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ARTHROPOD DIVERSITY LOSS DUE TO MONOCULTURE PRACTICE IN SOUTH LAMPUNG, INDONESIA

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ABSTRACT

It has been widely known that animal biodiversity is higher in 'more natural' environment than agricultural system. Arthropod is one of phyla in animalia kingdom which member includes 90% of identifiable animal species and their diversity can act as bioindicator of environment health. The objective of this study is to compare arthropod diversity in mixed plantation, pasture, and monoculture plantation in South Lampung, Indonesia. Forty pitfall traps were set at 1 m interval in each area. Mixed plantation has the highest diversity index and the lowest dominance. Our result suggested that land-use change from natural environment, which is reflected by mixed plantation, into pasture and monoculture plantation has reduced arthropod diversity in South Lampung.

Key words: mixed plantation, oil palm, pasture, Shannon's diversity index.

INTRODUCTION

It has been widely known that animal biodiversity is higher in 'more natural' environment than agricultural system (Andow 2011, Fahrig et al. 2011, Stein et al. 2014). Undisturbed habitat provides available niche, refuges, and divergent adaptation for animal living in that area (Stein et al. 2014). Consequently, land-use change from natural forest into agricultural system or urban area causes tremendous biodiversity loss (Vitousek et al. 1997, McKinney 2008, Wilcove et al. 2013).

Arthropod is one of phyla in animalia kingdom which member includes 90% of identifiable animal species (Moore 2006) and their diversity can act as bioindicator of environment health. That is due to their short generation time, high sensitivity to environmental change, and important role in ecosystem (Maleque et al. 2009, Straalen 1998). Their live is hinged on producers acting as resource and they cannot maintain their diversity in disturbed area (Haddad et al. 2009).

This study analyses the arthropod diversity in mixed plantation, pasture, and monoculture oil palm plantation in South Lampung, Indonesia. Mixed plantation had partial shrub cover and reflects the most undisturbed area among the three. Hence, it is predicted that the decreasing plantation diversity from mixed plantation into pasture and monoculture oil palm plantation will reduce arthropod diversity (Siemann et al. 1998, Symstad et al. 2000, Wilby et al. 2006, Maleque et al. 2009). Consequently, mixed plantation should have the highest arthropod diversity. The objective of this study is to compare arthropod diversity in mixed plantation, pasture, and monoculture plantation in South Lampung, Indonesia.

MATERIAL AND METHODS

1. Study sites

Sampling was conducted between early July and the end of August 2018 in

the dry season in South Lampung, Indonesia. This area has a tropical climate. Arthropods were sampled from three areas: mixed plantation in Panjang (5°29'19.7"S 105°19'40.0"E), pasture (5°19'52.36"S 105°20'32.11"E), and monoculture oil palm plantation in Jati Agung (5°19'50.64"S 105°20'29.44"E). Mixed plantation had mean soil temperature of 30.2 °C. This area had partial shrub cover and consisted of banana plantation (*Musa domestica*), tepus (*Elateriospermum tapos*), sugar palm (*Arenga pinnata*), Java ginger (*Curcuma zanthorrhiza*), grasses, and bushes. Meanwhile, pasture had mean soil temperature of 54.4 °C and was dominated by grasses. The monoculture plantation had mean soil temperature of 31.2 °C and was dominated by oil palm (*Elais guinensis*).

2. Arthropod extraction

Arthropods were extracted by setting pitfall traps. Forty pitfall traps (volume = 250 ml, diameter = 6.5 cm) were set at 1 m interval in each area. The traps were filled with 60 ml of ethanol 70% and a drop of acetic acid to kill the trapped arthropods. Traps were open for a night.

3. Arthropod analysis

The extracted arthropods were identified up to order or family using criterion by Brusca & Brusca 1990 and Borror et al. 1996. We used Shannon's diversity index (H') and Simpson's dominance (D) to assess arthropod diversity and dominance. The indices are defined as:

$$H' = - \sum pi \ln pi$$

$$D = \sum pi^2$$

where *pi* is the proportion of individuals of the i^{th} species (amount of i^{th} species / total number of arthropods) (Magurran 1998).

RESULTS

The result showed that mixed plantation has the highest diversity index and the lowest dominance (Table 1). Meanwhile, pasture and monoculture plantation have similar diversity index and dominance.

Ants are the most abundant arthropod caught in the three areas. Ant (black) 2 and *Collembola* was mostly caught in pasture. Mantidflies was mostly caught in oil palm monoculture. Meanwhile, mixed plantation consisted of the most unique species, namely: ant (black) 3, diplura (red), fairyfly, two species of larvae, two species of mites, spider (red), two species of web-spinners.

Table 1. Arthropods abundance and diversity in pasture, oil palm monoculture, and mixed plantation.

Morphospecies	Family	Order	Class	Number of individual from each area		
				Mixed plantation	Pasture	Oil palm monoculture
Ant (black) 1	Formicidae	Hymenoptera	Insecta	16	17	43
Ant (black) 2	Formicidae	Hymenoptera	Insecta	24	118	23
Ant (black) 3	Formicidae	Hymenoptera	Insecta	12	0	0
Ant (red) 1	Formicidae	Hymenoptera	Insecta	49	0	35
Ant (red) 2	Formicidae	Hymenoptera	Insecta	69	82	68
Beetle (black)	Cerambycidae	Coleoptera	Insecta	0	2	2
Beetle (brown)	Cerambycidae	Coleoptera	Insecta	11	0	1
Centipede	Geophilidae	Geophilomorpha	Chilopoda	0	1	0
Collembola	Tomoceridae	Entomobryomorpha	Collembola	18	73	35
Collembola 2	Isotomidae	Entomobryomorpha	Collembola	1	1	0
Cricket	Gryllidae	Orthoptera	Insecta	5	27	8

Damselfly	Protoneuridae	Odonata	Insecta	0	1	1
Diplura (red)	Parajapygidae	Dicellurata	Insecta	2	0	0
Diplura (white)	Campodeidae	Rabdhura	Insecta	0	2	0
Earwig	Anisolabididae	Dermaptera	Insecta	17	0	2
Fairyfly	Mymaridae	Hymenoptera	Insecta	5	0	0
Grasshopper	Acrididae	Orthoptera	Insecta	1	1	0
Larva (brown) 1	?	Lepidoptera	Insecta	1	0	0
Larva (brown) 2	?	Lepidoptera	Insecta	0	1	0
Larva (red)	?	Lepidoptera	Insecta	1	0	0
Mantidflies	Mantispidae	Neuroptera	Insecta	6	2	147
Mayfly	Beatidae	Ephemeroptera	Insecta	0	0	1
Micro bee flies	Mythicomyiidae	Diptera	Insecta	0	0	1
Micro bee flies	Mythicomyiidae	Diptera	Insecta	0	7	0
Millipede	Spirobolidae	Diplopoda	Spirobolida	0	1	2
Mite	Acaridae	Astigmata	Arachnida	0	1	0
Mite 2	Histiostomatidae	Astigmata	Arachnida	1	3	1
Mite 3	Cunaxidae	Trombidiformes	Arachnida	0	1	0
Mite 4	Cunaxidae	Trombidiformes	Arachnida	1	0	0
Mite 5	Cunaxidae	Trombidiformes	Arachnida	4	0	0
Mosquito	Culicidae	Diptera	Insecta	0	0	1
Pill bug	Janiridae	Isopoda	Malacostraca	0	0	3
Rove beetle	Staphylinidae	Colepotera	Insecta	1	1	0
Spider (black)	Araneadae	Araneae	Arachnida	1	3	0
Spider (brown) 1	Araneadae	Araneae	Arachnida	5	19	6
Spider (brown) 2	Araneadae	Araneae	Arachnida	0	1	0
Spider (red)	Araneadae	Araneae	Arachnida	2	0	0
Spider (white)	Araneadae	Araneae	Arachnida	0	0	1
Web-spinner (black)	Oligotomidae	Embiidina	Insecta	0	1	1
Web-spinner (brown)	Oligotomidae	Embiidina	Insecta	2	0	0
Web-spinner (red)	Teratembiidae	Embiidina	Insecta	2	0	0
TOTAL				257	366	382
SPECIES RICHNESS				25	23	20
Shannon's diversity index (H')				2.337	1.927	1.903
Simpson's dominance (D)				0.137	0.205	0.214

Here, we showed that arthropod diversity decreases in more disturbed habitat. Herbivore species richness is increased along with the increase of plant species abundance as plantation acts as resource for arthropods (Siemann et al. 1998, Donoso et al. 2010). Consequently, the predator and parasites abundance should be higher in that area (Andow 1991, Sieman et al. 1998). They can feed on greater variety of herbivore, maintain reproducing population, utilize hosts, and exploit the herbivores (Siemann et al. 1998). Hence, our result showed that arthropod can be used as bioindicator in South Lampung.

Mixed plantation consists of more arthropod species than pasture and oil palm plantation. It was not surprising that mixed plantation had the highest species richness since it had the most environmental heterogeneity which includes land-cover, vegetation, and microhabitat (Stein et al. 2014). Pasture and oil palm plantation has similar diversity index and dominance. However, pasture has higher species richness and we thought it was due to higher more different natural cover type (Fahrig et al. 2011).

Ants are the most arthropod caught in this study. This result is agreed with the previous study mentioned that ants are considered as the most abundant predator on the ground, lower vegetational (Floren et al 2002), and tropical rainforest canopy (Wilson 1987, Vasconcelos 1999, Davidson et al 2003). The occurrence of these ants are concomitant with the

increasing of tree species (Donoso et al 2010) as numerous arboreal ants taxa forage extensively for plants and insect exudate (Davidson et al 2003).

Our result suggested that land-use change from natural environment, which is reflected by mixed plantation, into pasture and monoculture plantation has reduced arthropod diversity in South Lampung. This result is in agreement with many previous studies (Perfecto et al. 1997, Stamps & Linit 1998, Haddad et al. 2009, Stein et al. 2014) and can be generalized into larger scale. Hence, the development of South Lampung should refer to "Rencana Tata Ruang Wilayah" published by "BAPPEDA" to conserve animal biodiversity.

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