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The effect of refuge block on the insect visitors to Apple crop in Batu, East Java

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Abstract

Pollination is an ecological process that provides important services to human. Pollination service in agroecosytems depends on several factors, including the land management systems used by farmers. The research aims to determine the daily and seasonal variation of insect pollinators visiting the apple tree and refuge block in apple Batu, East Java. Observations on insect pollinators were done visually, were patterns of daily visit of insect pollinators to flowers analyzed by comparing the frequency of visiting in period range of time I, II, III, and IV. Enviromental factors (temperature, humidity and light) were measured. Comparative data analysis of insect community structure and refuge block obtained from the abundance and diversity (Shannon-Wiener). Daily and seasonal variation of insect pollinators of apples was done comparing the rates in flowering and fruiting seasons. Insect pollinators of apples collected in the spring plantation was higher (234 individuals) than the fruit season (169 individuals). Diversity index value of insect pollinators in the spring was higher (2.06) compared to the fruit season (1.87). Abundance of insect pollinators of flowers and fruits between seasons, is significantly different based on significance value of < 0.05. The similarity between spring and fruit season with Bray Curtis index is 0.93 %. Community structure of insect pollinators in apple plantations dominated from genus *Apis mellifera* (44) and Sphecidae (24), while in the fruit season was by the genus Formicidae (55) and Syrphidae (31). Analysis of environmental factors includes temperature, humidity and light intensity on the abundance of insect pollinators found a positive correlation with the R-square value of 66.4 %.

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Introduction

Pollination is an ecological process fundamental for the maintenance of the viability and diversity of flowering plants and provides important ecosytems services to human. Pollination is an ecosystem service that is essential to support the production of a wide of crops. Pollination involves the transfer of genetic information between plants through pollen and it is required for the sexual reproductions of plants. Pollination is required for the production of a wide range of crops including fruits (Klein *et al.,* 2007).

In the last decades, the provision of the pollination service by and managed pollinators has shown a gradual but steady decline. Causes for this decline include the general intensification of agriculture, the use of monocultures, parasites and diseases, pesticides use, urbanization, and reductions in the availability of natural ecosystem nearby fields as a resting, foraging or nesting area for wild pollinators (Biesmeijer *et al*., 2006). Although the loss of pollination services has, to date, been confined to increase our understanding of pollination as a critical element in the world's food supply, and to raise the attention given to maintain pollination services in agricultural management (Klein *et al*., 2007).

One of the approaches available to raise the interest and sustainable use of pollution services is through the economic valuation of pollination. Because pollination services, in particular those provided by wild insects, their value may be insufficiently considered in decision making processes. Consequently, there is a need to review potential valuation methods and analyze the current understanding of the value of pollination service. The way in which pollination service generates economic value is scale dependent. At the local scale, the service supports farmer income, whereas the national scale the service is important for ensuring apple supply. At these scales, the consumers and producers surpluses of the service vary, and different valuation methods need to be considered (Diaz *et al*., 2007).

Apple plant is type of tree that can not do a self. Apple flowers depend on insect pollinators; studies about pollination system have increased recently because of the decline. In most of those studies have concerned to have advantages of the provision of pollination services by suite of unmanaged pollinators (Asmuni, 2012). The objective of this study is determining the daily and seasonal variation of insect pollinator visiting the apple tree and refuge block in apple crop Batu, East Java.

Materials and methods

This study was conducted on June to December 2012 in Bumiaji Batu (8°05'S, 112°80'E, 950 m in altitude). In each study site, samplings were established based on visual observation. To calculate insect visitor abundance per number of open flowers, five observations were established per field. Aal five trees in each field were observed for observation perods throughout the day, (0700-08.15; 09.00-10.15; 12.00-13.15; and 15.00-16.15). The sampling efforts were repeated for times in each seasonal flowering phenology.

Observations of refuge block visitors were made by walking around the trees and recording all insect families and abundance during a 15-min period. When species identity was not determined at the time of observation, specimens were collected and taken back to the laboratory for identification. The insect collections from each sampling unit were sorted and identified into families based in standard identification (Borror *et al*., 1989). This combination plants refuge block was AB (*Ageratum conyzoides* and *Bidens pilosa*), AC (*Ageratum conyzoides* and *Campsicum annuum*), BC (*Bidens pilosa* and *Campsicum annuum*), ABC (*Ageratum conyzoides, Bidens pilosa* and *Campsicum annuum*).

The differences in the abundance and diversity were analyzed by using general linear model analyzis of variance (ANNOVA), seasonal flowering phenology (flowering season and fruiting season) and time (observation periods) as between-subject factors and sampling dates as a within-subject factor.

Community composition of insect pollinators showed by Importance Value Index (IVI) which calculated by adding relative abundance and relative frequency. Species diversity was determined based on Shannon-Wiener Index (Krebs, 2001).

$$H = - \sum_{i} Pi.^{2} \log Pi$$

The Pi is the proportion of the *i* species in the total sample.

Communities similarity determined by Morisita Index (Krebs, 2001).

$$C_H = \frac{2. \sum X_{ij} . X_{ik}}{[(\sum X^2_{ij} / N^2_j) + (\sum X^2_{ik} / N^2_k)] N_j . N_k}$$

Where, C_H =Morisita Index, X_{ij}, X_{ik} = number of species *i* in community *j* and *k*, N_j = number of species in community *j*, N_k = number of species in community *k*. The Morisita Index range from a value of 0 where there is no species overlap between the communities, to value of 1 when exactly the same species are found in both communities. All of data were tabulated and compiled by using Microsoft Excel 2007 and analyzed by PAST Program. The flower visitor compositions in all locations were compared by using Bray-Curtis. Applied to analyze the relationship between the abundance of family and environmental variables (location, number of flower of fruit (resource abundance), phenology, period, temperature, humidity, and light intensity).

Results and discussion

There were 403 individuals observed visually in apple crop Batu, East Java. Overall the sample insect showed that apple flowers were visited by 234 individuals and 14 families of insects belonging to 4 orders, while apple fruits were visited by 169 individuals and 13 families of insect belonging to 4 orders (Table 1.). The result on table 1. showed pollination insect (*) and non-pollination insect.

Table 1. Mean of dominant groups of insect visitors in apple crop Bumiaji village.

Orders	Families / Species	Diversity		Total
		Flowers	Fruits	
Diptera	Syriphidae*	32	32	64
	Tachinidae	14	13	27
	Megachylidae*	17	0	17
Hymenoptera	Apidae*	80	22	102
	*Allagapta oblique**	15	1	16
	Sphecidae*	33	0	33
	Copestylum sp.*	10	3	13
	Vespidae*	7	1	8
	Formicidae	0	71	71
Lepidoptera	*Catopsilia pyranthe**	1	3	4
	Delias sp.*	7	2	9
	*Hypolimnas bolina**	6	3	9
	Chrysomelidae	1	3	4
	Noctuidade*	4	0	4
	Borbo sp.*	7	7	14
Coleoptera	Coccinellidae	0	8	8
	Total	234	169	403

This study showed that the abundance of insect visitors of apple tree was highest in apple flowers. Importance Value Index (IVI) indicates the influence of species against their community (Osnas, 2010). The result showed that two phase apple crop there were varied composition of insect pollination communities which dominated by Formicidae, *Apis melifera,* Syrphidae, and Sphecidae (Fig.1.). This result was supported by the present study Asmuni (2012). *Apis melifera* was dominat in apple flowers, so their habitat (flowers and fruits apple) need to conserved for to support their life and to increase apple production (Fig. 2.).

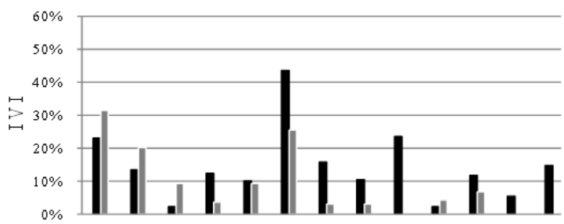

Fig. 1. Variation of insect pollination community composition in apple crop in Batu.

It indicated that communities equilibrium in environment was still good. However, it is necessary to increase ecosystem diversity quality in all phase to increase their ecological services too. The higher diversity index related with the better complexity of interaction among species, so it may contribute to equilibrium community and environment.

One of biotic factor that influence pollination insect diversity is vvegetation structure. Flowers phase has the higher variation of vegetation structure than the fruits phase. This area is dominated by many apple flowers, which play role as pollination insect shelter, habitat, food resource. This result as well as present study increased apple production, open canopy and pesticides impact on it bringing out high pollination insect diversity.

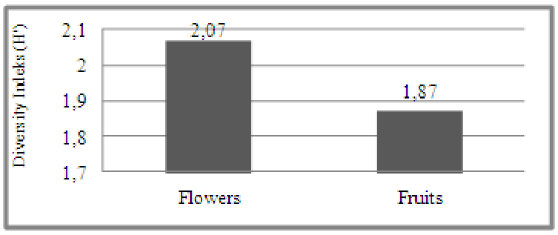

Fig. 2. Diversity index of pollination insect in apple crops Batu, East Java.

The important roles of vegetation stuctures is not only influence pollination insect diversity in apple crop, but also pollination insect communities similarity index between flowers phase and fruits phase. The pollination insects communities similarity index based on Morisita Index in both area was high (Fig.4.).

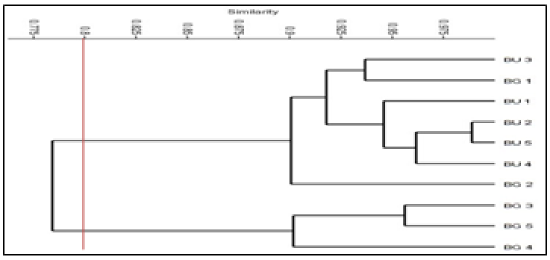

Fig. 3. Dendrogram of pollination insect community's similarity in flowers and fruits apple orchard.

Pollination insect abundance in all phase was variated based on temporal spread, with rrelative abundance reached from 0.2 to 7 % which observed at 09.00-10.00 a.m (Fig.5.). The pollination insect activity predicted start from 9-11 p.m and influenced by light and observation so their abundance decrease along the time. Besides that, it is the best time to produce nectar in great volume and precise sugar concentration for butterfly's requirement. This condition indicate that variation of quantity and quality of nectar production was influenced by weather and time (Davies, 2008).

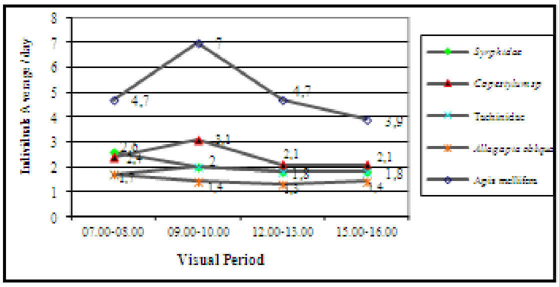

Fig. 4. Relative abundance based on temporal in apple flowers.

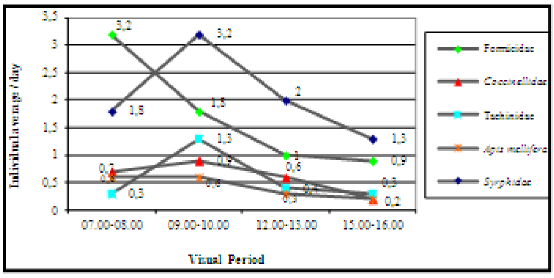

Fig. 5. Relative abundance based on temporal in fruits apple.

Conclusions

The result showed that pollination insect composition in flowers and fruits apple was dominated by Formicidae, *Apis melifera,* Syrphidae, and Sphecidae. The diversity index of all sites showed moderate rank, indicated that communities equilibrium in environmental was still good. In this case, apple flowers has the highest of diversity index, it was about 2.07. Apple flowers have high similarity index based on Morisita Index. The highest abundance of butterflies was observed at 07.00-10.00 a.m. *Apis melifera* has temporal spread all.

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