

Insect Diversity in Mangrove Communities in Small Islands of Wakatobi National Park, Southeast Sulawesi, Indonesia

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ABSTRACT

Insects play very important role in mangrove community as pollinators, predators, as well as prey. They also play role in the decomposition process, cycles of matter and energy flow. The diversity of insects is related to the diversity of the mangrove community, directly or indirectly. This study reveals the diversity of insects on mangrove communities in small islands national park Wakatobi, Southeast Sulawesi, Indonesia. We used line transects toward the shoreline crossing mangrove formation, up to mangrove formation that bordering with land plants. In each transect, several 10 x 10 m observations plots were laid according to the width of the mangrove communities. Insects were collected using insect nets, pitfall traps and leaf litter samples. Shannon Weiner index of diversity (H) was computed. The results showed variation in number of insects between islands. At Keledupa Island, there are 7 orders of insects that include 21 families and 39 genera. At Lentea Island there are 5 orders, including 15 families and 28 genera. At Hoga island, there were only 4 orders, 8 families, and 13 genera. Among them, there were 19 species of arboreal insects, 21 species of soil insects and 5 species of aquatic insects. The dominant insects were Hymenoptera, with 11 species. The diversity index of insects was highest in Kaledupa Island (3.481), followed by Lentae Island (3.252), and Hoga island (2.44). The other significant finding of the study is that the saline water insect both Hemiptera and Diptera (brine flies) were recorded for the first time from Indonesia in the mangrove community of Kaledupa and Lentea Island.

Key Words: Mangrove; Small Islands; Arboreal Insect; Ground Insect; Aquatic Insect; Diversity Index; Wakatobi National Park.

INTRODUCTION

Diversity and conservation of insects are very important in the ecosystem, although insects are non-charismatic and little-studied organism (Hughes et al. 2000). Insects inhabit almost all habitats in the ecosystems; water, soil, aerial, arboreal, etc. The role of insects is undoubtedly

very important for the sustainability of life. Insects act as pollinators, predator once prey. Directly or indirectly insect role in decomposition, material cycles and energy exchange. Some of insect also play role as indicator for environment health (Scudder 2009). There are positive correlation between insect diversity and community diversity (Adeduntan et al. 2013).

Wakatobi National Park is a conservation area; is composed of several small islands. Wakatobi is an acronym of the three islands in the name of the region, namely: Wangi-Wangi, Tomia and Kaledupa Island. There are several other small islands in this area, namely Derawa, Lentea and Hoga. Compared with other places however, our knowledge of the flora and fauna of mangrove community in Wakatobi area are still very limited and poorly documented. On the other hand, the data base is needed for the continuation of the community in the life and functionality. Jamili (2010) explained that in Kaledupa, Lentea and Hoga islands there are some true mangrove species, ie there are 6 species mangrove in Kaledupa namely: *Rhizophora mucronata*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, *Sonneratia alba*, *Avicennia marina* and *Lumnitera littorea*; there are 4 species in Lentea island, namely: *R. mucronata*, *R. granatum*, *S. alba*, and *A. marina*; and only two in Hoga Island, i.e.: *Osbornia octodonta*, and *Pemvis aciduta*. Furthermore, Jamili (2010) explained that earlier research has shown that mangrove ecosystems in small islands of Wakatobi National Park have a diversity of habitats and ecologically unique character of existing mangrove vegetation. The width of the zone of mangrove community in Kaledupa is highest among other islands; reaching 600 m, while on the Lentea island it is only 140 m, and on Hoga island only 80 m (Jamili 2010).

Mangrove conservation is very important for their role in ecosystem. Mangroves occupy the intertidal zone that interacts strongly with aquatic, inshore, upstream and terrestrial ecosystem. Mangrove help support a diverse flora and fauna of marine, freshwater and terrestrial species. Mangrove community plays an important role in maintaining the complexity and affect the diversity and distribution of animals associated with the ecological system (Twilley et al. 1996). Insects play an important part in the mangrove ecological system both as consumer and transporters in the energy flow and material circulation of the system. Insect diversity is the potential biological and ecological index to recognize environmental change and quality of the mangrove ecosystem. Insects are cosmopolitan organisms, with successful life in almost all habitats and have a great role for a community. Some adult insects are beneficial and others detrimental. But from the ecological viewpoint, insects play a large role as pollinators, decomposer, predator, as well as prey. There are several studies on the insect association with mangroves, both on insect herbivores (Murphy 1990,

Kathiresan 2003, Vang et al. 2005, Tokeshi et al. 2007, Nagelker et al. 2008), aquatic insects (Simson, 1976, Cheng et al. 2010), and soil insects, saprophagous, saproxylic (Cogni and Freitas 2002, Cogni et al. 2003, Cannicci et al. 2008, Nagelkerken et al. 2008). Mchenga and Ali (2013) reported, that there are 103 species of insects in the mangroves on Zinzibar Island, dominated with 27 species of hymenopteran. Currently, only few studies on mangrove fauna have been conducted in the Wakatobi National Park area (Suriana and Jamili 2013). This paper examines the diversity of insects on mangrove communities in Kaledupa, Lentea and Hoga island, both existing on above the surface of the ground (arboreal or aerial), as well as in a puddle of water under the mangrove stands.

MATERIAL AND METHODS

Study sites

The location and methods of research same with was used in previous studies (Suriana and Jamili 2013), namely three small islands in the Wakatobi National Park, Kaledupa, Lentea and Hoga Island. Kaledupa Island is Marine Protection Zone, lie on 5 ° 20' - 5 ° 40' south latitude and 123 ° 40' - 124 ° 00' east longitude. On this island the mangrove community thickness is 600 m, more than mangrove community in two another islands. Mangrove community in Lentea Island thickness is 140 m. Hoga is Marine Research Station, lie on 05°27'323'' south latitude and 123°46'195'' east longitude. Mangrove community thickness only 80 m (Figure 1). The location decision based on the results of previous studies, showed that the mangrove community in these three islands have different habitat (habitat in Kaledupa is mud, while rock and sand in Lentea and Hoga islands clearly rock) so there was different ecological character of mangrove vegetation (Jamili 2010).

At each study site (Kaledupa, Lentea and Hoga Island) is made the line transect toward the shoreline crossing mangrove community, up to mangrove formation that bordering with land plants. In each transect 10 x 10 m observation plots were laid continuously on the left and the right side along the transect line. The number of plots on each transect varied depending on the thickness of the mangrove community on each island.

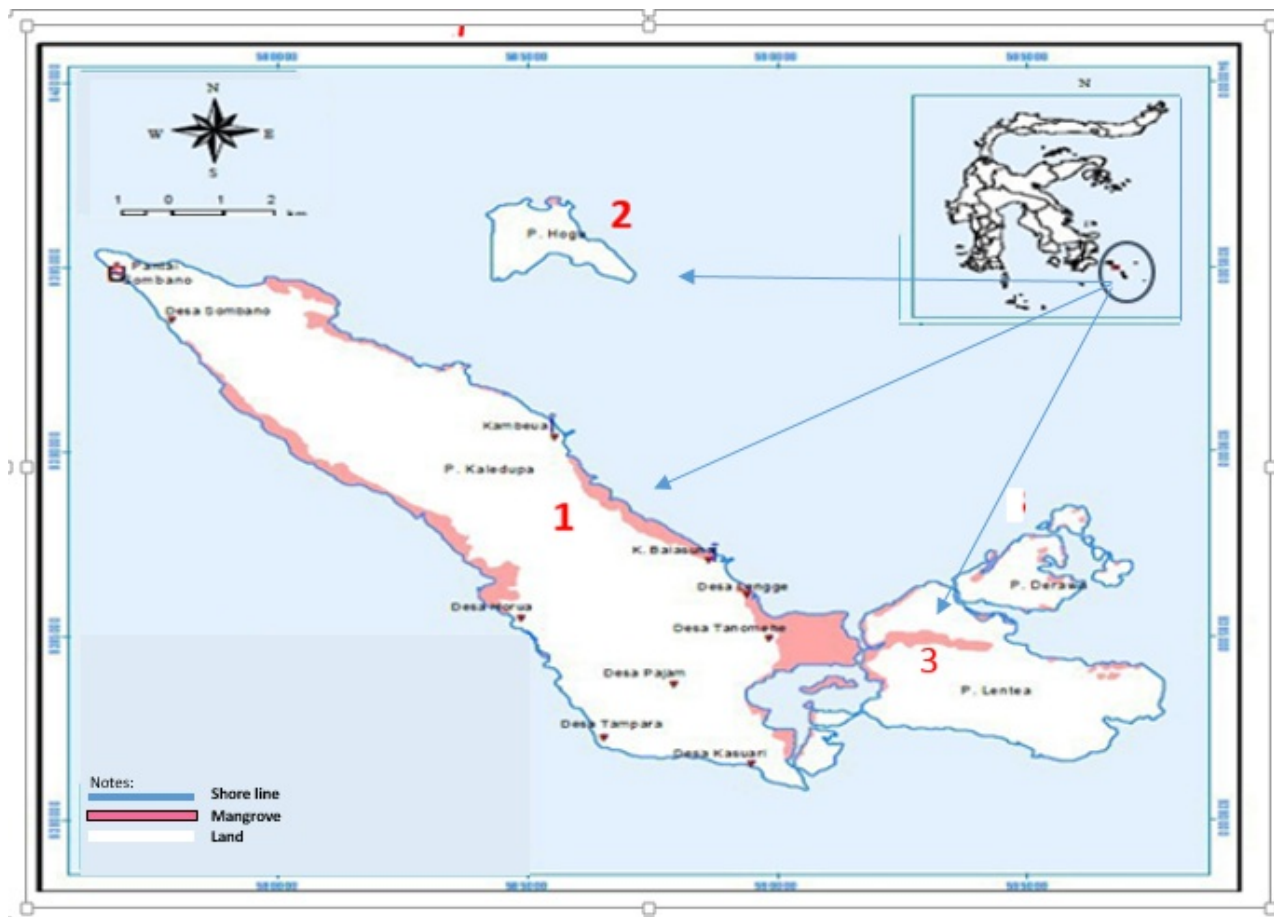


Figure 1. Map of the study sites; circle is small islands of Southeast Sulawesi Island.

Data Collection and Insect Identification

Collecting specimens of insects, using insect nets, pitfall traps, and leaf litter samples. Insect nets are used, there are two sizes, namely net with diameter 38 cm, length 60 cm, and the handle length 175 cm, to capture aerial insects at the around stands of mangrove, and insect nets with 15 cm in diameter, 25 cm in length and handles 45 cm, to catch water insects that trapped at the pace a small puddle when water at low tide. Pitfalls made from plastic tube diameter 7 cm, and 12 cm height. The pitfalls traps added $\frac{3}{4}$, 70% alcohol, 3 drops of glycerin to avoid evaporation excess. These traps are buried in the observation plot, when the tide is low. Traps were immediately taken back before the tides increase (effective within ± 3.5 hours).

In Hoga island insect collection from ground using leaf litter samples, because at this island, the situation is very rocky. Specimen obtained was placed in a bottle

that contained 70% alcohol and labelled with the location of the observation. Lepidoptera were stretched carefully and then stored in an envelope. Insect collection was then sorted by common traits for identification in the Zoology Laboratory of Halu Oleo University, Kendari, Southeast Sulawesi. Observation of small insects were made using Leica EZ4HD stereo microscope and Nikon coolpix G80 camera.

The main reference for the identification of insects was Boror et al. (1996) while the reference point on the lower taxa was based on Buck et al. (2008) for the identification of Vespidae; Simson (1976) for marine Diptera; Couri et al. (2006), Nihel and Carvalho (2009) for Muscidae (Diptera); Anderson and Polhemus (1976), Stearn and Krieger (2008) for Hemiptera, Lawrence and Britton (1994), and Hava (2004) for Coleoptera, Packer et al. (2007), for the Apidae, Bolton (1994) and Hashimoto (2011), for Formicidae (Hymenoptera).

Table 1. Species Diversity, Dominance, Richness index of Insect Mangrove in Kaledupa, Lentea and Hoga Island, Southeast Sulawesi.

No.	Species (Order: Family)	H'(ni) in each Island			Habitat
		Kaledupa	Lentea	Hoga	
1.	<i>Parcoblatta</i> sp. (Blattida: Blattidea)	-0.106(49)	-	-	Ground
2.	<i>Chrisomelli</i> sp. (Coleoptera: Crisomellida)	-0.041 (14)	-0.091 (28)	-0.030 (28)	Arboreal
3.	<i>Scapidium</i> sp. (Coleoptera: Staphylinidae)	-0.070 (28)	-0.122 (42)	-0.083 (77)	Ground
4.	<i>Dendoctuonus</i> sp. (Coleoptera: Scotylidae)	-0.106 (49)	-0.107 (35)	-	Ground
5.	<i>Trimiomelba</i> sp. (Coleoptera: Pselapsidae)	-0.095 (42)	-0.107 (35)	-	Ground
6.	<i>Attagenus</i> sp. (Coleoptera: Dermestidae)	-0.083 (35)	-0.091 (28)	-	Ground
7.	<i>Melanoptalma</i> sp. (Coleoptera: Latridae)	-0.024 (7)	-	-	Ground
8.	<i>Odobrevia</i> sp. (Coleoptera: Cerabidae)	-	-0.136 (49)	-0.128 (119)	Ground
9.	<i>Ephidra riparia</i> (Diptera: Ephidridae)	-0.126 (63)	-0.136 (49)	-	Mud
10.	<i>Dimorfia cognate</i> (Diptera: Muscidae)	-0.083 (35)	-0.074 (21)	-	Arboreal
11.	<i>Musca</i> sp. (Diptera: Muscidae)	-0.095 (42)	-0.122 (42)	-0.053 (49)	Aerial
12.	<i>Neomyia</i> sp. (Diptera: Muscidae)	-0.056 (21)	-	-	Aerial
13.	<i>Musca domestica</i> (Diptera: Muscidae)	-0.095 (42)	-0.091 (28)	-	Aerial
14.	<i>Culex</i> sp. (Diptera: Culicidae)	-0.162 (91)	-0.136 (49)	-	Aerial
15.	<i>Trepobates</i> sp1. (Hemiptera: Gerridae)	-0.095 (42)	-0.107 (35)	-	Aquatic
16.	<i>Trepobates</i> sp 2. (Hemiptera: Gerridae)	-0.041 (14)	-0.074 (21)	-	Aquatic
17.	<i>Gerris</i> sp. (Hemiptera: Gerridae)	-0.083 (35)	-0.122 (42)	-	Aquatic
18.	<i>Microvelia</i> sp. (Hemiptera: Microvelidae)	-0.041 (14)	-0.074 (21)	-	Aquatic
19.	<i>Limnogaonus</i> sp. (Hemiptera: Staphylinidae)	-0.070 (28)	-	-	Aquatic
20.	<i>Rophalidia marginata</i> (Hymenoptera: Vespidae)	-0.070 (28)	-	-0.075 (70)	Arboreal
21.	<i>Eumenes</i> sp1. (Hymenoptera: Vespidae)	-0.056 (21)	-0.091 (28)	-0.068 (63)	Arboreal
22.	<i>Eumenes</i> sp2. (Hymenoptera: Vespidae)	-0.056 (21)	-0.091 (28)	-0.083 (77)	Arboreal
23.	<i>Polistes</i> sp. (Hymenoptera: Vespidae)	-0.070 (28)	-0.122 (42)	-	Arboreal
24.	<i>Trigona</i> sp. (Hymenoptera: Apidae)	-0.106 (49)	-0.149 (56)	-0.083 (77)	Arboreal
25.	<i>Bombus</i> sp. (Hymenoptera: Bombyidae)	-	-	-0.023 (21)	Aerial
26.	<i>Oecophyla smaragdina</i> (Hymenoptera: Formicidae)	-0.185 (112)	-0.202 (91)	-0.173 (161)	Arboreal
27.	<i>Componatus</i> sp. (Hymenoptera: Formicidae)	-0.106 (49)	-0.122 (42)	-	Arboreal
28.	<i>Iridomyrmex</i> sp. (Hymenoptera: Formicidae)	-0.126 (63)	-0.107 (35)	-0.098 (91)	Ground
29.	<i>Crematogaster</i> sp. (Hymenoptera: Formicidae)	-0.145 (77)	-0.149 (56)	-	Ground
30.	<i>Aenictus</i> sp. (Hymenoptera: Formicidae)	-0.070 (28)	-0.074 (21)	-	Arboreal
31.	<i>Achantomyrmex</i> sp. (Hymenoptera: Formicidae)	-0.083 (35)	-0.161 (63)	-	Ground
32.	<i>Tapinoma</i> sp. (Hymenoptera: Formicidae)	-0.116 (56)	-0.136 (49)	-	Ground
33.	<i>Centromyrmex</i> sp. (Hymenoptera: Formicidae)	-0.116 (56)	-	-	Ground
34.	<i>Hypoponera</i> sp. (Hymenoptera: Formicidae)	-0.070 (28)	-	-	Ground
35.	<i>Tetraopnera</i> sp. (Hymenoptera: Formicidae)	-0.106 (49)	-	-	Ground
36.	<i>Plusia</i> sp. (Lepidoptera: Noctuidae)	-0.218 (147)	-0.183 (77)	-	Arboreal
37.	<i>Artona</i> sp. (Lepidoptera: Zygenidae)	-0.041 (14)	-	-	Aerial
38.	<i>Neptisnata nandina</i> (Lepidoptera: Nymphalidae)	-0.056 (21)	-	-	Arboreal
39.	<i>Neptis</i> sp. (Lepidoptera: Nymphalidae)	-	-0.074 (21)	-0.045 (42)	Arboreal
40.	<i>Eurema</i> sp. (Lepidoptera: Peridae)	-0.070 (28)	-	-	Arboreal
41.	<i>Caetophilus</i> sp1. (Orthoptera: Gryllacrididae)	-0.056 (21)	-	-	Ground
42.	<i>Caetophilus</i> sp2. (Orthoptera: Gryllacrididae)	-0.083 (35)	-	-	Ground
	Diversity Index (H')	3.481	3.532	2.444	
	Dominance Index (D)	0.037	0.042	0.10	
	Richness Index ($R1$)	5.143	3.839	1.755	

Data analysis

Data were analysed separately for each island. The parameters observed, namely: the insect richness, used the formula proposed by Margalef (Ludwig and Reynolds 1988):

$$R = (S - 1) / \ln N$$

where,

R = Species richness index, S= Number of species, N = Total number of individual species, Ln= Logarithm natural.

Diversity index was calculated using the formula by Ludwig and Reynold (1988):

$$H' = - \sum_{i=1}^s [(ni / N) \ln(ni / N)]$$

where, H' = Species diversity, ni = Number of species, and N = Total number of all species

RESULTS AND DISCUSSION

The record of the collected species of this study available on request and all specimens were deposited at the Laboratory of Zoology, Department of Biology, Faculty of Mathematics and Natural Science, Halu Oleo University, Kendari, Southeast Sulawesi, Indonesia.

Insect Diversity at Kaledupa Island Mangrove

Collection of insects on mangrove communities on the island is obtained on the stand: *Rhizophora mucronata*, *Bruguiera gymnorhiza*, *Ceriops tagal*, *Sonneratia alba*, *Avicennia marina* and *Lumnitera littorea*. Retrieved 8 order consist of 21 family 39 genera (species). The ant (Hymenoptera: Formicidae) found on both ground and arboreal. The aerial insect consist of butterfly and moth (Lepidoptera); bee, wasp (Hymenoptera); flies and mosquito (Diptera); leaf beetle (Coleoptera). Ground insect dominated of beetle (Coleoptera), two species of cockroach (Orthoptera) and one species of cricket (Blattidae). Saline water insect consist of Hemiptera and Diptera (brine flies). Diversity, richness and dominance index habitat of each insects are presented in Table 1.

Table 1 showed that the diversity of species was higher in the order Hymenoptera, which was 15 of the 39 species, or 38.5%. Of these, the dominant family Formicidae (ant) as many as 10 species. Ants are found

most of the ants are nesting on the floor/ground surface in mangrove stands, except *Oecophylasmargadina* and *Componatus* sp. nesting on the mangrove tree. Five other species of Hymenoptera are wasps and bee (Vespidae and Apidae families). Insects of the latter aspollinator insect. While most of the wasp and other insect are predatory.

The next largest was Coleoptera and Diptera orders, consist of five species. Coleoptera found a ground, except *Chrysomellasp* that are arboreal. Mucidae dominant of Diptera order, consist of four species. The latest is Culicidae (*Culex* sp) and Ephydriidae (*Ephidria riparia*); brine flies.

The most of Lepidoptera that found in this study is butterflies, while *Plusiasp* is moth. Insects with a small number is the order Orthoptera with 2 species, and Blattida (*Parcoblatta* sp). All of these insects are ground. From those data appears that dominant insect habit in ground.

Insect Diversity at Lentea Island Mangrove

Collection of insects on mangrove communities on the island is obtained on the stand: *Rhizophoramucronata*, *R. granatum*, *S. alba*, and *A. marina*. Retrieved 5 insect orders that consist of 15 families with 28 genera (species). Similar with Kaledupa Island, dominant insect in the mangrove community on these island is Hymenoptera, with ant that found both arboreal and ground. Index of diversity, richness and dominance as well as insect habitats are presented in Table 1.

Based on Table 1, the insects most commonly found on the Lentea Island is the Hymenoptera order (39.3% of the total 28 species). This insect is dominated by Formicidae family (ants), the rest is Vesvidae and Apidae family (wasp and bee). Coleoptera, Hemiptera and Diptera were found in mangrove Kaledupa also found on the Lentea Island. Aquatic insects were also found in Lentea Island mangrove community.

Insect Diversity at Hoga Island Mangrove

Collection of insects on mangrove communities on these island is obtained on the *Osborniaoctodonta* and *Phemvisaciduta* stand. Retrieved 4 orders of insects that includes 8 family, 13 genera (species). Dominant insect is Hymenoptera, both aerial, arboreal and ground. The rest is Coleoptera, Diptera and Lepidoptera. Index of diversity, richness and dominance as well as insect habitats are presented in Table 1.

Compared with the previous two islands, insect diversity in Hoga Island smaller, only 4 of the order. Nevertheless there is a tendency that the order Hymenoptera always dominate other orders; consists of four species of ants, two species of wasp, bee and bumble bee (*Bombus* sp.). Insects are the least Lepidoptera, only one species of butterfly (*Neptis* sp.). Similarly Kaledupa and Lentea, Coleoptera found on this island is generally a ground insects.

Index of diversity, richness and dominance are also smaller than the same index in the other two islands.

These data explain that the type and thickness of mangrove communities associated with diversity of insects found. It this is the reason for differences in diversity at all three locations compared to the abundance of certain insects are related to the status of mangrove growth. In the mangrove Hoga Island only two types, but when done sampling the flowering mangrove, so that insect pollinators (wasps, bee and bumble bee) is more common.

Abundance of insects in a habitat are closely related to the ecological functions of the insect. Santos et al. (2007), explains that there is a significant correlation between diversity of vegetation with diversity of insects. The ants, for example, some species are found in all locations that observed. This phenomenon relates to the ecological function of those insect. *Oecophyla smaragdina* that build nests on mangrove leaves, ants are predators of insects for *Hypolycaenaerylus*, avoliator mangrove (Tokeshi et al. 2007, Suriana and Jamili 2013). Cogni and Freitas (2002) explains that in his observations on the mangrove in the Forest of Southeast Brazil always find more than one species of ants at the same time and on the same trunk. Plants housing ant colonies were more common in the mangrove than in the sandy forest (Cogni et al. 2003). The existence *Rhopalidiamarginata* and *Tetragona* sp. related to ecological function as a pollinator (Suriana and Jamili 2013), the insect looking mangrove pollen from flowering. That some kind of wasp building a nest on the underside of leaves of mangrove (Santos 2007).

This result is also supported by research conducted by Rahmawati et al. (2005) which shows the diversity of soil insects on the stand of *Cerriopstagal* and *Rhisophora* spp. Unlike other insects. Lepidoptera relatively little is found it is associated with the most existence of insect on mangroves, because the mangrove as habitat for larvae, whereas specimens sampled was adult insect (imago). Imago butterflies and moths usually seek nectar in plants instead of mangrove (Sutrisno 2008).

The value of diversity index in Kaledupa Island was

high compared with other sites. Likewise, the dominance index and the index of species richness. This is consistent with the previous explanation that plant diversity was positively correlated with the diversity of insects. Inversely plant diversity is closely linked to habitat complexity (Santos 2007). Mangrove is a habitat for a wide variety of animals, including insects. Some of insects are found abundantly, and the other in small amounts (Nagelkerken et al. 2008). However, the topography of the three small islands (locations) studies have differences with each other, so that the mangrove community is also different. The fact that the mangrove community in three islands were used as study sites showed dominance of ant species. There are 10 genera (species) of ants, four species were found in all study sites. The ants are unique insects, for those who live on the mangrove trees adapt to these habitats, even doing symbiosis with insects another (Grampurohitand Karkhanis 2013, Nielsen et al. 2005) for the sake of survival there. For those that live in the soil as well as there are some behavioral adaptations that allow the nest containing the larvae and the queen is not compromised when inundated during high tides (Nielsen 1997). It is interesting that in the study, there are 5 species of aquatic insects found, and one species of brine flies on mangrove community in Kaledupa and Lentea islands. These insects have not been reported from the mangrove community in Indonesia. Cheng et al. 2010 explaining that the insect water saline (Hemiptera) act as prey of seabirds. Meanwhile, Samson (1967), Axtell (1967), reported that the mangrove community Dipetera role as predators, as well as for certain animal pests

CONCLUSION

Diversity of insect in three islands are varies. There are 7 of the order of insects that includes 21 family 39 genera in Keledupa Island. There are 5 orders, 15 families with 28 genera, in Lentea Island, and there are 4 orders, 8 families, 13 genera, in Hoga Island. Of these there are 19 species of arboreal insects, 21 species of soil insects and 5 species of aquatic insects. The dominant insect order Hymenoptera is the predominant species namely ant, *Oecophilasmaragdina*. The highest diversity index in Kaledupa (3.48), then Lentae (3.25), and Hoga Island (2.44). The other significant finding of the research is that the saline water both Hemiptera and Diptera (brine flies) has never been a record from Indonesia was found at the mangrove community of Kaledupa and Lentea Island.

ACKNOWLEDGMENTS

Special thanks go to Drs. Simon for his assistance in the field, and Muhsin, Spd, M.Si for his assistance in lab work to make this study a success. The research was financed by the fund Fundamental Research/BOPTN UHO 2014.

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Received 24 March 2015;

Accepted 18 August 2015