



Fruit Flies: Biodiversity, Species Complex and Economic Importance

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Fruit flies (Diptera: Tephritidae) have emerged as one of the most serious insect pests of crops of horticultural importance across the globe. Among this dipteran pest, the genus *Bactrocera* Macquart is a major pest with immense economic importance. Approximately 500 species are recorded in this genus besides having reports of existence of pest complex. Researchers are utilizing various techniques including molecular along with the traditional taxonomy to bring more clarity on the species issue. Such investigations will help increase our knowledge regarding biodiversity of fruit flies.

Introduction

Fruit flies are also known as Peacock flies or ornamental flies due to their strutting behavior and wing vibrating. Fruit flies are medium sized, two winged flies (Dipterans) in which the hind wings are modified as balancing organs during flight. They are economically important insect pests which attack a wide variety of fruits, as well as a few vegetable crops. The family of Tephritidae (true fruit flies) includes some of the world's most serious agricultural pests. In India Tephritidae are represented by 243 species in 74 genera (Anonymous, 2014). The tephritid fly, *Bactrocera cucurbitae* (Coquillett), is one of the most serious pests of cucurbits, while the guava fruit fly, *B. zonata* Saunders, is a serious pest of guava.

Fruit flies can cause 30-100% economic losses annually in various crops such as gourds, melons and summer guavas (DFID 2005). In the Indo-Malayan region the melon fruit fly, *B. cucurbitae* (Coquillett) is considered the most destructive pest of melons. This pest also causes serious losses in the production of melons, cucumbers and tomatoes in Hawaii, USA. Fruit flies have gained international significance because they are highly invasive species that have greatly expanded their geographical distribution over the last century. These insects have been found throughout Asia and the Pacific islands, where they cause severe losses to many commercially important tropical and subtropical crops, especially fruits.

Approximately 4400 fruit fly species belonging to the family Tephritidae exist across the world (Norrborn 2004). About 200 of these species fall in the pest category, since they cause economic losses to various fruit, vegetable and flower crops (Carroll *et al.* 2002). Of these pest species, the larvae of roughly 35% are pests of soft fruits (White and Elson-Harris 1992). In the subfamily Dacinae from the Indian region, 41 pest species from 27 genera are reported from

Himachal Pradesh (Agarwal and Sueyoshi 2005). Recently, Prabhakar *et al.* (2012) reported six new fruit fly species from Himachal Pradesh state. The genus *Bactrocera* Macquart (previously known as *Dacus* Fabricius) is the largest among the tribe Dacini (Drew 1989). Fruit flies belonging to this genus are economically and agriculturally important due to the serious damage they inflict on commercial fruits and vegetables. One of the major constraints on commercial horticulture production is the onslaught of *Bactrocera* species, which are invasive and polyphagous pests. About 440 species of this genus were recorded from the Oriental, Pacific and Australian regions (Wang *et al.* 2008). About 22 species are listed as economically important pest species in Asia (Asian Fruit Fly IPM Project 2012). More information about the source of names and the taxa can be found in “The BioSystematic Database of World Diptera” (BDWD) (Anonymous, 2014b). A few important damaging and widespread species within genus *Bactrocera* include *B. tau* Walker, *B. zonata* Saunders, *B. cucurbitae* Coquillett, etc.

The oriental fruit fly, *B. dorsalis* (Hendel), is a major pestiferous tephritid which is known to have a species complex containing over 70 species (Clarke *et al.* 2005, Schutze *et al.* 2012), and is widely distributed in Asia, Australia and the Pacific islands. About 11 species which are closely related to *B. dorsalis* were identified and grouped in the *B. dorsalis* complex by Hardy (1969). The first comprehensive revision of this pest complex, which described 40 new species, was published by Drew and Hancock (1994), and resulted in raising the total number of species to 52 in the Asian region. At present, the *B. dorsalis* complex is considered to contain 75 described species (Clarke *et al.* 2005). The morphological analysis based on color differences by Clarke *et al.* (2005) resulted in referring four sibling fruit fly species {*B. dorsalis* (Hendel), *B. papayae* (Drew and Hancock), *B. philippinensis* (Drew and Hancock) and *B. carambolae* (Drew and Hancock)} as *B. dorsalis* sensu lato (s.l.). Interestingly, the adults of these four species are morphologically identical, except for minor color pattern differences (Drew and Hancock 1994), a few measurable differences in genitalia characters (Iwahashi 1999), and variations in wing shape (Schutze *et al.* 2012). These minor characteristics help to distinguish the sibling species with only limited reliability. It is interesting to note that males of most of the *B. dorsalis* complex species are attracted to either of the two kairomone lures, methyl eugenol or cuelure. However, the *B. dorsalis* s.l. species are only attracted to methyl eugenol.

A complex of sibling species exists, though few clearly distinct species exist in the sub-family Dacinae. The majority of these species pose a serious economic threat to agriculture due to the direct damage done to commercial horticulture (Yong *et al.* 2010). These losses can approach 100% in cucurbit species due to the melon fly, *B. cucurbitae* (Dhillon *et al.* 2005), on mango (12-60%), papaya (12-60%) and guava (40-90%) (Allwood *et al.* 1997). In South-East Asia, the *B. dorsalis* complex contains a number of significant fruit fly pest species (Drew 1994). The family Tephritidae was revised by Korneyev (1999), who proposed that *Bactrocera* and *Cacus* are separate genera of the tribe Dacini (Sub-family Dacinae). Within the genus *Bactrocera*, 629 species are described out of 880 in the tribe Dacini (Drew 2004). Recently, San Jose *et al.* (2013) reported to contain over 500 species in this genus, representing the majority of fruit fly pests in both tropical and subtropical countries.

Some of the morphological characters between sibling species are mainly female-specific, which makes it difficult to use adult specimens in species identification, since attractants such as methyl eugenol attract only male flies to the traps (White and Elson-Harris 1992). Sometimes current species identification has to rely greatly on the geographical distribution of a species (Iwahashi 2001), since exact origin of the specimen helps in identification. Some constraints do occur in using geography as a taxonomic character (Fitzpatrick, 2009). Currently, very limited information is available on *Bactrocera* molecular systematics, and it is mainly limited to surveying mitochondrial genes. By using two mitochondrial genes (COII and 16S) Smith *et al.* (2003) concluded that the *B. dorsalis* complex was monophyletic in nature. However, in another study using the mitochondrial genes COI and COII genes, Nakahara and Muraji (2008) concluded that the *B. dorsalis* complex was paraphyletic. Therefore, integration of all available techniques is currently the most useful approach to accurate identification of the fruit fly species complex.

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