PLE 0.21. Clypeus height 0.07. Chelicerae 5.44 long, 0.86 wide. Palp and leg measurements: pedipalp 6.73 [2.28, 0.79, 1.72, 1.94], leg I 11.77 [0.73, 0.64, 4.65, 4.84, 0.91], II 9.49 [3.01, 0.49, 2.46, 2.89, 0.64], III 8.83 [3.13, 0.56, 1.84, 2.49, 0.81], IV 9.24 [3.1, 0.33, 2.50, 2.81, 0.49]. Leg formula: 1243.

Distribution. India, Colombia, Brazil, Australia, Central America, Guyana, Philippines, Caribbean, West Africa (World Spider Catalog, 2025).

***Tetragnatha nitens* (Audouin, 1826)**

Eugnatha nitens Audouin, 1826: 323, plate 2, fig. 2 (♀).

Eugnatha pelusia Audouin, 1826: 325, plate 2, fig. 3 (♂♀).

Tetragnatha extensa Nicolet, 1849: 516, plate 4, fig. 5 (♀, misidentified)

Dinognatha [dandridgei] Thorell, 1869: 63 (unjustified emendation of generic name).

Tetragnatha nitens Dalmas, 1917: 365 (synonymy of *Tetragnatha dandridgei*); Castanheira et al., 2019: 486, figs. 14A–J, 15A–L, 16A–F, 20E (♂♀, synonymy of *T. caporiaccoi* [= *T. tullgreni* Caporiacco, 1947], *T. decipiens* and *T. peruviana*); Castanheira et al., 2022: 197, figs. 12A–B, 13A–C (♂♀, Synonymy of *Tetragnatha*

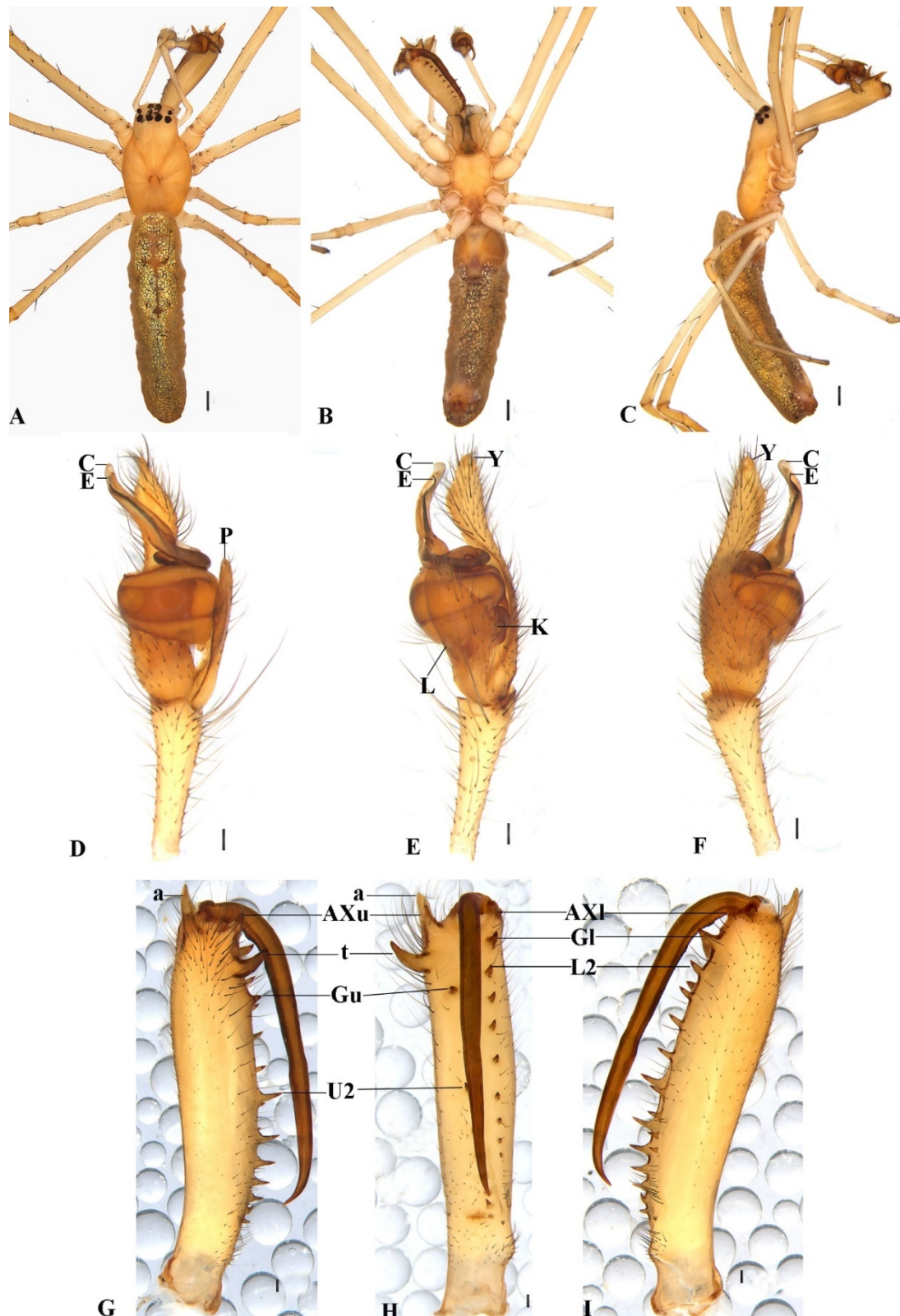


FIGURE 4.1.50. *Tetragnatha nitens* (Audouin, 1826), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, ventral view, F, dorsal view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.1 mm.

americana and *T. labialis*); Dippenaar-Schoeman et al., 2023: 42, figs. 1–9 (♂♀).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. **INDIA: Kerala:** Thrissur district, Thommana, paddy field 10°20'31"N, 76°15'03"E, 17 m, 13 May 2022, leg. Anju K. Baby, 2 ♂ 1 ♀. Wayanad district, Thrissilery, paddy field 11°50'36"N, 76°01'42"E, 795 m, 02 December 2022, leg. Anju K. Baby & Manu K. Baby, 2♂ 1♀.

Diagnosis. Males of *T. nitens* are most similar to *T. bogotensis* Keyserling, 1865, in having elongated ‘a’, and prolonged AXu and ‘t’. Males differ from the latter by having chelicerae with a thinner AXu and sickle like ‘t’, Gu shorter than U2. Pedipalp with longer and thinner tibia and conductors twisted in the distal half, exposing the emboli. Females differed from the latter in having chelicerae with short and blunt AXI, basal cusp (BC) larger, and Gu connected to U2 by a thin and dark ridge.

Redescription. Male (Fig. 4.1.50). Carapace flat, elongated, anteriorly constricted, medially enlarged, gradually narrowing towards the posterior rim, and yellowish. Anterior eyes are strongly recurved, AMEs closer than PMEs, AMEs larger, and PLEs located far from median eyes. Clypeus yellow. Fovea distinct and deep. Labium subquadrate and brownish. Maxillae longer, anteriorly broad, with distinct scopulae. Sternum brownish-yellow, with strong intercoxal extensions and a few hairs. Chelicerae with extremely elongated paturon, almost 5.5x longer than wide with dense hairs near the fang; ‘a’ strong with wide basis, bent at the middle, pale brownish with bifurcated apex; ‘t’ bulky, sickle-shaped, positioned below the AXu with blunt tip. AXu large, broad basis, closer to a fang basis with blunt apex, and shares the same basis with ‘t’. Upper row of chelicerae with nine teeth: Gu smaller,

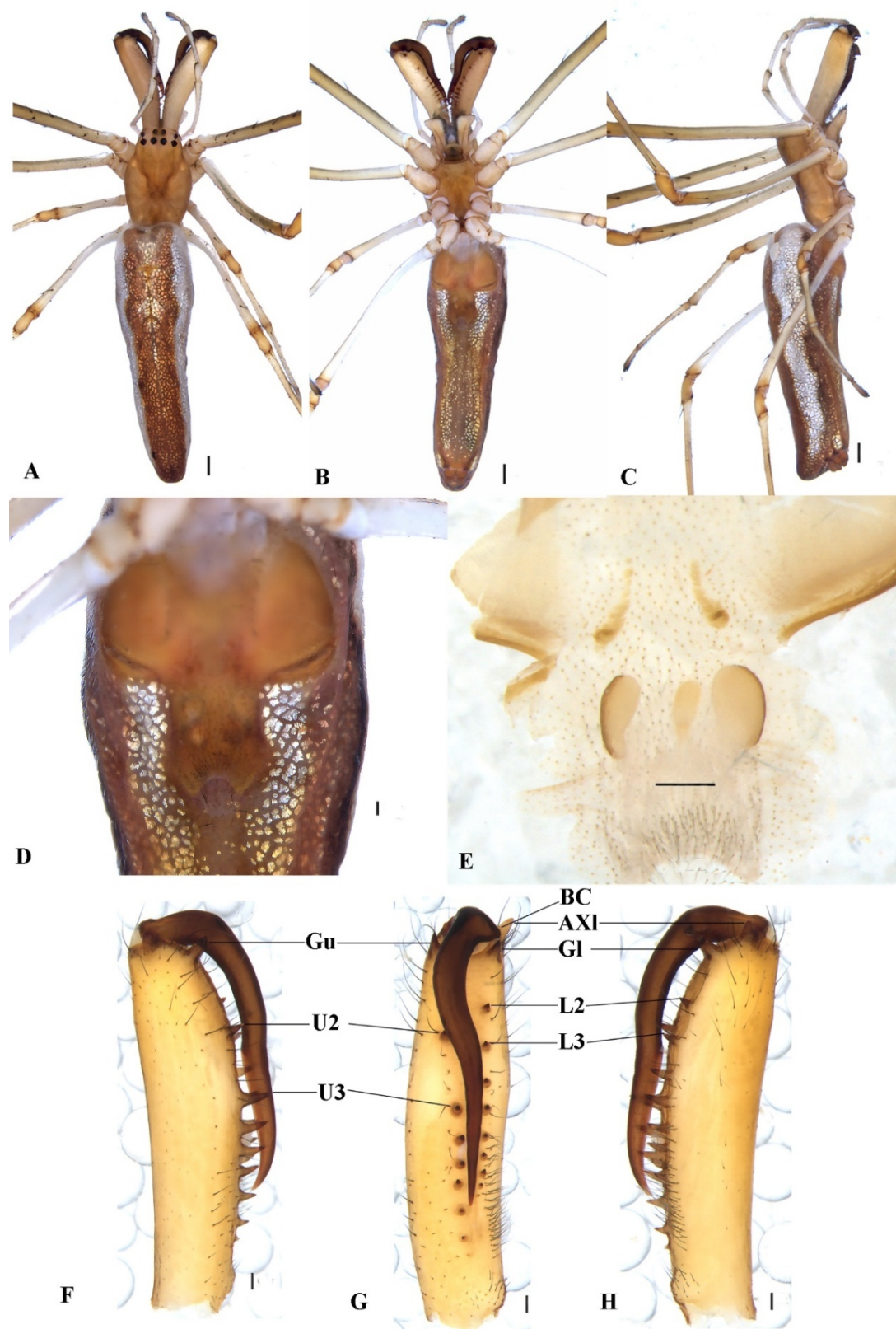


FIGURE 4.1.51. *Tetragnatha nitens* (Audouin, 1826), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.1 mm.

protruding and projected outward; U2 longer than Gu, very sharp and a large gap between Gu and U2; U3 thinner, thorn-like, and a significant gap between U2 and U3; U4 with wide basis and narrowing towards the apex; U5 similar shape to U4; U6 distally narrowing and outward directed; U7 strongly bent at the middle towards the upper side; U8 small; U3–U8 wavy and decreasing in size; U9 vestigial. AXI blunt and closer to fang basis. Lower row with nine teeth: G1 linear, stout, and very sharp; L2 upward directed, followed by six teeth decreasing in size. Legs brownish yellow. Abdomen median-sized; dorsum with golden guanine spots; venter yellowish brown with numerous golden guanine spots. Pedipalps with long tibia, elongated cymbium with sparse spines; tegulum small with two parallel brown stripes and dorsally constricted; paracymbium elongated with divided notch, numerous spines, and a large knob at the ectal side; translucent lobe short and almost transparent; conductor proximal half bulky, twisted at the mid-length with fairly divided apex; embolus thin, distally slanted with blunt apex.

Measurements. Total length: 8.35. Carapace 2.97 long, 1.56 wide. Abdomen: 5.38 long, 1.46 wide. Ocular area length 0.39, width 0.36. Eye diameters: AME 0.13, ALE 0.08, PME 0.12, PLE 0.09. Clypeus height 0.08. Chelicerae 2.88 long, 0.53 wide. Pedipalp 4.74 [2.19, 0.66, 0.81, 1.08], leg I 17.28 [6.66, 1.11, 4.80, 3.94, 0.77], II 14.52 [4.91, 0.92, 4.65, 3.12, 0.92], III 7.38 [2.35, 0.61, 1.64, 2.00, 0.78], IV 15.40 [5.03, 0.76, 4.30, 4.35, 0.96]. Leg formula: 1423.

Female (Fig. 4.1.51). Carapace, eyes, clypeus, fovea, labium, maxillae, and sternum, as in males. Chelicerae shorter than in males. Paturon yellow, 4x longer than wide, with few spines. AXu absent. Upper row of chelicerae with nine teeth: Gu stout, protruding, with a wide basis and not much closer to the fang basis; U2 linear,

smaller than Gu; U3 very long; the distance between Gu & U2 almost similar to the distance between U2 and U3; U4 slightly bent at the middle; U5 similar in shape to U4; U6 smaller than U5; U7 projected outward; U8 very pointed; U9 small with blunt apex. AX1 closer to the fang basis with blunt apex. Lower row with ten teeth: G1 stout with curved apex; L2 triangular and a significant gap between G1 & L2; L3 linear; L4, L5 and L6 similar in shape and equidistant; L7 gently bent at the middle followed by two teeth; L10 vestigial. Cheliceral fang brownish, with distinct basal cusp and proximal half gently curved. Abdomen anteriorly enlarged and gradually narrowing towards the apex; dorsum brownish with golden guanine spots medially and numerous silver guanine spots laterally; venter brownish, with numerous golden and silver guanine spots. Epigynal fold longer than wide with curved tip. Internally, a pair of spermathecae which are elongated and anteriorly enlarged; central membranous sac small, about half the length of the spermathecae, with short stalk.

Measurements. Total length: 8.64. Carapace 2.69 long, 1.45 wide. Abdomen: 5.95 long, 1.81 wide. Ocular area length 0.33, width 0.36. Eye diameters: AME 0.13, ALE 0.05, PME 0.12, PLE 0.10. Clypeus height 0.09. Chelicerae 2.08 long, 0.52 wide. Pedipalp 2.25 [0.44, 0.90, 0.17, 0.74], leg I 21.28 [6.15, 0.86, 6.43, 6.42, 1.42], II 14.29 [4.46, 0.79, 3.92, 4.01, 1.11], III 5.93 [2.10, 0.46, 1.31, 1.41, 0.65], IV 14.11 [4.63, 0.79, 3.77, 3.82, 1.10]. Leg formula: 1243.

Distribution. New Zealand, Tropical and subtropical Asia, Pacific Island, America, South Africa, Macaronesia, Saint Helena, Mediterranean, Madagascar (World Spider Catalog, 2025).

***Tetragnatha serra* Doleschall, 1857**

Tetragnatha serra Doleschall, 1857: 409 (♂); Doleschall, 1859: plate 8, fig. 5 (♂); Thorell, 1878: 111 (♀). Merian, 1911: 182, figs. Q–T. (♂♀); Okuma, 1987: 75, figs.

24A–F (♀); Okuma, 1988b: 203, figs. 16A–F (♀); Song et al., 1999: 223, figs. 126E, 128Q (♀); Zhu et al., 2003: 180, figs. 95A–F (♀); Anju et al., 2024b: 994, figs. 7A–H, 8A–B (♀).

Material examined. INDIA: Kerala: Wayanad district, Arattuthara, paddy field, 11°37'52"N, 76°16'34"E, 873 m a.s.l., 7 December, 2022, leg. Anju K. Baby, 1♂ 5♀. Kottayam district, Moonnilavu 9°44'55"N, 76°47'02"E, 70 m, 15 May 2023, leg. Anju K. Baby & Adheena Shaji, 2♂ 4♀.

Diagnosis. Males of the species resemble *T. hirashimai* Okuma, 1987, in having ‘a’ with blunt apex, ‘rsu’ set apart by large distance from ‘T’, fangs without any cusps. The species also differ from the latter by having Gu extremely large and curved, Gl and L2 much closer to the fang basis, and AXI very small and ‘a’ displaced to the lateral side. Females of *T. serra* are most similar to those of *T. hirashimai* where both species have elongated chelicerae, Gu bulky, U2 long and widely separated from Gu, AXI present, and epigynal fold posteriorly enlarged with a blunt apex. However, it can be separated from *T. hirashimai* in having not much larger Gl, AXI absent, and cheliceral fang with small basal cusp (cheliceral fang with median cusp in *T. hirashimai*) (Okuma 1987, figs. 24A–E, 26A–K; 1988b, figs. A–F; Zhu et al., 2003, figs. 95B–F).

Redescription. Male (Fig. 4.1.52). Carapace anteriorly constricted, medially broad and gradually narrows towards posterior rim, elongated and pale yellow; dark patches near fovea extends towards the posterior rim. Cephalic region slightly elevated; cephalic groove dark and distinct. Anterior eyes strongly recurved, ALEs on the tubercles, PME's centrally placed than AMEs and all eyes with dark border.

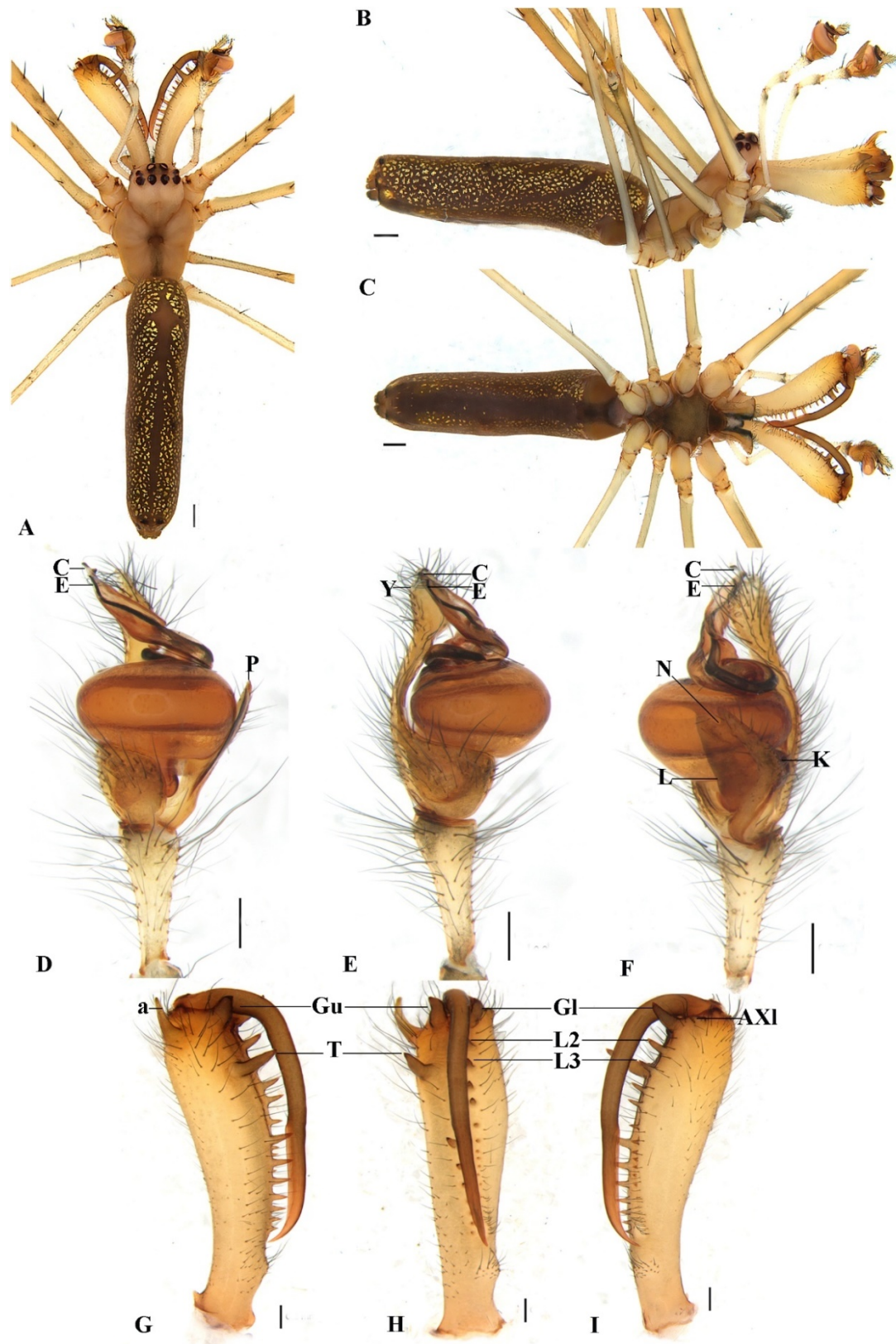


FIGURE 4.1.52. *Tetragnatha serra* Doleschall, 1857, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.2 mm.

Fovea deep, distinct and dark. Labium dark and subquadrate. Sternum brownish with sparse hairs and strong intercoxal extensions, with bifid posterior extension. Chelicerae with paturon elongated, slender, nearly 5x longer than wide, pale yellow and brownish yellow near fang basis; 'a' slender, long, with blunt apex. AXu absent. Upper row with nine teeth: Gu bulky with wide basis, distally curved, upward directed, 'T' long, slightly displaced from the row, distance between T' and U3 larger than Gu and 'T', 'rsu' with seven teeth decreasing in size. AXI flattened, small, blunt, displaced from the row and closer to fang basis. Lower row with thirteen teeth: G1 thumb-shaped, stout, long, protruding, L2 thinner, L3 distally curved, L4 & L5 about similar shape, G1–L4 equidistant, G1–L5 projected upward, L11 slightly displaced from the row, L6–L12 directed outward and decreasing in size, L13 vestigial, a moderate gap between L12 and L13. Cheliceral fang long, brownish, serrated. Legs pale yellow. Abdomen cylindrical, elongated; dorsum covered by yellow guanine spots, with longitudinal grey patch and six transverse patches, posteriorly with two black spots; venter greyish with yellow guanine spots. Pedipalp with long tibia, tegulum wider than long, with two parallel transverse brownish stripes; cymbium long, proximally broad and distally narrowed; conductor broad at the base, folded midway, with a small bifurcation at the apex; embolus dark, thickened at the base, distally narrowing, and distal half enclosed with conductor; paracymbium long, with divided notch, translucent knob wide and extending towards the apex, ectal side with a knob which is nearly oval and dark.

Measurements. Total length 11.37. Carapace length 2.15, width 1.55. Abdomen length 5.69, width 1.07. Ocular area length 0.47, width 0.39. Eye diameters: AME 0.13, ALE 0.08, PME 0.12, PLE 0.11. Clypeus height 0.12. Length of chelicerae 2.83, width 0.56. Pedipalp and leg measurements: pedipalp 3.92 [1.23, 0.48, 0.59,

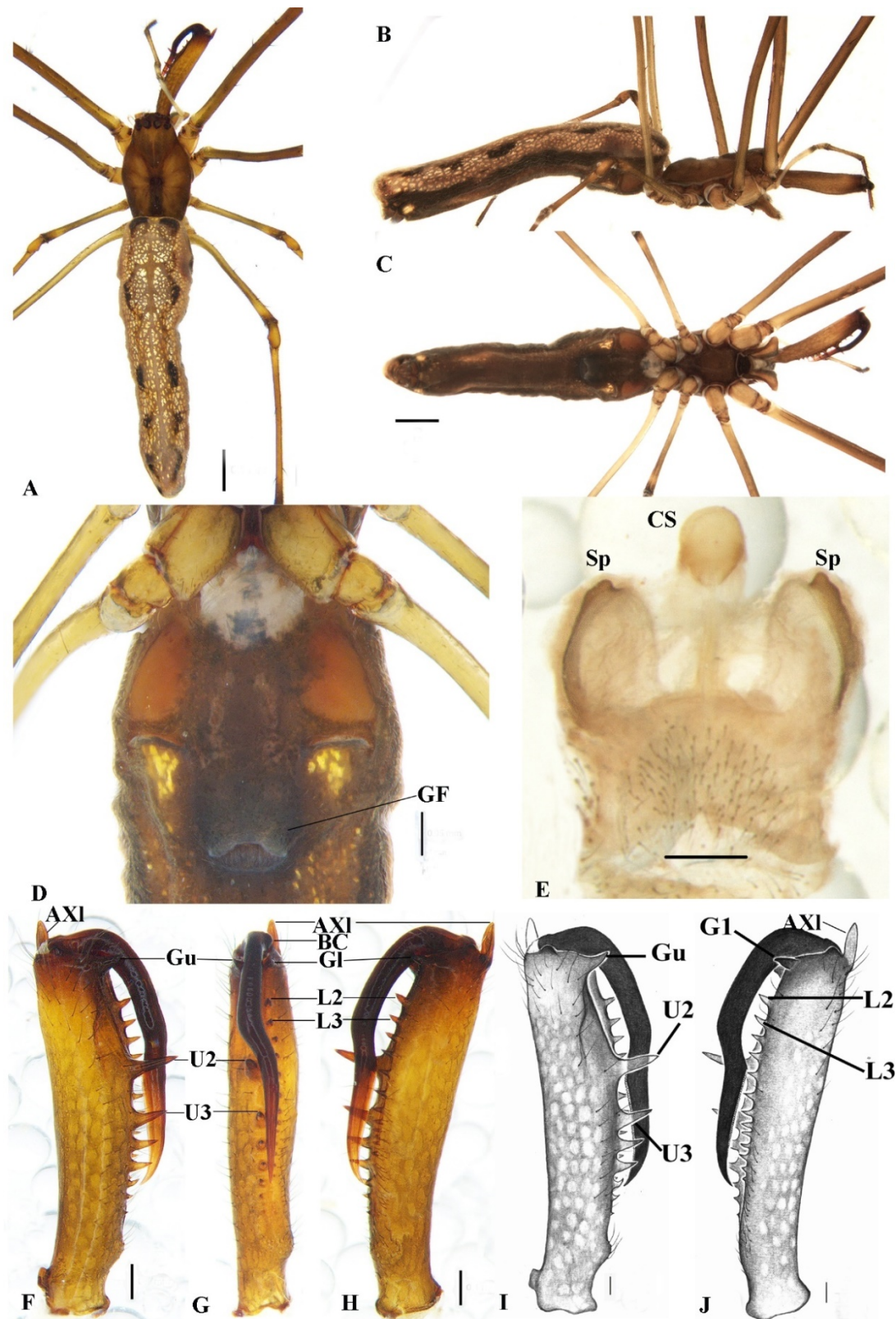


FIGURE 4.1.53. *Tetragnatha serra* Doleschall, 1857, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–J: 0.2 mm.

1.06], leg I 36.83 [10.96, 1.02, 10.70, 11.85, 2.30], II 19.80 [6.55, 0.77, 5.46, 5.62, 1.40], III 8.58 [2.82, 0.54, 1.82, 2.51, 0.89], IV 18.59 [6.65, 0.66, 4.99, 5.06, 1.23].

Leg formula: 1243.

Female (Fig. 4.1.53). Carapace anteriorly constricted, medially broad and gradually narrows towards posterior rim, elongated and light brown, darker on sides; dorsally with brown patches arising from PLEs, passing through the fovea, reaching the posterior rim. Cephalic region slightly elevated; cephalic groove dark and distinct. Eyes, fovea and sternum as in male. Legs brownish yellow. Chelicerae with paturon slender with irregularly scattered circular markings, elongated, nearly 5.5x longer than wide, and brownish yellow. AXu absent. Upper row with eight teeth: Gu bulky with stout basis, distally curved, pointed and closer to fang basis; U2 slender, straight, very sharp, and very elongated, distance between Gu and U2 about 2x larger than distance between U2 and U3; U3–U8 thorn-like and decreasing in size. AXI large with blunt apex, positioned at the lateral side of paturon near fang basis. Lower row with fourteen teeth: G1 stout, relatively short with a round basis, projected outward, opposite to Gu and closer to fang basis; L2–L7 pointed, smaller than G1 and with similar size, L2 located a significant gap after G1; L8–L14 very reduced and slightly decreasing in size. Cheliceral fang fairly serrated, slightly enlarged and curved midway, distal half clearly slanted, uniformly tapering from midway, brown with brownish-yellow apex, and bearing a short and blunt basal cusp. Abdomen anteriorly broad, elongated, and almost 3x longer than carapace; dorsum pale brown with scattered guanine spots, lateral sides with five pairs of black patches, anterior pair more prominent than the rest; venter dark brown, slightly elevated, small scattered silvery spots on either side of epigynal fold below the book lungs, and a pair of silver spots above spinnerets. Epigynal fold wider than long,

elevated with gently curved tip. Internal genitalia composed of pair of spermathecae, broad at the base, 1.5x longer than wide, anteriorly constricted, slanted inward with curved apex, with dark brownish lateral edges, and connected to central membranous sac which is relatively small, nearly globular, slightly narrowed towards posterior side and placed above spermathecae with long stalk.

Measurements. Total length 8.87. Carapace length 2.36, width 1.41. Abdomen length 6.51, width 1.42. Ocular area length 0.61, width 0.93. Eye diameters: AME 0.15, ALE 0.09, PME 0.14, PLE 0.10. Clypeus height 0.14. Length of chelicerae 2.49, width 0.45. Epigynal fold length 0.56, width 0.62. Pedipalp and leg measurements: pedipalp 2.69 [1.00, 0.31, 0.77, 0.61], leg I 27.42 [7.82, 1.02, 7.89, 8.91, 1.78], II 12.81 [3.26, 0.71, 4.29, 3.60, 0.95], III 6.08 [2.04, 0.45, 1.42, 1.55, 0.62], IV 14.48 [5.14, 0.47, 3.89, 4.25, 0.73]. Leg formula: 1432.

Distribution (Fig. 4.1.54). Indonesia, India, China, Thailand (World Spider Catalog, 2025).

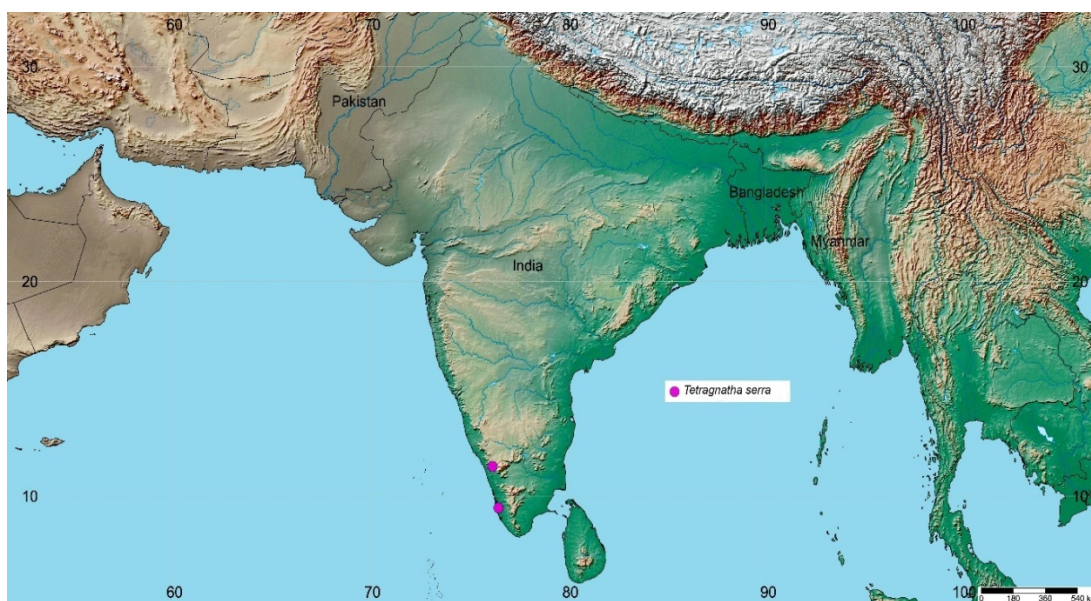


FIGURE 4.1.54. Distribution of *Tetragnatha serra* in India.

***Tetragnatha squamata* Karsch, 1879**

Tetragnatha squamata Karsch, 1879: 65, plate. 1, fig. 3 (♂♀); Bösenberg & Strand, 1906: 176, plate 3, fig. 5, plate 15, fig. 405 (♂♀).

Tetragnatha laochenga Barrion, Barrion-Dupo & Heong, in Barrion et al., 2013: 32, figs. 35A–F (♀).

Tetragnatha squamata Baba & Tanikawa, 2015: 36, 5 (♂♀); Lin et al., 2023: 518 (synonymy of *T. bandapula* and *T. laochenga*); Anju et al., 2024c: 132, figs. 1A–B, 2A–F, 3A–F, 4A–D, 5A–D (♂♀).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. INDIA: Kerala: Thrissur district, Pullu Kole wetlands 10°27'27.04"N, 76°09'08.24"E, 27 November 2021, leg. E. H. Vishnudas & A. V. Sudhikumar, 2♂. Muriyad Kol wetlands, Thommana 10°20'31"N, 76°15'03"E, 17 m, 24 February 2023, leg. Anju K. Baby, 1♀.

Diagnosis. *Tetragnatha squamata* is one of the smallest species in the genus *Tetragnatha* (Yin et al., 2012). It resembles *T. vermiformis* Emerton, 1884 (Zhu et al., 2003). Males of both species have elongated bodies, and chelicerae with pointed ‘a’ and small IC, but differ from *T. vermiformis* in having small U2 (which is large, pointed and represented as ‘T’ in *T. vermiformis*), absence of AXI and fang with small OC, palp with enlarged tegulum and moderate-sized conductor. Females of *T. squamata* differs in having abdomen ovoid, chelicerae with similar sized Gu and U2, Gl and L2 closely placed, long genital fold, and internal genitalia with a pair of spermathecae with triangular-shaped central membranous sacs (whereas two pairs of spermathecae in *T. vermiformis* and lack a central membranous sac).

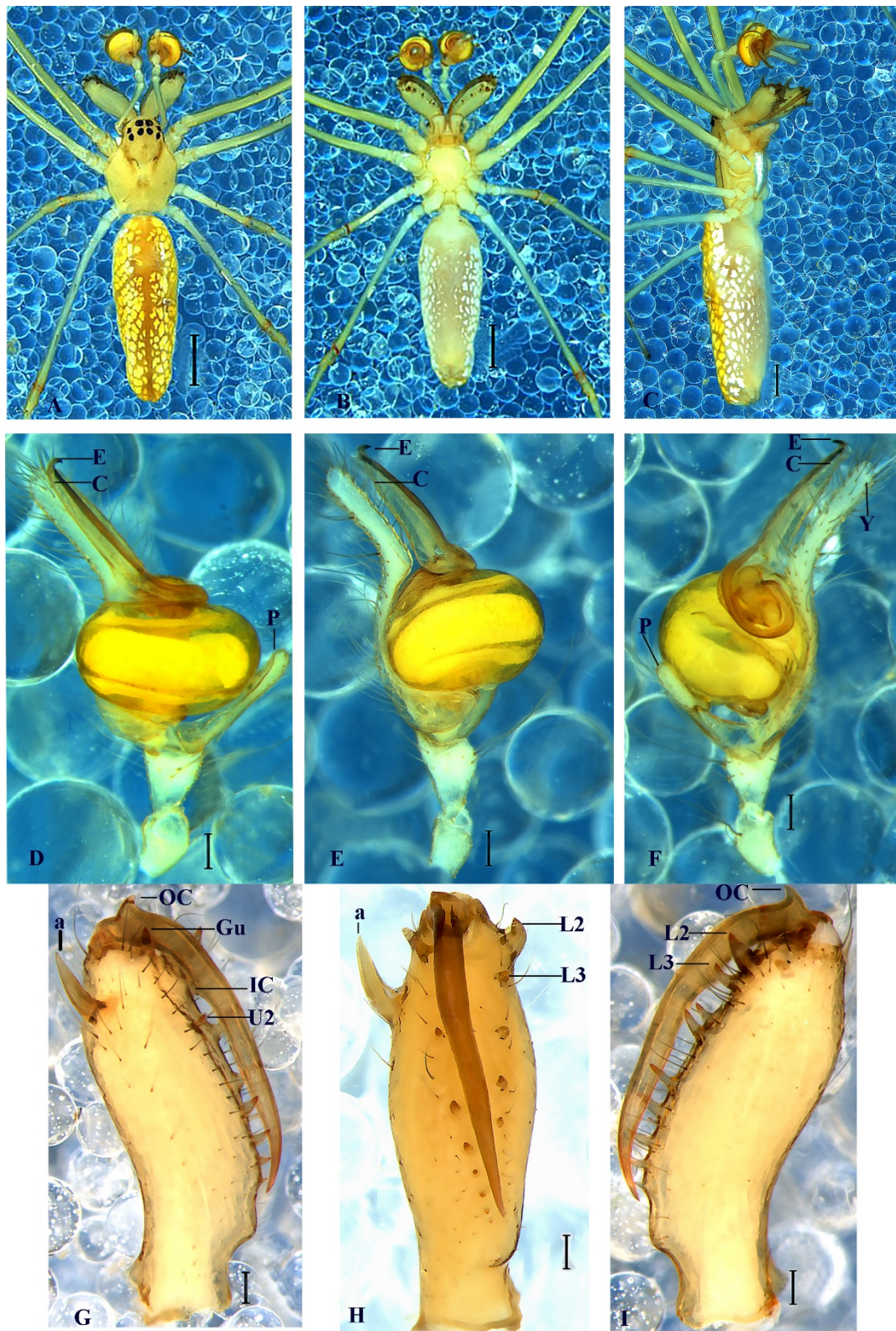


FIGURE 4.1.55. *Tetragnatha squamata* Karsch, 1879, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.2 mm.

Description. Male (Fig. 4.1.55). Carapace anteriorly narrowed, medially broad with distinct fovea and pale yellow. Two rows of eyes strongly recurved and ALEs small. Clypeus yellow. Labium yellowish-brown, maxillae yellow and elongated; sternum yellow and heart-shaped. Chelicerae long, slender, brownish yellow. ‘a’ extremely elongated, tapering, directed upward; Gu stout, not much closer to the fang base. Upper row of chelicerae with six promarginal teeth: U2 small, pointed, set apart by a large gap between from Gu and U3; U3 larger than U2 followed by three teeth. AXI absent. Lower row with five teeth: G1 large, bulky, considerably curved at the distal end; L2 closer to G1 and bends at the middle towards the upper side; L3 straight, directed upward, slightly separated from L2 followed by two teeth. Cheliceral fang strongly geniculate with small OC and IC, constricted at the middle, with the distal end inserting between two rows of teeth. Abdomen cylindrical, elongated, yellow, covered with brownish yellow markings on the middle along with golden yellow spots, laterally with silvery spots; venter with dark grey on the middle and silvery spots on each side. Legs light yellow. Palpal segments brownish yellow; cymbium long, creamy white, with numerous spines; conductor thin, transparent, and twisted with embolus. Embolus long, brownish yellow, originated from the middle of the bulb. Paracymbium thick, nearly transparent, and rounded at the tip.

Measurements. Body length 4.87. Carapace length 1.73, width 1.16. Abdomen length 3.14, width 1.15. Ocular area length 0.22, width (at the middle) 0.25. Eye diameters: AME 0.12, ALE 0.08, PME 0.09, PLE 0.09. Clypeus height 0.16. Length of chelicera 1.38, width 0.45. Palp and leg measurements: pedipalp 5.13 [2.42, 0.13, 0.29, 2.32], leg I 13.23 [3.62, 0.62, 4.50, 3.82, 0.67], II 9.73 [2.79, 0.56, 3.26, 2.70, 0.42], III 5.08 [0.93, 0.41, 1.45, 1.70, 0.59], IV 9.33 [2.62, 0.50, 2.76, 2.83, 0.62].

Leg formula: 1243 (Anju et al., 2024c).

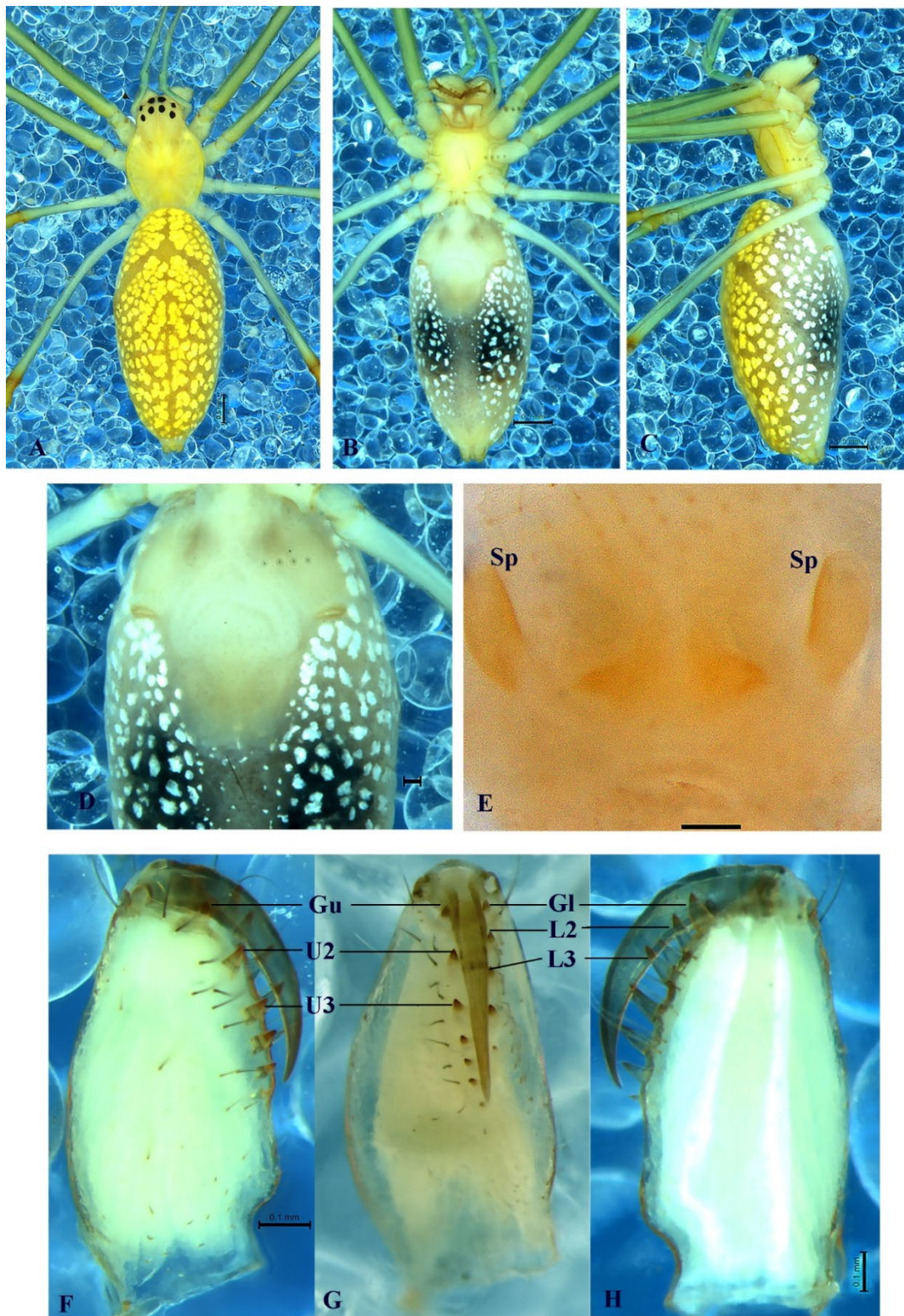


FIGURE 4.1.56. *Tetragnatha squamata* Karsch, 1879, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–J: 0.2 mm.

Female (Fig. 4.1.56). Carapace golden yellow, anteriorly narrowed, medially broad, fovea, and cephalic furrow indistinct. Two rows of eyes strongly recurved; ALEs small. Clypeus pale yellow. Labium elongated. Maxillae transparent. Sternum pale yellow and heart-shaped. Chelicerae stout, pale straw colour with brownish yellow teeth. AXu absent. Upper row of chelicerae with six teeth: Gu large, straight, pointed with large base; U2 projected upward, followed by four teeth equally spaced and arranged in descending series. AXI absent. Lower row with five teeth: G1 large, stout, tapering, distal half bends towards the upper side and slightly separated from fang base; L2 long, slender, positioned closer to G1; L3 larger than L2 followed by two teeth opposite to U3 and U4. Cheliceral fang brownish-yellow and nearly transparent. Abdomen ovoid, brownish yellow markings with golden yellow spots on the dorsal; laterally with silvery spots; venter with black markings on the middle along with silvery spots. Leg I & II yellowish brown; legs III & IV transparent with brownish yellow markings. Genital fold long, broad, slightly bulged, and sclerotized with a round apex; internally with elongated spermathecae with a large central membranous sac.

Measurements. Body length: 5.27. Carapace length 1.58, width (at the middle) 1.11. Abdomen length 3.69, width (at the middle) 1.59. Ocular area length 0.23, width 0.25. Eye diameters: AME 0.10, ALE 0.04, PME 0.08, PLE 0.08. Clypeus height 0.12. Length of chelicera 0.78, width (at the middle) 0.36. Leg I 13.37 [3.67, 0.55, 4.09, 3.92, 1.14], II 10.29 [2.87, 0.57, 3.04, 2.90, 0.91], III 5.82 [1.78, 0.42, 1.44, 1.62, 0.50], IV 9.49 [2.92, 0.45, 2.62, 2.75, 0.75]. Leg formula: 1243 (Anju et al., 2024c).

Distribution (Fig. 4.1.57). Japan, India, Korea, China, Taiwan, Russia (World Spider Catalog, 2025).

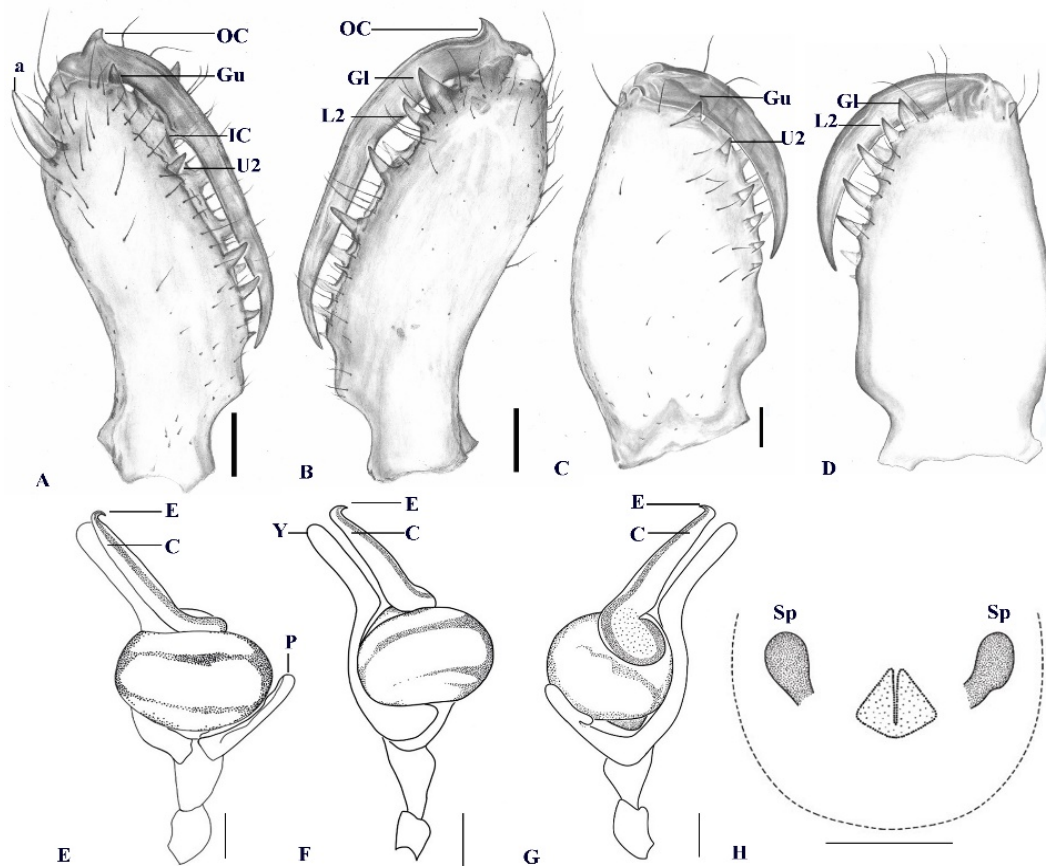


FIGURE 4.1.57. *Tetragnatha squamata* Karsch, 1879, male (A, B, E–G), female (C, D, H). A, B, left chelicerae, A, same, dorsal view, B, same, ventral view. C, D, left chelicerae, same dorsal view, D, same, ventral view. E–G, left palp, E, same, mesal view, F, same, dorsal view, G, same ventral view. H, epigynum, dorsal view. Scale bars: A–G: 0.1 mm. H: 0.05 mm.

Tetragnatha viridorufa Gravely, 1921

Tetragnatha viridorufa Gravely, 1921: 411 (♂♀); Gravely, 1921a: 434, 445, figs. 6a–b (♂♀); Sunil Jose et al., 2004: 182, figs. 1–19 (♂♀).

Material examined. INDIA: Kerala: Kozhikode district, Peruvannamuzhi dam 11°35'46"N 75°49'16"E, 90 m, 21 April 2022, leg. Anju K. Baby & Manu K. Baby, 2♂ 2♀. Wayanad Wildlife Sanctuary, Tholpetty 11°57'04"N 76°03'43"E, 883 m, 9 June 2023, leg. Anju K. Baby & Manu K. Baby, 1♀. Thrissur district, Pullu Kol wetlands 10°27'17"N, 76°09'14"E, 26 m, 21 January 2025, leg. Anju K. Baby & Muhsina 2♂, 4♀.

Diagnosis. Males of *T. viridorufa* can be distinguished from all other *Tetragnatha* spp. by having greenish body colour, posterior end of the paturon slightly curved towards the lateral side, pedipalp with extremely slender cymbium, a small bifurcation at the distal end of the conductor, paracymbium without any notch. Females can be distinguished by having greenish body colour, internal genitalia with two pairs of spermathecae, anterior pair of spermathecae smaller than the posterior pair, and chelicerae with small AXu positioned on the lateral side of the chelicerae and closer to the fang basis.

Redescription. Male (Fig. 4.1.58). Carapace elongated, medially enlarged, posterior rim curved inward; cephalic region nearly square anteriorly and elevated, and yellowish brown. Fovea deep, nearly roundish, and dark. Two rows of eyes strongly recurved, PME's closer than AME's. Clypeus yellowish brown. Labium subquadrate and brownish. Maxillae elongated, anteriorly enlarged, and pale yellowish. Paturon elongated, slender; 'a' long, slender, curved, and distally protruding. AXu absent. Upper row of chelicerae with ten teeth: Gu extremely long, thinner, and apex curved upward; U2 thinner, shorter than Gu with pointed tip; U3 small, bent at the middle; U4 longer than U3; U5 straight and directed downward, followed by five teeth decreasing in size; Gu–U5 almost equidistant. AXI absent. Lower row of chelicerae with seven teeth: G1 moderate-sized and closer to fang basis; L2 thorn-like; L3 & L4 same shape as L2; L5 upward-directed; L6 longer than L5; L7 smaller and outward-directed. Cheliceral fang extremely long, distal end curved inward and brownish. Abdomen elongated; dorsum pale brownish (greenish when in live) with random guanine spots; posterior end slightly enlarged and slanted; venter pale brownish with brownish parallel longitudinal stripes. Legs yellowish-brown. Sternum with strong intercoxal extensions and yellowish brown. Pedipalp with long tibia; tegulum small

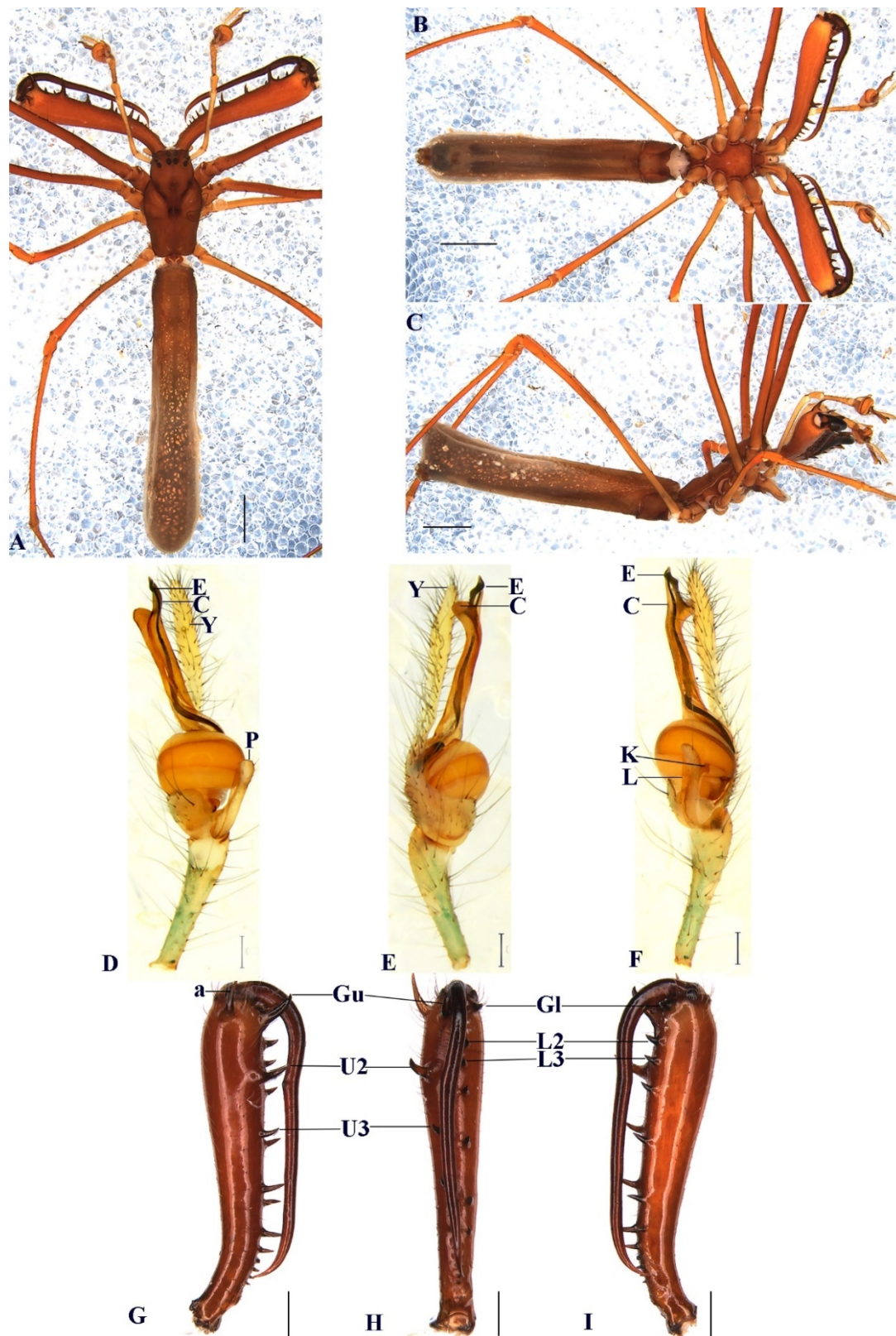


FIGURE 4.1.58. *Tetragnatha viridorufa* Gravely, 1921, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, mesal view, E, dorsal view, F, ventral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.2 mm.

with two parallel brownish lines cymbium long, slender, with numerous macrosetae; embolus long, thin, distally curved, and black; conductor bulky, distally with a bifurcation and brownish; paracymbium short, slender, anteriorly curved, translucent lobe thin, and a large knob at the ectal side.

Measurements. Total length: 7.08. Carapace 2.37 long, 1.45 wide. Abdomen: 4.71 long, 0.55 wide. Ocular area length 0.26, width 0.25. Eye diameters: AME 0.07, ALE 0.04, PME 0.07, PLE 0.06. Clypeus height 0.11. Chelicerae 1.91 long, 0.51 wide. Palp and leg measurements: pedipalp 2.57 [1.52, 0.24, 0.21, 0.60], leg I 36.88 [12.00, 1.51, 9.51, 11.44, 2.42], II 20.90 [7.01, 0.58, 6.11, 5.73, 1.47], III 9.28 [3.02, 0.69, 1.99, 2.73, 0.85], IV 18.91 [6.43, 0.81, 5.22, 5.03, 1.42]. Leg formula: 1243.

Female (Fig. 4.1.59). Carapace, eyes, fovea, clypeus, maxillae, sternum, and legs as in males. Paturon elongated, anteriorly enlarged, and brownish. AXu small, linear, protruding, positioned close to fang basis and lateral side of paturon. Upper row of chelicerae with ten teeth: Gu extremely larger, strongly curved towards the upper side with a pointed apex; U2 small, distal half bent towards the upper side; U3 larger than U2; U4 blunt, U5 & U6 similar in shape; U7 directed outward; U8 straight and protruding; U9 triangular, followed by small U10. Lower row with eight teeth: G1 small and closer to the fang basis; L2 extremely large with wide basis and pointed tip; L3 & L4 very small with pointed apex; L5 linear and directed outward; L6 & L7 straight followed by small L8. Cheliceral fang extremely long and brownish. Abdomen elongated; dorsum pale brownish (greenish when in live) with numerous guanine spots and posteriorly slanted; venter brownish without any markings. Epigynal fold short and strongly curved inward. Internally a pair of spermathecae, anteriorly broad, posteriorly constricted, widely separated with a large central membranous sac.

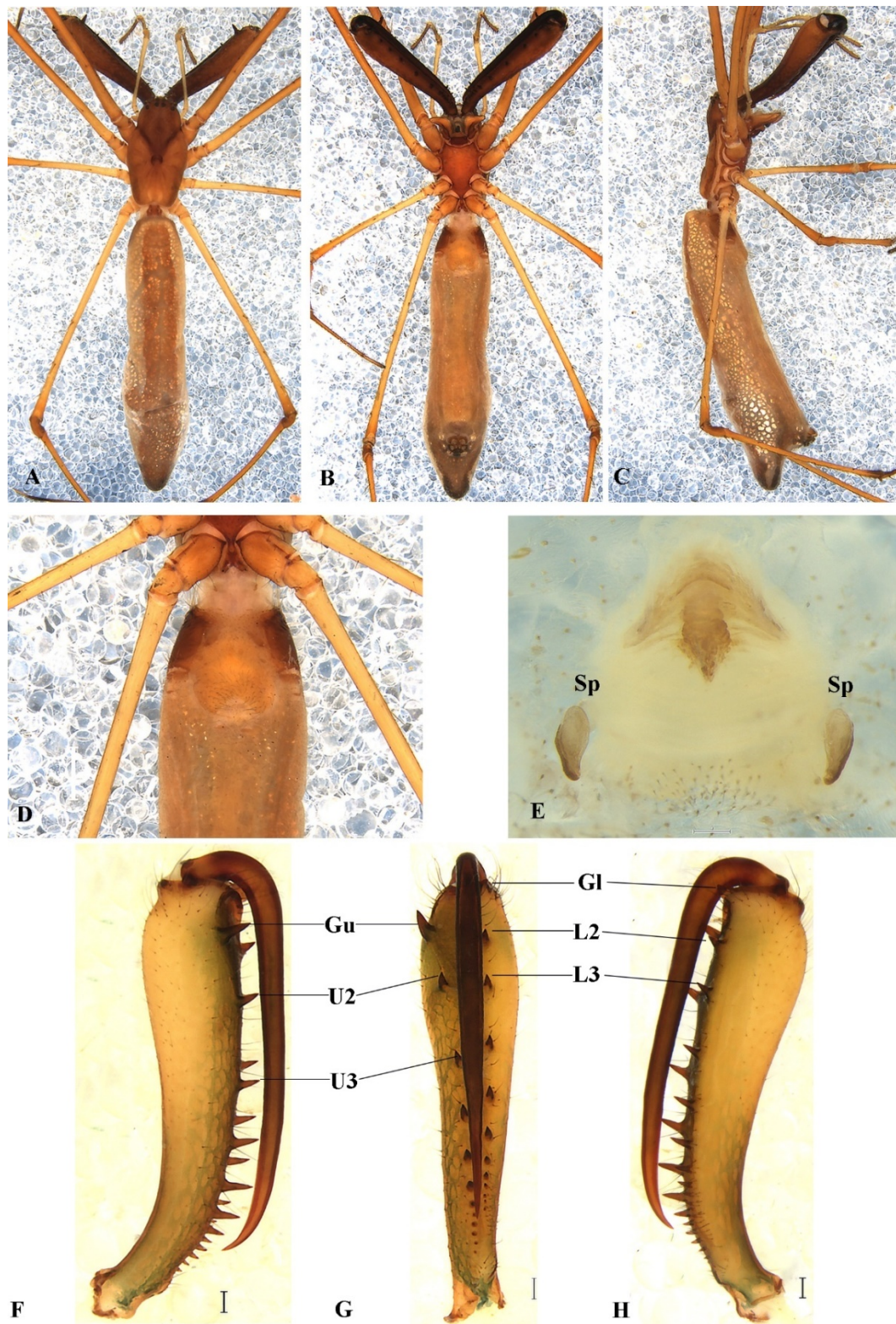


FIGURE 4.1.59. *Tetragnatha viridorufa* Gravelly, 1921, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.2 mm.

Measurements. Total length: 6.84. Carapace 2.21 long, 1.40 wide. Abdomen: 4.63 long, 0.58 wide. Ocular area length 0.27, width 0.26. Eye diameters: AME 0.08, ALE 0.04, PME 0.07, PLE 0.06. Clypeus height 0.09. Chelicerae 1.82 long, 0.56 wide. Palp and leg measurements: pedipalp 3.83 [1.57, 0.51, 0.47, 1.28], leg I 36.58 [11.31, 1.42, 10.33, 11.31, 2.21], II 19.62 [6.37, 0.61, 5.70, 5.62, 1.32], III 8.56 [2.81, 0.64, 1.82, 2.50, 0.79], IV 18.17 [6.23, 0.71, 4.91, 4.99, 1.33]. Leg formula: 1243.

Distribution. India (World Spider Catalog, 2025).

4.1.7. Genus *Tylorida* Simon, 1894

Diagnosis. *Tylorida* species differs in having yellow guanine spots on the dorsum of the abdomen rather than silvery guanine spots, tegulum enlarged, copulatory ducts with numerous folds and wrinkles and copulatory openings widely separated, fertilization ducts oriented in the same direction of copulatory ducts, spermathecae larger and balloon-like, epigynal plate larger, sperm ducts with numerous coils, cymbial dorso-basal process long and perpendicular to the cymbium.

Type species. *Tylorida striata* Thorell, 1877.

Key to *Tylorida* species

- 1a. Abdomen with strong hump and cheliceral margin without any protrusion..... *T. striata*
- 1b. Abdomen without any humps and cheliceral margins with prominent protrusions.....2

- 2a. Tibia short, conductor distally with two distinct twists, cymbial dorso-basal process linear without any curves at the end..... *T. ventralis*
- 2b. Tibia long, conductor distally with single twist, cymbial dorso-basal process curved at the end.....**3**
- 3a. A pair of black spots on the posterior end of the abdomen, paracymbium long and slender, disto-median triangular process smaller, posterior of the epigynal fold constricted..... *T. flava*
- 3b. Black spots are absent on the abdomen, paracymbium short and stout, disto-median triangular process larger, and epigynal fold semicircular *T. marmorea*

***Tylorida flava* Sankaran, Malamel, Joseph & Sebastian, 2017**

Tylorida flava Sankaran et al., 2017: 296, figs. 1A, 3A–F, 4A–H (♀); Anju & Sudhikumar, 2023: 24, figs. 1A–C, 2A–F (♂).

Material examined. INDIA: Kerala: Wayanad District, Makkiyad Hills 11°45'18"N, 75°54'25"E, 820 m, 18 April 2022, leg. A.V. Sudhikumar & Anju K. Baby, 2♂ 2 ♀. Wayanad district, Chirappullu Hill 11°42'37"N, 75°54'12"E, 1,517 m, 25 May 2022, leg. Anju K. Baby & Manu K. Baby, 2♂. Idukki district, Anakkulam 10°09'33"N 76°54'49"E, 342 m, 09 December 2023, leg. Anju K. Baby & Greeshma T. S., 2♂. Thrissur district, Chimmini Wildlife Sanctuary 10°25'51"N 76°29'27"E, 146 m, 15 December 2023, leg. Anju K. Baby & Greeshma T. S., 2 ♀.

Diagnosis. Males of *T. flava* are most similar to the males of *T. marmorea* (Pocock, 1901), but can be separated by the following combination of characteristics: Cheliceral promargin with large rounded tubercle near the distal tooth and a rounded

tiny tubercle set apart from the distal tooth on the retromargin (vs. cheliceral promargin lacking tubercle on the base but with a slightly bifid tubercle near the distal tooth of retromargin); cymbial dorso-basal process long, protruding, and projected towards the dorsal side (vs. with short cymbial dorso-basal process and slightly folded retrolaterally); strong paracymbium with broad apex in contact with subtegulum (vs. paracymbium with apical warp touching the tegulum). Females are most similar to *T. striata* (Thorell, 1877) but can be separated from the latter by the following characters: abdomen without any humps (strong abdominal humps in *T. striata*), enlarged epigynal plate (vs. much compressed epigynal plate in *T. striata*), copulatory ducts and fertilization ducts are much longer.

Redescription. Male (Figs. 4.1.60, 4.1.62). Carapace olive green, cephalic region much darker towards the fovea. Two rows of eyes strongly recurved; ocular area dark, lateral eyes contiguous and located on the tubercles. Clypeus black. Fovea distinct. Labium yellowish brown and rectangular. Maxillae elongated with distinct scopulae. Sternum heart-shaped, yellowish-black, with long black hairs and a conspicuous bifid posterior extension. Chelicerae yellowish brown and small. Upper row of chelicerae with three teeth: Prt1 closer to fang basis, and a large distance between Prt1 and Prt2; distal one located on the upper end of the tubercle sharing the same basis. Lower row with four teeth: Ret1 and Ret2 curved, Ret3 straight and pointed; Ret4 curved at the middle; a tiny tubercle set apart from the distal tooth and opposite to the large, rounded tubercle. Abdomen elongated, greyish; dorsum with median longitudinal black patches and a pair of black spots on the posterior side; laterally with silvery spots; venter with a pair of black spots located on the sides of lateral spinnerets. Legs yellowish without annulations. Prolaterally, femur III with single row of trichobothria, and femur IV with two rows of trichobothria. Palpal

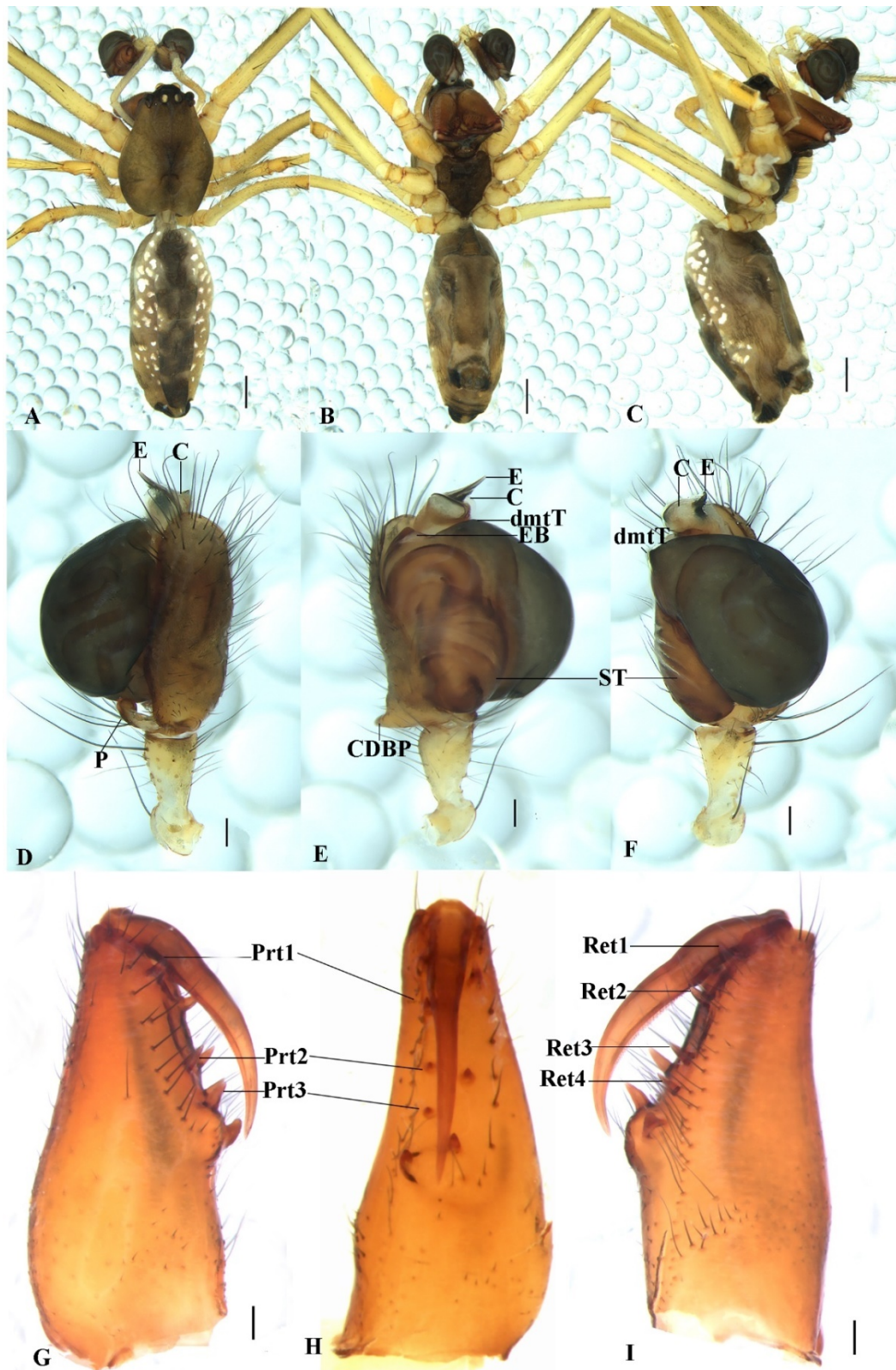


FIGURE 4.1.60. *Tylorida flava* Sankaran, Malamel, Joseph & Sebastian, 2017, male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.1 mm.

segments yellow. Tegulam dark brown and nearly globular; distomedian triangular process small, prominent, and facing towards the embolic base; subtegulum light brown; cymbium with broad base, bent towards the ventral side; prolaterally with a small, flat, cone-like process on the posterior end; cymbial dorso-basal process long, thickened at the base, with the distal end protruding and slightly projected towards the dorsal side; paracymbium long with broad apex, and the distal end in contact with subtegulum; embolus short, blackish, protruding with an apical twist, and slightly slanted distally; embolic base short, flat, and lying in close contact with the conductor base; conductor, thick, nearly transparent, and enclosing the embolus distally (Anju & Sudhikumar, 2023).

Measurements. Total length: 4.76. Carapace 1.86 long, 1.41 wide. Abdomen: 2.87 long, 1.27 wide. Ocular area length 0.36, width 0.34. Eye diameters: AME 0.14, ALE 0.12, PME 0.11, PLE 0.09. Clypeus height 0.06. Chelicerae 1.31 long, 0.53 wide. Pedipalp 2.81 [1.38, 0.15, 0.33, 0.95], leg I 26.84 [7.29, 0.94, 7.72, 9.77, 1.12], II 14.61 [4.32, 0.56, 3.88, 4.81, 1.04], III 5.90 [2.01, 0.35, 1.23, 1.67, 0.64], IV 13.73 [3.36, 0.45, 3.92, 4.95, 1.05]. Leg formula: 1243 (Anju & Sudhikumar, 2023).

Female (Fig. 4.1.62). Carapace anteriorly constricted, medially enlarged, and gradually constricted towards the posterior rim, pale yellowish. Eyes, fovea, clypeus, sternum, labium, and maxillae as in males. Chelicerae short, stout, and brownish-yellow with strong spines. Upper row of chelicerae with three teeth: Prt1 larger with blunt tip; Prt2 slightly curved upward; Prt3 thinner and triangular. Lower row with four teeth: Ret 1 stout, strongly curved and closer to the fang basis; Ret2

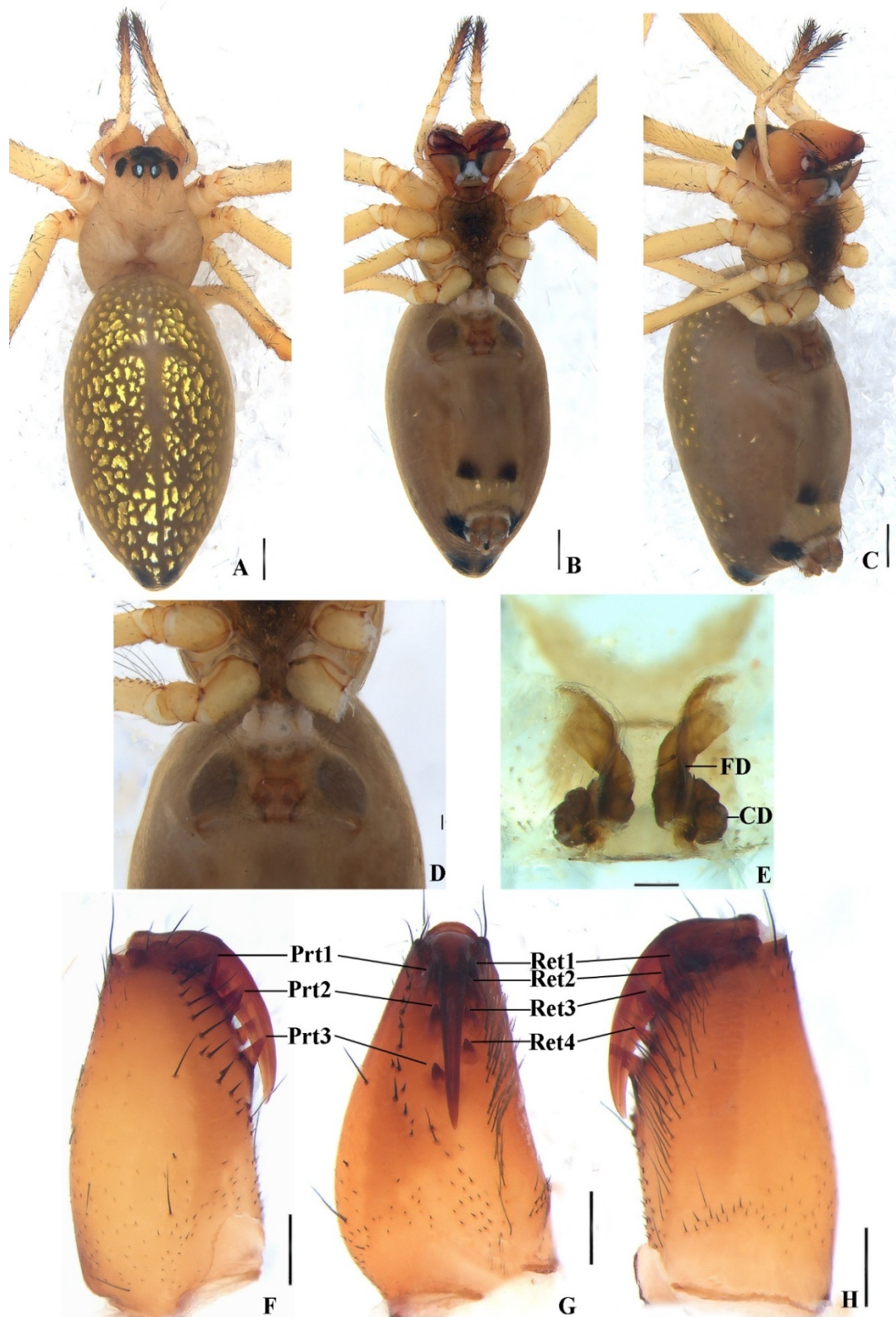


FIGURE 4.1.61. *Tylorida flava* Sankaran, Malamel, Joseph & Sebastian, 2017, female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.2 mm.

thinner, long and closer to Prt1; Prt3 short and thinner; Prt4 linear with straight tip and a significant gap between Prt3 and Prt4. Cheliceral fang short, brownish, and serrated. Abdomen oval; dorsum greyish with numerous guanine spots; posteriorly with a pair of black spots; venter greyish; a pair of large black spots positioned above the anterior spinnerets; and a pair of black spots on either side of the spinnerets. The epigynal plate broad, proximally constricted, and distally enlarged. Internally, copulatory ducts with numerous folds, brownish, anterior ends oriented opposite sides, distal half enlarged; fertilization duct long, tubular, transparent, and posteriorly with a twist; spermathecae large, balloon-like, and transparent.

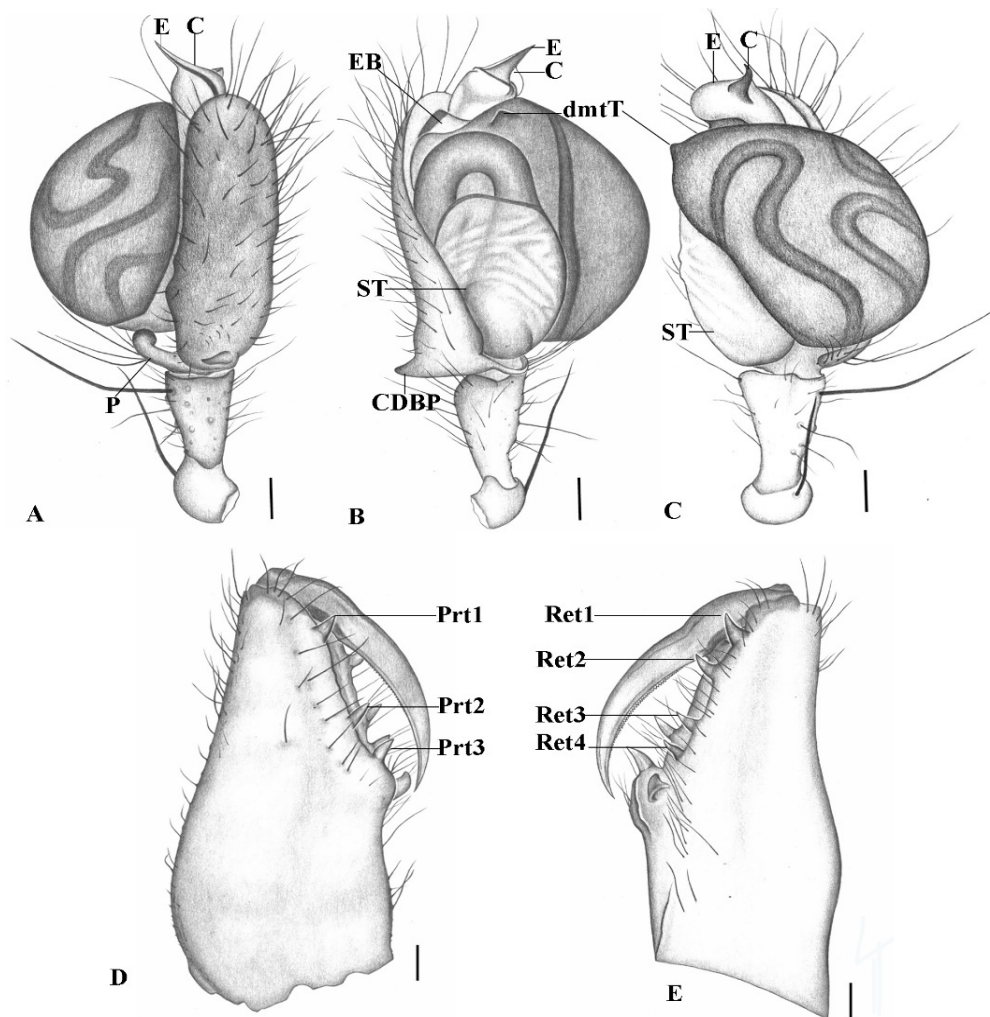


FIGURE 4.1.62. *Tylorida flava* Sankaran, Malamel, Joseph & Sebastian, 2017, male (A–E), left palp (A–C), A, prolateral view, B, ventral view, C, retrolateral view. Left chelicerae (D, E), D, dorsal view, E, ventral view. Scale bars: A–E: 0.1 mm.

Measurements. Total length: 7.20. Carapace 2.63 long, 1.72 wide. Abdomen: 4.57 long, 3.00 wide. Ocular area length 0.40, width 0.38. Eye diameters: AME 0.15, ALE 0.07, PME 0.13, PLE 0.08. Clypeus height 0.09. Chelicerae 1.32 long, 0.57 wide. Palp and leg measurements: pedipalp 2.59 [0.96, 0.22, 0.48, 0.93], leg I 15.17 [5.51, 1.13, 4.66, 2.77, 1.10], II 11.04 [3.47, 0.65, 2.36, 3.54, 1.02], III 4.66 [1.10, 0.44, 0.74, 1.70], IV 9.09 [3.24, 0.33, 1.79, 3.05, 0.68]. Leg formula: 1243.

Distribution (Fig. 4.1.63). India (World Spider Catalog, 2025).

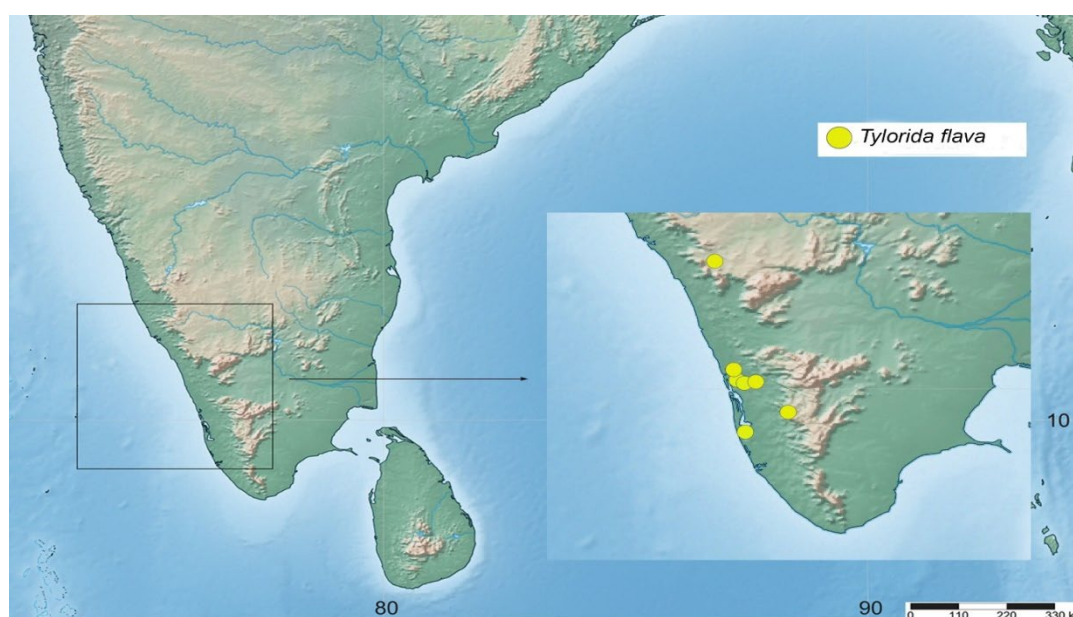


FIGURE 4.1.63. Collection localities of *Tylorida flava* in Kerala.

***Tylorida marmorea* (Pocock, 1901)**

Orsinome marmorea Pocock, 1901: 479 (♂♀); Gravely, 1921b: 448, figs. 7a–b (♂♀).

Tylorida cylindrata Zhu, Wu & Song, 2002: 26, figs. 1A–H (transferred from *Leucauge*).

Tylorida sataraisensis Kulkarni & Lewis, 2015: 2, figs. 1b, 2b, 3b, 4, 5b, 6–7, 9–10 (♂).

Tylorida marmorea Sankaran et al., 2017: 297, figs. 1B–C, 2A, 5A–F, 6A–D, 7A–C, 8A–H, 9A–D, 10A–I, 11A–F, 12A–E (♂♀, transferred from *Orsinome*, synonymy of *T. cylindrata* and *T. sataraisensis*); Sankaran et al., 2020: 199, figs. 3A–G (♂♀ synonymy of *Pachygnatha silentvalliensis*).

(For complete list of references, see World Spider Catalog, 2025).

Materials examined. INDIA: Kerala: Malappuram district, Nellikkuthu 11°16'37"N, 76°13'33"E, 11 October 2021, leg. Anju K. Baby, 1♂ 3♀. Kozhikode district, Kakkadampoyil waterfalls 11°20'45"N 76°06'51"E, 490 m, 15 October 2021, leg. Anju K. Baby & Suryanarayanan T. B., 2♂ 4♀. Wayanad district, Chirappullu Hill 11°42'37"N, 75°54'12"E, 1,517 m, 25 May 2022, leg. Anju K. Baby & Manu K. Baby, 4♂ 3♀. Neyyar Wildlife Sanctuary, Thiruvananthapuram, Charupara 8°32'02"N 77°09'00"E, 120 m, 29 December 2022, leg. Anju K. Baby & Rajesh, 2♂ 2♀. Kottayam district, Aruvickal waterfalls 9°23'43"N 76°45'37"E, 70 m, 14 May 2023, leg. Anju K. Baby & Adeena Shaji, 3♀. Wayanad wildlife Sanctuary, Tholpetty 11°57'04"N 76°03'43"E, 883 m, 9 June 2023, leg. Anju K. Baby & Manu K. Baby, 2♂ 3♀. Wayanad district, Periya Reserved Forest 11°50'14"N 75°51'06"E, 756 m, 12 November 2023, leg. Anju K. Baby & Manu K. Baby, 9♂ 12♀. Kannur district, Kanjirakolly, Alakapuri waterfalls 12°08'33"N 75°37'42"E 356 m, 22 November 2023, leg. Anju K. Baby & Nikhil K. J., 2♂ 4♀. Idukki district, Mankulam 10°07'02"N 76°55'38"E, 699 m, 09 December 2023, leg. Anju K. Baby & Abhijith, 1♀. Idukki district, Anakulam 10°09'25"N, 76°54'51"E, 358 m, 10 December 2023, leg. Anju K. Baby & Greeshma T. S., 5♂ 4♀. Thrissur district, Chimmini Wildlife Sanctuary 10°25'52"N 76°29'27"E, 147 m, 14 December 2023, leg. Anju K. Baby & Greeshma T. S., 3♂ 4♀.

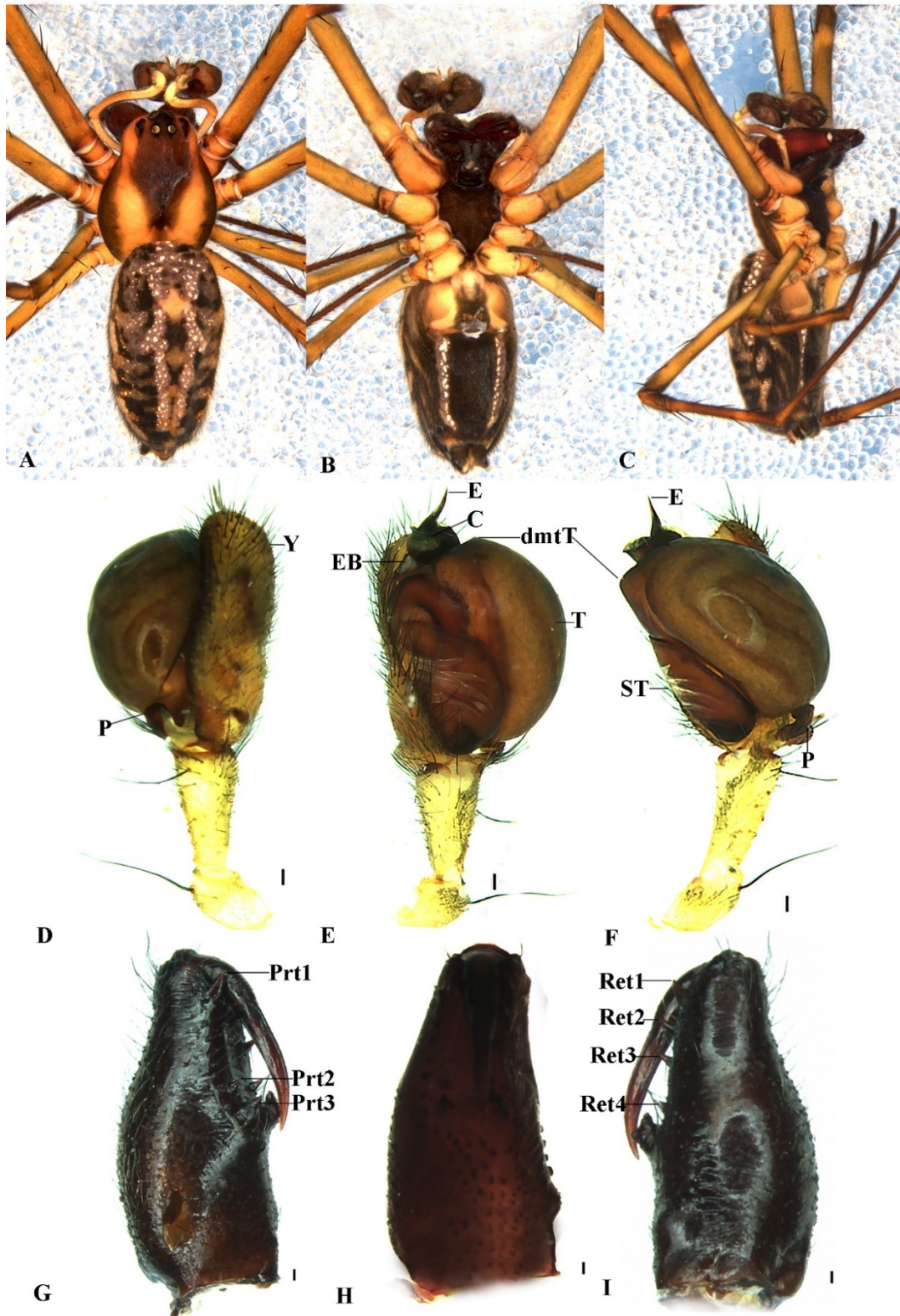


FIGURE 4.1.64. *Tylorida marmorea* (Pocock, 1901), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.1 mm.

Diagnosis. Males of *T. marmorea* most resemble those of *T. ventralis*, but can be separated from the latter in having short and stout cymbial dorso-basal process with strongly curved apex, conductor without any folds at the apex (vs. more than two folds in *T. ventralis*), upper row chelicerae without any knobs, but lower row with a large bifurcated protrusion. Females also show similarities to *T. ventralis* but can be distinguished from the latter by the following characteristics: epigynal plate nearly circular, copulatory ducts wide, and proximal half oriented nearly vertical (vs. oriented horizontally in *T. ventralis*).

Redescription. Male (Fig. 4.1.64). Carapace anteriorly constricted; cephalic region much darker and extends to the fovea, reaching to the posterior rim, laterally with dark contour. All eyes with black border; anterior median eyes larger than posterior median eyes. Clypeus brownish-yellow. Labium dark brownish. Maxillae constricted at the base. Sternum dark brownish, with sparse hairs and without any intercoxal extensions. Chelicerae slender and dark brownish. Upper row of chelicerae with three teeth: Prt1 closer to fang basis; Prt2 very small, blunt, and with a large gap between Prt1 and Prt2; Prt3 larger and proximal half wider. Lower row of chelicerae with four teeth: Ret1 larger, slightly bent at the middle with a blunt apex; Ret2 slender; Ret3 triangular; Ret4 very small, followed by a large protrusion with bifurcated apex. Cheliceral fang short, serrated, and brownish. Abdomen elongated; dorsum greyish with random black markings and guanine spots; venter black, anteriorly yellowish near the pedicel; centrally two parallel longitudinal greyish stripes with silver guanine spots. Legs yellowish-brown. Pedipalp with moderate-sized tibia and cymbium; tegulum light brownish; subtegulum dark brownish; sperm duct highly convoluted; disto-median triangular process distinct; cymbial dorso-basal process short, thick, pointed with wide basis and curved apex; paracymbium

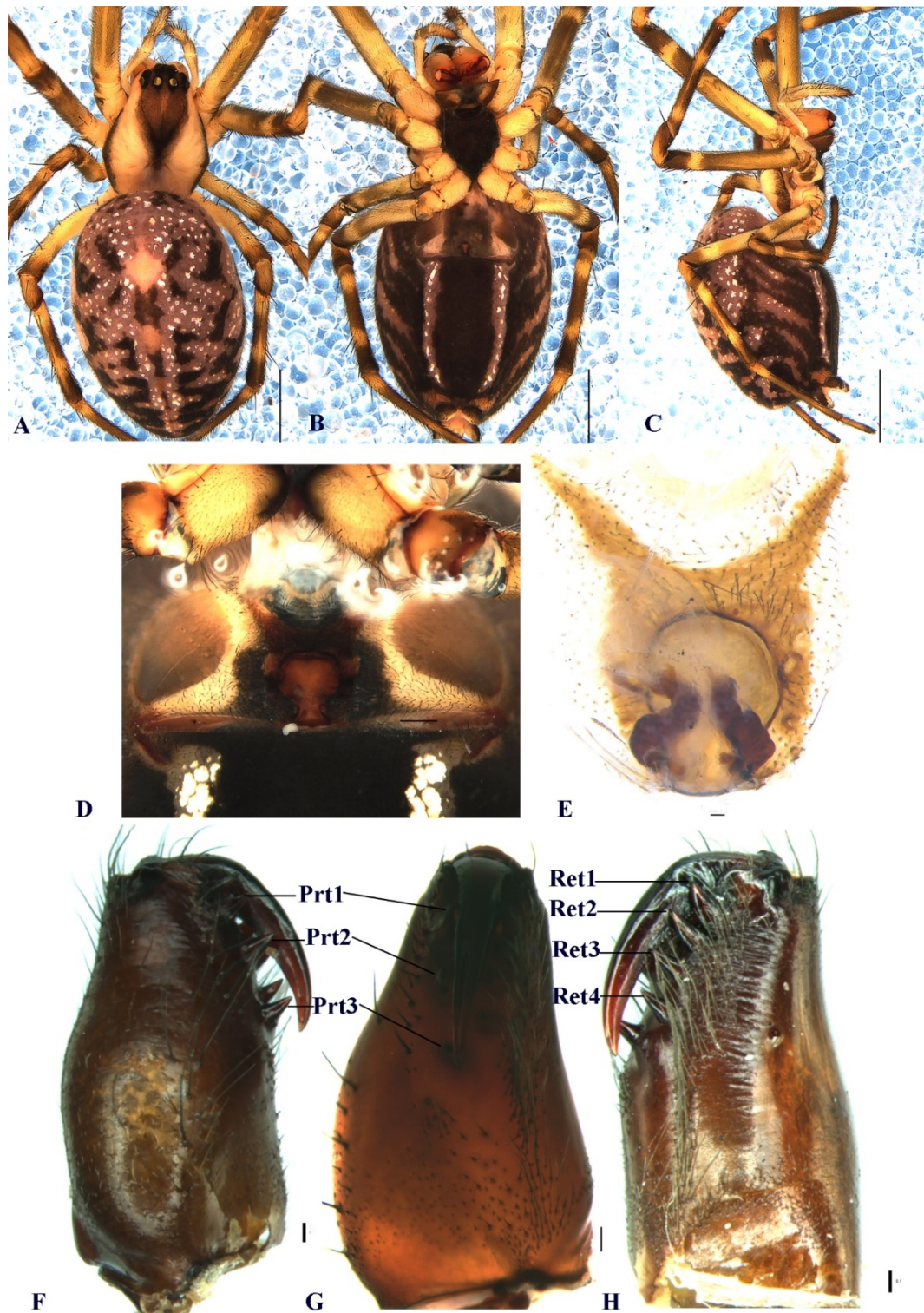


FIGURE 4.1.65. *Tylorida marmorea* (Pocock, 1901), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.2 mm.

short, curved, distal half enlarged and touching the tegulum; embolic base wide with protruding apex; conductor broad, transparent and close in contact with embolic base.

Measurements. Total length: 9.29. Carapace 4.01 long, 2.29 wide. Abdomen: 5.28 long, 2.92 wide. Ocular area length 0.29, width 0.31. Eye diameters: AME 0.27, ALE 0.20, PME 0.19, PLE 0.17. Clypeus height 0.29. Chelicerae 2.29 long, 0.82 wide. Palp and leg measurements: pedipalp 4.42 (2.32, 0.49, 0.61, 1.00). Leg I 30.49 [8.06, 1.92, 8.00, 10.32, 2.19], II 22.35 [6.26, 1.52, 5.38, 7.42, 1.77], III 10.21 [3.41, 0.87, 2.08, 2.81, 1.04], IV 17.29 [5.47, 1.07, 4.11, 5.36, 1.28]. Leg formula 1243.

Female (Fig. 4.1.65). Carapace, eyes, fovea, clypeus, labium, maxillae, sternum, and legs as in males. Chelicerae short, brown, with numerous spines. Upper row of chelicerae with three teeth: Prt1 bulky, triangular, and much closer to the fang basis; Prt2 the same size as Prt1; Prt3 triangular; all teeth almost equidistant. Lower row of chelicerae with four teeth: Ret1 larger, thumb-shaped; Ret2 same shape to Ret1 but smaller; Ret3 smaller than Ret2; Ret4 linear, upward directed with blunt apex. Cheliceral fang short, brown, and serrated. Abdomen greyish; dorsum with numerous black spots and random guanine spots; venter black, centrally two parallel longitudinal greyish stripes with silver guanine spots. Epigynal plate round; internal fertilization duct narrow, distinct, initially with a twist and oriented inward; copulatory duct brownish, with numerous folds, medially close each other; the distal half narrower than the proximal half. Spermathecae large, balloon-like, and transparent.

Measurements. Total length: 11.79. Carapace 4.88 long, 3.86 wide. Abdomen: 6.91 long, 4.24 wide. Ocular area length 0.30, width 0.32. Eye diameters: AME 0.31,

ALE 0.27, PME 0.22, PLE 0.21. Clypeus height 0.33. Chelicerae 2.71 long, 0.90 wide. Palp and leg measurements: pedipalp 5.34 (1.63, 0.70, 1.02, 1.99). Leg I 39.94 [11.01, 2.48, 10.34, 13.42, 2.79], II 28.81 [8.30, 2.11, 6.99, 9.00, 2.41], III 13.79 [4.55, 1.31, 2.87, 3.75, 1.31], IV 23.71 [7.72, 1.60, 5.49, 7.11, 1.79]. Leg formula 1243.

Distribution. India, China (World Spider Catalog, 2025).

***Tylorida striata* (Thorell, 1877)**

Meta striata Thorell, 1877: 427 (♀); van Hasselt, 1882: 25 (♂).

Tylorida striata Tanikawa, 2005: 151, figs. 1–2, 5–6 (♂♀, synonymy of *T. magniventer*); Dimitrov et al., 2008: 51, figs. 1A–D (♂, synonymy of *Sternospina concretipalpis*); Kulkarni & Yadav, 2015: 3, figs. 1a–c, 3 (female, synonymy of *Tylorida stellimicans*).

Tylorida nicobarensis Breitling, 2015: 5 (Transferred from *Linyphia*).

Tylorida striata Sankaran et al., 2017: 308, figs. 1D, 2B, 7D–F, 12F–G, 13A–F, 14A–G (♂♀, synonymy of *T. nicobarensis*).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. INDIA: Kerala: Malappuram district, Vazhikadavu 11°23'13"N, 76°20'43"E, 78 m, 15 October 2021, Anju K. Baby & Adarsh P. K., 1♀. Thrissur district, Pullu Kol wetlands 10°27'17"N, 76°09'14"E, 26 m, 27 November 2021, leg. Anju K. Baby, 4♂ 6♀. Thrissur district, Thommana, paddy field 10°20'31"N, 76°15'03"E, 17 m, 13 May 2022, leg. Anju K. Baby & Greeshma T. S., 3♂ 4♀. Thrissur district, Sree Kerala Varma College Campus 10°31'47"N, 76°11'

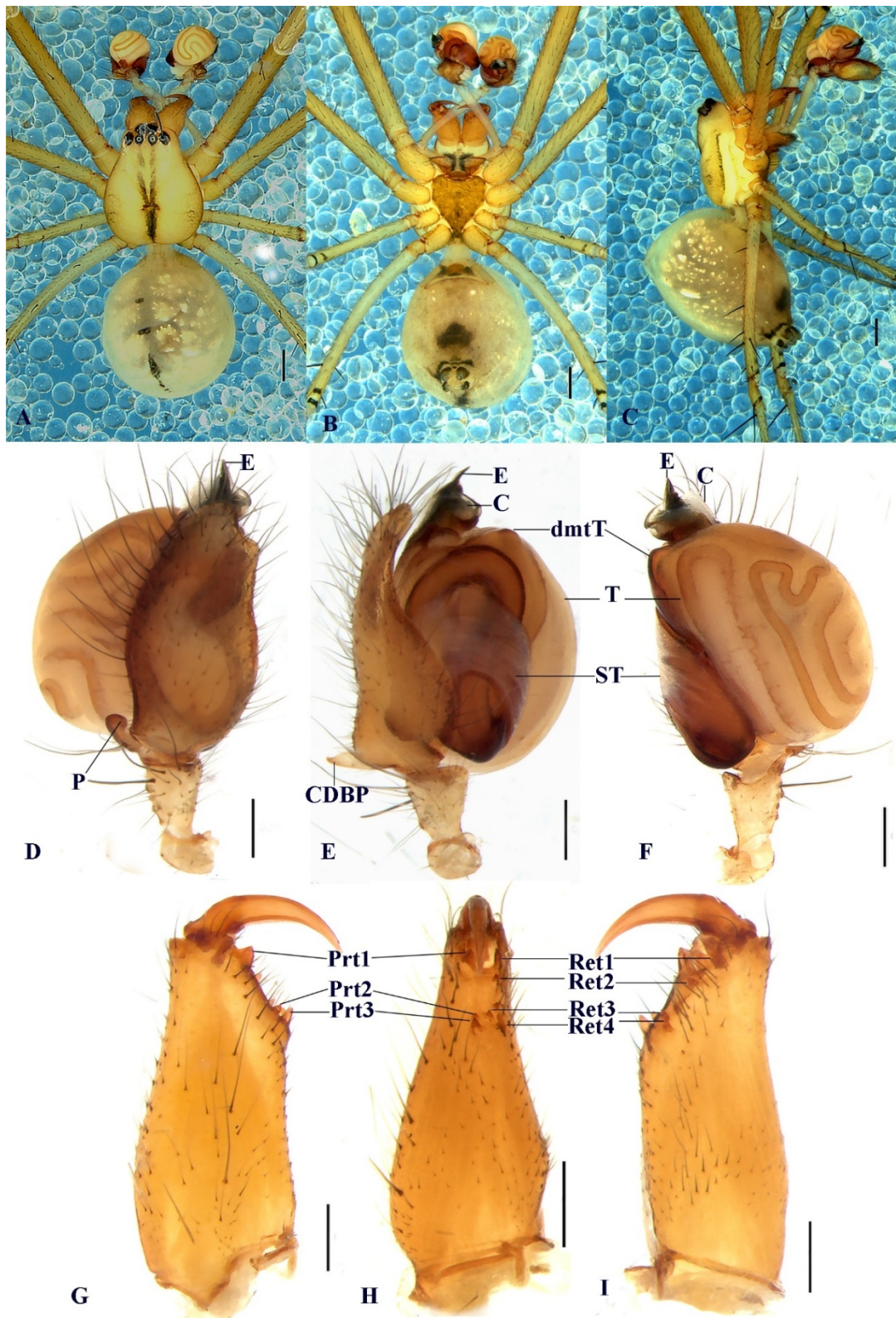


FIGURE 4.1.66. *Tylorida striata* (Thorell, 1877), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.2 mm.

43°E, 32 m, 11 July 2022, leg. Anju K. Baby & Sari K. V., 1♀. Wayanad district, Koilery 11°47'02"N, 76°02'33"E, 745 m, 02 December 2022, leg. Anju K. Baby & Manu K. Baby, 2♂ 3♀. Wayanad district, Periya, paddy field 11°48'28"N 75°51'44"E, 772 m, 13 November 2023, leg. Anju K. Baby & Binu P., 2♂ 4♀. Thrissur district, Manakkodi, paddy field 10°29'06"N 76°10'18"E, 26 November 2023, leg. Anju K. Baby & Greeshma T. S., 2♀. Idukki district, Viripara 10°08'41"N, 76°95'74"E, 100 m, 08 December 2023, leg. Anju K. Baby & Greeshma T. S., 2♀. Wayanad district, Thrissilery, Paddy field 11°50'42"N, 76°01'29"E, 773 m a.s.l., 14 January 2025, leg. Anju K. Baby & Nikhil K. J., 1♂ 2♀.

Diagnosis. *T. striata* most similar to *T. ventralis* (Thorell, 1877), but can be easily distinguished from the latter in having strong abdominal hump, cheliceral margins without any protrusions, tegulum much enlarged, disto-median triangular process distinct and larger, paracymbium stout, cymbial dorso-basal process short with blunt apex, copulatory duct much compressed dorsally with short distal half, and fertilization duct wide with a single fold.

Redescription. Male (Fig. 4.1.66). Carapace yellow with brownish contour, centrally with two black patches arising near the median eyes, and reaches to the fovea and extends to the posterior rim as a single line. Anterior eyes strongly recurved, AMEs centrally placed than PMEs, and all eyes with black border. Fovea distinct, deep, with inverted U-markings. Clypeus yellow. Labium subquadrate and brownish-yellow. Maxillae long, posteriorly narrowed, with distinct scopulae. Sternum heart-shaped, with numerous hairs, and without intercoxal extensions. Chelicerae slender, short, and brownish yellow. Upper row of chelicerae with three teeth: Prt1 bulky and protruding; Prt2 small, set apart by a large distance from Prt1; Prt3 triangular, larger and closer to Prt2, and located on a knob. Lower row of

chelicerae with three teeth: Ret1 larger and closer to the fang basis, projected upward; Ret2 smaller than Ret1 and closer to Ret1; Ret3 set apart by a large distance from Ret2. Cheliceral fang short and serrated. Legs brownish yellow. Abdomen oval, yellow, with shiny guanine spots; dorsum with strong abdominal hump; venter with random shiny guanine spots, brown patches above the epiandrous fusules, surrounded by black spots, a broad black patch above the spinnerets. Pedipalp with short tibia; subtegulum brownish; tegulum large and pale yellow; disto-median triangular process distinct; cymbial dorso-basal process short, with thick base, distally bent, and pointed at the apex; paracymbium proximally constricted with broad apex touching the tegulum; conductor almost transparent and folded with embolus throughout the length; embolic base thick and flat; embolus thick, dark, and protruding.

Measurements. Total length: 3.43. Carapace 1.54 long, 1.25 wide. Abdomen: 2.01 long, 1.24 wide. Ocular area length 0.30, width 0.32. Eye diameters: AME 0.12, ALE 0.06, PME 0.12, PLE 0.07. Clypeus height 0.03. Chelicerae 1.04 long, 0.57 wide. Palp and leg measurements: pedipalp 2.28 (1.04, 0.16, 0.23, 0.85). Leg I 14.78 [3.32, 0.73, 4.63, 5.10, 1.00], II 7.14 [1.31, 0.43, 2.26, 2.50, 0.64], III 3.45 [0.84, 0.31, 0.78, 1.08, 0.44], IV 5.54 [0.81, 0.37, 1.84, 2.05, 0.4]. Leg formula 1243.

Female (Fig. 4.1.67). Carapace, eyes, fovea, clypeus, labium, maxillae, sternum, and legs as in males. Chelicerae short and yellowish. Upper row of chelicerae with three teeth: Prt1 with stout basis and closer to fang basis; Prt2 slender than Prt1; Prt3 triangular with blunt tip and slightly displaced from the row; and all teeth almost equally spaced. Lower row with four teeth: Ret1 closer to the fang base and strongly bent at the distal end; Ret2 about similar shape but smaller and parallel to Ret1; Ret3 thinner; Ret4 about similar shape to Ret3 and with a blunt tip. Cheliceral fang short,

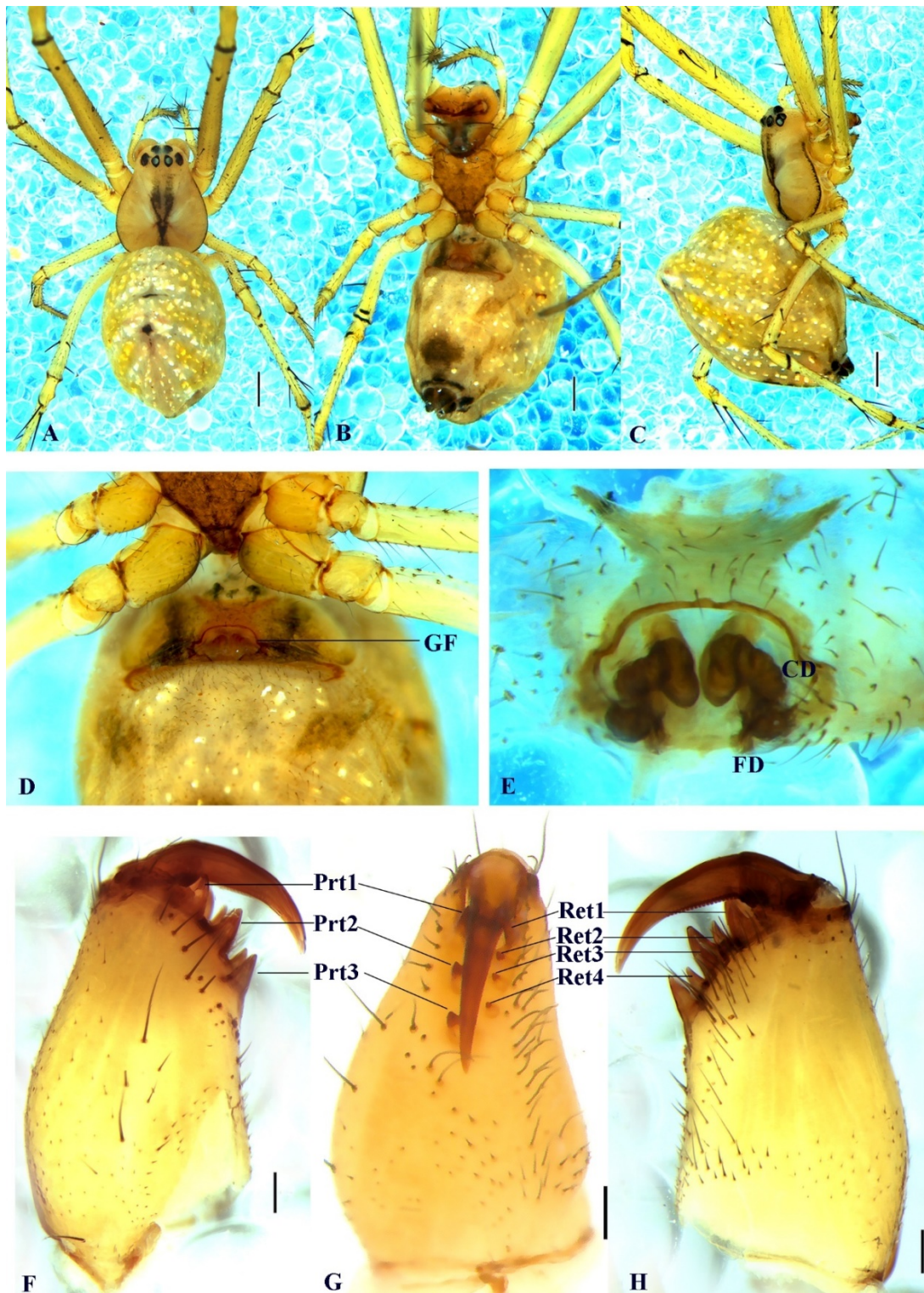


FIGURE 4.1.67. *Tylorida striata* (Thorell, 1877), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.2 mm.

brownish, and serrated. Abdomen oval, pale yellowish; dorsum with shiny yellow and golden spots, with a strong abdominal hump at the mid-dorsal region as in males; venter pale yellowish, brownish patches near the pedicel, with sparse silver spots, and a broad brownish patch above the spinnerets. Epigynal plate wider than long; internal genitalia as in figures; fertilisation duct short, with a single twist; copulatory duct flattened, compact, occupying the entire length of the epigynal plate, with numerous folds and wrinkles. Spermathecae elongated, transparent, connected to the copulatory duct, and oriented to the lateral sides.

Measurements. Total length: 4.88. Carapace 1.78 long, 1.42 wide. Abdomen: 3.51 long, 2.31 wide. Ocular area length 0.32, width 0.31. Eye diameters: AME 0.11, ALE 0.04, PME 0.10, PLE 0.05. Clypeus height 0.04. Chelicerae 1.09 long, 0.48 wide. Palp and leg measurements: pedipalp 1.81 (0.28, 0.69, 0.15, 0.69). Leg I 15.32 [4.25, 0.89, 4.03, 5.02, 1.13], II 8.92 [2.64, 0.68, 1.99, 2.78, 0.83], III 4.37 [1.38, 0.30, 1.03, 1.12, 0.54], IV 6.59 [1.23, 0.56, 1.88, 2.27, 0.65]. Leg formula: 1243.

Distribution. Australia, Comoros, South East Asia, India, China (World Spider Catalog, 2025).

***Tylorida ventralis* (Thorell, 1877)**

Meta ventralis Thorell, 1877: 423 (♂♀).

Anopas ventralis Archer, 1951: 7, 8–9 (Transferred from *Leucauge*).

Tylorida ventralis Chrysanthus, 1975: 31, 117–120 (transferred from *Anopas*); Zhu et al., 2002: 29, 4A–J (synonymy of *L. sphenoida*); Sankaran et al., 2017: 310, figs. 1E–F, 2C, 7G–I, 12H–I, 15A–F, 16A–J, 17A–O, 18A–O, 19A–E (synonymy of *L. pondae*).

(For complete list of references, see World Spider Catalog, 2025).

Material examined. INDIA: Kerala: Kannur district, Madayipara 12°01'53"N, 75°15'18"E, 53 m, 18 October 2021, leg. Anju K. Baby & Arun P. G., 1♂ 2♀. Nilgiri Biosphere Reserve, Malappuram district, Nellikkuthu 11°22'53"N, 76°21'30"E, 84 m, 12 October, 2021, leg. Anju K. Baby, 2♂ 4♀. Pathanamthitta, Gavi 9°26'09"N 77°09'55"E1, 206 m, leg. Vishnu Das E. H., 1♀. Ernakulam, Kothamangalam 10°03'32"N, 76°38'07"E, 42 m, 10 December 2021, leg. Shilpa K. R., 2♀. Wayanad district, Makkiyad 11°44'59"N, 75°54'05"E, 811 m, 26 December, 2021, Anju K. Baby & Manu K. Baby, 1♂ 3♀. Kannur district, Valapattanam 11°55'44"N, 75°21'19"E, 28 m, 13 March 2022, leg. Anju K. Baby, 3♂ 7♀. Kannur district, Ezhome 12°02'25"N 75°17'51"E47 m, 15 March, 2022, leg. Anju K. Baby, 1♀. Kozhikode district, Peruvannamuzhi dam 11°35'51"N, 75°49'27"E, 100 m, 21 April 2022, leg. Anju K. Baby, 3♂ 2♀. Kottayam district, Erattupetta 9°41'06"N, 76°46'14"E, 72 m, 30 July 2022, leg. Anju K. Baby, 5♂ 4♀. Kollam district, Palaruvi waterfalls 8°56'40"N, 77°09'48"E, 382 m, 18 September 2022, leg. Anju K. Baby & Murukan, 2♂ 4♀. Kollam district, Aryankavu 8°58'41"N 77°08'54"E, 348 m, 19 September 2022, leg. Anju K. Baby & Manu K. Baby, 3♂ 5♀. Kasaragod district, Uppala 12°40'25"N, 74°54'12"E, 29 m, 29 September 2022, leg. Anju K. Baby & Sibi K. K., 3♂ 4♀. Kottayam district, Illikkal Kallu 9°45'06"N, 76°49'20"E, 901 m, 15 December 2022, leg. Anju K. Baby, 2♀. Kottayam district, Ilaveezhappoonchira 9°47'34"N 76°47'26"E, 860 m, 16 December 2022, leg. Anju K. Baby & Roshna V. Shaju, 1♂ 2♀. Thiruvananthapuram district, Puravimala 8°31'41"N, 77°10'53"E, 114 m, 29 December, 2022, leg. Anju K. Baby & Rajesh, 3♂ 6♀. Palakkad, Thavalam 11°05'46"N, 76°35'33"E, 550 m, 03 February, 2023, leg. Anju K. Baby & Manu K. Baby, 2♂ 5♀. Wayanad wildlife Sanctuary, Tholpetty

11°57'04"N 76°03'43"E, 883 m, 14 May 2023, leg. Anju K. Baby & Manu K. Baby, 4♂ 2♀. Idukki district, Viripara 10°08'41"N, 76°95'74"E, 100 m, 08 December 2023, leg. Anju K. Baby & Greeshma T. S., 4♂ 12♀. Idukki district, Kanthalloor 10°12'15"N, 77°12'19"E, 718 m, 11 January 2024, leg. Anju K. Baby & Greeshma T. S., 1♂ 2♀. Idukki district, Chinnar Wildlife Sanctuary, Alampetty 10°18'34"N, 77°11'13"E, 765 m, 10 January 2024, leg. Anju K. Baby & Natarajan, 1♂ 3♀. Thrissur district, Chimmuni Wildlife Sanctuary 10°25'52"N, 76°29'27"E, 147 m, 30 January 2023, leg. Anju K. Baby, 3♂ 5♀. Thrissur district, Christ College Campus 10°21'15"N 76°12'48"E, 40 m, 22 October 2023, leg. Anju K. Baby, 2♂, 3♀. Wayanad district, Thrissilery, Paddy field 11°50'42"N, 76°01'29"E, 773 m a.s.l., 14 January 2025, leg. Anju K. Baby & Nikhil K. J., 3♀.

Diagnosis. *T. ventralis* most resembles *T. marmorea* (Pocock, 1901), but males of the species differ from the latter by having a large and bluntly rounded tubercle on the retromargin of chelicerae, embolus distally short, elongated cymbial dorso-basal process without any curves. In females, copulatory ducts highly compressed with long distal half, and narrow fertilization ducts (while stout in *T. marmorea*).

Redescription. Male (Fig. 4.1.68). Carapace elongated and anteriorly constricted; pale yellow and black patches arise from the ocular region, darken near the fovea, and extend to the posterior rim, with black patches on the lateral edges. Anterior eyes strongly recurved, AMEs raised, ALEs located on the knobs, and the ocular quadrangle longer than wide. Fovea deep and dark. Clypeus brownish. Labium subquadrate and dark. Maxillae long with distinct scopulae. Sternum heart-shaped, dark, with numerous hairs. Chelicerae short, dark brownish, and laterally with bulging. Upper row of chelicerae with three teeth: Prt1 closer to the fang basis; Prt2 smaller and with a moderate gap from Prt1; Prt3 tooth larger, followed by a

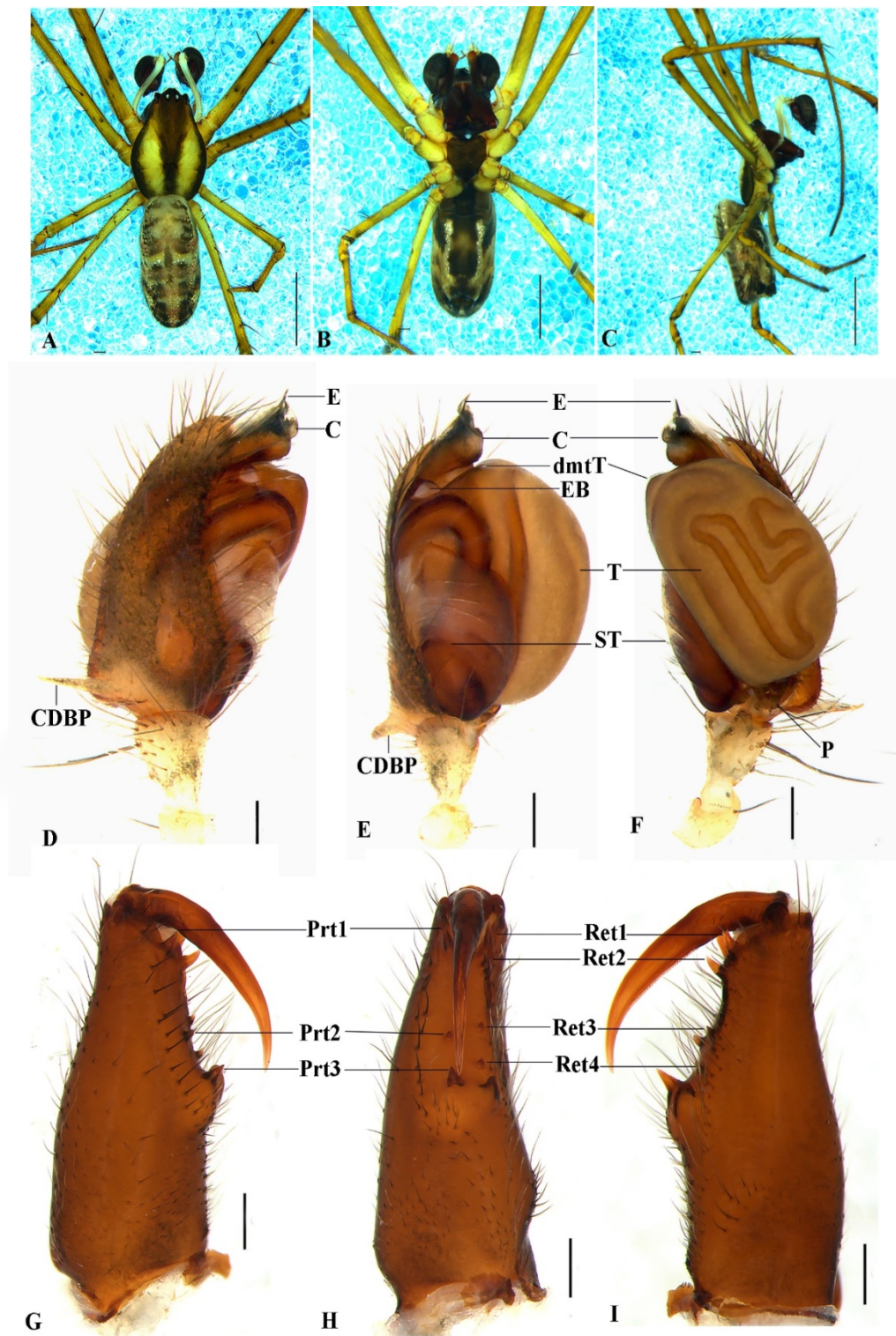


FIGURE 4.1.68. *Tylorida ventralis* (Thorell, 1877), male (A–I). A, male habitus, dorsal view, B, same, ventral view. C, same, lateral view. Left palp (D–F); D, prolateral view, E, ventral view, F, retrolateral view. Left chelicerae (G–I), G, dorsal view, H, lateral view, I, ventral view. Scale bars: A–C: 0.5 mm. D–I: 0.2 mm.

moderate-sized knob. Lower row with four teeth: Ret1 and Ret2 closely placed; Ret3 smaller; Ret4 sharper, followed by a distinct protrusion. Legs brownish yellow. Abdomen elongated; dorsum greyish with numerous small golden guanine spots, a pair of black spots on the posterior end, and parallel transverse black patches; venter greyish with black patches, centrally with two parallel light greyish patches along with numerous silver guanine spots; laterally greyish with fade black stripes and numerous golden guanine spots. Spinnerets posteriorly placed. Pedipalp with moderate-sized tibia; tegulum dark and sperm duct with numerous folds, sperm duct initially broad and distally narrowing; broad cymbium, with long spines; CDBP long, slender, and very sharp; paracymbium short and touching the tegulum with distinct distomedian triangular process; embolus twisted with conductor with protruding apex, embolic base distinct; conductor almost transparent and distally twisted with two folds.

Measurements. Total length: 3.18. Carapace 1.08 long, 0.73 wide. Abdomen: 2.10 long, 0.77 wide. Ocular area length 0.35, width 0.33. Eye diameters: AME 0.68, ALE 0.27, PME 0.56, PLE 0.32. Clypeus height 0.11. Chelicerae 1.88 long, 0.56 wide. Palp and leg measurements: pedipalp 3.64 [1.72, 0.26, 0.35, 1.31], leg I 13.90 [3.92, 0.53, 3.60, 5.05, 0.80], II 8.15 [2.32, 0.52, 2.04, 2.70, 0.57], III 3.21 [1.03, 0.32, 0.65, 0.93, 0.28], IV 6.15 [2.01, 0.34, 1.39, 1.96, 0.45]. Leg formula: 1243.

Female (Fig. 4.1.69). Carapace, eyes, fovea, clypeus, labium, and maxillae as in males. Chelicerae short, stout, yellowish brown. Upper row with three teeth; Prt1 triangular, with stout basis and closer to fang basis; Prt2 smaller than Prt1, slightly bent at the middle towards the upper side; Prt3 straight, with wide basis, upward directed and pointed. Lower row with four teeth: Ret1 extremely stout with wide

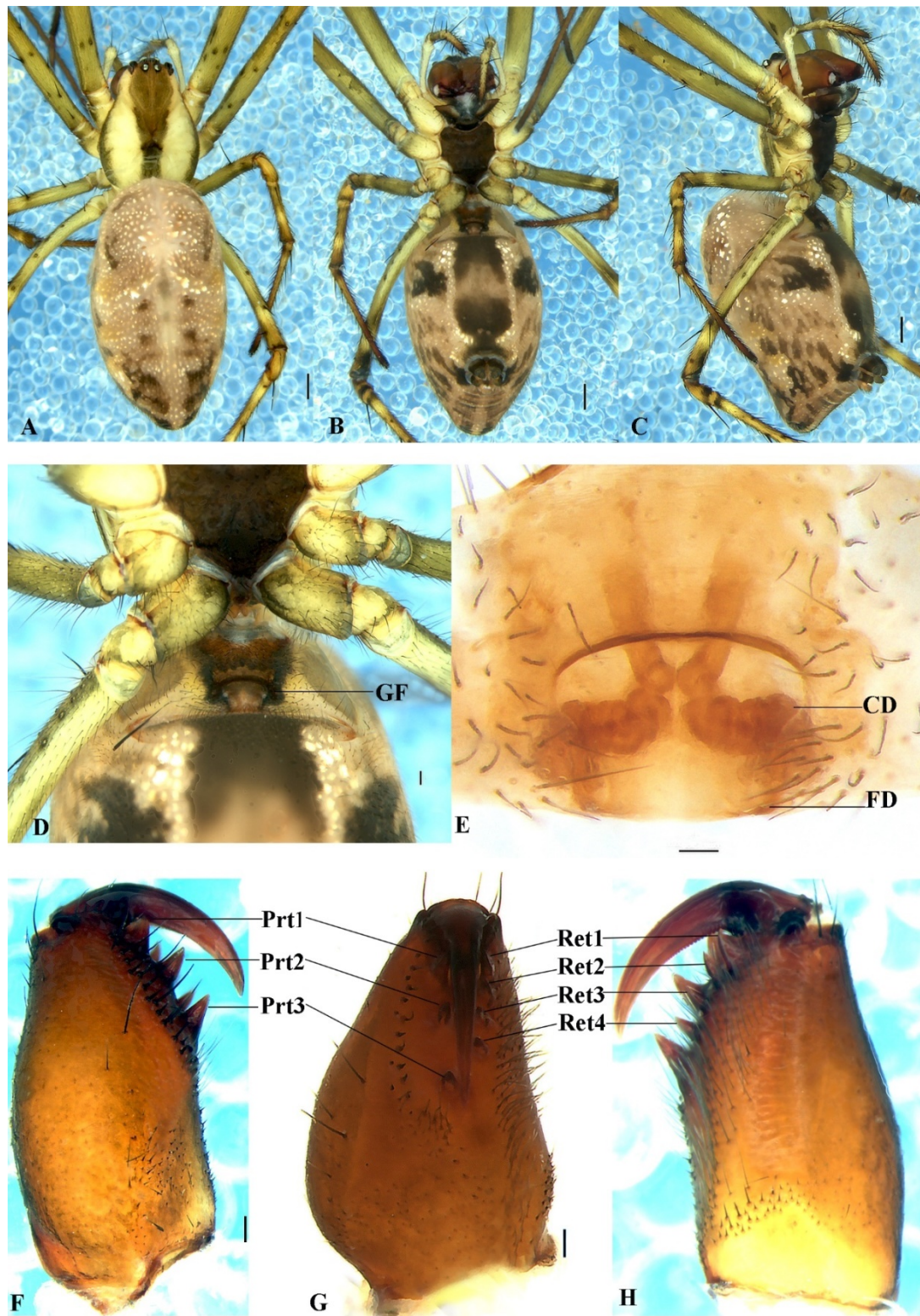


FIGURE 4.1.69. *Tylorida ventralis* (Thorell, 1877), female (A–H). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, lateral view, H, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F–H: 0.1 mm.

basis and closer to fang basis; Ret2 smaller, slightly bent at the middle, parallel to Ret1 and pointed; Ret3 linear with sharp apex; Ret4 smaller than Ret3 and directed upward. Cheliceral fang short, serrated, and yellowish brown. Legs yellowish with green patches. Abdomen elongated; dorsum greyish, with numerous golden guanine spots and random black patches, posteriorly with a pair of black spots; venter greyish, with shiny guanine spots, centrally with longitudinal black patches arising near the epigynal fold extending to near the anterior spinnerets and the black patches lined by shiny silver guanine spots, laterally with random black patches. Epigynal fold flat and subquadrate. Internal genitalia composed of copulatory ducts with numerous folds; the proximal half oriented horizontally and lies close to each other at mid-length, and the distal part oriented in the opposite direction; spermathecae globular and transparent; fertilisation ducts small, narrow, sclerotized, and parallel to each other.

Measurements. Total length: 7.70. Carapace 3.21 long, 1.97 wide. Abdomen: 4.49 long, 2.19 wide. Ocular area length 0.42, width 0.45. Eye diameters: AME 0.18, ALE 0.17, PME 0.14, PLE 0.09. Clypeus height 0.12. Chelicerae 1.12 long, 0.70 wide. Palp and leg measurements: pedipalp 3.02 [0.95, 0.25, 0.66, 1.16], leg I 23.94 [8.11, 1.53, 7.64, 5.31, 1.35], II 16.75 [4.96, 1.09, 4.10, 5.44, 1.16], III 7.06 [2.11, 0.55, 1.49, 2.05, 0.86], IV 13.39 [4.48, 0.82, 3.11, 4.17, 0.81]. Leg formula: 1243.

Distribution. New Guinea, Pakistan, Taiwan, India, Japan (World Spider Catalog, 2025).

4.1.8. Genus *Atelidea* Simon, 1895

Diagnosis. The genus *Atelidea* can be distinguished from all other tetragnathids in having following characteristics: carapace with thick black contour, lateral eyes

prominent, AMEs larger with less interocular space, male pedipalp simple, long tibia with several spines, tegulum small, sperm duct less convoluted, embolus protruding, CDBP strong and extended, paracymbium flap-like and not touching the tegulum, epigynal plate small and semicircular, copulatory ducts with numerous folds with enlarged spermathecae (Alvarez-Padilla & Benjamin, 2011).

Type species. *Atelidea spinosa* Simon, 1895.

***Atelidea* sp.**

Material examined. **INDIA: Kerala:** Idukki district, Viripara 10°08'41"N, 76°95'74"E, 100 m, 01 February 2024, leg. Anju K. Baby & Greeshma T. S., 1♀.

Description. Female (Fig. 4.1.70). Carapace flat, yellowish with dark contour; cephalic groove distinct. All eyes with black border; AMEs larger, lateral eyes elevated and numerous black spots near the posterior eyes and a parallel black line arising between PMEs. Clypeus yellow. Fovea distinct with dark markings and extends to the posterior rim. Labium dark brownish and subquadrate. Maxillae moderate-sized, constricted at the base, with distinct scopulae. Sternum dark brownish with a strong posterior extension. Chelicerae short, stout, spiny, proximal half yellow, and distal half dark. Upper row of chelicerae with three teeth: all teeth are almost equidistant; Prt1 closer to the fang basis; Prt2 larger with a pointed apex; Prt3 smaller and upright. Lower row of chelicerae with four teeth: Rrt1 wider and thumb-shaped; Ret2 with blunt apex and shares the same basis with Ret1; Ret3 straight; Ret4 same shape as Ret3. Cheliceral fang short, geniculate, with colour combination of dark brown and yellow. Legs yellow with black markings; femur IV with two rows of trichobothria. Abdomen nearly oval; dorsum greyish with random

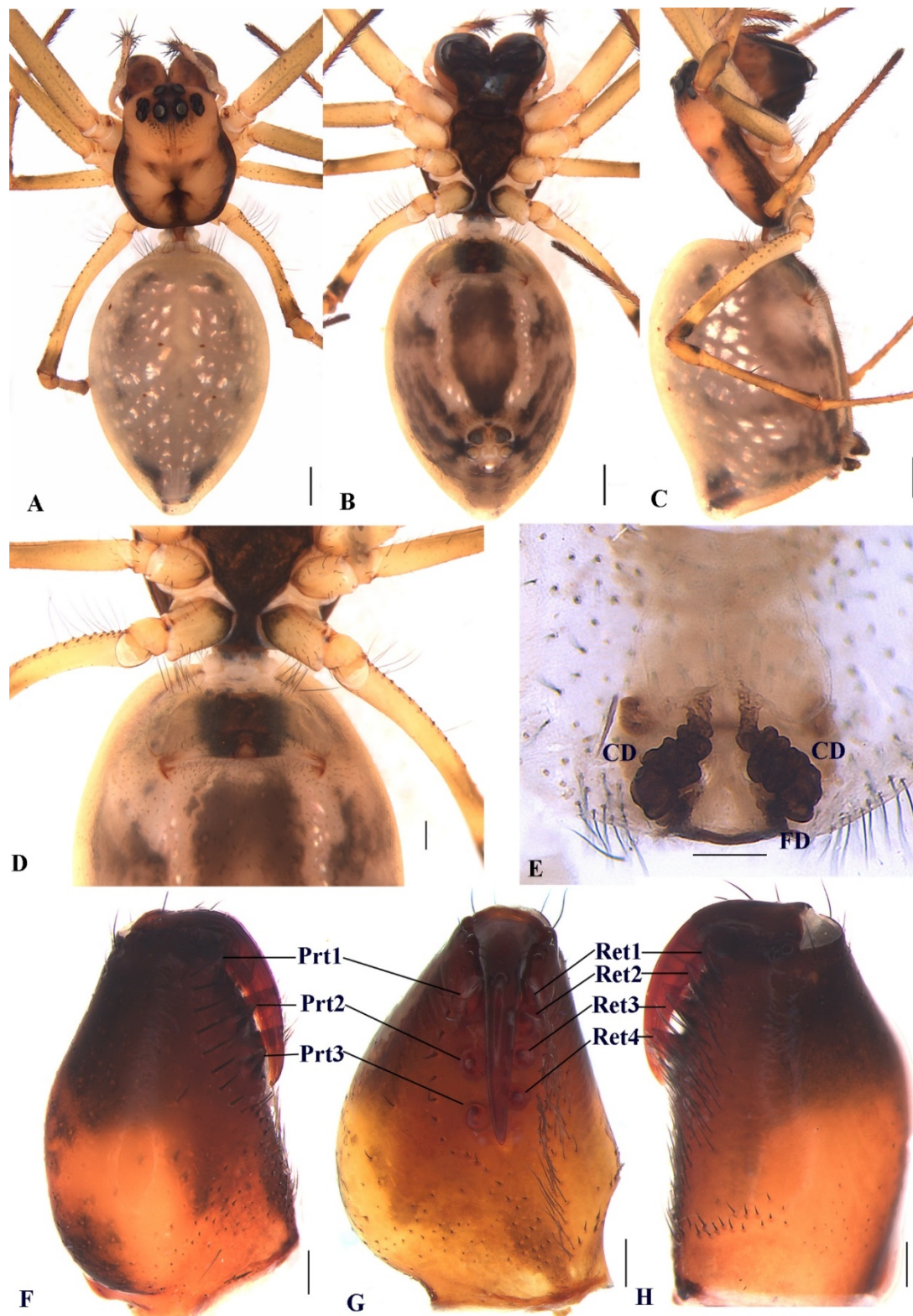


FIGURE 4.1.70. *Atelidea* sp., female (A–G). A, female habitus, dorsal view, B, same, ventral view. C, same, lateral view. Epigynum (D, E); D, same, ventral view, E, dorsal view. Left chelicerae (F–H), F, dorsal view, G, ventral view. Scale bars: Scale bars: A–C: 0.5 mm. E: 0.05 mm. D, F, G: 0.1 mm.

black patches and numerous silvery guanine spots; posterior end slightly extended and elevated, with a pair of black spots on either side; venter greyish, centrally with longitudinal dark greyish patch surrounded by a few silvery guanine spots and several black patches. Epigynal plate small and semicircular; internally copulatory ducts with numerous folds; fertilization duct small, initially with a twist; spermathecae elongated, transparent, and oriented upward.

Measurements. Total length: 5.50. Carapace 1.86 long, 1.67 wide. Abdomen: 3.64 long, 2.46 wide. Ocular area length 0.32, width 0.31. Eye diameters: AME 0.15, ALE 0.11, PME 0.14, PLE 0.08. Clypeus height 0.08. Chelicerae 1.14 long, 0.67 wide. Palp and leg measurements: pedipalp 3.57 [0.21, 0.44, 0.17, 0.34], leg I 10.68 [2.90, 0.75, 2.77, 3.12, 1.14], II 7.67 [2.38, 0.51, 1.78, 2.18, 0.82], III 4.17 [1.33, 0.31, 0.90, 1.10, 0.53], IV 6.45 [1.88, 0.46, 1.57, 1.83, 0.71]. Leg formula: 1243.

Distribution. India.

4.2. Barcoding of tetragnathid spiders of Kerala using molecular markers

The CO1 and 18S rRNA sequences generated after the Sanger sequencing method were subjected to trimming and deposited in NCBI-GenBank. During the present study, the CO1 and 18S barcodes of 25 species were generated, and voucher specimens were deposited with proper voucher codes under corresponding accession numbers (Table 4.1). Two specimens did not amplify for both genes even after multiple attempts. The forward and reverse sequences were generated in the PCR amplification and consensus sequences were generated from these bidirectional reads. Prior to the NCBI submission, the quality of the sequences was checked and the low-quality ends (both 5' and 3') were trimmed using the software BioEdit v7.2.5, resulting in high-quality partial sequences of CO1 (~600 bp) and 18S rRNA (~700 bp) genes. No stop codons were detected in the CO1 sequences after checking in the ExPASy translate tool, in fact reflecting the quality of the sequences. The nucleotide sequences were further checked for sequence similarity and species identity was confirmed using the BLAST tool. The overall nucleotide composition of CO1 sequences was calculated as A=23.3%, T=41.3%, G=20.9%, and C=14.5%. This constitutes an overall AT content of 64.6% and a GC content of 35.4%. Furthermore, the overall AT content and GC content of the 18S rRNA gene represent 50.3% and 49.8%, respectively.

Sl. No.	Species	Voucher	Accession number		Locality
			CO1	18S	
1	<i>Dolichognatha chimminiensis</i>	CDZ_DoCh1	PV738584	PV771005	Chimmini Wildlife Sanctuary, Thrissur
2	<i>Leucauge decorata</i>	CDZ_LeDe1	PV785615	PV803575	Paddy field, Thrissilery, Wayanad
3	<i>Leucauge fastigata</i>	CDZ_LeFa1	PV786103	PV803139	Pozhuthana Reserved Forest, Wayanad

4	<i>Leucauge rubromaculata</i>	CDZ_LuRu1	PV796074	PV800201	Kanthalloor, Idukki
5	<i>Leucauge tessellata</i>	CDZ_LuTs1	PV798837	PV798871	Chinnar Wildlife Sanctuary, Madathala, Idukki
6	<i>Orsinome vethi</i>	CDZ_OrVe1	PV798890	PV799288	Chimmini Wildlife Sanctuary, Thrissur
7	<i>Tylorida ventralis</i>	CDZ_TyVn1	PV805277	PV789679	Wayanad Wildlife Sanctuary, Wayanad
8	<i>Tylorida striata</i>	CDZ_TySt1	PV805278	PV789727	Paddy field, Manakkodi, Thrissur
9	<i>Tylorida flava</i>	CDZ_TyF11	PV800298	PV810364	Chimmini Wildlife Sanctuary, Thrissur
10	<i>Tylorida marmorea</i>	CDZ_TyMa1	-	PV816788	Chimmini Wildlife Sanctuary, Thrissur
11	<i>Mesida culta</i>	CDZ_MeCu1	-	PV816787	Pozhuthana Reserved Forest, Wayanad
12	<i>Glenognatha dentata</i>	CDZ_GlDe1	PV765552	PV803137	Pullu kol wetlands, Thissur
13	<i>Tetragnatha ceylonica</i>	CDZ_TeCe1	PV799331	PV802544	Paddy field, Thrissilery, Wayanad
14	<i>Tetragnatha cochinchensis</i>	CDZ_TeCo1	PV791426	PV800199	Pozhuthana Reserved Forest, Wayanad
15	<i>Tetragnatha geniculata</i>	CDZ_TeGe1	PV794563	PV798806	Kanthalloor, Idukki
16	<i>Tetragnatha hasselti</i>	CDZ_TeHs1	PV790226	PV793398	Wayanad Wildlife Sanctuary, Wayanad
17	<i>Tetragnatha javana</i>	CDZ_TeJa1	PV776866	PV785345	Paddy field, Thrissilery, Wayanad
18	<i>Tetragnatha keyserlingi</i>	CDZ_TeKe1	PV802621	PV802562	Neyyar Wildlife Sanctuary, Thiruvananthapuram
19	<i>Tetragnatha lauta</i>	CDZ_TeLt1	PV785471	PV789646	Ranipuram Reserved Forest, Kasaragod
20	<i>Tetragnatha mandibulata</i>	CDZ_TeMn1	PV776609	PV785307	Karimutty waterfalls, Marayoor, Idukki

21	<i>Tetragnatha squamata</i>	CDZ_TeSq1	PV793528	PV793682	Muriyad Kol wetlands, Thrissur
22	<i>Tetragnatha viridorufa</i>	CDZ_TeVi1	PV791427	PV800200	Pullu Kol wetlands, Thrissur
23	<i>Tetragnatha jaculator</i>	CDZ_TeJr1	-	PV818498	Paddy field, Thrissilery, Wayanad
24	<i>Tetragnatha serra</i>	CDZ_TeSe1	-	PV818499	Moonnilavu, Kottayam
25	<i>Tetragnatha nitens</i>	CDZ_TeNi1	PV802916	-	Paddy field, Thrissilery, Wayanad

TABLE 4.1. Accession numbers of all sequences that are submitted to NCBI along with voucher codes and collection localities.

The CO1 and 18S barcodes generated during the study are provided below in FASTA format. Additionally, the two-dimensional DNA barcodes are provided, which were prepared using the tool Bio-Rad DNA Barcode Generator.

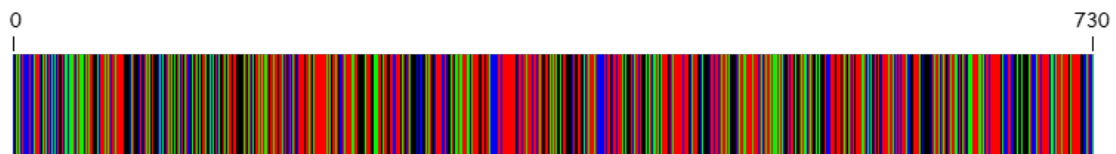
Dolichognatha chimminiensis sp. nov.

Accession nos.: PV738584, PV771005

>PV738584.1 *Dolichognatha chimminiensis* voucher CDZ_DoCh1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

CACTGGTCAACAAATCATAAAGATATTGGGACTTTATATCTTATTTTTGG
GGCATGGGCTGCTATAGTGGGCACAGCTATRAGAGTACTGATCCGAGTA
GAGTTAGGACAGTCAGGTAGATTGTTGGGGGATGATCAGTTATATAATG
TTATTGTTACTGCTCATGCTTTTGTTATGATTTTTTTTATAGTTATGCCTAT
TTAATTGGGGGATTTGGAAATTGATTGGTTCCTTTGATGCTAGGGGCGC
CGGATATGGCTTTTCCTCGGATGAATAATTTAAGATTTTGGTTGTTACCC
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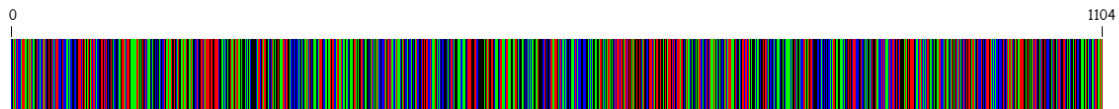
AGATCAATAGATTTTGGCTATTTTTCTTTGCATTTGGCAGGGGCTTCTTCT
ATTATAGGGGCTATTAATTTTATTTCTACTATTATAAATATACGGTCTTGA
GGTATAACTATGGAGAGGGTCCCTTTGTTTGTATGATCTGTTTTAATCAC
AGCTGTGCTTTTATTACTCTCTTTACCGGTTTTAGCGGGGGCTATTACTAT
GCTATTAAGTATCGAAATTTAATACTTCTTTTTTTGACCCTTCCGGAGG
AGGGGATCCCATTTCTTTTTCAACATTTATTTTGATTTTTTTGGCCATCCA



>PV771005.1 Dolichognatha chimminiensis voucher CDZ_DoCh1 small subunit
ribosomal RNA gene, partial sequence

AAGGTCCACCTATCGGTGGTCACTTTCCCGTCCCAACACCGGCCGGTTTC
TGATAGATGATCTTCACCGGTTGTCTGCGGTGACCGGCAAGTTTACTTTGA
AAAAATTAGAGTGCTCAAAGCAGGCGCGACGCCTGAATAATGGTGCATG
GAATAATGGAATAGGMCCTCGGTTCTATTTTGTTGGTTTTTCGGAACACGA
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GGTGAAATTCTTGGACCGCCGCCACGACGAAYTACTGCGAAAGCATTTG
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 AGCGGTGTTTCAGCCGCACGAAACGGAGCAAAAACAGGTCAGGAYRCCC
 TTAGATGTTTCGGGGCCGCACGCGCGCCACATTGAAGGAAACAGCGTGTG
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 GGGATAGTGTTTTGCAACTATCACACTTGAACGAGGAATTCCCAGTAAG
 CATGAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTGTACACACCG
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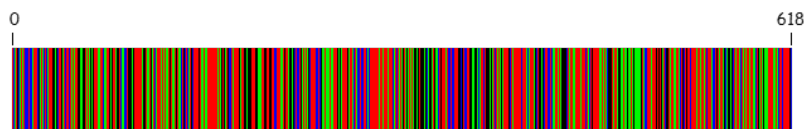
Leucauge decorata

Accession nos.: PV785615, PV803575

>PV785615.1 *Leucauge decorata* voucher CDZ_LeDe1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

TTTGGAGCTTGATCTTCTATARTTGAAMGGMTATKAGAGKTTTAATTC
 KAATTGAGTTAGGTCAACCTGGGAGTTTTTTAGGTAATGATCATTATAT
 AATGTAATYGTAAGTCTCATGCTTTTGTAATAATTTTTTTTATAGTGATG
 CCTATTTTGATTGGAGGGTTTGGAATTGGTTGGTTCCTTTAATGTTAGG
 AGCTCCTGATATAGCTTTTCCTCGAATAAATAATTTGAGATTTTGATTAC
 TACCTCCTTCACTTTTTTTTATTATTTATTTTCATCTATAGTAGATATAGGAG
 TGGGAGCAGGATGAACTGTTTATCCTCCTTTGGCGTCCTTGAAGGACAT
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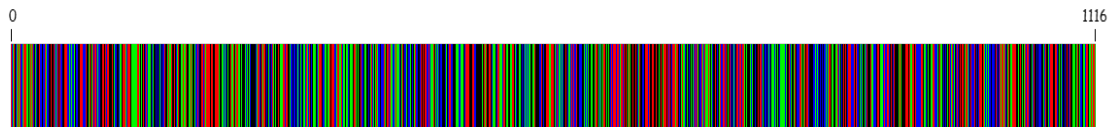
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TACTATATTATTAAGTATAGAAAATTTAATACTTCTTTTTGC



>PV803575.1 *Leucauge decorata* voucher CDZ_LeDe1 small subunit ribosomal
RNA gene, partial sequence

GACGGTCCGCCTACCGGTGGTCACTGTCCGGTTCCACACCAGCCGGTTT
CCCTGGATGATCTTCACCGGTTGTCTTGGGTGACCGGCAAGTTTACTTTG
AAAAAATTAGAGTGCTCAAAGCAGGCGCGACGCCTGGATAATGGTGCAT
GGAATAATGGAATAGGACCTCGGTTCTATTTTGTTGGTTTTAGGAACACG
AGGTAATGATTAAGAGGGACAGACGGGGGCATTTCGTATTGCGACGCTAG
AGGTGAAATTCTTGGACCGCCGCACGACGAACTACTGCGAAAGCATTTG
CCAAGAATGTTTCCATTAATCAAGAACGAAAGTTAGAGGTCCGAAGGCG
ATCAGATACCGCCCTAGTTCTAACCATAAACGATGCCAGCCAGCGATCC
GGCTGTGTTCCCTCAAATGACACGCCGGGCAGCTTCCGGGAAACCAAAGC
TTTTGGGTTCCGGGGGGAGTATGGTTGCAAAGCTTAAACTTGAAGGAAT
TGACGGAAGCGCACACAAGGAATGGGGCCTGCGGTTTAATTTGACTCAA
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AGCTCTTTCTTCATTCTGTGATAGGTGGTGCATGGCCGTTTCTGGTTGGTG
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AGATGTTTCGGGGCCACACGCGCGCCACATTGAAGGAATCAGCGTGTGCT

TTCCCTGTCCGACAGGACTGGGTAACCCGTTGAAACTCCTTCGTGCTGGG
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 CGAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTGTACACACCGCC
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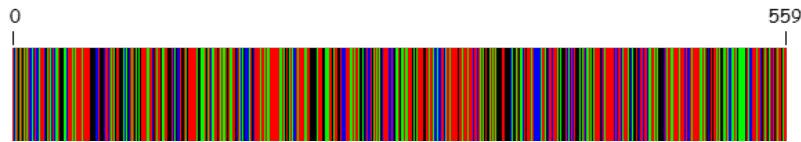


Leucauge fastigata

Accession nos.: PV786103, PV803139

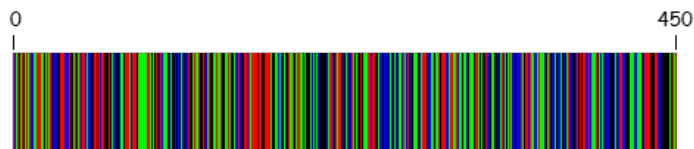
>PV786103.1 *Leucauge fastigata* voucher CDZ_LeFa1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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 AGCTATGAGAGTTTAAATTCGTATTGAATTGGGTCAGCCTGGTAGTTTTT
 TAGGAAATGATCAATTGTATAATGTAATTGCTACAGCCCATGCTTTTATT
 ATAATTTTTTTAATAGTGATACCTATTTTAATTGGGGGATTGGAATTG
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 ATAATTTGAGATTTTGGTTATTACCACCTTCATTATTTTTGTTATTTATTTT
 TTCTATAGTGGATATAGGGGTTGGGGCAGGATGAACTGTTTATCCCCCAT
 TAGCTTCTTTAGAGGGTCACTCTGGGAGATCAATAGATTTTGCTATTTTTT
 CTCTTCATTTAGCAGGTGCTTCTTCAATTATAGGGGCTATTAATTTTATTT
 CTCCTATTTTAAATATGCGTGTTATAGGAATACCAATAGAAAAAGTACCT
 TTATTCGTATGATCTGTATTGATT



>PV803139.1 *Leucauge fastigata* voucher CDZ_LeFa1 small subunit ribosomal RNA gene, partial sequence

GCCGGTTTCCCTGGATGATCTTCACCGGTTGTCTTGGGTGACCGGCAAGT
 TTACTTTGAAAAAATTAGAGTGCTCAAAGCAGGCGCGACGCCTGGATAA
 TGGTGCATGGAATAATGGAATAGGACCTCGGTTCTATTTTGTGTTGTTT
 TGAACACGAGGTAATGATTAAGAGGGACAGACGGGGGCATTTCGTATTGC
 GACGCTAGAGGTGAAATTCTTGGACCGCCGCACGACGAACTACTGCGAA
 AGCATTTGCCAAGAATGTTTCCATTAATCAAGAACGAAAGTTAGAGGTC
 CGAAGGCGATCAGATACCGCCCTAGTTCTAACCATAAACGATGCCAGCC
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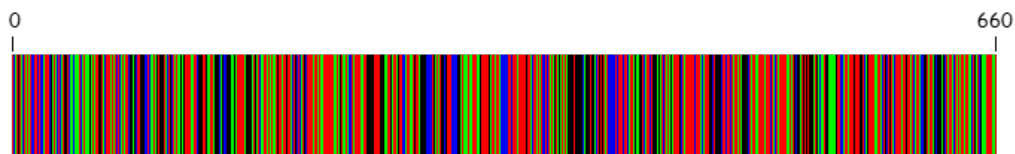
Leucauge rubromaculata

Accession nos.: PV796074, PV800201

>PV796074.1 *Leucauge rubromaculata* voucher CDZ_LuRu1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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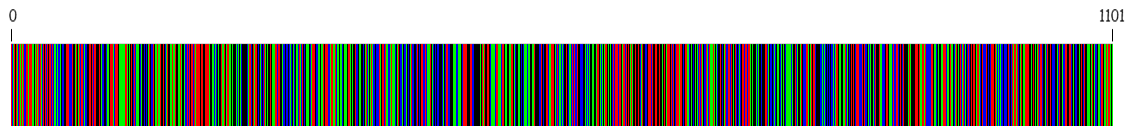
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 ATTGGGGGTTTTGGGAATTGATTAGTTCCATTAATGTTAGGGGGCCCCTGA
 TATGGCGTTTCCCCGGATAAATAATTTAAGTTTTTGATTATTACCCCCTTC
 TTTATTTTTGTTACTTATATCCTCTATAGTAGATATAGGGGTGGGGGCAG
 GGTGGACTGTGTATCCCCCTCTTCTTCATTAGAAGGTCATTCTGGGAGA
 TCTATAGATTTTGCTATTTTTTCTTTACATTTGGCTGGGGCTTCTTCTATTA
 TAGGGGCTATTAATTTTATTTCTACTATTTTAAATATGCGGATGTGTGGG
 ATGACAATGGAAAAAGTTCCATTATTTGTTTGGTCAGTTTTAATTACTGC
 TGTACTTTTATTGTTATCATTACCGGTATTAGCGGGAGCTATTACTATATT
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>PV800201.1 Leucauge rubromaculata voucher CDZ_LuRu1 small subunit
 ribosomal RNA gene, partial sequence

TACTGTCTGTTCTCAACACCAGCCGTTTCCCTGGATGATCTTCACCGGT
 TGTCTTGGGTGACCGGCAAGTTTACTTTGAAAAAATTAGAGTGCTCAA
 GCAGGCGCGATGCCTGAATAATGGTGCATGGAATAATGGAATAGGACCT
 CTGTTCTATTTTGTGTTTGTAGGAACACGAGGTAATGATTAAGAGGGAC
 AGACGGGGGCATTCGTATTGCGACGCTAGAGGTGAAATTCTTGGACCGC
 CGCACGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTCCATTAAT
 CAAGAACGAAAGTTAGAGGTCCGAAGGCGATCAGATACCGCCCTAGTTC
 TAACCATAAACGATGCCAGCCAGCGATCCGGCTGCGTTCCTCAAATGAC

GCGCCGGGCAGCTTCCGGGAAACCAAAGCTTTTGGGTTCGGGGGGGAGT
 ATGGTTGCAAACTTAACTTGAAGGAATTGACGGAAGCGCAAACAA
 GGAATGGGGCCTGCGGTTCAATTTGACTCAACACGGTGCAACTCTCCTG
 GCCCGGACACAGGAAGGATTGACAGATTGAGAGCTCTTTCTTGATTCTGT
 GATAGGTGGTGCATGGCCGTTTCTGGTTGGTGGAGTGATTTGTCTGCTTT
 ATTGCGTTAACGAGCGAGACTCTAGCCTACTAAATAGACGGTGCGATCC
 TTCTGAGTCGCACGTTCTTCTTAGAGGGACAGGCGGKGTTTCAGCCGCAC
 GAAGCAGAGCAAAAACAGGTCAGGATGCCCTTAGATGTTTCGGGGCCACA
 CGCGCGCCACATTGAAGGAATCAGCGTGTGCTTTCCCTGTCCGACAGGA
 CTGGGTAAACCCGTTGAACTCCTTCGTGCTGGGGATAGGGGTTTGTAATT
 ATCCCCCTTGAACGAGGAATTTCAAGTAAGCATGAGTCATCAGCTCGTGT
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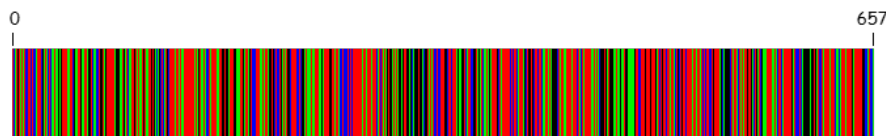
Leucauge tessellata

Accession nos.: PV798837, PV798871

>PV798837.1 *Leucauge tessellata* voucher CDZ_LuTs1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

ATAAGAGTTTAAATTCGAATTGAATTAGGTCAACCTGGTAGTTTTTTAGG
 GAATGATCAATTGTATAATGTAATTGTGACAGCTCATGCTTTTATTATAA
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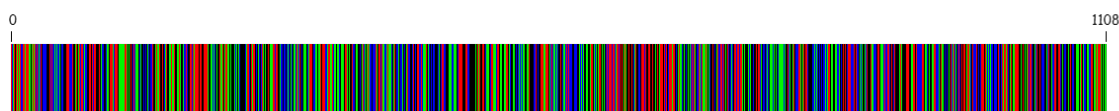
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TAAGATTTTGGTTATTACCTCCCTCTCTTTTTTTATTATTTATTTTCATCTAT
AGTGGATATAGGAGTTGGAGCAGGGTGGACGGTATATCCTCCTTTGGCT
TCTTTAGAAGGTCATTCCGGTAGATCAATAGATTTTGCTATTTTTTCTCTT
CATTTAGCTGGTGCTTCTTCAATTATAGGGGCTATTAATTTTATTTCTACT
ATTTTAAATATACGGGTGATGGGAATAAGAATGGAAAAAGTTCCTTTGTT
TGTTTGATCTGTTCTTATTACTGCTGTTCTTTTATTATTATCTCTTCCTGTT
TTAGCAGGGGCTATTACTATATTGTTGACTGATCGAAATTTTAATACTTC
ATT
TTTTGATCCCTCAGGGGGAGGTGATCCTATTTTATTTCAACATTTATTTTG
ATTTTTTGGCCATCCA



>PV798871.1 *Leucauge tessellata* voucher CDZ_LuTs1 small subunit ribosomal
RNA gene, partial sequence

TCACTGCCCCGGGTCTCCACACCAGCCGGGTTTCCCTGGATGATCTTCAC
CGGTTGTCTTGGGTGACCGGCAAGTTTACTTTGAAAAAATTAGAGTGCTC
AAAGCAGGCGCGACGCCTGGATAATGGTGCATGGAATAATGGAATAGG
ACCTCGGTTCTATTTTGTGTTGTTTATAGGAACACGAGGTAATGATTAAGAG
GGACAGACGGGGGCATTCGTATTGCGACGCTAGAGGTGAAATTCTTGGA
CCGCCGCACGACGAACTACTGCGAAAGCATTGCGCAAGAATGTTTCCAT
TAATCAAGAACGAAAGTTAGAGGTCCGAAGGCGATCAGATACCGCCCTA
GTTCTAACCATAAACGATGCCAGCCAGCGATCCGGCTGCGTTCCTCAAAT
GACGCGCCGGGCAGCTTCCGGGAAACCAAAGCTTTTGGGTTCCGGGGGG

AGTATGGTTGCAAAGCTTAACTTGAAGGAATTGACGGAAGCGCACACA
 AGGAATGGGGCCTGCGGTTTAATTTGACTCAACACGGTGCAACTCTCCC
 GGCCCGGACACAGGAAGGATTGACAGATTGAGAGCTCTTTCTTCATTCT
 GTGATAGGTGGTGCATGGCCGTTTCTGGTTGGTGGAGTGATTTGTCTGCT
 TTATTGCGATAACGAGCGAGACTCTAGCCTACTAAATAGACGGTGCGAT
 CCTTCTGAGTCGCACGTTCTTCTTAGAGGGACAGGCGGTGTTTCAGCCGCA
 CGAAACAGAGCAAAAACAGGTCAGGATGCCCTTAGATGTTTCGGGGCCAC
 ACGCGCGCCACATTGAAGGAACCAGCGTGTGCTTTCCTGTCCGACAGG
 ACTGGGTAACCCGTTGAAACTCCTTCGTGCTGGGGATAGGGGTTTGAA
 TTGTCCCCCTTGAACGAGGAATTCCCAGTAAGCGCGAGTCATCAGCTCGT
 GTTGATTACGTCCCTGCGCTTTGTACACACCGCCCGTCGCTATTATCGAT
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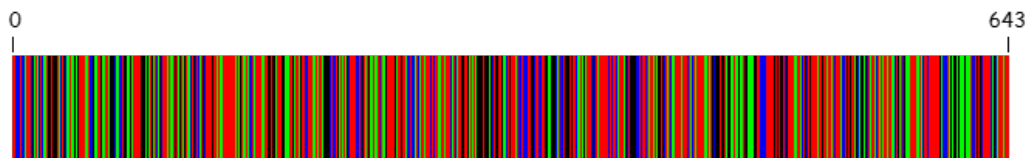
Orsinome vethi

Accession nos.: PV798890, PV799288

>PV798890.1 *Orsinome vethi* voucher CDZ_OrVe1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

ATGGTGGGTACTGCAATAAGAGTTTTAATCCGAATTGAATTAGGGCAAC
 CTGGAAGATTTTTGGGAGATGATCAGCTTTATAATGTAGTAGTAACTGCT
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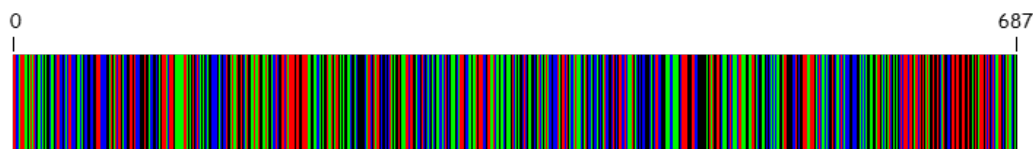
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 TCGCTATTTTTTCTCTTCATTTAGCTGGGGCCTCTTCTATTATAGGTGCTA
 TCAATTTTATTTCTACTATTTTAAATATGCGGGTGGTAGGAATAAGAATG
 GAAAAGGTTCCCCTTTTTGTGTGGTCRGTTTTAATTACTGCTGTTTTATTG
 TTATTATCTTTACCTGTGTTAGCAGGAGCTATTACTATATTATTAAGTAT
 CGAAATTTTAATACTTCTTTTTTTGACCCTAGAGGAGAAAGAAATCCTGT
 GCTTTTTCAGCATTTATTT



>PV799288.1 Orsinome vethi voucher CDZ_OrVe1 small subunit ribosomal RNA
 gene, partial sequence

GAACAGAGGCAAGCTTCCGCACTTCCCGAACAGCCGGCCGGTTTCCCCG
 GATGATCTTGACCGGTTGTCCCGGGTGGACCGGCGAGTTTACTTTGAAAA
 AATTAGAGTGCTCAGAGCAGGCCCGACGCCTGGATAATGGTGCATGGA
 ATAATGGAATAGGACCTCGGTTCTATTTTGTGTTTAAAGGAACCAGAG
 GTAATGATTGAGAGGAACGGACGGGGGCATTTCGTATTGCGGCGCTAGAG
 GTGAAATTCTTGGACCGTCGCACGACGAACCACTGCGAAAGCATTTGCC
 AAGAATGTTTCCGTTAATCAAGAACGAAAGTCAGAGGCTCGAAGGCGAT
 CAGATACCGCCCTAGTTCTGACCATAAACGATGCCAGCCAGCGATCCGG
 CTGCGTTCCTCAAATGACGCGCCGGGCAGCTTCCGGGAAACCAAAAAGCT
 TTTGGGTTCGGGGGGAGTATGGTTGCAAAGCTCAAACCTAAAGGAATT
 GACGGAAGCGCACACAAGGATTGGGGCCTGCGGTTTAATTTGACTCAAC

ACGGTGCAACTCACCCGGCCCGGACACAGGAAGGATTGACAGATCGAG
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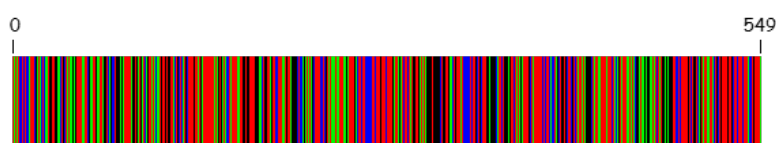


Tylorida ventralis

Accession nos.: PV805277, PV789679

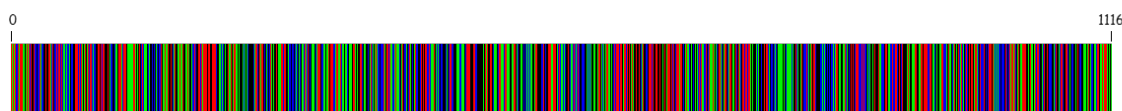
>PV805277.1 *Tylorida ventralis* voucher CDZ_TyVn1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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TGGGAGATTTTATAGGTGATGATCAGTTATACAATGTTGTGGTTACTGCTC
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TTGGGAAGTGGTTAGTTCCTTTAATGTTAGGGGCTCCAGATATAGCTTTT
CCTCGTATAAATAATTTAAGATTTTGACTTCTTCCCCCTTCTTTGTTTCTTT
TGATTAGATCTTCTATGGTTGATATAGGGGTGGGGGCTGGTTGAACTGTT
TATCCCCCTCTTGCTGCTTTGGAGGGGCATTCTGGGAGTTCTATAGATTTT
GCTATTTTTTCTCTTCACCTAGCTGGTGCTTCGTCTATTATAGGGGCTATT
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GAGGGTTCCTCTTTTTGTCTGGTCAGTATTAATTACTGCTGTTTTGTTGCT
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>PV789679.1 Tylorida ventralis voucher CDZ_TyVn1 small subunit ribosomal RNA gene, partial sequence

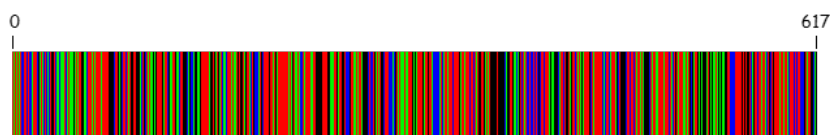
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GTAATGATTAAGAGGGACAGACGGGGGCATTTCGTATTGCGACGCTAGAG
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AAGAATGTTTCCATTAATCAAGAACGAAAGTTAGAGGTTCTGAAGGCGAT
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GCATGAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTGTACACACC
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***Tylorida striata***

Accession nos.: PV805278, PV789727

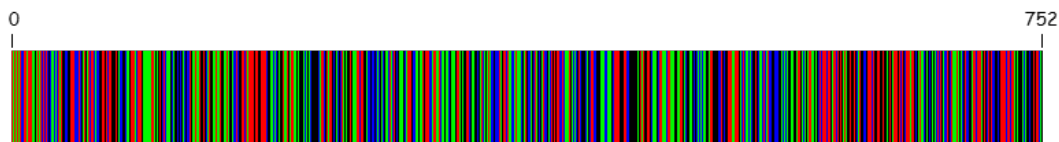
>PV805278.1 *Tylorida striata* voucher CDZ_TySt1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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AGTTACTGCCCATGCTTTTGTTATGATTTTTTTTATAGTAATACCTATTTT
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TTCTATAGATTTTGCTATTTTTTCACTTCATTTAGCTGGGGCTTCTTCTATT
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>PV789727.1 *Tylorida striata* voucher CDZ_TySt1 small subunit ribosomal RNA gene, partial sequence

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 GCGACGCCTGAATAATGGTGCATGGAATAATGGAATAGGACCTCGGTTC
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 GGGGCATTTCGTATTGCGACGCTAGAGGTGAAATTCTTGGACCGCCGCAC
 GACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTCCATTAATCAAGA
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 GGGCAGCTTCCGGGAAACCAAAGCTTTTGGGTTCCGGGGGGAGTATGGT
 TGCAAAGCTTAAACTTAAAGGAATTGACGGAAGCGCACACAAGGATTG
 GGGCCTGCGGTTTAATTTGACTCAACACGGTGCAACTCATCCGGCCCCGG
 ACACAGGAAGGATTGACAGATTAAGAGCTCTTTCTTGATTCTGTGATAG
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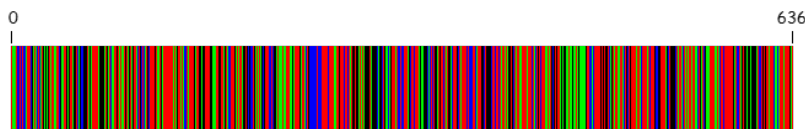
Tylorida flava

Accession nos.: PV800298, PV810364

>PV800298.1 *Tylorida flava* voucher CDZ_TyF11 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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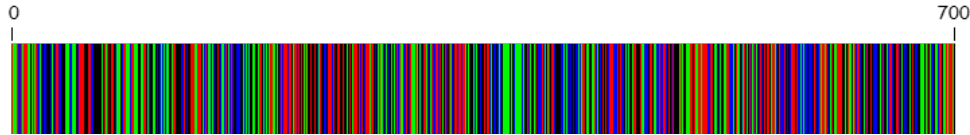
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GGTGGATATAGGGGTAGGGGCAGGCTGAACAGTTTATCCTCCTTTAGCTT
CTTTAGAAGGGCACTCTGGATGTTCTATGGACTTTGCTATTTTCTCCCTTC
ATTTGGCTGGGGCTTCTTCTATTATAGGTGCTATTAATTTTATTTCTACTG
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>PV810364.1 Tylorida flava voucher CDZ_TyFl1 small subunit ribosomal RNA
gene, partial sequence

CACGCCGGGCAGCTTCCGGGAAACCAAAGCTTTTGGGTTCCGGGGGGAG
TATGGTTGCAAAGCTTAACTTAAAGGAATTGACGGAAGCGCACACAAG
GATTGGGGCCTGCGGTTTAATTTGACTCAACACGGTGCAACTCACTCGGC
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CTGAGTCGTACGTTCTTCTTAGAGGGACAGGCGGTGTTTCAGCCGCACGA
AAAAGAGCAAAAACAGGTCAGGATGCCCTCAGATGTTTCGGGGCCACAC
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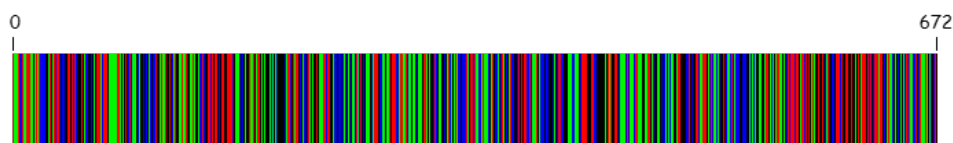
Tylorida marmorea

Accession no.: PV816788

>PV816788.1 Tylorida marmorea voucher CDZ_TyMa1 small subunit ribosomal
RNA gene, partial sequence

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AAAAATTAGAGTGCTCAAAGCAGGCGCGACGCCTGGATAATGGTGCATG
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GGTAATGATTGAGAGGGACAGACGGGGGCATTCGTATTGCGACGCTAGA
GGTGAAATTCTTGGACCGCCGCACGACGAACTACTGCGAAAGCATTTGC
CAAGAATGTTTCCATTAATCAAGAACGAAAGTTAGAGGCTCGAAGGCGA
TCAGATACCGCCCTAGTTCTAACCATAAACGATGCCAGCTAGCGATCCG
GCTGTGTTTCCTCAAATGACCCGCCGGGCAGCTTCCGGGAAACCAAAGCT
TTTGGGTTCCGGGGGGAGTATGGTTGCAAACTCAAACCTAAAGGAATT
GACGGAAGCGCACACAAGGATTGGGGCCTGCGGTTCAATTTGACTCAAC
ACGGTGCAACTCACCCGGCCCGGACACAGGAAGGATTGACAGATTAAGA
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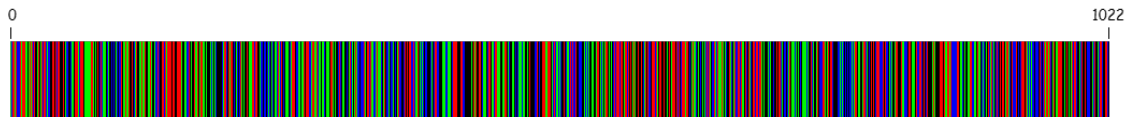
Mesida culta

Accession no.: PV816787

>PV816787.1 *Mesida culta* voucher CDZ_MeCu1 small subunit ribosomal RNA
gene, partial sequence

TGGATGATCTTCACCGGTTGTCTTGGGTGACCGGCAAGTTTACTTTGAAA
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TAATGATTAAGAGGGACAGACGGGGGCATTCGTATTGCGACGCTAGAGG
TGAAATTCTTGGACCGCCGCACGACGAACTACTGCGAAAGCATTTGCCA
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GACGGTACGATCCTTCTAAGTCGTACGTTCTTCTTAGAGGGACAGGCGGT
GTTCAGCCGCATGAAACAGAGCGAAAACAGGTCAGGATGCCCTTAGATG

TTCGGGGCCACACGCGCGCCACATTGAAGGATTCAGCGTGTGCTTTCCT
GTCCGACAGGATTGGGTAACCCGTTGAAAGTCCTTCGTGCTGGGGATAG
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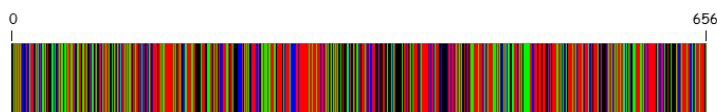
Glenognatha dentata

Accession nos.: PV765552, PV803137

>PV765552.1 *Glenognatha dentata* voucher CDZ_GlDe1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

ATAGTGGGAACAGCTATAAGAATATTAATTCTGAATTGAATTAGGTCAAG
TAGGTTTCATTATTAGGAGATGATCACTTATATAATGTTATTGTCAGTCTGCT
CATGCTTTTGTATATAATTTTTTTTATAGTTATGCCAATTTTAATTGGGGGA
TTTGGAATTGATTAGTCCCTTTAATGTTAGGGGCCCCTGATATAGCTTT
TCCTCGAATAAATAATTTAAGTTTTTGACTTTTACCCCTTCTTTTTTTTA
TTATTTATTTCTTCTATAGTAGATATAGGAGTGGGAACTGGATGAACTGT
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TTGCTATTTTTTCTTTCATTTGGCGGGGGCTTCTTCTATTATAGGTGCTG
TAAATTTTATTTCTACTATTTTAAATATACGCATACAAGGAATTTCTATA
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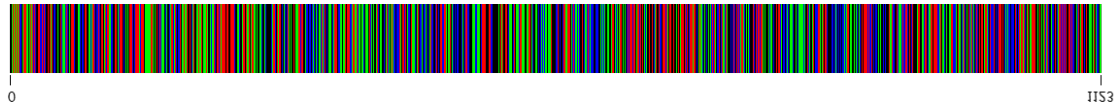
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TTATTCCAGCATTTATTTTGA



>PV803137.1 Glenognatha dentata voucher CDZ_GlDe1 small subunit ribosomal
RNA gene, partial sequence

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CGTTGGAACATTCGCCTCGTTGATCTTAACCGGTTGACTTTGCGAGAGTT
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GCCAGCCAGCGATCCGGCTGCGTTCCTTAGAATGACGCGCCGGGCAGCT
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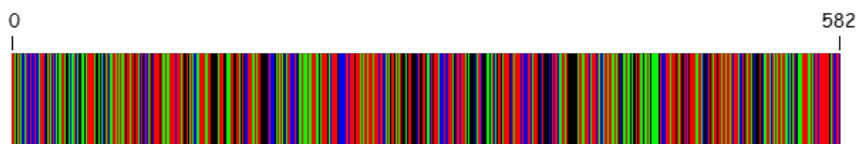


Tetragnatha ceylonica

Accession nos.: PV799331, PV802544

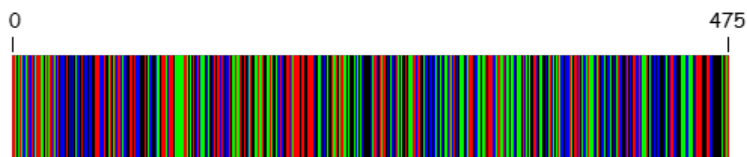
>PV799331.1 *Tetragnatha ceylonica* voucher CDZ_TeCe1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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>PV802544.1 Tetragnatha ceylonica voucher CDZ_TeCe1 small subunit ribosomal RNA gene, partial sequence

TACTGCCCCGTGCGCGACCGTGCCGCCGGTTTCCCTGGATGATCTTCACCG
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 AAGCAGGCTGTTCTCGCCTGAATAATGGTGCATGGAATAATGGAATAGG
 ACCTCGGTTCTATTTTGTGTTGGTTTTTCGGAACGCGAGGTAATGATTAAGAG
 GGACAGACGGGGGCATTCGTATTGCGACGCTAGAGGTGAAATTCTTGGA
 CCGCCGCACGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTCCAT
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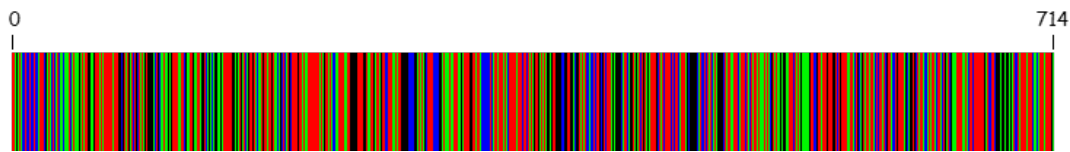
Tetragnatha cochinensis

Accession nos.: PV791426, PV800199

>PV791426.1 Tetragnatha cochinensis voucher CDZ_TeCo1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

TCAACAAATCATAAAGATATTGGAAGTTTATATTTTTTATTTGGCGTATG
 ATCTGCTATAGTGGGGACTGCAATAAGAGTTTAAATTCGAATTGAATTAG
 GTCAGACAGGAAGATTTTTTGGAGATGATCAGTTGTACAATGTTATTGTA
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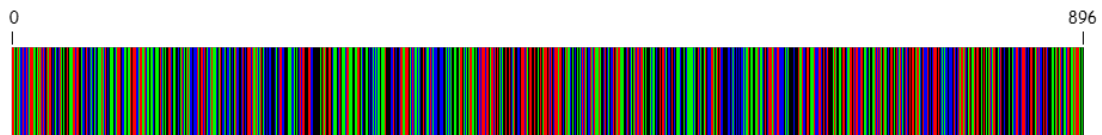
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 GGGCTATTAATTTCAATTTCTACTATTATAAATATACGTATAAGAGGAATT
 TCTATAGAAAAAGTTCCGTTATTTGTTTGGTCTGTTTTAATTACTGCAGTA
 TTATTACTCTTATCGTTACCTGTTTTAGCAGGTGCTATTACCATATTACTT
 ACTGATCGAAATTTTAATACTTCTTTTTTTGATCCTTCGGGAGGAGGAGA
 TCCTATTTTATTTCAACATTTATTTTGA



>PV800199.1 Tetragnatha cochinensis voucher CDZ_TeCo1 small subunit
 ribosomal RNA gene, partial sequence

TCGTATTGCGACGCTAGAGGTGAAATTCTTGGACCGTCGCACGACGAAA
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 TCAGAGGTTCTGAAGGCGATCAGATACCGCCCTAGTTCTGACCATAAACG
 ATGCCAGCCAGCGATCCGGCTGCGTTTCTAATACATGACGCGCCGGGCA
 GCTTCCGGGAAACCAGAGCTCTTGGGTTCGGGGGGGAGTATGGTTGCAA
 AGCTGAAACTTAAAGGAATTGACGGAAGCGCACACAAGAAATGGGGCC
 TGC GGCTTAATTTGACTCAACACGGTGCAACTCACCCGGCCCGGACACA
 GGAAGGATTGACAGATTAAGAGCTCTTTCTTGATTCTGTGACAGGTGGTG
 CATGGCCGTTTCTAGTTGGTGGAGTGATTTGTCTGCTTTATTGCGATAAC
 GAGCGAGACTCTAGCCTACTAAATAGGCTGCAGCCTGTATTAAAGGCT

GCAGATCTTCTTAGAGGGACAAGCGGTGTTTCAGCCGTGCGAAACGGAGC
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AATGAAGGAATCAACGTGCTTTATCCTTCCCCGACAGGGGCGGGTAATC
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AACGAGGAATCTCTAGTAAGCGTTGAGTCATCAGCTCGTGTTGATTACGT
CCCTGCGCTTTGTGCACACCGCCCGTCGCTATTATCGATGAATGTTGGAG
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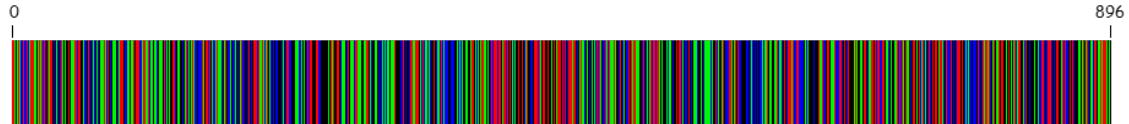
Tetragnatha geniculata

Accession nos.: PV794563, PV798806

>PV794563.1 *Tetragnatha geniculata* voucher CDZ_TeGel cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

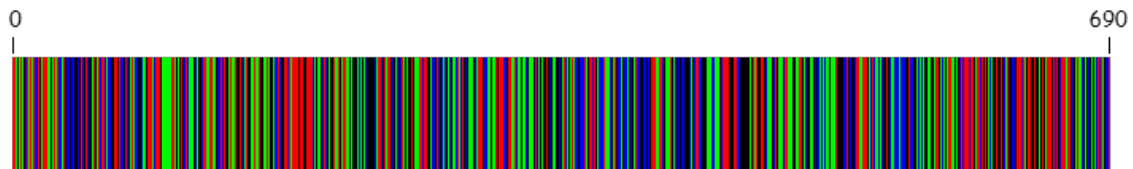
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>PV798806.1 Tetragnatha geniculata voucher CDZ_TeGe1 small subunit ribosomal
RNA gene, partial sequence

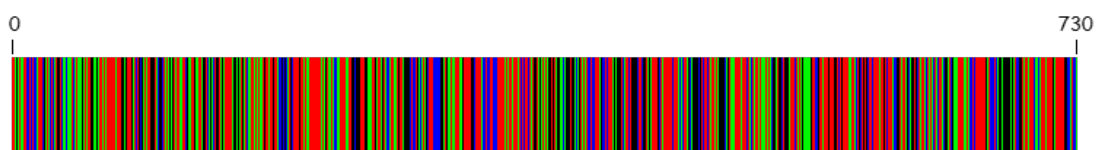
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AACTACTGCGAAAGCATTGCGCAAGAATGTTTCCGTTAATCAAGAACGA
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ACACAGGAAGGATTGACAGATTAAGAGCTCTTTCTTGATTCTGTGACAG
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*Tetragnatha hasselti*

Accession nos.: PV790226, PV793398

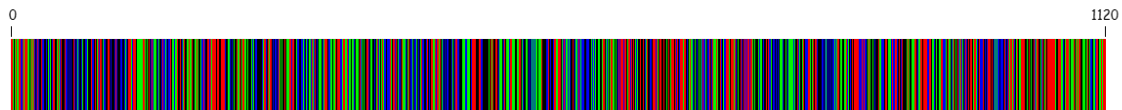
>PV790226.1 *Tetragnatha hasselti* voucher CDZ_TeHs1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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 GTTACCGCGCATGCTTTTGTTATAATTTTTTTTATAGTAATACCAATTTTA
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 TCGGTAGATTTTGCTATTTTTTCTTTACACTTAGCAGGGGCGTCTTCTATT
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 GATTTCTATAGAAAAAGTTCGTTATTTGTTTGGTCTGTTTTAATTACTGC
 TGTGCTTCTTTTATTGTCTTTACCGGTATTAGCAGGTGCTATTACTATACT
 ACTTACGGATCGAAATTTAATACCTCTTTTTTTGATCCCTCAGGAGGGG
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>PV793398.1 Tetragnatha hasselti voucher CDZ_TeHs1 small subunit ribosomal RNA gene, partial sequence

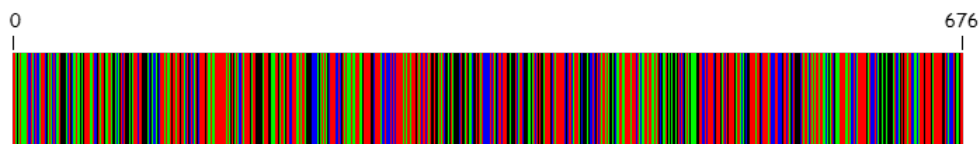
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CAAAGCTTTTGGGTTCGGGGGGGAGTATGGTTGCAAAGCTGAAACTTA
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CGTGTTTTTCCCTCTCCGATAGGAGCGGGTAACCCGTTGAAACTCCTTCG
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***Tetragnatha javana***

Accession nos.: PV776866, PV785345

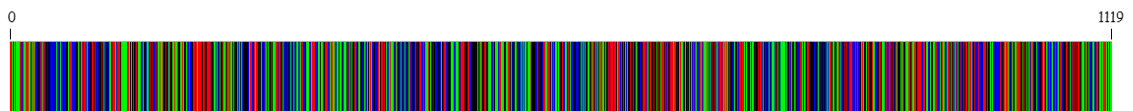
>PV776866.1 *Tetragnatha javana* voucher CDZ_TeJa1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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GCTTTTGTAATAATTTTTTTTATAGTGATACCTATTTTGATTGGGGGATTT
GGAAATTGATTAGTTCCTTTAATATTAGGGGCCCCAGATATAGCTTTTCC
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>PV785345.1 *Tetragnatha javana* voucher CDZ_TeJa1 small subunit ribosomal RNA gene, partial sequence

CGGCTTACTGGCGGCCCCGCGACCGACCGCCGGATTTCCCCGGATGATCTT
CACCGGTTGTCCCGGGTGACCGGCAAGTTTACTTTGAAAAAATTAGAGT
GCTCAAAGCAGGCAACTGTGCCTGAATAATGGTGCATGGAATAATGGAA
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CCTAGTTCTGACCATAAACGATGCCAGCCAGCGATCCGGCTGCGTTCCTC
AAATGACGCGCCGGGCAGCTTCCGGGAAACCAAAGCTTTTGGGTTCGGG
GGGGAGTATGGTTGCAAAGCTGAACTTAAAGGAATTGACGGAAGCGC
ACACAAGAAATGGGGCCTGCGGCTTAATTTGACTCAACACGGTGCAACT
CACCCGGCCCGGACACAGGAAGGATTGACAGATTAAGAGCTCTTTCTTG
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TAGGAGTGGGTAACCCGTTGAAACTCCTTCGTGCTAGGGATAGGAAATT
GTAATTGTTTTCTTGAACGAGGAATTCCCAGTAAGCATTGAGTCATCAG
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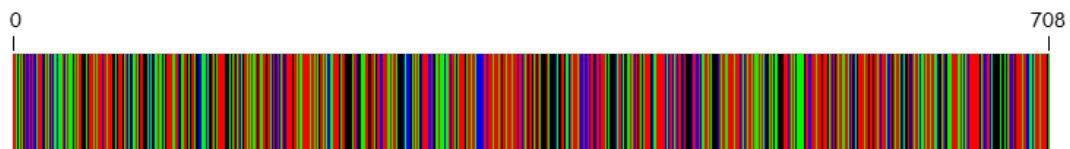


Tetragnatha keyserlingi

Accession nos.: PV802621, PV802562

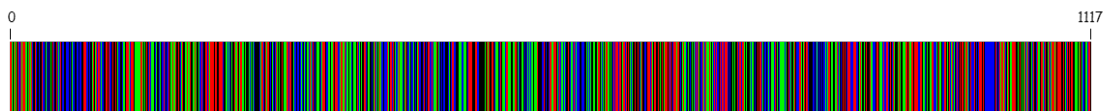
>PV802621.1 *Tetragnatha keyserlingi* voucher CDZ_TeKe1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

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 CAAACAGGTAGATTTTTTGGGAGATGATCAGTTATATAATGTAATTGTTAC
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 CTTTTCCTCGAATAAACAATCTTAGATTTTGATTATTACCCCCTTCTTTAT
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>PV802562.1 *Tetragnatha keyserlingi* voucher CDZ_TeKe1 small subunit ribosomal RNA gene, partial sequence

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GCGATCCGGCTGCGTTCCTCAAATGACGCGCCGGGCAGCTTCCGGGAAA
CCAAAGCTTTTGGGTTCCGGGGGGAGTATGGTTGCAAAGCTGAACTTA
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GACTCAACACGGTGCAACTACCCGGCCCGGACACAGGAAGGATTGACA
GATTAAGAGCTCTTTCTTGATTCTGTGACAGGTGGTGCATGGCCGTTTCT
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GGACAAGCGGTGTTTCAGCCGCACGAACTGAGCAAAAACAGGTCAGGA
TGCCCTTAGATGTTCGGGGCCGCACGCGCGCCACATTGAAGGAATCAGC
GTGTGCTTTCCCTTTCCGATAGGAGTGGGTAACCCGTTGAACTCCTTCG
TGCTAGGGATAGGAAATTGTAATTGTTTTCTTGAACGAGGAATTCCCAG
TAAGCCTTGAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTGTGCC
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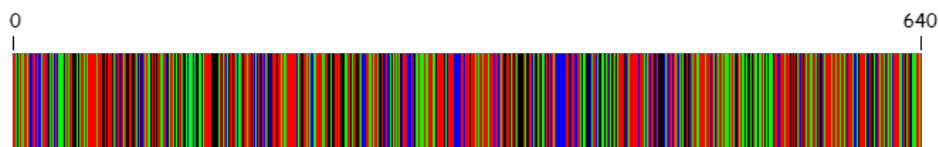


Tetragnatha lauta

Accession nos.: PV785471, PV789646

>PV785471.1 *Tetragnatha lauta* voucher CDZ_TeLt1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

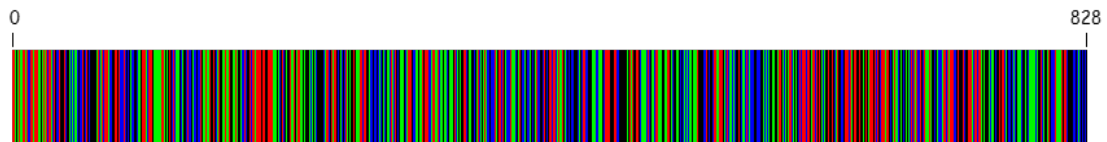
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ATCTTTACCAGTTTTAGCTGGAGCTATTACTATACTTTTAACTGATCGAA
ATTAT



>PV789646.1 *Tetragnatha lauta* voucher CDZ_TeLt1 small subunit ribosomal RNA gene, partial sequence

TTACTGCCTGGGTCGGACACAACGCCTGCTGCGGGGGATCATCTTTACCG
GTTGTCCCTCGCGACCGGCAAGTTTACTTTGAAAAAATTAGAGTGCTCAA
AGCAGGCTCCGACCGCCTGAATAATGGTGCATGGAATAATGGAATAGGA

CCTCGGTCTTATTTTGTGGTTTTAAAGACGTCGAGGTAATGATTAAGAG
 GGACAGACGGGGGCATTTCGTATTGCGACGCTAGAGGTGAAATTCTTGGA
 CCGCCGCACGACGAACTACTGCGAAAGCATTGTTGCCAAGAATGTTTCCAT
 TAATCAAGAACGAAAGTCAGAGGTTCTGAAGGCGATCAGATACCGCCCTA
 GTTCTGACCCTAAACGATGCCAGCCAGCGATCCGGCTGCGTTCTTCATAA
 TGACGCGCCGGGCAGCTTCCGGGAAACCAAAGCTTTTGGGTTCCGGGGG
 GAGTATGGTTGCAAACTCGAACTTAAAGGAATTGACGGAAGCGCACAC
 AAGAAATGGGGCCTGCGGCTTAATTTGACTCAACACGGTGCAACTCACC
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 GTGACAGGTGGTGCATGGCCGTTTCTAGTTGGTGGAGTGATTTGTCTGCT
 TTATTGCGATAACGAGCGAGACTCTATCCTGCTAAATAGGCGACCCATTC
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 CACGAAACGGAGCAAAAACAGGTCAGGATGCCCTAAAATGTTTCGGGGC
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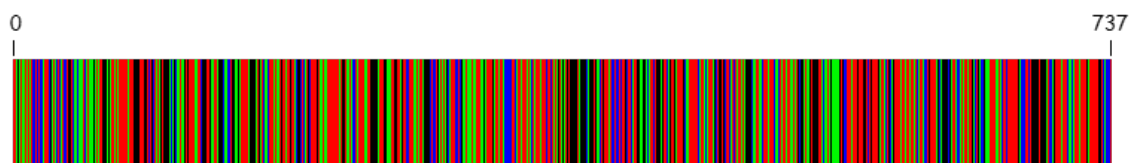
Tetragnatha mandibulata

Accession nos.: PV776609, PV785307

>PV776609.1 *Tetragnatha mandibulata* voucher CDZ_TeMn1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

TCCTGGTCAACAAATCATAAAGATATTGGGAGATTATATTTTTTATTTGG
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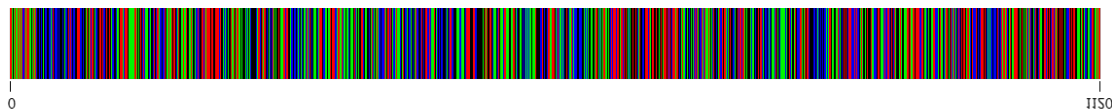
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CTTCATTATTTATACTATTTATTTCTTCTATAGTAGATGTGGGGGTAGGGG
CAGGGTGAACGTGTTTATCCTCCTCTTGCTTCATTGGAAGGACATTCTGGG
AGTTCAGTTGATTTTGCAATTTTTCATTACATTTAGCTGGTGCTTCATCT
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TGGGGTTACAATAGAAAAAGTGCCTTTATTTGTTTGGTCTGTTTTGATTA
CTGCAGTTTTATTATTATTATCATTACCTGTTTTAGCAGGGGCGATTACCA
TATTATTGACTGACCGAAATTTTAATACTTCTTTTTTTGACCCTTCTGGGG
GTGGGGATCCAGTTTTATTTCAACATTTATTTTGATTTTTTGGTCACCCT



>PV785307.1 Tetragnatha mandibulata voucher CDZ_TeMn1 small subunit
ribosomal RNA gene, partial sequence

GGCGCGAGCCGGCCACTGCCCCGCGGGCGACCGTCTCGCCGGTTTCCGCG
GATGATCTTGACCGGTTGTCCGTGGTGACCGGCAAGTTTACTTTGAAAAA
ATTAGAGTGCTCAAAGCAGGCTGCTTACCGCCTGAATAATGTTGCATGG
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GTAATGATTAAGAGGGACAGACGGGGGCATTTCGTATTGCGACGCTAGAG
GTGAAATTCTTGACCGCCGCACGACGAACTACTGCGAAAGCATTTGCC
AAGAATGTTTCCATTAATCAAGAACGAAAGTCAGAGGTTCTGAAGGCGAT
CAGATACCGCCCTAGTTCTGACCATAAACGATGCCAGCCAGCGATCCGG
CTGCGTTCCTCAAATGACGCGCCGGGCAGCTTCCGGGAAACCAAAGCTT

TTGGGTTCCGGGGGGGAGTATGGTTGCAAAGCTGAAACTTAAAGGAATTG
 ACGGAAGCGCACACAAGAAATGGGGCCTGCGGCTTAATTTGACTCAACA
 CGGTGCAASTCACCCGGCCCGGACACAGGAAGGATTGACAGATTAAGAG
 CTCTTTCTTGATTCTGTGACAGGTGGTGCATGGCCGTTTCTAGTTGGTGG
 AGTGATTTGTCTGCTTTATTGCGATAACGAGCGAGACTCTAGCCTACTAA
 ATAGACTGGCGATCCTGTTACAGTGGCCAGGTCTTCTTAGAGGGACAAG
 CGGTGTTTCAGCCGCACGAAACTGAGCAAAAACAGGTCAGGATGCCCTTA
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 ATAGGAAATTGTAATTGTTTTCTTGAACGAGGAATTCCCAGTAAGCATT
 GAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTGTGCACACCGCCC
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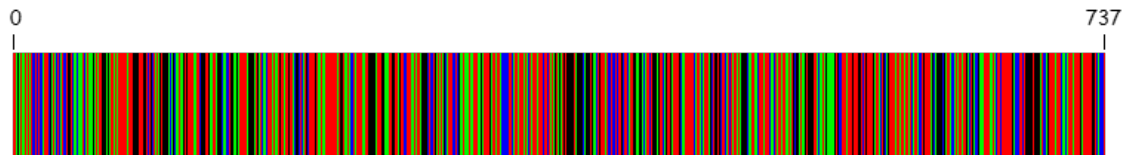
Tetragnatha squamata

Accession nos.: PV793528, PV793682

>PV793528.1 *Tetragnatha squamata* voucher CDZ_TeSq1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

TAGGTGACGACCAACTATACAATGTTATTGTAACAGCTCATGCTTTTGTA
 ATAATTTTTTTTATAGTGATACCTATTCTAATTGGGGGGTTTGGGAATTG
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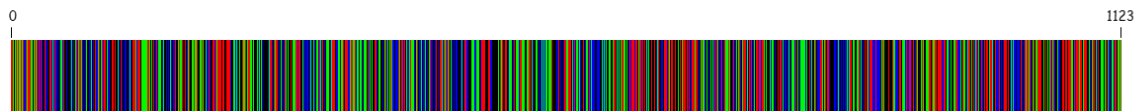
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 CTTTACATTTGGCAGGGGCGTCTTCTATTATAGGGGCTGTTAATTTTATTT
 CTACAATTATTAATATACGAATAGCGGGAGTTTCGATGGAAAAAGTTCC
 TTTATTTGTGTGATCTGTTTTAATTACAGCAGTTTTATTACTTTTATCTTTA
 CCAGTTTTAGCAGGTGCTATCACCATATTATTAGCAGATCGAAATTTTAA
 TACTTCTTTTTTTTGATCCTTCTGGGGGTGGGGATCCAGTTTTATTCAACA
 TTTATTTTGAT



>PV793682.1 Tetragnatha squamata voucher CDZ_TeSq1 small subunit ribosomal
 RNA gene, partial sequence

TCTCGGTCCGGTTCCTCCGGCAACTGGCGGGCAGCGATCATTACGGCA
 GGCCAGCGTCCATGATCTTGACCGGTTGTGGACGTCGGCCGGCACGTTTA
 CTTTGAAAAAATTAGAGTGCTCAAAGCAGGCGCGACGCCTGGATAATGG
 TGCATGGAATAATGGAATAGGACCTCGGTTCTATTTTGTGTTGTTTTCGGA
 ACACGAGGTAATGATTAAGAGGGACAGACGGGGGCATTTCGTATTGCGAC
 GCTAGAGGTGAAATTCTTGGACCGCCGCACGACGAACTACTGCGAAAGC
 ATTTGCCAAGAATGTTTCCATTAATCAAGAACGAAAGTCAGAGGTTTCGA
 AGGCGATCAGATACCGCCCTAGTTCTGACCATAAACGATGCCAGCCAGC
 GATCCGGCTGCGTTACTATCATGACGCGCCGGGCAGCTTCCGGGAAACC
 AAAGCTTTTGGGTTCGGGGGGGAGTATGGTTGCAAAGCTGAAACTTAAA
 GGAATTGACGGAAGCGCACACAAGAAATGGGGCCTGCGGCTTAATTTGA
 CTCAACACGGTGCAACTCACCCGGCCCGGACACAGGAAGGATTGACAGA

TTAAGAGCTCTTTCTTGATTCTGTGACAGGTGGTGCATGGCCGTTTCTAG
TTGGTGGAGTGATTTGTCTGCTTTATTGCGATAACGAGCGAGACTCTAGC
CTGCTAAATAGGCTGCAGATCGATTTTCAGTCTGCAGTTCTTCTTAGAGGG
ACAAGCGGTGTTTCAGCCGCACGAACTGAGCAAAAACAGGTCAGGATG
CCCTTAGATGTTTCGGGGCCGCACGCGCGCCACATTGAAGGAATCAGCGT
GTACTTTCCCTCCCCGATAGGGGTGGGTAACCCGTTGAAACTCCTTCGTG
CTAGGGATAGGAAATTGTAATTGTTTTCTTGAACGAGGAATTCCCAGTA
AGCATTGAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTGTGCACA
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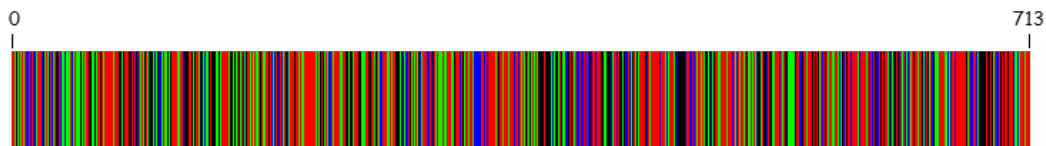
Tetragnatha viridorufa

Accession nos.: PV791427, PV800200

>PV791427.1 *Tetragnatha viridorufa* voucher CDZ_TeVi1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

TGGTCAACAAATCATAAAGATATTGGAAGATTGTATTTTTTATTTGGAGT
TTGGTCTGCTATAGTAGGGACAGCCATAAGAGTTTTAATTCGGGTTGAGT
TAGGACAAGTGGGAAGATTTTATAGGAGATGATCAGTTATATAATGTAAT
TGTCACTGCTCATGCATTTGTTATAATTTTTTTTATAGTGATACCTATTTT
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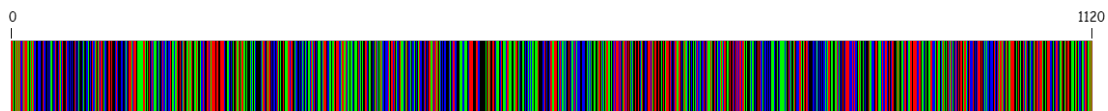
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 TCAGTAGATTTTGCTATTTTTTCTTTACATTTAGCGGGGGCTTCCTCTATT
 ATAGGAGCAGTTAATTTTATTTCTACTATTATGAATATACGGATGGCTGG
 AATTTCTATGGAAAAAGTTCGGTTATTTGTGTGATCTGTATTAATTACAG
 CTGTTCTTTTACTTTTATCTCTGCCTGTGTTAGCAGGTGCTATCACTATGT
 TATTGACTGATCGAAATTTTAACACTTCTTTTTTTGATCCTTCAGGGGGTG
 GTGATCCTGTGTTGTTTCAACATTTATTT



>PV800200.1 Tetragnatha viridorufa voucher CDZ_TeVi1 small subunit ribosomal
 RNA gene, partial sequence

CGGCCCCGGTCCGGCGCAAGCCTGGCTACTGGGTCCGCGCGGTTCGCAGGG
 CAGGCCAGCGTCCATGATCTTGACCGGTTGTGGGCTCGGGCCGGCACGT
 TTACTTTGAAAAAATTAGAGTGCTCAAAGCAGGCTCCACGCCTGAACAA
 TGGTGCATGGAATAATGGAATAGGACCTCGGTTCTATTTTGTGTTTTC
 GGAACGCGAGGTAATGATTAAGAGGGACAGACGGGGGCATTCGTATTGC
 GCCGCTAGAGGTGAAATTCTTGACCGGCGCACGACGAACTACTGCGAA
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 TGA CTCAACACGGTGCAACTCACCCGGCCCGGACACAGGAAGGATTGAC
 AGATTAAGAGCTCTTTCTCGATTCTGTGACAGGTGGTGCATGGCCGTTTC

TAGTTGGTGGAGTGATTTGTCGGCTTAATTGCGATAACGAGCGAGACTCC
 AGCCTGCTAAATAGGTCGACCATACTTGAAGTGGTCGTCTCTTCTTAGAG
 GGACAAGCGGTGTCCAGCCGCGCGAAACGGAGCAAAAACAGGTCAGGA
 TGCCCTTAGATGTTTCGGGGCCGCACGCGCGCCACATTGAAGGAATCAGC
 GTGCTTTTCCCTCTCCGATAGGAGCGGGTAACCCGTTGAAACTCCTTCGT
 GCTTGGGATAGGAACTTGCAATTGTTTTCTTGAACGAGGAATTCCCAGT
 AAGCATAGAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTGTGCAC
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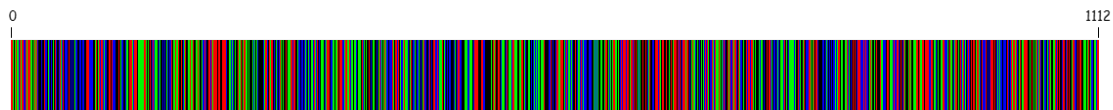
Tetragnatha jaculator

Accession no.: PV818498

>PV818498.1 *Tetragnatha jaculator* voucher CDZ_TeJr1 small subunit ribosomal RNA gene, partial sequence

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 ACGAGGTAATGATTAAGAGGGACAGACGGGGGCATTCGTATTGCGACGC
 TAGAGGTGAAATTCTTGACCGCCGCACGACGAACTACTGCGAAAGCAT
 TTGCCAAGAATGTTTCCATTAATCAAGAACGAAAGTCAGAGGTGCGAAG
 GCGATCAGATACCGCCCTAGTTCTGACCATAAACGATGCCAGCCAGCGA

TCCGGCTGCGTTCCTCAAATGACGCGCCGGGCAGCTTCCGGGAAACCAA
AGCTTTTGGGTTCCGGGGGGAGTATGGTTGCAAAGCTGAAACTTAAAGG
AATTGACGGAAGCGCACACAAGAAATGGGGCCTGCGGCTTAATTTGACT
CAACACGGTGCAACTCACCCGGCCCGGACACAGGAAGGATTGACAGATT
AAGAGCTCTTTCTTGATTCTGTGACAGGTGGTGCATGGCCGTTTCTAGTT
GGTGGAGTGATTTGTCTGCTTTATTGCGATAACGAGCGAGACTCTAGCCT
ACTAAATAGACTCGGTATCCTATTCGTACCGAGGTCTTCTTAGAGGGACA
AGCGGTGTTTCAGCCGCACGAAACTGAGCAAAAACAGGTCAGGATGCCCT
TAGATGTTTCGGGGCCGCACGCGCGCCACATTGAAGGAATCAGCGTGTGC
TTCCCTCTCCGATAGGAGTGGGTAACCCGTTGAAACTCCTTCGTGCTAG
GGATAGGAAATTGTAATTGTTTTCTTGAACGAGGAATTCCCAGTAAGC
ATTGAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTGTGCACACCG
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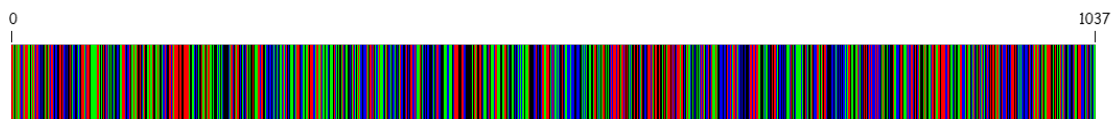
Tetragnatha serra

Accession no.: PV818499

>PV818499.1 Tetragnatha serra voucher CDZ_TeSe1 small subunit ribosomal RNA
gene, partial sequence

TTCCGCGGATGATCTTCGCCGGTTGTCCGCGGTGACCGGCACGTTTACTT
TGAAAAAATTAGAGTGCTCAGAGCAGGCCGAATTCGCCTGAATAATGG
TGCATGGAATAATGGAATAGGACCTCGGTTCTATTTTGTGTTGTTTTAGG
AACGCGAGGTAATGATTAAGAGGGACAGACGGGGGCATTCGTATTGCGA

CGCTAGAGGTGAAATTCTTGGACCGCCGCACGACGAACTACTGCGAAAG
 CATTGCCAAGAATGTTTCCATTAATCAAGAACGAAAGTCAGAGGATCG
 AAGGCGATCAGATACCGCCCTAGTTCTGACCATAAACGATGCCAGCCAG
 CGATCCGGCTGCGTTCCTCAAATGACGCGCCGGGCAGCTTCCGGGAAAC
 CAAAGCTTTTGGGTTCGGGGGGGAGTATGGTTGCAAAGCTGAAACTTAA
 AGGAATTGACGGAAGCGCACACAAGAAATGGGGCCTGCGGCTTAATTTG
 ACTCAACACGGTGCAACCCACCCGGCCCGGACACAGGAAGGATTGACAG
 ATTGAGAGCTCTTTCTTGATTCTGTGACAGGTGGTGCATGGCCGTTTCTA
 GTTGGTGGAGTGATTTGTCTGCTTTATTGCGATAACGAGCGAGACTCTAG
 CCTGCTAAATAGGCCCCGCCGTCCTCATTCTACCGCGGCGGGCTTCTTCTT
 ARAGGGACAAGCGGTGTTTCAGCCGCGCGAAACTGAGCAAAAACAGGTC
 AGGATGCCCTTAGATGTTCGGGGCCGCACGCGCGCCACATTGAAGGAAT
 CAGCGTGTGCTCTCCCTCTCCGATAGGAGCGGGTAACCCGTTGAAACTCC
 TTCGTGCTAGGGATAGGAACTTGTAATTGTTTTCTTGAACGAGGAATTC
 CCAGTAAGCATCGAGTCATCAGCTCGTGTTGATTACGTCCCTGCGCTTTG
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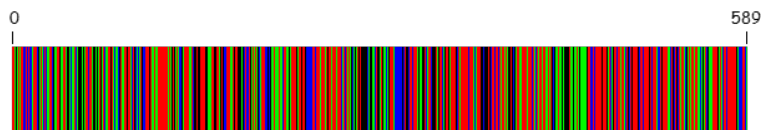


Tetragnatha nitens

Accession no.: PV802916

>PV802916.1 *Tetragnatha nitens* voucher CDZ_TeNi1 cytochrome c oxidase subunit I (COX1) gene, partial cds; mitochondrial

ATTCGAATTGAATTAGGACAATCAGGGAGATTCTTAGGAGATGATCAAT
TGTACAACGTAATTGTTACTGCACATGCCTTTGTAATAATTTTTTTTATAG
TGATACCGATTTTAATCGGTGGTTTTGGAAATTGGTTAGTGCCTTTAATG
TTGGGAGCTCCTGATATAGCATTTCGCGAATAAATAACTTAAGATTTTG
ATTGTTGCCCCCTTCTTTATTTATGTTATTTATTTTCATCTATAGCAGATGT
GGGGGCAGGAAGTGGATGAACAGTTTACCCCCGCTGGCTTCTTTAGAA
GGTCATTGCGGTAGTTCAGTTGATTTTGCTATTTTTTCTTTACATTTGGCG
GGTGCTTCTTCTATTATAGGTGCGATTAATTTTATTTCTACTATTATTAAT
ATGCGAATAAGAGGGGTAAGAATAGAAAAAGTTCCTCTTTTTGTTTGAT
CAGTTCTTATTACTGCTGTTTTGCTTCTTTTGCTTTACCTGTTTTAACTGC
TGCTATTACGATATTATTAACAGATCGAAATTTTGATACTTCTTTTTTTGA
CCCTTCA



4.3. Evolutionary relationship between members of Tetragnathidae in Kerala and other Tetragnathidae across the world

The interrelationship among tetragnathids was inferred by concatenating nucleotide sequences of CO1 and 18S rRNA gene regions. A total of 44 taxa representing 34 species were selected for the analysis including two outgroups. The homology of the sequences was also checked during the process. The multiple sequence alignment was done by MEGA12 and the final alignment comprises 1583 nucleotide sequences in which the CO1 (620 bp) sequences were assembled at the outset, followed by 18S rRNA (963 bp) sequences. The pairwise genetic distance matrix was computed by MEGA12 and it reflects the transition or transversion bias which accounts for the quantitative measure of genetic divergence among tetragnathids. The genetic distance was calculated by the Kimura 2-Parameter (K2P) method and the mean intraspecific distance ranges between 0.0003 and 0.006 and the mean interspecific distance ranges from 0.046 to 0.087 (Table 4.2).

The evolutionary relationship was inferred using the Neighbour Joining tree with the sum of branch length 1.44, which is given below (Fig. 4.2). The complete deletion method was employed to eliminate the gaps as well as missing data and resulted in a data set of 1316 nucleotide sequences. In the analysis, the 1st, 2nd, 3rd, and noncoding positions were also taken into account. The Maximum Composite Likelihood method was adopted to infer the evolutionary distances. The optimal tree was obtained from the 10,000 bootstrap replicates and the major clades show high (>80%) bootstrap support. This phylogenetic analysis grouped tetragnathids into four subfamilies such as Tetragnathinae, Leucauginae, Metainae, and Nanometinae. The monophyly of the subfamilies such as Tetragnathinae, Metainae, and Nanometinae are well supported with high bootstraps, whereas the subfamily

Leucauginae shows paraphyly where the genera *Tylorida*, *Mesida* and *Orsinome* form a distinct clade. Most importantly, the Neighbour Joining (NJ) tree seems to be almost congruent with the Maximum Likelihood (ML) tree.

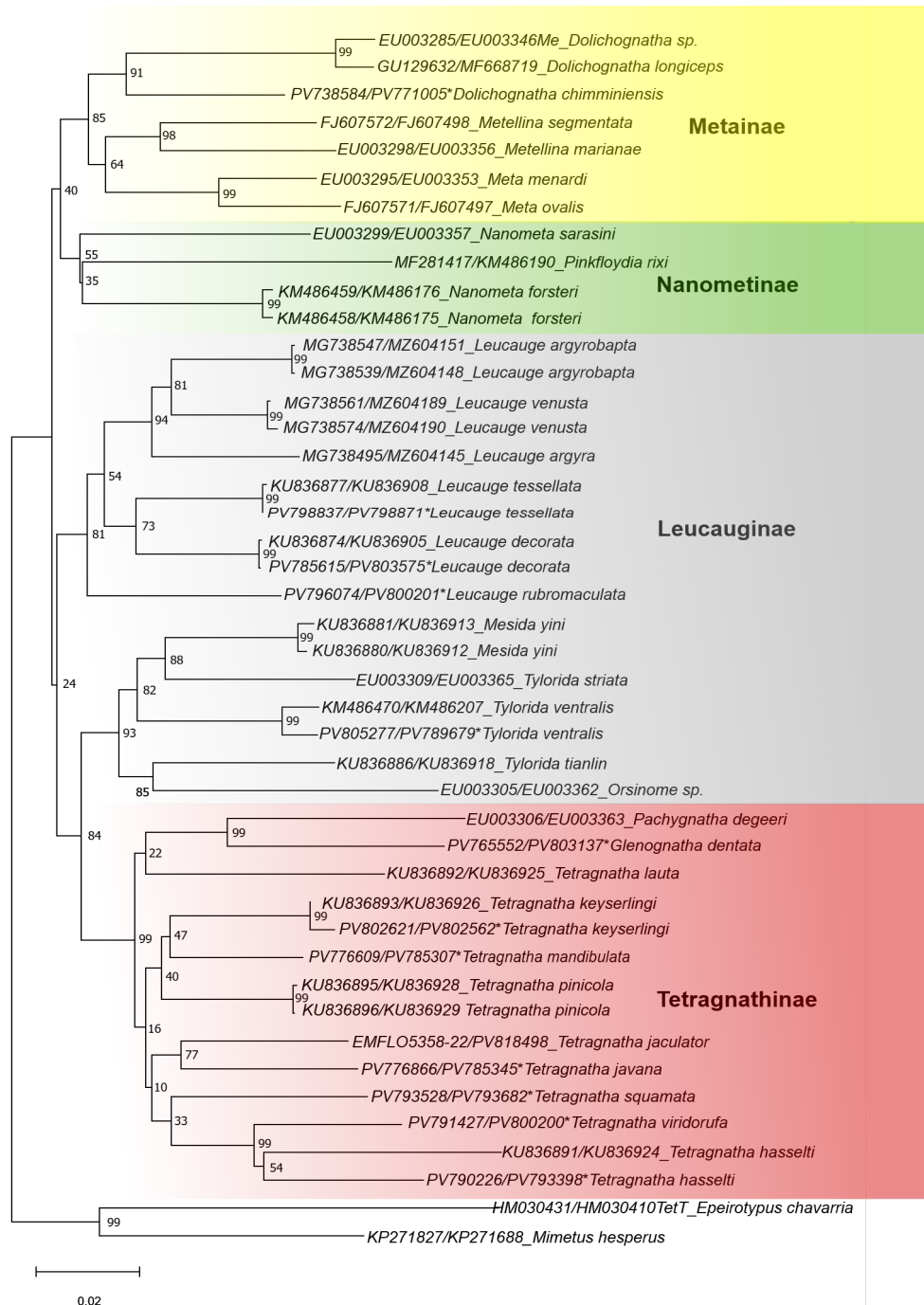


FIGURE 4.2. Phylogeny of Tetragnathidae by the Neighbour Joining method. The subfamilies are highlighted and the taxa with asterisks represent the newly generated sequences.

Species	Interspecific distance (mini-maxi)	Mean±SD	Intraspecific distance (mini-maxi)	Mean±SD
<i>Tetragnatha pinicola</i>	0.052-0.099	0.075±0.011	0.0-0.0007	0.0003±0.001
<i>Tetragnatha squamata</i>	0.065-0.100	0.082±0.008	-	-
<i>Tetragnatha javana</i>	0.065-0.110	0.087±0.011	-	-
<i>Tetragnatha jaculator</i>	0.066-0.098	0.082±0.008	-	-
<i>Tetragnatha keyserlingi</i>	0.057-0.109	0.083±0.013	0.0-0.0045	0.002±0.001
<i>Tetragnatha mandibulata</i>	0.052-0.108	0.080±0.014	-	-
<i>Glenognatha dentata</i>	n/a	-	-	-
<i>Pachygnatha degeeri</i>	n/a	-	-	-
<i>Tetragnatha hasselti</i>	0.076-0.118	0.097±0.010	0.0-0.0087	0.004±0.002
<i>Tetragnatha viridorufa</i>	0.060-0.094	0.077±0.008	-	-
<i>Tetragnatha lauta</i>	0.076-0.118	0.097±0.010	-	-
<i>Orsinome sp.</i>	n/a	-	-	-
<i>Tylorida tianlin</i>	0.073-0.083	0.078±0.002	-	-
<i>Tylorida ventralis</i>	0.076-0.078	0.077±0.0005	0.0-0.0131	0.006±0.003
<i>Mesida yini</i>	n/a	-	0.0-0.0045	0.004±0.001
<i>Tylorida striata</i>	0.075-0.083	0.079±0.002	-	-
<i>Dolichognatha sp.</i>	0.014-0.077	0.045±0.015	-	-
<i>Dolichognatha longiceps</i>	0.014-0.078	0.046±0.016	-	-
<i>Dolichognatha chimminiensis</i>	0.077-0.078	0.077±0.0002	-	-
<i>Metellina segmentata</i>	0.063	0.063	-	-
<i>Metellina marianae</i>	0.063	0.063	-	-
<i>Meta menardi</i>	0.042	0.042	-	-
<i>Meta ovalis</i>	0.042	0.042	-	-
<i>Leucauge venusta</i>	0.041-0.076	0.058±0.008	0.0-0.0022	0.001±0.0005
<i>Leucauge argyrobapta</i>	0.041-0.079	0.060±0.009	0.0-0.0007	0.0003±0.0001
<i>Leucauge argyra</i>	0.051-0.089	0.070±0.009	-	-
<i>Leucauge decorata</i>	0.047-0.076	0.061±0.007	0.0-0.0007	0.0003±0.0001
<i>Leucauge tessellata</i>	0.047-0.066	0.056±0.004	0.0-0.0007	0.0003±0.0001
<i>Leucauge rubromaculata</i>	0.064-0.085	0.074±0.005	-	-
<i>Nanometa forsteri</i>	0.080-0.084	0.082±0.001	0.0-0.0024	0.001±0.0006
<i>Nanometa sarasini</i>	0.080-0.084	0.082±0.001	-	-
<i>Pinkfloydia rixi</i>	n/a	-	-	-
<i>Epeirotypus chavarria</i>	n/a	-	-	-
<i>Mimetus hesperus</i>	n/a	-	-	-

TABLE 4.2. The pairwise genetic distance of the 44 taxa calculated by the Kimura 2-Parameter (K2P) method using MEGA12.

The Maximum Parsimony (MP) was performed by the software MEGA12 based on the Subtree-Pruning-Regrafting (SPR) algorithm (Nei & Kumar, 2000). This process resulted in the most parsimonious tree with length 2906 and with consistency index (CI) 0.33 (0.29) and retention index (RI) 0.52 (0.52). The optimal tree was generated

from 10,000 bootstrap replicates. The initial trees were obtained by the random addition (10 replicates) with maximum parsimony search level 1 and 1st, 2nd, 3rd, and noncoding codon positions were also included in the analysis. Finally, the dataset includes 1577 positions after processing eight parallel threads. The interrelationship among tetragnathids was fairly resolved in the analysis where the subfamilies Tetragnathinae, Leucauginae, Metainae, and Nanometinae form distinct clades. Unlike the Neighbour Joining tree, the subfamily Leucauginae forms a monophyletic clade with the genera *Leucauge*, *Tylorida* and *Mesida* in the MP analysis. Additionally, the subfamily Leucauginae also shows sister group relationship with the subfamily Nanometinae. Apart from NJ, BI, and ML analysis, the subfamily Metainae remains as distinct clade in MP tree, whereas the subfamilies such as Metainae and Nanometinae exhibit sister group relationships in all other analyses. The subfamily Nanometinae was found to be sister group with the subfamily Leucauginae with extremely low nodal support (3%) (Fig. 4.3). Above all, the topology of the Maximum Parsimony (MP) tree is almost congruent with the Bayesian Inference (BI) tree.

The software programme jModelTest provided GTR+G+I as the best-fit nucleotide substitution model under the Bayesian Information Criterion (BIC) with gamma a shape (α) parameter of 0.55 and an invariable sites (I) proportion of 0.27. The negative log likelihood (-lnL) was calculated 6597.6569 and the substitution rates among nucleotide pairs are as follows: R[AC]=1.18, R[AG]=1.53, R[AT]=1.11, R[CG]=0.96, R[CT]=2.68, R[GT]=1.00. The Bayesian Inference (BI) was performed using the software package BEAST v1.7.4, which was run for 3.83 hours. The nucleotide substitution model, the general time reversible (GTR) was preferred for the analysis with the site heterogeneity model GAMMA+Invariant

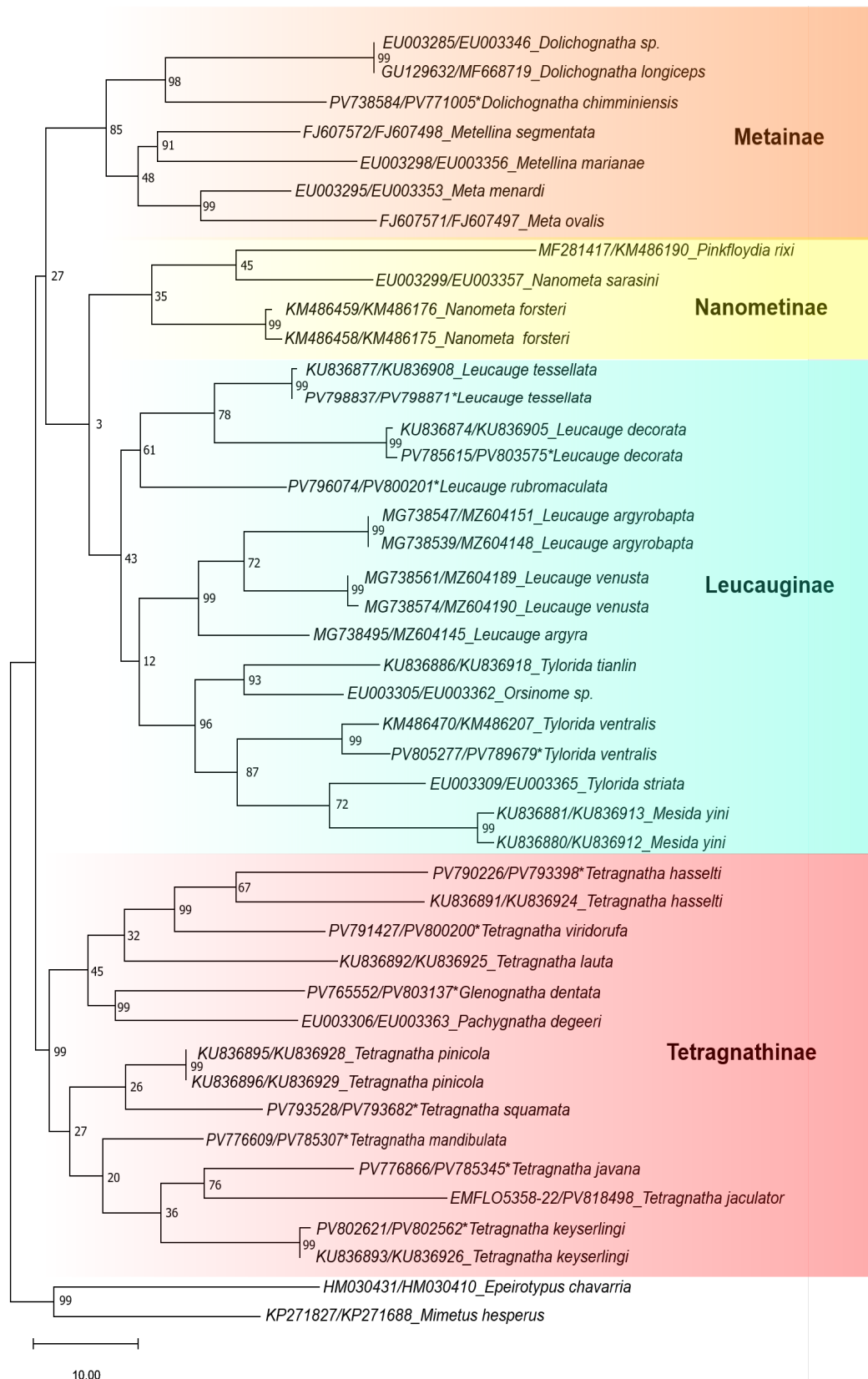


FIGURE 4.3. The most parsimonious tree using MEGA12. The values at the nodes represent bootstrap, and the subfamilies are highlighted.

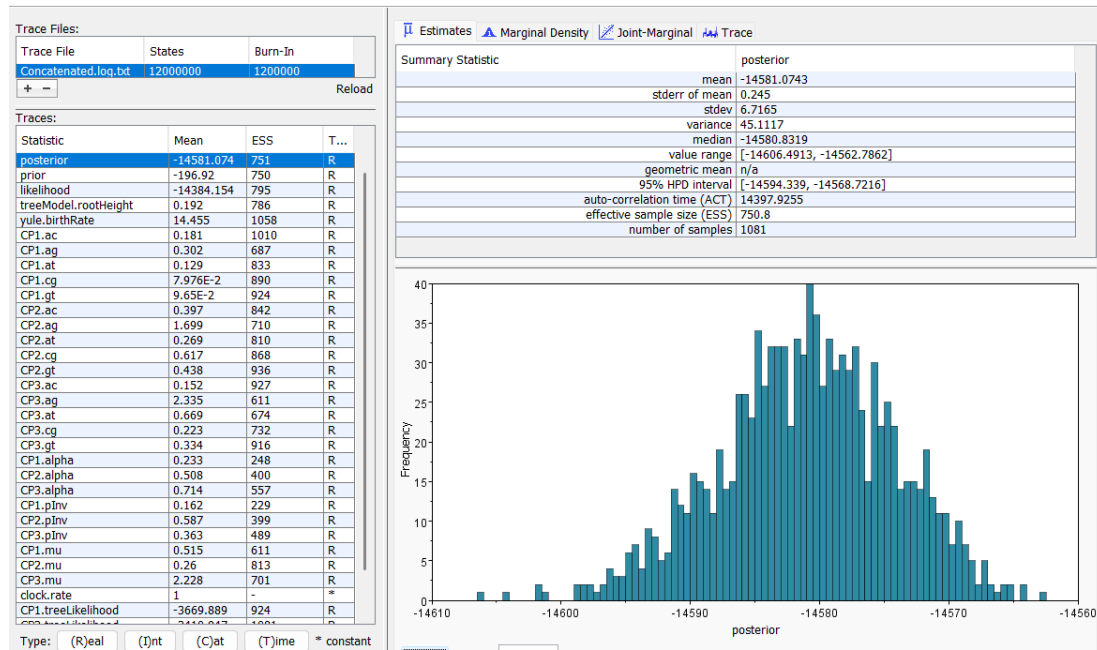


FIGURE 4.4. The output of convergence of MCMC chains by Tracer v1.7.2 with high Effective Sample Size (ESS) for all parameters.

sites. Additionally, the analysis utilizes empirical base frequencies with four Gamma categories. The nucleotide sequences were partitioned into codon positions such as three partitions, 1, 2, and 3. The strict molecular clock model was followed with a fixed clock rate of 1.0, under an assumption of uniform rates across the branches. The analysis was also performed with the tree prior, speciation: Yule Process (Yule, 1925; Gernhard, 2008), which is a pure birth process and generated a phylogenetic tree under the coalescent process random starting tree. To approximate the posterior probability distribution of the phylogenetic tree, the analysis relied on the Markov Chain Monte Carlo (MCMC) algorithm with the length of chain 12,000,000 and set an echo state to screen every 10,000 generations and log parameter interval of every 10,000. The stable posterior distribution and convergence were confirmed by Tracer v1.7.2. The high effective sample size (ESS) values (>200) were observed for all parameters with 95% HPD interval after burn-in, 12000000 (Fig. 4.4). The maximum clade credibility tree (MCCT) with mean node height was obtained from

the programme TreeAnnotator version 1.7.4 with burn-in of 1000 of the total sampled trees. The Bayesian Inference (BI) analysis resolves the interrelationships among tetragnathids at high a resolution than the NJ method and the MP approach where the subfamilies Metainae and Nanometinae show a sister group relationship and the subfamily Leucauginae forms a monophyletic group with 100% posterior probability value as the nodal support. The subfamily Tetragnathinae also forms a distinct clade with the genera *Tetragnatha*, *Pachygnatha* and *Glenognatha* and it is supported by high posterior probabilities (Fig. 4.5).

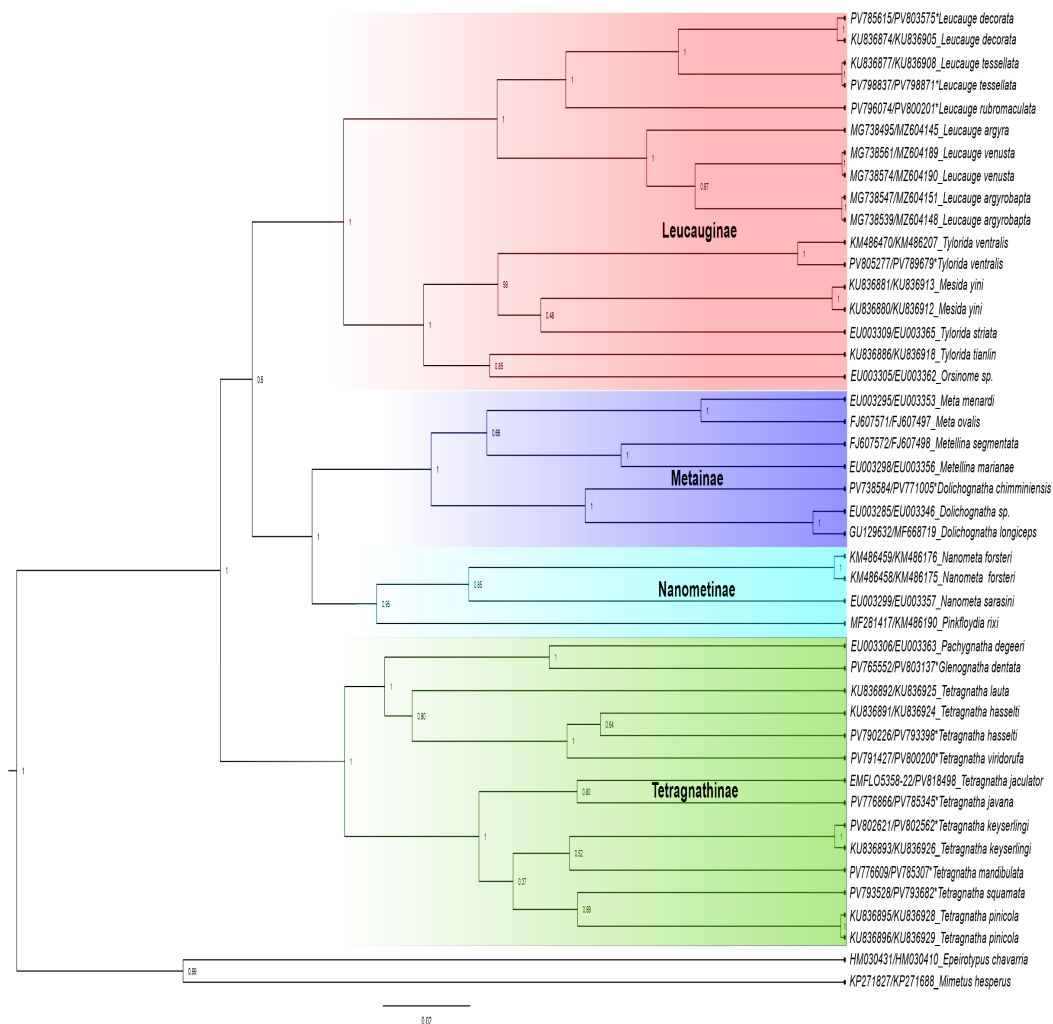


FIGURE 4.5. Inferring phylogeny of the family Tetragnathidae by Bayesian Inference (BI) using BEAST software. The values at the nodes are posterior probabilities. The subfamilies are highlighted and the taxa with asterisks represent the newly generated sequences.

The Maximum likelihood (ML) analysis was done by IQ-TREE version 3.0.1 and performed under the nucleotide substitution model GTR+GAMMA+I+R3, which was determined by the ModelFinder. The best-fit model was obtained under the Bayesian Information Criterion (BIC) with 95% confidence sets (BIC=29793.761, AIC=29267.787, AICc=29280.863, LogL=-14535.894). The model of rate heterogeneity is denoted as Invariable sites + FreeRate with 3 categories. The

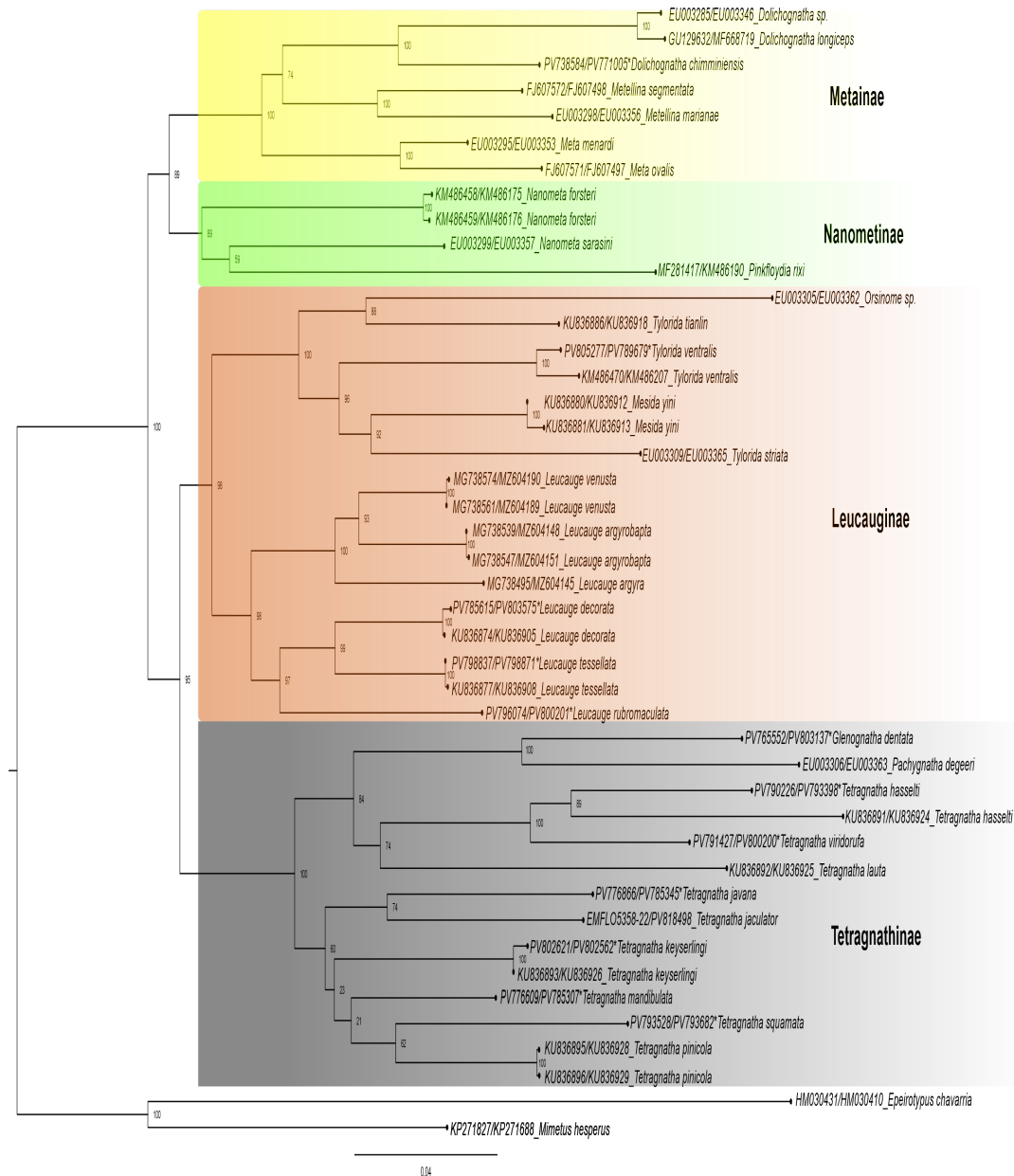


FIGURE 4.6. Phylogenetic relationship of the family Tetragnathidae by Maximum Likelihood analysis using IQ-TREE. The subfamilies are highlighted and the taxa with asterisks represent the sequences generated during the study. The values at the nodes are ultrafast bootstrap support.

proportion of invariable sites was observed as 0.5108. The relative substitution rates as follows: R(A-C): 0.5838, R(A-G): 4.8722, R(A-T): 1.7955, R(C-G): 0.7052, R(C-T): 3.2060, R(G-T): 1.0000. About 62.47% of input nucleotide sequences (1583 nucleotides) seemed to be constant sites in the dataset and the invariant sites constitute 62.47% along with 619 distinct site patterns and 451 parsimony informative sites. The stable consensus tree was constructed from 1000 bootstraps with a log-likelihood of -14535.86. Additionally, the branch lengths were optimized by maximum likelihood in the original alignment. The optimal tree shows the highest ultrafast bootstrap (UFBoot) in the major clades (>70%) which reveals the robustness of the phylogenetic tree and ultimately provides the evidence for the reliability of the interrelationship among tetragnathids. The phylogenetic relationship inferred from the ML approach is given below (Fig. 4.6). In this analysis, the subfamily Leucauginae was found to be the sister clade to the subfamily Tetragnathinae and all the subfamilies were recovered as distinct monophyletic groups.

CHAPTER 5

DISCUSSION

5. DISCUSSION

In earlier times, relying on the morphological and genitalic characteristics confounded the classification of the family Tetragnathidae and resulted in the frequent exchanges between taxa and several other taxonomic ambiguities. Even after relying on the cheliceral morphology, certain factors like inadequate descriptions, inconsistency in terminologies, and improper illustration often led to several taxonomic uncertainties. The integrated analysis of taxonomy and molecular data could deeply resolve species boundaries and the internal relationship between tetragnathids. Here we discuss the previous studies on the family Tetragnathidae that have been carried out in Kerala and the taxonomy of collected tetragnathids, as well as the internal relationships inferred from the molecular approaches.

5.1. Studies on tetragnathids in Kerala

In past decades, tetragnathids have been known from Kerala mainly through the diversity studies as well as from the documentations in the form of checklists. For instance, Sebastian et al. (2005) reported families such as Tetragnathidae and Araneidae as the dominant groups with the record of *Tetragnatha mandibulata* as the most abundant species from the irrigated rice ecosystem in Central Kerala. Likewise, in another study, tetragnathids constitute one of the dominant families among spiders which comprises 12 species under five genera from the rice ecosystem of Kuttanad (Sudhikumar et al., 2005). In a similar way, the diversity and abundance of tetragnathids were documented from the rice fields of south Kerala with the report of 11 species and *T. mandibulata* as the dominant species (Anis & Premila, 2016). In the same manner, the family Tetragnathidae was recorded as the most dominant group which constitutes 38.11% of the total spider population from

the paddy fields of Muriyad Kol wetlands (Sudhikumar & Nafin, 2018). Rajeevan et al. (2019) documented seven species which belong to the genera such as *Tetragnatha*, *Leucauge*, and *Tylorida* from the different ecosystems of the Western Ghats region of the Wayanad district.

As tetragnathids are the major composition of predators in rice ecosystems, Babu & Prasad (2022) assessed the composition as well as the habitat selection of tetragnathids from the paddy fields of Kuttanad and recorded 12 species and suggested that the habitat preferences are greatly influenced by the abundance of predators, crop seasons and microhabitats. They also recorded the family Tetragnathidae as one of the most predominant groups from the rice ecosystem in the nearby regions of the Kuttanad paddy field with a report of nine species (Babu & Prasad, 2023).

The taxonomy of the family Tetragnathidae in Kerala has been represented by relatively few scholarly works and still remains in its infancy. For instance, an exclusive taxonomic revision on a tetragnathid genus had not been done in Kerala until Sankaran et al. (2017) explicitly reviewed the genus *Tylorida* for the first time from Kerala. In addition, the study also recorded the genus *Atelidea* Simon, 1895 for the first time from India, which was collected from Ponmudi in Thiruvananthapuram district. Additionally, they transferred *Orsinome marmorea* to the genus *Tylorida* and also proposed new synonymies to *T. marmorea*. Malamel & Sebastian (2018) reassessed the taxonomic position of *Leucauge granulata* and proposed three new synonymies based on the specimens collected from the Pathiramanal island in Alappuzha district. Malamel et al. (2018) recorded the genus *Wolongia* Zhu, Kim & Song, 1997 from India for the first time and introduced a nominal species collected from the same locality.

5.2. Taxonomic remarks on the tetragnathid fauna of Kerala

The research has recorded a total of 27 tetragnathids under eight genera from the state of Kerala, which constitutes 48% of the Indian tetragnathid fauna. Of these, one species is new to the scientific world, five are new records from India, four are new records from the Western Ghats, nine are new records from Kerala, and two new synonymies, and it also include the first description of males of two species. A total of 56 tetragnathid species under 10 genera have been recorded from India to date (Caleb & Sankaran, 2025).

The new species, *Dolichognatha chimminiensis*, described during the study, represents the third record of the genus from India (Caleb & Sankaran, 2025). The new species described herein is the fourth representative of the six-eyed *Dolichognatha* species from around the world to date (Anju et al., 2024a). Tetragnathids with six eyes are not common; genera such as *Dolichognatha* and the cave-dwelling spider group, *Meta* are the only groups with six eyes (WSC, 2025). Though, the fact is that, as mentioned in the introductory part of the thesis, the selection regime that facilitates the evolution of this morphological divergence remains unelucidated (Dimitrov et al., 2010).

The genus *Tetragnatha*, the species-rich group among tetragnathids, has cosmopolitan distribution (WSC, 2025). The taxonomic identification of the genus is primarily based on cheliceral morphology rather than genitalic characters, where the haplogyne genital morphology of females and pedipalps of males actually contribute to species delimitation to a lesser extent (Murphy & Murphy, 2000). During the study, *Tetragnatha lauta*, *T. squamata*, and *T. serra* were recorded for the first time from this country and the distribution of these species is still confined to Asia,

whereas the newly recorded *T. jaculator* has been distributed across the world (Anju et al., 2024b). Until we recorded *T. cochinensis* from the nearby region of Athirappilly waterfalls in Thrissur district, the taxonomic account on this species was confined to the original description and during this study we explicitly redescribed this species after a century and provided detailed account of the cheliceral dentitions along with its genitalic morphology (Anju et al., 2021a). As the genus *Tetragnatha* is the species-rich group in this family, an exploratory survey in many more habitats may introduce many undescribed species from this state in the future.

The high-level intraspecific variations in various taxa complicate the taxonomy of the subfamily Leucauginae. For instance, during the research, variations were observed in the genital morphology among females of *L. rubromaculata* with differences in the coiling of copulatory ducts, and size and shape of spermathecae. This is the first to record the species from this country and was previously recorded only from Sri Lanka; hence, the study recorded the species for the first time in the Western Ghats and the second time in the world (Anju et al., 2025). Sankaran et al. (2017) also reported the variations in the genitalic and somatic characters in the genus *Tylorida*. The distinct intraspecific variations in the body morphology, colour pattern, and genitalic features were observed among the species *T. marmorea*. Two distinct colour morphs such as yellow and silver morphs could be found among *T. ventralis* and discrete variations could be observed in the morphology of pedipalps among the males of the same species. Even though this study transferred *T. culta* to the genus *Mesida* on the basis of previous descriptions and illustrations, the taxonomic account of the species was inadequate, and detailed photographs were

unavailable, and these could be availed through this current study (Figs. 4.1.19, 4.1.20).

Even though the distribution of *Leucauge fastigata* in the oriental region is common, as it has numerous taxonomic revisions and distribution records, the taxonomic account of the males of the same is inadequate owing to the fact that it is very difficult to find them in the field as they are small. In the present study, males of the species were recorded and it is the first record in the country (Anju et al., 2021b). The genus *Atelidea* is one of the least species-rich groups in the family Tetragnathidae with only two records, *A. spinosa* and *A. nona* and the latter species was recorded from the Ponmudi in the Thiruvananthapuram district based on male specimens (Alvarez-Padilla & Benjamin, 2011; Sankaran et al., 2017; World Spider Catalog, 2025) and the single female specimen belonging to the same genus collected during the current study could not be identified up to the species level.

New synonymies of *Tetragnatha javana* and *T. hasselti*

Examining type materials of biological specimens is inevitable in validating species identity especially in circumstances where the original description lacks proper diagnostic characters or illustrations and also proper taxonomic revisions, and most importantly, conflicting conditions related to synonymization and sexual dimorphism (Schuchert, 1897). We examined type materials of five *Tetragnatha* species such as, *T. javana*, *T. hasselti*, *T. andamanensis*, *T. cochinensis*, *T. chamberlini*, and a *Leucauge* species, *L. dorsotuberculata*. While examining the holotype of *T. chamberlini*, which was poorly diagnosed solely on the body morphology such as colour pattern, body markings, shape etc., rather than exclusive

account of the cheliceral morphology, here emphasises the significance of the existence of biological samples as type materials. Gajbe (2004), in his original description, noted the close similarity of the species to *T. javana*. Further, examining the same with the allotype of *T. javana* shows the congruence of the body morphology and cheliceral dentitions of *T. chamberlini* with *T. javana*, thereby proposing *T. chamberlini* as the junior synonym of *T. javana*.

T. andamanensis was originally described by Tikader (1977) and collected from the South Andaman, India. In the original description, the cheliceral morphology of the female specimen was briefly described with a detailed account of the morphological characters. On the other hand, the cheliceral morphology of males was completely ignored. Biswas & Raychaudhary (1996) redescribed this species but he adopted the same illustrations of Tikader, and the redescription also completely disregarded the cheliceral characteristics of males. While examining the paratype of *T. andamanensis*, the cheliceral dentition of this species exactly matches with that of *T. hasselti*. Thus, *T. andamanensis* should be considered as the junior synonym of *T. hasselti*.

5.3. Barcoding of tetragnathids

A total of 45 barcodes were generated during the study, in which CO1 barcodes constitute 21 and 24 barcodes belong to 18S and of these, 18 sequences were new entries to nucleotide databases. CO1 barcodes with high-quality sequences reveal the robustness of the primers and stand as the eligible marker for resolving deep phylogenetic signals. The BLAST search also provided the highest rate of homology for CO1 sequences during the study. Even though 18S barcodes showed a

comparably higher amplification rate in the present study, the barcode region consists of numerous ambiguous sequences which actually hinders phylogenetic signals. Besides, the GENBANK entries for 18S are comparatively few and the CO1 outperforms in the public repositories, which limit the BLAST search as well as the final dataset for the phylogenetic study. The utility of CO1 barcodes for the species delineation of tetragnathids was corroborated by Nasir (2016) and the interrelationships were inferred from the combination of CO1 and 18S gene regions. The reliability of CO1 barcodes for the identification of tetragnathids was also mentioned in several other studies (Candek & Kuntner, 2015; Coddington et al., 2016; Salgueiro-Sepulveda & Alvarez-Padilla, 2018).

To overcome contradictions in the barcodes that were generated during the present study, CO1 and 18S rRNA gene regions were concatenated to reconstruct the phylogeny of tetragnathids. Using a combination of nuclear and mitochondrial markers is common in spiders for species delimitation (Astrin et al., 2006; Lopardo & Uhl, 2014; Wang et al., 2018) and this was also recorded in tetragnathids (Nasir et al., 2023; Ballesteros & Hormiga, 2018). The barcode data generated during the current study were satisfactorily concordant with the traditional morphological characters. So, the barcode data in fact provides the authenticity to the traditional taxonomic identification and the integrative approach complements the drawbacks of each method (Sheth & Thaker, 2017).

The present study showed a distinct barcoding gap between interspecific and intraspecific distance among tetragnathids and the mean interspecific distance ranged between 4% to 9% and the maximum intraspecific distance was observed below 1%. The threshold value of mean intraspecific distance is 1.4% and the mean interspecific distance varies up to 16% (Barrett & Hebert, 2005; Ballesteros &

Hormiga, 2018) and it may vary between taxa influenced by sampling and different taxonomic approaches (Candek & Kuntner, 2015). The genetic variations in the present study reside within the threshold limit. Here we used the threshold of 3% divergence for species discrimination, which matches with the universal threshold criteria accepted for arthropods (Hebert et al., 2003a, b).

5.4. Phylogenetic relationship of the family Tetragnathidae

In the present study, the phylogeny of tetragnathids was reconstructed using the concatenated nucleotide sequences of CO1 and 18S. The interrelationships were inferred from the dataset of 44 taxa including 12 sequences generated during the research employing four different methods, such as Neighbour Joining (NJ), Maximum Parsimony (MP), Maximum Likelihood (ML), and Bayesian Inference (BI). The phylogenetic coherence of the family Tetragnathidae could be observed across the trees where the outgroups were appropriately rooted outside the ingroups. While reconstructing the phylogenies, all the taxa were perfectly grouped into four subfamilies such as Tetragnathinae, Leucauginae, Metainae, and Nanometinae. With the support of molecular evidence, previous studies also grouped tetragnathids under four subfamilies (Alvarez-Padilla et al., 2009; Hormiga & Griswold, 2014; Kallal & Hormiga, 2018; Alvarez-Padilla et al., 2020; Ballesteros & Hormiga, 2021).

The monophyly of the subfamily Tetragnathinae was conspicuously apparent across the phylogenies with the clustering of three genera such as *Tetragnatha*, *Glenognatha* and *Pachygnatha*. The genera *Pachygnatha* and *Glenognatha* were represented by a single taxon and formed sister groups in every phylogenetic approach under the highest nodal support. Morphological congruence is visible in

these taxa where both have branched canoe-shaped tapetum in lateral eyes, median tracheae, broad sperm duct, and haplogyne genitalia (Levi, 1980; Alvarez-Padilla & Hormiga, 2011). Of particular importance, this sister group relationship is consistent across various phylogenetic analyses; meanwhile, these analyses were also performed on small datasets, therefore this could be confirmed after an explicit study on these groups (Dimitrov & Hormiga, 2011; Hormiga, 2017; Kallal & Hormiga, 2018; Alvarez-Padilla et al., 2020).

The genus *Tetragnatha* represented by nine species, strictly showed paraphyly across the analysis. In all the analysis except the NJ tree, *T. hasselti*, *T. viridorufa*, and *T. lauta* formed a distinct clade along with the genera *Glenognatha* and *Pachygnatha*. Additionally, *T. pinicola*, *T. squamata*, *T. mandibulata*, *T. keyserlingi*, *T. javana* and *T. jaculator* were clubbed together throughout the attempts. Apart from this, in NJ tree, these groupings could not be found; rather, the genera formed three clusters where the genera *Glenognatha* and *Pachygnatha* were grouped with *T. lauta*. Along with this *T. keyserlingi*, *T. mandibulata* and *T. pinicola* were formed another cluster and rest of the members of the genus *Tetragnatha* were grouped together but with considerably low nodal support (<20), implying that this clustering cannot be considered as valid when the NJ tree prefers the genetic distance matrix instead of actual sequence characters. Not similar, but the clustering of the genus under the three groups can be detected in the study of Gillespie (1997) who considered the interrelationships among the members of the genus *Tetragnatha* from the Hawaiian archipelago. Meanwhile, it would be challenging to compare the interrelationship of collected *Tetragnatha* species with Hawaiian species, as these have clear distinctions from the continental species.

The sister group relationship of *T. hasselti* with *T. viridorufa* is consistent across the phylogenies and the morphological similarity of these species are obvious. Additionally, *T. javana* exhibited a close relationship with *T. jaculator* and was supported with high node confidence values (>70). In addition, the phylogenetic position of *T. squamata* is consistent with *T. pinicola* in BI, ML and MP trees whereas the NJ tree resulted in different topology where *T. squamata* exhibited a sister group relation with the cluster of *T. hasselti* and *T. viridorufa*.

The monophyly of the subfamily Leucauginae was fairly resolved in ML, BI, and MP analysis with the clustering of four genera such as *Leucauge*, *Tylorida*, *Mesida* and *Orsinome*. The genus *Leucauge* recovered as a distinct clade in BI, ML, and NJ analysis, while the genera such as *Tylorida*, *Mesida*, and *Orsinome* clustered together across the phylogenies. Even though this is contradicted in the NJ analysis showing a paraphyletic clustering where the genera *Tylorida*, *Mesida*, and *Orsinome* clustered with the lineage of Tetragnathinae, this branching cannot be accounted for, as it was supported by extremely low bootstraps (>30).

The major clade *Leucauge* herein recovered as a monophyletic group in BI and ML analysis with strong posterior probabilities (100%) and bootstraps (98%), and the NJ tree with a modest nodal confidence value (81%). The findings herein are congruent with the deduction of Ballesteros & Hormiga (2021) where they considered the possible hypothesis that traditionally the genus follows the paraphyly, and they redefined the genus after an explicit molecular phylogenetic analysis where they detected the genera *Opadometa* Archer, 1951, *Opas* Pickard-Cambridge, 1896, *Mecynometa* Simon, 1894, and *Alcimosphenus* Simon, 1895, circumscribed under the genus *Leucauge* to accomplish the goal of monophyly. Levi (1980) also

mentioned the morphological congruence of previously mentioned taxa with the genus *Leucauge*.

The monophyletic assemblage of *Leucauge* contradicted in the MP tree where *L. argyra*, *L. venusta* and *L. argyrobapta* were nested within the cluster of the genera *Tylorida*, *Mesida*, and *Orsinome* but the branching was supported by weak bootstraps (<30), so the paraphyly cannot be taken into account as the genus forms a distinct clade in the rest of the analyses with maximum node confidence. Even so, a stable sister group relation could be observed between *L. tessellata* with *L. decorata* and between *L. venusta* and *L. argyrobapta* across the phylogenetic analysis.

The branching pattern of *L. rubromaculata* was stable throughout the analysis, where it clearly branched out before the clade of *L. tessellata* and *L. decorata* and showed a consistent sister group relationship with these groups across the phylogenies. The American endemic species included in the analysis such as *L. vensusta* and *L. argyra* were always clubbed together with *L. argyrobapta* across the phylogenetic analyses. The morphological congruence between these species is obvious. This close relationship between the taxa could also be found in various phylogenetic analyses. Since most of the members of the genus were undescribed and poorly diagnosed based on a single sex, many taxa remain to be tested (Ballesteros & Hormiga, 2021).

The genus *Tylorida* exists as a nonmonophyletic clade throughout the analyses, actually agreeing with the observation of Ballesteros & Hormiga (2021), and apart from this, the phylogenetic position of the same could not be confirmed from the previous studies as it was poorly represented by a single taxon (Alvarez-Padilla et al., 2009; Kallal & Hormiga, 2018; Alvarez-Padilla et al., 2020). The genus *Tylorida*

disclosed the sister group relation with the genera *Orsinome* and *Mesida* across the phylogenetic approaches, and this has been represented in the prior studies (Dimitrov & Hormiga, 2011; Dimitrov et al., 2017).

Mesida yini, the only representative taxon of the genus *Mesida* herein, is closely related to *T. striata* and the relationship was stable throughout the analyses, though the phylogenetic placement of the genus is yet to be established. Ballesteros & Hormiga (2021) put forward that, as the genus has 14 representatives, exploring additional taxa could resolve the exact position of the genus; probably some of the members may reside within the clade of *Leucauge*. The morphological congruence is obvious among *Mesida* and *Tylorida* as they have silvery markings on the abdomen with distinct sexual size dimorphism, though the *Mesida* species can be discriminated by the presence of a prominent median spur on the male chelicerae (Ballesteros & Hormiga, 2021).

The genus *Orsinome* also represented herein by single taxon, limits the understanding of deep phylogenetic relationships of the same, though the phylogenetic placement within the subfamily Leucauginae was well supported throughout the phylogenetic approaches. This is conflicted in the recommendation of Alvarez-Padilla et al. (2009), where they placed *O. sarasini* under the Nanometinae. Kallal & Hormiga (2018) refuted this classification with the support of multiloci phylogenetic analysis. While revising the subfamily Leucauginae with broad sampling data, the members of the genus were retained within the subfamily Leucauginae (Ballesteros & Hormiga, 2021). Thus, this study also agrees with the placement of the genus within the subfamily Leucauginae with the modest phylogenetic evidence, but a revisionary approach could resolve the deep phylogeny of the same.

The genera *Dolichognatha*, *Meta* and *Metellina* constitute the subfamily Metainae. In prior studies, the composition of the subfamily was always inconsistent. Alvarez-Padilla et al. (2009) proposed, the subfamily constitutes *Metellina*, *Dolichognatha*, and *Chrysometa*. This composition was contradictory to the phylogenetic placement by Dimitrov & Hormiga (2011), Alvarez-Padilla & Hormiga (2011), Kallal & Hormiga (2018) and Alvarez-Padilla et al. (2020) where they excepted the genus *Chrysometa*, and Kallal & Hormiga (2018) also proposed the genus *Chrysometa* is more related to Nanometinae. Herein, the subfamily formed a monophyletic clade in all the phylogenetic analyses under high nodal support. The monophyly of the subfamily was also evident in the recent studies with strong branch support (Hormiga, 2017; Kallal & Hormiga, 2018; Alvarez-Padilla et al., 2020).

The new species, *Dolichognatha chimminiensis*, described during the current research, formed a monophyletic clade with *Dolichognatha* sp. and *D. longiceps* across the phylogenetic analysis with high nodal support. In all the analysis, the new species described herein diverged before the rest of the *Dolichognatha* species. Dimitrov et al. (2010) synonymised the genus *Atimiosa* with *Dolichognatha* to be rendered as monotypic. In the present analysis, the genus *Dolichognatha* is sister to *Meta*+*Metellina* clade in all the cases except in ML tree where it showed a close relationship with *Metellina* than to *Meta*. The sister group relationship varies across different studies; however, the affinity of the genus with *Metellina* is also supported by the findings of Dimitrov et al. (2010) based on the morphological data. Aside from this, molecular evidences suggest that the genus is either sister to recently described genus *Zhinu* or *Zhinu*+*Metellina* clade (Kallal & Hormiga, 2018). Though the recently described genus was not circumscribed in our analysis, thus, the sister group relationship of the genus *Dolichognatha* remains unclear.

The genera *Meta* and *Metellina* were represented by two taxa, where they formed distinct monophyletic groups and recovered sister group relationships with each other across the phylogenies under modest node confidence, except in the ML tree where the genus *Metellina* showed a close relationship with *Dolichognatha* and the *Meta* formed a distinct group and exhibited a sister group relationship with all other Metaines under maximum ultrafast bootstraps. The sister group relationship of *Meta* with all other Metaines are also evident in various multigene phylogenetic analyses (Dimitrov et al., 2017; Kallal & Hormiga, 2018).

The genus *Meta* remains as unrevised where many of the metaines and metaine-like tetragnathids were tentatively placed within the genus without proper taxonomic description (Kallal & Hormiga, 2018). Even so, the close relationship between *Meta menardi* and *M. ovalis* and also between *Metellina segmentata* and *M. marianae* is highly supported in all the analysis with maximum node confidence values.

The subfamily Nanometinae recovered a sister lineage relation with Metainae in the BI, ML and NJ trees whereas in the MP tree, it was closely related to Leucauginae but it was weakly supported by bootstraps as well. These were contradicted in the findings of Alvarez-Padilla et al. (2020) where the subfamily is most related to the cluster of taxa (*Taraire*, *Tawhai*, *Allende*, *Chrysometa*, *Metleucauge*) which were not received subfamily designation. This implies that extensive sampling data could fairly resolve the internal relationship between these taxa. Apart from this, the monophyly of the subfamily was well supported in all the analyses and this is also confirmed by Kallal & Hormiga (2018) and Alvarez-Padilla et al. (2020). The presence of synapomorphy like stridulatory organ in males also supports the monophyly of the subfamily, though such organs are absent in the book lungs of recently introduced genus *Pinkfloydia* (Hormiga, 2017).

The genera *Nanometa* and *Pinkfloydia* are sister lineages, and the relationship was consistent throughout the phylogenetic approaches. The phylogenetic position of *P. rixi*, the only representative taxon of the Australian-exclusive genus *Pinkfloydia* was unresolved and the relationship with other taxa was unstable owing to the poor taxon representation of this subfamily in this analysis.

The phylogeny of the genus *Nanometa* was dubious in the analysis due to the insufficient taxon representations. Nevertheless, the BI tree offers a cue for the possibility of the genus *Nanometa* to be monophyletic with decent ultrafast bootstraps. The explicit phylogenetic analysis of Nanometinae corroborates the previous remarks with broad sampling data where *Nanometa* species clubbed together and the monotypic genus *Pinkfloydia* diverged before the *Nanometa* clade (Kallal & Hormiga, 2018; Alvarez-Padilla et al., 2020).

Overall, in all the phylogenetic analysis, the family Tetragnathidae revived as monophyletic group and the grouping was stable under various phylogenetic approaches. The higher-level phylogenetic analyses exploring multiple loci, including nuclear and mitochondrial genes also consistently reveal the monophyletic assemblage of the family within the araneoid lineage (Alvarez-Padilla et al., 2009; Dimitrov et al., 2017; Hormiga, 2017; Kallal & Hormiga, 2018; Alvarez-Padilla et al., 2020; Ballesteros & Hormiga, 2021). Nevertheless, the expanded sampling data could unequivocally complement missing gaps in the phylogenetic information and the deep interrelationship between tetragnathids.

Since the taxonomy and molecular phylogeny of Tetragnathidae in Kerala has not been previously documented, this analysis prevails as the preliminary study for understanding species boundaries and evolutionary relationships between

tetragnathids and it can effectively be used for further investigations. Overall, the integrative approach effectively curtails taxonomic ambiguities and concurrently resolve the complex evolutionary relationship between taxa. Molecular data contributes to validating species boundaries, actually augmenting the reliability of existing traditional taxonomic frameworks. Most notably, the multilocus analysis of a broader dataset, including sequence data of nuclear and mitochondrial genes from various biogeographical regions would be essential to enhance phylogenetic resolution.

CHAPTER 6

SUMMARY AND CONCLUSION

6. SUMMARY AND CONCLUSION

The present study is the first to systematically investigate the taxonomy and molecular phylogeny of long-jawed spiders (Family: Tetragnathidae) in Kerala with the purpose of delimiting species boundaries and understanding interrelationships between them. A meticulous sampling was employed for a period of two years and five months (August 2021-January 2024) in various habitats of 14 districts of Kerala state. An exploratory survey was carried out in a total of 80 localities in Kerala state, explicitly searching for samples by hand, sweep net or beating method. Multiple individuals were collected and preserved in 70% ethanol, and 3-5 samples were stored in absolute ethanol for molecular analysis and these were diligently examined, photographed, diagnosed and described along with taxonomic keys and illustrations, morphometric characters were recorded and the distributions were also mapped. Type materials were deposited at the reference collection at the Centre for Animal Taxonomy and Ecology (CATE), Department of Zoology, Christ College (Autonomous), Irinjalakuda, Kerala, India, and the National Zoological Collections at the Zoological Survey of India, Western Ghat Regional Centre (WGRC), Kozhikode, Kerala.

The new species *Dolichognatha chimminiensis*, from Chimmini Wildlife Sanctuary, part of the Western Ghats, described during the research, has atypical morphology with six eyes and designated male as holotype and female as paratype. Since tetragnathids with six eyes are rare, the new species represents the third of six-eyed *Dolichognatha* species. As Kerala state has exceptional biodiversity, especially rich spider fauna, four tetragnathids documented during the research were endemic to India, such as *Tetragnatha cochinensis*, *T. viridorufa*, *Tylorida flava*, and *Atelidea*

sp. The type genus *Tetragnatha* has been cosmopolitically distributed and four *Tetragnatha* species as well as a *Leucauge* species were recorded for the first time from India and are given below:

- ❖ *Tetragnatha lauta*
- ❖ *Tetragnatha squamata*
- ❖ *Tetragnatha serra*
- ❖ *Tetragnatha jaculator*
- ❖ *Leucauge rubromaculata*

A total of 27 tetragnathid species under eight genera have been documented which account for 48% of the tetragnathid fauna present in our country. Since in India, 36% of the subfamily Leucauginae were described solely on a single sex, reassessing these taxa is particularly necessary; hence, males of *Leucauge fastigata* and *Tylorida flava* were recorded for the first time in India and this is the first to describe the latter species with an exhaustive account of its body morphology including genitalic characteristics. Additionally, the type material status of *L. dorsotuberculata* was updated with notes on the holotype and paratype of the species which were deposited at the reference collection of NZC-ZSI, Kolkata. Along with this, *Tetragnatha chamberlini* was synonymized with *T. javana* and *T. andamanensis* was designated as a junior synonym of *T. hasselti* and these were proposed after a meticulous examination of type materials sourced from designated museums around the world. The suboptimal morphological characterization of tetragnathids has led to misidentification and many other taxonomic discrepancies and this has been complemented by revising the description with a substantial account of the morphological characters particularly cheliceral dentitions. Likewise, *T. cohinensis*, *T. geniculata*, and *T. serra* were rigorously redescribed.

Barcode data generated during the study were perfectly congruent with the species identification employed by traditional taxonomic approaches. The partial sequences of mitochondrial protein coding marker CO1 (~600 bp) and nuclear gene marker 18S (~700 bp) were amplified and a total of 45 barcodes were generated from which 18 are new entries to nucleotide databases. The utility of the CO1 barcode for establishing species boundaries has been well substantiated, and the combined dataset efficiently elucidated the deep evolutionary relationship between tetragnathids.

In phylogenetic analysis, the concatenated nucleotide sequences of CO1 and 18S fairly resolved the evolutionary relationship between tetragnathids. The phylogeny was composed 44 terminals including 12 sequences which were generated during the research and 32 sequences retrieved from the public nucleotide repositories like GenBank and BOLD databases. Different phylogenetic approaches like Neighbour Joining (NJ), Maximum Parsimony (MP), Bayesian Inference (BI) and Maximum Likelihood (ML) analyses grouped tetragnathids into four subfamilies such as Tetragnathinae, Leucauginae, Metainae, and Nanometinae. The NJ and MP analyses were employed by the software programme MEGA v12 after generating high-quality sequences by BioEdit v7.2.5. BI analysis was performed by the sophisticated software package BEAST v1.7.4 under GTR+G+I as the best-fit nucleotide substitution model and the optimal ML tree was yielded by means of IQ-TREE v3.0.1.

The monophyly of the family Tetragnathidae was evident across the analyses where two outgroups were properly rooted outside the ingroups. The monophyletic assemblage of the subfamily Tetragnathinae was consistent, though the type genus *Tetragnatha* strictly followed a paraphyly, but an explicit molecular revision has not

yet been explored in this group to date, a comprehensive analysis with a broader dataset can elucidate the deep interrelationship of the same. Except in NJ, the monophyly of Leucauginae was fairly recovered throughout the analyses under high nodal support whereas the NJ tree rendered a different topology but was weakly supported. The newly described *Dolichognatha chimminiensis* clustered with all other *Dolichognatha* species and was recovered as a monophyletic assemblage within the Metainae. The genera *Nanometa* and *Pinkfloydia*, the only circumscribed genera under Nanometinae recovered a close relationship across the phylogenies.

Since the traditional taxonomic approaches limit the species delineation in certain circumstances, DNA barcodes can effectively complement the conventional taxonomic methods and the integrative framework facilitates the understanding of deep evolutionary relationships. Therefore, this study is relevant when the taxonomy of tetragnathids in Kerala is profoundly inadequate and it serves as the preliminary study and can effectively be used as a reference for future research expeditions. Moreover, Kerala is well known for rich flora and fauna occupying regions of Western Ghats, many tetragnathids yet to be discovered. Of utmost relevance, tetragnathids are potential predators in various ecosystems particularly in agricultural ecosystems; the understanding of tetragnathid fauna would significantly contribute to establishment of various conservation strategies in the future.

CHAPTER 7

RECOMMENDATIONS

7. RECOMMENDATIONS

The outcome of the present study gives fundamental knowledge on the taxonomic status of tetragnathid fauna of Kerala with a robust account of its evolutionary relationships, though the limitations and knowledge gaps still persist and actually pave the way for further investigations. To advance the current findings which were accomplished through the study, certain recommendations are outlined here intended to optimize methodological approaches and advance the overall understanding of evolutionary patterns.

- ❖ Examining the type materials and availing the remarks of the same could verify the validity of many poorly described species especially members of the subfamily Leucauginae, whose taxonomic status has not yet been updated after the original description.
- ❖ Since the majority of the tetragnathids inhabit watery areas, an exploratory survey focusing on habitat types like rivers, streams and wetland areas would lead to the uncovering of many more undescribed species.
- ❖ As leucaugines exhibit altitudinal variations, sampling from different elevational gradient would give an understanding of morphological variation among species occurring in different elevational ranges.
- ❖ The web building behaviour of Tetragnathidae can be monitored across different groups owing to the fact that members of the family were previously recognised as model organisms for assessing patterns of web architecture.

- ❖ Multi-loci approaches can overcome limitations formulated from exploring limited gene markers and the multigene analysis enhances the phylogenetic resolution.
- ❖ Phylogenetic analysis with a broad dataset including nuclear and mitochondrial sequences from various biogeographic regions would augment the accuracy of evolutionary patterns and would give a comprehensive representation of genetic diversity.
- ❖ This study also suggests the comprehensive revision of the subfamily Tetragnathinae and especially an exhaustive study on the type genus *Tetragnatha* and the collaborative data from different parts of the world would give the phylogenetic coherence of the genus.
- ❖ Even though the information about the fossil record of the family Tetragnathidae is scarce, the estimation of molecular divergence of the family could be possible through external calibration points and the reliable outcome of phylogenomic analysis of the superfamily Aranoidea can effectively be used for inferring time calibrated evolutionary pattern.

REFERENCES

REFERENCES

- Adobe Inc. (2020). *Adobe Photoshop (Version 2020)*. [Computer software]. <https://www.adobe.com/photoshop>
- Agnarsson, I., Coddington, J. A. & Kuntner, M. (2013). *Systematics: progress in the study of spider diversity and evolution*. Spider research in the 21st century: trends and perspectives, pp. 58–111. <http://hdl.handle.net/10088/22574>
- Alvarez–Padilla, F. (2007). Systematics of the spider genus *Metabus* OP–Cambridge, 1899 (Araneoidea: Tetragnathidae) with additions to the tetragnathid fauna of Chile and comments on the phylogeny of Tetragnathidae. *Zoological Journal of the Linnean Society*, 151(2), 285–335. <https://doi.org/10.1111/j.1096-3642.2007.00304.x>
- Álvarez–Padilla, A., Kallal, R. J. & Hormiga, G. (2020). Taxonomy and phylogenetics of Nanometinae and other Australasian orb–weaving spiders (Araneae: Tetragnathidae). *Bulletin of the American Museum of Natural History*, 438, 1–107. doi:10.1206/0003–0090.438.1.1
- Alvarez–Padilla, F. & Benjamin, S. P. (2011). Phylogenetic placement and redescription of the spider genus *Atelidea* Simon, 1895 (Araneae, Tetragnathidae). *Zootaxa*, 2761(1), 51–63. doi:10.11646/zootaxa.2761.1.4
- Alvarez–Padilla, F. & Hormiga, G. (2011). Morphological and phylogenetic atlas of the orb–weaving spider family Tetragnathidae (Araneae: Araneoidea). *Zoological Journal of the Linnean Society*, 162(4), 713–879. doi:10.1111/j.1096-3642.2011.00692.x
- Alvarez–Padilla, F. (2008). Higher level systematics of the spider family Tetragnathidae and revision of the genus *Metabus* (Araneae). The George Washington University. ProQuest Dissertations & Theses, pp. 1–710.
- Álvarez–Padilla, F., Dimitrov, D., Giribet, G. & Hormiga, G. (2009). Phylogenetic relationships of the spider family Tetragnathidae (Araneae, Araneoidea) based on morphological and DNA sequence data. *Cladistics*, 25(2), 109–146. doi:10.1111/j.1096-0031.2008.00242.x
- Anis Joseph, R. & Premila, K. S. (2016). Species composition and quantitative analysis of Tetragnathid spiders, Tetragnathidae (Araneae) in rice fields. *International Journal of Fauna and Biological Studies*, 3(3), 158–160.
- Anju, K. B., Bhagirathan, U. & Sudhikumar, A. V. (2021a). Redescription of *Tetragnatha cochinchensis* (Araneae: Tetragnathidae) after a century in India. *Serket*, 18(1), 85–90.
- Anju, K. B., Bhagirathan, U. & Sudhikumar, A. V. (2021b). Redescription of *Leucauge fastigata* (Simon, 1877) (Araneae: Tetragnathidae) with first report of male from India. *Serket*, 18(2), 161–166.

- Anju, K. B. & Sudhikumar, A. V. (2023). First description of male long-jawed orb-weaver spider (*Tylorida flava*). *Taprobanica*, 12(1), 24–25, pl. 13–14. doi:10.47605/tapro.v12i1.298
- Anju, K. B., Asha, T. J. & Sudhikumar, A. V. (2024a). A new six-eyed species of *Dolichognatha* O. Pickard Cambridge, 1869 from India (Araneae, Tetragnathidae). *Zootaxa*, 5523(1), 146–150. doi:10.11646/zootaxa.5523.1.10
- Anju, K. B., Sen, S., Asha, T. J., Sudhin, P. P., Sudhikumar, A. V. & Castanheira, P. de S. (2024b). Taxonomic notes and new records of *Tetragnatha* (Araneae: Tetragnathidae) in India, with the redescription of three species. *Arachnology*, 19(7), 988–997. doi:10.13156/arac.2024.19.7.988
- Anju, K. B., Bhagirathan, U. & Sudhikumar, A. V. (2024c). First record of long-jawed spider *Tetragnatha squamata* Karsch, 1879 (Araneae: Tetragnathidae) from India. *Records of the Zoological Survey of India*, 124(2), 131–137. doi:10.26515/rzsi/v124/i2/2024/168214
- Anju, K. B., Sen, S., Sudhin, P. P. & Sudhikumar, A. V. (2025). First Record of *Leucauge rubromaculata* Benjamin, 2024 (Araneae, Tetragnathidae) from India. *National Academy Science Letters*, 1–5. <https://doi.org/10.1007/s40009-025-01645-y>
- Astrin, J. J., Huber, B. A., Misof, B., & Kluetsch, C. F. (2006). Molecular taxonomy in pholcid spiders (Pholcidae, Araneae): evaluation of species identification methods using CO1 and 16S rRNA. *Zoologica Scripta*, 35(5), 441–457. <https://doi.org/10.1111/j.1463-6409.2006.00239.x>
- Babu, N., & Prasad, G. (2022). Species diversity and vertical stratification of spiders of the family Tetragnathidae Menge, 1866 (Araneae) in different paddy farming practises at Kuttanad, Kerala, India. *Entomon*, 47(3), 323–328.
- Babu, N., & Prasad, G. (2023). Spider richness in Kuttanad, a major low-lying rice agroecosystem in Central Kerala, India. *Records of the Zoological Survey of India*, 123 (iS2), 535–542.
- Ballesteros, J. A. & Hormiga, G. (2018). Species delimitation of the North American orchard-spider *Leucauge venusta* (Walckenaer, 1841) (Araneae, Tetragnathidae). *Molecular Phylogenetics and Evolution*, 121, 183–197. <https://doi.org/10.1016/j.ympev.2018.01.002>
- Ballesteros, J. A. & Hormiga, G. (2021). Molecular phylogeny of the orb-weaving spider genus *Leucauge* and the intergeneric relationships of Leucauginae (Araneae, Tetragnathidae). *Invertebrate Systematics*, 35(8), 922–939. <https://doi.org/10.1071/IS21029>
- Barrett, R. D. & Hebert, P. D. (2005). Identifying spiders through DNA barcodes. *Canadian Journal of Zoology*, 83(3), 481–491. <https://doi.org/10.1139/z05-024>

- Barrion, A. T. & Litsinger, J. A. (1995). *Riceland spiders of South and Southeast Asia*. CAB International, Wallingford, UK, pp. 700.
- Barrion, A. T., Barrion-Dupo, A. L. A., Catindig, J. L. A., Villareal M., O., Cai, D., Yuan, Q. H. & Heong, K. L. (2013). New species of spiders (Araneae) from Hainan Island, China. *UPLB Museum Publications in Natural History*, 3, 1–103. doi:10.5281/zenodo.269136
- Barrion–Dupo, A. L. A. & Barrion, A. T. (2014). First record of genus *Prolochus* Thorell, 1895 (Araneae: Tetragnathidae) from the Philippines, with description of a new species from Mt. Makiling Forest Reserve, Laguna. *Philippine Entomologist*, 28(2), 194–201.
- Basu, D. & Raychaudhuri, D. (2016). Rice Land inhabiting Long Jawed Orb Weavers, *Tetragnatha* Latreille, 1804 (Tetragnathidae: Araneae) of South 24–Parganas, West Bengal, India. *World Scientific News*, 55, 210–239.
- Benjamin, S. P. (2024). Tetragnathid spiders from Sri Lanka: description of two new species (Araneae: Tetragnathidae). *ZooNova*, 35, 1–11. doi:10.5281/zenodo.13484738
- Benson, D. A., Boguski, M. S., Lipman, D. J., Ostell, J., Ouellette, B. F., Rapp, B. A. & Wheeler, D. L. (1999). GenBank. *Nucleic Acids Research*, 27(1), 12.
- Bianchini, G., & Baracaldo, S. P. (2024). TreeViewer: Flexible, modular software to visualise and manipulate phylogenetic trees. *Ecology and Evolution*, 14(2), 10873. 1–16. <https://doi.org/10.1002/ece3.10873>
- Bio–Rad Laboratories. (n.d.). *Bio–Rad DNA Barcode Generator* [Software]. <http://www.bio–rad.com/>
- Biswas, V. & Raychaudhuri, D. (1996). Tetragnathid spiders of Bangladesh (Araneae: Tetragnathidae). *Annals of Entomology, Dehradun*, 14, 45–59.
- Blackledge, T. A., Scharff, N., Coddington, J. A., Szűts, T., Wenzel, J. W., Hayashi, C. Y. & Agnarsson, I. (2009). Reconstructing web evolution and spider diversification in the molecular era. *Proceedings of the National Academy of Sciences*, 106(13), 5229–5234. <https://doi.org/10.1073/pnas.0901377106>
- Blagoev, G., Hebert, P., Adamowicz, S. & Robinson, E. (2009). Prospects for using DNA barcoding to identify spiders in species-rich genera. *ZooKeys*, 16, 27–46. doi: 10.3897/zookeys.16.239
- Bodkhe, A. K. & Manthen, S. V. (2015). A new species of the genus *Dolichognatha* O. P. Cambridge, 1869 (Araneae: Tetragnathidae) from India. *Indian Journal of Arachnology*, 4(1), 26–29.
- Bösenberg, W. & Strand, E. (1906). Japanische Spinnen. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 30, 93–422.
- Brescovit, A. D. & Cunha, F. de S. (2001). Four new species of *Dolichognatha* Pickard–Cambridge, 1869 from Brazil and description of

- the female of *D. maturaca* Lise, 1993 (Araneae: Tetragnathidae). *Bulletin of the British Arachnological Society*, 12, 97–104.
- Brescovit, A. D., Rodrigues, E. N. L., Álvarez-Padilla, F. & Ott, R. (2025). Taxonomic revision of the spider genus *Azilia* Keyserling, 1881 (Araneae: Tetragnathidae). *Megataxa*, 18(1), 188–261. doi:10.11646/megataxa.18.1.2
- Bristowe, W. S. (1958). *The world of spiders*. The New Naturalist, Collins, pp. 1–304.
- Bryant, E. B. (1940). Cuban spiders in the Museum of Comparative Zoology. *Bulletin of the Museum of Comparative Zoology*, 86, 247–532.
- Cabra-García, J. & Brescovit, A. D. (2016). Revision and phylogenetic analysis of the orb-weaving spider genus *Glenognatha* Simon, 1887 (Araneae, Tetragnathidae). *Zootaxa*, 4069(1), 1–183. doi: 10.11646/zootaxa.4069.1.1
- Cabra-García, J., Hormiga, G. & Brescovit, A. D. (2014). Female genital morphology in the secondarily haplogyne spider genus *Glenognatha* Simon, 1887 (Araneae, Tetragnathidae), with comments on its phylogenetic significance. *Journal of Morphology*, 275(9), 1027–1040. <https://doi.org/10.1002/jmor.20280>
- Caleb, J. T. D., Ghosh, D. & Kumar, V. (2018). On two new synonyms of the orb-weaving spider *Orsinome vethi* (Hasselt, 1882) (Araneae, Tetragnathidae). *Zootaxa*, 4444(3), 342–346. doi:10.11646/zootaxa.4444.3.9
- Caleb, J.T.D. & Sankaran, P.M. (2025). Araneae of India. Version 2025, online at <http://www.indianspiders.in> (accessed on 09 December, 2025).
- Candek, K., & Kuntner, M. (2015). DNA barcoding gap: reliable species identification over morphological and geographical scales. *Molecular Ecology Resources*, 15(2), 268–277. <https://doi.org/10.1111/1755-0998.12304>
- Cardona-Rivera, G. A. & Cotoras, D. D. (2021). Differences in web structure of *Tetragnatha tenuissima* (Araneae: Tetragnathidae) due to environmental conditions. *Arachnology*, 18(8), 953–957. <https://doi.org/10.13156/arac.2021.18.8.953>
- Castanheira, de Souza P., Baptista, R. L. C., Pizzetti, D. D. P., & Teixeira, R. A. (2019). Contributions to the taxonomy of the long-jawed orb-weaving spider genus *Tetragnatha* (Araneae, Tetragnathidae) in the Neotropical region, with comments on the morphology of the chelicerae. *Zoosystematics and Evolution*, 95(2), 465–505.
- Castanheira, P. de S. & Baptista, R. L. C. (2020). Notes on slender species of the long-jawed spider genus *Tetragnatha* (Araneae, Tetragnathidae) with description of three new species. *Zootaxa*, 4768(1), 43–75. doi:10.11646/zootaxa.4768.1.4

- Castanheira, P. de S. & Baptista, R. L. C. (2021a). Redescription of *Tetragnatha guatemalensis*, *T. laboriosa* and *T. jaculator*, with new synonymies of genus *Tetragnatha* (Araneae: Tetragnathidae) in the Neotropical region. *Journal of Natural History*, 54(47–48), 3031–3057. doi:10.1080/00222933.2021.1890252
- Castanheira, P. de S. & Baptista, R. L. C. (2021b). Tailed species of the orb-weaving spider genus *Tetragnatha* (Araneae: Tetragnathidae) in the Neotropical region. *Arachnology*, 18(7), 649–655. doi:10.13156/arac.2020.18.7.649
- Castanheira, P. de S., Baptista, R. L. C. & Oliveira, F. S. M. (2022). Five new species of the long-jawed orb-weaving spider genus *Tetragnatha* (Araneae, Tetragnathidae) in South America, with a key to the species from Argentina and Brazil. *Evolutionary Systematics*, 6(2), 175–210. doi:10.3897/evolsyst.6.91418
- Ceccolini, F. & Cianferoni, F. (2022). Nomenclatural changes for two spider genera as a consequence of homonymy (Arachnida: Araneae). *Arachnology*, 19(1), 14–15. doi:10.13156/arac.2022.19.1.14
- Champion, H. G. & Seth, S. K. (1968). *A revised survey of the forest types of India*. Government of India Press. pp. 62.
- Chen, S. H. (1997). Two newly recorded spiders of the genera *Tetragnatha* and *Leucauge* (Araneae: Tetragnathidae) in Taiwan. *Biological Bulletin of the National Taiwan Normal University*, 31, 113–118.
- Chickering, A. M. (1957a). Notes on certain species of *Tetragnatha* (Araneae, Argiopidae) in Central America and Mexico. *Breviora Mus. Comp. Zool.*, 67, 1–4.
- Chickering, A. M. (1957b). The genus *Tetragnatha* (Araneae, Argiopidae) in Panama. *Bull. Mus. Comp. Zool.*, 116, 301–354.
- Chikuni, Y. (1989). *Pictorial encyclopedia of spiders in Japan*. Kaisei-sha Publishing Co., Tokyo, pp. 310.
- Churchill, T. B. & Arthur, J. M. (1999). Measuring spider richness: effects of different sampling methods and spatial and temporal scales. *Journal of Insect Conservation*, 3(4), 287–295.
- Coddington J.A. & Levi, H.W. (1991). Systematics and evolution of spiders (Araneae). *Annu Rev Ecol Syst*, 22, 565–592. <https://www.jstor.org/stable/i310052>
- Coddington J. A., Agnarsson I., Cheng R., Čandek K., Driskell A., Frick H., Gregorič M., Kostanjšek R., Kropf C., Kweskin M., Lokovšek T., Pipan M., Vidregar N. & Kuntner M. (2016). DNA barcode data accurately assign higher spider taxa. *PeerJ* 4:e2201 <https://doi.org/10.7717/peerj.2201>

- Coddington, J. A. (1990). Ontogeny and homology in the male palpus of orb-weaving spiders and their relatives, with comments on phylogeny (Araneoclada: Araneoidea, Deinopoidea). *Smithsonian Contributions to Zoology*, 496, 1–52.
- Coddington, J. A. (2005). *Phylogeny and classification of spiders. Spiders of North America: an identification manual*. American Arachnological Society, pp. 18–24.
- Coddington, J. A., Young, L. H., & Coyle, F. A. (1996). Estimating spider species richness in a southern Appalachian cove hardwood forest. *Journal of Arachnology*, 111–128. <https://www.jstor.org/stable/3705945>
- Cunningham, C. W., Zhu, H., & Hillis, D. M. (1998). Best-fit maximum-likelihood models for phylogenetic inference: empirical tests with known phylogenies. *Evolution*, 52(4), 978–987. <https://doi.org/10.1111/j.1558-5646.1998.tb01827.x>
- Diaz, J. H. (2004). The global epidemiology, syndromic classification, management, and prevention of spider bites. *The American Journal of Tropical Medicine and Hygiene*, 71(2), 239–250.
- Dimitrov, D. & Hormiga, G. (2009). Revision and cladistic analysis of the orb weaving spider genus *Cyrtognatha* Keyserling, 1881 (Araneae, Tetragnathidae). *Bulletin of the American Museum of Natural History*, 2009(317), 1–140. doi: <https://doi.org/10.1206/317.1>
- Dimitrov, D. & Hormiga, G. (2011). An extraordinary new genus of spiders from Western Australia with an expanded hypothesis on the phylogeny of Tetragnathidae (Araneae). *Zoological Journal of the Linnean Society*, 161(4), 735–768. doi: <https://doi.org/10.1111/j.1096-3642.2010.00662.x>
- Dimitrov, D., Álvarez-Padilla, F. & Hormiga, G. (2007). The female genital morphology of the orb weaving spider genus *Agriognatha* (Araneae, Tetragnathidae). *Journal of Morphology*, 268 (9), 758–770. <https://doi.org/10.1002/jmor.10543>
- Dimitrov, D., Álvarez-Padilla, F. & Hormiga, G. (2008). Until dirt do us apart: on the unremarkable palp morphology of the spider *Sternospina concretipalpis* Schmidt & Krause, 1993, with comments on the genus *Prionolaema* Simon, 1894 (Araneae, Tetragnathidae). *Zootaxa*, 1698, 49–56. doi:10.11646/zootaxa.1698.1.3
- Dimitrov, D., Álvarez-Padilla, F. & Hormiga, G. (2010). On the phylogenetic placement of the spider genus *Atimiosa* Simon, 1895, and the circumscription of *Dolichognatha* OP–Cambridge, 1869 (Tetragnathidae, Araneae). *American Museum Novitates*, 2010(3683), 1–19. <https://doi.org/10.1206/669.1>

- Dimitrov, D., Benavides, L. R., Arnedo, M. A., Giribet, G., Griswold, C. E., Scharff, N. & Hormiga, G. (2017). Rounding up the usual suspects: a standard target gene approach for resolving the interfamilial phylogenetic relationships of ecribellate orb weaving spiders with a new family rank classification (Araneae, Araneoidea). *Cladistics*, 33(3), 221–250. <https://doi.org/10.1111/cla.12165>
- Dippenaar-Schoeman, A. S., Haddad, C. R., Foord, S. H. & Lotz, L. N. (2023). The Tetragnathidae of South Africa. Version 2. *South African National Survey of Arachnida Photo Identification Guide, Irene*, pp. 50. doi:10.5281/zenodo.7513261
- Doleschall, L. (1859). Tweede Bijdrage tot de kennis der Arachniden van den Indischen Archipel. *Acta Societatis Scientiarum Indo-Neerlandicae*, 5(5), 1–60.
- Dondale, C. D. & Redner, J. H. (2003). *The orb-weaving spiders of Canada and Alaska: Araneae: Uloboridae, Tetragnathidae, Araneidae, Theridiosomatidae*. NRC Research Press. pp. 45.
- Dondale, C. D., Redner, J. H., Paquin, P. & Levi, H. W. (2003). *The insects and arachnids of Canada. Part 23. The orb-weaving spiders of Canada and Alaska (Araneae: Uloboridae, Tetragnathidae, Araneidae, Theridiosomatidae)*. NRC Research Press, Ottawa, pp. 371.
- Doyle, J. J. & Gaut, B. S. (2000). *Evolution of genes and taxa: a primer*. Plant Mol. Biol., pp. 1–23. https://doi.org/10.1007/978-94-011-4221-2_1
- Drummond, A. J., Suchard, M. A., Xie, D. & Rambaut, A. (2012). Bayesian phylogenetics with BEAUti and the BEAST 1.7. *Molecular Biology and Evolution*, 29(8), 1969–1973. <https://doi.org/10.1093/molbev/mss075>
- Dupérré, N. (2023). New light on some historical type specimens - in relation to the South American spider (Araneae) fauna. *New Zealand Journal of Zoology*, 50(1), 118–277. doi:10.1080/03014223.2022.2123835
- Dupo, A. L. B. & Barrion, A. T. (2009). *Taxonomy and general biology of delphacid planthoppers in rice agroecosystems. Planthoppers: new threats to the sustainability of intensive rice production systems in Asia*, International Rice Research Institute, pp. 3–155.
- Eberhard, W. G. & Huber, B. A. (1998). Courtship, copulation, and sperm transfer in *Leucauge mariana* (Araneae, Tetragnathidae) with implications for higher classification. *Journal of Arachnology*, 26(3), 342–368. doi: <https://www.jstor.org/stable/3706241>
- Eberhard, W. G. (1982). Behavioural characters for the higher classification of orb-weaving spiders. *Evolution*, 36(5), 1067–1095. <https://doi.org/10.2307/2408084>

- Emerson, B. C. (2025). Delimiting Species—Prospects and Challenges for DNA Barcoding. *Molecular Ecology*, 34(5), 1–8. <https://doi.org/10.1111/mec.17677>
- Eskov, K. Y. & Marusik, Y. M. (2024). A comparative morphology of trichobothrial bases in araneoid spiders and its significance for the phylogeny and system of the superfamily Araneoidea (Arachnida, Araneae). *ZooKeys*, 1219, 1–60. doi:10.3897/zookeys.1219.133002
- Folmer O., Black M., Hoeh W., Lutz R. & Vrijenhoek R. (1994). DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology*, 3(5), 294–9. <https://bit.ly/2x9R9WL>
- Fomichev, A. A. & Omelko, M. M. (2025). A new six-eyed species of *Dolichognatha* O. Pickard–Cambridge, 1869 (Araneae: Tetragnathidae) from Southeast Asia. *Far Eastern Entomologist*, 517, 1–8. doi:10.25221/fee.517.1
- Forest Survey of India (2025). *India State of Forest Report 2021*. Ministry of Environment, Forest and Climate Change, Government of India. <https://fsi.nic.in>
- Gajbe, P. U. (2004). Spiders of Jabalpur, Madhya Pradesh (Arachnida: Araneae). *Records of the Zoological Survey of India*, Occasional Paper, pp. 1–154.
- Gasteiger, E., Alexandre G., Christine H., Ivan I., Ron D. A., & Amos B. (2003). ExPASy: the proteomics server for in-depth protein knowledge and analysis. *Nucleic Acids Research*, 31 (13), 3784–3788.
- Gernhard, T. (2008). The conditioned reconstructed process. *Journal of Theoretical Biology*, 253(4), 769–778.
- Gillespie, R. (1991). Hawaiian spiders of the genus *Tetragnatha*: I. Spiny leg clade. *Journal of Arachnology*, 174–209. <https://www.jstor.org/stable/3705891>
- Gillespie, R. (1992a). Hawaiian spiders of the genus *Tetragnatha*: I. Spiny leg clade. *Journal of Arachnology*, 19, 174–209. <https://www.jstor.org/stable/3705891>
- Gillespie, R. (1992b). Hawaiian spiders of the genus *Tetragnatha*: II. Species from natural areas of windward east Maui. *Journal of Arachnology*, 20, 1–17. <https://www.jstor.org/stable/3705785>
- Gillespie, R. (1994). Hawaiian spiders of the genus *Tetragnatha*: III. *Tetragnatha acuta* clade. *Journal of Arachnology*, 22, 161–168. <https://www.jstor.org/stable/3705613>
- Gillespie, R. (2002). Hawaiian spiders of the genus *Tetragnatha*: IV new, small species in the spiny leg clade. *Journal of Arachnology*, 30, 159–172. [https://doi.org/10.1636/0161-8202\(2002\)030\[0159:hsotgt\]2.0.co;2](https://doi.org/10.1636/0161-8202(2002)030[0159:hsotgt]2.0.co;2)

- Gillespie, R. (2003a). Marquesan spiders of the genus *Tetragnatha* (Araneae: Tetragnathidae). *Journal of Arachnology*, 31, 62–77. [https://doi.org/10.1636/0161-8202\(2003\)031\[0062:msotgt\]2.0.co;2](https://doi.org/10.1636/0161-8202(2003)031[0062:msotgt]2.0.co;2)
- Gillespie, R. (2003b). Spiders of the genus *Tetragnatha* (Araneae: Tetragnathidae) in the Society Islands. *Journal of Arachnology*, 31, 157–172. [https://doi.org/10.1636/0161-8202\(2003\)031\[0157:sotgta\]2.0.co;2](https://doi.org/10.1636/0161-8202(2003)031[0157:sotgta]2.0.co;2)
- Gillespie, R. (2003c). Hawaiian spiders of the genus *Tetragnatha* (Araneae: Tetragnathidae): V. Elongate web-builders from Oahu. *Journal of Arachnology*, 31, 8–19. [https://doi.org/10.1636/0161-8202\(2003\)031\[0008:hsotgt\]2.0.CO;2](https://doi.org/10.1636/0161-8202(2003)031[0008:hsotgt]2.0.CO;2)
- Gillespie, R., Croom, H. B., & Hasty, G. L. (1997). Phylogenetic relationships and adaptive shifts among major clades of *Tetragnatha* spiders (Araneae: Tetragnathidae) in Hawai'i. *Pacific Science*, 51(4), 380–394.
- Gravely, F. H. (1921a). Some Indian spiders of the subfamily Tetragnathinae. *Records of the Indian Museum*, Calcutta, 22, 423–459.
- Gravely, F. H. (1921b). The spiders and scorpions of Barkuda Island. *Records of the Indian Museum*, Calcutta, 22, 399–421.
- Griswold, C. E., Coddington, J. A., Hormiga, G. & Scharff, N. (1998). Phylogeny of the orb-web building spiders (Araneae, Orbiculariae: Deinopoidea, Araneoidea). *Zoological Journal of the Linnean Society*, 123(1), 1–99. <https://doi.org/10.1111/j.1096-3642.1998.tb01290.x>
- Hall, T. A. (1999). BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleic Acids Symposium Series*, 41 (41), pp. 95–98.
- Hall, T. A. (2004). BioEdit version 7.0. 0. Distributed by the author, website: www.mbio.ncsu.edu/BioEdit/bioedit.html.
- Hebert, P. D., Cywinska, A., Ball, S. L. & DeWaard, J. R. (2003a). Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, 270(1512), 313–321. doi: 10.1098/rspb.2002.2218
- Hebert, P. D., Ratnasingham, S. & De Waard, J. R. (2003b). Barcoding animal life: cytochrome c oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 270(1), S96–S99. doi: 10.1098/rsbl.2003.0025
- Hesselberg T. & Simonsen, D. (2019). A comparison of morphology and web geometry between hypogean and epigean species of *Metellina* orb spiders (family, Tetragnathidae). *Subterranean Biology*, 32: 1–13. <https://doi.org/10.3897/subtbiol.32.36222>

- Hesselberg, T. (2015). Exploration behaviour and behavioural flexibility in orb-web spiders: A review. *Current Zoology*, 61(2), 313–327. doi:10.1093/czoolo/61.2.313
- Hingston, R. W. G. (1927). Protective devices in spiders' snares, with a description of seven new species of orb-weaving spiders. *Proceedings of the Zoological Society of London*, 97(2), 259–293. doi:10.1111/j.1096-3642.1927.tb02261.x
- Hormiga, G. & Griswold, C. E. (2014). Systematics, phylogeny, and evolution of orb-weaving spiders. *Annual Review of Entomology*, 59(1), 487–512. doi:10.1146/annurev-ento-011613-162046
- Hormiga, G. (2017). The discovery of the orb-weaving spider genus *Pinkfloydia* (Araneae, Tetragnathidae) in eastern Australia with description of a new species from New South Wales and comments on the phylogeny of Nanometinae. *Zootaxa*, 4311(4), 480–490. doi: 10.11646/zootaxa.4311.4.2
- Hormiga, G., Eberhard, W. G. & Coddington, J. A. (1995). Web-construction behaviour in Australian *Phonognatha* and the phylogeny of nephiline and tetragnathid spiders (Araneae, Tetragnathidae). *Australian Journal of Zoology*, 43(4), 313–364. <https://doi.org/10.1071/ZO9950313>
- Huelsenbeck, J. P. & Crandall, K. A. (1997). Phylogeny estimation and hypothesis testing using maximum likelihood. *Annual Review of Ecology and Systematics*, 28(1), 437–466. <https://doi.org/10.1146/annurev.ecolsys.28.1.437>
- Kallal, R. J. & Hormiga, G. (2018). An expanded molecular phylogeny of metaine spiders (Araneae, Tetragnathidae) with description of new taxa from Taiwan and the Philippines. *Invertebrate Systematics*, 32(2), 400–422. <https://doi.org/10.1071/IS17058>
- Kaston, B. J. (1948). Spiders of Connecticut. *Bulletin of the Connecticut State Geological and Natural History Survey*, 70, 1–874.
- Kerala State Council for Science, Technology and Environment (2011). *State of environment and related issues: EIACP PC Hub Kerala*. Retrieved on 30 September, 2025. <http://www.kerenvis.nic.in/Home.aspx>
- Kim, J. P., Kim, S. D. & Lee, Y. B. (1999). A revisional study of the Korean spiders, family Tetragnathidae Menge, 1866 (Arachnida: Araneae). *Korean Arachnology*, 15(2), 41–100.
- Kim, S. T. & Lee, S. Y. (2013). Arthropoda: Arachnida: Araneae: Mimetidae, Uloboridae, Theridiosomatidae, Tetragnathidae, Nephilidae, Pisauridae, Gnaphosidae. Spiders. *Invertebrate Fauna of Korea*, 21(23), 1–183.
- Kulkarni, S. S. & Yadav, S. (2015). Bridging the distributional gap of *Tylorida striata* (Thorell, 1877) and new synonymy (Araneae:

- Tetragnathidae). *Biodiversity Data Journal*, 3(e4878), 1–12. doi:10.3897/BDJ.3.e4878
- Kulkarni, S. S. (2014). A new species of the genus *Tylorida* Simon, 1894 (Araneae: Tetragnathidae) from a rocky outcrop in the northern Western Ghats, India. *Journal of Threatened Taxa*, 6(3), 5558–5561. doi:10.11609/JoTT.o3606.5558–61
- Kulkarni, S. S. & Lewis, T. R. (2015). Description of male *Tylorida sataraisensis* Kulkarni, 2014 (Araneae, Tetragnathidae) with notes on habits and conservation status. *Biodiversity Data Journal*, 3(e4451), 1–11. doi:10.3897/BDJ.3.e4451
- Kumar, S., Stecher, G., Suleski, M., Sanderford, M., Sharma, S. & Tamura, K. (2024). MEGA12: Molecular Evolutionary Genetic Analysis version 12 for adaptive and green computing. *Molecular Biology and Evolution*, 41(12), 1–9. <https://doi.org/10.1093/molbev/msae263>
- Kuntner, M. & Álvarez-Padilla, F. (2006). Systematics of the Afro–Macaronesian spider genus *Sancus* (Araneae, Tetragnathidae). *Journal of Arachnology*, 34(1), 113–125. doi:10.1636/H04–27.1
- Kuntner, M., (2005). A revision of *Herennia* (Araneae: Nephilidae: Nephilinae) the Australasian coin spiders. *Invertebr. Syst.*, 19, 391–436.
- Kuntner, M., 2006. Phylogenetic systematics of the Gondwanan nephilid spider lineage Clitaetrinae (Araneae, Nephilidae). *Zool. Scr.*, 35, 19–62.
- Lam–Tung N., Heiko A. S., Arndt von H. & Bui Q. M. (2015). IQ–TREE: A Fast and Effective Stochastic Algorithm for Estimating Maximum-Likelihood Phylogenies. *Molecular Biology and Evolution*, 32(1), 268–274. <https://doi.org/10.1093/molbev/msu300>
- Levi, H. W. (1980). The orb–weaver genus *Mecynogea*, the subfamily Metinae and the genera *Pachygnatha*, *Glenognatha* and *Azilia* of the subfamily Tetragnathinae north of Mexico (Araneae: Araneidae). *Bulletin of the Museum of Comparative Zoology*, 149, 1–74.
- Levi, H. W. (1981). The American orb–weaver genera *Dolichognatha* and *Tetragnatha* north of Mexico (Araneae: Araneidae, Tetragnathinae). *Bulletin of the Museum of Comparative Zoology*, 149, 271–318.
- Levi, H. W. (1986). The Neotropical orb–weaver genera *Chrysometa* and *Homalometa* (Araneae: Tetragnathidae). *Bulletin of the Museum of Comparative Zoology*, 151(3), 91–215.
- Levi, H. W. (2005). Identity and placement of species of the orb weaver genus *Alcimosphenus* (Araneae, Tetragnathidae). *Journal of Arachnology*, 33, 753–757.

- Levi, H. W. (2008). On the tetragnathid genera *Alcimosphenus*, *Leucauge*, *Mecynometa* and *Opas* (Araneae, Tetragnathidae). *Journal of Arachnology*, 36(1), 167–170. doi:10.1636/A07–67SC.1
- Librado, P. & Julio R. (2009). DnaSP v5: a software for comprehensive analysis of DNA polymorphism data. *Bioinformatics*, 25(11), 1451–1452.
- Lin, Y. J. & Yang, N. (2023). A new species of *Metellina* Chamberlin & Ivie, 1941 (Araneae: Tetragnathidae) from Beijing, China. *Acta Arachnologica Sinica*, 32(2), 131–136. doi:10.3969/j.issn.1005–9628.2023.02.013
- Lin, Y. J., Wu, L. B., Cai, D. C., Li, S. Q., Barrion, A. T. & Heong, K. L. (2023). Review of 43 spider species from Hainan Island, China (Arachnida, Araneae). *Zootaxa*, 5351(5), 501–533. doi:10.11646/zootaxa.5351.5.1
- Locket, G. H., Millidge, A. F. & Merrett, P. (1974). *British spiders (Vol III)*. Ray Society, London, pp. 314.
- Lopardo, L. & Uhl, G. (2014). Testing mitochondrial marker efficacy for DNA barcoding in spiders: a test case using the dwarf spider genus *Oedothorax* (Araneae: Linyphiidae: Erigoninae). *Invertebrate Systematics*, 28(5), 501–521.
- Lopardo, L., Giribet, G. & Hormiga, G. (2011). Morphology to the rescue: molecular data and the signal of morphological characters in combined phylogenetic analyses—a case study from mysmenid spiders (Araneae, Mysmenidae), with comments on the evolution of web architecture. *Cladistics*, 27(3), 278–330.
- Madden, T. (2013). The BLAST sequence analysis tool. *The NCBI Handbook*, 2(5), 425–436.
- Maddison, D. R., Swofford, D. L. & Maddison, W. P. (1997). NEXUS: an extensible file format for systematic information. *Systematic Biology*, 46(4), 590–621.
- Malamel, J. J. & Sebastian, P. A. (2018). On the taxonomic status of *Leucauge granulata* (Walckenaer, 1841); *Leucauge argentata* (Cambridge, 1869); *Leucauge bengalensis* Gravely, 1921; *Leucauge tuberculata* Wang, 1991: a case of synonymy (Araneae: Tetragnathidae). *Journal of Asia-Pacific Biodiversity*, 11(3), 408–415. DOI:10.1016/j.japb.2018.04.006
- Malamel, J. J., Nafin, K. S., Sankaran, P. M. & Sebastian, P. A. (2018). First record of the spider genus *Wolongia* Zhu, Kim & Song, 1997 from India with the description of a new species (Araneae, Tetragnathidae). *Zootaxa*, 4407(1), 145–150. doi: 10.11646/zootaxa.4407.1.13
- Menge, A. (1866). Preussische Spinnen. Erste Abtheilung. *Schriften der Naturforschenden Gesellschaft in Danzig* (N.F.) 1, 1–152.

- Merian, P. (1911). Die Spinnenfauna von Celebes. Beiträge zur Tiergeographie im Indoaustralischen Archipel. *Zoologische Jahrbücher, Abteilung für Systematik, Geographie und Biologie der Tiere*, 31, 165–354.
- Murphy, F. & Murphy, J. (2000). *An introduction to the spiders of South East Asia with notes on all the genera*. Malaysian Nature Society, Kuala Lumpur, pp. 388.
- Nafin, K. S. (2022). Diversity and ecology of spiders (Order: Araneae) in Muriyadkol Wetlands of Kerala (doctoral dissertation, Christ College, Irinjalakuda), University of Calicut, pp. 1–570.
- Nascimento, F. F. & Yang, Z. (2017). A biologist's guide to Bayesian phylogenetic analysis. *Nature Ecology and Evolution*, 1(10), 1446. <https://doi.org/10.1038/s41559-017-0280-x>
- Nasir, D. M. (2016). Distribution of spiders in Malaysia with special emphasis of the systematics and ecology of the orb-web spider (Araneae: Tetragnathidae) (doctoral dissertation, University of Malaya (Malaysia). pp. 153–155.
- Nasir, D. M., Goh, T. G., Mohamed, Z. & Yusoff, N. (2018). Relationships between morphology and web characteristics of four spider species (Araneae: Tetragnathidae) in Malaysia. *Taiwanese Journal of Entomological Studies*, 3(1), 1–11.
- Nasir, D. M., Su, S., Low, V. L., Mohamed, Z. & Yusoff, N. (2023). DNA barcodes of tetragnathid spiders (Araneae: Tetragnathidae) in Malaysia. *Pakistan Journal of Zoology*, 55(2), 881.
- Nei, M., & Kumar, S. (2000). *Molecular Evolution and Phylogenetics*. Oxford University Press, New York. pp. 126–329.
- Nentwig, W., Blick, T., Gloor, D., Jäger, P. & Kropf, C. (2019). Tackling taxonomic redundancy in spiders: the infraspecific spider taxa described by Embrik Strand (Arachnida: Araneae). *Arachnologische Mitteilungen*, 58, 29–51. doi:10.30963/aramit5809
- Nojima, K. (2024). Spiders newly recorded from Okayama Prefecture, Japan. *Kishidaia*, 125, 37–40.
- Nyffeler, M. & Benz, G. (1987). Spiders in natural pest control: a review 1. *Journal of Applied Entomology*, 103(1–5), 321–339. <https://doi.org/10.3929/ethz-a-005794601>
- Okuma, C. (1968). Preliminary survey on the spider-fauna of the paddy fields in Thailand. *Mushi*, 42(8), 89–118.
- Okuma, C. (1983). New synonymies and new records of some cosmopolitan species of the genus *Tetragnatha* (Araneae: Tetragnathidae). *Esakia*, 20, 69–80.
- Okuma, C. (1987). A revision of the Australasian species of the genus *Tetragnatha* (Araneae, Tetragnathidae). *Esakia*, 25, 37–96.

- Okuma, C. (1988a). A revision of the genus *Tetragnatha* Latreille (Araneae, Tetragnathidae) of Asia, Part I. *Journal of the Faculty of Agriculture, Kyushu University*, 32(3), 165–181.
- Okuma, C. (1988b). A revision of the genus *Tetragnatha* Latreille (Araneae, Tetragnathidae) of Asia, Part II. *Journal of the Faculty of Agriculture Kyushu University*, 32, 183–213.
- Okuma, C. (1988c). Five new species of *Tetragnatha* from Asia (Araneae: Tetragnathidae). *Esakia*, 26, 71–77.
- Okuma, C., Kamal, N. Q., Hirashima, Y., Alam, M. Z. & Ogata, K. (1993). *Illustrated monograph of the rice field spiders of Bangladesh*. Institute of Postgraduate Studies in Agriculture, pp. 93.
- Ott, R., Rodrigues, E. N. L. & Brescovit, A. D. (2023). On the genus *Diphya*: notes on the Brazilian *D. bicolor* and a new species from Ecuador (Araneae: Tetragnathidae). *Iheringia, Série Zoologia*, 113(e2023004), 1–13. doi:10.1590/1678-4766e2023004
- Paik, W. H. & Namkung, J. (1979). Studies on the rice paddy spiders from Korea. *Seoul National Univ.*, pp. 101.
- Petrunkévitch, A. (1911). A synonymic index-catalogue of spiders of North, Central and South America with all adjacent islands, Greenland, Bermuda, West Indies, Terra del Fuego, Galapagos, etc. *Bulletin of the American Museum of Natural History*, 29, 1–791.
- Pocock, R. I. (1900). *The fauna of British India, including Ceylon and Burma. Arachnida*. Taylor and Francis, London, pp. 279. doi:10.5962/bhl.title.48423
- Pocock, R. I. (1901). Descriptions of some new species of spiders from British India. *Journal of the Bombay Natural History Society*, 13, 478–498.
- Posada, D. (2008). jModelTest: phylogenetic model averaging. *Molecular Biology and Evolution*, 25(7), 1253–1256. <https://doi.org/10.1093/molbev/msn083>
- Rajeevan, S., Kunnath, S. M., Varghese, T. & Kandambeth, P. P. (2019). Spider diversity (Arachnida: Araneae) in different ecosystems of the Western Ghats, Wayanad region, India. *South Asian Journal of Life Science*, 7(2), 29–39.
- Rambaut, A. (2018). *FigTree v1. 4.4*. [Computer software]. Institute of Evolutionary Biology, University of Edinburgh. Retrieved from <http://tree.bio.ed.ac.uk/software/figtree/>
- Roewer, C. F. (1942). Katalog der Araneae von 1758 bis 1940. *Bremen*, 1, 1–1040.
- Rozas, J., Ferrer-Mata, A., Sánchez-DelBarrio, J. C., Guirao-Rico, S., Librado, P., Ramos-Onsins, S. E. & Sánchez-Gracia, A. (2017). DnaSP 6: DNA sequence polymorphism analysis of large data sets. *Molecular biology and evolution*, 34(12), 3299–3302.

- Rubinoff, D. (2006). Utility of mitochondrial DNA barcodes in species conservation. *Conservation Biology*, 20(4), 1026–1033. <https://doi.org/10.1111/j.1523-1739.2006.00372.x>
- Saccone, C., De Giorgi, C., Gissi, C., Pesole, G. & Reyes, A. (1999). Evolutionary genomics in Metazoa: the mitochondrial DNA as a model system. *Gene*, 238(1), 195–209. [https://doi.org/10.1016/S0378-1119\(99\)00270-X](https://doi.org/10.1016/S0378-1119(99)00270-X)
- Saitou, N. & Nei, M. (1987). The neighbor-joining method: a new method for reconstructing phylogenetic trees. *Molecular Biology and Evolution*, 4(4), 406–425. <https://doi.org/10.1093/oxfordjournals.molbev.a040454>
- Salgueiro–Sepulveda F. J. & Alvarez–Padilla, F. (2018). New species of the orb-weaving spider genus *Chrysometa* (Araneae, Tetragnathidae) from oak forests near of the Pico de Orizaba National Park (Veracruz, Mexico). *Zootaxa*, 4450(3), 301–330.
- Sankaran, P. M., Caleb, J. T. & Sebastian, P. A. (2020). A new Indian species of the orb-weaving spider genus *Glenognatha* Simon, 1887, with a new combination and a new synonymy of *Tylorida marmorea* (Pocock, 1901) (Araneae, Tetragnathinae). *Zootaxa*, 4808(1), 196–200. doi: 10.11646/zootaxa.4808.1.12
- Sankaran, P. M., Malamel, J. J., Joseph, M. M. & Sebastian, P. A. (2017). On the genus *Tylorida* Simon, 1894 with the first record of the genus *Atelidea* Simon, 1895 from India (Araneae: Tetragnathidae, Leucauginae). *Zootaxa*, 4353(2), 294–326. doi: 10.11646/zootaxa.4353.2.3
- Schuchert, C. (1897). What is a type in natural history? *Science*, 5(121), 636–640.
- Sebastian, P. A., Mathew, M. J., Beevi, S. P., Joseph, J. & Biju, C. R. (2005). The spider fauna of the irrigated rice ecosystem in central Kerala, India across different elevational ranges. *Journal of Arachnology*, 33(2), 247–255. <https://doi.org/10.1636/05-08.1>
- Selden, P. A. & Penney, D. (2010). Fossil spiders. *Biological Reviews*, 85(1), 171–206. doi:10.1111/j.1469-185X.2009.00099.x
- Selden, P.A. (1990). Lower Cretaceous spiders from the Sierra del Montsech, north-east Spain. *Palaeontology*, 33, 257–285.
- Sen, S., Dhali, D. C., Saha, S. & Raychaudhuri, D. (2015). Spiders (Araneae: Arachnida) of reserve forests of Dooars: Gorumara National Park, Chapramari Wildlife Sanctuary and Mahananda Wildlife Sanctuary. *World Scientific News*, 20, 1–339.
- Sensenig, A.T., Agnarsson, I. & Blackledge, T.A. (2011). Adult spiders use tougher silk: ontogenetic changes in web architecture and silk biomechanics in the orb-weaver spider. *Journal of Zoology*, 285 (1), 28–38. <https://doi.org/10.1111/j.1469-7998.2011.00809.x>

- Sheth, B. P. & Thaker, V. S. (2017). DNA barcoding and traditional taxonomy: an integrated approach for biodiversity conservation. *Genome*, 60(7), 618–628.
- Shorthouse, P. D. (2010). SimpleMappr, an online tool to produce publication-quality point maps. (Retrieved from <https://www.simplemappr.net>. Accessed October 09, 2025).
- Simo, M., Álvarez, L. & Laborda, Á. (2016). The orb-weaving spider genus *Chrysometa* in Uruguay: distribution and description of a new species (Araneae, Tetragnathidae). *Zootaxa*, 4067(5), 589–593. doi:10.11646/zootaxa.4067.5.7
- Simon, E. (1894). *Histoire naturelle des araignées. Deuxième édition, tome premier. Roret, Paris*, pp. 489–760. doi:10.5962/bhl.title.51973
- Simon, E. (1895). *Histoire Naturelle Des Araignees 2. Encyclopedique de Roret, L. Mulo, Librairie-Editeur, Paris*. 761–1084. doi:10.5962/bhl.title.51973
- Simon, E. (1906). Voyage de M. Maurice Maindron dans l'Inde méridionale (mai à novembre 1901). 8^{me} Mémoire. Arachnides (2^e partie). *Annales de la Société Entomologique de France*, 75(3), 279–314.
- Smith, H. M. (2008). Synonymy of *Homalopoltyx* (Araneae: Araneidae) with the genus *Dolichognatha* (Araneae: Tetragnathidae) and descriptions of two new species. *Zootaxa*, 1775, 1–24. doi:10.11646/zootaxa.1775.1.1
- Song, D. X. & Zhu, M. S. (1994). On some species of cave arachnids of China. *Sixtieth Anniversary of the Founding of China Zoological Society: Memorial Volume Dedicated to the Hundredth Anniversary of the Birthday of the Late Prof. Sisan Chen (Z. Chen)*. China Science and Technology Press, Beijing, pp. 35–46.
- Song, D. X., Zhu, M. S. & Chen, J. (1999). *The spiders of China*. Hebei Science and Technology Publishing House, Shijiazhuang, pp. 640.
- Spafford, R. D. & Lortie, C. J. (2013). Sweeping beauty: is grassland arthropod community composition effectively estimated by sweep netting. *Ecology and Evolution*, 3(10), 3347–3358. <https://doi.org/10.1002/ece3.688>
- Stoliczka, F. (1869). Contribution towards the knowledge of Indian Arachnoidea. *Journal of the Asiatic Society of Bengal, part II (Physical Science)*, 38(4), 201–251, pl. 18–20.
- Sudhikumar, A. V. & Nafin, K. S. (2018). Diversity of spiders in the organically cultivated paddy fields of Muriyad Kol wetlands, Kerala, India. *Perspectives on Biodiversity of India*, 232.
- Sudhikumar, A. V., Mathew, M. J., Sunish, E. & Sebastian, P. A. (2005). Seasonal variation in spider abundance in Kuttanad rice agroecosystem, Kerala, India (Araneae). *European Arachnology*, 1, 181–190.

- Sunil Jose, K. (2014). First record of *Dolichognatha longiceps* (Thorell, 1895) from India (Araneae: Tetragnathidae). *Munis Entomology and Zoology*, 9(1), 473–477.
- Sunil Jose, K., Davis, S., Sudhikumar, A. V. & Sebastian, P. A. (2004). Redescription of *Tetragnatha viridorufa* Gravely from Kerala, India, Araneae: Tetragnathidae. *Journal of the Bombay Natural History Society*, 101, 182–184.
- Takahashi, K. & Nei, M. (2000). Efficiencies of fast algorithms of phylogenetic inference under the criteria of maximum parsimony, minimum evolution, and maximum likelihood when a large number of sequences are used. *Molecular biology and evolution*, 17(8), 1251–1258. <https://doi.org/10.1093/oxfordjournals.molbev.a026408>
- Tanikawa, A. (2005). Japanese spiders of the genus *Tylorida* (Araneae: Tetragnathidae). *Acta Arachnologica*, 53(2), 2004, 151–154. doi:10.2476/asjaa.53.151
- Tanikawa, A. (2009). *Hersiliidae, Nephilidae, Tetragnathidae, Araneidae*. In: Ono, H. (ed.) *The spiders of Japan with keys to the families and genera and illustrations of the species*. Tokai University Press, Kanagawa, pp. 149, 403–463.
- Thompson, J. D., Gibson, T. J. & Higgins, D. G. (2003). Multiple sequence alignment using ClustalW and ClustalX. *Current Protocols in Bioinformatics*, (1), 2–3.
- Thompson, J. D., Gibson, T. J., Plewniak, F., Jeanmougin, F. & Higgins, D. G. (1997). The CLUSTAL_X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research*, 25(24), 4876–4882. <https://doi.org/10.1093/nar/25.24.4876>
- Thorell, T. (1878). Studi sui ragni Malesi e Papuani. II. Ragni di Amboina raccolti Prof. O. Beccari. *Annali del Museo Civico di Storia Naturale di Genova*, 13, 5–317.
- Thorell, T. (1890). Studi sui ragni Malesi e Papuani. IV, 1. *Annali del Museo Civico di Storia Naturale di Genova*, 28, 5–421.
- Thorell, T. (1891). Spindlar från Nikobarerna och andra delar af södra Asien. *Kongliga Svenska Vetenskaps-Akademiens Handlingar*, 24(2), 1–149.
- Thorell, T. (1892). On some spiders from the Andaman Islands, collected by E. W. Oates, Esq. *Annals and Magazine of Natural History*, (6) 9(51), 226–237. doi:10.1080/00222939208677308
- Tikader, B. K. (1966). Studies on spider fauna of Khasi and Jaintia Hills, Assam, India. *Journal of the Assam Science Society*, 9, 139–154.

- Tikader, B. K. (1970). Spider fauna of Sikkim. *Records of the Zoological Survey of India*, 64, 1–83.
- Tikader, B. K. (1977). Studies on spider fauna of Andaman and Nicobar Islands, Indian Ocean. *Records of the Zoological Survey of India*, 72, 153–212.
- Tikader, B. K. (1982). *Part I. Family Araneidae (= Argiopidae). Typical orb-weavers. In: The fauna of India. Spiders: Araneae. Vol. II.* Zoological Survey of India, Calcutta, pp. 1–293.
- Tikader, B. K. (1987). *Handbook, Indian spiders. The Survey.* Zoological Survey of India, Calcutta, pp. 1–251
- Tso, I. M. & Tanikawa, A. (2000). New records of five orb-web spiders of the genera *Leucauge*, *Mesida*, and *Eriovixia* (Araneae: Tetragnathidae and Araneidae) from Taiwan. *Acta Arachnologica*, 49(2), 125–131. doi:10.2476/asjaa.49.125
- Tullgren, A. (1902). Spiders collected in the Aysen Valley by Mr P. Dusén. *Bihang till Kongliga Svenska Vetenskaps-Akademiens Handlingar*, 28(IV, 1), 1–77.
- Tyagi, K., Kumar, V., Kundu, S., Pakrashi, A., Prasad, P., Caleb, J. T. & Chandra, K. (2019). Identification of Indian spiders through DNA barcoding: cryptic species and species complex. *Scientific Reports*, 9(1), 14033. <https://doi.org/10.1038/s41598-019-50510-8>
- Vollrath, F. & Selden, P. (2007). The role of behaviour in the evolution of spiders, silks, and webs. *Annu. Rev. Ecol. Evol. Syst.*, 38(1), 819–846. <https://doi.org/10.1146/annurev.ecolsys.37.091305.110221>
- Walckenaer, C. A. (1841). *Histoire naturelle des Insects. Aptères. Tome deuxième.* Roret, Paris, pp. 549. doi:10.5962/bhl.title.61095
- Wang, L. Y., Irfan, M., Chen, H. M. & Zhang, Z. S. (2022). Seven new species of *Meta* Koch, 1836 (Araneae, Tetragnathidae) from southwest China. *European Journal of Taxonomy*, 834, 117–147. doi:10.5852/ejt.2022.834.1905
- Wang, L. Y., Zhang, Z. S. & Peng, X. J. (2020). *Dolichognatha bannaensis* new species, a six-eyes tetragnathid spider from China (Araneae, Tetragnathidae). *Zootaxa*, 4809(1), 197–200. doi:10.11646/zootaxa.4809.1.14
- Wang, Z. L., Yang, X. Q., Wang, T. Z., & Yu, X. (2018). Assessing the effectiveness of mitochondrial COI and 16S rRNA genes for DNA barcoding of farmland spiders in China. *Mitochondrial DNA Part A*, 29(5), 695–702. <https://doi.org/10.1080/24701394.2017.1350949>
- Whiting, M. F. (2002). Mecoptera is paraphyletic: multiple genes and phylogeny of Mecoptera and Siphonaptera. *Zoologica Scripta*, 31(1), 93–104. <https://doi.org/10.1046/j.0300-3256.2001.00095.x>

- Whiting, M. F., Carpenter, J. C., Wheeler, Q. D. & Wheeler, W. C. (1997). The Strepsiptera problem: phylogeny of the holometabolous insect orders inferred from 18S and 28S ribosomal DNA sequences and morphology. *Systematic Biology*, 46(1), 1–68. <https://doi.org/10.1093/sysbio/46.1.1>
- Wong, T. K., Ly–Trong, N., Ren, H., Baños, H., Roger, A. J., Susko, E. & Minh, B. Q. (2025). IQ–TREE 3: Phylogenomic Inference Software using Complex Evolutionary Models. *Molecular Biology and Evolution*, 29(1), 3345–3358. <https://ecoevorxiv.org/repository/object/8916/download/16665/>
- World Spider Catalog (2025). World Spider Catalog. Version 26. Natural History Museum Bern, online at <http://wsc.nmbe.ch>, accessed on 19 March 2025. doi: 10.24436/2
- Yaginuma, T. (1986a). *Spiders of Japan in color (new ed.)*. Hoikusha Publishing Co., Osaka, pp. 305.
- Yang, Z. (1996). Phylogenetic analysis using parsimony and likelihood methods. *Journal of Molecular Evolution*, 42(2), 294–307. <https://doi.org/10.1007/BF02198856>
- Yang, Z. & Rannala, B. (1997). Bayesian phylogenetic inference using DNA sequences: a Markov Chain Monte Carlo method. *Molecular Biology and Evolution*, 14(7), 717–724. <https://doi.org/10.1093/oxfordjournals.molbev.a025811>
- Yin, C. M., Peng, X. J., Yan, H. M., Bao, Y. H., Xu, X., Tang, G. & Liu, P. (2012). Fauna Hunan: Araneae in Hunan, China. *Hunan Science and Technology Press, Changsha*, 1, 465–466.
- Yoshida, H. (2009). The spider genus *Leucauge* (Araneae: Tetragnathidae) from Taiwan. *Acta Arachnologica*, 58(1), 11–18. doi:10.2476/asjaa.58.11
- Yoshida, M. (1999). Spinnerets silk spigots morphology of Araneidae, Tetragnathidae, Theridiidae and Linyphiidae (Araneae: Araneoidea). *Acta Arachnologica*, 48(1), 1–22. <https://doi.org/10.2476/asjaa.48.1>
- Yule, G. U. (1925). II.—A mathematical theory of evolution, based on the conclusions of Dr. JC Willis, FR S. *Philosophical Transactions of the Royal Society of London. Series B, containing papers of a biological character*, 213(402–410), 21–87.
- Zhang, C. (2018). *Tetragnathidae, Nephilidae, Araneidae*. In: Zhang, F. & Xue, X. F. (eds.) *Fauna of Tianmu Mountain. Volume II. Arachnida. Araneae Eriophyoidea*. Zhejiang University Press, Hangzhou, pp. 47–57.
- Zhang, D. X. & Hewitt, G. M. (2003). Nuclear DNA analyses in genetic studies of populations: practice, problems and prospects. *Molecular ecology*, 12(3), 563–584. <https://doi.org/10.1046/j.1365-294X.2003.01773.x>

- Zhu, M. S. & Zhang, B. S. (2011). Spider Fauna of Henan: Arachnida: Araneae. *Science Press, Beijing*, pp. 558.
- Zhu, M. S., Song, D. X. & Zhang, J. X. (2003). *Fauna Sinica: Invertebrata Vol. 35: Arachnida: Araneae: Tetragnathidae*. Science Press, Beijing, pp. 418.
- Zhu, M. S., Wu, C. & Song, D. X. (2002). A revision of the Chinese species of the genus *Tylorida* (Araneae: Tetragnathidae). *Acta Arachnologica Sinica*, 11, 25–32.

APPENDICES

LIST OF PUBLICATIONS

Journal articles

- Anju, K. B., Sen, S., Sudhin, P. P., & Sudhikumar, A. V. (2025). First Record of *Leucauge rubromaculata* Benjamin, 2024 (Araneae, Tetragnathidae) from India. *National Academy Science Letters*, 1-5.
- Anju, K. B., Asha, T. J. & Sudhikumar, A. V. (2024a). A new six-eyed species of *Dolichognatha* O. Pickard Cambridge, 1869 from India (Araneae, Tetragnathidae). *Zootaxa*, 5523(1): 146-150. doi:10.11646/zootaxa.5523.1.10
- Anju, K. B., Sen, S., Asha, T. J., Sudhin, P. P., Sudhikumar, A. V. & Castanheira, P. de S. (2024b). Taxonomic notes and new records of *Tetragnatha* (Araneae: Tetragnathidae) in India, with the redescription of three species. *Arachnology*, 19(7): 988-997. doi:10.13156/arac.2024.19.7.988
- Anju, K. B., Bhagirathan, U. & Sudhikumar, A. V. (2024c). First record of long-jawed spider *Tetragnatha squamata* Karsch, 1879 (Araneae: Tetragnathidae) from India. *Records of the Zoological Survey of India*, 124(2): 131-137. doi:10.26515/rzsi/v124/i2/2024/168214
- Anju, K. B. & Sudhikumar, A. V. (2023). First description of male long-jawed orb-weaver spider (*Tylorida flava*). *Taprobanica*, 12(1): 24-25, pl. 13-14. doi:10.47605/tapro.v12i1.298
- Anju, K. B., Bhagirathan, U. & Sudhikumar, A. V. (2021a). Redescription of *Tetragnatha cochinensis* (Araneae: Tetragnathidae) after a century in India. *Serket*, 18(1): 85-90.

- Anju, K. B., Bhagirathan, U. & Sudhikumar, A. V. (2021b). Redescription of *Leucauge fastigata* (Simon, 1877) (Araneae: Tetragnathidae) with first report of male from India. *Serket*, 18(2): 161-166.

Articles in proceedings

- Anju, K. B., T. S. Greeshma, Sudhikumar, A. V. (2023). Diversity and Abundance of Long-Jawed Spiders (Araneae, Tetragnathidae) in Selected Ecosystems in Thrissur, Kerala. *Proceedings of the International Seminar, Advanced techniques in biological research (ATBR-2023)*, pp. 41-45.
- Anju, K. B., Bhagirathan, U. & Sudhikumar, A. V. (2021). Taxonomy and Phylogeny of Long Jawed Spiders (Araneae: Tetragnathidae)-A Review. *Millennium Zoology*, 22(1), 2021, pp. 5-9.

PRESENTATIONS

- Presented a research paper titled 'Diversity and Abundance of Long-Jawed Spiders (Araneae, Tetragnathidae) in Selected Ecosystems in Thrissur, Kerala', in a two-day international seminar (ATBR, 2023), organised by IQAC, KKTM Government College, Pullut, on November 22–23, 2023.
- Presented a research paper titled 'Diversity, Composition and Web Characteristics of Orb-Weaving Spiders in the Muriyad Kole Wetlands' at INSIGHT 2025, organised by MES Keveeyam College, Valanchery, in association with the Kerala State Higher Education Council, held on January 21–23, 2025.

PARTICIPATION AND TRAINING

- Attended a three-month online training programme on nucleotide sequence trimming, editing, reverse translation, consensus sequence creation, frame shift rectification, NCBI submission, and software analysis (BioEdit, Clustal, IQ Tree (ML), and BEAST package (BI)) conducted by the lab Marigenome, Ernakulam, Kerala, from May 2025 to July 2025.
- Attended the international conference on Integrating Disciplines for Sustainable Development, organised by INSIGHT 2025 and MES Keveeyam College, Valanchery, in association with the Kerala State Higher Education Council, held on January 21-23, 2025.
- Attended a two-day Multidisciplinary National Conference and Research Expo 2024 organised by the researcher's forum of Christ College (Autonomous), Irinjalakuda, on February 14-15, 2024.
- Attended a two-day interdisciplinary workshop on the Basics of Map Preparation using Geographic Information System (GIS) jointly organised by the Teaching Learning Centre, the Scholars Connect researcher's forum of Christ College & the Department of Geology and Environmental Science, Christ College, Irinjalakuda, on 12 February 2024.
- Attended the online training programme "DNA Sequence Analysis: A Comprehensive Guide", organised by MYTOSCIpro, a venture of Marigenome, Matsyasevanakendra (MSK), and assisted by the Fisheries Department of Kerala and PMMSY from the 27th to the 29th of June, 2024.

- Attended a two-day International Seminar on Advanced Techniques in Biological Research (ATBR-2023) organized by IQAC, KKTU Government College, Pullut, on November 22-23, 2023.
- Attended the national training program on Research Methodology using Chat GPT and AI tools, scheduled for the 11th and 12th of December 2023 at the Kerala Veterinary and Animal Sciences University.
- Participated in a six-day hands-on training programme on isolation of DNA (manual and kit method), primer designing, amplification of DNA (PCR), purification of DNA (gel elution/column pass), sequence analysis (phylogeny, SNP detection, InDel detection), and MEGA-X under the guidance of Dr Beena P S, at OmicsGen LifeSciences Pvt. Ltd, Kochi.
- Participated online in the 33rd European Congress of Arachnology conducted from September 4 to 9, 2022, in Greifswald, Germany.