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# Floristic composition and species diversity in three habitat types of heath forest in Belitung Island, Indonesia

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**Abstract.** *Oktavia D, Pratiwi SD, Munawaroh S, Hikmat A, Hilwan I. 2021. Floristic composition and species diversity in three habitat types of heath forest in Belitung Island, Indonesia. Biodiversitas 22: 5555-5563.* Exploring plant diversity, structure, and composition of vegetation in forest ecosystems is necessary for understanding the mechanism of species coexistence and forest dynamics, moreover in a unique and vulnerable ecosystem such as tropical heath forest (*kerangas*). We investigated the composition and structure of vegetation of heath forests in East Belitung, Indonesia in three habitat types, namely primary heath forest (*rimba*), secondary heath forest (*bebak*), and grassland (*padang*). Vegetation analysis was conducted using the combination of transect and plot method to calculate the importance value index (IVI) for all species and biodiversity indicators for each habitat type. We recorded 157, 135, and 31 species in *rimba*, *bebak*, and *padang*, respectively. The top three dominant families of species found were Myrtaceae, Clusiaceae, and Euphorbiaceae. In *rimba*, *Syzygium lepidocarpa* had the highest IVI for seedlings, *Calophyllum lanigerum* had the highest IVI for saplings, and *Schima walichii* had the highest IVI for trees. In *bebak*, *Guioa pleuropteris* had the highest IVI for seedlings, *Garcinia hombroniana* had the highest IVI for saplings, and *Schima walichii* had the highest IVI for trees. In *padang*, *Fimbristylis sp.* had the highest IVI for seedlings, while *Leptospermum flavescens* had the highest IVI for saplings and trees. Some pioneer species were found such as *Rhodomyrtus tomentosa*, *Rhodamnia cinerea*, *Syzygium buxifolium*. We also found two carnivorous plants *Drosera burmannii* and *Nepenthes gracilis* in *padang*, indicating that this habitat type is poor in nutrients in the soils. We suggested that the presence of species composition in the three habitat types of heath forest is an essential plant resource to be conserved and sustainably utilized. Establishing reserve areas to protect natural habitat and biodiversity is encouraged to provide proper ecosystem function for the people and nature.

**Keywords:** Conservation, heath forest, kerangas forest, Myrtaceae, plant diversity, vegetation analysis

## INTRODUCTION

Heath forest (*kerangas*) is a forest ecosystem type in a tropical region that grows on podzolic soil with a sandy texture, poor in nutrients and has low pH (Katagiri et al. 1991; Luizão et al. 2007; Oktavia et al. 2015). The vegetation of heath forest is generally characterized by a high density of vegetation, presence of carnivorous plants, woody liana, and the size of trees trunk is relatively small (Brunig 1974; Davies and Becker 1996). This condition indicates that heath forest is vulnerable to disturbance and difficult to restore once degraded (Becker and Wong 1993; Tyree et al. 1998; Hattori et al. 2019). Therefore, in Indonesia, heath forest is protected and belongs to the high conservation value ecosystem because of the uniqueness of the ecosystem and its ecological function.

The distribution of heath forests in Indonesia can be found in Sumatra and Kalimantan (Whitten et al. 1984 and Mackinnon et al. 1996). One of the regions in Indonesia that has heath forests in Sumatra is Belitung Island (Whitmore 1984). This island is globally also recognized as a part of the savanna corridor in Sundaland (Bird et al. 2005). The heath forest ecosystem might be the main forest ecosystem in Belitung Island, which stands almost entirely of Belitung Island (Whitten et al. 1984). However, the forest cover in Belitung is now under threat by the rapid development of rubber and oil palm plantations, mining of tin and quartz sand, illegal logging, and regional development. Despite its vulnerability to disturbance along with the threatening processes that occur in health forests including in Belitung, this ecosystem gets less conservation attention which might be able to the poor physical condition that gives the impression of unproductive land. (Becker and Wong 1993; Tyree et al. 1998).

The ecological mechanism associated with species diversity has long been a focus of ecological-based research. Abiotic interaction and habitat filtering are also thought to be important contributors to the formation of species communities (Chesson 2000). Many studies have shown that biotic stress is the primary limiting factor in the

enhancement of species diversity during the early stages and species composition is influenced by a variety of edaphic influences (Sellan et al. 2019). In heath forests, the richness, structure, and composition of species are linked to edaphic and topographic factors, and soil acidity may play a significant role in shaping forest vegetation communities.

Understanding the structure and composition of tree vegetation is one of the parameters that must be considered in the management of the conservation forest ecosystem (Hossen et al. 2021; Onrizal et al. 2005; Templeton et al. 2019; Dodo and Hidayat 2020). This is particularly important for several reasons. Tree vegetation in a forest ecosystem plays a crucial role in providing and maintaining ecosystem services and biodiversity habitat, which has potential uses for bioprospecting. The condition of vegetation also provides insight on the state of intactness and degradation of a forest ecosystem to inform the conservation strategies, the needs for restoration, regenerative ability, and successional process in the present time and in the future (Budiharta et al. 2014).

Information of floristic composition in Belitung Island is necessary for future development, particularly to support conservation effort of heath forest and restoration activities when necessary. According to the traditional landscape in Belitung, there are three habitat types based on the successional stages, namely *rimba* (primary forest), *bebak* (secondary forest), and *padang* (grassland) (Fakhrurrazi 2001). *Rimba* is a natural ecosystem that grows on podsol soil type (*tana teraja*) in a relatively higher location, or in a humid/wet environment, while *bebak* is a successional forest that grows on community-owned land, usually a former field to cultivate *Piper nigrum* (Fakhrurrazi 2001). *Padang* is a special heath forest that is formed as a climax ecosystem after the heath forest is severed by fire disturbance (Whitten et al. 1984). This study aimed to identify the floristic composition, structure of trees species, and diversity in the three habitat types or vegetational conditions (i.e., primary forest, secondary forest, and grassland) of heath forest in Belitung Island.

## MATERIALS AND METHODS

### Study area

This study was conducted in East Belitung District, Belitung Island, Indonesia (Figure 1). The north side of East Belitung is bordered by the South China Sea and the south side is bordered by the Jawa Sea. The East Belitung District has a total area of approximately 250.691 ha.

Locations for data collection were on heath forest at three habitat types. The first is a primary heath forest (*rimba*) in the Gunung Sepang Protection Forest, Kelubi village, Manggar sub-district (Figure 2.A) and located at 02˚46.833' S and 108˚07.761' E. The second is a secondary heath forest (*bebak*) in Kelubi village, Manggar sub-district (Figure 2.B) and located at 02˚50.274' S and 108˚09.450' E. The third is a grassland (*padang*) in the Gunung Sepang Protection Forest, Kelapa Kampit sub-district (Figure 2.C) and located at 02˚50.282' S and 108˚09.208' E.

### Data collection

Vegetation data were collected using a combination of transect and plot methods (Kusmana 1997). Ten transects were established with the length of 100 m, consisting of 10 observations plots measuring 10 m × 10 m for each plot. The distance between the transects was 100 m. Each observation plot was divided into three sub-plots to measure vegetation based on growth stages. Each individual plant found in the plot was measured stem diameter at breast height (DBH) using a tape diameter, then classified whether it included saplings or trees. Seedlings were defined as woody plants with a height < 1.5 m and were surveyed along with shrubs, herbs, and lianas at 2 m × 2 m sub-plot. Saplings were defined as woody plants with height > 1.5 m and were surveyed at 5 m × 5 m sub-plot. Trees were defined as woody plants with DBH ≥ 10 cm and were surveyed at 10 m × 10 m sub-plot. The DBH size was used as the basis for calculating the basal area for trees.

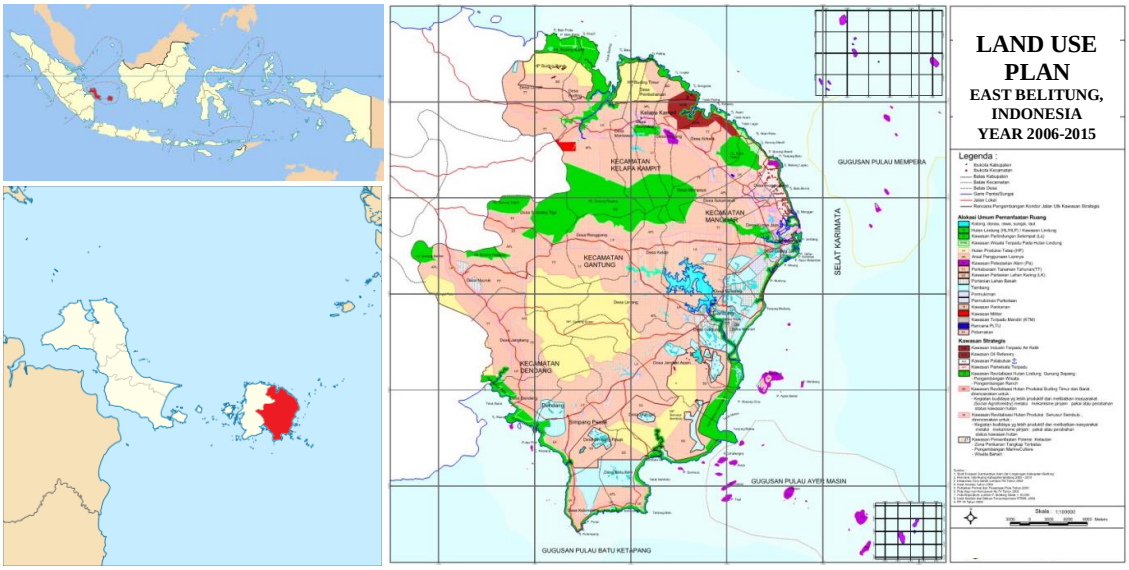


**Figure 1.** Map study site in East Belitung District, Kepualauan Bangka Belitung Province, Indonesia

**A** **B** **C**

**Figure 2.** Three habitat types of heath forest observed in this study: A. Primary forest (*rimba*); B. Secondary forest (*bebak*); C. Grassland (*padang*)

Meanwhile, we only counted the number of individuals of each species for seedlings, shrub, herbs, liana, and sapling in each sub-plot. Some plant species were identified directly on the plots, while some other identifications were carried out by making herbarium specimens. Identification of herbarium collections was conducted at the Herbarium Bogoriense LIPI Cibinong, Bogor, Indonesia.

**Data analysis**

*Importance value index (IVI)*

The data obtained from the results of the vegetation analysis were analyzed quantitatively by calculating the Importance Value Index (IVI) of each species found. The IVI value has helped to understand the ecological significance of the species in community structure. The IVI of trees was the sum of relative density, relative frequency, and relative dominance, which ranges between 0 and 300 (Mueller-Dumbois and Ellenberg 1974). For seedlings and saplings, it was the sum of relative density and relative frequency, so that the maximum IVI would be 200. Basal area ($m^2$) is the area occupied by a cross-section of stem at breast height = [3.14 × (DBH/2)2]. We calculated relative density, relative frequency, and relative dominance as follows:

Density = number of individual of species/ total number of sample plots

Relative density = (number of individual species A/ number of all individual species) × 100%

Frequency = number of quadrats with species A/ total number of all quadrats

Relative frequency = (frequency of species A/ total frequency of all species) × 100%

Dominance = basal area of species A/ total area sampled

Relative dominance = (dominance of species A/ total dominance of all species) × 100%

*Species diversity, richness, and evenness*

The diversity of plant species was determined using the Shannon Diversity Index (Ludwig & Reynolds 1988) with the formula:

$$H' = -\sum_{i=1}^{s} pi \ln pi \text{ , where } pi = \frac{ni}{N}$$

Where, H' is the diversity index community A, ni is number of individuals of the i species, and N is the total number of individuals of all species

The larger of H' of a community, the more stable the community is. The value of H' = 0 can occur if there is only one species in one sample (sample) and maximum H if all species have the same number of individuals and this indicates a perfectly distributed abundance (Ludwig et al. 1988).

Species richness was measured using the Margalef Index (Ludwig et al. 1988) as follow:

$$R = \frac{S - 1}{\ln (N)}$$

Where, R is the richness index of community A, S is the total number of species, and N is the total number of individuals of all species.

For the evenness of species, it is used to determine the symptoms of dominance among each species in a location. The formula used to calculate the Evennes value (Ludwig et al. 1988) was:

$$E = \frac{H'}{\ln (S)}$$

Where, E is the evenness index of community A, H' is the Shannon diversity index, and S is a total number of species.

## RESULTS AND DISCUSSION

**Species richness of heath forest in three habitat types**

Plant community consists of a group of plants, each of which has its characteristics. We found 157, 135, and 31 species are *rimba*, *bebak*, and *padang*, respectively (Figure 3). In total, across the three habitats of heath forest three were 224 species belonging to 72 families of plants from various habitus (shrubs, herbs, and lianas) and tree growth stages (seedlings, saplings, and trees).

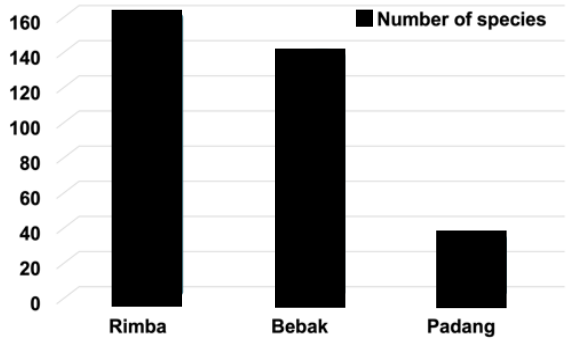


**Figure 3.** Number of species in three habitat types of heath forests (i.e., *rimba*, *bebak*, and *padang*) in East Belitung, Indonesia

Different types of ecosystems affect the number of species and individuals found (Vockenhuber et al. 2011; Laliberté et al. 2014). Plant species in *rimba* were dominated by tolerant and semi-tolerant species. The low number of pioneer species was due to the high mortality of late pioneers and gradually replaced by shade-tolerant species that could grow under the canopy of late pioneers (Walters and Reich 1999; Lilles et al. 2014). Some of the pioneer species found in the *rimba* are *Rhodomyrtus tomentosa*, *Melastoma polyanthum*, and *Lycopodium cernuum*. In *rimba*, the existence of pioneer shrubs and herbs was low because the vegetation succession in *rimba* relatively reached its climax state.

Plant species found in *bebak* are dominated by semi-tolerant species, i.e., species that can grow in newly opened and sub-climax ecosystems such as *Syzygium lineatum* and *Lithocarpus blumeanus*. *Bebak* is located not far from *rimba*, usually *bebak* is a former field to cultivate *Piper nigrum*. The number of species in *bebak* was lesser than *rimba* due to the younger age of the vegetation succession than in *rimba*.

The floristic composition of *padang* was the least among the three habitat types. This is because of the physical conditions in *padang* that were very open with extreme environmental conditions, thus only species that are tolerant to sunlight and able to adapt to nutrient-poor conditions can survive in *padang* (Aarssen 1997; Liu et al. 2006; Maire et al. 2012). Pioneer species found in *padang* included the *Fimbrystilis* sp., *Panicum* sp., and *L. cernuum*. Interestingly, one climax species was also found in *padang* namely *Shorea belangeran*, at the seedling stage. This is because the *padang* ecosystem is directly adjacent to the *rimba*, so it is possible for seeds to be spread by the wind. According to Whitten et al. (1984), the grassland ecosystem in Bangka and Belitung is dominated by small trees, such as *Baeckia frutescens* and *Melaleuca cajuputi*. At the research site of this study, however, the *B. frutescens* did not dominate. This can be caused by the high density of grass in *padang*, so that the competition for nutrients is quite high, both intraspecies and interspecies (Hau and Corlett 2002).

The dominant plant families in the studied site were Myrtaceae, Clusiaceae, Euphorbiaceae, Rubiaceae, and Fabaceae (Figure 4). The dominance of species from the Myrtaceae might be due to the adaptability of some members of the Myrtaceae family to nutrient-poor heath forest soils. Species of Myrtaceae tend to be well adapted to critical lands such as heath forests and thus dominate the community (MacKinnon et al. 1996; Wisheu et al. 2000; Aiba and Kitayama 2020). Several species of Myrtaceae are also pioneer plants, such as *R. tomentosa*, *Rhodamnia cinerea*, *Syzygium buxifolium*. In addition, Annonaceae, Nepenthaceae, Droseraceae, Sapotaceae and other families were also found. In Brunig (1974) study which examined heath forests in Sarawak, relatively many members of the Myrtaceae family were also obtained.

**Floristic composition ground cover vegetation**

In this study, ground cover vegetation consisted of seedlings, shrubs, herbs, lianas, rattan, and pandanus. The observation across 100 observation plots in rimba obtained 119 plant species, consisting of 72 species of seedlings, six species of shrubs, 12 species of herbs, 27 species of lianas, and two species of rattan. The most dominant plant species in *rimba* was *Syzygium lepidocarpa* with IVI of 20.20% and a density of 13,475 ind/ha (Table 1). Plant species with the lowest IVI consisted of several species including *Symplocos adenophylla*, *Memecylon olygoneurum*, and *Edospermum diadenum* with 0.14%. The high heterogeneity of species in *rimba* is indicated by the occurrence of 23 species in a plot measuring 2 x 2 $m^2$. The role of biodiversity in forest ecosystem may promote the succession process and support the niche complementarity effect for the mechanism of species coexistence (Carroll et al. 2011; Barrufol et al. 2013; Rodrigues et al. 2019). The five dominant plant species in *rimba*, which are shown in Table 1 were species from the seedlings of tree species. The presence of shrubs and herbs as pioneer species in *rimba* were not dominant, because of the condition of the ecosystem in the *rimba* which relatively reached the climax stage and low light availability.

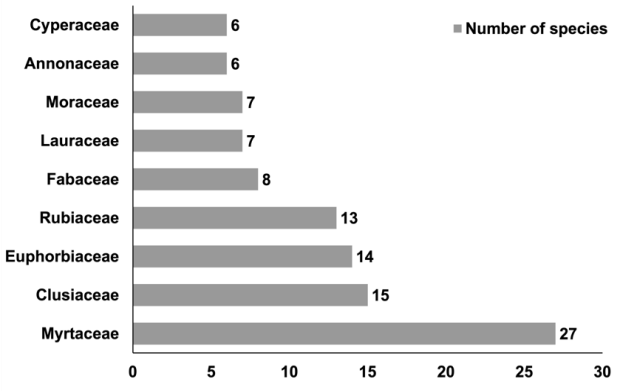


**Figure 4.** Distribution of number of species in nine dominant plant families in heath forest in East Belitung

The results of observation in *bebak* obtained 110 plant species of ground cover vegetation, consisting of 61 species of seedlings, nine species of shrubs, 16 species of herbs, 22 species of lianas, one species of rattan, and one species of pandanus. Species with the highest important values were *Guioa pleuropteris* (12.57% with a density of 3,600 ind/ha) and *Syzygium euneura* (12.09% with a density of 3,025 ind/ha) (Table 1). The species with the smallest IVI were *Elaeocarpus palembanicus* (0.15% and a density of 25 ind/ha). Some of the lianas found were *Lygodium microphyllum*, *Dalbergia rostrata*, and *Salacia oblongifolia*.

In *padang*, there were 31 plant species of ground cover vegetation consisting of eight species of seedlings, three species of shrubs, 16 species of herbs, and two species of lianas. The highest IVI of 51.14% was the *Fimbristylis* sp. with a density of 85,250 ind/ha (Table 1).

One unique was *Drosera burmanii* with IVI of 19.71%. This species is often neglected and rarely found anywhere else, but it occurred in *padang* (grassland). In addition to *D. burmanii*, one Nepenthes species was also found in *padang*, namely *Nepenthes gracilis*. This funding is in accordance with Whitmore (1984) that state grassland (*padang*) ecosystem is a suitable habitat of *Nepenthes* sp. and *Drosera* sp. Mansur (2007) stated that Nepenthes has a high tolerance for high light intensity and can also grow in a shaded environment. In our study, dry soil conditions did not limit the life of *D. burmanii*. Even in moist and watery soil conditions, *Drosera* can grow well (Baranyai and Joosten 2016; Witono et al. 2020).

The number of species and individuals of ground cover vegetation in the three habitat types of heath forest was relatively varied. Especially in *rimba* and *bebak*, the number of species was quite high. This can be caused by the location of the *rimba* which was directly adjacent to *bebak*, so that the spread of seeds of several plant species in *bebak* can grow in the *rimba* and vice versa. While in *padang*, the number of species is relatively small, but the IVI value of the 31 species obtained is very high compared to *rimba* and *bebak*. This was the case for *Fimbristylis* sp. which almost covered the entire floor of *padang*. This species is a pioneer species that have been existed in *padang* for a very long time. According to the local community, *padang* was originally formed as the result of great fires that occurred in ancient times (hundreds of years ago). The fires were triggered by the friction of the trees in the heath forest which was very dry due to the long dry season. Once the land becomes *padang*, it is very difficult (if not impossible) to be restored as forest again.

**Floristic composition of saplings**

Across 100 observation plots in *rimba*, in total there were 93 species at the sapling stage. The number of saplings obtained was more than the number of seedlings. This shows an inverted pyramid of species structure, meaning that some species might disappear when they grow to a more mature stage. The decline in species number at the saplings stage can be caused by the replacement of pioneer species that are no longer shade-tolerant so that they are unable to grow to the saplings (Itoh et al. 1995).

In *rimba*, the species with the highest IVI was *Calophyllum lanigerum* (17.27% with a density of 900 ind/ha) (Table 2). Five species with the highest IVI as sapling stage were relatively evenly distributed, suggesting that the dominance of the five species in *rimba* was relatively balanced. According to MacKinnon et al. (1996), the most prominent characteristic of heath forests is to have trees that are low in stature and small in diameter. One of the species at the sapling stage was *Tristaniopsis obovata*, which was very easily recognizable at the study site because it has red stems and peeling bark. The wood of *T. obovata* is quite hard and is often used as fence wood.

**Table 1.** Importance value index of five dominant ground cover vegetation in *rimba* (primary forest), *bebak* (secondary forest), and *padang* (grassland) in heath forest in East Belitung.

| Location | Local name | Scientific name | Family | IVI (%) |
|---|---|---|---|---|
| *Rimba* | Samak | *Syzygium lepidocarpa* | Myrtaceae | 20.20 |
| | Betor Padi | *Calophyllum depressinervosum* | Clusiaceae | 16.23 |
| | Singkang | *Syzygium lineatum* | Myrtaceae | 11.24 |
| | Kelebantuian | *Syzygium euneura* | Myrtaceae | 10.20 |
| | Sisilan | *Syzygium rostratum* | Myrtaceae | 7.95 |
| *Bebak* | Pulas | *Guioa pleuropteris* | Sapindaceae | 12.57 |
| | Kelebantuian | *Syzygium euneura* | Myrtaceae | 12.09 |
| | Tenam | *Psychotria viridiflora* | Rubiaceae | 11.21 |
| | Jemang | *Rhodamnia cinerea* | Myrtaceae | 10.28 |
| | Seru | *Schima wallichii* | Theaceae | 9.42 |
| *Padang* | Kucai *Padang* | *Fimbristylis sp.* | Cyperaceae | 51.14 |
| | Rumput jenis C | *Eriocaulon sp.* | Eriocaulaceae | 32.67 |
| | Kerupit *Padang* | *Panicum sp.* | Poaceae | 27.53 |
| | Drosera | *Drocera burmanii* | Droceraceae | 19.71 |
| | Rumput *Padang* bola | *Rhynchospora aurea* | Cyperaceae | 15.23 |

**Table 2.** Importance value index of five dominant saplings in *rimba* (primary forest), *bebak* (secondary forest), and *padang* (grassland) in heath forest in East Belitung.

| Location | Local name | Scientific name | Family | IVI (%) |
|---|---|---|---|---|
| *Rimba* | Betor Belulang | *Calophyllum lanigerum* | Clusiaceae | 17.27 |
| | Kelebantuian | *Syzygium euneura* | Myrtaceae | 10.82 |
| | Meleman | *Psychotria malayana* | Rubiaceae | 10.76 |
| | Jemang | *Rhodamnia cinerea* | Myrtaceae | 10.75 |
| | Pelawan Kiring | *Tristaniopsis obovata* | Myrtaceae | 10.59 |
| *Bebak* | Kiras | *Garcinia hombroniana* | Clusiaceae | 21.50 |
| | Jemang | *Rhodamnia cinerea* | Myrtaceae | 18.11 |
| | Kelebantuian | *Syzygium euneura* | Myrtaceae | 11.05 |
| | Samak | *Syzygium lepidocarpa* | Myrtaceae | 10.86 |
| | Seru | *Schima wallichii* | Theaceae | 10.81 |
| *Padang* | Sekuncong | *Leptospermum flavescens* | Myrtaceae | 88.46 |
| | Gelam | *Malaleuca leucadendron* | Myrtaceae | 56.41 |
| | Pelawan kiring | *Tristaniopsis obovata* | Myrtaceae | 55.13 |

The results of the analysis of sapling vegetation in *bebak* obtained 76 species. The number of saplings obtained was higher than the number of seedlings. The sapling species with the highest IVI were *Garcinia hombroniana* (21.50% with a density of 1,292 ind/ha), *R. cinerea* (IVI of 18.11% and a density of 800 ind/ha) (Table 2). Sapling density in *bebak* (7,032 ind/ha) was lower than in *rimba* (8,804 ind/ha). Several species at the seedling stage were still found at the sapling stage, such as *S. euneura*, *R. cinerea*, and *S. wallichii*. Species of annual plants or trees also began to be found, for example *Durio zibethinus*, *Artocarpus integer*, and *Archidendron pauciflorum*. Secondary succession on ex-agricultural land will be dominated by annual plant species for one or two years until they are replaced by plants with longer life cycles (Widiyatno et al. 2017). Vegetation cover in *bebak* is relatively more open than in *rimba*. This was due to the fact that *bebak* has fewer tree stands than in the *rimba*. In addition, the age of vegetation succession in *bebak* was only 10 years old, so the succession process is still ongoing. Based on field observation, the 30-years old *bebak* is almost like *rimba*, both in terms of species richness and the appearance of a relatively dense formation which might be due to the quality of microsite in both ecosystems (Mayoral et al. 2019).

In *padang*, there were three plant species at the sapling stage. The sapling species with the highest significance value was *Leptospermum flavescens* at 88.46% (Table 2) with a density of 20 ind/ha, equal to the density of *T. obovata*. The grassland ecosystem was indeed dominated by undergrowth. The condition of vegetation in *padang* was relatively thin and dry due to a lack of nutrients. The *L. flavescens* is a small tree species that are potential bioactive for honey production in Australia (Santos et al. 2021). The leaves are small and somewhat sharp is a form of morphological adaptation to extreme ecosystem conditions to reduce evaporation (Bodner et al. 2015; Fernández-Marín et al. 2020).

**Floristic composition of trees**

The results of the analysis of tree-level vegetation in the *rimba* obtained 51 plant species from 22 families. This number is less than at the seedling and sapling levels. The tree-level was dominated by species from Myrtaceae (23.5%). However, the species with the highest importance from the family Theaceae, i.e., *S. wallichii* with an IVI of 53.36% and a density of 105 ind/ha (Table 3). This species is often found in upland forests in Java. Another species that also had IVI above 50% is *S. lepidocarpa* with a density of 144 ind/ha.

One of the typical plant species of the heath forest is *Cratoxylum glaucum* with an IVI of 15.02%. This species is also the dominant species found in the heath forest of Bako National Park, East Malaysia (Katagiri et al. 1991). Based on diameter class, trees in the *rimba* were dominated by 10 - 20 cm diameter class, which contributed 74.53% of the 683 individual trees found or 509 ind/ha. According to Onrizal et al. (2005), the highest diameter class distribution of the heath forest stands of Danau Sentarum National Park, West Kalimantan, is 2 - 10 cm (6010 ind/ha), while 10 - 20 cm had a density of 670 ind/ha**.**

We obtained 35 plant species belonging to 18 families for trees in *bebak*. This number is less than at the seedling and sapling levels. Nevertheless, the tree level was also dominated by species from Myrtaceae (17.64%). The highest IVI at the tree level was *S. wallichii* from the family Theaceae with IVI of 103.00% with a density of 109 ind/ha (Table 3). The *S. wallichii* has a wide range of suitable habitats to grow from an altitude of 100 - 1600 m above sea level (Boojh & Ramakrishnan 1982). This species is also a pioneer species as well as a climax species, so it can grow well in the *rimba* and *bebak* (Vaidhayakarn and Maxwell 2010). We also found *Archidendron pauciflorum* which is a plant species that is commonly cultivated. Another species found was *Ilex cymosa* which usually lives in somewhat open vegetation, and is quite well adapted to fire (Whitmore 1984).

**Table 3.** Important value index of five dominant trees in *rimba* (primary forest) and *bebak* (secondary forest) in heath forest in East Belitung, Indonesia

| Location | Local name | Scientific name | Family | IVI (%) |
|---|---|---|---|---|
| *Rimba* | Seru | *Schima wallichii* | Theaceae | 53.36 |
| | Samak | *Syzygium lepidocarpa* | Myrtaceae | 52.15 |
| | Jemang | *Rhodamnia cinerea* | Myrtaceae | 16.07 |
| | Gerunggang | *Cratoxylum glaucum* | Clusiaceae | 15.02 |
| | Betor Padi | *Calophyllum depressinervosum* | Clusiaceae | 14.69 |
| *Bebak* | Seru | *Schima wallichii* | Theaceae | 103.00 |
| | Jering | *Archidendron pauciflorum* | Fabaceae | 48.18 |
| | Samak | *Syzygium lepidocarpa* | Myrtaceae | 15.48 |
| | Medang kalong | *Cinnamomum parthenoxylon* | Lauraceae | 13.10 |
| | Mensira | *Ilex cymosa* | Aquifoliaceae | 12.37 |

Trees that grow in *padang* have very hard, dry, and very rare wood. The results of the analysis of tree-level vegetation in *padang* obtained two plant species. The tree-level species with the highest importance were *L. flavescens* at 180.60% with a density of 2 ind/ha and sapling *Combretocarpus rotundatus* at 119.40% with a density of 1 ind/ha. The two species were only found in one observation. The low number of trees in *padang* implies the level of vulnerability of this area from disturbance. The bark of *L. flavescens* is very hard and dry which is an adaptation to the extreme environment. Acidic and nutrient-poor soil conditions do not support the survival of other species found at the seedling to sapling and tree levels. However, this is indeed a characteristic of the desert ecosystem (Eldridge et al. 2018).

In general, it can be seen that there are differences in species that dominate in each type of heath forest and at each growth stage. The species at the seedling level that dominated in the *rimba* was *S. lepidocarpa*, whereas this species did not dominate at the sapling and tree levels. At the tree level, *S. wallichii* dominated in *rimba* and *bebak*. The composition and dominance of vegetation in an ecosystem will change in the future due to the differences in the survival rate of a species against the dynamics of the ecosystem both physically and biotically as well as external disturbances (Comita et al. 2014; Moustakas and Evans 2015; Zhu et al. 2018).

**Species diversity, richness, and evenness at three habitat types of heath forest**

The value of species diversity of saplings and trees in *rimba* (i.e., 3.73 and 3.09) was higher than in *bebak* and *padang* (Figure 5.A). The more climax of an ecosystem it will be followed by an increase in the number of species that can live there at the seedling level and only certain species can survive. Therefore, a decrease in the value of diversity from the seedling level to the tree level can occur. A change in the dominant species during the pioneer stage will result in an adjustment in the interspecific relationship of the community (Aiba et al. 2012; García-Cervigón et al. 2013).

The seedling's diversity in *rimba* was lower than that in *bebak* (i.e., 3.86 and 4.03). This could be due to the number of individuals of each species in *rimba* was not evenly distributed (Ludwig et al. 1988). *Padang* had a very low diversity value of seedlings, saplings, and trees (i.e., 2.34, 1.07, and 0.67) when compared to *bebak* and *rimba*. The diversity index varies depending on the forest type and growth stages. Changes in the species diversity index occur because of the biological properties of the forest, which are always growing and developing (Kissinger 2002). Furthermore, changes in diversity can occur quickly because of human actions or natural processes.

*Rimba* and *bebak* had similar species richness index at the seedling stage with 14.35 and 14.44, respectively (Figure 5.B). The closeness of ecosystem types may also contribute to this slight variance. Because *bebak* was a secondary forest that had been utilized for shifting-cultivation and had been abandoned for ten years, there were many species present there, particularly pioneer species (Guimarães Vieira and Proctor 2007; Karthik et al. 2009). Some species have a tendency for rapidly colonizing pioneer stands (Li et al. 2005). The total number of individuals of all species has an impact on the value of species richness. The value of richness decreases as the total number of individuals of all species in an ecosystem grows. On the other hand, the value of richness increases where at the same number of species but has a smaller total number of individuals of all species (Ludwig et al. 1988).

Seedlings, saplings, and trees had the lowest species richness in the grassland ecosystem (*padang*) with 3.27, 0.78, and 0.91, respectively. Only three species were found at the sapling stage with a total of 52 individuals per hectare. Only two species were found at the tree stage, equal to three individuals per hectare. This is an extremely modest number, indicating that the sapling and tree species richness in *padang* was very low. *Bebak* had the highest seedling plant species evenness value compared to *rimba* and *padang*. In *padang*, the value of plant species evenness at the seedling and tree stage was the greatest. In *padang*, only two species with a total of three individuals which causes the evenness value of trees plant species in *padang* to be higher, namely 0.97 (Figure 5.C). In *rimba*, the evenness value of the trees stage was 0.78 which is due to the number of individuals from 51 tree species. Compared to *rimba*, *padang* ecosystem had more severe habitat conditions, and the composition of herbaceous and shrub species was shown to be affected by environmental filtering and dispersal limitation, with the niche process of environmental filtering playing a leading role (Lebrija-Trejos et al. 2010).

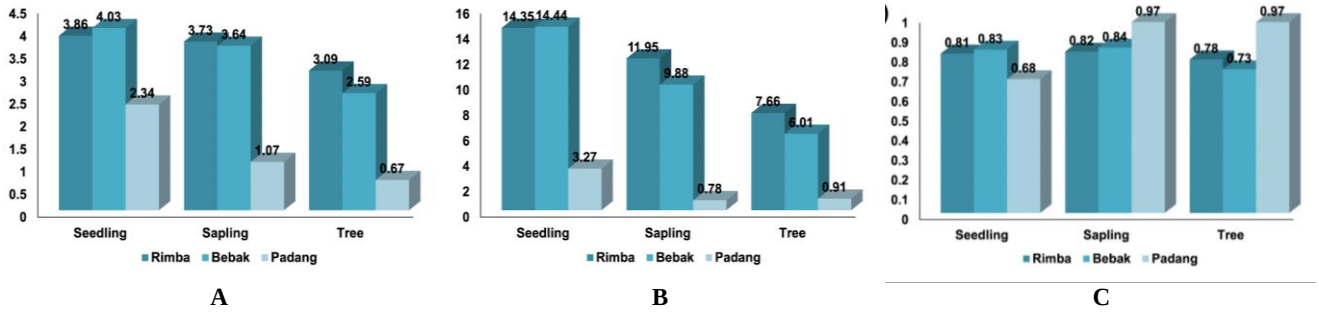


**Figure 5.** Biodiversity indicators of vegetation at different growth stages in three habitats of heath forest in East Belitung: A. Species diversity index; B. Species richness index; and C. Species evenness index

An essential goal in community ecology is to understand the processes that drive community assembly. Several mechanisms ranging from entirely deterministic to stochastic have been offered to explain the high number of species present in some ecological communities (Kraft et al. 2015). Many plant species have specific abiotic requirements for successful germination, and thus the germination stage represents the first point at which habitat filtering can occur. The potential for a particular functional type such as trees, shrubs, herbs, and lianas to drive forest dynamics could have important implications for forest management (Lebrija-Trejos et al. 2010; Loiola et al. 2015). Understanding the ecological role of environmental heterogeneity and plant functional types through functional traits approach, species-habitat association, and population dynamics are essential because it provides basic information about plant community dynamics. We suggested that the presence of species composition in the three habitat types of heath forest in Belitung Island is an essential plant resource to be conserved and sustainably utilized. Establishing reserve areas to protect natural habitat and biodiversity is encouraged to provide proper ecosystem function for the people and nature. The encouragement to conduct several ecological-based research is also necessary to improve global knowledge of heath forests in the tropical region.

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