Asian Journal of Conservation Biology, December 2020. Vol. 9 No. 2, pp. 214-220 AJCB: FP0138
ISSN 2278-7666 ©TCRP Foundation 2020

Inventory of woody plants in the forest area of mount Mutis Nature Preserve in East Nusa Tenggara, Indonesia

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(Received: September 16, 2020; Revised: November 18 , 2020; Accepted: November 24, 2020)

ABSTRACT

The Mount Mutis is a nature preserve in the East Nusa Tenggara which has determined as a conservation forest. The vegetation is unique with dominated by forest homogeneous ampupu *(Eucalyptus urophylla* S.T.Blake*)*. This uniqueness makes the Mount Mutis an essential water resource for the society around that area and thus, the preserve area needs to have to be kept under the ecosystem conservation of the Mount Mutis. However, some human-induced activities such as grazing, land clearing, and conflagration can destroy all the existence of the ecosystem and cause disappear the present and not yet identified species. Therefore, it is required to make an inventory study in order to have knowledge of the woody plant species in the forest area of Mount Mutis. In the study, 56 species from 32 families were identified and the Myrtaceae and Rutaceae have the highest number of species among these families. These species are consist of 89% tree habitus, shrub 9%, and underscrub 2%. *E. urophylla* S.T. Blake and *Pittosporum timorense BI*. are native species of Timor and both are the dominant species. *E. urophylla* is known for its very high timber production, nesting sites for honeybees and cuscus, and a host of fungi.*P. timorense BI*. isused as firewood and its leaves are eaten by livestock.The other species as used the colour of *tenun ikat*, as a medical plant, and food ingredients. Sandalwood (*Santalum album* L.) as an endemic speciesis rarely found.

Key words: Ampupu (*Eucalyptus urophylla* S.T.Blake), Inventory, Mount Mutis, Nature Preserve, Woody Plants

INTRODUCTION

Indonesia is a country that has a lot of islands more than 17000 islands and they are located between two biogeography areas namely Oriental and Australia. This geographic location causes Indonesia to have high diversity compared to Brazil and Colombia. This is also supported by Indonesia's forest area of around 120.6 million ha or about 63 percent of Indonesia's land area (Ministry of Environment and Forestry, 2018).

Forests contain a lot of flora and fauna, therefore they must be preserved. According to Indonesia Constitution Number 41, 1999, there are three functions of forest; protected forest, production forest, and conservation forest. From three types of forest above, the conversation forest is more protected and can't be exploitation and keep through it originally. One kind of the conservation forest is nature preserve.

The nature preserve is an area which had determined in ordera species, habitat, ecosystem, geology condition and the ecological process always protected without intervene by human. The main purpose from this nature preserve is scientific study and guiding environment (Ministry of Environment and Forestry, 2018). One of the nature preserve in east Nusa Tenggara is Mutis mountain has determined as a conservation forest to protect all the ecosystem inside for the development all the original species

According to the data of Natural Resources Conservation Center in east Nusa Tenggara (2018) in generally, types of ecosystem mountainous forest nature preserve of Mutis mountain is a kind of homogeneous forest of *ampupu* (*Eucalyptus urophylla* S.T.Blake) grown originally in bigger space of land. And then, there are some kinds of tree as *Eucalyptus alba* Reinw. Ex Blume*, Olea paniculata* R.Br.*, Decaspermum glaucesceus, Pittosporum timorense BI., Vaccinium varingiaefolium* Miq.*, Vitex negundo* L.*, Homalanthus populneus (Geiseler) Pax., Eugenia littorale (BI.)* Meijer Drees, *Toddalia asiatica* (L.) *Lam., Harrisonia perforata* (*Blanco*) *Merr., Dacrycarpus imbricatus* Blume de Laub., *Maessa virgata* A. DC.and variety of pteridophyta and grasses. The unique vegetation with the topography condition and forest nature phenomenon of Mount Mutis nature preserve indicated that nature resource is bigger and benefit for the environment.

The bigger environment income given by Mutis mountain is water source for the electric power station; micro hydro power which serve all the people in *Nenas* village, useful for mineral water package (Mutis Qua) and by the government municipal water corporation connected by pipe until Soe city. As its name 'Mutis' it has meaning the source of water that function divided the water to serve all the people. By the local people (Timor tribe), Mutis mountain means as Mama (mother). It irrigates Timor island for the fertilizer of land and the habitat for the flora and fauna. It seems an attitude from a mother to her children (Anna, 2015).

The next observation of Anna (2015) result stated that people who lived around that area nature preserve of Mutis mountain as a forest that supports the life needed and their culture so the society interaction with it is bigger. A part of the area used as field of sharped. There are also that use the nature resource inside it

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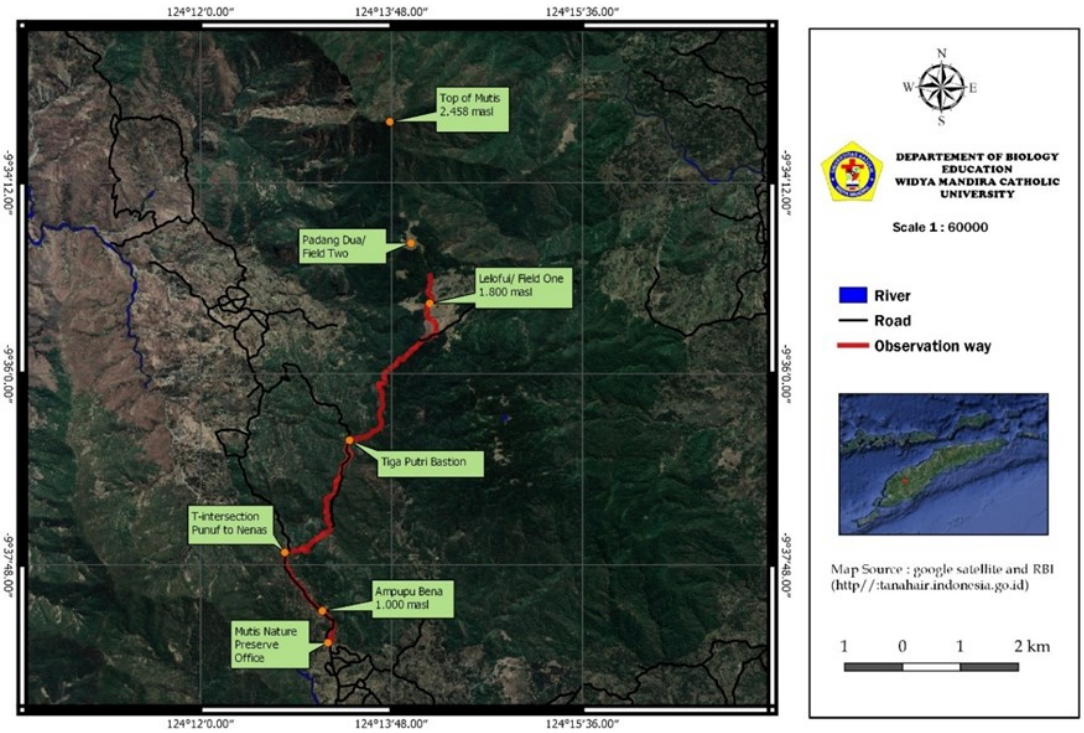

Figure 1. Study site in Mount Mutis nature preserve

for firewood and place for ritual. This case indicated that Mount Mutis is not a nature preserve, but opinion of the people think that Mount Mutis forest as Mama (mother), and they believe that Rock, soil, water, and tree are part of body for them, therefore the local people there save and used the Mount Mutis forest as well.

Although as in the others forest area, Mount Mutis has some problems. World Wide Fund (WWF) (2010) report stated that the first problem in this area is low of the regeneration from special species, one of them is ampupu (*Eucalyptus urophylla* S.T.Blake). There is also predicted the problem because of the wild animals freely enter to the forest area of Mutis mountain. According to Anna (2015), Natural Resources Conservation Center organizer was worry because the wild animals wild eat all the ampupu tree start growing. WWF (2010) stated that free animals with big population can caused the land becomes hard so make difficult for the seed to grow. Ecosystem will damage because the wild animals like wild horses will caused erosion and sedimentation, and dry of the land. The original seed has been grown appear on the land will demage by the wild horse first for feed before it grows up. If this condition let it be continue so it will bring a serious impact for the ecosystem conservation in the forest area.

The others serious The others serious impact cause the low generation ampupuis forest conflagration.The forest conflagration can happen because the natural factor like dry season and thunderbolt and people activities. The area of nature preserve of Mutis mountain sometimes has the conflagration with one of the local people start to planting corn by using fire to burn the garden under the mountain. Some opinions state that fires can destroy all plant species with a high severity, especially in the crown fire type (Bond & Keane, 2017). Dako *et al*. (2019) said that the conflagration in Mount Mutis as a often phenomenon that happens between August to October. Although Kaho and Marimpan (2014) reports, that observated the conflagration show the classification based on Wells *et al*. (1998), the worst conflagration level in nature preserve of Mutis mountain is low fire severity is < 2%. But the dominated conflagration by the type of free fire continually, so will make the moderate fire severity until come to the high fire severity which make bigger damaged for all the ecosystems and eliminate all the species plant which until now has not been identified.

The study about to find all the species plant in Mutis mountain is still limited. Data from the Natural Resources Conservation Center only revealed 19 species of flora out of grasses and pteridophyta. Because of that, it needs inventory to know all the species of woody plant as a source to take a decision in organizing, restoration, and the income function of Mount Mutis nature preserve.

MATERIALS AND METHODS

The inventory was carried out in March 2020 in the nature preserve of Mutis mountain, south of central Timor regency, east Nusa Tenggara Province. The nature preserve is located at 124º10 - 124º20 east longitude and 9º30 - 9º40 south latitude and also has an area around 1231561 ha. The method used is the exploration conducted along the lower mountain forest. The observation starts from an altitude of 1000 m.a.s.l to 1800 m.a.s.l which includes four stations, *Ampupu Bena – Punuf Nenas* T-junction – *Benteng Tiga Putri - Lelofui/Padang Satu* (Figure 1). All woody plant species found along the way were inventoried by recording local names and taking pictures. Unidentified plant species sampled for further identification. The data obtained were analyzed descriptively.

RESULTS AND DISCUSSION

56 species of woody plants were found in the forest area of the nature preserve of Mutis mountain. These species are belonged to 32 families (Table 1).

Table 1. List of woody plant species in the nature preserve of Mutis mountain

Sl No.	Local Name	Scientific Name	Family	Habitus
1	Ampupu	*Eucalyptus urophylla* S.T. Blake	Myrtaceae	Tree
2	Uanini	*Eugenia microcyma* K. & V.	Myrtaceae	Tree
3	Oben	*Eugenia littorale* (BI.)Meijer Drees	Myrtaceae	Tree
4	Hu'e	*Eucalyptus alba* Reinw. Ex Blume	Myrtaceae	Tree
5	Kujawas	*Psidium guajava* L.	Myrtaceae	Treelet
6	Manukmolo	*Syzygium rostratum* (Bl.) D.C	Myrtaceae	Tree
7	Lelonaes	*Citrus sinensis* L.	Rutaceae	Tree
8	A'pipsa'u	*Harrisonia perforate* (Blanco) Merr.	Rutaceae	Underscrub
9	Kismolo	*Toddalia asiatica* (L.) Lam.	Rutaceae	Tree
10	Lelokase	*Citrus reticulata* Blanco	Rutaceae	Tree
11	No tenu	*Euodia macrophylla* BI.	Rutaceae	Tree
12	Sensenanoana	*Acronychia trifoliate* Zoll. Ex Mor	Rutaceae	Tree
13	Biufluke	*Mallotus Phillippinensis* Muell. Arg	Euphorbiaceae	Tree
14	Matoi	*Homalanthus populneus* (Geiseler) Pax	Euphorbiaceae	Tree
15	Baefkenu	*Macaranga tanarius* (L.) Müll.Arg.	Euphorbiaceae	Tree
16	Hau mael	*Bischofia javanica* Blume	Euphorbiaceae	Tree
17	Name mtasa	*Acalypha caturus* Blume	Euphorbiaceae	Tree
18	Niko	*Grewia koordersiana* Burret	Malvaceae	Tree
19	Nismetan	*Pterocymium tinetorium* (Blanco) Merr.	Malvaceae	Tree
20	Benafo	*Kleinhovia hospital* L.	Malvaceae	Tree
21	Liubako	*Podocarpus amara* Blume	Podocarpaceae	Tree
22	Tune	*Dacrycarpus imbricatus* Blume de Laub.	Podocarpaceae	Tree
23	Hau solalu	*Podocarpus neriifolius* D. Don	Podocarpaceae	Tree
24	Bijaema	*Litsae glutinosa* (Lour.) C.B.Rob.	Lauraceae	Tree
25	Hauaminat	*Cinnamomum burmanii* (Nees & T.Nees) Blume	Lauraceae	Tree
26	Kauli fuj	*Cyphomandra betacea* (Cav.) Sendtner	Solanaceae	Shrub
27	Kaubasu	*Solanum torvum* Sw.	Solanaceae	Shrub
28	Hau nitu	*Acer laurinum* Hassk.	Sapindaceae	Shrub
29	Maon nafu	*Dodonea viscosa* Jacq.	Sapindaceae	Tree
30	Nunu napa	*Ficus benjamina* L.	Moraceae	Tree
31	Hau molo	*Maclura cochinchinensis* (Lour.) Corner.	Moraceae	Tree
32	A'tastasi	*Vitex negundo L.*	Lamiaceae	Tree
33	Jaet muti	*Gmelina arborea* Roxb.	Lamiaceae	Tree
34	Hau laku	*Rapanea hasseltii* (Blume ex Scheff.) Mez	Primulaceae	Tree
35	Nismoko	*Maessa virgate* A. DC.	Primulaceae	Tree
36	A'kumfuj	*Alangium villosum* (BI.) Wang	Alangiaceae	Tree
37	Pulsima	*Ehretia acuminate* R. Br.	Boraginaceae	Tree
38	Ajaob	*Casuarina junghuhniana* Miq.	Casuarinaceae	Tree
39	Loam	*Trema orientalis* (L.) Blume	Cannabaceae	Tree
40	Katapfuj	*Terminalia copelandii* Elmer	Combretaceae	Tree
41	Natbona	*Pittosporum timorense BI.*	Pittosporaceae	Tree
42	A'kuna	*Vaccinium varingiaefolium* Miq.	Ericaceae	Tree
43	Angka'i	*Albizia chinensis* (Osbeck) Merr.	Fabaceae	Tree
44	Hau sisfafe	*Neolitsea cassiaefolia* (BI.) Merr	Lauraceae	Tree
45	Laesilo	*Scurrula obovata* (BI.) G. Don	Loranthaceae	Tree
46	Manmana	*Melastoma sylvatica* Blume	Melastomataceae	Shrub
47	Keolnasi	*Aphanamyxis polystachya* (Wall.) R.N. Parker	Meliaceae	Tree
48	Hau neknail	*Nyssa javanica* (Bl.) Wang.	Nyssaceae	Tree
49	Hau besi	*Olea paniculata* R.Br.	Oleaceae	Tree
50	Hau kauna	*Glochidion zeylanicum* (Gaertn.) A. Juss.	Phyllanthaceae	Tree
51	Bokhail	*Drypetes microphylla* Pax. & Hoffm	Putranjivaceae	Tree
52	A'masi	*Photinia notoniana* Wall.	Rosaceae	Tree
53	Akleo	*Symplocos cochinchinensis* (Lour.) S. Moore	Symplocaceae	Tree
54	Hau meni	*Santalum album L.*	Santalaceae	Tree
55	Kusmelo	*Wikstroemia androsaemifolia* Decaisne	Thymelaceae	Tree
56	Pangkase	*Lantana camara* L.	Verbenaceae	Shrub

Table 1 shows that the most species come from the Myrtaceae and Rutaceae, 6 species each. 5 species belong to the Euphorbiaceae family. Malvaceae and Podorcarpaceae each have 3 species. The Lauraceae, Solanaceae, Sapindaceae, Moraceae, Lamiaceae and Primulaceae families each have 2 species. The other 21 families have 1 species each. The woody plants found consisted of trees, shrubs and underscrub (Figure 2).

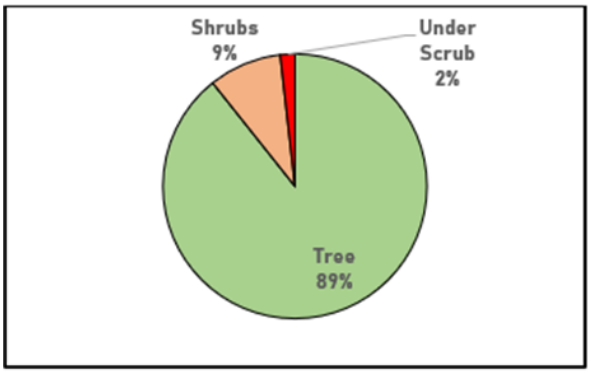

Figure 2. Habitus presentance of woody plants

Figure 2 indicated that the woody plant species in the nature preserve of Mutis mountain forest were dominated by 50 species of trees (89%, 5 species of shrubs (9%) and 1 species of underscrub (2%). The dominance of tree-lined vegetation in the nature preserve of Mutis mountain forest area is due to the suitability of tropical rain forest habitat where the structure of the basic components of the forest is a tree with an average height of 30 m. Nature preserve of Mutis mountain includes primary tropical rain forests with annual average rainfall reaching 2000 - 3000 mm each year compared to other areas in Timor Island so that they are the wettest areas with five dry and seven wet months (WWF, 2010). This condition is in accordance with the type that dominates thenature preserve of Mutis mountain forest area, namely *Eucalyptus urophylla* S.T.Blake, which has a height of 25 - 35m which forms the top layer of the canopy.

Eucalyptus urophylla S.T.Blake (Figure 3) is a species belonging to the Myrtaceae family. This species controls the entire forest from *Ampupu Bena* forest to *Padang Lelofui* so that *E. urophylla* (ampupu) is the denominator of *Lelofui* forest because it is located along an altitude of 1500 m.a.s.l to the top of G. Mutis, ± 2400 m.a.s.l. This is consistent with the report of Farida *et al*. (2005) that the upper canopy layer of the Mount Mutis forest is dominated by *E. urophylla.*

E. urophylla is an endemic species to Indonesia and is found in the island of east of Indonesia namely Timor, Lembata, Wetar, Alor, Adonara and Pantar (Fiqa & Oktavia, 2020). The existence of *E. Urophylla* in the Mount Mutis Nature Reserve has a major impact on the lives of the people around the area. Ecologically *E.urophylla* S.T. Blake is a nesting place for certain fauna such as cuscus (*Phalanger* sp). This is because the location of the *E. Urophylla* S.T. Blake trees which are quite close to one another with the canopy covering each other makes it easier for the cuscus to move from one tree to another (Farida *et al*., 2005). *E. urophylla* S.T. Blake is also a mother tree producing honey namely *Apis* (Anna, 2015). Honey from Mount Mutis is one of the sources of community income around the nature reserve. In addition to honey, people also use *E. urophylla* S.T. Blake as a producer of ampupu mushrooms. The fungus if young is used as vegetables and the old is used as fuel. Branches derived from *E. Urophylla* S.T.Blake trees are also used by the community as firewood to warm the body during the rainy season, cooking and to preserve corn so as not to be damaged (Anna, 2015).

Several studies have also successfully explored the benefits of Eucalyptus including being used for ornamentation, greening, latex, cosmetics (Saadaoui *et al*. 2017), essential oils used in the food, beverage, pharmaceutical and fragrance industries (Vecchio *et al*., 2016).

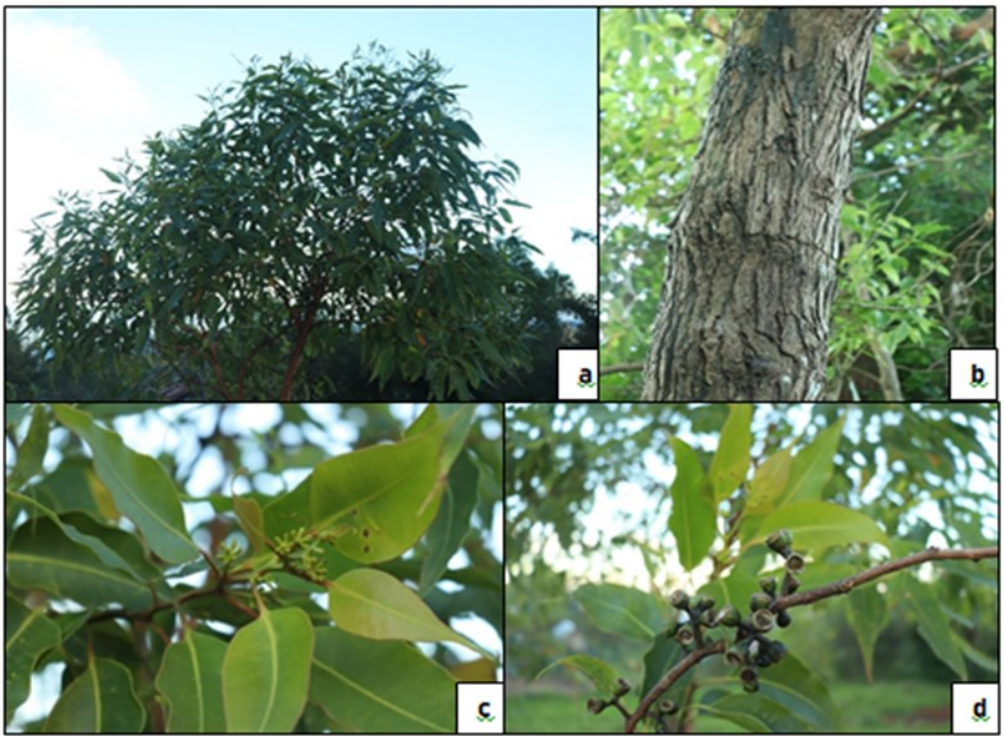

Figure 3. *E. urophylla* S.T. Blake, a. tree, b. stem, c. leafs& flowers, d. fruits

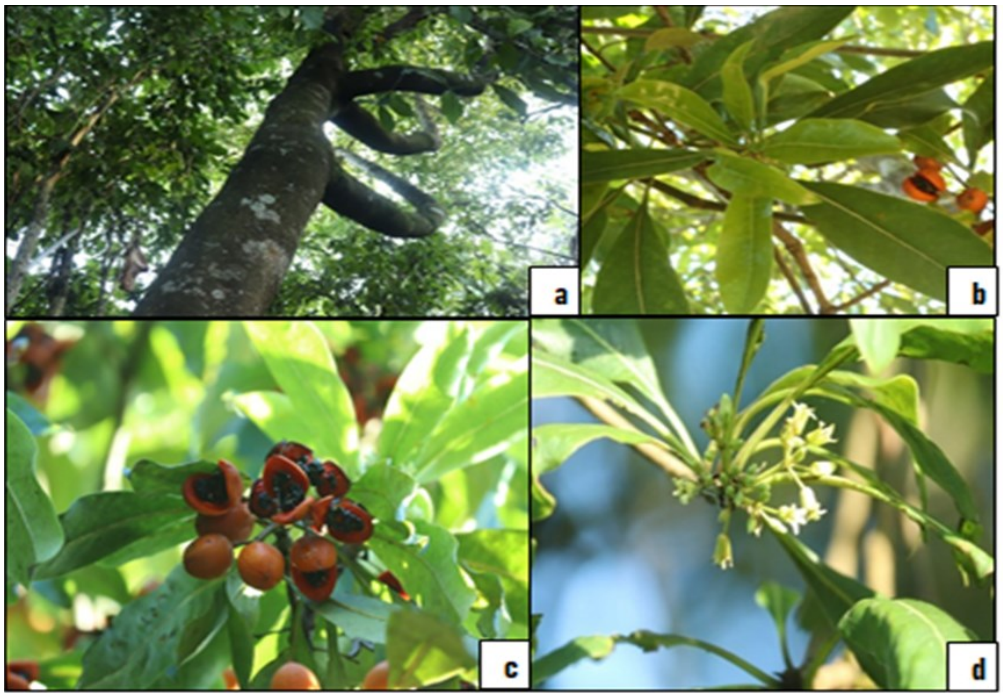

Figure 4. *Pittosporum timorense* BI., a. stem, b. leaves, c.fruits d. Flowers

E. urophylla is also used for the production of biochar (Viega *et al*., 2017), furniture (Filho *et al*., 2018), used in pulp and paper industry (Zanuncio *et al*., 2016), even has been managed intensively as the main species of plantation forest in several countries (Du *et al*., 2015; Viera and Rodríguez-Soalleiro, 2019; Van Bich *et al*., 2019;). This is of course because it has high economic value and can be harvested in short rotation (Ferreira *et al*., 2017).

Based on the several benefits of *E. urophylla* mentioned above, the Mutis mountain forest was designated as a nature reserve to protect its existence and sustainability. However, the regeneration of *E. urophylla* is very worrying. This is due to the presence of allelopathy of the parent tree on the growth of tillers. In addition, the presence of loose cattle in the forest area makes the soil on the forest floor solid and makes it difficult for seeds to grow (WWF, 2010). Compaction of forest soils can change the structure and texture of the soil so that there is a reduction in infiltration and increased surface runoff which results in the carrying of humus and nutrients so that the soil is infertile.

Another dominant species that is also found along the path of observation is *natbona* (*Pittosporum timorense* BI.) from the *Pittosporaceae* family. Have similarities with *P. moluccanum, P. microcalya* R & V and *P. monticolum* Miq. Setiyarini *et al*. (2020), and are species whose natural distribution is western Australia and Asia. This plant is a tree with a height of up to 20 meters and has branches and branches with varying leaves. The flowers have 5 parts, fruit is oval and the young fruit is green while the ripe one is orange (Figure 4). Fruit type is capsule. It has a strong smell and emits a lot of sticky lymph fluid (Setiyarini *et al*., 2020), so it is efficacious as a medicinal plant. Some reports regarding the benefits of natbona include the stems being used as a malaria medicine by the Malacca community (Taek *et al*., 2018), natural pesticides (Rohman *et al*., 2019).Nevertheless the use of *P. Timorense* BI. by the people around the Mutis mountain area is only limited to being used as firewood (Anna, 2015), while the leaves are used for animal feed.

From the 56 species, there are also *Eucalyptus alba* Reinw. Ex Blume, which are also native to Timor, Australia, Papua New Guinea, and have been planted throughout the tropics (Yoro *et al*., 2020).*E. alba* Reinw. Ex Blumeand *E. Urophylla* S.T.Blake can hybridize to form new species and have been widely used in reforestation in Congo. *E. alba*Reinw. Ex Blumeis able to adapt well to areas with dry climates in low conditions. Similar to *E. Urophylla* S.T.Blake, people can take honey bees from *E. alba* Reinw. Ex Blume. The taking process is carried out in a traditional manner which is regulated by a strong customary arrangement. In agriculture, *E. alba* has an important role because it is allelopathic in the growth of certain plant seedlings (Shiwani *et al*., 2015).Several papers have reported the chemical composition of essential oil leaves (Barka *et al*., 2017) and the leaves of *E. alba* show antibacterial activity against several pathogenic bacteria so that it has the potential for the food industry and pharmaceutical products (Yoro *et al*., 2020).

Other species are also used by the community of around the nature preserve of Mutis mountain areaas dye *tenun ikat* such as *matoi* stem (*Homalantus populneus* (Geiseler Pax). The black color comes from the *ajaob* tree stem (*Casuarina junghuhniana* Miq.) And also the red color. Weaving is a characteristic for Timorese where women are obliged to for weaving For those weaving is the identity of a woman (Anna, 2015).

The total of 23 species are living sites and as food for cuscus food such as *D. imbricatus* Blume de Laub., *P. neriifolius* D. Don, *S. abovata* (Bl.) G. Don, *N. cassiaefolia* (Bl.) Merr., *A. villosum* (BI.) Wang, *M. virgate* A. DC., *D. viscosa* Jacq., *A. laurinum* Hassk., *S. torvum* Sw., *C. betaceae* (Cav.) Sendtner, *L. glutinosa* (Lour.) C.B.Rob., *P.guajava* L., *S.rostratum* (Bl.) D.C., *C.sinensis* L., *C. reticulate*Blanco, *E. macrophylla* BI. (Farida *et al*., 2005). In addition, there are also many species of trees in the forest area whose trunks are widely used by local residents as building materials, namely *Dacrycarpus imbricatus* Blume De Laub. and *Gmelina arborea* Roxb. The leaves are used as fodder for

Figure 5. *Vaccinium varingiaefolium*Miq. a. tree, b.leafs& flowers

Eugenia microcyma K & V and *Ficus benjamina* L., the fruit can be eaten by humans like *C. sinensis* L., *C. reticulata* Blanco and *P. guajava* L., there are also certain types such as *M. phillippinensis* Muell. Arg, and *H. perforate* Blanco Mer. The leaves are used for medicinal wounds. And *F. benjamina* L. is used to place the placenta of a newborn baby.

Another type that is also found is *Vaccinium varingiaefolium* Miq. (Figure 5). The local name of this plant is' *a'kuna*. In observations found that a large number of trees that are estimated to have hundreds of years old in the area of ampupu bena forest that forms the *'bonsai forest'*. The shoots are red-purple and have hard stems and *buni* fruit.

Vaccinium varingiaefolium Miq. it is also an endemic plant for Indonesia (Sholikhah *et al*., 2017) and is found on the islandof Java naturally and only in high agricultural areas above 1,000 above the sea level (Soleha *et al*., 2020). Information about the benefits of this plant has not been widely published. However, several studies have shown that akuna stems have analgesic and anti-inflammatory effects. While the purplish red shoots have an antioxidant effectpotential as tumor suppressor (Soleha *et al*., 2020).

On the other hand one of the endemic species in the Mount Mutis nature preserve, sandalwood (*Santalum album* L.), is hardly found. It was observed that only a few trees were still small (Figure 6). Even though the island of Timor is one of its life habitats for *S. album* L.

Figure 6. *Santalum album* L.

Up to now there has been no trace of the population of *S. album* in the Mount Mutis nature preserve. According to information from AMAF, the surrounding community, Mr. Mateos Anin, stated that the population of sandalwood has decreased due to the East Nusa Tenggara Provincial Regulation No. 16 of 1986 concerning sandalwood, which generally regulates that ownership of sandalwood both in government and community land is a government monopoly or belongs to the government. this has caused public hatred for injustice so that the sandalwood that is growing is burned and uprooted. besides harvesting exceeds the productivity of fires, theft, and grazing livestock that kill all sandalwood growth.

CONCLUSION

Species of woody plants found in the forest of Mutis nature preserve were 56 species. Plant composition is dominated by trees with 50 species (89%) with the most dominant species being *ampupu* (*E. urophylla* S.T. Blake) and *natbona* (*P. Timorense* BI.). *Ampupu* is known for its very high timber production, a place where honey bees and cuscus nest, and is a place where fungi are attached. Whereas *P. Timorense* BI. is used as firewood and the leaves are eaten by cattle. Other types are used as tie weaving dyes, cuscus food/feed and some for medicines and food stuffs. Whereas sandalwood as an endemic type is rarely found.

ACKNOWLEDGEMENTS

Thanks to Ministry of Research and Technology of the Republic of Indonesia for funding this research, and also to all Management Managers of the Mount Mutis nature preserve area in South Central Timor Regency, east Nusa Tenggara Province and Permits and cooperation so that this research can be carried out as expected.

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