



## The first record of *Caenis* Stephens, 1835 in Australia (Ephemeroptera: Caenidae) with descriptions of two new species

PHILLIP J. SUTER<sup>1,2\*</sup>, JULIA H. MYNOTT<sup>1,4</sup> & JEFF M. WEBB<sup>1,3</sup>

<sup>1</sup>Department of Environmental Management and Ecology, La Trobe University, Wodonga, Victoria, Australia, 3690.

<sup>2</sup>Centre for Freshwater Ecosystems, La Trobe University, Wodonga, Victoria, Australia, 3690.

<sup>3</sup>[p.suter@latrobe.edu.au](mailto:p.suter@latrobe.edu.au); <https://orcid.org/0000-0002-6116-2885>

<sup>4</sup>Current address: Rhithron Associates, Inc., 33 Fort Missoula Road, Missoula, Montana, USA, 59804.

[jmw975@yahoo.com](mailto:jmw975@yahoo.com); <https://orcid.org/0000-0002-7266-7192>

<sup>4</sup>Centre for Freshwater Ecosystems, La Trobe University, Wodonga, Victoria, Australia, 3690.

[j.mynott@latrobe.edu.au](mailto:j.mynott@latrobe.edu.au); <https://orcid.org/0000-0001-5073-4692>

\*Corresponding author. [p.suter@latrobe.edu.au](mailto:p.suter@latrobe.edu.au)

### Abstract

Two species of *Caenis* with straight forceps with a terminal tuft of spines are described from northern Australia. Male imagoes and nymphs of *C. hanleyi* n. sp. are described from reared material from the Alligator Rivers Region in the Northern Territory and *C. binda* n. sp. is described only from male imagoes collected from streams in the Wet Tropics of Queensland. *C. hanleyi* differs from *C. binda* by the structure of the forceps with *C. binda* being longer and narrower with longer apical spines. These are the first records of the genus *Caenis* in Australia.

**Key words:** Mayflies, taxonomy, Caeninae, Caenini

### Introduction

The Caenidae are a world-wide family of mayflies that are absent only from Antarctica, New Zealand and New Caledonia (Malzacher and Staniczek 2007). The genus *Caenis* is the most speciose with some 160 species described currently recorded from all biogeographical realms except Australia, New Zealand and Iceland (Malzacher 2022). There are currently five species of *Caenis* described from the Australian realm: *C. novaeguineae* (van Bruggen, 1957), *C. insularis* (Demoulin, 1969), *C. marwakensis* Malzacher and Staniczek, 2018, *C. ungulata* Malzacher and Staniczek, 2018 and *C. vanuatensis* Malzacher and Staniczek, 2007. *Caenis ungulata* and *C. vanuatensis* are known only from adult females and nymphs, *C. marwakensis* from nymphs and subimaginal features of the pharate male, *C. novaeguineae* and *C. insularis* from adult males. Flowers (1990) recorded a *Caenis* sp from Fiji with Type 4 forceps but only illustrated the genitalia. This species has not been formally described and named.

Currently, the Caenidae are represented in Australia by 12 described species in three genera: *Tasmanocoenis* Lestage 1930 (6 spp); *Wundacaenis* Suter, 1993 (3 spp); and *Irpacaenis* Suter, 1999 (3 spp). Suter (1999a) recognised an additional 11 un-described species of *Tasmanocoenis* and two un-described species of *Irpacaenis*.

Two species, one from northern Queensland and one from the Northern Territory, assigned to *Tasmanocoenis* by Suter (1992, 1999a), had distinctive forceps in the male imagoes. This species (sp H in Suter 1992, 1999a) had long straight forceps with apical tuft of spines which differed from the straight, broad and internally grooved forceps of *Irpacaenis* (Suter 1999) and the strongly curved forceps in *Tasmanocoenis* (Harker 1957, Suter 1984, Alba-Tercedor and Suter 1990) and *Wundacaenis* (Suter 1993). Malzacher (1991, 2022) examined the trait evolution of the male genitalia of the Caenidae and recognised four types of forceps in the genus *Caenis*, namely, Type 1 short, broad and rounded apically, Type 2 long and apically with a sharp point, Type 3 long with a number of short trichomes extending beyond apex and Type 4 long with a terminal tuft of long spines. The two new species, described here, both have Type 4 forceps. Given the forceps structure the Australian species are here described in the genus *Caenis* as *Caenis binda* n. sp. from the Wet Tropics in northern Queensland and *Caenis hanleyi* n. sp. from the Northern Territory.

## Materials and methods

Adults were collected using UV light traps, and nymphs were collected using a kick or sweep sampling techniques with a 250µm mesh net. All habitats present were sampled.

Specimens were preserved in 95–100% ethanol. Imagoes and nymphs were dissected and mounted on slides using Euparal.

Illustrations were prepared with a DinoEye Eyepiece camera using a Zeiss Axiolab microscope using both phase contrast and differential interference contrast (DIC) to obtain the best images. Depth of field was achieved with multiple photographs which were 'stacked' using Helicon Focus Ver. 7.6.1 (Helicon Soft Ltd 2000). These images were used to prepare line drawings. Measurements of individual segments or structures were made using an eyepiece graticule. Segment ratios of maxillary and labial palps are given as Segment I (length in mm): Segment II length/Segment I Length : Segment III length/Segment I length and the leg ratios are Femur Length (length in mm) : Tibia length/femur length : tarsal length/Femur length : tarsal claw length/Femur length. Types are deposited in the Museum and Art Gallery of the Northern Territory and the Queensland Museum. Other material is held at the Environmental Research Institute of the Supervising Scientist, Darwin, Northern Territory (no deposition code indicated) and at the Centre for Freshwater Ecosystems, La Trobe University, Albury-Wodonga.

## Results

### *Caenis binda* n. sp.

(Figure 5c, 6)

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*Tasmanocoenis* Sp H in part, Suter 1999a

**Type Material** (Deposited in the Queensland Museum). **Holotype**: Male imago on slide. Queensland (Qld), Freshwater Creek by Crystal Cascades caravan park off Redlynch Intake Road; 16.5833E, 145.6978S; 3 July 2008; coll. JM Webb (JMW), JH Hawking (JHH), PS, S. Moore (SM); LaTrobe University (LTU) accession no. JWA712a; T258326. **Paratypes**: 2 male imagoes on slides details as for holotype LTU accession no. JWA712b–c; T258327 and T258328; 1 male imago in ethanol, Granite Creek at Mareeba to Mt Malloy Road; 16.9847E, 145.4192S; 1 July 2008; JMW, JHH, PS, SM; LTU accession no. JWA1718; T258329; 1 male imago in ethanol Freshwater Creek by Crystal Cascades caravan park off Redlynch Intake Road; 16.5833E, 145.6978S; 26 June 2008; JMW, JHH, PS, SM; University (LTU) accession no. JWA1728; T258330; 1 male imago in ethanol Babinda Creek at A1 (Bruce Highway); 17.3643E, 145.9156S; 27 June 2008; JMW, JHH, PS, SM; LTU accession no. JWA1706; T258331.

**Other Material Examined**. One male imago, Queensland. Freshwater Creek by Crystal Cascades caravan park off Redlynch Intake Road; 16.5833E, 145.6978S; 3 July 2008; JMW, JHH, PS, SM; LaTrobe University (LTU) accession no. JWA1601. One male imago, Granite Creek at Mareeba to Mt Malloy Road; 16.9847E, 145.4192S; 1 July 2008; JMW, JHH, PS, SM; LTU accession no. JWA1719. One male imago, Freshwater Creek by Crystal Cascades caravan park off Redlynch Intake Road; 16.5833E, 145.6978S; 3 July 2008; JMW, JHH, PS, SM; LaTrobe University (LTU) accession no. JWA1727. One male imago, Babinda Creek at A1 (Bruce Highway); 17.3643E, 145.9156S; 27 June 2008; JMW, JHH, PS, SM; LTU accession no. JWA1705. One male imago, Babinda Creek at A1 (Bruce Highway); 17.3643E, 145.9156S; 27 June 2008; JMW, JHH, PS, SM; LTU accession no. JWA1707. One male imago, Granite Creek at Mareeba to Mt Malloy Road; 16.9847E, 145.4192S; 1 July 2008; JMW, JHH, PS, SM; LTU accession no. JWA1717. 1 male imago. Lacey's Creek at Cassowary Road (El Arish Mission Beach Road); 17.8512E, 146.0644S; 2 July 2008; JMW, JHH, PS, SM; LTU accession no. JWA1726.

**Diagnosis**. *C. binda* can be characterised by the following combination of characters. In the male : body length 1.7–1.8 mm; base of antennal flagellum not dilated (Fig. 6c, 6d); penes with median concavity and lobes broad, rectangular (Fig. 6b) styliger plate length 0.6 times width (Fig. 6b); lateral sclerite short, narrow, triangular (Fig. 6b); forceps long and narrow, tapering from base to apex, 5.8 times longer than mid width (Fig. 6c); forceps with five apical bristles with one very long, three mid length and one short (Fig. 6c); forceps length 2–3 times longer than longest apical bristle; abdomen lacking lateral processes and femora with apical dark marking.

### Description

**Male Imago** (n=6): Body Length 1.7–1.8 mm; wing length 1.6–1.9 mm; terminal filament length 3.8–4.3 mm. Head: Base of antennae not dilated; pedicel 1.4–1.8 x longer than scape, flagellum length 0.4–0.5 mm (Fig. 6d, e). Prosternum triangular with straight lateral sides, apex broadly rounded (Fig. 5c). Legs slender and delicate; forelegs longer than mid and hind legs; tarsomeres of fore tarsus apically not broadened, fore tarsal claws similar, both blunt and ovoid (Fig. 6g); mid and hind tarsal claws dissimilar one blunt and one slender, curved and sharp. Tarsal segment formula of foreleg 2, 4, 3, 5, 1. Femora of legs with dark apical elongate spot (Fig. 6f). Foreleg femur 0.31–0.44 mm long, tibia 1.4–1.5 x femur length, tarsus 1.1–1.4 x femur length. Mid leg length 0.34–0.36 mm, tibia 0.7–0.8x femur length, tarsus 0.4–0.5x femur length. Hind femur length 0.34–0.36 mm, hind tibia 0.7 x femur length, hind tarsus 0.5–0.7 x femur length. Scutellum broad, posteriorly with indentation, broadly rounded. Wings 2.0–2.2 x longer than wide (Fig. 6a), with hind margin lined with long hairs which are longest in anal and cubital region and short in radial region. Abdomen without markings on sternites, sternites VI–VIII lacking lateral filaments. Penis with median concavity and each lobe rectangular. Forceps long, broad, tapering from base to apex and straight (Fig. 6c), not curved; 2–3 x longer than longest apical spine length; at base 3 x longer than wide, at mid length 5.8 x longer than wide, at apex 11.2 x longer than wide with tuft of five apical spines, one very long and three approx. half-length of longest spine and 1 very short; surface covered with long setae/hairs. Three terminal filaments 3.8–4.3 mm long.

Nymph unknown.

**Etymology.** From the traditional owners' (the Yidinji people) name 'binda' meaning waterfall as a description of the 'Cascades' on Freshwater Creek near Cairns, Queensland ([www.cairnsconnect.com](http://www.cairnsconnect.com) accessed 22 September 2022).

### ***Caenis hanleyi* n. sp.**

(Figures 1–5)

LSID urn:lsid:zoobank.org:act:5A7C1E45-FC7E-414D-9A48-406E787E12EC

*Tasmanocoenis* sp H (Suter, 1992)

*Tasmanocoenis* sp H in part (Suter, 1999a)

**Type Material** (Deposited in the Museum and Art Gallery of Northern Territory). **Holotype:** 1 Male imago and nymphal exuvium on three slides. Magela Ck at Ranger outlet pipe 12.68S 132.93E 19 May 1988, emerged on 27 May 1988; Identification no. ARR37, ARR38 and ARR39; coll. P. Suter (PS); NTMI011230. **Paratypes:** 1 male imago and nymphal exuvium on 4 slides. Same details as holotype; Identification no. ARR33, ARR34, ARR35 and ARR36; coll. PS; NTMI011231. 1 nymph on 2 slides. Magela Ck at Ranger outlet pipe 12.68S 132.93E 17 Feb 1988; Identification no. ARR28 and ARR29; coll. P. Dostine (PD); NTMI011232. 1 nymph in ethanol. Magela Ck downstream of pontoon 12.64S 132.90E 9 May 2019 JH; NTMI011233. 1 nymph in ethanol. Magela Ck upstream pool 12.67S 132.93E 2 Sept 2021 JH; NTMI011234. 1 nymph in ethanol. Nourlangie Ck 12.856S 132.777E 13 May 2021 JH; NTMI011235.

**Other Material Examined.** Northern Territory 3 nymphs, Cooper Ck at Narbalek 12.3S 133.33E 27 May 1988 PS; 20 male imagoes 10 nymphs, Magela Ck at Ranger outlet pipe 12.68S 132.93E 19 May 1988 PS, 17 Feb 1988 PD; 1 nymph, Gulungul Ck at inlet to Gulungul Billabong 12.63S 132.88E 16 May 1988, April 1989 PS; 4 nymphs, Magela Ck at inlet to Mudginberri Billabong 12.60S 132.88E 18 May 1988, April 1989 PS; 2 nymphs, Radon Springs 12.75S 132.92E 18 May 1988 PS; 7 nymphs, Baroalba Springs 12.82S 132.87E April 1989 PS; 2 nymphs, Koolpin Ck 13.48S 132.58E 25 May 1988 PS; 1 nymph, Gulungul Ck at highway crossing 12.65S 132.867E 15 Oct 2006 Identification no. GCH152CN J. Hanley (JH); 1 nymph, Coomalie Ck at road to Bachelor east of Lichfield National Park 13.0104S 131.1136E 24 Sept 2009 Identification no. JWA1959, PS, J. Webb (JW), J. Hawking (JH), M. Halsey (MH); 5 nymphs, Magela Ck downstream of pontoon 12.64S 132.90E 9 May 2019 JH; 11 nymphs, Magela Ck upstream pool 12.67S 132.93E 2 Sept 2021 JH; 1 nymph, Nourlangie Ck 12.856S 132.777E 13 May 2021 JH.

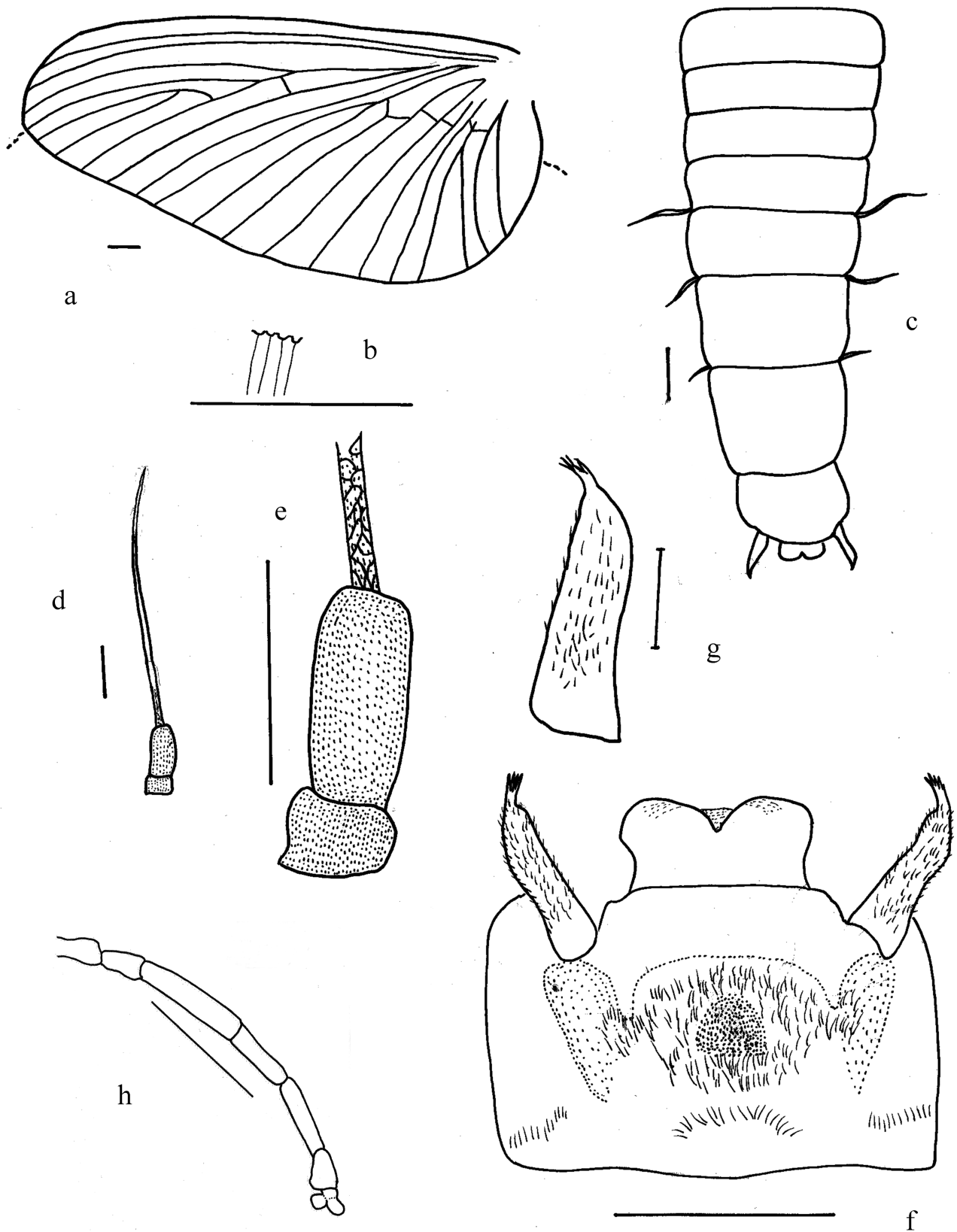
**Diagnosis.** *C. hanleyi* can be characterised by the following combination of characters. In the male imagoes: body length 1.7–2.2 mm; base of antennal flagellum not dilated (Fig. 1d, 1c); penes with median concavity and rounded lateral lobes (Fig. 1f); styliger plate with apex straight (Fig. 1f); forceps long, broad and straight >7 times longer than terminal spines; apical tuft of four spines on an apical stalk (Fig 1f, 1g). In the nymphs, body length

2.2–2.5 mm; body colour dark brown with antennae, and legs dark (Fig. 2a, 2b, 2c, 4c); body surface covered with distinct short rounded triangular tubercles (Fig. 5b, 5c, 5d); segment II of maxillary palp shorter than segments I and III (Fig. 3b); labial palp with segment II long 1.5–1.6 x longer than segment III (Fig. 3c, 3d); left mandible with three apical teeth and an inner lateral tooth on outer incisors (Fig. 3f, 3h); anterior lateral margin of mesonotum lacking lateral projections (Fig. 4e); coxae of legs without small rounded processes; fore femur transverse row of <10 setae (Fig. 2c, 2i); tarsal claws of fore and mid legs lacking teeth or denticles (Fig. 2d, 2f); hind claw with short microhairs (Fig. 2h); abdominal segment I lacking long setae on posterior margin (Fig. 4a, 4e); segments VII and VIII with long setae on posterior margin (Fig. 4a, 4e); postero-lateral spines on abdominal segment IV–IX (Fig. 4a); posterior margin of sternite IX convex; first gill with segment II 2.5–4.0x longer than segment I (Fig. 4d); operculate gills with Y-shaped ridge reduced (Fig. 2j), outer margin slightly serrated; mesal ridge with approx. eight short bifid setae basally and 3 long pinnate setae (Fig. 2j, 2l), gill dorsal surface covered with short triangular tubercles and net-mesh (Fig. 5f). Submarginal row of microtrichia running closely to lateral margin, ending in middle of hind margin of gill (Fig. 2j, 2k); microtrichia simple fringed apically (Fig. 2k); third to sixth gill oval with >25 tracheal filaments which have multifid (2–4) tracheal branches (Fig. 5).

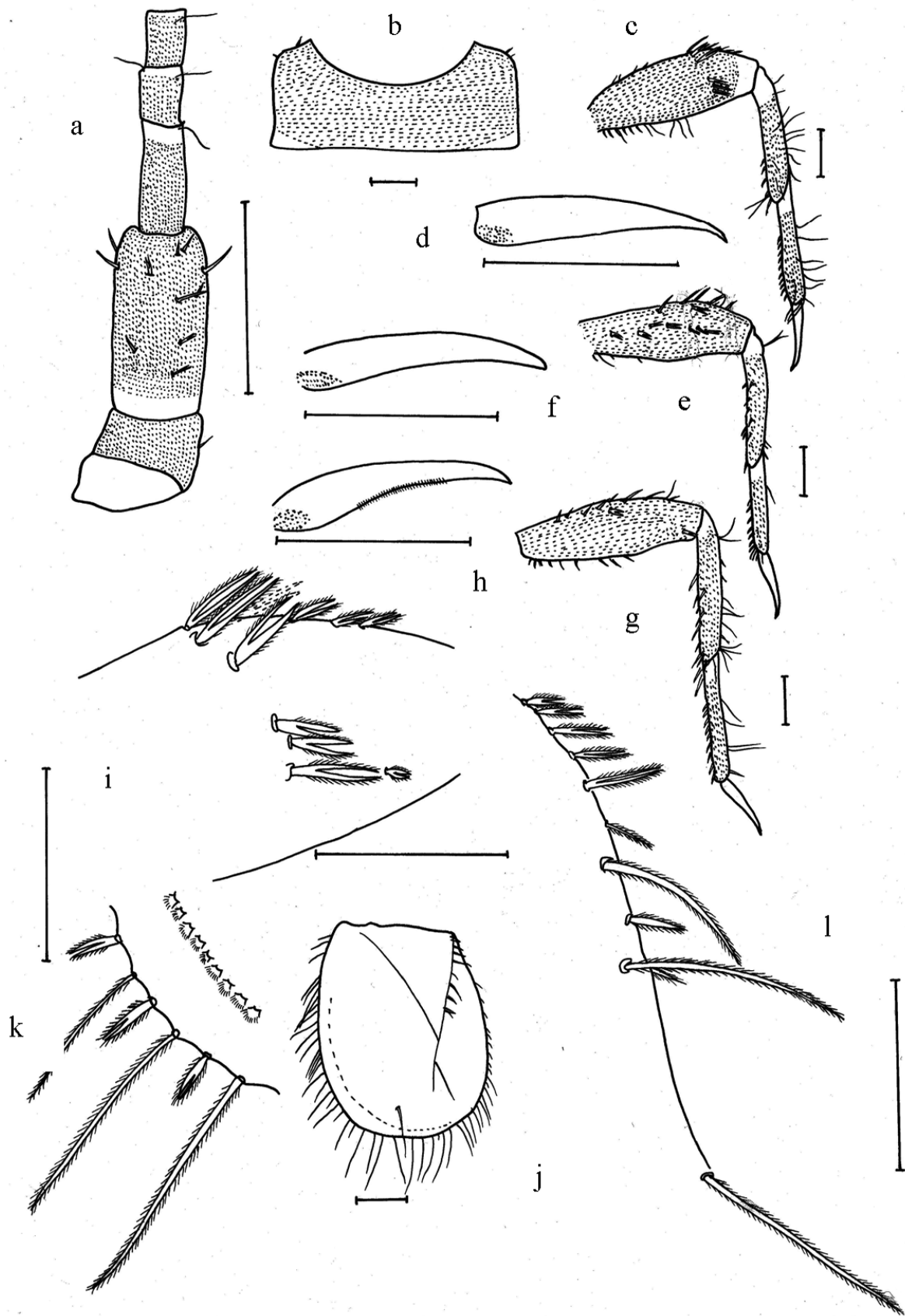
### Description

**Male imago** (n=3). Body Length 1.7–2.2 mm; wing length 1.4–1.6 mm terminal filament length 3.5–3.8 mm. Head: Base of antennal flagellum not dilated (Fig. 1d, 1e). Antennal pedicel, scape and base of flagellum tinged brown; pedicel 1.7–3.5 x longer than scape, flagellum length 0.47–0.52mm (Fig. 1d, e). Prosternum triangular with straight lateral sides, apex broadly rounded (Fig. 5a, 5b). Legs slender and delicate; forelegs longer than mid and hind legs; tarsomeres of foretarsus apically not broadened, foretarsal claws similar, both blunt and ovoid (Fig. 1h); mid and hind tarsal claws dissimilar one blunt and one slender, curved and sharp. Tarsal segment formula of foreleg 2, 3=4, 5=1. Femora lacking apical markings. Leg ratios: Foreleg 1.00 (0.39–0.42 mm) : 1.10–1.28 : 0.79–0.87. Middle leg 1.00 (0.40–0.41 mm) : 0.63–0.73 : 0.49–0.50. Hind leg 1.00 (0.42–0.44 mm) : 0.62–0.73 : 0.48–0.52. Scutellum broad, posteriorly broadly rounded. Wings 1.94–2.0 x longer than wide (Fig. 1a), with hind margin lined with long hairs which are longest in anal and cubital region and short in radial region (Fig. 1b). Abdomen: Without markings on sternites, with lateral filaments on abdominal segments IV–VIII (difficult to see or may be dislodged in some specimens) (Fig. 1c). Sternite IX and genitalia (Fig. 1f); styliger plate rectangular length one third width, central sclerite dome shaped, lateral sclerites broad, wider than base of forceps, apophyses short slightly curved inwards; penes with median concavity and rounded lateral lobes. Forceps long, uniformly broad and straight (Fig. 1g), not curved; 7–10 x longer than apical spine length; 3.32–4.00x longer than wide, with tuft of four apical spines and surface covered with long setae/hairs. Three terminal filaments 3.50–3.85 mm long.

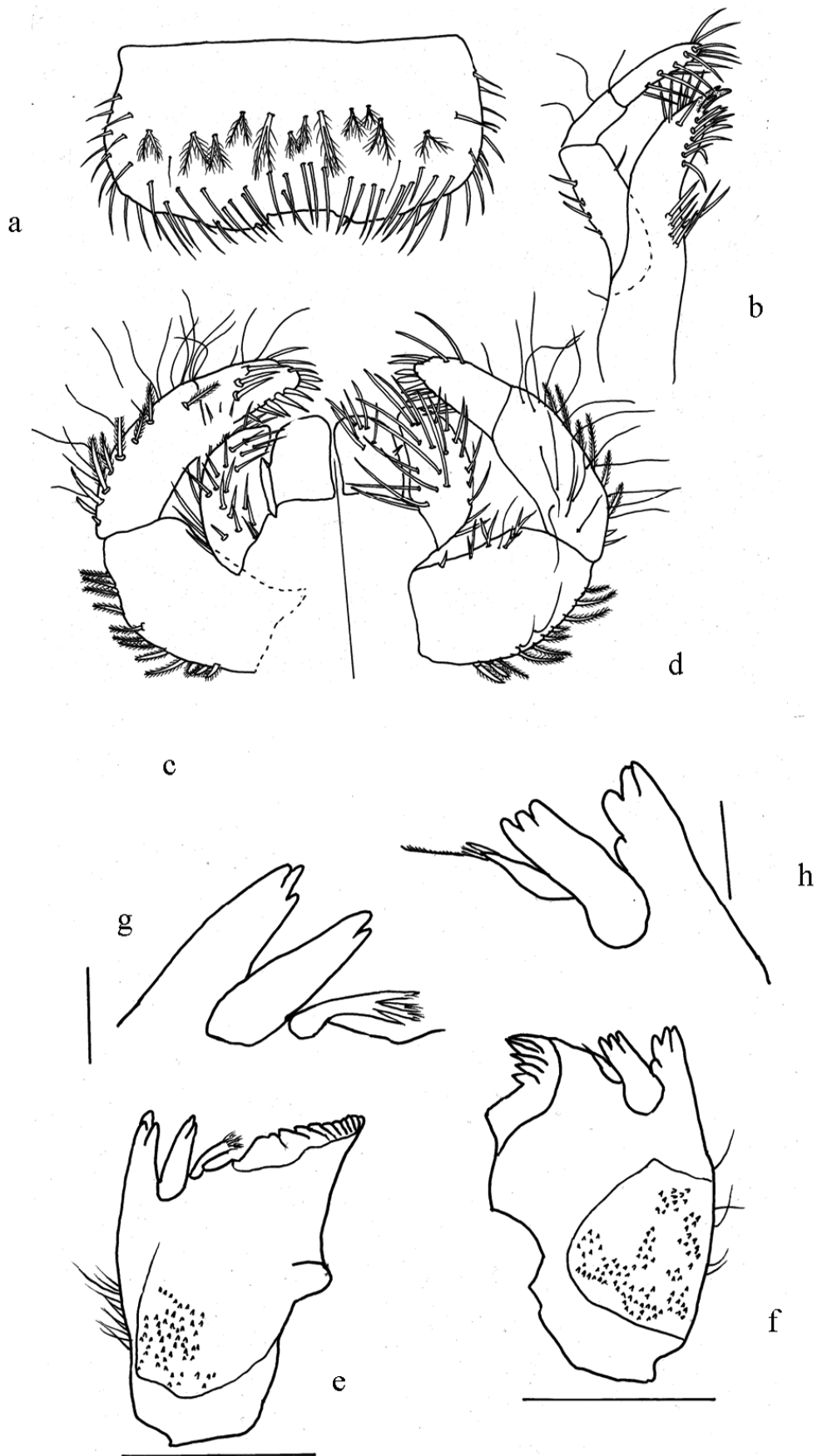
**Nymph** (n=10). Body length: males 2.2–2.5mm; terminal filaments 2.0 mm; females 3.6 mm long. General body colour brown, without mottled markings (Fig. 4e). Head dark brown with light central area in the fronto-clypeal region between antennae; antennae with scape, pedicel and base of flagellum brown (Fig. 2a); pedicel 0.06–0.07mm, 2.0–2.3 x length of scape, antennal length 0.76–1.14 mm long. Head covered in small triangular tubercles (Fig. 5b, c), genae not bulged. Mouthparts: Labrum broadly emarginate, width 2.0 x length with long setae along margins, long simple setae posterior to concavity and those along mid row bifid and pinnate (Fig. 3a). Left mandible (Fig. 3e) with long pinnate setae on outer margin, incisors paired, outer incisors with three apical teeth and a single tooth on inner margin, inner incisors with three teeth (Fig. 3h); prostheca robust slightly divided apically with long multifid setae; edge between prostheca and molars lined with short bristles; base of mandible with area of short tuberculate ornamentation. Right mandible (Fig. 3e) with long pinnate setae on outer margin; incisors paired, outer incisors with three teeth; inner incisors with two teeth (Fig. 3g); prostheca robust with multifid apical setae; inner margin of mandible with row of setae; base of mandible with area of short tuberculate ornamentation. Maxilla (Fig. 3b) galeo-lacinia with three apical teeth and row of setae on inner margin; base with a separate row of setae; maxillary palp three segmented, longer than galeo-lacinia, segment ratio 1.00 (0.07–0.08 mm) : 0.66–0.78 : 1.05–1.22. Labium (Fig. 3c, d) paraglossae longer than glossae; proximal segment of labial palp 1.33–1.70 x longer than broad; lateral margin with 12 short, robust pinnate setae; distal segment short, triangular; segment ratio 1.00 (0.07–0.10 mm): 0.89–1.13 : 0.48–0.73. Thorax: Pronotum brown without markings (Fig. 2b), covered with short triangular tubercles (Fig. 5e); antero-lateral margin with 1–2 short spine setae. Mesonotum without distinct markings, with short triangular tubercles on postero-lateral surface and linear rows on surface of wingpads (Fig. 5d). Legs all tinged brown with rows of rounded triangular tubercles, lacking coxal process. Foreleg (Fig. 2a) tinged brown, femur with transverse row of four long bifid setae and four short bifid setae (Fig. 2i); tibia with three long setae on transverse surface, three spines on ventral surface, apical spine longest; dorsal surface with long fine hairs;



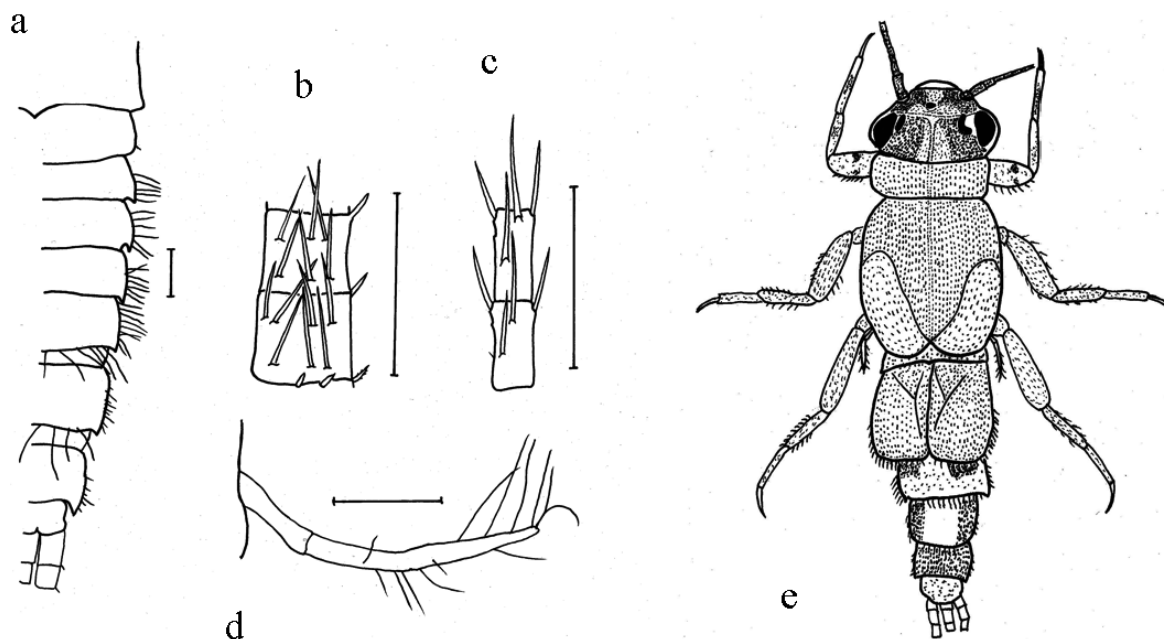
**FIGURE 1.** *Caenis hanleyi* n. sp. male imago. a, wing, dotted markings show the extent of the marginal hairs; b, hairs on wing margin; c, abdomen with lateral projections; d, antenna; e, antennal base; f, genitalia; g, forceps; h, fore tarsus. Scale lines a–h = 0.1 mm.



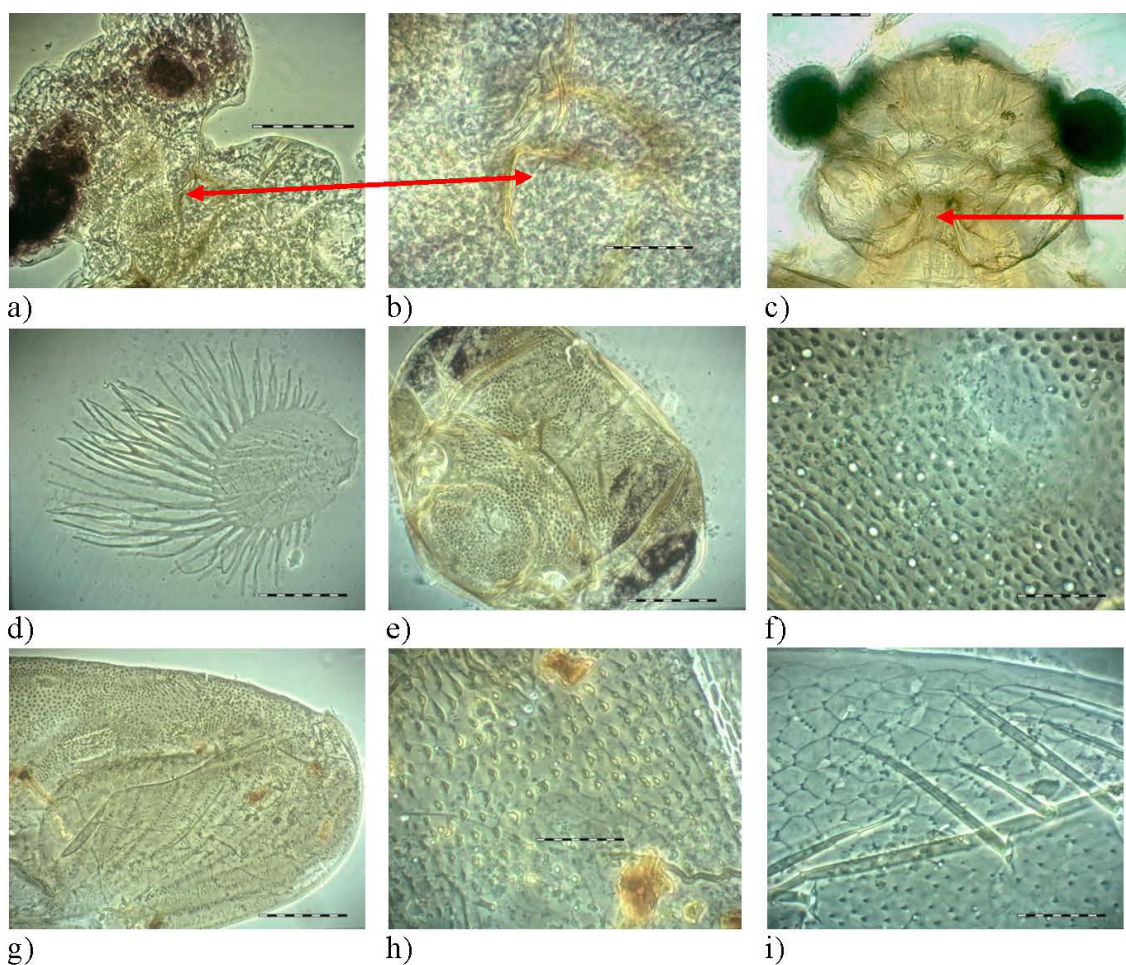
**FIGURE 2.** *Caenis hanleyi* n. sp. nymph. a, antenna base; b, pronotum; c, foreleg; d, tarsal claw of foreleg; e, mid leg; f, tarsal claw of mid leg; g, hindleg; h, tarsal claw of hind leg with comb of bristles; i, foreleg transverse row of bifid setae; j, second gill; k, margin of second gill and microtrichia; l, setae on mesal ridge of second gill. Scale lines = 0.1 mm.



**FIGURE 3.** *Caenis hanleyi* n. sp. mouthparts of nymph. a, labrum; b, maxilla; c, labium, dorsal (left), d, ventral (right); e, right mandible; f, left mandible; g, right incisors; h, left incisors. Scale lines = 0.1 mm.

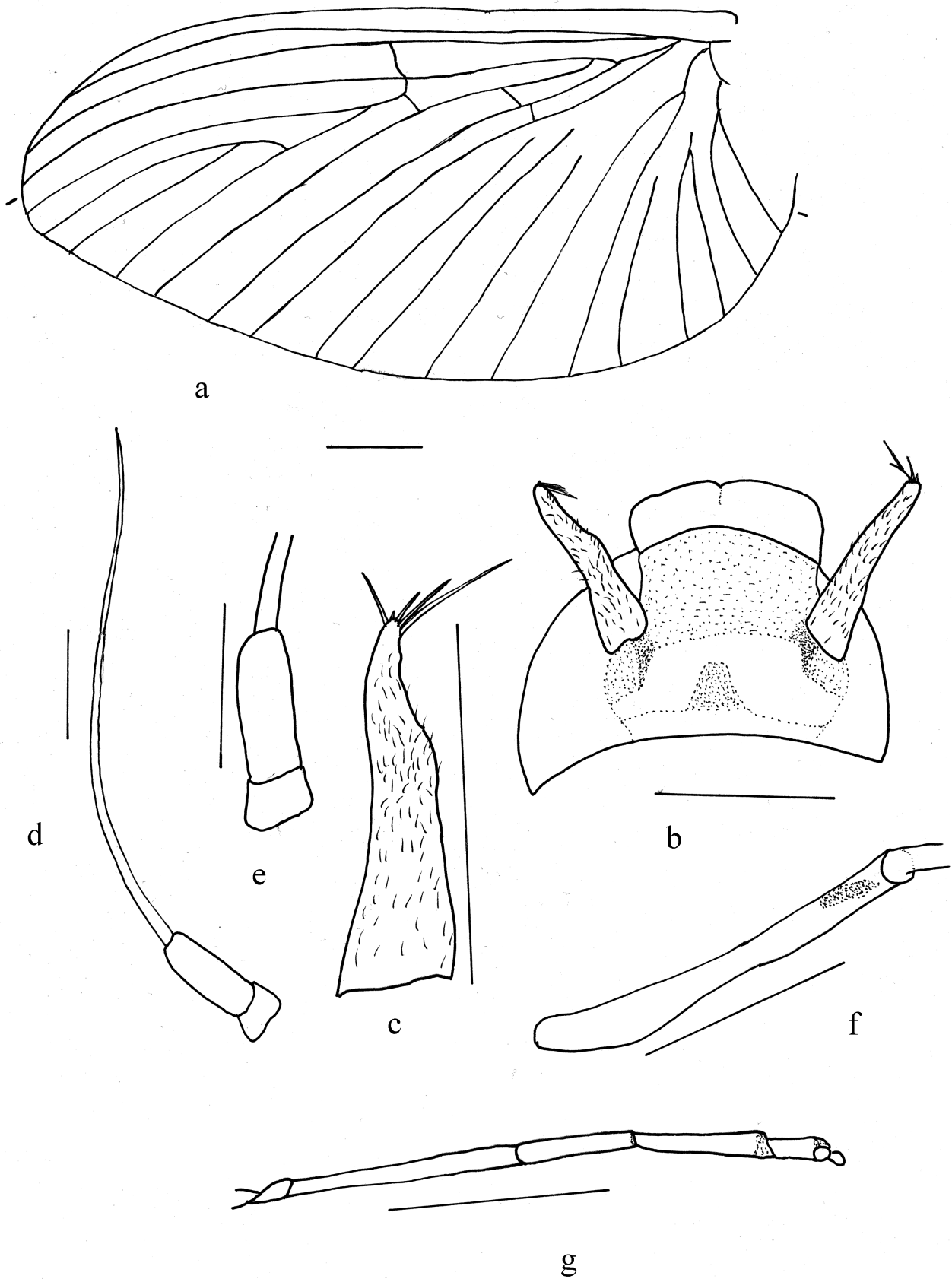


**FIGURE 4.** *Caenis hanleyi* n. sp. nymph. a, abdominal setae; b, setae on base of terminal filaments; c, setae on mid area of terminal filaments; d, first gill; e, habitus. Scale lines = 0.1 mm.



**FIGURE 5.** a, *Caenis hanleyi* n. sp. prosternum of male imago; b, enlarged photo of prosternum arrowed; c, *C. binda* n. sp. prosternum of male arrowed; d, *C. hanleyi* nymphal gill IV; e, ornamentation on head; f, enlarged detail of tubercles on frons; g, ornamentation on mesonotum; h, enlarged detail of tubercles on pronotum; i, ornamentation on 2nd gill. Scale lines a, c, d, e, g = 0.12mm; b, f, h, i = 0.03mm.





**FIGURE 6.** *Caenis binda* n. sp., male imago. a, wing, markings at margins show extent of hairs along the posterior margin; b, genitalia; c, forceps showing apical bristles; d, antenna; e pedicel and scape of antenna; f, femur of foreleg; g, fore tarsus. Scale lines, a, d, f, g = 0.2 mm; b, c, e = 0.1 mm.

tarsus with five spines on the ventral margin, dorsal and transverse surface with long fine hairs; tarsal claw long and slender, slightly curved and smooth, 0.52–0.61 x tarsus length (Fig. 2d). Mid leg (Fig. 2e) tinged brown; femur with row of 3–4 bifid setae; tibia with long blunt setae on dorsal surface; inner margin with five sharp spines; surface of segment covered with long fine hairs; tarsus with nine sharp spines on inner margin; long fine hairs on surface of segment, tarsal claw long and smooth, 0.56–0.62 x tarsal length (Fig. 2f). Hind leg (Fig. 2g) tinged brown; dorsal surface with 2–3 spatulate setae; tibia with long blunt setae on dorsal surface, inner margin with approx. six sharp spines; surface of segment with long fine hairs; tarsus with dual row of spine setae on inner margin and surface with long fine hairs; tarsal claw long, slender, curved with comb of fine, short setae in basal half, 0.51–0.54 x tarsal length (Fig. 2h). Ratios of segments: Foreleg 1.00 (0.40–0.42 mm): 0.60–0.70 : 0.62–0.67 : 0.35–0.38. Middle leg 1.00 (0.37 mm): 0.72 : 0.55. Hind leg 1.00 (0.39 mm): 0.80 : 0.64. Femur length to width ratios, fore femur 2.5–3.0; mid femur 3.0–3.5; hind femur 2.9–3.4. Abdomen: Tergites brown with light square medial marking on segment VIII, segments VII and X light brown, segment IX dark brown. Posterior margin of abdominal tergite I without setae; tergite II with short triangular process between operculate second gills; hind margins of tergites VII and VIII with numerous long setae; postero-lateral spines on abdominal segment IV–IX (Fig. 4a). Dorsal surface with small triangular tuberculate ornamentation. Sternite of abdominal segment IX with convex posterior margin. Caudal filaments with basal segments with short lateral setae, 0.4 x segment length but with intersegmental setae equal to segment length (Fig. 4b); mid-apical segments of caudal filaments with lateral and intersegmental setae long 0.6 x segment length (Fig. 4c). Gills: First gill two segmented with apical segment 2.0–2.5 x longer than basal segment (Fig. 4d). Second gills operculate 1.3x longer than wide (Fig. 2j), with outer and posterior margins lined with long pinnate setae each separated by short bifid setae (Fig. 2k); inner margin with shorter setae, outer margin slightly serrated; mesal ridge with approx. eight short bifid setae basally and three long pinnate setae (Fig. 2l), and short triangular tubercles along its posterior length; gill dorsal surface covered with short triangular tubercles and net-mesh (Fig. 5f). Submarginal row of microtrichia running closely to lateral margin, ending in middle of hind margin of gill (Fig. 2j); microtrichia simple, fringed apically (Fig. 2k). Third to sixth gill oval with >20 filaments each with multifid (2–3) tracheal branches (Fig. 5a).

**Etymology.** Named in honour of Julie Hanley who has supported our work in the Alligator Rivers region of the Northern Territory with fresh material whenever requested.

**Ecological observations.** Lotic, in the main streams in slow flowing water where there an accumulation of fine organic material. Specimens were also collected from organic rich, highly coloured, isolated pools at Radon Springs where daytime temperature exceeded 30°C in May 1988.

## Discussion

*Caenis binda* and *C. hanleyi* have forceps similar to the Type 4 forceps of Malzacher (2022) and resembles the three species described from male imagoes from the Australasian realm namely: *C. insularis* from the Bismarck Archipelago (Demoulin 1969), *Caenis marawakensis* from New Guinea (Malzacher and Staniczek 2018) and *C. novaeguineae* from the Wissel Lakes in New Guinea (van Bruggen 1957). *Caenis novaeguineae* (van Bruggen, 1957) was originally described in the genus *Tasmanocoenis* but Malzacher and Staniczek (2007) believed this species to belong in *Caenis* but did not assign a new combination as they had not sighted the material. In a subsequent paper Malzacher (2022), on the basis of the morphology of the genitalia, referred to this species as *Caenis novaeguineae*. An undescribed species from Fiji (Flowers 1990) also has Type 4 forceps.

Although all the *Caenis* species from the Australian realm have the tuft of spines on the forceps the base of the antennal flagellum is dilated in *C. novaeguineae* but not in *C. hanleyi*, *C. binda* and *C. marawakensis* (unknown in *C. insularis* and Fijian species) whereas *C. marawakensis* and the Fijian species have triangular lobes of the penes which are absent in *C. hanleyi*, *C. binda*, *C. novaeguineae* and *C. insularis*. The forceps of *C. hanleyi* and the Fijian species are >7x length of the spines which are on a short, distinct stalk whereas the other species all lack a stalk and the forceps are approx. 3x length of the apical spines. *C. hanleyi* male imagoes differs from *C. binda* in the shape of the forceps which are long and broad versus long and tapering; four short apical spines on a stalk versus four long and one short apical spines without a stalk; lateral sclerite rectangular as broad as base of forceps versus short and triangular and much narrower than base of forceps.

In the nymphs only *C. unglata*, *C. vanuatensis*, *C. marawakensis* and *C. hanleyi* have been described.

Similarities for all these species include: body size of males (2–3 mm) and females approx. 3.3–3.8 mm; gill II with Y-shaped ridge reduced and the gills III–VI with >20 filaments most with 2–3 branches. Tarsal claws of the hind leg with a single row of short bristles in all except in *C. marawakensis* which has no bristles; posterior margin of abdominal segments VII and VIII with setae except in *C. ungulata* which has setae only on segment VII; microtrichia on the ventral surface of gill II simple with short base fringed apically except in *C. ungulata* which has a longer basal stalk fringed apically. *C. hanleyi* differs from the other species in being almost uniformly brown with antennae and legs brown compared to yellowish brown in the other species; legs without banding versus legs light yellowish with darker banding; genae not bulged versus others all bulged; gill II with tubercles and net mesh ornamentation on dorsal surface versus only few setae, or tubercles or lacking any ornamentation; fore femur with transverse row of four long and four short pinnate, divided spatulate setae versus nine long and six short spatulate bristles in *C. marawakensis*, nine spatulate bristles in *C. ungulata* and 11 long pinnate bristle in *C. vanuatensis*.

*Caenis binda* and *C. hanleyi* both have type 4 forceps and are similar to the species described from New Guinea, Fiji and Vanuatu, and extends the distribution of *Caenis* into northern Australia.

This is consistent with Malzacher's biogeography and phylogeny (Malzacher 2022) with this group of *Caenis* expanding from Africa after separation from South America into the Palearctic, Oriental and beyond the Wallace Line into New Guinea and Northern Australia.

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