Fig visitor's behaviour in Ungaran mountain, Indonesia

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Abstract. Figs (Ficus spp.) has important roles in an ecosystem, for instance as food source for frugivorous, especially birds. The aims of this study were to determine species richness of bird that commonly visited Ficus trees in Ungaran mountain area and analyze their behaviour in dietary among fig visitors. This study used observatory method. Based on preliminary observation, we determined eight species of Ficus tree as samples to be observed according to fruit size and its availability during study. Observations were conducted at 6 - 10 am and 3 - 5 pm. Based on the results, we found 29 species of birds from 16 families and one mammal species who visited Fig trees. The observations showed four different bird activities: only perched, eating fig, eating insects, and eating fruit and insects. Ordination analysis resulted that inter-specific interactions among figs frugivorous tend to use niche partitioning mechanism based on different arrival time and canopy position. This mechanism minimizes the occurrence of competition in obtaining similar resources.

1. Introduction

Fig tree (Ficus spp) is a genus of woody plants belonging to the Moraceae family [1]. Ficus has a variety of habitus, namely trees, climbers, shrubs, epiphytes, and strangulation hemiepiphytes[2]. Ficus consists of about 750 species and distributed in tropical and subtropical areas throughout the world [3]. There are about 72 species on Java island [1].

Ficus has many roles in forest ecosystem. Lateral root system of ficus able to grip soil well, which helps in maintaining water management and preventing erosion [4]. In addition, large and dense canopy of Ficus makes it able to absorb a lot of carbon dioxide. The large Ficus canopy also serves as a shelter for many animals such as birds and insects. Ficus is able to provide fruit in abundance throughout the year [5]. The fruit of Ficus is a source of food for many frugivores. A total of 92 bird species, 12 mammal species, and 8 insect species are known to eat Ficus fruit [6].

The use of ficus by birds is not only in terms of eating fruit. There are three kinds of behaviour of Ficus utilization by birds during the ripening period; eating fruit, eating insects, and only visiting Ficus tree [7]. In addition, fig size affects the number of bird species that eat it. There is a negative correlation between fruit size and the number of fig frugivore birds. The smaller of fruit size, the greater number of bird species frugivores [8].

Mount Ungaran is one of the mountains in Central Java. Mount Ungaran is administratively located in Semarang Regency and Kendal Regency with a peak height of about 2050 m above sea level [9]. The tree vegetation found on Mount Ungaran include Engelhardtia aceriflora, Sterculia macrophylla, Casuarina equisetifolia, Murraya paniculata, Knema glauca, Evodia glabra, Celtis petandra, Terena incerta, Litsea sp., and Ficus sp. Genus Litsea sp. and Ficus are common species that are mostly found here [10]. There are 10 species of Ficus included in the composition of Hornbill bird feed on Mount Ungaran. According to the results of preliminary observations, we determined eight species of Ficus tree as samples to be observed according to fruit size and its availability during study. Observations were conducted at 6 - 10 am and 3 - 5 pm. Based on the results, we found 29 species of birds from 16 families and one mammal species who visited Fig trees. The observations showed four different bird activities: only perched, eating fig, eating insects, and eating fruit and insects. Ordination analysis resulted that inter-specific interactions among figs frugivorous tend to use niche partitioning mechanism based on different arrival time and canopy position. This mechanism minimizes the occurrence of competition in obtaining similar resources.

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Ungaran. These species include *Ficus cubiba*, *Ficus fistulosa*, *Ficus melinocarpa*, *Ficus microcarpa*, *Ficus variegata*, *Ficus ribes*, Jurang, Bulu, Preh honey, and Preh pulutan[11],[12]. Management of a forest area must be supported by adequate ecological data so that all conservation efforts do not fail. Studies to find out basic data on population, distribution, home range patterns, habitat requirements, foraging behaviour, and food availability are essential for animal conservation[13]. One of the important basic data is foraging behaviour. The study of the behaviour of fig frugivores will help reveal the interactions between one species and another and the surrounding environment, so it is very necessary to determine the right conservation actions.

This study aims to examine the behaviour of fig frugivores to determine species composition and interactions among fig visitors. The basic data obtained can be used to predict whether the interactions that occur among fig visitors lead to competition or ecological niches mechanism.

2. Methods
Research was conducted in the Mount Ungaran area of Central Java, specifically in Kalisidi and Gentong Hills during September 2018 - February 2019. The population in this study were all Ficus plants and all bird species found in the Mount Ungaran area. The samples observed were Ficus plants in the Mount Ungaran area which were in the fruiting period and birds that were observed visiting the Ficus plant samples in research sites. The determination of the Ficus samples to be observed takes into account several factors, including access to accessible locations, Ficus in the fruiting and ripening phases, as well as potential data as frugivore feed from previous studies.

Observation method was used in this research. The parameters observed were the species of birds that visited Ficus and their activities. The activities of birds when visiting the sample trees included perching, eating fruit, eating insects, and eating fruit and insects. Observations were made in the morning at 6 to 10 am, and in the afternoon at 3 to 5 pm. This time was chosen because birds are the most active animals in the morning, activities during the day decrease and will increase in the afternoon [14]. Observations on each sample were carried out three times, which were carried out on different days.

Data were analyzed using R statistical program [15]. The ordination method was used to see the pattern of fig visitors based on arrival time, departure time, and ficus canopy section.

3. Results and Discussion
Preliminary observations in the field found some ficus tree species that began to bear fruit. Those species then used as samples for observations of fig visitors activities. The eight ficus species were *Ficus drupacea*, *F. involucrata*, *F. lanata*, *F. microcarpa*, *F. padana*, *F. stupenda*, *F. glaberrima* and *F. villosa*.

*Ficus involucrata* was recorded as the most visited by birds. *Ficus glaberrima*, *Ficus mirocarpa*, and *Ficus involucrata* were categorized as the small fruit size, with a total number of visits was 681 visits, a bigger amount than Ficus with medium fruit category, *Ficus villosa*, *Ficus drupacea*, and *Ficus padana*, which had 392 visits. The smaller the fruit size of the Ficus, the more birds come to visit it [8].

This study only focused on observing fig visitors which active during the day (diurnal). During the observation, most of visitors found active at ficus tree belonged to a group of birds (aves), while the other was a group of mammals, namely Squirrels (*Callosciurus* sp.) from Sciuridae family. Based on the observation, there were 28 species of birds from 16 families visited Ficus tree. Fig visitors’ behaviour showed four different activities (Figure 1); perching only, eating fruit (fig), eating insects, and eating fruit and insects. There were 12 species of birds (Table 1) that were observed consuming fig, and some ate fig and insects on the ficus tree.
Figure 1. Four main activities of fig visitors: perching only, eating figs, eating insect, eating figs and insect.

Table 1. List of fig frugivore birds in Ungaran mountain

| No. | Local name       | Species name              | Family         |
|-----|------------------|---------------------------|----------------|
| 1   | Cabai Bunga-Api  | *Dicaeum trigonostigma*   | Dicaeidae      |
| 2   | Cucak Kutilang   | *Pycnonotus aurigaster*   | Pycnonotidae   |
| 3   | Kadalalan Birah | *Rhamphococcyx curvirostris* | Cuculidae     |
| 4   | Kadalalan Kembang | *Zanclostomus malkoha* | Cuculidae     |
| 5   | Merbah Cerucuk  | *Pycnonotus goiavier*     | Pycnonotidae   |
| 6   | Merbah Corok-Corok | *Pycnonotus simplex* | Pycnonotidae   |
| 7   | Punai Penganten | *Treron grieicauda*       | Columbidae     |
| 8   | Serindit Jawa    | *Loriculus pusillus*      | Psittacidae    |
| 9   | Takur Tulung Tumpuk | *Megalaima javensis* | Capitonidae   |
| 10  | Takur Tenggeret | *Megalaima australis*     | Capitonidae   |
| 11  | Uncal Kouran     | *Macropygia ruficeps*     | Columbidae     |
| 12  | Uncal Loreng     | *Macropygia unchall*      | Columbidae     |

Birds with the highest number of visits were from Capitonidae, Columbidae, and Pycnonotidae families. Ficus visitor birds were dominated by three major groups; cucak-cucakan group (Pycnonotidae), takur group (Capitonidae), and pergam group (Columbidae), about 80% of each group ate fig[2]. Some of the bird activities that can be observed when visiting Ficus included eating, eating both fruit and insects, choosing a perch on the tree canopy, and time to visit Ficus tree. This study recorded that 12 species (39%) of birds ate Ficus fruit, 8 species (29%) ate insects, 2 species (7%) ate fruit and insects, and 7 species (25%) only perched. Merbah and Kutilang (Pycnonotidae) ate fig and insects. Cucak-cucakan birds are primarily fruit-eating birds, although they also eat insects. Abai Bunga-Api (*Dicaeum trigonostigma*) and Punai Pengantin (*Treron grieicauda*) had an eating Ficus fruit percentage of 91% and 84%, higher than Takur (*Megalaima australis*) which was only 64% even though the number of visits was higher.

Capitonidae family birds were the longest visit duration with an average duration of 7 minutes. Punai birds often came in large groups. Cucak-cucakan birds were often seen in pairs or in small
Figure 2. Ordination of fig frugivore bird species (points with different colors) based on the time of arrival (arrival), time of departure (depart), and bird position on tree canopy (site).

Figure 2 shows that the interaction between fig visitors tends to be niche partitioning based on temporal (arrival and departure times) and space (canopy sites). This mechanism minimizes the occurrence of competition in obtaining similar resources. Niche theory predicts that coexisting species will partition resources to limit the effects of interspecific competition[16].

4. Conclusion

Birds of the Capitonidae, Columbidae, and Pycnonotidae families were fig frugivores that most frequently visited several species of ficus trees. The interactions between species of frugivore ficus tend to lead to the division of niches based on visiting times and different canopy areas on the same tree, thus minimizing the occurrence of competition.

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