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Has *Nepenthes pitopangii* Chi C. Lee, S. Mc Pherson, Bourke & M. Mansur a rare and endemic flowering plant of Sulawesi, been extinct in its original nature?

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ABSTRACT

Nepenthes pitopangii Chi C. Lee, Mc Pherson, Bourke & M. Mansur (Nepenthaceae), is an endemic pitcher plant to Sulawesi. The population of this plant at its type locality is only two individuals, on the other hand human activities like rattan and dammar collecting by local community and ecotourism activity have contributed to a decline in the population. The purpose of this research is to assess the current condition of the habitat of *Nepenthes pitopangii* at its type locality in Lore Lindu National Park. Field work was done in the period of September 2016-September 2017. The vegetation of *Nepenthes pitopangii* habitat was studied by using botanical exploration methods. The result showed that both location had been heavily damaged due to habitat human activities with no further evidence of the precense of *N pitopangii* at either site. Additionally, We noted a number of plant species arround the habitat which were widespread in montain forest of Lore Lindu National Park such as *Xanthomyrtus angustifolia* (Myrtaceae), *Weinmania lucens* (Cunoniaceae), *Vaccinium palawanensis* (Ericaceae), *Phyllocladus hypophylus* (Podocarpaceae), *Drymis piperita* (Proteaceae), *Gleichenia vulcanica*, *Stricherus truncatus, Lycopodiella cernua* and *Dicksonia blumei* .

Key words: *Nepenthes pitopangii*, rare and endemic plant, Lore Lindu National Park, Central Sulawesi

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INTRODUCTION

Nepenthes spp are unique and beautiful flowering plant. Locally in Malesian region, some species are utilized for cooking especially rice dishes, medicinal uses and for making rope. Many of *Nepenthes* species are cultivated and across the world as ornamental plants. Cheek and Jebb (2001) reported eight (8) species of Nepenthaceae for Sulawesi, of which four species are endemic. These numbers are comparatively low compared to the neighboring island of Borneo, where there are more than 30 species, of which 70% are endemic. Less species of *Nepenthes* in Sulawesi may be due to a lack of botanical exploration in Sulawesi, but in recent years several new species have been described from Sulawesi, such as *Nepenthes pitopangii* (Lee et al 2009), *Nepenthes undulatifolia* (Lee et al, 2009 in Mc Pherson 2009), *Nepenthes nigra* (Nerz et al, 2009 *in* Mc Pherson 2009) and *Nepenthes minima* (Cheek and Jebb 2016).

Nepenthes pitopangii Lee, Mc Pherson, Bourke & Mansur, endemic to the Indonesia island of Sulawesi. It was first collected by the author with Holotypus: RP. 2054 (CEB) dated 30 May 2007 from Lore Utara District, Poso Regency in the montane forest of Lore Lindu National Park, Central Sulawesi. The species is named for Dr. Ramadhanil Pitopang, a curator of the Herbarium Celebense (CEB) Universitas Tadulako Palu, who has studied the flora of Central Sulawesi for over 18 years (Lee et al. 2009).

Nepenthes pitopangii is represents an interesting contribution to the flora of Sulawesi, together with a number of other plants which is recently described as a new species for science that comes from Sulawesi in particular of biogeography Wallacean region. On the other hand, human activities such; i) forest convertion into cacao plantation (Steffan-Dewenter et al, 2007), ii) rattan and dammar collecting, and iii) ecotourism activities like bird watching as well as mountainaring have lead to change on ecosystems and biodiversity in the region. Many studies have showed that the decline in the population of some species in this region, even tend to be scarce due to those human activities (Pitopang et al 2004; 2012a ; Gradstein et al 2007).

The purpose of this research is to study the current condition of the habitat of Nepenthes pitopangii at its original environment in Lore Lindu National Park, Central Sulawesi Indonesia.

II MATERIALS AND METHODS

Research Sites

Study area

The study is conducted in two locations as natural habitat of *N pitopangii*

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i.e. Helipad station at 01^0 18' 33.9" S and 120^0 18' 33,1" E with alt. 1900 m asl. and Torenali at 01^0 19' 788" S and 120^0 19' 697" E with alt. 1700 m asl. Those research sites are located at Sedoa village, Lore Utara District Poso Regency (Fig.1)

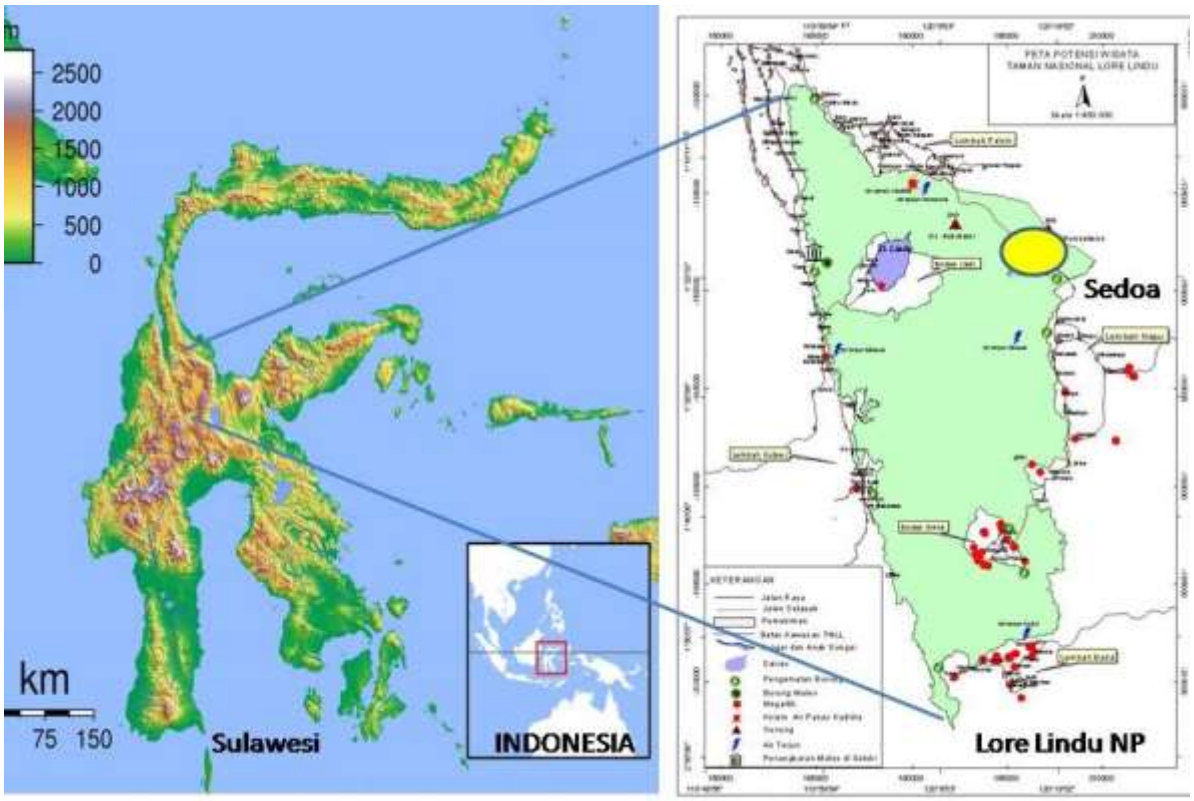

Figure 1. Map of research site (yellow spot, track path toward to Mt. Rore Kautimbu) at the eastern part of the Lore Lindu National Park, Central Sulawesi, Indonesia.

Field sampling

Field work was made in the periode from September 2016 - September 2017. All plants species which are growing surrounding the habitat of *Nepenthes pitopangii* were recorded by using "botanical exploration methods" (van Balgooy and Tantra 1986). Voucher specimen for all plant material with flowers and fruits were collected in sets of at three (3) duplicates and deposited in Herbarium Celebense (CEB) and Laboratory of Biodiversity Faculty of Mathematics and Natural Sciences Tadulako University Palu. Identification was done in the field, in CEB, and in the Laboratory of Biodiversity Faculty of Mathematics and Natural Sciences Tadulako University Palu

The diversity of wildlife such as species of avifauna and mammals were recorded based on the results of direct observation and interviews from the local community. Several environmental

parameters including air temperature, relative humidity, pH were measured. The relative humidity at the start and end of the exposure period were measured using a digital thermo-hygrometer (Corona^{R}Model: GL 99), whereas precipitation data obtained from Meteorological Geophysical Palu

Secies distribution

Phytogeographical of plant species were obtained from Flora Malesiana series (de Laubenfels, 1988 ; Sleumer 1966 ; Nooteboom 1988; Mabberley, Pannell and Sing 1995 ; de Wilde 2000, Kanis 1971 ; Kalkman 1993; Supadmo 1972 and complemented and updated by checking the collection in the Herbarium Celebense (CEB), Palu.

RESULTS AND DISCUSSIONS

Habitat Characteristic

Based on the observation to the natural habitat of *Nepenthes pitopangii* at two research sites in the Lore Lindu National Park the habitat type was classified to high montane forest of Sulawesi (Whitten et al 1987). The geographical position and characteristic of habitat *Nepenthes pitopangii* Lee is presented in Table 1.

Table 1. The geographical position and characteristic of habitat *Nepenthes pitopangii* Lee in both research sites in Lore Lindu National Park.

No	Parameter	Research sites	
		Torenali	Helipad
1	Geographical position * Longitude (S) Latitude (E)	 01^{0} 19’ 788 120^{0} 19’ 697”	 01^{o} 18’ 33.9” 120^{o} 18’ 33,1
2	Altitude (m asl.)	1700	1900
3	Habitat description	Lightly disturbed natural montane forest, many large tree surrouding the habitat, soil surface very wet, associated with ferns. Habitat was disturbed by human activity,	Secondary vegetation, open area, small rock on the soil surface, associated with ferns, *Vaccinium* (Ericaceae), *Phyllocladus hypophyllus*.
4	Canopy cover (%)	60	20
5	Relative Humidity (%)**	77 – 85%	77 – 85%
6	Temperature (^{o} C)** Maximum Manimum	 26-36 12-17	 26-36 12-17

7	Rainfall (mm)**	3,000	3,000
8	Soil condition Nitrogen content (%) Phosphor (ppm)	 0.1 4.21	 0.1 4.01

Notes: * = Direct measurement, ** = LLNP (2002), *** Saleh et al (2013)

Our survey of *Nepenthes pitopangii* foccused on two different reseach sites (Torenali and Helipad). Both of the sites were the location where this species first collected and found in Lore Lindu National Park. There are some different characteristics of the habitat. Research site 1 (Torenali) is very close to the track to Mt.Rorekautimbu. There are large tree species surrounding the habitat. While research site II (Helipad) is characterized by secondary vegetation on small rock on the soil surface. Both of research sites are situated in Montane forest of Lore Lindu National Park, Central Sulawesi, Indonesia. The location shows small-scale disturbances very close-by the path toward to Mt. Rore Kautimbu at the altitude 1650 m asl with relative humidity between 77-85%, daily temperature between 26-36^{o} C (maximum), 12-17^{o} C (minimum) and annual rainfall 3,000 mm/year. The characteristic of soils are very rich in accumulation organic matter and classified into Glesols, Folic histosol, Folic cambisols (IUSS WRB, 2014) developed on granite rock on level terrain on gently sloping ridges or mid-slope terraces.

Plant diversity

We conducted a field exploration to check the presence of the species of *Nepenthes pitopangii* in their original habitat, as well as to study the diversity of plant species around the habitat using botanical exploration methods. There were fourty (40) plant species recorded from both research sites. Is was consisted of 27 species from research site 1 (Torenali) and 18 from research site II (Helipad) respectively. List of plant species is provided in Table 2.

Table 2. List of plants species that growing surround the habitat of *Nepenthes pitopangii* Lee in the studied area :

No	Botanical Name	Family	Habitus	Sites		Distribution
				I	II	
1	*Castanopsis accuminatisima* Rehder	Fagaceae	Tree	√	√	Malesia
2	*Lithocarpus celebicus* (Miq.) Rehder	Fagaceae	Tree	√		Sulawesi, Filipina
3	*Pandanus sarasinorum* Warb	Pandanaceae	Tree	√	√	Endemic Sulawesi
4	*Neolitsea javanica* (Blume) Backer	Lauraceae	Tree	√		West Malesia

5	*Adinandra celebica* Koord.	Theaceae	Tree	√		Endemic Sulawesi
6	*Eucalyptus deglupta* Blume	Myrtaceae	Tree	√		Sulawesi, Mindanao, Seram, papua
7	*Quintinia apoensis* (Elmer) Schltr.	Parachrypiaceae	Tree			Central Sulawesi, Papua
8	*Gastonia serratifolia* (Miq) Phillipson	Araliaceae	Tree	√	√	Malesia
9	*Acronychia trifoliata* Zoll.& Moritzi	Rutaceae	Tree	√		Malesia
10	*Pinanga caesia* Blume	Arecaceae	Tree	√		Endemic
11	*Acmena accuminatisima* (Blume) Merr. & L.M. Perry	Myrtaceae	Treelet	√	√	Malesia
12	*Litsea ferruginea* Blume	Lauraceae	Tree			West Malesia
13	*Drimys piperita* Hook.f	Winteraceae	Treelet	√		Sulawesi, Borneo, Papua, Malesia
14	*Santiria sp*	Burseraceae	Treelet			
15	*Weinmannia lucen* Baker	Cunoniaceae	Treelet	√		Sulawesi, Filipina
16	*Pittosporus mollucanum (Lam) Miq.*	Pittosporaceae	Treelet	√		
17	*Eurya accuminata* DC	Theaceae	Treelet	√		Malesia
18	*Phyllocladus hypophyllus* Hook	Phyllocladaceae	Tree	√		Sulawesi, Wallacea, Papua, New Guinea, Filipina, Kalimantan
19	*Dacrycarpus imbricatus* (Blume) de Laub	Podocarpaceae	Treelet	√		Malesia
20	*Vaccinium palawanense* Merr	Ericaceae	Shrub		√	Sulawesi, Filipina
21	*Psychotria celebica* Miq.	Rubiaceae	Shrub	√		Endemic Sulawesi
22	*Xanthomyrtus angustifolia* A.J. Scot	Myrtaceae	Shrub	√	√	Sulawesi, Papua
23	*Litsea ferruginea* Blume	Lauraceae	Treelet			East Malesia
24	*Viburnum amplificatum* J Kem	Caprifoliaceae	Treelet		√	Borneo, Sulawesi
25	*Macaranga cf.costulata* Pax & K.Hoffm	Euphorbiaceae	Treelet	√		
26	*Themeda arguens* L	Poaceae	Herb		√	
27		Rubiaceae	Herb		√	
28	*Anaphalis javanica* (DC.) Sch.Bip.	Asteraceae	Herb		√	Sumatra, Java, Borneo, Sulawesi, PNG
29	*Mischocarpus sundaicus* Blume	Sapindaceae	Shrub		√	
30	*Agathis celebica* (Koord.) warb.	Araucariaceae	Tree		√	Sulawesi, Filipina
31	*Trachymene acerifolia* C. Norman	Umbeliferae	Herb	√		Lesser Sunda, Sulawesi
32	*Nepenthes mirabilis* (Lour) Rafarin	Nepenthaceae	Climber	√		Malesia, North Australia, Cambodia, Laos, Myanmar, China (Hainan)
33	*Dissochaeta celebica* Blume	Melastomataceae	Climber		√	Endemic Sulawesi
34	*Dipteris conyugata* Reinw.		Teresterial fern	√	√	Indochina, southern China, Taiwan, Malesia to New Calodenia and Australia.
35	*Gleichenia vulcanica* Blume	Gleicheniaceae	Teresterial	√	√	Pantropical

			fern			
36	*Sticherus truncatus* (Willd.) Nakai	Gleicheniaceae	Teresterial fern	√	√	Indochina, Malesia, North Australia
37	*Lycopodiella cernua* (L.) Pic. Serm	Lycopodiaceae	Teresterial fern	√	√	Neotropics, Malesia
38	*Dicksonia blumei* (Kunze) Moore	Dicksoniaceae	Tree fern		√	Malaysia, Indonesia, Philippines and PNG
39	*Racemosbamboo celebica* Dransfield	Poaceae	Climber	√		Sulawesi
40	*Rubus mollucanus* L	Rosaceae	Climber	√		All over Malesia, Thailand, Vietnam, Fiji, Caledonia,
41	***Nepenthes pitopangii***	**Nepenthaceae**	**Climber**	**X**	**X**	**Central Sulawesi**

Data source : Primary data (2017). √ = present, **X** = absent

The result of observation showed that there was no more *Nepenthes pitopangii* at both habitat (Table 2 and Figure 2). We noted that habitat destruction of species might be due to the fact that both sites are easily accessed by the people and visitors of the Park. Both of the habitats are located on the hiking trail to Mount Rorekautimbu. It was previously used by vehicles transporting timber by Forest Concession Company ("HPH Kebun Sari") and helipad formerly used for helicopter landing. Both locations indicated that the habitat was disturbed by the people who acrossed this place for several purposes like hiking as well as damar and rattan collection. The extinction of *Nepenthes pitopangii* might also be caused by the people who illegally collected the specimen without permission from park authority. However, it was suspected that such species still exist, but it still needs exploration effort intensively to ensure the presence of species. The limited of time, the difficulty of terrain and the presence of military operations in the region were also a limited factor in revealing the existence of the species.

In Lore Lindu National Park, Central Sulawesi, especially in the mountain forest around the route to Mount Rorekautimbu and surrounding areas was reported as many as 5 species of *Nepenthes* namely: *Nepenthes pitopangii, Nepenthes tentaculata, Nepenthes maxima* and *Nepenthes nigra* (Lore Lindu National Park Office, 2016).

As one of the main tourist destination in Lore Lindu National Park, the area around the Rorekautimbu mountain was visited by many domestic and international tourists, because the location is very easy access from Palu, the Capital city of Central Sulawesi Province. Besides, the region is the home of the charming of Wallacean biological

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diversity, especially the mountain flora and fauna of Sulawesi. (LLNP, 2016). The area was also very important for local people (ethnically called "Topo Baria") who lived around the village of Sedoa, where most people had livelihoods to collect resin of damar and rattan (Alberta M, village leader, 2018, pers. comm.)

Based on IUCN Red list (http://www.iucnredlist.org/details/49000915/0, 2017) and Lee et al. (2009) that conservation status of *Nepenthes pitopangii* is categorized as vulnerable under criterion D2 which lies within a protected area (PA). However, the PA site supports just one plant, which appears to be under threat from plant collectors. The area of occupancy and extent of occurrence are both 8 km2. Fortunately, the other known locality supports a few hundred plants (population size is about 400 mature individuals) and it is probable that other, undiscovered subpopulations exist. Nevertheless, based on current knowledge, the conservation status of *N. pitopangii* has the potential to change suddenly given the threat of collection and the species would benefit from a systematic monitoring programme. The species is listed on CITES Appendix II.

The major vegetation of habitat *Nepenthes pitopangii* were composed by *Castanopsis accuminatisima* (Fagaceae), *Lithocarpus celebicus* (Fagaceae), *Pandanus sarasinorum* (Pandanaceae), *Neolitsea celebica* (Lauraceae), *Agathis celebica* (Podocarpaceae), *Adinandra celebica* (Theaceae), *Eucalyptus deglupta* (Myrtaceae), *Phylocladus hypophyllus, Quintinia apuensis, Gastonia serratifolia, Pinanga caesea* (Arecaceae), *Santiria* sp, *Acmena accuminatisima* (Myrtaceae) and *Listea feruginea* (Lauraceae). Sapling and shrub species were *Pittosporum moluccanum, Eurya accuminata, Gastonia seratifolia, Drymis piperita, Phyllocladus hypophyllus, Litsea feruginea, Weinmania sp, Magnolia vriescana, Vaccinium palawanensis* and *Xanthomyrtus angustifolius*. There were some species of herbs such as *Themeda arguens, Anaphalis javanica, Mischocarpus sundaicus* and *Trachymene acerifolia.* We also noted a pitcher plant *Nepenthes maxima*, an endemic climber bamboo (*Racemosbamboo celebica*). Some species of teresterial fern such as *Dipteris conjugata, Gleichenia vulcanica, Stricherus truncatus, Lycopodiella cernua* and *Dicksonia blumei* were found.

Vegetation of habitat is the main constituent of mountain forests of Sulawesi in Lore Lindu National Park which is rich in Fagaceae-Myrtaceae, some of which are endemic to Sulawesi such as *Pandanus sarasinorum* (Pandanaceae), *Adinandra celebica* (Theaceae), *Quintinia apoensis* (Parachrypiaceae), *Pinanga caesea* dan

Racemosbamboo celebica. Some species such as *Eucalyptus deglupta* (Myrtaceae), *Drymis piperita* (Proteaceae), *Weinmania lucen, Phyllocladus hypophyllus, Vaccinium palawanensis, Xanthomyrtus angustifolia* (Myrtaceae*), Litsea ferruginea* (Lauraceae), *Agathis celebica* (Araucariaceae) have limited distribution in Sulawesi, the Philippines and eastern part of Malesia. The flora of Mt Rorekautimbu was formerly known from the floristic studies of van Balgooy and Tantra (1986), Culmsee et al. (2011), Pitopang (2012[b]) and Brambach et al (2016). The forest is rich in chesnut family (Fagaceae), conifers and Myrtaceae..

Phytogeography of Sulawesi Island is located in the Wallacea region, an area that has an unique biodiversity. Isolation geography of the Sulawesi island and environmental conditions, such as variations in topography, gradient elevation, and variations in soil types has allowed spesifically the development of flora and fauna in the bioregion (Siebert 2002; Pitopang 2012[b]). Total species richness and endemism of Sulawesi are comparable to those of Sumatra, Java, Borneo and New Guinea, in spite of the very different geological history of Sulawesi and the greater distance of the island to the mainland (Roos *et al*. 2004). Whereas the islands of Borneo, Sumatra and Java had terrestrial connections to the mainland Asia in the past, Sulawesi was always isolated from these islands as well as from New Guinea by deep maritime straits as shown by Hall (1995) through the reconstruction of the Malay archipelago since 50 million ago. Approximately 15% of the known flowering plant species of Sulawesi are endemic (Whitten *et al*, 1987). Van Balgooy *et al*. (1996) recognized 933 indigenous plant species on Sulawesi and of these 112 were endemic to the island.

Neighborhood habitat of *Nepenthes pitopangii* also rich in various kinds of wildlife from different taxa. Based on the data recorded, several types of mammals such as Highland anoa (*Bubbalus quarlesii*), Cuscus bear (*Aliurop ursinus*) and a number species of Avifauna with their natural distribution limited on the island of Sulawesi such as *Dicaeum aureolimbatum*), *Ptilinopus fischeri, Dicaeum nehrikorni, Dicrurus Montanus, Myza celebensis, Myza sarasinorum, Cyornis hoevelli, Ficedula bonthaina, Loriculus exilis, Rhapidura teysmanii, Scissirostrum dubium, Enodes erythrophris, Scolopax celebensis, Geomalia hendrichia, Artamus monachus* are found (Mallo 2015)

Fig. 2. Habitat of *Nepenthes pitopangii* at two research sites in the Lore Lindu National Park, Central Sulawesi. 1 (above left). Location I, Torenali, Track to Mt. Rorekautimbu, 2. The second collection of *Nepenthes pitopangii* (taken 2008), 3. There is no more *Nepenthes pitopangii* at Torenali (surveyed by author 2016), 4 (above right) Location II, Helipad. 5. *Nepenthes pitopangii*, Photograph by author (2013) at Helipad, 6. Current condition of habitat at Helipad (Surveyed by author (2017)

It was concluded the habitat had been heavily damaged due to habitat human activities with no further evidence of the precense of *N pitopangii* at either site. Additionally, We noted a number of plant species arround the habitat which were widespread in montain forest of Lore Lindu National Park such as *Xanthomyrtus angustifolia* (Myrtaceae), *Weinmania lucens* (Cunoniaceae), *Vaccinium palawanensis* (Ericaceae), *Phyllocladus hypophylus* (Podocarpaceae), *Drymis piperita* (Proteaceae), *Gleichenia vulcanica*, *Stricherus truncatus*, *Lycopodiella cernua* and *Dicksonia blumei* We noted a various kinds of wildlife from different taxa in the habitat.

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