

# THE EPHEMEROPTERA (MAYFLIES) OF SOUTH AUSTRALIA

by

P. J. SUTER<sup>1</sup>

Department of Zoology, University of Adelaide, Adelaide, South Australia 5000

(Manuscript accepted 2 July 1985)

## ABSTRACT

SUTER, P. J. 1986. The Ephemeroptera (Mayflies) of South Australia. *Rec. S. Aust. Mus.* 19(17): 339-397.

In a study of the Ephemeroptera of South Australia, thirteen species have been recognised. All species have been described from both adult and nymphal material and keys enabling their identification are included. Five new species have been recognised, *Atalophlebia auratus* sp. nov., *Nousia pilosa* sp. nov., *Ulmerophlebia pipinna* sp. nov., *Cloeon paradieniensis* sp. nov., and *Centroptilum elongatum* sp. nov.; and one species transferred from each genus *Atalophlebia* and *Atalonella* to *Nousia*. (*Nousia inconspicua* (Eaton) comb. nov. and *Nousia fuscula* Tillyard comb. nov.). The first associated nymphal descriptions of five previously described species *Nousia inconspicua* (Eaton), *N. fuscula* (Tillyard), *Baetis soror* Ulmer, *Cloeon fluviatile* Ulmer, and *Tasmanocoenis tillyardi* (Lestage) are also made. Two species have been redescribed from South Australian material; *Atalophlebia australis* (Walker), and *A. australasica* (Pictet) and one species of *Tasmanophlebia* is described but not formally named.

## INTRODUCTION

The first species of mayfly in South Australia was recorded by Eaton in 1871 when *Leptophlebia inconspicua* was described from Adelaide. In subsequent papers 1883-1888 Eaton placed this species into the new genus *Atalophlebia*. Since that date only two other records of the Ephemeroptera in South Australia have been made. Harker (1954) recorded *Atalophlebia australasica* from Tillyard's 1934 collection near Mount Gambier; and Timms (1974) recorded a "*Caenis* sp." in Valley Lake, Mount Gambier, and L. Edward near Millicent. Both Williams (1968) and Riek (1970) acknowledge the presence of mayflies in South Australia, but neither mention any specific families or genera.

With the exception of the species described by Eaton (1871) the other records of Ephemeroptera are from the wet South East of South Australia. It appears that because South Australia is the driest State in Australia, the existence of freshwater in regions other than the South East had been ignored, leaving a large gap in

our knowledge of Australian freshwater invertebrates, and zoogeographical relationships of these animals.

Preliminary collections from the Fleurieu Peninsula, the Mount Lofty Ranges and the Flinders Ranges showed that mayflies were abundant in all permanent freshwater streams, waterholes and in many dams and reservoirs. Further collections from the freshwater habitats in South Australia have led to the recognition of 13 species of Ephemeroptera, all but one of which have nymph and adult associations confirmed in the laboratory or in the field.

All 13 species have been described from both adult and nymphal material and keys to their identification are included. Five new species have been recognised, *Atalophlebia auratus*, *Nousia pilosa*, *Ulmerophlebia pipinna*, *Cloeon paradieniensis* and *Centroptilum elongatum*; one species transferred from each genus *Atalophlebia* and *Atalonella* to *Nousia* (*Nousia inconspicua* (Eaton) comb. nov. and *Nousia fuscula* (Tillyard) comb. nov.) and the first associated nymphal descriptions of five previously described species; *Nousia inconspicua* (Eaton), *N. fuscula* (Tillyard), *Baetis soror* Ulmer, *Cloeon fluviatile* Ulmer and *Tasmanocoenis tillyardi* (Lestage) made. Enlarged descriptions of *Atalophlebia australis* (Walker), and *A. australasica* (Pictet) are also given. A single species of *Tasmanophlebia* was also recorded and is described, but since a revision of the Siphonuridae is being prepared by Dr I. C. Campbell material has been sent to him to include in his more detailed studies of this group.

## MATERIALS AND METHODS

Collection of nymphs was by dip-net with mesh-pore size of 500  $\mu$ m, or by hand of nymphs clinging to the under-surface of rocks or bark in streams. Adults were collected by beating the vegetation along river banks with an insect net, or by sweeping the net through a swarm. Specimens were preserved in 70% ethyl alcohol with 5% glycerol.

Specimens for study were dissected under a Wild M5 stereoscopic microscope, and the appendages (legs and wings of adults; legs, mouth-parts and gills in nymphs) were mounted on glass slides using "Euparal" or Polyvinyl lacto-phenol mounting media. The sterna, and nymphal abdominal terga, were prepared using the techniques of Tsui and Peters (1972, 1975), and the

<sup>1</sup> Present address: State Water Laboratory, Engineering and Water Supply Department, Private Mail Bag, Salisbury Post Office, South Australia 5108.

nymphal tentoria were studied by the methods given by Hudson (1951).

Genitalia and eggs were either mounted on slides or prepared for the Scanning Electron Microscope (S.E.M.) using critical-point drying which eliminated both shrinkage and distortion. They were then mounted and coated with Au/Pd and examined using an E.T.E.C. Autoscan with an operating voltage of 5, 10, or 20 KV.

Illustrations of wings and body colour-patterns were made using a Wild M3 or M5 stereoscopic microscope with an attached drawing head. Legs, mouthparts, gills and high magnification ( $>100\times$ ) illustrations were drawn using a Wild compound microscope and camera lucida.

Wing venation terminology is based on Tillyard's (1932) scheme, and as illustrated in Figures 1a and 1b used by Peters & Edmunds (1964, 1970, 1972) and Edmunds, Jensen & Berner (1976). Each segment of the fore, middle and hind legs of the nymph and male imago is compared to the length of the femur, and is expressed as a ratio. The absolute length of the femur is given last in parenthesis.

In figures of the labium the method used by Peters & Edmunds (1964, 1970, 1972) is followed, with the ventral surface shown on the right hand side of the illustration, and the dorsal surface on the left. Comparative measurements of the segments of the labial palpi and maxillary palpi are expressed as ratios, compared with the proximal segment length, which is given in parenthesis. All measurements are given in millimetres.

#### KEYS TO THE SOUTH AUSTRALIAN EPHEMEROPTERA

The following keys will serve to distinguish the male imago and mature nymphs of the species of Ephemeroptera recorded in South Australia. Figures are included with each couplet to give illustrated examples of the key characters, although occasionally these are not required (e.g. "terminal filament present" as compared with "terminal filament absent").

The key to the imagos is primarily for male specimens because species identification of the female imagos is often very difficult as external morphological characteristics of the female show generic, rather than specific affinities. Only direct association with nymphs can allow accurate identification of females, using external characters. However, with the limited South Australian mayfly fauna, the females have also been included in the key and can be distinguished by external morphological characters in all genera with the exception of *Nousia*. The external characteristics are useful to distinguish this genus, but species separation is difficult without direct nymphal association, or a study of the morphology of fertilized eggs. Identification of subimagos is not as successful. Generic segregating characters are present in subimagos, and generic identification can be made using the imago key.

For specific identification it is necessary to refer to the subimago characteristics listed in the description of each species.

#### KEY TO SOUTH AUSTRALIAN ADULT EPHEMEROPTERA

- 1a Hind wings comparatively large, about half as long as the fore wing (Figs 28a, b). Male penes long and tubular (Figs 30a, b) ..... Siphonuridae  
Only one representative in South Australia: *Tasmanophlebia* sp.
- 1b Hind wings small or entirely absent ..... 2
- 2a(1) Fore wings with many cross-veins; hind wings small, also with many cross-veins (Figs 1a, b; 3a, b; 5a, b; 8a, b; 10a, b; 12a, b, c; 17a, b) ..... Leptophlebiidae 3
- 2b Fore wings with few cross-veins, clear open appearance, hind wings present or absent, if present reduced, with cross-veins few or absent (Figs 21a, b; 23a, b; 25a; 31a, g) ..... 9
- 3a(2) Tarsal claws of each pair similar, elongate, slender, hooked distally (Figs 1g; 3g; 5h; 8g; 10g; 12f); fore wings  $<3.5 \times$  longer than wide (Figs 1a; 3a; 5a; 8a; 10a; 12a) ..... 4
- 3b Tarsal claws of each pair dissimilar, one elongate, slender, hooked distally, one blunt with a distal tooth, club shaped (Fig. 17h); fore wings  $>3.5 \times$  longer than wide. Male genitalia (Figs 17c; 19a, b) ..... *Ulmerophlebia*  
Only one species in South Australia: *U. pipinna* sp. nov.
- 4a(3) Large species, body length  $> 8$  mm; fore wing 7-13 mm; Sc of hind wing reaches wing margin at 9/10 wing length (Figs 1b; 3b; 5b) ... *Atalophlebia* 5
- 4b Small species, body length  $< 8$  mm; fore wing 5-8.5 mm; Sc of hind wing reaches wing margin at 3/4 of wing length (Figs 8b; 10b; 12b) ..... *Nousia* 7
- 5a(4) Males and females with terminal filament; body colour yellow-brown (orange); female with ninth abdominal sternite deeply incised (Figs 1e; 5i) . 6
- 5b Males without terminal filament (present in females); body colour black. Male genitalia (Figs 3c, d; 7c, d); female with ninth abdominal sternite with shallow incision (Fig. 3e) ..... *Atalophlebia australasica*
- 6a(5) Fore wings with darker pterostigmatic region, cross-veins of costal and subcostal spaces shaded with black, hind wings and rest of fore wings hyaline (Fig. 1a, b); body yellow with black thorax. Apices of penes widely separated and divergent (Figs 1c, d; 7a, b) ..... *A. australis*
- 6b Fore wings tinged entirely with yellow, pterostigmatic region darker than rest of wing; hind wing grey-brown, darker than fore wing (Fig. 5a, b). Apices of penes convergent (Figs 5c, d; 7e, f) ..... *A. auratus* sp. nov.
- 7a(4) Two halves of penes distinctly separated forming a U-shape (Figs 10c, d; 15c, d); with a small triangular spine on inner margin (visible using transmitted light, Fig. 10c) ..... *Nousia fuscula*
- 7b Two halves of penes held close together, without spine ..... 8
- 8a(7) Penes with two ventral lobes near apex (Figs 8a; 15a, b) ..... *N. inconspicua* comb. nov.
- 8b Penes without ventral lobes (Figs 12d, e; 15e, f) ... *N. pilosa* sp. nov.

- 9a(2) Males with turbinate eyes (females without dorsal compound eyes); marginal intercalaries short, developed between the ends of the main veins (Figs 21a; 23a; 25a, g); hind wings present or absent . . . . . Baetidae 10
- 9b Males and females with small lateral eyes, dorsal compound eyes absent; no marginal intercalaries present (Fig. 31a); hind wings absent. Penes fused with apical indentation, forceps strongly bowed (Figs 30c; 31d) . . . . . Caenidae
- Only one species in South Australia: *Tasmanocoenis tillyardi*
- 10a(9) Hind wings present . . . . . 11
- 10b Hind wings absent . . . . . *Cloeon* 12
- 11a(10) Marginal intercalaries of fore wing paired (Fig. 21a). Male genitalia (Fig. 19c; 21d) . . . . . *Baetis*
- Only one species in South Australia: *B. soror*
- 11b Marginal intercalaries of fore wing single (Fig. 23a). Male genitalia (Figs 19d; 23d) . . . . . *Centroptilum*
- Only one species in South Australia: *C. elongatum* sp. nov.
- 12a(10) Males with turbinate eyes, yellow; terminal segment of forceps triangular (Figs 19f; 25i); females with costal and subcostal spaces of wings shaded red/brown; body length > 7 mm . . . . . *Cloeon paradieniensis* sp. nov.
- 12b Males with turbinate eyes, sepia; terminal segment of forceps small and globular (Figs 19e; 25d); females with costal and subcostal spaces of wings opaque, milky; body length < 5 mm . . . . . *C. fluvatile*

#### KEY TO THE NYMPHS OF SOUTH AUSTRALIAN EPHEMEROPTERA

- 1a Head prognathous; tail filaments with whorls of setae at apex of each segment, body dorso-ventrally flattened. Families Leptophlebiidae; Caenidae . . . . . 2
- 1b Head hypognathous; tail filaments fringed laterally with long fine setae, body usually cylindrical. Families Baetidae; Siphonuridae . . . . . 9
- 2a(1) Seven pairs of gills inserted laterally on abdomen, each gill consisting of a pair of lamellae . . . . . 3
- 2b Six pairs of gills, 1st very small mono filament, 2nd enlarged to form an elytriform gill cover, remaining pairs bearing long tracheal filaments (Figs 32b, c, d) . . . . . Caenidae: *Tasmanocoenis*
- Only one species in South Australia: *T. tillyardi*.
- 3a(2) Gill base broad with one apical filament, lined with fine setae (Fig. 18c), legs and body covered with long fine setae (Fig. 20) . . . . . *Ulmerophlebia*
- Only one species in South Australia: *U. pipinna* sp. nov.
- 3b Gills lanceolate or linear, with one apical filament (Figs 9c; 11c; 13c), apex with multiple tracheal filaments (Figs 2c; 4c), body not covered with long fine setae . . . . . 4
- 4a(3) Gills lanceolate or linear, not branched at apex into tracheal filaments (Figs 9c; 11c; 13c) . . . . . *Nousia* 5
- 4b Gills broad at apex, with each lamella subdivided into tracheal filaments (Figs 2c; 4c) . . . . . *Atalophlebia* 7
- 5a(4) Gills lanceolate (Figs 9c; 13c); proximal segment of labial palpi narrow, 2 × longer than wide (Figs 9g; 13g) . . . . . 6
- 5b Gills linear (Fig. 11c); proximal segment of labial palpi broad, 1.67 × longer than wide (Fig. 11g); prostheca of left mandible robust with serrated apex (Fig. 11i); dorsal abdominal markings irregular black and white (Fig. 14e) . . . . . *N. fuscula*

- 6a(5) Dorsal abdominal marking with a broad median light stripe (Fig. 14d); labrum rectangular, 2 × wider than long (Fig. 9d); femora with few fine setae (Fig. 9a) . . . . . *N. inconspicua* comb. nov.
- 6b Dorsal abdominal marking with narrow light regions on segments 4-10 (Fig. 14f); labrum almost square 1.5 × wider than long (Fig. 13d); femora lined with numerous long fine setae (Fig. 13a) . . . . . *N. pilosa* sp. nov.
- 7a(4) Apex of gills with each lamella trifurcate (Fig. 2c) . . . . . *Atalophlebia australis*
- 7b Apex of gills multifurcate with more than three tracheal filaments (Fig. 4c) . . . . . 8
- 8a(7) Ninth abdominal segment with only one backward pointing spine (Fig. 14c); no dark markings on legs (Fig. 6a) . . . . . *A. auratus* sp. nov.
- 8b Ninth abdominal segment with two backward pointing spines (Fig. 14b); femur and tibia with broad bands of black (Fig. 4a) . . . . . *A. australasica*
- 9a(1) Four pairs of gills present, first pair elytriform, covering last three pairs. Postero-lateral margins of abdominal segments produced into backward pointing spines (Fig. 28g) . . . . . Siphonuridae: *Tasmanophlebia*
- Only one species in South Australia: *Tasmanophlebia* sp.
- 9b Seven pairs of gills present, postero-lateral margins of abdominal segments not produced into backward pointing spines . . . . . Baetidae 10
- 10a(9) Gill lamellae double on abdominal segments 1-6, single on 7th (Figs 26e; 27e); hind wing sheaths absent . . . . . *Cloeon* 11
- 10b Gill lamellae single on abdominal segments 1-7 (Figs 21i; 24d); hind wing sheaths present . . . . . 12
- 11a(10) Paraprocts with 27-30 spines (Fig. 27d); maxillary palpi with terminal spines on distal segment (Fig. 28f); without definite abdominal colour pattern . . . . . *Cloeon paradieniensis* sp. nov.
- 11b Paraprocts with 17-22 spines (Fig. 26d); maxillary palpi without terminal spines on distal segment (Fig. 26i); abdominal pattern as in Fig. 26c . . . . . *C. fluvatile*
- 12a(10) Labrum with deep median V-shaped concavity with a tooth on each side of the lateral margins of the concavity, near the apex (Fig. 24e); tarsal claws very long and slender (Fig. 24a) . . . . . *Centroptilum elongatum* sp. nov.
- 12b Labrum rounded, with shallow U-shaped concavity (Fig. 21j); tarsal claw short (Fig. 21f) *Baetis soror*

#### FAMILY LEPTOPHLEBIIDAE

Peters and Edmunds (1964, 1970) recorded the systematic history of the family and listed characterizations based on Ethiopian and Eastern Hemisphere material.

#### GENUS ATALOPHLEBIA Eaton 1881

Burmeister, 1839: 800 (In *Baetis*); Pictet, 1843: 189-191 (In *Baetis*) *B. australasica*; Walker, 1853: 538 (In *Ephemer*) *E. australis*; 1853: 559-561 (In *Baetis*) *B. australasica*, *B. costalis*; Eaton, 1871: 78-81 (In *Leptophlebia*); 1881: 193-194 (Type species *A. australis*); 1884: 83-91; Ulmer, 1908: 40-46; 1916: 2-17; 1919: 16-23; Needham & Murphy, 1924: 34-36; Tillyard, 1926: 63-64; 1934: 1-16; 1936: 30-49; Harker, 1950: 8-17; 1954:

243-252; 1957: 63-68; Kimmins, 1960: 294; Riek, 1970: 239; Tsui & Peters, 1975: 542-544.

*Type Species: Atalophlebia australis* (Walker).

Detailed characteristics of the genus are given in Suter (1980).

#### *Atalophlebia australis* (Walker) 1853

*Ephemera australis* Walker, 1853: 538; *Leptophlebia australis* Eaton, 1871: 78; *Atalophlebia australis* Eaton, 1881: 193-194; 1884: 86; Tillyard, 1934: 1-16.

This species was fully described by Tillyard (1934) in a study of the type species of *Atalophlebia*. Therefore much of the detailed description is unnecessary, but measurements and ratios have been included. A transparency of the genitalia of the lectotype designated by Tillyard (held in the British Museum of Natural History) has been examined, but the actual specimen has not been seen. The following description is based on South Australian representatives, and includes measurements not recorded by Tillyard.

#### Male Imago

|                          | $\bar{x}$ | SD   | n  | Range       |
|--------------------------|-----------|------|----|-------------|
| Body Length              | 10.69     | 1.38 | 14 | 8.80-12.50  |
| Notal Length             | 3.65      | 0.39 | 15 | 3.20- 4.20  |
| Mesonotal Width          | 1.93      | 0.27 | 15 | 1.52- 2.28  |
| Pronotal Width           | 1.50      | 0.16 | 5  | 1.24- 1.64  |
| Fore Wing Length         | 11.84     | 0.87 | 9  | 9.92-12.48  |
| Hind Wing Length         | 3.45      | 0.37 | 10 | 2.52- 3.72  |
| Cerci Length             | 28.00     | 2.86 | 5  | 25.00-32.60 |
| Terminal Filament Length | 23.35     | 1.40 | 4  | 22.00-25.00 |

**Thorax:** Fore leg femur length  $1.18 \times$  middle leg femur length, and  $1.07 \times$  hind leg femur length. Ratios of leg segments (Note: in middle and hind legs, second ratio is tibia +  $T_1$  length: femur length): fore leg  $1.00 : 1.34 : 0.11 : 0.51 : 0.44 : 0.34 : 0.21$  (2.34 mm); middle leg  $1.00 : 1.00 : - : 0.11 : 0.10 : 0.09 : 0.19$  (1.99 mm); hind leg  $1.00 : 1.04 : - : 0.10 : 0.09 : 0.08 : 0.17$  (2.18 mm). Mesosternum: basisternum length  $1.13 \times$  width,  $0.62 \times$  furcasternum length, furcasternum length  $0.77 \times$  width, posterior margin with a short triangular indentation, lateral margins of furcasternum strongly sclerotized and dark brown.

**Wings:** Fore wing  $2.75 \times$  longer than wide. Hind wing (Fig. 1b)  $1.62 \times$  longer than wide.

**Abdomen:** yellow with dark brown markings dorsally (Fig. 1h). Segments 8, 9, 10 yellow-brown, ventrally yellow with light brown markings (Fig. 1i).

**Genitalia:** (Figs 1c, d) forceps yellow-brown. Penes broad, with a V-shaped median indentation, ventral sperm duct openings obvious (Figs 7a, b).

#### Mature Male Nymph (Fig. 14a)

|                | $\bar{x}$ | SD   | n | Range      |
|----------------|-----------|------|---|------------|
| Head Width     | 2.22      | 0.06 | 7 | 2.12- 2.28 |
| Notal Length   | 3.21      | 0.07 | 7 | 3.12- 3.34 |
| Pronotal Width | 2.14      | 0.18 | 7 | 1.80- 2.30 |

|                          |       |      |   |             |
|--------------------------|-------|------|---|-------------|
| Mesonotal Width          | 2.42  | 0.09 | 7 | 2.24- 2.48  |
| Cerci Length             | 16.03 | 0.86 | 4 | 15.05-17.10 |
| Terminal Filament Length | 13.54 | 0.96 | 5 | 12.31-14.54 |

**Thorax:** Pronotum width  $0.96 \times$  head width. Mesonotum  $1.09 \times$  wider than head. Legs (Fig. 2a) yellow-brown with brown bands on each segment. Tarsal claws short and curved with 20-25 peg-like ventral denticles (Fig. 2b). Femora of fore and middle leg equal in length, hind leg longest,  $1.12 \times$  fore femur length. Ratios of leg segments: fore leg  $1.00 : 1.05 : 0.53$  (1.88 mm); middle leg  $1.00 : 0.97 : 0.43$  (1.90 mm); hind leg  $1.00 : 1.02 : 0.43$  (2.10 mm). Femur length to width ratios: fore leg 3.16, middle leg 3.26, hind leg 3.54. Sternum: prosternum width equal to anterior width of mesobasisternum. Mesosternum: basisternum length equal to or slightly longer than furcasternum, sternocostal suture present. Metasternum: basisternum  $4-5 \times$  wider than long, width slightly less than mesofurcasternum.

**Abdomen:** (Fig. 14a) posterior margins of tergites with large singular spines, with smaller spines basally. Cerci well developed, longer than terminal filament. Gills, seven pairs, each consisting of a pair of lamellae with three tracheal filaments per lamella (Fig. 2c).

**Mouthparts:** labrum (Fig. 2d)  $2.78 \times$  wider than long, mid-anterior indented, rugose, with 4-5 rounded tubercles (Fig. 2e). Left mandible (Fig. 2h); outer incisors with four teeth, inner with three, prostheca robust (Fig. 2i). Right mandible (Fig. 2j); outer incisors with three apical teeth, with five serrations on inner margin of third tooth, inner incisors with two teeth, inner lateral margin with up to five spines, prostheca long and slender with four spines along length (Fig. 2k). Hypopharynx (Fig. 2f). Maxillae (Fig. 2l): proximal segment of palp  $2.24 \times$  longer than wide, segment ratios;  $1.00 : 1.22 : 0.66$  (0.32 mm). Labium (Fig. 2g): proximal segment of palp  $1.81 \times$  longer than wide, segment ratios;  $1.00 : 0.80 : 0.60$  (0.37 mm).

#### Female Imago

Colour similar to male, ninth abdominal sternite with deeply incised posterior margin (Fig. 1e), seventh sternite produced posteriorly, slightly hooked when viewed laterally (Fig. 1f). Fore legs shorter than in male. Sternum broader than male, mesobasisternum length  $0.85 \times$  width, mesofurcasternum  $0.65 \times$  width.

#### Subimago

Black to dark brown, wings shaded grey with hyaline lambda ( $\lambda$ ) marking complete (see Tillyard, 1934).

#### Female Nymph

Similar to but larger than male, lacking dorsal compound eyes.

### Diagnostic Characteristics

1. Genitalia of male imago (Figs 1c, d and Figs 7a, b).
2. Distinctive yellow-brown (orange) colour described by Walker (1853) and Tillyard (1934) as "red", and "rufopiceous above; venter dull light burnt-umber, approaching rusty brown" by Eaton (1884).
3. Distinctive pattern of subimago.
4. Nymphal gills with trifurcate filaments (Fig. 2c).
5. Form and shape of mandibles, incisors and prosthecae (Figs 2h, i, j, k).

### History and Discussion

In 1853 Walker briefly described *Ephemera australis* from Dr Hooker's 1842 collection from Tasmania. This species was later placed in the genus *Leptophlebia* (Eaton 1871) and subsequently (Eaton 1881) was designated the genotype for the new genus *Atalophlebia*. Walker referred to the "red" abdomen, and Eaton referred to rufo-piceous coloration, "an unusual character for this genus" (Tillyard 1934). Tillyard's extensive descriptions of the male imago, subimago and nymph of *A. australis* enable relatively easy recognition of all stages of this species, but the coloration in the living material differs from that of dry pinned specimens. Newly caught and alcohol-preserved adults have a distinctive orange colour, not red, as is the case in dry specimens.

### Material Examined

**SOUTH AUSTRALIA.** South East: Brown Lake, Bakers Range Drain, Eastern Division Diversion Drain, Mt. Hope Drain, Reedy Creek Drain, Sutherlands Drain and Valley Lake. Mt. Lofty Ranges: Marne R., Para R., Torrens R. Southern Flinders Ranges: Back Creek, Julia Creek, Rocky River.

**VICTORIA.** Clunes, Tarango Dam, Neerin, Lake west of Harrow, L. Hattah, L. Wendouree, Ballarat, Konongwootong Reservoir, Rocklands Reservoir, Surrey R.

**TASMANIA.** Break O'Day R., Lagoon of Islands, L. Leake.

### *Atalophlebia australasica* (Pictet) 1843

*Baetis australasica* Pictet, 1843: 189-190; Walker, 1853: 559; *Leptophlebia australasica* Eaton, 1871: 78-79; *Atalophlebia australasica* Eaton, 1884: 86-87; Ulmer, 1916: 2-3; Harker, 1950: 28; 1954: 248-249.

### Male Imago

|                  | $\bar{x}$ | SD   | n  | Range       |
|------------------|-----------|------|----|-------------|
| Body Length      | 10.10     | 0.86 | 26 | 8.60-11.46  |
| Notal Length     | 3.13      | 0.24 | 8  | 2.84- 3.60  |
| Pronotal Width   | 1.09      | 0.10 | 8  | 2.84- 3.60  |
| Mesonotal Width  | 1.54      | 0.13 | 8  | 1.44- 1.80  |
| Fore Wing Length | 10.33     | 1.10 | 18 | 9.23-12.83  |
| Hind Wing Length | 3.02      | 0.41 | 18 | 2.40- 3.96  |
| Cerci Length     | 28.20     | 2.72 | 8  | 24.00-31.00 |

**Head:** dark brown to black. Dorsal compound eyes dark red-grey, lateral eyes dark grey.

**Thorax:** shiny black. Pronotum narrower than head. Mesonotum without markings. Legs: fore legs black with two darker bands on femur, one mid-, one distally, T<sub>1</sub> partially fused to tibia. Middle and hind legs shorter than fore leg, light yellow-brown with two black bands on femora, one mid, one distal, tibiae with one proximal band, T<sub>1</sub> fused to tibia with joint apparent. Fore leg femur length 1.20 × middle leg femur length, and 1.06 × hind leg femur length. Ratios of leg segments: fore leg 1.00 : 1.39 : 0.13 : 0.53 : 0.48 : 0.39 : 0.20 (2.26 mm); middle leg 1.00 : 0.93 : 0.08 : 0.11 : 0.09 : 0.08 : 0.16 (1.88 mm); hind leg 1.00 : 1.01 : 0.08 : 0.09 : 0.08 : 0.07 : 0.15 (2.13 mm). Mesosternum: basisternum length 1.12 × width, 0.66 × furcasternum length, lateral margins anteriorly expanded, posterior margin truncated, furcasternum length 0.71 × width, posterior margin with a triangular indentation.

**Wings:** fore wing (Fig. 3a) 2.77 × longer than wide, pterostigmal region brown, costal and subcostal cross-veins broadly shaded with black, bulla in Sc surrounded by black marking. Hind wing (Fig. 3b) 1.60 × longer than wide, costal space with 1-3 proximal and 6-10 distal cross-veins.

**Abdomen:** light brown with darker markings dorsally (Fig. 3h) ventrally grey with light patches on segments 3-9 (Fig. 3i). Cerci stout, black-brown with the last 3-5 mm buff, terminal filament absent.

**Genitalia:** (Figs 3c, d): penes broad at base, with concave lateral margins and bulbous distal region, fused, centrally, giving a triangular apex (Figs 7c, d).

### Mature Male Nymph (Fig. 14b)

|                          | $\bar{x}$ | SD   | n | Range       |
|--------------------------|-----------|------|---|-------------|
| Head Width               | 2.38      | 0.11 | 9 | 2.28- 2.60  |
| Notal Length             | 3.41      | 0.41 | 9 | 3.00- 4.32  |
| Pronotal Width           | 2.44      | 0.15 | 9 | 2.28- 2.76  |
| Mesonotal Width          | 2.70      | 0.22 | 9 | 2.48- 3.12  |
| Cerci Length             | 12.74     | —    | 2 | 12.14-13.34 |
| Terminal Filament Length | 12.82     | 0.35 | 3 | 12.42-13.40 |

**Head:** dark brown-black. Dorsal compound eyes red-black, lateral eyes black. Antennae yellow-brown, longer than head is wide.

**Thorax:** dark brown with pale mid-longitudinal line. Pronotum wider or narrower than head (geographically variable). Mesonotum 1.11 × wider than head. Legs yellow brown with black bands on each segment, femora with two bands (one mid-, one distal), tibiae with two bands (one proximal, one distal), tarsi with a broad band covering proximal half (Fig. 4a). Fore femur 1.05 × longer than middle femur, hind femur 1.15 × longer than fore femur. Tarsal claws short, curved, with 15-20 peg like denticles (Fig. 4b). Ratios of leg segments: fore leg 1.00 : 1.02 : 0.50 (2.24 mm); middle leg 1.00 : 0.98 : 0.37 (2.21 mm); hind leg 1.00 : 1.06 : 0.36 (2.42 mm). Femur length to width ratios:

fore leg 3.18, middle leg 3.42, hind leg 3.61. Mesosternum: basisternum length equal to furcasternum length, sternacostal suture present. Metasternum: basisternum  $3.7\text{--}5 \times$  wider than long, width equal to width of mesofurcasternum.

**Abdomen:** brown, patterned (Fig. 14b), lateral flange of segment 9 with two spines, outer largest, inner rounded; posterior margin of tergum with spines arranged singularly. Cerci well developed, terminal filament longer than lateral filaments. Gills: multifurcate (Fig. 4c), each gill consisting of a pair of lamellae with 8-20 tracheal filaments per lamella.

**Mouthparts:** labrum (Fig. 4d)  $3.41 \times$  wider than long, mid anterior margin indented, rugose (Fig. 4e). Left mandible (Fig. 4h): outer incisors with three large teeth, inner with three large teeth, prostheca robust, crenulated with 6-8 blunt teeth (Fig. 4i). Right mandible (Fig. 4j): outer incisors with five teeth, inner incisors with two teeth and four small spines on inner lateral margin, prostheca, slender, with crenulations on outer margin of 2-4 tubercles, distally with a long spine (Fig. 4k). Hypopharynx (Fig. 4f). Maxillae (Fig. 4l): proximal segment of palp  $2.80 \times$  longer than wide, segment ratios,  $1.00 : 1.19 : 0.69$  (0.41 mm). Labium (Fig. 4g): proximal segment of palp long and broad,  $1.97 \times$  longer than wide, segment ratios  $1.00 : 0.67 : 0.68$  (0.42 mm).

#### *Female Imago*

Larger than male, similar colour and dorsal markings, 9th abdominal sternite with shallow incision on posterior margin, 7th sternite produced posteriorly forming a bulbous projection (Figs 3e, f). Fore legs shorter than in male, sternum and thorax broader than male, mesobasisternum length of  $0.81 \times$  width,  $0.63 \times$  furcasternum length, furcasternum length  $0.61 \times$  width. Terminal filament present.

#### *Subimago*

Dull, black-brown, wings uniformly shaded grey, no "lambda" pattern, terminal filament present.

#### *Diagnostic Characteristics*

1. Genitalia of male imago (Figs 3c, d; 7c, d).
2. Lack of terminal filament in adult male.
3. Subimago with uniform grey wings.
4. Nymphs with multifurcate tracheal gill filaments (Fig. 4c).
5. 9th abdominal segment with two spines on the posterolateral margin.
6. Form and shape of mandibles, incisors and prosthecae (Figs 4h-k).

#### *History and Discussion*

*Atalophlebia australasica*, originally described by Pictet (1843), has been redescribed by Eaton (1871,

1884), by Ulmer (1916) and Harker (1954). The description given by Pictet was not extensive enough to enable recognition of this species as more Australian species were described. Eaton (1871, 1884) redescribed this species and illustrated the wings and genitalia. Ulmer (1916) designated material from northern Queensland as *A. australasica*, and described the male and female imagos, and the subimago. Ulmer noted differences in the venation of the hind wing of these specimens when compared with Eaton's (1884) illustration, but did not comment on the apparent differences in the genitalia as illustrated by Eaton. Harker (1950) recorded that Ulmer (1919) had placed *A. australasica* as a synonym of *A. costalis* (Burmeister). In 1954, Harker noted, after examining material in the British Museum, that *A. australasica* as designated by Eaton was distinctly different from *A. costalis* as determined by Tillyard, and redescribed all stages of the species.

Although the male imago description is of the holotype (as inferred by the statement "fore legs are missing in holotype and paratypes"), Harker included a record of a well-developed terminal filament. Pictet's (1843) description included only one caudal filament measurement, consistent with the accompanying illustration, and of descriptions of species lacking the terminal filament. Eaton (1871, 1884) also included only one measurement. Ulmer (1916) recorded only the lateral cerci "Die Schwanzborsten (2 beim ♂) sind schwarzbraun . . ." but recorded the presence of the terminal filament in the male subimago. Harker (1954) also noted that material examined from Mt Gambier (from Tillyard's 1934 collection) was consistent with her recognition of this species. Adult males of *A. australasica* from south-east South Australia and the Fleurieu Peninsula lack the terminal filament, consistent with the type description. Harker's record mentions no variability of expression of the terminal filament (as described for *A. australis* by Tillyard 1934). Therefore, since subsequent collections, as well as the type material all lack this filament, its presence as indicated by Harker must be suspect.

A comparison of Figs 3c, and 7c, with the illustration of the *A. australasica* genitalia by Harker (1954) shows little resemblance. The South Australian material of this species, examined in this study, was initially considered different from previously described species. However, a comparison of an air-dried specimen and a critical-point dried specimen revealed two different penes characteristics. The air-dried specimen closely resembles the illustration presented by Harker, from a dry, pinned preparation. The lateral lobes of air-dried specimens curl in towards the mid-line, producing a long narrow structure. The critical-point dried specimens represent more closely the living, or alcohol-preserved, characteristics of the genitalia, with the lateral lobes of the penes maintaining their lateral position.

*Material Examined*

**SOUTH AUSTRALIA.** South East: Cress Ck, Deep Ck, Eight Mile Ck, Hitchcock Drain, Jerusalem Ck. Mt. Lofty Ranges: Blackfellow Ck, Brownhill Ck, Bull Ck, Cudlee Ck, Currency Ck, Dam at Carey's Gully, Dam at Ashton, Deep Ck, First Ck, Fourth Ck, Little Para R., Morialta Ck, Onkaparinga R., Sturt R., Torrens R., Wakefield R. Fleurieu Peninsula: Carrickalinga Ck, Coolawang Ck, The Deep Ck, (Delamere), Finnis R., Gold Digging Swamp, Hindmarsh R., Inman R., Kangarilla Ck, Myponga Ck, No Where Else Ck, Tookayerta Ck, Yankalilla R. Kangaroo Island: Breakneck R., De Mole R., Middle R., Rocky R., South West R.

**VICTORIA.** Crawford R., Eumarella R., Fitzroy R., Glenelg R., Shaw R.

*Atalophlebia auratus* sp. nov.*Holotype Male Imago*

|                          |          |
|--------------------------|----------|
| Body Length              | 7.95 mm  |
| Notal Length             | 2.60 mm  |
| Pronotal Width           | 1.04 mm  |
| Mesonotal Width          | 1.27 mm  |
| Fore Wing Length         | 7.44 mm  |
| Hind Wing Length         | 2.23 mm  |
| Cerci Length             | 19.67 mm |
| Terminal Filament Length | 15.57 mm |

General colour yellow-brown, fore wings yellow, hind wings grey.

**Head:** dark brown. Antennae short, basal segment 0.12 mm long, 1.5 × longer than wide, 2nd segment 0.1 mm long, 2.5 × longer than wide, flagellum 0.24 mm long. Dorsal compound eyes pink-brown, lateral eyes dark grey. Ocelli dark brown laterally, white anteriorly.

**Thorax:** shiny black. Pronotum narrower than head. Legs: fore legs long, femur and tibia dark brown, tarsal segments dark brown, no banding on any segment, T<sub>1</sub> partially fused to tibia. Middle and hind legs shorter, light brown without banding, tarsal segments 1-4 with distal spine, T<sub>1</sub> fused to tibia, join visible. Fore leg femur length 1.03 × middle leg femur length, and 0.95 × hind leg femur length. Ratios of leg segments: fore leg 1.00 : 1.14 : 0.09 : 0.40 : 0.40 : 0.28 : 0.19 (1.84 mm); middle leg 1.00 : 0.77 : - : 0.10 : 0.08 : 0.16 (1.78 mm); hind leg 1.00 : 0.98 : - : 0.08 : 0.10 : 0.07 : 0.17 (1.94 mm). Sternum dark black-brown. Prosternum triangular, longer than wide. Mesosternum; basisternum length 1.17 × width, 0.78 × furcasternum length 0.89 × width, lateral margins of median longitudinal invagination divergent, posterior margin concave (Fig. 5e).

**Wings:** fore wing (Fig. 5a) tinged throughout with yellow-brown, veins yellow-brown, pterostigma darker than rest of wing, cubital region shaded grey, length

3.35 × width, pterostigmatic cross-veins forked in left wing, simple, not forked in right wing, cross-veins present in proximal half of costal region. Hind wing (Fig. 5b) grey-brown, darker than fore wing, shaded completely, length 2.06 × width, costal hump not large, costal space with nine cross-veins.

**Abdomen:** yellow-brown dorsally, lighter yellow ventrally, dorsal tergites with dark brown-black markings laterally, and light mid-longitudinal stripe along all segments (Fig. 5f). Sternites yellow-grey, with light red-brown circular markings on mid-line (Fig. 5g). Cerci long, terminal filaments well developed but not as long or robust as cerci.

**Genitalia** (Figs 5c, d; 7e, f): forceps with long proximal segment, broadest proximally, narrows half way along length, 2nd segment short, globular, distal segment longer, ovoid, rounded apically. Penes broad at base, tapering towards apex with apices held close together, curving upwards in profile.

*Mature Female Nymph* (Fig. 14c)

|                          |          |
|--------------------------|----------|
| Body Length              | 9.20 mm  |
| Head Width               | 2.03 mm  |
| Notal Length             | 2.22 mm  |
| Pronotal Width           | 1.90 mm  |
| Mesonotal Width          | 2.19 mm  |
| Cerci Length             | 15.20 mm |
| Terminal Filament Length | 14.66 mm |

General colour brown.

**Head:** brown. Lateral eyes black, ocelli black. Tentorial body almost square, length 0.95 × width. Antennae 4.8 mm long.

**Thorax:** pronotum brown without markings, width 0.95 × head width, 2 stout spine setae on anterior margin, no setae on lateral margin. Mesonotum brown, broad, width 1.08 × head. Legs light brown without banding (Fig. 6a). Tarsal claws with 31-35 peg-like denticles (Fig. 6b), segment ratios: fore leg 1.00 : 0.98 : 0.49 (1.81 mm); middle leg 1.00 : 0.96 : 0.48 (1.81 mm); hind leg 1.00 : 0.96 : 0.47 (1.97 mm). Femur length to width ratios; fore leg 3.77, middle leg 4.11, hind leg 4.48. Sternum: prosternum, length 0.73 × width, wider than anterior margin of mesosternum. Mesosternum: basisternum rectangular, width 0.68 × length. Metasternum: basisternum short, width 5.71 × length.

**Abdomen:** brown dorsally with black patches on lateral flanges of segments 1-7, segments 1-5 otherwise brown without markings, segments 6, 7, 8, 9 with central light stripe, segment 10 light brown (Fig. 14c). Segment 9 with a single postero-lateral spine. Cerci and terminal filament well developed, cerci longer. Gills: multifurcate, with numerous fine tracheal filaments on each lamella.

**Mouthparts:** labrum (Fig. 6c) length 0.40 × width, anterior margin with median concavity lined with five rounded tubercles (Fig. 6d). Left mandible (Fig. 6g):



outer incisors with three apparent (four actual) teeth; inner incisors with three teeth, prostheca robust with 8-10 pointed teeth on external margin (Fig. 11h). Right mandible (Fig. 6i): outer incisors with three teeth and a fourth shoulder-like ridge on third tooth, two small tubercles on mesal margin, inner incisors with three teeth, inner most with two small tubercles laterally, prostheca long, narrow with one small external spine and two terminal spines (Fig. 6j). Hypopharynx (Fig. 6e). Maxillae (Fig. 6k). Segment ratios of palp 1.00 : 1.10 : 0.67 (0.30 mm). Labium (Fig. 6f): proximal segment of palp broad, length 1.61 × width, distal segment triangular, segment ratios 1.00 : 0.80 : 0.62 (0.38 mm).

#### Female Imago

Reared in laboratory. Wing and body coloration resemble male, body robust, filled with eggs. Ninth abdominal segment with a deep ventral cleft (Fig. 5i); sternite of seventh abdominal segment slightly produced posteriorly (Fig. 5j).

#### Subimago

Similar to male imago, wing colour dull yellow-grey, without marking.

#### Male Nymph

Smaller than female, head with red-brown compound eyes.

#### Diagnostic Characteristics

1. Genitalia of male imago; shape of forceps segments two and three and shape of penes (Figs 5c, f; 7e, f).
2. Wing coloration in both fore and hind wings.
3. Lack of banding on legs of adults.
4. Multifurcate gills of nymphs.
5. Only one postero-lateral spine on abdominal segment 9.
6. Shape of mandibles, incisors and prosthecae (Figs 6g-j).
7. Lack of banding on legs of nymphs (Fig. 6a).
8. Dorsal colour pattern of nymph and adults (Fig. 14c; and Fig. 5f).

#### Type Locality

Bakers Range Drain, west of Penola, South Australia. Grid Reference on 1 : 250 000 map series, Penola Sheet: 357393. Collected 22 November 1977 by D. N. Suter and P. J. Suter.

TABLE 1. COMPARISON OF QUALITATIVE CHARACTERISTICS OF *ATALOPHLEBIA AUSTRALIS*, *A. AUSTRALASICA* AND *A. AURATUS* FROM SOUTH AUSTRALIA

| Character  | <i>A. australis</i>                              | <i>A. australasica</i>            | <i>A. auratus</i>                          |
|--|--|-----------------------------------|--|
| Male Imago   |  |                                   |  |
| Body colour  | Yellow-brown                                     | Black-brown                       | Yellow-brown                               |
| Fore wing colouration                              | Pterostigma only (yellow)                        | Pterostigma only (brown)          | Totally yellow                             |
| Hind wing colouration                              | Clear  | Clear                             | Grey                                       |
| Penes  | Separate apically                                | Fused apically with lateral lobes | Fused apically without lateral projections |
| Legs   | Femur banded                                     | Femur banded                      | No banding                                 |
| Fusion of tarsal Segment 1 of fore leg             | Partial  | Partial                           | Partial                                    |
| Fusion of tarsal Segment 1 of middle and hind legs | Fused  | Fused                             | Fused                                      |
| Terminal filament                                  | Present-absent                                   | Absent                            | Present                                    |
| Nymph  |  |                                   |  |
| Dorsal eye colour ♂                                | Sepia  | Red-black                         | Pink-brown                                 |
| Lateral eye colour                                 | Black  | Black                             | Black                                      |
| Legs: banding                                      | Femora 2 bands<br>Tibiae 2 bands<br>Tarsi 1 band | 2 bands<br>2 bands<br>1 band      | Absent<br>Absent<br>Absent                 |
| Postero-lateral spines on abdominal segment 9      | Single   | 2 spines                          | Single                                     |
| Abdominal tergite spines                           | Large singular spines with smaller basal spines  | Singular spines                   | Single spines with smaller basal spines    |
| Gills  | Trifurcate                                       | Multifurcate                      | Multifurcate                               |
| Left mandible                                      |  |                                   |  |
| Incisors Outer                                     | 4  | 3                                 | 4  |
| Incisors Inner                                     | 3  | 3                                 | 3  |
| Prostheca  | Robust-serrated                                  | Robust-serrated                   | Robust-serrated                            |
| Right mandible                                     |  |                                   |  |
| Incisors Outer                                     | 3  | 5                                 | 3  |
| Incisors Inner                                     | 2  | 2                                 | 3  |
| Prostheca  | Long, slender with 4 spines                      | Slender-serrated                  | Long, narrow                               |



### Type Specimens

*A. auratus* is only known from the type locality. Holotype male and paratypes are placed in the Museum of Victoria. The wings and legs of the holotype male are mounted on slides, and the mouthparts, legs and gills of the female nymph are also mounted on slides. The genitalia and body of the holotype are maintained in ethanol.

### Type Habitat

Near the source of Bakers Range Main Drain, which is a man-made drain, draining the swamps of Bakers Range in the South East of South Australia. The water at the type locality was evaporating rapidly during November 1977, when the type collection was made. *A. australis* was also present at this locality.

### Etymology of Specific Epithet

The specific epithet *auratus* (L), ornamented with gold, refers to the golden coloration of the forewings which make this species distinct from all other described *Atalophlebia* species.

### Affinities

In adult characters the wing coloration, genitalia and lack of banding of the legs distinguish this species from other described species in the genus *Atalophlebia*. The nymph, however, resembles the nymph of *A. australasica* in possessing multifurcate gills. Although smaller than *A. australasica* (a character to be used with great care) the lack of banding of the legs, the presence of only one postero-lateral spine on the 9th abdominal segment, the mandible incisors and prosthecae all distinguish *A. auratus* from *A. australasica*. A comparison of qualitative characteristics which distinguish the three *Atalophlebia* species found in South Australia is presented in Table 1.

### GENUS *NOUSIA* Navás, 1918

Navás, 1918: 213; 1925: 308; Ulmer, 1919: 20 (In *Atalophlebia*); Needham & Murphy, 1924: 35-37; Lestage, 1931: 52; Traver, 1946: 420; Harker, 1950: 30-32; 1954: 242-243; 1957: 69-71; Riek, 1970: 239; Peters & Edmunds, 1972: 1411; Tsui & Peters, 1975: 540-542; Pescador & Peters, 1985: 91-123.

*Type Species: Nousia delicata* Navás by original designation. Detailed characterisation of this genus is given by Pescador & Peters (1985) and Suter (1980). There has been considerable discussion of the validity of the genus *Atalonella* in Australia (Tsui and Peters 1972; Suter 1980) and following the work of Pescador & Peters (1985) the South Australian species are placed in the genus *Nousia*. Although differences between the South American and Australian species exist (e.g. egg structure) until a full revision is performed all *Atalonella* species should be considered as belonging to the genus *Nousia*.

### *Nousia inconspicua* (Eaton) 1871 comb. nov.

*Leptophlebia inconspicua* Eaton, 1871: 79-80; *Atalophlebia inconspicua* Eaton, 1884: 87; Ulmer, 1908: 43-44; Tillyard, 1936: 31; Harker, 1950: 28; 1954: 265.

### Male Imago

|                          | $\bar{x}$ | SD   | n  | Range       |
|--------------------------|-----------|------|----|-------------|
| Body Length              | 7.27      | 0.50 | 26 | 6.07- 7.95  |
| Notal Length             | 2.26      | 0.15 | 26 | 2.02- 2.62  |
| Pronotal Width           | 0.96      | 0.09 | 16 | 0.84- 1.08  |
| Mesonotal Width          | 1.19      | 0.08 | 26 | 1.04- 1.32  |
| Fore Wing Length         | 7.25      | 0.52 | 26 | 5.74- 8.36  |
| Hind Wing Length         | 1.43      | 0.14 | 26 | 1.20- 1.80  |
| Cerci Length             | 10.60     | 0.80 | 11 | 9.41-12.14  |
| Terminal Filament Length | 12.67     | 1.01 | 10 | 11.11-14.02 |

General colour black, with light transparent regions between abdominal segments, giving a banded appearance.

*Head:* black. Dorsal compound eyes light brown, lateral eyes grey.

*Thorax:* dark brown-black. Legs: fore legs dark brown, without banding. Middle and hind legs shorter, light brown, without bands.  $T_1$  fused to tibia, suture apparent. Ratios of leg segments: fore leg 1.00 : 1.46 : 0.14 : 0.48 : 0.45 : 0.33 : 0.17 (2.13 mm); middle leg 1.00 : 1.07 : 0.06 : 0.08 : 0.08 : 0.07 : 0.16 (1.44 mm); hind leg 1.00 : 1.13 : 0.06 : 0.08 : 0.08 : 0.07 : 0.16 (1.49 mm).

*Wings:* fore wings (Fig. 8a)  $3.29 \times$  longer than wide, pterostigmal region slightly opaque, with simple cross-veins in distal 1/3 only, proximal region of subcostal space without cross-veins, distal region with very faint cross-veins, cubital and anal regions with few cross-veins. Hind wing (Fig. 8b)  $1.55 \times$  longer than wide, 4-5 cross-veins in distal region of costal space, absent in proximal half, subcostal space with 3-5 cross-veins.

*Abdomen:* black with light central marking dorsally (Fig. 8h), all segments light brown ventrally (Fig. 8i).

*Genitalia* (Figs 8c, d): distal segment of forceps globular. Penes broad, fused along entire length, extending beyond constriction of proximal segment of forceps, ventral lobes triangular with base separate anteriorly, sperm ducts open on mid line (Figs 15a, b).

### Mature Male Nymph (Fig. 14d)

|                          | $\bar{x}$ | SD   | n  | Range     |
|--------------------------|-----------|------|----|-----------|
| Head Width               | 1.59      | 0.04 | 13 | 1.54-1.70 |
| Notal Length             | 1.95      | 0.08 | 13 | 1.80-2.12 |
| Pronotal Width           | 1.50      | 0.08 | 13 | 1.38-1.56 |
| Mesonotal Width          | 1.58      | 0.07 | 13 | 1.50-1.72 |
| Cerci Length             | 9.92      | —    | 1  | —         |
| Terminal Filament Length | 10.77     | —    | 1  | —         |

*Head:* dark brown. Dorsal compound eyes dark reddish brown.

*Thorax:* legs brown, no banding (Fig. 9a). Ratios of leg segments: fore leg 1.00 : 0.92 : 0.52 (1.39 mm); middle leg 1.00 : 0.92 : 0.44 (1.39 mm); hind leg 1.00 :

0.98 : 0.36 (1.49 mm). Femur length to width ratio: fore leg 3.17, middle leg 3.20, hind leg 3.35.

**Abdomen:** brown dorsally with a light stripe down mid-line (Fig. 14d), posterior margins of terga with large singular spines, with smaller spines between them. Gills lanceolate (Fig. 9c), lamellae with numerous tracheal branches.

**Mouthparts:** labrum (Fig. 9d) 2 × wider than long, median cavity without obvious rounded denticles (Fig. 9e). Left mandible (Fig. 9h): outer incisors with three teeth, inner with three teeth, prostheca long and slender, apically with two rounded teeth (Fig. 9i). Right mandible (Fig. 9j): outer incisors with three teeth, inner with 2-4 teeth, prostheca simple, narrow with one apical spine (Fig. 9k). Hypopharynx (Fig. 9f). Maxillae (Fig. 9l): proximal segment of palp 2.06 × longer than wide, segment ratios 1.00 : 0.92 : 0.80 (0.22 mm). Labium (Fig. 9g): proximal segment of palp 1.98 × longer than broad, distal segment with 3-4 short apical spines, segment ratios; 1.00 : 0.79 : 0.64 (0.35 mm).

#### *Female Imago*

More robust than male, uniform brown. Fore wings with cross-veins along entire costal and subcostal spaces. Hind wings with cross-veins in radial, median and cubital sectors. Anal plate with a deep V shaped incision (Fig. 8e), no ovipositor (Fig. 8f). Egg, oval, 0.12 mm long, 0.09 mm wide with a polar cap of two rings of tubular projections on each apex (Fig. 16a).

#### *Subimago*

Black with uniformly grey wings.

#### *Diagnostic Characteristics*

1. Genitalia: penes shape, broad, fused, with triangular ventral lobes (Figs 8c, d and Figs 15a, b).
2. Lack of cross-veins in proximal regions of C and Sc spaces of fore wings (Fig. 8a).
3. Egg morphology, polar caps with 2 rows of tubular processes (Fig. 16a).
4. Nymphal gills lanceolate (Fig. 9c).
5. Mandibles, incisors and prosthecae shape (Figs 9h-k).
6. Proximal segment of labial palp long and narrow (Fig. 9g).
7. Dorsal white stripe on abdomen (Fig. 14d).

#### *History and Discussion*

Until this study *N. inconspicua* had the distinction of being the only species described from South Australia. Eaton (1871) described and placed it in *Leptophlebia*, noting the black and white patterning of the abdomen. His illustration of the genitalia differs from the scanning electromicrograph (Figs 15a, b) as he showed separate penes lobes. This separation of the

two lobes of the penes is observed with air-dried specimens, and may occur with slide-mounted material. Living, critical-point dried, and alcohol-preserved specimens possess genitalia with the two lobes held close together as illustrated in the micrograph. The type locality of this species is Adelaide, but the river or stream from which the holotype was collected is unknown. In 1884 Eaton placed *Nousia inconspicua* in the new genus *Atalophlebia* where it has remained until the present study. Ulmer (1908) added to Eaton's description from material from the South-West of Western Australia. He included illustrations of male genitalia, both wet-preserved in alcohol and dried, showing the separation of the paired penes lobes in the dried preparation. From the illustrations of the wings (the presence of cross-veins in the proximal half of the C and Sc regions of the fore wing) and genitalia it is difficult to know if the species described by Ulmer is *N. inconspicua* or a different species.

Tillyard (1936) recognised two groups within the genus *Atalophlebia*, and he included *N. inconspicua* in the group with the smaller species i.e. "smaller species, expanding from one-half to three-quarters of an inch (fore wing from 5 to 8 mm long)". Since this species is not recorded in Tasmania, no description was given, and in fact it is only referred to in the adult key. All the other species from the smaller sized group were later placed in the genus *Atalonella* by Harker (1954), but *N. inconspicua* was left in *Atalophlebia*.

The nymphs and adults of this species, as described above, have characteristics which distinguish them from the genus *Atalophlebia*, but are consistent with the generic characteristics of *Nousia*. Consequently *N. inconspicua* is now formally placed in the genus *Nousia*.

#### *Material Examined*

**SOUTH AUSTRALIA.** Mt. Lofty Ranges: Aldgate Ck, Blackfellow Ck, Brownhill Ck, Bull Ck, Currency Ck, Deep Ck, Fifth Ck, Finnis R., Fourth Ck, Little Para R., Marne R., Morialta Ck, Onkaparinga R., Scott Ck, Sturt R., Torrens R. Southern Flinders Ranges: Back Ck, Nectar Brook Dam, Rocky R., Schumacher Ck, Skillogalee Ck, Spring Ck, Wakefield R. Fleurieu Peninsula: Anacotilla Ck, Carrickalinga Ck, Coolawang Ck, The Deep Creek (Delamere), Gold Digging Swamp, Hindmarsh R., Kangarilla Ck, Myponga Ck, Yankalilla R. Kangaroo Island: Breakneck R., Cygnet R., De Mole R., Grassy/Sheep Ck, Middle R., North East R., Rocky R., South West Bay R., South West R., Stunsail Boom R.

#### *Nousia fuscula* (Tillyard, 1936)

*Atalophlebia fuscula* Tillyard, 1936: 44-47; *Atalophlebia fuscula* Harker, 1950: 28; *Atalonella fuscula* Harker, 1954: 242-243, 264; Scholes, 1961: 31-33.

*Male Imago*

|                          | $\bar{x}$ | <i>SD</i> | <i>n</i> | <i>Range</i> |
|--------------------------|-----------|-----------|----------|--------------|
| Body Length              | 6.58      | 0.32      | 23       | 5.82- 7.01   |
| Notal Length             | 2.02      | 0.11      | 21       | 1.84- 2.20   |
| Pronotal Width           | 0.87      | 0.06      | 10       | 0.74- 0.92   |
| Mesonotal Width          | 1.02      | 0.09      | 20       | 0.82- 1.12   |
| Fore Wing Length         | 6.41      | 0.28      | 22       | 5.90- 6.97   |
| Hind Wing Length         | 1.29      | 0.09      | 23       | 1.12- 1.40   |
| Cerci Length             | 10.32     | 0.62      | 12       | 9.23-11.11   |
| Terminal Filament Length | 11.67     | 0.76      | 8        | 10.77-13.00  |

**Head:** black. Dorsal compound eyes, brown-grey.

**Thorax:** black. Fore legs black without banding. Middle and hind legs brown without banding. Ratios of leg segments: fore leg 1.00 : 1.29 : 0.14 : 0.49 : 0.44 : 0.28 : 0.16 (1.64 mm); middle leg 1.00 : 1.15 : - : 0.11 : 0.09 : 0.09 : 0.15 (1.38 mm); hind leg 1.00 : 1.20 : - : 0.09 : 0.08 : 0.09 : 0.15 (1.58 mm). Fore leg femur length 1.19  $\times$  middle leg femur length, and 1.04  $\times$  hind leg femur length.

**Wings:** fore wing (Fig. 10a) 3.13  $\times$  longer than wide, pterostigmal region slightly tinged with brown, cross-veins slanted, simple, costal space proximal to bulla with 3-7 very faint cross-veins, subcostal space with 2-4 cross-veins in proximal half, 7-10 in distal half. Hind wing (Fig. 10b), 1.52  $\times$  longer than wide, 3-4 cross-veins in distal region of costal space, absent in proximal half, subcostal space with 4-6 cross-veins.

**Abdomen:** black, with brown and light brown markings (Fig. 10h); ventral pattern (Fig. 10i).

**Genitalia** (Figs 10c, d): distal segment of forceps globular. Penes lobes widely separated, cylindrical, constricted near apex, apex rounded, lobes apparently sheathed, inner margin with a small spine hidden within sheath, visible in mounted preparations examined using transmitted light (Fig. 10j), but not in the Scanning Electron Micrographs (Figs 15c, d).

*Mature Male Nymph* (Fig. 14e)

|                 | $\bar{x}$ | <i>SD</i> | <i>n</i> | <i>Range</i> |
|-----------------|-----------|-----------|----------|--------------|
| Head Width      | 1.44      | 0.06      | 6        | 1.36-1.50    |
| Notal Length    | 1.71      | 0.07      | 4        | 1.64-1.80    |
| Pronotal Width  | 1.28      | 0.04      | 4        | 1.22-1.32    |
| Mesonotal Width | 1.33      | 0.06      | 4        | 1.26-1.40    |

Cerci and terminal filament damaged in available specimens.

**Head:** dark brown. Dorsal compound eyes reddish brown.

**Thorax:** pronotum with spine setae on antero-lateral margins. Legs brown, not banded (Fig. 11a). Ratios of leg segments: fore leg 1.00 : 0.87 : 0.55 (1.18 mm); middle leg 1.00 : 0.84 : 0.39 (1.19 mm); hind leg 1.00 : 0.91 : 0.38 (1.40 mm). Femur length to width ratios, fore leg 2.74, middle leg 2.82, hind leg 3.11.

**Abdomen:** colour pattern irregular (Fig. 14e). Spines on posterior margins of terga occur either separately or in pairs. Gills (Fig. 11c); linear, lamellae lacking tracheal branches, or, if present, very short.

**Mouthparts:** labrum (Fig. 11d) 2  $\times$  wider than long; median cavity with four to six rounded denticles (Fig. 11e). Left mandible (Fig. 11h), outer incisors with three apical teeth, inner incisors with three teeth, prostheca broad, robust, outer and apical margin serrated (Fig. 11i). Right mandible (Fig. 11j); outer incisors with three apical teeth, inner incisors with two teeth, prostheca simple, long and narrow with one apical spine (Fig. 11k). Hypopharynx (Fig. 11f). Maxillae (Fig. 11l), proximal segment of palp 2.11  $\times$  longer than wide. Segment ratios: 1.00 : 0.71 : 0.78 (0.21 mm). Labium (Fig. 11g); proximal segment of palp 1.57  $\times$  longer than broad, segment ratios; 1.00 : 0.71 : 0.69 (0.29 mm).

*Female Imago*

More robust than male, wings similar, hind wings with more cross-veins in radial, median and cubital sectors. Anal plate with a deep V shaped incision (Fig. 10e), no ovipositor (Fig. 10f). Eggs oval 0.12 mm  $\times$  0.09 mm, polar caps with three rings of tubular processes (Fig. 16b).

*Subimago*

Dull black, wings opaque, dark grey.

*Diagnostic Characteristics*

1. Male genitalia, lateral lobes of penes widely separate, small spine on mesal margin of lobes (Figs 10c, d and Figs 15c, d).
2. Cross-veins in proximal region of costal and subcostal spaces (Fig. 10a).
3. Egg polar cap with 3 coronae of tubular processes (Fig. 16b).
4. Nymphs have linear gills with few tracheal branches on lamellae (Fig. 11c).
5. Mandibles, shape of incisors and prosthecae (Figs 11h-k).
6. Proximal segment of labial palpi broad (Fig. 11g).
7. Abdominal colour pattern irregular (Fig. 14e).

*History and Discussion*

Tillyard (1936) described the adults (male and female), subimago, and nymph of *N. fuscula* placing it in his distinct group of small species of the genus *Atalophlebia*. Harker (1954) recognised that all the species Tillyard placed in this second group of small-sized species belonged in the genus *Atalonella*. These species now belong to the genus *Nousia*, and *N. fuscula* is formally included in this genus.

The male genitalia are distinctive in *N. fuscula*, with a small spine on the mesal margins of the penes lobes, but the associated nymph in South Australia differs from the description and illustration given by Tillyard (1936). The gill illustrated by Tillyard shows a more lanceolate lamella with numerous tracheal branches, both shape and tracheation are inconsistent with the associated nymphs of South Australia. Nymphs of Tillyard's description were not found at Tookayerta

Creek (the only locality where *N. fuscula* is present on the Fleurieu Peninsula), but one of a similar description to his was recorded from Deep Creek, east of Port Macdonnell in the South East of South Australia. Similar nymphs from the Grampians, Victoria, were bred through and *N. pilosa* sp. nov. was the associated adult. Field observations suggest that *N. fuscula* emerges before *N. pilosa*, therefore leaving *N. pilosa* nymphs in the stream. This observation was repeated by the author in the South East of South Australia, the Grampians, Victoria, and in Tasmania. The nymphs of *N. fuscula* from Tasmania (collected in February 1978 and associated with adults) were similar to those in South Australia. From these observations it appears that Tillyard indirectly associated the nymph in the stream with the flying adults and emerged subimagos rather than by breeding through the nymphs and directly associating these with the resulting adults.

#### Material Examined

**SOUTH AUSTRALIA.** South East: Cress Ck, Deep Ck, Eight Mile Ck. Fleurieu Peninsula: Tookayerta Ck. **VICTORIA.** Aire R., Albert R., Beehive Ck, Crawford R., Cumberland Falls (Marysville), Darlots Ck, Genoa Ck, Howqua R., Jimmy's Ck, Little R., McKenzie R., Mt. Zero Channel, Stony Ck (Halls Gap), Tanjil R., Tarwin R., Toorong Falls (Noojee).

**NEW SOUTH WALES.** Leatherbarrel Ck, Styx R., Wallagaraugh R.

**TASMANIA.** Break O'Day R., Dee R., George R., Great Forester R., Isis R., Macquarie R., Rostrevor Ck.

#### *Nousia pilosa* sp. nov.

##### Holotype Male

|                          |          |
|--------------------------|----------|
| Body Length              | 7.50 mm  |
| Notal Length             | 1.90 mm  |
| Pronotal Width           | 0.93 mm  |
| Mesonotal Width          | 1.17 mm  |
| Fore Wing Length         | 7.67 mm  |
| Hind Wing Length         | 1.23 mm  |
| Cerci Length             | 9.05 mm  |
| Terminal Filament Length | 12.00 mm |

**Head:** black-brown. Dorsal eyes pink/brown.

**Thorax:** pronotum black, narrower than head. Fore leg without banding, femur dark brown, tibia and tarsi light brown,  $T_1$  partially fused to tibia; middle and hind legs with dark brown femora each with one black band at 3/4 of length, tibiae and tarsi light brown,  $T_1$  fused to tibia. Ratios of leg segments: fore leg 1.00 : 1.52 : 0.08 : 0.48 : 0.51 : 0.38 : 0.15 (1.92 mm); middle leg 1.00 : 1.22 : - : 0.07 : 0.07 : 0.07 : 0.11 (1.62 mm); hind leg 1.00 : 1.35 : - : 0.09 : 0.08 : 0.07 : 0.13 (1.67 mm).

**Wings:** fore wing (Fig. 12a)  $3.3 \times$  longer than wide, pterostigmal region with simple, slanted cross-veins, proximal 2/3 of costal space without cross-veins, subcostal space without proximal cross-veins, distal

region with seven. Hind wing (Fig. 12b, c)  $1.52 \times$  longer than wide; 2 cross-veins in distal region of costal space, absent in proximal half, sub costal space with 3 cross-veins.

**Abdomen:** dark brown with mid-dorsal light brown region on segments 2-7, segments 8-10 dark brown (Fig. 12g); ventrally light brown (Fig. 12h). Base of each segment of caudal filaments tinged with brown giving a banded appearance.

**Genitalia** (Figs. 12d, e): second segment of forceps short, ovoid, distal segment globular. Penes fused, apex with 2 lobes, ventral surface lacking lobes (Figs 12d, 15e, f).

##### Mature Male Nymph (Fig. 14f)

|                  |                 |
|------------------|-----------------|
| Head Width       | 1.20 mm         |
| Notal Length     | 2.30 mm         |
| Pronotal Width   | 1.09 mm         |
| Mesonotal Width  | 1.31 mm         |
| Caudal Filaments | Damaged in type |

**Head:** light brown, light marking in centre of frons. Dorsal eyes red-brown.

**Thorax:** pronotum width  $0.91 \times$  head width, few spine setae present on antero-lateral margin. Legs light brown, without banding, margins of segments lined with long fine setae (Fig. 13a). Tarsal claws with 12 peg-like teeth (Fig. 13b). Ratios of leg segments: fore leg 1.00 : 0.96 : 0.40 (1.70 mm); middle leg 1.00 : 0.95 : 0.31 (1.77 mm); hind leg 1.00 : 1.01 : 0.29 (1.93 mm). Femur length to width ratios: fore leg 3.13, middle leg 3.39, hind leg 3.70.

**Abdomen:** dark brown with light central marking (Fig. 14f). Gills (Fig. 13c) lanceolate with single terminal tracheal filament, lamellae with tracheal branches obvious.

**Mouthparts:** labrum (Fig. 13d)  $1.5 \times$  wider than long; anterior margins with a median cavity with six rounded denticles (Fig. 13e), one row of setae behind median cavity. Left mandibles (Fig. 13h); outer incisors with three apical teeth, inner incisors with three apical teeth and two ridges on inner margin, prostheca broad basally, long and slender distally with three terminal teeth (Fig. 13i). Right mandible (Fig. 13j); outer incisors with three apical teeth, inner incisors with two teeth; prostheca slender, elongate with a long terminal spine (Fig. 13k). Hypopharynx (Fig. 13f). Maxillae (Fig. 13l); palpi, proximal segment  $1.79 \times$  longer than wide. Segment ratio 1.00 : 0.68 : 0.68 (0.27 mm). Labium (Fig. 13g); palpi, proximal segment  $2.26 \times$  longer than broad, distal segment; apex with four short teeth, segment ratios; 1.00 : 0.77 : 0.49 (0.44 mm).

##### Female Imago

Unknown.

##### Diagnostic Characteristics

1. Genitalia of male imago (Figs 12d, e and Figs 15e, f).
2. Gills of nymphs lanceolate, similar to *N. inconspicua* (Fig. 13c).

**GENUS *ULMEROPHLEBIA* Demoulin 1955**

Demoulin 1955: 228-229; Tsui and Peters 1975: 538.

**Male Imago**

Fore wings  $3-3.5 \times$  longer than wide, with numerous cross-veins, those in the subcostal space are upright and parallel. Hind wing with narrow costal region with numerous cross-veins apically, Sc joins wing margin at  $3/4$  of wing length, MA forked, single intercalary present. Tarsal claws dissimilar, one blunt club-shaped, one long, slender, hooked distally (Fig. 17h). Forceps three-segmented, basal segment very long. Penes much shorter than basal segment of forceps, not reaching narrowing of this segment. Cerci longer than terminal filament.

Type Species: *Ulmerophlebia mjobergi*.

**Mature Nymph**

Head without tusk-like projections, labrum with a small convex projection on mid-anterior margin. Labial palpi three-segmented. Maxillary palpi three-segmented, distal segment very small. Gills on abdominal segments 1-7 paired, each consisting of a pair of broad, ovate lamellae, with apical tracheal filaments fringed with long fine hairs. Body and legs fringed with long fine setae. Abdominal segments 6-9 with postero-lateral margins produced into backward-pointing projections.

**History and Discussion**

*Ulmerophlebia* was described by Demoulin (1955) to include a species described by Ulmer (1916) in the genus *Euphyrus* as *E. mjobergi*. Subsequently Ulmer (1920) placed this species in *Deleatidium* and, Harker (1953) accepted this determination. In 1955, Ulmer noted that the 2CuA were parallel, the hind wings had an Sc which joined the wing margin at  $3/4$  of wing length and resembled *Atalonella*. However, the short pointed penes of *D. mjobergi* separated this species from *Deleatidium* and *Atalonella*, and therefore a new generic designation was made. The only generic description is made by Ulmer (1916) in his species description and, therefore the characteristics of the imago are included here.

The nymph of *Ulmerophlebia* has never been formally described and, therefore the generic characteristics are also given here.

In the nymphal characteristics *Ulmerophlebia* resembles very closely nymphs of *Jappa* Harker. The only major distinguishing feature is the lack of frontal horns characteristic of this latter genus. Riek (1970) also made note of this similarity although indirectly, by stating that the eastern states' nymphs of the genus *Jappa* lack frontal horns. Tsui & Peters (1975) examined the thoracic morphology of nymphs of *Ulmerophlebia* and, although the nymphs had not been described or associated with adults they found only 4 of the 16

character states that they examined differed from nymphs of *Jappa*. These, plus the absence of frontal horns are the only differences in the nymph.

In the adults the major differences are the length of the penes, which in *Jappa* are almost equal to the length of the basal segment of the forceps and, the shorter Sc vein in the hind wing which extends almost to the apex of the wing in *Jappa*. Tsui and Peters (1975) recorded 1 of 6 character states that differed.

Clearly *Jappa* and *Ulmerophlebia* are closely related and future research may demonstrate that the two are congeneric. However, on the basis of the limited South Australian material, this is not possible as part of this work.

***Ulmerophlebia pipinna* sp. nov.****Holotype Male Imago**

|                          |          |
|--------------------------|----------|
| Body Length              | 9.44 mm  |
| Notal Length             | 2.54 mm  |
| Pronotal Width           | 0.92 mm  |
| Mesonotal Width          | 1.33 mm  |
| Fore Wing Length         | 9.31 mm  |
| Hind Wing Length         | 2.03 mm  |
| Cerci Length             | 14.10 mm |
| Terminal Filament Length | 11.97 mm |

Body colour reddish brown, abdomen darker dorsally.

**Head:** dark brown, with a white patch between ocelli. Antennae short, 1 mm long, basal segment twice as long as wide, flagella 0.87 mm long.

**Thorax:** light brown dorsally with white patches on scutoscuteum, laterally with patches of white and pink. Legs light brown, femora with two dark bands, one distally, and one at  $2/3$  of length,  $T_1$  partially fused to tibia, join apparent. Ratios of leg segments: fore leg 1.00 : 1.74 : 0.07 : 0.65 : 0.60 : 0.47 : 0.19 (1.84 mm); middle leg 1.00 : 1.28 : 0.04 : 0.09 : 0.09 : 0.06 : 0.20 (1.49 mm); hind leg 1.00 : 1.09 : 0.04 : 0.08 : 0.06 : 0.06 : 0.15 (1.80 mm). Sternum dark brown (Fig. 17e). Prosternum with heavily sclerotized base. Mesosternum: basisternum length  $1.46 \times$  width,  $0.79 \times$  furcasternum length, posterior margin rounded; furcasternum length  $0.87 \times$  width, lateral margins of median longitudinal invagination divergent posteriorly, posterior margin slightly concave.

**Wings:** hyaline. Fore wing (Fig. 17a), length  $3.5 \times$  width, cross-veins in pterostigmal region simple, costal cross-veins extending along entire length, slightly shaded with grey, cross-veins of subcostal space also shaded with grey. Hind wing (Fig. 17b), length  $2 \times$  width, costal hump not exaggerated, costal space with 5 cross-veins distally.  $R_1$  straight,  $R_s$  joins MA in centre of wing, MA straight, MP branched in proximal half of wing, anal region without cross-veins.

**Genitalia:** forceps light brown, proximal segment long, 0.74 mm, broad at base, narrows approximately half way along length, second segment almost square, distal segment longer, narrow proximally. Penes paired, very short, extending half way to narrowing of proximal segment of forceps, separate, mesal margins divergent, lobes simple (Figs 17c, d; 19a, b).

3. Labrum long (width  $1.5 \times$  greater than length) (Fig. 13d).
4. Prosthema shape of left and right mandibles (Figs 13i, k).
5. Legs lined with numerous long fine setae (Fig. 13a).

#### Type Locality

Type material was collected from Second Wannon River on the road from Halls Gap to Dunkeld, Grampian Mountains, Victoria. Grid Reference on 1 : 250 000 map series Ballarat Sheet: 547396. Collected 25 November 1977 by D. N. and P. J. Suter.

#### Type Specimens

Holotype male, and nymphal exuvium are placed in the Museum of Victoria. The wings and legs of the holotype are mounted on slides, and the body and genitalia are maintained in ethanol. The nymphal exuvium is mounted on slides. Three paratype males, two mature males and three mature female nymphs are included in the type series. Slides of a nymph, and adult male imago from Hitchcock Drain, South East South Australia, are also included.

#### Type Habitat

The Second Wannon River in the Grampians Mountains, is a moderately fast-flowing stream over cobble-sized rocks.

#### Etymology of Specific Epithet

The specific epithet *pilosa* (L) for hairy refers to the long, fine setae which line the margins of the legs distinguishing this species from *N. inconspicua* and *N. fuscula*.

#### Affinities

In the adult characters *N. pilosa* resembles closely *N. inconspicua*, with the penes fused, and lacking spination. *N. fuscula* is distinctly different with V-shaped penes, and internal spines. Although superficially similar, the penes of *N. inconspicua* and *N. pilosa* are distinct, with *N. inconspicua* with obvious ventral lobes, and separated basal halves of the penes (Figs 15a, b). *N. pilosa* lacks the ventral lobes, and the penes are fused along their entire length.

In nymphal characters *N. pilosa* resembles *N. inconspicua*, possessing lanceolate gills, but lacks the obvious dorsal white stripe on the abdomen, characteristic of *N. inconspicua*. The mouthpart structure, especially the labrum (Fig. 13d) and prosthecal structure (Figs 13i, k), and the fine setae on the legs, clearly distinguish *N. pilosa* from both *N. inconspicua* and *N. fuscula*.

A comparison of qualitative characteristics of the three species of *Nousia* from South Australia is given in Table 2.

#### History and Discussion

As mentioned previously the description of *N. fuscula* nymphs given by Tillyard (1936) is similar to that of *N. pilosa* and the associated nymph of *N. fuscula* differs from the description given by Tillyard. *N. fuscula* and *N. pilosa* appear ecologically separated by the timing of maturation and the imago mating flights. Therefore, it is possible that Tillyard indirectly associated the nymphs and adults collected from the River Shannon, Tasmania. Consequently it appears that the nymph of *N. pilosa* was indirectly ascribed to *N. fuscula*. The present descriptions are based on associated material, and distinguishes the nymphs of these two co-occurring species.

TABLE 2. COMPARISON OF QUALITATIVE CHARACTERISTICS OF *NOUSIA INCONSPICUA*, *N. FUSCULA* AND *N. PILOSA* FROM SOUTH AUSTRALIA

| Character        | <i>N. inconspicua</i>   | <i>N. fuscula</i>  | <i>N. pilosa</i>   |
|------------------|---|--|--|
| Male Imago       |   |  |  |
| Legs: banding    | Absent  | Absent   | Present  |
| Penes            | Fused apically<br>Ventral lobes present<br>No internal spines | Separate apically<br>Ventral lobes absent<br>Internal spines present | Fused apically<br>Ventral lobes absent<br>No internal spines |
| Nymph            |   |  |  |
| Legs: banding    | Uniform brown   | Absent   | Present  |
| Gills            | Broad lanceolate  | Linear   | Broad lanceolate   |
| Lamellae trachea | Plentiful, branched   | Few, simple  | Plentiful, branched  |
| Left mandible    |   |  |  |
| Incisors Outer   | 3   | 3  | 3  |
| Incisors Inner   | 3   | 3  | 3  |
| Right mandible   |   |  |  |
| Incisors Outer   | 3   | 3  | 3  |
| Incisors Inner   | 2   | 2  | 2  |
| Prosthema Left   | Slender, two terminal spines                                  | Robust, apex serrated  | Slender with lateral comb                                    |
| Prosthema Right  | Slender, two terminal spines                                  | Slender, two terminal spines   | Slender apex with three spines                               |
| Labial palpi     | Slender   | Broad  | Slender  |
| Labrum           | Width $\div 2 \times$ length                                  | Width $\div 2 \times$ length   | Width $< 2 \times$ length                                    |
| Hypopharynx      | Not divided   | Deeply divided   | Not divided  |

*Mature Female Nymph* (Fig. 20)

|                          |         |
|--------------------------|---------|
| Head Width               | 1.96 mm |
| Notal Length             | 3.12 mm |
| Pronotal Width           | 2.32 mm |
| Mesonotal Width          | 2.36 mm |
| Cerci Length             | 8.25 mm |
| Terminal Filament Length | 9.71 mm |

**Head:** brown. Lateral eyes black. Antennae 3.08 mm long with whorls of setae at apex of each segment. Tentorial body; width  $2.33 \times$  length.

**Thorax:** brown. Pronotum, brown with black-brown median marking, lateral margins lined with long fine setae. Legs brown, with one mid and one distal black band on femora; tibiae and tarsi not banded (Fig. 18a). Tarsal claws short and curved, with 12-16 small rounded ventral denticles (Fig. 18b). Femora of fore and middle legs almost equal in length, hind leg longest,  $1.34 \times$  fore femur length. Ratios of leg segments: fore leg  $1.00 : 1.04 : 0.37$  (1.66 mm); middle leg  $1.00 : 0.94 : 0.33$  (1.60 mm); hind leg  $1.00 : 0.87 : 0.26$  (2.14 mm). Femur length to width ratios: fore leg 2.18, middle leg 2.22, hind leg 2.68. Sternum: prosternum triangular with apex truncated, sternacostal suture absent. Mesosternum: basisternum, almost square, length  $0.92 \times$  width, and equal to furcasternum length, sternacostal suture present. Metasternum: basisternum narrower than mesofurcasternum, width  $4.75 \times$  length.

**Abdomen:** dark brown with light central stripe on segments 4-7, segments 8, 9, and 10 dark brown (Fig. 20). All segments with long fine setae dorsally. Caudal filaments well developed, terminal filament longer than cerci. Gills (Fig. 18c).

**Mouthparts:** labrum (Fig. 18d)  $2.12 \times$  wider than long, lateral margins angular lined with long fine setae, mid anterior margin with seven tubercles, three tubercles on each side of a large sharp central projection (Fig. 18e), dorsal surface covered with long setae. Left mandible (Fig. 18h); lateral margin lined with long setae, incisors displaced mesally, outer incisors with two large teeth and four smaller teeth on mesal margin, inner incisors with three apical teeth and one small lateral tubercle, prosthema narrow with six spines (Fig. 18i). Right mandible (Fig. 18j); outer margin lined with long setae, incisors displaced mesally, outer incisors rugose, with three apical teeth, with four lateral tubercles, inner incisors with two apical teeth and one lateral tubercle, prosthema long, spinous (Fig. 18k). Hypopharynx (Fig. 18f). Maxillae (Fig. 18l) galeo-lacinia rectangular, row of sixteen rake setae on ventral surface, rake setae also interspersed within apical brush; mesal corner with one large rake spine, inner margin lined with long fine pinnate setae; palpi longer than galeo-lacinia, proximal segment  $2.33 \times$  longer than wide, second segment long and broad,  $1.88 \times$  longer than wide, distal segment very short, triangular, covered with long setae, apex with two short spines, segment ratios  $1.00 : 0.94 : 0.29$  (0.36 mm). Labium (Fig. 18g); proximal segment of palpi  $1.71 \times$  longer than wide, segment ratios  $1.00 : 0.65 : 0.58$  (0.41 mm).

*Female Imago*

Unknown.

*Subimago*

Unknown.

*Male Nymph*

Unknown.

*Diagnostic Characteristics*

1. Genitalia of male imago, penes very short and simple (Figs 17c, d; 19a, b).
2. Wing length  $3.5 \times$  width (Fig. 17a).
3. Femora of imago with two black bands.
4. Nymph without frontal lobes (Fig. 20).
5. Labrum with one mid anterior projection and three denticles on each side (Figs 18d, e).
6. Maxillary palpi three segmented (Fig. 18l).
7. Lateral projection of glossae of labium (Fig. 18g).
8. Mandibles, shape and form of incisors and prosthecae (Figs 18h-k).

*Type Locality*

Second Wannon River, Grampian Mountains, Victoria, Grid Reference on 1 : 250 000 map series Ballarat Sheet: 547396. Collected 25 November 1977 by P. J. and D. N. Suter.

*Type Specimens*

The holotype male is deposited in the Museum of Victoria. Two paratype imagos are also placed in the Museum of Victoria. The wings and legs of the holotype male are mounted on slides, and the genitalia and body are in ethanol. The female nymph is mounted on slides.

*Type Habitat*

The Second Wannon River in the Grampian Mountains, is a moderately fast-flowing stream over large cobble-size rocks. The nymphs were collected using a kick-sample technique, and therefore there is no certainty of the habitat being occupied by this species.

*Etymology of Specific Epithet*

The penes of *U. pipinna* are very short and simple, hence the specific epithet *pipinna* (L) for small penes.

*Affinities*

The male imago of *U. pipinna* can be distinguished from *U. mjobergi* by the short simple penes. In *U. mjobergi* the penes are short and boot shaped, having a lateral angular projection, absent in *U. pipinna*.



**Material Examined**

**SOUTH AUSTRALIA.** South East: Cress Ck, Eight Mile Ck, Hitchcocks Drain.

**VICTORIA.** Crawford R., Fitzroy R., Fyans Ck, Shaw R., Wannon R., Second Wannon R.

**FAMILY BAETIDAE**

This family occurs on every continent, and is represented in Australia by the genera *Baetis* Leach, *Bungona* Harker, *Centroptilum* Eaton, *Cloeon* Leach and *Pseudocloeon* Klapálek.

Characterization of the Baetidae can be found in Edmunds, Jensen and Berner (1976).

**GENUS BAETIS** Leach 1815

Leach, 1815: 137; Burmeister, 1839: 800 (*B. costalis* later placed in *Atalophlebia*); Pictet, 1843: 189-191 (*B. australasica* later placed in *Atalophlebia*); Walker, 1853: 559-561 (*B. australasica*, *B. costalis*); Eaton, 1871: 110; 1881: 196; 1885: 156-158; Ulmer, 1908: 44-45; Tillyard, 1926: 64; 1936: 50-53; Harker, 1950: 21-24, 29; 1954: 263-264, 266; Scholes, 1961: 36-38; Riek, 1970: 235.

Type Species: *Baetis bioculatus* (Linn. Fabr.).

The first record of *Baetis* from Australia was made by Ulmer (1908) when *B. soror* was described from Western Australia. Tillyard (1936) described *B. frater* from Tasmania, and Harker (1950) added two further species *B. baddamsae* and *B. confluens* from New South Wales. In 1954, Harker described *B. sogerensis* from Port Moresby, New Guinea, but this species has not been recorded on the Australian mainland.

Müller-Liebenau (1969, 1973) recorded and discussed the characteristics used in the revision of the European species of *Baetis*; these characteristics have been found to be useful in the present study. The following redescription of the male adult, and the original description of the nymph of *B. soror* Ulmer, include the characteristics which Müller-Liebenau (1969, 1973) found to be species specific.

***Baetis soror* Ulmer 1908**

*Baetis soror* Ulmer, 1908: 44-45; Tillyard, 1926: 64; Harker, 1950: 29; 1954: 266.

**Male Imago**

|                  | $\bar{x}$ | SD   | n  | Range       |
|------------------|-----------|------|----|-------------|
| Body Length      | 5.45      | 0.45 | 18 | 4.40- 6.00  |
| Notal Length     | 1.59      | 0.21 | 14 | 1.36- 2.00  |
| Pronotal Width   | 0.62      | 0.08 | 12 | 0.54- 0.76  |
| Mesonotal Width  | 0.88      | 0.08 | 12 | 0.74- 1.00  |
| Fore Wing Length | 4.93      | 0.51 | 30 | 4.20- 5.82  |
| Hind Wing Length | 1.01      | 0.16 | 30 | 0.80- 1.26  |
| Cerci Length     | 11.57     | 0.92 | 5  | 10.25-12.50 |

General colour brown.

**Head:** dark brown. Dorsal turbinate eyes yellow, oval, lateral eyes black.

**Thorax:** light brown. Pronotum narrower than head. Legs; buff, slender. Fore legs longer than middle and hind legs, fore leg femur length  $1.23 \times$  middle leg femur length, and  $1.25 \times$  hind leg femur length, middle and hind legs with four tarsal segments. Ratios of leg segments: fore leg 1.00 : 1.80 : 0.08 : 0.78 : 0.62 : 0.37 : 0.18 (0.93 mm); middle leg 1.00 : 0.98 : 0.16 : 0.13 : 0.07 : 0.20 : - (0.75 mm); hind leg 1.00 : 0.97 : 0.16 : 0.13 : 0.07 : 0.20 : - (0.76 mm). Tarsal claws dissimilar, one blunt, club-shaped, one slender with a terminal hook.

**Wings:** fore and hind wings hyaline with light brown venation. Fore wing (Fig. 21a)  $2.67 \times$  longer than wide, pterostigmal region slightly opaque (milky) with 7-10 cross-veins, anastomosed, branched or incomplete, proximal region of costal space without cross-veins. Hind wing with triangular costal projection, three longitudinal veins, second forked with one intercalary, one proximally located cross-vein in costal space (Fig. 21b).

**Abdomen:** brown, with black marking (Fig. 21c). Cerci long, terminal filament reduced to a basal stump.

**Genitalia:** proximal segment of forceps cylindrical, second segment bulbous, fused to third segment, third segment long and slender, distal segment short but  $3 \times$  longer than wide, rounded, bulbous distally. Covers of penes broad, extending beyond bulbous second segment of forceps, bluntly pointed with divergent apices (Figs 21d; 19c).

**Mature Male Nymph (Fig. 21e)**

|                          | $\bar{x}$ | SD   | n  | Range     |
|--------------------------|-----------|------|----|-----------|
| Head Width               | 0.97      | 0.07 | 22 | 0.86-1.06 |
| Notal Length             | 1.50      | 0.14 | 17 | 1.30-1.74 |
| Pronotal Width           | 0.87      | 0.09 | 17 | 0.76-1.00 |
| Mesonotal Width          | 1.27      | 0.13 | 17 | 1.06-1.46 |
| Cerci Length             | 3.43      | 0.50 | 7  | 2.60-4.16 |
| Terminal Filament Length | 2.29      | 0.24 | 7  | 2.00-2.60 |

Body cylindrical, light brown.

**Head:** brown, dorsal compound eyes sepia, lateral eyes black. Antennae long without apical projection on basal segment.

**Thorax:** mesonotum brown with an oxbow shaped white marking beside mesonotal suture. Legs buff-grey with darker femur-tibia joint (Fig. 21f). Tarsal claws short curved with ventral peg-like denticles (Fig. 21g). Ratios of leg segments: fore leg 1.00 : 0.72 : 0.64 (0.77 mm); middle leg 1.00 : 0.71 : 0.58 (0.79 mm); hind leg 1.00 : 0.68 : 0.54 (0.82 mm). Femur length to width ratios: fore leg 3.15, middle leg 3.45, hind leg 3.70.

**Abdomen:** brown, without definite markings. Posterior margins of terga with short sharp spines. Paraprocts curved, lined with 17-24 spines (Figs 21h; 22a, b). Gills (Figs. 21i), margins serrated with one fine bristle alternating with each serration (Fig. 21i), first gill small without clear trachea, gills 2-7 with black branched trachea, 3,4,5, largest, ovate, 1,7 narrower.

**Mouthparts:** labrum (Fig. 21j) ovoid, length  $0.58 \times$  width, with deep concavity in centre of anterior margin (Fig. 21k), two small median denticles within concavity. Left mandible (Fig. 21n) outer incisors with three teeth, outer tooth broad and robust, inner incisors with one long central tooth and three shorter lateral teeth, prostheca robust with one large curved apical tooth with 3-4 spines in concavity of tooth (Fig. 21o). Right mandible (Fig. 21p); outer incisors with first tooth robust with two small inner teeth, inner incisors with 1-2 long central teeth with two (one each side) lateral teeth, prostheca long and narrow with outer margin lined with 6-7 setae (Fig. 21q). Hypopharynx (Fig. 21r). Maxillae (Fig. 21l); galeo-lacinia long and narrow with pointed apex, lined with four stout teeth, ventrally with a line of pinnate setae and a line of curved setae below teeth, palpi longer than galeo-lacinia, three-segmented, segment ratios  $1.00 : 1.45 : 0.36$  (0.10 mm), distal segment with a short tooth, all segments with short fine setae. Labium (Fig. 21m); palpi, length of proximal segment  $2.06 \times$  width, inner margin of second segment produced forming a lobe, segment ratios  $1.00 : 0.71 : 0.33$  (0.19 mm).

#### *Female Imago*

Wings similar, lacking dorsal compound eyes, fore legs shorter than male, body colour cream, abdomen broad.

#### *Female Nymph*

Similar to male, lacking dorsal compound eyes, lateral eyes black.

#### *Diagnostic Characteristics*

1. Hind wings with three longitudinal veins, second forked (Fig. 21b).
2. Third and fourth segments of forceps elongated (Figs 21d; and Fig. 19c).
3. Dorsal compound eye yellow in imago.
4. Incisors and prosthecae of left and right mandibles (Figs 21n-q).
5. Number of spines on paraprocts (Figs 21h; 22a, b).

#### *History and Discussion*

Ulmer (1908) described *Baetis soror* from south-west Western Australia. This species resembles the South Australian species in hind wing venation and forceps structure. Ulmer recorded that "the costal and subcostal region of the fore wings are weakly tanned (browned)" *sic.* translation from Ulmer, 1908, but the South Australian specimens possess a milky costal and subcostal region. Müller-Liebenau (1973) stated "the colour of the pterostigma can be useful, especially when one separates two related species in the same material". This colour difference is usually associated with other character differences (genitalia and hind wing venation) and is not used as a primary specific character. Until further material from Western

Australia is made available, it is considered that this single feature which differs from the type description is not enough to validate erection of a new species for the South Australian material. This material is therefore designated as *Baetis soror* Ulmer.

#### *Material Examined*

**SOUTH AUSTRALIA.** South East: Eight Mile Ck; Deep Ck, Jerusalem Ck, Mosquito Ck, Hitchcock Drain. Mt. Lofty Ranges: Deep Ck, Little Para R. Fleurieu Peninsula: The Deep Ck (Delamere), Finnis R., Hindmarsh R., Inman R., Tookayerta Ck, Yankalilla R. Southern Flinders Ranges: Nectar Brook Ck, Spring Ck. Northern Flinders Ranges: Balcanoona Ck, Brachina Ck, Bunyeroo Ck, Elatina Ck, Emu Ck, Wirrealpa Ck.

#### **GENUS *CENTROPTILUM* Eaton 1869**

Eaton, 1869: 131-132; 1871: 107-108; 1885: 174-175; Harker, 1957: 75-76; Riek, 1970: 235.

Type Species: *Centroptilum luteolum* Eaton.

*Centroptilum* is also a cosmopolitan genus, but it was not until Harker (1957) described *C. collendum* from Kuringae Chase, New South Wales, that an Australian species was recognised. A new species *C. elongatum* sp. nov. which is recorded in South Australia, is described from associated material from the Wannon River, Victoria. *C. elongatum* has a limited distribution in South Australia and although many nymphs are present in the collections there are relatively few adult specimens. Consequently the type series was taken from a much larger collection made in Victoria, from which some assessment of variation of character expression could be made.

#### ***Centroptilum elongatum* sp. nov.**

##### *Holotype Male*

|                   |          |
|-------------------|----------|
| Body Length       | 8.20 mm  |
| Notal Length      | 2.01 mm  |
| Pronotal Width    | 0.95 mm  |
| Mesonotal Width   | 1.33 mm  |
| Fore Wing Length  | 7.05 mm  |
| Hind Wing Length  | 1.72 mm  |
| Cerci Length      | 14.02 mm |
| Terminal Filament | absent.  |

**Head:** light brown. Dorsal eyes turbinate with upper portion brown/orange, oval, lateral eyes grey.

**Thorax:** pronotum brown. Metanotum dark brown with median backward-produced projection (Fig. 23c). Legs; fore leg femur light brown, tibia and tarsal segments darker brown, middle and hind legs light brown, tarsal segments darker brown.  $T_1$  fused to tibia in all legs. Fore leg longer than middle and hind legs, fore leg femur length  $1.19 \times$  middle leg femur length, and  $1.16 \times$  hind leg femur length. Ratios of leg segments (second value is the combined tibia +  $T_1$

length to femur length): fore leg 1.00 : 1.18 : - : 0.50 : 0.44 : 0.26 : 0.16 (1.60 mm); middle leg 1.00 : 0.75 : - : 0.19 : 0.10 : 0.08 : 0.16 (1.34 mm); hind leg 1.00 : 0.74 : - : 0.19 : 0.10 : 0.07 : 0.16 (1.38 mm). Sternum light brown (Fig. 23e).

**Wings:** hyaline. Fore wing (Fig. 23a);  $2.78 \times$  longer than wide, costal and subcostal spaces shaded with yellow, pterostigma with 10-14 cross-veins, some forked, one faint cross-vein in costal space present or absent, subcostal space with six cross-veins. Hind wing (Fig. 23b);  $2.15 \times$  longer than wide, with a curved costal projection, three longitudinal veins, second forked with one intercalary, two cross-veins between first and second longitudinal veins.

**Abdomen:** brown dorsally with red tinges in patches on segments 2-4 and 6-9, segment 1 dark brown (Fig. 23c). Light brown ventrally with paired brown markings on each side of median line.

**Genitalia** (Fig. 23d; Fig. 19d): forceps four-segmented, proximal segment rectangular  $1.6 \times$  longer than wide, second segment fused to third segment, third segment long and slender, bowed slightly, distal segment shorter, rounded apically. Pene covers paired, rectangular, rounded apically, divergent, extending beyond apex of proximal segment of forceps.

#### *Mature Male Nymph* (Fig. 23f)

|                          |         |
|--------------------------|---------|
| Body Length              | 7.68 mm |
| Head Width               | 1.32 mm |
| Notal Length             | 2.12 mm |
| Pronotal Width           | 1.16 mm |
| Mesonotal Width          | 1.68 mm |
| Cerci Length             | 4.20 mm |
| Terminal Filament Length | 3.44 mm |

Body colour brown.

**Head:** brown. Dorsal compound eyes red-brown.

**Thorax:** brown. Legs yellow-brown with black patches distally on femur about  $2/3$  of length (Fig. 24a); tibia and tarsi yellow-brown, not marked. Tarsal claws very long and slender, half tarsal length, lined proximally with 13-20 fine denticles, distal half smooth and tapering. Ratios of leg segments: fore leg 1.00 : 0.63 : 0.66 (1.28 mm); middle leg 1.00 : 0.62 : 0.54 (1.30 mm); hind leg 1.00 : 0.62 : 0.52 (1.30 mm). Femur length width ratios: fore leg 4.92, middle and hind leg 5.42.

**Abdomen:** brown, with tinges of red-brown, patterned as in Fig. 23f. Posterior margin of tergites with long spines and smaller minute spines between them. Hind margin of sternites similarly lined with long spines and only minute inner basal spines. Paraprocts rounded, with 25 large spines on internal and apical margins (Fig. 24c; Fig. 22d); hind margins of ninth sternite with developing forceps, separated by a concave depression with 24 spines (Fig. 24b; Fig. 22c). Gills with black, branched trachea (Fig. 24d), first gill smallest, half-moon-shaped, fifth and sixth largest, margins

serrated with one short fine bristle in each depression.

**Mouthparts:** labrum rectangular (Fig. 24e), length  $0.77 \times$  width, with a broad, deep, V-shaped concavity, with truncated apex, and lateral denticles near apex (Fig. 24f). Left mandible (Fig. 24i), outer incisors with four large teeth apically and four smaller teeth along inner margin, outer margin with one long spine, inner incisors with three large apical teeth and 3-4 small tubercles on inner basal margin, prostheca long, broadest proximally with paired apical projections, one long and slender with one apical spine seta, the other shorter, curved and blunt, with a sharp opposing tooth (Fig. 24j). Right mandible (Fig. 24k): outer incisors with three large teeth, outer margin with one long tapering spine, inner incisors with two contiguous teeth, prostheca strap-like, long and slender with 2-3 minute spines on apex, and two long setae near mid region (Fig. 24l). Hypopharynx simple, median lobe with a large, bulbous, apical tubercle (Fig. 24h). Maxillae (Fig. 24m): palpi three-segmented, longer than galeo-lacinia, basal segment long and slender,  $3.67 \times$  longer than wide, lined with short fine setae, segment ratios 1.00 : 0.55 : 1.09 (0.22 mm). Labrum (Fig. 24e): palpi three-segmented proximal segment  $2.43 \times$  longer than wide, second segment narrow proximally, broad distally, distal segment short, broad with concave apical margin, segment ratios 1.00 : 0.71 : 0.35 (0.34 mm).

#### *Female Imago*

Resembles male, but lacks dorsal turbinate eyes. Body length 7.95 mm, fore wing length 7.45 mm, hind wing length 2.87 mm. Thorax grey, abdomen red-brown. Costal margin of fore wing brown. Fore leg shorter than in male. Sub-anal plate with paraprocts lacking spines.

#### *Female Nymph*

Similar to male, lacking dorsal compound eyes, lateral eyes black. Ninth abdominal sternite hind margin square and lined with spines.

#### *Diagnostic Characteristics*

1. Genitalia, shape of last segment of forceps (Fig. 23d; Fig. 19c).
2. Hind wing lacks acute costal projection (Fig. 23b).
3. Number of spines on paraprocts of nymphs (Figs 24b, c; Figs 22c, d).
4. Incisors and prostheca of mandibles (Figs 24i-l).
5. Labrum shape (Fig. 24e).
6. Saddle-like colour pattern on abdomen (Fig. 23f).

#### *Type Locality*

Wannon River just above Wannon Falls, near Wannon, Western Victoria, Grid reference 1 : 250 000 map series Hamilton Sheet: 353482. Collected 30 October, 1977 by P. and A. Suter and A. Wells.

### Type Specimens

The holotype male and nymphal type are located in the Museum of Victoria. Five paratype male imagos and paratype nymphs are also placed in the Museum of Victoria and five paratype male imagos and nymphs are placed in the South Australian Museum.

### Type Habitat

The nymphs were found in fast-flowing water about 500 m above the Wannon Falls. Adult males and females were swarming in the afternoon sun above a grass covered bank about 10 m above the water's edge.

The habitat records of this species in South Australia are quite variable, but may reflect only the season and flow conditions of the streams from which the collections were made. Collections from Kangaroo Island, and Mosquito Creek in South East South Australia during spring, indicated that *C. elongatum* nymphs occupied a similar habitat to that observed in Victoria. However, in Carrickalinga Creek on the Fleurieu Peninsula, a collection was made in November 1977 when the creek was in the process of drying, and pools were being formed. It was from one of these stationary *Juncus* lined pools, that the only record of *C. elongatum* on the Fleurieu Peninsula, was made. At times of higher water levels and discharge, *C. elongatum* may be found occupying the faster-flowing waters, rather than the stationary pool habitat recorded in November 1977.

### Etymology of Specific Epithet

The specific epithet *elongatum* refers to the elongated distal segment of the forceps of the male imago. This long segment distinguishes *C. elongatum* from *C. collendum* Harker, the only other species in this genus described from Australia.

### Affinities

Of the diagnostic features, the genitalia and hind wing characteristics clearly distinguish *C. elongatum* from *C. collendum* Harker. Harker's (1957) description records that the nymphs of *C. collendum* have long tarsal claws: "about equal in length to the tarsus itself". *C. elongatum* has much shorter tarsal claws, being about half the tarsal length. Other differences between the nymphs are not obvious from Harker's description, and the nymphal morphotype of *C. collendum* has not been examined.

### Material Examined

**SOUTH AUSTRALIA.** South East: Mosquito Ck. Fleurieu Peninsula: Carrickalinga Ck. Kangaroo Island: Breakneck R., DeMole R., Rocky R., South West R., Stunsail Boom R., Western R.  
**VICTORIA.** Jimmy's Ck, Mt. Emu Ck, Wannon R.

### GENUS *CLOEON* Leach 1815

Leach, 1815: 137; Eaton, 1868: 87-88; 1871: 102; 1885: 179-181; Klapálek, 1905: 106-107; Ulmer, 1916: 17; 1919: 54; Tillyard, 1926: 64; 1936: 53-55; Harker, 1950: 24, 29; 1954: 266; 1957: 72-73; Scholes, 1961: 38-39; Riek, 1970: 236.

Type Species: *Cloeon dipterum* (Linn. Fabr.).

### History and Discussion

The genus *Cloeon* was erected in 1815 by Leach, to include *C. dipterum* (Linn. Fabr.). Eaton (1868) noted "A species (1 specimen in British Museum) is reputed to be from S. Australia", and in 1885 he included Australia in the distribution of this cosmopolitan genus.

The first confirmed record of *Cloeon* in Australia was made by Ulmer (1916) when he recorded *C. virens* Klapálek (incorrectly spelt as *C. viridis* Klap. by Ulmer and later by Tillyard, 1926) from the Kimberley district, N.W. Australia. This species was originally described from Java by Klapálek (1905). A further species *C. fluviatile* Ulmer was described by Ulmer (1919) from New Guinea, and was later recorded at Armidale (N.S.W.) by Harker (1950), who added the description of the egg.

Tillyard (1936) recorded *C. tasmaniae* from the Macquarie R., Tasmania, and described the male and female imagos, and the subimago. Harker (1957) described the first *Cloeon* nymph in her description of *C. nandirum* from Townsville, Queensland.

The present study recognises one new species, and *C. fluviatile* Ulmer from South Australia, and the descriptions include the characteristics used by Müller-Liebenau (1969, 1973) in her revision of *Baetis*. The nymph of *C. fluviatile* is described from South Australian material.

### *Cloeon fluviatile* Ulmer 1919

*Cloeon fluviatile* Ulmer, 1919: 54-57; Harker, 1950: 24, 29; 1954: 266.

The following description is based on one male imago from the Third Spring on the Oratunga Loop, Flinders Ranges, South Australia, collected 9 April 1977 by P. J. Suter.

---

|                  |         |
|------------------|---------|
| Body Length      | 4.12 mm |
| Notal Length     | 1.40 mm |
| Pronotal Width   | 0.56 mm |
| Mesonotal Width  | 0.80 mm |
| Fore Wing Length | 4.32 mm |
| Cerci Length     | 8.53 mm |

---

Terminal Filament absent.

**Head:** dark brown. Antennae light brown 0.72 mm long. Dorsal eyes turbinate, upper portion yellow-brown, lateral portion lighter brown.

**Thorax:** brown, notal sutures black. Legs; buff,  $T_1$  fused in middle and hind tibia, only partially fused in fore tibia. Ratios of leg segments: fore leg 1.00 : 1.76 : 0.07 : 0.68 : 0.49 : 0.27 : 0.20 (0.82 mm); middle leg 1.00 : 0.82 : - : 0.28 : 0.15 : 0.08 : 0.18 (0.78 mm); hind leg 1.00 : 0.86 : - : 0.26 : 0.12 : 0.07 : 0.19 (0.86 mm). Sternum brown (Fig. 25c).

**Wings:** hyaline. Fore wing (Fig. 25a) length 2.70 × width, costal and subcostal region opaque, cream-coloured, milky in pterostigmal region, pterostigma with 2-4 cross-veins, no cross-veins in proximal region of costal space, subcostal space without cross-veins.

**Abdomen:** red-brown with light brown median markings on segments 1-7, segments 8, 9, 10 red-brown (Fig. 25b). Light red-grey ventrally. Cerci long, white with red-brown joints every fourth segment, terminal filament absent.

**Genitalia** (Figs 25d-f; 19e): Forceps proximal segment rectangular, length 0.69 × width, second segment slender, partially fused with third segment which is long and slender, distal segment short, with a basal stalk and globular apex. Penes covers large and obvious, extending to middle of second segment of forceps, separate, rectangular, apices divergent. Subgenital plate with a posterior brown projection which separates proximal segments of forceps.

#### Mature Male Nymph

|                          |           |
|--------------------------|-----------|
| Body Length              | 5.08-5.60 |
| Head Width               | 1.02-1.08 |
| Notal Length             | 1.60-1.74 |
| Pronotal Width           | 0.92-0.98 |
| Mesonotal Width          | 1.38-1.46 |
| Cerci Length             | 3.50-5.40 |
| Terminal Filament Length | 1.62-3.80 |

Body cylindrical, general colour light brown.

**Head:** brown. Dorsal compound eyes red-brown. Antennae long, 3 × longer than head width.

**Thorax:** pronotum width 0.91 × head width, brown with light markings. Mesonotum width 1.35 × head width, uniformly light brown. Legs cream with brown banding, one band on distal 1/3 of femur, one proximally on tibia, tarsus with one proximal and one distal band (Fig. 26a). Tarsal claws long and slender with two ventral rows of peg like denticles (Fig. 26b). Ratios of leg segments: fore leg 1.00 : 0.73 : 0.63 (1.01 mm); middle leg 1.00 : 0.74 : 0.54 (1.03 mm); hind leg 1.00 : 0.68 : 0.53 (1.16 mm). Femur length-width ratios: fore leg 4.87, middle leg 5.01, and hind leg, 5.27.

**Abdomen:** brown, with dark brown rectangular patches on each segment, edged with light brown, a central light stripe on each segment (Fig. 26c), lateral flanges of segments 7-10 lined with spines, 1-2 spines on postero-lateral margins. Posterior margins of tergites with large single spines. Paraprocts with 16-22 spines on inner and apical margins, largest spine at apex, smaller mesally (Fig. 26d). Gills (Fig. 26e) with paired lamellae on segments 1-6, single on segment 7, black

branched trachea, margins serrated with short fine bristle in each depression.

**Mouthparts:** labrum (Fig. 26f) rectangular, 1.94 × broader than long with a U-shaped concavity in centre of anterior margin (Fig. 26g). Left mandible (Fig. 26j); robust, outer incisors with 3-4 large teeth, inner incisors with 4-5 teeth, prostheca with three apical denticles and two sharp spines (Fig. 26k). Right mandible (Fig. 26l) robust, outer incisors with three apical teeth, inner incisors with three large and one small teeth, prostheca long and slender, mesal margin near apex with two short spines and one small denticle (Fig. 26m). Hypopharynx (Fig. 26n). Maxillae (Fig. 26i) galeo-lacinia slender, with three well developed apical teeth, lined mesally with 12-15 large spine setae, palpi longer than galeo-lacinia, proximal segment 5.83 × longer than wide, segment ratios; 1.00 : 0.80 : 0.82 (0.15 mm), distal segment lacks apical spines. Labium (Fig. 26h); palpi: length of proximal segment 2.20 × width, apical margin of distal segment concave lined with short spine setae, segment ratios; 1.00 : 0.61 : 0.80 (0.22 mm); glossae shorter than paraglossae.

#### Female Imago

Lacks dorsal compound eyes, lateral eyes black, fore leg shorter than male, otherwise similar to male imago.

#### Female Nymph

Similar to male nymph, lacks dorsal compound eyes, lateral eyes black, thorax broad, wider than head.

#### Diagnostic Characteristics

1. Distal segment of forceps minute, globular (Figs 25d-f; 19e).
2. Turbinate eyes yellow/brown.
3. Incisors and prostheca of left and right mandibles (Figs 26j-m).
4. Distal segment of maxillary palpi without apical spines (Fig. 26i).
5. Paraproct spination (Fig. 26d).

#### History and Discussion

*C. fluviatile* was described in 1919 by Ulmer from specimens from New Guinea. Harker (1950) recorded this species from Armidale, New South Wales, and described the egg. Since the type material is held in the Berlin Museum (Ulmer 1919) or the Stockholm Museum (Harker 1950, 1954) it was not available for this study. The South Australian specimens have no features which distinguish them from the species described by Ulmer, and until the type material is examined they are placed as *C. fluviatile* Ulmer.

#### Material Examined

**SOUTH AUSTRALIA.** Mt. Lofty Ranges: Torrens R. Southern Flinders Ranges: Ohlenmeyer Reservoir,

Rocky R., Wild Dog Ck. Northern Flinders Ranges: Balcanoona Ck, Bendieuta Ck, Brachina Ck, Elatina Ck, Emu Ck, Eregunda Ck, Kanyaka Ck, Marolana Ck, Mt. Chambers Ck, Parachilna Ck, Stubbs Waterhole, Willigan Ck, Creek in Warren Gorge.

*Cloeon paradieniensis* sp. nov.

*Holotype Male*

|                  |          |
|------------------|----------|
| Body Length      | 7.80 mm  |
| Notal Length     | 2.96 mm  |
| Pronotal Width   | 0.92 mm  |
| Mesonotal Width  | 1.20 mm  |
| Fore Wing Length | 7.05 mm  |
| Cerci Length     | 15.73 mm |

*Head:* brown. Antennae short, 1.02 mm, buff. Dorsal eyes turbinate, yellow dorsally, brown laterally.

*Thorax:* brown, pronotum narrower than head. Legs: white-cream, fore leg longer than middle and hind legs, fore leg femur length  $1.06 \times$  middle leg femur length, and equal to hind leg femur length.  $T_1$  of middle and hind legs fused to tibia. Ratios of leg segments: fore leg 1.00 : 1.68 : 0.05 : 0.70 : 0.50 : 0.28 : 0.18 (1.48 mm); middle leg 1.00 : 1.01 : - : 0.29 : 0.13 : 0.06 : 0.16 (1.40 mm); hind leg 1.00 : 0.99 : - : 0.26 : 0.12 : 0.06 : 0.15 (1.46 mm).

*Wings:* hyaline (Fig. 25g);  $2.89 \times$  longer than wide, veins buff, transparent, pterostigmal region with 3-4 cross-veins, well separated, proximal region of costal space with two cross-veins, sub-costal space with two cross-veins in distal half.

*Abdomen:* red-brown with a light brown dorsal stripe, segments 8 and 9 dark red-brown, 10 lighter (Fig. 25h). Cerci long, terminal filament reduced to a vestigial stump.

*Genitalia* (Figs 25i-k; 19f): forceps proximal segment short and broad; second segment short, narrower than proximal segment, almost fused with third segment; third segment long and narrow, bulbous apically; distal segment short and angular, conical. Penes covers broad, extending beyond fusion of second and third segments of forceps, bluntly pointed, apices divergent.

*Mature Male Nymph*

|                          |         |
|--------------------------|---------|
| Head Width               | 1.31 mm |
| Notal Length             | 1.96 mm |
| Pronotal Width           | 1.15 mm |
| Mesonotal Width          | 1.64 mm |
| Cerci Length             | 6.23 mm |
| Terminal Filament Length | 4.59 mm |

Body cylindrical, red-brown dorsally, light brown ventrally.

*Head:* dorsal compound eyes red-brown (sepia). Antennae long, 4.92 mm, proximal and second segment brown, flagellae buff.

*Thorax:* pronotum width  $0.88 \times$  head width, brown with median longitudinal white stripe. Mesonotum width  $1.25 \times$  head width, brown with light median

longitudinal stripe. Sternum light brown, with little sclerotization. Legs buff without markings (Fig. 27a). Tarsal claws long and slender, with two ventral rows of peg-like denticles. Ratios of leg segments: fore leg 1.00 : 0.67 : 0.58 (1.44 mm); middle leg 1.00 : 0.67 : 0.51 (1.56 mm); hind leg 1.00 : 0.79 : 0.60 (1.68 mm). Femur length to width ratios: fore leg 5.18, middle leg 6.05, hind leg 6.51.

*Abdomen:* red-brown dorsally, yellow-brown ventrally, without definite colour pattern, overlap of segments darker brown. Lateral margins of segments 7-10 lined with spines, postero-lateral margins with 2-3 spines, posterior margins of tergites with large and small irregularly placed spines. Paraprocts broadly triangular, lined on mesal margin with 27-30 large spines (Fig. 27b). Cerci long, terminal filament shorter, every fourth segment red-brown, giving banded appearance. Gills; lamellae paired on segments 1-6 (Fig. 27e), seventh single, margins of gills serrated with a single fine bristle.

*Mouthparts:* labrum (Fig. 27c) rectangular,  $1.5 \times$  broader than long with a deep concavity in centre of anterior margin (Fig. 27d). Left mandible robust (Fig. 27i), outer incisors with four teeth, inner incisors with 3-4 teeth, prostheca robust with a corrugated apex of 5-6 rounded teeth and two long spines mesally (Fig. 27j). Right mandible (Fig. 27k) robust, outer incisors with four teeth, inner-incisors with two large teeth and two smaller teeth, prostheca robust with apex of 6-8 tooth-like ridges (Fig. 27l). Hypopharynx (Fig. 27g) simple, median lobe rounded with a small median bulbous projection. Maxillae (Fig. 27f) galeo-lacinia long and narrow, with three well developed sharp teeth apically, palpi longer than galeo-lacinia, proximal segment  $5.33 \times$  longer than wide, segment ratios 1.00 : 0.69 : 0.88 (0.24 mm), distal segment fringed with fine setae, and two small terminal teeth. Labium (Fig. 27h) palpi three segmented, length of proximal segment of palpi  $2.74 \times$  width, apical margin of distal segment slightly concave, segment ratios 1.00 : 0.56 : 0.48 (0.33 mm); glossae shorter than paraglossae.

*Female Imago*

Without dorsal compound eyes, fore legs shorter than male. Fore wing: costal and subcostal spaces shaded with red-brown, twelve cross-veins in costal space. Body colour red-brown.

*Female Nymph*

Similar to male, lacks dorsal compound eyes, lateral eyes black, thorax broader than male, pronotum wider than head.

*Diagnostic Characteristics*

1. Distal segment of forceps conical shape (Figs 25i-k; 19f).
2. Turbinate eyes yellow.

3. Female with costal and subcostal spaces shaded red-brown.
4. Incisors and prostheca of left and right mandibles (Figs 27i-l).
5. Paraproct spination (Fig. 27b).
6. Maxillary palpi with terminal spines on distal segment (Fig. 27f).

#### Type Locality

Little Para River at Paracombe, Mt. Lofty Ranges, South Australia, Grid Reference 1 : 250 000 map series, Adelaide Sheet: 179695. Collected 20 October, 1976 by J. H. Diener and P. J. Suter.

#### Type Specimens

Holotype male and nymphal type and allotype female are located in the Museum of Victoria. This short type series is because this species is only known from two collections from the type locality, and one is the drain system of the South East. Further material has not been collected.

#### Type Habitat

The nymphs were found in a non-flowing pool system in a culvert beside the Paracombe road. The pool was overgrown with *Nasturtium* sp. and *Lemna* sp. Adults were raised in the laboratory from mature nymphs collected from the type locality.

#### Etymology of the Specific Epithet

The specific epithet *paradieniensis* refers to the river (Little Para River), and is in recognition of J. H. Diener whose collection from the Little Para River was the first of this species.

#### Affinities

*Cloeon paradieniensis* resembles all the described Australian species, but it can be readily distinguished by the conical shaped distal segment of the forceps of the male imago. The nymph can only be compared with *C. nandirum* Harker and *C. fluvatile* Ulmer, the only Australian species associated with their nymphs. The shape of the labrum clearly distinguish the nymphs of

TABLE 3. TABULATED COMPARISON OF ALL DESCRIBED SPECIES OF *CLOEON* IN AUSTRALIA — DATA COLLECTED FROM THE PRESENT STUDY AND FROM PUBLISHED DESCRIPTIONS BY KLAPÁLEK (1905), ULMER (1919), TILLYARD (1936) AND HARKER (1957)

| Character                 | <i>Cloeon fluvatile</i>                                | <i>C. paradieniensis</i>      | <i>C. nandirum</i> | <i>C. virens</i>          | <i>C. tasmaniae</i> |
|---------------------------|--|-------------------------------|--------------------|---------------------------|---------------------|
| <b>Male Imago</b>         |  |                               |                    |                           |                     |
| Body length (mm)          | 4.12   | 7.80                          | 7                  | 6                         | 7                   |
| Fore Wing length (mm)     | 4.32   | 7.05                          | 4                  | 6                         | 6                   |
| Fore Wing width (mm)      | 1.60   | 2.44                          | 1.6                | 2.27                      | 2.4                 |
| Cerci length (mm)         | 8.53   | 15.73                         | —                  | 11-12                     | 12                  |
| Eye colour                | Sepia  | Yellow                        | Orange             | —                         | Buff-pink           |
| Pterostigmal cross-veins  | 2-4  | 3-4                           | 5                  | 4-5                       | 5                   |
| C/Sc basal cross-veins    | 0  | 2-5                           | 0                  | 6                         | —                   |
| Sc/R cross-veins          | 0  | 2-6                           | 0                  | 7                         | —                   |
| Costal colouration        | Milky  | Milky                         | Milky              | Emerald Green in females. | Cream               |
| <b>Genitalia</b>          |  |                               |                    |                           |                     |
| Forceps, terminal segment | Short and narrow                                       | Triangular                    | Long and narrow    | Short and narrow          | Globular            |
| Penes covers              | Rectangular, flat apically                             | Pointed apically              | ?                  | ?                         | ?                   |
| <b>Nymph</b>              |  |                               |                    |                           |                     |
| Body length (mm)          | 5.08-5.60  | —                             | 6                  | Unknown                   | Unknown             |
| Head width (mm)           | 1.02-1.08  | 1.31                          | —                  |                           |                     |
| Cerci length (mm)         | 3.50-5.40  | 6.23                          | —                  |                           |                     |
| Terminal filament length  | 1.62-3.80  | 4.59                          | —                  |                           |                     |
| Legs                      | Banded   | Not banded                    | Not banded         |                           |                     |
| <b>Left Mandibles</b>     |  |                               |                    |                           |                     |
| Outer incisors            | 3-4 teeth  | 3-4 teeth                     | —                  |                           |                     |
| Inner incisors            | 4-5 teeth  | 5-6 teeth                     | —                  |                           |                     |
| Prostheca                 | 3 denticles + 2 sharp spines                           | 5-6 teeth + 2 long spines     | —                  |                           |                     |
| <b>Right Mandibles</b>    |  |                               |                    |                           |                     |
| Outer incisors            | 3 teeth  | 4 teeth                       | —                  |                           |                     |
| Inner incisors            | 3 large, 1 small                                       | 2 large, 2 small              | —                  |                           |                     |
| Prostheca                 | Long and slender, 2 short spines + 1 denticle apically | Robust, 6-8 tooth-like ridges | —                  |                           |                     |
| Maxillary palpi           | No terminal teeth                                      | 2 terminal teeth              | —                  |                           |                     |



*C. paradieniensis* and *C. nandirum*, but as the type material is in the British Museum, and the description given by Harker (1957) was not comprehensive enough, no further character comparisons are possible.

The nymphs of *C. paradieniensis* can be distinguished from *C. fluvatile* Ulmer initially by size, the latter species being less than 6 mm, the former greater than 7.5 mm. The number of spines on the paraprocts, the lack of bands on the femora, spines on the distal segment of the maxillary palpi, and the shape of the prostheca of the right mandible also distinguish the two species found in South Australia. Tabulated comparisons of all Australian *Cloeon* species is given in Table 3, with data taken from the present study, and from published descriptions by Klapálek (1905), Ulmer (1919), Tillyard (1936) and Harker (1957).

### FAMILY SIPHLONURIDAE

A full revision of this Family is at present being prepared by Dr I. Campbell, Chisholm Institute of Technology, Victoria.

#### GENUS *TASMANOPHLEBIA* Tillyard 1921

Tillyard, 1921: 409-412; 1926: 62; 1933: 12-13; 1936: 27; Lestage, 1935a: 132; 1935b: 350-353 (in part as *Tasmanophlebioides*); Harker, 1950: 29; 1954: 267; Riek, 1955: 268-269; 1970: 235; Scholes, 1961: 21-23.

Type Species: *Tasmanophlebia lacustris*.

As mentioned above, Dr I. Campbell is revising the Siphonuridae and therefore material of the single species of *Tasmanophlebia* recorded in South Australia has been forwarded to him for comparison with other Australian species. No specific designation has been made for the South Australian species.

#### *Tasmanophlebia* sp.

The following description is of one male imago from Tookayerta Creek, Fleurieu Peninsula, South Australia. Adult specimens are rare in collections from South Australia, and for this reason the mean, ranges and standard deviations are based on only three animals.

#### Male Imago

|                          | $\bar{x}$ | SD                    | n | Range      |
|--------------------------|-----------|-----------------------|---|------------|
| Body Length              | 10.40     | 1.03                  | 3 | 9.40-11.46 |
| Fore Wing Length         | 9.54      | 0.90                  | 3 | 8.53-10.26 |
| Fore Wing Width          | 2.90      | 0.43                  | 3 | 2.42- 3.25 |
| Hind Wing Length         | 4.53      | 0.61                  | 3 | 3.86- 5.06 |
| Hind Wing Width          | 2.51      | 0.26                  | 3 | 2.23- 2.74 |
| Cerci Length             | 4.71      | (other cerci damaged) |   |            |
| Terminal Filament Length | 0.24      | 0.14                  | 3 | 0.08- 0.32 |

**Head:** light brown. Dorsal region of compound eyes burgundy.

**Thorax:** brown. Fore leg dark brown, longer than middle and hind legs, fore leg femur length  $2.11 \times$  middle leg femur length and  $1.87 \times$  hind femur length. Middle and hind legs light brown, first tarsal segment

fused to tibia. Ratios of leg segments: fore leg 1.00 : 0.67 : 0.63 : 0.47 : 0.52 : 0.47 : 0.28 (2.24 mm); middle leg 1.00 : 0.84 : - : 0.17 : 0.17 : 0.14 : 0.29 (1.06 mm); hind leg 1.00 : 0.80 : - : 0.17 : 0.17 : 0.12 : 0.28 (1.20 mm).

**Wings:** fore and hind wings hyaline, tinged with yellow, veins brown. Fore wing (Fig. 28a)  $3.31 \times$  longer than wide, costal and subcostal region shaded with brown, radial and proximal regions of median, cubital and anal veins tinged with yellow. Hind wing (Fig. 28b);  $1.79 \times$  longer than wide, half as long as forewing, subcostal space shaded with brown, costal, subcostal and proximal regions of the radial and anal veins tinged with yellow.

**Abdomen:** brown, speckled with black, segments 8 and 9 with median black stripe and two convex lateral stripes, segment 10 black (Fig. 28c). Cerci long, dark brown, terminal filament vestigial, of 1-4 segments.

**Genitalia** (Figs 28d, e; 30a, b): forceps three-segmented, subgenital plate broad forming forceps base, proximal segment very long and narrow, middle segment shorter, but elongated, distal segment just shorter than middle, rounded apically. Penes long, narrow, extending to mid proximal segment of forceps, lobes tubular, almost fused, rounded at apices.

#### Mature Male Nymph (Fig. 28g)

|                          | $\bar{x}$ | SD   | n | Range       |
|--------------------------|-----------|------|---|-------------|
| Head Width               | 1.71      | 0.12 | 6 | 1.52- 1.84  |
| Body Length              | 12.64     | 1.00 | 4 | 11.18-13.40 |
| Notal Length             | 2.91      | 0.21 | 6 | 2.58- 3.20  |
| Pronotal Width           | 1.77      | 0.12 | 6 | 1.58- 1.88  |
| Mesonotal Width          | 2.26      | 0.16 | 6 | 2.00- 2.44  |
| Cerci Length             | 5.09      | 0.29 | 3 | 4.71- 5.41  |
| Terminal Filament Length | 4.68      | 0.13 | 3 | 4.52- 4.83  |

Colour mottled sandy brown.

**Head:** small, light brown. Compound eyes large, red-brown dorsally, black laterally. Antennae 1.30 mm long.

**Thorax:** pronotum as wide as head, mottled grey-brown. Mesonotum width  $1.32 \times$  head width, mottled brown. Legs yellow-brown, femora with a brown patch on posterior margin, joints of tibia and tarsi dark brown, tarsi with brown bands along length, equivalent to tarsal segments of adult (Fig. 29a). Tarsal claws long and slender  $0.50-0.71 \times$  length of tarsus, smooth without denticles. Ratios of leg segments: fore leg 1.00 : 0.46 : 0.85 (1.25 mm); middle leg 1.00 : 0.41 : 0.67 (1.30 mm); hind leg 1.00 : 0.44 : 0.74 (1.32 mm). Femur length to width ratios similar; fore leg 3.44, middle leg 3.25, hind leg 3.56.

**Abdomen:** dorso-ventrally flattened, with medial dorsal crest of curved posteriorly directed projections on segments 1-7; process on segment 1 small, 2, 3, largest, becoming less prominent from segment 4-7 (Fig. 28g). Lateral flanges of each abdominal segment semi-transparent, postero-lateral margin sharply produced. Paraprocts separate, smooth, developing

forceps large (Figs 22e, f). Gills; on segments 1-4, first pair broadly ovoid, operculate, other three pairs with paired lamellae, transparent, with well-developed gill lamellae lined with fine setae (Figs 29b-e).

**Mouthparts:** labrum (Fig. 29f) rectangular, length  $0.44 \times$  width, anterior margin smooth (Fig. 29g). Left mandible (Fig. 29k) robust, incisors widely separate, outer group with three apical teeth, and a ventral row of short setae, inner incisors with three apical teeth and a row of short setae, prosthema broad at base, anterior margin tapers to form a long narrow projection with 3-4 short spines (Fig. 29l). Right mandible (Fig. 29m) robust, incisors widely separate, outer group with two apical teeth, and a ventral row of short setae, inner incisors with three apical teeth and a ventral row of short setae, prosthema broad at base, curved, apex divided into two separate lobes, posterior lobe largest (Fig. 29n). Hypopharynx (Fig. 29i): median lobe deeply bifid. Maxillae (Fig. 29j); apical angle of galeo-lacinia with three or four spine setae, palpi three segmented, longer than galeo-lacinia, segment ratios;  $1.00 : 0.86 : 0.77$  (0.35 mm). Labium (Fig. 29h): palpi three-segmented, length of proximal segment  $1.3 \times$  width, segment ratios;  $1.00 : 0.86 : 0.51$  (0.37 mm); glossae with one small pointed tubercle distally.

#### Diagnostic Characteristics

1. Genitalia; shape of forceps and penes (Figs 28d, e; 30a, b).
2. Dorsal crest of nymph with curved posteriorly directed projections on abdominal segments 1-7 (Fig. 28g).
3. First abdominal gill ovoid, rounded posteriorly (Fig. 29b).
4. Lateral flanges of abdominal segments narrow.
5. Shape of incisors and prosthecae of mandibles (Figs 29k-m).

#### Material Examined

**SOUTH AUSTRALIA.** Fleurieu Peninsula: Tookayerta Ck, Yankalilla R.

**VICTORIA.** Gawkers Ck, Stokes Ck.

#### FAMILY CAENIDAE

The Caenidae was recognised as a distinct group of mayflies by Eaton (1883) when he included the genera *Tricorythus*, *Leptohyphes* and *Caenis* in Section 7 of his Revisional Monograph. Banks (1900) erected the tribe Caenini and Thew (1960) states that "according to the Copenhagen decision of the International Commission on Zoological Nomenclature, Banks should be credited with the authorship of the family."

Lestage (1930, 1938) refers to the Caenidae as the Brachycercidae, but with the exception of Demoulin (1955b), the Brachycercidae has not been recognised by authors working on the Australian Ephemeroptera. Tillyard (1936), Harker (1950, 1954, 1957), Thew (1960),

Riek (1970), Soldan (1978) and Suter (1979, 1984) have all recognised the family Caenidae.

In 1978 Soldan described a new genus of caenid from Australia (*Pseudocaenis*) from nymphal material only, but Suter (1984) demonstrated that this genus was a synonym of *Tasmanocoenis*.

#### GENUS TASMANOCOENIS Lestage 1930

Puthz, 1975: 412; Soldan, 1978: 128; Suter, 1979: 82; Suter, 1984: 105.

Type Species: *Tasmanocoenis tonnoiri*.

The genus *Tasmanocoenis* has been reviewed by Suter (1984) and further discussion is not included here. In the present study all caenid material from South Australia was *Tasmanocoenis tillyardi* (Lestage).

#### *Tasmanocoenis tillyardi* (Lestage) 1938

*Caenis scotti* Tillyard, 1936: 56-58; *Coenis tillyardi* Lestage, 1938: 320; *Caenis scotti* Harker, 1950: 24-26, 29; *Caenis tillyardi* Harker, 1954: 266; *Tasmanocoenis tillyardi* Demoulin, 1955b: 4; Harker, 1957: 77; van Bruggen, 1957: 33; Thew, 1960: 202; Scholes, 1961: 39-41; "*Caenis*" *scotti* Williams, 1968: 169.

#### Male Imago

|                          | $\bar{x}$ | SD   | n | Range      |
|--------------------------|-----------|------|---|------------|
| Body Length              | 3.25      | 0.14 | 7 | 3.12- 3.52 |
| Notal Length             | 1.45      | 0.07 | 7 | 1.32- 1.52 |
| Pronotal Width           | 0.68      | 0.06 | 7 | 0.55- 0.72 |
| Mesonotal Width          | 0.84      | 0.08 | 7 | 0.67- 0.90 |
| Fore Wing Length         | 3.15      | 0.14 | 7 | 2.96- 3.36 |
| Cerci Length             | 11.30     | —    | — | —          |
| Terminal Filament Length | 12.00     | —    | — | —          |

Colour dark black-brown.

**Head:** brown, with light brown epicranial sutures. Compound eyes lateral, black. Antennal base brown, one-segmented, flagellae long, 0.54 mm.

**Thorax:** robust, dark black-brown (Fig. 31b). Pronotum narrower than head. Mesonotum wider than head. Legs slender, pale brown-grey; fore legs longer than middle and hind legs, fore leg femur  $1.15 \times$  middle leg femur length and  $1.28 \times$  hind femur length. Ratios of leg segments: fore leg  $1.00 : 1.93 : 0.09 : 0.57 : 0.26 : 0.25 : 0.16$  (0.69 mm); middle leg  $1.00 : 0.55 : 0.08 : 0.05 : 0.05 : 0.07 : 0.08$  (0.60 mm); hind leg  $1.00 : 0.61 : 0.08 : 0.05 : 0.05 : 0.07 : 0.08$  (0.54 mm). Tarsal claws similar in fore leg, both blunt, club-shaped, dissimilar in middle and hind legs, one blunt club-shaped, one slender and sharp. Sternum (Fig. 31c): prosternum triangular, apex truncated, lateral margins separated anteriorly, slightly longer than broad. Mesosternum dark black-brown, basisternum length  $1.19 \times$  maximum width, sterna-costal suture well developed, furcasternum length  $0.65 \times$  width, and  $0.65 \times$  basisternum length, posterior margin straight.

**Wings** (Fig. 31a): short and broad, length  $1.72 \times$

width, hyaline with milky-opaque pterostigma, venation reduced, simple, almost lacking cross-veins, posterior margins may be lined with fine setae.

**Abdomen:** short, cylindrical, segments 1-5 very short, light brown, and speckled with black, segments 8 and 9 lighter. Cerci long, transparent, terminal filament longer, both tipped with long fine setae.

**Genitalia** (Figs 31d; 30c): forceps one-segmented, bowed, sharply pointed with ventral mesal groove, penes lobed, fused with a small apical indentation, sclerotized basally.

*Mature Male Nymph* (Fig. 31e)

|                          | $\bar{x}$ | SD   | n  | Range     |
|--------------------------|-----------|------|----|-----------|
| Head Width               | 0.96      | 0.04 | 21 | 0.90-1.04 |
| Notal Length             | 1.62      | 0.10 | 21 | 1.40-1.76 |
| Pronotal Width           | 1.00      | 0.06 | 21 | 0.78-1.04 |
| Mesonotal Width          | 1.14      | 0.05 | 21 | 1.00-1.20 |
| Cerci Length             | 3.03      | 0.16 | 3  | 2.92-3.22 |
| Terminal Filament Length | 3.39      | 0.18 | 3  | 3.28-3.60 |

Body colour brown.

**Head:** dark brown. Antennae light brown, basal segment 0.16 mm long, flagellum 1.46 mm (Fig. 32e). Tentorial body rectangular, length  $0.79 \times$  width.

**Thorax:** pronotum brown, lateral flanges lighter, semi-transparent, anterior margins with spine setae,  $0.96 \times$  wider than the head. Mesonotum dark brown. Legs light brown, margins lined with spine setae (Fig. 32a). Tarsal claws short, curved with 4-6 small ventral denticles, otherwise smooth. Ratios of leg segments: fore leg 1.00 : 0.73 : 0.65 (0.68 mm); middle leg 1.00 : 0.70 : 0.59 (0.68 mm); hind leg 1.00 : 0.76 : 0.60 (0.74 mm). Femur length to width ratios: fore leg 2.81, middle leg 2.86, and hind leg 2.95.

**Abdomen:** brown, with square patterns of brown on each side of median line. Operculate gill of second segment covers segments 3-5, segment two with median backward-projecting spine, postero-lateral margins produced forming backward pointing projections. Cerci and terminal filament dark brown, well developed. Gills; on segments 1-6, first pair single, filamentous with indistinct segments, lined with fine setae (Fig. 32b), second pair operculate with raised triangular region dorsally, mesal ridge with few setae, outer ridge not reaching posterior margin of gill covers, margins lined with long setae (Figs 32c; 30d); third-sixth pairs laminate with 40-50 tracheal fringes, single or bifid, few trifid, third gill largest (Fig. 32d).

**Mouthparts:** labrum (Fig. 32f) rectangular, width  $2.34 \times$  length, anterior margin with slight median concavity with 2-3 small denticles (Fig. 32g). Left mandible (Fig. 32j): outer incisors with three apical teeth and one shorter mesal tooth, inner incisors with three apical teeth, prosthema robust with apical brush of setae (Fig. 32k). Right mandible (Fig. 32l): outer incisors with 2-3 apical teeth, inner with two, prosthema robust with apical brush of setae (Fig. 32m). Hypo-

pharynx (Fig. 32i) with square median lobe, slightly concave anteriorly. Maxillae (Fig. 32n); galeo-lacinia short and narrow, with 3-4 robust apical spines, mesal margin lined with stout spine setae, palpi three-segmented, longer than galeo-lacinia, segment ratios 1.00 : 0.70 : 1.07 (0.12 mm). Labium (Fig. 32h): palpi three-segmented, proximal segment length  $1.47 \times$  width, segment ratios 1.00 : 0.78 : 0.53 (0.13 mm); glossae rectangular.

*Female Imago*

Similar to male, sternum and notum broader, tarsi four segmented, tarsal claws, each pair dissimilar, one blunt, club-shaped, one curved and sharp.

*Female Nymph*

Body shape similar to male, more robust than male, i.e. head width of last instar greater than male, wing sheaths longer, second abdominal operculate gill longer, covering segments 3-6, fore, middle and hind femora longer.

*Diagnostic Characteristics*

1. Genitalia of male with curved sharp forceps and fused penes with a small apical indentation, not extending beyond apices of forceps (Figs 31d; 30c).
2. Labrum rectangular (Fig. 32f).
3. Structure of mandibles, incisors and prosthecae (Figs 32j-m).

*History and Discussion*

Tillyard (1936) described *Caenis scotti* from the South Esk River at Clarendon, Tasmania. Lestage (1938) noted that *C. scotti* was preoccupied by a species described by Ulmer in 1924 (referred to by Thew, 1960) and renamed the Tasmanian species *Coenis tillyardi*. Harker (1950) apparently was unaware of this name alteration and described a nymph which she assigned to *Caenis scotti*. Subsequently in 1954 she recognised the name change, and maintained the generic recognition as *Caenis*. Demoulin (1955b) reviewed the genus *Tasmanocoenis* and recognised that *Caenis tillyardi* belonged in the genus *Tasmanocoenis*, an observation validated by the review of the Caenidae by Thew (1960).

Williams (1968) noted that *Caenis* and *Tasmanocoenis* in Australia were probably synonymous, and illustrated gills of "*Caenis*" *scotti* after Harker (1950). Riek (1970) noted, as had Demoulin (1955b) and Thew (1960), that *Tasmanocoenis* was the only Australian genus in the Caenidae but records of nymphs of *Caenis* sp. were made by Timms (1974) in a benthic study of three South Australian volcanic lakes. This record and all others from South Australia belong to the one species, *T. tillyardi*.

### Material Examined

**SOUTH AUSTRALIA.** South East: Drain L, Drain K, Eastern Division Diversion Drain, Eight Mile Ck, Hitchcock Drain, Mosquito Ck, Mt. Hope Drain, Sutherland's Drain. Mt. Lofty Ranges: Deep Ck, Eleanor R., Sturt R., Torrens R., Waite Institute Pond. Fleurieu Peninsula: Anacotilla Ck, Carrakalinga Ck, Deep Ck, Hindmarsh R., Inman R., Kangarilla Ck. Lake Alexandrina: Tookayerta Ck, Yankalilla R. Kangaroo Island: Breakneck R., Cygnet R., Grassy/Sheep Ck, North-East R., Tin Hut/Bullock Ck, South West R., South West Bay R. Southern Flinders Ranges: Broughton R., Nectar Brook Ck, Ohlenmeyer Reservoir, Rocky R., Schumacher Ck, Spring Ck. Northern Flinders Ranges: Arkaba Ck, Arkaroola Ck, Balcanoona Ck, Bendieuta Ck, Brachina Ck, Bunyerroo Ck, Elatina Ck, Emu Ck, Enorama Ck, Eregunda Ck, Hot Springs (Paralana), Kanyaka Ck, Marolana Ck, Mount Chambers Ck, Nepouie Ck, Old Wirrealpa Springs, Oraparina Ck, Oratunga Ck, Parachilna Ck, Stubbs Waterhole, Willigan Ck, Teatree Ck, Warren Gorge C, Wilpena Ck, Wockerawirra Ck, Wooden-dimna Ck. Eyre Peninsula: Old Woolshed Dam. **VICTORIA.** Crawford R., Darlots Ck, Gawkers Ck, Glenelg R., Lake Wendouree (Ballarat), Mount Emu Ck, Pigeon Hole Ck, Rocklands Reservoir, Stoke Ck, Surrey R., Wando R., Wannon R., Wennicott R. **TASMANIA.** Elizabeth R., Lagoon of Islands, Macquarie R., Rileys Creek Reservoir, Geeveston.

### ACKNOWLEDGMENTS

This work was supported by a Commonwealth of Australia Post Graduate Research Award and by research funds of the Zoology Department, University of Adelaide. Special thanks must go to my supervisor, Dr J. E. Bishop for his valuable advice, encouragement, and constructive criticism throughout this study. Thanks also to Prof. W. D. Williams for his encouragement and guidance, and to all people who assisted in collecting material from throughout South Australia. I would also like to thank my wife, for her support during the study.

### REFERENCES

- BANKS, N. 1900. New genera and species of Nearctic Neuropteroid insects. *Trans. Am. Entomol. Soc.* 26: 239-259.
- BURMEISTER, H. C. C. 1839. *Handbuch der Entomologie, Vol. 2, part 2, Neuroptera*. Reimer, Berlin. 757-1050.
- DEMOULIN, G. 1955a. Note sur deux nouveaux genres de Leptophlebiidae d'Australie. *Bull. Ann. Soc. R. Belg Entomol.* 91: 227-229.
- DEMOULIN, G. 1955b. Les Brachycercidae Australiens. Le genre *Tasmanocoenis* Lestage. *Bull. Mus. R. Hist. Nat. Belg.* 31: 1-7.
- EATON, A. E. 1868. An outline of a re-arrangement of the genera of Ephemeridae. *Ent. Mon. Mag.* 5: 82-91.
- EATON, A. E. 1869. On *Centropitulum*, a new genus of the Ephemeridae. *Entomol. Mon. Mag.* 6, 131-132.
- EATON, A. E. 1871. A monograph on the Ephemeridae. *Trans. R. Entomol. Soc. London* 19: 1-164.
- EATON, A. E. 1881. An announcement of the new genera of the Ephemeridae. *Entomol. Mon. Mag.* 17: 191-197.
- EATON, A. E. 1883-1888. A revisional monograph of recent Ephemeridae or mayflies. *Trans. Linn. Soc. London (Zool.) Ser.* 2, 3, 1-352.
- EDMUNDS, G. F. Jr. 1973. Some critical problems of Family relationships in the Ephemeroptera. In "Proceedings of the 1st International Conference of Ephemeroptera" (Peters, W. L., and Peters, J. G., eds.), pp. 145-154. E. J. Brill, Leiden.
- EDMUNDS, G. F. Jr. 1975. Phylogenetic biogeography of mayflies. *Ann. Mo. Bot. Gard.* 62: 251-263.
- EDMUNDS, G. F. Jr., JENSEN, S. L., & BERNER, L. 1976. The Mayflies of North and Central America. University of Minnesota Press, Minneapolis.
- HARKER, J. E. 1950. Australian Ephemeroptera. Part 1. Taxonomy of New South Wales species and evaluation of taxonomic features. *Proc. Linn. Soc. N.S.W.* 75: 1-34.
- HARKER, J. E. 1954. The Ephemeroptera of Australia. *Trans. R. Entomol. Soc. London.* 105: 241-268.
- HARKER, J. E. 1957. Some new Australian Ephemeroptera. *Proc. R. Entomol. Soc. London. Ser. B.* 26: 63-78.
- HUDSON, G. B. 1951. Studies in the comparative anatomy and systematic importance of the hexapod tentorium — IV. Ephemeroptera. *J. Entomol. Soc. South Afr.* 14: 3-23.
- KIMMINS, D. E. 1960. The Ephemeroptera types of species described by A. E. Eaton, R. McLachlan and F. Walker, with particular reference to those in the British Museum (Natural History). *Bull. Br. Mus. (Nat. Hist.), Entomol.* 9: 269-318.
- KLAPÁLEK, F. 1905. Plecopteren und Ephemeriden aus Java. *Naturhist. Mus. Hamburg.* 22: 103-107.
- LANDA, V. 1973. A contribution to the evolution of the Order Ephemeroptera based on comparative anatomy. In "Proceedings of the 1st International Conference on Ephemeroptera" (Peters, W. L., and Peters, J. G., eds.), pp. 155-159. E. J. Brill, Leiden.
- LEACH, W. E. 1815. Entomology. In *Brewster's Edinburgh Encyclopaedia* (1830) 9: 57-172.
- LESTAGE, J. A. 1930. Notes sur le premier Brachycercidien decouvert dans la faune australienne *Tasmanocoenis tonnoiri* sp. nov. (Ephemeroptera) et remarques sur la famille des Brachycercidae. *Mem. Soc. R. Belge Entomol.* 23: 49-60.
- LESTAGE, J. A. 1931. Contribution à l'étude des Ephéméroptères VIII. Les Ephéméroptères du Chili. *Bull. Ann. Soc. R. Belge Entomol.* 71: 41-60.
- LESTAGE, J. A. 1935a. Contribution à l'étude des Ephéméroptères IX. Le groupe Siphonuridien. *Bull. Ann. Soc. R. Belge Entomol.* 75: 77-139.
- LESTAGE, J. A. 1935b. Contribution à l'étude des Ephéméroptères XII. Les composantes australiennes et neo-zélandaises du Groupe Siphonuridien. *Bull. Ann. Soc. R. Belge Entomol.* 75: 346-358.
- LESTAGE, J. A. 1938. Contribution à l'étude des Ephéméroptères XX. Notes synonymique; *Coenis scotti* Till (1935) nec Ulmer (1930) = *Coenis tillyardi* nom. nov. *Bull. Ann. Soc. R. Belge Entomol.* 78: 320.
- MÜLLER-LIEBENAU, I. 1969. Revision der europäischen Arten der Gattung *Baetis* Leach, 1815 (Insecta, Ephemeroptera). *Gewässer Abwasser* 48/49: 1-214.
- MÜLLER-LIEBENAU, I. 1973. Morphological characters used in revising the European species of the genus *Baetis* Leach. In "Proceedings of the 1st International Conference on Ephemeroptera" (Peters, W. L., & Peters, J. G., Eds.), pp. 182-198. E. J. Brill, Leiden.
- NAVÁS, R. P. L. 1918. Insectos chilenos. *Bol. Soc. Aragonesa Cienc. Nat.* 17: 212-230.
- NAVÁS, R. P. L. 1924. Insectos Neotropica. 1. *Serie Rev. Chilena de Hist. Nat.* 29: 305-313.
- NEEDHAM, J. G. & MURPHY, H. E. 1924. Neotropical mayflies. *Bull. Lloyd Lib Mus.* 24 *Entomol. Ser.* 4: 1-79.
- PESCADOR, M. L. & PETERS, W. L. 1985. Biosystematics of the Genus *Nousia* from Southern South America, (Ephemeroptera: Leptophlebiidae: Atalophlebiinae) *J. Kansas. Entomol. Soc.* 58(1): 91-123.
- PETERS, W. L. & EDMUNDS, G. F. Jr. 1964. A revision of the generic classification of the Ethiopian Leptophlebiidae (Ephemeroptera). *Trans. R. Entomol. Soc. London* 116: 225-253.
- PETERS, W. L. & EDMUNDS, G. F. Jr. 1970. Revision of the generic classification of the eastern hemisphere Leptophlebiidae (Ephemeroptera). *Pac. Insects* 12: 157-240.
- PETERS, W. L. & EDMUNDS, G. F. Jr. 1972. A revision of the generic classification of certain Leptophlebiidae from South America (Ephemeroptera). *Ann. Entomol. Soc. Am.* 65: 1398-1414.
- PICTET, F. J. 1843. *Histoire Naturelle Generale et Particulière des Insectes Névroptères. Famille des Ephémérines*. Geneve and Paris.
- PUTHZ, V. 1975. Eine Caenidengattung aus dem Amazonasgebiet (Insecta: Ephemeroptera: Caenidae). *Amazoniana* 3: 411-415.

- RIEK, E. F. 1970. Ephemeroptera (Mayflies). In *The Insects of Australia* (sponsor C.S.I.R.O.), pp. 224-240. University of Melbourne Press, Melbourne.
- RIEK, E. F. 1973. The Classification of the Ephemeroptera. In "Proceedings of the 1st International Conference on Ephemeroptera" (Peters, W. L., and Peters, J. G., eds.), pp. 160-178. Leiden: E. J. Brill.
- SCHOLES, D. 1961. Fly-Fisher in Tasmania. Melbourne University Press, Melbourne.
- SOLDAN, T. 1978. New genera and species of Caenidae (Ephemeroptera) from Iran, India and Australia. *Acta Entomol. Bohemoslov.* **75**: 119-129.
- SUTER, P. J. 1979. A revised key to the Australian genera of mature mayfly (Ephemeroptera) nymphs. *Trans. R. Soc. S. Aust.* **103**: 79-83.
- SUTER, P. J. 1984. A re-description of the genus *Tasmanocoenis* Lestage (Ephemeroptera: Caenidae) from Australia. *Trans. R. Soc. S. Aust.* **108**: 105-111.
- THEW, T. B. 1960. Revision of the genera of the Family Caenidae (Ephemeroptera). *Trans. Am. Entomol. Soc. (Philadelphia)* **86**: 187-205.
- TILLYARD, R. J. 1921. A new genus and species of May-Fly (Order Plecoptera) from Tasmania, belonging to the Family Siphonuridae. *Proc. Linn. Soc. N.S.W.* **46**: 409-412.
- TILLYARD, R. J. 1926. Order Plecoptera (or Ephemeroptera) (Mayflies) In "The Insects of Australia and New Zealand". Angus and Robertson, Sydney.
- TILLYARD, R. J. 1932. Kansas Permian insects. Pt. 15. The Order Plecoptera. *Am. J. Sci. Ser. 5*. **23**: 97-134; 237-272.
- TILLYARD, R. J. 1933. The mayflies of the Mount Kosciusko region. I. (Plecoptera). Introduction and Family Siphonuridae. *Proc. Linn. Soc. N.S.W.* **58**: 1-32.
- TILLYARD, R. J. 1934. The trout-food insects of Tasmania. Part I. A study of the genotype of the mayfly genus *Atalophlebia* and its life history. *Pap. Proc. R. Soc. Tasmania* **1933**: 1-16.
- TILLYARD, R. J. 1936. The trout-food insects of Tasmania. Part II. A monograph of the mayflies of Tasmania. *Pap. Proc. R. Soc. Tasmania* **1935**: 23-59.
- TIMMS, B. V. 1974. Morphology and benthos of three volcanic lakes in the Mt. Gambier district, South Australia. *Aust. J. Mar. freshw. Res.* **25**: 287-297.
- TRAYER, J. R. 1946. Notes on neotropical mayflies. Part I. Family Baetidae, sub family Leptophlebiinae. *Rev. Entomol. (Rio de J.)* **17**: 418-436.
- TSUI, P. T. P. & PETERS, W. L. 1972. The comparative morphology of the thorax of selected genera of the Leptophlebiidae (Ephemeroptera). *J. Zool.* **168**: 309-367.
- TSUI, P. T. P. & PETERS, W. L. 1975. The comparative morphology and phylogeny of certain Gondwanian Leptophlebiidae based on the thorax, tentorium, and abdominal terga (Ephemeroptera). *Trans. Am. Entomol. Soc. (Philadelphia)* **101**: 505-595.
- ULMER, G. 1908. Trichopterae and Ephemeridae. *Fauna Sudwest-Australiens* **II**. 25-46.
- ULMER, G. 1916. Results of Dr E. Mjöberg's Swedish Scientific Expedition to Australia 6. Ephemeroptera. *Ark. Zool.* **10**: 2-18.
- ULMER, G. 1919. Neue Ephemeroptera. *Arch. Naturgesch.* **85**: 1-80.
- ULMER, G. 1920. Uebersicht über die Gattungen der Ephemeroptera nebst Bemerkungen über einzelne Arten. *Stett. Ent. Ztg.* **81**: 97.
- ULMER, G. 1938. Chilenische Ephemeropteren, hauptsächlich aus dem Deutschen Entomologischen Institut, Berlin-Dahlem. *Arch. morph. taxon. Ent.* **5**: 85-108.
- VAN BRUGGEN, A. C. 1957. On two species of mayflies from the Wissel Lakes Central New Guinea (Ephemeroptera). *Nova Guinea*, n.s. **8**: 31-39.
- WALKER, F. 1853. Catalogue of the Species of Neuropterous Insects in the Collection of the British Museum. Part III, pp. 533-585. British Museum (Natural History), London.
- WILLIAMS, W. D. 1968. "Australian Freshwater Life: The Invertebrates of Australian Inland Waters". Sun Books, Melbourne.

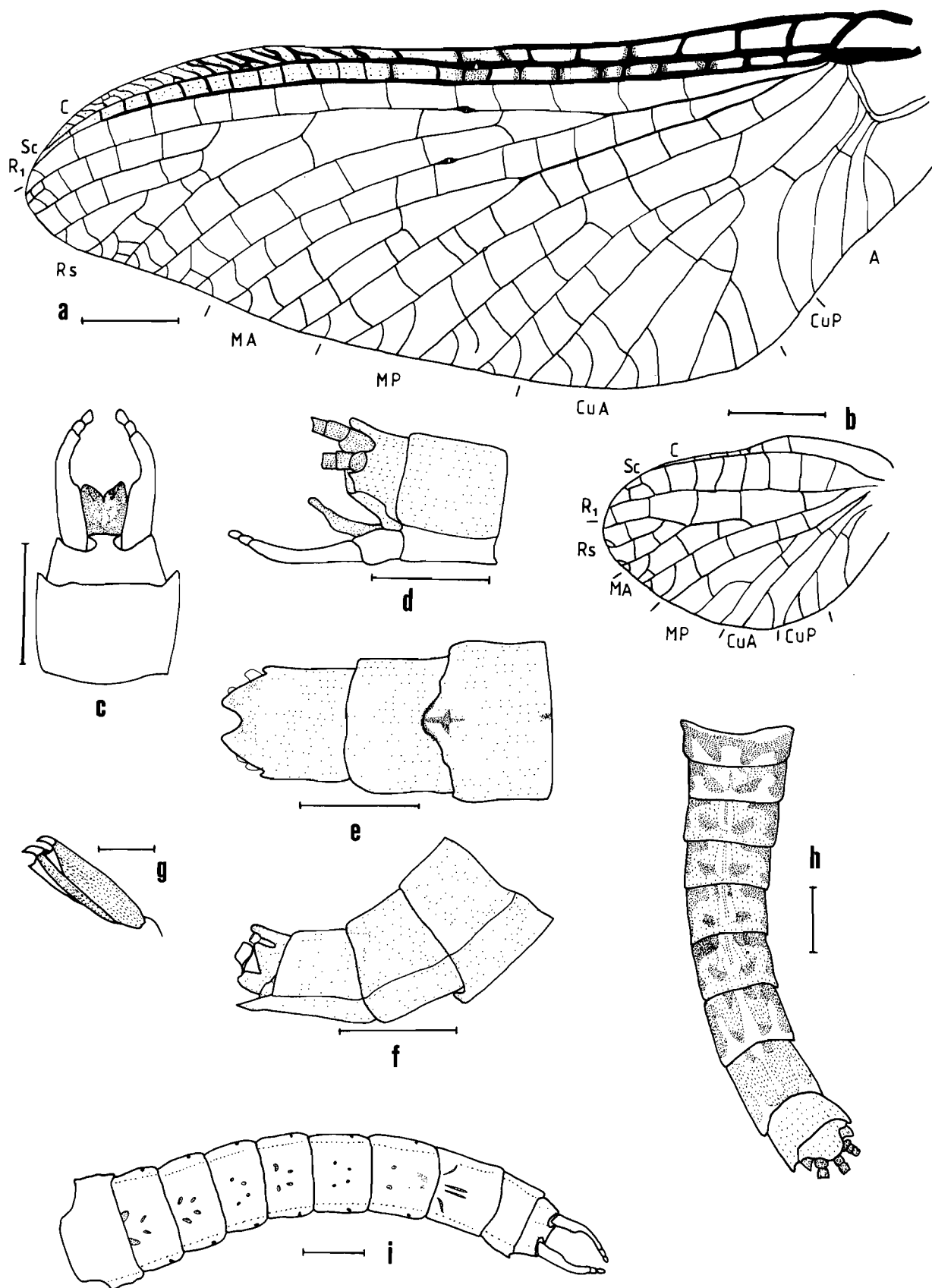


FIG. 1. *Atalophlebia australis*. a-d, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view. e-f, female imago: e, abdominal segments 7-10, ventral view; f, abdominal segments 7-10, lateral view. g-i, male imago: g, fore claws; h, dorsal abdominal colour pattern; i, ventral abdominal colour pattern. Scale line: a-f, h-i, 1 mm; g, 0.1 mm.

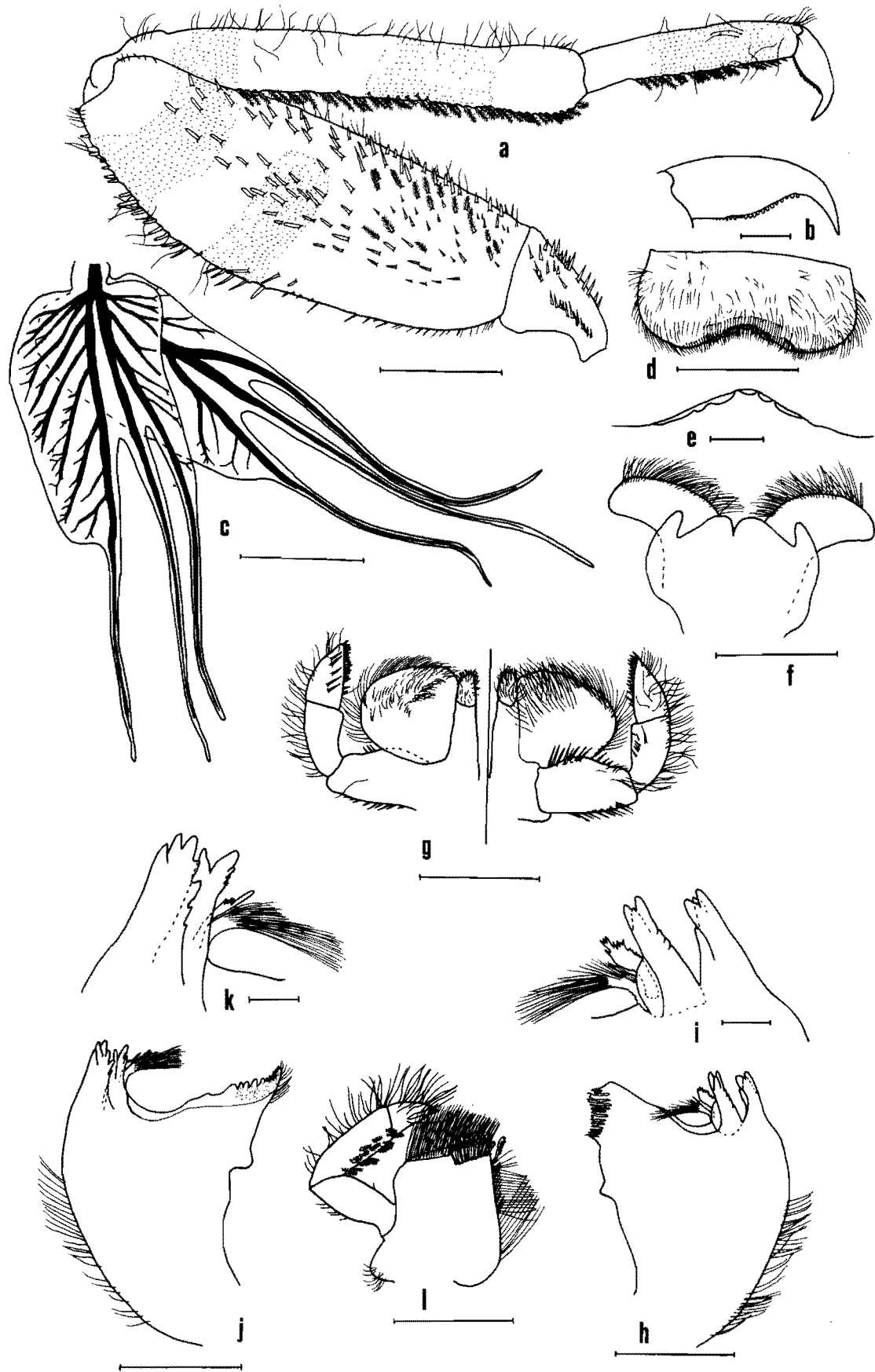


FIG. 2. *Atalophlebia australis*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca, enlarged; l, right maxilla, ventral view. Scale lines: a, c, d, f, g, h, j, l, 0.5 mm; b, e, i, k, 0.1 mm.



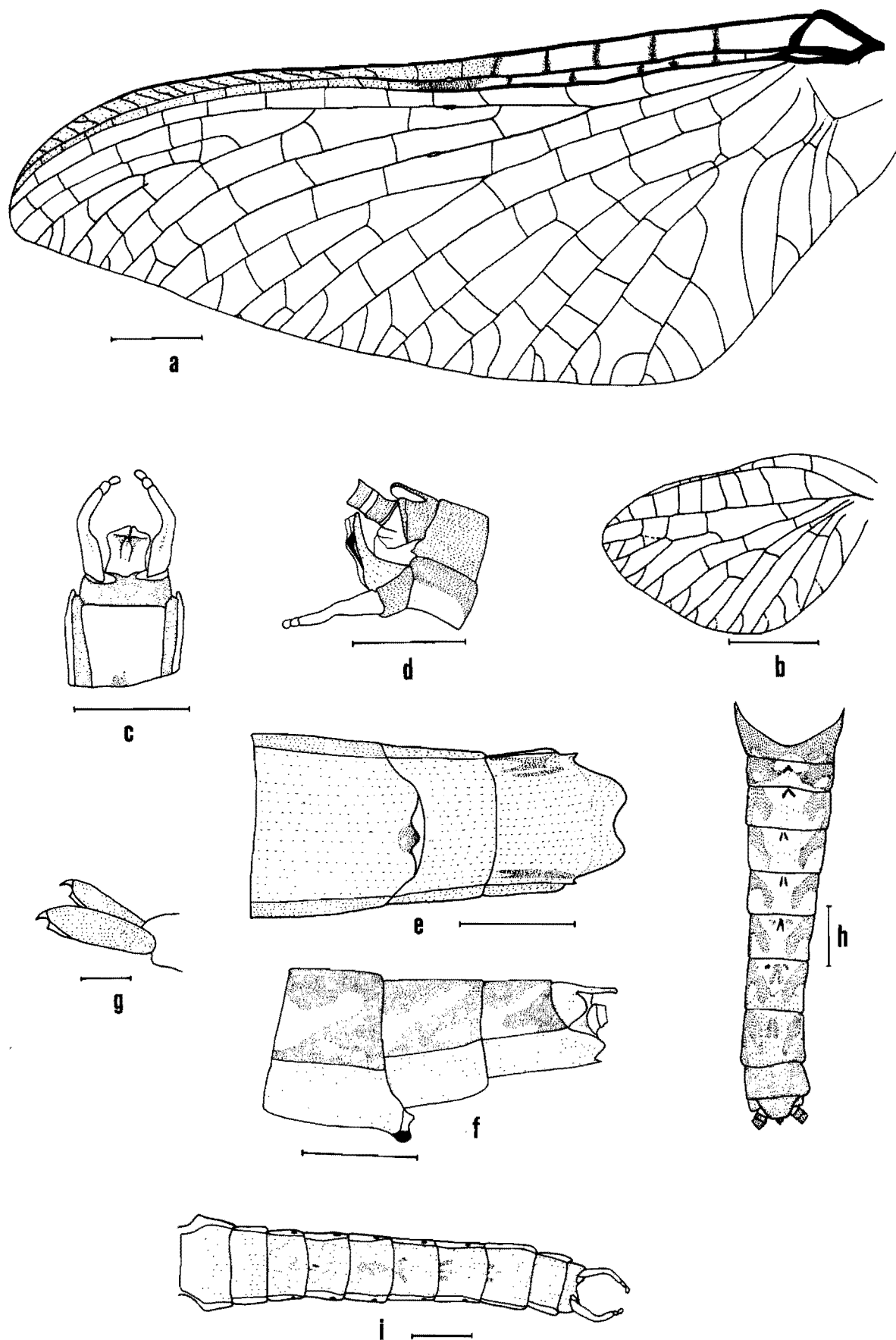


FIG. 3. *Atalophlebia australasica*. a-d, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view. e-f, female imago: e, abdominal segments 7-10, ventral view; f, abdominal segments 7-10, lateral view. g-i, male imago: g, fore claw; h, dorsal abdominal colour pattern; i, ventral abdominal colour pattern. Scale line: a-f, h-i, 1 mm; g, 0.1 mm.

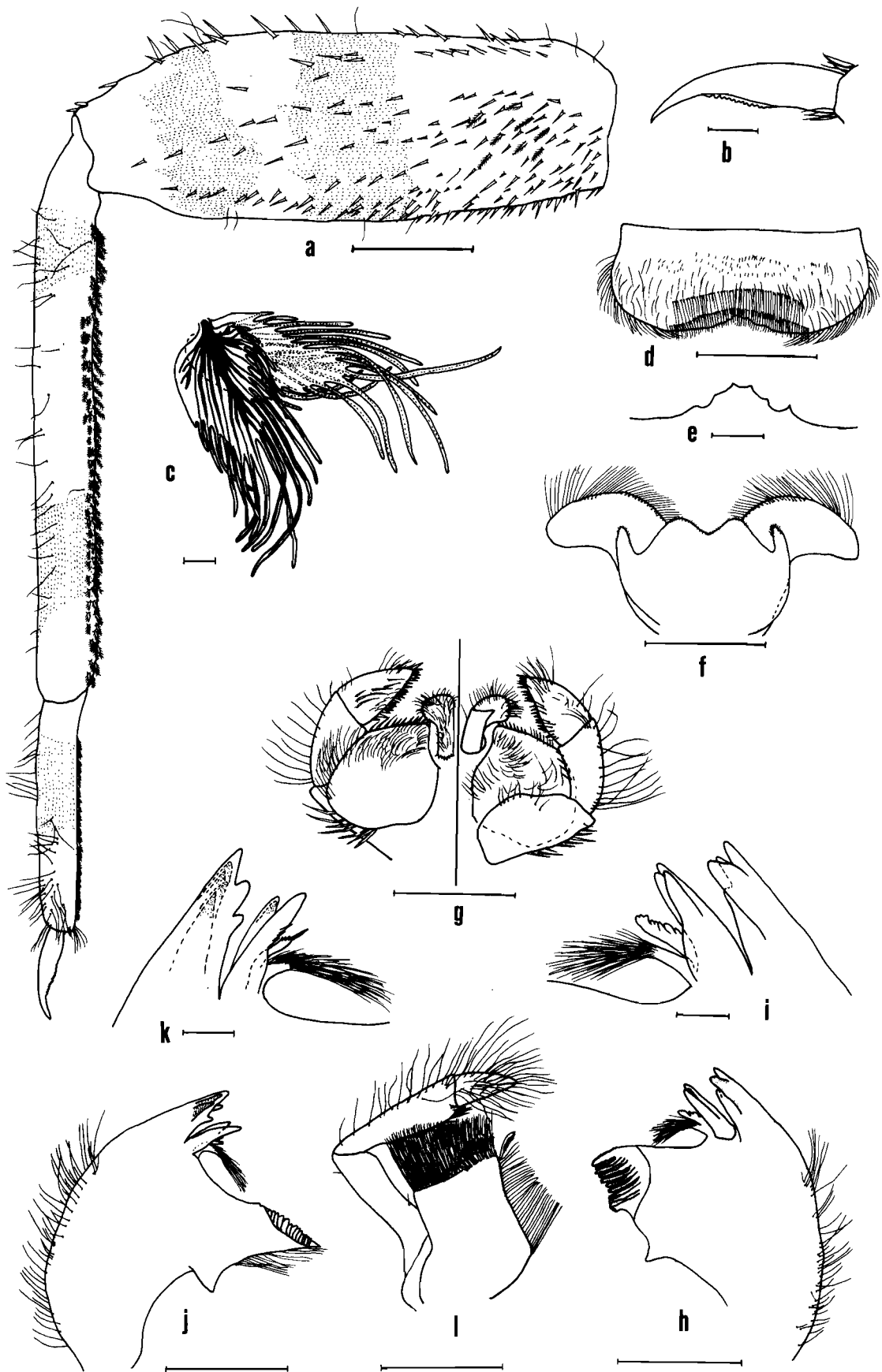


FIG. 4. *Atalophlebia australasica*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prosthema, enlarged; j, right mandible, ventral view; k, right incisors and prosthema enlarged; l, right maxilla, ventral view. Scale line: a, c, d, f, g, h, j, l, 0.5 mm; b, e, i, k, 0.1 mm.

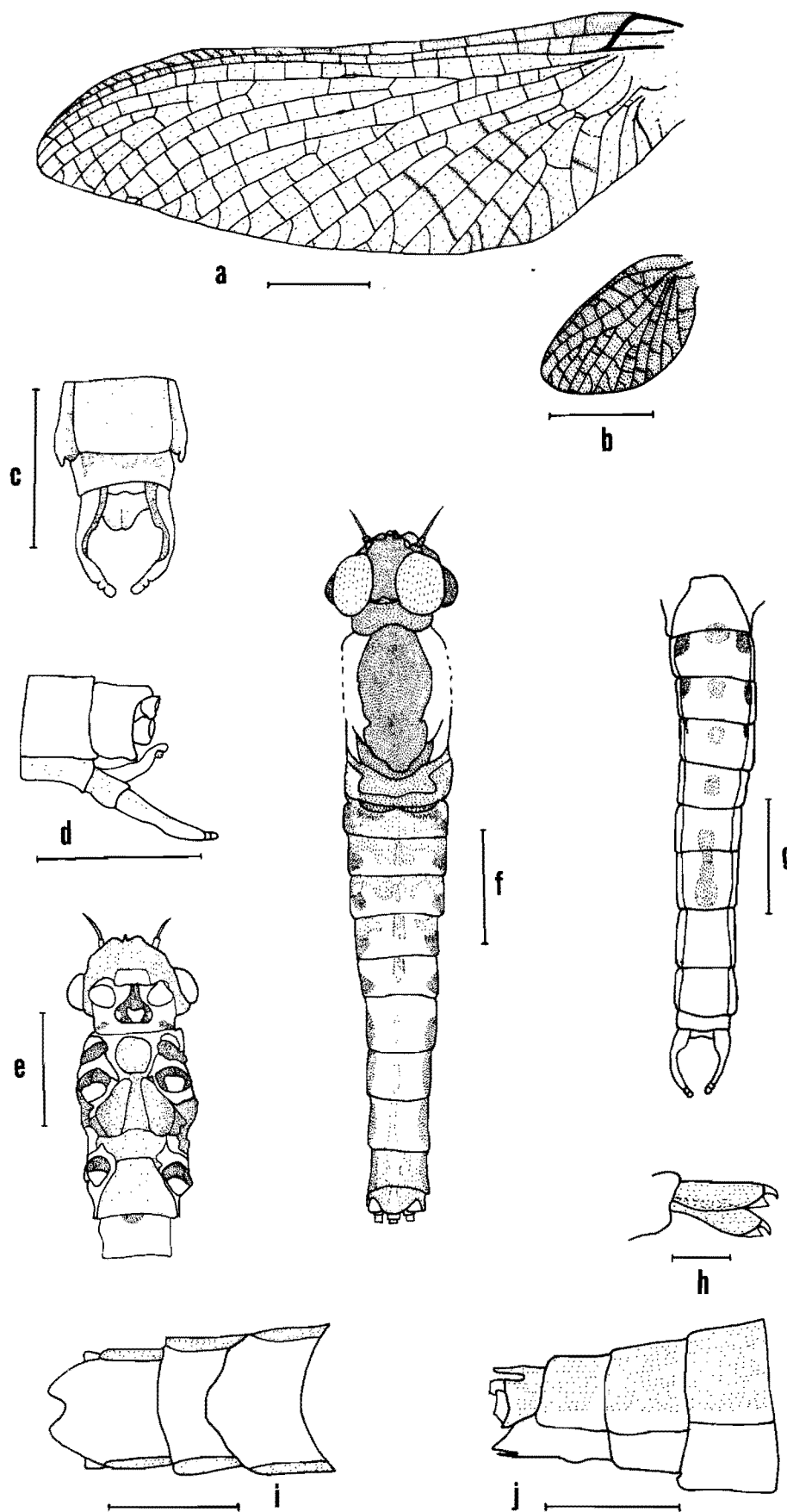


FIG. 5. *Atalophlebia auratus*. a-h, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view; e, thoracic sternite; f, dorsal colour pattern; g, ventral abdominal colour pattern; h, fore claw. i-j, female imago: i, abdominal segments 7-10, ventral view; j, abdominal segments 7-10, lateral view. Scale lines: a-g, i, j, 1 mm; h, 0.1 mm.

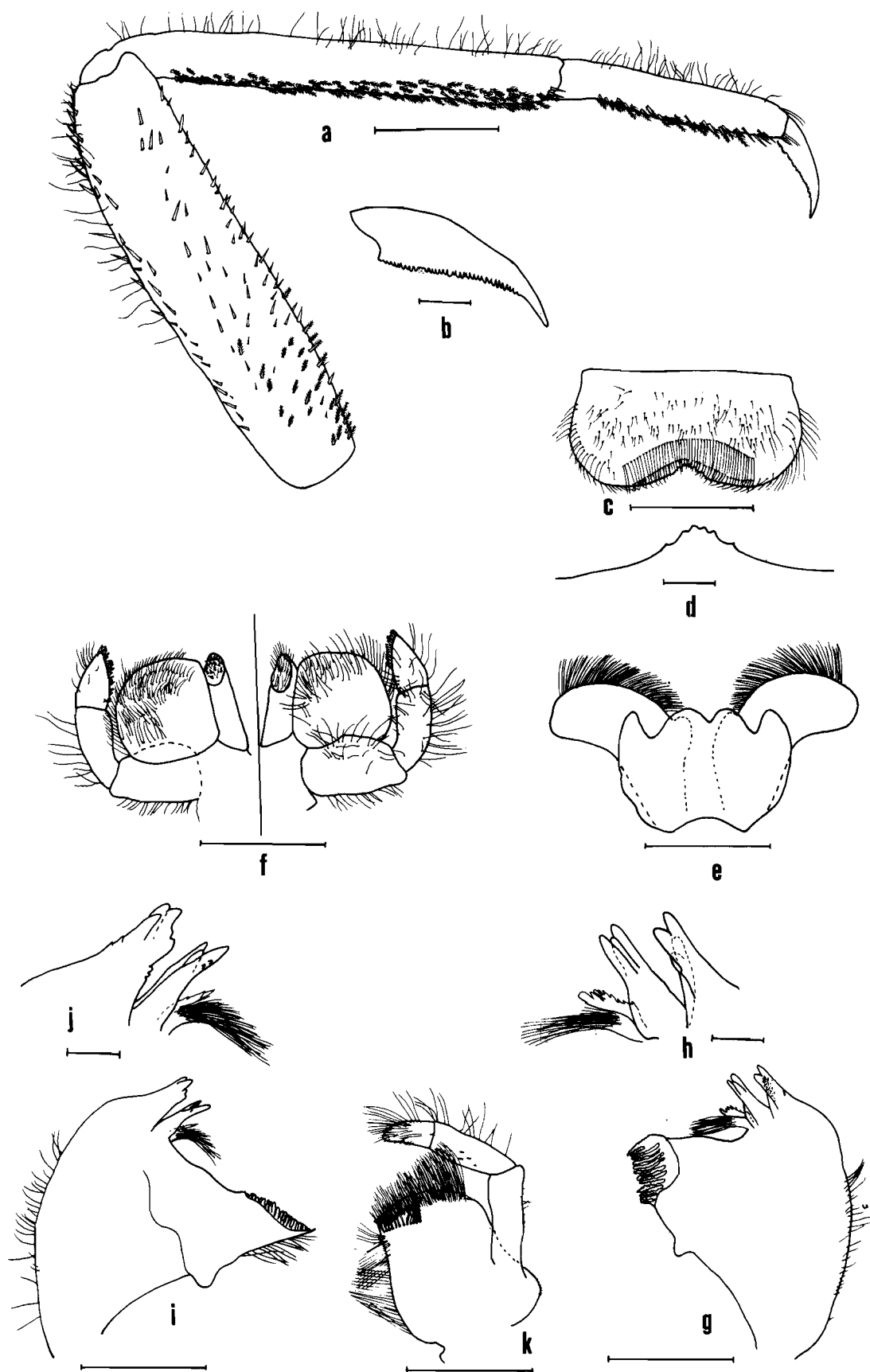


FIG. 6. *Atalophlebia auratus*, mature nymph: a, fore leg; b, fore claw; c, labrum, dorsal view; d, antero-median emargination of labrum, enlarged; e, hypopharynx; f, labium, dorsal (left) and ventral views; g, left mandible, ventral view; h, left incisors and prosthema, enlarged; i, right mandible, ventral view; j, right incisors and prosthema, enlarged; k, left maxilla, ventral view. Scale lines: a, c, e, f, g, i, k, 0.5 mm; b, d, h, j, 0.1 mm.

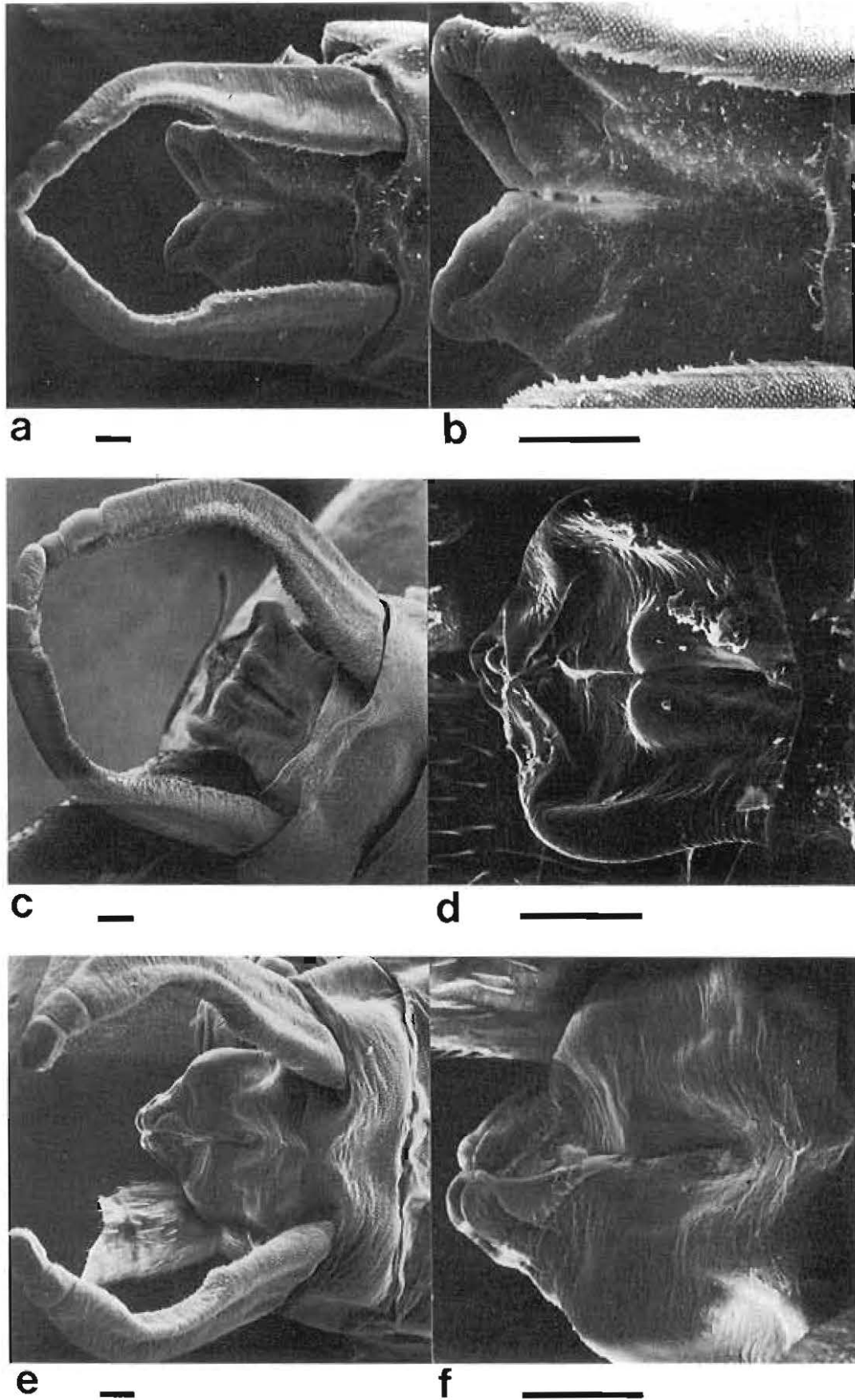


FIG. 7. SEM micrographs of genitalia of *Atalophlebia* male imagos. a-b, *Atalophlebia australis*: a, genitalia, ventral view; b, penes, ventral view, enlarged. c-d, *Atalophlebia australasica*: c, genitalia, ventral view; d, penes, ventral view, enlarged. e-f, *Atalophlebia auratus*: e, genitalia, ventral view; f, penes, ventral view, enlarged. Scale lines: 100 μm.

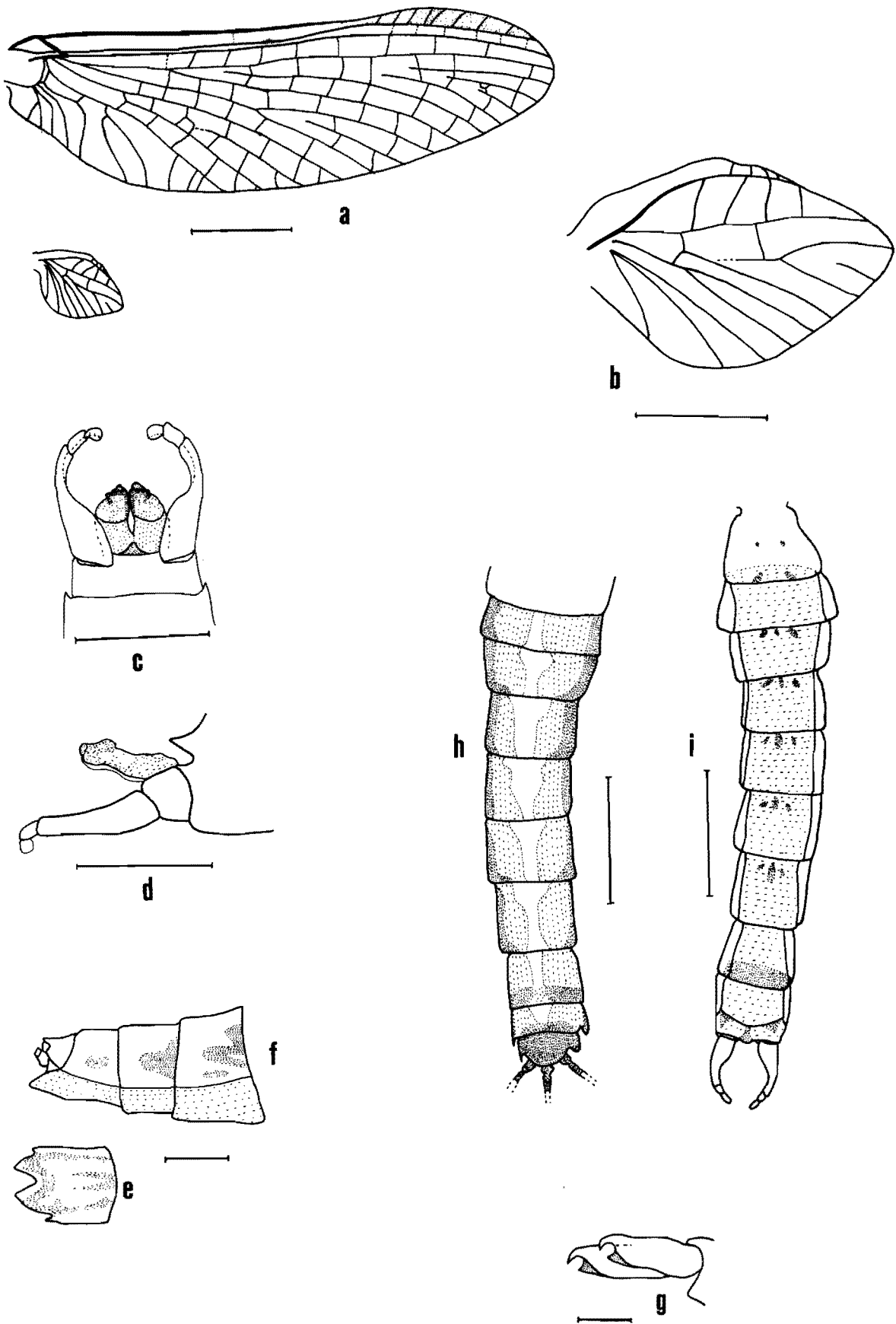


FIG. 8. *Nousia inconspicua*. a-d, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view. e-f, female imago: e, abdominal segment 10, ventral view; f, abdominal segments 7-10, lateral view. g-i, male imago: g, fore claws; h, dorsal abdominal colour pattern; i, ventral abdominal colour pattern. Scale lines: a, h, i, 1 mm; b-f, 0.5 mm; g, 0.05 mm.

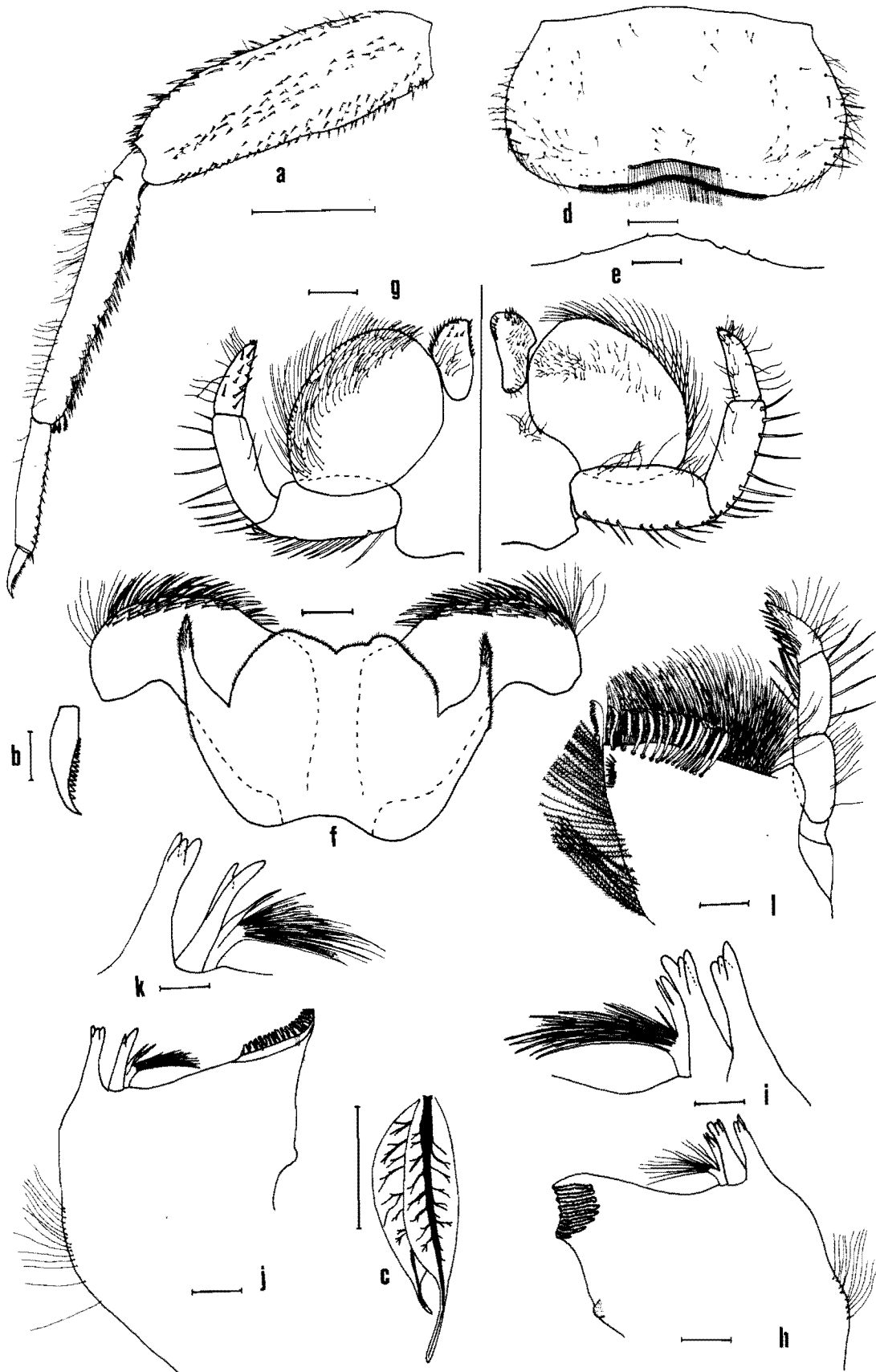


FIG. 9. *Nousia inconspicua*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca, enlarged; l, left maxilla, ventral view. Scale lines: a, c, 0.5 mm; b, d, f, g, h, j, l, 0.1 mm; e, i, k, 0.05 mm.



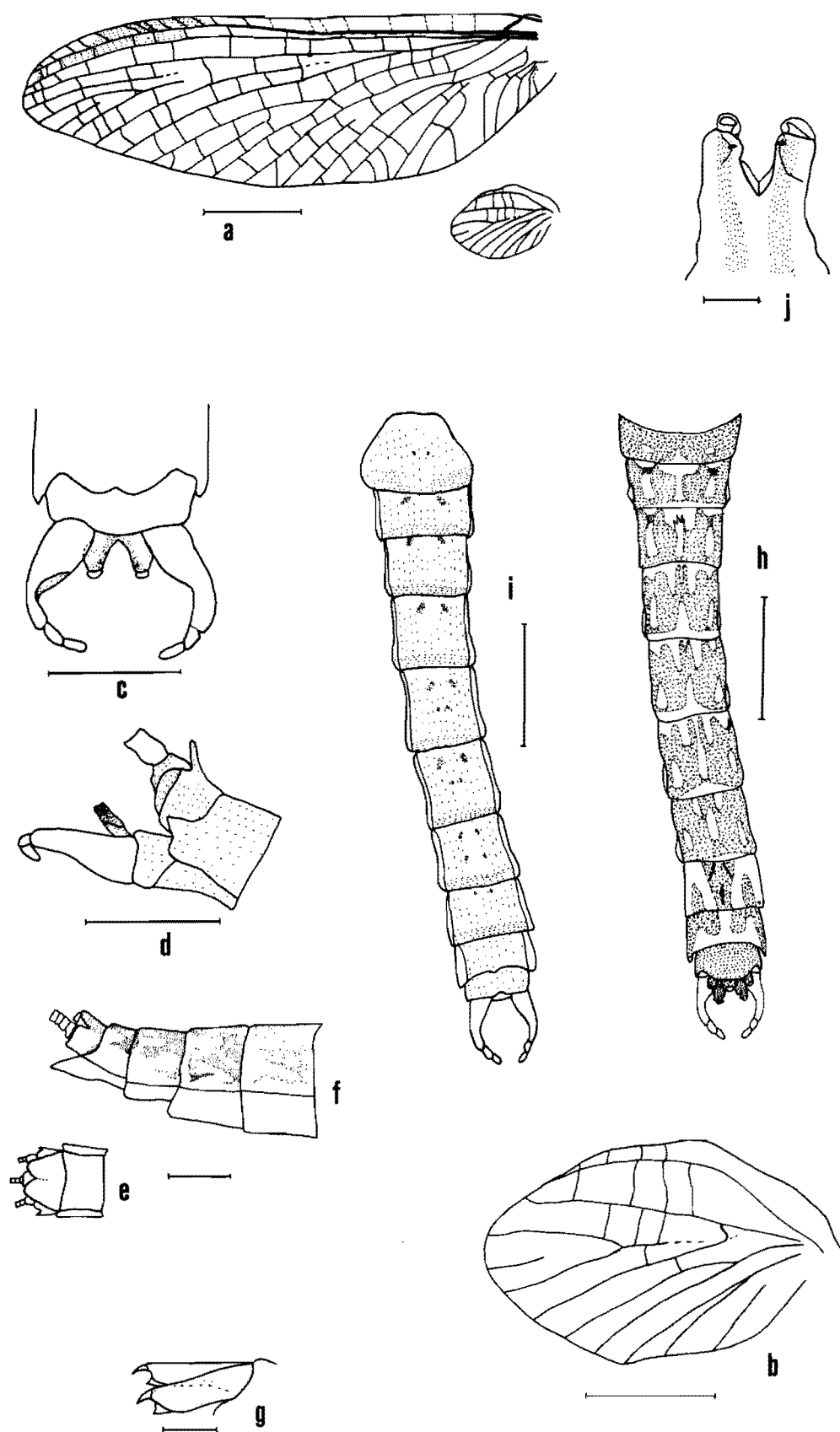


FIG. 10. *Nousia fuscata*. a-d, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view. e-f, female imago: e, ventral view of abdominal segment 10; f, abdominal segments 6-10, lateral view. g-j, male imago: g, fore claws; h, dorsal abdominal colour pattern; i, ventral abdominal colour pattern; j, penes enlarged, ventral view. Scale lines: a, h, i, 1 mm; b, c, d, e, f, 0.5 mm; j, 0.1 mm; g, 0.05 mm.

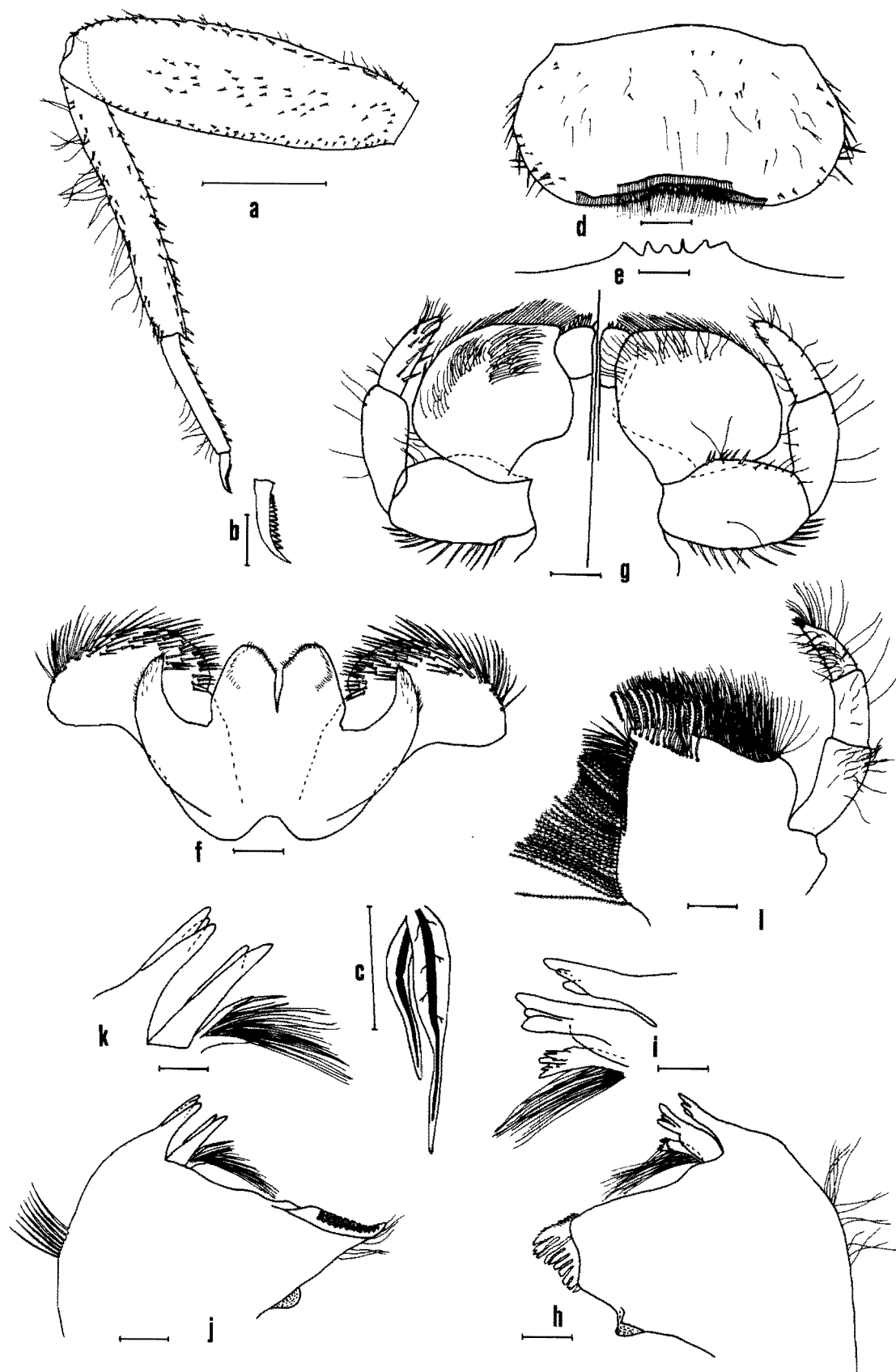


FIG. 11. *Nousia fuscata*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prosthema, enlarged; j, right mandible, ventral view; k, right incisors and prosthema, enlarged; l, left maxilla, ventral view. Scale lines: a, c, 0.5 mm; b, d, f, g, h, j, l, 0.1 mm; e, i, k, 0.05 mm.

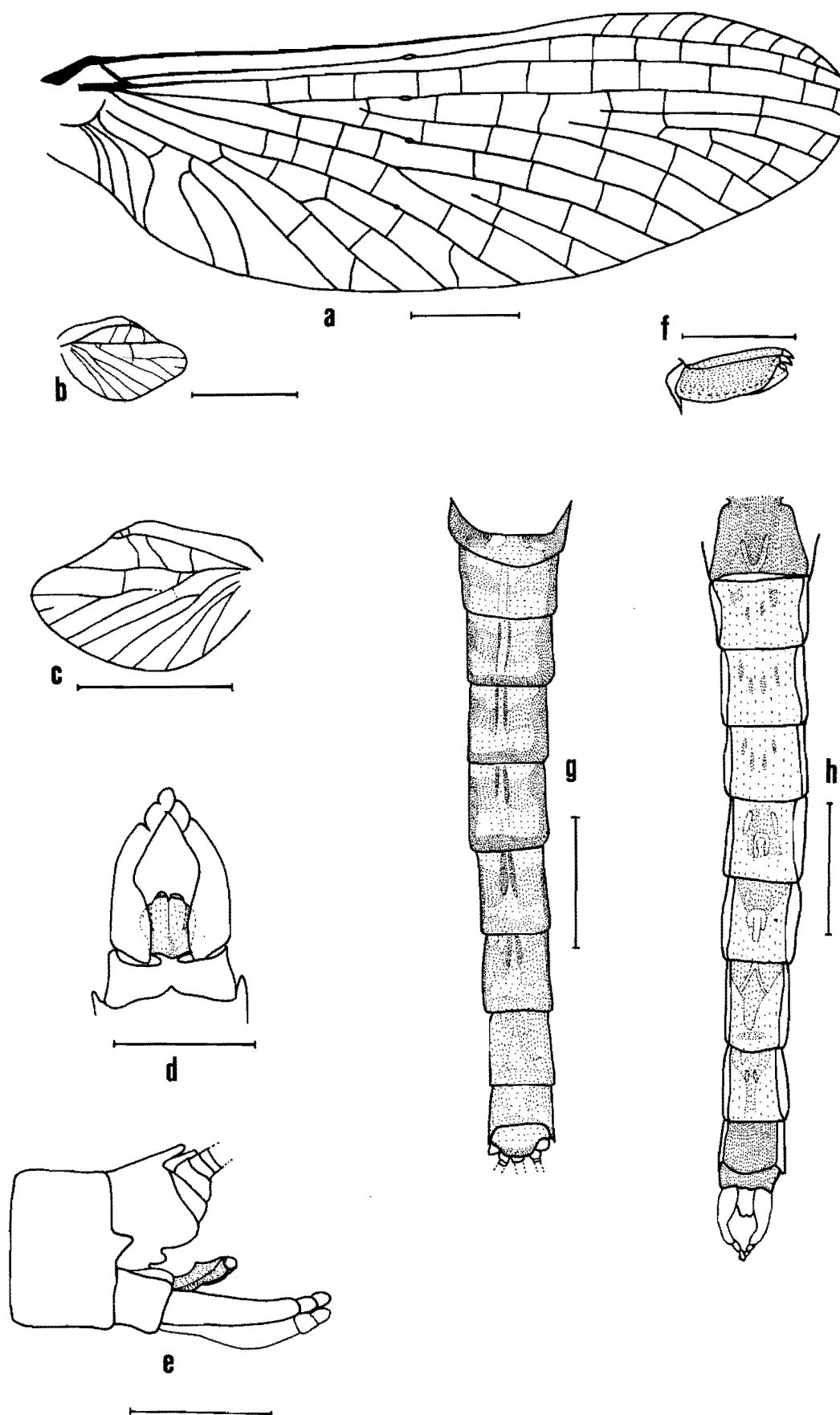


FIG. 12. *Nousia pilosa*. a-h, male imago: a, fore wing; b, hind wing; c, left hind wing, enlarged; d, genitalia, ventral view; e, genitalia, lateral view; f, fore claws; g, dorsal abdominal colour pattern; h, ventral abdominal colour pattern. Scale lines: a, b, g, h, 1 mm; c-e, 0.5 mm; f, 0.1 mm.

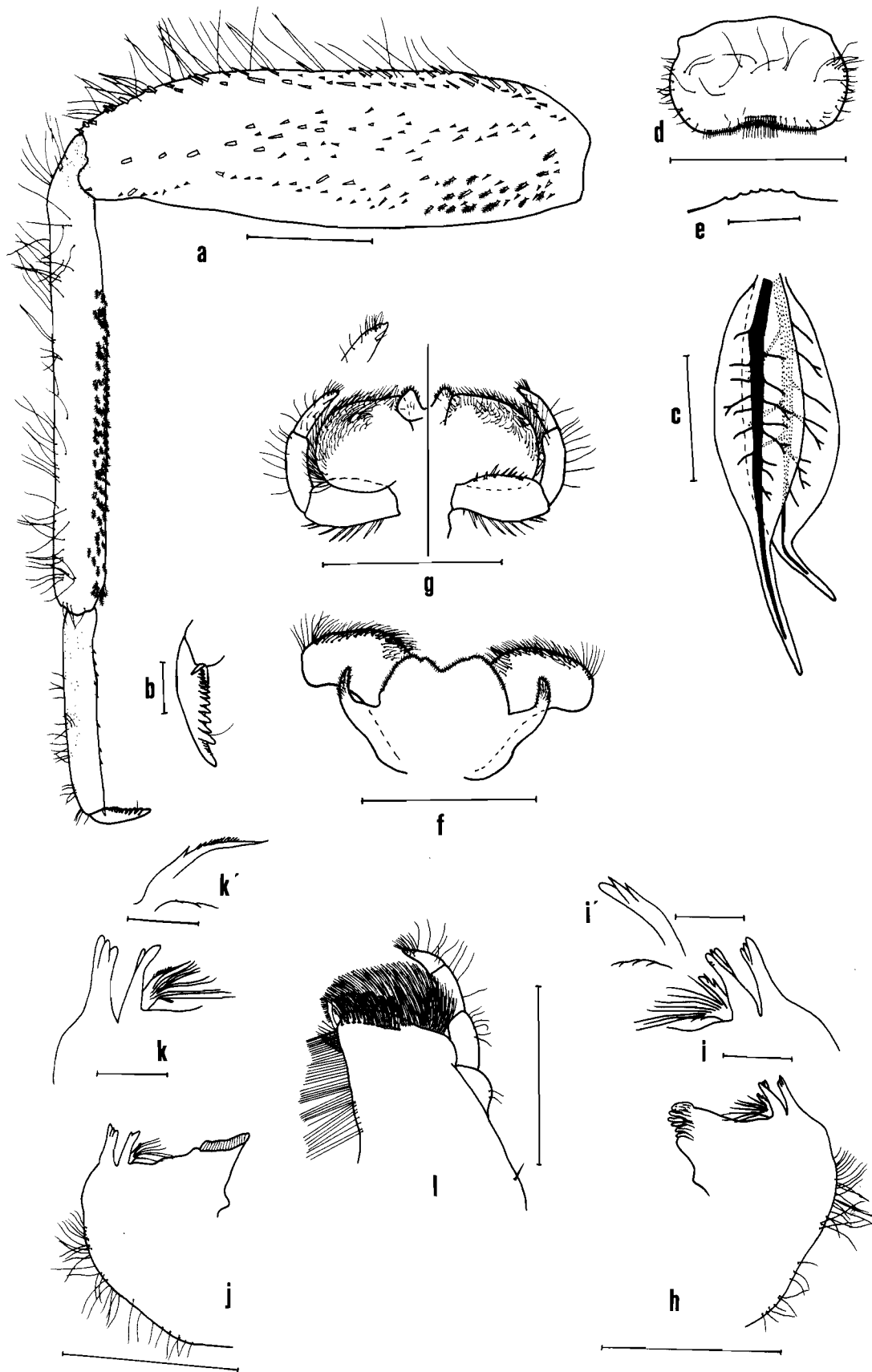


FIG. 13. *Nousia pilosa*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prosthema, enlarged; i', left prosthema, enlarged; j, right mandible, ventral view; k, right incisors and prosthema, enlarged; k', right prosthema, enlarged; l, left maxilla, ventral view. Scale lines: a, c, d, f, g, h, j, l, 0.5 mm; b, e, i, k, 0.1 mm; i, k, 0.05 mm.

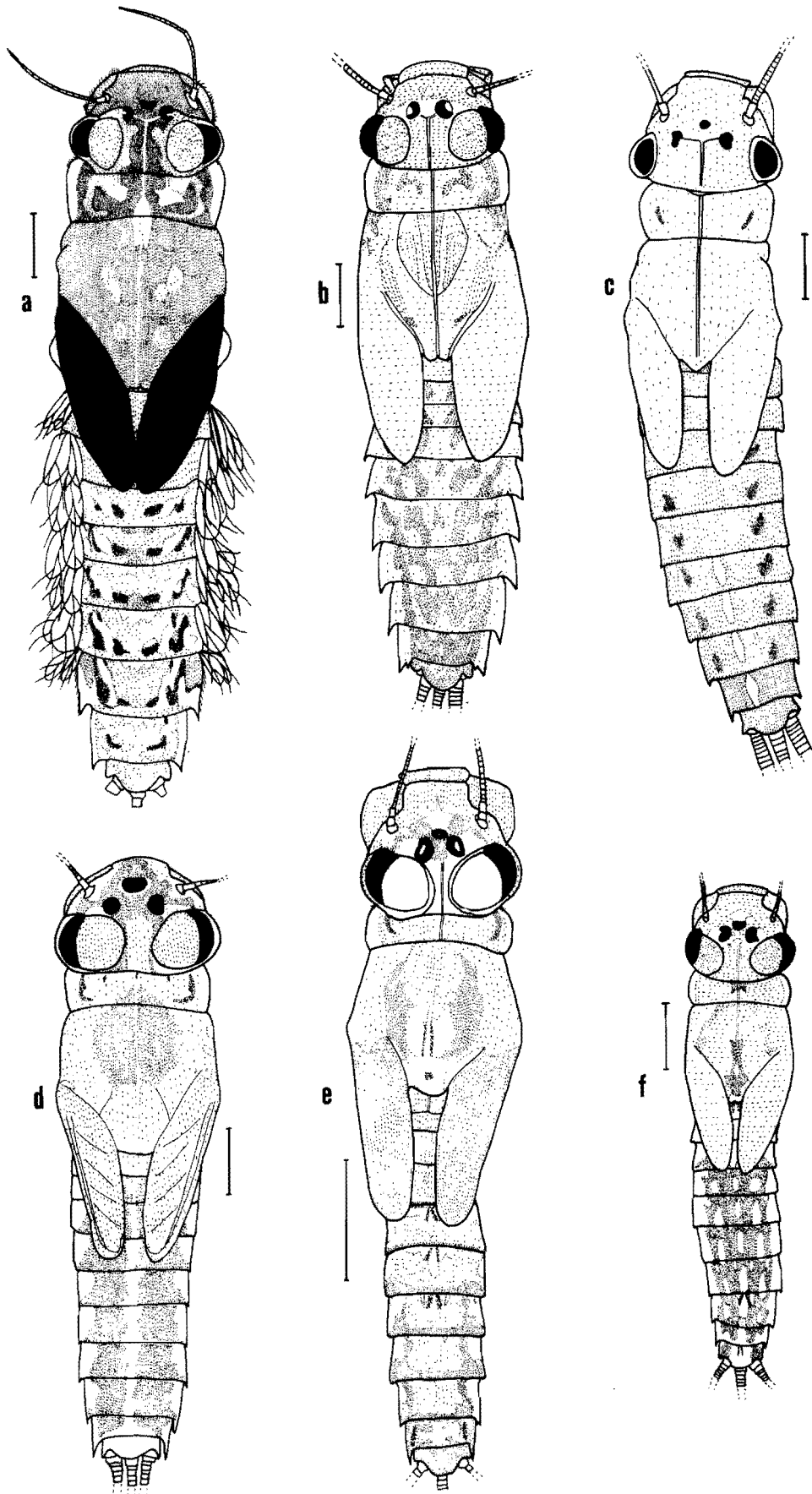


FIG. 14. Dorsal colour patterns of *Atalophlebia* and *Nousia* mature nymphs. a, *Atalophlebia australis*; b, *Atalophlebia australasica*; c, *Atalophlebia auratus*; d, *Nousia inconspicua*; e, *Nousia fuscula*; f, *Nousia pilosa*. Scale lines: 1 mm.

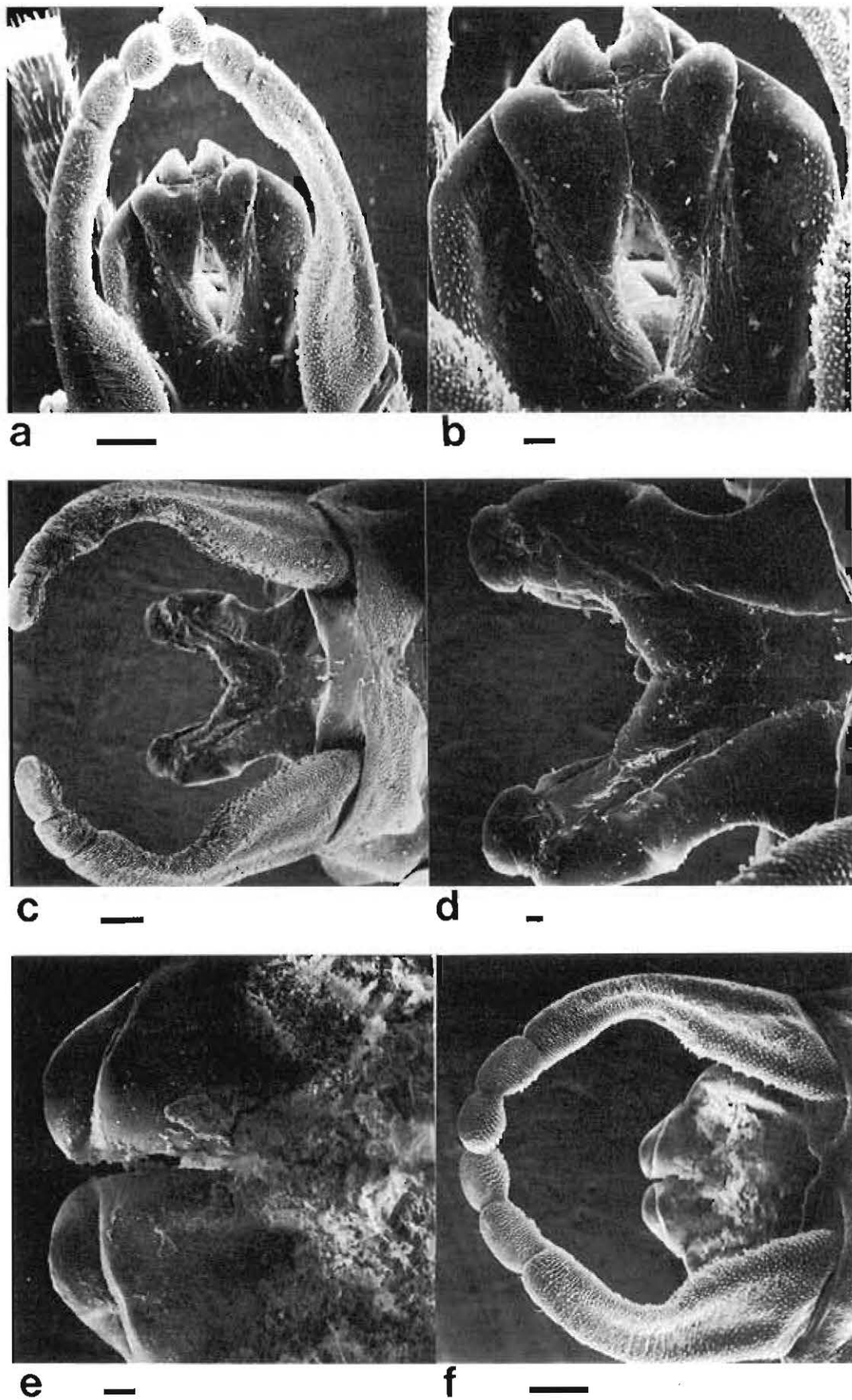


FIG. 15. SEM micrographs of genitalia of *Nousia* male imagos. a-b, *Nousia inconspicua*: a, genitalia, ventral view; b, penes, ventral view, enlarged. c-d, *Nousia fuscula*: c, genitalia, ventral view; d, penes, ventral view, enlarged. e-f, *Nousia pilosa*: e, penes, ventral view, enlarged; f, genitalia, ventral view. Scale lines: a, c, f, 100  $\mu$ m; b, d, e, 10  $\mu$ m.

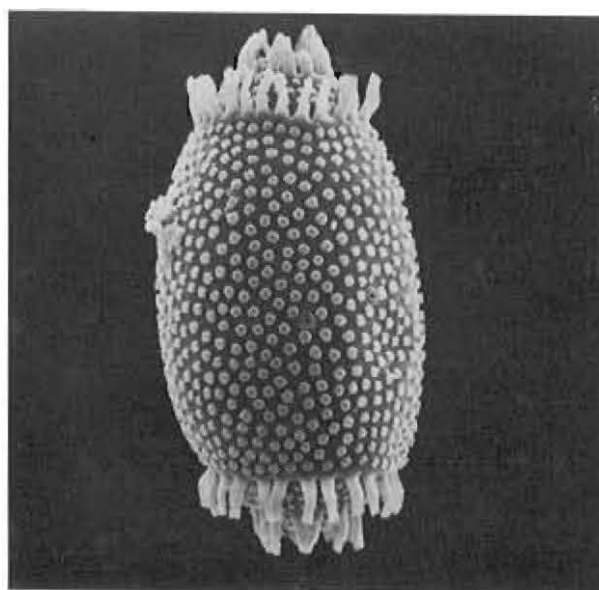
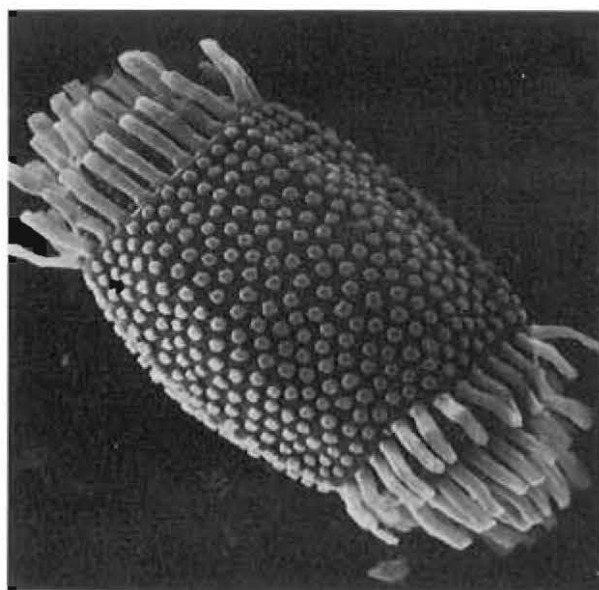
**a****b**

FIG. 16. SEM micrographs of eggs of a, *Nousia inconspicua*; and b, *Nousia fuscata*, illustrating the general similarity of morphology, but distinct polar caps of each species. Scale line: 10  $\mu$ m.

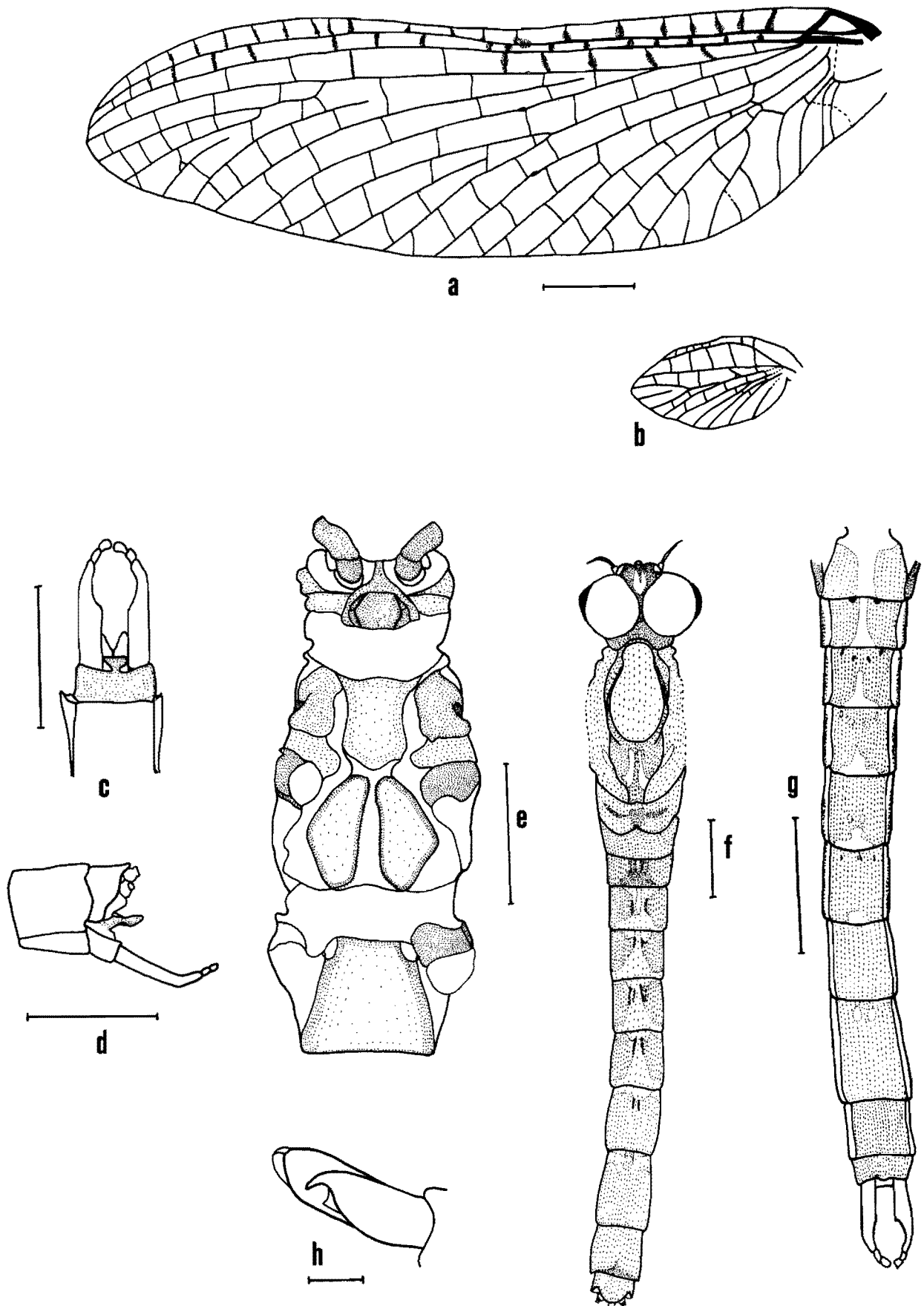


FIG. 17. *Ulmerophlebia pipinna*, male imago: a, fore wing; b, hind wing; c, genitalia, ventral view; d, genitalia, lateral view; e, thoracic sternite; f, dorsal colour pattern; g, ventral abdominal colour pattern; h, fore claws. Scale lines: a-g, 1 mm; h, 0.5 mm.



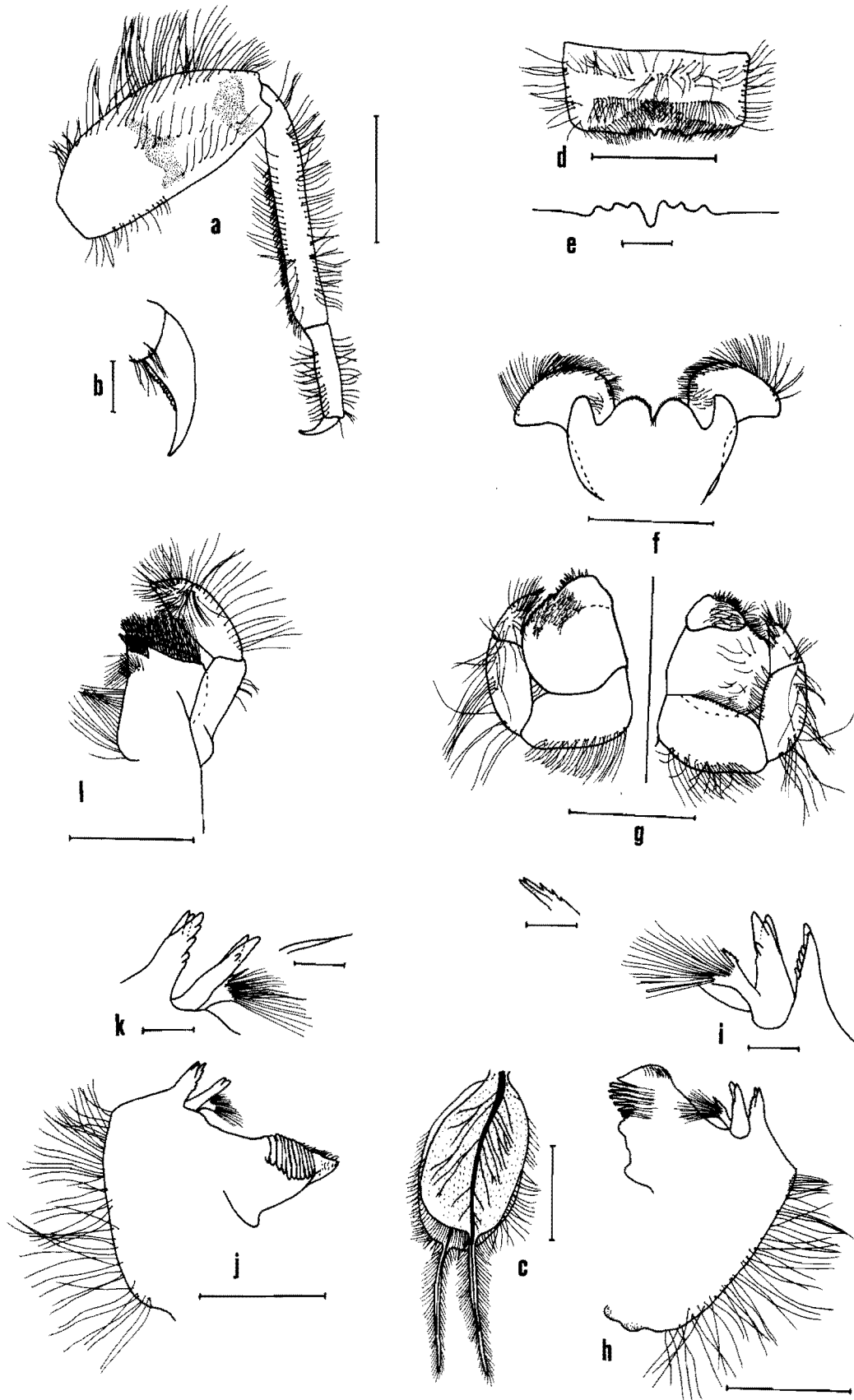


FIG. 18. *Ulmerophlebia pipinna*, mature nymph: a, fore leg; b, fore claw; c, third abdominal gill; d, labrum, dorsal view; e, antero-median emargination of labrum, enlarged; f, hypopharynx; g, labium, dorsal (left) and ventral views; h, left mandible, ventral view; i, left incisors and prostheca, enlarged and prostheca, enlarged; j, right mandible, ventral view; k, right incisors and prostheca, enlarged and prostheca, enlarged; l, left maxilla, ventral view. Scale lines: a, c, d, f, g, h, j, l, 0.5 mm; b, e, i, k, 0.1 mm; prostheca, 0.05 mm.

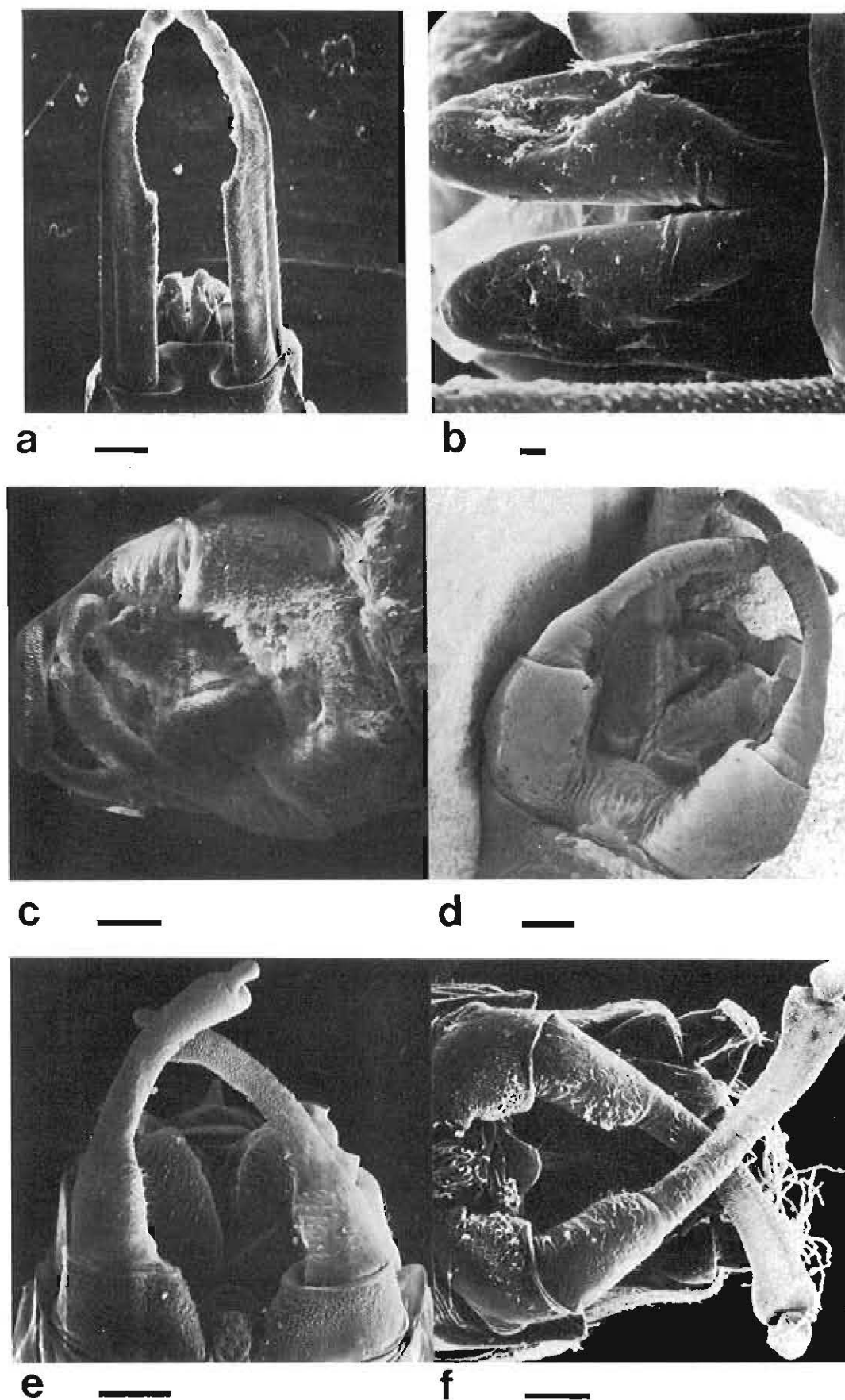


FIG. 19. SEM micrographs of some Australian mayflies. a-b, *Ulmerophlebia pipinna*: a, genitalia, ventral view; b, enlarged ventral view of penes. c-e, ventral view of genitalia of c, *Baetis soror*; d, *Centroptilum elongatum*; e, *Cloeon fluviatile*; f, *Cloeon paradieniensis*. Scale lines: 100  $\mu$ m.

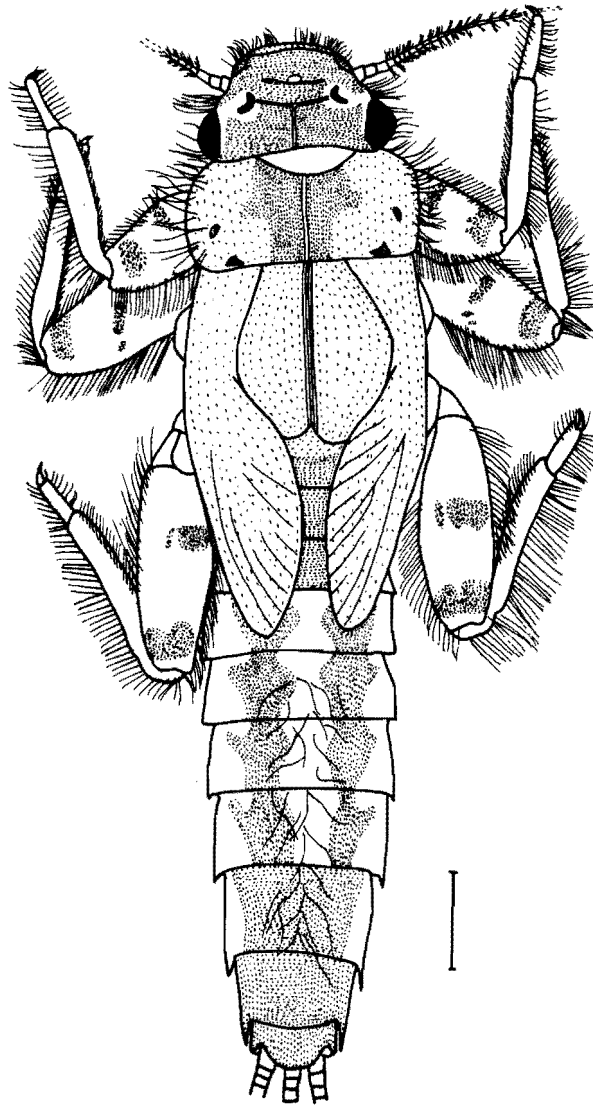


FIG. 20. Dorsal colour pattern of mature female nymph of *Ulmerophlebia pipinna*. Scale line: 1 mm.

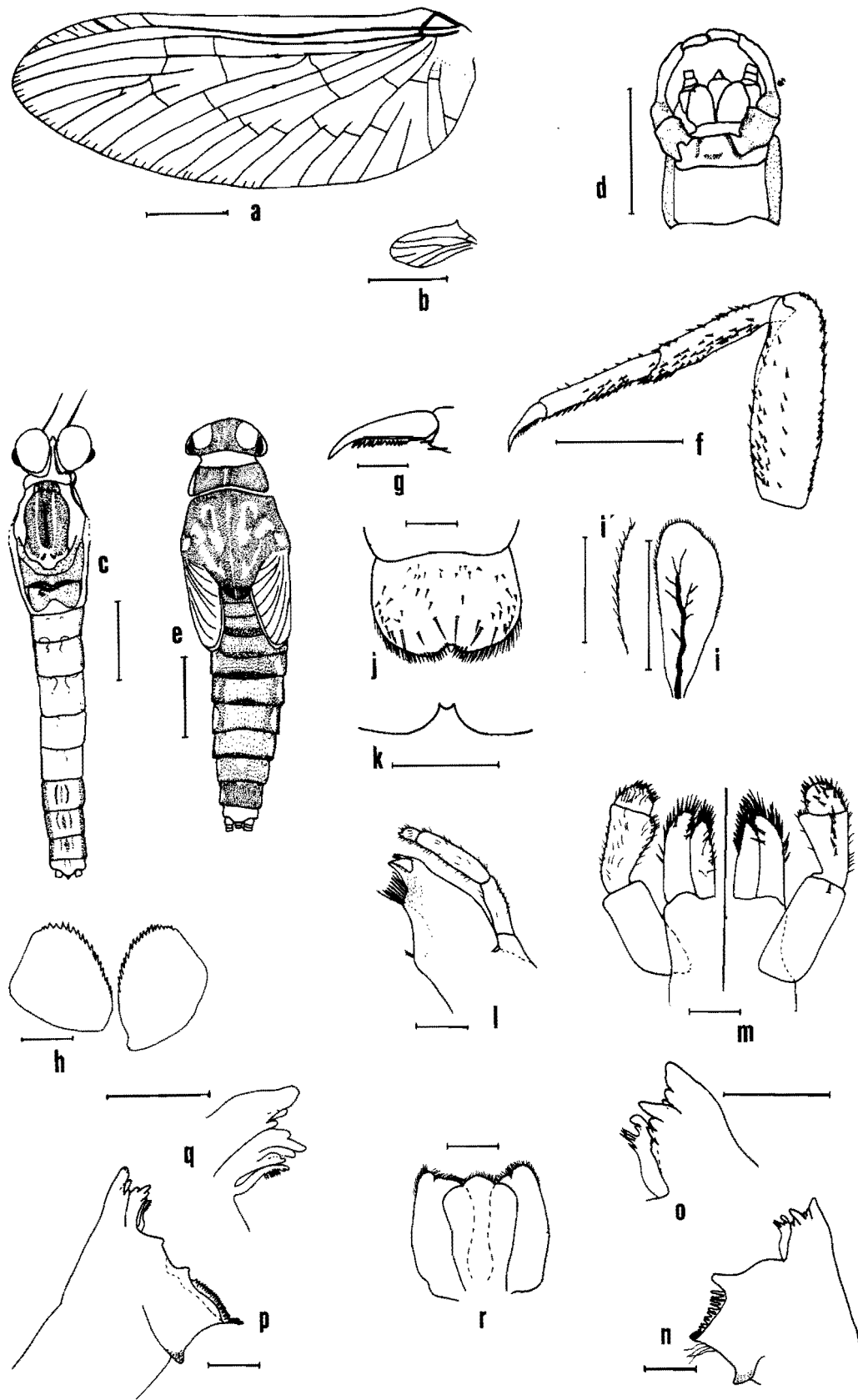


FIG. 21. *Baetis soror*. a-d, male imago: a, fore wing; b, hind wing; c, dorsal colour pattern; d, genitalia, ventral view. e-r, mature nymph: e, dorsal colour pattern; f, fore leg; g, fore claw; h, paraprocts, ventral view; i, third abdominal gill; i, margin of gill, enlarged; j, labrum, dorsal view; k, antero-median emargination of labrum, enlarged; l, left maxilla, ventral view; m, labium, dorsal (left) and ventral views; n, left mandible, ventral view; o, left incisors and prosthema, enlarged; p, right mandible, ventral view; q, right incisors and prosthema, enlarged; r, hypopharynx. Scale lines: a, b, c, e, 1 mm; d, f, i, 0.5 mm; g, h, i, j-r, 0.1 mm.

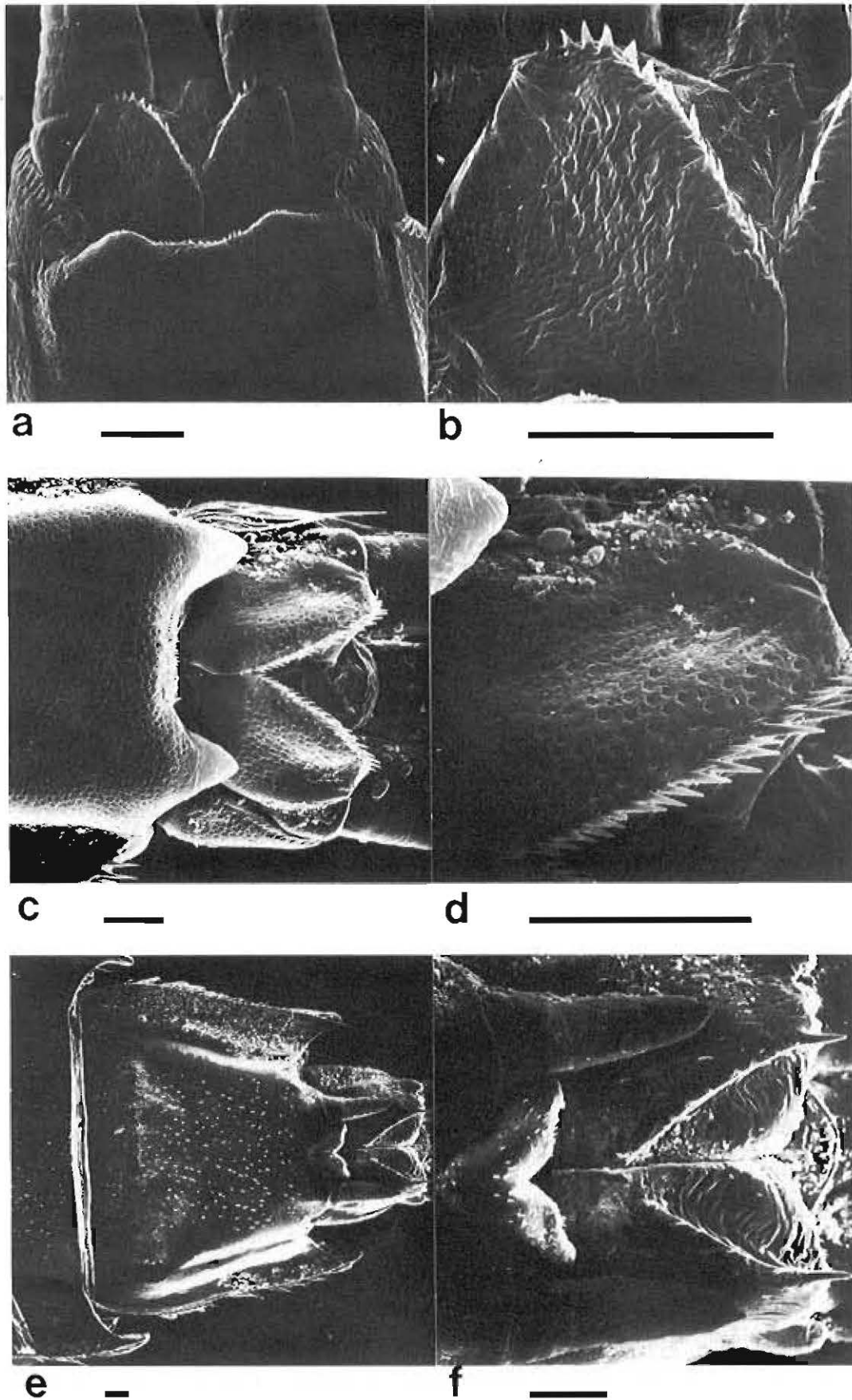


FIG. 22. SEM micrographs of the paraprocts of nymphs of *Baetis soror* (a, b); *Centroptilum elongatum* (c, d) and *Tasmanophlebia* sp. (e, f). Scale lines: 100  $\mu$ m.

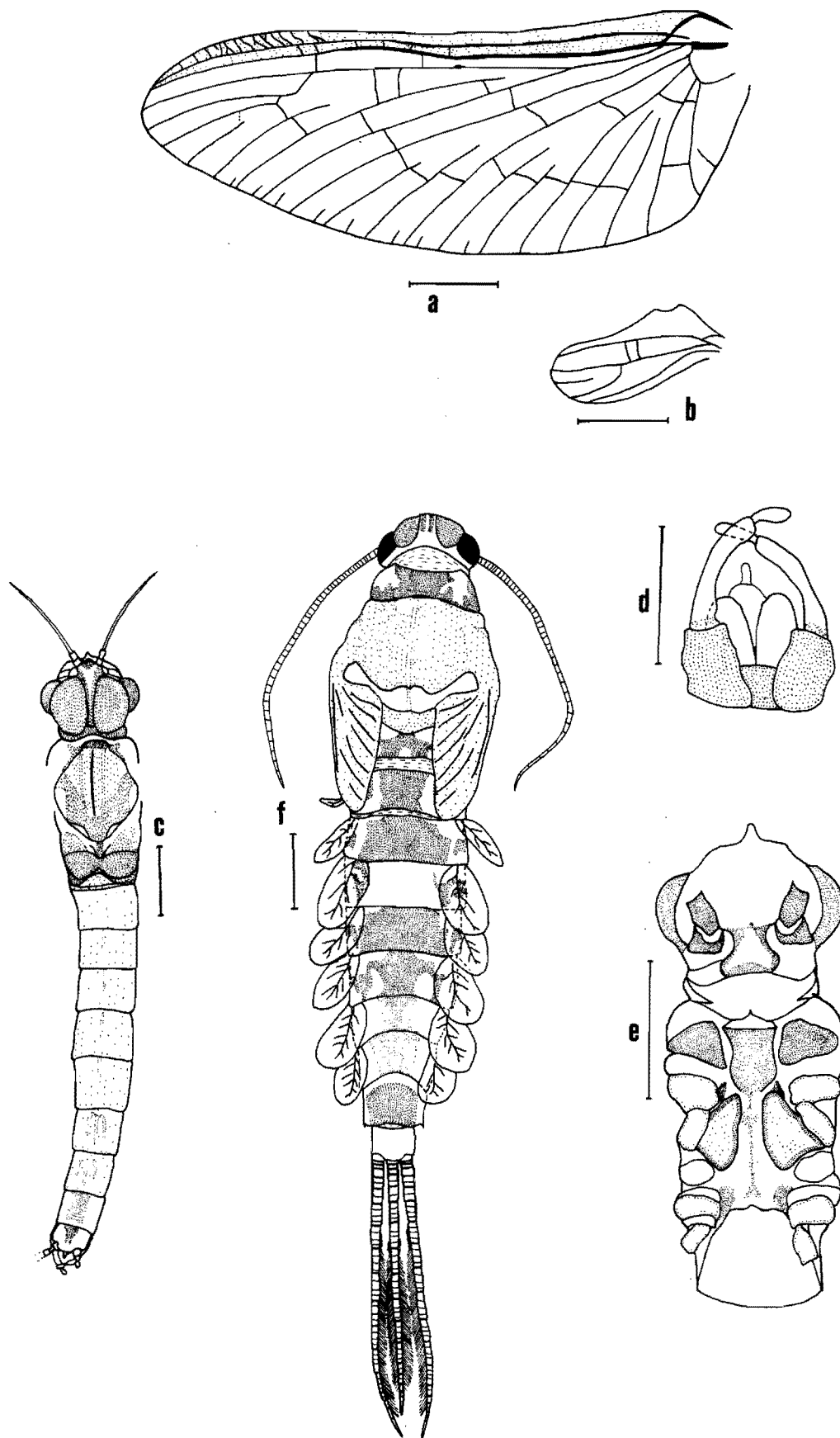


FIG. 23. *Centroptilum elongatum*. a-e, male imago: a, fore wing; b, hind wing; c, dorsal colour pattern; d, genitalia, ventral view; e, thoracic sterna. f, mature nymph: dorsal colour pattern. Scale lines: a, b, c, e, f, 1 mm; d, 0.5 mm.

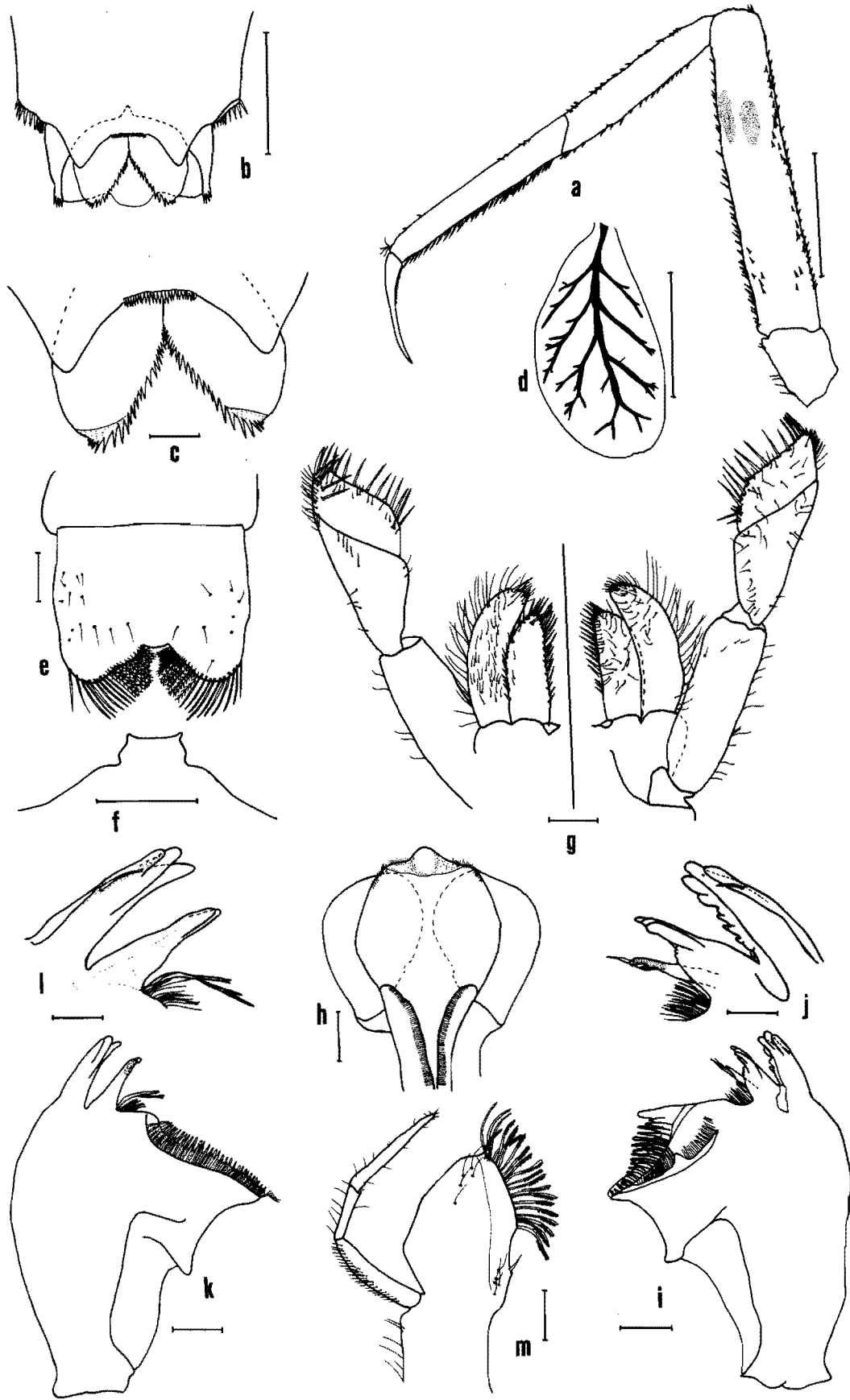


FIG. 24. *Centroptilum elongatum*, mature nymph: a, fore leg; b, paraprocts, ventral view; c, paraprocts, enlarged; d, third abdominal gill; e, labrum, dorsal view; f, antero-median emargination of labrum, enlarged; g, labium, dorsal (left) and ventral views; h, hypopharynx; i, left mandible, ventral view; j, left incisors and prostheca, enlarged; k, right mandible, ventral view; l, right incisors and prostheca, enlarged; m, right maxilla, ventral view. Scale lines: a, b, d, 0.5 mm; c, d, e, f, g, h, i, k, m, 0.1 mm; j, l, 0.05 mm.

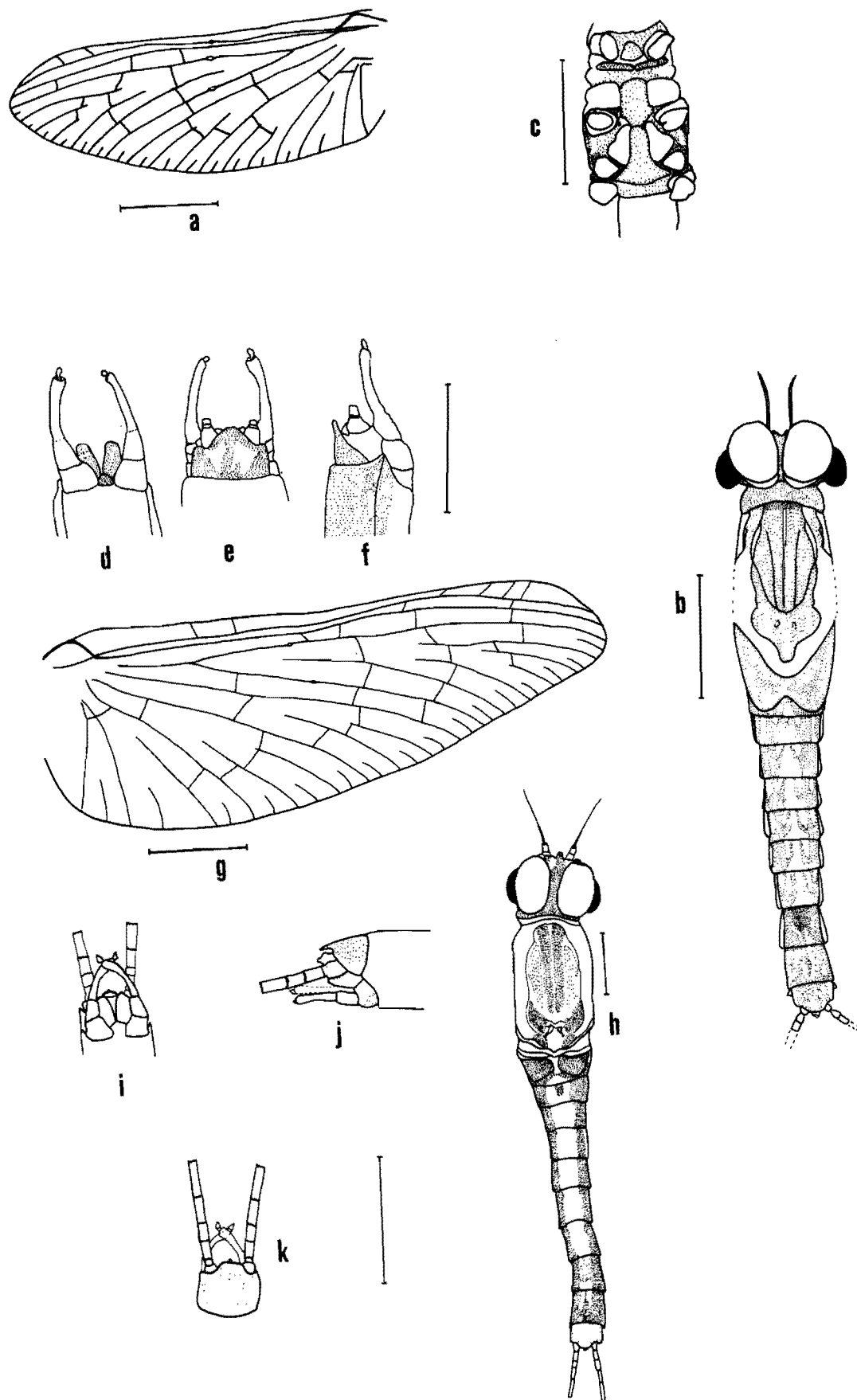


FIG. 25. *Cloeon fluviatile*. a-f, male imago: a, fore wing; b, dorsal colour pattern; c, thoracic sterna; d, genitalia, ventral view; e, genitalia, dorsal view; f, genitalia, lateral view. *Cloeon paradieniensis*. g-k, male imago: g, fore wing; h, dorsal colour pattern; i, genitalia, ventral view; j, genitalia, lateral view; k, genitalia, dorsal view. Scale lines: a, b, c, g-k, 1 mm; d, e, f, 0.5 mm.



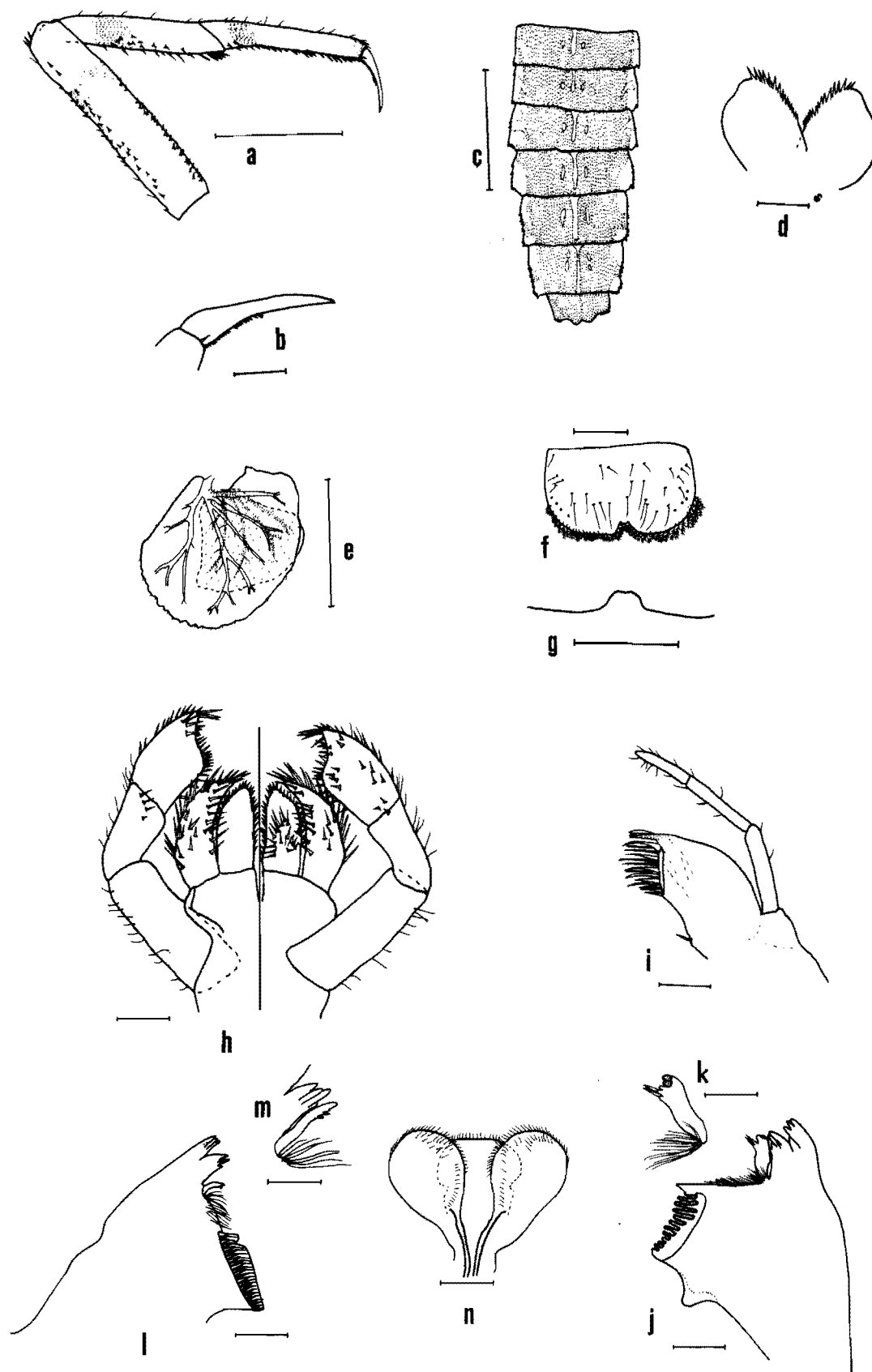


FIG. 26. *Cloeon fluviatile*, mature nymph: a, fore leg; b, fore claw; c, dorsal abdominal colour pattern; d, paraprocts; e, third abdominal gill; f, labrum, dorsal view; g, antero-median emargination of labrum; h, labium, dorsal (left) and ventral views; i, left maxilla, ventral view; j, left mandible, ventral view; k, left prostheca, enlarged; l, right mandible, ventral view; m, left prostheca, enlarged; n, hypopharynx. Scale lines: c, 1 mm; a, e, 0.5 mm; b, d, f-j, l, n, 0.1 mm; k, m, 0.05 mm.

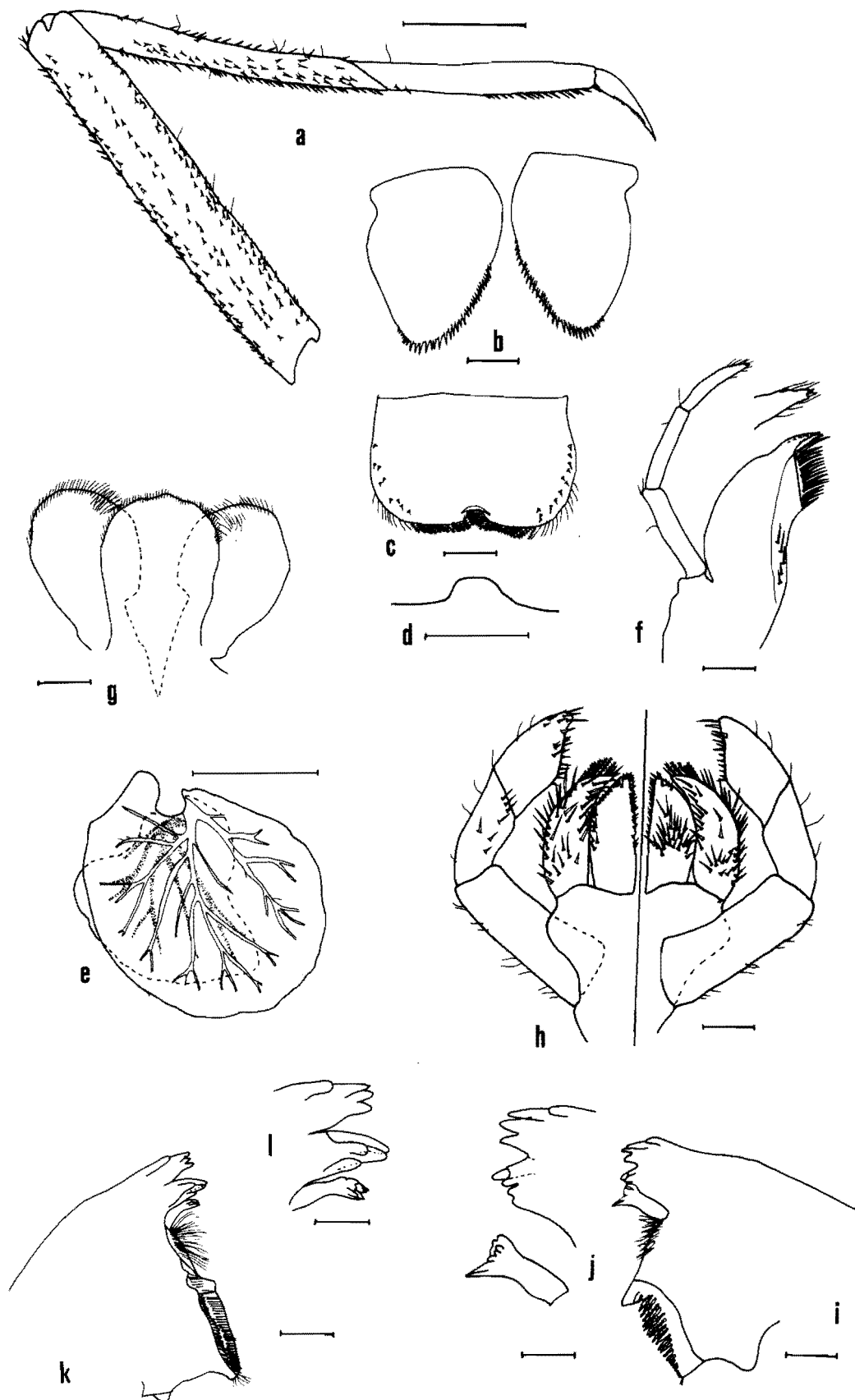


FIG. 27. *Cloeon paradieniensis*, mature nymph: a, fore leg; b, paraprocts; c, labrum, dorsal view; d, antero-median emargination of labrum; e, third abdominal gill; f, right maxilla, ventral view, with enlarged apex of terminal segment of the palp; g, hypopharynx; h, labium, dorsal (left) and ventral views; i, left mandible, ventral view; j, left incisors and prosthema, enlarged; k, right mandible, ventral view; l, right incisors and prosthema, enlarged. Scale lines: a, e, 0.5 mm; b-d, f-i, k, 0.1 mm; j, l, 0.05 mm.

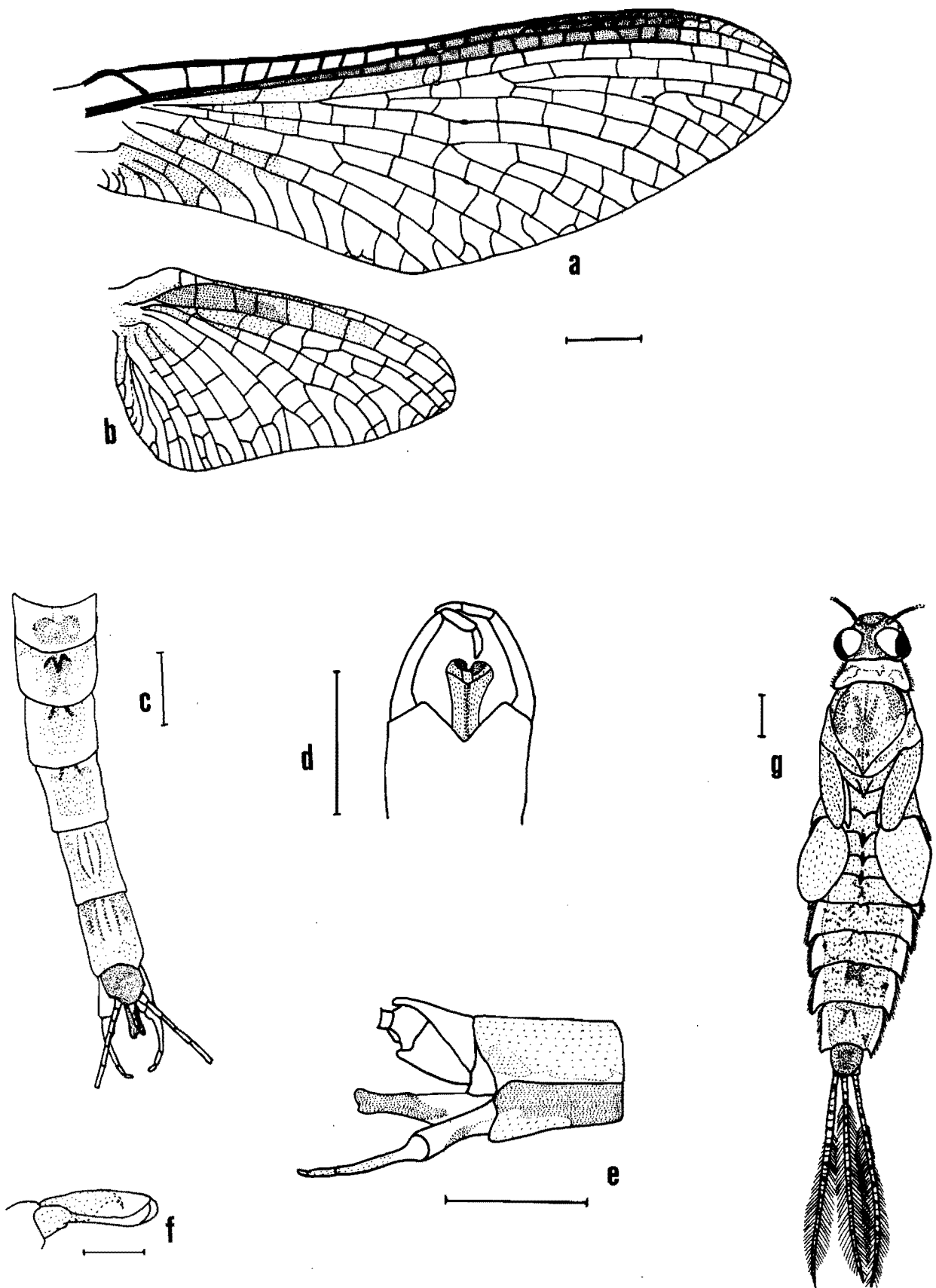


FIG. 28. *Tasmanophlebia* sp. a-f, male imago: a, fore wing; b, hind wing; c, dorsal abdominal colour pattern; d, genitalia, ventral view; e, genitalia, lateral view; f, fore claws. g, mature nymph: dorsal colour pattern. Scale lines: a-e, g, 1 mm; f, 0.1 mm.

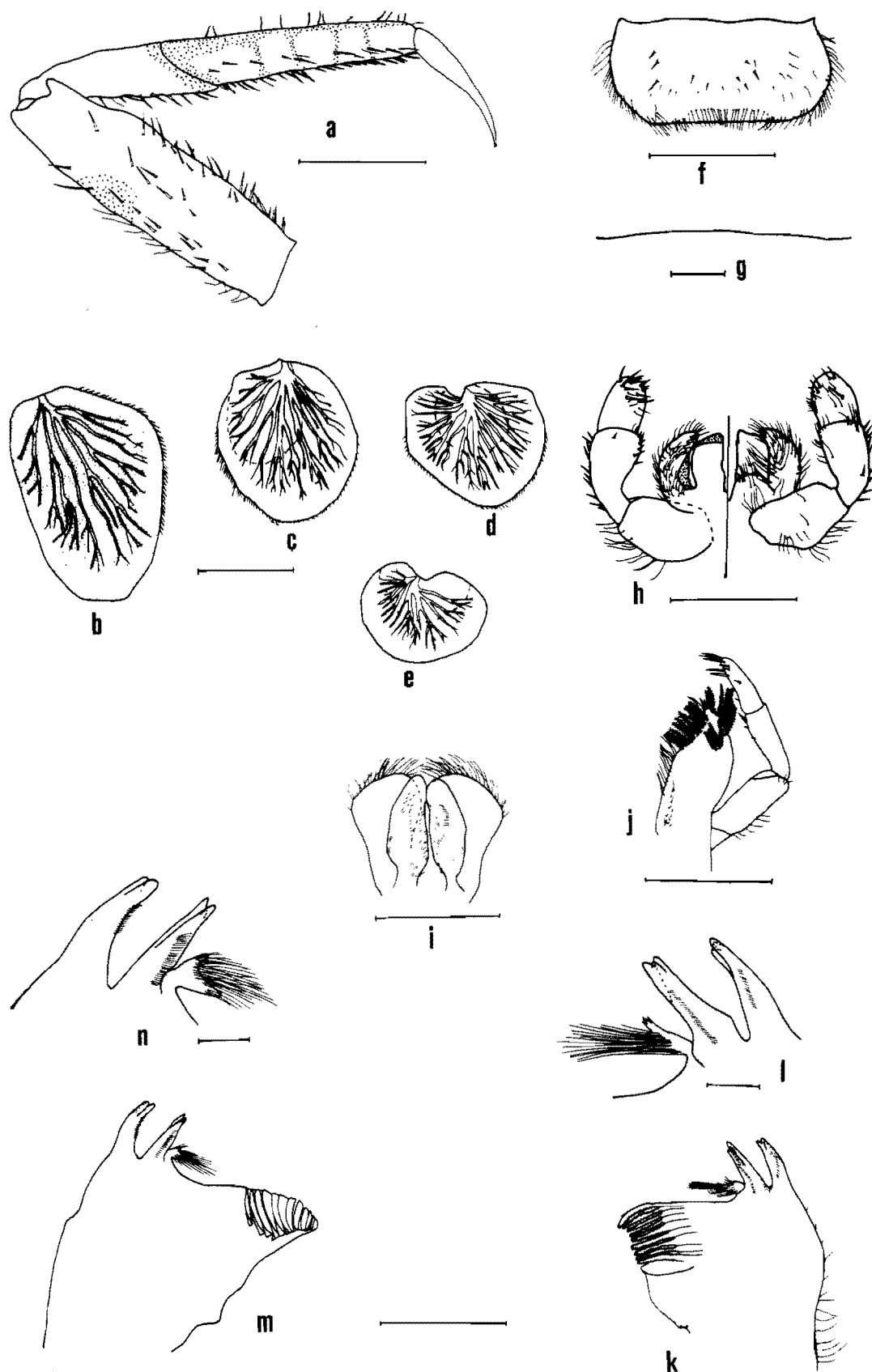


FIG. 29. *Tasmanophlebia* sp. mature nymph: a, fore leg; b, first abdominal gill; c, second abdominal gill; d, third abdominal gill; e, fourth abdominal gill; f, labrum, dorsal view; g, antero-median emargination, enlarged; h, labium, dorsal (left) and ventral views; i, hypopharynx; j, left maxilla, ventral view; k, left mandible, ventral view; l, left incisors and prostheca, enlarged; m, right mandible, ventral view; n, right incisors and prostheca, enlarged. Scale lines: b-e, 1 mm; a, f, h-k, m, 0.5 mm; g, l, n, 0.1 mm.

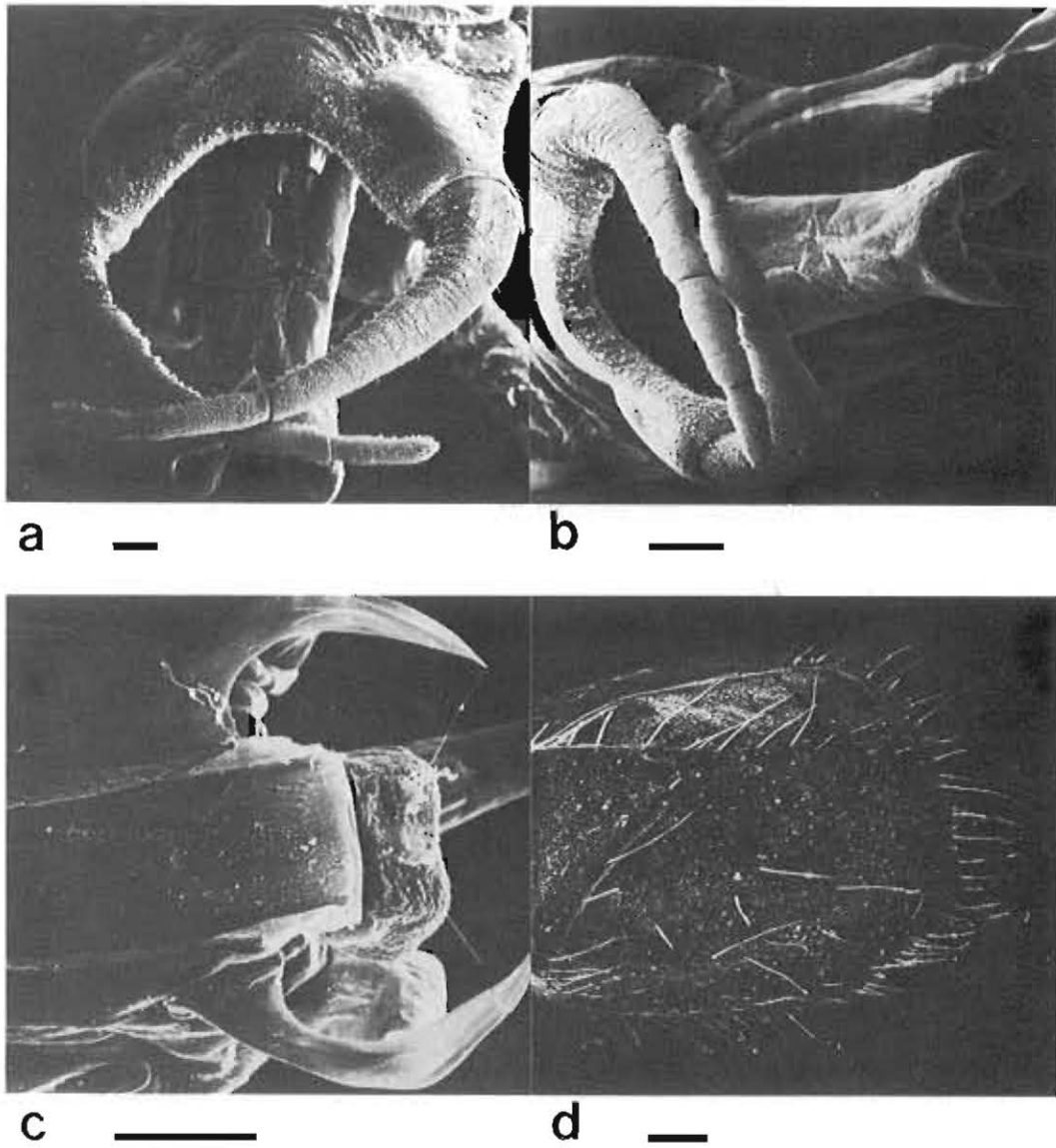


FIG. 30. SEM micrographs of *Tasmanophlebia* sp. and *Tasmanocoenis tillyardi*. *Tasmanophlebia* sp. a, b, genitalia of male imago, ventral views. *Tasmanocoenis tillyardi*. c, genitalia of male imago, ventral view; d, second gill of mature nymph. Scale lines: 100  $\mu$ m.

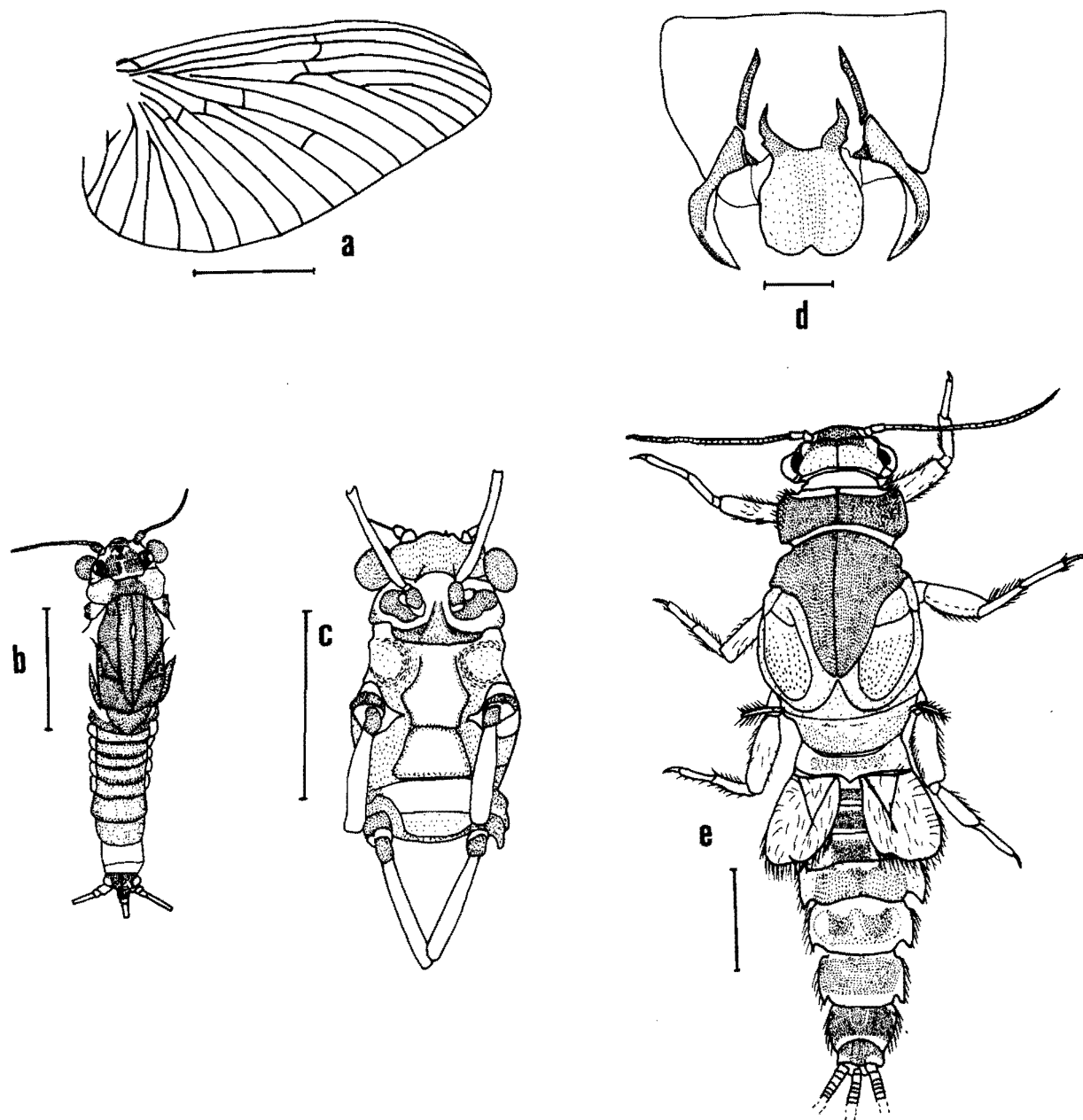


FIG. 31. *Tasmanocoenis tillyardi*. a-d, male imago: a, fore wing; b, dorsal colour pattern; c, thoracic sterna; d, genitalia, ventral view. e, mature nymph: dorsal colour pattern. Scale lines: a-c, e, 1 mm; d, 0.1 mm.

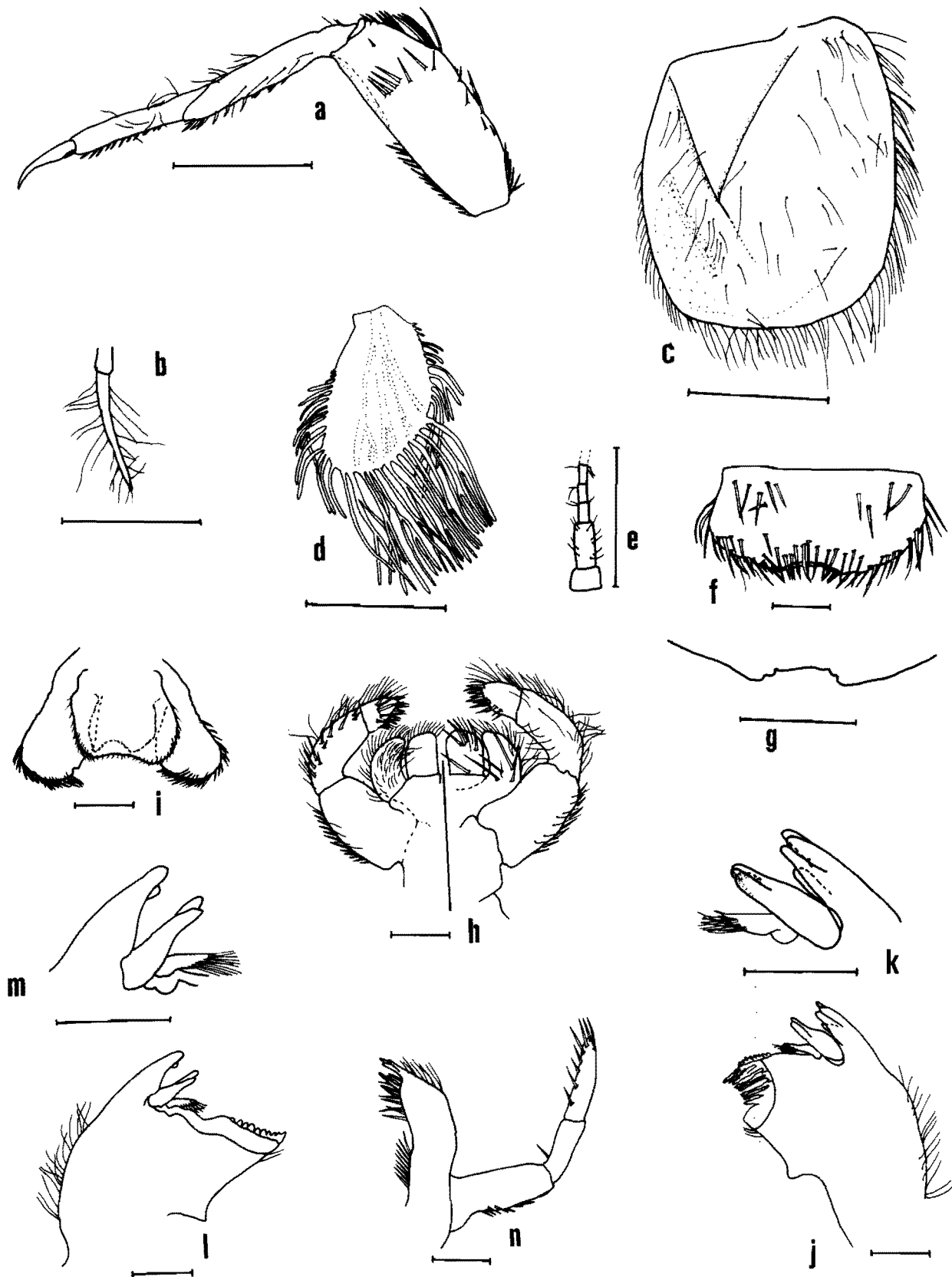


FIG. 32. *Tasmanocoenis tillyardi*, mature nymph: a, fore leg; b, first abdominal gill; c, second abdominal gill; d, third abdominal gill; e, basal antennal segments; f, labrum, dorsal view; g, antero-median emargination of labrum, enlarged; h, labium, dorsal (left) and ventral views; i, hypopharynx; j, left mandible, ventral view; k, left incisors and prosthema, enlarged; l, right mandible, ventral view; m, right incisors and prosthema, enlarged; n, left maxilla, ventral view. Scale lines: a-e, 0.5 mm; f-n, 0.1 mm.