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RESEARCH ARTICLE

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Diet Composition and Feeding Preferences of Javan Gibbons (*Hylobates moloch*) in the Cikaniki Resort, Mount Halimun Salak National Park

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Abstract
The Javan Gibbon (*Hylobates moloch*) is a frugivorous primate that relies on fruit as the main component of its diet. Environmental conditions can influence food availability for these species, which in turn affects their behavior and survival. However, detailed data in how seasonal variations impact the gibbon's diet remain limited, making it challenging to design effective conservation strategies. Thus, understanding these diet preferences is crucial. To address these knowledge gaps, this study aims to analyze the differences in diet composition and feeding preferences of the Javan Gibbon during different seasons at the Cikaniki Resort, Gunung Halimun Salak National Park (GHSNP). We used scan sampling with a 10-minute interval to record the activity of gibbons continuously from January to December 2022, and we found that the diet composition of Javan Gibbons did not differ significantly between the rainy and dry seasons. A total of 73 plant species from 34 families were consumed by the Javan Gibbon throughout 2022, with the dietary composition consisting of 69% fruit, 19% young leaves, 10% flowers, and 2% invertebrates. Javan Gibbon's food preference in both seasons continued to show fruit as the primary source. The most frequently consumed plants were from the Moraceae family, particularly *Ficus villosa* and *Ficus heteropleura*.

Keywords: feeding ecology, frugivory, seasonal variation, Moraceae

1. Introduction

The Javan Gibbon (*Hylobates moloch*) is an endemic primate of Indonesia, with the remaining population estimated at around 4,000–4,500 individuals (Nijman 2004). It can only be found in the provinces of West Java, Banten, and parts of Central Java at elevations ranging from 0 to approximately 1,600 meters above sea level (Supriatna and Ramadhan 2016). Gunung Halimun Salak National Park (GHSNP) is one area with the largest Javan Gibbons population on the island of Java, with an estimated 900–1,221 individuals (Smith *et al.* 2018). GHSNP is a tropical montane forest area with lowland, upland, and montane rainforests in the West Java–Banten provinces (Galudra *et al.* 2005). The relatively stable and well-preserved forest in GHSNP makes it a highly suitable habitat for the Javan Gibbon and other endemic wildlife species such as the Javan Surili (*Presbytis comata*) and the Javan Lutung (*Trachypithecus auratus*).

The population of the Javan Gibbon continues to decline due to hunting and land conversion (Dewi *et al*. 2016), leading to its conservation status being classified as endangered on the International Union for Conservation of Nature and Natural Resources (IUCN) Red List (Nijman 2020). It is also listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which prohibits all forms of international trade of the species (Nijman 2006). Nationally, the Javan Gibbon is protected under the Wild Animal Protection Regulation No. 266 of 1931 and the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.106/MENLHK/SETJEN/KUM.1/6/2018.

As a frugivorous primate, Javan Gibbon has a natural fruit-dominated diet. In GHSNP from July 2007 to March 2008, the diet consisted of 62.5% fruits, 23.7% leaves, and 11.8% flowers (Kim *et al.* 2011). It is similar to a study on Lowe's monkeys (*Cercopithecus lowei*) in Ghana, which showed differences in feeding preferences between seasons. During the rainy season, Lowe's monkeys consumed more shoots (44.8 ± 3.9%), whereas in the dry season, they consumed more fruit (71.2 ± 3.3%) (Bempah *et al*. 2021). Another study on the Black-crested Gibbon (*Nomascus concolor*) stated that diet composition is not fixed and depends on food availability. The Black-crested Gibbon consumed a lot of fruit in October (82.7%) and April (77.8%) (Fan *et al*. 2009). Flower consumption peaked in April (47.0%) and February (43%), while leaf consumption occurred in December and January when other food types were unavailable. Additionally, different seasons are also factors influencing food availability. Many factors influence the food selection of Javan Gibbons, such as food availability, age, body weight, digestion, and climate. Seasonal variation affects food selection in primates, including the Javan Gibbon (Karyawati 2012). Food availability in GHSNP tends to be low

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during moderate rainfall intensity, between ≥200 and ≤400 mm per month (Dewi 2016).

Based on these considerations, research is needed on Javan Gibbon adaptation to different seasonal conditions, particularly regarding their diet composition and feeding preferences during the rainy and dry seasons. Therefore, this study aims to determine the differences in Javan gibbon diet composition and feeding preferences during the rainy and dry seasons in the Cikaniki Resort, Gunung Halimun Salak National Park.

2. Materials and Methods

2.1 Time and Location

This research was conducted from January to December 2022 at the KIARA long-term research station, located in the Citalahab Forest (-6.741296, 106.523438), Cikaniki Resort, Gunung Halimun Salak National Park, Bogor Regency, West Java Province (Figure 1).

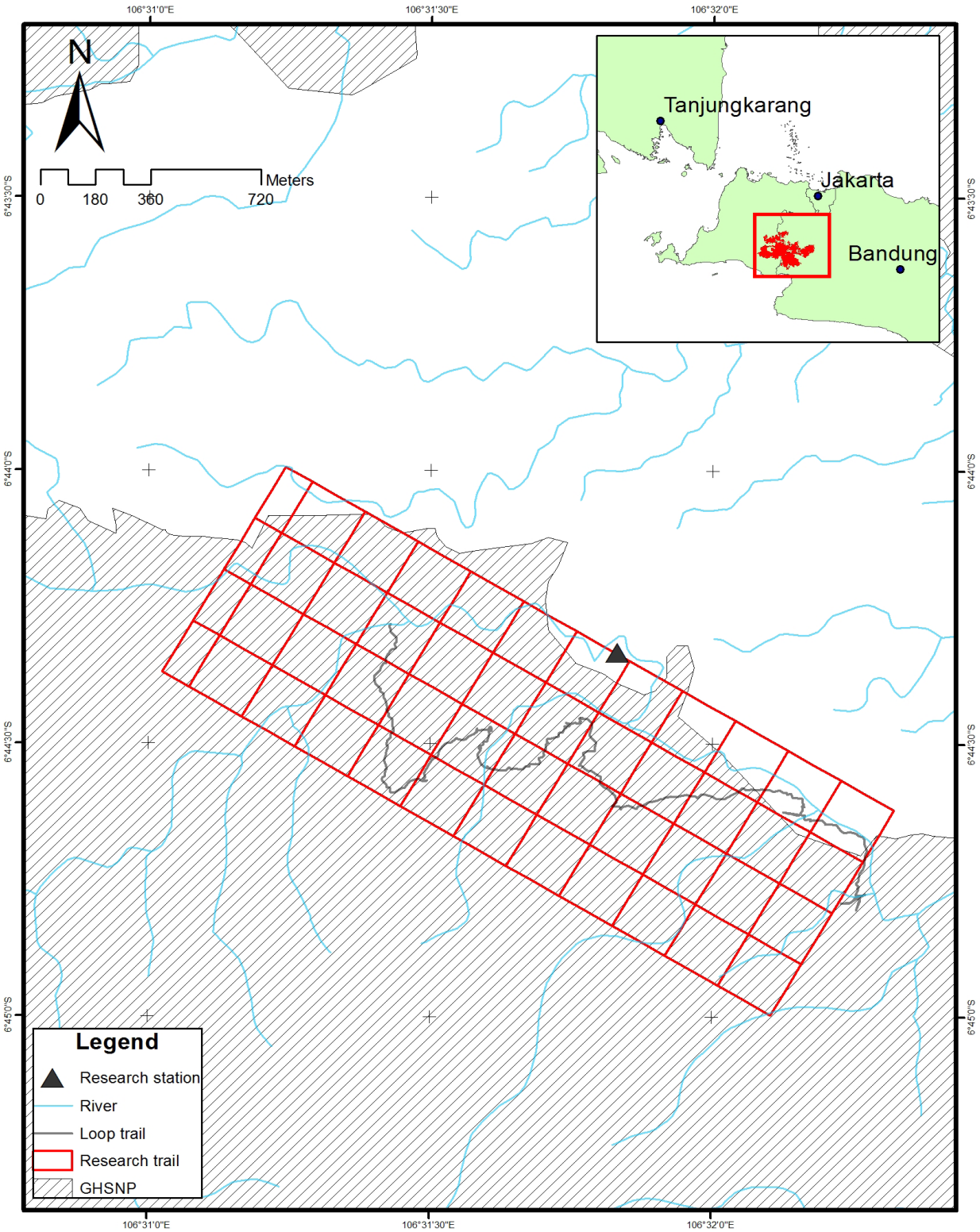

Figure 1. Location map of the study in Citalahab Forest, Cikaniki Resort, Gunung Halimun Salak National Park.

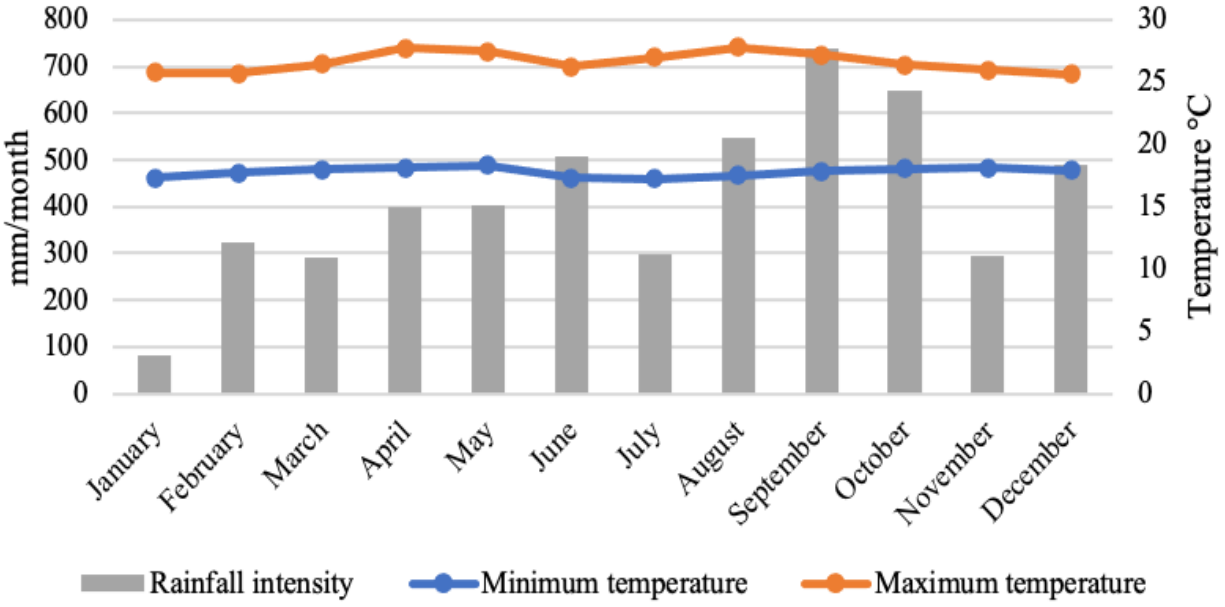

Figure 2. Total rainfall and average minimum and maximum temperatures in GHSNP per month in 2022.

2.2 Data Collection

The data used in this study were monitoring data collected from January to December 2022 by the Javan Gibbon monitoring team of the KIARA Foundation. The data were obtained from three groups of Javan Gibbons: A, B, and S. The individuals observed in this study were adult males and females from each group.

Daily activity observations of the Javan Gibbon were conducted over 86 days, totaling 755 hours and 50 minutes of observation time. Monitoring was carried out Monday to Friday by the Javan Gibbon Monitoring Team from 05:00h to 17:00h, following the gibbons from their sleeping tree to the next sleeping tree. Each group was observed alternately for 2–3 days per week across the three Javan Gibbon groups. The data recorded focused on daily feeding behavior, including the type and part of food plants consumed (fruit, young leaves, and flowers) and other known food sources such as invertebrates. Observations were conducted using the scan sampling method with instantaneous recording at 10-minute intervals (Altmann 1974).

The food plant data obtained through field observations were identified by comparing the observed plant characteristics with an existing database. Local guides familiar with the plant species' regional names also assisted with plant identification in the field.

2.3 Climate Conditions

Based on seasonal forecasts from the Meteorology, Climatology, and Geophysics Agency (BMKG) in 2022, the Cikaniki Resort area in Gunung Halimun Salak National Park experiences the rainy season from September to February and the dry season from March to August (BMKG 2021, 2022). Through our digital temperature data and by using rain gauge, the total annual rainfall in 2022 was 5,018.7 mm, with the highest monthly rainfall recorded in September at 739 mm, and the lowest in January at 80.3 mm (Figure 2). Meanwhile, the average temperature in the study area was 22.18°C, ranging from 16.1°C to 28.07°C (Figure 2).

2.4 Analysis of Data

The recorded data on dominant food plant identification were analyzed descriptively and presented in diagram form using Microsoft Excel 2019. In addition, the parts of the food plants consumed by the Javan Gibbon were recorded and categorized based on the season in which they were consumed (rainy or dry season), then statistically analyzed using SPSS 27 software with the Wilcoxon Signed Ranks Test, due to the non-normal distribution of the data. This analysis provides information on the differences in composition and preferences of food plants consumed by the Javan Gibbon during the rainy and dry seasons.

3. Results

3.1 Daily Activities

The percentage of daily activities performed by the Javan Gibbon in 2022 was as follows: resting 54.43%, feeding 30.18%, moving 11.31%, and social activities 4.08% (Figure 3). These results are consistent with the findings of Kim *et al*. (2011), which reported that the dominant daily activities of Javan Gibbons in the same area were resting (41%), feeding (36%), moving (11%), and social interaction (6%), respectively. The high percentage of resting activity each month and the relatively low movement level suggest that natural food sources within their home range were still sufficiently available, reducing the need for extensive movement or foraging.

3.2 Types of Feed

In 2022, Javan Gibbons consumed 73 plant species from 34 families, consisting of various growth forms:

55% of their food sources came from trees, 40% from lianas, and 5% from epiphytes. In addition to plants, the gibbons consumed invertebrates, accounting for 1% of their diet during the observation period. Moraceae was the most frequently consumed among the plant families throughout the year (Figure 4).

3.4 Composition and Preferences

Based on feeding times, fruit was consistently the most consumed food item by Javan Gibbons. The first recorded feeding activity at 06:00h showed that fruit made up 90.37% of their intake, marking it the peak time for fruit consumption. Young leaf consumption increased toward midday, with the highest recorded at 14:00h, reaching 30.93%. Flower consumption peaked in the late afternoon, at 16:00h., making up 22.33%. Invertebrates were primarily consumed in the morning, accounting for 2.96%. Overall, fruit remained the most consistently consumed plant part by Javan Gibbons throughout the morning, midday, and afternoon (Figure 5).

Fruit consistently remained the top priority and preferred food type for Javan Gibbons, with a percentage of 73% during the rainy season and 64% during the dry season (Figure 6). However, based on the Wilcoxon Signed Ranks Test results, there was no significant difference in diet composition between the rainy and dry seasons ($p > 0.05$). During the rainy season, the gibbons consumed 65 plant species, with a diet composition of 73% fruit, 18% young leaves, 7% flowers, and 2% invertebrates. In contrast, they consumed 57 plant species during the dry season,

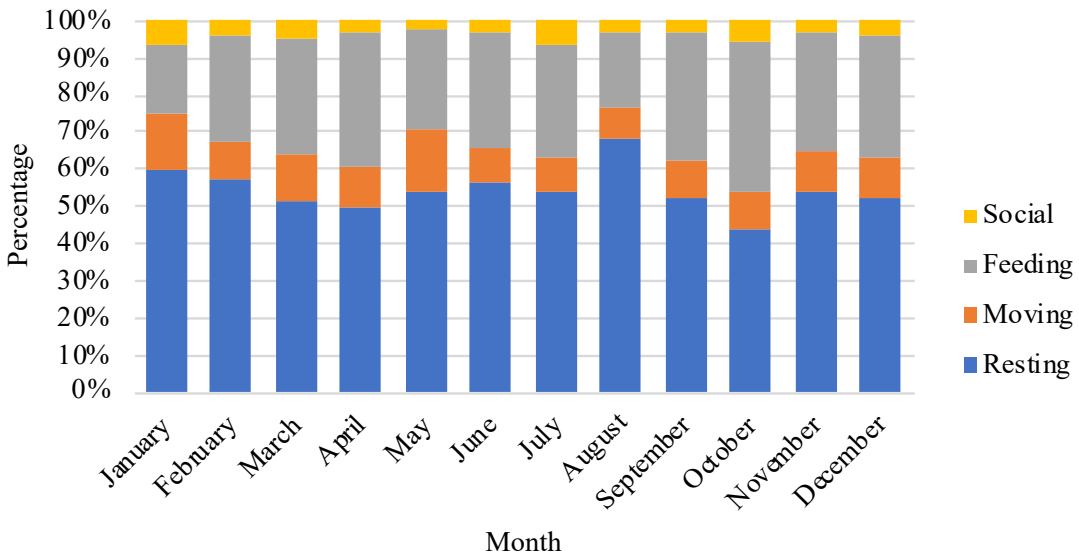

Figure 3. Daily activities of Javan Gibbons in the period January - December 2022.

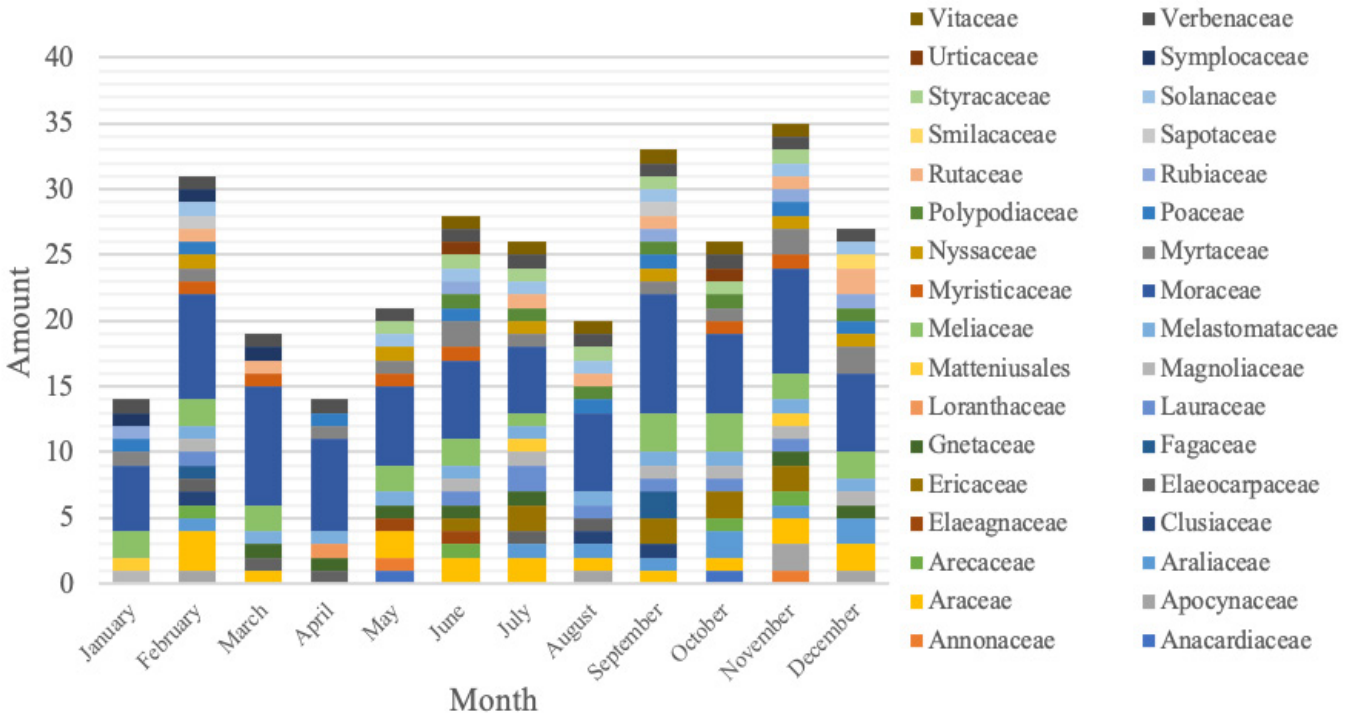

Figure 4. Number of types of Javan Gibbon feed based on family per month at Cikaniki Resort, TNGHS.

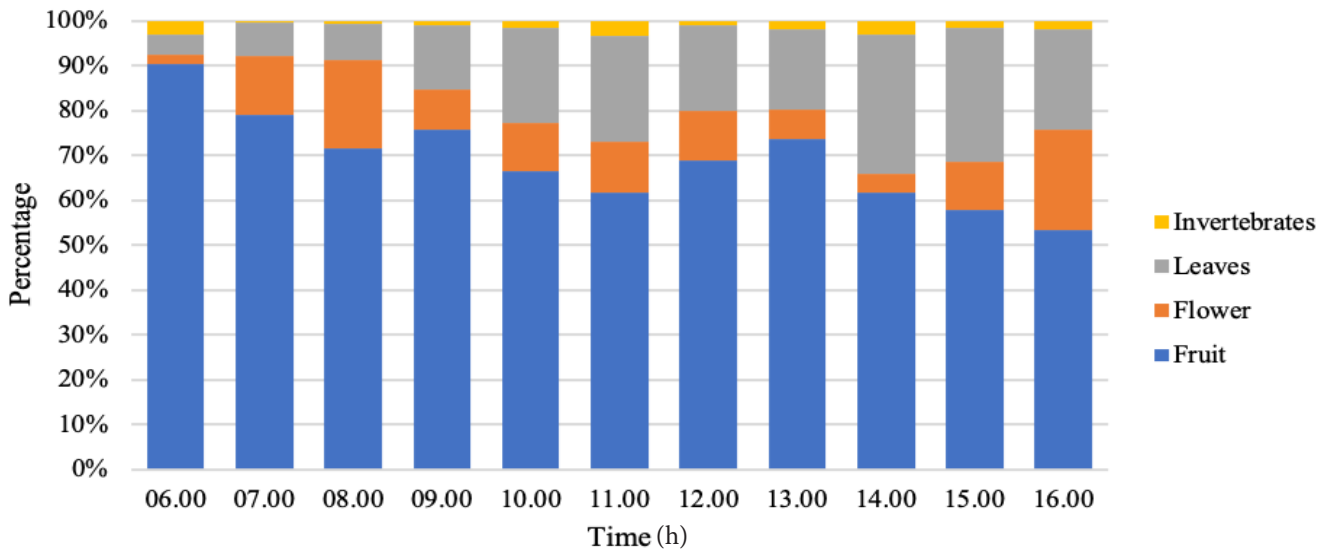

Figure 5. Percentage of plant parts consumed by Javan Gibbons based on time.

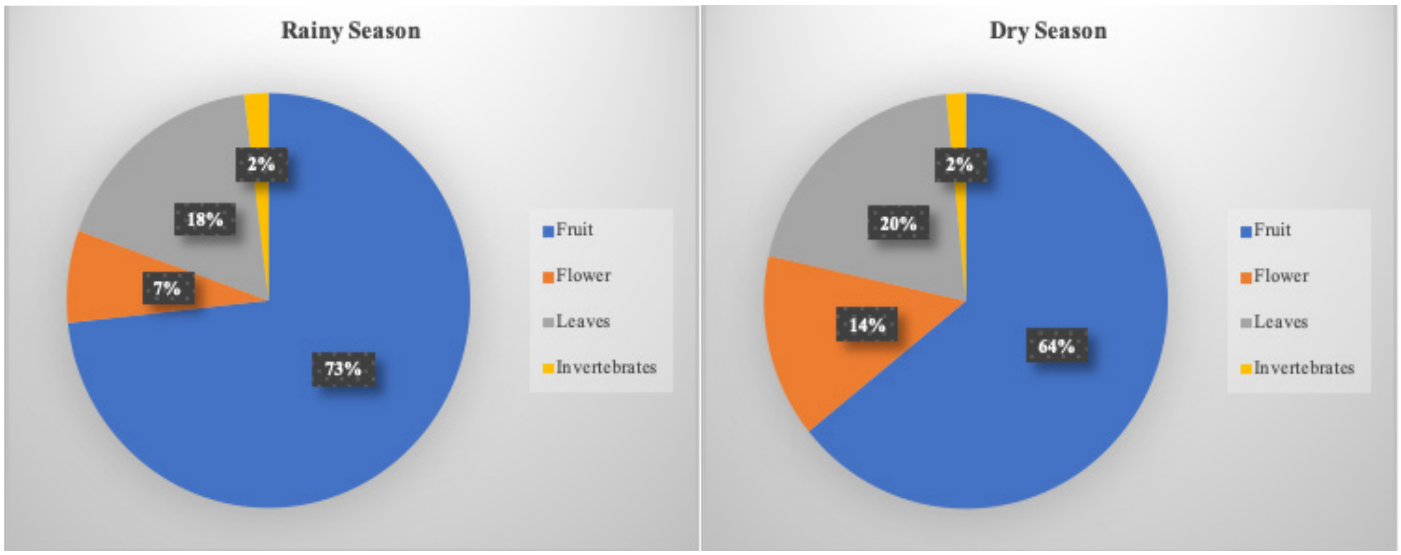

Figure 6. Feed preferences and composition of Javan Gibbons at Cikaniki Resort, GHSNP based on the parts consumed in the rainy season (January, February, September, October, November, and December) and dry season (March, April, May, June, July, and August).

with 64% fruit, 20% young leaves, 14% flowers, and 2% invertebrates (Figure 6).

During the rainy season, the fruit consumed by Javan Gibbons came from 49 plant species. The most consumed fruit-bearing species included *Ficus heteropleura*, *Ficus villosa*, *Ficus punctata*, *Ficus annulata*, *Ficus* sp., *Nyssa javanica*, *Dissochaeta fallax*, *Symplocos cochinchinensis*, and *Schefflera aromatic*. In the dry season, the gibbons consume fruit from 39 plant species. The dominant species whose fruits were consumed included *Ficus punctata, Ficus villosa*, *Ficus heteropleura*, *Ficus annulata*, *Cestrum laevigetum*, *Knema cinerea*, *Bruinsmia styracoides*, and *Dissochaeta fallax*.

The composition of young leaves consumed by Javan gibbons consisted of 38 plant species in total. The gibbons consumed young leaves from 28 plant species during the rainy season. Some of the most frequently consumed species included *Ficus heteropleura*, *Ficus cuspidata*, *Bambusa* sp., *Dysoxylum parasiticum*, *Scindapsus marantaefolus*, *Magnolia elegans*, *Lithocarpus sundaicus*, *Syzygium pycnathum*, *Oleandra pistillaris*, *Litsea cubeba*, *Mussaenda frondosa*, and *Epipremnum pinnatum*. In the dry season, young leaves were consumed from 32 plant species. Frequently consumed species included *Ficus cuspidata*, *Ficus heteropleura*, *Ficus* sp., *Ficus padana*, *Scindapsus marantaefolus*, *Oleandra pistillaris*, *Sandoricum koetjape*, *Litsea cubeba*, *Melicope latifolia*, *Syzygium pycnathum*, and *Schefflera aromatica*.

The gibbons consumed flowers from a total of ten plant species. During the rainy season, Javan Gibbons fed on the flowers of *Sandoricum koetjape*, *Dysoxylum parasiticum*, *Cinnamomum parthenoxylon*, *Syzygium pycnathum*, *Villebrunea rubescens*, and *Heptapleurum luridum*. They consumed flowers from *Sloanea sigun*, *Callicarpa pentandra*, *Sandoricum koetjape*, *Dysoxylum parasiticum*, and *Cinnamomum parthenoxylon* in the dry season.

4. Discussions

4.1 Daily Activities

The consistently high resting activity observed each month, along with limited movement activity, indicates that the availability of natural food within the Javan Gibbon's home range remains relatively abundant. Food availability influences the movement activity of Javan Gibbons, as seen from their daily range size—the wider the home range, the lower or more scattered the food availability tends to be (Dewi 2016). Differences in habitat also contribute to variations in daily activity patterns. For instance, Javan Gibbon groups in GHSNP show different activity patterns compared to those in neighboring national park, the Gunung Gede Pangrango National Park, where the highest activity observed was feeding (39.88%), followed by resting (35.96%), moving (15.95%), and social activities (8.21%) (Iskandar 2011). Javan Gibbons typically engages in feeding activities during the morning and late afternoon. Their feeding activity decreases around midday as this time is usually allocated for resting and social interactions within the group, such as grooming.

4.2 Types of Feed

The number of plant species consumed by Javan Gibbons depends on the condition of their habitat. Javan Gibbons living in Gunung Gede Pangrango National Park (GGPNP) consumes 83 plant species (Ario 2011). Meanwhile, those inhabiting Ujung Kulon National Park (UKNP) consume as many as 125 plant species from 43 families (Asquith *et al*. 1995). Differences in forest vegetation composition are influenced by climate and forest type in each area. Forest type and climate, such as rainfall and temperature, determine the structure and composition of a forest (Slik *et al*. 2009). GGPNP, with an annual rainfall intensity of 3,000–4,200 mm, consists of tropical rainforest zones including sub-montane, montane, and sub-alpine forest types (Rozak *et al*. 2016). In contrast, the forest type in UKNP is characterized by lowland tropical rainforest, with its highest elevation being the Honje Mountains at 620 meters above sea level (Vahlevi 2020).

The Moraceae family is one of the most preferred food sources for Javan Gibbons compared to the 34 other plant families. A study in Gunung Gede Pangrango National Park also identified 18 plant species from the Moraceae family as part of the Javan Gibbon's diet (Ario 2011). Generally, plants from the Moraceae family grow in lowland forests and tropical rainforests, but they can also be found in temperate forests with four seasons (Yaghsyah *et al*. 2022). In addition to the Javan Gibbon, other primate species such as the Hainan Gibbon (*Nomascus hainanus*) and the Yellow-cheeked Gibbon (*Nomascus gabriellae*) also prefer food from the Moraceae family (Bach *et al*. 2017; Deng and Zhou 2018). Ficus species do not have a specific fruiting season and can produce fruit year-round, with various species fruiting at different times (Yelastri 2023). In 2022, two plant species from the Moraceae family were frequently consumed by Javan Gibbons in the study area: *Ficus heteropleura* (known locally as *Ficus oren*) and *Ficus villosa* (*Ficus kisigung*).

4.3 Composition and Preferences

Fruit is the preferred food source for Javan Gibbons in rainy and dry seasons due to its abundant availability in the Citalahab forest area. This finding is relevant to the fact that Javan Gibbon is a frugivorous primate. Javan Gibbons in this study area exhibits behavioral strategies that allow them to consume fruit consistently throughout the year (Kim *et al*. 2011). No seasonal variation significantly alters the gibbons' feeding behavior due to the year-round availability of food sources, mainly fruit, which dominates their diet with a percentage of 62.5%. This condition is considered a positive factor for the long-term survival of the Javan Gibbon.

Habitat and climate differences can influence gibbons' feeding patterns, as observed in the Hainan Gibbon (*Nomascus hainanus*) in Bawangling National Nature Reserve, China (Deng and Zhou 2018). In this location, Hainan Gibbons consume more fruit during the rainy season, while in the dry season, their diet consists mainly of leaves, buds, and flowers. Another example is the Southern Yellow-cheeked Gibbon (*Nomascus gabriellae*) in Cat Tien National Park, Vietnam, which consumes more leaves during the dry season and more fruit during the rainy season when fruit availability is abundant (Bach *et al*. 2017).

During the rainy season, the variety of food plant species available to wildlife, including the Javan gibbon, is relatively higher compared to the dry season. This is because the rainy season provides abundant water sources, which help a wide range of plants to produce fruit. Sufficient rainfall can enhance plant flowering, producing fruit as a food source for wildlife (Prayogo *et al*. 2024). Rainfall positively correlates with the phenology of tropical rainforest plants (Dunham *et al*. 2018).

In conclusion, our study demonstrates that the Javan Gibbon at Cikaniki Resort, Gunung Halimun Salak National Park, maintains a consistently fruit-dominated diet throughout the year, with no significant differences in composition between the rainy and dry seasons. Across 2022, gibbons consumed 73 plant species from 34 families, with Moraceae, particularly Ficus villosa and Ficus heteropleura, being the most important food sources. These findings provide valuable insights for conservation management, emphasizing habitat protection and the safeguarding of critical plant species to support the Javan Gibbon population in the wild.

However, this study is limited by its focus on only three gibbon groups in a specific location over a one-year period. The findings may not fully represent feeding ecology in other parts of the species' range, where habitat conditions and plant phenology may differ. In addition, the study did not quantify phenological patterns, which could provide a more complete understanding of seasonal influences on diet.

Future research should expand observations across multiple sites and years, incorporate phenological monitoring, and explore the influence of habitat quality and climate variability on feeding behavior.

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