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Insect diversity profile of mangrove ecosystem in Menipo Nature Tourism Park, East Amarasi, East Nusa Tenggara

To cite this article: Chatarina Gradict Semiun *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **823** 012050

IOP Conf. Series: Materials Science and Engineering **823** (2020) 012050 doi:10.1088/1757-899X/823/1/012050

Insect diversity profile of mangrove ecosystem in Menipo Nature Tourism Park, East Amarasi, East Nusa Tenggara

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Abstract. Insects are one of the biotic components that make up the mangrove ecosystem. The diversity of insects is believed to be used as one of the bio-indicators of the condition of the mangrove ecosystem. This study aimed at determining the profile of insect diversity in the mangrove ecosystem in Menipo Nature Tourism Park, East Amarasi, East Nusa Tenggara. The study was conducted in February 2018 to June 2018. Insect capture was carried out using the yellow pan trap method. Data analysis was done quantitatively to determine the profile of mangrove insects. The profile of mangrove insect diversity was determined based on species richness index, Shannon-Wienner diversity index, evenness index, and Jaccard similarity index. The results showed that there were 14 species, 11 families, and 5 orders with a total number of 56 individuals in mangrove ecosystem of Menipo Nature Tourism Park. Genetic wealth of mangrove buffer was still relatively low (R1 <3.5). The diversity of mangrove insects was classified as moderate (H '= 1- 3). All mangrove insects had almost the same level of evenness (E <1). The similarity index of mangrove insects in Menipo Nature Tourism Park, East Amarasi ranges from 0.18 to 0.5, meaning that the similarity of mangrove insect species among the three stations was different from each other.

1. Introduction

Indonesia has the largest mangrove and the largest biodiversity in the world. Mangroves are a tidal habitat comprised of salt-tolerant trees and shrubs. Compare to rainforests, mangroves have a mixture of plant types. Sometimes the habitat is called a tidal forest or a mangrove forest to distinguish it from the trees that are also called mangroves [6]. Mangrove forest is a type of forest that grows in tidal areas which are flooded during high tide and free from inundation at low tide with the plant community tolerating salt [10]. Mangrove plants have a special ability to adapt to extreme environmental conditions, such as inundated soil conditions, high salinity and less stable soil conditions [20].

In Indonesia, the area of mangrove forest is reduced, along with the rapid needs of the community, as well as the increasing development in the coastal area. The conservation of mangroves in the coastal area of Menipo Nature Tourism Park is very important because of the ecological and economic functions provided by the mangrove ecosystem. Ecologically mangroves have very important functions i.e. as a food chain in water, as the place where various types of fish, shrimps and mollusks live [10]. In addition, mangrove ecosystem also acts as a protector against waves, serves as sinks for carbon, and provides a nutrient sink [21].

Insects are one of the biotic components that make up the mangrove ecosystem. The study of insect diversity can help in preserving and managing mangroves well and sustainably. Insects, as a component of biodiversity, also have an important role in the food chain as herbivores, carnivores, and detriors [9]. In addition insects also function as a bio-indicator environment [8]. The diversity of insects is believed to be used as one of the bio-indicators of the condition of a mangrove ecosystem. Insect diversity provides a unique response to the level of environmental damage so that it has the potential as an indicator species to detect changes and environmental health [14].

The important role of insects in the ecosystem and the many types of insects that have not been identified become the reason why it is worth doing to examine the profile of insect diversity in the mangrove ecosystem. On the other hand, research on insects is still rarely done especially in the mangrove area; as a result, the information gathered from this field is still limited.

2. Material and Method

2.1 Time and location of the study

This research was conducted in the mangrove area in Menipo Nature Tourism Park (Figure 1). The location for observation was determined based on the type of mangrove stand. Separation and identification of insects were carried out in the Biology Laboratory Widya Mandira Catholic University. The study was conducted in February 2018 until June 2018.

2.2 Materials and tools

The materials used in this study were mangrove stands, insects that were caught by yellow traps, detergent, plastic bags, label papers, and 70% alcohol. The measurement of environmental factors was done by using GPS and air thermometer.

In collecting samples, the tools used were yellow traps, tweezers, plastic bags, rubbers and writing instruments. In identifying insect samples a microscope was used with a magnification of 20 times, and a digital camera (Sony DSC-S730) was used for documentation.

2.3 Description of the study area

Menipo Nature Tourism Park is composed of savanna ecosystems, coastal forests, and mangrove forests [1]. The savanna ecosystem is dominated by *lontar* (*Borassus flabellifer),* acid (*Tamarindus indica*), *kesambi* (*Schleichera oleosa*), and *waru* (*Hibiscus tiliaceus*).

Mangrove forests are dominated by *Rhizophora mucronata*, *Rhizophora stylosa*, *Ceripos tagal*, *Bruguiera conjugate* (*Bruguiera gymnorrhiza* (L.) Lamk) and *Bruguiera exaristata*, and additional components in the form of peanut leaves (*Ipomea pes-caprae*) and rolls (*Spinifex littoreus*). This is in line with the research findings (Table 1). In addition, the people in Enoraen and Pakubaun villages have local wisdom, namely the prohibition on logging of mangroves and the destruction of coral reefs.

Table 1. Geographical condition and types of mangrove trees in the study area

No	Station	Mangrove Species
1	I	*Ceriops tagal; Ceriops decandra; Rhizopora mucronata; Bruguiera gymnorrhiza* (L.) Lamk
2	II	*Ceriops tagal; Ceriops decandra; Rhizopora mucronata*
3	III	*Bruguiera exaristata; Ceriops tagal; Bruguiera gymnorrhiza* (L.) Lamk *; Rhizopora apiculata*

Figure 1. Sampling location

Mangrove plants characteristically range from trees (like species of *Avicennia*), *Rhizophora*, to shrubs (species of *Aegiceras*, *Aegialitis*, *Pemphis*, and *Conocarpus*), to the trunkless palm (*Nypa fruticans*) and ground fern (*Acrostichum*). Further, trees and shrubs vary where they might be columnar and erect (*Pelliciera rhizophorae*, *Bruguiera parviflora*), to spreading, sprawling (*Acanthus spp*., *Scyphiphora hydrophylacea*), and multiple-stemmed (*Ceriops decandra*). Growth form might also vary with in the same species (*Lumnitzera littorea* and *Rhizophora*), having both an erect tree form, and low tangled thicket forms. In general, edge plants (both waterfront and land-ward) have lower limbs and foliage, and their stems are laterally sprawling and sinuous, rather than erect and straight. Some species typically form combined closed canopies (*Avicennia marina*, *Rhizophora apiculata*, *Bruguiera parviflora*, *Bruguiera gymnorhiza*, *Camptostemon schultzii*, *Xylocarpus spp*.), while others are commonly found as under canopy plants beneath the closed canopy (like species of *Aegiceras, Cynometra*, *Acanthus*, *Acrostichum*, and *Ceriops decandra*) [6].

2.4 Work procedures

The line method was used as the sampling plot for data retrieval. At each location one path was created. The path length was 100 m and the width was 10 m with the direction parallel to the coastline. In each lane, a plot of 10 m x 10 m was made with a distance between plots on the lane was 20 m. Each type of stand was made in four plots. Insect capture was done using the yellow pan trap, a yellow tray with a length of 12 cm, a width of 20 cm, and a height of 6 cm. The yellow pan trap was placed in a 10 m × 10 m plot and filled with detergent liquid so that insects trapped would not fly and die. Yellow pan trap was installed for 24 hours started at 06.00 PM. Five pieces of yellow pan trap with a diagonal position were placed in each plot. Insect capture by using yellow pan trap was carried out for two days at each observation area. The measurement of insects' environmental factors was done by measuring ecological temperature. Temperature was measured using an air thermometer by placing the tool in the middle of the sampling plot.

The captured insects were separated and identified based on morphospecies in the Biology Laboratory Widya Mandira Catholic University. Insects' identification process was carried out by using an identification source in the form of an insectarium and identification guide books that already exist. The books used in insect identification are: A Field Guide to Insects in 1970, by Donald J. Borror and Richard E. White; Introduction of Insect Lessons, in 1996, by Donald J. Borror, Charles A. Triplehorn, and Norman F. Johnson translated by Partosoedjono; and Hymenoptera of the World: An

Identification Guide to Families, 1993, by Henry Goulet and John T. Huber.

The data obtained in this study were variable quality data on insects, which was tabulated using Microsoft Excel 2010 Data analysis was done quantitatively to determine the profile of mangrove insects. The profile of mangrove insect diversity was determined based on the species richness index (equation (2)), the Shannon-Wienner diversity index (equation (1)), evenness index (equation (4)), and Jaccard similarity index (equation (3)). The equation of the index is presented as follows:

$$H' = -\Sigma pi \ln pi;\ pi = ni/N \quad (1)$$

$$R1 = \frac{S-1}{\ln N} \quad (2)$$

$$Cj = \frac{J}{(a+b-j)} \quad (3)$$

$$E = \frac{H'}{\ln(S).} \quad (4)$$

Information:

H '	=	diversity index	N	=	Total number of all individuals
R1	=	species richness	S	=	Number of types
E	=	evenness type	J	=	Number of species found in habitat a and b
Cj	=	the same type of jaccard	a	=	Number of species found in habitat a
Pi	=	The proportion of the number of individuals with the number of individuals in all types	b	=	Number of species found in habitat b
ni	=	Number of species individuals i			

3. Results and Discussion

3.1 Types of mangrove ecosystem insects in Menipo Nature Tourism Park

In mangrove ecosystem of Menipo Nature Tourism Park there was found 14 species, 11 families, and 5 ordos with a total number of 56 individuals (Table 2). The findings of each station were described as follows: there were 8 families at Station I, there were 3 families at station II, and there were 4 families at station III. In identifying mangrove insect specimens, it was limited to the family level. This was because the damaged road infrastructure has caused some specimens to suffer from damage due to shocks on the way to the laboratory. Besides that, some traps were lost (especially at station II) allegedly due to high tide at night.

Table 2. Types of mangrove insects caught in *yellow pan trap*

No	Ordo	Family	Species	Station		
				I	II	III
1	Diptera	Ptychopteridae		4		
		Dolichopodidae	*Tentanocara vicina*	5		
		Syrphidae		3		
		Xylomidae				2
		Sciaridae		2		
		Culicidae	Big black mosquito	5		5
2	Hymenoptera	Formicidae	Big black ant	2		1

			Big black ant with wings			2
			Big red ant	4	3	1
3	Coleoptera	Colydiidae		2		8
		Buprestidae				1
4	Hemiptera	Aphididae		1	1	
5	Lepidoptera	Lyonetiidae			1	

In all three stations, mangrove insects were found from the family of Formicidae. Formicidae (ants) is one of the families of the Hymenoptera ordo whose existence is ubiquitous, and the number exceeds most other land animals. These animals also play a role in the translocation of organic matter from the surface into the soil and are able to adapt to paddy habitats following changes in land conditions and plant age. Naturally, ants could be preferred as an indicator of environmental condition changes; it also roles to maintain the nutrition cycle and structure of soils. Ants can be used for habitats indicator status [25].

Tentanocara vicina was only found at station I. This species belonged to Dolichopodidae family. The Dolichopodidae family is usually small to medium -sized and can live in various conditions. But it is generally found in marshy areas and grasslands [5].

At stations I and III large black mosquitoes were found. These insects are members of the Culicidae family with extensive distribution. There are about 3,523 species of mosquitoes (Culicidae) described throughout the world [12]. Male mosquitoes do not bite, while female mosquitoes bite so that they are considered pests. Mosquitoes can also act as vectors carrying diseases such as malaria, filariasis, encephalitis, and others. The Culicidae family is divided into 3 subfamilies i.e. Anophelinae, Culicinae, and Toxorhynchitinae [5]. Mosquitoes are always found where the air is relatively cool and the humidity is high. Many species live within a few meters of the ground whereas many sylvan species occur primarily in the forest canopy. Vertical distribution is largely dependent on feeding preferences. All males and the females of many species feed exclusively on plant liquids, including nectar, honeydew, fruit juices and exudates [11].

Colydiidae and Buprestidae are families from Coleoptera order found in station I and III. The Colydiidae are widely distributed and diverse family of beetles found throughout the world and on many oceanic islands. Many species are saproxylic, feeding on fungi associated with decomposing wood, or else are predaceous on the larvae of scolytin [17]. The beetle family Buprestidae (jewel beetles) comprises about 15000 species and has a world-wide distribution and most of the species are distributed in the humid tropics and semi desert areas of the planet [2].

Aphididae was found at stations I and II. The About 4,700 species of aphids popularly known as plant-lice or ant-cows, constitute a group of small-sized (0.7 to 7.0 mm in length) insects that suck the phloem fluid of plants and about 1000 species are injurious to crops throughout the world [23]. Aphididae family in Indonesia is commonly called *Kutu daun*. *Kutu daun* can be identified with a typical peach-like shape with a pair of cornicles at the posterior end of the abdomen. Cornelike cornicles are tube-like structures arising from the fifth and sixth segments of the dorsal abdomen (Borror et al. 1996). *Kutu daun* has different body sizes, shapes, and colors. These differences can be influenced by host and environmental factors [13]. The population density influences physiological changes in plants such as withered, death of shoots, deciduous leaves, leaf shape changes, and plant death**.**

3.2 Richness index

Richness of mangrove insects refers to the number of species found in an ecosystem. The total number of species in a community depends on the sample size and time. Some indices are recommended to measure Richness species that are not dependent on sample size but based on the relationship between a community and the total number of individuals observed which increases by increasing sample size [16].

Based on the criteria of Ludwig and Reynolds (1988), the richness index of mangrove insects in Menipo Nature Tourism Park was low (R1 <3.5). The observation data showed that the highest richness index value was at station I (R1 = 2.40), followed by station III (R1 = 2.00), and station II (R1 = 1.44) (Figure 2).

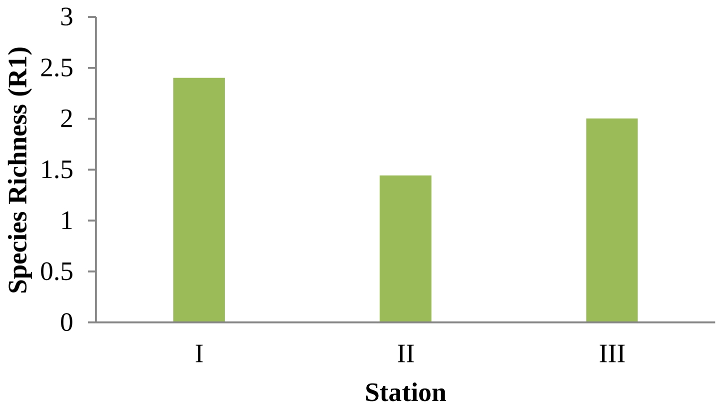

Figure 2. Mangrove insect species richness index in Menipo Nature Tourism Park

Wealth index value is strongly influenced by the number of mangrove species found. Based on the results of the data analysis, it was revealed that the index value of mangrove insect species in Menipo Nature Tourism Park had a low value of wealth. High and low levels of mangrove insects were influenced by the presence of food sources and climate. A stable climate conditions caused insect species wealth to be high [22].

3.3 Diversity index

The observation results (Figure 3) indicated that the diversity index of mangrove insects in Menipo Nature Tourism Park was classified as medium (H ’= 1- 3). Moderate species diversity indicated the number of individuals was not diverse [7].

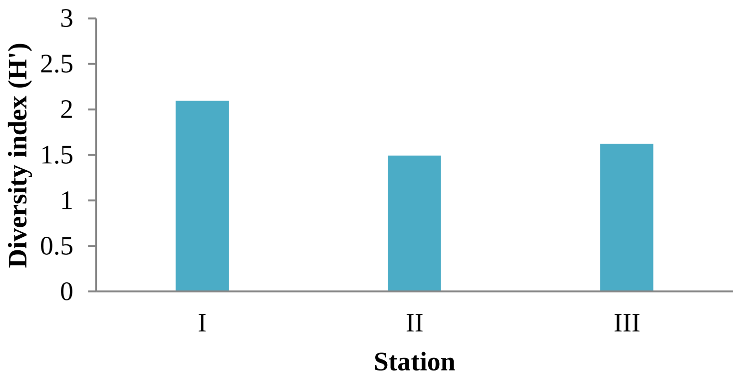

Figure 3. Mangrove insect diversity index in Menipo Nature Tourism Park

Based on Figure 3, the value of the diversity index from high to low sequentially was station I (2.10), Station III (1.62), and station II (1.49). The diversity index depends on the food chain. The more complex the food chain then the higher the value of the diversity index in an ecosystem. Within an ecosystem that has an abundance and diverse high-flying insects, there were complex interactions in the food chain that can support ecosystem stability. In addition, the differences in mangrove insects encountered in Menipo could be attributed to the fact that there are more desirable mangrove trees that could attract insect and create a conducive environment for insect habitats.

3.4 Evenness index

The analysis results of the evenness index (E) of mangrove insects in Menipo Nature Tourism Park (Figure 4) approached 1 (<1). In concerns to the value of E which approaches 1, all types of insects have similar levels of evenness [16]. The evenness index in succession from high to low was station I (0.95), station III (0.72), and station II (0.72).

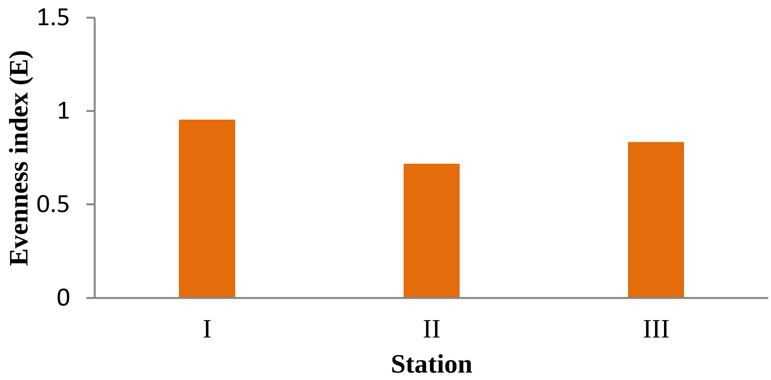

Figure 4. Evenness index of mangrove insects in Menipo Nature Tourism Park

According to Odum (1993) [24] if the evenness index is > 0.5, then evenness is high. It is because the soil physic-chemistry of land of research station is not much different. The high index of evenness of mangrove insects is caused by these animals that have almost the same ability to utilize various environmental conditions to sustain their lives [7].

The Jaccard similarity index (Cj) ranges of 0-1, when approaching the value of 1 it shows the level of similarity between habitat is high, and when approaching the value of 0 it indicates the level of similarity between habitat is low [18]. Based on Figure 5 the similarity index of mangrove insect species in Menipo Nature Tourism Park ranged from 0.18 - 0.5. The range of values tends to approach the value of 0, meaning that the similarity of mangrove insect species among the three stations was different from each other. It is due to the different constituent components of mangrove vegetation among three stations so that only certain species can live and adjust according to the environmental conditions in each location.

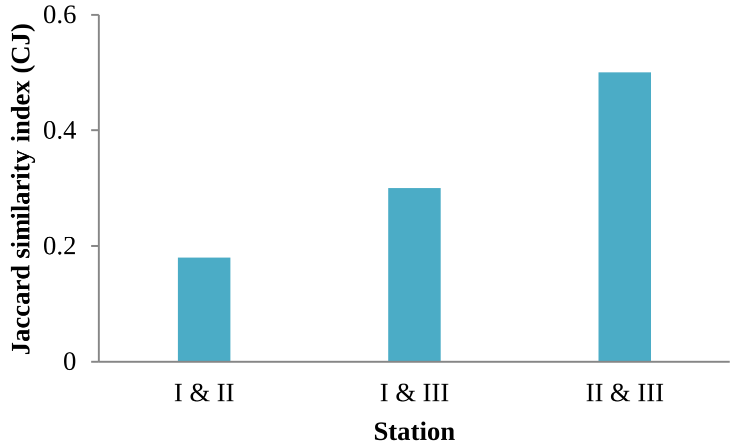

Figure 5. Jaccard similarity index of mangrove insects in Menipo Nature Tourism Park

The abiotic factor measured in this study was only the ecological temperature. The ecological temperature at station I was 27 °C, station II, and station III had the same ecological temperature value of 27.5 °C. Insects can live in a certain range of effective temperatures (i.e., minimum temperature of 15 °C, optimum temperature of 25 °C, and maximum temperature of 45 °C) [15]. Insects have a certain temperature range where they can live. Outside the range, insects will die of cold and heat, which affects the process of insect physiology.

4. Conclusion

Based on the findings and discussion, it can be concluded that the types of mangrove insect families found in the mangrove ecosystem in Menipo Nature Tourism Park were Ptychopteridae, Dolichopodidae, Syrphidae, Xylomidae, Sciaridae, Culicidae, Formicidae, Colydiidae, Buprestidae, Aphididae, and Lyonetiidae. The richness index of mangrove insects found in mangrove ecosystems in Menipo Nature Tourism Park was still relatively low (R1 <3.5). The data observation showed that the highest richness index value was at station I (R1 = 2.40), followed by station III (R1 = 2.00), and station II (R1 = 1.44).

The diversity of mangrove insects found in the mangrove ecosystem in Menipo Nature Tourism Park was classified as moderate (H '= 1-3). The value of the diversity index sequentially from high to low was station I (2.10), station III (1.62), and station II (1,49). All mangrove insects found in the mangrove ecosystem of Menipo Nature Tourism Park had almost the same level of evenness (E <1). Evenness index of all types in succession from high to low was station I (0.95), station III (0.72) and station II (0.72). The similarity index of mangrove insect species in Menipo Nature Tourism Park ranged from 0.18 to 0.5. The range of values tends to approach the value of 0, meaning that the similarity of mangrove insect species among the three stations was different from each other.

Acknowledgments

Thank you to the Chancellor of Widya Mandira Catholic University through LPPM, who fully funded this research in 2018. The team that had helped and had supported the implementation of this research.

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