

# A new species of pest fruit fly (Diptera: Tephritidae: Dacinae) from Sri Lanka and Africa

R.A.I. Drew<sup>1\*</sup>, K. Tsuruta<sup>2</sup> & I.M. White<sup>3</sup>

<sup>1</sup>International Centre for Management of Pest Fruit Flies, Griffith University, Nathan Campus, Queensland 4111, Australia

<sup>2</sup>Yokohama Plant Protection Station, Ministry of Agriculture, Forestry and Fisheries, 5-57 Kita-nakadori, Yokohama, 231-0003 Japan

<sup>3</sup>Department of Entomology, The Natural History Museum, Cromwell Road, London, SW7 5BD, U.K.

A new species of Dacinae, *Bactrocera* (*Bactrocera*) *invadens* sp.n., from Sri Lanka and Africa, is described and illustrated. This is a pest species that has recently been introduced into eastern Africa and has subsequently made a rapid expansion across tropical Africa. Known distribution and host records are also presented.

**Key words:** Tephritidae, fruit flies, Dacini, *Bactrocera*, Africa, invasive species, plant quarantine.

## INTRODUCTION

While there is a need to revise the Dacinae of Southeast Asia, the pest species are generally known. Those in the *dorsalis*-complex were defined by Drew and Hancock (1994) while Allwood *et al.* (1999) recorded the known host plant records of pest and non-pest species. Recently, a pest species was recorded for the first time in Kenya (Lux *et al.* 2003) and has subsequently been found in countries across tropical Africa. From recent records, it has spread over, at least, ten countries in central Africa and is already attacking important food crops. Consequently, it is now recognized as highly invasive and possessing a wide range of plant hosts, cultivated and wild. There is little doubt that this fruit fly species will become one of major economic importance with considerable implications for agriculture in Africa and its Plant Pest Quarantine and export programmes.

Whilst this has been recognized as an invading species belonging to an Asian species complex, its origin and identity were initially unknown. More recently, large numbers of this species were found in a collection of Dacini made in Sri Lanka by one of the authors (KT). Consequently, it is now described in this paper to make it known to science and the wider agricultural community. Descriptive terminology follows the glossary of White *et al.* (2000).

Acronyms for museum collections and other institutions are as follows: ANIC, Australian National Insect Collection, Canberra; BMNH, The Natural History Museum, London; CIRAD,

Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Cotonou, Benin; ICIPE, International Centre of Insect Physiology and Ecology, Nairobi; MRAC, Royal Museum of Central Africa, Tervuren, Belgium; NMKE, National Museum of Kenya, Nairobi; QDPI, Queensland Department of Primary Industries, Brisbane; SANC, South African National Collection of Insects, Pretoria; YPPS, Yokohama Plant Protection Station, Yokohama.

### *Bactrocera* (*Bactrocera*) *invadens* sp. n.,

Figs 1–4

#### *Description of male*

*Head.* Vertical length 1.62 mm. Frons length 1.36 times breadth; red-brown with fuscous around frontal and orbital setae and on anteromedial hump; frontal and orbital setae strong and black: one orbital, two frontal setae; lunule pale fuscous. Ocellar triangle black. Vertex pale fuscous. Face fulvous with a medium to large oval black spot in each antennal furrow; length 0.51 mm. Occiput entirely red-brown (occasional specimens with black scutum possess dark fuscous to black patterns on red-brown base colour), fulvous along eye margins; 4–8 strong black postocular setae. Antenna, scape and pedicel red-brown, first flagellomere red-brown with fuscous on apex and outer surface; length of segments: 0.2 mm, 0.31 mm, 0.86 mm.

*Thorax.* Scutum with base colour mostly dark orange-brown and occasionally black; when dark orange-brown, it manifests a lanceolate dark

\*To whom correspondence should be addressed.  
E-mail: d.drew@griffith.edu.au

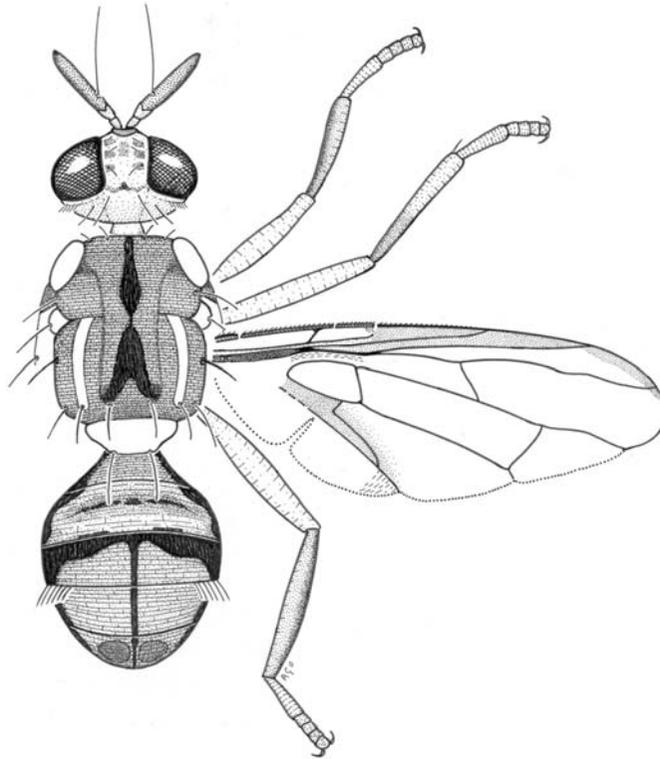


Fig. 1. *Bactrocera (Bactrocera) invadens*, adult male

pattern similar to *Bactrocera (Bactrocera) cacuminata* (Hering) that varies from fuscous to black and some specimens have, in addition, large black markings between postpronotal lobe and notopleural callus; when black, it possesses dark orange-brown below and behind lateral post-sutural vitta, around notopleural suture and inside postpronotal lobe. Pleural areas dark fuscous to black with red-brown below postpronotal lobe. Yellow markings as follows:

postpronotal lobe; notopleural callus; medium-sized anepisternal stripe reaching midway between anterior margin of notopleural callus and anterior notopleural seta dorsally, continuing to katapisternum as a transverse spot, anterior margin convex; anatergite (posterior apex black); anterior three-fifths katatergite (remainder black); narrow to medium-width parallel-sided lateral postsutural vitta ending at or just behind intra-alar seta. Mediotergite black laterally, red-brown

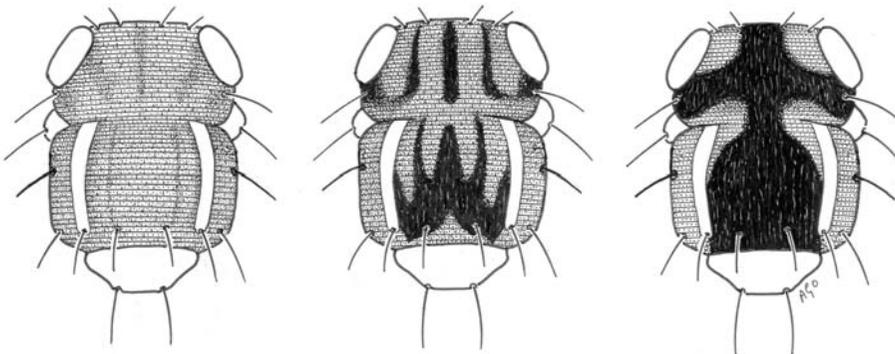


Fig. 2. Variations in scutum patterns for *Bactrocera (Bactrocera) invadens*.

centrally. Scutellum yellow except for narrow black basal band. Setae: apical scutellar, prescutellar acrostichal, intra-alar, anterior and posterior supra-alar, anepisternal, anterior and posterior notopleural, and two pairs scapular.

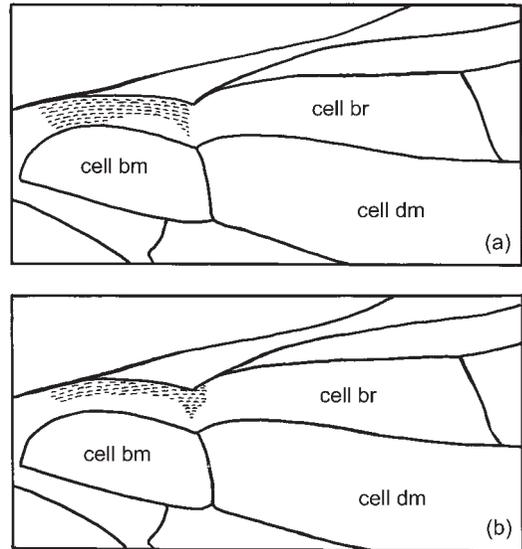
*Legs.* Femora entirely fulvous; foretibiae pale-fuscous to fuscous, midtibiae fuscous basally and pale fuscous apically, hindtibiae dark fuscous; tarsi entirely fulvous.

*Wings.* Length 5.4–6.9 mm; cells bc and c colourless; microtrichia in anterodistal corner of cell c only; remainder of wing colourless except fuscous cell sc, narrow fuscous costal band confluent with  $R_{2+3}$  and remaining very narrow apically to end just beyond apex of  $R_{4+5}$ , a narrow pale fuscous anal streak ending before wing margin; dense aggregation of microtrichia around  $A_1+Cu_2$ ; supernumerary lobe of medium development.

*Abdomen.* Oval; terga free; pecten present on tergum III. Tergite I orange-brown with narrow lateral dark fuscous to black margins; tergite II orange-brown with narrow lateral dark fuscous to black margins and a narrow transverse dark fuscous to black band across central area but not reaching lateral margins; tergites III–V orange-brown with a 'T' pattern comprising a transverse black band across anterior margin of tergite III, which varies from being shallow to deep, and sometimes broadly expanded along lateral margins to leave only a small postero-submedial orange brown area; and a narrow to medium-width medial longitudinal dark fuscous to black stripe over all tergites III–V; narrow lateral dark fuscous margins on all three tergites. Tergite V usually with a fuscous to black band along outer third of anterior margin, and extended posteriorly along lateral margin. Ceromata on tergite V oval and slightly darker than the orange-brown ground colour. Posterior lobe of surstylus short, sternum V with a deep concavity on posterior margin.

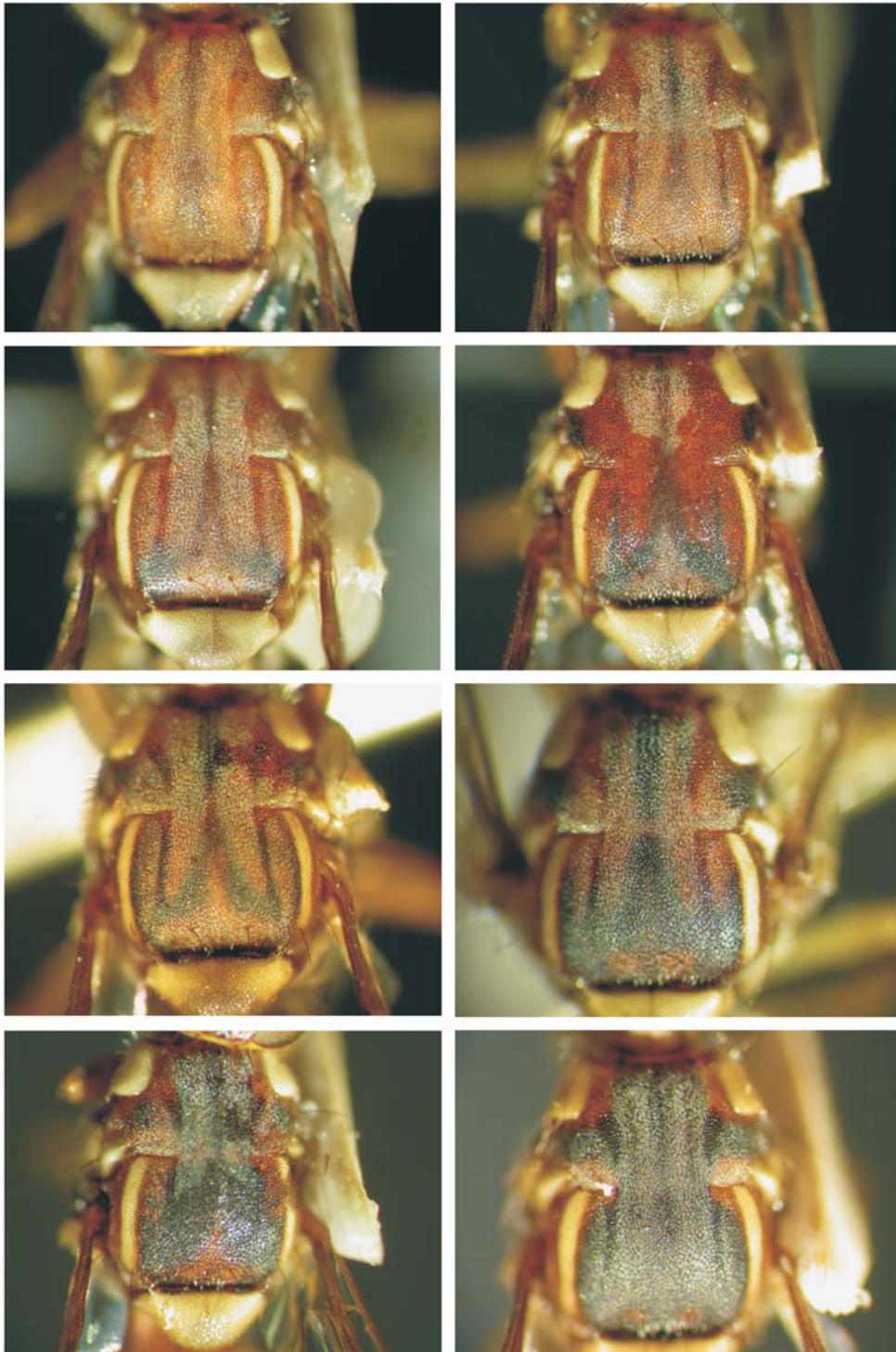
#### Description of female

As for male except no dense aggregation of microtrichia around  $A_1+Cu_2$ ; supernumerary lobe weak; no pecten present on tergite III. Oviscape orange-brown tending fuscous apically, dorso-ventrally compressed and tapering posteriorly in dorsal view. Ratio of length of oviscape to length of tergum V, 0.9:1. Aculeus needle shaped, 1.6 mm [too few females were available for comprehensive study], 0.71 times as long as cell dm (measured along posterior edge).



**Fig. 3.** Microtrichia patterns in cell br for (a) *Bactrocera (Bactrocera) invadens* and (b) *Bactrocera (Bactrocera) kandiensis* Drew and Hancock.

*Material examined.* Holotype ♂, KENYA: Coast, Matuga, 12.iii.2003, ICIPE sample T1, methyl eugenol trap (NMKE). Paratypes: 16♂, same data as holotype; 1♀, Coast Prov., Tiwi, Capricio Cottages, 2.ii.2003, Leg. A. Manrakhan (code AFFI-2), McPhail trap baited with NuLure; 1♂, Coast Reg., Coast Prov., Shimba Hills, 398 m., 9.ii.2003, R.S. Copeland, TAMRAF project sample AM2498, reared ex *Strychnos mellodora* fruit; 1♀, Coast Prov., Muhaka, 26.ii.2003, Leg. A. Manrakhan (code AFFI-1), on (not reared) citrus. BENIN: 4♂, Penessoulou, .vi.2004, Leg. G. Goergen, methyl eugenol trap; 4♂, Niaouli, 20.x.2004, Leg. G. Goergen, methyl eugenol trap; 11♂, Cotonou, IITA Station, 16.ix.–14.x.2004, Leg. J.F. Vaysierres (RVA1628-38), mixed methyl eugenol and cue lure trap. CAMEROON: 3♂, 1♀, Esse, 22.viii.2004, Leg. M. Tindo, reared ex *Psidium guajava* fruit; 2♂, 5♀, Esse, 23.viii.2004, Leg. F.X.N. Abanda, reared ex *Psidium guajava* fruit. SENEGAL: 2♂, Abbaye Keur Moussa, 13–17.xii.2004, Leg. J.F. Vaysierres (codes RVA 1645-6), methyl eugenol trap; 2♀, Abbaye Keur Moussa, 8.vi.–21.ix.2004, Leg. J.F. Vaysierres (codes RVA 1643-4), trap baited with *Torula* yeast. SRI LANKA: 4♂, 18.xii.1994; 8♂, 19.xii.1994; 4♂, 20.xii.1994; 6♂, 21.xii.1994; 7♂, 22.xii.1994; Thaladuma, Negombo, K. Tsuruta, attracted to methyl eugenol; 1♂, Piachaud Garden, Kandy, 14.vii.1993, K. Tsuruta, attracted to methyl



**Fig. 4.** Sequence of scutum colour patterns from red-brown to black that may be present on *Bactrocera* (*Bactrocera*) *invadens*.

**Table 1.** Aedeagus lengths (length of distiphallus, excluding glans).

Species	Range (mm)	Mean (mm)	<i>n</i>	Source
<i>B. dorsalis</i>	2.46–2.70	2.59	34	Taiwan (type country)
<i>B. invadens</i>	2.61–2.96	2.83	26	Kenya (type country)
<i>B. invadens</i>	2.65–2.93	2.86	48	Sri Lanka

eugenol; 1♂, Gannoruwa Mountain, Kandy, 4.x.1993, K. Tsuruta, attracted to methyl eugenol; 1♂, Kundasale, Kandy, 22.xi.1993, K. Tsuruta, attracted to methyl eugenol. TANZANIA: 2♂, 3♀, Morogoro, Sokoine University of Agriculture, horticultural unit orchard, .xii.2003, Leg. M. Mwatawala, reared, ex *Mangifera indica* fruit. TOGO: 4♂, Kloto, 900 m, x.2004, Leg. G. Goergen, methyl eugenol trap. UGANDA: 4♂, Semiliki Park, 20.vii.2004, Leg. G. Goergen, methyl eugenol trap. A hundred paratypes distributed as follows: 3♂ in ANIC, 10♂, 2♀ in BMNH, 13♂, 2♀ in CIRAD, 10♂, 8♀ in MRAC, 10♂ in NMKE, 10♂, 3♀ in QDPI, 10♂ in SANC, 19♂ in YPPS. Long series of alcohol-preserved trapped males (not designated as paratypes) were also examined from Kenya and Uganda.

**Distribution.** Sri Lanka, with adventive populations in Benin, Cameroon, Ghana, Kenya (type locality), Nigeria, Senegal, Sudan, Tanzania, Togo and Uganda; specimens from Ghana, Nigeria and Sudan were in a poor state of preservation and were not designated as paratypes.

**Hosts.** Guava (*Psidium guajava* L.), mango (*Mangifera indica* L.), citrus (*Citrus* sp.), papaya (*Carica papaya* L.) and some wild hosts, in Africa (these will be reported in a paper by African-based workers). Its hosts in Sri Lanka are unknown as the survey there was based on male lure trapping (Tsuruta *et al.* 1997; Tsuruta & White 2001).

**Attractant.** Methyl eugenol.

**Etymology.** Named *B. invadens* as a description of its rapid invasion of the African continent.

## DISCUSSION

*Bactrocera invadens* is similar to *Bactrocera* (*Bactrocera*) *dorsalis* (Hendel), from Southeast Asia, and *Bactrocera* (*Bactrocera*) *kandiensis* (Drew and Hancock), from Sri Lanka, in possessing a very narrow costal band and anal streak, scutum black (in some specimens only), parallel-sided lateral postsutural vittae and abdominal tergites III–V with a dark 'T' pattern and narrow dark lateral markings on all three terga. It differs from both

species in having the scutum base colour dark orange-brown with a dark fuscous to black lanceolate pattern (in most specimens), from *B. dorsalis* in having a longer aedeagus (Table 1) and narrow lateral postsutural vittae, and from *B. kandiensis* in having femora entirely fulvous. A further differentiating character is in the basal area of cell br, above cell bm. *B. invadens* and *B. dorsalis* have a bare colourless area adjacent to cell bm approximately one half the length of this cell, compared with *B. kandiensis* that has a larger area that is also much paler fuscous (Fig. 3). In addition, *B. dorsalis* differs from *B. invadens* and *B. kandiensis* in never having the dark transverse band across tergite III broadly reaching tergite IV, and the dark anterolateral band on tergite V is rarely extended as far mesally. However, the colour patterns of the scutum and abdomen of *B. invadens* are remarkably variable compared to other species in the *B. dorsalis* species complex, and some specimens are almost inseparable from *B. dorsalis*, while most are clearly differentiated, e.g. by a uniformly pale scutum (unknown in mature *B. dorsalis*), or the broad dark markings on the abdomen (also unknown in *B. dorsalis*).

This species appears to have invaded Africa from the Indian subcontinent, and was only discovered in Sri Lanka after it was first found in Africa, where it is of significant economic importance (Mwatawala *et al.* 2004). The rapid spread across tropical Africa (Table 2) and growing records in edible fruit crops are strong indicators of this pest status. It is possible that it may have been overlooked in some areas and its place of first discovery should not be assumed to be its point of first invasion into Africa. However, it was first found in Kenya soon after the completion of a programme of monthly fruit collections carried out from February 1999 to January 2003 by R.S. Copeland (Texas A&M University and ICIPE), at sites ranging from Mount Elgon in the west, to the coast in the southeast (Copeland *et al.* 2004). This was followed by less frequent collections (until late 2004), one of which yielded the first

**Table 2.** Chronology of discovery of *Bactrocera invadens* across Africa.

Country	Date first discovered	Collecting information
Kenya	February 2003	Bred from fruit
Tanzania	December 2003	Bred from fruit
Sudan	May 2004	Methyl eugenol trapping
Benin	June 2004	Methyl eugenol trapping
Uganda	July 2004	Methyl eugenol trapping
Cameroon	August 2004	Bred from fruit
Togo	October 2004	Methyl eugenol trapping
Senegal	October 2004	Torula yeast liquid trap
Ghana	January 2005	Methyl eugenol trapping
Nigeria	January 2005	Methyl eugenol trapping

reared specimen (9.ii.2003). The first specimen (2.ii.2003) was a female trapped using NuLure protein in a nearby area of coastal Kenya, by A. Manrakhan from Mauritius, at that time of ICIPE, who was familiar with *B. dorsalis* from having trapped it in her own country during its 1996 outbreak. Although methyl eugenol was not widely used in Kenya up until that date, it had been deployed at sites in Kenya and other African countries (including Tanzania) in 1999–2000 by ICIPE's African Fruit Fly Initiative. Samples examined by one of us (I.M.W.) did not contain *B. invadens*, suggesting that it was either not yet present or at least at a low abundance.

## REFERENCES

- ALLWOOD, A.J., CHINAJARIYAWONG, A., DREW, R.A.I., HAMACEK, E.L., HANCOCK, D.L., HENGSAWAD, C., JIPANIN, J.C., JIRASURAT, M., KONG KRONG, C., KRITSANEPAIBOON, S., LEONG, C.T.S. & VIJAYSEGARAN, S. 1999. Host plant records for fruit flies (Diptera: Tephritidae) in South East Asia. *The Raffles Bulletin of Zoology*, Supplement No. 7.
- COPELAND, R.S., WHITE, I.M., OKUMU, M., MACHERA, P. & WHARTON, R.A. 2004. Insects associated with fruits of the Oleaceae (Asteridae, Lamiales) in Kenya, with special reference to the Tephritidae (Diptera). In: Evenhuis, N.L. & Kaneshiro, K.Y. (Eds) *D. Elmo Hardy Memorial Volume. Contributions to the Systematics and Evolution of Diptera. Bishop Museum Bulletin in Entomology* **12**: 135–164.
- DREW, R.A.I. & HANCOCK, D.L. 1994. The *Bactrocera dorsalis* complex of fruit flies (Diptera: Tephritidae: Dacinae) in Asia. *Bulletin of Entomological Research*, Supplement Series 2: 1–68.
- LUX, S.A., COPELAND, R.S., WHITE, I.M., MANRAKHAN, A. & BILLAH, M.K. 2003. A new invasive fruit fly species from the *Bactrocera dorsalis* (Hendel) group detected in East Africa. *Insect Science and its Application* **23**: 355–360.
- MWATAWALA, M.W., WHITE, I.M., MAERERE, A.P., SENKONDO, F.J. & DE MEYER, M. 2004. A new invasive *Bactrocera* species (Diptera: Tephritidae) in Tanzania. *African Entomology* **12**: 154–156.
- TSURUTA, K., WHITE, I.M., BANDARA, H.M.J., RAJAPAKSE, H., SUNDARAPERUMA, S.A.H., KAHAWATTA, S.B.M.U.C. & RAJAPAKSE, G.B.J.P. 1997. A preliminary note on the host-plants of fruit flies of the tribe Dacini (Diptera, Tephritidae) in Sri Lanka. *Esakia* **37**: 149–160.
- TSURUTA, K. & WHITE, I.M. 2001. Eleven new species of the genus *Bactrocera* Macquart (Diptera: Tephritidae) from Sri Lanka. *Entomological Science* **4**: 69–87.
- WHITE, I.M., HEADRICK, D.H., NORRBOM, A.L. & CARROLL, L.E. 2000. Glossary. In: Aluja, M. & Norrbom, A.L. (Eds) *Fruit Flies (Tephritidae): Phylogeny and Evolution of Behavior*. 881–924. CRC Press, Boca Raton.