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Short Communication: Diversity and distribution of epiphytic orchid *Dendrobium* section *Spatulata* on the host plants in the Cycloop Mountain Nature Reserve of Papua, Indonesia

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Abstract. *Arobaya AYS, Zuhud EAM, Siregar IZ, Irawati. 2022. Short Communication: Diversity and distribution of epiphytic orchid* Dendrobium *section* Spatulata *on the host plants in the Cycloop Mountain Nature Reserve of Papua, Indonesia. Biodiversitas 23: 2025-2034.* Knowledge of species diversity and distribution is indispensable to assist in formulating a sound conservation strategy. This is truly significant for epiphytic orchids that grow on tree surfaces or phorophytes. The data and information are still limited despite their important role as biological indicators in forest ecosystems. The aim of the study was to carry out an inventory of epiphytic orchids and the phorophytes (host tress) in the Tropical Rain Forest of Cycloop Mountain Nature Reserve. The study took place in four sites located in the regency and city of Jayapura. Exploratory and sampling strip methods of 20x100 m^2 were employed during the fieldwork. Orchids were observed and samples were collected based on their distribution in the host plants divided into five zones (Stem zone I and II; Crown zone III to V). The habitat's vegetation profiles were described using computer-aided design (CAD) verse 2018. Plant samples were identified in herbarium Manokwariense and the identified species were incorporated into CAD. Nineteen species of *Dendrobium* section *Spatulata* were identified as living as an epiphyte on the 12 phorophytes. These orchids and the host plants were described, determined and analyzed using PATN software. Most orchids are growing abundant in zone II and III. The phorophytes hosting the orchids in the lowland are mainly *Syzygium* and *Intsia*, while in the highland are *Agathis* and *Podocarpus*. Two types of vegetation profiles were described as savannah woodland in the low land area and coniferous trees vegetation in the highland above 650 m above sea level.

Keywords: Biodiversity, Cycloop Mountain NR, epiphytic orchids, Papua, phorophyte

INTRODUCTION

The conservation area of Cycloop Mountains Nature Reserve (CMNR) is an important habitat for various types of vegetation harbor various epiphytic plants. One of the epiphytes that grow naturally in the nature reserve and is recognized as ornamental plant is Orchidaceae. This flowering plant family is estimated to consist of 400 genera (Dressler 1981). One of the largest genera after *Bulbophyllum* is *Dendrobium* which has a diversity of up to 2000 species (Lavarack et al. 2000). Therefore the genus was classified into 41 sections (Schlechter 1914). One of the recognizable sections of *Dendrobium* that is often used as an ornamental plant in plant breeding programs and orchid exhibits is *Dendrobium* Sw section *Spatulata* Lindl (Chalmers 2011; Clement 2014; Reitano 2012; Walker 2013).

Dendrobium section *Spatulata* has a wide geographical distribution ranging from the Northern part in the Philippines southward to the Australian State of Queensland and from the Western part in Java eastward to the Pacific islands to Samoa (Cribb 1986; Lavarack et al. 2000; Millard 1999). Only one species has emerged in Western Indonesia such as Java, West Timor and Sulawesi: *Dendrobium capra* J.J.Sm., *Dendrobium taurinum* Lindl. and *Dendrobium busuangense* Ames in the Philippines; And more than two species can be found in the Pacific Islands such as the Solomon Islands, Vanuatu, Fiji, Samoa, New Britain and New Caledonia (Cribb 1986; Lavarack et al. 2000). In Australia, the record indicates eight species and several natural hybrids on the East Coast of Queensland, ranging from Cape York to Rockhampton and New South Wales (Dockrill 1992; Jones 2006). More than half of the species in this section are found in Indonesia New Guinea (formerly known as Irian Jaya) and Papua New Guinea (Lavarack et al. 2000; Millar 1999; Tkatchenko and Kami 2006).

This means that New Guinea and the surrounding islands are central to species diversity (Cribb 1986; Handoyo 2021; O'Byrne 1994). Considering the richness of species scattered in various ecosystems and their habitat profile is a type of ecosystem, especially in CMNR and surrounding areas, further investigation related to the limited data and important information needed is associated with: (i) the diversity of orchid species from the *Dendrobium* section *Spatulata* that lives on its host; (ii) the distribution of individuals per species grown on each host and (iii) detailed vegetation profiles of ecosystem types. Hence this research was conducted with the aim to: (i) uncover the species diversity of this section, (ii) analyze the potential per orchid species and its host, and (iii) analyze and document the profile of orchid habitat on various types of vegetation contained in the CMNR area.

MATERIALS AND METHODS

Study area

The research was conducted in Maribu Tua and Tablanusu villages of West Sentani District of Jayapura Regency for one month from 1st to 31st August 2020, Angkasa Village of North Jayapura Sub-District and Pasir Enam of Tanjung Ria Sub-District in Jayapura City for two weeks from 18th November to 2nd December, 2020 (Figure 1). The four locations of the study were determined based on differences in vegetation types: Coastal Forest in Tablanusu and Pasir Enam, Lowland Rainforest in Maribu Tua and High Mountain Forest in Angkasa. Coastal Forests are in the Western and Eastern parts of CMNR at Jayapura Regency, Lowland Forests are in the Western part of CMNR, and the Tropical Mountain Forest is in the Eastern part of CMNR of Jayapura City. The climate type around the Cycloop Mountains Nature Reserve is typed A, with the average temperature per month during the day ranging from 30 to 32 degrees and at night between 25 to 28°C. Humidity ranges between 65 and 70% during the day, 80 and 85% at night. Rainfall ranges between 45 and 225 mm per year with average rainy days varying between 148 and 175 mm in a year (BMKG Papua Province, 2020).

Data collection

Plans materials

Orchid species found growing on hosts are collected at four sites located within the Cycloop Mountains Nature Reserve (CMNR), which reflects four types of tropical rainforest vegetation. The process of identification, description and determination of species is carried out by making a herbarium specimen from orchid samples collected during observation of both flowering and non-flowering. Flowering orchid plants are made with as many as five duplicates and non-flowering as many as three duplicates to be used as herbarium material (Figure 2). The two duplicates are preserved as a living collection for subsequent observations when flowering. Other living collections are dried and stored in the Herbarium Manokwariense at the Center for Biological Diversity (PPKH) of the University of Papua (UNIPA).

Potential of orchids and host plants

During field observations, data on volatile morphological characters such as scent, color and sap from both orchids and host are immediately recorded in field notebooks. Tree species are identified by taking a small portion of the branches that are still attached to the twigs and making herbarium material. Herbarium samples are preserved using methyl alcohol and dried using an oven at a temperature of 30 degrees Celsius. The samples are sent and stored in the *Herbarium Manokwariense* to be compared to previously collected herbarium collections (BW and NG). The identification and determination process also uses specimens that can be accessed online from herbaria in PNG. Documentation of herbarium photographs collected from the field is made into duplicates sent to the Bogoriense herbarium (Figure 2).

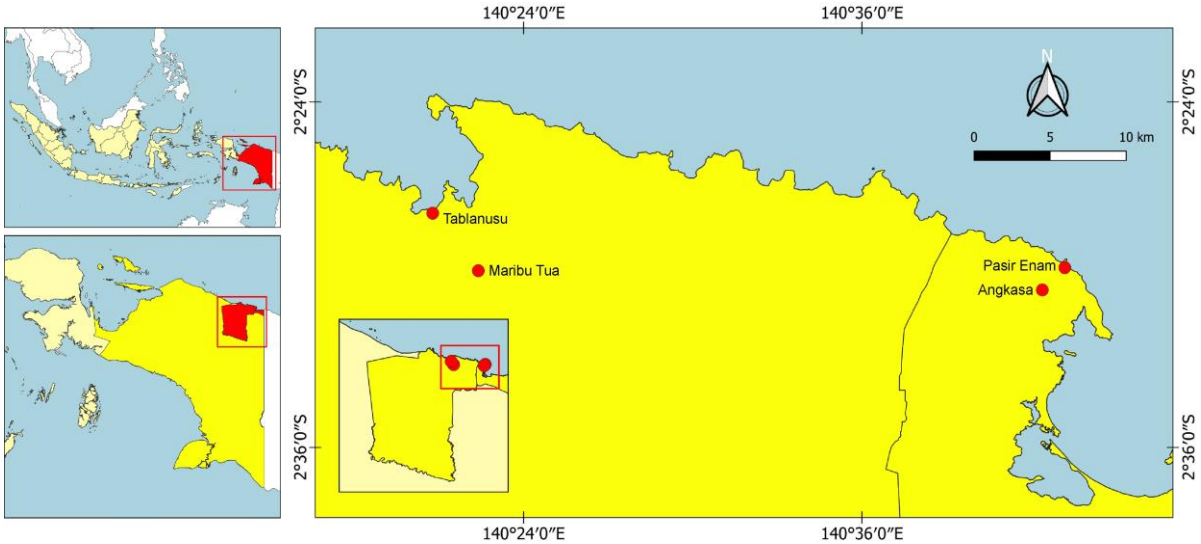

Figure 1. Location of Maribu Tua village (2º29'51.62"S, 140º22'23.53"E), Tablanusu village (2º27'51.68"S, 140º20'46.53"E) indicating the sampling sites of the Western site of CMNR; and Pasir Enam (2°29'45.14"S, 140°43'11.33"E) and Angkasa (2°30'31.63"S, 140°42'23.54"E) sites represented the Eastern part of CMNR

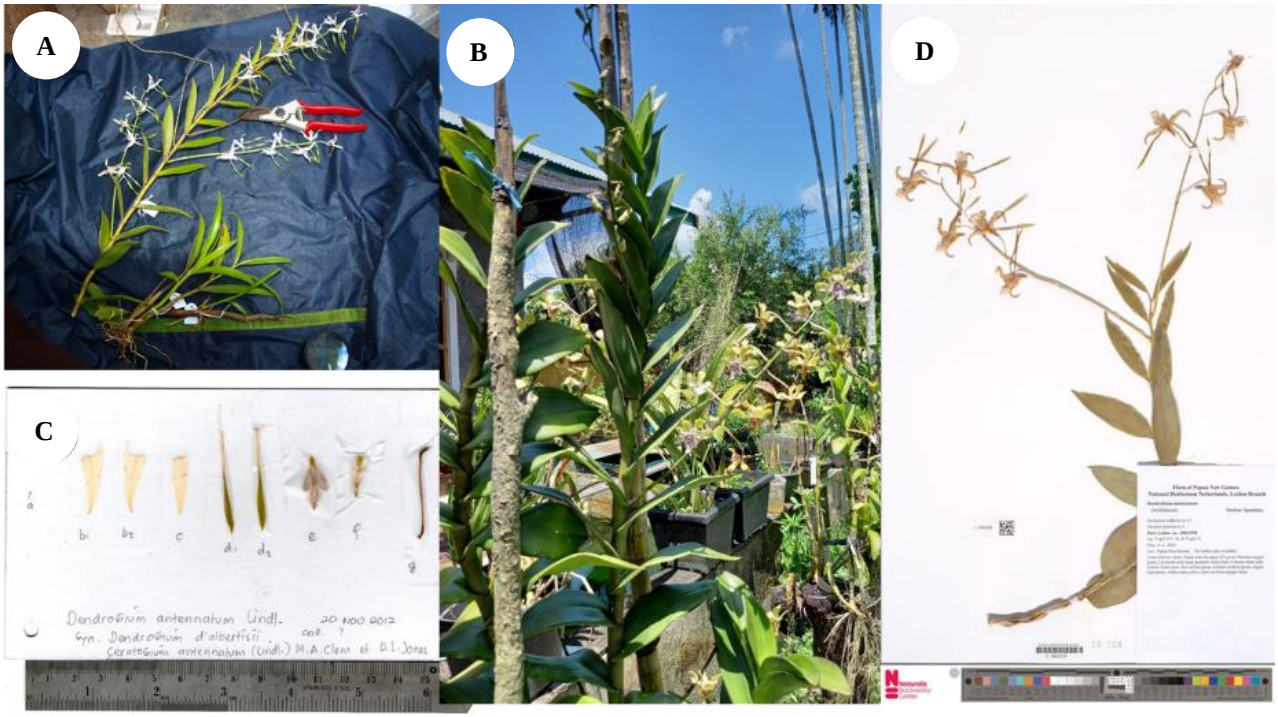

Figure 2. Examples of herbarium material from *Dendrobium antennatum* Lindl. (A) and flower card (C), living plants of *Dendrobium violaceoflavens* J.J.Sm. (B) used in the process of description, identification and determination of species, and for validation of species done by comparing specimen results from the field with materials stored in *Herbarium Manokwariense* in Manokwari and PNG *Herbarium* in Port Moresby that can be accessed online (D)

Data on the potential of orchid and host species is obtained by observing line transect at each location. The transect is made perpendicular to the contours. The mainline is made along 500 m and 5 lines of 250 m long are placed along the main track with a distance between the lanes of 100 m each and a track width of 20 m (Nurfadilah 2015). Observations were made along five lines. Each clump of orchids grown on a host found in each observation pathway is recorded by following the method of epiphyte distribution on the host (Johannson 1974). Distribution zoning is divided into 5, namely: I = 1/3 from the base of the main trunk, II = 2/3 from the top of zone I to the branch-free area, III = 1/3 The inner canopy, IV = 1/3 The central canopy, V = 1/3 of the outer canopy.

Description of habitat

Habitat was described by a profile of vegetation data at each location which is obtained by creating a plot measuring 70 m long and 10 m wide. All types of plants comprised in the observational plot are recorded and documented to be mapped for their distribution on the plot. The creation of a profile diagram based on the results of plant identification in the herbarium and incorporated using AutoCAD software verse 2018.

Data analysis

Data of orchid species diversity resulting from descriptions of morphological characters were analyzed using the PATN program (Belbin 2003). Data on potential orchid species and their host is processed using the Excel™ program. The parameters measured are the relative frequency of the host (%Ft), the relative abundance of orchids (%Fo), the average number of individual orchid species in each host species (Ji/Jt), the average number of orchid species in host species (Js/Jt), and the vertical distribution of orchids in hosts (Yulia and Budiharta 2011a,b).

Frequency relative of the host plants (%Ft)

$$\%\,Ft = \frac{Nt}{\text{Total number of all phorophytes}} \times 100\%$$

Nt = the number of tree in plot as host plants

Relative abundance of orchid (%Fo)

$$\%\,Fo = \frac{No}{\text{Total number of all orchid species}} \times 100\%$$

No= the number of individual orchid species in the plot

The average number of individual orchids per species on the host plant=

$$\frac{Ji}{Jt}$$

Ji= individual number of orchids, Jt= individual number of species of host plant

The average number of orchid species per species of host plant=

$$\frac{Js}{Jt}$$

Js= the number of orchid species, Jt= individual number of each species of host plant

Vertical distribution of orchids on species of host plants is determined by calculating the average number of orchids that grow on each zone of the stem (I-II) and canopy (III-V).

Analysis of plant data for profile diagrams is obtained by combining the results of species identification and sketches of plant features using software of the AutoCAD verse 2018.0.

RESULTS AND DISCUSSION

Diversity of orchid species and the host plants

Orchid plants observed during the fieldwork were recorded for 69 species that spread naturally in various host species that grow in the CMNR area. 19 of the 69 species identified as *Dendrobium* section *Spatulata* and the remaining orchids are species of other sections of the *Dendrobium* and other orchid genera (Figure 3). Each site display uniqueness of orchid species such as *Dendrobium discolor*, *Dendrobium lasianthera*, *Dendrobium lineale* that can only be seen in Maribu tua which represent the western part of CMNR, whereas *Dendrobium schulleri* and *Dendrobium violaceoflavens* mostly encounter in at the Eastern part of The CMNR and further into the Southeast to buffer zone of CMNR. Cribb (1986) revised the whole *Spatulata* section with morphological approaches and recorded 46 species. Up to 41% of the revised species are listed as growing within the CMNR area. Other studies using morphological approaches (Metusala 2019), flower and fruit anatomy (Indraloka et al. 2019), including the publication of orchid species in reference books (Handoyo 2021; Schuiteman 2013) and the colonization of mycorrhiza in orchid roots (Nurfadilah et al. 2016) also add complexity to the diversity of this section. This complexity was notified more than a decade ago by Kraenzlin (1910).

Species of the host plants are inventoried and identified as twelve species in the observational plot (Figure 4). Each host plant shows a variety of branching and bark surfaces. This circumstance provides a suitable habitat for epiphytic plants, including orchids, to germinate from plantlets and become developed plants (Johansson 1974). The rough surface of the stems or tree trunks tends to be a preferable venue to accommodate orchid seeds to grow well (Flores-Palacio and Ortiz-Pulido 2005). Research on the host plants of the epiphytic orchid species that spreads naturally in secondary forests in Coban Trisula, Malang, East Java revealed the dispersal of recorded orchids abundantly in the inner (III) and middle (IV) canopy of trees (Nurfadilah 2015). *Castanopsis javanica* (Blume) A.DC. and *Engelhardia spicata* Lesch. ex. Blume is recorded as host species cultivated by many individual orchids.

Potential of orchid species and the host plants

The twelve species recorded from vegetation analysis at the observation site host fourteen species of epiphytic orchids, including *Dendrobium* section *Spatulata* (Figure 5). The twelve species are *Syzygium malaccense* (L.) Merr. & L.M Perry, *Syzygium samarangense* (Blume) Merr. & L.M. Perry, *Swietenia macrophylla*, which are introduced and grown naturally inside CMNR, *Dipterocarpus indicus*, *Pometia pinnata*, *Podocarpus blumei* (C. Presl.) Kuntse, *X. novoguinensis*, *Agalia* sp., *Podocarpus* sp., *Intsia bijuga*, *Albizia falcataria*, and *Agathis labillardieri*. Five species are recorded to have a frequency of more than 10% to be hosts found often overgrown by epiphytic orchids, namely *A. labillardieri, Xanthostemon novoguineensis, P. blumei*, *P. pinnata* and *S. macrophyla*. *S. macrophylla* can grow in the CMNR area when in the early 1980s there was a program of reforestation and land rehabilitation due to forest clearing for transmigration settlements and logging to conservation areas in Indonesia New Guinea such as in TN Wasur (FWI-GFW 2001) including in CMNR. Forest rehabilitation and reforestation efforts are carried out in areas of forest that experience deforestation and land degradation through the planting of tree species (Barr et al. 2011) including *S. macrophylla*.

Analysis of the relative frequency signifies the distribution of fourteen species of epiphytic orchids on the host plants (Figure 6). Thirteen species can be identified up to the species category namely *Bulbophyllum longicaudatum*, *Bulbophyllum* aff. *lineolatum*, *Coelogyne asperata*, *Dendrobium antennatum*, *Dendrobium bifalce*, *D. lasianthera*, *D. lineale*, *Dendrobium macrophyllum*, *Dendrobium shiraiishi*, *Dendrobium spectabile*, *Grammatophyllum scriptum*, *Grammatophyllum speciosum* and *Grammatophyllum stapeliiflorum*. The rest were identified up to the level of genera namely *Bublophyllum* sp3. Four species had a percentage presence in the study location of more than 10% namely *B. longicaudatum* (16%), *D. lasianthera* (15%), *G. stapeliiflorum* (16%), and *D. lineale* (10%). The remaining orchids accounted for a percentage below 10%.

The results of an analysis of the average number of individual orchids in each host species showed that *S. malaccense*, *P. blumei*, and *D. indicus* became hosts that were recorded overgrown by epiphytic orchids with values above 10 clumps (Figure 7). When viewed from the average number of orchid species per host species, the picture of the data is slightly different. *Agathis labillardieri* Warb (8 species) became a host that has a diversity of epiphytic orchid species more than those that grow on *S. samarangense* (6 species) and *Podocarpus* sp. (5 species) (Figure 8). The distribution of epiphytic orchids based on five categories of zoning in host plants indicates that zones III and II become habitats that are overgrown with orchids (Figure 9). Four species are listed in zone III: *D. lasianthera*, *G. stapeliiflorum*, *D. spectabile* and *Bulbophyllum* aff. *lineolatum*. In zone II, five species are *Bulbophyllum* aff. *lineatum*, *D. lineale*, *Bulbophyllum* sp3, *D. bifalce* and *G. stapeliiflorum*.

Vegetation profiles of the habitat of orchids

The general condition of vegetation in western CMNR is a combination of savannah woodland forests, swamp forests and lowland rainforests and high mountains. Many woody savannah forests are dominated by plants of the Myrtaceae family, such as the genus *Melaleuca and Syzygium*, and the Fabaceae family of the genus *Acacia* and *Albizia*. Type Savannah woodland forest known as conservation areas in Merauke Regency is an example of a habitat where most tree species host orchids (Arobaya et al. 2020).

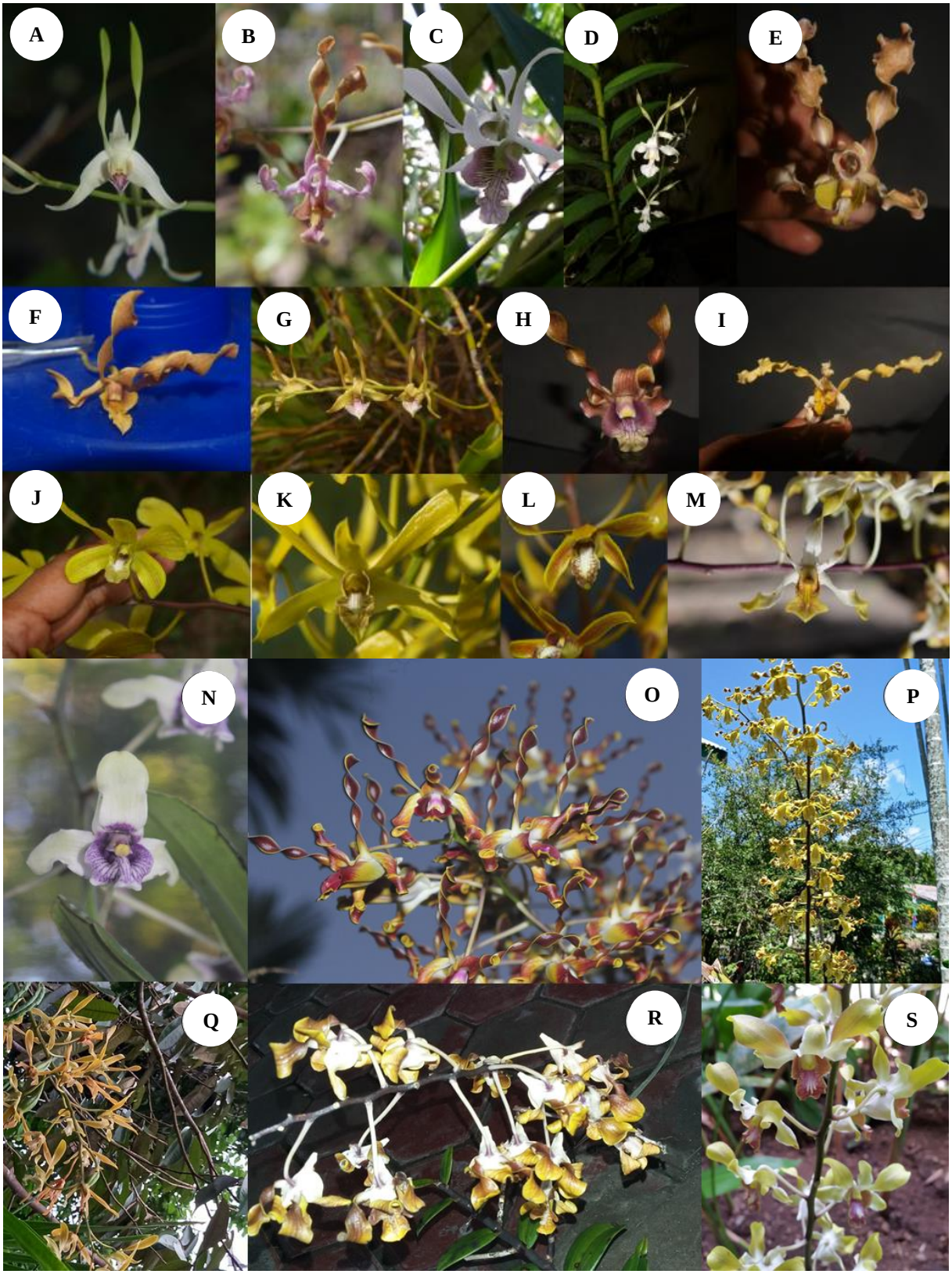

Figure 3. Sample on *Dendrobium* section *Spatulata* recorded from the fieldwork identified as *Dendrobium antennatum* Lindl. (A), *Dendrobium devosianum* J.J.Sm. (B), *Dendrobium lineale* Rolfe (C), *Dendrobium strepsiceros* J.J.Smith (D), *Dendrobium discolor* Lindl. (E), *Dendrobium trilamellatum* J.J.Smith (F), *Dendrobium bicaudatum* Reinw. ex. Lindl. (G), *Dendrobium helix* Cribb (H), *Dendrobium* aff. *strebloceras* Reich.f. (I), *Dendrobium schulleri* J.J.Smith (J), *Dendrobium mirbelianum* Gaud. (K), *Dendrobium sylvanum* Reichb.f. (L), *Dendrobium canaliculatum* R.Br. (M), *Dendrobium violaceoflavens* J.J.Smith (N), *Dendrobium lasianthera* J.J.Smith (O), *Dendrobium conanthum* Schltr. (P), *Dendrobium sylvanum* Reichb.f. (Q), *Dendrobium ordoardi* Kraenzl. (R), *Dendrobium* aff. *spathulatum* L.O. Williams (S)

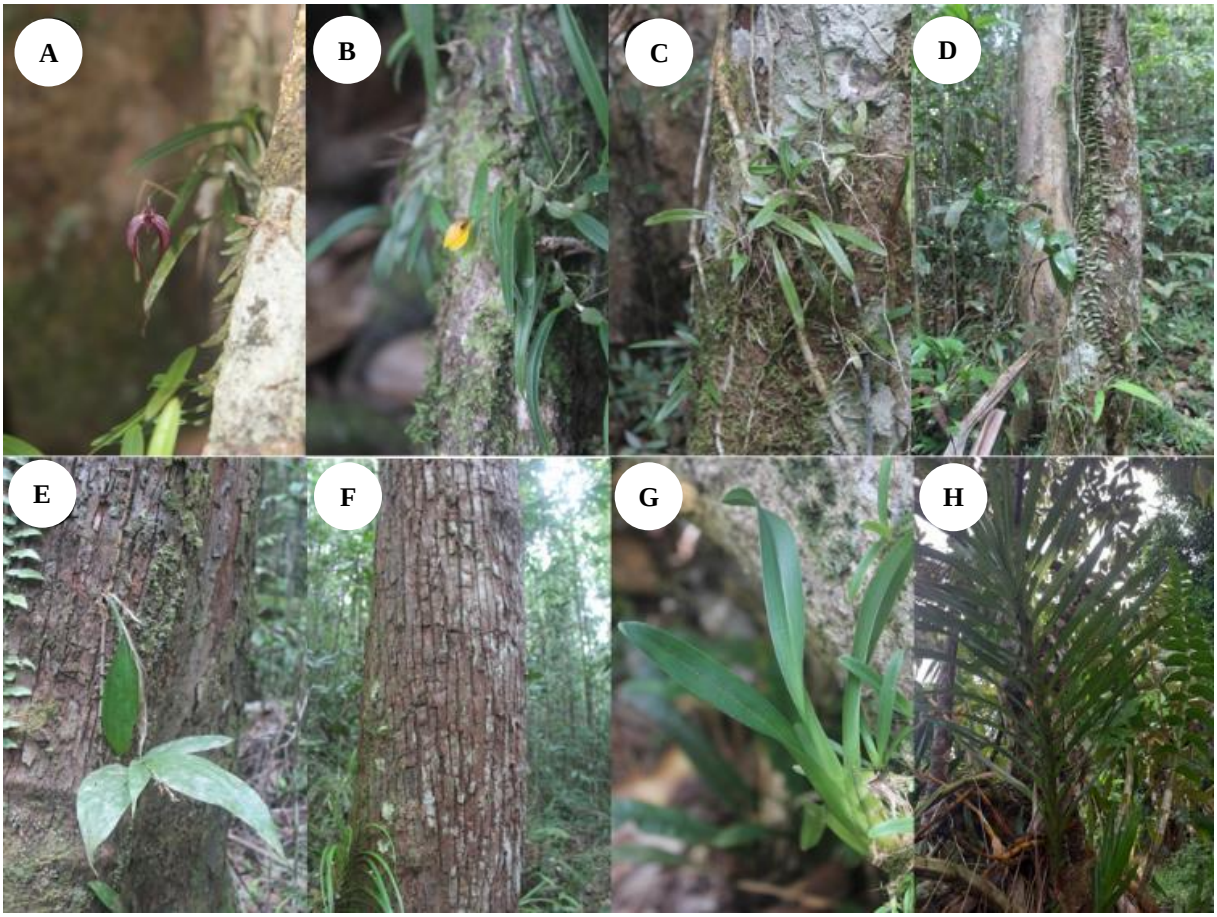

Figure 4. The species of trees that host the epiphytic orchid species. The surface of tree trunks and stem that host epiphytic orchids within the CMNR area: *Bulbophyllum longicaudatum* J.J.Sm. on *Mangifera indica* L. (A), *Bulbophyllum* aff. *lineolatum* Schltr. on *Pometia acuminata* J.R. Forst. & G. Forst. (B), *Bulbophyllum* sp3 on *Intsia bijuga* (Colebr.) Kuntze (C), *Bulbophyllum* sp4 on *Pometia pinnata* J.R. Forst. & G. Forst. (D), *Claderia viridiflora* Hook.f. on *Swietenia macrophylla* King (E), *Dipodium pictum* (Lindl.) Rchb.f. on *Swietenia macrophylla* King (F), *Grammatophyllum scriptum* (L.) Blume on *Arthocarpus communis* J.R. Forst. & G. Forst. (G), *Grammatophyllum speciosum* Blume and *Dendrobium lineale* Rolfe on *Xanthostemon novaguineensis* Valeton (H)

This area shares common vegetation types as displayed in the Australian region in which the orchid species resemble the area (Jones 2006), such as *D. antennatum* that can be seen in the savannah woodlands (Kusumastuti et al. 2021). Other types of vegetation encountered during the fieldwork are swamp forests dominated by the Sago *Metroxylon* and the giant grass of the family Poaceae. Lowland rainforests are dominated by the genera of *Agathis*, *Intsia*, *Litsea*, *Pometia*, *Podocarpus*, *Xanthostemon*. Orchids such as *D. lasianthera*, *D. lineale*, *Dendrobium mirbelianum*, *D. violaceoflavens* can be found in this particular ecosystem. This condition is somewhat different from those found in the northern to eastern parts of CMNR bordering the Pacific Ocean. In the East to the North sites, there are enclaves of mangrove vegetation and coastal forests. This sites is dominated by *Rhizopora mucronata* and *Rhizophora apiculate* as species indicators in mangrove forests. Species like *D. schulleri* commonly grow in this type of vegetation. *Baringtonia asiatica*, *Hibiscus tiliaceus*, *Terminalia catappa* and *Cocos nucifera* enrich the coastal forests (Figure 10); and species of *P. pinnata* and *I. bijuga* inhabit the lowlands. Further inland, there is topography with the contours of hills and highland rainforests to high mountains. Topography is highly affected for the epiphytic orchid to thrive (Hartini and Aprilianti 2020).

The composition of species that comprises the profile of vegetation in lowland tropical rainforests in the village of Maribu Tua provides a different picture of the condition of secondary forests when viewed from the density of vegetation (Figure 11). The difference can be seen in the forest area that has been widely opened by the community for shifting cultivations. So when observations have selected the condition of vegetation that still describes the hue of natural vegetation in addition to the cultivation of plants that cover the forest area. Based on the area of observations in the field, the vegetation structure in the diagram profile consists of five layers of vegetation, namely: the dominant layer, which is often referred to as the top layer that stands vertically (emergent layers) with a plant height of more than 20 m, the canopy layer that forms the forest vegetation cover hood (Canopy layers) with a plant height range of 15-20 m, Medium layers or that arrange the composition of vegetation under the canopy layer (Under storey layers) with a plant height range of 7-15 m, a perdu layer consisting of woody plants with heights

ranging from 1-7 m, and forest floor layers consisting of grasses and herbs with heights below 1 meter. The species that make up the composition of vegetation and structure consist of eight species, namely: (i) *Arthocarpus communis*, (ii) *P. pinnata*, (iii) *Timonius* sp., (iv) *A. falcataria*, (v) *P. blumei*, (vi) *Ficus benjamina*, (vii) *Dicksonia* sp., (viii) *Sida acuta*, herbaceous plant, *Physalis* sp, *Ixora* sp., grasses classified as Gramineae or Poaceae.

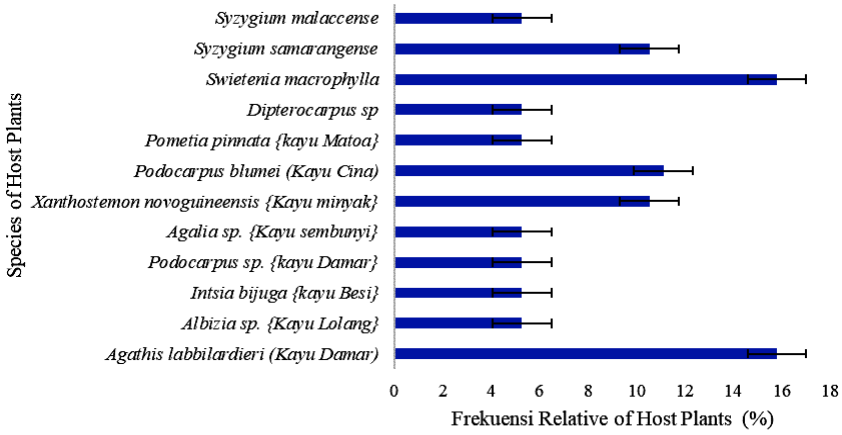

Figure 5. Frequency relative of host plants

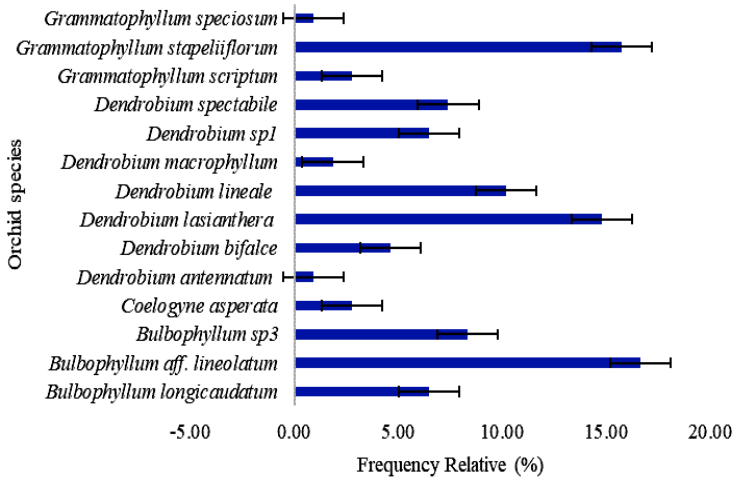

Figure 6. Frequency relative of orchid (%)

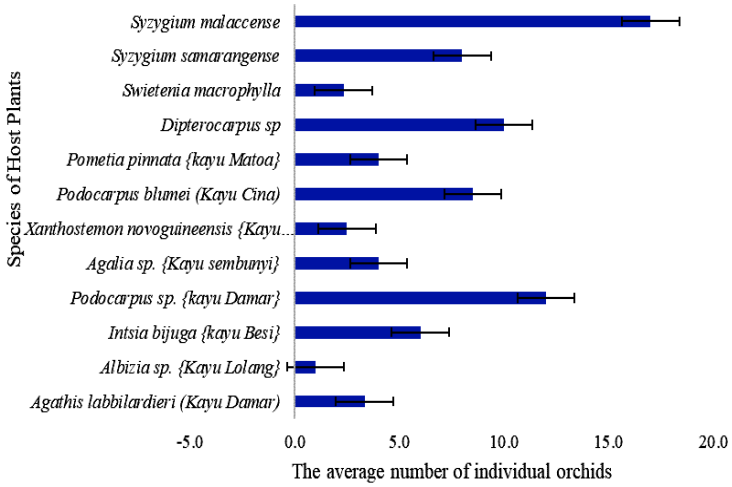

Figure 7. The average number of individual orchids per host plants

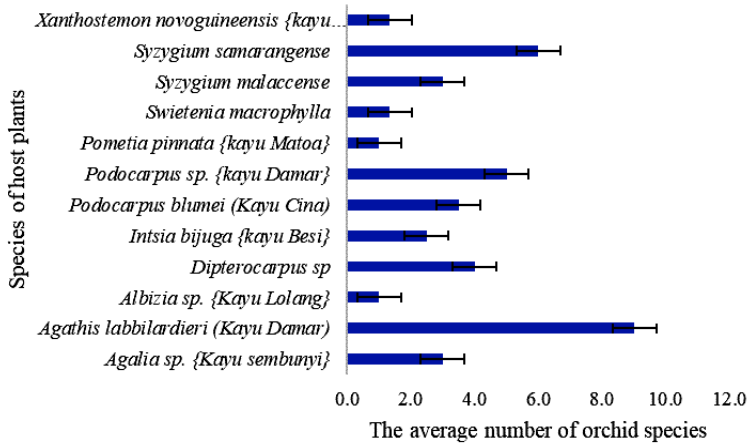

Figure 8. The average number of orchid species per host plants

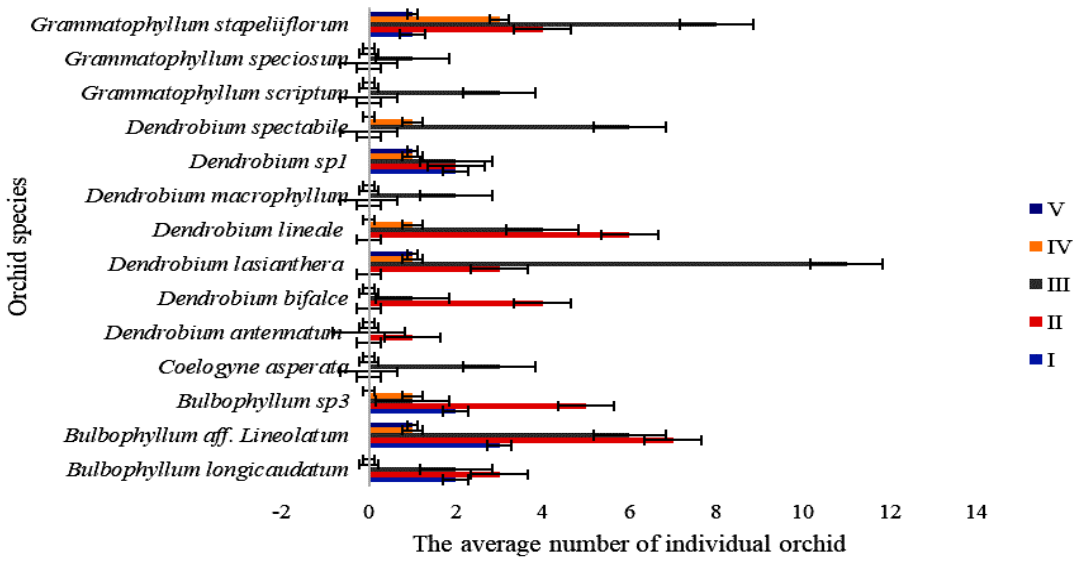

Figure 9. Distribution of orchid species based on zones at the host plants (stem for zone I and II, tree canopy for zone III, IV and V)

The composition of species that shape the vegetation profile in the tropical mountains rainforest at elevation of 1000 m above sea level in the village of Angkasa provides an overview of the type of needle leaf forest often found in high mountainous areas in Papua. Similar types of mountain vegetation also become the habitat of orchids studied in protected forest areas in East Java (Yulia and Budiharta 2011a). However, it is not a primary forest because there are shifting plantations around the forest. It is also a hiking path of recreation area (Yulia and Budiharta 2011b). This forest has undergone succession and has become a secondary forest. Species that comprise the composition and structure of vegetation are still overgrown by natural plants. In this type of forest can be made four layers, namely: (i) Dominant layer or emergent with a plant height of more than 20 m, (ii) Canopy/co-dominant layer with a plant height range of 10-20 m, (iii) Medium layer or understorey with a plant height range of 1-10 m, and (iv) Forest floor covering layer that grows less than 1 meter. The four species of trees observed and documented at each layer are: (i) *Araucaria kauki*, (ii) *Podocarpus blumei*, (iii) *Casuarina junghuhniana*, (iv) *Araucaria cunninghamii* and (v) herbs from the family Euphorbiaceae and the grasses of the Poaceae family (Figure 12).

In addition, there are also liana, mosses (*lichens*) and Arecaceae families, such as rattan from the species *Calamus* sp. An overview of vegetation structure in addition to using the CAD approach method, can also be done using terrestrial laser scanner (TSL) methods such as those applied in the study of mixed forest planting to increase the complexity of vegetation structures in oil palm plantation areas (Zemp et al. 2019). The results of the study

showed that the complexity of vegetation structure increased in oil palm plantation areas after three years of planting fruit, wood and sap producing crops. In addition, the TLS method is more effective in projecting the vegetation structure of the measuring plot covering an area of 40x40 m^2 when compared to a plot measuring 5x5 m^2.

Each habitat reveals the diversity and uniqueness of orchid species. Certain species can be seen only in specific habitats, such as *Dendrobium mirbelianum* and *Dendrobium schulleri* growing on the mangrove to the coastal line. similar circumstances also happened to *Dendrobium lineale*, *Dendrobium lasianthera*, and *Dendrobium violaceoflavens* that can be found in the lowland forest.

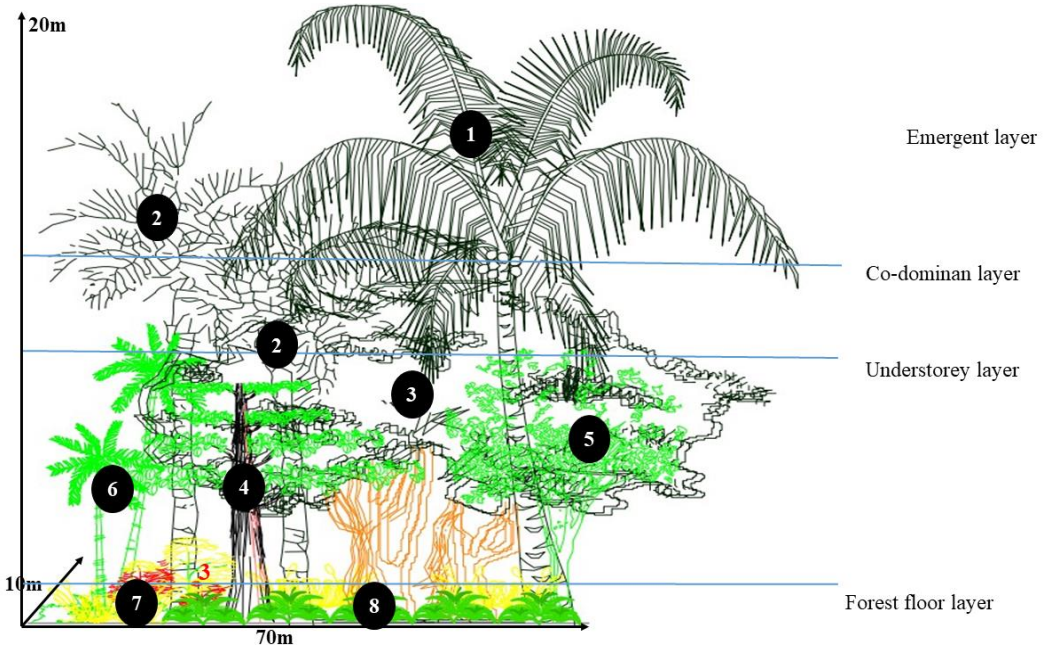

Figure 10. Profile diagram of vegetation in the Coastal line forest in Tablanusu

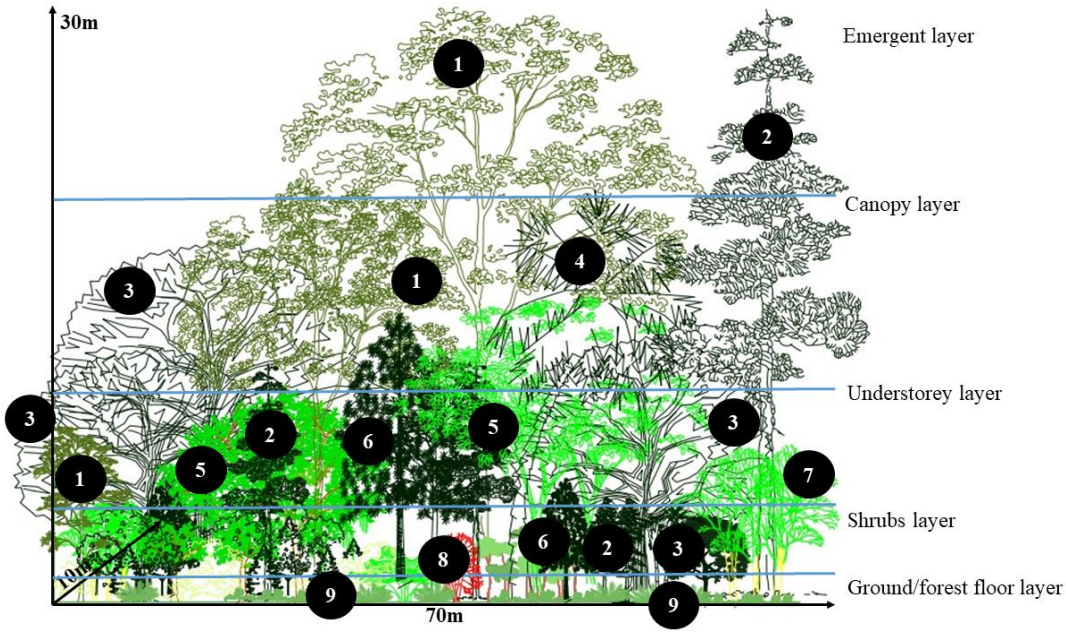

Figure 11. Profile diagram of vegetation in the tropical lowland forest in Maribu Tua

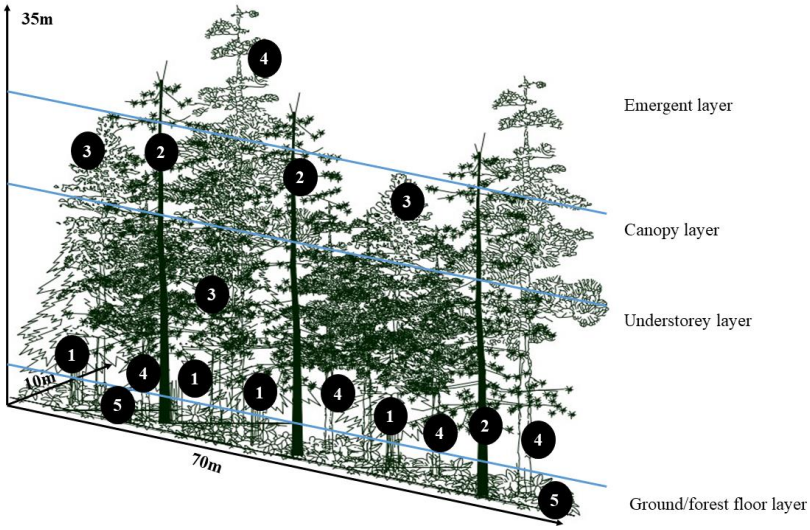

Figure 12. Profile diagram of vegetation in the mountain site in Angkasa

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