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Petrosavia sakuraii (Makino) J.J.Sm. ex Steenis on Mount Sibuatan, North Sumatra

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ABSTRACT

This study presents new findings on *Petrosavia sakuraii* (Makino) J.J.Sm. ex Steenis, collected from Mount Sibuatan, North Sumatra. *P. sakuraii* (Makino) J.J.Sm. ex Steenis is a rare mycoheterotrophic plant in Indonesia, and its existance has not been scientifically reported until now. The research was conducted from July to November 2022 in the Gunung Sibuatan Protected Forest, Karo, North Sumatra. Data collection was carried out through exploratory methods. The samples found were documented and identified using various references. The results of the study include descriptions, illustrations, flowering and fruiting periods, habitat, distribution, and conservation status of *P. sakuraii* (Makino) J.J.Sm. ex Steenis. According to the IUCN Red List, this plant is classified as Data Deficient (DD) due to limited global data. Therefore, this finding contributes to the knowledge of the distribution of *P. sakuraii* (Makino) J.J.Sm. ex Steenis. This report marks the first recorded presence of this species in North Sumatra, specifically on Mount Sibuatan.

Keywords: Mount Sibuatan, *Petrosavia sakuraii* (Makino) J.J.Sm. ex Steenis, petrosaviaceae

INTRODUCTION

Petrosavia sakuraii (Makino) J.J.Sm. ex Steenis belongs to the family *Petrosaviaceae*. This group is classified as mycoheterotrophic, monocotyledonous, leafless, and rare, with its body only visible at certain times. It inhabits dark, mountainous rainforests and is distributed across Japan, China, and Southeast Asia (Cameron et al., 2003). Mycoheterotrophic plants lack chlorophyll, meaning they rely on other living organisms, specifically fungi or mycorrhizae, for survival (Handayani et al., 2020), similar to parasitic plants. These plants either lack chlorophyll entirely or have very low levels of it, possess significantly reduced leaves, and produce large quantities of seeds (Leake, 2005; Merckx, 2013a; Muhaimin et al., 2017).

The roots of *Petrosavia sakuraii* form a symbiotic relationship with fungal mycelium, similar to that found in mycorrhizae, but with a different direction of nutrient flow—from the fungus to the plant. As a result, this relationship is more accurately described as exploitative rather than cooperative. It is assumed that mycoheterotrophic plants are involved in a tripartite association: a relationship between the mycoheterotrophic plant, the fungus, and a photosynthetic plant, where the fungus obtains carbon from the green plant through true mycorrhizae (Nuraliev et al., 2019). The dependence on fungal mycelium or mycorrhizae supplements or replaces photosynthesis as a source of carbon and energy (Watkinson, 2016).

In this case, the green plant serves as the primary source of carbon, and the mycoheterotrophic plant can be indirectly considered a parasite of the green plant through the shared mycorrhizal fungus. Thus, mycoheterotrophy refers to a plant's ability to obtain carbon from fungi (Merckx, 2013a; Merckx, 2013b).

The family *Petrosaviaceae* consists of two genera: *Japonolirion* Nakai and *Petrosavia* Becc., distributed across East Asia and Southeast Asia

(Bhat et al., 2018; Cameron et al., 2003; Ohashi, 2000). Both genera belong to the order *Petrosaviales*. Although *Petrosavia* Becc. is embryologically similar to *Japonolirion* Nakai, *Petrosavia* Becc. is recognized as a distinct genus (Tobe & Takahashi, 2009). Currently, three species of *Petrosavia* Becc. have been identified: *Petrosavia sakuraii* (Makino) J.J.Sm. ex Steenis, *Petrosavia sinii* (K. Krause), and *Petrosavia stellaris* Becc. These species share many morphological similarities, particularly between *Petrosavia sakuraii* (Makino) J.J.Sm. ex Steenis (which has long leaf scales and shorter bracts compared to the flower stalk) and *Petrosavia sinii* (K. Krause) with longer bracts than the flower stalk. However, *Petrosavia stellaris* Becc., is distinct, exhibiting whorled inflorescences (Makino, 1903; Ohashi, 2000; Xinqi & Tamura, 2000).

Petrosavia sakuraii (Makino) J.J.Sm. ex Steenis was first collected from Mount Ena in Japan, in a shaded forest. Makino (1903) explained that the species was named in honor of Hanzaburo Sakurai, who was the discoverer and a botanist. Recent investigations into *Petrosavia sakuraii* (Makino) J.J.Sm. ex Steenis were conducted by Remizowa et al. (2017) in Vietnam, where the species was found in mixed primary and secondary mountain forests. Bhat et al. (2018) added new records from Arunachal Pradesh, India, where the species was discovered in primary forests with thick leaf litter and was suspected to be living epiphytically alongside mosses.

Several sources indicate that there have been no specific reports on the discovery of *P. sakuraii* (Makino) J.J.Sm. ex Steenis in Indonesia. These studies only mention its distribution in Indonesia (Liu et al., 2020), northern Sumatra (Xinqi & Tamura, 2000; Bhat et al., 2018; Nuraliev et al., 2022), the Gayo Highlands (Makino,1903), and West Sumatra (Ohasi, 2000). Therefore, the discovery of *P. sakuraii* (Makino) J.J.Sm. ex Steenis in Indonesia needs to be scientifically documented and reported.

According to Bhat et al. (2018); Makino (1903); Remizowa et al. (2017), an exploration was conducted in the Gunung Sibuatan Protected Forest, Karo, North Sumatra, in 2017. During this exploration, a small, pale-yellow achlorophyllous plant species was found growing on leaf litter on the forest floor. In 2022, data collection was repeated for research purposes, and specimens were gathered and documented. The specimens were examined and compared to relevant literature (Bhat et al., 2018; Makino, 1903; Steenis & Wilde, 1984). Based on morphological characteristics, the species was confirmed as *Petrosavia sakuraii* (Makino) J.J.Sm. ex Steenis. This marks the first report of its presence in North Sumatra, specifically on Mount Sibuatan.

METHOD

The research was conducted from July to November 2022 in the Gunung Sibuatan Protected Forest, Karo, North Sumatra. Data collection followed an exploratory method, along the Mount Sibuatan hiking trail through Nagalingga Village, from the forest entrance to the first shelter. Every sample found was documented, and several samples were collected for herbarium purposes. Morphological characterization was carried out using relevant literature, and plant organs such as rhizomes, stems, leaf scales, flowers, and fruits were measured using measuring tapes and calipers (Bhat et al., 2018; Makino, 1903; Nuraliev et al., 2019; Steenis & Wilde, 1984).

Description of the research location

The Gunung Sibuatan Protected Forest is classified as a tropical montane and subalpine forest. Administratively, it spans the Karo and Dairi Regencies in North Sumatra. The management of this protected forest is overseen by Forest Management Unit XV Kabanjahe, Karo Regency, under the Department of Forestry, North Sumatra Province (Nadhifah et al., 2018). Ritonga (2019) explains that Mount Sibuatan, with an elevation of 2,457 meters above sea level, is the highest peak and "roof" of North Sumatra. While this protected forest has high plant

biodiversity, there is limited available information. However, it still maintains a well-preserved forest ecosystem. For this research, the chosen location was the hiking trail from Nagalingga Village, Merek, Karo, North Sumatra, at an elevation of 1,543–1,754 meters above sea level, with coordinates ranging from N 02°55'01.2" E 098°28'03.6" to N 02°54'49.0" E 098°27'28.2".

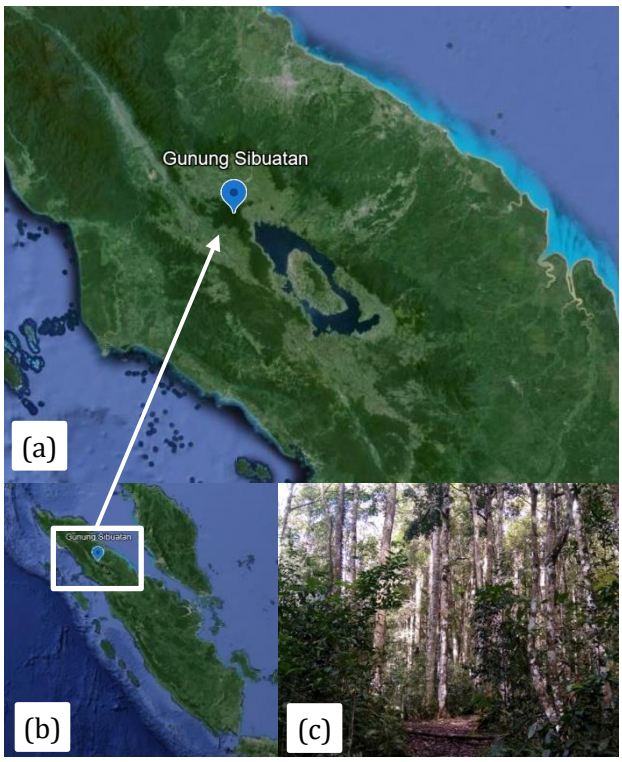

Figure 1. (a) Location of Mount Sibuatan; (b) Map of Sumatra Island; (c) Habitat where the specimen was found.
Source (a & b): Taken from Google Maps on February 2, 2024.

RESULTS AND DISCUSSION

Petrosavia sakuraii (Makino) J.J.Sm. ex Steenis

This mycoheterotrophic plant is characterized as herbaceous, monocotyledonous, monoecious, leafless, growing upright, pale yellow in color, sometimes white, and hairless, with a height of 9.8–15.2 cm. The rhizome is hard and slender, covered with dense, transparent scales; the scales are lanceolate-ovate with pointed tips and and measure up to 3 mm in length. The stem is erect, emerging from the rhizome, with 1–2 stems per plant. It has nodes (each node bears a scale leaf), is pale yellow in color, and hairless. The leaves are pale and modified into scales, alternating, transparent, lanceolate, with pointed tips, and 2–4 mm in length. The inflorescence is terminal and racemose (clustered), consisting of 5–15 flowers per stem. The flowers are pale yellow, bisexual, with a diameter of 3–4 mm, and have pale yellow bracts. There is one bracteole attached to the flower stalk. There are 6 stamens with round anthers. The pistil is composed of 3 parts, with an ovate ovary. The fruit is a 3-chambered capsule with a brown stigma at the tip.

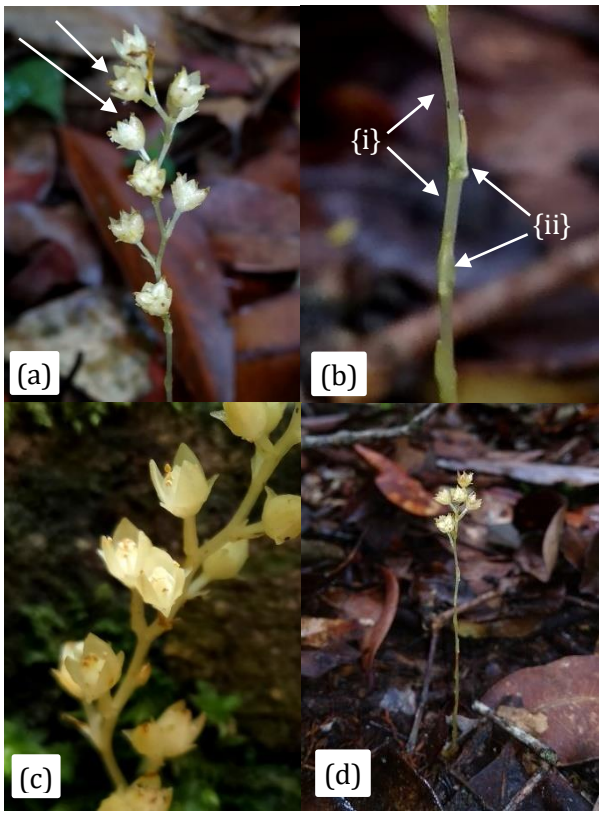

Figure 2. Morphology of *Petrosavia sakuraii* (Makino) J.J.Sm. ex Steenis: (a) inflorescence; (b) stem {i} and scales {ii}; (c) flower; (d) habitus.

Flowering and Fruiting: July to November.
Habitat: Terrestrial, growing on thick, decayed leaf litter on the forest floor of the primary forest of Mount Sibuatan, at an elevation of 1,543–1,754 meters above sea level.
Distribution: India, Vietnam, China (central and southern regions), Hainan, Japan, Taiwan, Myanmar, Thailand, and Indonesia (reported only in northern Sumatra) (Bhat et al., 2018; Jin & Mint, 2018; Liu et al., 2020; Makino, 1903;

Nuraliev et al., 2022; Remizowa et al., 2017; Xinqi & Tamura, 2000).

Conservation Status: *Petrosavia sakuraii* (Makino) J.J.Sm. ex Steenis is considered a unique plant, only found at certain times, specifically during and at the end of the rainy season. It is incapable of photosynthesis and relies on a symbiotic relationship with mycorrhizae to obtain nutrients (Handayani et al., 2020a, 2020b). Mycoheterotrophic plants form associations with specific fungi that are also linked to autotrophic plants. Although indirectly, they are closely connected to autotrophic plants that form symbiotic relationships with fungi, with a high degree of overlap in autotrophic partners tending to interact with similar groups of mycoheterotrophic plants.

According to Bhat et al. (2018) *P. sakuraii* (Makino) J.J.Sm. ex Steenis is a rare plant species, possibly due to its high specificity for certain arbuscular mycorrhizal fungi. Based on the observation of aseptate hyphal coils in the cortical cells of the roots of *P. sakuraii* (Makino) J.J.Sm. ex Steenis, the arbuscular mycorrhiza was identified as the Paris type (Yamato, M. et all., 2011), characterized by hyphae, coils, and intracellular arbusculate coils (Dickson 2004). Tamura (1998) added that *Petrosavia* has a root cortex consisting of 4-6 layers of parenchyma cells containing mycorrhizal hyphae, further proving that *P. sakuraii* (Makino) J.J.Sm. ex Steenis is highly dependent on mycorrhizae.

In its natural habitat, this plant has been found in small numbers, particularly along hiking trails and in areas where local communities collect humus, which may gradually damage its habitat. The species is increasingly threatened by habitat destruction, exacerbated by expanding deforestation. According to the IUCN Red List (2024), the conservation status of this plant is classified as Data Deficient (DD), meaning there is insufficient information on its abundance and/or distribution to assess its risk of extinction.

Due to the limited data on this species worldwide, this finding provides additional information on the distribution of *P. sakuraii* (Makino) J.J.Sm. ex Steenis. The report marks the first documentation of this species in North Sumatra, specifically on Mount Sibuatan. It expands the knowledge of the distribution of *P. sakuraii* (Makino) J.J.Sm. ex Steenis in Indonesia, which was previously limited to the Gayo Highlands (Aceh) and West Sumatra.

CONCLUSION

Petrosavia sakuraii (Makino) J.J.Sm. ex Steenis is a mycoheterotrophic plant species distributed across East and Southeast Asia. It grows in symbiosis with mycorrhizae in primary montane forests. In Indonesia, this species has been reported in northern Sumatra, specifically in the Gayo Highlands (Aceh) and West Sumatra. This research marks the first study documenting its presence in North Sumatra. The discovery of *P. sakuraii* (Makino) J.J.Sm. ex Steenis adds valuable information on the distribution of this rare species, which has not previously been reported in North Sumatra.

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