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Mapping the Unique Tree Species in Tambora National Park for The Development of Eco-Tourism-Based Science Modules

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Abstract — The objective of this research is to map the unique tree species composing the vegetation in the tropical, sub-mountain, and mountain zones of Tambora National Park. This study is essential for the development of teaching materials, specifically eco-tourism-based science modules, which have been implemented in Tambora National Park. Data collection was carried out on four hiking trails: Kawinda Toi, Doro Ncanga, Piong (Kore), and Pancasila. The data collection techniques used namely plot transects and exploration methods. The results showed that in the tropical zone (1-1000 m asl), the dominant tree species were pato (Buchacania sessifolia) with an Importance Value Index (IVI) of 41.86%, monggo putih (Syzigium sp.) with an IVI of 34.00%, and monggo merah (Syzigium polyanthum) with an IVI of 33.80%. In the sub-mountain zone (1000-2000 m asl), the dominant species were cemara gunung (Casuarina junghuhniana) with an IVI of 44.50%, sarume ara (Acronychia trifoliata) with an IVI of 40.23%, sarou (Engelhardtia spicata) with an IVI of 40.19%, and kosok (Myrsine avenis) with an IVI of 38.75%. In the mountain zone (above 2000 m asl), the dominant species was cemara gunung (Casuarina junghuhniana) with an IVI of 300%. Endemic species identified included Elaeocarpus batudulangii (endemic to Nusa Tenggara) and Parachidendron pruinosum var. sumbawaense (endemic to Sumbawa Island). The populations and distribution of these endemic species are very limited. Other noteworthy species include klanggo (Duabanga moluccana), sori hitam (Syzigium acuminatissimum), and sori putih (Syzigium racemosum). The output of this research is a science module in the form of a Field Guide and booklet based on eco-tourism interpreting the unique forest trees for teaching ecosystem materials in secondary schools and as a guide for tourists, as well as providing information for the management of Tambora National Park in West Nusa Tenggara.

Keywords: Unique Tree Species; Science Module; Tambora National Park.

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1. Introduction

Tambora National Park is one of two national parks in West Nusa Tenggara, offering mountain landscapes as a nature tourism destination. The area's terrain is primarily mountainous with dense vegetation cover, moderate to steep slopes, and historical remnants from the 1815 eruption, making it an attractive location for nature tourism activities such as caldera observation, jungle trekking, water tourism, and special interest tourism. One of the facilities supporting these activities is the presence of trails for wildlife and plant observation [2].

Jungle trekking, which involves hiking to the caldera of Tambora National Park, is supported by dense vegetation and a cool, comfortable trail environment. This activity can be done on four hiking trails: Piong (Kore), Kawinda Toi, Doro Ncanga, and Pancasila, each offering unique features, advantages, and challenges that meet the needs for recreation and nature tourism. Along the way, visitors can enjoy the beauty of the dense and unique forest formations.

Besides nature tourism, Tambora National Park can also be developed as a center for scientific tourism, such as plant species interpretation through special interest eco-tourism activities [7]. This development is feasible because, in addition to its supporting natural conditions, Tambora National Park has a high diversity of plant species [5,7,10]. Scientific tourism activities in the form of eco-tourism can be carried out through research and development of plant species recognition, development of natural laboratories, demonstration plots, or botanical gardens, among others.

To support the interest in such tourism, data revealing the unique vegetation of Tambora National Park is needed. The vegetation data from this research is essential for creating science modules in the form of field guides for tourists engaging in jungle trekking and eco-tourism-based scientific booklets for teaching ecosystem materials in middle schools, focusing on the unique plant formations along the hiking trails in Tambora National Park.

2. Methodology

This research was conducted over three months on four hiking trails: Kawinda Toi, Doro Canga, Piyong, and Pancasila in Tambora National Park. Materials and equipment used included basic maps in the form of Landsat images, GPS, binoculars, digital cameras, sacks, plastic bags, measuring tapes, machetes, pencils, field notebooks, hanging labels, and alcohol.

Data collection was based on elevation at each trail: tropical zone (1-1000 m asl), sub-mountain zone (1000-2000 m asl), and mountain zone (above 2000 m asl). A 20 m x 20 m quadrat was placed using purposive random sampling. The length of each hiking trail varied, resulting in 40 plots in the tropical zone, 30 plots in the sub-mountain zone, and 20 plots in the mountain zone. Tree data collection involved measuring the diameter at breast height (dbh) within each plot. Data collection was conducted concurrently with taxonomic data collection using the exploration method outside the plots, following [6].

Tree species identification referred to the literature by [1,5, 11, 12,13]. Scientific names were identified in the field and the laboratory. Unidentified plant species were sent to Herbarium Bogoriense for species name determination. Herbarium specimens were measured for morphological structure and described.

Measurements of relative density, relative dominance, relative frequency, and importance value index (IVI) for each tree species were conducted after field data collection. Absolute and relative density values for each species were determined using the formula:

$$\text{Absolute density (AB)} = \frac{\text{Number of individual trees per species}}{\text{Total plot area}}$$

$$\text{Relative density (RDe)} = \frac{\text{Absolute density of a species}}{\text{Total density of all species}} \times 100\%$$

The measurement of absolute frequency values and relative frequencies of each type is carried out with the formula:

$$\text{Absolute frequency (AF)} = \frac{\text{The number of plots occupied species}}{\text{Total number of plots}}$$

$$\text{Relative frequency (RFr)} = \frac{\text{Absolute frequency of a species}}{\text{Total frequencies of all species}} \times 100\%$$

The measurement of the absolute dominance value and relative dominance of each type is carried out by the following formula:

$$\text{Absolute dominance (ADo)} = \frac{\text{Area of the basic field of the species}}{\text{Total plot area}}$$

$$\text{Relative dominance (RDo)} = \frac{\text{Absolute dominance of a species}}{\text{Total dominance of all species}} \times 100\%$$

The Importance Value Index (IVI) for each species was calculated by summing the relative density, relative frequency, and relative dominance: IVI = RDe + RFr + RDo

The information obtained from this research is expected to be used to develop science modules on ecosystems for secondary school education. Thus, these science modules can serve as supplementary learning materials in schools, contributing to increased knowledge and attitudes of students regarding the unique vegetation in Tambora National Park. The module development method follows the 4D model by [9], including Define, Design, Develop, and Disseminate. The output of this research is an eco-tourism-based science module on unique tree species in Tambora National Park, serving as an independent learning resource for middle school students and a reference for eco-tourism development in West Nusa Tenggara.

3. Results and Discussion

3.1. Tropical Zone (1-1000 m asl

In the lowland forest of Tambora National Park at elevations of 1-1000 m asl, 34 species were recorded, dominated by pato (*Buchacania sessifolia*) with an IVI of 41.86%, monggo putih (*Syzigium* sp.) with an IVI of 34.00%, monggo merah (*Syzigium polyanthum*) with an IVI of 33.80%, and *Duabanga moluccana* with an IVI of 21.10% (Table 1).

Table 1. IVI of trees found in the tropical zone (1-1000 m asl) in Tambora National Park.

Local Name	Scientific Name	AD (ind/ha)	RDe (%)	AF	RFr (%)	ADo (m^2/ha)	RDo (%)	IVI (%)
Sori hitam	*Syzigium acuminatissimum*	1	0.70	0.06	1.47	0.096	0.24	2.41
Sampi loka	*Alangium villosum*	1	0.70	0.06	1.47	0.043	0.11	2.28
Tula	*Alstonia spectabilis*	1	0.70	0.06	1.47	0.236	0.60	2.77
Rupee	*Bischofia javanica*	3	1.39	0.06	1.47	0.689	1.75	4.62
Pato	*Buchacania sessifolia*	43	21.61	0.33	8.82	4.490	11.42	41.86
Honca	*Casearia grewiaefolia*	1	0.70	0.06	1.47	0.108	0.28	2.44
Ntingi	*Crypteronia paniculata*	4	2.09	0.11	2.94	1.755	4.47	9.50
Maladi	*Dendrocnide stimulants*	1	0.70	0.06	1.47	0.073	0.18	2.35
Haju afi	*Diospyros maritima*	13	6.27	0.33	8.82	0.603	1.53	16.63
Safare rangga	*Drypetes* sp.	3	1.39	0.06	1.47	0.104	0.26	3.13
Klanggo	*Duabanga moluccana*	7	3.49	0.11	2.94	5.766	14.67	21.10
Subaha	*Elaeocarpus sphaericus*	18	9.06	0.17	4.41	2.204	5.61	19.08
Bangsal	*Engelhardtia spicata*	3	1.39	0.06	1.47	2.209	5.62	8.49
Karanga	*Eriglossum rubiginosum*	1	0.70	0.06	1.47	0.043	0.11	2.28
Ncambu wera	*Exocarpos latifolius*	2	1.00	0.11	2.94	0.071	0.18	4.12
Malata	*Ficus calophylla* var. *minor*	1	0.70	0.06	1.47	2.340	5.95	8.12
Naa	*Ficus fulva*	4	2.09	0.06	1.47	0.586	1.49	5.05
Safiri	*Mallotus philippensis*	7	3.49	0.17	4.41	0.639	1.62	9.52
Mbune	*Glochidion zeylanicum* var. *arborescens*	1	0.70	0.06	1.47	0.104	0.26	2.43
Rino	*Grewia eriocarpa*	6	2.79	0.11	2.94	1.839	4.68	10.41
Rafu	*Leea acuelata*	1	0.70	0.06	1.47	0.047	0.12	2.29
Sareo	*Macanga tanarius*	1	0.70	0.06	1.47	0.043	0.11	2.28
Menga	*Melia azedarach*	1	0.70	0.06	1.47	0.157	0.40	2.57
Konca /Ntimu	*Neonauclea excelsa*	3	1.39	0.11	2.94	0.150	0.38	4.72
Katowi	*Palaquium amboinense*	3	1.39	0.11	2.94	0.152	0.39	4.72
Loa	*Protium javanicum*	1	0.70	0.06	1.47	0.283	0.72	2.89
Katende mbote	*Rhus taitensis*	1	0.70	0.06	1.47	0.226	0.58	2.74
Sambi	*Schleichera oleosa*	4	2.09	0.11	2.94	1.029	2.62	7.65
Luhu	*Shoutenia ovata*	1	0.70	0.06	1.47	0.043	0.11	2.28
Monggo merah	*Syzigium polyanthum*	25	12.55	0.33	8.82	4.886	12.43	33.80
Sori putih	*Syzigium racemosum*	13	6.27	0.28	7.35	1.171	2.98	16.61
Monggo putih	*Syzigium* sp.	18	9.06	0.28	7.35	6.910	17.58	34.00
Mengi	*Toona sureni*	1	0.70	0.06	1.47	0.131	0.33	2.500
Rangga	*Ziziphus rotundifolia*	1	0.70	0.06	1.47	0.082	0.21	2.38

Legend: AB = Absolute density; RDe = Relative density; AF = Absolute frequency; RFr = Relative frequency; ADo = Absolute dominance; RDo = Relative dominance; IVI = Important Value Index.

Measurements showed that pato (*Buchanania sessilifolia*) found in Tambora can reach a height of 41 m with a trunk diameter of 60 cm. This finding is supported by [4], who reported that *Buchanania sessilifolia* can reach a height of 42 m and a trunk diameter of up to 82 cm.

Pato (*Buchanania sessilifolia*) is the most dominant tree due to its habitat. Observations showed that *Buchanania sessilifolia* grows in dryland forests near rivers in Tambora, especially along the Kawinda Toi hiking trail. This is supported by the ecological requirements for the optimal growth of *Buchanania sessilifolia* as described by [4].

[13].

Fig. 1. Pato (*Buchanania sessilifolia*): a. Trunk, b. Inflorescence, c. Branch.

Klanggo (*Duabanga moluccana*) is a large, non-buttressed tree with drooping branch tips. The flowers are in flat panicles at the end of the branches, and the anthers are curved. The fruit is a capsule that splits open when ripe. It thrives in dry soil. This species is known for its rapid growth, approximately twice as fast as *Shorea leprosula*. According to [8], *Duabanga moluccana* is highly potential for reforestation due to its growth speed.

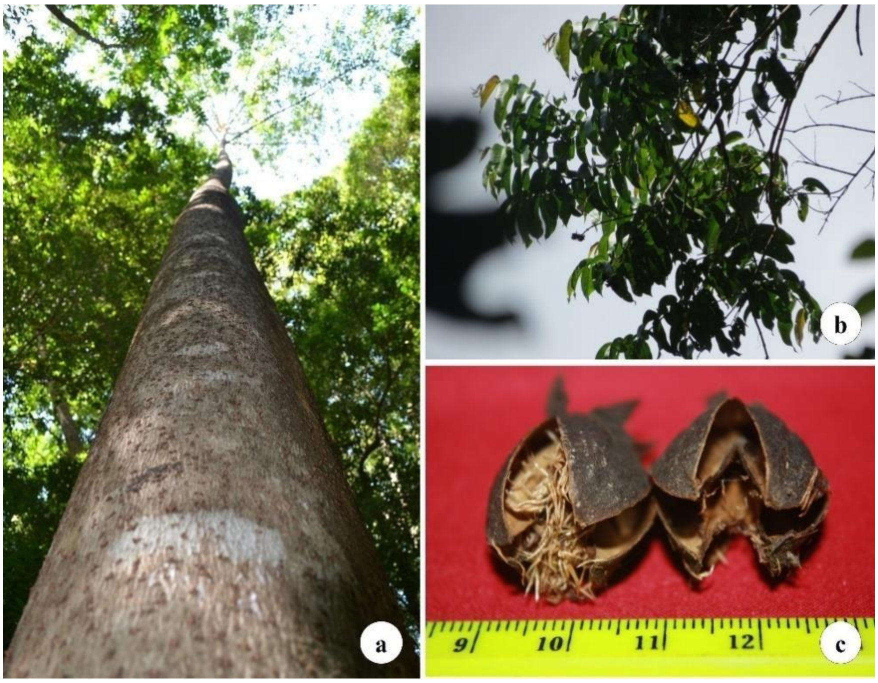

Fig. 2. Klanggo (*Duabanga moluccana*): a. Trunk, b. Drooping branches, c. Fruit with seeds.

Duabanga moluccana is a mascot tree of the West Nusa Tenggara region. This tree is very characteristic in the infraspecific category within Tambora National Park. There are two varieties of *Duabanga moluccana*: the white variety and the red variety. Further research is needed to confirm the taxonomic status and uniqueness of these two varieties. The population of this tree is very abundant and dominant in the southern part of Mount Tambora. However, the population of *Duabanga moluccana* in Tambora National Park is decreasing due to illegal logging. The distribution of *Duabanga moluccana* in the Lesser Sunda Islands includes Mount Tambora to West Sumbawa at an altitude of 160-1,200 meters above sea level, Maluku, Papua, Bali, and Lombok [13].

Fig. 3. Endemic Plant sarume ara 2 (*Elaeocarpus batudulangii*): a. Trunk, b. Branch, c. Seedling.

The Elaeocarpaceae found on Mount Tambora (Figure 3) has morphologically ovate leaves with serrated edges. The leaf stalk has nodes at both ends. The fruit is oval with a dirty blue surface. Based on identification, this Elaeocarpaceae is *Elaeocarpus batudulangii*. The distribution of *Elaeocarpus batudulangii* in Indonesia is very limited, and it is an endemic species of Nusa Tenggara [5] that needs protection, especially in the Mount Tambora area. In this region, this species is found growing in tropical rainforest habitats with very limited populations. The Mbojo tribe, native to Bima and Dompu districts on Sumbawa Island, knows this species as sarume ara 2. This endemic plant was discovered outside the research plot during explorations.

3.2 Sub-Mountain Zone (1000-2000 m asl)

In the sub-mountain zone at elevations of 1000-2000 m asl, the dominant species were cemara gunung (*Casuarina junghuhniana*) with an IVI of 44.50%, sarume ara (*Acronychia trifoliata*) with an IVI of 40.23%, sarou (*Engelhardtia spicata*) with an IVI of 40.19%, and kosok (*Myrsine avenis*) with an IVI of 38.75%. These species were consistently found along the Kawinda Toi hiking trails.

Table 2. IVI of trees found in the sub-mountain zone (1000-2000 m asl) in Tambora National Park.

Local Name	Scientific Name	AD (ind/ha)	RDe (%)	AF	RFr (%)	ADo (m^2/ha)	RDo (%)	IVI (%)
Sori hitam	*Syzigium acuminatissimum*	13	5.45	0.35	9.84	0.97	2.60	17.89
Sarume ara	*Acronychia trifoliata*	40	16.36	0.59	16.39	2.78	7.48	40.23
Paradendron	*Parachidendron pruinosum* var. *sumbawaense*	3	1.21	0.12	3.28	0.45	1.21	5.70
Rupee	*Bischofia javanica*	7	3.03	0.24	6.56	1.40	3.78	13.37
Cemara gunung	*Casuarina junghuhniana*	29	12.12	0.18	4.92	10.20	27.46	44.50
Saraa	*Celtis tetrandra*	3	1.21	0.06	1.64	0.33	0.89	3.74
Sarou	*Engelhardtia spicata*	28	11.52	0.41	11.48	6.39	17.20	40.19
Malata	*Ficus calophylla* var. *minor*	10	4.24	0.06	1.64	1.33	3.57	9.45
Mbune	*Glochidion zeylanicum* var. *arborescens*	29	12.12	0.29	8.20	4.16	11.20	31.52
Karau	*Litsea* sp.	10	4.24	0.12	3.28	0.59	1.59	9.11
Kabaho kafa	*Melastoma affine*	1	0.61	0.06	1.64	1.20	3.23	5.47
Bebokar	*Meliosma pinnata*	4	1.82	0.06	1.64	0.43	1.16	4.61
Kosok	*Myrsine avenis*	35	14.55	0.59	16.39	2.90	7.81	38.75
Konca/Ponte	*Nauclea* sp.	4	1.82	0.12	3.28	0.48	1.28	6.38
Sori putih	*Syzigium racemosum*	10	4.24	0.12	3.28	2.86	7.69	15.21
Monggo putih	*Syzigium* sp.	1	0.61	0.06	1.64	0.14	0.39	2.63
Papi	*Wenlandia densiflora*	12	4.85	0.18	4.92	0.55	1.48	11.24

Legend: AB = Absolute density; RDe = Relative density; AF = Absolute frequency; RFr = Relative frequency; ADo = Absolute dominance; RDo = Relative dominance; IVI = Important Value Index.

Cemara gunung (*Casuarina junghuhniana*) is a pioneer species that dominates areas affected by volcanic eruptions. It has adapted to grow in poor soil conditions due to its symbiotic relationship with actinomycetes, which aid in nitrogen fixation, and mycorrhizae that improve nutrient uptake [8].

Figure 4. Sarume ara (*Acronychia trifoliata*): a. Stem, b.Trifoliatus leaves, c. Seedling.

Field observations show that *Acronychia trifoliata* on Mount Tambora has an average trunk height of less than 22 m and a trunk diameter of less than 25 cm. This is different from the description by [8], which states that in the mountains of Java, this tree species can reach a height of 26 m and a trunk diameter of up to 30 cm. The leaves and flowers are similar to those found in the mountains of Java [8], with leaves consisting of three leaflets, each 7-15 cm long and 4-8 cm wide; the flowers are pure white; and the fruit is pale-colored. The presence of this species can indicate mixed forest in Tambora National Park, typically found at an altitude of 1,097-1,600 m asl.

Engelhardtia spicata found on Mount Tambora is a tree that can reach a height of 21 m and a trunk diameter of 1-1.2 m, with pinnate leaves up to 24 cm long. These characteristics match the description reported by [8], for *Engelhardtia spicata* in the mountains of Java, which are 15-30 m tall with a trunk diameter of up to 1.5 m and pinnate leaves 20-50 cm long. In the Mount Tambora area, *Engelhardtia spicata* is found in both seasonal and tropical rain forests at altitudes of 400-1,700 m asl. This plant often invades open areas and frequently forms pure stands on Mount Tambora.

Fig. 5. Sarou (*Engelhardtia spicata*): a. Trunk, b. Female flowers, c. Seedling.

Kosok (*Myrsine avenis*) is a member of the Myrsinaceae family. This family contains yellow or brown resin at its tips [3]. In the Mount Tambora area, *Myrsine avenis* is found in elfin and mossy forests on ridges and slopes. It typically grows at altitudes of 1,167-1,929 m asl. The presence of this tree in Tambora National Park can potentially serve as a bioindicator of altitude and humidity.place altitude and humidity.

Fig. 6. Kosok (Myrsine avenis): a. Trunk, b. Branch with fruit, c. Fruit

Field observations indicate that along the Kawinda Toi hiking trail in Tambora National Park, many trees from the Myrtaceae are found. Species of this family include *Syzygium acuminatissimum*, *Syzygium polyanthum*, *Syzygium racemosum*, and *Syzygium* sp. In several locations in the tropical zone (1-1000 m asl) and sub-mountain zone (1000-2000 m asl), these tree species are found in dense populations. In some places at these altitudes, members of the Myrtaceae form pure or mixed stands, often associated with each other. The large, straight trunks of Myrtaceae members can be a tourist attraction along the Kawinda Toi trail in Tambora National Park. These four Myrtaceae species are crucial in Tambora National Park as they are the main food sources for honey bees.

Fig. 6. Flowers of *Syzigium species:* a. *Syzigium acuminatissimum*, b. *Syzigium polyanthum*, c. *Syzigium* sp.

Parachidendron pruinosum var. *sumbawaense* is an endemic species of Sumbawa Island, belonging to the Mimosaceae. The population of this tree species is very small in Tambora National Park, making its conservation a priority.

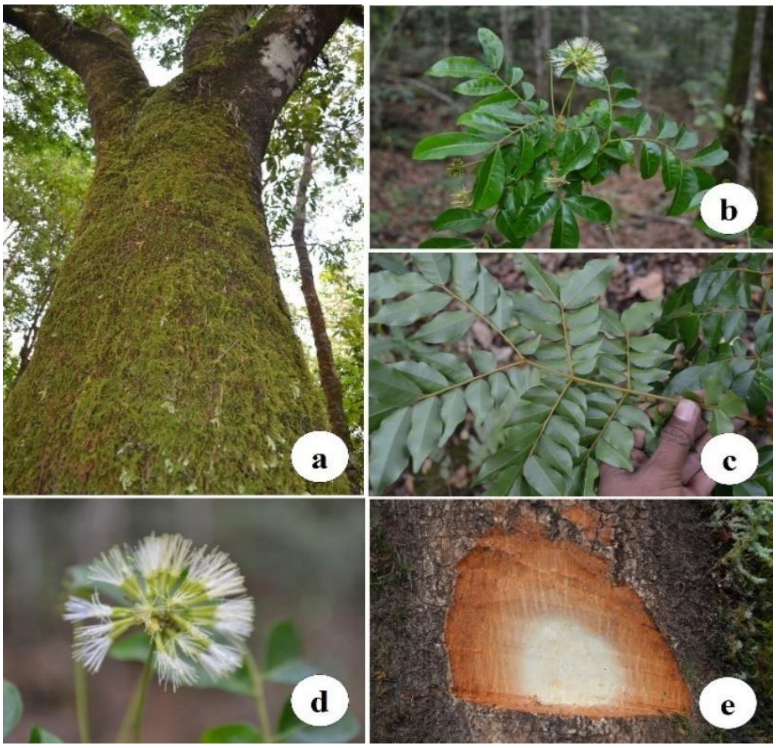

Figure 7. Endemic plant *Parachidendron pruinosum* var. *sumbawaense*: a. Trunk, b. Branch with flowers, c. Underside of compound leaves, d. Capitulum flower, e. Bark section.

3.3 Mountain Zone (above 2000 m asl)

In the mountain zone, which is above 2000 m asl, cemara gunung (*Casuarina junghuhniana*) was the dominant species with an IVI of 300%, indicating it is the primary species present in this elevation range. The adaptation of *Casuarina junghuhniana* to high altitudes and its role in soil stabilization and nitrogen fixation make it a critical species for this zone.

Table 3. IVI of trees found in the mountain zone (above 2000 m asl) in Tambora National Park.

Local Name	Scientific Name	AD (ind/ha)	RDe (%)	AF	RFr (%)	ADo (m^2/ha)	RDo (%)	IVI (%)
Cemara gunung	*Casuarina junghuhniana*	64	100.00	0.19	100.00	7.87	100.00	300.00

Legend: AB = Absolute density; RDe = Relative density; AF = Absolute frequency; RFr = Relative frequency; ADo = Absolute dominance; RDo = Relative dominance; IVI = Important Value Index.

Figure 8. Haju angi or cemara gunung (*Casuarina junghuhniana*) formation in Tambora National Park.

Haju angi or mountain pine (*Casuarina junghuhniana*) resembles pine or conifer trees. The fruit is round, similar to pine cones. *Casuarina junghuhniana* grows at altitudes of 1,450-2,400 m asl on Mount Tambora. This species often forms tight tree stands on mountain slopes, particularly in nutrient-rich basins between ridges. According to [8], *Casuarina junghuhniana* is a pioneer species.

The results of this study indicate a diverse and unique vegetation structure along the hiking trails in Tambora National Park, which can be utilized for developing eco-tourism activities and educational science modules. The presence of endemic species such as *Elaeocarpus batudulangii* and *Parachidendron pruinosum* var. *sumbawaense* highlights the conservation importance of this area. The development of eco-tourism-based science modules can provide an innovative approach to environmental education, enhancing student knowledge and promoting conservation awareness.

4. Conclusion

The mapping of unique tree species in Tambora National Park revealed significant diversity in the tropical, sub-mountain, and mountain zones. The findings emphasize the potential for eco-tourism development and educational module creation, leveraging the unique biodiversity of the park. The dominant species identified, along with the presence of endemic species, underscore the ecological value of Tambora National Park and its potential as a natural laboratory for scientific and educational purposes. This research provides outputs in the form of the development of ecotourism-based science modules on ecosystem materials in junior high schools and provides information contributions for the management of Mount Tambora National Park.

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References

[1] Backer, C.A. & Bakhuizen, R.C. V. B., 1968. Flora of Java (Spermatophytes only) Vol. I., II, III. The Netherlands.

[2] BKSDA NTB, 2013. Laporan Kajian Potensi Kawasan Gunung Tambora Sebagai Calon Taman Nasional. Kementerian Kehutanan.

[3] Dasuki, U. A. 1991. Bahan Kuliah Sistematik Tumbuhan Tinggi. Pusat Antar Universitas, Bidang Ilmu Hayati, Institut Teknologi Bandung.

[4] Hou, D. (1978). Florae Malesianae praecursores LVI. Anacardiaceae. Blumea: Biodiversity, Evolution and Biogeography of Plants, 24(1), 1-41.

[5] Monk, K.A., Fretes, Y. D., & Reksodiharjo-Lilley, G. 2000. Ekologi Nusa Tenggara dan Maluku. Prenhallindo. Jakarta.

[6] Partomihardjo, T. & Rahajoe, J.S. 2004. Pengumpulan Data Ekologi. Dalam Pedoman Pengumpulan Data Keanekaragaman Flora. Pusat Penelitian Biologi. LIPI, Bogor – Indonesia.

[7] Santika, Y., & Hidayat, A. (2017, May). Vascular plant diversity of Mount Tambora, Sumbawa Island: 200 years after devastated eruption and its potential. In Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia (Vol. 3, No. 2, pp. 194-198). DOI https://doi.org/10.13057/psnmbi/m030205

[8] Sastrapradja, S., Kartawinata, K., Soetisna, U., Roemantyo, Wiriadinata, H., & Soekardjo, S., 1979. Kayu Indonesia. Proyek Sumber Daya Ekonomi. Lembaga Biologi Nasional: LIPI, Bogor.

[9] Thiagarajan, S., Semmel, D. & Semmel, M. I. 1974. Intructional Development For Training Teachers Of Exceptional Children: A Sourcebook. Central for Innovation on Teaching the Handicaped, Minneapolis.

[10] Tim Terpadu. 2015. Laporan Penelitian Terpadu Dalam Rangka Penelitian Perubahan Fungsi Dalam Fungsi Pokok Kawasan Hutan Dari Kawasan Cagar Alam, Suaka Margasatwa, Dan Taman Buru Seluas ± 71.645,64 Hektar Menjadi Kawasan Taman Nasional Di Kabupaten Bima Dan Kabupaten Dompu Provinsi Nusa Tenggara Barat. Kementerian Lingkungan Hidup dan Kehutanan, Jakarta.

[11] Steenis, V. 2010. Flora Pegunungan Jawa. Pusat Penelitian LIPI, Bogor.

[12] Whitmore, T.C. 1983. Tree Flora of Malaya – A Manual for Foresters. Vol. II. Malaysia: Art Printing Works Sdn. Bhd.

[13] Whitmore, T.C., Tantra, I.G.M. & Sutisna, U. 1989. Tree Flora of Indonesia Chek List For Bali, Nusa Tenggara and Timor. Agency for Forestry Reseaarch and Development, Forest Research and Development Centre. Bogor. Indonesia.