Butterfly abundance and presence of their host plant at Bantimurung-Bulusaraung National Park, Indonesia

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Abstract. The famous butterfly conservation areas in South Sulawesi, Bantimurung-Bulusaraung National Park, are gradually being replaced by intensively used farmland especially in lowland and submontane regions. The objectives of the research were to identify butterfly species and their host plant served as larvae food, nectar and pollen source in three different altitudes at Bantimurung-Bulusaraung National Park. The research was conducted based on transect methods at Bantimurung-Bulusaraung National Park, Maros Regency, South Sulawesi, Indonesia from April to October 2018. Butterflies and their food were observed in three locations at different altitudes of 0-300 m above sea level (asl), 400-700 m asl, and above 700 m asl. The observation indicates a variation in the butterfly species found in different altitudes based on the presence of host plants. A total of 59 individual butterfly samples collected were divided into four families: Papilionidae (7 species), Pieridae (2 species), Nymphalidae (1 species) and Saturniidae (1 species). A further dispersal study based on seasons is needed in order to build a good taxonomic database for Sulawesi butterflies conservation.

1. Introduction
The extremely high rate of species extinction has been developed in the tropics, where biological diversity can be found the most. However, studies on biodiversity in tropical countries are still lacking due to the shortage of taxonomic and ecological studies. Hence, even a rough estimation of species diversity is still difficult. Forest with different plant types impacts to flower visitors or pollinators such as butterflies [1-3]. Insect community ecologists, working in the tropics, believe that they have special problems compared with their colleagues studying plants and butterflies. The number of species is different in the whole subjects; and with the exception of a few taxonomic groups in which the butterflies are the most prominent, field identification is impossible or very difficult. Under such conditions, butterfly as an important pollinator in nature seems to be one of the most promising materials to examine the present situations of biodiversity and their interaction with host plants in tropical regions. Deforestation together with increased hunting levels has been shown to dramatically effects the island endemic wildlife especially for endemic butterflies [4-5] living in natural habitat [6-8].

Increased habitat diversity in crops can decrease population densities of butterflies in the forest. Conservation is made involving protection and maintenances of the butterfly population in natural habitat [9-12]. In addition, intensive study of host plant demography and interspecific interactions at
particular ecological research sites is necessary. The host plant inventories are more than just species lists but include an estimate of the relative abundance of the consumer butterflies with some basic ecology as well. For example, whether host plants are trees, grasses, epiphytes, information on their basic soil and requirements should be included [7,12,13]. The objectives of the research are to identify butterfly species and their host plant served as larvae food, nectar and pollen sources in three different altitudes at Bantimurung-Bulusaraung National Park.

2. Material and methods

2.1. Field study site
Research was conducted based on transect methods at Bantimurung-Bulusaraung National Park (BBNP), Maros district, South Sulawesi, Indonesia from April to October 2018. Bantimurung-Bulusaraung National Park (4.8012°S, 119.8235°E) is the main part of karst mountain which spreads from Maros to Pangkep districts [14]. The location is a rainfall forest and suitable habitat for the butterfly. The elevation of the area up to 100 m above sea level with an average precipitation of approximately 1.800 – 2.500 mm per year. Minimum and maximum air temperature ranging from 22 - 31°C, relative humidity ranging 68 – 85% and soil pH of 5.47 – 6. BBNP contains karst mountain, rainfall forest, waterfall and Bantimurung river as an important clean water supply for the local community surrounding the conservation areas. The area in the different altitudes started from waterfall to karst mountain [15]. Samples were taken from three locations in different altitudes (A = 0 - 300 m; B = 400 – 700 m; C = > 700 m). The activities conducted at five samplings in every location along transects according to the methods developed by Pellet et al. [16] and Pollard and Yates [17].

2.2. Butterfly observation
All butterflies using plants for living sources were recorded. The observation was conducted once a week from 08.00 am – 13.00 pm. Butterflies were captured using an insect net for identification and tagged with a marker near the abdomen. Butterfly was identified on-site using a magnifying glass and then released to nature [18]. The identification of the butterflies was carried out using available references [10,11,15,19] and the diversity of butterfly was calculated using Shannon-Wiener Index Diversity [9].

2.3. Identification of the butterfly host plants
Butterfly host plant is an important food source for larvae and adults. Host plants were collected from a similar location with a butterfly in three different altitudes. All samples were brought to the Natural Laboratory at BBNP. The identification of the butterfly host plant was carried out using references and scientific sources [19-22].

3. Results and discussion

3.1. Butterfly and host plant preference
The study demonstrated that butterflies visited host plants, particularly with broad leaves in three different altitudes. Common butterfly species have different preferences for their host plant. Different host plant species were visited by butterflies depend on their needs i.e. as a source of larvae food, nectar, and pollen. Female butterflies playing an important role in choosing host plants for their offspring (Table 1).

Aristolochia tagala is one of the important plants in Bantimurung areas. It is suitable as larvae food for Troides spp. because their leaves contain attractant to butterfly namely aristolochic acid, a natural chemical compound that very toxic for another organism [23]. According to Yao [24] A. tagala or pipevine Dutch family Aristolochiaceae, is a climbing plant that has a scattered distribution in primary lowland and hill forest in altitude of 0 m to 350 m. The finding of research Troides spp. and
Pachliopta aristolochiae as a strong competition fed on A. tagala especially in the dry season. This is a fact about the negative effect of replaced forest function on farmland.

Few flowering trees such as Cassia sp., Caesalpinia pulcherrima and Clerodendron japonicum served their flowers contain nectar source to the butterflies. However, many alternative nectar or pollen sources from flowering weeds found around the observation site. Ngatimin et al. [18] found that flowering weed of Lantana camara flowers is a nectar source for Graphium androcles. Similar finding on butterfly nectar sources was reported by Salmah et al [19] in West Sumatra. Butterflies with a specific mouthpart called proboscis, prefer fed on Verbenaceae, Caesalpiniaceae, and Rutaceae [10]. Nectar from flowers varies in their carbohydrate composition. The viscosity and diameter of the flower base affect the easiness of butterfly to feed [13,25,26]. Sugar provides more energy and increasing butterfly fitness i.e longevity and female reproductive capacity. The nectar concentration varies based on season and plant health status. According to Lundgren [26]; Takasu and Lewis [27], nectar concentration generally higher during the dry season. Wacker and Fadmario [28] stated that nectar is not the only source of sugar but also contains nitrogenous substances that improve butterfly fitness.

Table 1. Host plant and its function for butterfly consumers in Bantimurung-Bulusaraung National Park, South Sulawesi.

| Host Plants/Family | Butterfly Consumers | Function in Nature |
|--------------------|---------------------|--------------------|
| Ageratum conyzoides L./ Asteraceae | Pachliopta aristolochiae | B |
| Annona muricata/ Annonaceae | Attacus atlas | A |
| Aristolochia tagala/Aristolochiaceae | Troides helena, Troides haliphron, Pachliopta aristolochiae | A |
| Cassia sp./ Caesalpiniaceae | Eurema sp. | B |
| Caesalpinia pulcherrima/ Caesalpiniaceae | Troides helena, Troides haliphron | B |
| Citrus sp./ Rutaceae | Delias hyparete, Papilio demoleus, Papilio demotion | A,B |
| Cleome rutidosperma/ Capparidaceae | Catopsylla pomona | B |
| Clerodendron japonicum/ Verbenaceae | Papilio blumei, Troides helena, Troides haliphron | B |
| Crotalaria striata L./ Papilionaceae | Papilio blumei, Catopsylla pomona | B |
| Hibiscus rosa-chinensis/ Malvaceae | Troides haliphron | B |
| Lantana camara/ Verbenaceae | Papilio demoleus | B |
| Mimosa pudica/ Mimosaceae | Catopsylla pomona | B |
| Passiflora sp./ Passifloraceae | Graphium agamemnon | B,C |
| Sida rhombifolia/ Malvaceae | Catopsylla pomona | B |
| Syneedrella nodiflora/ Asteraceae | Eurema sp. | B |

Note: A = leaves as larvae food source; B = flowers as nectar source; C = flowers as pollen sources

3.2. Biodiversity of butterfly

Data collected in the recent study show that 59 individual butterflies captured and identified in the location of the research can be categorized into four families: Papilionidae (7 species), Pieridae (2 species), Nymphalidae (1 species) and Saturniidae (1 species) (Table 2). Based on the result from three different locations of butterfly observation, the four families preferred habitat at lowland (0 – 300 m), and three families at medium land (400 – 700 m), respectively. In fact, no butterfly families found in the highland (> 700 m). Based on the observation, many butterfly species were found in
sandy soil near the river. Commonly, butterfly found in sandy soil are for puddling behavior. The behavior means butterfly will find some water contain minerals for themselves and substitute from urine or fruits contain alcohol. In addition, Phon et al., [29] stated that generally, the numbers of each species puddling were significantly correlated with counts of similar species in flight. Finding in observation site, very limited butterfly species puddling in the same places.

Table 2 show that all of the number of Shannon-Wiener Index Diversity butterfly species found to be in low level (H < 1). Climate change from wet to dry season contribute to the butterfly biodiversity. Beside, butterfly behavior have negative impact of their habitat, while the other problem causing a decrease in the number of butterfly in Bantimurung-Bulusaraung National Park because they moved to another place in the rainforest. This condition makes more butterfly in endangered species status [5,18].

| Field study site | Butterfly Family | Species | Elevation (m) | H’ |
|------------------|------------------|---------|---------------|----|
| A (0 - 300 m)    | Papilionidae     | T. Helena | 102           | -0.003 |
|                  |                  | T. haliphron | 115           | -0.017 |
|                  |                  | P. aristolochiae | 120         | -0.012 |
|                  |                  | G. agamemnon | 122           | -0.012 |
|                  |                  | P. blumei | 122           | -0.007 |
|                  |                  | P. demoleus | 122           | -0.012 |
|                  |                  | P. demolion | 208           | -0.017 |
| Nymphalidae      |                  | D. hyparete | 215           | -0.023 |
| Pieridae         |                  | C. pomona | 211           | -0.050 |
| Saturniida       |                  | Eurema sp. | 250           | -0.003 |
|                  |                  | A. atlas (larvae) | 250       | -0.003 |
| B (400 – 700 m)  | Papilionidae     | P. demoleus | 405           | -0.003 |
|                  |                  | T. haliphron | 415           | -0.001 |
| Nymphalidae      |                  | D. hyparete | 410           | -0.001 |
| Pieridae         |                  | C. pomona | 421           | -0.017 |
| C (> 700 m)      |                  | -        | -             | -  |

The recent study confirmed a need for mating areas in different altitudes, an open space to be “butterfly meeting point” and suitable for mating behaviour. Based on visual observation, butterfly prefer location near water with sandy soil. This puddling habit near the specified condition seem to increase the butterflies fitness. According to Pellet et al. [16] and Pullin [1], the endemic forest trees contain more canopies and suitable for protecting the butterfly from extreme condition. The ability in searching and marker their environment is very important for butterfly survival. Studies on pollen dispersal and pollination type in Anthocephalus macrophyllus [30,31] assist to determine whether the species suffering inbreeding depression in the population.

Based function of plants, three butterfly family showed preferences in host plants as a nectar/pollen source and four family preferred their leaves as a food source. Salmah et al. [19] stated that particular P. demoleus and P. demolion butterflies prefer Citrus sp. as nectar and food source for adult and larve.

4. Conclusions

Based on the observation, all of Shannon-Wiener Index diversity of butterfly species are in the lowest level (H < 1). The research presence different number of butterfly species in different altitude based on their needs especially for food presence. For further research a dispersal study based season is necessary in order to build a good taxonomic database for Sulawesi butterflies.
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