Memoirs of Museum Victoria 58(2): 247–254 (2001)

REDESCRIPTION OF *BUNGONA* HARKER WITH NEW SYNONYMS IN THE AUSTRALIAN BAETIDAE (INSECTA: EPHEMEROPTERA)

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Abstract

Suter, P.J. and Pearson, M.J., 2001. Redescription of *Bungona* Harker with new synonyms in the Australian Baetidae (Insecta: Ephemeroptera). *Memoirs of Museum Victoria* 58(2): 247–254.

The monospecific genus *Bungona* Harker is redefined and descriptions of the imago and nymphs of *Bungona narilla* Harker are provided. Two species described by Lugo-Ortiz and McCafferty (1998) as *Cloeodes fustipalpus* and *C. illiesi* are recognised as being conspecific and junior synonyms of *Bungona narilla*. *Bungona narilla* is distributed along the east coast of Australia from North Queensland to Tasmania and nymphs occur in shallow, slow flowing, cobble streams.

Introduction

Harker (1957) erected the genus *Bungona* and *Bungona narilla*, type species, on the basis of a nymph and adult from Coal and Candle Creek, Sydney. The adult was distinguished from the genus *Pseudocloeon* by the shape and number of segments of the forceps and the nymphs were distinguished by the shape of the labial palpi and the maxillary palpi being 3-segmented. As the Australian baetid fauna became better known through the Monitoring River Health Initiative it was clear that the original description of the nymph was inadequate to distinguish *Bungona* from other baetid genera. The British Museum of Natural History has no record of type material having been deposited in spite of assertions that types were lodged (J. Harker, pers. comm). Dean and Suter (1996) and Suter (1997) redefined the genus in terms of the nymph, and noted that a number of distinguishing characters were not recorded by Harker (1957).

Direct association of an adult and nymph from the Rose River in Victoria and adults and nymphs from the New England area in New South Wales has enabled verification that the nymphs described by Dean and Suter (1996) and Suter (1997) are conspecific with *Bungona narilla* Harker.

Lugo-Ortiz and McCafferty (1998) recorded the genus *Cloeodes* Traver, 1938 from Australia. They described two new species *C. fustipalpus* and *C. illiesi*, without citing any Australian papers. The two species clearly belong in *Bungona* as redefined by Dean and Suter (1996) and subsequently verified. *Bungona* has numerous nymphal and imaginal characteristics which distinguish it from *Cloeodes* as defined by Traver (1938) and redefined by Waltz and McCafferty (1987a, b). Character states of *C. fustipalpus* and *C. illiesi* are within the variation of *Bungona narilla* and both are treated as junior synonyms of *Bungona narilla*.

Nymphs were collected using a hand-held 250 µm mesh, dip net held downstream of disturbed substrate, or by hand picking of nymphs clinging to the under-surface of rocks. Mature nymphs were kept in 1L plastic rearing containers which had mesh lids and which contained river water and a cobble. These were maintained in the stream or in the laboratory until the subimago emerged. The subimago was then removed and placed in a dry rearing container to complete the final moult. All specimens were preserved in 75% ethanol.

Nymphs were dissected and mounted on slides in polyvinyl lacto-phenol mounting medium. Illustrations were prepared with the aid of a camera lucida. Mouthparts were viewed ventrally (except labrum) and the labium is illustrated with the ventral surface shown on the right hand side of the illustration and the dorsal surface on the left. Comparative measurements of segments of labial palpi, maxillary palpi and legs are expressed as ratios compared with the proximal

segment length, which is given in parentheses. Ranges of segment lengths are also presented in parentheses. At least 20 specimens were used for nymphal morphometric parameters. All measurements are given in millimetres.

The specimens examined were collected by numerous people identified by initials, as follows; AB (Andrew Boulton), BC (Bruce Chessman) DNR (Department of Natural Resources, Queensland), DO (David Oldmeadows), JD (John Dean), MN (Mark Nelson), MP (Melanie Pearson), PM (Phil Mitchell), PS (Phil Suter), SB (Stuart Bunn) and TC (Tim Curmi).

The neotype is placed in the Australian National Insect Collection (ANIC), CSIRO, Canberra, and all other material is held in the senior author's collection.

Bungona Harker

Bungona Harker, 1957: 73.—Campbell, 1988: 9.—Dean and Suter, 1996: 22.— Suter, 1997: 2.

Cloeodes.—Lugo-Ortiz and McCafferty 1998: 122–128. (not *Cloeodes* Traver, 1938).

Type species. Bungona narilla Harker, 1957 (original designation).

Diagnosis. Male Imago (Figs 1–5). Forewings with paired marginal intercalaries from radial to cubital sectors (Fig. 3); pterostigmatal veinlets entire; base of vein MA2 attached to crossvein between MA1 and MP1. Hind wings absent. Tarsal claws dissimilar. Posterior margin of metanotum not deeply emarginate (Fig. 1); metascutellar hump lacking a dorsoposterior projection (Fig. 2). Forceps 4-segmented, segment 3 elongate, segment 4 longer than wide; segment 1 lacking long basal bristles; segment 2 with very short bristles (Figs 4 and 5).

Mature Nymph (Figs 6–22): Head hypognathous. Labrum slightly broader than long, with a shallow median notch (Fig. 13). Left mandible with incisors apically separate, prostheca robust and digitate, margin between incisors and molars lacking tuft of setae, thumb of molar area triangulate and elevated above plane of incisor base (Figs 16 and 17). Right mandible with incisors separate apically, prostheca bifid, margin between incisors and molars with tuft of setae present (Figs 14 and 15). Maxillae palpi with 3 segments, palpi subequal to length of galeolacinia, galeolacinia with 4–5 apical teeth (Figs 18–20). Labium with 3-segmented palpi, terminal segment short, bulbous, medially broader than basal width, segment 2 without inner apical lobe; glossae and paraglossae equal in length (Fig. 22).

Thorax lacking hindwing pads. Femora lack a femoral patch or villopore, with long robust blunt setae on dorsal margin, apically with a pair of contiguous setae (Fig. 6). Tibiae with subproximal arc of long fine setae, with a longitudinal row of long fine setae on dorsal margin, adjoining proximal arc (Fig. 6). Tarsi with a longitudinal row of long fine setae on dorsal margin (Fig. 6). Tarsal claw short, edentate (Fig. 7).

Abdominal terga with triangular, serrated, scales which lack fine setae (Fig. 10), posterior margins with triangular teeth (Fig. 11). Abdominal sternites with scales and a row of short, fine setae on segments 4–6; posterior margins with long triangular teeth. Abdominal colour pattern with tergites 9 and 10 dark. Gills asymmetrical, ovate to pointed apically, with serrated and ciliated inner margins (Figs 8 and 9). 3 caudal filaments; terminal filament shorter than cerci, fringed with setae on lateral margins; cerci fringed on inner margin.

Remarks. While both adults and nymphs of the type species were described, Harker (1957) did not record the edentate claws, tarsal and tibial setal fringes, sternal setae and other nymphal characters which distinguish this genus from other Australian baetids. The problem posed by the absence of type material of the type species has been overcome by successful rearing of adult material. Comparison of adults with Harker's descriptions has confirmed the identity of *Bungona narilla*.

Waltz and McCafferty (1987a, b) revised *Cloeodes* and closely related genera (Waltz and McCafferty, 1987b). Lugo-Ortiz and McCafferty (1998: 122) commented that *Cloeodes* had "edentate tarsal claws, a conspicuous arc of long, fine, simple setae on the tibiae and setal tufts on sterna 2–6." They considered the two species they described from Australia to belong in *Cloeodes*. However, the Australian species possesses a row of setae only on sterna 4–6, and can be clearly distinguished from *Cloeodes* and other closely related genera by the following combination of adult and nymphal characters:

Male imago with pterostigmatic veinlets entire, base of vein MA_2 attached to crossvein between MA_1 and MP_1. Hind wings absent. Tarsal claws dissimilar. Posterior margin of metanotum not deeply emarginate, metascutellar hump lacking a dorsoposterior projection. Forceps four-segmented, segment 3 elongate, segment 4 longer than wide, segment 1 lacking long basal bristles, segment 2 with very short bristles. Mature nymph with incisors of left mandible apically separate.

Right mandible with incisors apically separated, prostheca bifid, margin between incisors and molars with tuft of setae present. Labial palpi with terminal segment short, bulbous, medially broader than basal width, segment 2 without inner apical lobe. Maxillae with 3 segmented palpi which is subequal to length of galeolacinia. Legs with tibiae possessing proximal arc of long fine setae adjoined to longitudinal row of long fine setae and tarsi with a row of long fine setae. Scales on abdominal tergites and sternites lacking fine setae, row of fine setae on sternites 4–6. Gills with serrated and ciliated margins.

Bungona and *Cloeodes* are closely related genera, but there are at least three adult and nine nymphal characters which clearly distinguish the Australian material from the revised characterisation of *Cloeodes* given by Waltz and McCafferty (1987a, b). Lugo-Ortiz and McCafferty (1998) did not mention the distinctive characters of the Australian material which here have been used to support the maintenance of *Bungona*. The "*Cloeodes* group" is widely distributed in South America (Waltz and McCafferty (1987a, b), Africa (Waltz and McCafferty , 1994), Madagascar (Lugo-Ortiz and McCafferty, 1999), Sri Lanka, China (Waltz and McCafferty, 1987a, b) and Australia (Lugo-Ortiz and McCafferty, 1998; this paper) and all share a number of characteristics but re-examination of this material is now warranted to establish the phylogenetic relationships.

Bungona narilla Harker

Bungona narilla Harker, 1957: 73, figs 48–57.

Cloeodes fustipalpus Lugo-Ortiz and McCafferty, 1998: 123–124, figs 1–9. (syn. nov.)

Cloeodes illiesi Lugo-Ortiz and McCafferty, 1998: 124–127, figs 10–18. (syn. nov.)

Material examined. Neotype herein selected. Adult male from Gara R. at Thalgarrah Field Study Centre, NSW, 30°26′S 151°29′E, 25 Nov 1998, PS and JD, ANIC.

Adults. **Vic.** 1 male reared from Rose R. RWC Gauge Station, 35°52′S 146°03′E, 18 Jan 1997, PS and MP; 1 male, same locality, 4 Feb 1997, PS and MP. **NSW**. 1 male reared from Gara R. at Thalgarrah Field Study Centre, 30°26′S 151°29′E, 25 Nov 1998, PS and JD; 10 males, Commissioners Waters on Andersons Rd E of Armidale, 30°34′S 151°47′E, 24 Nov 1998, PS and JD; 4 males Gara R. E of Armidale on Armidale to Coffs Harbour Rd, 30°32′S 151°48′E, 24 Nov 1998, PS and JD.

Nymphs. **Qld.** 4 nymphs, Booloumba Ck, Conondale Ranges, 26°42′S 152°38′E, 4 May 1993, SB; 2 nymphs, Sunday Ck site 5, 17°55′S 145°09′E, 30 May 1992, SB; 2 nymphs, Bundaroo Ck, Conondale Ranges, 26°42′S 152°37′E, 20 May 1993, SB; 3 nymphs, Koolmoon Ck near Tully, 17°45′S 145°38′E, 31 Jul 1990, 29 Nov 1990, SB; 6 nymphs, Stony Ck, Conondale Ranges, 26°50′S 152°46′E, 15 Mar 1993, 15 Nov 1993, SB; 6 nymphs, un-named Ck, Upper Conondale Ranges, 26°52′S 152°44′E, 20 May 1993, SB; 5 nymphs, Mt Barney Ck at Mt Maroon, 28°14′S 152°44′E, 2 Nov 1998, DNR; 1 nymph, Little Yabba Ck at Sunday Ck Rd, 26°36′S 152°37′E, 18 May 1999, DNR. **NSW**. 1 nymph, Kangaroo R., Upper Kangaroo Valley, 34°42′S 150°35′E, 23 Sep 1972, JD; 1 nymph, Wollondilly R. at Murphys Crossing, 33°43′S 150°30′E, 16 Nov 1990, BC; 4 nymphs, Bellinger R. at Cool Ck, 30°27′S 152°37E, 23 Sep 1994, AB; 1 nymph, Imlay Ck/Wallaugh R. junction, 37°14′S 149°42′E, 27 Oct 1995, AB; 2 nymphs, Collombatta Ck (MACL02), 30°54′S 152°44′E, 18 Sep 1994, AB; 3 nymphs, Chandler R. at Carten, 30°44′S 152°02′E, 5 Nov 1995, AB. 6 nymphs, Goorudee Rivulet, North of Adaminaby, 35°59′E 148°46′E, 11 Mar 2000, PS and TC; 1 nymph, Commissioners Waters on Andersons Rd E of Armidale, 30°34′S 151°47′E, 24 Nov 1998, PS and JD; 2 nymphs, Gara R.. E of Armidale on Armidale to Coffs Harbour Rd, 30°32′S 151°48′E, 24 Nov 1998, PS and JD; 10 nymphs, Woolomombi R. near Kilcoy Cemetery, 30°26′S 151°49′E, 25 Nov 1998, PS and JD; 10 nymphs, Gara R. at Thalgarrah Field Study Centre, 30°26′S 151°29′E, 25 Nov 1998, PS and JD; 24 nymphs, Tilbuster Ck (Commissioners Waters), 30°29′S 151°42′E, 25 Nov 1998, PS and JD; 5 nymphs, Dumaresq Ck on Weir Rd u/s Armidale, 30°29′S 151°37′E, 25 Nov 1998, PS and JD; 28 nymphs, Gara R. on Guyra-Dorrigo Rd., 30°12′S 151°4′E, 25 Nov 1998, PS and JD; 9 nymphs, Marowan Ck near Glencoe, 29°56′S 151°43′E, 26 Nov 1998, PS and JD; 5 nymphs, Maybole Ck, SW of Glen Innes, 29°53′S 151°38′E, 26 Nov 1998, PS and JD; 3 nymphs, Chandler R. on Lynock Rd, 30°18′S 152°05′E, 26 Nov 1998, PS and JD; 7 nymphs, Guy Fawkes R. at Ebor, 30°24′S 152°20′E, 27 Nov 1998, PS and JD; 1 nymph, Bellinger R., 23.7 km u/s of Thora, 30°28′S 152°35′E, 29 Nov 1998, PS and JD; 4 nymphs, Mongarlowe R. 1.8 km d/s Monga Settlement, 35°33′S 149°55′E, 1 Dec 1998, PS and JD; 1 nymph, Trib. Mongarlowe R. at Monga turnoff to Monga, 35°32′S 149°56′E, 1 Dec 1998, PS and JD; 12 nymphs, Mongarlowe R. 100 m W of turnoff to Monga, 35°32′S 149°56′E, 1 Dec 1998, PS and JD; 3 nymphs, Shoalhaven R. at Bombay Bridge, 7.7 km W of Braidwood, 35°26′S 149°43′E, 1 Dec 1998, PS and JD. **Vic.** 2 nymphs, King R. upstream of Lake William Hovell, 36o56′S 146o27′E, 7 Jun 1990, 12 Nov 1991, PM; 10 nymphs, Rose R. at "Bennies", 36°58′S 146°31′E, 6 Dec 1996, 14 Jan 1997, PS and MP; 8 nymphs, Rose R. RWC Gauge Station, 35°52′S 146°03′E, 18 Jan 1997, PS and MP. Tas. 1 nymph, Wilmot R. on Spellmans Rd, 41°31′S 146°10′E, 13 Oct 1994, DO and MN; 3 nymphs, Rubicon R., Smiths Rd, 41°19′S 146°34′E, 6 Oct 1994, DO and MN.

Description. Male Imago. Body length: 4.6 mm. Cerci length: 8.4 mm. Forewing length: 4.2 mm. General colour brown with cream abdominal

markings, abdominal segments 1–2 with central cream marking, 3 dark brown, 4 cream, 5–6 dark brown, 7–10 light brown. Head: turbinate eyes on high stalks, separate, reddish-brown dorsally (Fig. 1). Thorax brown; posterior margin of metathorax with shallow emargination (Fig. 1), meta-scutellar hump lacking a posterior projection (Fig. 2); legs cream, ratio of fore leg segments 1.00: 1.05: 0.01: 0.58: 0.34: 0.20: 0.13 (1.0 mm); middle and hind leg measurements similar, ratio of segment lengths 1.00: 0.74: 0.09: 0.18: 0.10: 0.08: 0.15 (0.72 mm). Wings hyaline (Fig. 3), pterostigma with 4–5 cross veins, intercalaries paired from R_2 - Cu vein, MA2 extending to and beyond MA_1-MP_1 crossvein. Forceps long, 4-segmented; segment 1 and 2 subequal, third segment elongate 1.3 times as long as segment 2, with slight constriction in basal half; segment 4 longer than wide, approx half segment 3 length (Fig. 4); segment 1 lacking tufts of basal bristles, segment 2 with few short basal bristles (Fig. 5).

Female Imago. Body length: 4.5 mm. Cerci length: 6.7 mm. Forewing length: 4.7 mm. General colour brown with cream central markings on abdominal segments. Head: eyes not turbinate, smaller, placed laterally. Legs all similar in length. Wings hyaline, similar to male.

Mature nymph. (all measurements based on 21 mature specimens). Body length: 3.9 mm (3.0–6.2 mm). Cerci length: 1.7 mm (1.1–2.1 mm). Terminal filament: 1.5 mm (1.0–1.9 mm). Antennal length: 0.9 mm (0.8–1.1 mm). Females generally larger than males. The description given by Lugo-Ortiz and McCafferty (1998) for the nymph is adequate and generally well illustrated. Additions only are given below.

Thorax: Fore legs (Fig. 6) with upper margins of femora with 4–9 blunt simple setae, apically with a pair of contiguous setae, lower margin with numerous short, fringed setae; fore tibiae with proximal arc of long fine setae and a longitudinal row of long fine setae, inner margin with 2–14 short fine setae, apically with pair of short fringed setae; tarsi with longitudinal row of long fine setae, inner margin with 4–10 short fringed setae with 2 apical setae; tarsal claw short lacking teeth (Fig. 7). Middle and hind legs similar, with outer margins of femora lined with 5–10 blunt setae, apically with pair of contiguous setae; tibiae with proximal arc of long fine setae and longitudinal row of long fine setae, inner margin with 4–10 short fine setae, apically with pair of short fringed setae; tarsi with longitudinal row of long fine setae, inner margin with 5–10 short fringed setae with 2 apical setae; tarsal claw short lacking teeth.

Ratios of leg segments: fore leg, 1.00: 0.62: 0.67 (0.72 mm); middle leg, 1.00: 0.60: 0.55 (0.72 mm); hind leg, 1.00: 0.56: 0.48 (0.75 mm).

Femur length to width ratios: fore leg, 4.83 (3.55–6.62); middle leg, 4.92 (3.79–5.92); hind leg, 4.62 (3.65–6.54).

Abdominal segments 1–7 with plate-like gills with serrated and ciliated inner margins (Figs 8b, 9b), first, fifth-seventh gills narrow apically pointed (Fig. 8a), second-fourth gills ovate (Fig. 9a), rounded apically (shape of gills variable within populations from narrow-pointed to broadly ovate). Abdominal colour pattern variable but with nineth and tenth segments brown. Scales on tergites and sternites triangular and serrated (Fig. 10), posterior margins of tergites with triangular spines (Fig. 11). Paraprocts with 10–18 well developed sharp marginal spines (Fig. 12), number varies with instar.

Mouthparts. Labrum (Fig. 13) almost square length 0.8 width, anterior margin with a medial concavity, anterior margin fringed with short bifid setae, submarginal row of spine setae. Right mandible (Fig. 14) outer incisor with 3–4 teeth and small subapical tooth, inner incisor with 3 teeth, prostheca bifid (Fig. 15) with lateral section strongly serrated (damaged in specimen described and illustrated as Fig. 3 by Lugo-Ortiz and McCafferty, 1998), margin between incisors and molars smooth or serrated with tuft of setae near molars. Left mandible (Fig. 16) outer incisor with 2–4 teeth, inner incisor with 3 large teeth, prostheca robust (Fig. 17), margin between incisors and molars smooth or serrated, lacking tuft of setae. Maxilla rectangular (Fig. 18) with 4 apical teeth (Fig. 19), maxillary palpi 3-segmented, palpi length subequal to galeolacinia (Fig. 20), apical segment longer than basal segment; segment ratios 1.00: 0.66 : 1.14 (0.07 mm, 0.04–0.09 mm). Hypopharynx as in Fig. 21. Labium (Fig. 22) with glossae and paraglossae long, narrow and pointed, labial palpi with 3 segments, apical segment ovoid, basal segment 1.73 times as long as broad, ratio of segments 1.00 : 0.87: 0.56 (0.15 mm, 0.12–0.18 mm).

*Remarks.*No new material has been found from the type locality but nymphs consistent with Harker's description have been recorded from streams of the Great Dividing Range in Queensland, New South Wales, Victoria and one specimen from Tasmania. Adults reared from the Rose R. in Victoria confirmed its identity. Lugo-Ortiz and McCafferty (1998) described *Cloeodes fustipalpus* from nymphs collected from the Chandler and Bellinger Rivers near Armidale in New South

Wales. This species cannot be differentiated from *B. narilla*, and is here synonymised.

Lugo-Ortiz and McCafferty (1998) differentiated a second species (*Cloeodes illiesi*) from a single nymph from Cascade Falls near Cairns on the basis of abdominal colour pattern, bifid right prostheca and a reduced maxillary palp. They stated that the colour pattern of *C. fustipalpus* ". . . varies somewhat among specimens . . ." . The pattern illustrated for *C. illiesi* is within the range of variation of *B. narilla*. The bifid prostheca is also consistent with *B. narilla*. The specimen they illustrated and described as *C. fustipalpus* had a broken prostheca (subsequently confirmed by McCafferty, pers. comm.). The maxillary palpi in *C.illiesi* may also be an aberration, as at least one specimen examined in this study had a short, 2-segmented maxillary palp on one side of the body, and a long, 3-segmented palp on the other. Such an aberration has also been observed in specimens of *Cloeon* in northern Australia. Although not specifically mentioned as distinguishing features in their paper, Lugo-Ortiz and McCafferty (1998) noted that the margin between the incisors and molars of the right mandible of *C. illiesi* differed from *C. fustipalpus* in that it was smooth, not serrated, the gills were narrow and less tracheated and the paraprocts had few scale bases. In the extensive material available for this study this combination of characters was not consistent even within a single population. For example, specimens with a smooth mandibular margin had broad, strongly tracheated gills and numerous paraproct scale bases, and specimens with narrow, poorly tracheated gills had numerous paraproct scales and serrated madibular margins. Early instar nymphs of the *fustipalpus* type had more pointed gills than older nymphs in the same population suggesting this character may be influenced by age and environment. *Cloeodes illiesi* is considered a junior synonym of *B. narilla*.

Distribution and ecology. North Queensland to Tasmania. Nymphs have been collected from streams of low gradient and low turbidity, mainly in foothill and lowland reaches. Large numbers have been recorded from shallow water (less than 20 cm) at the edge of cobble streams where velocities were very low. In the Conondale Ranges, southern Queensland, specimens were collected from bedrock in shallow, still, edge habitat. They were observed on the upper surface of the rock during the day and when disturbed only swam a few centimetres and then settled. Adults were not collected with UV light traps, and few were collected by sweep netting the riparian vegetation. A single specimen was collected from a swarm of baetid males at a height of 8–10m above the Rose River.

Acknowledgements

The financial support from the Land and Water Resources Research and Development Corporation under the National Healthy Rivers Program and the Australian Biological Resources Study is gratefully acknowledged. Thanks to all who have provided us with material particularly Dr Stuart Bunn, John Dean, Phil Mitchell, David Oldmeadows, Mark Nelson, Dr Andrew Boulton, Dianne Conrick, Dr Satish Choy and Dr Richard Marchant. Special thanks to John Dean for comments on an earlier draft.

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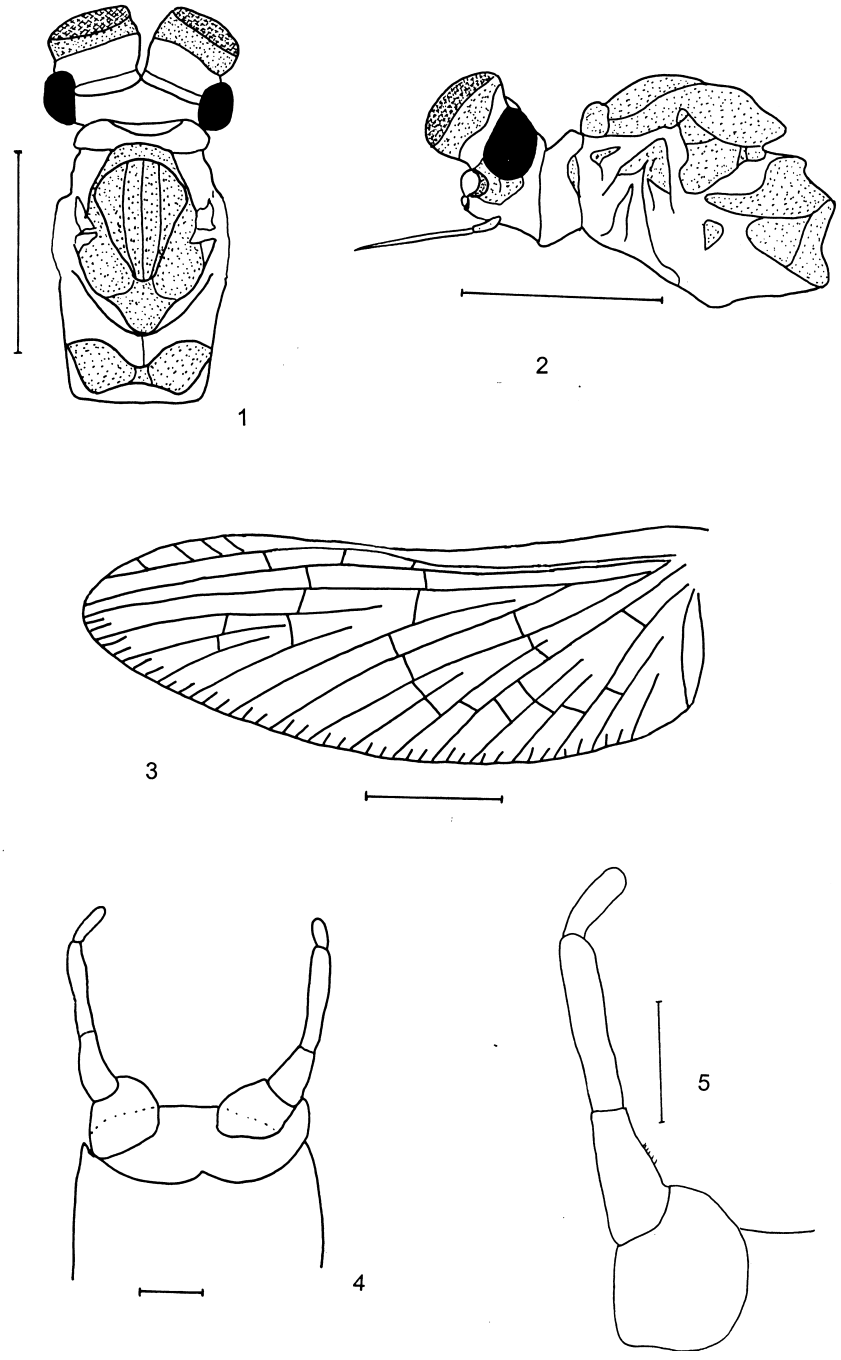
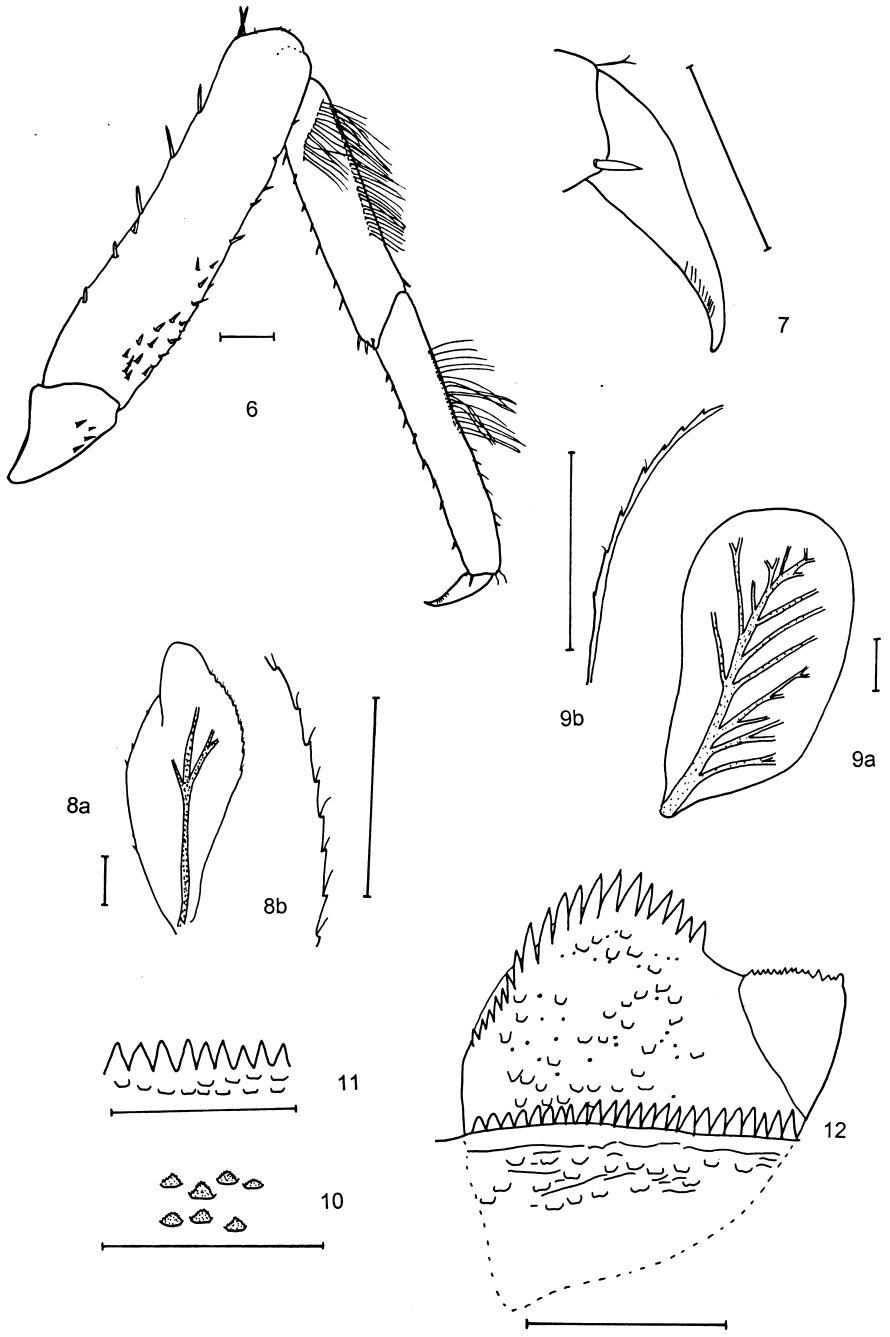
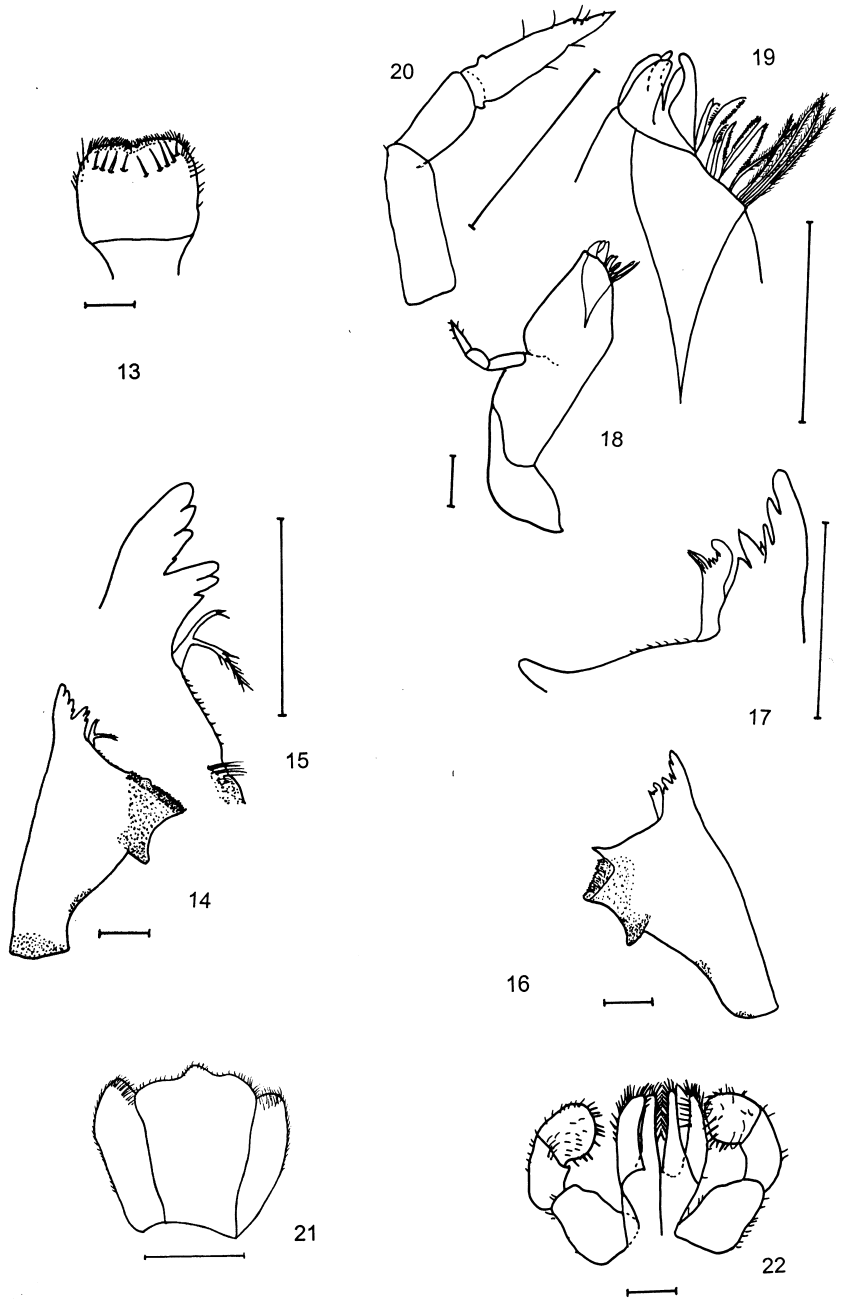


Figures 1–5. *Bungona narilla*, male imago. 1, dorsal view of head and thorax; 2, lateral view of head and thorax; 3, forewing; 4, ventral view of male forceps; 5, enlarged view of right forcep. Scale lines: 1 mm (Figs 1–3); 0.1 mm (Figs 4–5).



Figures 6–12. *Bungona narilla*, nymph. 6, foreleg; 7, tarsal claw; 8, sixth abdominal gill, (8a, whole gill; 8b, lateral margin of gill); 9, third abdominal gill, (9a, whole gill; 9b, lateral margin of gill); 10, scales on tergites; 11, posterior margin of fourth abdominal tergite; 12, paraproct. Scale lines: 0.1 mm.



Figures 13–22. *Bungona narilla*, nymph. 13, labrum; 14, right mandible; 15, incisors and prostheca of right mandible; 16, left mandible; 17, incisors and prostheca of left mandible; 18, maxilla; 19, apex of maxilla; 20, maxillary palp; 21, hypopharynx; 22, labium, dorsal (left) and ventral (right) aspects. Scale lines: 0.1 mm.