

## Occurrences and field identities of fruit flies in sweet orange (*Citrus sinensis*) orchards in Sindhuli, Nepal

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### ABSTRACT

Protocol based fruit fly surveillance made in 2014-15 in citrus orchards in Sindhuli district revealed six species of *Bactrocera* flies, namely *Bactrocera minax* (Enderlein), *B. cucurbitae* Coquillett, *B. dorsalis* (Hendel), *B. zonata* (Saunders), *B. tau* Walker and *B. scutellaris* (Bezzi), and one species of *Dacus longicornis* Wiedeman. Except *B. minax*, other fruit flies were collected in male lure traps, while *B. minax* fruit flies were also reared to adults from infested sweet oranges. Each species of fruit flies has been morphologically identified up to species level for field identification purpose. *D. longicornis* is reported for the first time from Nepal.

**Keywords:** Fruit fly, surveillance, male fruit fly lure, *Bactrocera minax*, *B. cucurbitae*, *B. dorsalis*, *B. zonata*, *B. tau*, *B. scutellaris*, *Dacus longicornis*.

### INTRODUCTION

Fruit flies (Diptera: Tephritidae) are among the important pests of horticultural crops which cause extensive damages and losses to vegetable and tree fruits throughout the world. Growing international trades of fruits have further increased their significance (Allwood *et al.*, 1997). Although fruit flies problem in vegetable- and tree- fruits were considered in Nepal since 1966 (Entomology Section, 1966), their seasonal abundances and vegetable fruit hosts preferences were scientifically investigated in 1970 (Pradhan, 1970). Their economic importance in world trade context has been highlighted in Nepal since the commercialization of agriculture in the country. In context to Nepal-China agreement in 2012 to exporting citrus fruits from Nepal to China with due consideration of insect quarantine regulations on the commodity (Nepal China Agreement, 2012) switched on a protocol based regular fruit fly surveillance in the citrus orchards of Sindhuli and Syangja districts (PPD, 2014). The preliminary fruit fly surveillance in the selected 64 ha sweet orange orchards in Sindhuli district during May to December, 2014 revealed *Bactrocera cucurbitae* Coquillett, *B. dorsalis* (Hendel), *B. zonata* (Saunders), *B. tau* Walker and *B. scutellaris* (Bezzi) in male lures (Sharma *et al.*, 2015).

Taxonomy based field identification of fruit flies is a felt need in Nepal which is not yet initiated. Recently, Gautam *et al.* (2015) acclaimed morphological traits like body colour and size, colour pattern, presence of thoracic vittae, their shapes and colours, wing morphology, and setae locations on the fruit fly body were suitable and comparatively easy measures to making their field identifications. Paul (2010) also favoured morphological features on the body of fruit flies for their clear-cut and unambiguous identifications. Thus taking a benefit of morphological

traits in the bodies of fruit flies, the male lure trapped fruit flies, *B. cucurbitae*, *B. dorsalis*, *B. zonata*, *B. tau*, *B. scutellaris*, *Dacus longicornis* Wiedeman, and fruit reared *Bactrocera minax* (Enderlein) have been identified and are presented in this paper.

## MATERIALS AND METHODS

Fruit flies were collected in male lure traps installed in different sweet orange (*Citrus sinensis*) orchards of Sindhuli, Nepal. Fruit fly male lures used were methyl eugenol and Cue-lure baited with Malathion 50 EC in sixty-four sets of Steiner traps provided by National Plant Protection Organization, Plant Protection Directorate, Hariharbhawan, Pulchowk, Lalitpur along with Fruit Fly Surveillance Protocol. Fruit fly collection as a part of surveillance is still continuing, and the collected fruit flies during May 2014 to April 2015 were specimens for identification. Trapped fruit flies were collected in every fortnight, and male lures along with cotton swab soaked Malathion 50 EC were replaced in every fifteen days. Fruit flies' morphological traits except setae locations on body were investigated in each specimen to identify it to species level. Hand lens was used to observe the morphological traits on the body of a fruit fly, and the identified specimen was photographed and displayed in the paper. Distinguishing morphological characters of adult fruit fly dealt in Singh (2015a) and a diagnostic key to the pest species of fruit flies dealt in Singh (2015b) were used to identify them. For the collection of fruit flies of *B. minax*, maggot infested sweet oranges were collected and reared to adult fruit flies. Similar identification treatments as dealt before were given to *B. minax* adults for their identification to species level. The identified specimens of fruit flies were dry preserved and harbored in the Field Diagnosis Laboratory, Ratanchura-2, Khaniyakharka, Sindhuli, Nepal.

## RESULTS AND DISCUSSION

### 1. *Bactrocera (Bactrocera) dorsalis* (Hendel) (Oriental fruit fly)

**Diagnosis:** **Face** fulvous with a pair of medium sized circular black spots; **scutum** with base colour black, medial postsutural vitta absent; **scutellum** yellow with a narrow black basal band; **legs** with segments mostly fulvous except fore-tibiae pale fuscous and hind tibiae fuscous; **wings** with cells bc and c colourless, microtrichia in outer corner of cell c only, narrow fuscous costal band confluent with R2+3 and remaining narrow around costal margin to end just beyond apex of R4+5, a narrow pale fuscous cubital streak, supernumerary lobe weak; **Abdomen:** abdominal terga III-V fulvous with a black 'T' pattern consisting of a narrow transverse black band across anterior margin of tergum III and a narrow medial longitudinal black band over all three terga, narrow dark fuscous to black anterolateral corners on terga IV and V.

**Distribution:** Widespread from the Indian subcontinent, across Southeast Asia and the northern Pacific (Drew *et al.*, 2007).

**Note:** *B. dorsalis* is reported from Kathmandu, Nepal in melon and peach in 12 July 1964 (Joshi & Manandhar, 2001).

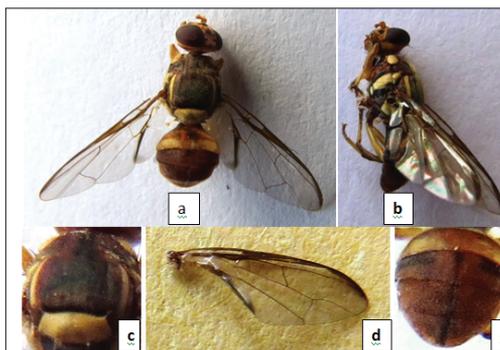


Plate 1: Field identifiable morphological structures in *Bactrocera dorsalis*  
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

**2. *Bactrocera (Bactrocera) zonata* (Saunders) (Peach fruit fly)**

**Diagnosis:** **Face** fulvous with small circular black spots; **scutum** entirely red-brown, medial postsutural vitta absent; **scutellum** yellow except for a narrow red-brown basal band; **legs** with all segments fulvous except hind tibiae pale fuscous; **wings** with cells bc and c colourless and devoid of microtrichia, pale fuscous costal band confluent with R2+3 and ending at apex of this vein, small fuscous spot around apex of R4+5, cubital streak absent but with a very pale fuscous tint in cell cup, supernumerary lobe weak; **Abdomen:** abdominal terga III V red-brown

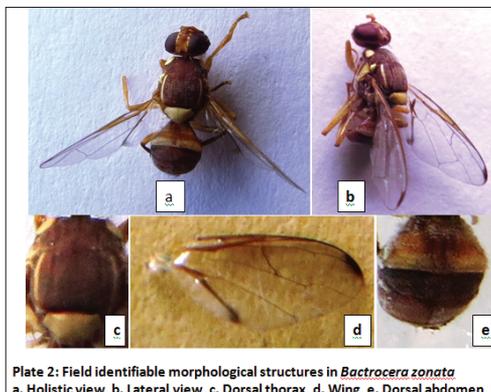


Plate 2: Field identifiable morphological structures in *Bactrocera zonata*  
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

with a narrow transverse black band across anterior margin of tergum III and expanding to dark fuscous across lateral margins and a narrow medial longitudinal black band over all three terga (these dark patterns can be reduced to a narrow transverse band across anterior margin of tergum III sometimes broken in the midline and the medial longitudinal band reduced to a narrow dark fuscous line on tergum V), a pair of oval red-brown shining spots on tergum V.

**Distribution:** Sri Lanka, India, Pakistan, Nepal, Vietnam and Bhutan (Drew *et al.*, 2007).

**Note:** *B. (B.) zonata* (as *B. zonatus*) is reported from Singh Durbar, Kathmandu, Nepal in peach and apple in 5 June 1968 (Joshi & Manandhar, 2001).

**3. *Bactrocera (Zeugodacus) cucurbitae* (Coquillett) (Melon fruit fly)**

**Diagnosis:** A medium sized species; **face** fulvous with large black oval spots; **scutum** red-brown with or without fuscous markings; lateral and medial postsutural vittae present;

**scutellum** entirely yellow; **legs** are with femora fulvous except for apical dark pattern which are red brown on four femora and fuscous to dark fuscous on mid and hind femora fore tibia fuscous, mid tibiae fulvous, hind tibiae, dark fuscous and all tarsai are fulvous. **wing** with a broad fuscous costal band paler between R2+3 and R4+5 and expanding into a large spot in apex of wing, pale infuscation along r-m cross vein and dark fuscous along dm-cu cross vein, a broad fuscous cubital streak; cells bc and c colourless; microtrichia in outer corner of cell c only; **Abdomen:** abdominal terga III-V red-brown with a 'T' pattern consisting of a narrow black transverse band across anterior margin of tergum III and a medium to broad medial longitudinal band over all three

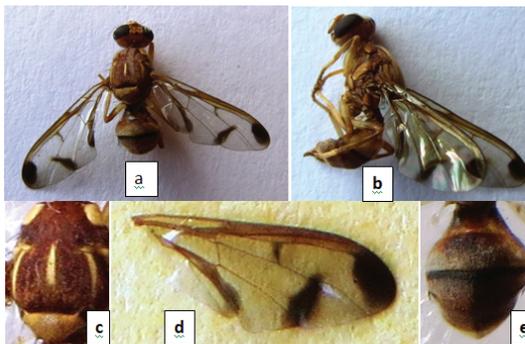


Plate 3: Field identifiable morphological structures in *Bactrocera cucurbitae*  
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

terga, anterolateral corners of terga IV and V fuscous to dark fuscous.

**Distribution:** Endemic to the region from Pakistan and India across Southeast Asia. Now tropical and subtropical countries, including Papua New Guinea, Solomon Islands, northern Pacific islands, northern Africa and Egypt are also invaded (Drew *et al.*, 2007).

**Note:** *B. (B.) cucurbitae* is reported from Kirtipur, Kathmandu, Nepal in pumpkin, cucumber and snake gourd in 12 September 1964 (Joshi & Manandhar, 2001).

**4. *Bactrocera (Zeugodacus) tau* (Walker)**

**Diagnosis:** A medium sized species; **face** fulvous with a pair of medium sized circular to oval black spots; **scutum** black with large areas of red-brown centrally and antero-centrally; lateral and medial postsutural vittae present; yellow spot anterior to mesonotal suture in front of lateral postsutural vittae; **scutellum** entirely yellow; **legs** are with femora yellow, front and hind tibiae tinged with brown and middle tibiae lightly brown tinged basally; **wing** with a narrow dark fuscous costal band overlapping R2+3 and expanding into a distinct apical spot and broad dark fuscous cubital streak; cells bc and c colourless; microtrichia in outer corner of cell c only; **Abdomen:** abdominal terga III-V fulvous with a black 'T' pattern and anterolateral corners of terga IV and V with broad black markings.

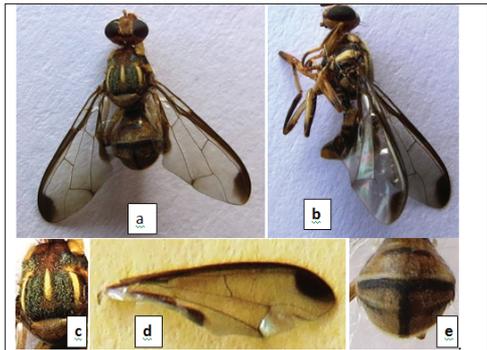


Plate 4: Field identifiable morphological structures in *Bactrocera tau*  
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

**Distribution:** Widespread across south and Southeast Asia (Drew *et al.*, 2007).

**Note:** *B. tau* is reported from Kathmandu, Nepal in bottle gourd in 30 September 1968 (Joshi & Manandhar, 2001).

**5. *Bactrocera (Zeugodacus) scutellaris* (Bezzi)**

**Diagnosis:** A small to medium sized species; **face** fulvous with a pair of transverse oval black spots pointed towards centre; **scutum** shining black; narrow lateral and medial postsutural vittae present; **scutellum** yellow with a distinct black apical spot; **legs** are with femora yellow, broadly black at apices, with front and middle tibiae yellow tinged with brown, hind tibiae entirely black. **wing** with a narrow dark fuscous costal band which is extremely narrow beyond apex of R2+3 and widening into a distinct spot around apex of R4+5, broad dark fuscous cubital streak present; cells bc

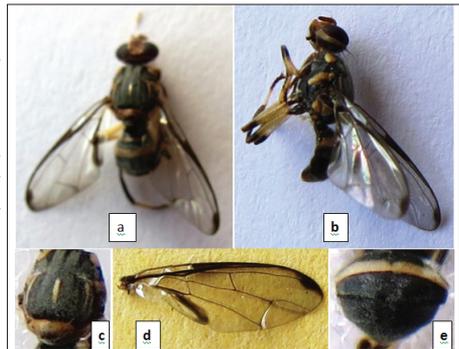


Plate 5: Field identifiable morphological structures in *Bactrocera scutellaris*  
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

and c colourless; microtrichia in outer corner of cell c only; **Abdomen:** abdominal terga III-V mostly dark fuscous to black.

**Distribution:** Widespread across south Asia to Southeast Asia (Drew *et al.*, 2007).

**Note:** *B. scutellaris* is reported from Nepal (Joshi & Manandhar, 2001).

### 6. *Dacus (Callantra) longicornis* Wiedemann

**Diagnosis:** **Face** fulvous with a pair of small irregularly oval black spots; **scutum** dark red-brown without distinct dark patterns, lateral and medial postsutural vittae absent; **scutellum** yellow except for broad red brown basal band; **legs** with fore femora dark red-brown to fuscous, mid femora dark red-brown to fuscous except fulvous on basal 1/4, hind femora dark fuscous, fore and mid tibiae dark red-brown to fuscous, hind tibiae dark fuscous, fore tarsi with all segments dark red-brown, mid and hind tarsi with basal segment fulvous and apical four segments red brown; **wings** with cells bc and c fuscous, dense microtrichia over all of cell c and most of cell bc, a broad dark fuscous costal band overlapping R4+5 for its entire length and sometimes becoming darker at apex, cubital streak indistinct but a broad pale fuscous area generally over cell cup and across wing margin towards cell dm, supernumerary lobe weak; **Abdomen:** abdominal terga III-V generally dark fuscous to black with a paler band often across posterior margin of tergum III, large orange-brown spots postero-centrally on terga IV and V with the spot on tergum V often expanded anteriorly into a medial longitudinal orange-brown band, oval shining spots on tergum V red-brown to dark fuscous.



Plate 6: Field identifiable morphological structures in *Dacus longicornis*  
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

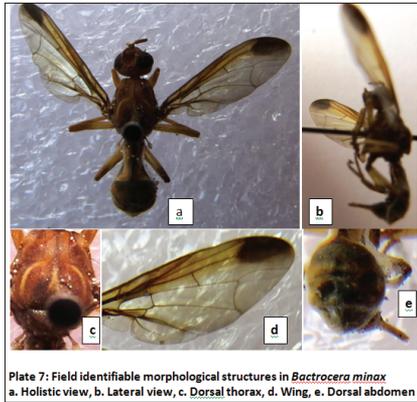
**Abdomen:** abdominal terga III-V generally dark fuscous to black with a paler band often across posterior margin of tergum III, large orange-brown spots postero-centrally on terga IV and V with the spot on tergum V often expanded anteriorly into a medial longitudinal orange-brown band, oval shining spots on tergum V red-brown to dark fuscous.

**Distribution:** Widespread across the region from southern Asia to Southeast Asia (Drew *et al.*, 2007).

**Note:** *Dacus longicornis* is reported for the first time from Nepal. The fruit fly is found in the sweet orange orchards in Sindhuli and in the mandarin orchards in Syangja.

### 7. *Bactrocera (Tetradacus) minax* (Enderlein) (Chinese citrus fly)

**Diagnosis:** An extremely large species; **face** fulvous with narrow elongate facial spots reaching oral margin; **scutum** red-brown without dark patterns, **scutellum** yellow with a narrow red-brown basal band; **legs** with all segments mostly fulvous; **wings** with cells bc and c fuscous, microtrichia in outer corner of cell bc and outer 1/2 of cell c, a broad fuscous costal band overlapping R4+5 and becoming darker towards the apex but not expanding into a spot, a narrow fuscous cubital streak but not reaching margin of wing, supernumerary lobe weak; **Abdomen:** abdomen elongate oval and petiolate (similar to many *Dacus* species), terga III-V orange-brown with a moderately broad transverse fuscous band across anterior margin of tergum III and a medium width medial longitudinal pale fuscous band over all three



terga, anterolateral corners of tergum IV fuscous, anterolateral corners of tergum V pale fuscous.

**Distribution:** Sikkim, India, Bhutan, China, Nepal (Drew *et al.*, 2007).

**Note:** *B. minax* (misidentified as *B. tsuneonis* Miyaka) was collected for the first time from sweet orange at Helambu, Sindhupalchok district in December 1984 (Joshi and Manandhar, 2001). While validating the said fruit fly species, Dr. Gary J. Steck, Florida State Collection of Arthropods, Florida, USA determined it being *B. minax*. Similarly, he identified the fruit fly specimens collected from sweet orange in Dhankuta dated 27 April 2007 being *B. minax*. Sweet oranges

in the eastern mid-hills of Nepal, particularly, Dhankuta and Tehrathum districts are reportedly seriously infested of *B. minax* fruit flies (NCRP, 2011). Recently conducted organized fruit fly surveillance of citrus orchards in Sindhuli district confirmed sweet orange being devastated by *B. minax* (Plates 7 and 8). *B. minax* is reported for the first time in sweet orange in Sindhuli district.



**PLATE 8:** Sweet orange devastation incurred due to *B. minax* infestation in citrus orchard, Sindhuli district.

a. Massive fruit drops b. Oviposited site on the fruit-rind c. Mature maggots inside a cut-opened fruit d. Fruit fly rearing e. Pupae f. Adult emerged from a pupa.

#### ***B. minax* rearing in the laboratory**

Heavy sweet orange fruit droppings occurred in the citrus orchards Sindhuli district during November-December 2014 (Plate 8a). The dropped fruits were collected in the orchards to

rearing to adult fruit flies. Female oviposited sites developed into light brown marks on the rind of fruits (Plate 8b) were found in the dropped fruits that consisted of creamy whitish maggots in the pulp (Plate 8c). The maggots were reared in plastic containers filled with moistened sand at bottom up to 5 cm in depth (Plate 8d). Pupae (Plate 8e) and adult fruit flies (Plate 8f) were comparatively bigger in size.

Male lure trapped species of fruit flies revealed *B. cucurbitae*, *B. dorsalis*, *B. zonata*, *B. tau*, *B. scutellaris* and *Dacus longicornis* being prevalent in the premises of sweet orange orchards in Sindhuli district during May 2014 to April 2015. Among the species, *D. longicornis* is reported for the first time in Nepal. *B. minax*, though reportedly occurred in citrus in the eastern Nepal particularly in Dhankuta and Tehrathum districts, its status in sweet orange in Sindhuli district was not known until the present investigation. Field identification morphological traits in each mentioned fruit fly species are described in this study, which can serve as field identification of these species for further studies.

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### REFERENCES

- ALLWOOD, A J (1997) Control strategies for fruit flies (Family Tephritidae) in the South Pacific. Proceedings of The Management of fruit flies in the Pacific, Nadi, Fiji; pp 171–178.
- DREW, R A I; ROMIG, M C; DORJI, C (2007) Record of dacine fruit flies and new species of *Dacus* (Diptera: Tephritidae) in Bhutan. *The Raffles Bulletin of Zoology* 55(1): 1–21.
- ENTOMOLOGY SECTION (1966) Annual Report, 1965-66. Entomology Section, Department of Agricultural Education and Research, Shree Mahal, Pulchok, Lalitpur, Nepal.
- GAUTAM, R D; SINGH, S K; KUMAR, R (2015) Management of important fruit flies with focus on their identification–Technical Manual, prepared for the NPPO, Nepal through the financial assistance from the Central Queensland University, Australia as a part of the AusAID-
- JOSHI, S L; MANANDHAR, D N (eds) (2001) Reference insects of Nepal. Entomology Division, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.
- NCRP (2011) Annual Report 2011. National Citrus Research Program, Paripatle, Dhankuta, Nepal.
- NEPAL CHINA AGREEMENT (2012) The agreement between People’s Republican China, General Administration on Quality Supervision, Monitoring and Quarantine and Government of Nepal. Department of Agriculture for Phytosanitary Protocol to export Nepalese citrus fruits from Nepal to China on 2012.
- PAUL, F (2010) Fruit flies in Asia (especially Southeast Asia) species, biology and management. Consultant (formerly Research Program Manager in Crop Protection, Australian Centre for International Agricultural Research (ACIAR), Canberra, Australia).
- PPD (2014) Survey protocol for fruit fly. Plant Protection Directorate, Harihar Bhawan, Pulchok, Lalitpur,

Nepal.PSLP Project. Westville Publishing House, New Delhi, India.

PRADHAN, R B (1970) Studies on the bionomics of *Dacus* spp. and life cycle of *Dacus dorsalis* Hendel (Trypetidae: Diptera) under different conditions of temperature and humidity. *Nepalese Journal of Agriculture* 5: 1–14.

SHARMA, D R; ADHIKARI, D; TIWARI, D B (2015) Fruit fly surveillance in Nepal. *Agricultural and Biological Sciences Journal* 1(3): 121–125.

SINGH, S K (2015a) Morphology of adult fruit fly and distinguishing characters of Order Diptera (Family:Tephritidae). In GAUTAM, R D; SINGH, K S; KUMAR, R (eds) *Management of important fruit flies with focus on their identification–Technical Manual*, prepared for the NPPO, Nepal through the financial assistance from the Central Queensland University, Australia as a part of the AusAID-PSLP Project. Westville Publishing House; New Delhi, India; 72 pp.

SINGH, S K (2015b) Key to the pest species and diagnostic characters. In GAUTAM, R D; SINGH, S K S; KUMAR, R (eds) *Management of important fruit flies with focus on their identification–Technical Manual*, prepared for the NPPO, Nepal through the financial assistance from the Central Queensland University, Australia as a part of the AusAID-PSLP Project. Westville Publishing House, New Delhi, 72 pp.