

# Revision of the genus *Innobindus* Jacobi (Hemiptera: Fulgoromorpha: Cixiidae) with the description of six new species and comments on other Australian Brixini genera

Birgit Löcker,<sup>1</sup> Murray J Fletcher<sup>1,2\*</sup> and Geoff M Gurr<sup>1,3</sup>

<sup>1</sup>Pest Biology and Management Group, University of Sydney, Sydney, NSW 2006, Australia

<sup>2</sup>Department of Primary Industries, Orange Agricultural Institute, Forest Road, Orange, NSW 2800, Australia

<sup>3</sup>School of Rural Management, Charles Sturt University, Orange, NSW 2800, Australia

## Abstract

Australian planthoppers of the genus *Innobindus* Jacobi are revised. A lectotype for *Innobindus multimaculatus* Jacobi is designated and six new species of *Innobindus* are described: *I. alternans*, *I. collessi*, *I. licinus*, *I. marginatus*, *I. robiniae* and *I. unicornis*. Maps of the known distribution for the species of *Innobindus* are presented and discussed. The Australian Brixini fauna, which appears to be restricted in distribution to Queensland and New South Wales, comprises a further two genera: *Solonaima* Kirkaldy and *Undarana* Hoch & Howarth. The majority of Brixini, including *Innobindus*, is non-cavernicolous; however, eight species within the genera *Solonaima* and *Undarana* have adapted to life in lava tubes and limestone caves. A key to genera and a checklist of the Australian species are presented.

**Key words** Auchenorrhyncha, Australia, *Solonaima*, sp.n., *Undarana*.

## INTRODUCTION

The Brixini (Hemiptera: Fulgoromorpha: Cixiidae) comprises eight genera from the Ethiopian, Oriental and Australian Regions (Emeljanov 2002), and three of these genera, *Innobindus* Jacobi, *Solonaima* Kirkaldy and *Undarana* Hoch & Howarth, are represented in Australia. Despite the majority of cixiids living above ground, six species of *Solonaima* and two species of *Undarana* are cavernicolous, living in limestone caves and lava tubes of northern Queensland (Hoch 1988, 2002; Hoch & Asche 1988; Hoch & Howarth 1989a,b,c; Erbe & Hoch 2004; Soulier-Perkins 2005). These species display varying degrees of cave adaptation such as a more planate body form, pilose antennae and clypeus, specialised hind tibial spination, a wax fringe on the wings, loss of pigment and reduction of eyes and wings (Hoch 2002; Hoch & Asche 1988; Hoch & Howarth 1989c). Nymphs and adults of cavernicolous species feed on tree roots that extend into the caves (Hoch & Asche 1988).

In our review of the Australian fauna, six undescribed species of the genus *Innobindus* Jacobi have been discovered and these are described below including a redescription of *Innobindus multimaculatus* Jacobi. Information provided on data labels of the specimens examined (e.g. light trap, flight inter-

cept trap, pyrethrum knockdown, malaise trap, pitfall trap, collected in rainforest) suggests that the species of this genus are non-cavernicolous. The habitat of nymphs remains unknown.

## MATERIALS AND METHODS

### Preparation of male genitalia

Male specimens were softened and dissected following the protocol described by Löcker *et al.* (2006).

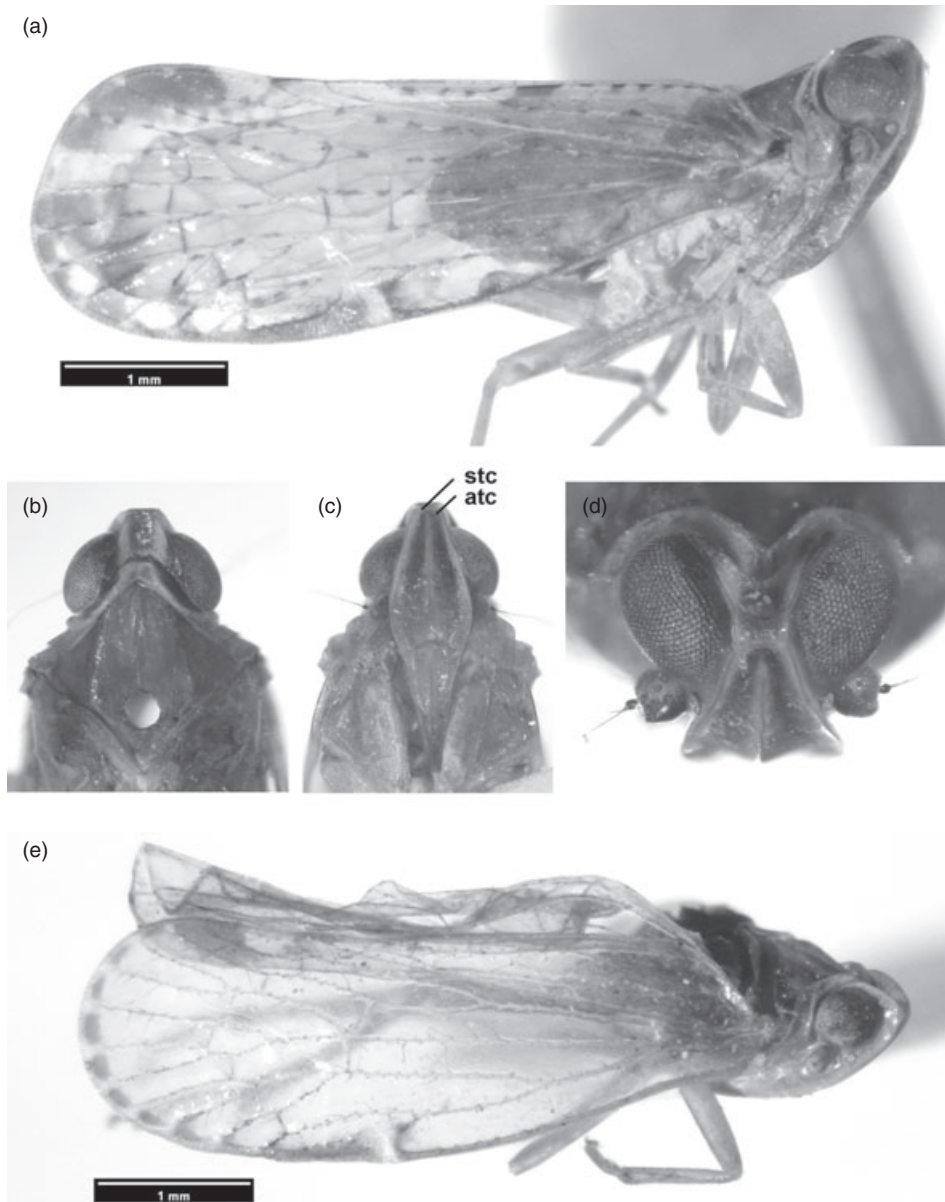
### Measurements

The morphological terms applied here are as used by Löcker *et al.* (2006) and illustrated in Figure 1c, except for the nomenclature applied in this paper to the venation of the tegmen, which follows Anufriev and Emeljanov (1988), and differs slightly from that applied in Löcker *et al.* (2006).

The following measurements were taken in this study:

- Body length: tip of head to posterior margin of forewing
- Width of vertex: width level with tip of basal emargination
- Length of vertex: subapical transverse carina to tip of basal emargination
- Length of frons: apical transverse carina to frontoclypeal suture, in median line

\*murray.fletcher@dpi.nsw.gov.au



**Fig. 1.** *Innobindus licinus*: (a) habitus; (b–d) head. *Innobindus marginatus*: (e) habitus. atc, apical transverse carina; stc, subapical transverse carina.

- Width of frons: at level of frontoclypeal suture
- Width of forewing: at level of apex of clavus
- Length of forewing: base to posterior margin of forewing

Abbreviations:

ANZSES: Australian and New Zealand Scientific Exploration Society Inc.

AMS: Australian Museum, Sydney

ANIC: Australian National Insect Collection, CSIRO, Canberra

NHRS: Naturhistoriska Riksmuseet, Stockholm

NSW: New South Wales

NZAC: New Zealand Arthropod Collection, Auckland

Qld: Queensland

QM: Queensland Museum, Brisbane

SAMA: South Australian Museum, Adelaide

UQIC: University of Queensland Insect Collection, Brisbane.

© 2007 The Authors

Journal compilation © 2007 Australian Entomological Society

**RESULTS**

**Key to Australian genera of Brixiini**

- 1 Pedicel of antennae at least 3× longer than its diameter (Fig. 6a) .....*Solonaima* Kirkaldy
- Pedicel of antennae not longer than twice its diameter (Figs 1d,6b) ..... 2
- 2(1) Vertex about 6× wider than long, bent ventrad (Fig. 6c) .....*Undarana* Hoch & Howarth
- Vertex less than 3× wider than long, facing dorsad (Fig. 5b) .....*Innobindus* Jacobi

A checklist of the known species of Brixiini is presented in Table 1.

**Genus *Innobindus* Jacobi**

*Innobindus* Jacobi, 1928: 31.

**Table 1** Species list of Australian Brixiini

---

Genus *Innobindus* Jacobi, 1928: 31

*licinus* group

*Innobindus licinus* Löcker sp.n.

*Innobindus marginatus* Löcker sp.n.

*Innobindus robiniae* Löcker sp.n.

*multimaculatus* group

*Innobindus alternans* Löcker sp.n.

***Innobindus multimaculatus*** Jacobi, 1928: 31

*Innobindus collessi* Löcker sp.n.

*Innobindus unicornis* Löcker sp.n.

Genus *Solonaima* Kirkaldy, 1906: 396

*Talaola* Distant, 1907: 294, synonymised by Muir, 1925: 104

\**Solonaima baylissa* Hoch & Howarth, 1989b: 395

*Solonaima bifurca* Hoch, 1988: 126

*Solonaima cedrivula* Hoch, 1988: 131

\**Solonaima halos* Hoch & Howarth, 1989b: 393

\**Solonaima irvini* Hoch & Howarth, 1989b: 395

*Solonaima minuta* Hoch, 1988: 132

*Solonaima monteithia* Erbe & Hoch, 2004: 4

*Solonaima nielsenii* Erbe & Hoch, 2004: 2

*Solonaima ornata* Hoch, 1988: 132

*Solonaima pallescens* Distant, 1907: 295

\**Solonaima pholetor* Hoch & Howarth, 1989b: 388

*Solonaima riocampa* Hoch, 1988: 129

***Solonaima solonaima*** Kirkaldy, 1906: 397

\**Solonaima stonei* Hoch & Howarth, 1989b: 391

\**Solonaima sullivani* Hoch & Howarth, 1989b: 388

Genus *Undarana* Hoch & Howarth, 1989a: 180

***Undarana tamborina*** Hoch & Howarth, 1989a: 182

*Undarana gloriosa* Hoch & Howarth, 1989a: 184

*Undarana towomba* Hoch & Howarth, 1989a: 186

*Undarana daybora* Hoch & Howarth, 1989a: 190

\**Undarana rosella* Hoch & Howarth, 1989a: 192

\**Undarana collina* Hoch & Howarth, 1989a: 192

---

Type species are in bold. Cavernicolous species are marked with an asterisk.

Type species *I. multimaculatus* Jacobi, 1928, by monotypy.

**Colour.** Body brown; forewing hyaline, colourless, sometimes with scattered brown marks and darker crossveins, legs light brown.

**Morphology.** Body length: ♂ 5.0–7.4 mm, ♀ 5.7–7.4 mm.

**Head:** Vertex with u- or v-shaped basal emargination; lateral carinae strongly elevated; median carina absent or present; apical and subapical carina well developed, straight or slightly curved, forming a rectangle (Fig. 4e–g). Maximum width of frons more than 2× apical width, evenly widening from apex to maximum width which is distinctly dorsad of centre of frontoclypeal suture; lateral carinae extending laterally, concealing base of antennae; median carina incomplete; frontoclypeal suture slightly semicircular bent upwards, median part not reaching level with lower margin of antennal scape; median ocellus present. Median and lateral carinae of postclypeus well developed; median carina of anteclypeus well developed; lateral carinae absent. Rostrum surpassing hind coxae.

**Thorax:** Pronotum with hind margin rectangular to slightly obtusely angled; median carina present. Mesonotum with 3

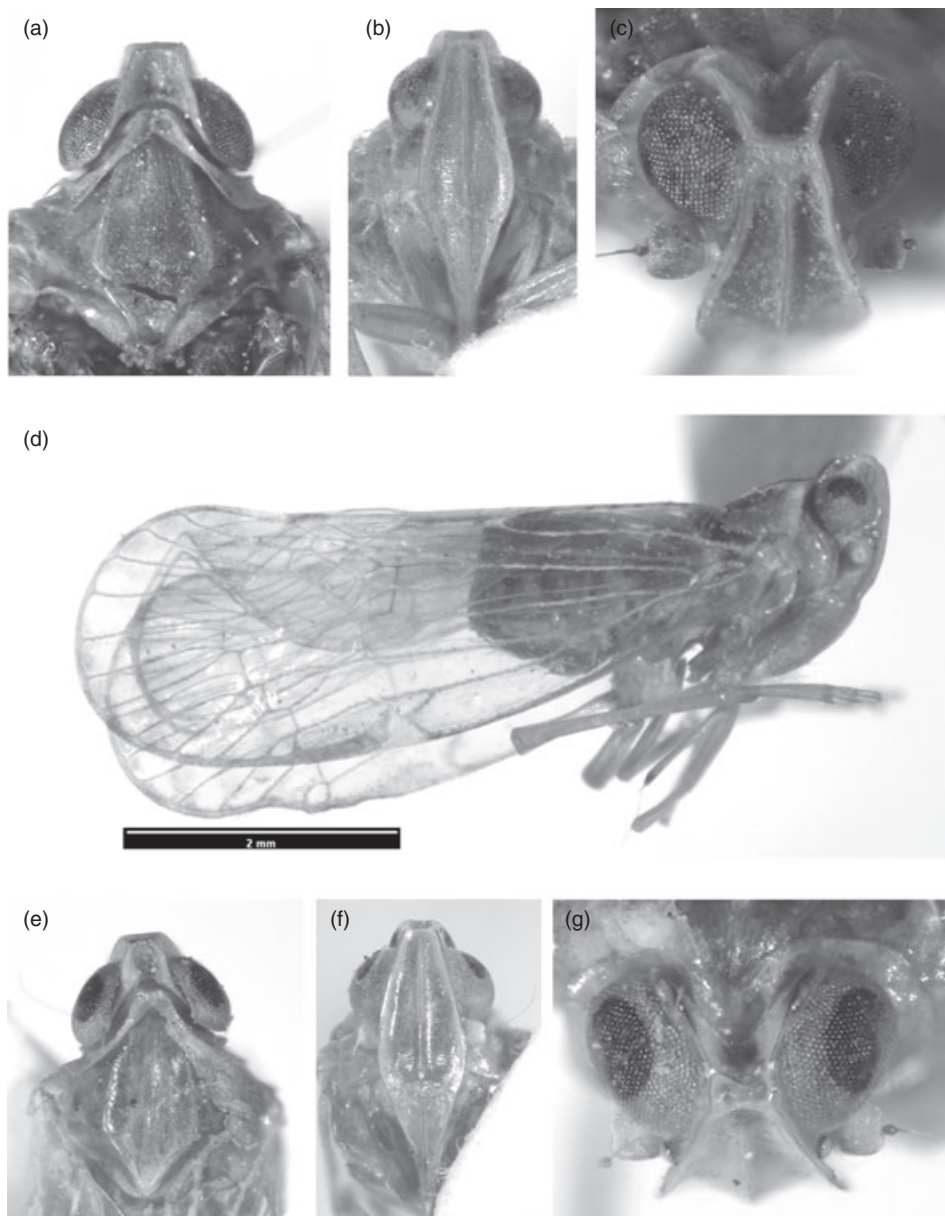
well-developed carinae. Forewing in resting position steeply tectiform, apices of wings touching; concavity at costal border; tubercles along veins; Sc+R+M forming a common stem; fork of ScRA+RP basad of fork of CuA1+CuA2; position of r-m at same level as or slightly basad of fork of MA+MP; icu distinctly distad of apex of clavus; RP apically trifid; additional subapical cell between branches of RP present; MA apically trifid; MP apically bifid; additional subapical cell between branches of MA present; fork of PCu+A1 distad of centre of clavus (rarely central within clavus); 10 (rarely 11) apical cells. Hind leg: tibia with 6 apical teeth forming uninterrupted row of spines or small gap present, dividing spines in two groups of three teeth; 1st tarsomere with 7 (rarely 8) apical teeth; 2nd tarsomere with 8 (rarely 7) apical teeth; tarsomeres usually without platellae; 2nd tarsomere with 0–3 fine setae underneath row of apical teeth.

**Distribution.** Queensland, NSW.

### Key to Australian species of *Innobindus* Jacobi

Note: This key is mainly based on male specimens, which means females can only be identified to the level of species group.

- 1 Lateral carinae of frons strongly elevated; median carina of frons incomplete, covering less than 3/4 of frons (Figs 3c,4b,f,5c); lateral carinae of frons continuous with those of clypeus (Figs 3c,4b,f,5c).....*multimaculatus* group...2
- Lateral carinae of frons slightly elevated; median carina of frons incomplete, covering more than 4/5 of frons (Figs 1c,2b,f); lateral carinae of frons and clypeus not continuous (Figs 1c,2b,f).....*licinus* group...5
- 2(1) Phallotheca right lateral with medium-sized spine (Fig. 10a); ventral with pair of very small spines as in Figure 10a.....*I. alternans* Löcker, sp.n.
- Phallotheca left lateral with medium-sized to very long spine (Figs 11a,12a,13a); ventral and right lateral without spines .....3
- 3(2) Phallotheca left lateral with very long spine (Fig. 12a).....*I. multimaculatus* Jacobi
- Phallotheca left lateral with medium-sized spine (Figs 11a,13a).....4
- 4(3) Flagellum left lateral with small spine as in Figure 13a; phallotheca ventral with medium-sized ridge as in Figure 13a .....*I. unicornis* Löcker, sp.n.
- Flagellum unarmed; phallotheca ventral with small ridge as in Figure 11a .....*I. collessi* Löcker, sp.n.
- 5(1) Phallotheca ventral with very long spine (b') with its tip curved caudad (Fig. 7a).....*I. licinus* Löcker, sp.n.
- Phallotheca ventral with short or medium-sized spine (b') with its tip curved dorsad or cephalad (Figs 8a,9a,b).....6
- 6(5) Phallotheca ventral with medium-sized spine (b') with its tip curved dorsad (Fig. 9a,b).....*I. robiniae* Löcker, sp.n.



**Fig. 2.** *Innobindus marginatus*: (a–c) head. *Innobindus robiniae*: (d) habitus; (e–g) head.

- Phallosome ventral with short spine (b') with its tip curved cephalad (Fig. 8a).....  
 .....*I. marginatus* Löcker, sp.n.

- Innobindus licinus* Löcker, sp.n.
- Innobindus marginatus* Löcker, sp.n.
- Innobindus robiniae* Löcker, sp.n.

**licinus group**

These 3 species share the following attributes and are therefore grouped together as the *licinus* group: vertex with or without median carina; lateral carinae of frons slightly elevated; median carina of frons incomplete, covering more than 4/5 of frons; lateral carinae of frons and clypeus not continuous; genital styles and ventromedian process as in Figures 7d, 8d and 9d; phallosome with 3–4 spines and a pair of very small, ventral spines arranged as in Figures 7a, 8a and 9a,b; flagellum unarmed.

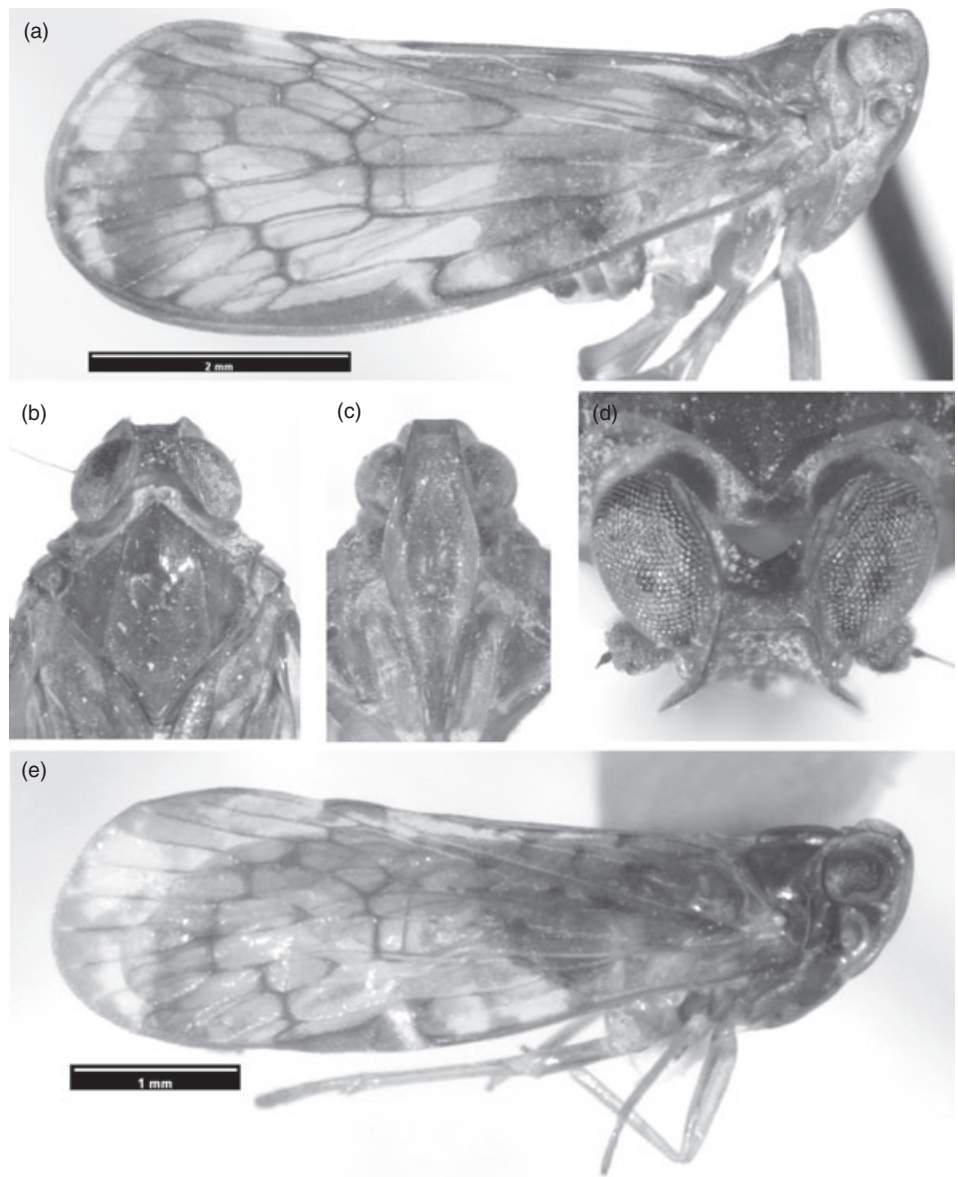
***Innobindus licinus* Löcker, sp.n. (Figs 1a–d, 7, 14a)**

**Types.** *Holotype*, ♂, **Australia, NSW**: 5 miles NW of Coffs Harbour, 800 ft, 1.xi.1965 (M.S. Upton) (ANIC), *Paratypes*, **NSW**: 6 ♂, 1 ♀, same data as holotype (ANIC).

**Etymology.** The Latin term 'licinus' means 'bent or turned upward'. Named after the upwardly curved spine (b) on the phallosome.

**Colour.** Vertex mid- to dark brown with 2 light brown stripes; face light brown, disc of frons darker; pronotum light brown, mesonotum darker; forewing hyaline, colourless with scattered brown marks, veins light brown with darker sections,





**Fig. 3.** *Innobindus alternans*: (a) habitus; (b–d) head. *Innobindus collessi*: (e) habitus.

crossveins and pterostigma mid-brown, tubercles concolorous with veins; legs light brown; abdominal sternites mid-brown. **Morphology.** Body length: ♂ 5.1–5.8 mm, ♀ 6.1 mm.

**Head:** Vertex 0.6–0.7× as long as wide. Frons 2.0–2.2× longer than wide.

**Thorax:** Forewing 3.0–3.2× longer than wide; MP apically bifid; costa with 16–23 tubercles; 10 apical cells. Hind leg: tibia with 1–5 very small lateral spines; tibia with 6 apical teeth forming uninterrupted row of spines; 1st tarsomere with 7 apical teeth; 2nd tarsomere with 8 apical teeth and 2–3 very fine setae underneath row of apical teeth, without platellae.

**Male genitalia:** Anal tube as in Figure 7b,c; genital styles and ventromedian process as in Figure 7d,e. Aedeagus (Fig. 7a): Phallosome ventral with pair of very small spines (a') and very long, strongly curved spine (b') with its tip curved caudad (upwards); left lateral with sinuate spine (c'); dorsal with slightly curved spine (d'). Flagellum unarmed.

***Innobindus marginatus* Löcker, sp.n.**  
(Figs 1e, 2a–c, 8, 14b)

**Types.** *Holotype*, ♂, **Australia, Qld:** National Park [Lamington NP], xii.1921 (H. Hacker) (QM QMT.133350), *Paratypes*, **Qld:** 1 ♂, same data as holotype (QM).

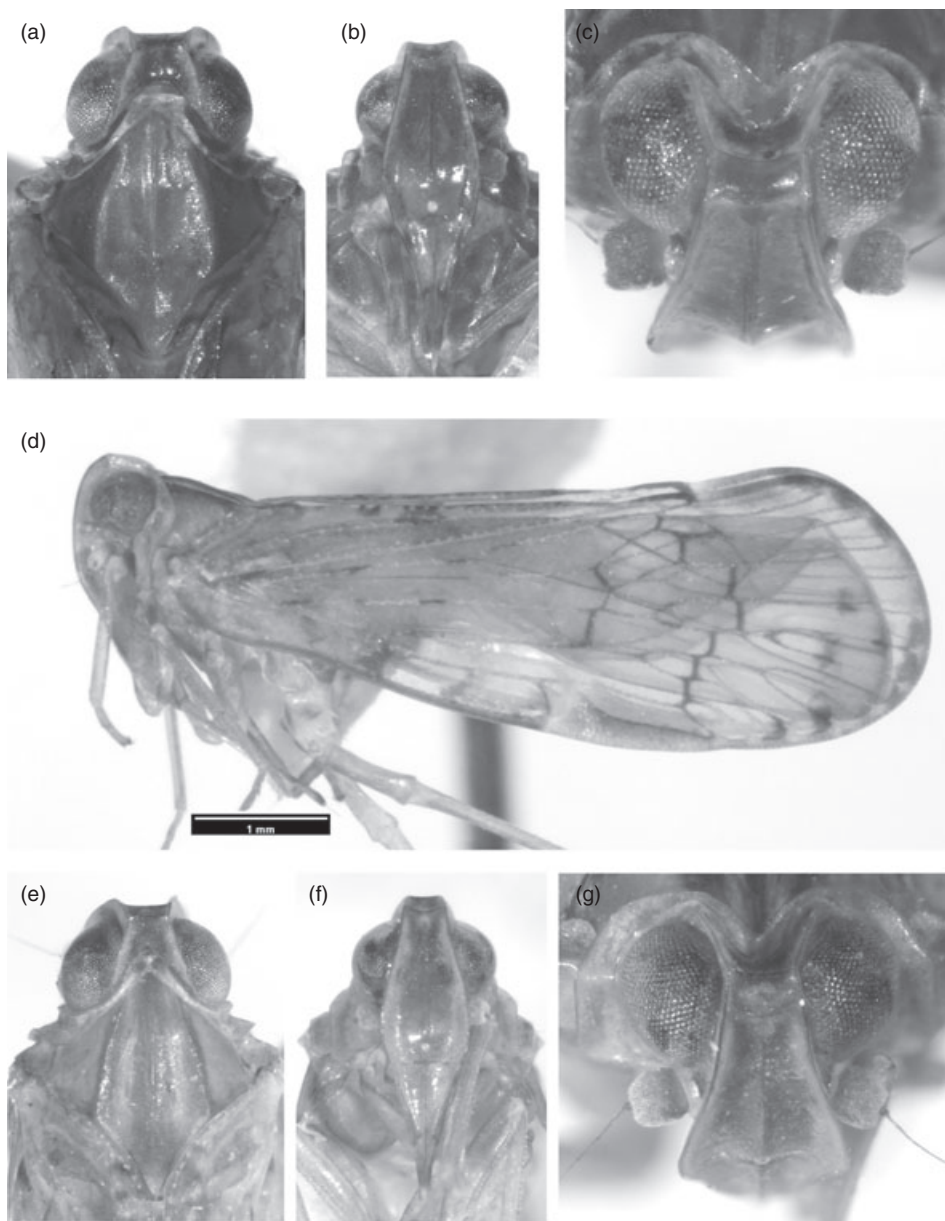
**Etymology.** Named after the distinctly coloured border of the wing.

**Colour.** Body light brown, forewing hyaline, colourless with brown marks (mainly along the apex of wing as in Fig. 1e), veins and tubercles light brown, pterostigma mid-brown; legs light brown.

**Morphology.** Body length: ♂ 5.3 mm.

**Head:** Vertex 0.7× as long as wide. Frons 2.1× longer than wide.

**Thorax:** Forewing 3.0× longer than wide; MP apically bifid; costa with 16–19 tubercles; 10 apical cells. Hind leg:



**Fig. 4.** *Innobindus collessi*: (a–c) head. *Innobindus multimaculatus*: (d) habitus; (e–g) head.

tibia with 2–3 very small lateral spines; tibia with 6 apical teeth forming uninterrupted row of spines; 1st tarsomere with 7 apical teeth; 2nd tarsomere with 8–9 apical teeth and 6–7 platellae, without fine setae.

**Male genitalia:** Anal tube as in Figure 8b,c; genital styles and ventromedian process as in Figure 8d,e. Aedeagus (Fig. 8a): Phallosome ventral with pair of very small spines (a') and short, slender spine (b') with its tip curved cephalad; left lateral with medium-sized, sclerotised spine (c'); dorsal with medium-sized, less sclerotised spine (d'); left lateral with minute spine (e'). Flagellum unarmed.

**Remarks.** The chaetotaxy of *I. marginatus* differs from other species within this genus in the presence of 6–7 platellae instead of 1–3 fine setae on the 2nd hind tarsomere.

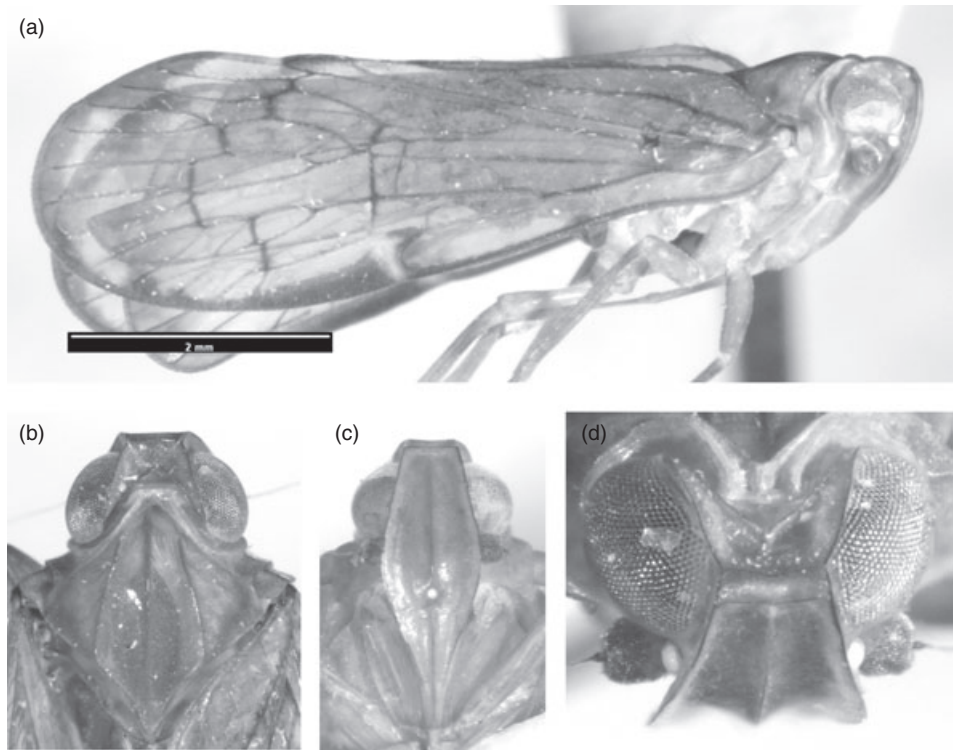
***Innobindus robiniae* Löcker, sp.n.**  
(Figs 2d–g, 9, 14c)

**Types.** *Holotype*, ♂, Australia, NSW: Lawson (Lea) (SAMA I21763).

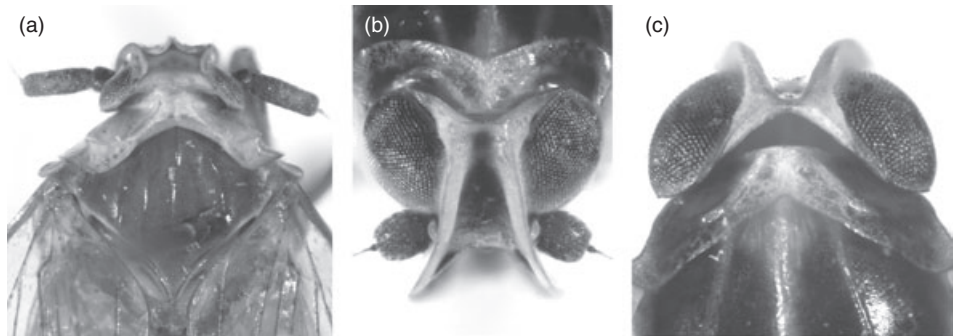
**Other material examined.** NSW: 1 ♂, Starrs Ck., Lansdowne S.F., NE Taree, rainforest, 6.–8.i.1988 (G. Williams) (AMS).

**Etymology.** Named in honour of Robin Thompson, a friend of the authors.

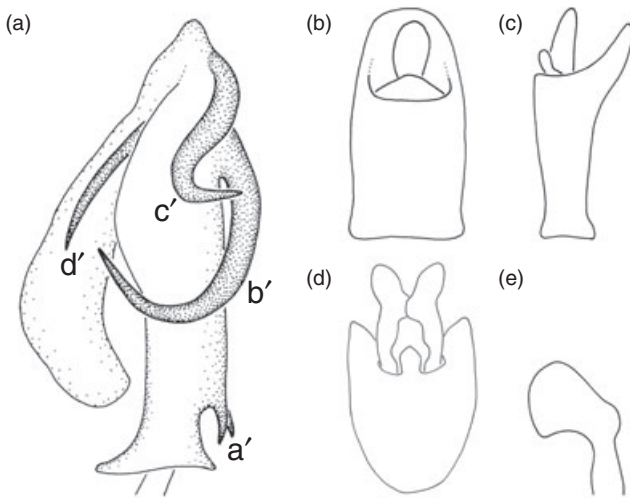
**Colour.** Body light brown, forewing hyaline, colourless with scattered brown marks, veins light brown with darker sections, tubercles concolorous with veins, pterostigma light or mid-brown; legs and abdominal sternites light brown.



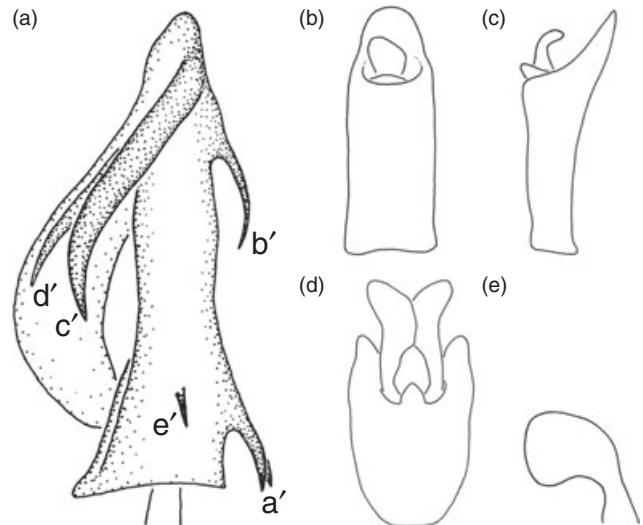
**Fig. 5.** *Innobindus unicornis*: (a) habitus; (b–d) head.



**Fig. 6.** *Solonaima* sp.: (a) head. *Undarana* sp.: (b, c) head.

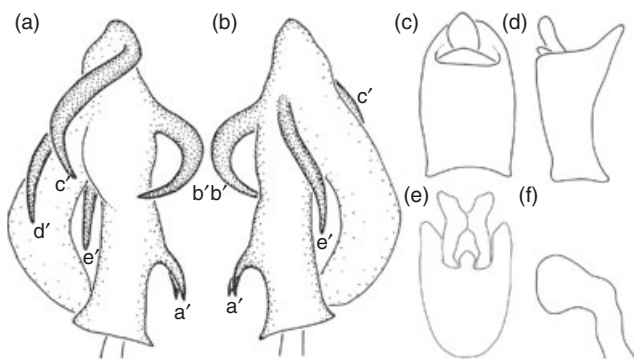


**Fig. 7.** *Innobindus licinus*: (a) aedeagus; (b, c) anal tube; (d, e) genital styles.

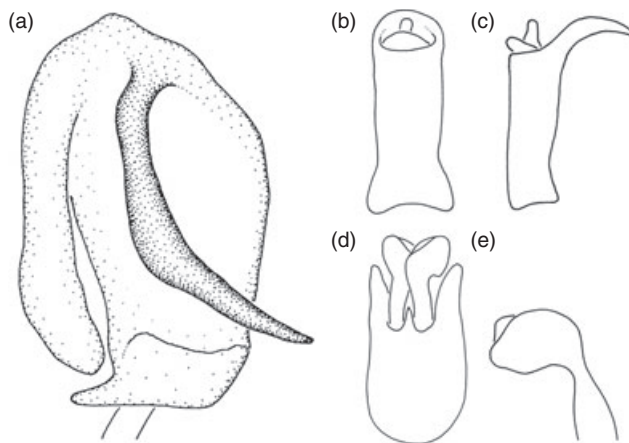


**Fig. 8.** *Innobindus marginatus*: (a) aedeagus; (b, c) anal tube; (d, e) genital styles.

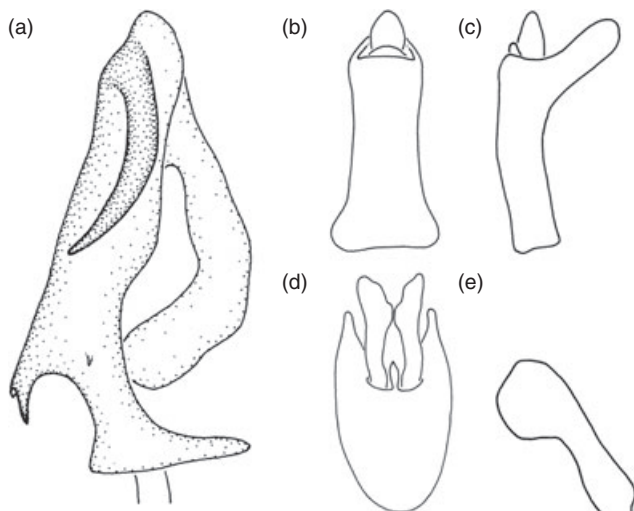




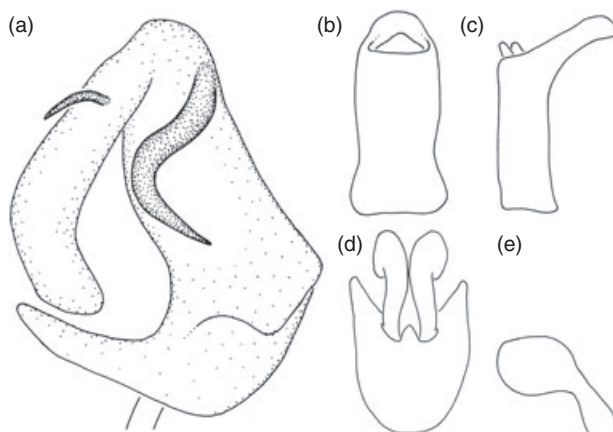
**Fig. 9.** *Innobindus robiniae*: (a, b) aedeagus; (a) left lateral; (b) right lateral; (c, d) anal tube; (e, f) genital styles.



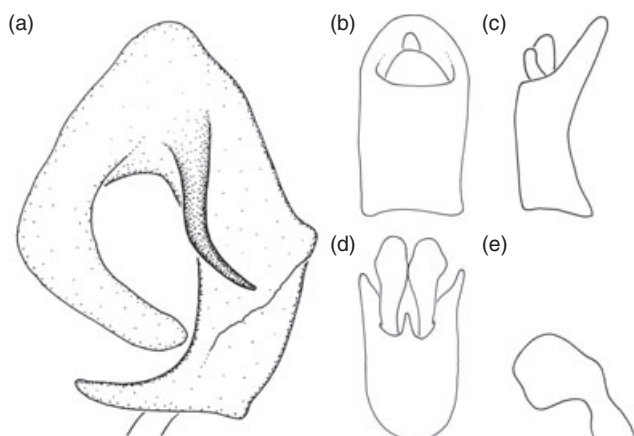
**Fig. 12.** *Innobindus multimaculatus*: (a) aedeagus; (b, c) anal tube; (d, e) genital styles.



**Fig. 10.** *Innobindus alternans*: (a) aedeagus; (b, c) anal tube; (d, e) genital styles.



**Fig. 13.** *Innobindus unicornis*: (a) aedeagus; (b, c) anal tube; (d, e) genital styles.



**Fig. 11.** *Innobindus collessi*: (a) aedeagus; (b, c) anal tube; (d, e) genital styles.

**Morphology.** Body length: ♂ 5.0–6.2 mm.

**Head:** Vertex 0.7× as long as wide. Frons 1.8–2.1× longer than wide.

**Thorax:** Forewing 2.9–3.3× longer than wide; MP apically bifid or trifid; costa with 17–25 tubercles; 10–11 apical cells. Hind leg: tibia with 2–5 very small lateral spines; tibia with 6 apical teeth forming uninterrupted row of spines or small gap present, dividing spines in 2 groups of 3 teeth; 1st tarsomere with 7 or 8 apical teeth; 2nd tarsomere with 7 or 8 apical teeth and 2–3 very fine setae underneath row of apical teeth, without platellae.

**Male genitalia:** Anal tube as in Figure 9c,d; genital styles and ventromedian process as in Figure 9e,f. Aedeagus (Fig. 9a,b): Phallosome ventral with pair of very small spines (a') and medium-sized, strongly curved spine (b') with its tip curved dorsad; left lateral with sinuate spine (c'); dorsal with slightly curved spine (d'); right lateral with slightly curved spine (e'). Flagellum unarmed.

**Remarks.** The specimen from Starrs Ck, NSW is excluded from the type series because it lacks spine (e') and is therefore not typical of the species.





**Fig. 14.** Known distribution. (a) *Innobindus licinus*; (b) *I. marginatus*; (c) *I. robinae*; (d) *I. alternans*; (e) *I. collessi*; (f) *I. multimaculatus*; (g) *I. unicornis*.

#### ***multimaculatus* group**

These 4 species, including the type species, share the following attributes and are therefore grouped together as the *multimaculatus* group: vertex lacking median carina; lateral carinae of frons strongly elevated; median carina of frons incomplete, covering less than 3/4 of frons; lateral carinae of frons continuous with lateral carinae of clypeus; phallosome lateral with medium-sized or very long, curved spine, ventral with a fringed ridge or a pair of very small spines; flagellum armed or unarmed.

*Innobindus alternans* Löcker, sp.n.

*Innobindus collessi* Löcker, sp.n.

*Innobindus multimaculatus* Jacobi, 1928

*Innobindus unicornis* Löcker, sp.n.

#### ***Innobindus alternans* Löcker, sp.n. (Figs 10, 13a–d, 14d)**

**Types.** *Holotype*, ♂, **Australia, Qld:** Lamington NP, 28.i.–3.ii.1963 (G. Monteith) (QM QMT.133351, originally UQIC).

*Paratypes*, Qld: 2 ♂, 1 ♀, same data as holotype (UQIC); 8 ♂, 3 ♀, National Park [Lamington NP], xii.1923 (H. Hacker) (QM).

**Other material examined.** Qld: 1 ♂, National Park [Lamington NP], xii.1923 (H. Hacker) (QM).

**Etymology.** In contrast to similar species of *Innobindus* the types of this species have the curved spine inserting on the right rather than the left side of the phallosome.

**Colour.** Body light, mid- or dark brown, mesonotum and disc of frons and vertex slightly darker; forewing hyaline, colourless, with scattered brown marks, veins light or mid-brown with a few paler sections, tubercles concolorous with veins, pterostigma mid-brown; legs light brown; abdominal sternites mid-brown.

**Morphology.** Body length: ♂ 6.2–7.4 mm, ♀ 6.8–7.4 mm.

*Head:* Vertex 0.5–0.7× as long as wide. Frons 2.0–2.3× longer than wide.

*Thorax:* Forewing 2.5–2.8× longer than wide; fork of PCu+A1 distad of centre of clavus; costa with 31–35 tubercles. Hind leg: tibia with 1–3 very small lateral spines.

*Male genitalia*: Anal tube as in Figure 10b,c; genital styles and ventromedian process as in Figure 10d,e. Aedeagus (Fig. 10a): Phallosome right lateral with medium-sized, curved spine; right and left lateral near base with minute spine; ventral with pair of very small spines. Flagellum unarmed.

**Remarks.** The specimen excluded from the type series has the medium-sized, curved spine of the phallosome left lateral instead of right lateral. Whether this is an aberration is uncertain. If not, the significance is unclear at this stage.

***Innobindus collessi* Löcker, sp.n.**  
(Figs 3e, 4a–c, 11, 14e)

**Types.** *Holotype*, ♂, **Australia, Qld**: Mt Edith Forest Road, 1.5 m off Danbulla Road, N.Qld, 6.v.1967 (D.H. Colless) (ANIC). *Paratypes*, Qld: 1 ♀, same data as holotype (ANIC); 1 ♂, Mt Graham, 8 km N Abergowrie, NE.Qld, pitfall trap, RF, 600–700 m, 26.xii.1986–17.i.1987 (S. Hamlet) (QM); 1 ♂, Karnak-Devil's Thumb, 8–12 km NW Mossman, N.Qld, 1080 m, flight intercept, 26.xii.1989–15.i.1990 (ANZSES Expedition) (QM); 1 ♂, Mt Williams, NE.Qld, 16.55S 145.40E, 1000 m, pyrethrum, trees and logs, 2.xii.1993 (Monteith & Janetzki) (QM).

**Etymology.** Named in honour of Dr Don H. Colless, eminent Australian dipterist, who collected the holotype.

**Colour.** Body light to mid-brown; forewing hyaline, colourless, with scattered brown marks, veins light brown with mid-brown sections, crossveins mid-brown, tubercles concolorous with veins, pterostigma mid-brown; legs light brown; abdominal sternites mid-brown.

**Morphology.** Body length: ♂ 5.3–6.1, ♀ 6.4 mm.

*Head*: Vertex 0.4–0.6× as long as wide. Frons 1.8–2.0× longer than wide.

*Thorax*: Forewing 2.7–3.0× longer than wide; fork of PCu+A1 distad of centre of clavus; costa with 26–36 tubercles. Hind leg: tibia with 2–3 very small lateral spines.

*Male genitalia*: Anal tube as in Figure 11b,c; genital styles and ventromedian process as in Figure 11d,e. Aedeagus (Fig. 11a): Phallosome left lateral with medium-sized, curved spine; ventral with small, fringed ridge. Flagellum unarmed.

***Innobindus multimaculatus* Jacobi**  
(Figs 4d–g, 12, 14f)

*Innobindus multimaculatus* Jacobi, 1928: 31 (fig. 18a–d)

**Types.** *Lectotype*, here designated, ♂ (examined), **Australia, Qld**: Malanda (Mjöberg) (NHRS). *Paralectotypes*, Qld: 2 ♀, same data as lectotype (1 ♀ MTD examined, 1 ♀ NHRS not examined). The 2 specimens examined match the features and type locality given in the original description. The male specimen is labelled 'Typus' and the female 'co-Typus'. Because the original description does not mention the designation of a holotype these specimens are regarded as syntypes. A lectotype is designated to provide a diagnostic reference for the species to ensure there is no confusion with several other Australian species described below.

**Other material examined.** Australia, Qld: 3 ♂, 2 ♀, Windsor T-land via Mt Carbine, N.Qld, rainforest, at light,

28.xii.1976 (R.I. Storey) (QDPI); 1 ♂, 1 ♀, 26 km up Tinaroo Ck Rd via Mareeba, N.Qld, 29.ix.–11.xi.1983 (Storey & Brown) (QDPI); 1 ♂, 26 km up Tinaroo Ck Rd via Mareeba, intercept trap, 28.i.–16.ii.1983 (Storey & Brown) (QDPI); 1 ♂, Mt Lewis, 11.3 km along Mt Lewis Rd, 16.35.31S 145.16.15E, ex light, 30.iv.1998 (G. Cassis) (AMS); 1 ♂, NE.Qld, Mt Demi, 7 km SW Mossman, 1100 m, pyrethrum knockdown in rainforest, 29.x.1983 (D.K. Yeates & G.I. Thompson) (QM); 1 ♂, 1 ♀, Mossman Bluff Track, 5–10 km W Mossman, N.Qld, 1300 m, flight intercept, 1.–17.i.1989 (Monteith, Thompson & ANZSES) (QM); 1 ♀, Mossman Bluff Track, 9 km W Mossman, N.Qld, 860 m, pyrethrum, 20.xii.1989 (Monteith & Thompson) (QM); 2 ♂, 3 km N Cape Tribulation, NE.Qld, 500 m, 20.ix.–7.x.1982 (Monteith, Yeates & Thompson) (QM); 1 ♂, same data, 23.ix.–7.x.1982, rainforest pitfall trap (QM); 1 ♂, 4 ♀, Bellenden Ker Range, Cable Tower 5, NE.Qld, 500 m, malaise, x.–xii.1982 (S. Montague) (QM).

**Colour.** Body light brown, mesonotum, disc of frons and vertex slightly darker; forewing hyaline, colourless, with scattered brown marks, pterostigma and veins light brown, crossveins darker, tubercles concolorous with veins; legs light brown; abdominal sternites light to mid-brown.

**Morphology.** Body length: ♂ 5.8–6.4 mm, ♀ 5.7–6.9 mm.

*Head*: Vertex 0.5–0.8× as long as wide. Frons 1.7–2.1× longer than wide.

*Thorax*: Forewing 2.8–3.1× longer than wide; fork of PCu+A1 distad of centre of clavus or central within clavus; costa with 24–33 tubercles. Hind leg: tibia with 0–4 very small lateral spines.

*Male genitalia*: Anal tube as in Figure 12b,c; genital styles and ventromedian process as in Figure 12d,e. Aedeagus (Fig. 12a): Phallosome left lateral with very long, curved spine; ventral with large, evenly curved, fringed, sheet-like ridge. Flagellum unarmed.

***Innobindus unicornis* Löcker, sp.n.**  
(Figs 5a–d, 13, 14g)

**Types.** *Holotype*, ♂, **Australia, Qld**: Mt Finnigan summit, NE.Qld, 15.49S 145.17E, 1100 m, rainforest, mv lamp, 20–21.xi.1998 (C.J. Burwell) (QM QMT.133349). *Paratypes*, Qld: 1 ♂, 1 ♀, same data as holotype (QM).

**Etymology.** The name is derived from the presence of a single spine on the flagellum.

**Colour.** Body light brown; forewing hyaline, colourless, apex of wing smoky brown, veins light to mid-brown, crossveins darker, tubercles concolorous with veins, pterostigma dark brown; legs light brown; abdominal sternites mid-brown.

**Morphology.** Body length: ♂ 6.8–6.9 mm, ♀ 7.2–7.4 mm.

*Head*: Vertex 0.5× as long as wide. Frons 1.9–2.0× longer than wide.

*Thorax*: Forewing 3.0–3.1× longer than wide; fork of PCu+A1 distad of centre of clavus; costa with 26–33 tubercles. Hind leg: tibia with 3–5 very small lateral spines.

*Male genitalia*: Anal tube as in Figure 13b,c; genital styles and ventromedian process as in Figure 13d,e. Aedeagus

(Fig. 13a): Phallotheca left lateral with medium-sized, sinuate spine; ventral with medium-sized, fringed ridge. Flagellum left lateral near base with small spine.

## DISCUSSION

The Australian Brixini are reported only from Queensland and NSW. Maps of the known distribution for the species of *Innobindus* are shown in Figure 14. The *licinus* group occurs in eastern NSW and south-east Queensland, whereas the *multimaculatus* group is restricted to north-east Queensland, with the exception of *I. alternans*, which occurs isolated from the other species of *Innobindus* in Lamington NP near the border between Queensland and NSW. Its distribution overlaps that of the *licinus* group. Moreover, the presence of a ventral pair of spines on the phallotheca of *I. alternans* is a feature shared with the *licinus* group. Nevertheless, features such as the strongly elevated lateral carinae of frons, the continuous lateral carinae of frons and clypeus, the length of the median carina of frons (covering less than three-fourths of frons) and the colour pattern of the wing support its placement within the *multimaculatus* group. *Innobindus alternans*, however, differs in the absence of the fringed ventral ridge that characterises all other species of the *multimaculatus* group. Although *I. alternans* possesses a single spine on the phallotheca, which is a feature of *multimaculatus* group, the spine inserts right lateral instead of left lateral as in the remaining species of the group. However, one of 12 specimens collected at Lamington National Park had the spine inserted on the left side of the phallotheca. The pair of ventral spines observed in the *licinus* group and *I. alternans* may represent a plesiomorphy, because it is also found in some species of other tribes such as Gelasatocephalini and Cixiini. Therefore, *I. alternans* may be basal to the remaining species in the *multimaculatus* group. However, a phylogenetic analysis is needed to test this hypothesis.

Within Cixiidae two different branching patterns of the Media in the tegmen exist: a trifold Media anterior, present in most Cixiidae, or a trifold Media posterior. Emeljanov (2002) lists Brixini and Mnemosynini as tribes having the latter attribute. However, this does not apply to the Australian Brixini, in which all specimens examined have a trifold Media anterior and a bifid Media posterior with the exception of the cavernicolous species *Solonaima baylissa* Hoch & Howarth, *S. halos* Hoch & Howarth and *S. irvini* Hoch & Howarth, in which Media anterior and posterior are either bifid or unforked.

## ACKNOWLEDGEMENTS

We are grateful to all collectors and curators of insect collections, who have enabled us to use their material for our research, in particular Dave Britton (AMS), Greg Daniels (UQIC), Jan Forrest (SAMA), Bert Gustafsson (NHRS), Geoff Monteith (QM) and Tom Weir (ANIC). Geoff Monteith

also provided valuable information on specimens collected by H. Hacker. This work has been undertaken by the first author as part of her PhD project. We acknowledge invaluable input in the developmental stages of this work by Marie-Claude Larivière (NZAC), without whom this project could not have been extended to include the Brixini. Our sincere thanks go to Holger Löcker for his generous assistance. Financial support from the Australian Biological Resources Study (ABRS), a division of the Australian Government's Department of the Environment and Heritage (DEH) and The University of Sydney and in-kind support from NSW Department of Primary Industries and Charles Sturt University are gratefully acknowledged.

## REFERENCES

- Anufriev GA & Emeljanov AF. 1988. Podotryad Cicadinea (Auchenorrhyncha) – tsikadovye. In: *Opredelitel' Nasekomykh Dal'nego Vostoka SSSR*, Vol. 2 (ed. A Lerp), pp. 12–495. Nauka, Leningrad, Russia [In Russian].
- Distant WL. 1907. Rhynchotal notes XLI. *Annals and Magazine of Natural History* **19**, 277–295.
- Emeljanov AF. 2002. Contribution to classification and phylogeny of the family Cixiidae (Hemiptera, Fulgoroidea). *Denisia* **4**, 103–112.
- Erbe P & Hoch H. 2004. Two new species of the Australian planthopper genus *Solonaima* Kirkaldy (Hemiptera: Fulgoroidea: Cixiidae). *Zootaxa* **536**, 1–7.
- Hoch H. 1988. Five new epigeal species of the Australian planthopper genus *Solonaima* Kirkaldy (Homoptera: Fulgoroidea: Cixiidae). *Beagle, Records of the Northern Territory Museum of Arts and Sciences* **5**, 125–133.
- Hoch H. 2002. Hidden from the light of day: planthoppers in subterranean habitats (Hemiptera: Auchenorrhyncha: Fulgoroidea). *Denisia* **4**, 139–146.
- Hoch H & Asche M. 1988. Cave-dwelling planthoppers of Australia (Insecta: Homoptera: Fulgoroidea). *17th ASF Biennial Conference-TROPICON, Lake Tinaroo, Far North Queensland*, 67–75.
- Hoch H & Howarth FG. 1989a. Reductive evolutionary trends in two new cavernicolous species of a new Australian cixiid genus (Homoptera: Fulgoroidea). *Systematic Entomology* **14**, 179–196.
- Hoch H & Howarth FG. 1989b. Six new cavernicolous cixiid planthoppers in the genus *Solonaima* from Australia (Homoptera: Fulgoroidea). *Systematic Entomology* **14**, 377–402.
- Hoch H & Howarth FG. 1989c. The evolution of cave-adapted cixiid planthoppers in volcanic and limestone caves in North Queensland, Australia (Homoptera: Fulgoroidea). *Mémoires de Biospéologie* **16**, 17–24.
- Jacobi A. 1928. Results of Dr E. Mjöberg's Swedish scientific expeditions to Australia 1910–1913. Rhynchota, Homoptera. 1. Fulgoridae und Cercopidae. *Arkiv for Zoologi* **19A**, 1–50.
- Kirkaldy GW. 1906. Leaf-hoppers and their natural enemies. *Bulletin of the Hawaiian Sugar Planters' Association Division of Entomology* **1**, 271–479.
- Löcker B, Fletcher MJ, Gurr GM, Holzinger WE & Löcker H. 2006. Taxonomic and phylogenetic revision of the Gelasatocephalini (Hemiptera: Cixiidae). *Invertebrate Systematics* **20**, 59–160.
- Muir F. 1925. On the genera of Cixiidae, Meenoplidae and Kinnaridae (Fulgoroidea: Homoptera). *Pan-Pacific Entomologist* **1**, 97–110.
- Soulier-Perkins A. 2005. Phylogenetic evidence for multiple invasions and speciation in caves: the Australian planthopper genus *Solonaima* (Hemiptera: Fulgoroidea: Cixiidae). *Systematic Entomology* **30**, 281–288.

Accepted for publication 4 August 2006.