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Some Ecological Characteristics and Vegetation Structure in the Distribution Area of Panax Stipuleanatus in Hoang Lien Mountain Range

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Abstract:

Panax stipuleanatus, a precious genetic resource, is classified as Critically Endangered (CR) in the Vietnam Red Data Book 2007 and in group IIa of Decree 32-CP. It is a species of high economic value that is being severely reduced in many individuals and mangrove plant communities and needs to be studied and preserved. A number of biological and ecological characteristics and vegetation structures in the distribution area of this species have been studied and determined. Specifically, the ambient temperature ranges from 4.9-25.5°C; humidity about 70-92%, rainfall 26-780 mm and sunshine hours 92-230 hours, soil with pH value 3.97; Total K₂O 9.10(g/kg), Fe⁺² 27.24 (g/kg), total P 0.33%; Total N 0.28% and total organic carbon 4.97%. *Panax stipuleanatus* is discovered under the canopy of mixed vegetation of subtropical broadleaf trees from an altitude of 1.300-1.800m, with a slope of 12-16%, where the density of plant species is about 1.460 trees/ha, including species of importance index > 5%, such as *Castanopsis* sp., *Lindera caudata* Hookf., *Lithocarpus fordianus* (Hemsl.) Chun, *Schefflera pauciflora* R. Vig., *Schimallichii* (DC.) Korth and *Prunus arborea* Blume. These are considered important data on ecological biology and the specific distribution area of *Panax stipuleanatus*, which is the foundation for researching, developing, and proposing preservation solutions, exploiting, and promoting this rare genetic resource in Vietnam.

Keywords: *Panax stipuleanatus*, ecological characteristic, vegetation structure, Hoang Lien mountain

1. Introduction

Panax stipuleanatus, also known as the *Panax stipulealatus* Tsai & K.m. Feng, *Panax stipuleanatus*, *Panax bipinnatifidus* Seem, *Panax vietnamensis*, *Panax bipinnatifidus*, etc. is discovered in Sa Pa district (Ham Rong mountain -

Sa Pa town and Ta Phin commune) and Bat Xat district (Trung Leng Ho commune), Lao Cai province (Nguyen Quang Vinh et al., 2017). This is a herbaceous plant with a height of about 25-75cm and 1.5-3 cm in diameter. Its rhizomes are fat and horizontal, with many depressions left by stem marks. There are rarely any branches; Each cluster usually has 1 stem bearing leaves, rarely 2 or 3, except where the rhizome tip is damaged, after branching and growing the corresponding number of shoots. Stems grow straight and smooth with a diameter of 0.3-0.6cm. *Panax stipulealatus* Tsai & K.m. Fenghas palmately compound leaf, consisting of 1-3 ones ringed at the top with peduncle 5-10 cm long. Five-leaflet structure with short stalk, oblong or lanceolate, pointed at both ends, 5-13 x 2-4 cm; serrated margins, or shallow cleft in a few young trees, the serrated edge of the shallow lobe; usually hairy veins on the leaf surface.

Panax stipuleanatus is one of 11 types of ginseng (*Panax spp*) containing:

- Many chemical components such as oleanolic acid, reducing sugar, 16 amino acids (including phenylalanine, leucin, isoleucin, valine, proline, histidine, lysine, cysteine...),
- Inorganic substances such as Fe, Ca, and especially containing olean-frame triterpene saponins (Tran Cong Luan et al., 2009)

Panax stipuleanatus is used in traditional medicine for blood circulation, prevention and treatment of cardiovascular disease, reduction of cholesterol in the blood and hypoglycemia, stimulation of the immune system, inhibition of bacteria and viruses, anti-inflammatory, pain relief, regulation of hormones and endocrine, restoration of health, prevention and slowing down of the aging process, etc. (Nguyen Thi Thu Huong et al., 2009).

Panax stipuleanatus is a precious genetic resource belonging to the critically endangered group (CR) in the Vietnam Red Data Book 2007 and in group IIa of Decree 32-CP. This species is rare in nature. However, its high economic value causes the fact that it is often exploited, leading to a serious decrease in the number of individuals and mangrove plant communities. In addition, forest product exploitation and forest burning for agriculture are the reasons why this precious genetic resource almost no longer exists in natural forests. Therefore, it is necessary to find solutions to conserve and develop this precious genetic resource to contribute to the biodiversity of Vietnam and the world.

The above fact shows that studying the biological and ecological characteristics of *Panax stipuleanatus* distributed in Hoang Lien National Park. Lao Cai is an essential and necessary basis in the study of this precious genetic resource in Vietnam, gradually mastering and developing the source of pharmaceutical raw materials from *Panax stipuleanatus* in order to exploit its medical and economic value effectively. Moreover, the conservation of *Panax stipuleanatus* will also contribute to reducing forest burning for swidden cultivation, protecting and developing the ecosystem in Hoang Lien National Park, Lao Cai province, Vietnam.

2. Experimental Research and Methods

2.1. Research Location

This study was carried out at Ban Khoang commune in Hoang Lien National Park in the Hoang Lien mountain range with an altitude of 3.143m above sea level. The national park is located in Sa Pa district, Lao Cai province, with coordinates 22°15'00" N and 103°30'00" E, with an area of 29.845 ha. This is the place where the subtropical climate and the high-humidity high tropical regions meet all year round.

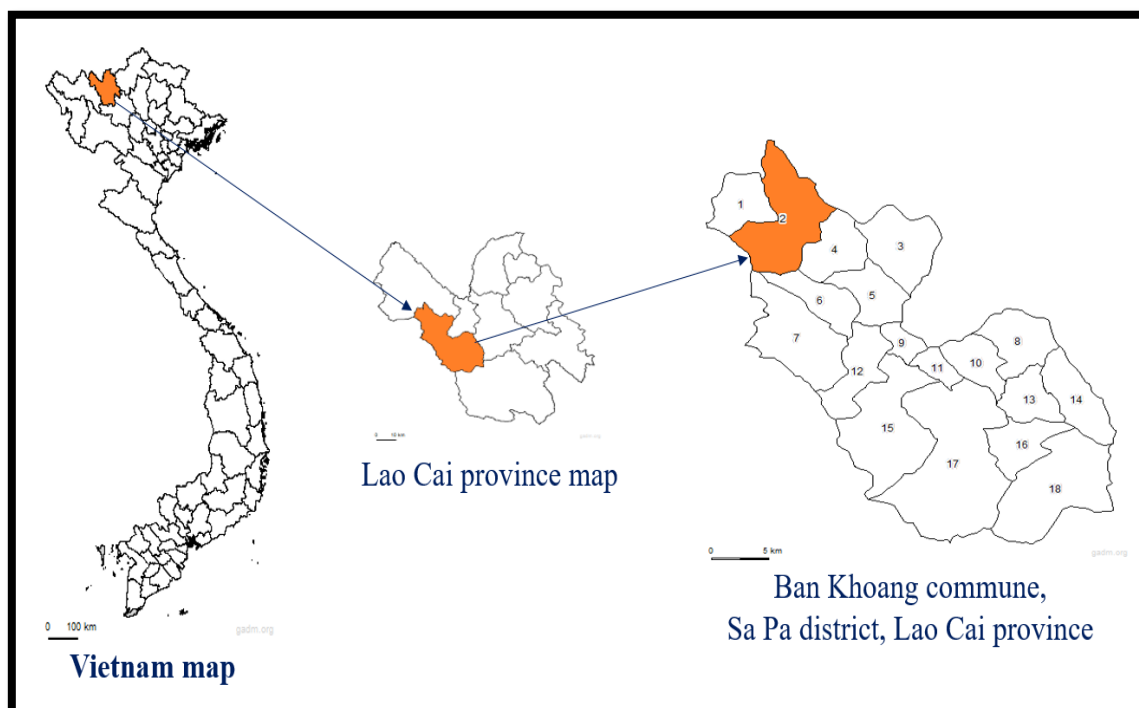


Figure 1: Study Area of *Panax stipuleanatus*

2.2. Study Respondent

The respondent of the study is *Panax stipuleanatus* (Figure 2).

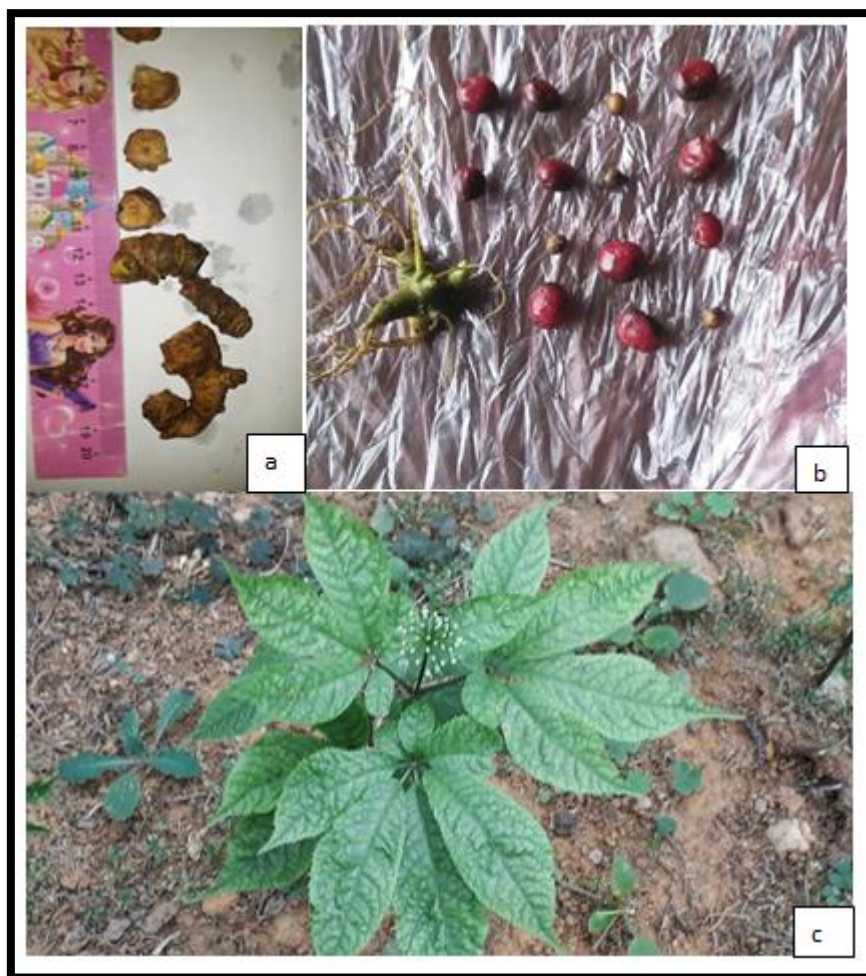


Figure 2: a. Tubers, b. Lower and Tuber, c. Tree Bearing Leaves and Flowers of *Panax Stipuleanatus*

2.3. Study Methods

2.3.1. Definition of Environmental Factors

Environmental factors such as temperature, humidity, rainfall, and sunshine hours from January to December 2019 of the study area are provided by Lao Cai Meteorological and Hydrometeorological Station.

2.3.2. Collection and Analysis of Soil Characteristics

About 30 soil samples were randomly collected in the mangrove plant communities of *Panax stipuleanatus* distributed in Hoang Lien National Park in Hoang Lien mountain range, Sa Pa district, Lao Cai province. The samples were taken in standard plots with dimensions 20m x 20m. Each standard plot contains 03 soil samples with a volume of 1,000 cm³/sample taken from the forest surface down to layer A. The samples in each plot are mixed together, packed in plastic bags, then transferred to the laboratory for sieving (2 mm) and drying (50°C) prior to analysis. Various parameters in the soil sample were determined, such as:

- pH,
- Ability to exchange cations (Ca⁺², Fe⁺², Mg⁺²),
- Total phosphorus,
- Total N (TN), and
- Total organic carbon (TOC)

The pH value was measured by conductivity in a 1:2 aqueous solution (Marrtin & Thormas, 2015), while the cation exchange capacity was determined spectrophotometrically (Delphine et al., 2008). Total organic carbon and total nitrogen in the soil samples were analyzed by infrared combustion (Pavlos et al., 2015). Total phosphorus in the soil was measured as described in Taylor's study (2000).

2.3.3. Analysis of the Structure and Composition of Vegetation

Vegetation was sampled along with sampling sites of *Panax stipuleanatus*. Sampling was performed by randomly setting up 30 standard plots sized 20m×20m on each site. Vegetation was determined for species richness, density, and diversity of all plots by standard methods (Whittaker, 1965; Sharma et al., 2009), where the abundance of species is the number of species per number of specific individuals, that is, the involved diversified species (Margalef, 1958). The tree stump area is calculated using the circumference at chest height (cbh) with the formula πr^2 , where r is the radius determined at the height of 1.3m. The stump area of a species is calculated by multiplying the density by the mean stump area, from which we can calculate the total area of trees of all species present in the standard plot. The relative dominance of a species is determined by the area of the tree stump. The sum of the relative frequency, relative abundance, and relative dominance values is the importance value index (IVI) (Sharma et al., 2009; Phillips, 1959).

2.3.4. Data Processing

The study results are presented as average \pm standard deviation (SD). Statistical analysis was performed using Microsoft Excel 2016 (Redmond, WA, USA, Microsoft Corp) and SPSS 22, in which the average value was calculated according to the following formulae:

$$\bar{a} = \frac{a_1 + a_2 + \dots + a_n}{n}$$

Here:

- \bar{a} is average
- a_1, a_2, \dots, a_n are the corresponding determined values for the first, second, etc. ..., n.
- n is the number of terms

3. Study Results

3.1. Weather and Climate Features of the Study Area

The variation of environmental factors such as temperature, humidity, rainfall, and sunshine hours in the study area from January to December 2019 at Ban Khoang commune, Sa Pa district, Lao Cai province, is described in figure 3. In general, different environmental factors varied during the study. Ambient temperature tends to increase from 4.9°C (January) to the highest 25.5°C (May), then gradually decrease to 5.1°C in December. Particularly, the temperature difference between day and night from January to June and December fluctuates between 7.8-11°C, while the distance between the lowest temperature and the highest temperature from July to November is 5.2-6.4°C. The air humidity in the study area is relatively high, fluctuating between 70-92%, which is favourable for the growth of plants, especially those living under the forest canopy. Notably, rainfall tends to increase from 36.7 mm (February) to 778.5 mm (August), then gradually decrease to 26.8 mm (November); January and December alone have rainfall of 251.2 mm and 50.6 mm, respectively. For the number of sunny hours in the year, there is a difference in the total number of sunshine hours between the months during the study period. The highest number of sunny hours is 230 hours in April, followed by February with 204 hours, then August (176 hours) and December (174 hours). March and September have similar hours of sunshine, respectively 162.3 and 166.4 hours; The remaining months have sunshine hours ranging from 92-125 hours. According to Ghazoul & Le Mong Chan (1994), the annual air temperature in Sapa area ranges from 1-29°C. Hoang Lien National Park is considered an area with a typical seasonal climate, such as "subtropical in summer" and "temperate in winter" (Kemp et al., 1995). According to Bennie et al. (2006), Marini Lorenzo (2007), and Khalid et al. (2016), environmental conditions play an essential role in the distribution and diversity of plants. Other studies have shown that changes in environmental factors influence changes in plant community composition (Heino, 2010; Mykrä et al., 2010; Vicyoero et al., 2018). This proves that the above climatic conditions reflect the typical ecological and biological characteristics of *Panax stipuleanatus* species distributed in Hoang Lien National Park, Sa Pa district, Lao Cai province, Vietnam.

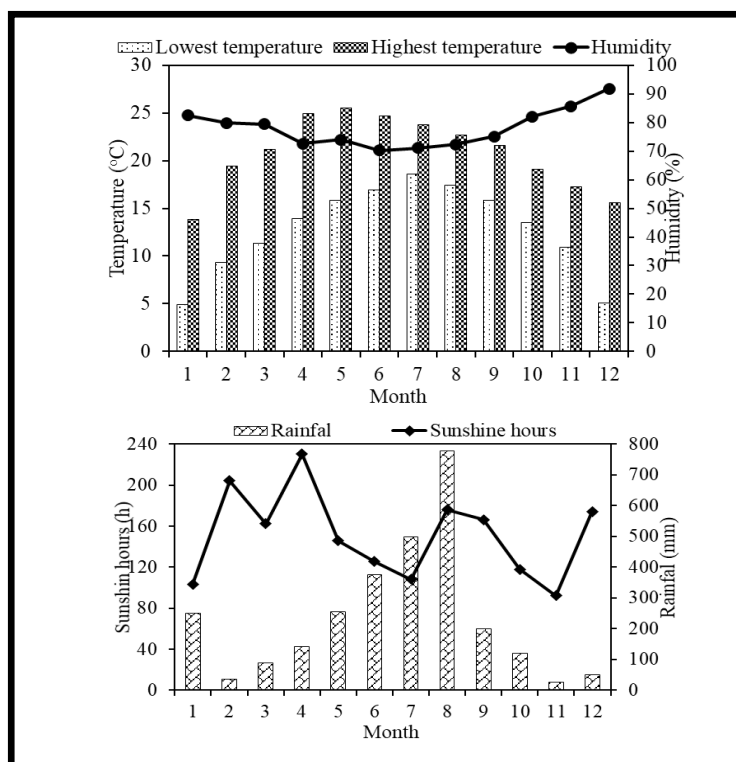


Figure 3: Features of Temperature, Humidity, Rainfall and Sunshine Hours of the Study Area

3.2. Soil Characteristics of the Study Area

Table 1 shows the results of the analysis of characteristics of soil samples collected in Hoang Lien National Park and Ban Khoang commune, Sa Pa district, Lao Cai province. The study results reveal that the total P, total N, and total organic carbon content were 0.33%, 0.28%, and 4.97%, respectively. The total K₂O composition in the soil sample was determined at 9.10 (g/kg), while the pH value calculated according to KCl of the studied soil sample was 3.97, which is similar to the study results of Nguyen Ngoc Kiem (2015), pH_{KCl} content of soil in Hoang Lien mountain area at different heights and depths ranged from 3.4 to 5.66. Previously, as per Podwojewski et al. (2011), pH_{KCl} content of soil samples collected at different heights of Mount Fan Si Pan ranged from 2.5 to 4.2. Fe²⁺ is considered to be the highest content of conferred cation detected in soil samples collected in the distribution area of *Panax stipuleanatus* with the content of 27.24 (g/kg); meanwhile, the content of Mg²⁺ and Ca²⁺ were 1.71 (Cmol+/kg) and 4.84 (Cmol+/kg) respectively. According to Myklestad (2004) and Marini Lorenzo et al. (2007), soil chemical and physical properties affect both richness of *Panax stipuleanatus* and plant uniformity. Earlier, Taiz & Zeiger (1991) showed that the availability of soil nutrients to plants is determined by the pH, which affects mangrove plant communities and the richness of *Panax stipuleanatus* (Laughlin & Abella, 2007). Changes in diversity and development of the species are influenced by soil nutrient content and the pH of the soil (Zhao et al., 2007; El-sheikh et al., 2010). In addition, soil nutrient composition can affect the structure of mangrove plant communities (Peña-Claros et al., 2012; Becknell and Power, 2014), and soil fertility is positively related to plant richness (Dybziński et al., 2008; Neri et al., 2012). This indicates that the characteristics of soil samples collected in the distribution areas of *Panax stipuleanatus* are the basis for reflecting the distribution, diversity, and special vegetation structure of this species in Hoang Lien National Park, Lao Cai province, Vietnam.

No.	Indicator	Unit	Content
1	Total K ₂ O	g/kg	9.10 ± 0.96
2	Total P	%P ₂ O ₅	0.33 ± 0.05
3	Total Nitrogen	%	0.28 ± 0.06
4	pH (KCl)	-	3.94 ± 0.08
5	Fe ²⁺	g/kg	27.24 ± 5.99
6	Mg ²⁺	Cmol+/kg	1.71 ± 0.29
7	Ca ²⁺	Cmol+/kg	4.84 ± 1.33
8	TOC	%	4.97 ± 0.98

Table 1: Content of Soil Components in the Study Area

3.3. Characteristics of Vegetation Structure and Flora (Ecological Dominance Storey)

The ecological dominance storey plays an important role in determining the growth and development of plants under the canopy (Thai Van Trung, 1978; Nguyen Nghia Thin, 2008; Tran Dinh Ly, 2019). According to Vo Van Chi (1997), *Panax stipuleanatus* is one of the plants that live under the natural forest canopy (forest vegetation), where there is high

humidity. Therefore, it is necessary to investigate and evaluate the ecological dominance storey where the natural presence of *Panax stipuleanatus* is recognized to determine the survival of the plants living under the canopy in general and *Panax stipuleanatus* in particular. Study results show that, in Hoang Lien mountain range, where the natural presence of *Panax stipuleanatus* is recognized, there are some characteristics of vegetation and flora (ecological dominance storey) as follows:

In general, *Panax stipuleanatus* mainly grows under the canopy of the subtropical mixed broad-leaved vegetation from an altitude of 1300-1800 m, with a slope of 12-16%, from 1/3 from the foot to the top, rarely or not it is at the crest of thunderstorms (where the moisture of the soil is relatively low).

The ecological dominance storey has some key features, such as:

- The density of plant species of about 1,460 trees/ha,
 - The average height of the tops (Hvn,m) is about 9.24 ± 3.72 m,
 - The average height under branches (Hdc,m) is about 5.86 ± 2.85 m,
- The average diameter at chest height (D1.3) is 14.55 ± 10.31 cm, including the following main species:
- Castanopsis sp*,
 - *Lindera caudata* Hook. f.,
 - *Lithocarpus fordianus* (Hemsl.) Chun,
 - *Schefflera pauciflora* R. Vig.,
 - *Schima wallichii* (DC.) Korth,
 - *Prunus arborea* Blum,
 - *Lindera nacusua* Merr.,
 - *Cinnadenia paniculata* L.,
 - *Aglaia sp*,
 - *Cinamomum tenuipilis* Kosterm.,
 - *Acer brevipes* Gagnep.,
 - *Machilus bonii* L.,
 - *Meliosma lepidota* Blume,
 - *Lithocarpus sp*,
 - *Elaeocarpus nitidus* Jack,
 - *Celastrus orbiculata* Thunb.
- In addition, there are some species of:
- Dung family (Symplocaceae),
 - rose family (Rosaceae),
 - Com family (Elaeocarpaceae),
 - De family (Fagaceae)

The role of each species is expressed through the importance index IVI%. The species with a value of $IVI > 5\%$ will appear in the species formation, specifically: *Castanopsis sp* (17.27%) + *Lindera caudata* Hook. f. (12.27%) + *Lithocarpus fordianus* (Hemsl.) Chun (10.08) + *Schefflera pauciflora* R. Vig. (5.51) + *Schima wallichii* (DC.) Korth (5.48) + *Prunus arborea* Blume (5.47) and other species (43.90%).

As per Elmqvist et al. (2003) and Dorren et al. (2004), vegetation structure and species diversity are essential components for the long-term survival of an ecosystem. In addition, information on the biodiversity of mangrove plant communities is essential in assessing the consequences of extensive habitat loss and degradation caused by human activities; at the same time as the basis for formulating and developing systematic strategies to conserve and manage them and forecast future forest composition (Christelle et al., 2019).

No.	Species Name	RD	RBA	RF	IVI%
1	<i>Castanopsis</i> sp	27.78	17.97	6.06	17.27
2	<i>Linderacaudata</i> Hook. f.	14.40	13.32	9.09	12.27
3	<i>Lithocarpusfordianus</i> (Hemsl.) Chun	8.00	10.12	12.12	10.08
4	<i>Schefflerapauciflora</i> R. Vig.	2.24	5.20	9.09	5.51
5	<i>Schimawallichii</i> (DC.) Korth	7.59	5.84	3.03	5.49
6	<i>Prunusarborea</i> Blume	6.89	6.51	3.03	5.48
7	<i>Linderanacusua</i> Merr.	7.05	4.55	3.03	4.88
8	<i>Cinnadeniapaniculata</i> Blume	3.72	2.88	3.03	3.21
9	<i>Aglaiasp</i>	3.52	2.78	3.03	3.11
10	<i>Cinamomumtenuipilis</i> Kosterm.	2.61	3.35	3.03	3.00
11	<i>Acerbrevipes</i> Gagnep.	3.21	2.63	3.03	2.96
12	<i>Machilusplatycarpa</i> Chun	1.30	2.69	3.03	2.34
113	<i>Meliosmalepidota</i> Blume)	1.98	2.01	3.03	2.34
14	<i>Lithocarpus</i> sp	1.82	1.93	3.03	2.26
15	<i>Celastrusorbiculata</i> Thunb.	0.95	2.52	3.03	2.16
16	<i>Enicosantheumpetelotii</i> (Merr.) Ban	0.66	2.37	3.03	2.02
17	<i>(Machilusodoratissima</i> Nees	0.55	2.31	3.03	1.96
18	<i>Beilschmiediarobusta</i> Alien	1.13	1.58	3.03	1.91
19	sp	1.12	1.58	3.03	1.91
20	<i>Microdesmiscasearifolia</i> Pl. in Hook.	0.77	1.40	3.03	1.73
21	<i>Castanopsisipachyrrachis</i> Hickel. et A. Camus	0.71	1.38	3.03	1.71
22	<i>Syzygiumzeylanicum</i> (L.)	0.70	1.37	3.03	1.70
23	<i>Saurauiatristyla</i> DC.	0.50	1.27	3.03	1.60
24	<i>Elaeocarpusnitidus</i> Jack	0.45	1.25	3.03	1.58

Table 2: Structure of Mangrove Plant Communities and Vegetation in the Distribution Area of *Panax Stipuleanatus*

4. Conclusion

Panax stipuleanatus is a species of plant distributed in areas with environmental temperature conditions ranging from 4.9-25.5°C; humidity is about 70-92%, rainfall is 26-780 mm, and sunshine hours are 92-230 hours. The soil of the distribution area has a pH of 3.97, total K 29.10 (g/kg), Fe⁺² 27,24 (g/kg), total P 0.33%, total N 0.28%, and total organic carbon 4.97%. *Panax stipuleanatus* mainly grows under the canopy of the subtropical mixed broad-leaved vegetation from an altitude of 1300-1800 m, with a slope of 12-16%, from 1/3 from the foot to the top, rarely or not it is at the crest of thunderstorms (where the moisture of the soil is relatively low).

The ecological dominance storey has some key features, such as:

- The density of plant species of about 1,460 trees/ha,
- The average height of the tops (Hvn,m) is about 9.24±3.72 m,
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- The average diameter at chest height (D1.3) is 14.55±10.31 cm

Species with a value of IVI>5% include:

- *Castanopsis* sp (17.27%),
- *Lindera caudata* Hook. f. (12.27%),
- *Lithocarpus fordianus* (Hemsl.),
- Chun (10.08),
- *Schefflera pauciflora* R. Vig. (5,51),
- *Schima wallichii* (DC.) Korth (5.48) and
- *Prunus arborea* Blume (5.47)

These important data on ecological biology and specific distribution area of *Panax stipuleanatus* are the rationale for formulating and developing strategies and plans for conservation, management, and promotion of the medicinal value of this genetic resource in our country.

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