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Caption: Large Indian Civet *Viverra zibetha*, Tricoloured Munia *Lonchura malacca* and *Hoya wightii* (Medium—pencil crayon on watercolour paper) © Supriya Samanta.



A new species of flat-headed mayfly *Afronurus meenmutti* (Ephemeroptera: Heptageniidae: Ecdyonurinae) from Kerala, India

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Abstract: A new species of mayfly (Heptageniidae: Ecdyonurinae) *Afronurus meenmutti* sp. nov. is described based on larvae and imagoes from the state of Kerala, southern India. The main characteristics that distinguish the new species from all other species are in having glossae oblong with two stout spines medially; lingua of hypopharynx deeply cleft; absence of postero-lateral spines on terga and gill I slightly lobate in the nymph. Hind wing with the acute costal process; stout spine dispersed on basal and surface of forceps in the adults.

Keywords: Kallar River, mature larva, mayfly, Meenmutti falls, taxonomy, Western Ghats.

The description of the mayfly genus *Afronurus* was illustrated by Lestage (1924) from Africa. Kimmins (1937) proposed the name *Cinygmima* for a single species known from India based on adults only with penes differentiation. Wang & McCafferty (2004) and Kluge (2004) were synonymised the genus *Cinygmima* with *Afronurus* (Braasch & Freitag 2008). Besides, median titillators of penis are reduced: they are either widely separated and diminished (in *assamensis* (C.), *yoshidae* (E.), *levis* (E)), or completely lost. This apomorphy is non-unique, but does not occur in other *Heptagenia*/f5=g4. Unique apomorphy of egg equator bears several additional anchors of another structure: the additional

anchor is many times larger than a usual anchor, and in coiled condition represents a flat spiral for those reasons they were synonymized with *Cinygmima* spp. (Koss & Edmunds 1974; Kopelke 1980; Flowers & Pescador 1984; Kang & Yang 1994). *Afronurus* Lestage is an old world heptageniid genus with 66 species described (Yannai et al. 2017) and includes 48 species from the Oriental region (Kimmins 1937; Braasch & Soldan 1984, 1987; Flowers & Pescador 1984; Braasch 1987, 1990, 2005, 2011; Venkataraman & Sivaramakrishnan 1989; Kang & Yang 1994; Nguyen & Bae 2003; Zhou & Zheng 2003; Braasch & Boonsoong 2010; Braasch & Jacobus 2011; Boonsoong & Braasch 2013). In India, five species of *Afronurus* have been recorded namely *A. assamensis* Kimmins, 1937, *A. curtus* Dubey, 1971, *A. solangensis* Dubey, 1971, *A. keralensis* Braasch & Soldan, 1987, and *A. kumbakkaraensis* Venkataraman & Sivaramakrishnan, 1987. For three decades, no species has been described in India. In this study, we describe a new species, *Afronurus meenmutti*, based on all life stages, from southern India.

MATERIALS AND METHODS

The material used in the present investigation was

ZooBank: urn:lsid:zoobank.org:pub:CCF6F48F-2501-4E7D-99A3-070CB676C876

Editor: Anonymity requested.

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preserved in 95% ethanol. The nymphs were collected by kick-net method in the riffle habitats on moderate to fast-flowing streams. Ample numbers of collected mature nymphs were kept in a plastic tray filled with cobbles and pebbles in the natural habitat covered with a mosquito net (1 x 2 m). The modified emergence trap was retained until adult emergence. This emergence trap was monitored each day in the morning and evening until all adults had emerged. Imagoes were carefully removed from the net and preserved in 95% alcohol. The collected specimens were examined using a NIKON 1270i stereo zoom binocular microscope. Drawings were prepared using a camera lucida. Holotype and paratypes were deposited in the Zoological Survey of India (in alcohol), Southern Regional Centre, Chennai, Tamil Nadu, India.

RESULTS

Afronurus meenmutti Balasubramanian & Muthukatturaja sp. nov. (Figure 1–18)

urn:lsid:zoobank.org:act:6F9F7C16-2C22-4B3B-AB0D-9C3DE1232CDA

Type material: Holotype (in ethanol): Reg.No. ZSI-SRC/I/E 425, 12.v.2018, one mature nymph, India, Kallar River, Kallar, Trivandrum District, Kerala State, India, 08.711°N, 77.128°E, 839m, coll. M. Muthukatturaja & C. Balasubramanian.

Paratypes (same data as holotype): Reg.No. ZSI-SRC/I/E 426, 5 mature nymphs deposited in Zoological Survey of India (Southern Regional Centre), Chennai, Tamil Nadu.

Mature Nymph: (Figures 1–13) (preserved in 95% ethanol) Dimensions (mm): body length (excluding cerci) 6.5; cerci length 1.84 times longer than body length; median caudal filament 12.0; width of head 2.0; antennae length 1.0. General body coloration brownish-yellow; legs brown.

Head: Dorsum brownish-yellow; scape and pedicel of antennae dark brown, flagellum pale. Mouthparts: emargination of labrum slightly concave (Figure 1); anterior margin with row of stout spines, size of stout spine increases anterolaterally; dorsum with sparse long setae and a clump of hair-like setae directed anteromedially on either side of dorsomedial margin. Right mandible (Figure 2a): incisors trifurcated with numerous serrations; inner incisor with 6–9 hairs laterally; molar with a thick spine at apex, below the molar 7 thin long setae present, clump of bipectinate setae present between molar and prostheca; 1/2 of lateral margin with thin long hairs apically; prostheca

with bipectinate processes. Left mandible (Figure 2b): incisors trifurcated with serrations; below the molar three long thin setae present. Maxilla (Figure 3): maxillary palp three-segmented; segment III much smaller than segment I & II; outer margin of segment II with long thin hairs and rows of thin setae apically; 1/3 of inner margin of segment II with short spines; segment I with long hairs at inner and outer margin; galea-lacinia with three acute spines; base of galea with clump of bipectinate setae, ventral base of galea-lacinia with numerous long hairs and 9–15 thin long setae; apex of galea-lacinia with row of comb-like setae. Lingua of hypopharynx (Figure 4) deeply cleft; sublingua slender deeply curved inwardly with long setae at anterior and lateral margin. Labium (Figure 5): two segmented labial palp; basal segment larger than apical segment; outer margin of apical segment with tufts of thin setae, inner margin with clump of short spines; glossae oblong with two stout spines medially (Figure 6); ventral margin with long thin setae; outer margin of glossae with row of long bipectinate setae; posterior and mesal margins of paraglossae with row of thin spines; anterior margin with a row of long setae.

Thorax: Brown, median suture pale, small pale maculae on pro and mesonotum. Legs: femora with scattered prominent brown maculae and median transverse band in fore and hindlegs, midleg macula scattered. Foreleg (Figure 7): length of femora; tibia; tarsi; claw viz., 4.0: 3.7: 1.0: 0.4. femora with row of long monopectinate setae at outer margin, inner margin and dorsal surface with sparse spatulate setae; outer margin of tibia with row of long setae and inner margin with row of few blunt spines, mesal margin with row of few spatulate setae; mesal margin of tarsi with 3 spatulate setae; claw slender, slightly curved with 5 denticles. Midleg (Figure 8): length of femora; tibia; tarsi; claw viz., 4.0: 3.7: 1.0: 0.4. coxae with row of very short spines at dorsomedial margin; posterior margin of trochanter with row of six spatulate setae; femora, tibia, tarsi and claw similar to foreleg. Hindleg (Figure 9): length of femora; tibia; tarsi; claw viz., 4.5: 3.7: 1.2: 0.3. coxa similar to midleg; trochanter similar to midleg except seven spatulate setae at posterior margin; femora similar to midleg except few blunt spines distally; tibia of inner margin with row of spines and with three long blunt spines at apically, distal margin with long blunt spine, mesal margin with row of bipectinate hairs; tarsi with three spatulate setae at apically and with row of very short spines at inner margin; claw hooked with 5 denticles.

Abdomen: Tergum brownish-yellow, sternum yellow;

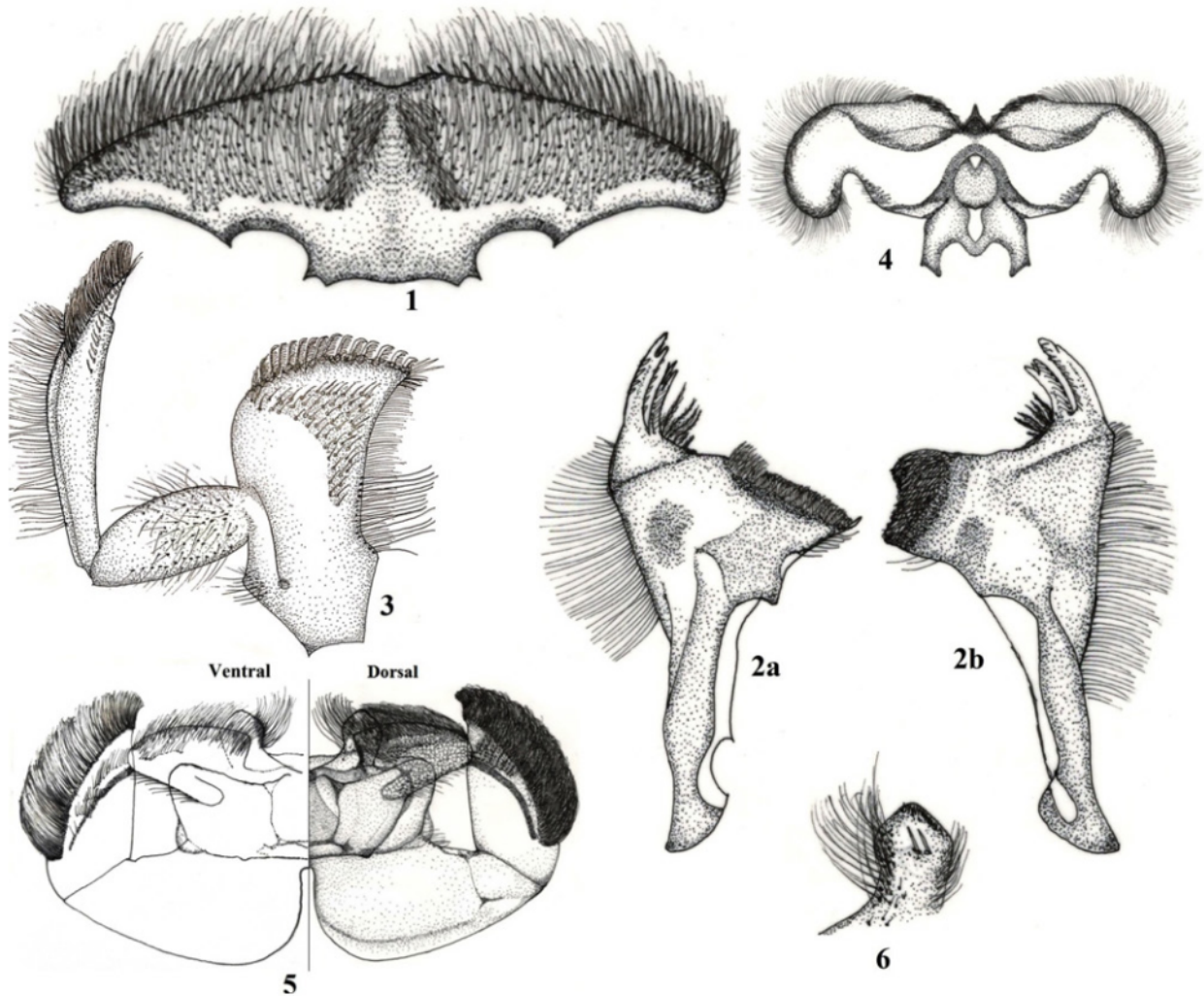


Figure 1–6. Mature larva of *Afronurus meenmutti* sp. nov. (dorsal view): 1—Labrum | 2a—Right mandible | 2b—Left mandible | 3—Maxilla | 4—Hypopharynx | 5—Labium | 6—Glossa enlarged.

posterior margin of terga IV–X with brown band medially; absence of postero-lateral spines in all terga; terga III–VII dark brown with pale yellow maculae, terga VIII–X washed yellow. Gills on abdominal segments (Figure 10–13) I–VI smoky black to translucent, dorsal lamella tracheated, ventral fimbriate; gill I slightly lobate; gill lamellae on abdominal segment 5 with acutely pointed apical elongation; gill VII single lamellate with well developed tracheation. Cerci brown at posterior region of each segment and reminders translucent.

Male imago: (Figures 14–18) (preserved in 95% ethanol) Dimensions (mm): Length: body, 7.5; forewings (Figure 14), 6.5; hindwing (Figure 15), 1.8. Width: forewings, 2.3; hindwing, 0.8; cerci, 17.0.

Head: length 0.5, light yellowish-brown, margin darker. Antennae 0.7, scape and pedicel of antennae yellowish brown, flagellum pale gray. Eyes whitish-

black. Basal half of ocelli black, apical half white. Dorsal diameter of eye 0.4; distance between compound eyes 0.1.

Thorax: Yellowish-brown, sutures pale; margins of pronotum brown; venter yellowish-brown. Legs yellowish-brown, all joints of femora, tibiae and tarsi dark brown, ratio of segments in forelegs (Figure 16) femur; tibia; tarsus viz., 2.0/ 2.15/ 3.3, claws pair alike, apically hooked with an opposing hook (Figure 17). Wings longitudinal and cross vein of fore and hind wings pale brown; membranous fore and hind wings hyaline, except cells C and Sc of fore wing pale gray; stigmatic area of forewing with 12 intercalary veins; MA forked near 1/2 of distance from the base of wing to margin; MP forked at 1/4 of distance from the base of wing to margin; anal veins with two fork; first anal area without pair of long intercalary; hind wing transparent, costal

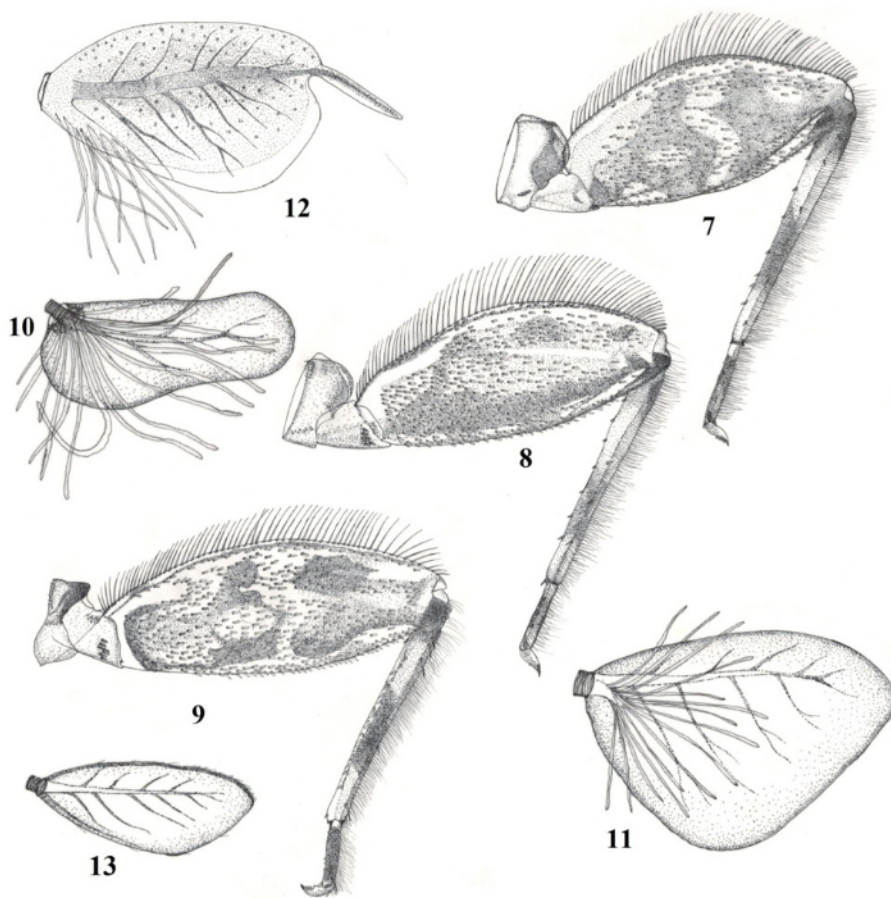


Figure 7–13. Mature larva of *Afronurus meenmutti* sp. nov.: 7—Foreleg | 8—Midleg | 9—Hindleg | 10—Gill I | 11—Gill V | 12—Gill VI | 13—Gill VII.

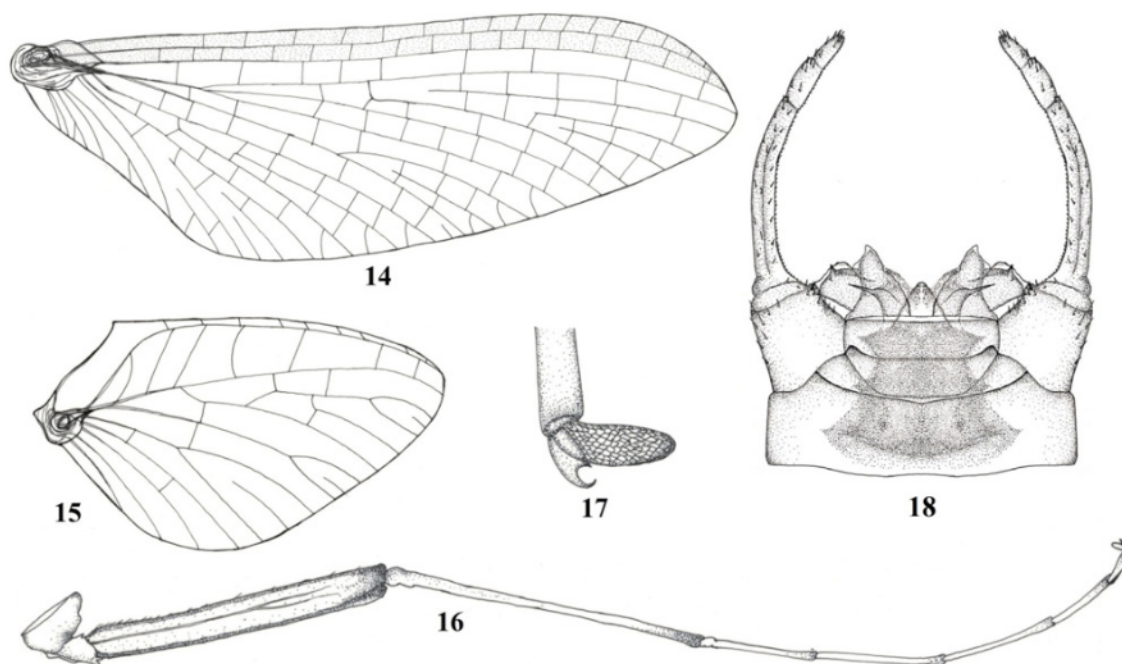


Figure 14–18. Adult of *Afronurus meenmutti* sp. nov.: 14—Forewing | 15—Hindwing | 16—Foreleg | 17—Foreclaw | 18—Genitalia (ventral view).

process acute.

Abdomen: Terga I–X washed with dark brown medially; terga washed yellow laterally except terga VII–X washed with yellowish-brown, lack of marking in postero-lateral edges of abdominal terga, terga I–X dark brown band on posterior margin medially; sterna yellowish-brown. Genitalia (Figure 18) forceps 0.7; penes 0.251; penes pale yellow; basal half of forceps uniformly washed with yellowish-brown, apical half pale brown; stout spine dispersed on inner and outer margin of forceps; outer lobe of penis much broader and slightly elevated; median titillators of penes well developed and prominent; cerci pale brown, annulations at articulations paler.

Female imago: (preserved in 95% ethanol) Dimensions (mm): Length: body, 8.5; forewings, 8.1; hindwing, 2.1. Width: forewings, 2.6; hindwing, 0.9; cerci, 19.0.

Head: Length 1.0, dark brown, margin darker. Antennae 0.8, scape, pedicel and flagellum of antennae as in male imago. Eyes and ocelli black. Dorsal diameter of eye 0.35; distance between compound eyes 0.8.

Thorax: Brownish-yellow, venter pale yellow; carinae darker; sutures paler. Legs femora of foreleg brownish-yellow remainders as in male imago, middles and hindleg yellow. Wings details as in male imago.

Abdomen: terga I–X yellowish-brown, posterior edges of all terga with dark brown band. Sterna yellow. Cerci pale yellow, annulations at articulation paler.

Etymology

The described new species is named after the place of collection, Meenmutti falls of Kallar River, Thiruvananthapuram district, Kerala.

Diagnosis

The larvae of *Afronurus meenmutti* sp. nov. can be separated from all other species by the following combination of characters: (i) lingua of hypopharynx deeply cleft; (ii) glossae oblong with two stout spines medially (iii) gill I slightly lobate (Figure 10); (iv) gill lamellae on abdominal segment V with acutely pointed apical elongation; (v) absence of postero-lateral spines on terga; (vi) maculae on midleg scattered (Figure 7–9). The imagoes of *Afronurus meenmutti* sp. nov. can be separated from all other species by the following combination of characters: (i) hind wing with acute costal process; (ii) outer lobe of penis much broader and slightly elevated; (iii) stout spines on forceps.

DISCUSSION

The flat-headed mayfly genus *Afronurus* has been recorded in the Palearctic and Oriental regions. In India, six species have been recorded. Of these, *A. kumbakkaraiensis* and *A. meenmutti* sp. nov. have all life stages described, whereas *A. assamensis*, *A. curtus*, and *A. solangensis* are known from adults and only the larvae of *A. keralensis* has been described.

The larvae of *A. meenmutti* sp. nov. differs from *A. kumbakkaraiensis* and *A. keralensis* by the following combination of characters: 1) gill I slightly lobate, 2) gill lamellae on abdominal segment V with acute apical elongation, 3) lingua of hypopharynx deeply cleft, 4) posterior-lateral spines absent on terga, 5) glossae oblong with 2 spines medially.

Male imagoes of *A. meenmutti* sp. nov. can be distinguished from *A. kumbakkaraiensis* and *A. assamensis* by the following combination of characters: (i) stout spine dispersed on basal and surface of forceps and (ii) outer lobe of penis much broader and slightly elevated. Female imagoes of *A. meenmutti* sp. nov. can be distinguished from *A. kumbakkaraiensis*, *A. assamensis*, *A. curtus*, and *A. solangensis* by the following combination of characters: (i) stigmatic area of forewing with 12 intercalary; (ii) size of fore and hind wings are smaller.

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