

A Preliminary Survey of the Fruit Flies (Diptera: Tephritidae: Dacinae) of Bangladesh

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Abstract. Thirteen species of *Bactrocera* and one species of *Dacus* were collected during field surveys in Bangladesh, including eight new country records, for a total of fifteen species confirmed to occur in the country. Color variation in Bangladesh *B. dorsalis* is similar to that observed in *B. invadens* in Africa and Sri Lanka.

Field research on dacine fruit flies in Bangladesh has mainly focused on surveying damage (Kabir et al. 1991, Akhtaruz-zaman et al. 1999b) and developing field control (Chowdhury et al. 1993, Akhtaruz-zaman et al. 1999a, Khan et al. 2007a,b) for cucurbit-infesting pest species, and species diversity has thus far not been well surveyed. In his taxonomic study of the Indian subcontinent species, Drew reported only one species of *Dacus* to occur specifically in Bangladesh, among 65 species of *Dacus* and *Bactrocera* (Drew 1998, Drew and Raghu 2002). We present in this paper an annotated species list, based on recent field surveys using male lure traps. Additionally, we demonstrate that color pattern variation observed in oriental fruit fly (*Bactrocera dorsalis*) in Bangladesh is similar to the variation observed in *B. invadens*.

Traps baited with male lures (cue-lure and methyl eugenol) were maintained at eight locations between May and October 2013. At each site, two traps, separately baited with the two lures, were hung in trees about 1.8 meters above the ground. Traps were made of 2 liter empty plastic

drinking water bottles, with two triangular lateral holes (approximately 25 x 30 x 30 mm) at mid height of the bottles. A lure plug with 2 g of lure (Scentry Biologicals, Billings, Montana, USA) and one half of a 25 x 90mm strip containing 10% dichlorvos (2,2-dichlorovinyl dimethyl phosphate) (Vaportape[®] II, Hercon Environmental, Emingsville, Pennsylvania, USA) were suspended from the trap's ceiling with a hook made of tie wire. Trapping locations, identified by numbers on Figure 1, and the range of collecting dates at each location, included: 1: Atomic Energy Research Establishment (AERE), in Savar Upazila, near Dhaka (13 May–28 September); 2: Institute of Nuclear Science and Technology (INST), near Dhaka (May); 3: Bhawal National Park (BNP), in Gazipur District (23 August); 4: Madhupur National Park (MNP), in Tangail District (20 September); 5: Jamalpur District (21–22 September); 6: Rooppur Nuclear Power Project site office Campus (RNPP), in Ishwardi Upazila, Pabna District (30 September–3 October); 7: Gurudaspur Upazila, in Natore District (21–23 May); and 8: Regional Horticultural Research

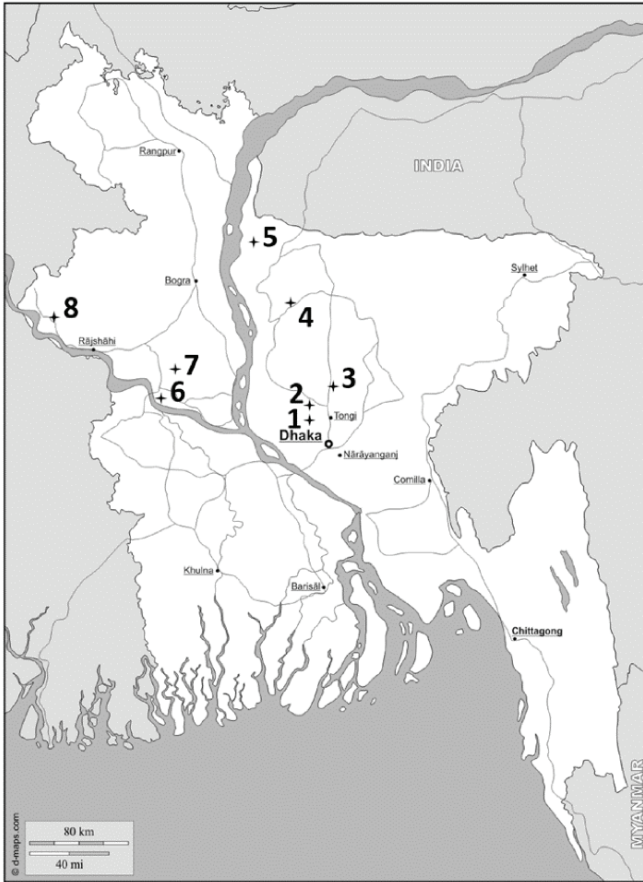


Figure 1. Collecting sites in Bangladesh.

Center Campus (RHRC), in Chapai Nawabganj District (30 June–2 July). All locations were in agricultural environments, except 3 and 4, located in forested national parks, but in proximity to agriculture.

A total of 1510 specimens was collected in traps (566 specimens in cue-lure, and 895 in methyl eugenol) or by hand with a net or vial (53 specimens). These belonged to 14 species, listed below. Genomic DNA was extracted from a leg and genetic sequencing of the mitochondrial gene cytochrome c oxidase I (COI, 780 bp) was performed on 62 specimens, covering every species collected during the survey, following the

methods described by San Jose et al. (2013). Sequences were compared with existing sequences, whenever available, to help confirm species identity. Pinned voucher specimens of all species were deposited in the University of Hawaii Insect Museum (Honolulu) and the Institute of Food and Radiation Biology of the Bangladesh Atomic Energy Commission (Dhaka).

Bactrocera (Bactrocera) dorsalis (Hendel) (oriental fruit fly) [AERE: 165 specimens, INST: 78, BNP: 27, MNP: 2, Jamalpur: 1, RNPP: 208, Gurudaspur: 52, RHRC: 333. Methyl eugenol]. Oriental fruit fly was by far the most numerous

species among all samples, with 57% of all collected flies. Recorded hosts in Bangladesh include mango (*Mangifera indica* L.), carambola (*Averrhoa carambola* L.), and guava (*Psidium guajava* L.) (Kabir et al. 1991).

This species exhibits in Bangladesh a broad range of scutum color pattern variation. The large series collected in RHRC was carefully examined and scutum and abdomen color of each specimen was assigned to one variant category, ranging from predominantly pale to predominantly dark, as illustrated on Figure 2. The proportion of specimens with each scutum color category, among the 326 specimens examined, was 7.4% in category A, 15.0% in B, 17.2% in C, 4.0% in D, 17.5% in E, 4.3% in F, 19.3% in G, and 15.3% in H. The proportion in each abdomen color category was 3.7% in category A, 32.2% in B, 50.3% in C, 12.6% in D, and 1.2% in E. The scutum color gradient, from lightest to darkest, was also correlated to a large extent with the lightest to darkest abdomen color gradient (graph insert on Fig. 2).

The scutum pattern variation is similar to that documented in *B. invadens* Drew, Tsuruta and White (Fig. 4 in Drew et al. 2005 and Fig. 3 herein), suggesting that the variation observed in *B. invadens* is not restricted to native Sri Lankan and invasive African populations, but more widespread on the Indian subcontinent, explaining the presence of *B. invadens* in Bhutan reported by Drew et al. (2007). To explore the relationship of Bangladesh *B. dorsalis* with related species in the complex, we sequenced the COI gene of 8 specimens of *B. dorsalis* (with scutum and abdomen color combinations B-B, B-C, B-D, C-C, G-D, H-D, E-C, and H-E) and 8 specimens of *B. invadens*, one of each scutum variant on Fig. 3, collected in 2010 in Burkina Faso, and compared them to the sequences published in San Jose et al. (2013). The proportion of each color category, among

566 specimens from Burkina Faso, was 6.2% in category A, 7.8% in B, 13.1% in C, 2.6% in D, 16.8% in E, 21.7% in F, 16.8% in G, and 15.0% in H (Fig. 3). The eight sequences were deposited in GenBank (www.ncbi.nlm.nih.gov) (see appendix), and analyzed with GARLI (Zwickl 2006) using the same model and with the same sequences included in the COI phylogeny from San Jose et al. (2013).

In the phylogenetic tree resulting from the analysis, all the individuals of *B. dorsalis* from Bangladesh and *B. invadens* from Burkina Faso were placed within the *B. dorsalis* sensu lato clade, which also included *B. papayae* Drew and Hancock, *B. carambolae* Drew and Hancock, and *B. philippinensis* Drew and Hancock. Our analysis and other recent studies (Ekesi and Mohammed 2010, Khamis et al. 2012, San Jose et al. 2013, Schutze 2013) suggest that the two species are genetically identical, produce viable offspring in the lab, and that *B. invadens* may just be a geographic color variant of *B. dorsalis*. In his original revision of the species complex (Drew and Hancock 1994), R.A.I. Drew listed *B. dorsalis* as widespread in Asia, from India to Taiwan. More recently (Drew and Romig 2013), he could not confirm the Bhutan record of *B. invadens* or the occurrence of *B. dorsalis* in India and Sri Lanka. In any case, whether regarded as a color variant of *B. dorsalis* or a separate species, the light colored form consistent with *B. invadens* is shown here to be relatively widespread over the Indian subcontinent rather than confined to Sri Lanka.

Bactrocera (Bactrocera) latifrons (Hendel) (solanum fruit fly) [AERE: 11 specimens, all collected by hand]. New record for Bangladesh. A pest of Solanaceae, widespread in tropical Asia, from India to Taiwan, and south to peninsular Malaysia.

Bactrocera (Bactrocera) nigrofemoralis White and Tsuruta [AERE: 2 speci-

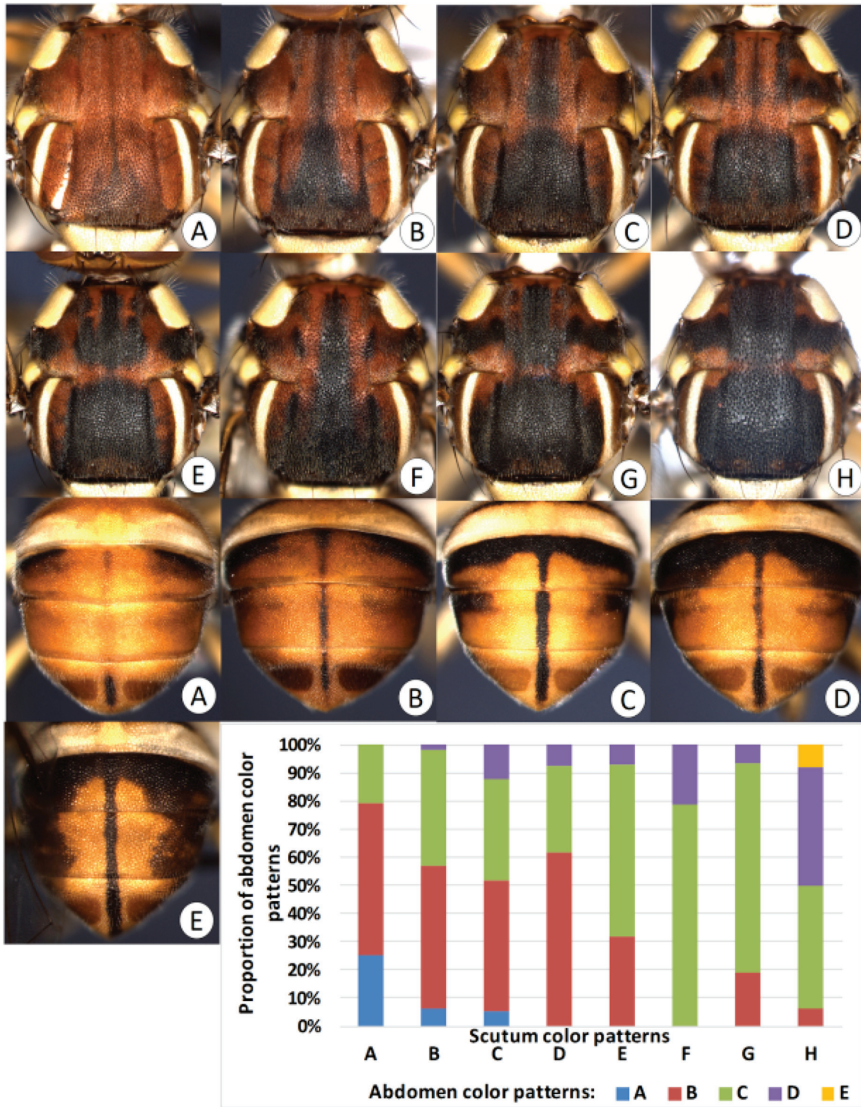


Figure 2. Color variation patterns on scutum and abdomen of *Bactrocera dorsalis* in Bangladesh. Insert graph shows the proportion of specimens of each abdomen color pattern (A to E), included in each scutum pattern series (A to H) on the X axis.

mens, Gurudasapur: 1, RHRC: 1. Cue-lure]. New record for Bangladesh. A common species in Sri Lanka, India, Pakistan, and Bhutan, bred from five species of edible fruits (Tsuruta and White 2001, Drew and Romig 2013).

Bactrocera (Bactrocera) rubigina (Wang and Zhao) [AERE: 79 specimens, BNP: 56. All but two females from cue-lure]. New record for Bangladesh. Originally described from China (Wang and Zhao 1989) and later recorded from

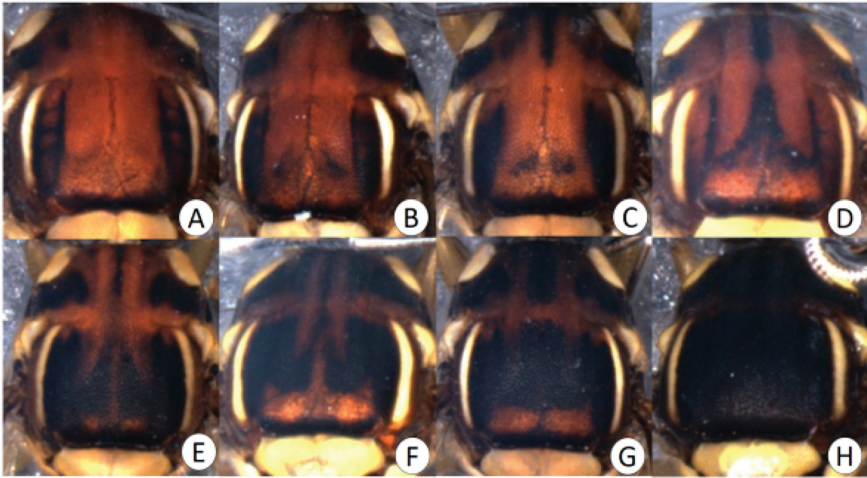


Figure 3. Color variation patterns on scutum and abdomen of *Bactrocera invadens* in Burkina Faso.

Bhutan, Thailand and Vietnam (Drew et al. 2007, Drew and Romig 2013). A non-economic species bred from *Litsea verticillata* Hance in China (Liang et al. 1993).

Bactrocera (Bactrocera) zonata (Saunders) (peach fruit fly) [INST: 13, Gurdaspur: 10, RHRC: 6. Methyl eugenol]. A common species on the Indian subcontinent, that also occurs, though less commonly observed, in Thailand and Vietnam. A major pest of cultivated fruits bred from mango in Bangladesh (Kabir et al. 1991).

Bactrocera (Bactrocera) species 45. [AERE: 1, in cue-lure]. New record for Bangladesh. Morphologically and genetically identical to species 45 of San Jose et al. (2013), also recorded in Laos, Cambodia, Thailand and China. It is likely to be *B. propinqua* (Hardy and Adachi), a species bred from *Garcinia* spp, but positive identification requires confirmation.

Bactrocera (Daculus) digressa Radhakrishnan [AERE: 1 specimen, RNPP: 2, RHRC: 2. Cue-lure]. New record for Bangladesh. This species was originally described in 1999 from Bangalore Province, Southern India, and subsequently

as *B. yercaudiae* Drew in 2002, declared a junior synonym by David and Ramani (2011). Host plant in India is *Alangium salviifolium* (L.f.) Wangerin (David and Ramani 2011).

Bactrocera (Hemigymnodacus) diversa (Coquillett) [INST: 39 specimens, all collected by hand]. Widespread from Pakistan to Vietnam. A pest of Cucurbitaceae at the flowering stage, bred from calabash (*Lagenaria siceraria* (Molina) Standl.) and pumpkin (*Cucurbita maxima* Duchesne) in Bangladesh (Kabir et al. 1991; Molla et al. 2000). The weak attraction to methyl eugenol reported by Drew and Romig (2013) was not observed in Bangladesh.

Bactrocera (Parasinodacus) cilifera (Hendel) [AERE: 1 specimen, in cue-lure]. New record for Bangladesh. This species is recorded from China, Taiwan, Laos, Vietnam, Peninsular Malaysia, and Thailand, where it was bred from male flowers of *Thladiantha hookeri* C.B. Clarke (Cucurbitaceae) (Allwood et al. 1999).

Bactrocera (Sinodacus) hochii (Zia). [MNP: 1 specimen, from cue-lure]. New record for Bangladesh. This cucurbit-

infesting species, bred among others from smooth luffa (*Luffa aegyptiaca* Mill.) (Allwood et al. 1999), is present in China, Vietnam, Thailand, Peninsular Malaysia, and Indonesia.

Bactrocera (Zeugodacus) caudata (Fabricius) [AERE: 1 specimen, RNPP: 17, Gurudasapur: 1, RHRC: 5. Cue-lure]. New record for Bangladesh. Widespread from India to China, and south to Indonesia. Larvae have been bred from male flowers of squash (*Cucurbita moschata* Duchesne) (Allwood et al. 1999).

Bactrocera (Zeugodacus) cucurbitae (Fabricius) (melon fly) [AERE: 25 specimens, INST: 19, BNP: 4, MNP: 5, Jamalpur: 66, RNPP: 60, Gurudasapur: 39, RHRC: 31. Cue-lure]. A major pest widespread in Asia, infesting primarily Cucurbitaceae at the flowering and fruiting stages. Hosts plants in Bangladesh are: winter melon (*Benincasa hispida* (Thunb.) Cogn.), watermelon (*Citrullus lanatus* (Thunb.) Matsum. & Nakai), ivy gourd (*Coccinia grandis* (L.) Voigt), melon (*Cucumis melo* L.), cucumber (*C. sativus* L.), pumpkin, calabash, tomato (*Lycopersicon esculentum* Mill.), angled luffa (*Luffa acutangua* (L.) Roxb.), smooth luffa, balsam-apple (*Momordica balsamina* L.), bittergourd (*M. charantia* L.), gac fruit (*M. cochinchinensis* Spreng.), spiny gourd (*M. dioica* Roxb. Ex Willd.), eggplant (*Solanum melongena* L.), and snakegourd (*Trichosanthes cucumerina* L.) (Kabir et al. 1991; Akhtaruzzaman et al. 1999b, Amin et al. 2011, Alim et al. 2012), with losses estimated at 10-30% of annual agricultural produce (Naqvi 2005). Populations are abundant throughout the year, but highest from April to June and lowest in October-November (Alim et al. 2012).

Bactrocera (Zeugodacus) tau (Walker) (pumpkin fruit fly) [AERE: 23 specimens, INST: 10, BNP: 2, MNP: 1, Jamalpur: 36, RNPP: 26, Gurudasapur: 5, RHRC: 6.

Cue-lure]. A moderately severe pest of Cucurbitaceae widespread in Asia. Hosts in Bangladesh include: winter melon, melon, cucumber, pumpkin, calabash, angled and smooth luffa, bittergourd, spiny gourd, gac fruit, and snakegourd (Kabir et al. 1991; Akhtaruzzaman et al. 1999b; Huque 2006). Detailed life history was published by Kabir et al. (1997).

Dacus (Callantra) longicornis (Wiedemann) [AERE: 11 specimens, RNPP: 15. Cue-lure]. A minor pest bred from fruit of 4 species of cucurbits (Allwood et al. 1999), widespread in Southeast Asia, west to Bhutan and Bangladesh, where it was first collected in 2008 (Khan 2009).

Dacus (Mellesis) polistiformis (Senior-White), a non-pest species present in India, Nepal, and China (Drew 1998, Drew and Romig 2013), was erroneously recorded as present in Bangladesh (Norrbom et al. 1998), collected in the Khasia Hills, which are actually part of India but bordering Bangladesh.

Dacus (Didacus) ciliatus Loew (Ethiopian fruit fly). An African pest of cucurbits not attracted to male lures, extending through the Middle East to the Indian sub-continent, including Bangladesh, where it infests fruits of cucumber (Akhtaruzzaman et al. 1999b). It was not collected in the present survey.

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Appendix: List and GenBank accession numbers for specimens of *Bactrocera dorsalis* and *B. invadens* sequenced for this paper

Bactrocera dorsalis from Bangladesh (INST): KF871265 (ms3745, scutum B, abdomen B), KF871266 (ms3746, C, C), KF871267 (ms3747, G, D), KF871268 (ms3749, H, D), KF871269 (ms3751, H, E). AERE: KF871270 (ms3794, E, C), KF871271 (ms3820, B, D). RHRC: KF871272 (ms3822, B, C). *Bactrocera invadens* from Burkina Faso (Yegouresso): KF871274 (ms0935, scutum A), KF871280 (ms0941, B), KF871275 (ms0936, C), KF871278 (ms0939, D), KF871279 (ms0940, E), KF871277 (ms0938, F), KF871276 (ms0937, G), KF871273 (ms0933, H).