



Analysis of Endemic Flora Diversity of North Sulawesi Indonesia as a Potential for Sustainable Ecotourism

Regina R. Butarbutar^{a*}, Hanny H. Pontororing^a
and Eva L. Baideng^a

^a Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sam Ratulangi, Manado, North Sulawesi, Indonesia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJOB/2022/v16i4306

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/94962>

Original Research Article

Received: 15/10/2022
Accepted: 23/12/2022
Published: 29/12/2022

ABSTRACT

Aims: This study aims to analyze the diversity of endemic flora of North Sulawesi Indonesia as a potential for sustainable ecotourism.

Place and Duration of Study: This research was conducted in the Batuputih Nature Tourism Park (BNTP), Bitung, North Sulawesi (Sulawesi Utara), Indonesia from April until June 2022.

Methodology: The data collection method is carried out using vegetation analysis where this method is a combination method between the path method and the banded line. The number of plot paths used in this study was 47 plots. The distance between the plot of the paths is 20 meters. Determination of the observation path plot is carried out by purposive sampling. Data obtained in the field were analyzed using the Shannon-Wiener species diversity index.

Results: The study's results found 61 types of plants at the sapling level, 29 at the pole level and 47 at the tree level. The plants that dominate Batuputih Nature Tourism Park (BNTP) at the level of

*Corresponding author: E-mail: reginabutarbutar@unsrat.ac.id;

mature trees belong to the family Malvaceae, while the plants that dominate at the level of piles and poles belong to the families Rubiaceae and Anacardiaceae. The value of plant species diversity at each level is greater than 3. The diversity index value at the sapling level is 3.75, the pole level is 3.15, and the tree level with a value of 3.11.

Conclusion: The diversity of flora species at the level of trees, pole and sapling in the Batuputih Nature Tourism Park area is included in the category of high abundance. This means that the diversity of flora species in the community is increasingly stable in the BNTP area. In this area, 2 (two) types of flora endemic to North Sulawesi are found as potential for sustainable ecotourism, namely the species of *Homalium celebicum* and *Pterospermum celebicum*. Both types of endemic plants have the potential to become icons or flagships of ecotourism in North Sulawesi.

Keywords: Diversity; endemic; flora; ecotourism; Batuputih Nature Tourism Park; North Sulawesi; Indonesia.

1. INTRODUCTION

Forests are habitats for diverse plants. Forest habitat is closely related to the living creatures in it. This is because forest habitats provide associations with each other such as food webs for animals and plants, flora and fauna shelters and maintaining the balance of the forest ecological system [1]. Flora diversity is one of the natural potentials that can be used as a means of recreational tourism. The morphological uniqueness of plant parts in the ecotourism area can be used as an interesting attraction.

North Sulawesi has the potential for natural beauty and cultural wealth that is highly valued in the ecotourism industry market. These natural potentials can be in the form of biological natural resources and their ecosystems, diversity of flora, fauna and natural symptoms with the beauty of unspoiled scenery. Flora diversity in an ecosystem is referred to as one of the biological resources that play an important role in the ecosystem [2]. The diversity of these plants and animals is of global significance, with various forest ecosystem types supporting a high level of endemism and biodiversity. One of the areas that have a diversity of flora and fauna is found in the Batuputih Natural Tourism Park (BNTP) in Bitung City.

In the Batuputih Bitung TWA area, there are several types of protected fauna, namely the Sulawesi Black Monkey (*Macaca nigra*), Tarsier (*Tarsier spectrum*), Sulawesi Bear Cuscus (*Ailurops ursinus*), and Hornbill (*Rhyticeros cassidix*). Tourists can enjoy the beauty of endemic fauna species in the BNTP area both from the morphology of the fauna and its habitat [3]. Batuputih Natural Tourism Park (BNTP) in Bitung is one of the conservation areas formed to provide education, recreation and tourism,

science and research, and cultural preservation [4].

Various types of flora diversity in BNTP have been known for quite a long time. In fact, some of them form the basis for designating this area as a conservation area. The diversity of flora species in an area is a potential natural resource that needs to be maintained and preserved. The decline in the diversity of endemic flora will certainly affect the stability of the ecosystem [5,6]. Data and information about the diversity of flora in the Batuputih Nature Tourism Park area are needed to be used as reference material in various fields, especially the development of environmentally friendly ecotourism. However, information related to data on the diversity of flora owned by BNTP area as a potential for sustainable ecotourism, especially from the ecological aspect, is still very lacking. This study aims to analyze the diversity of endemic flora of North Sulawesi as a potential for sustainable ecotourism.

2. MATERIALS AND METHODS

This research was carried out at the Batuputih Natural Tourism Park in Bitung City from April to June 2022. The data collection method in the field employed vegetation analysis where this method is a combination method between the path method and the banded line. The manufacture of transect plots is divided into observation plots with the following sizes: 1) 5 m x 5 m (25 m²) for observation of the sapling level; 2) 10 m x 10 m (100 m²) for pole level observation; and 3) 20 m x 20 m (400 m²) for tree-level observations. Breast Height measurements were made at the height of approximately chest level or 1.3 m above sea level.

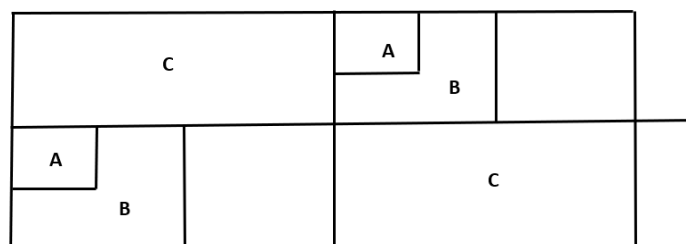


Fig. 1. Design of the observation plot of the transect path method
 A= Plot 5 x 5 m² (sapling); B = Plot 10 x 10 m² (pole) ; C = Plot 20 x 20 m² (tree)

The number of plot paths used in this study was 47 plots. The distance between the paths is 20 meters. Determination of the observation path is carried out by purposive sampling.

The determination of the dominant type is based on the important value index (INP) which refers to the relative density (DR), relative frequency (FR), and relative dominance (DR) values of each type [7]. An important value index is a quantitative parameter used to express the degree of dominance (degree of mastery) of types in a plant community. Furthermore, the diversity of flora species (H') in TWA Batuputih was analysed using the Shannon-Wiener diversity index with the following formula [8,9] :

$$H' = - \sum (p_i \ln p_i)$$

With : H' = Diversity Index

p_i = Comparison of the number of individuals of one type with the number of individuals of the entire sample in the plot.

The species diversity index according to Shannon–Wiener which has been obtained based on the results of calculations and analysis is interpreted as follows:

1. The value of H' is > 3 indicated that the diversity of species on a transect is highly abundant.
2. The value of H' is 1 ≤ H' ≤ 3 indicated that the diversity of species on a transect is moderately abundant.
3. The value of H' < 1 indicates that the diversity of species on a transect is little or low.

The high diversity of flora in an area means that the potential for flora in that area is high. This means that the diversity of flora species in the community is increasingly stable in the Batuputih TWA area.

3. RESULTS AND DISCUSSION

Batuputih Natural Tourism Park (BNTP) located within Tangkoko National Park is a forest that is in the same area as Tangkoko Nature Reserve, Duasudara Nature Reserve and Batu Angus Nature Park. This area has long been recognized for its abundance of natural resources, including a variety of endemic flora, fauna, and beautiful and intriguing landscapes (Fig. 2).

The BNTP area with an area of 615 ha, is intended for the development of natural tourism. BNTP is geographically located between 12503'-125015' BT and 1030'-1034 N. Administratively, the government includes North Bitung District, Bitung City, North Sulawesi Province. In general, the BNTP area has a topography from flat to gentle (0-35 mdpl) ranging from coastal forests and lowland forests, has rainfall of 2,500-3,000 mm / year, an average temperature of 20°C - 25°C [11]. Overall the Batuputih Nature Tourism Park area is presented in Fig. 2.

Based on the results of the study, 47 species of trees, 29 species of pole-level and 61 species of sapling levels were found on the sampling plot. Families that have a relatively large number of species at the level of trees (3–5 species) are Anacardiaceae, Apocynaceae, Euphorbiaceae, Fabaceae, Rubiaceae, Moraceae, and Malvaceae. This means that the dominance of the family at the tree level in the Batuputih Natural Tourism Park (BNTP) area is only dominated by the seven families. Ecologically, family members at the level of trees have better adaptability and tolerance than other families. Among the seven families that dominate the BNTP area of the Malvaceae family, the most numerous are *Grewia koordersiana* Burret, *Kleinhovia hospital* L., *Pterocymbium javanicum* R.Br., *Pterospermum celebicum* Miq. and *Pterospermum diversifolium* Blume. Furthermore, the family Moraceae consists of the species *Artocarpus dadah* Miq., *Ficus chrysolepis* Miq., *Ficus* sp. and *Ficus variegata* Blume (Table 1).

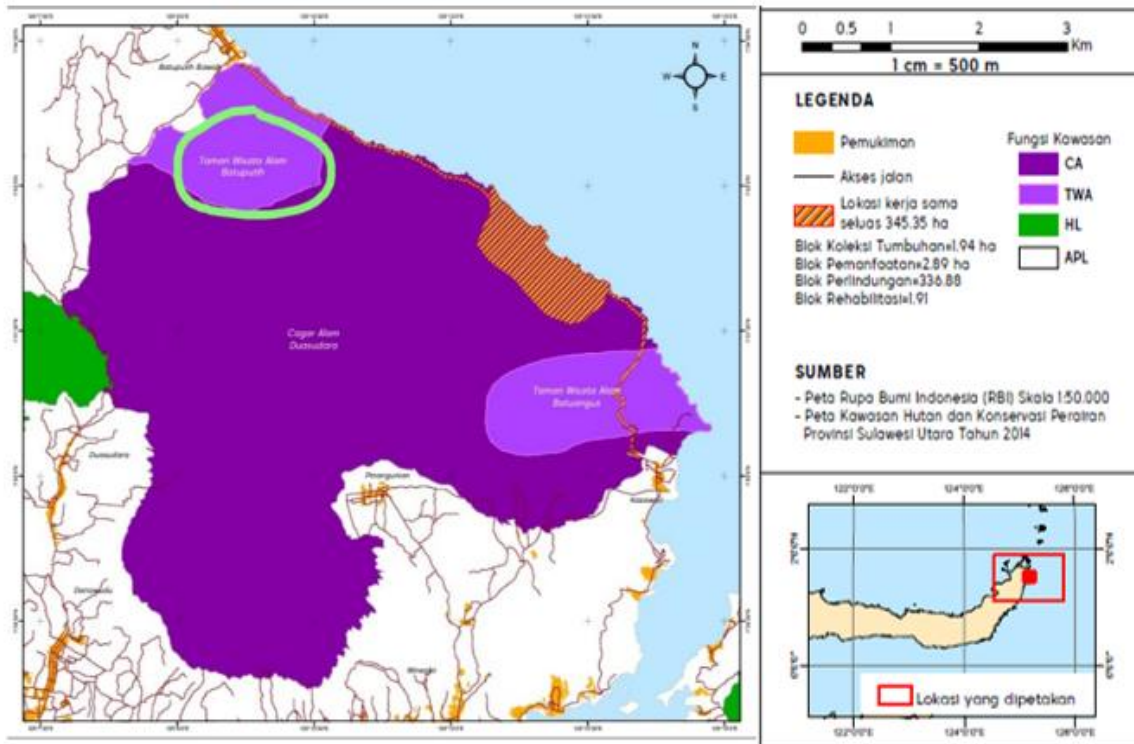


Fig. 2. Research map in the Batuputih Natural Tourism Park area [10]

Table 1. Plant species and families that dominate the Batuputih Natural Tourism Park (BNTTP) at the level of mature trees

No.	Plant Species	Family	Important Value (%)
1	<i>Grewia koordersiana</i> Burret	Malvaceae	0,97
2	<i>Kleinhovia hospital</i> L.	Malvaceae	18,04
3	<i>Pterocymbium javanicum</i> R.Br.	Malvaceae	1,79
4	<i>Pterospermum celebicum</i> Miq.	Malvaceae	1,54
5	<i>Pterospermum diversipolium</i> Blume	Malvaceae	0,89
6	<i>Artocarpus dadah</i> Miq.	Moraceae	4,54
7	<i>Ficus chrysolepis</i> Miq.	Moraceae	0,90
8	<i>Ficus</i> sp.	Moraceae	0,94
9	<i>Ficus variegata</i> Blume	Moraceae	14,39

Ecologically the important value indicated by each species is an indication that the type is considered dominant in the area because it has higher frequency, density and dominance values than other species. The highest INP value proves that this plant has good environmental adaptation. *Tectona grandis* is a plant species with the highest importance value at the level of mature trees, namely 41.68%. While the lowest important value is found in the species of *Pterocarpus indicus*, which is 0.81%. *Tectona grandis* is a plant species with the highest importance value at the level of trees, namely 41.68%. While the lowest important value is

found in the type of *Pterocarpus indicus*, which is 0.81%.

Pole-level trees that have a family with a relatively large number of species (2-3 species) are Apocynaceae, Burseraceae, Euphorbiaceae, Fabaceae, Lecythidaceae, Malvaceae, Rubiaceae and Anacardiaceae. This means that the dominance of the family at the pole level in the Batuputih Natural Tourism Park (BNTTP) area is dominated by eight families. Among the eight families that dominate the BNTTP region of the white stone family Rubiaceae consists of the species *Guettarda speciosa* L., *Morinda citrifolia*

L. and *Morinda bracteata* Roxb. and the family Anacardiaceae with the types *Buchanania arborescens* Blume (Blume), *Dracontomelon mangiferum* Blume (Blume) and *Koordersiodendron pinnatum* Merr. with the most types (Table 2).

The index of important values indicated by each species of plant is an indication that the species is considered dominant in the area because it has higher frequency, density and dominance values than other species. The highest INP value proves that this plant has good environmental adaptation [12]. *Barringtonia acutangula* is a type of plant with the highest importance at the pole level, which is 39.29%. While the lowest important value is found in the species of *Barringtonia asiatica* and *Diospyros maritima*, which is 3.39%. The species of *Barringtonia acutangula* with the highest INP describes its ability to affect the environment in which it grows much greater than that of the species of *Barringtonia asiatica* and *Diospyros maritima* with the lowest INP.

Families with a relatively large number of species at the sapling level (3 – 5 species) are Lamiaceae, Clusiaceae, Malvaceae, Rubiaceae, Euphorbiaceae, Fabaceae and Anacardiaceae. This means that the family's dominance at the sapling level in the BNTP area is dominated by seven families. Among the seven families that dominate the BNTP area is the family

Anacardiaceae consisting of the species *Buchanania arborescens* Blume (Blume), *Dracontomelon dao* (Blanco) Merr. & Rolfe, *Dracontomelon mangiferum* (Blume) Blume, *Koordersiodendron pinnatum* Merr. and *Mangifera* sp. (Table 3).

The highest INP value indicates that this plant has good environmental adaptation. *Palaquium obovatum* is a species of plant with the highest importance at the pole level, which is 13.27%. While the lowest important value is found in the species of *Alstonia scholaris* (L.) R. Br., *Buchanania arborescens* Blume (Blume), *Calophyllum inophyllum* L., *Crateva nurlava* Buch.-Ham., *Cubilia rumphii* Blume, *Dendrocnide microstigma* (Gaudich. ex Wedd.) Chew, *Diospyros cauliflora* Blume, *Drypetes* sp., *Ficus septica* Burm.f., *Garcinia daedalanthera* Pierre, *Garcinia tetrandra* Pierre, *Gliricidia sepium* (Jacq.) Walp., *Macaranga tanarius* (L.) Müll.Arg, *Pterocarpus indicus* Willd., *Pterospermum celebicum* Micq., *Sterculia insularis* R.Br. and *Tabernaemontana macrocarpa* Jack which is 0.73%. The type of *Palaquium obovatum* with the highest INP describes its ability to affect the environment in which it grows much more than the type with the lowest INP. Another factor is the lack of plant density at the level of sapling, poles and trees causing these plants to be more dominant because it is easier to get water nutrients, and Sun.

Table 2. Plant species and families that dominate the Batuputih Natural Tourism Park (BNTP) area at the pole level

No.	Plant Species	Family	Important Value (%)
1	<i>Guettarda speciosa</i> L.	Rubiaceae	4,78
2	<i>Morinda bracteata</i> Roxb.	Rubiaceae	21,67
3	<i>Morinda citrifolia</i> L.	Rubiaceae	19,39
4	<i>Buchanania arborescens</i> Blume (Blume)	Anacardiaceae	4,24
5	<i>Dracontomelon mangiferum</i> Blume (Blume)	Anacardiaceae	8,52
6	<i>Koordersiodendron pinnatum</i> Merr.	Anacardiaceae	9,99

Table 3. Plant species and families that dominate the Batuputih Natural Tourism Park (BNTP) area at the sapling level

No.	Plant Species	Family	Important Value (%)
1	<i>Buchanania arborescens</i> Blume (Blume)	Anacardiaceae	0,73
2	<i>Dracontomelon dao</i> (Blanco) Merr. & Rolfe	Anacardiaceae	2,01
3	<i>Dracontomelon mangiferum</i> (Blume) Blume	Anacardiaceae	4,68
4	<i>Koordersiodendron pinnatum</i> Merr.	Anacardiaceae	4,95
5	<i>Mangifera</i> sp.	Anacardiaceae	8,48



Fig. 3. *Pterospermum celebicum* Miq. (Endemic flora in BNTP area, North Sulawesi)



Fig. 4. *Homalium celebicum* Koord. (Endemic flora in BNTP area, North Sulawesi)

The value of plant species diversity at each tree level is greater than 3. The level of the sapling with a diversity index of 3.75, the level of the pole with a value of 3.15, and at the tree level with a value of 3.11. On 47 plots or plots of observations obtained relatively equal diversity index values. This shows that the habitat conditions in all observation plots are relatively homogeneous, when viewed from the aspect of disturbance to the ecosystem, because in all places in BNTP there is no periodic destruction. This is understandable because the area is a nature conservation area. The results of the calculation of the species evenness index showed that the values were relatively homogeneous, ranging from 3.11- 3.75. The diversity of flora species at the level of trees, poles and sapling in the BNTP area is included in the category of high abundance. This means that the diversity of flora species in the community is increasingly stable in the BNTP area.

The species diversity index is important information about a community [13]. The wider

the sample area and the more species encountered, the higher the species diversity index value. Relatively low diversity index values are common in communities that have climaxed. To maintain high diversity, communities need regular and random disruptions. Highly stable, regionally widespread, and homogeneous communities have a lower diversity index than mosaic forest forms or are regionally disturbed periodically by fire, wind, floods, pests, and human intervention. Usually after the disturbance has passed, there will be an increase in species diversity to the point where the community reaches a climax.

The results showed that in the BNTP area there were two endemic flora species of North Sulawesi, namely the species *Homalium celebicum* Koord. and *Pterospermum celebicum* Miq. (Fig. 3 and Fig. 4). Based on the morphological shape of the stems and leaves of these two endemic flora species, it provides a very interesting visual attraction for tourists visiting BNTP. The uniqueness of these two

endemic flora species can be a symbols of conservation and have a high selling value for North Sulawesi. Both species are found at the level of mature trees and sapling. The diversity of both flora species is a special morphology attraction for tourist destinations [14-17]. This endemic species is also found in the entrance corridor of BNTP. Species *Homalium celebicum* Koord. and *Pterospermum celebicum* Miq. has the potential to be an icon or flagship of ecotourism in BNTP area North Sulawesi, Indonesia.

4. CONCLUSION

Based on the results of research, 47 species of adult trees, 29 species of pole level and 61 types of sapling levels were found on the sampling plot. Families that have a relatively large number of species at the level of trees are Anacardiaceae (3 species), Apocynaceae (3 species), Euphorbiaceae (3 species), Fabaceae (3 species), Rubiaceae (3 species), Moraceae (4 species), and Malvaceae (5 species). A relatively large number of families at the sapling level are Lamiaceae (3 species), Clusiaceae (3 species), Malvaceae (4 species), Rubiaceae (4 species), Euphorbiaceae (4 species), Fabaceae (4 species) and Anacardiaceae (5 species). In pole-level plants the largest number of families are Apocynaceae (2 species), Burseraceae (2 species), Euphorbiaceae (2 species), Fabaceae (2 species), Lecythidaceae (2 species), Malvaceae (2 species), Rubiaceae (3 species) and Anacardiaceae (3 species). The diversity of flora species at the tree, pole and sapling levels in the Batuputih Natural Tourism Park (BNTP) area is included in the high abundance category with a diversity index value of 3.75 at the sapling level, 3.15 at the pole level and at the tree level with a value of 3.11. In the BNTP area there were two species of flora endemic, namely the species *Homalium celebicum* Koord. and *Pterospermum celebicum* Miq. Based on the morphological shape of the stems and leaves of these two endemic flora species, it provides a very interesting visual attraction for tourists visiting BNTP. The uniqueness of these two endemic flora species can be a symbols of conservation and have a high selling value for North Sulawesi. Both species of these plants are found at the level of mature trees and sapling. Species *Homalium celebicum* Koord. and *Pterospermum celebicum* Miq. has the potential to be an icon or flagship of ecotourism in BNTP area North Sulawesi, Indonesia.

ACKNOWLEDGEMENTS

We would like to extend our sincere gratitude to the Rector of Universitas Sam Ratulangi Manado, North Sulawesi, Indonesia for providing funding for this research through the Institute for Research and Community Service (LPPM). Thank you as well to the students who directly participated and contributed to this research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Agustina DK. Vegetasi pohon di hutan lindung. Malang: UIN Press; 2010.
2. Butarbutar RR, Purnomo M, Hakim L, Sastrahidayat IR, Soemarno. Plants as flagship species in tourism destination: A case study at Mount Mahawu Tomohon, North Sulawesi, Indonesia. International Journal of Conservation Science (IJCS). 2015;6(4):715-728.
3. Baware F, Kiroh HJ, Wungow RH, and Kawatu M. Dampak pembangunan program ekowisata berbasis satwa endemik di Tangkoko Bitung. Jurnal Zootek. 2017;37(2):448-463.
4. Lowing AE, Rimbing SC, Rembet GDG, and Nangoy MJ. Karakteristik sarang *Tarsius spectrum* di Cagar Alam Tangkoko Bitung Sulawesi Utara. Jurnal Zootek. 2013;32(5):61-73.
5. Hakim L. Dasar-dasar ekowisata. Malang: Bayumedia Publishing; 2004.
6. Indriyanto. Ekologi hutan. Jakarta: Bumi Aksara; 2006.
7. Soerianegara I and Indrawan A. Ekologi hutan Indonesia. Bogor: Laboratorium Ekologi Hutan Fakultas Kehutanan. IPB; 1998
8. Krebs CJ. Ecological methodology. Third Edition. New York: Harper Collins Publisher; 1989.
9. Stiling, P. Ecology, theories and applications. New Jersey: Prentice Hall International Inc.; 1996.
10. BKSDA. Peta Kawasan Taman Wisata Alam Batuputih. Balai Konservasi Sumber Daya Alam Sulawesi Utara; 2021.
11. MENLHK. Informasi 521 Kawasan Konservasi Region Kalimantan-Sulawesi. Bogor; 2016.
12. Brandt P, Abson DJ, Dellasala DA, Feller R, Von Wehrden H. Multifunctionality and

- biodiversity: Ecosystem services in temperate rainforests of the Pacific Northwest, USA. *Biological Conservation*. 2014;169:362-371.
13. Barbour MG, Burk JH, Pitts WD and William FS. *Terrestrial plant ecology*. Third Edition. California Inc.: Addison Wesley Longman; 1999.
 14. Hakim L, Soemarno and Hong SK. Challenges for conserving biodiversity and developing sustainable island tourism in North Sulawesi Province, Indonesia. *Journal of Ecology and Field Biology*. 2012;35(2): 61-71.
 15. Sargent RD and Otto SP. The role of local species abundance in the evolution of pollinator attraction in flowering plants. *The American Naturalist*. 2006;167(1):67-80.
 16. Pickering CM and Hill W. Review: Impacts of recreation and tourism on plant biodiversity and vegetation in protected areas in Australia. *Journal of Environmental Management*. 2007;85(4): 791-800.
 17. Klanderud K, Birks HJB. Recent increases in species richness and shifts in altitudinal distributions of Norwegian mountain plants. *The Holocene* Sage Publications. 2013; 13(1):1-6.

© 2022 Butarbutar et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/94962>