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New findings of the *Caenis ulmeriana*-group (Ephemeroptera: Caenidae) in the Western Ghats, India

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ABSTRACT. *Caenis ulmeriana* Malzacher, 2015 is recorded for the first time from the Western Ghats, India. Prior records of this species encompass Java, Sumatra, Thailand, Myanmar, and the Philippines. Notably, the Indian population of *C. ulmeriana* showcases variability, including slight changes in the shape of forceps in the male subimago and increased denticulation in the midclaw, a reduced number of setae in the Y-ridge of tergalius II, and differing shape of sternum IX in the larvae compared to other continental and island populations. The species number of *Caenis* Stephens, 1835 has now increased to twelve in India. A distributional map detailing the range of *C. ulmeriana* in the Oriental region is also provided herein.

Keywords: *Caenis*, mayflies, morphological variability, new record, Tamil Nadu

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INTRODUCTION

The genus *Caenis* Stephens, 1835 is the largest mayfly genus in terms of species number which accounts for about 165 species based on published records and globally widespread genus, except in the New Zealand, Antarctica and various oceanic islands (Malzacher, 2022; Srinivasan et al., 2023b). However, Indian Caenidae has ineffectively been investigated compared to other parts of the Oriental region with only two genera. So far, five species of *Clypeocaenis* Soldán, 1978 (Muthukatturaja et al., 2020; Balasubramanian & Muthukatturaja, 2021; Srinivasan et al., 2022) and seven species of *Caenis* (Malzacher, 2015; Srinivasan et al., 2021, 2023a, 2023b; Muthukatturaja & Balasubramanian, 2021) have been discovered in the last decade. However, the number of undiscovered species in Caenidae is probably high compared to the discoveries that were made. Until now, twelve species of *Caenis* were recorded in India: *C. incurva* Malzacher, 2015, *C. picea* Kimmins, 1947, *C. piscina* Kimmins, 1947, *C. srinagari* Traver, 1939 from North India and *C. kimminsis* Ali, 1967, *C. maratha* Malzacher, 2015, *C. americani* Srinivasan, Sivaruban, Barathy, Malzacher & Isack, 2021, *C. maduraiensis* Balasubramanian & Muthukatturaja, 2021, *C. kaegies* Srinivasan, Sivaruban, Barathy & Isack, 2023, *C. venkataramani*

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Srinivasan, Sivaruban, Barathy & Isack, 2023, *C. arunachalami* Srinivasan, Sivaruban, Barathy & Isack, 2023 and *C. limai* Srinivasan, Sivaruban, Barathy & Isack, 2023 from South India. However, the validity of *C. kimminsis* is highly questionable by several authors (Staniczek et al., 2020; Srinivasan et al., 2021) and Srinivasan et al. (2023a) proposed *C. kimminsis* as 'species inquirenda'.

The Western Ghats of India span a length of approximately 1600 kilometers, stretching from Gujarat in the west to Kerala in the south. Renowned as a global biodiversity hotspot, as designated by Myers et al. (2000), this region has an exceptional array of endemic flora and fauna. Additionally, the presence of diverse geo-climatic barriers and gradients further underscores the significance of the Western Ghats as a landscape for investigating evolutionary processes and resulting phylogeographical patterns (Sivaramakrishnan et al. 2023). Continuing the ongoing exploration of mayflies in this region, *Caenis ulmeriana* Malzacher, 2015, has been documented for the first time in the southern Western Ghats based on larval specimens. This discovery adds to the growing understanding of mayfly diversity and distribution within this biodiverse region.

MATERIAL AND METHODS

The larvae of the new record were collected in December 2020 by hand-picking from the Anai Pillayar Kovil Dam in the Theni district in Tamil Nadu. The collected specimens were preserved in 80% ethanol. The morphological characters were studied with the help of LABOMED Luzeo 6Z stereo zoom and LABOMED Lx400 microscopes and photos were acquired using a MiaCam CMOS AR 6 pro microscope camera and editing of photos was done by Adobe Photoshop ver 7.0. The distributional map was done with the help of the software SimpleMappr (Shorthouse, 2010). The subimaginal characters are extracted from the male last instar larva, as the genital structures didn't change during larval and subimaginal moult (Kluge, 2004). The species identification is based on the original description and keys of Malzacher (2015) and Malzacher & Sangpradub (2021) respectively, and the derivation of terminology is mostly based on Malzacher (1991, 2015). The materials are deposited in the American College Museum (AMC), Madurai, Tamil Nadu, India.

RESULTS

Taxonomic hierarchy

Class Insecta Linnaeus, 1758

Order Ephemeroptera Hyatt & Arms, 1891

Family Caenidae Newman, 1853

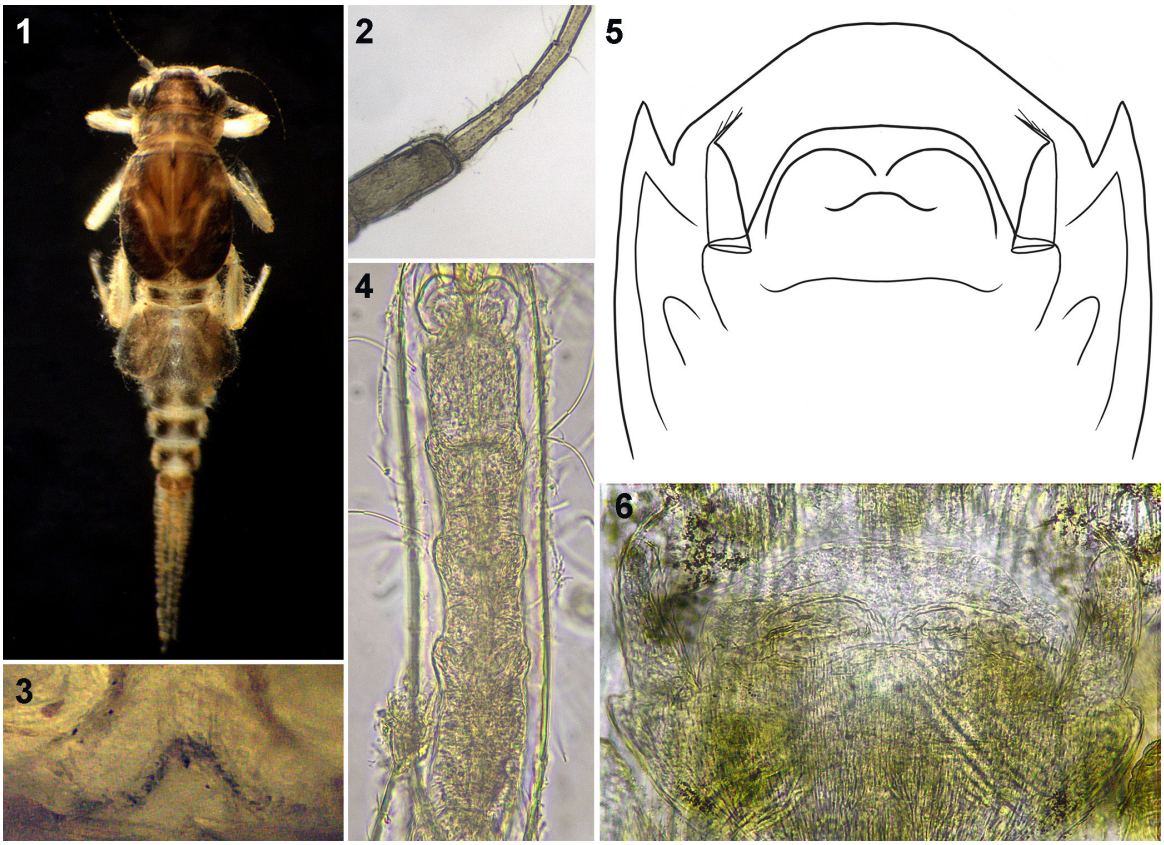
Genus *Caenis* Stephens, 1835

***Caenis ulmeriana* Malzacher, 2015** (Figs 1–28)

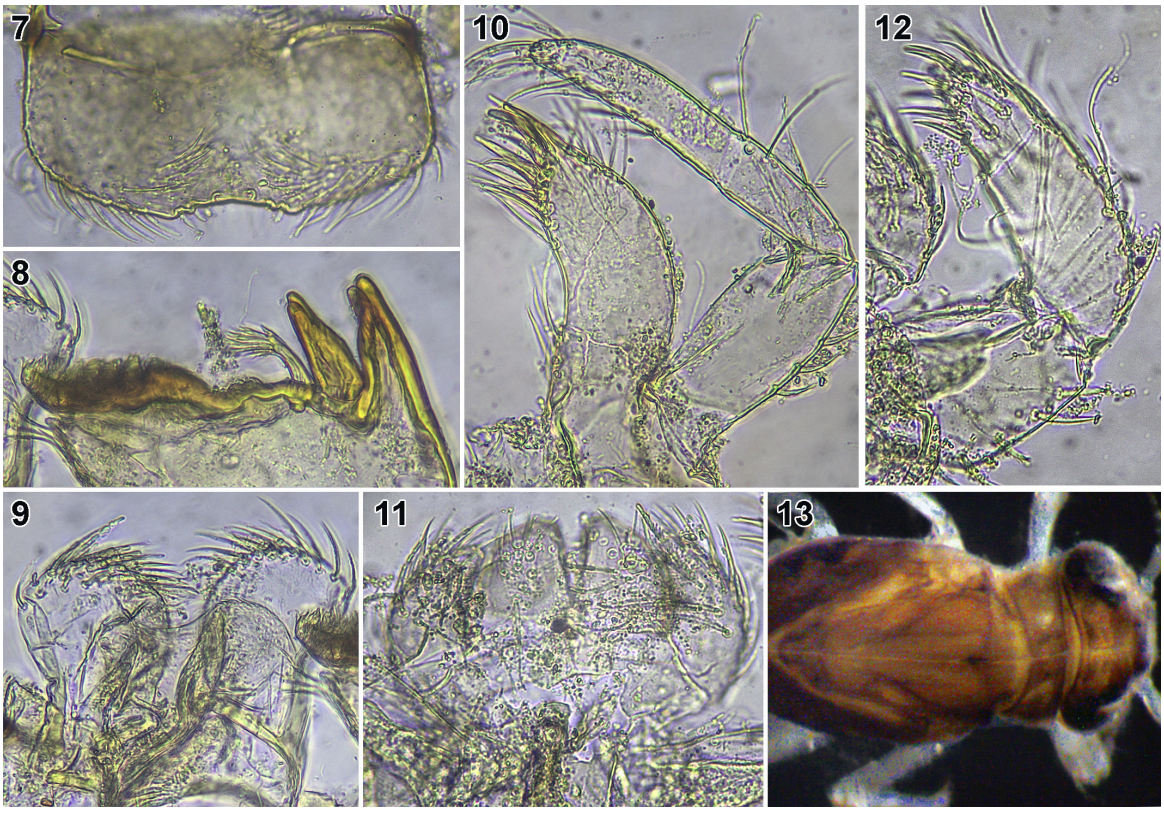
Material examined. One male mature larva (AMC/ZN/279) and two female larvae (AMC/ZN/280), India, Tamil Nadu, Theni district, Anai Pillayar Kovil Dam, 10°03′07″N, 77°34′02″E; 336 m. a.s.l., 23-XII-2020, leg. P. Srinivasan & R. Isack.

Distribution. The species is reported from India (**new record**), Java (Malzacher, 2015), Sumatra (Malzacher, 2015), Thailand (Malzacher, 2015; Malzacher & Sangpradub, 2021), Myanmar (Malzacher, 2023) and Philippines (Malzacher, 2023) (Fig. 28).

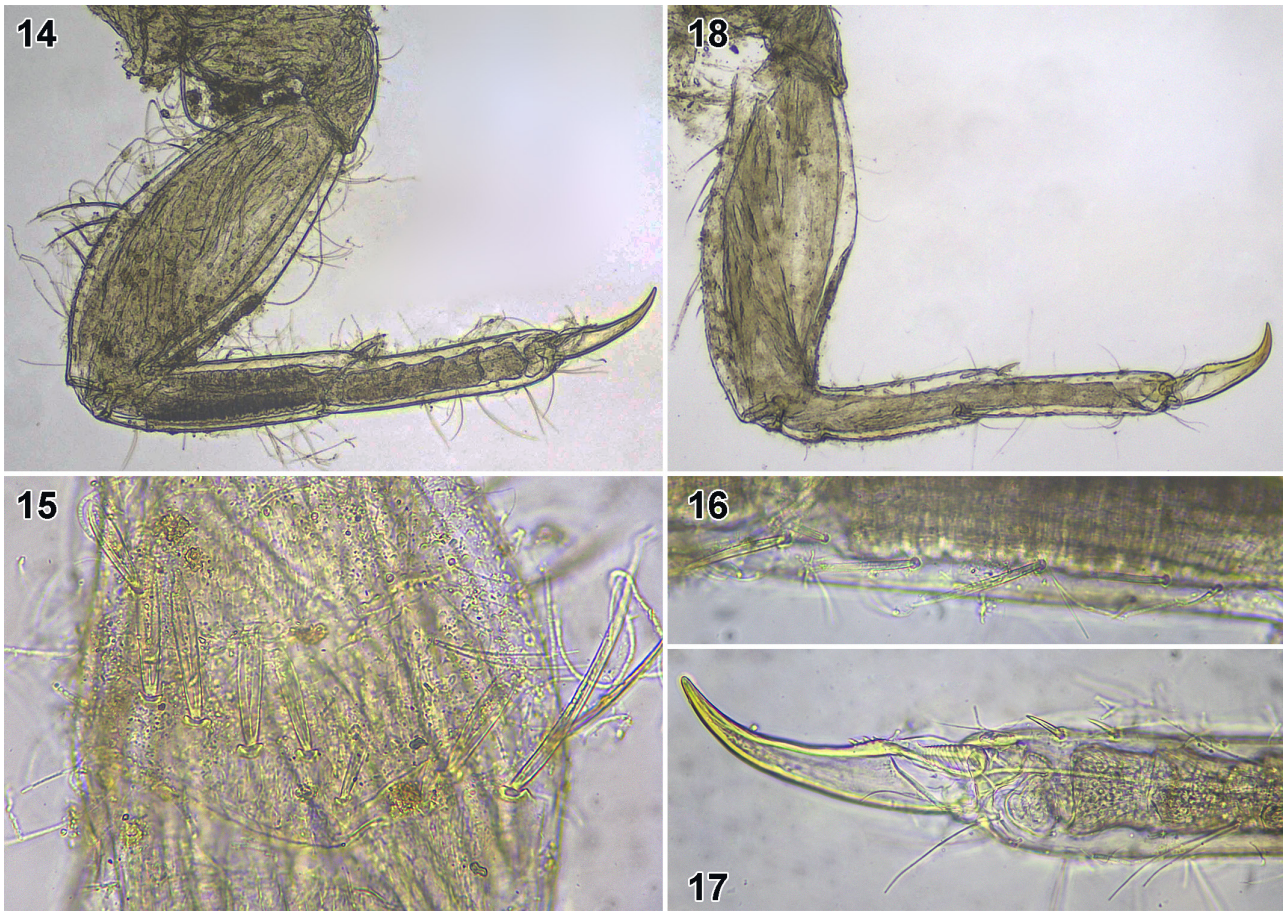
Diagnostic characters. *Caenis ulmeriana* can be distinguished from all other *Caenis* species by the following combination of characters: Imago (Imaginal characters extracted from the male last instar larva): base of antennal flagellum not dilated (Fig. 2); prosternal triangle forming cone-shaped structure (Fig. 3); foretarsus segments 2–4 each with a lateral and median projections (Fig. 4); penis broad and rounded, ventral fold forming a semicircular or semielliptical process (Fig. 5); forcipes moderate, straight, sides apically converging with a rigid elongated spine or a moderate spine equipped with an apical tuft of long spines (Fig. 6).



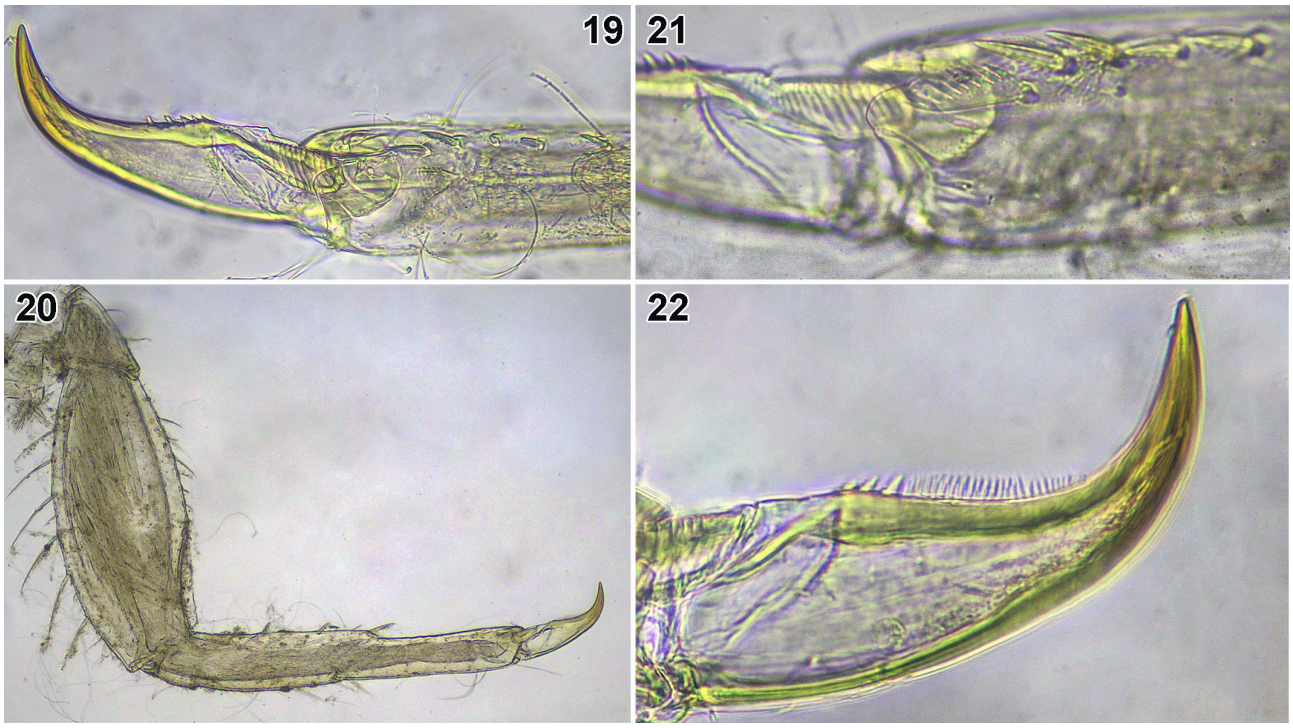
Figures 1–6. *Caenis ulmeriana* Malzacher, 2015. **1.** Male mature larva, dorsal view; **2.** Antenna; **3.** Prosternal triangle; **4.** Fore tarsomeres; **5, 6.** Visible subimaginal genitalia.



Figures 7–13. Larva of *Caenis ulmeriana* Malzacher, 2015. **7.** Labrum; **8.** Right mandible; **9.** Hypopharynx; **10.** Maxilla; **11.** Glossa and paraglossa; **12.** Labial palp; **13.** Head and thorax



Figures 14–18. Larva of *Caenis ulmeriana* Malzacher, 2015. **14.** Foreleg; **15.** Closer view of transverse row of setation in forefemur; **16.** Closer view of setation in foretibia; **17.** Foreclaw; **18.** Midleg.



Figures 19–22. Larva of *Caenis ulmeriana* Malzacher, 2015. **19.** Midclaw; **20.** Hindleg; **21.** Closer view of setation in hindtarsus; **22.** Hindclaw.