

IDENTIFICATION AND TAXONOMICAL STUDIES OF FRUIT FLIES ON CUCURBITS IN KASHMIR VALLEY

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ABSTRACT

The study was carried out during 2008-2009 at six locations namely Batamaloo, Dal and Shalimar in district Srinagar, Chadoora, Bugam and Narkara in district Budgam. Various cucurbit crops namely cucumber, bottle gourd, ridge gourd and bitter gourd were selected. Four species of fruit flies on cucurbits namely *Bactrocera cucurbitae*, *B. dorsalis*, *B. tau* and *B. scutellaris* were identified on the basis of taxonomical characters, while *B. scutellaris* was first time reported from Kashmir valley.

INTRODUCTION

Jammu and Kashmir is located in the northern part of the Indian sub continent in the vicinity of the Karakoram and western mountain ranges. Geographically, the Kashmir valley lies between 33°55'-34°50' North latitude and 74°30'-75°35' East longitude. The average elevation of the valley is 5,300 feet above sea level. Many insect pests attack fruits and vegetables, none have garnered greater notoriety than Tephritid fruit flies and they are recognized worldwide as the most important threat to the horticultural industry (Barnes, 2004; Ekesi and Billah, 2007). However, during the last decade, there has been a slow but steady increase in awareness of the importance of fruit flies in the region partly due to their direct damage and in their importance in export fruits and vegetables as well as the recent invasions into areas where they were not present. This region represents the endemic habitat of fruit fly belonging to subfamily Dacinae in India. Consequently, an accurate knowledge of the species in this region will be significant to our current understanding of regional Dacine biogeography.

The subfamily Dacinae consisting primarily of two major genera, *Bactrocera* Macquart and *Dacus* Fabricius, is distributed from the southern and eastern African continent, across southern Asia and the Indian subcontinent, through eastern Asia and across the southern Pacific zone (Drew, 2004). The dacine fruit flies of the Indian subcontinent have received considerable attention in studies by Bezzi (1913;1916), Hering (1938;1956), Kapoor (1971;1993), Kapoor *et al.* (1980), Munro (1939), Perkins (1938), Drew and Hancock (1994), Drew *et al.* (1998), Drew and Raghu

(2002) and Drew and Roming (2007). Of 243 known species in 79 genera from India, 41 species of 27 genera have been reported from Himachal Pradesh (Agarwal and Sueyoshi, 2005). Recently, six fruit fly species were reported for the first time from Himachal Pradesh by Prabhakar *et al.* (2012).

The work of Munro (1984) evaluated *Dacus* genus family level, Dacidae and divided it into fifty genera defined by trivial characters, many of which contained only one species. Prior to the work of Drew (1989a) most authors placed *Bactrocera* species within the genus *Dacus* although a few authors treated the present subgenera as distinct genera (Cogan and Munro, 1980 and Munro, 1984). The reason for separating *Bactrocera* from *Dacus* were explained by Drew (1989 b) and the separation was supported by the variation in larval characteristics. Before the separation of above mentioned genera, peach/guava fruit fly was named as *D. zonatus* (Saunders). Due to recent developments in taxonomy of fruit flies, this species is named as *Bactrocera zonata* (Saunders).

The accurate identification of pest species is essential for any pest management programme and regulating the entry of pest species to a pest free zone, but due to homoplasmy in morphological characters of fruit flies, the accurate identification of species is very difficult for fruit fly researchers who are not taxonomists, farm workers and graduate students. Taxonomic keys are of utmost importance in the identification of the species during different research programmes. The present study has been formulated with objective of the correct identification and taxonomy of fruit flies attacking various cucurbit crops.

MATERIALS AND METHODS

Extensive survey was conducted during 2008-2009 in two districts of Kashmir valley in order to study the occurrence of fruit flies associated with cucurbit crops. Two districts namely Srinagar and Budgam were selected. In each district three locations were selected for this purpose. In district Srinagar, the locations were Batmaloo, Shalimar and Dal, while in district Budgam the locations were Chadoora, Narkara and Bugam. The survey was conducted at weekly intervals on different cucurbit crops viz. bottle gourd, cucumber, ridge gourd and bitter melon. The collected fruit flies were preserved in 70 per cent ethyl alcohol for the purpose of detailed taxonomical studies. Materials in 70 per cent alcohol in plastic homeopathic vials were sent to Department of Entomology, University of Agriculture Sciences, GKVK Campus, Bangalore, India for taxonomical identification.

Permanent slides of each species of fruit fly were also made by dissection of specimen. The whole insect (fruit fly) was dipped for overnight or boiled for 20-30 minutes with 10 per cent KOH solution to get the musculature sufficiently relaxed. Later KOH was removed by washing these specimens in distilled water for two or three times. The dissection was performed in a cavity block, with the help of fine forceps and needles. Necessary body parts including antennae, wings, legs and genitalia were separately dissected under a binocular stereoscopic microscope SZ-61 (Olympus). The dissected body parts were transferred to glacial acetic acid in another cavity block and at this stage acid fuchsin was also used for staining. After 10-15 minutes, specimen parts were again washed with fresh glacial acetic acid to remove the excess stain. Then the same was transferred to carboxylol (1 part of carboxylic acid + 3 parts of xylene) for 15 minutes. After getting clean the body parts of specimens were mounted on a plain slide in DPX under glass cover slip.

Photographs were taken from field camera and digital camera attached with stereozoom microscope. For drawing purpose, a drawing Table attached with binocular microscope CX-31 (Olympus) was used for drawing of different body parts on a plain paper with the required magnification.

Lastly, on the basis of illustrations and other taxonomic characters, description of species were made and also diagnostic key was prepared with suitable illustrations.

Key to identification of fruit flies (*Bactrocera* spp.)

Wings with infuscation on crossvein in addition to costal band and cubital streak; scutellum entirely red brown or fuscous to dark fuscous markings (Plate 1 and 1a) —————

Bactrocera (*Zeugodacus*) *cucurbitae* (Coquillett) - Wings colourless, at most with costal band and cubital streak — 2
Costal band confluent with R_{2+3} ; all femora entirely fulvous; cubital streak present and distinct (Plate 2 and 2a) ———
————— *B. (Bactrocera) dorsalis* (Hendel) - Costal band overlapping R_{2+3} (sometimes pale over R_{2+3}) ———3
Scutellum entirely yellow; scutum red brown with distinct black markings lateral to medial post-sutural vittae; costal band just overlapping R_{2+3} (Plate 3 and 3a) —————

————— *B. (Zeugodacus) tau* (Walker).

Scutellum yellow with a distinct apical black spot; a small

yellow spot anterior to mesonotal suture as an extension of each lateral post-sutural vitta; a broad cubital streak present (Plate 4 and 4a) ————— *B. (Zeugodacus) scutellaris* (Bezzi).

RESULTS AND DISCUSSION

Bactrocera (*Zeugodacus*) *cucurbitae* (Coquillett)

Bactrocera (*Zeugodacus*) *cucurbitae*- Drew, 1989a: 212; Norrbom *et al.*, 1998: 102; Drew and Raghu, 2002: 348-349; Drew and Roming, 2007: 9-10.

Dacus cucurbitae Coquillett, 1899; Froggat, 1909: 84-85

Bactrocera cucurbitae- Bezzi, 1913: 96-97

Chaetodacus cucurbitae- Bezzi, 1916: 109-110; Hendel, 1915: 426, 1927: 28; Shiraki, 1933: 73-76

Strumeta cucurbitae- Perkins, 1938: 127

Dacus (*Strumeta*) *cucurbitae*- Hardy and Adachi, 1954: 164-165; Hardy, 1973: 38-40, 1974: 27-29

Dacus (*Zeugodacus*) *cucurbitae*- Drew, 1973: 23-27; Hardy, 1977: 57, 1982:203, 1983: 36

Dacus aureus-Tseng and Chu, 1982:85

Material examined

J and K: 50 males, Srinagar and Budgam, 29th- 43rd standard week, 2008, coll; S. A. Ganie. All specimens attracted to methyl eugenol, deposited in biosystemic laboratory, SKUAST-K, Shalimar, Srinagar.

Distribution

Worldwide: Egypt, Kenya, Mauritius, Réunion, Tanzania, California, Australia, Papua New Guinea, Indonesia, Iran, Japan, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand, United Arab Emirates and Viet Nam, Afghanistan, Bangladesh, Brunei, Cambodia, China (Guangdong, Guangxi, Hainan, Jiangsu, Yunnan), Christmas Island and Hong Kong. India: Andaman and Nicobar Islands, Andhra Pradesh, Bihar, Delhi, Haryana, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal and Jammu and Kashmir.

Local: Kashmir Valley (Srinagar and Budgam).

Diagnostic characters

This species can be easily identified on the basis of following characters (Plate 1).

It is a medium sized species face fulvous with pair of large black oval spots; scutellum entirely red brown or with fuscous to dark fuscous markings. The post parental lobes and notopleura are present and yellow in colour mesopleural strip slightly wider than notopleuron dorsali. The wings are broad fuscous costal band paler between R_{2+3} and R_{4+5} and expanding into a large spot in apex of wing. The wings are with broad fuscous cubital streak and have distinct fuscous pattern around dm-cu, cross vein and a weak pale fuscous pattern around r-m, cross vein. The 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

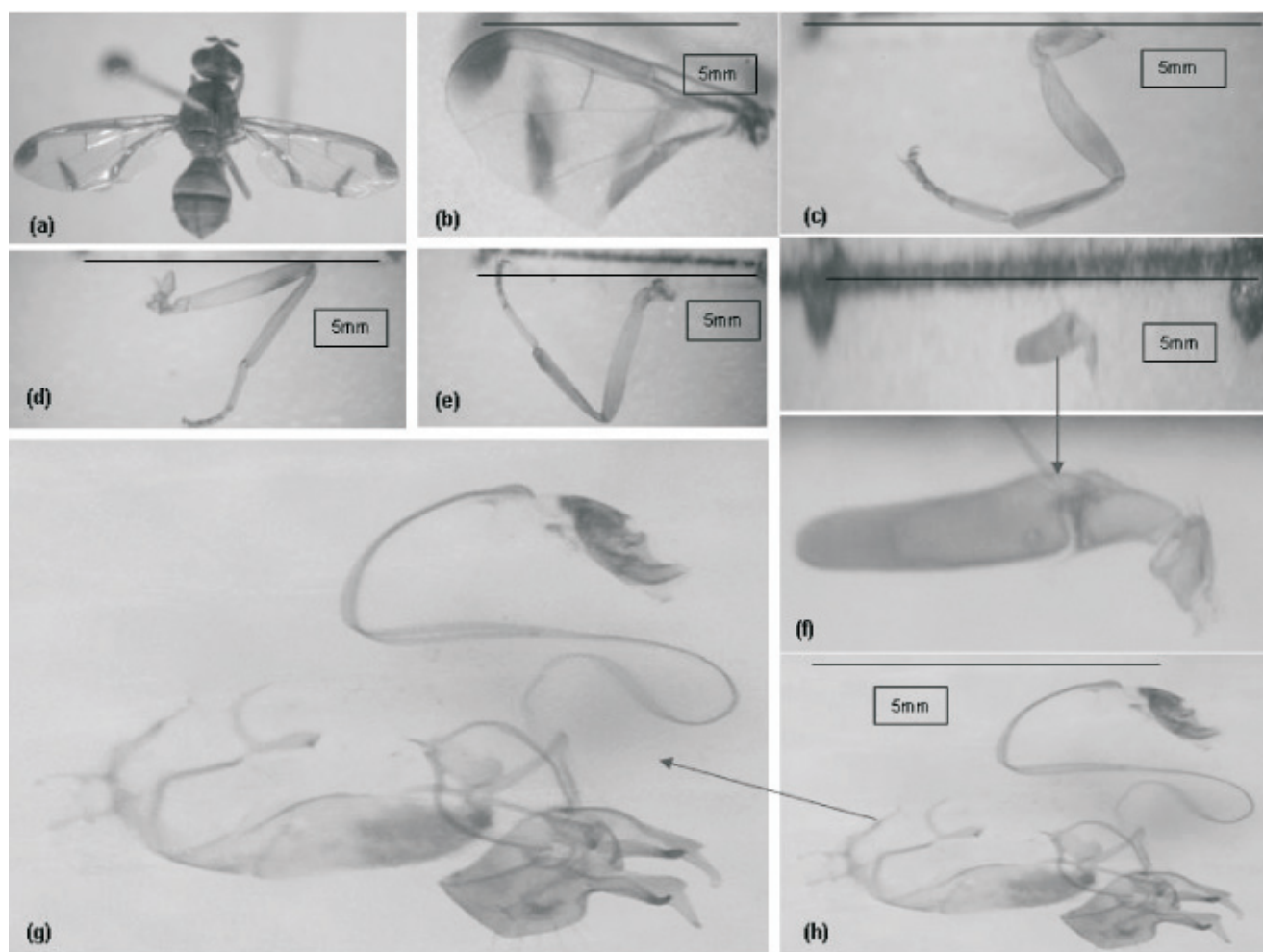


Plate 1: *Bactrocera cucurbitae* (Coquillett); a) Adult, b) Wing, c) Fore leg, d) Mid leg, e) Hind leg, f) Antenna, g) Male genitalia

and all tarsi are fulvous. The abdominal terga III-V orange brown in colour with a distinct 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 terga and with anterolateral corners of terga IV and V fuscous to dark fuscous.

Remarks

This species is widely distributed in south-east Asia and spread to many parts of the world and is recognized as one of the major worldwide tephritid pest. It has been spread to many countries from its area of endemism and is generally more common in disturbed or cultivated habitats.

Bactrocera cucurbitae is best distinguished by the red brown scutum with dark markings, lateral and medial post sutural vittae present, wing with a distinct spot in apex of costal band and infuscation around the r-m and dm-cu cross veins. Similar results were found by Drew and Raghu (2002).

Bactrocera (Bactrocera) dorsalis (Hendel)

Bactrocera (Bactrocera) dorsalis- Drew and Hancock, 1994: 17; Norrbom et al., 1998: 90; Drew and Raghu, 2002: 336; Drew and Roving, 2007:3.

Dacus ferrugineus- Fabricius, 1805:274

Dacus dorsalis- Hendel, 1912:18

Bactrocera ferruginea- Bezzi, 1916: 104

Chaetodacus ferrugineus var. *dorsalis*- Hendel, 1915:426

Chaetodacus ferrugineus- Bezzi, 1916:104

Chaetodacus ferrugineus dorsalis-Bezzi, 1916:104

Chaetodacus ferrugineus var. *okinawanus*- Shiraki, 1933:62; Hardy and Adachi, 1956:8; Hardy, 1969:402

Dacus (Strumeta) dorsalis- Hardy and Adachi, 1956:7; Hardy, 1969:395-402, 1973:41-42, 1974:29-31

Strumeta dorsalis- Hering, 1956: 63

Strumeta ferruginea- Hering, 1956: 63

Strumeta dorsalis okinawana- Shiraki, 1968:23

Dacus (Bactrocera) dorsalis- Hardy, 1977:49-50; Drew, 1982: 60-63; Drew, 1989a: 63

Material examined

J and K: 35 males, Srinagar and Budgam, 29th- 43rd standard week, 2008, coll.; S.A. Ganie. All specimens attracted to methyl euginol, deposited in biosystemic laboratory, SKUAST-K, Shalimar, Srinagar.

Distribution

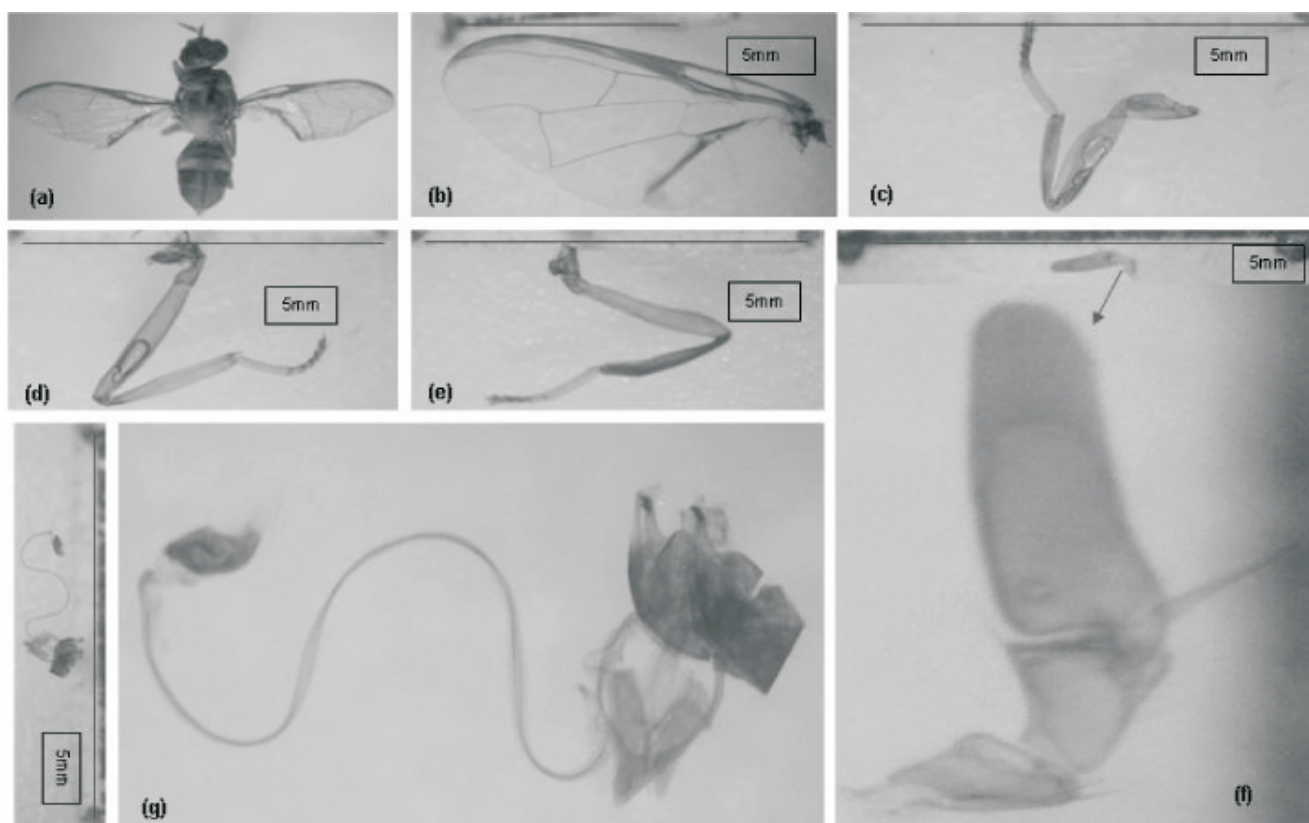


Plate 2: *Bactrocera dorsalis* (Hendel) a) Adult, b) Wing, c) Fore leg, d) Mid leg, e) Hind leg, f) Antenna, g) Male genitalia

Worldwide: California, Florida, Rota, Bangladesh, Bhutan, Cambodia, China, Hong Kong, Japan, Lao, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan, Thailand (northern), United Arab Emirates and Viet Nam.

India: Assam, Bihar, Delhi, Haryana, Karnataka, Maharashtra, Manipur, Orissa, Punjab, Himachal Pradesh, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal and Jammu and Kashmir.

Local: Kashmir Valley (Srinagar and Budgam).

Diagnostic characters

This species can be easily identified on the basis of following characters (Plate 2).

The face has a conspicuous back spot below each antenna. The thorax typically is mostly dark with two prominent yellow strip dorsally a yellow scutellum and yellow areas laterally. The wings are clear, except of a thin, continuous brown band extending from the stigma to the wing tip, and an oblique, band of brown overlapping the posterior cubital streak. The legs are with segments which are mostly fulvous except fore tibia pale fuscous and hind tibiae fuscous. The abdomen has a prominent 'T' shaped black pattern on a light brown background plus variable other dark markings laterally.

Remarks

This species occurs in a Broad Swath from Pakistan and India East to southern China, Taiwan and South-east Asia (Steck, 2008). Within India, this species is wide spread but appears more common in the subtropical zones.

Bactrocera dorsalis is similar to *B. carambola* Drew and Hancock, *B. papayae*, *B. occipitalis* (Bezzi) and *B. philippinensis* Drew and Hancock in possessing the general colour pattern of *dorsalis* complex species. *Bactrocera dorsalis* is distinguished in possessing a narrow costal band (confluent with R_{2+3}), a narrow medial dark band on terga III-V forming the stem of the 'T' and narrow lateral dark markings on the same terga (Drew and Raghu, 2002). Similar results were reported by Drew and Roming (2007)

Bactrocera (*Zeugodacus*) *tau* (Walker)

Bactrocera (*Zeugodacus*) *tau*- Liang *et al.*, 1993: 138; Wang, 1996: 72; Norrbom *et al.*, 1998, 104; Drew and Roming, 2007 : 12.

Dasyneura tau- Walker, 1849: 1074

Dacus hageni- de Meijere, 1911: 375

Dacus caudatus var. *nubilus*- Hendel 1912: 16

Dacus nubilus ssp. *femoralis*- Hendel, 1934: 11

Dacus (*Zeugodacus*) *tau*- Hardy, 1977:60

Material examined

J and K: 25 males, Srinagar and Budgam, 29th- 43rd standard week, 2008, coll.; S.A. Ganie. All specimens attracted to methyl euginol, deposited in biosystemic laboratory, SKUAST-K, Shalimar, Srinagar.

Distribution

Worldwide: Thailand, Bangladesh, Bhutan, Pakistan, Sri Lanka, Bhutan, Vietnam, Southern China, Taiwan, Peninsular

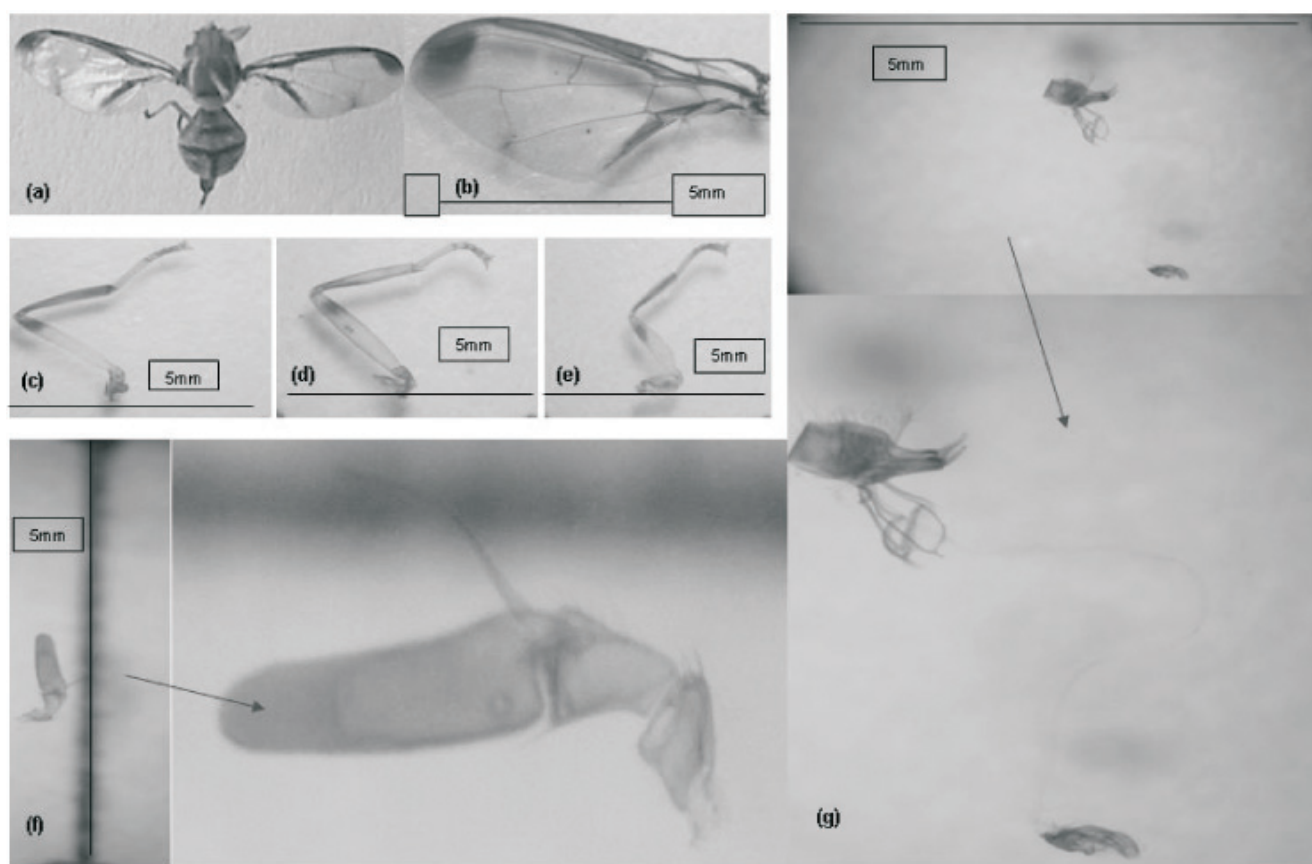


Plate 3: *Bactrocera tau* (Walker); a) Adult, b) Wing, c) Fore leg, d) Mid leg, e) Hind leg, f) Antenna, g) Male genitalia

Malaysia, Singapore, East Malaysia and Indonesian provinces. India: Himachal Pradesh, Tamil Nadu, Karnataka, Punjab, Rajasthan and Jammu and Kashmir.

Local: Kashmir Valley (Srinagar and Budgam).

Diagnostic characters

This species can be easily identified on the basis of following characters (Plate 3).

The face is fulvous with a pair of medium sized circular to oval black spots. The thorax is with conspicuous black markings in area between lateral and median postsutural yellow vittae, also area behind each humerus. The wing is with a narrow dark fuscous costal band overlapping R_{2+3} and extending into a distinct apical spot and broad dark fuscous cubital streak. The legs are with femora yellow, front and hind tibiae tinged with brown and middle tibiae lightly brown tinged basally. The abdominal terga III-V fulvous with a black 'T' pattern and antero-lateral corners of terga IV and V with broad black markings.

Remarks

This species is widely spread across South and South-east Asia. It is a new record for Kashmir collected from ridge gourd. This species can be misidentified as it belongs to a complex of closely related species. It is identified by the presence of costal band expanded into a distinct spot at apex, abdominal terga III-V fulvous with a black 'T' pattern and lateral margins of terga IV and V with either antero lateral corners dark and or

with lateral longitudinal dark bands over both terga. Similar results were reported by Drew and Roving (2007).

Bactrocera (Zeugodacus) scutellaris (Bezzi)

Bactrocera (Zeugodacus) scutellaris- Liang et al., 1993:138; Norrbom et al., 1998: 103; Drew and Roving, 2007: 10-11.

Bactrocera scutellaris- Bezzi, 1913: 98

Zeugodacus malaisci- Hering, 1938: 4

Dacus pusaensis- Kapoor and Katiyar, 1970: 252

Dacus (Zeugodacus) scutellaris- Hardy, 1973: 68; Hardy, 1977:59; Wang, 1996: 70.

Material examined

J and K: 05 males, Srinagar and Budgam, 29th-43rd standard week, 2008, coll.; S.A. Ganie. All specimens attracted to methyl euginol, deposited in biosystemic laboratory, SKUAST-K, Shalimar, Srinagar.

Distribution

Worldwide: Bangladesh, Bhutan, Thailand, Pakistan, Sri Lanka, Southern China, Taiwan, Peninsular Malaysia, Singapore and Indonesian provinces.

India: Himachal Pradesh, Tamil Nadu, Karnataka, Rajasthan and Jammu and Kashmir. Local: Kashmir Valley (Budgam).

Diagnostic characters

This species can be easily identified on the basis of following characters (Plate 4).

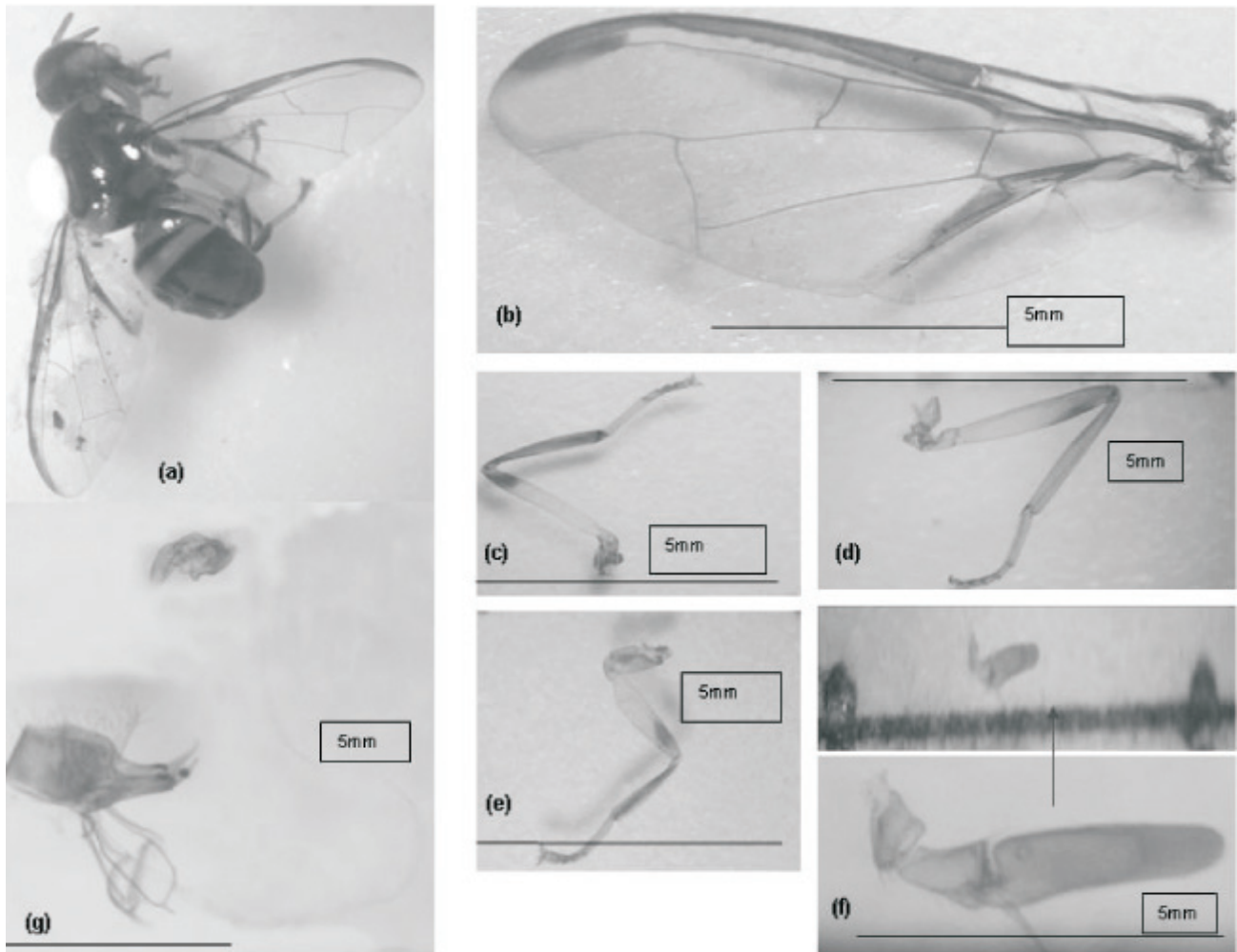


Plate 4: *Bactrocera scutellaris* (Bezzi); a) Adult, b) Wing, c) Fore leg; d) Mid leg, e) Hind leg, f) Antenna, g) Male genitalia

The face is fulvous with a pair of transverse oval black spots pointed towards centre. The thorax is entirely black in ground colour except for usual yellow markings. The scutellum is

yellow in colour with a distinct black apical spot. The wings are hyaline with a narrow dark fuscous costal narrow band which is extremely narrow beyond apex of R_{2+3} and widening into a distinct spot around apex of R_{4+5} and broad dark fuscous cubital streak is also present. The legs are with femora yellow, broadly black at apices, with front and middle tibiae yellow tinged with brown, hind tibiae entirely black. The abdomen is predominantly black, narrowly yellow on apex of first tergum and broadly so on apex of second tergum also tinged with yellow on apex of 5th tergum.

Remarks

It is widely spread across south-Asia to south-east Asia. It is a new record for Kashmir, collected from Chadoora of district Budgam from ridge gourd.

It is readily distinguished by the shining black scutum, very narrow lateral and medial postsutural vittae, scutellum yellow with a dark spot at apex, costal band extremely narrow beyond apex of R_{2+3} and with a small spot around apex of R_{4+5}

abdominal terga IV-V mostly dark fuscous to black. Similar results were reported by Drew and Rooming (2007) and Drew and Raghu (2002).

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