Short Communication

Inventory of prong-gilled mayflies (Ephemeroptera: Leptophlebiidae) of India with records of endemic taxa

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26 September 2018 | Vol. 10 | No. 10 | Pages: 12389–12406
10.11609/jott.3873.10.10.12389-12406
Inventory of prong-gilled mayflies (Ephemeroptera: Leptophlebiidae) of India with records of endemic taxa

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Abstract: The present study investigated leptophlebiid mayfly in 48 sampling sites from 11 states and one union territory of India including earlier report. It deals with diagnostic characters, diversity, distribution and status of 26 species belonging to 12 genera under two subfamilies of Leptophlebiidae from India. Twenty-three of them are endemic to India inclusive of 15 species and six genera are endemic to the Western Ghats and four species are endemic to the Himalaya. Due to this high percentage of endemism, conservation of habitats and microhabitats harbouring this ancient gondwanan lineage gains priority.

Keywords: Endemic taxa, Eastern Ghats, Himalaya, identification, Western Ghats.

The Leptophlebiidae Banks, 1900 or ‘prong-gilled’ mayflies are a cosmopolitan, specious and morphologically diverse family. The oldest identified leptophlebiid fossil is Aureophlebia sinitshenkovae Peters and Peters from the Upper Cretaceous, dated to about 90 million years ago (Peters & Peters 2000), and representatives of the modern subfamilies are documented from Baltic Amber, dated to about 50 million years ago (Hubbard & Savage 1981). The Leptophlebiidae consists of approximately 110 genera and more than 600 described species, roughly a quarter of all currently recognized species of mayflies. In understudied regions like Madagascar, taxonomic work on leptophlebiids is expected to yield upwards of 15 genera and 100 species new to science (Benstead et al. 2003). Leptophlebiid mayflies are considered to have undergone extensive adaptive radiation resulting in their present occupation of different aquatic microhabitats (Tsui & Peters 1975) and highly diverse gill morphologies. Previously, gill morphology has been linked to ecological factors (Peters et al. 1964; Riek 1973; Towns & Peters 1996). Leptophlebiid has maximum diversity in the Southern Hemisphere (Edmunds, 1972). It represents one of the major stem groups within the Ephemeroptera consisting of relatively ancestral and highly derived components (McCafferty & Edmunds 1979). Leptophlebiidae is a basal lineage and a sister group to a relatively derived clade that includes a pair of sister groups, Scaphodonta and Pannota (McCafferty & Wang 2000), in addition to a more basal lineage represented by the Behningiidae (McCafferty 2004).

Faunistic studies on Leptophlebiidae have progressed significantly in India. Sporadic taxonomic studies on
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Leptophlebiidae were conducted in Himalayan streams by Dubey in the early 1970s and two species viz., *Atalophlebia chialhnia* (Dubey, 1971) and *Thraulodes marhienus* (Dubey, 1970) were described from imagos. The genus *Atalophlebia* Eaton, 1881 is known only from Australia, and the genus *Thraulodes* Ulmer, 1920 is known only from the New World and hence the species are probably misplaced at the generic level (Hubbard & Peters 1978). Detailed studies using standardized generic delineations of Eastern Hemisphere Leptophlebiidae (Peters & Edmunds 1970) have resulted in the discovery of several new species belonging to ten genera, from India. Two genera viz., *Choroterpes* Eaton, 1881 and *Thraulus* Eaton, 1881 are widely distributed, two genera viz., *Gilliesia* Peters and Edmunds, 1970 and *Isca* Gillies, 1951 have an Oriental distribution and six genera viz., *Edmunsulda* Sivaramakrishnan, 1985, *Indialis* Peters & Edmunds, 1970, *Klugephlebia* Selvakumar, Subramanian & Sivaramakrishnan, 2016, *Nathanella* Demoulin, 1955, *Notophlebia* Peters & Edmunds, 1970 and *Petersula* Sivaramakrishnan, 1984 are endemic to the Western Ghats and probably many of them are of a Gondwanan in origin. Presently, 26 species belonging to 12 genera under this family are reported in India (Sivaramakrishnan 2016; Selvakumar et al. 2016, 2017a, b). The aim of the present study is to provide diagnostic characters, extension of distribution, endemic status and comprehensive knowledge of Leptophlebiidae species from India.

**Material and Methods**

Collections were made in streams and river basins of the all over India during 2009 to 2015. The present study investigated leptophlebiid mayfly in 48 sampling sites from 11 states and one union territory of India including earlier report (Table 1). Sampling area is mountainous with waterfalls and streams, and holds promise as harboring taxa. Collecting was conducted with an aquatic D-frame net. In streams, the substrate was kick-sampled, allowing the current to carry organic debris, including insects, into the net. Waterfalls were sampled by scouring the rock surfaces by hand, allowing the current to carry insects into the net. Along stream margins and in ponds, vegetation was swept with the aquatic D-frame net. All insects were preserved into 70% ethyl alcohol. Mayfly nymphs are particularly fragile because the gills and terminal filaments detach from the body very easily. Therefore, when possible, series of specimens were collected to maximize the likelihood of obtaining intact specimens and accurate determinations. To minimize damage to specimens, mayflies were collected in containers separate from other aquatic insects. Collected samples were brought to laboratory and were examined using a Leica M205A microscope and identified using published taxonomic literature and type specimens in the Zoological Survey of India (ZSI) and Southern Regional Centre (ZSI/SRC), Chennai. Identified specimens were deposited in ZSI, Kolkata, ZSI, SRC, Chennai and Department of Zoology (DZ), The Madura College (MC), Madurai.

**Results**

**Systematic Account**

Twenty six species belonging to 12 genera under two subfamilies of Leptophlebiidae from India are documented. All genera and species are presented alphabetically for convenience. This order should in no way be regarded indicating phylogeny.

<table>
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<th>Order: Ephemeroptera</th>
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<tr>
<td>Suborder: Rectracheata</td>
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<td>Superfamily: Leptophlebioidea</td>
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<td>Family: LEPTOPHLEBIIDAE</td>
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<td>Subfamily: Atalophlebiinae</td>
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<tr>
<td>1. <em>Atalophlebia chialhnia</em> Dubey, 1971</td>
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<td>2. <em>Choroterpes (Choroterpes) kaegies</em> Selvakumar, Subramanian &amp; Chandra, 2017</td>
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<td>3. <em>Choroterpes (Choroterpes) peteri</em> Tong &amp; Dudgeon, 2003</td>
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<td>4. <em>Choroterpes (Dilatognathus) nicobarensis</em> Selvakumar &amp; Chandra, 2017</td>
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<td>5. <em>Choroterpes (Dilatognathus) nigella</em> (Kang &amp; Yang, 1994)</td>
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<td>6. <em>Choroterpes (Euthraulus) alagarensis</em> Dinakaran, Balachandran &amp; Anbalagan, 2009</td>
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<td>11. <em>Indialis badia</em> Peters &amp; Edmunds, 1970</td>
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<td>12. <em>Indialis rossi</em> Peters, 1975</td>
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<td>13. <em>Isca (Isca) purpurea</em> Gillies, 1951</td>
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<td>15. <em>Nathanella indica</em> Demoulin, 1955</td>
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<td>17. <em>Notophlebia ganeshi</em> Kluge, 2014</td>
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<td>18. <em>Notophlebia hyalina</em> Peters &amp; Edmunds, 1970</td>
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20. *Petersula courtallensis* Sivaramakrishnan, 1984
22. *Thraulodes morhieux* Dubey, 1970
23. *Thraulus gopalan* Grant & Sivaramakrishnan, 1985
25. *Thraulus semicastaneus* (Gillies, 1951)

Subfamily: Leptophlebiinae
26. *Gilliesia hindustanica* (Gillies, 1951)

Subfamily: Atalophlebiinae
diagnosis: Atalophlebiinae can be differentiated from Leptophlebiinae by the possession of square facets in the dorsal portion of the eyes of adult males (Peters & Gillies, 1995), a trait unique among hexapods, as well as by leg and styliiger plate characters (Peters 1980; Kluge 1994) and a suite of nymphal mouthpart characters [e.g., patterning and arrangement of hairs and setae and shape/emargination of the labrum (Peters 1980)].

Genus: *Atalophlebia* Eaton, 1881
Remarks: The genus *Atalophlebia* Eaton, 1881 is known only from Australia and hence the species, *Atalophlebia chialhnia* Dubey, 1971 probably misplaced at the generic level (Hubbard & Peters 1978).

1. *Atalophlebia chialhnia* Dubey, 1971
Diagnosis: *Atalophlebia chialhnia* can be differentiated by the following characters: In the subimago (i) forewing 9mm in length, 3.5mm in width, translucent brown, venation pale white; and (ii) tarsal claws similar, slender, hooked (Dubey 1971).
Distribution: Known only from type locality Alhni River (Himachal Pradesh).
Status: Endemic to the Himalaya.
Remarks: Diagnostic characters are provided based on original description. Larva and imago are unknown. Further detailed study is required to assign this species to suitable genus.

Genus: *Choroterpes* Eaton, 1881
Type species: *Choroterpes lusitanica* Eaton, 1881
Diagnosis: The *Choroterpes* complex is recognised by the following characters: in the larvae (i) a pair of slender filaments of first abdominal gill different from gills 2–6; (ii) apex of glossae provided with broad spatulate setae and (iii) posterior row of setae on the labrum arises close to its middle (except in some *Neochoroterpes*). In the adults (i) in forewing, MP (Media Posterior) symmetrical fork while in MP₂ asymmetrical; (ii) cubital area broad with four (sometimes three) intercalaries; (iii) forceps in the male abruptly widened in its basal and (iv) penes as two simple lobes, very short to elongate and lacking spines or accessory lobes (Selvakumar et al. 2013).

Distribution: Oriental, Palearctic, Afrotropical, Nearctic and Neotropical.
Status: Wide distribution.

Subgenus: *Choroterpes* s. s. Eaton, 1881
Diagnosis: This subgenus *Choroterpes* can be differentiated from other subgenera by the following combination of characters: In the larvae (i) a broad, terminal lobe on the lamina of gills 2–6 and indistinguishable characters in the adults between subgenera.

2. *Choroterpes* (*Choroterpes*) *kaegies* Selvakumar, Subramanian & Chandra, 2017 (Image 1)

Diagnosis: This species can be distinguished from all known species of *Choroterpes* (C.) by the following characters: In the larva (i) anterior median emargination of labrum broad; (ii) each femur with a dark brown spot at middle and near apex; (iii) gill 1 single and slender and (iv) upper and lower lamellae of gills 2–7 with three apical processes, median process relatively slender and longer than laterals (Selvakumar et al. 2017b).

Distribution: Himachal Pradesh and Meghalaya.
Status: Endemic to the Himalaya.
Remarks: Adult stage is unknown.
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3. Choroterpes (Choroterpes) petersi Tong & Dudgeon, 2003 (Image 2)


**Diagnosis:** This species can be differentiated from other species by the following combination of characters: In the larvae (i) abdominal gill 1 slender with dorsal and ventral portions; (ii) median projection of gills 2–7 plate-like and markedly larger and longer than laterals and (iii) labrum with three transverse rows of setae on dorsal surface, middle row without setae medially; anteromedian margin of labrum with a deep U-shaped ventral incision. In the adults (i) male genital penes each with a finger-like process on the top, acute costal projection of the hindwings and (ii) apex located approximately 2/3 distance from base (Tong & Dudgeon 2003).

**Distribution:** India (Karnataka, Kerala and Tamil Nadu) and China: Hong Kong.

**Himachal Pradesh**

**Status:** Oriental distribution.

**Remarks:** This species was originally described from Hong Kong based on reared larvae and adults in the laboratory (Tong & Dudgeon 2003). Larvae of this species from southern Western Ghats is extension of its distributional range down south to 8–11° north of equator by Selvakumar et al. (2015).

**Subgenus: Dilatognathus Kluge, 2012**

**Diagnosis:** This subgenus can be differentiated from other subgenera by the following combination of characters: In the larvae (i) abdominal gills 2–7; (ii) labrum widened with median incision; (iii) maxilla with inner-apical projection stretched or not stretched to a tusk-like process with ventro-apical flange, palp elongated and bears long filtering setae; (iv) labial palp elongated and bears long filtering setae which form regular longitudinal rows.

4. Choroterpes (Dilatognathus) nicobarensis Selvakumar & Chandra, 2017 (Image 3)

**Material examined:** 5154-5155/H13, 3 larvae, 4.iv.2012, Andaman and Nicobar Islands, Nicobar District, Great Nicobar Biosphere Reserve (GNBR), East West Road, 16th km, Galathea tributary, 6.588° N & 93.518° E, 62m, coll. E. Eyarin Jehamalar; 5156/H13, 4 larvae, 10.xi.2010, GNBR, East West Road, Govind Nagar, a stream on nature trail ½ km away from forest check post, 7.002° N & 93.528° E, 106m, coll. E. Eyarin Jehamalar; 5157/H13, 1 larva, 06.xi.2010, GNBR, East West Road, Govind Nagar, 12th km, 7.001° N & 93.528° E,
83 m, coll. E. Jayar Himalalar.

**Diagnosis:** This species can be distinguished from all other species by the structure of the maxillary apex which lacks a tusk, with well-developed ventro-apical flange and dentiseta directed distally (Selvakumar et al. 2017a).

**Distribution:** Andaman and Nicobar Islands.

**Status:** Endemic to Andaman and Nicobar Islands.

**Remarks:** Adult stage is unknown.

5. *Choroterpes (Dilatognathus) nigella* (Kang & Yang, 1994) (Image 4)

**Material examined:** 7367/H13, 3 larvae, 21.iv.2015, Arunachal Pradesh, Lower Subansiri District, Ranga River, 27.396°N, 93.757°E, 625 m, colls. K.A. Subramanian & B. Sinha; 7372/H13, 10 larvae, 23.iii.2013, West Bengal, Darjeeling (Sikkim border), Rishikhola, Rishi River, 27.169°N, 88.635°E, 554m, coll. Srimoyee Basu; 7368/H13, 5 larvae, 3.ii.2007, Meghalaya, Jaintia Hills district, Wah Malidar, Malidar Village, colls. J. Lyngdoh & Party.

**Diagnosis:** This species can be distinguished from all other species by (i) the labrum with deep median emargination and (ii) sharp semicircular impression on the dorsal surface (Kang & Yang 1994).

**Distribution:** India, Thailand, Hainan and Taiwan Islands.

**Status:** Oriental distribution.

**Remarks:** Larva and adult are known.

**Subgenus: Euthraulus** Barnard, 1932

**Diagnosis:** This subgenus *Choroterpes* can be differentiated from other subgenera by the following combination of characters: in the larvae (i) gills 2–6 bear three narrow filaments on the apex of each lamina and indistinguishable characters in the adults between subgenera.

6. *Choroterpes (Euthraulus) alagarensis* Dinakaran, Balachandran & Anbalagan, 2009 (Image 5)

**Material examined:** MCDZ/E-5, 6 larvae, 11.viii.2013, Tamil Nadu, Tirunelveli, Nambiyar river at Checkpost, 08.262°N & 77.313°E, 227m, coll. C. Selvakumar; MCDZ/E-12, 6 larvae, 11.vii.2009, Tamil Nadu, Tirunelveli, Ramanathi, above dam, 08.848°N & 77.314°E, 237m, coll. C. Selvakumar; MCDZ/E-13, 8 larvae, 20.vii.2013, Tamil Nadu, Tirunelveli, Gadana River, above dam (Kallar), 08.480°N & 77.180°E, 144m, coll. C. Selvakumar; MCDZ/E-14, 5 larvae, 17.vi.2013, Tamil Nadu, Tirunelveli, Gundur, Kannupulimettu, 08.562°N & 77.122°E, 164m, coll. C. Selvakumar; MCDZ/E-15, 7 larvae, 28.ix.2013, Tamil Nadu, Dindigul, Kodaikanal, Moolaiyar, 10.050°N & 77.145°E, 1,435m, coll. C. Selvakumar; MCDZ/E-10, 3 larvae, 29.vii.2012, Dindigul, Kodaikanal, Manjaluru river, Moolaiyaru, 10.141°N & 77.291°E, 1,216m, coll. C. Selvakumar.

**Diagnosis:** This species can be distinguished from other species by the following combination of characters. In the larvae: (i) labrum anteromedian emargination well broad and ‘U’ shaped; (ii) mandibles with outer margin slightly angled a tuft of setae at angle; and (3) apical, median and basal part of femora with dark brown spots. In the imagos: (i) hind wing dark brown marking on nodus; (ii) forceps and penes yellow and (iii) penis lobes short (Dinakaran et al. 2009).

**Distribution:** Eastern and Western Ghats.

**Status:** Endemic to the Eastern and Western Ghats.

**Remarks:** Larva and adult are known.

7. *Choroterpes (Euthraulus) nambiyarenisis* Selvakumar, Arunachalam & Sivaramakrishnan, 2013 (Image 6)

**Material examined:** MCDZ/E-11, 4 larvae, 22.ii.2010, Tamil Nadu, Tirunelveli, Nambiyar river at Checkpost, 08.262°N & 77.313°E, 227m, coll. C. Selvakumar; MCDZ/E-12, 6 larvae, 11.vii.2009, Tamil Nadu, Tirunelveli, Ramanathi, above dam, 08.848°N & 77.314°E, 237m, coll. C. Selvakumar; MCDZ/E-13, 8 larvae, 20.vii.2013, Tamil Nadu, Tirunelveli, Gadana River, above dam (Kallar), 08.480°N & 77.180°E, 144m, coll. C. Selvakumar; MCDZ/E-14, 5 larvae, 17.vii.2013, Tamil Nadu, Tirunelveli, Gundur, Kannupulimettu, 08.562°N & 77.122°E, 164m, coll. C. Selvakumar; MCDZ/E-15, 7 larvae, 28.ix.2013, Tamil Nadu, Dindigul, Kodaikanal, Moolaiyar, 10.050°N & 77.145°E, 1,216m, coll. C. Selvakumar; MCDZ/E-16, 5 larvae, 02.v.2013, Karntaka, Agumbe, Jogigudi falls, 13.295°N & 75.061°E, 514 m, coll. C. Selvakumar.

**Diagnosis:** This species can be identified by the following combination of characters: In the larvae (i) anteromedian emargination of labrum comparatively narrow and deeply cleft (‘V’ shaped), lateral margin broadly acute; (ii) mandibles with outer margin comparatively deeply angled with a tuft of setae at angle; apical and median dark brown dark brown maculae at femora and (iii) dorsal and ventral lamellae plate-like narrow and terminated in three slender subequal process, tracheae unbranched (Selvakumar et al. 2013).

**Distribution:** Karnataka, Kerala and Tamil Nadu.

**Status:** Endemic to the Western Ghats.

**Remarks:** Adult stage is unknown.

8. *Choroterpes (Euthraulus) parvula* (Gillies, 1951)

**Material examined:** 5480/H13, 1 male imago, 2 male subimagos and 2 female subimagos, 29.iii.2014,
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Diagnosis: Choroterpes (Euthraulus) parvula (Gillies, 1951) can be distinguished from other species by the following combination of characters: In imago (i) foreceps base not divided, but extended to cover base of penes in a gently rounded curve; forceps stout, four segmented, jointed, basal broad and rounded, second long and curved, arising from the outer half of the basal, third segment incompletely divided from preceding, fourth segment thick and elongate; (ii) penes simple, without appendages, skittle-shaped, continuous at the base, separated apically; and (iii) ninth sternum of female with subanal plate well developed and with a very slight apical notch (Gillies 1951).

Distribution: Chhattisgarh and Madhya Pradesh.

Status: Endemic to India.

Remarks: Larva is unknown.

Subgenus: Monochoroterpes Kluge & Jacobus, 2015

This subgenus Choroterpes can be differentiated from other subgenera by the following combination of characters: in the larvae (i) gills 1–7 unilamellate, terminated in three processes with slender, subequal processes.

9. Choroterpes (Monochoroterpes) nandini Selvakumar & Sivaramakrishnan, 2015 (Image 7)

Material examined: MCDZ/E-17, 1 male and 1 female larvae, 03.v.2013, Karnataka, Sringeri, Nanthini hole, 13.232°N & 75.104°E, 640m, colls. C. Selvakumar & K.G. Sivaramakrishnan; MCDZ/E-18, 2 female larvae, 03.v.2013; Sringeri, Srimane falls, 13.231°N & 75.104°E, 716m, colls. C. Selvakumar & K. G. Sivaramakrishnan.

Diagnosis: Choroterpes (Monochoroterpes) nandini can be distinguished from C. (Monochoroterpes) monophyllus by the following combination of characters: (i) median emargination of labrum moderately deep, without denticles; (ii) gills 2–7 without tracheation and (iii) abdominal segment 6 and 7 without colour pattern (Selvakumar et al. 2015).

Distribution: Karnataka part of the Western Ghats.

Status: Endemic to the Western Ghats.

Remarks: Adult is unknown.

Genus: Edmundsula Sivaramakrishnan, 1985

Type species: Edmundsula lotica Sivaramakrishnan, 1985

Diagnosis: This genus can be distinguished from other genera of Leptophlebiidae by the following combination characters: In adults: (i) fork of MP and fork of Icu₁ from CuA in the forewings occur about 1/3 of the
distance from the base of wings to margin; both forks symmetrical; (ii) costal margin of hind wings possesses a blunt costal projection; apex of costal projection located less than ½ distance from base of wings; (iii) claws of a pair dissimilar, one apically hooked, the other obtuse, pad-like; (iv) penes divided, tubular, broader at base and tapering towards apex; apex of each penis lobe curved ventrally and (v) ninth sternum of female cleft apically. In larvae: (i) gills present on abdominal segments 1–7; (ii) dorsal and ventral portions of lamellae of gill 1 slender and lanceolate with few tracheae; (iii) dorsal and ventral portion of lamellae of gills 2–7 lanceolate, long, and smoothly tapered near apex; (iv) segment 3 of labial palpi with a row of short heavy spines on inner dorsal margin; (v) denticles on claws progressively larger apically, apical denticle much larger and (vi) posterolateral spines occur on abdominal segments 4–9, spines progressively larger posteriorly, apices of spines on segments 8–9 sharp (Sivaramakrishnan 1985).

**Distribution:** Tamil Nadu and Karnataka.

**Status:** Endemic to the Western Ghats.

**Remarks:** Occurs in the some part of the Western Ghats.

**Genus: Indialis Peters & Edmunds, 1970**

Type species: *Indialis badia* Peters and Edmunds, 1970

**Diagnosis:** This genus can be differentiated from all other Leptophlebiid genera by the following combination of larval characters: In the larvae (i) abdominal gills 1–7 alike and slender with tracheae branched; (ii) a large tooth-like projection present on inner anterior margin of the maxillae; (iii) tarsal claws hooked, with a row of denticles that progressively larger apically and (iv) five denticles present on anteromedian emargination of labrum. In the adults: (i) more than two intercalaries in cubital area of forewings; (ii) vein of MP forked less than 1/2 of distance from base to margin and (iii) apex of each penis lobe bulbous and reduced tip, outer margin of apical half each penis lobe without a row of spinules (Peters & Edmunds 1970).

**Distribution:** Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

**Status:** Endemic to southern India.

**Remarks:** Peters and Edmunds (1970) established *Indialis* for the species *I. badia* based on one male subimago and forty nine larvae collected by W.L. Peters and J.G. Peters in Kerala and Andhra Pradesh states of India. Sivaramakrishnan (1985a) described the female imago and egg structure of *I. badia* from the Tamiraparani River, southern Western Ghats. Peters (1975) described *I. rossi* from a male imago from Kerala state.

**11. Indialis badia** Peters & Edmunds, 1970 (Image 9)

**Material examined:** MCDZ/E-22, 4 larvae, 04.vii.2009, Tamiraparani river, Papanasam, 08.423°N & 77.220°E, 108m, coll. C. Selvakumar; MCDZ/E-23, 20 larvae, 04.vii.2009, Tamiraparani River at Kallidaikurichi, 08.413°N & 77.273°E, 105m, coll. C. Selvakumar; MCDZ/E-24, 2 larvae, 28.09.2013, Kodaikanal, Moolaiyar, 10.050°N & 77.145°E, 1,216m, coll. C. Selvakumar; MCDZ/E-25, 1 larva, 09.xi.2013, Andhra Pradesh, Chittoor district, Tada falls, 13.602°N & 79.845°E, 100m, coll. C. Selvakumar; MCDZ/E-26, 1 larva, 03.v.2013,
Karnataka, Sringeri, Nanthinihole, 13.232°N & 75.104°E, 640m, coll. C. Selvakumar.

**Diagnosis:** This species can be identified by the following combination of characters: In the larvae (i) third segment of the labial palp without a row of spine on the inner dorsal margin; rather sparse or scattered setae on the outer margin the mandibles; (ii) posterolateral spines on abdominal segments 5–9; (iii) denticles on dorsal claws increase in size apically; (iv) tip of the dorsal claw strongly hooked and (v) trachea of gills branched. In the adults (i) MP forked more basally than the fork of vein Rs; (ii) Cu-A area of fore wings narrower and less developed than *I. rossi* and (iii) costal projection of hind wings narrower than *I. rossi* (Peters & Edmunds 1970).

**Distribution:** Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

**Status:** Endemic to southern India.

**Remarks:** Egg, larva and adults are known to this species.

12. *Indialis rossi* Peters, 1975

**Material reported:** California Academy of Science, 1 male imago, 22.iii.1962, Kerala, Kottayam District, Kittikanam, near Peermaade, 1,000m, colls. E.S. Ross & D.Q. Cavagnaro.

**Diagnosis:** This species can be distinguished from *I. badia* by the following combination of characters: In the adults (i) all cross veins in forewings surrounded with narrow, yellowish-brown clouds; (ii) abdominal segments 1–7 translucent and washed with brown; (iii) caudal filaments pale, with wide, dark brown annulations at articulations and (iv) costal projection of hind wings well developed and broadly rounded at apex (Peters 1975).

**Distribution:** Kerala.

**Status:** Endemic to the Western Ghats.

**Remarks:** Diagnostic characters are provided based on original description by Peters 1975. Larval stage is unknown.

**Genus: Isca Gillies, 1951**

Type species: *Isca (Isca) purpurea* Gillies, 1951

**Diagnosis:** This genus can be differentiated from all other leptophlebiid genera by the following combination of characters. In the imago, (i) hind wings absent; (ii) cross veins absent in basal 1/2 of cell C in forewings; (iii) tarsal claws dissimilar; and (iv) segments 2 and 3 of male genital forceps short. In the larvae, (i) abdominal segments extend around to venter of abdomen; (ii) dorsal and ventral portion of abdominal gills 2–6 slender and tracheae unbranched; gill 7 consists of 1 slender lamella and tracheae unbranched; (iii) claws apically hooked, and with a row of denticles; apical denticle larger; and (iv) small posterolateral spines present on abdominal segments 7–9, and spines progressively...
larger posteriorly (Peters & Edmunds 1970).

**Distribution:** Hong Kong, India, Sri Lanka and Thailand.

**Status:** Oriental distribution.

**Remarks:** Gillies (1951) established the genus *Isca* from male and female imagos of *I. purpurea* that collected in Hong Kong and India. Larva of *Isca* was described by Peters & Edmunds (1970) and two new species of *Isca* also described. Larvae of these two species were congeneric with those of *I. purpurea*. However, the adults are so morphologically distinct from *I. purpurea* and each other that two new subgenera viz., *Minyphlebia* Peters & Edmunds, 1970 and *Tanyocola* Peters & Edmunds, 1970 were established for these species by Peters & Edmunds (1970).

**Subgenus *Isca* s.s. Gillies, 1951**

**Diagnosis:** This subgenus can be differentiated from all other leptophlebiid genera by the following combination of characters: (i) vein MA forked a little more than 1/2 of distance from base to margin, fork asymmetrical; cilia present along posterior margin of wings; (ii) abdominal terga extend around onto venter of abdomen; this most marked on segment 7 but scarcely at all on segments 1 and 2; (iii) penes divided, tubular, broad, apex of each penis lobe curved inwardly and ventrally; (iv) ninth sternum of female apically cleft.

13. *Isca (Isca) purpurea* Gillies, 1951 (Image 10)

**Material examined:** MCDZ/E-27, 2 larvae, 19.ix.2009, Tamil Nadu, Tirunelveli, Tamiraparani river, Vanatherham falls, 08.625°N & 77.311°E, 263m, coll. C. Selvakumar; MCDZ/E-28, 4 larvae, 06.xi.2012, Nambiyar river, Nambikovil, 26.206°N & 77.295°E, 412m, coll. C. Selvakumar; MCDZ/E-29, 1 larva, 31.iii.2012, Kodaikanal, Gunder, 10.133°N & 77.270°E, 2,323m, coll. C. Selvakumar; MCDZ/E-30, 4 larvae, 09.xi.2013, Andhra Pradesh, Chittoor District, Tada falls, 13.602°N & 79.845°E, 100m, coll. C. Selvakumar; MCDZ/E-31, 1 larva, 03.v.2013, Karnataka, Srimanae falls, 13.231°N & 75.104°E, 716m, coll. C. Selvakumar; MCDZ/E-32, 1 larva, 03.v.2013, Karnataka, Nandini hole, 13.232°N & 77.104°E, 640m, coll. C. Selvakumar.

**Diagnosis:** This species can be differentiated from all other leptophlebiid genera by the following combination of characters. In the imago (i) hind wings absent; (ii) cross veins absent in basal 1/2 of cell C in forewings; (iii) tarsal claws dissimilar; and (iv) segments 2 and 3 of male genital forceps short. In the larvae (i) abdominal segments extend around to venter of abdomen; (ii) dorsal and ventral portion of abdominal gills 2-6 slender and tracheae unbranched; gill 7 consists of 1 slender lamella and tracheae unbranched; (iii) claws apically hooked, and with a row of denticles; apical denticle larger; and (iv) small posterolateral spinas present on abdominal segments 7–9, and spines progressively larger posteriorly (Gillies 1951).

**Distribution:** India (Andhra Pradesh, Karnataka, Tamil Nadu and West Bengal) and Hong Kong.

**Status:** Oriental distribution.

**Remarks:** Larva and adult stages are known.

**Genus:** *Klugephlebia* Selvakumar, Subramanian & Sivaramakrishnan, 2016

**Type species:** *Klugephlebia kodai* Selvakumar, Subramanian & Sivaramakrishnan, 2016

**Diagnosis:** This genus can be differentiated from all other genera of Atalophlebiinae by the following combination of characters: In the imago: (i) vein MP forked slightly less than half of distance from base to margin, MP2 attached at base to vein MP1 by a crossvein; (ii) costal margin of hindwings with bluntly convex projection; apex of costal projection located less than half distance from base; (iii) claws of a pair dissimilar, one apically hooked, the other obtuse, paddle-like and (iv) segments 2 and 3 of forceps short, apex of segment 3 rounded, base of forceps broad, inner margin forming a smooth bend near middle of forceps; penis divided, tubular, broader at base and tapering towards apex. In the larvae: (i) gills present on abdominal segments 1–7; dorsal and ventral portions of lamellae of gill 1 slender and lanceolate with branched tracheae, dorsal and ventral portions of lamellae of gills 2–7 wider and lanceolate, long and suddenly tapering at apex; (ii) fore and mid femora with a regular row of long, thin setae on outer margin; denticles on claws progressively larger apically; (iii) length of the labrum more than half of the width, lateral lobes rounded, anteriomedian emargination deeply cleft, apparently with two denticles; proximal transverse setal row laterally curved distally; (iv) maxillary palp short, with long setae on third segment and third segment of labial palp with 5–6 thick, spine-like setae on dorsal surface, inner and outer margins with short, thin setae (Selvakumar et al. 2016).

**Distribution:** Known only from type locality Kodaikanal, Palni Hills (Tamil Nadu).

**Status:** Endemic to the Western Ghats.

**Remarks:** The genus was established for the single species, *Klugephlebia kodai* Selvakumar, Subramanian & Sivaramakrishnan, 2016.
14. **Klugephlebia kodai** Selvakumar, Subramanian & Sivaramakrishnan, 2016 (Image 11)

**Material examined:** ZSI/SRC-I/E 16-18, 3 imagos and 5 larvae, 01.ii.2015, Tamil Nadu, Dindigul, Kodaiakanal, Pillar Rock stream, 10.123°N & 77.275°E, 2,185m, colls. C. Selvakumar & T. Sivaruban.

**Diagnosis:** This species can be differentiated from all other genera of Atalophlebiinae by the following combination of characters: In the imago: (i) vein MP forked slightly less than half of distance from base to margin, MP2 attached at base to vein MP1 by a crossvein; (ii) costal margin of hindwings with bluntly convex projection; apex of costal projection located less than half distance from base; (iii) claws of a pair dissimilar, one apically hooked, the other obtuse, paddle-like and (iv) segments 2 and 3 of forceps short, apex of segment 3 rounded, base of forceps broad, inner margin forming a smooth bend near middle of forceps; penis divided, tubular, broader at base and tapering towards apex. In the larvae: (i) gills present on abdominal segments 1–7; dorsal and ventral portions of lamellae of gill 1 slender and lanceolate with branched tracheae, dorsal and ventral portions of lamellae of gills 2–7 wider and lanceolate, long and suddenly tapering at apex; (ii) fore and mid femora with a regular row of long, thin setae on outer margin; denticles on claws progressively larger apically; (iii) length of the labrum more than half of the width, lateral lobes rounded, anteriomedian emargination deeply cleft, apparently with 2 denticles; proximal transverse setal row laterally curved distally; (iv) maxillary palp short, with long setae on third segment and third segment of labial palp with 5–6 thick, spine-like setae on dorsal surface, inner and outer margins with short, thin setae (Selvakumar et al., 2016).

**Distribution:** Known only from Palni Hills (Tamil Nadu).

**Status:** Endemic to the Western Ghats.

**Remarks:** The species was described both larva and adult.

**Genus Nathanella** Demoulin, 1955

**Type species:** *Nathanella indica* Demoulin, 1955

**Diagnosis:** This genus can be distinguished from all other genera by the following combination of characters: In the larvae (i) abdominal gills present on segments 1–7; and dorsal and ventral portions of lamellae leaf-like and apically terminated three projections, median longer than laterals; (ii) outer margin of mandibles smoothly curved basally and straight apically with a row of hair in the apical half; (iii) anteromedian margin of labrum straight with 5 broad-based denticles and (iv) lateral margins of the head capsule broadly expanded. In the adults (i) hind wings absent; (ii) vein MP3 of fore wings attached at base to vein MP1, and CuA by a cross vein, and attachment of vein MP3 to MP7 greater than 1/4 to 1/3 distance from base to margin; (iii) penes divided, straight with apex expanded dorsally and (iv) claw similar (Peters & Edmunds 1970).

**Distribution:** Karnataka, Kerala and Tamil Nadu.

**Status:** Endemic to the Western Ghats.

**Remarks:** Demoulin (1955) established *Nathanella* for a distinctive species, *N. indica* known only from male imagoes collected in southern India. Sivaramakrishnan et al. (1996) described female imago and larvae of *N. indica* and male and female imagoes and larvae of *N. saraswathiae* from Kerala border, near Bodi Mettu.

15. **Nathanella indica** Demoulin, 1955 (Image 12)

**Material examined:** MCDZ/E-33, 2 larvae, 28.ix.2013, Tamil Nadu, Kodaiakanal, Perumalimalai, 10.161°N & 77.331°E, 1,484m, coll. C. Selvakumar.

**Diagnosis:** This species can be distinguished from *N. saraswathiae* by the following combination characters: In the larvae: (i) median projection of abdominal gills broad and approximately twice length of laterals; (ii) tracheation in gills uniformly distributed; and (iii) distal, irregular light brown maculae on femora of legs. In the adults: (i) membrane of fore wing golden brown, cross veins in cells C and Sc narrowly clouded with brown; (ii) abdominal terga 3–7 of male brown except irregularly pale apically; and (iii) dorsal margin of styliger plate of male broadly convex (Demoulin, 1955).

**Distribution:** Known only from Palni Hills (Tamil Nadu).

**Status:** Endemic to the Western Ghats.

**Remarks:** Male imago was described by Demoulin (1955). Female imago and larva were described by Sivaramakrishnan et al. (1996).

16. **Nathanella saraswathiae** Sivaramakrishnan, Venkataraman & Balasubramanian, 1996 (Image 13)

**Material examined:** MCDZ/E-34, 4 larvae, 06.xi.2012, Tamil Nadu, Nambiyar river, Nambikovil, 08.260°N & 77.295°E, 386 m, coll. C. Selvakumar; MCDZ/E-35, 4 larvae, 10.v.2014, Kerala, Silent Valley, tributary of Kunthipuzha river, 11.274°N & 76.456°E, 923m, coll. C. Selvakumar.

**Diagnosis:** This species be identified by the following combination of characters: In the larvae (i) median projection of abdominal gills narrow and approximately 1-1/2 length of laterals; (ii) main trunk of tracheae of gills forked near distal half of lamellae and (iii) medial
and distal, irregular black maculae on femora of legs. In
the adults (i) membrane of fore wing hyaline with weak
brown tint, veins in forewing broadly clouded with dark
brown; (ii) maculae on male abdominal terga 3–7 and
(iii) dorsal margin of styliger plate of male convex with
a median shallow depression (Sivaramakrishnan et al.
1996).

**Distribution:** Kerala and Tamil Nadu.
**Status:** Endemic to the Western Ghats.
**Remarks:** This species is found above 1,400m in very
small, well-shaded, intermittent streams.

**Genus:** *Notophlebia* Peters & Edmunds, 1970

**Type species:** *Notophlebia hyalina* Peters & Edmunds,
1970

**Diagnosis:** This genus can be distinguished from
other genera of this family by following combination
of characters: In the larvae: (i) both distal and proximal
transverse setal rows regular; (ii) gills present on
abdominal segments 1–6; and (iii) apical denticle on the
tarsal claws greatly enlarged. In the adults: (i) hind wings
absent; (ii) MP of forewing without symmetric fork and
(iii) apically each penis lobe bears a slender pointed
serrate projection (Peters & Edmunds 1970).

**Distribution:** Karnataka, Kerala and Tamil Nadu.
**Status:** Endemic to the Western Ghats.
**Remarks:** This genus was established for the species
*Notophlebia hyalina* Peters & Edmunds (1970) from Tamil
Nadu. Only three species viz., *N. hyalina*, *N. ganeshi* and
*N. jobi* are described in this genus from India.

17. **Notophlebia ganeshi** Kluge, 2014 (Image 14)

**Material examined:** MCDZ/E-36, 2 larvae, 10.v.2014,
Kerala, Silent Valley, tributary of Kunthipuzha River,
11.274°N & 76.456°E, 923m, coll. C. Selvakumar;
MCDZ/E-37, 1 larva, 03.v.2013, Karnataka, Sringeri,
Srimane falls, 13.231°N & 75.104°E, 716m, coll. C.
Selvakumar.

**Diagnosis:** This species can be identified by the
following combination of characters: In the larvae (i)
abdominal gills narrower; (ii) third segment of maxillary
palp with moderately long, slender setae, situated
densely and irregularly and (iii) third segment of labial
palp with moderately long filtering setae on dorsal
side and directed apically-inward. In the adults (i)
apically each penis lobe bears a slender pointed serrate
projection straight, lobe forms convexity laterally with a
small sharp incision medially (Kluge 2014).

**Distribution:** Karnataka and Kerala.
**Status:** Endemic to the Western Ghats.
**Remarks:** The larva of this species has non-
dilatognathan mouth apparatuses.

18. **Notophlebia hyalina** Peters & Edmunds, 1970

**Material reported:** Florida A & M University, 1 male
imago, 02.i.1962, Tamil Nadu, Kanyakumari, Kunjankhuzi,
Prong-gilled mayflies of India


Diagnosis: This species can be identified by the following combination of characters: In the larvae (i) clila occur on posterior margin of fore wings; (ii) membrane of anal area of fore wings enlarged posteriorly; and (iii) penes of male genitalia tubular, straight, and pointed (Peters & Edmunds 1970).

Distribution: Known only from the type locality Kunjankhuizi, Tamil Nadu.

Remarks: Diagnostic characters are provided based on the original description. Larva is unknown.

120m, coll. F. Schmid.

20. Petersula courtallensis Sivaramakrishnan, 1984 (Image 16)


Diagnosis: This species can be distinguished by the following combination of characters: In the larvae (i) labrum expanded and angled laterally; (ii) anterior margin of lingua of hypopharynx deeply cleft; apex of submedian lobes of lingua possesses a rack like process; (iii) outer margin of basal ½ of mandibles smoothly curved, while apical ½ almost straight; a row of hairs extends from mid outer margin almost to base of incisors; (iv) abdominal gills occur on segments 1–7 and are plate-like with margins unevenly fringed with broad filamentous processes and (v) posterolateral spines occur on abdominal segments 3–9 and progressively larger posteriorly. In the adults: (i) vein MP₁ of fore wings attached at base to vein MP₁ more than 1/3 of the distance from base to margin; (ii) costal margin of hind wings convex or with a rounded costal projection; (iii) each penis lobe with ventromedially directed spine-like projection near apex; (iv) claws of a pair alike, apically hooked with an opposing hook and (v) 9th sternum of female shallowly cleft apically (Sivaramakrishnan 1984).

Distribution: Karnataka, Kerala and Tamil Nadu.

Remarks: The genus Petersula was established for P. courtrallensis from the southern Western Ghats by Sivaramakrishnan 1984. A second species, P. nathani described based on adult from the Anamalai hills of southern Western Ghats (Sivaramakrishnan & Hubbard 1984). The genus is widespread in the Western Ghats.

Genus: Petersula Sivaramakrishnan, 1984

Type species: Petersula courtrallensis Sivaramakrishnan, 1984

Diagnosis: This genus can be distinguished from other genera by the following combination of characters: In the larvae: (i) labrum expanded and angled laterally; (ii) anterior margin of lingua of hypopharynx deeply cleft; apex of submedian lobes of lingua possesses a rack like process; (iii) outer margin of basal ½ of mandibles smoothly curved, while apical ½ almost straight; a row of hairs extends from mid outer margin almost to base of incisors; (iv) abdominal gills occur on segments 1–7 and are plate-like with margins unevenly fringed with broad filamentous processes and (v) posterolateral spines occur on abdominal segments 3–9 and progressively larger posteriorly. In the adults: (i) vein MP₁ of fore wings attached at base to vein MP₁ more than 1/3 of the distance from base to margin; (ii) costal margin of hind wings convex or with a rounded costal projection; (iii) each penis lobe with ventromedially directed spine-like projection near apex; (iv) claws of a pair alike, apically hooked with an opposing hook and (v) 9th sternum of female shallowly cleft apically (Sivaramakrishnan 1984).
Prong-gilled mayflies of India

Selvakumar et al.


Material reported: Bernice P. Bishop Museum, 1 male imago, 02.v.1963, Tamil Nadu, Coimbatore, Kadamparai, 1,070m, coll. P.S. Nathan.

Diagnosis: This species can be distinguished from the only other species in the genus, *P. courtallensis* by the following characters: in imago: (i) terga 1–7 translucent and yellowish brown and washed with brown; terga 8–10 opaque brown; (ii) paired longitudinal, submedian lines present on terga 3–5; (iii) vein MP of fore wings attached at base only to vein MP, with a crossovein and (iv) length of spinline projection arising from near apex of each penis lobe nearly 1/3 length of penis (Sivaramakrishnan & Hubbard 1984).

Distribution: Known only from type locality, Anamalai Hills (Tamil Nadu).

Status: Endemic to the Western Ghats.

Remarks: Diagnostic characters are provided based on the original description. Larva is unknown.

Genus: *Thraulus* Eaton, 1881

Type species: *Thraulus bellus* Eaton, 1881

Diagnosis: The genus can be differentiated from all other genera of the Leptophlebiidae by the following combination of characters. In the imago, (i) fork of vein MP of fore wings is closer to base of wings than fork of vein Rs; (ii) 2 intercalaries occur in cubital area of fore wings; (iii) penes tubular, divided and simple; and (iv) costal projection of hind wings acute and well developed, except for the costal projection of *T. bellus* which is more rounded. In the nymph, (i) dorsal and ventral portions of abdominal gills 2–7 ovate with fringed margins; (ii) dorsal and ventral portions of abdominal gills 1 slender, lanceolate, or ovate with fringed margins, or dorsal portion slender, lanceolate and ventral portion ovate with fringed margins; (iii) lateral tips of superlingua of hypopharynx emarginated; and (iv) tarsal claws hooked and narrow and with a row of denticles that are progressively larger apically (Peters & Edmunds 1970).

Distribution: Oriental, Afrotropical and Paleartic.

Status: Wide distribution.

Remarks: Presently, this genus encompasses 15 valid species, of which three are from Paleartic, three from Afrotropical and nine from Oriental realms (Barber-James et al. 2013). In India, the genus *Thraulus* Eaton, 1881 has 3 species viz., *T. gopalani* Grant & Sivaramakrishnan, 1985 described from both imago and larvae, *T. mudumalaiensis* Soman, 1991 described only from larvae and *T. semicastaneus* (Gillies, 1951) described only from imago.

23. *Thraulus gopalani* Grant & Sivaramakrishnan, 1985 (Image 17)

Material examined: MCDZ/E-51, 4 larvae, 26.xii.2013, Tamil Nadu, Tirunelveli, Tamiraparani river, Kottumthalam, 08.4200N & 77.2130E, 181m, coll. C. Selvakumar.

Diagnosis: This species can be distinguished from all other described species of *Thraulus* by the following combination of characters: in the imago (i) claws dissimilar; (ii) forewing hyaline, veins dark brown; (iii) hindwing hyaline, costal process obtusely pointed; and (iv) ovipositor yellowish-brown, two-segmented, first segment wider basally than apically, length one and one-fourth times its width (Dubey, 1970).

Distribution: Known only from the type locality, Marhi (Himachal Pradesh).

Status: Endemic to the Himalaya.

Remarks: Diagnostic characters are provided based on the original description. Larva is unknown.

%almost straight; a row of hairs extended from mid outer margin almost to base of incisors; (iv) abdominal gills occur on segments 1–7 and plate-like with margins unevenly fringed with broad filamentous processes and (v) posterolateral spines occur on abdominal segments 3–9 and progressively larger posteriorly. In adults (i) vein MP₂ of fore wings attached at base to vein MP₁ more than 1/3 of the distance from base to margin; (ii) costal margin of hind wings convex or with a rounded costal projection; (iii) each penis lobe ventromedially directed spine-like projection near apex; (iv) claws of a pair alike, apically hooked with an opposing hook and (v) 9th sternum of female shallowly cleft apically (Sivaramakrishnan 1984).

Distribution: Karnataka, Kerala and Tamil Nadu.

Status: Endemic to the Western Ghats.

Remarks: This species is wide distribution and abundant in the Western Ghats.

22. *Thraulus marhieus* Dubey, 1970


Diagnosis: This species can be identified by the following combination of characters: in the imago (i) claws dissimilar; (ii) forewing hyaline, veins dark brown; (iii) hindwing hyaline, costal process obtusely pointed; and (iv) ovipositor yellowish-brown, two-segmented, first segment wider basally than apically, length one and one-fourth times its width (Dubey, 1970).
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Combination of characters: In the larva (i) labrum with a rectangular mesal emargination anteriorly; (ii) inner row of the dorsal setae located just anterior to middle of the labrum; (iii) outer margin of the mandibles lacks a tuft of setae at the base of the incisors; (iv) denticles on the claws decrease in size apically; and (v) abdominal gills 1 with a dorsal lanceolate portion and a ventral fimbriate lamellar portion and abdominal gills on segments 2–7 with dorsal and ventral fimbriate lamellar portions. In the adult (i) upper portion of male eyes separated; (ii) forewings with a narrow dark brown band between costal brace and vein A 

Diagnosis: Known only from the Mutha River, Pune (Maharashtra).

Status: Endemic to the Western Ghats.

Remarks: Diagnostic characters are provided based on the original description. Larva is unknown.

24. Thraulus mudumalaiensis Soman, 1991

Material reported: ZSI/SRC I-E 1a-p, female larva, 2.iv.1988, Tamil Nadu, Nilgri, Mudumalai, 950m, coll. A.K. Arumuga Soman.

Diagnosis: Thraulus mudumalaiensis can be distinguished from all other known species by the following combination of characters: In larvae: (i) claws with five minute denticles in apical set and 10 larger denticles in basal row in which the size increases medially, then decreases apically; (ii) labrum without denticles in the emargination, two rows of setae on dorsal side and an irregular intermittent setae ventrally in between two dorsal rows, a cluster of setae of either of the anterolateral side of its venter; (iii) coastal area of forewing pads hyaline, without longitudinal brown streak; (iv) mandibles with lateral sides smoothly rounded with some setae on mid region; (5) segment 2 of maxillary palp almost equal to the length of segment 1, segment 3, 0.74 the length of segment 2 and (6) segment 2 of labial palp 0.7 the length of segment 1, segment 3 a little longer than segment 2 (Soman, 1991).

Distribution: Known only from Nilgri, Tamil Nadu.

Status: Endemic to the Western Ghats.

Remarks: Diagnostic characters are provided based on the original description. Adult is unknown.

25. Thraulus semicastaneus Gillies, 1951

Material reported: British Museum (Natural History), 5 male imagoes, 13.ix.1945, Maharashtra, Pune, Mutha River, coll. M.T. Gillies.

Diagnosis: This species can be identified by the following combination of characters: in the imago (i) penes simple, narrow and divided but closely appressed; (ii) forewing translucent colourless, main veins amber, cross veins fine and numerous, two cubital intercalaries only, stigma containing 9–11 simple, sinuous vein-lets; and (iii) hindwing short, somewhat triangular, with tall costal spur and sharply upturned subcosta (Gillies 1951).

Distribution: Known only from the Mutha river, Pune (Maharashtra).

Status: Endemic to the Western Ghats.

Remarks: Diagnostic characters are provided based on the original description. Larva is unknown.

Subfamily: Leptophlebiinae

Diagnosis: Leptophlebiinae can be differentiated from Atalophlebiinae by a suite of mouthpart characters and an elongate and deeply cleft ninth sternum in adult females (Peters & Edmunds 1970; Peters 1980; Kluge 1994).

Genus Gilliesia Peters & Edmunds, 1970

Type species: Gilliesia hindustanica (Gillies)

Diagnosis: This genus can be differentiated from other genera of the Leptophlebiidae by the following combination of characters: In imago (i) hind wings present and well developed; (ii) vein MP, of the fore wings with independent of vein MP, ; (iii) female without ovipositor or egg guide; and (iv) 9th sternum of the female deeply cleft apically. In larva (i) posterolateral expansions of on abdominal segments 9 only well developed; (ii) gills long, slender and slightly forked at 2/5 basally; (iii) glossae narrow tapered, with dense thickened-long hairs on ventral surface; and (iv) length of maxilla palpi segment three more than 1.6 times length of segment 2; apical-blunted, with numerous setae (Peters & Edmunds 1970).

Distribution: China, India and Thailand.

Status: Oriental distribution.

Remarks: The genus Gilliesia Peters & Edmunds, 1970 was established for the species Thraulus hindustanicus Gillies, 1951 described based on adult specimens only. Gilliesia hindustanica is known from India (Gillies 1951; Peters & Edmunds 1970). The second species, G. pulchra Zhou, 2004, was described from Southwestern China also based on adult stages only (Zhou 2004). Recently, third species G. ratchaburiensis Boonsoong & Sartori, 2015 described based on male and female imagoes, nymphs and eggs collected in western Thailand by Boonsoong & Sartori (2015).
Table 1. Details of sampling sites with list of species reported

<table>
<thead>
<tr>
<th>State/Union territory</th>
<th>District</th>
<th>River</th>
<th>Site</th>
<th>Date of collection</th>
<th>Latitude (°N)</th>
<th>Longitude (°E)</th>
<th>Altitude (m)</th>
<th>Species collected/reported</th>
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<tbody>
<tr>
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<td>Govind Nagar</td>
<td>12th km</td>
<td>06.xi.2010</td>
<td>7.001</td>
<td>93.528</td>
<td>83</td>
<td>C. (Dilatognathus) nicobarensis Selvakumar &amp; Chandra, 2017</td>
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</tr>
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<td>Andhra Pradesh</td>
<td>Chittoor</td>
<td>Tada falls</td>
<td>09.xi.2013</td>
<td>13.602</td>
<td>79.845</td>
<td>100</td>
<td>C. (Dilatognathus) nigella (Kang &amp; Yang 1994)</td>
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<td>Kameng Frontier Division</td>
<td>15.x.1961</td>
<td>930</td>
<td>Gilliesia hindustanica (Gillies, 1951)</td>
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<td>Kabirdham</td>
<td>Sakri River</td>
<td>Chapri</td>
<td>29.iii.2014</td>
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<td>81.074</td>
<td>444</td>
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<td>Alhni River</td>
<td>Lemru</td>
<td>25.iii.2014</td>
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<td>Tunga River</td>
<td>Minu Hole</td>
<td>19.x.2015</td>
<td>13.344</td>
<td>75.061</td>
<td>655</td>
<td>C. (Choroterpes) petersi Tong &amp; Dudgeon, 2003</td>
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<td>Karnataka</td>
<td>Shimoga</td>
<td>Jogigudi falls</td>
<td>02.x.2013</td>
<td>13.295</td>
<td>75.061</td>
<td>514</td>
<td>C. (Euthraulus) nambiyarensis Selvakumar, Arunachalam &amp; Sivaramakrishnan, 2013</td>
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<tr>
<td>Karnataka</td>
<td>Shimoga</td>
<td>Nanthiri hole</td>
<td>03.x.2013</td>
<td>13.232</td>
<td>75.104</td>
<td>640</td>
<td>C. (Choroterpes) nandini Selvakumar &amp; Sivaramakrishnan, 2015; Edmundsula lotica Sivaramakrishnan, 1985; indialis badia Peters &amp; Edmunds, 1970; isca (isca) purpurea Gillies, 1951; Petersula courtallensis Sivaramakrishnan, 1984</td>
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<td>Attappadi</td>
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<td>76.3214</td>
<td>550</td>
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<td>412</td>
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<td>Pune</td>
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<td>10.i.1945</td>
<td>79.078</td>
<td>93.175</td>
<td>1,658</td>
<td>Choroterpes (Monochoroterpes) nandini Selvakumar &amp; Sivaramakrishnan, 2015; Edmundsula lotica Sivaramakrishnan, 1985; indialis badia Peters &amp; Edmunds, 1970; isca (isca) purpurea Gillies, 1951; Petersula courtallensis Sivaramakrishnan, 1984</td>
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<td>Khroang Village</td>
<td>02.iii.2016</td>
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<td>Thangasalai Village</td>
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<td>25.591</td>
<td>92.054</td>
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<td>Malidar Village</td>
<td>03.iii.2007</td>
<td>22.384</td>
<td>82.483</td>
<td>383</td>
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<td>Tamil Nadu</td>
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<td>Nambiyar</td>
<td>Nambikovil</td>
<td>23.ii.2012</td>
<td>08.260</td>
<td>77.295</td>
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<td>State/Union territory</td>
<td>District</td>
<td>River</td>
<td>Site</td>
<td>Date of collection</td>
<td>Latitude ('N)</td>
<td>Longitude ('E)</td>
<td>Altitude (m)</td>
<td>Species collected/reported</td>
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<td>08.260</td>
<td>77.295</td>
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<td>Edmundula lotica Sivaramakrishnan, 1985; Isca (Isca) purpurea Gillies, 1951; Nathanella saraswathi Sivaramakrishnan, Venkataraman &amp; Balasubramanian, 1996</td>
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<td>08.262</td>
<td>77.313</td>
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<td>Alwarkurichi</td>
<td>11.viii.2013</td>
<td>08.470</td>
<td>77.240</td>
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<td>19.ix.2009</td>
<td>08.625</td>
<td>77.311</td>
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<td>08.420</td>
<td>77.213</td>
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<td>Kallidaikurichi</td>
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<td>08.413</td>
<td>77.273</td>
<td>105</td>
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<td>Adavayinayar</td>
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<td>03.xi.2013</td>
<td>08.045</td>
<td>77.135</td>
<td>273</td>
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<td>Virudhunagar</td>
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<td>08.362</td>
<td>77.145</td>
<td>1,435</td>
<td>C. (Euthraulus) alagarenis Selvakumar, Balachandran &amp; Anbalagan, 2009; Inelialis badia Peters &amp; Edmunds, 1970</td>
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<td>Dindigul</td>
<td>Kodaikanal</td>
<td>Kodaikanal (Pillar Rock)</td>
<td>01.ii.2015</td>
<td>10.123</td>
<td>77.275</td>
<td>2,185</td>
<td>Klugephlebia kodai Selvakumar, Subramanian &amp; Sivaramakrishnan, 2016</td>
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<td>Dindigul</td>
<td>Kodaikanal</td>
<td>(Perumalimalai)</td>
<td>28.xi.2013</td>
<td>10.161</td>
<td>77.331</td>
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<td>Nathanella indica Demoulin, 1955; Petersula courtellensis Sivaramakrishnan, 1984</td>
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<td>Coimbatore</td>
<td>Kadamparai</td>
<td>02.x.1963</td>
<td>10.050</td>
<td>77.145</td>
<td>1,744</td>
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<td>Thami</td>
<td>Kurangani River</td>
<td>Bodimettu</td>
<td>21.i.2010</td>
<td>10.050</td>
<td>77.145</td>
<td>1,744</td>
<td>Notophlebia jobi Sivaramakrishnan &amp; Peters, 1984</td>
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</table>
Prong-gilled mayflies of India

Selvakumar et al.

State/Union territory | District | River | Site | Date of collection | Latitude (°N) | Longitude (°E) | Altitude (m) | Species collected/reported
---|---|---|---|---|---|---|---|---
Kanyakumar | Kunjankhuzi | 02.1.1962 | 120 | Notophlebia hysolina Peters & Edmunds, 1970
West Bengal | Darjeeling | Rishi River | Rishikhoti | 23.III.2013 | 27.169 | 88.635 | 554 | C. (Dilatognathus) nigella (Kang & Yang 1994)

26. Gilliesia hindustanica (Gillies, 1951)

Material reported: British Museum (Natural History), 4 male and 6 female imagoes, 18–23.IX.1946, West Bengal, Darjeeling, 1,524m, coll. M.T. Gillies; University of Utah and Florida A & M University, 2 male and 2 female imagoes pinned, 15 male imagoes, 10 female imagoes, 5 male subimagos and 4 female subimagos in alcohol, 15.v.1961, Assam, North East Frontier Agency, Kameng Frontier Division, Lifakpo, 930m, coll. F. Schmid.

Diagnosis: This species can be distinguished from all other known species by the following combination of characters: In the larvae (i) tibiae of forelegs equal in length to tarsi, fore femur dark brown; (ii) abdominal terga dark brown with pitch brown on terga 1–8; (iii) apex of penis lobes broad, each lobe bent laterally and then ventrally; (iv) apex of female sternum 9 with V-shaped deep median cleft and (v) costal projection well developed and rounded, apex located about 1/2 distance from base (Gillies 1951).

Distribution: Assam and West Bengal (Darjeeling).

Status: Endemic to the Himalaya.

Remarks: Diagnostic characters are provided based on the original description. Larva is unknown.

Discussion

The present study deals with diagnostic characters, diversity, extension of distribution and status of 26 species belonging to 12 genera under two subfamilies of Leptophlebiidae from India. Twenty-three of them are endemic to India inclusive of 15 species and six genera viz., Edmundsula Sivaramakrishnan, 1985, Indialis Peters & Edmunds, 1970, Klugephlebia Selvakumar, Subramanian & Sivaramakrishnan, 2016, Nathanella Demoulin, 1955, Notophlebia Peters & Edmunds, 1970 and Petersula Sivaramakrishnan, 1984 are endemic to the Western Ghats and four species are endemic to the Himalaya. Due to this high percentage of endemism, conservation of habitats and microhabitats harbouring this ancient gondwanan lineage gains priority.

References


References


Communications

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First record of Yellow-Rumped Flycatcher Ficedula zanthopygia (Hay, 1845) (Aves: Passeriformes: Muscicapidae) in eastern India
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Additional field records provide further resolution of the distribution of the Water Monitor Varanus salvator (Squamata: Varanidae) in northwestern Myanmar
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The first record of The Blue Admiral Hislopia malayensis Annandale, 1916 (Lepidoptera: Lepidoptera) from Bangladesh

First record of Hislopia malayensis Annandale, 1916 (Lepidoptera: Lepidoptera) from Bangladesh

Notes on Jasminum andamanicum N.P. Balakr. & N.G. Nair (Oleaceae) from Andaman & Nicobar Islands, India

Miscellaneous

National Biodiversity Authority