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DIVERSITY OF THE ORTHOPTERA AT THE INSTITUT TEKNOLOGI SUMATERA

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Abstract: Orthoptera are important members of almost all terrestrial ecosystems, playing roles as both consumers and prey. Diversity refers to the various species found within a particular area. This study aims to determine the diversity index, dominance index, and evenness of the order Orthoptera at the Institut Teknologi Sumatera. Data collection on Orthoptera diversity was conducted and identified in the Zoology Laboratory at Institut Teknologi sumatera. Purposive sampling was used as the sampling technique, based on specific considerations. Observations were carried out at four locations around Institut Teknologi Sumatera and analyzed using diversity index, dominance index, and evenness index formulas. This study found 12 genera from the order Orthoptera. The diversity of Orthoptera at ITERA was categorized as moderate, with the diversity index (H') values recorded as follows: Station I (1.879); Station II (1.765); Station III (1.626); and Station IV (1.843). No dominant individuals were found at any station. The evenness index at ITERA was categorized as high, with values of 0.784 at Station I; 0.767 at Station II; 0.678 at Station III; and 0.742 at Station IV, where Station I had the highest evenness value.

Keywords: diversity, orthoptera, purposive sampling

INTRODUCTION

The order Orthoptera is one of the living organisms with a significant number of species, reaching almost 20,000 types [1]. Orthoptera are primarily herbivores, but some act as predators of other insects [2]. Orthoptera inhabits various environments or ecosystems, including shrubs, forests, agricultural lands, residential areas, etc. They forage by moving from place to place, and sometimes, the areas they visit can be damaged due to their large numbers, such as in cultivated plants[3].

Some Orthoptera have wings, while others do not. Orthoptera that possess wings generally have four wings. The hind wings are thin, membranous, and broad, and when at rest, these insects fold their forewings over them. The forewings, with numerous wing veins, can be elongated, and their texture can be thickened and somewhat rigid, known as tegmina. The hind wings have a membranous texture, are broad, and contain numerous veins. The Orthoptera order also has hind legs that are larger and longer than the middle legs. These enlarged hind legs are used for jumping and producing sound, though some species of Orthoptera also produce sound using their wings.

The types of Orthoptera known in Indonesia include the wooden grasshopper (*Valanga nigricornis*), stick insect (*Phobaeticus chani*), leaf insect (*Phyllium fulchrifolium*), cricket (*Gryllus mitratus*), praying mantis (*Hierodula vitrea*), monkey grasshoppers (*Eumastacidae*), and others [4]. Orthoptera are important members of almost all terrestrial ecosystems, consumers, and prey. Large-scale outbreaks of certain grasshopper species can cause significant losses to the food and forestry industries [5].

Understanding biodiversity requires comprehensive information on the number of individuals and their functions or roles within an ecosystem and their habitat[6]. Orthoptera are insects with a broad habitat distribution [7]. The abundance of insect species is primarily determined by their reproductive activity, which is supported by a suitable environment and the availability of food sources. In tropical regions, insect abundance and reproductive activity are also influenced by seasonal and environmental factors. Abundance refers to the number of individuals present in a specific area within a community. The presence of Orthoptera serves as an indicator of ecosystem health and landscape degradation [8].

The research on the diversity of grasshopper species in green bean agricultural land in Manusak Village, located in East Kupang District, found a moderate diversity level (H' = 1.882) [2]. Another study conducted on the rice field ecosystem in Banyuasin Village, Riau Silip District, Bangka Regency, showed a moderate diversity level (H' = 1.7) [3]. Differences in an ecosystem's structure and composition result in variations in ecosystem characteristics, which influence the diversity and abundance of the organisms living within it. Institut Teknologi Sumatera has various types of vegetation diversity, including naturally growing and purposefully managed plants. Therefore, researching the diversity of the Orthoptera order is important to understand its role and species in different vegetation types at Institut Teknologi Sumatera. Additionally, no similar study has yet been conducted in this area. The aim of this study is to determine the diversity of grasshopper species at the Institut Teknologi Sumatera in different habitat types.

RESEARCH METHODS

Data collection on the diversity of the Orthoptera order was carried out at Institut Teknologi Sumatera (Figure 1) and identified in the Zoology Laboratory at Institut Teknologi Sumatera. Purposive sampling is a sampling technique based on specific considerations. The primary goal of purposive sampling is to obtain logically selected samples that can be considered representative of the population being studied [9]. Sampling was conducted using an insect net and the hand sorting method. Observations were conducted in the morning from 07:00 – 10:00 AM WIB and in the afternoon from 03:00 – 05:00 PM WIB [2]. These observations were conducted at four locations around ITERA (Figure 1). At these four locations, one closed area was observed: the vegetation around Buildings E and F (Station I). The open habitats include the Institut Teknologi Sumatera Botanical Garden (Station II), Reservoir A (Station III), and the area around the ITERA TPB Dormitory (Station IV). This was done to compare the three open vegetation areas, and one closed vegetation area.

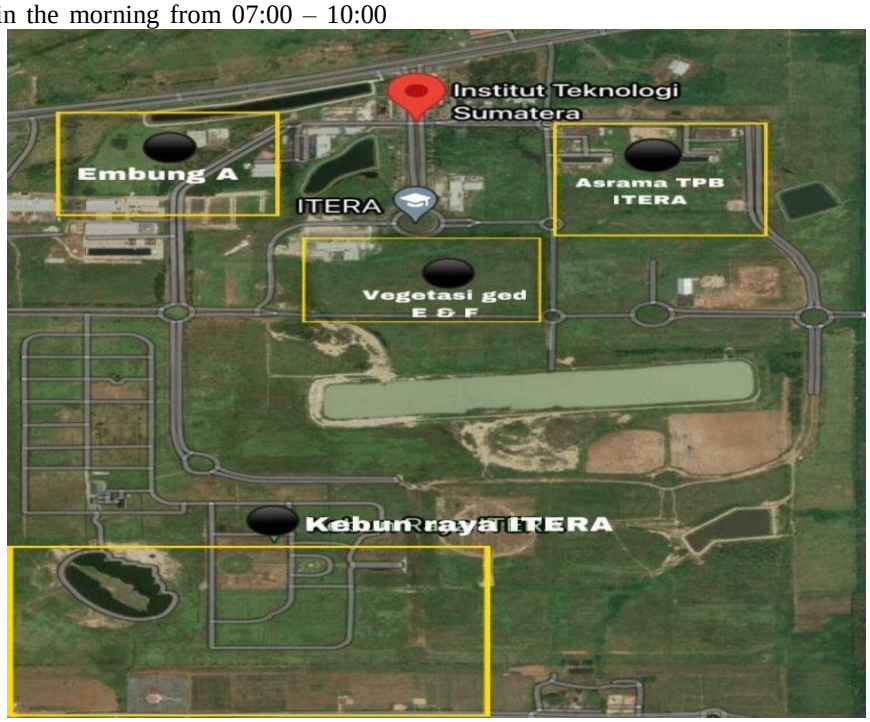

Figure 1. Map of the research locations around

The specimens obtained were placed in 70% alcohol, which serves to kill the specimens, and then left to air dry. The specimens were pinned using a needle at the posterior pronotum, just to the right of the body's midline. They were then placed on a mounting board to position the insect. The mounting board is cork, which allows the needles to be inserted deeply. These needles adjust the legs and antennae and stabilize the specimen during dryness. Drying was carried out using an oven for 3 days at 50°C. Once the specimens were dry, they were placed in a collection box [10].

The preserved samples will be counted and identified based on their genus. Insect identification is carried out up to the genus level using references such as journals, including Stal and Ann 1861[11], reference of *Cicada septendecim* to the genus *Tibicen*, and introduction to insect [10]. Data collection and identification of insect species are done by observing the morphological characteristics of the Orthoptera order, such as the color of the abdomen, wing color, skin color, and thorax color. After the samples are observed, they are photographed using a smartphone camera [3].

Primary data management involves processing data analyzed up to the genus level. The data is then processed to determine biodiversity using formulas for the Diversity Index (H'), evenness index, and dominance index. The diversity index (H') mathematically describes the state of a population and helps facilitate the analysis of information regarding the number of individuals of each species in a community. Therefore, calculations are performed using the Shannon-Wiener equation. A low, medium, or high H value can indicate the value of the evenness index.

Shannon-Wiener Diversity Index (H'):

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

Description:
H': Shannon-Wiener diversity index
Pi: Proportion of the total species based on the i-th species
The criteria for diversity, according to Odum, 1993 [12], are:
H<1:Low diversity
1<H<3 :Moderate diversity
H>3:High diversity

The dominance index is a parameter that indicates the level of concentration of dominance

(control) of a species within a community. Dominance refers to a situation where one species has a greater quantity than others, making it more dominant. The dominance index ranges from 0 to 1, with a smaller value indicating no species dominating. In contrast, a more considerable dominance index value indicates the presence of a particular species dominating [12]. The dominance index is calculated using Simpson's dominance index formula [12]:

Dominance Index (D) Simpson's:

$$\mathbf{D = \Sigma p_i^2}$$

Description:

D: Simpson's Dominance Index

pi: Proportion of individuals in the i-th species

The criteria for the Dominance Index, according to Oddum, 1993 [12], are:

0<D<0.5: Low dominance

0.5<D<0.75: Moderate dominance

0.75<D<1: High dominance

The evenness index is a calculation used to determine the evenness or distribution of each species within a community. The evenness value between each community will indicate the presence of species that dominate or have a high individual count. The evenness value can be determined using the formula:

E = H'/ ln S

E: Evenness Index

H': Diversity Index

S: Number of species

Criteria:

E ≤ 0.4 : Low evenness

0.4 < E < 0.6 : Medium evenness

E > 0.6 : High evenness

Environmental parameters observed included light intensity, whereas temperature and humidity measurements were recorded using a thermohygrometer before each observation session.

RESULTS AND DISCUSSION

Based on the research conducted at the Institut Teknologi Sumatera, 12 genera were found at four observation station points. At Station I, 161 individuals were found; at Station II, 204 individuals were found; at Station III, 136 individuals were found; and at Station IV, 145 individuals were found (Table 1).

Table 1. Diversity of the Order Orthoptera at 4 Observation Stations at Institut Teknologi Sumatera

NO	Famili	Genus	Station I	Station II	Station III	Station IV	ni	pi	H
1	Acrididae	*Teratodes*	5	8	15	9	37	0.078	0.199
2		*Acrida*	53	12	5	15	85	0.180	0.308
3		*Phlaeoba*	0	2	3	5	10	0.021	0.082
4		*Caryanda*	11	0	8	0	19	0.040	0.129
5		*Trilophidia*	34	2	9	3	48	0.101	0.232
6		*Anacridium*	14	19	8	42	83	0.175	0.305
7		*Gastrimargus*	9	43	21	14	87	0.184	0.311
8		*Oxya*	2	1	2	1	6	0.013	0.055
9	Tettigoniidae	*Neoconocephalus*	5	13	2	6	26	0.055	0.159
10		*Conocephalus*	1	37	6	27	71	0.150	0.285
11	Grillidae	*Anaxipha*	1	0	0	0	1	0.002	0.013
12	Pyrgomorphidae	*Atractomorpha*	26	67	57	23	173	0.366	0.368
Total (N)			**161**	**204**	**136**	**145**	**473**	1	**2.080**
H'			1.879	1.765	1.626	1.843			
E			0.784	0.767	0.678	0.742			
D			0.197	0.203	0.227	0.171			

Description:

H': Diversity Index

E: Evenness Index

D: Dominance

Based on the research conducted at the four observation stations in Institut Teknologi Sumatera, 12 genera of the order Orthoptera were found, belonging to four families. The most commonly found family was Acrididae, while the least commonly found families were Gryllidae and Pyrgomorphidae.

The genera found at stations I–IV were *Teratodes*, *Neoconocephalus*, *Acrida*, *Atractomorpha*, *Anacridium*, *Gastrimargus*, *Oxya*, *Phlaeoba*, *Anaxipha*, *Conocephalus*, *Trilophidia*, and *Caryanda*. The total number of individuals recorded in ITERA was 646. According to Table 4.1, based on the diversity index (H') calculation, the highest diversity index was found at Station I, with H' = 1.879, categorized as moderate diversity. At station II, H' = 1.765, also categorized as moderate diversity. Station III had the lowest diversity, with H' = 1.626. Based on the dominance index (D) calculation, the values obtained were Station I: D = 0.197, Station II: D = 0.203, Station III: D = 0.227 and Station IV: D = 0.171. Each Station showed low dominance. The evenness index (E), as seen in Station I: E = 0.784, Station II: E = 0.767, Station III: E = 0.678 and Station IV: E = 0.742. Each Station in ITERA exhibited high evenness.

The research found that the diversity of Orthoptera at the four stations was moderate. This indicates that the area has a healthy and relatively balanced ecosystem, allowing for trophic interactions within the Orthoptera order. The results of this study are consistent with the research on the diversity of

grasshopper species in green bean agricultural land in Manusak Village, located in East Kupang District, found a moderate diversity level (H' = 1.882) [2]. Another study conducted on the rice field ecosystem in Banyuasin Village, Riau Silip District, Bangka Regency, showed a moderate diversity level (H' = 1.7) [3].

Density, vegetation types, and various environmental factors influence the diversity index. If the habitat experiences disturbances or pressures, such as land clearing, grass cutting, and human activities, the diversity of species and the number of individuals found will likely decrease. Disturbances to vegetation were observed at the research stations, where the H' values across all four stations did not differ significantly. This is because the vegetation at each observation station consists of similar plant species. The E and F vegetation areas at Station I are considered closed environments, as they contain dense trees, grass, and tightly packed plants.

Meanwhile, at Station II, located in the botanical garden, the vegetation includes dragon fruit plantations and grass and reeds surrounding the plantation. The vegetation is more open at Stations III and IV, with significant human activity observed. Various grass species are found, particularly food sources such as leaves, stems, grasses, reeds, and trees around the observation sites, along with other green plants, which are generally similar in composition.

From Table 1, it can be seen that no dominance was found at any of the four research stations. The dominance index (D) values were 0.197 at Station I, 0.203 at Station II, 0.227 at Station III, and 0.171 at Station IV, all indicating low dominance. This suggests the community is stable without experiencing ecological pressures that could lead to environmental changes. The results of this study are consistent with the research on the diversity of grasshopper species in green bean agricultural land in Manusak Village, located in East Kupang District, found low dominance [2]. According to [13], dominance indicates low species richness with an uneven distribution**,** meaning that certain species dominate over others within the observed community. The absence of dominance across the four observed stations suggests that the ecosystem remains relatively stable, which aligns with the moderate diversity index results.

The evenness in this study, as shown in Table 1, indicates that the evenness in Institut Teknologi Sumatera is categorized as high. A high species evenness value suggests that the abundance of individuals within the habitat is nearly evenly distributed. The high species evenness in Institut Teknologi Sumatera is influenced by the availability of food sources for Orthoptera, which are evenly distributed across the various observation stations.

From the 12 insect genera from the order Orthoptera found, individuals from the genus *Atractomorpha* were the most frequently observed**.** This is due to the green plant ecosystem and water beneath the vegetation, which provide a sufficient food supply for this genus at the research sites, particularly stations II and III**.** This genus typically does not migrate frequently, but *Atractomorpha* can travel long distances if its original habitat no longer provides sufficient food sources. The characteristics of *Atractomorpha*'s habitat include tall grasses, green vegetation near water, reeds, and dense plants. Additionally, *Atractomorpha* is not very aggressive when captured using the hand-sorting method or an insect net. This study aligns with the research conducted in Lubuk Pinang Kabupaten Mukomuko, where *Atractomorpha* crenulata was frequently found due to the abundance of tall grasses and dense vegetation in the study area [14].

In Table 1, it is shown that the least observed genus in this study was *Anaxipha***.** *Anaxipha* is a generalist predator that is typically found in agricultural ecosystems. Since none of the four research stations were agricultural ecosystems, *Anaxipha* was rarely found. Even when present, it was difficult to capture due to its aggressive nature and sword-like tail, which gives a stinging sensation when touched by humans, making the sampling and collection process challenging [15].

Based on field observations, environmental factors estimated to influence Orthoptera insects' activity at the observation stations have been measured (Table 2). The environmental factors at the research location in ITERA ranged from an air temperature of 26.4℃ to 40.4℃ and air humidity between 48% and 82%, while light intensity ranged from 7,040 to 37,200 Lux. The number of individuals found at each station indicates that the measured environmental factors represent the optimal conditions for Orthoptera insects to be active (Table 2).

Environmental factors play a crucial role in determining the presence of insects, especially those from the order Orthoptera. During field data collection, frequent weather changes, including high temperatures and sudden shifts, limited the presence of insects, particularly winged ones. The presence of insects in a particular location is influenced by environmental factors, including high rainfall, which can reduce insect activity [16]. The research findings in Table 2 indicate that air temperature ranged from 26.4℃ to 40.4℃, air humidity varied between 48% and 82%, while light intensity ranged from 7,040 to 37,200 Lux. The effective temperature range for insect survival has a minimum of 15℃, an optimum of 25℃, and a maximum tolerance of 45℃ [17]. Therefore, the temperature in ITERA is within the tolerable range for insects, particularly those from the order Orthoptera. A study also found that grasshopper (Orthoptera) diversity is generally determined by environmental factors [18]. The temperature in rice fields ranged between 21℃ and 39℃, with an average of 30℃, which is suitable for Orthoptera insects. Exposure to excessively high

temperatures can damage an insect's body system, potentially leading to death. Additionally, air humidity influences insect activity, such as evaporation and jumping behavior [19].

Table 2. The Relationship Between Environmental Factors and the Number of Individuals at the Four Stations

Station	Temperature (°C)	Humidity (%)	Light intensity (lux)	Number of individuals
1	27.9 – 33.0	68 - 82	9610 - 25200	161
2	27.7 - 33.2	69 - 81	13100 - 37200	204
3	26.4 - 33.2	66 - 81	7040 - 37200	136
4	29.8 - 40.4	48 - 81	15500 - 37200	145

CONCLUSION

This study found 12 genera from the order Orthoptera. The diversity of Orthoptera at ITERA was categorized as moderate, with the diversity index (H') values recorded as follows: Station I - 1.879, Station II - 1.765, Station III - 1.626, and Station IV - 1.843. No dominant individuals were found at any station. The evenness index at ITERA was categorized as high, with values of 0.784 at Station I, 0.767 at Station II, 0.678 at Station III, and 0.742 at Station IV, where Station I had the highest evenness value.

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