Species composition, structure and endemicity of flora Malesiana in the Udayana urban forest, Mataram City

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Abstract. Udayana urban forest in Mataram City, West Nusa Tenggara (NTB) province boasts the endemic Flora Malesiana. This research aims to describe the structure, composition and the authenticity of Flora Malesiana in this area. We used a census method (100% measurement) to identify the species and measured the diameter and height of all trees species with the diameter of more than 2 cm. The results showed that the 64 species belong to 27 families. The urban forest is dominated by Fabaceae family (27.39%) with its 18 species (28.13%) of plants being invasive. The species dominance index (C) is in the range of 0.00012-0.24, indicating that there is no concentration of the species in the plant community. The ecology index showed a low level for seedling, a moderate to high level for sapling and pole, and a high level for trees. The horizontal structure is almost in the form of an inverted J-curve, neither a dynamic nor a natural forest. Vertical stand structure shows that the canopy stratification in the Udayana urban forest is mostly in stratum C (91.33%).

1. Introduction

As the capital of the West Nusa Tenggara (NTB) province, Mataram City is within the bio-ecoregion area of the Lesser Sunda Islands. Geographically located across the Lombok strait makes Mataram city one of the primary nodes of regional trade and service, industry and ecotourism activities in the central Indonesia region (West Nusa Tenggara Province Regional Regulation Number 3/2010) [1]. On the other hand, the phytogeography has given an identity of authenticity (endemism) to the country’s rich biodiversity.

Kusmana and Hikmat [1] states that Indonesia is listed as one of the world's biodiversity centers that constitutes 25% of the world's flowering plant species. Around 20,000 species or 40% of this are endemic/native plants to Indonesia, which includes Flora Malesiana. Considering the high endemicity of biodiversity in Indonesia, the efforts to maintain the existence is done through the establishment of urban forest allocation. As a part of the conservation, urban forests should take up of at least 30% of the total city area. As mandated in the Republic of Indonesia Government Regulation No. 63/2002, Article 27 Point (d), urban forest can be utilized to conserve endemic germplasm in Indonesia.

However, in reality, most of the urban forest is developed by the local government based only on the proportion and distribution of urban forest areas stated in central government standard without considering the characteristics of the region's ecological vulnerability parameters. It can be seen from the plant selection, which consists of many non-endemic plants. This is unfortunate because each
region in Indonesia has its specific species that is suitable for the urban forests’ biophysical characteristics.

Introducing new species does not always have a negative impact. In fact, introduced species can also provide many benefits, such as for the production of wood, latex, fruit, and many others. However, introduced species can also be invasive and defeat the native species, hence change the structure and composition of the genetic pools in a particular ecosystem. Moreover, they can also spread pests that threaten the biodiversity in a particular area and change the micro climate. This is one of the causes of the decline or loss of biodiversity in many regions, including the forest biodiversity in urban areas.

Therefore, it is vital to obtain the primary data of the structure and composition of Udayana urban forest in terms of types and endemicity of Flora Malesiana in NTB province. This is a first step to determine the criteria and indicators of plant species suitability based on the autecological parameters.

2. Research methods

2.1. Location and time of research

This research was conducted from January to July 2020 in the green line of Udayana urban forest, Mataram City, NTB province with an area of 12.25 ha. The research location can be seen in Figure 1.

![Figure 1. Research location map](image)

2.2. Materials and tools

The material used in this study is tree stands and regeneration, as well as other habitus contained in the current study’s site. The tools used in this study include 30-meter measuring tape, Phitband meter, Haga-hypsometer, GPS, tally sheet, stationery, digital camera and Microsoft Office software.
2.3. Method of collecting data
This research was carried out through field surveys to determine the types of constituent trees at the site by using a comprehensive tree census method (IS=100%), which includes the data of the trees, the poles, the saplings seedlings and the undergrowth. The data on seedlings and the undergrowth were taken by the name of species and the number of individuals. Meanwhile, data for saplings, poles and trees were taken by the species names, the number of individuals, and the measured diameter at breast height (DBH), the crown diameter (longest and shortest), the free height of the branches, and the total height of the trees. The growth variable refers to Soerianegara and Irawan [2] and Kusmana [3]. The limitations of the growth in this study are:

a. Seedlings are fresh saplings with a diameter of <2 cm and a height of <1.5 meters
b. Saplings are rejuvenation with a diameter of 2-9.9 cm and height of >1.5 meters
c. Poles are a young tree with a diameter of 10-19.9 cm
d. Trees are a mature tree with a diameter of ≥20 cm

Besides, secondary data were also taken from the vegetation environmental data, which included altitude, temperature and humidity.

2.4. Data analysis

2.4.1. Composition of plant species

2.4.1.1. Identify the originally species. This analysis focuses on the registration of all plant species found in the research location by identifying the Latin names and families, as well as their origins as documented in the literature. References used in the species identification are [4–10]. The analysis focuses on a local tree species, Flora Malesiana.

2.4.1.2. The dominance of species (IVI). The data of Udayana urban forest vegetation obtained were processed by using the following formula by Soerianegara and Irawan [2] and Kusmana [3]:

\[ IVI_i = \left( \frac{\left( n_i / A \right)}{\sum \left( n_i / A \right) x 100\%} \right) + \left( \frac{\left( p_i / p \right)}{\sum \left( p_i / p \right) x 100\%} \right) + \left( \frac{\left( BA_i / A \right)}{\sum \left( BA_i / A \right) x 100\%} \right) \]  \hspace{1cm} (1)

In the formula, IVI represent important value index of i species, \( n_i \) indicates the total individu of i species, A indicates the total of measurement area, \( p_i \) indicates the number of plot found i species, \( p \) indicate the total of plot and \( BA_i \) indicates the total Basal Area of i species.

2.4.1.3. Ecological index. These ecological indices use the following formula:

\[ H' = -\sum \left[ \left( n_i / N \right) \ln \left( n_i / N \right) \right] \] \hspace{1cm} (2)

\[ R_1 = \frac{S - 1}{\ln N} \] \hspace{1cm} (3)

\[ E = \frac{H'}{\ln N} \] \hspace{1cm} (4)

\[ C = \sum \left( \frac{n_i}{N} \right)^2 \] \hspace{1cm} (5)

In these formulas, \( H' \) represents Shannon-Wiener Index, \( R_i \) represents Margalef Index, \( E \) represents Evenness Index, \( C \) represents Simpson Index, \( n_i \) denotes the total individu of i species, \( N \) denotes total individu and \( S \) denotes the number of species.
Magurran [11] states that the criteria for $H'$ consist of $H' < 1.5$, which indicates low species diversity, the value of $1.5 < H' < 3.5$ indicates moderate species diversity, and $H' > 3.5$ indicates high species diversity. Meanwhile for $R_1$, the criteria consist of $R_1 < 3.5$, which indicates low species richness, the value of $3.5 < R_1 < 5.0$ indicates as moderate species richness, and $R_1 > 5.0$ indicates as high species richness. The evenness index $(E)$ criteria consist of $E < 0.3$, which indicates the low species evenness, the value of $0.3 < E < 0.6$ classifies as moderate species evenness and $E > 0.6$ indicates high species evenness. [12] states that if a stand is controlled by only one species, the $C$ value ranges $(0.5 \geq C \geq 1)$. In other words, there has been a concentration of a plant species. Conversely, if the value of $C$ is at $(0 \leq C \leq 0.5)$, then there will be no concentration of species where there are several species dominating simultaneously.

2.4.2. Stand structure. Stand structure can be described horizontally by the plants’ diameter class versus the density (individuals plant/ha) and vertically by describing height class versus density (individuals/ha).

3. Results and discussion

3.1. Composition of plant species

The result of the observations and vegetation analysis of Udayana urban forest found that out of the 1614 trees, there are 27 families, 59 genera and 64 plant species with dominant species being Fabaceae family (14 species), followed by Meliaceae and Myrtaceae (4 species) and Anacardiaceae, Clusiaceae, Lamiaceae, Malvaceae and Sapindaceae (3 species) (Table 1). Figure 2 shows that the two most dominant families are Fabaceae (27.39%) and Combretaceae (10.16%). According to [13], the family level can be said to be dominant vegetation if it has a percentage of $>20\%$ of the total individuals, while $10-20\%$ is codominant. The Fabaceae family is found in a large number and dominates the Udayana urban forest because it has many open areas and land-use changes, which is an ideal habitat for this plant family. Furthermore, Fabaceae family seeds come in pods, so they can quickly spread with the help of animals or humans. Fabaceae families are the third-largest taxon of flowering plants in the world after Asteraceae (Compositae) and Orchidaceae, consisting of 770 genera and more than 19,500 species [14–17]. Meanwhile, Combretaceae is a family that has a wide distribution in tropical and subtropical regions with the spread habitat of shrubs, lianas and trees of around 23 genera and 600 species [18–20].

![Figure 2. The number of Udayana urban forest species in each family](image-url)

Overall, out of a total of 1614 stands (Table 1), the top 5 species recapitulated were S. saman at 193 individuals/ha (11.96%), F. decipiens at 142 individuals/ha (8.80%), T. mantaly at 88 individuals/ha...
(5.45%), *S. mahagoni* at 87 individuals/ha (5.37%) and *P. longifolia* at 84 individuals/ha (5.20%). The high number of *S. saman* species is because this species flowers throughout the year with hundreds of pods containing 5–20 seeds, which easily grow when they touch the ground.

Table 1 also shows that, apart from the tree species, one small shrub was founded in the Lamiaceae family (*T. vulgaris*) and one palm species in the Arecaceae family (*R. regia*). Nevertheless, the most common genera found were *Syzygium* with three species, namely *Calophyllum, Terminalia* and *Ficus*, each with two species. Table 1 also documents several types of potentially invasive introduced plants that must be managed more carefully in the future. This is because Mataram City, or the NTB province in general, is located within the bio-ecoregion area of the Lesser Sunda Islands and the transitional flora of Wallacea with high endemic biodiversity [1,21,22]. These identified species have been registered nationally and internationally as invasive alien species (IAS). They have the potential to destroy native species and biodiversity, as well as cause ecosystem degradation and habitat loss because they can decrease the ground water and the soil fertility, and change the biotic interactions and other ecosystem processes [8,9,16,17,24–26].

Based on the field data processing of Udayana urban forest, from a total of 64 species, 46 of them are Flora Malesiana species (71.88%) and 18 of them (28.13%) invasive species (Figure 3). It has been recorded in the Fabaceae family’s invasive plant species, namely (*A. pavonina, B. purpurea, D. regia, E. crista-galli, L. leucochepala, S. saman*, and *T. indica*). Also, other invasive species are namely from the family Annonaceae (*P. longifolia*), Arecaceae (*R. regia*), Bignoniaceae (*S. campanulata*), Combretaceae (*T. mantaly*), Lamiaceae (*T. vulgaris*), Lauraceae (*P. americana*), Meliaceae (*S. mahagoni*), Muntingiaceae (*M. calabura*), Myrtaceae (*C. citrinus*), Sapindaceae (*F. decipiens*), and Sapotaceae (*M. zapota*).

These invasive species have been recorded in the previous studies in various places in Indonesia. The results show that they pose a risk to threaten the local native ecosystem. Examples of such invasion are seen in the case of *S. saman* in the rehabilitation zone Meru Betiri National Park, East Java [27], *L. leucochepala* in the karst area of Mount Cibodas, West Java; in the coastal forest vegetation of Sabutung, South Sulawesi; in Protected Forest Management Unit (FMU) Sorong, West Papua [16,17,28,29], *S. campanulata* in Bedugul, Bali and in Protected Forest Management Unit (FMU) Sorong, West Papua, as well as in Gunung Meja Manokwari Natural Tourism Park, West Papua [16,17,30], *A. pavonina* in the Kuningan botanical garden, West Java [31] and *B. purpurea* at the Sukaraja Atas resort, South Bukit Barisan National Park [32]. These species have substantial impacts on the areas, both ecologically and economically.

### Figure 3. Percentage of plant species based on endemicity

The dominancy of the potentially invasive plants may be due to the local regulation that aims to diversify the plants in the urban forest. The central government regulations such as Minister of Public Works Regulation Number 5 of 2008 recommended the number of plant types without paying...
attention to the endemicity. The recomendation is also not supported by proper urban forest studies when in fact t. The plan should not only pay attention to plant functions and requirements, but also the potential and risk of introducing a new plant.

Table 1. Recapitulation of inventory and originally of Udayana urban forest

| Family                  | Gebus           | Spesies                          | Total Found | Habitus | Originally |
|-------------------------|-----------------|----------------------------------|-------------|---------|------------|
|                         |                 |                                  | Total       | %       |            |
| Anacardiaceae           | Dracontomelon   | Dracontomelon dao (Blanco) Merr. & Rolfe. | 39          | 2.42    | 25         |
|                         | Lannea          | Lannea coronandelica (Houtl.) Merr. | 9           | 0.56    | 25         |
|                         | Mangifera       | Mangifera indica L.              | 14          | 0.87    | 25         |
| Annonaceae              | Polyalthia      | Polyalthia longifolia Sonn.      | 84          | 5.20    | 21, 30, 41 |
|                         | Stelechocarpus  | Stelechocarpus burahol (Blume) Hook. f. & Thomson. | 36          | 2.23    | 25         |
| Apocynaceae             | Ochrosia        | Ochrosia oppositifolia (Lam.) K. Schum. | 67          | 4.15    | 25         |
| Araucariaceae           | Agathis         | Agathis dammara (Lamb.) Rich.    | 68          | 4.21    | 25         |
| Areceae                 | Roystonea       | Roystonea regia (Kunth) O.F. Cook | 1           | 0.06    | 11, 14, 22, 26, 38, 42 |
| Bignoniaceae            | Spathodea       | Spathodea campanulada P. Beauv.  | 28          | 1.73    | 46         |
| Burseraceae             | Canarium        | Canarium indicum L.              | 29          | 1.80    | 25         |
| Casuarinacae            | Casuarina       | Casuarina equisetifolia L.        | 3           | 0.19    | 25         |
| Clusiaceae              | Calophyllum     | Calophyllum inophyllum L.         | 44          | 2.73    | 25         |
|                         |                 | Calophyllum soulastrri Burm. f.  | 32          | 1.98    | 25         |
|                         | Garcinia        | Garcinia dulcis (Roxb.) Kurz     | 3           | 0.19    | 25         |
| Combretaceae            | Terminalia      | Terminalia catappa L.            | 76          | 4.71    | 25         |
|                         |                 | Terminalia mantaly H. Perrier    | 88          | 5.45    | 23         |
| Dipterocarpaceae        | Dipterocarpus   | Dipterocarpus retusus Blume      | 4           | 0.25    | 25         |
| Ebenaceae               | Diospyros       | Diospyros macrophylla Blume      | 1           | 0.06    | 25         |
| Fabaceae                | Acacia          | Acacia auriculiformis A. Cunn. ex Benth. | 8           | 0.50    | 25         |
|                         | Adenanthera     | Adenanthera pavonina L.          | 4           | 0.25    | 10, 13, 14, 20, 36, 38, 43, 45 |
|                         | Albizia         | Albizia chinensis (Osbeck) Merr. | 19          | 1.18    | 25         |
|                         | Archidendron    | Archidendron eulyearia (Jack) I. C. Nielsen | 2          | 0.12    | 25         |
|                         | Bauhinia        | Bauhinia purpurea L.             | 47          | 2.91    | 5, 8, 21, 24, 28, 29, 32, 41 |
|                         | Cassia          | Cassia fistula L.                | 8           | 0.50    | 25         |
|                         | Delonix         | Delonix regia (Boj. ex)          | 36          | 2.23    | 23         |
| Genus                  | Species                              | Height (m) | Tree Morphology | Tree Number |
|------------------------|--------------------------------------|------------|-----------------|-------------|
| Erythrina              | Erythrina cristagalli L.             | 28         | Tree            | 2, 36, 34, 44 |
| Leucaena               | Leucaena leucocephala (Lam.) de Wit   | 2          | Tree            | 7, 18, 39   |
| Maniltoa               | Maniltoa grandiflora (A. Gray) Scheff.| 63         | Tree            | 25          |
| Pterocarpus            | Pterocarpus indicus Willd.            | 16         | Tree            | 25          |
| Samanea                | Samanea saman (Jacq.) Merr.           | 193        | Tree            | 10, 12, 13, 17, 26, 31, 33, 45 |
| Senna                  | Senna siamea (Lam.) Irwin et. Barneby | 9          | Tree            | 25          |
| Tamarindus             | Tamarindus indica L.                  | 7          | Tree            | 16, 23      |
| Gmelina                | Gmelina arborea Roxb.                | 46         | Tree            | 25          |
| Thymus                 | Thymus vulgaris L.                    | 1          | Shrub           | 27, 40      |
| Tectona                | Tectona grandis L.f.                 | 18         | Tree            | 25          |
| Litsea                 | Litsea glutinosa (Lour.) C. B. Rob.   | 1          | Tree            | 25          |
| Persea                 | Persea americana Mill.               | 1          | Tree            | 11, 26      |
| Barringtonia           | Barringtonia racemosa (L.) Spreng.   | 1          | Tree            | 25          |
| Duabanga               | Duabanga moluccana Blume             | 1          | Tree            | 25          |
| Lagerstroemia          | Lagerstroemia speciosa (L.) Pers.    | 61         | Tree            | 25          |
| Hibiscus               | Hibiscus tilaeus L.                  | 33         | Tree            | 25          |
| Pterospermum           | Pterospermum javanicum Jungh.        | 20         | Tree            | 25          |
| Sterculia              | Sterculia foetida L.                 | 1          | Tree            | 25          |
| Lansium                | Lansium parasiticum (Osbeck) Sahni & Bennett | 3 | Tree | 25 |
| Sandoricum             | Sandoricum koeljape (Burm.f.) Merr.  | 1          | Tree            | 25          |
| Swietenia              | Swietenia mahagoni (L.) Jacq.        | 87         | Tree            | 4, 6, 14, 15, 19, 22, 38 |
| Toona                  | Toona sureni (Blume) Merr.           | 2          | Tree            | 25          |
| Artocarpus             | Artocarpus heterophyllus Lam.        | 10         | Tree            | 25          |
| Ficus                  | Ficus benjamina L.                   | 4          | Tree            | 25          |
| Ficus                  | Ficus elastica Roxb. ex Hornem.      | 15         | Tree            | 25          |
| Muntingia              | Muntingia calabura L.                | 4          | Tree            | 2, 9, 11, 32, 42 |
| Callistemon            | Callistemon citrinus (Curtis) Skeels | 11         | Tree            | 3           |
| Syzygium               | Syzygium formosum (Wall.) Masam.     | 1          | Tree            | 25          |
| Syzygium               | Syzygium polyanthum (Wight) Walp.    | 2          | Tree            | 25          |
| Syzygium               | Syzygium samarangense (Blume) Merr. & L. M. Perry | 16 | Tree | 25 |

7
Table 2 shows the species that play a role in forests with an IVI value > 15% at the tree level are S. saman (54.33%) and A. oppositifolia (29.54%) and O. burahol (18.05%), F. glandiflora (12.83%), C. longifolia (12.31%), M. mindanaoense (11.83%), and G. soulatii (11.79%). The species that play a role at the sapling level have an IVI > 10%, namely T. diversifolia (19.27%) at sapling level with 31 species and 18 individuals/ha (1.12%) and T. diversifolia (9.77%) and A. oppositifolia (9.25%) at seedling level with 4 species. The total basal area of all tree species is 126.52 m²/ha, of which most (91.15% or 115.32 m²/ha) is found at the tree level, followed by at the pole level (8.09% or 10.23 m²/ha) and the last (0.77% or 0.97 m²/ha) at sapling level.

Table 3 shows that T. mantaly has the highest IVI at seedling and sapling growth rates with a high level of control. In contrast, at the pole level, it is dominated by F. decipiens with moderate control and tree levels in the S. saman species with high tenure levels. [33][34][35] state that high IVI value means that the species is dominant. It shows that the species is more powerful than other species. Simultaneously, the species with the second highest IVI value after the dominant species (or called codominant) are predicted to replace the dominant species in the next succession because they can adapt after the dominant breed. Table 3 presents the dominant tree species in terms of their growth rates. These species are found in large densities, evenly distributed throughout the area, and they have a large diameter at the growth rates of poles and trees. Besides, the dominant species are invasive so that can utilize the most available resources compared to the other plant types. It shows that plants significantly correlate with their place of growth (habitat) in terms of species distribution, density and dominance.

Previous studies [35–41] confirm that species play an essential role in forest communities if the tree and pole levels have an IVI value > 15% and saplings and seedlings levels have an IVI value > 10%.

| Phyllanthaceae | Antidesma | Antidesma bunius (L.) Spreng. | 42 | 2.60 | Tree | 25 |
|---------------|-----------|--------------------------------|----|------|------|----|
| Rubiaceae     | Morinda   | Morinda citrifolia L.           | 7  | 0.43 | Tree | 25 |
|               | Nauclea   | Nauclea orientalis (L.)         | 1  | 0.06 | Tree | 25 |
| Sapindaceae   | Filicium  | Filicium decipiens (Wight & Arn.) Thwaites | 142 | 8.80 | Tree | 16, 21, 23, 41 |
|               | Pometia   | Pometia pinnata J.R. Forst. & G. Forst. | 8  | 0.50 | Tree | 25 |
|               | Schleicheria | Schleicheria oleosa (Lour.) Oken | 1  | 0.06 | Tree | 25 |
| Sapotaceae    | Manilkara | Manilkara zapota (L.) P. Royen  | 2  | 0.12 | Tree | 11, 39, 42 |
|               | Minusops  | Minusops elengi L.              | 2  | 0.12 | Tree | 25 |
| Thymelaeaceae | Gyrinops  | Gyrinops versteegii (Gilg.) Domke | 1  | 0.06 | Tree | 25 |

Total of Number Individuals 1614 100.00

3.2. Dominance of species (IVI)

The results of the stand inventory (Table 2) show that there are 798 individuals/ha (49.44%) at the tree level with 50 species, 487 individuals/ha (30.17%) at the pole level with 49 species, 311 individuals/ha (19.27%) at sapling level with 31 species and 18 individuals/ha (1.12%) at seedling level with 4 species. The total basal area of all tree species is 126.52 m²/ha, of which most (91.15% or 115.32 m²/ha) is found at the tree level, followed by at the pole level (8.09% or 10.23 m²/ha) and the last (0.77% or 0.97 m²/ha) at sapling level.

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C. inophyllum (11.42%), A. dammara (10.59%), and H. tiliaceus (10.11%). At the seedling level, the species that played a role were T. mantaly (86.11%), G. arborea (52.78%), M. zapota and T. vulgaris (30.56%).

Based on the observations and the data presented, it is clear that the dominant species at one growth rate are not always dominant at another growth rate. However, the species that dominate at each growth rate are the invasive species. It is possible that if not treated immediately, they will disturb and change the natural ecosystems, which can leads to degradation of wealth and biodiversity of the Udayana urban forest.

Table 2. Recapitulation of IVI for each type of growth rate of Udayana urban forest

| Growth Rate | No. | Species                                      | D (ind/ha) | LBDS (m²/ha) | IVI (%) |
|-------------|-----|----------------------------------------------|------------|---------------|--------|
| **Trees**   | 1   | Archidendron clypearia (Jack) I. C. Nielsen  | 2          | 0.1772        | 2.40   |
|             | 2   | Acacia auriculiformis A. Cunn. ex Benth.     | 7          | 0.5915        | 3.39   |
|             | 3   | Adenanthera pavonina L.                      | 4          | 0.8149        | 3.21   |
|             | 4   | Agathis dammara (Lamb.) Rich.                | 29         | 2.0010        | 7.37   |
|             | 5   | Albizia chinensis (Osbeck) Merr.             | 18         | 13.3231       | 15.81  |
|             | 6   | Antidesma bunius (L.) Spreng.                | 36         | 2.7353        | 8.88   |
|             | 7   | Artocarpus heterophyllus Lam.                | 2          | 0.1809        | 2.41   |
|             | 8   | Bauhinia purpurea L.                         | 17         | 0.5844        | 4.64   |
|             | 9   | Callistemon citrinus (Curtis) Skeels.        | 7          | 0.2740        | 3.11   |
|             | 10  | Calophyllum inophyllum L.                    | 16         | 3.3301        | 6.89   |
|             | 11  | Calophyllum soulattri Burm. f.               | 2          | 0.0491        | 2.29   |
|             | 12  | Canarium indicum L.                         | 25         | 1.4918        | 6.43   |
|             | 13  | Cassia fistula L.                            | 8          | 1.2534        | 4.09   |
|             | 14  | Casuarina equisetifolia L.                   | 1          | 0.1256        | 2.23   |
|             | 15  | Delonix regia (Boj. ex Hook.) Raf.           | 32         | 6.3196        | 11.49  |
|             | 16  | Dipterocarpus retusus Blume                  | 4          | 0.4398        | 2.88   |
|             | 17  | Draccontomelon dao (Blanco) Merr. & Rolfe.   | 15         | 2.3997        | 5.96   |
|             | 18  | Duabanga moluccana Blume                    | 1          | 0.3116        | 2.40   |
|             | 19  | Erythrina crista-galli L.                   | 23         | 1.3844        | 6.08   |
|             | 20  | Ficus benjamina L.                           | 4          | 1.9503        | 4.19   |
|             | 21  | Ficus elastica Roxb. ex Hornem.              | 13         | 8.9870        | 11.42  |
|             | 22  | Filicium decipiens (Wight & Arn.) Thwaites   | 62         | 3.6130        | 12.90  |
|             | 23  | Gmelina arborea Roxb.                        | 9          | 0.9117        | 3.92   |
|             | 24  | Hibiscus tiliaceus L.                        | 14         | 0.9709        | 4.60   |
|             | 25  | Lagerstroemia speciosa (L.) Pers.            | 27         | 1.5453        | 6.72   |
|             | 26  | Lanea coromandelica (Houtt.) Merr.           | 5          | 0.4658        | 3.03   |
|             | 27  | Lansium parasiticum (Osbeck) Sahni & Bennet | 3          | 0.0871        | 2.45   |
|             | 28  | Mangifera indica L.                          | 9          | 1.2446        | 4.21   |
|             | 29  | Manilkara zapota (L.) P. Royen              | 1          | 0.0707        | 2.19   |
|             | 30  | Maniltoa grandiflora (A. Gray) Scheff.       | 2          | 0.1075        | 2.34   |
|             | 31  | Morinda citrifolia L.                        | 5          | 0.3818        | 2.96   |
|             | 32  | Muntingia calabura L.                        | 1          | 0.0346        | 2.16   |
|             | 33  | Nauclea orientalis (L.) L.                   | 1          | 0.3630        | 2.44   |
|             | 34  | Ochrosia oppositifolia (Lam.) K. Schum.      | 24         | 1.0260        | 5.90   |
|             | 35  | Polyalthia longifolia Sonn.                  | 38         | 3.0806        | 9.43   |
|             | 36  | Pometia pinnata J.R. Forst. & G. Forst.      | 5          | 0.1743        | 4.76   |
|             | 37  | Pterocarpus indicus Willd.                   | 13         | 3.9985        | 7.10   |
|             | 38  | Pterospermum javanicum Jungh.                | 10         | 1.4041        | 4.47   |
| No. | Scientific Name (Common Name) | Number of Poles | Pole Count | Total Count |
|-----|------------------------------|-----------------|------------|-------------|
| 39  | *Samanea saman* (Jacq.) Merr. | 178             | 34,6266    | 54.33       |
| 40  | *Senna siamea* (Lam.) Irwin et. Barneby | 5               | 0.6335     | 3.18        |
| 41  | *Spathodea campanulata* P. Beav. | 20              | 3.0240     | 7.13        |
| 42  | *Stelechocarpus burahol* (Blume) Hook. f. & Thomson. | 1               | 0.0415     | 2.16        |
| 43  | *Sterculia foetida* L.         | 1               | 0.1809     | 2.28        |
| 44  | *Swietenia mahagoni* (L.) Jacq. | 30              | 4.1640     | 9.37        |
| 45  | *Syzygium formosum* (Wall.) Masam. | 1               | 0.0855     | 2.20        |
| 46  | *Syzygium samarangense* (Blume) Merr. & L. M. Perry. | 6               | 0.4252     | 3.12        |
| 47  | *Tamarindus indica* L.         | 5               | 0.6155     | 3.16        |
| 48  | *Tectona grandis* L.f.         | 15              | 1.1441     | 4.87        |
| 49  | *Terminalia catappa* L.        | 37              | 2.0821     | 8.44        |
| 50  | *Terminalia mantaly* H. Perrier | 4               | 0.0906     | 2.58        |
|     | **Total of Number**            | **798**         | **115,317**| **300**     |

The remaining entries list additional pole species with their counts, including:

| No. | Scientific Name (Common Name) | Number of Poles | Pole Count | Total Count |
|-----|------------------------------|-----------------|------------|-------------|
| 1   | *Acacia auriculiformis* A. Cunn. ex Benth. | 1               | 0.0154     | 2.40        |
| 2   | *Agathis dammara* (Lamb.) Rich. | 28              | 0.5711     | 13.37       |
| 3   | *Albizia chinensis* (Osbeck) Merr. | 1               | 0.0177     | 2.42        |
| 4   | *Antidesma bunius* (L.) Spreng. | 5               | 0.1685     | 4.71        |
| 5   | *Artocarpus heterophyllus* Lam. | 24              | 0.5295     | 12.14       |
| 6   | *Bauhinia purpurea* L.         | 4               | 0.1138     | 3.97        |
| 7   | *Calophyllum inophyllum* L.    | 17              | 0.3017     | 8.48        |
| 8   | *Calophyllum soulattri* Burm. f. | 16              | 0.2160     | 7.77        |
| 9   | *Canarium indicum* L.         | 4               | 0.1890     | 4.71        |
| 10  | *Casuarina equisetifolia* L.   | 2               | 0.0272     | 2.72        |
| 11  | *Delonix regia* (Boj. ex Hook.) Raf. | 4               | 0.0611     | 3.46        |
| 12  | *Diospyros macrophylla* Blume | 1               | 0.0079     | 2.32        |
| 13  | *Dracontomelon dao* (Blanco) Merr. & Rolfe. | 16              | 0.2501     | 7.77        |
| 14  | *Erythrina cristagalli* L.     | 4               | 0.1888     | 4.71        |
| 15  | *Filicium decipiens* (Wight & Arn.) Thwaites | 65              | 1.4480     | 29.54       |
| 16  | *Garcinia dulcis* (Roxb.) Kurz | 3               | 0.0564     | 3.21        |
| 17  | *Gmelina arborea* Roxb. | 3               | 0.0386     | 3.03        |
| 18  | *Gyrinops verstegii* (Gilg.) Domke | 1               | 0.0283     | 2.52        |
| 19  | *Hibiscus tiliaceus* L.        | 9               | 0.2368     | 6.20        |
| 20  | *Lagerstroemia speciosa* (L.) Pers. | 30              | 0.5972     | 14.04       |
| 21  | *Lannea coromandelica* (Houtt.) Merr. | 4               | 0.0389     | 3.24        |
| 22  | *Leucaena leucocephala* (Lam.) de Wit | 2               | 0.0287     | 2.73        |
| 23  | *Mangifera indica* L.         | 3               | 0.0830     | 3.47        |
| 24  | *Maniltoa grandiflora* (A. Gray) Scheff. | 28              | 0.4051     | 11.75       |
| 25  | *Mimusops elengi* L.          | 2               | 0.0279     | 2.72        |
| 26  | *Morinda citrifolia* L.       | 2               | 0.0334     | 2.78        |
| 27  | *Muntingia calabura* L.       | 1               | 0.0133     | 2.38        |
| 28  | *Ochrosia oppositifolia* (Lam.) K. Schum. | 37              | 0.8747     | 18.19       |
| 29  | *Persea americana* Mill.      | 1               | 0.0095     | 2.34        |
| 30  | *Polyalthia longifolia* Sonn. | 22              | 0.5753     | 12.18       |
| 31  | *Pometia pinnata* J.R. Forst. & G. Forst. | 1               | 0.0597     | 2.83        |
| 32  | *Pterocarpus indicus* Willd.   | 1               | 0.0254     | 2.49        |
| 33  | *Pterospermum javanicum* Jungh. | 8               | 0.1666     | 5.31        |
| 34  | *Roystonea regia* (Kunth) O.F. Cook | 1               | 0.0133     | 2.38        |
|   | Species                                      | Number | Height (m) | Diameter (cm) |
|---|---------------------------------------------|--------|------------|---------------|
| 36| Samanea saman (Jacq.) Merr.                 | 14     | 0.3815     | 8.64          |
| 37| Sandoricum koetjape (Burn.f.) Merr.         | 1      | 0.0283     | 2.52          |
| 38| Schleicheria oleosa (Lour.) Oken            | 1      | 0.0283     | 2.52          |
| 39| Senna siamea (Lam.) Irwin et. Barneby       | 3      | 0.0560     | 3.20          |
| 40| Spathodea campanulata P. Beauv.             | 8      | 0.2031     | 5.67          |
| 41| Stelechocarpus burahol (Blume) Hook. f. & Thomson. | 11     | 0.1535     | 5.80          |
| 42| Swietenia mahagoni (L.) Jacq.               | 25     | 0.4661     | 11.73         |
| 43| Syzygium polyanthum (Wight) Walp.           | 1      | 0.0007     | 2.32          |
| 44| Syzygium samarangense (Blume) Merr. & L. M. Perry | 8      | 0.1871     | 5.51          |
| 45| Tamarindus indica L.                        | 2      | 0.0455     | 2.90          |
| 46| Tectona grandis L.f.                        | 3      | 0.0787     | 3.43          |
| 47| Terminalia catappa L.                       | 27     | 0.6585     | 14.02         |
| 48| Terminalia mantaly H. Perrier               | 26     | 0.3987     | 11.28         |
| 49| Toona sureni (Blume) Merr.                  | 2      | 0.0265     | 2.71          |
|   | Total of Number                             | 487    | 10.2331    | 300           |
| Saplings                                |        |            |              |
| 1 | Agathis dammara (Lamb.) Rich.               | 11     | 0.0371     | 10.59         |
| 2 | Antidesma bunius (L.) Spreng.               | 1      | 0.0038     | 3.94          |
| 3 | Artocarpus heterophyllus Lam.               | 4      | 0.0118     | 5.73          |
| 4 | Barringtonia racemosa (L.) Spreng.          | 1      | 0.0038     | 3.94          |
| 5 | Bauhinia purpurea L.                        | 6      | 0.0279     | 8.04          |
| 6 | Calophyllum inophyllum L.                   | 11     | 0.0451     | 11.42         |
| 7 | Calophyllum soulatri Burn. f.               | 14     | 0.0503     | 12.92         |
| 8 | Dracontomelon dao (Blanco) Merr. & Rolfe.   | 8      | 0.0373     | 9.65          |
| 9 | Erythrina crista-galli L.                   | 1      | 0.0013     | 3.68          |
| 10| Ficus elastica Roxb. ex Hornem.             | 2      | 0.0079     | 4.68          |
| 11| Filicium decipiens (Wight & Arn.) Thwaites  | 15     | 0.0565     | 13.88         |
| 12| Gmelina arborea Roxb.                       | 29     | 0.0629     | 19.04         |
| 13| Hibiscus tiliaceus L.                       | 10     | 0.0356     | 10.11         |
| 14| Lagerstroemia speciosa (L.) Pers.           | 4      | 0.0118     | 5.73          |
| 15| Litsea glutinosa (Lour.) C. B. Rob.         | 1      | 0.0020     | 3.75          |
| 16| Mangifera indica L.                         | 2      | 0.0035     | 4.23          |
| 17| Manilkara grandiflora (A. Gray) Scheff.     | 33     | 0.1059     | 24.76         |
| 18| Muntingia calabura L.                       | 2      | 0.0041     | 4.29          |
| 19| Ochrosia oppositifolia (Lam.) K. Schum.     | 6      | 0.0212     | 7.34          |
| 20| Polyalthia longifolia Sonn.                 | 24     | 0.0688     | 18.05         |
| 21| Pometia pinnata J.R. Forst. & G. Forst.     | 2      | 0.0127     | 5.18          |
| 22| Pterocarpus indicus Willd.                  | 2      | 0.0079     | 4.68          |
| 23| Pterospermum javanicum Jungh.               | 2      | 0.0114     | 5.05          |
| 24| Samanea saman (Jacq.) Merr.                 | 1      | 0.0028     | 3.84          |
| 25| Senna siamea (Lam.) Irwin et. Barneby       | 1      | 0.0050     | 4.07          |
| 26| Stelechocarpus burahol (Blume) Hook. f. & Thomson. | 24     | 0.0747     | 18.65         |
| 27| Swietenia mahagoni (L.) Jacq.               | 32     | 0.0900     | 22.80         |
| 28| Syzygium polyanthum (Wight) Walp.           | 1      | 0.0013     | 3.68          |
| 29| Syzygium samarangense (Blume) Merr. & L. M. Perry | 2      | 0.0100     | 4.91          |
|   | Total of Number                             | 311    | 0.9692     | 300           |
Table 3. Dominant and codominant species based on the IVI at various growth rates in Udayana urban forest

| Growth rates | Family       | Species                    | IVI (%) |
|--------------|--------------|----------------------------|---------|
| Seedlings    | Combretaceae | T. mantaly H. Perrier      | 86.11   |
|              | Lamiaceae    | G. arborea Roxb.           | 52.78   |
| Saplings     | Combretaceae | T. mantaly H. Perrier      | 29.56   |
|              | Fabaceae     | M. grandiflora (A. Gray) Scheff. | 24.76 |
| Poles        | Sapindaceae  | F. decipiens (Wight & Arn.) Thwaites | 29.54 |
|              | Apocynaceae  | O. oppositifolia (Lam.) K. Schum. | 18.19 |
| Trees        | Fabaceae     | S. saman (Jacq.) Merr.     | 59.33   |
|              |              | A. chinensis (Osbeck) Merr. | 15.81   |

3.3. Ecological index

Based on the results of the data analysis, the ecological index values at various levels of growth in the research location are presented in Figure 4, which shows that the value of the dominance index (ID) at various levels of plants in the research location is low or close to zero (0.04 – 0.35 < 0.5). This condition illustrates that there is almost no concentration by a species and that the dominant species in each growth rate is relatively spread out. Therefore, the ability to control each species in the community is relatively balanced and the preservation of species diversity can be maintained with specific ecological requirements that take into account the internal disturbance (invasive species) and external disturbance (human).

Species diversity index (H') is a value that indicates the size of species found in an area against the various species, as well as the environment that supports these species at each growth level. The H' value (Figure 4) shows that the seedlings level has an H' value of 1.23 while at the saplings, poles and tree levels, respectively 3.21, 3.61, and 3.52. The value of the species diversity index for seedlings is <1.5, so this condition is classified as low diversity. This shows that the community at the seedling level is composed of only a few dominant species [40–42]. At the pole and tree level, the diversity index value is categorized as high. [43] added that the big diversity index value indicates that there is a large environmental carrying capacity for the survival and more stable forest communities.

The evenness index (E') is used to determine the stability or stability of species in a community. Figure 4 shows that, at the sapling level, the evenness index value is the highest (E > 0.6), which is 0.93 compared to the pole and tree levels of 0.58 and 0.90, while at the seedling level the E' value is only 0.21. Previous studies [42,43] state that the evenness value is related to the even distribution of each type related to dominance. The higher the evenness value, the more even the distribution, which means that the value of E' will be inversely proportional to the ID value.
Species richness index (R1) is used to determine the amount of plant species richness in a community. The value of R1 in Figure 4 shows that the growth rate of seedlings is low (1.04 < 3.5), while the saplings and trees are high (R1 ≥ 5.0). The value of R1 was obtained from the number of species found in the research location. Previous studies [44,45] stated that species richness is directly proportional to the number of species in a community. The more types of plants in the community, the higher the R1 value it has.

3.4. Stand structure
The stand-structure of tropical rain forest can be described vertically and horizontally. Figure 5 shows that the horizontal structure is almost in the form of an inverted J-curve. It cannot be said to be dynamic or normal-forest. Density decreases as the stands' diameter increases.

The graph in Figure 5 shows density/ha in the 10-19.9 cm and >60 cm diameter distribution is larger than the 2-9.9 cm and 50-59.9 cm diameter distribution. The high and low number of individuals in a particular diameter class illustrates the forest's condition that has changed stand structure that affects the sustainability of the subsequent forest stand regeneration.

The condition of the Udayana urban forest's horizontal stand structure means that the individual trees' density at the growth rate requires much energy over time. So, there will be a competition between individuals of the same type and of different species in getting sufficient sunlight and nutrients as well as in defending against disturbances and affects the forest community structure through a secondary succession process [30,33–35,43,46,47].
The vertical structure of a stand-in tropical rain is generally known by classifying each tree. According to the height class following the tree stratum, namely E (0-1 m), D (1-4 m), C (4-20 m), stratum B (20-30 m), and stratum A (> 30 m) [2,3,12,46,48]. Based on Figure 6, known that in general, the Udayana urban forest stand community has three strata with a lower B stratum than C and D strata. In details, the highest number of individuals are in the high class of 4-20 m (91.33%) and followed by high class of 1-4 m (6.20%), and the last is at the height of 20-30 m (2.48%). This data shows that the Udayana green open space community is a stand dominated by young trees growing to reach their climax height. [2] added that stratum C categorizes as a future tree.

Kusuma and Susanti [34] added that the high-class distribution pattern shows that the number of individuals decreases with increasing tree height due to high competition in obtaining nutrients, groundwater and light. So, it is difficult for a species to reach a particular stratum, only the species’ old tree species. The climax alone can reach a particular stratum so that the number of trees is small and appears discontinuous. Besides, the dominance of potentially invasive causes also changes in the vertical structure. Introduced species that can grow in various environmental conditions have wide tolerance and can reproduce vegetatively quickly. They also have high adaptive spreading ability, ‘different phenology’ (quickly build dense shade, grows first, and is green longer), and can fill the same ecological niches, especially those that are disturbed or poor in vegetation types [8,9,16,17,49,50].
4. Conclusion
The research results show that Udayana urban forest is composed of 27 families, 54 genera and 64 species, which are dominated by invasive species at each growth level, namely *T. mantaly*, *F. decipiens*, and *S. saman*. Besides, the stand structure in Udayana urban forest has also experienced disturbances as evidenced by the horizontal and vertical structures that do not resemble the inverted J curve, and the canopy stratification of Udayana RTH only consists of 3 strata. The dominance of invasive species plays a critical role in the community, especially the control of growth space, so that it affects the changes in the structure and composition of stands in the Udayana urban forest.

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References
[1] Kusmana C and Hikmat A 2015 *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan* 5 187–198
[2] Soerianegara I and Indrawan A 1998 *Indonesian Forest Ecology* (Bogor : Forest Ecology Laboratory, Department of Forest Management, Forestry Faculty, Bogor Agricultural University)
[3] Kusmana C 2017 *Survey Methods and Intrepetation of Vegetation Data* (Bogor : Penerbit IPB Press)
[4] Lemmens R H M J, Soerianegara I, Keating W G, Wong W C and Ilic J 1994 *Plant Resources of South East Asia vol 5(1) Timber Trees: Major Commercial Timbers* ed Ishemat S and RHMJ Lemmens (Bogor: Prosea Foundation)
[5] Lemmens R H M J, Soerianegara I and Wong W C 1995 *Plant Resources of South East Asia vol 5(2) Timber Trees: Minor Commercial Timbers* ed RHMJ Lemmens Ishemat SI and Wong WC (Bogor: Prosea Foundation)
[6] Sosef M S M 1998 *Plant Resources of South East Asia vol 5(3) Timber Trees: Lesser Known Timbers* ed Sosef MSM Hong LT and Prawirohatmodjo S (Bogor: Prosea Foundation)
[7] Sankaran KV and Suresh TA 2013 *Invasive Alien Plants in the Forests of Asia and the Pacific* (Bangkok: Food and Agriculture Organizations of the United Nations Regional Office for Asia and the Pacific)
[8] Tjitrosoedirdjo S, Tjitrosoedirdjo S S and Setyawati T 2016 *Invasive Plant and Their Management Approach* (Bogor : SEAMEO BIOTROP)
[9] Tjitrosoedirdjo S S, Mawardi I and Tjitrosoedirdjo S 2016 *75 Important Invasive Plant Species In Indonesia* (Bogor : SEAMEO BIOTROP)
[10] Witt A 2017 *Guide to the Naturalized and Invasive Plants of Southeast Asia* (Oxfordshire: CAB International)
[11] Magurran A E 1988 *Ecological Diversity and Its Measurement* (London : Croom Helm Ltd)
[12] Misra K C 1980 *Manual of Plant Ecology (second edition)* (New Delhi: Oxford and IBH Publishing Co)
[13] Johnston M and Gilman M 1995 *Biodiversity and Conservation* 4 339–362
[14] Raes N, Saw L G, van Welzen P C and Yahara T 2013 *South African Journal of Botany* 89 265–272
[15] [LPWG] Legume Phylogeny Working Group 2017 *Taxon* 66 44–77
[16] Yuliana S and Lekitoo K 2018 *Jurnal FAOAK* 2 89–102
[17] Yuliana S and Lekitoo K 2018 *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia* 4 92–96
[18] Akinsulire O P, Oladipo O T, Illoh HC and Mudasiru OM 2018 *Ife Journal of Science* 20 371–389
[19] Marjenah and Ariyanto 2018 *Jurnal Penelitian Ekosistem Dipterokarpa* 4 57–70
[20] Rahate S, Hemke A and Umekar M 2019 *International Journal of Pharmacaetical Sciences Review and Research* **58** 22–29

[21] Widjaja E A, Rahayuningsih Y, Rahajoe J S, Ubaidillah R, Maryanto I, Walujo E B and Semiadi G 2014 *The Current Indonesian Biodiversity* ed Suhendra Mf, Wahyu R H, Dewi S P and Helmiawan M (Jakarta: LIPI Press)

[22] Darajati W 2016 *Indonesian Biodiversity Strategy and Action Plan (IBSAP) 2015–2020* (Jakarta: Kementerian Perencanaan Pembangunan Nasional/ BAPPENAS).

[23] Gallardo B, Clavero M, Sanchez, M I and Vila M 2016 *Global Change Biology* **22** 151–163

[24] Schirmel J, Bundschuh M, Entling M H, Kowarik I and Buchholz S 2016 *Global Change Biology* **22** 594–603

[25] David P, Thebault E, Anneville O, Duyck P F, Chapuis E and Loeuille N 2017 *Advances in Ecological Research* **56** 1–60

[26] Bartz R and Kowarik I 2019 *Neo Biota* **43** 69–99

[27] Brillianti D H 2016 *Invasive Potential of Trembesi (Samanea saman Jacq.) in Rehabilitation Zone of Meru Betiri National Park East Java* (Bogor : IPB University)

[28] Widianti P and Kusmana C 2014 *Jurnal Silvikultur Tropika* **5** 69–76

[29] Priosambodo D 2018 *Jurnal Ilmu Alam dan Lingkungan* **9** 19–30

[30] Sutomo, Darma I D P, Sujarwo W, Priyadi A, Kuswantoto F and Iryadi R 2018 *Ecology of Bedugul Basin Bali* ed Sutomo, Fernandez J C, van Etten E, Sujarwo W (Bogor: SEAMEO BIOTROP)

[31] Astari W, Rosleine D, Lastini T, Wahyu J C and Manggala R 2020 *IOP Conference Series: Earth and Environmental Science* **528** 012002

[32] Sayfulloh A, Riniarti M and Santoso T 2020 *Jurnal Sylva Lestari* **1** 59–73

[33] Fajri M and Supartini 2015 *Jurnal Penelitian Ekosistem Dipterokarpa* **1** 55–62

[34] Kurniasari M, Budhi S and Fernando T 2015 *Jurnal Hutan Lestari* **3** 8–14

[35] Indriyani L, Flamin A and Erma 2017 *Ecogreen* **3** 49–58

[36] Nurhadi, Hudiyono and Mulyana M 2018 *Jurnal Silvikultur Tropika* **6** 137–146

[37] Ghufrona RR, Kusmana C and Rusdiana A 2015 *Jurnal Silvikultur Tropika* **6** 15–26

[38] Istomo and Sari PN 2019 *Journal of Natural Resources and Environmental Management* **9** 608–625

[39] Nahlunnisa H, Zuhud EAM and Santosa Y 2016 *Media Konservasi* **21** 91–98

[40] Kirno F, Astiani D and Ekamawanti HA 2018 *Jurnal Hutan Lestari* **7** 11–20

[41] Whitmore TC 1990 *An Introduction to Tropical Rain Forest* (New York: Oxford University Press)

[42] Zulharman 2017 *Natural B. 4* 78–87

[43] Richards P W 1964 *The Tropical Rain Forest: An Ecological Study* 2nd Edition (Cambridge: Cambridge University Pr)

[44] van Steenis 2010 *Javanese Mountain Flora* (Bogor: LIPI Press)

[45] Hermawan R, Hikmat A, Prasetyo LB and Setyawati T 2017 *Jurnal Nusa Sylva* **17** 80–90