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Redescription of *Cloeon bicolor* Kimmins, 1947 (Ephemeroptera: Baetidae) from Southern India

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ABSTRACT

***Cloeon bicolor* was described based on the adult from West Bengal by Kimmins (1947). Even though being common in India, it was reported in the literature quite rarely, and its known distribution to date includes Malaysia, Singapore and Thailand. Recently, specimens were collected in Maduari and Tirunelveli (Tamil Nadu) and examined the material, and provide the description of larvae for the first time and re-description of adults (male and female) from associated material by rearing.**

Key words : Baetidae, cloeoninae, India, mayfly, redescription, taxonomy.

INTRODUCTION

Cloeon Leach 1815 is one of the earliest genera of mayfly with worldwide distribution except in Antarctica (Barber-James *et al.,* 2013). It is one of the most common and widespread genera of the subfamily Cloeoninae with more than 75 described species to till date (Salles *et al.*, 2014; Kluge, 2021). Larvae of *Cloeon* Leach inhabit the lentic or stagnant water and slow moving water. Adults can be collected in the riparian vegetation of streams, ponds and lakes as well as artificial habitats. *Cloeon* Leach can be distinguished by the following characters: in larvae (i) double rounded gills on segments I to VI and gills VII simple; (ii) sclerotized spines on the lateral margins of the abdomen; (iii) segment III of labial palp apically tapered or falcate; (iv) legs long and slender, tarsal claws elongated with two rows of numerous denticles; (v) median caudal filament equal to the cerci. In the adult stage: (i) forewing with single intercalary veins; (ii) hindwings absent; (iii) female forewing with costal and subcostal fields coloured in some species; (iv) male with 3-segmented gonopods without lateral extensions, segment III reduced, genital plate rounded or conical (Salles *et al.*, 2014).

In India, twelve species viz., *C. bengalense* (Kimmins 1947), *C. bicolor* (Kimmins 1947), *C. bimaculatum* (Eaton, 1885); *C. harveyi* (Kimmins, 1947), *C. inscriptum* (Bengtsson, 1914), *C. kashmiri* (Traver, 1939), *C. kimminsi* (Hubbard, 1974), *C. marginale* (Hagen, 1858), *C. pulchellum* (Banks, 1913), *C. siccum* (Gillies, 1949), *C. taeniolatum* (Navás, 1931), *C. variegatum* (Chopra, 1924) were reported and described based on adults but the descriptions inadequate and incomplete. Mukherjee *et al.* (2012) have described the larvae of *Cloeon harveyi* (Kimmins, 1947) and redescribed the adult and also reassignment of the *Procloeon harveyi* to genus *Cloeon*. *Cloeon bicolor* Kimmins, 1947 was described based on the adult from West Bengal by Kimmins (1947) and the larval stage unknown. In this context, larva of *Cloeon bicolor* Kimmins, 1947 is described for the first time and the adults (male and female) are redescribed from associated material by rearing.

MATERIALS AND METHODS

The larvae were mainly collected by kick-net sampling and hand picking. Adults were reared from larvae in plastic cages placed in natural current water. All materials were stored in 85% Ethanol. Permanent mounts of specimens were made in

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Hoyer's medium to enable detailed microscopic observations. Drawings were made using an Olympus BX43 microscope. Photographs were taken with Leica M205A microscope and the combined photographs were enhanced digitally using Adobe Photoshop CS6. All the specimens are deposited in Faunal Repository of Himalayan Ecosystem, High Altitude Regional Centre, Zoological Survey of India, Solan, Himachal Pradesh, India.

RESULTS AND DISCUSSION

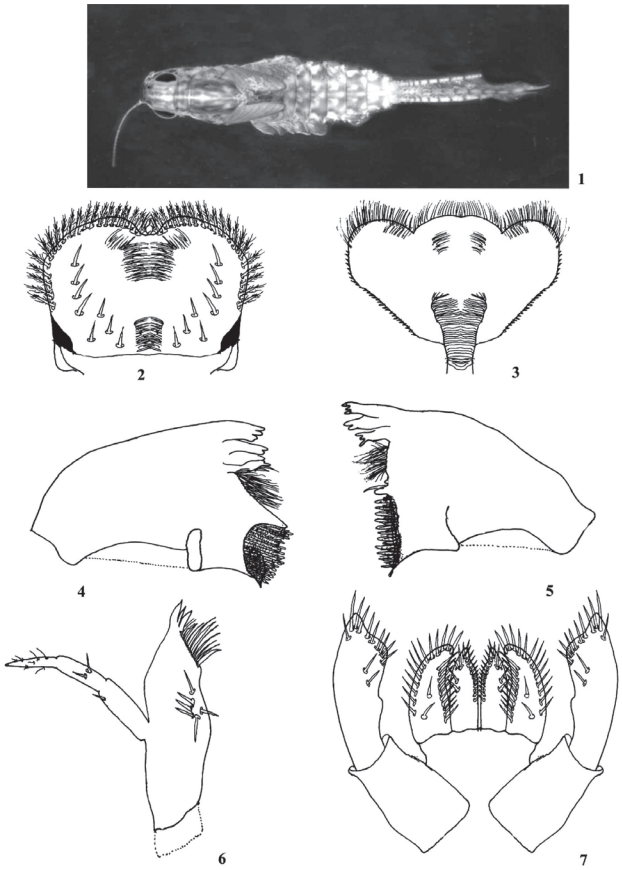
Cloeon bicolor Kimmins, 1947 (Figs. 1-17)

Material examined : 2 larva, 2 male imagoes, India, Tamil Nadu, Madurai, Tiruvedakam, Vaigai River, 10.4758ºN, 77.96025ºE, 198-200 m, 11.06.2016, Colls. T. Kubendran and T. Rathinakumar (Reg. No. I-3295). 2 larvae, India, Tamil Nadu, Tirunelveli, Alwarkurichi, Ramanathi River, 08.47058ºN, 77.24075ºE, 109-111 m, 11.08.2016, Colls. T. Kubendran and C. Selvakumar (Reg. No. I-3296). 5 larvae and 2 images, INDIA, Tamil Nadu, Tirunelveli, Alwarkurichi pond, 08.465073ºN, 77.240476ºE, 87-90 m, 20.12.2016, Colls. T. Kubendran and C. Selvakumar (Reg. No. I-3297).

Diagnosis : *Cloeon bicolor* Kimmins, 1947 can be diagnosed by the following combination of characters: In imago (i) forewing of female with bicolored streak on costal and subcostal areas (Fig. 16); (ii) absence of reddish spots on abdominal segments III and VI of male (Fig. 14) and (iii) abdominal patterns of female lacking lateral extension on segments III and VI (Fig. 15). In larvae (i) labrum with well-developed anteriomedian emargination (Fig. 2); (ii) labial segment 3 apically pointed (Fig. 7) and (iii) abdominal sterna without setae or scale bases, posterior margin with spines (Fig. 13).

Description : *Mature larva* (in alcohol) : Male : Body length 6.5 - 6.8 mm; cerci 4.0 - 4.5 mm; medium caudal filament 3.6 mm; Female: Body length 6.0 - 6.3 mm; cerci 3.5 - 4.0 mm; medium caudal filament 3.4 mm. Colouration. Head yellow with two longitudinal brown stripes with vermiform marks. Male turbinate eyes honey brown. Antennae yellow. Thorax medium amber brown with symmetrical darker spots apicomedially of each segment. Legs generally uniformly ecru, in some specimens with a small brown dot in middle of lateral margin of femora. Tergal coloration yellow and brown. Pattern rather similar between different terga: medially brown and laterally yellow; terga I, IV, VII and IX generally lighter. Sterna ecru without pattern or coloration. Cerci yellow with broad brown stripe at 2/3 of length, brown annulations every four segments (Fig. 1).

Head : *Antennae* (Fig. 8) straight and few small setae inner side. *Labrum* (Fig. 2). Dorsal surface with abundant long, stout setae arranged in a row; distal margin laterally with feathered setae, other setae simple, medium and stout. *Hypopharynx* (Fig. 3) with broad, rounded lingua covered with short fine setae, outer margin serrated, superlingua only slightly expanded covered with short fine setae. *Right mandible* (Fig. 4) with 2 partially fused sets of incisors, outer set with 3 denticles and inner with 2 denticles, prostheca with 3 denticles and a comb-shaped structure, tuft of abundant setae between prostheca and mola. *Left mandible* (Fig. 5) with 3 partially fused sets of incisors, outer with 3



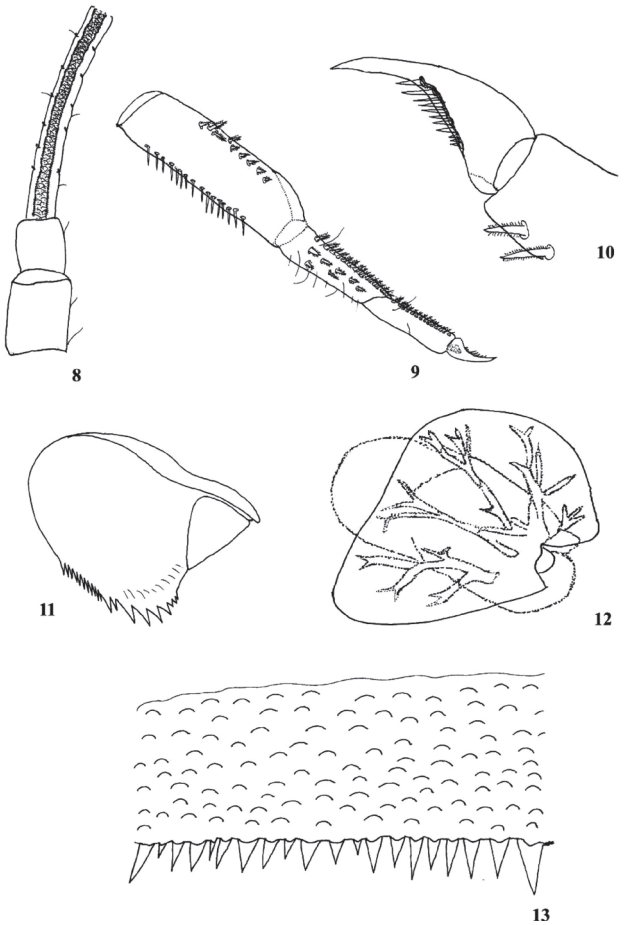
Figs. 1-7. *Cloeon bicolor* Kimmins, 1947. (1) Larva dorsal view; (2) Labrum; (3) Hypopharynx; (4) Right mandible; (5) Left mandible; (6) Maxillae; (7) Labium.

denticles, median with 2 denticles and inner with single denticle; stout prostheca with thin denticles, tuft of abundant setae between prostheca and mola. *Maxillae* (Fig. 6) with long, slim teeth, none of them opposed to others, apex of galea-lacinia with one row of fine setae and one row of stout setae and three dentisetae, palp 3 segmented with a few thin and stout setae, segment I approximately 1.6 x length, segment II 1.3 x length of segment III. *Labium* (Fig. 7) with glossae subequal to paraglossae, margin of glossae with short and stout setae, ventrally covered with medium and thin setae, paraglossae falcate with long and stout setae roughly arranged in rows, labial palp 3-segmented, segment I slender subrectangular, 0.8 x length of segment II and III combined, segment II enlarged apically, 2 pointed setae laterally, outer apical edge of III segment of labial palpus well developed and inner margin 'S'- shaped with a row of 10 pointed setae subparallel to margin of segment.

Thorax : *Foreleg* (Fig. 9) femora dorsally with one row of about 9 stout pointed and branched setae, one row of about 16 pointed setae suparallel to dorsal margin. Tibiae dorsally with one row about 15 pointed branched setae, ventral margin with small hairs, subapical setae absent; tarsal claw (Fig. 10) with a row of 10 - 15 teeth long pointed setae, subapical setae absent. Hindwing pads absent.

Abdomen : Tergites shagreened with scale bases, posterior margin with short pointed spines. Sternites without scale bases but with numerous very long, thin setae, posterior margin of sternites I to V smooth, without spines, posterior margin of sternites VI to IX with small spines, lateral margin of abdominal segment VIII with about 9 slender spines, lateral margin abdominal segment IX with about 11 slender spines, round margin of the abdominal tergum X which possesses subequal marginal spines. *Gills* (Fig. 12) I to VI with double lamellae, upper lamellae reduced, tracheation well developed, only marked apically on the lower lamellae, gill VII simple and small than the others. *Paraproct* (Fig. 11) with very few scale bases, margin with about 20 irregular spines, postero-lateral extension without scale bases, margin without spine. Posterior margin of abdominal terga long and pointed spines, rounded scale bases (Fig. 13). Cerci yellow with abundant thin setae on the inner margin in basal half, apical half extremely thin and without setae, median caudal filament similar to cerci except with setae on both margins; tail marked with dark rings.

Male imago (*in alcohol*) : *Length* : body 5.0 - 5.2 mm; fore wing 4.0 - 4.2 mm; cerci 11.0 - 11.5 mm (Fig. 14). *Head* : turbinated eyes dark brown, darker basally. *Thorax* : forewings uniformly hyaline with costal and subcostal areas opaque; veins and cross veins not coloured; single intercalary veins; pterostigma absent; cross veins 10 - 13 (Fig. 16). *Legs* : uniformly whitish. Abdominal tergites without any pattern, tergites I to VII whitish; dorsal base of segment III-V light red pigment, tergites VIII-X light reddish. *Genitalia* (Fig. 17) with third segment of gonopods clearly separated from segment II, apex of segment I broader than segment II; segment II apically expanded, inner side of segment I and II with small simple setae; segment III short and ovoid. Well-developed genital plate inverted triangular,



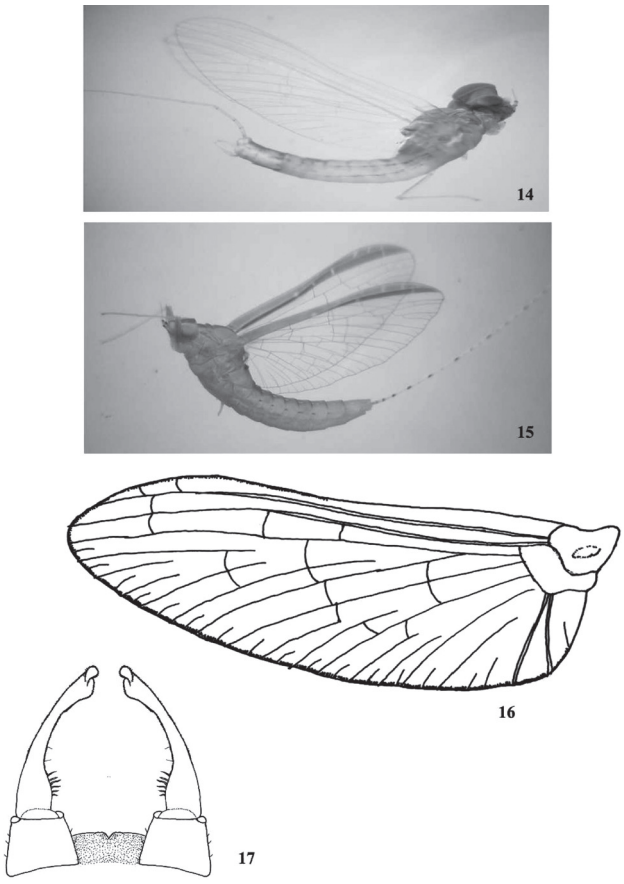
Figs. 8-13. *Cloeon bicolor* Kimmins, 1947. (8) Antennae; (9) Fore leg; (10) Fore claw; (11) Paraproct; (12) Gill - IV; (13) Abdominal tergal spines.

highly sclerotized and concave. Characters of hind tarsal index (ratio of length of first segment to length of 3rd segment 2:1).

Female imago (*in alcohol*) : *Length* : body 4.8 - 5.0 mm; forewing 4.0 - 4.2 mm; cerci 12.0 - 12.5 mm (Fig. 15). *Head:* yellowish with median colored pattern. *Thorax* : forewings uniformly hyaline; costal area uniform light brown; subcostal area solid brown; veins and cross veins colored; single intercalary veins; pterostigma with 4 - 5 cross veins. *Legs* : uniformly whitish. Abdominal tergites uniformly dark brown. Characters of hind tarsal index (ratio of length of first segment to length of 3rd segment 2:1).

Distribution : India (Karnataka, Kerala, Madhya Pradesh, Tamil Nadu and West Bengal), Malaysia, Singapore and Thailand.

Ecology : Larvae of *Cloeon bicolor* Kimmins, 1947 were collected from margin of Vaigai river (Tiruvedakam, Madurai) on patches of grasses and macroalgae. The water and atmospheric temperature in the collecting site were 22 ± 2°C and 25 ± 2°C respectively. The water current of the stream was 0.60 - 0.72 m/sec. The pH of the locality was between 6.8 and 7.5. The water depth of the stream was ranged 10 - 15 cm. The substrates mainly consisted of sand and boulders. Larvae and imagoes are associated by rearing.



Figs. 14-17. *Cloeon bicolor* Kimmins, 1947. (14) Male imago; (15) Female imago; (16) Male forewing; (17) Genitalia.

Cloeon bicolor Kimmins, 1947 was described based on the adult from West Bengal by Kimmins (1947). Even though being common in India (Karnataka, Kerala, Madhya Pradesh, Tamil Nadu and West Bengal), it was reported in the literature quite rarely and its known distribution to date includes Malaysia, Singapore and Thailand (Gillies, 1949; Sivaramakrishnan *et al.*, 2009). Larvae of *C. bicolor* Kimmins, 1947 are found in slow waters, temporary ponds, rice fields, reservoirs, slow moving streams and rivers and the margins of lakes. In India, female of *C. bengalense* Kimmins, 1947, *C. bicolor* Kimmins, 1947 and *C. kimminsi* Kimmins, 1947 are coloured costal and subcostal field of forewing. However, *C. bicolor* is distinguished from others two species by costal area of forewing uniform light brown and subcostal area solid brown. The others two species have costal and subcostal area of forewing brown in *C. bengalense* and yellow-green costal streak in *C. kimminsi*. *Cloeon biclor* is widely distributed in India and nearby countries and *C. bengalense* and *C. kimminsi* are restricted only in West Bengal state of India.

AUTHORS' CONTRIBUTION

He conducted the field survey and reared the specimen for the present investigation. He also co-ordinated the entire manuscript in the present form (TK); He assisted to writing the introduction and Photoshop work of the manuscript (MV); He assisted to writing the discussion part of manuscript and arrangement of photographs (CS); She assisted to write the description of the species (FJ); He co-ordinated to prepare the manuscript and improved before submission (KAS); He assisted during field survey to rear the specimen for re-description (TR).

DECLARATION

The authors declare that they have no conflict of interests.

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