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Distribution of Nocturnal and Diurnal Insects in Green Open Space Areas at Syiah Kuala University Campus

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Abstract:
Background*: University Campus Syiah Kuala has a plant area as green open space for various fauna. In the plant parts found in the open space of Syiah Kuala University there are various types of insects, found in every plant. Therefore, this study aims to determine the distribution of nocturnal and diurnal insects in the green open space.*
Materials and Methods*: This study aims to determine the distribution pattern of insects and to assess the level of similarity of insect species in the green open space. The method used in this research is observation by purposive sampling. The research subjects were insect species found in the campus green open space area. The time of the study was carried out in January 2021. To determine diversity, direct observations were carried out in the field to look for distribution patterns, diversity index, frequency of presence, species acidity index, and cluster analysis presented in the form of a dendogram.*
Results*: The results showed that the pattern of the distribution of insects was 2.48 (clustered). The diversity index value ranges from 1 to 1.8 in the low category. The highest frequency of insect presence has a value of 62.50%, namely mosquitoes, and the lowest is 3.13%, there are 18 types of insects. The similarity index of the four stations has the highest value of 11.4 and the lowest value of 0. The dissimilarity index value of each station is 92 and the closest similarity level is 98.*
Conclusion: *The Pattern of distribution of insects and the level of similarity of insects at each station are influenced by the types of plants from each green open space.*
Key Word*: Green Open Space, Diversity, Species Distribution, Dendogram.*

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I. Introduction

Green Open Space (RTH) is an elongated or clustered area whose use is more open, as a place to grow for plants, either naturally or planted for necessities. RTH is divided into public green open space and private green open space (itself). Public green space is an open space that is owned and managed by the local government and is used for the public or community interest.

Public green open space can be in the form of city parks, public cemetery parks, and green lines along river and beach roads. Private green open space includes gardens in the yard of houses or buildings owned by private or community plants planted with plants. Public green open space has a proportion of 20% that must be provided by the city regional government so that it can allow its wide use by the community (Law No. 26, 2007 concerning Spatial Planning).

Green open space is also a resource that supports the diversity of fauna, and one of them is ground surface insects. Insects include animals from the Phylum Arthropoda with the largest number of members, and almost 72% of animals in nature belong to the insect group. These animals are also included in the biodiversity that must be maintained and preserved from the threat of extinction. Bioindicators of the condition of an ecosystem can be seen from the diversity of insect species[1].

Insects have a very large variety, ranging from color, shape, development process, and distribution[2]. Insect life varies, ranging from insects on the surface of the soil, in the soil, plant roots, trees, branches, twigs and in other parts of the organs in plants. The diversity of insects that occupy parts of plants causes the pattern of dominance and distribution of insects in plant parts to vary[3].

Insects usually occupy habitats, namely trees in forests, shrubs, grasses, shade plants, mosses, and parts of plant organs such as flowers, leaves, stems, and roots[4]. Insects also have a certain temperature range to survive. The temperature range is generally between 15^0C for the effective temperature, the optimum temperature is 25^0C, and the maximum temperature is 45^0C[5].

Insects have various roles in human life and the presence of insects can be found everywhere, causing insects to have an important role in ecosystems and human life. Insects have various roles including as natural

enemies of pests, weed control, insect pollinators, product producers, food ingredients and waste decomposers. In addition, insects can also harm humans because of their destructive nature to food, clothing and plants. Insects can also act as vectors of a disease[4].

Syiah Kuala University campus has a plant area, as green open space for various fauna. RTH on the Campus include RTH at the Faculty of Economics, Postgraduate Program, Faculty of Agriculture and RTH, Faculty of Teacher Training and Education. The plant species found in Syiah Kuala University's green open space are very diverse. The orders found in the open space of Syiah Kuala University include Fabales, Pinales, Myrtales, Sapindales, Euphorbiales, Gentianales, Rubiales and others. In the plant parts found in the open space of Syiah Kuala University, there are various types of insects, found in each plant of different types.

The results of the preliminary study showed that in the green space area of Syiah Kuala University, several species of insects were found. The insect species are *Diplocheila* sp, *Gryllus* sp, *Dolichoderus* sp, *Camponotus* sp, hornbill ants, ladybugs, mealybugs and aphids, butterflies, wasps, *Nomia punctata* and dragonflies. Specifically, the level of species distribution in each plant organ found in the open space of Syiah Kuala University has not been documented.

The results of a preliminary study of insect species found in the open space of Syiah Kuala University, Banda Aceh, included 12 species. The species of insects found varied in each type of plant. In addition, many scientific studies on the diversity of insect species and the distribution of insect species have been carried out by Andrianni et al., 2007; Hadi et al., 2015; Ulrich *et al*., 2015; Sari et al., 2018[6,7,8,9]. The research was conducted in Mount Gede Pangrango, West Java, and also carried out in the Bogor area. The results of this study only reveal the Diversity Index and Morista, while research related to the distribution and diversity of each plant species and organ is still very limited. Therefore, this research was conducted to answer the distribution of nocturnal and diurnal insects in the Green Open Space area at Syiah Kuala University Campus, Banda Aceh.

II. Material And Methods

This research uses a quantitative approach, a research approach that involves measurement and observation as well as theory testing and the type of research used in this study is observation, which is where the researcher observes directly and directly collects species from groups of insects found at the research site.

Study Design: *Purposive sampling*

Study Location: Region area of 682 990 mof green space[2] in the area of Syiah Kuala University

Study Duration: January 2021.

Objek penelitian: Insect species found in the Green Open Space of Syiah Kuala University, Darussalam Banda Aceh.

Parameter Penelitian: the diversity of insect species found in the Green Open Space Area at Syiah Kuala University Campus.

Procedure methodology: Data collection is determined subjectively based on the observation station. Each station was analyzed for insect species, patterns of distribution of insects, diversity of insects, and similarities of insect species. The method of data collection is done by setting observation stations, each station is determined by a tree species subjectively. Every insect present at the station was recorded and then analyzed using a predetermined formula.

Insects that were caught were then analyzed for calculating the distribution pattern of insect species, diversity index, species similarity index, and cluster analysis using the following formula:

1. Distribution Pattern

Insect Patterns of each green open space were analyzed using the Morisita Index formula, with the following formula[10]:

$$I_d = \text{n}\,\frac{\sum X^2 - N}{N\,(N-1)}$$

Description:

I_d = Morisita dispersion index
nf =(X) = Total frequency of observations
N = Total number of individuals in (n)
$\sum X^2$ = Square of the number of individuals per observation point

The criteria for the Morisita Index are as follows:

a. I_d = 1, then the distribution is random
b. I_d < 1, then the distribution is uniform
c. I_d > 1, then the distribution is clumped

2. Diversity

Index The species diversity index is used to compare the high and low species diversity of insects obtained using the Shannon-Weiner Index (H') with the formula:

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

Description:
Pi = Comparison of the number of individuals of a species with the whole species (ni/N)
Ni = Number of individuals of the i-species
N = Total number of individuals of all species

The criteria for the Diversity Index (H') are[11]:

a. < 1.0 = Low diversity, low productivity, as an indication of heavy pressure and unstable ecosystem
b. 1.0 – 3.322 = Moderate diversity, moderate productivity, moderate environmental pressure, fairly stable ecosystem
c. > 3.322 = High diversity, good ecosystem stability, high productivity, resistant to ecological pressures.

3. Frequency of Presence The

Frequency of presence of insect species on plant parts in Unsyiah Green Open Space was analyzed using the FK formula, with the following formulation[12]:

$$FK = \frac{\text{Jumlah spesies yang hadir pada bagian tumbuhan}}{\text{Total spesies semua bagian tumbuhan}} \times 100\%$$

Where if:
FK = 0 – 25% (very rare attendance)
FK = 25 – 50 % (rare attendance)
FK = 50 – 75% (moderate attendance)
FK = 75 – 100% (absolute attendance)

4. Similarity Index (Similarity Index)

Similarity-Jaccards Index formula, namely:

IS x 100%

Information:
a = Number of species found at Station I
b = Number of species found at Station II
c = Number of species found at Stations I and II

5. Cluster/Group Analysis

After obtaining the calculated value from IS, then the value is arranged in the form of an IS matrix and grouped and combined between two similar groups (highest IS value and lowest ID value). Merging is done until all pairs of stations are formed into certain groups, and then the results are drawn in the form of a tree dendogram (phylogram) so that similarities between stations are compared.

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III. Result

Diversity Index

Diversity is the number of a species that already exists at a time in a particular community[4]. Environmental factors at each station also affect the diversity found at that station.

Table 1. Number of Species and Index of Species Diversity at Each Station

No	Station	Number of Species	Diversity	Category
1.	I (Faculty of Economics)	25	1.15	Low
2.	II (Post Graduate)	31	1	Low
3.	III (Faculty of Agriculture)	23	1, 09	Low
4.	IV (FKIP)	24	1.18	Low

Based on the observation table above, it can be seen that the average diversity of insect species at all stations ranges from 1 to 1.18 or is included in the low category. The higher the diversity index at a station, the better the level of insect species diversity in the area.

Frequency of Presence The frequency of

Presence is the intensity of the presence of an insect and describes the distribution of insect species on high land[13]. The highest frequency of presence contained in the observation table is mosquitoes which have the highest value of 62.50%. Mosquitoes are insects that are active at night (nocturnal) and their presence is evenly distributed in almost all observation plots. Furthermore, the insect that has the highest value is the black ant which has a value of 50%. While the insects that had the lowest attendance value of 3.13% were 18 types of insects.

Table 2. Number of Species and Frequency of Species Presence at Each Station

No	Species	Number of plots found	Total number of plots	FK(100%)
1	Black Ant	16	32	50.00%
2	Red Ant	8	32	25.00%
3	Big black ant	6	32	18 ,75%
4	Little red ants	6	32	18.75%
5	Millipedes	1	32	3.13%
6	Little black ants	11	32	34.38%
7	Centipedes	1	32	3.13%
8	Little brown ants	9	32	28.13%
9	Small spiders	2	32	6.25%
10	Mosquitoes	20	32	62.50%
11	Sugar ants	1	32	3.13%
12	Small mosquitoes	1	32	3.13%
13	Rangrang	2	32	6.25%
14	Woodlice	1	32	3.13%
15	Crickets	4	32	12.50%
16	Tomcat	3	32	9.38%
17	Flour beetle	3	32	9.38%
18	Grasshopper	2	32	6.25%
19	Small Grasshopper	2	32	6.25%
20	Butterflies white	1	32	3.13%
21	Brown butterfly	1	32	3.13%
22	Brown grasshopper	1	32	3.13%
23	Small brown grasshopper	1	32	3.13%
24	Weevil Wasp	3	32	9.38%
25	Long mosquito	1	32	3.13%
26	Kemarang	1	32	3.13%
27	Cricket	3	32	9.38%
28	Planthopper	1	32	3.13%
29	Spider	1	32	3.13%
30	Small cockroach	2	32	6.25%
31	Wasp small	1	32	3.13%
32	dragonfly	2	32	6.25%
33	ladybug	1	32	3.13%
34	Ant queen	3	32	9.38%
35	Stone javelin beetle	2	32	6.25%
36	Rhino beetle	1	32	3.13%
37	Small round beetle	1	32	3.13%
38	Paper wasp	2	32	6, 25%
39	Walang sangit	2	32	6.25%
40	Ringet/ Agas	4	32	12.50%
41	Chocolate beetle	2	32	6.25%
42	Laron	5	32	15.63%

No	Species	Number of plots found	Total number of plots	FK(100%)
43	Black dung beetle	2	32	6.25%
44	Wasp	4	32	12.50%
45	Spider Wasp	2	32	6.25%
46	Rhinoceros Beetle	3	32	9.38%
47	Brown Beetle	2	32	6.25%
48	Lovebug Beetle	1	32	3.13%
49	English Wasp	4	32	12.50%
50	Flies	4	32	12.50%
51	Tree spider	2	32	6.25%

Similarity Index (Similarity Index)

Species Similarity Index is a value that indicates the level of similarity in the composition of a particular animal population obtained by comparing 2 certain communities[14]. From the calculation results of the Similarity Index (IS) contained in the four stations can be seen in table 4.3. At Station I, the highest index value is 10.1 and the lowest index value is 1.1. At Station II it has the highest index of 5.5 and the lowest index value is 0. At Station III it has the highest index of 9.8 and the lowest index value of 2.5. At Station IV, it has the highest index of 11.4 and the lowest index value of 0.

Table 3. Number of Species and Frequency of Species Presence at Each

IS Station Station I	IS Station II	IS Station III	IS Station IV
6.5	3.5	5.2	6, 2
7.1	1.2	3.9	11.4
3.8	3.8	5.6	4.3
4.7	1.3	6.3	4.2
5.5	1.4	4.7	8
5.8	2.9	3.1	3.6
5.2	2.8	4.2	8.3
3.1	3.7	3.8	3.3
2.5	2.4	3.5 3.5	3.0
6.5	4, 0	4.9	5.3
7.0	5.4	8	2.0
8.4	4.2	7.1	2
10.1	2.1	7.1	3.6
6.8	5.5	2.7	0
6 ,3	3.6	7.7	3.8
5.0	4.3	6.6	0
6.7	2.4	5.7	2.8
5.9	4.4	5.3	3.9
5.2	3, 4	3.4	3.8
10	0.5	4.6	6.7
4.7	2.8	2.5	3.1
5.4	2.7	2.8	6.9
3.6	2.2	2.6	2.8
3.6	0	2.5	5.2
3.7	4.7	5.4	3.1
7.6	1.3	5.4	2.4
5.0	4.0	3.4	6.8
4 ,3	2.6	5	4.9
3.7	5.0	4.5	4.3
5.8	2.1	4.1	2
7.1	1.7	4.2	4.7

IS Station Station I	IS Station II	IS Station III	IS Station IV
5.7	3.0	2 ,5	4.4
5.0	3.8	6.3	4.8
4.1	2.3	5.5	2.1
4.8	1.3	4.9	5.9
6.1	1.2	2.5	4.4
5.6	1.7	6.3	10.5
5.5	1.3	5.5	3.9
3.7	0.7	4.9	3.5
5.8	3.2	3.1	9, 3
3.2	3.9	2.9	7.1
4.4	3.1	2.7	0
2.7	3.8	9.8	8.2
3.5	1.5	8	7.3
1.1	2, 0	6.8	0

Cluster Analysis

In Figure 1. shows the distance between each station I of the 10 observation plots. Plots that are close together and connected by connecting lines show that the distance between the two plots is closer when compared to the other plots. The dendogram image shows the separation of each plot into several groups, namely: the first group consisting of plots 2, 6, 5, 3 and 4.

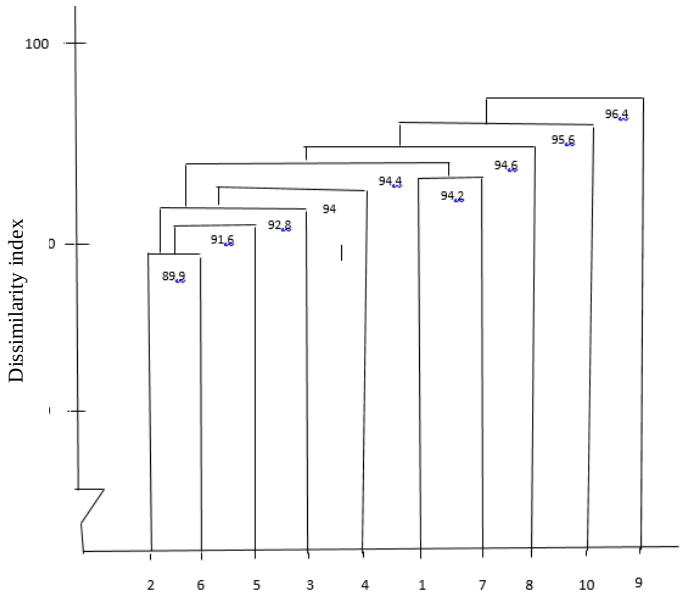

Figure 1. Dendogram Station I

This indicates that the types of insects in plot 2 are the same as in plot 6, and the types of insect species in plot 5 are closer to plots 2 and 6. Plot 3 is closer to plots 2, 6, and 5. Plot 4 is closer to plots. plot 3. The second group, namely plots 1, 7, 8, and 10 means that the types of insect species in plot 1 are the same as plot 7, and plot 10 is closer to plot 8. The last plot is the type of insect species that is farthest from plot 2, 6, 5, 3, 4, 1, 7, 8, 10 is plot 9 which shows that there are differences in insect species that are farthest from the other plots.

In Figure 2. It can be seen that the first group that has the most similar level of kinship is plots 2, 7, 4, and 9. The types of insect species in plot 9 are the same as plot 4, and plot 7 is the same as plot 2, while plot 7 is more like plot 4. The second group is plots 1, 5, 8, and 3. The types of insect species in plot 5 are the same as plot 8 and closer to plot 1. Plot 3 is the most similar to plot 5. The last two plots with the most distant species are plot 10 and plot 6.

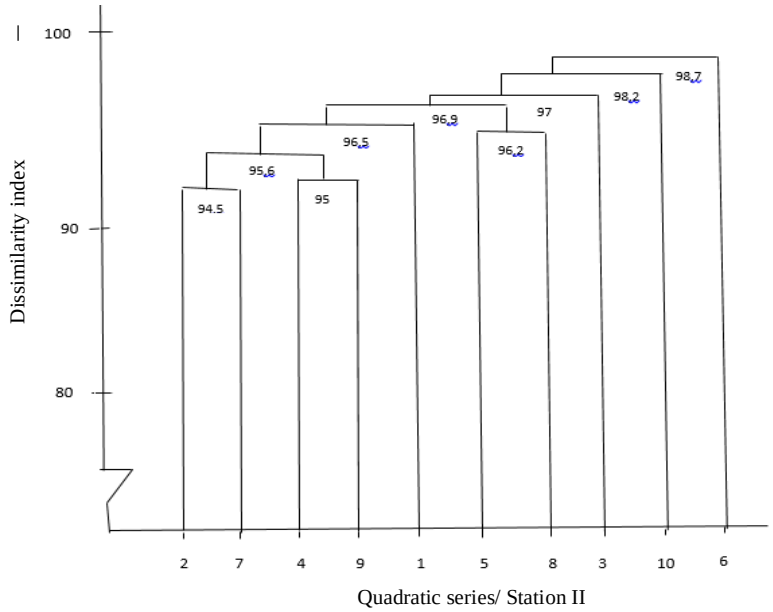

Figure 2. Dendrogram Station II

In Figure 3. It can be seen that the first group that has the level of species similarity is plots 2, 4, 5, and 1. Plot 2 types of insect species are the same as plot 4, and Insects in plot 5 and plot 1 are the same as plot 2 and plot 4. The second group is plots 8, 9, 10, and 6. The types of insect species in plot 8 and plot 8 are the same, plot 10 has a closer relationship with plot 9 and plot 8. While plot 6 is closer to plot 10. The most distant insect species similarity level from plots 2, 4, 5, 1, 8, 9, 10, and 6 is plot 3 and plot 7.

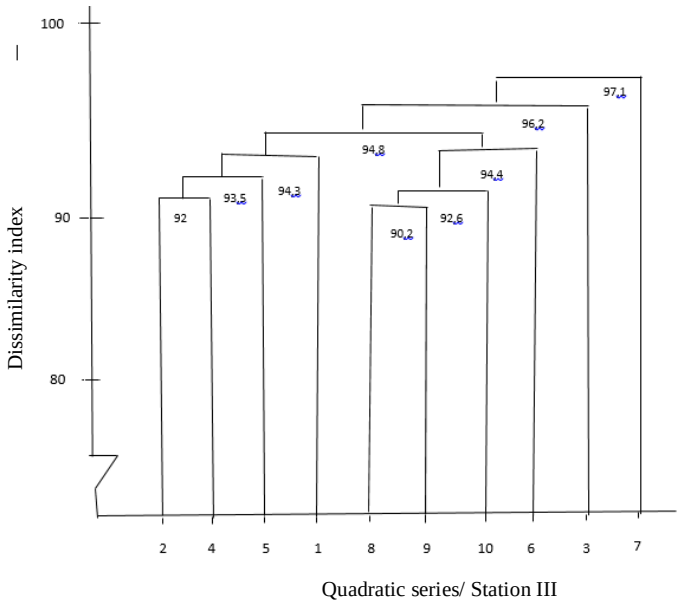

Figure 3. Dendogram Station III

In Figure 4. It can be seen that plot 1 is the same as plot 3, while plot 6 is the same as plot 8. Plot 5 is the same as plot 10, and plot 7 is the same as plot 9. The insect species in plot 10 are closer to plot 2, while the Insects in plot 4 are closer to plot 7 and plot 9. Plot 4 is the plot that has the furthest level of similarity between plots 1 and plot 3. From the results of the dissimilarity index, it can be seen that the greater the dissimilarity index value for each observed plot is compared, the lower the similarity.

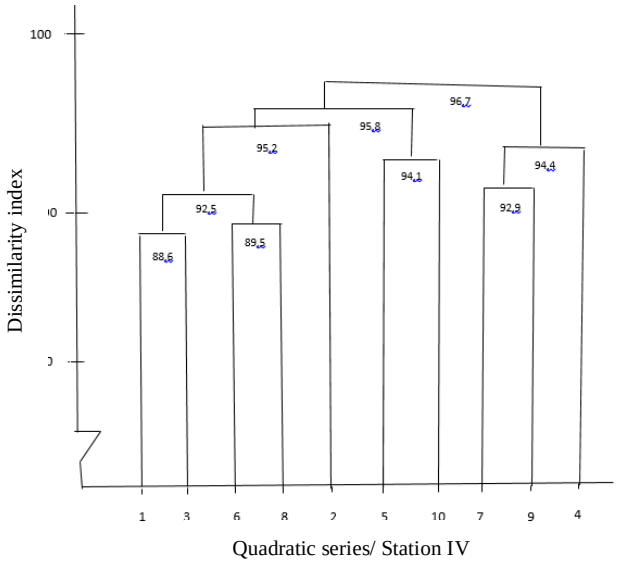

Figure 4 Dendogram Station

IV. Discussion

Insect Distribution Patterns

Based on the results of research conducted at 4 observation stations, a distribution value of 2.48 was obtained where the distribution pattern of insects in the observation station area was clustered. The nature of the spread of clusters is generally possessed by insects because of the tendency to clump together, gathering from various degrees representing the most common traits. Insects that have the ability to group are usually caused by the presence of limiting factors for the existence of the population[14].

The distribution patterns of an area can be influenced by the degree of socialization within a population, interactions with other species, the availability of resources, and so on. Dispersive factors can cause the distribution of members of the population. The most common insects found are ants. Ants can be used as one of the bioindicators of an ecosystem. Ants and plants have a great reciprocal relationship, namely as pollinators and can also provide fertilizer to plants. Ants can also serve as decomposers, pollinators, create soil aeration, predators and indicators15.

Diversity Index

Diversity of a species is said to be high if it has a high complexity in a community caused by the very high interactions of species that occur within a community and the presence of various types of constituent species. Said to be low species diversity in a community if the species that are in a community has a small amount and species that occupy a dominant16.

Based on the results of research at the four stations found 51 species of insects belonging to 13 orders. From the research results, it is known that the order of Hymenoptera is a group of orders with the most species of insects found, namely 12 species and followed by the order group of Coleoptera with 10 species. This indicates that these two orders have a wide distribution area and high adaptability[17]. Ants, which are an order of Hymenoptera, are the most dominant group of terrestrial animals in the tropics, and have an important role in living ecosystems. The presence of ants on the ground (terrestrial) and on the tree (arboreal) is quite diverse because these two areas have a fairly diverse availability of food supplies. Black ants were more often found at each station because black ants were more active in looking for food supplies and could adapt better to the existing habitat conditions[18].

Frequency of Presence

The presence of insects in a plant is influenced by a mechanism *bottom-up*, namely the condition of nutrients in the soil will affect the performance of the plant and will subsequently affect the presence of these insects. The relationship between plant performance and visitors (herbivorous insects and pollinators) is determined by various attractants, including the feed ingredients found in flowers (pollen, nectar, water, etc.), the smell of the attractant, and the shape of the flower. sexually alluring[19].

The Similarity Index (Similarity Index)

The species similarity index is needed to determine the level of species similarity between communities in the observed habitat. If the similarity between 80 – 100% is considered the same, 50 – 80% is considered different and < 50% is considered significantly different. Environmental factors also affect the survival of insects, namely temperature, humidity, and wind speed.

Cluster Analysis

The existence of a type of insect in a habitat is influenced by environmental factors, namely air temperature, humidity, light, vegetation and food availability[20]. Insects have a certain temperature range in which insects can live, insects will die if they pass this tolerance range[21]. Further Handani et al. (2014) explained that temperature has a very important influence on the physiological processes of insects. Temperature will affect insect activity, distribution, growth and reproduction of insects[22].

V. Conclusion

The pattern of distribution of insects at 4 stations is 2.48, where the pattern of distribution of insects is clustered. Insect species diversity index at all stations ranged from 1-1.18 so it was included in the low category. Insects that have a high frequency of presence are mosquitoes which have a value of 62.50%, while insects that have a low frequency of presence are 18 types of insects which have a value of 3.13%. The Similarity Index (IS) at station I has the highest index value of 10.1 and the lowest index value of 1.1. At station II it has the highest index of 5.5 and the lowest index value is 0. At station III it has the highest index of 9.8 and the lowest index value of 2.5. Station IV has the highest index of 11.4 and the lowest index value of 0. The similarity index of the four stations has the highest value of 11.4 and the lowest value of 0. The dissimilarity index value of each station ranges from 92 and the farthest level the resemblance is 98.

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