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The genus *Hishimonus* Ishihara in Australia (Hemiptera: Cicadellidae: Deltocephalinae: Opsiini) including description of three new species

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ABSTRACT

The Australian species of *Hishimonus* Ishihara are reviewed. Three new species are added to the fauna: *H. leichhardti* sp. nov., *H. malipatili* sp. nov. and *H. spatulatus* sp. nov. *Hishimonus diffractus* Dai & Fletcher, is recorded from Australia for the first time and *H. passiflorae* (Evans) is redescribed. *H. melaleucae* (Kirkaldy) is excluded from the genus. A key for the determination of the Australian species of *Hishimonus* is provided. The relationships of the Australian fauna with the Oriental fauna are briefly discussed. □
taxonomy, Membracoidea, new records.

Hishimonus Ishihara, 1953, was last revised by Knight (1970) who recognized 25 species, 17 of which were described as new. A number of additional species have subsequently been added to the genus from Japan and Korea (Ishihara 1972; Okada 1978), China (Kuoh 1976; Li 1988, 2011; Cai & Kuoh 1995; Li & Wang 2004), India (Knight 1973; Subba Rao & Ramakrishnan 1990; Ramachandra Rao 1991), Indonesia (Kamitani 2011) and Thailand (Dai *et al.* 2013). The number of recognized species is currently 48 most of which are limited to the Oriental region with extensions into the Ethiopian, Australian and eastern Palaearctic regions.

The Australian fauna, as treated by Knight (1970), included three species, *H. passiflorae* (Evans), *H. festivus* Knight which is restricted to Christmas Island and West Java in Indonesia (Kamitani, 2011) and *H. melaleucae* (Kirkaldy) which was listed but not included in Knight's (1970) study through lack of material of that species. *Hishimonus festivus* is not included in this paper since it does not occur in the Austral-

ian region but is recorded on Christmas Island, an Australian territory in the Oriental region.

Knight (1970) noted that the species of the genus show remarkable uniformity in external appearance, a factor which has led to confusion between a number of species, a situation clarified by Knight (1970). The characteristic coloration, with mottled pale brown tegmen with a large circular or triangular brown spot on the hind margin forming a circle or diamond-shape when the wings are folded, is also shared with related genera such as *Hishimonoides* Ishihara, *Naevus* Knight and *Litura* Knight. Knight's omission of *H. melaleucae* from his 1970 revision was unfortunate since this species does not have this characteristic colour pattern but has the tegmina uniformly whitish with evenly scattered brown speckling and no indication of a dorsal patch.

Some species of *Hishimonus* are known to be of economic importance through transmission of plant pathogens such as phytoplasmas. No Australian species has been recorded as the

vector of a plant disease but they clearly have the potential, and delineation and understanding of the species present is a critical step in detection and management of such disease systems.

MATERIALS AND METHODS

Terminology follows Dai *et al.* (2013). The photographs in Figures 1 and 2 were taken with a Q Imaging digital camera on a Leica M165C stereo microscope, captured in Q-Capture Pro 7 (SciTech P/L) and compiled in Auto-Montage Pro (Synoptics Ltd). The resulting images were improved and prepared as plates using Adobe Photoshop CS2. Abbreviations for collections are AM, Australian Museum, Sydney, NSW; ANIC, Australian National Insect Collection, Canberra, ACT; ASCU, NSW Agricultural Scientific Collections Unit, Orange, NSW; BMNH, The Natural History Museum, London, UK; BPBM, The Bernice P. Bishop Museum, Honolulu, Hawaii, USA; QDPI, Queensland Dept of Primary Industries, Brisbane, Queensland; QM, Queensland Museum, Brisbane, Queensland; NTMD, Northern Territory Museum, Darwin, Northern Territory; NWAFA, Northwest Agriculture and Forestry University, Yangling, Shaanxi Province, China; SAM, South Australian Museum, Adelaide, South Australia.

SYSTEMATICS

Hishimonus Ishihara, 1953

Hishimonus Ishihara, 1953: 38. [Type species *Thamnotettix sellatus* Uhler, 1896, by original designation].

Diagnosis. A description of the genus, modified from Knight (1970), was provided by Dai *et al.* (2013).

Remarks. Ishihara (1953) designated *Acocephala disciguttus* Walker, 1857 as the type species and listed *T. sellatus* as a synonym. Knight (1970) notes that an examination of Walker's original type material of *A. discigutta* demonstrates that Ishihara (1953) misidentified the species so that the type species of *Hishimonus* is *T. sellata* with *Hishimonus discigutta*, sensu Ishihara (1953) as a junior synonym. Ishihara realised his mistake and used *T. sellatus* as the name of the type species in subsequent publications.

The species of *Hishimonus* can be recognised by the presence of the distinctive circular

brown marking dorsally in the centre of the folded tegmina and identified through examination of the processes associated with the aedeagus. The dorsal patch may be ill-defined in some individuals. Knight (1970) states that the presence of two slender basal processes anterior to the aedeagal shafts in the male genitalia is a derived character within the genus. Of the known Australian species, only *H. passiflorae* has this feature.

Key to Australian species of *Hishimonus* (based on males)

1. Aedeagus with pair of short straight processes medially, anterior to base of shafts (Fig. 3C). *H. passiflorae* (Evans)
 - Aedeagus without such processes anterior to base of shafts. 2
2. Aedeagal shafts, in posterior view, tapered or of equal width from base to apex so base is as wide as, or wider than, rest of shaft (Fig. 4C, D). *H. diffractus* Dai, Fletcher & Zhang
 - Aedeagal shafts, in posterior view, not tapered from base to apex. 3
3. Aedeagal shafts, in posterior view, widest near apex (Figs 6C, 7C). 4
 - Aedeagal shafts, in posterior view, widest at midlength (Fig. 5C). *H. leichhardti* sp. nov.
4. Aedeagal shafts, in posterior view, more or less straight, wide throughout (Fig. 6C). *H. spatulatus* sp. nov.
 - Aedeagal shafts, in posterior view, curved from base, narrow throughout (Fig. 7C). *H. malipatili* sp. nov.

Hishimonus passiflorae (Evans, 1941)

(Figs 1A, 3A–D)

Eutettix passiflorae Evans, 1941: 40.

Hishimonus disciguttus – Evans, 1955: 20 [misidentification of *Acocephalus disciguttus* Walker, 1857].

Hishimonus passiflorae – Knight, 1970: 134.

Material examined. NEW SOUTH WALES: 3 ♂♂, Pearl Beach, near Woy Woy, 11–12.ii.1985, Fletcher, Macdonald, Hoile, Gillespie, at light (ASCU); 8 ♂♂, Pearl Beach, near Woy Woy, 10.ii.1995, A. Westcott & F. Swindley, at light (ASCU); ♂, Mangrove Mountain, near Gosford, 26.ii.1981, M.J. Fletcher, on *Passiflora edulis* (ASCU); ♂, Rydalmere, near Sydney, 20.i.1970, M.I. Nikitin, light trap (ASCU); ♂, Rydalmere, near Sydney, 1.v.1967, L.R. Greenup, m.v. light (ASCU); ♂, Rydalmere, near Sydney, 12.v.1967, light trap

(ASCU); ♂, same data as previous but 14.i.1970 (ASCU); ♂, Lord Howe Island, 25.i.1991, R. Schwartz, at light (ASCU). QUEENSLAND: ♂, CSIRO Long Pocket site, Brisbane, viii.1978, malaise trap (QDPI); ♂, Rex Range Lookout, via Julatten, 9.xi.-2.xii.1981, malaise trap (QDPI).

Description. Face pallid yellowish, dorsum testaceous with pale brown markings. Tegmen pale whitish with evenly scattered brown mottling, becoming denser and darker towards apex of tegmen medially; distinct pale brown posterior patch, pallid medially against hind margin. Legs pale brown with dark brown spots.

Male genitalia. Subgenital plates relatively narrow, rounded externally to apical process. Paramere with well developed preapical lobe, apical process narrow, tapering, slightly sinuate, apically acute. Connective with arms slightly longer than stem. Aedeagus with pair of short straight processes medially on basal apodeme; shafts strongly divergent from base then curved dorsally to apical gonopore, bearing lateral narrow process from lateral margin to gonopore, extending lateroventrally.

Remarks. Knight (1970) noted that the holotype male (collected Sydney, NSW, viii.1937, N.S. Noble) was missing from the Australian Museum and based his recognition of this species on a male and female paratype (Sydney, NSW, 16.ii.1931, K.K. Spence) still extant in the AM.

This is the only Australian species with a pair of short anterior processes mounted anterior to the base of the shafts on the basal apodeme of the aedeagus. This feature was regarded by Knight (1970) as a derived condition. The species was first described from passionfruit (*Passiflora edulis*) but it is known to have a wide host range on native and exotic species of plants. Knight (1970) recorded the species from New South Wales, Solomon Islands and Fiji. Material in this study records the species from the eastern seaboard of Australia from Sydney to the Wet Tropics of North Queensland.

Hishimonus diffractus Dai & Fletcher, 2013
(Figs 1B, 4A–E)

Hishimonus diffractus Dai & Fletcher 2013: 311.

Material examined. Holotype, ♂, China: Jiangxi, Suichuan, 13.viii.2004, Wei Cong & Yang Meixia (NWAUFU). NEW SOUTH WALES: 2 ♂♂, Wallarah Creek, Bluehaven, 8 km NE of Wyong, 31.iii.1986,

G.R. Brown, m.v. light; 2 ♂♂, Rydalmere, 8.vii.1984, G.R. Brown & H.M. Holmes, malaise trap; ♂, Rydalmere, 7.vi.1984, G.R. Brown; ♂, Rydalmere, near Sydney, 22–23.vii.1981, J. McGechan & M.J. Fletcher, ex rotating trap; ♂, Lord Howe Island, 5.ii.1992, G.R. Brown, at u.v. light; ♂, same data as previous but 6.ii.1992; 2 ♂♂, same data as previous but 14.i.1992; 2 ♂♂, same data as previous but 31.viii.1992; ♂, same data as previous but Neds Beach, 5.ii.1992 (all ASCU). QUEENSLAND: ♂, Yeerongpilly, Brisbane, 1–10.i.1982, malaise trap (QDPI). SOUTH AUSTRALIA: ♂, Mitcham, 24.xi.1977, R.V. Southcott, indoors, at light (SAM). WESTERN AUSTRALIA: 3 ♂♂, Como, Perth, xii.2001, M.L. Moir (ASCU, NWAUFU).

Description. Head and thorax pale testaceous with scattered pale brown mottling. Tegmen whitish, becoming translucent apically, covered with small brown markings, denser and darker apically, with apical veins brown. Dorsal pale brown patch well defined, margined anteriorly with brown, with clear patch medially against claval margin.

Male genitalia. Subgenital plate outwardly broadly curved to apex with finger-like apical process. Paramere with preapical lobe poorly developed, apical lobe elongate, curved slightly outwards, apically more or less parallel with opposing process. Connective short with arms longer than stem. Aedeagus in posterior view with shafts moderately divergent from base, slightly tapering to apex which curves anteriorly, with gonopore on posterior side slightly beyond half length and with short, triangular projection. In lateral view, shaft narrows at gonopore with anterior process continuing to strongly anteriorly recurved acute apex.

Remarks. A new Australian record. This species was first recognized in China as part of the second author's doctoral research and described by Dai *et al.* (2013) from China and Thailand. Its presence in Australia is unexpected and is discussed below.

Hishimonus leichhardti sp. nov.
(Figs 1C, 5A–E)

Material examined. HOLOTYPE, ♂, Sue Island, Torres Strait, 17–23.v.1985, Donaldson & Hamacek, malaise trap, ASCTHE004687 (QM-T189772). PARATYPES: 2 ♂♂, same data as holotype (ASCU); 3 ♂♂, same data as holotype but D-vac (QDPI); 5 ♂♂, same data as holotype but at light (QDPI); ♂, same data as holotype but 21.v.1985, 'at light (am)' (QDPI); ♂,

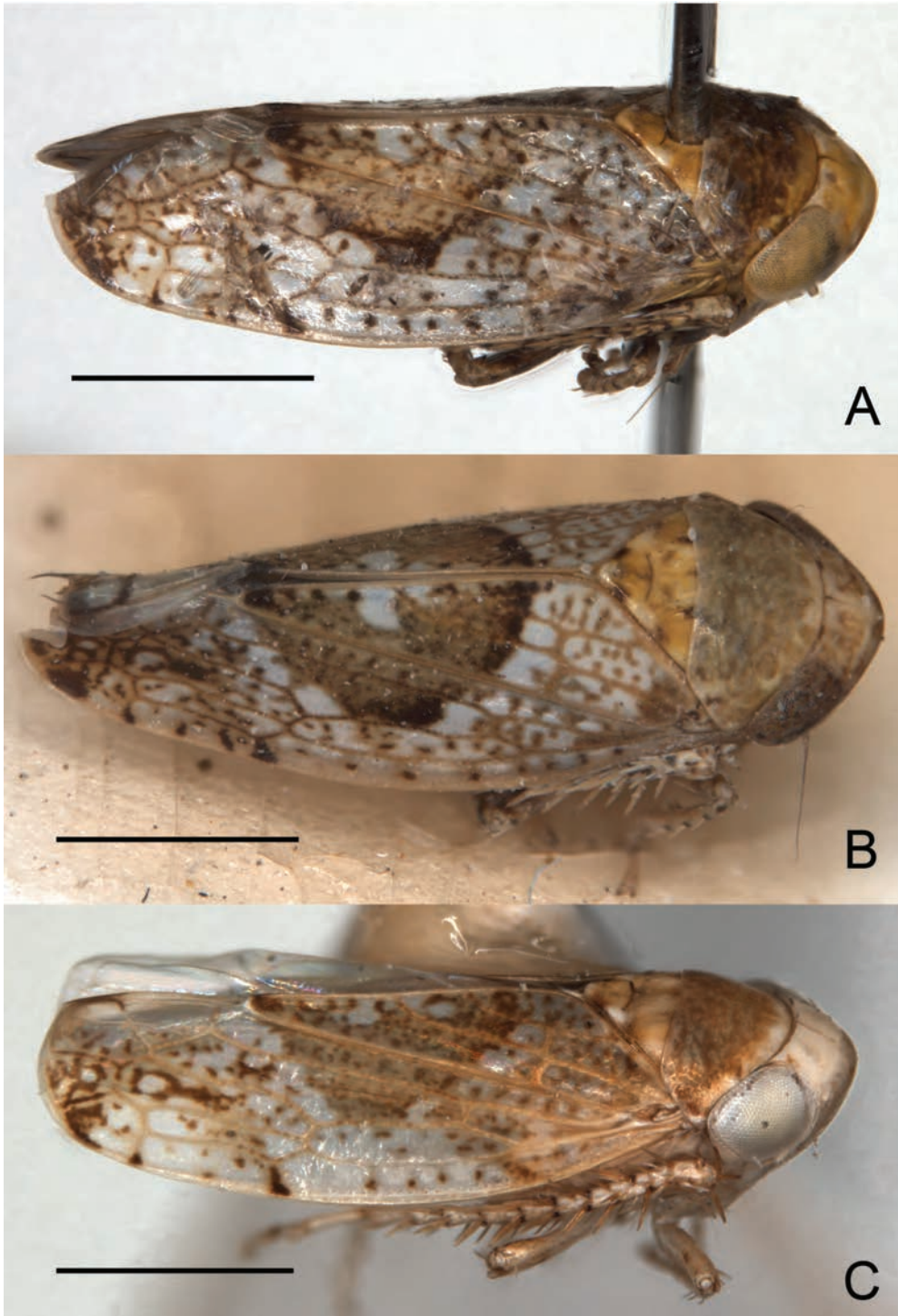


FIG. 1. *Hishimonus* spp. habitus: A. *H. passiflorae*; B. *H. diffractus*; C. *H. leichhardti* sp. nov. Scale line = 1.0 mm.



FIG. 2. *Hishimonus* spp. habitus: A. *H. spatulatus* sp. nov.; B. *H. malipatili* sp. nov. Scale line = 1.0 mm.

same data as holotype but yellow pan trap (QDPI); 2 ♂♂, Yam Island, 22.iii.1985, J.W. Turner, at light (QDPI); ♂, Yam Island, 09°54'S, 142°46'E, 28.xi.–2.xii.1986, Houston & Sadler, malaise trap (QDPI); ♂, Cooloolo National Park, S.E. Qld, 6.iii.1984, I.D. Galloway, rainforest beside closed road (QDPI).

Description. Head pale greenish white. Pronotum mainly brown with pale speckling, pale along anterior margin. Scutellum whitish with pale yellow laterally margined with brown. Tegmen pale coffee brown on basal half with darker brown spot at apex of costal cell and some brown extending towards apex. Large pale area along costal margin around midlength of tegmen. Pale brown dorsal patch ill-defined, not discernible in some specimens.

Male genitalia. Subgenital plates broadly rounded on external margin to base of apical process. Paramere with preapical lobe moderately developed, rounded, apical lobe straight, directed

slightly laterally, apically acutely rounded. Connective with lateral arms slightly shorter than stem. Aedeagus without basal processes, in posterior view, shafts divergent, outwardly prominent at midlength, then narrowed to preapical gonopore with apex of shaft produced to form apical pointed process in line with shaft. In lateral view, shafts curved evenly to gonopore with apical process extended short distance from gonopore and recurved anteriorly.

Etymology. The species name honours Ludwig Leichhardt, Prussian explorer and naturalist, who explored parts of northern Australia in the first half of the 19th century.

Remarks. This species shows some similarities to *H. arcuatus* Knight, from Sri Lanka, and *H. concavus* Knight, from the Philippines, which also have simple aedeagal shafts surmounted by a process apically which curves anteriorly

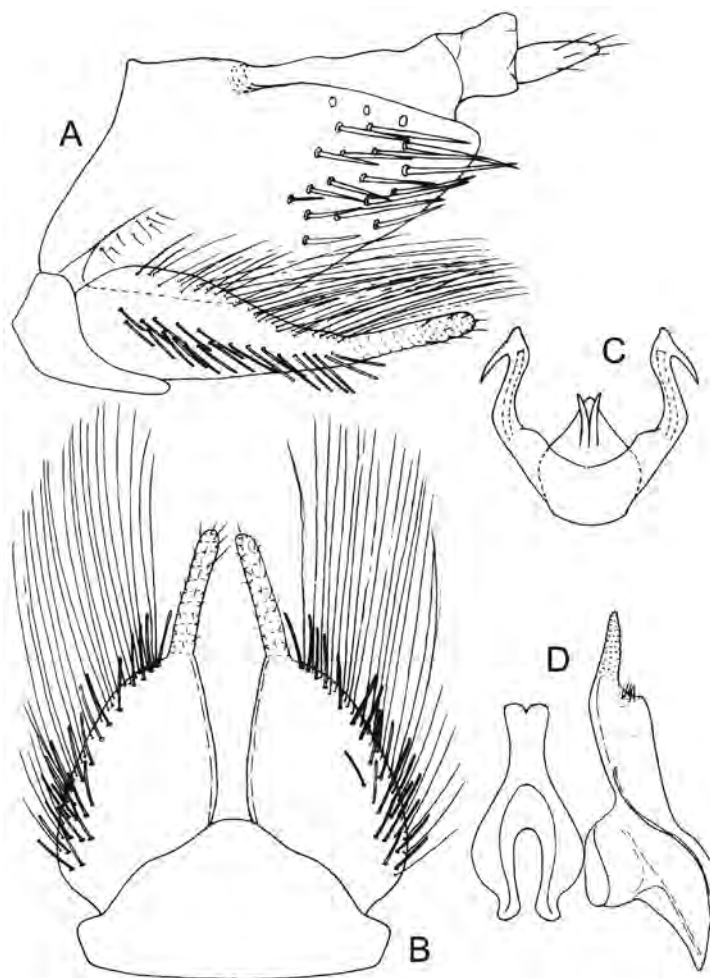


FIG. 3. *H. passiflorae* male genitalia: **A**. Terminalia, lateral view; **B**. Terminalia, ventral view; **C**. Aedeagus, posterior view; **D**. Paramere and connective, ventral view.

beyond the gonopore and the apical lobe of the paramere extended slightly laterally. However, it differs from both species in the shape of the shafts in posterior view.

***Hishimonus spatulatus* sp. nov.**

(Figs 2A, 6A–E)

Material examined. HOLOTYPE, ♂, 1 km SE of Mt Cook, Qld, 15°30'S, 145°16'E, 13.x.1980, T. Weir, ASCTHE004696 (ANIC).

Description. Head and thorax pale greenish yellow, crown, pronotum and scutellum with faint brown mottling, sparse on crown. Tegmen pale whitish translucent with fine brown

markings on crossveins and in some cells, becoming denser medially towards apex which is mainly brown. Dorsal brown patch well defined, margined anteriorly and ventrally with darker brown.

Male genitalia. Subgenital plate broadly rounded laterally with distinct apical finger-like process. Paramere with preapical lobe very small and rounded, apical lobe elongate, directed posteriorly, apically rounded. Connective short with arms longer than stem. Aedeagus in posterior view with shafts divergent from base, with lateral flange enlarged around gonopore to form lateral triangular lobe and medial rounded lobe. In lateral view, aedeagus curving evenly

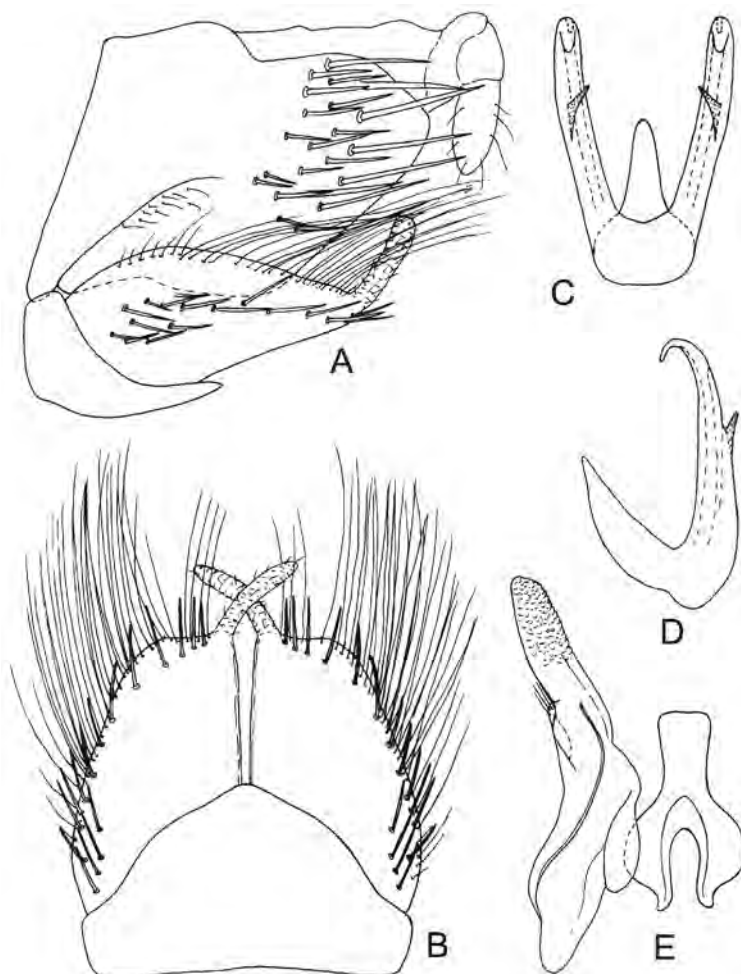


FIG. 4. *H. diffractus* male genitalia: **A**. Terminalia, lateral view; **B**. Terminalia, ventral view; **C**. Aedeagus, posterior view; **D**. Aedeagus, lateral view; **E**. Paramere and connective, ventral view.

from base to apex with lateral triangular flange curving anteriorly. Aedeagus without basal processes.

Etymology. The species name is based on the spatulate apical area of the aedeagal shafts.

***Hishimonus malipatili* sp. nov.**

(Figs 2B, 7A–E)

Material examined. HOLOTYPE, ♂, Daly River, N.T., 13°45'S, 130°42'E, 9–10.viii.1980, M.B. Malipatil, m.v. light, (NTMD).

Description. Head and scutellum pale greenish yellow, pronotum brownish with transverse pale markings. Tegmen pale whitish with scattered brown spots becoming denser at apex.

Dorsal spot well defined, margined almost throughout with dark brown with pale area against hind margin of tegmen.

Male genitalia. Subgenital plate rounded externally from base to apex with distinct apical finger-like lobe. Paramere with small rounded preapical lobe and apical lobe elongate, directed slightly laterally and minutely denticulate. Connective short with stem longer than arms. Aedeagus, in posterior view, with shafts narrow curving dorsally to preapical gonopore situated on internal posterior face, surmounted outwardly with broad triangular process and medially with short acute point. In lateral view, aedeagal shafts curved from base to gonopore

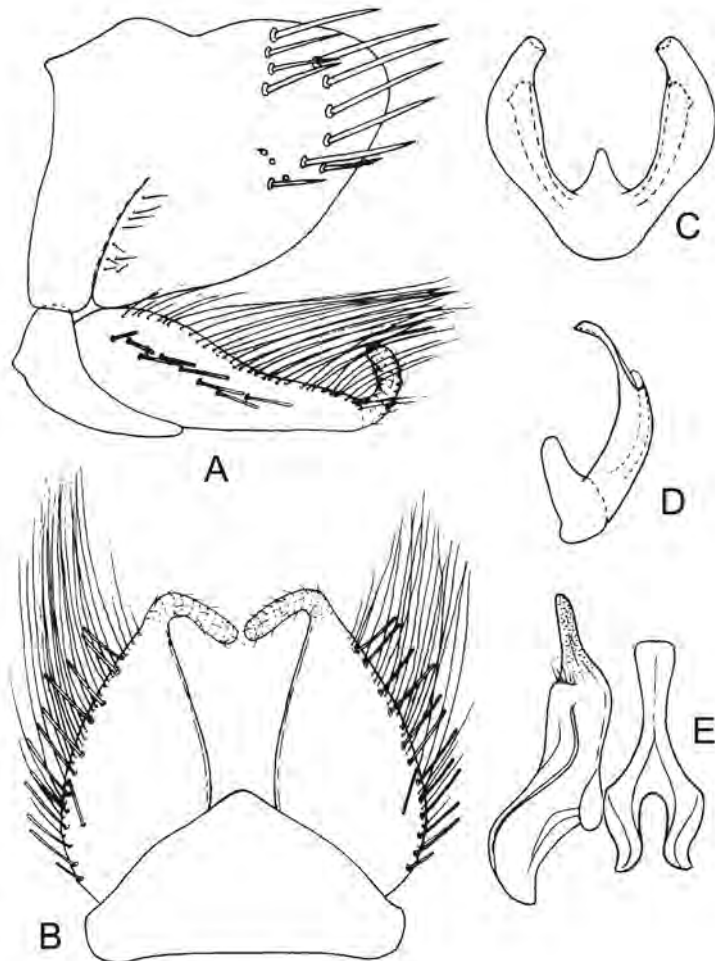


FIG. 5. *H. leichhardti* male genitalia: **A**. Terminalia, lateral view; **B**. Terminalia, ventral view; **C**. Aedeagus, posterior view; **D**. Aedeagus, lateral view; **E**. Paramere and connective, ventral view.

with posterior short acute process and extending on anterior side to form elongate acute process.

Etymology. The species name honours Dr M.B. Malipatil, renowned Australian heteropterist, who collected the type specimen.

Hishimonus melaleuca (Kirkaldy, 1907)

Eutettix melaleuca Kirkaldy, 1907: 53.

Hishimonus melaleuca – Evans, 1966: 236.

Remarks. This species was omitted from Knight (1970) since he did not have material for study. The present work has demonstrated that a number of Australian species share the colour

pattern found in *H. melaleuca* and this group also displays features of the male genitalia that set them apart from the rest of the genus as defined by Knight (1970). On this basis, *H. melaleuca* is here excluded from *Hishimonus*, and it, along with ten new Australian species, will be placed in a new genus in a subsequent publication.

DISCUSSION

The Australian fauna is distinct from the rest of the genus *Hishimonus* with most of the species endemic. The exceptions are *H. passiflorae*, which was recorded by Knight (1970) from the

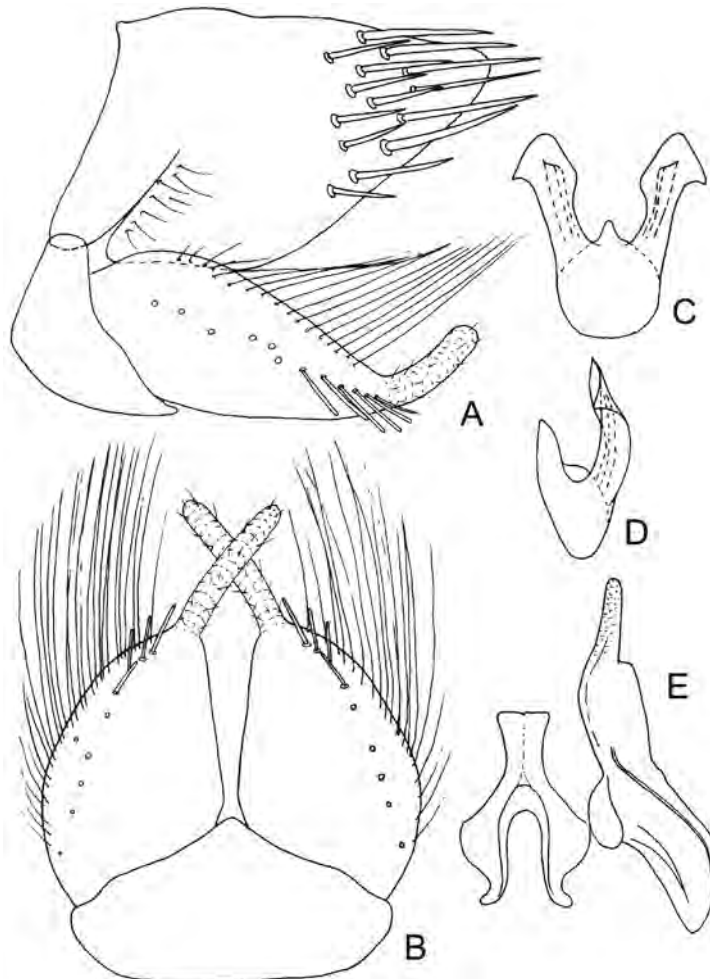


FIG. 6. *H. spatulatus* male genitalia: A. Terminalia, lateral view; B. Terminalia, ventral view; C. Aedeagus, posterior view; D. Aedeagus, lateral view; E. Paramere and connective, ventral view.

Solomon Islands and Fiji, and *H. diffractus* which is otherwise known from China and Thailand. This latter species is possibly adventive in Australia although now widespread along the eastern seaboard of mainland Australia, including Lord Howe Island, and also recorded in Mitcham, a suburb of Adelaide, and Como, a suburb of Perth. The external similarity of the species of *Hishimonus* has implications for monitoring possible incursions of exotic vector species when accurate identification is dependent on examination of male genitalia. Development of cheap and effective molecular tests for such species will alleviate this problem.

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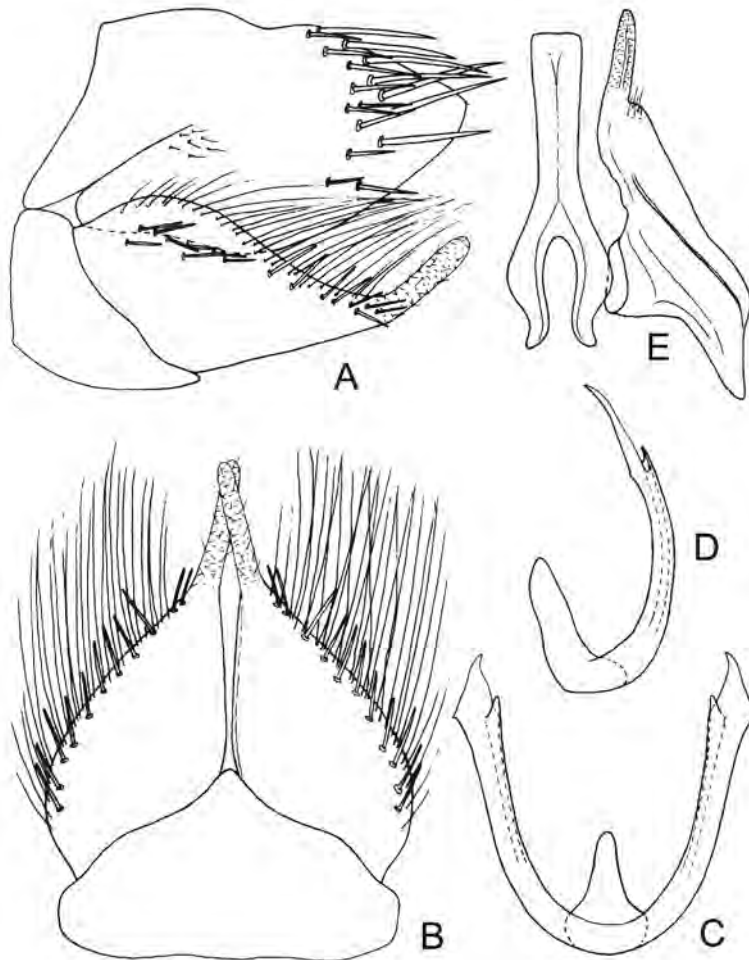


FIG. 7. *H. malipatili* male genitalia: **A**. Terminalia, lateral view; **B**. Terminalia, ventral view; **C**. Aedeagus, posterior view; **D**. Aedeagus, lateral view; **E**. Paramere and connective, ventral view.

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