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Research Article

Species Composition of Fruit Flies (Diptera: Tephritidae) in Sorong and Raja Ampat, West Papua

Komposisi Spesies Lalat Buah (Diptera: Tephritidae) di Kabupaten Sorong dan Raja Ampat, Papua Barat

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ABSTRACT

Fruit fly monitoring is an important part of integrated pest management since it provides information about fruit flies species composition in any given area. The aim of this study was to find out species composition of fruit fly in the city of Sorong, and both Sorong and Raja Ampat Regencies. Sampling was conducted from June to November 2016 using trapping method. There were 19 species of fruit flies in the whole sampling locations, consist of 11 species attracted to cue-lure and 8 species attracted to methyl eugenol. *Bactrocera frauenfeldi* was the dominant species in trap baited with cue-lure, while *B. umbrosa* and *B. dorsalis* were dominant in trap baited with methyl eugenol. Fruit fly diversity index in Raja Ampat Regency and city of Sorong were low while diversity index in Sorong Regency was relatively moderate.

Keywords: fruit fly, monitoring, species composition, West Papua

INTISARI

Monitoring lalat buah merupakan bagian penting dalam pengelolaan hama terpadu yang memberikan informasi tentang komposisi lalat buah di suatu area. Tujuan dari penelitian ini adalah untuk mengetahui komposisi spesies lalat buah di Kabupaten Sorong, kota Sorong dan Kabupaten Raja Ampat. Pengambilan sampel dilakukan mulai dari Juni sampai November 2016 dengan metode pemasangan perangkap. Total terdapat 19 spesies lalat buah dari seluruh wilayah pengambilan sampel, dengan 11 spesies yang tertarik cue lure dan 8 spesies tertarik metil eugenol. Bactrocera frauenfeldi *adalah lalat buah yang paling dominan pada perangkap dengan atraktan* cue lure *sedangkan* B. dorsalis *serta* B. umbrosa *dominan pada perangkap dengan atraktan metil eugenol. Indeks keragaman jenis lalat buah di Kabupaten Raja Ampat dan Kota Sorong termasuk rendah sedangkan di Kabupaten Sorong indeks keragamannya relatif sedang.*

Kata kunci: komposisi spesies, lalat buah, monitoring, Papua Barat

INTRODUCTION

Fruit fly (Diptera: Tephritidae) is recognised as one of important pest that can cause substantial damage to commercial and non commercial fruits in the tropical and subtropical areas around the world. They are posed as threat for horticulture planting because of their damage incidence and quarantine implication. Fruit fly presence causes lost of market opportunities and, consequently restrictions imposed on the trade of fresh commodities by the importing countries (Drew, 1989).

Fruit fly can spread if fruits and vegetables infested with eggs or larvae are transported by travellers or in commercial consignments (Putulan *et al*., 2004). As the gate of Papua and path to an international tourist destination of Raja Ampat, Sorong has a strategic position as a main entry point and major transit area for human traffic and trading, especially for fruit and vegetables commodities. Increasing of trading traffic however will increase the risk of fruit flies deployment from one area to another (Siwi *et al*., 2006). The presence of fruit flies can be a threat to the development of the agricultural

sector, since The city of Sorong become one of fresh commodities suppliers for Sorong Regency and surrounding area. Monitoring using a trapping method is an effective way to detect the existance of fruit fly and obtain information of the diversity, abundance, dominance and distribution of fruit flies in the field. Informations based on monitoring program provide information that can be used to arrange strategic plan and effective control in integrated pest management. It is also necessary for developing quarantine protocols for domestic and overseas trade of fresh fruits and vegetables.

Information of fruit fly diversity in Papua is well known according to the numerous study of Drew *et al.* (1989; 2004) but there is a lack of information on the distribution and composition of fruit flies species in West Papua especially in Sorong and Raja Ampat. Therefore, the objective of this study were to analyze the composition of fruit fly species in Sorong Regency, city of Sorong, and Raja Ampat Regency and percentage of fruit fly species in various land use system.

MATERIALS AND METHODS

Location and Time Sampling

The studies were carried out in three locations: Sorong Regency (District of Aimas, Mariyat, and Makbon), city of Sorong (District of West and East Sorong) and Raja Ampat Regency (District of Waisai). Sampling time were in the period of June to November 2016. Traps baited with three different lures were used in this study. Fruit flies samples were collected by installed trap in trapping site and coordinates point recorded using Global Positioning System (GPS) Garmin Montana 650. All location choosed based on purposive sampling method considered by the accessible to the trapping site.

Sampling Method

Fruit flies were collected using the modified Steiner trap containing with 0.5 mL attractant. Modified Steiner trap made from clear cylinder plastic container (14.5 cm height, 11 cm in diameter). There were small pipe at each end, 3 cm in diameters for entry path. Cotton wick treated with attractant and sprayed with insecticide (transflutrin 0.05%) was suspended inside the trap using wire. All traps were placed in choosen districts based on land use system, consist of home estate, orchard and forest. Methyl eugenol, Cue-lure, and Trimed lure were used for attractant. Traps consist of 2 methyl eugenol trap, 2 cue-lure trap and 2 trimed lure trap in each land use system and installed for 2 month for each location. There were total 216 number of traps in the trapping site. Distribution of traps were done systematically in the field, with 5 to 20 m in distance for trap with the different kind of attractant and 1 km in distance for trap with the same kind of atractant (IAEA, 2003). All traps were hung in horizontal position and attached to tree branch with wire within the canopy, approximately 1 to 1.5 m above the ground (Hasyim *et al.*, 2006). Fruit flies collected every week and attractant added at the same time when the traps were cleared. Captured fruit flies were wrapped with tissue paper and placed in a labelled small plastic jar contained of silica gel to prevent mould.

Identification and Preservation

Fruit flies collected from trap were identified in Entomology Laboratorium, Agricultural Quarantine Station of Sorong. Fruit flies were counted and identified using USB digital microscope and Olympus Leica LZ 16 stereo microscope. Identification were done at species level based on morphological characteristics of head, thorax, abdomen and wing pattern. Identification using these following references: *Economic Fruit Flies of The South Pacific Region* by Drew *et al*. (1982), *Fruit Flies of Economic Significance Their Identification and Bionomics* by White and Elson-Harris (1992) and Plant Health Australia (2011). Preservation done using stagging or doublemounting method refer to Gullan and Cranston (1992). This method involves pinning fruit fly with a micropin (5 mm) to a polyporus blocks stage that is mounted on a macropin (39 mm).

Data Analysis

The structure of fruit fly was determined in each location (Sorong Regency, city of Sorong, and Raja Ampat Regency) and calculations were done based on all captured fruit fly in the trap. Diversity were calculated using the Shannon-Wiener Index by formula

$$H' = -\sum (pi.ln\ pi)$$

< 1.5 : low diversity
1.5 – 3.5 : moderat diversity
>3.5 : high diversity

Dominance (D) is when one species presents a frequency of superior to 1/S. (S is the total number of species in the community) (Sá *et al.*, 2012).

RESULTS AND DISCUSSION

Fruit Fly Species Found in All Sampling Locations

During this experiment, a total of 16,712 individual fruit flies were captured from all trapping locations. There were 19 fruit flies species collected consist of Genus Bactrocera and Dacus. Eleven species attracted to cue-lure including *Bactrocera. frauenfeldi*, *B. cucurbitae, B. recurrens*, *B. repanda*, *B. mollucensis*, *B. thistletoni*, *B. paramusae*, *B. trifasciata*, *B. curreyi*, *B. strigifinis*, and *B. furvilineata*. Eight species were found in trap contained with methyl eugenol including *B. dorsalis*, *B. carambolae*, *B. umbrosa*, *B. retrorsa*, *B. curvifera*, *B. fulvicauda*, *B. paracurvifera*, and *Dacus impar*. There were no fruit fly captured in trap with trimed lure attractant.

Several fruit fly species captured in the sampling locations have been reported by Drew (1989). In general, morphological characteristic used in adult fruit fly identification including the morphological characteristic of head, thorax, wing and abdomen (Drew, 1989; White & Harris, 1994). The difference between Dacus and Bactrocera genus lies on the abdomen. The terga of Bactrocera has a clear segment while Dacus have a fused terga. Dacus also has petiole similar to wasps (Siwi *et al*., 2006). Several species in Genus Bactrocera have similar morphological characteristics. Some spesies like *B. carambolae* and *B. dorsalis* look similar but quite different in their abdomen. *Bactrocera dorsalis* belong to the Oriental fruit fly species complex, which includes 52 described species in Asia. Members of the complex are recognized by their clear wings without transverse bands and t-shaped black band on abdomen. *Bactrocera carambolae* has a dark fuscous to black and rectangular shape in anterolateral corner of fourth tergum segment while *B. dorsalis* has transverse black band across anterior margin of third tergum which is broken in the midline. *B. frauenfeldi* is native to the Pacific region. *B. frauenfeldi* identified by its entirely dark postpronotal lobes, the dark triangle shaped mark on the scutellum and the short tapered lateral vittae on the scutum (Drew, 1989). Other fruit fly similar with *B. frauenfeldi* in wing pattern were also found. This species has black and yellow pale part of its postpronotal lobes and the scutellum has a entirely yellow color without dark triangle shaped mark. The author assumed that maybe it is a variation among *Bactrocera frauenfeldi* species and need a study futhermore. Some species found in this study have distinctive morphological characteristics including *B. curvifera*, *B. recurrens*, *B. trifasciata*, *B. repanda*, *B. fulvicauda*, *B. retrorsa*, and *B. umbrosa*. Morphological characteristics were different between those species. Some species has a typical wing pattern like *B. curvifera*, *B. umbrosa*, and *B. retrorsa* while others has a typical pattern on their abdomen like *B. trifasciata*. Distinctive morphological characteristics makes them quite distinguishable from other species.

Fruit flies species which are endemic in Pacific region and Papua New Guinea found in this study including *B. frauenfeldi*, *B. curvifera*, *B. repanda*, *B. strigifinis*, *B. mollucensis*, *B. thistletoni*, *B. furvilineata*, *B. retrorsa*, and *Dacus impar*. These species commonly exist in eastern part of Indonesia including West Papua but not in other parts of Indonesia. According to Drew (2004), the high levels of endemism in each area indicates that the speciation has occured in relative isolation over a considerable period of time. The Dacini fauna in Asia, Southeast Asia, and Pacific region appear to have speciated primarily over the Tertiary Period, influenced by combination of oscillations in topography, localized climate and land bridges during glaciation cycles. There are 13 species shared between Australia and Papua New Guinea and 6 species shared between Papua New Guinea and South East Asia. For the Dacini, the demarcation line between endemic Papua New Guinea fauna and that of South East Asia appears to be the eastern part of Wallacea line. Speciation caused spatial isolation for particular species. Cospeciated proccess or coevolution also affected the relationship between fruit fly and their plant host including their behaviour and physiology system (Drew, 2004).

Diversity Index and Species Dominance

Diversity index and fruit fly dominance were counted in each location. Diversity index of fruit fly species in Sorong Regency, Sorong city and Raja Ampat Regency were 1.76, 1.38, and 1.39 respectively (Table 1). Value diversity in Sorong Regency were higher than value diversity in Sorong city and Raja Ampat Regency. According to Shannon index, diversity index in Sorong Regency was moderate while diversity index in Sorong city and Raja Ampat Regency categorized as a low diversity index. Species diversity influenced by various factors such as season, spatial distribution, environment stability,

Table 1. Diversity index of fruit fly species in all sampling locations

Location	Total individu (N)	Number of species (S)	Diversity index (H')
Sorong Regency	6801	19	1.76
City of Sorong	7757	14	1.38
Raja Ampat Regency	2154	15	1.39

Table 2. Dominance categories of fruit fly species in Sorong Regency (District of Aimas, Mariyat, and Makbon)

Attractant	Fruit fly species	N	F	D Value	D
ME	*Bactrocera umbrosa*	1799	0.265	0.053	D
	Bactrocera dorsalis	2063	0.303	0.053	D
	Bactrocera curvifera	315	0.046	0.053	ND
	Bactrocera fulvicauda	197	0.029	0.053	ND
	Bactrocera carambolae	288	0.042	0.053	ND
	Bactrocera paracurvifera	24	0.004	0.053	ND
	Bactrocera retrorsa	6	0.001	0.053	ND
	Dacus impar	1	0.000	0.053	ND
CUE	*Bactrocera cucurbitae*	243	0.036	0.053	ND
	Bactrocera frauenfeldi	1613	0.237	0.053	D
	Bactrocera mollucensis	110	0.016	0.053	ND
	Bactrocera recurrens	68	0.010	0.053	ND
	Bactrocera paramusae	18	0.003	0.053	ND
	Bactrocera thistletoni	40	0.006	0.053	ND
	Bactrocera repanda	2	0.000	0.053	ND
	Bactrocera trifasciata	5	0.001	0.053	ND
	Bactrocera curreyi	5	0.001	0.053	ND
	Bactrocera strigifinis	2	0.000	0.053	ND
	Bactrocera furvilineata	2	0.000	0.053	ND

Remark: ME = methyl eugenol, CUE = cue-lure, N = number of individuals, F = relative frequency, D = dominance, being dominant (D) and non dominant (ND).

host diversity, competition and others complex factors (Huston, 1979). Based on the observations in the field, agricultural land in Sorong has more diverse cultivated plants than the agricultural land in Sorong city or Raja Ampat Regency. Sampling area in Sorong Regency also wider than Sorong city and Raja Ampat Regency. These cause an opportunity to get even more diverse species which means that the spesies numbers were higher. Moreover, low or moderate diversity index happens when there is a dominant species. Dominant species is a species that have a high value of abundance. According to Odum (1971), value of diversity index will become high when all individu come from different species and the value is low when there is individual from single species. The study showed that *B. frauenfeldi*, *B. dorsalis*, and *B. umbrosa* were dominant in all sampling location. *B. frauenfeldi* were the most dominant species captured in trap contained with cue-lure while *B. dorsalis* and *B. umbrosa* were dominant in trap with methyl eugenol attractant (Table 2, 3, and 4). *B. curvifera* were also a dominant species found in methyl eugenol trap in Raja Ampat Regency (Table 4)

Species dominance was caused by various factors including host range, abundance and host distribution, parasitism and other competition. The dominance of fruit flies species from Bactrocera genus like *B. frauenfeldi* and *B. dorsalis* are polyphagous while Dacus species in South East Asia and Pacific regions have limited host and none has developed to became significant (Drew, 1989). *Bactrocera frauenfeldi* has been recorded on more than 72 host plant species in 45 genera and 29 families. Known host species are mostly commercial or edible fruit. *Bactrocera frauenfeldi* attacks commercial host plant including guava, malay apple, mango, sauh, and breadfruit and attack wild host like tropical

Table 3. Dominance categories of fruit fly species in Sorong city (District of East Sorong and West Sorong)

Attractant	Fruit fly species	N	F	D Value	D
ME	*Bactrocera umbrosa*	2901	0.374	0.071	D
	Bactrocera dorsalis	1471	0.190	0.071	D
	Bactrocera curvifera	193	0.025	0.071	ND
	Bactrocera fulvicauda	169	0.022	0.071	ND
	Bactrocera carambolae	147	0.019	0.071	ND
	Bactrocera paracurvifera	9	0.001	0.071	ND
CUE	*Bactrocera cucurbitae*	55	0.007	0.071	ND
	Bactrocera frauenfeldi	2767	0.357	0.071	D
	Bactrocera mollucensis	5	0.001	0.071	ND
	Bactrocera paramusae	2	0.000	0.071	ND
	Bactrocera recurrens	33	0.004	0.071	ND
	Bactrocera thistletoni	2	0.000	0.071	ND
	Bactrocera repanda	2	0.000	0.071	ND
	Bactrocera strigifinis	1	0.000	0.071	ND

Remark: ME = methyl eugenol, CUE = cue-lure, N = number of individuals ; F = relative frequency; D = dominance, being dominant (D) and non dominant (ND).

Table 4. Dominance categories of fruit fly species in Raja Ampat Regency (District of Waisai)

Attractant	Fruit fly species	N	F	D Value	D
ME	*Bactrocera umbrosa*	210	0.097	0.067	D
	Bactrocera dorsalis	741	0.344	0.067	D
	Bactrocera curvifera	163	0.076	0.067	D
	Bactrocera fulvicauda	20	0.009	0.067	ND
	Bactrocera carambolae	50	0.023	0.067	ND
	Bactrocera retrorsa	4	0.002	0.067	ND
	Bactrocera paracurvifera	1	0.000	0.067	ND
CUE	*Bactrocera cucurbitae*	22	0.010	0.067	ND
	Bactrocera frauenfeldi	928	0.431	0.067	D
	Bactrocera mollucensis	5	0.002	0.067	ND
	Bactrocera paramusae	2	0.001	0.067	ND
	Bactrocera recurrens	5	0.002	0.067	ND
	Bactrocera thistletoni	1	0.000	0.067	ND
	Bactrocera repanda	1	0.000	0.067	ND
	Bactrocera strigifinis	1	0.000	0.067	ND

Remark: ME = methyl eugenol, CUE = cue-lure, N = number of individuals, F = relative frequency, D = dominance, being dominant (D) and non dominant (ND).

almond in Australia (White & Harris, 1992). *Bactrocera dorsalis* was bred from 193 host species, from 114 genera and 50 families in South East Asia. Result from host range survey across Indonesia from Aceh to Papua showed that *B. dorsalis* attack 9 host plant families including Anacardiaceae, Annonaceae, Sapindaceae, Solanaceae, Thymelaeaceae, Lauraceae, Caricaceae, Combretaceae, and Rutaceae (Suputa *et al*., 2010). All those plant families not only categorized as a horticultural plant but some of it is a forestry plant that served as an alternative host plant. Availability of alternative host plant will increase their adaptability. *Bactrocera umbrosa* were also dominant species in this study. Main host plant of *B. umbrosa* belong to Moraceae family including jackfruit, breadfruit, and cempedak. Other record said it is also attack bitter gourd (White & Harris, 1992). Based on the observation in the field, there were many plant from Artocarpus group like jackfruit and breadfruit available in sampling area especially in the home estate area. Host plant that cultivated in high quantities and available all the time make the food source always fulfilled. This condition affected the population and distribution

of fruit fly species in such area. Fruit fly will move away if the food source has been reduced (Harris *et al.*, 2003; Vaysseres *et al*., 2009; Nishida, 1980).

Percentage of Fruit Fly Species in Various Land Use System

Percentage of fruit fly species were counted based on the land use system: home estate, orchard and forest. There were 18 species captured in the forest while in the home estate and orchard were 14 species respectively. The result showed that the number of fruit flies species in the forest are more prevalent than fruit fly found in the orchard or home estate. Percentage of all fruit fly species in each land use system is shown in Figure 1.

Fruit fly species commonly found in the forest including *Bactrocera mollucensis*, *B. retrorsa*, *B. repanda*, *B. curvifera*, and *B. thistletoni* although in this study some of them sometimes found in home estate near the forest. In Raja Ampat Regency for example, swidden fields is common thing. Location of home estate or orchard are very close to the forest area, so that fruit fly species commonly found in forest are also found in the orchard or home estate area. Some species like *B. umbrosa*, *B. dorsalis*, and *B. frauenfeldi* present in all land use system in high percentages compared to other species due to their wide host range, but species like *B. retrorsa*, *B. strigifinis*, and *B. furvilineata* found only in forest area. It is showed that *B. retrorsa*, *B. strigifinis*, and *B. furvilineata* have limited host plant that only available in forest habitat. Heterogenous habitat like forest is known as an area with high and stable vegetation diversity. Number of fruit fly species in this kind of area also high although some of them are not the dominant species. According to Harris *et al.* (2003), high number of host plant diversity will affect the diversity, abundance and distribution of fruit fly species in such area. Number of fruit fly species based on land use system is shown in Figure 2.

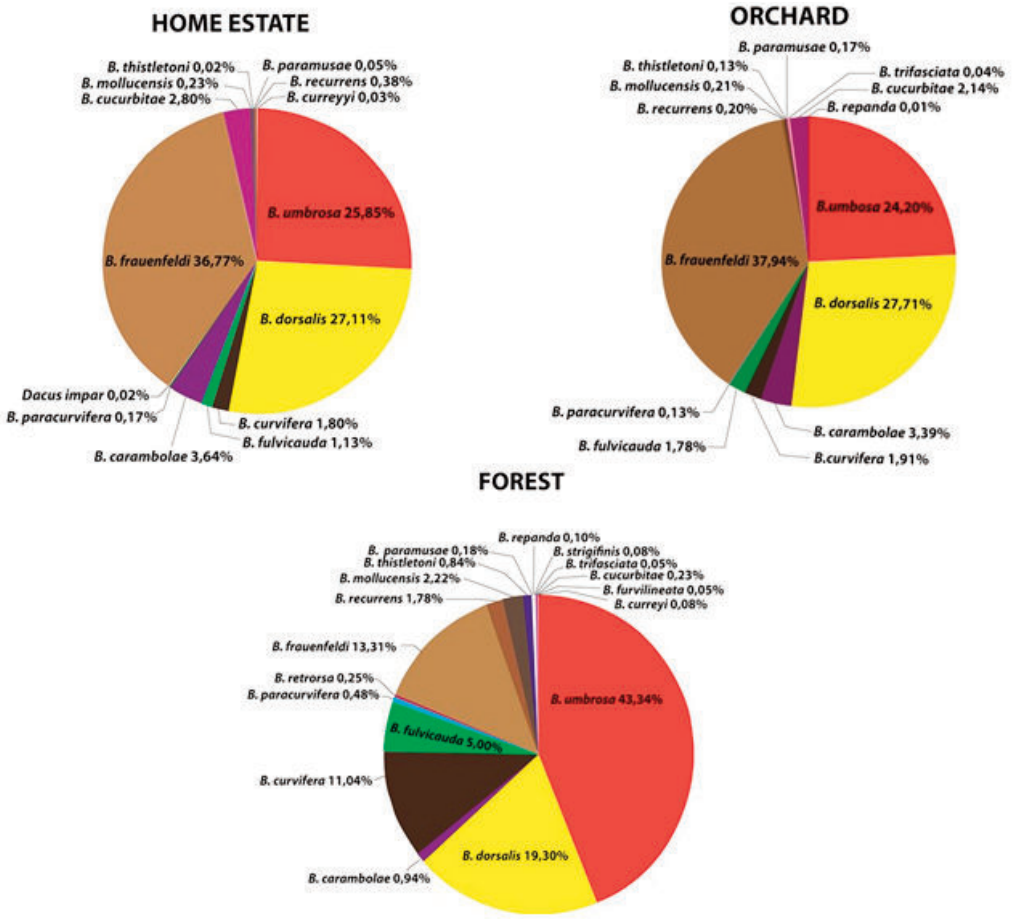

Figure 1. Percentage of fruit fly species in all sampling locations based on the land use system

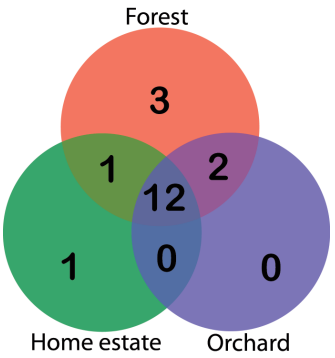

Figure 2. Total of fruit fly species in all sampling locations based on the land use system

CONCLUSION

There were 19 fruit flies species collected in the areas consist of the genera Bactrocera and Dacus. Eleven fruit flies species were attracted to cue-lure and 8 species were attracted to methyl eugenol. No fruit fly captured in trap with trimed lure means that the sampling areas are still free from the Genus Ceratitis, which is a quarantine pest in Indonesia. Diversity index in Sorong Regency was moderate while diversity index in Sorong city and Raja Ampat Regency were low according to Shannon-Wienner index. Dominant species in this study were B. *frauenfeldi*, *B. dorsalis*, *B. umbrosa*, and *B. curvifera* (Raja Ampat). Based on land use system, numbers of fruit fly species captured in the forest were higher than in the orchard and home estate because vegetation diversity in forest more various although some species found in forest is non dominant fruit fly species.

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