A survey of fruit flies (Tephritidae: Dacini) of District Swat, Khyber Pakhtunkhwa Province, Pakistan

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Abstract

For the first time, a taxonomic survey of tropical fruit fly species has been conducted in northern Pakistan. The survey was carried out over the Spring and Autumn fruiting season, May to September, in the years 2020 and 2021, using traps baited with the male lures, cue lure and methyl eugenol, Fruition Nova female fruit fly orientated traps, hand collecting using nets, and fruit sampling. Eight species of *Bactrocera* Macquart were collected, all notable pest species. For the first time, *Bactrocera divenderi* Maneesh, Hancock & Prabhakar is reported from Pakistan. Host and lure records are listed and include, for the first time, host plant records for *Bactrocera invadens* Drew, Tsuruta and White from the Indian sub-continent. Large numbers of five species were collected on Fruition Nova traps, demonstrating the efficacy of the new Fruition Nova fruit fly trap technology.

Key word: Fruit fly, Identification, Traps, Swat

Introduction

For most of the past century, tropical fruit fly species in the Tribe Dacini have been recognized as the most important insect pests of many fruit and vegetable crops. Consequently, with their impact on crop losses and international trade restrictions, extensive research has been carried out on areas of taxonomy, ecology, pest management and biosecurity. Much of the taxonomic research has been concentrated on the South Pacific and South-East Asia over the past century, culminating in the comprehensive revisions of Drew (1989), Drew and Romig (2013), Drew and Romig (2022), and illustrated keys to species by Drew and Romig (2016). However, over the last two decades there have been field collections of fruit flies, primarily using male lure traps, across the Indian subcontinent resulting in a number of valuable publications. In particular, surveys and publications have covered Bangladesh, Bhutan, India, Nepal and Sri Lanka.

A review of the publications covering the dacine fauna of these countries provides us with the most current knowledge of species and, in particular, pest species from the subcontinent. For Bangladesh, Leblanc *et al*. (2013, 2019a) recorded 37 species from six years of field surveys using traps baited with the male lures, cue lure, methyl eugenol and Zingerone. For Bhutan, Drew *et al.* (2007) recorded 29

species based on male lure trapping and host fruit collections representing the first data on the Dacini of that country. The land mass of India has received most attention with publications by Drew and Raghu (2002) recording 21 species in the rainforests of the Western Ghats based on male lure trapping, the Agarwal & Sueyoshi (2005) catalogue of Indian fruit flies, David and Ramani (2011) presenting an illustrated key to species, David *et al.* (2016) publishing one new species from the Andaman and Nicobar Islands and one from Karnataka plus a new distribution record, David *et al.* (2017) presenting new species and new records with an updated subgenera key, David and Ramani (2019) publishing new species and a comprehensive revision of species based on the morphological characters of the male genitalia, and Vasudha *et al*. (2019) recording 92 species from India and presenting a scholarly overview of aspects of their biogeography, biology, phylogenetic relationships and pest status. Maneesh *et al.* (2022) described one new species, a new distribution record, a key to the *nigrotibialis* complex and additional morphological and host data on *Bactrocera invadens* Drew, Tsuruta & White. For Nepal, Leblanc *et al.* (2019b) presented a checklist and new country records of 26 species based on male lure trapping. Male lure trapping, and host fruit surveys in Sri Lanka resulted in the recording of 39 species (12 of which were new species) (Tsuruta *et al*., 1997; Tsuruta & White, 2001; Leblanc *et al.*, 2018).

Despite the advances in our knowledge of the subcontinent dacine fauna, as noted above, little has been published on that from Pakistan. From a taxonomic perspective, Mahmood (1999, 2005) presented some information on the *Bactrocera tau* complex and described a new species from Pakistan. Stonehouse *et al.* (1997, 2002) assessed the economic impact of pest fruit flies on crop production in Pakistan, while Kakar *et al.* (2014) provided data on crop losses in guava, peach and bitter gourd caused by three *Bactrocera* species in the northern Khyber Pakhtunkhwa region. These papers, however, did not define the actual species causing the damage to the specific crops. To add to this knowledge, a survey involving trapping and host fruit collecting was conducted in the Swat District of North West Pakistan, where fruit flies are major pests of horticultural crops. The results are presented in this paper.

Horticulture Ecosystem in the Swat Valley

The Swat Valley is a high-altitude region of the Khyber Pakhtunkhwa Province of Pakistan. The elevation ranges from 600 m to 6,000 m, with an average of 980 m, making it an ideal climatological area for growing a range of temperate and subtropical fruit crops. Summer monsoon rainfall and irrigation from the Swat River and its tributaries provide adequate water for crops growing in the sandy-loam soils. The valley is known for producing a wide range of high-quality fruits and vegetables including large areas of stone and pome fruits and citrus, all of which are susceptible to fruit fly attack. Consequently, understanding and managing the fruit fly problem is high priority. The foundation leading to sound solutions is the accurate definition of the pest species and the particular crops that they attack.

Materials and Methods

Field sampling was conducted from the months of April to September over the years 2020 and 2021.

Male lure trapping. Steiner type traps were set in a large high density peach orchard at Agricultural Research Institute, Mingora and at locations throughout the Swat Valley. Traps were baited separately with either Redox (cue lure) or Attrex (methyl eugenol) plus insecticide. Traps were processed separately to avoid cross contamination of lure. Specimens were taken from the traps and identified at the Biocontrol laboratory of the Entomology section, Agricultural Research Institute, Mingora, using a Zeiss

stereomicroscope and using the keys in Drew and Romig (2016). Identifications were confirmed by R.A.I. Drew.

Female traps. Yellow Fruition Nova traps were set in the peach orchard at Mingora and specimens collected from the sticky surfaces at approximately 1-to-2-week intervals. All specimens were sexed and identified as described above for male lure trapping.

Hand collections. On occasions specimens of adult fruit flies were hand collected using a long-handled insect collecting net and identified as above.

Fruit sampling and fly rearing. Over the study period, as crops matured, samples were taken for flies to be reared out, as follows – apple, apricot, guava, mango, peach, pear, *Ziziphus jujuba*, and vegetable crops comprising bitter gourd (*Momordica charantia*), bottle gourd (*Lagenaria ciceraria*), cucumber, squash, tomato and zucchini. All samples were taken into the Bio-control Entomology laboratory for fruit flies to be reared out. The samples were all maintained separately and placed on soil for pupae to develop. When fruit flies emerged, they were fed a sugar and protein diet for 14 days in order to develop full coloration needed for identification. The fruit and fruit fly samples were held at approximately 26±1 C° and 65±5% relative humidity.

From the survey, reference specimens were curated and are held in the Mingora laboratory for permanent record.

Results

The following eight species, all in the genus *Bactrocera*, were collected.

Bactrocera (Bactrocera) divenderi Maneesh, Hancock & Prabhakar, *B. (Bactrocera) invadens* Drew, Tsuruta & White, *B. (Bactrocera) zonata* (Saunders), *B. (Javadacus) cucurbitae* (Coquillett), *B. (Javadacus) tau* (Walker), *B. (Zeugodacus) caudata* (Fabricius), *B (Zeugodacus) diversa* (Coquillett), *B. (Zeugodacus) scutellaris* Bezzi.

Species Diagnoses

Bactrocera (Bactrocera) divenderi Maneesh, Hancock & Prabhakar

Fig. 1.

Bactrocera (Bactrocera) divenderi Maneesh, Hancock & Prabhaker in Maneesh *et al*., 2022: 240.

Material examined. Three males, Agricultural Research Institute, Mingora, Swat, Pakistan, 29.vii.2021, attracted to cue lure.

Diagnostic characters. Face black; postpronotal lobes and notopleura yellow; scutum entirely black, lateral postsutural yellow vittae narrow and reaching or almost reaching *ia*. setae, medial postsutural yellow vitta absent, no yellow spot anterior to notopleural suture, mesopleural stripe reaching to the anterior *npl*. seta dorsally, scutellum yellow with a narrow black basal band; legs with fore and mid femora black and hind femora fulvous except apical third black; cells bc and c colourless, microtrichia in outer corner of cell c only, a narrow fuscous costal band confluent with R_{2+3} and remaining narrow around

apex of wing; abdomen oval, terga free, pecten present on tergum III of males, tergum III black, terga IV -V black except with narrow orange-brown areas either side of a broad medial longitudinal black band, ceromata black, sterna dark fuscous.

Attractant. Cue lure.

Host fruits in Pakistan. No known record.

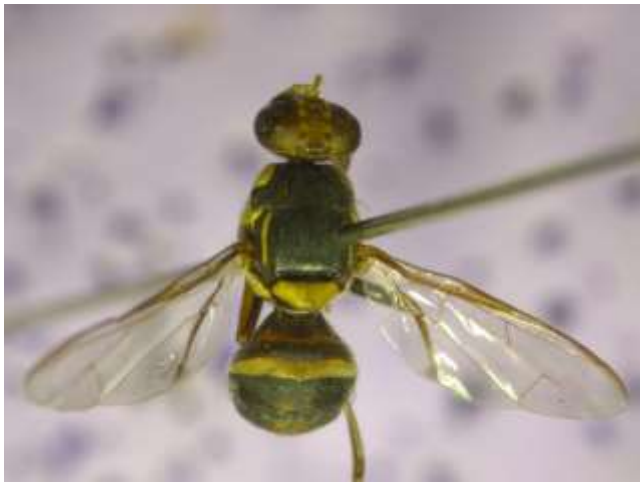

Fig. 1. *Bactrocera (Bactrocera) divenderi* Maneesh, Hancock & Prabhakar

Remarks. This species belongs to the *nigrotibialis* complex as defined by Drew & Romig (2016) and appears to have displaced *B. zonata* as a pest of peach and nectarine in the Solan district of northern India (Maneesh *et al.*, 2022). This complex now consists of 14 species (Maneesh *et al.*, 2022) and *B. divenderi* appears to be localised in northern India, northern Pakistan and Bhutan.

***Bactrocera (Bactrocera) invadens* Drew, Tsuruta & White**

Fig. 2.

Bactrocera (Bactrocera) invadens Drew, Tsuruta & White 2005: 149; Drew *et al*., 2007: 4; Drew & Romig, 2013: 99, 2016: 3-7, 124; Maneesh *et al.*, 2022: 245.

Material examined. 20 males, Agricultural Research Institute, Mingora, Swat, Pakistan, 21.vii.2020, attracted to methyl eugenol; a large series of specimens collected on Fruition Nova traps.

Diagnostic characters. Face fulvous with a pair of oval black spots; scutum varies from entirely red-brown to red-brown with dark fuscous to black lanceolate-shaped patterns and occasionally entirely black (the lanceolate patterns vary and mostly are similar to those on *Bactrocera cacuminata* (Hering) in Australia), postpronotal lobes and notopleura yellow, lateral postsutural yellow vittae narrow and parallel-sided reaching the *ia*. seta, medial postsutural yellow vitta absent, mesopleural stripe reaching midway between anterior margin of notopleuron and anterior *npl.* seta dorsally; legs with all femora entirely fulvous, fore and mid tibiae fuscous and hind tibia dark fuscous; cells bc and c colorless with microtrichia in outer concern of cell c only, a narrow fuscous costal band confluent with R_{2+3} and remaining narrow around apex of wing; abdomen oval, terga free, pecten present on tergum III of males, abdominal terga III-V red-brown with a general dark fuscous to black 'T' pattern with the transverse band across base of

tergum III usually widening to cover the lateral third of the tergum and with the anterolateral corners of terga IV and V dark fuscous to black, ceromata generally red-brown and occasionally dark fuscous, sterna pale colored.

Attractant. Methyl eugenol.

Host fruits in Swat, Pakistan. Bred from peach, pear, apricot, apple, guava, mango, and *Ziziphus jujuba*.

Fig. 2. *Bactrocera (Bactrocera) invadens* Drew, Tsuruta & White

Remarks. *Bactrocera invadens* is morphologically distinct in possessing a variety of dark colour patterns on a red-brown scutum and abdomen. These patterns have been photographically presented by Drew et al. (2005), Leblanc *et al.* (2013) and Maneesh *et al*. (2022) and are so unique that *B. invadens* cannot be confused with other *Bactrocera* species. Although considered to be a synonym of *Bactrocera dorsalis* (Hendel) by some authors, the unique color patterns on the scutum and abdomen combined with the narrow lateral postsutural yellow vittae, and distinct differences in aedeagal structure, set *B. invadens* aside as a distinct species. Even in the case where some specimens of *B. invadens* possess a black scutum similar to *B. dorsalis*, the unique abdomen color patterns and narrow lateral postsutural yellow vittae of *B. invadens* still separate these two species.

The small percentage of the population with an entirely black scutum is often misidentified as *B. dorsalis.* As a result of such misidentification of *B. invadens* as *B. dorsalis*, incorrect host and distribution records recently have been published for Madagascar by Rasolofoarivao *et al*. (2021), for Comoros by Raveloson Ravaomanarivo *et al.* (2022) and India by Nair *et al.* (2022). The correct host records for *B. invadens* in these publications are as those listed for *B. dorsalis*. Further, Nair *et al.* (2022) have identified incorrectly some species, again resulting in incorrect geographic distribution records. For example, their *Zeugodacus cilifer*, known throughout Southeast Asia is most likely *Bactrocera (Zeugodacus) scutellaris* Bezzi from India, *Zeugodacus hochii* from South East Asia is most likely *Bactrocera (Sinodacus) brevipunctata* David & Hancock from India, *B. nigrifacia* Zhang, Ji & Chen known from China and Thailand probably is *Bactrocera (Bactrocera) nigrotibialis* (Perkins) and *B. nigrofemoralis* White & Tsuruta probably is *Bactrocera (Bactrocera) divenderi* Maneesh, Hancock & Prabhakar. Further, as *Bactrocera (Sinodacus) bogorensis* (Hardy) is limited to Indonesia, their *Z. bogorensis* will not be that species.

***Bactrocera (Bactrocera) zonata* (Saunders)**

Fig. 3.

Dasyneura zonatus Saunders, 1842: 61.

Bactrocera (Bactrocera) zonata – Norrbom *et al*., 1998: 96; Drew & Raghu, 2002: 345; Drew *et al*., 2007: 6; Drew & Romig, 2013: 194.

Material examined: 10 males, Agricultural Research Institute, Mingora, Swat, Pakistan, 26.vii.2020, attracted to methyl eugenol; a series of specimens collected on Fruition Nova traps.

Diagnostic characters. Face fulvous with a pair of black spots; scutum mostly red-brown, postpronotal lobes and notopleura yellow, parallel-sided lateral postsutural yellow vittae reaching *ia*. seta, medial postsutural yellow vitta absent, mesopleural stripe reaching to anterior *npl*. seta dorsally; legs with all segments fulvous except red-brown on apices of femora and pale fuscous hind tibiae; cells bc and c colorless, a narrow fuscous costal band confluent with R_{2+3}, a small fuscous spot across apex of R_{4+5}, anal streak almost absent; abdominal terga III-V red-brown with a black 'T' pattern, narrow dark anterolateral corners on terga IV and V, ceromae red-brown.

Attractant. Methyl eugenol.

Host fruits in Pakistan. Bred from peach, pear, apricot, guava and mango.

Fig. 3. *Bactrocera (Bactrocera) zonata* (Saunders)

Remarks. *Bactrocera zonata* is regarded as a major pest species throughout its geographic range (Drew & Romig, 2013) and causes crop losses in the Swat region of Pakistan. A closely related species, *Bactrocera affinis* (Hardy), occurs in southern India. See Drew & Romig (2013) for differentiating characters.

***Bactrocera (Javadacus) cucurbitae* (Coquillett)**

Fig. 4.

Dacus cucurbitae Coquillett, 1899: 129

Bactrocera (Zeugodacus) cucurbitae – Drew, 1989: 212; Drew & Romig 2013: 279.

Zeugodacus cucurbitae – Virgilio *et al.*, 2015: 171.

Bactrocera (Javadacus) cucurbitae – Hancock & Drew, 2018: 259.

Material examined: 15 males, Agricultural Research Institute, Mingora, Swat, Pakistan, 5.viii.2020, attracted to cue lure; a series of specimens collected on Fruition Nova traps.

Diagnostic characters. Face fulvous with a pair of large black spots; scutum red-brown usually with dark markings, postpronotal lobes and notopleura yellow, lateral and medial postsutural yellow vittae present, a yellow spot anterior to notopleural suture, mesopleural stripe reaching midway between anterior margin of notopleuron and anterior *npl*. seta dorsally; legs with all segments fulvous to dark fulvous; cells bc and c colorless, a broad fuscous costal band confluent with R_{4+5} and expanding into a large spot at wing apex, pale fuscous along *r-m* cross-vein and dark fuscous over *dm-cu* cross-vein; abdominal terga III-V orange-brown with a black 'T' pattern, anterolateral corners of terga IV and V dark fuscous.

Attractant. Cue lure.

Host fruits in Pakistan. Bred from tomato, cucumber, squash, zucchini, bottle gourd, bitter gourd.

Fig. 4. *Bactrocera (Javadacus) cucurbitae* (Coquillett)

Remarks. *Bactrocera cucurbitae* is now widespread around the world and one of the major pest species in the genus *Bactrocera* Macquart Hendel (See Drew & Romig, 2013 for details of distribution and hosts). The subgenus *Zeugodacus* Hendel was raised to generic level by Virgilio *et al*. (2015) based primarily on molecular evidence. In contrast, Hancock & Drew (2018) retained *Zeugodacus* as a subgenus of *Bactrocera* based on morphological, ecological and biogeographic data, a classification that is more holistic and thus used herein.

***Bactrocera (Javadacus) tau* (Walker)**

Fig. 5.

Dasyneura tau Walker, 1849: 1074.

Dacus (Zeugodacus) tau – Hardy, 1977: 60.

Bactrocera (Zeugodacus) tau – Drew & Romig, 2013: 353.

Bactrocera (Javadacus) tau – Hancock & Drew, 2018: 260.

Material examined: 10 males, Agricultural Research Institute, Mingora, Swat, Pakistan, 21.vii.2020, attracted to cue lure; a series of specimens collected on Fruition Nova traps.

Diagnostic characters. Face fulvous with a pair of black spots; scutum black with areas of red-brown, postpronotal lobes and notopleura yellow, lateral and medial postsutural yellow vittae present, a yellow spot anterior to notopleural suture, mesopleural stripe reaching midway between anterior margin of notopleuron and anterior *npl*. seta dorsally, scutellum entirely yellow; legs with femora fulvous with or without preapical dark spots, fore and hind tibiae fuscous to dark fuscous, mid tibiae fulvous with fuscous basally; wings with cells bc and c colorless, a narrow dark fuscous costal band overlapping R_{2+3} and with a distinct apical spot, a broad dark fuscous anal streak, supernumerary lobe strong and keel shaped; abdominal terga III-V fulvous with a black 'T' pattern and with anterolateral corners of terga IV and V broadly black, abdominal sterna dark.

Attractant. Cue lure.

Host fruits in Pakistan. Tomato, cucumber, squash, zucchini, bottle gourd, bitter gourd.

Fig. 5. *Bactrocera (Javadacus) tau* (Walker)

Remarks. *Bactrocera tau* is a common species throughout South-East Asia and the Indian subcontinent. It is also a major economic pest species with a wide host range (see Drew & Romig, 2013). Because it belongs to a large complex of closely related species it is difficult to identify. A good character that defines it is the large keel-shaped supernumerary lobe in the wing.

***Bactrocera (Zeugodacus) caudata* (Fabricius)**

Fig. 6.

Dacus caudatus Fabricius, 1805: 276.

Dacus (Zeugodacus) caudatus – Hardy & Adachi, 1954: 186.

Bactrocera (Zeugodacus) caudata - Drew & Romig, 2013: 277; Hancock & Drew, 2018:262.

Material examined: 1 female, Agricultural Research Institute, Mingora, Swat, Pakistan, 5.ix.2021, hand collected.

Diagnostic characters. Face fulvous with a narrow black line across oval margin; scutum entirely black, postpronotal lobes and notopleura yellow, lateral and medial postsutural yellow vittae present, a yellow spot anterior to notopleural suture, mesopleural stripe reaching almost to anterior *npl*. seta dorsally, scutellum entirely yellow; legs with femora fulvous with dark apical markings, tibiae fuscous to dark fuscous; wings with cells bc and c colorless, a narrow fuscous costal band confluent with R_{2+3} and becoming broad at apex, a broad fuscous anal streak; abdominal terga III-V orange-brown with a black "T" pattern and dark fuscous to black anterolateral corners of terga IV and V, abdominal sterna dark.

Collection method. Collected by hand through a long handled insect collecting net

Host fruits in Pakistan. As this species only attacks flowers of some species of Cucurbitaceae, it has not been reared from fruits during the fruit sampling program in Swat.

Fig. 6. *Bactrocera (Zeugodacus) caudata* (Fabricius)

Remarks. *Bactrocera caudata* is widely distributed across South-East Asia where it causes crop losses in some Cucurbitaceae by destroying flowers. Morphologically it can be confused with some species in the *Bactrocera tau* complex but is distinct in possessing a transverse black line across the oral margin of the face.

***Bactrocera (Zeugodacus) diversa* (Coquillett)**

Fig. 7.

Dacus diversus Coquillett, 1904: 139.

Bactrocera (Hemigymnodacus) diversa – Drew & Romig, 2013: 205.

Bactrocera (Zeugodacus) diversa – Hancock & Drew, 2018: 262.

Material examined: 8 males, Agricultural Research Institute, Mingora, Swat, Pakistan, 21.vii.2020, attracted to methyl eugenol.

Diagnostic characters. Face entirely fulvous in male specimens, with a narrow transverse dark band across oral margin in females; scutum entirely black, postpronotal lobes and notopleura yellow, lateral and medial postsutural yellow vittae present, a yellow spot anterior to notopleural suture, mesopleural stripe reaching to anterior *npl.* seta dorsally, scutellum yellow; legs with femora fulvous tending red-brown basally, tibiae dark fuscous and becoming paler apically; wings with cells bc and c colorless, a narrow dark fuscous costal band confluent with R_{2+3} and widening across apex of R_{4+5}, a broad dark fuscous anal streak; abdominal terga III-V orange-brown with a black 'T' pattern and dark anterolateral corners on terga IV and V.

Attractant. Methyl eugenol (recorded as weak by Drew and Romig (2013).

Fig. 7. *Bactrocera (Zeugodacus) diversa* (Coquillett)

Host plants in Pakistan. This species has been recorded as attacking flowers of a wide range of species of Cucurbitaceae and thus has not been reared from fruits in the Swat survey. Like *B. caudata* it is an economic pest by destroying the flowers of cucurbit crops.

***Bactrocera (Zeugodacus) scutellaris* Bezzi**

Fig. 8.

Bactrocera scutellaris Bezzi, 1913: 98.

Dacus (Zeugodacus) scutellaris – Hardy, 1973: 68.

Bactrocera (Zeugodacus) scutellaris – Drew & Romig, 2013: 339; Hancock & Drew, 2018: 262.

Material examined. 7 males, Agricultural Research Institute, Mingora, Swat, Pakistan, 5.viii.2020, attracted to cue lure.

Diagnostic characters. Face fulvous with a pair of transverse black spots; scutum entirely black, postpronotal lobes and notopleura yellow, narrow lateral and medial postsutural yellow vittae present, a small yellow spot anterior to notopleural suture, mesopleural stripe equal in width to notopleuron dorsally, scutellum yellow with a black apical spot; legs with all femora fulvous basally and black apically, fore and hind tibiae dark fuscous to black, mid tibiae fuscous tending paler apically; wings with

cells bc and c colorless, a narrow dark fuscous costal band confluent with R_{2+3} and widening across apex of R_{4+5}, a broad dark fuscous anal streak; abdominal terga mostly dark fuscous to black.

Attractant. Cue lure.

Host plants in Pakistan. Because the species has only been recorded as attacking flowers of species of Cucurbitaceae (Allwood *et al.*, 1999), it has not been reared from fruits collected in the Swat survey.

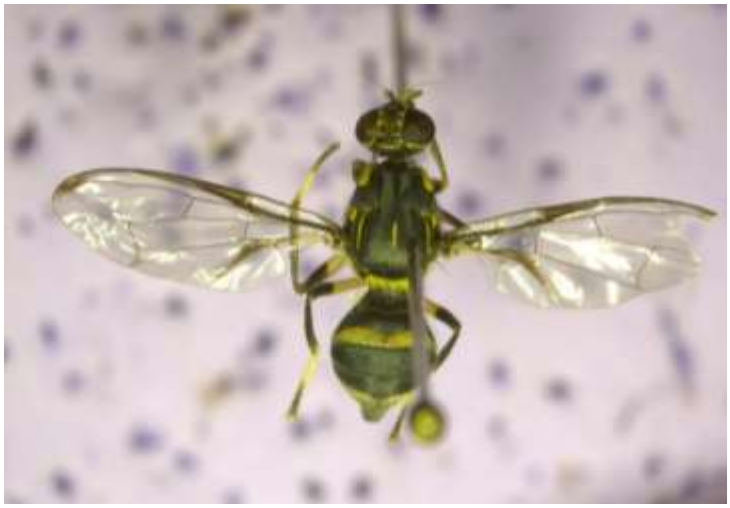

Fig. 8. *Bactrocera (Zeugodacus) scutellaris* Bezzi

Remarks. *Bactrocera scutellaris* belongs to a complex of similar species and is widespread across South-East Asia and the Indian subcontinent. It is classed as an economic pest because it destroys flowers of some cucurbit crops.

Host fruit and lure records

Two *Bactrocera* species were reared from orchard host fruits (Table1) and two species from vegetable crops (Table 2).

Table 1*: Bactrocera* species reared from orchard host fruits in the Swat district of Pakistan (+ = positive record).

Fruit	***Bactrocera zonata***	***Bactrocera invadens***
Peach (7 varieties)	+	+
Pear (4 varieties)	+	+
Apricot	+	
Apple		+
Guava	+	+
Mango	+	+
Ziziphus jujuba		+

Table 2: *Bactrocera* species reared from vegetable crops in the Swat district of Pakistan (+ = positive record)

Fruit	*Bactrocera cucurbitae*	*Bactrocera tau*
Tomato	+	+
Cucumber	+	+
Squash	+	+
Bottle gourd (*Lagenaria siceraria*)	+	+
Bitter gourd (*Momordica charantia*)	+	+
Zucchini	+	+

Seven *Bactrocera* species were collected through the trapping program and the species responses are given in Table 3.

Table 3: Records of *Bactrocera* species collected at the traps baited with different lures (+ = positive record).

Species	Cue lure	Methyl eugenol	Fruition Nova trap
Bactrocera divenderi	+		
Bactrocera invadens		+	+
Bactrocera zonata		+	+
Bactrocera cucurbitae	+		+
Bactrocera tau	+		+
Bactrocera diversa		+	
Bactrocera scutellaris	+		+

Conclusions

Fruit fly species in the genus *Bactrocera* are major pests of horticultural crops in the Swat district of Pakistan. If uncontrolled, entire crops can be lost leading to serious food shortages. While *Bactrocera zonata* has been recorded also across South-East Asia, it appears to be a more serious pest species in the Indian subcontinent. Similarly, *Bactrocera invadens* originated in the Indian subcontinent and is adventive across Africa. *Bactrocera cucurbitae* and *Bactrocera tau* are widespread across the entire regions of South-East Asia and the Indian Subcontinent with *B. cucurbitae* adventive across the north and south Pacific. *Bactrocera diversa* was recorded by Drew and Romig (2013) as having a weak response to methyl eugenol while Leblanc *et al.* (2013) recorded no response to this lure, so the attraction to this lure in this study is quite notable. The collection of large numbers of specimens of five major pest species on the Fruition Nova traps provides valuable data and is evidence that these Fruition Nova lure traps will become important tools for both fruit fly pest monitoring and field pest management for Pakistan. The Fruition Nova traps also attracted large numbers of mature female fruit flies, thus adding value to this new technology.

Conflict of interests

The author declared no conflict of interests.

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