

Description of A New Archaeococcoid of the Genus *Perissopneumon* Newstead (Hemiptera: Coccoomorpha: Monophlebidae) from India

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A new archaeococcoid (Hemiptera: Coccoomorpha: Monophlebidae), *Perissopneumon kalyaniense* Das & Das sp. nov., is described from specimens collected on twigs of *Glycosmis pentaphylla* (Retz.) DC. (Rutaceae), a medicinal plant from Kalyani, West Bengal, India. The new species is similar to *Perissopneumon ferox* Newstead 1900, but can be distinguished by different character states of ventral multilocular pores and anal tube. An updated identification key to the species of *Perissopneumon* Newstead found worldwide is provided. The current status of the genus *Perissopneumon* Newstead is discussed.

Key words: Archaeococcoid, Identification key, Monophlebidae, *Perissopneumon*, New species, West Bengal.

BACKGROUND

Scale insects or coccids are plant sap-sucking sternorrhynchan Hemiptera that include all members of the infraorder Coccoomorpha and superfamily Coccoidea (Schaefer 1996; Bourgoin and Campbell 2002; Gullan and Martin 2009). Traditionally, the superfamily Coccoidea is divided into two informal groups, the archaeococcoids and the neococcoids (Gullan and Cook 2007; Kondo et al. 2008). The extant archaeococcoids comprise 11 families of the Margarodidae *sensu* Morrison 1928 plus the Ortheziidae, Carayonemidae, Phenacoleachiidae and Putoidae (Gullan and Cook 2007). The relationships of most of the higher taxa of paraphyletic archaeococcoids are not resolved at present and affiliations of some archaeococcoid genera and even their family-level status are uncertain (Foldi 1997 2016; Gullan and Cook 2007; Hodgson and Hardy 2013).

The relationships of most of the higher taxa

of paraphyletic archaeococcoids are not completely resolved at present (Foldi 1997; Gullan and Cook 2007; Hodgson and Hardy 2013; Vea and Grimaldi 2016) and affiliations of some archaeococcoid genera and even their family-level status are uncertain (Foldi 2016).

Among 11 families derived from Margarodidae *s. l.*, Monophlebidae Signoret is the most speciose (Ben-Dov 2011; García Morales et al. 2016) and contains the largest number of pestiferous species attacking fruits, ornamentals (Foldi 2016) and forest plants, mostly in tropical and subtropical regions. The best-known species, the cottony cushion scale *Icerya purchase* Maskell is thought to be of Australian origin. It became notorious in the 1880s because of spectacular contemporaneous infestations of citrus orchards in California and South Africa. Another species, the Seychelles scale *I. seychellarum* (Westwood), is a pest of breadfruit trees, *Atrocarpus altilis* (Parkinson) Fosberg in India (Ayyar 1930) and of many plants in South Africa (Munro and

Fouche 1936), South-East Asia (Capco 1959), Japan (Kuwana 1922), and the South Pacific islands (Butcher 1983; Williams and Butcher 1987).

Drosicha stebbingi (Stebbing) and *D. mangiferae* (Stebbing) are serious pests of mangoes and other fruit trees in India and Pakistan (Rahman and Latif 1944; Sen and Prasad 1956; Atwal et al. 1969; Bindra and Sohi 1974; Karar et al. 2010; Sarkar et al. 2017). *Drosicha stebbingi* (Stebbing) is an important pest of *Shorea robusta* Roth and *Syzygium cumini* (L.) Skeel in India (Stebbing 1903; Varshney 2005).

In India, the archaeococcoid fauna consists of 44 species belonging to 15 genera in 4 families, and among them the family Monophlebidae contains more than 90% of the reported species (Ben-Dov 2011; García Morales et al. 2016; Varshney 1992; Unruh and Gullan 2008; Joshi et al. 2021). In India, this group of insects deserves study in the light of recent systematic concepts.

In this paper, we describe and illustrate a new archaeococcoid species, *Perissopneumon kalyaniense* sp. nov., from West Bengal, India, based on adult female morphology. The species was found feeding on *Glycosmis pentaphylla* (Retz.) DC. (Rutaceae), a perennial shrub indigenous to south and south-east Asia. The plant is used extensively within these regions as a traditional medicine for the treatment of a variety of ailments. An updated identification key to the world species of *Perissopneumon* Newstead is provided.

***Perissopneumon* Newstead (1900)**

The genus *Perissopneumon* (Hemiptera: Monophlebidae) was erected by Newstead (1900) to include his new species *P. ferox* Newstead 1900 from North Konkan, India, obtained from a nest of the ant, *Oecophylla smaragdina* Fabricius (Hymenoptera: Formicidae). The genus was placed as a synonym of *Stigmacoccus* Hempel by Cockerell (1902), but this was not accepted by Newstead (1908). Newstead (1911) described a second species *zimmermanni* under *Perissopneumon*; however, it was transferred to *Stigmacoccus* Hempel by Lindinger (1913). Morrison (1928) thought that the species might be placed in the genus *Pseudaspido proctus* Morrison. Foldi (2001) accepted this and placed *zimmermanni* in *Pseudaspido proctus*, but recently it was transferred to the genus *Aspido proctus* Newstead by Watson (2022).

Morrison (1928) resurrected the genus *Perissopneumon*, based on the original description and, despite not having examined the slide mounts of the genotype of *Perissopneumon*, he included another species, *Lophococcus convexus* Morrison (1920), in the genus.

Morrison (1927) erected the genus *Drosichiella* Morrison to contain two described species, *Monophlebus tamarinda* Green (1908) and *M. phyllanthi* Green (1923), and described a new species, *Drosichiella tectonae* Morrison (1927). He designated *Monophlebus tamarinda* as the type species of *Drosichiella* and considered the new genus to be very near to *Drosicha* Walker, but differed from it by having disk pores within the atrium of each abdominal spiracle. In his monograph, Morrison (1928) provided more details and a key to separate these three species of *Drosichiella*. Takahashi (1942) described a new species, *D. cellulosa* Takahashi 1942, from Thailand that also has disk pores within the atrium of each abdominal spiracle.

Rao (1950) redescribed *P. ferox* and synonymized *Drosichiella* with *Perissopneumon*, based on their shared character of disk pores within the atrium of each abdominal spiracle. He also removed *Lophococcus convexus* Morrison from the genus *Perissopneumon* by transferring it to his new genus *Misracoccus* Rao (1950). However, Rao (1950) was unaware of *D. cellulosa* Takahashi, so his redefined *Perissopneumon* contained only four species. Later, Tang and Hao (1995) transferred *D. cellulosa* to *Perissopneumon* and provided a key to all five species of *Perissopneumon*. The name *P. cellulosa* (Takahashi) was emended to *P. cellulosus* (Takahashi) by Williams (2011).

The placement of *Perissopneumon* Newstead in higher taxa and its generic definition are also still not stable. Morrison (1927) placed *Drosicha* Walker and *Drosichiella* Morrison in his new tribe Drosichini Morrison 1927, nested in the former subfamily Monophlebinae *sensu* Morrison (1927 1928) (currently elevated to family level, *i.e.*, Monophlebidae). Morrison (1928) placed *Perissopneumon* in a catch-all tribe Monophlebini Cockerell in the same subfamily. Gavrilov-Zimin (2018), following the traditional classification, revised the composition of the tribe Monophlebulini (within subfamily Monophlebinae *sensu* Morrison (1927 1928)) to include *Perissopneumon* along with nine other genera. The main common character he considered for this tribe was the presence of wax pores within the atrium and/or just around the opening of each abdominal spiracle.

Foldi (2001) transferred *Perissopneumon* (*Drosichiella*) *tectonae* (Morrison) to the genus *Drosicha* Walker; this was accepted by ScaleNet (García Morales et al. 2016). However, while listing species of *Drosicha* in a recent paper (Foldi 2016), Foldi did not include *tectonae* in the list. So, here we consider *Perissopneumon* Newstead as a small oriental genus containing only five valid species including *tectonae*.

MATERIALS AND METHODS

Twigs bearing mature female scale insects were collected from roadside *Glycosmis pentaphylla* in West Bengal, Nadia, at Kalyani (22.9747°N, 88.4337°E) in April 2021. Adult female specimens were preserved in 70% ethyl alcohol, and the cuticles were later prepared as permanent slide mounts following the method of Hodgson and Henderson (2000) but without staining.

The description of the adult female below is based on the slide-mounted holotype, seven slide-mounted and two alcohol preserved paratypes. Digital images of fresh and cleared mature females were captured using Nikon Eclipse Ci and Nikon SMZ 25 stereozoom microscopes fitted with a Nikon DS-Fi3 digital camera; for the study of the morphology, both the microscopes were used. Drawings of the whole-body slide mounts were prepared using a drawing tube attached to a Nikon Eclipse Ci compound microscope; following the usual convention in Coccoomorpha taxonomic illustrations, features of the dorsum are shown on the left side of the drawing, and those on the venter are shown on the right side. Around the main body outline, some details of important parts are shown enlarged but not all drawn to the same scale.

The terminology in Morrison (1928) and Foldi (2009) are used to describe the adult female. Body width measurements were taken across the widest part of the body. All measurements are given as a range in μm except for body length, body width and antennal length, which are given in millimetres (mm).

The holotype and two paratype specimens were deposited into the collection of the Zoological Survey of India, Kolkata, India (ZSI), and two paratypes were deposited into the B. K. Das collection in the Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India (BCKV).

RESULTS

TAXONOMY

Order Hemiptera
Suborder Sternorrhyncha
Infraorder Coccoomorpha
Family Monophlebidae Signoret 1875
Genus *Perissopneumon* Newstead 1900

Perissopneumon Newstead 1900

Type species: *Perissopneumon ferox* Newstead 1900.

Drosichiella Morrison 1927 (synonym)

Type species: *Monophlebus tamarinda* Green 1908.

Generic diagnosis: The definition of the genus *Perissopneumon* is nebulous due to lack of a real comprehensive understanding of the genus and its comparative status. Based on the available descriptions of five species and notes on the genus by Newstead (1900), Green (1923), Morrison (1927 1928), Takahashi (1942), Rao (1950) and most recently by Gavrilov-Zimin (2018), the generic characters of adult female may be summarized as: abdominal spiracles dorsal, numbering 7 pairs, each with prominent band of disk pores within atrium; thoracic spiracle each with a band of wax pores on the collar or just around the opening; antennae eight segmented, stout, the terminal segment longest; derm with circular to oval areoles around each pores and setal bases; multilocular pores each with a single central loculus and mostly 4–8 peripheral loculi; ventral cicatrices, if present, large, 1 or 3 in number, closely associated in a defined area situated posterior to vulva; anal opening sclerotized, with a band of wax pores.

Perissopneumon kalyaniense Das and Das sp. nov.

(Figs. 1–3)

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Material examined: *Holotype:* INDIA: West Bengal, Kalyani (22.97°N, 88.43°E), 25. iv. 2021, coll. A. Das, ex. *Glycosmis pentaphylla*, 1 adult ♀ mounted on slide (ZSI, Registration No. 12211/H15).

Paratypes: Same collection data as for holotype; 2 adult females mounted singly (ZSI), registration nos. 12209/H15 and 12210/H15; and 5 adult females mounted singly and 2 adult females in one vial of alcohol (BCKV).

Etymology: The species is named after the type locality, Kalyani, combined with the Latin suffix *-ense*, meaning “from a locality or place”.

Description of adult female: The description is based on 10 adult females (the holotype, and 9 paratypes) and measurements are only from 5 good quality slide mounted specimens only.

Appearance in life (Figs. 1A–D): Adult females found on twigs and small stems of the host. They are large, broadly elongated oval with anterior end sinuate, posterior end rounded and dorsum convex; covered with a whitish mealy powder. Body colour dull orange, legs and antennae deep brown, and eyes dark brown.

Slide-mounted adult female: body shape and size: Body elongate oval (Figs. 2A, 3A), 9.5–10.5 mm long, broadest across abdomen which is 6.0–6.5 mm wide.

Derm of slide mounted adult female (Fig. 2L): Derm densely crowded with small stout setae,

multilocular pores and circular to oval translucent cells or areoles, generally each areole surrounds the base of a seta or pore, infrequently areoles of two setae or a pore and a seta combined; areoles associated with pores are larger than those associated with setae. Derm rather thick, not sclerotized, internally with apodeme-like thickening at the inter-segmental areas; both dorsal and

ventral surfaces with a few scattered, irregularly shaped bare areas of cuticle without pores or setae (Figs. 2F, 3F) surrounded by small setae. Dorsal submargin with ten small roughly circular translucent membranous areas on each side, present singly at anterior of each of the seven abdominal spiracles (Fig. 2d), on meso- and meta-thorax, and a comparatively larger one on anterior



Fig. 1. *Perissopneumon kalyaniense* Das & Das sp. nov. A and B, adult females on branches of *Glycosmis pentaphylla* (Retz.) DC. C and D, dorsal and ventral views, respectively, of alcohol preserved adult female.

part of head.

Setae: Small, stout, straight or slightly curved setae, each 50–75 μm long (Fig. 2L), covering whole body, comparatively denser and longer in marginal and sub-marginal areas. Medium length to long setae with collared bases present at intervals along the margin, each 320–450 μm long (Figs. 2K, 3G), more numerous in posterior marginal areas of the body. Macro-setae also found on inter-antennal region (numbering 10–14, each 300–315 μm long), dermal areas laterad of labium (each 300–350 μm long), surrounding anal orifice (each 170–175 μm long), and some moderately long setae also sparsely scattered throughout.

Multilocular pores (Figs. 2N, 3I): Dorsum with only 4 types of multilocular pores, each with thickened rim and unilocular centre of various shapes: (i) multilocular pores each 8–8.5 μm in diameter, with 4 rim loculi and elliptical to pentagonal centre, abundant throughout; (ii) multilocular pores each 10.5 μm in diameter, with 5 rim loculi and elliptical to pentagonal centre, sparsely present; (iii) multilocular pores each 12–12.5 μm in diameter, with 6 rim loculi and elliptical to pentagonal centre, rarely present; (iv) multilocular pores each 8 μm in diameter, with 4 rim loculi and approximately triangular centre, frequent throughout and fairly evenly distributed.

Multilocular pores on venter same as dorsum; pores each with 4 rim loculi and both elliptical to pentagonal and triangular centres mostly distributed on anterior part of body, and pores with 5 or 6 rim loculi abundantly present around ventral cicatrices.

Antenna (Figs. 2B, 3B): Antennae stout, each 8 segmented, 1.8–2.0 mm long; each segment bearing a few medium-sized setae. Basal segment stout, broadest and quadrate; second and third subequal, cylindrical, slightly longer than wide; fourth segment cylindrical, but thinner than preceding; fifth, sixth, and seventh segments each subequal to fourth but wider at the distal end; terminal segment longest, elongate, equal to or longer than six and seven together. Lengths of individual segments: I: 200–220 μm ; II: 195–200 μm ; III: 225–250 μm ; IV: 175–200 μm ; V: 200–215 μm ; VI: 225–230 μm ; VII: 200–225 μm ; and VIII: 400–425 μm . Interantennal setae numbering 10–14, with lengths varying, 300–315 μm .

Eye: Eyes subglobose or truncately conical, each located near antennal base, 150 μm in basal diameter.

Rostrum (Figs. 2E, 3D): stout conical, obscurely 3 segmented, about 400–410 μm long; apical segment with numerous long setae, each 300–350 μm long and small sensory tuft of setae at tip.

Leg (Figs. 2C, 3C): Legs all well developed, with all the segments bearing strong setae; inner and outer edges of each tibia and tarsus beset with stout spine-

like setae. Each trochanter with a long trochanteral seta, 375–425 μm long; claw single, stout, moderately curved, bluntly pointed, with a pair of simple fragile unguis digitules. Lengths of metathoracic leg segments: coxa, 700–750 μm ; trochanter, 520–550 μm ; femur, 1200–1250 μm ; tibia, 1230–1250 μm ; tarsus, 700–720 μm long; claw stout, 150–180 μm long, moderately curved, bluntly pointed, with a pair of simple, pointed and fragile, unguis digitules not exceeding claw apex.

Thoracic spiracles (Figs. 2M, 3E): Thoracic spiracles ventral, stout, all of approximately equal size; each 300–315 μm long with atrium 300–320 μm long and 100–120 μm wide, with about 65–75 multilocular pores.

Abdominal spiracles (Figs. 2I, 3J): Abdominal spiracles dorsal, numbering seven pairs, present on abdominal segments II–VIII, each with a short sclerotized cylindrical tube or atrium with a slightly expanded inner end and circular opening, about 45–50 μm diameter, and with a band of disc pores (numbering about 18–21) in wall of atrium.

Anal opening (Figs. 2G, 3J): Anal opening surrounded by numerous long setae, each 170–175 μm long. Anal tube weakly sclerotized, long (340–360 μm), with a sclerotized inverted pear-shaped opening rim (maximum width 130–140 μm) and the rim is studded with obscured wax pores arranged mostly in a single row, some points with double pore width.

Cicatrices (Figs. 2H, 3K): Three large ventral cicatrices present, confined within a semicircular to irregularly quadrate area, posterior to vulva; median cicatrices largest, elongate, 325–350 μm long, lateral cicatrices irregular in shape, each 290–300 μm long.

Marsupial opening (Fig. 2J): Large, 500–600 μm in long margins lined with setae, each 50–75 μm long.

Diagnostic comments: *Perissopneumon kalyaniense* Das and Das sp. nov. and *P. ferox* Newstead are similar in having a single, unique type of abundantly distributed dermal pore that has four rim loculi and a tri-angular centre, an important character state that distinguishes them from other species of *Perissopneumon*. *Perissopneumon kalyaniense* resembles *P. ferox* in having three ventral cicatrices. However, *P. kalyaniense* is easily distinguished from *P. ferox* by the following combination of features (character states of *P. ferox* in parenthesis): (i) ventral derm with 4–6 rim loculi (4–8 rim loculi); (ii) Anal tube long (short), with a pear-shaped opening (circular opening), and anal opening ring having wax pores arranged mostly in a single row, some points with double pore width.

Distribution: The new species is known from Kalyani area of West Bengal, India.

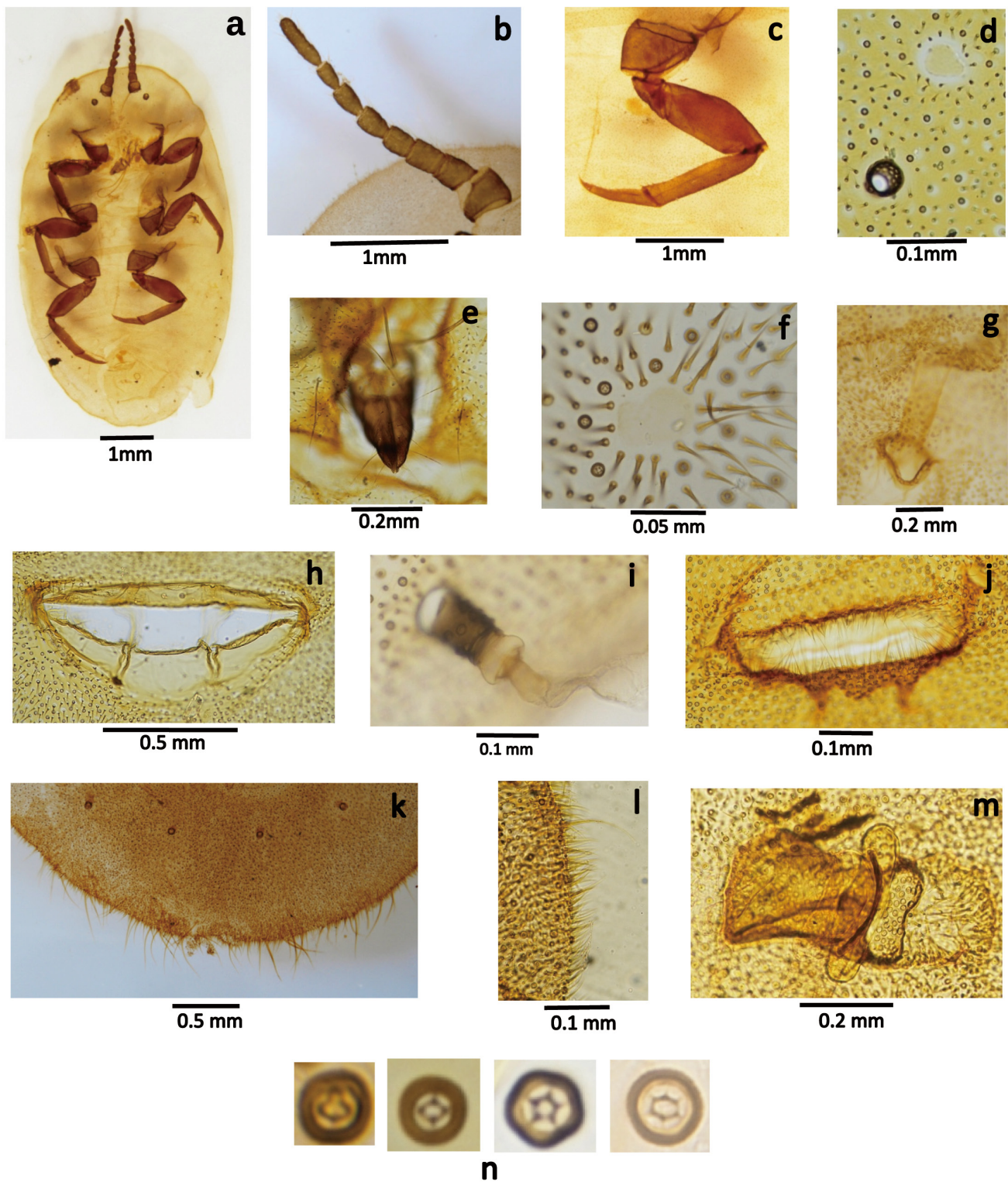


Fig. 2. Diagnostic characters of a slide-mounted adult female, *Perissopneumon kalyaniense* Das & Das sp. nov. A, whole body (ventral view). B, antenna. C, hind leg. D, abdominal spiracle and nearby translucent membranous area. E, beak. F, bare areas of cuticle without pores or setae. osteole like structure derm. G, anus. H, cicatrices. I, abdominal spiracle. J, marsupial opening. K, posterior marginal area. L, lateral marginal area. M, thoracic spiracle. N, different multilocular pores.

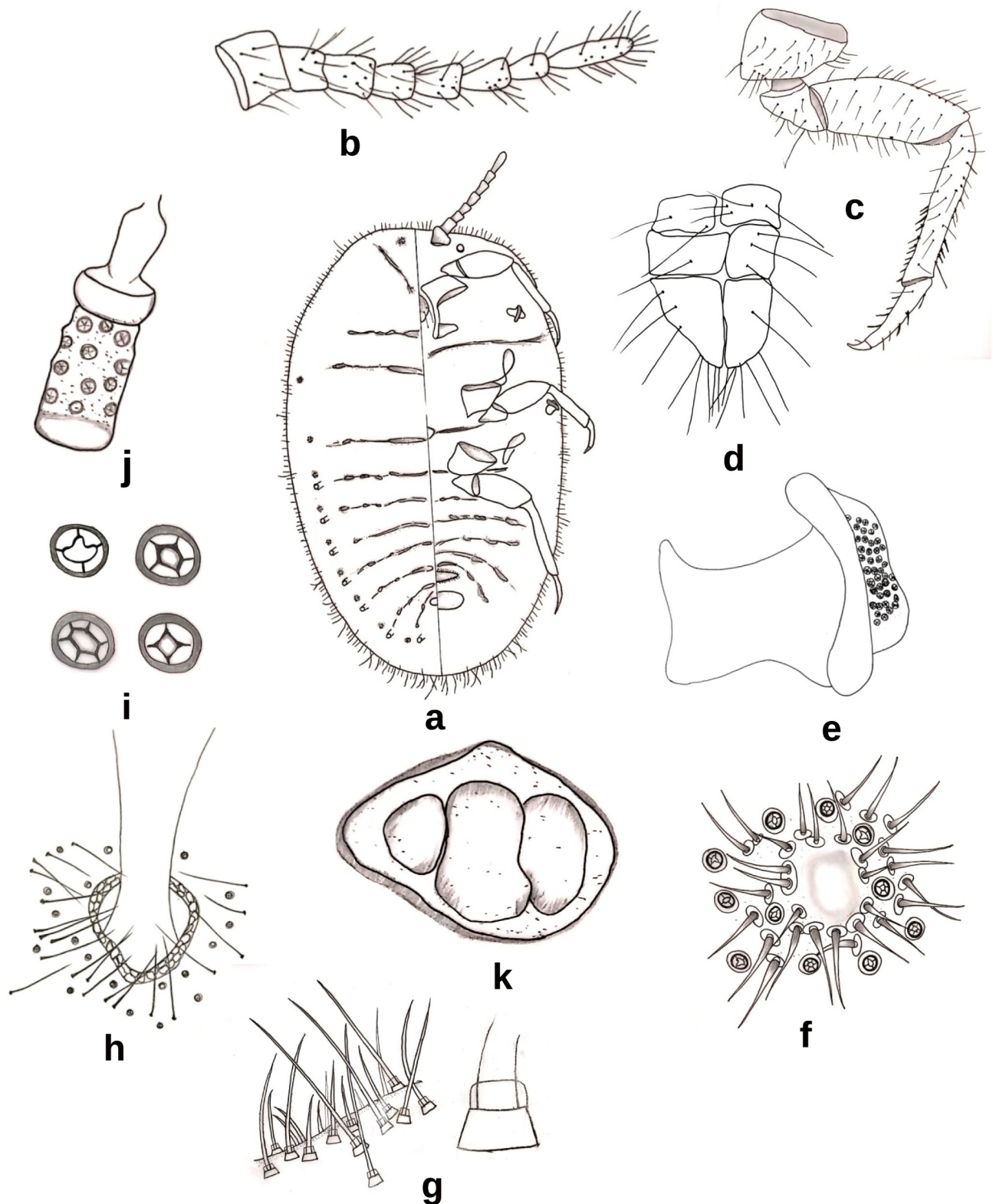


Fig. 3. Taxonomic illustration of diagnostic characters of adult female, *Perissopneumon kalyaniense* Das & Das sp. nov. A, whole body. B, antenna. C, hind leg. D, beak. E, thoracic spiracle. F, bare areas of cuticle without pores or setae. G, marginal setae. H, anus. I, multilocular pores. J, abdominal spiracle. K, ventral cicatrices.

Key to world species of *Perissopneumon* Newstead

Based on adult females and modified after Tang and Hao (1995): the key does not necessarily reflect phylogenetic relationships.

1. Derm with abundant multilocular pores each containing 4-rim loculi and an approximately triangular centre 2
- Derm without multilocular pores with approximately triangular centre centres 3
2. Ventral derm with multilocular pores each containing 4–8 rim loculi *ferox* Newstead
- Ventral derm with multilocular pores each containing only 4–6 rim loculi *kalyaniense* Das and Das sp. nov.
3. Dermal alveoli distributed densely, the distance between alveoli smaller than the diameter of a larger one; with a single ventral cicatrice *cellulosus* (Takahashi)
- Dermal alveoli distributed sparsely, the distance between alveoli greater than the diameter of a larger one; ventral cicatrices numbering three or absent 4
4. The great majority of dorsal disk pores each with more than 4 rim loculi; ventral cicatrices absent *phyllanthi* (Green)
- The great majority of dorsal disk pores with only 4 rim loculi; ventral cicatrices large, numbering 3 5
5. Atrium of each abdominal spiracle containing about 12–18 multilocular pores; derm strongly sclerotized, dark at maturity ...
- *tamarindus* (Green)
- Atrium of each abdominal spiracle containing about 25–30 multilocular pores; derm not as above *tectonae* (Morrison)

DISCUSSION

Perissopneumon Newstead is now known as a small oriental genus containing six valid species including *P. kalyaniense* described above. The taxonomy of this group is poorly studied. The definition and composition of the genus *Perissopneumon* has been changed several times since its establishment in 1900 and its generic definition still has not been clearly stated. Moreover, the higher taxonomic position of *Perissopneumon* is not stable. Morrison (1928) placed it within tribe Monophlebini Cockerell but placed *Drosichiella* Morrison (synonymized with *Perissopneumon* by Rao (1950)) in the tribe Drosichini Morrison; however, Gavrilov-Zimin (2018) accommodated *Perissopneumon* within the tribe Monophlebulini Morrison. The higher taxonomic status of *Perissopneumon* needs to be determined based on molecular data.

CONCLUSIONS

The study describes a new species of the genus *Perissopneumon* Newstead from West Bengal, India. The new species, *P. kalyaniense*, close to *P. ferox*, is the

first addition to this poorly studied genus in 75 years. We think many new *Perissopneumon* species are yet to be discovered and described. The generic characters of *Perissopneumon* are summarized based on the available descriptions of recognized members. An updated identification key to the species of *Perissopneumon* is provided. Our study further highlights the need for reassessment of the higher taxonomic placement of this small oriental genus.

List of abbreviations

ZSI, Zoological Survey of India, Kolkata, India.
BCKV, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India.

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Authors' contributions: AD collected material in the field, dissected and mounted the specimens, took pictures of the specimens and made the illustrations; AD and BKD wrote the manuscript; both the authors approved the final draft.

Competing interests: The authors declare that they have no conflict of interests.

Availability of data and materials: Holotype and some paratypes of the new species are housed at the Zoological Survey of India (ZSI), Kolkata, India and are publicly available. Other paratypes are deposited in the B. K. Das collection in the Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India (BCKV) and are available on request.

Consent for publication: All authors agree to the publication of this work in Zoological Studies.

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applicable.

REFERENCES

- Atwal AS, Bhatti DS, Sandhu GS. 1969. Some observations on the control of mango mealy bug *Drosicha mangifera* Green (Hemiptera: Coccidae). *J Res, Punjab Agr Univ* **6**(1):107–114.
- Ayyar TVR. 1930. A contribution to our knowledge of South Indian coccidae (scales and mealybugs). *Bull Agric Res Inst Pusa* **197**:1–73.
- Ben-Dov Y. 2011. An updated checklist of the scale insects (Hemiptera: Coccoidea) of the Margarodidae *sensu lato* group. *Zootaxa* **2859**:1–62. doi:10.11646/zootaxa.2859.1.1.
- Bindra OS, Sohi BS. 1974. A note on control of mango mealy bug in Punjab. *Indian J Hortric* **31**(1):102–103.
- Bourgoin T, Campbell B. 2002. Inferring a phylogeny for Hemiptera: falling into the 'autapomorphic trap'. *Denisia* **4**:67–82.
- Butcher CF. 1983. Cottony Cushion Scale, Seychelles Scale and Egyptian Fluted Scale. South Pacific Commission Advisory Leaflet, **16**:4 pp. South Pacific Commission, B.P. Noumea, New Caledonia.
- Capco A. 1959. A list of plant species of the Phillipines with special reference to field crops, fruit trees and vegetables. *Philipp J Agric* **22**:3–80.
- Cockerell TDA. 1902. The nomenclature of the Monophlebinae Coccidae. *Science* **15**:717–718. doi:10.1126/science.15.383.717.
- Foldi I. 1997. Defense strategies in scale insects: phylogenetic inference and evolutionary scenarios (Hemiptera, Coccoidea). *Mém Mus natl hist nat, Sér A Zool* **173**:203–230.
- Foldi I. 2001. A world list of extant and fossil species of Margarodidae *sensu lato* (Hemiptera, Coccoidea). *Nouv Rev Entomol* **18**:195–231.
- Foldi I. 2009. Archaeococcoid scale insects (Hemiptera: Coccoidea) from the tropical high mountains of the Andean Cordillera, South America. *Zootaxa* **2300**:1–38. doi:10.11646/zootaxa.2300.1.1.
- Foldi I. 2016. New archaeococcoids from Guyana and Malaysia, with discussion of the tribes Llaveiini and Drosichini (Hemiptera, Cocomorpha, Monophlebidae). *Bull Soc Entomol* **121**(3):289–308.
- García Morales M, Denno BD, Miller DR, Miller GL, Ben-Dov Y, Hardy NB. 2016. ScaleNet: A literature-based model of scale insect biology and systematics. Database. doi:10.1093/database/bav118.
- Gavrilov-Zimin IA. 2018. Ontogenesis, morphology and higher classification of archacococcids (Homoptera: Coccinea: Orthozoiidae). *Zoosystematica Ross* **2**:1–264. doi:10.31610/zsr/2018.supl.2.1.
- Green EE. 1908. Remarks on Indian scale insects (Coccidae), Part III. With a catalogue of all species hitherto recorded from the Indian continent. *Mem Dep Agric India (Ent Ser)* **2**:15–46.
- Green EE. 1923. XVI. – On the type of *Monophlebus* (*Drosicha*) *contrahens* (Walk.), with description of a new species from Ceylon. *Ann Mag Nat Hist (9th Ser)* **12**:168–171.
- Gullan PJ, Cook L. 2007. Phylogeny and higher classification of the scale insects (Hemiptera: Sternorrhyncha: Coccoidea). In: Zhang ZQ, Shear WA (eds) *Linnaeus Tercentenary: Progress in Invertebrate Taxonomy*. *Zootaxa* **1668**:413–425. doi:10.11646/zootaxa.1668.1.22.
- Gullan PJ, Martin JH. 2009. Chapter 244 - Sternorrhyncha: (jumping plant-lice, whiteflies, aphids and scale insects). In: Resh VH, Cardé RT (eds) *Encyclopedia of Insects*. Amsterdam, Academic Press, pp. 957–967. doi:10.1016/B978-0-12-374144-8.00253-8.
- Hodgson CJ, Henderson RC. 2000. Coccidae (Insecta: Hemiptera: Coccidae). *Fauna of New Zealand*. No. 41. Manaaki Whenua Press, Lincoln, Canterbury, 264 pp.
- Hodgson CJ, Hardy NB. 2013. The phylogeny of the superfamily Coccoidea (Hemiptera: Sternorrhyncha) based on the morphology of extant and fossil macropterous males. *Syst Entomol* **38**:794–804. doi:10.1111/syen.12030.
- Joshi S, Navik O, Kumar V. 2021. A new species of *Icerya* Signoret (Hemiptera: Cocomorpha: Monophlebidae) and a key to species of the genus found in India. *Zootaxa* **4920**(2):200–210. doi:10.11646/zootaxa.4920.2.2.
- Karar H, Sayyed AH, Arif MJ, Asfaq M, Aslam M. 2010. Integration of cultural and mechanical practices for management of the mango mealybug *Drosicha mangiferae*. *Phytoparasitica* **38**:223–229. doi:10.1007/s12600-010-0094-8.
- Kondo T, Gullan PJ, Williams DJ. 2008. Coccidology. The study of scale insects (Hemiptera: Sternorrhyncha: Coccoidea). *Corpoica Cienc y Tecnol Agropecu* **9**(2):55–61. doi:10.21930/rcta.vol9_num2_art:118.
- Kuwana I. 1922. Studies on the Japanese Monophlebinae. The genus *Narajicoccus*. Contribution 1. Department of Agriculture and Commerce of the Imperial Plant Quarantine Station. Tokyo, 58 pp.
- Lindinger L. 1913. Afrikanische Schildläuse. V. Die Schildläuse Deutsche-ostafrikas. *Jahrb der Hamburg Wiss Anst* **30**:59–95.
- Morrison H. 1920. The nondiaspine Coccidae of the Phillipine Islands, with descriptions of apparently new species. *Philipp J Sci* **17**:147–202.
- Morrison H. 1927. Descriptions of new genera and species belonging to the Coccid family Margarodidae. *Proc Biol Soc Wash* **40**:99–109.
- Morrison H. 1928. A classification of the higher groups and genera of the coccid family Margarodidae. USDA, Washington D.C. *Tech Bull* **52**:1–239.
- Munro H K, Fouche FA. 1936. A list of the scale insects and mealybugs and their host plants in South Africa. *Sci Bull/ Union of South Africa, Dept of Agriculture and Forestry* **158**:1–102.
- Newstead R. 1900. Observation on Coccidae (No. 17). *Entomol Mon Mag (2nd Ser, Vol. 11)*: **36**:247–251.
- Newstead R. 1908. On the structural characters of three species of Coccidae affecting cocoa, rubber and other plants in Western Africa. *J Econ Biol* **2**:149–157.
- Newstead R. 1911. On a collection of Coccidae and Aleyrodidae, chiefly African, in the collection of the Berlin Zoological Museum. *Mitt Zool Mus Berl* **5**:155–174.
- Rahman KA, Latif A. 1944. Description, bionomics and control of the giant mealybug *Drosicha stebbingi*, Green (Homoptera: Coccidae). *Bull Entomol Res* **32**:197–209.
- Rao PV. 1950. The status of the genus *Perissopneumon* Newstead and description of the new genus *Misracoccus* (Hemiptera: Coccoidea). *Proc R Entomol Soc Lond, Ser B: Taxonomy* **19**:114–120.
- Sarkar A, Nandi PS, Chakraborty K. 2017. Description, bionomics and bio-rational control of mango mealy bug, *Drosicha mangiferae* Glover (Coccidae: Hemiptera) at Malda, West Bengal. *Int J Appl Environ Sci* **12**(4):661–672.
- Schaefer CW. (Ed.) 1996. *Studies on Hemipteran Phylogeny*. Proc Thomas Say Pub Entomol, Entomol Soc Am, Lanham, Maryland, 244 pp.
- Sen AL, Prasad D. 1956. Biology and control of the mango mealy bug *Drosicha mangifeiae* Green. *Indian J Entomol* **18**:127–147.
- Stebbing EP. 1903. Departmental notes on Insects that Affect Forestry. 2. Office of the Superintendent of Government Printing, Calcutta, pp. 151–334.

- Takahashi R. 1942. Some injurious insects of agricultural plants and forest trees in Thailand and Indo-China. II. Coccidae. Report. Government Research Institute. Department of Agriculture. Formosa **81**:1–56.
- Tang FT, Hao JJ. 1995. The Margarodidae and others of China. Chinese Agricultural Science Technology Press Beijing, P. R. China, 738 pp.
- Unruh CM, Gullan PJ. 2008. Identification guide to species in the scale insect tribe Iceryini (Coccoidea: Monophlebidae). Zootaxa **1803**:1–106. doi:10.11646/zootaxa.1803.1.1.
- Varshney RK. 1992. A check list of scale insects and mealy bugs of South Asia, (Part-1). Rec Zool Surv India, Occ Paper **139**:1–152.
- Varshney RK. 2005. Coccid insects in the Western Shivalik Himalaya and Co-adjacent areas (Insecta: Hemiptera: Coccoidea). Rec Zool Surv India **105(3–4)**:141–168.
- Vea IM, Grimaldi DA. 2016. Putting scales into evolutionary time: the divergence of major scale insect lineages (Hemiptera) predates the radiation of modern angiosperm hosts. Sci Rep **6(23487)**:1–11. doi:10.1038/srep23487.
- Watson GW. 2022. Towards identification of the scale insects (Hemiptera: Coccoidea) of continental Africa: 2. Checklists and keys to six archaeococcoid families. Zootaxa **5105(3)**:301–356. doi:10.11646/zootaxa.5105.3.1.
- Williams DJ, Butcher CF. 1987. Scale insects of Vanuatu (Hemiptera: Coccoidea). N Z Entomol **9**:88–99.
- Williams DJ. 2011. Some words used in scale insect names (Hemiptera: Sternorrhyncha: Coccoidea). Zootaxa **3087**:66–68. doi:10.11646/zootaxa.3087.1.3.