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A REVIEW OF THE SUBGENUS *JAVADACUS* HARDY OF *BACTROCERA* MACQUART (DIPTERA: TEPHRITIDAE: DACINAE)

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Abstract

The *Bactrocera* Macquart subgenus *Javadacus* Hardy is reviewed and five SE Asian species recognised. Four additional species from SE Asia and Australia, previously included in *Javadacus*, are transferred to subgenus *Bactrocera*, with *B. unirufa* Drew placed as a new synonym of *B. melanothoracica* Drew. Based on its type species, subgenus *Javadacus* is included in the *Zeugodacus* group of subgenera. A key to species is included.

Introduction

The *Bactrocera* Macquart subgenus *Javadacus* Hardy was established for the West Javanese species *Bactrocera montana* (Hardy) (Hardy 1983). Drew and Romig (2013, 2016) included seven Southeast Asian species, two of which, together with three Australian species (Drew 1989), are transferred here to subgenus *Bactrocera*, based on their male sternite V and surstylus characters.

Based on the type species and others here included, the shallow posterior emargination to sternite V and the elongate posterior surstylus lobes in males, plus its overall appearance, place subgenus *Javadacus* in the *Zeugodacus* group of subgenera as defined by Drew (1989). Virgilio *et al.* (2015) and De Meyer *et al.* (2015) referred it to the *Bactrocera* group of subgenera on the basis of ‘*B. unirufa* Drew’, a species now known to actually belong in subgenus *Bactrocera* (see Hancock and Drew 2015) and here placed in synonymy with *B. melanothoracica* Drew. Accordingly, *Javadacus* species were not transferred by De Meyer *et al.* (2015) to their ‘genus’ *Zeugodacus* Hendel and they are also retained here within genus *Bactrocera*, following Drew and Romig (2013) and Hancock and Drew (2015) in this regard.

Genus *Bactrocera* Macquart Subgenus *Javadacus* Hardy

Dacus (*Javadacus*) Hardy, 1983: 26. Type species *Dacus* (*Javadacus*) *montanus* Hardy, 1983, by original designation.

Definition. Abdominal sternite V of male with a shallow posterior emargination; posterior lobe of male surstylus elongate and narrow; pecten of cilia present on abdominal tergite III of male; postpronotal setae absent; supra-alar setae absent; prescutellar acrostichal setae present; one pair of scutellar setae; scutum with medial postsutural yellow vittae present and lateral postsutural yellow vittae extending anterior to suture as distinct spots.

Response to male lures. Cue lure (4 species) or none known (1 species).

Included species. *Bactrocera (J.) javanensis* (Perkins) (= *transtillum* Hering), *B. (J.) montana* (Hardy), *B. (J.) scutellaria* (Bezzi), *B. (J.) semisurstyli* Drew & Romig, *B. (J.) trilineata* (Hardy).

Host plants. One species recorded from *Coccinia grandis* (Cucurbitaceae); others unknown (Drew and Romig 2013).

Comments. This subgenus appears to be closely related to the large subgenus *Zeugodacus*, differing in having both supra-alar and basal scutellar setae absent.

B. (Javadacus) javanensis (Perkins)

Afrodacus javanensis Perkins, 1938: 132. Type locality Mt Ardjoeno, E. Java.

Strumeta transtillum Hering, 1952: 265. Type locality Idjen, Ongop-ongop, E. Java. Syn. Drew and Romig, 2013: 208.

Dacus (Afrodacus) javanensis (Perkins): Hardy 1955: 9.

Bactrocera (Javadacus) javanensis (Perkins): Norrbom *et al.* 1999: 98; Drew and Romig 2013: 208.

Distribution. East Java, Indonesia. Recorded from Mts Arjuno and Ijen.

Host plant. None known.

Male lure. None known.

Comments. Illustrated by Drew and Romig (2013).

B. (Javadacus) montana (Hardy)

Dacus (Javadacus) montanus Hardy, 1983: 27. Type locality Cibodas, W. Java.

Bactrocera (Javadacus) montana (Hardy): Norrbom *et al.* 1999: 98; Drew and Romig 2013: 208.

Distribution. West Java, Indonesia. Recorded from Mt Gede.

Host plant. None known.

Male lure. Cue lure; the record from methyl eugenol (Hardy 1983) appears to be either an error or the result of contaminated lures.

Comments. Illustrated by Drew and Romig (2013).

B. (Javadacus) scutellaria (Bezzi)

Chaetodacus scutellarius Bezzi, 1916: 110. Type locality Goorghalli Estate, S. Mysore, India.

Dacus (Bactrocera) scutellarius (Bezzi): Hardy 1977: 52.

Bactrocera (Bactrocera) scutellaria (Bezzi): Norrbom *et al.* 1999: 95.

Bactrocera (Javadacus) scutellaria (Bezzi): Drew and Raghu 2002: 328; Drew and Romig 2013: 211.

Distribution. Southern India.

Host plant. None known.

Male lure. Cue lure.

Comments. Illustrated by Drew and Romig (2013).

B. (Javadacus) semisurstyli Drew & Romig

Bactrocera (Javadacus) semisurstyli Drew and Romig 2013: 212. Type locality Suli, Ambon, Indonesia.

Distribution. Ambon I., Maluku, Indonesia.

Host plant. None known.

Male lure. Cue lure.

Comments. This species has a fulvous face with a pair of oval fuscous spots and entirely red-brown femora. Illustrated by Drew and Romig (2013).

B. (Javadacus) trilineata (Hardy)

Dacus (Afrodacus) trilineatus Hardy, 1955: 12. Type locality Sarakki Village, Bangalore, India.

Bactrocera (Javadacus) trilineata (Hardy): Norrbom *et al.* 1999: 98; Drew and Raghu 2002: 328; Drew and Romig 2013: 213.

Distribution. India, Sri Lanka, Thailand and Vietnam.

Host plant. *Coccinia grandis* (Cucurbitaceae) (Drew and Romig 2013).

Male lure. Cue lure.

Comments. Illustrated by Drew and Romig (2013). Specimens from Thailand and Vietnam have a smaller black area on the notopleural lobe, broader postsutural lateral yellow vittae and entirely fulvous hind femora; these are currently regarded as conspecific (Drew and Romig 2013).

Excluded species

The following two Asian and two Australian species currently included in subgenus *Javadacus* differ in lacking a medial postsutural yellow vitta and the presutural extensions of the lateral postsutural vittae on the scutum. They also have a deeply emarginate posterior margin to male sternite V and produced but still relatively short posterior surstylus lobes (Figs 1-2). This, plus their non-cucurbitaceous host plants, better places them in subgenus *Bactrocera*, to which they are referred. The slightly produced posterior surstylus lobe seen in these species also occurs in *B. (Queenslandacus) exigua* (May) [HT examined, in Queensland Museum, Brisbane] but the short cell bcu extension seen in the latter species suggests that it is not closely related. In all known cases, males respond to methyl eugenol or isoeugenol, chemically similar attractants that are rarely found outside the *Bactrocera* group of subgenera.

B. (Bactrocera) aberrans (Hardy)

Dacus (Afrodacus) aberrans Hardy, 1951: 118. Type locality Lake Barrine, Queensland, Australia.

Afrodacus mesoniger May, 1952: 8. Type locality Toowoomba, Queensland, Australia. Syn Drew 1989: 189.

Bactrocera (Javadacus) aberrans (Hardy): Drew 1989: 189.

Distribution. Known with certainty only from SE Queensland (Toowoomba, Mt Tamborine and Ashgrove) and the Atherton Tableland in NE Queensland.

Host plants. *Cinnamomum oliveri*, *C. virens*, *Litsea leefeana*, *L. reticulata* and *Neolitsea dealbata* (Lauraceae) (Hancock *et al.* 2000).

Male lure. Weakly attracted to isoeugenol (Royer 2015). Reports from cue lure (Huxham and Hancock 2002) are misidentifications.

Comments. Identification of this species is difficult and some previous records (*e.g.* Huxham and Hancock 2002) refer to aberrant individuals (with supra-alar setae lacking) of other *Bactrocera* species. Two males from Cooktown with a relatively narrow anepisternal stripe, recorded by Royer and Hancock (2012) as possibly *B. unirufa*, are now believed to belong to *B. aberrans*. Illustrated by Drew (1989).

B. (Bactrocera) melanothoracica Drew

Bactrocera (Javadacus) melanothoracica Drew, 1989: 190. Type locality Yam I., Torres Strait, Australia.

Bactrocera (Javadacus) unirufa Drew, 1989: 191. Type locality Bellenden Ker Range, Queensland, Australia; **syn. n.**

Bactrocera (Bactrocera) melanothoracica Drew: Hancock and Drew 2015: 101.

Bactrocera (Bactrocera) unirufa Drew: Hancock and Drew 2015: 101.

Distribution. Torres Strait islands and Cape York to Kennedy (near Cardwell) in NE Queensland (Royer and Hancock 2012).

Host plant. Not recorded, but possibly *Tabernaemontana pandacaqui* (Apocynaceae) (Royer and Hancock 2012).

Male lure. Methyl eugenol.

Comments. This species is very variable in the extent of the black areas on the scutum but the area lateral of the postsutural lateral yellow vitta is always red-brown. Prescutellar acrostichal setae are present and supra-alar setae are normally absent. Male sternite V and surstylus lobes are as in *B. (B.) pallescentis* (Hardy) (*cf.* Figs 1-2). Examination of holotypes of both *B. melanothoracica* and *B. unirufa* [in Queensland Museum, Brisbane], plus a large series of specimens from throughout the species' range, indicates that only one taxon is involved, with *B. unirufa* here placed in synonymy. Both taxa were illustrated by Drew (1989).

B. (Bactrocera) nigrita (Hardy)

Dacus (Afrodacus) aberrans nigritus Hardy, 1955: 5. Type locality Singapore.

Bactrocera (Javadacus) nigrita (Hardy): Norrbom *et al.* 1999: 98; Drew and Romig 2013: 209.

Distribution. Recorded from Singapore and Vietnam.

Host plant. *Cinnamomum iners* (Lauraceae) (Hardy 1955).

Male lure. A single specimen has been collected at methyl eugenol (Drew and Romig 2013).

Comments. Illustrated by Drew and Romig (2013).

B. (Bactrocera) pallescentis (Hardy)

Dacus (Afrodacus) aberrans pallescentis Hardy, 1955: 5. Type locality Ranikhet, Uttar Pradesh, India.

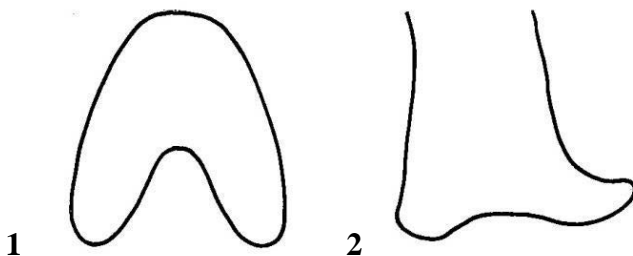
Bactrocera (Javadacus) pallescentis (Hardy): Norrbom *et al.* 1999: 98; Drew and Romig 2013: 210.

Distribution. Northern India (Uttar Pradesh).

Host plant. *Mimusops* sp. (Sapotaceae) (Hardy 1955).

Male lure. None known.

Comments. The male sternite V and surstylus lobes are shown in Figs 1-2; they are from one of five paratype males now in the Natural History Museum, London. This species was illustrated by Drew and Romig (2013).



Figs 1-2. *Bactrocera (Bactrocera) pallescentis* (Hardy), paratype male: (1) sternite V; (2) surstylus lobes.

Key to species of subgenus *Javadacus*

- 1 Scutum red-brown with a pair of broad, black submedial bands and a yellow lateral band between postpronotal and notopleural lobes; postsutural lateral yellow vittae short and triangular, ending well before postalar setae; wing with costal band crossing vein R_{2+3} and broad across apex of cell r_{4+5} , ending at apex of vein M; abdominal tergite III orange-

- brown with black lateral margins [eastern Indonesia (Ambon)]
 *B. (J.) semisurstyli* Drew & Romig, 2013
- Scutum mostly black with no lateral yellow band between postpronotal and notopleural lobes; lateral postsutural vittae long and parallel sided, almost reaching or enclosing postalar setae; wing with costal band not crossing vein R_{2+3} except at apex and ending no more than halfway between apices of veins R_{4+5} and M; abdominal tergite III black or with a black medial vitta 2
 - 2 Abdomen orange-brown with broad black lateral markings on tergites IV and V and a black T-shaped pattern along anterior margin of tergite III and medially on tergites III-V; face fuscous to black or with a black band along oral margin 3
 - Abdomen largely black, at most with submedial pale areas on tergite V and posterior margins of tergites III and IV; face fulvous or with a pair of large black spots 4
 - 3 Wing with a narrow infuscation enclosing DM-Cu crossvein; face fulvous with a narrow black band along oral margin [Indonesia (East Java)]
 *B. (J.) javanensis* (Perkins, 1938)
 - Wing without a narrow infuscation enclosing crossvein DM-Cu; face dark fuscous to black and glossy [Indonesia (West Java)]
 *B. (J.) montana* (Hardy, 1983)
 - 4 Face with a pair of large, transverse, oval black spots; notopleural lobe entirely black; scutellum black at apex; all femora extensively black on apical half to two-thirds [southern India]
 *B. (J.) scutellaria* (Bezzi, 1916)
 - Face fulvous without black spots; notopleural lobe at most with anterior half black; scutellum entirely yellow at apex; fore, mid and often hind femora entirely fulvous [India, Sri Lanka, Thailand and Vietnam]
 *B. (J.) trilineata* (Hardy, 1955)

Discussion

Subgenus *Javadacus* has no synapomorphies that clearly define it, being separated from subgenus *Zeugodacus* solely on the basis of setal reduction (supra-alar setae absent plus only one pair of scutellar setae). These are unreliable characters and the subgenus is likely to be polyphyletic. The Ambonese *B. (J.) semisurstyli* differs significantly from the other included species and, apart from the setal characters, closely resembles *B. (Z.) buruensis* White from Buru and Sulawesi and *B. (Z.) flavipilosa* (Hardy) from Sulawesi in most morphological details, including those of the face, scutum, wings, legs and abdomen (see Drew and Romig 2013). These three species, all from Wallacea (Zone C of Hancock and Drew 2015), likely form a related group within subgenus *Zeugodacus*.

The remaining species form two species-pairs: *B. (J.) javanensis* plus *B. (J.) montana* from East and West Java respectively; and *B. (J.) scutellaria* from southern India plus *B. (J.) trilineata* from much of South and Southeast Asia. The former pair have largely pale abdomens with black T-shaped and lateral markings, while the latter pair have largely black abdomens. These pairs might also prove to be unrelated and derived independently from subgenus *Zeugodacus* by character reduction. However, all five species are retained here in *Javadacus* pending a detailed review of the large and complex subgenus *Zeugodacus sensu stricto*.

Of the species here included in *Javadacus*, two occur in the Indian subcontinent (Zone A), one being shared with SE Asia (Zone B). The two Indonesian species (Zone B) are endemic to Java, while the Wallacean species (Zone C) is endemic to Ambon.

Although recent molecular studies (e.g. Virgilio *et al.* 2015) suggest that *Zeugodacus* represents a separate genus closer to *Dacus* Fabricius than to other groups of *Bactrocera* subgenera, a recent study by Jiang *et al.* (2016), while supporting a sister-group relationship between *Zeugodacus* and *Dacus* on molecular grounds [shared plesiomorphies?], noted that further evidence was required before taxonomic raising of *Zeugodacus* to genus could be validated. Jiang *et al.* (2016) noted that such action should be based on more complete taxon sampling, more comprehensive molecular data combining mitochondrial genomes and nuclear genes and on more taxonomic, biological and biogeographic evidence. Morphological and biological data contradicting a direct *Dacus-Zeugodacus* relationship were discussed by Hancock and Drew (2015) and no true synapomorphies linking them have been identified. We therefore continue to regard *Javadacus* as belonging in the *Zeugodacus* group of subgenera within genus *Bactrocera*.

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