Habitat Characteristic of *Taxus sumatrana* (Miquel) de Laub in The Kerinci Seblat National Park

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Abstract. Sumatran yew (*Taxus sumatrana*) tree contain taxane diterpenoid, an effective anti-cancer drug. *Taxus* population in the world is declining due to overexploitation. Study on habitat characteristic of *T. sumatrana* was conducted in Kerinci Seblat National Park. Twenty four Plots of 20 x 20 m were laid purposively in the habitat of *T. Sumatrana* to determine the structure and composition of the vegetation. At each plot data on the physical component such as land slope, air temperature and humidity were also measured. Soil samples were taken around *T. sumatrana* trees at 4 different depths i.e. 0-10 cm, 10-20 cm, 20-40 cm, and 40-60 cm and brought to a soil laboratory for physical and chemical properties analysis. The result showed that *T. sumatrana* occupied a middle canopy stratum and the trees were easily found, however at sapling level was rare and the seedling level was not present at the plots. *T. sumatrana* commonly grows to clump at a steep slope, high humidity, and cold temperature. The soil at the habitat of *T. sumatrana* is porous and fertile.

1. Introduction

Sumatran Yew, *Taxus sumatrana* is locally known as cemara sumatera, tampinur batu, or kayu taji is in the family of Taxaceae sub-division of gymnosperms. The species is found in several tropical and subtropical climates countries such as Afghanistan, Tibet, Nepal, Vietnam, India, Burma, China, Philippines, and Taiwan [1]. Taxus is usually grown in the highlands ridge hill or a valley at an altitude of 1500-2800 m asl [2]. In Indonesia, the known distribution of *T. sumatrana* is only in Kerinci Seblat National Park. Recently, however, our research team found populations of *T. sumatrana* at Sibuaton Protected Forest of North Sumatera and Pagar Alam Protected Forest at South Sumatera Selatan province [3].

Biomedical research of anti-cancer drug revealed that genus *Taxus* contains taxane diterpenoids (marketed as Taxol) that demonstrated potential use as an anti-cancer chemotherapeutic compound ([4], [5]. Research has also begun to investigate non-cancer diseases such as Alzheimer’s, Kaposi’s sarcoma, and kidney sclerosis [6]. Taxane diterpenoids are extracted from the bark, leaves, branches, twigs, and roots of *Taxus* trees. One crucial obstacle is a low concentration (0.001 -0.05 %) of these compounds in the trees. Moreover, the therapy of each cancer patient requires roughly eight 60-year-old *Taxus* trees ([6].

The growing demand for taxol application leads to its industrial production through direct extraction from *Taxus* trees. As a consequence, the population of *Taxus*, including *T. sumatrana* is declining [7][2]. *T. sumatrana* is dioecious, very difficult to regenerate and grow very slowly so if the population is declining, extinction can occur in the absence of conservation measures.
This study aimed to obtain the habitat characteristics of *T. sumatrana* both biotic components (the vegetation structure and composition) and physical components (slope, air temperature, and humidity, soil properties). The result of the study will be used as base information to develop ex-situ conservation of *T. sumatrana* on Java Island, Indonesia.

2. **Methods**

2.1 **The study site**

The study was conducted at Mount Kerinci forest of the Kerinci Seblat National Park. Administratively, the study site is located in the village of Kresik Tuo, Kayu Aro District, Kerinci regency, Jambi province. Geographically the study sites located at 100° 31'08" -102° 44'01" E and 1°07'13" - 3°26'14". The soil type is red yellow Podsolic and andosol (somewhat grayish black). The altitude of the research sites is 200-3805 m above sea level with undulating, hilly, and mountainous topography with a land slope ranges between 25-45% ([8], [9], [10]).

In general, rainfall in this region is quite high and evenly distributed. Average annual rainfall is about 2,300 mm. The rainy season lasts from November to May with peak rainy season in December, while the dry season lasts from July to October. The average air temperature varied from 28° C in the lowlands, up to 9° C at the summit of Mount Kerinci. The humidity is about 80-100%. ([9] [8], [10].

![Figure 1. Map of Study Site in the Kerinci Seblat National Park](image1)

2.2 **The procedure**

For vegetation analysis, 24 plots of 20 m x 20 m were laid purposively in the habitat of *T. sumatrana*. Each plot was purposively laid in the spot where *T. sumatrana* tree was found, therefore, inside the plot, there was always at least one *T. sumatrana* tree. The 24 plot were distributed evenly at three different elevations namely 1300 m asl (8 plots), 1800 m asl (8 plots) and 2300 m asl (8 plot) to represent low, middle and high elevation.

The 20 x 20 m plots were used to inventory trees. The plots of 5 x 5 m and 2 x 2 m were nested inside the main plot (Figure 2) to inventory sapling, and seedling level respectively. The criteria for trees, sapling, and seedlings are as follows [11]:

- Tree is plant with a diameter at breast height (1.3 m) ≥ 10 cm, for the buttressed tree diameter was measured at 20 cm above the buttresses.
- Sapling is plant with high ≥ 1.5 m to young trees with a diameter <10 cm.
- Seedling is regeneration plant from sprouts to plant high ≤ 1.5 m.
Tree to sapling inventory was carried out by recording species, diameter and height while seedling is carried out by recording species and counting the stems. To get proper scientific name voucher herbarium of each species were collected and identified at the Herbarium of the Forest Research and Development Center, Bogor.

The collected data were analyzed to determine the dominant species. Dominant species is the species with the highest importance value in the vegetation community ([12]). Dominant species can be obtained by analysis of important value index (%) which is the sum of relative density, relative frequency and relative dominance of each species in the sample plots as shown by the following formula [11]:

\[
Density (D) = \frac{Number\ of\ Individual}{Total\ Plot\ area}
\]

\[
Relative\ Density = \frac{Density\ of\ a\ species}{Density\ of\ all\ species} \times 100\%
\]

\[
Frequency (F) = \frac{Number\ of\ Plot\ with\ a\ certain\ species}{Total\ Number\ of\ Plots}
\]

\[
Relative\ Frequency = \frac{Frequency\ of\ a\ species}{Frequency\ of\ all\ species} \times 100\%
\]

\[
Dominance (Do) = \frac{Basal\ Area\ of\ a\ certain\ species}{Total\ Plot\ area}
\]

\[
Relative\ Dominance = \frac{Dominance\ of\ a\ species}{Dominance\ of\ all\ species} \times 100\%
\]

For physical component, air temperature and humidity of the environment were measured with Thermo hygrometer, the slope of the land was measured by clinometers and soil humidity and pH were measured with Soil Tester TAKEMURA DM5. Soil samples were taken around Taxus trees at 4 different depths i.e.: 0-10 cm, 10-20 cm, 20-40 cm and 40-60cm. Soil samples then were brought to soil laboratory at Bogor for further soil physical and chemical analysis.
3. Result and Discussion

3.1 Species composition

3.1.1 Tree level. Since the plot was laid purposively to cover at least one tree of *T. Sumatrana*, therefore *T. sumatrana* were excluded from the calculation of dominant species in the tree level or otherwise will mislead that *T. sumatrana* is dominant species. According to Sundarapandian and Swamy [13], the important value index is one of the parameters that describe the role of the species in the community. Dominant species in the low level of elevation were Podocarpus neriifolia, Actinodaphne sp., Lithocarpus cyclophorus. The presence of a particular tree species especially the dominant one in the area indicates the ability of the species to adapt to local environmental conditions. Smith [14] stated that the dominant species is the species that utilized the environment they occupied efficiently than other species at the same place. When compared with observations at middle altitude, the dominant species were *Acmena acuminatissima*, *Canangium odoratum*, and *Engelhardia serrata*. While in the high-level elevation the dominant species were *Acmena acuminatissima*, *Orchthocharis borneensis*, *Actinodaphne sp.*

Table 1. The First three dominant species at tree level

| No. | Scientific Name         | Family     | RD   | RF   | DoR   | IVI   |
|-----|-------------------------|------------|------|------|-------|-------|
| 1300 m asl |                           |            |      |      |       |       |
| 1   | Podocarpus neriifolia   | Podocarpaceae | 4.17 | 2.21 | 31.91 | 38.29 |
| 2   | Actinodaphne sp.        | Lauraceae  | 5.21 | 2.21 | 29.34 | 36.75 |
| 3   | Lithocarpus cyclophorus | Fagaceae   | 12.50| 8.70 | 5.53  | 26.73 |
| 1800 m asl |                           |            |      |      |       |       |
| 1   | Acmena acuminatissima   | Myrtaceae  | 16.28| 13.72| 33.21 | 63.21 |
| 2   | Canangium odoratum      | Annonaceae | 11.63| 11.07| 21.27 | 43.97 |
| 3   | Engelhardia serrata     | Junglandaceae | 12.79| 11.07| 9.12  | 32.99 |
| 2300 m asl |                           |            |      |      |       |       |
| 1   | Acmena acuminatissima   | Myrtaceae  | 19.05| 20.62| 26.40 | 66.06 |
| 2   | Orchthocharis borneensis| Marantaceae | 22.22| 20.62| 21.71 | 64.55 |
| 3   | Actinodaphne sp.        | Lauraceae  | 9.52 | 17.11| 14.51 | 41.15 |

3.1.2 Sapling level. At the sapling level, the first three dominants at the low level of elevation were *Acmena acuminatissima*, *Lithocarpus cyclophorus*, and *Syzygium grandis*, while the middle level of elevation was dominated by *Acmena acuminatissima*, *Lithocarpus cyclophorus* and *Orchthocharis borneensis*. At the high level of elevation, the dominant species were *Acmena acuminatissima*, *Argostemma angustifolia*, *Orchthocharis borneensis*. *Acmena acuminatissima* dominated the sapling level at all three different elevations. Naturally, *Acmena acuminatissima* distributed from low elevation to 3000 m asl. So it is not surprising that the species dominate from low to the high level of elevation. *Acmena acuminatissima* usually grow on the hillsides and ridges and able to survive in with poor sandy to ultrabasic soils. The capabilities of living in poor soil make them easy to dominate the area. *T. sumatrana* is not listed in the first three dominant species at the sapling level since the species exists in low density in all the three different elevation level. It shows that the study site is still in the range elevation of *T. sumatrana* habitat.
Table 2. The first three dominant species at sapling level

| No | Nama Botani          | Famili    | Kr  | Fr  | Dr  | INP  |
|----|----------------------|-----------|-----|-----|-----|------|
| 1300 m asl          |           |          |     |     |     |      |
| 1  | Acmena acuminatissima| Mytaceae  | 20.00| 20.83| 55.40| 96.24|
| 2  | Lithocarpus cyclophorus| Fagaceae | 6.00 | 8.33 | 1.94 | 16.28|
| 3  | Syzygium grandis      | Mytaceae  | 4.00 | 4.17 | 4.63 | 12.80|
| 1800 m asl          |           |          |     |     |     |      |
| 1  | Acmena acuminatissima| Mytaceae  | 28.30| 20.69| 20.23| 69.23|
| 2  | Lithocarpus cyclophorus| Fagaceae | 18.87| 10.34| 24.64| 53.85|
| 3  | Orchthocharis borneensis| Marantaceae | 9.43 | 13.79 | 21.21| 44.44|
| 2300 m asl          |           |          |     |     |     |      |
| 1  | Acmena acuminatissima| Mytaceae  | 11.93| 10.42| 26.81| 49.15|
| 2  | Argostemma angustifolia| Rubiaceae | 10.09| 10.42| 6.85 | 27.36|
| 3  | Orchthocharis borneensis| Marantaceae | 7.34 | 8.33 | 7.52 | 23.19|

3.1.3. Seeding Level. At the seedling level, the dominant species is much more diverse as shown in Table 2. There are no species at the seedling level dominant in three different levels of altitude. Surprisingly T. sumatrana seedling was not found in the seedling level. It showed the regeneration of this species is not easy or have many constrain.

Table 3. The dominant species at the seedling level at three different elevation level.

| No  | Nama Botani          | Famili    | Kr  | Fr  | INP  |
|-----|----------------------|-----------|-----|-----|------|
| 1300 m asl          |           |          |     |     |      |
| 1  | Diplazium pallidum   | Polypodaceae | 10.13| 7.32 | 17.44|
| 2  | Syzygium clavinyrtus | Myrsinaceae | 12.66| 2.44 | 15.10|
| 3  | Acmena acuminatissima| Mytaceae  | 7.59 | 7.32 | 14.91|
| 1800 m asl          |           |          |     |     |      |
| 1  | Ardisia javanica     | Myrsinaceae | 24.79| 18.75| 43.54|
| 2  | Diplazium pallidum   | Polypodaceae | 16.53| 18.75| 35.28|
| 3  | Rynchosphora corymbosa| Cyperaceae | 16.53| 6.25 | 22.78|
| 2300 m asl          |           |          |     |     |      |
| 1  | Ardisia javanica     | Myrsinaceae | 21.88| 17.86| 39.73|
| 2  | Elastostema sessile  | Urticaceae | 19.53| 7.14 | 26.67|
| 3  | Quercus gemelliiflora| Fagaceae  | 15.63| 7.14 | 22.77|

Taxus sumatrana at sapling and seedling level were rare. It is possibly because the seed of Taxus sumatrana is very tiny with hard-coated, a character of the seed buried in the soil seed bank. Therefore, it is suggested that Taxus seeds are buried in the soil seed bank and only able to germinated when sunlight available from the forest gap. Sutisna [15] stated that a species hold important role if Important Value Index of seedlings and saplings is more than 10 percent, and tree-level is15 percent. Taxus sumatrana may not hold an important role in its habitat since the seedling and saplings were rare.
3.2. Vegetation structure

In most habitats, vegetation provides the main structure of the environment. This complexity facilitates biodiversity and ecosystem services. Most of the tree in the habitat of *T. sumatrana* is not so tall and only several species become emergent trees. *T. sumatrana* mostly occupies middle canopy tree as shown in the figure 2. Trees in habitat *T. sumatrana* create a closed-canopy forest. Sunlight only enters the forest floor when there is a gap creating from the tree or big branch fall. In term of diameter, *T. sumatrana* can reach more than 100 cm as shown in figure 3.

![Vegetation Structure](image1)

**Figure 3.** Vegetation structure at the habitat of *T. sumatrana*

![Diameter Structure](image2)

**Figure 4.** Diameter Structure of trees in the habitat of *T. sumatrana*
3.3. **The physical component in the habitat of** *T. sumatrana*

At each plot physical component such as land slope, air temperature, humidity and soil pH were taken and presented at table 4. Soil physical and chemical properties were presented at table 5, 6, and 7.

**Table 4.** Physical component around habitat of *Taxus sumatrana*.

| Parameter       | Range value | Average |
|-----------------|-------------|---------|
| Slope           | 11° – 58°   | 31°     |
| Temperature     | 16° C – 23° C | 19° C  |
| Air humidity    | 70% - 91%   | 80 %    |
| Soil pH         | 6.0 – 7.3   | 6.8     |
| Soil humidity   | 58% – 52%   | 55 %    |

**Table 5.** Physical properties of soil at the Habitat of *Taxus sumatrana*

| Soil Sample Sites       | Soil Horizone | Soil Texture (%) |
|-------------------------|---------------|------------------|
|                         | Sand | Dust | Clay |
| 1.400-1500 m dpl.       | 0-10 | 58   | 32   | 10   |
| Low Altitude            | 10-20 | 59   | 29   | 12   |
|                         | 20-40 | 43   | 46   | 11   |
|                         | 40-60 | 50   | 42   | 8    |
| 1.800-1900 m dpl.       | 0-10 | 49   | 69   | 20   |
| Middle Altitude         | 10-20 | 61   | 29   | 10   |
|                         | 20-40 | 67   | 23   | 10   |
|                         | 40-60 | 62   | 29   | 9    |
| 1900-2000 m dpl.        | 0-10 | 63   | 30   | 7    |
| Higher Altitude         | 10-20 | 65   | 25   | 10   |
|                         | 20-40 | 54   | 32   | 14   |
|                         | 40-60 | 65   | 28   | 7    |

Table 5 showed that soil physical properties of the three sites were similar. It might be because all the three sites are in the same landscape so that possibly coming from the same soil formation. Soil texture is dominated by sand-dust so the soil must be very porous. Clay fill a small part of the texture and lead to excellent condition for germination because more clay makes the soil hard and crack at the dry season and offering a harsh condition to germinate and grow.

**Table 6.** Soil Cation Exchange

| Soil sample sites       | Soil Horizon top – down | Ca    | Mg    | K     | Na   | Total | CEC |
|-------------------------|-------------------------|-------|-------|-------|------|-------|-----|
| 1400-1500 m asl Low alt | 0-10                    | 18.98 | 1.78  | 0.81  | 0.21 | 21.78 | 18.50 |
|                         | 10—20                   | 7.56  | 0.99  | 0.37  | 0.01 | 8.93  | 8.84 |
|                         | 20—40                   | 3.25  | 1.11  | 0.69  | 0.07 | 5.12  | 4.07 |
|                         | 40—60                   | 4.75  | 1.16  | 0.69  | 0.08 | 6.68  | 5.76 |
| 1800-1900 m asl Middle  | 0-10                    | 8.69  | 1.31  | 0.16  | 0.28 | 10.44 | 14.83|
|                         | 10—20                   | 4.16  | 0.65  | 0.15  | 0.29 | 5.25  | 7.63 |
|                         | 20—40                   | 1.93  | 0.29  | 0.06  | 0.26 | 2.54  | 3.27 |
|                         | 40—60                   | 1.35  | 2.56  | 0.05  | 0.26 | 4.22  | 5.85 |
As shown in Table 6, the chemical composition of Calcium, Magnesium, Natrium dan Kalium vary wildly with a wide range. It shows that *T. sumatrana* can grow on a wide range of habitat.

Cation exchange capacity (CEC) shows soil fertility. Soil considered fertile if it is held 15-28 CEC (Darmawan, pers. Com, 2018). Table 7 showed that soil at the habitat of *T. sumatrana* is fertile especially the topsoil. Soil samples were taken from three different altitudes, however, there is no clear relation between fertility and altitude. The most fertile soil is topsoil at high altitude (1900 – 2000 m asl) while the most unfertile soil is topsoil at middle altitude (1800-1900 m asl). The common pattern of the soil fertility is the deeper the soil, the less fertility will be. Therefore sample taken from deeper spot should be less fertile. However, the empirical data from this study did not show a clear pattern as shown by CEC value at four different depth that does not have a clear pattern.

| Soil Sample Sites          | Soil Horizon | Organic matter | pH       |
|----------------------------|--------------|----------------|----------|
|                            | top - down   | C              | N        | C/N     | H₂O | KCl |
| 1400-1500 m asl Low altitude | 0-10         | 8.17           | 0.51     | 16      | 6.0 | 4.5 |
|                            | 10-20        | 4.59           | 0.43     | 11      | 6.1 | 5.2 |
|                            | 20-40        | 3.12           | 0.31     | 10      | 6.0 | 5.1 |
|                            | 40-60        | 3.16           | 0.31     | 10      | 5.9 | 5.1 |
| 1800-1900 m asl Middle altitude | 0-10         | 9.56           | 0.91     | 11      | 5.3 | 4.6 |
|                            | 10-20        | 11.24          | 0.64     | 18      | 5.2 | 4.5 |
|                            | 20-40        | 8.02           | 0.42     | 19      | 5.3 | 4.6 |
|                            | 40-60        | 4.46           | 0.31     | 14      | 5.3 | 4.6 |
| 1900-2000 m asl High altitude | 0-10         | 9.10           | 0.92     | 10      | 5.3 | 4.7 |
|                            | 10-20        | 6.68           | 0.36     | 19      | 5.4 | 4.7 |
|                            | 20-40        | 12.13          | 0.66     | 18      | 4.6 | 3.9 |
|                            | 40-60        | 11.84          | 0.37     | 32      | 5.4 | 4.8 |

Beside CEC. soil fertility could also be seen from the decomposition state shown by the C/N ratio. The higher the C/N ratio, the higher the fertility will be. Optimal C/N ratio is in between 10-15 (Dharmawan. Pers. com. 2018). If the C/N ratio less than 10 that is mean that the soil contains a lot of raw organic material. From table 7, we can conclude that the habitat of *Taxus sumatrana* is relatively fertile.

4. Conservation Implication

Studies on the distribution and ecology revealed that *T. sumatrana* only grows on steep slopes on high mountains. Population densities in nature range between 17 trees -31 trees/ha [3]. A threat that might lead to a population decline and extinction is limited distribution. Nevertheless, the population of *T. sumatrana* is found in a juridical safe area, namely National Parks, and Protected Forests. Therefore, is sustainability very much depends on the security of the area. National parks and
protected forests in Indonesia are still objects of encroachment, theft, and other illegal activities including a possible change in designation. T. sumatrana found in their habitat commonly large in diameter at breast height between 22-120 cm with a height ranging from 15-20 m. The big tree is a target for timber theft or illegal logging. Illegal logging can occur in state forests if needed wood increases while wood supply is limited. Therefore safeguarding the habitat of the Taxus is important.

5. Conclusion
Structurally T. sumatrana considered middle tree species none of them reaching the emergent trees. Taxus sumatrana at tree level were present abundantly at Mount Kerinci. In contrary sapling and seedling level of T. sumatrana are rare. T. sumatrana commonly grows to clump at a steep slope, high humidity, and cold temperature. The soil at the habitat of T. sumatrana is porous and fertile.

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References
[1] Artanti N S, Tachiban L B S, Kardono and Sukiman H 2011 Screening of Endophytic fungi Having Ability for antioxidative and α-glucosidase Inhibitor Activities Isoated from Taxus sumatrana Pakistan Journal of Biological Sciences 14 1019-1023.
[2] Huang C, Chiang T and Hsu T 2008 Isolation and characterization of microsatellite loci in Taxus sumatrana (Taxaceae) using PCR-based isolation of microsatellite arrays (PIMA) Conservation Genetic 9 471-473.
[3] Susilo A 2015 Taxus sumatrana: Sebaran, Potensi dan Strategi Konservasi. Prosiding Workshop “Promoting Conservation of Selected High Value Indigenous Species of Sumatra”. KLHK, Badan Litbang dan Inovasi, Balai Penelitian Teknologi Serat Tanaman Hutan Bekerjasama dengan International Tropical Timber Organization.
[4] Shen Y-C, Cheng K-C,Lin Y-C, Cheng Y-B, Khalisil Y Cheng. A.T. Khalil A T, Guh J-H, Chien C-T, Teng C-M, Chang Y-T 2005 Three New Taxane Diterpenoids from Taxus sumatrana J. Nat. Prod. 68 90-93
[5] Iszkulo G P, Kosinski M and Hajnos 2003 Sex influences the taxanes content in Tasus baccata. Acta Physiol Plant 35 147-152.
[6] Cope E A 1998 Taxaceae: the genera and cultivated species. Bot Rev 64 291-322.
[7] Shi Q W, Oritani T and Sugiyama T 1999 Two new taxane diterpenoids from the seeds of the Chinese yew. Taxus yunnanensis J. Asian Nat. Prod. Tes 2 71-79.
[8] Holden J, Januar A and Martyr D J 2003 The Asian Tapir in Kerinci Seblat National Park. Sumatra: evidence collected through photo-trapping Orxy 37 34-40.
[9] Linkie M, Martyr D J, Holden J, Yanuar A, Hartana A T, Sugardjito J and Leader-Williams N 2003 Habitat destruction and poaching threaten the Sumatran tiger in Kerinci Seblat National Park. Sumatra Orxy 37 41-48.
[10] Anonymous 2003 Kerinci Dalam Angka 2003. BAPPEDDA Bekerja Dengan BPS Kabupaten Kerinci Sungai Penuh. Kerinci
[11] Soerianegara I and Indrawan A 1982 Ekologi Hutan Indonesia. Departemen Managemen Hutan. Fakultas Kehutanan IPB (Bogor: IPB Press)
[12] Kusmana C 1997 Metode Survei Vegetasi (Bogor: IPB Press)
[13] Sundarapandian S M and Swamy PS 2000 Forest ecosystem structure and composition along an altitudinal gradient in the Western Ghats. South India Journal of Tropical Forest 12 104-123
[14] Smith R L 1977 *Element of Ecology* (New York : Harper & Row. Publisher)

[15] Sutisna U 1981 *Komposisi jenis hutan bekas tebangan di Batulicin, Kalimantan Selatan. Deskripsi dan analisis. Laporan No. 328*. Balai Penelitian Hutan. Bogor i 2018.

Appendix 1. Important Value Index Calculation at tree level at the low altitude (1500 m asl)

| No. | Scientific Name                   | Famili          | D  | RD | F   | RF | BA | Do  | RD | IVI |
|-----|----------------------------------|-----------------|----|----|-----|----|----|-----|----|-----|
| 1   | Cinnamomum iners Reinw. ex. Blume | Lauraceae       | 25.0| 0  | 5.56| 0.50| 6.25| 0.508| 2  | 2.1175 | 2.60 | 14.40 |
| 2   | Lithocarpus cyclophorus A. Canus  | Fagaceae        | 50.0| 0  | 11.11| 0.67| 8.33| 0.758| 5  | 3.1605 | 3.88 | 23.32 |
| 3   | Canarium littorale Blume          | Burseraceae     | 8.33| 1.85| 0.17| 2.08| 0.009| 0.0396| 0.05 | 3.98 |
| 4   | Lithocarpus palidus (Blume) Rehd  | Fagaceae        | 8.33| 1.85| 0.17| 2.08| 0.045| 0.1886| 0.23 | 4.17 |
| 5   | Sterculia parvifolia Wall.        | Sterculiaceae   | 8.33| 1.85| 0.17| 2.08| 0.010| 0.0433| 0.05 | 3.99 |
| 6   | Beilschmiedia glabra Koster.      | Lauraceae       | 8.33| 1.85| 0.17| 2.08| 0.017| 0.0737| 0.09 | 4.03 |
| 7   | Ficus congesta Korth.             | Moraceae        | 8.33| 1.85| 0.17| 2.08| 0.078| 0.3248| 0.40 | 4.33 |
| 8   | Acmena acuminatissima M.et.P.     | Mytaceae        | 33.33| 3  | 7.41| 0.67| 8.33| 0.461| 3  | 1.9221 | 2.36 | 18.10 |
| 9   | Syzygium grandis Wight.           | Mytaceae        | 8.33| 1.85| 0.17| 2.08| 0.010| 0.0433| 0.05 | 3.99 |
| 10  | Adinandra dasyanta Korth.         | Theaceae        | 8.33| 1.85| 0.17| 2.08| 0.012| 0.0512| 0.06 | 4.00 |
| 11  | Lithocarpus bennettii Rehd.       | Fagaceae        | 8.33| 1.85| 0.17| 2.08| 0.025| 0.1061| 0.13 | 4.07 |
| 12  | Payena leerii                     | Sapotaceae      | 20.83| 3  | 4.63| 0.17| 2.08| 0.239| 8  | 0.9993 | 1.23 | 7.94 |
| 13  | Antidesma tetrandum Bime          | Euphorbiaceae   | 8.33| 1.85| 0.17| 2.08| 0.013| 0.0553| 0.07 | 4.00 |
| 14  | Pouteria sp.                      | Sapotaceae      | 20.83| 3  | 4.63| 0.33| 4.17| 0.819| 8  | 3.4159 | 4.19 | 12.99 |
| 15  | Canangium odoratum B.             | Annonaceae      | 12.50| 0  | 2.78| 0.33| 4.17| 0.033| 4  | 0.1391 | 0.17 | 7.12 |
| 16  | Chloranthus officinalis Bime      | Chloranthaceae  | 8.33| 1.85| 0.17| 2.08| 0.034| 0.1444| 0.18 | 4.11 |
| 1   | Persea odoratissima               | Lauraceae       | 20.8 |    |     |     | 2.08 |    |     | 0.58 |


|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 7 | Kosterm | 8.33 | 1.85 | 0.17 | 0.113 | 0.4727 | 4.52 |
| 8 | Actinodaphne sp. | Lauraceae | 20.8 | 3 | 4.63 | 0.17 | 2.08 | 4.022 | 9 | 16.762 | 2 | 20.56 | 27.28 |
| 9 | Podocarpus neriifolia | Podocarpaceae | 16.6 | 7 | 3.70 | 0.17 | 2.08 | 4.376 | 0 | 18.233 | 2 | 22.37 | 28.16 |
| 0 | Podocarpus neriifolius | Podocaeraceae | 16.6 | 7 | 3.70 | 0.33 | 4.17 | 0.081 | 3 | 0.3368 | 0.42 | 8.29 |
| 1 | Elaeocarpus macrocerus | Elaeocarpaceae | 12.5 | 0 | 2.78 | 0.33 | 4.17 | 1.114 | 6 | 4.6442 | 5.70 | 12.64 |
| 2 | Ligustrinus sp. | Oleaceae | 25.0 | 0 | 5.56 | 0.17 | 4.17 | 0.087 | 8 | 0.3656 | 0.45 | 10.17 |
| 3 | Mastixia pentandra | Cornaceae | 12.5 | 0 | 2.78 | 0.33 | 4.17 | 0.042 | 6 | 0.1777 | 0.22 | 7.16 |
| 4 | Sycopsis dunii | Hamamelidaeaeae | 8.33 | 1.85 | 0.17 | 2.08 | 0.116 | 5 | 0.4853 | 0.60 | 4.53 |
| 5 | Orchthocharis borneensis | Blume | 16.6 | 7 | 3.70 | 0.33 | 4.17 | 0.049 | 5 | 0.2063 | 0.25 | 8.12 |
| 6 | Taxus sumatranas | Taxaceae | 50.0 | 0 | 11.11 | 0.33 | 4.17 | 5.851 | 0 | 24.379 | 2 | 29.91 | 45.19 |
| 7 | Sloanea sigun (Blume) | Elaeocarpaceaeae | 8.33 | 1.85 | 0.83 | 10.42 | 0.007 | 9 | 0.0327 | 0.04 | 3.98 |
| 8 | Phyllagathis rotundifolia | Blume | 8.33 | 1.85 | 0.17 | 2.08 | 0.007 | 9 | 0.0327 | 0.04 | 3.98 |
| Total | | | 450 | 100.0 | 0 | 8.00 | 0 | 100.0 | 0 | 21.91 | 5 | 81.512 | 100.0 | 0 | 300.0 | 0 |
Appendix 2. Important Value Index Calculation at tree level at the middle altitude (1800 m asl)

| No. | Scientific Name                  | Family      | D   | RD  | F    | RF   | BA   | Do   | RD   | IVI  |
|-----|---------------------------------|-------------|-----|-----|------|------|------|------|------|------|
| 1   | Cinnamomum iners Reinw.         | Lauraceae   | 8.33| 2.06| 0.17 | 2.44 | 0.2377 | 0.9903 | 2.41 | 6.91 |
| 2   | Lithocarpus cyclophorus         | Fagaceae    | 8.33| 2.06| 0.17 | 2.44 | 0.0087 | 0.0361 | 0.09 | 4.59 |
| 3   | Argostemma angustifolia Bl.     | Rubiaceae   | 16.67| 4.12|      |      | 0.00  | 0.4710 | 1.9623 | 4.78 | 8.91 |
| 4   | Argostemma angustifolia Bl.     | Rubiaceae   | 8.33| 2.06| 0.17 | 2.44 | 0.0380 | 0.1585 | 0.39 | 4.89 |
| 5   | Nephrolepis falcata            | Oleandraceae| 8.33| 2.06| 0.17 | 2.44 | 0.0087 | 0.0361 | 0.39 | 4.89 |
| 6   | Chionanthus ramiflora Wall.    | Olaceae     | 25.00| 6.19| 0.33 | 4.88 | 0.3658 | 1.5240 | 3.71 | 14.78|
| 7   | Acmena acuminateissima         | Myrtaceae   | 58.33| 14.43| 0.83 | 12.20 | 2.5481 | 10.6170 | 25.88 | 52.50|
| 8   | Ardisia villosa Val.           | Myrsinaceae | 8.33| 2.06| 0.17 | 2.44 | 0.0201 | 0.0838 | 0.20 | 4.71 |
| 9   | Lithocarpus bennettii Rehd.    | Fagaceae    | 8.33| 2.06| 0.17 | 2.44 | 0.0314 | 0.1310 | 0.32 | 4.82 |
| 10  | Schima wallichii Korth.        | Theaceae    | 8.33| 2.06| 0.17 | 2.44 | 0.0380 | 0.1585 | 0.39 | 4.89 |
| 11  | Mycetia fasciculata Blume      | Rubiaceae   | 8.33| 2.06| 0.17 | 2.44 | 0.3320 | 1.3832 | 3.37 | 7.87 |
| 12  | Antidesma tetrodum             | Euphorbiaceae| 8.33| 2.06| 0.17 | 2.44 | 0.0177 | 0.0737 | 0.18 | 4.68 |
| 13  | Pouteria sp.                   | Sapotaceae  | 29.17| 7.22| 0.50 | 7.32 | 0.6223 | 2.5929 | 6.32 | 20.85|
| 14  | Canangium odoratum B.          | Annonaceae  | 41.67| 10.31| 0.67 | 9.76 | 1.6318 | 6.7990 | 16.57 | 36.64|
| 15  | Litsea noronhiae Blume         | Lauraceae   | 8.33| 2.06| 0.17 | 2.44 | 0.0168 | 0.0702 | 0.17 | 4.67 |
| 16  | Actinodaphne sp.               | Lauraceae   | 16.67| 4.12| 0.33 | 4.88 | 0.1457 | 0.6070 | 1.48 | 10.48|
| 17  | Podocarpus neriifolia Don.     | Podocarpaceae| 8.33| 2.06| 0.17 | 2.44 | 0.0330 | 0.1376 | 0.34 | 4.84 |
| 18  | Elaeocarpus macrocerus         | Elaeocarpaceae| 8.33| 2.06| 0.17 | 2.44 | 0.0314 | 0.1310 | 0.32 | 4.82 |
| 19  | Elaeocarpus pierrei K.et V.    | Elaeocarpaceae| 8.33| 2.06| 0.17 | 2.44 | 0.1964 | 0.8185 | 1.99 | 6.50 |
| 20  | Engelhardia serrata Blume      | Jangladaceae| 45.83| 11.34| 0.67 | 9.76 | 0.7001 | 2.9172 | 7.11 | 28.21|
| 21  | Orchthocharis borneensis       | Marantaceae | 8.33| 2.06| 0.17 | 2.44 | 0.0573 | 0.2387 | 0.58 | 5.08 |
### Appendix 3. Important Value Index Calculation at tree level at the high altitude (2300 m asl)

| No. | Scientific Name                     | D    | RD   | F    | RF   | BA   | Do   | RD   | IVI  |
|-----|-------------------------------------|------|------|------|------|------|------|------|------|
| 1   | Cinnamomum iners Reinw. ex. Biune   | 16.67| 5.48 | 0.17 | 2.86 | 0.4190| 1.7459| 6.62 | 14.95|
| 2   | Lithocarpus cyclophorus A.Canus     | 33.33| 10.96| 0.50 | 8.57 | 0.7632| 3.1799| 12.05| 31.58|
| 3   | Argostemma angustifolia Bl.         | 12.50| 4.11 | 0.17 | 2.86 | 0.1684| 0.7017| 2.66 | 9.63 |
| 4   | Argostemma angustifolia Bl.         | 8.33 | 2.74 | 0.17 | 2.86 | 0.0380| 0.7017| 2.66 | 9.63 |
| 5   | Acmena acuminateissima M.et.P.      | 50.00| 16.44| 1.00 | 17.14| 1.5224| 6.3434| 24.04| 57.62|
| 6   | Antidesma tetrandum Biune           | 8.33 | 2.74 | 0.17 | 2.86 | 0.0250| 0.7017| 2.66 | 9.63 |
| 7   | Canangium odoratum B.               | 12.50| 4.11 | 0.17 | 2.86 | 0.0718| 0.2992| 1.13 | 8.10 |
| 8   | Actinodaphne sp.                    | 25.00| 8.22 | 0.83 | 14.29| 0.8370| 3.4876| 13.22| 35.72|
| 9   | Podocarpus nerifolia Don.           | 12.50| 4.11 | 0.17 | 2.86 | 0.2514| 1.0476| 3.97 | 10.94|
| 10  | Ligustrinus sp.                     | 16.67| 5.48 | 0.33 | 5.71 | 0.2927| 1.2195| 4.62 | 15.81|
| 11  | Engelhardia serrata Blume           | 8.33 | 2.74 | 0.17 | 2.86 | 0.1257| 0.5238| 1.98 | 7.58 |
| 12  | Orchthocharis borneensis Blume      | 58.33| 19.18| 1.00 | 17.14| 1.2519| 5.2162| 19.77| 56.09|
| 13  | Taxus sumatrana                     | 41.67| 13.70| 1.00 | 17.14| 0.5670| 2.3624| 8.95 | 39.79|
| **Total** |                                | **304**| **100.00**| **5.833**| **100.00**| **6.334**| **26.390**| **100.00**| **300.00** |
### Appendix 4. Important Value Index Calculation at sapling level at the low altitude (1500 m asl)

| No. | Scientific Name            | Family     | D   | RD  | F   | RF  | BA  | Do   | RD  | VI  |
|-----|---------------------------|------------|-----|-----|-----|-----|-----|------|-----|-----|
| 1   | Acmena acuminatissima.    | Mytaceae   | 666.67 | 20.0 | 0.83 | 20.8 | 3   | 0.076 | 2   | 5.077 | 55.40 | 96.24 |
| 2   | Lithocarpus cyclophorus   | Fagaceae   | 200.00 | 6.00 | 0.33 | 8.33 | 0.002 | 7   | 0.178 | 1   | 1.94 | 16.28 |
| 3   | Syzygium grandis          | Mytaceae   | 133.33 | 4.00 | 0.17 | 4.17 | 0.006 | 4   | 0.424 | 3   | 4.63 | 12.80 |
| 4   | Lithocarpus bennettii     | Fagaceae   | 133.33 | 4.00 | 0.17 | 4.17 | 0.005 | 7   | 0.378 | 5   | 4.13 | 12.30 |
| 5   | Psychotria viridiflora    | Rubiaceae  | 133.33 | 4.00 | 0.17 | 4.17 | 0.005 | 0   | 0.335 | 2   | 3.66 | 11.82 |
| 6   | Ipomoea aquatica         | Convolvulaceae | 133.33 | 4.00 | 0.17 | 4.17 | 0.005 | 0   | 0.335 | 2   | 3.66 | 11.82 |
| 7   | Cinnamomum iners          | Lauraceae  | 133.33 | 4.00 | 0.17 | 4.17 | 0.003 | 9   | 0.256 | 7   | 2.80 | 10.97 |
| 8   | Lasianthus occulus Miq.   | Rubiaceae  | 133.33 | 4.00 | 0.17 | 4.17 | 0.003 | 9   | 0.256 | 7   | 2.80 | 10.97 |
| 9   | Pouteria sp.              | Sapotaceae | 133.33 | 4.00 | 0.17 | 4.17 | 0.003 | 9   | 0.256 | 7   | 2.80 | 10.97 |
| 10  | Orchthocharis borneensis  | Marantaceae | 133.33 | 4.00 | 0.17 | 4.17 | 0.003 | 9   | 0.256 | 7   | 2.80 | 10.97 |
| 11  | Sloanea sigun             | Elaeocarpaceae | 200.00 | 6.00 | 0.17 | 4.17 | 0.001 | 0   | 0.068 | 1   | 0.74 | 10.91 |
| 12  | Schima wallichii Korth.   | Theaceae   | 133.33 | 4.00 | 0.17 | 4.17 | 0.002 | 8   | 0.188 | 6   | 2.06 | 10.22 |
| 13  | Turpinia sphaerocarpa     | Staphiliaceae | 133.33 | 4.00 | 0.17 | 4.17 | 0.002 | 8   | 0.188 | 6   | 2.06 | 10.22 |
| 14  | Taxus sumatrana           | Taxaceae   | 133.33 | 4.00 | 0.17 | 4.17 | 0.002 | 8   | 0.188 | 6   | 2.06 | 10.22 |
| 15  | Manglietia glauca Blume   | Magnoliaceae | 133.33 | 4.00 | 0.17 | 4.17 | 0.002 | 0   | 0.131 | 0   | 1.43 | 9.60 |
| 16  | Persea odoratissima       | Lauraceae  | 133.33 | 4.00 | 0.17 | 4.17 | 0.002 | 0   | 0.131 | 0   | 1.43 | 9.60 |
| 17  | Argostemma angustifolia   | Rubiaceae  | 133.33 | 4.00 | 0.17 | 4.17 | 0.001 | 3   | 0.083 | 8   | 0.91 | 9.08 |
| 18  | Curculigo lalifolia Dryand.| Liliaceae  | 133.33 | 4.00 | 0.17 | 4.17 | 0.000 | 7   | 0.047 | 1   | 0.51 | 8.68 |
| 19  | Styx paralleneorum.      | Styraceae  | 133.33 | 4.00 | 0.17 | 4.17 | 0.000 | 4   | 0.047 | 5   | 0.51 | 8.68 |
| Taxon          | Genus     | Species          | Family  | 7  | 1   |
|---------------|-----------|------------------|---------|----|-----|
| Lithocarpus palidus | Fagaceae | 133.33 | 4.00  | -  | 0.00 |
| Total         |           | 3,333 | 100   | 0  | 100  |

**Notes:**
- 2
- 0
- 4.00
- 0.00
- 0.005
- 0
- 0.335
- 2
- 3.66
- 7.66
- 300.0
Appendix 5. Important Value Index Calculation at sapling level at the middle altitude (1800 m asl)

| No. | Scientific Name              | Family      | D     | RD     | F     | RF     | BA    | Do     | RD     | IVI     |
|-----|-------------------------------|-------------|-------|--------|-------|--------|-------|--------|--------|---------|
| 1   | Acmena acuminatissima        | Mytaceae    | 1000.0| 28.30  | 1.00  | 20.69  | 0.028 | 1900.0 | 20.23  | 69.23   |
| 2   | Lithocarpus cyclophorus      | Fagaceae    | 666.67| 18.87  | 0.50  | 10.34  | 0.034 | 2313.5 | 24.64  | 53.85   |
| 3   | Orchthocharis borneensis      | Marantaceae | 333.33| 9.43   | 0.67  | 13.79  | 0.029 | 1991.9 | 21.21  | 44.44   |
| 4   | Argostemma angustifolia Bl.  | Rubiaceae   | 400.00| 11.32  | 0.67  | 13.79  | 0.002 | 178.1  | 1.90   | 27.01   |
| 5   | Taxus sumatrana              | Taxaceae    | 200.00| 5.66   | 0.33  | 6.90   | 0.018 | 1214.4 | 12.93  | 25.49   |
| 6   | Mycteria fasciculata Blume   | Rubiaceae   | 200.00| 5.66   | 0.50  | 10.34  | 0.002 | 195.1  | 2.08   | 18.08   |
| 7   | Lithocarpus pseudomoluccanus | Fagaceae    | 200.00| 5.66   | 0.17  | 3.45   | 0.006 | 403.3  | 4.29   | 13.40   |
| 8   | Actinodaphne sp.             | Lauraceae   | 133.33| 3.77   | 0.17  | 3.45   | 0.006 | 445.2  | 4.74   | 11.96   |
| 9   | Ligustrinus sp.              | Olaceae     | 66.67 | 1.89   | 0.17  | 3.45   | 0.006 | 424.3  | 4.52   | 9.85    |
| 10  | Canangium odoratum B.        | Annonaceae  | 133.33| 3.77   | 0.17  | 3.45   | 0.002 | 151.9  | 1.62   | 8.84    |
| 11  | Plectotinia sp.              | Rubiaceae   | 66.67 | 1.89   | 0.17  | 3.45   | 0.002 | 131.0  | 1.39   | 6.73    |
| 12  | Payena leerii                | Sapotaceae  | 66.67 | 1.89   | 0.17  | 3.45   | 0.000 | 21.0   | 0.22   | 5.56    |
| 13  | Pouteria sp.                 | Sapotaceae  | 66.67 | 1.89   | 0.17  | 3.45   | 0.000 | 21.0   | 0.22   | 5.56    |
| Total|                              |             | 3533.0|        | 4833.0|        | 141.0 | 9391.0|        | 300.0   |
### Appendix 6. Important Value Index Calculation at sapling level at the high altitude (2300 m asl)

| No. | Scientific Name          | Family   | D    | RD  | F   | RF  | BA  | Do   | RD  | IVI  |
|-----|--------------------------|----------|------|-----|-----|-----|-----|------|-----|------|
| 1   | Acmena acuminatissima    | Mytaceae | 866.67 | 11.93 | 0.83 | 10.42 | 0.060 | 8 | 4.052 | 3 | 26.81 | 49.15 |
| 2   | Argostemma angustifolia  | Rubiaceae | 733.33 | 10.09 | 0.83 | 10.42 | 0.015 | 5 | 1.035 | 8 | 6.85  | 27.36 |
| 3   | Orthocharis borneensis   | Marantaceae | 533.33 | 7.34  | 0.67 | 8.33  | 0.017 | 1 | 1.136 | 7 | 7.52  | 23.19 |
| 4   | Actinodaphne macropylla  | Lauraceae | 533.33 | 7.34  | 0.67 | 8.33  | 0.017 | 1 | 1.136 | 7 | 7.52  | 23.19 |
| 5   | Myctea fasciculata       | Rubiaceae | 400.00 | 5.50  | 0.67 | 8.33  | 0.016 | 6 | 1.106 | 5 | 7.32  | 21.16 |
| 6   | Engelhardia serrata      | Jungladaceae | 600.00 | 8.26  | 0.50 | 6.25  | 0.014 | 1 | 0.940 | 2 | 6.22  | 20.73 |
| 7   | Chionanthus ramiflora    | Olaceae   | 533.33 | 7.34  | 0.50 | 6.25  | 0.013 | 1 | 0.876 | 1 | 5.80  | 19.38 |
| 8   | Lithocarpus bennettii    | Fagaceae  | 200.00 | 2.75  | 0.33 | 4.17  | 0.017 | 1 | 1.144 | 1 | 7.57  | 14.49 |
| 9   | Lithocarpus cyclophorus  | Fagaceae  | 266.67 | 3.67  | 0.33 | 4.17  | 0.011 | 4 | 0.762 | 1 | 5.04  | 12.88 |
| 10  | Canangium odoratum B.    | Annonaceae | 466.67 | 6.42  | 0.33 | 4.17  | 0.005 | 0 | 0.331 | 3 | 2.19  | 12.78 |
| 11  | Ficus benjamina L.       | Moraceae  | 266.67 | 3.67  | 0.33 | 4.17  | 0.008 | 1 | 0.536 | 9 | 3.55  | 11.39 |
| 12  | Macropanax disperum      | Araliaceae | 266.67 | 3.67  | 0.33 | 4.17  | 0.008 | 1 | 0.536 | 9 | 3.55  | 11.39 |
| 13  | Pouteria sp.             | Sapotaceae | 200.00 | 2.75  | 0.33 | 4.17  | 0.004 | 2 | 0.277 | 6 | 1.84  | 8.76  |
| 14  | Taxus sumatrana          | Taxaceae  | 133.33 | 1.83  | 0.17 | 2.08  | 0.005 | 0 | 0.387 | 4 | 2.56  | 6.48  |
| 15  | Syzygium grandis         | Mytaceae  | 266.67 | 3.67  | 0.17 | 2.08  | 0.001 | 4 | 0.094 | 3 | 0.62  | 6.38  |
| 16  | Ardisia villosa Val.     | Myrtaceae  | 266.67 | 3.67  | 0.17 | 2.08  | 0.001 | 4 | 0.094 | 3 | 0.62  | 6.38  |
| 17  | Ficus variegata Blume    | Moraceae  | 200.00 | 2.75  | 0.17 | 2.08  | 0.003 | 2 | 0.210 | 1 | 1.39  | 6.23  |
|   | Species              | Family    | 2 | 6 | 100.0 | 8.000 | 0.227 | 15.11 | 100.0 | 300.0 |
|---|----------------------|-----------|---|---|-------|-------|-------|-------|-------|-------|
| 18| Lasianthus stipularis| Rubiaceae | 133.33 | 1.83 | 0.17  | 2.08  | 0.0039 | 0.2567 | 1.70  | 5.62  |
| 19| Harpulia arborea     | Sapindaceae | 133.33 | 1.83 | 0.17  | 2.08  | 0.0024 | 0.1585 | 1.05  | 4.97  |
| 20| Michelia scortechinii| Magnoliaceae | 133.33 | 1.83 | 0.17  | 2.08  | 0.0003 | 0.0210 | 0.14  | 4.06  |
| 21| Podocarpus neriifolia | Podocarpaceae | 133.33 | 1.83 | 0.17  | 2.08  | 0.0003 | 0.0210 | 0.14  | 4.06  |
|   | **Total**            |           | 7267 | 100.0 | 8.000 | 100.0 | 0.227 | 15.11 | 100.0 | 300.0 |
Appendix 7. Important Value Index Calculation at seedling level at the low altitude (1500 m asl)

| No. | Scientific Name                             | Family      | D   | RD  | F   | RF  | IVI  |
|-----|--------------------------------------------|-------------|-----|-----|-----|-----|------|
| 1   | Diplazium pallidum Moore.                  | Polypodaceae| 13,333 | 10.13 | 0.50 | 7.32 | 17.44 |
| 2   | Syzygium clavinyrtus K.et.V.               | Myrsinaceae | 16,667 | 12.66 | 0.17 | 2.44 | 15.10 |
| 3   | Acmena acuminatissima M.et.P.              | Mytaceae    | 10,000 | 7.59  | 0.50 | 7.32 | 14.91 |
| 4   | Meliosma nitida Blume                      | Sabiaceae   | 11,667 | 8.86  | 0.33 | 4.88 | 13.74 |
| 5   | Quercus gemelliflora Blume                 | Fagaceae    | 10,000 | 7.59  | 0.17 | 2.44 | 10.03 |
| 6   | Phoebe macrophylla Blume                   | Lauraceae   | 6,667  | 5.06  | 0.33 | 4.88 | 9.94  |
| 7   | Polyosma angulata Blume                    | Sabiaceae   | 5,000  | 3.80  | 0.33 | 4.88 | 8.68  |
| 8   | Mycetia fasciculata Blume                  | Rubiaceae   | 6,667  | 5.06  | 0.17 | 2.44 | 7.50  |
| 9   | Itea macrophylla Wall.                     | Saxifragaceae| 3,333 | 2.53  | 0.33 | 4.88 | 7.41  |
| 10  | Orthothecaris borneensis Blume Prunus               | Marantaceae | 3,333 | 2.53  | 0.33 | 4.88 | 7.41  |
|     | arborea (Blume) Kalkman.                   |             |       |       |     |     |      |
| 11  | Palaquium rostratum (Miq.) Burck           | Sapotaceae  | 3,333 | 2.53  | 0.17 | 2.44 | 4.97  |
| 12  | Actinodaphne sp.                           | Lauraceae   | 3,333 | 2.53  | 0.17 | 2.44 | 4.97  |
| 13  | Symplocos cochinchenensis Lour             | Symplocaceae| 3,333 | 2.53  | 0.17 | 2.44 | 4.97  |
| 14  | Flagellaria indica Linn.                   | Flagellariaceae| 3,333 | 2.53  | 0.17 | 2.44 | 4.97  |
| 15  | Curculigo lalifolia Dryand.                 | Liliaceae   | 1,667  | 1.27  | 0.17 | 2.44 | 3.70  |
| 16  | Psychotria viridiflora R.                   | Rubiaceae   | 1,667  | 1.27  | 0.17 | 2.44 | 3.70  |
| 17  | Flacourtia inermis Roxb.                    | Flacouriaceae| 1,667 | 1.27  | 0.17 | 2.44 | 3.70  |
| 18  | Elaeocarpus sp.                            | Elaeocarpceae| 1,667 | 1.27  | 0.17 | 2.44 | 3.70  |
| 19  | Magnolia candollei Blume                   | Magnoliaceae| 1,667 | 1.27  | 0.17 | 2.44 | 3.70  |
| 20  | Amorphophallus variabilis Blume            | Araceae     | 1,667  | 1.27  | 0.17 | 2.44 | 3.70  |
| 21  | Distylium stellarea OK.                    | Hamamelidaceae| 1,667 | 1.27  | 0.17 | 2.44 | 3.70  |
| 22  | Antidesma tetrandum Blume                  | Euphorbiaceae| 1,667 | 1.27  | 0.17 | 2.44 | 3.70  |
| 23  | Turpinia sphaerocarpa Hassk.                | Staphilaceae| 1,667 | 1.27  | 0.17 | 2.44 | 3.70  |
| 24  | Litsea noronhae Blume                      | Lauraceae   | 1,667  | 1.27  | 0.17 | 2.44 | 3.70  |
|   | Species                        | Family      | Num  | L  | W  | H   | Jumlah |
|---|-------------------------------|-------------|------|----|----|-----|--------|
| 26| Podocarpus neriifolius D.Don. | Podocaeraceae | 1,667 | 1.27 | 0.17 | 2.44 | 3.70  |
| 27| Villebrunea rubescens Blume    | Urticaceae   | 1,667 | 1.27 | 0.17 | 2.44 | 3.70  |
| 28| Ardisia javanica A.Dc.         | Myrsinaceae  | 1,667 | 1.27 | 0.17 | 2.44 | 3.70  |
| 29| Mastixia pentandra Blume       | Cornaceae    | 1,667 | 1.27 | 0.17 | 2.44 | 3.70  |
| 30| Ficus deltoidea Jack.          | Moraceae     | 1,667 | 1.27 | 0.17 | 2.44 | 3.70  |
| 31| Homalomena rubra Hassk.        | Araceae      | 1,667 | 1.27 | 0.17 | 2.44 | 3.70  |
| 32| Hydrocotyle sibthorpioides     | Apiaceae     | 1,667 | 1.27 | 0.17 | 2.44 | 3.70  |
|   | Jumlah                        |             | 131,667 |   |     |     | 100.00 | 6.83 | 100.00 | 200.00 |
Appendix 8. Important Value Index Calculation at seedling level at the middle altitude (1800 m asl)

| No. | Scientific Name               | Family      | D     | RD | F   | RF | IVI  |
|-----|--------------------------------|-------------|-------|----|-----|----|------|
| 1   | Ardisia javanica A.Dc.         | Myrsinaceae | 50,000| 24.79| 1.00 | 18.75 | 43.54 |
| 2   | Diplazium pallidum Moore.      | Polypodaceae| 33,333| 16.53| 1.00 | 18.75 | 35.28 |
| 3   | Rynchosphora corymbosa Briton. | Cyperaceae  | 33,333| 16.53| 0.33 | 6.25  | 22.78 |
| 4   | Argostemma angustifolia Bl.    | Rubiaceae   | 18,333| 9.09 | 0.17 | 3.13  | 12.22 |
| 5   | Acmena acuminatissima M.et.P.  | Mytaceae    | 11,667| 5.79 | 0.33 | 6.25  | 12.04 |
| 6   | Nyssa javanica Blume           | Nyssaceae   | 10,000| 4.96 | 0.33 | 6.25  | 11.21 |
| 7   | Orchthocharis borneensis Blume  | Marantaceae | 8,333 | 4.13 | 0.33 | 6.25  | 10.38 |
| 8   | Taxus sumatrana                | Taxaceae    | 6,667 | 3.31 | 0.33 | 6.25  | 9.56  |
| 9   | Asplenium affine Sw.           | Polypodaceae| 8,333 | 4.13 | 0.17 | 3.13  | 7.26  |
| 10  | Syzygium lineata Duthie        | Mytaceae    | 5,000 | 2.48 | 0.17 | 3.13  | 5.60  |
| 11  | Actinodaphne macropylla Nees   | Lauraceae   | 5,000 | 2.48 | 0.17 | 3.13  | 5.60  |
| 12  | Psychotria viridiflora R.      | Rubiaceae   | 3,333 | 1.65 | 0.17 | 3.13  | 4.78  |
| 13  | Symplocos fasciculata Zoll.    | Symplocaceae| 1,667 | 0.83 | 0.17 | 3.13  | 3.95  |
| 14  | Ardisia humilis Vahl.          | Liliaceae   | 1,667 | 0.83 | 0.17 | 3.13  | 3.95  |
| 15  | Mycetia fasciculata Blume      | Rubiaceae   | 1,667 | 0.83 | 0.17 | 3.13  | 3.95  |
| 16  | Kleinhovia hospita L.          | Sterculiaceae| 1,667 | 0.83 | 0.17 | 3.13  | 3.95  |
| 17  | Symingtonia populnea Steen.    | Hamamelidaceae | 1,667 | 0.83 | 0.17 | 3.13  | 3.95  |

**Jumlah** 201,667 100.00 5.33 100.00 200.00

Appendix 9. Important Value Index Calculation at seedling level at the high altitude (2300 m asl)

| No. | Scientific Name               | Family      | D     | RD | F   | RF | IVI  |
|-----|--------------------------------|-------------|-------|----|-----|----|------|
| 1   | Ardisia javanica A.Dc.         | Myrsinaceae | 46,667| 21.88| 0.83 | 17.86 | 39.73 |
| 2   | Elastostema sessile Forest.    | Urticaceae  | 41,667| 19.53| 0.33 | 7.14  | 26.67 |
| 3   | Quercus gemelliflora Blume     | Fagaceae    | 33,333| 15.63| 0.33 | 7.14  | 22.77 |
| 4   | Diplazium pallidum Moore.      | Polypodaceae| 16,667| 7.81 | 0.67 | 14.29 | 22.10 |
|   | Species                        | Family          | Value  | Percentage | Width (cm) | Height (cm) |
|---|-------------------------------|-----------------|--------|------------|------------|-------------|
| 5 | Madhuca sericea (Miq.) H.J.Lam | Sapotaceae      | 33,333 | 15.63      | 0.17       | 3.57        | 19.20       |
| 6 | Aspelnium affine Sw.          | Polypodaceae    | 8,333  | 3.91       | 0.33       | 7.14        | 11.05       |
| 7 | Kleinhovia hospita L.         | Sterculiaceae   | 5,000  | 2.34       | 0.33       | 7.14        | 9.49        |
| 8 | Nyssa javanica Blume          | Nyssaceae       | 5,000  | 2.34       | 0.17       | 3.57        | 5.92        |
| 9 | Vernonia arborea Ham.         | Asteraceae      | 5,000  | 2.34       | 0.17       | 3.57        | 5.92        |
|10 | Antidesma sp.                 | Euphorbiaceae   | 3,333  | 1.56       | 0.17       | 3.57        | 5.13        |
|11 | Acmena acuminatissima M.et.P. | Mytaceae        | 3,333  | 1.56       | 0.17       | 3.57        | 5.13        |
|12 | Polyosma angulata Blume       | Sabiaceae       | 3,333  | 1.56       | 0.17       | 3.57        | 5.13        |
|13 | Podocarpus motleyi (Parl.) Dummer | Podocarpaceae | 1,667  | 0.78       | 0.17       | 3.57        | 4.35        |
|14 | Chionanthus ramiflora Wall.   | Olaceae         | 1,667  | 0.78       | 0.17       | 3.57        | 4.35        |
|15 | Symplocos cochinchenensis Lour | Symplocaceae    | 1,667  | 0.78       | 0.17       | 3.57        | 4.35        |
|16 | Orchthocharis borneensis Blume | Marantaceae     | 1,667  | 0.78       | 0.17       | 3.57        | 4.35        |
|17 | Taxus sumatrina               | Taxaceae        | 1,667  | 0.78       | 0.17       | 3.57        | 4.35        |
| **Total**                     |                 | 213,333         | 100.00 | 4.67       | 100.00      | 200.00      |