

## *Irpacaenis*, a new genus of Caenidae (Ephemeroptera) from Australia

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### Abstract

A new genus, *Irpacaenis*, is erected to include three new species of Australian caenid mayflies based on nymphal and subimago characteristics. The genus is diagnosed by weakly sclerotised straight forceps which are not grooved but are hooked apically; styliger plate and associated sclerites weakly sclerotised in the subimago; and, in the nymph, the absence of long setae over much of the body, rugose appearance caused by smooth tubercles which cover the body and legs, the presence of a medial projection on tergite 2 which is long and narrow with the length greater than the basal width, and the presence of a row of short sharp spines on the posterior margins of abdominal tergites 1, 2 and 7–10. The distribution of *Irpacaenis* extends from northern Queensland down the eastern coast of Australia to the Gippsland area of Victoria.

### Key words

Australia, Caenidae, mayflies, new species.

## INTRODUCTION

Collections from the National Rivers Program and, in particular, the Monitoring River Health Initiative (MRHI) have included caenid mayfly nymphs that are distinctly different from all the species described in the two previously recognised Australian caenid genera, *Tasmanocoenis* Lestage and *Wundacaenis* Suter. Although these specimens are rare, and have not previously been associated with adults, Dean and Suter (1996) included these nymphs in a generic key collectively as 'Caenid Genus C'. The species described here are from the Queensland monitoring program, collections held in the Museum of Victoria and the author's collection from the upper Murray River. Only two nymphs from one species were successfully reared to subimago, although numerous attempts were made to associate the nymphs and adults directly. The subimago can be clearly distinguished from all described adult species on the basis of the structure of the male genitalia. Additional light-trap collections from localities where the nymphs were present did not include any adults.

Three species are recognised from the nymphal material, all of which occur in Queensland, but one is widespread down the east coast of Australia into the Gippsland region of Victoria.

## MATERIALS AND METHODS

Nymphs were collected as part of a macroinvertebrate monitoring program from different habitats using a sweep net. The bulk collections were preserved in formalin and after sorting in the laboratory were maintained in 75% ethanol. Additional collections were made by hand picking from logs, and a 6-W UV-light trap was used to seek adults. Nymphs and subimagos were associated by rearing in 1 L containers.

Nymphs were dissected and mounted on slides in Euparal or polyvinyl lacto-phenol mounting medium. Illustrations

were made with the aid of a camera lucida. Terminology and most characters used in the descriptions follow Malzacher (1984, 1986).

All types are placed in the Australian National Insect Collection (ANIC), CSIRO, Canberra. The Victorian material is held in the Museum of Victoria, Melbourne, and materials provided by the Monitoring River Health program have been returned to the state agencies.

Collections have been provided by various institutions and they are identified by the abbreviations: Queensland Department of Primary Industries (QDPI); Museum of Victoria (MV); AWT Ensight (AWT).

### *Irpacaenis* gen. n.

**Type species.** *Irpacaenis deani* sp. n.

**Description.** Imago: Unknown.

Subimago: Head with separate lateral eyes. Antennal pedicel 2–3× longer than scape, flagellum 0.8 mm long. Thorax robust; pronotum narrower than head. Prosternum triangular longer than broad, apex sharp (Fig. 2); abdominal segments lack postero-lateral projections. Legs slender and delicate; males with five tarsal segments on all legs, females with four tarsal segments; in males tarsal claws of forelegs similar, both blunt and club shaped, dissimilar in mid and hind legs, one blunt club-shaped, one slender, curved and acute; females with all pairs dissimilar. Tarsal segment formula of male foreleg 5,3,1,2,4. Wings (Fig. 1) opaque;  $iR_2$  joins  $R_2$  in middle of wing;  $ICuA_1$  forked with  $CuA_2$ ; posterior margin fringed with short setae. Genitalia: (Figs 4,5) very weakly sclerotised, forceps straight, not grooved (Fig. 5). Penes broad; styliger plate broad, convex; lateral sclerite weakly sclerotised (Fig. 4). Three terminal filaments present.

Mature nymph: Head slightly rugose, lacking protuberances. Pedicel of antenna 2–3× length of scape (Figs 6,41,75),

with a few short setae. Pronotum as wide as head, rectangular in shape, lateral margins lacking setae; antero-lateral margin with or without short setae; surface covered with small, rounded tubercles (Figs 9,43,77). Mesonotum lacking lobes on antero-lateral corners; dorsal surface covered with small, rounded tubercles. Legs rugose, margins lined with setae, femora of fore, middle and hind legs with or without complex branched microtrichia and/or small spines on surface (Figs 14,49,86); tarsal claws of fore, middle and hind legs with three to 13 blunt proximal teeth (Figs 15–17, 50,51,52,83,84,85). Abdominal segments 7 and 8 with or without setae on posterior margin of tergite (Figs 108–110); setae absent on abdominal tergite 1. Abdominal tergite 2 with narrow median projection (Figs 108–110), basal width less than apical height (Figs 19,54,88). Posterior margin of abdominal tergites 1,2,7–10 with distinct, short, sharp spines (Figs 22,56,90). Posterior margin of abdominal sternite 9 usually convex (Figs 21,91) or with a shallow medial concavity (Fig. 57). Abdominal segments 4–7 or 4–8 with small postero-lateral projections (Figs 19,54,88). Terminal filament longer than cerci. Six pairs of gills on abdominal segments 1–6. First gill filamentous, two-segmented with long setae (Figs 18,53,87). Second gill operculate with a weakly developed triangular dorsal ridge, mesal ridge strongly developed with few short setae, extending almost to posterior margin of gill (Figs 27,61,95); surface of gill with complex branched microtrichia and spines (Figs 32,66); margin of gill lined with short setae, submarginal row of microtrichia present on ventral side of gill (Figs 64,98). Gills 3–6 triangular or rounded with tracheal filaments single, bifid or multifid. Mouthparts: Labrum rectangular, 1.8–2.1× broader than long, anterior margin with a shallow median concavity, lateral and anterior margins with setae and hairs (Figs 33,67,100). Mandibles stout, usually with marginal setae, outer incisors with three to four teeth, inner with two teeth, inner margins of incisors with row of fine setae (Figs 34,36,68,70,101, 103). Glossae of hypopharynx not produced, anterior margin concave, paragnaths lined with setae (Figs 38,72,105). Maxillae slender, with three to four spines at apices; palpi three-segmented (Figs 39,73,106). Labium with three-segmented palpi, basal segment broad, length < 1.5× width (Figs 40,74,107).

**Remarks.** *Irpacaenis* can be distinguished from all other genera in the Caenidae, including *Tasmanocoenis* and *Wundacaenis*, by the following combination of subimaginal and nymphal characters:

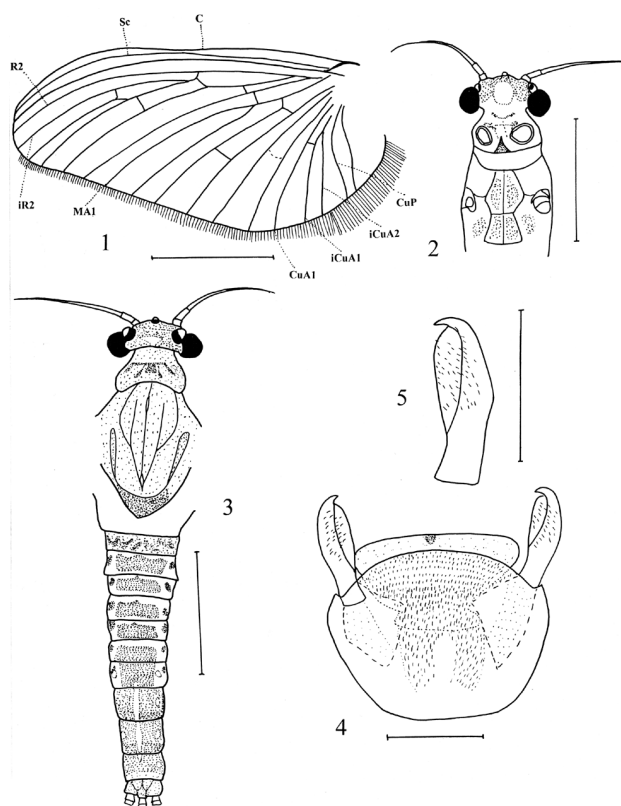
Subimago: Forceps weakly sclerotised, broad, straight, not grooved and with apical hook; styliger plate and associated sclerites weakly sclerotised, abdominal segments without lateral projections.

Nymph: Mesonotum without distinct lobes on antero-lateral margins; setae absent on abdominal tergite 1; sternite of abdominal segment 9 convex; gill cover with strongly developed mesal ridge which extends almost to posterior margin; thorax covered with small globular tubercles, and generally lacking hairs or setae; legs, abdominal tergites and gill cover usually with complex branched microtrichia and/or

small spines; posterior margins of abdominal tergites 1, 2, 7–10 with distinct, sharp spines; postero-lateral spines on abdominal segments 4–7 or 4–8; tergite 2 with narrow medial projection with basal width less than length.

*Irpacaenis* was originally recognised as a distinct genus (Caenid Genus C) in the Caenidae by Dean and Suter (1996). With the description of *Irpacaenis*, there are now three genera of Caenidae recognised in Australia. Alba-Tercedor and Suter (1990) reviewed *Tasmanocoenis* and *Wundacaenis* was described by Suter (1993). All three genera are placed in the subfamily Caeninae on the basis of the nymphal characteristics (Malzacher 1997), and the triangular prosternum in the adults. However, Malzacher (1997) notes that *Tasmanocoenis* and *Wundacaenis* have genital features which suggest they belong in the Brachycercinae. Unlike *Tasmanocoenis* and *Wundacaenis*, the genitalia of *Irpacaenis* with forceps weakly developed and not grooved and reduced sclerotisation is consistent with the subfamily Caeninae (Malzacher 1997).

The absence of thoracic hair and rugose appearance of the nymphs of *Irpacaenis* are distinctive in the Australian caenid fauna. *Irpacaenis* nymphs can also be distinguished clearly from *Wundacaenis* by the absence of the mesothoracic lobes and from *Tasmanocoenis* by the strongly developed mesal ridge, which extends to near the posterior margin of the gill



**Figs 1–5.** *Irpacaenis deani*, male subimago: (1) forewing; (2) head and thorax, ventral; (3) dorsal view of subimago; (4) genitalia; (5) left forcep. Scale bar = 1 mm for Figs 1–3; = 0.1 mm for Figs 4,5.

cover. In addition, *Irpacaenis* has a narrow projection on the medial margin of the second abdominal tergite which is longer than its basal width. In contrast, the basal width of this projection in *Wundacaenis* and *Tasmanocoenis* is equal to or greater than its length.

The distribution of *Irpacaenis* extends from northern Queensland near Cairns down the east coast to the Gippsland region of Victoria. Collections from New South Wales are limited, except from near Armidale, but it is likely that this genus is widespread in streams of the Great Dividing Range. Nymphs have been recorded from edge, riffle and macrophyte habitats.

**Etymology.** *Irp-* from the Wik-Mungkan language of the indigenous people of the Cape York Peninsula, Queensland (Thieberger & McGregor 1994), for 'tribal markings' referring to the distinct rugose nature of the body and the spines and microtrichia of the legs, gill covers and abdominal tergites of the nymphs of the genus.

### Key to the mature nymphs of *Irpacaenis*

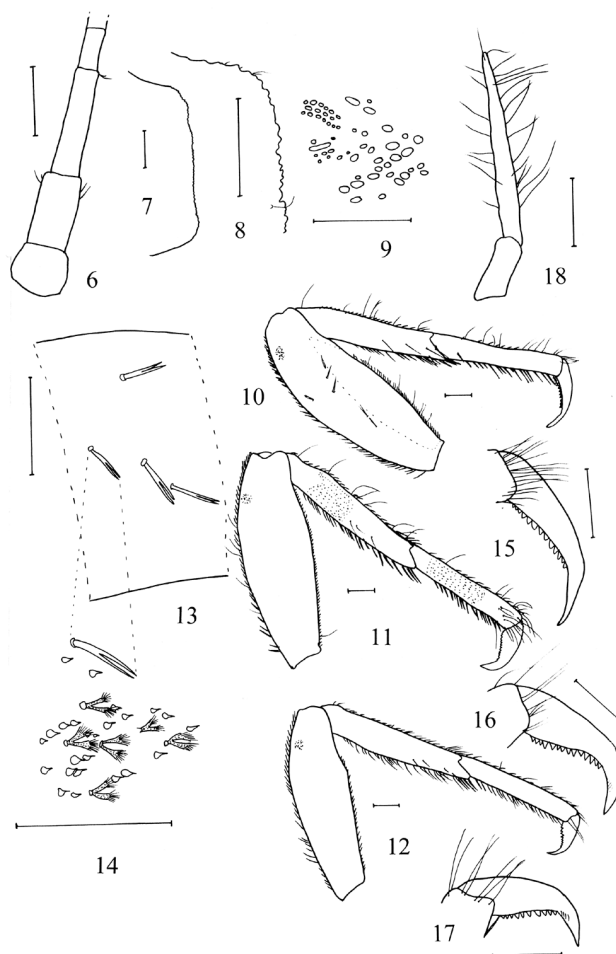
- 1 Setae present on the posterior margin of abdominal tergites 7 and 8 (Fig. 110); medial projection on abdominal tergite 2 small, less than 3/4 of segment length; abdominal tergite 1 with a small medial spine present in mature nymphs (Fig. 88) ..... *I. kaapi* sp. n.
- Setae absent on abdominal tergites 7 and 8 (Figs 108, 109); medial projection on abdominal tergite 2, small or large, abdominal tergite 1 without a small medial spine (Figs 19, 54) ..... 2
- 2(1) Medial projection on abdominal tergite 2 small, less than 3/4 of segment length (Fig. 108); first gill short, apical segment < 4× basal segment length (Fig. 18) ..... *I. deani* sp. n.
- Medial projection on abdominal tergite 2 long, greater than segment length (Fig. 109); first gill long, apical segment > 6× basal length (Fig. 53) ..... *I. coolooli* sp. n.

### *Irpacaenis deani* sp. n. (Figs 1–40, 108)

**Types.** **Victoria:** holotype subimago male, mounted on one slide, cast skin of nymph mounted on one slide, Kiewa River at Kiewa, 36°15'S, 147°01'E, coll. 6.i.1998 (emerged 10.i.1998), P. Suter; paratypes: one subimago female and cast skin in ethanol, same data as holotype; **New South Wales:** four nymphs, Murray River upstream of Walwa, 35°58'S, 147°47'E, 10.ix.1997, A. Conallin; five nymphs, Rosewood R. near Dorrig National Park, 30°23'S, 152°46'E, 24.iv.1995, A. Boulton; **Queensland:** 30 nymphs, Logan R. at Rathdowney, 28°13'S, 152°52'E, 12.x.1994, coll. QDPI; two nymphs, Mulgrave R. at Goldsborough, 17°15'S, 145°46'E, 17.x.1994, coll. QDPI. All deposited ANIC.

**Other material examined.** **Queensland:** one nymph, Luster Ck, at road crossing, 16°40'S, 145°15'E, 12.x.1994; two nymphs, Searys Ck at Bracken Log, 25°58'S, 153°04'E, 14.xi.1994; one nymph, Tewah Ck at Coop's Corner,

26°04'S, 153°02'E, 2.xi.1994; six nymphs, Obi Obi Ck at Gardners Falls, 26°46'S, 152°52'E, 3.xi.1994; one nymph, Obi Obi Ck at Aplin Rd, 26°46'S, 152°49'E, 3.xi.1994; two nymphs Running Ck, at Camping Ground, 28°19'S, 152°56'E, 12.x.1994; all collected by QDPI, deposited in Queensland Museum. **New South Wales:** three nymphs, Bishops Ck, 30°24'S, 152°38'E, 23.ix.1994, A. Boulton; three nymphs, Bellinger R. at Gordanville Crossing, 30°25'S, 152°51'E, 22.vii.1994, 22.ix.1994, A. Boulton; one nymph, Bellinger River at Cool Ck, 30°27'S, 152°37'E, 23.ix.1994, A. Boulton; two nymphs, Styx R. at Jeogla, 30°35'S, 152°10'E, 20.ix.1994, A. Boulton; one nymph, Chandlers R. at Carten Rd, 30°43'S, 152°02'E, 5.xi.1995, A. Boulton; two nymphs, Macleay R. at Georges Junction, 30°45'S, 152°11'E, 19.ix.1994, A. Boulton; one nymph, Cedar Ck, Blue Mountains, 33°49'S, 150°19'E, 1.x.1990, AWT; four nymphs, Upper Kangaroo River, approximately 8 km NE of



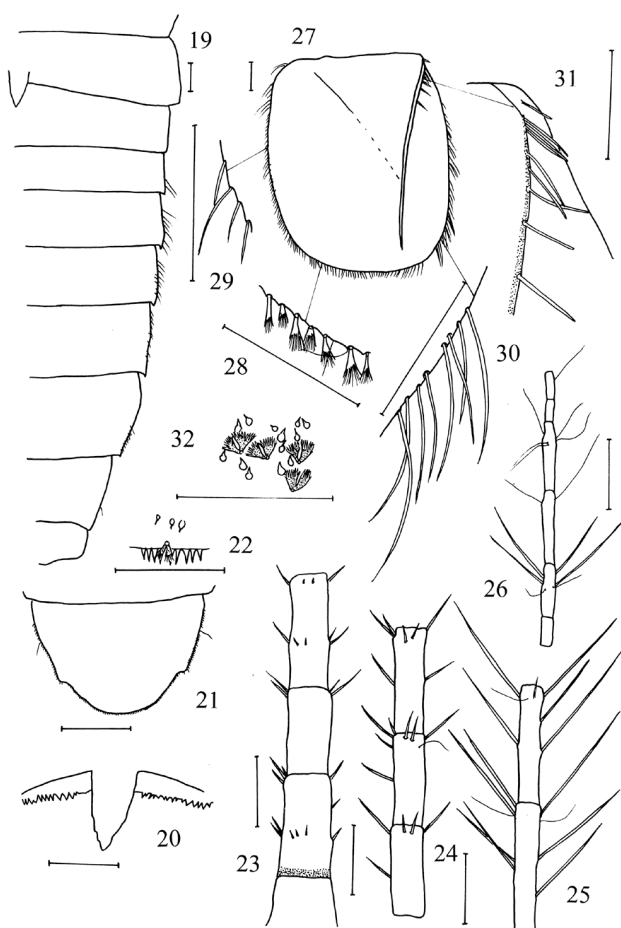
**Figs 6–18.** Nymphal characteristics of *Irpacaenis deani*: (6) base of antenna; (7) right-hand edge of pronotum; (8) antero-lateral margin of pronotum; (9) tubercles on dorsal surface of pronotum; (10) foreleg; (11) mid leg; (12) hind leg; (13) setae on fore femur; (14) fore femur surface detail; (15) fore tarsal claw; (16) mid tarsal claw; (17) hind tarsal claw; (18) first gill. Scale bars = 0.1 mm.

Kangaroo Valley, 34°42'S, 150°35'E, 25.ii.1973, John Dean. **Victoria:** 10 nymphs, Kiewa River at Kiewa, 36°15'S, 147°01'E, 6.i.1998, P. Suter; four nymphs, Mitta Mitta River, 4 km NW of Eskdale (Site 5), 36°27'S, 147°13'E, 13.xi.1977, DES; one nymph, Mitta Mitta River, 14 km NW of Dartmouth Dam Wall (Site 3), 36°30'S, 147°25'E, 14.xi.1977, DES; one nymph, Mitta Mitta River, 8 km NW of Dartmouth Dam Wall (Site 2 A), 36°31'S, 147°27'E, 15.xi.1977, DES; one nymph, Mitta Mitta River, Mitta Mitta camping ground (Site 4 A), 36°32'S, 147°22'E, 7.xi.1977, DES; one nymph, Mitta Mitta River, 0.5 km W of Dartmouth Dam Wall (Site 1 A), 36°34'S, 147°32'E, 13.xi.1977, Dartmouth Environmental Survey (DES); four nymphs, Macalister River at Caledonia River Confluence (Site Mc10), 37°28'S, 146°33'E, 6.xii.1977, Thomson River Survey (TRS); one nymph, Jackson Ck, Sunbury, 37°36'S,

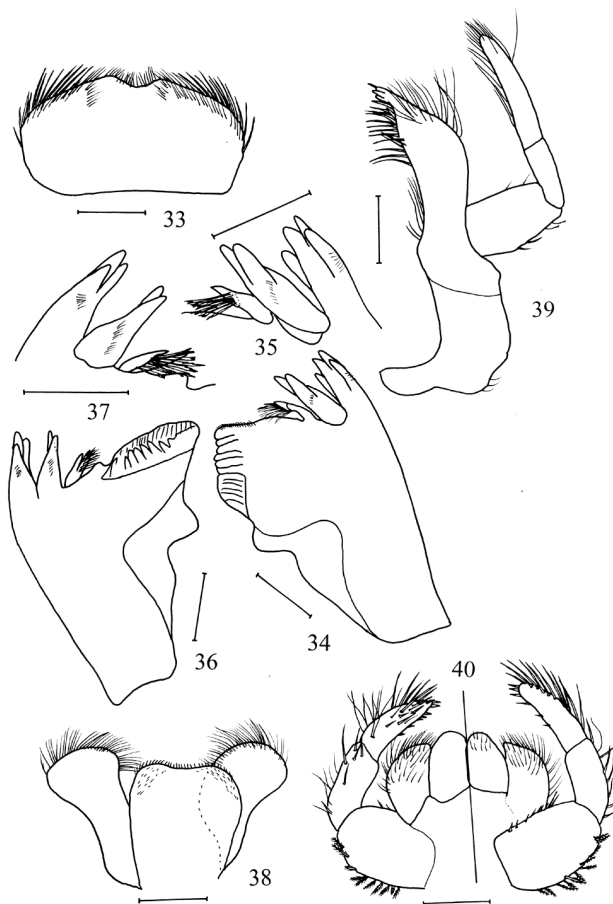
144°43'E, 24.xi.1987, L. Metzeling; four nymphs, Macalister River at Wellington River confluence (Site Mc20), 37°37'S, 146°38'E, 17.xi.1977, TRS; one nymph, Macalister River, 7 km NNW of Glenmaggie Weir (Site Mc21), 37°51'S, 146°44'E, 18.xi.1977, TRS; two nymphs, Macalister River 0.5 km downstream of Glenmaggie Weir (Site Mc22), 37°54'S, 146°48'E, 18.xi.1977, TRS; seven nymphs, Macalister River at Manson's Bridge, Newry to Tinambra Rd (Site Mc23), 37°57'S, 146°53'E, 19.xi.1977, TRS; one nymph, Thomson River on Tinambra to Rosedale Rd (Site T25), 37°59'S, 146°43'E, 4.xii.1976, TRS; two nymphs, Thomson River 4 km upstream of Cowwarr Weir (Site T22), 38°01'S, 146°43'E, 4.xii.1976, TRS; one nymph, Tyers River, Moe-Walhalla Rd, 38°03'S, 146°20'E, 24.ii.1974, J. Blyth; all deposited in Museum of Victoria.

**Description.** Imago: Unknown.

**Subimago:** Body length: male 3.5 mm, female 4.7 mm. Wing length: male 2.8 mm, female 4.0 mm. Terminal filament length 2–2.2 mm. Thorax robust; pronotum narrower than head. Prosternum triangular longer than broad, apex sharp (Fig. 2). Head and thorax light brown, abdomen with tergites dark grey, segments 7–8 with central light stripe



**Figs 19–32.** Nymphal characteristics of *Irpacaenis deani*: (19) postero-lateral spines on abdomen; (20) medial spine on second abdominal tergite; (21) hind margin of ninth abdominal sternite; (22) spines on posterior margin of seventh abdominal tergite; (23) basal segments of caudal filament; (24) segments 8–10 of caudal filament; (25) mid segments of caudal filament; (26) apical segments of caudal filament; (27) second gill; (28) setae on posterior margin of second gill; (29) setae on outer margin of second gill; (30) setae on inner margin of second gill; (31) setae on mesal ridge of second gill; (32) microtrichia and spines on surface of second gill. Scale bars = 0.1 mm.



**Figs 33–40.** Nymphal characteristics of *Irpacaenis deani*: (33) labrum; (34) left mandible; (35) incisors and prostheca of left mandible; (36) right mandible; (37) incisors and prostheca of right mandible; (38) hypopharynx; (39) maxilla; (40) labium, dorsal (left), ventral (right). Scale bars = 0.1 mm.



(Fig. 3); abdominal segments lack postero-lateral projections. Genitalia: (Figs 4,5) very weakly sclerotised, forceps straight, not grooved, with a curved hook apically, surface covered with short bristles (Fig. 5). Penes broad without central indentation; styliger plate broad, convex; lateral sclerite long, not strongly sclerotised (Fig. 4).

**Nymph:** Body length 3.2–5.0 mm; cerci 2.7–4.7 mm; terminal filament 3.2–5.0 mm; females larger than males. General body colour brown; head dark brown. Antenna with scape, pedicel, and flagellum brown, pedicel 2–3× length of scape, with one to four short setae; length of first segment of flagellum approximately 1.5× pedicel length (Fig. 6); antenna 1.5–2.0 mm long. Thorax: Pronotum brown with darker area laterally, antero-lateral margin without setae, short fine hairs present (Figs 7,8), covered with small smooth tubercles (Fig. 9). Mesonotum width equal to width of pronotum, no mottled pattern; covered with small smooth tubercles. Legs lightly banded, sometimes not obvious, (Figs 10–12); femora of all legs with a black spot in distal third; tibiae and tarsi darker basally; fore femur with five to six bifid, setae in a longitudinal row (Figs 10,13), surface covered with branched microtrichia and small bulbous spines (Fig. 14); claws long, slender, slightly curved with nine to 16 proximal teeth (Figs 15–17). Ratios of leg segments: foreleg 1.00:0.76:0.66 (0.72 mm); middle leg 1.00:0.82:0.66 (0.70 mm); hind leg 1.00:0.86:0.63 (0.78 mm). Femur length:width ratios: foreleg 3.2 (2.9–3.9), middle leg 3.0 (2.7–3.4), hind leg 3.3 (2.9–3.5). Abdomen: Tergites brown with a pair of medial black lines and darker region laterally; sternites light brown, slightly darker laterally; posterior margin of tergites 7 and 8 without setae; lateral backward pointing spines small, on segments 4–8 (Fig. 19), posterior margin of tergite 2 with a short medial projection which is less than the segment width (Figs 19,20), posterior margin of ninth sternite convex (Fig. 21); tergites 1,2,7–10 with sharp spines on posterior margins (Fig. 22). Caudal filaments with second segment sclerotised basally giving a banded appearance; basal segments elongate, 3× longer than wide, intersegmental and apical setae 0.3× segment length (Fig. 23); segments 8–12 with intersegmental and apical setae, all 0.5–0.6× segment length (Fig. 24); mid segments elongate, usually with both intersegmental (intersegmental setae may be absent) and apical setae, 1–3× segment length (Fig. 25); apical segments 31–44 narrow, length 2–3× width with occasional long, fine hairs (Fig. 26). Gills: First gill two-segmented apical segment length 3.8× basal segment length (Fig. 18); second gill (Fig. 27) with short fringed bristles on posterior margins (Fig. 28), outer margin with short spine setae (Fig. 29), inner margin with longer setae (Fig. 30); mesal ridge robust with seven to 10 short bifid and spine setae basally (Fig. 31); surface of gill with branched complex microtrichia and short bulbous spines (Fig. 32); third to sixth gills oval, fringed with branched tracheal filaments. Mouthparts: Labrum (Fig. 33) with dense setae, broadly emarginate, width 1.9× length. Left mandible (Fig. 34) without long setae on margins, outer incisors with three to four teeth and a row of short setae on inner surface, inner incisors with two

teeth also with row of short setae, prostheca robust, bifid with long apical setae (Fig. 35); right mandible (Fig. 36) outer margin without long setae, outer incisors with three apical teeth, row of short setae present, inner incisors with two teeth and row of short setae, prostheca robust, bifid with tuft of setae (Fig. 37). Hypopharynx (Fig. 38). Maxilla (Fig. 39): galeo-lacinia with four to five apical teeth, palp longer than galeo-lacinia, segment 3 long, segment ratios 1.00:0.68:1.13 (0.14 mm). Labium (Fig. 40), paraglossae as long as glossae; proximal segment of labial palp 1.5× longer than broad, lateral margin with about 10 short, robust pinnate setae; distal segment long, lined with long spine setae; segment ratios 1.00:0.92:0.86 (0.14 mm).

**Remarks.** *Irpacaenis deani* can be distinguished from the other species in the genus by the following combination of characters: pronotum lacking antero-marginal setae; femora of foreleg with longitudinal row of setae; presence of small medial projection on abdominal tergite 2; lack of setae on abdominal tergites 7 and 8; lack of setae on margins of mandibles; and the presence of intersegmental setae in the mid and apical regions of the caudal filaments.

The male and female subimagos of this species are the only known adults of the genus. *Irpacaenis* differs from *Tasmanocoenis* and *Wundacaenis* in the following characters: non-sclerotised nature of the forceps and styliger plate and associated sclerites; forceps straight, not grooved, with an apical hook; and prosternum triangular with a sharp pointed apex.

*Irpacaenis deani* has been recorded from riffle, edge and macrophyte habitats. In the Kiewa River nymphs were found on logs in flowing water, but were rare. While adults were not collected in light traps, other caenid species were common. Numerous nymphs were brought back to the laboratory, but only two were successfully reared to subimago.

**Etymology.** After John Dean, an Australian ephemeropterist, who provided the first specimens of this species from Kangaroo River in NSW.

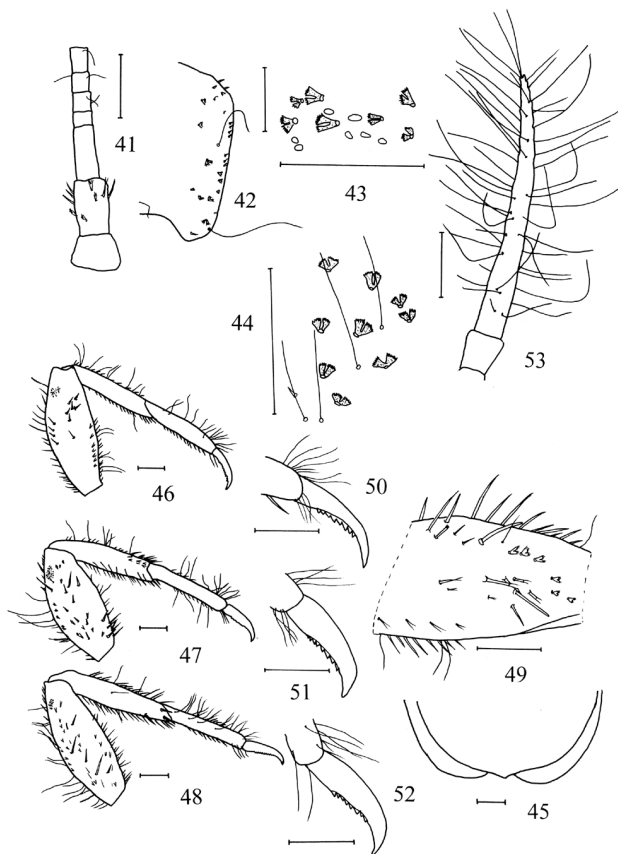
### *Irpacaenis coolooli* sp. n. (Figs 41–74, 109)

**Types. Queensland:** holotype nymph, mounted on two slides, Seary's Ck at Braken Log, 25°58'S, 152°49'E, 2.xi.1994, D. Conrick; paratypes: one nymph in ethanol, same data as holotype; two nymphs in ethanol, Noosa R. at Cooper's Corner, 26°03'S, 153°00'E, 2.xi.1994, D. Conrick; all deposited in ANIC.

**Description.** Imago and Subimago: Unknown.

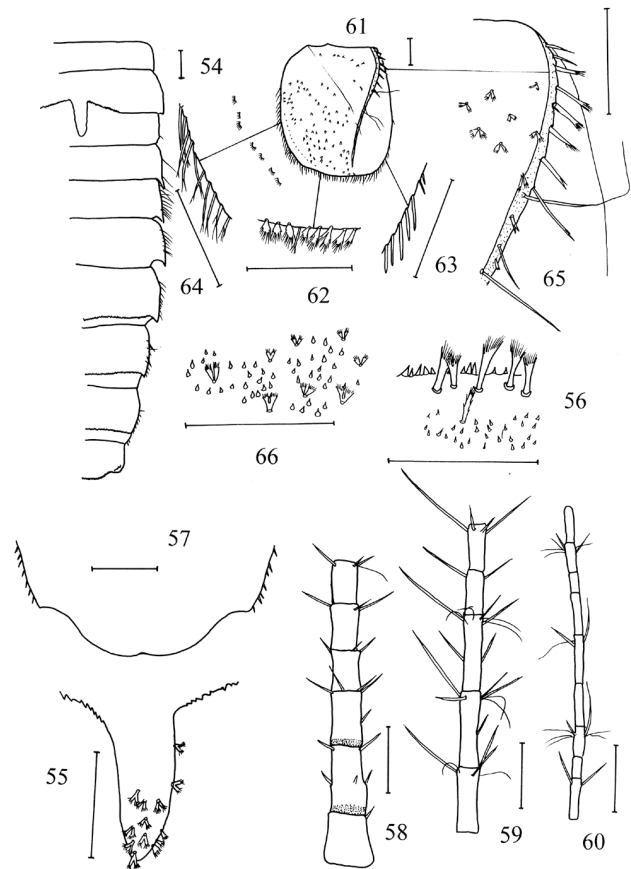
**Nymph:** Body length 5.7 mm; cerci 2.6 mm; terminal filament 2.9 mm. General body colour brown, head brown. Antenna with pedicel 2× length of scape, with a few short setae and complex branched microtrichia, length of segment 1 of flagellum equal to length of pedicel (Fig. 41); antennae 1.7 mm long. Thorax: Pronotum (Fig. 42), brown with no clear markings, lateral margins lighter, antero-lateral margin with one to two short setae, postero-lateral margin with occasional long fine hairs, branched microtrichia present; dorsal

surface with branched microtrichia and rounded tubercles (Fig. 43). Mesonotum width equal to width of pronotum; branched complex microtrichia and a few long fine hairs present on dorsal surface (Fig. 44). Metanotum with pointed posterior margin (Fig. 45). Legs uniformly brown with black spot in distal third of femora; femora, tibiae, and tarsi densely lined with spine setae and long fine hairs (Figs 46–48); fore femur with robust divided setae in a longitudinal row (Fig. 49), branched microtrichia and divided hair setae present; tarsal claws of foreleg long, slender, slightly curved, with nine proximal teeth (Fig. 50); femora of middle and hind legs with bifid setae and branched microtrichia; tarsal claws of middle legs with seven to eight proximal teeth (Fig. 51), hind legs with nine to ten proximal teeth (Fig. 52). Ratios of leg segments: foreleg 1.00:0.70:0.67 (0.52 mm); middle leg 1.00:0.80:0.71 (0.51 mm); hind leg 1.00:0.70:0.56 (0.66 mm). Femur length to width ratios: foreleg 2.74, middle leg 2.55, hind leg 3.30. Abdomen: Tergites brown; sternites light without markings, hind margins of tergites 7 and 8 lacking long setae; tergite 2 with long medial projection, length greater than segment length (Figs 54, 55, 109); lateral backward pointing spines small on segments



**Figs 41–53.** Nymphal characteristics of *Irpacaenis coolooli*: (41) base of antenna; (42) lateral margin of pronotum; (43) microtrichia and tubercles on surface of pronotum; (44) microtrichia on mesonotum; (45) posterior margin of metanotum; (46) foreleg; (47) mid leg; (48) hind leg; (49) setae on fore femur; (50) fore tarsal claw; (51) mid tarsal claw; (52) hind tarsal claw; (53) first gill. Scale bars = 0.1 mm.

4–7 (Fig. 54); posterior margin of ninth sternite slightly concave (Fig. 57); hind margins of tergites 1, 2, 7–10 with sharp spines, short fringed bristles present, surface with small spines (Fig. 56). Caudal filaments with basal segment 2 and 3 with basal ring of sclerotisation, segment length 1.5–2× width, intersegmental setae present, 0.3× segment length, apical setae 0.3–0.8× segment length (Fig. 58); segments 7–12 elongate, 3× width, apical setae 0.8–1× segment length, fine hairs present (Fig. 59); apical segments short and narrow, 3–4× longer than wide, segments with setae 2–3× segment length, some lacking setae (Fig. 60). Gills: Apical segment of 1st gill 7× basal segment length (Fig. 53); second gill (Fig. 61) with short complex fringed bristles on posterior margins (Fig. 62), inner margin with blunt setae (Fig. 63) and outer margin with fringed setae (Fig. 64); mesal ridge with eight to 10 apically fringed setae basally (Fig. 65) branched complex microtrichia present; submarginal row of scales on ventral surface simple (Fig. 64); surface of gill with branched complex microtrichia and small spines (Fig. 66); third to sixth



**Figs 54–66.** Nymphal characteristics of *Irpacaenis coolooli*: (54) postero-lateral spines on abdomen; (55) medial spine on second abdominal tergite; (56) posterior margin of seventh abdominal tergite; (57) ninth sternite; (58) basal segments of caudal filament; (59) mid segments of caudal filament; (60) apical segments of caudal filament; (61) second gill; (62) setae on posterior margin of second gill; (63) setae on inner margin of second gill; (64) setae on outer margin of second gill; (65) setae on mesal ridge of the second gill; (66) microtrichia and spines on surface of second gill. Scale bars = 0.1 mm.

gills oval, fringed with multifid tracheal filaments. Mouthparts: Labrum (Fig. 67) with long setae, broadly emarginate, width  $1.8\times$  length. Left mandible (Fig. 68) with few short setae on margins, outer incisors with three apical teeth and one inner lateral tooth, row of short setae present, inner incisors with two teeth, row of short setae present, protheca robust with long multifid setae (Fig. 69). Right mandible (Fig. 70) outer margin with few short setae, outer incisors with three apical teeth, short setae present, inner incisors with two teeth and short setae, prostheca robust, with multifid apical setae (Fig. 71). Hypopharynx (Fig. 72). Maxilla (Fig. 73), galeo-lacinia with four apical teeth, palp longer than galeo-lacinia, segment 3 long, segment ratios 1.00:0.75:1.25 (0.10 mm). Labium (Fig. 74), paraglossae as long as glossae; proximal segment of labial palp  $1.3\times$  longer than broad, lateral margin with six to eight short, apically divided, robust setae; distal segment long, blunt apically; segment ratio 1.00:1.00:0.76 (0.11 mm).

**Remarks.** This species can be distinguished from all other species in *Irpacaenis* by the following combination of characteristics: pronotum with one to two antero-lateral margin setae; metanotum with posterior margin pointed; mid and hind femora with longitudinal rows of setae or bristles;

femora short; abdominal tergite 2 with very long medial projection, length  $>$  width of segment; first gill with apical segment very long,  $7\times$  length of basal segment; and terminal filaments lack intersegmental setae in mid and apical region.

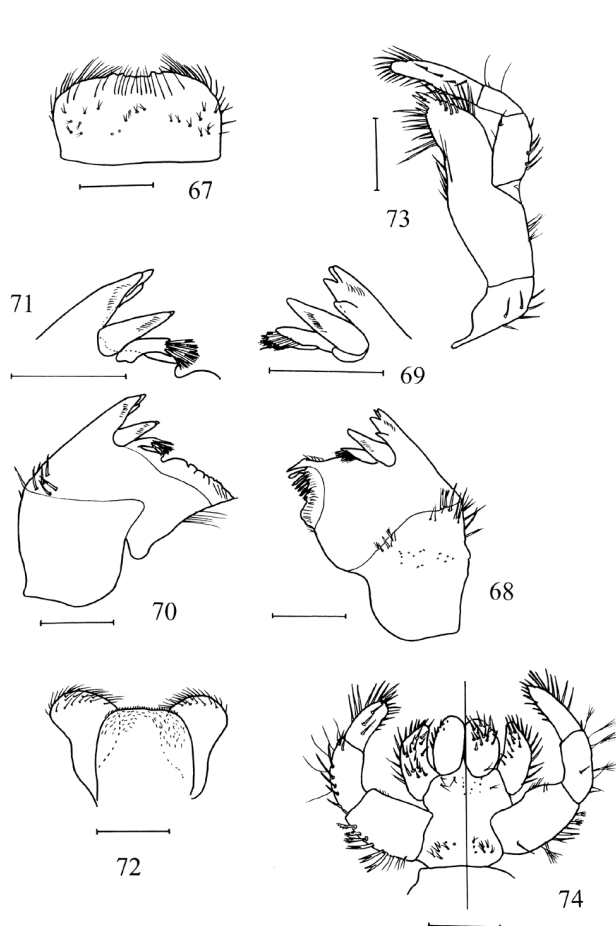
This species was collected from edge and riffle habitats in two streams near the Cooloola National Park near Gympie in the upper Mary and Noosa Rivers Catchments. Numerous streams in the same area were also sampled, but no additional material was collected.

**Etymology.** *coolooli* refers to the geographical proximity of this species with the Cooloola National Park.

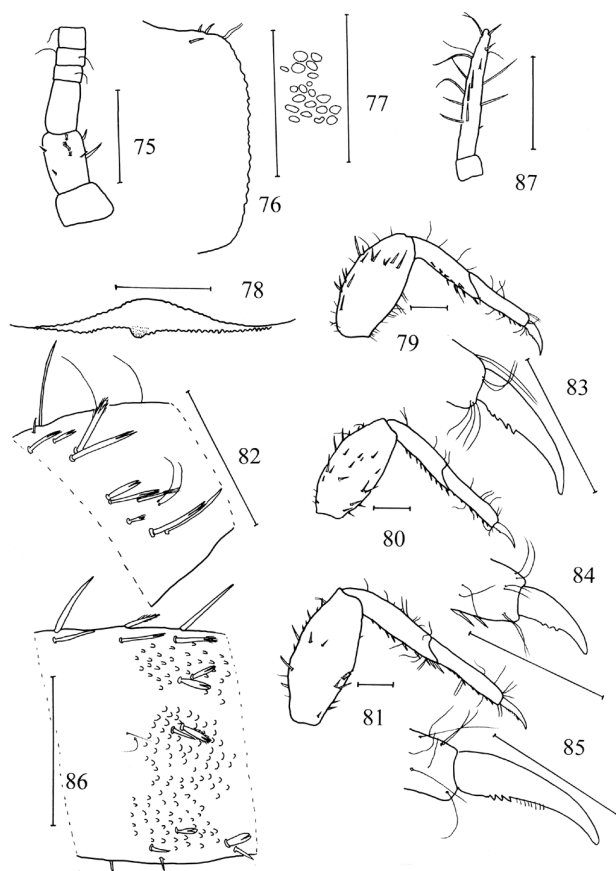
### *Irpacaenis kaapi* sp. n. (Figs 75–107, 110)

**Types.** Queensland: holotype nymph, mounted on two slides, Laura River, at Coalseam Ck,  $15^{\circ}37'S$ ,  $144^{\circ}29'E$ , 14.x.1994, coll. QDPI; paratypes: three nymphs in ethanol, same data as holotype; 1 nymph, Walsh R. at Rookwood,  $16^{\circ}59'S$ ,  $144^{\circ}17'E$ , 18.x.1994, coll. QDPI; all deposited in ANIC.

**Description.** Imago and Subimago: Unknown.



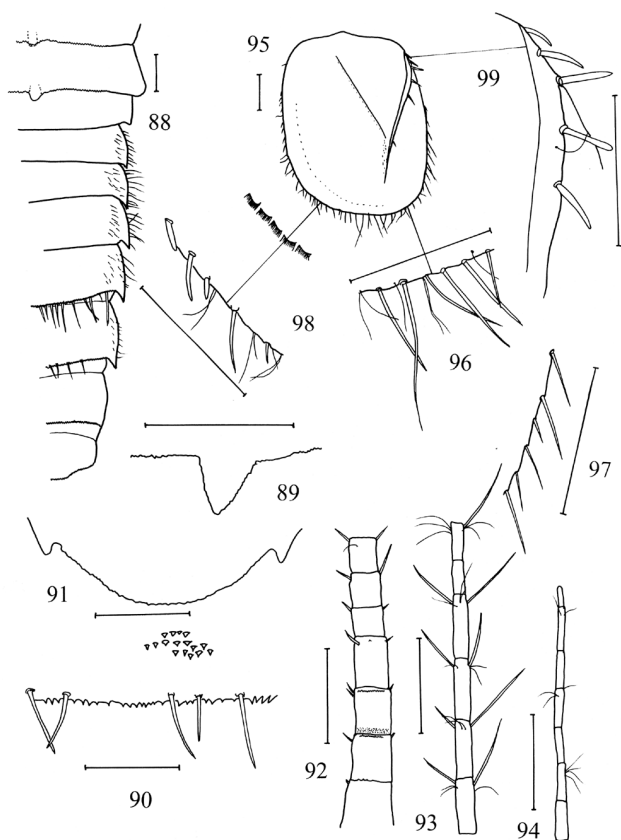
**Figs 67–74.** Nymphal characteristics of *Irpacaenis coolooli*: (67) labrum; (68) left mandible; (69) incisors and prostheca of left mandible; (70) right mandible; (71) incisors and prostheca of right mandible; (72) hypopharynx; (73) maxilla; (74) labium, dorsal (left), ventral (right). Scale bars = 0.1 mm.



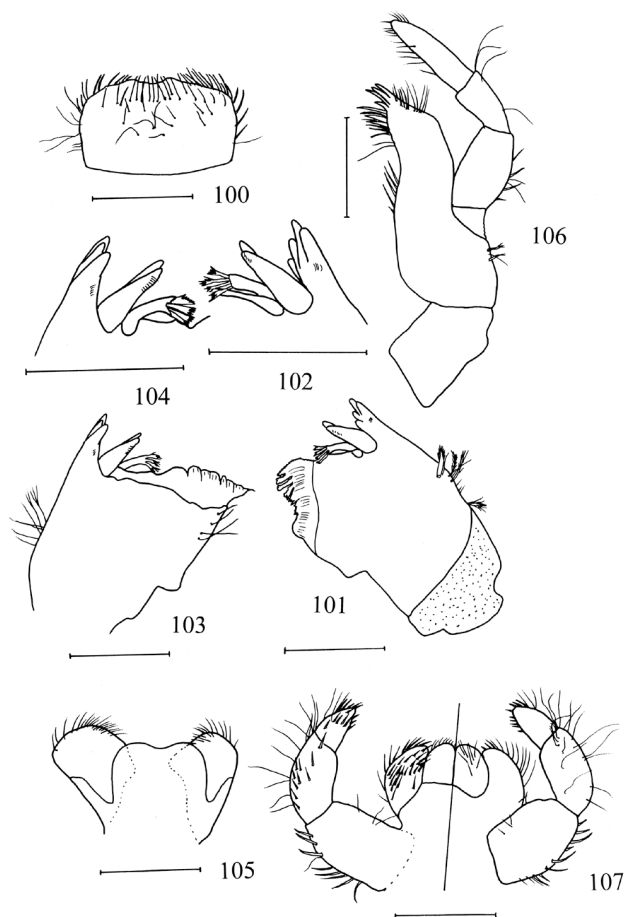
**Figs 75–87.** Nymphal characteristics of *Irpacaenis kaapi*: (75) base of antenna; (76) lateral margin of pronotum; (77) tubercles on surface of pronotum; (78) posterior margin of metanotum; (79) foreleg; (80) mid leg; (81) hind leg; (82) setae of transverse row of fore femur; (83) fore tarsal claw; (84) mid tarsal claw; (85) hind tarsal claw; (86) surface of hind femur; (87) first gill. Scale bars = 0.1 mm.

Nymph: Body length 2.5 mm; cerci 1.15 mm; terminal filament 1.19 mm. General body colour brown; head brown. Antenna with pedicel  $2.3\times$  length of scape, with four to six short setae, length of segment 1 of flagellum  $0.8\times$  pedicel length (Fig. 75); antennae 0.75 mm long. Thorax: Pronotum, slightly broader than head, antero-lateral margin with one to two short spine setae, lateral margins crenulate (Fig. 76), dorsal surface with rounded tubercles (Fig. 77). Mesonotum as wide as pronotum, dorsal surface lacking microtrichia; posterior margin of wing pads crenulate (Fig. 78); posterior margin of metathorax with small medial spine (Fig. 78). Legs not banded, femora without markings (Figs 79–81); fore femur with transverse row of eight to 10 bifid bristles (Fig. 82), surface rough, tuberculate, claws long, slightly curved, with four small proximal teeth (Fig. 83); femora of middle and hind legs with rugose surface of rounded tubercles, with rows of setae present (Fig. 86); tarsal claws of middle leg with two to three proximal teeth (Fig. 84); claw of hind leg with three to four proximal teeth and a short

comb of fine hairs (Fig. 85). Ratios of leg segments: foreleg 1.00:0.62:0.62 (0.32 mm); middle leg 1.00:0.68:0.68 (0.31 mm); hind leg 1.00:0.65:0.62 (0.40 mm). Femur length to width ratios: foreleg 2.00, middle leg 2.10, hind leg 2.50. Abdomen: tergites and sternites brown without markings; tergite 1 without dorsal setae, short medial projection present (Fig. 88); hind margin of tergite 2 with small medial projection, length less than segment width (Figs 88,89); hind margins of tergites 7 and 8 with numerous long setae (Figs 88,90); lateral backward pointing spines large, on segments 4–8 (Fig. 88), posterior margin of ninth sternite convex (Fig. 91); hind margin of tergites 1, 2, 7–10 with row of short spines (Fig. 90). Caudal filaments with basal segments short, length slightly longer than wide, segment 3 with basal sclerotised band, apical setae short  $0.2\text{--}0.5\times$  segment length (Fig. 92); mid segments elongate  $1.5\text{--}3\times$  longer than wide, apical setae long,  $1\text{--}1.5\times$  segment length (Fig. 93); apical segments short and narrow, length  $3\times$  width, fine hairs present on some segments (Fig. 94). Gills: First gill very short, apical segment  $5.7\times$  basal segment length (Fig. 87); second gill (Fig. 95) with long setae on posterior

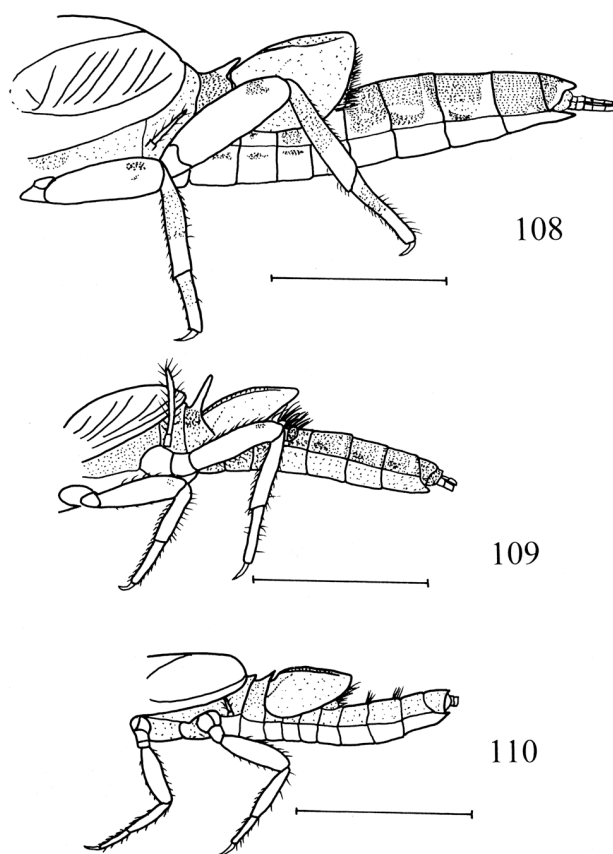


**Figs 88–99.** Nymphal characteristics of *Irpacaenis kaapi*: (88) postero-lateral spines on abdomen; (89) medial spine on second abdominal tergite; (90) posterior margin of eighth abdominal tergite; (91) ninth sternite; (92) basal segments of caudal filament; (93) mid segments of caudal filament; (94) apical segments of caudal filaments; (95) second gill; (96) setae on posterior margin of second gill; (97) setae on inner margin of second gill; (98) setae on outer margin of second gill; (99) setae on mesal ridge of second gill. Scale bars = 0.1 mm.



**Figs 100–107.** Nymphal characteristics of *Irpacaenis kaapi*: (100) labrum; (101) left mandible; (102) incisors and prosthema of left mandible; (103) right mandible; (104) incisors and prosthema of right mandible; (105) hypopharynx; (106) maxilla; (107) labium, dorsal (left), ventral (right). Scale bars = 0.1 mm.





**Figs 108–110.** Lateral views of abdomens of *Irpacaenis* spp. nymphs: (108) *I. deani*; (109) *I. coolooli*; (110) *I. kaapi*. Scale bars = 1 mm.

margins (Fig. 96), inner and outer margins with shorter bristles (Figs 97,98); mesal ridge with five to six short setae basally (Fig. 99); submarginal row of microtrichia on ventral surface simple (Fig. 98); surface of gill rugose with smooth tubercles; third to sixth gills oval, fringed with multifid tracheal filaments. Mouthparts: Labrum with long setae, broadly emarginate (Fig. 100), width  $1.6\times$  length. Left mandible (Fig. 101) outer margin with numerous long setae, outer incisors with three apical teeth and one inner tooth, row of short setae present, inner incisors with two teeth and row of short setae present, prostheca robust, with multifid apical setae (Fig. 102), basal region of mandible rugose. Right mandible (Fig. 103) with few long setae on margins, outer incisors with three teeth and short setae present, inner incisors with two teeth and short setae present, prostheca robust with long multifid setae (Fig. 104); basal region of mandible rugose. Hypopharynx (Fig. 105). Maxilla (Fig. 106), galeo-lacinia with four apical teeth, palp longer than galeo-lacinia, apical segment long, segment ratios  $1.00:0.72:1.11$  (0.09 mm). Labium (Fig. 107), paraglossae as long as glossae;

proximal segment of labial palp  $1.43\times$  longer than broad, lateral margin with about eight robust setae; distal segment short, triangular; segment ratio  $1.00:0.90:0.50$  (0.10 mm).

**Remarks.** This species can be distinguished from all other species in *Irpacaenis* by the following combination of characters: segment 1 of antenna shorter than pedicel; fore femora with transverse row of setae; small medial projection on posterior margins of metanotum, first and second abdominal tergites; projection on tergite 2 short, less than segment width; tarsal claws with  $<5$  ventral teeth, hind tarsal claws with ventral teeth and a comb of short fine hairs; abdominal tergites 7 and 8 with long setae; first gill very short; palp of labium with short third segment.

**Etymology.** The specific epithet *kaapi* is from *kaap* which in the Wik-Mungkan language of the indigenous people of the Cape York Peninsula, Queensland, is the word for 'wet season' (Thieberger & McGregor 1994).

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