JOURNAL OF NATURAL SCIENCES AND MATHEMATICS RESEARCH

Diversity of soil Arthropods in Red Chili (*Capsicum annuum* L.) farm in Sindumartani Village, Ngemplak, Sleman, Yogyakarta

Ichsan Luqmana Indra Putra[1]*, Andika Setyo Budi[1]
[1]Laboratory of Ecology and Systematics, Biology Department, Universitas Ahmad Dahlan, Indonesia

Abstracts

Corresponding author:
ichsan.luqmana@bio.uad
.ac.id

The purpose of this study was to identify soil arthropods and calculate the index of diversity, richness, evenness, dominance and importance index in chili farming land, Sindumartani Village, Ngemplak, Sleman, DIY. The research was conducted by monitoring the research location, sampling and data analysis. The method used is to use a pitfall trap. Data collection was carried out at 3 locations by placing sampling plots at 4 pitfall traps 40 m longEach research location was named station 1, station 2 and station 3. Then the data were analyzed using the formula for diversity index, wealth, evenness, dominance and important value index. The results showed that the soil arthropods found were 8 orders, 11 families and 15 species. The calculation results obtained from the diversity index value (H`) at station 1 is 1.10986, at station 2 is 1.09405 and at station 3 is 1.17118. The value of the species richness index is obtained from data at station 1 which is 1.40877, at station 2 is 1.99049 and at station 3 is 1.79858. The value of the species evenness index obtained by data at station 1 is 0.48201, at station 2 is 0.45208 and at station 3 is 0.50864. The dominance index value obtained by data at station 1 is 0.51820, station 2 is 0.56397 and at station 3 is 0.50471.

1. Introduction

Soil is a living ecosystem in which there is an abundance of various types of microbes and invertebrate animals including soil arthropods. The diversity of soil arthropods found in the soil has a lot of influence on the biological, physical and chemical factors of a soil ecosystem so that the presence of soil arthropods can play a role in fertility, soil productivity and good bioindicators for an ecosystem, in this case agricultural ecosystems [1].

Research on the diversity of soil arthropods that has been carried out on chili

plantations in Sigi Regency, among others, Agustinawati et al [4], found 9 orders of soil arthropods and 13 families. In the research of Ma`arif et al [5] in Tabanan, Bali. Soil arthropods found included the Order Hymenoptera, Coleoptera, Orthoptera, and Dermaptera and some but not many were the Order Homoptera, Hemiptera, and Diptera. Meanwhile, research by Sumarauw et al [6] found an abundance of 12 types of soil insects consisting of 8 orders.

Sindumartani Village is one of the villages in the Ngemplak District in Sleman Regency and includes villages that make chili plants as the main commodity of agricultural products. However, research on soil arthropods in chili farms, especially in the study of diversity in Sindumartani Village, is still not available, so the researchers intend to conduct research on the diversity of soil arthropods in chili farms in the area. This research was conducted to identify the diversity of soil arthropods based on the taxonomic level of soil arthropods on chili farms in Sindumartani Village, Ngemplak, Sleman, Yogyakarta Special Region with the hope of adding information related to soil arthropod diversity.

2. Experiments Procedure

The steps to be taken in data collection are as follows:

Research site monitoring

Monitoring the location of the research site as a direct reference to the condition of the research location with the aim of knowing the place of research and then setting it as a sampling location. Determination of the location based on the presence of chili farming areas. As for the location of the research, it is on a chili farm owned by residents in Sindumartani Village, Ngemplak District, Sleman Regency, Yogyakarta Special Region. The scheme for

determining the location of the sampling plot was carried out using a 40 m^2 transect method divided into 4 areas (1 area: 10 m2) with three replications. Every 10 meters a pitfall trap is placed [7] and a yellow pan trap [8] according to the plot placement scheme.

Sampling Stages

The location to be observed is the Chili Farming Land, Sindumartani Village, Ngemplak Regency, Sleman District, Special Region of Yogyakarta. An observation point was determined in the chili farming area with a 40 m transect line which later every 10 m a pitfall trap plot would be installed for sampling. In each sampling plot, 4 pitfall traps were placed every 10 m on the 40 m transect line. Each data will be named station 1, station 2 and station 3. Observed abiotic environmental indicators including (pH and soil moisture with a soil tester, humidity of air temperature with a Thermohygrometer).

Sampling was carried out for 9 days with an interval of 3 days. Then a pitfall trap was prepared to catch the arthropods on the ground. Pitfall traps are placed at 16 points that have been spread horizontally on chili farming land. The pitfall trap is placed at ground level. Pitfall traps that have been installed every morning at 06.00 then pick up the next day at 06.00. Pitfall traps are made of clear plastic cups that have previously been filled with a liquid detergent water mixture in a ratio of 1:3 in 100 ml of clean water [9]. Samples of soil arthropods that had been trapped in the Pitfall trap were taken and then the specimens were rinsed with clean water and put into a clock bottle that had previously been given 70% alcohol as an arthropod collection and brought to the laboratory for identification.

Data analysis

The data analysis in this diversity research is using the calculation of the Species Diversity Index and the Dominance Index. As for the species diversity index, it can be calculated using the Shannon-Wienner formula as follows [10]:

$$H` = -\Sigma\ pi\ Ln\ pi \qquad (1)$$

where: H` is Shannon-Wiener diversity index, Pi is Proportion of the i-th species in the total sample, and ln is Natural logarithm.

According to Konopinski [11], the value of H` is defined as follows:

H` = < 1 : Low diversity; H` = 1 - 3 : Medium diversity; and H` = > 3 : High diversity.

3. Results and Discussion

The results showed that the diversity and dominance index values at station 1 were 1.41 and 0.52; at station 2 the diversity and dominance index values are 2.01 and 0.56; while at station 3, the diversity and dominance index values were obtained at 1.80 and 0.51. Based on the results of the study, it was found that the value of species diversity from station 2 was higher than other stations 1 and 3. This was because at station 2, there were more species than stations 1 and 3, namely 11 species.

The value of the Dominance Index obtained at each station shows the same result, which is in the range of 0.5. This means that the dominance of the three stations is moderate and the community is stable. Soil arthropods found at station 1 on chili farms in Sindumartani Village, Ngemplak, Sleman, Special Region of Yogyakarta were obtained as many as 595 individuals consisting of 6 orders and 7 families. The orders found included Orthoptera, Hymenoptera, Araneae, Coleoptera, Diptera and Decapoda. One of the dominant orders is the Hymenoptera Order of the ant group (Figure 1).

Figure 1. Order Hymenoptera Family Formicidae found in research

Soil arthropods found at station 2 on chili farms in Sindumartani Village, Ngemplak, Sleman, Yogyakarta Special Region were obtained as many as 152 individuals from 6 orders and 7 families. The orders found included Orthoptera, Hyemnoptera, Araneae, Coleoptera, and Diptera. Soil arthropods found at station 3 on chili farms in Sindumartani Village, Ngemplak, Sleman, Yogyakarta Special Region were obtained as many as 149 individuals consisting of 6 orders and 8 families. The orders found included Orthoptera, Hyemnoptera, Araneae, Coleoptera, Diptera and Diplopoda. One of the less dominating orders is the Decapoda Order (Figure 2).

Soil arthropod diversity is determined by several factors that affect the presence and abundance of soil arthropods [20,21]. These factors include temperature, soil acidity (pH) and soil moisture. In addition, litter thickness can also affect the level of diversity and abundance of soil arthropods in an ecosystem [2,3]. The density and thickness of the litter found on the soil surface on chili farming lands indicate that if the availability of food in sufficient quantity will result in the value of the soil arthropod diversity index in chili farming

land being high, and vice versa [4]. In addition, the thickness of the litter can also be used as a place to lay eggs or shelter from predators.

Figure 2. Order Decapoda found in research

The results of temperature measurements at station 1 ranged from 25.7 - 27.3oC, at station 2 it ranged from 24 - 26.5oC and at station 3 it ranged from 25.7 - 26.3oC. Foraging activities of soil arthropods are directly affected by temperature factors [12, 13]. According to Ghiglieno et. al. [14], temperature is one of the factors that affect the high and low diversity of arthropods, especially soil arthropods. If an ecosystem has a high temperature, soil arthropods may die or migrate to other places [15, 16].

The results of soil pH measurements at station 1 got a value of 7, while at stations 2 and 3 had the same value, namely 8. The degree of acidity (pH) is one of the factors that affect the level of diversity of soil arthropods. According to Menta & Remelli [17], the optimum condition of pH in good soil for the survival of soil arthropods is 6-8. If the soil pH in an area has a pH value that is either too acidic or too alkaline, it can be said that arthropods will have a diversity index value. small ones [18,19].

4. Conclusion

The conclusion of this research is that the diversity index value (H`) at station 1 is 1.41; station 2 of 2.01; and station 3 of 1.80. The value of the dominance index obtained in this study is at station 1 of 052; station 2 of 0.56; and at station 3 of 0.51.

Acknowledgment

References

[1] Jumar, "*Entomologi Pertanian*," Jakarta: Erlangga, 2000.

[2] J.G. Palacios-Vargas, G. Castano-Meneses, J.A. Gomez-Anaya, A. Martinez-Yrizar, B.E. Mejia-Recamier and J. Martinez-Sanchez, "Litter and soil arthropods diversity and density in a tropical dry forest ecosystem in Western Mexico," *Biodiversity Conservtion*, vol. 16, pp. 3703-3717, 2007.

[3] G.O. Sopsop and L. Lit. Jr. Ireneo, "Soil-litter arthropod assemblage in dipterocarp forest, agroforestry area and mahogany plantaton in Makiling Forest Reserve, Laguna," *Journal of Nature Studies*, vol. 14, no. 1, pp. 47-65, 2018.

[4] Agustinawati, M.H., Toana, dan A., Wahid, "Keanekaragaman arthropoda tanah permukaan tanah pada tanaman cabai (*Capsicum annuum* L.) dengan sistem pertanaman yang berbeda di Kabupaten Sigi, *Jurnal Agrotekbis*, vol. 4, no. 1, pp. 9, 2016.

[5] S. Ma`arif, N.M., Suartini, dan I.K. Ginantra, "Diversitas serangga permukaan tanah pada pertanian holtikultura organik di Banjar Titigalar, Desa Bangli, Kecamatan Baturiti,

Kabupaten Tabanan. Bali, *Jurnal Biologi*, vol. XVIII, no. 1, pp. 28-32, 2014.

[6] I.K. Sumarauw, R., Siahaan, dan E.L. Baldeng, "Keanekaragaman fauna tanah pada agroekosistem tanaman tomat (*Solanum lycopersicum* L.) di Desa Raringis, Langowan Barat, Minahasa, Sulawesi Utara, *Jurnal Biologi*, vol. 8, no. 3, pp. 157, 2019.

[7] I.L.I. Putra dan H.N.S. Sahnan, "Inventory of predatory insects in banana germplasm Umbulharjo Yogyakarta," *Journal of Biotechnology and Natural Science*, vol. 1, no. 1, pp. 1-11, 2021.

[8] I.L.I. Putra dan L.B. Utamie, "Keanekaragaman serangga musuh alami pada tanaman cabai di Desa Wiyoro, Kecamatan Banguntapan, Kabupaten Bantul, Yogyakarta," *Al-Kauniyah*, vol. 13, no. 1, pp. 51-62, 2020.

[9] I.L.I. Putra, H. Setiawan, dan N. Suprihatini, "Keanekaragaman jenis semut (Hymenoptera: Formicidae) di sekitar Kampus 4 Universitas Ahmad Dahlan Yogyakarta," *Biospecies*, vol. 14, no. 2, pp. 20-30, 2021.

[10] S.M. Adelusi, R.T. Ada, and E.A. Omudu, "Diversity and abundance of insects species in Makurdi, Benue State, Nigeria," *International Journal of New Technology and Research*, vol. 4, no. 6, pp. 52-57, 2018.

[11] M.K. Konopinski, "Shannon diversity index: A call to replace the original Shannon's formula with unbiased estimator in the population genetics studies," *PeerJ*, vol. 8, pp. 1-16, 2020.

[12] P. Jayatilaka, A. Narendra, S.F. Reid, P. Cooper and J. Zeil, "Different effects of temperature on foraging activity schedules in sympatric *Myrmecia* ants," *The Journal of Experimentl Biology*, vol. 214, pp. 2730-2738, 2011.

[13] B.C. Lister and A. Garcia, "Climate-driven declines in arthropod abundance restructure a rainforest food web," *PNAS*, vo. 115, no. 44, pp. 1-10, 2018.

[14] I. Ghiglieno, A. Simonetto, F. Orlando, P. Donna, M. Tonni, L. Valenti and G. Gilioli, "Response of the arthropod community to soil characteristics and management in the Franciacorta Viticultural Area (Lombardy, Italy)," *Agronomy*, vo. 10, no. 740, pp. 1-15, 2020.

[15] P. Kardol, W.N. Reynolds, R.J. Norby and A.T. Classen, "Climate change effects on soil microarthropods abundance and community structure," *Applied Soil Ecology*, vo. 47, no. 1, pp. 37-44, 2011.

[16] T. Jaworski and J. Hilszczanski, "The effect of temperature and humidity changes on insects development and their impact on forest ecosystems in the context of expected climate change," *Forest Research Papers*, vo. 74, no. 4, pp. 345-355, 2013.

[17] C. Menta and S. Remelli, "Soil health and arthropods: From complex system to worthwhile investigation," *Insects*, vol. 11, no. 54, pp. 1-21, 2020.

[18] G. Castano-Meneses, I. Mercado, N. Garcia-Calderon and J.G. Palacios-Vargas, "Correlation between arthropods and physicals and chemical characteristics of water and soil retained in *Tillandsia violacea* (Bromeliaceae) in an Abies-Quercus Forest in Central Mexico," *Applied Ecology and Envronmental Research*, vol. 11, no. 1, pp. 179-922, 2014.

[19] V. Nsengimana, B.A. Kaplin, F. Francis and D. Nsabimana, "Use of soil and litter arthropods as biological indicators of soil quality in forest plantations and agricultural lands: A review," *Faunistic Entomology*, vol. 71, pp. 1-12, 2018.

[20] B.Y. Schindler, A.B. Griffith, and K.N. Jones, "Factors influencing arthropod diversity on green roofs," *Cities and The Environment*, vol. 4, no. 1, pp. 1-20, 2011.

[21] H. Zayadi, L. Hakim, and A.S. Leksono, "Composition and diversity of soil arthropods of Rajegwesi Meru Betiri National Park," *The Journal of Tropical Life Science*, vol. 3, no. 3, pp. 166-171, 2013.