



(RESEARCH ARTICLE)

Biodiversity mapping of *Dendrobium* Sw. section *Spathulata* Lindl. in the Ramsar Site of Wasur National Park of Indonesia New Guinea

Arobaya Agustina Yohana Setyarini ^{1,2,*}, Heipon Agape ¹, Sinery Anton Silas ³ and Wakum Abner ⁴

¹ *Laboratorium Konservasi dan Lingkungan Hidup, Fahutan UNIPA, Jl. Gunung Salju Amban, 98314, Manokwari, West Papua Province, Indonesia.*

² *Biodiversity Research Center in University of Papua, Manokwari, West Papua, Indonesia.*

³ *Research Center for Environmental Science at University of Papua, Manokwari, West Papua, Indonesia.*

⁴ *Ranger and Officer of Wasur National Park in Merauke, Papua Province, Indonesia.*

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Abstract

Wasur National Park is a vast area of tropical lowland forest, swamp forest, savannah and wetland in the far south-east corner of Papua-Indonesia. It is bordered by the sea to the south and PNG to the east. It lies within the Trans-Fly region of New Guinea and both the habitat and birds have much in common with northern Australia only 200 km to the south. The site is very seasonal, with both a pronounced wet and dry season. This park displays a tremendous biodiversity of flora and fauna. One prime example of flowering plants is Orchids species. Most orchids in this park resembles to the Australian plants as it share similar vegetation types of heath forest and savanna woodland. Knowledge of orchid diversity from this park is poorly acknowledged. This preliminary study aims to document species diversity, to map diversity and distribution of orchid species of *Dendrobium* section *Spathulata* and the host plants in the national parks. The study is conducted in six sites i.e. Bokem, Sota, Rawa Dongami, Rawa Biru, Wasur village, and Yanggandur. The plants were collected and recorded whenever they are encountered on the host trees. In total 40 orchid plants are collected and identified using bio-molecular techniques combined with morphological characters. 11 species recorded from *Dendrobium* section *Spathulata* i.e. *Dendrobium canaliculatum*, *Dendrobium carronii*, *Dendrobium d'albertisii*, *Dendrobium devosianum*, *Dendrobium discolor*, *Dendrobium ionoglossum*, *Dendrobium johannis*, *Dendrobium nindii*, *Dendrobium semifuscum*, *Dendrobium sylvanum* and *Dendrobium trilamellatum*. Other species from *Dendrobium* section *Phalaenanthe* such as *Dendrobium bigibum*, *Dendrobium* section *Calyptrorchilus* i.e. *Dendrobium smilliae* dan *Dendrobium capituliferum*, *Dendrobium* section *Dendrocorynae*, and one species of *Pomatocalpa marsupiale*. During the field observation, we noticed hunting activity run by vendors and hunters. This activity brings impact to the sustainability of the plants. Vendors are mainly locals who inhabit and land tenure in this park.

Keywords: Diversity; Orchids; Epiphyte; Phorophyte; Ramsar Site; Wasur NP-Papua

1. Introduction

A Wasur National Park is geographically located at 140°27' to 141°2' E and 8°5' to 9°7' S. The Park is border to Sungai Maro in the the North and Arafura Sea in the South, Merauke City in the West and Tonda Negara Wildlife reserve of Papua New Guinea. The Park was established by the Ministry of Forestry in 1997 as National Park with 413,810 ha. Wasur National Park is a vast area of tropical lowland forest, swamp forest, savannah and wetland in the far south-east corner of Papua. It is bordered by the sea to the south and PNG to the east. It lies within the Trans-Fly region of New Guinea and both the habitat and birds have much in common with northern Australia with only 200 km to the south. The site is very seasonal, with both a pronounced wet and dry season. The main objective of preserving the

* Corresponding author

E-mail address: agustinaarobaya@yahoo.com

park is to protect biodiversity and water resources. Aside of this, the national park is sheltering a remarkable biodiversity of flora and fauna. The vegetation type is dominated by tree family of *Myrtaceae* to which is predominantly known to the heath forests ecosystem. This family host many epiphytic plants. One prime example of an epiphytic plant occurs in the park, well-known as an ornamental plant, is *Orchidaceae*.

Most studies from this park were focus on a landscape and socio-cultural based. Not many work has been published which gives a comprehensive review of diversity and distribution of orchids as well as the host plants (phorophyte) in this particular sites [1]. The fact that this park is well-known for unique vegetation types that can only be found in the southern part of New Guinea Island. Uniqueness of the vegetation types resemble to the Australian Plants [2]. As well as many localities are relatively inaccessible has led to difficulties in estimating the actual distribution of the orchid species. Notwithstanding, information about orchid diversity and distribution from this park is limited. Comprehensive research is required to determine species diversity and the localities of population, the habitat preferences providing suitable environment for this plant. This preliminary study is designed to assess species diversity, documented and mapping the distribution of orchids in particular *Dendrobium* Sw. section *Spathulata* Lindl. in Wasur National Park. This knowledge will contribute significantly in filling the gap of flowering plant diversity atlas from the park in particular and biodiversity of Papua in general.

2. Material and methods

2.1. Location and Time

The study was conducted in six sites inside the National Park i.e: Bokem, Rawa Dongami, Sota Wasur Kampung, Rawa Biru and Yanggandur from July 25th to August 8th 2013, 25 October- 1 November 2018. The study sites were purposively selected according to the possible accessibility by road and the nurseries own by local community inside the park. The last location is Sota district which located at the border line between RI and PNG. In depth interview was conducted to the respondents to gain knowledge of locals on species diversity and their hunting activity of the orchid species. We did not set the line transect and plot sampling during the fieldwork due to the circumstance of the park that are mostly cover with the swamp area. Instead we explore the dry heath forest and conduct and interview with respondents. These sites are visited as there are few orchid' nurseries run by locals who are land tenure and inhabit the parks over generations.

2.2. Data Collection and Analysis

To map distribution of species within the park, all data were recorded using GPS and transfer into QGIS software. Details of individual and species distribution are not presented in this manuscript due to the conservation matter. However, general information to where the plants are collected is presented on the map as well as coordinate of each location.

All data involve scientific and vernacular name, morphological features are recorded into tally sheet for further analysis. 40 Orchid plants were collected and preserve as herbarium materials and living collections. 37 pressed-floral dissection cards were used to assist in morphological identification of species (Figure 1). Description of morphological characters of orchid were recorded, determined and identified with references [3] [4] [5] [6] [7] [8] [9], whereas the host trees are refer to [10] and [11]. For thoroughgoing identification process, DNA samples was extracted from dried-silica-gel leave tissues, proceed and stored at the Australian Tropical Herbarium for further species determination.

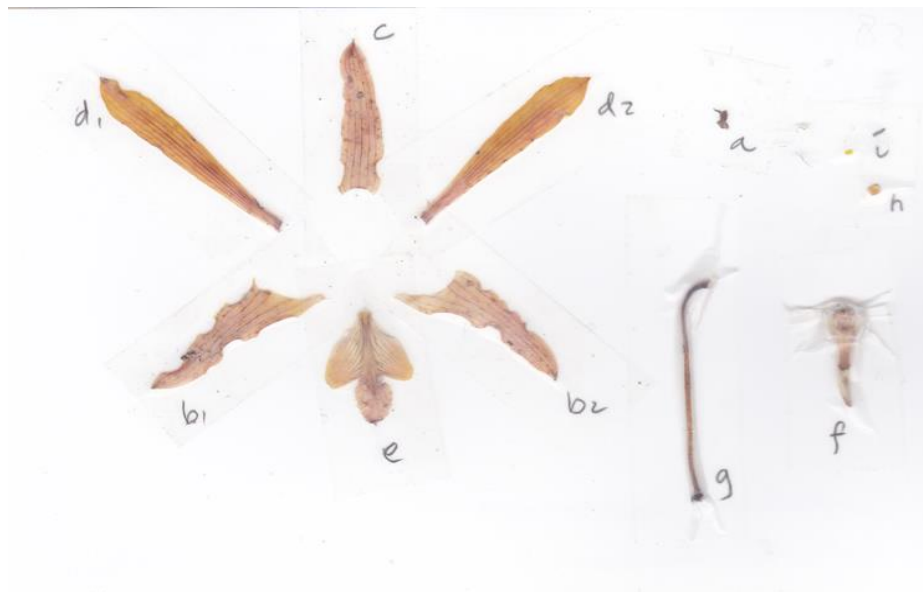


Figure 1 A pressed-floral dissection cards from *Dendrobium devosianum* J.J. Smith collected from the field (a. bract; b. lateral sepals; c. dorsal sepal; d. petals; e. labellum; f. gynostemium; g. pedicel; h. pollen cap; i. pollinia) (Collected and pressed by AYSA).

3. Results and discussion

3.1. Species Diversity

In Total 40 samples are collected from the field. Of these 24 specimens were identified using morphological features combined with biomolecular technique as *Dendrobium canaliculatum* R.Br., *Dendrobium carronii* Lavarack & P.J. Cribb, *Dendrobium d'albertisii* Rchb.f., *Dendrobium devosianum* J.J.Sm., *Dendrobium discolor* Lindl., *Dendrobium johannis* Reichb.f., *Dendrobium ionoglossum* Schltr., *Dendrobium nindii* W. Hill, *Dendrobium semifuscum* (Reichb.f.) Lavarack & P.J. Cribb, *Dendrobium sylvanum* Reichb.f. and *Dendrobium trilamellatum* J.J.Smith, (Figure 2). These species were classified into *Dendrobium* Sw. section *Spathulata* Lindl. [12]. Morphological characters define as character states were adopted from [13]. The remaining 16 orchids were classified as the out-group i.e. *Dendrobium biggiba* Lindl., *Dendrobium phalaenopsis* Fitzg., *Dendrobium litorale* Schltr. *Dendrobium bracteosum* Rchb.f., *Dendrobium smiliae* (F. Muell.) Fitzg., *Dendrobium sp1*. All recorded species epiphytes to the host plants that identified as *Acacia mangium* Wild., *Anthocephalus chinensis* A. Rich., *Banksia* sp., *Corymbia* sp., *Melaleuca cajuputih* Powell, *Melaleuca leucadendron* (L.) L., and *Melaleuca viridiflora* Sol ex. Gaertn (Figure 3).



Figure 2 Example of *Dendrobium* Sw. section *Spathulata* Lindl.: a. *Dendrobium carronii* Lavarack & P.J. Cribb; b. *Dendrobium johannis* Rchb.f.; c. *Dendrobium discolor* Lindl.; d. *Dendrobium d'albertisii* Rchb.f.; e. *Dendrobium canaliculatum* R.Br. (foto: Andrea Lim, Agape Heipon dan Agustina Y S Arobaya).



Figure 3 Example of the host tree of *Melaleuca cajuputih* where *Dendrobium discolor* hosted. (foto: Agustina Arobaya)

As can be seen from datasets in Table 1, the most common host trees for the orchids belongs to family *Myrtaceae*. Data indicates the genus *Melaleuca* is the preferable host tree and profitable habitat for these orchids group. The bark of this genus offers best positioned-media for a dust-like seed of orchids nesting to the stem. This family is an indicator of the vegetation type of heath forests that can only be found in the southern part of New Guinea Island. Other genera of host trees recorded from family *Proteaceae* is *Acacia* and *Banksia*. They are the common genera associated with *Melaleuca* in the heath forest vegetation. These last two genera were spotted at one study site in Sota district.

Based on this checklist, *Dendrobium d'albertisii* is scattered evenly in the national park as it can be spotted in all host trees. Followed by *Dendrobium discolor* and *Dendrobium canaliculatum*. Most orchids grow as epiphyte covering the tree trunk from zone 1 to zone V [14]. The inland of the park still display a suitable environment for both the orchids and its host trees. The park displays an area with a rugged terrain covering with the wetland of swamp area that is still becoming a pristine forest inside the park, in particular nearby by Rawa Dongami and Rawa Biru where many migrant birds from the southern hemisphere frequently visit these swamps. *Dendrobium nindii* identified by [15] share the similar morphological characters as it does in *Dendrobium ionoglossum*. Dissimilarity appears on the length of petals and sepals in which *D. nindii* possess long petals and sepals than that of *D. ionoglossum*. These characters were tested through molecular approach to which they split the two species into two branches (Arobaya et al., unpublished work). These species are dispersed following the host trees of *Melaleuca cajuputih* and *Acacia mangium*.

Table 1 Checklist of orchids recorded with the host trees in the Wasur National Park

No	Species	Host tree	location
1	<i>Dendrobium d'albertisii</i>	<i>Anthocephalus chinensis</i>	Bokem
2	<i>Dendrobium d'albertisii</i>	<i>Melaleuca leucandendron</i>	08°38'33"
3	<i>Dendrobium d'albertisii</i>	<i>Melaleuca viridiflora</i>	
4	<i>Dendrobium d'albertisii</i>	<i>Melaleuca cajuputih</i>	
5	<i>Dendrobium canaliculatum</i>	<i>Melaleuca cajuputih</i>	
6	<i>Dendrobium discolor</i>	<i>Melaleuca cajuputih</i>	
7	<i>Dendrobium johannis</i>	<i>Melaleuca leucandendron</i>	
8	<i>Dendrobium johannis</i>	<i>Melaleuca cajuputih</i>	

9	<i>Dendrobium johannis</i>	<i>Melaleuca leucadendron</i>	
10	<i>Dendrobium johannis</i>	<i>Melaleuca viridiflora</i>	
11	<i>Dendrobium semifusum</i>	<i>Melaleuca leucadendron</i>	
12	<i>Dendrobium semifusum</i>	<i>Melaleuca viridiflora</i>	
1	<i>Dendrobium canaliculatum</i>	<i>Melaleuca viridiflora</i>	Rawa Dongami
2	<i>Dendrobium discolor</i>	<i>Melaleuca viridiflora</i>	08°31'11"
3	<i>Dendrobium johannis</i>	<i>Melaleuca viridiflora</i>	
4	<i>Dendrobium semifusum</i>	<i>Melaleuca viridiflora</i>	
1	<i>Dendrobium d'albertisii</i>	<i>Melaleuca leucadendron</i>	Yuss Indicen
2	<i>Dendrobium canaliculatum</i>	<i>Melaleuca cajuputih</i>	08°31'27"
3	<i>Dendrobium carronii</i>	<i>Melaleuca leucadendron</i>	
4	<i>Dendrobium discolor</i>	<i>Melaleuca leucadendron</i>	
5	<i>Dendrobium johannis</i>	<i>Melaleuca leucadendron</i>	
6	<i>Dendrobium semifusum</i>	<i>Melaleuca cajuputih</i>	
7	<i>Dendrobium smilliae</i>	<i>Melaleuca cajuputih</i>	
8	<i>Pholidota imbricata</i>	<i>Melaleuca cajuputih</i>	
1	<i>Dendrobium d'albertisii</i>	<i>Melaleuca cajuputih</i>	Wasur Kampung 2
2	<i>Dendrobium canaliculatum</i>	<i>Melaleuca cajuputih</i>	08°31'26-28"
3	<i>Dendrobium carronii</i>	<i>Melaleuca cajuputih</i>	
4	<i>Dendrobium discolor</i>	<i>Melaleuca cajuputih</i>	
5	<i>Dendrobium johannis</i>	<i>Melaleuca cajuputih</i>	
6	<i>Dendrobium semifusum</i>	<i>Melaleuca cajuputih</i>	
7	<i>Dendrobium sp.1</i>	<i>Melaleuca cajuputih</i>	
8	<i>Dendrobium nindii</i>	<i>Melaleuca cajuputih</i>	
9	<i>Dendrobium ionoglossum</i>	<i>Melaleuca cajuputih</i>	
10	<i>Grammatophyllum speciosum</i>	<i>Melaleuca cajuputih</i>	
11	<i>Oncidium sp.</i>	<i>Melaleuca cajuputih</i>	
1	<i>Dendrobium d'albertisii</i>	<i>Melaleuca leucadendron</i>	Yanggandur
2	<i>Dendrobium bifalce</i>	<i>Melaleuca leucadendron</i>	08°32'08-19"
3	<i>Dendrobium canaliculatum</i>	<i>Melaleuca leucadendron</i>	
4	<i>Dendrobium devosianum</i>	<i>Melaleuca leucadendron</i>	
5	<i>Dendrobium discolor</i>	<i>Melaleuca leucadendron</i>	
6	<i>Dendrobium johannis</i>	<i>Melaleuca leucadendron</i>	
7	<i>Dendrobium smilliae</i>	<i>Melaleuca leucadendron</i>	
8	<i>Dendrobium johannis</i>	<i>Melaleuca leucadendron</i>	
9	<i>Dendrobium sp. 1</i>	<i>Melaleuca leucadendron</i>	
10	<i>Dendrobium nindii</i>	<i>Melaleuca leucadendron</i>	
11	<i>Dendrobium trilamellatum</i>	<i>Melaleuca leucadendron</i>	
12	<i>Diplocoulobium sp.</i>	<i>Melaleuca leucadendron</i>	

13	<i>Grammatophyllum speciosum</i>	<i>Melaleuca leucadendron</i>	
14	<i>Oncidium</i> sp.	<i>Melaleuca leucadendron</i>	
15	<i>Pholidota imbricata</i>	<i>Melaleuca leucadendron</i>	
16	<i>Vanda</i> sp.	<i>Melaleuca leucadendron</i>	
1	<i>Bulbophyllum</i> sp.	<i>Banksia</i> sp	Sota
2	<i>Dendrobium</i> aff. <i>polysema</i>	<i>Melaleuca cajuputih</i>	08°25'25"
3	<i>Dendrobium d'albertisii</i>	<i>Banksia</i> sp	
4	<i>Dendrobium bifalce</i>	<i>Banksia</i> sp	
5	<i>Dendrobium bigibum</i> (big flower)	<i>Banksia</i> sp	
6	<i>Dendrobium bigibum</i> (small flower)	<i>Banksia</i> sp	
7	<i>Dendrobium discolor</i>	<i>Anthocephalus chinensis</i>	
8	<i>Dendrobium smilliae</i>	<i>Anthocephalus chinensis</i>	
9	<i>Dendrobium ionoglossum</i>	<i>Acacia mangium</i>	
10	<i>Flickingeria</i> sp.	<i>Acacia mangium</i>	
11	<i>Grammatophyllum speciosum</i>	<i>Acacia mangium</i>	

3.2. Threat and opportunity

Almost all species of *Dendrobium* section *Spathulata* have exotic and economic values. These rewards have triggered the species to be hunt. The intensive exploration of orchid species was spotted during the observation. This activity is mostly conducted by the locals who manage the nurseries and other orchid hunter who visits the park (Figure 4). On the other hand selling these orchids bring economic benefit to locals instantly. Species observed that were sold in the nurseries are *D. canaliculatum*, *D. carronii*, *D. devosianum*, *D. discolor* and its variety, *D. johannis*, *D. trilamellatum*, *D. ionoglossum* and *D. trilamellatum*. These species become a preferable species to buyers as the plants display colorful and have long lasting flowers aside from its variable size of stems. Few of these species have fragrance that of in the interest of the buyers. Buyers can be classified as researchers, plant enthusiasts such as vendors and collectors that come not only from around Merauke Regency but also from outside Papua.

According to IUCN red list for threaten species [16], most of these orchids are categorized as least concern (LC) to vulnerable (VU) in the wild, some of the species are classified to data deficiency (DD) due to the lack of information and documentation as well limited input from research in the region (Figure 5). As can be seen from the figure, the trend toward threaten species tends to increase by 2018. This figure provides the highest number of species in each category. The IUCN categories for threaten species is congruent with the Indonesian law for biodiversity [17]. The threat spotted during the fieldwork were listed as: residential and commercial development, agriculture and aquaculture practices, transportation and corridor services, biological resources uses, human intrusion and disturbance to the habitat, natural modification for development of new administrative area, climate changes and severe weather. The most current threaten activity is development of infrastructure of road inside the park. These threats contribute significantly to the existence and sustainability of habitat for orchid and its host species in the wild. Some of the orchid species tends to grow on certain host plants such as *Melaleuca cajuputih* and *Eucalyptus* sp. These host plants are used by locals as firewood. Intensity of cutting down the trees for such purposes is promptly endangered the orchid species.



Figure 4 Orchid's nursery runs by locals who inhabit the national park (photo: Agape Heipon †).

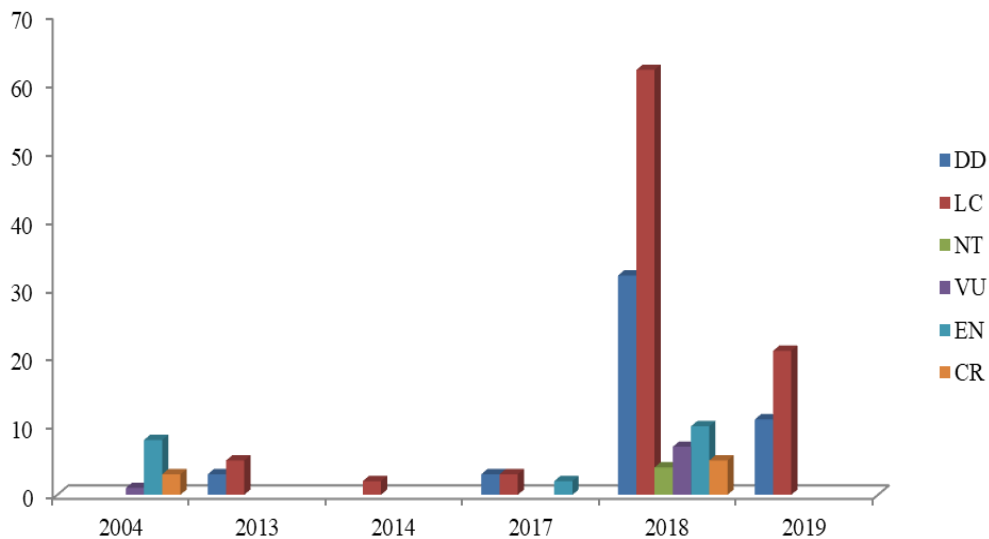


Figure 5 Number of species listed in each IUCN Red List categories for threatened species between 2004 and 2019. DD-Data Deficiency, LC-Least Concern, NT-Near Threatened, VU-Vulnerable, EN-Endangered, CR-Critically Endangered (Source: IUCN Red List, accessed 2/2/2020, 12:00am).

3.3. Orchid map

Details of location of species distribution on the map are not presented due to the conservation strategy. The presentation of this map can only give brief information to where the species occurred and collected in their natural habitat (Figure 6). Two study sites noted as the wetland i.e. Rawa Dongami and Rawa Biru. Rawa Dongami is a trans-fly spot for migrant birds from southern hemisphere. The Rawa Biru is a water source to supply clean water for inhabitants in Merauke regency. The remaining study sites represent dry heath forests in the tropic that have vegetation type resemble to the Australian plants of savanna woodland [10]. The species indicate this type of vegetation mostly dominated by family *Myrtaceae* such as *Eucalyptus*, *Banksia* and *Melaleuca species* [2]. Further management strategy on how to conserve as well as benefit from this orchid diversity requires multi stakeholder joint venture involving locals who own the land.

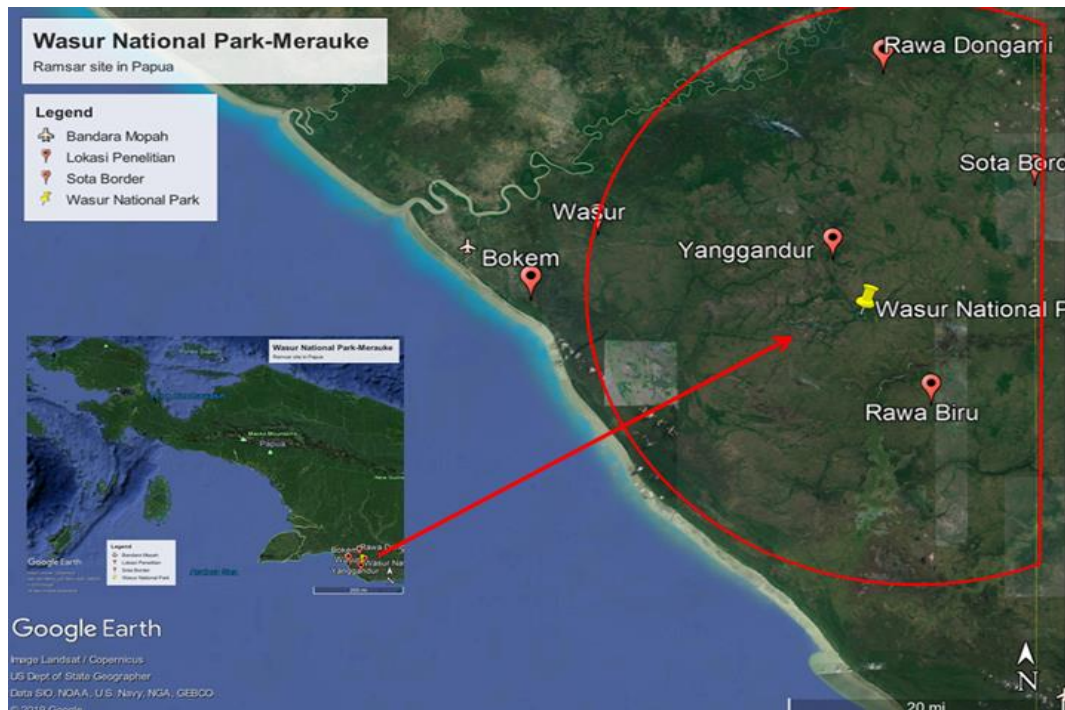


Figure 6 Map of study sites of orchid distribution from *Dendrobium* section *Spathulata*, adopted and modified from Google Earth Pro (Accessed 01/02/2020; 4:48pm). Red mark indicates the location where interview being conducted as well as orchid samples are collected.

4. Conclusion

Taking into consideration that Wasur National Park holds substantial biodiversity treasures. The resources have supporting locals who inhabit the land over generation. One of the most natural prosperity is orchid plants from genus *Dendrobium* section *Spathulata*. In relation to orchid's diversity, the study sites have 11 species of section *Spathulata*. While the remaining 16 samples were categories as an out-group species. Should transect method was applied in collecting specimens, level of diversity may increase and more species will be discovered. Diverse *Melaleuca* species were dominant as host tree in surrounding study sites with small number of *A. chinensis*, *A. mangium* and *Banksia* Sp. This preliminary study has indicated the benefit come from this plant and supporting daily life of people living in and around the national park. Biodiversity mapping within the national park will further help the management of the park for development of orchid conservation program. This requires a lot of work for improvement as there are other prospective for economic benefit such as recreational park inside and field station for student who has interest in conservation to do their field work and gain knowledge from the park as well.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest regarding the publication of this paper.

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