Population structure of woody plant in malaka (*Phyllanthus emblica*) habitat, Padang bolak, North Sumatra

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Abstract. Malaka is a wild plant that generally grows in subtropical and tropical regions including India, Thailand, Pakistan, Sri Lanka, China and Indonesia. In Indonesia, this plant found disjunct in Java, Ternate and North Sumatra. Malacca seed is known as traditional medicine for diabetes, cancer, liver, ulcers and anemia. People in South Tapanuli also used the leaf as traditional food ingredients. Information regarding to distribution and habitat of Malacca in North Sumatra is still quite limited. Therefore our research aims to determine the population structure and malacca association in Padang Bolak Julu. The population structure and plant species associations were conducted through vegetation analysis by purposive sampling and the association is calculated using the Ochiai, Dice, and Jackard index values. The results showed that the malaka IVI at the level of seedlings, saplings, poles and trees were 150.35, 131.83, 112.04 and 102.23, respectively. Malaka plants are high association patterns and positively associated with *P. obovatum* in the location.

1. Introduction

*Phyllanthus emblica* or locally known as malaka in Indonesia, is small to medium sized of fruity tree and reach 8-18 meters. The species was belong to member Euphorbiaceae that widely distributed in some subtropical and tropical countries including including India, Thailand, Pakistan, Sri Lanka, China and Indonesia and native to tropical southeastern Asia. Originally, it was cultivated in Madagascar and some other countries over the world [1]. In Indonesia, this plant is distributed in Java, Sunda, Ternate, and North Sumatra [2]. In North Sumatra malacca can be found in arid regions such as Padang Lawas, Padang Lawas Utara and Central Tapanuli [3].

Malaka has great potential for further utilization considering almost all parts of plant can be used both as medical and other uses. Malaka has high source of vitamin C which reaches 200 - 900 mg / 100 g [4]. Phytochemical study of this species found several norbisabolane and bisabolane derivatives from the root [5], phyllanemblinins B-F in the leaves and branches [6]. The fruit extract shows
antiproliferative [8], gastroprotective [7] and antioxidant activities. In Indonesia, especially in North Sumatra, local people only use the leaf for food ingredients called holat [9].

The research on malaka utilization and population structure in North Sumatra still quite limited. Population structure of species is able to describe the number of individuals in each growth stage of species to determine its productivity [10]. The information of population structure was needed for formulate the management and conservation strategies. Therefore this study aims to identify the population structure of Malacca Habitat in Pamuntaran Village, Padang Bolak Julu District, Padang Lawas Utara Regency.

2. Materials and Method

2.1. Sampling site
The research was conducted in Pamuntaran Village, Padang Bolak Julu District, Padang Lawas Utara Regency, North Sumatra. The research location and sampling location can be presented in Figure 1.

2.2. Vegetation analysis
Vegetation analysis was carried out using purposive sampling based on occurrence of malaka in certain sites [11]. There was total of tree transects established at the sites with five plots/quadrats for each transect. A line was drawn for each transect starting from the forest edge with the minimum length of transect was 200 m. In each transect, nested plots were established with the size of 2 x 2m², 5 x 5 m², 10 x 10 m and 20 x 20 m² to record all necessary data for seedling, sapling, pole, and tree. The collected data consist of vegetation, stem diameter and identification of specimens. Secondary data consist of environment condition such as temperature, slope, and soil pH, and geographical location.

Figure 1. Research location of malaka
The dominance and biological success of some species with a single value was expressed using Importance Value Index (IVI) that has been developed by [12], [13], and [14]. IVI able to describe the ecological importance of a species than an absolute measure such as density, dominance, and frequency. IVI of each species was calculated by summing the relative value relative density (RD) and relative frequency (RF), for seedling and sapling, whereas pole and tree by summing relative density (RD), relative frequency (RF), relative basal area (RBA).

2.3. Relative density
Relative Density (RD) was the average number of individuals of given species out of the total of samples examined in a study area [15]. It is calculated using the following formula:

\[
RD = \frac{\text{Total number of individual of species}}{\text{Total number of all individual of all species}} \times 100\%
\]

2.4. Relative frequency
Frequency indicates the number of sampling plots which species occurs compared with of all sampling plots and the presence or absence of a species [15]. It is calculated using the following formula:

\[
RF = \frac{\text{Frequency of respective species}}{\text{Frequency of all species}} \times 100\%
\]

2.5. Relative basal area
Dominance is defined as the sum of basal areas of all individuals of a species [15]. Relative Basal Area (RBA) is calculated using the following formula:

\[
RBA = \frac{\text{Basal area of a species}}{\text{Total basal area of all species}}
\]

2.6. Importance value index
Importance value index or IVI can be calculated by:

\[
\text{IVI} = \text{RD} + \text{RF} + \text{RBA} \quad \text{for pole and pole}
\]

\[
\text{IVI} = \text{RD} + \text{RF} \quad \text{for seedling and sapling}
\]

2.7. Species association
Association describes the relationship between plants in a location. An association study was conducted to see whether there relationship between the malaka and other the specific vegetation in its habitat. The approach used uses the Ochiai index. Association analysis was performed based on value measurements by calculating the Ochiai indices. If there was no association pattern, the value is 0 and a value of 1 when the maximum association.

3. Results and Discussion
Malaka grows wild in hilly areas with hard soil texture and little vegetation. The malaka habitat (Figure 2) dominated *Cyperus rotundus* and *Imperata cylindrica*. Another factor that causes low vegetation conditions in malacca habitat is burning activities that have been carried out by local people for land clearing for agriculture and plantations purpose. Several factors such as climate, soil and others that influence vegetation growth. According [16], malaka can be found in all climate type with annual rainfall range from 630 - 800 mm, it tolerates with high temperatures until 46˚C, suitable for fertile loam soils, tolerate with light and heavy soils except very sandy soil and acidic to salty soil (pH 6.5-9.5, EC 5dsm-1, ESP 30-40).
Figure 2. Malacca habitat in Padang Bolak

Quantitative vegetation studies provide a vegetation description, their distribution and classification patterns and economical and ecological value in the future. The quantitative of vegetation studies can be determined by using the Important Value Index (IVI). The IVI were sum of valuation on relative density, relative dominance, and relative frequency [17]. The result at vegetation analysis showed that at the seedling level, only 3 species were found at the site (Table 1). Malaka resides in top rank species with IVI value 150.35, followed by Atilmang (40.97) and the Palaquium abovatum (8.48).

Table 1. IVI Value of seedling stage.

| No | Plant species           | RD   | RF   | IVI   |
|----|-------------------------|------|------|-------|
| 1  | Phyllanthus emblica     | 78.13| 72.22| 150.35|
| 2  | Altimang               | 18.75| 22.22| 40.97 |
| 3  | Palaquium abovatum     | 3.13 | 5.56 | 8.48  |

At the sapling, six species were found in research location (Table 2). Malacca has the highest IVI value (131.82) while Vitex pubescens have the lowest IVI value (5.40). At the sapling stage, altimang was disappear from the location. This condition might be caused by some growth factor or the species, facing certain constraint [10].

Table 2. IVI value of sapling stage.

| No | Plant species           | RD   | RF   | IVI   |
|----|-------------------------|------|------|-------|
| 1  | Phyllanthus emblica     | 76.27| 55.56| 131.83|
| 2  | Leucaena leucocephala  | 6.78 | 14.81| 21.59 |
| 3  | Altimang               | 6.78 | 11.11| 17.89 |
| 4  | Gliricidia septum      | 5.08 | 7.41 | 12.49 |
| 5  | Palaquium abovatum     | 3.39 | 7.41 | 10.80 |
| 6  | Vitex pubescens        | 1.69 | 3.70 | 5.40  |

At the pole stage, seven species were found (Table 3). Malacca still dominates the vegetation at the location. It can be seen from IVI value (112.04), then followed by the Mayang (57.86). M. gigantea and Psidium guajava have the lowest IVI value (18.07).

Table 3. IVI Value on pole stage.

| No | Plant species           | RD   | RF   | RBA  | IVI   |
|----|-------------------------|------|------|------|-------|
| 1  | P. emblica              | 55.77| 42.42| 13.85| 112.04|
| 2  | P. abovatum             | 19.23| 24.24| 14.39| 57.86 |
| 3  | L. leucocephal          | 15.38| 18.18| 14.33| 47.90 |
| 4  | Tabu sira               | 3.85 | 6.06 | 15.61| 25.51 |
| 5  | M. gigantea             | 1.92 | 3.03 | 13.11| 18.07 |
| 6  | V. pubescens            | 1.92 | 3.03 | 15.61| 20.56 |
| 7  | P. guajava              | 1.92 | 3.03 | 13.11| 18.07 |
At the tree stage, eight plant species were found (Table 4). The highest IVI was obtained by malaka (102.23), while the lowest is *M. gigantea* (13.52).

**Table 4.** IVI value of tree stage.

| No | Plant species | RD  | RF  | RBA  | IVI   |
|----|---------------|-----|-----|------|-------|
| 1  | P. emblica    | 50.77 | 41.67 | 9.86 | 102.23 |
| 2  | P. abovatum  | 21.54 | 25.00 | 10.95 | 57.49  |
| 3  | G. arborea   | 3.08  | 2.78  | 28.19 | 34.04  |
| 4  | L. leucocephala | 9.23 | 8.33  | 9.72  | 27.28  |
| 5  | Tabu sira    | 7.69  | 8.33  | 10.80 | 26.83  |
| 6  | V. pubescens | 3.08  | 5.56  | 11.14 | 19.77  |
| 7  | G. sepium    | 3.08  | 5.56  | 10.15 | 18.78  |
| 8  | M. gigantea  | 1.54  | 2.78  | 9.20  | 13.52  |

Based on the results of vegetation analysis malaka has the highest IVI value at all of growth stage. Although found in all growth stage, the malaka distribution was disjunct and found in small population. It might be limited growth condition, which can be shown on dry and hard soil conditions and hilly topography [9]. The high IVI value of malaka in all growth stages denotes that this species has its range of niche preferences and capability to establish over a large area. Species with high IVI value at seedling, sapling and pole stage presume will also dominate the next stand structure. It is in accordance with [18] who state that the regeneration stage (seedlings, saplings, and poles level) will be as substitute tree for old or dead trees.

### 3.1. Species association

Species interactions are important aspect on species succession. The association can be quantified using positive and negative value. The negative association of two species might be a result of competition or differences in habitat preference [19], while a positive pattern might be the result of facilitation or neutrality and similarity in habitat preference. On tree stage, malaka have high association with all species at tree stage (Table 5). The pattern of the positive association between species is common in tropical and subtropical forests [20].

**Table 5.** Association of malaka on tree stage.

| No | Plant species | Assoc. Index | Assoc. type |
|----|---------------|--------------|-------------|
| 1  | P. abovatum  | 0.77         | +           |
| 2  | L. leucocephala | 0.62 | +           |
| 3  | Tabu sira    | 0.56         | +           |
| 4  | V. pubescens | 0.37         | +           |
| 5  | M. gigantea  | 0.37         | +           |
| 6  | G. arborea   | 0.26         | +           |
| 7  | G. sepium    | 0.26         | +           |

When a natural disaster or anthropogenic disturbance on location occurred, a positive association may be simply translated as the occurrence of one species will be followed by the finding of its pair. Various direct and direct factors or mechanisms both biotic and abiotic may be the cause for the pattern of positive and negative associations between species. In research location, anthropogenic disturbance such as land clearing using burning technique almost happens every year and the remaining species diversity in the location becomes lower. It can be seen by the lower number of the juvenile stage (seedling and sapling) in the location.
4. Conclusions
Ten species were found in malaka habitat from seedling, sapling, pole and tree. The lower number of species in the location might be caused by dry and hard soil condition and regularly burning activities in the location. Malaka was the dominant species in the site with IVI were 150, 35, 131, 83, 112, 04 and 102, 23 respectively. Association index showed that malaka have high association pattern with P. obovatum.

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