

DIVERSITY OF FRUIT FLIES (DIPTERA: TEPHRITIDAE) ATTRACTED BY ME LURE IN CSC-BG GERMPLASM CARAMBOLA PLANTATION

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ABSTRACT

Diversity of fruit flies (Diptera: Tephritidae) attracted by me lure in CSG-BG germplasm carambolae plantation. Germplasm Garden (KPN) Cibinong Science Center–Botanical Garden (CSC-BG) is one of the gardens that conserve and utilizes Indonesian local germplasm, one of which is carambolae. The current problem in KPN is the attack of fruit flies (*Bactrocera* spp.). This study was conducted to determine the diversity of fruit flies in the KPN carambola plantation area. A total of eight traps were placed randomly in the plantation area. Each trap contained 1 mL of methyl eugenol pheromone solution. Identification of fruit flies was carried out based on three morphological differences, they were wings, abdomen, and hind legs. There were 317 fruit flies collected and separated into three species, namely *Bactrocera carambolae*, *B. papayae*, dan *B. umbrosa*, of which *B. carambolae* had a dominance index of 0.74 and abundance index of 85%. Data on the types of fruit flies can be used as primary data to determine the preparation of pest prevention efforts.

Key words: abundancy, *Bactrocera* spp., carambola, dominance, methyl eugenol

INTRODUCTION

In Indonesia, horticultural crops, especially fruits, are highly demanded by consumers, one of which is carambola that is also known as star fruit. Carambola is one of the horticultural products that has high potential to be cultivated and commercialized in Indonesia (Nursaimatussaddiyah, 2016). In 2019, star fruit production in Indonesia reached 106,070 tons (BPS, 2021).

Fruit flies are one of the main limiting factors in star fruit production worldwide, including Indonesia. The attack was recognized by the presence of black spots on the skin of the fruit as the adult insects laid their eggs. The hatched eggs will eat the flesh of the fruit, causing the fruit to rot then fall. In the dry season, the yield loss is around 1–2%, while in the rainy season the yield loss reaches up to 40%. In severe attacks, yield loss could reach 100% (Indriyanti *et al.*, 2014).

Bactrocera spp. is a group of fruit flies that widely distributed in the tropics including Asia, the South Pacific,

and Australia (Vargas *et al.*, 2015). As many as 90 species have been reported in Indonesia, especially in western Indonesia. However, only 8 species are considered important pests, they are *Bactrocera* (*Bactrocera*) *albistrigata* (de Meijere), *B. (Zeugodacus) cucurbitae* (Coquillett), *B. (B.) dorsalis* Hendel., *B. (B.) papayae* Drew and Hancock., *B. (B.) umbrosa* (Fabricius), *B. (Z) tau* (Walker), *B. (B.) carambolae* Drew and Hancock., and *Dacus* (*Callantra*) *longicornis* (Wiedemann) (Siwi & Hidayat, 2006). In Bogor Regency, it has been reported that 18 species have been found and some of them were identified as *B. umbrosa*, *B. carambolae*, *B. papayae* and *B. latifrons* (Larasati *et al.*, 2016).

The Germplasm Plantation (KPN) in the Cibinong Science area is a fruit plant conservation area that collected from several locations in Indonesia, including star fruit. Recently, fruit flies attacks on carambola plants in KPN are very high. Until now, however, studies on the diversity of fruit flies in the Cibinong Science Center area, especially KPN Cibinong Science Center-

Botanical Garden (CSC-BG) are still limited. This study aims to determine the diversity of fruit flies in KPN.

MATERIALS AND METHODS

Research Site. The study was conducted in January–February 2016. A survey to collect fruit fly samples was carried out in the carambola plantation area of KPN CSC-BG. The samples were taken to the Entomology Laboratory, Center for Biological Research, Indonesian Institute of Sciences (LIPI) for the identification process.

Field Observation. Field observations were carried out on 105 carambola plants in KPN CSC-BG. Plant height ranged from 7 to 10 m. Fruit sampling was taken by purposive random sampling.

Fruit Fly Collection. Fruit flies were collected by using pre-made traps. A total of 8 traps were randomly placed in the carambola plantation area with 5 m distance between traps (Indriyanti *et al.*, 2014). The fruit fly trap was made from a modified 600 mL plastic bottle (Figure 1). A total of 1 mL of methyl eugenol (ME) pheromone (HOGY, SMAgro) was dripped onto a cotton swab and put inside the trap. Traps then placed on plants with a height of 2 to 4 m above ground level with leaf shade conditions. Following Manurung *et al.* (2012), the traps were set for 6 hours (from 05.30 to 11.30 AM Jakarta, Indonesia time).

Population Calculation and Identification. The fruit fly population was calculated based on the number of fruit flies in each trap. Identification was carried out

using a binocular microscope (Olympus type SZH ILLK) with a magnification of 10×. Observations were made on the shape of the wings, abdomen, and hind legs. Identification was referred to Siwi & Hidayat (2006) and Larasati *et al.* (2016).

Population Dominance. The calculation of the dominance index of fruit flies population was using the following formula (Ludwig & Reynold, 1988):

$$D = \sum_{i=1}^s \left[\frac{n_i}{N} \right]^2$$

- D = Simpson Dominance index;
 S = the total number of species;
 n_i = the total number of organism of species –i;
 N = the total number of organisms of all species;
 P_i = n_i/N = proportion of total abundance represented by species –i.

The degree of dominance are divided into 3 categories (Maesyora *et al.*, 2018):

0.01–0.30 = low dominance;

0.31–0.60 = moderate dominance;

0.61–1.00 = high dominance.

Population Abundance. Fruit fly abundance was calculated using the following formula (Brown *et al.*, 1998):

$$A = \frac{a}{b} \times 100\%$$

- A = abundancy;
 a = number of i species in location X;
 b = total population of all species observed in location X.



Figure 1. Fruit fly trap. (A) ME treated cotton; (B) Trap bottol.

RESULTS AND DISCUSSION

Symptoms of Fruit Fly Attack on Carambola. On the infected fruit, there are black spots caused by the ovipositor puncture of the female fly (Figure 2b). Healthy star fruit has a shiny skin without any dark brown spots (Figure 2a). Soon after hatching, the larvae burrow into the flesh of the fruit, causing fruit rot (Figure 2c). A female fruit fly will lay between 1–10 eggs in one fruit. A fruit fly is able to lay up to 40 eggs per day (Kardinan *et al.*, 1998).

Until now, attractants have been widely used for fruit flies management and one of the attractants is methyl eugenol. Methyl eugenol was firstly discovered by Howlett (1877–1920) which was used as an attractant for mango fruit flies (Verghese *et al.*, 2013). This attractant was derived from plants and it has been reported can be used to trap up to 23 species of fruit flies (Omkar, 2016). In Indonesia, methyl eugenol was applied by dripping the attractant on the hanging cotton which was placed inside a 600 mL, 1000 mL or 1500 mL plastic bottle (Sodiq *et al.*, 2016).

Fruit Fly Identification. We collected 3 different species of fruit flies (Figure 3): *B. papayae* (A), *Bactrocera carambolae* (B), and *B. umbrosa* (C). Identification was done by morphological characteristics referred to the fruit fly identification key (Diptera: Tephritidae) (Larasati *et al.*, 2016). The characteristics of the Genus *Bactrocera* are rounded abdomen,

separated tergum, non-precarious waist, and various colors of thorax (Larasati *et al.*, 2016). The identification by observing the differences in the wings, abdomen, and hind legs, was resulted three species of fruit flies; the *B. papayae* that characterized by a narrow medial longitudinal black band over abdominal terga III and IV and the length of the species was approximately 6.2–6.4 mm, the thorax has scutum in dominant black, and have hairy anterior (Figure 4a); the *B. carambolae* that characterized by the costal band elongated and narrowed at the tip of the wing. the thorax has scutum in black with yellow band on the lateral part (Figure 4b); and *B. umbrosa* that characterized by 3 transverse bands from the costal margin to the underside of the wing and the thorax has black scutum with short hair (Figure 4c).

The morphology of the wings, abdomen, and hind limbs were seen in Table 1. The complete description of the fruit flies obtained is as follows (Siwi & Hidayat, 2006): *B. papayae* sensu (Drew & Hancock, 1994) has the local name papaya fruit fly. It was spread in Thailand, Indonesia (Nusa Tenggara, Sulawesi and Flores I.), Christmas Island, Australia and New Guinea. *B. papayae* has the following characteristics: black spots on the face are found in each of the pical indentations. The thorax has dominant black color at the scutum and has supra-alar hair on the anterior side, the scutum with yellow/orange bands on the lateral side (lateral postsutural vittae). Has wings with black bands on the costal and anal lines, very clear bc cells, abdomen with



Figure 2. Carambola fruit condition in KPN plantation area. (A) healthy fruit; (B) attacked fruit (outside); (C) attacked fruit (inside).



Figure 3. The fruit fly species collected in carambola plantations area. (A) *B. papayae*; (B) *B. carambolae*; (C) *B. umbrosa*.

well-defined segments, 3rd digit in males with pical (feather comb) on each side. Characteristics on tergite-3 with transverse lines. There is no spot on the pical femur of the female forelegs. The femur of the middle leg is yellow.

Bactrocera umbrosa sensu Fabricius 1805 has the local name Jackfruit fruit fly. Spread in Malaysia, Papua New Guinea, Thailand and the Philippines. *B. umbrosa* has characteristics of black spots on the face, easily recognized by the appearance of three transverse bands on its wings, black scutum with yellow stripes on both lateral sides, hairs on the anterior supra alar and acrostichal pre-scutella and 2 hairs on the scutella. The legs are yellow, the basal and posterior parts are hairy. The appearance of the abdomen varies, sometimes with a black discoloration on the lateral side (Table 1). Males have pectin and are attracted to methyl eugenol.

Bactrocera carambolae sensu (Drew & Hancock, 1994) has the local name star fruit fly. Spread

in Thailand, India, Malaysia and Indonesia. *B. carambolae* has wings with black bands on the costal and anal streaks, the apex is shaped like a fishing rod. The scutum thorax is mostly dark black with yellow bands on the lateral side (lateral 22 post-sutural vittae). The post-pronotal is yellow or orange. The lateral side of the anepisternum has yellow spots (Notopleuron to Cathepisternum). There is a black or dark brown spot on the apical femur of the female fruit fly's forelegs. The abdomen is brown-orange in color with a clear pattern.

Dominance and Abundance of Fruit Fly Population.

Among the three types of collected fruit flies (*B. carambolae*, *B. papayae*, and *B. umbrosa*), the *B. carambolae* is the dominant type of fruit fly, with a dominance index of 0.74. The greater or higher the level of community diversity, the more diverse species found in an area (Oka, 1995). When species diversity is high, then a species does not necessarily become dominant

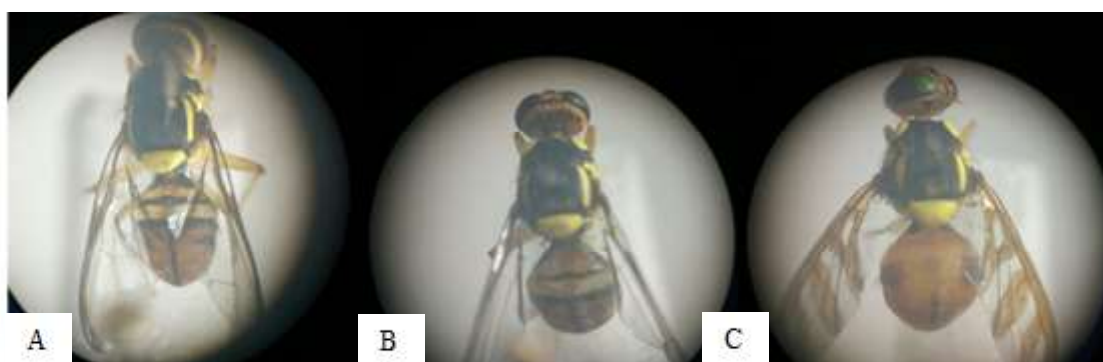


Figure 4. Observation using stereo microscope with 10 x magnification. (A) *B. papayae*; (B) *B. carambolae*; (C) *B. umbrosa*.

Table 1. Fruit flies morphology

No	Characteristic	<i>B. papayae</i>	<i>B. carambolae</i>	<i>B. umbrosa</i>
1	Thorax	Scutum dominant black, have hair on the anterior	Scutum black with yellow band on the lateral part	Scutum black with short hair.
2	Wing	Wings with black costal band and vivid anal streak. Thin black band on the ribs to the apex	The wings had black costal band. The apex of the wing is shaped like a fishing rod	Wings with fuscous to brown costal band. There are three transverse bands on the wings
3	Abdomen	The abdomen is brown-orange in color with a thin and clear "T" pattern	Abdomen with a clear "T" pattern and there is a black rectangular pattern on tergum IV	Abdomen terga III-V color reddish brown with black on the lateral side of the ke tergum III
4	Leg	All tibia reddish black except the apical part of the middle tibia	Femur and tibia are yellow-brown	Hind leg has brown color

and vice versa. The non-dominant type of fruit fly is a species that is rarely found and has a small abundance. These rare fruit flies may be species that settle and forage in a habitat or may be only incidental explorers (non-permanent) from adjacent habitats or even migratory species (Ricklefs, 1978). While the dominant species is a species with a very large abundance because this species has a large number of individuals, biomass, and important value so that it dominates the community (Ricklefs, 1978).

Totally, 317 fruit flies obtained from the star fruit plantation area. They showed differences in abundance between species. The most common fruit flies found in the star fruit plantation area were *B. carambolae* whose population was 85.80% followed by *B. papayae* and *B. umbrosa* which reached 13.25% and 0.95%, respectively (Table 2). *B. carambolae* is the most abundant type of fruit fly found in this study. The abundance of the fruit fly population has a strong correlation with the percentage of attacks. The higher the abundance, the higher the percentage of attacks, and vice versa, the lower the abundance of fruit flies, the lower the percentage of attacks in the field. The abundance of dominant fruit flies causes a dominant percentage of attacks on certain plants. The percentage of attack depends on environmental conditions and the vulnerability of the type of fruit attacked (Gupta & Verma, 1978; Dhillon *et al.*, 2005). The abundance of a population of organisms, apart from being caused by host and environmental factors, is also influenced by natural enemies. Natural enemies have an important role in regulating fruit fly populations in the field.

Based on the analysis result, *B. carambolae* is a type of fruit fly with a dominant and abundant population in the star fruit plantation area of KPN Cibinong. This due to star fruit is one of the hosts of *B. carambolae* (Siwi & Hidayat, 2006). *B. carambolae* attacks star fruit due to its distinctive odor and color, thin skin and soft flesh (Indriyanti *et al.*, 2014). The second largest population found in this study was *B. papayae* (Figure 4a) while *B. umbrosa* (Figure 4c) was found only slightly, this was because the fly's host was jackfruit or banana (Siwi & Hidayat, 2006). Fruit flies

B. carambolae and *B. papayae* are the species with the most abundant population in an area (Ginting, 2009). This is because these species are polyphagous which can utilize various types of fruit plants as hosts which are abundantly available all the time and spread widely in very high populations and the adaptability of the fruit fly is higher. The abundance of fruit fly populations differs from one place to another because it is related to the presence of the host (fruit). A large area will support an increase in species population due to the availability of food sources and suitable habitat (MacArthur & Wilson, 1967). In addition to star fruit plants, *B. carambolae* also attacks several other fruit plants such as guava, water guava, tomatoes, kluwih, and chili (Tariyani *et al.*, 2013). The Cibinong Germplasm Garden, which is one of the ex situ conservation areas at the Cibinong Science Center, currently has a collection of 18 types of fruit and 82 varieties of selected Indonesian fruit plants, including durian, rambutan, carambola, mango, sapodilla, guava, soursop, mangosteen, orange, and so on (Priadi *et al.*, 2013).

Identification of the type of fruit fly is important to do as an initial step in controlling the fruit fly pests. Efforts to reduce or control fruit flies can be done by improving the sanitation of star fruit land and removing rotten fruit that falls to the ground. This is related to the life cycle of fruit flies. There are four phases in the fruit fly life cycle and are included in complete metamorphosis, namely egg, larva, pupa, and imago (Siwi & Hidayat, 2006).

CONCLUSION

The fruit flies found in the starfruit plantation area of KPN CSC-BG were *B. carambola*, *B. papayae*, and *B. umbrosa* with the most abundant and dominant population of fruit fly was *B. carambolae* with dominance index of 0.74 and abundance index of 85%.

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Table 2. Fruit Fly (*Bactrocera* spp.) species dominance trapped in star fruit plantation area

Species	Total	Simpson dominance index	Dominance criteria	Abundance (%)
<i>B. carambolae</i>	272	0.74	High	85.80
<i>B. papayae</i>	42	0.02	Low	13.25
<i>B. umbrosa</i>	3	0.0001	Low	0.95
Total	317			100

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