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## A new species of the genus *Cloeon* Leach, 1815 from China (Ephemeroptera: Baetidae)

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### ABSTRACT

*Cloeon micki* sp. n., a new species of baetid mayfly from China is described and illustrated based on larval and imaginal stages associated by laboratory rearing. The new species is characterised by the presence of a dark brown or dark purple elliptical marking on abdominal tergites II and V, which readily distinguishes it from other members of the genus *Cloeon* Leach, 1815. The known distribution of the new species is Hong Kong, Guangdong and Henan provinces.

<http://www.zoobank.org/urn:lsid:zoobank.org:pub:7ED660DD-513B-4A0E-AC68-877D7DC5E7D4>

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### KEYWORDS

Ephemeroptera; Baetidae; mayfly; taxonomy; *Cloeon*; new species; China

## Introduction

*Cloeon* Leach, 1815 was one of the first genera of mayflies to be separated from *Ephemera* Linnaeus, 1758 and was established (along with *Baetis* Leach, 1815) by Leach. This genus has often been confused with *Procloeon* Bengtsson, 1915 and *Centroptilum* Eaton, 1869, and there are some disagreements on its systematic position (Gillies 1949; Sowa 1975; McCafferty and Waltz 1990; Kluge and Novikova 1992). The generic concept of *Cloeon* was recently revised and clarified by Kluge (2012, 2016). It is characterised by gills with widened double lamellae on abdominal segments I–VI and single gill on VII in the larval stage, a male imago with a rounded or conical penial bridge, and a female imago that usually has a forewing with a coloured margin.

*Cloeon* is one of the most widespread and speciose genera of Baetidae (Gillies 1980, 1985, 1988), with an almost cosmopolitan distribution (Kluge and Novikova 1992). Until recently, however, *Cloeon* was absent from the Neotropics, but is now represented there by the Afrotropical species *C. smaeleni* Lestage, 1924 that has become established in Brazil (Salles et al. 2014) and the Holarctic species *C. dipterum* (L., 1761) has been discovered in Argentina and Chile (Banegas et al. 2020). *Cloeon*

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larvae are most commonly encountered in lentic habitats but are also found in slowly flowing stream or river reaches where they are typically associated with aquatic plants or trailing vegetation along the banks. The Chinese species of *Cloeon* have received little study, although imaginal stages of eight species have been recorded by Navás (1930, 1933a,b) and You and Gui (1995). In 1998, we found an unknown *Cloeon* species in Hong Kong which we suspected was new to science (Tong 2001). The first author (X.T.) then sent the specimens (including larvae and both sexes of imagoes) to Mick T. Gillies who, in early 1999, determined that it was indeed an undescribed species (Mick T. Gillies, personal communication, 1999). In the present paper, we describe this new species of *Cloeon* from China based on the larval and imaginal stages of individuals associated by laboratory rearing.

## Material and methods

Larvae of the new species were collected with a D-frame net from aquatic plants at the various collection sites (see below). Some of the larvae were immediately preserved in vials containing 90% ethanol, while a subset of living individuals with well-developed wing pads were transported to the laboratory in a plastic container containing pond water and aquatic plants. Individuals were reared to emergence in the laboratory, and each reared imago together with its mature larval exuvia and subimaginal skin were stored in single vial containing 90% ethanol. Preserved specimens of both stages were dissected under the stereomicroscope and mounted on slides in Hoyer's solution for examination, illustration and photography using a ZEISS Imager A1 microscope with a Photometrics CoolSNAP digital camera attached. Measurements and ratio ranges given presented herein are for preserved mature larvae and imagoes reared in the laboratory only. Type specimens have been deposited in the Insect Collection, South China Agricultural University (SCAU), Guangzhou, China.

## Results

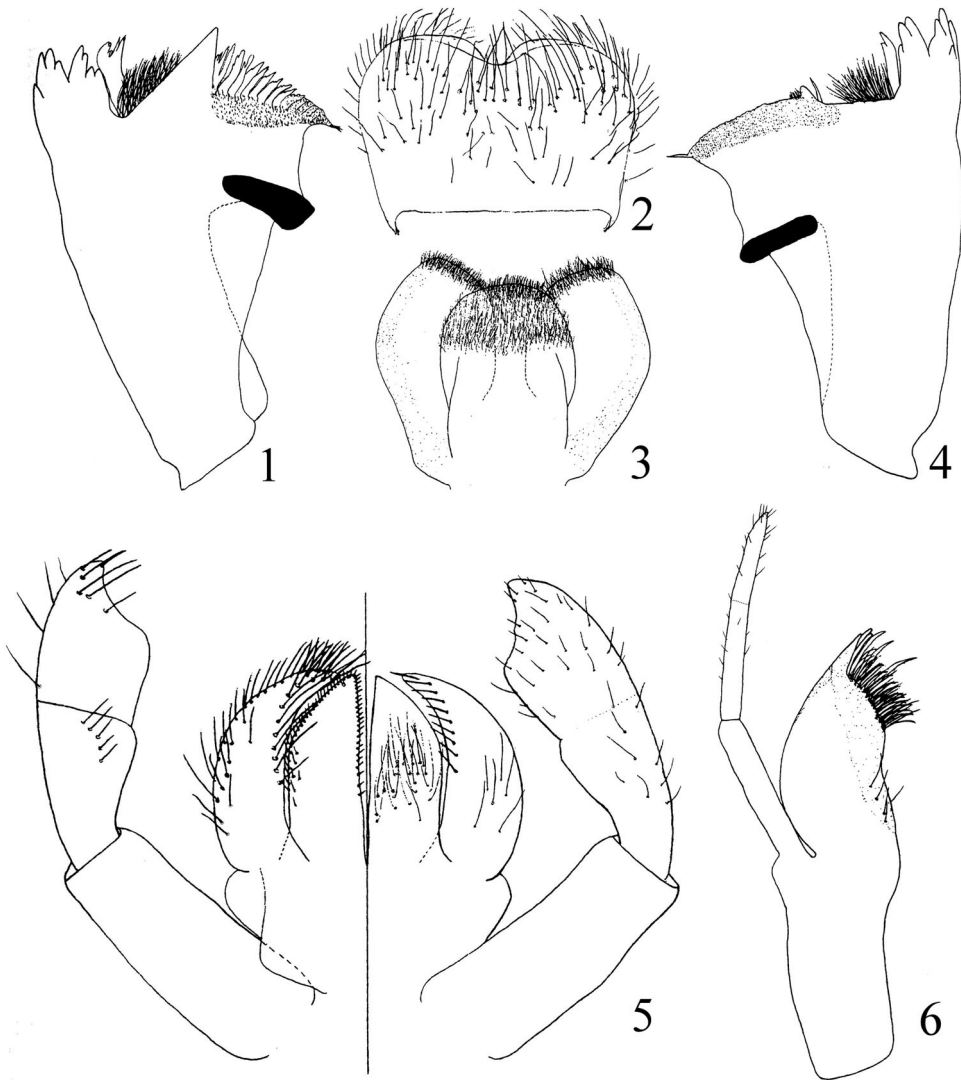
### *Cloeon micki* sp. n.

(Figures 1–31)

#### *Material examined*

**Holotype.** 1 ♂ imago, China, Hong Kong, Sai Kung, Cheung Sheung, 22°25'44"N, 114°18'34"E, 28.X.1998, leg. X.L. Tong (SCAU).

**Paratypes.** 10 mature larvae (two mounted on slides), 4 ♂, 4 ♀ imagoes (1 ♂ imago mounted on a slide), China, Hong Kong, Sai Kung, Cheung Sheung, 22°25'44"N, 114°18'34"E, collected on the aquatic plants from a pond, 18.XI.1998, leg. X.L. Tong (in SCAU); 3 mature larvae, 4 ♂, 4 ♀ imagoes, same locality and habitat as holotype, 28.X.1998, leg. X.L. Tong (SCAU); 1 mature larva, China, Henan Province, Nanyang City, Xixia County, Xiping Town, Xiahe River, 22.XI.2007, leg. B.F. Li, X.L. Tong (SCAU); 4 mature larvae, China, Henan Province, Hebi City, Qihe River, 10.IV.2015, leg. B.Q. Pan, X.L. Tong (SCAU); 2 mature larvae, China, Guangdong Province,

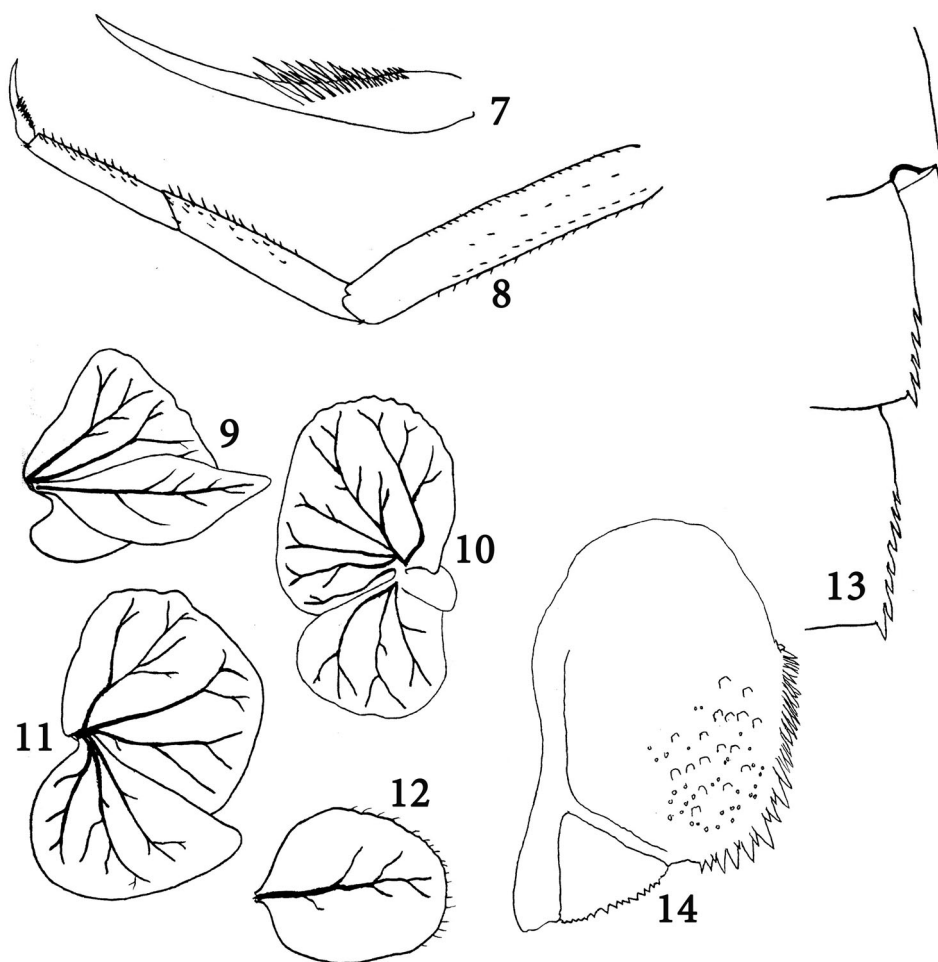


**Figures 1–6.** Mouthparts of *Cloeon micki* sp. n., mature larva: (1) left mandible; (2) labrum, dorsal view; (3) hypopharynx; (4) right mandible; (5) labium (left: dorsal view; right: ventral view); (6) maxilla.

Guangzhou City, Zengcheng, Ningxi Town, 19.VI.2015, leg. B.Q. Pan (SCAU); 5 mature larvae, 2 ♂, 2 ♀ imagoes, China, Hong Kong, Ma On Shan, Mui Tsz Lam, 4.XI.1998, leg. X.L. Tong (SCAU); 2 mature larvae (one mounted on a slide), 3 ♂, 2 ♀ imagoes, China, Hong Kong SAR, Lantau Is., Tai O Road near the Ling Yan Temple, 18.XII.1996, leg. X.L. Tong (SCAU).

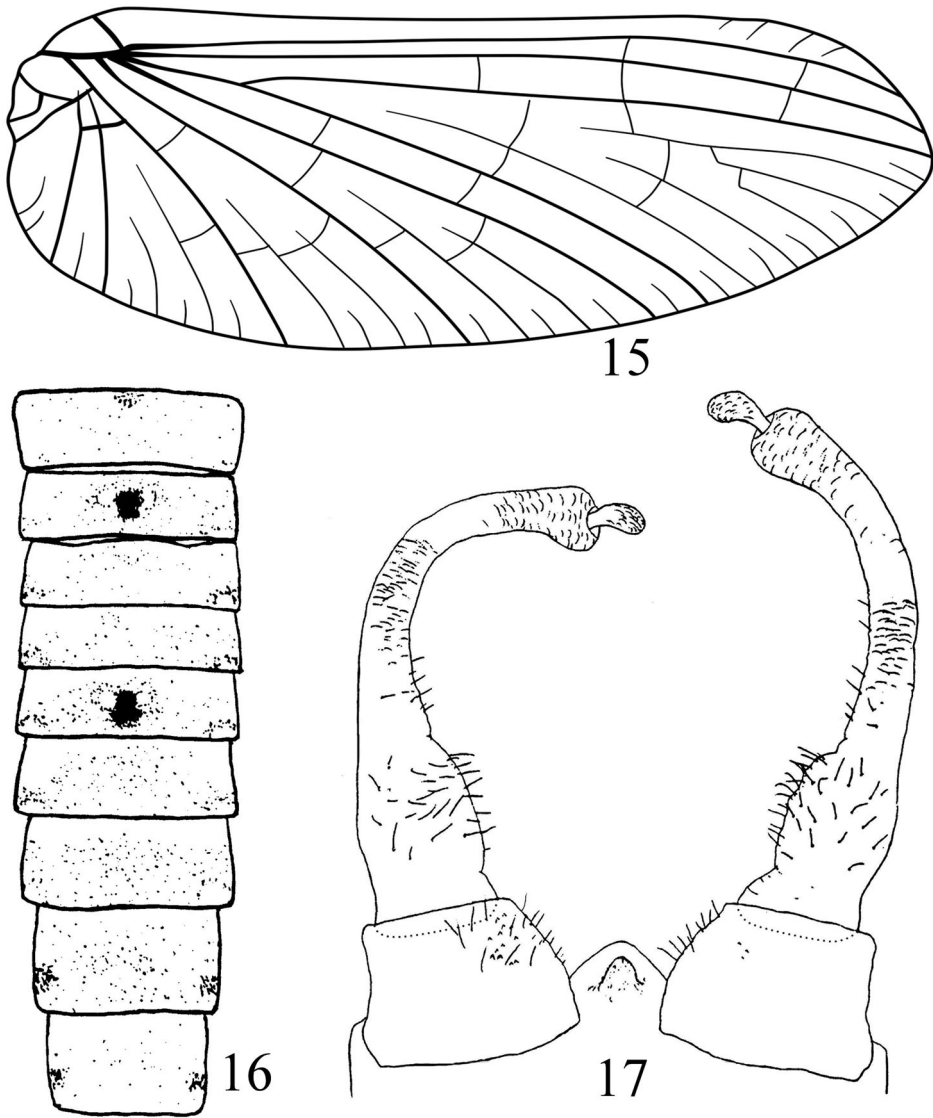
#### **Description of mature larva**

**Measurements.** Body length 4.4–5.2 mm. Antennae length 3.4–3.8 mm. Cerci length 3.0–4.0 mm.



**Figures 7–14.** *Cloeon micki* sp. n., mature larva: (7) tarsal claw of foreleg; (8) foreleg; (9) gill I; (10) gill III; (11) gill V; (12) gill VII; (13) lateral margins of abdominal segments VII–IX; (14) paraproct.

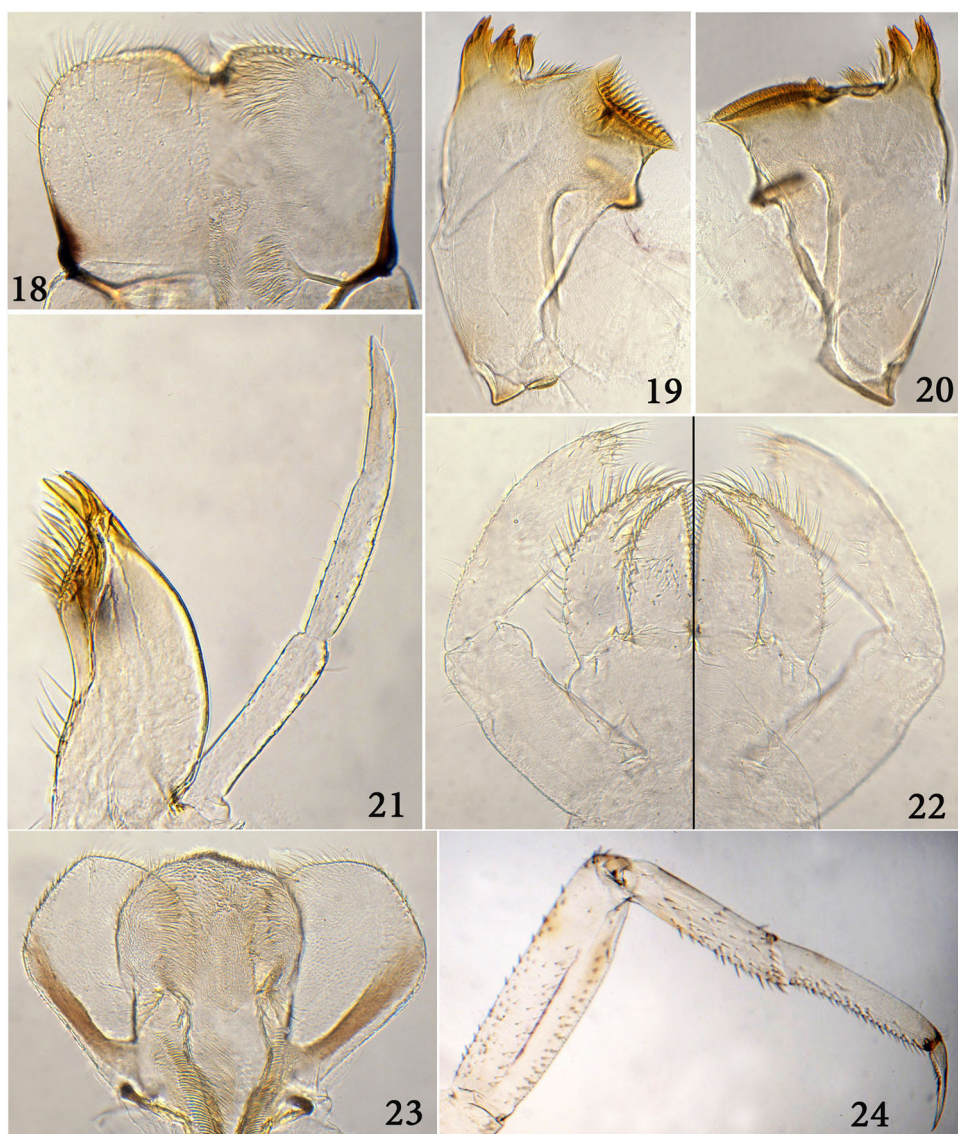
**Head.** Vertex light yellow or pale yellow-brown, with two rows of irregular brown spots. Antennae long, approximately 3–4 times length of head capsule; flagella pale, pedicels and scapes pale brown, tinged with purple-red distally. Labrum (Figures 2, 18) rectangular, approximately 1.6 times wider than long; anterior margin with a median notch, dorsal surface with fine and simple setae, ventrally bordered, with feathered setae and an anterior submarginal row of 4–5 simple setae on each side (Figure 18). Hypopharynx as in Figures 3 and 23. Left mandible (Figures 1, 19) with two sets of incisors, outer with 4 denticles and inner with 4 denticles; prostheca robust and approximately 1/4 width of fused incisors, apically with 3 acute denticles. Right mandible (Figures 4, 20) with two sets of incisors, outer with 4 denticles and inner with 3 denticles: prostheca robust and approximately 1/5 width of fused incisors, with a long acute apical denticle and two weakly developed shorter denticles. A dense bunch of setae between prostheca and mola of both, left and right, mandibles. Maxillae (Figures 6, 21) with row of 4–5 long setae on medial hump; maxillary palpus



**Figures 15–17.** Imago of *Cloeon micki* sp. n.: (15) forewing of male imago; (16) abdominal tergites of female imago; (17) male genitalia.

indistinctly 3-segmented, slender and extending beyond galea-laciniae, segment II subequal to terminal segment in length. Labium (Figures 5, 22) with glossae subequal to paraglossae; palpus 3-segmented, segment II with subapical dorsal row of 3–5 robust setae; margin of glossae with short and stout setae, ventrally with dense setae medially; inner margins of paraglossae with a row of 8–10 robust dorsal and ventral setae.

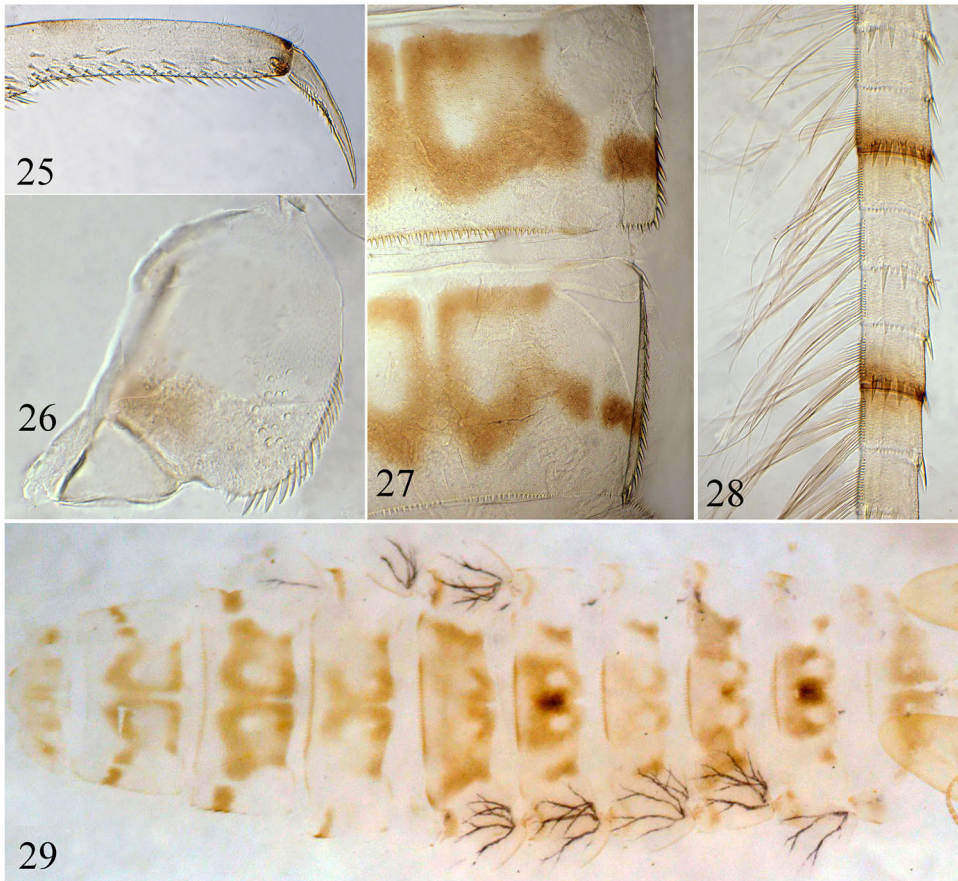
**Thorax.** Pronotum pale luteous, with brown irregular markings submedially and sublaterally. Meso- and metanotum light brown, with some pale longitudinal markings. Hindwing pads absent. Femora (Figures 8, 24) light yellow, with a subapical brown



**Figures 18–24.** *Cloeon micki* sp. n., mature larva: (18) labrum (left: dorsal view; right: ventral view); (19) left mandible; (20) right mandible; (21) maxilla; (22) labium (left: ventral view; right: dorsal view); (23) hypopharynx; (24) foreleg.

band, and short, stout, acute dorsal and ventral setae; villopore absent (Figure 8). Tibiae yellow, with a subproximal light brown band and a ventral row of robust, sharp setae. Tarsi yellow shading into light brown basally and apically, with numerous robust, acute setae ventrally (Figure 25). Tarsal claws light yellow, with two rows of distinct, acute denticles successively increasing in length towards distal claw (Figures 7, 24–25).





**Figures 25–29.** *Cloeon micki* sp. n., mature larva: (25) tarsus and claw; (26) paraproct; (27) lateral margins of abdominal segments VIII–IX; (28) cercus (partial); (29) abdominal tergites I–X.

**Abdomen.** General colouration light yellow to pale yellow-brown. Colour pattern of abdominal tergites I–X as in [Figures 29–30](#): segments II–IX each with a pair of pale spots submedially; tergites II and V each with single conspicuous dark brown or dark purple elliptical marking medially. Segments II–VII with a single postero-lateral spine, segment VIII usually with 4–6 lateral spines (some specimens with 8 spines), and segment IX usually with 6–9 lateral spines (some specimens with 13 spines) ([Figures 13, 27](#)). Posterior marginal spines well developed and present on all tergites, but alternating between one long and one short on tergites II–VIII. Abdominal sterna cream. Gills ([Figures 9–12](#)) on abdominal segments I–VII well tracheated; gills I–VI with double lamellae, dorsal lamella of gill I lanceolate and slightly longer than ventral lamella, gills II–VI with rounded or semicircular dorsal lamella and smaller than ventral lamella; gill VII with a single and rounded lamella. Paraprocts with a few trapezoidal scales scattered over surface; the inner apical margin bears numerous pointed denticles ([Figures 14, 26](#)). Caudal filaments light yellow, with a dark brown annulation every fourth segment ([Figure 28](#)); median terminal filament slightly shorter than cerci ([Figure 30](#)).



**Figures 30–31.** Larval habitus of *Cloeon micki* sp. n.: (30) female larva (fresh); (31) male larva (long preservation).

#### **Description of male imago**

Body length 4.5–5.0 mm. Forewing length 4.5 mm. Cerci 9.4 mm. Head pale yellow-brown. Flagella of antennae light brown; pedicels cream and light brown distally; scapes cream and with purple-red markings inner-distally. Turbinate eyes dark orange-yellow, well developed. Forewings (Figure 15) hyaline, with shading into brown basally, veins and single marginal intercalaries pale; costa slightly serrated; pterostigma with 4 veinlets not reaching subcostal vein; hindwings absent. Legs cream. Foreleg slender and elongate, much longer than midleg and hind leg. Proportions of length of femur, tibia and tarsal segments as follows: foreleg 32:56:20:14:8:6; midleg 30:28:8:4:3:4; hind leg 32:30:8:4:4:5. Abdominal tergite I light yellow-brown, tergites II–VI cream and semiluculent, VII–X pale brown; tergite II with a distinct dark purple or black median line or double median lines; tergite V with a conspicuous dark purple or black median line and 2 purple-red markings submedially; tergites III and VI each with 2 purple-red markings laterally. Genital forceps (Figure 17) off-white, 3-segmented; first segment of forceps broadest, with fine hairs on inner margin; segment II long and with a sub-basal swelling on inner margin; segment III small and globular; segments II–III covered with wrinkles densely. Penial bridge prominent medially, with a small membranous protuberance between forceps bases and penial bridge (Figure 17). Cerci off-white.

### Description of female imago

Body length 4.5 mm. Forewing length 4.7 mm, Cerci length 7.5 mm. General body colouration pale luteous. Vertex pale without markings; compound eye black or dark yellow-green (in life); ocelli off-white; flagella of antennae smoky; pedicels pale, with purple-red rings distally, scapes pale, with dark purple-red inner-distally. Mesonotum pale, with two longitudinal dark luteous markings medially; forewings hyaline, with light yellow-brown veins; costa slightly serrated; hindwings absent. Femora cream; tibiae and tarsi light yellow-brown. Abdominal segments luteous (some specimens with a lateral pale purple-red marking on tergites III and VI); tergites II and V each with a grey-brown spot medially (Figure 16). Cerci off-white, with purple-red annulations at apex of each segment.

### Diagnosis

The larva of the new species has a single conspicuous dark brown or purple elliptical marking on the abdominal tergites II and V, which is also evident in the imaginal stage of both sexes. However, due to the abdominal segments II–VI semitransparent in male imago, the marks are not as obvious as those in female imago (Figure 16). The dark markings on the abdominal tergites II and V are hypodermal, which suggests that it is present in all life stages. This remarkable character allows *Cloeon micki* sp. n. to be distinguished easily from congeneric species, especially those in Oriental Region (Navás 1930, 1933a,b; Kimmins 1947; Gillies 1949; You and Gui 1995). However, this character may not be reliable in specimens whose markings have faded through long preservation in ethanol (Figure 31), hence their specific identification may need to be based on the following combination of larval characters: (1) maxillae with row of 4–5 long setae on medial hump, with 3-segmented maxillary palpus, but with the suture between segment II and terminal segment weakly expressed (Figure 6); (2) segment III of labial palpus slender than apical width of segment II (Figure 5); (3) femora with a subapical brown band, tibiae yellow, with a subproximal light brown band (Figure 30); (4) spines on posterior margin of abdominal tergites II–VIII alternating between one long and one short; and (5) caudal filaments light yellow, with a dark brown annulation every fourth segment (Figures 28, 30). The male imago of the new species differs from other *Cloeon* in the presence of a small median membranous protuberance between the bases of the genital forceps and penial bridge (Figure 17).

### Etymology

*Cloeon micki* sp. n. is dedicated to Dr Mick T. Gillies, who confirmed that it was a new species, to honor his contributions to the study of Ephemeroptera in general and to Hong Kong mayflies in particular. To avoid confusion, we use the specific epithet ‘*micki*’ instead of ‘*gilliesi*’ which was preoccupied by Ali (1970) although it is, in fact, an invalid name: i.e., an objective synonym of *Cloeon gillican* Ali, 1967 (Hubbard and Peters 1978).

## Ecology

The larvae of *C. micki* sp. n. usually live among aquatic plants in lentic habitats such as ponds, or even stream pools. Sometimes co-occur with *C. harveyi* (Kimmins, 1947). The larvae seem to have some tolerance for organic pollution as they are occasionally found in murky water with abundant phytoplankton.

## Distribution

Based on current collection records, this new species has a wide geographical range from the tropical-subtropical transition region of southern China (Hong Kong and Guangdong) to temperate-subtropical central China (Henan).

## Acknowledgements

We wish to acknowledge Dr Weifang Shi for providing colour images and Dr David Gallacher, Baoqiang Pan and Binfeng Li for help with field work. Thanks are also due to the referees for their advice and constructive comments.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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## References

- Ali, S.R. (1970), 'Certain Mayflies (Order: Ephemeroptera) of West Pakistan', *Pakistan Journal of Science*, 22, 119–124.
- Banegas, B.P., Túnez, J.I., Nieto, C., Fañani, A.B., Casset, M.A., and Rocha, L. (2020), 'First Record of *Cloeon dipterum* (L.) (Ephemeroptera: Baetidae) in Buenos Aires, Argentina', *Revista de la Sociedad Entomológica Argentina*, 79, 24–33.
- Bengtsson, S. (1915), 'Eine Namensänderung', *Entomologisk Tidskrift*, 36, 34.
- Eaton, A.E. (1869), 'On *Centroptilum*, a New Genus of the Ephemeridae', *Entomologist's Monthly Magazine*, 6, 131–132.
- Gillies, M.T. (1949), 'Notes on Some Ephemeroptera Baetidae from India and South-East Asia', *Transactions of the Royal Entomological Society of London*, 100, 161–177.
- Gillies, M.T. (1980), 'An Introduction to the Study of *Cloeon* Leach (Baetidae, Ephemeroptera) in West Africa', *Bulletin de l'I.F.A.N. series A*, 42, 135–156.
- Gillies, M.T. (1985), 'A Preliminary account of the East African Species of *Cloeon* Leach and *Rhithrocloeon* gen. n. (Ephemeroptera)', *Aquatic Insects*, 7, 1–17. <http://dx.doi.org/10.1080/01650428509361193>

- Gillies, M.T. (1988), 'Descriptions of the Nymphs of Some Afrotropical Baetidae (Ephemeroptera). I. *Cloeon* Leach and *Rhithrocloeon* Gillies', *Aquatic Insects*, 10, 49–59. <http://dx.doi.org/10.1080/01650428809361310>
- Hubbard, M.D., and Peters, W.L. (1978), 'A Catalogue of the Ephemeroptera of the Indian Subregion', *Oriental Insects Suppl*, 12, 1–43.
- Kimmins, D.E. (1947), 'New Species of Indian Ephemeroptera', *Proceedings of the Royal Entomological Society of London. Series B, Taxonomy*, 16, 92–100.
- Kluge, N.J. (2012), 'Non-African Representatives of the Plesiomorphion Protopatellata (Ephemeroptera: Baetidae)', *rej*, 20, 361–376.
- Kluge, N.J. (2016), 'A New Subgenus *Oculogaster* Subgen. n. for Viviparous Representatives of *Procloeon* s. l., With Discussion about Status of the Generic name *Austrocloeon* Barnard 1932 and the Species Name *africanum* Esben-Petersen 1913 [Cloeon] (Ephemeroptera, Baetidae)', *Zootaxa*, 4107, 491–516.
- Kluge, N.J., and Novikova, E.A. (1992), 'Revision of the Palaearctic genera and subgenera of Mayflies of the Subfamily Cloeoninae (Ephemeroptera, Baetidae) with Description of New Species from the USSR', *Entomological Review*, 71, 29–54.
- Leach, W.E. (1815), 'Entomology', *Brewster's Edinburgh Encyclopaedia*, 9, 57–172.
- Lestage, J.A. (1924), 'Études sur les Ephémères du Congo Belge. II. Un nouveau Cloëon du Katanga (*Cloeon smaeleni* nov. sp.)', *Revue Zoologique Africaine*, 12, 426–428. [http://www.ephemeroptera-galactica.com/pubs/pub\\_l/publestagej1924p426.pdf](http://www.ephemeroptera-galactica.com/pubs/pub_l/publestagej1924p426.pdf)
- Linnaeus, C. (1758), 'Systema Naturae per regna tria naturae: secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis', Tomus I, Editio Decima, Reformata, Holmiae, 824 pp.
- Linnaeus, C. (1761), 'Fauna Suecica', Ed. II., Stockholmiae, No. 1477.
- McCafferty, W.P., and Waltz, R.D. (1990), 'Revisionary Synopsis of the Baetidae (Ephemeroptera) of North and Middle America', *Transactions of the American Entomological Society*, 116, 769–799. [http://www.ephemeroptera-galactica.com/pubs/pub\\_m/pubmccaffertyw1990p769.pdf](http://www.ephemeroptera-galactica.com/pubs/pub_m/pubmccaffertyw1990p769.pdf)
- Navás, L. (1930), 'Névroptères et insectes voisins. Chine et pays environnants. 1ère Série', *Notes d'Entomologie Chinoise, Musée Heude*, 1, 1–12.
- Navás, L. (1933a), 'Névroptères et insectes voisins. Chine et pays environnants. 4e Série', *Notes d'Entomologie Chinoise, Musée Heude*, 1, 1–23.
- Navás, L. (1933b), 'Névroptères et insectes voisins. Chine et pays environnants. 5e Série', *Notes d'Entomologie Chinoise, Musée Heude*, 1, 1–10.
- Salles, F.F., Gattolliat, J.-L., Angeli, K.B., De-Souza, M.R., Gonçalves, I.C., Nessimian, J.L., and Sartori, M. (2014), 'Discovery of an Alien Species of Mayfly in South America (Ephemeroptera)', *ZooKeys*, 399, 1–16.
- Sowa, R. (1975), 'What is *Cloeon dipterum* (Linnaeus, 1761)? - The Nomenclatural and Morphological Analysis of a Group of the European Species of *Cloeon* Leach (Ephemera: Baetidae)', *Insect Systematics & Evolution*, 6, 215–223. [http://www.ephemeroptera-galactica.com/pubs/pub\\_s/pubswar1975p215.pdf](http://www.ephemeroptera-galactica.com/pubs/pub_s/pubswar1975p215.pdf)
- Tong, X.L. (2001), 'The Mayflies (Insecta: Ephemeroptera) of Hong Kong' Ph.D. thesis, The University of Hong Kong, Hong Kong, 273 pp.
- You, D.S., and Gui, H. (1995), *Economic Insect Fauna of China. Fasc. 48. Ephemeroptera*, Beijing, China: Science Press, pp. 152.