Study of *Ficus* in West Block Batang Toru Forest Region, North Tapanuli District, Indonesia

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Abstract. The study of figs or *Ficus* in west block of Batang Toru forest has been conducted to obtain information regarding species diversity and the distribution of *Ficus*. Study site was determined using purposive random sampling and data was collected in 20 plots measuring 500 x 10 m in size. The study found 28 species of *Ficus* found in the area in which 12 species were found inside the plot. Of all the species, 14 species (50%) were semi-epiphyte, 13 species (46%) were terrestrial and only one species (4%) was liana. The most dominant species for trees, poles, saplings, and seedlings was represented by *Ficus xylophylla*, *F. globosa*, *F. globosa*, and *F. villosa*. Figs diversity for trees, poles, and saplings was categorized as medium according to the Shannon’s index with the value of 1.47-1.70, while seedlings diversity was categorized as low with the value of 0.22. The equitability index of trees, poles, saplings and seedlings was about of 0.32-0.95. Most species inhabited secondary forest in the altitude of 700-1000 m asl. However, two species (*Ficus crassiramea* and *F. curtipes*) were also observed in the altitude more than 1000 m above sea level. The study then presented the baseline information about figs in west block of Batang Toru forest as conservation region.

1. Introduction

Tropical rain forest region of Indonesia has been known for its numerous floristic biodiversity. Among diverse plants found in rain forest, figs or members from *Ficus* spp. are one of interesting plants to study and research. *Ficus* are categorized as important member of Moraceae regarding their specific roles in rain forest. Occurrence of *Ficus* in rain forest may be looked as important feature through spesies service such as: providing feed and shelter for birds, insects, reptiles and mammals, absorbing pollutants like carbon dioxide and lead, and being used as traditional remedies [1]. It is then not arguable that members of Ficus have been studied extensively due to their importance in inhabiting or structuring certain forest region [2]. *Ficus* consists of 750 species which are mainly found in all tropical and subtropical region. *Ficus* were assumed to have originated from Malesiana region such as: Indonesia, Malaysia, Philippine, Papua, Brunei and Singapore [3].

Batang Toru Forest Region or *Kawasan Hutan Batang Toru* (KHBT) is part of rain forest region of North Sumatra with high value of biodiversity and economic as well as playing ecological function in hydrology. The region covers diverse vegetations which structure three main ecosystems: subalpine forest, peat forest at 900 – 1200 m and Dipterocarpaceae forest. Each ecosystems are dominated with different tree vegetations. Total of 688 plants species can be found at KHBT, some of them are
identified as *Ficus* [4]. Although *Ficus* has been known to construct rain forest ecosystem at KHBT, little is known about their actual species diversity and ecology.

In supporting the conservation effort in KHBT and insufficient information of *Ficus* diversity, we would like to obtain informations regarding their occurrence and species lists as baseline information for future reference and efforts.

2. Materials And Methods

2.1 Study area
Research was conducted at research station of Yayasan Ekosistem Lestari, Sumatran Orangutan Conservation Programme (YEL-SOCP) located inside of KHBT. The KHBT administratively located at Subdistrict of Pahae Jae, District of Tapanuli Utara, province of North Sumatra. Plants specimens were investigated at Herbarium Medanense, University of Sumatera Utara, Medan. Study sites were determined using purposive random sampling methodology.

2.2 Sampling Procedures
Total of 20 transect lines with length of 500 m were made to survey *Ficus* vegetation on sites. Following the transects, observation was carried out by exploring left and right path along 5 m from the line for trees (stem diameter > 20 cm), poles (stem diameter 10 – 20 cm) and sapling (stem diameter < 10 cm, height > 1.5 m) categories; and 1 m for seedling category (height < 1.5 m). *Ficus* found in this study were counted, identified and measured for its stem diameter. Unknown specimens were collected for further identification. Each species were recorded for their geographical distribution using Global Positioning System (GPS). Exploration was also carried out at outside of transect lines (study site) to obtain *Ficus* diversity around research station of YEL-SOCP.

2.3 Data analysis
Numerical data were subjected to standard ecological analysis such as: Density (Individu/ hectare), Relative density (%), Frequency, Relative frequency (%), Basal area, Dominance, Relative dominance (%), Importance Value Index (IVI), Shannon-Wiener diversity index (H’) and equitability index (E) [5]. Data were analyzed descriptively.

3. Results and Discussion
The study found 28 species of *Ficus* in which 12 species were found inside plot while 16 species at outside of plot or around research station of YEL-SOCP or outside plot (Table 1). Different types of habit can be found inside and outside of plot. Majority of *Ficus* were classified into semi-epiphyte constituting 50% or 14 species of total, while 46% or 13 species were terrestrial and 4% or 1 species was liana. Semi-epiphytes may benefit members of *Ficus* by providing various structures in the forest as well as access to sunlight for generating photosynthesis. This condition provided juveniles with abundant sunlight to ensure proper growth in contrary to other lifestyle like terrestrial ones. Importance Value Index (IVI) were further calculated from across *Ficus*’ categories (trees, poles, saplings and seedlings) to gain understanding of dominance and adaptability of figs species.

Importance Value Index of *Ficus* with various categories were shown in Table 2. For trees category, *Ficus xylophylla* had the highest IVI (89.53%) while the lowest value was from *F. crassstamea* (28.95%). The highest percentage of relative density and frequency (30%) was shown by *F. xylophylla*. The highest percentage of relative dominance (29.53%) was also shown by *F. xylophylla*. For poles category, *F. globosa* had the highest IVI (138.40%) while the lowest IVI was from *F. sumatrana* and *F. xylophylla* (26.07%). The highest percentage of relative density, frequency and dominance was shown by *F. globosa* with percentage of 50, 40, and 48.40% respectively. For saplings category, *F. globosa* had the highest IVI (67.80%) while the lowest IVI was from *F. altissima* and *F. globosa* (5.53%). For seedlings category, there were only two species of Ficus found during the study. *Ficus villosa* had the highest IVI (188.23%) while the lowest IVI was from *F. sinuata*.
(11.76%). Plants with wide range of tolerance towards biotic and abiotic factors tend to be distributed across large area in their habitat [6]. Shannon-Wiener’s diversity (H’) and Equitability (E) index across four categories were shown at Table 3.

Table 1. Species checklist of Ficus at West Blok of Batang Toru Forest

| Species | Plot | Location | Outside Plot |
|---------|------|----------|--------------|
| F. altissima* | √ | | √ |
| F. ampelasa | - | | √ |
| F. aurata** | - | | √ |
| F. cf. delosyce* | √ | | - |
| F. cf. pallescens* | - | | √ |
| F. cf. ruginervia | - | | √ |
| F. consaciata* | √ | | √ |
| F. crassiramea* | √ | | √ |
| F. curtipes* | √ | | √ |
| F. deltoidea* | - | | √ |
| F. fistulosa** | - | | √ |
| F. fulva** | - | | √ |
| F. geocarpa** | - | | √ |
| F. globosa* | √ | | √ |
| F. grossularioides** | - | | √ |
| F. ischnopoda** | - | | √ |
| F. lepicarpa** | - | | √ |
| F. miquelli** | - | | √ |
| F. obscura* | - | | √ |
| F. padana** | - | | √ |
| F. ribes** | - | | √ |
| F. sinuata** | √ | | √ |
| F. sumatrana* | √ | | √ |
| F. sundica* | √ | | √ |
| F. variegata** | - | | √ |
| F. villosa*** | √ | | - |
| F. xylophylla* | √ | | √ |
| Ficus sp. 1* | √ | | √ |
| Total | 12 | 26 |

Notes: √ = Present, - = Absence, * = Semi-epiphyte, ** = Terrestrial, *** = Liana

Table 2. Importance Value Index (IVI) of Tree, Poles, Sapling and Seedling

| Spesies | Count | D (Ind/ha) | F | Dm | RD (%) | FR (%) | RDm (%) | IVI (%) |
|---------|-------|-----------|---|----|--------|--------|--------|--------|
| Ficus crassiramea | 1 | 0.1 | 0.05 | 0.0032 | 10 | 10 | 8.9519 | 28.9519 |
| F. globosa | 2 | 0.2 | 0.10 | 0.0066 | 20 | 20 | 18.7677 | 58.7677 |
| F. sumatrana | 1 | 0.1 | 0.05 | 0.0039 | 10 | 10 | 11.0518 | 31.0518 |
| F. sundica | 2 | 0.2 | 0.10 | 0.0074 | 20 | 20 | 20.9307 | 60.9307 |
| F. xylophylla | 3 | 0.3 | 0.15 | 0.0104 | 30 | 30 | 29.5330 | 89.5330 |
| Ficus sp. 1 | 1 | 0.1 | 0.05 | 0.0038 | 10 | 10 | 10.7383 | 30.7383 |
| Total | 10 | 1 | 0.5 | 0.0353 | 100 | 100 | 100 | 300 |
### Poles

| Species      | Count | D (Ind/ha) | F   | RD (%) | IVI (%) |
|--------------|-------|------------|-----|--------|---------|
| *Ficus altissima* | 1     | 0.1        | 0.05| 2.5    | 3.0303  |
| *F. cf. delosyce* | 1     | 0.1        | 0.05| 2.5    | 3.0303  |
| *F. consaciata* | 2     | 0.2        | 0.1 | 5.0    | 6.0606  |
| *F. globosa*     | 6     | 0.6        | 0.2 | 9.5    | 12.3030 |
| *F. sumatrana*   | 1     | 0.1        | 0.05| 2.5    | 3.0303  |
| *F. xylophylla*  | 1     | 0.1        | 0.05| 2.5    | 3.0303  |
| **Total**       | 12    | 1.2        | 0.5 | 100    | 200     |

### Saplings

| Species      | Count | D (Ind/ha) | F   | RD (%) | IVI (%) |
|--------------|-------|------------|-----|--------|---------|
| *Ficus altissima* | 1     | 0.1        | 0.05| 2.5    | 3.0303  |
| *F. consaciata* | 3     | 0.3        | 0.15| 7.5    | 9.0909  |
| *F. curtipes*  | 2     | 0.2        | 0.1 | 5.0    | 6.0606  |
| *F. globosa*   | 15    | 1.5        | 0.5 | 37.5   | 30.3030 |
| *F. sinuata*   | 1     | 0.1        | 0.05| 2.5    | 3.0303  |
| *F. sumatrana* | 5     | 0.5        | 0.2 | 12.5   | 15.1515 |
| *F. sundaica*  | 3     | 0.3        | 0.15| 7.5    | 9.0909  |
| *F. xylophylla*| 10    | 1          | 0.4 | 25     | 24.2424 |
| **Total**     | 40    | 4          | 1.65| 100    | 200     |

### Seedlings

| Species      | Count | D (Ind/ha) | F   | RD (%) | IVI (%) |
|--------------|-------|------------|-----|--------|---------|
| *Ficus sinuata* | 1     | 0.5        | 0.05| 5.8824 | 5.8824  |
| *F. villosa*  | 16    | 8          | 0.8 | 94.1176| 94.1176 |
| **Total**    | 17    | 8.5        | 0.85| 100    | 200     |

**Table 3. Diversity and Equitability Index across Ficus’ categories**

| Categories     | $H'$  | $E$  |
|----------------|-------|------|
| Trees          | 1.6957| 0.9464|
| Poles          | 1.4735| 0.8223|
| Saplings       | 1.6971| 0.8161|
| Seedlings      | 0.2237| 0.3227|

The highest diversity index was shown from trees and saplings categories followed by poles, while the lowest was from seedlings. From the equitability index, trees, poles and saplings categories showed equal distribution within study site while for seedlings tend to show unequal distribution. We also surveyed and found differences in distribution of *Ficus* species across elevations (metre above sea level). Overall distribution of *Ficus* was shown in Table 4. Other contribution factor that affect the abundance of semi-epiphytes figs was the elevation of study site. Study showed that most species occupied habitat $< 1000$ masl. Such elevation was classified as lowland rain forest with usual vegetation dominated by semi-epiphytes. Most species occupied site with elevation of 800 – 1000 m, contributing 27 species over 28 species. Only 1 species, namely *Ficus* sp. 1 occupied site with elevation of 900 –1000 while two species were still found at 1000 – 1100 m namely *F. crassiramera* and *F. curtipes*. Lowland rain forest are known to be dominated by members of Dipterocarpaceae, Ficus, Agathis, Castanopsis, Palaquium dan Diospyros [7]. Climber Ficus are known to be highly dense in lowland forest, and tend to decrease for about 8.4% of their population per interval of 100 m elevations [8]. Other study reported that in West Sumattra forest, *Ficus* are highly known to inhabit
their habitat with altitude ranging from 300 – 543 masl [9]. The results then may differ according to spatial-scale and geographical location of the forest.

Table 4. Distribution of Ficus across elevations.

| Species          | Elevations       |
|------------------|------------------|
|                  | 700-<800 | 800 - <900 | 900 - <1000 | 1000 - <1100 |
| Ficus altissima  | -        | -         | √           | -            |
| F. xylophylla    | -        | -         | √           | -            |
| F. amplexes      | -        | -         | √           | -            |
| F. aurata        | -        | -         | -           | -            |
| F. cf. delosyce  | -        | -         | -           | -            |
| F. cf. pallescens| -        | -         | -           | -            |
| F. cf. ruginervia| -        | √         | √           | -            |
| F. consaciata    | -        | √         | √           | -            |
| F. crassiramea   | -        | -         | -           | √            |
| F. curtipes      | -        | -         | -           | √            |
| F. deltoidea     | -        | -         | -           | -            |
| F. fistulosa     | -        | √         | -           | -            |
| F. fulva         | √        | -         | -           | -            |
| F. geocarpa      | -        | -         | -           | -            |
| F. globosa       | -        | √         | -           | -            |
| F. grossularioides| -       | √        | -           | -            |
| F. ischnopoda    | -        | √         | -           | -            |
| F. lepicarpa     | -        | -         | -           | -            |
| F. micuelli      | -        | √         | -           | -            |
| F. obscura       | -        | √         | -           | -            |
| F. padana        | -        | √         | -           | -            |
| F. ribes         | -        | √         | -           | -            |
| F. sinuata       | -        | -         | √           | -            |
| F. sumatrana     | -        | √         | -           | -            |
| F. sundica       | -        | √         | -           | -            |
| F. variegata     | -        | -         | -           | -            |
| F. villosa       | -        | √         | -           | -            |
| Ficus sp. 1      | -        | -         | -           | -            |

Our study reported the first information baseline regarding Ficus ecological aspect within research station of YEL-SOCP. Research station of YEL-SOCP was known to be inhabited by Orangutans (Pongo abelii) as their natural habitat and this study revealed natural state of fruit availability in the forest specifically those which produced by members of Ficus. Fruit-producing figs are considered as major fruit provider for various species of animal in the rain forest, especially in the lowland rain forest. This finding also support the presence of Orangutan which are most likely known to inhabit lowland rather than in highland rain forest [8]. Not only Orangutans, but also other frugivorous animals also gained benefit from mutualism with members of fruit-producing figs. The study conducted in Otún Quimbaya Flora and Fauna Sanctuary in Colombia showed that 36 avian species and three mammal species consume 60% of fruits available in the forest from members of Ficus [10]. Members of Ficus were also reported as microhabitat for certain herbivorous insects living by side, mostly of leaf-chewing and sap-sucking insects [11]. This mutualism then construct harmonism in ecological aspect by generating and maintaining biodiversity between inter-connecting species [12,13]. Most figs found were semi-epiphytes. The lifestyle showed versatile dominance in terms of species and number of figs in their habitat. Other study conducted in Bornean lowland rain forest reported twenty-seven species of semi- or hemi-epiphyte figs. The habit showed several advantages
regarding access to sunlight and microsite settlement to grow larger maximum size [14]. Therefore, this strategy of habit play a significant role in occupying various niche in the forest structures.

4. Conclusion
West Block Batang Toru forest is inhabited by twenty-eight species or members of fruit-producing \textit{Ficus}. The figs may support the living of other organisms as shown by their abundance and dominance as productive semi- or hemi-epiphyte figs. Various ecological aspects were obtained following categorization from seedling, sapling, pole and tree figs. The lowland type of rain forest support the growth and dispersion of certain species as shown by differences in site occupation across elevations. The information gained from this study then may be used as references for future management and conservation of Batang Toru forest by the officials and NGOs.

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