Insects as Pollinator of *Rafflesia zollingeriana* Koord. Flower in Resort Bandealit, Meru Betiri National Park

H Anggunira, C S Putri, S R Iskandar, B D S Aji, F Hasanah*, R A Rambe, A Setyawan, I Hermawan, R D Permata, I Kismaiyarni, K Syifa, H E Nindiar, N F Haneda, L Rusniarsyah

Department of Silviculture, Faculty of Forestry, IPB University (Bogor Agricultural University), Bogor, Indonesia

*Corresponding author email: hashaascoof@gmail.com

**Abstract.** *Rafflesia zollingeriana* Koord. is a typical Indonesian flora located in Meru Betiri National Park. It is a diecious flower whose need pollinators for its pollination. This study guessed to predict the type of insect pollinators of *R. zollingeriana* Koord. at Bandealit Resort, Meru Betiri National Park (TNMB). Data retrieval uses yellow pan trap and sweeps net for observing flying insects and behavioral observation to deal with insects that are active in *R. zollingeriana* Koord. Measurements of temperature, humidity, and canopy density carried out on sample plots. Estimation of pollinator done by comparing flying insects found with insects that are active in flower. There are 589 individuals of insect trapped consisting of 45 families, 12 orders, and five individuals unidentified. There are four female flowers and one male flower that blooms. Attractive insects as pollinators are Lucilia from Calliphoridae family, Diptera order.

1. Introduction

Indonesia is one of the countries that has abundant types of flora and fauna with diverse characteristics. One of the typical Indonesian flora is the *Rafflesia zollingeriana* Koord. *R. zollingeriana* Koord is a species of Rafflesia that spreads in Java [1, 2], but currently only found in TNMB [3]. Although this flora is endemic in Java, its existence is threatened because its use as a drug and reproductive system is still unknown. Rafflesia is a type of sizeable single-flowered two-house whose reproductive system is still unknown [4]. Rafflesia's reproduction is relatively low due to an unbalanced sex ratio in nature [5]. In addition, the low reproductive capacity may due to the characteristic of the flowers that classified as unisexual and thus require the help of insects in pollination [6].

Insects have various roles in nature, one of which is as a pollinator. Insect pollinators consist of groups of Hymenoptera, Lepidoptera, Diptera, Coleoptera, and Thysanoptera. These insect groups can carry or collect pollen and have different adaptations so that only certain species are capable as fertilizing agents of individual flowers [7]. Insect pollinator of *R. zollingeriana* Koord. flower is not known much yet, therefore a unique study related to insects that act as pollinators of these flowers is needed.

2. Method

This study aims to observe insects that act as *R. zollingeriana* Koord flower pollinators at Bandealit Resort. Sampling plot for data collection was made using purposive sampling. *R. zollingeriana* Koord. serve as a center plot. Two sample plots consisted of 25 working area of 20 m x 20 m established.
2.1. Catching flying insects
Flying insects are captured using the sweep net method and yellow-pan trap. The sweep net method performed by the point count technique on the transect line every 10 m distance on each working area, carried out at 08.00-12.00 AM (GMT+7) and 1.00-4.00 PM (GMT+7). Yellow-pan traps placed in 2 pieces in each work plot. The installation of the yellow-pan trap is carried out for 6 hours starting at 08.00 AM until 4.00 PM (GMT+7).

![Figure 1. Map of trapping](image-url)

2.2. Pollinator insect observation
Observations made after R. zollingeriana Koord blooming. A central trap of 5 m x 5 m made as a boundary for the observation area. Observation with behavioral observation technique was carried out for 10 minutes with three replications for each flower.

2.3. Measurement of environmental factors
The environmental factors measured are temperature, humidity, and canopy density. Temperature and humidity measured with thermometer, while canopy density is measured by using a densiometer.

2.4. Separation and identification of insects
Trapped insects were separated and identified at the Forest Entomology Laboratory, Department of Silviculture, Faculty of Forestry IPB University. The insect identification process is carried out using an insect collection at the Insect Museum of the Plant Protection Department, IPB University as well as insect identification manuals.

2.5. Insect Data Analysis
Analysis is done for composition of orders and families and the number of individuals in each sample plot. The estimation of insect pollinator R. zollingeriana Koord is done by comparing the data of flying insects and behavioral observation data based on the order.

3. Result and discussion
R. zollingeriana Koord. belongs to the family Rafflesiaaceae and is a holoparasitic plant that is entirely dependent on other plants for food needs. This group of plants does not have chlorophyll grains, but has suction or haustorium roots, and is the liana plant of the genus Tetrastigma [4]. According to Lestari et al. [8], R. zollingeriana has an annulus and ramen spreads to the window.

Flying insects in the study area consisted of 12 orders and 45 families and unidentified five individuals with a total of 589 individuals. Sample plot-1 consisted of 10 orders and 28 families, and unidentified two individuals with the number of insects found are 158 individuals. In the sample plot-2, 431 individuals were caught consisting of 8 orders, 32 families, and three unidentified individuals.
The spread of insects is limited by geological and ecological factors so that there are differences in the number of insect species. This difference is due to differences in climate, season, altitude, and type of food [9]. Sample plot-1 located at 176 m asl, while sample plot-2 at 304 m asl. The different altitude supports different numbers of flying insects. In addition, temperature and humidity also affect the presence of insects in each sample plot. Temperature influences insect activity, geographical and local distribution, and development. Humidity affects the evaporation of insect body fluids and the selection of suitable habitats [10]. According to Natawigena [11], insects can move at a minimum temperature of 15°C and a maximum temperature of 45°C.

| Table 1. Number of flying insects by order |
|-------------------------------------------|
| Ordo            | Sample plot-1 | Sample plot-2 |
|-----------------|---------------|---------------|
| Hymenoptera     | 112           | 376           |
| Orthoptera      | 4             | 5             |
| Diptera         | 18            | 14            |
| Homoptera       | 2             | 0             |
| Coleoptera      | 11            | 4             |
| Hemiptera       | 2             | 5             |
| Odonata         | 2             | 0             |
| Lepidoptera     | 2             | 22            |
| Blattodea       | 1             | 0             |
| Mantodea        | 2             | 0             |
| Apachyoidea     | 0             | 1             |
| Dermaptera      | 0             | 1             |
| Unidentified    | 2             | 3             |

Bandealit Resort has an average temperature of 26.11°C, average humidity of 75.69% and average canopy density of 85.73%. The temperature in the Sample plot-1 was 27.09°C with a humidity of 74.63%, while the Sample plot-2 had a temperature of 25.13°C and a humidity of 76.75%. These environmental conditions indicate that the environment still supports insects to move in both sample plots. The number of insects in the Sample plot-2 is higher than the Sample plot-1 because the environmental conditions of the sample plot are more supportive to insects to maintain their water content so that the insect activity found is higher. These different conditions resulted to the different composition and number of insects in each sample plot (Table 1).

According to Lala et al. [12], vegetation structure will form different canopy densities and affect the presence of insects. Canopy density in the Sample plot-1 is 78.13% whereas 93.33% in the Sample plot-2. This condition support the number of insects in the Sample plot-2 higher than the number of insects in the Sample plot-1. Table 1 also showed that in the TNMB Bandealit Resort, insects as a pollinator were exist. These insects belong to the order Hymenoptera, Diptera, Coleoptera, and Lepidoptera [7].

3.1. Predicting pollinator insects Rafflesia zollingeriana Koord

One fresh blooming female flower and one withered blooming male flower found in Sample plot-1. The flowers in Sample plot-2 consist of two rotten female flowers and one fresh blooming female flower.

Figures 2 showed that from the four orders of flying insects that act as pollinators, there were only two orders of active flying insects in the R. zollingeriana Koord. flower, namely the Diptera order (Family Culicidae and Calliphoridae) and the Hymenoptera order (Formicidae family). The Formicidae family that observed active in the flower of R. zollingeriana Koord. were eight individuals crossed the bud, and three individuals crossed the perigon. Two individuals from the Culicidae family crossed perigon and three individuals perched on perigon. The Calliphoridae family were the most active insects in the R. zollingeriana Koord flower, consisted of 15 individuals perched on the perimeter, two individuals perched on the disc, and five individuals entered the flower through the window. Estimation
of pollinators based on insects that move into the flower due to Rafflesia's reproductive organs are under the disc.

![Diagram](image)

**Figure 2.** Insect activity on *R. zollingeriana* in Sample plot-1 (Left) and Sample plot-2 (Right)

Based on the activity of these insects, this study suggested a Calliphoridae family insect from the order Diptera as an insect that play a role in pollinating *R. zollingeriana* Koord. flowers. Insects from the family who are active in flowers in both sample plots are green flies from Lucilia genus. This findings were in line with the statement of Hidayati and Walck [13] that the *R. price* pollinators are Lucilia and Chrysomya. In addition, Chrysomya, Lucilia, and Sarcophaga found in many activities in *R. kerrii* and *R. patma*, so they are act as pollinators of these types.

**References**

[1] Zuhud E A M, Hikmat A, Nadzrun J 1998 Rafflesia Indonesia: Diversity, Ecology, and Conservation [*Rafflesia Indonesia: Keanekaragaman, Ekologi dan Pelestariannya*] (Bogor: The Indonesian Wildlife Fund and Faculty of Forestry IPB University).

[2] Zuhud E A M 1989 Ecological study of *R. zollingeriana* Kds in Meru Betiri National Park, East Java [*Kajian ekologis R. zollingeriana Kds di Taman Nasional Meru Betiri, Jawa Timur*]. (Bogor: IPB University (Bogor Agricultural University))

[3] Darmadja B, Guntoro DA, Rohmah N, Atmodjo ND, Ananda AA 2011 Information Book Rafflesia Flower in Meru Betiri National Park [*Buku Informasi Bunga Rafflesia di Taman Nasional Meru Betiri*] (Jember : Meru Betiri National Park Office).

[4] Hikmat A 2006 *Jurnal Media Konservasi*, 11, 105-108.

[5] Galang R and Madulid D A 2006 A second new species of Rafflesia (Rafflesiaeaceae) from Panay Island, Philippines. *Folia Malaysia*, 7, 1–8.

[6] Zuhud E A M, Hermidiah N, Hikmat A 1999 *Jurnal Media Konservasi*, 6, 23-36.

[7] Siregar A Z, Darma B, Fatimah Z 2014 *Journal of Agroecotechnology*, 2,1640-1647.

[8] Lestari D, Hikmat A, Zuhud E A M 2014 *Botanical Gardens Bulletin*, 17, 69-78.

[9] Borror D J, Triplehorn C H, Jonhson N F 1992 *An introduction to the study of insects* Partosoodjono (Translator) (Yogyakarta: Gajah Mada University Press).

[10] Haneda N F, Kusmana C, Kusuma F D 2013 *Journal of Tropical Silviculture*, 4, 42 – 46.

[11] Natawigena H 1990 *Agricultural Entomology* (Bandung : Orba Shakti).

[12] Lala F, Wagiman F X, Putra N S 2013 *Indonesian Entomology Journal*, 10, 70-77.

[13] Hidayati S N, Walck J L. 2016 *Botanical Gardens Bulletin*, 19, 67 – 78