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Effect of Land Altitude on Pollen Diameter *Xylocopa* spp. in Central Sulawesi, Indonesia

Masrianih[1], I Made Budiarsa[2], Fatmah Dhafir[3], Manap Trianto[4]

[1]Department of Biology Education, Faculty of Teacher Training and Education, Tadulako University, Palu City, Indonesia
[2]Department of Biology Education, Faculty of Teacher Training and Education, Tadulako University, Palu City, Indonesia
[3]Department of Biology Education, Faculty of Teacher Training and Education, Tadulako University, Palu City, Indonesia
[4]Department of Biology Education, Faculty of Teacher Training and Education, Tadulako University, Palu City Indonesia

Abstract:- Pollen is used by bees as a source of protein to support life and increase bee productivity. The sizes and types of pollen carried by bees vary greatly. Plants originating from the highlands are likely to produce pollen diameters that are different from those from the lowlands. It is necessary to measure the diameter of pollen that honey bees feed from different plant types to find out the food source that bees prefer. This research aims to determine the effect of height on the diameter of pollen from various types of plants carried by honey bees to increase production. The research method used in this research is field experimental. The research design used a completely randomized design (CRD) linear model with 3 altitude treatments, namely height 0-100 masl (P1), height 400-499 masl (P2) and height 800-899 masl (P3). The research results show that altitude has a very real influence (P<0.05) on bee pollen diameter. The largest average pollen diameter located at P2, namely 53,260c ± 5,703 µm for pollen width (Equatorial) and 58,144c ± 5,894 µm for pollen length (Polar). Then the average of the second diameter at height P3, namely 47.825b ± 5.426 µm for pollen length (Polar) and 51.435b ± 5.867 µm for pollen width (Equatorial). Apart from that, the smallest average pollen diameter is located at P1 with pollen width (equatorial) of 32.258a ± 2.544 µm and pollen length (pollen) of 38.157a ± 3.752 µm. To meet pollen needs, bees do not depend on diameter certain things specifically. The largest pollen that a bee can swallow is pollen in diameter equatorial pollen between 9.63 µm to 94.79 µm.

Keywords:- *Xylocopa spp., Pollen, Diameter, Height.*

I. INTRODUCTION

Xylocopa spp. requires food to sustain its life, either in the form of nectar or flower pollen (pollen). [1] said that almost all flowering plants are used as a food source for honey bees. Pollen is pollen from flowering plants used for pollination of plants. Pollen is obtained from flowers produced by anthers as male sex cells of plants which have different shapes and colors depending on them of plant varieties. The protein content in pollen depends on the type of plant producing the pollen [2]. Pollen is obtained from flowers produced by the antennae of the plant's male sex cells. Pollen is eaten by bees primarily as a source of protein, fat, carbohydrates and some minerals. One bee colony needs about 50 kg of pollen per year. About half of the pollen is used for larval food [3]. This preference (like) for pollen is influenced by color and smell, such as flower color [4]. Bees harvest pollen grains using mandibles and almost all body parts, with very small pollen from flowers which are then placed in corbicula or pollen baskets and carried to the nest in pellet form [5].

The diversity of plant vegetation influences the productivity of bees to produce honey, pollen, royal jelly, propolis and beeswax. The more plants available, the more food there is for bees. An influencing factor in the success of bee cultivation is the availability of bee food in the form of flowering plants. The flowers of these plants contain nectar, pollen, or nectar and pollen which are very influential in the production of honey that will be produced by bees [6].

The height of a place affects the air temperature and humidity of each area, where the higher the place (asl), the lower the air temperature in that place [7]. Air temperature and humidity can affect the diversity of vegetation in an area because each plant needs a certain environment to grow, for example coffee and quinine plants live in highlands and cold temperatures. Parigi Moutong Regency is an area that has varying altitudes ranging from 0 – 3000 meters above sea level (asl). Each height in this area has a variety of plant vegetation at each height. The number of plant varieties as a source of pollen for bees is influenced by the altitude, where the higher the altitude is correlated with the denser the existing vegetation [8]. Differences in altitude will produce pollen in different quantities and sizes [9].

II. MATERIALS AND METHODS

The research method used in this research was a field experiment with 3 variables and 8 replications. The variable observed was the diameter of honey bee pollen found at different heights according to the terrain classification. Determining the sampling location is done by looking at the location point map on the smartphone's Global Positioning System (GPS) based on the altitude. In the Smartphone GPS application, the coordinates and altitude of the location are listed, GPS plays an important role in determining accuracy [10]. Then a survey was carried out to determine the presence of bees and plant vegetation.

A. Bee Pollen Collection

Prepare the bees and take them to the research location. Install an artificial pollen trap in the setup and collection tank to collect pollen carried on the bee's limbs. Flower pollen from bees was taken and weighed using a micro digital scale, 0.5 grams for each replication. Pollen is put in an envelope and labeled.

B. Sampling Plant Pollen

Take flower samples from flower plants located at a maximum distance of 500 m from the bee colony by picking flowers that have fully bloomed then put them in an envelope and label them with the species code. The results were photographed and used as comparison material to identify the pollen carried by the bees.

C. Identify Plant Samples

Flower plants taken as samples are photographed to make identification easier. Plant identification is done by asking local residents and using a tropical plant identification book, namely the Flora book written by Dr. C.G.G.J. van Steenis, et al in 2013.

D. Measurement of Bee Pollen Diameter

Pollen samples that have been weighed are placed in a reaction/petri dish. Insert into the tube a sugar water solution with a concentration of 20% (20 grams of sugar dissolved in 100 cc of water) as much as 1:1 (0.5 grams of pollen: 0.5 ml of sugar solution). If the sample is still too concentrated, add diluent so that when the pollen is prepared, it can be observed clearly and does not accumulate. The pollen that was dropped above was diluted, the glass object was then observed under a microscope lens. Observation and taking photos of pollen using a Nikon Eclipse Ci trinocular microscope with a magnification of 10 x 40. Pollen samples from bees were observed and identified by comparing them with pollen samples from flowers. Followed by measuring pollen diameter with the help of NIS Instrument 64 bit software.

E. Data Analysis

The results of observations on additional variables were analyzed descriptively. The main variables of the study were designed using a completely randomized design (CRD) with the following linear model:

$$Yij = \mu + \alpha i + \varepsilon ij$$

Information:
Yij = Diameter of honey bee pollen in treatments 1-3 and replications 1-8. μ = common mean value. αi = influence of heights 1-3. εij = experimental error in experimental units 1-8th repetition of treatment 1-3.

III. RESULTS AND DISCUSSION

A. Air Temperature at the Research Location

Air temperature at the research location was measured using an Innotech brand digital thermometer. Temperature measurements were taken at 07.00 WITA when collecting bee pollen. Based on conditions in the field, the environmental temperature at each altitude have differences. At P1 there is a temperature 24.1ºC, then P2 has a temperature 27.5ºC, then at P3 it has a temperature 23.5ºC.

B. Humidity

Humidity is measured using an Innotech brand thermo hygrometer. Humidity measurements were carried out at the time of sample collection, namely 07.00 WITA. The data obtained is based on conditions in the field, each height has a difference in air humidity, at P1 it has 63% humidity, then at P2 it has 83% humidity, then at P3 it has 84% humidity.

C. Effect of Height on Diameter Bee Pollen

The results of observations of pollen diameter were observed using a Nikon Eclipse Ci microscope with the help of NIS Instrument 64 bit software at various heights. The pollen obtained at P1 was 17 types and 9 plants could be identified, at P2 there were 16 types with 8 types that could be identified, then at P3 there were 17 types of plants and 10 types of plants could be identified. Plant pollen carried by the Apis cerana honey bee has varied shapes, including circular, elliptical and triangular.

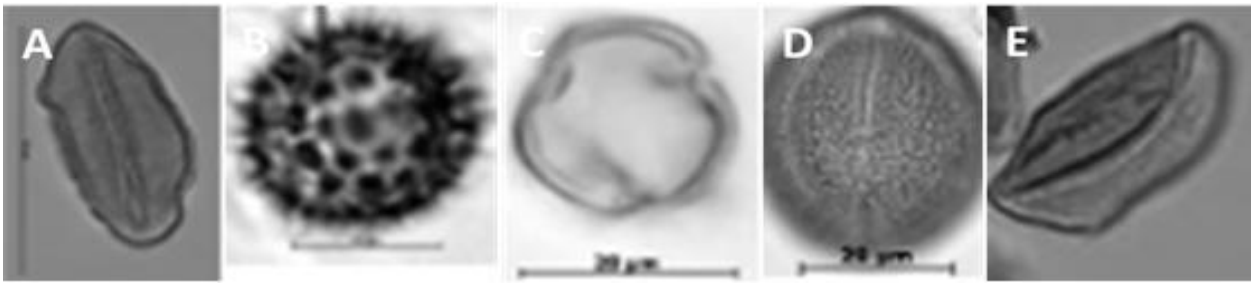

Fig 1. Pollen form A. Oblate, B. Echinate, C. Reticulate, D. Granulate, and E. Psilate

D. Pollen Equatorial Diameter

The results of observations of the equatorial diameter of pollen at various heights showed that altitude had a significant effect ($P < 0.01$) on the equatorial diameter of pollen. The equatorial diameter in P1 has a very significant difference compared to other treatments, while in P2 and P3 there is a significant difference. The treatment height of 0 meters above sea level (P1) has the smallest average equatorial diameter, namely 21.149 equatorial μm. pollen The second average diameter is at an altitude of 874 meters above sea level (P3) with an average equatorial diameter of 36.914 μm. Apart from that, the largest average diameter is at a height of 423 meters above sea level (P2) of 42.159 μm.

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Table 1. Pollen equatorial diameter

Treatment	Equatorial diameter
P1	21.149 ± 1.453 µm a
P2	42.159 ± 4.692 µm b
P3	36.914 ± 4.315 µm b

In P1, more pollen was found from *Cocos nucifera*, *Acasia* sp and *Ageratum* sp. At the P2 collection location, many *L. leucocephala* L., *Acasia* sp and *Mimosa pudica* were found. A part from that, P3 found a lot of pollen from *Zea mays, Acasia* sp, *Mimosa pudica* and *Lantana camara* plants. *Acasia* sp pollen was found in all colonies at all three altitudes, so it can be said that this type of pollen is the main pollen source for *A. cerana*. The types of pollen collected by bees have different equatorial diameters. The largest equatorial pollen diameter of the three treatments taken by the *Apis cerana* honey bee was pollen from the *Zea mays* plant, namely 93.68 µm, while the pollen with the smallest equatorial diameter taken was *Mimosa pudica* pollen measuring 8.52 µm.

The differences in pollen diameter are caused by genetic characteristics and environmental influences at the three altitudes. The genetic characteristic in question is that the pollen carried by bees comes from various different types of plants so they have different shapes and sizes. A part from genetic influences, environmental factors such as the availability of water and mineral nutrients as well as the influence of temperature, humidity and light intensity which are closely related to altitude also have a big influence on pollen diameter and the type of pollen carried by bees. It was proven that the types of pollen found in the three treatments, namely *Acasia* sp pollen taken by bees had different equatorial diameters at each height, P1 had a diameter of 29-34 µm, P2 had a diameter of 32-47 µm and P3 had a diameter of 36-70 µm.

E. Pollen Polar Diameter

From the analysis that has been made, altitude has a very significant effect ($P < 0.01$). The average pollen diameter analyzed from three different altitudes had very significant differences, the largest polar diameter at an altitude of 423 meters above sea level (P2) was 49.033 µm. The second average polar diameter is at an altitude of 874 meters above sea level (P3) with an average polar diameter of 40.324 µm. A part from that, the smallest average polar diameter at a height of 0 meters above sea level (P1) is 27.046 µm.

P2 has a polar diameter. The largest polar diameter of pollen taken by *Xylocopa* spp. from P1, P2 and P3 is *Zea mays* pollen, 97.99 µm, while the smallest polar length is *Mimosa pudica* pollen, 8.93 µm. This is due to differences in vegetation in Parigi Moutong Regency which has many plants that produce pollen with a larger diameter than others. The differences above are due to differences in genetic characteristics and different environments at each different altitude. [11] said that differences in altitude and temperature at these three altitudes affect the genetic characteristics of plants in producing pollen of different sizes.

The difference in equatorial diameter and polar length in pollen above can be interpreted as meaning that bees in taking pollen do not depend on certain specific diameter sizes. Bees can adapt to changes in the diameter of pollen available at various altitudes, so that all three altitudes can support the life of honey bees. The adaptation of bees as pollinating insects that search for pollen can be seen in the large number of hairs on the bee's body and the presence of pollen baskets on the hind legs.

Table 2. Pollen equatorial diameter

Treatment	Polar diameter
P1	27,046 ± 2,641 µm a
P2	49,033 ± 4,983 µm c
P3	40,324 ± 4,756 µm b

The hairs on the bee's body speed up the harvest of pollen, the pollen from all over the body is combed using the legs and put into the pollen basket [12]. Honey bees take pollen based on the availability of abundant flowering plants around the nest with the characteristics stated by [13], namely that the pollen is oily or sticky gummy so it easily sticks to the insect's body. Longest pollen. has various surface ornaments, including bumps, spikes or rough surfaces.

IV. CONCLUSION

This research proves that altitude treatment has an effect on the diameter of plant pollen collected by bees, both polar diameter and equatorial diameter. This is because differences in altitude have different vegetation and climates, resulting in plants with different pollen diameters. In taking pollen as a food source, bees do not depend on a certain pollen diameter to meet the bees' living needs. Bees can adapt to differences in diameter at various heights so that these three heights can support the life of bees. Pollen that can support the life of *Xylocopa* spp bees. in this study was pollen with an equatorial pollen diameter between 8.52 µm to 93.68 µm and a pollen polar diameter of 8.93 µm to 97.99 µm.

➢ *Author Contributions*

MM and MT surveyed the region for collection of pollen and performed the laboratory analysis. IMD, FD, and MT carried out the results analysis, manuscript writing and figures charting. MM performed the statistical analysis for this data. All authors in the manuscript have contributed substantially.

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➢ *Conflicts of Interest*

The authors declare no conflict of interest.

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